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# Neritic tuna fishery along the Indian coast and biology and population characteristics of longtail and frigate tuna

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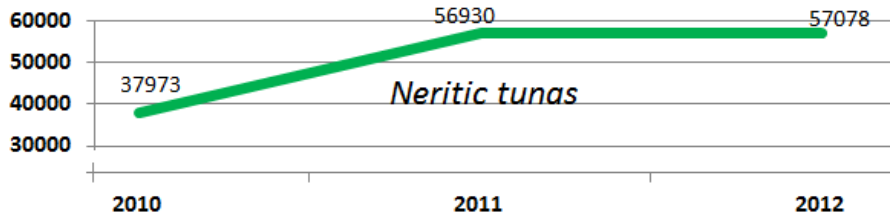
## ABSTRACT

Neritic tuna fishery in 20012 was supported by five species namely; Kawakawa (*Euthynnus affinis*), frigate tuna (*Auxis thazard*), bullet tunas (*Auxis rochei*), longtail tuna (*Thunnus tonggol*) and bonito (*Sarda orientalis*t). Their catch was 57,078 t and constitute 70.3 % of the total tuna catch of the country. Landings during 2008-'12 varied between 37,785 t (2010) and 57,078 t (2012) with an average of 48,172 t. Neritic tunas mainly form non-targeted catch in most gears along the area. Despite their distribution and abundance along entire coast, fishery is mainly centered around south and nortthwest coasts where traditionally high fishing activities are in vogue. The extent of neritic tuna fishing varies depending on prevailing fishing practices of the area and local demand for tuna. Evaluation of spatio-temporal distribution pattern, abundance and fishery suggested that resource are being under-utilized from large areas of the Indian mainland coast and Island territories. The fishery biological observations and stock assessment of component species also indicates that stock in general is healthy with sufficient spawning stock biomass to sustain the stock and yield.

## Introduction

The coast based fishery along the Indian coast witnessed considerable changes over the years. However, the neritic tuna remain as an incidental bye-catch in other fisheries targeting seerfishes and like fishes. The resources and fishery was supported by five species; Kawakawa (*Euthynnus affinis*), frigate tuna (*Auxis thazard*), bullet tunas (*Auxis rochei*), longtail tuna (*Thunnus tonggol*) and bonito (*Sarda orientalis*t). Their landing is maintaining an uptrend in production since 1985 with wide annual fluctuations and contribute 1.5-2.0 % of the total marine fish production of the country.




Neritic tuna production trend from Indian waters

**Fishery**

Neritic tunas were exploited by traditional, motorized and mechanized fleets. These vessels generally operate multiple gears- gillnets, hooks and line (handlines, longlines, pole and lines etc.), purse-seine, ring seine and trawl along shelf waters. Annual production for the year 2012 was 57,078 t and represent 69.6% of total tuna production (81,751 t). Kawakawa was the most dominant (57.6%) in the neritic tuna catch followed by longtail (25.1%) and frigate tuna (15.0%). They were landed round the year with peaks during February and July-September. Gillnets landed 49% of the resource catch followed by puse-seines and ring-seines 22.8, hooks and line (11.2%) and the rest by trawls and other gears.

| Species | 2008 | 2009 | 2010 | 2011 | 2012 | Mean |
|---|---|---|---|---|---|---|
| *E. affinis* | 32,406 | 28,563 | 21,271 | 32,937 | 32,772 | 29,590 |
| *A.thazard* | 8,341 | 7,661 | 6,688 | 10,173 | 8,534 | 8,279 |
| *A.rochei* | 613 | 1,119 | 4,502 | 2,321 | 1,213 | 1,954 |
| *T. tonggol* | 5,939 | 3,808 | 5,323 | 11,116 | 14,285 | 8,094 |
| *S.orientalis* | 70 | 361 | 189 | 383 | 274 | 255 |
| Total | 47,369 | 41,512 | 37,973 | 56,930 | 57,078 | 48,172 |

Species by landings of neritic tunas

Major share of the catch was landed along the northwest coast (36.9%), followed by southwest (33.6%) and southeast (20.4 %) coast. West coast contributed 70.5 % to the neritic tuna production. Fishing activity along this region was relatively high. Catch from northeast coast was very low.

**Long tail tuna**

They are the second dominant species in the landing after kawakawa. Their fishery restricted to west coast and Andaman waters with major abundance and fishery (96%) from northwest coast. Fishery is maintaining a steady uptrend with annual production of 14,285 t. They support round the year fishery with peak landings during September-February.

Major share of the catch was landed by gillnets (77.7%), followed by hooks and lines (13.2 %). Trawls and purse-seines also land this species in small quantities.

**Frigate tuna**

Annual landings declined during the year to 8,534 t from 10,173 t (2011) and formed 15.0 % of the neritic tuna catch. Major share (79.5%) of their catch was from southern coasts. They are caught by hooks & lines and gillnets which respectively contributed 45.9 and 35.4% to the catch. Other gears landing the species are ring seines, trawl and purseseines. Fishery occurred round the year with peak during April - May and September - December.

**Biology of Species**

**Longtail tuna**

*Length distribution in the catch*

Catch was supported by 28-106 cm fishes with 68.7 cm as mean. Major share (74.5%), was constituted by 50-86 cm size groups.

*Length-weight relationship*: Length weight relationship for the unsexed population was estimated and can be expressed using the relationship, $W = 0.0148 * L^{3.0}$ This indicated that the species follow a perfect isometric pattern in growth.

*Age, growth and longevity*

The growth parameters; asymptotic length ($L\infty$), growth constant (K) and age at zero length ($t_o$) were estimated respectively as 120.5 cm, 0.513/year and -0.0319 years by modal length progression of cohorts over time. Growth was described by the von Bertalanffy

model and it shows that the species grow relatively fast in length. They attain 29.4, 50.6, 79.7, 97.2, and 107.7 cm by the end of 0.5, 1, 2, 3 and 4 years. However, growth in weight is slow compared to other species of the genera.

The age length data shows that minimum age of the fish in the catch is 5.8 months and maximum 49.1 months (4.1 years). Major share of the catch was supported by 1 to 2.4 year old fishes with 1.6 year as mean age.

*Food and feeding*

The species is non-selective opportunistic feeder, feeds on teleost fishes (82%), crustaceans (4.6 %) and molluscs (13.4%). Sardines (*Sardinella* sp.), anchovies (*Thryssa* sp.), scads (*Decapterus* sp. and *Selar* sp.), ribbonfishes (*Trichiurus* sp.), flying fish, hemiramphids, small tuna (*Auxis rochei*), threadfin breams and small perches (*Lethrinus* sp) dominate the fish components in the diet. Crustaceans in the food are penaeid prawns, *Acetes* sp., pelagic crabs and stomatopods. Squid, octopus and gastropods represented the molluscan component.

*Sexual maturity and spawning*

Males and females represented almost equally in the population and exhibit no sexual dimorphism in growth and maturity. Gonads at all stages of development were observed throughout the year. As evidenced by the presence of fishes with matured and spent gonads in the catch, they mature and spawn round the year with two peaks in spawning; during August-December and April-May. Fishes with gravid gonads were observed only less frequently in the catch, indicating probable migration of fishes with the attainment of gonadal maturity.

Full sexual maturity and spawning was observed from 48 cm onwards. Estimate of size at maturity by logistic curve is 51.8 cm. Age of the fish at this size was 12.8 months. Two to three distinct batches of eggs were observed in the matured ovary indicating batch spawning in the species.

*Fecundity*

Fecundity estimate varied between 227,364 and 1092,891 eggs per fishes measuring 53.7 and 79.4 cm. The relative fecundity found to increase with the size of the fish and it varied between 103,347 and 147,688 respectively in the smallest and largest fish studied with a mean of 132,840.

*Optimum size for exploitation and size at capture*

Based on the size at maturity, the optimum size (Lopt) and age for exploitation was estimated respectively as 56.2 cm and 1.2 years. This size enable nearly 80% of the recruit a chance to mature and spawn before being caught. The length at which 50% of the stock ($L_c$), became susceptible to gillnet fishery was estimated was 51.24 cm and 1.05 years.

*Recruitment pattern*

Recruitment is bimodal with young ones being recruited into the fishery throughout the year with a major pulse in recruitment during May-June and a minor in August-September. The size of the species at recruitment is 28 cm during May-June and 23 cm during August September. The growth rate of the species shows that May–June recruit derived from the post monsoon spawning and the August recruits from pre-monsoon months.

*Mortality and Exploitation*

Estimates of natural mortality was 0.97 $y^{-1}$ and fishing mortality 2.37. Fishing mortality was large due to thd presence of large proportions of smaller fishes in the catch. Exploitation rate was also large 0.707 compared to $E_{max}$ (0.485), which will provide maximum yield for species.

***Stock Assessment***

Estimates of standing and spawning stock biomass from the exploited grounds shows the availability of large proportion of spawning stock biomass, to the order of 65.4% in the EEZ, which is sufficient to ensure successful reproduction and recruitment into population.

**Frigate tuna**

*Length composition*

Landings was supported by 18 to 56 cm fishes dominated by 25–40cm size groups. Mean size in the catch was 34.7 cm. The estimated length-weight relationship was log W = -2.082723 + 3.081 log L (n = 884, $r^2$= 0.92) indicating near isometric growth pattern.

*Food and feeding*

They are opportunistic carnivore, feeding on crustaceans, cephalopods and finfishes. Crustaceans were dominated by the non-penaeid prawns, *Acetes* spp. and crabs and cephalopods by squid, *Loligo duvaucelli*. Finfish component in the diet were sardines, anchovies, mackerels, scads and tuna juveniles.

*Growth*

Growth parameters, Lα and K was 57.95 cm and 1.2 year-$^{1}$ and the asymptotic weight (Wα) was 3205 g. Their size at first capture (Lc) was 32.83 cm at an age ($t_c$) of 0.69 year. Growth performance index was 3.605 and $t_0$ at -0.0075 years. The von Bertalanffy growth equation was: $Lt = 57.95 [1 - e^{- 1.2 (t + 0.0075)}]$. They grow to 40.75 cm and 52.77 cm, at the end of 1$^{st}$ year and 2$^{nd}$ year respectively. Their longevity was 2.49 years.

*Reproductive Biology*

They attain sexual maturity at 29.7 cm fork length at the age of 7 months. Gravid, ripe and spent females were recorded throughout the year with peak occurrence during February and July-October, suggesting prolonged spawning season. Mature females accounted for 37.2% of the catch, followed by spent ones (23.7%). Their relative fecundity ranged between 6,97,531 to 11,63,438 eggs/kg body weight with an average of 8,07,986. Fecundity generally increased with the weight and size of the fish.

*Recruitment pattern*

The species exhibited a 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. The minor peak was in June and this pulse produced 11.2 % of the recruits. The smallest length of recruitment was 18 cm.

*Mortality, exploitation and VPA*

The mortality rates M, F and Z were 1.65, 3.24 and 4.89, respectively. Present exploitation rate was 0.658, exploitation ratio 0.66 and the $E_{max}$ 0.778. The large value of $E_{max}$ over the present exploitation, indicates that the stock remain under-exploited and offer scope for increasing their production.

VPA indicated that main loss from the stock up to 21 cm was due to natural causes. Fishes became more vulnerable to fishing 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 48.9 cm.

*Yield/recruit*

The maximum yield and yield/recruit could be obtained by increasing the present level of fishing by 100 %. The maximum yield and yield per recruit obtained by doubling the present fishing effort is 11,484 t and 342.1 g, whereas at the present level of fishing, it is 8,279 t and 332.3 g. The increase in relative yield at the increased effort would be 38.7%.

*Stock and MSY*

The estimates of their annual total stock, biomass and MSY in the present fishing grounds were 16,966 t, 3,444 t and 13,100 t, respectively. The spawning stock biomass (SSB) at the present level of fishing is 48.7 % indicating the existence of an healthy stock for the species

**Summary**

Indian EEZ is very extensive and is characterised by high productivity and species richness. The distribution pattern, indicate presence of neritic tunas all along coastal waters of the Indian coast. The diet of oceanic tunas and other species further indicated the availability of many neritic species in appreciable numbers in deeper waters, especially around Island systems, seamounts, ridges and knolls. Evaluation of fishery scenario and spatial production pattern indicate that fishery in general is

restricted to coastal waters of selected areas, where naturally high fishing activities are in vogue. The fishery biological observations and stock assessment of component species indicate that stock in general is healthy with sufficient spawning stock biomass to support successful recruitment. It further indicates that component species as a whole are exploited below the optimum levels offering some scope for further improving their production from the present fishing grounds. Also there is scope for increasing production from the coastal waters of presently less exploited areas and deeper waters. Their abundance and potential from such areas needed to be assessed for expanding their fishery and production.

The distribution pattern of component species indicate their abundance all along the Indian coast. This offers scope for improving their production from presently less exploited areas of the coast.