UPDATED CATCH RATES OF SWORDFISH (*XIPHIAS GLADIUS*) CAUGHT BY MOROCCAN LONGLINE FLEET IN THE MEDITERRANEAN SEA, 2012-2019

Noureddine Abid[1] & Mohammed Malouli Idrissi[1]

SUMMARY

The catch rates from the Moroccan longline fleet targeting swordfish in the Mediterranean Sea, from 2012 to 2019, were analyzed using the General Linear Modelling approach (GLM), under lognormal error assumption in order to compute standardized abundance indices. The relative abundance index decreased between 2012 and 2016, but remained relatively stable since then.

RÉSUMÉ

Les taux de capture de la flottille palangrière marocaine ciblant l'espadon en Méditerranée entre 2012 et 2019 ont été analysés au moyen de l'approche de modélisation linéaire généralisée (GLM), en postulant une erreur log-normale afin de calculer les indices d'abondance standardisés. L'indice d'abondance relative a diminué entre 2012 et 2016, mais est resté relativement stable depuis lors.

RESUMEN

Se analizaron las tasas de captura de la flota palangrera marroquí que se dirigió al pez espada en el mar Mediterráneo, de 2012 a 2019, utilizando el método del enfoque de modelación lineal generalizado (GLM), bajo el supuesto de error lognormal, a fin de calcular índices de abundancia estandarizados. El índice de abundancia relativa disminuyó entre 2012 y 2016, pero permaneció relativamente estable desde entonces.

KEY WORDS

Mediterranean Sea, swordfish, catch rates, General linear modelling (GLM)

[1] INRH, regional Centre of Tangier, noureddine.abid65@gmail.com

1. Introduction

During the period 1990-2011, the Moroccan driftnet fishery was one of the most important fisheries exploiting the Mediterranean swordfish. The vessels were mainly operating in the Strait of Gibraltar, but others are operating in the south Alboran sea.

After the driftnet ban of in 2012, the total catches of swordfish in the Mediterranean have been reduced by 31% during the period 2012-2015. Nevertheless, with the development of the artisanal longline fleet, the Mediterranean swordfish catches have been steadily increasing since then to reach 1013 tonnes in 2018.

The swordfish stocks are assessed at regional level by the International Commission for the Conservation of Atlantic tunas (ICCAT) mainly by means of Analytical and production models which make use of relative abundance indices from the major fisheries targeting this species (Anonymous, 2013).

The scientific monitoring of the Moroccan swordfish fishery in the Mediterranean Sea was of a great importance at the regional level, especially in terms of updating the trend of the relative abundance index. The ICCAT scientific committee has used this index for the assessment of the Mediterranean swordfish stock in 2007, 2010 and 2014 and 2016 (Anonymous, 2008; 2011; 2015; 2017).

The standardization of catches rate of the Mediterranean swordfish by eliminating the effect of the external factors other than the stock abundance is required for the stock assessment purposes (Anonymous, 2013). The aim of this document is to update the relative annual abundance index from the longline swordfish fleet in the Mediterranean (Abid and al. 2017) to be taken into consideration in the 2020 stock assessment.

2. Material and methods

2.1 Description of data source

The catch (in weight) and effort data per trip related to the Moroccan longline fleet targeting swordfish in the Mediterranean during the period 2012-2019, were collected from the commercial fishing statistics recorded in the fish market at the ports of Tangier, M'diq. Al Hoceima and Nador.

The structure of the dataset is as follow: date of landing, vessel name, GRT, catch in weight, estimated number of hooks. A total of 1279 daily trips were available for analysis.

2.2 Size/age range of fish

The abundance index is applied to fish whose size ranged from 100 to 240 cm LJ-FL, with an average size of 145cm LJ-FL. These sizes correspond to fish aged 2-9 years**.**

2.3 Management regulation

The Moroccan driftnet fishery has known a noticeable development since the early 90s in terms of fishing effort and the volume of swordfish catches. It recorded a peak of about 5000 TM in 1997. Nevertheless, with the driftnet ban in 2012, the fishing effort as well as the catches displayed a downtrend with respect to the period 1999-2011 and has not exceed on average catch of 850 TM during the period 2012-2018 where the catches have been made only by longliners.

2.4 Model standardization

As recommended by the SCRS, the fishing effort for longliners is estimated in number of hooks deployed by fishing vessels. The length of each trip varies from 2 to 7 days, with an average of 5 days. During one fishing day, one fishing operation is carried out deploying about 1000 hooks. The nominal CPUE was defined as the total weight of swordfish in kg/1000 hooks.

All the daily trips catch rate data were analysed by means of the General Linear Modelling analysis (Gavaris, 1980; 1988) to analyse the effect of the year, month and the interaction Year: Month on the catch rate and compute an annual standardized abundance index, under a lognormal error distribution.

In the present analysis, we considered 10 levels for the factor month. The vessel size was not considered in this analysis as the overall length (LOA) is similar among vessels.

The step AIC analysis was performed to select the statistically significant factors in the final model.

For longliners, the final model is as follow:

$$\mathbf{Log\ CPUE}_{w} = \mathbf{U} + \mathbf{Y}_{i} + \mathbf{M}_{j} + \mathbf{Y}_{i}\mathbf{:}\ \mathbf{M}_{j} + \mathbf{e}_{ijk}$$

Log : natural logarithm
CPUE $_{w}$: catch rate in weight
U : intercept
Y $_{i}$: year effect
M $_{j}$: month effect
Y $_{i}$: **M** $_{j}$: interaction between factors year and month
e $_{ijk}$: error

3. Results and discussions

The numbers of observations (trips) by year, month combination levels for longliners are summarised in the **Table 1.** In general, the number of trips analysed by level combination seems to be satisfactory.

The figure 1 display the distribution of Log CPUEw by year and by month. Differences in CPUE can be observed among years, months.

The table 2 shows the results of the deviance analysis. All the factors considered in the analysis: *year, month, and the interaction* year*month are statistically significant at 0.5% level. The selected model explains about 21% of the total deviance. The factors year, month and the interaction Year*month contribute with 15%, 17% and 68% of the total deviance, respectively.

The selected model fit well the observed data as the residuals distribution follows a normal pattern **(Figure 2).**

The nominal CPUE, the standardized CPUEs, with their corresponding lower and upper confidence interval (95%), the coefficient of variation (CV) are presented in the **Table 3.** The trend of the annual standardized index is illustrated by the **Figure 3**.

References

Abid, N., Ben M'hamed.A & Malouli Idrissi. M. 2017.Updated catch rates of swordfish (xiphias gladius) caught by the moroccan fleet in the strait of gibraltar, 1999-2015. Collect. Vol. Sci. Pap. ICCAT, 73(3): 1115-1132

Abid, N and Idrissi, M. 2011. Standardized catch rates of swordfish (X*iphias gladius*) caught by the Moroccan driftnet fleet in the Mediterranean Sea. Period 1999-2009. Collect. Vol. Sci. Pap. ICCAT, 66(4): 1480-1488

Anon. 2008. Report of the 2007 Mediterranean swordfish stock assessment session. Collect. Vol. Sci. Pap. ICCAT, 62(4): 951-1038.

Anon. 2011. Report of the 2010 ICCAT Mediterranean swordfish stock assessment meeting. Collect. Vol. Sci. Pap. ICCAT, 66(4): 1405-1470

Anon. 2013. Report of the 2012 meeting of the ICCAT working group on stock assessment methods. Collect. Vol. Sci. Pap. ICCAT, 69(3): 1354-1426.

Anon. 2015. Report of the 2014 ICCAT Mediterranean Swordfish Stock Assessment meeting (*Heraklion, Greece, 21-25 July 2014*). Collect. Vol. Sci. Pap. ICCAT, 71(5) : 1870-1879

Anon. 2017. Report of the Mediterranean swordfish stock assessment session (Casablanca, Morocco, 11-16 July 2016Collect. Collect. Vol. Sci. Pap. ICCAT, 73(3): 1005-1096

Gavaris, S. 1980, Use of multiplicative model to estimate catch rate and effort from commercial data. Can.J.Fish. Aquat.Sci.37: 2272-2275

Gavaris, S. 1988, Abundance indices from commercial fishing. Collected papers on stock assessment methods. CAFSAC Res. Doc.88/61. 167 pp.

Table 1. Number of observations by factors levels combination for Mediterranean swordfish longliners (2012-2019)

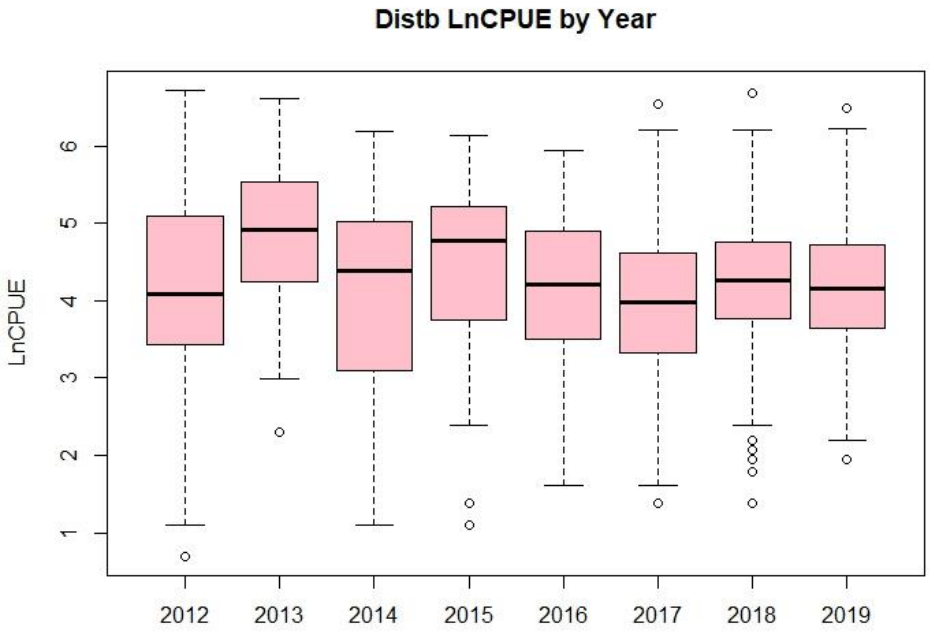
Month/year	2012	2013	2014	2015	2016	2017	2018	2019	Total
1	5	11	13	11	8	20		7	75
2	6	8	10		4	7			35
3	2		3	1	2	8			16
4		2	5	1	12	45	90	82	237
5	1	3	1		12	60	100	133	310
6	2			1	5	21	30	31	90
7			1		2	5	1		9
8			3	1	2	24	1	21	52
9	11	10	5	2	13	24	63	62	190
12		8	26	11	7	80	69	64	265
Total	**27**	**42**	**67**	**28**	**67**	**294**	**354**	**400**	**1279**

Table 2. Analysis of deviance results for swordfish longliners in the Mediterranean Sea

Factors	df	Residual deviance	Change in deviance	F	Pr(>F)	% in the total deviance
Null		1137.15				
Year	7	1101.20	35.957	6.9914	3.435e-08***	14.796
Month	9	1060.22	40.982	6.1977	1.392e-08***	16.864
Year: Month	45	894.14	166.073	5.0231	< 2.2e-16***	68.339

Table 3. Nominal cpue, standardized abundance index with corresponding 95% upper and lower confidence limits and coefficient of variation. longliners, 2012-2019

Year	Nom cpue	Std cpue	Upper	Lower	CV(%)
2012	192.13	276.912	553.722	138.481	6.64
2013	189.84	164.003	240.874	111.664	4.02
2014	110.24	190.499	343.990	105.497	6.06
2015	141.88	156.778	328.863	74.740	7.96
2016	106.01	58.971	73.419	47.366	2.86
2017	76.89	67.877	85.940	53.610	2.98
2018	93.49	91.440	116.825	71.570	2.88
2019	90.32	73.946	146.906	37.221	8.74



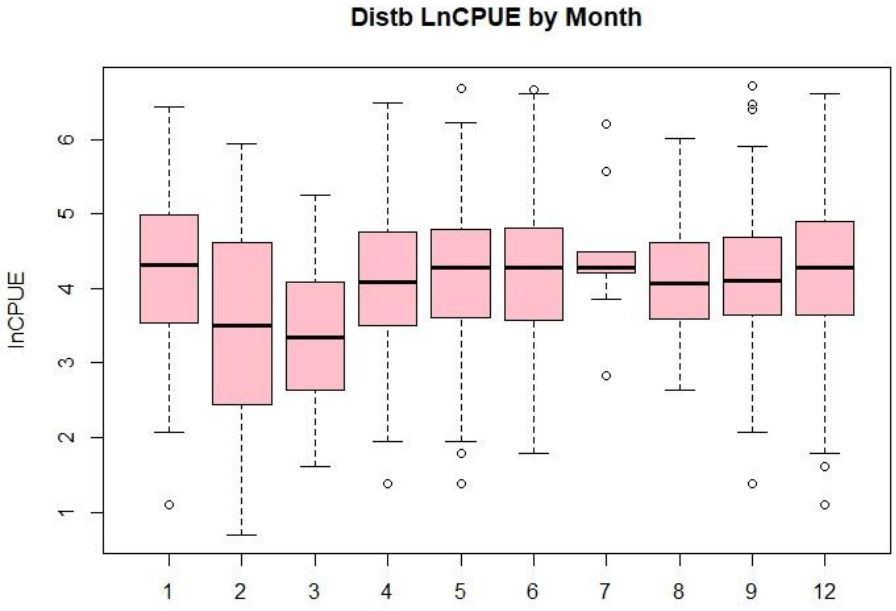


Figure 1. Box plots indicating the distribution of Log CPUE by year (A) and Month(B) for swordfish longliners in the Mediterranean Sea

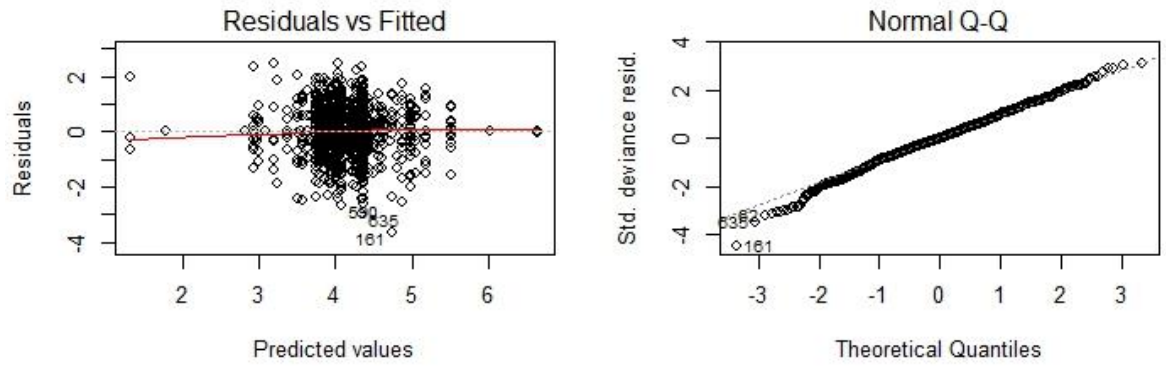


Figure 2. Diagnosis plots: normal qq plots **(A)** and residuals vs fitted positive catch distribution **(B)** for Swordfish longliners

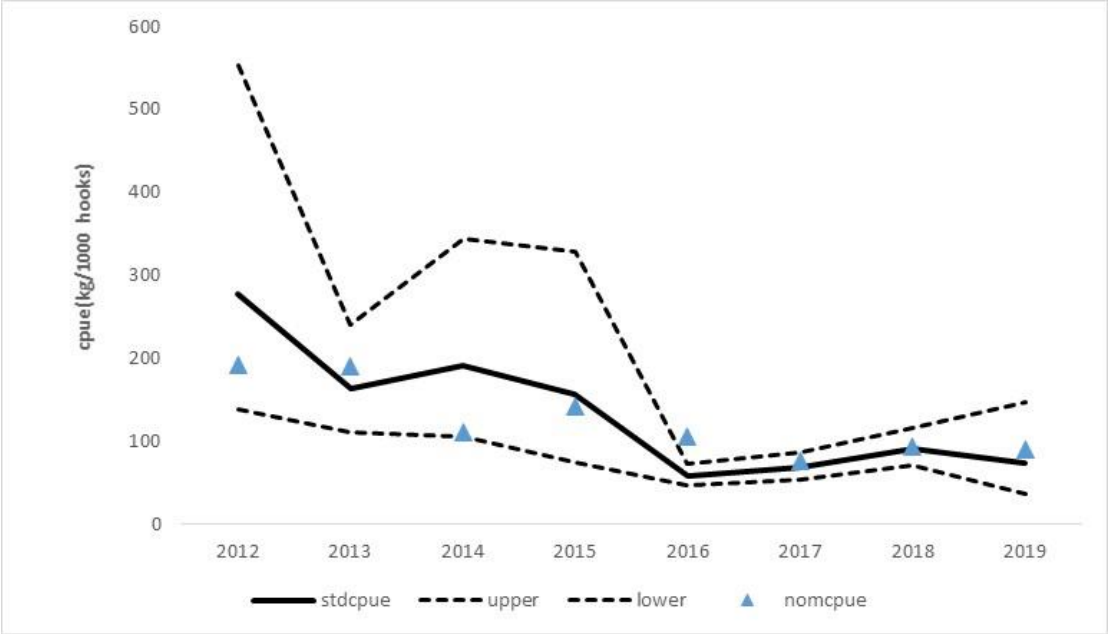


Figure 3. Standardized abundance index, with its corresponding upper and lower confidence limits for Swordfish longliners, 2012-2019.