EVOLUTION OF CPUE OF TUNISIAN PURSE SEINES CATCHED BLUEFIN TUNA *THUNNUS THYNNUS* (L. 1758) IN THE CENTRAL MEDITERRANEAN

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SUMMARY

This work describes the evolution from 2009 to 2014 of CPUE of the Tunisian purse seines operating in the central Mediterranean Sea. Data were analyzed following a General Linear Modelling (GLM) approach under log-normal error assumption. The GLM showed the effect of the factor year.

RÉSUMÉ

Ce travail analyse l'évolution de 2009 à 2014 de l'indice de capture par unité d'effort CPUE des senneurs tunisien 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-normal. La modélisation par GLM a montré l'effet du facteur année.

RESUMEN

*Este trabajo analiza la evolución desde 2009 hasta 2014 del índice de captura por unidad de esfuerzo (CPU) de los cerqueros tunecinos que pescan atún rojo en el Mediterráneo central. Los datos fueron analizados utilizando el enfoque del Modelo Lineal Generalizado (GLM), con un enfoque de distribución del error lognormal. La modelación mediante GLM mostró el efecto del factor año.**KEYWORDS*

Thunnus thunnus, *purse seine, CPUE, generalized linear model, Tunisia*

1. Introduction

The proportion of the total admissible catch (TAC) of Tunisia for bluefin tuna *Thunnus thynnus thynnus* on the stock of the East Atlantic and Mediterranean is around 7.9% (7.8880702). The bluefin tuna since the closing of the Madragues of Sidi Daouad and Monastir, were only caught by purse seine. The fishing season was for 2 months until 2009 and now is one month (**Table 1**).

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. Then, the aim of this study is to analyze the evolution the CPUE of the BFT purse seines in the Tunisian fisheries (central Mediterranean Sea) from 2009 to 2014.

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. Fishing effort was reported in terms of the fishing days. The Tunisian purse seines catch and effort statistics from 2009 to 2014 were used. Data were per year and boat.

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The catch is 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 of the CPUEs to reach in the last year (6568 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 (**Figure 3**).

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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Oritz de Urbina J., Fromentin J.-M., Restrepo V.R., Arrizabalaga H., and de la Serna J.M. 2007. Standardized CPUE of bluefin tuna (*Thunnus thynnus*) caught by Spanish traps for the period 1981-2004. Collect. Vol. Sci. Pap. ICCAT, 60(3): 913-927.

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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

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

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

Year	*Nb. observation*	*CPUE*	*SD*	*SE*	*LOWER*	*UPPER*
2009	38	4.093	3.770	0.612	2.854	5.332
2010	37	3.220	1.510	0.248	2.717	3.724
2011	23	1.436	0.509	0.106	1.215	1.656
2012	21	4.340	2.040	0.445	3.411	5.269
2013	21	4.314	2.824	0.616	3.028	5.600
2014	21	6.554	2.929	0.639	5.220	7.887

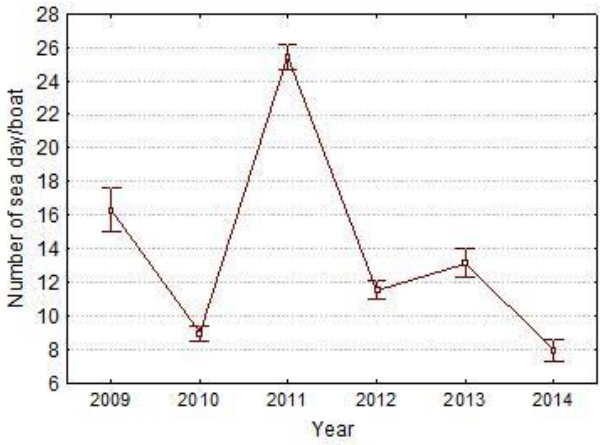

Figure 1. Annual evolution of the effort (+/- 0.95SE) of Tunisian purse seines.

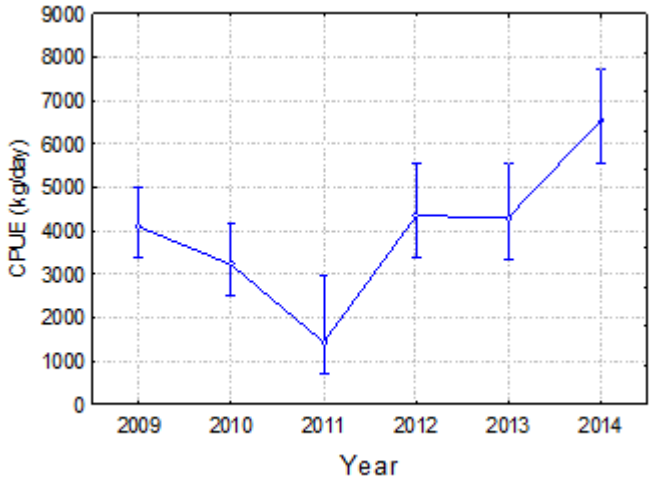

Figure 2. Annual evolution of CPUE (+/- 0.95SE) predicted mean of Tunisian purse seines.

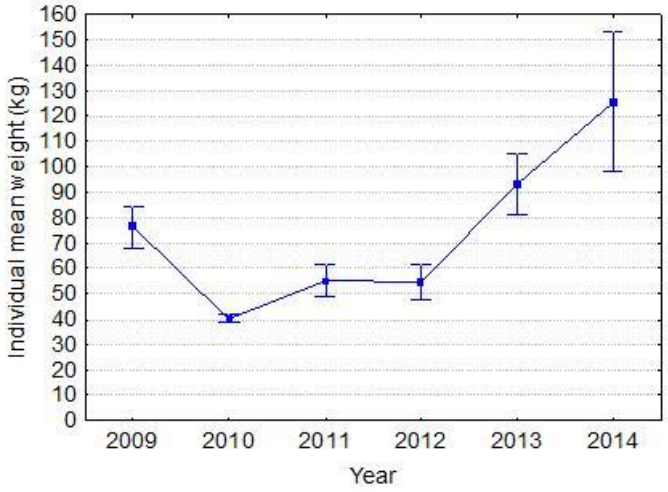

Figure 3. Evolution of individual mean weight (+/- 0.95SE) of bluefin Tuna caught by Tunisian purse seines.