UPDATED CATCH RATES OF SWORDFISH FROM THE MOROCCAN SWORDFISH LONGLINE FISHERY IN THE NORTH ATLANTIC, 2005 - 2012

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SUMMARY

A total of 826 positive trips from the Moroccan swordfish longline fleet operating in the North Atlantic Ocean during the period from 2004 to 2008, were analyzed by the GLM modelling approach, assuming a log-normal distribution error. The relative biomass index of abundance didn't show any clear trend. But in overall it has shown a slight increasing trend over the period 2005-2012.

RÉSUMÉ

Un total de 826 sorties positives de la flottille palangrière marocaine ciblant l'espadon dans l'océan l'Atlantique Nord au cours de la période 2004-2008 ont été analysées par l'approche de modélisation GLM, postulant une distribution d'erreur lognormale. L'indice d'abondance de la biomasse relative n'a fait apparaître aucune tendance claire. Mais, de manière générale, il a dégagé une légère tendance à la hausse au cours de la période 2005-2012.

RESUMEN

Se analizaron en total 826 mareas positivas de la flota de palangre marroquí dirigida al pez espada y que opera en el océano Atlántico norte durante el periodo 2004 a 2008 utilizando un enfoque de modelación GLM que asumía una distribución de error lognormal. El índice de abundancia de biomasa relativa no mostraba ninguna tendencia clara. Pero, en general, ha mostrado una tendencia ligeramente ascendente durante el periodo 2005-2012.

KEYWORDS

Swordfish, Morocco, Longline fleet, North Atlantic, CPUEw, GLM

1. Introduction

The Moroccan longline fishery targeting swordfish in the North Atlantic Ocean is relatively recent compared with other traditional tuna and tunas like species fisheries. This fishery started in 2003, and has known a remarkable development in the last recent years in terms of catches. The swordfish fishing occurs along the year, with higher catches during the third and the fourth quarter of the year (Abid *et al.* 2009). In terms of catches, this fishery has contributed in the most recent years with 400 TM on average. The longline fleet is operating off the Moroccan Atlantic waters between the latitudes 20 and 26 N°.

The main objective of this paper is to update the biomass index of abundance used in the 2009 Atlantic swordfish stock assessment session (Abid *et al.*, 2010b) to be taken into account in the 2013 North Atlantic swordfish session.

2. Material & methods

2.1 Description of the data source

The Moroccan swordfish longline fishery operating in the north Atlantic started in 2003. The catch and effort data for the two first years of development of this fishery were not used in the analysis given the very low number of observations. Thus, only data from 2005 up to date were used in the index standardization analysis. The quality of data was first checked before starting any analysis. The number of positive trips is very high in this fishery, so the percentage of negative trips is negligible.

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In total, the catch and effort data from 826 positive trips carried out by this commercial fleet during the 2005-2012 periods were available for GLM analysis. These data were obtained from the National Fisheries Office (ONP) which is the body responsible for the fish commercialisation at fish market at the Dakhla port.

The size data of swordfish caught by this fishery are missing for the last 2 years. However, the current abundance index is supposed to reflect the relative abundance of fish aged 2-5 years old (110 to 150cm LJ-FL) which largely dominate the catches. The average weight of fish is comprised between 30 and 40kg, LJ-FL.

2.2 Catch rate standardisation

The unit effort is expressed as the total number of hooks; it is calculated as the product of the number of fishing days at sea and the average number of hooks used during one fishing operation (1000 hooks). The number of fishing days per trip for each vessel was calculated as the time elapsed between its two consecutive landing dates at the fish market.

For the relative abundance index standardization, we considered the *Year* and the *Quarter* as explanatory factors and the Log catch (in weight) per unit effort (CPUEw) as the response variable. The GLM approach for analysis of variance was applied to the nominal CPUE, assuming a lognormal distribution error. The F test and the Step AIC analysis were used to select the factors statistically significant at 1% in the final model.

The final selected model is defined as follows (Gavaris, 1988):

$$\text{Log}(CPUEw) = u + Y_i + Q_j + Y_i * Q_j + e_{ij}$$

$CPUE_w$: catch per unit effort in weight
U: overall mean
Log: natural logarithm
Y_i: effect year
$Q_j * Y_i$: effect interaction Quarter and Year
e_{ij}: error

The fishery is relatively stable and the current management measures seem to have no impact on the CPUE data. Furthermore, this fishery hasn't known recently big technological changes nor do changes in condition market that may have affected catch rates.

3. Results

The number of observations for each factors combination levels is displayed in the **Table 1.** The number of observations is in general satisfactory.

The selected model explained around 26% of the total deviance in the response variable. The factors *Year*, Quarter and their interaction term are statistically significant at 1% level. These factors explain about 12% and 5.6% and 8.2% of the total deviance, respectively **(Table 2).**

The pattern in the residuals distribution, residuals against fitted values and QQ plots show that the selected model fit best the observed data **(Figure 1).**

The annual nominal and standardized biomass index, with corresponding upper and lower confidence limit, the coefficient of variation are displayed in the **Table 3.**

The standardized biomass index of the relative abundance shows a slight increasing trend over 2005-2012 time period **(Figure 2)**.

References

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Table 1. Number of observations for each factors combination level.

Year/Quarter	1	2	3	4	Total
2005	8	24	22	25	**79**
2006	41	12	31	52	**136**
2007	36	15	19	20	**90**
2008	18	16	26	21	**81**
2009	24	6	28	34	**92**
2010	34	17	41	34	**126**
2011	36	12	35	34	**117**
2012	24	24	27	30	**105**
Total	221	126	229	250	**826**

Table 2. Deviance analysis and F test results.

Model	Df	Deviance	Resid. Df	Resid. Dev	% explained deviance	F	Pr (>F)
NULL			825	387.28			
Year	7	46.44	818	340.83	12%	18.32	< 2.2e-16 ***
Quarter	3	21.73	815	319.11	5.6%	20.00	1.668e-12 ***
Year: Quarter	21	31.59	794	287.52	8.2%	4.15	1.891e-09 ***

Table 3. Annual nominal and standardized CPUE in weight, with their corresponding upper and lower confidence limit at 95%. Moroccan swordfish LL fishery in the North Atlantic.

Year	Nom. CPUE	Predicted CPUEw	Upper	Lower	CV
2005	662.39	449.80	665.68	303.93	3.4%
2006	283.88	394.47	517.67	300.59	2.4%
2007	217.04	342.38	530.70	220.89	4.0%
2008	306.57	369.14	566.17	240.68	3.8%
2009	307.12	516.49	722.85	369.05	2.8%
2010	454.49	445.47	623.44	318.30	2.9%
2011	314.35	437.67	612.54	312.73	2.9%
2012	324.89	560.02	800.97	391.56	3.0%

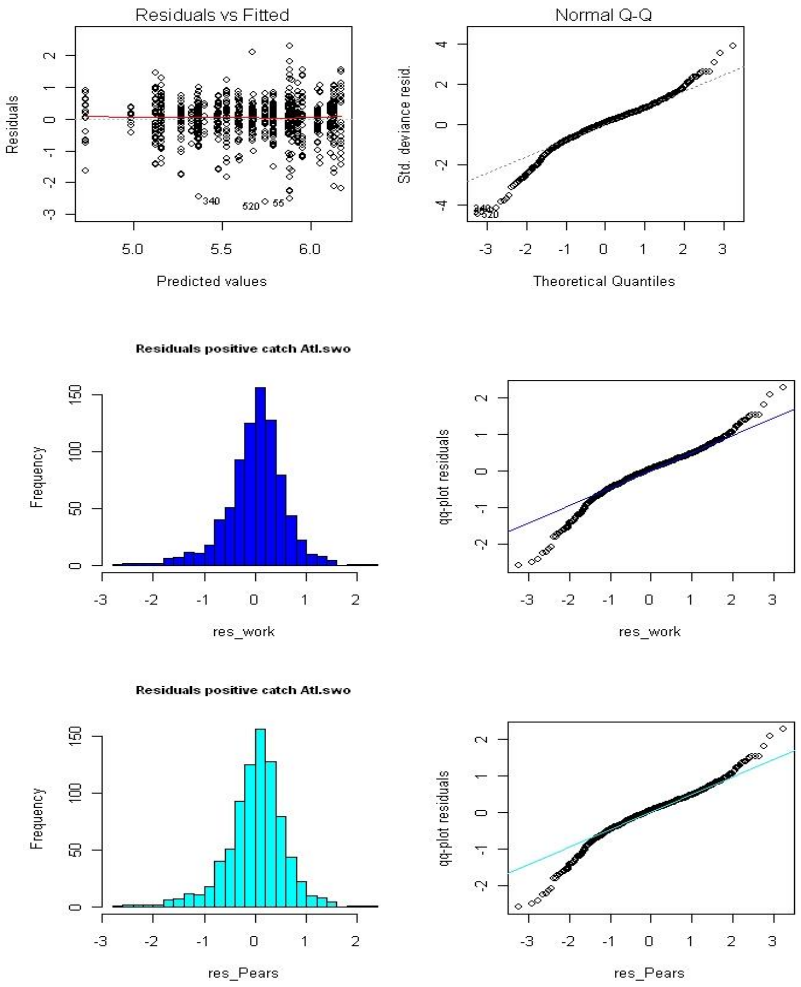

Figure 1. Diagnosis plots from the GLM analysis. Moroccan swordfish LL fishery in the North Atlantic Ocean.

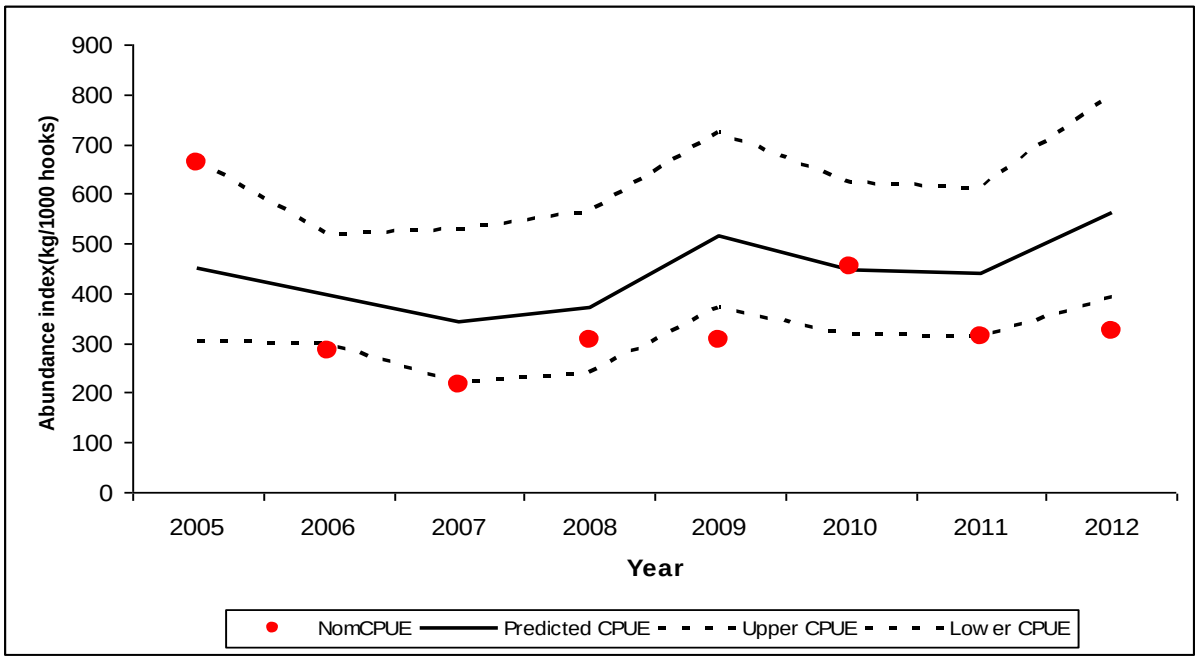

Figure 2. Trend of the standardized biomass index. Moroccan swordfish LL fishery in the North Atlantic Ocean, 2005-2012.