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Part Three

FEBRUARY 1991

NATIONAL SYMPOSIUM ON RESEARCH AND DEVELOPMENT IN MARINE FISHERIES

MANDAPAM CAMP

16-18 September 1987

Papers Presented
Sessions V, VI & VII

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

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Dr. P. S. B. R. JAMES
Director
Central Marine Fisheries Research Institute
E. R. G. Road
Cochin-682 031, India

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Paper 84

STRATEGIES FOR TUNA FISHERIES DEVELOPMENT AND MANAGEMENT IN THE INDIAN EXCLUSIVE ECONOMIC ZONE

P.S.B.R. James and P.P. Pillai

Central Marine Fisheries Research Institute, Cochin-31

ABSTRACT

In recent years, one of the significant changes in the International tuna industry has been both the reduction and redeployment of the major tuna fishing fleets of the world. These developments coupled with the declaration of the 200 miles EEZ, have altered the pattern of tuna resources exploitation and motivated a number of developing countries to extend their operations and participate in the International tuna fishery.

In the present communication, a retrospect of National tuna fishery is presented, the strategies and perspectives for the development and management of tuna fisheries, chiefly through augmentation and melioration in the (i) traditional small scale sector, (ii) medium commercial fishery sector, and (iii) large scale commercial fishery sector are presented with substantiating data and information. The prime need of tapping the skipjack tuna resources from the oceanic sector of the EEZ of India and strategies involved in the augmentation of skipjack production by planned development of the small scale fishery sector around our oceanic islands are discussed. The prospects of acquisition and utilisation of the vessel capacity, equipments and expertise of the developed nations in the operational sector of large scale commercial tuna fishery for yellowfin and bigeye from the EEZ, and other policy options for tuna fishery development in the oceanic waters are reviewed.

The need for development and improvement of post-harvest technology on coastal and oceanic tunas and tuna products as part of diversification of exports of marine products is emphasised.

INTRODUCTION

A worldwide review of tuna fishing industry indicate that various developments in the recent past have resulted in the restructuring of the tuna industry including the reduction and redeployment of major tuna fishing fleets. These developments have prompted many developing countries world over to enter into tuna fishery and expand tuna fishing activities in their EEZ. In the Indian Ocean, the present trend of events show that several nations are attracted towards the successful emergence of purse seine fishery by distant nations in the tropical western Indian Ocean. The EEZ of India comprising of about 2 million Km^2 of sea area under her jurisdiction, a coastal belt of about 6000 miles and insular realms around the Lakshadweep and Andaman and Nicobar islands hold considerable potential for the production of tunas in the industrial sector.

In the present communication, a review of the tuna fishing industry developments worldwide is presented. Data collected on the trend of production of tunas and billfishes in the Indian Ocean during recent years have been synthesised with particular reference to yellowfin tuna, bigeye tuna, skipjack tuna and longtail tuna. Present status of tuna fishery in India, both in the small scale sector and in the exploratory operations are critically analysed, and priority areas of attention such as optimisation of production in the inshore waters and around insular realms, and develoment of EEZ fisheries emphasised. Options for augmentation of tuna production and their post-harvest utilisation in the artisanal and industrial sectors are discussed and conclusions drawn in the present study.

REVIEW OF WORLDWIDE DEVELOPMENTS IN TUNA FISHING INDUSTRY

According to a recent estimate (FAO, 1986), the world catches of 'major' species of tunas recorded an increase of 21 % of 1 733 000 t to 2 099 000 t between 1979 and 1984. Although countries such as Japan, U.S.A., Spain, France, Taiwan and Republic of Korea are responsible for the major part of the catches, their share of world catch declined from 74% in 1979 to 69% in 1984. Tuna production by developing countries such as Indonesia, Philippines, Mexico, Venezuela, Solomon Is, Maldives, Ecuador, Ghana, Brazil, Panama, Sri Lanka, Australia and others recorded an increase of about 45% from 445 000 t in 1979 to 656 000 t in 1984, contributing to about 31% of the world tuna catch in recent years. Trend of production of canned tunas also evinced the same trend. Developed countries recorded a decline of 24% of the world canned tuna production from 1979 to 1984 while the share of developing countries increased from 12% (1979) to 36% (1984) (Table 1).

A review of the status of the resources of the world's traditional tuna fishing grounds indicate that in the Eastern Atlantic a significant decline in the catch rate of tunas was felt in early 1980 due mainly to the increased fishing pressure. This has forced several purse seiners, especially those belonging to the French, Cote d'Ivore and Spanish tuna fleets to leave this area in 1983. As a result of significant reduction in fishing effort, the Eastern Atlantic stock of tunas began to rebuilt itself and the yield of yellowfin tuna increased by about 20 % in 1985. In the Eastern Pacific, total yield of tunas fell to a very low level in 1977, and in 1982 most of the tuna fishing fleets moved to the Western Pacific. Following reduced fishing effort in 1982 and 1983, the tuna catches and the yields increased sharply in this area, resulting in the return of tuna fleets to Eastern Pacific. In the Western Pacific, where the major tuna fishing grounds are located around Papua-New Guinea area and south of the Micronesian Federated States, yield of vessel especially of U.S.A. and Japan continue to be high. In the Indian Ocean, the tuna catches increased very rapidly in 1983 and 1984 due mainly to the purse seine fishery and in 1985 despite a 15% increase in purse seine fishing effort and significant extension of fishing ground, yellowfin tuna catches levelled off while catch of skipjack reached about 65 000 t. Recent tuna fisheries developments by coastal countries, restriction of access by distant nations to favoured fishing grounds and the relative conditions of present producer nations and the countries which posses the resources would determine the long term trends of the complex world tuna fisheries. However, the Indian Ocean with less problems of access to tuna resources is potentially attractive to distant water tuna fishing fleets, and uncontrolled increase in the fishing effort would result in a significant decline in the yield of tunas and profit.

Historical review of Japanese tuna fleet operations indicate that since 1950, concomitant with the construction of large tuna fishing vessels the area of operations expanded and the export oriented fishery covered the Pacific, Atlantic and Indian Ocean. In the 60's, due mainly to the developments in the Japanese economy, increased labour charge and weak market for canned tuna, continued expansion of the fishery became difficult. Consequently, Japanese fleet operators started aiming at the production of deep frozen tuna for the *sashimi* market by installing modern freezing equipments on board. Other problems faced by the tuna fleet operators in the 70's and early 80's were the worldwide energy crisis, which led to unprecedented increase in fuel prices in 1973 and 1979, followed by restriction in operations as a result of declation of 200 miles EEZ by countries form 1977. Of recent, Japanese tuna industry has also had to face poor market conditions in both demestic and overseas sectors. Effective measures were adopted to economise tuna fishing operations by reducing labour force, minimising fuel oil consumption, reducing number of vessels in the tuna fleet and re-

Table 1. World tuna catches and canned tuna production

Tuna catches(x 1000 t.)

	1979	1980	1981	1982	1983	1984
Developed countries *	1288	1338	1250	1285	1365	1453
(%)	(74.3)	(74.5)	(69.9)	(71.0)	(70.1)	(69.2)
Developing countries **	445	458	537	526	581	646
(%)	(25.7)	(25.5)	(30.1)	(29.0)	(29.9)	(30.8)
Grand total	1733	1796	1787	1811	1946	2099

(* = Japan, U.S.A., Spain, France, Taiwan and Rep. Korea : ** = Indonesia, Philippines, Mexico, Venezuela, Solomon Is, Maldives, Ecuador, Ghana, Brazil, Panama, Sri Lanka, Australia and others)

Canned tuna production

	1979	1980	1981	1982	1983	1984	1985
Developed countries *	489	486	524	485	519	539	502
(%)	(88)	(83)	(77)	(76)	(75)	(69)	(64)
Developing countries **	65	102	154	152	170	238	278
(%)	(12)	(17)	(23)	(29)	(25)	(31)	(36)
Grand total	554	588	678	637	690	777	780

(* = U.S.A., Japan, Italy, France, Spain and Taiwan : ** = Thailand, cote d'Ivoire, Philippines, Mexico, Ecuador and others)

(Source: FAO, 1986)

placing them with more efficient fewer ones with productive fishing methods. Consequently, the number of longline vessels were reduced since 1980, and several pole and line fishing vessels have been replaced with purse seiners(Fig. 1).

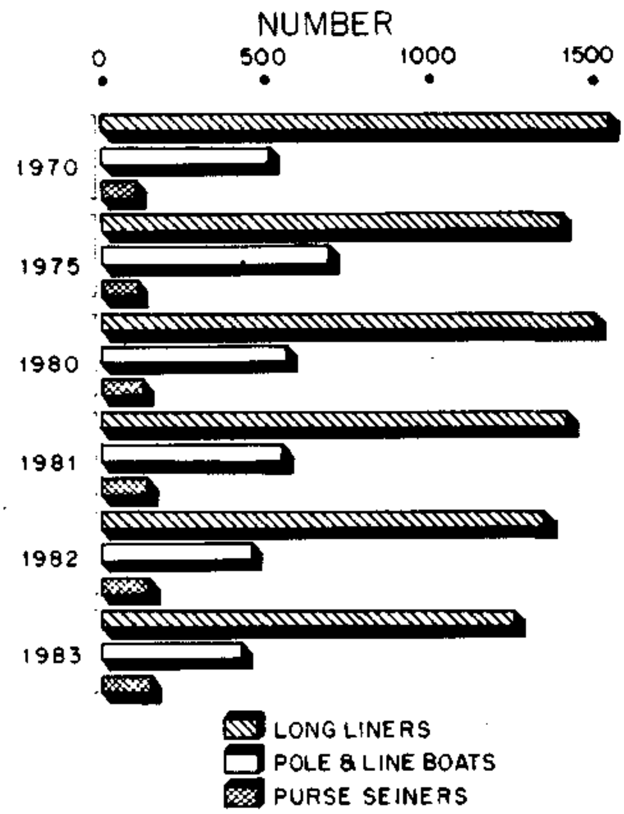

Fig.1. Rationalisation of the Japanese tuna fishing fleet during the period 1970 to 1983

The U.S.domestic tuna fishing fleet expanded steadily from 1960 till 1983. Initially, fishing was carried out by small local tuna clippers off California, but more efficient purse seiners were added to the tuna fleet, and in the late 70's and early 80's larger purse seiners with capacities of 1000 - 12000 tonnes were in operation. Fishing operations were expanded as far south as Chile, west to the Philippines and east to African coast. The U.S. tuna fleet which were concentrated in the eastern Pacific grounds moved to western Pacific Area in 1980 consequent to the increased competition, dwindling tuna catch rate (partly due to the *El Nino* conditions) and restrictive, U.S. Marine Mammals Regulations. However, relatively high operating costs, reduced demand for small skipjack tuna in the purse seine fishery and dissipation of the *El Nino* have led to a reversal of the trend. Redeployment of fleet between the western and eastern Pacific Ocean resulted in the reduction in the number of vessels in the U.S. tuna fleet in 1985 with a concomitant decline in tuna production (Fig. 2).

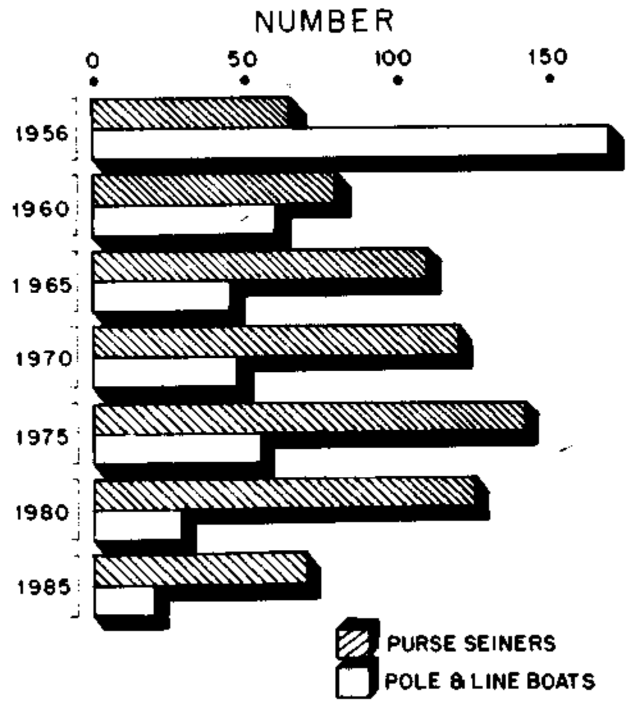

Fig.2. Trend of variation of the U.S. domestic tuna fleet (number of vessels) during the period 1956 to 1085

The tuna industry in the eastern Pacific has traditionally been dominated by the U.S.A., but in recent years Latin American countries have expanded their tuna fishery operations. Production (U.S.A.) of tunas which accounted for 83% of the total catch from the eastern pacific declined to 36% in 1985 while production by Latin American countries increased considerably from 14% to 57%, especially due to the rapid expansion of Mexican tuna fleet and to a lesser extent the enhanced fishing capacity of both Ecuador and Venezuela (Table 2).

Philippines, Thailand and Indonesia in the S.E.Asia are the important new entrants in the International tuna fishing industry.Tuna production in the philippines have shown a record increase from 9000 t to 117 000 t from 1971 to 1984, as a result of the introduction of large scale tuna purse seining in combination with FADs which was followed by export oriented frozen tuna industry in the country. However, since 1981 the Philippine frozen tuna export has declined drastically and resulted in import of tuna for meeting the demand of local tuna processing industry since then. Growth over fishing, resource depletion, over-capitalisation in the tuna industry coupled with increased operating costs and prevailing economic conditions in Philippines exacerbated the situation, and further tuna exporters in Philippines have been confronted with external problems and increased competition from other tuna processing and exporting nations.

Table 2. Tuna production (tonnes) in the eastern Pacific Ocean, by country

Country	1970	1980	1984	1985
Costa Rica	-	4547	3799	4103
Ecuador	17 744	18 188	35 222	39 591
Mexico	11 755	36 375	71 893	95 263
Peru	998	665	156	-
Venezuela	-	-	21 226	33 048
Panama	6 432	11 644	-	-
Cayman Is	-	4 325	-	-
Latin America countries	36 929	75 744	132 296	172 005
United States	219 249	225 016	107 232	109 680
other countries	7 320	42 145	5238	21 183
Grand Total	263 498	341 905	244 766	302 868

(Source: FAO, 1986)

In Thailand, tuna production (mostly longtail tuna) showed a remarkable increase from 10 000 t in 1975 to 86 000 t in 1983, accompanied by a rapid increase in the production and export of canned tuna which also have increased from 28000 t in 1983 to 87 100 t in 1985. Total tuna and tuna like fish production in Indonesia was estimated to be 226,000 t in 1984. Skipjack tuna accounted for about 34% and yellowfin and other tunas about 14% and the rest constituted by tuna-like fishes. Potential fishing grounds exist west of Sumatra and south of Java in the Indian Ocean and most of the export oriented tuna production activities are carried out in the eastern Indonesia.

The development of industrial tuna fishing operations in west Africa was due to the entry and expansion of foreign participation especially by van Camp and Star-Kist of U.S.A., Ghana, Cote d' Ivore, Senegal and Republic of Congo are the major countries capable of industrial tuna fishery in the west African Coast.

During the period 1983-84, a large part of French, Ivorian and Spanish tuna fleets left Atlantic Ocean and entered Indian Ocean due mainly to the decreasing trend of catch rate of yellowfin tuna (3.3 t per day) in the tropical eastern Atlantic. In the Indian Ocean, during 1984-85 average catch of yellowfin tuna for the same vessels was 5.8 t per day, a value 75% higher than that in the Atlantic. Catch per day of skipjack tuna was 5 t in the Indian Ocean in 1984-85, which was 2.8 t in 1980-83 in the Atlantic Ocean.

INDIAN OCEAN

In the Indian Ocean, Japanese tuna longline fishery commenced in 1953 followed by Taiwan and Korea in the 60's. Historical review of their fisheries, expansion and production are presented earlier (Silas and Pillai, 1982). An organised pole and line fishery for tunas has been in vogue in Sri Lanka, Maldives and Lakshadweep (India). Consequent to the mechanisation of fishing crafts and introduction of effective

Table 3. Production of tunas, tuna-like fishes and billfishes (tonnes) in the Indian Ocean, 1980-85

Species-wise and Gear-wise

Species/Group	1980	1981	1982	1983	1984	1985
Yellowfin tuna	34064	36435	46828	60663	93503	100768
Bigeye tuna	31303	32378	39144	44168	35604	41949
Albacore	11637	13233	23205	17180	15119	9628
Southern Bluefin tuna	24205	26065	29136	36741	30163	28002
Skipjack tuna	45835	45792	52620	61594	101922	136303
Tuna-like fishes *	68670	66134	91859	85764	88088	121330
Billfishes **	9817	10692	10836	10083	11082	15555
TOTAL	225531	230729	293628	316193	375481	453535

(* = Longtail tuna, little tuna, frigate tuna, bullet tuna and oriental bonito; ** = Blue marline, black marlin, striped marlin, sailfish and sword fish)

Longline fishery	37.9%	37.4%	37.2%	36.7%	25.2%	21.8%
Pole & line fishery	12.6%	11.8%	8.8%	10.5%	12.0%	12.4%
Purse seine fishery	1.0%	1.5%	5.5%	10.1%	29.9%	30.9%
Gillnet fishery	0.6%	1.5%	8.1%	10.3%	7.9%	13.5%
Unclassified	47.9%	47.8%	40.4%	32.4%	25.0%	21.4%

Source: IPTP Data Summary No.7, 1985

Table 4. Tuna species caught(tonnes) by countries in the Indian Ocean and by distant nations, Indian Ocean, 1983-85

Country & Gear	YELLOWFIN TUNA 1983	1984	1985	BIGEYE TUNA 1983	1984	1985	SKIPJCK TUNA 1983	1984	1985
Japan (LL)	7039	7467	9263	18425	13516	16502	3	2	9
(PS)	193	-	109	59	-	175	592	-	547
Korea (LL)	15337	9895	12017	16651	11481	12438	8	-	-
Taiwan (LL)	4211	1369	5099	8474	8163	9060	9	22	36
(GN)	-	-	16	-	-	-	-	-	-
France & Ivory Coast (PS)	10773	38718	35227	-	1214	2685	10075	30629	36281
Spain, Panama & U.K. (PS)	-	16392	19823	-	829	253	-	9561	27433
Indonesia (LL)	-	585	441	-	-	-	-	-	-
(PS)	-	27	29	-	-	-	-	356	388
(GN + TRL)	5888	3635	4073	-	-	-	12458	10091	9214
Seychelles (LL)	43	198	140	37	171	74	-	-	-
(TRL)	114	-	7	-	-	-	-	-	-
Kenya (LL)	322	-	-	237	-	-	2	-	-
(OG)	-	-	-	-	-	-	31	45	63
Mosambique (LL)	-	177	-	-	9	-	-	-	-
(PL)	15	11	15	1	-	-	60	154	80
Sri Lanka (LL)	905	644	222	-	-	-	-	-	-
(PL)	452	258	27	-	-	-	2095	1510	1757
(GN)	7237	5151	6145	-	-	-	11178	8714	10070
India (PL+TRL+GN)	-	-	-	-	-	-	1801	3488	3276
Maldives (PL)	5984	6893	5797	-	-	-	19491	31714	42170
(TRL)	257	230	269	-	-	-	210	335	432
Mauritus (PS)	1057	1234	914	284	250	747	1396	2500	2026
(TRL + HL)	-	50	-	-	-	-	0	350	-
Pakistan (GN)	-	-	-	-	-	-	733	694	1309
D.R.Yemen (GN)	80	12	511	-	1356	-	400	12	7
S. Africa (OG)	166	-	84	-	-	-	13	-	4
Australia (OG)	18	41	43	-	-	-	-	-	550
Comoros (OG)	120	130	140	-	-	-	340	350	360
TOTAL :	60663	93504	100783	44168	36969	41937	61594	101922	136303

(LL = Longline fishery; PS= Purse seine fishery; GN = Gill net fishery; TRl = Troll line fishery; HL = Hooks and Line ; OG = Other gears)
Source: IPTP Data Summary, No.7, 1985)

synthetic fishing gear materials surface tuna production evinced an increasing trend in many of the Indian Ocean countries which employ a variety of gears such as drift gillnets, coastal purse seines, troll lines and hooks and lines. Since the entrance of French, Ivorian and Spanish vessels in the surface tuna fishery by purse seining in the Indian Ocean in the mid 80's, total production of surface tuna, especially yellowfin and skipjack from the tropical western Indian Ocean remarkably increased.

Total production of oceanic tunas such as yellowfin, bigeye, albacore southern bluefin and skipjack tunas, coastal tunas and billfishes during the period 1980-1985 is presented in Table 3. In the case of yellowfin tuna, production by longline gear was in the range 18,960 to 30,100 t during the period, whereas production by purse seine gear has increased tremendously from about 140 t in 1981 to 56,150 t in 1985 with an average production of 62,044 t. Average annual production of other oceanic tunas such as bigeye, albacore and southern bluefin tunas were 37,400, 15,000 and 37,400 t respectively during 1980-85. As in the case of yellowfin tuna, introduction of purse seining in the oceanic area was instrumental for the increase in production of skipjack tuna from 1,468 t in 1980 to 66,680 t in 1985. Total catch of this species by pole and line fishery, mainly by Sri Lanka, Maldives and India (Lakshadweep) recorded an increase from 18,760 t in 1973 to 46,628 t in 1985 (average 74,000 t) due mainly to the mechanisation in this sector. Average production rates of other coastal tunas and billfishes were about 86,970 t and 11,344 t respectively during 1980-85 in the Indian Ocean.

Estimated gear-wise landing of tunas and billfishes during the same period from the Indian Ocean indicate that on an average longline gear contributed about 32.7%, Pole and line gear 11.4%, purse seines 13.5% and gillnets 7.0%. About 35% of the catches were made by gears the details of which are not available (IPTP, 1987). Impact of purse seine gear in the augmentation of total production of tunas is evident from the increase in the contribution of this gear to the total catch from 1% in 1980 to 31% in 1985.

In view of the significance of four species of tuna viz., yellowfin tuna, bigeye tuna, skipjack tuna and longtail tuna which hold potential as commercially exploitable stocks in the central equatorial Indian Ocean and in the EEZ and contiguous high seas around India, particular attention has been given in this document to synthesise the changing trend of their production. A summary of the estimates of surface and subsurface production and country-wise catches of these species are presented in Fig. 3 and Table 4.

Yellowfin tuna (Thunnus albacares)

Annual fluctuations in the total production of yellowfin tuna was noted till 1983, but the development of surface fishery by distant nations has been instrumental for the spurt in production from about 61,000 t in 1983 to 100,800 t in 1985. Percentage contribution by countries in the Indian Ocean evinced a declining trend (38.1% to 19.0%) whereas that by distant nations increased (61.9% to 81.0%) during the period 1983-85. Similarly, production by sub-surface fishery also showed declining trend from 45.9% to 26.9% during the above period. In the surface fishery, total production of yellowfin tuna increased from 54.1% to 73.1% during 1983-85 due mainly to the development of purse seine fishery in the tropical western Indian Ocean. Major tuna fishing Indian Ocean countries in this region are dependent on the surface fishery of yellowfin resource and as opined by Sivasubramaniam (1986), industrial artisanal yellowfin tuna fishery interaction assumes considerable importance for the development and management of the resource of the species in the equatorial subregion of Indian Ocean.

Bigeye tuna (Thunnus obesus)

Production of bigeye tuna fluctuated between 36,970 t and 44,168 t during 1983 and 85, the major share being taken by longline fishery (average 93.4%). Production by surface fishery, mainly by purse seine operations was negligible and amounted to 0.8% in 1983 to 9.2% in 1985.

Skipjack tuna (Katsuwonus pelamis)

Oceanic longline fishery contribute less than 1% of the total fishery production of skipjack in the Indian Ocean although high hook-rates for this species in the Arabian Sea during January-March was recorded (Marcille, 1985; Pillai and Silas, 1986). Skipjack tuna production has substantially increased form about 61,600 t in 1983 to 136, 300 t in 1985. Production of this species in the surface fishery by distant nations increased from 17.3% to 47.2% during the same period. In view of the fact that countries in this area employ traditional pole and line and gillnets to capture surface schooling skipjack tuna, possible interac-

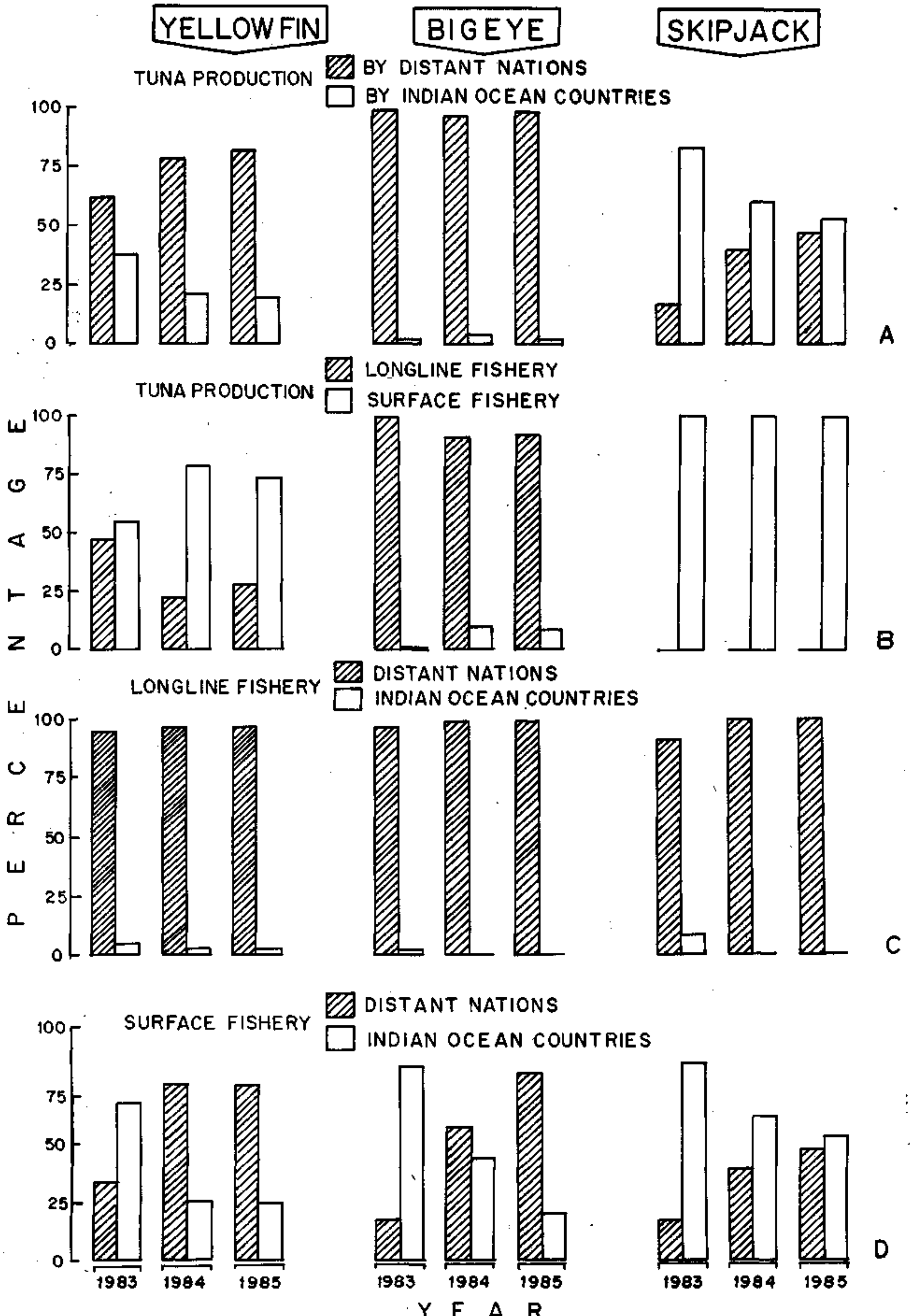

Fig.3. Percentage composition of yellowfin tuna, bigeye tuna and skipjack tuna in the fishery by distant nations, and countries in the Indian Ocean (A), in the longline and surface fisheries (B), and in the longline and surface fisheries by distant nations and countries in the Indian Ocean (C.D).

tion between emerging purse seine fishery and artisanal fishery should be viewed with serious concern.

Longtail tuna (Thunnus tonggol)

A brief summary of production of longtail tuna in the Indian Ocean during the period 1983-85 is as follows:

	1983	1984	1985
Total longline catches(t) :	295	319	-
Total surface catches(t) :	15662	19040	23694

Countries in the Indian Ocean are responsible for the total production of this species. Production by longline fishery (Iran) was negligible, forming only 1.7% of the total catch of this species. Other countries in the Indian Ocean producing longtail tuna by surface gears are Australia, Thailand, Malayasia, India, Iran, UAE, DR Yemen and AR Yemen. Total production of longtail tuna fluctuated between 15,660 t in 1983 to 23,690 t in 1985. Of the total production of this species, drift gillnets landed about 88% and purse seiners, mainly along the west coast of Thailand about 11% . Yesaki (1986) summarised the trend of production of longtail tuna in the Indian Ocean, and according to him the areas of present highest production of this species are the Gulf of Oman and eastern Arabian Sea, and extension of gillnet fishery into outer continental shelf would enhance its production in other countries.

OVERVIEW OF TUNA FISHERY IN INDIA

Around the mainland of India, there is no effort expended specifically for tunas and the catches are mainly incidental to other large pelagics. A traditional pole and line fishery, targeted exclusively to capture skipjack and yellowfin tunas is in vogue, for over a long period of time, only in the Lakshadweep islands. During the period 1981-1986 exploratory and training longline operations were conducted in the Arabian Sea, Bay of Bengal and equatorial Indian Ocean areas (Silas and Pillai, 1985, 1986; James and Pillai, 1987).

Small-scale sector

Tuna production around the mainland of India is chiefly confined within the 50 m depth zone. Major crafts and gears engaged in the fishery in the artisanal fishery sector, as reviewed recently are presented in Table 5.

The catch and effort in tuna fishery for earlier years have been discussed by Silas and Pillai (1983, 1985,1986 a,b), Silas *et al* (1984,1986) and James and Pillai (1987). During the period 1980-1984, tuna and billfish catch fluctuated between 17,000 t and 21,950 t, and in 1985 and 1986 tuna production has been estimated at 30,700 t and 34,060 t respectively (CMFRI, 1986; unpublished data). State-wise distribution of tuna catches for the recent period (1984-86) is presented in Table 6. On an average about 73.7% of the total production is from the west coast of India, 11.9% from the east coast and 13.5% and 0.9% from and Lakshadweep Is. and Andaman Nicobar Is. respectively. Percentage composition of different species of tunas and billfishes during the period 1984-86 were as follows:

Species/Group	Percentage composition		
	1984	1985	1986
Euthynnus affinis	54.7	51.8	53.3
Auxis spp.	8.1	9.7	24.9
Thunnus tonggol	1.0	17.4	0.5
Katsuwonus pelamis	16.6	12.1	9.3
Other tunas	13.7	6.0	7.6
Billfishes	5.9	3.0	4.4

Table 5. Characteristics of crafts and gears engaged in tuna production in India

	Craft			Fishing gear			
Type	OAL (m)	Material	Power (HP)	Length (m)	Depth (m)	Mesh size (cm)	No. of crew
Drift gill netters	7.6-9.1	wood	24-45	800-1200	5-8	6.5-14.0	3-4
Purse seiners	13.0-14.0	wood	105-120	400-600	40-60	1.4	16-25
Pole and Line boats	7.9-9.1	wood	10-40	Pole = 3-4	-	-	10-15
Troll line Boats	3.0-8.8	wood	sail	Pole = 3-4	-	-	4-10

(Estimates by CMFRI)

Seasonality in the production of tunas recorded were : post-monsoon period along the west cost of India, Pre-monsoon months along the east coast of India and post-monsoon and pre-monsoon periods around the Lakshadweep Is.

Total production of tunas by small scale purse seine fishery along Goa, Kerala and Karnataka coasts indicate a declining trend from 1982-83 to 1984-85 as detailed below:

	1982-83	1983-84	1984-85	1985-86
Goa	-	3	-	209
Kerala	43	1	13	607
Karnataka	928	862	529	2486
Total	971	866	542	3302

Oceanic species of tunas such as skipjack and yellowfin tunas constitute the major scombroid resources taken by the pole and line fishery with live-baits in the Lakshadweep (Silas *et al*, 1986; James *et al*, 1987 MS). At Minocy, the pole and line fishery has been in vogue for a number of years, and from the 60's this fishing method was adopted in the northern islands also, and in recent years are chiefly concentrated around Minocy, Agatti, Bangaram, Perumul Par reef, Suheli Par and Bitra Islands.

Total catch of tunas by pole and line fishery in the Lakshadweep during the period 1976 to 1985 is presented in Fig.4. During the period the total tuna production fluctuated between 1116 t and 4355 t with an average catch of about 2521 t during the period. Total landing of tunas recorded an increasing trend from 1977 to 79, and after recording a fall in production in 1980, the catch recorded steady increase to 4355 t in 1984 and in 1985, about 3780 t tunas were landed (Information Kit for Lakshadweep Features, RRL, Trivandrum, 1986).

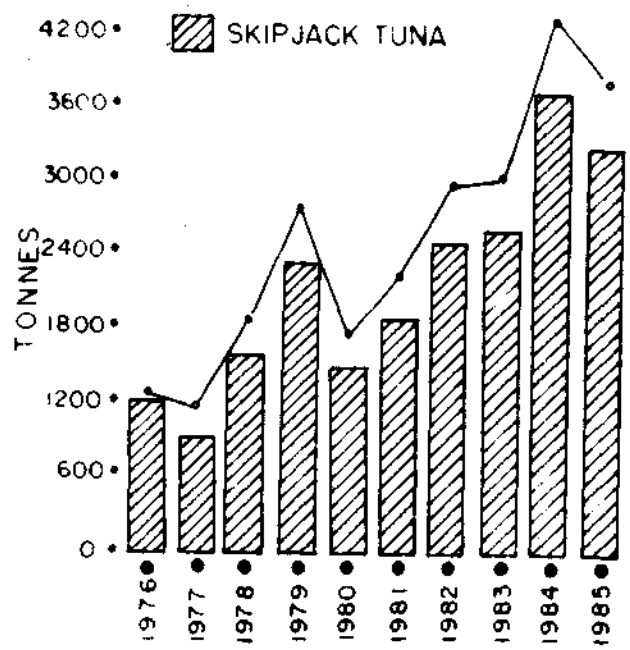

Fig.4. Tuna production in the Lakshadweep, 1976-1985. Vertical bars indicate estimated composition of skipjack tuna.

During the period 1984-85 season, a total of 4842 t of tunas were landed in the inslands (Table 7). Assuming these figures are indicative of the trend of production of tunas in the Lakshadweep in recent years, it is estimated that tunas constitute about 83% of the total catch in this area and about 53% of tuna production was from Agatti and nearby islands of Bangaram, Perumul Par and Suheli Par. Total average annual production rate has been estimated as 17.8 t/unit, and high catch rates were recorded at Agatti, Bitra and Minicoy for over a decade if apportioning is done as 86% of total tuna catch as skipjack and 11% as yellowfin 533 t in 1984-85.

Table 6. State-wise distribution of tuna catches(tonnes) - recent trend

States	1984 (Landing)	(%)	1985 (Landing)	(%)	1986 (Landing)	(%)
West Bengal	31	0.15	-	-	-	-
Orissa	31	0.15	65	0.21	377	1.11
Andhra Pradesh	866	4.25	1776	5.79	1321	3.88
Tamil nadu	2561	12.58	843	2.75	2409	7.07
Pondicherry	91.	0.45	47	0.15	213	0.62
Kerala	6168	30.31	9885	32.12	14943	43.87
Karnataka	1113	5.47	2964	9.66	6658	19.56
Goa	150	0.74	230	0.75	127	0.38
Maharashtra	2812	13.81	1873	6.10	1960	5.75
Gujarat	2002	9.84	9042	29.47	1831	5.38
Lakshadweep	4313	21.19	3775	12.30	3849	11.30
Andaman & Nicobar	215	1.06	215	0.70	369	1.08

Table 7. Tuna Production in the Lakshaweep, 1984-85

Island	No.of mechanised boats in operation	Total fish catch (t)	Tuna catch (t)	Tuna production (%)	Annual production rate (C/unit) (t)
Androth	30	399	202	4.2	6.7
Ameni	30	199	132	2.7	4.4
Agatti	55	2691	2570	53.1	46.7
Bitra	10	224	182	3.7	18.2
Chetlat	18	271	218	4.5	12.1
Kadamat	14	166	74	1.5	5.3
Kalpeni	10	179	55	1.1	5.5
Kiltan	25	245	109	2.3	4.4
Kavaratti	45	896 *	767 *	16.4 (?)	17.7(?)
Minicoy	35	523	503	10.4	14.4

(* Presumed inclusive of tuna catch from suheli Par Area)

(Source: Planning Dept., Secretariat, Kavaratti, 1986)

Silas et al (1986) while discussing the exploited and potential resources of tunas in the Lakshadweep summarised the results of studies carried out by CMFRI at Minicoy. Data collected on the catch, effort and species composition of tunas during the period 1981-82 to 1986-87 is as follows:

	Effort (units)	Catch (Tonnes)	C/SE (kg)	Catch/unit baits (Kg)	Skipjack tuna(%)	Yellowfin tuna (%)
1981-82	1241	321	258	115	85.4	14.9
1982-83	1112	381	343	134	81.2	10.6
1983-84	1370	345	252	107	79.6	12.1
1984-85	2422	569	235	133	94.2	5.7
1985-86	2575	623	242	139	85.9	14.0
1986-87	2859	722	253	112	91.0	8.6

Despite the increase in the total units operated and catch, mean value of C/SE (units) during the period was around 260 Kg with slight variations during different years. Similarly, although production of live-baits increased quantitatively, tuna production per unit of live-bait (Kg) did not show concomitant increase. As an average, skipjack tuna averaged 86% and yellowfin tuna 11% of the total tuna catch. Little tuna and rainbow runner constituted the rest of the catch.

Longline fishery

Silas and Pillai (1985,1986), Varghese *et al* (1984), Joseph (1986), Joseph and John (1986), Sivaprakasam and Patil (1986) and James and Pillai (1987) have summarised the details of tuna longline operations by the vessels *M.V. Prashikshani* and *Matsyasugandhi* in the Arabian Sea, Bay of Bengal and equatorial Indian Ocean areas during the period 1981 to 1986.

Joseph and John (1986) recorded catch rate of tunas as 47.59%, 38.19%, 35.76% and 62.30% in the areas Arabian Sea, Bay of a Bengal, Andaman Sea and equatorial Indian Ocean areas respectively. In the Arabian Sea, the area off Mangalore-Karwar Coast was found to be the richest tuna ground with average hook-rates of 12.9% (14^0-72^0),11.3% (13^0-73^0) and 8.2% (14^0-71^0). Productive yellowfin tuna fishing grounds in the Arabian Sea based on longline catch rates have been charted out by Rao and Pillai (In: Silas *et al.*, 1986). Bi- monthly pattern of distribution of hook-rate of tunas, as estimated by Joseph and John (1986) was highest (1.48-2. 74%) in the Arabian Sea during September-December period, in the Bay of Bengal (1.13-1.18%) during January-April period and in the equatorial Indian Ocean Area (1.22-2.19%) during October-November period. According to Sivaprakasam and Patil (1986), during 1985-86 an increase in the catch rate of tunas was noted in the longline fishery. In the Arabian Sea Area, a total effort of 65,450 hooks were expended and the hooked rate of tunas varied from 0.26-0.39% during May to September, then increased from 6.38-24.98% from October to January (5.94% in December) and 10.92 to 17.30% from Februrary to March. They also indicated a northerly migration of yellowfin tuna starting from October (10^0N) extending up to March (14^0N) in the Arabian Sea.

Swaminath *et al.* (1986) presented the results of synoptic longline surveys of tuna resources by *M.V Prashikshani* in the area 6^0-15^0N. and 67^0-97^0E. (northern Indian Ocean) during the period April, 1983 to June, 1986. A total of 240 t of fishes were caught of which yellowfin constituted 73%,bigeye 0.8%, skipjack 2.1%, billfishes 5.4% and pelagic sharks 17.5%. The increase in catch rate of tunas from 0.2%

in 1981-82 to 8.8% in 1986 might be due to the expertise developed during the course of long-line operations. Zone-wise hooked rate indicate that the area between $15^0 - 23^0N; 74^0 - 67^0E$ and $8^0 - 15^0N.; 78^0 - 67^0E$ are productive for tuna fishery with hook rates recorded as 6.2% in both the areas. For yellowfin tuna, highest hook-rate of 27.9% was recorded from the area 14-17, followed by areas 14-72 (HR=17.4%) and 15-72 (HR=10.2%). During the intensive tuna fishery conducted during October, 1985 - May, 1986, a potential tuna ground was located off Karntaka-Konkan coast between 12^0 and 15^0N. and $71^0$and 73^0E. Tunas constituted 87.9%, bill-fishes 3.9%, pelagic sharks 6.7% and others 0.6% of the total catch. Hooked rate of yellowfin tuna varied from 4.4% in October, 85 to 26.2% in February, 1986. The period February-April, 1986 was found to be most productive in tuna fishery with yield estimated between 4,543 and 5,716 kg per 1000 hooks.

Data on 'fishing intensity' and 'effective effort', as estimated by Pillai and Srinath (1986) for yellowfin tuna fishery taken by Japanese longliners in the Indian Ocean are necessary to derive at conclusions on the factual catch rates of tunas in the longline fishery. Further, only limited data on the size distribution of yellowfin tuna in the longline fishery are available from the oceanic waters of the Indian sub-region. Silas *et al.*, (1986) indicated that 2 and 3 year old yellowfin tunas are exploited by longline fishery from the EEZ of India and contiguous high seas, based on the data collected during the longline operations by CIFNET. Swaminath *et al.*, (1986) also recorded the size range of yellowfin tuna in the longline fishery as between 60 to 180 cm, with maximum number caught in the size range 110-140 cm representing two and three year old fishes. As opined by Sivasubramaniam (1986), in the absence of sufficient size distribution data no definite conclusions could be made on (i) the recruitment of larger groups (2 and 3 year old fishes) to the long-line fishery from the surface components (young ones and 1 year old taken by pole and line fishery) "resulting in the increased hook rate during winter months", and (ii) "possible continuation of the northward migration of tunas" suggested by Sivaprakasam and Patil (1986).

Results of exploratory tuna resource surveys by longline operations by Thailand in the Andaman Sea ($05^0$30' - $14^0$02') since 1965 are presented in Table 8. An estimated total of 56, 190 hooks were operated in the survey conducted in 10 phases. Hook-rate of tunas varied from 0.3-2.6% (Poreeyanond and Kambud, 1985). Catch rate of longline boats (100 GT) off Bali, western Indonesia in the southern Andaman Sea during the years 1984 and 1985 has been reported by Gafa (1986). The catch was dominated by yellowfin tuna, and the mean hook-rates during 1984 and 1985 were 1.39 and 1.41 for mean efforts of 131, 615 and 361, 000 hooks respectively. Productive months were March-May and December in 1984, and April-July in 1985 (Table 9).

The hook-rates of yellowfin tuna in the Japanese and Taiwanese longline fishery (1984) and Korean longline fishery (1980)in the area 0^0 -15^0N. and 70^0 - 95^0E were calculated from the print outs by the IPTP (1987) and presented in Table 10. Total hook-rate estimated was 1.77%, 1.39% and 1.23% and hook rate of yellowfin tuna was 0.49% and bigeye tuna 0.63%. Indepth analysis of data indicate that maximum production of yellowfin tuna (1.40% HR) was from the area 15^0 - 20^0N; 80^0 -95^0E in the Japanese and Taiwanese longline fishery whereas it was from the area 10^0 - 20^0N; $70^0 95^0$E in the Korean longline fishery.

DISCUSSION

An overview of production of tunas and tuna-like fishes in the small scale sector in India indicate that drift gill nets are the prevalently used gear in the tuna fishery, followed by pole and lines. The increasing trend in the adoption of drift gillnetting are mainly due to: (i) relatively low cost of operation in that a small vessel without ancillary gears and minimal fuel consumption can be utilised in this fishery, (ii)

Table 8. Production of tunas in the longline fishery in the Andaman Sea : Thailand

Area	Effort (Baskets)	Hook-rate (%)	Average hook-rate (%)
05°38'-13°14'N	1384	0.2-5.6	1.3
07°32'-14°02'N	1158	0.2-8.2	2.6
07°54'-11°15'N	2159	0.7-7.3	2.0
05°30'-08°38'N	868	0.1-0.9	0.6
06°12'-08°55'N	800	0.2-1.5	1.0
05°25'-11°10'N	975	0.7-1.5	1.0
09°05'-11°01'N	479	0.2-0.5	0.3
05°37'-08°16'N	615	0.3-4.2	2.2
08°04'-09°03'N	1200	0.1-3.2	1.4
05°30'-08°5'N	1600	0.1-1.2	0.3

Table 9. Production of tuna in the longline fishery in the Andaman Sea : Off Bali, western Indonesia

Month	1984 Effort (x1000 Hooks)	Hook rate (%)	1985 Effort (x1000 hooks)	Hookrate (%)
January			473	1.45
February	95	1.00	374	1.05
March	203	1.74	64	1.11
April	47	1.32	564	1.64
May	88	1.74	328	2.10
June	275	1.19	301	1.42
July	350	0.94	407	1.72
August	95	1.43	357	1.40
September	45	1.56	418	1.20
October	103	1.25	353	1.12
November	62	1.18	162	1.41
December	78	1.95	198	1.32

Table 10. Annual Hooked Rate of yellowfin tuna and bigeye tuna in the Japanese (1984), Taiwanese (1984) and Korean(1980) longline fishery in the northern Indian Ocean

	Area		Hook-rate (%)	
		Total tunas	Yellowfin tuna	Bigeye tuna
Japanese longline fishery	0^0-5^0N			
	75^0-90^0E.	1.90	1.16	0.50
	5^0-10^0N			
	70^0-90^0E.	1.50	0.49	0.74
	10^0-15^0N			
	85^0-90^0E.	1.47	0.64	0.51
	15^0-20^0N			
	85^0-95^0E.	2.20	-	1.41
Taiwanese longline fishery	0^0-5^0N			
	70^0-95^0E.	1.12	0.70	0.30
	5^0-10^0N			
	90^0-95^0E.	0.90	0.24	0.41
	10^0-15^0N			
	80^0-95^0E.	1.13	0.04	0.72
	15^0-20^0N			
	80^0-85^0E.	2.29	-	1.64
Korean longline fishery	0^0-5^0N			
	70^0-100^0E.	1.21	0.72	0.37
	5^0-10^0N			
	70^0-100^0E.	1.50	1.21	0.14
	10^0-15^0N			
	70^0-95^0E.	1.13	0.03	0.77
	15^0-20^0N			
	70^0-90^0E.	1.09	0.04	0.73

(Source: IPTP Data Record, Vol.1, 1987)

ease of fabrication and maintenance of the gear, (iii) gillnets are rigged to entangle rather than gill with the result that a wide variety of commercially important fishes such as seerfishes, pomfrets, catfishes, sharks etc.are also caught during fishing, and (iv) possibilitiy of carrying out day time trolling as drift net operations are conducted at night.

Augmenting production of tunas through drift gillnetting employing mechanised vessels and motorised canoes has been discussed by Silas and Pillai (1986). Based on a case study carried out at Cochin it was assumed that each boat could harvest annually or seasonally about 25-30 t of large pelagics and tunas constitute about 20% of the total catch; thus, the average catch of tunas that could be achieved is about 6 t of tunas per annum/or season per boat. Major improvements required in this sector are the better catch storage facility, employment of energy saving devices and introduction of mechanisation in the hauling operations which would increase soaking time and catch rate. Seasonal conversion of 9.6 - 13.0 m OAL shrimp trawlers, with slight modifications in the hauling system would enhance operational range of drift gillnet fishery.

Employment of small purse seiners (OAL = 18 m: HP=45) to catch tunas is increasing in the west coast of Sumatra in the tropical Indian Ocean. In India about 500 purse seiners (13-14 m OAL; 105-120 HP) are engaged in the pelagic fishery landing about an average of 1420 t of tunas during the period 1983-86 along the west coast of India. Sivasubramaniam (1986) opined that the size of craft and gear, engine power and expertise in handling may permit only a moderate expansion of the fishery in the artisanal sector. However, interaction of this fishery and coastal drift gillnet fishery on the stocks of coastal tunas needs careful appraisal.

The mainstay of tuna fishery in the Laskhadweep islands is the small-scale pole and line (live-bait) fishery. Relatively small capital investments involved, ability to harvest small schools of fish, mobility to operate from small ports with minumum technical support and ability to utilise the unskilled labour are the advantages of this fishery. Introduction of mechanisation in the early 60's and the spread of pole and line fishing practice, which was in vogue in Minicoy to some of the northern islands such as Agatti, Bitra, Suheli Par, Perumul Par etc are the two recent developments is this sector. The trend of tuna fishery in the Lakshadweep has been reviewed by Silas *et al.* (1986) based on the information gathered at Minicoy. Recently, the present trend, constraints and strategies for future development of small scale pole and line fishery at Lakshadweep has been critically reviewed by James *et al.* (1987:MS).

At present mechanised boats of 7.9 - 9.1, OAL and 10 - 40 HP and non-mechanised boats of 3.0 - 7.70 m OAL are employed in the day fishing for tunas. One of the strategies for augmenting production of tunas in this sector in the Lakshadweep would be the introduction of a new generation of boats (15 - 20 , OAL), with adequate navigational and fish storage facility for 4 to 5 days of fishing. At the modest estimation of production of 60 - 100 tonnes of tunas per season per such boat, and estimating average production of tunas per kg of bait as 120 kg, the requirement of each boat/season will be about 0.5 to 0.8 t of baits. Introduction of about 100 boats of this generation would enhance the production of yellowfin and skipjack to the tune of about 10,000 t by 2000 A.D.

Expansion of pole and line fishing method is limited by the availablity of suitable live-bait resources in quantity, their maintenance and transportation, availabliity of tuna schools in fishing grounds, response to chumming, expertise of fishermen etc. Recent aimed bait-fish resource surveys conducted by the CMFRI in the Lakshadweep have proved beyond doubt the vast resource of potential live-bait species belonging to the families Dussumieridae, Apogonidae, Caesionidae, Pomacentridae and Atherinidae (other than the traditionally used sprat, *Spratelloides delicatulus*) around Agatti, Bangaram, Perumul Par, Suheli Par, Kadamat, Kalpeni and Bitra. *S. delicatulus*, a shallow water resident species, with good chumming quality and easily fished by surrounding nets in desired numbers is the only species currently exploited in the tuna pole and line fishery in the islands other than Minicoy. Major constraints in the utilisation of this species is the large scale mortality at the time of capture, storing and transporation. Since the fishery is chiefly dependent on the availablity of this species, its scarcity often result in abrupt suspension of tuna fishery. Exploiting the bait fishes belonging to Apogonidae, Caesionidae and Pomacentridae should be encouraged in all the islands which will lead to augmentation of live-bait production and dispel the threat of overfishing and consequent depletion of the exploitable stocks of *S. delicatulus*.

Interference with the lagoon ecosystem by acitivities such as dredging, and fluctuation in the seasonal recruitment of migrant bait species were the major reasons attributed to the scarcity of tuna live-baits in the Lakshadweep (James *et al.*, 1986). Further, consequent to the introdcution of mechanisation the pole and line fishing fleet which consisted of about 9 boats in 1963 increased to 94 boats in 1973 and 272 boats in 1984-85 with a concomitant production of tunas from about 366t in 1963 to 1 020 t in 1973 and to a record catch of 4,355 t in 1984, resulting in exploitation pressure on resident species.

The potential species of tunas in the offshore ranges of India are the skipjack and yellowfin tunas. Hence it is felt that one of the immediate steps which appears feasible and practicable in the development of small scale surface fishery in the EEZ of India is the strengthening and expansion of ploe and line fishery and introduction of medium sized purse seiners in the Lakshadweep, especially in the northern islands.

Under large scale commercial fishery sector, augmentation of production of tunas can be achieved by the proper deployment and management of oceanic purse seiners and improvements and expansion of longline fishery. As opined by Silas and Pillai (1986) successful surface fishery for tunas can be achieved by large scale purse seine operations through joint venture/ownership agreements. However, in the operation sector in both these types of fisheries, acquisition, utilisation and economic management of vessel capacity, equipments and expertise of developed nations is a prerequisite.

Historical review of the development and recent trend of the industrial tuna purse seine fishery in the tropical Indian Ocean were summarised by Marcille (1985), Hallier (1985), Hallier and Marsac (1985), Cort (1985), Watanabe (1985) and Michard and Hallier (1986). Surveys and experimental fishing employing purseines commenced in the Indian Ocean from 1981, and in 1984 French and Spanish purse seiners shifted their operational range from Atlantic to the Indian Ocean, and the present status of distant nation's fleet of purse seiners in the tropical Indian ocean by country of registration is as follows:-

Year/country:	France	Spain	IvoryCoast	Mauritius	Panama	U.K.	Total
1984	20	6	4	1	1	-	32
1985	23	10	2	1	1	1	38
1986 (1/86-10/86)	21	11	-	1	1	1	35

The pure seine fleets based in Seychelles operated in the area $42^o - 72^o E$ and $12^o S - 5^o N$ in the equatorial western Indian Ocean. A spurt in the production of skipjack and yellowfin tunas was recorded since 1984, and about 55% of the production of these species are taken by the distant water nations in recent years (Table 3).

Information provided by Silas and Pillai (1982) on the prevailing conditions of thermocline, current pattern and sea surface temperature provide information on the concentration of skipjack and yellowfin tunas in this area. Use of remote sensing for delineating productive sectors in the oceanic areas and concentration of surface shoaling species of tunas, especially by time series maps from satellites such as IRSS, LANDSAT and NIMBUS-7 are important in this connection (James *et al.*, 1986). Marcille (1985) while concluding potential fishing grounds and seasons for oceanic purse seining in the Indian Ocean based on the analysis of the prevailing meteorological and hydrographic conditions and current systems indicated potentially succesuful purse seine season in the Andaman Sea as March-May and Lakshadweep Sea as November-May. Employment of 10-12 purse seines with annual production capacity of 6000 t and 20 purse seiners each of 4,000 t production capacity would lead to the production of about 150,000 t of tunas (yellowfin and skipjack) from the oceanic waters around India and contiguous high seas (Silas and Pillai, 1986). Development of large scale purse seining should be planned in a regulated manner since: (i) the fishery result in the harvesting of young yellowfin tunas, and may affect the recruitment of this species to the longline fishery, (ii) it may also affect the availability of surface species of tunas such as skipjack and yellowfin tunas to the existing traditional fishery in the tropical Indian Ocean Area (employing drift gillnets, pole and line and coastal purse seining) which evinced fluctuations and oscillations during the period 1976 to 1985 (Table 11).

As stated earlier, longline fishery surveys carried out in the Arabian Sea, Bay of Bengal, Andaman Sea and Tropical Indian Ocean have charted out productive areas and northward shift in the seasonal pattern of abundance of yellowfin tunas (Joseph and John, 1986; Sivaprakasam and Patil, 1986). Marcille (1985) indicated earlier an apperent seasonal migratory pattern of yellowfin tuna northwards during October to March and southwards during April to September in the Arabian Sea, based on the analysis of data collected from the longline fishery. The operational aspects, constraints and management problems of longline fishery within the EEZ of India and contiguous high seas were dealt with earlier (Silas and Pillai, 1982). Effort should be made to enter into commercial longline fishery initially through joint venture arrangements. About 150 longliners with annual production capacity of 450 t of tunas anually would be required for achieving a production target of 60,000 - 75,000 t of oceanic tunas especially yellowfin tuna and bigeye tuna.

PRODUCT DEVELOPMENT AND MARKETING

Development and improvement of post-harvest technology on coastal and oceanic tunas and tuna products assumes importance while planning for augmenting production of tunas and to diversify exports of marine products.

Based on the market value and utilisation of meat, yellowfin tuna, skipjack tuna and longtail tuna are classified as 'light meat tunas' and tuna-like fishes such as little tuna, frigate and bullet tunas and bonito as 'red meat tunas'. Improvement in the post-harvest technology, product development and marketing combined with infrastructure for increasing demand for tuna within the country and in the export market would be one of the options for augmenting production of this resource. Developing internal markets for red meat varieties such as little tuna, frigate and bullet tunas and bonito in fresh, frozen and processed form through improved processing technology would lead to the augmentation of their production in the coastal small scale fishery sector. Eventhough smoked and cured *masmin* from tuna prepared indegenously, is the major product in Lakshadweep today, technology for improving the quality of *masmin* and new products from tunas will have to be attempted keeping in view the market preference due to the fact that at present there

Table 11. Trend of Production of Skipjack tuna and Yellowfin tuna by countries, 1976-85 (Tonnes)

INDONESIA *			SRI LANKA **	
TOTAL	(INDEX)	YEAR	TOTAL	(INDEX)
6830	(100)	1976	19137	(100)
4269	(63)	1977	17119	(89)
6904	(102)	1978	16363	(860)
9760	(143)	1979	30838	(1610)
10921	(160)	1980	19606	(103)
9929	(145)	1981	21420	(112)
14756	(216)	1892	21600	(113)
18346	(269)	1983	32018	(120)
13736	(201)	1984	18050	(94)
13387	(195)	1985	18834	(98)
MALDIVES ***			INDIA (LAKSHADWEEP)+	
24983	(100)	1076	1291	(100)
18815	(75)	1977	1116	(86)
17408	(70)	1978	1875	(145)
22425	(90)	1979	2794	(216)
50215	(201)	1980	1780	(138)
25896	(104)	1981	2220	(172)
19385	(78)	1982)	2950	(221)
25942	(104)	1983	3050	(236)
39172	(157)	1984	4355	(337)
48668	(195)	1985	3775	(292)

(* = Trolling, drift gillnetting; ** = Drift gillnetting, Pole and line fishery; *** Pole and line fishery, trolling; + = Pole and line fishery; trolling) is no organised marketing system for *masmin* at Lakshadweep. Development of an organised marketing system will be beneficial to the tuna fishermen since it can solve to some extent the present constraints in getting profitable markets and sudden fall in price of the products. In view of the economical returns, quality improvement and steady market for *masmin* chiefly in the mainland of India and export should be explored and developed.

There is scope for development and expansion of tuna canneries for producing canned packs of tunas for internal consumption. At Minicoy, an average of about 70 t of tunas are canned annually by the Govt. Canning Factory, and at Agatti a scheme for establishing canning factory has recently been proposed.

Processing of tuna wastes economically is another area to be considered immediately in the Lakshadweep Island. Observations conducted by CMFRI at Minicoy and Agatti islands indicate that about 5-8% of body weight of tunas at Minicoy and 34-43% of body weight of tunas at Agatti are discarded as 'waste' in the indegenous *masmin* processing industry. Effective small scale waste utilisation method by converting them to fish meal or as ensilage should be explored and implemented.

CONCLUSIONS

As stated elsewhere in the present study, tuna fishery potential in the high seas and the insular realms of India is in the resources of skipjack and yellowfin tunas. Available data indicate that the production of yellowfin tuna in the surface fishery has already exceeded that by longline fishery and the production of skipjack has increased considerably in recent years.

There has been a traditional small scale fishery for skipjack and yellowfin tunas in the tropical northern Indian Ocean by Indonesia, Sri Lanka, Maldives and India, and the rate of production of these species evinced fluctuations and oscillations for the past one decade. Index of decrease/increase in the production of these two species in the surface fishery of these countries during the period 1978-86 is presented in Table 10. In Indonesia, the catches steadily improved from 1978; in Sri Lanka catches were relatively high during 1981-83, and since then shown a declining trend in recent years; in Maldives, after a decline in production in 1981, the catch rate increased from 1983-85; in the Lakshadweep (India) a steady increase in the production of these two species was noted since 1980 - all these developments are attributed to the addition to the fleet, large scale mechanisation and expansion of fishing grounds. Production of yellowfin and skipjack tunas has dramatically been increased with distant nations taking about 55% of their total production from the area where traditional fishery in the artisanal sector has been in existence.

Development and management of tuna fishery require basic data on the stock structure, migratory patterns and biological parameters of different species. Although estimates of mortality, exploitation rate and stock structure of yellowfin and skipjack tunas are available (Silas *et al*, 1986; James *et al*, 1987), in view of the oceanwide distribution pattern of these species, their highly migratory nature and limited area of coverage in the studies, these represent "a bench mark for optimum exploitable level within the exploited ranges, limited by the carrying capacity of these ranges" (Sivasubramaniam, 1986). Further, the differential growth rates estimated for these species from this sub-region may be due to the age specific migration of these species (Skipjack, K=0.22 - 0.62; yellowfin, K = 0.32 - 0.50). In order to derive at realistic estimates on the interaction of the fisheries in the small scale sector (surface) and in the large scale commercial sector (surface and sub-surface), data over an extended period of time and wider area on the catch-effort statistics and size distribution by sex and species are prerequisites.

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