STANDARDIZED CPUE OF BLUEFIN TUNA (*THUNNUS THYNNUS*) CAUGHT BY MOROCCAN TRAPS FOR THE PERIOD 1986- 2013

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SUMMARY

*Relative abundance indices of bluefin tuna (*Thunnus thynnus*) caught by the Moroccan traps in the Atlantic area close to the Strait of Gibraltar were updated up to 2013. Standardized CPUEs were estimated through a General Linear Modeling (GLM) approach under a negative binomial error distribution assumption. A remarkable increase of the relative abundance index is observed in 2012- 2013, reflected by the huge number of fish released after the achievement of the quota.*

RÉSUMÉ

*Des indices d'abondance relative de thon rouge (*Thunnus thynnus*) capturé par des madragues marocaines dans la zone atlantique proche du détroit de Gibraltar ont été actualisés jusqu'en 2013. Des CPUE standardisées ont été estimées par le biais d'une approche de modélisation linéaire généralisée (GLM) en postulant une distribution d'erreur binomiale négative. Une augmentation spectaculaire de l'indice d'abondance relative est observée en 2012-2013, reflétée par le grand nombre de poissons remis à l'eau une fois le quota atteint.*

RESUMEN

*Se actualizaron hasta 2013 los índices de abundancia relativa de atún rojo (*Thunnus thynnus*) capturado por almadrabas marroquíes en el área cercana al Estrecho de Gibraltar. Las CPUE estandarizadas se estimaron mediante un enfoque GLM con un supuesto de distribución de error binomial negativa. Se observó un importante incremento del índice de abundancia relativa en 2012 y 2013, que se refleja en el gran número de ejemplares liberados tras el consumo de la cuota.*

KEYWORDS

Bluefin tuna, Relative abundance, Moroccan traps, GLM

1. Introduction

The Moroccan traps relative abundance index has been traditionally used for VPA - calibrating purposes at the EBFT Stock Assessment Sessions (Anonymous, 2013, 2011, 2009).

The purpose of this document is to update previously reported information on bluefin tuna standardized catch rates for Moroccan traps (Abid and Idrissi, 2011, Abid *et al*., 2009 & Abid *et al*., 2007)

In order to implement Rec. [08.05], Rec. [10.04] and Rec. [12-03] the Moroccan Administrations set up a *quota-by-gear* system, starting in 2009. As a result, the traps were forced to release previously caught fish once the awarded quota was reached. The estimated number of released fish, reported by the traps operators since 2009 was included in the data base for the current analysis.

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2. Material and methods

Description of data source

The annual catch data in number of BFT as well as the number of fish released were obtained from traps operators. For the purpose of updating the relative abundance index for the Moroccan traps, the data used concerned only 4 traps for which the longest time series data are available.

Size/age range of fish

This index is applied to spawners whose size ranged from 200 to 280 cm CFL, which correspond to fish aged 10+ years (Abid *et al*, 2013) **(Figure 1).** This is consistent with studies which demonstrated that the individuals of these age groups are fully selected by Spanish traps.

Management regulation

The Moroccan trap fishery remained stable for many years both in term of the geographic location and the technical characteristics of traps. Nevertheless, with the significant reduction in quota since 2010 coupled with the higher number of BFT entering the traps, during the month of May, the fishing season of Moroccan traps has become shorter and has not been longer than 3 weeks in the three last years (25^{th} April -15^{th} May).

In order to take into account the effect of the recent management regulation on the catch rates, an estimation of the number of fish released by each trap was obtained from the traps operators to be taken into account in the total catch in number standardisation. As it was assumed in the previous analyses, the fishing effort of traps for the whole season was considered to be the same over the whole time series.

Model standardisation

A Generalized Linear Modeling (GLM) approach (McCullagh and Nelder, 1989) was applied with total catch in number as the response variable and the year and *trap* as the explanatory factors, under a negative binomial error distribution assumption (Ortiz de Urbina *et al*, 2007).

3. Results

Deviance analysis results are reported in **Table 1**. Based on its statistical significance as well as the percentage of the deviance explained by each factor, the final model for CPUE in number of fish for the whole fishing season included both factors *year* and *trap*. The selected model explains about 66% of the variability in the response variable. The factor Year explains roughly about 56%.

Diagnostic plots (residuals *vs* fitted values and cumulative normalized residual plots) are shown in **Figure 2**. In general, residual patterns are not far from expected under the negative binomial error distribution assumption, which suggests a reasonably good fit.

Annual standardized relative abundance index with corresponding 95% confidence limit, the coefficients of variation, as well as the nominal CPUEs are reported in **Table 2.** Trend for the estimated standardized catch rates is shown in **Figure 3**.

The highest values of the index recorded in the two last years are mainly due to the high number of fish released by traps. More than 10 000 and 32 000 fish were released in 2012 and 2013, respectively, after the quotas had been reached, which represent on average 1 000 and 3200 fish released by trap.

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Table 1. Deviance analysis results. BFT catch in number. Moroccan Traps. 1986- 2013. *Δ deviance refers to change in deviance; % deviance: percent of deviance explained with respect to the null model; p-value: χ^2 probability between consecutive models*.

Model factors	*Residual df*	*residual deviance*	*Δ deviance*	*% deviance*	*p-value*
null	93	293.47			
Year	66	127.71	165.76	56.48	< 2.20E-16
Year+ Trap	63	99.22	28.50	9.71	2.86 E-06

Table 2. GLM estimated standardized relative abundance indices, with corresponding 95% upper and lower confidence limit, nominal CPUE and coefficient of variation (CV %). BFT catch in number. Moroccan Traps. 1986- 2013.

Year	*Nom.CPUE*	*Std.CPUE*	*Upper*	*Lower*	*CV*
1986	680.0	1933.4	6350.9	588.6	8.5%
1987	516.0	1467.3	4823.5	446.3	8.8%
1988	1291.0	3669.9	12041.7	1118.4	7.8%
1989	974.0	1062.3	2500.6	451.3	6.6%
1990	295.5	411.8	755.8	224.4	5.4%
1991	966.0	1773.2	3246.7	968.5	4.3%
1992	177.5	253.1	465.5	137.6	5.9%
1993	261.8	347.3	637.9	189.1	5.6%
1994	320.8	428.8	787.0	233.7	5.4%
1995	169.3	255.5	469.9	138.9	5.9%
1996	369.7	411.2	817.9	206.8	6.1%
1997	889.0	1039.6	2063.1	523.9	5.3%
1998	1309.3	1682.1	3336.3	848.1	4.9%
1999	788.0	1086.5	2156.0	547.5	5.2%
2000	1003.8	1271.8	2329.2	694.4	4.5%
2001	2271.5	3579.5	6551.5	1955.7	3.9%
2002	1498.0	2849.9	5216.6	1556.9	4.0%
2003	844.8	1806.5	3307.6	986.6	4.3%
2004	387.5	567.9	1041.5	309.7	5.1%
2005	1031.5	1743.7	3192.8	952.4	4.3%
2006	803.8	1234.1	2260.4	673.8	4.5%
2007	1409.3	2396.8	4387.6	1309.3	4.1%
2008	787.0	1150.2	2106.8	627.9	4.6%
2009	1002.3	1324.7	2426.0	723.3	4.5%
2010	840.7	1192.7	2366.7	601.1	5.2%
2011	668.5	1040.0	1905.1	567.7	4.6%
2012	1475.3	2034.6	4035.5	1025.8	4.8%
2013	5366.0	6862.5	13604.8	3461.5	4.1%

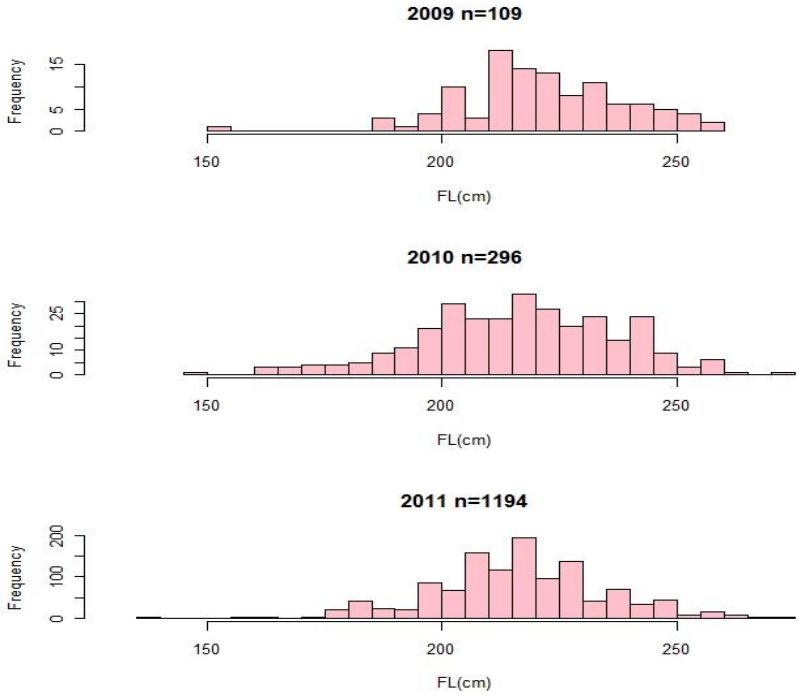

Figure 1. The annual size frequencies of BFT catch by Moroccan Atlantic traps, 2009-2011.

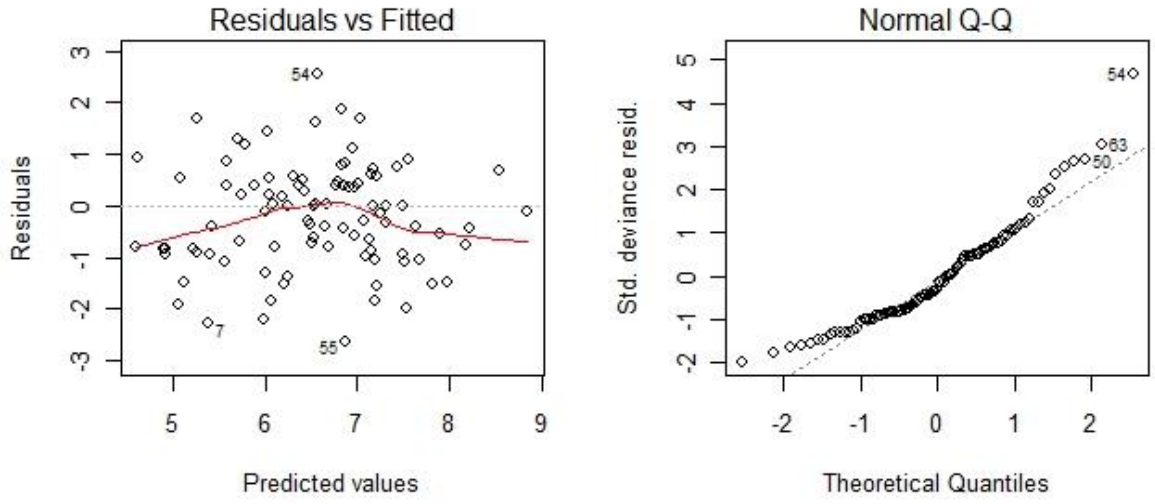

Figure 2. Diagnostic plots: residuals *vs* fitted values and cumulative normalized residual plot.

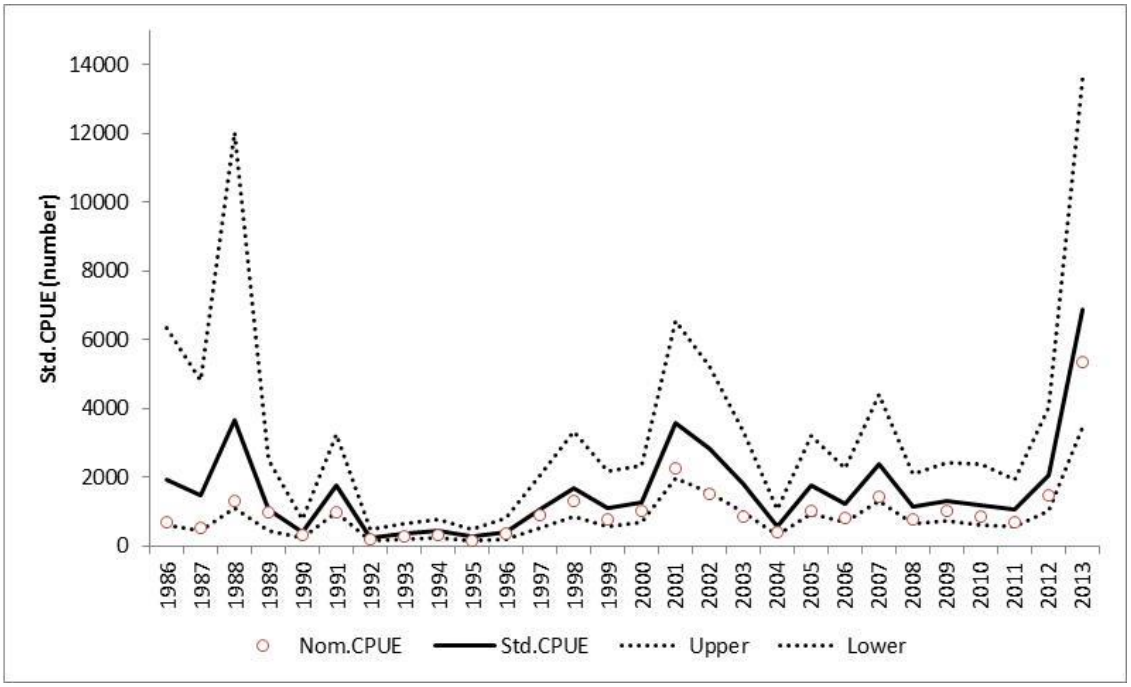

Figure 3. Estimated standardized relative abundance index and corresponding 95% confidence limits Moroccan traps, 1986- 2013.