UPDATED STANDARDIZED JOINT CPUE INDEX FOR BLUEFIN TUNA (*THUNNUS THYNNUS*) CAUGHT BY MOROCCAN AND SPANISH TRAPS FOR THE PERIOD 1981- 2012

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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 1981-2012. 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 2012. 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- 2012. 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 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 catch 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 2012.

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- 2012.

	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
2012		1	1	1	1	1	1	1

Table 2. Deviance analysis results. BFT catch in number. Moroccan and Spanish Traps. 1981- 2012. *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) ***Model factors***	***residual df***	***residual deviance***	**Δ *deviance***	**% deviance**	***p-value***
null	210	545.58			
Year	179	387.10	158.48	29.05	2.20E-16
Year+ Trap	172	222.01	165.09	30.26	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- 2012. Catch for the whole season.

year	nominal	index	scaled	std. Error	CV	upp95CI	low95CI
1981	1541.000	1541.000	1.000	847.477	54.995	3202.055	0.000
1982	1008.000	2082.706	1.352	681.978	32.745	3419.384	746.028
1983	2187.000	2190.738	1.422	717.334	32.744	3596.712	784.763
1984	2524.000	2407.816	1.563	788.377	32.742	3953.035	862.597
1985	1297.000	1633.908	1.060	535.100	32.750	2682.705	585.111
1986	475.000	790.836	0.513	207.259	26.208	1197.064	384.608
1987	703.000	869.560	0.564	227.852	26.203	1316.149	422.970
1988	2090.000	2034.845	1.320	532.667	26.177	3078.871	990.818
1989	574.000	1065.667	0.692	258.698	24.276	1572.714	558.620
1990	1218.000	1233.861	0.801	267.187	21.655	1757.547	710.175
1991	986.000	1457.982	0.946	315.654	21.650	2076.663	839.301
1992	602.000	631.416	0.410	136.906	21.682	899.751	363.081
1993	655.000	653.886	0.424	141.765	21.680	931.745	376.027
1994	1045.000	687.427	0.446	149.018	21.678	979.503	395.351
1995	565.000	448.142	0.291	97.272	21.706	638.794	257.489
1996	1852.000	753.590	0.489	172.009	22.825	1090.727	416.452
1997	2312.000	1993.891	1.294	454.513	22.795	2884.735	1103.046
1998	1906.000	1859.878	1.207	423.988	22.797	2690.895	1028.860
1999	2804.000	2284.273	1.482	520.653	22.793	3304.753	1263.793
2000	1278.000	1486.883	0.965	321.904	21.650	2117.813	855.952
2001	1274.000	2564.459	1.664	554.933	21.639	3652.128	1476.790
2002	2173.000	2263.649	1.469	489.882	21.641	3223.817	1303.480
2003	434.000	1330.270	0.863	303.787	22.837	1925.693	734.847
2004	1214.000	663.103	0.430	143.758	21.680	944.868	381.337
2005	1128.000	1344.392	0.872	291.089	21.652	1914.927	773.857
2006	481.000	1274.775	0.827	276.035	21.654	1815.803	733.748
2007	1161.000	2003.335	1.300	433.588	21.643	2853.167	1153.502
2008	1675.000	1271.652	0.825	275.359	21.654	1811.356	731.948
2009	1964.000	1759.322	1.142	380.820	21.646	2505.729	1012.916
2010	3533.000	2091.298	1.357	477.226	22.820	3026.660	1155.936
2011	1167.000	1352.535	0.878	292.850	21.652	1926.522	778.548
2012	2817.000	2380.672	1.545	543.212	22.818	3445.367	1315.976

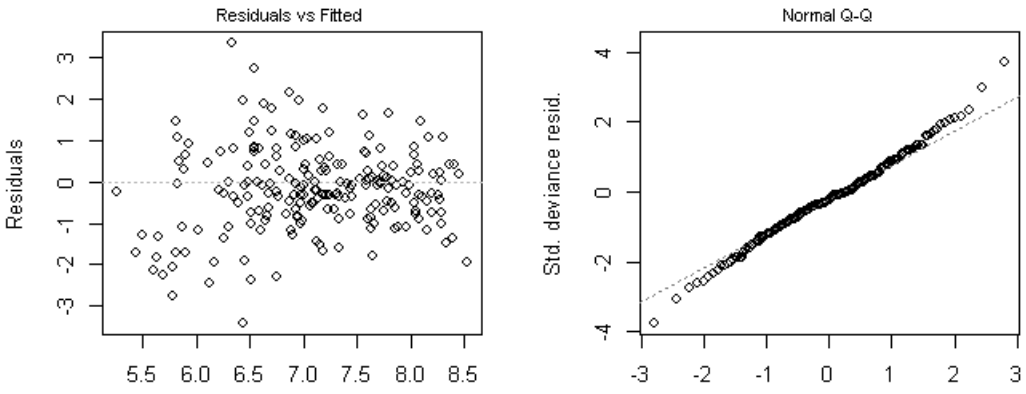

Figure 1. Diagnostic plots: residuals *vs* fitted values and cumulative normalized residual plot.

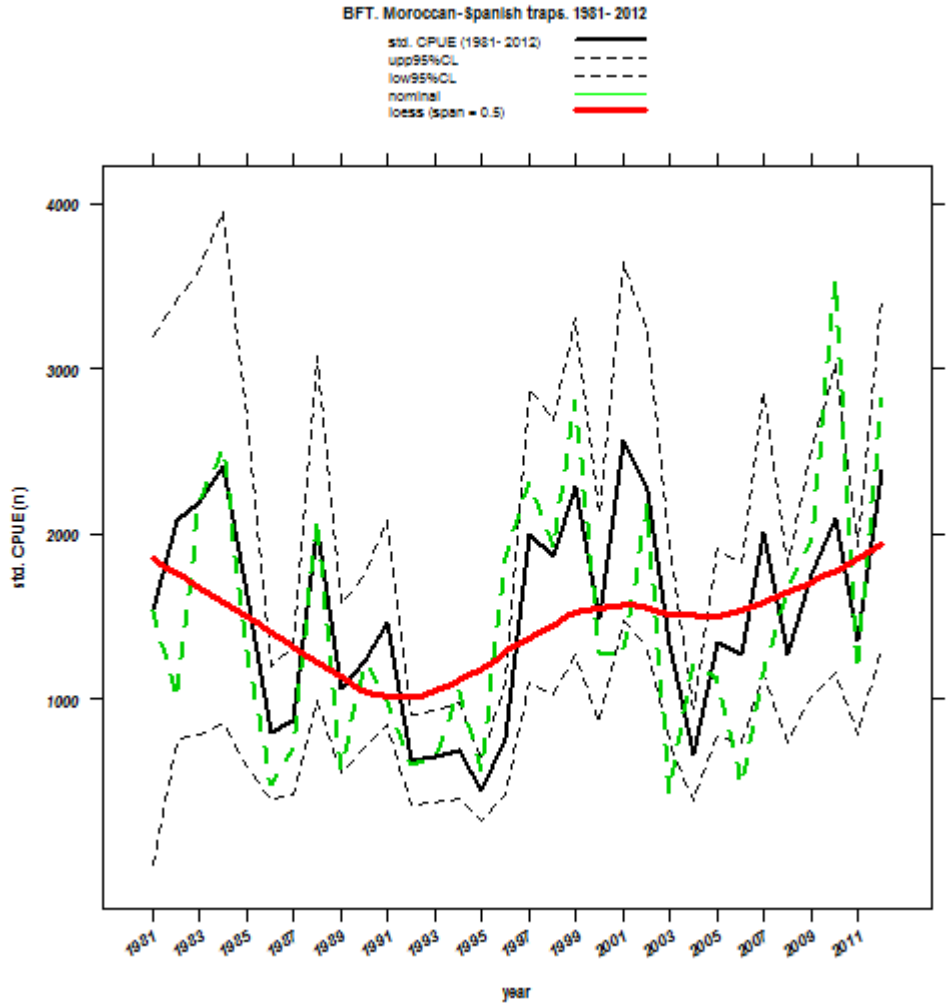

Figure 2. Nominal and estimated standardized relative abundance index and corresponding 95% confidence limits (normal approximation). Moroccan and Spanish traps. 1981- 2012.