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Part Three

FEBRUARY 1991

NATIONAL SYMPOSIUM ON RESEARCH AND DEVELOPMENT IN MARINE FISHERIES

MANDAPAM CAMP

16-18 September 1987

Papers Presented
Sessions V, VI & VII

CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
(Indian Council of Agricultural Research)
P. B. No. 2704, E. R. G. Road, Cochin-682 031, India

Central Marine Fisheries Research Institute
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MAN-POWER NEEDS FOR MARINE FISHERIES BY 2000 AD

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ABSTRACT

Formal training of operatives for marine fishing industry started in late forties when the erstwhile Deep Sea Fishing Station commenced training activities. However, organised training for fisheries personnel commenced with the establishment of CIFNET (erstwhile CIFO) and CIFE in the early sixties. The former catered to the manpower needs for operating the fishing vessels while the latter produced the managerial/administrative personnel for shore support. Today a number of fishery colleges and Agricultural colleges supplement the training activities of these two training establishments in fisheries-related disciplines.

Accent on innovations of harvest and post harvest technologies of marine capture fisheries has necessitated upgradation and modernisation of training processes of CIFNET. This has been done following a series of studies and evaluations commensurate with the type and kind of technologies, breed and nature of craft and gear introduced etc. In addition to meeting the domestic needs, the trained manpower is the national wealth which is spared for development of industry in friendly developing countries to our advantage due to the inflow of foreign exchange. Reckoning the present pace of growth of our marine fishing industry a projection of the manpower needs for 2000 AD is attempted in the present paper. The nature and specialities of the human resources that would be needed that time have been attempted to be identified and the innovation to be made in the production process are outlined.

MAN-POWER PLANNING

Man-power planning is the scheduling of programmes to develope human resources in line with national goals of economic development, in a dynamic situation, imbalances of the manpower demand and supply relationship are to be accepted. However, the need is to create conditions which will reduce likelihood of severe ensuring imbalances. While formulating new educational system to achieve goals of manpower planning, the system has to face the challenge.

1. To re-arrange educational priorities to meet requirements of the occupational structure.
2. To modernise the courses and skilled forms in tune with the shift in the nature of skills needed.

New technology not only generates new challenging occupations in new and old industries on the technical content to some of the existing occupations but tend to undergo qualitative change.

NEED FOR MAN-POWER DEVELOPMENT FOR MARINE FISHERIES

The Govt. of India has been committed to development of fisheries, both marine and inland sectors. The objectives of fisheries development are:

1) To increase production of protein-rich foods

2) To exploit valuable natural resources available in the seas around the country

3) To increase foreign exchange earning

4) To generate new employment potential

5) To help the social and economic advancement of the fishing communities.

Increased production in the marine fisheries sector is now possible only by extending area of exploitation into the offshore and deep sea regions. For achieving this there is need for the use of advanced technology. Such technological developments, particularly in the exploitation of deep sea resources, called for a suitable trained man-power with fairly good knowledge of complex technologies, varieties of skills and familiarity of instruments.

TRENDS IN MAN-POWER DEVELOPMENT

Fisheries training leading to certification is a relatively new concept and has its origin in the need to reduce the high extent and mortality rates of fishing boat cruise, improve their economic efficiency and improved working conditions of the individual fishermen.

Fisheries training has by tradition been the 'father to son' activity or atleast through participation in local operations where informations of skill have been imparted through participation in the activities, when trips were short and fishing subsistence oriented technology was the main focus. In the temperate regions (Developed countries) boat building techniques have lead to the marine fleets being comprised of larger among vessels and the fishing fleets have tended to follow these trends, although there has been other constraints of development. Nevertheless increase in the size of fishing crafts lead to the expansion of trips in both distance and time which in turn created certain needs for trained personnel in the use of sail, navigation, fishing and fish preservation. Increased demand for fish from industrial areas coupled with identification of new and extensive offshore region/new methodology knowledge, how to make the use of ice for fish preservation, sail and steam followed by mechanical propulsion and ever-increased markets results in larger wide ranging and more sophisticated fishing fleets. Eventually, fishing cruises were a global nature and long operation required the wide variety of skills and expertise.

Before International boards were active, perhaps the most embarassing legislation was the British Merchant Shipping Act of 1893 and subsequent up- dating amendments. Operating throughout colonial emperor the legislation became the state in Indian in 1931. The state laid down conditions for obtaining certificates of competency of sea-going vessels and also for fishing vessels operating in certain waters. Thus the certificate of competency while ensuring that the help was well and truly trained to handle his vessel did not provide for any test or technological capability of skills were expected to be acquired in the course of the 2,3 or 4 year period prior to being examined.

EVOLUTION OF MAN-POWER DEVELOPMENT IN INDIA

The first step of technological advancement in the field of marine fisheries attempted in India was the mechanisation of suitable indigenous crafts and introduction of newly designed mechanised boats deploying the existing fishing methods of set and drift gill nets more efficiently and undertaking the new industrial fishing methods of 'Bottom trawling' using gears made of synthetic fibre in the West Indian coast. It was the introduction of a new fishing technology and fishing gear technology in the field of artisanal fisheries. Success of such a programme dependent on availability of trained man-power. With FAO Assistance the Govt. of India established a chain of fishermen training centres all over India in the 1950s. These training centres have the limited objective of training the artisanal fishermen in the operation of small mechanised fishing boats and their maintenance. There are at present 31 such fishemen training centres in the country with total intake capacity of around 900 candidates. About 800 candidates have so far trained in these sectors. The minimum entry requirement of these centres is the basic education upto 5th standard with atleast 5 years fishing experience.

MANNING OF OCEAN-GOING FISHING VESSELS

The statutory requirements for manning ocean going fishing crafts and the higher levels of engineering knowledge demanded by the complexity of engines and mechanisms made the creation of technical man-power an essential pre-requisites for further development of Marine fisheries as an Industry. The introduction of

ocean going fishing vessels attracted the provisions of the Indian Merchant Shipping Act 1958 (Merchant Shipping Act was revised to meet the demands of the technical man-power after independence for purposes of manning and safety at sea). The rules under Merchant Shipping Act 1958 require that all fishing vessels of 15 tons net and above have to be registered with the Mercantile Marine Department of Directorate General of Shipping, Ministry of Transport.

The Skippers and Engineers of deep sea fishing vessels and highly trained qualified personnel requires several years of training and experience before they could qualify themselves for the respective certificates of competency. Facilities of training of the above personnel did not exist in the country till 1948. Personnel had to be sent to UK to receive training considering the importance and specialised nature of training Govt. of India initiated an adhoc training programme in 1948 under the then Deep Sea Fishing Organisation, Bombay. But the training programme consisted of a broad practical training on board the vessels of the deep sea fishing organisation. No theoretical knowledge was imparted. To overcome these deficiencies, a Committee of Fisheries and Education was constituted by the Govt. of India in 1959 under the Chairmanship of Dr. N.K. Panikkar then the Fisheries Development Adviser to Govt. of India. On the recommendations of the Committee the Central Institute of Fisheries Nautical & Engineering Training (erstwhile Central Institute of Fisheries Operatives) was established in Cochin in 1963. The objectives of CIFNET are:

- Create technical manpower for the operation of deep sea fishing vessels.
- Create technical manpower to run the shore establishments that support the operation of deep-sea fishing vessels.
- Create teachers for fishermen training centres run by the maritime states and union territories.
- Conduct various refresher training programmes for the vessel operatives and shore technicians/managers.
- Provide technical consultancy service in all matters concerned with marine fishing with special reference to technical manpower requirements.
- Help developing nations in the South-east Asian, Gulf and African regions to create technical manpower for the operation of their fishing fleets and running of their supporting shore establishments. The details of the 7 regular courses undertaken by CIFNET are given below:

Name of the Course	Duration (months)	Capacity			
		Cochin	Madras	Visakha-patnam	Total
Fishing Secondhands Course	15	40	40	20	100
Engine Drivers Course	15	40	40	20	100
Boat Building Foremen Course	15	20	Nil	Nil	20
Shore Mechanics Course	12	20	20	Nil	40
Advanced Diploma in Fishing Gear Technology	12	10	-	-	10
Radio Telephone Operators Course	9	15	15	Nil	30
Teachers Training Course	6	10	Nil	Nil	10

EDUCATION AND TRAINING FOR DEVELOPING MANAGERIAL AND ADMINISTRATIVE PERSONNEL

A demand for managerial and administrative personnel are meant for the Graduate and post-graduate level education recently introduced by some Indian Universities besides the two-year post-graduate diploma course, D.F.Sc. at the Central Institute of Fisheries Education, Bombay under ICAR. The Central Institute of Fisheries Education (CIFE) Bombay was established in 1961 in pursuance of the recommendations of the Committee under Dr. N.K.Panikkar. CIFE was assigned responsibility of providing post-graduate level education in fisheries to create administrative and managerial personnel to plan and execute development programme. The 4 year graduate course in Fisheries, B.F.Sc. and 2 year post graduate level course in Fisheries

Science, M.F.Sc. conducted by the College of Fisheries in Mangalore, under the University of Agricultural Sciences, Bangalore produces Graduates and post graduates required for the above purpose. Similar courses leading to B.F.Sc. and M.F.Sc. are conducted by the Kerala Agricultural University in Cochin, Tuticorin Fisheries College under the Tamil Nadu Agricultural University, Maharashtra Vidyapeet etc.

EDUCATION AND TRAINING FOR SCIENTISTS AND TECHNOLOGISTS

Fishery/Marine Biology is the special subject for Post-graduate level is offered by Universities of Kerala, Cochin, Madras, Karnataka, Annamalai, Madurai and many other Universities. Facilities are also available for carrying out research on fish and fisheries leading to doctoral and post-doctoral degrees in Central Marine Fisheries Research Institute, Central Institute of Fisheries Technology, Central Institute of Fisheries Education, besides the Universities mentioned above.

PRESENT STATUS

Education and training in Fisheries in our country has now evolved into four tier pattern. These are:

1. Personnel for the introduction and implementation of new technologies in the field of artisanal fisheries (base level).

2. Statutorily required personnel for manning ocean going fishing vessels and technical personnel handling, processing, marketing, maintenance of vessels and machinery and fabrication of fishing gears (under Graduate and Graduate level).

3. Managerial and administrative personnel to plan and execute Fisheries Development programmes (Graduate and Post-graduate level).

4. Scientific and technical personnel for exploration of the resources and Scientific and Technological advancement in Fisheries (Post graduate level).

About 10,000 candidates has so far been trained in the fishermen training centres, besides exposing the artisanal fishermen to the various development in fishing technology. This has helped in the increase of the mechanised fleet of about 25,000 during last 3 decades. The candidates who had undergone training in CIFNET is given in Table 1.

It can be seen that 2760 candidates have undergone training in the various courses conducted by CIFNET. The trained man-power has helped the commercial fishing fleet of our country consisting of about 100 vessels to operate efficiently besides about 60 to 70 Skippers and Engineers are working in the Overseas countries like Nigeria, Gulf countries etc.

MANPOWER NEEDS BY 2000 AD

As far as responsibility of CIFNET goes, it has to create the required manpower for manning ocean going fishing vessels that would be flying the Indian flag by 2000 AD. The projection has been worked out on the basis of available information gathered from the Ministry of Agriculture, from the trend of the construction of new fishing vessels within the country and outside the country etc. There are many unknown factors which worked as a constraint in making realistic projection. The unknown factor being the availability of funds for huge capital investment in the form of fishing vessels, development of necessary engines and external markets for the new species of fish to be caught, the correctness of the resources position and the policies of Govt. of India. A very reasonable projection of the increase in the Indian fishing fleet of vessels of more than 25 GRT showed the picture of 800 vessels by the year 2000 AD. The details of the accommodation of the projection has given in Annexure-I. Annexure-II gives a projection of the flow of certified hands to man the fishing vessels during the period 1987 - 2000 AD. It is found that the supply of the certified hands would be adequate to meet the demand by 2000 AD. However, it would be necessary to take an indepth review of the supply position of the trained manpower periodically in order to ensure that there is always inadequate supply to meet the demand. The fact that the creation of manpower is long drawn process and advanced planning is very essential. Annexure-III gives a picture of flow sheet showing the demand and supply of certified officers year by year from 1987 to 1990 and then for every 5 years.

In addition to the above certified personnel it is anticipated that about 3000 vessels of less than 25 GRT also will be added to the small scale fisheries sector. These vessels will have the

Table 1 Number of Candidates trained by CIFNET in different Courses

Name of the Course	Duration (months)	Capacity Cochin	Madras	Visakha patnam	Total	Total No. of candidates trained
Fishing Secondhands Course/ Mate Fishing Vessels Course	15) 18)	40	40	20	100	1028
Engine Drivers Course/Engine Driver Fishing Vessel Course	15) 18)	40	40	20	100	1008
Boat Building Foremen Course	15	20	-	-	20	98
Shore Mechanics Course	12	-	20	-	20	170
Gear Technicians Course/ Advanced Diploma in Fishing Gear Technology	12	10	-	-	10	133
Teachers Training Course	6	10	-	-	10	32
Engineer (FV) Course for DME's	12	-	-	10	10	18
Special In-service training Programmes to National/Departmental candidates	Based on Specific requirements					205
Special Training programmes to Overseas candidates sponsored by FAO/Commonwealth Secretarist/Foreign Govts/GOI	-do-					68
Total						2760

Annexure I

PROJECTED FISHING FLEET STRENGTH BY 2000 AD
(Vessels above 25 GRT)

Category of vessels	Target						Achivement / Expected Achievement					
	1987	1988	1989	1990	1995	Total in 2000	1987	1988	1989	1990	1995	Total in 2000
Imported	100	130	160	160	200	230	100	130	160	160	200	230
Indigenous	35+15	60+15*	80+15*	90+15*	140+15*	180+15*	15+25*	25+40*	30+50*	35+65*	55+105*	75+145*
Chartered	120	180	180	180	200	215	120	180	180	180	200	215
Obligatory Purchase against Charter	20	40	60	70	110	140	15	40	50	60	100	140
TOTAL	290	425	495	515	665	780	275	415	470	500	660	805

* vessels owned and operated by certified personal.

Annexure II

FLOW CHART OF CERTIFIED HANDS FOR FISHING VESSELS DURING 1987 - 2000 AD

Catagory	Availability of Certified personal in						Total	
	1987	1988	1989	1990	1995	2000	Demand	Supply
Skippers	323	50	50	50	250	250	1000	973
Mates / Fishing Secondhands	426	50	50	50	250	250	1100	1076
Engineer(FV)	158	35	35	35	200	200	800	663
Engine Driver(FV)	395	50	50	50	250	250	1100	1045

Annexure III

FLOW SHEET SHOWING DEMAND AND SUPPLY OF CERTIFIED OFFICERS

Certified hands	1987 Demand	1987 Supply	Excess/ Less	1988 Demand	1988 Supply	Excess/ Less	1989 Demand	1989 Supply	Excess/ Less	1990 Demand	1990 Supply	Excess/ Less	1995 Demand	1995 Supply	Excess/ Less	2000 Demand	2000 Supply	Excess/ Less
Skipper	275@	323	Adequate-	415	373	Less	480	423	Less	490	473	Less	690	723	Adequate	890	973	Adequate
Mates/ Secondhand Fishing	275	426*	-do-	415	476	Adequate	480	526	Adequate	490	576	Adequate	690	826	-do-	890	1076	-do-
Engineer (FV)	275	158	Less	415	193	Less	480	228	Less	490	263	Less	690	463	Less	890	663	Less
Engine Driver (FV)	275	395	Adequate	415	445	Adequate	480	495	Adequate	490	545	Adequate	690	795	Adequate	890	1045	Adequate

@ Second Hand Fishing Vessels Certificate holders only are posted in chartered vessels.

* About 80 are in foreign countries.

necessary endurance and capability of imparting training, further the responsibility of manning these fishing vessels will be with the State Govts.

STRATEGIES OF MEETING NEEDS

The strategies already chalked out by CIFNET to meet the qualitative and quantitative needs of trained man-power for the marine fishing industry by 2000 AD is discussed below:

In 1977, the conference convened by the Inter Governmental Maritime Organisation (IMO) at Torremolinos (Spain) on the convention of safety of fishing vessels, 1977 was adopted. Govt. of India was one of the members of the Conference.

Convension applies to every new fishing vessels of 24 m. in length and over which are used commercially for catching fish, whales and other living resources of the sea. The resolution No.8 of the Conference requested Inter Governmental Maritime Organisation (IMO) to consider the problems of training and certification of crew of fishing vessels in co-operation of the International Labour Organisation and Food and Agricultural Organisation of the UN. On the basis of these recommendations the Director General of Shipping has already framed rules to 3 grades of certificates by substantially upgrading the syllabus. The new certificates proposed to come into force are:

1) Mate Fishing Vessels
2) Skippers of fishing vessels Gr.II
3) Skippers of fishing vessels Gr.I

The candidates will have to undergo the following compulsory courses before they qualify for any certificate of competency.

1) Mate of fishing vessel
   i. First Aid
   ii. Radar Observation
   iii. Life boat course
   iv. Elementary fishing technology
2) Skipper Gr.II
   i. Fire fighting
   ii. Radio telephony
   iii. Advanced fishing technology
3) Skipper Gr.I
   i. Radar simulator

The second major highlight is that, fishing technology which had not been accepted as a subject hitherto for the existing competency certificate examinations has given its due importance. Any one who has to pass a competency certificate examination for the deck side of fishing vessels will have to pass the appropriate examination in fishing technology - either elementary or advanced fishing technology.

The new syllabus, compared to the old one, has been substantially enhanced in its contents and enrichment. In order to help officers who have not been groomed in the new subject-matter CIFNET would conduct refresher course for the benefit of the existing officers so that they can be brought upto the level required by the new examination rules.

In line with the proposed rules the batches of Fishing Second Hands Course from 1983 have been taught the new updated syllabus of the Mate Fishing Vessel Competency certificate examination by CIFNET.

SHORT TERM CERTIFICATE COURSES

Arrangements are being made by CIFNET to conduct the following short term courses in order to complete the transition from the existing certificate courses to the new certificate courses envisaged.

1) Elementary and advanced fishing technology certificate course granted under Rule 7.
2) Approved Radar observers Certificate course.
3) Approved life boatman certificate course.
4) Approved rader simulator course.

ENHANCEMENT OF SYLLABUS FOR ENGINEERING CERTIFICATE

The Consultative Committee of CIFNET constituted a sub committee to study the problems and formulate the revised syllabus and system of certification. The committee had prepared the enhanced syllabus and the same was forwarded to the Director General of Shipping, Bombay for necessary action. The expanded syllabus in refrigeration and hydraulics have been introduced from the Batch 1986.

NEW TRAINING COURSES

With the advancement of technology in fishing vessels, fishing gears, fish handling and navigational equipments, highly skilled technical manpower will be required to command the new vessels in the coming years. The following courses are proposed to meet the demand of highly skilled manpower.

i. Two Diploma level courses of 3 years duration, one for Fisheries Nautical Science and the second in Fishing Engg. by CIFNET.
ii. Advanced Diploma Course in Fishing Gear Technology of 12 months duration has been already started. It is meant for the technical officers working in the fisheries organisations both inside and outside the country.
iii.Advanced Diploma Course in Fleet Management for officers in-charge of operation of fishing vessels both inside and outside the country.

SHORT TERM PROGRAMMES FOR INSERVICE PERSONNEL

It is necessary that inservice personnel should be exposed to short term training programme to make them keep abreast of the advancement of technology and to improve their knowledge and to acquire higher qualifications. It is proposed to have inservice programme to proper activities for Engineer fishing vessel certificate examination, skipper fishing vessel certificate examination, mate fishing vessel, second hand fishing vessel/engine driver fishing vessel certificate examination. Some of the courses mentioned above have been already started.

CONCLUSION

From the discussion of the information about the demand of trained manpower by 2000 AD and the position of the supply, it is clear that the National Institutes will be able to raise to the occasion to produce the required technical manpower in terms of quantity and quality. However, it is very essential that additional facilities of training aids, space, etc. will have to be considerably improved in order to make the standard of training to compare with the international Institutes. Training aids such as simulators for training in the use of electronic equipments for fish finding and navigation, class room facilities, residential facilities etc. will have to be improved adequately.

Paper 66

HUMAN RESOURCES DEVELOPMENT IN FISHERIES

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ABSTRACT

Human resources development is an important part of fisheries development. Keeping this in view, the Government of India established the Central Institute of Fisheries Education (CIFE) at Bombay in 1961. The Institute during its eventful 25 years of service has provided the requisite trained manpower at different levels for fisheries development, industry, research, education, training and extension. In addition to regular courses, a large number of short term training programmes on selected topics have also been conducted at national and international levels to meet specific demands. The Institute is today recognised as the centre of excellence in higher education in fisheries.

INTRODUCTION

India ranks seventh among the leading fish producing countries of the world with the present total fish production of 2.8 million tons. The Government of India has fixed a target of 4 million tons of fish production by the end of VIIth Five Year Plan. International conference on Fisheries Development 2000 A.D., held at New Delhi in 1985 has envisaged a target of 6 million tons with 3 million tons expected to come from marine fisheries. Trained manpower at different levels is of paramount importance to achieve this target. These manpower requirements can only be met through suitably structured multi-disciplinary educational programmes. The paper briefly discusses the present facilities available for Fish-

eries Education, Training and Extension at CIFE alongwith the suggestions to re-orient it to meet the national needs.

HISTORICAL REVIEW

Fisheries education and training in India commenced with the starting of two All-India fisheries training courses of one year duration, one each for inland and marine fisheries. The former course was started at the Central Inland Fisheries Research Institute, Barrackpore in 1948 and the latter at the Central Marine Fisheries Research Institute, Madras (later Mandapam) in 1950. The centre for marine fisheries training was closed later due to lack of trainees. Almost during the same period, State Governments of Andhra Pradesh, Kerala and Tamil Nadu started diploma level course in their respective polytechnics. Except the one in Tamil Nadu, the courses in other states were discontinued later.

Introduction of mechanised fishing fleet during the fifties, led to the establishment of chain of fisherman training centres in different maritime states starting with Satpati (Maharashtra) training centre in 1954. These centres impart training to fishermen on various aspects of operation, maintainance of small mechanised fishing boats, modern fishing methods, navigation and seamanship.

Consequent to the introduction of various fisheries developmental programmes during the first and second five year plans, the need for trained manpower was strongly felt. The Government of India, constituted a Committee on Fisheries Education in 1959 to suggest suitable measures to meet the manpower requirement. The Committee in its report pointed out that none of the existing Universities and colleges of the country could provide the required specialised education and training in fisheries, and recommended establishment of a post-graduate training centre to impart training to district level officers deputed by various State Governments. This led to the establishment of central Institute of Fishereis Education (CIFE), at Bombay in 1961. The Committee also recommended creation of another centre to meet the trained manpower for ocean-going fishing vessels and the fishing industry. The Central Institute of Fisheries Operatives (CIFO) now called Central Institute of Fisheries Nautical and Engineering Training (CIFNET) was established in 1963, at Cochin for this purpose.

Two centres for imparting training to inland fisheries operatives were established in 1967 one each at Agra (Uttar Pradesh) and Hyderabad (Andhra Pradesh) under the administrative control of CIFE, Bombay. During the same year, the Inland Fisheries Training Centre at Barrackpore established in 1948 also came into the fold of CIFE, Bombay. The operative training centre at Hyderabad was later converted into Central Fisheries Extension training centre in 1973. The CIFE came under the administrative control of ICAR in 1979. During 1986, the Operative Training Centre at Agra and Fisheries Extension Training Centre at Hyderabad were shifted to Chinhat (Uttar Pradesh) and Kakinada (Andhra Pradesh) respectively.

Some of the Universities of Agricultural Sciences established fisheries colleges to impart graduate/post-graduate courses in fisheries during late sixties and seventies. Few traditional universities and Indian Institutes of technology also introduced specialised course in fisheries and allied aspects.

PRESENT FACILITIES AND ACHIEVEMENTS - CIFE, BOMBAY.

The CIFE with its Head Quarters at Bombay has 3 training centres one each at Barrackpore (West Bengal), Kakinada (Andhra Pradesh) and Chinhet (Uttar Pradesh). It has 2 fresh water fish farms one each at Balabhadrapuram (Andhra Pradesh) and Powarkheda (Madhya Pradesh) and a brackish water fish farm at Kakinada (Andhra Pradesh), which form main field facilities for imparting practical training on fresh and brackishwater aquaculture. For imparting ship board training, the Institute has acquired sophisticated training cum research vessel *'M.V. Saraswati'*. The major objectives of the Institute are -

(a) To conduct under-graduate, post-graduate and doctoral degree programmes in fisheries science.
(b) To conduct research in basic disciplines viz., genetics, nutrition, ichthyopathology, reproduction, physiology etc.
(c) To conduct short-term and long-term training courses in different specialised disciplines of fisheries science.
(d) To demonstrate on a limited scale the proven technologies developed by the I.C.A.R. fisheries institutes.

1. Regular courses

At its headquarter's Bombay the Institute offers a multidisciplinary two year post-graduate diploma course in fishery science, with an intake capacity of 40 condidates per year. The course is comprehensive one, covering all essential aspects of fishery science and prepares the candidates to be development officers to work efficiently both in the inland and marine fisheries. They have also been found to fit well in research, teaching and industrial sectors. A very high component of field work and practical training is the main feature of this course. The students have 1 month of ship board training, 2 months of field work in farms and 2 1/2 months of educational tour to various places of fisheries importance. They prepare a comprehensive field report and also work for dissertation on a specific topic in fisheries. These dissertations now form a store house of knowledge on various aspects of fisheries science.

The Institute also conducts a 2 years M.Sc. course in Fisheries Management with affiliation to the University of Bombay. Many Universities have recognised the Institute as a study centre for Masters and Doctoral degrees by research in Applied Zoology and Bio-chemistry.

The Institute runs a one year post-graduate certificate course in Inland Fisheries Development and Administration at its Barrackpore Centre. The course is primarily designed to train inservice candidates of the state fisheries departments and organisations with intake capacity of 40. The course content includes fishery biology, resources,their conservation, inland aquaculture, fishery engineering, technology, fisheries economics and management.

At its extension training centre in Kakinada, the Institute offers 10 months post-graduate certificate course on fisheries extension methods and techniques for the benefit of in-service personnel deputed by the state fisheries departments and organisations. The intake capacity of the course is 25. The course content includes fish breeding, fish culture, extension techniques and transfer of technology.

The training centre of the Institute at Chinhet conducts 9 months post-matric course in inland fisheries operatives to the inservice personnel deputed by the various state fisheries departments and organisations. The annual admission capacity of the course is 40. The course content includes aspects of inland fisheries of India, fish seed production and culture techniques, reverine and reservoir fisheries.

The Institute at its headquarters and centres has so far trained 2746 candidates under different courses, including 77 candidates sponsored from neighbouring countries of Africa and Asia. During its 25 years of service the Institute has provided trained manpower at different levels required for planning and development of fisheries. The Institute can be proud in that, many of its trainees continue to occupy pivotal postition in fisheries organisations, in India and neighbouring countries like Nigeria, Fiji, Sri Lanka, Indonesia and Sudan.

2. Short-term courses

The CIFE, Bombay conducts 2 regular short term courses every year, one on the management of 'Fresh Water Fish Farms' and the other on management of 'Brackish Water Fish Farms' at its fresh water and brackishwater fish farms in Balabhadrapuram and Kakinada respectively for the benefit of fish farmers, entrepreneurs and educated unemployed youths.

In these programmes the major emphasis is laid on practical training starting from handling of the brooder till the fry is reared for sale. As a result of these short term programmes, large number of fish seed farms have come up in the private sector. Besides these two regular short term programmes, the Institute has been running courses of short duration varying from 5 days to 6 months on different aspects of fisheries at its headquarters, sub-centres and field centres for different target groups. So far 1022 persons have been trained in these short term programmes.

The Institute played a key role in bringing vocationalisation in fisheries. In collaboration with the NCERT, New Delhi, the Institute conducted a short term programme in 'Fisheries for vocatioal teachers' for the first time in the country. It was followed up by preparing instructional manual/syllabus in fisheries at 10 + 2 level to be adopted at the national level. To upgrade the knowledge and practical skills of fisheries teachers in the management of fish seed farms, a practical short term training was conducted at the Institute's Fresh Water Fish Farm, Balabhadrapuram. The Institute has also been actively involved in the development of vocational courses in fisheries at the state level for the Government of Maharashtra.

Recognising the Institute's role in human resources development in fisheries, the Interna-

tional organisations like FAO/UNDP, Commonwealth secretatiat have been sponsoring training programmes at the Institute for the participants from various developing countries in different aspects of fisheries development. The duration of the training varied from a few days to 3 months.

3. Research accomplishments

The research carried out at the Institute has led to the development of many systems for development and utilisation of fisheries resources. These include:

(a) Development of carp and prawn hatchery systems, including live and formulated feed for fish and prawn larvae.
(b) Fish stock assessment in north-west Indian EEZ.
(c) Development of fish products based on low value fish.
(d) Fish seed production in semi-arid areas and culture of marine prawns and fish in Inland saline soils of Haryana.

4. Transfer of technology

Demonstrations of proven technologies developed by the Institute have led to extension and transfer of the same for the benefit of users. A few are mentioned below:

(a) Installation of a number of CIFE D-81 hatcheries in many states of India with significantly good results.
(b) The technology guidance and extension support of the Institute, have led to the adoption of fish-based mixed farming by a large number of farmers in coastal districts of Andhra Pradesh totalling over 160.

RE-ORIENTATION OF THE EXISTING PROGRAMMES

The Indian Council of Agricultural Research proposed to develop CIFE into a deemed to be University, and re-organise the existing programmes. The presently conducted two year diploma course in fisheries science at the headquarters will be converted into a Masters degree course. In additon, the Institute will also start an under graduate course leading to the degree of Bachelor of Fisheries Science.

The existing one year certificate course in inland fisheries administration and development at Barrackpore would be upgraded into a two year M.Sc. in inland fisheries and aquaculture. The centre will also run a course leading to Bachelor of Fisheries Science with special emphasis on inland fisheries.

The certificate course on fisheries extension techniques and methods at Kakinada will be strengthened by including aspects of marine fisheries extension and integrated rural development.

The existing nine months operatives training course at Chinhet will be phased out gradually and replaced by short term programmes of 4 to 5 months duration in certain specialised areas for the benefit of state deputees.

Doctoral programmes will also be initiated at the headquarters in different disciplines. The post-graduate programmes will be conducted in close collaboration with other ICAR Institutes by making use of their infra-structural facilities and expertise.

CENTRAL FISHERIES UNIVERSITY

The CIFE, Bombay is the pioneer fisheries educational institute in the country. It has been imparting post-graduate education in fisheries since its inception and has developed elaborate and diversified infrastructure facilities required for effective insturction in all aspects of fisheries.

Since 1969, some of the Agricultural Universities have also started imparting undergraduate/post-graduate courses in fisheries in their colleges of fisheries. At present there are six fisheries colleges in the country and some more are in the offing. Some of the traditional universities and Indian Institutes of Technology also offer courses in fisheries and allied sciences.

Fisheries is multi-disciplinary applied science. For imparting effective instruction in fisheries, shopisticated equipments, laboratory facilities, ocean going vessels etc., are needed besides experts in diverse disciplines. Institutions without essential infra-structure facilities and resources are bound to turn out graduates/post-graduates with different levels of educational attainments. To avoid such a situation, it is suggested that Central Fisheries University should be set up to maintain uniform standards in respect of course content, duration etc., throughout the country for similar courses run by different organisations. The University could also be entrusted with the responsibility of ensuring adequacy and skill of teaching staff and adequacy of infrastructure facilities. Creation of such a University will go a long way in ensuring standard and quality of fisheries education in the country.

RESEARCH AND DEVELOPMENT IN MARINE FISHERIES EXTENSION IN TAMIL NADU

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ABSTRACT

Improvement in the standard of living of fishing households and fishing labour households and optimal utilisation of fishery resources for employment, production and export are the important goals of marine fisheries extension service. Despite the increasing attention of the Government to fisheries extension work, majority of fisherfolk are caught in a vicious cycle of poverty and indebtness. The paper analyses the present strategies of fisheries extension service in Tamil Nadu, identifies the pitfalls and lists suggestions for improving the efficiency of fisheries extension work in the state. The extension teaching methods used for individual contact, group contact and mass contact, the subject-matter fields covered in extension teaching with their relative importance. The characteristics and extension personnel, research support provided, co-ordination among the various agencies involved and participation of the clientele and their organisations are analysed and discussed. The analysis helped in identifying the major impediments to success of extension efforts. The analysis provided a basis for evolving future extension strategies focussed on marine fisheries development. It provides suggestions in term of personnel requirement, effective extension methods, thrust areas among different subject-matter-fields, co-ordination among organisations concerned with marine fisheries and extension research support. The recommendations will be of use to the organisations concerned with fisheries extension in their approach to tone up the service of fisheries extension.

INTRODUCTION

In the process of attaining growth with social justice individual fisherman cannot be ignored. Improvement in the standard of living fishing households and optimal utilisation of fishery resources with efficiency in employment generation, production, preservation and marketing are important goals of marine fisheries extension service. Research and development in marine fisheries extension should equip the extension service to face the challenges of fishery sector successfully. An attempt is made to analyse present extension service in Tamil Nadu to identify pitfalls and to offer suggestions for improving efficiency of extension service in the state.

MARINE FISHERY OF TAMIL NADU

The state with a 1000 km coastline and 41,412 km^2 continental shelf accounts for 16% of India's total marine fish production. About 4.64 lakhs fisherfolk depend on fishing for their livelihood. The fishery employs about 90% of fishermen and 20% of fisherwomen. About 54% of fishermen housholds own gears while about 42% of them own crafts. Ninety per cent of the crafts are non-mechanised (Anon, 1986). Average annual income of the fishing households in Tamil Nadu is Rs. 2,915/-. If we consider Rs. 3,500/- per annum as cut-off point for poverty line, approximately 73% of the fishing housholds live below the poverty line.

RESEARCH AND DEVELOPMENT IN MARINE FISHERIES EXTENSION

Among the 497 studies published in Indian Journal of Extension Education during 1965-'81, studies on adoption and diffusion accounted for about 20%, extension methods for 16.50% and communciation for 13.50% (Siddaramaiah and Raghavendra, 1983). But contributions from marine fisheries extension were very negligible. Very few studies that have been published later were in the area of adoption and diffusion.

Fisheries extension should have two distinct branches, one for aquacultural extension and other of marine fisheries extension. As aquacultural extension is similar to agricultural extension, the methods of agricultural extension can be followed as such. However, the case of marine fisheries extension is different. Special attention should be bestowed to undertake and publish research studies to strengthen marine fisheries extension service. As the fisheries field is in an early stage of development, priority may be given to launch research studies that would have an immediate and direct impact on transfer of technology.

The discipline of marine fisheries extension draws its contents from extension research, principles of behavioural sciences and accumulated field experience. As the studies in marine fisheries extension are only a few, one looks for accumulated field experience. The field experience of the extension agency has neither been recorded nor accumulated for the benefit of others.

Lack of training in extension education to most of the incumbents of the extension service deprived them of the exposure on principles of behavioural sciences. Ultimately, the present day extension workers of marine fisheries extension service have only the technology and need the 'know-how' of transferring the technology. The basic knowledge of social sciences that have a bearing on fishing households, expertise in effective communication, familiarity with reliable sources of information, understanding of background, philosophy, objectives, policies and organisation of extension system and knack of applying the principles of behavioural sciences to extension teaching, supervision and administration might contribute to the know-how of transferring technology.

The extension personnel need exposure on process and methods of analysing local problems, organising target population in villages, stimulating leadership among them, problems and procedures of educating adults, and techniques and processes of evaluating extension programmes.

The marine fisheries extension would bring about efficiency in production, conservation, management, processing, preservation, marketing and distribution primarily. It would also aim to bring about better household living, youth development, leadership development and community development. However, at present efforts are diluted regarding the first four essential elements and attenion is focussed on the last four. When there is insufficient income, people cannot enjoy better family living. Hence, there should be a shift in the focus, from welfare measures to productive enterprise. In no way, it would undermine the importance of welfare measures.

MARINE FISHERIES EXTENSION SERVICE IN TAMIL NADU

Organisational chart of the Department of Fisheries, Tamil Nadu, indicates that there are four extension centres manned by Assistant Directors under the control of a Joint Director (Research and Extension). Of the four centres, one at the Head Quarters is for information and statistics. Of the rest, only two centres do marine fisheries extension work with not more than four extension workers. Research and Development institutions like CMFRI, EFP, MPEDA and TNAU with its regional stations also take up fisheries extension work. Training institutes like CIFNET, Central Polytechnic Institute and Fisheries Training Centres (six) of the Directorate of Fisheries impart training on Fishery technology.

PROBLEMS OF MARINE FISHERIES EXTENSION SERVICE

Marine fisheries extension service suffers from the following problems:

1. Marine fisheries extension service is manned by inadequate manpower who have less exposure on extension education.
2. Technology evolved by research organisation do not reach extension workers and then fishermen.
3. There is inadequate feed-back from extension workers on problems of fishermen.
4. Information on area of fishing and method of fishing are not available to extension workers and fishermen.
5. Extension teaching methods like individual contact, group contact and mass contact are not used effectively.
6. Co-ordination between various organisations concerned with marine fishery development is not effective.

SUGGESTIONS FOR IMPROVING MARINE FISHERIES EXTENSION SERVICE

Following suggestions may be considered for improving the marine fisheries extension service.

The Directorate of Fisheries should devote its full attention for extension work following the exemplary role played by the Directorate of Agriculture in the state.

In Japan every extension worker caters to the needs of 500 fishing households and one technical specialist advises four extension workers. In Orissa, on an average each marine extension officer handled as many as 733 cases during 1983-84 and 556 cases during 1984-85 (Anon, 1985). But, at present, Tamil Nadu does not have more than a dozen persons to do marine fisheries extension work. On considering

situation in Tamil Nadu, at least one fisheries extension worker for every 250 fishing housholds and one fisheries extension officer for every two workers may be provided for the state. Thus, about 350 extension workers and 175 extension officers are required to man the marine fisheries extension service at grass-root level.

Further, the extension workers may be selected from candidates having SSLC qualification and a diploma certificate in fisheries with special courses on fisheries extension. Similarly, the extension officers need to be selected from graduates of fisheries who have undergone fisheries extension courses.

Technology generated by all the Research and Development Organisations should go through the process of adaptive trials and demonstrations by scientists. A formal forum at various levels (similar to variety release committe of Agricultural Universities) need to be created to evaluate applicability of innovations. The extension education scientists are to be involved in all stages of 'technology development' so as to ensure that needs of client system are sufficiently met.

The organsiations concerned with development of marine fisheries sector should have sound linkages, both vertical and horizontal. A device has to be designed for the purpose similar to the 'Monthly Zonal Workshops' in Training and Visit system. It should provide a forum for discussing feed-back also.

Individual contact, group contact and mass contact methods need to be selected depending on situational factors. However, among the mass media, Radio and TV are to be preferred because of higher illiteracy (57%) level. In contrast to the present pattern of broadcasting, telecasting, a definite schedule has to be evolved. Training programmes for extension workers and fishermen need to be organised to impart skill and knowledge.

The technology transfer process should consist of the thrust areas like traditional crafts, modern crafts, gears, processing, preservation, sources of information and other assistance, marketing and distribution, scientific methods of capture based on indices, environment education, peoples participation and alternative employment.

CONCLUSION

The marine fisheries extension service needs concentrated efforts of development Departments with drastic policy intervations to revitalise the whole system. It may be concluded that only with a strong faculty of fisheries extension research, and with a dynamic extension organisation capable of meeting the challenges by deploying extension personnel having exposure on principles, philosophy, contents and methods of fisheries extension, the marine fisheries extension service can be strengthened.

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EXTENSION SERVICE FOR PRAWN FARMING

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ABSTRACT

The technology of prawn culture in India is still traditional and extensive called trapping-cum-holding in brackishwater ponds, but adoption of imporved extensive prawn culture technology is claimed to be picking up fast in several places notably in West Bengal, Kerala, Andhra Pradesh and Orissa. The production from such culture practices is estimated at 15000-17000 tons/year, accounting for about 5% of the total prawn production in India. The technology of scientific prawn culture is now available. Though steps are being taken to motivate, and encourage the fish farmers to take up prawn culture on scientific lines to increase their income, lack of an appropriate extension network is felt to be a major handicap in the field. This paper attempts to review the various extension services available for taking up prawn culture by the fish farmers, identifies the pitfalls and proposes a working fisheries extension programme for prawn culture in India.

INTRODUCTION

The word extension conveys the sense of stretching out to the villagers and workers in their respective field beyond the four-walls of conventional school and college systems. It is a method by which people are motivated through appropriate approaches. However, extension is a discipline by itself involving both art and science. Science, because it involves technolgy to impart better and more knowledge than what is existing on the subject in a most efficient and effective way and, art, because of its attractive way of presentation and passing on the information to others. Therefore fisheries extension could well mean disseminating information on fisheries in a effective and efficient way.

HISTORY OF FISHERIES EXTENSION IN INDIA

As early as 1928, the Royal Commission of Agriculture recommended modernisation of fishing to be brought about through research, extension and co-ordination of various departments related to Agriculture. The development of fisheries was included under integrated production programme in the year 1950 in order to augment fish production. In 1952, the Krishnamachari Committee recommended setting up of countrywide extension services in the field of agriculture. The first fishery extension organisation was set up in 1950 in the CIFRI as a nucleus of an extension service unit. Later, in the Second Five Year Plan more units were added under the Ministry of Agriculture and in the Vth plan budget an allotment of Rs.1512.40 million was made. In the VIth plan, an amount of Rs.3711.40 million (1980-85) and in the VIIth plan (1985-90) a sum of Rs.4991.90 million were allotted, which are little compared to developed countries like the USA which spent an estimated amount of $ 1200 million on extension activities.

Simultaneously from IIIrd Five Year Plan onwards the State Governments made conscious efforts towards fisheries extension by allocating funds for the purpose of their annual plans. Unlike dairy or poultry development, natural resources for fisheries development are varied and land limitation is not a constraint. The scope for development is virtually limitless.

The National Seminar on Fisheries Extension held at Cochin from December 8-10, 1980 has observed in most unequivocal terms that the existing extension service is, "totally inadequate and ill-equipped to utilise opportunities for enhancing fish production and improving rural economy". Since then fisheries extension was accorded importance and priority at various levels and now every organisation involved in fisheries education, research or development has an extension wing. However, this system still remains unorganised with no co-ordination at all.

They are insufficiently manned and it is not uncommon to see this area being given last priority and least importance. There are instances wherein extension service was thrust upon some officers as an act of punishment. Budget allocations in several state fisheries departments for extension services were insignificant because of the attitude that investment in extension is unproductive because it does not directly result in production. Therefore, it may not be incorrect to conclude that the present status of fisheries extension in the country is totally inadequate.

EXTENSION FOR PRAWN FARMING

Predominance of frozen prawns in the Indian marine products exports, since their introduction to the international market, made several organisations concerned with prawn farming to undertake extension activities. Since frozen prawn continued to be the main item of export, accounting for a share of 57.32% (49203 tonnes) in terms of quantity and 82.03% (Rs. 377.93 crores) in terms of value against the total Indian marine products export of 85843 tonnes fetching Rs.460.67 crores during 1986-87, prawn farming received a fillip from the MPEDA which got itself involved in prawn farming in a big way. It has in fact, for the first time, taken organised and co-ordinated efforts to establish an extension service for prawn farming. It has established a Regional Centre for prawn farming in every maritime state for development of prawn farming. The activities of each Regional Centre can be broadly classified as follows:

1. Survey of brakishwater areas and finding their suitability to prawn farming.
2. Preparation of plans and estimates for construction of prawn farms.
3. Issuance of feasibilty reports for developing new prawn farms.
4. Extension of technical assistance to prawn farmers.
5. Supply of inputs like prawn seeds, fish poison, filter screen etc., at cost price.
6. Conducting prawn seed resource surveys and identifying such collection centres.
7. Demonstration of commercial viability of prawn farming in farmer's ponds.
8. Demonstration of advanced farming techniques.
9. Conducting training courses to farmers and entrepreneurs in prawn farming.

The extension and development programmes of the Regional Centres have helped the farmers to bring in more brackishwater areas under prawn culture as well as to conduct the farming operations successfully. For example, during the past five years, the Regional Centre(RC), Machilipatanam has surveyed (Micro Level) over 6700 ha for their suitability to prawn farming. After a detailed survey (micro-level) of 908.0 ha the R.C has prepared project feasibility reports for 785.56 ha of prawn ponds. It has located new prawn seed collection centres in Krishna and West Godavari Districts. Technical assistance for conducting prawn farming on scientific lines has been extended to over 228 registered farmers having 583.10 ha of prawn ponds. The R.C has so far conducted eleven training courses and trained 232 farmers in prawn culture. Further, it has supplied inputs like prawn feed, fish poison, filter meshes and ice boxes to prawn farmers. The result being that the area under prawn farming in Andhra Pradesh is likely to exceed 2000 ha and the production of pond-raised prawns has increased from a mere 1.5 tonnes in 1981-82 to 354 tonnes in 1986-87.

During the 7th Five Year Plan, the MPEDA has introduced new promotional schemes for the development of prawn farming:

1) Financial assistance (subsidy) to develop new prawn farms.
2) Financial assistance for setting up of prawn hatcheries and seed banks.
3) Supply of subsidised prawn feeds.

Another important agency involved in extension activities for prawn farming is the B.F.D.A. The B.F.D.A's are prominent in Orissa. However, regarding their role in prawn farming, it is claimed that, they have not achieved the targets set under departmental schemes like brackishwater development, fishery publicity, training of farmers and even in the case of Fishermen Group Accident Insurance Scheme they have done pretty badly under the beneficiary-oriented programmes executed through the agency of D.R.D.A. particularly in the anti-poverty sector.

The constraints to the development of extension service for prawn farming are:

1) Lack of trained personnel to man the extension units.
2) Lack of understanding and co-ordination or horizontal linkage among various agencies involved in executing comprehensive development programme leading to improper im-

plementation, wastage of funds and poor results.

3) Lack of adequate funds to implement extension programmes.
4) The development programmes do not reflect the felt needs of the target group and our technological findings are not based on feed-and-feed back system.
5) It is claimed that there were leakages and malpractices in the administration of subsidy and loan due to ignorance of the beneficiaries.
6) The major handicaps were the poor scale of financing which was too low to generate adequate income, reluctance of banks to extend loan facilities to weaker sections, and inadequate institutional support for supply of raw material, inputs and infrastructure.
7) The number of beneficiaries are fixed on uniform basis per block without considering the population size or extent of poverty in the block or availability of local resources or felt needs of the target groups hence social justice is not ensured.

STRATEGIES FOR DEVELOPING EXTENSION SERVICE FOR PRAWN FARMING

A six point strategy is suggested for strengthening extension service for prawn farming.

1) Horizontal linkage among all governmental and non-governmental agencies involved in the fisheries sector should be ensured. This would facilitate identification of issues of priority basis, elimination of duplication of efforts, effective and efficient utilization of the scarce funds, availability of sufficient number of extension personnel and realisation of set targets ultimately.
2) Non availability of trained technical personnel is another problem that merits our attention. Fisheries training at every level should include extension courses also. Graduates despatched from various Fisheries Colleges could be picked up to man the extension services as they have right blend of fisheries science and fisheries extension sciences. In many Indian fisheries research institutes, agricultural extension officers are handling this job. Such positions should be filled in with Fisheries Graduates (specialised in Fisheries Extension). The various fisheries training programmes given to department staff should also include fisheries extension courses adequately.
3) The budget allocations to extension wing at various levels have been meagre and paltry. This is because of the attitute that investment in extension is unproductive because it does not directly result in production. This attitude should change and adequate budget allocations should be made.
4) Provision of necessary working facilities like field kits, vehicles, audio-visual equipments etc to the extension staff is necessary.
5) Regular meetings between the various governmental and non-governmental agencies involved in fisheries extension should be conducted to ensure exchange of information. This should be of immense help to all of them and facilitate a sustained growth for every one of them. The communication gap could as well be narrowed down if not bridged.
6) The various governmental and non-governmental agencies, involved in this field may try to obtain assistance and aids available from several international/regional aiding agencies or development organisations.

TRAINING FISHERWOMEN IN FISH PROCESSING

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ABSTRACT

A project on training fisherwomen for their participation in rural development, sponsored by Ford Foundation (U.S.A), has been started by the Centre for Agricultural and Rural Development Studies, T.N.A.U.,at the Fisheries College, Tuticorin. The project aims to select a few literate rural women with leadership qualities for imparting to them a training in the organisational and managerial aspects of a viable fish processing enterprise. It also aims to assist the trained fisherwomen in organising and operating cottage industries by continued technical backing and thus making the production units demonstration centres for the benefit of other women in the region.

The preliminary survey helped in identifying 5 candidates from each of the 3 selected villages. The pre-survey revealed the respondents' choice of subject-areas to undergo training and their enthusiasm to learn techniques for the preparation of fish products like fish pickle and Masi Meen. It also revealed their desire to be exposed to new products like fish wafers, fish oil, fish meal, shark fin-rays etc. The pre- and post-evaluations of the training programme helped in i) identifying training needs in the fields of marketing and financial management; ii) identifying some low-cost technological substitutes for some of the commercial products (eg: 'Gadi' for vineger); iii) identifying the products or techniques appreciated by the trainees and the products or techniques that received lukewarm response with reasons for such a response; iv) identifying the level of managerial efficiency gained by the trainees and the kind of support required for each individual to start cottage industries. The programme is being followed up by interpersonal contacts and the co-ordinated efforts of the development departments.

INTRODUCTION

The potential role of rural women in Agricultural and allied sectors is well known. In addition to the tasks performed at home, the fisherwomen engage in other productive activities. The income generating jobs performed by the fisherwomen of Tamil Nadu include some of the fishing related activities such as net making, net mending, fish handling, dry fish preparation and marketing. However, their potential contribution to the development of small-scale fisheries is not recognised properly due to the social and cultural discrimination against women in fishing communitites. Hence the need for specific projects for fisherwomen development is felt. Experts like Ms. Edeltraud Drewes, socio-economist of the Bay of Bengal Programme (BOBP), have expressed similar concern. The BOBP reports that the fisherwomen will be able to compete their counterparts on better terms if given adequate training and also emphasises the need for training fisherwomen in income generating activities such as fishery product and by-product development, marketing crafts etc.

To improve the standard of living of the fishing communities, the Central and State Governments, Universities, Voluntary organisation and Overseas Development Agencies take part in implementing development projects. The Ford Foundation of United States, a philanthropic organisation with its branch at New Delhi, contributes over $ 200 million for the development goals in India. Ford Foundation sponsors various development programmes and one such is a project on Training Rural Women for their participation in Rural Development that has been sanctioned to Tamil Nadu Agricultural University. The Training programme has the following objectives: (1) to select a few educated rural women with leadership qualities and to impart training to them in the organizational and managerial aspects of income generating, viable, economic activities such as dairying, sericulture and fish processing/fish culture, (2) to assist trained women in the organization and running of the units by continued technical back-up and to make the units demonstration centres for the benefit of other women in the locality. During the period from 1982 to 1985, 45 rural women got trained each in sericulture and dairying at Tamil Nadu Agricultural University, Coimbatore. Training of rural women in dairy enterprise management is in progress at the Agricultural College and Re-

search Institute, Madurai and 60 women have been trained so far. A similar project is under way at Fisheries College, Tuticorin, a constituent body of Tamil Nadu Agricultural University. The three years project will be in operation till 1990. Two batches of 15 fisherwomen each will be trained every year. Four training programmes will be in fish processing enterprise management and two will be in fish culture enterprise management. Thus a total of 90 fisherwomen will get trained under this project and each training programme will have the following plan of action (1) Pre-survey (2) Training programme (3) Follw-up programme and (4) Post-performance evaluation of the programme.

The first batch of fisherwomen training in fish processing enterprise management was organised during March-April 1987 at Fisheries College, Tuticorin.

SELECTION OF VILLAGE

Three fishing villages of Chidambaranar District namely, Therespuram, Tharuvaikulam and Punnakayal of Tuticorin, Ottapidaram and Thiruchendur Taluks respectively were identified for the selection of participants for the training programme. While Therespuram is a fishing village very close to Tuticorin town, Tharuvaikulam and Punnakayal are about 15 kms and 30 kms away from Tuticorin, respectively.

PRELIMINARY SURVEY

Prior to the selection of the participants a preliminary survey in all the three villages was conducted. The objectives of the pre-survey were to (1) understand the literacy level of female labour force (2) examine the involvement of female labour force in income generating activities (3) find out the skills possessed by the female labour (4) study their knowledge in fish processing techniques (5) find out the extent of adoption of fish processing techniques known to them and (6) understand their willingness to undergo a training in fish processing and their choice of subject-areas in fish processing (In this context, the term female labour force is used to include the age group from 14 to 55 years).

The sample size for the pre-survey in each village was 30. Two Assistant Professors and two Fishery Assistants were the investigators for the sample survey. A pilot survey prior to the pre-survey was conducted at Tharuvaikulam and Punnakayal during which fisherwomen in each village were interviewed in order to pre-test the schedule for pre-survey and based on the responses the schedule was revised.

The co-operation of an official of the Fisherwomen Extension Service, the Presidents of Fisherwomen Co-operative Societies and the Parish Priest of one of the Villages helped in conducting successful survey in the Villages. These personalities were initially approached and explained about the purpose of survey.

SALIENT FINDINGS OF PRE-SURVEY

Literacy Level

The survey revealed that the literacy level of fisherwomen in all the three villages is low.

It is evident from Table I that the majority of the respondents have received only primary school education and the mean percentage of those was 63.33.

Table I *Literacy level of respondents*

(in percentage)

Village	Illiterates	Primary Sl. Education	Middle Sl. Education	High Sl. Education	Higher Secondary Sl. Education
Therespuram	10.00	70.00	10.00	6.67	3.33
Tharuvaikulam	13.33	70.00	10.00	3.33	3.33
Punnakayal	13.33	50.00	30.00	6.67	0
Mean	12.22	63.33	16.67	5.56	2.22

Skills and Employment:

The only income oriented fishing related activity in which the majority of respondents have skill and involvement is net making/net mending and this is supported by the Table 2. The average number of days of involvement of a fisherwomen in net making doesn't exceed 75 days/annum at the rate of 8 hours of work/day.

Table 2 *Employment of respondents in fishing related and non-fishing related activities*

(in percentage)

Activities	Therespuram	Tharuvaikulam	Punnakayal
Fishing related:			
1. Net making	20.00	13.33	26.67
2. Dry fish preparation	20.00	0	10.00
Non-Fishing related:			
1. Tailoring	13.33	3.33	16.67
2. Handicrafts	0	0	0
3. Weaving	0	13.33	0
4. Match Factory work	0	10.00	0
5. Toddy sales	0	3.33	0

Another fishing related activity in which 10-20% of the respondents had been involved is dry fish preparation. The purpose of preparing dry fish has been invariably reported to be domestic consumption.

Though many respondents possess skill in tailoring only a few own sewing machine and do tailoring. Bamboo-basket making is another non-fishing related activity apart from tailoring. While this activity was observed in all the three villages, weaving, employment in match factories and selling toddy are some of the non-fishing related activities of the fisherwomen of Tharuvaikulam.

AWARENESS AND KNOWLEDGE IN FISH PROCESSING TECHNIQUES

A uniform pattern in the degree of awareness and knowledge of fisherwomen in fish processing techniques could be observed in all the three villages. Majority of the repsondents had sound knowledge in the dry fish preparation techniques with an exception of about 50% of the respondents of Tharuvaikulam village. The question posed to test the awareness and knowledge in some other fish processing techniques such as the preparations of fish pickle, fish meal, fish oil, fish sauce, "Masi", etc., revealed their non-awareness and ignorance of those techniques by the majority of the respondents. A few respondents had partial knowledge in the preparations of fish pickles, "Masi", fish oil, and fish meal and almost all the fisherwomen invariably preferred to get trained mainly in the preparations of fish pickles and "Masi" and their order of preference to learn the techniques was for the preparations of fish pickles, "Masi", fish meal, fish oil, fish wafers, fish soup powder, shark fin rays and fish sauce.

Adoption of Fish Processing Techniques

Inspite of their sound knowledge in dryfish preparation majority of them mentioned that they prepare dryfish only for their own use and that too occasional. A very few are involved in the dry fish preparation for the purpose of selling. Similarly, though a few respondents have a partial knowledge in the preparation of fish pickles and 'Masi' etc., none seems to prepare the products even for their own use.

Willingness to undergo Training

It is needless to say that any kind of training that helps earning to supplement family income will positively attract the poor to express their willingness to undergo the training. While this was true with majority of the respondents of the three villages, there were also exceptional respondents who expressed their non-willingness

because of their commitments like childcare and household duties of their larger family. It was interesting to observe that about 30% of respondents of Tharuvaikulam village comprising both married and unmarried women were not willing to undergo any type of training offered outside their village and this may be attributed to the social and cultural values prevalent in their village.

Selection of Participants

Soon after the completion of Pre-survey in the three villages, the next task was to select the participants for the training programme. Three factors were considered for selection viz., (1) Age - between 18 and 45 (2) Educational Qualification minimum completion of primary school education and (3) leadership qualities with managerial abilities. The key-informant technique of leadership selection was used. The Extension Officer (Inspector of Fisheries) of Fisherwomen Extension Service, Department of Fisheries, Tamil Nadu and the Presidents of Fisherwomen Co-operative Societies were the key-informants. They were briefed on the modalities of the selection of participants and were entrusted with the selection as they do have fairly good contacts with the village women.

Training Programme

The first batch of 15 day training for fisherwomen in fish processing was inaugurated on 30-03-'87 and that extended upto 22-04-'87. On the day of inauguration of the training programme, only the Registration of the participants was carried out and the training classes started from the next day with the pre-evaluation of the trainees.

Pre-evaluation

Prepared schedules, of pre-evaluation of the trainees was given to each trainee to get it filled up by themselves. Questions were so designed to (1) understand their present level of knowledge and adoption of fish processing techniques and (2) identify the trainees' preference to learn the fish processing techniques during the training programme.

To begin with the training classes, some of the general lectures like the role of women in rural development and need for training women in viable economic activities (techniques), nutritional value of fish, availability of fishery resources for fish processing and hygienic handling of fish from catch to processing etc., were delivered by the concerned faculty members of the College. Some of the important subjects covered during the training include hygienic way of dry and salt curing of fish, preparation of pickles from fish, oyster and prawn, and preparations of fish meal, fish oil, fish maws, fish soup powder, fish wafers and "Masi". On top of all, the utilisation of trash fish and fish wastes was demonstrated to the trainees in the programme. Group discussions were also arranged for the benefit of the trainees. Two panel discussions were conducted, the first one on Government aid to small industries, and the second one on credit facilities to small industries and procedures for availing themselves of the facilities. Officials from small Industries Service Institute (SISI), District Industries Centre (DIC) and Lead Bank and Nationalised Commercial Banks participated and explained the concerned procedures to the trainees. The trainees interacted with the officials by seeking clarifications.

Post-evaluation

On the last working day of the training programme the post-evaluation of the trainees was made. As followed in the pre-evaluation, the trainees were distributed with prepared schedules to fill up by themselves. The post-evaluation schedule included some questions from the subject areas dealt with during the programme to test their knowledge gained from the training. The questions were centred around their views about the training programme and their plan after the completion of the training.

The pre-and post-evaluation of trainees revealed the following:

Both the knowledge and adoption were maximum for the dryfish preparation in all the three villages viz., 60-100% and 50-80% respectively compared to a few other techniques in which their knowledge and adoption varied from 10-25% and 10-20% respectively.

The response of the trainees for their knowledge in all the fish processing techniques at post-evaluation was 100%.

The over all ranking of fish processing techniques to them was also done both at the pre-and post-evaluations. The order of overall ranking at the pre-and post-evaluations is given in Table 3.

Table 3 *Training Priorities (ranks)*

Techniques	Pre-evaluation	Post-evaluation
Dry fish	7	3
Fish oil	4	6
Fish pickle	1	1
Fish Meal	7	2
Fish sauce	9	5
Fish Manure	6	4
Fish soup powder	8	7
Shark fin rays	10	10
"Masi"	2	8
Fish wafers	3	9
Fish spirals	5	6
Isinglass	12	11
Chitosan	11	12

Remarkable variation in rankings by the trainees was observed and the post-evaluation ranking depicted the following:

The techniques ranked 1 to 7 at the post-evaluation require a very few low-cost equipments/utensils for their preparations as evident from their order of ranking viz., preparation of fish pickle, fish meal, dry fish preparation, fish manure, fish sauce, fish oil and fish soup powder. On the other hand the rest of techniques involve either costly equipments such as smoking kiln for "Masi", grinder for the preparation of fish wafers etc., and/or chemicals such as sodium hydroxide for chitosan preparation and hydrochloric acid for shark fin rays. Thus, it is very obvious from the above results that the trainees prefer to involve in such preparations as fish pickles, fish sauce etc., which require less capital investment and that are simple to adopt. It is also felt that the ranking doesn't seem to have been done based on the market value of the products. Thus the ranking helped in identifying the techniques appreciated by the trainees and those that received lukewarm response with reasons for such a response.

The views of the trainees revealed the training needs on the areas of marketing and financial management. They felt that the channels of marketing the fish products they intend to prepare might have been enlightened to them. In fact, realising the need for the knowledge in the areas of marketing for the trainees, efforts were made to arrange for a group discussion similar to the panel discussions conducted for the benefit of trainees. However, unfortunately the same couldn't be conducted as desired because of the luke-warm attitude of the officials.

More over the trainees had expressed that the assistance for availing of credit and marketing the products would enable them to start cottage industries to prepare the fish products they learnt during the training. They had expressed their desire to demonstrate techniques they learnt to the other village women and to involve them in similar income generating activities. This explained their confidence to start and efficiently manage their own cottage industries.

As a wind fall benefit the interaction with the trainees revealed that a local substitute called "Gadi", a fermented palmyrah product was available for vineger as preservative. The local substitue was preferred because of its better quality and less cost. Such an exposure on local practices may help us evolve appropriate low-cost technology for the fishing households.

Follow-up Programme

The programme is being followed-up by interpersonal contacts and by the co-ordinated efforts of the Development Departments. The experience will be of immense use in planning and conducting training programmes in future.

POST-GRADUATE EDUCATION, TRAINING AND EXTENSION AT CENTRAL MARINE FISHERIES RESEARCH INSTITUTE, COCHIN

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ABSTRACT

In view of the increasing demand for trained personnel to meet the requirements of mariculture and brackishwater culture activities in the country, the Central Marine Fisheries Research Institute took steps to institute a post-graduate education programme in mariculture at the Institute, leading to the M.Sc. and Ph.D. degrees awarded by the Cochin University of Science and Technology. Through this programme a number of post-graduates have been turned out in the subject during the past seven years. The students were given both theoretical and practical instructions in different aspects of mariculture including basic subjects like physiology, nutrition, genetics and pathology. The Scientists of the Institute constitute the faculty for the programme and a number of members of the faculty have also been trained abroad in different specilisations. The Programme also had the advantage of consultants from other countries who have contributed greatly to its improvement and also in the development of infrastructural facilities at the Insitute. As a result of the consultancy, a number of manuals on special subjects have also been published. The Krishi Vigyan Kendra and the Trainers' Training Centre handle a number of courses at the farmers level and at the trainers level based on the technologies developed at the Institute. In addition, an integrated programme of training including subjects in agriculture, animal husbandry and home management is also conducted.

INTRODUCTION

Fish production in the marine sector in India has been dependent, almost fully, on capture fisheries and it seems to have stagnated around 1.5 million tonnes in recent years. Demand for fish, nevertheless, is steadily on the increase. Increasing fish production by adopting aquaculture practices may prove to be one of the effective alternatives to meet the increasing demand for fish. There is good scope for development of coastal aquaculture in the country as we have vast brackishwater areas and salt water lagoons, left mostly fallow, all along the coast. However, successful management and execution of coastal aquaculture requires a cadre of trained personnel and competent expertise. It was with this intention that a "Centre of Advanced Studies for Post-graduate Education and Research in Mariculture", was started at the Central Marine Fisheries Research Institute, Cochin in July, 1979 with financial assistance from the UNDP and the ICAR. Several ad-hoc programmes also have been organised by the Institute under various projects at different levels, in an attempt to take the technologies developed at the Institute to the farmers and entrepreneurs.

A. POST-GRADUATE EDUCATION AND RESEARCH PROGRAMME IN MARICULTURE

Objectives

1. Institution of post-graduate degree courses such as M.Sc. and Ph.D. in mariculture for creating a cadre of professionally qualified personnel to meet the requirement of research, managerial and executive level manpower.

2. Strengthen research programmes in mariculture and related subjects utilizing investigations by research fellows.

3. Develop infrastructure for teaching and advanced research.

4. Arrange advanced overseas training in identified priority areas under the faculty improvement programme for scientists involved in teaching and research activities.

5. Draw services of expert consultants from developed countries in areas where Indian expertise is lacking.

6. Organise seminars, workshops and special lectures on topics relevant to mariculture.

7. Establish linkages with other organisations both in India and abroad for exchange of views and ideas and extension activities.

ACTIVITIES AND ACHIEVEMENTS

1. Teaching programme

The Centre, in collaboration with the Cochin University of Science and Technology, offers a two year M.Sc. and a three year Ph.D.degree course since 1980.

The course programme for M.Sc. comprises of four semesters with subjects of basic sciences, marine biology, coastal hydrography, and physiology, endocrinology and cytogenetics of marine animals in the 1st semester; fisheries, fish and

fishery biology, finfish culture and fish farm engineering technology in the 2nd semester; culture of crustacea, culture of seaweeds and research methodology in the 3rd semester; and management of marine culture farms and extension and dissertation in the 4th semester.

The Ph.D. programme consists of two semesters of course work in the 1st year followed by research on selected topics. The course work in the 1st semester is on mariculture and it is common for all Ph.D. candidates. Syllabus for this includes an overview on mariculture, current concepts on the biology of cultivable finfishes and shellfishes, finfish culture, prawn culture, lobster culture, crab culture, mussel culture, oyster culture, pearl culture, clam culture, seaweed culture, site selection and grow-out structures, production economics and extension, biostatistics and research techniques. The 2nd semester, however, is specific to the topic of work selected in the Ph.D. programme. The areas identified as priorities for Ph.D. specialisation fall under the broad heading of ecology, physiology, nutrition, endocrinology, pathology, biology of cultivable species and different culture systems.

Ten candidates are admitted for each course every year. Seven batches were taken for each course so far as per details given in Tables 1 and 2.

The topics of research for which Ph.D.degrees have already been awarded are:

1. Culture and growth kinetics of selected nanoplankters.

2. Reproductive physiology of Indian species of the genus *Perna* (Family Mytilidae).

3. Studies on sporulation and propagation of selected Agarophytes.

4. Studies on the ecology and productivity of saline lagoons.

5. Pathological investigations in penaeid prawns.

6. Nutritional studies in juvenile *Penaeus indicus* with reference to protein and vitamin requirements.

2.Faculty improvement programme

A total of 28 scientists have been trained under this programme in countries like USA, France, U.K., Japan, Philippines, Belgium, Spain, Malaysia, China, Australia, Netherlands and Canada for periods ranging from two to six months on specialised subjects such as integrated fish farming, Oyster hatchery, Fish seed production, Mullet culture, Milk fish culture, Cage and pen culture of *Tilapia*, Mussel culture, Lobster culture, Invertebrate tissue culture, *Macrobrachium* culture and Crustacean genetics, Seaweed culture and genetics, Marine fish genetics, Molluscan genetics, *Eucheuma* culture, Culture of live feed organisms, Fish and shell-fish nutrition, Bioenergetics, Biochemistry of steroids, Crustacean physiology, Reproductive physiology of fish and shellfish, Reproductive physiology of marine prawns, Endocrinology of fish and shellfish, Bioassay procedure and experimental design on toxicity studies, Aquaculture and water quality management, Aquatic pathobiology, Fish diseases, Applied ecology of mangrooves, and Aquaculture economics.

Table 1 M.Sc..Degree Course

Batch No.	Year Admitted	Completed	No. of candidates Discontinued	Continuing
1.	1980-82	10	9	1	-
2.	1981-83	15	12	3	-
3.	1982-84	10	10	-	-
4.	1983-85	10	10	-	-
5.	1984-86	9	8	1	-
6.	1985-87	9	-	-	9
7.	1986-88	9	-	-	9
	Total	72	49	5	18

Table 2 Ph.D.Degree Course

Batch No.	Year	Admitted	Completed	Discontinued	Continuing	Synopsis submitted	Thesis submitted	
							Result awaited	Degree awarded
1.	1980-83	4	4	-	-	-	-	3
2.	1981-84	9	9	-	-	-	4	3
3.	1982-85	10	8	2	-	-	1	-
4.	1983-86	11	1	4	6	2	-	-
5.	1984-87	10	-	5	5	-	-	-
6.	1985-88	10	-	2	8	-	-	-
7.	1986-89	10	-	2	8	-	-	-
	Total	64	22	15	27	2	5	6

3. Expert consultancy

Fifteen scientists from abroad were invited to give training and guidance for improving teaching and research programmes. The subjects on which consultancy was made available were Environmental physiology, Reproductive Physiology of finfish and shellfish, Crustacean physiology and nutrition, Fish and shellfish nutrition in Indias, Fish/shrimp nutrition, Culture of live food organisms, Oyster biology and culture, Tissue culture of marine invertebrates, Fish and shellfish genetics, Fish and shellfish endocrinology, Microbial ecology in grow-out ponds, Fish and shellfish pathology in India, Fish and shellfish diseases, Water quality management in Aquaculture and Aquaculture Engineering.

4. Equipments

Under the financial assistance of UNDP, the Institute has acquired a number of sophisticated equipments necessary for advanced research in mariculture. These include a transmission-cum-scanning Hitachi-H-600 Electron Microscope, LBK-400 Amino Acid Analyser, Tecator Fibretec, Soxtec, Kjeltec and Ds.40 Digestive systems, Sorval Rc-5B Centrifuge, Polarographic Analyser, Hewlet Packard Gas Chromatograph, Pharmacia Column chromatographic systems, LKB Ultra Microtome, Mettler Electronic Balance, Olympus Vanox Research Microscope, A.O. Cryostat Microtome, Sartorias Microbalance, Chemlab SB-5 Freeze Drier, Spectronic 2100 Clinical Analyser, A.O. Phase Star Microscope and Potentiometric Recorder.

5. Seminars, workshops, group discussions and special lectures

A total of 69 seminars and 158 group discussions were organised under the programme in Expert Consultancy on topics related to fields of consultancy.

The Institute organised five National Workshops on aspects related to mariculture in the country. Of these, two workshops were organised in collaboration with the University of Madras and one with the Marathwada University. At the Institute level, 12 workshops were conducted by the Expert Consultants. The themes of the above workshops were Mussel farming, Crustacean biochemistry, Fish and shellfish nutrition, Marine invertebrate reproduction, Invertebrate endocrinology, Methodology and techniques of induced breeding of finfish, Approaches of finfish and shellfish pathology investigations, Application of genetics in aquaculture, Physiology and moulting in crustacea, Culture of live food organisms with special reference to *Artemia*, Marine toxins, Water quality management in mariculture, Methods and design of experiments in environmental biochemistry, Nutritional quality of live food organisms and their enrichment, Hormone isolation and assay, and Techniques for estimation of bacterial growth ratio and productivity in aquaculture pond system.

The Centre also arranged 45 special lectures by National and International Scientists/professors as part of its educational programme in mariculture.

6. Research programmes

Fortynine short-term and 22 long-term projects were handled by the M.Sc. and Ph.D. students respectively. Presently nine short-term and 27 long-term topics are being worked out. Topics of research under this programme are related to ecological studies on culture systems, soil and water, its microbiology, mangroves, benthos, primary production and pollution; seaweeds and seagrass; seed resources, seed transportation and hatchery production; general biology of cultivable organisms; ecophysiology, reproductive physiology and endocrinology; nutrition, nutritional requirements and feed development, digestion and metabolism, live food culture and their nutritive values; pathology and genetics. While Ph.D. degrees were awarded to six candidates, results of theses submitted on the following subjects to the Cochin University of Science and Technology are awaited.

1. Studies on ecophysiology of *Penaeus indicus* in the grow-out systems.
2. Studies on histological and biochemical changes during spermatogenesis in *Mugil cephalus* and related species.
3. Studies on larval nutrition in the pearl oyster *Pinctada fucata*.
4. Studies on Indian Cichlids.
5. Larval biology of the spiny lobsters of the genus *Panulirus*.

Two other topics on which synopses have been submitted to the University are:

1. Role of trace elements on the growth and physiology of selected microalgae.
2. Biochemical genetics of selected commercially important penaeid prawns.

Work on 9 other topics was completed and on 5 others is nearing completion.

7. Publications

The programme under mariculture has brought out a series of manuals in research methodologies as CMFRI Special Publications. They are, Manual of research methods for crustacean biochemistry and physiology, Manual of research methods for fish and shellfish nutrition, Manual of research methods for marine invertebrate reproduction, Approaches to finfish and shellfish pathology investigations, Application of genetics in aquaculture, Manual of research methods for invertebrate endocrinology, Production and use of *Artemia* in aquaculture, Manual of marine toxins in bivalve molluscs and general consideration of shellfish sanitation, Handbook on diagnosis and control of bacterial diseases in finfish and shellfish culture, Mariculture research under the Centre of Advanced Studies in Mariculture, Water quality management in aquaculture, A practical manual for studies on environmental physiology and biochemistry of cultivable marine organisms, and Theorems of environmental adaptations. Nutritive value of live food organisms and their enrichment, Neuroendocrine research and techniques, Techniques for estimation of bilateral growth rates and productivity in aquaculture pond system and Approaches to physiological studies on moult cycle in crustacea are under publication.

About 32 papers/articles bave been published in various periodicals on the basis of work done under the programme on mariculture.

8. Utilisation of manpower

The teaching and education programme in mariculture was started in the country to build up a cadre of trained personnel. The candidates who have successfully come out are suitably employed. A number of them are engaged in conducting further research or teaching at university levels. Some have joined as managers or executives of non-government organisations dealing with mariculture, farming and export. MPEDA, TATA, Hindustan Lever, Vorion Chemicals, Commercial Banks, Insurance Companies, Research organisations, Universities and State Fisheries Departments have absorbed most of the candidates.

B. FISHERIES TRAINING AND EXTENSION

The various research programmes of the Central Marine Fisheries Research Institute have resulted in the development of new technologies in the field of marine fisheries relating to both capture and culture. Concerted efforts have been made since 1978 to impart training to the end-users through programmes organised under various projects at different levels. The regular training programmes organised under various projects of the Institute during 1979 included training in marine prawn culture, pearl culture, edible oyster culture, underwater investigations using SCUBA diving, fishery resources assessment and population dynamics. Subsequently all

these training programmes have been brought under the Trainers' Training Centre of CMFRI.

1. Training in marine prawn culture

Considering the importance of prawn culture in increasing production, the Crustacean Fisheries Division of CMFRI conducted a training course in the year 1978 for 12 inservice personnel belonging to the Marine Product Export Development Authority and Fisheries Departments of Gujarat, Maharashtra, Karnataka, Kerala, Tamil Nadu and Andhra Pradesh, on the various aspects of marine prawn culture. In 1979, 22 Research Scholars recruited under the sponsored project 'Assessment of Fry Resources of Culturable Penaeid Prawns at Selected Centres in Kerala and Karnataka were trained for two weeks in prawn and fish seed collection, identification and quantitative and qualitative analysis of seed samples. Besides, training was also imparted to 10 quality control supervisors of the MPEDA in identification of commercially important prawns, lobsters and crabs. Two officers, one from Indonesia and the other from Bahrain, underwent training in prawn filtration/culture and biology of shrimps, respectively, for two months.

2. Training in pearl culture

In order to update knowledge in the latest techniques of pearl culture, nine officials working on related aspects and belonging to Gujarat, Tamil Nadu, Andaman and Nicobar, Lakshadweep, CMFRI and also the Philippines, were given training on the various aspects of pearl oyster culture and production of cultured pearl.

3. Training in edible oyster culture

The objective of the training programme in edible oyster culture was to transfer the technology to small and marginal farmers/fishermen to form a source of additional income to them and also to generate self-employment for the unemployed. Fifteen fishermen were trained under this project. Besides, a batch of students from the University of Madras undergoing the Postgraduate Diploma Course in Mariculture were also trained in these culture techniques.

4. Training in underwater investigation by SCUBA diving

SCUBA diving is one of the most reliable methods for underwater investigations on marine resources. A training programme was conducted at the Institute for a period of eight weeks in order to train scientists and technicians in the principles and methodology of SCUBA diving. Five persons from various Departments and CMFRI participated in the training.

5. Training in fishery resources assessment and population dynamics

It is very essential that the research and technical personnel engaged in marine fisheries research, education and development programmes in the country be trained in fishery resources assessment and population dynamics. Twentytwo officials from various State Fisheries and other Departments, Fisheries Colleges and CMFRI have been trained under this programme.

6. Training in sampling techniques for assessment of exploited marine fisheries resources

The Institute has developed a stratified multistage random sampling design which is widely used for the collection of marine fisheries catch statistics. It is necessary that the field staff of the Fisheries Departments of Maritime States also follow the same method to facilitate easy comparison of the data. To ensure this the Institute has been training State Fisheries officials in the sampling methodology. So far, 35 inservice personnel from various States have been trained under this project.

7. Training programmes of Trainers' Training Centre

A Trainers' Training Centre for 'Marine Fisheries' was sanctioned by the ICAR in October, 1983. It functions under CMFRI as a complementary scheme along with the Krishi Vigyan Kendra at Narakkal. The TTC started training programmes in 1984 with the help of scientists of CMFRI who have actually developed the various technologies of the Institute on mariculture and marine resources assessment were brought under the TTC scheme. Inservice personnel are given training in prawn farming and hatchery production of marine prawn seed at the KVK/TTC and MPHL, Narakkal; in seaweed culture at the Regional Centre of CMFRI, Mandapam Camp and in edible oyster culture and hatchery production of oyster seed at the Tuticorin Research Centre of CMFRI, Tuticorin.

In addition to the above courses, training is given in fisheries resources assessment with special reference to sampling techniques and population dynamics and in SCUBA diving, to offcials sponsored by various government and autonomous agencies and private institutions.

The Training on the post-harvest technology in fisheries included theory and practical classes on principles of quality control in fish and shellfish processing, preservation by different methods, preparation of diversified products such as pickles, wafers, soup powder and cutlets using low cost fish and preparation of other products of commercial importance like sharkfin rays.

The number of persons trained in various technologies at the different centres are given below:-

1. Prawn farming	12
2. Hatchery production of marine prawn seed	21
3. Seaweed culture	7
4. Edible oyster culture	13
5. Hatchery production of oyster seed	11
6. Sampling techniques for assessment of exploited marine fisheries resources	19
7. Fishery Resources Assessment	16
8. Post-harvest technology in fisheries	5
Total	104

8. Summer Institutes

CMFRI has conducted five summer institutes to impart training in various fields of aquaculture. Fifteen persons participated in the Summer Institute on 'Coastal Aquaculture' conducted in 1974 at CMFRI, Cochin. In 1977 another Summer Institute was conducted by the Institute on 'Breeding and rearing of penaeid prawns' and 16 persons participated. At Tuticorin Research Centre of CMFRI a Summer Institute was conducted in 'Culture of edible molluscs' in 1980 in which 16 persons from different State and Central Government departments were trained. A Summer Institute on 'Hatchery Production of prawn seed and culture of marine prawns' was conducted in 1983 for 22 persons from various government and other agencies, at the Prawn Culture Laboratory, Narakkal. In May 1987 a Summer Institute on 'Recent Advances in Finfish and shellfish Nutrition' was conducted at Cochin and it was attended by 29 participants from all over the country.

9. KVK Training Programme

Training farmers is a critical input for the rapid transfer of latest technologies in the field of Agriculture, Animal Husbandry, etc. Therefore, the ICAR has estabilished Krishi Vigyan Kendras at various places in the country as innovative institutions for vocational training in agriculture and allied subjects. A Krishi Vigyan Kendra was sanctioned to the Central Marine Fisheries Research Institute, Cochin at Narakkal, in December, 1976 and it started functioning in 1977 with some of the staff from the Institute. Training courses based on the principle of 'Learning by Doing' have been conducted for small and marginal farmers and fishermen in an attempt to urge them to adopt modern technologies. Young farmers and school dropouts are also selected for training to familiarise them with the scientific farming methods and for generating self-employment opportunities. These training courses are designed according to their needs and the duration and venue decided.

The main theme of the training at Narakkal is scientific prawn/fish farming which is most suited to the Vypeen Island and other coastal areas of Ernakulam District of Kerala. The duration of the training courses varies from 5 to 30 days. In all, 174 courses have been conducted since the inception of the scheme and a total of 3016 persons, including 1523 women were trained. Of these 1160 persons belonged to Scheduled Castes and 5 to Scheduled Tribes.

In order to create an awareness on the various aspects of agricultural and animal production as well as health and home science, short-term courses have been arranged with the help of subject matter specialists from the various State Government Departments, Agricultural University and Financing Agencies through which most of the loans to farmers are channelised. Thus, 3 training courses on coconut cultivation, which is a part-time occupation of the people of the area were conducted benefitting 34 persons. Similarly, through nine courses on vegetable cultivation 289 women were trained, while 75 persons were trained in paddy-cum-fish culture. Lectures and demonstrations were also arranged on social forestry for the benefit of 208 persons.

Under the discipline of Animal Husbandry, 10 courses were conducted on poultry farming training 312 men and women. Two courses were conducted on duck farming with 64 women participating in them. Short-term training courses were arranged on the various aspects of Livestock Management such as clean milk production, food and fodder production, calf care and other management procedures on nine occasions, training 214 persons.

Training courses on Home Science and Hygiene were conducted for women and girls. Three courses on 'Nutrition' were attended by 110 women, while 266 girls were trained in the 'Preservation of fruits' during 10 courses. Three courses were conducted on 'Environmental sanitation' with special reference to epidemics, their occurrence and control in which 75 women participated.

In addition to the above, three training courses were arranged on "Finance and Financing Agencies in Prawn and Fish Farming" for the benefit of 104 farmers.

LAB-TO-LAND PROGRAMME

The Lab-to-Land programme of the ICAR, designed to transfer the technologies developed in the ICAR Institutes to the farmers' field, was implemented by CMFRI and KVK in three phases and now the fourth phase is in progress. In the

Ist phase, the farmers were adopted for implementation of various technologies at the respective places where they seemed feasible. Thus, at Cochin 125 farm families were adopted for scientific prawn/fish farming. Three families were adopted for prawn/fish farming at Quilon. For mussel culture and prawn culture, 206 farm families were selected in Madras while 10 fishermen families were adopted for mussel culture at Elathur village in Kozhikode District. At Tuticorin, 11 fishermen families were adopted for edible oyster farming. Seaweed culture was taken up as technology for transfer at Mandapam adopting eight fishermen families. This phase of the programme was implemented with the active participation of the scientific and technical staff of the various research centres of the Institute.

During the 2nd phase of LLP, the programme was implemented at Valappu, Cochin only; with special permission of the ICAR to adopt the same families to make them confident in scientific farming of prawns and fishes to continue the enterprise by themselves. In this phase, 128 families were adopted and the programme was implemented by a team of scientists from CMFRI and staff of KVK.

The 3rd phase was implemented by KVK adopting 60 farm families for prawn farming integrated with coconut cultivation on the bunds. The families were selected from various villages of Ernakulam District.

During the 4th phase, 85 families were adopted for prawn/fish farming. The critical inputs included mini-sluice gates costing Rs. 200/- each made on a design by KVK with mango wood for use in small holding like canals in coconut groves and small ponds and also vegetable seeds and fertilizers for cultivation during the rainy season.

Demonstration projects

Scientific farming of prawns in hitherto unutilised canals in coconut groves was successfully demonstrated by KVK in the canals and fields of ex-trainees from different localities for convincing the prospective farmers on the advantages of the systems over the traditional method.

Application of mahua oil cake for eradication of predators from the culture fields was demonstrated in some canals at Narakkal and a perennial field at Kadamakkudi. Application of ammonia which is the latest and cheaper method for eradication of undesirable organisms was demonstrated in seasonal fields in Alleppey, Ernakulam and Trichur Districts. This resulted in a good number of enquiries from the prospective and active farmers and they are given necessary advice and assistance in the matter.

Radio talks

In order to create an awareness of the importance of scientific farming in prawns among the farming community, 21 programmes were broadcast over the Trichur Station of All India Radio. This included talks by the KVK. Besides, a lesson on 'Integrated Prawn Farming' by the Calicut Station of AIR.

Film shows

A number of film shows were arranged for the benefit of the trainees and visitors to the KVK. In all, about 165 film shows were arranged, of which 106 were on campus and 59 off the campus. In addition to the documentary film 'Mariculture' on the activities of the CMFRI, other films on topics such as Animal Science, Environment, Health and Nutrition were also screened.

Melas and Farmers'days

The KVK conducted 2 'Krishi melas', one 'Matsyamela' and one Farmer's celebration in collaboration with CMFRI at different places in Vypeen Island. Besides, a 'Karshaka Sammelanam' was organised by KVK for the benefit of farmers adopted under LLP.

Inauguration of a NES Block level 'Vanamahotsava' was conducted at the KVK campus.

The KVK participated in the World Food Day celebrations organised by the Canning Centre of Food and Nutrition Board, Government of India at Malipuram.

On 16th october, 1986, the CMFRI participted in the World Food Day celebrations in which the focal theme was "Fishermen and Fishing Communities'. On this day, special training programmes were conducted at the KVK for girls on the preparation of nutritious recipes with cheap and readily available ingredients by the Canning Centre and "the preparations of diversified products from fish" by KVK/TTC.

Exhibitions

The CMFRI has actively participated in 25 exhibitions organised by various government and voluntary agencies. This include exhibitions at Cochin organised by the Corporation of Cochin, Rotary Club, Al-amin Trust, Congress Centenary Celebration Committee, Integrated Fisheries Project, Central Institute of Fisheries Technology, etc., from time to time. The Institute has also participated in exhibitions organised by other ICAR Institutes. In the AGRI EXPO '77 at New Delhi, the CMFRI participated along with DARE.

The Research Centres of CMFRI also have organised exhibitions at Mandapam, Tuticorin and Madras and participated in exhibitions organised by other agencies at Bombay, Goa, Mangalore, Calicut, Vizhinjam, Tuticorin, Madras, Mini-

coy and Waltair. These exhibitions have given the public an opportunity to get first hand information about the research and development activities of CMFRI in marine fisheries.

Seminars/Workshops/Symposia

The CMFRI has conducted a number of seminars to disseminate information gathered, transfer the technologies developed and assess the nature and extent of exploitation of the resources along the Indian coasts, from time to time, at Cochin, Tuticorin, Mandapam and Madras, in which the Scientists of the Institute have actively participated. Besides, the scientists of the Institute have participated in all the symposia organised by the Marine Biological Association of India, viz., Symposia on Scombroid fishes, Crustacea, Mollusca, Corals and Coral reefs, Coastal Aquaculture, Endangered species of marine animals and contributed papers.

The Institute's staff have participated in the several workshops and seminars organised by the Institute at different centres and also other agencies such as MPEDA, Universities and other Institutes. As part of the extension activities, the staff of the KVK have participated in a number of seminars/workshops such as 'Role of Small Scale Fisheries and Coastal Aquaculture in Integrated Rural Development'. 'Southern Regional Agricultural Information Communication Workshop', seminar on 'Brackishwater fish culture', workshop on 'Regional Development Programme' organised by the Kerala State Government and UNICEF; 'Development Week' celebrations organised by Vyttila NES Block at Fisheries College, Panangad; meetings organised by the Cooperative Land Mortgage Bank for discussion on 'Schemes for financing prawn farming'and 'Farmers' Meet' organised by MPEDA and State Bank of Tranvancore to discuss about the loan scheme to be launched by the bank with the technical assistance from government agencies. The Officer-in-Charge of KVK has attended the Rural Programme Advisory Committee meetings of All India Radio, Trichur Station, IRDP Advisory Committee of Vypeen NES Block and monthly workshops of the Kerla Agricultural Extension Programme.

CONCLUSIONS AND RECOMMENDATION

The programme of the Centre of Advanced Studies in Mariculture under UNDP/ICAR financial assistance was to be completed by 1986. After a phasing out period of six months it came to a close in September, 1986. UNDP has spent about 0.7 million US dollars on the programme. The ICAR likewise has spent about Rs. 3.8 million. According to official estimates the country needs a lot more trained hands in the field. Considering this, the ICAR has permitted to continue the project during the VII Five Year Plan period as a Post-graduate Education and Research Programme of CMFRI. The huge investment on the infrastructure and the expertise developed in the Institute through consultancy and faculty improvement programme are justifiably being utilised by continuing the programme. The expertise available in the Institute ranges widely in specialised subjects like Fishery Biology, Marine Biology, Oceanography, Statistics, Economics, Management, Electronics, Engineering, Physiology, Genetics, Nutrition, Pathology, Pollution, Soil Science, Animal Husbandry, Veterinary Science, Dairy Science, Poultry Science, Home Science, Library Science and Extension. The Institute has a well developed Krishi Vigyan Kendra (KVK) and Trainers' Training Centre (TTC) to take care of the transfer of technology to the farming community through programmes on learning by doing. The Institute arranges from time to time short-term training courses in a variety of subjects like culture of prawns, molluscs, fishes and seaweeds, stock assessment, population dynamics, collection and compilation of fish statistics and Nutrition which are attended by candidates from within the country and abroad. A number of candidates from the Afro-Asian countries have undergone training in the Institute on various aspects of fishery science. Further, a number of teachers from Agricultural Universities also have been admitted for higher studies under the Faculty Improvement Programmes. Under such circumstances it seems imperative to continue permanently the teaching and research programmes, and recognising the Institute as an international Centre for offering courses in Fishery Science and allied subjects.

Paper 72

FISHERIES IN MAHARASHTRA STATE

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ABSTRACT

Maharashtra State, endowed with a coastline of 720 km, has a continental shelf of 87,000 sq. km. The shelf up to 40 fathoms with an area of 44,000 sq. km possesses rich fisheries potential and almost the entire present fishing activity is restricted to this zone. The harvestable potential of this zone is estimated at 3.74 lakh tonnes. The shelf between 40 and 100 fathoms, measuring 43,000 sq. km., has harvestable potential of 0.80 lakh tonnes. The paper deals with the potential fishery resources, status of traditional fishing, developmental activities in the areas of mechanisation, construction of fishing harbours and other infrastructural facilities, as well as fishermen welfare activities like the functioning of co-operative societies.

INTRODUCTION

Maharashtra State endowed with a coastline of 720 km. has a continental shelf of 87,000 sq.km. The shelf upto 40 fathoms admeasuring 44,000 sq. km.possesses rich fisheries potential and almost entire present fishing activity is restricted to this zone. The harvestable potential of this zone is estimated as 3.74 lakh tonnes. The shelf between 40 to 100 fathoms admeasuring 43,000 sq. km. has harvestable potential of 0.80 lakh tonnes. Marine fisheries activities of this state have been described.

MECHANISATION

Mechanisation of fishing crafts scheme was introduced in the first year plan, 1951-52, to augment the marine fish production in the State. Government encouraged the fishermen to a great deal to respond favourably for mechanisation. Since the scheme was newly introduced and with the view to popularise substantial incentive were offered. Almost 100% capital cost was borne by the Government in the form of loan and subsidy. This resulted in increase in the fishing fleet of mechanised vessels considerably. At present there are 5638 mechanised vessels which carry out fishing within 0 - 40 fathom zone. Pecularity about mechanisation programme in Maharashtra, is that certain types of indigenous sail boats were quite suitable for mechanisation and also for conversion as trawlers with small modifications. Therefore, the indigenous designs of boats were adopted for mechanisation. Hence there was no necessity of introducing newly designed mechanised boats in Maharashtra as was done in other States. Such boats could be built at the fishing villages by traditional boat building carpenters.

The marine fish landing during the period 1975-76 to 1985-86 varied from 255 thousand tonnes to 377 thousand tonnes. Commercially important varieties are shrimps (25%), Ribbon fish (5%), Bombay duck (18%), Prawns (10%), Anchoviella (5%), *Otolithes* spp. (5%), Pomfrets (5%) each (Table 1). The other varieties such as *Hilsa ilisha*, mackerel, seer fish, lobsters, tunnies, cuttle fish, carangids, *Upenoides* sp.etc. are found in 0 - 40 fathom zone. The share of mechanised vessels to the total catch is 90%.

I) Status of traditional fishing

At present, Maharashtra has fishing fleet of 15059, of which 5638 are mechanised fishing vessels and 9421 are non-mechanised fishing boats. In Maharashtra, both mechanised and non mechanised boats use traditional gears like bagnet and gillnet, but gears used by mechanised fishing vessels are larger and are operated in comparatively deeper waters. The rampan - shore seine - is used by non-powered country crafts, while trawl net is used by mechanised fishing vessels. Out of the marine landing of 3,77,352 tonnes for the year 1985-86, landings of trawlers are 82,943 tonnes. The remaining 2,94,409 tonnes are by employing traditional fishing methods (Table 2).

II) Effect of mechanisation programme on traditional fishing

Prior to 1950-51 traditional gears such as gillnets, bagnets, shore seines, long liners were used by non-mechanised crafts. However, due to the motorisation of the crafts it was possible to increase number of hauls in case of bagnet, to increase number of pieces in case of gillnets with the view to exploit the area upto 40 fathoms and as such fishermen undertook motorisation. This has resulted in increased marinefish production, with increase in number of mechanised boats and their fishing activities in inshore waters. Traditional fishermen suffered a set back to a certain extent. There were frequent conflicts among the mechanised boat owners and traditional fishermen. In order to provide protection to the traditional fishermen the state Govenment enacted Maharashtra Marine Fishing Regulation Act, 1981 which brought into force from 4th August, 1982.

III) Harvestable Potential

Harvestable potential (tonnes) of Maharashtra upto the continental shelf is given below -

District	0-40 fathoms	40-100 fathoms	Beyond 100 fathoms
Thane	95,000	27,000	122,000
Gr.Bombay	57,000	11,000	68,000
Raigad	154,000	22,000	176,000
Ratnagiri	68,000	27,000	95,000
Total	374,000	87,000	461,000

It will be seen that harvestable potential upto 0 - 40 fathoms is reached in the State. It will be seen that the potential of one district is more exploited than the other. This is because migration of mechanised vessels take place from one district to another.

A study group was set up by Government of Maharashtra in September 1975 to report the financial viability of additional programme on mechanisation of fishing boats in the State. The study group concluded that it would be safer to restrict the number of small and medium sized mechanised boats which would be operative upto 40 fathom depth.

The present fishing fleet of the State is about 15059 out of these the number of mechanised vessels is about 5638. Thus there is no scope of mechanising the additional vessels in the State.

IV) The present scheme and future desirable schemes for the welfare of traditional fishermen

Under the present schemes related to mechanisation the financial assistance is extended to fishermen engaged in traditional fishing through fisheries co-operative societies under National Co-operative Development Corporation pattern and to the individual fishermen or their groups under individual subsidy scheme.

Table 1 *Yearwise Marine Fish Production of Maharashtra State for the Year*

(Fig in tonnes)

Year	Elasmo-branchs 1	Eel 2	Cat-fishes 3	Sardine 4	Ancho-viella 5	Variety Trisso-cles 6	Ribbon Fish 7	Otoli-thes 8	Pomfre-ts 9	Harpo-don 10	Prawns 11	Shrimp 12	Miscelle-neous 13
1975-76	9741	26070	12243	6383	25646	5673	28291	16485	16193	70561	45568	91815	47343
1976-77	8201	8483	9088	4701	23251	6400	23128	20005	16514	88504	29974	122935	30961
1977-78	10044	5868	10811	5015	18621	5009	15473	17872	9320	48958	30207	74452	40302
1978-79	8001	11190	9687	3474	21156	6101	18579	18611	12581	75809	37078	103035	60969
1979-80	8508	6421	10386	2860	16604	4996	18734	20182	13490	77310	26460	99204	23194
1980-81	11169	8940	13024	21182	17772	6492	20174	19592	20548	60747	30542	79556	64442
1981-82	7945	3805	11053	12045	11681	4895	18624	15852	20986	44383	24990	67674	46132
1982-83	7480	1611	11501	2325	129112	4526	13395	14211	12758	51221	28446	80588	41283
1983-84	8433	2283	10435	6702	13500	9119	15607	15551	29514	54093	28004	57830	59988
1984-85	7230	2714	7148	5993	19170	4968	17766	13750	12002	70070	37347	94881	67583
1985-86	7451	4928	7625	12577	14764	3590	15565	18955	8504	56020	29224	115895	82256

LBY/

Table 2 *Estimated Annual Marine Fish Landings of mechanised, sailing, Toney and Rampan vessels in the State*

(Figures in tonnes)

Sr. No.	Year	Type of vessel			
		Mechanised	Sailing	Toney	Rampan
1.	1975-76	354690	296564	10269	7399
2.	1976-77	336677	38490	11779	5199
3.	1977-78	260556	21198	7202	2996
4.	1978-79	344202	26455	10779	4835
5.	1979-80	311625	27999	13050	5675
6.	1980-81	320107	27651	13431	12971
7.	1981-82	251587	13486	13449	10343
8.	1982-83	262421	9104	8201	2530
9.	1983-84	287932	7564	8091	6472
10.	1984-85	340252	5851	7632	6529
11.	1985-86	343891	5852	6533	21076

Under N.C.D.C. pattern 80% finance required for construction of mechanised boats comes from NCDC by way of reimbursed finance in the form of 60% loan and 20% subsidy. The fishermen co-operatives however receive financial assistance in the form of 25% special redeemable share capital, 55% loan and 20% subsidy from State Government.

Under Individual schemes 25% of the cost of mechanised fishing vessel is given as subsidy to individual fishermen or their group who have raised funds from financial institutions for the construction of mechanised vessels.

In addition to these schemes subsidy is given under Integrated Rural Development Programme scheme for the construction of boats and also mechanisation. For this purpose fishermen should be small fishermen and limit of subsidy is Rs. 3,000/- per fisherman and Rs. 5,000/- if he is from Scheduled tribe.

FISHING HARBOURS

Due to the rapid pace of mechanisation programme there is considerable increase in fish production. It is imperative to provide landing and harbour facilities along the coast for quick unloading of fish which is highly perishable. Keeping this in view, Department has formulated the scheme viz. "Improvement of Fishing Harbour". Under this scheme construction of fullfledged fishing harbour and other works such as removal of rocks in navigational channels, provision of lights, construction of jetties etc. are undertaken. This scheme is implemented through Port Department. Besides this, crash programme for basic ammenities such as fish drying platforms, open sheds, guide poles, approach roads etc. at minor ports is implemented through Port Department.

There are 184 landing centres in the State. Sasson Dock harbour in Bombay is only the existing fishing harbour in the State. Construction of Mirkarwada fishing harbour in Ratnagiri district is in progress. Besides this construction of other four harbours namely Agardanda, Rewas in Raigad, Satpati in Thane district and Deogad and Vengurla in Sindhudurg district is proposed.

PRESERVATION AND TRANSPORT FACILITIES

Increase in production due to increase in mechanisation has necessited the creation of infrastructural facilities for preservation, transport and marketing. This requirement of the trade has been recognised all along and the programme of introduction of ice factories, cold storage, transport facilities and construction of hygenic fish markets has been implemented. Financial assistance to fisheries co-operatives and local bodies is extended for this purpose. There are 135 ice factories/cold storage plants with a cold storage capacity of 2700 tons/day out of which 25 ice plants are in co-operative sector. Seventy eight transport vehicles are engaged in transport of fish. To cope up with the requirement it is proposed to provide financial assistance for setting up more ice/cold storage plants, and purchase of transport vehicles. For this a provision of Rs. 40 lakhs has been provided in the VIIth five Year Plan. In addition, Rs. 130 lakhs will be availed from the NCDC.

FISHERIES CO-OPERATIVES

The structure of fisheries co-operative societies is of three-tier with primary societies at the village level (base), their federations at the district or regional level and Maharashtra Rajya Machhimar Sahakari Sangh Ltd., Bombay at the State (apex) level. The Department's policy of giving the benefit of most of its developmental schemes to the co-operatives continued. At the same time for the working capital as well as other financial needs, the Department continued to encourage institutional finance and in case of the difficulties expressed by society in getting institutional finance, efforts were made at the district level to sort out those difficulties and to help the society in getting institutional finance. The progress made by the fishery co-operatives during 1984-85 and the position obtaining as on 30th June, 1985 for the different years is as follows :

Primary societies

1. Number of primary societies increased by 118 so as to reach 1085 as on 30-6-1985.
2. The total membership increased by 9546 to reach 136472.
3. Share capital of primary societies stood at Rs.360.22 lakhs as on 30-6-1985
4. Reserve and other fund increased by Rs. 91.82 lakhs and stood at Rs. 280.68 lakhs at the close of the year 1984-85.
5. Working capital increased by Rs. 43.64 lakhs and stood at Rs. 1790.44 lakhs at the close of the year 1984-85.

6. The total value of fish sale by primary societies Rs. 739.32 lakhs as on 30-6-1985.

Out of 1085 primary societies, 446 made a total profit of Rs. 69.11 lakhs as against a loss of Rs. 26.17 lakhs sustained by 514 primary societies, during the reported year.

District/Regional level federations

There are 14 federations at the district and regional level of which 3 district federations are functioning for maritime districts and of the remaining eleven, four regional federations are functioning in Vidarbha, Marathwada, Solapur and Khandesh; 7 districts federations are functioning at Chandrapur, Yeotmal, Nasik, Bhandara, Jalgaon, Amravati and Vardha. Those federations have a total membership of 10132. Their members paid up share capital is Rs. 67.13 lakhs and Government's share capital contribution Rs. 60.36 lakhs. The reserve and other funds of these federations amounted to Rs. 59.21 lakhs. Their total borrowing were at Rs. 138.12 lakhs of which Rs. 92.97 lakhs were from Government and Rs. 41.43 lakhs from banks. These federations have marketed fish to the extent of Rs. 454.42 lakhs.

Apex level co-operative federation

The Maharashtra Rajya Machhimar Sahakari Sangh Ltd., Bombay has been functioning as the apex institution of co-operative fisheries in the State. It has been revitalised under a programme sanctioned by the Government in Agricutlure and Co-operation Department with effect from 1-11-1973. Though the sangh was earning profit during the last 6 years, it sufferred heavy loss during 1982-83 owing chiefly to its ice factories, cold storages, freezing complex and fish meal plant, together known as Sassoon Dock complex. Its acumulated loss increased from 17.36 lakhs to 32.91 lakhs as on 30-6-1985; 212 societies including district and divisional federations and 2156 individuals are members of the apex federation. During the year it sold fresh fish on commission basis for Rs. 1.45 crores. Fishery and other requisities were sold to the extent of Rs. 13.25 lakhs and fish seed (carp fry) were sold to the extent of Rs. 32.61 lakhs.

MAHARASHTRA MARINE FISHING REGULATION ACT

With the view to safeguard the interest of traditional fishermen, this State has enacted Maharashtra Marine Fishing Regulation Act, 1981 which came into force from 4th August 1982. As per the provisions of this Act fishing vessels are to be registered with the Port Department. Registration fee for registration of mechanised fishing vessel is ten rupees whereas for non-mechanised fishing vessel fee is five rupees. After registeration fishing vessels are entitled for fishing licence which is issued by the Department of Fisheries. This fishing licence is renewed every three years for which licence fee is as under :

a) Mechanised fishing vessel fitted with an engine having the horse power exceeding 50 H.P.	Rs. 100/-
b) Mechanised fishing vessel fitted with an engine having the horse-power not exceeding 50 H.P.	Rs. 50/-
c) Non-mechanised fishing vessel having gross registered tonnage exceeding 3 tons	Rs. 20/-
d) Non-mechanised fishing vessel having gross registered tonnage not exceeding 3 tons.	Rs. 10/-

1) Constitution of Dist. Advisory Committee

State Government has constituted a District Advisary Committee for each coastal district. As there are five coastal districts, five District Advisory Committees are formed in the State. District Magistrate being the Chairman and Assistant Director of Fisheries of the District as a member Secretary, with representatives of State Port Department and Police Department as members. Besides these members, the Chairman of the Committee is empowered to co-opt. representatives of other Government Departments and fishermen. This committee gives advise to the State Government while making the regulations to be enforced under the Act regarding -

i) reservation of specified areas of the sea for fishing by vessels of specified type.

ii) prohibition of vessels of specified type or specified types from fishing in any specified area.

iii) laying down maximum number of fishing vessels of specified type to be allowed for fishing in specified area.

iv) laying down the maximum number of fishing vessels of specified types to be registered in each of the ports in the District.

v) regulation or prohibition to catch specified species of fish in any specified area.

vi) regulation or prohibition of specified fishing gear in specified areas.

vii) prescribe timing for fishing operations where it is necessary to do so.

viii) any other matter which would facilitate effective enforcement of the provisions of the Act.

2) Regulation of Fishing

The State Government after consultation with Advisory Committee, by order notified in the official Gazette, regulate, restrict or prohibit -

a) the fishing in any specified area by such class or classes of fishing vessels as may be specified; or,

b) number of fishing vessels which may be used for fishing in any specified area; or

c) the catching in any specified area of such species of fish and for such period as may be specified in the orders; or,

d) the use of such fishing gear in any specified area as may be prescribed.

In making an order, State Government have regard to the following matters -

a) The need to protect the interests of different sections of persons engaged in fishing, particularly those engaged in fishing using traditional fishing.

b) The need to conserve fish and to regulate fishing on scientific basis;

c) The need to maintain law and order in the sea.

d) Any other matter that may be prescribed.

After consultation with the District Advisory Committee, Government of Maharashtra has imposed the restriction on fishing operation as follows -

1) Operation of trawl gear by mechanised fishing vessels is prohibited from sea shore to 5 fathoms and 10 fathoms depth zone.

2) Fishing by mechanised fishing vessel is banned from 1st June to the Narali Paurnima.

3) Operation of trawl gear by mechanised fishing vessels is prohibited between 6 p.m. and 6 a.m.

4) Fishing by mechanised fishing vessels of any type with more than six cylinder engines is prohibited within territorial waters of Maharashtra i.e. upto 12 nautical miles.

3) Enforcement

For enforcement of the restrictions which are imposed under the Maharashtra Marine Fishing Regulation Act 1981, there are 22 licencing officers - one each in marine Taluka. Besides this there are eight enforcement officers in four marine districts. For this purpose 4 patrol boats are in operation. Enforcement Officer is responsible officer on this boat under whose direction patrol boat is operated by subordinate staff. Responsibilities of the Enforcement Officer is to maintain law and order on the sea. Enforcement Officer has powers to enter and search fishing vessel if he feels fishing vessel is used or has been used in contravention of any of the provisions of the Act.

4) Penalties & Adjudication

Enforcement Officer is supposed to make a report to the adjudicating officer i.e. Tahsildar, if he belives that any fishing vessel is being used or has been used in contravention of any of the provisions of this Act. Adjudicating Officer after holding an enquiry decided whether any person has used any fishing vessel in contravention of any of the provisions of Act. When such person is found guilty by Adjudicating Officer, he may impose a penalty not exceeding -

(a) five thousand rupees if the value of the fish involved is one thousand rupees or less.

(b) five times the value of fish, if the value of fish involved is more than one thousand rupees.

(c) five thousand rupees, in any other case, including a case where there has been no catch of fish, as may be adjusted by Adjudicating Officer. This amount of the penalty is recoverable as an arrear of land revenue.

5) Constitution of Appellate Board

In each district, District Magistrate shall constitute the Appeallate Board for the whole district. Any person aggrieved by an order of the Adjudicating Officer may within thirty days from date on which the order is made prefer an appeal to the Appealeate Board. On receipt of an appeal, the Appellate Board may after holding such inquiry as it deems fit, and after giving the parties concerned a resonable oportunity of being heard, confirm, modify or set aside the order appealed against and decision of the Appellate Board shall be final.

MISCELLENEOUS

1) Deep Sea Fishing

There is little knowledge about deep sea fishing resources beyond 40 fathoms. Fishery Survey of India has conducted survey beyond 40 fathoms, but the survey so far made does not give any indication about the economic aspects

of the survey. In absence of the adequate knowledge regarding the fishery resources of the deep sea area it has not been possible to identify the type and size of the vessel most suitable for economic exploitation of fisheries in deep sea. This department has requested the Fishery Survey of India to conduct the survey of deep sea fishing recently.

2) Accident Group Insurance Scheme

This is the scheme for grant of subsidy towards premium on personal Accident policy. This is a centrally sponsered scheme. Implementation of this scheme started from 1982-83. However, this scheme is modified from 1st December, 1985. The period of insurance policy is one year and insurance premium for the year is Rs.9/- only. Out of which fishermen's share is Rs.1.50, Govt. of India's share is Rs.4.50 and State Govt. share is Rs.3/- per fisherman. The share contributed by Central Government and State Government for the year from 1984-85 is as under.

Year	Central Govt.	State Govt.
1) 1984-85	Rs. 61,632	Rs. 30,816
2) 1985-86	Rs. 1,48,710	Rs. 74,355

3) National Welfare Fund For Fishermen

This is centrally sponsored scheme sharable 50:50 basis between Central and State Government. This scheme envisages to provide basic civil amenities to the fishermen such as housing, community hall, drinking water supply & credit societies. Under this scheme three-tier developed fishermen villages are to be selected. For this purpose three fishermen Villages - two from marine districts and one from inland district are being selected.

Paper 73

STATUS REPORT ON MARINE FISHERIES DEVELOPMENT IN TAMIL NADU

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ABSTRACT

The declaration of Exclusive Economic Zone extending up to 200 miles from the coastline has provided a great opportunity to exploit the fishery resources. The fishey resources, the number of traditional craft, mechanised fishing boats and other shore facilities available are indicated. The various schemes implemented by the Department to increase marine fish production in Tamil Nadu are narrated. Future plans of the Department for maintaining and improving the fishery is also discussed.

INTRODUCTION

Tamil Nadu has a coast line of about 1000 km. and a continental shelf area of 41,412 sq.km. With India's declaration of 200 miles (320km) Exclusive Economic Zone additional 74,947 million sq. m. are available for exploitation. The continental shelf are the most productive part of the ocean and this area represents about 20.6% of the area of Exclusive Economic Zone. The estimates of potential catch from Exclusive Economic Zone of Tamil Nadu vary from 400,000 to 800,000 tonnes.

The sea is at present exploited by more than 38,000 traditional crafts and 2500 mechanised fishing boats of 30' and 32' which operate mainly in the inshore areas. The present level of marine fish production is 2.45 lakh tonnes and rank 3rd among maritime states. Tamil Nadu is also 3rd largest fish exporting State earning foreign exchange to the tune of Rs.50 crores every year.

TRADITIONAL CRAFTS

The fishing fleet of Tamil Nadu consists of about 40,500 crafts of which 94% are traditional crafts and non-mechanised and these crafts contribute to nearly 70% of the marine fish landings. Of the total number of 38,000 country crafts 29,000 are catamarams and 9,000 are vallams and canoes. When compared to the fishing fleet in 1978, the number of traditional crafts mainly catamarams has shown a decrease from 37,084 to 36,571. The reason for the shortfall is due to the change in the attitude of the fishermen to go in for vallams and canoes as against the traditional catamarams. Of the total fishermen families, only about 42% families own their crafts.

MECHANISED FISHING BOATS

Wooden mechanised fishing boats were introduced from the year 1955 and upto 1985-86, 2502 boats have been supplied under various Schemes. Fisheries Department had supplied 1721 boats under hire purchase system to groups of fishermen with varying degrees of subsidy. 112 boats have been supplied to fishermen through District Cooperative Federation. Tamil Nadu Fisheries Development Corporation have supplied 602 boats with the loan assistance from Commercial Banks. National Cooperative Development Corporation has supplied 51 boats to Fisherman Co-operative Societies with 25% subsidy. It could be seen that fish production increased considerably due to the operation of mechanised fishing boats and this was the single major factor responsible for increasing fish production from the year 1956-57 to 1980-81.

FIBREGLASS REINFORCED PLASTIC BOATS

On the recommendations of the working group for Fisheries, Fibreglass Reinforced boats of 25' were introduced for gill netting. Various sizes of Fibre glass Reinforced Plastic boats 18',20' and 25' were supplied to fisherman under various schemes and since the operation of these boats are intended for a limited purpose, these boats have not become popular. With a view to suppliment the traditional catamarams, Beach Landing Crafts were introduced recently with the design furnished by BOBP/FAO as well as by Danish experts. These are expensive compared to the traditional crafts both in captial cost as well as maintenance since these boats are powered and heavy subsidies offered by Government under various schemes are gradually finding acceptance from the fishermen. Large scale introduction of these boats is on the anvil and with the operation of these boats in large number the traditional fishermen can get better catches and consequently higher income.

MECHANISATION OF TRADITIONAL CRAFTS

In addition to reduce the capital investment on the traditional crafts and at the same time to increase the operational efficiency of the existing crafts, a Scheme of mechanisation of traditional crafts has been introduced with a suitable subsidy. This Scheme is proving quite popular among fishermen of Tirunelveli and Kanayakumari Districts and more than 800 boats have been mechanised by providing outboard motors to catamarams and inboard engines to vallams.

INFRASTRUCTURE FACILITIES

With the increasing number of mechanised crafts along the coast, these boats need berthing facilities, larger boats will need fishing harbours and other infrastructure facilities that go with it, such as supply of ice, repair facilities for hulls and engines etc. Under Plan Schemes, major fishing harbours at Madras and Tuticorin and minor harbours at Cuddalore, Nagapattinam, Pashayar and Thondi were commissioned. Landing jetties are provided at Malipattinam, Koddikarai, Rameswaram and Mandapam. Major fishing harbours at Chinnamuttom and minor harbour at Valinokkam and landing jetty at Kottai pattinam are under construction.

There are 6 Fisheries Training Centres located in Madras, Cuddalore, Nagapattinam, Mandapam and Colachel with a capacity to train 310 fishermen in a year in modern methods of fishing. Junior Mechanic Courses are being conducted in Nagapattinam, Tuticorin and Colachel for 60 fishermen candidates in a year for imparting extensive engineering in repairing and overhauling of marine diesel engines.

There are 5 Inshore Fishing Stations located at Madras, Cuddalore, Mallipattinam, Remeswaram and Kanyakumari for demonstrating to the fishermen in modern methods of fishing and in locating fishing grounds. They have done pioneering work in educating this fishermen in the use of trawl nets.

EXPORT OF MARINE FISH PRODUCTS

Frozen shrimps, lobster tails, cuttle fish, shark fins, dried fish are the items exported from Tamil Nadu. The export earnings of Tamil Nadu which was Rs.50.00 lakhs in 60's increased to Rs.30 crores in 70's and it was 51.28 crores in 1984-85. There is scope for further improvement in export performance of marine products through better exploitation of exportable varieties.

DEEP SEA FISHING

In order to exploit the offshore area, Government of India have permitted fishing companies to operate 21 chartered fishing vessels with base at Madras and Truticorin. The initial investment in Deep Sea Fishing is considerable and hence private investment is not attached to this profession. As a policy, Government have been recommending Industrial licence for 100% export oriented projects. Likewise, Tamil Nadu Government also recommend for acquisition of deep sea fishing vessels with the loans from Government of India.

FISH PRODUCTION

The total landings of marine fish production for the year 1985-86 is 2,44,759 tonnes comprising demersal varieties 1,33,687 tonnes (54.62%) and pelagic varieties 1,11,072 tonnes (45.38%). The marine fish production which was 50,000 t in 1950-51 has increased tremendously during the next two decades and reached 2.3 lakh tonnes in 1981-82. However, marine fish production is more or less static during the last six years. The total marine fish production and the number of mechanised fishing boats distributed by various schemes are shown in Table-1. It could be seen that the number of mechanised boats supplied has been mainly responsible for the increase in fish production. The important fishes that are landed are anchovies, silver bellies, lesser sardines, ribbon fish and elasmobranchs.

Table I. *Number of Boats in Operation and the Fish Landing*

Year	No. of Boats	Fish landings (Lakh tonnes)
1956-57	11	0.61
1961-62	95	0.93
1966-67	456	1.75
1971-72	1053	2.13
1976-77	2245	2.01
1981-82	2437	2.35
1985-86	2502	2.44

CONCLUSION

It will be seen from the Table-1 that the fish production has a direct relation to the number of mechanised fishing boats in operation. The fish production has been more or less stagnant during the last few years mainly because there is no appreciable increases in the mechanised fishing fleet. It will be possible to step up the marine fish production considerably by increasing the inputs in the form of mechanisation of country crafts, introduction of mechanised boats and deep sea fishing vessels and popularistion of new fishing gears and with additional infrastructure facilities like fishing harbours, jetties, ice plants, freezing plants and cold storages. Such a package of scheme is to be introduced from the year 1987-88 and these schemes when implemented are expected to usher in Blue Revolution in Tamil nadu.

CIFE CONTRIBUTION TO MARINE FISHERIES R & D

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ABSTRACT

The CIFE contributions to marine fisheries R&D are mainly in the areas of stock assessment, brackishwater farming, fishing and product diversification, fishery socio-economics and technology transfer. Stock assessment studies, limited to the west coast and particularly to the northwest coast include the stocks of *Colilia dussumieri, Otolithus cuvieri, Johnius glaucus, Polynemus heptadactylus, Harpodon nehereus, Arius thalassinus, Nemipterus japonicus,* all-northwest coast inshore species, penaeid prawns, *Rastrelliger kanagurta, Sardinella longiceps and xancus pyrum.* In respect of brackishwater fisheries, R & D activities are concerned with prawn hatcheries, seed banks, low input culture, live feed culture and fishery estates. Simple techniques for making laminated Bombay duck, fish wafers and minced meat have been developed for the purpose of product diversification. High opening bottom trawling has been experimentaly proven to be more productive than the traditional bottom trawling, and is being popularised. Studies on profitability of mechanised fishing indicate some prospects for additional investment. Small private owned brackishwater farms are more profitable than large government owned farms, indicating thereby the need to privatise the farm sector. The fisheries co-operative society at Versova investigated in detail by the CIFE for its success, is recommeded to be a model for other fisheries societies in the country. Technology transfer is effected through periodic short term training courses on subjects of critical importance to specific target groups including fish farmers, fishermen, processors, entrepreneurs etc.

OBJECTIVE OF CIFE

The Central Institute of Fisheries Education (CIFE) was established in the year 1961 at Bombay as a premier institute for fisheries education at the postgraduate level, under the Union Ministry of Agriculture. The Institute came under the administrative control of the Indian Council of Agricultural Research (ICAR), with effect from the first April 1979. Under the Ministry, the primary objective of the Institute remained as postgraduate fisheries education to the inservice personnel of the fisheries departments of various states. With the transfer of the Institute to the ICAR, the objectives were redefined to include fisheries research and extension, besides education.

The Institute's marine fisheries research programmes are modest and are carried out primarily at its headquarters at Bombay and at the Brackishwater Fish Farm (BWFF), Kakinada in Andhra Pradesh. The Institute's Inland Fisheries Training Centre (IFTC) at Barrackpore in West Bengal carries out some studies on the estuarine fisheries of the Sunderbans while its Operational Research Project unit at Sultanpur in Haryana has initiated culture of marine finfish and prawns in the saline soil areas in the hinterlands.

INFRASTRUCTURE FOR MARINE FISHERIES R & D

At the headquarters in Bombay, marine fisheries research programmes and projects are carried out through the departments of Marine Fisheries & Ocean Management, Fish Processing Technology, Fishing Technology, Aquaculture, Fisheries Economics and Project Planning & Evaluation. Two marine fishing vessels including a larger (120' overall length) sophisticated *M.V. Saraswati* and a smaller (38' overall length) *M.F.V. Narmada* are in active use in support of all marine fisheries research and training programmes particularly along the north west coast of India. The M.F.V. *Harpodon* (37' overall length) which was in active operation for 16 years from 1967 to 1982 was decommissioned and disposed off in 1986. The M.F.V. *Sunderbans* (55' overall length) at the IFTC Barrackpore is being used for the Sunderban esturine studies. Research data from the cruises of *M.V. Saraswati* are processed by means of a work horse level 4 computer (Hindustan Computers Ltd.) which is also used in fish stock assessment studies.

The department of Fish Processing Technology is equipped with deep freezers, vertical freezer, blast freezer, plate freezer, refrig-

erators, cold storage, Torry kiln, can seaming machines, cannery retort, mixers, filter, mincers, cutters, deboning machines, slicing machines, centrifuges etc. The fishing technology laboratory has a larger number of models of fishing craft and gear both artisanal and mechanised, meant primarily to serve as teaching and demonstration aids. There is a general and reference collectiom museum of marine fishes, attached to the department of Marine Fisheries. A small but well equipped outdoor aquaculture unit within the main campus at Bombay has facilities for small scale prawn breeding and seed production and for testing the growth effects of various formulated and natural feeds. This is a self contained unit with a brackishwater well, overhead tanks, biological filters, plastic pools, cement tanks, air-blowers, pumps, aerators, airlift systems, machine for formulated feeds and plankton culture systems.

The Institute's brackishwater fish farm at Kakinada has a total farm area of 8.0 ha with ponds ranging from 0.14 ha 0.224 ha for the culture of penaeid prawns and brackishwater fish. A well equipped prawns hatchery has been set up at this centre for both seed production and demonstration purposes.

ONGOING RESEARCH PROJECTS

The major marine fisheries research projects that are being carried out currently were initiated in 1983 and 1984. They include : (1) The biology and dynamics of certain exploited marine fish populations; (2) Stock assessment of offshore fisheries resources off the northwest coast of India beteewn 19^0 and 20^0 N latitudes; (3) Fisheries oceanography of the northwest coast between 16^0 22^0 N latitudes; (4) Improvement in harvesting technology including highopening trawls for small scale fishing in the Bombay coast; (5) Biochemistry and spoilage dynamics of minced fish meat; (6) Marine fish product development; (7) Proteinases and polyphenolase enzymes in marine finfish and shellfish; (8) Breeding of penaeid prawns and larval rearing to stock size; (9) Culture of brackishwater fish and prawns; (10) Brackishwater fish and prawn seed prospecting; (11) Transportation of adult and seed fish and prawn under continuous aeration, and (12) Utilisation of wind energy in brackishwater farming.

MARINE FISH STOCK ASSESSMENT

Coilia dussumieri

The stock of *C.dussumieri* occurs mainly in the inshore area to a depth of about 50 m between 19^0 N and 21^0 N latitudes and between 71^0 E and 73^0 E longtitudes along the coasts of Maharashtra and Gujarat. For 1982-83, the annual total stock was estimated to be 29,162 t the average or standing stock 10,144 t, the absolute number of recruits 5.2 $x10^9$ and the mean number of fish in the stock 1.8 x 10^9. The annual catch of 13922 t in 1982-83 represents 47.74% exploitation.

The fishing intensity was much lower in 1982-83 (F=1.4) than in 1963-64 (F=3.1) due to significant shift towards night trawling for the shrimp fisheries rather than for *C. dussumieri.* In night trawling *C. dussumeri* forms only stray catches as it ascends up with the zooplankton during nights. Fishing could be increased modestly from the 1982-83 level (f=1.40) to the optimum (F=2.5 to 3.0), keeping the size at first capture constent at 8.8 cm (=age 0.4 year) to increase the yield per recruit from 3.1 g to 3.4 g. Operation of dolnets of less than 15 mm codend mesh should be discouraged (Irene Fernandez, 1986, Irene Fernandez and Devaraj, MS).

Otolithus cuvieri

O.cuvieri forms about 25% of the sciaenid fishery along the northwest coast. The total annual stock for 1982-83 in the Maharashtra Gujarat inshore area to a depth of about 50 m was estimated to be 45,820 t, the standing stock 27,573 t, the number of recruits 0.459 x 10^9, the mean population number 0.39 x 10^9 and the yield in number 0.0959 x 10^9. The yield in weight of 6,873 t in 1982-83 formed only 15% of the annual total stock. The mean weight of fish in the catch was 72 g; the number of fish per kg was about 14. the maximum sustainable yield (MSY) of 20,783 t could be obtained at 65% exploitation (Gulati, 1987).

Johnius glaucus.

J.glaucus forms about 20% of the sciaenied fishery along the northwest coast. In 1983 the total stock in the Maharashtra-Gujarat in shore grounds to a depth of about 50 m was 14,624 t, the standing stock 5,645 t, the MSY 6,623 t, the

number of recruits 244 x 10^6, the mean number of fish in the exploited phase 39 x 10^6, yield in weight 4,811, t yield in number 58 x 10^6 and the mean weight of fish in the catch 93 g. The annual yield of 4,811 t indicated that 36.4% of the stock was being exploited. Increasing the present yield to the level of MSY would require considerable increase in the exploitation rate from the present 36.4% to about 75% (Kamath, MS).

Polynemus heptadactylus

P.heptadactylus forms about 40% of the total polynemid (threadfins) catch along the northwest coast comprising Maharashtra and Gujarat. The annual stock of *P.heptadactylus* in 1982-83 in the inshore grounds along this coast has been estimated to be a meagre 4,794 t, the standing stock 2,936 t, the MSY 1,802, the number of recruits 49.0 x 10^6, yield in weight 1,606 t, yield in number 38.8 x 10^6 and the mean weight of fish in the catch 41.4 g. The annual catch of 1,606 t represents an exploitation rate of 33.5% while at the MSY of 1,802 t the exploitation rate is 88% for the present age of 0.43 year at first capture (Ivan, 1987).

Bombay duck (Harpodon nehereus).

The yield per recruit of 13.0 g at F=1 and E=0.42 (42% exploitation rate) in 1984-85 was also the maximum sustainable yield per recruit (Hameed Batcha, 1986). Therefore, the 1984-85 yield of 121,680 t for the northwest coast (61,256 t for Maharashtra and 60,424 t for Gujarat) should be the same as the MSY, and the exploitation rate of 42% be considered as the optimum for stabilising the fishery. The number of recruits into the fishable stock is estimated to be 9.0133 x 10^9.

Arius thalassinus.

A.thalassinus forms about 50% of the catfish catch along the Maharashtra-Gujarat coast where in 1984-85, the total catfish landing was 20,712 t. In the case of *A.thalassinus*, the exploitation rate in 1986 was found to be 37% for the present low levels of F=0.45 and age at first capture (t_c) of about one year. The annual yield per recruit (Y/R) can be maximised from the present 40 g to 55 g by increasing t_c to 2 years and F to 1.8 (Naik, 1987).

Nemipterus japonicus and "all-demersal".

Preliminary estimates by the swept area method applied to bottom trawl fishery data for *MV Saraswati* for 1983-85 indicate that the standing stock of *N.japonicus* in the 30-200 m deep grounds was 55,465 t for Karnataka-Goa, 266,006 t for Maharashtra and 1,053, 114 t for Gujarat. The standing stock of "all-demersals" was 308,958 t for Karnataka-Goa 1,213,854 t for Maharashtra and 2,820,588 t for Gujarat. Thus, the standing stock of *N.japonicus* forms 18%, 22% of the standing stock of all demersals in the 30-200 m deep grounds off the Karnataka-Goa, Maharashtra and Gujarat coasts respectively. The total area between the 30 m and 200 m depths is 3.341 x 10^6 ha for Karnataka-Goa 13.027 x 10^6 ha for Maharashtra and 16.418 x 10^6 ha for Gujarat. The standing stock of *N.japonicus* per hectare was 16.6kg, 20.4 kg and 64.1 kg while that of all demersals was 92.5 kg, 93.2 kg and 171.8 kg respectively in the Karnataka-Goa, Maharashtra and Gujarat grounds.

Potential yield estimates including the pelagics and the demersals for the northwest coast of India, using various methods, range from 0.15 x 10^6 to 2.64 x 10^6 t (Bapat *et al.*, 1982). Assuming the standing stock to be about the same as the annual stock, which in the 50-200 m grounds remains poorly exploited, the potential yield may be taken as 25% of the standing stock. On this yardstick, the potential yield of *N.japonicus* for the Maharashta-Gujarat continental shelf would be about 329,780 t (25% of 1,319,120 t), but the annual yield in 1984 was a meagre 8,940 to (4,682 t for Maharashtra and 4,258 t for Gujarat) by the inshore trawl fishery from grounds to a depth of about 50 m (Devaraj and Gulati, MS)

In an earlier study by Biradar (1987) based on *M.V.Saraswati* bottom trawl fishery data for April-May 1984, the standing stock of demersals in the 30-200 m deep grounds off the Karnataka coast was estimated to be 130,000 t comprising 38,000 t of *N.japonicus*, 19,000 t of *Arius* spp, 15,000 t of *Priacanthus macracanthus*, 11,000 t of *Saurida tumbil* and 47,000 t for other demersals. Eightyfive percentage of the demersal stock was limited to the 30-49 m and 50-99 m depth zones in almost the same ratio; 68% of the *N.japonicus* stock was available within the 50-99 m depth zone; catfish stocks were limited to the 30-49 m zone only; about 50% of the *P.macracanthus* stock was confined to the 100-200 m depth zone; and, 75% of *S.tumbil* stock was found in the 50-99 m depth. Out of the estimated stock of 76,450 t of demersals in the almost unfished 50-200 m depth grounds, 38,225 t was considered

as the potential yield. The potential yield from *N.japonicus* stock in the 30-200 m deep grounds is 15,672 t which.is 41% of all-demersals, but the yield in 1984 was only 1,525 t (Biradar, 1987).

Potential yield from inshore fisheries along the northwest coast

On the basis of time data comparising annual catch and effort for 1956-85, three levels of yields were identified for the Gujarat inshore fishery. The MSY was estimated to be 97,891 t for an optimum fishing effort (f_{msy}) of 24.076 x 10^6 manhours for the lowest level of yield comprising the years from 1956 to 1972, 146,465 t for 27.653 x 10^6 manhours for the middle level comprising 1973 and 1974 and 252,981 t for 42.472 x 10^6 manhours for the highest level comprising 1981 to 1984-85. The shift in the level of yield from the lowest to the highest reflects the shift in the quality of fishing technology from a purely traditional nonmechanised state from 1956 to 1972 to an essentially mechanised state since 1973 (Prabhu, 1987).

In the case o f Maharashtra inshore fisheries, two levels of yield could be identified - a high level with MSY 273,922 t for f_{msy}=48.563 x 10^6 manhours for 1956, 1957, 1964 to 1966, 1970 to 1974 and 1981 to 1984-85 and a low level with MSY=160,479 t for f_{msy}=39.674 x 10^6 manhours for 1958 to 1963 and 1967 to 1969. While the high yields in 1956, 1957 and 1964 to 1966 are attributable, *inter alia*, to above normal biological productivity, that for 1970 to 1974 and 1981 to 1984-85 is due to mechanisation (Lodhi, 1987).

The sum MSY of 512,659 t for the highest levels for Maharashtra and Gujarat is close to the potential yield of 540,000 t estimated by George *et al* (1977), indicating thereby that the entire inshore fishing grounds are being exploited to about the optimum since the early seventies. Realising the need to extent the fishery into much deeper grounds, the industry has introduced a fleet of about 250 second generation trawlers (47' overall length) operating from Veraval and Bombay bases since 1980 in the 50 to 100 m deep grounds.

Optimisation of the west coast penaeid prawn fishery.

From time series data comprising annual yield and effort for the west coast penaeid prawn fishery for the period 1971 to 1984-85, the annual MSY has been estimated to be 115,205 t comprising 54,277 t for Kerala, 7,399 t for Karnataka, 3,952 t for Goa, 36,649 t for Maharashtra and 12,928 t for Gujarat while the optimum effort in terms of annual number of trawlers operating daily for about 215 days a year is 4,594 comprising, 1,730 for Kerala, 760 for Karnataka, 553 for Goa 876 for Maharashtra and 675 for Gujarat.

Economic performance of the trawler fleet indicates the maximum economic yield (MEY) of penaeid prawns from the west coast to be 95,368 t including 44,931 t for Kerala, 6,125 t for Karnataka, 3,277 t for Goa, 30,338 t for Maharashtra and 10,702 t for Gujarat. The economically optimum effort (f_{mey}) in terms of number of trawlers operating daily for about 215 days a year is estimated to be 3,438 comprising 1,460 for Kerala, 641 for Karnataka, 467 for Goa, 739 for Maharashtra and 570 for Gujarat.

After the advent of commercial trawling by about 1968, the annual yield has stabilised at an average of 97,094 t and the annual effort at an average of 3,793 trawlers operating daily for about 215 days a year during 1971-85. The stabilised yield includes 43,471 t for Kerala, 5,924 t for Karnataka, 2,943 t for Goa, 34,111 t for Maharashtra and 10,645 t for Gujarat while the stabilised effort (number of trawlers) includes 1,546 for Kerala, 657 for Karnataka, 290 for Goa, 740 for Maharashtra and 560 for Gujarat.

Since penaied prawns are a near monopoly product, the difference between MSY and MEY and between f_{msy} and f_{mey} is insignificant, and the stabilised yield and effort show remarkable agreement with the biologically or economically optimum yield and effort (Kalawar *et al.*, 1985; Deveraj and Smita, 1988; Devaraj and Smita, MS).

Rastrelliger kanagurta

In 1972-75 when t_c was 0.3 year and F=2.1, Y/R was 16 g while the maximum Y/R of 20 g could be obtained by keeping the t_c value at 0.3 year and increasing the F value to 3.5 (Biradar, 1985). By increasing F from 2.1 to 3.5, the average annual yield of 69,557 t for 1972-75 could have been increased by about 25% to attain the MSY of 86,946 t.

For 1956-73 when the average annual catch was 81,095 t the estimated mean annual standing stock was 94,722 t (73,277 t for Kerala and Karnataka; 21,445 t for Goa to Ratnagiri), The mean annual total stock 242,592 t (198,084 t for Kerala and Karnataka; 53,508 t for Goa to Ratnagiri) and the mean annual MSY 121,296 t (94,367

t for Kerala and Karnataka; 26,926 t for Goa to Ratnagiri). The mean production gap of about 40,000 t was mainly due to under exploitation in 1956 (by 41%), 1969 (by 24%), 1972 (by 39%) and 1973 (by 37%), particularly in 1972 and 1973 when the MSY was very substantial at 419,414 t and 250,893 t respectively. Therefore, catches exceeding the MSY taken in most years, resulting in overexploitation by 11 to 40% over and above the 50% stock level (considered to be the optimum) could not reduce the production gap.

The mean annual number of 744.53 x 10^6 fish landed in Kerala and Karnataka during 1934-73 was comparised of 14.1% 0 year group (1 to 5 months), 70.36% 0.5 year group (6 to 11 months), 12.45% 1 year group (12 to 17 months) and 3.09% 1.5 year group (18 months and above). The length of 215 mm at the optimum age of exploitation (0.83 year or 9.9 months) at which the biomass of a given cohort is at its maximum belongs to the fully recruited 0.5 year group. The bell shaped (Ricker type) stock-recruitment curve shows that the recruits are at their maximum of 5.13 x 10^9 at a spawner (parent) strength of 230.856 x 10^6 fish. At F + M = Z = 0.68 +1= 1.68 the spawner population attains its optimum level (230.856 x 10^6). AT F = 0.68 the MSY in terms of recruits is 4.9 x 10^9 (=5.13 x 10^9 minus 0.23 x 10^6). Since the Y/R for M=1, t_c = 0.5 year and F = 0.68 is about 25 g, the MSY from 4.9 x 10^9 recruits is 122, 461 t (Kalawar *et al.*, 1985).

Sardinella longiceps.

For 1972-75 when F=2.5, t_c = 0.5 year and E =0.56, Y/R was 7 g as against the maximum Y/R of 8 g at F = 5 and t_c = 0.5 to 0.6 year. Thus, by doubling the present F, Y/R could be increased only by 14%. The age of oil sardine at first spawning is about one year which is higher than the age at entry into the exploited phase. Hence, fishing at higher intensities could lead to reduction in the spawning stock to levels at which recruitment could be affected (Biradar, 1985).

By doubling the present F=2.5, the average annual yield of 143,133 t for 1973-75 could have been increased only by 14%, that is, by 20,039 t to attain the MSY of 163,172 t. However, stock-recruitment relation of the Ricker type fitted for the population shows the maximum recruits to be 45 x 10^9 at F = 1.8, which could yield 297,000 t on a sustained basis (Biradar and Gjosaeter, MS).

The annual yield of oil sardine since 1956 for the southwest coast shows that the yield has more or less stabilised since 1961 with average annual yield of 173,424 t for 1961-65, 174,910 t for 1969-73, 153,312 t for 1974-78 and 177,631 t for 1979-83 closely agreeing with the MSY estimate of 163,172 t and the average annual yield of 267,906 t for 1966-86 agreeing with the MSY estimate of 297,000 t. It is likely that in 1966-68, F was close to 1.8 resulting in a near maximisation of recruits while during the other periods F was less or more than the optimum.

The Indian sacred chank (Xancus pyrum)

The average annual stock of adult chanks (>60 mm maximum shell diameter) in the Gulf of Mannar is estimated to be 2,009,454 of which 44.83% is exploited. The initial stock size, however, varies from year to year, and hence, there exists different levels of optimum yields (MSY) for different levels of initial stock size.

In the case of the central and southern Gulf of Mannar fishery operating from Tuticorin, six strata of stock abundance have been indentified. The MSY ranged from 143,016 adult chanks for the lowest (6th) stratum to 1,064,079 adult chanks for the highest (1st) stratum for optimum effort ranging from 18,768 diverdays (6 diverdays = 1 canoe day: diving seasons extends from November/December to March/April) for the lowest stratum to 51,195 diverdays for the highest stratum.

In the case of the northern Gulf of Mannar fishery operating from Ramanad, there were five strata of stock abundance, with MSY ranging from 69,160 adult chanks for the highest stratum for an effort of 14,619 diverdays.

The MSY (=a^2/4b where a and b are the constants in the regression of Y/f, i.e., the number of adult chanks per diverday on f,i.e., the effort in diverday) and the corresponding optimum effort (f_{msy} = a/2b) can be estimated in advance at the beginning of each diving season by substituting Y/f and f for the first few days of diving in the following equations (the general equations is Y/f = a - bf) to find out the value of a which is the index of initial stock size.

Y/f=a - 0.000401 f for Tuticorin fishery

Y/f=a - 0.00164 f for Ramnad fishery

Since the slope is constant and only the Y-intercept a varies, MSY and f_{msy} could be predicted once a is determined from the above relations. Advanced estimates of MSY and f_{msy} shall form the basis for regulating the fishery at its optimum level for any current season.

The yield cycle of four years comprising a peak, a vallely and a peak at intervals of two years, noticed in the Tuticorin fishery for over 100 years

from 1876-77 to 1985-86, suggests the need for closing the fishery for an year, two years after each peak, in order to revive the stocks.

Chank fisheries in the Palk Bay and the Coramandel coast yield annually an average of 48,986 and 24,486 chanks respectively while in Kerala the average annual yield is 20,138 chanks.

The average annual stock of chanks in the intertidal Gulf of Kutch is 25,234 of which only 30.6% is exploited, but additional catch is possible only for the 60-80 mm diameter size chanks as the >81mm diameter size chanks are already well exploited. There is prospect for increasing the present supplies by introducing SCUBA diving in the 20 to 30 m deep grounds in the Gulf of Mannar and by exploiting the Gulf of Kutch beyond the intertidal zone (Devaraj and Ravichandran, 1987).

BRACKISHWATER FARMING

Prawn hatchery and seed production

The institute initiated studies on penaeid prawn hatcheries and seed production in 1977 at Bombay, it estabilished a hatchery at its brackishwater farm in Kakinada and set up a pilot hatchery at Okha in collaboration with the Department of Fisheries of Gujarat in 1979. Various species were successfully bred and their larvae reared upto PL 8 at Bombay. From 1978 to 1984, a total of 334,000 postlarvae were produced and a portion of it sold to farmers near Bombay and in Goa. Details of the hatchery designed and developed by the CIFE, experimental studies to determine optimum hydrographic conditions in hatcheries and production ponds, artificial feed and disease problems are available in Hameed Ali and Dwivedi (1977; 1981), Hameed Ali (1980), Hameed Ali *et al.*, (1982) and Dwivedi *et al.*, (1984).

Prawn culture

Under technical guidance from the Institute's Kakinada centre, five parties have set up prawn seed banks in coastal Andhra Pradesh for the supply of seeds to shrimp farmers in and outside this state. A high density rearing system for tiger prawn seed at the rate of one million seed/ha, with 85.45% survival over a period of one month has been developed at the Institute's Kakinada centre (Somalingam and Murthy, 1984). A simple method of low input culture was developed for the tiger prawn at the Kakinada centre. The survival rate from postlarval to crop state was about 50%, the yield about 250 kg/ha and the income about Rs. 18,750/- ha at the rate of Rs. 75/kg against a cost of Rs. 5,850. Two to three crops could be grown per year (Gopalakrishna, 1983). Under technical guidance and training from this Institute, well over 75 private brackishwater shrimp farms have come up in coastal Andhra Pradesh since 1984. The yield of prawns, mainly the tiger prawns, in these farms is about 300 to 400 kg/ha/crop of 3 to 4 months. The confidence gained through this experience is encouraging more and more private involvement in prawn culture in Andhra Pradesh.

Juvenile tiger prawns of 27.7 mm average size collected from low lying coastal areas near Kakinada were successfully acclimatised to freshwater conditions with 96% survival. In acclimatisation, the initial salinity of 30 ppt was progressively reduced by 10% per day for the first two days (i.e., to 25 and 15 ppt), by 5% per day for the next two days (i.e., to 10 and 5 ppt) and by 1% per day for the remaining six days (i.e., to 5,4,3,2,1 and 0 ppt) (Reddi *et al.*, 1984). Since 1985, the Kakinada centre has been able to successfully culture tiger prawns together with major carps in slightly saline soil areas inundated by freshwater, in Andhra Pradesh, This practice has now become very popular with the fish farmers in the State. At Jagannaickpur, near Kakinada, one seasonal 0.4 ha freshwater tank has yielded at the rate of 1.1 t tiger prwan/ha/year together with major carps and milkfish at the rate of 12 t/ha/year in a crop of 10 months. The tank was fertilised with raw cattledung, single superphos and rice bran at 10,000 : 250 : 100 kg/ha on 16.8.83 and then stocked with prawn and fish seed at 42,000/ha. After stocking, the above fertilizers were applied at 100 : 75 : 50 kg/ha at intervals of 10 days for the entire crop duration (Tiwari, *et al.*, MS).

Tiger prawn cultured in a 0.004 ha freshwater tank by stocking seed (15 mm; 0.01 g size) at the rate of 60,000/ha yielded at the rate of 312.45 kg/ha in a crop of 3 months and 15 days (Tiwari and Razivi, MS).

Fish culture

The method of low input culture for milkfish developed at the Kakinada centre involves : (1) manuring with cowdung, single superphos and urea at 5000 : 250 : 50 kg/ha/crop of six months, half this dose is applied five days before stocking while the balance is applied in five equal monthly

instalments after stocking; and (2) stocking at the rate of 4000 fingerlings/ha. The yield per ha per crop of six months was 750 to 1000 kg, worth about Rs. 9,000 for an investment of only Rs. 1,700, as there was no artificial feeding. The income could be doubled by raising two crops per year. Low input milkfish culture is best suited to saline soil areas, tailends of canals under tidal influence and low lying water lodged areas unfit for agriculture (Gopalkrishna, 1983 b). Monoculture of *Mugli cephalus*, stocked under the above conditions at 2500 fingerlings/ha resulted in individual growth of 500 g and yield of 1000 kg/ha in one year. *Lates calcarifer*, stocked at 2000 fingerlings/ha and fed with trash fish, yielded 500 kg/ha/year.

Mass culture of live food organism

Brachionus plicatilis, inhabiting salt lakes and backwaters, is a nutritive plankton of optimum size (120-250 μ) suitable for feeding prawn and fish larvae. It can be cultured in 300 l tanks under air lift circulation and by using cheap inorganic manures like pigdung, cowdung, chicken manure, oil cake and super-phosphate. It is tolerant to 4 to 65 ppt salinity, but peak production is limited to 4 to 20 ppt. Continuous regeneration is ensured by the production of both mictic and amictic eggs. Under optimum conditions, the density of *B. plicatilis* rises upto 155 individuals/ml in 13 to 16 days; high density generally lasts for 4 to 6 days (Reddy, 1982).

Marine Planktonic ciliates such as *Fabrea salina* and *Euplotes sp* inhabiting saltwater impoundments and backwaters serve as excellent feed for crustacean and fish larvae. They are delicate and slow moving and are easily caputred by the feeding larvae. *F. salina* is 60-300 μ and completes the life cycle in 20 to 25 hours while *Euplotes sp* is 45-90 μ and the life cycle lasts for 10 to 11 hours. They can be cultured on inert feeds such as cowdung, chicken manure, rice bran etc, lack chitinous shells and are easily digestible. Both are euryhaline, *F. salina* being tolerant to 20-90 ppt salinity and *Euplotes* sp to 20-35 ppt salinity. *F. salina* forms cysts which can be stored for 2 to 3 months in hatchable condition. Mass culture with 60/ml density for *F.salina* and 1250/ml for *Euplotes* sp can be developed in 6 to 7 days (Parveen Rattan and Dwivedi, 1982).

Natural populations of the brine shrimp, *Artemia parthenogenetica*, have been located at the Bhayander and Meera Road salt pan complexes near Bombay. Significant quantities of *Artemia* cysts could be harvested periodically from these two areas. On a request, one kg of *Artemia* Bombay cyst (ABC) harvested and processed by this institute, was supplied to the Tamilnadu Fisheries Development Corporation, Madras on 20.4.1987. The Institute has developed a continuous mass culture method for the brine shrimp in 300 l cement pools, (Dwivedi, *et al.*, 1980). An ingeneous method has been developed for the automatic seperation of nauplii from the adult stock in order to ensure regular supplies of nauplii to prawn hatcheries (Ansari, 1987). Besides, a floating device has been developed for the automatic collection of zooplankton from intensive zooplankton production ponds. This device is recommended for adoption in aquaculture systems in India (Dwivedi, 1984).

Fishery estates

The concept of brackishwater fishery estates, as conceived by the CIFE, is one that aims at the construction of large brackishwater farm complexes to promote area development, gainful employment among the weaker sections and integrated farming (with prawn, fishes, cattle, poultry, pig, coconut, vegetable and fruit as its ingredients) in mangrove ecosystems which, without reclamation at enormous cost, are of little use for agriculture. The CIFE blueprint for a model farm involves a total coast of Rs. 11.2 million including Rs. 5 million for hundred farm ponds of one ha each, Rs. 3 million for a shrimp hatchery and seed bank, Rs. 0.5 million for technology training centre for the farmers and Rs. 2.7 million for civil amenities such as rural huts, hospital and school. After construction the farm ponds may be leased to farmer families on nominal rents. At the rate of one pond for every fish farmer family of four, one hundred families will be gainfully employed in each estate (Dwivedi and Ravindranathan, 1982).

The government of Maharashtra spends annually about ten million rupees for the reclamation of mangroves known locally as kharlands, to make them suitable for agriculture. Since reclamation is costly and the agricultural yield from reclamied lands poor, this amount could be spent in the construction of fishery estates at the rate of one per year. In Maharashtra the total kharland area is about 12,000 ha, which has a potential to develop into about 120 estates and employ 12,000 farmer families. However, in the interest of expediency, it will be necessary to equitably allocate the kharlands between fishery

estates and entrepreneurs interested in shrimp culture.

Each one hactare pond has the potential of generating a minimum income of Rs. 28,750 per crop from aquaculture alone through the harvest of about 250 kg prawn (at Rs. 75/kg) and 2,000 kg fish (at Rs. 5/kg), using minimum input technologies. Since at least two crops could be raised per year, the annual income would be about Rs. 60,000 which is a fabulous Rs. 5000 per month per family. During their extra times, the members of the family can undertake alternative jobs such as in capture fisheries, processing, marketing, net making etc, besides collection of fish and prawn seed from the wild for their own use or for sale to the seed banks. Income from the other components of the integrated system would also be substantial while the wastes and refuses could be recycled back into the system as feed or fertilizers for the different components.

Aquaculture in hinterland saline soil areas

The Institute has been able to culture successfully on an experimental scale *Penaeus mondon, Mugil cephalus* and *Etroplus suratensis* in the saline subsoil waters at Sultanpur in Haryana. This success opens up considerable scope for the commercial culture of these species in the vast barren saline soil areas in Haryana, Punjab, Rajesthan and Uttar Pradesh. Experiments for one year have shown that in 0.03 to 0.05 ha ponds *P. monodon* (N=196) registered 16% survival, growing from 20 mm (0.5 g) to 240 mm (125 g), *M. cephalus* (N=90) recorded 50% survival, growing from 25 mm (1 g) to 522 mm (950 g) While *E. suratensis* (N=85) registered 90% survival, growing from 65 mm (35 g) to 150 mm (80 g). The salinity in the ponds was found to be 6.5 to 16 ppt, pH 7.02 to 8.75 and dissloved oxygen 5.8 to 10.16 ppm; however, the thermal regime (15 to 36^{0}C) limites the period of culture to the months of April to October (Dwivedi and Lingaraju, 1986). *E. suratensis* has bred in these ponds in mid July 1984, five months after stocking as fingerlings (Anon, 1984).

Windmill in shrimp farms

One windmill installed at the institute's brackishwater fish farm worked for 4,714 hours in 360 days lifting 17.701 m^3 water into cement cisterns stocked with tiger prawn seed. With continuous supply of water lifted by the windmill, the survival of tiger prawn was found to be 50-60% which was better than that in the other cisterns (Madhusudhana Rao, *et al.*, 1986).

DIVERSIFICATION IN FISHING AND PRODUCTS

Product diversification

The Institute has developed simple techniques for making laminated Bombay ducks, fish wafers and minced fish meat. At the instance of this Institute, a Bombay firm has developed a machinery for fish wafer at a cost of Rs. 150,000, with an installed capacity for 200 kg/day, requiring a daily labour of ten workers. The wafer making process consists of dressing, immersion in 20% brine for thirty minutes, autoclave cooking for twenty minutes, mixing with tapioca starch at 1 : 1 and adding sugar at 0.2%. The cost of production in 1977 was Rs. 6/kg of wafer and there was no consumer resistance upto a sale price of Rs. 12/kg. MS Spaceage Marine Food Products, Bombay conducted initial production trials, which however could not succeed as the necessary market linkages were not readily available then (Dwivedi, 1977).

Preliminary studies in 1977 showed that a small machinery for making minced fish meat (keema) would cost about Rs. 20,000 and the project would breakeven at a price of Rs. 6/kg of frozen fish keema. The demand for fish kemma depends on how popular fish bergres and cutlets become in sophisticated eating places (Dwivedi, 1977; Ramananada Rao, 1979).

In respect of canning, it was found that the nutritive value of canned *Otolithus argenteus*, as evaluated by the total nitrogen content and available lysine, did not alter much either during heat processing or during storage over a period of nine months at 28 $\pm$ 5^0 C (Ramananda Rao and Gadre, 1986).

Product quality

Prawns Landed in Bombay during the monsoon season are found to have black spots or melanosis which degrades the product and reduces its value significantly. Melanosis is caused by the action of the enzyme called polyphenalase ozidase, which can be prevented by the following treatment.

(1) removal of head as soon as prawns are landed;

(2) avoiding air pockets while icing or packing in ice-seawater mixture;

(3) immersing in 70^0 C water;

(4) or alternatively, treating with sodium metabishulphite and sodium bicarbonate solution to protect from atmospheric air and oxygen. The Institute has worked on polyphenalase oxidase enzyes in India for the first time and studies their action on various species of shrimps and prawns (Madhusudhna Rao, *et al.*, 1986).

Fishing diversification

Fishing trails with a 20.7 m highopening two seam shrimp trawl and a 21 m traditional shrimp trawl off Bombay at 15 to 30 m depths have shown that the catch per hour was 28.18 kg for the former and 15.42 kg for the latter. The study thus indicates that the highopening trawl is 1.82 times more efficient than the traditional one. The catch in both the trawls is mainly of sciaenids, *Coilia dussumeri,* catfishes and skates (Anon., 1984). It is propossed to popularise highopening trawls, initially along the Bombay coast.

SOCIO-ECONOMICS

Boat profitability

Economic studies conducted in 1983 at the Sasson Dock, Bombay, indicated high profits accruing to boat owners on account of high prices of fish prevailing in Bombay. 40'trawlers with 66 Hp engines realised each in 230 days of fishing 18.28% return on the capital employed, gross profit of Rs. 593,496, net profit of Rs. 508,736, earnings of 1.86 per unit of investment, net profit ratio of 0.51 and gross profit ratio of 0.60 (Rao, 1984).

At Murud village in Maharashtra, 30' gillnetters with 16 to 20 Hp engines earned a net income of Rs. 33,800 each in 1983. Deducting the expense of Rs. 20,000 per family of four, there was a surplus of Rs. 13,800 to be used for loan payments in ten annual instalments (Rao, 1984).

Shrimp trawling operations conducted in 1980 off Tiruchendur in the Gulf of Mannar by mechanised vessels indicated supernormal profits. Comparative study of three 32' trawlers including one wooden, one wooden sheathed and one fully FRP, each with 66 HP Ashok Leyland engines, showed returns on capital employed (for 280 days) to be 36.35%, 44.60% and 99.36% respectively, while the cost-benefit ratio was 1.26, 1.33 and 1.60 respectively. The FRP boats were more economical to operate because of their lightness, higher speed, low fuel consumption and longer time spent in fishing (Rao and Anrose, 1983).

Economic analysis of two Mexican trawlers (23.16 m each) operating from Visahkapatnam indicated a net profit of Rs. 644,000 by both the boats in 1979-80 from a total earning of Rs. 3,144,000 realised from about 50 tons of prawns and 1200 tons of quality fish against an expenditure of Rs. 2,500,000. The rate of return on the net worth of Rs. 3,500,000 was about 0.92 (Rao, 1982).

Rapid growth in the fleet of small mechanised shrimp trawlers in Kerala from 769 trawlers per day in 1973 to 3,500 trawlers per day in 1980 resulted in considerable erosion in the annual net profit per trawler from a maximum of Rs. 537,500 in 1976 to a minimum of Rs. 5,805 in 1982. There is need to optimise the fleet at 1,460 trawlers per day at which the net profit per day for the trawler sector in Kerala will be Rs. 2.127×10^6 (or Rs. 457.305×10^6 per year of 215 fishing days). At this economically optimum level of fishing effort, the annual yield from trawl fishery would be 91,323 t comprising 44,931 t of shrimps and 46,392 t of finfish. The optimum number of trawlers may be chosen each year by about March or April by lot. The surplus vessels may be deployed in alternative fisheries such as for the whitebaits, rock perches, red snappers, breams, cephalapods, sharks and larger pelagics (Devaraj and Smita, 1988).

Observations on 377 marine fishermen households from different parts of the country indicated that the average annual net profit for a mechanised fishing boat (trawlers, gillnetters and purse seiners combined) was Rs. 31,070. The rate of return was about 20%. Expenditure included wages (31%), fuel (23%), repairs to craft and gear (13%), mobile oil, food and sales commission (13%) and depreciation (20%) (Rao, 1985).

Fibreglass mould boats (18' long) which work like catamarans were being built by MS Irwin Boat Yard at Visakhapatnam, at a cost of Rs. 13,000 each in 1980 price. On the basis of estimated sale income of Rs. 20,000 from 10 tons of fish and expenditure of Rs. 11,600 per year, the return on the capital employed was estimated to be 60% and the cost-benefit ratio 0.72 (Rao, 1982).

Versova: a sucessful fishing village

The Versova fishing village near Bombay has 3821 active fishermen among a total population of 7,120 fishermen (1985 census). Most of the fishermen are active workers in the fishing industry while about 600 fishermen are engaged in

fish retailing in the Bombay city markets. Most of the boat crew are from Ratnagiri district, as the employment opprotunities and wages are much higher in Versova. There are about 265 mechanised boats, 39 sailing boats and 334 nonmechanised carrier boats, called dhonies. In 1982-83, 44,259 t of fish (accounting for 5.68% of the annual catch in Maharashtra) valued at 19.88 crores of rupees (16.56% of the value of the catch in Maharashtra) were landed.

The sucess of this fishing village is attributed to four major factors which include well organised local boat construction and supply system, a well managed fishermen co-operative society, abundant supply of labour from Ratnagiri district in southern Maharashtra and the proximity to the Bombay city markets. Evidently this village could serve as a good example for other Indian fishing villages.

The Versova fisheries co-operatives society, one of the very few successful societies in the country, had in 1983-84 a membership of 1,179, a turnover of Rs. 3.47 lakhs. As on the 30th June 1984, its share capital was Rs. 3.09 lakhs and its total fund Rs. 30.23 lakhs. The Society's assets include an ice plant and cold storage, diesel oil pump, transport trucks etc. Timely recovery of loans is ensured by linking credit with production and marketing. There is no interest on loans in the first year, but the commission on fish sold through the society is charged at 9% against the normal 7%. A part of the loan is deducted at source at about 10% of the sales on any given day and credited to the loan account. One of the factors responsible for the success of this society is the efficient marketing linkage it has developed to co-ordinate and guide production, assembly, processing, storage and distribution of fish, thus making marketing an integral part of the social system. Being nearer to the city markets, marketing costs are lower and net returns higher. As a result the fishermen enjoy much higher standards of living. Wages to crew are quite attractive, they range from Rs. 35 to more than 50 per day per head and are paid daily, monthly or annually. Share system is also in vogue. Although wages do not increase as much as the increase in fish prices, boat crew are given ample incentives in the form of free food, clothes, other daily allowances and paid leave for 15 days a year (Subbarao and Mathur, 1984: Anon, 1985: Kohli and Subba Rao, 1986).

NATIONAL AWARENESS AND TECHNOLOGY TRANSFER

National awareness

With view to creating national awareness on the need for the proper utilisation of the marine living resources and the need to have a comprehensive development programme for coastal zones, the institute organised a number of international and national symposia. They include: (1) Multiuse of Coastal Zone held from the 20th to the 22nd November 1975 (proceedings published in *Indian Fish. Ass.* 5 (1&2) 1975 issued in April 1975): (2) Lab to Land Programme and Workshop on Ocean Management held on the 5th and 6th April 1977 (proceedings published in *Indial Today & Tommorrow* 8 (3) 1979): and (3) Management of Marine Living Resources in the Exclusive Economic Zone on the 16th December 1981 (proceedings published in *India Today & Tommorrow)* 9 (2), 1982).

Technology transfer

The Institute has been conducting short term training courses periodically on various aspects on marine fisheries for the purpose of technology transfer among the users. In all, 14 courses, each lasting from 7 to 30 days, were conducted on the Management of Brackishwater Fish farms at Kakinada and over 250 farmers and technicians trained. Twenty entrepreneurs underwent a 15 day course on the Management of Prawn Hatchery at Bombay; 86 rural youth were trained through two TRYSEM (training rural youth for self employment) Programme in Brackishwater Fish and Prawn Culture at Kakinada. Under the same programme for two months, 21 rural youth were trained in Prawn Seed Collection and Seed Banks at Kakinada. 54 fish processors were given training on the utilisation of Low Prices Fish over two courses, each lasting 5 to 8 days at Bombay. 18 candidates underwent the courses on the Management programme for Executive of Fisheries Co-operatives, Institutional Finance for Fisheries Development and Fisheries Economics, lasting 1 to 15 days at Bombay. 21 bank officials underwent a 7 day course on Fisheries Development through Institutional Finance at Bombay. 17 higher secondary teachers participated in the 28 day NCERT Training Programme in Fisheries for Vocational Teachers.

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A SUGGESTED PLAN FOR DEVELOPMENT OF MARINE FISHERIES SECTOR OF ANDHRA PRADESH

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ABSTRACT

A suggested plan for the development of marine fisheries sector of Andhra Pradesh is presented here. The condition of the state fisheries shows stagnation of overall productivity of the waters. Andhra Pradesh contributed on an average 1.47 lakh tonnes, forming around 9% of the total fish catches of India (in 1984). The following are major areas to be considered for proper planning and development. Several of the stocks are being fished in a narrow coastal belt and there is thus concern on the depletion of these resources; secondly, there is the threat of increasing incursion of foreign fishing vessels; thirdly, the increasingly fast degradation of coastal waters by multiple users on the one hand and multiplication of traditional users on the other; lastly, the potential of aquaculture is yet to be fully assessed.

The plan hence recommends four major but broad thrusts for the overall development which includes management and conservation of marine fisheries; prevention of pollution and degradation of wetlands as pertaining to fish habitats: strengthening the commercial fishing industry, particularly of the 200 miles EEZ; and aquaculture as an additional technology.

The implementation of the plan is to be vested with the State Department with collaboration from Research Institutes and Universities and agencies such as Rural Development, Irrigation and Power, Environment and pollution control Board. The implementation of action plans depends on information available. It also needs a management regime or Task Force. Legislation and organisational changes will be needed.

The management and development of these four thrust areas are detailed further with recommendations in each area of action.

INTRODUCTION

The suggested Plan for development of coastal/marine fisheries sector of Andhra Pradesh is a comprehensive outline of major thrusts in which the State's marine/coastal fisheries resources are to be managed and best utilized for the well-being of the rural fisheries sector.

A target date for achieving goal can be set up ten years from now viz., the year 1996. Similarly a few major thrusts or goals or development can be planned for, instead of a diffuse and far-much-spread out target.

The condition of the State's fisheries, the increasing demands on the prawn fisheries should be viewed with some concern. The main points of concern are as follows:

1. Many of the fish stocks, especially prawns, are being fished in a narrow coastal zone and there is thus concern for depletion or threatened depletion of these stocks.

2. There is a constant and rapid incursion of foreign fishing vessels off the coasts without proper agreement or joint ventures with our country which is also a major factor in the depletion of important resources. Monitoring of catches of these vessels is necessary to guard our resources.

3. Increasingly fast degradation of estuarine, coastal marine environment threatens the coastal marine fisheries.

4. Potential of aquaculture is to be studied on an area by area basis for evaluating economics of alternate employment to rural fishermen as well as its environmental impact in the coastal zone. Based on the above review four major thrusts in the development of Marine Fisheries Sector as an overall programme of rural development are envisaged in the plan as follows :

1. Management and conservation of marine fisheries.

2. Sterngthening the commercial fishing industry within reasonable limits and imposing ceilings on boats, nets and catches. Permits to foreign vessels, phased exploitation of the 200 miles EEZ. Marketing of product meeting the consumer demands of the state as well as National and International exports. The prevention of pollution and degradation of wetlands as pertaining to fish habitats viz., mainly conservation.

3. Aquaculture as an alternative technology

in the context of an integrated rural development to be developed by State Department of Fisheries.

The implementation of the plan rests with the State Department of Fisheries, A.P. requiring coordination of state and Central Government and other agencies such as Universities, rural development agencies, water pollution control board and water resources and irrigation and ecology and environment sector authorities. Implementation also requires understanding of the needs for such priorities, and support by way of funding.

In each thrust of action, further progress will depend on the state of information available for the next course of action. A few of the areas in which implementation of action has already begun are: the establishment of coast guard at Visakhapatanam for marine security, the establishment of a few fishing harbours (at Visakhapatnam, Kakinada, Nizampatnam and Bhavanampadu); voluntary cuts on trawler operations (at Visakhapatanam harbour ?) and the preventive actions taken by the State Board for prevention and Control of water pollution etc., to control release of effluents and, issuing guidelines on the siting or location of industries vis-a-vis their effluent releases and effect on human beings.

For each plan of action however, a management regime needed to be established as also a monitoring body (a task force). Legislation and organisational changes will be needed along with interaction with other bodies connected with coastal zone and marine zone. This has to be worked out in detail where necessary with short-term research and inventory type projects.

THE STATUS OF THE ANDHRA PRADESH FISHERIES: BACKGROUND

With a coastaline of 970 km, Andhra Pradesh is the largest maritime state in peninsular India. It contributes around 1.3 lakh tonnes (average of 1970 - 1980) of fish and shell fish to the national grid, forming around 9% of the total catches of India. The contribution of marine exports (sea food) is around 6% of which contribution from prawn alone is around 5%.

Several new management (technological) skills have been developed and introduced in the state such as :

i) Beach landing mechanised craft fitted with in-board engine and capable of easy surf crossing.

ii) Four new fishing habours to give berthing facilities for 100-300 small mechanised boats and large trawlers.

iii) A boat building yard at Kakinada.

iv) Brackishwater aquaculture.

While these measures for management of fisheries have been developed, the State has not made any progress in regard to the controls on fishing activity such as regulation of fishing effort or curbing free access to fishing areas. No doubt it is a national problem and a National Fisheries Law has to be promulgated. Albeit the same, the State has a responsibility towards its fisheries resources protection which is also dwindling due to other user patterns such as land use and water use, cutting down of managroves, dredging and mining in near-shore waters and so on. Perhaps meaningful control has been difficult and at times altogether absent.

The Condition of stocks

The capability of Andhra Pradesh coastline to yield catch has stagnated around 1.3 lakh tonnes in 1980. New innovations in craft and distant area fishing from the coastline seems to have indicated possibilities of greater yields (Anon, 1978, Narayanappa *et al.*, 1968).

Our knowledge of the marine ecosystem and changes occurring due to man-made interferences area by area, are limited, The continued increase in fishing effort might in the long terms introduce changes in ecological relationships and have serious, unpredictable consequences.

On many fishing grounds, a variety of species exist in the same area, at the same time. Trawls catch a mixture of species in addition to their principal target species. The incidental catches of fish which are "unwanted" and thrown back indiscriminately causes serious ecological changes and also undue changes in the pray-predator relationships. The recent "concentration" of all fishing effort on prawns alone, is one of such examples.

Fish Habitat Degradation

Physical encroachments and effects of effluent releases, be it from industry or agriculture and navigation are serious handicaps that must be viewed with concern. Information of impact on these changes is lacking and must forthwith form a part and parcel of programmes for impact studies.

The establishment of industries, fertilizer factories on shore lines, of ecologically sensitive areas such as the Kakinada Bay where thousands of

fishermen make their livelihood, must be viewed with concern and the Department of Fisheries must push forward its claim for obtaining impact studies before such siting is permitted (Rajyalakshmi, 1987; Sivaji Rao, 1987). Similar studies are needed and interaction with River Valley Development Boards about scientifically based quantum release of water to estuarine areas to prevent undue changes in the environment. The increasing salinity caused by reduced flows are known to have a serious impact on shell-fish environments and prawn/fish nursery areas.

The Commercial Fishing Industry

The commercial fishing industry of AP is large in view of its vast coastline, big lagoons such as Collair and Pulicat, and a number of reserviors, rivers and tanks. About 3 lakh fishermen make their livelihood on this besides middlemen employed in marketing, processing and export industry. More than 80% of the fishing craft is individually owned (unless middle-men controlled due to non-payment of loans taken) and more than 80% are small craft. Even in the processing industry the trend is similar. With one or two exceptions the processing plants are small - unit operations.

Following the trends in the All India Landings (in a range of 12-14 lakh tonnes in 1975-1982) the landings of Andhra Pradesh also showed fluctuations (in a range of 0.8-1.56 lakh tonnes). The prawn production continued to contribute around 4.80 to 6.67% during this period except during 1982 when it went upto 8.97% (CMFRI, 1983).

In the same period the increase in effort (both fishermen population as well as their craft and gear) has doubled. This trend indicates possibility of further rise in effort. Further, the efficiency of craft and gear has improved by new innovations in techonology, as shown earlier.

Fish and Fish-food supply

As per present estimates the Andhra Pradesh yield of fish, prawns and others has already attained the maximum sustainable yield (whether it has attained or crossed the economically sustainable yield does not seem to have been estimated). If haversting of unconventional species of squids, cephalopods and other crustaceans is increased (and potential of these are to be estimated by exploratory survey in offshore and depth zones), then there is a possibility of increase in yield and diversification of yields and markets. The present stagnation in yield suggests that the harvest should be reduced to insure against ecological damage and other long-term adverse effects.

THE FUTURE PROSPECTS

Two studies are urgently needed, if they have not been already undertaken when the World Bank assistance has been sought for construction of the fishing harbours of the State. They are:

i) The Economic value of the marine fisheries resources to the state: (a) at the present fishing level, (b) by management techonology, such as surf boats, mechanised boats capture of new species and (c) by the exploitation of 200 miles economic zone (either by own operations or by foreign vessel lease or chartering).

ii) Economic forecast of the industry say, for the next decade.

Both studies can be allotted to State Economics Bureau (or other Institutes) and a report be obtained.

Some assumptions that can be made in this regard are that the capture fisheries produce is going to substantially increase from other sectors.

In the processing industry side, the gains would rise more than marginally considering the international trends in prawn export trade and introduction of other finfish into the processing industry. We can use these base-line reference points to plan for the future prospects. To sum up, unless proper habitat improvements are made, controls set on efforts and yields, diversification in marketed product is done, the prospects of greater yields are not seen.

The nature of changes that are required to be made to improve the present trends or to prevent deterioration are given below.

Thrust Area 1

Free access of fishing boats/trawlers to some shallow areas such as, for example, Kakinada Bay may lead to undesirable economic consequences and depletion of fisheries by overfishing. Excessive capital and labour are attracted to free access. The inability to curb free entry into coastal fisheries might result in overexploitation, overcapitalization and conflicts between different users (Rajyalakshmi *et al.*, 1986).

The overall depletion of degradation of resources can be curbed only by comprehensive management. An authority for this purpose must

be created. This body requires information on available stocks and the factors affecting them. National Fisheries Research Institutes have acquired considerable statistical data over a number of years and these data can be made use of by the management authority.

Thrust Area 2

The degradation and decline in the fish habitats must be stopped forthwith by resorting and enhancing and establishing protected area or sancturies in some. Full implementation of existing legislation is necessary. New legislations must be passed where necessary in this regard so that they can provide legal basis to limit habitat losses and degradation. The present effort to limit the lossess face constraints because of the lack of proper consideration to fisheries needs in the planning such as controls or consultations when changes are made on land and water uses, permitting industrial establishments and operations in shore areas. More studies are to be emphasized on habitat losses, particularly of mangroves. To offset this loss restoration programmes can be combined with aforestation programmes of the DRDA and IRRP and Forests Departments i.e. planting of mangrove seedlings in addition to casuarina in certain estuarine areas.

Taking Kakinada Bay as an example of a site specific changes can be seen that mangroves are being removed for aquaculture and industry. Industries such as fertilizer companies are permitted to be sited on the Bay shoreline. These will have critical effects upon fish stocks of the Bay. The conservation measures are essential here.

The relevancy of the research programmes should be through (i) identification of high-priority research needs: (ii) periodic inventory of habitat areas to determine losses and (iii) monitoring the effect of decisions alre dy implemented in some fisheries habitats.

RECOMMENDATIONS

Area 1: Improved management and conservation of marine fisheries

To improve the management of fish stocks, basically policies, plan and institutional managements are needed. They require:

- that all interested parties are brought in to form a forum to advise on the needs for management.

- As much scientific knowledge as possible on the stocks (i.e., the resource) their habits and ecological relationships.

- Limit entry to any fishing areas based on the above information first educating the fishermen on the biological and economic aspects (for example, the State Department can limit the number of trawlers operating in a given area and also limit the area of operation). Funding for proper surveillance to assure compliance with management programmes.

- Develop necessary legislative authority. Manage stocks for optimum utilization i.e., (i) for some stocks it may be better to prohibit fishing for a short while to rebuild a stock. (ii) or to prevent capture of other incidental species while catching prawns.

- Information booklets be brought out on specific areas such as Kakinada Bay (East Godavari Dist) to point out the fisheries potential and need for conservation.

Strengthening may be done through improved technology base on one hand and improved marketing system on the other.

Most of this action lies in management area. For instance improving the resources by way of restoration programmes, continued availability of stocks, alternative technology such as aquaculture, and improved craft, gear and processing technology and if possible, limit entry to fishing.

National utilization of resources is the prime objective. Whether joint Government-industry or privately managed programmes can be taken up (if not already done) wherein government will provide the needed technology other inputs and financial support. This can best apply to offshore fishing which, at present is given to foreign vessels.

Another method is to think in terms of comprehensive catch-to market systems (i.e. integrating capture, processing and marketing) whereby middlemen are eliminated.

Area 2: Management of fish habitats

It is to be reemphasized that protection of fish habitats prevents deterioration, degradation of these habitats and results in restoration and enhancement of areas; declaring sanctuaries/protected areas without detriment to other compatible uses of the area. In this programme, the State Board for Prevention and Control of Water pollution and Forest and Environment Depts. must coordinate their activities with Fisheries and National environmental policy acts must be

brought in.

Restoration work can include replanting of mangrove seedling; enhancement by way of preventing effluent releases and stocking of juveniles and so on.

- Environmental impact statement by all industries must include impact on fish habitats and losses thereby.

- Educate public through extensive activities, TV and radio information etc. Make public also party to these conservation programmes.

- Funding to undertake these activities must be provided for, separately.

- Quick dissemination of information (by research, survey etc.) to serve particular needs.

- A Coastal Zone Management Legislation is needed.

Land use districts can be zoned in the basis of following categories: 1. Urban, 2. Agricultural, 3. Conservation and 4. Rural. Departures from this are to be allowed only by permit system. Indentification of hurdles is very much essential here and universities, fisheries organisations can undertake quick short-term studies in this regard whatever the earlier failures may be.

In this context an integrated approach to development of coastal fisheries to minimise the trawler (industrial) versus small-scale fisheries conflicts and at the same time protect the resources must be developed by involving both the groups in the decision making process.

Area 3: Aquaculture

Competing uses of the coastal areas, and taking into account the fact that fishing at times is a part time occupation, this sector should be part and parcel of an integrated rural development plan. Aquaculture helps to add income to the family beside providing occupation and food and helps to divert pressure from the fast depleting coastal fisheries.

Therefore, it will be a strategy to increase production and or divert attention from the capture to culture fisheries to prevent stress on some species.

The output from aquaculture (fresh and brackishwater) in Andhra Pradesh has been tremendously on the rise in the current decade and might be accounting for about 0.1 lakh tonnes, roughly 10% of total Andhra Pradesh production. The state can expect to further increase this production to 40% in the near future in view of the rising costs of Agricultural production and a good demand at Howrah market for freshwater fish and international market for the shrimp.

In Andhra Pradesh aquaculture of major carps began a century ago but it is in the current decade that the seed production has multiplied to supply almost the entire need of the aquaculture industry of the state. This is both in public and private sectors. The seed production, however, has not become a feasible technology in regard to the brackishwater fish and prawns. Hence, brackishwater aquaculture industry is lagging far behind. Private or public aquaculture has not yet touched oysters, clams and catfish and no expansion has taken place in regard to the giant freshwater prawn, *Macrobrachium resenbergii*.

There is quite a good scope for increasing fish production in Andhra Pradesh by developing/expanding hatcheries and also encouraging farming of shell-fish such as molluscs in the inshore areas such as bays/creeks.

For some species such as the major and exotic carps the technologies of seed production and farming are well known and production per unit area can be readily increased to meet the demand. For other species, particularly in brackishwater species, available technology must be further augmented vis., for shrimp, molluscs,crabs, lobsters and marine fishes (mullets, *Chanos,Lates* etc.).

The important advantage of aquaculture in Andhra Pradesh is the availability of water resources in many coastal areas thus avoiding competitions with other uses. Production records from private industries demonstrate the success of major and exotic carp culture and provide also a basis for estimating their potential for expansion. The carp production has increased from about 10 tonnes in 1970 to about 1000 tonnes in 1980. With adequate markets and prices, it can be expected to be doubled during the next half a decade.

Although all the trends point out to the expansion of aquaculture, there is no sign of diversification on the part of the private industry in regard to the species to be cultured. For instance, viable technology is available for freshwater prawn farming so also is a ready shrimp market. But it has not taken off yet although its commercial viability has been proved in countries such as Hawaii. Adequate quantities of clean freshwater is needed. Similarly is the need for unpolluted brackishwater in the coastal zone. But competition for water does exist and these problems

i.e. zoning, waste disposal/control and, licensing must first be attended to.

Many Government organisations, both central and state are involved to some degree in development of aquaculture. Each is independent of the other without an overall plan. No attempt has been made to make a unified effort to guide and coordinate these multifarious efforts.

Since it is proved that aquaculture is a tool for augmenting the state supply of aquatic food (protein source) and offers opportunity for making use of hitherto un-or underutilized resources such as the brakishwaters, a state wide policy is needed to organise this as an industry and also to protect the costal zone.

The objectives of a specific plan and policy statement in aquaculture development would be:

- To maintain or increase fish production using a broad spectrum of species. To provide scientific, technical, legal and institutional base needed for the development of aquaculture. To facilitate easy flow of or dissemination of research results by way of extension activities.

- A state level body would engage in activities providing leadership, joint planning and coordination of programmes with all parties including international agencies concerned in aquaculture development (viz., the State Government, the academic body, the private sector etc.).

- Research and development to provide biological information and development of aquaculture of certain species shall be done.

- Other institutional hindrances to progress of aquaculture would be tackled in co-operation with other groups such as economics, legal and social ones.

Starting a State Fisheries Institute for Education and Training of scientific/technical personnel, an Institute is very much the need of the day, not simply to develop graduates and postgradutes in fisheries science but training of fisheries managers, scientists with multidiciplinary approach to the development of the coastal and marine zone to preserve, protect, and enhance the same for fisheries, for maintaining the aesthestic values of the shore line, for pure water resources. These trained personnel in different disciplines are needed under extended jurisdiction to meet the needs of the new threats to environment.

A college of comprehensive fisheries including Marine Affairs may then be started immediately anywhere along the coastal areas of the state, staffed by teachers possessing experience in multidisciplinary aspects of aquatic living resources.

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THE STATUS OF PRAWN FISHERY AT JAKHAU, GUJARAT

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ABSTRACT

During the past one decade, Jakhau has become an important seasonal (September to March) fishing centre in Kutch, attracting an increasing number of fishermen and traders from different parts of Gujarat. The prawn fishery contributed 24% of the total trawl landings during the 1985-86 season. The prawn fishery is chiefly supported by penaeids like *Penaeus monodon, P. indicus, P. semisulcatus, Metapenaeus brevicornis, M. kutchensis,* and non penaeids like *Hippolysmata ensirostris and Exopalaemon styliferus.* The peak season for the fishery is from October to January. The average catch per unit effort for prawns showed a clear decline during 1985-86 and 1986-87 seasons. This is apparently attributed to the fact that increasing number of migrant fishermen come here to fish, leading to overfishing. Management measures, that should be taken to conserve the stock in these fishing grounds are suggested.

INTRODUCTION

Jakhau (23^0 14.5' N and 68^0 36.5' E) is an important seasonal (September to March) fishing centre in Kachch district of Gujarat. However, there is no information available on the status of fisheries of this area. Studies made so far include a general survey of the prawn fishery of the Saurashtra (Srivatsa, 1953), economic value of prawn fishing industry (Lacumb. 1960), occurrence of *Metapenaeus kutchensis* in the Gulf of Kachchh (George *et al.*, 1963), distribution of prawn species in the coastal waters of Kachchh (Ramamurthy, 1963, 1964, 1967), study of prawn grounds in the north-western division of India (Virabadhra Rao and Dorairaj, 1966), and observation on total prawn catch of Saurashtra coast (Kagwade, 1967). More recently observations on prawn fishery in the Gulf of Kachchh (Deshmukh, 1975), studies on the fishery at Sukhper and Lakhpat areas in Kachchh (Sarvaiya, 1978) and a survey of the prawn resources within the exclusive economic zone of the north west (including Kachchh) coast of India (Bapat *et al.* 1982) have been reported.

As a part of our research programme to evaluate the anthropogenic pressure on the natural resources of the Gulf of Kachchh, we examined in some detail the prawn fishery at Jakhau. The present paper analyses prawn catches landed by trawlers, and suggests management measures aimed towards optimum utilization of the stock in these fishing grounds.

MATERIAL AND METHODS

Fishing, particularly prawn fishing, in Jakhau waters was studied. Simultaneously, anthropogenic pressure on mangroves and the existing fishing facilities about the fishery and status of mangroves in the vicinity was gathered by interviewing fishermen during our frequent visits to the site. Total catch for each season was estimated from the data obtained from Department of Fisheries, Govt. of Gujarat. Effort data in terms of number of boats operating, were obtained from the Port Office, Jakhau. Additional data, namely, fishing schedule, location of fishing grounds, quality of catch and expenses incurred in fishing, were obtained by interviewing about 10% of the fishermen at Jakhau during 1985-86 and 1986-87 seasons. The rainfall data was obtained in Nailya, which is 26 km north of Jakhau. Effort is defined as the number of boats operating in season. Catch per unit effort (c.p.u.e) is the catch by one vessel in unit time (1 trip).

RESULTS

Historical background

Traditional fisheries exploiting the prawn and fish stock, with bag-nets, hooks and lines and other gear have existed for a long time. The trawl fishery began in 1978 with the arrival of trawlers from Kotda, Madhwad, Veraval, Porbander, Salaya, Sikka and Sachana (Fig.1). In later years fishermen from other places also started camping at Jakhau.

Today, the fishery at Jakhau is largely seasonal and mainly carried out by migrant fishermen. The trawlers mainly catch prawns by using trawl nets while the OBM (out board motor fitted boats) mainly catch fish like Bombay duck, sharks and rays, by using large bag-nets and gill-nets.

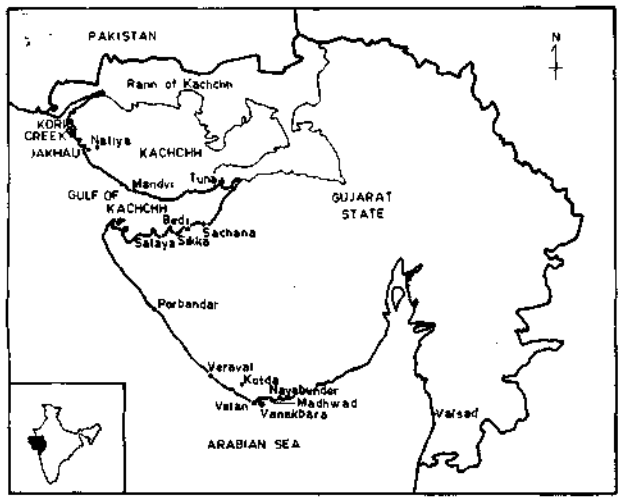

Fig. 1. Map of Gujarat showing location of places from which migrant fishermen come to Jakhau for fishing.

Migrant fishermen

The migrant fishermen from the different stations come to Jakhau and camp there, from September to March. During the 1986-87 season, the proportion of trawlers of migrant fishermen of different place that operated from Jakhau are illustrated in Fig 2. The percentage of migratory OBM operated from Jakhau for the same season are shown in Fig.3.

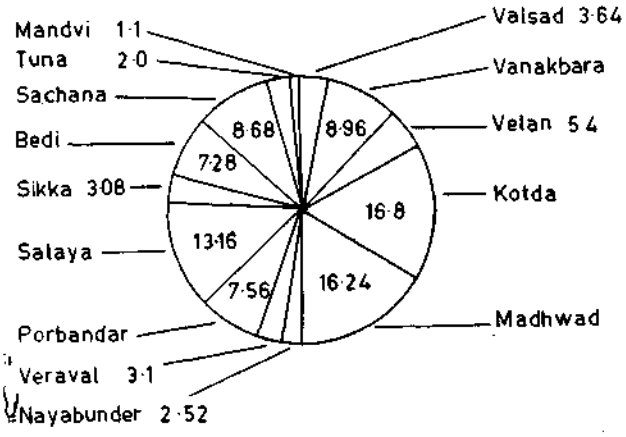

Fig. 2. Stationwise proportion in percentage, of migrant trawlers at Jakhau.

Resident fishermen

The total resident fishermen population at Jakhau is 330, of which 150 are active fishermen. They have only 14 non-mechanised boats which operate during the lean season (April to August) so that most of the fishermen go on foot for fishing using traditional gear. In the peak season when the migrant fishermen arrive, most of the resident fishermen work as sailors cum helpers on the trawlers. A few of them are engaged by the fish traders who also come and camp at Jakhau during the fishing season, to sort and pack the catch. Some of the villagers of Jakhau who at other times do farming, set up their shops such as tea stalls and barber shops, during the fishing season and have some additional income.

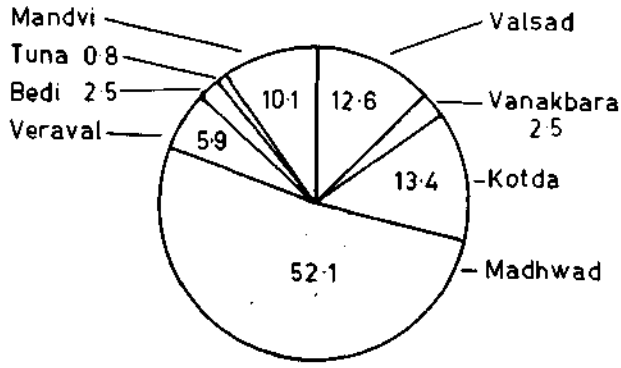

Fig. 3. Stationwise proportion, in percentage, of OBM boats to Jakhau.

Fishery

The trawlers varying in length from about 12 to 14 m, fitted with 102 HP engines and equipped with otter trawls with head rope length varying from 5 to 6 m and with cod end stretched mesh of 2 cm are operated in this region, mostly within 6-8 fathoms. The boats generally go in pairs for 4 to 6 days fishing. They make 5 to 6 trips in a month, with an average of 180 fishing hours per month per boat. For each trip, approximately 25 to 40 kg of wood from mangroves *Avicennia marine*, and terrestrial plants *Acacia sp* and *Prosopis juliflora* is cut from nearby sources and utilised as fuel for cooking. During each trip 8 to 10 slabs (a slab of 140 kgs) of ice are also carried along. Fishing during a trip is carried out day and night off the west coast of Kachchh, extending for about 64 kms from Jakhau. The prawns are decapitated on board and preserved in ice. On landing the catch at Jakhu, the prawns are sorted into the 4 sale groups and sold directly to the prawn traders.

Prawn species

About 10 species of prawns are caught and grouped into 4 groups for sale, in decreasing order of size and price as follow: (1) *Jumbo Penaeus monodon, P.indicus, and P.merguiensis*, (2) medium white-*Metapenaeus brevicornis, M.kutchensis* and small individuals of *Penaeus indicus*, (3) medium brown - *Parapenaeopsis hardwickii, Metapenaeus monoceros* and small individuals of the large species, and (4) tiny-*Exopalemon styliferus, Hippolysmata ensirostris* and *Parapenaeopsis stylifera.*

During the 1986-87 season, the proportion of different groups in a trawl catch was jumbo-15.5%, medium white - 2.93%, medium brown-33.31% and tiny - 48. 25.0% The number of individuals per unit weight for each group was as follows : jumbo - 70 to 90, medium white - 160 to 200, medium brown - 160 to 200 and tiny -200 to 400.

Prawn catch statistics

Among 37 fishing centres in the Kachchh district, Jakhau is the most important one. Out of average catch of about 17,834 tonnes per annum of fin fish and prawns landed in Kachchh as a whole, during 1978 to 1987, about 4126 tonnes were landed at Jakhau. In the annual catch landed, proportion of prawns was about 25% at Jakhau as compared to about 17% for the Kachchh district as a whole (Table 1). Consequently, Jakhau contributed about 31% of 2364 tonnes of prawns landed annually in the Kachchh district (Table 2). This illustrates the importance of Jakhau in the prawn fishery of Kachchh.

Prawn fishery at Jakhau seemed to have passed through three phases during the period from 1978 - 1989 (Fig. 4 ; Table 3) as follows:

1978-1983. During this period, the number of trawlers operating in different years varied but little. Total prawn catch and c.p.u.e. stagnated more or less at about the same level until 1981-82 season, but there was a dramatic spurt in the total catch as well as c.p.u.e. during the 1982-83 season.

1983-85. Apparently attracted by high c.p.u.e. in 1982-83 season, an increasing number of trawlers started operating from Jakhau year after year starting from 1983-84 season. From 1983-84 to 1984-85 season there was a progressive increase in the total catch as well as c.p.u.e.

1985-1987. During 1985-86 and 1986-87 seasons increase in the number of trawlers continued, but c.p.u.e. progressively declined.

There is no significant correlation between the annual rainfall recorded at Naliya and c.p.u.e. (Table 3) at Jakhau. Table 4 shows that in an annual catch proportion of sale groups jumbo, medium brown and tiny varied in different years, but on the average they constituted 27%, 38%, and 33% respectively, medium white which fetches higher price than the medium brown (Table 5) constituted only about 2% of the catch.

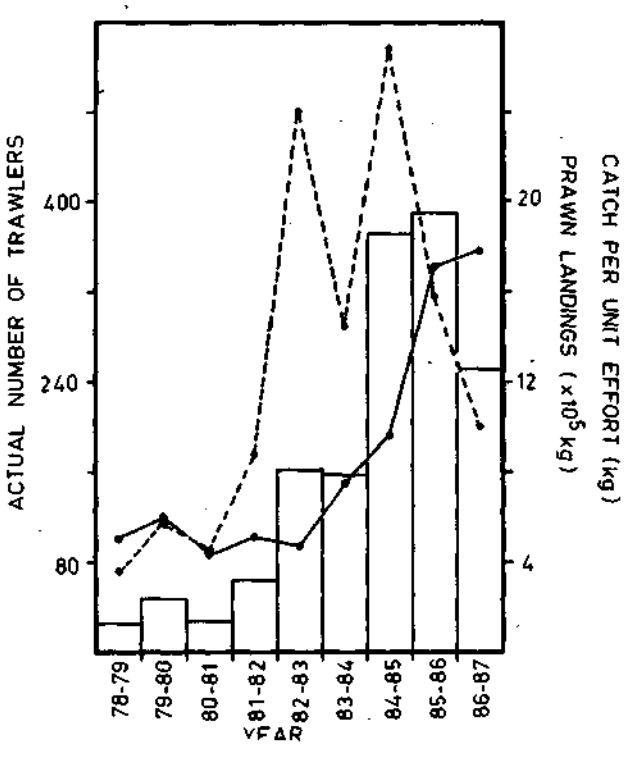

Fig. 4. Total prawn catch (histogram), number of trawlers operating (solid line) and the c.p.u.e. (broken line) in different seasons at Jakhau.

Infrastructure

Infrastructure for fishery at Jakhau is highly inadequate.(1) Jetty at Jakhau port has faulty construction and is unusable for docking boats; It has been so designed that the trawlers during low tide slide underneath it and sustain damages.(2) There is no proper water supply at the port, so that the fishermen are forced to purchase water throughout the season from the wells of an agricultural community about 12 kms inland. (3) Though there is electricity at the port, no electric connections are ever given to the fishermen, so

Table 1. *Jakhau catch in comparison to Kachchh as a whole.*

Period	Kachchh district total catch (tonnes)	Percentage		Jakhau total catch (tonnes)	Percentage	
		Fish	Prawn		Fish	Prawn
1978-79	6226.8	83.2	16.8	1757.6	92.2	7.8
1979-80	5658.1	83.9	16.1	2233.6	88.9	11.1
1980-81	4108.6	69.0	31.0	450.9	68.8	31.2
1981-82	6334.3	76.0	24.0	579.5	43.8	56.2
1982-83	13784.6	84.2	15.8	2762.9	70.5	29.5
1983-84	23314.5	86.2	13.8	3399.1	76.9	23.1
1984-85	34288.0	86.3	13.7	6396.2	70.5	29.1
1985-86	35477.0	88.5	11.5	8366.3	76.6	23.4
1986-87	31314.0	92.6	7.4	1187.6	88.7	11.3
Average	17833.99	88.32	16.68	4125.97	75.21	24.74

Table 2. *Percentage contribution of Jakhau fishery to the prawn catch in Kachchh*

Period	Kachchh district prawns (tonnes)	Jakhau %
1978-79	1049.6	13.0
1979-80	916.1	26.9
1980-81	1277.5	11.0
1981-82	1522.9	21.0
1982-83	2184.8	37.2
1983-84	3232.5	24.2
1984-85	4690.0	39.6
1985-86	4085.0	47.8
1986-87	2320.9	54.5
Average	2364.37	30.58

Table 3. *Summary of year-wise prawn catch at Jakhau*

Period	Number of trawlers	Prawn catch (tonnes)	Catch per unit effort (kgs.)	Rainfall (mm)
1978-79	105	136.6	36.15	505
1979-80	120	247.3	57.25	925
1980-81	87	140.6	44.91	550
1981-82	103	325.9	87.91	741
1982-83	94	814.2	240.61	309
1983-84	150	784.3	145.24	389
1984-85	193	1860.8	267.82	228
1985-86	343	1955.9	158.40	132
1986-87	357	1266.4	98.53	222
Average	172.44	836.89	126.31	444.56

Table 4. *Proportion of different sale groups in the Jakhau Prawn catch*

Period	Prawn catch at Jakhau (tonnes)	Percentage			
		Jumbo	medium white	medium brown	tiny
1984-85	1860.8	32.14	1.07	27.85	38.92
1985-86	1955.9	33.58	1.82	52.73	11.85
1986-87	1266.4	15.50	2.93	33.31	48.25
Average	1694.4	27.07	1.94	37.96	33.00

Table 5. *Cost and net gain of trawlers*

Period	Expenses incurred per trip (Rs.)	Selling price of prawn per kg (Rs.)				Net profit per trip
		jumbo	medium white	medium brown	tiny	
1984-85	1408	40	25	20	8	4431.74
1985-86	1577	55	[illegible]	25	12	3753.85
1986-87	1843	60	[illegible]	30	15	871.70
Average	1609.33	51.66	[illegible].66	25.0	11.66	3016.09

that they have to use lanterns and carry out unloading and sorting of the catch under poor light at night.(4) The dirt road from Jakhau village to the port (12 km) is a rough unfinished one making the transportation difficult and time consuming. (5) Two private dispensaries are set up, during the season, but they charge exhorbitant fees for medication, as the government health services are not extended to jakhau.

Mangroves

There is a luxuriant growth of mangroves north of Jakhau. Because of the arid climate and proximity of the international border with Pakistan, this part of the coast is sparsely populated and unlike many other places in the Gulf of Kachchh, the anthropogenic pressure on the mangroves is not severe. The cutting of mangroves is carried out mainly by fishermen while they are on fishing trip.

DISCUSSION

Proximity of mangroves to fishing ground is favourable for prawn fishery, since the relation between prawn recruitment and mangrove area appears to be logarithmic (FAO, 1980). Mangroves are considered as nursery grounds since many species of penaeid prawns spend the early months of their life in shallow inshore waters. The juveniles feed on the algae, minute organisms and organic detritus (Panikkar, 1952) which are readily available in the mangrove ecosystem. It seems possible that the large catch of prawns in Jakhau waters could be attributed to the good growth of mangroves. Another factor contributing to the large catch landed here could be the pollution free waters, since there are no industries or big ports on this part of the coast.

There is considerable reduction in the mangrove vegetation in the greater part of Gulf of Kachchh due to grazing by camels and cutting of the wood by the fishermen for fuel. Before large scale destruction of mangroves spreads to Jakhau, preventive measures should be taken to stop the cutting down of mangroves by providing an alternate source of fuel to the coastal people. Simultaneously, the existing mangroves can be augmented by planting new ones.

It is often reported that the rainfall increases the prawn catch in a particular area (Ramamurthy, 1967). Qasim (1972) observed that during monsoon enrichment of coastal waters takes place due to upwelling, by which bottom waters from great depths are brought to the surfaces. The upwelled water is very rich in nutrients but has very little dissolved oxygen, and since it comes very close to the shore, has a profound influence on the prawn population. However, the rainfall data recorded at Naliya does not show any relation to the catch landed at Jakhau. A possible explanation is that the catchment areas of rivers opening near about Jakhau, and the Rann of Kachchh from which the rain water is eventually drained by Kori Creek being far away form Naliya, the fresh water discharge on the Jakhau coast is not approximated by rainfall recorded at Naliya.

Table 6. *Statement of expenditure incurred per boat per fishing trip at Jakhau*

Description of expenditure	1984-85 expenses (Rs.)	1985-86 expenses (Rs.)	1986-87 expenses (Rs.)	Average
Diesel	725	800	963	289.33
Ice	208	240	280	242.67
Salary for crew	275	300	325	300.00
Provisions	150	175	200	175.00
Tobacco/Beedies	10	12	15	12.33
Water	5	10	10	8.33
Repairs	35	40	50	41.67
Total	1408	1577	1843	1609.33

Analysis of the costs and earnings (Table 5 & 6) of the average prawn trawler showed that even with the present heavy fishing, the operation is profitable. The fishery is therefore not at the moment in economic difficulty, though vulnerable to changes in prices of fuel or prawns and environmental factors like drought which may affect the cost of commodities, such as, ice and water. The net income benefit was sufficient for the 1986-87 season, but in comparision to the two previous seasons there is a substantial drop in profits. Fishing at the level estimated to give a maximum yield of prawns (343 boats/season, 1985-86 yielding 1955.9 tonnes) would give a net return (value of catch less costs) of about 46 million rupees. Slightly higher economic returns per trawler could result from a fishing effort less than that giving the maximum catch. However, a drastic reduction in the effort would lead to great reduction in the catch, thus causing unemployment to many fishermen and the women (approximately 500/season) who are brought every season from places like Vanakbara, Diu and Kodinar, to sort and pack the catch. An intermediate level of effort, of around 200 to 250 boats per season would seem an acceptable compromise between high catch, high employment and high economic returns for the continued sustenance of the stock at optimum harvesting levels. This can be regulated by initiating the resident fishermen to take active part in fishing.

Profit in fishing can also be increased by a decrease in cost of fishing by improving facilities like construction of a tar road from the jetty to the Jakhau village for quick transport of the catch, supplying water to fishermen through tankers during the fishing season, providing cold storage facilities at the jetty and by installing a government mobile hospital to deal with the various health hazards faced by the fishermen.

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Paper 77

STATUS AND PROGRAMMES OF MARINE FISHERIES DEVELOPMENT AND MANAGEMENT IN LAKSHADWEEP

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ABSTRACT

Tuna and tuna like fishes of Indian seas which remain largely underexploited at present, hold the greatest promise for development of fishing industry in India. The percentage composition of total tunas in the all India marine fish production ranged from 0.3 in 1970 to 1.36 in 1984-85. Lakshadweep a group of coral islands in the Arabian sea has got the distinction of being the only region in India where an organised fishery for tuna has been established in the small scale mechanised sector. Lakshadweep waters consisting of 20000 sq.kms. of territorial waters and 400000 sq.kms. of exclusive economic zone is potentially rich for tuna and shark. It is estimated that Lakshadweep waters support of fishable stock of 50000 tonnes of skipjack, 50000 tonnes of deep water tuna and allied species and 1 lakh tonnes of shark. Against this the present exploitation is 4807 tonnes of tuna in 1986 forming 87% of its total marine fish catch and around 16% of the total tuna catch of India. The principal gear employed is pole and line. Troll lines and hand lines form subsidiary gears.

The progress achieved in the fisheries sector of Lakshadweep is remarkable. From a meagre annual fish catch of 500 tonnes in 1960 the production has leaped to 5535 tonnes by 1986. Out of the total population of 42000 who are basically coconut growers about 5000 persons find employment in fisheries sector either directly or indirectly. The contribution of income from fisheries sector at current price is about Rs. 2.21 crores annually which works out to a per capita oncome of Rs. 527. The average catch of a pole and line tuna fishing boat is 70 tonnes worth Rs. 2.7 lakh for 6 months of operation in a year. The income per fishermen is worked out to Rs. 15000 for the said period.

These reachievements were made possible due to proper planning and execution of fisheries developmental schemes during the past 25 years. The fisheries developmental activities in Lakshadweep started in the year 1959. Prior to this fishing was primitive with catch insufficient even for local consumption. Tuna was not caught in any island except Minicoy. Various schemes were drawn up and launched by the Deptt. of fisheries for the proper exploitation of the fishery resources of the area. As a result, the fish production gradually increased and by 1986 the fish catch registered 5535 tonnes, Introduction of mechanised boats, popularisation of pole and line, long line and troll line fishing, conducting experimental and demonstration fishing, training of manpower, setting up boat building yards, canning factory and workshops, issue of fishery requisites and oil, providing infrastructural facilities, research and development for the improvement of craft and gear were the important schemes taken up and implemented by the Deptt. of fisheries. The objectives and functions of the Deptt. and the history of fisheries development in Lakshadweep are explained in this paper.

INTRODUCTION

The 36 small islands and islets and submerged reefs lying scattered in the Arabian sea, 250 to 460 km off Cochin between 8^0 and 12^0-$30'$ latitude (north) and 71^0 and 74^0 longitude (east) form the Lakshadweep group of islands. Out of these only 10 are inhabited. This Union Territory having an area of 32 sq.km. is the smallest among all the States and Union Territories in India. But it is unique in terms of its water spread area. It possesses a lagoon area of 4200 sq.km, 20000km. of territorial waters and 400000 sq. km. of exclusive economic zone. According to 1981 census the population of Lakshadweep is

42000. The area of individual island ranges from 0.1 sq.km. to 4.8 sq.km.

Each island except Andrott has a lagoon on the western side with a sandy beach. Lagoons provide safe anchorages for small and medium size fishing boats. The islands are of coral formation. The lagoons and reef provide suitable coral habitat for innumerable varieties of animals and plants. Outside the lagoon the sea bottom steeps down abruptly leaving a very narrow rocky continental shelf.

The oceanic waters surrounding the islands are potentially rich in living resources such as tuna, shark and bill fishes. The area around the islands and submerged reefs are particularly rich in fishery resources, the important of which are (1) Agatti, (2) Bangaram, (3) Tinnakara, (4) Parali, (5) Perumulpar, (6) Pitty, (7) Suheli, (8) Bitra, (9) Cheriyapaniyam, (10) Valiyapaniyam, (11) Kadmat, (12) Andrott, (13) Kalpeni, (14) Elikalpeni, (15) Minicoy.

Good fishing for skip jack in the above places is due to the high concentration of tuna shoals around.

BACKGROUND INFORMATION

The developmental activities in Lakshadweep received a real impetus after the area was formed into a Union Territory in the year 1956. A planned programme for the development of fisheries in Lakshadweep commenced with the establishment of a fisheries section in 1959. Prior to this, fishing in Lakshadweep was by primitive methods of harpooning and cast netting confined to lagoon and reef area with small rowing crafts. However, there existed a regular tuna pole and line fishery in Minicoy using rowing crafts known as 'Mas Odies'. In all other islands tuna fishing was unknown and fish catch was hardly sufficient even for daily consumption. The only source of income to the people was through coconut cultivation. The socio economic condition of the islanders had not undergone any change during the past many centuries. Palm leaf huts, few primitive fishing implements like harpoon and cast nets, superstitious belief, education limited to primary schools, majority below poverty line-these were the general nature of life style of the island community during early sixtees.

A fisheries Department was set up at Kavaratti in 1959 under a fisheries Officer on deputation from Kerala state marked the beginning of the fisheries developmental activities in Lakshadweep. The objectives assingned to were:

1) to step up fish production,
2) motivate the people to take up modern methods of fishing by extension, education and training and by providing incentives,
3) to organize intensive surveys on marine fishery resources,
4) processing and marketing of fish.

After making a preliminary assessment of the nature and extend of the resources available, a strategy for the fisheries development of the area was chalked out. Appropriate fishing crafts and gear and fishing methods and processing were identified. The following schemes were introduced for the realisation of the objectives.

1) Introduction of mechanised fishing boats
2) Training of fishermen in modern methods of fishing and handling of mechanised fishing boats, both on the mainland and islands
3) Experimental fishing to locate fishing grounds and to determine appropriate fishing methods
4) Transfer of technology in fishing and processing
5) Issue of fishing boats to islanders
6) Establishment of boat building yards, workshops and processing units
7) Providing infrastructural facilities like Jetties, Marking Buoys etc.

A brief account of the implementation of each of the scheme mentioned above, problems encountered and how far they have succeeded in yielding the desired result are given in this paper.

INTRODUCTION OF MECHANISED BOATS

This was the first step taken by the Deptt. after its formation in 1959. As the existing indigeneous crafts were found not suitable for installation of inboard engines, small mechanised boats from mainland were procured. The first 9.14 metres long mechanised boats were introduced in the year 1959 at Kavaratti. There was much opposition from the local fishermen especially from Minicoy against mechanisation. They feared that the sound produced by the engine would frighten away tuna shoals and claimed that mechanisation would be a failure in pole and line fishing. But practical demonstration in pole and line fishing with mechanised boats in the year 1962 had proved that their fear was not real. There was immediate demand for boats and to meet this 39 mechanised boats were procured from mainland. These boats were open type pablo boats of size 7.62 and 9.14 metres.

Transfer of Technology

In Minicoy the traditional pole and line tuna fishing employing indigeneous sailing crafts called 'mas Odies'was in vogue since about a century with an average annual catch of about 300 tonnes. In 1962 the mechanised boats introduced by the Deptt. for pole and line fishing was proved a tremendous success. But in other islands fishing continued to be the traditional harpooning for shark and bill fishes with practically no fishing for tuna. Transfer of technology of pole and line fishing available in Minicoy to other islands was therefore to be taken on priority basis.

Demonstration Fishing Units

In order to accomplish the task of transfer of technology Depttl. fishing units were set up in all the islands. The first demonstration tuna fishing vessel was introduced in Agatti in the year 1963 which was a mas odi (indigeneous sailing craft of Minicoy). The mas odi was soon replaced by mechanised boats of size 9.14 m. Local fishermen were given intensive training in tuna fishing under the guidance of experts recruited from Minicoy. Simultaneously local people were recruited as fishermen to work in Depttl. boats to accelerate the process.

Fishermen by nature are, as they are everywhere, very conservative and to prevail on them to accept any thing new is a onerous task. They would believe that what the depttl.personnel had developed was a low cost technology most suitable for harvesting the tuna resources. So the Deptt. had to intensify motivation through extension and education. As incentive, liberalised subsidy (100% on cost of engines and 50% on hull) was offered in the issue of boats at the initial stages. The number tuna catches landed by the demonstration fishing boats could create great enthusiasm among the islanders and confidence in taking up tuna fishing as a vocation. By 1975 pole and line technique was picked up in all the islands and consequently the demonstration programme was wound up.

Training of Personnel

Success of implementation of any programme however prudently and scientifically concieved, depends mainly on the skill of the personnels who are involved in it. To the local fishermen of Lakshadweep operation of mechanised boats and fishing with them were the two different fields in which they were new. Hence when the programmes of mechanisation of fishing crafts was taken up it was felt necessary to make the fishermen trained in the field. In order to fulfil this objective a fishermen training programme was organised in 1959 in which local fishermen were trained in the running and maintenance of mechanised boats, fabrication and mending of fishing gear, fishing with trolling and pole and line and long line and fish curing with salt. This training course of 6 months duration which was continued upto 1968 produced 209 trained hands. Later on the training programme was institutionalised by establishing a Fishermen Training Centre in 1972 at Minicoy. So far 300 persons have been trained in the fishermen training centre. Apart from giving training to local people of Lakshadweep, the fisheries department gave practical training in pole and line fishing to fishermen deputed by Andaman and Nicobar administration during 1977. Trained technical hands to spearhead various developmental schemes was an important necessity. To meet this requirement, 88 officials were got trained in different disciplines at various fisheries institutions like CIFNET, CIFE, etc. Table 1. gives details of technical manpower available with the Deptt.

Mechanised
Boat on Subsidy

The programme of mechanisation was launched by the Deptt in order to step up fish production by the exploitation of the rich tuna and shark resources. Though the response from the islanders towards mechanisation was not encouraging during initial stages the Deptt was able to overcome the situation gradually, through extension, education, demonstration and various kinds of incentives including liberalised subsidy schemes. Under this scheme of "issue of mechanised boats to fishermen" boats are issued on subsidised cost repayable in monthly instalments within a period of 9 years. In the beginning the subsidy allowed was @ 100% on the cost of the engine and 25% on the cost of the hull. By 1968 the scheme become popular and Govt. of India reduced the rate of subsidy in stages. The present rate is 33 1/3% on the cost of engine and 20% on the cost of the hull. So for under the scheme 312 Nos of boats have been issued by the Deptt. to local fishermen. The details of islandwise issue of boats are given in Table 2. This is the major scheme launched by the Deptt. Which made remarkable impact on

Table 1. *Availability of Trained Manpower for the Fishery Sector in Lakshadweep*

Sl. No.	Description of Training	No. of people trained
1.	Fishermen trained at Beypore	12
2.	Fishermen trained at department boat in islands	209
3.	Fishermen trained in shark liver/oil extraction, Calicut	4
4.	Tuna-lognline (Deepsea fishing) at Cochin	2
5.	Beach-de-mer Extraction and flying fish fishing operation at Nagapatanam, Madras	2
6.	Carpenters - Brunton and Company, Cochin	2
7.	Training in boat building, Kakinada	1
8.	M.P.P.T.C.,Mangalore-Training in fish processing	1
9.	Shore machanics I.N.P., Cochin	14
10.	Post Graduate diploma in fishery science at Central Institute of Fisheries Education, Bombay	13
11.	Training in repair and maintanances of out board engine at Cochin	4
12.	No. of persons trained in fishermen Training Center, Kadmath	152
13.	Fishing second hand/Mate fishing vessel course at CIFNET Cochin	27
14.	Engine driver Course at CIFNET, Cochin	15
15.	Boat building forman course at -do-	3
16.	Shore mechanics course at -do-	5
17.	Gear technician course at -do-	1
18.	Radio telephone operators course -do-	2
19.	Teacher training course at -do-	1
	Total	470

the socio economic condition of the islanders. In proportion with the increase in the number of boats the total fish landings also shot up to new heights. Table 3 and 4 shows the yearwise fish landings from 1972 to 1986.

Table 2. *Island-wise number of boats in Lakshadweep in 1986*

Islands	Pole and line	Long line	Troll line	Engged For shipping purposes	Total
Agatti	51	6	-	6	63
Amini	2	2	19	10	33
Androth	-	-	34	-	34
Bitra	10	-	-	-	10
Chetlat	-	4	12	5	21
Kadmath	-	3	5	10	18
Kalpeni	-	-	5	10	15
Kavaratti	16	-	15	16	47
Kiltan	-	-	16	12	28
Minicoy	35	-	-	5	40
Total	114	15	106	74	309

Mechanisation of Indegenous Crafts

Simultaneous with the issue of mechanised fishing boats facilities were extended to the fishermen by the Deptt to mechanise the traditional fishing vessels of Minicoy by inboard engines. The small country crafts of other islands were supplied with outboard motors at subsidised cost. So far 250 outboard motors have been issued for mechanisation of small crafts through the Deptt. and IRDP. These outboard fitted crafts are being used for troll line operation and lagoon fishing.

Fishery Requisites on Subsidy

While popularising fishing by mechansied boats it was necessary for the local fishermen convinced of the efficiency of various types of essential fishery requisites like nylone twin, monifilament, etc. In order to make these goods available they were issued at subsidised cost through fisheries units in all the inhabited islands. The scheme served very well, far, allowing the subsidy, though it was discontinued when it was popular and fishermen were financially capable of buying at actual cost.

HSD Lubricating Oil

The supply of HSD oil required for operation of fishing boats was carried out by the Deptt. from the very beginning of mechanisation. In the absence of diesel oil outlets by Petroleum Companys as on the mainland, the work of purchase and supply of HSD and lub oil is still done by the Deptt of Fisheries. A subsidy of 30 paise per litre of HSD is given to the fishermen.

EXPLORATORY FISHING

Besides the rich skip jack resources, Lakshadweep waters is rich in sharks and deep swimming tunas. In order to have an assessment of the potential and to locate rich fishing grounds the Deptt offisheries started long line operation using 11.60 metres long boats in the year 1966. The exploratory fishing conducted during

Table 3. *Island wise year wise tuna landings in Lakshadweep 1972 - 86 (in tonnes)*

Year	Agatti	Amini	Androth	Bitra	Chetlat	Kadmath	Kalpeni	Kavaratti	Kiltan	Minicoy	Suheli	Annual	Total
1972	136	7	49	5	23	26	12	35	4	217	-	513	
1973	419	24	26	84	16	18	8	28	24	375	-	1021	
1974	518	32	60	116	77	32	14	45	28	333	-	1254	
1975	718	79	69	79	238	61	45	76	32	542	-	1932	
1976	542	44	33	103	39	37	54	70	39	330	-	1291	
1977	392	67	72	49	14	40	30	62	19	420	-	1166	
1978	899	64	173	92	36	49	21	211	19	311	-	1875	
1979	1314	72	303	118	116	100	62	207	86	415	-	2794	
1980	490	46	179	104	32	43	27	150	54	644	-	1760	
1981	820	81	196	126	38	37	41	395	23	485	-	2236	
1982	550	77	243	345	48	38	63	150	102	427	821	2966	
1983	731	53	283	166	96	36	59	164	55	273	1121	3037	
1984	2000	110	210	140	129	58	48	111	93	615	798	4313	
1985	2013	123	183	185	329	113	133	118	173	289	116	3774	
1986	1936	91	334	526	151	39	134	273	103	946	274	4807	

Table 4. *Yearwise Specieswise Fish Landings in Lakshadweep 1972-86 (in tonnes)*

Name of species	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Barracuda	7.5	11.6	17.2	17.4	20.8	14.9	17.9	10.8	13.7	12.5	10.5	21.1	13.9	8.0	7.6
Coral fish	21.4	29.9	40.6	42.3	53.6	51.1	35.1	31.9	28.8	22.9	26.9	19.9	21.9	6.6	13.9
Caranx	29.7	63.1	60.9	60.9	94.3	65.2	59.6	57.9	77.8	104.9	88.7	59.2	45.2	49.6	51.1
Flying fish	17.5	42.4	43.1	29.6	41.8	29.9	33.6	15.8	28.9	15.5	24.9	29.5	15.4	6.3	13.2
Gar fish	18.8	49.8	26.9	29.1	34.1	57.9	144.2	100.9	99.1	112.9	87.1	100.1	61.8	38.9	42.6
Goat fish	13.1	37.0	32.8	33.1	58.3	29.1	27.2	27.1	26.9	25.1	27.1	33.3	24.3	28.3	45.9
Octopus	17.1	20.0	15.8	18.9	39.8	23.3	19.7	15.6	11.0	14.3	22.3	12.6	13.6	11.1	10.9
Perches	72.3	112.6	132.9	116.7	192.4	154.9	127.1	127.3	250.8	221.8	230.1	257.5	115.3	63.8	71.9
Ray	81.2	75.8	88.7	158.9	151.8	133.6	29.2	171.5	58.7	21.5	18.6	71.8	88.7	70.8	37.0
Rainbow Runner	10.9	15.9	25.8	25.4	49.0	56.5	36.1	76.2	125.7	93.5	126.2	92.2	68.5	44.9	36.5
Sail fish	41.9	51.5	58.3	42.9	29.0	24.5	13.9	15.9	13.3	17.2	42.4	37.3	41.5	73.5	45.3
Seer fish	50.2	77.5	90.9	65.9	85.7	41.5	41.3	23.9	21.4	49.7	99.5	63.1	58.7	58.5	36.3
Shark	76.4	94.1	163.0	157.3	201.4	161.9	168.7	192.5	225.4	188.9	220.3	253.1	198.2	156.9	97.5
Trigger fish	8.4	14.5	6.9	8.9	5.1	7.5	7.4	4.6	3.6	7.4	6.8	9.8	6.9	18.1	9.7
Tuna	513.3	1021.5	1254.9	1932.1	1290.9	1165.5	1874.9	2794.3	1756.9	2236.4	2965.9	3036.7	4312.9	3774.8	4807.2
Miscellaneous	101.7	136.6	173.1	165.1	223.4	197.2	143.9	179.7	162.3	155.9	209.0	203.7	244.3	219.5	209.5
Total	1081.2	1853.7	2231.8	2905.4	2571.5	2214.5	2780.3	3845.8	2906.7	3300.3	4201.2	4300.7	5330.7	4625.5	5535.7

Table 5. *Result of Longline operation by the Departmental 30 and 38 footer near the islands of Agatti and Kadamath and submerged reef of Valiyapani*

Station/Months of operation	Sharks						Otherfishes	
	Depth of operation (in M)	No.of hooks	No.	Total weight (kg)	Catch/ 100 hooks	Average wt (kg)	No.	Total weight (kg)
1. March / April 1971	30	1010	119	5455	11.8	45.8	4	181
2. November / December, 71 and February, 72	30	570	42	2275	7.4	54.2	Nil	Nil
3. February / March, 1972	30	680	48	2517	7.1	52.5	Nil	Nil
4. April / May, 1972	30	645	38	2415	6.0	63.6	Nil	Nil
5. November / December, 72 and January, 73	110	1330	110	7606	8.3	70.0	4	239
6. March and April, 73	110	1972	131	8489	7.3	65.0	Nil	Nil
7. February, 73	110	485	56	2369	11.6	42.0	3	162
Total		6512	544	31126			11	582
Average					8.4	57.2		

the period 1965-75 around Agatti, Kadmat and submerged reefs of Valiyapani at a depth of 30 to 110 meters disclosed that Lakshadweep waters can support a rich and sustained fishery for shark. The average hooking rate was 8.4% which was comparabe to the best. The average weight of one shark was 57 kgs. The results of long line operation is given in Table 5. Since most of the parts of the sharks can be profitably utilised the long line operation was proved highly economical. The long line operated by the Deptt was of Japanese specification meant for catching deep water tuna. But 95% of the catch constituted shark. Gradually this fishing method was popularised and at present there are 15 boats operating long line on regular basis.

Long Line Gear on Subsidy

When the long line fishing operation was proved a success, steps were initiated by the Deptt to popularise this gear among fishermen. As a part of the promotional efforts the Deptt supplied long line gear fabrication materials to promising fishermen on subsidy.

CONSTRUCTION OF MECHANISED BOATS

The demonstration fishing, issue of mechanised boats on subsidised cost and various other incentives, provided the required stimulus for growth of the fishing industry. During the initial period i.e. from 1959 to 1965 boats were purchased from mainland to meet the requirements of the fishermen. In order to keep pace with the growing demand of boats and to provide employment to the local talents in carpentry profitably a boat building yard was established in Kavaratti in the year 1963. The yard provided employment to 50 persons. So far 153 boats of sizes 7.62, 9.14 and 11.6 metres have been launched from this yard. The demand for mechanised boats was increasing and to meet this the second boat building yard was established in the years 1974 at Chetlat. A total of 119 boats have been constructed from this yard.

SETTING UP OF WORKSHOPS

Repairs to fishing boats are to be attended promptly so as to minimise loss of fishing days. Taking engines to mainland every time for repairs is not practical due to high cost of transport and local facilities had to be built up and the first fisheries workshop was started in Kavaratti in 1961. This was followed by workshops in all the inhabited islands equipped with essential machinery. These workshops are a real boon to the fishermen.

SUPPLY OF SPARE PARTS

Lakshadweep being a remote area where there are no marine engine spare parts dealer, the responsibility of purchase and supply of this items to fishermen is also vested with the Fisheries Deptt.

FISH CURING

The demonstration of curing shark and processing tuna was under taken by the Deptt in all islands by constructing curing yards and smoking kilns. Prior to sixtees sun drying without salt was employed for curing fishes, other than tuna and salt curing method was unknown. In order to popularise salt curing, demonstration programmes in scientific way of salt curing was orgainsed by the Deptt. Simultaneously a scheme to issue salt to fishermen on subsidy was also formulated. Salt curing of fish is now very popular in all the islands.

SETTING UP OF CANNING FACTORY

As a result of implementation of various developmental schemes the production of tuna in island went up substantially which necessitated appropriate modifications in the post harvest technology also. The entire tuna caught in the island was processed into a dried smoked product called 'mas' which has a shelf life of about one year. In order to have a sophisticated product out of tuna acceptable to both internal and foreign markets a pilot canning plant was set up at Agatti in the year 1963. As the pilot plant was found successful action was initiated for the establishment of a canning factory at Minicoy. The tuna canning factory with a production capacity of 10000 cans per day with an ice plant of 5 tonnes and a cold storage of 20 tonnes capacity was commissioned in the year 1969. The produce from this factory is well received both in home and foreign markets. The present production in the factory is around 1,25,000 cans during a season. The factory has opened avenues of employment to 50 persons directly. This is the only tuna factory in India exclusively for tuna. Inspite of various constraints the factory has been able to keep up the production targets through out the period. The production during the last five year is given in Table 6.

Table 6 *The Production and sales of the minicoy canning factory 1980-86*

YEAR	PRODUCTION	
1981-82	51,976	Cans
1882-83	76,050	"
1983-84	75,752	"
1984-85	1,22,012	"
1985-86	1,09,985	"
TOTAL	4,35,775	"

MARKETING AND PROCUREMENT

Lakshadweep has to depend on mainland for almost all of its day to day requirements. A supply and marketing wing was therefore established in Cochin in the year 1973 to cater the needs of the Fisheries Deptt. Purchase and supply of stores required for running boat building yards, canning factory and work shops, purchase and supply of spares and fuel required for sale to fishermen, marketing of tuna cans are the important functions discharged by this office at Cochin.

INFRASTRUCTURAL FACILITIES

The Deptt. of fisheries has diverted its attention for providng adequate infrastructural facilities to support the industry. Jetties have been constructed in important islands. One slipway installed at Kavaratti is used for hauling up/launching of boats. Oil storage tanks are installed in all the islands for supply of oil to fishing boats.

Submerged reefs and sand beaks like Valiyapani, Cheriyapani are rich fishing grounds. But only few boats venture to go to these areas for fishing for want of navigational aids and processing facilites. The Deptt. has recently provided marking buoys at Valiyapani and Cheriyapani to make these places easily accessible to boats. A concrete platform has also been made at Valiyapani to be utilised for fish processing works and for resting. Such facilities for other places are also proposed in the 7th plan.

COLLECTION OF STATISTICAL DATA

Statistics is a powerful tool to evaluate the performance of an industry and to formulate developmental policies. Recognising its significance in the planning process, a well organised statistical wing has been set up in the Deptt as early in sixtees consisting of a net work of collection centres with Field Assts, Statistical Asst and technical officers. In Lakshadweep daily fish landing data are collected from each craft at the landing site by complete enumeration and not by random sampling. Because of this complete enumeration system, the statistical data on fish landings of Lakhadweep bear greater degree of accuracy. The daily fish landing data craftwise, gearwise and species wise-are collected by the field assistants posted in each island. The data collected are sent to the headquarters at the end of everymonth and tabulated, analysed and interpreted by the statisical wing of the fisheries directorate. Quarterly bulletins on fish landings are prepared and released regularly from the Directorate.

DIVERSIFICATION IN FISHING

The importance of pole and line as a commercial gear for the exploitation of tuna resources was soon recognised by the industry. Since tuna fishing season was confined to few months in a year the need for a diversification in fishing efforts was felt. The troll line, an effective gear for seer fish, tuna, bill fishes and barracuda and long line for sharks were the two gears introduced by the Deptt. to achieve the goal of diversification. In Andrott, Kiltan, Chetlat and Kadmat the main fishing gear used is troll line. The types of fishing gear employed in different islands are given in Table 2.

EXPERIMENTS ON MARICULTURE

Deptt has also made attempts in the field of mariculture which has assumed much popularity in recent years. Attempt was made by

the Deptt to culture mussel in Kavaratti lagoon. About 2000 mussel spats were transported from Calicut to Kavaratti during August, 1974 for trial culture adopting the rope culture method demonstrated by CMFRI Cochin in the summer Institute held in 1974. But the attempts did not succeed. Attack from predatory fishes, lack of adequate planktous, absence of suitable culture sites in the lagoon protected from wind and wave action are some of the reasons attributed to the culture failure.

Pearl oyster culture on an experimental basis was started at Kavaratti in the year 1981 when the occurrence of oyster spats *'Pinctada fucata'* was noticed on the reefs of the islands. The spats were collected from the reef during low tides and were reared in plasitc buckets which were kept suspended from the rafts moored in lagoon. The culture operation was then shifted to Bangaram island where more suitable sites without much wave action were located. Officials of the Deptt. were trained in the CMFRI. However, it was noticed later on that only a very small percentage of the spats collected was of pearl oyster; both *P. fucata* and *P. margaritifera* were seen in small quantities. During 1985, four cultured pearls of size 4 mm to 7 mm have been produced in Bangaram. Shortage of spats of *Pinctada* spp. in the collection nearly failed the experiments. However, due to the timely help by the CMFRI by supplying *Pinctada fucata* from Tuticorin Research Centre enabled the Deptt to continue the culture which is under progress.

SURVEY OF SEAWEED RESOURCES

Marine algal resources of Lakshadweep are quite large. They are found to grow profusely on the reefs and lagoons of all the islands in varying densities. According to the survey conducted on the algal resources by the Central salt and marine chemical Research Institute and the Deptt of Fisheries Lakshadweep, the estimated standing crops of the Agaro-phytes was 1540 tonnes. Out of 82 species collected during the survey, 60 species are found in estimable quantities. The estimated quantities of economic seaweeds are as follows:

Gelidiella acerosa	945	tonnes
Gracilaria edulis	420	"
Gelidium rigidum	75	"
Geliopsis repens	70	"

In contrast, the alginophytes resources are scarce - about 15 tonnes consisting of species of *Turbinaria* and *Sargassum*.

The Deptt has examined in detail the scope for commercial exploitation of the seaweeds and the feasibility of starting on agar agar plant in the island. But the proposal was dropped for want of techno- economic feasibility. Huge requirement of water, electrical power and fuel, problems in transportation of coal to the islands low rate of replenishment of the raw material after initial harvest were some constraints which discouraged the administration in going ahead with the agar agar project. Seaweeds form the major food of harbivores such as Surgeon fishes and turtles which are the dominent members of the lagoons ecosystem. It is feared that large scale exploitation of seaweeds may be disastrous to these organisms.

SURVEY OF HOLOTHURIANS

Many species of sea cucumbers are available in the lagoons of all the islands which are economically important for the Beche-de-mer industry. The occurrence of species as *Actinopyga mauritiana, Bohadsehia argus, Holothuria atra, Holothurianobilis, and Thelenota ananas* are found in varying densities in manyp islands. A survey of the resources was conducted by the Deptt. in collaboration with a private firm in Tamil Nadu during 1975-76. Though the firm could collect and process a large number of sea cucumbers it was found that resource is not abundant enough for a commercial venture.

EXPORT OF ORNAMENTAL FISHES

The multi coloured tropical coral fishes available in abundance in the island's lagoons and reefs offer promising export of ornamental fishes to west European countries. Lakshadweep fisheries department and Marine Products Export Development Authority, Cochin jointly undertook a survey of these resources in 1985 and as a pilot project undertook a survey of these resources in 1985 and as a pilot project some trial consignments of ornamental fishes have been exported to Netherland. The team identified more than 100 species of ornamental fishes belonging to 28 families-that could be exploited and marketed in Europe. Further a study team consisting of officials of MPEDA and Deptt of Fisheries Lakshadweep attended a training mission in Netherland in 1986 on packing and transportation of ornamental fishes. The trial consignment had a

mortality rate of 8% only on transit which is negligible and shows export is fensible. A scheme for export of these fishes has been submitted to the Ministry and sanction awaited.

IMPROVEMENTS IN CRAFT AND GEAR

The Deptt has succeeded in introducing the most suitable design of the craft to the fishing industry. Pole and line is the principal gear used in Lakshadweep. In order to increase the efficiency of the fishing technique new designs of the crafts were experimented to suit the peculiar neture of the area. Initially three types of boats were introduced by the Deptt. They were 9.14 m, 7.62 m. and the island pattern. Out of this 7.62 meters boat was found more suitable on account of its menoevrability in shallow reef conditions and low fuel consumption. Since this was found well acceptable to the industry attention was given for the production of these boats. During 1984 boat of 6 m long was introduced by the Deptt mainly for pole and line. This was a multi purpose low cost boat operated by 7 HP out board motor intended to meet the aim of one boat for each family. The boat is under trial run with different gears.

Live bait chumming and spraying water are two techniques employed in attracting tuna fish to aggregate around fishing boats in pole and line fishing. Two persons are now employed in a tuna fishing boat to spray water. This is not only hard but also inefficient. If mechanical spraying is introduced instead of hand spraying it will improve the effciency of fishing considerably. A spraying mechanism was developed by the Deptt and it was inaugurated at Kavaratti on 15.8.84. Experimental pole and line fishing with mechanical sprayer conducted by the Deptt at Agatti during 1984 was a great success. This device is now accepted by the industry.

INTRODUCTION OF 'PAYAYOS'

The Deptt has succeeded in introducing artificial fish aggregates known as 'PAYAYOS'. During 1981 two aggregates were tried one each in Kavaratti and Agatti. The device was fabricated using empty oil barrels and coconut leaves. These experiments were successful. The aggregate at Kavaratti was drifted away and lost during monsoon. One moored at south west of Agatti is still maintained. Agatti fishermen regularly fish the tuna shoals congregating around it, by pole and line, troll line and hand line. Dolphin fish, rainbow runners, and *Caranx* sp are other varieties caught.

REQUIREMENT OF RESEARCH SUPPORT

The success of pole and line fishing depends on the availability, catching and preservation of live baits in live condition. *Spratelloids sp, Chromis cacruleus, Caesio caeruleus, Apogon* sp are some of the bait fishes most commonly used. Fishermen almost fully depend on the lagoon for their live bait requirements. In islands other than Minicoy no scarcity for live baits has been felt so far and the species mostly dependent is *Spratelloides delicatulus* locally called 'Hondeli'! But as the number of fishing boats is increasing year by year there is proportional increase in demand for live bait. To meet this demand it will be necessary to find ways to produce more live bait which could be possible by creating artificial habitats. A scheme for this has been approved by the Govt of India and it will be implemented on experimental basis if proved successful.

ENVIRONMENTAL PROTECTION

The islands are nature's precious gifts. The beauty of the islands and fisheries development of the area depends on maintain the ecosystem of lagoon and reef. The bait fish which form the integral part of tuna fishery is collected from the lagoon. Realising the importance of the environmental protection the Deptt has taken action. Banning of unauthorised collection of corals and boulders, enforcing control over blasting and dredging are the major steps taken in this direction. Plans are under way to declare and maintain one or two of the island lagoons as National Marine Park.

ACHIEVEMENTS

The impact of the Fisheries developmental activities on the social and economic life of the islanders is quite significant. The main thrust of development was on augmenting fish production and economic uplift of the population. Both these objectives have been fulfilled. The fish production which was 500 tonnes in 1960 rose to 5535 tonnes in 1986 (Fig.1). The value of export dried fish rose from Rs.11.2 lakhs in 1972 to Rs. 1.94 crores in 1986. The production trend of fish indicate that there has been a growth in the total fish landing in Lakshadweep. The catch of tuna has increased even more rapidly (Table 3) during the same period, the average rate of growth being 18% per annum while the corresponding growth

of total fish landings during the same period being 7% per annum. Consequently the contribution of tuna in the total landings increased from 71% in 1982 to around 87% in 1986. This shows the domination of tuna fishery in the fishing industry of Lakshadweep.(Fig 2.)

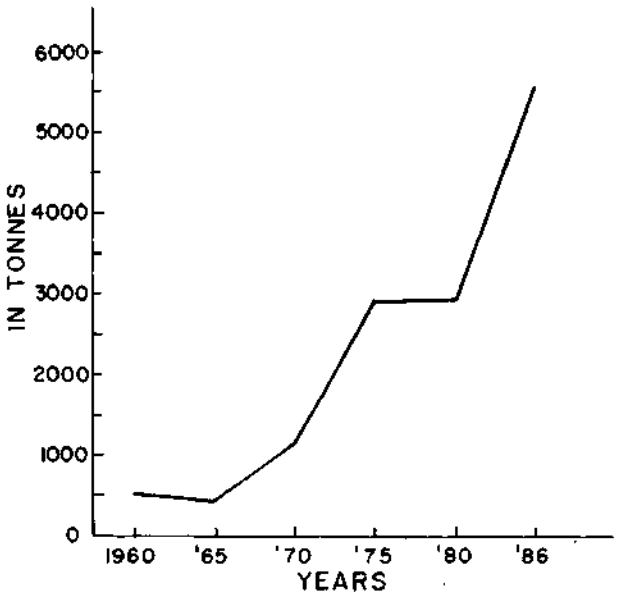

Fig. 1. Fish Landings in Lakshadweep 1960 - 86

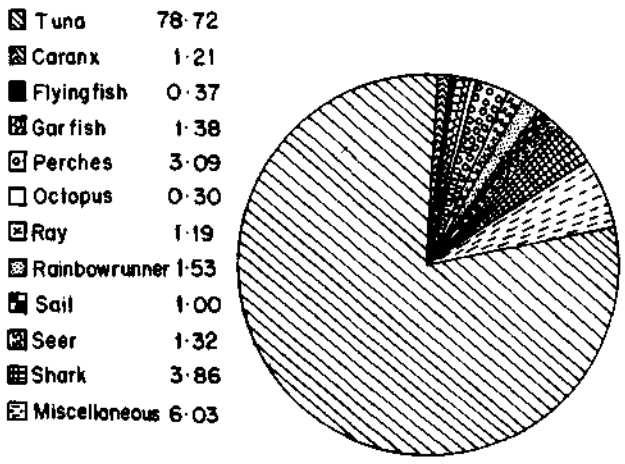

Fig. 2. Composition of fish catch in Lakshadweep based on averages for in years 1982 - 86

The comparative information on total all India tuna landings and tuna catch in Lakshadweep indicate that the contribution of Lakshadweep to the total tuna landings of India has increased from 3.7% in 1965 to around 16% in 1984. It is also significant to note that while the total tuna catch of the country as a whole remained almost stagnant around the level of 19000 to 20000 tonnes per annum from 1980 to 1984, the tuna catch in Lakshadweep registered a conspicuous increase during the same period.

The emergence of four major pole and line fishing centres viz Agatti, Suheli, Bitra and Minicoy is a great achievement. The economic progress achieved by the people of these islands is quite enviable. The pole and line fishermen derive a high rate of returns which is not attainable from any other trade in the island. Out of the four centres, Agatti island is the most important one landing about 46% of the tuna caught in Lakshadweep. A comparative account of the total fishing efforts and catch per unit effort is given in Table 7. Highest CPUE is at Agatti (419 kgs) followed by Bitra (252 kgs) and Minicoy (179 kgs).

A case study of 15 pole and line fishing boats operated at Agatti during the year 1984 was conducted for the entire year to find out different items of imput cost for fish production and the extend of profit gained by a boat. The study has revealed important findings. The capital investment required for the fishing gear and accessories excluding cost of boat is worked out as Rs.16660/-. All the items under variable cost such as fuel, consumption, repair charges, freight etc. shown in Table 8 are actuals collected during the survey. The average total cost of production including fishermen share (labour) was accounted to find out the net proift. The fishermen share constitute the share of 9 fishermen on board. (50% of the catch to the owner of the boat and 50% to the fishermen on board).

It is found that fishermen share accounted for 77.8% of the total variable cost. This cost would have come down if the boat introduced mechanical water sprayers for chumming. Fuel accounted for only 9.1% of the total operational cost which is very low compared to boat operated in mainland. This is because of the engines of low HP employed in tuna fishing boat. Under miscellaneous items (Table 8) various costs such as commission, freight, refreshment etc. are included.

The average net profit of a boat owner after deducting fishermen share, variable cost and overhead charges is Rs.85590/-. The average total earnings per fishermen per fishing season of about 6 months is Rs. 14963/- i.e. a monthly income of Rs. 1247/-. Normally tuna fishing boats are purchased and operated on partnership by

Table 7. *Comparative data on fishing effort and C P U E in major tuna landing centers of Lakshadweep for 1982 - 86*

Years	AGATHI			MINICOY			BITRA		
	Total tuna catch (t)	Total efforts	Catch per unit effort (kg)	Total tuna catch (t)	Total efforts	Catch per unit effort (kg)	Total tuna catch (t)	Total effort	Catch per unit effort (kg)
1982	551	2038	270	353	2140	164	94	533	176
1983	731	1750	417	254	2298	110	188	969	194
1984	2054	4486	457	523	2670	195	179	939	190
1985	2013	4288	469	255	2597	98	142	627	226
1986	1937	4010	483	946	2878	328	526	1107	475
Average		-	419		-	179		-	252

Table 8. *Details of operational cost and earnings of tuna fishing boats at Agatti for 1984*

(A case study)

Name of boat	Capital cost in Rs.	Earnings per boat in Rs.	Total variable cost	Total overhead (interest & depre-ciation) in Rs.	Total cost (4+5)	Profit per boat in Rs.
1	2	3	4	5	6	7
Indira	75160	165800	117605	14856	132461	33339
Jupiter	64248	232940	146234	12875	159109	73821
Neptune	64248	325910	203713	12875	216588	109322
Sainaba	55204	206608	136720	10803	147523	59085
Badrinath	48082	281674	183566	5047	188613	93061
Siddikkal Akbar	60404	337333	214610	13582	228192	109141
Gadapani	55204	368528	228484	9909	238393	130135
Pollack	48237	222630	150885	5662	156547	66083
Kadeeja	55204	308695	202155	10801	212956	95739
Aynama	70404	257940	163707	14083	177790	80150
Hajara	55204	263088	168041	10803	178844	84244
Punjab	51117	260800	162656	5199	167855	92945
Total		3231946	2078376	126495	2204871	1027075
Average per boat		269329	173198	10541	183739	85590

2-3 persons. If all the fishermen of the boat are (9 persons) co-owners of the boat, the fishermen share need not be taken into account to compute the net profit. In that case the average net income per fishermen per fishing season is worked to Rs. 24473/-. The above study indicates that tuna fishing operation is a highly profitable enterprise to be taken up by a group of people.

By 25 years of developmental activities, the fisheries sector of Lakshadweep has grown into a major one providing the largest scope for self employment opportunities. Out of the total population of 42000 who are basically coconut growers, above 5000 people find employment in fisheries sector. The 313 Nos. of mechanised boats issued by the Deptt has given direct employment to about 3000 fishermen with attractive income. The establishment of ancillary industries such as boat building yards, canning factory, workshops, fish marketing etc have proivded additional source of employment with lucrative income. The ultimate aim of any Govt. is the economic prosperity of its citizens. It is a matter of pride that this has been achieved as a result of fisheries development. A few islands as a whole and a sizable population in other islands have achieved economic self sufficiency by availing the avenues opened by the fisheries sector. The low cost diversified fishing methods such as troll lines, long line and gill nets introduced by the Deptt are being profitably employed in islands like Andrott, Amini and Kiltan where there is no scope for pole and line fishing.

The marine aquarium and museum set up by the deptt is the outcome of sustained efforts and dedicated team work of the staff of fisheries Deptt. Proper planning and execution coupled with resource availability has made the museum a major attraction with scope for research studies.

Resource surveys conducted by the Deptt have been helpful to study the feasibility of exploitation of seaweeds, octopus and lobsters. The exploratory fishing conducted by the Deptt have succeeded in locating rich fishing grounds for sharks. The Deptt has always been keen in increasing the efficiency of fishing. The innovation of 'Payayos' and mechanical water sprayers have been to the industry.

PROGRAMMES AND TARGETS FOR THE FUTURE

The small scale tuna fishery now existing in the islands can be further developed by increasing the strength of the boats and thereby landing more fish. However, shortage of man power to work more boats is the main constraint in the matter. The introduction of mechanical water sprayer will reduce the man power requirements in each pole and line fishing boat by 2 and with this savings more boats can be operated. The long term solution in this regard is to attract eudcated unemployed persons in the territory for fishing and serious efforts are made in this regard.

At present 774 tonnes of dried mas is produced from 4250 tonnes of fresh tuna in Lakshadweep. It is sold out in mainland and it fetches Rs.25-35 per kg. This product has long shelf life and excellent taste. It is possible to find a wider market and better price for this product by adopting hygienic method of production and modern packaging system. This will be an inducement for the fishermen to increase fishing efforts. Popularisation of mas should include demonstration of different recipes using mas in different parts of the country. Employment of a mobile snake bar with a market promotion unit is proposed to achieve this objective. Sanction of the Govt. of India on the scheme is already received and the scheme will be launching soon.

COMMERCIAL EXPLOITATION OF TUNA

The present production of 4800 tonnes of tuna from the small scale fishing sector cover only a fraction of the available resource. The bulk of the resource is beyond the operational range of the present small crafts. India has not yet made any attempt for the commercial exploitation of tuna of high seas despite high potential established. Tuna is a much sought after commodity in frozen form in foreign markets. The unexploited tuna resource are either getting perished or get migrated. So the urgent step to be taken is to start commercial operation by employing large purse seiners, pole and line vessel and long liners in collaboration with some foreign country to begin with. The Govt. of India has accepted the necessity of a fisheries development corporation for the above and final sanction is awaited.

STATUS AND PROGRAMME OF MARINE FISHERIES DEVELOPMENT IN THE UNION TERRITORY OF PONDICHERRY

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ABSTRACT

Development of marine fisheries in the Union Territory dates back to 1955-56, after the merger of the former French territories of Pondicherry, Karaikal, Mahe and Yanam. The union Territory has a coastline of 45 km and a fishermen population of about 34,000. The annual fish production of the Territory has risen from a megre 900 t in the begining to more than 20,000 t in recent years.

This paper deals with mainly the various developmental activites such as the introduction of mechanised boats, beachlanding craft, outboard motors, provision of cold storages, transport facilities fish curing yards, construction of fisheries harbour, fishlanding platforms, subsidies provided to the fishing activities and training imparted to the fishermen undertaken since the Second Five Year Plan period. It also presents the various social welfare schemes for improvement of the fishing community and its socio-economic conditons.

The development of fishing in this Union Territory was initially taken in the year 1955-56 after the marger of this former French territory comprising the 4 regions Pondicherry, Karaikal, Mahe and Yanam. As all these regions are endowed with coastline rich in good varieties of food fishes and exportable quality of shrimps and crustaceans priority was given in developing marine fishing.

With a coastline of 45 km and a fishermen population of 34,000 out of which an estimated 13,150 are active fishermen, marine fishing was initially limited to traditional methods of catamarans and country boats. The fish production was a megre 900 t per annum. Fisheries Department in this Union Territory was established during the year 1955. Begining with the II Five year Plan more attention was given for the development of marine fishing.

In order to increase marine fish production the scheme "Introduction of Mechanised fishing boats" was launched. Under the scheme mechanised fishing boats of 30' and 32' size with synthetic fish net twine was supplied to fishermen on loan-cum-subsidy basis. Initially a subsidy of 33 1/3% was allowed on the cost of boat & net and the loan was recoverable in 54 instalments spread over a period of 6 years. This scheme is still being continued with a reduced subsidy of 12 1/2%. So far 385 numbers of 30'& 32' fishing boats were distributed to the fishermen of this Union Territory.

Along with the above scheme introduction of FRP boats was also implemented with loan-cum-subsidy benefits, and so far 146 FRP boats have been distributed to the fishermen.

Another scheme introduced recently for the development of marine fishing is the "Introduction of Beach Landing boats" designed by Food and Agricultural Organisation, under Bay of Bengal Programme.

In order to assist a fairly large number of tradional fishermen in possessing their own fishing units comprising of catamarans/country boats and nets the scheme "Assistance to small scale fishermen" was introduced from the year 1984-85 onwards. Under this scheme assistance by

way of 40% loan, 40% subsidy and 20% being the beneficiaries contribution is given for procurement of fishing units.

Assistance by way of subsidy of 25% is given to those who desire to motorise their country crafts with out-board motors procured though institutional finance.

Essential fishing requesites and salt are made available to fishermen at 20% subsidy rates through the Fishermen Co-operative Federation and Fishermen Co-operative Marketing union.

Besides the above scheme introduced to augment fish production programmes to support the post harvest technology are also implemented. Under this programme Ice-cum-Cold storage units are to be established in all important fishing landing centres. So far 4 such units are in this Union Territory.

For transporting the catches from landing centres to marketing places fish transport vans are provided to fishermen through the Fishermen Co-operative Societies at nominal hire charges.

Essential infrastructural facilities in selected coastal fishing villages such as fish landing platform, auction hall, fish drying platform, net mending shed, community building etc., are provided wherever necessary.

Under the Centrally Sponsored Scheme one fishing harbour at an estimated cost of Rs. 208.56 lakhs is under construction at Pondicherry.

The entire fishermen population have been brought under Co-operative fold by establishing Fishermen Co-operative Societies in all the fishing villages.

All the welfare schemes such as Housing and Colonisation for fishermen under which an outright subsidy of Rs. 2500/- is granted for construction of houses, savings-cum-relief fund, Group Insurance scheme etc., are implemented through the Fisherman Co-operative Societies.

In the field of Research and Investigation one Inshore Fishery survey station of Pondicherry & Karaikal, using different types of craft and tackles is functioning to locate the potential fishing grounds and to determine the effectiveness of different kinds of gear in different zones and season. These Informations are diseminated among fishermen for their benefit.

Fisher youths are deputed to different training centres for training in improved methods of fishing, handling of mechanised boats, fabrication and mending of nets in batches at Govt. cost. Technical personnel of the department are also deputed to several Central Institutes for training in different courses.

All the above programmes started in 1956 and expanded through the years with particular emphasis in marine fishing with the result that the marine fish production has reached 20,119 t in the year 1986-87. The Socio economic conditions of fishermen also have considerably improved.

ROLE OF NABARD IN FINANCING MARINE FISHERIES PROJECTS

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ABSTRACT

National Bank for Agriculture and Rural Development is the apex organisation dealing with the policy, planning and operational matters relates to credit for development of agriculture and allied sectors including marine fisheries. NABARD has been playing a significant role in promoting marine fisheries development as a refinancing agency as well as developemntal agency through conducting training programmes, supporting innovative type of schemes and funding research projects. NABARD has been extending refinance assistance to schemes for acquiring fishing vessels, mariculture and for building infrastructural facilities. The experiences of NABARD in implementing various fisheries schemes is discussed in this paper. The significant features of the pilot credit project implemented in Orissa with BOBP assistance are highlighted. With view to increasing the participation of financial institutions in the process of marine fisheries development, suggestions are made to improve flow of credit to marine fisheries.

INTRODUCTION

Marine Fisheries is an important economic activity in the Indian economy. The development of villages in the coastal belt is closely linked to the fishing and its ancillary industries. The Indian Exclusive Economic Zone with an estimated potential of 4.5 million tonnes of harvestable fish holds great promise as a complementary source of protein food for the growing population as well as for augmenting export earnings of the country. Marine fisheries provides large scale employment to the economically weaker sections and plays a significant role in the overall improvement of the socio-economic conditions of rural population in the coastal belt. Special emphasis has, therefore, been given to development of marine fisheries under successive Five Year Plans. As a result, the marine fish production in the country increased from 5.34 lakh tonnes in 1951 to 17.71 lakh tonnes in 1985. The earnings from export of marine products also increased from mere Rs.3.3 crores to Rs.400 crores during this period.

The first four Five Year Plans gave special importance to mechanisation of fishing vessels for increasing fish production. Initially, mechanisation programme was mainly for trawlers. Later, it was extended to gill-netters and purse-seine boats. Introduction of deep-sea vessels during the Fourth Plan period ushered in the era of industrial crafts has been attempted to increase the efficiency of the traditional fishing vessels. The financial assistance for these programmes was initially provided by Central and State Governments as subsidy and soft loan. As the technologies became popular, the Government withdrew its support and the industry was supported by commercial and cooperative banks with refinance assistance from Agriculture Refinance Corporation (ARC). Having recognised the need for long-term investment credit in marine fisheries, the erstwhile ARC (later renamed as Agriculture Refinance & Development Corporation) included fisheries under its refinance programmes. The first scheme for marine fisheries was sanctioned by ARC in 1969 through the District Central Cooperative Bank in Karnataka. Since then, this organisation has been playing a significant role in promoting marine fisheries activities as a refinancing and development agency.

OBJECTIVES OF NABARD

The National Bank for Agriculture and Rural Development (NABARD) was established in 1982 as an apex orgnisation to deal with all aspects relating to policy, planning and operational matters in the field of credit for agriculture and allied activities. The functions of erstwhile ARDC were taken over by NABARD in addition to the functions of Agricultural Credit Department and Rural planning and Credit Cell of Reserve Bank of India. The main activities of NABARD include pro-

viding refinance to banks for promoting various developmental activities in rural areas, strengthening the various institutions to ensure an effective credit delivery system and coordinating the activities of all the institutions engaged in rural development. In marine fisheries, the main objective of NABARD is to provide institutional finance to marine fishing industry so as to increase the overall fish production on a sustained basis and to improve the socio-economic conditions of the fishermen community.

ROLE OF NABARD

NABARD provides refinance assistance to long-term credit for acquiring fishing vessels as well as for building up infrastructural facilities. NABARD has so far sanctioned 1700 schemes in fisheries with a total financial assistance of Rs. 212 crores. Majority of these schemes are for mechanised fishing vessels. The schemes are generally formulated by banks in consultation with developmental agencies. To facilitate formulation of schemes on proper lines, NABARD has circulated detailed guidelines to all the banks. NABARD also takes initiative in identifying new technologies evolved by Research Institutes and formulating suitable bankable schemes for implementation by banks.

Schemes are appraised in detail by NABARD for its econmic and financial viability. Wherever necessary, field studies are also conducted to assess the technical feasibility and economic viability of the schemes. NABARD gives special emphasis to monitoring of schemes to ensure proper implementation. Evaluation of schemes implemented by banks is also conducted to assess the impact of implementation. The findings of such studies provide valuable data for refining the schemes.

As an apex organisation, NABARD has been issuing policy guidelines to commercial and cooperative banks to ensure proper credit flow to various activities and regions in the country. Due importance is given to remove regional imbalances and to check over-exploitation of resources. For instance, introduction of mechanised vessels is being encouraged by NABARD in Andhra Pradesh, Orissa and West Bengal while restrictions have been imposed on financing for small size trawlers and purse-seiners in Karnataka.

In order to familiarise officials of banks and development agencies with the latest technologies, scheme formulation and appraisal, NABARD has been conducting training programmes. With the persistent efforts of NABARD, several banks in the country have been able to build up technical manpower to formulate and implement fisheries schemes. NABARD has also been supporting research projects by sanctioning grants from its Research and Development Funds. Research projects aimed at evolving improved technologies having immediate application in the industry are given preference. NABARD has so far sanctioned two research projects in marine sector, one for developing ferro-cement catamaran and another for modernising fishing vessels in the south-east coast. Research Institutions, Governments as well as private organisations engaged in applied research are eligible for availing of research grants from NABARD

TYPES OF SCHEMES

NABARD has sanctioned schemes for almost all types of activities in marine fisheries involving medium and long term investments. The different types of mechanised vessels financed by NABARD are stern trawlers (30-36 feet length), out-rigger trawlers (52-54 feet length), deep sea trawlers (23 m length) and tuna vessels (53 m length). NABARD has, however, recently taken a policy decision not to refinance for deep-sea vessels costing more than Rs.30 lakh (i.e. below 23 m size). The recently established ICICI is expected to provide finance for deep-sea fishing vessels. In traditional sector, the credit requirement is mainly of medium term nature for acquiring country crafts and for acquiring/ replacing the nets. The common types of country crafts that have been refinanced are Catamaran, dug-out canoe and plank-built boats. In recent years, schemes have also been sanctioned for mechanisation of country crafts through installation of in-board and out-board engines.

Refinance has also been sanctioned to schemes for ice-plants, cold storage, freezing plants, fish-meal plant, auction-hall, workshop, transportation and marketing. Financing for such infrastructural facilities is generally considered only if it forms part of an integrated scheme involving production, processing and marketing. NABARD has sanctioned two such major integrated projects in Gujarat and Andhra Pradesh with assistance from world Bank to the extent of US $ 73 millions.

An innovative type of scheme sanctioned by

NABARD is for culture of pearl oysters. This scheme has been sanctioned to a joint sector company in Tamil Nadu. This is perhaps the first commercial venture in mariculture in the country.

TERMS AND CONDITIONS OF REFINANCE

Commercial banks, Regional Rural Banks, Land Development Banks and Cooperative Banks are eligible for availing refinance from NABARD. The ultimate borrowers could be individuals, group of fishermen, cooperative societies, partnership firms or registered companies. The extent of refinance sanctioned to banks under fisheries schemes varies from 80 to 90% of the bank loan. The repayment period is generally fixed taking into account the economic life of assets, surplus income generated and the repaying cpacity of the borrower. Initial grace period is also allowed wherever necessary. NABARD allows special concession to small farmers by way of lower interest rate, longer repayment period and lower margin money. Minimum margin money prescribed by NABARD for small farmers and other category of farmers is 5% and 15% of the toal project cost respectively. Subsidy amout available, if any, is also permitted to be treated as margin money. At the prevailing rates of interest, NABARD charges 8.5% and 10.0% interest to banks in respect of refinance from farmers and other category of farmers respectively and banks in turn are allowed to charge 10% and 12.5% to respective category of borrowers.

EXPERIENCE OF NABARD IN IMPLEMENTING SCHEMES

NABARD has been extending refinance to diverse activities in marine fisheries through private and cooperative sector. Apart from well established technologies, NABARD is willing to support any innovative scheme backed up by sound technology.

Notwithstanding the commitment of NABARD and financing banks in supporting marine fisheries, it is observed that the share of marine fisheries in the total disbursements of banks is declining over the past 5-6 years. The marine fish production has also been stagnating since 1983. Some of the factors responsible for this trend are:

1. Limited scope for introducing new vessels in in-shore waters as there is already saturation of fishing vessels in this area;

2. High investment cost of medium and large sized vessels. The fishermen as well as technocrats are unable to contribute even 15% of the project cost as margin money for obtaining bank loans;

3. Lack of appropriate indigenous technology for diversified purpose of fishing;

4. Lack of suitable infrastructural facilities for supporting expansion of off-shore and deep-sea fishing fleet. All the existing larger vessels have been concentrating at Vishakapatnam fishing harbour.

One of the major problems faced by financial institutions in marine fisheries sector is the high overdue position of bank loans in some regions. It is difficult to assign any one particular reason for this as the situation has been built up as a result of interaction of various factors including willful default by some entrepreneurs. Following are some of the factors brought out by NABARD during its follow-up studies in various States.

1. Increasing operational cost due to escalation in fuel cost and wages for labourers. The cost of diesel has increased by over 200% during the last 8 years. The wholesale price index of diesel oil has increased from 213.0 in 1977 and 433.1 in 1985. As against the earlier system of fixed wages, the crew are now demanding a share of catch as wages which in some States is as high as 30% of catch besides allowance for food during fishing days. Though this system of wage payment has an in-built incentive for bringing more catch, the marginal return to the owner gets reduced. The cost of fuel and labour wages together account for about 70% of the operational cost of mechanised fishing vessels. This has sharply eroded the profit margin of the boat owners. However, it is significant to note that the vessels operated by owners themselves have earned better profit than those managed by non-fishermen owners.

2. Marine fish landings are characterised by wide fluctuations from season to season and year to year. Since the annual instalment of loan of mechanised vessels is substantial, one year of poor catch would add to the loan burden to such an extent that the fishermen generally find it difficult to clear the instalments over the subsequent years. Irrespective of the number of days of fishing and the income realised, fishermen have to pay the premium on insurance of vessel and loan. This adds on to the overdue burden. However, NABARD has been allowing

fairly longer repayment period to offset the lower income during some seasons.

3. There was unregulated increase of fishing vessels in certain localised areas leading to reduction in catch per unit effort. Consequently, the vessels could not earn surplus income to the extent envisaged while formulating schemes.

4. There was no proper follow-up action and supervision of fishing vessels at landing centres. Banks were not having adequate supervisory staff to monitor the fish catch and income of individual boats.

5. Recovery of loan from groups of fishermen and cooperative societies were by and large unsatifactory due to lack of understanding among partners, poor management of cooperative societies and lack of involvement and accountability on the part of the members of the societies.

6. Marketing tie-up arrangement envisaged in cooperative sector did not work satisfactorily. Middlemen were still found to play a major role in providing informal credit to fishermen for the working captial requirement and controlling the marketing of catch.

7. There was general lack of saving habit among the fishermen. Income during good season was either spent lavishly or diverted for other purposes. Consequently, fishermen had to resort to borrowing from middlemen during the lean season to tide over the situation.

In this connection it is worth mentioning the experinece of bankers in Orissa in implementing a pilot Credit Project for financing taditional fishermen launched with the active cooperation of Bay of Bengal Project and the State Fisheries Department. The recovery of bank loan was as high as 90% under this project. Flexible nature of scheme to suit the requirement of individual fisherman, proper identification of borrowers, timely release of loan and intensive monitoring by the officials of fisheries department and banks were largely responsible for the success of this project. This approach deserves to be repeated in other maritime States also.

SUGGESTIONS

Financial institutions like NABARD and other banks can play a vital role in promoting marine fisheries through credit support. The persepective lending programme drawn up by NABARD for next few years envisages financing for medium-size trawlers,long liners, beach landing crafts, FRP boats, mechanisation of traditional crafts and building up infrastructural facilities. Financing for culture of seaweed, edible oysters, mussels etc. would also be considered. However, in order to facilitate formulation of suitable schemes for these ventures and to ensure its successful implementation, the following suggestions may be considered by research organisations and developmental agencies.

1. Comprehensive data on fisheries resource in the off-shore and deep -sea regions of the Exclusive Economic Zone should be collected. FSI may consider taking up intensive survey by employing different types of vessels in selected region so as to generate adequate data regarding the economics of exploiting resources in that region.

2. The research institutions should come out with specific recommendations regarding the advisable limit of fishing efforts in a particular area and/or particular varieties of fishes. Banks can accordingly plan their lending programmes and contribute towards checking over-exploitation of fish stock.

3. At present, almost all the medium and large size trawlers in the country are operating in the northern Bay of Bengal with Visakhapatnam as base. Other fishing harbours on the east coast at Roychowk, Madras and Dhamra have failed to attract the entrepreneurs. Government should take immediate steps to provide necessary facilities at these harbours. Additional fisheries harbours should also be developed on the east coast and west coast to cater to the medium and large size vessels.

4. A major constraint in promoting tuna fishing is the lack of proper infrastructural facilities for preserving tuna under conditions acceptable for export market. Only tuna stored at -40^0C is accepted in Japanese market. Therefore, there is need to fabricate frozen storages and Tuna vessels having temperature below -40^0C in the fishhold.

5. In order to improve the economic viability of deep-sea fishing vessels, suitable market should be created for low priced fishes. These fishes could perhaps be converted into appropriate value added products.

6. In order to reduce the operational cost of mechanised vessels, Government may consider providing excise duty exemption on HSD used by all types of fishing vessels. Similarly marine diesel engines may be exempted from excise duty as is being done for agricultural pumpsets.

Priority should be given for designing fuel saving devices for installation on small as well as large size vessels.

7. There is a need to develop a specialised marine fisheries extension net-work in the State Fisheries Departments. Besides other extension work, this network can assist the bankers in identifying suitable beneficiaries, in ensuring proper utilisation of loan, and in timely recovery of the bank loan. A beginning in this direction has already been made by the Department of Fisheries in Orissa State.

Since resource is becoming a constraint for several State Government in promoting various developmental programmes, it would be desirable to give importance for "Development Through Credit" by involving financial institutions in the development programmes. NABARD as an apex institution has been playing a significant role in Fisheries Development of the country but now with greater awareness all around a concerted effort among the research organisations, developmental agencies and financial institutions will go a long way in achieving the targets as envisaged under the Planned Programmes.

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MARINE FISHERIES DEVELOPMENT IN TAMIL NADU

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ABSTRACT

Fisheries development is governed by the stock of fishery resources, the level and types of fishing effort and the use of diversified craft and gear. The growing importance of fishery resources and the level of their exploitation are traced in this paper. The marine capture fisheries account for a substantial proportion of the total fish production in Tamil Nadu. The present level of fish landings, their seasonal variation and the major species groups are brought out. The developmental programme aimed at increasing fish production are reviwed. The need for innovations in and diversification of fishing methods is highlighted. The impact of investment on fish production is analysed with a time frame of ten years. Basic needs of fisherfolk which have a bearing on fisheries development are identified. Technological developments made over the last decade are mentioned with a note on the extent of non-adoption of new technology and the major determinants thereof are pointed out for remedying the situation. Culture practices in suitable areas along the coasts are stressed to provide employment opportunities that step up production. Developments in the preservation and processing of the seafoods are presented and the scope for the establishment of a stable internal and external market is explored. The state of affairs of marine or coastal fisheries management and suggestions for toning up resource management are stressed. The need for sea ranching and SCUBA diving is indicated. The vital feature of training and the nature and areas of extension programmes are also pointed out for ushering in speedier development of the sector.

INTRODUCTION

Tamil Nadu is one of the important maritime states of India with a geographical area of 1,30,069 km^2 (BOBP, 1983). Her coast both on the east and west runs to 1000 Km, which is the second longest in the country. Among the maritime states, Tamil Nadu took the lead in starting a department of Fisheries way back in 1907. Fisheries development in the state could be evidenced by its second rank in inland fish production and third rank in marine fish production. The contribution of marine sector to the total fish production of the state is more in terms of both quantity (60%) and value(72%) as could be seen form Table 1.

Table 1 *Annual marine and inland fish production in terms of quantity and value*

Year	Fish production (tonnes) Marine	Inland	%of marine products in Total	Value of fish production in Rs. lakhs Marine	Inland	% of marine fish value in Total
1980-'81	230532	165000	58.28	4580	1590	74.23
1981-'82	235820	165000	58.83	6460	2475	72.30
1982-'83	240012	175000	57.83	6519	2800	69.95
1983-'84	246204	160204	60.58	8440	3204	72.48
1984-'85	248533	160000	60.84	8363	3360	71.33
Average			59.27			72.06

Further, marine fish production is purely by capture while inland fish production is also by culture. Thus, there is a clear indication that marine fish production can be enhanced by culture operations apart from implementing improved methods of fishing. What is required for further development in marine fisheries is the implementation of productive schemes for the culture of molluscs, seaweeds and prawns.

There is an urgent need for marine fisheries development in the state. More than 80% of the population of Tamil Nadu consume fish. The present per capita consumption is only 9 kg. While in advanced countries, it is about 15 kg. The minimum per capita daily requirement for consumption is fixed as 50 g in Tamil Nadu against the actual availability of only 30 g. Hence, to bridge the gap and combat malnutrition and also to steadily improve our fish trade in external markets, it becomes necessary to scientifically assess and optimally utilise our fishing resources.

MARINE FISHERY RESOURCES

The continental shelf of Tamil Nadu has got a total area of 41,412 Km^2, represented by 16,058 Km^2 of inshore waters (0-10 fathoms) 7197 km^2 of offshore waters (10-40 fathoms) and 18,157 km^2 of the deep sea more than 40 fathoms (MPEDA, 1984). Tamil Nadu coast is divided into Coromandal coast, Palk Bay, Gulf of Mannar and the Wedge Bank which have specific regional characteristics. The areas present in the regions, their coastal length, demersal and pelagic fishes and important crafts used are furnished in Table.2.

Resource assessment of the pelagic and demersal fisheries of Tamil Nadu has been done by several survey agencies and their findings have been dealt in detail by Srinivasan (1980), according to whom the available potential is 11.50 lakh tonnes. The present average rate of exploitation during the last three years of the decade is around 2.60 lakh tonnes. Hence we have to improve our fishing effort. Further, our coastal waters are comparatively free from pollution. The shallow (0 - 50 m) and deeper regions (50 - 200 m) of the coasts are reported to be fertile with a fish production of 12 t/km^2 and 6 t/km^2 respectively.

Districtwise general fisheries information of the resources are given in Table 3 for an understanding of the facts, facilities and manpower, which may help in planning fisheries schemes in the state for the development of the sector.

The productive ecosystems such as estuaries, lagoons, backwaters, mangroves etc, which totally occupy an extent of 56,000 ha of brackishwaters, have a vital place in the fisheries scenario. They serve as suitable breeding and nursery grounds for many valuable species and offer scope for the collection of seeds including the precious prawn juveniles for culture (BOBP, 1983; MPEDA, 1980). The brackishwater spreads, suitable for development in the state are the Pulicat lake, Killai and Ennore backwaters, Adayar, Marakkanam, Vellar and Coleroon estuaries and Vedaranaym - Muthupet swamp. Considerable number of studies have been made on the ecology, resources and productivity for utilisation (Krishnamurthy, 1964; Ramadhas, 1977; Sundararaj, 1974; Sundararaj and Krishnamurthy, 1974).

Apart from the brackishwaters, a total of 15,000 ha of low lying coastal land, owned by the departments of Revenue, Salt, Forest and Railways are available for aquaculture. If all the

Table 2 *Region-wise coasted areas, demersal and pelagic fish production*

Parts of Tamil Nadu Coastal Region	Area & Length in Km.	Demersal fish	Pelagic fish	Important crafts used
Coromandal Region	Pulicat to Kodikarai 350 km	Ribbon fish Silver bellies shrimp	Sardines Anchovies Flyingfish Tuna Mackerel Seer Fish	Catamarans
Palk Bay and Gulf of Mannar	Tanjore Pudukottai Ramnad Tuticorin Tirunelveli 590 km	Silver bellies Perches Silver bellies	Sardines Seer fish Sardines Anchovies Tuna	Athiramapatinam Thiruppalaikudi Type boats Tuticorin Type vallams and boats Catamarans
Wedge Bank	Southwest coast of Kanyakumari District 60 km	Shrimp Deep sea Shrimp Lobster		

Source : BOBP, 1983

Table 3. *General Fisheries Information*

Maritime Districts	Coastal Length Km	No. of marine Fishing villages	Population	Density/ coastal length	Population/ village	No. of landing centers	No. of crafts Mecha-nised	Non-mecha nised	Total No. of gears
Madras	26	40	46232	1778	1156	10	343	2442	2662
Chengalpattu	135	64	38723	287	605	58	2	5784	11580
S. Arcot	89	56	42040	472	751	41	186	3681	10644
Thanjavur	216	84	87128	403	1037	75	760	6244	175854
Pudukkottai	39	29	10157	260	350	14	84	1085	13617
Ramanathapuram	261	99	65844	252	665	69	724	4330	72885
Tirunelveli	166	26	58779	354	2261	28	1073	3790	59814
Kanyakumari	68	44	14897	1690	2611	48	470	9215	15612
TOTAL	1000	442	463800	464	1049	343	3912	36571	362678

–Source Tripathy, 1986

lands could be brought under the ownership of a single agency like PFDA (Prawn Farmers Development Agency), which might lease them out to farmers, the subsidy facility of the MPEDA could be utilised for the development of brackiswater prawn farm. But the other problem is the low tidal amplitude. In most places, the daily average of tidal fluctuation is only around 0.5 m, requiring the use of pumps. Certain aspects on the engineering studies may lay the road for developing these areas. Using pumpsets for letting in water to the culture ponds increase the cost of production. Yet, prawn farming would make it economically worth viable. The districtwise distribution of brackishwaters and their fringing low lying lands in the state are given in Table 4.

Table 4 *Brackishwater areas in Tamil Nadu*

Districts	Brackishwaters (ha)	Low lying lands (ha)
Chinglepet	14,841	2,263
South Arcot	8,072	2,704
Thanjavur	31,426	7,297
Pudukkottai	-	247
Ramanathapuram	874	1,385
Tirunelveli	401	566
Kanyakumari	265	18
Total	55,897	14,880

(Source : BOBP, 1983)

According to Desai (1984), the potential brackishwater areas of the State have not been fully utilised for culture while 20,000 ha in West Bengal, 5117 ha in Kerala, 4,800 ha in Karnataka and 81 ha in Gujarat have been brought under culture. Committed involvement in this direction may lead to the development of profitable prawn practice, in which a dent has been made by the private sector.

There is bright scope for the development in this area in the light of the techonological developments and the support of the MPEDA for prawn farming and the establishment of the much needed hatcheries and prawn seed banks.

FISHERY RESOURCE USE

Fishery resources of Tamil Nadu coasts are exploited more (60%) by traditional fishing crafts (8,000 country boats and 30,000 catamarans) than by trawlers. These crafts, do not operate beyond the inshore waters. The present level of catch in the state is only about 20% of the stock. This clearly reveals the need for increasing our fishing efficiency and for the expansion of the area of fishing particularly in the offshore and the deep sea, which together constitute about 63% of the continental shelf area.

An analysis of fish catch data from 1955-56 to 1985-86 shows as in Table.5 that there has been general increase in the catch rate.

Table 5

Marine Fish Production in Tamil Nadu

Year	Marine fish Production (tonnes)	Increase over previous period	Percentage increase
1955-56	57,000	-	-
1965-66	1,65,000	1,08,000	190
1975-76	2,00,172	35,172	21
1985-86	2,44,759	44,587	20

(Source : Pandiyan, 1986)

It could be seen in Table 5 that rapid development has taken place in the earlier period and that the pace has not been sustainable, in the latter periods. An analysis made recently for the last 10 years of marine fish production, relating to the financial input indicated good correlation (Sundararaj, *et al.* 1987). However, the degree of development should have been more due to the need and the availability of a broad spectrum of resources. Since marine fisheries are capital intensive, there is need for the allotment of more funds for the development of the sector in the state.

In the history of marine fisheries, traditional crafts were responsible for a greater share of fish catch. But, after the introduction of the mechanisation programme as part of the first five year plan and the subsequent plans, the trend changed considerably and production increase could be achieved from 50,000 t per annum in the early 50's to a peak of 2,25,000 t in the 70's. Yet, considering the fish stock, production seems to be less since fishery is not exploited beyond 50 m depth (CMFRI,1987).

The contribution of deep sea fishing vessels to the annual marine fish landing is less than one per cent (Srinivasan, 1985). The fishery resources of the deep sea, which have not been adequately surveyed, need proper assessment of their stock. Though deep sea fishing is a more capital intensive task, the cost of one vessel being about Rs.100 lakhs, meaningful investment must be made with confidence to harvest the deep sea. Perhaps, chartering of foreign deep sea fishing vessels may be taken up initially and subsequently, learning from the experience with regard to the fishing grounds, types of fishing vessels, fishing methods etc, the TNFDC may continue deep sea fishing by itself successfully in the line of the operation of the Mexican trawlers.

DEVELOPMENT OF TRADITIONAL FISHERMEN AND THEIR FISHING CRAFTS

The traditional fishing sector, which contributes a large share in fish capture needs urgent and adequate support for improving fishing efficiency and increasing production. Around 2500 mechanised boats have been provided on credit with subsidy from the beginning of the 2nd Five Year Plan till the end of the 6th plan (Anon, 1986 b).

The Bay of Bengal Programme (BOBP) of the FAO, functioning from Madras in the State has designed a beach landing craft, suitable for the surf beaten areas of Tamil Nadu coast. Field tests conducted involving local fishermen has proved that IND.25/IND.20 beach crafts have better performance. They are free from the disadvantages of the catamarans such as limited range coverage, less carrying capacity, low productivity and no protection for the crew and the hazarduous fishing operation during bad weather. Instead, improved range and increased fishing time offer scope to the fishermen for a better financial status through more fishing resulting in five rupees increased per day income than the worked out income (Rs.27.50) through a catamaran. Further, though it costs Rs.10,000 (Rs.2,500 more than catamaran), its durability is about three fold greater. Hence, beach landing crafts can have a bright future in Tamil Nadu. They are being popularised at present.

The Kottar Social Service Society in Kanyakumari District, first implemented the programme of motorisation of the traditional crafts during 1966 (Anon, 1986 b). The Government took up this task from 1981-82 and supplied outboard motors to catamarans and in-board engines to canoes and Vallams. So far, 250 outboard motors and 264 inboard engines have been distributed. A total of 884 outboard motors/inboard engines have been fitted by private owners also. This scheme is very popular in Kanyakumari and Tirunelveli districts and is gaining momentum in other districts. The State Government offers 20% subsidy for each engine up to a limit of Rs. 2,500 and the commercial banks provide the balance of 80% as loan to the fishermen. The MPEDA is also running a developmental programme with the attracation of enhanced subsidy ceilling of Rs.5000 (Swamy, 1987).

SUPPLY OF MECHANISED FISHING BOATS

The programme of mechanisation began during 1955 when the government issued orders for the construction of mechanised boats of 28', 30' and 32'. The boats were supllied to the co-operatives and groups of fishermen. The details of boats supplied are presented in Table.6.

Table 6

Boats supplied by Different Sources

Sources of boat supply	No. of boats supplied
Fisheries Department	1721
Co-operative Fedaration	112
Private Entrepreneurs	16
Tamil Nadu Fisheries Development Corporation	602
National Co-oparative Development Corporation	51
Total	2502

(Source : Anon, 1986 b)

The value of the boats distributed is Rs.1832.44 lakhs. The Government encouraged extending subsidy on the distribution of mechanised boats. However, step by step, there was cut in this as seen in Table.7.

Table 7

Details of subsidy for Motorisation of Traditional crafts

Year	Details of subsidy
1958-'59 to	50% on the cost of engine
1967-68	25% on the cost of hull
1968-'69	25% on the cost of entire boat
1970-'71	20% -do-
1971-'72	15% -do-

(Source : Anon, 1986 b)

Service Centres for the mechanised crafts were established in Nagapattinam, Rameshwaram, Tuticorin, Colachel, Madras, Mandapam and Cuddalore between the years 1963 and 1970. The fishermen may be trained to attend minor repairs of marine diesel engines of mechanised crafts and ouboard/inboard engines of motorised traditional crafts.

BERTHING FACILITIES

Safe anchorage, as a major infrastructural facility is an important requisite for the mechanised vessel along with other basic amenities such as diesel bunks, water, fish landing and auctioning facilities. The details of berthing facilities made and are being developed are presented in Table.8.

Table 8 *Details of Berthing Facilities*

Details	Place and year of completion		Capacity
Major Fishing Harbours	Tuticorin	1976	400 MFBs*, 10 Trawlers
	Madras	1983	500 MFBS, 50 Trawlers
Minor Fishing Harbours	Cuddalore	1963	40 MFBs
	Nagapattinam	1969	10 MFBs
Landing jetty ('T' Head Jetty)	Mandapam	1962	
	Rameswaram	1972	
	Mathipattinam	1980	
	Kodiakkarai	1982	
	Work in progress		
Major Fishing Harbour	Chinnamuttom		240 MFBs, 10 Trawlers
Minor Fishing Harbour	Valinokkam	150 MFBs	
	Thondi	100 MFBs	
	Pazhayar	75 MFBs	
Landing jetty	Kottaipattinam	40 MFBs	

(Source : Anon, 1986 b) * Mechanised Fishing Boats

Closing of river mouths due to siltation is a problem in several fishing villages. This problem has more biological impact on the migration of fishes. Matured prawns may not be able to enter the sea for breeding and as well, the juveniles may not be able to enter the fertile brackishwaters with rich planktonic food for feeding. Thus several valuable resources may be depleted and particularly availability of prawn seeds may be drastically affected. Hence, suitable remedial measures must be made for a scientific and meaningful coastal management.

FISHING REGULATION ACT 1983

Frequent conflicts between the traditional and mechanised fisherman while fishing are common. This being a hurdle for fisheries development, the State Government enacted the marine fisheries regulation Act 1983, which permits catamarans and other country crafts alone to conduct fishing upto 3 nautical miles from the shores. Mechanised vessels can fish only beyond this limit. Further, they must leave for fishing by 5 am and return for berthing before 9 pm.

WELFARE PROGRAMMES

Among the welfare programmes of the State Government in operation, services of the co-operative societies, schemes for quick transportation and link roads, housing, relief to fishermen through ex-gratia payment of relief, communication of weather warnings and shelter for cyclones are worth mentioning.

CO-OPERATIVES

Since most fishermen do not save for a 'rainy day' they have to borrow from the middlemen during lean season thereby placing themselves in the clutches of the middlemen. To relieve them, 235 marine fishermen co-operative societies have been formed by the Govt. and sufficient funds are channalised for working capital (Anon, 1986 c). Through these co-operatives, the development grants flow to the fishermen for their economic upliftment. The performance of the fishermen/fisherwomen co-operatives may be studied in-depth to formulate policies for toning up the societies.

QUICK TRANSPORTATION AND LINK ROADS

The 'quick transport scheme' was introduced in 1950 to facilitate quick transportation of catches, in fresh condition to the markets at concessional hire charges. Under this scheme, 10 vans were purchased initially and by the end of the 5th Five Year Plan, 56 vehicles were purchased. But, since the co-operatives could not run the vehicles on no loss no profit basis, paying the hire charges, the scheme could not continue beyond 1974. However, the Govt. came forward to remove the major constraint of link roads, connecting coastal villages and their nearest roads. In a phased manner, from 1956/60, link roads were laid. From February 1980 to July 1983 alone, the Government has accorded sanction for 86 link roads with an investment of 181.50 lakhs (Anon, 1986). Such programmes are likely to continue in the state in the light of the rapid and continued improvement in transport facilities in the state.

HOUSING

To have basic amenities, fishermen have been provided 4917 houses under special housing scheme and 11724 houses under free housing sceheme (Anon, 1986 c). Also, to enable the fishermen to have the facility to assemble for meetings and social functions, about 25 community halls have been constructed. Panchayat Unions are looking after their utilisation and maintanance.

WEATHER BULLETINS

During periods of cyclonic weather, to save fishermen and their crafts from danger, the department of fisheries, in consultation with the authorities of the Dept. of Port, Meteriology and Navy, takes all precautionary steps to broadcast and announce weather warnings. It has also given transistor sets to fishermen co-operative societies to enable the fishermen to hear AIR broadcasts on weather warning. Facilities have also been made for aerial search of the missing fishermen in the sea. Search operations are done by the cost guards placed in the stations at Mandapam and Madras.

Since fishermen suffer more for shelter, particularly during the cyclone periods, 100 cyclone shelters have been constructed in six coastal districts utilising an amount of 110 lakhs, obtained from national and international philanthropic organisations.

NATURAL CALAMITIES

When fishermen are affected by natural clalmities liberal and immediate relief measures are extended on 50% grant and 50% loan basis. Now, considering the real problems of the affected fishermen, the government assistance is extended fully on the basis of grant. From the year 1977/78 to 1985/86, a total of Rs.322.39 lakhs have been utilised towards relief measures (Anon, 1986 c).

Fishermen and chank divers if happened to lose their life in the sea an ex-gratia amount of Rs.5000/- is paid as relief and another Rs. 5000 is payable to the children of the diceased fisherman to take vocational training. Though 248 families have been benefited, none has utilised the accompanying relief measure facility for vocational training.

This can be taken as a clear index of the lack of awareness of the fishermen of the rigidity in this system or of the lack of opportunity or suitable representation from the affected side. There can be some flexibility towards genuine and reasonable utilisation of the relief.

Implementation of the group insurance scheme, among the fishermen supports them

well with the relief of Rs.15,000 in case of death and Rs.7500 in case of any disability.

COASTAL FARMING

Compared to inland fish culture, coastal farming is not simple since the ecosystems are beyond human control. Yet we have to manage with them and exploit the culture possibilities to meet the rising demand for fish. Sincere attempts made by CMFRI, NIO and BOBP (FAO) have resulted in the development of viable technologies for farming the edge of the sea.

Rack culture technique has been developed by the CMFRI (Tuticorin) and perfected to culture *Crassostrea madrasensis*. In this method, individual oysters are reported to attain a size of 90 mm in a year and the yeild obtained range from 120 to 150 t/ha/yr with a total meat weight of about 12 t (Nagappan Nayar, 1980). Experimental culture carried out on oysters in Vaigai estuary at Athankarai in Tamil Nadu (Rao *et al.* 1983), Bheemunipatnam backwaters (Andhra Pradesh), Mulki estuary (Karnataka), Cochin backwaters (Kerala) and Goa also have yielded good production and profit indicating the culture prospects (Nagappan Nayar, 1987).

Raft culture technique has been developed for the culture of *Perna indica* and *P. viridis*. Among the various experiments conducted on green mussel using this technique in Madras (Near Kovalam in the sea and in Ennore estuary), Calicut, Goa (in estuary), Vizhinjam, Ratnagiri, Waltair and Tuticorin the maximum annual production of 480 t/ha was achieved in Goa (Parulekar, 1980). In the same technique *Perna indica*, the brown mussel has yielded an annual production of 150 t/ha in Vizhinjam Bay and 180 t/ha in the open sea of Vizhinjam (Appukuttan, 1980; Appukutan *et al.* 1980). Developing an on-bottom culture technique for clams, Narasimham (1980) has reported a possible productivity of 92.4 t/ha/yr.

Continued research work carried out in Tamil Nadu by CMFRI to regain the fame of the Indian Pearl oyster, *Pinctada fucata* from 1972, has resulted in the perfection of the culture technique, production of cultured pearls, success in induced breeding and the management of hatchery (Alagarswami, 1987). Attempts taken in sea ranching programmes stand as a sign of scientific management for rebuilding the stock in the sea.

Farming fin fishes such as milk fish, mullet etc. in coastal water ponds is also in progress in Mandapam and Tuticorin. It is possible to culture seaweeds like *Gracilaria edulis, G. corticata, Gelidiella acerosa* and *Sargassum* sp. in coir ropes and attain appreciable yield (CMFRI, 1978). Considering the importance given to seaweed culture in Japan and China and also the values of the seaweeds including the use for the preparation of medicinal compounds, culture practices must be taken up on mass scale. This will lead to the establishment of the seaweed based industries offering employment opportunities.

Considering the low and defective tidal amplitude in Tamil Nadu coast, the BOBP had developed the technique of pen culture and has experimentally proved the technological and economical viability of the same in Killai. Field works such as pen errection, screening of predators, reinforcement of pen walls against crab cuts and the use of appropriate mesh size have been perfected. This viable technique has yielded prawn (*Penaeus monodon*) production from 600 to 700 kg/ha/80 days in different pens (Karim, 1983; Karim and Victor Chandra Bose, 1985).

Between research achievements and development in the coastal areas, there is a definite gap, possible due to problems in technology transfer and non provision of the basic needs such as cultivable areas and financial support. A policy decision may be taken by the government and the cultivable areas may be allotted on lease to the fishermen, trained in prawn farming. Prawn Farmer's Development Agencies (PFDA) may also be formed in the coastal districts for an organised development along the successful lines of the FFDA.

Steps must be taken to establish seed banks in all the coastal districts with provision for a hatchery. The present extension system should be made practical and more meaningful linking the farmers with the technologists, financial organisations and the traders.

The techniques developed for application are successful but their economic viability may be a question. Further, the problems of area selection and area allotment should be studied in detail. After ascertaining success in different area of the state through various demonstrations, mariculture programmes may be taken up.

The weakness in fisheries extension could be easily understood by the fact that no technology is known to the concerned people, other than prawn farming. Further, the scope for consumption of molluscan meat is also unpopular among

them since extension activities are not regular, adequate and co-ordinated. The various problems encountering the extension work need to be identified correctly for a remedy.

In accepting the productive technologies, finance seems to be a vital constraint among the coastal people. Hence, the government may advise organisations for liberal financial support besides its own support. Having developed the other priority sector in the country or state considerably, it is ideal to attach importance to Fisheries with reference to aquaculture. If blue revloution should become a reality, there must be fair allotment and free flow of finance towards coastal fisheries development.

TECHNICAL MANPOWER

Tamil Nadu has developed technical manpower mainly by the CAS in Marine Biology and the Fisheries College. Suitably trained field level supportive staff have been brought out by the training centres in the state (Selvaraj and Sundararaj, 1987). The above valuable human resource can be utilised in implementing several production oriented projects, developmental schemes and management measures to solve the threatening unemployment problems and provide the much needed protein food for the state and to increase the export of sea foods.

FISHERIES TRAINING CENTRES

For mechanisation programmes to be effective, fishermen should be trained to operate and maintain the mechanised crafts and in fishing methods. Hence the government set up Fishermen Training Centres (FTC) in Tuticorin (1956), Nagapattinam (1957) and Madras (1961) in different years and three more centres in Cuddalore, Colachel and Mandapam during 1964. These centres offer practical training to 310 fishermen annually. So far 3000 fishermen have been trained (Anon, 1986 b). In a recent study, Selvaraj (1986) has pointed out the priority requirements of the fishermen for a rapid fisheries development.

An analysis of the national budget allotment during the past five year plans reveal that adequate provisions have not been made to fisheries sector. They were not even 1% of the maximum provision given to certain sectors like irrigation and flood control or 2% of that alloted for Agriculture as sharply pointed out by Desai (1984). The allotment in Tamil Nadu state for the year 1986-87 was 302 lakhs. These would highlight lack of attention focused on fisheries both at national and state levels respectively.

EXPORT OF MARINE PRODUCTS

About 41 items of marine products are exported to international markets. Frozen shrimps, lobster, cuttlefish and squid, crab meat and fish are important materials among them. A total of 26 seafood freezing plants are present in Tamil Nadu with the capacity to freeze 181 t/day with a total storage capacity of 4363 tonnes. Due to the need for more good quality prawns, prawn farming should be given priority in the state. This area needs more encouragement with total technical support, financial assistance and effective extension programme. Tamil Nadu had recently (1984-'85) exported 18,792 tonnes of marine products worth of Rs. 5128 lakhs in which the share of prawns was about 70% (Anon, 1986 d).

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Technical Session VI

MARINE FISHERIES DEVELOPMENT

Paper 71

STRATEGIES FOR MARINE FISHERIES DEVELOPMENT IN INDIA

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ABSTRACT

Four decades of planned development of marine fisheries in India has raised the production level from about 0.5 to 1.6 million tonnes per annum. This growth in tonnage is not commensurate with the effort that has been expended over the period in terms of planning, research and development. Stagnation in production has been witnessed during the last decade. The deep-sea fishing programme is yet to yield any tangible result by way of a quantum jump in production, and its contribution has been marginal, not able to influence the overall production trend. However, marked changes have taken place in the pattern of exploitation and resources during the span of 40 years.

The paper analyses the cause and effect of some of the important aspects of marine fishery development in the maritime States and Union Territories. Resource research at various periods of time has come out with tentative recommendations on strategies that may be adopted in development of particular fisheries. These have, willy nilly, not been given a try, perhaps due to several constraints. Taking into consideration the present scenario of research and development, strategy options are indicated for management and development of the marine fisheries of the country.

INTRODUCTION

India has gone through 40 years of fisheries development. Marine fish production has increased from 0.5 million tonnes in 1950 to 1.6 million tonnes now. Thanks to the bilateral assistance received in the early stages and the business acumen of small entrepreneurs, the coastal trawl fishery has reached almost its zenith, with the support of the Government. The purse-seiners and more recently, the process of motorisation, have changed the character of the fishery. Further bilateral and international assistance and the national development with institutions and infrastructure have made India strong in many areas of fisheries management and development. The E.E.Z. has added a new dimension of opportunities and challenges. In the export front country has done very well.

Despite all these developments, the marine fish production has stagnated during the last decade and the overall growth rate has shown a declining trend. The time is ripe now to have an introspection of our past programme and their achievements and evaluate the present opportunities to increase production. These aspects are discussed in the paper and strategy options for management and development of marine fisheries are indicated.

TRENDS IN ALL INDIA MARINE FISH PRODUCTION

The marine fish production of India, since it began to be estimated in 1950 by the Central Marine Fisheries Research Institute has shown its growth as given below:

Period	Average Annual production (t)	Growth rate over the Previous period (%)
1951-55	565,543	-
1956-60	762,911	34.90
1961-65	735,131	3.64
1966-70	943,209	28.71
1971-75	1,200,434	27.27
1976-80	1,330,892	10.87
1981-85	1,502,592	12.90

After an initial spurt of growth of about 7% per annum during 1956-60, production came down during 1961-65 showing a slight reduction. Again it picked up during 1966-70 with a growth rate of

5.74% per annum. In 1970, production crossed the 1 million tonne mark. This period witnessed the consistently high landings of oil sardine with an all-time high of 301,641 t in 1968. During 1971-75, the growth rate was maintained at 5.45 % per annum. The next five years (1976-80) showed a poor growth rate of 2.17% per annum, as also the succeeding period (1981-85) with 2.58%. In fact, production fluctuated on a plateau from 1975 to 1982 between 1.25-1.42 million t. It was only in 1983, it crossed the 1.5 million t mark (1.546 million t). Production increased to 1.631 million t in 1984. After a slump in 1985 with 1.535 million t, it has reached about 1.693 million t in 1986, an all-time high so far.

A comparison of group-wise landings for the more important species based on average annual production during 1979, 1980 and 1981 and that during 1982-83, 1983-84, 1984-85 (because of shift to financial year) has been made in Table 1. The two periods represent the pre-1.5 million t and post-1.5 million t production per annum and the table has been prepared to find out the resources which had shown gains and losses. It is seen from the Table 1 that most of the groups had shown gains as follows: anchovies (54,321), perches (24,400 t), carangids (20,926 t) penaeid prawns (18,463 t), oil sardine (18,834 t), elasmobranchs (15,726 t), sciaenids (11,450 t), silverbellies (10,312 t), catfish (8514 t), pomfrets (8488 t) and lesser sardines (2392 t). Those which had shown losses were mackerel (25,521 t), bombay duck (16176 t), ribbonfish (12,068 t) and non-penaeid prawns (1118 t). The three groups, anchovies, perches and carangids together accounted for 50% of the total gain of the period. These groups, along with catfish have the potential for further development. Among those which have shown loss, ribbonfish will have future scope for exploitation.

Table 2 provides an overview of the trends in different sectors, pertaining to the above period for the years the effort data are readily available. For this exercise, all fishing units fitted with inboard or out-board engines/motors for propulsion such as crafts operating gill nets, dol nets, hook & lines and bag nets, have been grouped together under category "Mechanised, others". The other three categories are distinct.

At the all-India level, the effort of small mechanised trawlers showed an increasing trend from 1284×10^3 unit operations in 1981 to 1631×10^3 units in 1983-84, but declined to 1467×10^3 units in 1984-85. However the landings have shown an increase throughout the period even in 1984-85. The catch rates also showed a steady increase from 300 kg/unit in 1981 to 378 kg/unit in 1984-85.

The effort of purse-seiners showed almost a two-fold increase in 1982-83 from 37,883 units of operation in 1981 to 71,048 units in 1982-83. There after, the effort decreased to 53,272 units in 1983-84, but picked up to 62,430 units in 1984-85. The quantum jump in effort in 1982-83, led to fall in production from, 1,13,147 t in 1981 to 81,952 t in 1982-83. In 1983-84, with a reduction in effort, the catch was almost at the level of 1982-83. The catch increased to 100,000 t in 1984-85 with a rise in effort. The catch rate which was 2987 kg per trip in 1981, was drastically reduced to 1153 kg in 1982-83, but picked up to reach 1616 kg in 1984-85.

The craft using motorised propulsion showed an increasing trend in effort during the period, doubling from 830×10^3 units of operation in 1981 to 1621×10^3 units in 1984-85. However, the landings did not show a corresponding increase. In fact, there was progressive reduction of landings during the two years following 1981, but showed a sudden spurt from 2.93 lakh t in 1983-84 to 4.89 lakh t in 1984-85. The catch rates showed a declining trend in this sector from 410 kg in 1981 to 266 kg in 1983-84 only to rise marginally to 302 kg in 1984-85.

Relatively, the effort, landings and catch rates were stable with slight fluctuations during the entire period for the non-mechanised sector. The effort ranged from 9877×10^3 units; landings from 4,58,870 t to 6,56,928 t and catch rates from 45 kg to 56 kg.

Thus the all-India picture showed a slow but steady increasing trend in the small mechanised trawler sector, a declining trend in the purse-seine sector, an unsettled trend in the mechanised propulsions craft sector and a stable trend with some fluctuations in the non-mechanised sector.

PRODUCTION AND POTENTIAL IN THE STATES

Gujarat

The annual average marine fish production during the decade 1975-84 was 2.21 lakh t, with a range from 1.71 lakh t in 1970 to 2.51 lakh t in 1984.

The fishing crafts consisted of 2894 mechanised boats and 4100 non-mechanised crafts.

Table 1. *Gains/losses in Landings of major groups of fishes during the periods 1979-81 and 1982-83 - 1984-85*

Groups	Production (t) Average of 1979-81	Production (t) Average of 1982-83 to 1984-85	Gain/loss (t)
Elasmobranchs	47,939	63,665	15,726
Catfish	50,651	59,165	8,514
Oil sardine	1,63,580	1,82,414	18,834
Lesser sardine	65,795	68,187	2,392
Anchovies	54,882	1,09,203	54,321
Bombay duck	1,19,779	1,03,603	- 16,1760
Perches	35,174	59,574	24,400
Sciaenids	88,355	99,805	11,450
Ribbonfish	58,536	46,468	- 12,068
Carangids	30,184	51,110	20,926
Silverbellies	59,705	70,017	10,312
Pomfrets	42,464	50,950	8,448
Mackerel	58,484	32,963	- 25,521
Penaeid prawns	1,03,080	1,21,543,	18,463
Non-penaeid prawns	61,349	60,230	- 1,119

Table 2. *Trend of effort, catch and CPUE at all-India level*

Description	1981	1982-83	1983-84	1984-85
1. Mechanised trawlers				
a) Landings (t)	3,85,571	5,26,046	5,43,346	5,53,802
b) Effort, x 10^3 units	1,284	1,660	1,631	1,467
c) CPUE (kg)	300	317	33	378
2. Purse Seine				
a) Landings (t)	1,13,147	81,952	75,179	1,00,880
b) Effort, x 10^3	37,883	71,048	53,272	62,430
c) CPUE (kg)	2,987	1,153	1,411	1,616
3. Mechanised, others				
a) Landings (t)	3,40,550	3,12,359	2,92,754	4,88,735
b) Effort, x 10^3 units	830	798	1,100	1,621
c) CPUE (kg)	410	391	266	302
4. Non-mechanised crafts				
a) Landings (t)	5,34,007	5,16,760	6,56,928	4,58,870
b) Effort, x 10^3 units	9,877	10,904	11,706	10,141
c) CPUE (kg)	54	47	56	45

Of the former, 1410 were trawlers, 1225 were gill netters, 241 were dol netters and 18 were other types.

The major resources are Bombay duck (33% of average landings), croakers (16%) penaeid prawns (5.3%), elasmobranchs (5.8%), pomfrets (8.2% in 1981), *Lactarius* (5.4% in 1983), non-penaeid prawns (2.3%), ribbonfish (4%) and catfish (6.1% in 1982).

The contribution of mechanised boats in the total landings of the State increased to 60% in the 1970s and reached 82% in 1984. The trawlers contribute to 55% of the catch of all mechanised boats, the drift/gill nets to 26% and the dol nets to 18%.

Using the Maximum Contribution Approach, the potential yield has been estimated as 3.3 lakh t. Maximum production already obtained was 2.5 lakh t in 1984 and, hence, a net addition of 0.8 lakh t appears possible. It has been suggested that there is scope to add additional about 300 drift/set gill netters in South Gujarat and Jamnagar coast, 380 trawlers in Kutch and Jamnagar coast, and about 100 dol netters in Saurashtra region to exploit the additional marine fisheries potential of the State, all in a phased manner (Balan, *et al.*, 1987).

Maharashtra

The average annual production was 2.73 lakh t, with a minimum of 2.32 lakh t in 1980 and a maximum of 3.06 lakh t in 1984. The pelagics contributed to 39.3% and the demersals to 60.7%.

The fishing crafts included 4557 mechanised boats, 46% of them bag netters, 29% trawlers and 25% gill netters. Non-mechanised crafts were about 7925 in numbers.

The major resources are Bombay-duck (range of production 45,162 t in 1982 - 82,136 t in 1981), non-penaeid prawns (32, 130 t in 1983 - 69,010 t in 1975), penaeid prawn (21,720 t in 1981 - 45,640 t in 1979), croakers (13,960 t in 1980 - 22,590 t in 1984), pomfrets (8,350 t in 1975 - 25,520 t in 1983) and catfish (8,240 t in 1975 - 13,420 t in 1984).

During the period of 1975-84 under review, research findings showed that Bombay-duck fishery fluctuated; non-penaeid resources showed decreasing trend; penaeids showed no discernible trend; croakers recorded increasing trend since 1980; pomfrets catch was about stable and catfish showed an increasing trend. The dol net catch showed an inverse relationship with effort expended. It has also been seen that landings by mechanised boats increased from 147,900 t (57.6%) in 1975 to 286,900 t (93.6%) in 1984. Non-mechanised landings were almost vanishing with only 6.4% contribution (19,400 t) by 1984 in the State's marine fish catch.

The potential yield, as calculated from the Maximum Contribution Approach, is 3.70 lakh t. Since a maximum catch of 3.10 lakh t has already been obtained, the net additional yield would be 0.6 lakh t. It has been estimated that 40% increase in the effort of trawlers and 50% increase in the effort of gillnetters, in phased manner, would be able to achieve the additional production. Raigad and Ratnagiri districts may come for special efforts for providing infrastructural facilities and increase in fishing units as suggested above (Srinath *et al.*,1987).

Goa

During the period 1975-84 the marine fish production in Goa varied between the minimum of 24,500 t in 1980 and maximum of 38,500 t in 1984, with an average of 33,800 t during the period 1980-84.

The mechanised fishing fleet consisted of 494 trawlers 274 gillnetters, 66 purse seiners and 74 others. The non-mechanised crafts were 2066 in number. The mechanised landings increased from 41.4% in 1975 to 89.3% in 1984. The trawler landings dominated with 68% followed by purse seiners (27%) and others (5%).

The annual average pelagic landings during 1975-84 were 16,330 t. Their contribution to total landings showed a decreasing trend from 71.1% in 1975 to 33.2% in 1983. The demersal average landings were 14,710 t. There was progressive increase in their contribution from 28.9% in 1975 to 66.8% in 1983. Among the pelagics, oil sardine dominated the landings during 1980-84 with an average annual contribution of 31%, followed by mackerel (16%) other sardines (11%) and carangids (9%). Among the demersals, penaeid prawns constituted 21%, stomatopods 11%, sciaenids 8% and catfish 8%.

The marine fisheries potential for Goa in the Inshore waters has been calculated to be about 54,000 t (Kurup *et al.*, 1987). It has been suggested by the above authors that there does not seem to be any scope for increasing the effort of purse seines and gillnetters. However, in the case of trawlers, about 100 boats can be additionally introduced in a phased manner with periodic monitoring of their impact.

Karnataka

During 1975-84, marine fish production varied form 87,000 t (1975) to 1,55,000 t (1982) with an annual average of 1,22,127 t. The landings were characterised by wide fluctuations and the magnitude was determined by oil sardine and mackerel production.

The fishing crafts included about 2000 mechanised boats with about 1500 trawlers, 300 purse-seiners and 29 gill netters, and about 6900 non-mechanised crafts. The mechanised boats contributed to 85.9% of production.

The pelagics accounted for 69.1% of the total marine fish production of the State and demersals for 30.9% . Oil sardine, mackerel and whitebait together contributed to more than 50% of the total landings. The percentage contribution of pelagics showed difference between the five-year periods of 1975-79 and 1980-84, which, respectively, were as follows: lesser sardines 2.0% and 5.3%; white bait 0.5% and 10.1%; ribbon fish 0.6% and 4.2%; carangids 1.0% and 5.0%; seerfish 1.6% and 4.4% and tunas 0.9% and 1.9% among those which showed increased contributions: mackerel 34.6% and 13.0% among those which showed decreased contributions: and oil sardine 46.7% and 48.4% which did not show much variation.

The contribution of demersal group to the total landings varied from 18.9% in 1975 to 46.4% in 1983. Catfish, silverbellies, sciaenids and penaeid prawns were the dominant groups. The percentage contributions of the different groups in the demersal landings during the five-year periods 1975-79 and 1980-84 were respectively - elamosbranchs 9.2% and 8.6%; catfish 21.1% and 16.7%; sciaenids 9.1% and 6.9%; silver bellies 10.6% and 9.4%; pomfrets 2.6% and 3.8%; pernaeid prawns 18.4% and 13.8% and others 29.0% and 40.8%.

The contribution of mechanised and non-mechanised boats to the total landings was 11.2% and 88.8% respectively in 1975. In 1977, the proportion suddenly changed to 57.5% and 42.5%. In 1984, the proportion was 89.6% and 10.4%, thereby showing that the non-mechanised sector has practically been eclipsed. In 1980, the mechanised landings were shared as 80.3% by purse-seines, 19.4% by trawlers and 0.3% by others. In 1984 the shares changed to 68.9%, 29.3% and 1.8% respectively.

In 1977, the year of introduction of purse-seines in Karnataka, the effort of purse seine operations was only 5000. In the following years the effort in number of operations was as follows: 1978- 19,000; 1979 - 26,000; 1980 - 20,000; 1981 - 31,000; 1982 - 55,000; 1983 - 39,000 and 1984 -45,000. The average CPUE for the period 1980-84 was as follows: 1980 - 3895 kg; 1981 - 3068 kg; 1982 - 1565 kg: 1983 - 1369 kg and 1984 - 1731 kg.

The maximum expected yield from the inshore waters has been calculated as 2.2 lakh tonnes (Kurup *et al.* 1987). The above authors, based on current information, have concluded that there does not seem to be any scope for increasing the fleet strength of purse seiners and small trawlers.

Kerala

Kerala accounts for about one-fourth of marine fish production of India. The average annual production in 1983 and 1984 has been 3.9 lakh t. The State produced the highest of 4.5 lakh t in 1973, after which there has been a steady decline reaching a low of 2.7 lakh t in 1981, picking up slowly thereafter. In general, production has been stagnant.

The fishing crafts in 1979-80 were 3038 small mechanised boats including 2630 trawlers, 362 gill netters, 37 purse seiners and 9 other categories. The purse seiners which were introduced in 1979 reached a number of about 70 in 1982 and has remained at that level since then. The most significant development has been the motorisation (outboard) of the country crafts which started in 1982, the number of which has reached about 4000 by 1984 and 6000 now. This is one of the fastest development programmes in the country. The non-mechanised crafts were about 26,000 in number.

Prior to 1980, the artisanal sector contributed over two-thirds of marine fish production in the State. By 1983, the change over took place and, in 1984, the mechanised sector (including the motorised canoes) took the two- thirds share of production. The motorisation with outboard engines gave a sudden fillip in production by this sector, though not increasing in any way the net production of the State. Prior to motorisation, the boat seines had a share of 22,400 t in 1981. On account of their greater mobility due to motorisation, their share went up to 1,11,900 t (29% of the State's marine fish production) in 1984. Similarly, the gill netters increased their catch from 470 t to 12,900 t in the same period. The share of purse-seines has remained at an

average of 16,000 t, accounting only for 5% of the State's production during 1980-1984, without showing any trend.

The annual pelagic fish landings (average of 1983 and 84) were 2.64 lakh t (68%) as compared to the demersal fish landings of 1.26 lakh t (32%). Taking the average of 1977 and 78, prior to introduction of purse-seines or motorisation of boat seines both of which are for pelagic species, the percentage composition of pelagics remained at 67.5% (2.42 lakh t)and demersals at 32.5% (1.17 lakh t), thereby clearly indicating that the modernisation of the craft/gear with respect to the pelagics, did not result in any deviation in the percentage contribution of these two groups. It has also shown that, in the given situation, the availability of resources has controlled production rather than the catchability of the craft/gear. Oil sardine, the mainstay of Kerala production has shown the fluctuations typical of the species. The 1983 and 84 average was 1.5 lakh t (38% of States's production). The same species had a share of 2.5 lakh t in 1968. It went down to an all-time low of 70,000 t in 1980. It has stabilised around 1.5 lakh t subsequently. The Indian mackerel production was 12,200 t (average of 1983 and 84). The species had a share of 1.0 lakh t in 1971. But the magnitude has come down considerably in the subsequent period. The penaeid prawns, the economic mainstay of the fishery, contributed to 32,600 t (average 1983 and 84), whereas it had a share of 84,770 t in 1973. In the recent years, it had shown fluctuations, but generally in the lower order of production. The whitebait with an average of 48,000 t in 1983 and 84 has generally remained steady about this level. Catfish production has fluctuated over 3 decades; having reached 33,500 t in 1974, it fluctuated around 11,000 t in the recent times. Coastal tuna production has been stable around 6000 t, although a maximum of 15,400 t was taken in 1979.

The CPUE of small trawlers came down from 325 kg/trip during 1975-79 to 240 kg/trip during 1980-84. The CPUE for the prawn components showed a similar decrease from 180 kg/trip to 85 kg/trip for the same period. The purse seiners' CPUE came down from 3110 kg/trip in 1980 to 1300 kg/trip in 1982, although it picked up to 2900 kg/trip in 1984.

The maximum catch prospects for the State in the presently exploited waters, has been estimated at about 4.8 lakh t (Jacob *et al.*, 1987). Considering the present level of production, production means, catch trend and economics, the suggestion made is not to add any more trawlers or purse seiners, but to add about 210 gillnetters with in-board engine in a phased manner. Since motorisation is recent, and its impact is yet to be critically evaluated, any increase in their number should wait further appraisal (Jacob *et al.*, 1987).

Tamil Nadu

The average annual marine fish production during 1975-84 has been 2.32 lakh t accounting for 16.7% of all-India production. The minimum during the decade was 2.06 lakh t in 1977 and the maximum was 2.81 lakh t in 1983.

The fishing crafts included 2757 mechanised boats, of which 2,614 were trawlers and 143 gillnetters, and 43,343 non-mechanised crafts. During 1975-84, the mechanised boats contributed an annual average of 94,148 t (41%) and the non-mechanised crafts the rest. The contribution of non-mechanised crafts which was 68.5% during 1975-79, came down to 51.48% during 1980-84. In 1982, the mechanised boats landed 1,27,742 t as against the 1,18,419 t by non-mechanised crafts. Of the mechanised catches, the six major centres Pudumanikuppam, Cuddalore, Nagapattinam, Mandapam, Rameswaram and Tuticorin together contributed to an average of 56,402 t during 1980-84. The balance between the two sectors has been delicate.

The demersal catches contributed to 54.6% with average landings of 1,26,528 t, compared to the pelagic landings of 1,05,350 t during 1975-84. In the traditional fisheries, silverbellies, with an average catch of 38,492 t, showed an increasing trend. Sardines (other than oil sardine) (average 28,240 t) showed an increasing trend from 1976 to 1984. Anchovies (16,192 t) showed a decreaing trend from 1975 to 1979 and an increasing trend thereafter. Elasmobranches (15,980 t) showed an increasing trend from 1982. Croakers (14,815 t) showed a decreasing trend from 1981. Ribbonfishes (13,022 t) continued with a decreasing trend since 1975. Penaeid prawns (11,741 t) showed an increasing trend from 1975 onwards. Crabs (10,359 t) showed an increasing trend after 1981. Carangids (9,729 t) showed an increasing trend during the decade. Perches (8,838 t) exhibited an increasing trend during 1978-84.

Analysing the trawler landings at some of the centres, the effective rate of increase per unit effort was found to be 0.73% at Rameswaram, 1.09% at Tuticorin, 3.87% at Pudumanikuppam,

1.23%at Mandapam and 1.5% at Cuddalore (Dharmaraja *et al.*, 1987). Scope for increasing catches further was seen only at Pundumanikuppam among the above centres.

By the Maximum Contribution Approach, the potential yield in the 0-50 m depth zone has been calculated at 3.25 lakh t (Dharmaraja *et al.*, 1987). Considering the average landings of 1982-84 at 2.60 lakh t, the additional potential is estimated to be 65,000 t. The share of the mechanised sector would be 35,000 t and that of the non-mechanised sector 30,000 t. Working on the present catch rates of trawlers at 250 kg/unit, the number of trawlers that can be additionally introduced is estimated at 560, which may be done in a phased manner. It has also been suggested that the mobility of the non-mechanised crafts may be increased by motorisation (Dharmaraja *et al.*, 1987).

Pondicherry

The average annual production during 1975-84 period was 10,340 t, with the maximum of 14,940 t in 1984 and minimum of 6,500 t in 1977. During 1983-84 period, the average production was 14,800 t.

The fishing crafts included 176 mechanised and 1750 non-mechanised crafts. The annual contribution of mechanised boats was 3,150 t (30.5%) and the rest (7,200 t at 69.5%) was from the non-mechanised crafts. The CPUE of mechanised boats which remained between 82-161 kg during 1975-79, steadily increased to 139 kg/trawler-day in 1984. About 91.1% of total mechanised catch was from trawlers, and the rest from gill netters.

The pelagics contributed annually to 6188 t and the demersals to 4155 t. The major groups, in their order of abundance, were other sardines, carangids, anchovies, perches, mackerel, silverbellies, crabs, croakers, penaeid prawns, flying fish and elasmobranchs.

The estimates of potential yield in the inshore waters were 19,000 t by Relative Response Model and 21,000 t by Maximum Contribution Approach (Dharmaraja *et al.*, 1987). Taking the mean of the two estimates (20,000 t), the additional catch expected is 5,200 t, of which the share of mechanised sector would be 1,800 t and that of the non-machanised sector 3,400 t. The existing trawlers as well as non-mechanised crafts can take the additional catch, in view of the recent increase in their catch rates. Motorisation of non-mechanised units has been suggested (Dharmaraja *et al.*, 1987).

Andhra Pradesh

Average annual marine fish production during 1975-84 has been 1.21 lakh t, with the minimum of 82,000 t in 1978 and maximum of 1,56,000 t in 1975.

The fishing units included 580 small trawlers and 36,000 non-mechanised crafts. During 1977-84 period the non-mechanised sector was dominant accounting for 74.36% of the State's marine fish production. During 1980-84, major contribution came from drift/gill nets(45%), followed by small trawlers (25%), shoreseines (13%), boat seines (12%) and others (5%). The pelagics contributed 53% of production and the demersals 47%. Data show that years with good landings of pelagics, particularly lesser sardines, have shown higher overall marine fish production in the State, implying the sway this group holds over the demersals.

The cleupeoids dominated the landings with 30% contribution. Ribbonfish (8%), croakers (8%), penaeid prawn (7%), elasmobranchs (6%), silverbellies (5%), perches (4%), catfish (4%), pomfrets (3%), mackerel (3%) and non-penaeid prawns (3%) were the other important groups in the fishery. The landings of penaeid prawns ranges from 5700 t in 1980 to 10,600 t in 1983 indicating no regular trend.

Besides the small trawlers, large trawlers (23 m and above), numbering about 70 were operating off Andhra coast from Visakhapatnam fisheries harbour. Catch and other details from these vessels were not available to the CMFRI. (Effort has been made very recently to get these data which are under analysis). For the mechanised boats, the CPUE ranges from 202 kg in 1980 to 384 kg in 1983, with an average of 284 kg during a period I980-84. No clear cut trend between effort expended and quantities landed was evident. Similar was the case with the traditionl sector.

In Visakhapatnam fisheries harbour, an average 130 small trawlers operated daily, during 1980-84, and the average CPUE was 220 kg. Penaeid prawns (10-15%), perches (17-28%), threadfin breams, croakers, carangids and lizard fishes constituted the important groups. In Kakinada fisheries harbour, the average number of trawlers operated was 160 and the average CPUE was 330kg. Penaeid prawn contribution (12-25%) was higher than at Visakhapatnam.

The potential yield in the 0-50 m depth has

been estimated at 2,03,000 t by the Maximum Contribution Approach (Alagaraja *et al.*, 1987). Considering the fact that a maximum of 1,56,000 t has been taken in 1975, the net additional potential is estimated at 50,000t. It has been suggested that in the first place, the average production level should be raised to 1,50,000 t. Of the additional 50,000 t, efforts may be made to harvest 25,000 t initially. The additional crafts required to achieve this, based on present catch rates, would be 1705 drift/gill netters, 87 small trawlers, 105 shore seine units, 370 boat seine units and 312 other types. In the next phase, the effort may be increased similarly to get the still remaining 25,000 t of the potential. Thus, by 2000 A.D., the presently estimated potential of 2,00,000 t may be fully harvested (Alagaraja *et al.*, 1987).

Orissa

The average annual production during 1975-84 was 34,027 t, with the maximum of 46,773 t in 1984 and minimum of 15,072 t in 1977.

The fishing crafts included 745 mechanised boats, of which 470 were trawlers and 275 gill netters, and 10,550 non-mechanised crafts. The contribution of mechanised sector to the fish production was 21,126 t (53%). The catch rate of trawlers has shown a consistent increase from 63 kg in 1980 to 358 kg in 1984.

The pelagics contributed to 15,993 t and the demersals to 18,034 t. The major groups are pomfrets (15%), croakers (13%) *Hilsa* (12%), catfish (9%), and prawns (4%). Exploratory survey indicated the occurrence of mackerel upto the 100-m contour line off the coast.

The potential yield, as derived from the Maximum Contribution Approach, is 75,500 t (Scariah *et al.*, 1987). Considering much higher estimates made by earlier studies, the potential yield is taken as 1,00,000 t. Net additional potential yield is calculated a 54,000 t. At the present level of catch rates, additional fishing units that can be introduced over the next 5 years are estimated at 160 numbers of trawlers, 140 gill netters and 1700 non-mechanised crafts (Scariah *et al.*, 1987).

West Bengal

The 1975-84 average annual production was 19,840 t, with the maximum of 39,910 t in 1984.

The fishing and supporting crafts included 1054 mechanised boats, of which 767 were gill netters and 287 were carrier boats, and 41,000 non-mechanised crafts. The mechanised boats contributed 53% of the State's marine fish production and the non-mechanised crafts 47%. The mechanised bag-net unit showed a CPUE of 613 kg, *'Jangal-Jal'* 265 kg and gill net 200 kg. The CPUE of non-mechanised crafts averaged 138 kg.

The pelagics formed 43% of the catches and the demersals 57%. The major species were non-penaeid prawns (10.6%), catfish (10.3%), pomfrets (9.8%), Bombay-duck (4.8%), penaeid prawns (4.6%) and *Hilsa* (4.8%).

The Maximum Contribution Approach showed the potential yield as 60,000 t (Philipose *et al.*, 1987). The net additional yield would be about 20,000 t. The additional crafts that could be introduced include 60 gillnet units, 10 bag-net units and *'Jangal-jal'* units among the mechanised boats and 150 non-mechanised craft (Philipose *et al.*, 1987).

STRATEGIES FOR DEVELOPMENT AND MANAGEMENT

Development objectives

The character of marine fishery resources of India, the geographical spread of the subcontinent, and the socio-economic and political system involved in the management and development of the fisheries are too complex for evolving a national policy which can be straight away implemented through plans and subsequently evaluated. The framers of our Constitution gave the responsibility of fisheries development to the States. The Center has a promotional role allocating resources to various schemes developed by the States as also sponsoring schemes. In the present context of EEZ, the development programmes outside the territorial waters of the States are managed by the Center. Thus even where a National Fisheries Policy has been evolved, the responsibility for implementation of the plans is divided among several agencies, and naturally the ex-post evaluation, if done, is within these agencies, and does not necessarily link up with the objectives of the National Policy. The objectives themselves may be too many such as to provide protein for the people, to provide employment, to uplift the socio-economic conditions of fishermen, to increase GNP and to increase foreign exchange earnings and, if taken together, might necessitate shifting of strategies too frequently resulting in unfulfilment in all the objectives.

Evolution of fishery sectors

India's marine fisheries which was singularly artisanal in the eighties and today we have the following five of them in commercial fisheries:

1. artisanal crafts
2. motorised crafts
3. coastal trawlers
4. purse seiners
5. deep-sea trawlers

The artisanal sector has been at the losing end with the emergence of the coastal trawlers. Its dominance in fish production has been irreversibly lost with the introduction of the motorised crafts, with in-board or out-board engines. The entry of purse-seiners, particularly in Karnataka, almost eclipsed the artisanal sector in the State. With all these advancements, the total marine fish production remained more or less level for about 10 years, thereby proving that the changes led only to sharing of resources now in a different proportion in the present fishing grounds and not to any sizable net increase in production. It also proved that the new investments made during the period did not result in additional production.

Marine Fishing Regulation Acts

Sharing of the resources as above, that is cutting into the economics of the weaker sector, did lead to conflicts resulting in violence, carnage and burning of boats. This led to enactment of regulations and framing of rules by the States delimiting zones for different sectors. Here again there has been no consensus among the different maritime States/Union Territories. While some did not feel the need of it, others enacted rules in haste leading to legal battles and yet others are considering the issue.

Subsequent to the Indian Fisheries Act of 1897, the Ministry of Agriculture Govt. of India enacted the Maritime Zones of India (Regulation of Fishing by Foreign Vessels) Act of 1981 and made the Rules of 1982 under the Act. As specified, the Act deals with fishing by foreign vessels under licence or charter in the EEZ outside the territorial water.

The Sates enacted Acts and framed Rules for regulating fishing in the territorial waters. Under Kerala Marine Fishing Regulation Act of 1980, the State regulated fishing activities under Rules framed in 1980 and subsequently. Fishing is prohibited for all fishing vessels fitted with mechanical means of propulsion, except motorised country crafts, upto 30 m depth in the area from Kollengode to Paravur and upto 20 m depth in the area from Paravur to Manjeswaram. Purse-seine is prohibited from operating within the territorial waters i.e. upto 12 n. miles from coast. The rules also ban the use of bottom trawl gears having less than 35 mm mesh in the specified area.

The Goa, Daman, Diu Marine Fishing Regulation Act was enacted in 1980. Under the rules, fishing with a mechanised boat is prohibited within 5 km from the coastline. The area upto 5 km is reserved for non-mechanised crafts and Rampan. The mesh regulation bans use of nets having less than 24 mm mesh for fish and less than 20 mm mesh for prawns.

The Maharashtra Marine Fishing Regulation Act of 1981 have rules, but for the present there are none on prohibition of fishing by any class of craft in any area. Similar is the case with the Karnataka Marine Fishing Regulation Act of 1986.

The rules made under the Tamil Nadu Marine Fishing Regulation Act of 1983 ban bottom trawling upto 3 n. miles from the coast. Within 3 n. miles non-mechanised boats can go for fishing with boat seines and hook & lines. The rules prohibit fishing within 100 m below a river mouth. The mesh regulation states that no gear less than 10 mm mesh, knot to knot, in respect of nets other than trawl nets shall be used. Although Pondicherry has not yet enacted an Act, mechanised boats are permitted to operate only at 7 fm depth and beyond between 6 A.M. and 6 P.M.

It is evident from the above that there has been no overall strategy for regulating fishing in the coastal waters and that the States have different approaches on the issue. The fish does not respect State boundaries in their migration. The resources are generally concentrated in the inshore waters. Fishermen of each sector is for economic gains from the common property resources. These are reasons for frequent violations of the rules, confiscation of boats and seeking judicial redress. More detailed discussions among fishery managers, scientists and the fishery sectors would be desirable before improving the rules under the Acts.

Management of coastal fisheries

Management of fisheries sector is beset with problems arising from the special characteristics of the resources. In the early stages of development of the fisheries, production has been in-

creasing steadily with effort as the growth rates up to mid seventies have indicated. Last 10 years, with the exception of recent two years, witnessed a depression in production against an escalation in effort, particularly in the coastal trawler sector. This is despite the purse seiners introduced into the scene and the sudden fillip in motorisation of country crafts.

The average annual growth rate fell sharply during this period as compared to the previous two decades. Today, the coastal trawler sector contributes to about 35% total marine fish production, the motorised crafts (drift/gill nets, bag nets, hook & lines etc.) to about 30%, the purse seiners to about 6% and the artisanal sector to about 29%.

The pelagics and demersals contribute equal share of about 50% each to the total marine fish production of the country. While the trawlers work on the demersal resources, the other gears work essentially on the pelagics; but since the operational depth of these gears is not much, part of demersal resources are caught in these gears too. The tropical pelagic shoaling fishes particularly oil sardine, lesser sardines, achovies and mackerel are known to be small in size and short-lived and they get into the fishery in their first year of life itself, and their contribution to fishery in the second year of life is much reduced. Studies so far have indicated that the fishery for these species is controlled more by fishery-independent factors than by fishery-dependent factors. Therefore, management of these fisheries would depend on a thorough knowledge of their distribution in their juvenile and spawning phases and distributing the effort by various sectors evenly so that the adult stocks are judiciously fished. Juveniles/young fish stocks cannot be exploited heavily both for reasons of future recruitment and economics of the fishery. This calls for sound knowledge on the resources and stocks on the research side and management decisions on distribution/allocation of effort by the different sectors with regulation of mesh size.

The erstwhile Pelagic Fisheries Project's studies have indicated the stock level of oil sardine at about 4.00 lakh t. Reviewing the oil sardine production of Kerala, Balan and Reghu (1979) concluded that the present level of pressure by the indigenous fishery will not have any adverse effect on the oil sardine stock.

The massive introduction of purse-seiners in Karnataka at one stroke in 1977, which was further augmented subsequently, has received attention of the scientists. This led to making several important recommendations on the management of purse-seine fishery. Jacob *et al.*, (1979), who studied the impact of purse-seiners on the Rampan fishery in the immediately following period, found that the Rampan units which were 75 in number in 1977 got reduced to 30 in 1979. The catch rate of Rampanies came down from 4.5 t/units operation in 1977 to 0.3 t/unit in 1979. Immediately about 1160 Rampan persons were thrown out of job. The above instance has been one of the major jolts in the fisheries sector in the recent times. The authors suggested enforcement areas of operation for purse-seiners and Rampans, as also to make plans to get more fishermen take to purse-siening.

More serious problems were encountered in the purse-seine fishery of Karnataka later. In 1979, the vessels landed unusually large catches of oil sardine in ripe-running condition. On timely observations on the above, the Central Marine Fisheries Research Institute brought the implications of such fishing on the spawning stocks and the Government of Karnataka appealed to the purse-seine fishermen to abstain from fishing during June-September period which coincided with the spawning period of oil sardine and mackerel (Silas *et al.*, 1980). Subsequently, during September-October 1980, the purse-seines were found catching large quantities of male catfish *Tachysurus tenuispinis* incubating eggs. At Mangalore, Malpe and Gangoli, the purse-seiners caught 528.4 t of adult catfish with 37.6 t of incubated eggs. Commenting on the wasteful and destructive fishing of purse-seines Silas *et al.*, (1980) made the following recommendations to manage the fishery.

(i) Identication and determination of the magnitude of specific resources,

(ii) Prevention of frequent shifting of base of operations of the the purse-seines,

(iii) introduction of mesh regulation and minimum legal size for capture,

(iv) delimitation of areas and period of operation for specific resources,

(v) control on annual/seasonal quota on catches, and

(vi) observance of closed seasons for purse-seines during the spawning period of pelagic fishes.

As the purse-seine effort was relentlessly in-

creased, the species compostion in the catches changed. Besides oil sardine, mackerel and catfish, anchovies, tuna (*Euthynnus affinis*, *Auxis thazard* and *A. rochei*), carangids, silverbellies, other clupeids, prawns, pomfrets and other miscellaneous fishes started appearing in the catches (Dhulkhed *et al.*, 1982). This led to advising the fishery managers of Karnataka to avoid heavy pressure on critical stages such as juveniles and spawning stocks of oil sardine, mackerel, catfish and horse-markerel. At this stage, the purse-seine operations had been prohibited from 1st June to 30th September. The vessels were operating in 20 m depth from September to January and 30-40 m from February onwards.

Heavy landings of whitebaits by purse-seines received further attention. The whitebait catch which was 73 t in 1978 in Mangalore increased to 721 t in 1979 and 4588 t in 1980. It came down to 2240 t in 1981 (Rao *et al.*,1982). The investigations pointed out that the mesh size of purse seines at 12-13 mm led to capture of very young fish of important pelagic species such as oil sardine, horse-mackerel and scad and warned that it was wasteful and would lead to decreased catches in future. The study recommended capture of whitebait which had completed one breeding cycle and was at the fag end of its life but advised redeployment of purse-seiners at all the major centres and building up of infrastructural facilities to avoid serious glut situations.

Against such a background of hasty strengthening of purse-seine fleet which exceeded 250 in numbers in a short time, Kerala made a cautious approach. The strength got itself restricted to about 60 units localised at Cochin. The impact study made by Jacob *et al.* (1982) found that at the present level of exploitation and availability, the effect of purse-seine fishery was not tangibly felt on the aritisanal fishery. The fluctuations in the catch of artisanal fishery during 1980-81 were attributed to decreased or greater availability of the stocks of oil sardine.

The few examples cited above on the management and development of the purse-seine fishery would vouchsafe for greater caution in managing the coastal fisheries.

Turning attention to the demersal resources, it is seen that the peaneid prawn fishery has been the prime concern of the fishery planners, managers and scientists. This is in view of the fact that this fishery has been the backbone of the Indian fishing industry in economic terms. The entire coastal trawler sector of the country is based on this resource and everything else caught is considered a bye-catch. During 1976-1985 period, the penaied prawn landings fluctuated between 83,540 t and 1,30,000 t, with an average of 1,12,460 t. The amplitude of fluctuations was greater in the major prawn-producing States of Kerala (average 34,884 t: variations plus 17,449 t and minus 12,616 t) and Maharastra (average 35,234 t; variation + 10,409 t and - 1,357 t) than in other States. Based on controlled breeding and domestication of many of the penaeid prawns, it has been proved that these prawns breed throughout the year. It has also been understood lately that prawns migrate long distances, for example from Cochin to Tirunelveli coast in Tamil Nadu, based on mark-recovery studies (Anon, 1982). It has generally been suggested that the prawn stocks are being fished about the optimum level, but in centres like Sakthikulngara, there are signs of economic overfishing, if not biological overfishing. George *et al.* (1980) felt that restriction on input of effort is the only probable approach to management. The mesh size of cod end of shrimp trawls has been progressively reduced at many centres. At Kakinada, the mesh which was 25 mm during 1967-70 was observed to have been reduced to 10-20 mm (82% less than 18 mm) in 1977 and further to 8-20 mm (85% less than 17 mm) in 1978. Rao *et al.* (1980) observed that, consequent to reduction in mesh size, there was variation in production of penaeid prawns: species composition changed and *Acetes* spp.entered the fishery for the first time; and size of prawns came down as exemplified by capture of *Metapenaeus dobsoni* less than 60 mm and *M. monoceros* in 81-90 mm range in relatively high proportion. It is now learnt that the trawlers have started increasing the mesh size having realised the above problems.

New knowledge on certain prawn resources has emerged in the recent times. Although, trawling at night is reportedly prohibited in Sakthikulangara, some trawlers operating in the night caught adults of *Penaeus canaliculatus*, 150-200 mm in length, at 19.6 kg/boat (Suseelan *et al.*, 1982). This species is never caught in day trawling and, therefore, will be lost to the fishery if night trawling is prohibited. Traditional fishermen resist night fishing. Thus it becomes a socio-economic problem for proper management and a development problem for utilisation of this

high value resource. Off Bombay waters, the occurrence of another high value prawn, the Kuruma prawn *Penaeus japonicus*, was high-lighted (Aravindakshan and Karbhari, 1982). At Sassoon Docks, the species is landed at 10-15 t per annum. Similarly occurrence of new prawn resources of *Metapenaeus stridulans, Parapenaeus longipes, Trachypenaeus curvirostris* and *Solenocera choprai* along Maharashtra coast was reported (Aravindakshan and Karbhari, 1983). A potential new resource of *Metapenaeus moyebi* in the estuarine fishery of Karnataka was brought to light (Sukumaran and Nandakumar, 1983). Such new scientific information should receive immediate attention for guiding the development of fisheries, especially for high value resource.

Diversification of the fishery has been very often advocated by every scientific forum but very little has been done in this direction. The resources available for diversification have been indicated. These are the anchovies, horse-mackerel, catfish, threadfin-breams, ribbonfish, sciaenids and perches which have further potential for exploitation in several States. Economic returns in such ventures will not be as good as in shrimp fishery for obvious reasons and this acts as a disincentive for diversification. Proper incentives for the fishery which would concentrate exclusively on such identified resources should be thought of as a new development strategy in order to reduce the heavy pressure on shrimps and obtain higher landings of other groups for overall increase in production. Since the resources are high in magnitude, investment on additional infrastructure required and post-harvest handling, processing and marketing may not be shied away. If the national policy is to provide additional fish protein to the people, diversification of fishing, away from shrimp, cannot be further postponed.

Deep-sea fishing

When Government of India established the Deep-Sea Fishing Station in 1946, the concept of deep sea fishing was perhaps narrow, to include areas adjacent to the area of operation of the artisanal sector. The survey vessels then were just adequate for that coverage. In 1970, with the addition of the new class of 17.5 m, trawlers, it was presumed that India was venturing into deep sea fishing. The Symposium on Development of Deep Sea Fishing organised that year discussed elaborately plans for deep sea fishjing (*vide* Proc. symp. Devl. Deep-Sea fishing, CIFO, Cochin, 1970). In the V and VI plan periods several new survey vessels for covering the Exclusive Economic Zone were added. Large Mexican-type trawlers (23-26 m OAL) were introduced by the private sector and, after going through ups and downs, this sector has now stabilised with 70-100 vessels at a single port at Visakhapatnam. Their operational range generally overlaps with the traditional sector as also the coastal trawlers, occassionally extending beyond. Analysis of fishing data of some of the vessels recently made available showed that the catch rates for prawns (headless weight) ranged from 16.3 kg to 20.1 kg per hour of trawling. With about 110 trawlers operating in the area upto Sandheads, the situation is near saturation.

Deep sea fishing is capital intensive and risk prone. The species resources are varied with a higher volume of low value shrimp/cuttlefish/fish. Since the tendency is to conserve fish hold space for the high-value-low-volume groups, much of the catch of the voyages is thrown overboard. Unless post-harvest technology develops in future to give added value to the deep sea resources, such wastage of non-conventional resources would continue to occur.

For a long time, it was the policy of 'go it alone' with regard to deep sea fishing. The enactment of Maritime Zones of India (Regulation of Fishing by Foregin Vessels) Act of 1981 provided for foreign collaboration under charter and licence in the fishery sector. Experience had shown that this did not provide the expected advantage to India in terms of resources data, manpower development and entrepreneurship. During a span of less than five years several thousand tonnes of fish had been caught by the chartered vessels and landed in foreign ports, and three to four times that quantity comprising uneconomic varieties had been caught and destroyed. Now a new policy of joint venture is in force and is yet to pick up momentum. The joint venture should be an intermediate step towards national development of deep sea fishing. The medium-term and long-term objectives should be kept in view rather than short-term gains. Appropriate monitoring, control and surveillance (MCS) system with necessary legal, operative and administratives structure should be introduced to oversee the performance of joint venture projects. As in the case of charter vessels, there will be wastage of resources by discarding the bye-catches, but this has to be avoided at any cost as such quanti-

ties of fish may be used for meeting the nutritional needs of the Indian people.

The Exclusive Economic Zone

The declaration of the Exculsive Economic Zone of India in 1977, under the UNCLOS treaty, has given us sovereign rights to explore, exploit, conserve and manage the living resources, besides the non-living resources over an area of about 2 million sq. km. This provides an opportunity as well as challenges and obligations to utilise the resources judiciously.

The potential fishery resources of the EEZ have been estimated as 4.5 million t by George *et al.* (1977) after shifting all the earlier estimates made by national and international agencies/scientists and the exploratory fishery survey data available at that time. Subsequently large amount of survey data has been generated through the operation of large survey and training vessels. The chartered vessels have provided some data to the national government. The industrial survey carried out by *M.T. Murena* has indicated the potential off the north-west coast. More recently F.O.R.V. *Sagar Sampada* has carried out several cruises in the entire EEZ and beyond. It is high time that a fresh critical appraisal is made using all the national data available now with various agencies and up-date our knowledge on the potential resources and annual stocks. This would help in planning future development programmes in the E.E.Z.

Outside the limits of the continental slope, the projected major resources are the tunas and the oceanic squids. The mesopelagics and bathypelagics, although their resources are estimated to be large, cannot be exploited economically at the present level of harvest and post-harvest technology. Silas and Pillai (1982) and Silas (1985 a, ed.) have indicated the potential of tunas and related species in the Indian ocean and the Indian EEZ. Already commercial tuna fishing has been initiated in India. Some amount of survey data have also recently become available on the tuna resources of Bay of Bengal and Arabian Sea based on the operations of Government of India vessels. Joint ventures in tuna fishing are likely to come up. The interest has to be sustained and guided for proper management and development of tuna fisheries. Tuna is a global fishery with a multinational character and India's strategy should include a development of internal market for tunas and tuna products to offset any adverse global trends.

With regard to oceanic squids, all the information in respect of Arabian Sea and Bay of Bengal is indicative of vast resources, based on acoustic survey and experimental hand-line fishing. Oceanic squid fishery is based on specialised technology and in many parts of the pacific and Atlantic, distant water fishining vessels of Japan, ROK, Spain and U.S.S.R. operate for cephalopods under licence or joint venture. Silas (1985 b, ed.) has given detailed information on the cephalopod resources of India and indicated the perspectives. Joint venture in this area seems inescapable as a practical approach to development of oceanic squid fishery in the EZZ.

Management of information

Within the country, during the last 40 years, a large volume of information has been generated on the fishery resources, their biology, environment, fishery characteristics, technology of production, preservation and processing, marketing and utilisation. Apart form historical interest, these data are valuable today. In the present stage of better understanding of prospects and problems of Indian fisheries, both in capture and culture, past information is also found useful in one way or another. Current information generation is even greater and faster with several agencies engaged in marine fishery and related activities, including research, development, industry and management. However, it is doubtful if the information in a processed or unprocessed form is readily available to one who has the most need for it. In the national interest, it is necessary that information of unclassified nature is speedily made available for planning and programming marine related activities in the country. The fisherman, entrepreneur, planner, developer, manager, evaluator and scientist are all handicapped for lack of a system which can retrieve data and provide in a reasonable time. This results in loss of time and improper assessment of situations and, may be, expensive unwise decisions at times. A strong, reliable data-base is very vital for planning, management and development of the marine fisheries. It is suggested that there should be a national policy management of fishery related information and strategies are to be developed for handling different categories of information with adequate infrastructure and modern equipment.

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Technical Session VII

MANAGEMENT OF MARINE FISHERIES

Paper 81

MANAGEMENT AND CONSERVATION OF MARINE FISHERY RESOURCES

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ABSTRACT

The marine fisheries resources of India including the EE Zone of about 2 million sq. km are of considerable magnitude. It is estimated that the Economic Zone may support about 4.5 million tonnes. They consist of demersal fishes, shoaling pelagic fishes, large pelagic fishes, crustaceans, cephalopods, sedentary molluscs, seaweeds, etc.

At present, the landings are confined mostly to inshore belt up to 50 metres in depth. Prawn resources are intensively fished. Pelagic fisheries like mackerel and sardine are highly fluctuating in this belt, due possibly to the limitations in operations and to migrating and breeding influences. Bombayducks are intensively fished. There is no fishing effort for cephalopods, tuna and tuna-like fishes worth mentioning, though their potential is rich.

Shell fisheries like oysters, mussels, clams, etc, cannot now be considered as organised fisheries, though there is subsistence fishing in selected regions. Pearl oyster fishery is highly fluctuating.

In view of the different nature of fisheries at different levels and in coastal, off-shore, deep sea and high sea areas, the varying intensities of fishing at different seasons, their behaviour, characteristics and the stocks, they call for different approaches for management. Conservation of the fisheries and the methods to be adopted will also naturally be different. The approach and strategy for each of these fisheries will have to be worked out carefully, taking into consideration the biological, economic, social and political problems, providing each type of fishery. Some of these aspects are highlighted in the paper.

INTRODUCTION

The marine fishing industry of India, though capable of becoming an important sector in the natural output has been growing at a slow rate. The present relatively low production is mainly due to the marine fisheries being not fully exploited in the inshore waters upto about 50m depth and being practically unexploited in the economic zone beyond 50m depth. The zone upto 50m is estimated to be capable of yielding a substantial quantity of fish additionally, while the deep sea fishery resources beyond 50m depth are of such a potential that the distantly based fishing fleets from USSR, Japan, Taiwan, S.Korea, Thailand etc. had found their exploitation in these waters economical.

EXCLUSIVE ECONOMIC ZONE OF INDIA

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

The extent of the areas of EEZ of India is indicated below:

1. The estimated area under
   EEZ of India - 20,00,000 sq.km
2. Area off West Coast including
   Lakshadweep (Lakshadweep 15%)
   - 8,60,000 sq.km (42%)
3. Off East Coast - 5,60,000 sq.km (28%)
4. Andamans and Nicobar Islands
   - 6,00,000 sq.km (30%)

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

Group	million t
(a) Demersal fishes	7.4
(b) Shoaling pelagic fishes	6.0
(c) Large pelagic fishes	0.7
(d) Crustacean and squids	0.3

Detailed information on the actual fish stocks in the Economic Zone of India is not available;

it is however, estimated that the Economic Zone may support about 4.5 million tonnes of living resources, of which a sizable part could be commercially exploitable fish stocks.

FISHERY RESOURCES

The marine fishery resource of India in the four main regions in north west, south west, lower east and upper east coasts comprise chiefly of

(1) Major pelagic resources, such as oil sardine, mackerel, seer fish, tuna and other pelagic resources of regional importance, such as lesser sardine, anchovies and ribbon fishes;

(2) Demersal fishery resources, such as perches, sciaenids, cat fishes, polynemids, flat fishes, pomfrets, eels, sharks and rays;

(3) Midwater fishery resources constituted by Bombay duck, silver bellies and horse mackerel;

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

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

(6) Sea weed resources.

The details of the fisheries potential in different depth ranges on both the coasts and the present production in these regions are presented in Tables 1 and 2. Joseph (1984) in his observations on potential resources from Indian EEZ has indicated the catch/hr in three sectors on the west coast and in three sectors on the east coast, as also in Wadge Bank and Gulf of Mannar for certain fisheries, which are of significance and abundance. It will be seen that thread fin bream, horse mackerel, cat fish, squids and cuttle fish and black ruff are abundant on the west coast; horse mackerel, perches, mackerel & squids on the east coast; thread fin bream, perches and squids on the Wadge Bank and perches and horse mackerel in the Gulf of Mannar.

Besides, cuttle fish and squids are abundant on the north west, south west and south east regions, including Wadge Bank. These are evident from the landings of the vessels which operated under charter in the eighties. Details of analyses of over 75 pair-trawlers which operated for about 3 years are not yet available. Deep sea lobsters and deep sea prawns are also present in large quantities in the south west and south east regions.

OCEANIC RESOURCES

The oceanic resources of India and their estimated potential are assessed at:

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

Their catch details are given in Table 3.

Table 3 - Region-wise and species-wise details of hooking rate of tunas as gathered from November '83 to October, 1985

Species	West coast	East coast	Andaman sea	Equatorial sea
Yellow fin	0.72	0.61	0.49	1.05
Big eye	0.05	-	0.02	0.12
Skipjack	0.07	0.13	0.02	0.12
Albacore	-	-	0.01	-
Marlin	0.13	0.22	0.18	0.70
Sharks	1.28	0.75	0.68	0.57
Others	0.18	0.32	0.13	0.10
Total	2.13	2.03	1.54	2.66

Shrimp Fisheries

There are about 20,000 mechanised fishing boats in the country. Most of these mechanised vessels have been predominantly concentrating on shrimps. There have been apprehensions that heavy mechanised fishing have caused over exploitation of shrimp resources in most areas. Immediate steps both directly and indirectly are required for conservation of shrimp resources in certain areas. It is considered necessary to carefully control and monitor the entry of additional mechanised boats except for crafts designed for diversified fishing operations and for exploring new areas - for efforts other than shrimp trawling. This calls for an urgent study and assessment.

There should be an endeavour to introduce new technoloty in the inshore waters by constructing and distributing FRP/Ferrocement boats of about 6-9m size and motorising them for gill nets and about 14-15m mechanised boats for bull trawling, gill netting and long lining.

Shrimp fishing with trawlers of more than 23m long is being done from Visakhapatnam and the fleet is on the increase. It is desirable to undertake a study on the impact of these vessels on the shrimp fisheries in the N.E. grounds, so as to take suitable restrictive and conservation measures.

Pelagic shoaling fishes

Pelagic fisheries like mackerel and sardines on the southwest coast are highly fluctuating due perhaps to limitations in operations, migrating and breeding influences. Eventhough investigations on these fisheries in the inshore areas

Table 1 - Details of the fishery potential in different depth ranges on the two coasts of India and the present production

Sl. No.	Regions	Fisheries Potential of EEZ x 10^6t	Potential yield t/sq.km upto 40m	40-160m	160-320m	Current Production(t) (1981)	Gap	Remarks
1.	Northwest region	1.0	5	4	1.90	500,000	47%	Deeper areas to be exploited for crustacean & cephalopod. 80% of present production is from inshore areas.
2.	Southwest region	1.15	*K 8.4 G 5.2	4.4 4.3	2.0 1.9	462,242	50%	60% of the potential are from deeper waters of EEZ pelagic/midwater.
3.	Southeast region	0.67	Not available			435,000	-	Midwater & demersal stocks, crustaceans & cephalopod.
4.	Northeast region	0.74	Not available-though Shrimp trawlers and Fishery Survey vessels are operating.					Crustaceans-mid water and demersal.
5.	Andamans & Nicobar	0.16						Tuna 1000,000 t pelagic shoaling fish 40,000 t; demersal stock 20,000 t.
6.	Lakshadweep	0.09	Tuna-Squids and Cuttle fish.					

*K - Kerala; G - Goa

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

Sl. No.	Region	Demersal high value %	Demersal low value %	Pelagic M.W.high value %	Pelagic M.W.low value %	Remarks
1.	Northwest region	51	8	21	14	53% to come from deeper waters.
2.	Southwest region	51	18	16	15	
3.	Southeast region	52	-	40	-	
4.	Andamans & Nicobar	12	-	63	25	100,000 t tuna and allied fish (25,000 t Yellow fin and 50,000 t of Skipjack)
5.	Northeast coast	Though all shrimp trawlers are based here; the data have not been analysed and made available, as also the results of fishing vessels on charter; which operated earlier from Port Blair.				
6.	Lakshadweep	(Details not available)				

have been undertaken for sometime, factors affecting the stocks remain to be studied in detail to understand the pressure of fishing on the stocks.

APPROACH TO DEVELOPMENT OF DEEP SEA AND HIGH SEA FISHERIES

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

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

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

Besides deeep sea fishing for bottom fish, the importance of tuna, squids and cuttle fish has been recognised and very little has been done so far in encouraging fishing for these fisheries, mainly because these require highly specialised types of fishing, involving heavy capital, organisation and management.

INDIAN TUNA FISHERY DEVELOPMENT - PERSPECTIVES AND A MANAGEMENT PLAN

Speaking at an International Conference "Fisheries Development in 2000 A.D" (New Delhi, 1985) Dr.W. Philip Appleyard, in a global context, opined that the marine demersal catches could be increased from 22 million to 37 million tonnes; the marine pelagic catches from 24 million to 50 million tonnes; tuna catches from around 3 million to at least 8 million tonnes and cephalopods from around 1 million to 10 million tonnes. A potential saving of post-harvest losses of 11 million tonnes may also be added to these to exceed 110 million tonnes of fishes needed by 2000 A.D.

A review of the production trend of tunas in recent years for the Indian Ocean and for India has been presented here. The prime requirement in the planning of tuna fishery development is to maintain and improve production targets with good management measures. By 2000 AD it has been proposed that tuna fishery development programme by India should achieve a commercial production target as follows :

Areas	Present Catch(t)	Catch (t) by 1990 (Silas & Pillai 1982)	Catch (t) by 2000 AD
Coastal species (Drift gillnetting, pole and line fishing and other methods of coastal fishing)	19,000	45,000	75,000
Skipjack and young Yellowfin tunas (Purse seining)	-	50,000	1,50,000
Large oceanic tunas (Long lining)	100	20,000	60,000 - 75,000
		1,15,000	2,85,000 - 3,00,000

In order to achieve the above objectives, the major input-output items in the tuna fishery development programme and the sectors through which they could be effectively implemented are;

(i) Augmenting production through improvement in the traditional small scale fishery sector (drift-gillnetting, coastal purse-seining, surface trolling).

(ii) Development and improvement of medium commercial fishery sector (Pole and line fishing and FAD's).

(iii) Development of large scale commercial fishery sector (large scale high sea purse seining and long-lining).

Tuna fishing is an international fishery and an export oriented industry. It is one of the important fisheries in the EEZ and in the contiguous international waters and cover the high seas. The Govt. of India have been trying to attract joint venture in Tuna fishing from 1965 onwards but with no effective result till date.

It is evident that Japan, USA, S.Korea and Taiwan have the necessary experience and expertise of tuna fishing in the Indian Ocean. It is important to consider programmes from these countries having a better knowledge of the fishing grounds and ready experience by sharing part of the cost. Studies undertaken by CMFRI in 1982 and 1985 indicate that India can certainly benefit from foreign expertise in specific areas like tuna fishing, fleet management, purse seining, long lining, post harvest technology and product development for different export markets.

Longlining from within and outside the EEZ

More information is available today on the longline fishery. The new effort is towards developing deep sea longlining. Continuous monitoring of the catch and effort of species taken by the longline fishery is needed. The longline fishery is also known to take the fish in ripe running condition, and restrictions on fishing of spawning stocks will be necessary. In the exploitation of the southern bluefin tuna, some amount of voluntary restrictive measures are already in vogue in the feeding and spawning grounds of this species.

One of the constraints in the proper stock assessment studies is that the catch and effort data by the foreign fleets are only partly available. Information is still wanting on catch and effort by the tuna vessels of the Republic of Korea as is evidenced by the catch statistics published by the FAO.

The collection of information should be standardised to include uniform type of log books for catch and effort data and data on biology and environment for stock assessment. Unless these are instituted under law it will be practically impossible to implement an effective monitoring system. The Government of India has developed a chartering policy which enables seeking collaborative arrangement for tuna fishing. All such arrangements, which are licensed, should take into consideration the use of standardised logs on board and the data collected should be fed into the National Fishery Data Centre.

Modality of controls for mangement plans for the fisheries of the EEZ of the Republic of Maldives has been suggested. The Government of the Republic of Seyschelles by promulgation of a Decree has indicated modalities for issue of licences for tuna longliners within its EEZ. While states may develop unilateral approaches towards licensing fishing from their EEZ by foreign fleets, the need for uniformity in data collection is also important.

Insufficiency of such information hamper estimations of the requirements and such vitally important assessments. While the cost of monitoring and collection of data on different species from the oceanic waters may be an expensive one, special "skipjack survey programmes" could be developed easily for specified regions. International collaboration in such programmes could be encouraged and a concerted effort be initiated on the lines of the South Pacific Commission for a Tuna Development Foundation.

For the proper development and management of the purse seine fishery, environmental parameters such as the thermocline structure and current pattern are pre-requisites and these need mapping. The thermocline structure would have an important role in the development of fishery for surface species and more ocean wide information on this would be needed. Satellite imagery of sea surface characteristics will eventually be an important tool to pinpoint areas of concentration of surface shoaling tunas such as

Skipjack, young Yellowfin and Albacore.

Surveillance

An ocean wide concern for such a resource is necessary. Within the EEZ one has to plan areas of fishing with diverse gears to prevent conflicts of interests, in other words limited entry into the fishery; total allowable catch for species/resources ie. quota; closed seasons or any regulations in fishing gear designs.

Surveillance has to be aimed at finding out the number of fishing vessels which are exploiting the resources and any infringements. Surveillance could be carried out by aerial reconnaissance or by our own fishing, Coast Guard and defence vessels. There is a need for developing such an integrated surveillance system and also a rapid transmission of information so that poaching could be curbed within our EEZ.

THE NEED FOR AN INTERNATIONAL COMMISSION FOR THE CONSERVATION OF INDIAN OCEAN TUNA

Many of the problems connected with the management of the tuna fishery transend national boundaries and EEZ. An effective implementation of monitoring, control and Surveillance cannot be a function of only the Coastal and island states of the Indian Ocean, as foreign countries, particularly Japan, Taiwan and Republic of Korea are also involved. Hence, a major international effort is necessary to see that the fisheries for the coastal and island states are developed and the tuna resources of the Indian Ocean are properly managed without generating conflicts or developing protective/exclusive attitude which may impede long-term policies.

Today's state of affairs permits unlimited entry into the tuna fishery. Added to this, estimates of catch and effort are not always available. Information on biological parameters such as size composition of the catch are wanting. The need for careful monitoring is evident from the experience gained from the expansion of the surface fishery in the Atlantic Ocean in 1960's which resulted in about 40 percent decline in the catches of Yellowfin tuna in the longline fishery (Joseph and Greenough, 1979). Added to this another factor to contend with is the great mobility of the fishing fleets. Hence, it is desirable to have an ocean-wide organisation to effectively collect and disseminate data to help in the management programmes. To achieve this end international cooperation is needed. It will be necessary to estimate the carrying capacity presently available in the Indian Ocean for tuna fishing along with the potential resources that could be tapped at levels of optimum sustainable yield. This would also need a centralised monitoring agency to estimate levels of abundance and effort expended and advise accordingly. The present mandate of the "Indo Pacific Fisheries Council" (IPFC) and "Indian Ocean Fishery Commission"(IOFC) will not be able to fulfill these objectives. As these organisations work under the U.N. There is an anomalous situation for non U.N. members cannot be a party. It is necessary to consider setting up of Tuna Development Foundation and International Commission for the Conservation of Indian Ocean Tuna.

Cephalopod Fishery

Cephalopods, though fished from the seas around India from very early times, the landings were less than 1,400 tonnes until 1972 and have been gradually increasing only from 1973 onwards with the commencement of export of frozen cephalopod products to several countries - a transition from a discarded to a state of elevation. The production rose steeply from 6,776 in 1974 to 29,964 tonnes in 1984. The bulk of the production includes cuttle fishes which account for about 60% and the rest consists of squids and negligible quantities of Octopii.

Cephalopod fishery accounts for 1 to 1.5 million tonnes form all oceans. More than half of the total are taken in the northwest and northeast Pacific and Atlantic oceans. Japanese fishery vessels in 1981 accounted for over 700,000 tonnes and she is also a major consumer. The potential yield of squids & cuttle fish in the Indian Ocean has been estimated at several hundred of thousands of tonnes and the Bay of Bengal accomodates the largest nursery of squid in the Indian Ocean (Gulland, 1973). Voss (1973) estimated the production potential of the region to be 500,000 tonnes. The exploitable production potential from the continental shelf waters is around 1,80,000 tonnes against the present pro-

duction of about 20,000 tonnes.

The Norwegian vessel, R/v. *Dr.Fridtjof nansen*, which surveyed northern Arabian Sea has frequently taken the oceanic squid *Symplectoteuthis oualaniensis* in such quantities as 8 kg at 21°57'N, 62°41'E and 58 kg at 23°37'N, 59°22'E. (Institute of Marine Research, 1975). The Fishery Agency of Japan (1976,1977) and Yamanaka *et al.* (1976) report that one of the most important findings during the cruises of *R.V. Shoyo maru* in the northern Arabian Sea Survey was the occurance of the potential pelagic squid, *Symplectoteuthis oualaniensis* (23-50cm) taken in jig fishing from wide areas in the northern Arabian Sea and central portion of the southern Arabian Sea. Recognizing the importance of cephalopods as a potential fishery resource, which is now not properly exploited, a major research project was initiated at the Central Marine Fisheries Research Institute on the spatial distribution, fisheries and biological aspects of economically important species in different areas along the east and west coasts of India. The present knowledge of the identity, distribution, existing fisheries, results of the exploratory fishing programmes and biological aspects of cephalopods of India are presented comprehensively, in CMFRI Bulletin No. 37 (1985).

The Landings and export of Capholopods in India are given below:-

	1976	1980	1984	1985
1. Total annual landings of cephalaopods in India(t)	10,826	11,335	29,964	NA
2. Annual exports from India (x 1000 Rs)	648	1,603	1,689	4,139

(Source-MPEDA Statistics, 1985)

This effort should be considered as an initiation to a much enhanced national programme to be closely linked with both the artisanal and commercial fisheries sectors. Immense potential exists in these sectors for the development of major fisheries for squids and cuttlefishes. The projects taken up at the Central Marine Fisheries Research Institute should help in improved data acquisition, stock assessment of important species and rapid dissemination of results with proper infrastructure facilities in manpower and vessel facilities. An active cooperative programme on product development and marketing of cephalo pod products, both domestic and export markets, should closely be linked with resources surveys and harvesting. This approach is necessary as the fishery exploitation is to commence now effectively. There is scope for increasing landings by specialised crafts and gear with bases in Veraval, Malpe, Tuticorin, Vizag and Port Blair.

Mussels and oysters

Pearl oyster fishery is characterised by wide fluctuations and is not an annual feature. The reasons attributed for the oysters not reaching fishable size in the natural beds are biological and physical *viz*-growth of *Modiolus* on oyster bed, excessive fish browsing on oysters, sea star migration, natural sand drift and fierce underwater current. As a large number of factors influence the spatfall and their growth on the pearl banks away from the coast, the management becomes difficult but they can be grown in sheltered bays among coral islands.

Mussels are gregarious and sessile and favour damp ledges and platforms rather than vertical edges. They grow on rocks, shingle and flats of mid littoral region. Rainfall, temperature, phyto-plankton production, pollution, predation, excessive despersal to areas where suitable sites do not exist, are some factors influencing the fisheries.

Based on a thorough knowledge of the resources and their biological and environment aspects, the management and conservation measures will have to be formulated (directed) for recommeding a minimum size, closed areas and closed seasons.

Outline and strategy

Commercial exploitation of the important fisheries in the EEZ and Indian Ocean are specialised and capital intensive and can be effectively inititated as joint ventures in collaboration with fishing company(s) from foreign country(s), who have the expertise, equipment, capital and market for the resources. Therefore, considerable effort in planning at the national level is

needed to generate interest among Indian entrepreneurs and the foreign firms in this field of development. The most important preparatory study required for this plan of development is an economic assessment of resources potential.

The varying nature of fisheries and fish resources complicates the adoption of a rigid system of economic zones, particularly in areas where resources are shared. The difficult task in such areas is to apportion the rights to resouces. As regards the unexploited fish stocks in the deeper and high sea areas of the Indian economic zone and the Indian Ocean, estimates of biomass have been used together with estimates of natural mortality and recruitment to derive estimates of potential annual yield.

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

Information on fish stocks in an area is important to enable planning a rational exploitation programme, to know how catches can be expected to respond to any increase or decrease in the fishing effort and the level of effort necessary to achieve the optimum yield. This information would also provide a basis for the management of the resources. But an assessment of the viability of exploiting these resources is equally important as this would form the motivation force for investment and as long as fishing is profitable, the area of exploitation will continue to expand. The demands for stock assessment advice are increasing. Many stocks especially in the near shore waters are heavily fished and therefore need management. Advice is needed for national planning and management, as well as the possibilities of increasing production from resources further offshore. The law of the sea places the responsibility on the coastal states to determine the potential of the resources in the EEZ and to manage them. Under the new regime of the sea, operations of fereign vessels under charter, joint venture or licence may be the most suitable way of finding out whether good offshore resources exist and if so, their distribution and approximate magnitude. The coastal state should apply appropriate controls to ensure getting full information.

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

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

CONCLUSION

A distinction has to be made between preexploration surveys, to provide and initial estimate of the potential yield and regular monitoring surveys, carried out at regular intervals to determine changes in the abundance of fish stock and continuous understanding of the fisheries for proper management and conservation for maintaining a balance. Of the many unexploited/under exploited fish stocks in our deeper and high sea areas, for which no economic assessment of the potential is available and which, as a consequence have not been developed, tunas, squids, cuttle fish, deep sea prawns and lobsters require attention on a priority basis, as

these are essentially export items with demand in the world markets and are oceanic in distribution and occur not only in the EEZ but even beyond in the international seas. Fishing operations for such fisheries will be important not only for exploitation and protection of EEZ but also to extend the range of fishing in the international areas and protect the resources, taking note of the influence of basic ocean characterisation on these resources. The approach and strategy for the development of each of these fisheries will have to be worked out seperately.

In view of the different nature of fisheries at different levels and in coastal, offshore, deepsea and high sea areas, the varying intensities of fishing at different seasons, their behaviour, characteristics and the stocks, they call for different approaches for management and conservation of the fisheries and the methods adopted will also naturally be different. The approach and strategy for each of these fisheries will have to be worked out carefully, taking into consideration the biological, economic, social and political problems, facing each fishery.

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MANAGEMENT AND CONSERVATION OF MARINE FISHERIES RESOURCES

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ABSTRACT

The present understanding of the term fishery management includes, besides conservation (avoiding over-fishing), other aspects like avoiding under-fishing of stocks, meting out social equity and affording consumer protection. Mathematical models developed, based on experience in temperate waters, are of doubtful applicability in the tropical waters. Moreover, in a populous country like India, employment, economic and social aspects are the dominant considerations. In India, while fish production has increased, the unit porduction of both mechanised and nonmechanised sectors has dropped to about 40%, but the higher price of fish, both in the export and domestic market, is sustaining the fishing industry.

Management (legislative) responsibility in respect of fisheries in India is divided between State Governments and Central Government. In the absence of precise biological indicators management dicisions are mostly based on economic considerations, administrative demands and political expediency. Management measures may include both conservation and promotion measures. Conservation measures include, closed season, ban on capture of berried females, closed waters, provision of fish passes, mesh regulations and legal size, levy of royalty/licence fee on a graduated scale, restriction on the number, manner and size of fishing units, banning of destructive and high efficeincy gear, habitat preservation, removal of weed fishes, prescribing TAC for shared stocks, etc. Promotional measures include small boat mechanisation, introduction of deep sea fishing and provision of related infrastructural facilities. Some practical considerations are outlined in the paper.

RELEVANCE OF MANAGEMENT

The earlier belief, that seas are inexhaustible, is not only considered invalid, but proper management measures are deemed necessary to sustain the fishery at the optimum level. The present understanding of fishery management includes:

(1) avoiding over-fishing and underfishing of stocks,
(2) meting social equity, and
(3) affording consumer protection.

Avoiding over-fishing

Kestaven (1962) indicated the sequential development of any fishery as:

(1) nascent,
(2) developing,
(3) stabilising,
(4) declining, and
(5) extinguished

The primary object of fishery management is to develop and sustain the yield from fishery at the highest level. Several authors have attempted to give the 'Potential Yield' (PY) of the Indian Exclusive Ecomomic Zone (EEZ), often based on an estimate of the standing stock of bio-mass, including standing stock of fish. However, since the PY may not be sustained, we have the concept of 'Maximum Sustainable Yield'(MSY). Estimation of MSY takes into account various oceanographic and biological factors, and mathematical models have been drawn up for this purpose. However, these models have serious limitations even for the temperate water species, characterised by restricted spawning period, fishery supported by several year-classes and relatively less interspecific competition. In our tropical waters with a multi-species regime and hence strong interspecific competition, protracted breeding season and hence overlapping length-frequencies and fewer year-classes, it is doubtful whether these models could be applied in our situation. In fact most of our fishery is suported by 0-year class, which makes our fishery highly volatile. Many of our species are reported from a wide geographic area, and it is not clear whether they belong to the same race or breeding stock. Under such a situation economic considerations are likely to prevail over biometric calculations of MSY.

Meting out social equity.

Over years the emphasis on fisheries management in India has shifted from production to social considerations. It is quite evident that the rules framed by states under the Marine/Fishing

Regulation Act is borne out of social considerations, rather than any strong biological considerations.

Consumer protection.

Except for an attempt in price control in West Bengal, no consumer protection measures are taken in respect of fish in India. In fact, the consumer is almost taken for granted, except in the case of items intended for export.

Exploitation of under-exploited fishery resources

Mechanization of fishing craft, the most important development scheme in marine fisheries, has been introduced ostensible with the intension of exploiting the under-exploited stocks. Encouragement to deep sea fishing is also with this object in view.

ECONOMIC ASSESSMENT

In all economic activities, there are two cost components, viz. a fixed cost and a variable cost. At a certain level of production the total cost (of production) is equal to the earning, or the production is at the break-even point. Performance at below the break-even point is at a loss, while

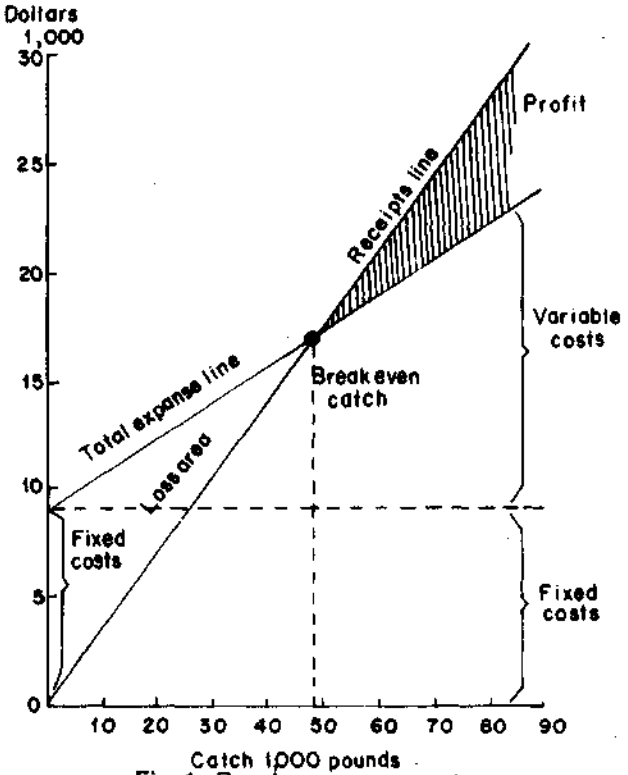

Fig 1. Break even concept

production above the break-even point is at a profit (Fig.1). But in actual practice, while there is a close relationship between fishing effort and cost, the catch rate (relationship between effort and production) would decline, as the catch approaches the stabilization level. The level of Maximum Profit (MP) is before the commencement of the decline. If the fishing effort is continued far beyond MP,a level of No Profit (NP) is reached, beyond which the fishing is at a loss. This is well illustrated in Fig.2. However, this proposition is not quite applicable in the case of artisanal fisheries, where the main input is the labour and the labour is generally paid at a percentage of the gross earning. Very often fishing even at a loss is continued in the hope of striking a good fishing. Another insufficiently appreciated factor is the price which floats inversely as the production, i.e. when the overall supply is small, the price shoots up, while bumper catches are landed the price not only crashes, but there may be no takes.

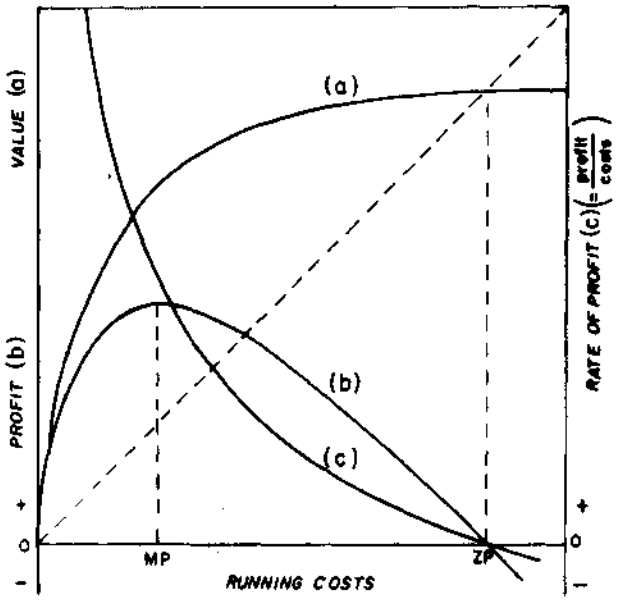

Fig 2. An exercise in bionomics: Curve (a) is a eumetric curve in which steady yield instead of being expressed in weight is now in money value, which is plotted against the economic equivalent of intensity fishing, namely, running costs. From those are derived (b) the annual profit and (c) the profit expressed as a rate on running costs, which in many situations bear a constant relation to capital outlay. MP-maximum profit point; ZP-zero profit point. (From Beverton and Holt, 1958, p. 417).

In such situation it is the Earning Per Unit Effort (EPUE) that determines the outlook on fisheries. In this context, as well as in the context of diverse catch co-efficients that go into the making of effort

statistics, the Catch Per Unit Effort (CPUE) has lost much of the original significance. However, CPUE is still being regarded as a reliable index for any specific boat-net combination.

MANAGEMENT CRITIERIA

By and large marine fisheries management in India has been adopting the principle of 'common heritage' with 'open access' to any one wanting to take up fishing as his vocation. This approach has not changed, eventhough in many areas fishing is showing signs of having reached a stablization level and further effort on these stocks might only lead to distribution of the same catch among more fishing units. Since the catch efficiency of different types of fishing effort is not the same, excessive effort can be particularly harmful to certain types of fishing, especially when high efficiency gear is deployed. This is probably what has happened in the Indian marine fishing scene. At the macro-level, it is seen that the contribution of the non-mechanised fishing sector has remained almost steady at around 5 lakh tonnes per annum over the past 35 years, while the number of non-mechanised craft has gone up by 2 1/2 times, indicating that the average catch of a non-machanised boat has dropped to 40% over these years. There has also been similar reductions in the catch of mechanised boats also. Mammen (1987) has pointed out that while during the last 33 year period, i.e. between 1953 to 1985, the whole-sale price index of 'all commodities' has gone up by 7.6 times, 'food items' by 6.7 times and meat by 12.7 times, the fish price has gone up by 18 times. It is really this steep rise in fish price that has sustained the fishing, inspite of the fall in catch rates. While the consumer is the worst hit in this process, the plight of the fishermen is a stagnation in his real income (i.e. at constant price). It has given extra employment, but not beyond the rate at which the Indian population has been rising. The questions to be considered before imposing management restrictions are:

(1) are the management proposals biologically desirable?
(2) are they economically sound?
(3) are they politically expedient?
(4) do they satisfy the administrative demands for the purpose of 'appearing to do justice for all'?.

These are difficult questions to answer. In many countries management measures then initiated were purposely harsh, or atleast more severe than appeared to warrant. But the departmental attitude was that it would be more convenient adminstratively to relax than to tighten controls, should an alteration is needed in later years. In this context, India is in an unenviable position. With hardly any restrictions, except with a fair degree of consent, or in support of the majority, which in other words is on considerations of political expediency. Moreover, it becomes difficult to establish beyond doubt whether a particular measure is biologically and economically desirable, especially since the artisanal fishermen would prefer to have some income, rather that remaining idle.

MANAGEMENT RESPONSIBILITY

The earliest fisheries legislation in India is the Indian Fisheries Act 1896, which by virtue of Article 372 of the Indian Constitution will continue to be in force until altered, repealed or amended by a competent legislature. This Act is obsolete as it concerns only with the operation of fixed engines, poisoning, dynamiting etc. However, many state governments have enacted state level fishery legislation under the enabling provision contained in the Indian Fisheries Act. Under the Indian Constitution, the legislative power in respect of 'fisheries' is with the state Government (vide item 21 of Part II of the 7th Schedule of the Constitution), while 'fishing and fisheries beyond the territorial waters' (Vide item 57 of Part I of the 7th Schedule of the Constitution) is with the Union Government. Eventhough this would appear that the Union Government has legislative power only in respect of fishing and fisheries beyond the territiorial waters (which is at present 12 nautical miles), the Union has control by virtue of proprietory rights in respect of 'things of value within the territorial zone (amended article No.297). Further Article 251 of the Constitution provides that in the case of inconsistency between laws made by the Parliament and the state legislatures, the laws made by the parliament shall prevail. The Marine Fishing Regulation Act, although drafted by the Central Government, was left to the states to legislate, as the main operational areas lay within the territorial waters, whereas the Maritime Zones Act was a pices of Central legislataion. In keeping with the provisions of legislative authority, the Rules framed under the Kerala Marine Regulation Act has banned the operation of mid water trawl, pelagic trawl, ring seine and purse seine within the entire territorial waters of Kerala, the extent to which the State has legislative powers. When Gujarat Govt. wanted the chartered vessels to keep off beyond the 40 fathom line, they had to move the Central Government to issue orders under the Maritime Zones Act. Hence the consitutional provison is that legislation on management and conservation of marine fisheries within the territorial water is within the competence of the states, while the Central Government can legislate in the entire sea. The Coast Guard is generally responsible for the enforcement of the Maritime Zones Act, while fishing regulation within the territorial waters is generally the responsibility of the state, for the state, for which an effective organization is yet to be created.

MANAGEMENT MEASURES

As already mentioned management measures in marine fisheries include both conservation and promotion. The usual conservation measures are:

(1) Closed season, ban on capture of berried females;
(2) Closed waters (sanctuaries) and provision of fish passes;
(3) mesh regulations, legal size etc.;
(4) levy of royalty, licence fee etc. on a selective basis;
(5) Restriction on the number, manner and size of fishing units;
(6) Reduction in the number of fishing units, and 'buy back';
(7) Prescribe Total Allowable Catch for shared stocks;
(8) Banning of destructive/ high efficiency fishing methods;
(9) Habitat preservation, pollution prevention etc.;
(10) Removal of weed fishes.

In the inland fishery sector a closed season for fishing is observed in many inland states. In Madhya Pradesh, fishing, transportation, possession and marketing of fish from public waters is a punishable offence during the closed season. In Australia, where closed season is observed in respect of marine fisheries, it is necessay to declare the fished out stocks before the commencement of the closed season. Here rules prohibit capture of berried lobster etc. In Tamil Nadu pools below dams, rapids and water falls, where migrating breeders are known to assemble, are identified and declared as fish sanctuaries. In Punjab fish passes are provided for the migrating breeders to negotiate such barriers. In the Indian marine fisheries, no closed season as such is prescribed, but the monsoon certainly restricts the fishing effort during the monsoon season, which is generally believed to be the main breeding season. In many coastal states, local conventions ban the use of synthetic (silk) nets during monsoon. In Goa, the Government was keen that insurance cover was not extended to mechanised boats during monsoon, so that they do not go out for fishing during monsoon. In Kerala the stance of the traditional fishermen to ban the operation of mechanised boats during monsoon spearked off a major law and order problem. However the two committees appointed by the Government of Kerala returned the verdict that 'Karikadi' fishery would be practically lost, if mechanised fishing during monsoon was banned. The results of exploratory survey in the Wadge Bank show that the fish catch rates are atleast double during the monsoon. In some states, mechanised boats are permitted to fish only during day time, for fear of damage to the gill nets operated by the traditional fishermen, eventhough results of research show that night fishing is more profitable.

Mesh regulations and impostition of 'legal size' are two imporant conservation measures. It is reported that mesh regulations were prescribed in England as early as the reign of king Edward III. In Australia, as many as 119 sea fish, 17 fresh water fish and 12 crustaceans have legal minima prescribed even in 1962. In many Indian inland states, minimum mesh sizes are prescribed for reservoir fishing to ensure that small major carps are not caught. In the trout fisheries of J & K, only licenced anglers are allowed to fish in trout waters and that too during day light and when escorted by a licensed 'fish shikari'. Many Indian marine states have started prescribing mesh regulations for marine fishing and fishing in back waters. In Kerala as per rules, the mesh should not be less 35 mm., but the fishermen are known to use extra thick twine in a bid to reduce the mesh opening.

Marine fishing is not a licensed industry in India, except for the chartered fishing vessels. However 'fixed engines' like stake nets,Chiness dip nets etc. and even prawn filtration are subject to annual licences. While various committees have recommended not to issue any more licences and to remove all unauthorised stake nets, their number is steadily on the increase. So also the restriction on the operation of stake nets etc. during incoming tide brightness of lights used for luring prawn etc. are observed more in their breach.

States like Gujarat, Rajasthan, UP., etc. levy royalty charge on inland fish caught from notified waters. The royalty amount may be as high as Rs.6/kg in respect of major carps, but may be nominal or free in the case of smaller fishes. Even then the minnow population is increasing. No such royalty system has been tried in marine fisheries, except in the case of chank fisheries.

It is well know that when the pressure of fishing increases, the catch per unit effort decreases. In many countries the public law often takes the side of the majority. Where the num-

ber of amateur (sports) fishermen exceeds that of professional fishermen and where the latter takes more fish, rules have been framed to restrict the number and size of nets used by the professional fishermen. In India and in almost all developing countries, the clash of interest is between the traditional fishermen, mostly operating non-mechanised boats, and the new comers into fishery mostly operating mechanised boats. In all these cases, laws are framed to protect the interests of the traditional non-mechanised sector.

In India,the fishing effort is steadily increasing and is heading towards a situation when fishing becomes unremunerative. In order to maintain the economic viability of fishing, it is necessary that the effort is regulated. In highly advance countries, strong measures are taken to reduce the fishing effort. This includes besides'limited entry' 'buy back' of licences already issued, states paying compensation to any who desire to retire from fishing and even scrapping /sinking of surplus fishing vessels.

All fishing methods are to some extent destructive, but some like anchor hooks in lobster fishing are definitely destructive. Similarly poisoning, dynamiting etc. are also destructive and are banned every where. There has always been a popular agitation against high efficiency gear like purse-seine, two boat trawl, and high opening bottom trawl etc. While the whole approach to development of fishing gear is to improve the catch efficiency, it is paradoxical that high efficiency should be the reason for banning them, albeit on the grounds of social equity.

Where stocks are shared, it is usual to prescribe catch limits to the participating nations/states, based on an estimate of Total Allowable Catch (TAC). In India, Kerala has already moved for constituting an InterStates Fisheries Commission, as they feel that all their restrictions on purse-seining is only benefitting the Karnataka Fishermen, and Karnatak has no such restrictions. . Similarly Hilsa is a shared stock, but, no proposals have emerged on the management of Hilsa fisheries on a regional basis.

Traditional fishermen often complain that trawl nets that scrape bottom is destroying fish habitat, fish eggs and laravae. This ,however, is not based on any valid observation. In some respects raking the bottom has a benefical effect. More over most species have their eggs and larvae in the surface waters. The habit of prawn and fish larvae to seek shallower waters also goes counter to this presumption. However, two areas, where the habitat is badly affected are the back waters and edge of the sea. For instance the Vembanad Lake, which forms a major nusery for Kerala's prawn, it intesively fished with rows and rows of stake nets, and from thousands of places from where prawn filtration is being carried out. Various industries discharge their effluents into the river which would flow into the Vembanad lake. The practics of retting coconut husks is another man-made pollution. To make matters worse, the saline protection works affect the migration of both marine and fresh water prawn and lead to the concentration of acidity to lethal levels and infestation by various fish parasites. The dredging of Vembanad lake, in a bid to recover sub-fossil clam deposit is leading to buring the highly productive detritus cover of the lake bottom with dredged soil, which is poor in fertility. Extensive reclamation of the lake for agricultural purposes, shrimp farming, etc. have also reduced the area available as nursery for prawn and other species (Mammen, 1984).

Another area where habitat destruction takes place is the edge of the sea, which are rich in post-larvae of a variety of fish species immediately after the monsoon. In fact the 'nonnavu fishery' with shore seines is nothing but a fishery of post-larval stages of fishes.

The impact of weed fishes that compete for food and space with the desirable fishes in the reservoir fisheries is fairly well recognised. While maintence of proper prey-predator ratio is often mentioned in management discussions, there are practical difficulties for such manipulatiuon. However, it is very clear that a reduction

in the number of major predators like sharks, that take a heavy toll of many food fishes, is capable of practical application.

Besides the conservation measures so far discussed, there is a promotional aspect in management. Introduction of mechanised boats has been one of impoartant measures taken, not only to increase access, but also to use more efficient gear with the aid of mechanical power. While the scheme has achieved this objective, it has also brought to light, some weakness, viewed in the context of social equity. Deep sea fishing is an extension of the principle of introducing small mechanised boats. Government has been assisting and encouraging deep sea fishing through measures like resource surveys, training of man power, creation of infrastructural facilities like fishing harbour, capital subsidy on indigenously constructed fishing vessels import of vessels, including second hand vessels, soft lending arrangements, chartering, joint ventures etc. However, these promotional measures were tempered with a host of restrictions on the area of operation, various rules and procedures etc., with the inevitable procedural delays.

PRACTICAL CONSIDERATIONS

Some practical considerations in the form of recommendations are given below to facilitate discussion.

General

1.It is time to consider formulating management measures in marine fisheries, as many of the exploited stocks are showing signs of stagnation in production. The problem of management would get further aggravated with the passage of time. Even otherwise also, it is not too early to consider such measures as marine fisheries research has been going on for the past 40 years by the various State Governments and by the CMFRI.

2. There should be a compulsory registration and licensing of fishing craft and gear. The licence fee should be on the basis of a 'fair rent' and should work as a deterrnet to the proliferation of fishing craft and gear. It is also necessary that registration marks are boldly exhibited for quick verification.

3. There should be an immediate freeze on the craft and gear to the number presently in use, pending a proper study of the economics of operation of various craft-gear combinations. If the study reveals that the number of craft-gear combinations is below sustainable levels, the level to which it could increase should be indicated by the study. If on the other hand, the maximum sustainable number of craft-gear combinations has already exceeded in certain areas, no more additions should be permitted and steps taken to reduce their number, by encouraging voluntary retirement on payment of compensation, 'buy back' arrangement, non replacement of craft and gear lost or otherwise become unusable, etc.

4. Data collection in the past had been largely on the basis of what was feasible, than dictated by the needs of management. It is necessary to identify the data requirements of effective management and develop a proper Management Information System (MIS).

5. As most exploited fisheries are on the basis of O-year class, with the new born getting recruited into the fishery within 2 or 3 months, of breeding, a Fishery Information and Forecasting Service (FIFS) should be so developed as to make forecasts well in advance of the commencement of the fishing season.

6. To avoid undue restriction on fishing, critical period of their life history, spawning grounds, nursery grounds etc. should be identified and need based management measures should be drawn up, keeping an eye on the feasibility of management, economics of fishing as well as considerations of social equity.

7. There is hardly any enforcement machinery in the states for enforcement of management laws. States may therefore consider creation of a separate force like Fishery Guards,

on the lines of Forest Guards with adequate boats, training in management measures, use of fire arms etc.

Prawn fisheries

1. It is generally believed that prawn with its protracted breeding habit, may not be a suitable candidate for enforcement of any kind of fishing restriction on the breeding stock. Moreover, in the conventional prawn fishery, most of the prawn breeders move further away into the sea where there is less risk of breeding stock being fished out. Since the critical larval and juvenile life history of most of the commercially important species are in the brackish water areas, there is a strong case for enforcement of conservation measures as well as protection of brackish water environment.*

2. Measures like removal of unauthorised stake nets, operation of such nets only when the tide is receding, use of only the approved type of illumination, use of larger mesh size, or in short strict compliance with the already existing regulation should be insisted on.

3. While the smaller prawns dominate the catches of backwater, a varying quantity of juveniles of the larger prawns are also caught. As many of them are collected in a dead condition due to the pressure of the water current, it is suggested that a trough like extension should be attached to the tail end of stake net and prawn filtration nets like the 'gamcha'of the spawn collection nets used in rivers. The live prawn juveniles caught could be seggregated into desirable and undesirable species. If the percentage of desirable species is significant, it could be sold as stocking material to the shrimp farmers, who will be ready to pay a much higher price. Otherwise the catch may be disposed off in the usual way. Such a procedure serves the objective of allowing the fishermen to continue their fishing, but realise a better income on one hand and provide the necessary advanced fry for stocking brackish water farms, including paddy fields currently used for prawn filtration (Mammen, 1984).

4. The habitat degradation of brackishwater lakes and esturies is more serious than what meets the eye. The more important suggestions are:

a) Effluent treatment of industries should be more stringent and if the effluents cannot be made absolutely harmless, Government should insist on discharge of such effluents further out into the sea where the currents are strong (Such a recommendation by the author has worked in the case of Zuary Agro-chemicals, Goa.)

b) The object of saline protection work could be achieved without deterent to the environment if only the surplus water flowing out during monsoon is retained in reservoirs to be let out during the summer months to keep the saline wedge at the desired level.

c) Alternate methods to retting should be found out so that use of back waters for retting of coconut husks could be avoided.

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*During 1978 MPEDA proposed to ban the export of shrimp of count more than 500, in a bid to discourage catching of very small shrimp from the backwaters. This move was opposed vigorously by fishermen and the exporters. According to them

1) there is no guarantee that prawn spared from fishing in the backwater would be caught back as a bigger prawn. In all probability, what is spared from fishing mortality would die of natural mortality.

2) Granting that a portion of the juvenile prawn spread from fishing in the backwater would ultimately be caught as bigger prawn by a fishing trawler, why should be brackishwater fishermen make this sacrifice for the trawler operator to prosper ?

3) In Cochin back waters, the overwhelming majority of the prawns caught are the smaller species, some of which are already mature. Any undue restriction on fishing in the back water would mean that this resource would remain unfished only to meet with a natural mortality

4) Why should the fishermen alone be blamed, when others also damage the environment, eg. by saline protection works, discharging industrial effluents, domestic seawage, dredging of lake bottom, retting of coconut husks etc.

All these are valid pointers to the nature of conservation to be adopted.

d) The practice of dredging the lake bottom for sub fossil clam deposits should stop, or alternately the dredged soil should be deposited between interlocking sheet piles to prevent dispersal.

Small pelagics

1.Small pelagics like oil sardine, mackerel, anchovies are some of the best studied fisheries in India. Although we have a wealth of information on these fishes, still we are lacking in certain vital information necessary for management. For instance, while these species reportedly have a wide geographic distribution, it is not clear whether we are not dealing with separte stocks. If they are not separate stocks, then the problem has wider ramifications and should be studied in that context. The information with regard to breeding areas, larval migration, natural mortality, etc. appear to be insufficient to suggest firm and appropriate management measures, that could be convincing. This doubt is accentuated by the disparity between the in-house forecasting by the CMFRI and the actual fishery and similar difference between the forcasting and reality in the case of Pelagic Fisheries Project.

2. A useful data thrown up by the CMFRI is the observation of large number of oozing oil sardine in purse-seine catches. It is possible that if fishing is suspended by these purse seiners on oil sardine for a while, it might result in large scale breeding, eventhough it is not clear whether this would have the expected impact on the ultimate fishery. It is therefore worth persuading the purse seine operators to cooperate by suspending fishing on the oozing fish and see whether there is the desired impact. If this works, more elaborate management measures on these lines could be thought of.

3. One of the recommendations of the erstwhile Pelagic Fisheries Project was the extension of fishing to the off-shore regions, where shoals are available for a longer duration. This is precisely what is being done by the purse-seiners. They also catch larger sized fish. However, it is to be established whether fishing these larger fish will have any adverse impact on the over all fish production.

4. We do not seem to have adequte information on fish eggs and larvae of the small pelagics, as commercial catches do not land them. Special survey on fish eggs and larvae is indicated to bridge the gaps in the MIS.

Cat fish fishery

The largeness of cat fish eggs and the largeness of the cat fish fry, when released from the buccal cavity of the incubating male are distinctive features of the cat fish. In the normal course, there should be better survival. However in certain areas, eg. Balasore coast, juvenile cat fishes are caught in enormous numbers. To what extent any imposition of restriction on the fishing of incubating males and the juvenile shoals will have their impact on the fishery should be watched and suitable management measures taken. Nevertheless-what appears more important is the extension of fishing effort on cat fish, as according to Joseph (1987) cat fish is among the lightly fished groups.

Shark fishing

Sharks being in the catgory of major predator, is not likely to have the effect of keeping down the weed fish population, but it is keeping down the population of many desirable food fishes. From the point of increasing shark catches, as well as to get the benefit of reducing predation on other esteemed food fishes, it is necessary that shark fishing is encouraged. According to Joseph (1987), sharks - both pelagic and demersal - are among the lightly exploited groups.

Other fishes

From the over all fish production point of view, fishes feeding on the lower trophic phase should support a good fishery, provided, fishing has the effect of thinning the stock on a fairly uniform rate. From this point of view, an increase on fishing on species like *Anchoviella* is indicated. It is a lightly fished resources also. Cephalopods, nemipterids, sciaenids, horse mackerel etc. are

other food fishes which are lighly fished. FSI has also found almost untouched resources of *Psenes, Priacanthus, Centrolophus* etc. which could be exploited, provide suitable value-added processing methods and suitable market strategy are developed.

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Paper 83

ROLE OF SOCIAL SCIENCE RESEARCH IN THE INTEGRATED DEVELOPMENT AND MANAGEMENT OF MARINE FISHERIES

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ABSTRACT

The importance of fisheries in the national economy needs no emphasis. The reasons for the development of fisheries in India are the same as in many of the Third World countries: the need to a) increased fish production, b) secure income and foreign exhcange, and c) provision of employment opportunities. This paper intends 1. to review and examine the current pace of social science research in marine fisheries, 2.to evaluate the performance of fishery policy and planning in India, and 3.to emphasise the need for sustained contribution of social science research for the integrated development and management of marine fisheries.It is found that the pace of social science research in the fisheries sector has hither to been rather limited. Excepting a few studies sponsored by Government and also some pioneering attempts by individual social scientists, systematic analytical research is lacking. The efforts of fishery policy and planning in India, so far, resulted in realising some of the national objectives in terms of growth of marine fish production and exports. Information about the improvement of the socio-economic conditions of fishermen is scanty. Due to absence of social science research interms of periodical evaluation of planning strategy, implementation mechanism and the resultant benefits, the desired results could not be achieved. Therefore, it is necessary to concentrate on problem oriented research to integrate the same with fisheries planning, and also to strengthen the social science research capacity for better development and management of marine fisheries.

INTRODUCTION

At the present stage of economic development, India relies heavily on its natural resource including fisheries. Since the principal objective of resource development is to achieve maximum sustained contribution to national output, it is imperative that natural resources should be harnessed in the process of production. This would help to achieve an optimum utilisation of resources resulting in a maximum increase of national income. The guiding principle of resource development applicable to renewable resources like fisheries, emphasis the need of using natural resources in such a way that a high technically and economically supportable level of national output may be sustained for an indefinite period (Datt and Sundharam, 1985 and Subba Rao, 1986).

The significance of fisheries development lies in its contribution to national economy. Fish, a staple food, supplies animal protein to 70% of the Indian population and the per capita consumption is 4 kg as against the actual requirement of 11 kg per annum. The contribution of income is estimated at Rs. 1,118 crores (1982-'83) which is 0.77% to the Gross Domestic Product (GDP) and forms 2.13 % to the primary sector. Overseas trade in fish and fish products secures

for the country Rs. 385.50 crores (1984) in foreign exchange accounting for 3.3% of the national foreign exchange earnings. Further, it provides employment directly to 1.8 million people besides to many more indirectly.

India, with an extensive coatline of 6,500 km and a continental shelf area of 5.8 million sq.km, has endowed with rich fisheries potential. Started as an avocation in the distant past, the marine fishery sector has risen to the status of an industry. Consequently, the marine fish production in India has almost trebled in a period of three and a half decades from 5,34,000 tonnes in 1951 to 16,31, 000 tonnes in 1984 (Table 1). Although, the annual rate of fish production is not in higher order when compared with the resource potential the achievement of the same was due to the concerted efforts of the multitude of marine fishermen, fishery scientists, fishery technologists and Government. The Seventh Five Year Plan has set an ambitious target of 2 million tonnes of marine fish production and Rs. 7,000 million worth of marine products exports (Table 2). It is envisaged to achieve these targets through judicious exploitation and management of the inshore fishery resources and extension of fishing operations into the Exclusive Economic Zone, besides some production through brackishwater aquaculture.

An attempt is made in this paper to analyse the possible contribution of social science research for the integrated development and management of marine fisheries. Specifically, it intends

1. to review and examine the current pace of social science research in the Indian marine fisheries,
2. to evaluate the performance of fishery policy and planning in India, and
3. to emphasise the need for sustained contribution of social science research for the integrated development and management of marine fisheries.

PRESENT STATUS OF SOCIAL SCIENCE RESEARCH IN INDIA

Research forms the backbone of development of fisheries on scientific lines and it needs no emphasis. Most of the advanced nations of the world have developed and achieved 'Fisheries Revolution' because of sustained and systematic research. The impact of this has been keenly felt even in India also. But the whole thrust of fisheries research in India so far has been centered round on biological and technological aspects, mainly aimed at the exploitation of fisheries resources.

On the other hand, the social and economic aspects of fisheries research has been completely ignored. The welfare of the fishermen, their investment and returns, the utilisation, marketing and distribution of fish and a host of other problems have not been taken care of. In this context, the observations of a distinguished natural fishery scientist, G.L. Kesteven, are worth noting. He says that "events in the fishery world over the past few decades have shown us that our natural sciences account of resources does not give us an adequate understanding of the behaviour of those resources, so that, in consequence, most changes take us by surprise and only rarely are we confident that we are acting for the best - any best - in our utilisation of resources. Yet, even more forcefully those events have shown us that our strategy of resource use is not a matter merely of how a resource reacts to what we do. There are technological, human and social elements to be taken into account, and for these we need a social sciences contribution" (Kesteven, 1972).

As outlined above, the current pace of social science research in the country in respect of fishery sector has hither to been rather negligible. There were no attempts prior to 1940 and immediately after, either by the Govenment or by the individual social scientists to promote social science research in fisheries. The only earlier reference was the unpublished report on 'Marketing of Fish in India' prepared in 1941 and published later in 1951 and again in 1961 (Government of India) with suitable modifications and improvements. Even today also it serves as a bench mark and valuable reference guide in the absence of other national fish marketing surveys. The Fish Sub-Committee (1945) emphasised the need for recruitment of the research staff by Central as well as Provincial Governments in order to conduct research studies on the aspects of marketing and distribution of fish, socio-economic conditions of fishermen, cooperatives, etc. But serious attention was not paid on these recommendations since the basic research in fisheries itself was in infancy at that time and even after. Seperate institutions were not created for the promotion of social science research in fisheries either by the Central Government or by the

Table 1 Marine fish production and exports in India

Year	Annual marine fish production (000'tonnes)	Share in total fish production (%)	Quantity in exports (000'tonnes)	Value in Rs crores	Average unit value realisation
1951	534	71.00	19.65	2.46	1.25
1956	719	71.00	18.14	3.72	2.05
1961	684	71.20	17.30	4.13	2.39
1966	890	65.10	19.15	13.52	7.06
1971	1161	62.70	34.03	39.17	11.51
1976	1353	61.50	62.15	170.86	28.96
1981	1378	56.40	75.37	286.71	38.04
1984	1631	57.20	89.91	385.50	42.88

Sources: 1. Various publications of Central Marine Fisheries Research Institute, Cochin.
2. Annual Statistics of Marine Products Exports, Marine Products Export Development Authority, Cochin.

Table 2 Targets for selected fisheries programmes in the Seventh Five Year Plan

Item	Unit	Base level 1984-85	Target 1989-'90
1. Marine fish production	M.Tonnes	17.50	22.00
2. Mechanised boats	numbers(cumulative)	20,000	25,000
3. Deep sea vessles	-do-	75	350
4. Habours/landing centres	-do-	86	140
5. Marine Products exports	Rs.in crores	385.50	700.00

Source: Seventh Five Year Plan 1985-'90, Vol. II, P.36.

Table 3 Percentage share of marine fish catch by mechanised and non-mechanised boats along the Indian coast.

In 000'tonnes

Year	Total catch by mechanised vessels	Share (%)	Total catch by non-mechanised vessels	Share (%)	Total marine fish production	Total (%)
1961	7	1.02	677	98.98	684	100.00
1966	13	1.46	877	98.54	890	100.00
1971	238	20.50	923	79.50	1161	100.00
1974	374	30.71	844	69.29	1218	100.00
1981	839	60.90	539	39.10	1378	100.00
1984	1150	71.16	466	28.84	1616	100.00

Source: Marine Fishery Information Service, T&E Services, Various Issues, Central Marine Fisheries Research Institute, Cochin.

State Governments. The Agro-Economic Research Centres set up in various parts of the country by the Ministry of Agriculture were confined to studies on agriculture, animal husbandry and dairying. However, it is striking to note with some satisfaction that the fisheries extension wing of the Central Marine Fisheries Research Institute, Cochin, undertook few studies on the socio-economics of fishermen. Recently a fishery economics unit is also started in the extension wing to carry out studies on eocnomics of fishing units following the recommendations of the National Commission on Agriculture (Anon, 1976). Further, excepting the study by Planning Commission (1971) on 'Evaluation Study of Mechanised Fishing Boats' and later by Naitonal Council of Applied Economic Research (Anon, 1980) on 'Demand for Fish and its Transportation and Storage' and also by IIM, Ahmedabad (1982) on 'Marketing', the Government did not sponsor any other study.

However, of late, some pioneering attempts have been made by individual social scientists like P.S. Rao, John Kurien and others including the author working in different universities and other social science research institutes spread over various parts of the country mainly from the coastal states to study on different aspects of fisheries like marketing of fish, costs and returns of fishing units, role of cooperatives. The studies serve as benchmark and provide background information for future studies. By and large, excepting the above few studies, there exists no plan for the development of social science research capacity to work on problems of fisheries development in the country.

PERFORMANCE OF FISHERY POLICY AND PLANNING IN INDIA

This section mainly deals with the performance of fishery policy and planning in India and highlights the need for social science research for the development and management of marine fisheries. It has been increasingly recognised that in any sector of development, the social science research contributes heavily for the sectoral policy and planning process. Therefore, this section firstly, reviews and examines the fisheries policy and planning process in India and highlights some of its achievements. Later, it discusses about the need based and possible areas of studies that the social scientists themselves or in association with natural scientists or technologists can undertake.

At present, social scientists in India are not making large contributions to the planning fisheries developemnt either in providing information to the planning process or in plan evaluation. In other words, the social science research support to fisheries development planning is small, and professional social scientists are not much involved in evaluating the possible implications of plan implementation. This is largely due to the lack of economists and other social scientists trained to work on problems of fisheries planning and developemt. However, given an opportunity, social scientists can more effectively structure their programmes to contribute to national development. In this context, the observations of renowned resource and fishery economist, Harlan C. Lampe (1976) is worth mentioning. He suggests that national interests might be well served by directing attention of social and other scientists to fisheries planning.

The Government policy regarding the development of marine fisheries envisages the exploitation of seafood fish potential in view of the nutritive food shortage in the country and also to derive other economic gains for the larger benefit of the nation as a whole. Therefore, the fisheries planning in the country is directed to achieve these ends. The successive Five Year Plans have three common objectives for fisheries development. They include:

a. to intensify and increase fish production,

b. to earn foriegn exchange through exports of marine products, and

c. to increase employment potential and income of the fishermen and to improve their socio-economic conditions.

The various marine fisheries development programmes which have so far been under taken to achieve the above objectives consist of: 1) mechansiation of fishing craft, 2) exploratory and experimental fishing to locate new grounds, 3) improvement of fishing methods, 4) increasing the suppply of fishery requisites, and 5) provision of facilities for landing, preservation, transport and marketing of fish. Besides, the Government has also attempted to step up fish production through exploitation of deep sea resources by deployment of deep sea trawlers in the areas of EEZ by encouraging the Indian entrepreneurs and also by joint ventures with foreign firms on chartering basis.

Now we are in the middle of the Seventh Plan. Attempts are just initiated to prepare a suitable approach for the Eighth Plan. Hence, a close perusal of the achivements of the earlier Plans in relation to the stated objectives in respect of fisheries development seems necessary to take stock of the situation.

A close examintion of trends of marine fish production in different periods indicates that in general, there has been a continuous increase of fish production, although it falls short of plan targets. Threefold increase can be noticed from 1951 to 1984. One important reason for this rise in fish catches in recent years may be attributed to increase in the number of mechanised boats and also to excessive fishing effort by them. Until 1970, the total marine landings were caught by the traditional craft and the share of mechanised boats was only 1.3%. With gradual increase in the number of mechanised boats in the subsequent years/plans, the share of their catch has also gone up. It can be seen from Table 3 that the contribution of mechanised boats was 30% in 1974 which has went up further to 70% in 1984. But the same was reversed in case of traditional craft. The most disquieting feature that can be noticed from Table 3 is that the productivity of traditional boats has deeply gone down. This suggests the need for a careful and indepth study.

As regards the exports of marine products also there has been continuous increase both in respect of quantity and value from 1961 onwards. While the quantum has registered a fivefold increase during the period 1961 - 1984, the value has jumped up 93 times. This is mainly due to higher unit value realisation in the market, which has also increased 18 times during the same period. Further, shrimp has been the major item of exports, and Japan and U.S.A. have been the major markets both together sharing 80% of the value of total marine products exports.

Coming to the third objective, i.e. increase in employment potential and incomes and improvement of the soci-economic conditions of fishermen, Dr.G.S. Dhillon, Union Minister for Agriculture, states that a number of Centrally sponsored schemes have been initiated recently, of which, some of these are production oriented while others are welfare oriented (Dhillon, 1987). However, the beneficial impact of these programmes have not been adequately studied inorder to intensify or modify the programmes to extend the benefits to majority of the fishermen.

It emerges from the above that during the period of three and half decades, a good number of schemes have been conceived and implemented for the promotion and development of marine fisheries. An essential prerequisite, in this context, is the thorough periodical evaluation of plan objectives and the implementaion mechanism and assessment of resultant benefits derived therefrom. Unless it is done, it is highly difficult to imagine to which direction the policy or the planning process is moving. It is here that social science research can play a key role in identifying the weakspots and set the things on right path.

In planning to achieve the objectives, there may be some national policy guidelines that impinge upon approaches used. Fisheries planning must essentially plan for national objectives and within national policy constraints. Lampe argues that "the lack of clearly stated fisheries policy is not necessarily a problem. What has been a problem is that fishery development plans have frequently overestimated the possible contribution of fisheries to national objectives. There is a certain propensity to plan for what is wanted, e.g. in terms of growth rates, rather than what might be achieved".

NEED FOR PROBLEM ORIENTED RESEARCH

We further stretch the discussion for highlighting the potential contribution of social science research. It is also to provide a clearer view of how social scientists can more effectively structure their programmes to contribute to national fisheries development. In general, there may be some good reasons for not attaining the plan objectives as envisaged. Firstly, there may be a possibility to overestimate or underestimate the resource potential and the potential performance of vessels and gear. Three factors contribute to those productivity estimates: 1) stock density, 2) technology, and 3) operation of the fishing unit. If the stock density is over estimated obviously catch rates are likely to be overestimated. The designed technology (the complex of vessels and gear) may not perform as anticipated, particularly if it involves a significant departure from techniques with which experience has been gained. Fishing operations may not be conducted as planned or with the intesity expected. The anticipated number of days at sea may not be achieved due to lack of incentives, failure of the organisation to provide leadership,

lack of replacement parts, and a veriety of other reasons. It is not surprising that errors are made in the information given with which planners have to deal. Where information is weak or lacking, assumptions are made which subsequently prove to the inconsistent with the facts.

The second important contributing factor is the inadequate data base. Fisheries statistics, accurately collected and complied, do provide information on the production performance of the sector and changes in vessels and gear, and can provide insights into developing problems and also helps to improve management decisions. At present, somewhat reliable statistics are avaiable on fish production and seafood exports. Statistics relating to fishing villages, landing centres, population, workers, craft and gear are simultaneously collected periodically by Fisheries Departments, Directorates of Economics and Statistics and by the CMFRI. Unfortunately, these are not comparable with each other. No economic data is available with regard to utilisation pattern, marketing, fish prices, infrastructural facilities, etc., based on scientific surveys or estimates. And this should not be delayed further.

The typical fisheries statistics which are collected annually/periodically, do not provide sufficient data base for analytical research either in the natural or social sciences. This emphasises the need for special surveys to provide the data base for problem oriented research, mainly in five ways;

1. One of the areas that needs attention is studies on costs and earnings and economic efficiency of fishing units. In India, there are 1,54,000 traditional craft, 20,000 mechanised boats and 128 deepsea trawlers. Even among the traditional craft, which vary in size and type, various types of gears are used depending upon various factors. Similarly, mechanised boats, varying in size and horse power of engine, use trawl, gill and purse seine nets. Large trawlers also vary in size and adopt different techniques. But in terms of cost, the gap is very large between one another. A number of studies are needed from time to time to identify in each category, a better craft-gear combination for a given area, season, fish, etc., which absorbs less costs and yields higher returns with higher economic efficiency and economic viability.

2. Normally, the marine fish are disposed at the points of production. Even the retailers could go little interior. While there may be sourse changes in these conditions in certain pockets in and around the fishing harbours and landing centres near urban areas through Government intervention but in majority of areas this situation continues to be the same. This is because of non-availability of transport, storage and processing facilities. While the people near the landing center feel glut of fish, those in interior places face fish famine. In general, consumption of fish varies from state to state and within each state from region to region to demand for specific species and quantities of fish are needed from time to time to ascertain and plan for the supply of fish and the infrastructural facilities. Besides, studies are required to understand the nature and structure of fish marketing, channels of marketing, number and type of agencies involved, price spread from producer to consumer and the role of Government in this regard.

3. Whenever Government proposes to undertake a project or a scheme relating to fisheries, the involvement and participation of fishermen are essential. Experience shows that introduction of nylon nets and mechanised boats met with resistance from the fishermen in the initial period and led to clashes between fishermen operating mechanised and traditional boats. Simlarly, the implementation of rural development programmes often met with little sucess. This is because people were not taken into confidence before the initiation of programme. Therefore, there is every need to conduct studies before hand with regard to their casts, tradition, value systems, community way of living, needs and aspirations and these should be taken care of while studying the socio-economic conditions. Besides, the studies also should include the impact of mechanisation or other projects on employment, income, consumption pattern and levels of living. Then only they can derive the intended benefits. Fishermen are subjected to occupational health hazards which needs attention.

4. In the course of time, a number of institutions have came into existence in India such as co-operative societies, joint public and private enterprises, fisheries corporations, fisheries development authorities, fishermen's associations, and contacts aid with international organisations also increased under various programmes. These institutions were required to speed up the innovative processes and increases output, to improve utilisation and also to increase fishermen's income. But hardly any information

is available regarding the progress and performance of these institutions and no studies were undertaken to find out the impact of these institutions on the sector economy, its structure and on the welfare of the fishermen.

In consequence, the kind of feedback for corrective action in plan implementation and future planning is not provided. As a matter of fact, the natural scientists do not undertake this type of research and it is only social scientists who can perform these tasks jointly with the natural scientists or technologists.

5. Finally, there is the need for efficient management of fisheries resources, their exploitation and utilisation. Hither to fisheries management is viewed only in the narrow sence of maintaining fish stocks (maximum sustainable yield) in the sea through a number of regulations. But efficient use of post harvest resources is also an important aspect that needs attention. Manageament is needed in every aspect of the fisheries sector till the product is reached to the ultimate consumer. Efficient management in processing, marketing and distribution of fish, control of fish prices, management of cooperatives, finance, exports, and so on. Experience of other countries showed that the natural scientists alone cannot tackle this problem. But joint efforts of both natural and social scientists, as an interdisciplinary group, shall go a long way for evolving suitable mechanism towards this end. Therefore, an integrated approach is necessary for efficient development and management of marine fisheries by strengthening the fishery based social science research. There is a need for setting up of a National Social Science Research Institute for fisheries which provides remedies to many - a - ills of the fishery sector.

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Paper 84

STRATEGIES FOR TUNA FISHERIES DEVELOPMENT AND MANAGEMENT IN THE INDIAN EXCLUSIVE ECONOMIC ZONE

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ABSTRACT

In recent years, one of the significant changes in the international tuna industry has been both the reduction and redeployment of the major tuna fishing fleets of the world. These developments coupled with the declaration of the 200 miles EEZ, have altered the pattern of tuna resources exploitation and motivated a number of developing countries to extend their operations and participate in the international tuna fishery.

In the present communication, a retrospect of National tuna fishery is presented, the strategies and perspectives for the development and management of tuna fisheries, chiefly through augmentation and melioration in the (i) traditional small scale sector, (ii) medium commercial fishery sector, and (iii) large scale commercial fishery sector are presented with substantiating data and information. The prime need of tapping the skipjack tuna resources from the oceanic sector of the EEZ of India and strategies involved in the augmentation of skipjack production by planned development of the small scale fishery sector around our oceanic islands are discussed. The prospects of acquisition and utilisation of the vessel capacity, equipments and expertise of the developed nations in the operational sector of large scale commercial tuna fishery for yellowfin and bigeye from the EEZ, and other policy options for tuna fishery development in the oceanic waters are reviewed.

The need for development and improvement of post-harvest technology on coastal and oceanic tunas and tuna products as part of diversification of exports of marine products is emphasised.

INTRODUCTION

A worldwide review of tuna fishing industry indicate that various developments in the recent past have resulted in the restructuring of the tuna industry including the reduction and redeployment of major tuna fishing fleets. These developments have prompted many developing countries world over to enter into tuna fishery and expand tuna fishing activities in their EEZ. In the Indian Ocean, the present trend of events show that several nations are attracted towards the successful emergence of purse seine fishery by distant nations in the tropical western Indian Ocean. The EEZ of India comprising of about 2 million Km^2 of sea area under her jurisdiction, a coastal belt of about 6000 miles and insular realms around the Lakshadweep and Andaman and Nicobar islands hold considerable potential for the production of tunas in the industrial sector.

In the present communication, a review of the tuna fishing industry developments worldwide is presented. Data collected on the trend of production of tunas and billfishes in the Indian Ocean during recent years have been synthesised with particular reference to yellowfin tuna, bigeye tuna, skipjack tuna and longtail tuna. Present status of tuna fishery in India, both in the small scale sector and in the exploratory operations are critically analysed, and priority areas of attention such as optimisation of production in the inshore waters and around insular realms, and develoment of EEZ fisheries emphasised. Options for augmentation of tuna production and their post-harvest utilisation in the artisanal and industrial sectors are discussed and conclusions drawn in the present study.

REVIEW OF WORLDWIDE DEVELOPMENTS IN TUNA FISHING INDUSTRY

According to a recent estimate (FAO, 1986), the world catches of 'major' species of tunas recorded an increase of 21 % of 1 733 000 t to 2 099 000 t between 1979 and 1984. Although countries such as Japan, U.S.A., Spain, France, Taiwan and Republic of Korea are responsible for the major part of the catches, their share of world catch declined from 74% in 1979 to 69% in 1984. Tuna production by developing countries such as Indonesia, Philippines, Mexico, Venezuela, Solomon Is, Maldives, Ecuador, Ghana, Brazil, Panama, Sri Lanka, Australia and others recorded an increase of about 45% from 445 000 t in 1979 to 656 000 t in 1984, contributing to about 31% of the world tuna catch in recent years. Trend of production of canned tunas also evinced the same trend. Developed countries recorded a decline of 24% of the world canned tuna production from 1979 to 1984 while the share of developing countries increased from 12% (1979) to 36% (1984) (Table 1).

A review of the status of the resources of the world's traditional tuna fishing grounds indicate that in the Eastern Atlantic a significant decline in the catch rate of tunas was felt in early 1980 due mainly to the increased fishing pressure. This has forced several purse seiners, especially those belonging to the French, Cote d'Ivore and Spanish tuna fleets to leave this area in 1983. As a result of significant reduction in fishing effort, the Eastern Atlantic stock of tunas began to rebuilt itself and the yield of yellowfin tuna increased by about 20 % in 1985. In the Eastern Pacific, total yield of tunas fell to a very low level in 1977, and in 1982 most of the tuna fishing fleets moved to the Western Pacific. Following reduced fishing effort in 1982 and 1983, the tuna catches and the yields increased sharply in this area, resulting in the return of tuna fleets to Eastern Pacific. In the Western Pacific, where the major tuna fishing grounds are located around Papua-New Guinea area and south of the Micronesian Federated States, yield of vessel especially of U.S.A. and Japan continue to be high. In the Indian Ocean, the tuna catches increased very rapidly in 1983 and 1984 due mainly to the purse seine fishery and in 1985 despite a 15% increase in purse seine fishing effort and significant extension of fishing ground, yellowfin tuna catches levelled off while catch of skipjack reached about 65 000 t. Recent tuna fisheries developments by coastal countries, restriction of access by distant nations to favoured fishing grounds and the relative conditions of present producer nations and the countries which posses the resources would determine the long term trends of the complex world tuna fisheries. However, the Indian Ocean with less problems of access to tuna resources is potentially attractive to distant water tuna fishing fleets, and uncontrolled increase in the fishing effort would result in a significant decline in the yield of tunas and profit.

Historical review of Japanese tuna fleet operations indicate that since 1950, concomitant with the construction of large tuna fishing vessels the area of operations expanded and the export oriented fishery covered the Pacific, Atlantic and Indian Ocean. In the 60's, due mainly to the developments in the Japanese economy, increased labour charge and weak market for canned tuna, continued expansion of the fishery became difficult. Consequently, Japanese fleet operators started aiming at the production of deep frozen tuna for the *sashimi* market by installing modern freezing equipments on board. Other problems faced by the tuna fleet operators in the 70's and early 80's were the worldwide energy crisis, which led to unprecedented increase in fuel prices in 1973 and 1979, followed by restriction in operations as a result of declation of 200 miles EEZ by countries form 1977. Of recent, Japanese tuna industry has also had to face poor market conditions in both demestic and overseas sectors. Effective measures were adopted to economise tuna fishing operations by reducing labour force, minimising fuel oil consumption, reducing number of vessels in the tuna fleet and re-

Table 1. World tuna catches and canned tuna production

Tuna catches(x 1000 t.)

	1979	1980	1981	1982	1983	1984
Developed countries *	1288	1338	1250	1285	1365	1453
(%)	(74.3)	(74.5)	(69.9)	(71.0)	(70.1)	(69.2)
Developing countries **	445	458	537	526	581	646
(%)	(25.7)	(25.5)	(30.1)	(29.0)	(29.9)	(30.8)
Grand total	1733	1796	1787	1811	1946	2099

(* = Japan, U.S.A., Spain, France, Taiwan and Rep. Korea : ** = Indonesia, Philippines, Mexico, Venezuela, Solomon Is, Maldives, Ecuador, Ghana, Brazil, Panama, Sri Lanka, Australia and others)

Canned tuna production

	1979	1980	1981	1982	1983	1984	1985
Developed countries *	489	486	524	485	519	539	502
(%)	(88)	(83)	(77)	(76)	(75)	(69)	(64)
Developing countries **	65	102	154	152	170	238	278
(%)	(12)	(17)	(23)	(29)	(25)	(31)	(36)
Grand total	554	588	678	637	690	777	780

(* = U.S.A., Japan, Italy, France, Spain and Taiwan : ** = Thailand, cote d'Ivoire, Philippines, Mexico, Ecuador and others)

(Source: FAO, 1986)

placing them with more efficient fewer ones with productive fishing methods. Consequently, the number of longline vessels were reduced since 1980, and several pole and line fishing vessels have been replaced with purse seiners(Fig. 1).

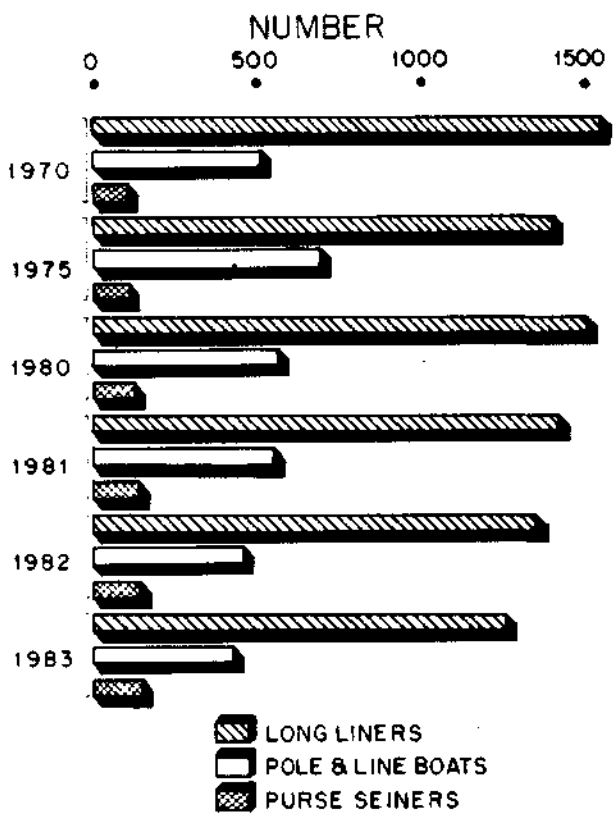

Fig.1. Rationalisation of the Japanese tuna fishing fleet during the period 1970 to 1983

The U.S.domestic tuna fishing fleet expanded steadily from 1960 till 1983. Initially, fishing was carried out by small local tuna clippers off California, but more efficient purse seiners were added to the tuna fleet, and in the late 70's and early 80's larger purse seiners with capacities of 1000 - 12000 tonnes were in operation. Fishing operations were expanded as far south as Chile, west to the Philippines and east to African coast. The U.S. tuna fleet which were concentrated in the eastern Pacific grounds moved to western Pacific Area in 1980 consequent to the increased competition, dwindling tuna catch rate (partly due to the *El Nino* conditions) and restrictive, U.S. Marine Mammals Regulations. However, relatively high operating costs, reduced demand for small skipjack tuna in the purse seine fishery and dissipation of the *El Nino* have led to a reversal of the trend. Redeployment of fleet between the western and eastern Pacific Ocean resulted in the reduction in the number of vessels in the U.S. tuna fleet in 1985 with a concomitant decline in tuna production (Fig. 2).

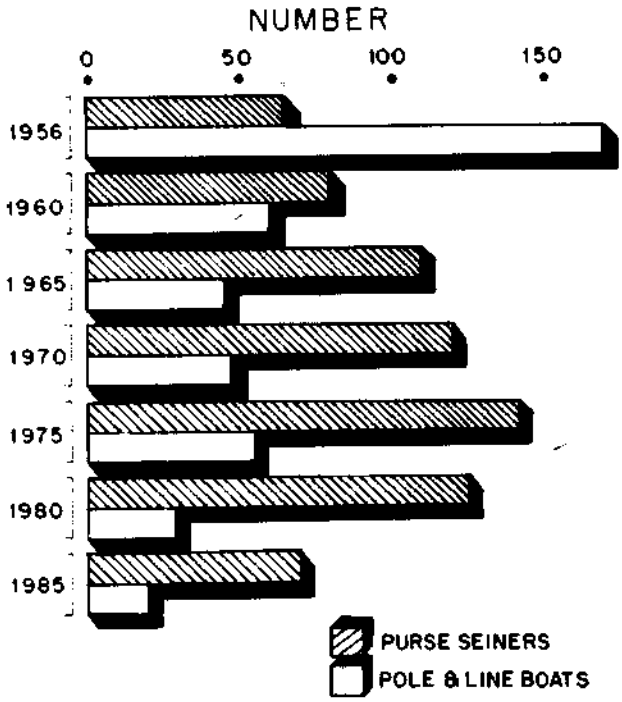

Fig.2. Trend of variation of the U.S. domestic tuna fleet (number of vessels) during the period 1956 to 1085

The tuna industry in the eastern Pacific has traditionally been dominated by the U.S.A., but in recent years Latin American countries have expanded their tuna fishery operations. Production (U.S.A.) of tunas which accounted for 83% of the total catch from the eastern pacific declined to 36% in 1985 while production by Latin American countries increased considerably from 14% to 57%, especially due to the rapid expansion of Mexican tuna fleet and to a lesser extent the enhanced fishing capacity of both Ecuador and Venezuela (Table 2).

Philippines, Thailand and Indonesia in the S.E.Asia are the important new entrants in the International tuna fishing industry.Tuna production in the philippines have shown a record increase from 9000 t to 117 000 t from 1971 to 1984, as a result of the introduction of large scale tuna purse seining in combination with FADs which was followed by export oriented frozen tuna industry in the country. However, since 1981 the Philippine frozen tuna export has declined dras-

tically and resulted in import of tuna for meeting the demand of local tuna processing industry since then. Growth over fishing, resource depletion, over-capitalisation in the tuna industry coupled with increased operating costs and prevailing economic conditions in Philippines exacerbated the situation, and further tuna exporters in Philippines have been confronted with external problems and increased competition from other tuna processing and exporting nations.

Table 2. Tuna production (tonnes) in the eastern Pacific Ocean, by country

Country	1970	1980	1984	1985
Costa Rica	-	4547	3799	4103
Ecuador	17 744	18 188	35 222	39 591
Mexico	11 755	36 375	71 893	95 263
Peru	998	665	156	-
Venezuela	-	-	21 226	33 048
Panama	6 432	11 644	-	-
Cayman Is	-	4 325	-	-
Latin America countries	36 929	75 744	132 296	172 005
United States	219 249	225 016	107 232	109 680
other countries	7 320	42 145	5238	21 183
Grand Total	263 498	341 905	244 766	302 868

(Source: FAO, 1986)

In Thailand, tuna production (mostly longtail tuna) showed a remarkable increase from 10 000 t in 1975 to 86 000 t in 1983, accompanied by a rapid increase in the production and export of canned tuna which also have increased from 28000 t in 1983 to 87 100 t in 1985. Total tuna and tuna like fish production in Indonesia was estimated to be 226,000 t in 1984. Skipjack tuna accounted for about 34% and yellowfin and other tunas about 14% and the rest constituted by tuna-like fishes. Potential fishing grounds exist west of Sumatra and south of Java in the Indian Ocean and most of the export oriented tuna production activities are carried out in the eastern Indonesia.

The development of industrial tuna fishing operations in west Africa was due to the entry and expansion of foreign participation especially by van Camp and Star-Kist of U.S.A., Ghana, Cote d' Ivore, Senegal and Republic of Congo are the major countries capable of industrial tuna fishery in the west African Coast.

During the period 1983-84, a large part of French, Ivorian and Spanish tuna fleets left Atlantic Ocean and entered Indian Ocean due mainly to the decreasing trend of catch rate of yellowfin tuna (3.3 t per day) in the tropical eastern Atlantic. In the Indian Ocean, during 1984-85 average catch of yellowfin tuna for the same vessels was 5.8 t per day, a value 75% higher than that in the Atlantic. Catch per day of skipjack tuna was 5 t in the Indian Ocean in 1984-85, which was 2.8 t in 1980-83 in the Atlantic Ocean.

INDIAN OCEAN

In the Indian Ocean, Japanese tuna longline fishery commenced in 1953 followed by Taiwan and Korea in the 60's. Historical review of their fisheries, expansion and production are presented earlier (Silas and Pillai, 1982). An organised pole and line fishery for tunas has been in vogue in Sri Lanka, Maldives and Lakshadweep (India). Consequent to the mechanisation of fishing crafts and introduction of effective

Table 3. Production of tunas, tuna-like fishes and billfishes (tonnes) in the Indian Ocean, 1980-85

Species-wise and Gear-wise

Species/Group	1980	1981	1982	1983	1984	1985
Yellowfin tuna	34064	36435	46828	60663	93503	100768
Bigeye tuna	31303	32378	39144	44168	35604	41949
Albacore	11637	13233	23205	17180	15119	9628
Southern Bluefin tuna	24205	26065	29136	36741	30163	28002
Skipjack tuna	45835	45792	52620	61594	101922	136303
Tuna-like fishes *	68670	66134	91859	85764	88088	121330
Billfishes **	9817	10692	10836	10083	11082	15555
TOTAL	225531	230729	293628	316193	375481	453535

(* = Longtail tuna, little tuna, frigate tuna, bullet tuna and oriental bonito; ** = Blue marline, black marlin, striped marlin, sailfish and sword fish)

Longline fishery	37.9%	37.4%	37.2%	36.7%	25.2%	21.8%
Pole & line fishery	12.6%	11.8%	8.8%	10.5%	12.0%	12.4%
Purse seine fishery	1.0%	1.5%	5.5%	10.1%	29.9%	30.9%
Gillnet fishery	0.6%	1.5%	8.1%	10.3%	7.9%	13.5%
Unclassified	47.9%	47.8%	40.4%	32.4%	25.0%	21.4%

Source: IPTP Data Summary No.7, 1985

Table 4. Tuna species caught(tonnes) by countries in the Indian Ocean and by distant nations, Indian Ocean, 1983-85

Country & Gear	YELLOWFIN TUNA 1983	1984	1985	BIGEYE TUNA 1983	1984	1985	SKIPJCK TUNA 1983	1984	1985
Japan (LL)	7039	7467	9263	18425	13516	16502	3	2	9
(PS)	193	-	109	59	-	175	592	-	547
Korea (LL)	15337	9895	12017	16651	11481	12438	8	-	-
Taiwan (LL)	4211	1369	5099	8474	8163	9060	9	22	36
(GN)	-	-	16	-	-	-	-	-	-
France & Ivory Coast (PS)	10773	38718	35227	-	1214	2685	10075	30629	36281
Spain, Panama & U.K. (PS)	-	16392	19823	-	829	253	-	9561	27433
Indonesia (LL)	-	585	441	-	-	-	-	-	-
(PS)	-	27	29	-	-	-	-	356	388
(GN + TRL)	5888	3635	4073	-	-	-	12458	10091	9214
Seychelles (LL)	43	198	140	37	171	74	-	-	-
(TRL)	114	-	7	-	-	-	-	-	-
Kenya (LL)	322	-	-	237	-	-	2	-	-
(OG)	-	-	-	-	-	-	31	45	63
Mosambique (LL)	-	177	-	-	9	-	-	-	-
(PL)	15	11	15	1	-	-	60	154	80
Sri Lanka (LL)	905	644	222	-	-	-	-	-	-
(PL)	452	258	27	-	-	-	2095	1510	1757
(GN)	7237	5151	6145	-	-	-	11178	8714	10070
India (PL+TRL+GN)	-	-	-	-	-	-	1801	3488	3276
Maldives (PL)	5984	6893	5797	-	-	-	19491	31714	42170
(TRL)	257	230	269	-	-	-	210	335	432
Mauritus (PS)	1057	1234	914	284	250	747	1396	2500	2026
(TRL + HL)	-	50	-	-	-	-	0	350	-
Pakistan (GN)	-	-	-	-	-	-	733	694	1309
D.R.Yemen (GN)	80	12	511	-	1356	-	400	12	7
S. Africa (OG)	166	-	84	-	-	-	13	-	4
Australia (OG)	18	41	43	-	-	-	-	-	550
Comoros (OG)	120	130	140	-	-	-	340	350	360
TOTAL :	60663	93504	100783	44168	36969	41937	61594	101922	136303

(LL = Longline fishery; PS= Purse seine fishery; GN = Gill net fishery; TRI = Troll line fishery; HL = Hooks and Line ; OG = Other gears)
Source: IPTP Data Summary, No.7, 1985)

synthetic fishing gear materials surface tuna production evinced an increasing trend in many of the Indian Ocean countries which employ a variety of gears such as drift gillnets, coastal purse seines, troll lines and hooks and lines. Since the entrance of French, Ivorian and Spanish vessels in the surface tuna fishery by purse seining in the Indian Ocean in the mid 80's, total production of surface tuna, especially yellowfin and skipjack from the tropical western Indian Ocean remarkably increased.

Total production of oceanic tunas such as yellowfin, bigeye, albacore southern bluefin and skipjack tunas, coastal tunas and billfishes during the period 1980-1985 is presented in Table 3. In the case of yellowfin tuna, production by longline gear was in the range 18,960 to 30,100 t during the period, whereas production by purse seine gear has increased tremendously from about 140 t in 1981 to 56,150 t in 1985 with an average production of 62,044 t. Average annual production of other oceanic tunas such as bigeye, albacore and southern bluefin tunas were 37,400, 15,000 and 37,400 t respectively during 1980-85. As in the case of yellowfin tuna, introduction of purse seining in the oceanic area was instrumental for the increase in production of skipjack tuna from 1,468 t in 1980 to 66,680 t in 1985. Total catch of this species by pole and line fishery, mainly by Sri Lanka, Maldives and India (Lakshadweep) recorded an increase from 18,760 t in 1973 to 46,628 t in 1985 (average 74,000 t) due mainly to the mechanisation in this sector. Average production rates of other coastal tunas and billfishes were about 86,970 t and 11,344 t respectively during 1980-85 in the Indian Ocean.

Estimated gear-wise landing of tunas and billfishes during the same period from the Indian Ocean indicate that on an average longline gear contributed about 32.7%, Pole and line gear 11.4%, purse seines 13.5% and gillnets 7.0%. About 35% of the catches were made by gears the details of which are not available (IPTP, 1987). Impact of purse seine gear in the augmentation of total production of tunas is evident from the increase in the contribution of this gear to the total catch from 1% in 1980 to 31% in 1985.

In view of the significance of four species of tuna viz., yellowfin tuna, bigeye tuna, skipjack tuna and longtail tuna which hold potential as commercially exploitable stocks in the central equatorial Indian Ocean and in the EEZ and contiguous high seas around India, particular attention has been given in this document to synthesise the changing trend of their production. A summary of the estimates of surface and subsurface production and country-wise catches of these species are presented in Fig. 3 and Table 4.

Yellowfin tuna (Thunnus albacares)

Annual fluctuations in the total production of yellowfin tuna was noted till 1983, but the development of surface fishery by distant nations has been instrumental for the spurt in production from about 61,000 t in 1983 to 100,800 t in 1985. Percentage contribution by countries in the Indian Ocean evinced a declining trend (38.1% to 19.0%) whereas that by distant nations increased (61.9% to 81.0%) during the period 1983-85. Similarly, production by sub-surface fishery also showed declining trend from 45.9% to 26.9% during the above period. In the surface fishery, total production of yellowfin tuna increased from 54.1% to 73.1% during 1983-85 due mainly to the development of purse seine fishery in the tropical western Indian Ocean. Major tuna fishing Indian Ocean countries in this region are dependent on the surface fishery of yellowfin resource and as opined by Sivasubramaniam (1986), industrial artisanal yellowfin tuna fishery interaction assumes considerable importance for the development and management of the resource of the species in the equatorial subregion of Indian Ocean.

Bigeye tuna (Thunnus obesus)

Production of bigeye tuna fluctuated between 36,970 t and 44,168 t during 1983 and 85, the major share being taken by longline fishery (average 93.4%). Production by surface fishery, mainly by purse seine operations was negligible and amounted to 0.8% in 1983 to 9.2% in 1985.

Skipjack tuna (Katsuwonus pelamis)

Oceanic longline fishery contribute less than 1% of the total fishery production of skipjack in the Indian Ocean although high hook-rates for this species in the Arabian Sea during January-March was recorded (Marcille, 1985; Pillai and Silas, 1986). Skipjack tuna production has substantially increased form about 61,600 t in 1983 to 136, 300 t in 1985. Production of this species in the surface fishery by distant nations increased from 17.3% to 47.2% during the same period. In view of the fact that countries in this area employ traditional pole and line and gillnets to capture surface schooling skipjack tuna, possible interac-

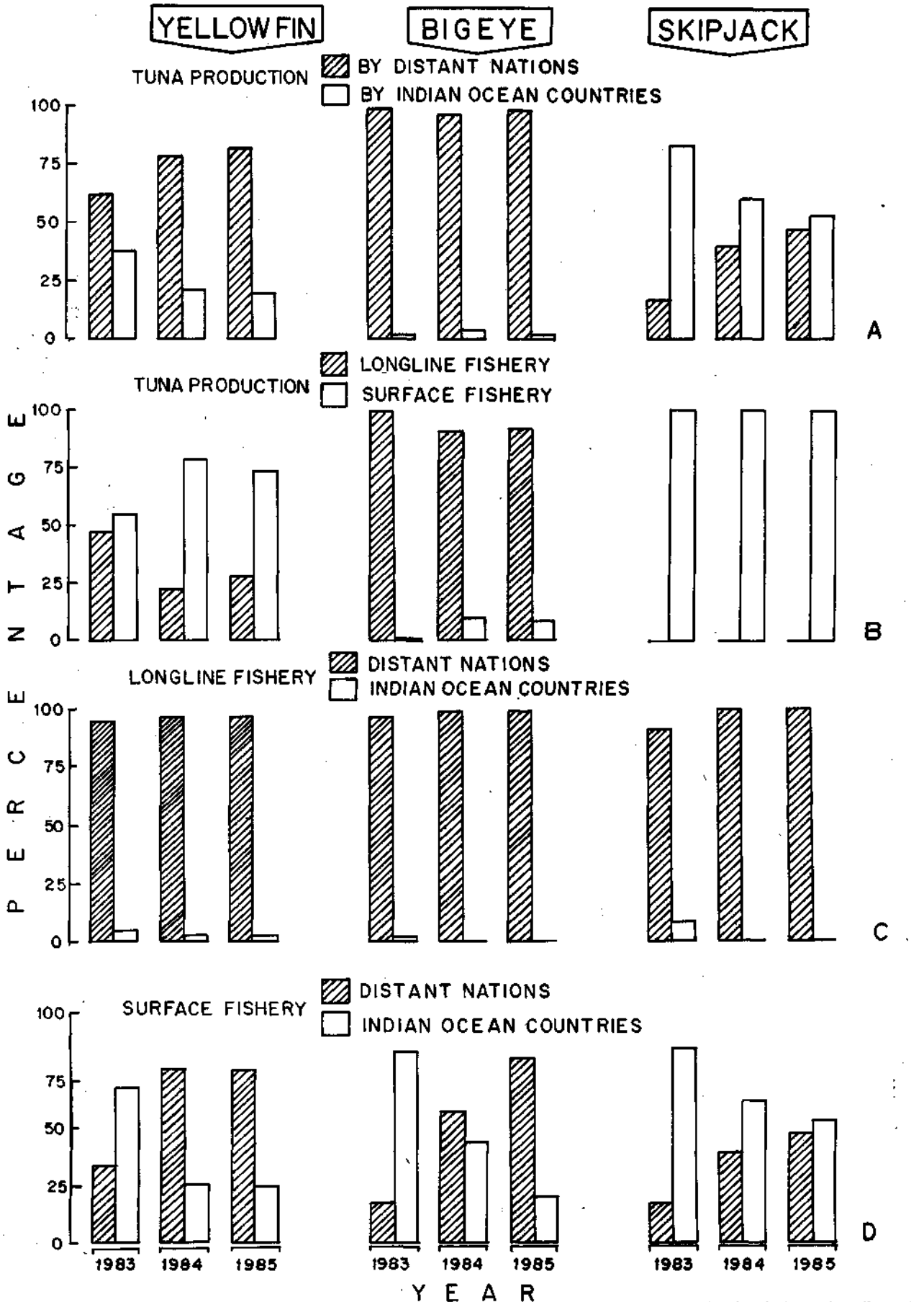

Fig.3. Percentage composition of yellowfin tuna, bigeye tuna and skipjack tuna in the fishery by distant nations, and countries in the Indian Ocean (A), in the longline and surface fisheries (B), and in the longline and surface fisheries by distant nations and countries in the Indian Ocean (C,D).

tion between emerging purse seine fishery and artisanal fishery should be viewed with serious concern.

Longtail tuna (Thunnus tonggol)

A brief summary of production of longtail tuna in the Indian Ocean during the period 1983-85 is as follows:

	1983	1984	1985
Total longline catches(t) :	295	319	-
Total surface catches(t) :	15662	19040	23694

Countries in the Indian Ocean are responsible for the total production of this species. Production by longline fishery (Iran) was negligible, forming only 1.7% of the total catch of this species. Other countries in the Indian Ocean producing longtail tuna by surface gears are Australia, Thailand, Malayasia, India, Iran, UAE, DR Yemen and AR Yemen. Total production of longtail tuna fluctuated between 15,660 t in 1983 to 23,690 t in 1985. Of the total production of this species, drift gillnets landed about 88% and purse seiners, mainly along the west coast of Thailand about 11% . Yesaki (1986) summarised the trend of production of longtail tuna in the Indian Ocean, and according to him the areas of present highest production of this species are the Gulf of Oman and eastern Arabian Sea, and extension of gillnet fishery into outer continental shelf would enhance its production in other countries.

OVERVIEW OF TUNA FISHERY IN INDIA

Around the mainland of India, there is no effort expended specifically for tunas and the catches are mainly incidental to other large pelagics. A traditional pole and line fishery, targeted exclusively to capture skipjack and yellowfin tunas is in vogue, for over a long period of time, only in the Lakshadweep islands. During the period 1981-1986 exploratory and training longline operations were conducted in the Arabian Sea, Bay of Bengal and equatorial Indian Ocean areas (Silas and Pillai, 1985, 1986; James and Pillai, 1987).

Small-scale sector

Tuna production around the mainland of India is chiefly confined within the 50 m depth zone. Major crafts and gears engaged in the fishery in the artisanal fishery sector, as reviewed recently are presented in Table 5.

The catch and effort in tuna fishery for earlier years have been discussed by Silas and Pillai (1983, 1985,1986 a,b), Silas *et al* (1984,1986) and James and Pillai (1987). During the period 1980-1984, tuna and billfish catch fluctuated between 17,000 t and 21,950 t, and in 1985 and 1986 tuna production has been estimated at 30,700 t and 34,060 t respectively (CMFRI, 1986; unpublished data). State-wise distribution of tuna catches for the recent period (1984-86) is presented in Table 6. On an average about 73.7% of the total production is from the west coast of India, 11.9% from the east coast and 13.5% and 0.9% from and Lakshadweep Is. and Andaman Nicobar Is. respectively. Percentage composition of different species of tunas and billfishes during the period 1984-86 were as follows:

Species/Group	Percentage composition		
	1984	1985	1986
Euthynnus affinis	54.7	51.8	53.3
Auxis spp.	8.1	9.7	24.9
Thunnus tonggol	1.0	17.4	0.5
Katsuwonus pelamis	16.6	12.1	9.3
Other tunas	13.7	6.0	7.6
Billfishes	5.9	3.0	4.4

Table 5. Characteristics of crafts and gears engaged in tuna production in India

	Craft			Fishing gear			
Type	OAL (m)	Material	Power (HP)	Length (m)	Depth (m)	Mesh size (cm)	No. of crew
Drift gill netters	7.6-9.1	wood	24-45	800-1200	5-8	6.5-14.0	3-4
Purse seiners	13.0-14.0	wood	105-120	400-600	40-60	1.4	16-25
Pole and Line boats	7.9-9.1	wood	10-40	Pole = 3-4	-	-	10-15
Troll line Boats	3.0-8.8	wood	sail	Pole = 3-4	-	-	4-10

(Estimates by CMFRI)

Seasonality in the production of tunas recorded were : post-monsoon period along the west cost of India, Pre-monsoon months along the east coast of India and post-monsoon and pre-monsoon periods around the Lakshadweep Is.

Total production of tunas by small scale purse seine fishery along Goa, Kerala and Karnataka coasts indicate a declining trend from 1982-83 to 1984-85 as detailed below:

	1982-83	1983-84	1984-85	1985-86
Goa	-	3	-	209
Kerala	43	1	13	607
Karnataka	928	862	529	2486
Total	971	866	542	3302

Oceanic species of tunas such as skipjack and yellowfin tunas constitute the major scombroid resources taken by the pole and line fishery with live-baits in the Lakshadweep (Silas *et al*, 1986; James *et al*, 1987 MS). At Minocy, the pole and line fishery has been in vogue for a number of years, and from the 60's this fishing method was adopted in the northern islands also, and in recent years are chiefly concentrated around Minocy, Agatti, Bangaram, Perumul Par reef, Suheli Par and Bitra Islands.

Total catch of tunas by pole and line fishery in the Lakshadweep during the period 1976 to 1985 is presented in Fig.4. During the period the total tuna production fluctuated between 1116 t and 4355 t with an average catch of about 2521 t during the period. Total landing of tunas recorded an increasing trend from 1977 to 79, and after recording a fall in production in 1980, the catch recorded steady increase to 4355 t in 1984 and in 1985, about 3780 t tunas were landed (Information Kit for Lakshadweep Features, RRL, Trivandrum, 1986).

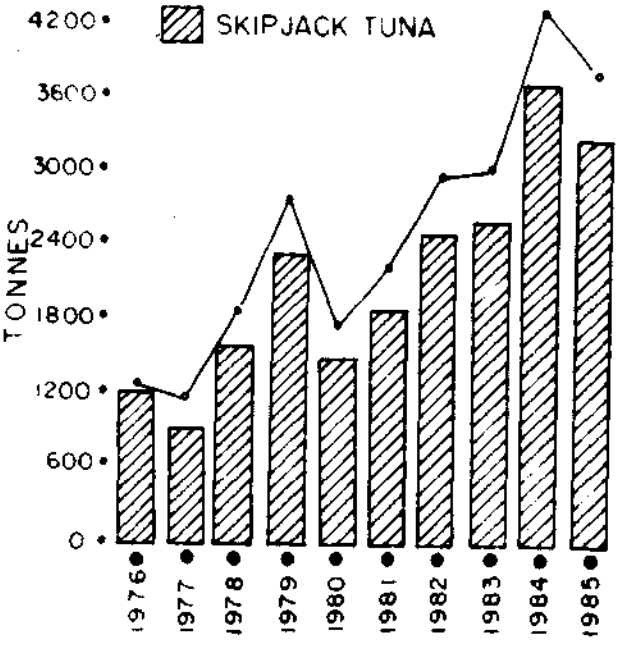

Fig.4. Tuna production in the Lakshadweep, 1976-1985. Vertical bars indicate estimated composition of skipjack tuna.

During the period 1984-85 season, a total of 4842 t of tunas were landed in the inslands (Table 7). Assuming these figures are indicative of the trend of production of tunas in the Lakshadweep in recent years, it is estimated that tunas constitute about 83% of the total catch in this area and about 53% of tuna production was from Agatti and nearby islands of Bangaram, Perumul Par and Suheli Par. Total average annual production rate has been estimated as 17.8 t/unit, and high catch rates were recorded at Agatti, Bitra and Minicoy for over a decade if apportioning is done as 86% of total tuna catch as skipjack and 11% as yellowfin 533 t in 1984-85.

Table 6. State-wise distribution of tuna catches(tonnes) - recent trend

States	1984 (Landing)	(%)	1985 (Landing)	(%)	1986 (Landing)	(%)
West Bengal	31	0.15	-	-	-	-
Orissa	31	0.15	65	0.21	377	1.11
Andhra Pradesh	866	4.25	1776	5.79	1321	3.88
Tamil nadu	2561	12.58	843	2.75	2409	7.07
Pondicherry	91.	0.45	47	0.15	213	0.62
Kerala	6168	30.31	9885	32.12	14943	43.87
Karnataka	1113	5.47	2964	9.66	6658	19.56
Goa	150	0.74	230	0.75	127	0.38
Maharashtra	2812	13.81	1873	6.10	1960	5.75
Gujarat	2002	9.84	9042	29.47	1831	5.38
Lakshadweep	4313	21.19	3775	12.30	3849	11.30
Andaman & Nicobar	215	1.06	215	0.70	369	1.08

Table 7. Tuna Production in the Lakshaweep, 1984-85

Island	No.of mechanised boats in operation	Total fish catch (t)	Tuna catch (t)	Tuna production (%)	Annual production rate (C/unit) (t)
Androth	30	399	202	4.2	6.7
Ameni	30	199	132	2.7	4.4
Agatti	55	2691	2570	53.1	46.7
Bitra	10	224	182	3.7	18.2
Chetlat	18	271	218	4.5	12.1
Kadamat	14	166	74	1.5	5.3
Kalpeni	10	179	55	1.1	5.5
Kiltan	25	245	109	2.3	4.4
Kavaratti	45	896 *	767 *	16.4 (?)	17.7(?)
Minicoy	35	523	503	10.4	14.4

(* Presumed inclusive of tuna catch from suheli Par Area)

(Source: Planning Dept., Secretariat, Kavaratti, 1986)

Silas *et al* (1986) while discussing the exploited and potential resources of tunas in the Lakshadweep summarised the results of studies carried out by CMFRI at Minicoy. Data collected on the catch, effort and species composition of tunas during the period 1981-82 to 1986-87 is as follows:

	Effort (units)	Catch (Tonnes)	C/SE (kg)	Catch/unit baits (Kg)	Skipjack tuna(%)	Yellowfin tuna (%)
1981-82	1241	321	258	115	85.4	14.9
1982-83	1112	381	343	134	81.2	10.6
1983-84	1370	345	252	107	79.6	12.1
1984-85	2422	569	235	133	94.2	5.7
1985-86	2575	623	242	139	85.9	14.0
1986-87	2859	722	253	112	91.0	8.6

Despite the increase in the total units operated and catch, mean value of C/SE (units) during the period was around 260 Kg with slight variations during different years. Similarly, although production of live-baits increased quantitatively, tuna production per unit of live-bait (Kg) did not show concomitant increase. As an average, skipjack tuna averaged 86% and yellowfin tuna 11% of the total tuna catch. Little tuna and rainbow runner constituted the rest of the catch.

Longline fishery

Silas and Pillai (1985,1986), Varghese *et al* (1984), Joseph (1986), Joseph and John (1986), Sivaprakasam and Patil (1986) and James and Pillai (1987) have summarised the details of tuna longline operations by the vessels *M.V. Prashikshani* and *Matsyasugandhi* in the Arabian Sea, Bay of Bengal and equatorial Indian Ocean areas during the period 1981 to 1986.

Joseph and John (1986) recorded catch rate of tunas as 47.59%, 38.19%, 35.76% and 62.30% in the areas Arabian Sea, Bay of a Bengal, Andaman Sea and equatorial Indian Ocean areas respectively. In the Arabian Sea, the area off Mangalore-Karwar Coast was found to be the richest tuna ground with average hook-rates of 12.9% (14^0-72^0),11.3% (13^0-73^0) and 8.2% (14^0-71^0). Productive yellowfin tuna fishing grounds in the Arabian Sea based on longline catch rates have been charted out by Rao and Pillai (In: Silas *et al*., 1986). Bi- monthly pattern of distribution of hook-rate of tunas, as estimated by Joseph and John (1986) was highest (1.48-2. 74%) in the Arabian Sea during September-December period, in the Bay of Bengal (1.13-1.18%) during January-April period and in the equatorial Indian Ocean Area (1.22-2.19%) during October-November period. According to Sivaprakasam and Patil (1986), during 1985-86 an increase in the catch rate of tunas was noted in the longline fishery. In the Arabian Sea Area, a total effort of 65,450 hooks were expended and the hooked rate of tunas varied from 0.26-0.39% during May to September, then increased from 6.38-24.98% from October to January (5.94% in December) and 10.92 to 17.30% from Februrary to March. They also indicated a northerly migration of yellowfin tuna starting from October (10^0N) extending up to March (14^0N) in the Arabian Sea.

Swaminath *et al.* (1986) presented the results of synoptic longline surveys of tuna resources by *M.V Prashikshani* in the area 6^0-15^0N. and 67^0-97^0E. (northern Indian Ocean) during the period April, 1983 to June, 1986. A total of 240 t of fishes were caught of which yellowfin constituted 73%,bigeye 0.8%, skipjack 2.1%, billfishes 5.4% and pelagic sharks 17.5%. The increase in catch rate of tunas from 0.2%

in 1981-82 to 8.8% in 1986 might be due to the expertise developed during the course of longline operations. Zone-wise hooked rate indicate that the area between $15^0 - 23^0N; 74^0 - 67^0E$ and $8^0 - 15^0N.; 78^0 - 67^0E$ are productive for tuna fishery with hook rates recorded as 6.2% in both the areas. For yellowfin tuna, highest hook-rate of 27.9% was recorded from the area 14-17, followed by areas 14-72 (HR=17.4%) and 15-72 (HR=10.2%). During the intensive tuna fishery conducted during October, 1985 - May, 1986, a potential tuna ground was located off Karntaka-Konkan coast between 12^0 and 15^0N. and $71^0$and 73^0E. Tunas constituted 87.9%, billfishes 3.9%, pelagic sharks 6.7% and others 0.6% of the total catch. Hooked rate of yellowfin tuna varied from 4.4% in October, 85 to 26.2% in February, 1986. The period February-April, 1986 was found to be most productive in tuna fishery with yield estimated between 4,543 and 5,716 kg per 1000 hooks.

Data on 'fishing intensity' and 'effective effort', as estimated by Pillai and Srinath (1986) for yellowfin tuna fishery taken by Japanese longliners in the Indian Ocean are necessary to derive at conclusions on the factual catch rates of tunas in the longline fishery. Further, only limited data on the size distribution of yellowfin tuna in the longline fishery are available from the oceanic waters of the Indian sub-region. Silas *et al.*, (1986) indicated that 2 and 3 year old yellowfin tunas are exploited by longline fishery from the EEZ of India and contiguous high seas, based on the data collected during the longline operations by CIFNET. Swaminath *et al.*, (1986) also recorded the size range of yellowfin tuna in the longline fishery as between 60 to 180 cm, with maximum number caught in the size range 110-140 cm representing two and three year old fishes. As opined by Sivasubramaniam (1986), in the absence of sufficient size distribution data no definite conclusions could be made on (i) the recruitment of larger groups (2 and 3 year old fishes) to the long-line fishery from the surface components (young ones and 1 year old taken by pole and line fishery) "resulting in the increased hook rate during winter months", and (ii) "possible continuation of the northward migration of tunas" suggested by Sivaprakasam and Patil (1986).

Results of exploratory tuna resource surveys by longline operations by Thailand in the Andaman Sea ($05^0$30' - $14^0$02') since 1965 are presented in Table 8. An estimated total of 56, 190 hooks were operated in the survey conducted in 10 phases. Hook-rate of tunas varied from 0.3-2.6% (Poreeyanond and Kambud, 1985). Catch rate of longline boats (100 GT) off Bali, western Indonesia in the southern Andaman Sea during the years 1984 and 1985 has been reported by Gafa (1986). The catch was dominated by yellowfin tuna, and the mean hook-rates during 1984 and 1985 were 1.39 and 1.41 for mean efforts of 131, 615 and 361, 000 hooks respectively. Productive months were March-May and December in 1984, and April-July in 1985 (Table 9).

The hook-rates of yellowfin tuna in the Japanese and Taiwanese longline fishery (1984) and Korean longline fishery (1980)in the area 0^0 -15^0N. and 70^0 - 95^0E were calculated from the print outs by the IPTP (1987) and presented in Table 10. Total hook-rate estimated was 1.77%, 1.39% and 1.23% and hook rate of yellowfin tuna was 0.49% and bigeye tuna 0.63%. Indepth analysis of data indicate that maximum production of yellowfin tuna (1.40% HR) was from the area 15^0 - 20^0N; 80^0 -95^0E in the Japanese and Taiwanese longline fishery whereas it was from the area 10^0 - 20^0N; $70^0$95^{0}E in the Korean longline fishery.

DISCUSSION

An overview of production of tunas and tuna-like fishes in the small scale sector in India indicate that drift gill nets are the prevalently used gear in the tuna fishery, followed by pole and lines. The increasing trend in the adoption of drift gillnetting are mainly due to: (i) relatively low cost of operation in that a small vessel without ancillary gears and minimal fuel consumption can be utilised in this fishery, (ii)

Table 8. Production of tunas in the longline fishery in the Andaman Sea : Thailand

Area	Effort (Baskets)	Hook-rate (%)	Average hook-rate (%)
05°38'-13°14'N	1384	0.2-5.6	1.3
07°32'-14°02'N	1158	0.2-8.2	2.6
07°54'-11°15'N	2159	0.7-7.3	2.0
05°30'-08°38'N	868	0.1-0.9	0.6
06°12'-08°55'N	800	0.2-1.5	1.0
05°25'-11°10'N	975	0.7-1.5	1.0
09°05'-11°01'N	479	0.2-0.5	0.3
05°37'-08°16'N	615	0.3-4.2	2.2
08°04'-09°03'N	1200	0.1-3.2	1.4
05°30'-08°5'N	1600	0.1-1.2	0.3

Table 9. Production of tuna in the longline fishery in the Andaman Sea : Off Bali, western Indonesia

Month	1984 Effort (x1000 Hooks)	Hook rate (%)	1985 Effort (x1000 hooks)	Hookrate (%)
January			473	1.45
February	95	1.00	374	1.05
March	203	1.74	64	1.11
April	47	1.32	564	1.64
May	88	1.74	328	2.10
June	275	1.19	301	1.42
July	350	0.94	407	1.72
August	95	1.43	357	1.40
September	45	1.56	418	1.20
October	103	1.25	353	1.12
November	62	1.18	162	1.41
December	78	1.95	198	1.32

Table 10. Annual Hooked Rate of yellowfin tuna and bigeye tuna in the Japanese (1984), Taiwanese (1984) and Korean(1980) longline fishery in the northern Indian Ocean

	Area	Hook-rate (%)		
		Total tunas	Yellowfin tuna	Bigeye tuna
Japanese longline fishery	0^0-5^0N			
	75^0-90^0E.	1.90	1.16	0.50
	5^0-10^0N			
	70^0-90^0E.	1.50	0.49	0.74
	10^0-15^0N			
	85^0-90^0E.	1.47	0.64	0.51
	15^0-20^0N			
	85^0-95^0E.	2.20	-	1.41
Taiwanese longline fishery	0^0-5^0N			
	70^0-95^0E.	1.12	0.70	0.30
	5^0-10^0N			
	90^0-95^0E.	0.90	0.24	0.41
	10^0-15^0N			
	80^0-95^0E.	1.13	0.04	0.72
	15^0-20^0N			
	80^0-85^0E.	2.29	-	1.64
Korean longline fishery	0^0-5^0N			
	70^0-100^0E.	1.21	0.72	0.37
	5^0-10^0N			
	70^0-100^0E.	1.50	1.21	0.14
	10^0-15^0N			
	70^0-95^0E.	1.13	0.03	0.77
	15^0-20^0N			
	70^0-90^0E.	1.09	0.04	0.73

(Source: IPTP Data Record, Vol.1, 1987)

ease of fabrication and maintenance of the gear, (iii) gillnets are rigged to entangle rather than gill with the result that a wide variety of commercially important fishes such as seerfishes, pomfrets, catfishes, sharks etc.are also caught during fishing, and (iv) possibilitiy of carrying out day time trolling as drift net operations are conducted at night.

Augmenting production of tunas through drift gillnetting employing mechanised vessels and motorised canoes has been discussed by Silas and Pillai (1986). Based on a case study carried out at Cochin it was assumed that each boat could harvest annually or seasonally about 25-30 t of large pelagics and tunas constitute about 20% of the total catch; thus, the average catch of tunas that could be achieved is about 6 t of tunas per annum/or season per boat. Major improvements required in this sector are the better catch storage facility, employment of energy saving devices and introduction of mechanisation in the hauling operations which would increase soaking time and catch rate. Seasonal conversion of 9.6 - 13.0 m OAL shrimp trawlers, with slight modifications in the hauling system would enhance operational range of drift gillnet fishery.

Employment of small purse seiners (OAL = 18 m: HP=45) to catch tunas is increasing in the west coast of Sumatra in the tropical Indian Ocean. In India about 500 purse seiners (13-14 m OAL; 105-120 HP) are engaged in the pelagic fishery landing about an average of 1420 t of tunas during the period 1983-86 along the west coast of India. Sivasubramaniam (1986) opined that the size of craft and gear, engine power and expertise in handling may permit only a moderate expansion of the fishery in the artisanal sector. However, interaction of this fishery and coastal drift gillnet fishery on the stocks of coastal tunas needs careful appraisal.

The mainstay of tuna fishery in the Laskhadweep islands is the small-scale pole and line (live-bait) fishery. Relatively small capital investments involved, ability to harvest small schools of fish, mobility to operate from small ports with minumum technical support and ability to utilise the unskilled labour are the advantages of this fishery. Introduction of mechanisation in the early 60's and the spread of pole and line fishing practice, which was in vogue in Minicoy to some of the northern islands such as Agatti, Bitra, Suheli Par, Perumul Par etc are the two recent developments is this sector. The trend of tuna fishery in the Lakshadweep has been reviewed by Silas *et al.* (1986) based on the information gathered at Minicoy. Recently, the present trend, constraints and strategies for future development of small scale pole and line fishery at Lakshadweep has been critically reviewed by James *et al.* (1987:MS).

At present mechanised boats of 7.9 - 9.1, OAL and 10 - 40 HP and non-mechanised boats of 3.0 - 7.70 m OAL are employed in the day fishing for tunas. One of the strategies for augmenting production of tunas in this sector in the Lakshadweep would be the introduction of a new generation of boats (15 - 20 , OAL), with adequate navigational and fish storage facility for 4 to 5 days of fishing. At the modest estimation of production of 60 - 100 tonnes of tunas per season per such boat, and estimating average production of tunas per kg of bait as 120 kg, the requirement of each boat/season will be about 0.5 to 0.8 t of baits. Introduction of about 100 boats of this generation would enhance the production of yellowfin and skipjack to the tune of about 10,000 t by 2000 A.D.

Expansion of pole and line fishing method is limited by the availablity of suitable live-bait resources in quantity, their maintenance and transportation, availabliity of tuna schools in fishing grounds, response to chumming, expertise of fishermen etc. Recent aimed baitfish resource surveys conducted by the CMFRI in the Lakshadweep have proved beyond doubt the vast resource of potential live-bait species belonging to the families Dussumieridae, Apogonidae, Caesionidae, Pomacentridae and Atherinidae (other than the traditionally used sprat, *Spratelloides delicatulus*) around Agatti, Bangaram, Perumul Par, Suheli Par,

Kadamat, Kalpeni and Bitra. *S. delicatulus*, a shallow water resident species, with good chumming quality and easily fished by surrounding nets in desired numbers is the only species currently exploited in the tuna pole and line fishery in the islands other than Minicoy. Major constraints in the utilisation of this species is the large scale mortality at the time of capture, storing and transporation. Since the fishery is chiefly dependent on the availablity of this species, its scarcity often result in abrupt suspension of tuna fishery. Exploiting the bait fishes belonging to Apogonidae, Caesionidae and Pomacentridae should be encouraged in all the islands which will lead to augmentation of live-bait production and dispel the threat of overfishing and consequent depletion of the exploitable stocks of *S. delicatulus*.

Interference with the lagoon ecosystem by acitivities such as dredging, and fluctuation in the seasonal recruitment of migrant bait species were the major reasons attributed to the scarcity of tuna live-baits in the Lakshadweep (James *et al.*, 1986). Further, consequent to the introdcution of mechanisation the pole and line fishing fleet which consisted of about 9 boats in 1963 increased to 94 boats in 1973 and 272 boats in 1984-85 with a concomitant production of tunas from about 366t in 1963 to 1 020 t in 1973 and to a record catch of 4,355 t in 1984, resulting in exploitation pressure on resident species.

The potential species of tunas in the offshore ranges of India are the skipjack and yellowfin tunas. Hence it is felt that one of the immediate steps which appears feasible and practicable in the development of small scale surface fishery in the EEZ of India is the strengthening and expansion of ploe and line fishery and introduction of medium sized purse seiners in the Lakshadweep, especially in the northern islands.

Under large scale commercial fishery sector, augmentation of production of tunas can be achieved by the proper deployment and management of oceanic purse seiners and improvements and expansion of longline fishery. As opined by Silas and Pillai (1986) successful surface fishery for tunas can be achieved by large scale purse seine operations through joint venture/ownership agreements. However, in the operation sector in both these types of fisheries, acquisition, utilisation and economic management of vessel capacity, equipments and expertise of developed nations is a prerequisite.

Historical review of the development and recent trend of the industrial tuna purse seine fishery in the tropical Indian Ocean were summarised by Marcille (1985), Hallier (1985), Hallier and Marsac (1985), Cort (1985), Watanabe (1985) and Michard and Hallier (1986). Surveys and experimental fishing employing purseines commenced in the Indian Ocean from 1981, and in 1984 French and Spanish purse seiners shifted their operational range from Atlantic to the Indian Ocean, and the present status of distant nation's fleet of purse seiners in the tropical Indian ocean by country of registration is as follows:-

Year/country:	France	Spain	IvoryCoast	Mauritius	Panama	U.K.	Total
1984	20	6	4	1	1	-	32
1985	23	10	2	1	1	1	38
1986 (1/86-10/86)	21	11	-	1	1	1	35

The pure seine fleets based in Seychelles operated in the area $42^{o}-72^{o}E$ and $12^{o}S-5^{o}N$ in the equatorial western Indian Ocean. A spurt in the production of skipjack and yellowfin tunas was recorded since 1984, and about 55% of the production of these species are taken by the

distant water nations in recent years (Table 3).

Information provided by Silas and Pillai (1982) on the prevailing conditions of thermocline, current pattern and sea surface temperature provide information on the concentration of skipjack and yellowfin tunas in this area. Use of remote sensing for delineating productive sectors in the oceanic areas and concentration of surface shoaling species of tunas, especially by time series maps from satellites such as IRSS, LANDSAT and NIMBUS-7 are important in this connection (James *et al.*, 1986). Marcille (1985) while concluding potential fishing grounds and seasons for oceanic purse seining in the Indian Ocean based on the analysis of the prevailing meteorological and hydrographic conditions and current systems indicated potentially succesuful purse seine season in the Andaman Sea as March-May and Lakshadweep Sea as November-May. Employment of 10-12 purse seines with annual production capacity of 6000 t and 20 purse seiners each of 4,000 t production capacity would lead to the production of about 150,000 t of tunas (yellowfin and skipjack) from the oceanic waters around India and contiguous high seas (Silas and Pillai, 1986). Development of large scale purse seining should be planned in a regulated manner since: (i) the fishery result in the harvesting of young yellowfin tunas, and may affect the recruitment of this species to the longline fishery, (ii) it may also affect the availability of surface species of tunas such as skipjack and yellowfin tunas to the existing traditional fishery in the tropical Indian Ocean Area (employing drift gillnets, pole and line and coastal purse seining) which evinced fluctuations and oscillations during the period 1976 to 1985 (Table 11).

As stated earlier, longline fishery surveys carried out in the Arabian Sea, Bay of Bengal, Andaman Sea and Tropical Indian Ocean have charted out productive areas and northward shift in the seasonal pattern of abundance of yellowfin tunas (Joseph and John, 1986; Sivaprakasam and Patil, 1986). Marcille (1985) indicated earlier an apperent seasonal migratory pattern of yellowfin tuna northwards during October to March and southwards during April to September in the Arabian Sea, based on the analysis of data collected from the longline fishery. The operational aspects, constraints and management problems of longline fishery within the EEZ of India and contiguous high seas were dealt with earlier (Silas and Pillai, 1982). Effort should be made to enter into commercial longline fishery initially through joint venture arrangements. About 150 longliners with annual production capacity of 450 t of tunas anually would be required for achieving a production target of 60,000 - 75,000 t of oceanic tunas especially yellowfin tuna and bigeye tuna.

PRODUCT DEVELOPMENT AND MARKETING

Development and improvement of post-harvest technology on coastal and oceanic tunas and tuna products assumes importance while planning for augmenting production of tunas and to diversify exports of marine products.

Based on the market value and utilisation of meat, yellowfin tuna, skipjack tuna and longtail tuna are classified as 'light meat tunas' and tuna-like fishes such as little tuna, frigate and bullet tunas and bonito as 'red meat tunas'. Improvement in the post-harvest technology, product development and marketing combined with infrastructure for increasing demand for tuna within the country and in the export market would be one of the options for augmenting production of this resource. Developing internal markets for red meat varieties such as little tuna, frigate and bullet tunas and bonito in fresh, frozen and processed form through improved processing technology would lead to the augmentation of their production in the coastal small scale fishery sector. Eventhough smoked and cured *masmin* from tuna prepared indegenously, is the major product in Lakshadweep today, technology for improving the quality of *masmin* and new products from tunas will have to be attempted keeping in view the market preference due to the fact that at present there

Table 11. Trend of Production of Skipjack tuna and
Yellowfin tuna by countries, 1976-85 (Tonnes)

TOTAL	INDONESIA * (INDEX)	YEAR	SRI LANKA ** TOTAL	(INDEX)
6830	(100)	1976	19137	(100)
4269	(63)	1977	17119	(89)
6904	(102)	1978	16363	(860)
9760	(143)	1979	30838	(1610)
10921	(160)	1980	19606	(103)
9929	(145)	1981	21420	(112)
14756	(216)	1892	21600	(113)
18346	(269)	1983	32018	(120)
13736	(201)	1984	18050	(94)
13387	(195)	1985	18834	(98)
	MALDIVES ***		INDIA (LAKSHADWEEP)+	
24983	(100)	1076	1291	(100)
18815	(75)	1977	1116	(86)
17408	(70)	1978	1875	(145)
22425	(90)	1979	2794	(216)
50215	(201)	1980	1780	(138)
25896	(104)	1981	2220	(172)
19385	(78)	1982)	2950	(221)
25942	(104)	1983	3050	(236)
39172	(157)	1984	4355	(337)
48668	(195)	1985	3775	(292)

(* = Trolling, drift gillnetting; ** = Drift gillnetting, Pole and line fishery; *** Pole and line fishery, trolling; + = Pole and line fishery; trolling)

is no organised marketing system for *masmin* at Lakshadweep. Development of an organised marketing system will be beneficial to the tuna fishermen since it can solve to some extent the present constraints in getting profitable markets and sudden fall in price of the products. In view of the economical returns, quality improvement and steady market for *masmin* chiefly in the mainland of India and export should be explored and developed.

There is scope for development and expansion of tuna canneries for producing canned packs of tunas for internal consumption. At Minicoy, an average of about 70 t of tunas are canned annually by the Govt. Canning Factory, and at Agatti a scheme for establishing canning factory has recently been proposed.

Processing of tuna wastes economically is another area to be considered immediately in the Lakshadweep Island. Observations conducted by CMFRI at Minicoy and Agatti islands indicate that about 5-8% of body weight of tunas at Minicoy and 34-43% of body weight of tunas at Agatti are discarded as 'waste' in the indegenous *masmin* processing industry. Effective small scale waste utilisation method by converting them to fish meal or as ensilage should be explored and implemented.

CONCLUSIONS

As stated elsewhere in the present study, tuna fishery potential in the high seas and the insular realms of India is in the resources of skipjack and yellowfin tunas. Available data indicate that the production of yellowfin tuna in the surface fishery has already exceeded that by longline fishery and the production of skipjack has increased considerably in recent years.

There has been a traditional small scale fishery for skipjack and yellowfin tunas in the tropical northern Indian Ocean by Indonesia, Sri Lanka, Maldives and India, and the rate of production of these species evinced fluctuations and oscillations for the past one decade. Index of decrease/increase in the production of these two species in the surface fishery of these countries during the period 1978-86 is presented in Table 10. In Indonesia, the catches steadily improved from 1978; in Sri Lanka catches were relatively high during 1981-83, and since then shown a declining trend in recent years; in Maldives, after a decline in production in 1981, the catch rate increased from 1983-85; in the Lakshadweep (India) a steady increase in the production of these two species was noted since 1980 - all these developments are attributed to the addition to the fleet, large scale mechanisation and expansion of fishing grounds. Production of yellowfin and skipjack tunas has dramatically been increased with distant nations taking about 55% of their total production from the area where traditional fishery in the artisanal sector has been in existence.

Development and management of tuna fishery require basic data on the stock structure, migratory patterns and biological parameters of different species. Although estimates of mortality, exploitation rate and stock structure of yellowfin and skipjack tunas are available (Silas *et al*, 1986; James *et al*, 1987), in view of the ocean-wide distribution pattern of these species, their highly migratory nature and limited area of coverage in the studies, these represent "a bench mark for optimum exploitable level within the exploited ranges, limited by the carrying capacity of these ranges" (Sivasubramaniam, 1986). Further, the differential growth rates estimated for these species from this sub-region may be due to the age specific migration of these species (Skipjack, K=0.22 - 0.62; yellowfin, K = 0.32 - 0.50). In order to derive at realistic estimates on the interaction of the fisheries in the small scale sector (surface) and in the large scale commercial sector (surface and sub-surface), data over an extended period of time and wider area on the catch-effort statistics and size distribution by sex and species are prerequisites.

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STRATEGIES FOR THE DEVELOPMENT AND MANAGEMENT OF PURSE SEINE FISHING IN INDIA

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ABSTRACT

Purse seine, an important bulk catching method was first evolved in the Atlantic Coast during the last quarter of the 19th century and in India the developmental efforts were initiated by the Indo-Norwegian Project in 1954 and the operations on commercial lines were taken up from 1976 onwards. Enterprising fishermen of Karnataka were the first to introduce this modern method of fishing, switching over from the traditional rampani nets. The purse seines spread to Kerala and Goa later. Initially boats of different length and deck arrangements were tried and after gaining competency, 15 m boat emerged as the suitable vessel with deck arrangement for portside operation of purse seine net of 600 m length and 55 m depth.

Competition and conflict arose between traditional fishermen and purse seine operators as their gears are operated in the inshore region and for the same pelagic species of fishes. Regulations were formulated delimiting the activity of purse seiners to avoid conflict resulting in the reduction of catch. In the light of the above situation the paper deals with the recommended strategy for management of resources and development of purse seine fishery in India.

INTRODUCTION

Some species of fishes aggregate to form large shoals, not staying near the bottom but found pelagically up to the surface. Such shoals were exploited before the introduction of modern methods of fishing only when they come to the sea surface or if they come near the shore, large fisheries occur and are caught by using simple fishing techniques. Instances of these are common around the world, also in Indian waters for sardine, mackerel, anchovy etc.These fishes are caught by indigenous fishing gear like the shore seine 'Rampani' when the shoals approach the shore and by boat seines like 'Iraguvala', 'Kollivala' and 'Thanguvala' and gill nets of encircling types when they appear near surface. During operation in deep waters when the lower edge of the nets do not reach the bottom, such methods cannot be fully successful as the encircled shoal will dive and escape from the zone of action of the gear unless the predatory fishes below the net prevent the fish from diving. This downward escapement can be prevented by surrounding the fish from all sides as well as from the bottom by hauling the foot rope of the net faster as in 'Lampara' net which is akin to the 'Kolli vala' of the Kerala coast. Quite different in construction and operation but with the same effect of closing the bottom horizontally, are the purse seines, by hauling the purse line. Purse seine is the most important gear for catching pelagic fishes and produces the highest percentage of the total catch of the world and considered as the most efficient bulk and energy saving fish catching method.

Purse Seines are made of long wall of netting with a float line and a sinker line of equal or slightly longer length. With this form of construction a deep bag as in 'Kolli vala' cannot be added and unlike the 'Kolli vala' the escapement of fishes from the lower side is prevented by closing the bottom by hauling the purse line which is passing through the purse rings hanging from the sinker line.

Purse seines are considered to be of recent origin in large scale fisheries for pelagic fishing. It is said to have been evolved from beach seines.

improved and used in the fjords of Rhode Island in 1826. Yet others think, a fisherman of Maine invented this net in 1837 (Scofield, 1951; Brandt, 1984). Later on, the purse seines were distributed to other parts of the world, to Sweden, Norway, Japan etc. In India this gear was first tried by Norwegians off Quilon around in 1956 (Mukundan and Hakkim, 1980)and Portuguese off Goa in 1957-58 (Sadanandan *et al.* 1975). Department of fisheries of Goa conducted Purse seinging from 1964 and results are discussed by Dhawan (1976). Intensive and systematic purse seineing was conducted by the erstwhile I.N.P (Menon, 1970). Shallow water purse seines were developed by I.N.P. after extensive fishing operations from 7.6 and 10.9 m. vessels, Thus it can be seen that purse seine is a comparatively new introduction and in fact the industry has taken up only in 1976, first in the state of Karnataka followed by Kerala. Since then any small developed or improvement made in the design of net or operation was carried out by the fishermen themselves.

A detailed description of the net is given by Scofield (1951), Green *et al.* (1971) of the American tuna purse seine, of the Norwegian and Icelandic purse seines by Thorsteinsson (1971) and of the Japanese type by Inoue (1971). The design details of the net used in Goa is described by Sadanandan *et al.* (1975) and the nets developed by I.N.P. suitable for 10.9 and 17.3 m vessels are given by Verghese (1974). Mukundan *et al.* (1980) give design and construction details of net made of materials available in the country and suitable for 13.2 vessel and Mukundan and Hakkim (1980) described a 400 m net suitable for vessels of 13.2 to 15 m length. Presently vessels engaged in commercial operations are using nets weighing about 1 to 1 1/2 tonnes having a length of 600 m and 55 m depth.

Theory of design for purse seine is described by Fridman (1973) and method of fabrication by Green *et al.* (1971), Hamre and Nakken (1971), Iitaka (1971), Inoue (1971) and McNeely (1961). The purse seines operated in this country are however designed based on exprience because size of the shoal, swimming speed and behaviour of fishes are not adequately understood. For the shallow water opertions the length /depth ratio is 10:1 and the main consideration while deciding the mesh size is the prevention of gilling of the prey and too small a mesh size would increase the weight of the net. The mesh size for the main body of the net is 16 to 18 mm and for the bunt is 12 mm for upper and lower selvedges or guardings mesh size are 20 and 60 to 70 mm respectively. Larger mesh size for the lower selvedge is to allow filtering of mud likely to pile up while pursing the sinker line to close the bottom.

Nylon, although lighter than cotton which is having a good sinking speed, is prefered because of its excellent properties. In Japan combination twines are used to improve sinking speed of nets (Iitaka, 1971). Material used for selvedges is polyethylene as it is cheaper , Knotted netting is used for the bunt and also for main body as against the common paractice of knotted for bunt and knotless for the main body. It is reported that the knotless netting made in this country is not strong and its service life is short and due to the difficulty in mending it is not used. Although mending is not a serious problem, the strength of the knotless netting require further investigation to improve the properties. If knotless netting is used the weight of the netting can be reduced. Hexagonal netting is used in Norwegian purse seine fisheries with many advantages, it is not yet tried even though it can be made in the country. The twine used is nylon 210D X 4 X 3 for the bunt 210D X 2 X 3 for the main body and polyethylene 1.5 mm dia. for the upper and 1.75 to 2 mm dia. for the lower selvedges. Polypropylene is used for various ropes including the purse line. About 3500 PVC cylinderical floats and 3000 sinkers each weighing 200g. are used. An ingenious modification effected by the fishermen themselves was the use of an additional line 30 to 40 cm above the sinker line and from this line hung the purse bridles supporting the rings. During hauling of purseline, it is found

advantageous because the sinker line will not get lifted from the ground thus preventing the escape of fish below the line. The estimated cost of the gear is around Rs. 4.5 lakhs. The size of the vessel ranges from 13.2 to 15 m and costs over Rs. 8.0 lakhs and are powered by engines 65 to 110 hp.

The deck equipment and deck arrangement are described by many authors (Scofield, 1951 and Green *et al* 1971). The deck arrangement of purse seiners of Goa was given by Sadanandan *et al.* (1975) and of Cochin by Verghese (1976) and Mukundan and Hakkim (1980). The hydraulic deck machinery is considered as one of the most important requirement for efficient and speedy hauling of the gear and contributed to the success of this fishing method in advanced countries. However, because of the prohibitive costs, it is not yet been used in the commercial seiners of India. C.I.F.N.E.T. has developed, installed and used for a long time, without any trouble an hydraulic winch for its 13.2 m vessel. The hauling of the purse line is by a mechanised gypsy (Hameed and Asok, 1987) and the hauling of the net is done by the crew.

Typical purse seine operations, sinlge boat, two boats, mother ship, starboard and port operations are described by Sadanandan *et al.* (1975), Verghese (1976) and and Mukundan and Hakkim (1980). In earlier years both starboard and port operations were found in Cochin, presently port opertaion is found most acceptable. The visual scouting is done eventhough in advanced countries Sonar and Echo sounders are indispensible for fish location and some cases aircrafts are employed for aerial scouting of shoal and guidance in setting the gear.

Catch per set is reckoned in the case of purse seines instead of catch per hour for trawling and the average works out to be 800 Kg per set, 3500 - 6000 kg per day is a very modest estimate. Verghese (1977) has described the details of conversion of a 10.9 m trawler to a purse seiner and has a projected surplus of Rs. 83,700/- for seine/trawl combintion operation. Mukundan and Hakkim (1980) from the information collected from a commercial vessel found a net profit of over 2.0 lakhs. This can be many times more in a good fishing season. Dhulkhed *et al*, (1982) worked out the break even point of a purse seiner to be Rs. 5.0 lakhs. Hameed and Asok (1987) found a profit of Rs. 3.5 lakhs per year and a pay back period is about two and half years.

As there is no reliable information, a detailed study would give more information on the quantity of fish landed and the economics of operation including the earning of the crew in comparison with other fishing techniques.

The sardines and mackerel constitute the major catches of purse seine and the new resources exploited are catfishes , anchovies and carrangids.

For the years 1960-71, Sekharan (1975) estimated the total stock of 9,50,000 t of oil sardine and mackerel with a standing stock of 4,60,000 t. The pelagic fisheries project has estimated a potential of 4,00,000 , 3,00,000 and 5,00,000 of sardines, mackerel and anchovies respectively on the west coast. Besides, there are other resources of catfishes, tuna etc. vulnerable for purse seining. The major species like sardine and mackerel have exhibited marked year to year fluctuations probably due to variations in year class strength caused by other factors.

During 1984-85, 1,65,537 t of sardines, 40,411 t of Indian mackerel and 1,10,373 t of anchovy were landed (CMFRI, 1986). A comparison of the available resources and the landings indicates that the resources are not fully exploited. Advantages of the available resources need to be tapped and fully utilized to achieve nearly all the national objectives.

The resources in the inshore region were exploited by the traditional fishermen with their indigenous craft and gear. With the introduction of modern fishing techniques like trawling, two boat mid water trawling and purse seining a new situation has arisen as both groups have to depend on the same resources more or less in the same area leading to conflict between them. Traditional fishermen mainly depending on the bottom and pelagic resources near to the shore

feel that their catches have decreased resulting in lower income (Kalawar *et al.*, 1985). The introduction of purse seining added one more dimension to the problem that is competetion for price for the same species. The unpleasant encounters created law and order problems leading to barring of fishing activities and delimitation of fishing zones. During the last 40 years, since independance, significant strides have been made in the overall development of fisheries both marine and inland and at present a plateau has been reached at least in marine sector. Therefore, it is imperative to give more attention for increasing fish production maintaining sustainable yield of the exploited resources, diversification of fishing and exploitation of new resources, for which new strategies have to be evolved to achieve the national goals, which are:

1. Our knowledge of the biology and dynamics of fish populations is far from adequate, therefore need further detailed study taking into consideration also the multispecies interaction.

2. There is very little information of the total effort and landings in the traditional and the mechanised sectors. It should be made obligatory to furnish the fishing data, where ever possible otherwise intensive action should be made to collect the same.

3. This would enable to predict the sustainable yield, the required number of vessels to be deployed, delimitation of the fishing zones and the banning of the fishing ativities during the breeding seasons.

4. The traditional fishermen who are engaged in fishing, should be encouraged to mechanise their craft to enable them to fish far from shore and to increase their fishing time and catch.

5. Employment opportunities may be made available to them in purse seining and other diversified fishing vessels.

6. Efforts should be made to improve the preformance of purse seine nets and boat to enable them to fish in deeper waters where sonar surveys may be conducted to enable catching of submerged shoals.

7. Anchovy resources are not fully exploited and research should be directed to exploit these resources by purse seining.

8. As purse seining is introduced very recently, much research work is not done for its improvement. Since it is an energy efficient method there is need for further development and Improvement.

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RESEARCH, CONSERVATION AND MANAGEMENT OF EDIBLE HOLOTHURIANS AND THEIR IMPACT ON THE BECHE-DE-MER INDUSTRY

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ABSTRACT

Very little research has been done on the edible holothurians form India. Although more than seventy species of holothurians are known from the shallow-waters of India only about ten species are found to be economically important. At present one species viz., *Holothuria (Metriatyla) scabra* Jaegaer is almost exclusively used in the Gulf of Mannar and Palk Bay and also in Andamans for the preparation of *beche-de-mer*. There are already indications of fishing pressure affecting the stocks. It is therefore necessary to collect data on catch, effort and length composition and also to study age and growth, length at first maturity, spawning, fecundity, development and culture, recruitment and dispersion to take necessary conservation methods to manage and monitor the resource rationally. The impacts of these studies on the *beche-de-mer* industry are discussed in detail in the paper.

INTRODUCTION

Although more than seventy species of holothurians are known from the shallow- waters of Indian seas, only about ten species are edible after processing them into a product known as *beche-de-mer*. Eventhough the *beche-de-mer* industry is a very ancient one having been introduced by the Chinese nearly thousand years ago, surprisingly very little attention has been paid to the industry. At present on an average, materials worth of Rs.20 lakhs is exported from India annually. In 1982 Government of India put a ban on the export of material below 75 mm size as a measure of conservation and this has resulted in a crisis for the industry with large quantities of material remaining in godowns. Since there is no internal market for the product the industry is agitating to get the ban lifted for the export of material already processed. The author has recently conducted a survey along the Palk Bay and the Gulf of Mannar coasts to study the present status of the industry. The data collected clearly indicate that there is fishing pressure in some pockets. To save the industry, overfishing should be avoided. The available resources should be properly managed by insisting on size restrictions at the time of capture and also observing closed fishing seasons . Much research needs to be done on the biology of holothurians such as age and growth, longevity, length at first maturity, spawning, fecundity, development and culture, recruitment and dispersion to take up necessary conservation methods and to manage and monitor the resources rationally. The industry should be introduced in Lakshadweep where holothurians which yield best quality beche-de-mer occur in good numbers. Processing should also be extended to various islands in Andaman and Nicobar group where the resource is good. In this way the industry can be diversified by processing other species of holothurians which are more valuable and occur in Andaman and Nicobar Islands and also at Lakshadweep.

RESEARCH

Very little research has been done on the edible holothurians of India. On the mainland the industry is restricted only along the Gulf of Mannar and Palk Bay. *Holothuria (Metriatyla) scabra* (Pl.I, A) and *Holothuria (Theelothuria) spinifera* (Pl.I,B) are at present used in the preparation of *beche-de-mer* on the mainland. The second species is not preferred by the merchants and the price offered is also very low. The exporters often remove them when purchasing this product.

James (1973, 1983) reported on the *beche-de-mer* resources from India and the sea cucumber resources from Andamans. There are a few papers which mention holothurians from the Indian region like those of Bell (1887) from Andamans, Thurston (1927) and Bell (1889) from Rameswaram, Thurston (1890) from the Gulf of Mannar, Thurston (1894) from Tuticorin and Pamban, Gravely (1927) from Krusadai and neighbourig islands, Gravely (1941) from Madras, Gideon *et al.* (1957) from Gulf of Kutch, Sane and Chhapgar (1962) from Bombay, Rao (1968) from Waltair, Gopalakrishnan (1969) from Gulf of Kutch, Rao (1973, 1975) from Andamans,

Mary Bai and Ramanathan (1977) from Kanyakumari, Parulekar (1981) from Malvan, Soota *et al.* (1983) from Andamans and Mukhopadhyay and Samanta (1983) from Lakshadweep. Surprisingly economically important holothurians were not listed by any one of them except Bell (1887), Parulekar (1981) and Soota *et al.* (1983) who listed 11 species as economically important for *beche-de-mer*. The present author initiated work on Indian echinoderms in 1963 and as a result of his efforts a number of papers have been published on the taxonomy of holothurians (James 1967, 1968,1969,1983,1986 a, 1986 b). As a result of his study one new family and some new species and several new records were brought to light.

Very little work has been done on the biology of holothurians particularly commercially important forms. Krishnaswamy and Krishnan (1987) have worked on the reproductive periodicity of *Holothuria (Metriatyla) scabra* and have stated that it has two spawning peaks, one in July and another in October. Mary Bai (1978) has published an account of the anatomy and histology of *Holothuria (Metrityla) scabra* and in 1980 she brought out a monograph on the same species giving details about the histology and anotomy and compiling the lists of species known from the Indian region. James (1978) has recorded a juvenile of *Holothuria (metriatyla) scabra* from algae from Mandapam (Palk Bay) in June. It is gratifying to note that detailed work on the biology of *Holothuria (Metriatyla) scabra* and *Holothuria (Theelothuria) spinifera* both used for *beche-de-mer* and on the hatchery development in *Holothuria (Metriatyla) scabra* has been taken up in CMFRI. Recently a break through was achieved in inducing this species to spawn in the laboratory for the first time in India by thermal stimulation. The fertilized eggs were successfully reared through various stages like Dipleurula, Auricularia, Doliolaria and Pentactula by feeding them on *Isochrysis galbane* and mixed culture of diatoms. They settled down to the bottom of the tank on the tenth day and were growing fast. The details of this breakthrough is given in James *et al.* (in press). There are now over 32,000 juveniles which are fed on the powder prepared from algae like *Ulva, Sargassum* etc. Some of them have grown to 20 mm in length in 40 days. This growth rate is high when compared to the growth rate in Japanese and Chinese farms. Now another project is taken up on the culture of *Holothuria (Metriatyla) scabra* making use of the seed produced in the hatchery. The success in the hatchery and culture of the species will go a long way to solve the shortage of material for the industry.

Some experiments have been conducted recently on the transportation of live material from Sethubavachatram to Mandapam covering 240 km by road to find out how they withstand transportation over long distances. Altogether ten holothurians belonging to the species *Holothuria (Metriatyla) scabra* were transported to Mandapam stocked in the aquarium. In the next three days six of them died and the rest of them were successfully transported to Tuticorin (135 km) by road and stocked in the hatchery without further mortality. On two occasions ten specimens of *Holothuria (Metriatyla) scabra* were transported by train from Tuticorin to Madras covering a distance of 650 km without any mortality. From the above experiments it is seen the specimens withstand better when they are transported during nights when the temperature is low.

James (1985) made an atttempt for the first time to culture *Holothuria (Metriatyla) scabra* by collecting juveniles and stocking them in enclosed area at Port Blair (Andamans). In February, 1978 a total of 462 juveniles ranging in length from 65 to 160 mm (modal class 81-90 mm) were collected from Seasostris Bay and broadcast in an enclosed area of 1.5 hectares near Aberdeen Jetty where the bottom was partly muddy and partly sandy. At the end of July, 1978 they had grown to 190-290 mm. The results were also published in CMFRI Newsletter (Anon, 1978). The incomplete experiment gave some indication of the possibilities of semiculture of holothurians. The most important aspect of culture is the development of hatchery system. As stated above success has been achieved in inducing the holothurians to spawn in the laboratory and to rear their larvae successfully.

HISTORY OF BECHE-DE-MER INDUSTRY

The *beche-de-mer* industry is very ancient in India. According to Hornell (1917) Chinese had constant trade with Southern India for more than thousand years. There is documented evidence to show that the Chinese had contacts with Periapatnam on the Gulf of Mannar coast since the twelfth century onwards. In search of *beche-de-mer* the Chinese men came to the shores

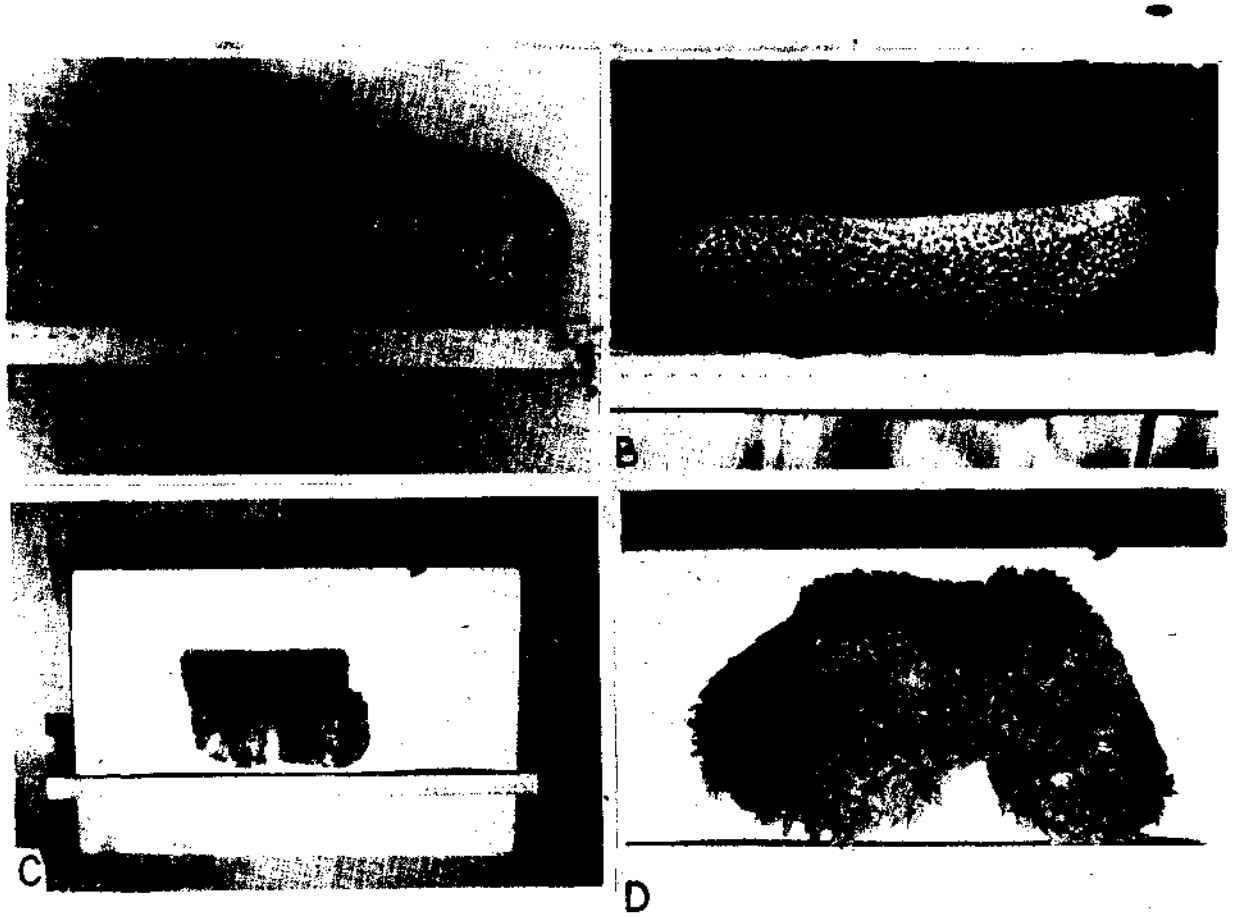
of Southern India and other places. Custom records are available for the export of *beche-de-mer* from 1898 onwards from the Madras Presidency. According to Mannadiar (1977), in Lakshadweep where there is no industry now it appeared to have flourished there once. Sir. W. Robinson who visited the South Canara Islands in 1844 -'45 reported that during the fishing season good many of the islanders were employed by the coastal Moplah merchants in the preparation of *beche-de-mer*. It had very good demand for the Chinese market at Bombay. But slowly the industry began to decline and by the time Mr. W.G. Underwood visited the islands in 1881-'82 the trade has almost died out. They were processed and sent to Mangalore in 'odams and then shipped to China. When the external demand declined the people neglected this industry and quite naturally it became extinct. The chief reason for the untimely death of the industry might have been the difficulty in transporting the material from a port like Mangalore on the West coast to China directly. Today from Madras it is easily transported to Signapore and Hongkong from where it is re-exported to China. Kloss (1903) states that Andamans is known for the *beche-de-mer* in ancient times. Later in recent years it is revived through the efforts of people from Tamil Nadu who are well conversant with the preparation of the product from the holothurian *Holothuria (Metriatyla) scabra*. However, they are ignorant of the processing methods for other species of holothurians and therefore the resource remains untouched till today though they can yield much more valuable *beche-de-mer* than the one from *Holothuria (Metriatyla) scabra*.

Collier (1830) was the first person who gave an account of the *beche-de-mer* of India. Hornell (1917) wrote a classical paper on the *beche-de-mer* industry, its history and recent revival. Though this paper mainly deals with the industry in the Gulf of Mannar and Palk Bay he has given some history of the *beche-de-mer* industry of Lakshadweep which is non existant today. Panning (1944) has summerised the *beche-de-mer* industy in various parts of the world including India. A number of publications have been issued on the subject in recent years by Jacob (1973), Shenoy (1977) and Durairaj (1982). Adithiya (1967) has described the industry from Sri Lanka. This country started a *beche-de-mer* processing factory in Mannar in 1974. Mr. Sachithananthan, FAO processing expert brought out a hand book for the fishermen on *beche-de-mer* of South Pacific Islands. This was edited by Baird (1974). Information on the *beche-de-mer* resources of India, the sea cucumber resources of Andamans and on quality improvement in *beche-de-mer* are available in James (1973, 1981, 1986a, 1986b). Sachithananthan (1986) published a paper on handling and processing of the sea cucumber *Holothuria (Metriatyla) scabra*. Eys (1986) published on the international market for the sea cucumber. The Ministry of Tourism, Marine and Forestry of the United Republic of Tanzania conducted a National Workshop on *beche-de-mer* during July 29th to August 2nd, 1985. It is very interesting to note that Robertson *et al.* (1987) showed for the first time that the Atlantic sea cucumber *Cucumaria frondosa* can also be processed and has export market. Recently James (1987) has published a paper on the prospects and problems of *beche-de-mer* industry in Andaman and Nicobar Islands.

Even as early as 1898 *beche-de-mer* worth of Rs. 15,380 was exported from India to Straits. The industry which was good during 1903- '05 exported *beche-de-mer* worth of Rs. 24, 300 in 1905 and this gradually decreased to Rs. 600 by 1913. In earlier years *beche-de-mer* from India and Sri Lanka used to be clubbed together and exported. From 1910 onwards accurate data is available as imports from Sri Lanka to India were stopped. The average export from India during 1898-'10 was 5534 kg. Since 1910 annual Indian export had fallen to 1,359 kg. This is partly due to First World War and partly due to the reduction in the wholesale rates at Penang. The history of the trade was one of definte fluctuations and the same has been documented by Hornell (1917). Hornell entered the *beche-de-mer* industry in 1916 when the trade was at an ebb and tried to revive the same on scientific lines (Hornell, 1917). He set up a Government experimental Factory for *beche-de-mer* at Tirupalakudi in 1915 and showed how it could be run on profitable lines.

The story of *beche-de-mer* industry in Lakshadweep is somewhat different. As stated earlier during 1844-'45 a good industry existed which died in 1881- '82. When Hornell visited Kiltan Island in 1908 he saw small quantitites of *beche-de-mer* processed from three species. Judging from the local names he has given, they are *Holothuria (Microthele) nobilis* (Pl.I, C), *Bohadshia argus* and *Actinopyga mauritiana* which are abundant even

today. He also noted that the methods of curing were different from those practised in the Palk Bay. They resembled the methods of processing adopted in Australia and Polynesia. Obiviously these methods were introduced by the Chinese. Ayyanger (1922) who made a survey of the fauna and fishing industries of the Lakshadweep noted that the *beche-de-mer* industry which was a success for sometime at Androth had been abandoned due to epidemic of cholera and this was attributed to the insanitary condition in which the curer kept his yard at that time. He states that at Kiltan it was once practised but no traces of the industry are found today. The failure is attributed to poor prices for the processed product. *Thelenota ananas* (Pl. I,D) is an important species from the Lakshadweep.



Pl. I *A. Holothuria (Metrityla) scabra* *B. Holothuria (Theelothuria) spinifera*
C. Holothuria (Microthele) nobilis *D. Thelenota ananas*

In recent years the Fisheries Department of Lakshadweep made some attempts to revive the industry. In 1967 they sent two persons to Rameswaram for one month to learn the processing of holothurians. They returned and processed different species of holothurians in the same method adopted for *Holothuria (Metriatyla) scabra*. They processed mostly *Holothuria (Microthele) nobilis* and handed over the samples to the Fisheries Department. Immediately after this one person from Madras came to Androth and processed nearly seven tonnes of *Holothuria (Microthel) nobilis* by paying a royalty of Rs. 1.00 per kg to the Administration. He procured specimens by paying five or ten paise for each specimen. He processed *beche-de-mer* at Kavaratti also. Fisheries Department restricted the collection of the specimens below 15cm size. After two years he wanted to return to Lakshadweep but the Administration did not give permission.

At Kiltan there is a place even today known as *Koka Pulikkayar* which means a place to boil

sea cucumbers. About 60-70 years back one person who is still living at Chetlat used to process *Holothuria (Microthele) nobilis* at Chetlat. He used to cut each specimen into four bits and boil and dry them. He used to process 5-10 specimens per day and was paid Rs. 30.00 per kg those days. In a year he could process only 20-30 kg. When every one started rediculing him for boiling sea cucumbers he finally gave up. The copper vessel used for boiling sea cucumbers is still available.

As stated earlier Andamans was once famous for *beche-de-mer* and later it was not processed there since the islands chiefly served only as penal settlement. In recent years people from Tamil Nadu have started processing *Holothuria (Metriatyla) scabra* at Andamans particularly around Port Blair even though more valuable species like *Actinopyga mauritiana*, *A. echinities* and *A. miliaris* occur there due to ignorance of their value and processing methods. Still processing is going on in a small scale. This has to be extended to other islands where resource is available.

PRESENT STATUS OF THE INDUSTRY

Since the prices offered for *beche-be-mer* in recent years is attractive there is an attempt to collect, process and export more material. In 1986 Hong Kong market offered US $ 17.00 per kg for large size *Beche-de-mer* (13-15 cm) processed from *Holothuria (Metriatyla) scabra*. 25-35 pieces weigh a kg. The export which was 91 tonnes in 1975 has gradually fallen to 11 tonnes in 1985. This is partly due to the ban imposed by the Government of India in 1982 on the export of material less than 7.5 cm in size. This was later relaxed to clear the accumulated material and this accounts for 71 tonnes export in 1983. In recent years large forms have become rare particularly around Tirupalakudi where intensive fishing is done since time immemorial. Thus while average size of the fresh holothurian *Holothuria (Metriatyla) scabra* collected from Tirupalakudi was 155 mm forming only 29% of the total. Those collected at Tuticorin had an average length of 217 mm which formed 70% of the collections there.

The increase in the percentage of smaller specimens at Tirupalakudi clearly indicates that this species is overfished. The percentage of small sized *beche-de-mer* increased during the year 1979-86. *Beche-de-mer* of 3-4" size which formed only 33% during '79-'80 increased to 80% during 1985-'86. Details of percentage of different sizes during the years 1979-86 are given in Table. I. The demands in foreign markets like Hong Kong and Singapore are more and they require about 10-20 tonnes per month and the suppliers in India are unable to meet the heavy demand. Lured by the high price offered and also due to the high demand they resort to processing small and immature forms thus endangering the stocks of the species. To meet the heavy demand in Kilakarai they are now processing *Bohadschia marmorata and Stichopus chloronotus*. If the industry has to be saved, conservative measures have to be taken up immediately and the industry should be diverted to other places especially Lakshadweep islands where there is no processing at all. It should also be extended to various islands in Andaman and Nicobar group where there is good resource. Even on the mainland the industry has been introduced at Tuticorin recently. Prior to 1970 not a single holothurian was fished and processed at Tuticorin. But today there is an organised industry where about 50 boats are engaged in diving operations for holothurians and daily Rs. 10,000 to 15,000 worth of holothurians are fished. Since this is a virgin area all the holothurians fished are large and the average size is 217 mm care should be taken to see that they are not over exploited.

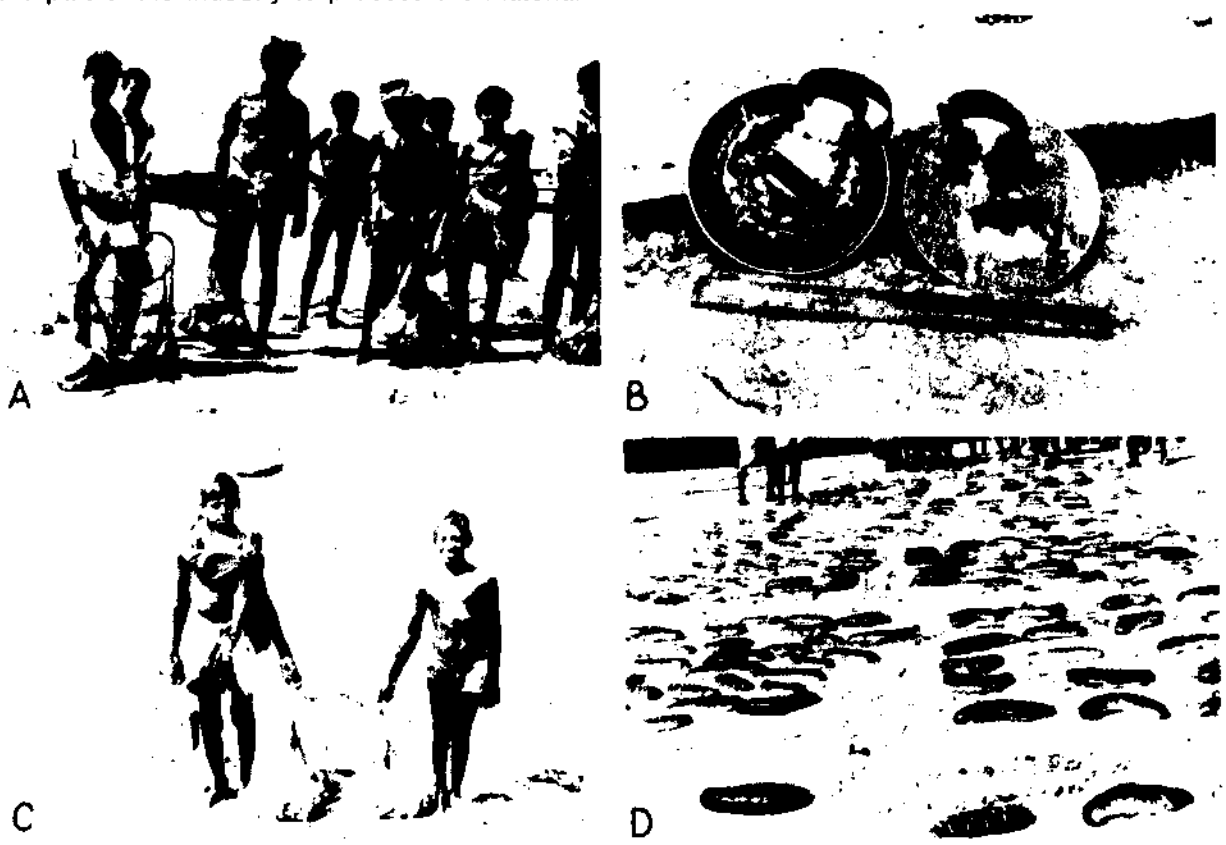
The details of fishing for holothurians at different places between Rameswaram and Tuticorin along the Tamil Nadu coast are given in Table 2. From this Table it is seen Rameswaram, Tirupalakudi and Sethubavachatram on the Palk Bay and Tuticorin on the Gulf of Mannar side are good centres for holothurians. Percentage of specimens above 7.5 cm are less in Tirupalakudi and Kattumavadi (20-30%).

At Rameswaram most of the holothurians landed are large. Tirupalakudi appears to be the main centre for holothurian collection since very long. Most of the holothurian divers hail from Mullimonai. At Tondi only one person is engaged in holothurian processing. In Pudupatnam most of the divers come from Tirupalakudi, Karangadu and Mullimonai. At Kottaipatnam one person is engaged in this industry for the past 15 years. Here large specimens fetch Rs.4.00 for each piece. *Beche-de-mer* above 7.5 cm is sold at Rs. 120 to 130 per kg. Each kg may contain 22-25 pieces. At Kattumavadi also only one person is engaged in processing holothurians for the past

25 years. There are no local divers in the village but drivers from Periapatnam and Kilakarai camp there and dive for holothurians during the season. At Mallipatnam only one person is engaged in holothurian processing for the past 20 years. There are no local divers in the village. Divers from Periapatnam regularly camp here during June and collect holothurians. At Tuticorin before 1970 there was no beche-de-mer industry. Here daily about Rs. 10,000 to 12,000 worth of holothurians are auctioned. About two tonnes of *beche-de-mer* are processed in a month(PP.II).

Kilakarai is the main centre for the export of *beche-de-mer*. At present there are three merchants there and two merchants in Ramnad exporting the material. Each merchant exports 20-25 tonnes of *beche-de-mer* annually. Small quantities are sent as accompanied baggage by air from Madras. Smuggling of material to Sri Lanka is now suspended due to disturbed conditions during 1987-'88.

In the last 20 years some changes have taken place in the industry. There has been an effort on the part of the industry to process the material in more hygenic manner due to the present day attractive prices offered. Material from India used to be rated low when compared to the product from Sri Lanka since the processing was done under most unhygenic conditions. Now nowhere the material is dried on the ground. It is always dried on coir rope mats. This will eliminate sand and other dirt sticking on to the material. In many places aluminium vessels are used for boiling the holothurians instead of rusted iron drums. James (1973) suggested the use of aluminium vessels in the place of iron drums. Now these have to be replaced by saucer-shaped pans preferably made out of hindalium. In the past two years divers are using round aluminium plates (Pl. II, B) for the feet as flippers. This enables them to cover greater distance under water with ease. This may also prove to be counter productive at times since the divers try to pick up all material irrespective of size with ease. Now regular fire wood is used in the place of dry cocount and palmyra leaves. The charcoal from the fire wood is collected and sold to hotel which gives additional income.



Pl. II

A. Divers returning after days catch B. Aluminium plates used as 'flippers' C. Boys returning after days catch D. *Holothuria (Metriatyls scabra* arranged in rows on sand before auction at Tuticorin

Table 1. Size-wise export of beche-de-mer (in kg)

Size	1979-80	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86
4"-6"	7031	4756	2054	3596	3051.5	2851	2123
	(16.9%)	(14.21%)	(3.06%)	(7.48%)	(3.8%)	(18.52%)	(19.5%)
3"-4"	13987	9332	6986	19192.5	22643	12545	8765
	(13.7%)	(27.89%)	(10.4%)	(39.93%)	(28.22%)	(81.48%)	(80.5%)
2"-3"	18301	15867	45675	22370.5	39021	–	–
	(44%)	(47.42%)	(66.59%)	(46.54%)	(48.64%)	–	–
Below 2"	2182	3502	13373	2906	15495	–	–
	(5.25%)	(10.46%)	(19.95%)	(6.04%)	(19.31%)	–	–
Total	41501	33457	67088	48065.0	80210.5	15396	10888

Source: Data compiled from the invoices registered in the MPEDA Regional Office, Madras.

PROBLEMS FACING THE INDUSTRY

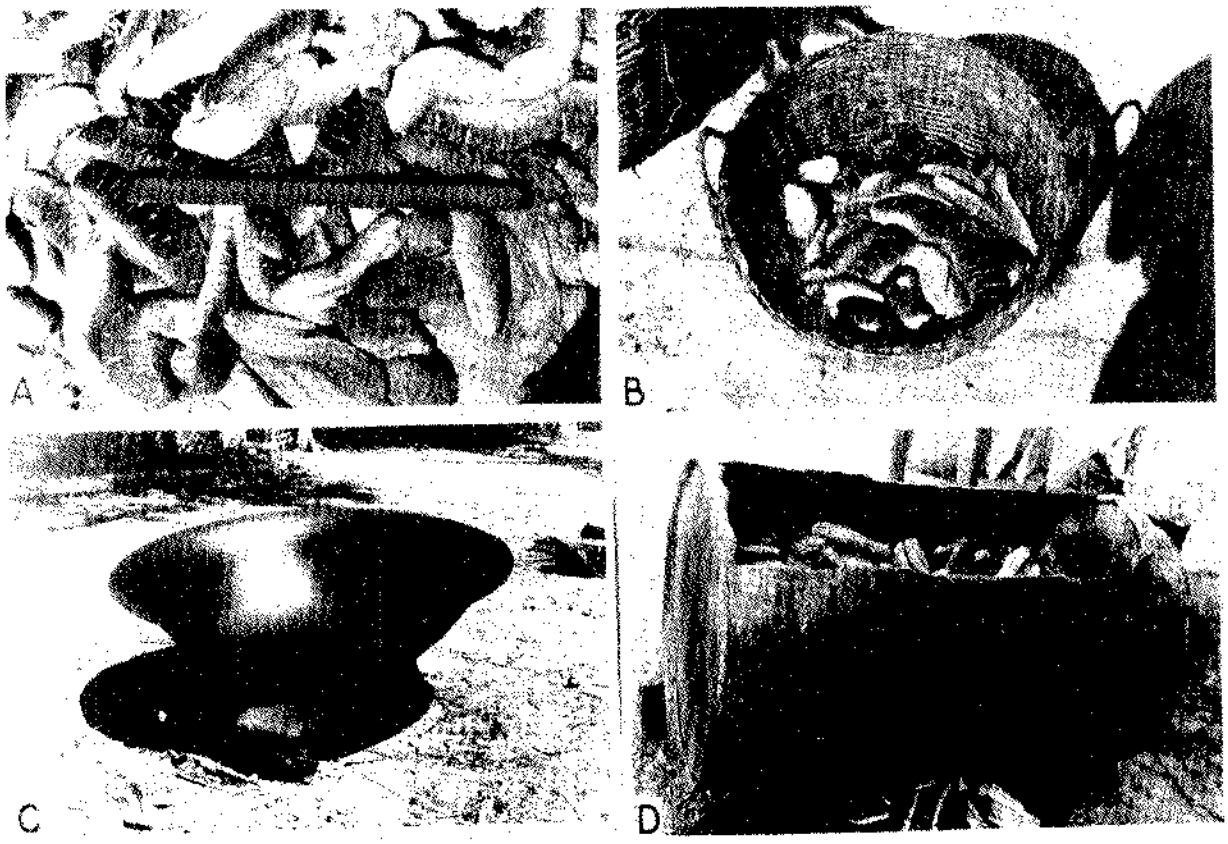
Singapore and Hong Kong need about 500 tonnes of *beche-de-mer* annually. The industry is in short supply of material for processing. This is largely due to the fact that they concentrate on a narrow strip of sea in the Gulf of Mannar and Palk Bay and exploit only two species *viz.*, *Holothuria (Metriatyla) scabra* (Pl. III, A & B) and *Holothuria (Theelothuria) spinifera*. No survey seems to have been conducted in the Palk Bay. Some information is available on the populations of *Holothuria (Metriatyla) scabra* off the shores of north-west coast of Sri Lanka (Palk Bay, Gulf of Mannar and Kalpitiya). This species is found to be distributed in depths of 6-20 metres. Production is estimated to be about 100-150 tonnes per annum. However ther is no information on the potential yield (Anon 1984). It is surprising that Salvadori(1961) recorded holothurians only in one station out of 168 stations covered by him and his team in the pearl and Chank beds in the Gulf of Mannar. In order to overcome the shortage of material the fishermen may launch out to other places like Andaman and Nicobar Islands and the Lakshadweep. In Andaman and Nicobar Islands there are more than 500 islands. No survey has been conducted in these islands for sea cucumbers. Good resources must be available in some of the islands which have not been visited so far by the persons invloved in the industry. In Andaman and Nicobar Islands and the Lakshadweep, holothurians which have much higher value than *Holothuria (Metriatyla) scabra* are available. Also the islands of Lakshadweep have to be exploited where there is no industry at present. In Lakshadweep the best quality holothurian *Holothuria (Microthele) nobilis* occurs in good numbers around some of the islands. In Lakshadweep another valuble holothurian is *Actinopyga mauritiana*. At Andamans at present *Holothuria (Metriatyla) scabra* is processed chiefly around Port Blair. Other valuble holothurians at Andamans are *Actinopyga mauritiana, A. echinites* which occur in good numbers. Other species like *Actinopyga miliaris and A.lacanora* are rare. These are not processed due to ignorance of their value and the ignorance of the processing methods. In fact the processing is more simpler for these species and the prices offered also more attractive. Another problem faced by the industry is the low price offered in the international market when compared to the product from Sri Lanka. This is due to the fact that the Indian material earned a bad name since it is processed under less hygenic conditions and also the final product is less attractive. The shape of the material is fixed during processing and this can be set right by using a flat saucershaped pans (Pl. III, C) instead of oil drums (Pl. III,D). The material has to be constantly stirred while boiling to get perfect cylindrical shape which is of utmost importance in deciding the price in the International market .

FUTURE PROSPECTS FOR THE INDUSTRY

The *beche-de-mer* industry in India has a bright future if it switchs over to other grounds like Lakshadweep and the various islands of Andaman and Nicobar which has the best quality holothurians for *beche-de-mer*. The industry has to diversify to other areas and other species. In the Andaman and Nicobar group there are more than 500 islands and if material is collected from islands which have not been tapped so far the rewards will be great. In order to encourage processing of other species it is necessry to send processed samples to Singapore and Hong Kong and ascertain the present rate. This will encourage the local people to take up processing of other species. James (1986) gave some suggestions to improve the quality of *beche-de-mer*. A workshop has to be conducted for persons involved in the industry to teach them how to process the material on scientific lines. This is very important step to be urgently taken up. The breakthrough achieved in inducing *Holothuria (Metriatyla) scabra* to spawn in the laboratory for the first time in India by thermal stimulation and later successfully rearing the larvae to juveniles will go a long way to solve the shortage of material faced by the industry. At present there are more than 32,000 juveniles in the size of 3-26 mm.

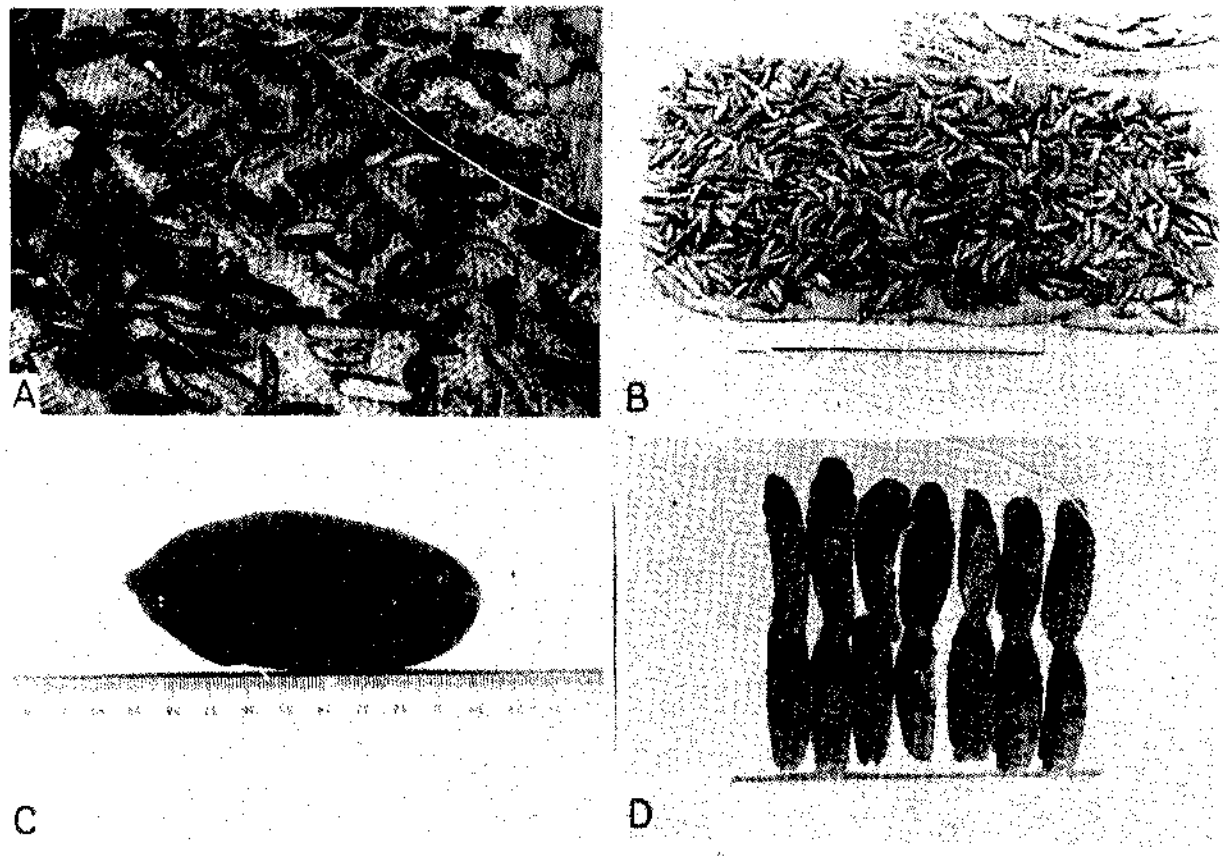
CONSERVATION

James (1985) has already pointed out that *Holothuria (Metriatyla) scabra* and *Holothuria (Theelothuria) spinifera* are likely to be endangered unless conservation methods are taken. Silas *et. al.* (1985) have reported on the depletion of the holothurian *Holothuria (Metriatyla) scabra* populations in the Gulf of Mannar. Government of India took a right decision in 1982 to put a ban on the export of *beche-de-mer* below the size of 7.5 cm size. The 7.5cm specimens



Pl. III

A. *Holothuria (Metriatyla) scabra* put as a heap before degutting B. *Holothuria (Metriatyla) scabra* being transported in basket C. Flat saucer-shaped pan used for boiling at Tondi. D. Conventional oil drum used for boiling.



Pl. IV

Beche-de-mer Of: A. *Holothuria (Metriatyla) scabra* dried on mat B. *Holothuria (Metriatyla) scabra* from Tirupalakudi, mostly undersized C. *Actinopyga miliaris* D. *Actinopyga echinites*

Table 2. Details of fishing for holothurians between Rameswaram and Tuticorin along Tamil Nadu Coast

Place	No. of boats engaged	Method of collection	Average landings per day (No.)	% of specimens above 7.5 cm
Rameswaram	60	Diving	500	67
Tirupalakudi	50	-do-	400	30
Karangadu	20	-do-	100	-
Tondi	-	Thalluvali	-	-
Periapatnam	7	Thalluvali	105	40
Pudupatnam	1	Diving	-	-
Kottaipatnam	1	-do-	125	-
Ammapatnam	-	Thalluvalai	15	-
Kattumavadi	-	Diving		20
Sethubavachatram	10	Diving/Thalluvali	1000	68
Mallipatnam	-	Diving	-	-
Tuticorin	30	-do-	1000	70

will be 200 mm in length in living condition. At this length *Holothuria (Metriatyls) scabra* is immature. It is essential to allow the animals to spawn atleast once in their life time to replenish the stocks. If this is not done the populations will be depleted drastically as it happened in and around Tirupalakudi. The average size of the material collected at Tirupalakudi is only 155 mm. Tirupalakudi, Mullimonai and Karangadu form the core area for the divers and the fishing pressure in a very restricted area is too much, leading to clear overfishing. At Tuticorin the industry has started recently and there is no over exploitation. The average size of the holothurians fishing is 127 mm which is above safe level. In this connection it is pertinent to note that *beche-de-mer* of *Holothuria (Metriatyla) scabra* exported from East Africa, Indonesia and Singapore is 10-18 cm in length. Although *Holothuria (Metriatyla) scabra* breeds round the year, it has two spawning peaks one in July and other in October as stated earlier. It is better not to collect and process the material round the year for two reasons. The first reason is that it can be quickly dried in the sum during January to May. Sun dried material is preferred to smoke dried ones in export market. Smoke dried product also incurs additional expenditure by way of fuel. The second reason is in summer there is no breeding peak. June to December may be declared as closed season.

MANAGEMENT

In any industry if a species has to sustain the industry it has to be judiciously managed without over exploiting the same. This becomes all the more important since we are ignorant of several aspects of its biology such as age and growth, spawning and fecundity, recruitment, distribution, size at first maturity and other aspects of its biology. Unless these aspects of biology are known it is highly dangerous to exploit the species indiscriminately. In case of holothurians over exploitation can easily take place as the animals are defenceless and almost stationery and offer no resistance when caught. Therefore to conserve the resource, regulation regarding the size at collection should be insisted. This can be strictly implemented by the Tamil Nadu Fisheries Department as they do in case of collection of chanks. Since the area of fishing is same for both, this can be easily monitored. The landing centres for holothurians are also limitted and therefore it can easily be regulated. Material below the size of 200 mm in length may be banned from catching. Even if they are caught and brought to the shore they can be put back into the sea since they live out of water for a long time. There should be closed seasons for the holothurian collection especially during the peak spawning periods, July and October. The active season for diving should be closed down by the end of June. The water in the Palk Bay also becomes somewhat turbid and rough preventing the divers to conduct their operations effectively. In fact the season in the Gulf of Mannar starts from October when the sea is calm. From November onwards the monsoon sets in and drying becomes a problem and therefore the processing is not in fully swing. It is interesting to note that the Lakshadweep Administration took the first conservation measures for holothurians when it restricted the collection of *Holothuria (Microthele) nobilis* below the size of 150 mm when processing was practiced during 1968 at Androth and Kavaratti Islands.

Apart from size restrictions and closed seasons which have to be strictly implemented attempts should be made to culture the species to agument production and boost up export. James (1985) made an attempt to culture *Holothuria (Matriatyla) scabra* at Port Blair by collecting juveniles and stocking them in enclosed areas (PL. V, A-D). In this type of work the first step is to locate the beds where juveniles are in large numbers. One such area could be Kundagal gut near Mandapam where juveniles of *Holothuria (Metriatyls) scabra* were seen buried during the low tide.

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RESEARCH NEEDS FOR THE BETTER MANAGEMENT OF DOLPHINS AND DUGONGS OF INDIAN COAST

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ABSTRACT

Taxonomy, age and growth, length range, reproductive biology, population parameters, seasons of occurrence and by-catch of dolphins and dugong are discussed. The research needs and areas requiring urgent attention are brought to focus. Suggenstions are made for designing gill nets that can be dectected by dolphins and preventing them from getting entangled. Safe guarding the habitat of dolphins and dugongs from degradation is suggested.

INTRODUCTION

The conservation of marine mammals is receiving global attention due to the endangered status of some of them and also because of declaration of Indian Ocean as a sanctuary for the marine mammals (James, 1985; Bhatt, 1985). James and Mohan (1987) recorded 14 species of Odontoceti from the Indian coast. While studying the osteological characters of the Indian dolphins, Mohan (1985, a) found that the common species of dolphins caught in the gill nets along the south west coast of India are *Stenella longirostris, Tursiops truncatus var. aduncus, Delphinus delphis var. tropicalis, and Sousa chinensis*.

The incidence of occurrence of dolphins in gillnets along the southwest coast from Goa to Cochin is higher than in other parts of the coast. In recent years dolphin by-catch has increased with the increase of gillnets and their extended operation in the sea due to the introduction of out board engines for the gill net fishing.

We have fairly good information on the distribution, seasonal occurrence, food and feeding habits, osteology and behaviour of the dugongs of Indian coast (Jones, 1959;Nair *et al*; 1975; James, 1974 and Mohan, 1980; 1982). However our information on their population parameters, reproductive biology and age structure are far from statisfactory and requires immediate attention.

DOLPHINS

Taxonomy

The species of dolphins occurring along the Indian coast show certain morphological differences from the same species found in Pacific and Atlantic oceans. The zygomatic width of rostral length ratio of *Delphinus delphis* of Indian coast was 2.14 to 2.15 whereas the ratio was 1.8 to 2.03 in the dolphin of South African coast. The zygomatic width-roastral length ratio of *Stenella longirostris* was found to be 1.48 to 1.55 whereas it was 1.53 to 1.57 in Costorican, Eastern Pacific and Hawai specimens (Perrin, 1975). In *Sousa chinensis* and *Tursiops truncatus var. aduncus* (Fig. 1) the differences in the ratios between the species occuring in India and other parts of the world is not much distinct. Still more detailed study is required involving more specimens from different areas. There is need to investigate the regional variation within the species.

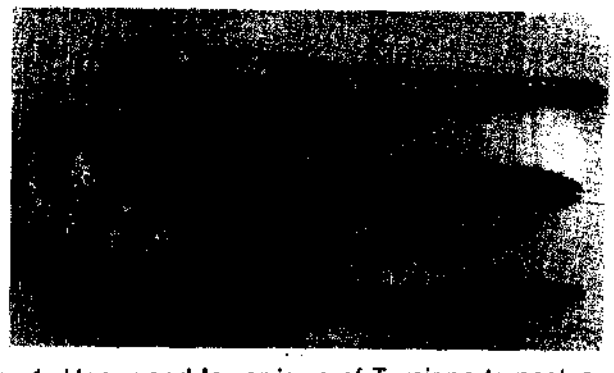

Fig. 1. Upper and lower jaws of *Tursiops truncatus var. aduncus* with dentition. Condylo basal length :495 mm.

Though about 33,224 gill nets are operating in Kerala, Karnataka and Goa coasts with different mesh size (George *et al*, 1981), dolphins are landed by the nets with large mesh size of 90-130 mm. These nets are commonly known as 'Ozhuku vala' (Drift net) and land fishes like *Cybium commersoni*, sharks and tuna. These nets operate at about 20-30 fathom at a distance 20-40 km from the shore. The recent introduction of out board motors have extended the operation of these nets.

Dolphins are entangled in the nets by accident or while trying to feed on the fishes caught in the nets (Fig. 3). Very often the dolphins damage the nets in their effort to free themselves. Fishermen do not always take the dolphins to the shore as it is difficult to handle them and also as it fetches comparatively low price than the fishes. Fishermen consider them as a menance and are willing to accept if methods are suggeted for preventing the dolphins from getting entangled in the nets.

If the nets are made detectable to dolphins, they may not get caught. The large meshes can be intermixed with smaller meshes of 15-20 mm at an interval of one meter so that the net can be detected by the dolphins. It was found that the dolphins cannot detect a net with streched mesh of more than 100mm (FAO, 1978). The nets also can be provided with sound source or reflectors which can alert the dolphins.

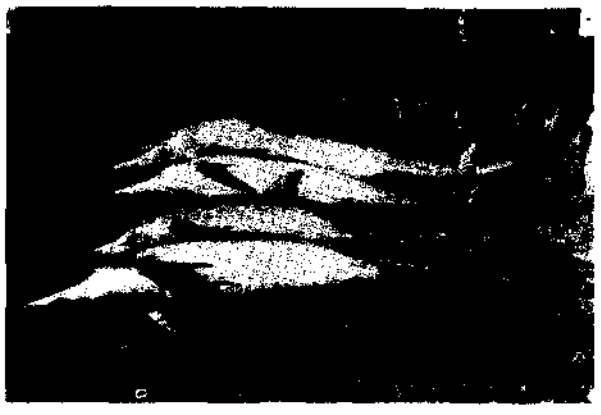

Fig.3. By-catch of dolphins in the Calicut fish market: *Stenella longirostris* and *Tursiops truncatus var.aduncus.*

STUDIES ON CAPTIVE ANIMALS

In India information on the dolphins kept in captivity is restricted to the observation of Mohan (1983) on the *Sousa chinensis* at the Calicut coast. In developed countries, most of the information on the behaviour, age and growth and reproductive biology come from observation made on the captive animals. These area of study also need more attention though it involves funds.

DUGONGS

We have fairly good information on the taxonomy, distribution, food and feeding habits of dugongs along the Indian coast. But the areas like reproductive biology, age and growth in nature, and population estimate are far from satisfactory.

Taxonomy

Though it was thought that there may be more than one sub-species of dugongs in its range of distribution, it is now observed that there is only one species of dugongs and difference may be due to local variation (Nair *et al*, 1975).

Age and Growth

Age and growth was observed on the dugongs kept in captivity (Fig.4). It was estimated that they may grow about 10cm per year and attain a length of 2.7m in 20 years (Nair *et al*, 1975). But in a recent study 45 growth rings were observed in a tusk of dugong from gulf of Mannar measuring 2630mm and it was supposed to be 45 years old. However, the relation between the rings in the tusk and the age has to be verified.

Fig.4. Two dugongs, *Dugong dugon* which were kept in captivity in the Regional Centre of CMFRI, Mandapam Camp.

to the marine mammals. These agencies (Forest Department) should be briefed periodically regarding the protection aspects.

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MARINE NATIONAL PARK AND CONSERVATION OF FISHERIES RESOURCES

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ABSTRACT

Industrial development often takes priority over other sectors in developing countries. In the process, problems like pollution of air, water, growth of slums, lack of sanitary facilities and other environmental hazards greatly increase, reaching to uncontrollable proportions. In the industrial development, in the sphere of both Fisheries and Tourism, mistakes of development are common. It is high time that we pay some attention to the proper planning and development of the seafood export industries along our fine fishing coast.

Similarly the other economic activities of sea, in particular the exploitation of the bed and coastal zones in the west coast for oil, have increased in recent years to such an extent that the detrimental effects on the ecological balance in some habitats are no longer minor.

IUFN and WWF have now launched a World Conservation Programme of the Oceans. The objective of the programme is the conservation of all marine forms of life. The urgent need for the establishment of Marine National Parks along the Indian Coastline for the purpose of conservation of our Fisheries resources is highlighted in the paper. On the east coast of India on the Tamil Nadu Coast, the fauna and flora of the Palk Bay and the Gulf of Mannar are the richest in India.

The Krusadi Island with the nearby Pulivasal and Shingle Islands and their reefs with the surrounding waters are proposed to be set aside as the Marine Park Research station. The string of sixteen coral islands streiching south and west of Krusadi Island should be declared as a Coral Reserve and the stretch of beaches west of Mandapam up to Tondi on the palk Bay and to valinokkam on the Gulf of Mannar side can be developed as excellent beach resorts.

INTRODUCTION

In a developing country like ours which strives for better standard of living for its people and economic independence, projects of industrial development often take priority over other sectors. In the process, problems like pollution of air, water, growth of slums, lack of sanitary facilities and other environmental hazards greatly increase, reaching at times to uncontrolable proportions. The recent upsurge in conservation, preservation of natural resources, concern for ecology etc. are consequent to the result of bad planning which only aimed at getting quick commercial profits and material achievements.

As in industrial development, both in the spheres of fisheries, and Tourism, mistakes of development are common. Our marine product export has already touched a figure of over 500 crores a year and it is hightime that we pay some attention to the proper planning and development of the seafood export industries along our fine fishing coast. Establishment of large marine product factories, boat building yards etc., may bring in development to a backward region but it has been noticed in several cases especially in the South-East cost of India that the development has simultaneously caused dirt and filth and pollution of air of the coastal environment. Similarly the other economic activites at sea, in particular the exploitation of the sea-bed and coastal zones on the West coast of India for oil have increased in recent years to such an extent that the detrimental effects to the ecological balance in some habitats are no longer minor and incidental. The rapid advancement of technology in our country with the recent establishment of a Department of Ocean Development and the activities of the O N G C will inevitably bring about even more intensive and diversified uses of the sea and the sea-bed in future.

Two leading international organisation concerned with conservation of wildlife and their enviornment, the International Union for Conservation of Nature and Natural Resources (IUCN) and the world Wildlife Fund (WWF) have now launched a World Conservation programme of the Ocean (Anonymous, 1978; Allen, 1978). In this programme particular importance is being given to coastal and estuarine environments, and there is specified emphasis on monitoring the conservation status of critical marine habitats throughout the world and on the requirements for

Bangaram Island in the Lakshadweep situated close to Kavarathi, the capital island has recently been declared as a tourist centre. There is no restriction to coral collecting, sport fishing and SCUBA diving in Bangaram. Fishing in the lagoon for tuna bait is also extensively carried out. Foreign tourists especially Italians, East Europeans and Russians are now attracted in large numbers to Bangaram. The establishment of a Marine National Park in Suheli par is bound to further increase the tourist traffic and put the Union Territory of Lakshadweep on the world map of tourism while conserving the wild life and the enviornment. (Fig 1 and 2)

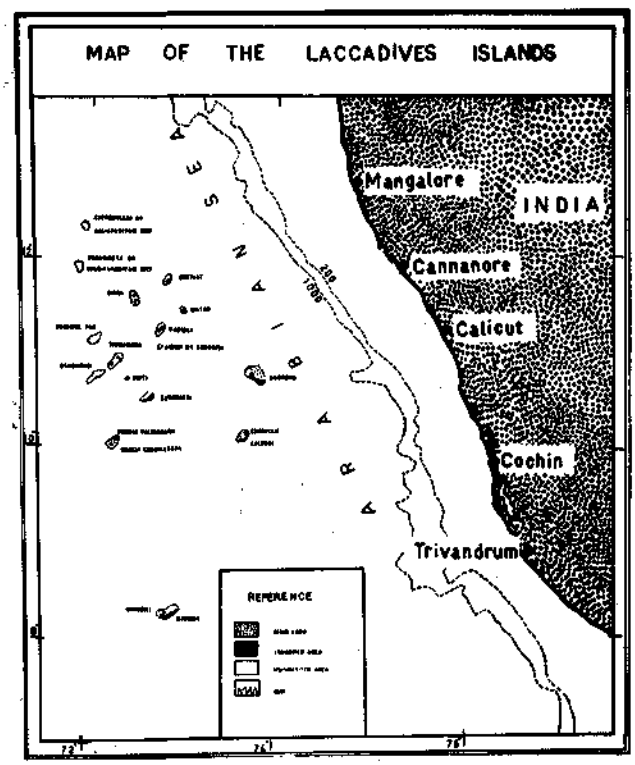

Fig. 1. Lakshadweep Islands.

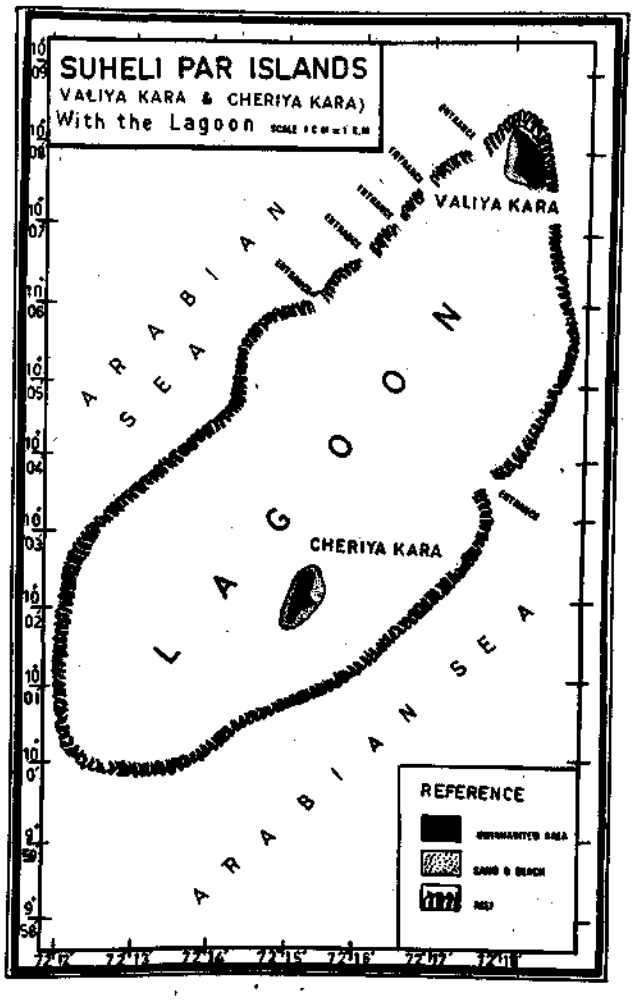

Fig. 2. Suheli lagoon and its islands, Valiakara and Cheriyakara.

PALK BAY AND GULF OF MANNAR

Marine National Park

On the east coast of India on the Tamilnadu coast, the fauna and flora of Palk Bay and the Gulf of Mannar are the richest in India. The chain of twenty coral islands of the region, with their reefs and shallow waters harbour a variety of animals and plants. The Gulf current enrich this fauna from day to day and the sheltered nature of the bay with its rich marine life and extensive beaches and the ancient and architecturally famous and beautiful temple of Ramaeswaram represent conditions ideally suited for the development of a Marine National Park (Fig.3)

Marine Park Research Station

The Krusadai Island with the nearby pulli-vasel and Shingle islands and their reefs with the surrounding waters are proposed to be set aside as the Marine Park Research Station (Fig.4).

The Krusadai Island is a small island roughly 3.22 km long and o.8 km wide. The southern side and the eastern part of the northern shore of the island is muddy and fringed with mangrooves. It has extensive coconut, palymyrah and casuarina grooves. The marine fauna is rich and varied and have been described by various workers, both foreign and Indian (Boergesen, 1937 a, 1937 b,

The Beach Resort

All the world over, especially from highly industrialised western countries, which have severe winter months, tourists travel to tropical areas where landscape is beautiful and the enviornment is unpolluted with natural bays and beaches to enjoy the sun, sand and the sea. The beach oriented tourist, travel for leisure and enjoyment and are altogether a different type of tourist from the scientist tourists who combine study with leisure. To attract these tourists considerable planning and development of our beaches are necessary.

In the island of Rameswaram, besides, the temple area on the eastern part of the island, there are vast stretches of uninhabited sandy beach areas especially on the Gulf of Mannar area between Dhanushkodi and Pamban and between the temple area and Pamban on the Palk Bay side.

Similarly the vast stretch of beaches west of Mandapm upto Tondi on the plak Bay and to Valinokkam on the Gulf of Manner side can be developed as excellent beach resorts for foreign tourists.

The Rameswaram Temple

The Rameswaram temple built on the eastern sea front of the Rameswaram island is a great centre of pilgrimage for tourists from all over India and has great architectural and aesthetic appeal to foreign tourists. The amenities for both tourists and pilgrims have to be considerably improved to further develop the place for international tourism.

CONCLUSIONS

Thus, the Palk Bay and the Gulf of Mannar area and the Suheli par in the Lakshadweep Archipelago should be designated as Marine National Parks. The Krusadai group of islands will make an excellent Marine Park Research Station, the rest of the islands in the Gulf of Mannar upto Tuticorin being set apart as the Coral Reserves. Industrial exploitation of coral reefs in this area should be strictly banned. Appropriate air/sea linkages and other amenities will have to be provided to encourage tourism in the area.

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