Received: 13 September, 2011

IOTC-2011-WPNT01-10

Tuna Fishery of India with Special Reference to Biology and Population Characteristics of Neritic Tunas Exploited from Indian EEZ

Prathibha Rohit[1], E.M. Abdussamad[2], K.P. Said Koya[3], M. Sivadas[4] and Subhadeep Gosh[5]

Central Marine Fisheries Research Institute
1.Mangalore, 2. Kochi, 3. Calicut, 4. Tuticorin, 5. Visakhapatnam.

ABSTRACT

Tuna fishery along the mainland coast of Indian and its Island territories were monitored to study the biology, population characteristics and level of exploitation especially of neritic tunas. Study showed that the exploitation levels for oceanic tunas and most of the neritic tunas are low and there is considerable scope for improving the production through targeted fishing.

INTRODUCTION

Tunas have been exploited along the Indian coast since the early seventies with the neritic tunas being the mainstay of the total tuna production of the country. Their exploitation has however been influenced greatly by local consumer preferences and marketing demands. Changing marketing patterns, improvements in transportation and storage facilities and development of value added products provided an impetus to the fishermen to harvest all commercially important resources including the neritic tunas resources. Further, modernization and adoption of innovative fishing methods increased endurance of the fishing crafts, improved fishing efficiency and encouraged fishing beyond territorial waters, and this resulted in overall increased catches.

Fishery

Craft and gear

Commercial fisheries for tunas and tuna like fishes of the country is very complicated involving fleets of varying specifications with different craft-gear combinations.Recently thousands of artisanal crafts were pressed in to fishing during by traditional fishermen all along the mainland and Island territories specifically for exploiting yellowfin tunas and associated resources (Table 1). Exploitation is mainly by small handlines, longlines, trolllines, pole & line

and gillnets which are longlines operated in the near-shore and outer shelf areas. Along the southeast coast several small to medium mechanized trawlers were modified to exploit tunas by operating large gillnets. The larger trawlers were converted to use long lines and were deployed mostly in shelf edge and adjacent oceanic waters to harvest yellowfin tunas. These fleets based at several major and minor harbours of mainland and islands generally carry different gears and operate the gill net, troll lines, long lines, etc. or a combination of different gears depending on the fishing condition.

In addition, several large vessels based in India under "letter of permit" (LOP) are involved in long lining. They are mainly large long liners specifically operated to exploit oceanic tunas and similar oceanic resources. They undertake long duration fishing trips staying at sea for extended periods of time and are bound by the rules and regulations set up in the LOP.

Category of vessel	**Fleet strength (in number)**
Mainland	
Traditional crafts	4,000-4,500
Converted trawlers (<24 m OAL)	812
Converted trawlers(>24 m OAL)	48
LOP vessels	142
Gillnetters	30
Lakshadweep	
Pole & line/Hand-line/gillnets	295
Traditional units (motorized &nonmotorized)	370
Andaman &Nicobar0	
Motorised -Hooks & line/gillnets	523
Non-motorised- Hooks & line/gillnets	1,334

Table 1. Tuna fishing fleet of India

Tuna production

Tunas contributed to about 2.5% of the marine fish production during 2006-'10. Their landings along the coast showed an increasing trend during 1986-2010 (Fig 1). Annual production ranged between 23,544 t in 1987 and 90,704 t in 2008. Average total tuna production

during the decade (1981-'90) was 23,922 t, which increased to 35,448 t in 1991-2000 (Fig 2). It further increased to 59,106 t during the last decade (2001-'10). Total tuna production reached an all-time high in 2008 and thereafter it showed a decline.

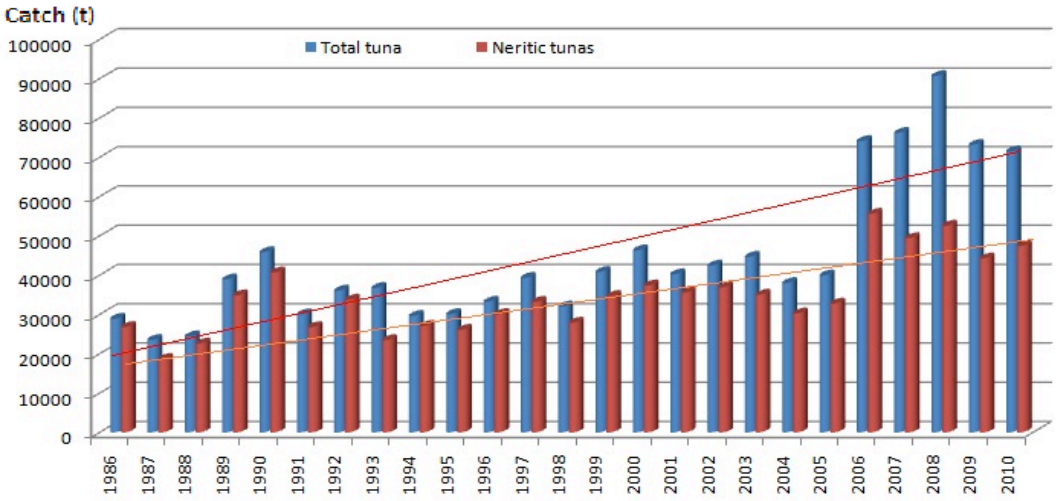

Fig. 1. Trend in tuna production by coastal based fishery along the Indian coast including *Island territories (*from 2006 onwards)

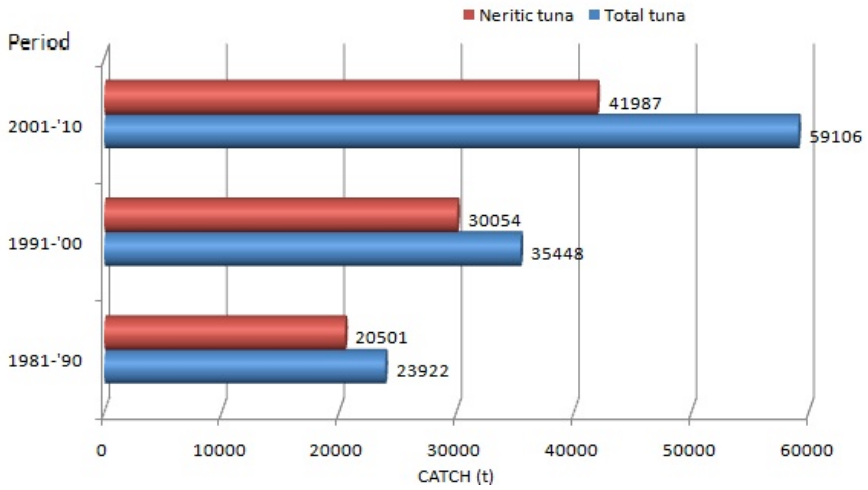

Fig. 2. Decade-wise trend in total and neretic tuna production along the Indian coast

Neritic tunas represented 64 % of the total tuna production of the country during 2006-'10 (Fig 3). They followed similar prouction trend as total tuna production during the period (Figs. 1&2). Production peaked in 2008 and then declined in 2009. However in 2010, catch marginally improved. The increase was due to the increased landings of all neretic tuna species except that of the little tuna/kawakawa.

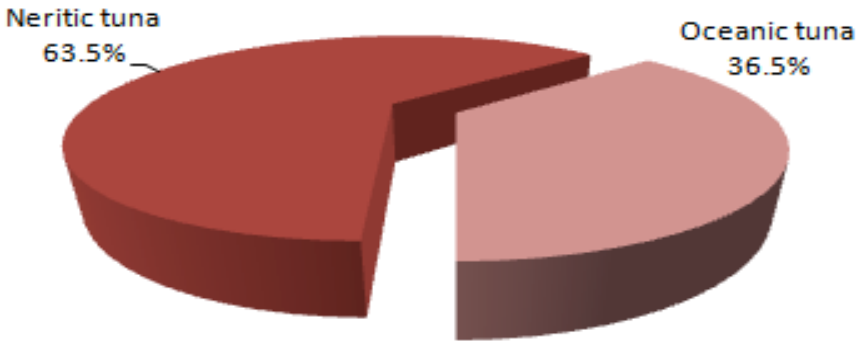

Fig 3. Average composition of neritic tuna in the total tuna production during 2006-'10

Species composition:

Tuna fishery in India is supported by 9 species, represented by 5 coastal/neretic and four oceanic tunas. The contribution of the different species to the total tuna catch of the country is given in Fig.4. Four genera viz., *Thunnus, Euthynnus, Auxis* and *Sarda* and five species – *T.tonggol, E.affinis, A.thazard*, *A.rochei* and *S.orientalis* comprise the neretic tuna catch. Of these, *E.affinis* is the most dominant species and occurs along entire Indian coast..

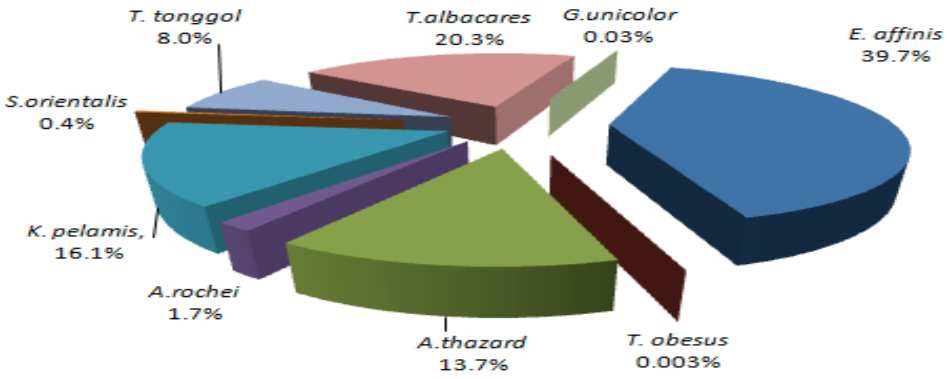

Fig 4. Average species composition of tuna coastal based fishery during 2006-'10

Region-wise production trend

Southern coast of the country was more productive (Fig 5). Southeast coast, comprising Tamil Nadu, Puduchery and Andhra Pradesh topped in tuna production during 2006-2010 with a catch of 31,900 t, forming 41.3% of the national yield. Southwest coast comprising Kerala, Karnataka and Goa harvested 21,900 t constituting 28.4 % of total yield.

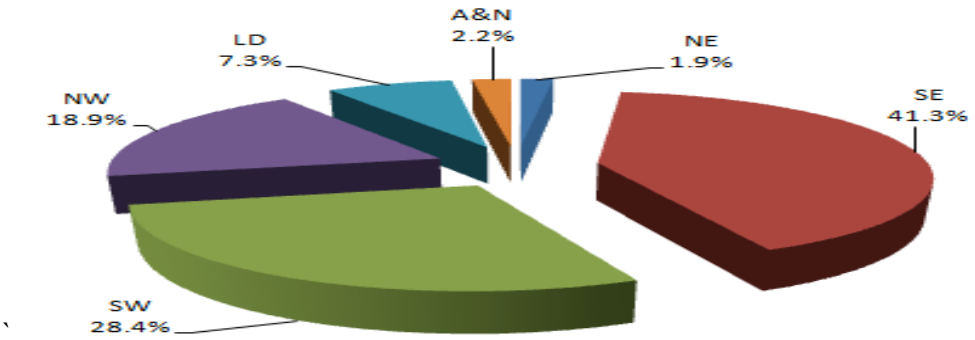

Fig.5. Regional contribution to total tuna production

Gear-wise production

Tuna along the Indian coast are exploited by a variety of gears (Fig 6). Exploitation is mostly done using gillnets and hooks and lines. Nearly 56% of the tuna catch is realized by gillnets and 25% by hooks and line (long-lines, hand-lines and troll lines). Other gears exploiting tuna as bye-catch include the purseseines, ringseines, trawls and bagnets.

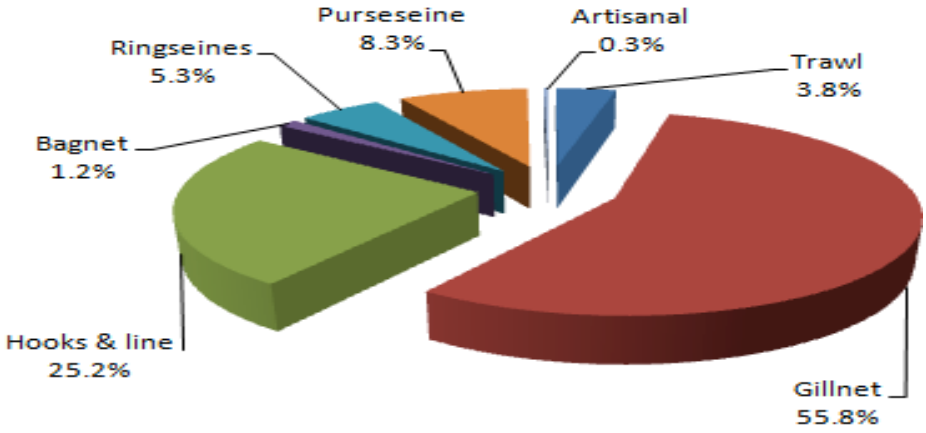

Fig. 6. Contribution by different gears to total tuna production

Distribution, fishery and biology of neritic tunas

Little tuna/Kawakawa (*Euthynnus affinis*)

E.affinis is the most dominant tuna species abundantly available all along the coast and is caught by a variety of gears. Major share (47.1%) of the catch is by gillnets followed by ring seines (19.2 %), purseseines (18.1 %) and hooks and line (11.8%). Kerala, Tamilnadu and Andhra Pradesh together contributed the major share of catch. Production of *E.affinis* after reaching a peak of 32,406 t in 2008, showed a declining trend to 28,563 t in 2009 and to 22,097 t (22.6%) in 2010. Production declined in all states, except in Maharashtra and Gujarat, where it improved.

E.affinis fishery was supported by 18-78 cm fishes. Regional difference in size range was noticed in catch. This probably can be attributed to the type of gear in which it has been caught and the nature of fishing. *E.afinis* matured and spawned round the year with peaks during July-August and November-January. Size at capture is larger than size at maturity, but lower than the optimum size (L_{opt}) for exploitation (Table 2). The exploitation rate shows that the stock is near optimum fishing pressure (Table 3). These findings suggest regulation of fishery to maintain the effort below the optimum level for sustaining the yield in the present grounds and expansion of fishing to less exploited areas for enhanced production.

Species	Lr	L_{max}	L_{mat}	L_{opt}	Lc
E. affinis	18	78.0	37.7	40.1	39.7*
A. thazard	18	51.0	27.5	28.8	28.4*
A. rochei	16	39.0	23.6	24.5	24.2*
T. tonggol	32	92	53	57.4	52.3*
S. orientalis	32	58	34	36	37.4**

**** Hooks& line/Gillnet **- Trawl***

Table 2. Estimates of biological reference points of tuna species

Species	Expl.rate	Fish. mortality	Total mortality	Nat. mortality	Level of exploitation
E. affinis	0.59	1.85	3.14	1.29	Near optimum
A. thazard	0.49	1.56	3.2	1.64	Below optimum
A. rochei	0.35	0.66	1.87	1.21	Below optimum

Table 3.Estimates of exploitation and mortality rates

Frigate tuna (*Auxis thazard*)

They were exploited by purseseines (38.6 %), hooks and line (33.5 %) and gillnets (26.0 %). Major share of the catch is from Tamilnadu and Kerala. Production after a continuous decline during 2007-2009, registered an increase (+ 96%) to an all time high of 13,912 ton in 2010. Production improved in all states, except in Andhra Pradesh, Kerala and Lakshadweep.

Fishery was supported by 18-51 cm fishes. They matured and spawed round the year with peak during September-January. Size at capture of the species is above the size at maturity and optimum size (L_{opt}) for exploitation (Table 2). Estimates of exploitation rate also indicate that they were exploited below the optimum level and had scope for improving the production from the present grounds (Table 3).

Bullet tuna (*Auxis rochei*)

This species was exploited mainly by gillnets (53.3 %) followed by hooks and line (29.4 %) and trawls (17.3 %). Production increased continuously during 2008-2010 due to improved contribution by gillnets and hooks and line. More than 86 % of the catch was contributed together by Tamilnadu and Kerala.

Fishery was supported by 14-39 cm fishes. They mature and spawn round the year with peak during July-September. Size at capture of the species is higher than the size at maturity but lower than the optimum size (L_{opt}) (Table 2). Estimates of exploitation rate indicate that they are exploited below the optimum level (Table 3). Above findings suggests that there are considerable scope for improving their production.

Long tail tuna (*Thunnus tonggol*)

Major abundance and fishery (96%) is from northwest coast comprising Maharashtra and Gujarat. They were exploited by gillnets (63.2%), hooks and line (20.3%) and ringseines/purseseines (16.5 %). Production declined in 2009 and then marginally improved in 2010.Their catch improved in all states except from Kerala and Gujarat.

Fishery was supported by 32-93 cm fishes. T.tonggol matured and spawned round the year with peak during September-January. Size at capture of the species is below the size at

maturity and L_{opt} (Table 2). This is mainly attributed to large proportion of small fishes in the gillnet catches. Adult populations are largely inaccessible to the present fishing units. Preliminary assessment shows considerable scope for improving their production. However measures are needed to improve the size of the exploited fishes.

Oriental bonito (***Sarda orientalis***)

They were exploited by trawl (50.8%), gillnet (32.3%), handline/longline (12.3%) and purse seine (4.6%). After a sudden spurt in production to 1,115 t along the mainland coast in 2009, catch declined sharply by 96.5% to a mere 39 t in 2010.

Fishery was supported by 32-59 cm fishes. They matured and spawned round the year with peak during May-September. Size at capture is higher than the size at maturity and optimum size (L_{opt}) for exploitation (Table2). Preliminary estimates of exploitation rate shows that the resource is at its initial phase of exploitation and had considerable scope for improving their production.

Food and feeding:

Studies on the diet of neritic tunas revealed that all species are non selective opportunistic carnivores feeding mainly on fishes. As they are mostly opportunistic feeder, the diet composition too showed variation depending on the availability of a particular food item in the vicinity, the time of capture, the area/ location of collection, depth of fishing, gear used for fishing, etc. Baits used formed one of the diet component and a certain amount of cannibalism was noticed in all species.

Growth:

Quite a few studies have been carried out on the growth of neritic tunas. The summary of different studies carried out in India is given in Table 4. Studies have been carried out in different parts of the country and probably the fishing techniques used also may have been different leading to differential size distribution. Difference in the growth and mortality values may be attributed to type of gear used length distribution in the catch and due to ecological differences in the different areas. A uniform growth pattern for all the different species based on

collection made from different location would definitely give a better picture of the general growth pattern followed by neretic tunas that occur along the Indian peninsula.

Species.	L_∞ (cm)	K/yr	F	Z	M	Location	Reference
E.affinis	81.0	0.3655				India	Silas et.al., 1985
	83.5	0.42	1.4	2.56	0.76	Inshore waters of India	James et al., 1993
	89.0	0.90	4.90	5.85	0.98	Indian seas	Pillai et al., 2002
	87.5	1.5	8.03	9.79		East coast of India	Kasim and Abdussamad, 2005
A.thazard	63.0	0.4898				India	Silas et.al., 1985
	56.0	0.77	1.79	3.28	1.26	Kerala	James et al., 1993
	56.0	0.77	2.85	4.05	1.26	Tamil Nadu	James et al., 1993
	54.0	0.87	3.20	4.40	1.20	Indian seas	Pillai et al., 2002
	53.8	1.04	3.19	4.87	1.58	East coast of India	Kasim and Abdussamad, 2005
T.tonggol	93.0	0.4898				India	Silas et.al., 1985
	94.0	0.48	0.35	1.22	0.80	Inshore waters of India	James et al., 1993
	92.5	1.2	0.7	1.86	1.2	Indian seas	Pillai et al., 2002
	108	0.55	3.414	4.214	0.8	Northwest coast	Pillai et al, 2003
A.rochei	37.0	0.60	1.77	3.04	1.2	Kerala	James et al., 1993
	34.0	1.1	2.96	4.81	1.85		Gopakumar & Ajithkumar, 2002
S.orientalis	66.0	1.0				India	Silas et.al., 1985

Table 4. Estimates of population parameters of neritic tunas exploited from Indian waters by different authors

Conclusion

Tuna has been exploited from Indian waters from time-immemorial as bye-catch of other major commercial fisheries. However, targeted fishing for tuna especially oceanic species in a commercial scale along the mainland is a recent development. With increased demand for 'Sashmi grade" tunas as well as other value added products in the export market, altered consumer preference and increased value for smaller tunas in the domestic sector, the tuna fishing industry is all geared up to increase production of both the coastal and ocean tunas in

the near future. The fact that the exploitation rates of all the neritic tunas along the Indian coast are low further indicates that there is ample scope for increasing production by increasing effort. *T.tonggol*, the only true neritic tuna species has very good meat quality and fetches a price equal to yellowfin tuna in most coastal states. Concerted effort to target this species will definitely yield better catches and also contribute to the over increase in total tuna production of the country.

Reference:

James,P.S.B.R. and P.P. Pillai. 1993. Tuna resources and fishery in the Indian EEZ- an update. Proc. National Tuna Conference, CMFRI, Cochin: 19-43.

James,P.S.B.R., P.P. Pillai, A.A.Jayaprakash, T.M.Yohannan, PonSiraimeetan, C.Muthiah, G.Gopakumar, N.G.K.Pillai, S.Reuben, R.Thiagarajan, K.P.SaidKoya, G.M.Kulakarni, M.V.Somaraju, K.N.Kurup, and T.V.sathianandan. 1992. Stock assessment of tunas from the Indian seas. *Indian J. Fish*., 39(3, 4):260-277.

James,P.S.B.R., P.P. Pillai, N.G.K. Pillai, A.A. Jayaprakash, G. Gopakumar, H. MohamadKasim M. Sivadas, K.P. Said Koya. 1993. Fishery, biology and stock assessment of small tunas. In: D.Sudarshan and M.E. John (Eds.) Tuna research in India, FSI, Bombay: 123-148.

Kasim, H.M. and E.M. Abdussamad, 2005.Stock assessment of coastal tunas along the west coast of India. In V.S. somavanshi, S.Varghese and A.K. Bhargava (EDS). Proc. Tuna Meet.-2003: 45-53.

Madan Mohan, P.Livingston and k.K.Kunnhikoya. 1985. Fishery and bionomics of tuna at Minicoy Island. *Bull. Cent. Mar. Fish. Res. Inst*., 36:122-237.

Pillai, P.P. 1993. Tuna fishery resources and and their exploitation by low energy fishing techniques. *Proc. Symp. Low Energy Fishing Techniques*. Society of Fisheries Technologists (India), CIFT: 39-43.

Pillai, P.P. and G.Gopakumar. 2003. Tunas. In Mohan Joseph M. and Jayaprakash, A.A. (Eds.) Status of Exploited Marine Fuishery resources of Inida. Central Marine fisheries research Institute, Kochi-682014, India.

Pillai,P.P., N.G.K. Pillai, C. Muthiah, T.M. Yohannan, H. MohamadKasim, G. Gopakumar, K.P. Said koya, B.Manojkumar, M. Sivadas, A.K.V.Nasser, U.Ganga, H.K. Dhokia, S. Kemparaju, M.M. Bhaskaran, M.N.K.Elayathu, T.S.Balasubramaniam, C. Manimaran,, V.A. Kunhikoya, and T.T. Ajith Kumar. 2002. Stock assessment of coastal tunas in the Indian seas. In: N.G.K.Pillai, N.G.Menon, P.P.Pillai and U.Ganga

(Eds.) *Management of Scombroid Fisheries*. Central Marine Fisheries Research Institute Kochi: 125-136.

Silas, E.G. 1985. Tuna Fisheries of the EEZ of India.- an introductory statement . *Bull.Cent. Mar. Fish. Res. Inst*., 36:1-5.

Silas, E.G.and P.P. Pillai. 1982. Resources of tuna and related species and their fisheries in Indian Ocean. *Bull. Cent. Mar. Fish. Res. Inst*., 32: 174p.

Silas, E.G.and P.P. Pillai. 1985. A critique on national tuna fishery. *Bull. Cent. Mar. Fish. Res. Inst*., 36:11-19.

Silas, E.G.and P.P. Pillai. M.Srinath, A.A.Jayaprakash, C.Muthiah, V.balan, T.M. Yohannan, PonSirameetan, Madan Mohan, P. Livingston, K.K. Kunhikoya, M. AyyappanPillai and P.. SadasivaSarma. 1985. A critique on national tuna fishery. *Bull. Cent. Mar. Fish. Res. Inst*., 36:11-19.