SCRS/2015/175 Collect. Vol. Sci. Pap. ICCAT, 72(7): 1754-1759 (2016)

ANALYSIS OF THE SIZE FREQUENCY DATA OF BLUEFIN TUNA (*THUNNUS THYNNUS*) OBTAINED FROM THE BIOLOGICAL SCRAPS SAMPLING, 2010-2014

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SUMMARY

The size of 2991 Bluefin tuna was estimated from biological scraps during the period from 2010 to 2014, using statistical relationships. The curved fork length of fish is from 139 cm to 301 cm, with a mean size of fish varying from 2016 to 234 cm. The statistical analysis showed that there are significant differences in size distribution of Bluefin tunas among years and traps. The comparison of the predicted mean weight and the observed mean weight of fish revealed that the statistical relationship used explained on average about 90% of the variability in the size of fish.

RÉSUMÉ

La taille de 2.991 thons rouges a été estimée à partir de fragments biologiques au cours de la période 2010-2014, à l'aide de relations statistiques. La longueur courbée à la fourche du poisson est de 139 cm à 301 cm, les poissons présentant une taille moyenne variant entre 201 et 234 cm. L'analyse statistique a montré qu'il existe des différences significatives dans la distribution de la taille du thon rouge entre les années et les madragues. La comparaison du poids moyen prédit et du poids moyen observé des poissons a révélé que la relation statistique utilisée expliquait en moyenne environ 90 % de la variabilité de la taille des poissons.

RESUMEN

Se estimó la talla de 2.991 atunes rojos mediante restos biológicos durante el periodo de 2010 a 2014 utilizando relaciones estadísticas. La longitud curva a la horquilla de los peces va desde 139 cm a 301 cm, con una talla media de los peces que varía desde 201 a 234 cm. Los análisis estadísticos mostraron que existen diferencias significativas en la distribución por tallas de los atunes rojos entre los años y entre almadrabas. La comparación del peso medio predicho y del peso medio observado de los peces reveló que las relaciones estadísticas utilizadas explicaban, de media, aproximadamente el 90% de la variabilidad en la talla de los peces.

KEYWORDS

Eastern Atlantic bluefin tuna, biological scraps, size frequency data, stereoscopic camera

1. Introduction

The size data are relevant information used in the analytical models for the Eastern Atlantic Bluefin tuna stock assessment by the SCRS. The Moroccan Atlantic traps are one of the most important fisheries targeting this species. The standardized combined index of EABFT from the Moroccan and the Spanish traps has been regularly used by SCRS in the last ICCAT stock assessment for this species (Anon, 2009; 2011; 2013, 2015).

Before 2006, the size frequencies data were missing for this fishery as most of fish is processed and sold directly into the sea where it is rapidly processed and frozen on board to ensure a high quality of the flesh. In order to provide ICCAT with an estimate of the catch at size data, a sampling program of biological scraps (mainly heads cut either at the pre-operculum or at the operculum) has been set up (Abid and Idrissi, 2007; Idrissi and Abid, 2009). As a result, some size sampling and catch at size data for this species were made available to the ICCAT for the period 2006-2014.

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The objective of this paper is to update the analysis of the size data of BFT catches by Moroccan traps previously presented (Abid *et al*., 2014) and to evaluate the robustness of the statistical relationship (Abid *et al*., 2013) to estimate the size of fish from biological scraps.

Material and methods

During the period 2010-2014, biological scraps (mainly heads or parts of heads) from 2991 AEBFT were measured daily at the port of Larache (North of Moroccan Atlantic coast) to estimate the size structure of catches made by Moroccan traps. Most of scraps were measured from the upper jaw to the posterior border of the preoperculum with a measuring tape to the nearest centimetre. When possible both the head length and the upper jaw- preoperculum length were measured on the same fish (**Figure 1**).

The Curved fork length of each sampled fish was calculated using statistical relationships established between the preoperculum and the Curved Fork Length and between the Operculum and the Curved Fork length previously presented (Abid *et al*., 2013). The estimated mean size of fish (Curved fork length CFL) by year was converted into its corresponding Strait fork length (SFL) using the relationship recently adopted by the BFT species group for the East stock, which is as follow:

$$CFL= -1.887 + 1.051* SFL$$

The estimated mean sizes (SFL) by year were then converted into their corresponding Round weight (RW) using the monthly length weight relationship (May) adopted recently by the species group for the EABFT:

$$RW= 3.508*10\text{-}05* SFL\hat{}\ 2.887$$

In order to evaluate the goodness of our statistical relationship estimate, the estimated individual mean weight (RW) by year were compared to the observed average weight of fish. The latter is calculated by dividing the total catch in weight for a given year by the total catch in number for the traps from which the biological scraps were sampled.

In 2014, it was possible to get the size data estimated by the stereoscopic camera for 126 Bluefin. These data came from a caging operation (1^{st} May 2014) conducted by a company that fattened a part of its Bluefin trap catches. The use of stereoscopic camera to estimate the size of caged fish is mandatory in compliance with the Rec. 12-07 and Rec. 13-08.

Finally, the size data of BFT estimated from biological scraps for 2014 were compared to those estimated by the stereoscopic camera to see if there are any significant differences.

2. Results and discussions

The number of fish sampled from the biological scraps by year for the 2010-2014 period is shown in the **Table 1.**

Figures 2 and 3 illustrate the size frequency distributions of Bluefin catches by Moroccan traps by year and by trap**.** The observed differences in the size distribution among years and traps (**Figures 4 and 5**) are statistically significant at 1% level (**Table 2).**

The mean size of fish has shown an upward trend since 2012 to reach a maximum of 234 cm CFL in 2014. This positive trend of the mean size is reflected by the increase in the mean weight of fish except for the year 2012. The ratio of the estimated mean weight and the observed mean weight of fish showed that varies between a minimum of 84% and a maximum of 98% in 2014 (**Table 3**). This suggests that the statistical relationships used underestimated to some extent the size of fish for some years (2010 and 2012), because they do not fully explain the variability in the size of fish. The biases associated to the use of different conversion factors used could also partially explain the differences.

The size range of Bluefin tuna catches by “Essahel” trap obtained from biological scraps in 2014 is quite similar to that estimated by the stereoscopic camera. It varies between 177 and 277 cm SFL for the biological scraps and comprised between 186 and 280 cm SFL for the stereoscopic camera (**Figure 6**). However the differences in the mean sizes estimated by the stereoscopic camera (232 cm, SFL) and the biological scraps (224cm, SFL) are statistically significant at 1% level (t= -2.776 and p= 0.00594). This could be due to the fact that fish caged the 1st May are of larger size than those caught later.

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Table 1. Number of sampled fish by year.

Year	*2010*	*2011*	*2012*	*2013*	*2014*
Samples number	698	1194	396	432	271

Table 2. Results of the analysis of variance.

	Df	**Sum Sq**	**Mean Sq**	**F value**	**Pr(>F)**
Year	4	91261	22815.3	60.329	< 2.2e-16 ***
Trap	12	74571	6214.3	16.432	< 2.2e-16 ***
Year: Trap	6	24796	4132.7	10.928	4.528e-12 ***

Table 3. Comparison of the individual observed mean weight and the estimated individual weight from biological scraps by year from 2010 to 2014.

Year	Observed mean weight	Estimated CFL	Estimated SFL	Estimated mean weight	Mean weight Ratio
2010	203	216	207	170	0.84
2011	210	227	217	195	0.93
2012	220	222	213	185	0.84
2013	213	228	218	198	0.93
2014	218	234	224	214	0.98

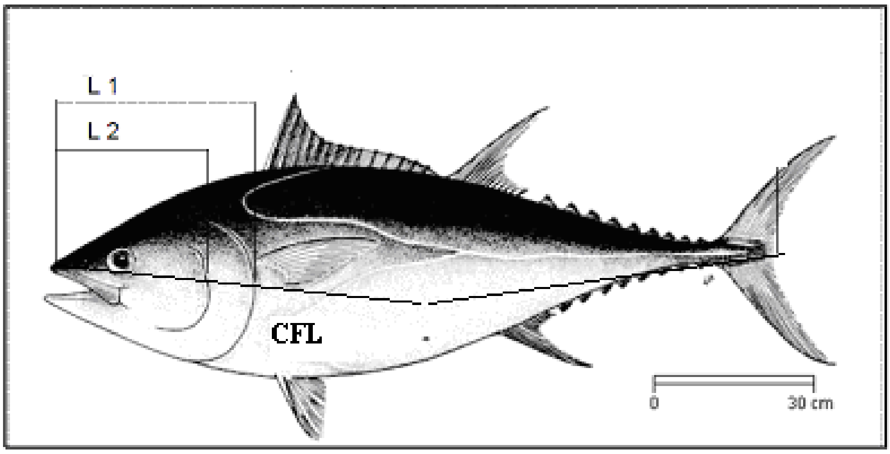

Figure 1. Main length measurements taken on bluefin tuna.

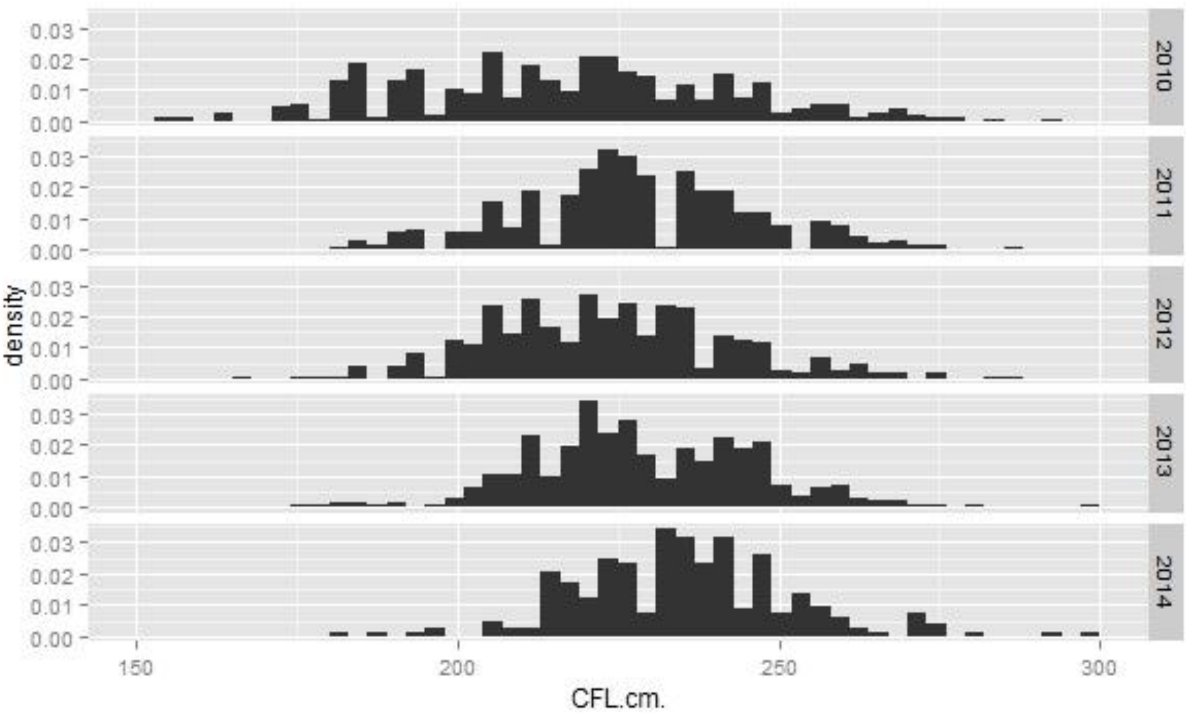

Figure 2. Yearly size frequency distribution of bluefin catches estimated from biological scraps, 2010-2014.

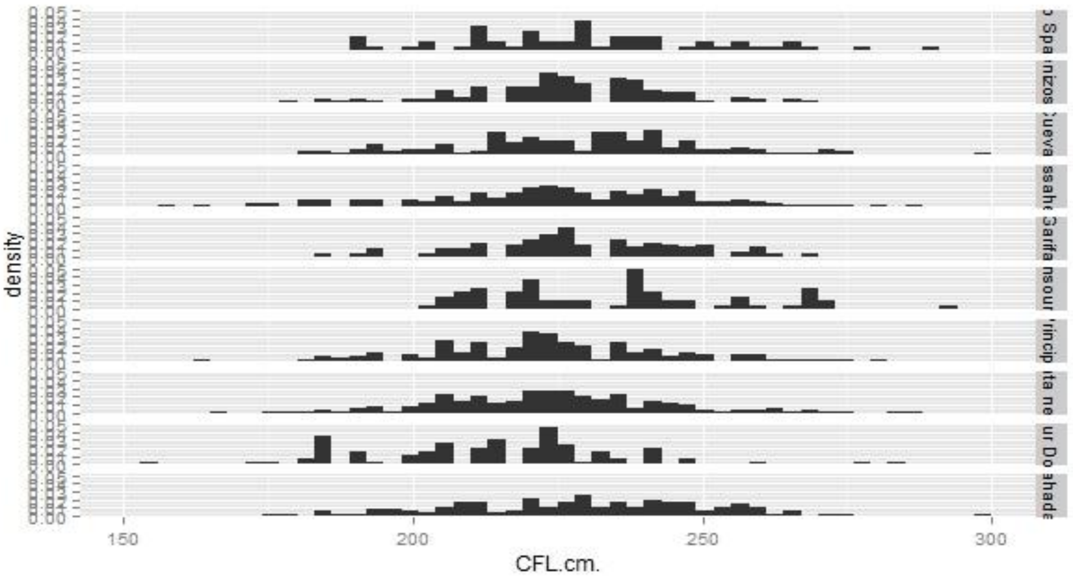

Figure 3. Size frequency distribution of bluefin catches by trap estimated from biological scraps, 2010-2014.

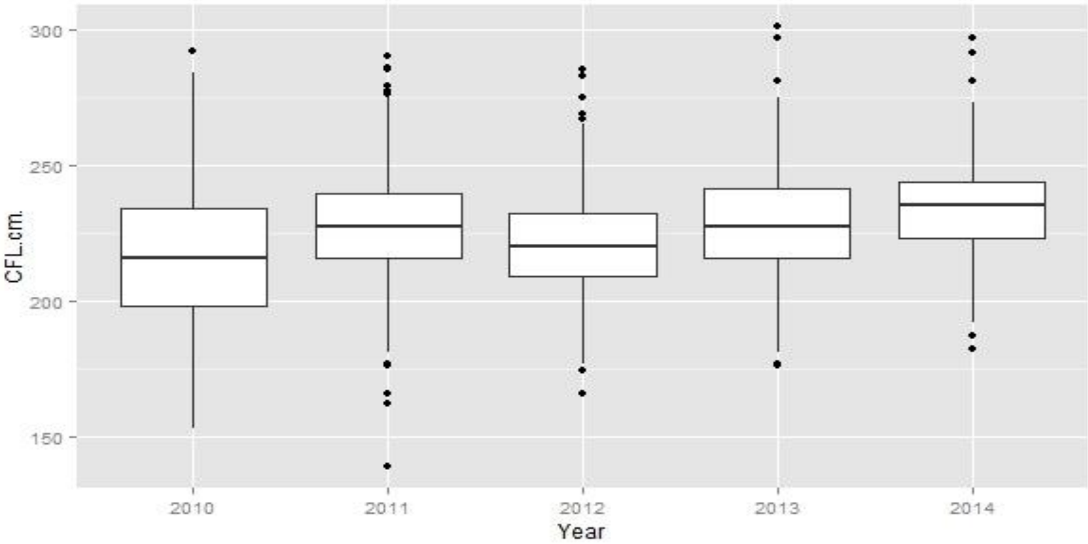

Figure 4. Boxes plot showing size distribution of bluefin tuna catches estimated from biological scraps, 2010-2014.

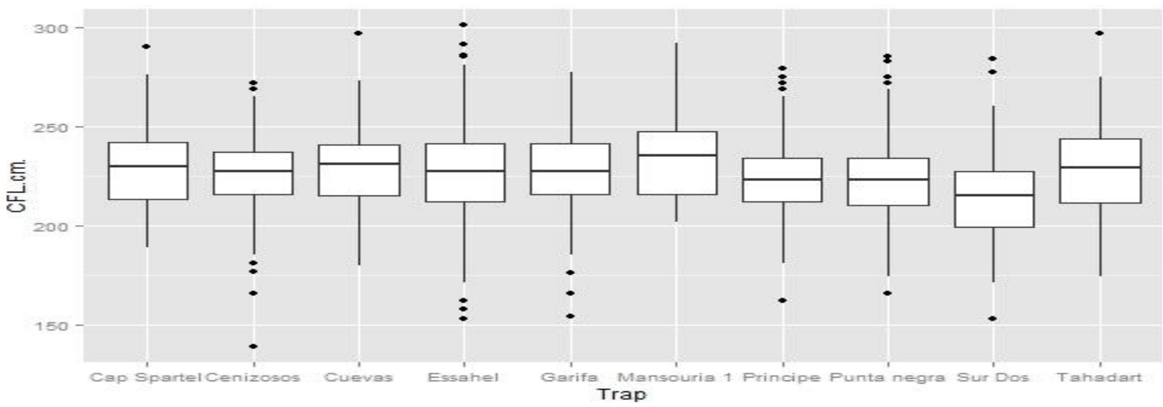

Figure 5. Boxes plot showing size distribution of bluefin tuna catches by trap estimated from biological scraps, 2010-2014.

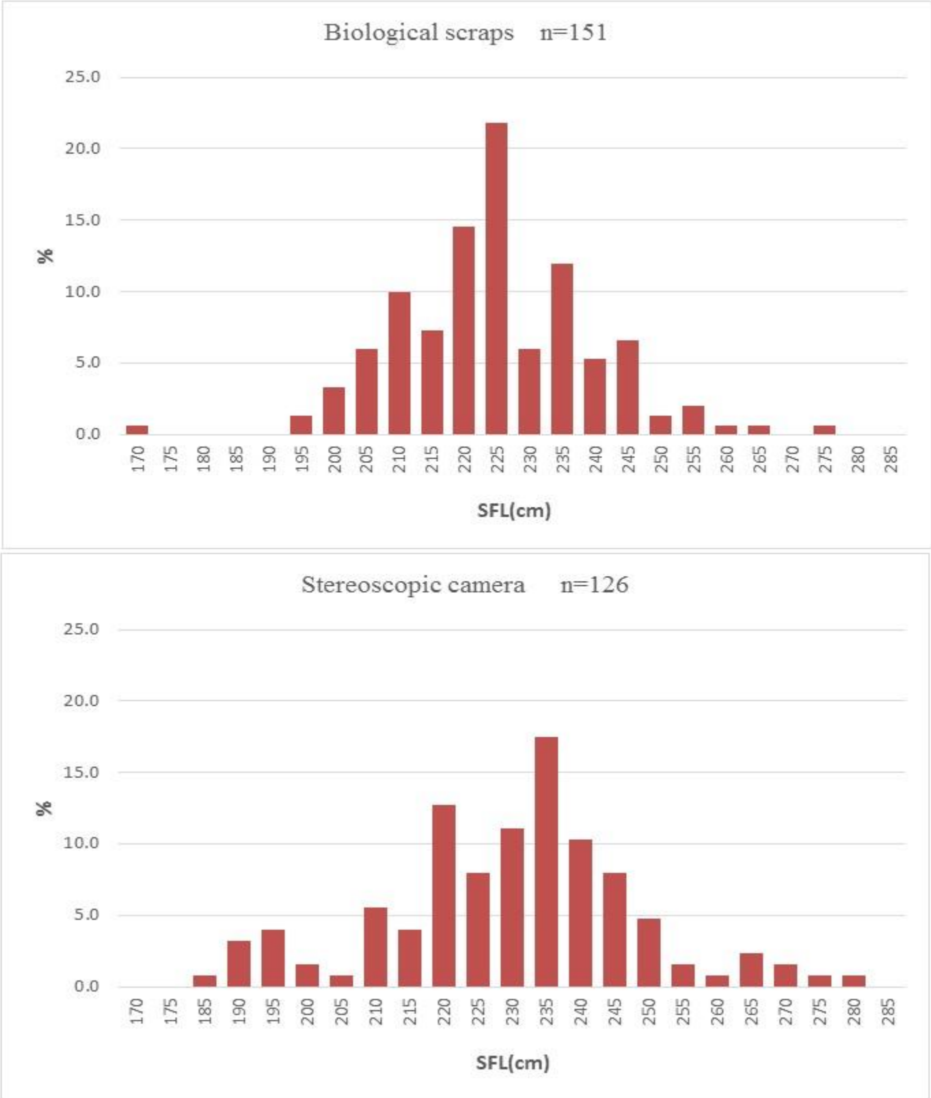

Figure 6. Comparison of the size frequency distribution of bluefin tunas catches obtained from biological scraps (6 - 12 May) with that estimated by the stereoscopic camera (1 May). Essahel trap. May 2014.