

GLM ADJUSTED NORTHERN ATLANTIC ALBACORE CPUE TREND BASED ON TAIWANESE LONGLINE CATCH DATA OF 1968-1995

Lin, Y.J.¹, Y. Chang¹, S.Y. Yeh¹

SUMMARY

Generalized linear model (GLM) was used to standardize the north Atlantic albacore CPUE series derived from Chinese Taipei 1968-1995 longline fisheries data provided by the Overseas Fisheries Cooperation Council of Chinese Taipei. Factors used in the GLM are year, season, fishing area, interaction between area and season, as well as the nominal CPUE of bigeye, yellowfin and other species. Three major areas, based on the areal-specific size and species composition characteristics, were identified and designated in this study.

The results obtained so far show that: (1) all the factors considered in GLM are highly significant; (2) the distribution of the standardized residual plot is fairly normal; (3) the GLM-adjusted CPUE trend indicated that (i) CPUE declined sharply at the beginning of the fisheries from early 1968 to 1971; (ii) a period of stable CPUE trend was observed in 1971-1984; (iii) the CPUE trend showed a slightly declining trend from 1984-1992, except for a minor peak period in 1988-1989; (iv) a slightly increasing trend was observed in 1993-1995.

RÉSUMÉ

Le modèle linéaire généralisé (GLM) a été utilisé pour standardiser les séries de CPUE du germon de l'Atlantique Nord issues des données des pêcheries palangrières du Taïpei chinois de 1968-1995, transmises par le Overseas Fisheries Cooperation Council. Les facteurs utilisés dans le GLM sont l'année, la saison, la zone de pêche, l'interaction entre la zone et la saison, ainsi que la CPUE nominale du thon obèse, de l'albacore et d'autres espèces. Trois principales zones, fondées sur la taille spécifique de la zone et les caractéristiques de la composition des espèces, ont été identifiées et déterminées dans cette étude.

Les résultats obtenus jusque là montre que : 1) tous les facteurs envisagés dans le modèle GLM sont d'une haute importance ; 2) la distribution du diagramme résiduel standardisé est assez normale; 3) la tendance de la CPUE ajustée par GLM a indiqué que i) la CPUE a brusquement décliné au commencement des pêcheries, du début de l'année 1968 à 1971 ; ii) en 1972-1984, on a observé une période de stabilité de la tendance de la CPUE ; iii) la tendance de la CPUE a présenté une légère tendance au déclin de 1984 à 1992, à l'exception d'un léger pic en 1988-1989 ; iv) en 1993-1995, on a observé une tendance légèrement croissante.

¹ Institute of Oceanography, National University, Taipei.

RESUMEN

Se empleó el modelo lineal generalizado (GLM) para estandarizar las series de CPUE de atún blanco del Atlántico norte deducidas de los datos de pesquería de palangre de Taipei Chino, 1968-1995, facilitadas por Overseas Fisheries Cooperation Council. Los factores utilizados en GLM son año, estación, caladero, interacción entre área y estación, así como la CPUE nominal de patudo, rabil y otras especies. En este estudio se identificaron y determinaron tres áreas principales, basándose en el tamaño específico del área y características de las especies.

Los resultados obtenidos hasta la fecha indican que: (1) todos los factores considerados en el modelo GLM son altamente significativos; (2) la distribución del diagrama residual estandarizado es bastante normal; (3) la tendencia de la CPUE ajustada con GLM indicó que (i) la CPUE declinó bruscamente a comienzos de las pesquerías, desde comienzos de 1968 hasta 1971; (ii) se observó un período de tendencia estable de la CPUE en 1972-1984; (iii) la tendencia de la CPUE mostró una ligera tendencia al declive desde 1984 a 1992, excepto un pequeño pico en 1988-1989; (iv) se observó una tendencia ligeramente ascendente en 1993-1995.

INTRODUCTION

The Atlantic albacore fishery is one of the most important distant water tuna fisheries around the entire world. Traditionally, Atlantic albacore population is considered to be separated by 5° N latitude into northern and southern stock for proper assessment and efficient management.

Generalized linear model methods have been extensively applied to adjust the Atlantic albacore cpue trends (Chang and Hsu, 1994, Hsu, 1996). Factors, such as: year, season, fishing area block and cpue of the other's species are commonly to considered in GLM for adjusting albacore cpue.

The purpose of this paper is thus to investigate relevant factors of historic Taiwanese longline data series into GLM methods to adjust the cpue trend of northern albacore stock.

MATERIALS AND METHODS

Taiwanese 1968-1995 longline fisheries data provide by the Overseas Fisheries Cooperation Council of the Republic of China, was used in this study. To begin with, the catch and normal effort data were identified and split into northern stock by 5° N. The resolution of the data, which were compiled from recovered logbooks of Taiwanese longline vessels, is by monthly, by 5x5 block, and by species.

Generalized linear model was used to adjusted the CPUE series of northern Atlantic Albacore stock. Main factors used in GLM are year(YR), season(QT), fishing area(AREA) and nominal cpue of bigeye(BYBET), nominal cpue of yellowfin(BYYFT), nominal cpue of other species(BYOTH) and interaction between them. The fishing area were subdivided into three area blocks according to albacore size distribution (Fig 1.) and species composition (Fig 2.) by subarea in northern Atlantic (Fig 3.). A interaction term between area and season was also included in the GLM model. Therefore, the formula of GLM is followed:

$$\text{LN}(\text{cpue}+1.0) = u + \text{YR} + \text{QT} + \text{AREA} + \text{BYBET} + \text{BYYFT} + \text{QT} * \text{AREA} + \text{QT} * \text{BYBET} + \text{QT} * \text{BYYFT} + \text{AREA} * \text{BYBET} + \text{AREA} * \text{BYYFT} + \text{AREA} * \text{BYOTH} + E$$

where CPUE is albacore catch in number per 1000 hooks, u is overall mean, E is error term with $N(0,S)$. F-test was conducted on all main effects and interactions terms to determine whether not each contribution significantly to the model.

RESULTS

Table 1 shows the ANOVA table of GLM analysis of northern Atlantic stock. All the factors considered in this study are significant and effective in GLM model.

The least-square adjusted cpue and its 95% confidence interval along with the nominal cpue are plotted in Fig 4. Their estimated values are tabulated in Table 2. The adjusted cpue sharply decline at the

beginning of the fisheries from the early 1968 to 1971, a period of stable cpue trend was observed in 1972-1984; the cpue trend appeared a slightly declined trend from 1984 to 1992 except a slight peak in 1988-1989; (iv) a slightly increase trend was observed in 1993-1995.

The standardized residual plots of the GLM model were showed in Fig. 5. A normal approximated distribution could be noted for northern Atlantic stocks.

Reference

- Chang, S.K. and C.C. Hsu. 1994. Adjusted Taiwanese longline CPUE of north Atlantic albacore stock from target species segregated catch data of 1968-1993. ICCAT/SCRS/94/45.
- Hsu, C. C. 1996. Stock structure identification of Atlantic albacore population using Taiwanese longline catch data. ACTA OCEANOGRAPHICA TAIWANICA. VOL. 35, NO. 3, 323-333.

Table 1. ANOVA table of the GLM model of the North Atlantic albacore.

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	83	2634.678653	31.7431163	92.18	0.0001
Error	3791	1305.506383	0.3443699		
Corrected Total	3874	3940.185036			

R-Square 0.668669

Source	DF	Type I SS	Mean Square	F Value	Pr > F
YR	27	926.8470981	34.3276703	99.68	0.0001
QT	3	115.54774	38.51591334	111.84	0.0001
AREA	2	923.8620872	461.9310436	1341.4	0.0001
BYBET	3	348.2269979	116.075666	337.07	0.0001
BYYFT	3	90.8100787	30.27002623	87.9	0.0001
QT*AREA	6	23.2645672	3.87742787	11.26	0.0001
QT*BYBET	9	62.83869609	6.98207734	20.27	0.0001
QT*BYYFT	9	41.17045982	4.57449554	13.28	0.0001
AREA*BYBET	6	67.91761711	11.31960285	32.87	0.0001
AREA*BYYFT	6	23.51795735	3.91965956	11.38	0.0001
AREA*BYOTH	9	10.67535345	1.18615038	3.44	0.0003

Source	DF	Type III SS	Mean Square	F Value	Pr > F
YR	27	169.5731749	6.28048796	18.24	0.0001
QT	3	19.49145934	6.49715311	18.87	0.0001
AREA	2	47.65823214	23.82911607	69.2	0.0001
BYBET	3	73.74785236	24.58261745	71.38	0.0001
BYYFT	3	16.34218903	5.44739634	15.82	0.0001
QT*AREA	6	21.33046778	3.55507796	10.32	0.0001
QT*BYBET	9	22.60470319	2.51163369	7.29	0.0001
QT*BYYFT	9	24.85025712	2.76113968	8.02	0.0001
AREA*BYBET	6	49.4053105	8.23421842	23.91	0.0001
AREA*BYYFT	6	25.7452147	4.29086912	12.46	0.0001
AREA*BYOTH	9	10.67535345	1.18615038	3.44	0.0003

Table 2. Adjusted CPUE(ACPUE) and its 95% lower(LCPUE) and upper bounds(UCPUE),nominal CPUE(NCPUE),total effort in hook ,and total albacore catches in number for the North Atlantic albacore fishery.

YEAR	ACPUE	LCPUE	UCPUE	NCPUE	HOOKS	CATCH
1968	20.2137	16.9502	24.0705	17.2195	7932772	136598
1969	17.3137	14.8242	20.1948	13.5049	9910696	133843
1970	14.517	12.525	16.8025	15.0306	14441453	217063
1971	8.5162	7.1839	10.0654	11.8484	14411345	170752
1972	8.8544	7.352	10.6271	25.7502	10771905	277379
1973	9.8469	8.1955	11.7949	27.1132	20517778	556302
1974	10.8453	9.2826	12.6456	25.7605	18120863	466802
1975	8.3866	7.0736	9.9132	28.5897	14402769	411771
1976	9.7096	8.2509	11.3983	26.4062	29939781	790597
1977	9.7245	8.3017	11.3649	23.657	30339201	717733
1978	9.2922	7.8513	10.9677	23.7184	19812151	469912
1979	9.7743	8.0772	11.7887	30.81	8855600	272841
1980	10.9698	9.2334	13.0008	30.8825	9430400	291234
1981	9.8513	8.372	11.5643	28.4755	10312819	293663
1982	11.7491	9.9863	13.7948	35.1141	17802359	625114
1983	11.3955	9.7164	13.3376	31.5655	22350495	705504
1984	9.4925	8.1276	11.0614	27.5051	30907730	850120
1985	8.1898	6.9985	9.5586	22.3687	33066099	739646
1986	6.7074	5.7313	7.825	19.5749	54717158	1071082
1987	6.9113	5.7784	8.2336	16.4646	24943415	410684
1988	12.4262	9.4741	16.2103	28.0238	7456691	208965
1989	9.7113	7.0562	13.2413	20.1619	4642113	93594
1990	4.4826	3.4999	5.6798	4.7988	18501358	88785
1991	7.1805	6.0037	8.5549	6.1501	36756532	226057
1992	5.362	4.2476	6.713	3.7232	27389266	101975
1993	6.3143	5.1368	7.7178	10.9721	22944008	251745
1994	6.2606	5.2218	7.4728	16.0081	28738313	460046
1995	7.6935	6.3194	9.3257	17.9493	14182901	254573

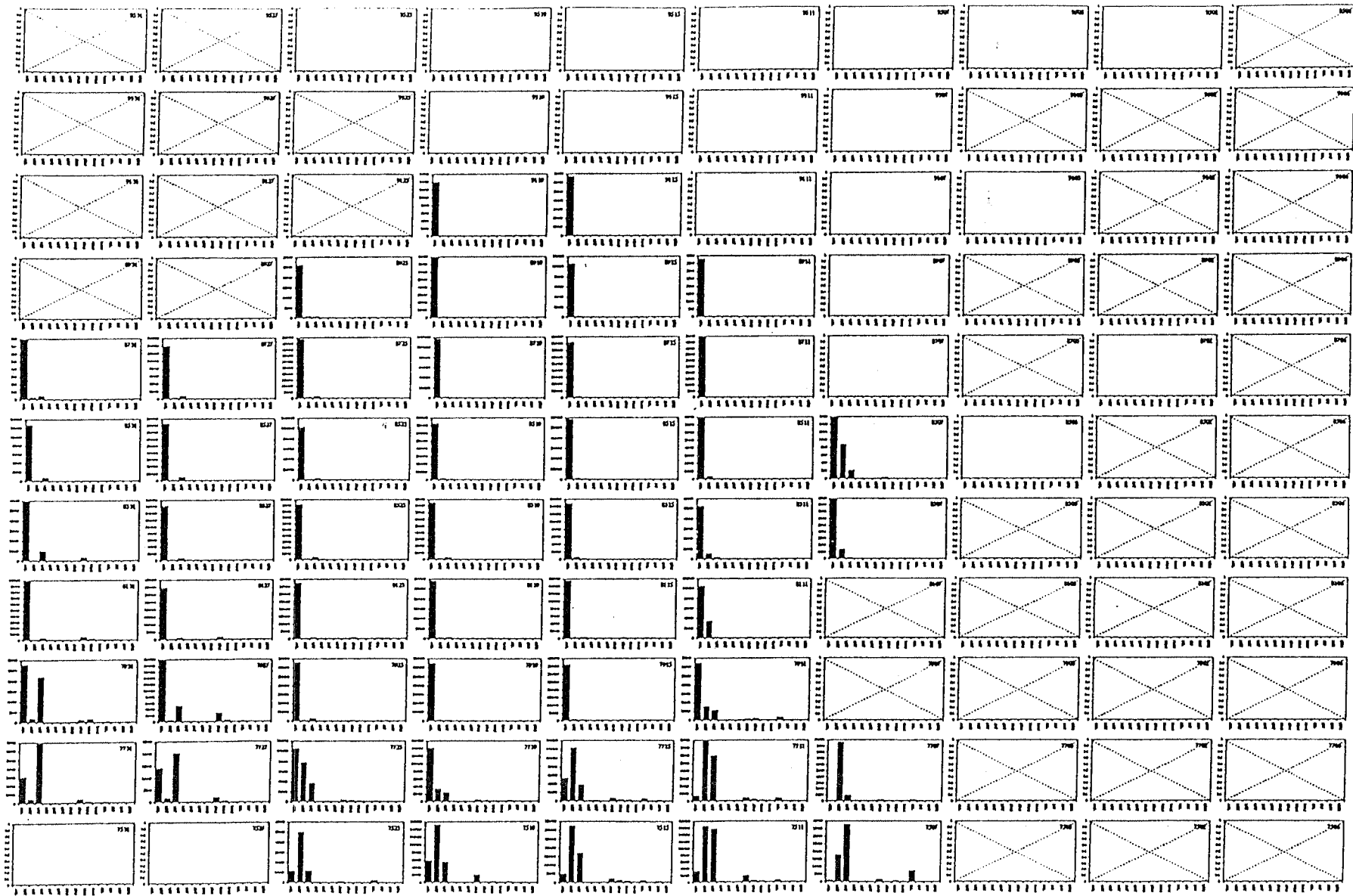


Fig. 1. Cumulative species composition by 5 x 10 block of Taiwanese longline fishery in northern Atlantic during 1968-1995.

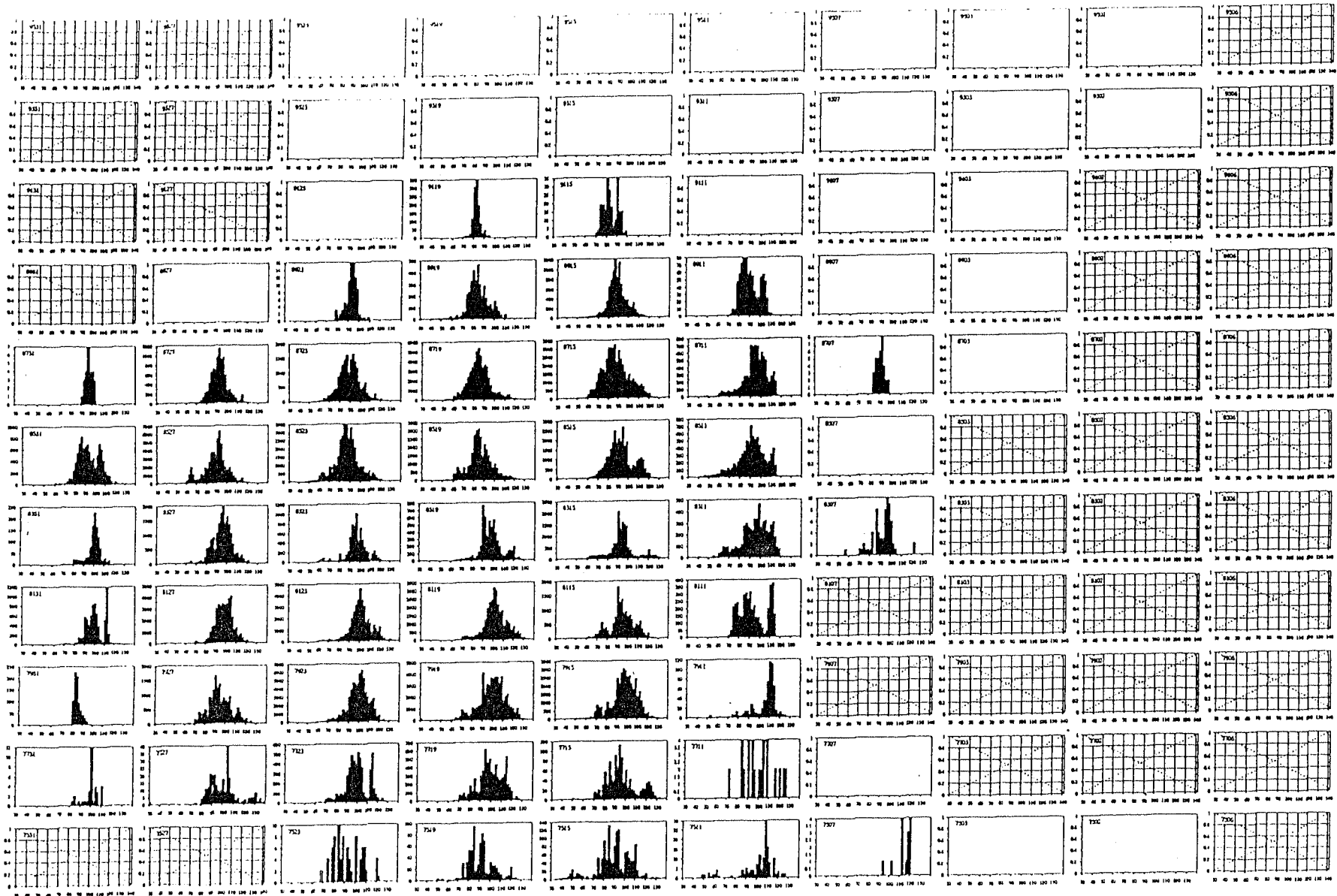


Fig. 2. Cumulative fork length distributions by 5 x 10 block of Taiwanese longline fishery in northern Atlantic during 1981-1995.

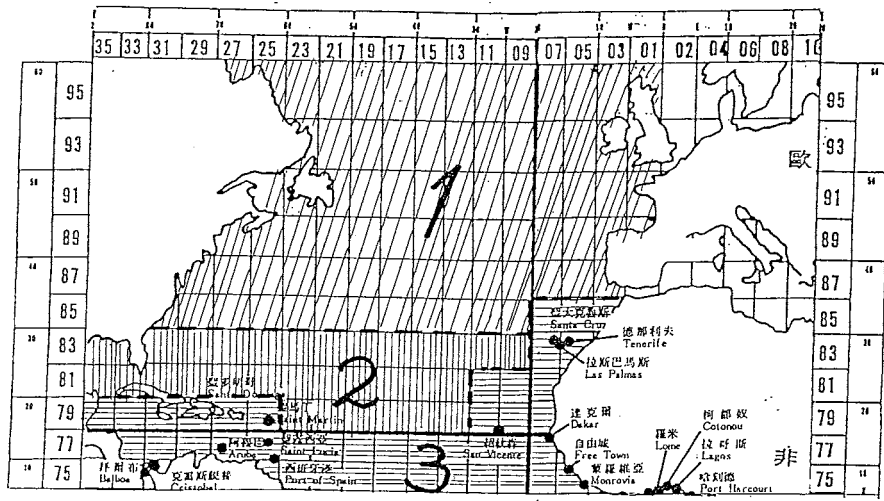


Fig 3. Map shows the definition of subarea in the north Atlantic used in the GLM analysis in this analysis.

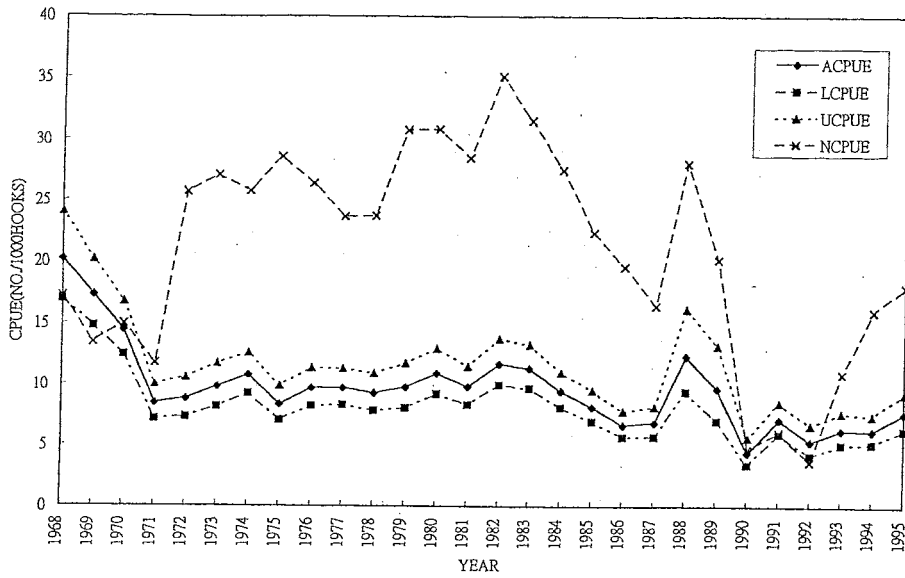


Fig 4. GLM adjusted North Atlantic albacore CPUE trend based on Taiwanese longline fisheries data set.

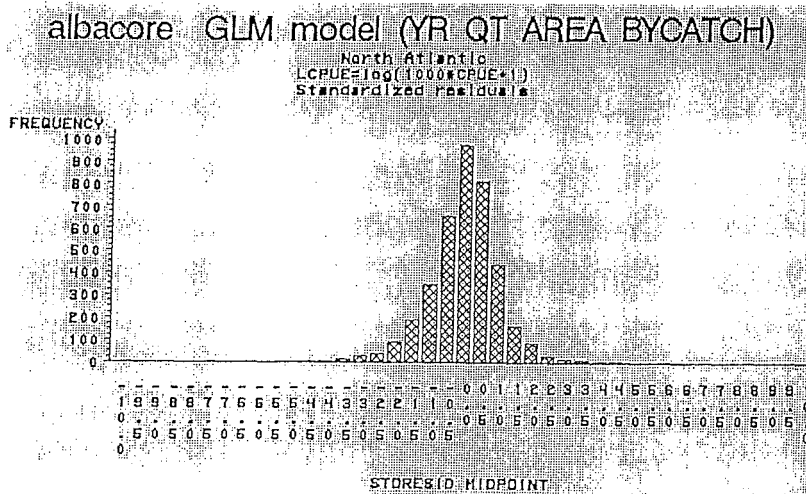


Fig 5. Standardized residual histogram for the formulated GLM analysis.