



International Journal of Fisheries and Aquatic Studies

E-ISSN: 2347-5129

P-ISSN: 2394-0506

(ICV-Poland) Impact Value: 5.62

(GIF) Impact Factor: 0.549

IJFAS 2019; 7(2): 129-133

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www.fisheriesjournal.com

Received: 26-01-2019

Accepted: 27-02-2019

Deishini Herath

a) Marine Biological Resources

Division, National Aquatic

Resources Research and

Development Agency, Colombo

15, Sri Lanka;

b) Department of Chemistry,

Faculty of Science, University of

Colombo, Colombo 3, Sri Lanka

Chintha Perera

Marine Biological Resources

Division, National Aquatic

Resources Research and

Development Agency, Colombo

15, Sri Lanka

Chamari Hettiarachchi

Department of Chemistry,

Faculty of Science, University of

Colombo, Cumaratunga

Munidasa Mawatha, Colombo 3,

Sri Lanka

Brian Murphy

Department of Fish & Wildlife

Conservation Virginia Tech

Blacksburg, VA 24061, USA

Length-weight and length-length relationships of three neritic tuna species of Sri Lankan coastal waters

Deishini Herath, Chintha Perera, Chamari Hettiarachchi and Brian Murphy

Abstract

The length-weight and length-length relationships were determined for the three neritic tuna species *Euthynnus affinis*, *Auxis thazard* and *Auxis rochei* caught within Sri Lankan waters. Samples were collected from October 2015 to September 2017. The R^2 values for all three species were higher than 0.9 and were highly significant ($p < 0.001$). The condition factor K , was 1.427, 1.476 and 1.361 for *E. affinis*, *A. thazard* and *A. rochei* respectively. The value of b in the length weight equation was shown to be 3.115, 3.431 and 3.408 for the three species indicating positive allometric growth patterns. Furthermore, the b values for the provinces studied were above 3.0 for all three species. The correlations between the total length, fork length and standard length, were also highly significant ($p < 0.001$). The results indicate that these three species are living in a favourable environment having a healthy growth pattern along the coastal regions of Sri Lanka.

Keywords: *Euthynnus affinis*, *Auxis thazard*, *Auxis rochei*, length-weight, length-length

1. Introduction

The length-weight relationships (LWR), length-length relationships (LLR) and Fulton's condition factor values are very useful in the management and conservation of fish resources [1]. These LWRs are useful in stock assessment models, in the estimation of biomass from length measurements, and for the comparison of the condition of fish between regions [2]. The LWRs are also important in comparing life histories of fish species [3]. The Fulton's condition factor can indicate the wellbeing of the fish, assuming that plumper fish are in a better condition [4]. LWRs have been reported for a large number of marine fish species [5, 6, 7], freshwater fish species [8, 9] and fish species in lagoons [10, 11]. These relationships have been studied in several countries surrounding the Indian Ocean, such as India [12, 13, 14], Pakistan [15] and Bangladesh [16, 17]. LWRs and LLRs have been studied in the past for tuna species other than neritic tunas in countries such as India [18] and Taiwan [19]. These relationships have been reported for skipjack tuna (*Katsuwonus pelamis*) of the South Atlantic [20], for bigeye tuna (*Thunnus obesus*), yellow fin tuna (*T. albacores*) and albacore (*T. alalunga*) of the Atlantic, Indian and Eastern Pacific Oceans [21] and for bluefin tuna (*T. thynnus*) in the Eastern Mediterranean sea [22]. LWRs, length-length relationships and condition factors have not yet been defined for many of the commercially important marine fish species found in Sri Lankan waters.

Euthynnus affinis (kawakawa), *Auxis thazard* (frigate tuna) and *A. rochei* (bullet tuna) are neritic tuna species found in the warm waters of the Indo-West Pacific [23]. They are an important group of fish species found in the coastal as well as the offshore fishery of Sri Lanka. *E. affinis* grows to a maximum fork length of 100 cm [24], while *A. thazard* and *A. rochei* grow to maximum fork lengths of 65 cm [25] and 50 cm [23] respectively. The LWR and LLR data for these three species have been determined for the total catches including the coastal and offshore catches of Sri Lanka [26], but have not yet been reported for the coastal catches reported only from the day-boats. Therefore, this study is aimed at gaining this information for the coastal catches of the three species of neritic tuna of Sri Lanka, which represent the stocks of the coastal waters surrounding the island.

Correspondence

Chintha Perera

Marine Biological Resources

Division, National Aquatic

Resources Research and

Development Agency, Colombo

15, Sri Lanka

2. Materials and Methods

A total of 488 samples of *E. affinis*, 408 samples *A. thazard* and 196 *A. rochei* were collected from three provinces around the Sri Lankan coast from October 2015 to September 2017. The samples were collected from Negombo and Beruwela in the Western Province, Chilaw and Kalpitiya in the North western Province and Dodanduwa, Galle and Weligama in the Southern Province of Sri Lanka (Fig. 1). The sampling was carried out by visiting the landing sites twice a month. The weight to the nearest 0.1 g, total length (TL), fork length and

standard length to the nearest 0.1 cm were measured for each fish collected. The length-weight relationship and length-length relationships were estimated for the pooled samples using a simple linear regression model. The length weight relationship equation used for calculation is $W=aL^b$ [27], where W is weight (g), L is total length (cm), a is the intercept and b is the slope. The Fulton's condition factor was determined using the equation $K=100W/L^3$ [3, 4]. In addition, the LW relationships and the K factors for individual provinces were evaluated separately.

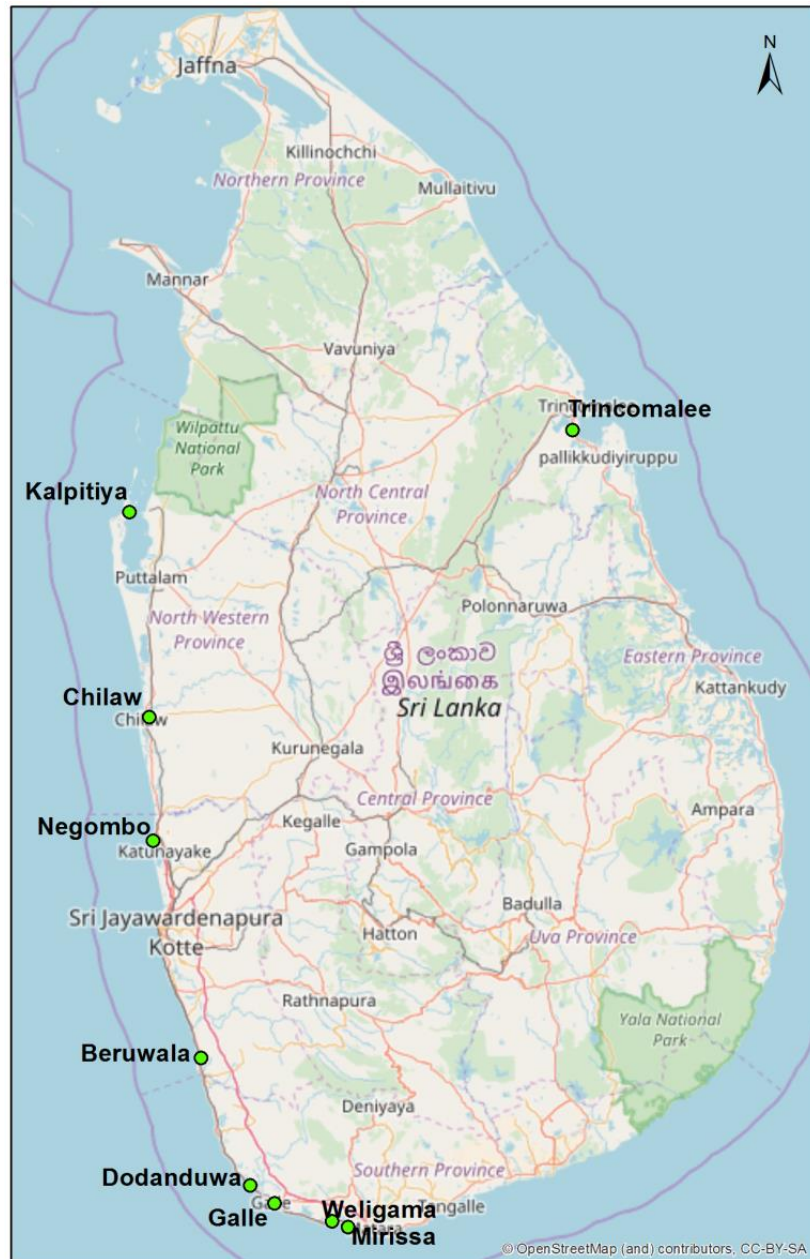


Fig 1: Map showing the locations from which *E. affinis*, *A. thazard* and *A. rochei* samples were collected [Negombo and Beruwela (Western Province), Chilaw and Kalpitiya (Northwestern Province), Dodanduwa, Galle and Weligama (Southern Province)].

3. Results and Discussion

The minimum, maximum and mean values of weights, total length, fork length and standard length ranges for the samples collected for the three species are given in Table 1. The b values for the three species were 3.115, 3.431 and 3.408 for *E. affinis*, *A. thazard* and *A. rochei* respectively and the correlation coefficient R^2 values ranged between 0.918 and 0.997 for the pooled samples of the three species respectively (Table 2). The growth parameters a and b and the coefficient

of determination (R^2) for the pooled samples of each species and for the individual provinces from which samples were collected, are given in Table 3. The b value of the LWR equation can be used to infer the growth condition of the fish in that environment. The b value in our study is >3.0 for pooled values of all three species, as well as for the Western, Northwestern and Southern Provinces separately, indicating that their growth conditions are favourable.

Table 1: Minimum, maximum and mean values of measurements obtained for weight and length parameters for the three species

Morphometric measurement	<i>E. affinis</i>			<i>A. thazard</i>			<i>A. rochei</i>		
	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean
Weight (g)	44.5	3590.7	942.6	118.9	1430.9	619.1	76.4	424.2	276.5
Total length (cm)	16.1	63.3	38.1	21.5	44.2	33.7	22.5	30.8	27.2
Fork length (cm)	15.1	60.5	35.5	20.1	42.0	32.0	21.2	29.7	26.0
Standard length (cm)	13.9	59.3	34.9	19.4	40.7	30.8	20.5	28.5	25.1

Similar studies have been done in India for these species. LWR has been calculated for *E. affinis* of Indian waters and a and b values have been shown to be 0.0254 and 0.889 respectively [28]. In a study carried out for *A. thazard*, the R² value has been 0.958 and the b value has been <3 indicating a negative allometric growth [29].

The LWR has been determined for *A. rochei* in Indian waters [30] and a and b values obtained have been 0.0076 and 3.243 respectively. The b value is very close to the value obtained in our study for *A. rochei*. In a study done for *A. rochei* of Turkish waters the b value has been shown to be 2.68, which has revealed that they are having a negative allometric growth and the R² value has been 0.73 [31]. Comparing the results obtained in our study show that these three species in our Sri Lankan waters are living in good conditions and are having healthy growth patterns.

Length-length relationships are important for comparative

growth studies in fisheries management issues [2]. The relationships between the three length parameters of each species were all highly significant (p<0.001) for the pooled samples of each of the three species. The Fulton's condition factor (K) is >1 in the overall as well as in the individual provinces, indicating that the condition for growth and survival is good in all provinces studied. The K factor can decrease if the health conditions of the fish are not good [21].

Though LLR have been determined for these three species in Sri Lankan waters [32], this is the first attempt at determining the LWR. Therefore, knowing the LWR for each of these three species will help biologists to determine the weight of a fish from length measurements taken in the field, as length measurements are more convenient to obtain in the field. These data will be useful in the management of these important neritic tuna resources of Sri Lanka in the future.

Table 2: Comparison of the LWR parameters and LLR parameters of the 3 species studied.

	<i>E. affinis</i>	<i>A. thazard</i>	<i>A. rochei</i>
Sample no. (n)	488	408	196
LWR equation	W=0.132L ^{3.115}	W=0.083L ^{3.430}	W=0.861L ^{3.408}
R ² value	0.989	0.981	0.918
b value	3.115	3.431	3.408
a value	0.132	0.083	0.861
Fulton's condition factor (K)	1.43	1.48	1.36
FL= a + bTL	FL=-0.260 + 0.939TL R ² =0.997	FL= - 0.483+0.963TL R ² =0.996	FL= - 0.051+0.957TL R ² =0.968
SL=a+bTL	SL= -0.795 + 0.917TL R ² =0.994	SL= - 0.582+0.929TL R ² =0.988	SL = 0.584+0.900TL R ² =0.932
SL=a+bFL	SL=-0.564 + 0.977FL R ² =0.997	SL= - 0.126+0.965FL R ² =0.992	SL = 0.674+0.938FL R ² =0.959

Table 3: LWR parameters for *E. affinis*, *A. thazard* and *A. rochei* for the different Provinces

	<i>Euhynnus affinis</i>				<i>Auxis thazard</i>				<i>Auxis rochei</i>			
	Overall	Western Province	North Western Province	Southern Province	Overall	Western Province	North Western Province	Southern Province	Overall	Western Province	North Western Province	Southern Province
Sample no. (n)	489	254	137	88	388	195	129	57	178	75	20	82
LWR equation	W=0.130L ^{3.114}	W=0.138L ^{3.087}	W=0.125L ^{3.139}	W=0.123L ^{3.165}	W=0.083L ^{3.431}	W=0.089L ^{3.388}	W=0.089L ^{3.521}	W=0.069L ^{3.550}	W=0.861L ^{3.408}	W=0.879L ^{3.308}	W=0.089L ^{3.759}	W=0.069L ^{3.490}
R ² value	0.989	0.989	0.987	0.990	0.981	0.985	0.984	0.968	0.918	0.879	0.950	0.925
b value	3.115	3.087	3.139	3.165	3.431	3.388	3.352	3.550	3.408	3.308	3.760	3.490
a value	0.132	0.138	0.130	0.123	0.083	0.089	0.072	0.069	0.861	0.099	0.051	0.077
Fulton's condition factor (K)	1.43	1.44	1.38	1.45	1.48	1.45	1.44	1.50	1.48	1.35	1.37	1.36

4. Conclusion

Based on the results obtained in this study for the b values, R² values and the Fulton's condition factors, it can be concluded that the three neritic tuna species, *E. affinis*, *A. thazard* and *A. rochei* in our Sri Lankan waters are living in favourable conditions and are having healthy growth patterns. Knowing the LWR for each of these three species will help biologists to

determine the weight of a fish from length measurements taken in the field. These data will be useful in the management of these neritic tuna resources of Sri Lanka in the future in a sustainable manner.

5. Acknowledgements

This work was funded by the National Aquatic Resources

Research and Development Agency (NARA), Sri Lanka.

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