RESEARCH ARTICLE

Studies on Population Characteristics of Frigate tuna, *Auxis thazard* (Lacepede,1800) Occurring in the North West Coast of India

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ABSTRACT- This study is an attempt to understand the population characteristics such as Length-weight relationships, age, growth, mortality, length at age and exploitation rate of Frigate tuna, *Auxis thazard* occurring in the North west coast of India. The data collected from various fish landing centers from 2008 to 2012 were considered for this study. The mean fork length and weight 32.35 cm and 1.040 kg were observed respectively. The length-weight relationship $W=2.4321x10^{-1}$ FL 2.27658, and r^2 0.9576 was obtained. The value of 'b' found to be less than 3 and hence this species was shown negative allometric growth. The growth parameters on von Bertalanffy for $L\infty$ estimated as 47.03, K was 1.30 and t_o was -0.23. The Phi-prime value (Φ) of 3.33 was derived. The length at age observed at the end of 1 to 4 years was 27.0, 42.0, 50.0 and 55.0 cm $year^{-1}$ respectively. The natural mortality (M) 1.00 $year^{-1}$, total mortality (Z) of 4.43 $year^{-1}$ and fishing mortality (F) 3.43 $year^{-1}$ were derived with the mean temperature of 27°C. The exploitation ratio (E) and exploitation rate (U) was 0.77. The results derived in the present study with regard to population characteristics of frigate tuna in the coastal waters of North west coast of India indicate catching of this species in the area to be minimized

Key-words- Exploitation ratio, Exploitation rate, Length-weight relationships, Length at age, Mortality

INTRODUCTION

Among the neritic tunas occurring in the Indian waters, under the genus *Auxis*, two species *viz.*, *Auxis thazard* and *Auxis rochei* are contributing to the marine fish landings to the tune of 13,418 tonnes during 2016 [1]. An increase of 64% of these species landings has been observed when compared to 2015 (8,176 t). Determinations of population characteristics are vital for understanding changing trends in the marine fish production and also to evaluate the level of exploitation. The effective fisheries management depends on the fish catch data, biological information and population characteristics etc. As per the literature, the developed countries in the world observed to conduct regular stock assessments for the major commercial fisheries, thereby, the resources are better managed. Commendable works on this species have been attempted by various researchers from the Philippines waters, Indonesia, Taiwan, Sri Lanka, and Thailand.

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The works of Ingles and Pauly [2] on the growth, mortality and recruitment of Philippines fishes, Yesaki [3-4] on biological and environmental observations from the West Coast of Thailand and age and growth of Kawa kawa, longtail tuna, and frigate tuna from the gulf of Thailand, Dwinpongo *et al.* [5] on the growth, mortality and recruitment of commercially important fishes in Indonesian waters, Lu *et al.* [6] on the growth and mortality of *A. thazard* in the Taiwan Strait and its adjacent seas, Yesaki and Arce [7] on review on the Auxis fisheries in Philippines and some aspects of biology of frigate and bullet tuna in the Indo-Pacific region, Tao *et al.* [8] on the age and growth changes and population dynamics of black pomfret and frigate tuna from the Taiwan strait, Geehan and Pierre [9] reviewed the statistical data of neritic tunas, Hartaty & Setyadji [10] on the population parameter of frigate tuna in the Sibolga and adjacent waters worth to be mentioned. From the Indian waters, these studies are very limited and the works carried out are pertaining to either entire coast of India or limited to a coast of the coastal district of maritime states of India and recent investigations are meagre rather scanty. Mentioned may be made of the works carried out from Indian waters by Pillai and Ganga [11] on the fishery and biology of tunas in the Indian seas, Silas *et al.* [12] on the population dynamics of tunas and stock assessment, Siraimeetan [13] on the fishery and

bionomics of tunas from Tuticorin coast, Joseph *et al.* [14] on the fishery, age & growth of kawa kawa and frigate tuna, Kasim [15] on fishery growth, mortality rate and stock assessment of *A. thazard* along Tuticorin coast of Gulf of Mannar, Jude *et al.* [16] on the gillnet selectivity studies for fishing frigate tuna in Tuticorin waters of south east coast of India, Kasim and Abdussamad [17] stock assessment of coastal tunas along the east coast of India, Abdussamad *et al.* [18] on Fishery and population characteristics of coastal tunas at Tuticorin, Ghosh *et al.* [19] on the fishery, population characteristics and yield estimates of coastal tunas from Veraval coast, Ghosh and Shivadas [20] on the fishery, population dynamics and stock structure of frigate tunas exploited from Indian waters, Abdussamad *et al.* [21] on the neritic tuna fishery along the Indian coast, biology and population characteristics of longtail and frigate tuna. Monitoring of changes in the population characteristics is very much essential as the present scenario of the harvested fishery is showing fluctuating trends. Therefore, regular studies are required to be carried out and hence this study is an attempt to derive the population parameters of *Auxis thazard* so as to understand whether this fishery is overexploited or at the risk of overfishing.

MATERIALS AND METHODS

The fish samples of *A. thazard* were collected from the commercial fish landings at Porbandar in the state of Gujarat, Sassoon Dock and New Ferry Wharf, Mumbai in the state of Maharashtra, India during 2008–12 (Fig. 1). A total of 924 specimens with a size ranging between 16 to 50 cm and weight between 0.200–1.880 kg were considered for this study. The equation $W=aL^b$ was applied to calculate the statistical relationship between length and weight. In order to understand the degree of association of two variables, the correlation coefficient was derived from length and weight data. The popular technique of computer analysis of monthly length-frequency distributions, FiSAT-II programme developed by Gayanilo *et al.* [22] was used for estimation of growth parameters.

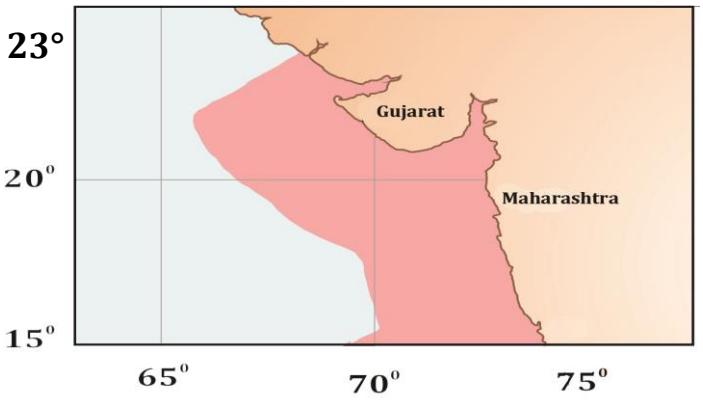

Fig. 1: Study area: North west coast of India

The total mortality (Z) was derived using Beverton and Holt model [23]. The natural mortality (M) was calculated using regression analysis developed by Pauly [24] with the average sea surface temperature 27°C. On estimating the mortality parameters, the exploitation ratio (E=F/Z) and exploitation rate ($U=F/Z*(1-e^{-Z})$) were calculated. After deriving the growth parameters, in order to understand the reliability index, these parameters are evaluated using Phi Prime Test (Φ) developed by Munro & Pauly [25] and Pauly & Munro [26] using the equation $\ln K + 2*\ln L\infty$.

RESULTS

Length weight relationship- Length weight relationship calculated for *A. thazard* was $W=2.4321x10^{-1} FL^{2.27658}$ wherein, the value of 'b' is less than 3 indicating negative allometric growth. The reason for less 'b' value might be due to an absence of juveniles. The coefficient of determination 'r^2' value was 0.96 indicating a high degree of correlation and better fit of length-weight relationship (Fig. 2).

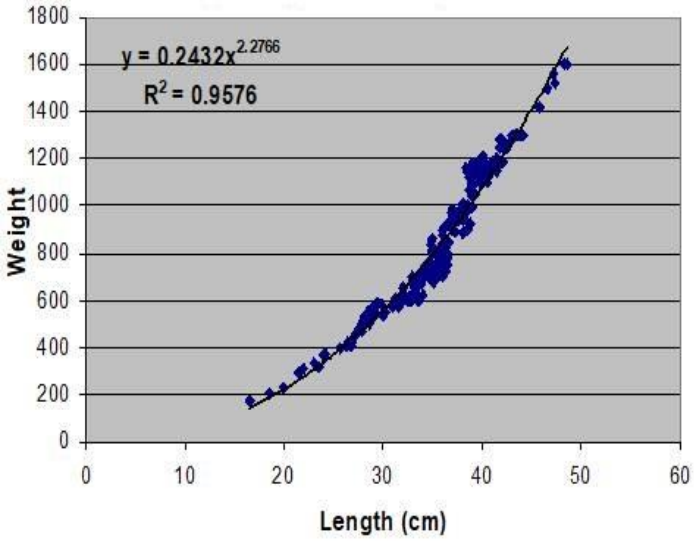

Fig. 2: Length-weight relationship for *A. thazard*

Growth parameters- The values of growth parameters derived were 47.38 cm, 1.35 and -0.23 for L∞, K, and t_o respectively. The length at an age at the end of 1–4 years was 26.5, 41.7, 50, and 55 cm per year respectively (Fig. 3). The growth performance index based on Phi prime test (Φ) was observed as 3.48. The value of Phi prime was not showed any significant difference.

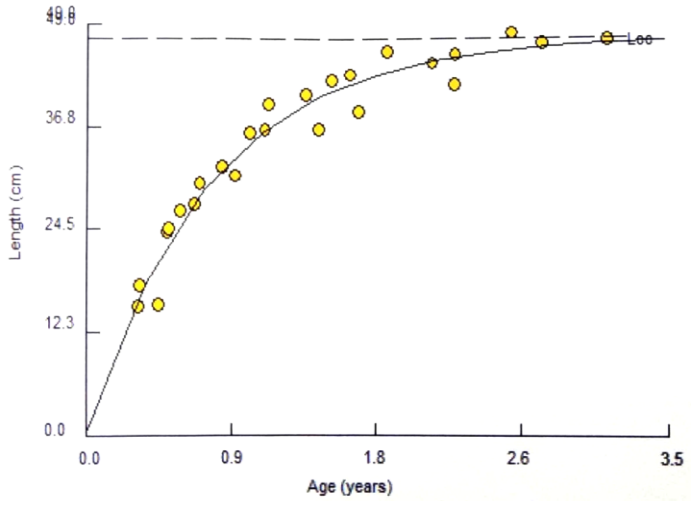

Fig. 3: Length at age for *Auxis thazard*

Mortality, exploitation rate and exploitation ratio- The total mortality (Z) calculated as 4.43 year^{-1} while the natural mortality was 1.00 year^{-1}. The fishing mortality (F) obtained was 3.43. The exploitation ratio (E) and exploitation rate (U) were estimated as 0.77 year^{1}, which was relatively high, indicating the sign of overexploitation. This species assessment status indicated that, the fishing mortality obtained in the study was 3.43 y^{-1} which is far higher than the targeted optimum fishing mortality (F_{opt}) of 0.42 y^{-1} and limit of fishing mortality (F_{limit}=0.58 y^{-1}) in terms of the biological reference point, thereby, overexploitation of this species in this region is indicated.

The estimates of growth and mortality parameters derived in the present study are showing variations in L∞ and K values with earlier estimates. The range of L∞ is between 47.38 (present study) to 58.00 (Pillai and Ganga, 1985) and the range of K value is from 0.51 (Lu *et al.*, 1991) to 1.35 (present study). These variations in population parameters might be the difference in the selection of samples and method of sampling application of different methodologies/ techniques. A comparative estimate of growth parameters, mortality rates and the exploitation ratio of frigate tuna from earlier studies are presented in Table 1.

Table 1: Comparative estimates of growth parameters, mortality rates and exploitation ratio of frigate tunas (*Auxis thazard*)

L∞ (cm)	K	t_0	M	Z	F	U	Length (cm), Age (years)				References
							I	II	III	IV	
54.50	1.02	-0.0118	1.53	8.83	7.30	0.80	31.4	44.5	50.0	52.3	Pillai and Ganga [11]
58.00	0.73	-0.0235	1.22	4.95	3.73	0.70	-	-	-	-	Pillai and Ganga [11]
53.75	0.98	-0.0132	1.52	5.43	3.91	0.70	-	-	-	-	Pillai and Ganga[11]
56.50	0.95	-0.0138	1.47	1.58	0.11	0.06	-	-	-	-	Pillai and Ganga[11]
48.44	0.51	-0.3598	0.90	1.14	0.23	0.10	-	-	-	-	Lu *et al.* [6]
52.90	0.82	-	-	-	-	-	29.0	42.0	48.0	-	Abdussamad *et al.* [18]
46.60	0.93	-0.0153	1.48	5.97	4.49	0.75	28.5	39.5	43.8	-	Ghosh *et al.* [19]
57.95	1.20	-0.0075	1.65	3.24	4.89	0.66	40.7	52.7	-	-	Ghosh *et al.* [20]
48.18	0.52	-0.3319	0.91	1.31	0.40	0.20	-	-	-	-	Tao *et al.* [8]
47.38	1.35	-0.2304	1.00	4.43	3.43	0.77	27.0	42.0	50.0	55.0	Present Study

DISCUSSION

In the length-weight relationship, the 'b' value obtained in the present study was less than 3 indicating negative allometric growth. This might be due to the absence of younger/ juvenile specimens. The K value obtained was 1.35 year^{-1} and this value is nearer to the value of 1.20 year^{-1} found by Ghosh *et al.* [20]. The length at age value at the end of 1-4 years derived as 27.0, 42.0, 50.0, and 55.0 cm year^{-1} respectively were comparable to the values calculated by Abdussamad *et al.* [18]. Growth performance index (Φ) derived using the parameters of L∞ and K value was 3.48, which is in confirmation with the value (3.31) obtained by Ghosh *et al.* [19]. The natural mortality (M) was 1.00 year^{-1}, total mortality (Z) was 4.43 year^{-1} and fishing mortality (F) was 3.43 year^{-1} derived, which were near to the values obtained by Lu *et al.* [16] and Pillai and Ganga [11].

From the past five years, the catch trends of *Auxis* sp. in the Indian waters have been showing fluctuations. *Auxis thazard* fishery was found to be the underexploited resource [18] during 2005, whereas, in 2010, it showed signs of over-exploitation, where the exploitation ratio was 0.75 year^{-1} obtained. In the present study the exploitation ratio of 0.77 year^{-1} was derived, thus showing signs of overexploitation which is in agreement with the studies of Ghosh *et al.* [19]. Therefore, this study was an attempted to monitor the population parameters in order to understand the status of exploitation of *A. thazard* in North-West coast of India.

CONCLUSIONS

Management of fisheries is a major concern for sustainable exploitation with due to consideration of

ecosystem and conservation of biodiversity. In order to meet the management strategies, assessment of fish stocks and population parameters are crucial. *A. thazard* has shown negative allometric growth and the exploitation ratio indicated signs of overexploitation. The fishing mortality (F) appears to be high therefore, this fishery needed proper management advisories. The result of this study, provided information on the changes in the population parameters thereby, useful in sustainable exploitation of this resource duly considering conservation and management issues in the North west coast of India.

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