

**UPDATED STANDARDIZED JOINT CPUE INDEX FOR
BLUEFIN TUNA (*THUNNUS THYNNUS*) CAUGHT BY MOROCCAN
AND SPANISH TRAPS FOR THE PERIOD 1981- 2013**

N. Abid¹, A. Faraj¹, J.M. de la Serna², D. Macías², S. Saber², J. Ortiz de Urbina²

SUMMARY

Relative abundance indices of bluefin tuna (Thunnus thynnus) caught by the Moroccan and Spanish traps in the area close to the Strait of Gibraltar were estimated for the period 1981-2013. Standardized CPUEs were estimated through a General Linear Modeling (GLM) approach under a negative binomial error distribution assumption.

RÉSUMÉ

Des indices d'abondance relative de thon rouge (Thunnus thynnus) capturé par des madragues espagnoles et marocaines dans la zone proche du détroit de Gibraltar ont été estimés pour la période allant de 1981 à 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.

RESUMEN

Se estiman índices de abundancia relativa para las capturas de atún rojo (Thunnus thynnus) de las almadrabas marroquíes y españolas del estrecho de Gibraltar para el periodo 1981-2013. Las CPUE se estandarizaron mediante técnicas de GLM asumiendo un error de tipo binomial negativo.

KEYWORDS

CPUE, Catch, Effort, Abundance, Trap fishing, Bluefin tuna

1. Introduction

The Moroccan and Spanish trap abundance indices have been traditionally used for VPA- calibrating purposes at BFT Eastern Stock Assessment Sessions (ICCAT 2011). These indices are applied to spawners' (age group 10⁺).

A previous document (Ortiz de Urbina *et al.*, 2006) explored the adequacy of the traditionally used effort unit and model error assumptions for the standardization of the trap CPUE index. Based on the conclusions of the above mentioned document, the BFT Eastern Stock Assessment Working Group decided to use standardized trap catch, in number of fish, assuming a negative binomial error distribution.

This document updates previously reported information (Ortiz de Urbina *et al.*, 2009; Ortiz de Urbina *et al.*, 2011; Abid and Idrissi, 2010; Abid *et al.*, 2012) on bluefin tuna standardized catch rates for both countries from 1981 to 2013.

In order to implement Rec.[06-05] and Rec.[08-05], both the Moroccan and Spanish Administrations set up a *quota-by-gear* system, starting in 2008. As a result, the traps are forced to release previously caught fish in case the awarded quota be reached. Data on Spanish catch for 2008 was not affected since the traps did not reach the awarded quota. For the period 2009- 2012, estimated number of released fish, reported by the traps operators

¹ Fisheries biologist, INRH, Regional Centre of Tangiers, Morocco

² Head of fisheries department, INRH, Casablanca, Morocco.

³ Instituto Español de Oceanografía (IEO- CO Málaga).

from both countries, was included in the data base for the analysis. For year 2013, scientific monitoring of the Moroccan traps was carried out as for previous years. On the other hand, scientific monitoring of the Spanish traps could not be carried out.

2. Material and Methods

Data were obtained from the Moroccan and Spanish trap fishery for bluefin tuna in areas close to the Strait of Gibraltar. Information on catch in number of individuals, size composition, effort, and trap characteristics was collected from 1981 to 2012 for the Spanish traps and from 1986 to 2013 for the Moroccan ones.

Table 1 shows the number of observations by factor considered in the model.

A Generalized Linear Modeling (GLM) approach (McCullagh and Nelder, 1989) with number of fish for the whole trap season as the response variable, *year* and *trap* as explanatory factors, and a negative binomial error distribution was used.

3. Results

Deviance analysis results are reported in **Table 2**. Based on its statistical significance as well as the percentage of the deviance explained by each factor, final model for catch in number of fish for the whole fishing season included both factors *year* and *trap*.

Diagnostic plots (residuals vs fitted values and cumulative normalized residual plots) are shown in **Figure 1**. 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 indices (fitted values and fitted values scaled to the first year in the time series) are reported in **Table 3** for catch in number of fish for the whole trap season.

Trends for the estimated standardized catch rates and corresponding 95 % confidence limits based on a normal approximation are shown in **Figure 2**.

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Table 1. Observations by factor. Moroccan and Spanish Traps 1981- 2013.

<i>Year</i>	<i>Country-trap</i>							
	<i>mo1</i>	<i>mo2</i>	<i>mo3</i>	<i>mo4</i>	<i>sp1</i>	<i>sp2</i>	<i>sp3</i>	<i>sp4</i>
1981	NA	NA	NA	NA	1	NA	NA	NA
1982	NA	NA	NA	NA	1	1	1	NA
1983	NA	NA	NA	NA	1	1	1	NA
1984	NA	NA	NA	NA	1	1	1	NA
1985	NA	NA	NA	NA	1	1	1	NA
1986	1	NA	NA	NA	1	1	1	1
1987	1	NA	NA	NA	1	1	1	1
1988	1	NA	NA	NA	1	1	1	1
1989	1	NA	1	NA	1	1	1	1
1990	1	1	1	1	1	1	1	1
1991	1	1	1	1	1	1	1	1
1992	1	1	1	1	1	1	1	1
1993	1	1	1	1	1	1	1	1
1994	1	1	1	1	1	1	1	1
1995	1	1	1	1	1	1	1	1
1996	1	NA	1	1	1	1	1	1
1997	1	NA	1	1	1	1	1	1
1998	1	NA	1	1	1	1	1	1
1999	1	NA	1	1	1	1	1	1
2000	1	1	1	1	1	1	1	1
2001	1	1	1	1	1	1	1	1
2002	1	1	1	1	1	1	1	1
2003	1	1	1	1	1	1	1	NA
2004	1	1	1	1	1	1	1	1
2005	1	1	1	1	1	1	1	1
2006	1	1	1	1	1	1	1	1
2007	1	1	1	1	1	1	1	1
2008	1	1	1	1	1	1	1	1
2009	1	1	1	1	1	1	1	1
2010	NA	1	1	1	1	1	1	1
2011	1	1	1	1	1	1	1	1
2012	1	1	1	1	1	1	1	1
2013	NA	1	1	1	NA	NA	NA	NA

Table 2. Deviance analysis results. BFT catch in number. Moroccan and Spanish Traps. 1981- 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.

(whole season)	residual	residual			
Model factors	df	deviance	Δ deviance	% deviance	p-value
null	213	545.58			
Year	181	391.73	181.41	31.65	2.20E-16
Year+ Trap	174	225.11	166.62	29.07	2.20E-16

Table 3. GLM estimated standardized relative abundance indices, standard errors and coefficient of variation (CV %). BFT catch in number. Moroccan and Spanish Traps. 1981- 2013. Catch for the whole season.

Year	Nominal	Index	scaled	std. Error	CV	upp95CI	low95CI
1981		768.36	1.00	439.39	57.19	1629.57	
1982		1038.12	1.35	359.55	34.63	1742.84	333.41
1983		1092.05	1.42	378.22	34.63	1833.35	350.74
1984		1200.27	1.56	415.68	34.63	2015.01	385.54
1985		814.46	1.06	282.12	34.64	1367.42	261.50
1986		394.33	0.51	110.63	28.05	611.16	177.50
1987		433.53	0.56	121.61	28.05	671.88	195.18
1988		1014.56	1.32	284.34	28.03	1571.87	457.24
1989		531.45	0.69	138.67	26.09	803.24	259.66
1990		614.37	0.80	138.83	22.60	886.47	342.27
1991		727.86	0.95	164.44	22.59	1050.15	405.56
1992		313.95	0.41	71.03	22.63	453.18	174.73
1993		325.36	0.42	73.61	22.62	469.63	181.09
1994		341.90	0.44	77.34	22.62	493.49	190.31
1995		223.43	0.29	50.61	22.65	322.62	124.24
1996		375.22	0.49	92.38	24.62	556.28	194.16
1997		992.41	1.29	244.05	24.59	1470.75	514.08
1998		925.14	1.20	227.52	24.59	1371.07	479.21
1999		1137.45	1.48	279.69	24.59	1685.64	589.26
2000		739.23	0.96	167.01	22.59	1066.57	411.90
2001		1284.62	1.67	290.08	22.58	1853.18	716.06
2002		1130.42	1.47	255.28	22.58	1630.77	630.06
2003		662.66	0.86	156.91	23.68	970.20	355.11
2004		332.36	0.43	75.19	22.62	479.73	184.99
2005		677.39	0.88	153.05	22.59	977.37	377.41
2006		633.94	0.83	143.25	22.60	914.70	353.18
2007		1000.60	1.30	225.99	22.59	1443.53	557.66
2008		634.18	0.83	143.30	22.60	915.05	353.32
2009		876.71	1.14	198.03	22.59	1264.85	488.57
2010		1042.24	1.36	246.59	23.66	1525.56	558.92
2011		674.97	0.88	152.50	22.59	973.87	376.06
2012		1187.75	1.55	280.99	23.66	1738.50	637.01
2013		4285.56	5.58	1419.51	33.12	7067.79	1503.33

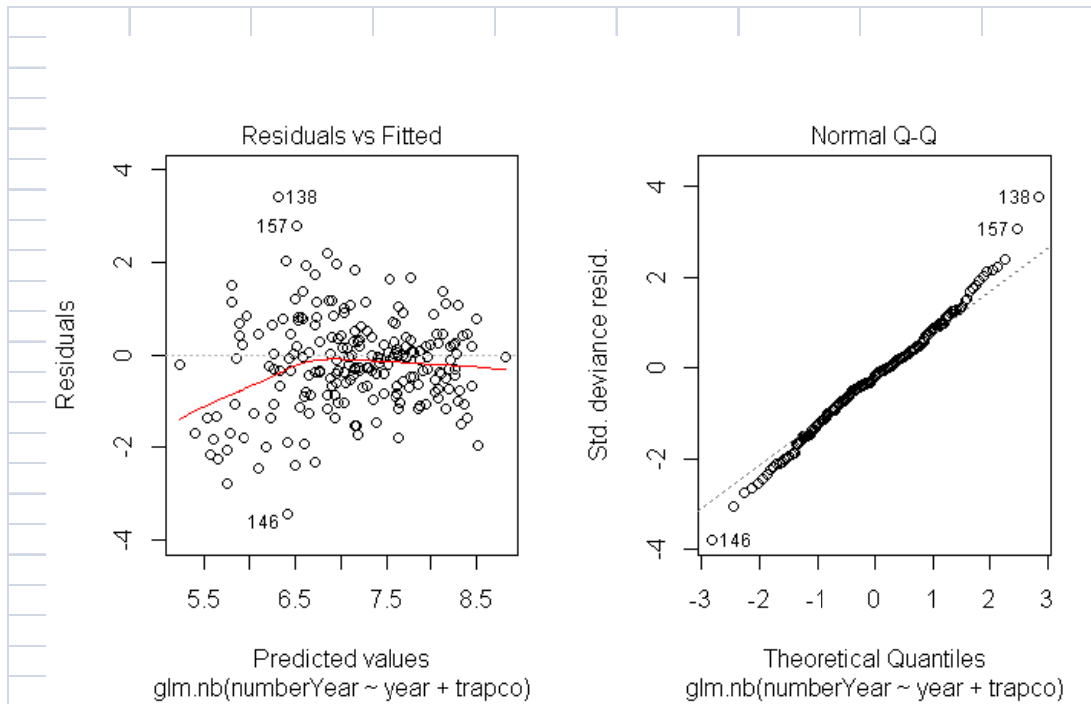


Figure 1. Diagnostic plots: residuals vs fitted values and cumulative normalized residual plot.

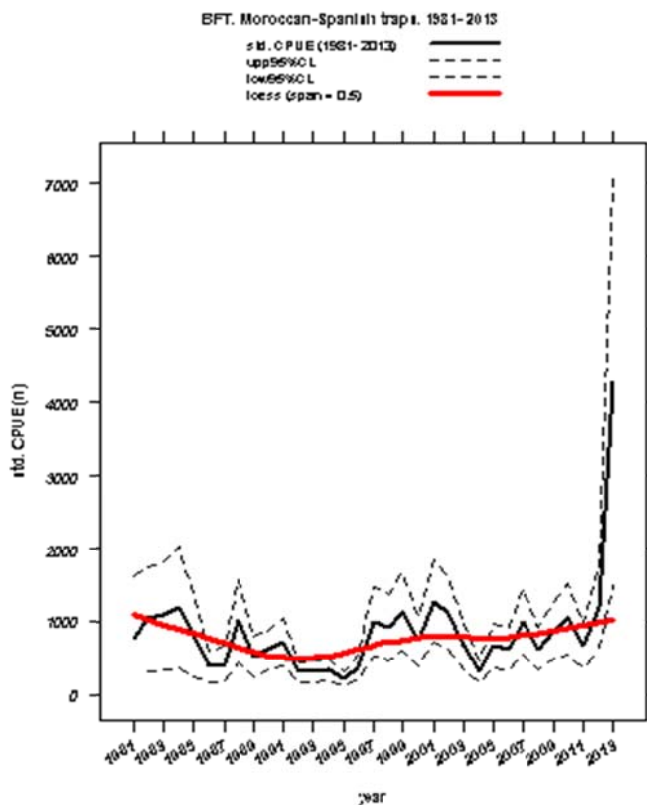


Figure 2. Estimated standardized relative abundance index and corresponding 95% confidence limits (normal approximation). Moroccan and Spanish traps. 1981-2013.