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27 Tuna fisheries of India

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ABSTRACT

Tunas constitute 3.7% of the total commercial pelagic fin fish production of the country (Av. 1992-96: 1,14,1067 t). The dominant species which support tuna fishery in the small scale sector in India are **Euthynnus affinis, Auxis thazard, A. rochei, Thunnus tonggol, Katsuwonus pelamis, Thunnus albacares and Sarda orientalis.** *Of the total tuna catch (Av.1992-96: 41,978 t), 77.6% has been landed from the west coast, 16.8% from the east coast 5% from the Lakshadweep and 0.5% from the Andaman & Nicobar islands. The status of production of different tuna species in India and their environmental preference are summarised. Biological features such as food and feeding habits, age and growth, size at first maturity, spawning and fecundity are briefly discussed. Trends in the production of tunas along the mainland coast of India and Lakshadweep, population parameters and the results of stock assessment are presented briefly. Suggestions for future research and options for tuna fishery development in India are also discussed. The present communication is a review of the works done during the past fifty years and discusses the present status and future strategy of tuna fisheries research and development in India.*

Introduction

The tuna fisheries in India is limited to the small scale sector with negligible inputs from the industrial sector. The results obtained till date from the exploratory surveys carried out by the Govt. of India vessels beyond the traditional fishing grounds, the industrial longline operations of foreign fishing fleets in the Indian EEZ, the rapidly increasing rate of exploitation of skipjack and yellowfin tunas in the traditional sectors of Maldives and Sri Lanka and the fast pace of growth and expansion of tuna purseseine fishery of France, Spain, Panama and Ivory coasts in the tropical western Indian Ocean area - all these have indicated the resource availability and rich tuna fishing grounds in the Indian EEZ and contiguous high seas. Despite the fact that there has been a remarkable increase in the landings of coastal tunas during the last two decades, their stocks remain to be one of the least exploited pelagic fin fish resources from the Indian EEZ.

For more than two decades, the Central Marine Fisheries Research Institute has taken efforts to collate and disseminate the fishery-dependent and fishery-independent factors connected with tuna fishery, and urged on several occasions immediate action , on the part of the government and the industry to modernise and expand the small scale sector and venture into high sea tuna fishery. Despite its being one of the thrust areas of development of marine fishery in the Indian EEZ, the momentum it received was very low and as a result the valuable and rich resources of skipjack and yellowfin tunas in our waters remain untapped commercially.

It is in this context an attempt has been made to highlight the present status and future potential of the tuna resources in the Indian EEZ. Information presented in this account will help the administrators in deciding on the technological options and management thrusts.

Material and methods

The data base on the present status of exploitation of tunas is the information available with the National Marine Living Resources Data Centre, C.M.F.R.I., Cochin. Standard methods are used in the study of the biology and population dynamics of tunas (Silas *et. al*, 1986; James *et.al.*,1992). Published works of several authors on the biology and population parameters of tunas are made use of in the study. A bibliography on tuna fisheries in the Indian seas has been recently compiled by John and Bhargava (1992).

Species composition

The species of tunas occurring in the Indian EEZ and their common size range (cm) are presented in Table 1. The coastal fishery comprises *of Euthynnus affinis, Auxis thazard, A. rochei, Thunnus tonggol* and *Sarda orientalis* in the order of their abundance. They are taken by the drift gillnets, purseseines, hooks and lines, and troll lines. The oceanic species are *Thunnus albacares, T. obesus, K. pelamis* and *T. alalunga*, which are chiefly fished by longlines operating in the deeper waters. *K. pelamis* and young ones of *T. albacares* are taken by pole and line and troll line gears in the Lakshadweep area.

Tunas environment

The temperature range for distribution, preferred temperature and habitat relative sizes of tunas are reproduced in Table 2 (Silas and Pillai, 1992). Most of the species of tunas respond instantly to the decrease in temperature. Certain upper and lower limiting temperatures determine the range of distribution of tunas in the ocean. Even though larger tunas have thermoregulatory capabilities, smaller tunas have limited capacity for thermoregulation. Temperature and forage have a major effect in critical situations and dissolved oxygen and illumination influence their distribution. Chemical nutrients and plankton biota influence their distribution through the forage organisms. The oceanic features, which play a major role in the distribution and migration of tunas are the oceanic currents, convergence and divergence, fronts, upwelling, thermocline topography and temperature gradients in the thermocline and position of islands, banks and land masses.

Table 1. Species of tunas in the Indian EEZ

Sl. No.	Scientific Name	Popular Name	Common size range (cm)
1	*Thunnus albacares*	Yellowfin	50-150
2	*T. obesus*	Bigeye	60-180
3	*T. alalunga*	Albacore	40-100
4	*T. tonggol*	Longtail tuna	40-100
5	*Katsuwonus pelamis*	Skipjack	35-80
6	*Auxis thazard*	Frigate tuna	25-40
7	*A. rochei*	Bullet tuna	15-30

8	*Euthynnus affinis*	Little tuna	20-68
9	*Sarda orientalis*	Oriental bonito	30-50
10	*Gymnosarda unicolor*	Dogtooth tuna	80-100

Table 2. Temperature range for distribution, preferred temperature and habitat relative size of tunas (as reproduced by Silas and Pillai, 1982)

Sl.No.	Scientific Name	*Temperature range for distribution(°C)	**Preferred temperature range (°C)	**Habitat
1.	*Sarda orientalis*	15-25 (15-22)	Temperate/ tropical	Coastal to pelagic/medium
2.	*Euthynnus affinis*	17-28 (18-23)	Tropical	Coastal to pelagic/medium
3.	*Auxis thazard*	-	Tropical	Coastal to pelagic/medium
4.	*Katsuwonus pelamis*	17-28 (19-23)	15-29	Pelagic migrator/ medium
5.	*Thunnus tonggol*	-	25-32	Neritic, continental
6.	*T. albacares*	18-31 (20-28)	23-32	Pelagic/large
7.	*T. obesus*	11-28	11-15 (18-22)	Deep, pelagic/ large
8.	*T. alalunga*	14-23	14-18 (15-21)	Pelagic migrator/ large

* Laevastu and Rosa, 1963 ** Sharp and Pirage. 1978

Figures in parenthesis indicate the temperature range for fishery.

Food and feeding

Major items of food of the different species of tunas observed by various authors, available in the published works are given in Table 3. Crustaceans (planktonic and adults), molluscs, other teleost fishes (juveniles and adults) and bait fishes constitute important items of their food. Other items include fish eggs and larvae and pelagic polychaetes. It is evident from the table that the feeding habit of species change with their growth. *Charybdis* sp. constitutes the favoured food item of *Thunnus albacares* taken by longline gear.

Table 3. Food and feeding habits of *E. affinis*, *A. thazard*, *A. rochei* and *K. pelamis* observed by various authors.

Species	Major food items	Authors
K. pelamis	Crustaceans, cephalopods, larval and juvenile fishes and baitfishes	Raju 1964
K. pelamis	Fishes, custaceans, squids, medusae, molluscs and plant matters	Thomas 1964
K. pelamis	*Sardinella* spp., *A. thazard*	Pon Siraimmeetan, 1986
T. albacares	Fishes, stomatopods, crab larvae and other crustacea	Thomas, 1964
T. albacares	Fishes, crustaceans, cephalopods	Silas *et al* 1986
T. albacares	*A. thazard* young ones unidentified fish	Pon Siraimeetan, 1986
	Teleost fishes, squids cuttle fishes, crabs *(Charybdys)*, stomatopods	John 1993
E. affinis	Crustaceans, gastropods, cephalopods, vertebrata (Pisces) fish larvae	Kumaran, 1964
E. affinis (juveniles)	Whitebaits, planktonic crustaceans	Pon Siraimeetan, 1986
E. affinis	*Sardinella* spp. unidentified fishes, skeletal remains of fish	Pon Siraimeetan,1986

A. thazard	Polychaetes, crustacea, insecta chaetognatha, cephalopods and fishes	Kumaran, 1964
A. thazard (juveniles)	Crustaceans, molluscs, ascidians, fish eggs and larvae	Pon Siraimeetan, 1986
A. thazard	*Anchoviella*, fish remains, *Loligo*, fish larvae, copepods, decapod larvae, amphipods, Megalopa, pteropods	Pon Siraimeetan, 1986
A. thynnoides (*A. rochei*)	*Sardinella* spp., *Anchoviella*, spp., *Leiognathus*,spp.carangids, crustacea and molluscs	Kumaran, 1964
S. orientalis	Crustacea, fishes	Kumaran, 1964
S. orientalis (juveniles)	Fishes	Pon Siraimeetan, 1986
S.orientalis	*Sardinella* spp.,*A. thazard* young ones, squids, skeletal remains of fishes	Pon Siraimeetan, 1986
T. tonggol	*Loligo*, *Sardinella* spp., *Sillago sihama*, skeletal remains of fishes	Pon Siraimeetan, 1986
I. platypterus	*Sardinella* spp., *Kovala koval*, *Loligo* sp.	Pon Siraimeetan, 1986

Age and growth

Estimated lengths at different ages of *E. affinis, A. thazard, T. tonggol, S. orientalis, K. pelamis* and *T. albacares* reported by various authors are presented in Table 4.

Table 4. Estimates of length at age of *E. affinis, A. thazard, A. rochei, T. albacares K. pelamis, T. tonggol* and *S.orientalis*

Species	Length at Age						Authors
	I yr	II yr	III yr	IV yr	V yr	VI yr	
E. affinis	31.43	46.60	57.14	64.44	69.50	-	Silas *et al.* 1986
A. thazard	29.20	42.20	50.30	55.00	-	-	-00 -
T. tonggol	42.30	61.90	74.00	81.30	85.90	-	- 00-
S. orientalis	44.70	58.00	63.00	65.00	-	-	- 00-
K. pelamis	40.7	49.3	56.2	62.00	-	-	Appukuttan *et al.* 1977
K.pelamis	36.00	57.00	69.00	-	-	-	Silas *et al.* 1986
K. pelamis	36.7	57.3	69.00	77.70	-	-	Madan Mohan and Kunhikoya, 1986
T. albacares	50.60	76.40	95.20	108.8	+118.30	-	Silas *et al.*, 1986
T.albacares	50.6	76.9	95.2	108.8	118.7	125.9	Madan Mohan and Kunhikoya, 1986
T. albacares	51.3	84.4	105.6	119.3	128.1	133.8	Pillai *et al.*, 1993

Size at maturity, fecundity and spawning

The size at first maturity, spawning period and fecundity of *E. affinis, A.*

thazard, A. rochei and *K. pelamis* are presented in Table 5. Spawning periods of different species have been found to vary considerably. However, broadly it can be stated that *E. affinis* spawns during the premonsoon (April-May) and post-monsoon (Oct-Nov) periods. The spawning period of *A. rochei* has been observed as during the post-monsoon period of September-October. A spawning peak for skipjack tuna *(Katsuwonus pelamis)* has been observed during January-April. Available information on the fecundity of *E. affinis, A. thazard, A. rochei* and *K. pelamis* are also given in Table 5. The relationship between fecundity (F) and the size (L) of different species of tunas has been observed to be :

E. affinis Log F = -3.66219 + 2.36111 log L

A. thazard Log F = -9.77991 + 4.75748 Log L

A. rochei Log F = -1.70881 + 1.50244 log L

K. pelamis Log F = -918.5705 + 23.27525 log L

Table 5. Size at first maturity, spawning and fecundity of *E. affinis, A. thazard, A. rochei* and *K. pelamis* as estimated/observed by various workers

species	Size at Ist maturity	Spawning period	Fecundity
E. affinis	43-44 cm (James *et al.*, 1992)	Oct-Nov and Apl-May (James *et al.* 1992)	210000 to 680000 Ova/ spawning (Rao, 1964)
			280000 egg/spawning (Rao, 1964)
		Sep-Oct and to a certain extent prolongs upto March (Muthiah, 1986) Apl-Sep (Rao, 1964) May-Nov (Jones, 1960)	
A. thazard	30 cm	August-Nov	6,01000 ova/Spawning (James *et al*, 1992 (Silas,1969)

		Oct-Nov (Muthiah , 1986) Dec-Jan (Jones & Kumaran, 1963) Aug-Sep (Rao, 1964)	
A. rochei	23 cm (James *et al*, 1992)	Sep (Muthiah 1986) Sep-Oct (James *et* al *1992)*	52,000 Ova/spawning (Silas 1969)
K. pelamis	40-45cm (Raju, 1964)	Feb-July (Raju, 1964)	317600-1332900 (Raju, 1964)
	44-45 cm (James *et al*, 1992) March-April (Yohannan *et al*, 1992) Jan-Apl Sept-Dec. (James *et.al*, 1992)	Throughout the year at Minicoy	1,70,000-680000 (Madan Mohan & Kunhikoya, 1986)

Fishery

Major gears

The major gears employed in the tuna fishery are drift gillnets, hooks and lines, purse seines, pole and lines and troll-lines. Long line gear is employed in the fishery for yellowfin tuna and deep-living big eye tuna. Detailed information on the crafts and gears employed in the tuna fishery has been given by Silas and Pillai (1982, 1986).

Trend in production

The trend in the annual all-India tuna production during the years 1965-1996 is presented in Fig. 1. The total tuna catch in India in the small scale sector fluctuated between 4500 t (1965) and 46,900 t in 1990. A progressive increase in the tuna catch was recorded from 1965 to 1996. Tuna production showed fluctuations and oscillations since 1965, and between 1982 and 1990 it ranged between 22,590 t and 46,990 t. Subsequently, the catch stabilised between 30,900 t (1991) and 45,000 t (1996). Of the total catch, as an average (1982-96), 77.6% has been landed from the west coast of India, 16.8% from the east coast, 5.1% from Lakshadweep and 0.5% from the Andaman and Nicobar islands. A state-wise comparison of tuna production indicates that along the west coast of India, Kerala ranked first (56.8%) followed by Gujarat (19.2%), Karnataka (11.6%), Maharashtra (10.2%) and Goa (2.2%) (Fig.2). Along the east coast, the contribution by Tamil Nadu was maximum (69.0%) followed by Andhra Pradesh (24.5%), Pondicherry (3.0%), Orissa (3.0%) and West Bengal (0.5%)(Fig.3).

The overall species composition of tuna fishery indicates that *E. affinis* constitute the major component (56%) followed by *A. thazard* and *A. rochei* (18%), *T.tonggol* (6%), *K. pelamis* (4%) and other tunnies including *T. albacares* and *S. orientalis* (16%) (Fig.4).

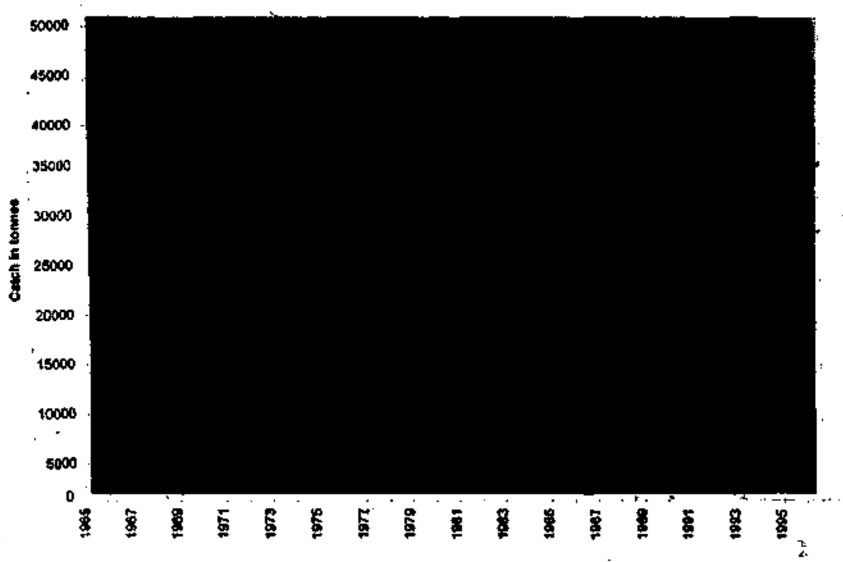

Fig. 1. Tuna landings in India during 1965-'96

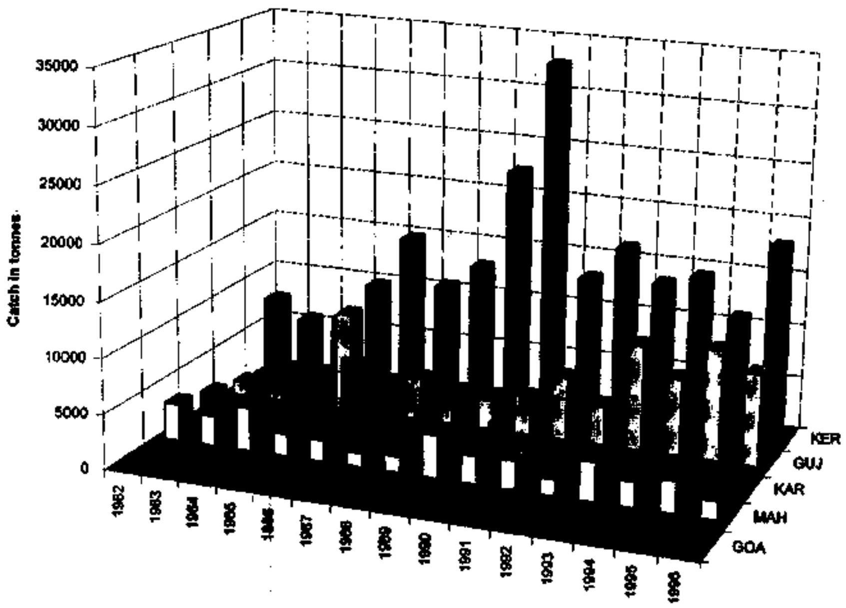

Fig. 2. Tunna landing in West coast (1982-'96)

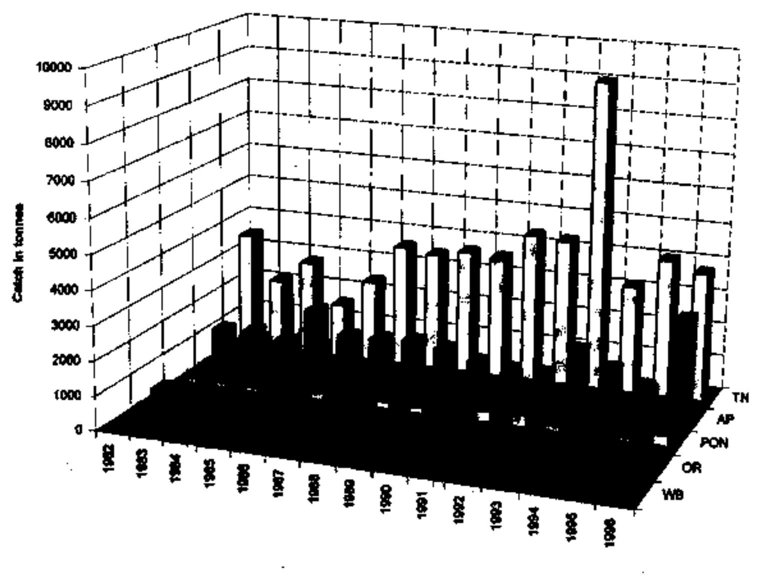

Fig. 3. Tuna landing in east coast (1982-'96)

The total fish landing and total tuna landing in Lakshadweep are shown in Fig.5. Tuna catch fluctuated between 1,760 t in 1980 (60.8% of total fish catch) and 11,566 t in 1994 (92.9% of total fish catch). Tuna landings showed a steady increase from 1980 and reached a peak in 1987. Subsequently, an all time peak landing of 11566 t was observed in 1994. Skipjack tuna constituted about 78%, followed by young ones of yellowfin tuna (12%) and other tunas such as *E. affinis*, *A. thazard*, and *Gymnosarda unicolor*.

The overall seasonal pattern of tuna fishery indicates that the

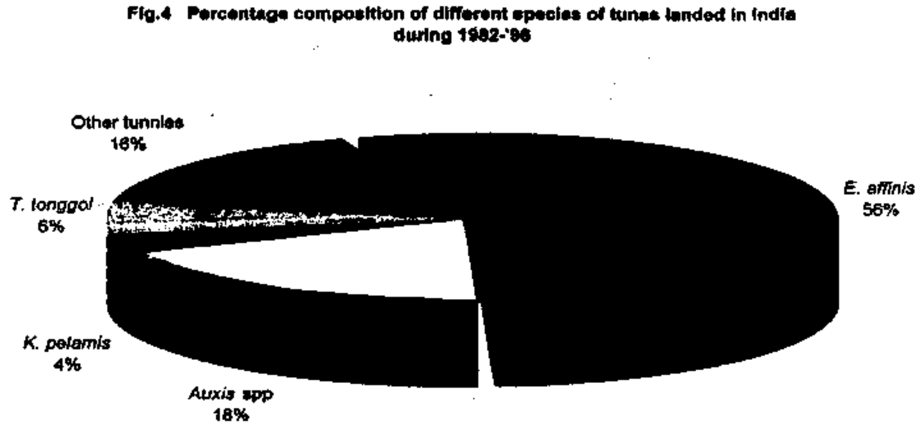

Fig. 4. Percentage composition of different species of tunas landed in India during 1982-'96

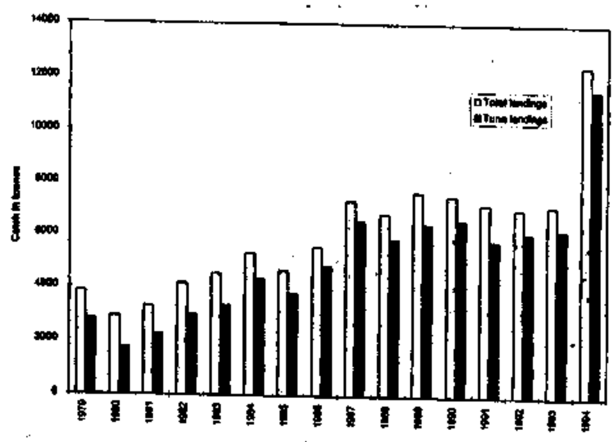

Fig. 5. Total production of tunnas and its contribution to the total landings in Lakshadweep Islands during the period 1979-'94

pre-monsoon and monsoon seasons are the productive periods along the south-west coast of India and the post-monsoon period along the Maharashtra and Gujarat coasts thereby indicating a seasonal shift in their concentration. In Lakshadweep, the December to February period was observed to bring the maximum catches of tunas. However, the changed pattern of mechanisation/ motorisation of the craft employed in the tuna fishery has altered the tuna fishery scenerio, with continued operation during monsoon period also.

Stock assessment

Available information on the population parameters (L_∞ K & t_0) and the results of stock assessments of *E. affinis*, *A. thazard*, *A. rochei*, *K. pelamis*, *T. tonggol* and *T. albacares*, estimated by various authors are presented in Tables 6 & 7.

Table 6. Population parameters of *E. affinis*, *A. thazard*, *A. rochei*, *K. pelamis*, *T. tonggol* and *T. albacares* estimated by various authors

	E. affinis (cm)	*A. thazard* (cm)	*S. orientalis* (cm)	*K. pelamis* (cm)	*T. albacares* (cm)	*T. tonggol* (cm)
K				0.22	0.32	
t_0				-	-0.34	
				(Appukuttan et al., 1977)		
L_∞	81.00	63.00	66.00	90.00	145.00	93.00
K	0.3655	0.4898	1.0005	0.4898	0.3200	0.4898
t_0	-0.3438	-0.2700	-0.1300	-0.0600	-0.3400	-0.2400
					(Silas et al., 1986)	
L_∞				90.00		
K				0.4898		
t_0				-0.06		
			(Madan Mohan & Kunhikoya, 1986)			
L_∞				84.3	145.00	
			A. rochei			
L_∞	83.50	56.00	37.00	80.19	-	94.00
K	0.420	0.770	0.638	0.650	-	0.480

			(James *et al.*, 1992)			
L∞	83.5	56.00	37.00	80.19	-	94.00
K	0.42	0.77	0.60	0.650	-	0.48
			(James *et al.*, 1993)			

Table 7. Stock assessment of *E. affinis*, *A. thazard*, *A. rochei*, *T. albacares*, *T. tonggol* and *K. pelamis* estimated by various authors (in tonnes)

	E.a	A.t.	A.r.	T.a.	T.t.	K.p.
MSY	15526	4852	896	-	641	4440
Biomass MSY	24310	1982	612	-	722	3702
					(James et al., 1992)	
MSY	25896	3946 (Kerala)	1457 (Kerala)	-	3069	-
Biomass MSY	28917	2254 (Kerala)	695 (Kerala)	-	2683	-
MSY	-	518 (T.Nadu)	-	-	-	-
Biomass MSY		314 (T. Nadu)			(James *et al*, 1993)	
MSY					620	(Pillai *et al.*, 1993)

In the present report the results of stock assessment (James *et al.* 1992) based on the data collected during 1984-88 are presented. Estimates of population parameters were made for six species *viz.*, *E. affinis*, *A. thazard*, *A. rochei*, *T. albacares*, *T. tonggol* and *K. pelamis*. The recruitment pattern indicated two pulses for little tuna, longtail tuna, frigate tuna and bullet tuna and only one pulse for skipjack tuna. The results of analysis indicate that for all the species the exploitation rate (F/Z) ranged from 0.05 to 0.80. For *E. affinis*, the decrease in effort to 66% of the current level would yield 341 tonnes. The present level of exploitation rate for *T. tonggol* is 0.499 with the estimated yield of 623 tonnes. It can be increased by 1.6 times to obtain the MSY of 642 tonnes. The MSY estimate for *A. thazard* is 4852 tonnes which can be obtained by increasing the effort by 1.2 times. With respect to *A. rochei*, the MSY of 896 tonnes can be obtained by increasing the effort by 1.6 times. For skipjack the estimated MSY of 4440 tonnes can be obtained by increasing the effort by 4.1 times to realize an additional yield of 300 tonnes.

This analysis indicates that the tuna stocks in the traditional coastal sector are exploited to the near optimum level. However, the migratory nature of tunas does not support this conclusion. Recent reports indicate that after the expansion of the area of operation the longtail (*Thunnus tonggol*) and the yellowfin (*T. albacares*) tunas are the dominant species in the drift gillnet fishery in the north-west sector. With regard to tuna live-baits, the economic utilisation and enhanced exploitation of all the species from the northern islands could enhance the tuna production in Lakshadweep.

Suggestions for future research

Existing data base to be strengthened by improving the system of data collection through increasing the sampling coverage to enable stock assessment of coastal and oceanic tunas. Extensive length frequency data should be collected both from the coastal and oceanic fisheries, with well planned sampling. The National Marine Living Resources Data Centre (NMLRDC) of CMFRI should be strengthened in association with FSI and the fishing Industry.

The existing production models may be critically evaluated for their suitability to assess the status of tuna stocks. If necessary, suitable production models need be developed to assess the stocks of migratory fish groups.

- Tagging experiments for studying the migration of oceanic tunas may be initiated in the Indian EEZ in collaboration with international agencies. Co-operative tagging programme with countries in the region sharing the same stocks, viz., India, Thailand and Indonesia in the Andaman sea, may be mooted. A programme for tagging may be taken up with the involvement and support of IOTC.

- Studies on the early life-history of tuna species has to be considered. Specific programme of research on the spawning and the larval stages of tunas in the Indian waters may be undertaken. Biological studies, studies on meristic characters, food content studies etc may be strengthened. Greater attention may be given to the environmental aspects of tunas. The studies may be continued for such a reasonable period as required for arriving at any predictable conclusion. Apart from SST, the effort may also be directed on other environmental meteorological parameters influencing tuna distribution and abundance. Studies may be made to establish the linkage between environmental data and commercial tuna fishing data.

- Effective training of the manpower for tuna fishing need to be organised in the form of a crash programme by FSI/CIFNET, seeking the support if necessary from the UN agencies such as FAO.

- Documentation and extension activities of the Institutes such as FSI/CMFRI/MPEDA has to be strengthened.

Options for tuna fishery development

- Diversification of crafts and gears in the small scale sector especially through greater use of mechanised drift gillnetters and other suitable gears. Such as monofilament longlines.

- Motorization of the small crafts should be further encouraged for enabling the small scale fishermen to expand the areas of operation resulting in higher yields as exemplified along the southwest coast of India.

- Considering the need for diversifying the existing fishing effort, a part of the fishing fleet engaged in shrimping may be diversified for tuna fishing. The deep sea shrimp trawlers, sona boats and mini trawlers may be considered in this scheme especially for monofilament longlining.

- Mobility of the purse-seine vessels is a critical factor in tapping large shoals of tunas, the occurrence of which has been reported by earlier authors in the neritic belt of Indian EEZ.

- It was recommended earlier to introduce 150 longliners each with a capacity to catch around 450 t of tuna annually.
- It will be worthwhile to initiate commercial purseseine fishing in the Indian EEZ and contiguous high seas. Recent developments in the purse seine activity by the industrial sector in the western Indian Ocean and the resultant catch of yellowfin and skipjack tunas from the tropical waters of Indian Ocean are encouraging. Succesful purseseine seasons were demarcated in the Lakshadweep Area as November to May and in the Andaman sea as March to May. Employment of 10-20 purse seiners, (industrial type 59-72 m OAL) with an annual fishing capacity of 6000 t, and 20 such purse seiners each with annual fishing/production capacity of 4000 t, would lead to the production of 110,000 t of tunas from the oceanic waters of Indian EEZ and contiguous areas.

Potential resources of tunas in Lakshadweep had been estimated variedly (60,000 t - 90,000 t). In view of the strategic importance of insular areas coupled with the focus on conservation of ecosystem and anticipated imbalances in the small scale sector by the introduction of large scale inputs, the plans are suggested for development of tuna fishery in the insular area in the following lines:

- Existing 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 a new generation of 15-20 m OAL boats with adequate navigational, chilling and storage facilities, as 2-3 days fishing would enhance the area and duration of fishing. Introduction of 80 boats of this size would produce 60-100 t of tunas per boat per annum.
- Shortage of manpower and expertise has been pointed out as constraints for the development of such programmes. This problem has to be solved by effecting inter-island movements of fishermen/boat through appropriate incentive schemes. Required training in modern methods of tuna fishing under joint venture programmes needs further

consideration.

Experimental fishing by purseseines, similar to the ones used in Andaman sea by Thailand (14-24 m OAL purseseiner; nets 1400 m long and 120 m deep; 14-18 m OAL purseseiner nets 665 m long and 100 m deep) for fishing surface schools of Skipjack *(Katsuwonus pelamis)*,longtail *(Thunnus tonggol)* and little tuna *(Euthynnus affinis)* by expertise developed by mainland fishermen could be tried to propagate purse seining around the oceanic islands by training and involving the local fishermen. The additional catch generated will be utilised in canning, *masmin* 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 the fishermen through extension service

For increasing value added products, chilled water storage on board and freezing the catch ashore should be tried.

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

Product development such as granulated *masmin*, tuna paste, tuna powder and improvement of the quality of *riha akru* would ensure more consumer acceptance and better returns to the fishermen. Development of an organised marketing system for *masmin* will be beneficial to the fishermen in getting proper market and avoiding price falls.

Quality control and hygienic methods of *masmin* production especially in the northern islands should be demonstrated. In the northern islands in the Lakshadweep nearly 30-35% of the body parts are wasted in the preparation of *masmin*. At Agatti in the northern islands, on an average, about 1130t of tuna meat are wasted per annum, which would fetch Rs.16-17 lakhs worth of first quality fish meal. Effective waste utilisation methods by converting them to fish meal or preserving the material by ensilaging for the preparation of cattle feed should be tried.

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