CONVERSION FACTORS FOR ATLANTIC BLUEFIN TUNA FORK LENGTH FROM MEASURES OF SNOUT LENGTH AND OTOLITH MASS

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SUMMARY

Conversion factors are presented for snout length and otolith mass measures that are commonly taken from heads of processed bluefin tuna. Conversions were: Curved Fork Length (cm) = 10.67 Snout Length (cm); Curved Fork Length = -76.18 + 552.75 (Otolith Mass) $^{0.33}$ (g) These conversions should be useful in obtaining fork length estimates in cases when fork length cannot be directly measured. Further, the conversion factor for snout length is sufficiently precise to warrant its inclusion in routine measures of Atlantic bluefin tuna for sampling programs and databases.

RÉSUMÉ

Le présent document se penche sur les facteurs de conversion des mesures de la longueur du museau et de la masse otolithique habituellement extraite de la tête du thon rouge transformé. Les conversions utilisées étaient les suivantes: longueur courbée à la fourche (cm) = 10,67; longueur du museau (cm); longueur courbée à la fourche = -76,18 + 552,75 (masse otolithique) 0,33 (g). Ces conversions seront utiles aux fins de l'obtention d'estimations de longueur à la fourche lorsque la longueur à la fourche ne peut pas être mesurée directement. De plus, le facteur de conversion de la longueur du museau est suffisamment précis pour justifier son inclusion dans les mesures de routine du thon rouge de l'Atlantique dans le cadre des programmes d'échantillonnage et des bases de données.

RESUMEN

Se presentan factores de conversión para mediciones de longitud del hocico y de masas de otolitos que suelen extraerse de las cabezas de los atunes rojos transformados. Los factores de conversión fueron: Longitud curva a la horquilla (cm) = 10,67 longitud del hocico (cm); Longitud curva a la horquilla = -76,18 + 552,75 (masa de otolito) ^{0,33} (g). Estos factores de conversión deberían resultar útiles para obtener estimaciones de longitud a la horquilla en los casos en que no puede medirse la longitud a la horquilla de forma directa. Además, el factor de conversión para la longitud del hocico es lo suficientemente precisa para justificar su inclusión en mediciones de rutina de atún rojo del Atlántico para los programas de muestreo y las bases de datos.

KEYWORDS

Biometric conversions, Otolith, Snout length, Thunnus thynnus

1. Introduction

Biological sampling for length, otoliths, and tissues from Atlantic bluefin tuna is dependent upon fishers and dealers such that whole and intact fish are often not available to the scientist or sampler. Further, opportunities to sample Atlantic bluefin tuna are often limited due to the periodic nature of their harvest and limited access to ports and cages where they are landed. On the other hand, dealers and fishers have been receptive to retaining and storing the heads of processed tuna for scientific sampling. Here, we evaluate and promote the use of snout and otolith mass conversion factors to increase biological sampling opportunities for size, age, population assignment, and other biological attributes.

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The snout measure is taken from the tip of the upper jaw to the anterior-most edge of the orbit with a flexible measuring tape to the nearest 0.1 cm (**Figure 1**). Otolith mass routinely measured in processing otoliths for age determination or population assignment. Otolith mass measures are performed on an analytical balance on intact, clean and dry sagittal otoliths. Measures of snout length, otolith mass, straight fork length and curved fork length were analyzed from three sampling programs undertaken by the University of Maryland Center for Environmental Sciences (CBL), the University of Maine (UMaine) and Gulf of Maine Research Institute (GMRI) (supported by the Large Pelagics Research Center), and Canada Department of Fisheries and Oceans. These groups sampled fish caught in US South Atlantic and Mid-Atlantic waters (CBL), and US (UMaine, LPRC and GMRI) and Canadian (DFO) Northwest Atlantic shelf waters during the period 1998-2012.

2. Results

A subset of CBL samples was measured for straight fork length (SFL) for which curved fork length (CFL) measures were not available (n=104 of 312). A conversion factor was estimated for predicting CFL from SFL for this same data set (**Table 1**). This conversion factor, CFL = 1.029 SFL, was nearly identical to one estimated for a larger sample of Western Atlantic bluefin tuna by Saltz *et al.* (2007), CFL=1.028 SFL, but slightly different than the one used currently by ICCAT (CLF = 1.047 SFL; ICCAT 2000).

Snout length was highly correlated with CFL (**Table 1; Figure 2**) over a representative size range of bluefin tuna (61-307 cm CFL; N=439). The regression was fit following removal of five outliers identified by studentized residuals. These outliers were all greater than 200 CFL and may have resulted from mis-measurement, misreporting, or natural variability. Regression residuals showed no systemic departure from predicted length with increasing size. The 95% prediction intervals were ± 13.7 cm of estimated CFL.

Otolith mass correlated to CFL in a non-linear manner. Of several transformations attempted, the isometric coefficient 3 (or, in predicting CFL from otolith mass, the coefficient 0.33) showed a reasonable fit (**Figure 3**). Otolith mass measures were available for a large sample (N=972) from a wide distribution of sizes (**Table 1**). Substantial variability existed in this relationship. Although a fairly high coefficient of determination was estimated (R^2=0.89), 95% predictions intervals were ±33.0 cm of estimated CFL.

3. Summary

In the event that intact Atlantic bluefin tuna are not available to the sampler or in instances where data is otherwise missing, measures of snout length and otolith mass are sufficiently precise to merit their routine measurement in biological sampling programs and their inclusion in ICCAT datasets. Snout length should be endorsed as an easy measure that can provide critical size information from processed fish, or as a means to corroborate other size measures. Predictions based on otolith mass were far less certain, but could still be used to ascertain broad size classes of bluefin tuna when other size data is not available. Otoliths are now routinely collected and measured for age determination and population assignment so data on otolith mass should be available in the future for a large number of individuals.

Acknowledgements

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Table 1.Conversions for curved fork length (CFL) and straight fork length (SFL) from snout length and otolith mass. For each linear regression, the size range, sample size and coefficient of determination are presented. All lengths are in cm; otolith mass is in g.

BFT – West Atlantic

Conversion	**Size Range (cm, CFL)**	**N**	**R^2**
CFL=1.029 SFL	61.0-160.0	56	0.99
CFL=10.67 Snout_Length	57.6-307.3	439	0.99
CFL= -76.18 + 552.75 (Otolith_mass)$^{0.33}$	61.6-308.0	972	0.89
SFL=0.972 CFL	61.0-160.0	56	0.99
SFL=10.37 Snout_Length	57.6-307.3	439	0.99
SFL=-74.05 + 537.27 (Otolith_mass)$^{0.33}$	61.6-308.0	972	0.89

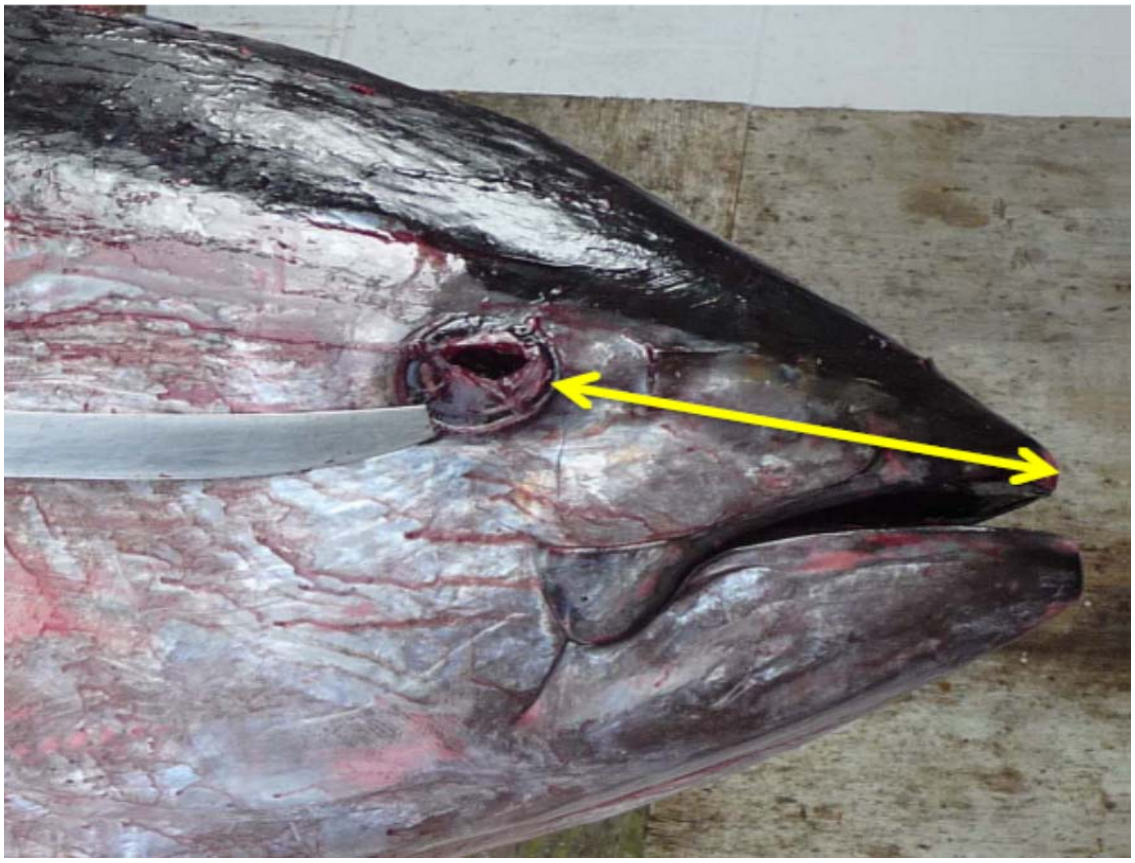

Figure 1. The snout length is taken with a flexible measuring tape from the tip of the upper jaw to the most anterior edge of the orbit.

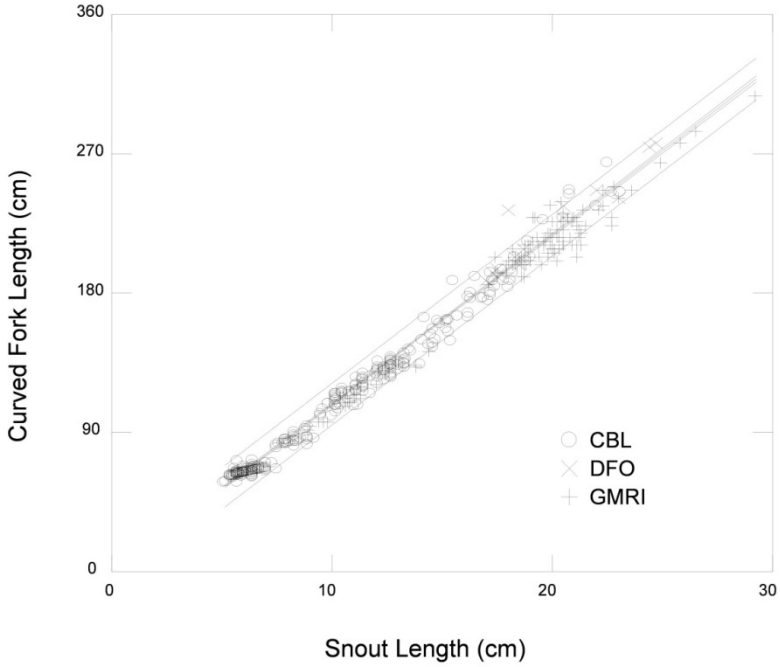

Figure 2. Prediction of Curved Fork Length from snout length for Atlantic bluefin tuna. Data collected from US (CBL and GMRI) and Canadian (DFO) fisheries. 95% Confidence and Prediction Limits are shown. Data is coded by different sampling entities.

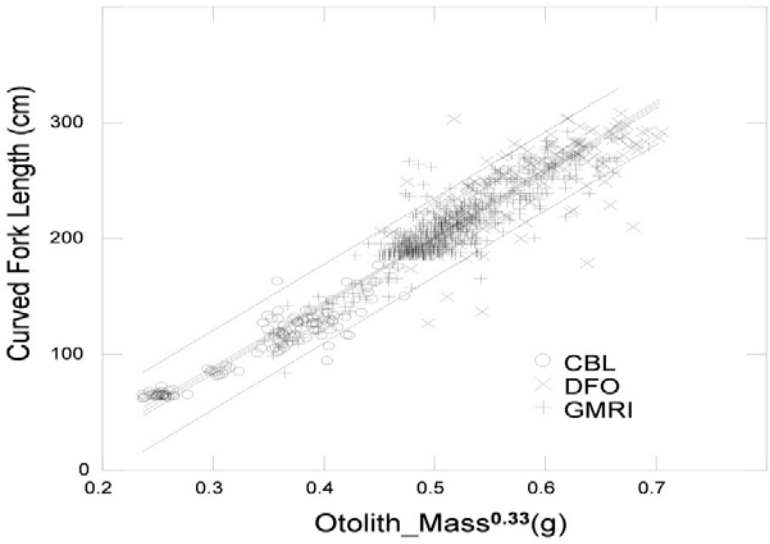

Figure 3. Prediction of Curved Fork Length from otolith mass for Atlantic bluefin tuna. Data collected from US and Canadian fisheries. 95% Confidence and Prediction Limits are shown. Data is coded by different sampling entities.