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Indian tuna fishery - production trend during yesteryears and scope for the future

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ABSTRACT

Fishery for tuna and tuna like fishes in the country have been in vogue from time immemorial and presently involve fishery by coastal based fleets of varying specifications with different craft-gear combinations and longline fishery by large oceanic fishing vessels. The former undertake short duration fishing trips and exploit mainly surface tunas in the outer shelf and adjacent oceanic waters. The tuna landings though nominal during 1950-2005, registered a continuous increase over the years from a minimum of 848 t (1951) to 46,334 t (2000). With the introduction of targeted fishing for oceanic tunas during 2005-'06, the landings improved and reached the maximum of 129,801 t in 2008. The fishery was supported by nine species, five coastal/neritic species and four oceanic species. Coastal tunas formed 57% of the tuna catch during 2006-'10 and was represented by the little tuna (*Euthynnus affinis*), frigate tuna (*Auxis thazard*), bullet tuna (*Auxis rochei*), longtail tuna (*Thunnus tonggol*) and bonito (*Sarda orientalis*). The oceanic species, which formed 43% of tuna catch, were yellowfin tuna (*Thunnus albacares*), skipjack tuna (*Katsuwonus pelamis*), dogtooth tuna (*Gymnosarda unicolor*) and bigeye tuna (*Thunnus obesus*). Information collected from different sources suggested that longliners operating in Indian EEZ and adjacent international waters caught around 87,000 t of tune annually during 2006-'10. Catch was supported by three species dominated by yellowfin tuna and small proportion of big-eye and dogtooth tuna. Since, fishery by coastal based units restricted to small areas and share of the catch by long liners from EEZ are not clearly known, systematic assessment of tuna stock in Indian EEZ is very difficult. However, the evaluation of the fishery scenario indicated only limited scope for improving tuna production from certain areas of coastal waters; whereas enormous scope remain for increasing tuna production from the oceanic waters of EEZ. However, since tunas being straddling resources shared by several nations, exploitation at one area will influence the fishery in other areas.

Keywords: Coastal tuna, Indian EEZ, Oceanic tuna, Potential yield, Tuna fishery

Introduction

Tuna and tuna-like fishes are important both from global demand and economic view points and include 40 species occurring in the Atlantic, Indo-Pacific Oceans and in the Mediterranean Sea. Archaeological evidence showed that, tunas being harvested by early Europeans in the area around Sweden, by Native Americans near British Columbia and by the people of the Joman culture near Japan. However, industrial fishing for tunas began in the 1950's and global production has tended to increase continuously from 0.6 million t in 1950 to over 6 million t in 2008. Catch of principal market tuna species was estimated as 4 million t in 2008, which represented about 67% of the total catch of all tuna and tuna-like fishes. Most of these catches were taken from the Pacific Ocean (70.2%), with the Indian Ocean contributing 20.4% with an estimated catch of 870,000 t and the rest by Atlantic Ocean and the Mediterranean Sea (9.5%). Major contributors to the global tuna production are skipjack tuna (57.5%), followed by yellowfin tuna (27.1%), bigeye tuna (9.6%), albacore (4.7%) and the rest (10.7%) by other species. According to assessments carried out during 2010 by the International Commission for the Conservation of Atlantic Tunas (ICCAT), Indian Ocean Tuna Commission (IOTC), Inter-American Tropical Tuna Commission (IATTC) and Western and the Central Pacific Fisheries Commission (WCPFC), the international organizations responsible for management of the tuna stocks of the world oceans, many tuna stocks are heavily exploited, some at unsustainable levels, and the catches in many cases are declining.

Tunas have been exploited along the Indian coast since time immemorial with neritic tunas being the mainstay of the tuna fishery till recently. Tunas in Indian waters are represented by nine species belonging to five genera, *Auxis, Euthynnus, Sarda, Katsuwonus* and *Thunnus*. Coastal/ neritic tunas are represented by five species and are being

exploited as an incidental catch in many commercial coastal fishery. Increased demand for sashimi grade tuna from export markets, improved harvesting methods, expansion of transportation and storage facilities and development of value added products provided an impetus for fishermen to harvest all commercially important resources including hitherto non-targeted oceanic resources. Modernisation and adoption of innovative fishing methods, increased endurance of the fishing crafts and improved fishing efficiency encouraged extension of fishing activities beyond territorial waters, resulting in overall increase in production from certain centres.

Status of tuna exploitation by the coastal fishery sector of the Indian EEZ has been reviewed and assessment of tuna stock has been done by many at different points of time (Silas and Pillai, 1985; James and Piliai, 1993; James *et al.,* 1992, 1993; Yohannan *et al.,* 1993; Pillai *et al*.. 1993; Modayil *et al*., 2005). Development of oceanic tuna fishery has been reviewed by several workers (Sudarsan *et al*., 1989; Somavanshi, *et al*., 1998; 1999; 2000; Sivadas, 2002; Somvanshi and Varghese, 2005). Several studies were also undertaken on the biology, fishery and stock assessment of tuna resources from the Indian coast (Silas, 1967; 1985; Silas *et al.,* 1979; 1985; Silas and Pillai, 1982; 1985; Siraimeetan, 1985; Mohan and Kunhikoya, 1985; John and Reddy, 1989; Pillai *et al*., 1993; James and Jayaprakash 1991; Sudarsan, *et al*., 1991; James *et al.,* 1992; John, 1998; Somvanshi *et al.* 2003; Gopakumar and Ajithkumar, 2005; Kasim and Abdussamad, 2005, Koya *et al.,* 2005; Pillai *et al*., 2005; Premchand *et al.,* 2005; Sivaraj *et al.,* 2005; Abdussamad, *et al*. 2008; Pillai and Ganga, 2008; Prathibha *et al.,* 2008).

Though tuna fishery gained importance in recent years, only limited information is available on the recent developments in the tuna fishery, production trends, stock characteristics and potential in the Indian EEZ including island territories. The present paper aims to fill the above information gap and to aid in developing guidelines for tapping the unexploited oceanic tuna potential of the country.

Materials and methods

Tuna fishery along the Indian coast was monitored along the six geographical fishing regions, north-west (NW), south-west (SW), south-east (SE), north-east (NE) Lakshadweep and Andaman & Nicobar territories during 2008-'10. Data on effort, catch, and species composition of tunas in the commercial fish landings were collected and biology of the species were studied. The national fishery data collected by Central Marine Fisheries Research Institute (CMFRI), Kochi was used as the baseline data in the present study. Details on the fishery were collected from the fishers through enquiry. The catch data collected for Lakshadweep under in-house research projects of CMFRI and that collected from the Fisheries Departments of Andaman and Nicobar were used in the study.

Tuna catch by long liners were estimated based on the information gathered from published reports (Pillai 2011) fishing industry and observations made on the catch of confiscated deepsea fishing vessels.

Results

Tuna fishery in India has a long history as that of the marine fisheries of the country. Tuna fishery involved coastal based fleets of varying specifications with different craft-gear combinations and large long liners (Table 1). Until eighties tuna remained as an incidental catch in many fisheries except in Lakshadweep, parts of Kerala and Tamil Nadu, where targeted fishery for tunas were in vogue. In Lakshadweep, well organised targeted fishery for skipjack tuna has been in vogue using pole and lines and trolllines. At Vizhinjam along the coast of Kerala, bullet tunas enjoy considerable local demand and targeted exploitation were being carried out using hand lines, small longlines and gillnets. At Tuticorin along the coast of Tamil Nadu, tunas and large pelagics were targeted by traditional fishermen using gillnets, trolllines and longlines from traditional crafts. Encouraged by the catch made by traditional fishermen, several trawlers were modified for gillnetting at Tuticorin for tuna and other large pelagics from deeper waters, in eighties.

Commercial longlining under charter scheme as a prelude to joint venture for oceanic tunas was initiated in mid-eighties and witnessed phenomenal growth over the years. They undertake long duration fishing trips, operate large longlines and gillnets, stay at sea for extended periods of time and rarely return to registered port. They fish both in the Indian EEZ and international waters and the catch is not landed or reported properly, but believed to be trans shipped in the mid-sea.

During the beginning of this decade, hundreds of traditional fishermen from the south-east coast ventured specifically for exploiting oceanic tunas and associated resources with great success. They operate small longlines/ handlines/trolllines/pole&lines/gillnets from artisanal crafts in the outer shelf areas. Encouraged by their success and also following the policy decision of the government to tap oceanic resources, several commercial trawlers were modified for longlining, mainly to exploit yellowfin tunas during 2005-'06. These fleets based at several major and minor harbours of the country, operate multiple gears, along with longlines mostly in shelf edge and adjacent oceanic waters. But, later driven by economic benefits, several of these units diverted their main target from tunas to billfishes

and elasmobranchs. The latest development in this line is the introduction of multiple pole and line with single hook fishery for medium sized yellowfin tunas in Lakshadweep waters.

Table 1. Fleet strength involved in the fisheries of tunas and related resources from Indian mainland and island territories

Fleet category	Fleet strength (no.)
Traditional crafts (motorised and non-motorised)- multiple gears	6,500-7,000
Converted trawlers (<24 m OAL) - multiple gears	840
Converted trawlers(>24 m OAL) multiple gears	48
Large longliners	80-110 (Pramod, 2010)

Fishery

Tuna fishery over the years has undergone several changes like modernisation of fishing practices along with diversification, intensification and extension of fishing to new grounds and landing from incidental bycatch to targeted commercial fishery. Landings registered steady increase from 848 t in 1951 to 129,801 t in 2008 (Fig. 1). During 2006-'10, the average tuna landings was 112,365 t and it ranged between 95,372 t and 129,801 t (Table 2). After reaching an all-time high in 2008, the landings showed a downward trend following diversion of effort towards lucrative resources. Estimated annual catch by oceanic fleets during 2006-'10 was 87,239 t and it ranged between 78,904 and 100,268 t which also showed a declining trend since 2008. These observations indicated that rather than the catch decline by diversion of effort, the global decline in production also appeared to exert an influence on the Indian tuna fishery.

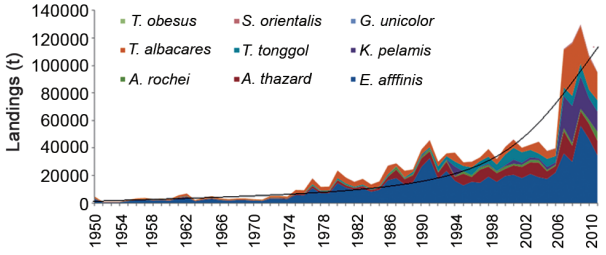

Fig. 1. Growth in tuna landings by coastal based fishery (**landings by Island territories included from 2006 onwards*)

The tuna catch in coastal based fishery during 2006-'10 was supported by 9 species, 5 coastal/neritic species and 4 oceanic species (Fig. 2a). Coastal/neritic tunas are the mainstay of traditional tuna fishery and represent 57% of the total tuna catch with an average landing of 64,039 t. Catch varied between 51,666 (2007) and 78,678 t (2008). Fishery was supported by little tuna (*Euthynnus affinis,* 40,757 t), frigate tuna (*Auxis thazard,* 11,969 t), bullet tunas (*Auxis rochei*, 3,131 t), longtail tuna (*Thunnus tonggol,* 7,332 t) and bonito (*Sarda orientalis*, 849 t). Oceanic species represented 43% of the total landings with an average landing of 48,335 t and it varied between 35,015 (2010) and 65,202 t (2007). Yellowfin tuna (*Thunnus albacares,* 27,277 t), skipjack tuna (*Katsuwonus pelamis,* 20,918 t*)* and small proportions of dogtooth tuna (*Gymnosarda unicolor,* 138 t) and bigeye tuna (*Thunnus obesus*, 2 t) supported the fishery. Tuna catch in oceanic fishery was supported by 3 species; dominated by yellowfin tuna (94.6%) and small proportion of dogtooth (1.5%) and big-eye tuna (3.9%) (Fig. 2b).

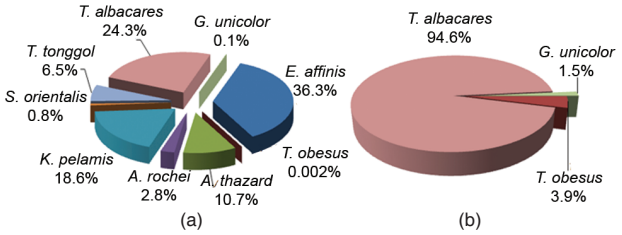

Fig. 2. Component species in the tuna catch (%) in (a) coastal and (b) oceanic fishery during 2006-'10

The tuna landings during 2006-'10 formed only 40% of the estimated potential (277,972 t) from the Indian EEZ. Coastal/neritic tunas are exploited at levels very close (98%) to their potential yield of 65,472 t. The assessment of fishery scenario indicate that coastal resources offer only limited scope for further improvement in production from the present fishing grounds. However, spatial production pattern indicate that fishery in general is restricted to selected areas. Their potential from less exploited areas have to be evaluated for expanding their fishery and production. Landings of oceanic tuna represent 23% of the potential (212,500 t), with landings of yellowfin tuna 23.3% (114,800 t), skipjack tuna 24.6% (85,200 t) and bigeye (12,500 t) and dogtooth tuna being almost un-exploited. Evaluation of the oceanic tuna fishery shows that fishing for oceanic species is restricted largely to traditionally known grounds around islands and seamounts and large areas of the EEZ largely

Table 2. Tuna harvest (tonnes) by coastal based fleets and oceanic fishing vessels during 2006-'10

Fishery and group	2006	2007	2008	2009	2010	Average
Coastal fishery	112049	116867	129801	107735	95372	112365
Oceanic fishery	88016	85770	100268	83238	78904	87239
Total tuna	200065	202637	230069	190973	174276	199604

remain underexploited by the coastal fleets. This offers considerable scope for improving their production through expansion of fishery to oceanic waters.

Production by gear

Tunas were caught both as incidental and targeted catch in many gears during 2006-'10 (Fig. 3, Table 3). Major share of the catch was realised in gillnets (51.7%) and hooks and line (24.8%). Other gears, which land tunas are pole & line, purseseines, ringseines, trawls and bagnets. Considerable variation was also observed in the catch composition by different gears as they fish in specific habitat of the system.

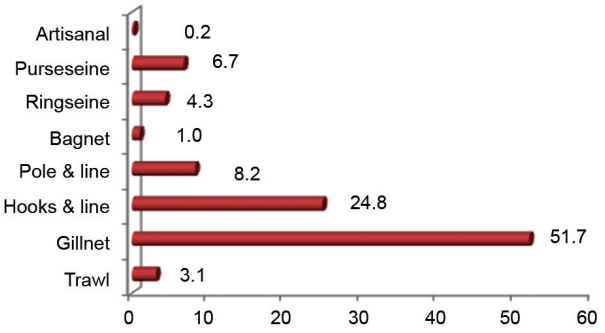

Fig. 3. Contribution (%) by different gears to total tuna production during 2006-'10

Major share of the landings in trawl was of small yellowfin tunas followed by little tunas (Table 3). Little tunas formed the major share of the catch in gillnets, hooks and line, bagnets, ringseines, purseseines and artisanal gears and skipjack tunas in pole and line. Yellowfin tunas formed the second dominant component in gillnets, hooks and line and in artisanal gears.

Production by region

Tunas are landed along the coast of mainland and island territories and supported fishing at varying levels from different regions (Fig 4). Almost 90.5% of the total tuna landings of the country is from the mainland coast with 47.3% of the landings from west coast and 43.2% from east coast. The major share of the catch, 41.3% is from south-east coast, followed by 28.4% from south-west and 18.9 % from north-west coast. Contribution by north-east is only nominal (1.9%). Lakshadweep contributed 7.3% and Andaman & Nicobar 2.2% to the national tuna landings.

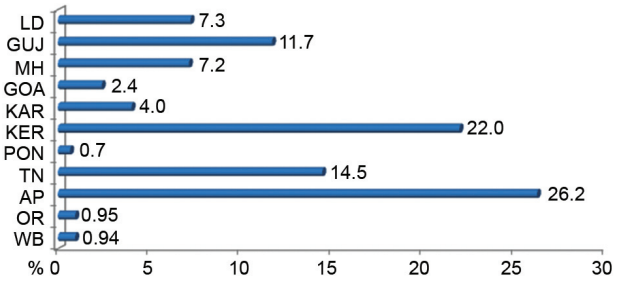

Fig. 4. State/island-wise contribution (%) to the national tuna landings

LD : Lakshadweep; GUJ : Gujarat; MH : Maharashtra; GOA : Goa; KAR : Karnataka; KER: Kerala; PON : Pondicherry; TN : Tamil Nadu; AP : Andhra Pradesh; OR : Odisha; WB : West Bengal

Mainland coast

Major share of the landings (101,707 t) was along the mainland coast, accounting for 90.5% of the total tuna landed during the period (Table 4). They are landed as one of the major resource by several types of gillnets, hooks and line, ringseines, purseseines, trawls and bagnets (Table 5). Along the mainland, landings was supported by 8 species, dominated by coastal/neritic species. Catch and catch composition varied considerably during the period from different regions.

North-east region

Tuna landings was very low (2,120 t) during 2006-'10 and it contributed only 1.9% of the national yield (Table 6). The landings has shown a declining trend after reaching an all-time peak in 2008. Fishery was supported by four species of coastal/neritic tunas (85.7%) and two oceanic species. They are landed mainly by gillnets, trawls,

Table 3. Gearwise species composition (%) of tunas landed along the Indian coast during 2006-'10

Species	Trawl	Gillnet	Hooks & line	Pole & line	Bagnet	Ringseine	Purseseine	Artisanal gears
E. affinis	27.8	44.4	40.6	26.9	69.8	85.6	48.6	44.4
A. thazard	3.2	13.9	22.4	0.4	25.5	8.5	32.2	10.6
A. rochei	0.7	0.4	2.1	0.0	0.0	0.1	0.3	0.0
K. pelamis	9.9	11.3	6.4	63.7	0.1	1.9	0.1	6.4
T. tonggol	12.0	9.9	3.5	0.0	0.0	0.1	3.2	0.0
T. albacares	46.0	19.8	24.1	9.1	4.6	3.8	15.6	38.7
G. unicolor	0.0	0.1	0.3	0.0	0.0	0.0	0.0	0.0
S. orientalis	0.5	0.2	0.5	0.0	0.0	0.0	0.0	0.0
T. obesus	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0

Table 4. State/island-wise average tuna landings (tons) during 2006-'10 along the Indian coast

Species	WB	OR	AP	TN	PON	KER	KAR	GOA	MH	GUJ	LD	A&N	Total
E. affinis	753	770	12261	6229	341	10416	2963	187	2274	2654	666	1243	40757
A .thazard	142	135	2128	1236	112	3807	571	2491	414	738	122	74	11969
A. rochei	1	2	58	652	12	2143	174	14	8	7	10	50	3131
K. pelamis	141	138	3824	2667	71	2140	437	0	2114	2753	6261	373	20918
T. tonggol	14	0	0	62	7	732	96	0	572	5402	0	447	7332
T. albacares	6	17	11182	5386	198	4868	279	1	2668	1558	1082	31	27277
G. unicolor	0	0	0	0	0	30	0	0	0	0	8	100	138
S. orientalis	0	0	12	20	0	557	2	0	5	56	0	199	849
T. obesus	0	0	0	0	0	0	0	0	0	0	0	2	2
Total	1058	1063	29464	16252	741	24693	4523	2693	8053	13168	8149	2518	112374

WB- West Bengal, OR- Odisha, AP- Andhra Pradesh, TN- Tamil Nadu, PON- Puducherry, KER- Kerala, GOA- Goa, MH- Maharashtra, GUJ- Gujarat, LD- Lakshadweep, A&N- Andaman & Nicobar

Table 5. Active coastal based fleets and major gears landing tuna along the Indian mainland coast

Vessel category and gear types	Fleet strength (nos.)
Traditional crafts (small longlines/troll lines/gillnets)	4,000-4,500
Small mechanised boats (modified trawlers) (<24 m OAL) (small longlines/troll lines/handlines/gillnets)	812
Large mechanised boats (modified trawlers) (medium longlines/troll lines/handlines/gillnets)	48
Mechanised gillnetters (modified trawlers)	28
Large oceanic vessels* (large long lines/purse seines)	80-110

ring-seines and hooks & lines. The low production can be attributed to low level of fishing restricted mainly to coastal waters. The catch composition in the hooks and line fishery along the Odisha waters for shark by Tamil Nadu fishers shows abundance of tunas, including oceanic species along the region. Evaluation of fishery scenario indicates scope for improving tuna production through intensification and extension of fishing activity to deeper waters.

Table 6. Tuna landings (tonnes) along the north-east coast during 2006-'10

Species	2006	2007	2008	2009	2010	Average
E. affinis	726	234	4173	2261	221	1523
A. thazard	305	108	513	6	453	277
A. rochei	2	4	1	1	4	3
K. pelamis	219	434	231	261	252	280
T. tonggol	0	8	24	24	15	14
T. albacares	87	0	0	32	0	24
Total	1340	788	4943	2586	945	2120

South-east region

Annual tuna landings varied between 42,139 and 50,295 t with an average of 46,456 t during 2006-'10 (Table 7) and contributed 41.3% to the national landings. Landings showed a declining trend since 2008. Fishery was supported by seven species; five coastal/neritic tunas (49.8%) and two oceanic species (50.2%). Gillnet contributed 52%, hooks and line 21% and purseseines and ringseines 16% of the landings. Trawls, bagnets and artisanal units also landed tuna in small numbers as incidental catch. Considerable effort has been expended by traditional fishermen for exploiting oceanic tunas, which resulted in increased contribution of tunas. However, these efforts were restricted within the outer shelf and inner oceanic waters, leaving vast areas of oceanic EEZ unexploited. Present observations and earlier reports from the region (Kasim and Abdussamd, 2005) showed that coastal resources are almost optimally exploited. However, fishery scenario suggests scope for increased production from the oceanic waters of the EEZ.

Table 7. Tuna landings (tonnes) along the south-east coast during 2006-'10

Species	2006	2007	2008	2009	2010	Average
E. affinis	14761	10199	26817	24472	17909	18831
A. thazard	1777	2988	2867	6719	3025	3475
A. rochei	15	10	482	314	2789	722
K. pelamis	9097	10421	3649	3620	6022	6562
T. tonggol	189	154	0	0	0	69
T. albacares	16299	23958	16437	13650	13485	16766
S. orientalis	0	0	43	102	11	31
Total	42139	47730	50295	48877	43240	46456

South-west region

Tuna landings varied between 21,997 and 40,727 t with an average of 31,909 t (Table 8) and contributed 28.4% of the national landings. Fishery was supported by eight species; five coastal/neritic tunas (75.7%) and three oceanic species (24.3%). Gillnets and hooks and line respectively landed 47.8% and 42.4% of the catch. Small quantity was also landed by purseseines and ringseines. Landings showed a decline since 2006 as with continuous decline in the catch of major coastal/neritic species and that of the oceanic species since 2007. Since there was no considerable decline in the effort along the coastal waters, decline in the coastal/neritic tunas can be attributed to their reduced abundance. Introduction of longlining initially yielded good catches of oceanic tunas, but shift in their target has resulted in reduced contribution thereafter. It is to be noted that coastal waters of Kerala is under intensive exploitation and contributed major share (77.4%) of the regions catch. Contribution by adjacent states, Karnataka and Goa are very poor, mainly due to low effort input. This situation warranted exploring the scope for improving production from the coastal waters of these states and from the oceanic waters of the region.

Table 8. Tuna landings (tonnes) along the south-west coast during 2006-'10

Species	2006	2007	2008	2009	2010	Average
E. affinis	14460	13572	17363	14477	7957	13566
A. thazard	12406	7192	5779	3357	5613	6869
A. rochei	2295	1818	1290	2595	3659	2332
K. pelamis	3170	6444	1052	1203	1015	2577
T. tonggol	2136	928	712	161	203	828
T. albacares	5898	6873	5278	4237	3457	5149
G. unicolor	0	0	26	61	64	30
S. orientalis	362	715	716	972	29	559
Total	40727	37542	32216	27063	21997	31909

North-west region

Landings varied between 17,709 t and 31,325 t with an average annual yield of 21,221 t (Table 9) and contributed 18.9% of the national tuna landings. Gujarat contributed major share (62%) of the catch. Landings after an initial increase has shown downtrend since 2008, mainly due to decline in oceanic tuna contribution. Seven species; five coastal/neritic (57.2%) and two oceanic (42.8%) species supported the fishery. Major share of the landings (78.8%) was by gillnet and small quantities by purseseines and trawls. Fishery is restricted mainly within the coastal waters and is under optimal fishing pressure. Possibilities for improved production from coastal waters of Maharashtra and from the oceanic waters of the region through extension of fishing to oceanic waters need to be explored.

Table 9. Tuna landings (tonnes) along the north-west coast during 2006-'10

Species	2006	2007	2008	2009	2010	Average
E. affinis	4653	4508	4307	3983	7188	4928
A. thazard	1501	1254	1073	705	1225	1152
A. rochei	6	9	7	4	51	15
K. pelamis	3857	3232	13233	3222	786	4866
T. tonggol	3368	5651	7929	5451	7471	5974
T. albacares	4324	6200	4764	4365	1474	4225
S. orientalis	0	0	11	283	9	61
Total	17709	20855	31325	18012	18203	21221

Lakshadweep

Lakshadweep seas represented by vast continental shelf (4,336 km^2), lagoons (4,200 km^2), territorial waters (20,000 km^2) and oceanic zone (400,000 km^2) is rich in tuna resources, especially oceanic species. Tuna production from the region varied between 7,550 t and 8,738 t, with an annual yield of 8,149 t (Table 10) and contributed 15.2% of the national landings. Fishery was supported by six species with the major portion by oceanic species (90.2%). Major gears landing tuna are pole and lines, troll lines, handlines and gillnets. Fishery is carried out with small pablo boats and motorised or non-motorised traditional crafts (Table 11) and fishing activity is restricted in the near shore waters within 40 km from the islands. Fishery scenario, indicate that near shore waters are well exploited and scope for enhancing production from the underexploited oceanic waters needs to be explored for expanding the fishery.

Table 10. Tuna landings (tonnes) along the Lakshadweep coast during 2006-'10

Species	2006	2007	2008	2009	2010	Average
E. affinis	311	227	2343	259	192	666
A. thazard	125	121	88	141	133	122
A. rochei	23	23	1	1	1	10
K. pelamis	6603	6236	5112	7059	6294	6261
T. albacares	709	929	854	1272	1650	1082
G. unicolor	16	15	0	6	4	8
Total	7786	7550	8398	8738	8274	8149

Table 11. Fishing fleet operated along the Lakshadweep coast

Category of vessel	Fleet strength (No.)
Pablo boats (pole & line/hand-line/ troll line/gillnet units)	295
Traditional units-motorised & non-motorised (gillnets/handlines)	370

Andaman and Nicobar Islands

Andaman Nicobar Islands systems with vast EEZ (0.6 million km^2) including narrow continental shelf (35,000 km^2), accounted nearly 28% of the Indian EEZ

and very rich tuna resources. However, marine fishery still remains to be developed and tuna landings during 2006-'10 was very low(2,518 t) ranging between 2,348 t and 2,721 t and contributed only 2.2% to the national landings (Table 12). Nine species, dominated by coastal tunas (79.9%) supported the fishery. Gillnets and hooks and lines operated from motorised and non-motorised traditional boats (Table 13) contributed major share of the landing. Due to the innate limitation of these fleets, fishing is restricted to coastal waters within 10 km from shore, leaving the entire oceanic region and its potential remains un-exploited. Earlier reports show tuna as the most abundant resource accounting nearly 75% of the total marine fishery potential of the EEZ of the island territory. Several estimates are available on the total marine fishery and tuna potential, which vary from few thousand tons to several lakh tons (Joseph, 1986; Sudarsan *et al.,* 1989; John *et al*., 2005). Fisheries Expert Team in 1977, estimated the tuna potential to be around 100,000 t with oceanic tuna alone around 82,000 t. As per the estimates of FSI, based on exploratory surveys, this region has one of the world's richest tuna stocks. But the present production is meagre, forming only 2.5% of the total tuna potential. This suggests that huge tuna potential remains untapped and there is tremendous scope for expanding fishery on a large scale through sincere efforts. However, information gathered indicates that several foreign fleets are expending considerable effort in this area; which needs to be verified.

Table 12. Tuna landings (tonnes) along the Andaman & Nicobar coast during 2006-'10

Species	2006	2007	2008	2009	2010	Average
E. affinis	1173	1200	1320	1320	1308	1243
A. thazard	70	72	79	79	78	74
A. rochei	47	48	53	53	52	50
K. pelamis	352	360	396	396	392	373
T. tonggol	422	432	475	475	471	447
T. albacares	2	2	5	5	102	31
G. unicolor	94	96	106	106	105	100
S. orientalis	188	192	211	211	209	199
T. obesus	0	1	1	1	4	2
Total	2348	2403	2646	2646	2721	2518

Table 13. Fishing fleet operating in Andaman and Nicobar waters (** Source: ANDFISH-2005*)

Category of vessel	Fleet strength (No.)
Motorised - Hooks & line/gillnets	523
Non-motorised- Hooks & line/gillnets	1,334

Poduction by species

Coastal/neritic tunas

Landings during 2006-'10 varied between 51,666 t and 78,678 t with an average of 64,074 t (Table 14). Several gears landed the resource, with major share by gillnets (53%), followed by hooks & line (25.5%), purse-seines and ring-seines (Table 15). After the peak in 2008, landings registered continuous decline, despite maintaining the fishing at the same level. Major share of the landing was from south-west coast (43%), followed by south-east coast (28%) and north-west (20%) coast (Fig. 5). Average production during the period was very close (98%) to the estimated potential (65,472 t). Annual production has exceeded the potential during 2008 and 2009 and then declined. The fishery biological observations and stock assessment of component species indicate that stock in general is healthy with exploitation of most species near optimum level, offering only limited scope for improved production from present grounds. The present fishing pattern indicate considerable scope for increasing the production from selected areas like north-east coast, coast of Karnataka, Maharashtra and Andaman-Nicobar Islands, where the present level of production remains relatively low compared to adjacent states.

Table 14. Annual landings (tonnes) of coastal/neritic tunas along the Indian coast during 2006-'10

Species	2006	2007	2008	2009	2010	Average
E. affinis	36085	29939	56322	46772	34775	40779
A. thazard	16184	11735	10400	11006	10527	11970
A. rochei	2389	1912	1835	2968	6556	3132
T. tonggol	6115	7173	9140	6111	8159	7340
S. orientalis	550	907	981	1568	257	853
Total	61323	51666	78678	68426	60275	64074

Table 15. Gear-wise landings (%) of coastal/neritic tunas during 2006-'10

Species	Trawl	Gillnet	Hooks & Line	Pole & line	Bagnet	Ring seine	Purse seine	Artisanal
E. affinis	2.0	52.3	23.0	5.0	1.6	8.4	7.4	0.2
A. thazard	0.6	45.9	35.4	0.2	1.6	2.3	13.8	0.2
A. rochei	2.7	27.1	67.6	0.0	0.0	0.4	2.3	0.0
T. tonggol	5.7	77.7	13.2	0.0	0.0	0.1	3.3	0.0
S. orientalis	5.5	42.3	51.1	0.0	0.0	0.0	1.1	0.0
Total	2.0	53.0	25.5	3.3	1.4	6.1	8.4	0.2

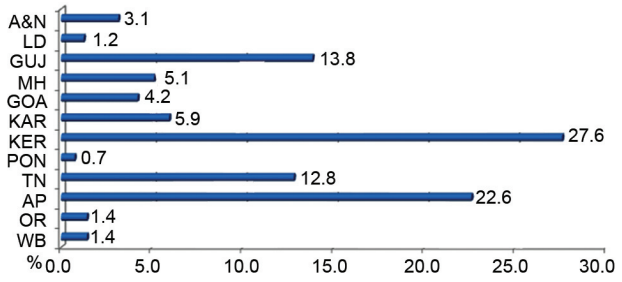

Fig 5. State/island-wise contribution (%) in the national coastal/ neritic tuna production during 2006-'10

Little tuna/Kawakawa (Euthynnus affinis)

Euthynnus affinis is the most dominant species abundantly available all along the coast with average landings of 40,779 t during 2006-'10 (Table 14). Several gears landed the species, with the major share by gillnet (52.3%), hooks and line (23.0%), ringseines (8.4%) and purseseines (7.4%) (Table 15). Major abundance and fishery was recorded from the southern coasts contributing 79.5% of the landings (Fig. 6). The general increasing trend in landings (Fig. 1) and results of stock assessment indicate some scope for increasing their yield from the present fishing grounds. Scope for expanding fishing to areas like waters of Karnataka, Maharashtra, Odisha and West Bengal, from where the present contribution is relatively low, needs to be explored.

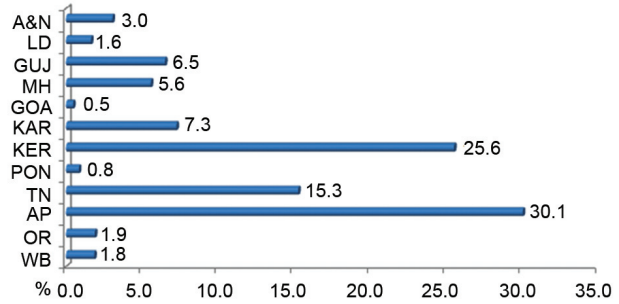

Fig 6. State/island-wise contribution (%) of little tuna to the national yield during 2006-'10

Frigate tuna (Auxis thazard)

This is the second dominant coastal species, distributed along the Indian coast with major abundance and fishery from southern coast which contributed 86.4% in their landings (Fig. 7). Major share of the landings is by gillnets (45.9%), hooks and line (35.4%), and purseseines (13.8%) (Table 15). The average annual landing during 2006-'10 was 11,970 t (Table 14). Landings after reaching a peak in 2006, declined and stabilised around 11,000 t in later years. The species was found more abundant in deeper waters associated with knolls and ridges. Present study indicates good abundance of the species along the Indian side of Chagos-Laccadive ridges indicating scope for increased production from the area. Stock assessment also suggests possibilities for enhancing their yield from the present grounds. Possibilities for increasing production from the coastal waters of north-east region, Karnataka, Maharashtra and Andaman-Nicobar territory, where tuna fishing is at its initial phase needs to be explored.

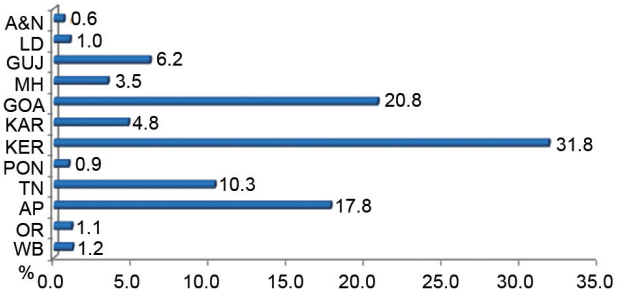

Fig. 7. State/island-wise contribution (%) to the national yield of little tuna during 2006-'10

Bullet tuna (Auxis rochei)

Major fishery is restricted to the southernmost part of Indian waters with nearly 75% of the landings in Kerala alone and 21% in Tamil Nadu (Fig. 8). Several gears landed the species, with major share by hooks and line (67.6%) and gillnets (27.10%) (Table 15). Landings during 2006-'10 varied between 1,835 t and 6,556 t with an average of 3,132 t (Table 14). Though the landings over the years exhibited increasing trend, results of stock assessment studies shows heavy fishing pressure on the stock, calling for caution and measures to reduce fishing pressure in the present grounds. Target fishing for bullet tuna by longlines and handlines, driven by local demands, prevails only along the southern districts of Kerala and the same can be attributed to their heavy landings from this part. Though, they are available along other regions, they are not caught in conventional gears owing to their relatively deepwater inhabitation. The species was found more abundant in deeper waters around knolls. Scope for improving their yield by target exploitation from other areas of abundance needs to be investigated.

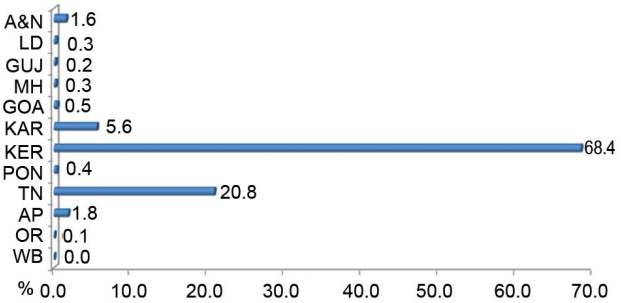

Fig. 8. State/island-wise contribution to the national landings of bullet tuna during 2006-'10

Long tail tuna (Thunnus tonggol)

Fishery is mainly along the west coast and Andaman waters with major abundance and fishery (96%) from north-west coast comprising Maharashtra and Gujarat (Fig. 9). Several gears landed the species, with major share by gillnet (77.7%) and hooks and line (13.2%) (Table 15). Present study shows that they are available in appreciable numbers over knolls and seamounts of Chagos-Laccadive ridge. Fishery during 2006-'10 registered an increasing trend and their annual landings varied between 6,111 t and 9,140 t with an average of 7,340 t (Table 14). Small to medium sized fishes supported the fishery with larger ones less frequent in the fishery. Their landings along the southern coast were supported by relatively smaller fishes than northern coast. Pattern of distribution, abundance and fishery indicated scope for improving production from less exploited areas like knolls, Chagos-Laccadive ridge and associated seamounts of west coast and Andaman and Nicobar waters.

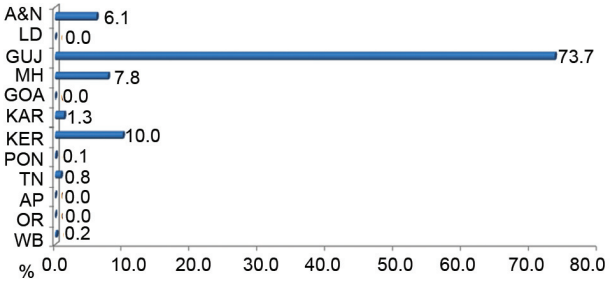

Fig. 9. State/island-wise contribution (%) to the national yield of long tail tuna during 2006-'10

Oriental bonito (Sarda orientalis)

They are distributed along the coasts of mainland and Andaman-Nicobar Islands and show close association with coral reefs and knolls. Major share of their landing was by hooks and line (51.1%) and gillnets (42.3%) (Table 15). Landings showed an upward trend with average annual landings of 853 t during 2006-'10 which varied between 257 t and 1,568 t (Table 14). Major abundance and fishery was from Kerala (65.6%), Andaman- & Nicobar (23.4%) and Gujarat coast (6.6%) (Fig. 10). Stock assessment and prediction analysis show that resource is at its initial phase of exploitation, indicating scope for improving production from present grounds. Scope for production from other area also needs further investigation.

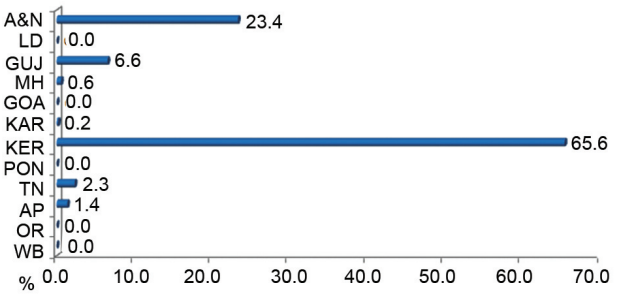

Fig. 10. State/island-wise contribution (%) of oriental bonito to the national yield during 2006-'10

Oceanic tunas

Oceanic tuna landings over the years exhibited a general increasing trend till 2007 and thereafter registered a downward trend. Landings varied between 35,015 t (2010) and 65,202 t (2007) during 2006-'10 with an average of 48,335 t (Table 16). The recent decline in the yield can be attributed mainly to the shift in the prime target of mechanised longline fishery sector to other more lucrative resources as discussed earlier. The declining trend in oceanic tuna production further suggested the possible reflection of global decline in the stock abundance of the highly migratory resources.

Table 16. Annual landings (tons) of oceanic tunas by coastal fishery along the Indian coast and catch by oceanic fleets during 2006-'10

Species	2006	2007	2008	2009	2010	Average
Landing by coastal fishery						
K. pelamis	23297	27127	23674	15761	14761	20924
T. albacares	27319	37963	27338	23560	20167	27269
G. unicolor	110	111	132	173	173	140
T. obesus	0	1	1	1	4	1
Total	50726	65202	51145	39495	35105	48335
Catch in oceanic fishery						
T. albacares	83260	80573	94851	78741	74641	82526
G. unicolor	1323	1289	1507	1251	1186	1311
T. obesus	3433	3908	3910	3246	3077	3402
Total	88016	85770	100268	83238	78904	87239
Grand total	138742	150972	151413	122733	114009	135374

Oceanic tuna are exploited mainly by gillnets (49%), hooks and line and pole and lines (Table 17). Major share

Table 17. Gear-wise landings (%) of oceanic tunas during 2006-'10

Species	Trawl	Gillnet	Hooks & Line	Pole & line	Bagnet	Ring seine	Purse seine	Artisanal
K. pelamis	2.4	44.8	24.9	27.1	0.0	0.6	0.0	0.1
T. albacares	7.3	51.8	30.3	3.8	0.2	0.8	5.3	0.5
G. unicolor	0.0	32.4	67.6	0.0	0.0	0.0	0.0	0.0
T. obesus	0.0	0.0	100.0	0.0	0.0	0.0	0.0	0.0
Oceanic	5.3	49.0	23.2	18.1	0.1	0.7	3.2	0.3

in landing was from south-east coast (48.3%), followed by north-west (18.8%), south-west (16.1%) and Lakshadweep (15.2%) (Fig. 11). The present production, excluding catch constitute 22.8% of the estimated potential (212,500 t) from the EEZ.

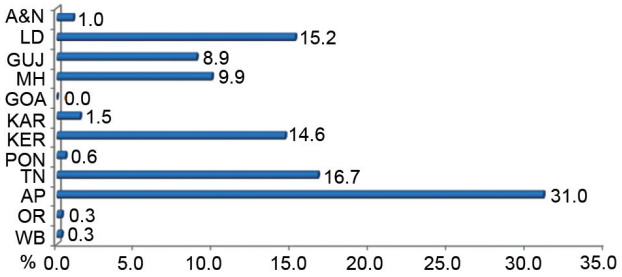

Fig. 11. State/island-wise contribution to the national oceanic tuna landings during 2006-'10

Yellowfin tuna (Thunnus albacares)

Thunnus albacares is the most dominant oceanic tuna species landed by coastal based fishery and oceanic fishery. Landings over the years exhibited a general increasing trend till 2007 and thereafter registered a continuous decline (Table 16). Average annual landings during 2006-'10 was 27,269 t and it accounts only 23.8% of their potential (114,800 t) in the EEZ. Average catch in oceanic fishery during the period was 82,526 t. Catch registered decline following the peak in 2008. Major share of the landings was by south-east coast (61.5%), followed by south-west and north-west coast (Fig. 12). Yield from island territories was negligible, where large abundance of this resource is reported. They are landed mainly by gillnet (51.8%) and hooks and lines (30.3%) (Table 17). This shows that exploitation range by the coastal based fishing fleets are very limited and fishery is mainly by small surface tunas. Large tunas which frequented deep oceanic waters largely remain inaccessible. Overall fishery scenario indicates considerable scope for improving production through extension of fishery to deeper oceanic areas. Special strategies needs to be evolved in order to tap the potential around island territories. To enable this, proper understanding on the distribution and abundance of the species in the EEZ over space and time needs to be developed.

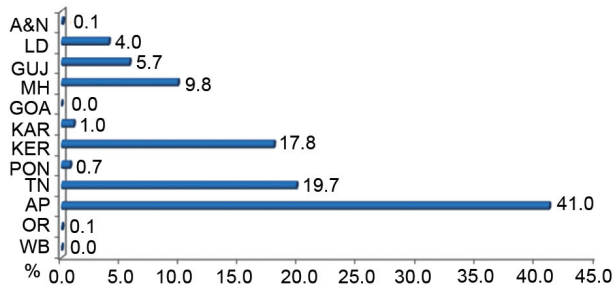

Fig. 12. State/island-wise contribution (%) to the national yellowfin tuna landings during 2006-'10

Skipjack tuna (Katsuwonus pelamis)

Katsuwonus pelamis is the second dominant component of oceanic tuna landings of the country. Landings over the years exhibited increasing trend till 2007 and thereafter declined. Average annual landing was 20,924 t during 2006-'10 (Table 16) and it accounted for only 24.6% of the estimated potential (85,200 t) from the EEZ. Gillnets, pole and lines and hooks and line were the major contributors landing 44.8%, 27.1% and 24.9% respectively of the total catch (Table 17). The species formed targeted fishery only along the Lakshadweep coast and contributed 29.9% to the national landings (Fig. 13). Along the mainland, south-east coast contributed maximum share (31.5%) followed by north-west and south-west coast. Exploitation range of this species is also very limited. Assessment of fishery scenario indicates considerable scope for expanding the fishery from around island territories and seamounts. However, distribution and abundance over space and time needs to be studied for assessing the potential and to evolve strategies for development.

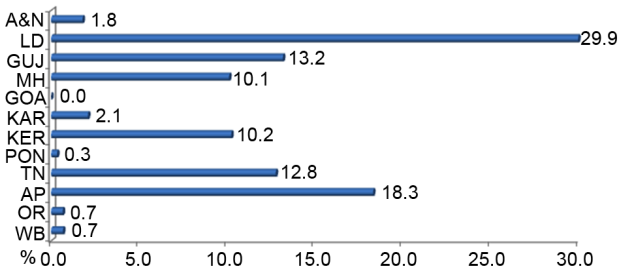

Fig. 13. State/island-wise contribution (%) to the national skipjack tuna landings during 2006-'10

Big eye tuna (Thunnus obesus)

Earlier studies documented the presence of good stock and potential in the Indian seas. But, they were not caught by the coast based fishery, except stray numbers from the Andaman waters (Fig. 14) and hence the entire potential (12,500 t) remain untapped. Average catch in oceanic fishery during the period was 3,402 t. Catch after the peak in 2008, registered decline. Since the species is available only in deeper waters, their non-representation in the landings confirms that coast based fisheries are exploiting only surface tunas and is not making any effort to fish deep water resources. Increased production of this species is possible only through extension of fishery to deeper waters using long lines.

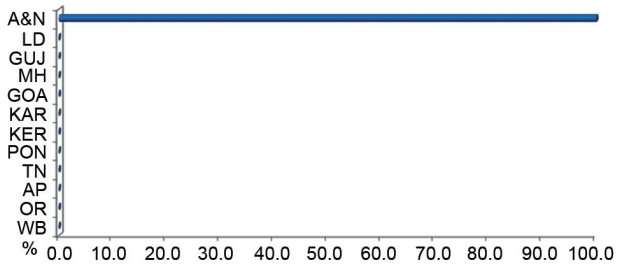

Fig. 14. State/island-wise contribution (%) of the big eye tuna to the national yield during 2006-'10

Dogtooth tuna (Gymnosarda unicolor)

The data indicate presence of this species in appreciable numbers in the seas around Andaman-Nicobar, Lakshadweep islands and also around oceanic ridges and associated seamounts. Average annual landings for the period 2006-'10 was low, (173 t) with major share of the catch from Andaman waters (Table 16; Fig. 15). Average catch in oceanic fishery during the period was 1,311 t. Catch after peak in 2008, registered decline. Fishery is at its initial phase and stock assessment and fishery evaluation indicate considerable scope for increasing production. Gathered information indicates good potential for recreational fishery along the areas of their abundance.

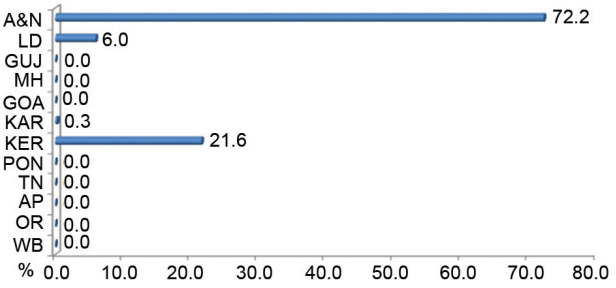

Fig. 15. State/island-wise contribution (%) of dogtooth tuna to the national landings during 2006-'10

Discussion

Evaluation of the fishery indicated varying scope for different species from different areas. Based on localised stock assessment, it has been reported that coastal tuna stocks in Indian waters were being exploited at near optimum level (Silas and Pillai, 1985; James *et al.,* 1992, 1993; James and Pillai, 1993; Yohannan *et al.,* 2005; Kasim and Abdussamad, 2005, Pillai *et al*., 2005; Pillai and Ganga, 2008). Coastal tunas have been exploited from Indian waters both as incidental bycatch and also as targeted catch since very long and the production reached very close to their estimated potential. However, the extent of fishing varies from region to region depending on the local demand. Accordingly, coasts of Kerala, Andhra Pradesh, Tamil Nadu, Goa and Gujarat are intensely exploited. Evaluation of the fishery scenario, shows only limited scope for increasing production from these areas. The scope for increasing production from less exploited coastal waters of other states, including island territories around Andaman-Nicobar needs to be explored.

On the other hand, major share of oceanic tuna stocks of Indian waters remain inaccessible to Indian fishers and offer considerable scope for expansion of fishery and yield. Earlier workers also made similar observations (Silas *et.al.,* 1979; 1985; Silas and Pillai, 1982; 1985; Sudarsan *et al*., 1989; Somavanshi, *et al*., 1999; 2000). Oceanic tunas were being exploited as targeted fishery at some part and as incidental catch in several coastal fishery. However, their operational areas are very limited to the outer continental shelf, adjacent oceanic waters, knolls and seamounts where these resources congregate, leaving large areas of oceanic waters and its resources unexploited by the nation. The distribution and abundance of oceanic resources over time and space have to be explored for planning strategies for development.

It is to be noted that except from Andhra Pradesh, Tamil Nadu, Kerala and Lakshadweep, no concerted efforts were made to tap oceanic resources. Fishing by these regions, however were limited to outer continental shelf and adjacent oceanic waters and seamounts along the Laccadive ridges, leaving major part of the oceanic EEZ untapped. Seas around oceanic island territories are reported to have the highest concentrations of oceanic tunas, but yield from these areas were very low. Though oceanic fishing vessels catch considerable quantum of oceanic tunas, the catch realised from the EEZ is not known. Evaluation of the fishery scenario indicates that vast areas of oceanic waters largely remain inaccessible to the coastal based fleets and hence have considerable scope for improving oceanic tuna production, through extension of fisheries activities. However, extent and mode of their exploitation from the EEZ as well as from the adjacent and international fisheries, exert considerable influence on the stock abundance and availability. Such interactions need to be seriously accounted from time to time, while assessing the stock and projecting potential.

Recent reports suggests sharp decline in the catch of major oceanic tunas from Indian Ocean as well as global waters, which is attributed to reduction in the effort input by purseseines (IOTC, 2010; 2011). However, these reports indicated heavy fishing activities along the Mascaren plateau, Chagos-Laccadive ridge and Andaman ridge in Indian Ocean. More than 1/3 of the catch from this area were by purseseines with nearly 50% of yellowfin and 85% of skipjack tunas from FAD (fish aggregating device) associated fishery. Since, smaller ones of all species

aggregate in large numbers around FAD's, it is to be assumed that catch in such fishery will be mainly constituted by sub-adults and small juveniles. Such fishing activities are very much rampant especially along the migratory routes by tracking their movement. These developments might have added to the decline in stock and yield of migratory species and this is an important aspect which requires immediate attention from all stake holder countries.

One of the issue in developing oceanic tuna fisheries is the lack of sufficient skilled crew. Fishers from southern Tamil Nadu are highly skilled in oceanic/distant water fishing since time imemmorial, but their interest is mainly on sharks. Skill of the fishers for oceanic fishing must be enhanced through scientific awareness on the distribution pattern of tunas and by providing proper training in tuna longlining. As has been discussed above, the present tuna fleets (modified trawlers) have operational limitation for fishing in oceanic waters. Since most of our inshore and deep sea trawlers have such limitations, their redeployment for deep sea fishing needs to be made with utmost care. Instead, large longliners with deep sea going facilities, adequate carrying capacity and onboard postharvest handling facility needs to be introduced from mainland and island territories. Also introduction of large factory or mother vessels should be considered, so that catch can be collected afresh in the mid-sea and transported to mainland or processed onboard.

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