

**UPDATED STANDARDIZED CATCH RATES BY AGE, SEXES COMBINED,
FOR THE SWORDFISH (*XIPHIAS GLADIUS*) FROM THE SPANISH LONGLINE FLEET
IN THE ATLANTIC, FOR THE PERIOD 1983-1996**

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SUMMARY

Standardized age-specific catch rates were updated using General Linear Modelling (GLM) procedures from trips carried out by the Spanish surface longline fleet in the Atlantic during the 1983-1996 period for the north and south stocks.

Indices were developed for ages ranging from 1 to 5+ using Gompertz growth models (sexes combined) for ageing the catch at size. The criteria used to define areas, time periods and models were very similar to those used in previous papers.

RÉSUMÉ

On a actualisé des taux de capture standardisés au moyen de techniques du Modèle Linéaire Généralisé (GLM) à partir de sorties individualisées effectuées par la flotte espagnole de palangre de superficie dans l'Atlantique entre les 1983-1996.

Les indices ont été élaborés pour les âge compris entre 1 et +5 en utilisant un modèle de croissance de type Gompertz (sexes combinés) dans les processus de transformation des répartitions de tailles en âges. Pour la définition de zones, périodes temporelles et modèles, on a utilisé des critères très similaires à ceux utilisés dans des documents antérieurs.

RESUMEN

Tasas de captura normalizadas fueron actualizadas mediante técnicas de Modelo Lineal Generalizado (MLG) a partir de mareas individualizadas realizadas por la flota española de palangre de superficie en el Atlántico entre los años 1983-1996.

Los índices fueron desarrollados para las edades entre 1 y 5+ usando un modelo de crecimiento tipo Gompertz (sexos combinados) en los procesos de transformación de las distribuciones de tallas en edades. Los criterios usados para la definición de áreas, períodos temporales y modelos fueron muy similares a los usados en documentos anteriores.

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1. INTRODUCTION.

Catch per unit of effort data from commercial fleets have been interpreted as indices of the abundance in a great number of fisheries. However, this interpretation may not necessarily be assumed 'a priori'. These indicators must be evaluated case by case, based on empirical knowledge of the fishery and taking into account the limits and risks that are implied by this assumption.

The Generalized Linear Modelling technique (GLM) (Robson, 1966; Gavaris, 1980; Kimura, 1981) seems to be a very useful instrument in the estimation of standardized catch rates, based on data from commercial fleets with unbalanced spatial and temporal activity.

The standardized catch rates of the Atlantic swordfish were used in the recent years as a routine basis, obtained by means of GLM procedures based on data from commercial fleets, some of which targeted this species while others did not (Hoey et al., 1989; Anonymous, 1989; Anonymous, 1991; Hoey et al., 1993; Nakano, 1993; Mejuto, 1993; Scott et al., 1993; Mejuto, 1994; Mejuto and De la Serna, 1995, Mejuto and De la Serna, in press). These approaches have become a basic routine task in the assessment of stocks within the ICCAT dynamics.

The activity of the Spanish fleet has been carried out historically in the North East Atlantic. Its progressive geographical expansion towards new zones in the North Central-West and South Atlantic has resulted in an increase in the number of observations by spatial-temporal cell with the passing of time. In the recent years an important change has been reported in the fishing strategy of the traditional fleet, targeting in some cases other species (Mejuto and De la Serna, in press).

2. MATERIAL AND METHODS

2.1 BASIC DATA:

The records used in the analyses are from the Spanish longline activity in the Atlantic Ocean from 1983 to 1996. Data are usually provided by records per trip obtained by the Spanish Oceanography Institute (IEO) when fish are landed at the different base ports used by the Atlantic fleet.

In the last decade, 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 introduced progressively and voluntarily. In this case, the information obtained per set is compiled in "sub-trips" (group of sets carried out consecutively in the same 5x5 degree square/month) 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 group of consecutive sets ('sub-trip') when available.

2.2. AGEING

The Gompertz's type equation (Anonymous, 1989) was used to obtain the catch at age (CAA) for ages 1 to 5+, for sexes combined. The 'slicing' methodology was done (Restrepo pers. comm.).

2.3. MODEL AND SPECIFICATIONS

The spatial definition was done using the same criteria as last paper (Mejuto and De la Serna, in press), very similar to previously reported papers (Mejuto, 1993; Mejuto, 1994; Mejuto and De la Serna, 1995). For the North-South Atlantic analyses the hypothetical boundary line was located at 5° N latitude, as assumed by the ICCAT. The year sequence from 1983 to 1996 was analyzed, when available, for combined sexes.

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 relatively constant over the years analyzed in terms of structure and configuration (Rey et al., 1988; Hoey et al., 1988). However in the recent years small improvements and changes in the fishing strategy were detected (see SCRS 96/141 for details).

The standardized analyses were done using the GLM procedure. The main effects considered were year, time and area. The following basic model was defined:

$$\text{LOG (CPUE)} = u + Y_i + Q_j + A_k + A_j * Q_k + e_{ijk}$$

u = overall mean.

Y_i = logarithm of the effect year i.

Q_j = logarithm of the effect time j.

A_k = logarithm of the effect area k.

e = logarithm of the normally distributed error term.

As in the previous papers :

a) Trips or "sub-trips" with values of CPUE = 0 from a particular age were omitted for the analyses. b) Trip records in which the number of fish sampled was less than 85% of the capture in number were not used. c) In order to improve the observation scheme, tentative areas 2 and 6 were combined and considered as area 2, areas 4 and 5 were combined as area 4 and areas 10 and 11 were combined as area 10. Additional methodological information can be seen in other papers previously cited.

3. RESULTS AND DISCUSSION

In general the number of observations per cell (spatial-temporal) may be considered satisfactory in the North Atlantic. However, due to the progressive geographical expansion of the fleet in recent years, some cells were not properly represented, especially at the beginning of the time series.

The number of available observations in the South Atlantic have only proved to be relatively important in the last four years. Therefore we would expect the results for the total Atlantic hypothesis to be very close to those obtained for the North Atlantic hypothesis as was reported in previous papers.

Standardized residual patterns by age obtained in each run in general show a normally distributed shape when there is a suitable number of observations.

Table 1 is a summary of the ANOVA results. The number of observations, R-square, mean square error (root) and F statistics for each age class and stock is provided.

Tables 2 and 3 provide information on estimated parameters, their standard error, relative CPUEs and upper and lower 95% confidence limits obtained for each age and stock. The standardized CPUEs for the different ages and stocks are plotted in figures 1 and 2. Additional information and data from long print-out results are available from the author upon request.

ACKNOWLEDGMENTS.

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NORTH Atlantic Spanish LL SWO, Age 1

YR	LSMEAN	STDERR	UCPU1	CPU1	LCPU1
1996	-1.02423	0.039806	0.38852	0.35936	0.33239
1995	-1.02500	0.038188	0.38697	0.35906	0.33317
1994	-1.04326	0.039717	0.38112	0.35258	0.32617
1993	-1.00416	0.043163	0.39907	0.36669	0.33695
1992	-1.13760	0.042828	0.34898	0.32088	0.29504
1991	-1.24826	0.046448	0.31470	0.28731	0.26231
1990	-1.11829	0.049654	0.36069	0.32724	0.29689
1989	-0.65038	0.047332	0.57322	0.52243	0.47614
1988	-0.51687	0.047363	0.65513	0.59705	0.54412
1987	-0.64713	0.058477	0.58813	0.52444	0.46765
1986	-0.90325	0.052081	0.44941	0.40580	0.36642
1985	-1.36840	0.075328	0.29585	0.25524	0.22020
1984	-1.37321	0.092312	0.30482	0.25437	0.21227
1983	-1.34614	0.092855	0.31354	0.26137	0.21788

NORTH Atlantic Spanish LL SWO, Age 2

YR	LSMEAN	STDERR	UCPU2	CPU2	LCPU2
1996	-0.41463	0.030723	0.70192	0.66090	0.62227
1995	0.05745	0.029466	1.12259	1.05960	1.00013
1994	-0.13695	0.030858	0.92683	0.87243	0.82123
1993	-0.17896	0.033473	0.89333	0.83661	0.78348
1992	-0.11237	0.033353	0.95462	0.89421	0.83762
1991	-0.09265	0.035834	0.97846	0.91210	0.85024
1990	0.23218	0.037517	1.35855	1.26223	1.17275
1989	0.04642	0.036876	1.12680	1.04823	0.97514
1988	-0.11413	0.037485	0.96083	0.89277	0.82953
1987	-0.02694	0.045132	1.06453	0.97441	0.89192
1986	-0.30083	0.038479	0.79878	0.74075	0.68694
1985	-0.32607	0.053604	0.80286	0.72279	0.65070
1984	-0.62782	0.062516	0.60451	0.53480	0.47313
1983	-0.45084	0.066191	0.72694	0.63849	0.56080

NOTH Atlantic Spanish LL SWO, Age 3

YR	LSMEAN	STDERR	UCPU3	CPU3	LCPU3
1996	-0.36835	0.028156	0.73142	0.69215	0.65498
1995	-0.01447	0.026905	1.03938	0.98599	0.93534
1994	-0.29331	0.028194	0.78848	0.74609	0.70598
1993	-0.10527	0.030830	0.95660	0.90051	0.84771
1992	0.10310	0.030464	1.17736	1.10912	1.04483
1991	0.19505	0.032393	1.29571	1.21601	1.14120
1990	0.16081	0.034276	1.25682	1.17516	1.09880
1989	-0.17780	0.033981	0.89527	0.83759	0.78362
1988	-0.06606	0.034242	1.00165	0.93663	0.87583
1987	0.03614	0.041264	1.12510	1.03768	0.95706
1986	-0.06626	0.034870	1.00270	0.93646	0.87460
1985	0.05183	0.047761	1.15787	1.05440	0.96018
1984	0.03196	0.055165	1.15212	1.03404	0.92807
1983	0.01659	0.059555	1.14464	1.01853	0.90632

STOCK	AGE	# OBSERVA.	F value	R squared	RMSE
North	1	6042	123.85	0.3658	0.9530
	2	6553	8519	0.2677	0.7675
	3	6591	54.20	0.1878	0.7018
	4	6488	58.01	0.2009	0.6824
	5+	6418	88.81	0.2802	0.7426
South	1	1207	23.74	0.3061	1.0511
	2	1460	39.28	0.3755	0.5995
	3	1481	20.08	0.2325	0.4733
	4	1480	31.63	0.3232	0.4831
	5+	1481	22.29	0.2516	0.5632

Table 1- Summary of ANOVA: Number of observations, F statistic, R square and mean square error (root), for each age class and run considered

Table 2. Estimated parameters, standard error, relative CPUEs and upper and lower 95% confidence limits. NORTH ATLANTIC, AGES 1-5+.

NORTH Atlantic Spanish LL SWO, Age 4

YR	LSMEAN	STDERR	UCPU4	CPU4	LCPU4
1996	-0.85534	0.026102	0.44939	0.42531	0.40251
1995	-0.56382	0.026312	0.59935	0.56923	0.54062
1994	-0.67172	0.027609	0.53944	0.51102	0.48410
1993	-0.46716	0.030311	0.66545	0.62707	0.59090
1992	-0.22511	0.029723	0.84669	0.79878	0.75357
1991	-0.23239	0.031651	0.84379	0.79303	0.74533
1990	-0.39840	0.033687	0.71763	0.67178	0.62885
1989	-0.46799	0.033167	0.66869	0.62660	0.58717
1988	-0.36511	0.033389	0.74148	0.69451	0.65051
1987	-0.24501	0.040145	0.84745	0.78333	0.72406
1986	-0.22210	0.033727	0.85605	0.80129	0.75003
1985	0.03354	0.046170	1.13326	1.03521	0.94565
1984	0.06366	0.053194	1.18452	1.06724	0.96158
1983	0.02679	0.057719	1.15210	1.02886	0.91881

NORTH Atlantic Spanish LL SWO, Age 5+

YR	LSMEAN	STDERR	UCPU5	CPU5	LCPU5
1996	-1.01134	0.031214	0.38687	0.36391	0.34231
1995	-0.73502	0.028973	0.50773	0.47970	0.45321
1994	-0.77556	0.029995	0.48855	0.46065	0.43435
1993	-0.56054	0.032922	0.60928	0.57121	0.53551
1992	-0.35475	0.032480	0.74785	0.70172	0.65844
1991	-0.45573	0.034581	0.67885	0.63437	0.59279
1990	-0.58605	0.036825	0.59858	0.55690	0.51812
1989	-0.58427	0.036302	0.59902	0.55788	0.51957
1988	-0.44508	0.036485	0.68873	0.64120	0.59695
1987	-0.31950	0.043631	0.79213	0.72720	0.66760
1986	-0.19085	0.036752	0.88858	0.82682	0.76935
1985	0.01277	0.050251	1.11911	1.01414	0.91901
1984	0.12506	0.057732	1.27110	1.13510	1.01366
1983	0.07501	0.062576	1.22094	1.08001	0.95535

Table 2. Cont.

SOUTH Atlantic Spanish LL SWO, Age 1

YR	LSMEAN	STDERR	UCPU1	CPU1	LCPU1
1996	-0.66447	0.08902	0.61506	0.51659	0.43388
1995	-0.79310	0.08832	0.54005	0.45421	0.38201
1994	-0.78371	0.09230	0.54961	0.45866	0.38276
1993	-0.79902	0.09327	0.54234	0.45173	0.37626
1992	-1.44026	0.12357	0.30409	0.23868	0.18734
1991	-1.12730	0.13479	0.42570	0.32686	0.25097
1990	-1.00850	0.22280	0.57869	0.37393	0.24163
1989	-1.96575	0.24511	0.23333	0.14432	0.08927

SOUTH Atlantic Spanish LL SWO, Age 2

YR	LSMEAN	STDERR	UCPU2	CPU2	LCPU2
1996	0.12569	0.04436	1.23815	1.13504	1.04052
1995	0.12619	0.04341	1.23641	1.13557	1.04295
1994	0.13282	0.04547	1.24978	1.14322	1.04575
1993	-0.37422	0.04533	0.75250	0.68853	0.63000
1992	-0.21543	0.05789	0.90457	0.80755	0.72093
1991	-0.02090	0.06895	1.12370	0.98165	0.85756
1990	-0.31337	0.11819	0.92799	0.73610	0.58390
1989	0.22429	0.12503	1.61150	1.26125	0.98713

SOUTH Atlantic Spanish LL SWO, Age 3

YR	LSMEAN	STDERR	UCPU3	CPU3	LCPU3
1996	0.70034	0.034814	2.15801	2.01567	1.88271
1995	0.85684	0.034184	2.52042	2.35709	2.20433
1994	0.62467	0.035774	2.00456	1.86882	1.74228
1993	0.36462	0.035246	1.54392	1.44086	1.34469
1992	0.46675	0.045515	1.74542	1.59646	1.46021
1991	0.66924	0.054170	2.17468	1.95562	1.75863
1990	0.67838	0.093278	2.37632	1.97927	1.64857
1989	1.03976	0.098620	3.44842	2.84232	2.34275

SOUTH Atlantic Spanish LL SWO, Age 4

YR	LSMEAN	STDERR	UCPU4	CPU4	LCPU4
1996	0.42958	0.03554	1.64849	1.53758	1.43413
1995	0.53840	0.03489	1.83565	1.71431	1.60098
1994	0.38926	0.03651	1.58644	1.47687	1.37487
1993	0.27321	0.03604	1.41127	1.31502	1.22534
1992	0.38934	0.04646	1.61847	1.47760	1.34898
1991	0.46115	0.05530	1.77015	1.58833	1.42519
1990	0.60098	0.09521	2.20809	1.83220	1.52029
1989	0.66305	0.10066	2.37598	1.95055	1.60130

SOUTH Atlantic Spanish LL SWO, Age 5+

YR	LSMEAN	STDERR	UCPU5	CPU5	LCPU5
1996	0.48497	0.04143	1.76302	1.62552	1.49874
1995	0.69422	0.04068	2.17011	2.00380	1.85024
1994	0.69177	0.04256	2.17298	1.99906	1.83905
1993	0.60818	0.04194	1.99625	1.83871	1.69360
1992	0.67734	0.05416	2.19231	1.97152	1.77297
1991	0.68220	0.06446	2.24928	1.98233	1.74706
1990	0.76509	0.11100	2.68804	2.16247	1.73965
1989	0.62550	0.11736	2.36885	1.88210	1.49536

Table 3. Estimated parameters, standard error, relative CPUEs and upper and lower 95% confidence limits. SOUTH ATLANTIC, AGES 1-5+.

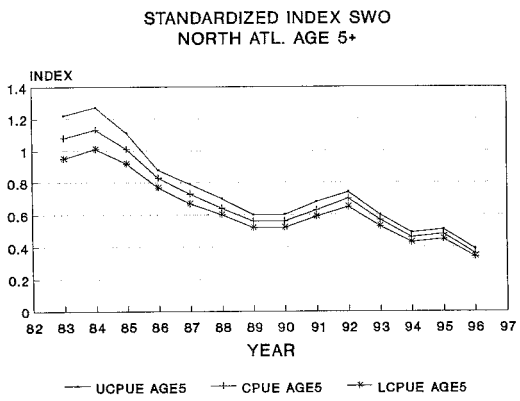
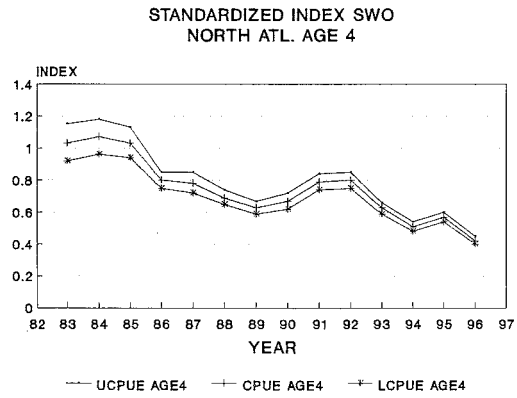
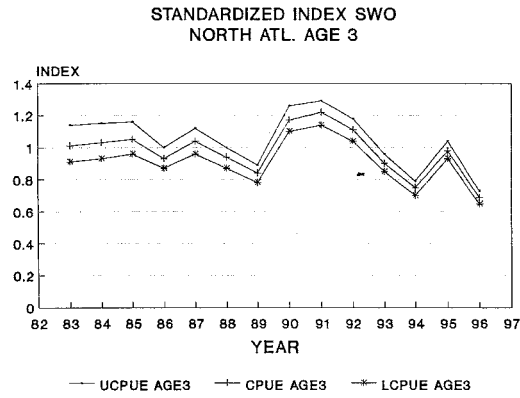
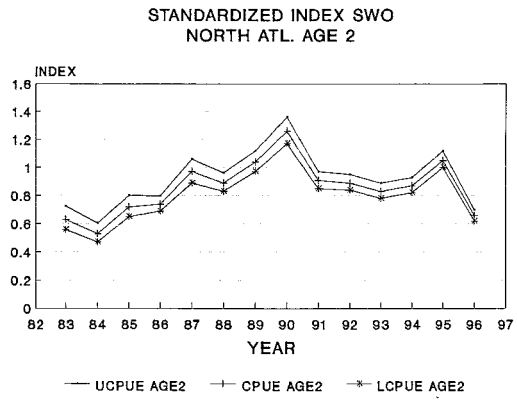
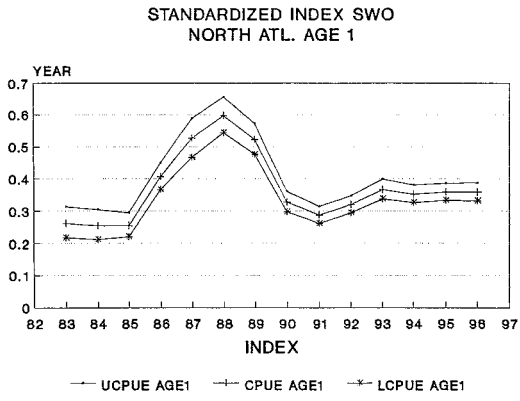


Figure 1.- Annual change of standardized catch rates index by age class. **NORTH ATLANTIC**. Ages: 1-5+. Sex: MALES+FEMALES. Gompertz growth model (Anonymous, 1989).

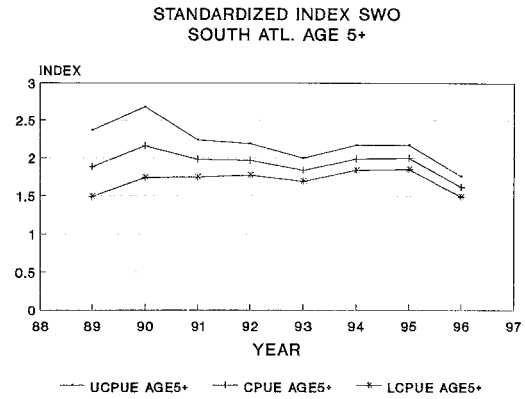
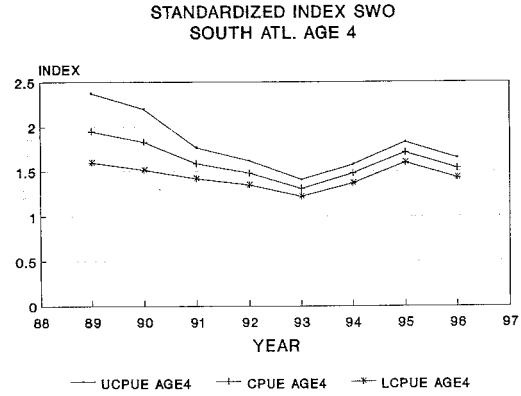
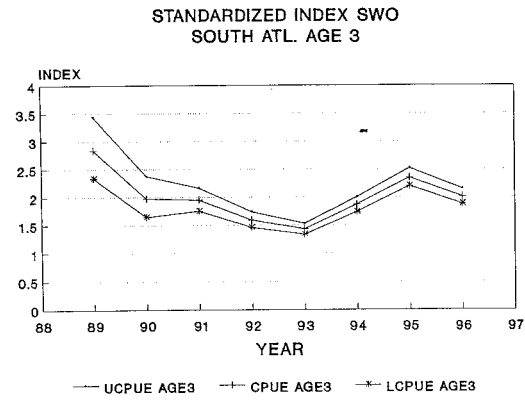
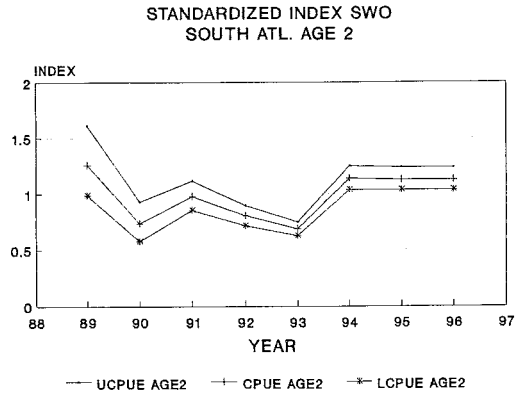
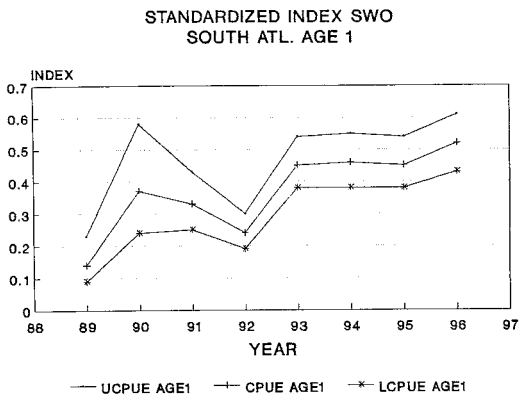


Figure 2.- Annual change of standardized catch rates index by age class. **SOUTH ATLANTIC**. Ages: 1-5+. Sex: MALES+FEMALES. Gompertz growth model (Anonymous, 1989).