UPDATE ON CPUE BLUEFIN TUNA CAUGHT BY TUNISIAN PURSE SEINES BETWEEN 2009 AND 2016

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SUMMARY

Bluefin catch rates of Tunisian purse seines from 2009 to 2016 were standardised. 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 on the catch per unit of effort CPUE. We note some similarity in the evolution of the CPUE and the mean weight of fish. The minimum standardized CPUE was recorded in 2011 (1436 kg/day). Maximum CPUE was reached in 2014 (6554 kg/day). Higher values were recorded in the last two years 2015 (4558 kg/day) and 2016 (4778 kg/day).

RÉSUMÉ

Les taux de capture par unité d'effort CPUE des senneurs tunisiens pêchant le thon rouge en Méditerranée centrale de 2009 à 2016 ont été standardisés. 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 significatif du facteur année. Nous notons une certaine similarité dans l'évolution des CPUE standardisées et le poids moyen des poissons. La CPUE minimale a été enregistrée en 2011 (1436 kg/jour). La valeur maximale a été atteinte en 2014 (6554 kg/jour), aussi des valeurs élevées ont été notées en 2015 (4558 kg/jour) et en 2016 (4778 kg/jour).

RESUMEN

Se estandarizaron las tasas de captura de los cerqueros tunecinos desde 2009 a 2016. Se analizaron los datos siguiendo un enfoque de modelación GLM con un supuesto de error lognormal. El GLM mostró el efecto significativo del factor año en la captura por unidad de esfuerzo, CPUE. Se observó cierta similitud en la evolución de la CPUE y el peso medio de los peces. La CPUE estandarizada mínima se registró en 2011 (1436 kg/día). La CPUE máxima se alcanzó en 2014 (6554 kg/día). Los valores más elevados se han registrado en los dos últimos años, 2015 (4558 kg/día) y 2016 (4778 kg/día).

KEYWORDS

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

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1. Introduction

In Tunisia, since the closing of traps in 2002 (Hattour *et al*. 2002) the bluefin tuna, were only caught by purse seines. 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 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 2016.

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 2016 (8 years), were analysed.

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 GLM showed a significant effect of the factors **Year** ($p<0.01$). The evolution of the standardised CPUE showed a low value in 2011 (1436 kg/day), and the maximum in 2014 (6568 kg/day). The CPUEs of 2015 decrease to reached the value of 4558 kg/day (**Figure 3; Table 2**). However, an increase of 5% was recorded between 2015 and 2016.

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 2**). Then we can observe some similarities in the evolution pattern of the CPUE and the mean weight of caught fishes.

The effort of purse seine can be object of biased estimation. Anonymous (2012) suggested to make difference between the sea days and sea searching days of fish schools. This precision can get sources data from vessels monitoring system (VMS).

4. Conclusion

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

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

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
2016	26 Mai-24 June	1 491.71	18 911.00	1461.33

Table 2. Predicted CPUE (kg/day) for Tunisian purse seines.

Year	Nb. Observations	CPUE	SE	LOWER	UPPER
2009	38	4093	0.097	3385	4950
2010	37	3220	0.125	2521	4114
2011	23	1436	0.355	715	2882
2012	21	4340	0.123	3410	5524
2013	21	4314	0.124	3384	5499
2014	21	6554	0.081	5586	7689
2015	25	4558	0.107	3693	5626
2016	27	4778	0.098	3939	5797

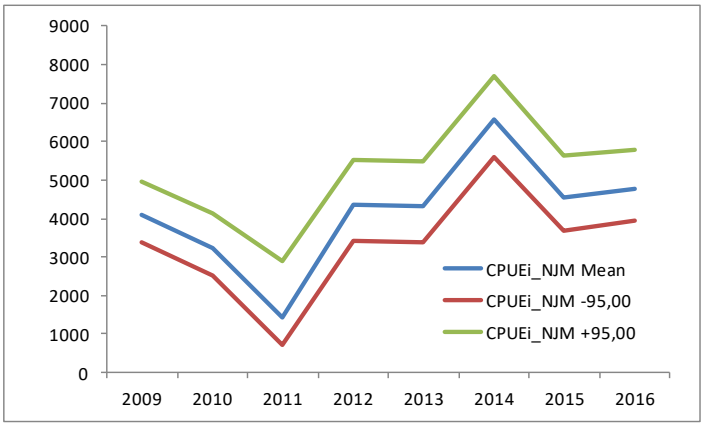

Figure 1. Annual evolution of CPUE predicted mean of Tunisian purse seines.

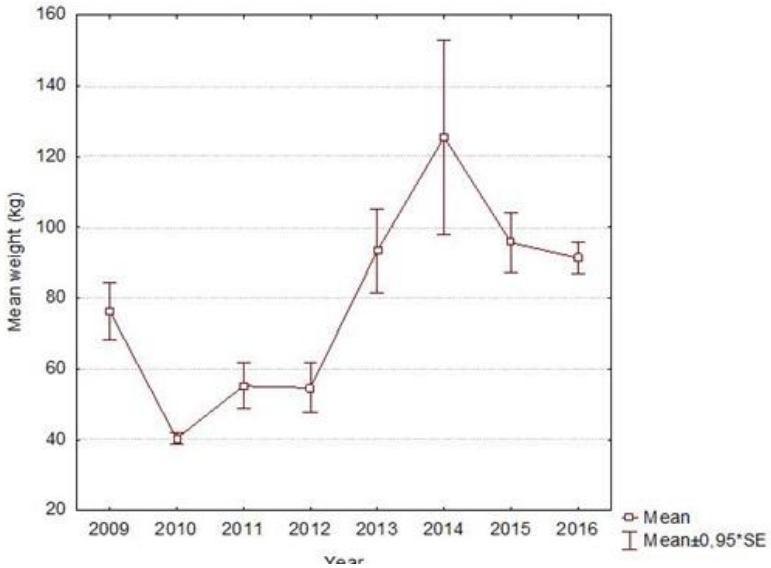

Figure 2. Evolution of individual mean weight of bluefin tuna caught by Tunisian purse seines.