SCRS/1992/150 Col.Vol.Sci.Pap. ICCAT, 40 (2) : 375-382 (1993)

AGE SPECIFIC STANDARDIZED CATCH RATES FOR ALBACORE (*THUNNUS ALALUNGA*) FROM THE SPANISH SURFACE FLEETS IN THE NORTH ATLANTIC, YEARS 1983-1991

Mejuto, J., B. García
Instituto Español de Oceanografía, P.O. Box 130, 15080 La Coruña, Spain

SUMMARY

Data from individual trips carried out between 1983 and 1991 by the Spanish fishery targeting albacore in the north Atlantic using traditional gear (troll and baitboat) were analyzed to obtain catch rate indices. Standardized age-specific catch rates were developed using General Linear Modelling (GLM) procedures, from two sets of age length keys, using the same methodology as in previous analyses. Available information (year, gear, area and time) were incorporated into the model. The variability rates explained by the model are in the 34 to 43 percent range for data set II.

RESUME

Les données sur des sorties individuelles de la pêcherie espagnole de germon dans l'Atlantique nord ayant utilisé des engins traditionnels, ligne traînante et appât vivant, ont été analysées pour en tirer des indices du taux de capture.

Des indices standardisés par classe d'âge ont été obtenus par le modéle linéaire généralisé (GLM). Les variables année, engin, zone et temps ont été incorporées dans le modèle. Les taux de variabilité expliqués par le modèle se situent dans l'éventail de 34 % à 43 % pour le jeu I de données, et entre 36 % et 43 % pour le jeu II.

RESUMEN

Los datos procedentes de mareas individuales realizadas entre 1983 y 1991 por la flota española dirigida al atún blanco en el Atlántico norte usando artes tradicionales - curricán y cebo vivo - fueron analizados para obtener índices de tasas de capturas.

Se obtuvieron índices estandarizados por clases de edad usando un Modelo Lineal Generalizado (GLM). Las variables año, arte, área y tiempo fueron incorporadas dentro del modelo. Las tasas de variabilidad explicadas por el modelo se encuentran en el rango de 34% a 43% para el set de datos I y entre el 36% y 43% para el set de datos II.

INTRODUCTION.

The data corresponding to catch per unit of effort (CPUE) from commercial fleets have frequently been used to estimate relative trends in stock abundance and to tune virtual population analyses (VPA) and to fit production models.

The generalized linear modelling technique (GLM) (ROBSON, 1966; GAVARIS, 1980, KIMURA, 1981) has proved to be a suitable methodology to obtain relative standardized catch rates, assumed as relative abundance indices.

This is probably true for stocks having relatively little variation in year-class strength (making ageing without the benefit of traditional age-length keys a more feasible task); and for stocks where the fishing technology is expected to maintain similar levels throughout the time series analyzed, thereby minimizing the possible effects of undetected increases in fishing power and subsequent changes in catchability (HOEY et al. 1989).

VPA tunning for North Atlantic albacore was carried out using nominal CPUE indices representing broad geographic and temporal strata (ANONIMO (I), 1991). However the huge variability in catch rates among gears/area/time (GARCIA & MEJUTO, SCRS 92/44) suggest that standardized indices are more advisable.

The purpose of this paper is to update previous analyses and to develop age-specific standardized CPUE trends for albacore using trip-by-trip data from the traditional Spanish bait boat and trolling fleets by means of similar methodology and criteria as in previous GLM analyses (MEJUTO, CONSER & GARCIA, 1992). More details about the methodology can be found in the paper previously cited as well as comments which may be probably useful in the interpretation of this paper.

1. DATA.

Data records were taken during the landing from trips carried out using traditional gears for the Spanish fishery of albacore in the North Atlantic -trolling and bait boat- during the period 1983-1991.

These trip records contain the following data:
(1) landing date
(2) type of gear
(3) number of fishing days
(4) location of the fishing effort (5 X 5 degree square)
(5) catch in numbers
(6) catch in weight (kg)
(7) number sampled at the landing port
(8) sample frequency distribution of catch-at-size (FL=30 to 135, in 1 cm intervals)

2. METHODS.

2.1. AGEING:

The transformation of the size distributions into ages (for ages 1, 2, 3, and 4) was done using two sets of yearly age length keys (YALKs) obtained from MULTIFAN estimates of numbers at age in the samples (ANONYMOUS (II), 1991; SANTIAGO, SCRS 92/48, pers. communication). Set I includes the catch at age obtained from the YALKs generated for the period 1975-1990. Set II includes the catch at age generated for the period 1983-1991. So two catch by age data bases were created and then analyzed.

As in previous analyses, YALKs were obtained using the sample size distributions from the third calendar quarter only (i.e. July - September). It was assumed that these YALKs were representative of the whole fishing season of the Spanish fleet. Although the fishing season generally extends from June until November, the largest catches are taken between July and September. The YALK for 1991 was assumed to be the same as for 1990 in both sets of data.

The fishery carried out by the Spanish fleet during the Fall of 1990 and 1991 in the areas around the Azores and records from the Mediterranean Sea were excluded from the analysis.

2.2. MODEL AND SPECIFICATIONS.

The two traditional gears used by the Spanish surface fleet, bait boat and trolling, were included in the analysis.

The seasonal migratory behavior of albacore, the fishing pattern of the Spanish fleets, and the number of trip observations available, were used jointly to establish area and time strata for the GLM analyses.

The areas used in the model are shown in Figure 1. The following time strata were selected:
Q1 = January - July
Q2 = August and September
Q3 = October - December

Note that the Q indicator here is not to be confused with the calendar quarters described in the Ageing Section, above.

Although indices of abundance were developed for ages 1, 2, 3, and 4, the fishery generally targets ages 2-4, with the actual catch being dominated by ages 2 and 3. The catch of individuals aged 1 and 4 may often depend more on the availability of the fish in any given year rather than stock size, and on the "success" achieved in the catch of the target fishing ages. The resulting indices of abundance for ages 1 and 4 should be viewed accordingly.

The analyses were carried out using GLM procedures (under SAS computer software). The main effects were considered to be year, gear, area and time. The following model was defined:

(1) LOG (CPUE) = u + Yi + Gj + Ak + Ql + eijkl

where the CPUE = the nominal CPUE of the observation (catch in number of fish of the corresponding age divided by the number of fishing days of the trip carried out in year i, by gear j, in area k, and time l).

u= overall mean.
Yi = logarithm of the effect of year i
Gj = logarithm of the effect of gear j
Ak = logarithm of the effect of area k
Ql = logarithm of the effect of time l
e = logarithm of the normally distributed error term

Observations having values of CPUE=0 were were omitted from the analysis.

Exploratory analyses were carried out last year introducing a gear-area interaction term into the model however results have indicated that they contribute to a minor extent, to the overall sum of squares in a variety of exploratory runs.

RESULTS AND DISCUSSION

As was expected, both sets of data catch at age obtained from YALKs (I and II) were very similar (Figure 2).

A total of 2160 trips from 1983 to 1991 were classified in spatial/temporal strata, as described above, and then analyzed.

The preliminary runs were carried out using the definition of 4 areas and 3 temporal strata. These first runs confirmed what was already empirically known about the fishing pattern as related to the migratory behavior of the species (BARD, 1974) and fishing pattern (GARCES, 1978). The number of observations for the months prior to July and after October was very scarce or nonexistent in some years.

It was found that standardized residuals having an absolute value greater than 2.5 tended, in most cases, to be negative (see discussion in SCRS 91/105).

Because of this, a 'second pass' GLM procedure was used to overcome this problem. Records whose absolute residual value was greater than 2.5 in the first pass (in most cases negative) were omitted from the analysis. The second pass procedure resulted in more symmetric residual distributions and the improvement of the statistical values.

Table 1 shows data for number of observations by year, area and time strata considered in the final runs.

Table 2 is a summary of the ANOVA results (second pass) subjected to these conditions, for data sets I and II. The variability rate explained by the model (R-squared) is between 35% and 43% for Set I and between 36% and 43% for Set II.

As in previous analyses standardized residual patterns for each age considered in general show a normal distribution when the number of samples is suitable. The residual pattern is very close to those obtained in previous years and the distribution is improved when restricted criteria is used in the record selection (second GLM pass).

Table 3 supplies information on estimated parameters, their standard error, the relative CPUE and upper and lower 95% confidence limits considered by age, for both sets of data. Trends obtained in both cases (set I and II) are very similar.

Age 1 (Fig. 3) shows trends that could be interpreted as exhibiting wide yearly fluctuations which could be justified based on the different strength of the recruitments. However, we must remember again that age 1 is not usually a target catch (in some cases it is even avoided) for the traditional fleets.

This catch is contingent upon a number of factors such as availability in the area/time stratum as well as the results obtained from the fishery on other ages. Thus these trends should not be interpreted strictly in terms of their relation to abundance.

Age 4 also shows wide yearly fluctuations. Traditionally age 4 is more representative in bait boat (BB) catches than in trolling (TROL) (GONZALEZ-GARCES et al.,1989). It is well-known that the success of the BB catches is conditioned, to a greater extent than TROL, by factors such as migration relatively far from the coastal areas, poor weather conditions, the relative concentration of schools, etc. These catch rates could be considered as abundance indices but with reservations, as in the case of age 1, although it shows a generally decrease trend. The values obtained at the present analyses differs from those obtained last year, especially for the period 1984-1986. These discrepancies could be explained by the diferences between YALKs used in both years. Transition between ages 3 and 4 seems to be more realistic in the present analyses.

As was explained in last year's analyses, the resulting indices for ages 2 and 3 are probably less affected by similar problems. These ages are highly represented in the catches of both fleets and are the targets of their activity. In market terms they are included in the same commercial category ("recortados" or "medium size"), and their abundance has traditionally been the reason for the success or failure of a fishing season. These indices have a strong empirical basis, are consistent (i.e. good transition between ages 2 and 3), and the model residuals and other diagnostics are behave well.

Age 2 (Fig. 3) shows a relatively stable trend in time with fluctuations over time, rising slightly until 1988 with a sharp drop in 1989 that breaks with the trend of the previous years. In 1990 it reaches about the mean value of the time series and in 1991 reaches the highest level of the time series.

Age 3 tends to be relatively stable, showing fluctuations in the period from 1983 to 1987. After 1987, there is a continuous decline during the time period from 1987-1991, following the trend obtained in the last analyses. This decline is not explained by the trends of the Age 2 indices.

Although it is necesary to follow these trends closely in the future , several possible interpretations among others have been suggested in previous papers to explain difference in levels for age 3 in relation to trends of age 2, which could be repeated in this paper.

As previously indicated, one possible hypothesis would be based on the assumption that there was a drop in the catchability of age 3 in the traditional gears at the end of the 80's because of changes or improvements in technology. However the opposite trend would be more likely.

There is no bio-economic reason that would explain a voluntary shift of the fleet toward other ages (the opposite would be expected at similar catch rate levels).

The hypothesis of an actual decrease in abundance of age 3 must also be considered. The general trends seen in age 2 indices do not appear to be consistent with the decline observed in the age 3 indices during the period after 1987. A possible explanation might reside in the fact that age 2 individuals were subject to a substantially higher mortality at the end of the 80's, which would have a direct effect on the age 3 catches of the following year. However, the results of the VPAs (ANONYMOUS (I), 1991) do not indicate that the fishing mortality for age 2, obtained from landings, has increased significantly in recent years.

Changes in the oceanographic conditions should not be discarded, especially in this fishery, but a symetrical effect should be expected at least over ages 2 and 3.

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

ACKNOWLEDGMENTS.
We would like to thank to Dr. Josu Santiago for providing the age length keys used for ageing. Dra. Victoria Ortiz has keep a untiring work helping to create the data bases.
We specially thank to Dr. Ramon J. Conser for helping us to create methodological bases for this analyses.

LITERATURE CITED.

ANONIMO, 1991 (I). Report of the Ad-Hoc meeting on progress in the ICCAT Albacore research program. Sukarrieta, 12-16 July, 1991.

ANONIMO, 1991 (II). Informe de las segundas jornadas de estudio ICCAT sobre el atún blanco-1990. Col. Vol. SCi. Pap. Vol. XXXIV: 170 pp.

BARD, F. X. 1974. Etude sur le germon (Thunnus alalunga Bonnaterre de l'Atlantique Nord. Elements de dinamique de population. ICCAT. Col. Vol. Sci. Pap, Vol. 2 : 198-224.

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

GARCIA, B. & MEJUTO, J. en prensa. A simple descriptive and comparative analysis of the activity of the peninsular spanish fleets targeting albacore (Thunnus alalunga), in the Atlantic Ocean from 1990-1991. ICCAT. SCRS/92/44.

GARCES, A. 1978. La pesca española de atún blanco, "Thunnus alalunga" (Bonn, 1978), durante la campaña de 1975. Bol. Inst. Espa. Oceano. Tomo IV. Parte III. pp: 77-100.

GONZALEZ-GARCES, A.; Ph. MOGUEDET & B. GARCIA. 1989. Análisis de la pesquería del Atlántico Norte: Estimación de los coeficientes de mortalidad por pesca y de los rendimientos en peso utilizando modelos estructurales. ICCAT. Col. Vol. Sci. Pap, Vol: XXX(I): 218-228.

HOEY, J.; R. CONSER; E. DUFFIE, 1989. Catch per unit effort information from de U.S. swordfish fishery. Col. Vol. Sci. Pap. Vol. XXIX: 195-227.

KIMURA, D.K. 1981. Standardized measures of relative abundance based on modelling log(CPUE) and their application to Pacific ocean perch. J.Cons. Int. Explor. Mer. 39:211-218.

MEJUTO, J., R. CONSER, B. GARCIA, (1992). Age specific standardized indices of abundance for albacore (Thunnus alalunga) from the Spanish surface fleets in the North Atlantic, 1983-1990. ICCAT Col. Vol. Sci. Pap. Vol. XXXIX (1):269-283.

ROBSON, D.S. 1966. Estimation of relative fishing power of individual ships. Res.Bull.Int.Comm. N.W. Atl. Fish, 3: 5-14.

SANTIAGO, J. en prensa. Composición en edades de la captura internacional de Atún blanco (Thunnus alalunga) del Atlántico Norte. Años 1975-1991. ICCAT. SCRS/92/48.

Spanish North Atlantic ALBACORE CPUE 1983-1991,
13:55 October 7, 1992

TABLE 1 OF AREA BY QTR
CONTROLLING FOR YR=83

AREA / QTR Frequency	1	2	3	Total
1	2	44	3	49
2	1	26	16	43
3	0	0	0	0
4	27	20	0	47
Total	30	90	19	139

TABLE 2 OF AREA BY QTR
CONTROLLING FOR YR=84

AREA / QTR Frequency	1	2	3	Total
1	12	29	0	41
2	3	12	0	15
3	0	0	0	0
4	24	30	0	54
Total	39	71	0	110

TABLE 3 OF AREA BY QTR
CONTROLLING FOR YR=85

AREA / QTR Frequency	1	2	3	Total
1	0	23	10	33
2	22	58	2	82
3	2	1	0	3
4	28	13	0	41
Total	52	95	12	159

TABLE 4 OF AREA BY QTR
CONTROLLING FOR YR=86

AREA / QTR Frequency	1	2	3	Total
1	1	49	23	73
2	2	15	13	30
3	34	3	0	37
4	17	24	0	41
Total	54	91	36	181

TABLE 5 OF AREA BY QTR
CONTROLLING FOR YR=87

AREA / QTR Frequency	1	2	3	Total
1	0	15	10	25
2	1	6	4	11
3	3	3	0	6
4	16	17	0	33
Total	20	41	14	75

TABLE 6 OF AREA BY QTR
CONTROLLING FOR YR=88

AREA / QTR Frequency	1	2	3	Total
1	6	54	22	82
2	6	48	28	82
3	31	9	0	40
4	16	34	0	50
Total	59	145	50	254

TABLE 7 OF AREA BY QTR
CONTROLLING FOR YR=89

AREA / QTR Frequency	1	2	3	Total
1	7	74	41	122
2	17	54	23	94
3	47	3	0	50
4	52	79	10	141
Total	123	210	74	407

TABLE 8 OF AREA BY QTR
CONTROLLING FOR YR=90

AREA / QTR Frequency	1	2	3	Total
1	2	27	32	61
2	15	90	34	139
3	64	4	5	73
4	60	73	0	133
Total	141	194	71	406

TABLE 9 OF AREA BY QTR
CONTROLLING FOR YR=91

AREA / QTR Frequency	1	2	3	Total
1	3	23	1	27
2	13	75	48	136
3	84	2	1	87
4	64	115	0	179
Total	164	215	50	429

Table 1.- Number of trips (number of observations) by year, area and time strata used in the analyses, years 1983-1991.

SET I

AGE	Numb. Obsrv.	R-square	Root Mean Square Err.	F Stat.
1	1955	0.3499	1.220	74.58
2	2072	0.4296	0.965	110.66
3	2090	0.4069	0.836	101.69
4	2071	0.3786	1.042	89.46

SET II

AGE	Numb. Obsrv.	R-square	Root Mean Square Err.	F Stat.
1	1991	0.3615	1.181	79.93
2	2076	0.4338	0.975	112.81
3	2084	0.4099	0.839	102.69
4	2063	0.3830	1.014	90.79

Table 2.- Number of observations, R-square, mean square error (root) and F statistic for each age class considered in the analyses, for Set I and II, respectively.

SET I

AGE LENTH KEY: 1975-1991

North Atlantic Spanish ALB, CPUE Age 1,<second pass>

YR	LSMEAN	STDERR	UCPU1	CPU1	LCPU1
91	3.53855	0.06658	39.3013	34.4934	30.2737
90	2.81182	0.06886	19.0898	16.6797	14.5738
89	2.43187	0.06828	13.0400	11.4067	9.9780
88	3.15997	0.08146	27.7418	23.6482	20.1587
87	0.41414	0.18929	2.2324	1.5404	1.0629
86	2.51459	0.09968	15.1036	12.4231	10.2183
85	2.94516	0.10729	23.5992	19.1235	15.4967
84	2.61475	0.12800	17.7046	13.7763	10.7195
83	1.29429	0.12482	4.6961	3.6769	2.8789

North Atlantic Spanish ALB CPUE, AGE 2, <second pass>

YR	LSMEAN	STDERR	UCPU2	CPU2	LCPU2
91	4.13243	0.05262	69.1966	62.4155	56.2989
90	3.68571	0.05370	44.3630	39.9309	35.9416
89	3.33772	0.05230	31.2371	28.1935	25.4465
88	3.81027	0.06474	51.3809	45.2575	39.8638
87	3.70241	0.11277	50.8964	40.8035	32.7120
86	3.51806	0.07526	39.1894	33.8145	29.1768
85	3.11914	0.08386	26.7628	22.7065	19.2650
84	3.35411	0.10043	35.0228	28.7649	23.6251
83	3.50215	0.08618	39.4399	33.3103	28.1333

North Atlantic Spanish ALB, CPUE Age 3, <second pass>

YR	LSMEAN	STDERR	UCPU3	CPU3	LCPU3
91	3.00097	0.046369	22.0416	20.1267	18.3782
90	3.20072	0.046757	26.9359	24.5771	22.4248
89	3.24615	0.043905	28.0269	25.7159	23.5955
88	3.42782	0.055013	34.3691	30.8561	27.7021
87	3.84608	0.097596	56.9478	47.0329	38.8442
86	3.31409	0.064003	31.2364	27.5537	24.3052
85	3.30207	0.071104	31.3107	27.2376	23.6943
84	3.37030	0.086278	34.5748	29.1956	24.6534
83	3.85968	0.073992	55.0057	47.5800	41.1568

North Atlantic Spanish ALB, CPUE Age 4, <second pass>

YR	LSMEAN	STDERR	UCPU4	CPU4	LCPU4
91	1.98693	0.05797	8.1845	7.3054	6.5207
90	2.15222	0.05757	9.6477	8.6182	7.6986
89	1.87264	0.05517	7.2593	6.5153	5.8476
88	2.46017	0.06920	13.4394	11.7349	10.2466
87	1.89207	0.12324	8.5098	6.6837	5.2494
86	2.64555	0.07972	16.5267	14.1361	12.0913
85	2.03453	0.08868	9.1364	7.6788	6.4537
84	2.51433	0.10628	15.3068	12.4283	10.0912
83	2.62729	0.09245	16.6560	13.8955	11.5925

Table 3.- Estimated parameters, standard error, relative CPUEs, and upper and lower 95% confidence limits, obtained in the final run of Set I.

SET II

AGE LENTH KEY: 1983-1991

North Atlantic Spanish ALB, CPUE Age 1,<second pass>

YR	LSMEAN	STDERR	UCPU1	CPU1	LCPU1
91	3.66820	0.06462	44.5651	39.2632	34.5920
90	2.91540	0.06636	21.0661	18.4968	16.2409
89	2.54520	0.06568	14.5282	12.7733	11.2305
88	3.26044	0.07867	30.4989	26.1417	22.4062
87	0.18386	0.16214	1.6733	1.2178	0.8862
86	2.66003	0.09491	17.2974	14.3612	11.9235
85	3.08925	0.10356	27.0476	22.0788	18.0228
84	2.78246	0.12297	20.7186	16.2814	12.7944
83	1.40669	0.11687	5.1685	4.1104	3.2689

North Atlantic Spanish ALB CPUE, AGE 2, <second pass>

YR	LSMEAN	STDERR	UCPU2	CPU2	LCPU2
91	4.09167	0.05324	66.5161	59.9247	53.9865
90	3.66472	0.05423	43.4879	39.1025	35.1593
89	3.28071	0.05266	29.5272	26.6314	24.0196
88	3.74894	0.06513	48.3619	42.5664	37.4653
87	3.70981	0.11392	51.3964	41.1118	32.8851
86	3.46314	0.07573	37.1305	32.0087	27.5934
85	3.08041	0.08470	25.7907	21.8455	18.5038
84	3.28824	0.10143	32.8577	26.9340	22.0782
83	3.47978	0.08705	38.6356	32.5756	27.4662

North Atlantic Spanish ALB, CPUE Age 3, <second pass>

YR	LSMEAN	STDERR	UCPU3	CPU3	LCPU3
91	2.94920	0.046899	20.9517	19.1117	17.4332
90	3.14475	0.047077	25.4860	23.2396	21.1912
89	3.18230	0.044182	26.3080	24.1257	22.1244
88	3.34492	0.055246	31.6498	28.4017	25.4870
87	3.80184	0.097978	54.5262	44.9991	37.1367
86	3.26228	0.064272	29.6752	26.1629	23.0662
85	3.27048	0.071713	30.3746	26.3917	22.9310
84	3.32185	0.086676	32.9866	27.8160	23.4701
83	3.82982	0.074299	53.4210	46.1814	39.9230

North Atlantic Spanish ALB, CPUE Age 4, <second pass>

YR	LSMEAN	STDERR	UCPU4	CPU4	LCPU4
91	2.09519	0.05671	9.0971	8.1401	7.2837
90	2.24731	0.05660	10.5894	9.4774	8.4822
89	2.04260	0.05374	8.5795	7.7217	6.9497
88	2.60571	0.06740	15.4382	13.5717	11.8923
87	2.04654	0.11994	9.8633	7.7970	6.1635
86	2.73463	0.07761	17.9888	15.4505	13.2703
85	2.16183	0.08641	10.3287	8.7195	7.3610
84	2.62033	0.10400	16.9384	13.8148	11.2672
83	2.70597	0.09005	17.9310	15.0297	12.5978

Table 4.- Estimated parameters, standard error, relative CPUEs, and upper and lower 95% confidence limits, obtained in the final run of Set II.

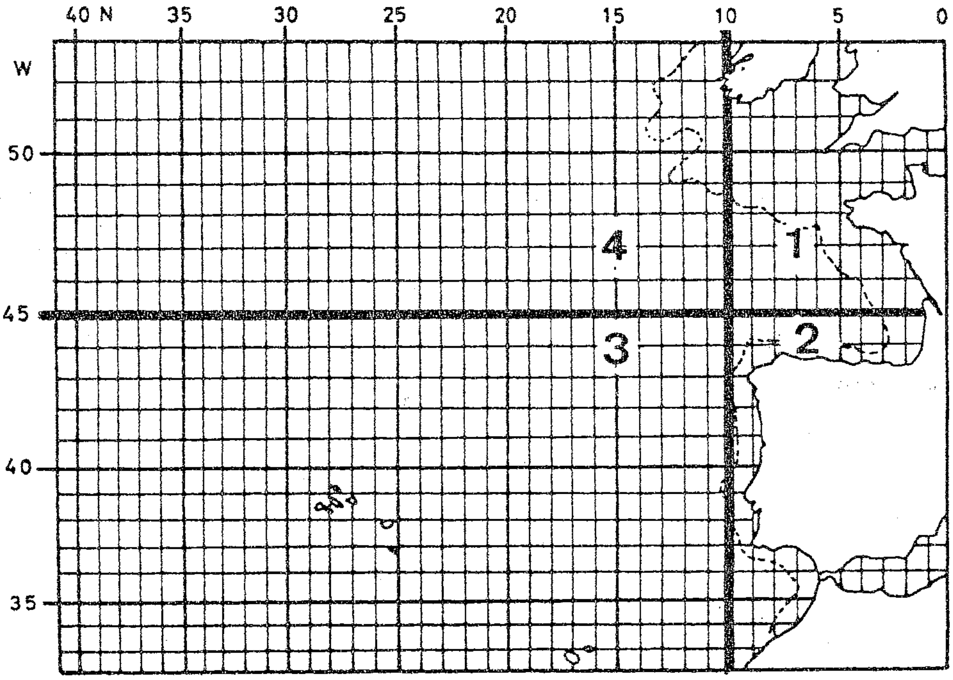

Figure 1: Geographical areas division used for the GLM analyses for he spanish albacore catch and effort data, 1983-1991.

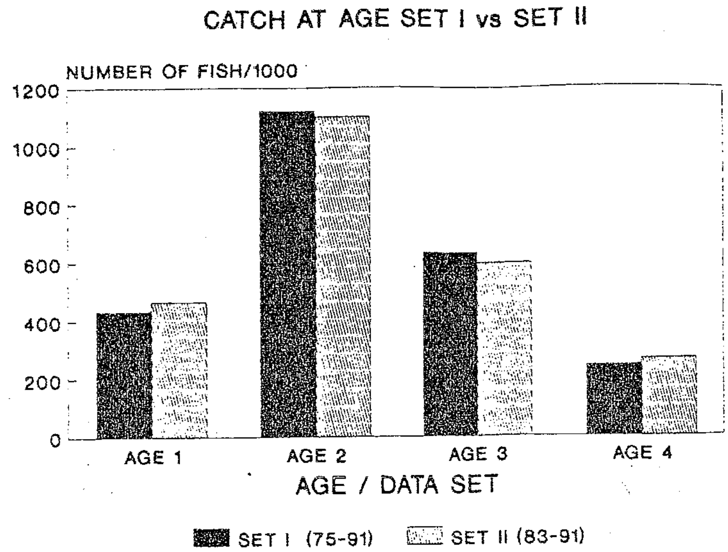

Figure 2.- Catch at age obtained from the two sets of age lenth keys used . Set I= years 1975-1991, Set II= years 1983-1991.

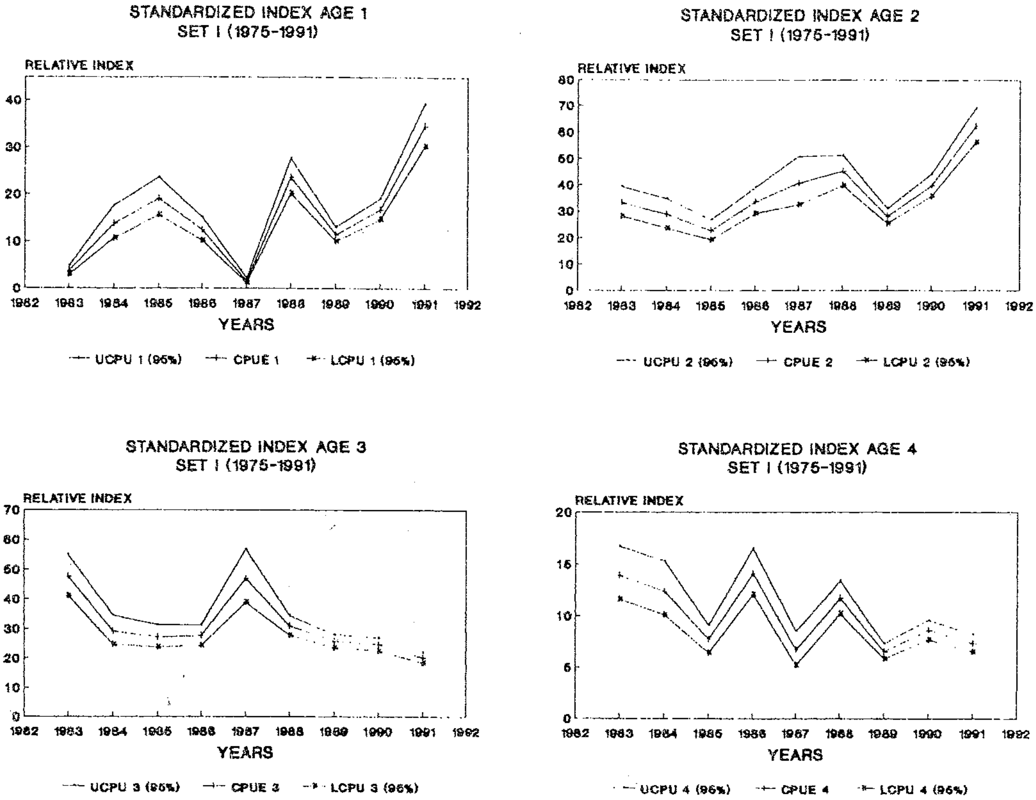

Figure 3.- Annual change of standardized CPUE, by age class 1, 2, 3 and 4. Set I= year 1975-1991.

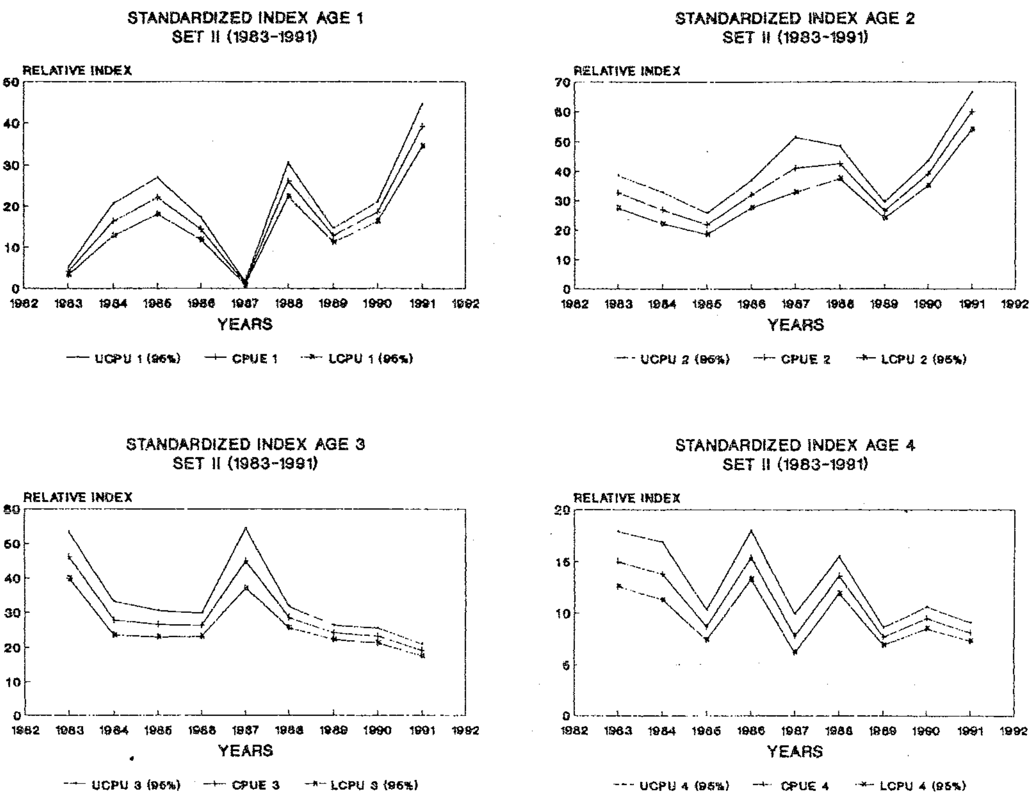

Figure 4.- Annual change of standardized CPUE, by age class 1, 2, 3 and 4. Set II= year 1983-1991.