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UPDATED STANDARDIZED JOINT CPUE INDEX FOR BLUEFIN TUNA (*THUNNUS THYNNUS*) CAUGHT BY MOROCCAN AND SPANISH TRAPS FOR THE PERIOD 1981- 2011

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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 1981-2011. Standardized CPUEs were estimated through a General Linear Modeling (GLM) approach under a negative binomial error distribution assumption.*

RÉSUMÉ

*Des indices d'abondance relative du 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 2011. 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 período 1981-2011. 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) on bluefin tuna standardized catch rates for both countries from 1981 to 2011.

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 and Moroccan catches for 2008 was not affected since the traps did not reach the awarded quota. Since 2009, estimated number of released fish, reported by the traps operators from both countries, was included in the data base for the current analysis.

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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 2011.

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 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- 2011.

	country-trap							
year	***mo1***	***mo2***	***mo3***	***mo4***	***sp1***	***sp2***	***sp3***	***sp4***
1981					1			
1982					1	1	1	
1983					1	1	1	
1984					1	1	1	
1985					1	1	1	
1986	1				1	1	1	1
1987	1				1	1	1	1
1988	1				1	1	1	1
1989	1		1		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		1	1	1	1	1	1
1997	1		1	1	1	1	1	1
1998	1		1	1	1	1	1	1
1999	1		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	
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		1	1	1	1	1	1	1
2011	1	1	1	1	1	1	1	1

Table 2. Deviance analysis results. BFT catch in number. Moroccan and Spanish Traps. 1981- 2011. *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	203	522.66			
Year	173	375.11	147.55	28.23	2.20E-16
Year+ Trap	166	214.81	160.30	30.67	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- 2011. Catch for the whole season.

year	*nominal*	*stand. index*	*scaled stand. index*	*std. Error*	CV(%)
1981	1541.00	1541.00	1.00	856.03	55.55
1982	1008.00	2061.62	1.34	682.58	33.11
1983	2187.00	2174.30	1.41	719.87	33.11
1984	2524.00	2391.52	1.55	791.75	33.11
1985	1297.00	1621.34	1.05	536.89	33.11
1986	475.00	781.72	0.51	207.32	26.52
1987	703.00	860.82	0.56	228.26	26.52
1988	2090.00	2014.26	1.31	533.60	26.49
1989	574.00	1071.04	0.70	263.25	24.58
1990	1218.00	1228.66	0.80	269.65	21.95
1991	986.00	1454.41	0.94	319.13	21.94
1992	602.00	630.44	0.41	138.54	21.97
1993	655.00	655.10	0.43	143.94	21.97
1994	1045.00	689.65	0.45	151.51	21.97
1995	565.00	447.47	0.29	98.43	22.00
1996	1852.00	756.43	0.49	174.89	23.12
1997	2312.00	1996.46	1.30	461.01	23.09
1998	1906.00	1849.79	1.20	427.17	23.09
1999	2804.00	2279.69	1.48	526.36	23.09
2000	1278.00	1497.16	0.97	328.50	21.94
2001	1274.00	2579.38	1.67	565.70	21.93
2002	2173.00	2257.33	1.46	495.12	21.93
2003	434.00	1318.13	0.86	304.97	23.14
2004	1214.00	665.17	0.43	146.15	21.97
2005	1128.00	1348.53	0.88	295.93	21.94
2006	481.00	1277.98	0.83	280.46	21.95
2007	1161.00	2006.59	1.30	440.16	21.94
2008	1675.00	1277.25	0.83	280.30	21.95
2009	1964.00	1576.03	1.02	345.79	21.94
2010	3533.00	2023.26	1.31	467.81	23.12
2011	1167.00	1406.38	0.91	308.61	21.94

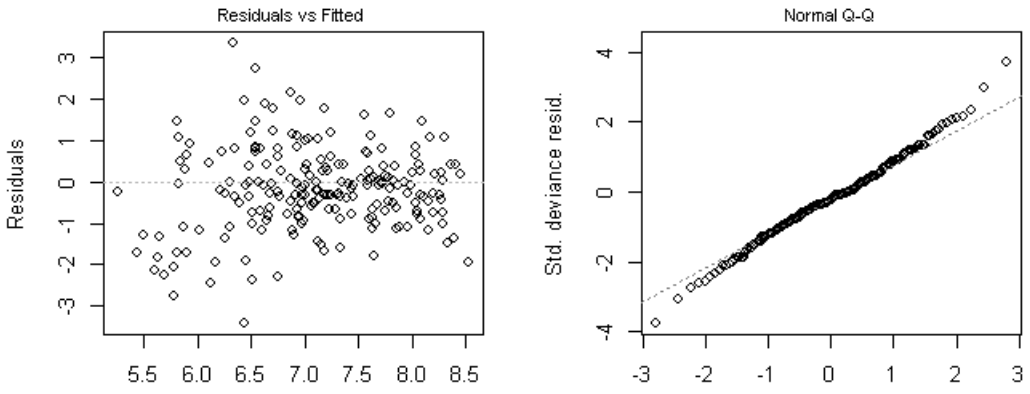

Figure 1. Diagnostic plots: residuals *vs* fitted values and cumulative normalized residual plot.

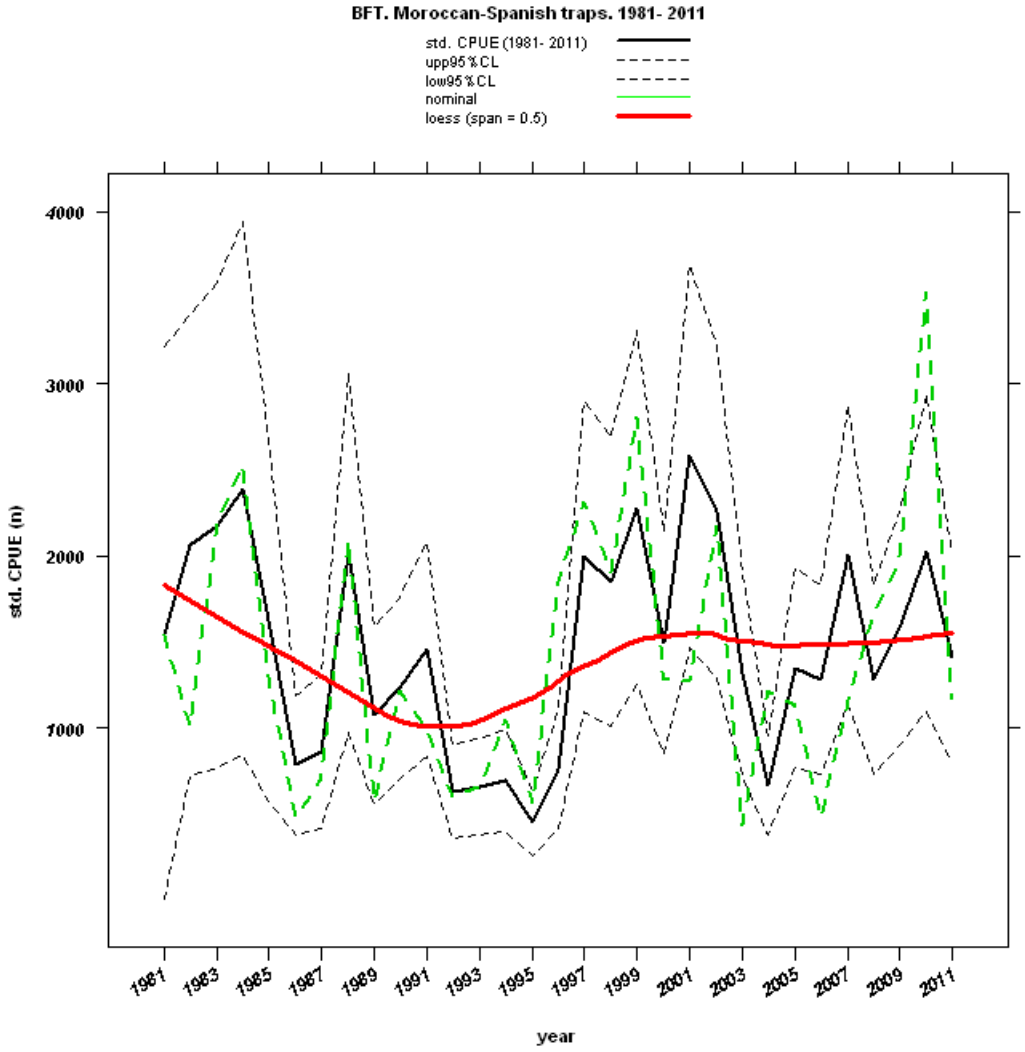

Figure 2. Nominal and estimated standardized relative abundance index and corresponding 95% confidence limits (normal approximation). Moroccan and Spanish traps. 1981- 2011.