STANDARDIZED INDICES OF ABUNDANCE AT AGE FOR SWORDFISH (XIPHIAS GLADIUS) FROM THE SPANISH LONGLINE FLEET IN THE ATLANTIC, 1983-92

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SUMMARY

As in previous papers, standardized age-specific indices of abundance were developed using General Linear Modeling (GLM) procedures using trips carried out by the Spanish surface longline fleet targeting swordfish in the Atlantic from 1983-1992.

Indices were developed for ages ranging from 1 to 5+ obtained by slicing corresponding to each one of the stock hypotheses traditionally adopted by ICCAT. The criteria used to define areas and time periods were very similar to those used in previous analyses.

The variability rate explained by the model was within the range 14% to 41%, very close to those obtained in previous analyses.

RESUME

A partir des données de marées réalisées par la flottille espagnole palangrière de surface qui vise l'espadon dans l'océan Atlantique durant la période 1983-92, des indices d'abondance standardisés ont été élaborés, par classes d'âge, en utilisant pour cela les méthodes du Modèle linéaire généralisé (GLM).

Les indices ont été élaborés pour les âges 1 à 5+ pour chacune des hypothèses de stock traditionnellement adoptées par l'ICCAT. Les critères dans la définition des strates spatio-temporelles ont été semblables à celles réalisées dans des analyses précédentes.

Le taux de variabilité indiqué par le modèle se situait entre 14 et 41%, dans la gamme des valeurs d'analyses précédentes.

RESUMEN

A partir de datos de mareas realizadas por la flota española de palangre de superficie dirigida al pez espada en el Océano Atlántico durante el periodo 1983-1992, se han desarrollado índices de abundancia estandarizados, por clases de edad, usando para ello procesos de Modelo Lineal Generalizado (GLM).

Los índices fueron desarrollados para las edades 1 a 5+ para cada una de las hipótesis de stock tradicionalmente asumidas por ICCAT. Los criterios en la definición de estratos espacio-temporales fueron similares a los realizados en análisis precedentes.

La tasa de variabilidad mostrada por el modelo se encontró entre el 14% y el 41%, dentro del rango de valores de análisis precedentes.
1. BACKGROUND

The CPUE data from the Spanish surface longline fleet targeting Atlantic swordfish have been traditionally used at the ICCAT workshops to define trends in the stock(s) of this Atlantic species.

Until 1987, the overall nominal indices in weight were used to estimate these trends (MEJUTO & GARCÉS, 1988). After the SWO workshop in 1987, standardized indices were developed as a ICCAT routine bases with data from the Spanish longline fleet (ANONYMOUS, 1986).

Standardized indices of relative abundance of swordfish, by size groups, assumed as "ages", have been developed in the last few years using commercial fleet data, (HOEY et al., 1989; ANONYMOUS, 1989; ANONYMOUS, 1991; ANONYMOUS, 1997; MEJUTO, in pressa).

The Generalized Linear Modelling technique (GLM) (ROBSON, 1966; GAVARIS, 1980; KIMURA, 1981) seems to be a very useful instrument in the estimation of relative abundance indices, based on data from commercial fleets with unbalanced spatial and temporal fishing patterns.

2. MATERIAL AND METHODS

2.1 BASIC DATA:

The records used in the analyses are from Spanish longline activity in the Atlantic Ocean. Data are usually provided by records per trip obtained by the Spanish Oceanography Institute (IBO) when fish are landed at the different base ports used by the Atlantic fleet. Records from the Mediterranean sea were rejected.

In recent years, with the introduction of vessels having freezing systems on board, and whose trips last over 60 days at sea, the use of log-books designed specifically for this fleet has been recommended to be introduced progressively and voluntarily.

In this case, the information obtained per set is compiled in a "sub-trip" (sets carried out consecutively in the same 5 x 5 degree squares) and is treated as an observation or trip of the traditional fleet.

Following the traditional criteria, nominal effort was defined by number of hooks (in thousands of hooks), calculated from the number of sets carried out, and the mean number of hooks per set or computing the number of hooks by set.

2.2. AGEING

As in previous years, the transformation of the distribution from sizes to ages 1, 2, 3, 4, 5+ was done by applying the technique known as "slicing", assuming that no overlapping existed between consecutive ages. The growth equation used was generated from mark-recapture data, assuming combined sexes (ANONYMOUS, 1989).

2.3. MODEL AND SPECIFICATIONS

The areas used in the analysis are shown in Figures 1. We have used the same criteria to define the areas as in previous year (MEJUTO in press).

For the North-South Atlantic analyses, the hypothetical boundary line was assumed to be located at 5° N latitude.

The year sequence from 1983 to 1992 was analyzed when available. A few observations available for the South Atlantic from 1988 to 1991 were tentatively analyzed.

The temporal definition corresponded to "quarters" as follows:

- Q1 = January, February, March
- Q2 = April, May, June
- Q3 = July, August, September
- Q4 = October, November, December

The surface longline gear of the Spanish fleet has remained constant over the years analyzed in terms of structure and configuration (REY, et al., 1988; HOEY, et al., 1988). Therefore, this variable was not taken into account in the model.

The analyses were done using the GLM procedure (under SAS computer PC software). The main effects considered were year, time, and area.

The following model was defined:

\[
\text{LOG (CPUE)} = u + Yi + Oj + Ak + Aj + Qk + eijk
\]

- \(u\) = overall mean.
- \(Yi\) = logarithm of the effect year \(i\).
- \(Qj\) = logarithm of the effect time \(j\).
- \(Ak\) = logarithm of the effect area \(k\).
- \(e\) = logarithm of the normally distributed error term.

As in previous works:

1.- Observations with values of CPUE = 0 were omitted from the analyses.

2.- Trip records in which the number of fish sampled was less than 5% of the capture in number were not used.

Areas 2 and 6 were combined and considered as area 2, just as areas 4 and 5 were combined as area 4 in order to improve the observation scheme (Figure 1).

Additional methodological information can be seen in papers previously done.
3. RESULTS AND DISCUSSION

Tables 1 to 3 show the number of observations used for each stock hypothesis.

In general, the number of area/time observations are satisfactory. However, for the South Atlantic there are very few available observations and the tentative analyses are presented for information purposes.

As in previous analyses, standardized residual patterns for each age/stock considered in general show a normal distribution when the number of observations is suitable. The residual plots are not included in this paper because they show the same pattern as in previous works.

Table 4 is a summary of the ANOVA results for each stock hypothesis. Number of observations, R-square, mean square error (root) and F statistics for each age class/stock hypothesis. The variability rate explained by the model (R-squared) is between 14% and 41%. This variability rate was within the range of values obtained in analyses carried out in previous years.

Tables 5 to 7 provide information on estimated parameters, their standard error, relative CPUEs and upper and lower 95% confidence limits obtained for each age and stock hypothesis. The CPUE trends and their confidence limits by age and hypothesis are shown in figures 2 to 4.

Additional data from long print-out results are available from the author upon request.

ACKNOWLEDGMENTS.

I would like to sincerely thank J.M. de la Serna, B. García, M. Quintans and E. Alot for their untiring work creating data bases.

LITERATURE CITED.


Table 1.- Number of trips (number of observations) by year, area and time strata used in the analyses for the OATLANTIC hypothesis.

Table 2.- Number of trips (number of observations) by year, area and time strata used in the analyses for the NORTH Atlantic hypothesis.
Table 3.- Number of trips (number of observations) by year, area and time strata used in the analyses for the SOUTH Atlantic hypothesis.

<table>
<thead>
<tr>
<th>Stock Hypothesis</th>
<th>Age</th>
<th>Number Obs.</th>
<th>R Square</th>
<th>Root mean square error</th>
<th>F Stat.</th>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td>3809</td>
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<td>.9769</td>
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Table 4.- Number of observations, R square, mean square error (root) and F statistic for each age class and stock hypothesis considered in the analyses.

Table 5.- Estimated parameters, standard error, relative CPUEs, and upper and lower 95% confidence limits by age group for the TOTAL Atlantic hypothesis.
Table 7.- Estimated parameters, standard error, relative CPUEs, and upper and lower 95% confidence limits by age group for the SOUTH Atlantic hypothesis.

<table>
<thead>
<tr>
<th>Age</th>
<th>Estimated Parameter</th>
<th>Standard Error</th>
<th>Relative CPUE</th>
<th>Lower 95% CI</th>
<th>Upper 95% CI</th>
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Table 6.- Estimated parameters, standard error, relative CPUEs, and upper and lower 95% confidence limits by age group for the NORTH Atlantic hypothesis.

<table>
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<th>Age</th>
<th>Estimated Parameter</th>
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<th>Relative CPUE</th>
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Figure 1.- Geographical areas division used for preliminary GLM analyses for the Spanish longline catch and effort data.
Figure 2. Annual change of standardized CPUE index by age class 1, 2, 3, 4, 5+ for the TOTAL Atlantic hypothesis.

Figure 3. Annual change of standardized CPUE index by age class 1, 2, 3, 4, 5+ for the NORTH Atlantic hypothesis.

Figure 4. Annual change of standardized CPUE index by age class 1, 2, 3, 4, 5+ for the SOUTH Atlantic hypothesis.