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Neritic tuna resources of Indian waters, yield trend, biology and population characteristics of major species

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ABSTRACT

India has a long coastline of 8,129 km and a vast EEZ of 2.02 million km^2 rich in fishery diversity and abundance. Fishery wealth is being exploited by 72,559 small to medium mechanized boats, 71,313 motorised crafts and 50,618 non-mechanised crafts. Mechanised sector consists trawlers, gillnetters, dolnetters, liners, ringseiners and purseseiners. Fishing activity is manned by 791,808 fulltime and 135,312 part-time fishers. They fish mainly along the continental shelf and adjacent oceanic waters. Gillnetters targets mainly large pelagics, such as spanish mackerels and tunas and liners perches and elasmobranchs. Fishery of neritic tunas were supported by five species and spanish mackerel by three species. Neritic tuna catch during 2005-‘13 varied between 32,942 t (2005) and 62,065 t (2013) with an average of 48,942 t. Despite distribution and abundance along entire coast, major share of the catch is being realized from south and nortthwest coasts. The fishery biological observations and stock assessment of component species indicates that stock in general is healthy with sufficient spawning stock biomass to sustain the stock and yield. Evaluation of spatio-temporal distribution pattern, abundance and fishery suggested that resource remain under-utilized from large areas of the coast. Trend analysis indicated that yield is increasing steadily over the years and that fishery is in the growing phase. Rapid assessment of the health of neritic tuna shows that stock is abundant and healthy along the Indian waters.

Introduction

Coastal tuna and tuna like fishes were exploited by gillnets, seines and small long-line operated from traditional and small mechanized crafts. They were also caught in varieties of other gears like trawls, troll-lines, hand-lines and bagnets. Fishery was

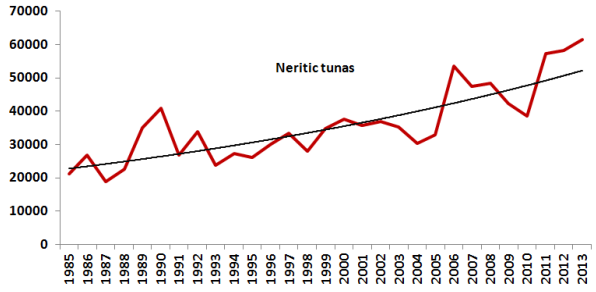
supported by spanish mackerels, coastal tunas, carangids, sharks, bararcudas etc. Fishery was monitored regularly by Central Marine Fisheries Research Institute (CMFRI) following stratified random sampling techniques. Data on effort, catch, species composition and biology of the species in the landings were collected and updated.

Fishery

Coastal tuna landings during the 2013 was 62,065 t which represent 67.6 % of the total tuna catch of the country. Five species; kawakawa (*Euthynnus affinis*-64.1%), frigate tuna (*Auxis thazard*-7.1%), bullet tunas (*Auxis rochei*-5.5%), longtail tuna (*Thunnus tonggol*- 20.2%) and bonito (*Sarda orientalis*t- 3.1%) supported fishery. Gillnets contributed major share (44.7%), followed by seines (43.5%), hooks and line (9.3%) and the rest by trawls and non-mechanised gears.

Species	2008	2009	2010	2011	2012	2013	Average
E. affinis	32,406	28,563	21,271	32,937	32,772	39,738	31,281
A.thazard	8,341	7,661	6,688	10,173	8,534	4287	7,614
A.rochei	613	1,119	4,502	2,321	1,213	3438	2,201
T. tonggol	5,939	3,808	5,323	11,116	14,285	12643	8,852
S.orientalis	70	361	189	383	274	1959	539
Total	47,369	41,512	37,973	56,930	57,078	62,065	50,488

Species by landings of neritic tunas



Production trend of coastal tunas in Indian waters over the years

Yield shown steady increase over the years from 20,853 t in 1985 to

over 62,065 t in 20013, with wide annual fluctuation. Extension of fishing activities to more areas including deeper waters added considerably to the increased production of tunas.

Component species in the fishery

Species	Trawl	Gillnet	H&L	PS	RS	BS & NM
A. rochei	0.1	16.7	73.9	5.8	3.5	0.0
A.thazard	0.8	63.2	10.6	9.4	16.2	0.3
E.affinis	2.5	27.9	6.1	39.7	23.4	0.5
T.tonggol	1.6	94.1	0.5	3.8	0.0	0.0
S.orientalis	6.8	76.1	17.0	0.0	0.0	0.1
Coastal tuna	2.2	44.7	9.3	27.2	16.3	0.3

Gear-wise contribution of neritic tunas during 2013

Kawakawa

Most dominant species, widely distributed and exploited along the Indian coast including island territories with large contribution from the southern coasts, especially from southwest coast. Major share of the landing was by seines (63.1%) and gillnets (27.9%). Small quantities were laded by hooks & lines (6.1 %) and trawls.

Frigate tuna

Distributed along the entire Indian coast, but major contribution (86.4%) to the fishery was from southern coast. Gillnets land the major share (63.2%), followed by seines (25.6%), hooks and line (10.6%) and trawl.

Bullet tuna

Target fishing by longlines and handlines, driven by domestic demands for the species, prevails along the southern coast and almost 96% of the landing was realized from the region. Hooks and lines land nearly 74% of the catch. They are also landed by gillnets and seines.

Striped bonito

Caught from around coral reefs and knolls along the mainland and island territories by gillnets (76%), hooks & line and trawls. Their fishery was restricted to southwest and north west coast of mainland and Andaman & Nicobar waters.

Longtail tuna

The second dominant species, caught mainly from the northwest mainland coast. Small quantities were also caught from southwest and Andaman coast. Gillnets landed major share (94%) of the catch.

Biology and population characteristics of Frigate tuna

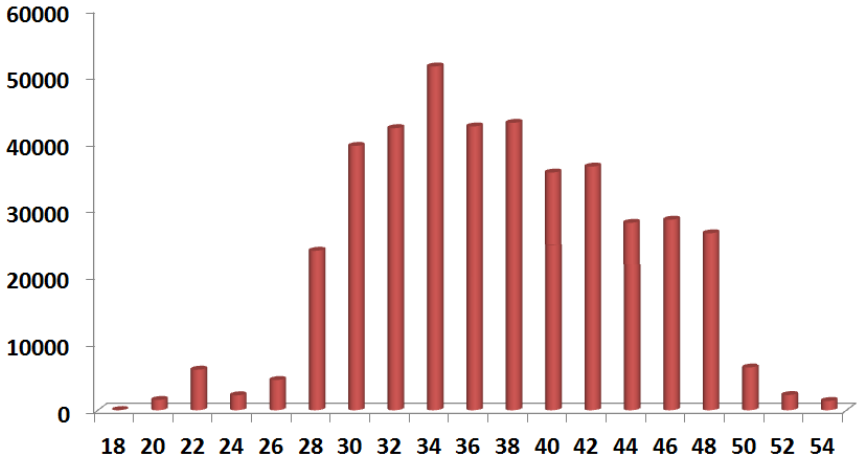
They constitute 7.1% of the neritic tuna landings by contributing 4,287 ton in 2013. Catch was highest in 2011 after which it has decreased in successive years. Frigate tuna being less demanded in the local markets, fishers generally avoid areas of their abundance. Coupled with it partial diversion of efforts for exploitation of high value oceanic tunas can be attributed to the decreased landing.

Seasonal pattern

Landed round the year with major part during April - May and September - December. Their monthly catch was highest in May followed by in September. Along the east coast peak fishery was during May and along west during September and October.

Length composition

Landings was supported by 18 to 56 cm (FL) fishes. Their length ranges were generally wider in the east coast than west coast. Length group 34-36 cm dominated the catch followed by the 38–40 cm group. Mean size in the catch was 36.4 cm and size at capture 30.6 cm

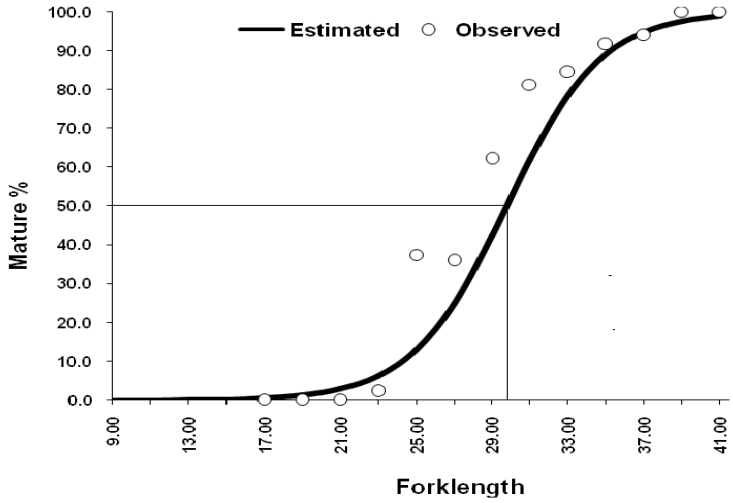


Size composition of Frigate tuna in the catch

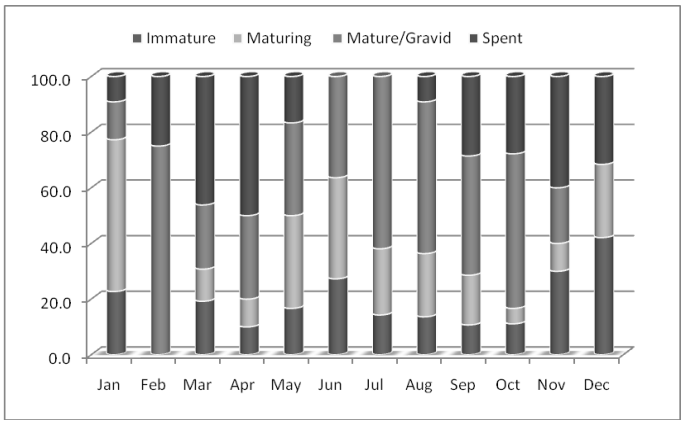
The length-weight relationship of *A. thazard* is estiamated as $W = 0.0033\ L^{3.467}$ (n = 884, r^2= 0.92), indicating that they follow allometric growth pattern.

Reproductive Biology

Species attain sexual maturity at 29.7 cm FL. Gravid and ripe females were recorded throughout the year with peak occurrence during February and July-October. This suggested that the species spawn over a prolonged period. Females with gravid gonads accounted 37.2% of the catch, followed by spent ones (23.7%), mature ones (21%) and immature ones (18.1%). The relative fecundity ranged between 6,97,531 to 11,63,438 eggs/kg body weight with an average of 8,07,986. The relative fecundity generally increase with the size of the fish.



Estimation of size at first maturity



Percentage occurrence of different maturity stages in the catch

Trophodynamics

Majority (74%) of the fishes observed were with empty stomachs, probably due to faster digestion or ejection of the prey while they got entangled in the net. Food was constituted by crustaceans, cephalopods and finfishes. Crustaceans were dominated by the non-penaeid prawn, *Acetes* spp. and crabs; cephalopods by the squid, *Loligo duvaucelli* and finfishes by sardines, anchovies, mackerels, scads and tuna juveniles.

Growth

The growth parameters, Lα, Wα and K were estimated as 57.95 cm, 3205 g and 1.2 year-^{1}, respectively. The growth performance index was 3.605, t_0 at -0.0075 years and longevity was 2.49 years. They attain 40.7 cm and 52.7 cm (FL), at the end of 1st year and 2nd year respectively. Age (t_c) at first capture (30.8 cm) in the gillnet was is 0.65 year. The fishery was supported primarily by 0+ year fishes.

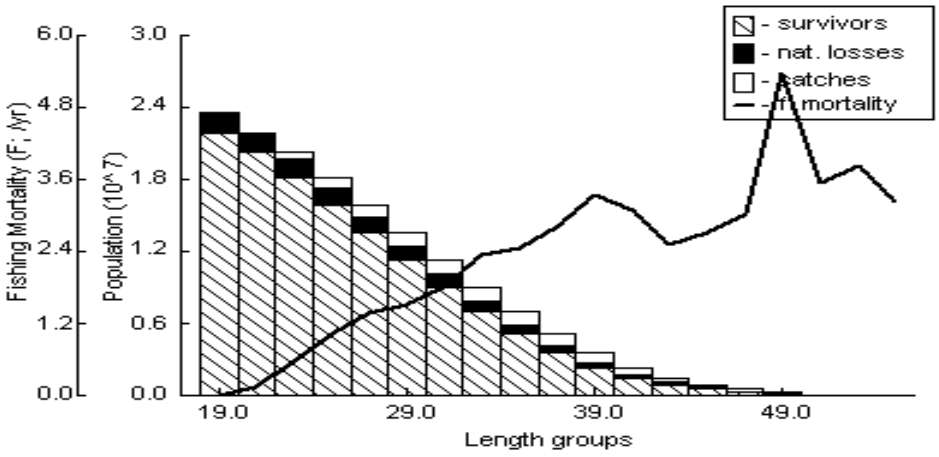
Recruitment pattern

Species exhibited bimodal recruitment pattern, with young ones being recruited into the fishery almost round the year. The major peak in recruitment was during February - April and this pulse produced 53.3 % of the recruits. A minor peak was observed in June which produced 11.15 % of the recruits. The smallest length at recruitment was 18.9 cm.

Mortality, exploitation and Virtual Population Analysis

Mortality M, F and Z estimates of the population was 1.65, 3.24 and 4.89, respectively. Eploitation rate was 0.658 and exploitation ratio was 0.661. E_{max}, 0.778 is higher than the present exploitation, indicating resources were exploited below the optimum level and offer some scope for increasing their production from the present fishing ground.s

VPA indicated that main loss in the stock up to 21 cm size was due to natural causes. Fishes became more vulnerable to gillnets after this size and mortality due to fishing increased and eventually outnumbered the natural losses from 31 cm onwards. The maximum fishing mortality of 5.36 was recorded at size of 49 cm.



Species which had higher growth coefficient of 1.2 per year and shorter lifespan of 2.5 years was found to have relatively higher natural mortality coefficient of 1.65 per year. The M/K ratio obtained in the present study was well within the normal range of 1 – 2.5, as suggested by Beverton and Holt (1959). As a rule the Z/K ratio of 1.0 is considered as growth dominated and if it is more than 2, then it is mortality dominated. In the present study it was more than 3, which showed that the stock is mortality dominated. It is evident from the result that since the value of E is lower than that of E_{max} and MSY higher than the annual catch, the stock is under low fishing pressure.

Population parameters of neritic tunas

Growth parameters				Lt-Wt reln (cm,g)		Length at maturity (Lm)
Species	**Loo**	**K**	**to**	**a**	**B**	
E.affinis	89.20	0.560	-0.0317	0.0254	2.889	37.70
A.thazard	57.95	1.200	-0.0075	0.0033	3.467	29.70
A.rochei	42.30	0.610	-0.0337	0.0076	3.249	23.60
S.orientalis	74.75	0.680	0.0000	0.0087	3.100	42.00
T.tonggol	123.50	0.524	-0.0319	0.0147	3.040	51.8

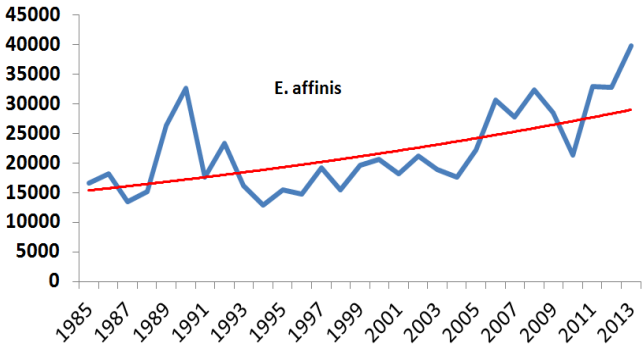
Biological Indicators of the species

Species	Lr	Lmax	Mean	Mode	Lc	Lopt	SSB-%
E.affinis	24.0	79.3	45.9	34, 58	41.4	38.9	53.6
A.thazard	18.0	56.0	36.4	35, 39	30.8	30.9	48.7
A.rochei	14.0	40.0	25.3	24.0	21.2	22.7	57.3
S.orientalis	16.0	68.0	42.7	49, 59	34.3	43.8	46.3
T.tonggol	38.6	83.0	49.7	47, 53	51.24	55.3	65.4

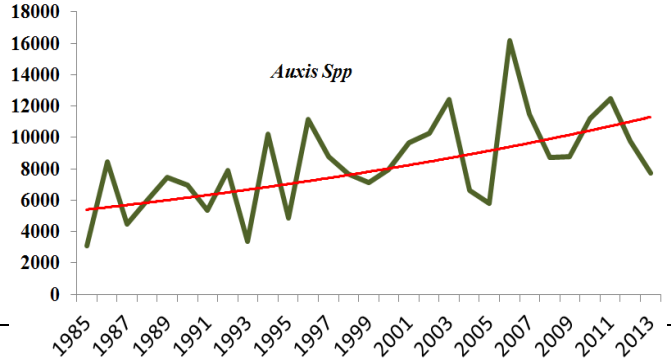
Trend analysis and Rapid stock assessment.

The trend analysis of the yield of coastal tuna as a whole and individual species separately shows that yield is increasing steadily over the years. Rapid stock assessment using historic maximum catch as basic reference shows that coastal tuna stock remains at abundant state. Among the component species except *Auxis* Spp, stock of all species are at abundant state, whereas the later at less abundant state.

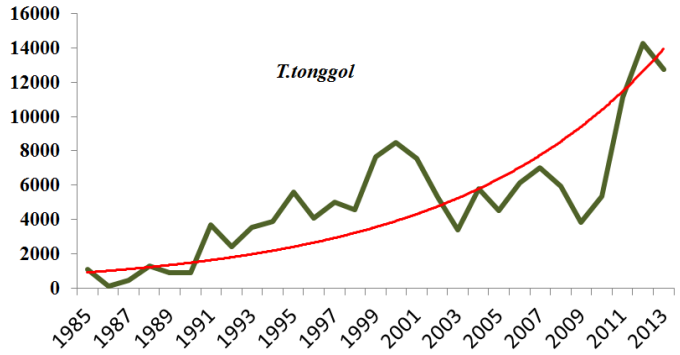
Trend in production of Kawakawa over the years



Trend in production of Auxis Spp over the years



Trend in production of Longtail tuna over the years



Conclusion

The fishing pattern shows that coastal based fishery restricted to limited areas of the coast. Presently, fishery is concentrated mainly along the southern and northwest coast. Fishery biological observations and stock assessment of component species indicate that neritic tuna stock in general is healthy with exploitation of most species below optimum level. These situation offer scope for improved production from present grounds and from less exploited areas of the coast.

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