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:

\[ SFL = 0.9596 \times CFL + 2.0985 \quad (R^2 = 0.9961) \]

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

\[ RWT = 5.496940 \times 10^{-5} \times SFL^{2.76094} \quad (R^2 = 0.98276) \]
\[ RWT = 5.719857 \times 10^{-5} \times CFL^{2.73796} \quad (R^2 = 0.98466) \]

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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 recopilaron 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:

\[ SFL = 0,9596 \times CFL + 2,0985 \quad (R^2 = 0,9961) \]

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

\[ RWT = 9 \times 10^{-5} \times SFL^{2,2796} \quad (R^2 = 0,98466) \]

\[ RWT = 9 \times 10^{-5} \times SFL^{2,2704} \quad (R^2 = 0,98276) \]

**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 (DiSV) - 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: \[ FL = 0.955 \times CFL \] (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 \( (SFL = 0.955\times CFL; \text{Parrack et al., 1979}) \). The authors suggest taking into consideration the new equation for further stock assessments:

\[
SFL = 0.9596\times CFL+2.0985 \quad (R^2 = 0.9961)
\]

Table 1 shows a comparison of some of the length measurement conversions using the two SFL-CFL equations as: \( SFL = 0.955\times CFL \) (Parrack et al., 1979) and \( SFL = 0.9596\times CFL+2.0985 \) (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 \( (RWT = 1.9607E^{-05}\times SFL^{3.0092}; \text{Arena}) \) which overestimated the total catches:

\[
RWT = 5.496940E^{-05}\times SFL^{2.76094} \quad (R^2 = 0.98276)
\]

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

\[
RWT = 5.719857E^{-05}\times CFL^{2.73796} \quad (R^2 = 0.98466)
\]

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

The authors wish to thank those persons and groups who made possible the data collection included and analysed in the present work.

The Masters and National Observers of Longliner Vessels.
References


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

<table>
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Figure 1. SFL-CFL relationship \( (SFL = 0.9596 \times CFL + 2.0985; R^2 = 0.9961) \) for Mediterranean bluefin tuna.
Figure 2. SFL-RWT relationship \( RWT = 5.496940E^{-05} \times SFL^{2.76094} \) for the Mediterranean bluefin tuna.

Figure 3. CFL-RWT relationship \( RWT = 5.719857E^{-05} \times CFL^{2.77996} \) for the Mediterranean bluefin tuna.
Figure 4. Biomass comparison when using different L-W relationships for Mediterranean bluefin tuna. Arena equation ($RWT = 1.9607E^{-05} \times SFL^{3.0092}$) and the Italian equation ($RWT = 5.496940E^{-05} \times SFL^{2.70694}$).