

AN UPDATE ON THE LENGTH-WEIGHT RELATIONSHIP FOR BLUEFIN TUNA CAUGHT BY LONGLINERS IN THE MEDITERRANEAN SEA

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SUMMARY

The present paper represents a continuity of data collection work that started in 2013. Our attempt is to provide a valid length-weight (L-W) equation to be used for the next stock assessment of the eastern Atlantic and Mediterranean Bluefin tuna (ABFT). Biometric analyses of Curved Fork Length (CFL), Straight Fork Length (SFL) and Round Weight (RWT) were performed in order to update the conversion factors used by ICCAT. Data from 345 specimens were collected by scientific observers aboard the Italian longliner vessels operating in the Mediterranean Sea during the fishing season of 2016 (May-June). The length and weight measurements were used for a new CFL/SFL conversion factor, as follows:

$$SFL = 0.9596 * CFL + 2.0985 \quad (R^2 = 0.9961)$$

Moreover, updated length-weight (SFL-RWT and CFL-RWT) relationships for the Bluefin tuna caught in the central Mediterranean Sea are presented as follow:

$$RWT = 5.496940E^{-05} * SFL^{2.76094} \quad (R^2 = 0.98276)$$

$$RWT = 5.719857E^{-05} * CFL^{2.73796} \quad (R^2 = 0.98466)$$

RÉSUMÉ

Le présent document représente une continuité des travaux de collecte de données qui ont débuté en 2013. Notre tentative est de fournir une équation valide longueur-poids (L-W) qui serait utilisée pour la prochaine évaluation des stocks de thon rouge de l'Atlantique Est et de la Méditerranée (EBFT). Des analyses biométriques de la longueur courbée à la fourche (CFL), de la longueur droite à la fourche (SFL) et du poids vif (RWT) ont été effectuées afin de mettre à jour les coefficients de conversion utilisés par l'ICCAT. Les données de 345 spécimens ont été recueillies par des observateurs scientifiques à bord de palangriers italiens opérant en Méditerranée pendant la saison de pêche de 2016 (mai-juin). Les mesures de longueur et de poids ont été utilisées pour un nouveau coefficient de conversion CFL/SFL, comme suit :

$$SFL = 0,9596 * CFL + 2,0985 \quad (R^2 = 0,9961)$$

En outre, des relations actualisées longueur-poids (SFL-RWT et CFL-RWT) pour le thon rouge capturé dans la mer Méditerranée centrale sont présentées comme suit :

$$RWT = 5,496940E^{-05} * SFL^{2,76094} \quad (R^2 = 0,98276)$$

$$RWT = 5,719857E^{-05} * CFL^{2,73796} \quad (R^2 = 0,98466)$$

RESUMEN

Este documento representa la continuación del trabajo de recopilación de datos que se inició en 2013. Nuestra intención es proporcionar una ecuación talla-peso (L-W) válida para utilizarla en la próxima evaluación del stock de atún rojo del Atlántico este y Mediterráneo (BFT).

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Se llevaron a cabo análisis biométricos de la longitud curva a la horquilla (CFL), de la longitud recta a la horquilla (SFL) y del peso vivo (RWT) con el fin de actualizar los factores de conversión que utiliza ICCAT. Los observadores científicos a bordo de palangreros italianos que operan en el Mediterráneo recopilaban datos de 345 ejemplares durante la temporada de pesca de 2016 (mayo-junio). Las mediciones de talla y peso se utilizaron para un nuevo factor de conversión CFL/SFL, de la siguiente manera:

$$SFL = 0,9596 * CFL + 2,0985 \quad (R^2 = 0,9961)$$

Además, se presentan relaciones talla-peso actualizadas (SFL-RWT y CFL-RWT) para el atún rojo capturado en el Mediterráneo central:

$$RWT = 9E^{-05} * SFL^{2,76094} \quad (R^2 = 0,98276)$$

$$RWT = 9E^{-05} * CFL^{2,73796} \quad (R^2 = 0,98466)$$

KEYWORDS

Thunnus thynnus, length-weight relationship, CFL, SFL, Mediterranean Sea, longliners

1. Introduction

Bluefin tuna (BFT) stock assessment requires the acquisition and analysis of catch-at-size and catch-at-age data from all BFT fishing industry; such analysis is carried out by the Scientific Committee on Research and Statistics (SCRS) which symbolise the scientific arm of the International Commission for the Conservation of Atlantic Bluefin Tuna (ICCAT).

Biometric studies of length and weight measurements are therefore important for empirical estimates of the catches during the BFT stock assessment.

Stock assessments made by the ICCAT-SCRS for the Atlantic and Mediterranean Bluefin tuna (ABFT) apply different L–W relationship (Parrack and Phares, 1979; Rey & Cort, unpublished; Arena, unpublished).

In recent SCRS Species Group meetings, these equations have been questioned and several new equations have been proposed to the SCRS Working Group (Santos *et al.*, 2004; Aguado-Gimenez & Garcia-Garcia, 2005; Tzoumas *et al.*, 2010; Deguara *et al.*, 2010 and 2012; Galaz, 2012; Cort *et al.*, 2013; Lombardo *et al.*, 2016). Cort *et al.* (2015) demonstrated that the adopted general equation for the eastern stock clearly underestimates the weight of the East Atlantic and Mediterranean BFT at specific periods of the year, in particular when fish are on high fattening condition (K equal or >2).

In view of the above considerations, the authors of the present paper propose an update on the L-W relationship for the Mediterranean bluefin tuna, caught by Italian longliners in the Mediterranean Sea during the fishing season 2016, suggesting a new conversion factor (SFL-CFL) and two different L-W equations for both Fork Length and Curved Fork Length.

2. Materials and Methods

Data collection was carried out by the scientific staff of OCEANIS Srl and Department of Life and Environmental Sciences (DiSVA) - Università Politecnica delle Marche, Ancona (Italy) within a data collection programme started in 2013. The area of study covers the fisheries of BFT in waters around Strait of Sicily, Ionian and Tyrrhenian Sea as well as in authorised landing docks. A total of 345 specimens were sampled during the period 15 May - 15 June 2016 and different biometric measurements were collected as: Curved Fork Length (CFL), Strait Fork Length (SFL) and Round Weight (RWT).

This data were used to work out a new SFL-CFL conversion factor that has been compared to the conversion factor adopted by the ICCAT-SCRS for Atlantic BFT: $FL = 0.955 * CFL$ (Parrack *et al.*, 1979).

The Allometric equation was used to fit the SFL-RWT relationship, $W = aL^b$, where W (Weight) and L (Length) are variables and a and b are parameters. The coefficient of determination (R^2) was used as index of the quality of the estimates.

3. Results and Discussion

It is clear that bluefin tuna stock assessment requires the acquisition and analysis of catch-at-size and catch-at-age data from all bluefin tuna fisheries.

Figure 1 presents a linear SFL-CFL relationship showing a qualitatively better conversion factor, as indicated by the coefficient of determination, than the equation approved by ICCAT ($SFL = 0.955 * CFL$; Parrack *et al.*, 1979). The authors suggest taking into consideration the new equation for further stock assessments:

$$SFL = 0.9596 * CFL + 2.0985 \quad (R^2 = 0.9961)$$

Table 1 shows a comparison of some of the length measurement conversions using the two SFL-CFL equations as: $SFL = 0.955 * CFL$ (Parrack *et al.*, 1979) and $SFL = 0.9596 * CFL + 2.0985$ (Lombardo *et al.*, SCRS-16-190).

Figure 2 presents the SFL-RWT relationship for the 2016 dataset used in this study showing better estimates of the data compared to the Arena equation ($RWT = 1.9607E^{-05} * SFL^{3.0092}$) which overestimated the total catches:

$$RWT = 5.496940E^{-05} * SFL^{2.76094} \quad (R^2 = 0.98276)$$

Figure 3 presents the CFL-RWT relationship for the same dataset as follows:

$$RWT = 5.719857E^{-05} * CFL^{2.73796} \quad (R^2 = 0.98466)$$

Figure 4 shows a comparison of the total BFT biomass, related to the dataset used in this study, calculated applying the Arena equation ($RWT = 1.9607E^{-05} * SFL^{3.0092}$) and the Italian equation ($RWT = 5.496940E^{-05} * SFL^{2.76094}$) compared to the real total biomass caught.

4. Conclusions

These data and equations can be a valuable contribution to the advancement of knowledge in the evaluation of bluefin tuna used at future bluefin tuna stock assessment sessions.

It should be noted that the utilization of the SFL-CFL relationship adopted by ICCAT-SCRS underestimates the real length of the fish while the SFL-CFL relationship obtained in this study shows a better fit with the real length measurements.

Moreover, the length-weight relationship adopted by the ICCAT-SCRS seems to overestimate the real bluefin tuna biomass caught by Italian longliners by up to 24.2% while the Italian equation underestimated it by 10.5%.

This underestimation and overestimation can greatly impact future bluefin tuna stock assessments.

5. Acknowledgments

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Table 1. Comparison of length measurement conversions using ICCAT conversion factor ($SFL = 0.955 * CFL$; Parrack *et al.*, 1979) and Italian conversion factor ($SFL = 0.9596 * CFL + 2.0985$).

Real Measurements		SFL Conversion	SFL Conversion
CFL	SFL	by ICCAT	by Italy
117	114	112	114
118	115	113	115
121	118	116	118
119	115	114	116
127	124	121	124
129	125	123	126
128	125	122	125
127	125	121	124
131	130	125	128
122	119	117	119
123	120	117	120
125	123	119	122
132	130	126	129
127	125	121	124
130	127	124	127
125	123	119	122
130	128	124	127
133	130	127	130
127	124	121	124

SFL-CFL

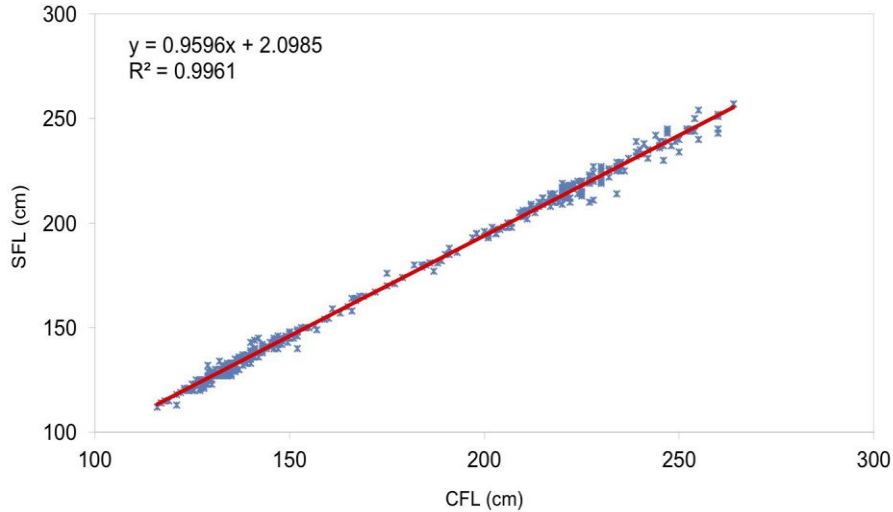


Figure 1. SFL-CFL relationship ($SFL = 0.9596 * CFL + 2.0985$; $R^2 = 0.9961$) for Mediterranean bluefin tuna.

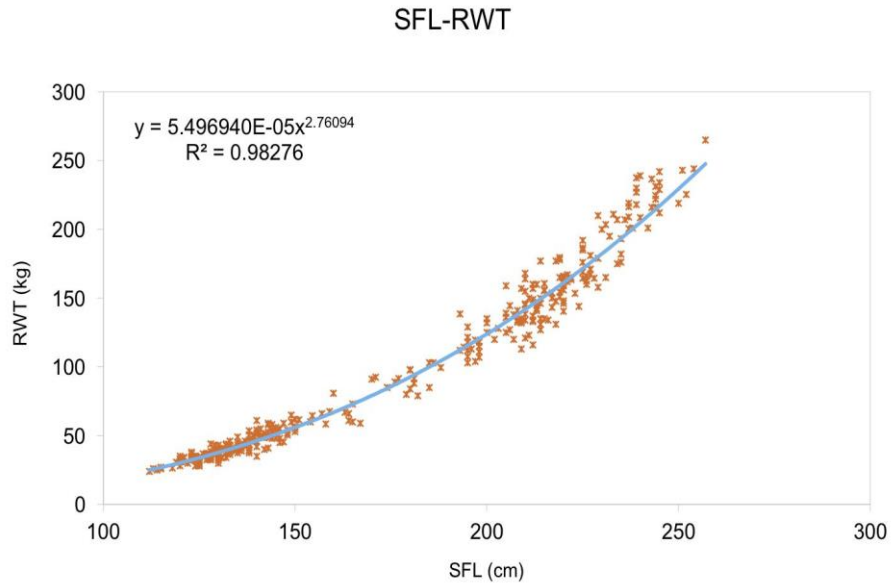


Figure 2. SFL-RWT relationship ($RWT = 5.496940E^{-05} * SFL^{2.76094}$) for the Mediterranean bluefin tuna.

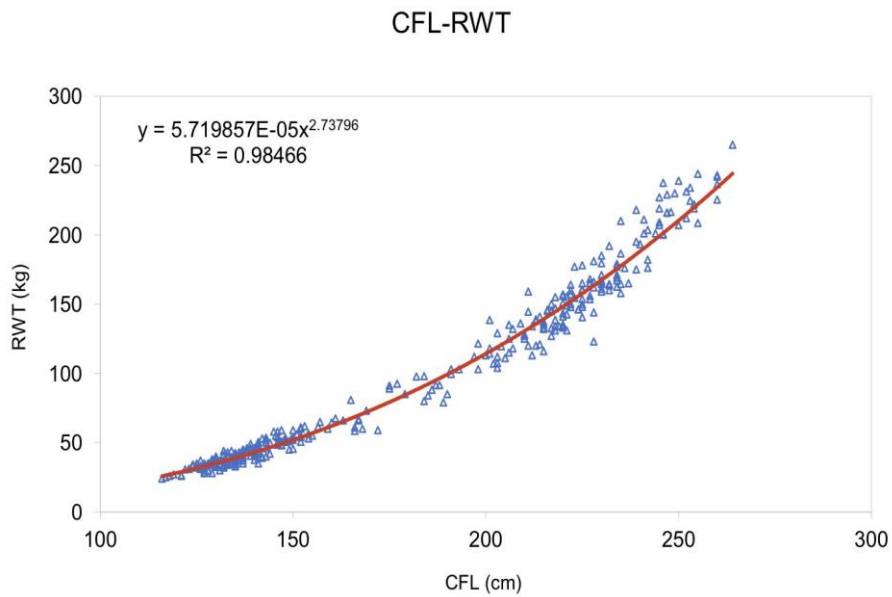


Figure 3. CFL-RWT relationship ($RWT = 5.719857E^{-05} * CFL^{2.73796}$) for the Mediterranean bluefin tuna.

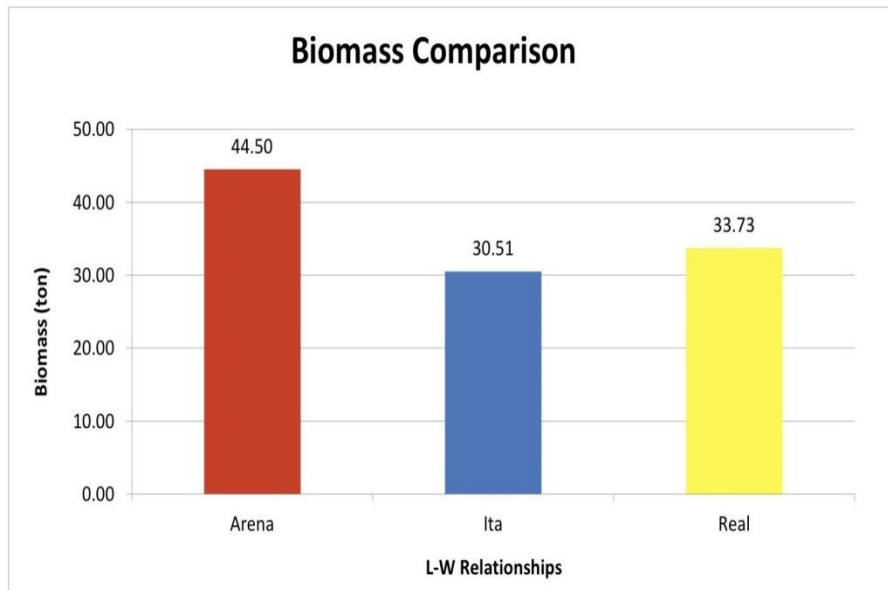


Figure 4. Biomass comparison when using different L-W relationships for Mediterranean bluefin tuna. Arena equation ($RWT = 1.9607E^{-05} * SFL^{3.0092}$) and the Italian equation ($RWT = 5.496940E^{-05} * SFL^{2.76094}$).