UPDATE OF CPUE BLUEFIN TUNA *THUNNUS THYNNUS* (L. 1758) CAUGHT BY TUNISIAN PURSE SEINES IN THE CENTRAL MEDITERRANEAN

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SUMMARY

The present paper analyse the evolution from 2009 to 2015 of Tunisian purse seines CPUE oppering in the central Mediterranean Sea. Data were analyzed following a General Linear Modelling (GLM) approach under log-normal error assumption. The GLM showed the significant effect of the factor year. We note a pattern similarity in the evolution of the CPUE and the mean weight of fish.

RÉSUMÉ

Cette étude analyse l'évolution, de 2009 à 2015, de l'indice de capture par unité d'effort (CPUE) des senneurs tunisiens pêchant le thon rouge en Méditerranée centrale. L'analyse des données a été effectuée en utilisant l'approche du Modèle Linéaire Généralisé (GLM), avec la supposition de la distribution de l'erreur log-normale. La modélisation par GLM a montré l'effet significatif du facteur année. Nous notons une similarité dans l'évolution de la CPUE et le poids moyen des poissons.

RESUMEN

Este estudio analiza la evolución desde 2009 hasta 2015 del índice de captura por unidad de esfuerzo (CPUE) de los cerqueros tunecinos que pescan atún rojo en el Mediterráneo central. El análisis de los datos se efectúa utilizando el enfoque del modelo lineal generalizado (GLM) bajo el supuesto de una distribución de error lognormal. La modelización mediante GLM muestra el efecto significativo del factor año. Se detectó una similitud en la evolución de la CPUE y en la del peso medio de los peces.

KEYWORDS

Thunnus thunnus, *purse seine, CPUE, GLM, Tunisia, Central Mediterranean*

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1. Introduction

Catch-per-unit-of-effort (CPUE) is usually assumed to be proportional to abundance and therefore included in the stock assessment as a relative index of abundance. The last work on Tunisian bluefin tuna fisheries CPUE had concerned the traps and it was in 2002 (Hattour *et al*., 2002). Since the closing of the Tunisian Madragues the bluefin tuna, were only caught by purse seine. The fishing season was for 2 months until 2009 and now is one month (**Table 1**).

Then, the aim of this study is to update (the last work of Zarrad and Missaoui, 2016) the evolution the CPUE of the BFT purse seines in the Tunisian fisheries (central Mediterranean Sea) from 2009 to 2015.

2. Material and methods

2.1 Description of data source

The data used in the present study were obtained from the General Direction of fisheries and Aquaculture (DGPA) of the Ministry of Agriculture (Tunisia). This data contains the number of fishing vessels, name of the vessel, time of the catch and amount of the catch.

The Tunisian purse seines catch and effort statistics from 2009 to 2015 were used. Data were per year and boat.

The catch was in weight and number. The effort had concerned the number days on the sea (NSD) and the number of fishing operation (NFO). The characteristics of the boats were collected and they concerned the length (LOA), the engine power (CV) and tonnage (Tx).

2.2 Model standardisation

Due to the importance of CPUE in many stock assessments and the assumption that CPUE is proportional to abundance, it is important that any other factors that may influence CPUE are removed from the index. The process of reducing the influence of these factors on CPUE is commonly referred to as standardizing the CPUE. There have been various methods developed to standardize CPUE. However, the most common method is the application of generalized linear models (GLM). GLMs are convenient because they have a long history, they are well understood, and they have accepted methods to choose factors, or variables, in a model.

The stock assessment model parameters are then modified to match the predicted relative index from the model with the CPUE based relative index of abundance. This is commonly referred to as fitting to the CPUE index, and it is carried out using an iterative function minimiser. The measure of how closely the indices match is usually a likelihood (or least squares) function based on the normal or log-normal distribution.

A Generalized Linear Modelling (GLM) approach (McCullagh and Nelder, 1989) was applied with catch in weight as the response variable and the year as the explanatory factor, under a log-normal error distribution (Ortiz de Urbina *et al*, 2007). The models included the main effects of year and the general form of the GLM used was:

$$CPUE \sim c + Year + e$$

where c = constant and e = error term.

Different unities of effort were test for the GLM modelling: NSD and NFO in first step, and effort combination of effort in the second step: NSD*CV, NSD*Tx and NSD*NFO. Statistical analysis, model fitting and graphs were accomplished under the STATISTICA Software (Statsoft Inc, version 7.1) and statistical inference was based on the 95% confidence level (Zar, 2010).

3. Results and discussion

The highest effort was recorded in the year 2011 and the minimum was in 2014 (**Figure 1**). The GLM showed the effect of the factors **year** ($p<0.01$). From the year 2009 (3116 kg/day) to the year 2011 (1456 kg/day), CPUE mean decreased and from the year 2012 (4204 kg/day) to the year 2014 an increase (6568 kg/day). The CPUEs of the last year 2015 decrease to reached the value of 4558 kg/day (**Figure 2**).

The mean weight pattern shows a decrease from 2009 to 2010, and an increase since 2011 (40.34 kg) to reach the value of 125.5 kg in 2014 and 95 kg in 2015 (**Figure 3**).

Then we can observe a similarity in the evolution pattern of the CPUE and the mean weight of fishes caught.

4. Conclusion

In conclusion, this paper provides the effect of the factor year on the evolution of the CPUE of the Tunisian purse seines operating in the central Mediterranean Sea. The CPUE showed an increase in the last years.

References

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Table 1. Purse seines fishing season and Tunisian TAC (tons).

Year	Purse seine fishing season	TAC-Tunisie	TAC E-Atl-Med	Catch
2009	16 Avril-14 June	2 254.48	28 500.00	1 932.00
2010	16 Mai-14 June	1 109.51	13 500.00	1 044.00
2011	16 Mai-14 June	1 017.56	12 900.00	852.00
2012	16 Mai-14 June	1 017.56	12 900.00	1 017.00
2013	26 Mai-24 June	1 057.00	13 400.00	1 057.00
2014	26 Mai-24 June	1 057.00	13 400.00	1 057.00
2015	26 Mai-24 June	1 247.97	15 821.00	1247.83

Table 2. Evolution of the annual fishing effort and CPUE (tons/day) of Tunisian purse seines.

Year	Nb. Authorised vissels	Nb. Active boats	Nb. Sea days	Nb. Fishing operations	CPUE NSD
2009	42	38	620	141	3.116
2010	42	37	331	74	3.153
2011	23	8	585	13	1.456
2012	21	12	242	13	4.204
2013	21	12	276	13	3.828
2014	21	8	166	15	6.568
2015	25	11	277	-	4.685

Table 3. Predicted CPUE (tons/day) for Tunisian purse seines.

Year	Nb. Observation	CPUE	SE	LOWER	UPPER
2009	38	4.093	0.098	3.378	4.959
2010	37	3.220	0.126	2.515	4.123
2011	23	1.436	0.358	711	2.900
2012	21	4.340	0.124	3.402	5.511
2013	21	4.314	0.125	3.377	5.600
2014	21	6.554	0.082	5.578	7.700
2015	25	4.558	0.108	3.686	5.636

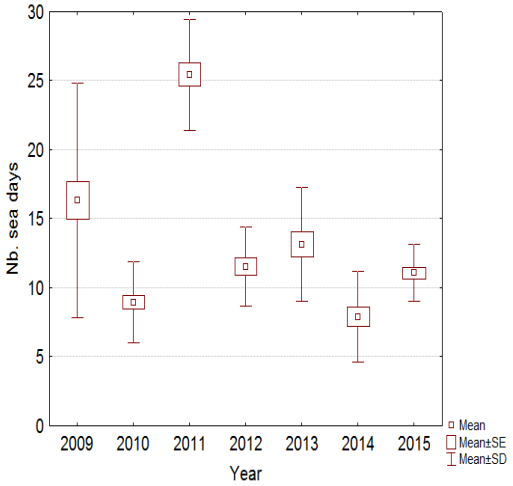

Figure 1. Annual evolution of the mean effort of Tunisian purse seines.

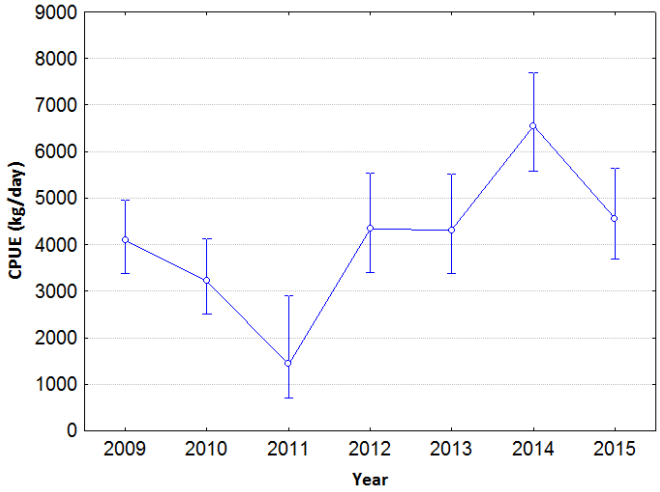

Figure 2. Annual evolution of CPUE predicted mean of Tunisian purse seines.

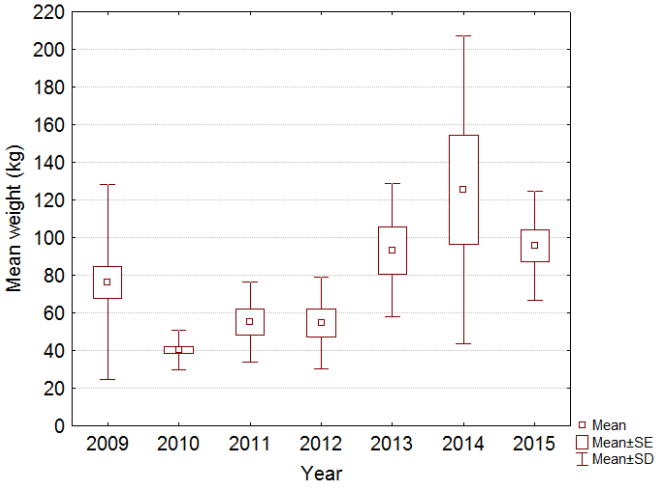

Figure 3. Evolution of individual mean weight of bluefin Tuna caught by Tunisian purse seines.