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PREFACE

Tunas constitute one of the important marine fisheries resources of our country, having an estimated potential of about 200,000 t in the EEZ. The current production of tunas and tuna like fishes from the coastal sector is estimated to be 37,000 t (1991). There is no organised tuna fisheries along our coasts except in the Lakshadweep, where the small scale fisheries for skipjack is established. Long line fishery under chartering foreign vessels to operate in Indian waters commenced in the year 1985 and revised policy on charter was introduced since 1987. The chartered fishing vessels conducted 81 voyages during 1990 and landed about 12,571 t of fishes of which yellowfin tuna constituted 82.3%, big eye 2.0%, billfishes 11.8% and other fishes 3.9%. The Govt. of India survey/training vessels, during their operation from 1983 to 1990 landed a total of 1244 t of fishes of which yellowfin constituted 743 t. The hooking rate of yellowfin tuna by the exploratory fishing vessels by India (1983-90:FSI) has been found to be 1.90/100 hooks. Tuna fishing is capital intensive and the fishing industry has not ventured into this field for want of adequate information on the resources, vessels suitable for exploitation, finance, marketing infrastructure and other constraints.

Central Marine Fisheries Research Institute as the premier organisation in the country for marine fisheries research, has the responsibility for providing guidelines and advice on the rational exploitation, conservation and management of these resources. In fulfilling this objective, the Institute has studied the tuna resources of the Indian Ocean as a whole and has made valuable contributions on the resource characteristics and assessment of the stocks of exploited resources along the mainland coasts and also in and around the Lakshadweep & Andaman-Nicobar Islands.

Exploratory surveys of tuna resources have been conducted over the years by organisations such as Fishery Survey of India, Central Institute of Fisheries Nautical & Engineering Training and Integrated Fisheries Project. As a development agency, Marine Products Export Development Authority is involved in promotional activities for the development of tuna fisheries.

Although the tuna resources, their fishery and development have been discussed at various levels in the past, these have not made an impact on the industry and tangible actions are yet to be taken for commercial exploitation of this resource, product development and export. There is great need for financial inputs and development of infrastructure to give a boost to the industry. Therefore the focal theme of the Conference revolved around the above aspects.

With a view to consolidate and update information on various aspects of tuna research and development the Central Marine Fisheries Research Institute (ICAR) organised the Conference, cosponsored by Marine Products Export Development Authority, Association of Indian Fishery Industries, Fishery Survey of India (Ministry of Food Processing Industries), Shipping Credit and Investment Company of India and Shipyards Association of India.

The Conference was conducted under five Technical Sessions, namely, Resources, Exploitation, Post harvest technology & utilization, Development of tuna fishing industry and Suitable vessels and gears for tuna fisheries.

This special publication entitled "Proceedings of the National Conference on Tunas" includes a Keynote address by Dr. E.G. Silas, Former Vice-Chancellor, Kerala Agricultural University, seven papers presented at the Conference and the recommendations.

I take this opportunity to thank the Chairman and the Rapporteurs of the different Sessions and the Members of the various Committees who were responsible for the successful conduct of this Conference. I also thank Shri M.S. Rajagopalan who functioned as the General Convener of the Conference, Dr. P. Vedavyasa Rao for formulating and finalising the Recommendations and Dr. P.P. Pillai, Dr. N. Gopalakrishna Pillai and Shri A.A. Jayaprakash for editing the papers and assisting me in publication.

P.S.B.R. James
Director

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PROCEEDINGS AND RECOMMENDATIONS

PROCEEDINGS

Inaugural Session

The Conference was inaugurated by Mr. Hari Krishna Shastri, Union Minister of State for Agricultural Research and Education. Dr.P.S.B.R. James, Director, CMFRI welcomed the distinguished participants, explained the purpose of Conference and overviewed the tuna resources and fishery in the Indian EEZ.

In the inaugural address the Minister said that India's tuna fishing needed support through adequate post-harvest technology. Exploitation activities could be augmented only when marketing was assured. He further said that eventhough tuna constituted about 2% of the total marine fish catch, this was of great importance in the tuna fishing industry because of its enormous export value. He opined that the industry was reluctant to venture into tuna fishing for want of more technical information and infrastructural facilities such as tuna fishing vessels, gears and manpower. He said that steps had to be taken to encourage the industry to invest in this field and tap the vast tuna resources of country's EEZ. He called for a greater interaction between research organisations, farmers, fishermen and industry to take the results of research to the ultimate end users.

Presiding over the function, Dr. P.V. Dehadrai, Deputy Director General (Fisheries), ICAR emphasised the need for concerted efforts for the development of tuna fishing and post harvest technology. He also underscored the need for the development of infrastructural facilities, mainly fishing harbours with adequate berthing space for deep sea fishing vessels, particularly tuna fishing vessels. He pleaded for a consortium approach to be adopted by the fishery enterprises for survey, exploitation, preservation, processing and marketing of tuna catches.

Further, Mr. C. Cherian, President, Sea Food Exporters Association of India and Vice-Chairman, Marine Products Export Development Authority pleaded for effective steps to promote tuna fishing. He had pointed out that several representations made to the government in regard to the need for introduction of tuna fishing vessels and the provision of the needed shore facilities, apart from the marketing aspect, went unheeded. There had been no tangible action taken by the government in this regard. He had appealed to the Minister to prevail upon the concerned authorities to ensure adequate active steps to promote this important sector of endeavour. A vote of thanks was proposed by the Convener Shri M.S. Rajagopalan, Principal Scientist of CMFRI.

Technical Sessions

The Conference consisted of five Technical Sessions in which eight papers including keynote address were presented by eminent Scientists, administrators and representatives of the Fishing Industry on various aspects of tunas and tuna fishery. About 150 delegates drawn from different organisations participated in the Conference.

Technical Sessions were as follows:

Session I	**Resources**		
	Chairman	:	Dr.S.Jones
	Rapporteurs	:	Dr.P.P.Pillai Dr.N.Gopalakrishna Pillai
Session II	**Exploitation**		
	Chairman	:	Shri K.Chidambaram
	Rapporteurs	:	Dr.C.Suseelan Shri M.M.Meiyappan
Session III	**Post-harvest technology and utilization**		
	Chairman	:	Shri M.R. Nair
	Rapporteurs	:	Dr. M.K. Kandoran Shri K.K. Balachandran
Session IV	**Development of tuna fishing industry**		
	Chairman	:	Shri T.K.A. Nair
	Rapporteurs	:	Shri J. Ramesh Shri P.K. Swamy

Session V **Evolving suitable vessels and gears for tuna fishing**

Chairman : Shri R. Sathiarajan

Rapporterus : Dr. Varghese P. Oommen
Mrs. S. Girija

In the Session-I, keynote address and two papers were presented. In his keynote address Dr. E.G. Silas, former Vice-Chancellor, Kerala Agricultural University, pointed out that at the present level of consumption of fish, the global fish requirements by 2000 A.D. was estimated to be about 110 million t as against the present production of 82 million t. He said that one component for filling up of this global gap was the harvesting of tuna and tuna like fishes which had stood today at 3.5 million t, and the scope for increasing production to over 8 million t during the next decade was projected. He said that there was incontrovertible evidence of adequate tuna resources in the Indian EEZ. Adequate measures to exploit the resources was needed.Central Marine Fisheries Research Institute and Fishery Survey of India stressed the need of enhancing tuna production, both in the small scale sector and in the oceanic sector. The yield of coastal tunas could be increased by the expansion of fishery to the new grounds, and also by introducing enhanced operation of drift gillnets in the deeper areas, introduction of aimed purse seining for tapping tuna resources and deep longlining, especially for yellowfin and bigeye tunas. Better post-harvest technology and foreign expertise have been mentioned as prerequisites. The necessity of surveying new grounds along the west and east coasts of India and around Andaman and Nicobar Islands was pointed out by the Fishery Survey of India towards further development of tuna fisheries in the EEZ of India. Technical Session-II mainly focussed on the present status of tuna fishery in Lakshadweep, and prospects for its development and management aspects and the integrated management of tuna fishery by development of fishing harbours, shore facilities, introduction of suitable tuna vessels and the needed marketing network. In the Technical Session-III, the nutritive value of tuna meat was discussed in detail; new products from skipjack tuna was suggested; marketing of tunas with special reference to export was pointed out, centralised vessel acquisition system, and manpower training needed in the tuna fishery were presented by Marine Products Export Development Authority, Association of Indian Fishery Industry and Central Institute of Fishery and Nautical Engineering Training. Evaluation of suitable vessels, size of the tuna long line vessels desired for operation in the Indian EEZ, hooking rate realised during the surveys and alternate baits for longlining were the main focal themes in the Sessions-IV and V. This was followed by a Plenary Session in the evening of 22nd April, 1989, where recommendations were presented.

Plenary Session

The Plenary Session was held on the evening of 22 April, 1989 under the Chairmenship of Dr. P.S.B.R. James who gave a succinct account of the presentations made by the speakers at the various sessions.

Mr. Chidambaram suggested that there should be a system of obtaining on charter, different types of tuna fishing vessels and operating them with experienced foreign fishing crew. In the light of experiences gained in such operations, further operations on joint venture basis between Indian and foreign enterprises should be encouraged. Such joint venture operations involving different types of tuna fishing vessels would lay the foundation for establishing the activity on an enduring basis in Indian waters. He also suggested that an organisation under the name "Indian Tuna Development Foundation" should be set up. The MPEDA could participate in the venture.

Mr. Edward P. Lewis enquired about the area where 42% of hooking rate in respect of yellowfin was obtained as mentioned by Mr. Sulochanan in his paper. He replied that hooking rate of 42% was the maximum obtained by FSI operations. In reply to a question by Mr. Ajit Gaikwad of SCICI, Mr. Sulochanan said that purse-seiner operations for tuna could be successful if there was a major fleet operating together with a common scouting arrangement.

Commenting on a point made by Mr. Biwalkar of SCICI that his organisation would not like to provide financial help to companies proposing to acquire only one vessel, Mr. Ouseph D. Attokaren, Director, MPEDA said that MPEDA was of the view that operations of a single vessel would also be viable.

RECOMMENDATIONS

The Conference took note of the availability of tuna resources in the Indian Exclusive Economic Zone and the contiguous Oceans and the recent development made in the fisheries by long line, purse seines and gill nets. It also noted the recent strides made by the countries boardering the Indian Ocean, particularly the South East Asian countries in the exploitation of the tuna resources, and their participation in the international tuna market.

Although the seas around India abound with tuna resources, the Conference observed with concern that the present exploitation by India has been very much restricted to only a few of the coastal stocks. The data available on the resources point out to the urgent necessity of stepping up of exploitation of this resource not only for the benefit of the country but also to increase foreign exchange earnings. The exploitation of the resource is also imperative in the emerging context of converting and utilizing the resources of the EEZ of the country.

Taking note of the priority assigned for the development of tuna fishing industry since the last decade and the constraints encountered for its slow pace of development in respect of the availability of finance, infrastructure facilities, suitable crafts and gears, expertise and other technical externalities, the Conference took the opportunity to take stock of the present position and endeavoured to identify the various requirements for revitalising the sector and for its accelerated development. The Conference deliberated in 5 technical sessions. On the basis of the presentation of papers by the experts/agencies involved in the sector and the discussions held, the Conference makes the following recommendations:

1. The Conference recommended that tuna resources of the coastal areas and high sea/oceanic tuna resources be treated separately for evolving strategies for tuna fishing operations, handling, processing and marketing.

2. Although certain information is available on the tuna resources of the country for the fishing industry to immediately go in for exploitation, it is recommended that scientific studies on different unit stocks, their resource characteristics and behavioural pattern be undertaken and a central data acquisition system to collect, collate and disseminate the information pertaining to resource exploitation and development be developed.

3. It is also recommended that exploratory surveys and experimental fishing in the EEZ be continued to provide the necessary information for the rapid development of the industry and for facilitating formulation of suitable exploitation strategies.

4. It was suggested that the facilities available at the National Marine Living Resources Data Centre of the CMFRI may be made use of for data acquisition and a separate system be developed for the collection of data on tuna resources not only from India but also from other countries in the Indian Ocean.

5. The Conference noted with great concern that during the last decade several neighbouring countries have stepped up fishing of Indian ocean tunas. In this context it is recommended that India should take immediate steps to promote tuna exploitation to a sizeable measure not only to retain its claim in case of any international cooperative management, but also to reap the resource available in the extended economic zone for the benefit of the country.

6. It was suggested that an Indian Ocean Tuna Commission be set up for looking into the various aspects of this resource with India actively participating in it.

7. The Conference recommends that the small scale sector should be strengthened for the effective exploitation of tuna resources all along the coastal zone and around Lakshadweep and Andaman & Nicobar Islands.

8. Introduction of medium fishing crafts for long lining, pole and line fishing and for gill netting may be encouraged with appropriate incentives and viable projects in this sector be drawn up. In the context of development of tuna fishery in Lakshadweep Islands, besides improving the capabilities of local fishery, it is suggested to utilise the manpower from the Islands and to base the activities in the main land to facilitate operation and post-harvest strategies.

9. Although the availability of live baits for tuna fishery at Lakshadweep waters is not a major constraint at present, it is noted, in course of time and in the context of increased exploitation, the availability of suitable live bait in adequate quantities may become a problem. The Conference, therefore, recommends that experimental work on live bait culture as also the survey of live bait resources may be undertaken.

10. Taking note of the development of small scale tuna fishing operations with 40-50 tonnes long liners in east Jawa, the Conference recommends that similar project may be taken up for Andaman & Nicobar Islands in view of the nearness of the Islands to Singapore and Malaysian markets.

11. The Conference further recommends that 15-20 m long liners may be introduced on experimental basis in the first instance and if the performance proves to be successful, this system of fishing may be promoted on a larger scale.

12. Having noted that an upgraded and standardised technology for production of masmin is already available, it is recommended that this technology may be popularised in the Lakshadweep Islands as well as in the main land.

13. Similarly, the Conference recommends that a pilot project be taken up for the production and marketing of tuna shavings and a market survey be conducted on its acceptability and promotion.

14. Canned tuna being an important and acceptable product needs encouragement. However the main constraint has been the high production cost and the nonavailability of cans in large quantities. Taking these aspects into consideration it is recommended that Government of India should be approached for bringing down the cost of cans so that the price of canned tuna would become competitive in international marketing and would also help in promoting domestic markets for the same. The processing Industry should also be encouraged to adopt modern technologies of packing tunas in flexible sachets. It is recommended that CIFT may take up pilot projects in this regard.

15. Having noted that 30% of the tuna catch after processing goes as processing waste at present, it is recommended that suitable technologies be developed to convert these wastes into useful products like animal feed.

16. Taking note of various constraints faced by the Industry for the exploitation of the vast tuna resources it was recommended that two consortia be organised, one for tuna fishing operations and the other for handling processing and export. It was also suggested that an India Tuna Development Foundation be developed in the country for the above purpose.

17. The Conference recommended that the existing fleet of large trawlers mainly catching prawns may be equipped for long line operation for tuna by bringing about simple modifications and it was recommended that Government may provide 50% of the cost as subsidy and the rest may be provided by the Financing Institutions on easy terms towards such a development.

18. It is recommended that the Government should promote joint ventures in tuna fishing on functional basis of technological needs, supply of tuna vessels and marketing arrangements without any excessive insist-

ance on equity participation either by the Indian entrepreneurs or by the foreign collaborators.

19. In order to accelerate the development of tuna fishing, the Conference strongly recommends that an institutional mechanism may be developed for promoting the tuna fishing industry by the Government of India. Such an Institution may acquire a fleet of tuna vessels as required and organise their operation through hire basis to selected entrepreneurs. It is further recommended that these institutions may have the responsibility of marketing of the catch landed by the vessels supported by it.

20. Having noted the inadequacy of infrastructural facilities for the development of tuna fishing activities, the Conference recommends that two frozen storage of 1000 tonnes at -55°C each may be set up, one at Madras and the other at Cochin, parallel to the development of tuna fishing.

21. To meet the manpower requirements for manning the Tuna fishing vessels, it is recommended that CIFNET may undertake a scheme for training of officers and operatives for this sector.

22. It is also recommended that CIFT may evolve a standard post-harvest technology on board the vessel for storage and processing as well as at the processing plants and train the manpower in this regard.

23. Being greatly concerned about the improper and inadequate financial arrangements acting as major constraints in the development of tuna fisheries, the Conference strongly recommended that action is needed by all concerned to streamline the procedure and make finance available for the development of the industry which would help commercial exploitation by considering to provide the industry the necessary impetus and incentives such as better debt equity ratio, lower rate of interest, encouragement to both small scale and industrial fishing and also to treat deep sea/oceanic fishing as 'no industry area' to attract 25% central subsidy.

24. This being a new area for financing with risks involved, the Conference recommends that SCICI should undertake a study of experiences of other countries in financing deep sea fishing projects with particular reference to tuna fishing projects and in the light of this, evolve a new set of norms for financing high sea fishing projects. It was emphasised that the norms applicable to other industries should not be applied to fishing industry because of its peculiar characteristics.

25. It is recommended that projects involving introduction of single vessel also should be considered by SCICI for extending financial assistance, since it is noted that several companies operating one vessel have also been doing well like other companies having more than one vessel.

KEY-NOTE ADDRESS

CAN INDIA AFFORD TO OPT OUT OF COMMERCIAL TUNA FISHING?

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INTRODUCTION

There is a growing concern about sustaining global food resources to keep pace with the growing population and other demands to meet the challenges of 2000 A.D. and beyond. Fisheries is no exception. It is estimated that at the present level of consumption of fish, the requirement by 2000 A.D. will be about 100 million tonnes as against the present production of about 82 million tonnes. One of the components projected for filling up a part of this gap is the harvest of tuna and tuna-like fishes, which stands today at about 3.6 million tonnes and is projected to increase to over 8 million tonnes during the next decade. While optimistic estimates as to how to fill such a gap through increased production of pelagic and demersal fisheries, including tunas and cephalopods and potential saving from past harvest loses and from aquaculture have been made, let us look at the scenario of Indian fisheries, particularly marine fisheries and more specifically tuna fisheries.

Ever since 1947 we have been trying to develop deep sea fishing without a proper perspective of what is meant by "Deep-sea Fishing". Our problem is that at inconvenient times we have been changing the nomenclature of organisations meant for the so-called "Deep-sea Fishing". By 1975 we were happy to announce that our neritic waters within 40 m. depth had been surveyed. Our artisanal fishermen have in some areas been fishing traditionally from beyond this depth!

With the declaration of the Exclusive Economic Zone in February 1976, hopes were high that we will be able to make a quantum jump in our marine fish production which even at that point of time was stagnating around 1.4 million tonnes. The outlook was that within a few years it would be possible for us to harvest if not all, at least a major part of the projected potential yield of 4.5 million tonnes from our seas. Fifteen years later where do we stand? We are still at the starting blocks with escalated conflicts between the artisanal and mechanised fishing sectors, and with a still greater concentration for shrimping with larger trawlers infringing into shallow neritic waters. As for annual production, we have, perhaps, added about 2,00,000 tonnes during the last one and a half decades. How much of this is due to refinements in catch data acquisition is not clear. Of course, there have been small pockets of success, notable being the motorization of traditional crafts such as the canoes and catamarans; the expansion of the coastal gillnet fisheries and the purse seining operation from Karnataka - Kerala waters.

The so-called joint venture programmes for pair trawling or bull trawling in the early eighties was a fiasco- a highly wasteful and dubious exercise of which the less said the better. It had brought no credit to the country. We have tided over the catastrophe, but still all our efforts have been towards saturation fishing for shrimp. On the infrastructure facilities available for the purpose, development of an industrial fisheries, or berthing facility for larger vessels or handling of hundreds of tonnes of frozen fish a day, we have a long way to go.

This week's report on marine products exports indicates that we have exceeded the target of Rs.580 crores by 10 crores, and one significant thing is that the comparatively new items other than shrimp registering over 100 per cent growth over the previous years both in volume and value. Again the emphasis is that we should invest in two areas, viz., brackish water aquaculture and tuna fishing.

Now we come down to the question whether tuna fishing has a priority in our scheme of things. From the way things are moving, the answer is "No". We are making no headway, while intense activities are going on all around involving many Indian Ocean nations and distant water fishing nations. The race is one for expanding and consolidating the position in a hitherto free entry system. Let us look at what is happening all around us.

SIGNIFICANT EVENTS IN THE INDIAN OCEAN

The last fifteen years have witnessed major changes in the Indian Ocean in the fisheries of tuna and tuna-like fishes, the more significant being:

Longline Fishery

1. The longline fishery for the yellowfin tuna (YFT), bigeye tuna (BET), albacore (ALB) and southern bluefin (SBF) which stood at around 64 thousand t in 1974 had by 1986 gone up to 102 thousand t. It is generally agreed that increased effort in the longline fishery may not result in increase in catch of the above species.

2. The longline catch of BET which stood at about 23 thousand t in 1970 went up to about 58 thousand t in 1978 by the introduction of deep longlining and was about 36.8 thousand t in 1985. There is a greater directed effort to harvest this species in preference to YFT by Taiwan and ROK longliners. The data obtained with these changes in the pattern of fishing for the BET has so far not helped us to know whether one or more stocks of this species exists in the Indian Ocean. It is felt that BET in the Indian Ocean is under-exploited at present.

3. The YFT in the longline catch attained a peak of 77 thousand t in 1968, but the annual production has been about 30 thousand t during the recent years. The longliners of Japan and ROK are more interested in the capture of BET on account of market preference and better economic returns.

4. The major longline effort for ALB is by Taiwan, the Japanese and ROK effort resulting in hardly 17% of the catch. Though Taiwan's effort has been chiefly targetted for the ALB, Taiwan reduced the number of longliners from 150 in 1984 to 127 in 1985 with consequent decrease in the catch from 31256 t to 25355 t respectively.

5. The SBF, the most preferred of tuna species, fetches the highest price. The longline catch from the Southern Indian Ocean between 40°S and 50°S by Japan in 1986 was about 20000 t, though in 1960, the catch was as high as 70 thousand t. The Australian and New Zealand catch of the SBF from surface fishery amounted to about 13 thousand t. This is perhaps the only species of tuna in the Indian Ocean, the stock position of which is discussed and closely monitored by the concerned fishing nations (Japan, Australia and New Zealand) and reviewed annually. The SBF resources of the Southern Oceans (Indian, Pacific and Atlantic) are considered as a whole and in 1985 about 300 Japanese longliners were operating in the SBF fishing grounds. This major shift for the SBF by the Japanese longliners commenced from 1967 from whence this has been the major targetted species by Japan.

Purse seining for Oceanic Tunas

The eighties has witnessed an explosive development in the tuna fisheries of the Indian Ocean with the introduction of the purse seine gear for SKJ and YFT. The operations which started with a Mauritian - Japanese joint venture in 1979 with a single purseseiner yielding about 3700 t today has transformed into a multi-national fisheries chiefly based at the Republic of Seychelles. The 1986 purse seine catch of SKJ and YFT had shot up to 147331 t. This single component has greatly contributed to taking the total tuna production from all the gears in the Indian Ocean from 259459 t in 1979 to 572147 t in 1986. Entrants into this fishery includes both distant water and Indian Ocean countries viz., France (with 20 purseseiners), Spain (15), United Kingdom (1), USSR (1), Japan (1), Vessels registered in Ivory Coast (2 in 1985), Panama (1), Mauritius (2) (Sakurai, 1986, 1987), and India (1). In 1984-85, the total number of purseseiners operating from Seychelles had gone up to 49.

The Spanish purseseine fleet in 1984 and 1985 captured a total of 38499 t of which the major components were YFT (15411 t) and SKJ (22854 t). The performance of the French Fleet in 1985 was a production of 68000 t of which 47% was YFT and 48% SKJ; giving a 11.7 t/fishing day performance.

Gillnet Fishery for Albacore

A more recent development in tuna fisheries in the Indian Ocean is the gillnet fishery for the ALB initiated by Taiwan. From a single vessel operation in 1984 the effort increased to 58 gillnetters in 1985 and 78 in 1986 with corresponding increase in production from 24 t to 4688 t to 15978 t respectively. The gillnet operations are seasonal from December to May and the catch is predominantly ALB.

Deep longlining for the Big-eye tuna

Deep longline, especially of the BET was introduced by ROK in 1973 and by 1977 the entire BET fishing ground North of 20°S was replaced by deep longlines. The average CPUE for BET was higher in the deep longline than in the regular longline where the CPUE of YFT was higher.

ROK longliners (151 vessels) caught 71 thousand t, mainly YFT and BET in 1979. Since then the fleet size decreased to 75 in 1984 and 62 in 1985 with the catch around 24 thousand t and 28 thousand t respectively.

Small Scale Fisheries

The small scale fisheries from the Indian Ocean which stood around 82000 t in 1972 had more than double to 193000 t by 1984-85. This has been mainly achieved through expansion in the gillnet fisheries for coastal species of tunas, especially the longtail tunny Thunnus tonggol from the Gulf of Oman, Iranian Coast and East Andaman Sea; and the Kawakawa Euthynus affinis from the West Coast of India, Sri Lanka and Maldives and improved data reporting systems. The Iranian catch of T. tonggol almost doubled from 6389 t in 1984 to 11848 t in 1985 and the catch from the Gulf of Oman is estimated at 25000 t. Similarly SKJ and young YFT have figured prominently in the coastal fisheries harvested by gillnets and purse seines. The frigate and bullet tunas (Auxis thazard and A. rochei) are chiefly caught along the coasts of India, Sri Lanka and Maldives. At present fish aggregating devices such as the "Payos" in the Philippines have not been established in the Indian Ocean, but going by experience from other geographical areas, introduction of FADs could also result in augmenting production of coastal species of tunas.

Tuna Fisheries Interaction

Interaction between some of the existing artisanal fisheries activities and newer development of commercial fisheries in the continental shelf waters of some of the coastal nations in the Indian Ocean area are now leading to conservation and regulatory actions. The limited entry system, seasonal fishing under licensing, closed areas and so on are coming into vogue. However, till recently interaction between related oceanic fisheries activities or oceanic and coastal fisheries were not matters of serious concern in the Indian Ocean area. However, since 1985 it has become imperative to look at the problem very critically, the immediate concern being the interaction between the rapidly developing purse seine fishery for SKJ and YFT in the Western Indian Ocean and its likely effects on the 'traditional' longline fishery for specific resources such as the YFT. The question is whether the yield per recruit (Y/R) would suffer a major or minor reduction or remain stable in spite of an intensive juvenile fishery for the YFT. Secondly, the effect of any such reduction would have in a directed fishery on adults of the target species (YFT) and other non-target associated species such as the billfishes. This issue has become crucial to form the focal theme of an Expert Consultation on Stock Assessment of tunas of the Indian Ocean held in Colombo, Sri Lanka, from 4 to 8 December 1986, and again in June 1988, at Mauritius under the auspices of the IPTP. The Consultations did not bring out any conclusive evidence, but drew attention to the need for intensive monitoring of the catch from the different fisheries in order to predict or identify any imbalances that may develop. It is also recognised that the YFT which occur in the longline fishery (adults) could be a good 'indicator' species. Highly migratory in nature, its pathways of movements in the Indian Ocean, landlocked in the north, may be quite different than what is witnessed in the Pacific and the Atlantic. Any disequilibrium resulting from an over-exploitation of juveniles by purseseining could affect recruitment of the large adult YFT caught by longline gear and a consequent reduction in the latter fishery or, if uneconomical, a phasing out of operations. An argument could be that the longline fishery could be kept economically going even at a reduced level of catch if it is possible to exploit large adult YFT besides the BET and billfishes. The fact that adult YFT are also subject to capture by the purseseine gear should be a matter of concern. No doubt, more information is needed to plan any regulatory measures for these oceanic pelagic fisheries.

The oceanic gillnet fishery has so rapidly developed for the ALB that within three years of the commencement of operations, the gillnet catch has surpassed the longline catch. This is another area of interaction which could have a direct effect on the longline fishery.

The large scale expansion of coastal fisheries, particularly through expansion in gill netting and small scale purseseining from continental shelf and adjacent waters should also have interactions with the oceanic purseseine and longline fishery in some areas where substantial quantities of young YFT are caught. Simulation models to look at such interaction may help, but what is needed is also reliable data base, an ocean-wide data acquisition system and also a major tagging programme to give a better understanding of many of these intricate problems. A delineation of the stocks of different species is also a pre-requisite.

Need for an International Commission for the Conservation and Management of the Indian Ocean Tuna Resources

Silas and Pillai (1982) proposed such an International Commission for the Indian Ocean since there was no existing mechanism to co-ordinate ocean-wide activities and help in the mánagement of this valuable resource. Tunas transcend national boundaries and being highly migratory, investigations on their biology and fisheries would need international co-operation. The FAO/UNDP Programme presently functioning as the Indo-Pacific Tuna Development and Management Programme has limited objectives and mandate. It functions basically as a data acquisition and monitoring centre. Perhaps, the infrastructure built up could form the nucleus for an ocean-wide Commission which could help in developing a coherent policy for the management of the Indian Ocean tuna fisheries and as suggested by Silas and Pillai (1982) help in funding and co-ordinating programmes on:

- Assisting the coastal and Island States to develop control measures for managing tuna stocks.

- Evolve policies and modalities for regulating access to fisheries.

- Advise coastal and Island States on stock, levels of exploitation and types of effort most suitable.

- Advise and assist Island States on specialised problems in developing tuna fisheries including setting up of fish aggregating devices.

- Develop an ocean-wide data centre for tuna and tuna fisheries based on distant water fishing efforts of countries as well as from the coastal and States in the Indian Ocean; the processing, analysis and dissemination of information on tuna stocks and monitoring of stocks.

- Surveillance

- Advise on better utilisation of bycatch.

- Identification of potential areas for development of surface and subsurface fisheries for tunas.

- Conduct large scale tagging of tunas and related species to obtain biological parameters on age, growth, maturity and longevity to enable understanding the interactions and competitions between different types of fisheries and the status of the stocks.

- Planned development of the artisanal and small scale tuna fisheries.

For the long term strategy of management of Indian Ocean tuna fisheries, such an International Commission will be the only effective mechanism.

CONCLUSION

In conclusion, I would like to say that we have made feeble attempts at tuna fishing from the high-seas. Some have been failures and it is necessary that these be critically analysed to see where the malady lies rather than cite these as examples and take a view that we can carry on even without veturing into this sector.

What we really need today is a renaissance in Indian Fisheries and this cannot be achieved by inaction, indecision or procrastination. None of us, I am sure, would like to see the day when quotas are fixed for highseas tuna catch from the Indian Ocean and find that India as a non-starter in tuna fisheries figures nowhere in the picture. The attitude should change from "Nobody cares for fisheries development" to one of action, from Advisory Boards in fisheries to Implementing Development Boards; from dismemberment of Marine Fisheries among various Ministries and Departments to a streamlined functional entity.

The first announcement to the National Conference says that "Although the tuna resources, their fishery and development have been discussed at various levels in the past, these have not made an impact on the industry and tangible action are yet to be taken for commercial exploitation of this resource, product development and export". I do not concur fully with this as I know that the industry has evinced great interest in exploiting the resource through joint venture programme, but where is the malfunction? Let us examine at this Conference.

How can we make this functional to tap at least a part of the annual production of tuna from the Indian Ocean valued in the international trade at over U.S.$ 10,000 million? Unless we have a Technology Mission for Marine Fisheries, nothing much is going to happen. There is an urgency in establishing Indian presence in oceanic tuna fishing and at no cost can we abdicate this responsibility. We should drastically re-orient our approach to this.

TUNA RESOURCES AND FISHERY IN THE INDIAN EEZ - AN UPDATE

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INTROUCTION

The scenario of tuna fishery in the Indian EEZ in recent years show that it is still limited to the small scale fishery sector with little inputs from the industrial sector. The results obtained till date from the surveys carried out by the Government of India vessels (FSI and CIFNET) in the EEZ beyond the traditional fishing grounds, the industrial longline operations of foreign fleets in the Indian EEZ and contiguous high seas, the rapid increasing rate of skipjack and yellowfin tuna production in the traditional sectors of the neighbouring insular states such as Maldives and Sri Lanka and the fast pace of growth, expansion and production in the tuna purse seine fishery of foreign fleets of France, Spain, Panama and Ivory Coast in the tropical Western Indian Ocean area - all these have indicated tuna resource availability and rich tuna fishing grounds in our EEZ and contiguous high seas. For more than a decade, the Central Marine Fisheries Research Institute has made earnest efforts to collate and disseminate the fishery dependent and fishery independent factors connected with tuna fishery, and urged in several platforms the necessity of immediate actions from the part of Government and Industry to modernise and expand the small scale sector and venture into high sea tuna fishery through charter arrangements/joint venture programmes, instead of waiting for indigenous development of vessels and expertise and cent percent data/information on the tuna resources of our EEZ. In several seminars and symposia and also in the International Meetings (FAO/IPTP) conducted recently, the fishery potential of tunas and related fishes in the oceanic sectors has been discussed, synthesised and strategies and policy plans for development of tuna fishery in India drawn. Despite its nature as one of the thrust areas of development of fishery in the Indian EEZ, the momentum towards it was in a slow pace, and the valuable and rich resources of skipjack and yellowfin tunas in our waters remain to be tapped commercially. However, the chartered vessel operations, which commenced from 1985, have landed about 855 tonnes of tunas and billfishes from the Indian EEZ during 1988.

The results of studies on the status of tuna fishery in the Indian EEZ are synthesised, and strategies/options open for the development and management **of tuna fishery in the Indian EEZ.**

REVIEW OF TUNA FISHERY

Presently, the tuna fishing activity in the Indian EEZ comprise of:-

(i) Fishing operations by small scale mechanised and non-mechanised vessels inside the 50 m depth zone all along the coast line of the mainland of India; (ii) Artisanal pole and line and trolling operations conducted in the vicinity of the oceanic islands of Lakshadweep; (iii) Operations by the oceanic survey/training vessels of the Government of India landing about 180 tonnes of tunas annually and (iv) Operation of the commercial longline owned by the private industry, and longline operations of the foreign vessels in the Indian EEZ under charter agreement which may be taking about 800-1200 tonnes of oceanic tunas (Sudarsan et al.,1988).

Small Scale Sector

Both mechanised and non-mechanised crafts are engaged in the exploitation of tunas in the mainland and operate multi-species gears such as the drift gill nets, purse seines and hooks and lines. The number of non-mechanised units such as the dugout canoes, plankbuilt boats and catamarans in 1983 amounted to 1,35,000 and about 20,000 mechanised boats were in operation in 1984. In Lakshadweep, mechanised boats (25' - 30') used for pole and line (live-bait) tuna fishing fishing number about 163 followed by those used for surface trolling which amount to 68 in recent years. Details of crafts and gears engaged in tuna fishery in the small scale sector have been described earlier by Silas and Pillai (1986 a, c).

Oceanic Sector

In the oceanic waters, large scale/commercial exploitation of tunas is yet to commence. Two longliners, Matsyasugandhi (OAL 31.5 m, GRT 245.8) and M.V. Prashikshani (OAL 34 m, GRT 211.99) conducted intensive surveys in the Arabian Sea up to lat. 16°N and preliminary surveys in the equatorial region and Bay of Bengal including Andaman Sea. The longliner-cum-purse seiner Matsyaharini (OAL 32.5 m, GRT 257.95) did intensive tuna exploration off the east coast of India between latitudes 10°N and 17°N. As of 1988, 8 longliners (200-800GT) were operating in the Indian EEZ under charter arrangements.

PRODUCTION TRENDS

Small scale sector along the coastal waters of the mainland and around insular region.

The production trend in tuna fishery has recently been dealt with in detail by Silas and Pillai (1986 a, c), James and Pillai (1987 and James and Jayaprakash (1988) the average catch of tunas during 1983-88 amounted to 27,695 tonnes, the production reached an all time peak of 35,600 tonnes in 1986 and declined to 31,700 tonnes in 1987 (Figs. 1 and 2).

Average state-wise production of tunas for the years 1986-87 indicate that Kerala ranked first contributing to 42% of the total all India tuna catch followed by Karnataka (19%), Lakshadweep (14%), Tamilnadu (7%), Maharashtra (6%) and Gujarat (5%). As per recent estimates, the mechanised units landed about 52% of the total tuna catch on the west coast of India, whereas the non-mechanised units were responsible for about 73% of the catch from the east coast.

Tunas are occasionally caught in the coastal purse seiners (11.5-13.5 m OAL, 110 HP) which operate along the coasts of Kerala (60 units), Karnataka (405 units), Goa (80 units) and Maharashtra (40 units). Catch of tunas, effort expened and catch rate in the purse seine fishery during the period 1985-87 is given in Table 1. The incidental catch of tunas in the purse seine gear operations during 1987 was very poor.

Annual average contribution to the tuna fishery during 1983-87 by the west coast amounted to 69%, east coast 14%, Lakshadweep 15% and Andaman & Nicobar islands 2%. The SW and SE regions of the mainland contributed to the bulk of the tuna catch, but the landing from the NE region evinced a steady increased (Fig. 3) from 1981 onwards.

Seasonal pattern of distribution of tuna catch indicates that maximum productive season for tunas along the Kerala and Karnataka coasts is the premonsoon-monsoon period, whereas in the Maharashtra-Gujarat coasts it is during the post-monsoon period indicating a seasonal shift in the concentration of tunas along the west coast of India. Such change in seasonal concentration was not observed along the east coast of India.

The catch rate (C/E) of tunas at the monitoring centres of CMFRI during 1987-88, as given in Table 2, indicate that the drift gillnetters, purse seiners, hooks and line units, pole and line and troll line units contributed to 40%, 11% 16% and 33% respectively during 1987-88 to the total tuna catch. C/E of drift gillnetters ranged from 8.7 to 121.0 Kg, purse seiners realised a catch rate of 22 to 805 Kg and that of hooks and line units 25 to 31 Kg. C/E in the pole and line fishery during the same period averaged to 313 Kg and that in the troll line fishery 14.0 Kg.

As an average, little tunny (Euthynnus affinis) contributed to 52% of the total catch, followed by frigate tunas (20%), skipjack tuna (16%), longtail tuna (2%) and other small tunas and billfishes (10%) (Table-3).

Recent studies by Silas and Pillai (1986 a, b and c), James and Pillai (1987), Varghese (1987), James et al. (1988 a, b), Pillai and Gopakumar (1988) Pillai et al. (1988) have dealt with the status of tuna fishery in Lakshadweep, and identified major constraints in further development and expansion of pole and line tuna fishery. Presently, mechanised boats of 2 sizes, viz. 7.9 m and 9.1 m OAL (10-40 HP) are employed for bait-fishing and tuna fishing, and non-mechanised boats of 3-5 m OAL are used for troll line fishery. Total catch of tunas by these gears in Lakshadweep during the period 1978-88 are presented in Table 4. During the period, the total tuna production fluctuated between 1769 tones and 6528 tonnes with an average catch of about 3410 tonnes of which skipjack tuna constituted about 86%, young yellowfin tuna 11% and tuna like - fishes 3% of the total catch (Fig. 2).

Average annual island-wise landing of tunas during 1978-88 period is presented in Table 4. Assuming this figures are indicative of the trend of production of tunas in Lakshadweep in recent years, it is estimated that tunas constitute about 85% of total marnie fish catch in this area and about 41% of the tuna production was from Agatti Island and neighbouring area.

In 1988, a total of about 5860 tonnes of tunas were landed in Lakshadweep by the operation of 163 pole and line units and 68 troll line units. Island-wise tuna production indicates that Agatti and nearby Bangaram, Perumul Par areas contributed the bulk of the tuna catch (48%) followed by Minicoy (18%), Suheli Pars (10%), Bitra (7%) and the rest of other islands. In the pole and line fishery, skipjack tuna dominated the catch (75%) followed by yellowfin tuna (12%). In the troll line fishery, yellowfin constituted about 60% of the total catch followed by skipjack tuna (30%).

Silas et al. (1986 a, b), James and Pillai (1987 a), James et al. (1987), (1988), and Varghese (1988) discussed the status of exploited resources of tunas and their stock and potential at Minicoy and Agatti islands. It was observed that in recent years variation in the tuna catch, effort expended and catch rate are regular phenomena in these islands. Catch rate (C/E) recorded an increase since 1984-85 period to recent years (1987-88) at Minicoy, whereas at Agatti Island the catch rate evinced a steady decline. The stock structure analyses by the above authors (average standing stock, total annual stock, rate of exploitation and MSY and fMSY estimates) indicate that skipjack tuna is exploited below the level of MSY, and there is considerable scope for tapping the resource of this species from Lakshadweep area.

Operations by Survey/Training Vessels

Longlining:

Results of tuna longline surveys in the Indian EEZ for different periods from 1983 to 1988 have been discussed by various authors (Joseph, 1986; Silas and Pillai, 1986a, b; Sulochanan et al., 1986; Sivaprakasam and Patil, 1986; Swaminath et al., 1986; Joseph and John, 1986; James and Pillai, 1991; James and Jayaprakash, 1988; John et al., 1988; Sudarsan and Somavanshi,, 1988; Sudarsan et al., 1988a,b). The aggregate survey coverage of the three vessels viz., Matsyasugandhi, M.V. Prashikshani (longliners) and Matsyaharini (longliner-cum-purse seiner) extended north of equator upto lat. 16°N, between long. 67°E and 95°E (Sudarsan et al., 1988a). Altogether 8.3 lakhs hooks were operated during the five year period covering all seasons, and the fishing effort (number of hooks operated) by these vessels were at the rate of 43%, 37% and 20% respectively of the total during the five years' coverage.

The average hooking rate of yellowfin tuna (Thunnus albacares) during the surveys was 2.62%. Among the three vessels, M.V. Prashikshani obtained 3.24% Matsyasugandhi 2.87% and Matsyaharini 0.9%. Average of hooking rates for yellowfin tuna recorded in the Indian Exclusive Economic Zone and contiguous areas are shown in Fig. 4. A high productive zone was identified between lat. 12°N - 16°N and long. 69°E - 74°E. Highest average hooking rates of 11.3% to 11.9% were obtained from the area 14° - 72°, 14° - 73° and 15° - 72° sectors and also off Tamilnadu Coast (Sudarsan *et al.*, 1988a).

Seasonality in the hooking rates indicated that they evinced major seasonal fluctuations. High catch rates were obtained from the Arabian Sea from lat. 10° - 15°N; long. 65° - 70°E during September to November and May. In the adjacent area near the west coast, the productive season was found to extend from August to May, with peak HR (above 5%) during November to April. In the Bay of Bengal, however, the productive period was found to extend from January to April, with highest hooking rate of 2.1% obtained during January. Gafa (1986) reported the mean catch rate of yellowfin tuna taken by longline boats (100 GRT) in the Southern Andaman Sea as HR 1.4%, and observed that productive months were March-July period.

Purse seining:

Purse seining by fishery survey of India vessels in deeper waters (up to 200 m depth) on the east and west coasts have indicated good fishing grounds for little tunny and frigate tunas, the former dominated in the catches from lat. 12°, 13°, 15° and 21°N. According to Sudarsan and Somavanshi (1988), from the upper east coast the skipjack and yellowfin tunas could be pursed by tracking their schools/aggregations.

Operations by Industrial longline vessels of foreign countries

The hooking rate of yellowfin tuna realised by Japanese and Taiwanese longline fishery (1984) and Korean longline fishery (1980), and the quarterly average catch rate in terms of HR(%) of this species by the above fleets (IPTP, 1987; 1988) indicate that maximum production of yellowfin tuna was centred in the area 10° - 20°N and 70° - 95° E, which was also identified by the Indian longline vessels as productive yellowfin ground (Fig. 5).

DISCUSSION

With the declaration of Exclusive Economic Zone (EEZ) in 1977, an urgency and responsibility have crept into assess about the living resources of our seas to plan development programmes to judiciously exploit and utilize the resources.

Despite significant strides made by different coutries in the Indian Ocean in the exploitation of the scombroid fish stocks from their EEZs, tunas and billfishes remain as the least exploited resource of the Indian EEZ. Tuna fishery in India is limited to small scale sector with only marginal inputs from the industry. One critical factor which has a significant way in the development of tuna fishery in the Indian EEZ is the "resource availability". We have obsessions with pre-investment surveys and pre-feasibility studies, and seek a foolproof data base before venturing in high sea tuna fishery which is capital intensive and involving risk element. The summary of information presented earlier in this paper does indicate that information on resource is not a lacuna. It is time opportune to consider the options open, and procure the type of vessels, facilities an expertise that may be needed for developing industrial tuna fishery in the Indian EEZ through joint venture/chartering arrangements.

Estimating potential stocks, and assigning production targets and improving them with appropriate management measures are major requirements in planning tuna fishery development in the Indian EEZ. The estimated potential of tunas in Indian EEZ is 500,000 - 800,000 tonnes, and it is conservatively estimated that about 250,000 tones could be exploited by augmentation of inputs and expansion of the tuna fishery. George et al. (1977) estimated a potential yield of 2,40,000 tonnes of tunas from the EEZ of India. Silas and Pillai (1982, 1986c) opined that by encouraging further developments in the artisanal sectors, and by developing oceanic purse seining and longlining the production of coastal and oceanic tunas from the Indian EEZ could be enhanced to a sustainable level of 1,15,000 tonnes. James et al. (1987) observed that the rich resources of yellowfin tuna, begeye tuna, oceanic skipjack, sailfish, marlins and oceanic sharks could profitably be exploited by the introduction of longlining and purse seining on commercial scale, and the total oceanic fish potential of these groups in the Indian EEZ is around 50,000 tonnes. Other estimates are those by Yesaki (1988) on potential yields of coastal (small) tunas as between 65,950 and 94,240 tonnes from the continental shelf areas of the west and east coasts of India and Anaman and Nicobar Islands and Lakshadweep Island, and by Chidambaram (1987) on the potential stock of 1,00,000 tonnes of tunas from the Andaman and Nicobar Islands and 90,000 tonnes from the Lakshadweep.

Joseph (1987) estimated the pelagic resource including tunas of the Lakshadweep and Andaman & Nicobar areas as 63,000 t and 139,000 t respectively. Sudarsan et al. (1988b) estimated the potential yield of tunas and billfishes from the EEZ of SW coast of India as 18,500 tonnes.

STRATEGIES/OPTIONS OPEN FOR THE DEVELOPMENT OF TUNA FISHERY IN THE INDIAN EEZ.

Tuna fishery in the shelf and slope areas of Indian EEZ

Augmenting production of coastal tunas through diversification of crafts and gears in the small scale sector, especially through greater use of drift gillnets and other suitable gears has been recommended by Silas and Pillai (1986c) and James and Pillai (1987a). The stocks of longtail tuna (*Thunnus tonggol*), which holds potential in the export market and are tapped by the neighbouring countries could be effectively exploited by expansion of fishing up to the continental shelf area (Yesaki, 1988). Motorisation of the small crafts should be further encouraged for enabling the fishermen to expand their area of operation, resulting in higher yields as exemplified at Vizhinjam, SW coast of India. Mobility of purse seine vessels is a critical factor in tapping the large shoals of coastal tunas the occurrence of which has been reported by Sudarsan and Somavanshi (1988) in the neritic belt of Indian EEZ.

Tuna fishery in the oceanic areas and contiguous waters of Indian EEZ

Longline and purse seine fisheries

The different aspects of longline fishery, operational methods, constraints and management problems from within the Indian EEZ of India have been discussed by Silas and Pillai (1986c) and James and Pillai (1987a), and have recommend to introduce 150 longliners each with a capacity to produce around 450 tonnes of tunas annually.

It will be worthwhile to initiate oceanic purse seining in our EEZ. Recent

Development in the purse seining activity by the industrial sector and the resultant catch of skipjack and yellowfin tunas from the tropical waters of Indian Ocean by foreign fleets are summarised in Table 5. Marcille (1985) indicated successful purse seine seasons in Lakshadweep Area as November to May and in the Andaman Sea as March to May. Employment of 10-12 purse seiners (Industrial type 59-72 m OAL purse seiners), with an annual production capacity of 6000 tonnes, and 20 purse seiners each of 4000 tonnes production capacity would lead to the production of about 1,10,000 tonnes of tunas from the oceanic waters of the Indian EEZ and contiguous high seas (Silas and Pillai, 1986c).

Tuna fishery in the high seas should be planned through joint venture/charter arrangements, the details of which have already been recently synthesised by Chidambaram (1987).

Tuna fishery around the insular region of Indian EEZ

The potential resources of tunas in the EEZ around Lakshadweep has been estimated as 50,000 tonnes (George et al., 1977) and as 90,000 tonnes (Chidambaram 1987) as against the present production level of about 6,500 tonnes. Strategies for development and management of tuna fishery in the small scale sector in this region has been documented earlier (Silas and Pillai, 1982, 1986c; James and Pillai, 1987a; James et al. 1987; Varghese, 1987, 1988; Pillai et al., 1988). Status of tunas fishery in the Andaman Sea has been reviewed recently (BOBP,1987).

In view of the strategic importance of the area, coupled with the focus on conservation of ecosystem and anticipated imbalances in the small scale sector by the introduction of large scale inputs, the development plans are suggested for tuna fishery in the following lines:

- Existing mechanised pole and line boats (7-9 m OAL) could be effectively modified with chilling and storage facilities. Adoption of mechanised sea water spray system would economise utilisation of live-baits.

- Introduction of new generation of 15-20 m OAL boats with adequate navigational, chilling and storing facilities and for 2-3 days fishing would enhance the area and duration of fishing operations; introduction of 80 boats of this size would produce 60-100 tonnes of tunas per boat per annum;

- Shortage of manpower (fishermen) and expertise have been pointed out as constraints for developments of such enhanced programmes. This problem has to be solved by effecting interisland movement of fishermen/boats through appropriate incentive schemes. Required training for local fishermen in modern methods of tunas fishing under joint venture programmes needs further consideration;

- Experimental fishing by purse seines similar to the ones used in the Andaman Sea by Thailand (Vessels:- 14-24 m OAL, purse seine net 1400 m long and 120 m deep; 14-18 m OAL, purse seine net 665 m long and 100 m deep) for fishing surface schools of skipjack, longtail and little tunas and expertise developed by mainland fishermen could be tried to propagate purse seining around the islands, by training and involving the fishermen. The additional catch generated will be utilised in canning, mas production and processing into frozen round/fillets

- Construction and installation of cheaper and long lasting FADs which would reduce scouting time for fishermen require urgent attention.

- Fishery forecasting system be developed and the results extended to fishermen through extension service.

In order to increase the value added products, chilled water storage on board, and freezing the catch ashore should be tried. In Lakshadweep, the chief method of disposal of the catch is by converting to masmin. Approximately, in Lakshadweep, 600 tonnes of masmin are produced annually in recent years, which is worth of about 2 crores rupees. Priority areas which need attention are:-

- Masmin production should be taken up at community processing level by providing much needed fuel to process the tuna meat; steam cooking, smoke houses etc. should be introduced to ease the production process.

- Produce development such as granulated mas and improvement of the quality of riha akru would ensure more consumer acceptance and better returns to the fishermen;

- Quality control and hygeinic methods of masmin production especially in the northern islands should be demonstrated; in the northern islands nearly 30-35% of the body parts are wasted during the process of masmin preparation (At Agatti, the estimated waste from tunas in 1988 was about 1124 tonnes which would have fetched Rs. 16 - 17 lakhs worth first quality fish meal). Effective waste utilisation methods by converting them to fish meal or preserving these materials by ensilaging for preparation of cattlefeeds should be tried;

- Development of an organised marketing system of masmin will be beneficial to the fishermen in getting proper market and accounting for price falls;

- The existing canning factory at Minicoy should be fully utilised to its maximum capacity.

The entire success of the pole and line fishery expansion programme depends on a steady supply of live-baits. Due to shortage of baits fishermen suspend fishing even during the peak fishing season. At Minicoy, in addition to sprats, a number of other livebaits are utilised whereas in other islands sprats are the only live-baits used, and large amount of breeding stocks are removed from the natural populations. Recent aimed live-bait surveys conducted from Minicoy Research Centre have indicated that a number of other species suitable as live-baits are available in most of the northern islands. Priority areas which should be considered immediately for the effective utilisation and management of the live-bait resource are:-

- Diversified fishing techniques such as light attraction, operation of ring nets/small purse seining should be introduced to exploit them. Pilot project including the demonstration by and participation of Minicoy fishermen should be commenced on experimental scale to exploit additional live-bait species in the northern islands;

- Live-bait impounding cages/bays should be designed and installed in the lagoon itself with the participation of fishermen who can effectively manage these systems. Experiments to breed some of the common live-bait species may be attempted.

- Economic utilisation of live-baits should be demonstrated through experimental programmes by scaling down stock mortality, use of specified confinement cages and widespread use of mechanised spray system. Experimental studies on reducing mortality of live-baits during storage and transportation are underway at the Research Centre of CMFRI at Minicoy.

- Artificial live-bait habitats (ARs) should be experimentally studied in the lagoons where damage to coral colonies occurred, and the results of these studies made public to protect the coral ecosystem. An effort in this line has already been initiated at the CMFRI Research Centre at Minicoy.

CONCLUSION

The gap between the exploitable tuna resources of the Indian EEZ and the present level of production is very wide. The fishery at present is largely confined to the small scale sector for coastal species. Different estimates of tuna resources in the Indian EEZ indicate that there is great scope for expanding the present fishery and also for development of industrial type of fishing through longlining and purse seining. Experiments and recent surveys indicate that longlining off the west coast could be economical. Other areas have to be quickly surveyed for commercial viability. Chartering/joint ventures or bilateral arrangements, although initiated in 1985 should be given more attention for industrial development of the fishery through appropriate incentives and arrangements.

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TABLE 1. Catch (tonnes), Effort (Units) and C/E (Kg) realised by small purse seiners

	1985	1986	1987
KERALA			
Total fish	15,112	4,646	904
Effort	4,695	2,563	1,167
Tunas	1,328	2,326	100
C/E (tunas)	282	907	85
KARNATAKA			
Total fish	76,941	117,386	105,947
Effort	40,015	41,481	41,897
Tunas	2,511	5,839	1,954
C/E (tunas)	62	140	46
GOA			
Total fish	13,363	5,950	25,192
Effort	9,721	8,542	22,028
Tunas	209	0	9
C/E (tunas)	21	-	0.4

TABLE 2. Catch, Effort and C/E of tunas and billfishes observed at the monitoring centres (1987-88).

Centre	Gear	Effort (units)	Catch (tonnes)	C/E (Kg)
Goa	DGN (M)	10,297	90.4	8.7
Mangalore	DGN (M)	5,046	48.4	9.6
	PS	11,097	537.5	48.4
Malpe	DGN (M)	8,338	101.0	12.1
	PS	13,198	303.3	23.0
Calicut	DGN (M)	9,460	614.5	64.9
Cochin	DGN (M)	14,683	342.2	23.3
	PS	1,451	48.2	101.9
Vizhinjam	DGN (M)	26,148	772.5	29.5
	DGN (N)	1,770	22.6	12.7
	HL (M)	40,380	1032.8	25.6
	HL (N)	8,863	39.4	4.4
Tuticorin	DGN (M)	9,780	1049.2	107.3
Madras	DGN (M)	1,157	50.1	43.3
Waltair	HL (M)	34,664	190.3	5.5
Minicoy	PL (M)	3,509	1235.0	352.0
	TRL (N)	366	5.0	14.0
Agatti	PL (M)	4,724	1293.0	274.0

(DGN = Drift gill net - mechanised, non-mechanised;
PS = Purse seine; HL = Hooks and lines - mechanised, non-mechanised;
PL = Pole and line; TRL = Troll line).

TABLE 3. Average annual species composition of tunas in the small scale fishery sector, 1986-88.

	1986	1987	1988	Average for three years
Little tuna	18,218	14,008	14,977	15,734
Frigate tunas	8,485	4,456	5,482	6,141
Skipjack	4,063	5,550	5,458	5,024
Longtail tuna	246	444	1,300	663
Other tunas & Billfishes	2,763	5,703	2,812	3,759

TABLE 4. Annual production of tunas and tuna - like fishes in Lakshadweep (1978-88) and Average Annual Island-wise tuna catch (1983-88).

Year	Total marine fish catch (t)	Total tuna catch (t)	Skipjack tuna (t)	Yellowfin tuna (t)	Others (t)	Islands & Par Areas	Average annual catch (t) (1983-88)
1978	2780	1875	1612	206	57	Minicoy	761
1979	3846	2794	2403	307	84	Agatti	2020
1980	2909	1769	1523	193	53	Suheli Pars	625
1981	3300	2241	1927	247	67	Kavaratti	205
1982	4201	2966	2551	376	89	Amini	93
1983	4301	3037	2612	334	91	Kadamat	55
1984	5331	4312	3708	474	130	Kiltan	145
1985	4629	3775	3247	415	113	Androth	241
1986	5536	4807	4134	529	144	Chetlat	172
1987	7299	6528	5614	718	196	Bitra	322
1988	6809	5855	4976	644	205	Kalpeni	82

TABLE 5. Gear-wise production of yellowfintuna and skipjack tuna in the Indian Ocean, 1982-87.

	Long line	Pole & Line	Purse seine	Other gears
		YELLOWFIN TUNA		
1982	30,088	4,243	1,241	11,256
1983	27,857	6,453	12,023	14,332
1984	20,335	7,162	56,371	9,635
1985	27,182	5,839	56,153	11,594
1986	36,072	5,202	59,060	13,909
1987	34,921	6,531	67,474	19,950
	(27%)	(5%)	(52%)	(16%)
		SKIPJACK TUNA		
1982	74	17,695	3,469	31,382
1983	22	21,646	12,063	27,863
1984	24	33,378	43,046	25,474
1985	45	46,628	66,675	21,646
1986	10	45,785	75,224	27,091
1987	12	41,872	93,135	28,326
	-	(26%)	(57%)	(17%)

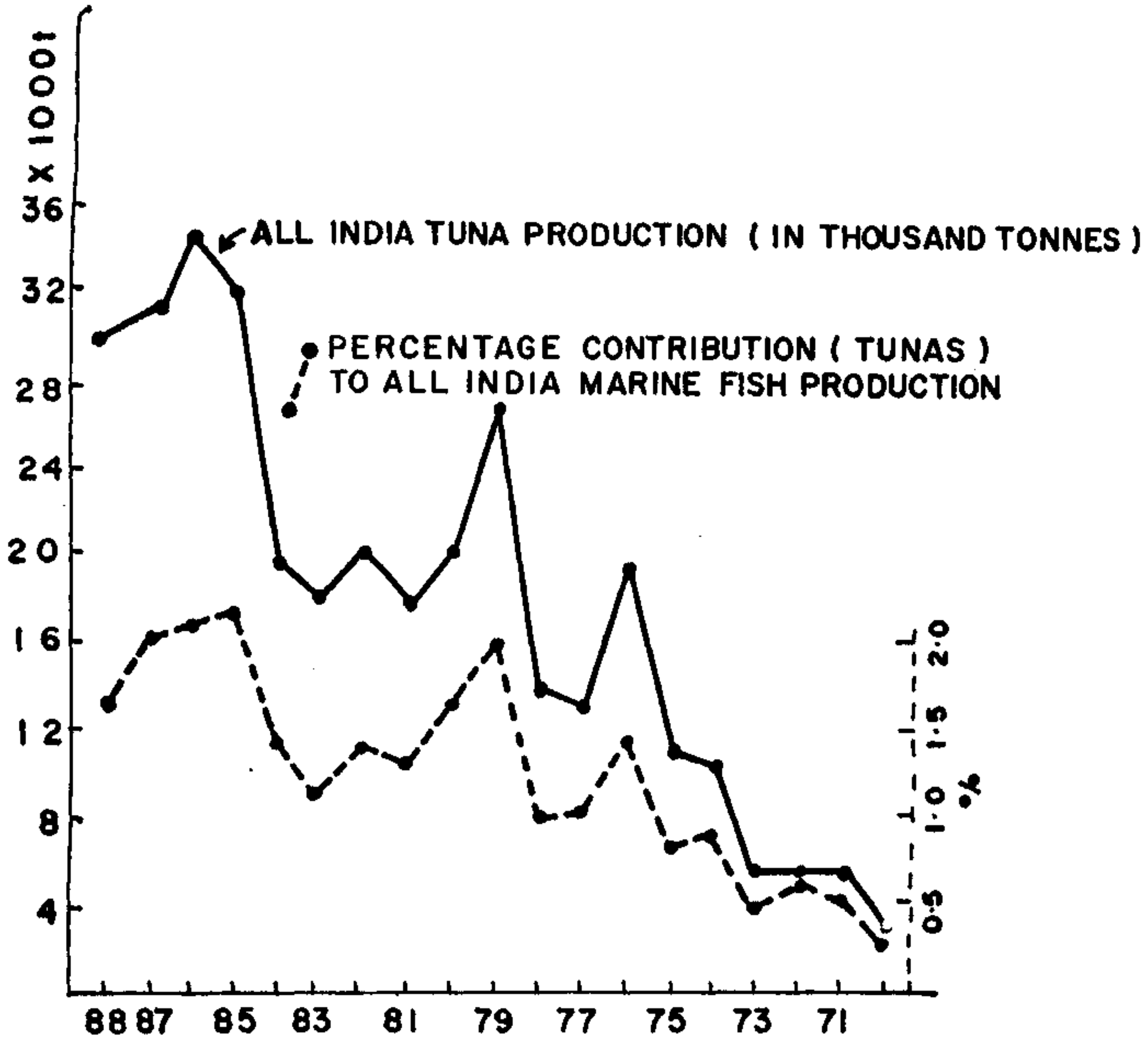

Fig. 1. ALL INDIA TUNA PRODUCTION AND ITS CONTRIBUTION TO TOTAL MARINE FISH LANDING IN INDIA, 1971-88

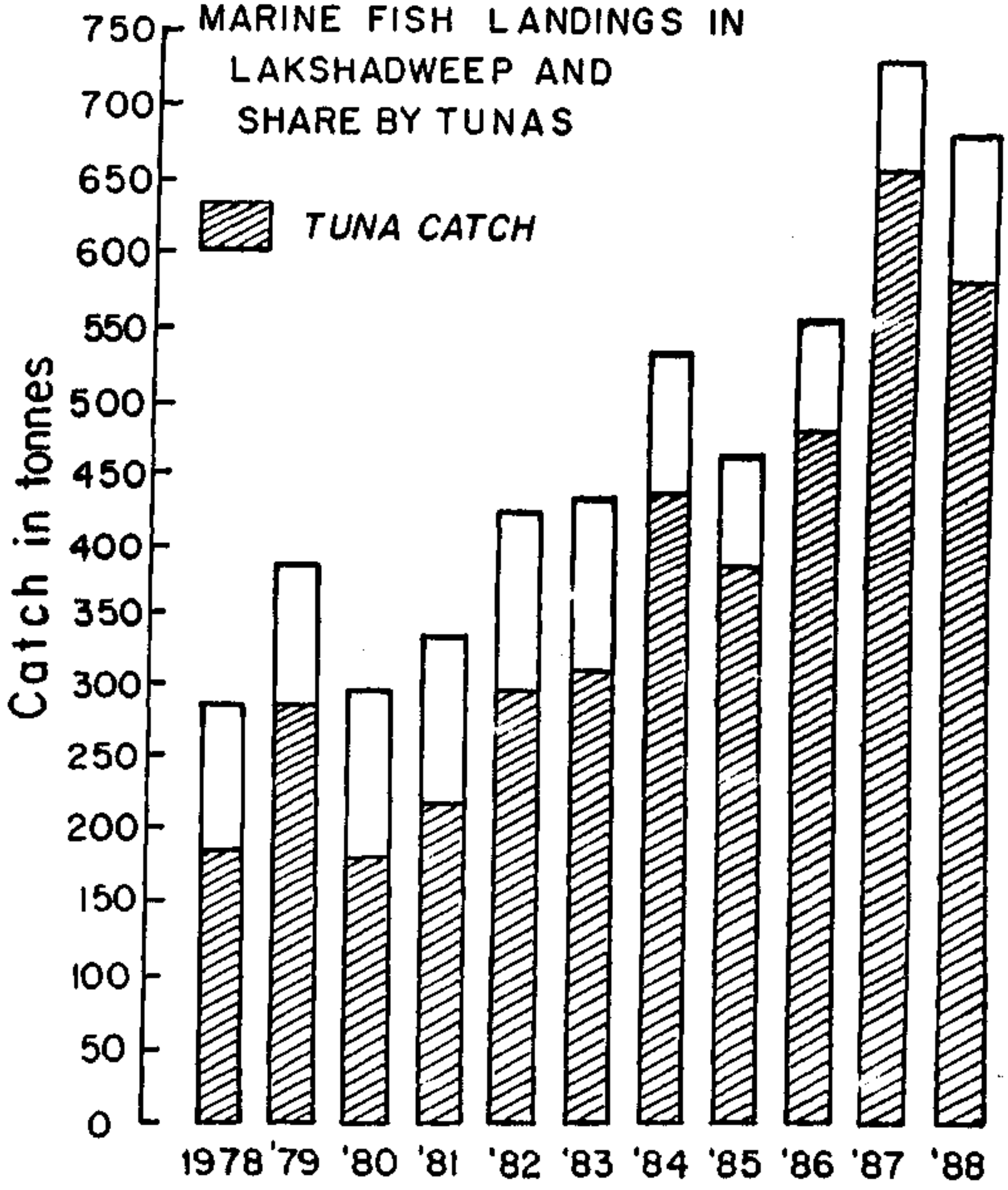

Fig. 2. MARINE FISH LANDING IN LAKSHADWEEP AND CONTRIBUTION OF TUNAS IN THE TOTAL CATCH, 1978-88

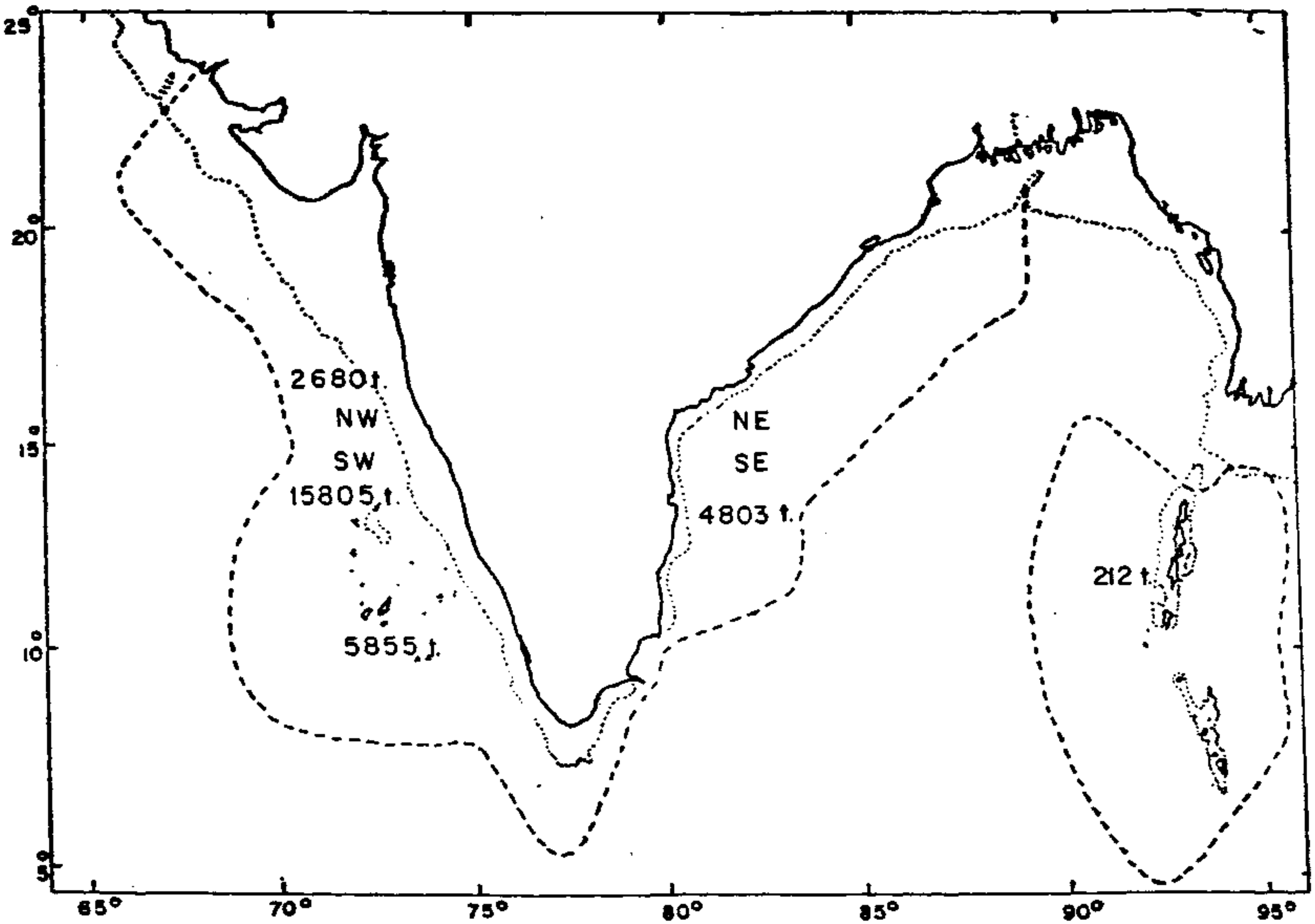

Fig. 3. PRESENT STATUS OF TUNA LANDING IN THE SMALL SCALE SECTOR FROM THE MAJOR REGIONS OF THE INDIAN EEZ

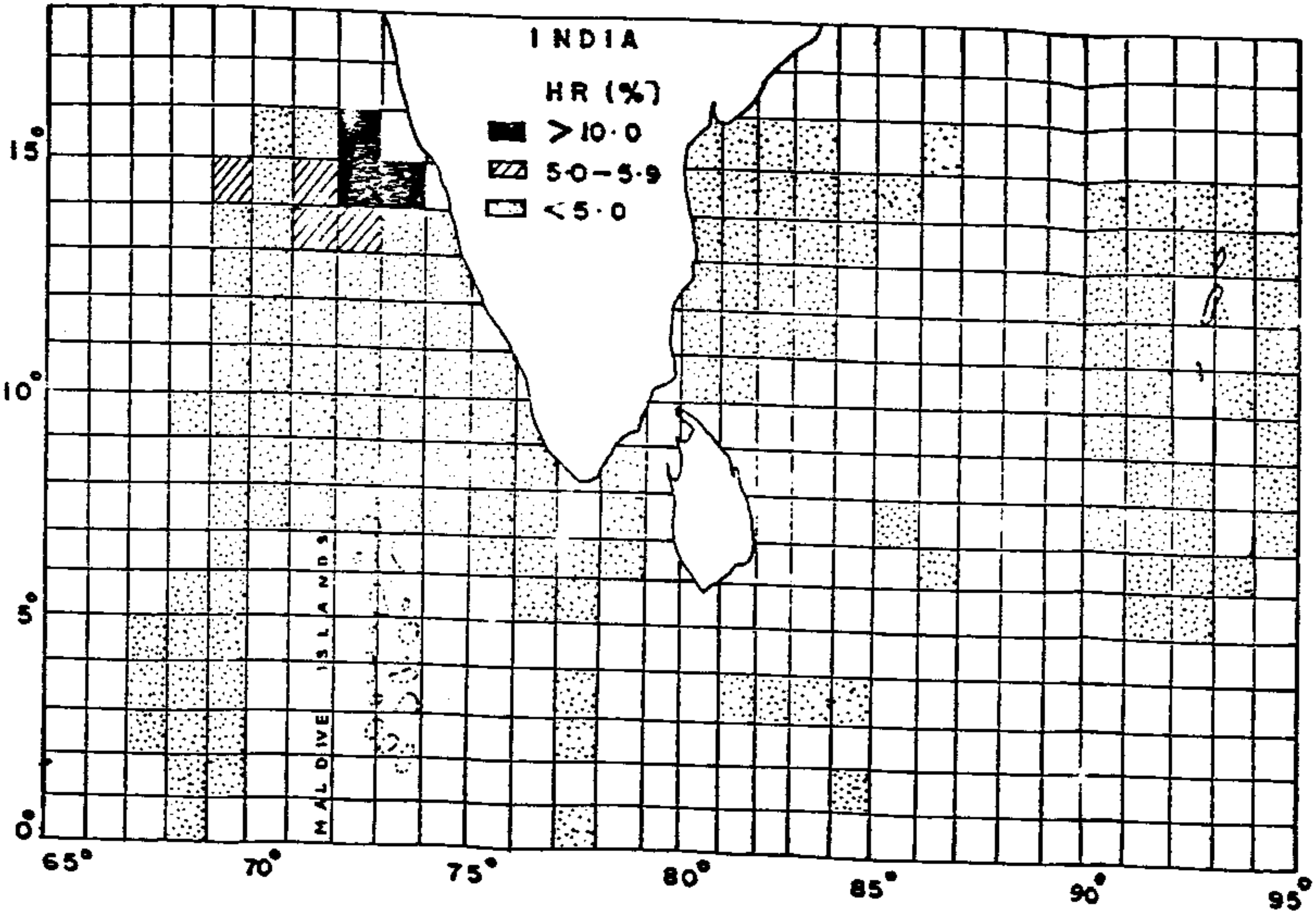

Fig. 4. PRODUCTION OF YELLOWFIN TUNA (HR %) BY THE EXPLORATORY/TRAINING VESSELS IN INDIAN EEZ AND CONTIGUOUS WATERS

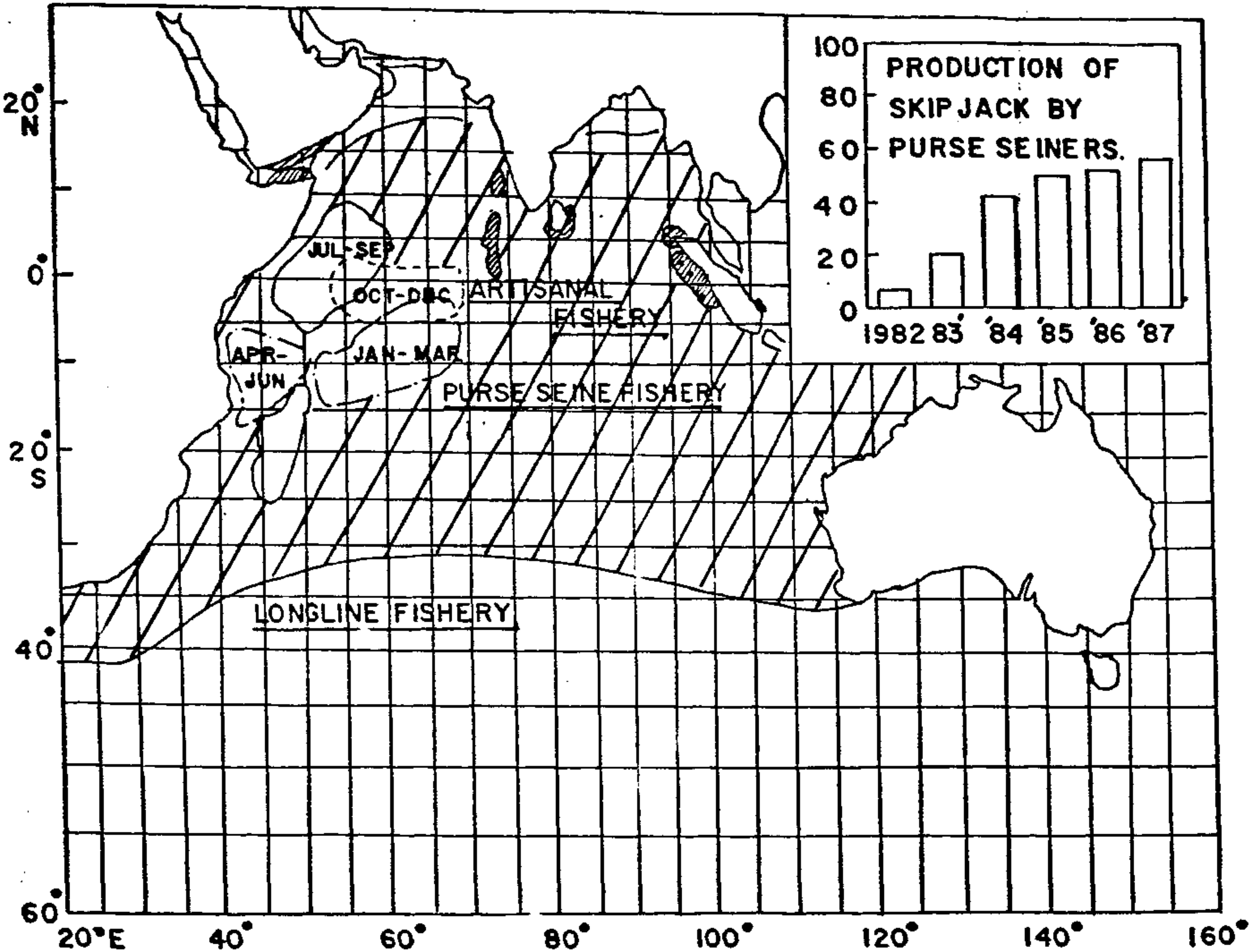

Fig. 5. TUNA FISHERY IN THE INDUSTRIAL AND SMALL SCALE SECTOR IN THE INDIAN OCEAN AND SHARE OF PURSE SEINE FISHERY IN THE TOTAL PRODUCTION OF SKIPJACK TUNA IN RECENT YEARS

ASSESSMENT OF OCEANIC TUNA AND ALLIED FISH RESOURCES OF THE INDIAN EXCLUSIVE ECONOMIC ZONE BASED ON EXPLORATORY SURVEYS

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INTRODUCTION

High Sea and distant water fishing by large vessels both for demersal and oceanic fish resources is still in its infancy in India. Just as the country took to mechanisation and modern fishing methods very late, in the early fifties, while many developed and developing countries were facing problems of over-fishing, high sea fisheries also has made a late beginning, only in the last few years, when most of the high sea fish stocks including tuna and tuna like fishes are under severe fishing pressure. These stocks which were practically in a virgin state in the early fifties, were heavily exploited by Japan, Korea, and Taiwan and as a result the tuna stocks in the Indian Ocean steadily came down. However, with the declaration of the 200 n.miles exclusive zone, by most of the maritime nations, the foreign fishing fleet had to be withdrawn and as a result the tuna stocks have started showing signs of revival. Recently, the Phillipines and Australia have started large scale exploitation of tuna stocks in their own territories. France, Spain and Italy have become major tuna fishing nations especially along the east and north African cost. However, India remained to be a silent spectator of all these developments. Early efforts made in India during the years 1961-63 (Meena Prayas) and 1968-71 (Pratap) when some of the smaller vessels were converted into long liners for exploratory tuna fishing, have not been successful though it created an awareness of the tuna resources in Indian waters (Eapen, 1964, Joseph, 1972, FAO, 1967, and 1976). It was only with arrival of Japanese aided tuna survey vessel Matsya Sugandhi and training vessel Prashikshani and conversion of Norwegian aided vessel Matsya Harini that the availability of rich tuna resources within the Indian EEZ, almost in virgin state, has been proved beyond doubt. Although the data pertaining to tuna fishing by foreign fishing vessels were available, and detailed compilation of the information of tuna resources have been made the Indian Fishing Industries were yet to be convinced, as no fishing data by any Indian vessels were available until recently in order to enable them to venture into tuna fishing projects. Results of tuna long lining by Matsya Sugandhi, Matsya Harini and Prashikshani had a major impact on the fishing Industry and as a result a large number of companies have gone for chartering of tuna long line vessels and acquiring their own tuna long line vessels.

The present paper overview the results of survey on marine resources of the Indian EEZ including tuna and allied fish species, their distribution, catch rates, seasonality, assessment of stocks etc. supplemented by the chartered vessels' data. The paper also presents the trends in the tuna fishing and future survey programme of the Fishery Survey of India.

Results of Exploratory Tuna Long Line Surveys

With the arrival of the Japanese aided survey vessel Matsya Sugandhi and training vessel Prashikshani during 1980 and also with the arrival of the Japanese Expert, Capt. E. Haruta, valuable data have been obtained on the tuna and allied fish resources of the Indian EEZ and also adjacent northern Indian Ocean. The results of these surveys have already been presented in several publications by the Fishery Survey of India, including Bulletins, Occasional Papers and Atlases (Sivaprakasam and Patil, 1987, Sivaprakasam and Sudarsan, 1988; John et al. 1988; Sudarsan et al., 1988a, b). In view of voluminous nature of the data, only the results of Matsya Sugandhi and Matsya Harini which have followed norms of random sampling with vast coverage of areas and seasons in systematic manner were analysed and results presented.

The vessels have covered a very large area of the Indian EEZ (Table-1). The South west coast has been very extensively surveyed followed by the South east cost. (Fig. 1). The Andaman & Nicobar waters and the equatorial waters have also been considerably sampled while North west coast and North east have only been marginally touched and the data are the inadequate. It will be of interest to know that the two sophisticated tuna long line survey vessels, Yellowfin and Blue Marlin acquired very recently under Japanese aid will be in a position to survey these areas and are expected to yield very interesting results if the data of chartered vessels presented later are any indication.

The average hooking rate in respect of all fish and yellowfin tuna is furnished in Table-2. It is observed that the southwest coast presents the most rosy picture with a very good average hooking rate of 0·6% to 3.76% for tuna, and the yellowfin forms almost entire catch.(Figs. 2&3)

Based on the exploratory survey and comparison of the MSY, hooking rate and area available in similar tropical areas, we have worked the annual potential for various zones while it must be admitted that the data are not adequate except for south west and south east coast. It is seen that the potential of deep sea swimming tuna and tuna like fishes are about 48,000 tonnes of which Yellowfin tuna forms about 27,000 tonnes. The major fishing grounds for Yellowfin tunas are along south west coast of India. It is hoped that based on further observations, the north west coast is likely to become one of the richest grounds for yellowfin tuna for which Fishery Survey of India is going to deploy a new tuna long line survey vessel Blue Marlin.

Table 2 presents the zone-wise catch rates, species composition by number and weight and the seasonal variation of tuna mostly comprising yellowfin tuna. It is observed that in respect of these parameters the south west coast is most productive and promising zone. It will be seen that hooking rate of tunas are the highest (3.76%) along south west coast followed by the equatorial waters and lower east coast. As already stated, data are inadequate for north west and north east coasts. All the zones except south west and lower east coast, require detailed surveys.

The composition of long line catches is mostly comprised of tunas in all the zones. In the south west coast it formed 72.37% while it was 66.1% in the equatorial waters. It was 33.7% in the lower east coast and 40% in the Andaman seas. While bill fishes are more in the lower east coast, sharks are more along the lower east coast and Adaman seas.

By weight, which is very important for marketing purpose, tunas form 76% of the catches along south west coast. The pattern of composition by weight is however more or less similar to that by number.

The seasonality of tunas especially the yellowfin tuna which forms 98-99% among the tunas, present a very interesting picture. While it is generally believed that the tunas move towards the north during the second half of the year it was observed in the present study that the season extends for 9 months in a year from September to May, with peak season during January to March along south west coast. The hooking rate ranged from 2.5 to 9.6% in this zone. The lower east coast also presents equally interesting picture though the hooking rate and the season are a little limited. The season extends from November to April with the hooking rate ranging from 0.9 to 1.3% with peak period in March. The data for other regions are inadequate and covers only a part of the EEZ.

The species-wise percentage composition within the tunas and bill fishes are given below:

Species	W.Coast	E. Coast	Andaman Sea	Equatorial Sea	Total
Tuna					
Yellowfin	97.7	93.6	95.7	93.5	97.2
Big eye	0.5	-	1.5	3.9	0.6
Skipjack	1.6	6.2	2.7	2.4	2.3
Bill fish					
Marlin	33.5	48.3	30.2	62.9	40.4
Sailfish	58.6	47.5	38.1	31.5	52.7
Sword fish	7.7	4.2	31.7	5.6	6.9

It is interesting to see that yellowfin forms the bulk of the tuna catches to the extent of 97% on the whole. The Big eye is available in substantial quantity mainly in equatorial waters as can be seen from the above Table. The skipjack forms only a small percentage ranging from 2 to 6. Among the bill fishes the sail fish forms the bulk followed by marlin while sword fish forms only a smaller percentage.

The tuna long line charter operations

The chartering of foreign fishing vessels with the objective of transfer of technology leading to joint ventures, has also increased knowledge of tuna and allied fish resources of the Indian EEZ. Table-3 the results are classified according to the area of operation namely west coast only, east coast only and and west coasts. The analysis is based on the declared catch and effort data. It is seen that the total hooking rate is quite high and comparable to our own survey results i.e. 5%. The hooking rate of yellowfin tuna was 1.8 while that of skipjack was 2.7 along the west coast and it was 0.8 and 3.7 respectively along the east coast. This is however not in agreement with our survey results as skipjack formed only a very smaller percentage. The catch per unit of effort with reference to different time parameters are also presented in Table 4. It is observed that the catch per fishing day was highest, i.e. 2.23 tonnes per fishing day along the west coast while it was 1.6 along the east coast. The catch per month was also highest along the west coast. On the whole the catch per voyage of 2-3 months was about 100 tonnes.

Big eye tuna, a prime species for sashimi market, is available mainly in the equatorial waters, is obvious from Table 4 which presents the result of operation of a chartered vessel for one voyage. It will be seen that the Big eye is available in better proportion between 3° to 9° north.

The results of some of the chartered vessels operating during September '88 to March '89 have revealed some very interesting results of far reaching effect. (Fig. 4). While the chartered vessels were earlier concentrating along south west coast, they have now moved towards north west coast during October - December with very high hooking rates ranging up to 4.8%. After this, the vessels moved to east coast and Andaman waters during January to March also obtaining high hooking rates of yellowfin tuna. These observations amply attest our earlier finding that Yellowfin tuna migrates northwards along both east and west coasts after the south west monsoon and go as far north as the continental limits and then they make a return sojourn.

Biological studies on yellowfin tuna

During the course of tuna long line surveys biological studies were also undertaken with a view to assess the yellowfin stocks. The growth and mortality parameters obtained from these studies are detailed below.

<u>Size composition</u>

Analysis of length frequency data collected during the surveys revealed that the yellowfins are recruited to the subsurface longline fishery in Indian waters while attaining about 75-80 cm fork length (John and Reddy, 1989). The first modal group was observed with a mean length of about 84 cm. The fishery is largely supported by age 3 and age 4 classes, the mean length of modal groups being in the rate of 120-140 cm. In 1984 frequency showed greater abundance of 75-90 cm size group compared to the samples in later period. The age 5+ yellowfins were rarely found in catches.

The largest species recorded was of 164 cm which will be of age 8 group according to the age scale estimated by Yesaki (1983) and about 7 year old based on Romanou and Korotkova (1988).

Growth parameters

The growth parameters of the yellowfin stock in Indian waters were estimated by different methods and the values obtained are in the range of 170-182 cm and K yr-1 0.25 - 0.31 (John and Reddy, 1989). Details are furnished in Table 5.

Table 5. Estimates of L_∞ and K of yellowfin tuna in Indian waters.

Method	L_∞ (cm)	K^{Yr-1}
Gulland & Holt method	182	0.25
Ford Walford method	179	0.27
Von Bertalanffy plot	-	0.31
ELEFAN I	170	0.30

Silas et al (1985) have worked out the parameters of L_∞ = 145 cm and K = 0.32 based on pole and line and gill net catches, where the L_∞ value appears to be a underestimate due to absence of larger specimens in the samples. Estimates of L_∞ by other authors from different parts of Indian Ocean are in the range of 173-212 cm.

Natural mortality

The natural mortality coefficient of the stock was estimated by John and Reddy (1989) following Pauly's empirical formula using the growth parameter values and mean environmental temperature and found the coefficient (M) in the range of 0.41 to 0.48.

DISCUSSION

The Indian waters are traditionally known to be rich, besides other resources in tuna and tuna like fishes. The Japanese, Korean and Taiwanese vessels have been fishing in our waters since early fifties. Inspite of the legal permission given for fishing under the charter policy, a large number of tuna vessels are reported to be illegally fishing in our Indian waters. The apprehension of six tuna long liners of 53.5 m length off Porbandar during October '88 by the Coast Guard is ample indication of the bounty of tunas that is available in our EEZ. The catch rates are comparatively high in our Indian waters as can be seen from Table 5 and this also implies that the tuna resources are practically unexploited at present. The catch rates also compare very favourably with the commercial data of 1978 pertaining to Japanese, Korean and Taiwanese vessels presented in Table 6.

As already stated elsewhere, the tuna resources of Indian waters are highly promising. In the context of the shrimp resources reaching the optimum level, the fishing companies are diversifying for deep sea lobster, squid and finfish resources. Among these, tunas have the best scope in view of the high price and ready export market. However, we have adequate data only for south west and lower east coasts. The north west coast and upper east coast and Andaman and Nicobar waters are yet to be surveyed. It is with this view that the Fishery Survey of India has acquired two sophisticated tuna long line survey vessels Yellow fin and Blue Marlin (36.5 m OAL, 700 PS and 310 GRT). These vessels have modern navigational and fish finding equipments including satellite navigator, FAX etc. and it should be possible to use the SST maps obtained from satellites through FAX for better understanding of the distribution of the tunas. It may also be stated here that purse seining survey by Matsya Varshini have shown the availability of little tuna shoals all along the south west coast. Long tail tuna, which is abundant in the upper Arabian sea including Iran, UAE and Pakistan, is yet another coastal species for future survey and development of exploitation.

The global and regional picture of the estimated potential and production of tuna and tuna like fishes (FAO, 1987) present some very interesting facts and the scope for augmenting tuna production. The world production of tuna and tuna like fishes steadily increased from 26.35 lakh tonnes in 1980 to 31.54 lakh tones in 1985. In eastern Indian ocean the production has fluctuated with a peak of 1.3 lakh tonnes in 1983 which has steadily declined to 1.08 lakh tonnes in 1986. However, in the western Indian ocean the catches have steadily increased from 1.63 lakh tonnes to 4.61 lakh tonnes in 1986. In India, the catches included mostly small coastal tunas and tuna like fish including seer fishes, the oceanic species being the skipjack and young yellowfin tunas from the Lakshadweep islands where the traditional pole and line fishery exists. The tuna production alone stands at 30,000 tonnes at present. Large tuna catch has been practically nil. The neighbouring countries of Pakistan, Sri Lanka, Maldives and Malaysia are however exploiting the stocks of large oceanic tunas like yellowfin.

Table 7 and 8 present the global production of tuna and tuna like fishes in the years 1982 to 1985/87 and species-wise estimated potential, production, the state of exploitation and the major fishing countries of the Indian ocean. It will be seen that among the various species, the yellowfin, the big eye, the skipjack and the billfish are relevant to our EEZ. Though most of the stocks are exploited moderate to heavy, there seems to be ample scope for further developing fishery for these species. The stock of yellowfin is estimated to be 1 lakh to 1.5 lakh tonnes in the Indian ocean whereas the estimate made in the present study show that about 27,000 tonnes are available in the Indian EEZ and the production is around 60000 tonnes at present mainly by chartered vessels and there is ample scope for further expansion. Skipjack also offers excellent scope with current production being 1.25 lakh tonnes against a potential of 2.0 to 4.0 lakh tonnes. Big eye is yet another choice species which is currently exploited at 39000 tonnes against the potential of 30-60,000 tonnes. It is hoped that the proposed survey of the northwest coast, east coast and Andaman and Nicobar waters by the newly acquired tuna survey vessels of FSI, yellowfin and blue marlin will open new avenue for further development of tuna fishery in India especially for the deep swimming oceanic tunas. The fishery survey of India also proposes to acquire a tuna purse seiner under Italian aid for the survey of the surface dwelling oceanic tunas including the skipjack and young yellowfin tunas.

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TABLE 1. Summary of Results of Tuna Longline Surveys in Indian E.E.Z.

		South West Coast	South East Coast	North West Coast	North East Coast	Andaman & Nicobar Seas	N. Equatorial Sea
1.	Area (lakh Km^2)	4.94	1.30	3.66	4.31	5.97	-
2.	Survey Vessels: deployed	M. Sugandhi	M. Harini & M. Sugandhi	M.Sugandhi	M.Harini & M.Sugandhi	M.Sugandhi	M.Sugandhi
	proposed	-	-	Blue Marlin	Yellowfin	Yellowfin	-
3.	Survey effort** (lakh hooks)	4.56	3.11	0.18*	0.07*	0.52	0.43
4.	Average H.R.and range***			Effort inadequate			
	a) All Fish	5.20 0.7 - 27.34 (Jan. 86)	2.76 0.4 - 7.4 (Feb. 87)			1.57	1.63
	b) Tunas	3.76 0.1 - 24.98 (Jan. 86)	0.93 0 - 4.12 (Dec. 86)			0.63	1.08
	c) Bill fishes	0.27 0 - 1.15 (Apr. 86)	0.40 0 - 1.29 (Oct. 86)			0.12	0.21
	d) Pelagic sharks	1.11 0.2 - 3.77 (May 86)	1.33 0 - 0.46 (Feb. 87)			0.70	0.33
	e) Others	0.06 0 - 0.33 (May 86)	0.10 0 - 0.46 (Sept. 86)			0.12	0.01

Cont 2

	South West Coast	South East Coast	North West Coast	North East Coast	Andaman & Nicobar Seas	N. Equatorial Sea
Estimated potential of Deepswimming tuna & tuna like fish ('000t) ****						
a) Tunas	17.1	0.9	6.3	1.8	1.3	27.4
b) Bill fishes	1.4	0.4	0.5	0.8	0.7	3.8
c) Pelagic sharks	6.3	1.5	2.3	3.0	2.6	15.8
d) Others	0.3	0.2	0.1	0.4	0.3	1.2
Total	25.1	3.0	9.2	6.0	4.9	48.2

* Operated in lat 15° only. As sampling is inadequate in terms of effort, area coverage and seasoal coverage, the results are not separately worked out.

** Also include fishing effort by M.V.Prashikshini.

*** Range indicates minimum and maximum monthly hooking rates.

**** Resources of South West Coast estimated based on the survey. The other figures are projected estimates.

TABLE 2. Results of tuna longline survey, hooking rate, species composition and seasonality

	South West Coast	Lower East Coast	Andaman Sea	Equatorial sea	Average
I. HOOKING RATE					
1. Tunas	3.76	0.93	0.63	1.04	2.44
2. Bill fishes	0.27	0.40	0.12	0.21	0.30
3 Sharks	1.11	1.33	0.70	0.33	1.13
4. Others	0.06	0.10	0.12	0.01	0.07
Total	5.20	2.76	1.57	1.63	3.94
II. SPECIES COMPOSITION (%)					
1. By number					
a. Tunas	72.37	33.66	40.00	66.10	61.80
b. Bill fishes	5.13	14.54	7.68	12.68	7.69
c. Sharks	21.36	48.27	44.27	20.09	28.58
d. Others	1.14	3.55	8.05	1.14	1.93
2. By Weight					
a. Tunas	76.03	33.67	47.63	63.53	65.08
b. Bill fishes	7.46	26.34	12.19	22.43	12.38
c. Sharks	16.29	39.24	38.36	13.84	22.16
d. Others	0.22	0.75	1.81	0.20	0.38
III. SEASONALITY OF YELLOWFIN TUNA					
January	7.81*	1.90**	Seasonal coverage limited.		
February	9.79	1.34			
March	8.06	2.36			
April	5.63	1.29			
May	1.98	0.56			
June	0.21	0.37			
July	0.30	0.35			
August	0.55	0.14			
September	2.55	0.17			
October	4.54	0.18			
November	5.10	0.86			
December	5.53	1.86			

* 1985-86 to 1987-88

** 1986-87 to 1988-89

TABLE 3. Results of tuna longline operations by F.V. Asian 28 during 2.6.88 - 8.8.88

Area	No. of hooks	Total hooking rate(%)	Hooking rate (%)			
			Big-eye	Yellow-fin	Bill fishes	Sharks
3 - 67	3951	0.68	0.25	0.05	0.07	0.30
5 - 66	7724	1.55	0.66	0.37	0.05	0.06
5 - 67	3807	1.05	0.50	0.34	0.10	0.10
7 - 70	1812	0.77	0.33	0.05	-	0.39
8 - 71	17212	2.33	0.73	0.10	0.02	1.47
8 - 72	7620	1.92	0.51	0.10	0.04	1.26
8 - 75	1812	0.99	0.27	0.05	0.05	0.61
9 - 70	7000	3.23	0.20	0.06	0.08	2.88
9 - 71	1715	1.98	0.06	0.12	0.06	1.75
11 - 74	1799	0.72	-	0.05	0.33	0.33
11 - 80	1750	0.17	-	0.11	-	0.06
12 - 72	4100	0.71	-	0.34	-	0.36
12 - 81	1750	0.51	-	0.34	0.06	0.17
15 - 80	1750	1.26	-	0.97	-	0.28
Total	63802	1.68	0.42	0.18	0.05	1.02

TABLE 4. Results of Chartered Longliners Operation in Indian EEZ.

July '85 to Jan. '89.

		West Coast Only		East Coast and West Coast		East Coast Only	
1.	No. of vessels	7		8		10	
2.	No. of voyages	11		11		20	
3.	No. of Months	20.75		33.00		36.75	
4.	Days at Sea	634		1003		1119	
5.	Fishing days/sets	457		703		910	
6.	Effort (lakh hooks)*	11.43		17.58		22.75	
7.	Declared Catch (tonnes)	1018.5		1086.8		1427.2	
8.	Catch/unit effort (tonnes)						
	a. Per Voyage	92.59		98.81		71.36	
	b. Per month	49.08		32.93		38.84	
	c. Per day at sea	1.61		1.08		1.28	
	d. Per fishing day	2.23		1.55		1.57	
9.	Hooking rate, by wt. (kg) and by No.	By wt.	By No.	By Wt.	By No.	By Wt.	By No.
	a. Yellowfin tuna	57.46	1.78	37.97	1.18	26.800	0.83
	b. Skipjack	12.77	2.72	3.75	0.80	17.23	3.67
	c. Bigeye tuna	3.45	0.07	5.42	0.11	0.01	-
	d. Billfishes	5.01	0.08	6.23	0.11	16.46	0.36
	e. Sharks	6.70	0.29	6.03	0.26	1.09	0.05
	f. Others	3.76	0.38	2.45	0.25	1.14	0.11
	Total	89.15	5.32	61.85	2.71	62.73	5.02

* Calculated on the basis of average 2500 hooks per set.

TABLE 5. Comparison of yellowfin tuna hooking rate from Indian seas and adjoining areas recorded in commercial fishing, experimental fishing and exploratory survey

Fishing type and area	Range of annual hooking rate (%)	Average hooking rate (%)
Commercial fishing[1]		
Bay of bengal[2]	0.27 to 0.83	0.39
W. of Sri Lanka	0.24 to 1.42	0.81
Experimental fishing (1982-83)[3]	0.43 to 1.10[4]	0.70
Lat. 1° - 8° N, Long. 77° - 83° E		
Exploratory survey (1983-88)	0.74 to 4.94	2.62
Lat. 0° - 16° N, Long. 68° - 85° E		

1. By Japan 1976-80; Korea 1976-79 and Taiwan 1976-82
2. In BOBP project area covering Burma, Thailand, Malaysia and Indonesia
3. By Sri Lanka, during July-August 1982 and April-May, 1983
4. Catch rate by weight converted to number taking average weight of yellowfin tuna as 31.8 Kg (Sulochanan et al., 1986).

TABLE 6. Yellowfin tuna hooking rates in grids of 5° lat. x 5° long. obtained by commercial longliners in 1978 and 1982, and by survey vessels during 1983-88.

Latitude	Data source		65°-70°E	70°-75°E	75°-80°E	80°-85°E	85°-90°E	90°-95°E
0°-5°N	Commercial	1978	-	1.04	1.66	-	0.35	0.44
		1982	-	0.07	0.19	-	0.19	0.24
	Survey	1983-88	1.01	-	0.46	0.83		-
5°-10°N	Commercial	1978	-	-	1.11	0.42	0.61	0.36
		1982	-	-	-	-	0.28	0.12
	Survey	1983-88	0.51	0.33	0.41	-	0.76	0.47
10°-15°N	Commercial	1978	-	-	-	0.33	0.34	-
		1982	-	-	-	-	0.68	0.64
	Survey	1983-88	2.16	5.34	0.04	0.94	0.96	0.68
15°-20°N	Commercial	1978	-	-	-	0.68	0.19	0.76
		1982	-	-	-	-	0.66	-
	Survey	1983-88	-	8.12	-	0.65	-	-

Commercial data : 1978 - Japan, Korea, Taiwan; 1982 - Taiwan.

TABLE 7. Oceanic tunas and bill fishes, small tunas and seer fishes of the world.

Ocean	Species	Main fishing countries (1984)	Estimated potential (000 t)	Catches (000 t)				State of exploitation
				1982	1983	1984	1985	
World	Tuna & tuna-like fishes	-	-	2753	2937	3132	3154	-
	S. Bluefin	Japan, Australia	35-40	43	43	40	29	Heavy
	Albacore	Taiwan, Korean, Rep. Japan	15-20 (Longline stocks only)	21	17	16	16	Moderate
	Yellowfin	Korean Rep.,Maldives, Sri Lanka, France	100-150	48	58	97	98	Probably heavy in the west
	Big eye	Korean Rep., Taiwan, Japan	30-60?	42	33	40	39	Moderate to heavy
	Skipjack	Maldives, Sri Lanka, Indonesia	200-400	51	61	104	120	Moderate
	Bill fishes	Korean Rep., Japan, Taiwan	10?	11	6	6	12	Moderate
	Total for Oceanic tunas & Billfishes			216	218	303	314	-
	Total for small tunas & seer fishes		200-300?	153	163	160	181	Probably Moderate

TABLE 8. Tuna and allied fish production World, Indian Ocean (East), Indian Ocean (West), India, Pakistan, Sri Lanka, Maldives and Malaysia.

('000 tonnes)

	1980	1981	1982	1983	1984	1985	1986	1987
World Production	2635	2650	2790	2940	3111	3154		
Indian Ocean (East)	113	89	111	131	128	125	108	751
(West)	163	196	244	251	304	370	461	
India								
a. Coastal species			47	46	45	44	62	55
b. Oceanic species			9	7	6	6	7	7
Total			56	53	51	50	69	62
Neighbouring countries								
Pakistan			19	13	11	16	19	23
Sri Lanka			37	36	29	29	28	30
Maldives			20	25	29	29	34	52
Malaysia			33	35	32	32	30	46

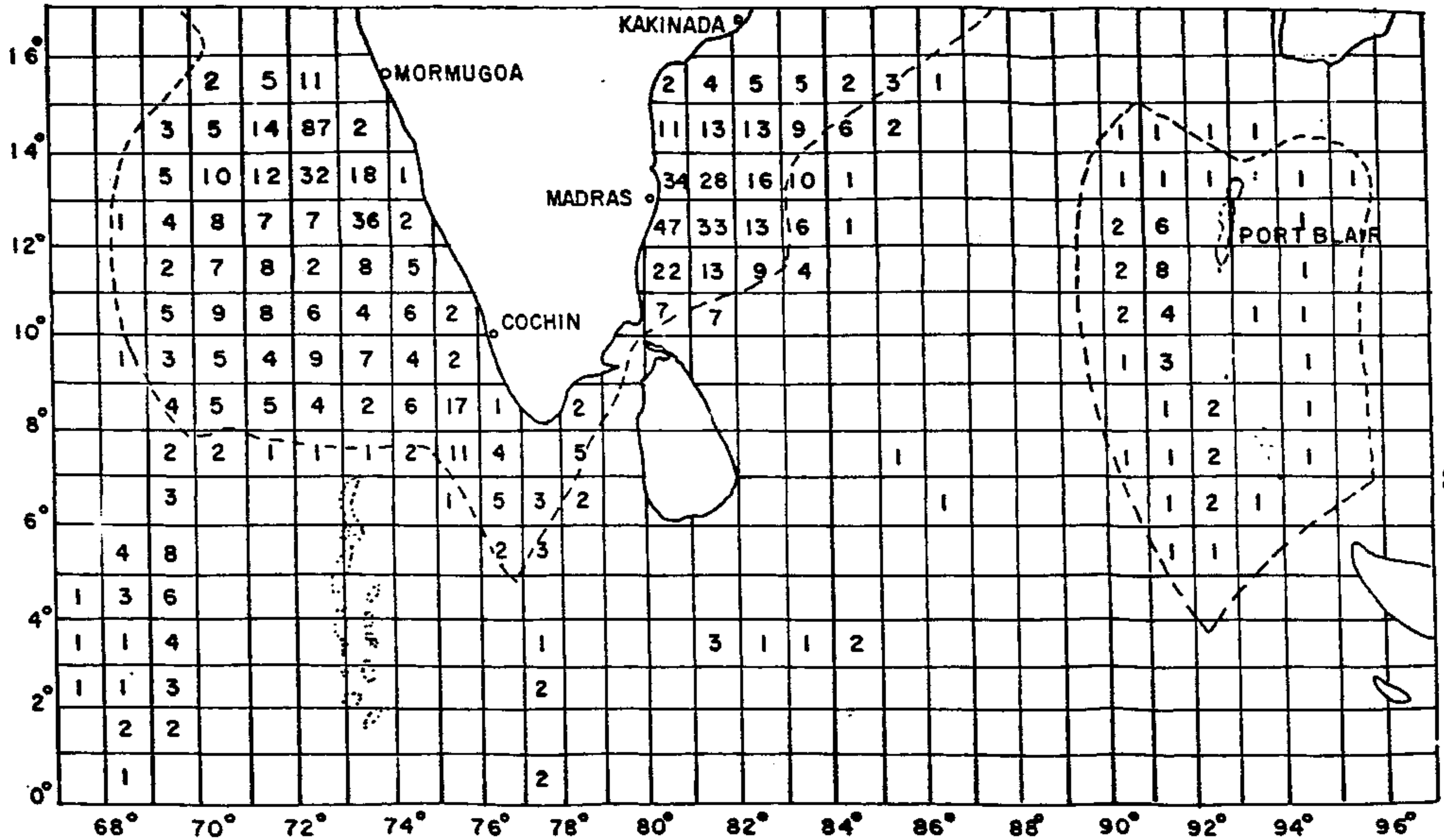
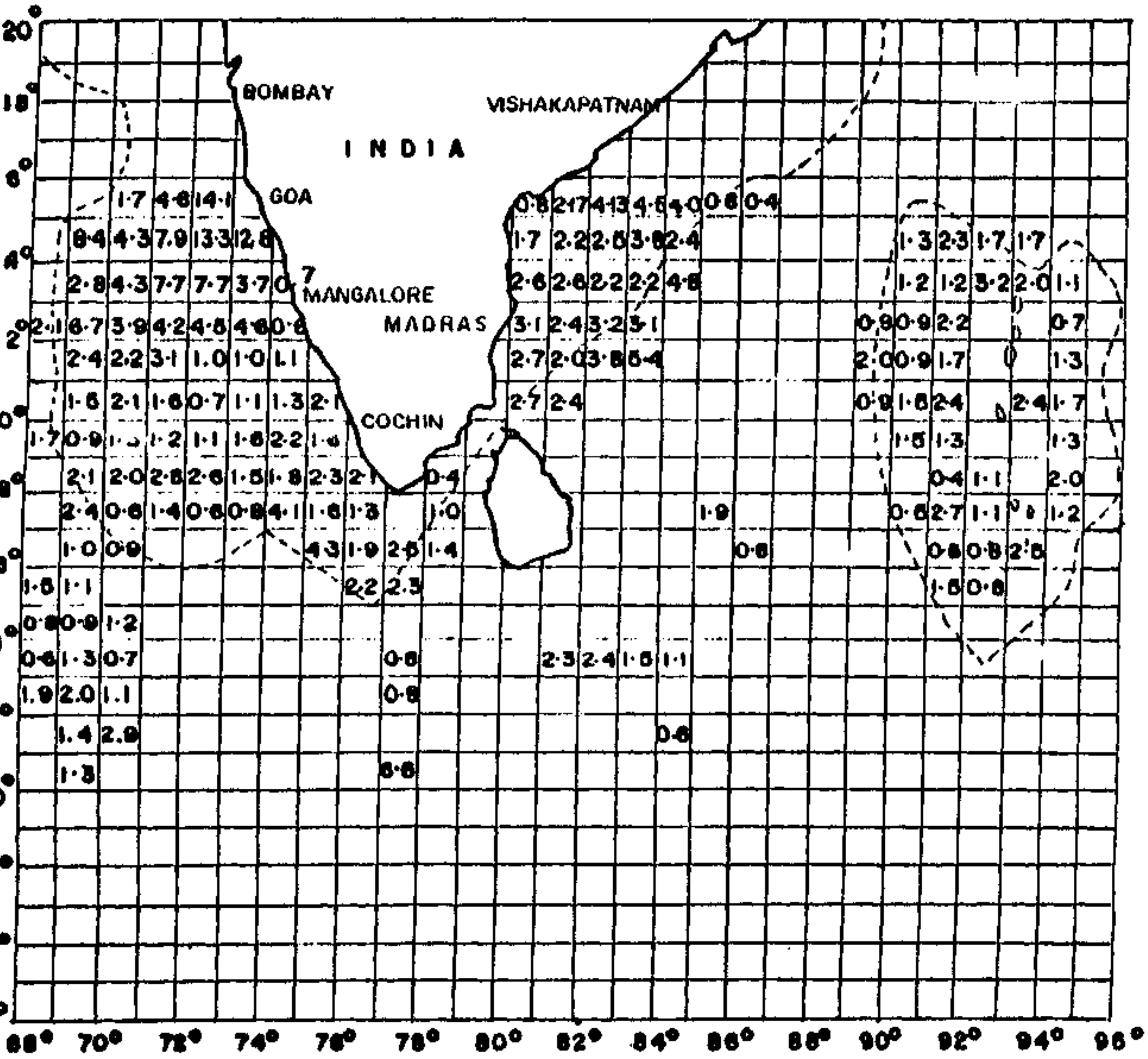


Fig. 1. DISTRIBUTION OF SAMPLING EFFORT IN TUNA SURVEY OCT 83–FEB. 1989

Fig. 2. AVERAGE HOOKING RATE OF ALL FISH BASED ON SURVEYS OCT. 83 — FEB. 1989



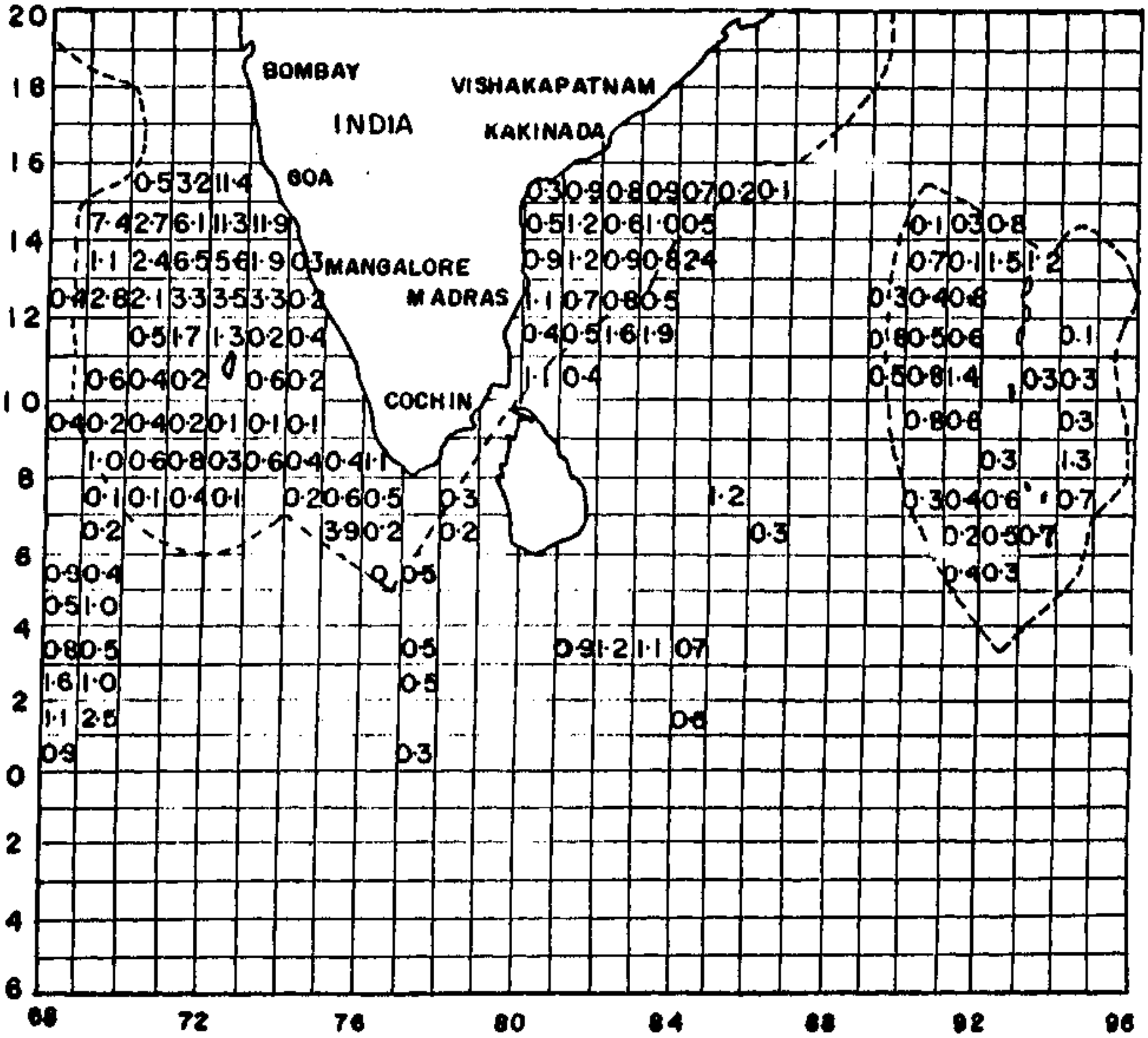


Fig. 3 . HOOKING RATE OF YELLOFIN TUNA OBTAINED IN SURVEYS OCT. 83— FEB. 1989

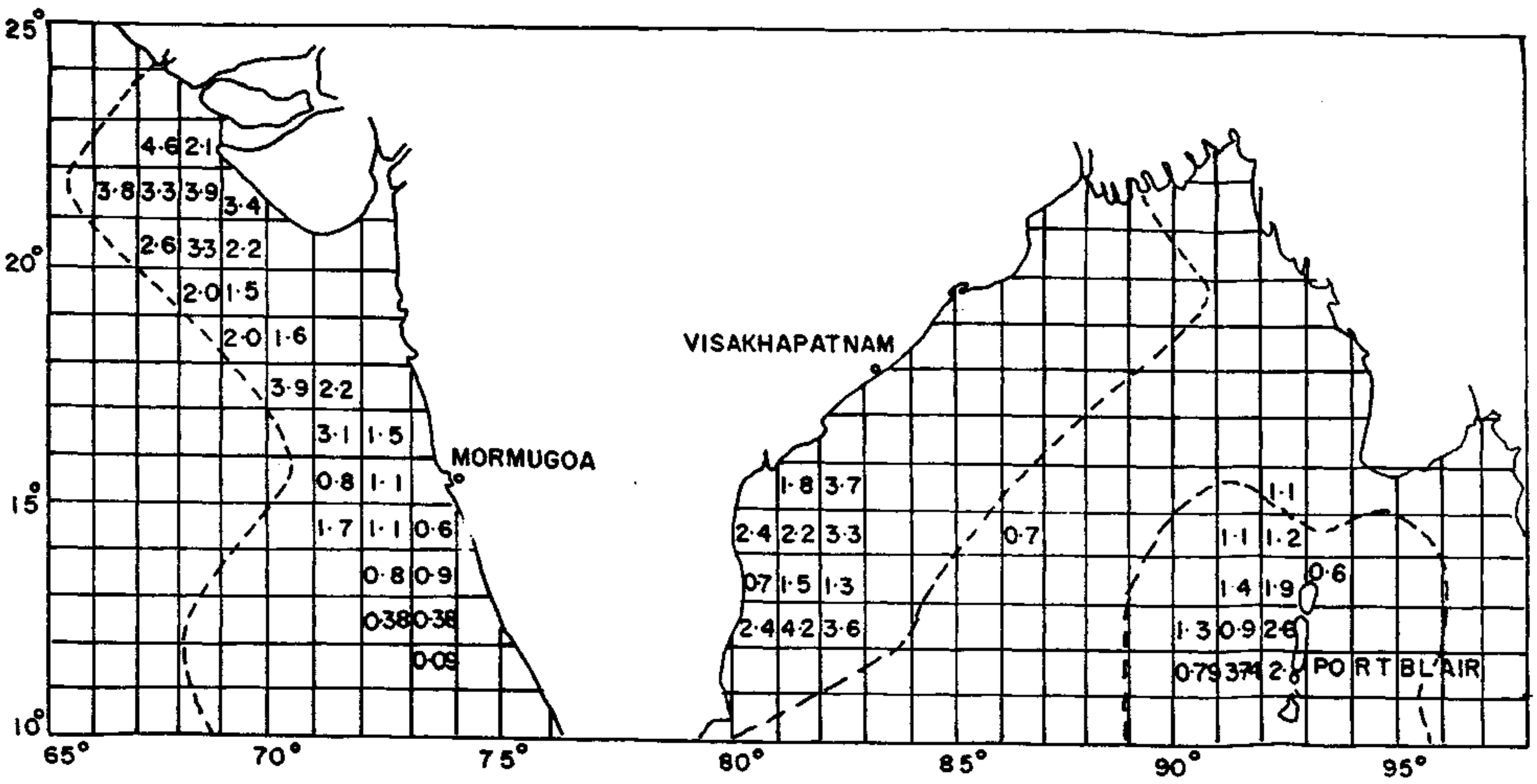


Fig.4· HOOKING RATE OF YELLOWFIN TUNA OBTANED BY SOME OF THE CHARTERED VESSELS OPERATED IN INDIAN EEZ DURING SEPT. 1988 TO MARCH 1989

PRESENT STATUS OF TUNA FISHERIES OF LAKSHADWEEP

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INTRODUCTION

Lakshadweep, the smallest among all the States and Union Territories of India consists of 36 Islands covering a land area of 32 sq. kms, a lagoon area of 4200 sq.kms, 20000 sq.kms. of territorial waters and 40000 sq. kms of Exclusive Economic Zone which are potentially rich in marine fishery resources. Tuna fishing has emerged as an organized and viable industry in many Islands. Out of the total, 6809 tonnes of fish landed in Lakshadweep in 1988, 86% is accounted by tunas contributing about 21% to the total all India tuna landings.

The tuna catch of the mainland coast of India is chiefly contributed by incidental catches where as in Lakshadweep the effort is specifically directed on tunas. Pole and line and troll line are the principal gears employed for capture. Hand lines and drift gillnets are also rarely used. Agatti, Bitra, Suheli and Minicoy are the major pole and line fishing centres which together contribute 75% of the total tuna catch.

BACKGROUND INFORMATION

Tuna pole and line fishing employing non-mechanised country crafts (Masodis) was in practise in Minicoy from time immemorial. But tuna remained uexploited by any of the other Islands prior to 1960 due to lack of knowhow on the part of local fishermen. Tuna pole and line fishing employing mechanised crafts was introduced in Lakshadweep in 1962. The Lakshadweep administration encourage the expansion of tuna fishery by introducing demonstration fishing vessels, and by providing boats, training and necessary infrastructural facilities. From a meagre annual fish catch of 500 tonnes in 1960 the production has leaped to 7300 tonnes by 1987 (Table 1). Out of the total population of 42,000, about 4000 persons find employment in fisheries sector directly and indirectly. The income contributed by the fisheries sector is Rs. 3.4 crores annually which works out to a percapita income of Rs. 810.

MATERIALS AND METHODS

The data used for the preparation of this paper are the boat-wise daily fish catch from pole and line and troll line fishing boats operated for the last 15 years from 1974 to 1988 at different Islands collected by staff of Fisheries Department. The method of collection of data was enumeration and this is followed in all the Islands of Lakshadweep. Normally a day's fish catch in a boat is composed of one or two size groups. Therefore total weight can be taken easily by multiplying the weight of one fish with number of fish in each size group. The data on fishing effort were collected from Agatti, Minicoy, Bitra and Andrott. Samples of tuna were collected from boats every day for taking length measurements. In this study the fishing effort is considered in terms of boat days. All the boats leave for fishing early in the morning and return by afternoon the same day.

FISHING GROUNDS AND AREAS

The oceanic waters surrounding the islands are potentially rich in living resources such as tunas, shark and billfishes. The areas around some of the Islands and submerged reefs are potentially rich in fishery resources, the important of which are given below:

Area	Location	Inhabited or not
Agatti	10°51'N - 72°11'E	Inhabited
Bangaram	10°56'N - 72°17'E	uninhabited
Thinnakara	10°56' - 72°18'E	"
Parali	10°57'N - 72°20'E	"
Perumal par	11°10'N - 72°20'E	"
Pitti	10°47'N - 72'32'E	"
Suheli	10°08'N - 72°18'E	"
Bitra	11°36'N - 72°10'E	Inhabited
Cheriya Paniyam	11°56'N - 71°54'E	Submerged reef
Valiya Paniyam	12°22'N - 71°52'E	Uninhabited
Kadamat	11°13'N - 72°47'E	Inhabited
Androth	10°49'N - 73°40'E	"
Kalpeni	10°05'N - 73°39'E	"
Eli Kalpeni	11°18'N - 74°00'E	Uninhabited
Minicoy	08°17'N - 73°04'E	Inhabited

CRAFTS AND GEARS

Mechanised boats of two sizes, ie. 7.93 metres and 9.14 meters OAL installed with 16-30 BHP diesel engines are being used for tuna fishing. The former having a beam of 2.18 M and installed with 16-19 BHP inboard diesel engines are more popular for pole and line fishing due to their shallow draught that suits the shallow nature of the reef. In the forward cockpit of the boat is kept a wooden live bait tank of dimension 1.6 x 0.6 x 0.8 metres. Details of crafts, gear employed in tuna fishery and operational aspects have been dealt with earlier (Madan Mohan et al., 1986; Ben Yami, 1980) (Table 2).

The pole and line tuna fishing depend completely on a constant supply of live bait and their survival until needed for the fishing operation. The lagoons provide good habitat for the growth of live bait which fall under two categories viz., migratory and resident forms. While the former enter the lagoon temporarily from outside the reef at different periods, the latter use the lagoon as their permanent habitat. The common species caught for the fishing are the following:

Spratelloides delicatulus
S. gracilis
Caesio chrysozona
Caesio pisang
Apogon sangiensis
Chromis caeruleus
Chromis ternatensis
Gymnocaesio argenteus
Lepidozygus tapeinosoma
Archamia fucata
Rhabdamia gracilis
Dussumieria hasselti
Pranesus pinguis

In Minicoy, pole and line fishermen utilize different species of live baits depending upon their availability. But in all other islands the fishermen depend on single species viz., Spratelloides delicatulus locally called "HONDELI" which make their appearance in big shoals on the shallow sandy areas inside the lagoon. The reason for the dependence on this single species is that it is found in abundance inside the lagoon throughout the fishing season and the efforts required for its capture is less compared to the capture of other species which are associated with coral boulders. The dependence on a single species in these islands does not mean that the species caught in Minicoy are not available there. Similarly sprats are available in Minicoy also. This indicates that utilisation of all the suitable species in each island could increase the tuna bait catch many fold.

Details of live-bait fishing by different types of nets have been published earlier (Pillai et al., 1986; Madan Mohan et al., 1986). In Minicoy, the live bait reservoir is traditionally made of local twigs. But in other island the same is made of GI sheet nailed to two semicircular wooden planks. The GI sheet and planks are perforated for water circulation and the reservoir is anchored inside the lagoon. Locally the reservoir is called "Chalapetti" (Laberi) in Minicoy which has a life of 1-3 years depending on the quality of sheets and maintenance. The size of the reservoir is usually 1.8 x 1 x 1 m and two wooden poles are tied longitudinally to the reservoir to help float the tank when it is towed to the vessel or anchored in the lagoon. From the reservoir the live bait is transferred to the bait tank in the boat by a square piece of cloth.

The details of pole and line and troll line fishing operations have been dealt with earlier (Madan Mohan, Livingston and Kunhikoya, 1986).

PROCESSING AND MARKETING

Tuna meat is processed in different methods, of which freezing, canning and drying are the most popular. In Lakshadweep the bulk of the surplus catch of tuna after local consumption is processed into a traditional product called 'MAS'. This product is very ideal for island conditions since the processing can be carried out with fuel available in plenty in the islands. This product resembles the traditional Japanese product 'KATSUWOBUSHI'.

Filleting is the first step in the preparation of Mas. The fish after washing is cut longitudinally along the back bone to form two pieces which again are cut longitudinally to form 4 pieces. The fillets are cooked in sea water with a little salt in aluminium vessels. The cooking is done for 2-3 hours and then the fish is left over night in the vessel to be smoked next morning. Smoking is done spreading the cooked fillets on iron grills placed over pits where coconut husks are burned. Smoking is continued till fish gets smoke colour. Besides being preservative, smoking gives particular taste and firmness to the flesh. After the smoking is over the fish fillets are spread on cudjan leaves on the sea shore under sun until they are dried hard like wood which takes about a week. The conversion from fresh whole fish to Mas is about 18% in weight.

The annual production of Mas in Lakshadweep is around 700 tonnes. Mas is packed in gunny bags and transported to mainland by ships and sold to dealers in Calicut, Mangalore or Tuticorin. The current price of mas ranges from Rs.30-45 per kg depending on catch and season. The production statistics of Mas in Lakshadweep for the period 1984-88 is given in Table 3.

A small portion of the tuna caught is canned in the canning factory set up in Minicoy in 1969 under government sector. The thoroughly cleaned fish is cooked in steam. The cooked fishes are cooled. Then the skin, bones and blackmeat are removed leaving only clean white meat which forms about 40% of the total body meat. The white meat is then cut into size and packed in cans along with refined oil and salt. Tuna is packed in brine too. The filled cans are vacuum sealed, washed and sterilized.

The tuna canning factory at Minicoy has a installed capacity of 1500 cans per 8 hours. An ice plant of 5 tonnes and a cold storage of 20 tonnes capacity are attached to it. The product from this factory are regarded in high esteem both in home and foreign markets. The present average production is around 1,12,000 cans during a season. The production trend for the last 6 years is given in Table 4. The factory has opened avenues of employment to 50 persons directly, the only factory in India where tuna is processed exclusively.

FISHING EFFORT, CATCH AND CATCH PER UNIT EFFORT

In 1974 the tuna catch was 1385 tonnes, which increased to 5855 tonnes in 1988 recording a rate of increase of 323%. This marked increase in the catch was mainly due to the increase in effort resulted by the introduction of more number of boats for fishing. Wide fluctuation in the tuna landings is noticed from 1974 to 1980. But the production from 1981 to 1988 indicate almost a steady increasing trend. There has been appreciable increase in the total fish landings as well. The tuna catch has increased more rapidly, the average rate of growth being 22% per annum during the period 1982-87, while the corresponding growth of total fish landings during the same period was 17%. The contribution of tuna in the total landings has increased from 62% in 1974 to around 86% in 1988. 6528 tonnes recorded in 1987 was the maximum tuna production during the 15 year period.

Agatti, Minicoy, Bitra and Suheli are the four major tuna landing centres in Lakshadweep. Out of these, Agatti is the most important one contributing 46% of the total tuna caught in Lakshadweep. The share of Minicoy is 20%, Bitra 9% and the balance 25% is contributed by other Islands together. A comparative account of fishing effort, catch per unit effort, in respect of Agatti, Minicoy and Bitra for 5 years is presented in Figs. 1 and 2. Highest CPUE is at Agatti (458 kg) followed by Bitra (341 kg) and Minicoy (236 kg).

Catch, effort and CPUE at three pole and line centres and one troll line fishing centre by month wise and species wise for the year 1988 indicate that Agatti, Minicoy and Bitra are the pole and line fishing centres and Androth Island was the troll line centre. The average total CPUE for 9 months period in Bitra (566 kg) was found higher than that of Agatti (539 kg) and Minicoy (375 Kg). Comparatively higher CPUE were obtained in November, December, January, February and March in all the three centres. However, in Agatti, during October also a higher CPUE was realised, the peak months being October, December, January and February. The peak fishing months for Minicoy were December, January and February and the same for Bitra were November, December, February and March. The months in which high effort were recorded were same for Minicoy and Agatti ie. November, December, January and February. With regard to Bitra high effort were recorded only in January and February. Among the three centres, the highest CPUE was 1399 kg recorded in November at Bitra. The corresponding figures for Agatti and Minicoy were 724 kg in October and 699kgs. in February respectively. The lowest CPUE was 23 kgs for Agatti in September and 41 kg for Minicoy in the same month. The lowest CPUE for Bitra was in October (8 kg).

There has been pronounced differece in the annual average total CPUE between pole and line fisheries at Agatti and Minicoy (539 kg. and 375 kg.) and troll fisheries in Androth (68 kg). The peak months in Androth were December, June, July and August with highest value of 84 Kg in June. The lowest CPUE was 20 kg recorded in April. While troll fishing is conducted during all the months in a year without much fluctuations in effort the pole and line fishery is restricted to the season commencing from September to May with peak period from December to March (Table-5).

TUNA LANDING - GEAR WISE AND SPECIES COMPOSITION

Pole and line and troll lines are the gears employed for exploitation of tuna in Lakshadweep. Number of pole and line boats and troll line boats operated from different islands are given in Table 2 and 247 mechanised boats and about 177 of country crafts fitted with OBM are currently engaged in catching tuna. Based on the average for the 5 year period, the annual production from these two gears were 3903 tonnes and 1152 accounting 77% and 23% respectively.

Skipjack was the principle species caught by pole and line which accounted to 81% in the total tuna landing in Agatti. Yellowfin was the second most important species contributing about 10%. Little tunny contributed 7% and the balance 2% was composed of Auxis sp. Dog-toothed tuna has been reported from some of the islands but quantity was negligible. Skipjack remains the main species caught in the troll catches of Androth (60%). But percentage composition of yellowfin (15%) and little tunny (18%) were comparatively higher than that of pole and line.

The maximum and common size range of tunas landed in Lakshadweep are given in Table 6.

ECONOMICS OF OPERATION

The pole and line fishing operation now being conduted in the small scale sector in Lakshadweep is proved to be highly economial. The approximate present cost of a pole and line fishing boat of length 7.9 M is Rs.1.25 lakhs which need only engines of lower HP ranging from 14 to 19. The total investment required for fishing gear and accessories is only about Rs.18000/-.

The average catch per boat works out to 42 tonnes in a year for a 6 months fishing period. At a reasonable rate of Rs. 5/- per kg of tuna the value of catch per boat comes to Rs. 2.1 lakhs a year. At the prevailing share of 50% to the fishermen (9 to 10 fishermen in a boat) the income for the fishermen is Rs. 1.05 lakhs. After deducting the running and maintenance expenditure the net earning for the boat owner is around Rs.75000/- in a year. There had been record catches of upto 105 tonnes of tuna in a season per boat at Agatti.

The existing small scale tuna fishery in the Islands can further be developed by increasing the number of boats. But the shortage of manpower stands as a major hurdle in this regard. The solution to the problem is diversion of the available man power to the productive sector of fishing from the present unproductive sectors. Reorientation of the existing educational system which will enable diversion of students not good at their studies at a lower stage towards fishing should be thought of.

The potential of tuna in Lakshadweep waters is 50,000 tonnes (Silas et al. 1986). Against this the present prodution of 6000 tonnes of tuna cover only a fraction of the exploitable resource. The bulk of the resource is beyond the operational range of the present small boats and is left untapped. This unexploited valuable resource that has a ready export market is either getting perished or migrated to the seas of other countries. This should be exploited by commercial operation employing large purse seiners long liners and pole and line vessels.

The two oceanic species that are exploited by small scale fisheries of Lakshadweep are skipjack and young yellowfin which enter the surface fishery in the coastal waters. But the deep swimming bigger ones of these two species generally contribute to the tuna longline fishery which is not exploited at present.

The exploratory fishing vessels of FSI which conducted tuna longline operation around Lakshadweep have located rich ground of deep water tunas. The tuna catch was composed of yellowfin 97.9%, bigeye 0.4% and skipjack 1.7%. The hooking rate recorded was 18.5% which was quite encouraging. The above results indicate that there is great scope for commercial tuna longline operation around Lakshadweep water.

The future course of fisheries development in Lakshadweep would be in favour of capitalising the fishing industry employing large purseseiners, pole and line vessels and longliners. In order to handle these capital oriented programmes, a Lakshadweep Development Corporation has already been set up with the intention to take up not only harvesting but the entire range of activities such as processing packaging and marketing of tunas.

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TABLE 1. Islandwise tuna landings (in tonnes) for the last fifteen years from 1974-88

Islands	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	Average
AGATTI	518	718	542	392	899	1314	490	820	550	731	2000	2014	1937	3141	2295	1224
AMINI	32	79	44	67	64	72	46	81	77	53	110	123	91	103	80	75
ANDROTT	60	69	33	72	173	303	179	196	243	283	210	183	334	198	237	185
BITRA	116	79	103	49	93	118	104	126	345	166	140	185	526	465	451	204
CHETLAT	77	238	39	14	37	116	32	38	148	96	129	329	151	144	181	118
KADMAT	32	61	37	40	49	101	43	37	38	36	58	113	39	37	47	51
KALPENI	144	45	54	30	20	62	27	41	63	59	48	133	134	58	58	65
KAVARATTI	45	76	70	62	211	207	150	395	150	164	111	118	273	303	259	173
KILTAN	28	32	39	19	19	86	55	23	102	55	93	173	103	256	187	85
MINICOY	333	542	330	420	310	415	644	485	428	273	615	289	946	1192	1250	565
SUHELI									822	1121	799	116	274	632	809	653
TOTAL	1385	1939	1291	1165	175	2794	1770	2242	2966	3037	4313	3776	4808	6529	5854	3050

TABLE 2. Details of fishing crafts in operation, island wise and gear wise for the year 1988.

Island	Mechanised Boat (25' and 30') (Pole and line)	Mehanised Boat (25' and 30') (Troll Line)	Mechanised Boat (25' and 30') Longline	Country craft fitted with OBM	Total (25' - 30')
AGATTI	65		4	20	69
AMINI	7	7	2	15	16
ANDROTT		20		25	20
BITRA	13		1	8	14
CHETLAT	7	4	1	20	12
KADMAT	4		3	4	7
KALPENI		4		15	4
KAVARATTI	31	19		20	50
KILTAN		14	5	15	19
MINICOY	36			20	36
TOTAL	163	68	16	162	247

TABLE 3. 'Mas' Production in Lakshadweep during the year 1984-88.

Year	Mas Production (in tonnes)	Value (Rs. in lakhs)
1984	576.670	136.75
1985	490.684	130.48
1986	576.494	164.10
1987	720.200	239.40
1988	690.400	234.79
Average	610.890	216.72

TABLE 4. The production and sales of the Minicoy Canning Factory for the last six years 1981-87

Year	Sales	Production
1981-82	26,963 cans	51,976 Cans
1982-83	36,432 "	76,050 "
1983-84	42,848 "	75,752 "
1984-85	62,684 "	1,22,012 "
1985-86	64,322 "	1,09,985 "
1986-87	126,796 "	1,04,000 "

TABLE 6. Maximum and common size range of tunas landed in Lakshadweep.

SPECIES		LENGTH (cms)	
Common name	Scientific name	Maximum	Common size range
Skipjack	*Katsuwonus pelamis*	85	20-64
Yellow fin	*Thunnus albacares*	150	25-75
Little Tunny	*Euthynnus affinis*	50	20-40
Frigate mackerel	*Auxis thazard*	40	25-35

TABLE 5. Fishing effort, Catch (kg) and CPUE (kg) of small scale troll line fishing operation at Andrott for 1988.

Month	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
No. of vessels	16	13	15	11	13	12	11	11	12	14	19	20	
No. of trips	347	289	355	258	253	228	236	223	277	294	389	360	3489
No. of effective fishing days	347	289	355	258	253	228	236	223	277	294	389	360	3489
Tuna total catch	23860	18600	14130	5110	11265	19130	17720	15140	21240	19220	32910	38675	237000
Skipjack 60%	14316	11160	8478	3066	6759	11478	10632	9084	12744	11532	19746	23205	142200
Yellowfin 15%	3579	2790	2119	766	1690	2869	2658	2271	3186	2883	4936	5801	35548
Little Tunny 18%	4295	3348	2543	920	2028	3443	3190	2725	3823	3460	5924	6961	42660
Frigat Tuna 7%	1670	1302	990	358	788	1340	1240	1060	1487	1345	2304	2707	16591
CPUE	69	64	42	20	45	84	75	68	77	65	84	107	68

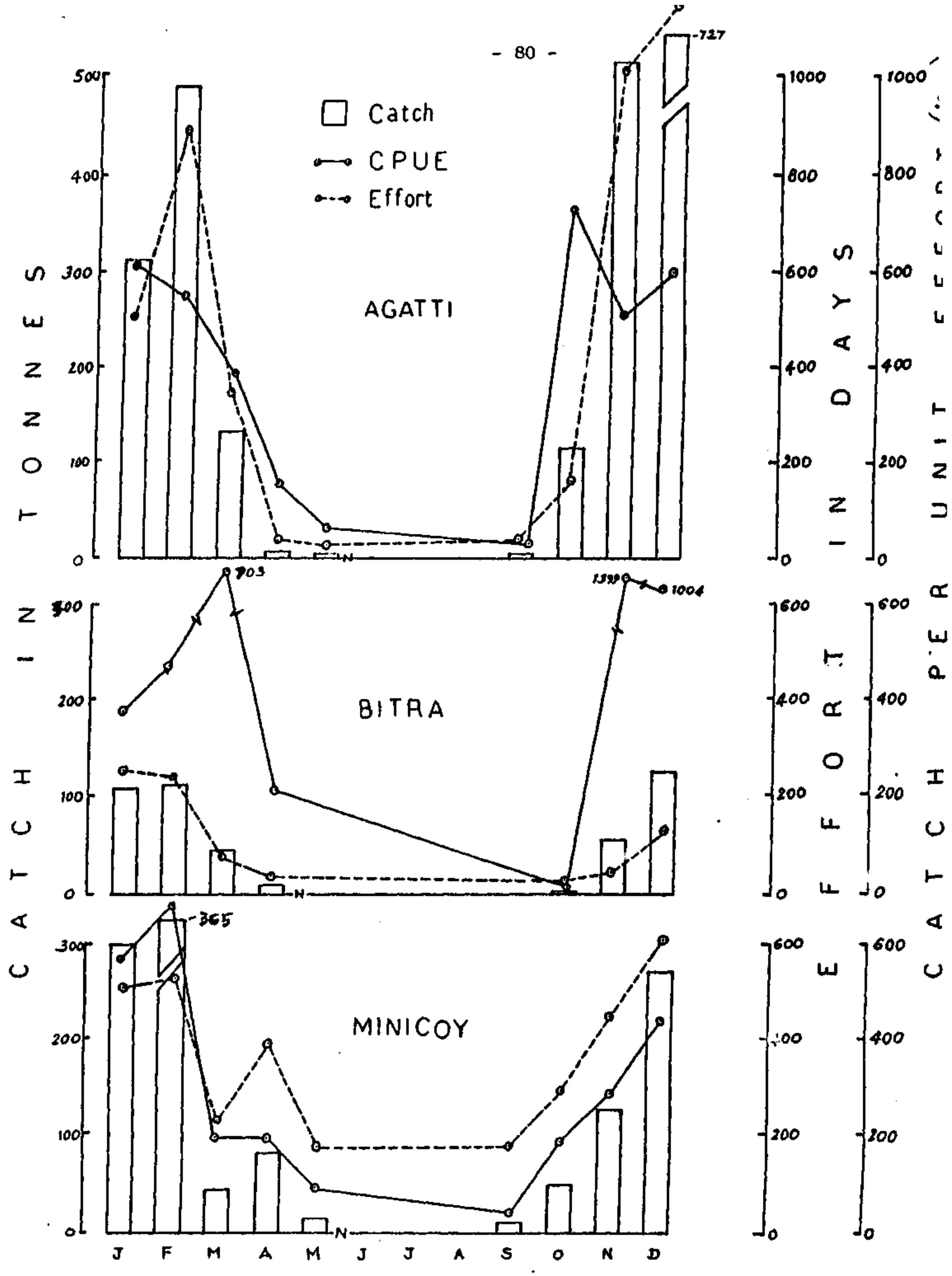

Fig. 1. MONTHLY CATCH EFFORT RELATIONSHIP OF TUNAS AT AGATTI, BITRA AND MINICOY 1988

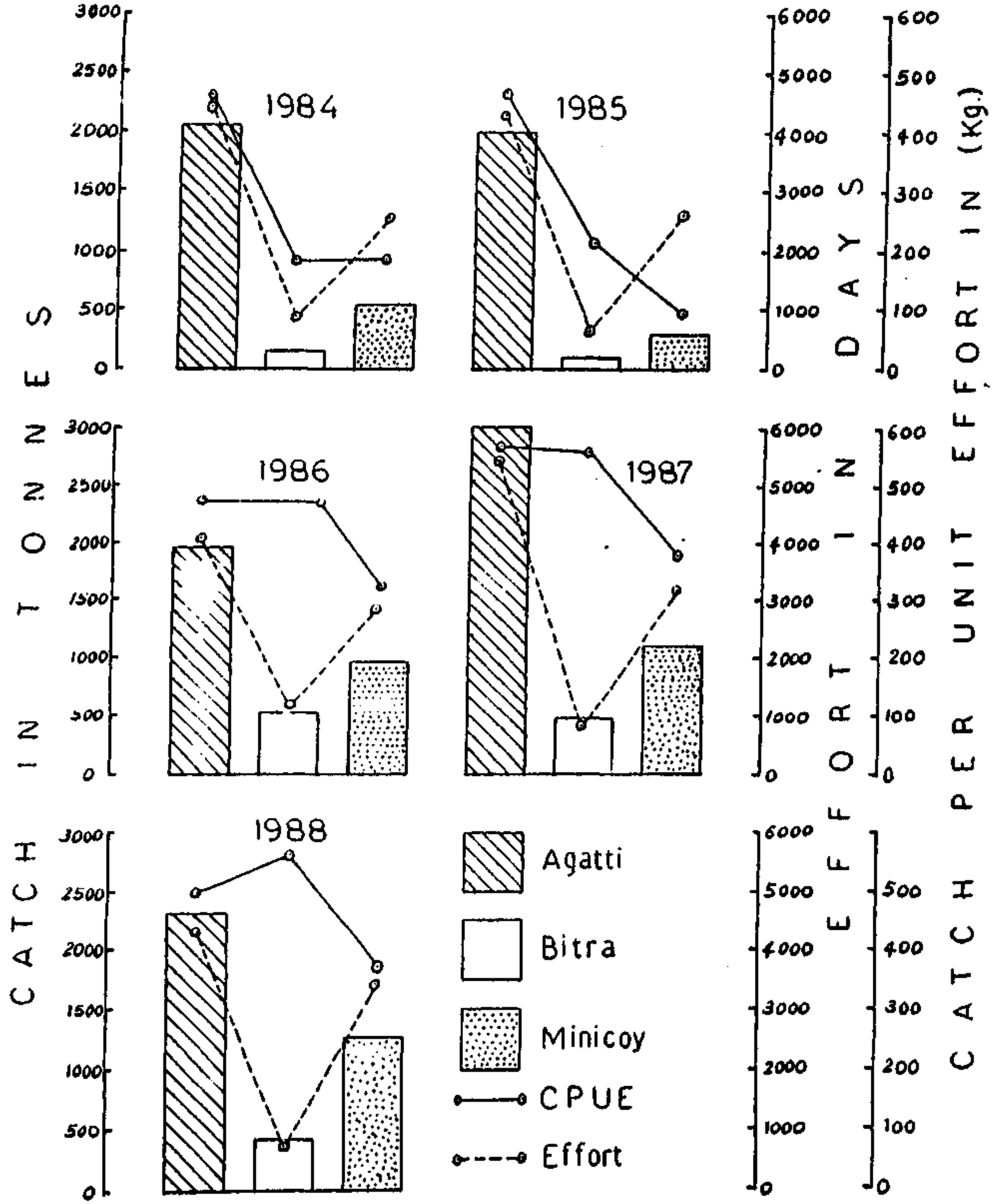

Fig 2. CATCH EFFORT RELATIONSHIP FOR 5 YEARS 1984-88 FOR TUNAS AT AGATTI, BITRA AND MINICOY

PROCESSING AND UTILIZATION OF TUNA

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INTRODUCTION

Popularly known as chicken of the sea, tunas comprising of a number of species forms a major world fishery. Against a world landing of 3,418,450 tonnes in 1986 the annual Indian catch is 30,000 tonnes eventhough the estimated annual exploitable resources in the country's Exclusive Economic Zone is around 2,00,000 tonnes. However, no organised effort has so far been made in the commercial exploitation of these species. Proper exploitation of these resources can, no doubt, add a new dimension to the Indian fishery sector by way of expansion of their catch and also provide a new raw material for the much needed diversification programme of its processing sector.

Tuna, fresh or processed in different styles, is a very important commodity in the world trade for fish and fishery products. The quantum of world production and trade in tuna and tuna products are presented in Tables 1a and 1b. But for some sporadic instances our contribution to the world trade in tuna and tuna products has been quite insignificant as is evident from Tables 2a,b where the data regarding export of processed tuna from India over a decade are presented.

Considering the above it can reasonably be assumed that if we step up exploitation of our tuna resources to a logical level and develop the necessary technological base to process them into products as needed by the overseas buyers, there is ample scope for development of a tuna based industry in our country. However, it should be emphasised that the success of an export market will also depend on the simultaneous development of a strong domestic market and promotional efforts are needed in this sector.

The tuna fishery of India is mainly located near Lakshadweep and Andaman islands. Their catch is mostly skipjack (Katsuwonus pelamis), a light meat variety tuna, most of which is going for preparation of 'Mas', canning as also for fresh consumption. The mainland catches from the inshore waters consist mostly of coastal tunas and bonitos which are the red meat varieties and are not very much relished as food fishes. They have a high proportion of red meat around the back bone and their flavour and taste are not acceptable.

White and light meat varieties of tuna like the albacore and yellowfin tuna have great demand in the export market either in fresh or processed form. However, these being oceanic species used to occur only sporadically in the Indian catches and therefore most of the research work reported from India on tuna are on the skipjack and little tuna (Euthynnus affinis).

BIOCHEMICAL COMPOSITION

Red and white meat of tuna show distinct differences in their biochemical compositions. Moisture, protein, nonprotein, nitrogen, sarcoplasmic proteins, free amino nitrogen, lactic acid, inorganic phosphorus and ribose are more in white meat while salt soluble protein, glycogen, fat, pigments etc. are more in the red meat. Concentration of haemoglobin and myoglobin are about five times more in red meat than in white meat. The red meat which is about 11% of the whole weight of the fish is accumulated more in the middle portion (12.8%) compared to the head (10.5%) or tail (9.5%) portions.

Moisture content shows a decreasing trend from head towards tail both in white meat and red meat. A similar trend is noticed with respect to salt soluble nitrogen which may be accounted for by the higher content of connective tissues in the tail portion. However, increase is noticed in the amino - nitrogen, ribose and inorganic phosphorus from head towards tail portion in red and white meats. Pigment concentration is more in the middle portion and fat accumulation is more in the red meat. Fat shows a decreasing content from head towards tail. Organoleptic evaluation also has shown the middle portion as better than the meat at head or tail portion (Chinnamma George, 1975).

NUTRITIONAL EVALUATION OF WHITE AND RED MEAT OF TUNA

Beause of the concentration of pigments, changes in which are more associated with the off odours of tuna and fat, which can easily undergo oxidation resulting in changes in flavour, red meat has a peculiar taste often not liked by consumers. However it is nutritionally comparable or even superior to white meat. It is significant to note that the protein of red meat is rich in essential amino acids and is also a rich source of energy and fat soluble vitamins A and D. Lipids of red meat has a high content of all essential amino acids. Red meat is also a rich source of iron. Proximate composition and calorific value of white and red meat is presented in Table 3 while their amino acid composition is given in Table 4. Requirements of aminoacids for humans per day as per FAO/WHO standards is given in Table 5 which definitely show that tuna meat in general and red meat in particular is an ideal source for all these essential amino acids. Mineral contents of tuna meat in comparison with that of skim milk powder is given in Table 6. Vitamin A and D contents in tuna meat are presented in Table-7.

The above data clearly indicate the superiority of red meat over white meat in several respects. Animal feeding studies using albino rats with formulated diets containing white meat, red meat and casein conclusively proved that tuna proteins are better than casein as a growth promoter, the proteins of red meat being the best.

Tuna meat in general,and red meat in particular having thus been established as superior to white meat and casein with respect to content of essential amino acids, essential fatty acids, vitamins A and D and minerals, experiments were conducted to study its effectiveness in combating malnutrition and anaemia in growing children in the age group 1-6 years deficient in essential nutrients in association with the Intensive Child Development Scheme of the Government of Kerala. The diets studied had the composition given in Table-8.

The studies conclusively proved that red meat is as effective in providing essential amino acids as white meat and casein and also that red meat can substantially improve heamoglobin levels in anaemic children a capacity not seen in milk protein, white meat and other protein sources except liver. A summary of the results of the child feeding trials is given in Table-9 (Mukundan et al.,1979; Mukundan, 1986).

FREEZING

Consumption of tuna is mostly in the canned form, but are mostly frozen on board, kept frozen and thawed immediately before delivery to the canneries. Brine freezing of whole tuna is the most popular method.

Some studies have been carried out on freezing and cold storage of skipjack in India. Skipjack was frozen as whole after evisceration and removal of gills, as fillets and as chunks and stored at -18°C. Periodical examination and evaluation of the samples biochemically as well as organoleptically showed that shelf life is maximum for whole fish estimated at 30 weeks and the least for fillets at around 20 weeks. During storage red meat becomes badly affected due to the changes in fat, particularly so in fillets which is also affected by dehydration (Chinnamma George, 1975).

Some of the major problems experienced in frozen tuna are the occasional development of green and brown discolourations which becomes evident on cooking. The pigment responsible for the normal pink colour in cooked meat is hemochrome, derived from the reaction of myoglobin with non-heme constituents. Browning is due to the formation of metmyoglobin in the muscle through autoxidation of ferrous myoglobin. Greening is due to pigments resulting from the oxidation of hemochrome that occurs when the meat is unduly exposed to oxidative condition during and after cooking.

Proper evisceration and removal of blood immediately after catch can reduce the risk of discolouration in tuna. It has been suggested that undesirable changes in yellowfin tuna meat can be averted if the fish is frozen at full rigor, stored at a temperature of -23° to -27° C and defrosted by still air at 10°C (Tanaka 1961).

CANNING

Canned tuna is a very popular item in several countries abroad particularly Japan, U.S.A., U.K., Canada as well as Western and Eastern Europe. There is no organised canning activity in India meant particularly for tuna except for that at Minicoy where a plant set up exclusively for canning tuna can produce about 1500 cans of 200 g net wt each per day. Other plants on the mainland occasionally process canned tuna depending on the availability of raw materials and demand from the market. Apart from its export potential canned tuna is also steadily gaining a domestic market.

A recent study has estimated the annual sales of canned fish products in the domestic market as being between 1000 and 1500 tonnes of which 60% is consumed by the civilian sector and the rest by the Armed Forces. This survey also highlights a severe under supply of canned fishery products especially for the military use. It is also stressed that the domestic market could easily consume double the present quantity without any promotional activity. Products now popular in these markets are canned sardine and mackerel, shippers and hoteliers being significant consumers for canned tuna (Rogers, Coulter and Jeffs, 1986).

It should be emphasised here that due to shortage and consequent rise in the price of sardine and mackerel most of the canneries have not been able to supply steadily to these markets. They work only for periods ranging from 40-120 days per annum. The cost of sardine and mackerel rising to uneconomic levels for canning, tuna and related oceanic species are sure to gain a place of prominence in the Indian canning sector.

Indian Standards Institution (Now Bureau of Indian Standards) has laid down quality standards for tuna canned in oil (IS:4304, 1976). According to these specifications only those species specified in Table-10 can be used for canning. Of these the canning requirements for three species viz. skipjack, yellowfin tuna and bigeye tuna to yield products conforming to the quality requirements laid down in Indian Standards have been worked out (Madhavan and Balachandran, 1971).

A good quantity of Indian catches of tuna is comprised of dark meat varieties, a prominent one being little tuna (Euthynnus affinis) which is not covered by the species mentioned by ISI. The dull colour of the meat, high proportion of red meat and the generally unacceptable taste and flavour reduces its overall acceptability either for fresh consumption or processing. To improve its acceptability in canned form a process has been worked out which involves canning in oil spiced with extract of red chilly. The red colour of oil masks the dull colour of meat and the slight pungency improves the overall taste and flavour of the pack (Balachandran, Vijayan and Jose Joseph, 1982).

Tuna canned in oil is most popular, but brine peak also is acceptable. A new trend is packing fish meat along with vegetables, peas, onions, etc. in spiced oil (Table 11).

MASMIN

A traditional product processed out of skipjack in Lakshadweep, masmin is a cured/smoked product. A substantial portion of the landed skipjack is converted into masmin. This is a product which also enjoyed some export market, particularly in the neighbouring south east Asian countries. However, the traditional product is processed employing crude methods and offers plenty of scope for improvement. With a view to improving its quality and increasing its marketability a modified method has been worked out which is as follows:

Fillets from fresh fish after washing are wound with ribbon like split green coconut leaves to prevent breaking of the meat and boiled for an hour in 3% salt solution or a mixture of sea water and fresh water in tinned copper vessel. After cooling the fish is smoked in a chamber for 3-4 hours. The coconut leaf winding is removed from partially smoked strips which are then dried for few hours. Smoking and drying are repeated three or four times until the meet strips are hard and dark brown in colour. The product has a normal shelf life of over an year. But with special care during storage and occasional redrying and resmoking it can be kept well for three to four years. Flow sheet for production of masmin is given in Table-12.

Being a low moisture product masmin is less prone to bacterial and enzymic spoilage. However it faces a serious threat in its susceptability to insect infestation, which occurs mostly when the product is in store. Infested products gradually gets reduced to a fine powder.

The islanders claim temporary protection against insect menace by covering the finished product with dry loose sand. As long as the product is under sand insect activity may be kept curbed. But contamination by insect eggs might have already taken place at any of the stages of processing and under favourable conditions the eggs may hatch and larve may come out. This may occur in the product which is ready packed for the market.

A very simple and effective method has been worked out to control insect infestation in masmin. This involves heat treating masmin for 15 minutes at 125°C followed by cooling and hermetically sealing in suitable containers (Valsan, 1968).

TUNA SHAVINGS

Another smoked cured product processed out of tuna is 'fish shavings'. The method of preparation involves dipping tuna fillets in saturated brine for an hour followed by smoking at 70-80°C for eight hours. The smoked fillets are further dried in air at 70°C for about 16 hours. The fillets which have become very hard by this time are trimmed and converted into thin shavings using a carpenter's planer. This can be packed in polythene bags or glass bottles and can be stored at ambient temperatures. Shelf life of the product is estimated as six months (Lokesh, Chandrasekhar and Hanumanthappa, 1987). Flow sheet for production of tuna shavings is given in Table-13.

TUNA PASTE

Tuna paste is another traditional product in Lakshadweep. This is prepared from the water used for boiling tuna fillets for processing masmin. Traditionally three parts of sea water with one part of fresh water is used for boiling tuna fillets. The same water is repeatedly used for boiling fresh batches of fillets until the water becomes thick. It is then further concentrated to yield a thick paste. Scrappings of dried masmin is some times added to the paste which will increase its nutritional value. The paste is stored in earthen ware vessels and is used as a flavouring agent. Shelf life of tuna paste is normally one to two years. Apart from the particular flavour it imparts, tuna paste is also good nutritionally. Proximate composition determined on a representative sample of paste is given in Table-14 (Valsan, Kandoran and Rao, 1964).

TUNA MEAT PICKLE

An an appetizer and as a side dish, pickles made out of a variety of vegetables, fish, shell fish or meat find a prominent place in Indian cuisine. Though became popular only recently, fish pickles are gaining popularity in the domestic market. There is more or less a sustained export market also for this commodity. Tuna meat has been found quite suitable for processing pickles. Light salted and partially dried small pieces of tuna meat (including black meat) is fried in vegetable oil and is mixed with prefried ingredients like ginger, green chilly, garlic chilly powder, and other flavouring agents etc. It is then well mixed with the required quantity of vinegar and balance salt, allowed to stand for few days and then packed in clean dry wide mouthed glass jar and closed (Vijayan, Balachandran and Surendran, 1987). It has been observed in the case of tuna pickle that absorption of vinegar by the fried pieces of fish is rather slow which is turn affects the hemogeneous appearance of product. Addition of a small quantity of edible gum like gum guaiac can correct this defect.

TUNA MEAL

As is true of any fish processing industry tuna processing also turns out good quantity of waste. The viscera alone will work out 3-8% of the whole weight of tuna. Head, fins, bones and red meat, if not used for human nutrition as discussed elsewhere, will be available as waste. An efficient way of utilization of this waste will be converting them into fish meal.

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Table 1 a. Production of preserved and processed tuna commodities except canned

Qty. in tonnes

	1981	1982	1983	1984	1985	1986
Frozen (excluding fillets)	60620	190542	144827	130315	152446	172387
Dried and unsalted	23708	27478	28628	26329	30324	31620
Dried, salted or in brine	88816	97047	99426	97503	97302	100703
Smoked	17220	18437	20638	18686	20996	21536

Table 1 b. Production and export of processed and preserved tuna (canned)

	1981	1982	1983	1984	1985	1986
Production	678283	636896	702077	781155	802273	913340
Exports	142811	136801	171901	199745	242921	306311

Table 2 a. Export of frozen tuna from India

Country		1978	1980	1986	1987
U.K.	Q	635			
	V	4,329			
Singapore	Q		20		
	V		160		
Japan	Q			2,90,940	49,995
	V			26,42,146	6,44,997
Switzerland	Q			30,000	
	V			3,71,245	
Malaysia	Q				38,304
	V				3,73,799
Italy	Q				38,249
	V				3,77,925

Q = Quantity - Kg. V = Value - Rs.

Table 2b. Export of canned tuna from India

Country		1978	1979	1980	1981	1984
Belgium	Q	12,480				
	V	2,01,643				
Spain	Q	1,056				
	V	18,015				
Saudi Arabia	Q		108			
	V		2,012			
U.A.E.	Q		368	2,919	5,376	720
	V		13,123	1,05,119	2,45,271	24,659
Iraq	Q				4,800	
	V				1,27,744	
Fed. Rep. Germany	Q			4,800		
	V			1,18,374		

Q = Quantity - Kg. V = Value - Rs.

Table 3. Proximate composition and calorific value of red and white meat of tuna in relation to liver tissue and whole egg

Type of meat	Moisture %	Fat %	Protein %	Carbo-hydrate %	Calorific value Kcal/100 g
Red meat	69.37	4.631	18.28	0.750	120
White meat	70.94	3.056	18.90	0.263	104
Liver tissue	70.90	4.200	19.80	3.60	133
Egg whole	74.00	11.50	12.80	0.70	159

Table 4. Amino acid composition of red and white meat of tuna

	Amino acid composition g/100g dry muscle	
	Red meat	White meat
Isoleucine	5.00	5.53
Leucine	8.57	8.50
Lysine	4.17	9.48
Methionine + cystine	3.88	3.80
Phenyl alanine	4.31	4.64
Tyrosine	Not determined	
Threonine	4.99	5.38
Valine	4.24	5.36
Histidine	2.38	5.36
Glutamic acid	13.35	14.01
Tryptophane	0.45	1.70
Arginine	4.65	5.95
Serine	3.83	4.59
Proline + hydroxy proline	7.18	6.21
Aspartic acid	7.46	7.92
Glycine	3.93	2.86

Table 5. FAO/WHO suggested pattern of essential amino acids

	Amino acid requirement g/day		
	Infant	Child	Adult
Isoleucine	3.5	3.7	1.8
Leucine	8.0	5.6	2.5
Lysine	5.2	7.5	2.2
Methionine + cystine	2.9	3.4	2.4
Phenyl alanine	6.3	3.4	2.5
Threonine	4.4	4.4	1.3
Valine	4.7	4.1	1.8
Histidine	1.4		

Table 6. Mineral composition of red and white meat of tuna in comparison to that of skim milk powder mg/100 g.

	Sodium	Potassium	Calcium	Iron
Red meat	107.3	78.5	442.2	36.47
White meat	156.75	1290.3	590.0	10.68
Skim milk powder	318.0	1240.1	1008.0	1.5

Table 7. Vitamin A and D content in tuna 1U/g

	Vit. A	Vit. D
Tuna white meat	140	7.5
Tuna red meat	1500	850.0

Table 8. Proximate composition of experimental diets

	Red meat diet	White meat diet	Skim milk powder diet
Moisture %	10.00	10.00	10.00
Protein %	10.00	10.00	10.00
Fat in protein source %	1.19	0.18	10.00
Ground nut oil %	-	1.01	1.09
Carbohydrate %	76.50	75.20	76.70
Balance as ash %	3.50	3.70	2.20

Table 9. Summary of results of feeding trials

	Average total intake kg.	Haemoglobin % before	Haemoglobin % after	Weight gain kg.	Height gain cm.
White meat diet	3.52	9-13.5	11-14	0.5-3.4	1.9-9
Red meat diet	3.37	9-13	13.1-16	0.25-1.75	1.3-4.5
Casein diet control	3.76	8.5-12	10.1-14.3	0-1.5	1-3.7

Table 10. Species of tuna which can be used for canning (as per IS 4304 - 1976)

English name	Species name
Yellowfin tuna	*Thunnus albacares*
Albacore	*Thunnus alalunga*
Bluefin tuna	*Thunnus thunnus* syn. *Thunnus thunnus orientalis*
Big eye tuna	*Thunnus mebachi* syn. *Thunnus obesus mebachi*
Northern bluefin tuna	*Thunnus tonggol* syn. *Kishionella tongga*
Oceanic skipjack	*Katsuwonus pelamis*

Table 11. Flow sheet for tuna canning

Tuna

Brine freezing on board

Drying up and holding in dry storage

thawing before unloading (temp. of fish about 28°F)

unloading

Quality evaluation
(mostly by organoleptic means)

grading

Butchering (removes viscera)
Cleaning in water

Precooking in steam after arranging in wheeled racks

Cooling (generally in cold rooms)

Cleaning, cutting and canning

Cleaned meat packed in cans, salt, oil and other optional flavouring ingredients added, exhausted, sealed and retorted.

Table 12. Flow chart for production of masmin

Tuna fillets

Winding with ribbon-like split green coconut leaves

Boiling in brine for an hr.

Cooling and smoking for 3-4 hrs in a chamber

Removing the coconut leaf winding and drying

Repeated smoking and drying for 3-4 times to get hard-brown product

Packing in gunny bags or other suitable containers

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Table 13. Flow sheet for production of tuna shavings

Tuna fillets

Brining in salted brine for one hour

Draining, smoking at 70°-80°C for eight hours

Drying smoked fillets in air at 70°C for 16 hours

Trimming the fillets and converting into shavings using carpenter's planer

Packing in polythene bags or glass bottles

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Table 14. Proximate composition of tuna paste

Moisture (%)	:	43.53
Total solids (%)	:	56.47
Ash content (%)	:	17.95
Acid insoluble ash (%)	:	0.07
Salt content (NaCl) (%)	:	10.40
Fat (dry wt. basis) (%)	:	0.60
Total nitrogen (%)	:	6.56
Non-protein N (%)	:	5.63
Amino N (%)	:	1.43
T.V.N. mg (%)	:	309.00
Calcium (%)	:	0.43
Phosphorus-P_2O_5 (%)	:	2.77

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EXPORT MARKETING PROSPECTS FOR TUNA

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INTRODUCTION

Success in the fishing industry depends not only on catching fish but also on knowing where and how to market fish. Increased production in itself is not enough to ensure greater economic returns from fisheries activities unless it occurs in combination with good marketing opportunities, increased marketing efforts and accurate and up-to-date market information.

Tunas are highly migratory fish that are widely distributed throughout the world oceans. Six species represent the focus of the economic interest in tunas viz., Skipjack tuna (*Katsuwonus pelamis*), Yellowfin tuna (*Thunnus albacares*) Bigeye tuna (*Thunnus obesus*), Albacore tuna (*Thunnus alalunga*), Southern Bluefin tuna (*Thunnus maccoyii*), and longtail tuna (*Thunnus tonggol*). The Frigate tuna (*Auxis thazard*), bullet tuna (*A. rochei*) the Sail fish (*Istiophorus platypterus*), the Black marlin (*Makaira indica*), the Blue marlin (*Makaira nigricans*), the Striped marlin (*Tetrapturus audax*), and the Swordfish (*Xiphias gladius*) constitute the Tuna like fishes.

More than 70 nations harvest tunas, of which five account for 70% of the total catch. These are, in the order of importance, Japan (39%), USA (13%), Spain (6%), Philippines and Indonesia (5% each). Approximately 36% of the catch is consumed by Japan and 31% by the USA.

Based on their market value and utilisation tunas can be grouped as follows: (i) White meat species (albacore), (ii) light meat species (yellowfin, skipjack, bigeye, southern bluefin, longtail tuna and yellowfin and bluefin) and (iii) tuna-likefishes (bonito, frigate and bullet tunas). Albacore tuna has the highest market preference in the USA because of the colour and flavour of the meat. Canned and frozen tunas are also preferred in the USA market. In Japan, which is the second largest market, tuna is used in two ways. One is 'sashimi' (raw eating) and the other is processing the raw material as canned products. However, only about 10% to 15% are estimated to be used in the canneries. Other countries in the Western Europe which form the third largest market for tuna products, mainly Italy, West Germany, France, Spain, Switzerland and U.K. entirely depend on either white meat or light meat species of tunas for their canneries. The tuna market structure in Japan, USA and the EEC countries and the future prospect of international trade on tuna products are examined in the present paper.

CURRENT SITUATION IN WORLD TUNA PRODUCTION & MARKETING

Tuna landing in the Eastern pacific between 1 January and 21 November 1988 amounted to 3,12,000 MT, about 20,000 MT more than in the same period of 1987. Most of the increase consisted of skipjack tuna in the western Pacific landings from January to October, 1988 in the South West Indian Ocean amounted to 150,000 MT which is 30,000 MT more than in the same period of 1987. The surplus consisted of yellowfin tuna. The Japanese tuna landings in the first three quarters of 1988 amounted to 417,000 MT, which is about 65,000 MT over the same period of 1987. All the increase consisted of skipjack. The present status of exploitation of the commercially important species of tunas is given in Tables 1 to 4. The markets for the major varieties of tunas are given in Tables 5 to 7.

JAPANESE TUNA MARKET

In comparison to the markets in the USA and Western Europe,the Japanese tuna market is quite diversified. Approximately 90 percent of the annual supply of bill fish, bluefin, bigeye and yellowfin tuna is utilised as fresh fish and sold in the 'sashimi' market. The remainder, an increasing portion of which is yellowfin is used primarily as raw material for canning.

Albacore is exclusively used for canning. Skipjack is used for the widest range of products. About 65% of the skipjack consumed on the domestic market is smoke-dried(Arabushi, katsuobushi and Kesuribushi)and 15% canned. The remaining portion is used for other purposes including Sashimi and Tataki (lightly roasted skipjack). Canned products account for 60-70 per cent of the skipjack exports; the rest is frozen skipjack exported for canneries abroad. The Japanese tuna production and import of tuna into Japanese markets during 1985-88 are given in Tables 8, 9 and 9(a) respectively.

The main suppliers of tuna are South Korea and Taiwan. They export mainly Sashimi tuna. The appreciation of Yen has been an incentive for these countries to increase their exports to these countries. Since tuna for Sashimi is used as a raw product, the highest possible quality is required.

Generally tuna with higher fat content are deemed as products of higher quality and are more expensive. Tunas caught in the colder currents of the sea, such as bigeye in the waters north of Hawaii and Southern bluefin have a higher fat content and are accordingly of higher quality. On the other hand tunas caught in the waters of lower latitudes., particularly, in tropical waters, are assumed to be of low quality. In the case of tunas caught in the waters of the same latitude, fish from deeper waters have a higher fat content than fish from the surface. Higher fat content is observed in the belly and this portion is called 'tore' which is most preferred in Japan. Other parts with reddish colour and low fat content are called 'Akami' and are assessed as low quality products (Tanabe, 1987).

The second consideration of the sashimi tuna is freshness and appearance of the products. The Japanese people attach importance to appearance such as colour, lusture and shape which are related to freshness. Raw fish is eaten frequently and freshness is extremely important for keeping flavour, aroma and texture in the raw fish. Even in cooked food, freshness is important as fish are often cooked simply and seasoned lightly to retain the natural taste and quality of the fish.

In 1988, the Japanese market is directed more towards yellowfin tuna, primarily for sashimi and secondly for canning. As the Yellowfin catch is stable around 120,000 MT annually, Japan has to meet demand through imports. In January/September '88 as much as 88,300 MT were imported, nearly 20,000 MT more than in the same period of 1987. Major yellowfin exporters to Japan are traditionally the Republic of Korea and Taiwan, but in 1988 Mexico emerged, shipping 14,200 MT during the first three quarters of 1988, compared to only

3,400 MT in the same period of last year (GLOBE FISH Highlights, 4/88). The Japanese albacore landings in 1988 are relatively poor (14% less in January/ September 1988 compared to the previous year) and prices have increased steadily in recent months to reach US $ 2900/MT in October 1988 on the Shimizu auction market.

USA TUNA MARKETS

The USA is second to Japan as the World's largest tuna producer. It is, however, the most important tuna canning nation in the world, the largest importer of frozen and canned tuna and the principal market for canned tuna products. On an average, 32% of the World's annual tuna catch are being sent to the US market. The preliminary landings and values of fresh/frozen tuna at US ports by US vessels during 1983-87 is given in Table 10 and Table 11, the import of tuna by USA is summarised. Imports of canned tuna to the USA were 31% higher - at 122,000 MT - in Jan./Sept. 1988 period than in Jan./Sep. '87, with Thailand keeping its leading market share. The canned tuna imports are expected to grow and exceed 40% of the annual market requirements by 1990.

EUROPEAN TUNA MARKETS

The European market for tunas, like the US market, is basically for canned products, although fresh tuna consumption is proportionately more important than in the USA. The preferred species are warm water or tropical ones, the European market is of considerable relevance to most developing countries of the Indo-pacific region. The important canned tuna markets are West Germany, UK and France absorbing about 75% of the total European canned supply, while the Scandinavian and Benelux markets are relatively small. Only France and Spain have significant fishing industries and France is by far the largest market for canned tuna in Western Europe.

The canned tuna market in Europe have grown rapidly over the years and continued to expand in 1987. Import volumes maintained their strong annual growth rate of 12% while prices were as an average 5% lower (in local currency) for the first 9 months of 1987 compared to that of the previous year. European domestic production increased and specialised in high value products, promoted by large brand named companies. The source-wise imports of canned tuna products into some of the leading countries in the Western European market are given in Tables 12 to 14.

THE SOUTHEAST ASIAN TUNA TRENDS

The tuna industries of two Southeast Asian Countries, Thailand and Philippines, have registered mixed fortunes.

The Philippines tuna industry remained static over the last five years, despite recent growth in the world canned tuna market. Production is heavily dependent on domestic production. Philippines canned tuna recovered and new markets were found within the EEC, which now accounts for 60% of the country's total canned tuna exports. There is less dependence on the US market which is expected to be beneficial in the long run. The export details of Philippines canned tuna is given in Table 15.

Thailand's trade figures are shown in Tables 16 and 17. Its early trade figures show a decline in 1987, frozen skipjack and bonito imports of nearly 25% compared to that of 1986. Despite the decline in frozen skipjack imports, exports of canned tuna exceeded slightly the 1986 record level. This was due to the increased yellowfin imports and by the use of cold storage holdings for canned production. In early 1988, Thai canneries also suffered strong competition for raw material from the USA and Japan and imports will have to be sought increasingly from other tuna catching nations.

TUNA FISHING INDUSTRY IN INDIA

It has been reported that 22 species of tuna and tuna-like fishes belonging to the tribe Thunnini and Sardini of the family Scombridae and bill fishes belonging to the families Istiophoridae and Xiphiidae are distributed in the Indian Ocean. Longtail tuna (T. tonggol) occurs mostly in the coastal waters. Skipjack (Katsuwonus pelamis) is a cosmopolitan species distributed in tropical and subtropical waters. Other species grouped under tuna-like fishes are distributed in coastal waters. All billfishes are widely distributed in the oceanic waters and the sailfish also occurs in coastal waters. India has virtually no share of the commercial catches of these species from the Indian Ocean except perhaps the marginal exploitation of the young yellowfin stock touching Lakshadweep archipelago, where the skipjack is the main resource which sustains the traditional pole and line fishery of the region.

Silas and Pillai (1982) suggested that the potential for increasing catches of tuna and related fish in the Indian ocean over the 1979 catch would lie between 0.28 to 0.55 million t. It is expected that a large part of this potential, increase is made up of skipjack tunas (0.19 to 0.37 million t. and small coastal tunas (0.04 to 0.13 million tonnes). For tunas and allied fish within India's EEZ the authors quote estimates of a potential increase of approximately 0.21 million tonnes. They suggest a 1990 production target of India's tuna fisheries of 115,000 MT of tunas or an increase of some 95,000 MT above the average 1978-79 catches. This estimates include 20,000 MT of large oceanic tunas and billfishes which will be produced by longlining.

Recently exploratory longlining by the Fishery Survey of India (FSI) and Central Institute of Fisheries Nautical and Engineering Training (CIFNET) vessels have indicated high hooking rates of the larger oceanic tunas and pelagic sharks from the EEZ of the country. It is seen that the yellowfin tuna is the dominant species in these catches in the Indian waters, whereas, bigeye tuna was more abundant in the equatorial waters and the albacore confined to Andaman Nicobar Seas (Joseph and John, '86). The very high hooking rate of yellowfin tuna (24-33%) off Karnataka within 150 miles from the coast by FSI and CIFNET vessels is of significance in these surveys.

In spite of the tuna resources availability as revealed by exploratory surveys and stock assessments, our present production is about 28,000 MT, the entire production almost coming from the coastal waters. We had recently introduced the three deep sea fishing vessels for tuna and export performance is given in Table 18.

MARKET PROSPECTS

Currently the world tuna market is getting strong. Despite ample supplies, the prices were not affected in 1988. The demand also remained steady because most of the export market wanted good stock of the raw materials in case the situation deteriorated (as it did in early 1987), and because the reexpanding of the US market created good opportunities and exigencies. The stabilisaztion of the US dollar signs that it could regain value slowly in the near future has been a significant incentive to this general trend. In fact, the battle for raw marterial is still ranging as canneries in the South East Asia prepare their finished products stocks for the opening of the low duty quota in the USA in 1989. In addition, consumption of canned tuna and fresh and frozen tuna continues to increase in the industrialised countries. From the outside, tuna looks like a market completely dominated by established producers, and impervious to new competition. This is not so. Developing countries like India has definitely good opportunities to enter into this market by diversifying our deepsea and distant water fishing. The market may be saturated with conventional products and constrained by unimaginative marketing. But, it is wide open to newcomers who can think beyond these limits.

TABLE 1. ALBACORE PRODUCTION

Area	Average production (MT)	Exploitation	Major Fishing nations
North west Pacific	53000	Fully exploited	Japan
North west Atlantic	30000	Fully exploited but recovering	Spain
Eastern central Pacific	25000	Some potential	USA, Japan, Taiwan Pc.

TABLE 2. YELLOWFIN PRODUCTION

Area	Average production (MT)	Exploitation	Major Fishing nations
Western Central Pacific	200000	Fully exploited	Japan, Philippines, USA, Indonesia
Eastern Central Pacific	140000	Fully exploited but recovering	USA, Mexico
Eastern Central Atlantic	110000	Fully exploited but recovering	Spain, France
Western Indian Ocean	50000	Nearing full exploitation	France

TABLE 3. SKIPJACK PRODUCTION

Area	Average Production (MT)	Exploitation	Major Fishing Nations
Western Central Pacific	380,000	Potential in some areas	Japan, USA, Indonesia, Philippines
North West Pacific	150,000	Fully exploited	Japan
Eastern Central Atlantic	110,000	Fully exploited	Spain, France
Eastern Central Pacific	110,000	Fully exploited	USA, Japan

TABLE 4. BIGEYE PRODUCTION

Area	Average Production (MT)	Exploitation	Major fishing nations
Eastern Central Pacific	60,000	Nearing full exploitation	Japan
Eastern Central Atlantic	30,000	Fully exploited	Spain, Japan
Western Indian Ocean	25,000	Some potential	Korea Rep.
Western Central Pacific	22,000	Fully exploited	Japan

TABLE 5. ALBACORE MARKETS

Country	Product Forms				
	Fresh	Sashimi	Frozen	Cured	Canned
USA			*		X
Japan			X		X
Spain	X		*		X
France	X		*		X
Switzerland					*

TABLE 6. YELLOWFIN MARKETS

Country	Product Forms				
	Fresh	Sashimi	Frozen	Cured	Canned
Japan	X *	X *	X *		X
Italy			*		X
USA			X *		X *
France			X *		*
United Kingdom					*
Spain	X		X		X
Canada					*

TABLE 7. SKIPJACK MARKETS

Country	Product Forms				
	Fresh	Sashimi	Frozen	Cured	Canned
Japan	X		X	X	X
USA			X *		X *
France			X *		X *
United Kingdom					*
FR Germany					*
Thailand			*		
Canada					X *

X = domestic * = imports

TABLE 8. JAPANESE TUNA LANDINGS

	January/September				Total
	1985	1986	1987	1988	1987
			(1000 MT)		
Bluefin					
fresh	2.5	2.6	3.5	2.6	3.9
frozen	12.3	9.6	8.6	7.4	12.8
Albacore					
fresh	10.9	11.2	12.8	12.2	18.8
frozen	29.2	23.3	22.9	18.5	28.2
Bigeye					
fresh	9.0	6.8	6.5	4.7	9.4
frozen	57.9	65.8	66.5	57.2	90.1
Yellowfin					
fresh	23.5	12.1	13.6	12.3	15.4
frozen	24.5	23.1	21.0	20.3	29.5
Skipjack					
fresh	41.8	68.7	18.8	52.5	61.8
frozen	134.9	173.5	144.4	197.8	195.6
Total					
fresh	87.7	101.4	88.9	115.9	109.3
frozen	288.0	295.3	263.4	301.2	356.2
Grand total	375.7	396.7	352.3	417.1	465.5

(Source: GLOBEFISH Highlights, 4/88)

TABLE 9. JAPANESE IMPORT OF TUNA AND TUNA-LIKE FISH

Q = Tonnes
V = US $ '000

	Fresh/Chilled/ frozen		1986	1987	1988
1.	Skipjack	Q:	2879	3854	3430
		V:	2260	3335	3527
2.	Albacore	Q:	2433	2992	3135
		V:	3338	4044	5534
3.	Yellowfin	Q:	66781	98106	120099
		V:	180106	248365	340740
4.	Bluefin	Q:	5246	5101	6231
		V:	44874	47845	87374
5.	Bigeye	Q:	60820	74418	77410
		V	188332	275965	358447
6.	Other Tunas	Q:	--	746	38
		V:	--	4796	196
7.	Marlin	Q:	16948	17217	14834
		V:	43323	48892	39365
8.	Fillets of Tuna and Marlin	Q:	--	3627	4672
		V:	--	26005	33653
	Total	Q:	155107	206061	229849
		V:	462233	659247	868836

(Sourcce: Japan Marine Products Importers Association)

TABLE 9(a). IMPORT OF TUNAS BY MAJOR COUNTRIES INTO JAPAN (JANUARY - OCTOBER)

Q = Tonnes V = US $ '000

	1987		1988	
Countries	Quantity	Value	Quantity	Value
I. FRESH OR CHILLED				
Korea	108	267	63	492
Taiwan	16547	113332	14108	110089
Philippines	3103	21253	3142	24518
Indonesia	873	5979	1857	14491
Guam	633	4335	441	3441
Australia	1035	7089	606	4729
Turkey	229	1568	92	718
USA	1591	10897	2125	16582
Singapore	314	2151	1658	12938
Sub-total (A)	24703	166871	26171	187998
II. FROZEN				
Korea	58428	400178	55670	434409
Taiwan	33118	226828	37891	295675
Panama	9327	63881	7471	58298
Indonesia	10544	72217	11827	92290
Mexico	3456	23670	16949	132258
Australia	3259	22321	1906	14873
USA	1738	11904	2752	21475
Singapore	1753	12006	4222	32946
Sub-total (B)	133908	833005	156956	1082224
Grand total (A+B)	158611	999876	183127	1270222

TABLE 10-USA: PRELIMINARY LANDINGS AND VALUES OF TUNA AT US PORTS BY US VESSELS, JANUARY TO DECEMBER

Q: Quantity in tonnes
V: Value in US$ '000

		1986	1987	% variation
Yellowfin	Q:	26300	30643	16
	V:	32126	54152	45
	$/T:	1219	1767	
Albacore	Q:	5155	3505	-32
	V:	6087	6037	46
	$/T:	1181	1722	
Skipjack	Q:	2314	7219	212
	V:	3237	8700	-14
	$/T:	1399	1205	
Bluefin	Q:	4846	1964	-59
	V:	6791	16463	498
	$/T:	1401	8382	
Bigeye	Q:	628	1499	139
	V:	5092	9495	-22
	$/T:	8113	6301	
Others	Q:	517	545	5
	V:	1242	1006	-23
	$/T:	2400	1846	
Total	Q:	39821	45375	14
	V:	54575	95803	54
	$/T:	1371	2111	

(Source: National Marine Fisheries Service)
(U.S. Department of Commerce)

TABLE 11 - U.S.: IMPORT OF TUNA

Q: Quantity in tonnes
V: Value in US$ '000

		1986	1987	% variation
Fresh or frozen	Q:	207491	200403	-3
	V:	238832	253907	10
	$/T:	1151	1267	
Canned	Q:	107329	96019	-11
	V:	228626	206920	1
	$/T:	2130	2155	
Total	Q:	314820	296422	-6
	V:	467458	460827	-1
	$/T:	1485	1555	

(Source: National Marine Fisheries Service)
(U.S. Department of Commerce)

TABLE 12. IMPORTS OF CANNED TUNA INTO UK

Country of origin	January/September 1985	1986	1987	1988	Total 1987
			(1000 MT)		
Thailand	2.9	13.0	15.2	18.3	18.1
Fiji	2.1	2.3	3.1	4.0	4.1
Mauritius	2.4	2.2	1.9	2.4	2.4
Philippines	2.2	1.9	1.4	1.4	1.5
Cote d'lvoire	2.7	2.3	0.9	1.1	1.9
Solomon Isl.	0.7	0.7	1.0	0.6	1.4
Japan	3.0	2.1	0.5	0.2	0.8
Total	18.2	26.7	25.6	30.7	32.3

TABLE 13. IMPORTS OF CANNED TUNA INTO FRANCE

Country of origin	January/September 1985	1986	1987	1988	Total 1987
			(1000 MT)		
Cote d'lvoire	12.4	13.3	22.0	19.1	27.0
Senegal	16.1	13.9	15.3	13.1	19.1
Seycchelles	0.0	0.0	0.0	2.8	0.5
Others	0.1	0.2	0.4	0.3	0.3
Total	28.6	27.4	37.7	35.3	46.9

Source: GLOBEFISH Highlights 4/88

TABLE 14. IMPORTS OF CANNED TUNA INTO FED.REP. OF GERMANY

Country of origin	1984	1985	1986	Jan.Nov. 1986	Jan.Nov. 1987
Thailand	7.3	10.8	15.1	13.9	15.3
Philippines	4.3	3.8	6.1	5.6	7.7
France	1.8	1.6	1.8	1.6	1.6
Taiwan, PC	2.6	1.3	1.2	1.2	1.3
Senegal	1.3	0.7	0.1	0.1	0.0
Others	1.9	0.9	1.2	1.0	1.9
Total	19.1	19.7	25.4	23.4	27.8

(Source: GLOBEFISH Highlights 1/88)

TABLE 15. EXPORTS OF CANNED TUNA BY PHILIPPINES

Destination	1984	1985	1986	1987
		(1000 MT)		
USA	11.1	16.5	13.2	10.1
Germany, FR	5.2	4.4	8.8	7.9
UK	3.3	2.6	2.2	7.9
Canada	2.2	2.8	1.2	1.3
Netherlands	0.2	0.2	0.4	1.2
Mozambique	*	*	1.1	0.5
Israel	*	*	0.6	0.5
Sweden	0.6	0.4	0.5	*
Others	1.9	1.0	1.1	4.8
Total	24.5	27.9	28.9	28.6

* included under others

TABLE 16. IMPORTS OF FROZEN TUNA (SKIPJACK AND BONITO)

Origin	1984*	1985*	1986	1987
		(1000 MT)		
USA	30.0	38.0	60.6	35.6
Japan	50.0	30.0	24.8	14.7
Indonesia	8.0	14.0	11.6	13.2
Taiwan, PC	-	-	1.1	12.4
Maldives	12.0	13.0	15.1	11.2
Solomon Islands	-	-	25.0	10.3
France	-	15.0	12.7	9.6
Seychelles	-	-	13.1	8.9
Korea, Rep	-	-	1.7	6.9
USSR	-	-	0.2	5.9
Singapore	-	-	9.4	4.0
Others	-	-	19.2	15.3
Total	100.0	120.0	194.5	148.0

* estimates from the Thai Food Processor Association

TABLE 17. EXPORTS OF CANNED TUNA BY THAILAND

Destination	1985	1986	1987
		(1000 MT)	
USA	59.2	79.5	69.0
UK	5.6	19.8	19.7
Canada	3.0	8.5	12.9
Germany, FR	7.4	11.2	12.7
Netherlands	1.6	3.6	4.7
Finland	1.1	1.9	3.6
Australia	1.6	2.6	3.5
Sweden	1.0	1.6	2.8
Denmark	1.3	2.5	2.0
Others	2.5	7.6	14.1
Total	87.1	142.0	145.0

(Source: GLOBEFISH Highlights 2/88)

TABLE 18. EXPORTS OF FROZEN TUNA FROM INDIA

Q: in tonnes
V: in Rs. lakhs

		1988-89 (APR-FEB)	1987-88	1986-87
Seychelles	Q:	140	-	-
	V:	14.57	-	-
Singapore	Q:	125	-	-
	V:	15.15	-	-
U.K.	Q:	63	-	-
	V:	13.73	-	-
Japan	Q:	-	50	160
	V:	-	6.45	18.03
Malaysia	Q:	-	-	38
	V:	-	-	3.74
Thailand	Q:	-	8	-
	V:	-	0.74	-
Italy	Q:	-	38	-
	V:	-	3,7	-
Switzerland	Q:	-	-	30
	V:	-	-	3.71
Spain	Q:	-	17	-
	V:	-	1.75	-
TOTAL	Q:	328	113	228
	V:	43.45	12.71	25.48

STATUS OF INFRASTRUCTURE AND DEVELOPMENT NEEDS FOR TUNA FISHING

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Sizeable stocks of tuna, particularly Yellowfin and Skipjack, are known to occur in the Indian Exclusive Economic Zone. It is also known that Big eye tuna also occurs, although in smaller quantities, apart from various other tuna and tuna-like species. What was a mere surmise concerning significant availability of tuna stocks in Indian waters until a few years back, has now been confirmed beyond doubt. The tuna vessels of the Fishery Survey of India and the Central Institute of Fisheries Nautical and Engineering Training, apart from over 25 chartered tuna long liners operating in Indian waters have been landing in a consistent manner substantial quantities of tuna, particularly Yellowfin, and Bigeye to some extent, apart from other tunas and tuna - like fishes. The hooking rate is reported to have been as high as 40%, while the common rate of hooking is stated to be from 10 to 20%, the lowest being 6%. There is, thus, an ample reassurance to the industry that tuna is an eminently suitable alternative target species with export potential for diversification of deep sea fishing in Indian waters. The benefit that flows out of this conclusion is that the existing shrimp trawlers, all of which operate for part of an year, can be equipped suitably for fishing for tuna.

As is known, there is more than one method for fishing for tuna. These include, purse-seining, long lining, pole and line fishing and gill netting. Of all these methods, it is felt that long lining system which has yielded good commercially viable results in Indian waters, is eminently suitable for incorporation on the presently operated shrimp trawlers, without in any way upsetting the existing arrangements on them for trawling. The bulk of the vessels constituting shrimp fishing fleet are not equipped to undertake deep sea lobster fishing operations. For these as well as the others, addition of tuna long lining system will undoubtedly prove to be a major means to impart year-round operational viability and a new hope to the owners of shrimp fishing vessels who are now engulfed by an economic crisis because of the limitations on shrimp trawling duration.

A study has been conducted by the Association of Indian Fishery Industries and it is seen that the aft-deck of shrimp trawlers has sufficient space to accommodate tuna long lining equipment capable of operating lines having a length of 30 to 60 km (600 to 1200 hooks) for 23 m long vessels and 60 to 90 km (1200 to 1800 hooks) in the case of 25 to 27 m long vessels.

The addition of tuna long lining equipment on the decks of the presently opertated vessels is now found feasible because of the successful introduction of mono-filament long lining system along Florida coast of USA in the past few years. This system eliminates the need to use cumbersome line haulers and other equipments. The compactness of the American system arises from the fact that 3.5 to 4.0 mm mono-filament of a continuous length is used as the main line which is wound on a line-reel that does not take much of space. So also, floatline and branch line spools are compact and are installed at the farthest feasible stern part of the deck. It may be mentioned here that 16 to 17.5 m long trawlers also can be equipped for Flordia type of tuna long lining with a line of about 30 km length.

There is a view that vessels for long lining should have a minimum over all length of 30 m This is true, but only for vessels meant for global fishing. This was also partly true for area boats as well until a few years back. The available technology at present, however, enable even smaller vessels to be equipped the Florida style of long lining. While 30 m long vessel may cost around US $ 3.5 million and a 23 m long vessel would cost US $ 1.2 million, a 17.5 m long vessel equipped for trawling and long lining would cost only around US $ 250,000.

The immediate need is to make the operations of the existing trawlers economically viable. As already explained, this will be possible only when they are equipped to operate economically all round the year. The first priority is therefore for the Government to come forward to help the shrimp trawling enterprises in equipping their vessels for tuna long lining as well. As an extension to this approach, it is also necessary to introduce a scheme for strengthening the fleet with vessels that are equipped for both stern trawling as well as tuna long lining/purse-seining/pole and line fishing.

It is known that there are sizeable stocks of Yellowfin tuna around Andaman and Nicobar islands. These resources could be exploited for exporting to the Sashimi market of Japan. It may be mentioned here that to cater to the needs of Sashimi market of Japan the holds of fishing vessels should be able to maintain a minimum temperature of -55°C. Another way is to equip smaller boats having only ice-holds with long lining equipment. Such vessels can conduct fishing for about six days at a time. If air-lifted to Japanese Sashimi market quickly after landing, such ice-preserved tuna is considered to be as good as the tuna preserved at -55°C.

What has been mentioned above is not a mere theoretical proposition. A private fishing firm of Indonesia, P.T.Minasanega Pertiwi, has recently chartered about 42 wooden tuna long liners (ice-boats) from Taiwan, to fish in the EEZ of Indonesia to the South of Java island. Although this company started its tuna operations only in September, 1988, it has already reached an export level of the order of 30 tonnes of Sashimi tuna a day to Japan. Since November, 1988 the Company has chartered a weekly cargo flight from Jakarta to Singapore. The fresh iced tuna is exported from Singapore later the same evening aboard planes operated by Nippon Cargo Air to Tokyo for the following morning's market. The company has now plans to expand its chartered fleet to about 75 numbers.

The achievement of the Indonesian company should dispel a strong but misconceived opinion, deep rooted and obsessive, that smaller vessels cannot undertake tuna long lining, particularly for export. The Indian entrepreneurship can emulate the Indonesian example. This is possible only when there is strong support from the Government and MPEDA in providing the needed facilities to the enterprisers in (a) equipping the presently operated 17.5 m long trawlers with tuna long lining equipment, (b) providing incentives to the owners of about 25 such vessels to operate off the Southern Andaman islands, and (c) to provide the needed facilities for the vessels to take their iced cargo to Singapore for delivery to an importer there for transhipment to Tokyo market. The whole activity can also be organised through a co-operative organization or a corporation. It will not take more than 72 hours for these vessels to reach Singapore from the Andaman area and the expenditure involved in this transhipment will not be much.

A similar strategy as outlined above can be adopted for catching tuna off the Southern Bay of Bengal and off South west coast with arrangement for pooling up the catches and transporting the same to the Western ports of Thailand or to Singapore.

Surely a viable and highly attractive scheme on the above mentioned lines could be worked out to introduce smaller tuna long lining-cum-trawling vessels for profitable operations. In fact, the Indian Government can launch a scheme, under which a few 16-18 m or even 20 m long tuna long liners are taken by the Governmental Organisations such as Fishery Survey of India, on time charter from Taiwan directly or through Singapore, Hong Kong or Indonesia for the purpose of providing training to selected candidates on commercial lines in tuna long lining operations for a few voyages. Once training on these lines is given, a large number of such liners can be taken on time charter by commercial enterprises without any Taiwanese crew and the owners can entrust operations to the Indian fishermen for operations in Andaman waters. Such a scheme can be implemented by a co-operative organization or a corporation or through private sector companies. If the operations are successful, similar vessels can be acquired by Indian enterprises from Indian yards who can equip themselves for constructing such vessels. Indian shipyards also can acquire drawings of larger tuna vessels of 20 M OAL and above and for constructing such vessels.

Under a present scheme, chartering of tuna long liners is encouraged by the Government. These vessels are operated by foreign crew, with a few Indian under studies. After the charter period is over, the vessels go back. This cycle of activity ends abruptly with no following benefits. Any scheme that involves the operations of foreign fishing operations in our waters should lead to the introduction of similar vessels. Therefore, the present charter scheme can be replaced by the Government by a scheme that provides for joint ventures based on operations of tuna long liners. Technical co-operation should be the main component of such joint ventures, instead of giving prominence to foreign investments. Another ingredient of the collaboration should be that the foreign Company would supply long liners to the Indian company under a hire purchase system, on payment of a nominal amount as down payment. The scheme should provide for the payment of the rest of the cost together with a nominal interest in predetermined instalments, on voyage to voyage basis. The foreign joint venture partner can be persuaded to agree to buy the catches at rates not lower than the prevailing international price. Out of the net earnings, the Indian joint venture company will have to agree to pay the cost in mutually acceptable number of voyage-wise instalments towards the repayment of the cost of the vessels. A scheme of this kind while having all the ingredients of the present charter scheme, will have the additional advantage of enabling the Indian enterprise to acquire vessels which can fly the Indian flag from the very beginning of the collaboration.

It will not be an easy job to prevail upon the fishery enterprises to add tuna fishing equipment on their presently operated 23-27 m long trawlers or to go in for new trawler-cum-long liners. Considerable encouragement by way of incentives from the Government is needed to bring about proposed shift towards tuna fishing. It is suggested that Government should provide a subsidy equal to 50% of the cost of installation of tuna long lining equipment on existing fishing vessels. The balance of the requirements should be given as loan by SCICI/NABARD/ Commercial banks under a guarantee from the Government of India. The Government should not hesitate to provide guarantees for the simple reason that this will be a very small sacrifice to bring about a major change in the national deep sea fishing pattern.

It will be necessary to set up or nominate an existing Central Organisation to prepare and implement an integrated scheme involving the introduction of new tuna long lining vessels/trawler-cum-tuna fishing vessels, preservation and storage of catches, and their export/domestic marketing. Without an organizational support it will be difficult to implement a scheme of this kind. This organization can also provide and run certain infrastructural facilities. As the activity grows, it will be necessary to have frozen storage facilities for tuna at -55°C. It is considered that Madras and Cochin are the most suitable harbours for unloading and storage of tuna landings. Frozen storages at -55°C one each at Cochin and Madras will have to be set up, as the implementation of the vessel introduction part is progressing. It is desirable that the centralised organization also takes up the work of tuna export, by buying tuna from various enterprises at specified rates. In the alternative, the companies concerned can utilise the facilities and export tuna on their own.

The integrated set of operations relating to development of tuna fishing require strong training support. CIFNET has to be geared up for the purpose. Another important aspect is the post-harvest technology relating to tuna. CIFT can be entrusted with the work of providing training to the floating staff on handling of tuna on deck, transfer into fish hold, transfer and storage at shore, quality maintenance, packing, etc.

ON THE NEED TO DEVELOP IDEAL FISHING METHODS, GEAR AND CRAFT SUITABLE FOR THE DEVELOPMENT OF TUNA FISHERIES IN INDIA

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INTRODUCTION

Tuna fishing in India is mainly limited to the small scale fisheries sector, with only limited involvement by the commercial fishing sector from India. Exploitation of the tuna resources at present is mainly from the coastal inshore and offshore regions of the mainland and the Union Territories of Lakshadweep. There was practically no development activities aimed at developing tuna fisheries till reccently, but the programme of mechanisation as well as introduction of synthetic netting materials have contributed to the increase in production of the coastal tuna resources. Eventhough there was noticeable increase in the landings of coastal tunas, the resource remains to be one of the major potential resource which can be exploited commercially both from the offshore and oceanic regions. However, chartered long line operation commenced from 1985 landed about 854 tonnes of tunas and billfishes in 1988 from the Indian EEZ.

While estimates are projected on the availability of tunas and tuna-like fishes for commercial exploitation from the inshore, offshore and oceanic regions, the most important requirement will be the ideal fishing method, gears and crafts suitable for commercial exploitation. Perhaps special development programmes aimed at developing tuna fisheries may also be necessary. This paper presents an account of the fishing methods, gear and craft which are presently used and the scope for development.

RESOURCE POTENTIAL

The potential yield of tuna and tuna-like fishes in the Indian EEZ up to 200 M depth has been estimated at 240,000 tonnes (George et al., 1977). The potential of tunas, bill fishes and sharks in the oceanic waters of the EEZ is taken to be in order of 500,000 tonnes (James et al., 1987). It is indicated that an annual catch of 25,000 tonnes of oceanic tunas, which includes about 17,000 tonnes of yellowfin tuna can be exploited from the Oceanic pelagic region in the EEZ off the South West Coast of India (Sudarsan et al., 1988). However, present rate of annual exploitation is reported to be around 34,000 tonnes during 1986 and around 30,000 during 1987. Apart from the above indicated estimated potential tuna resources available for commercial exploitation, there are other encouraging factors like the overall revival of world tuna fisheries, and an overall increase in world tuna production.

It is reported that the Spanish and French purse seiners operating in the Indian Ocean from Seychelles have increased their catch substantially during the last few years. A latest report states that the French Tuna Purse Seiners operating in the Indian EEZ have recorded an annual catch of more than 6000 tonnes per vessel, with one vessel recording a catch of 6754 tonnes (Fishing News International February 1989- Vol.28,No.2). Similarly purse seiners operating off the West African Coast have also recorded better catches. It is also reported that the "giant bluefin tuna" weighing between 227 Kg to 318 kg have now started appearing for the first time after about 50 years. Against this background there appears to be sufficient scope and an urgent need also to develop tuna fishery in the country.

FACTORS INFLUENCING THE USE OF APPROPRIATE FISHING GEAR AND METHODS

Temperature and pelagic food availability have direct effect on the distribution of tunas. Oceanographical phenomena like currents, upwelling, temperature gradients in thermocline etc. also affects the movement and distribution of tuna.

Tunas are known for their circum-world distribution and they congregate where special environmental conditions prevail. They occur as commercially exploitable resource from the temperate to tropical waters and show distinctive migratory routes as well as spawning and feeding locations. They occur on surface and sub-surface layers and sometimes in deep water layers also. This complex nature of the resource necessitates the use of various techniques for exploiting them. Due to its highly migratory nature greater mobility is needed for the fishing fleet.

In India, eventhough, there is no established commercial tuna fishery as such, except the pole and line fishing aimed at exploiting the skipjack tuna being conducted in the Union Territory of Lakshadweep, other coastal tunas like little tuna, frigate tuna bonito, longtail tuna etc., are also being exploited by using various techniques like gill netting, trolling, shore seining, small boat purse seining etc.

It has been indicated by scientists that the major component that will contribute to the increase in production of tuna will be the skipjack tuna. Bulk of the targeted production of skipjack tuna and yellowfin in the surface fishery can be exploited by purse seining. Larger oceanic tunas and bill fishes, in the subsurfce fishery can be exploited by long lining. Big eye tuna can be caught in deep long lining.

PRESENT STATUS OF TUNA FISHING IN INDIA WITH REFERENCE TO THE FISHING GEAR AND METHODS EMPLOYED AND SCOPE FOR DEVELOPMENT

As indicated earlier, tuna fishing in India is an activity limited to the small scale fisheries sector and the only organised tuna fishery in the country is the traditional pole and line fishery of the Union Territory of Lakshadweep.

Surface gill netting (drift netting), traditional long lining, trolling, small boat inshore purse seining and shore seining are not exclusively aimed at exploiting the tuna resources. However, exclusive catch of tuna are reported from surface gill netting operations. Similarly the large number of small and medium purse seiners fishing along the west coast, fishing mainly for sardine and mackeral have also reported very good catches of tuna.

While major species caught in the Lakshadweep area are the oceanic skipjack and young yellowfin, the major catch of tuna from the main land are little tuna and other tuna like species like bonito, frigate mackerel, frigate tuna etc.

The following are the fishing methods used at present for exploitation of the tuna resources:

POLE AND LINE FISHING

Pole and line fishing is the traditional fishing method practiced by the Lakshadweep fishermen ever since fishing avocation has been practiced by them. This method, even though may appear to be very simple is a very skilled operation and requires expertise and experience.

The principle employed is to offer live baits and attract the fish near the boat. When the fish congregates near the boat and start feeding on the bait the barbless hooks attached to long poles on a line are dropped into the midst of the feeding shoal. The tuna mistaking the hook as live bait takes it and get caught in the hooks. The moment the fish takes the hook the line with the hooked fish is lifted up with the pole and swung on to the deck. As the fish falls on deck, it gets dehooked automatically as the hooks is barbless and the operation is resumed. The operation is very fast and the catch depends on the skill and expertise of the fishermen. 4 to 8 fishermen may be operating the pole and line depending on the size of the boat.

The craft used in this fishery were the traditional plank built boats locally known as "Ody"/"Hody" of the size range of 9 to 11 M OAL, which subsequently were replaced by mehanised boats of 9 to 10 M OAL. The traditional boats were propelled by sails and oars and the stern was very low, where the fishing rack (fishing platform) was built up, extending a little towards the stern side, for enabling the fishermen to stand and operate the pole and line. Special compartments with small holes drilled were also provided which permitted sea water to enter for enabling the live baits to remain alive. In the mechanised boats, separate live bait tanks are provided with provision for running sea water. These vessels were also built with very low stern and the fishing racks built up at stern and extending little towards the sides at stern.

In India, only one large commercial pole & line vessel was introduced in the private sector in 1984. The vessel is 57.85 M OAL and powered by an engine of 2000 H.P. The operations were reported to be not successful due to non-availability of live baits.

Apart from the suitability of the vessel and properly trained fishing crew, the success of the pole and line fishery depends on the availability of suitable live bait. Nonavailability as well as short supply of live bait being one of the indication of the problem for the pole and line fishery, perhaps a programme for the culturing of live bait can be considered.

By encouraging the small scale fishermen to increase their fishing effort by rendering suitable assistance and incentives, including the supply of live bait can substantially increase production of the skipjack and young yellowfin tuna resources. For the development of oceanic commercial pole and line fishery, in the light of the unsuccessful operations by a large pole and line vessel, it is worthwhile considering the possibility of a Government agency introducing a modern pole and line vessel, based on the results of which suitable promotional schemes can be introduced.

GILL NETTING

Drift Gill Netting/Drift Netting is one of the most important traditional fishing methods practiced all along the Indian coast for the exploitation of various pelagic species. Tunas are caught in surface gill nets both from the inshore and offshore regions along with other species. Occasionally exclusive tuna catches are also reported.

Exclusive surface gill netting, using appropriate mesh sized gill nets using medium size vessels of 12-16 M OAL and perhaps more, with an endurance of atleast two days can be considered appropriate for developing inshore and offshore surface gill netting for tuna.

In this context, it is worth mentioning the results of the recent operation of a Japanese chartered gill netter-cum-squid jigger in the Indian EEZ. The vessel appears to have made only one short voyage and had to return, as vessel is reported to have lost a major portion of the gill net. On personal enquiry, it was understood that the vessel was operating a fleet of gill net of approximately over 70 KM in length and equipped with radio bouys. As the catches in the gill net was unusually heavy more than 3/4 portion of the gear along with the gilled fish was pulled down, got broken and lost. On the remaining 1/4 of portion of the gear, the catches were approximately 50 tonnes of tuna mainly skipjack

The above being an indication of the possibility for oceanic gill netting, there appears to be suficient scope for encouraging entrepreneurs to initiate oceanic gill netting for tuna. A suitable crash programme can be initiated for encouraging both the small scale setor fishermen as well as the commercial fishing sector to venture into surface gill netting for tuna.

PURSE SEINING

As indicated earlier, a portion of the presently exploited tuna resources is contributed by the small and medium size purse seiners (within the size range of 13 to 15 M OAL) operating mainly for sardine and mackeral. Perhaps by encouraging entrepreneurs to enter into inshore and offshore tuna purse seine operations there is a possibility of increasing tuna catch by this method. In India, commercial purse seining exclusively for tuna was initiated only by one party M/s. Indus Foods Ltd., in a joint venture collaboration with an American firm. While the vessel was a 68 M OAL super seiner which was successfully fishing off US coast, their operations in the Indian EEZ were reported to be a failure. In fact, the vessel with special permission from the Government of Seychelles was fishing in the EEZ of that country also, where more than 40 French and Spanish purse-seiners were reported to be fishing very successfully. Due to various technical reasons the operations were not successful. Personal enquiry with the Indian skipper onboard revealed that the purse seine net which the vessel was carrying was very old and on many occasions the bunt area (sack) used to give way and the impounded shoal got lost. It was also stated by the skipper that the vessel had to spend considerable time in "scounting" (searching for shoals) and the shoals which they could detect on many occasions in the EEZ were very thin and not worth setting the net, while in the Seychells EEZ the shoals were considerably large and thick. The vessel had a helicopter onboard for locating shoals, but for various technical reasons the helicopter could not be used by them and the vessel had to resort to conventional scounting (steaming in search of shoals) which consumed many days and could have been avoided if the helicopter could be used.

From the unsuccessful operation of the above indicated vessel,one need not be pessimistic on the prospects of tuna purse seining in India. If the problems, short falls and draw backs experienced by the above vessel can be identified and corrective measures taken, there appears to be ample opportunity for the development of oceanic tuna purse sening in India. Perhaps special development programme with necessary incentives can attract entrepreneurs to venture into oceanic purse sening for tuna.

The French and Spanish tuna purse seiners being operated in the Indian Ocean from Seychelles base ranging in size of 63-70 M OAL can be considered suitable for developing oceanic tuna purse sening in India also. The success of purse seine fishery depends mainly on the availability of shoals which are of reasonable intensity, and the age old problem of tuna fishing is the location of fish shoals. Before the introduction of radar, sonar etc., the only method was by visual observation of surface shoals. Detection of "white caps" (Boiling tuna) as well as "low flying birds" which were the only indication of surface shoaling tuna. Introduction and use of electronic equipments like sonar and radar in fishing have helped in the location of surface and sub-surface tuna shoals. However, these equipments also have their own limitations. To overcome the time wasted for searching the fish shoals which amounted, even to few days on certain occasions, helicopters were introduced for the fishing. Off late, tuna purse seining companies having a number of purse seiners even employ low flying air crafts to locate fish shoals and pass on the information to the vessels with respect to the position, density of shoals movement etc, which enabled purse seiners to move towards the located shoals without wasting time and fuel in search of shoals.

LONG LINING

Long lining is a traditional fishing method, and is being praticed in India all around the coast including Union Territories by the artisanal fishermen in the small scale fishery sector. Both drift long lines and set bottom lines are being operated by the traditional fishermen for various species of fish. Even though the drift long lines are not operated aimed at catching tuna, tuna catches are reported from traditional drift long lines also. The species caught are mainly little tuna, bonito and frigate mackeral in the mainland and skipjack and young yellowfin from the Union Territory Islands.

Long lining for tuna is perhaps one of the most important fishing methods practiced throughout the world especially Japan, Korea, Taiwan etc., and infact all these countries have large commercial tuna long line fleets operating all around the oceans. Declaration of the EEZ by many countries and a general decline in the tuna long line fishery have resulted in the vessels of these countries being offered for charter fishing as well as sales to many developing countries including India.

In India there is no commercial tuna long lining activity as such, except by a single vessel owned by a company in the private sector. The vessel is of 314.57 GRT, having an OAL of 53.02 M and powered by a 1110 HP Engine. The vessel is rigged for long lining and gill netting. It is reported that, even though the initial tuna long lining operations were encouraging, of late the operations are not successful. The gill net operation also from this vessel is reported to be not encouraging. The vessel is second hand and old and the party reported various technical problems. One problem according to the party is the non-availability of fish, which cannot be accepted. As tuna is highly migratory, various oceanographical parameters, which controls its migration is to be studied properly, before setting the lines or deciding to set lines.

The results of operation of the Government of India Tuna long liners being encouraging, and the reported reasonably good catches by the chartered tuna long liners, indicate the possibility of commerial tuna long lining in Indian waters.

The recently acquired two sophisticated tuna long liners, with automatic line shooting facilities etc., by the Fishery Survey of India, is expected to start operations shortly. It is hoped that the results of operation of these vessels and the existing tuna long liners of the Government of India, Fishery Organisation can play a very vital role in establishing the commercial viability of tuna long lining India.

Based on the projected estimation on the availability of tuna resources and results of operation of the tuna long liners, of the Government of India, Fishery Organisation and results of operation of chartered vessels, it can be assumed that there is sufficient scope for the development of commercial tuna long lining in India.

CONCLUSION

The scope for development of tuna fisheries in India is briefly indicated on the basis of the projected estimates and the results of various types of fishing activities both in the small scale fisheries sector and commercial sector on the availability of tuna resources for commercial exploitation. The suggestions made are open for discussion. While discussing the points regarding the development of tuna long line fishing, various aspects like the size of the vessel, including powering, capacity and endurance etc. will have to be taken into consideration. On the fishing capability, equiping the vessel with conventional long lining system or the modern auto-lining system etc., are also to be discussed. The use of monofilament main line, branch line and float line instead of nylon or polyester twisted twine also may be discussed. Use of monofilament for long lining can save lot of storage space needed otherwise. This aspect is very significant when small and medium vessels are rigged for tuna long lining for offshore fishing. But for large commercial tuna long liners the adaptability of monofilament lines is to be studied.

The use of FAD's (Fish Aggregating Devices) for attracting tuna and the effectiveness of it in the tuna pole and line fishery, hand lining and even purse seining may also be considered. The advantage and scope of utilising the Satellite Remote Sensing data for the location of tune shoals and its migration etc., for the development of purse seine fishery in India may also be considered.