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Fishery and length based population parameters of little tuna, *Euthynnus affinis* (Cantor, 1849) from Gulf of Mannar, Southwestern Bay of Bengal.

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Little tuna is the third major tuna species landed along Tuticorin coast after Yellow fin and Skipjack tuna. The species is mostly harvested by large meshed drift gillnets where minor and seasonal catches comes from trawls and lines. Few months post fishing ban period are peak fishing season with high catch rates. There does exist, a seasonal shift in fishing ground in response to changing wind and current pattern. The species showed a positive allometric growth with ‘b’ estimated as 3.1989. Asymptotic length (L_∞) and growth coefficient (K) were 79.0 cm and 0.63 yr^{-1}, respectively. The natural, fishing and total mortality were calculated as 1.03 yr^{-1}, 1.37 yr^{-1} and 2.40 yr^{-1}, respectively. The current exploitation ratio of 0.57 is considerably lower than E_{max} indicating the possibility of enhancing the production from the capture fisheries.

[Keywords: growth; Length-weight relationship; mortality; Tuticorin.]

Introduction

Little tuna is a marine, pelagic-neritic and oceanodromous tuna species[1]. Its vertical distribution ranges from surface to the depth of up to 200 metres[2]. As far as horizontal distribution is concerned, it is an open water species with close proximity to the shores in a temperature range of 18° to 29 °C. The young ones are also reported to enter bays and harbor area[3]. Canned and frozen tuna are prized commodity in the global seafood market. They are also consumed on fresh, salted, dried and smoked forms[4, 5]. Along the Indian coast, *Euthynnus affinis* has distribution all along the Indian coastline and are commercially exploited throughout its distribution for human consumption[6, 7]. Little tuna contributed 35446 tones i.e. 38.7 % of total national tuna landings of 91,635 t, which makes it the most dominant species in catch followed by by *Thunnus albacares* with 16792 t (18.32 %) during 2016[8]. The little tunas are caught across all months of the year with highest recorded landings during June to October, while September forms the major fishing season along the southeast coast of India[9].

Along Tuticorin coast, tunas are harvested by traditional fishermen using large meshed drift gillnets (*Paruvalai*), trawl nets (*Meanmadi*), longlines (*Keraimattu*) and handlines (*Oodukayiru*). Among these four types of gears, around 90% of the tuna landings comes from large meshed drift gillnets. Many developing countries have expanded and intensified their fishing activities to increase tuna production from their EEZ especially from deeper waters and India is not an exception to it[10,11]. Substantial development has happened in tuna fishing owing to the incorporation of OBM motors in traditional catamarans and fitting of inboard engines to many artisanal plank-built boats in Tamil Nadu since 1990s[12, 13]. Balasubramaniam[14] has given a detailed account on the conversion of trawlers into gillnetters for the exploitation of tuna fishery resources from the deeper waters.

Previous studies and published reports indicated that considerable little tuna resources remain untouched in the Indian seas, especially in deeper waters[15-18]. There do exists some studies on tunas from the area under current study[18-20], but the rapid changing fishery especially in terms of its gradual shift towards deeper waters, there is a need for an updated documentation on the fishery and the population characters which are the functions of fisheries dependent factors. The present study is an attempt to provide insight in little tuna fisheries along the coast.

Material and Methods

The present investigation is based on information collected during June 2016 to May 2017 along the Tuticorin coast (163.5 km). Four fish landing centers viz. Tuticorin Fishing Harbor (078.16 °E and 08.79 °N), Tharuvaikulam (078.89° E and 08.17 °N), Kombudurai (078.14 °E and 08.58 °N) and Therespuram (078.16 °E and 08.81 °N) were periodically visited for collection of details related to gears and craft in operation, fishing grounds, effort spent, catch realized and length composition for *E. affinis*. Landings data in weight and numbers from each boat were recorded for each sampling day which is subsequently multiplied by the total number of crafts engaged in fishing on the day to establish average catch of the day. The average catch of the day is raised to the total catch of the month by multiplying by the actual fishing days in the month. For the estimation of catch per unit effort (CPUE), effort is recorded in terms of total boats undertaking fishing trips during the particular month. Length composition in the catch by gillnets, longlines and handlines fishery was collected at weekly intervals.

Length weight relationship was estimates as per LeCren[21]. For estimation of length weight relationship some rarely landed smaller specimens from small mesh gillnets were also included. Monthly decomposed length composition data were used to estimate population parameters. ELEFAN was employed for working out feasible combination of L_∞ and K. Pauly's Empirical Equation and Length-converted catch curve routine in FiSAT software package were employed for estimation of natural mortality (M) and total mortality (Z) respectively[22]. Fishing mortality (F) was estimated by deducting natural mortality from the total mortality. The ratio of fishing mortality and total mortality gave exploitation ratio (E). Beverton and Holt model was applied for working out Yield per recruit (Y/R) for the species[23].

Results

Euthynnus affinis along Tuticorin coast is being exploited mainly by gillnets of mesh size 120-145 mm (96.60 %), longlines 2.03 % (hooks size 4 to 8), trawl net 1.32 % and handlines 0.05 % (Fig. 1). The monthly length composition of the catch showed that the major catch is constituted by 34.5 to 54.5 cm size range, more or less uniformly distributed in each length class (class width of 4 cm) throughout the year. Drift gillnets with large meshes have been traditionally contributing to the Little tuna fisheries along the Tuticorin coast, nevertheless a minor contribution also comes from, longliners, trawlers and handlines. The length of the landed specimens oscillates between 29 cm and 68 cm. Fishes in the length range of 49 to 52 cm forms the bulk of the catch with a contribution of 17.33 % followed by 45 to 48 cm and 53 to 56 cm with 15.25 % and 15.21 %, respectively of the total catch. The monthly mean length of capture ranged between 43.68-49.73 cm (Fig 2).

Bulk landing of little tuna took place at Tharuvaikulam and Therespuram fish landing centers which accounted for 72.33 % and 25.94 % of total landings, respectively whereas minor landings do took place on occasional basis at Thoothukudi fishing harbour and Kombudurai fish landing centre. Large meshed drift gillnets operated by the mechanized gillnetters, converted trawlers and motorized plank built boats "*Vallam*" with engine power varying from 48 to 108 hp are involved in tuna fishing alon g the coast. Apart from that, longlines operated by motorized plank built boats (20 to 48 hp), FRP boats with engine power 9.9 to 15 hp and trawl nets operated by the single day trawlers with engine power 200 to 600 hp also harvest little tuna but in lesser quantum. Based on the information collected from fishermen, large meshed gillnets were operated up to 100 nautical miles distance in south off Kanniyakumari and up to 110 nautical miles in north off Nagapattinam from the landing center under study. Drift gillnets were operated at depth of 20 to 500 m and longlines at depth of 20 to 60 m.

Multiday gillnet fishery constitutes a fishing trip of 4-11 days unlike longlines and trawl fishing which is limited to 1 to 3 and 1 days respectively. The crew number was 5-8 for drift gillnetters, 2-3 for longliners

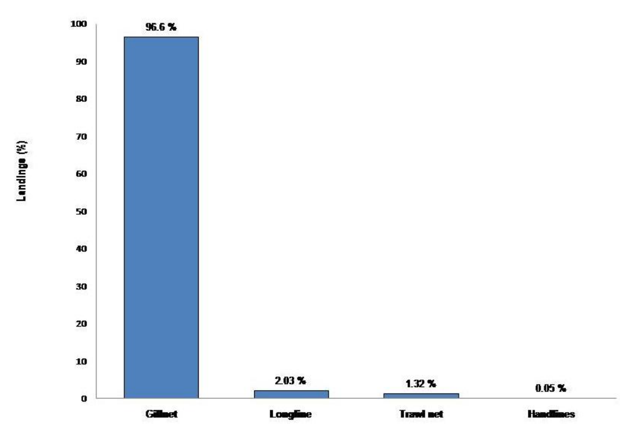

Fig 1 — Gear-wise landings (%) of *Euthynnus affinis* along Tuticorin coast of Tamil Nadu (June 2016 to May 2017) and 10-12 for trawlers. June was the most productive season for *E. affinis* at Tharuvaikulam, with highest recorded CPUE (101.03 kg/day) whereas April with CPUE of 4.97 kg/day was the leanest season. The annual average CPUE was calculated as 50.63 kg/day. June to November was the operational season for large meshed drift gillnets at Therespuram landing centre. The most productive and leanest season were July (CPUE = 48.31 kg/day) and October (CPUE = 32.79 kg/day), respectively. The average CPUE was estimated as 40.27 kg/day. Short period of April and May supports Longline fishery for *E. affinis* with a mean CPUE of 35.02 kg/day. Trawlers were operated from Thoothukudi Fishing Harbour throughout the year except closed fishing season (15 April to 30 May). The maximum and minimum CPUE were observed during May (1.2 kg/day) and November (0.21 kg/day), respectively (Table 1).

Euthynnus affinis was the third major tuna species of commercial importance caught along the coast with 16.85 % share in total tuna landings. *E. affinis* was landed throughout the year with bulk of landing concentrated during few months post ban period (June to October). The maximum landing was observed

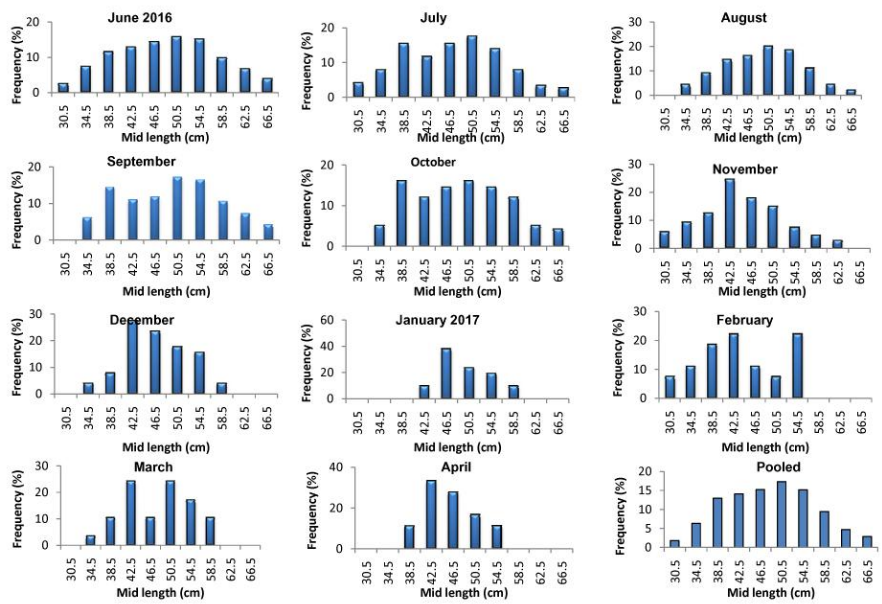

Fig 2 — Length frequency distribution in catch of *Euthynnus affinis* from June 2016 to May 2017

Table 1 — Monthly Catch (kg), Effort (unit) and Catch Per Unit Effort (CPUE) of *Euthynnus affinis* in different gears along Tuticorin coast during June 2016 to May 2017

Month	Large meshed drift gillnets of Tharuvaikulam			Large meshed drift gillnets of Therespuram			Longlines of Therespuram			Longlines of Kombudurai			Handlines of Kombudurai			Trawl net of Thoothukudi Fishing Harbour			Total Catch (kg)
	Effort (Boat days)	Catch (kg)	CPUE (Kg/day)	Effort (Boat days)	Catch (kg)	CPUE (Kg/day)	Effort (Boat days)	Catch (kg)	CPUE (Kg/day)	Effort (Boat days)	Catch (kg)	CPUE (Kg/day)	Effort (Boat days)	Catch (kg)	CPUE (Kg/day)	Effort (Boat days)	Catch (kg)	CPUE (Kg/day)	
Jun’16	920	92951	101.03	770	36436	47.32	-	-	-	-	-	-	-	-	-	2760	1748	0.63	131135
Jul	1150	98208	85.40	990	47831	48.31	-	-	-	-	-	-	-	-	-	2750	1342	0.49	147381
Aug	990	90442	91.36	800	34261	42.83	-	-	-	-	-	-	-	-	-	2520	798	0.32	125501
Sep	800	76958	96.20	595	21515	36.16	-	-	-	-	-	-	-	-	-	1792	688	0.38	99161
Oct	855	78585	91.91	500	16395	32.79	-	-	-	-	-	-	-	-	-	2360	620	0.26	95600
Nov	540	25533	47.28	270	9235	34.20	-	-	-	-	-	-	-	-	-	1854	396	0.21	35164
Dec	700	10612	15.16	-	-	-	52.5	5138	97.87	-	-	-	-	-	-	2500	590	0.24	16340
Jan’17	720	5360	7.44	-	-	-	47.5	1560	32.84	276	611	2.21	391	309	0.79	2420	664	0.27	8504
Feb	630	4302	6.83	-	-	-	57.5	1515	26.35	352	850	2.41	-	-	-	1710	666	0.39	7333
Mar	880	8242	9.37	-	-	-	60	2431	40.52	504	1025	2.03	-	-	-	2464	541	0.22	12239
Apr	495	2460	4.97	-	-	-	55	373	6.78	-	-	-	-	-	-	825	990	1.20	3823
May	-	-	-	-	-	-	57.5	333	5.79	-	-	-	-	-	-	-	-	-	333
Average	789	44878	50.63	654.17	27612	40.27	55	1892	35.02	377	829	2.22	391	309	0.79	2178	822	0.42	56876

during July whereas minimum was during May (Fig 3). The LWR (length-weight relationship) for the species is established as $W=0.0062L^{3.1989}$ which is indicative of hyper-allometric growth pattern (Fig 4). The estimated growth parameters were asymptotic length (L_{∞}) = 79.00 cm and growth coefficient (K) = 0.63 yr^{-1}. The Von Bertalanffy growth function for *E. affinis* is presented in Figure 5.

The month wise recruitment pattern in percentage of little tuna is demostrated in Figure 6. The major recruitment was observed during the period of April to July (49.08%). Pauly's emperical formula gave the natural mortality rate (M) 1.03 $year^{-1}$ when mean temperature was taken as 29.5 ^{0}C. The total mortality rate (Z) as 2.40 $year^{-1}$ using length converted catch curve (Fig. 7). 1.37 yr^{-1} and 0.57 were the respective values for fishing mortality rate (F) and exploitation ratio (E). The dominance of natural mortality as the major mortality component was evident up to 46.5 cm when the length frequency data were subjected to the virtual population analysis (Fig 8). A significant fishing mortality was observed for a length class 37-40 cm onwards. Relatively high fishing pressure was observed for penultimate length class (57-60 cm).

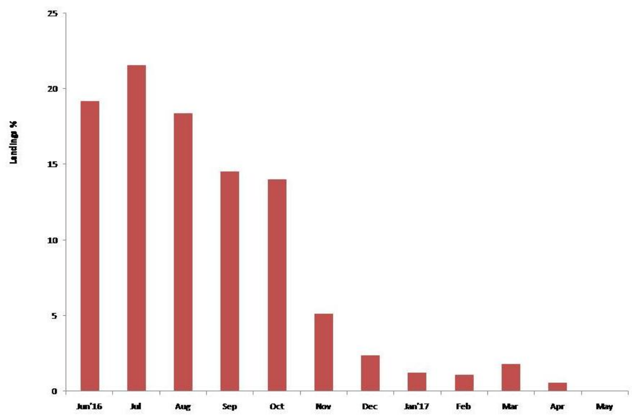

Fig 3 — Monthwise landings of *Euthynnus affinis* along Tuticorin coast of Tamil Nadu (June 2016 to May 2017)

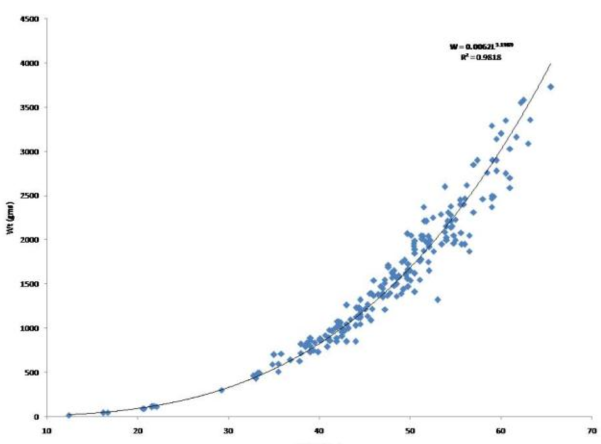

Fig 4 — Length-weight relationship of *Euthynnus affinis* from Tuticorin coast, Tamil Nadu.

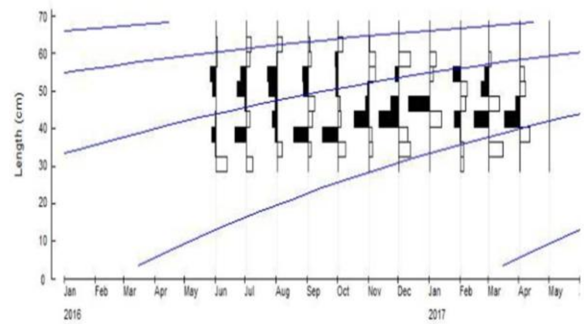

Fig. 5 — von Bertalanffy growth plot of *Euthynnus affinis* from Tuticorin coast, Tamil Nadu.

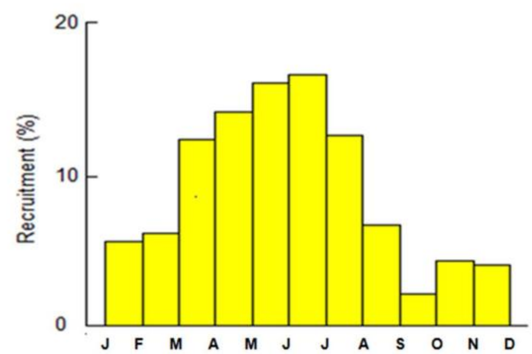

Fig 6 — Recruitment pattern of *Euthynnus affinis* from Tuticorin coast, Tamil Nadu.

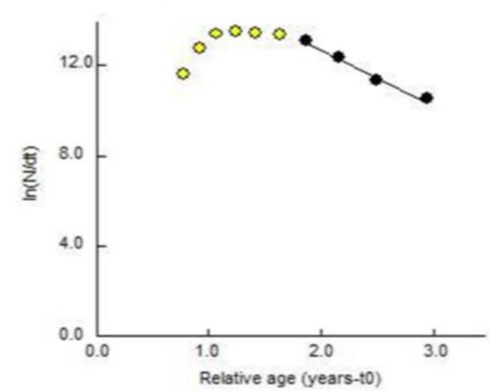

Fig 7 — Length converted catch curve of *Euthynnus affinis* from Tuticorin coast, Tamil Nadu.

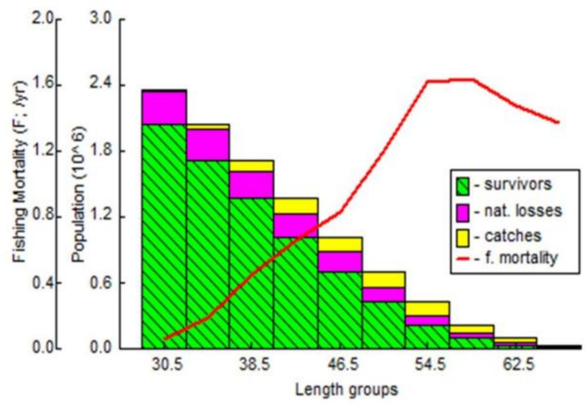

Fig 8 — Virtual Population Analysis (VPA) of *Euthynnus affinis* from Tuticorin coast, Tamil Nadu.

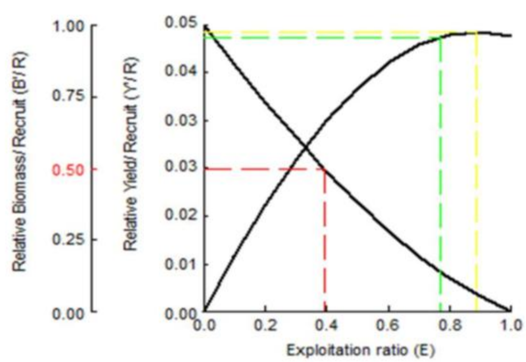

Fig 9 — Relative yield per recruit of *Euthynnus affinis* from Tuticorin coast, Tamil Nadu.

The present exploitation ratio (E) was 0.57 whereas the E giving highest relative yield per recruit was estimated as 0.885 (E_{max}) (Fig. 9). The present E (>0.5) is indicative of fishing pressure above the recommended and hence further intensification of the fishing may not be good for the stock sustainability.

Discussion

The dominance of large meshed sized gillnets (96.6 %) in tuna exploitation is not a new phenomenon along Tuticorin and has been documented earlier also[18,24]. The dominance of narrow size range in length composition also indicated the pre-dominance of a size selective gillnet fishery. The minimal monthly variation in mean length of capture is yet another indication of selective fishing pressure on mid length group fishes. The size range and annual mean length of catch (48.22 cm) in current stusdy is marginally smaller than recorded by Abdussamad *et al*.[18]. The contributions from other gears are basically incidental and non-targeted. The two of the landing centers namely, Tharuvaikulam and Therespuram operating large mesh gillnets were the hub of tuna landings including little tuna (>98 %) along Tuticorin coast. The operation of the drift gillnets for exploitation of tuna shows spatial shift with season. The expanse is from off Kanniyakumari in south to off Nagapattinam in north. The spatial shift is in response to the varying wind and current direction which is believed to be the reason for shoreward movements of tuna[25,26].

The bulk landings of little tuna were concentrated in few months immediately after closed season. Around 60 % annual landings were during June to August and figures rose to 87 % till October. Abdussamad *et al*.[18] recorded a substantial high tuna landings concentrated during June to August (85 %) based on the data collected during 1989-2002. The current figures substantially differ from them as the catch dynamics and species composition has underwent a change over the years. The little tuna which enjoyed the status of most dominant tuna in landing has slide down to third position after Yellowfin and skipjack Tuna along Tuticorin coast. The higher catch rates were observed during peak fishing season which is obvious as the catch rates determines whether the effort needs to be spent or not on resources. Barring gillnets all other modes of tuna harvest are either incidental or seasonal and hence their contribution is fairly less in tuna landings. Similar findings were also form the part of earlier documentations[18].

The length-weight relationships estimated earlier varied from moderately hypoallometric to slightly hyperallometric[9, 27, 28]. In the present study, the estimates indicated significant positive allometry for the species. The R-squared value of 0.9818 for the relationship in the current studies reflects the fairly robust estimates of the parameters. The current estimates of growth parameters L_∞ and K i.e. 79 cm and 0.63 yr^{-1}, respectively is in concurrence with the earlier estimates from Indian waters[9, 18]. The estimates from Gujarat coast are slightly different from ours with lower values for both L_∞ and K[28, 29]. The variations could be attributed to difference in both fisheries dependent and independent factors across study areas.

The calculated value of fishing mortality in current study is substantially lower than the estimate made by Abdussamad *et al*.[18]. The reason could be the shift of fishing pressure from little tuna towards bigger size tuna species like Yellowfin and Skipjack tuna which could be seen in the relative contribution of the species towards total tuna landings. The dominance of natural mortality as the major component of natural mortality continued up to the length class of 45-48 cm which is marginally higher than the results obtained by virtual population analysis (VPA) carried out by Abdussamad *et al*.[18] and substantially higher than found by Pratibha *et al*.[9] and Nissar *et al*.[28]. The major difference for the later quoted works is due to the difference in fishery like gears, mesh size and depth of operation which invariably decides the dominant length class in catches.

The current estimate of exploitation rate was found to be in relative proximity to the estimates made by Pratibha *et al*.[9] for the species on national scale and Nissar *et al*.[28] from NW coast. The current exploitation rate of 0.57 is less than earlier estimates of 0.70 and 0.63[18, 30] from the SE coast and also less than E_{max} of 0.885 indicating the possibility of enhancing the production of the species from capture fishery.

A year round recruitment with peak contribution (49.08 %) during April-July was evident with no or insignificant minor secondary peak unlike the results obtained by Pratibha *et al*.[9] based on national estimates having peak recruitment during October-December. The difference in scale of study could be the possible reason for difference. The national estimates might have underscored the regional variation in these population parameters.

The variation in estimates of population parameters across the different study area despite having representation from similar size ranges in samples, signifies the importance of regional variation among the residing population induced by variable fisheries dependent and independent factors. Despite a preferred shift towards larger species of tuna along the coast, little tuna still forms considerable fisheries with a scope of increasing production from capture fisheries. Nevertheless, the fisheries need to be monitored on regular basis to ensure the sustainability of the resources.

Conclusion

The study highlights the importance of regional studies of a particular stock and its mode of exploitation to devise location specific management plan. Tuna fisheries along the main land of India in general and Tamil Nadu in particular has vast scope for expansion nevertheless an eye need to be kept on the response of resource towards its exploitation to ensure both sustainability and optimum socio-economic benefits that can be achieved out of this.

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References

1 Riede, K., Global register of migratory species from global to regional scales, In: *Final Report of the R&D-Projekt 808 05 081*, (Federal Agency for Nature Conservation, Bonn, Germany) 2004 pp. 329.

2 FAO-FIGIS, Species Fact sheets: *Euthynnus affinis* (Retrieved from www.fao.org)

3 Poisson, F., Compilation of information on neritic tuna species in the Indian Ocean, in: *IOTC-2006-SC-INF11*, (IOTC) 2006, pp. 1-23

4 Collette, B. B., Scombridae. Tunas (also, albacore, bonitos, mackerels, seerfishes, and wahoo). In: *FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. . Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles*, (FAO, Rome) 6 (2001) pp. 3721-3756.

5 Frimodt, C., *Multilingual illustrated guide to the world's commercial warm water fish*, (Fishing News Books, Oxford, England) 1995, pp. 215.

6 Silas, E. G. and Pillai, P. P., Taxonomy and distribution of tunas, tuna like fishes and billfishes in the Indian Ocean, *Bull. Cent. Mar. Fish. Res. Inst.*, 32 (1982) 3-23.

7 Khan, M. Z., Age, growth mortality and stock assessment of *Euthynnus affinis* (Cantor) from Maharashtra waters, *Indian J. Fish*., 51 (2004) 209-221.

8 CMFRI, *Annual Report 2016-17*, (CMFRI, Cochin) 2017, pp. 1-345.

9 Prathibha. R., Chellappan, A., Abdussamad, E., Joshi, K. K., Koya, K. P. S., Sivadas, M., Ghosh, S., Rathinam, A. M. M., Kemparaju, S., Dhokia, H. K., Prakasan, D. and Beni, N., Fishery and bionomics of the little tuna, *Euthynnus affinis* (Cantor, 1849) exploited from Indian waters. *Indian J. Fish*., 59(3) (2012) 33-42.

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

11 James, P. S. B. R. and Pillai, P. P., Strategies for tuna fisheries development and management in the Indian Exclusive Economic Zone, in: *CMFRI Bulletin 44: National Symposium on Research and Development in Marine Fisheries Session*, (CMFRI, Kochi) 1991, pp. 619-642.

12 Pillai, P. K. M., Balakrishnan, G., Varghese, V. and Rajendran, V., Appraisal on the marine fishing craft and gear of the Indian coast, in: *Marine Fisheries Research and Management*, (CMFRI, Kochi) 2000, pp. 190-221.

13 Thirumilu, P., Mahadevanpillai, P. K., Poovannan, P. and Bose, M., Specifications of different artisanal and mechanized fishing craft employed in marine fisheries along Tamil Nadu coast, *Mar. Fish. Info. Serv., T & E Ser.*, 128 (1994) 1-12.
14 Balasubramanian, T. S., Modification of craft and gear in diversified tuna fishery undertaken at Tharuvaikulam, Gulf of Mannar, India. *Mar. Fish. Info. Serv., T&E Ser.*, 164 (2000) 19-24.
15 Sivaprakasam, T. E., Tuna fishing in Indian waters, in: *Proceedings of the Seminar on Fisheries-A Multibillion Dollar Industry*, (Madras) 1995, pp. 1-6.
16 Mitra, G. N., Tuna is the mainstay of fishing in deep-sea zone of Indian EEZ, *Fishing Chimes*, 19(1) (1999) 77-79.
17 Pillai, N. G. K. and Ganga, U., Scombroid fishery of the Indian Ocean - An overview, in: *Management of scombroid fisheries*, (CMFRI, Kochi) 2002, pp. 14-23.
18 Abdussamad, E. M, Pillai, P. P., Kasim, H. M. and Balasubramaniam, T. S., Fishery and population characteristics of coastal tunas at Tuticorin, *J. Mar. Biol. Ass. India*, 47(1) (2005) 50-56.
19 Siraimeetan, P., On the occurrence, size distribution, morphometry and feeding habits of the juveniles of *Euthynnus affinis* (Cantor), *Auxis thazard* (Lacepede) and *Sarda orientalis* (Temminck and Schlegel) along the Tuticorin coast in the Gulf of Mannar, south-east coast of India, *Bull. Cent. Mar. Fish. Res. Inst.*, 36 (1985) 104-114.
20 Yesaki, M., Estimates of age and growth of kawakawa (*Euthynnus affinis*), longtail tuna (*Thunnus tonggol*) and frigate tuna (*Auxis thazard*) from the Gulf of Thailand based on length data, *Indo-Pac. Tuna Dev. Mgt. Prog*., 17 (1989) 94–108.
21 LeCren, E. D., The length weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*), *J. Anim. Ecol.*, 20 (1951) 201-219.
22 Gayanilo, F. C. and Pauly, D., *The FAO-ICLARM Stock Assessment Tools (FISAT) Reference manual*, (FAO, Rome) 1997, pp.1-196.
23 Beverton, R. J. H. and Holt, S. J., *On the dynamics of exploited fish populations*, (Fishery Investigations Series, London) 1957, pp. 1-533.
24 Kasim, H. M, Status of the World Tuna Fishery with Special Reference on the Strategies for the Development and Management of Tuna Fishery in Indian Waters, in: *The Fifth Indian Fisheries Forum proceedings*, (AFSIB, Mangalore) 2000, pp. 297-207.
25 Silas, E. G., Tuna fishery of the Tinnevelly Coast, Gulf of Mannar. Proceedings of the symposium on scombroid fishes Part II, in: *Marine Biological Association of India Symposium Series*, (MBAI) 1967, pp.1083-1118.
26 Abdussamad, E. M., Pillai, N. G. K. and Balasubramanian, T. S., Population characteristics and fishery of Yellowfin tuna, *Thunnus albacores* landed along the Gulf of Mannar Coast, Tamil Nadu, India, *Egypt. J. Aquat. Res.*, 34(2) (2008) 330-335.
27 Ahmed, Q., Yousuf, F., Sarfraz, M., Ali, Q. M., Balkhour, M., Safi, S. Z. and Ashraf, M. A., *Euthynnus affinis* (little tuna): fishery, bionomics, seasonal elemental variations, health risk assessment and conservational management, *Front. Life Sci.*, 8(1) (2014) 71-96.
28 Nissar, K. K. S., Ghosh, S., Rashid, F., Desai, A. Y. and Phadke, G. Fishery, population characteristics and yield estimates of little tuna (*Euthynnus affinis*) along the Veraval coast of India, *J. Exp. Zool. India*, 18(1) (2015) 103-106.
29 Ghosh, S., Pillai, N. G. K. and Dhokia, H. K., Fishery population characteristics and yield estimates of coastal tunas at Veraval, *Indian J. Fish*., 56 (3) (2010) 157-161.
30 Kasim, H. M. and Mohan, S., Tuna fishery and stock assessment of component species off Chennai coast, *Asian Fish. Sci*., 22 (2009) 245-256.