Management of Scombroid Fisheries

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Stock assessment of coastal tunas in the Indian seas

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ABSTRACT

Tuna and billfish production from the Indian coastal waters, Lakshadweep and Andaman and Nicobar islands during the period 1985-'99 averaged 40,204 t. The contribution by *E.affinis*, *A.thazard*, *T.tonggol*, *K.pelamis* and *T.albacares* (young ones) were 18,504 t, 6,852 t, 3,093 t, 3,392 t and 2,211 t respectively. Drift gill net was the major gear employed in the coastal tuna fishery. The length frequency data collected on the above species during 1990-'98 at seven centres along the Indian coast were analysed employing FiSAT programme to estimate their growth and mortality parameters, exploitation rates and relative yield per recruit. In the present study, the growth parameters L_∞ and K, length at first capture (L_c), and mortality rates are given. Along the coastal waters of India the exploitation rate (E) of *E.affinis* varied in different states, being 0.86 along Kerala-Karnataka belt, 0.77 in Gujarat and 0.75 in Tamilnadu. Based on Y/R the optimum exploitation rate (E_{opt}) of *E.affinis* is 0.4 only indicating that the current exploitation level of this species in coastal waters is relatively high. The exploitation rates of *A.thazard*, *T.tonggol* and *T.albacares* were 0.72, 0.3 and 0.81 respectively with (E_{opt}) being 0.40, 0.42 and 0.37 respectively for these three species, indicating that there is further scope for increasing the exploitation of *T.tonggol* in the coastal waters while others are being exploited relatively at a high rate in recent years.

INTRODUCTION

Tunas constitute one of the economically important marine fisheries resources and during 1985-'99, their production from Indian seas fluctuated between 24,287 t (1987) and 53,662 t (1992) with an average annual production of about 40,200 t forming 3.6 % of the total pelagic fish production. The status of exploitation of coastal tunas occurring in the Indian seas in recent years has been dealt with elsewhere (Pillai *et al.*, 2000). The stock assessment of tunas occurring in the Exclusive Economic Zone (EEZ) of India has been attempted earlier (Silas and Pillai, 1985; James *et al.*, 1993; Yohannan *et al.*, 1993 and Pillai *et al.*, 1993). After the published studies based on data during the period 1984-'88, considerable changes in the trend of production were recorded since 1989, making it imperative to carry out a re-examination of the population parameters, status of exploitation and stock assessment of tunas from the Indian seas.

MATERIALS AND METHODS

The statewise and all India tuna landings data for the period 1989-

'98 were taken from NMLRDC of CMFRI. Length frequency data collected from six major fish landing centres along the west and east coasts of India during the above period formed the basis of the estimates. Data collected from Veraval has been raised to the average annual catch of Gujarat and from Mangalore and Malpe to Karnataka state. Data collected from Kochi, Calicut and Vizhinjam were pooled and raised to the average annual catch of Kerala and from Tuticorin raised to the catch of Tamilnadu . Growth parameters were estimated based on the pooled data for the states of Kerala, Karnataka and Goa (west coast) and Tamilnadu (east coast). Length converted catch curve method (Pauly, 1984) was used to obtain estimates of total mortality(Z) while the natural mortality (M) was estimated using Pauly's (1980) method, the average water temperature being taken as 28.5°C. The exploitation ratio (U) was estimated using the equation $U= F(1-e^{-z})/Z$. The annual total stock was estimated by the equation Y/U where Y is the average annual catch of the particular species. Relative yield per recruit (Y/R) was estimated as given in ELEFAN module of FiSAT which indicated the maximum exploitation rate (E_{max}) and optimum exploitation rate (E_{opt}).

RESULTS

The growth parameters L_∞ and K (annual) of different species estimated by ELEFAN (Table 1) and mortality rates obtained by the catch curve analysis (Figs. 1, 2, 3, 4) were as follows :

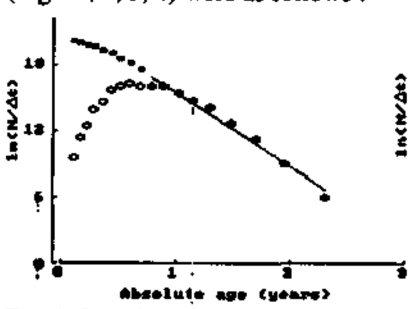

Fig. 1. Length converted Catch Curve analysis of *E. affinis*. (Input parameters L_∞ 89.0 cm K=0.9yr $^{-1}$) Z=5.85 E=0.8

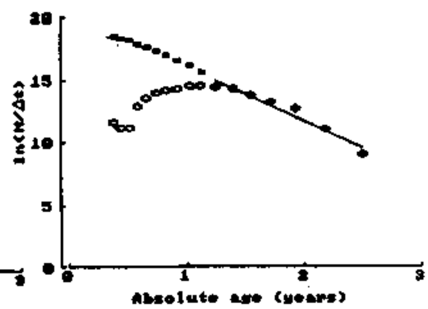

Fig. 2. Length converted Catch Curve analysis of *A. thazard*. (Input parameters L_∞ 54cm K=0.87yr $^{-1}$) Z=4.4 E=0.70

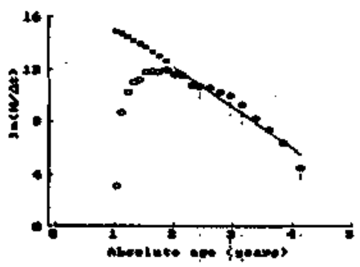

Fig. 3. Length converted Catch Curve analysis of *T. albacares*. (Input parameters L_∞ 172 cm K=0.39yr $^{-1}$) Z=3.10 E=0.81

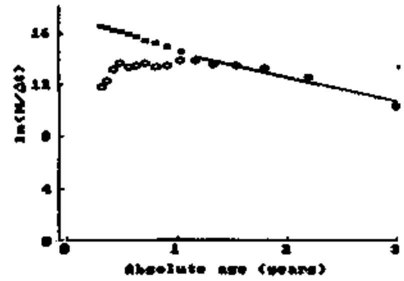

Fig. 4. Length converted Catch Curve analysis of *T. tonggol*. (Input parameters L_∞ 92.5 cm K=1.2yr $^{-1}$) Z=1.86 E=0.40

Table1. Estimated growth parameters and mortality rates

Species	L_∞(cm)	K(annual)	Z	F	M	U	L_c(cm)
E.affinis	89.0	0.90	5.85	4.90	0.98	0.8	44
A.thazard	54.0	0.87	4.40	3.20	1.20	0.7	35
T.albacares	172.0	0.39	3.1	2.5	0.6	0.8	104
T.tonggol	92.5	1.2	1.86	0.7	1.2	0.3	681

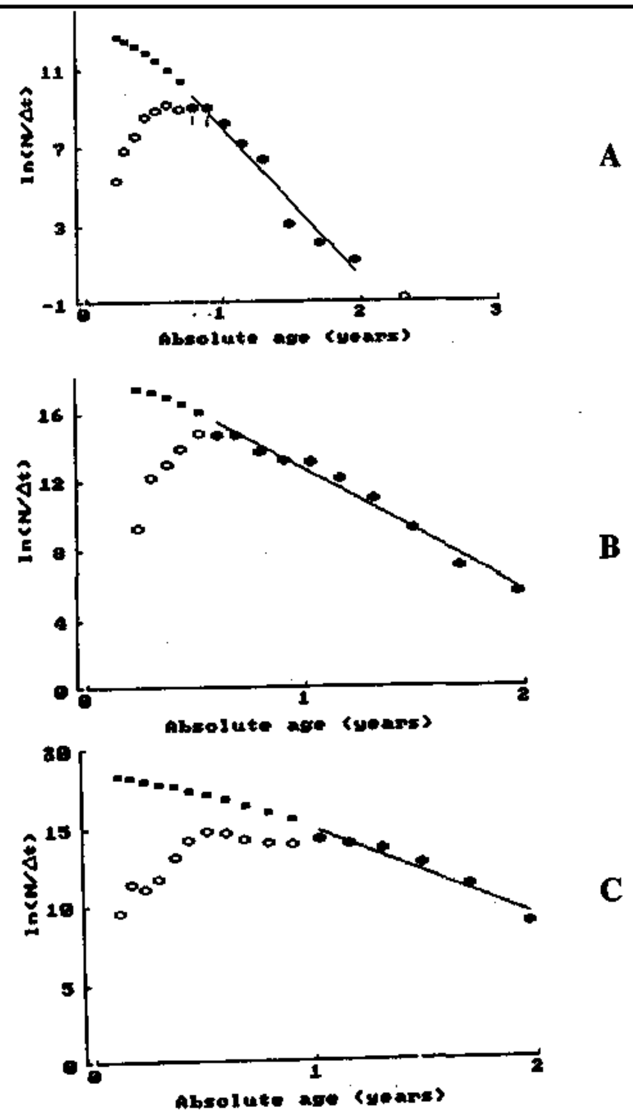

Fig. 5. State-wise Catch Curve analysis of *E.affinis* fishery
(A) Kerala E=0.86; (B) Karnataka E=0.86 (C) Gujarat E=0.77

Based on the growth parameters the lengths at age for different species have been esimated as follows:

Species	L_∞ (cm)	K(annual)	Length (cm) at age (years) I	II	III	IV
E.affinis	89.0	0.90	52.8	74.3	83.0	86.6
A.thazard	54.0	0.87	31.4	44.5	50.0	52.3
T.albacares	172.0	0.39	55.5	93.2	118.6	135.9
T.tonggol	92.5	1.20	64.6	84.1	89.9	91.7

Parameters such as E_{opt} E_{max} and Exploitation ratio (U) were studied for assessing the status of exploitation of different species of tunas which are given below:

Species	E_{opt}	E_{max}	present E	Av.annual total stock (t) (at start of year) (Y/U)
E.affinis	0.35	0.7	0.80	23,130
A.thazard	0.42	0.9	0.70	9,788
T.albacares	0.40	0.7	0.81	2,764
T.tonggol	0.40	0.9	0.40	10,310

The coastal tunny *E.affinis* is the most intensively exploited coastal tuna species followed by *A.thazard* .The exploitation of *E.affinis* is relatively high in the south-west coast comprising the states of Kerala and Karnataka (E=0.86) compared to Gujarat in the north-west (E= 0.77) and Tamilnadu (E=0.75) on the south-east coasts (Fig. 5).

DISCUSSION

The morphological and reproductive characteristics, population sizes and genetic frequencies of species are adjusted to their environments by natural selection and species inhabiting different environments show different patterns of life history characteristics (Adams, 1980). The relationship between habitat, ecological strategies and population parameters has been termed as r and K selection (Macarthur and Wilson, 1967) with a K strategist species having a large L_∞ and low K from the von Bertalanffy growth equation, large body size and delayed maturity and an r selected species having small L_∞ and high K values, small body size and early maturity (Adams, 1980). While no species are r or K selected in an absolute sense, fisheries based on more r selected species are likely to be of a boom and bust nature but those based on more K selected species will be characterised by relatively stable population sizes and catch levels. However, once these fisheries are overfished it would take a long time for stocks to rebuild (Adams, 1980). The K value of the various tuna species vary between 0.4 and 1.2 indicating a relatively slow growth pattern and the need to evolve appropriate exploitation strategies.

James *et al.* (1993) estimated the length at first maturity (L_m) of *E.affinis* , *A.thazard* and *A.rochei* at 44, 32 and 23 cm respectively. In the present study the length at first capture (L_c) of the various species studied like of *E.affinis* , *A.thazard, T.albacares* and *T.tonggol* were 44, 35, 92 and 68 cm respectively which indicates that except perhaps for *E.affinis* all other species have an opportunity to spawn at least once before they are captured, reducing the risk of recruitment and growth overfishing to occur.

FAO (1993) while discussing the reference points (RP) used in fishery mangement, like maximum sustainable yield (MSY), reports that they are mostly useful for assessment of single stocks and less applicable to highly migratory resources such as tunas.This is because often, multiple fisheries occur at different locii on the overall migratory routes of tunas and these local fisheries are seasonal and very short. Therefore declines in catch rate with time and size cannot be unambiguously attributed to fishing as opposed to migration. Yohannan *et al.* (1993) also observed that environmental conditions and forage availability are key factors in deciding the availability and abundance of tunas. As regards the tuna fishery in Indian waters, non availability of catch- effort and length frequency data from the whole range of distribution of a particular species of tuna mainly because this fishery is limited to the small scale sector and there is seasonality in the availability of various species, pose difficulties in arriving at conclusions regarding the growth and mortality estimates and stock structure. Therefore a practical approach would be to consider each fishing location to be assessed as favouable or unfavourable in relation to a size based RP and the optimal size at first capture (L_c) as judged from the yield per recruit analysis which will ensure that a certain spawning biomass survives to replenish the fished stock. Also it is desirable that while estimating the exploitation rate and optimum yield of tunas, both commercial fishery and exploratory survey data are considered to arrive at meaningful conclusions.

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