

TEMPORAL CPUE TRENDS OF THE GREEK DRIFTING LONGLINE SWORDFISH FISHERIES IN THE EAST MEDITERRANEAN

George Tserpes¹, Panagiota Peristeraki¹

SUMMARY

Indices of abundance of swordfish (Xiphias gladius) from the Greek longline fisheries operating in the eastern Mediterranean are presented for the period 1987-2013. Annual standardized indices were estimated by means of Generalized Linear Modeling techniques and the predictor variables included the Year, Month and Area of fishing. In addition catchability changes occurred in the fisheries were also taken into account. CPUE differences were found to be statistically significant for all predictors examined and the standardized annual indices from 2000 onwards are generally lower than those estimated for the previous years.

RÉSUMÉ

Les indices d'abondance de l'espadon (Xiphias gladius) des pêcheries palangrières grecques opérant dans la mer Méditerranée orientale sont présentés pour la période 1987-2013. Les indices annuels standardisés ont été estimés au moyen des techniques de modélisation linéaire généralisée et les variables de prédiction comprenaient l'année, le mois et la zone de pêche. En outre, les changements de capturabilité survenus dans les pêcheries ont également été pris en compte. Les différences de CPUE se sont avérées statistiquement importantes pour tous les prédicteurs examinés et les indices annuels standardisés à partir de 2000 sont généralement plus bas que ceux estimés pour les années antérieures.

RESUMEN

Se presentan los índices de abundancia del pez espada (Xiphias gladius) de las pesquerías griegas de palangre que operaban en el Mediterráneo oriental durante el periodo 1987-2013. Se estimaron índices estandarizados anuales por medio de técnicas de modelación lineal generalizada y las variables de predicción incluían año, mes y zona de pesca. Además, se tuvieron en cuenta los cambios adicionales en la capturabilidad ocurridos en las pesquerías. Se halló que las diferencias en la CPUE eran estadísticamente significativas para todos los valores de predicción examinados y los índices estandarizados anuales desde 2000 en adelante eran por lo general menores que los estimados para los años previos.

KEYWORDS

Swordfish, Mediterranean, Catch/effort

1. Introduction

Swordfish (*Xiphias gladius*) is a commercially important migratory fish heavily fished in the Atlantic and Mediterranean. According to ICCAT records, Greece is among the three most important swordfish producers in the Mediterranean and the Greek swordfish fisheries exploit the eastern part of the Mediterranean basin covering a large area, extending from the east Ionian to the Levantine seas. The gear used is drifting surface long-lines and two different longline types are used: the Classical and the “so-called” American, owing its name to its similarity to the longline used for tuna fishery in the Atlantic.

¹Hellenic Centre for Marine Research, P.O. Box 2214, 71003 Iraklion, Greece. E-mail: gtserpes@hcmr.gr

The main goal of the present work is to estimate annual standardised abundance indices based on commercial catch per unit effort (CPUE) data series obtained from Greek fleets exploiting the Aegean Sea and the eastern Levantine basin. In the current work we attempt to update a previously estimated series (Tserpes *et al.*, 2011) not only through the use of additional data but considering also catchability changes occurred throughout the years. Data analysis has been accomplished by means of widely used Generalised Linear Modelling (GLM) techniques.

2. Materials and methods

Data have been collected in the frames of past European and national projects and included spatial and temporal information on catch and effort in as much as possible detail, i.e. on an individual boat trip basis. CPUE observations were expressed in terms of kg/1000 hooks as it commonly adopted in ICCAT. Sampling, which was based on information from landings on the major (pilot) landing ports, covered the activities of the Greek fishing vessels exploiting different areas of the eastern Mediterranean from 1987-2013 (**Figure 1**).

The collected data covered the activities of the two main swordfish fleets operating in the country, the fleets of Kalymnos and Hania. Generally, catches of both fleets represent 50-70% of the total Greek production (Tserpes *et al.* 2002). These fleets mainly exploit the central, south-eastern Aegean Sea but occasionally extend their activities to the northern Aegean and Levantine basin. Fishing is mainly carried out using drifting surface long-lines through February to September as it prohibited by national law from October to January and recently there have been established the additional ICCAT closures. Since the late 90's the fishing vessels started progressively to use a modified version of the traditional long lines, similar to that employed for the tuna fishery in the Atlantic. The modified gear, which is known as American-type longline, differs from the traditional one as regards the length and diameter of mainline and branch lines, as well as, the distance between branch lines. Moreover, it is usually set deeper than the traditional one and always uses fluorescent material to attract the fish. Nowadays, most boats involved in the fishery on a systematic basis are using the American gear and even vessels using the traditional gear are also employing fluorescent material.

Past studies have demonstrated that the catchability (in terms of biomass) of the American type long-line is 36% higher than that of the traditional gear (Tserpes and Peristeraki 2004). Besides based on observations and discussions with fishers it seems that the use of light on the traditional gear increases its catchability by about 20% with reference to the “standard” gear.

Original CPUE data were modified to reflect the catchability differences mentioned in the previous paragraph and following they were analyzed, by means of Generalised linear modelling (GLM) techniques (McCullagh and Nelder 1983). Preliminary runs, based on the deviance residuals plots, have shown that a model assuming a negative binomial error structure with a log link function was the most appropriate for the available data set. The predictor variables included in the model were year, month, area as main effects, as well as, the second order interactions between month and area. Interaction terms including the “year” effect were not examined as they may bias the year effect standardized estimates.

Thus, the general form of the GLM used was:

$$CPUE \sim c + Year + Month + Area + Month:Area + e$$

where c = constant and e = error term

Model fitting was accomplished under the R language environment (R Development Core Team 2013) and statistical inference was based on the 95% confidence level.

3. Results and Discussion

A total of 4614 data records were analysed that were collected in the period 1987-2013 with the exception of 1989, 1996 and 1997. Five fishing areas were considered: A = Cretan sea, B = Central Aegean, C = South-eastern Aegean, D = Levantine and E = North Aegean (see also **Figure 1**). There is no any outstanding feature in the deviance residual plot suggesting that the model is inappropriate for the observations (**Figure 2**). The analysis of deviance table indicated that all effects were significant on the 95% statistical level (**Table 1**).

The standardized model estimates of CPUE by year are given in **Table 2** and illustrated in **Figure 3**. Although CPUE levels do not show any clear trend over years, it is clear that estimated rates from 2000 onwards are generally lower (with the exception of 2013) than those of the earlier years. The rate of 2013 is similar to those observed in middle-late 90s.

References

McCullagh, P. and Nelder, J.A. 1983. Generalized Linear Models. Chapman and Hall, London.

R Development Core Team, 2013. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. ISBN 3-900051-07-0, URL <http://www.R-project.org>.

Tserpes, G., and Peristeraki, P. 2004. Catchability differences among the longlines used in the Greek swordfish fishery. Col. Vol. Sci. Pap. ICCAT, 56(3): 860-863.

Tserpes, G., Peristeraki, P., Di Natale, A., Mangano, A. 2011. Analysis of swordfish (*Xiphias gladius*) catch rates in the central-eastern Mediterranean. Col. Vol. Sci. Pap. ICCAT, 66(4): 1495-1505.

Table 1. Analysis of deviance table for the GLM model fitted to the long-line CPUE data from the Greek fleets.

<i>Source</i>	<i>LR Chisq</i>	<i>Df</i>	<i>Pr(Chisq)</i>
Year	506.10	23	<0.001
Month	90.81	7	<0.001
Area	73.82	4	<0.001
month:Area	81.53	28	<0.001

Table 2. Standardized model CPUE estimates (kg/1000h) by year.

<i>Year</i>	<i>Std CPUE</i>
1987	120.94
1988	142.57
1990	128.73
1991	170.08
1992	68.39
1993	123.15
1994	162.76
1995	99.92
1998	191.51
1999	145.99
2000	114.62
2001	120.49
2002	96.96
2003	118.18
2004	119.12
2005	116.72
2006	123.54
2007	130.54
2008	122.51
2009	106.69
2010	126.70
2011	98.79
2012	98.02
2013	149.34

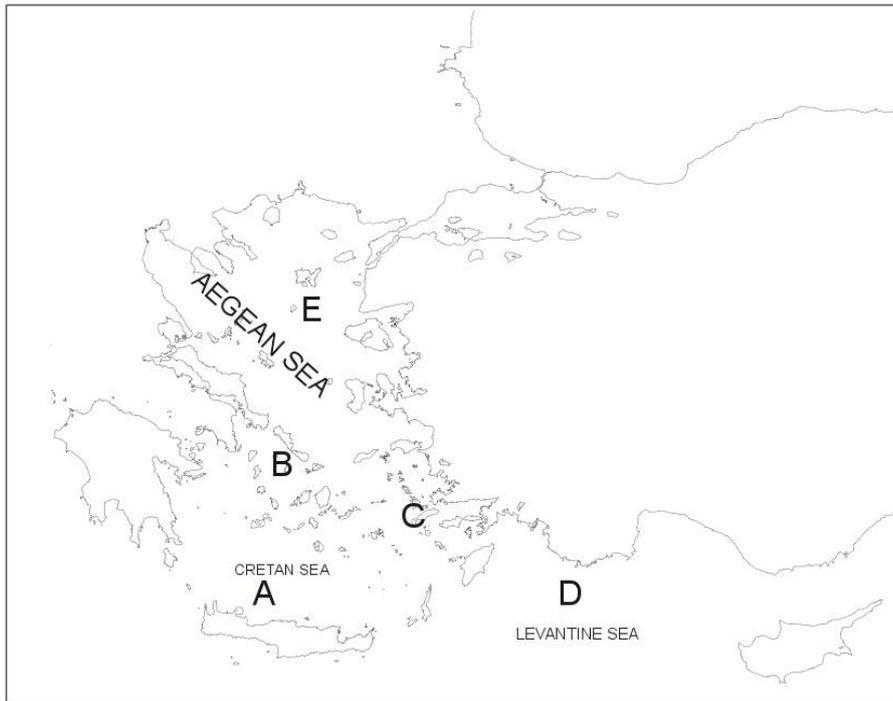


Figure 1. Map of the eastern Mediterranean indicating the main areas exploited by the studied fleets. A = Cretan sea, B = Central Aegean, C = Southeastern Aegean, D = Levantine and E = North Aegean

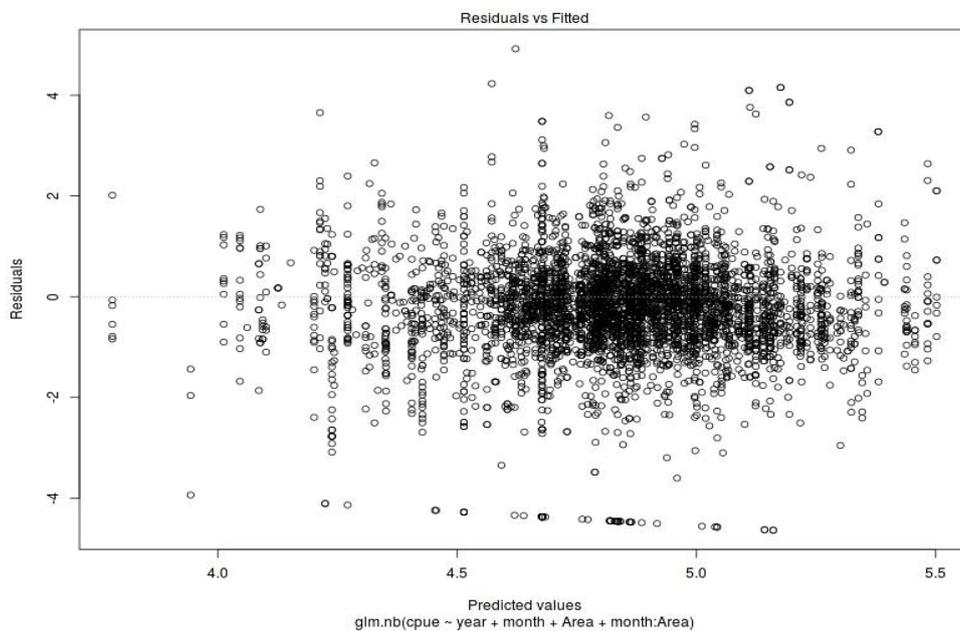


Figure 2. Residual deviance plot of the generalized linear model fitted to Greek long-line data.

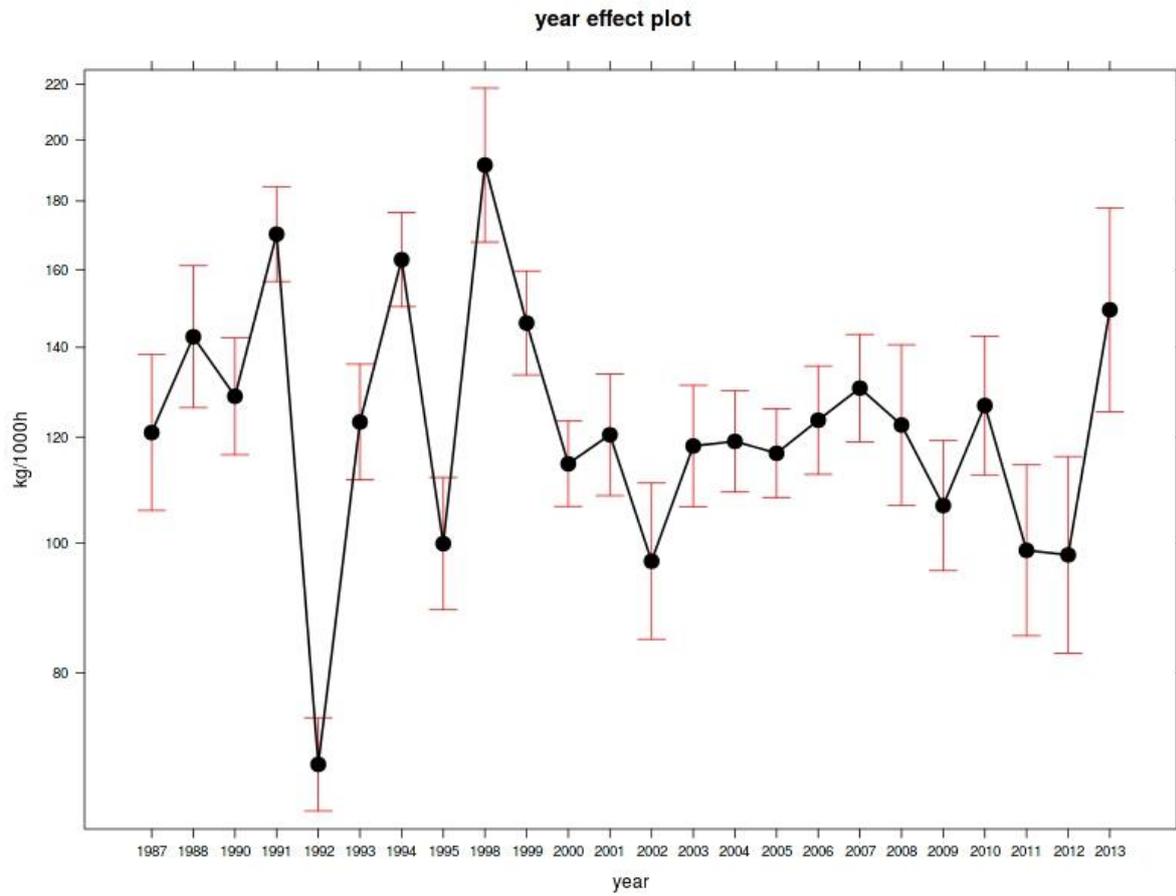


Figure 3. GLM derived standardized CPUE estimates by year. Vertical lines indicate the 95% confidence intervals of the corresponding estimates.