STANDARDIZATION OF SOUTH ATLANTIC ALBACORE CPUE BY USING GLM WITH AREA-TIME-SPECIES ADJUSTMENTS ON TAIWANESE DATA

Chi-Lun Wu[1] , Shean-Ya Yeh[2] and Hsi-Chiang Liu[2]

ABSTRACT

Based on the Taiwanese longline fisheries data provided by the Tuna Research Center of the Institute of Oceanography, National Taiwan University, the geographic distribution of the yearly nominal albacore catch rate in number indicated that (1) most albacore were caught in the areas between 10° S to 45° S latitude; (2) there is no consistent high nominal albacore CPUE concentration shown, in general, by Taiwanese fishing activities in the south Atlantic, whereas the pattern of fishing activities showed a diversification towards the east and southeast areas of the ocean from the late 1980s to the early 1990s; (3) GLM methods with area-time-species adjustments were used in this study and the CPUE trend indicated that the adjusted CPUE declined at the beginning of the fisheries in the early 1970s, and then leveled off to about 11-15 fish per thousand hooks until the late 1980s. A slight decline was observed in 1990-1992 before recovering significantly in 1993.

RESUME

D'après les données palangrières taïwanaises fournies par le Tuna Research Center de l'Institute of Oceanography, National Taiwan University, la distribution géographique du taux nominal annuel de capture du germon indique que : (1) la plupart des germons ont été capturés dans la zone allant de 10° à 45° de latitude Sud ; (2) les activités de pêche taïwanaises dans l'Atlantique Sud ne montrent pas en général de concentration constamment élevée de CPUE nominale du germon, alors que les caractéristiques de la pêche montraient une diversification entre les parties Est et Sud-Est de l'océan de la fin des années quatre-vingt au début des années quatre-vingt-dix ; (3) cette étude utilise des méthodes GLM avec ajustements zone-époque-espèce, et la tendance de la CPUE montre que la CPUE ajustée a baissé lors des débuts de la pêcherie au début des années soixante-dix, puis s'est stabilisée, et était d'environ 11-15 poissons/1.000 hameçons jusqu'à la fin des années quatre-vingt. Une légère baisse a été observée en 1990-92, suivie d'un rétablissement significatif en 1993.

RESUMEN

Basándose en los datos de pesquerías de palangre de Taiwan facilitados por "Tuna Research Center of the Institute of Oceanography, National Taiwan University", la distribución geográfica de la tasa anual nominal de captura de atún blanco en número indicaba que (1) la mayor parte del atún blanco fue capturado en las áreas entre 10°S a 45°S de latitud; (2) en el Atlántico sur, en general las actividades pesqueras de Taiwan no muestran una concentración alta de CPUE nominal de atún blanco, mientras que los esquemas de actividades pesqueras mostraron una diversificación hacia las zonas este y sudeste del océano en el período de finales de los años 80 a comienzos de los 90; (3) en este estudio se utilizaron métodos GLM con ajustes área-tiempo-especie, y la tendencia de la CPUE indicó que la CPUE ajustada declinó a comienzos de las pesquerías a principios de los años 70, nivelándose a partir de entonces, con unos 11-15 peces por mil anzuelos hasta avanzados los años 80. Se observó un ligero declive en 1990-1992, y se recuperó de manera significativa en 1993.

[1]. Assistant Researcher, Taiwan Fisheries Research Institute, Keelung, Taiwan, ROC;

[2]. Professor, Institute of Oceanography, National Taiwan University, Taipei, Taiwan, ROC.

1. INTRODUCTION

Generalized linear model (GLM) methods have been extensively studied and applied to standardize the Atlantic albacore *CPUE* trends (Tsou 1989; Yeh *et al.*, 1993). Factors of area-time-gear attributes, such as: year, quarter, area block, and depth of deployment are some commonly used attributes to be brought into consideration when adjusting albacore *CPUE*. Uozumi (1993) suggested and demonstrated the importance of bringing in species effect for the better adjustment of a component species *CPUE* when the fisheries concerned are multi-species in nature.

The purpose of this paper is thus to identify and to bring relevant factors of area-time-species attributes of historic Taiwanese longline data series into GLM models to standardize the *CPUE* trend of the south Atlantic albacore resource.

2. MATERIALS AND METHODS

The Taiwanese 1968-1992 longline fisheries data set, which is kindly provided by the Tuna Research Center of the Institute of Oceanography of the National Taiwan University, is the major source of data to be used in this analyses. The resolution of the data, which were compiled from recovered logbooks of Taiwanese longline vessels, is by monthly 5^0 x 5^0 block and by species.

Four main factors of year, quarter, aggregated area, and percentage catch rate of bigeye and yellowfin, as well as relevant interactions between effects based on the results of significant tests of F-value, were included and formulated as follows:

$$log(cpue+1.0)=u+yr+season+area+be+yf+others+(seasonxarea)+(seasonxbe)+(bexyf)$$

3. RESULTS

The geographic distribution of south Atlantic albacore nominal yearly *CPUE* from 1969 to 1992 is shown in Figure 1. The major fishing areas for south Atlantic albacore were from 10^0 S to 45^0 S latitude. Although there seem to be no consistent high albacore *CPUE* concentrations in this period, a slightly higher albacore *CPUE* was found on both sides of the ocean than in the middle part of the ocean.

Chang *et al.* (1993) developed an algorithm of designating the daily longline operation to be a regular or a deep longlining attribute according to its catch composition. The implication of such a practice on the Taiwanese Atlantic longline data set can thus further subdivide the original Task II data set into the regular and the deep longline subgroups. The results of the geographic distribution of Taiwanese longline fishing effort by (1) the regular and (2) the deep longlining attributes are presented by Chang *et al.* (1994).

As shown in Figure 1, the general pattern of geographic distribution of south Atlantic albacore is quite similar to those in the previous years. However, a rather consistent lack of information in the northeastern and the central parts of the ocean has been observed from 1988 to 1992. A moderate geographic extension of fishing activities from the southwestern towards the south-central portion of the ocean, as compared with those years of 1988-1992, was observed in 1993.

Yeh *et al.* (1993) indicated the importance of appropriate fishing area demarcation for a better abundance index estimation, particularly when a fleet has changed it target species. Based on the best available information on the Taiwanese fleet distribution and its catch composition, the south Atlantic Ocean was divided into three subdivisions, as shown in Figure 2, for the designated area effect in this analyses.

The results of significant tests of effects are shown in Table 1. The residual plot of the GLM model is shown in Figure 3 and the adjusted south Atlantic albacore *CPUE* trend by using GLM method is shown in Figure 4. The *CPUE*s decreased from 24 fish per thousand hooks in 1969 to about 13 fish per thousand hooks in 1972. The catch rates leveled off in the mid 1970s to about 11-15 fish per thousand hooks until late 1980s. A slightly lower level of albacore catch rate, of about 9 fish per thousand hooks, is observed in 1990-1992. Yet a significant recovery in the 1993 catch rate is expected according to 1993 nominal *CPUE* provided by Chang *et al.* (1994).

4. DISCUSSION

The results of this analyses indicate that the species effect is very important in formulating a GLM model to adjust the *CPUE* trend. Phenomena of sharp declines in albacore nominal *CPUE* when a fleet changed its target species have been observed both in the Japanese longline fleet in the late 1960s and in the Taiwanese longline fleet in the late 1980s. The effect of a change in the target species can be effectively adjusted to a certain degree by using GLM with area-time-species factors.

The geographic distribution of Taiwanese yearly longline fishing activities in the late 1980s to early 1990s showed slightly different distribution patterns compared with the previous years and this factor may also have contributed to the downward trend in albacore nominal *CPUE*. It is therefore recommended that if detailed information on fishing practices are available, further factors should be incorporated into the model for a better tuning of the albacore *CPUE* during the target changing period.

5. ACKNOWLEDGMENTS

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Table 1. Analysis of variance from the General Lineral Model for South Atlantic albacore.

Sources	DF	Sum of Squares	Mean Square	F value	Pr > F
Model	70	5182.8341519	74.0404879	199.39	0.0001
Error	6048	2245.7999705	0.3713294		
Corrected Total	6118	7428.6341223			
	R-Square	C.V.	Root MSE		
	0.697683	22.0104900	0.6093680		

Sources	DF	Type III SS	Mean Square	F value	Pr > F
YEAR	24	332.3176689	13.8465695	37.29	0.0001
SEASON	3	37.8079064	12.6026355	33.94	0.0001
AREA	2	214.3321489	107.1660745	288.60	0.0001
BET	4	403.3991278	100.8497819	271.59	0.0001
YFT	3	128.9504906	42.9834969	115.76	0.0001
OTH_SP	4	256.7030731	64.1757683	172.83	0.0001
SEASON*AREA	6	32.5380384	5.4230064	14.60	0.0001
SEASON*BET	12	34.4252881	2.8687740	7.73	0.0001
BET*YFT	12	56.8734044	4.7394504	12.76	0.0001

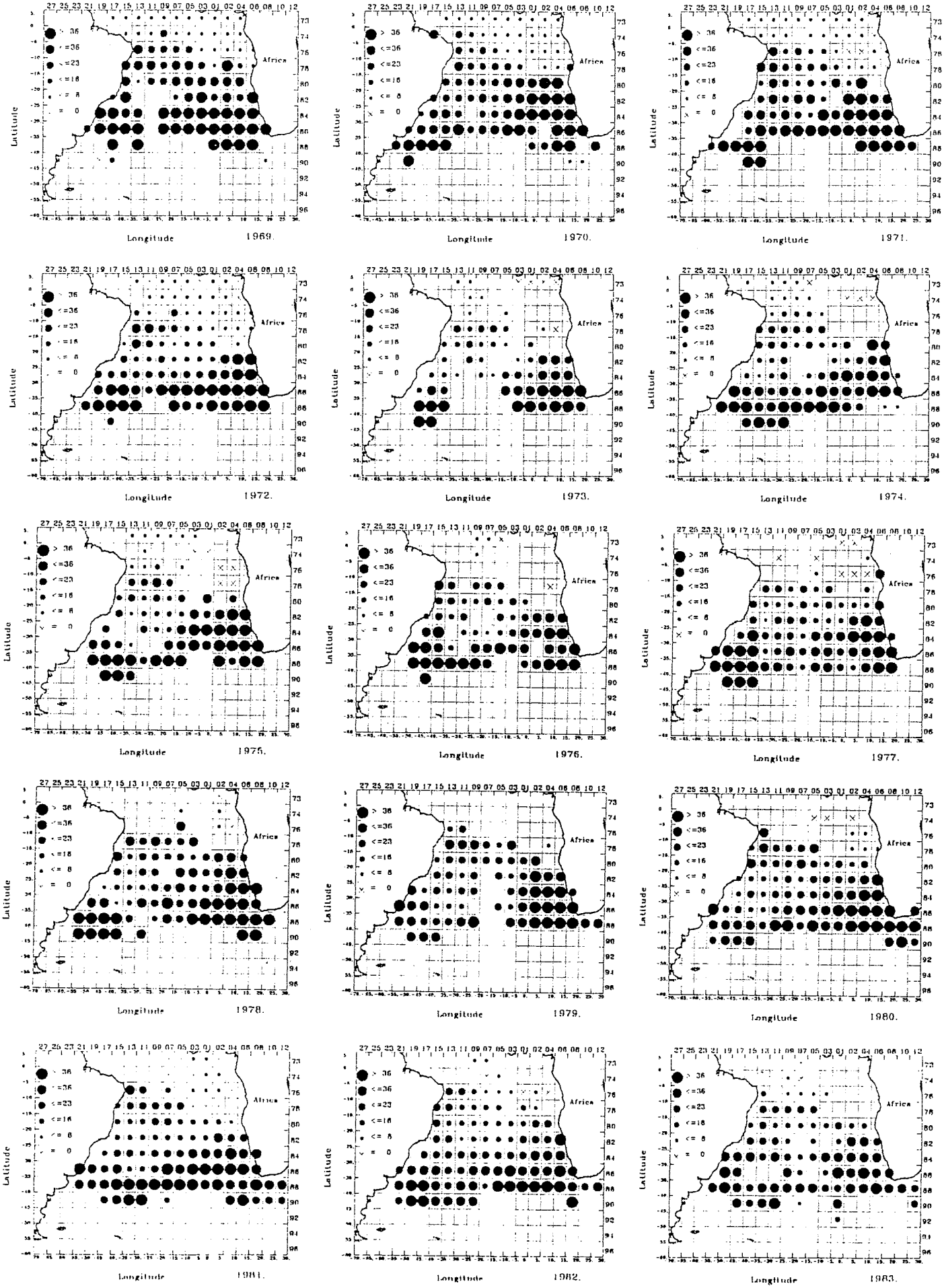

Fig. 1. Geographic distribution of yearly nominal albacore CPUE compiled from Taiwanese longline data from 1969-1992.

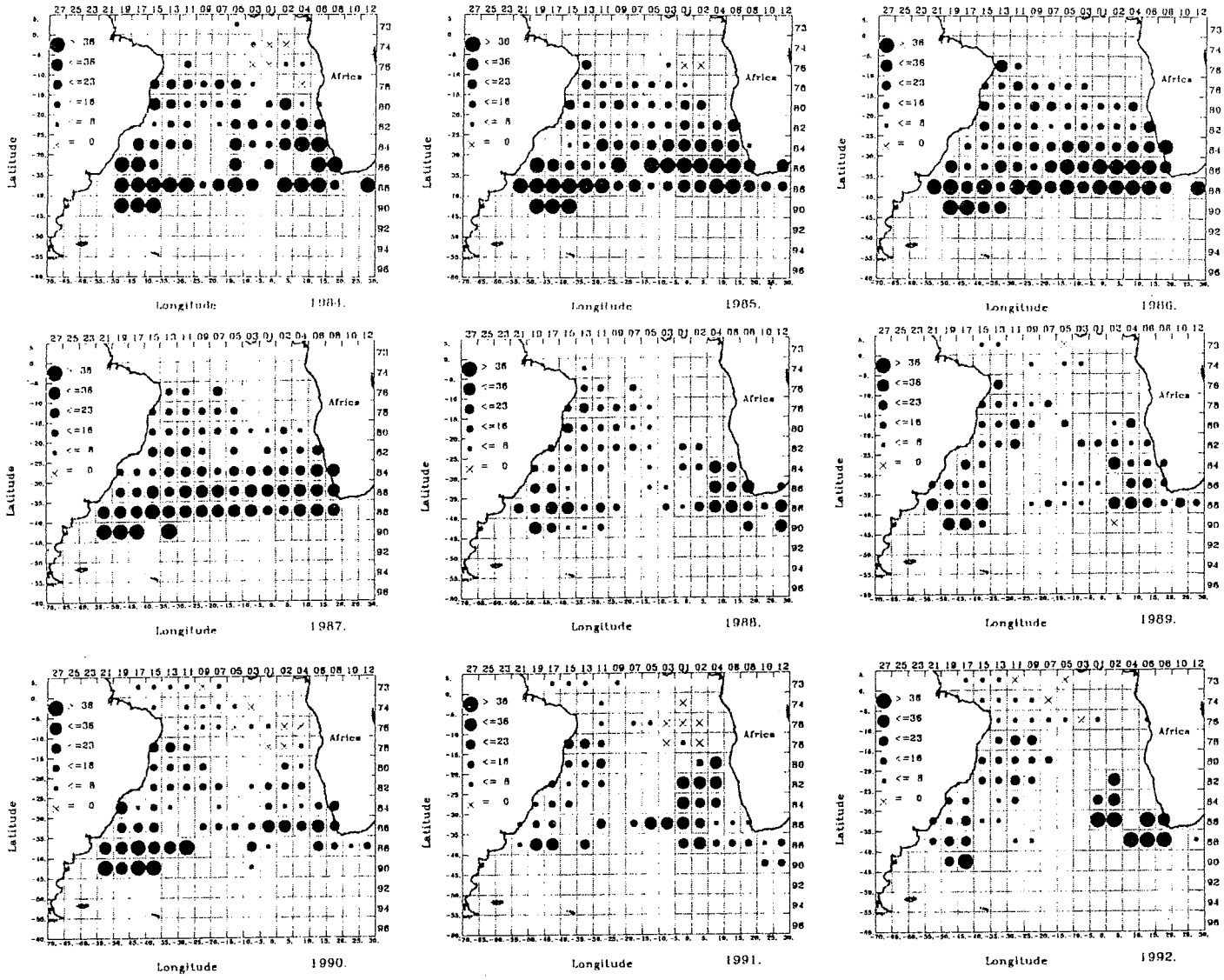

Fig. 1. Continued.

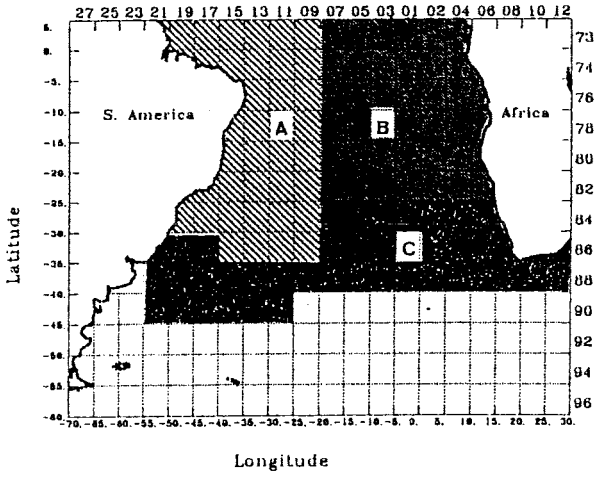

Fig. 2. Demarcation of subdivisions of South Atlantic used in the GLM analyses in this study.

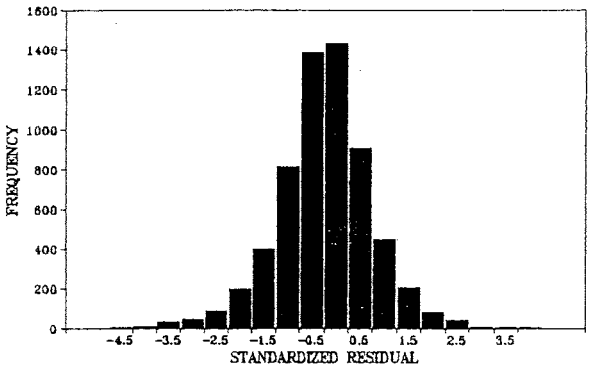

Fig. 3. Plot of residuals of the formulated GLM analysis.

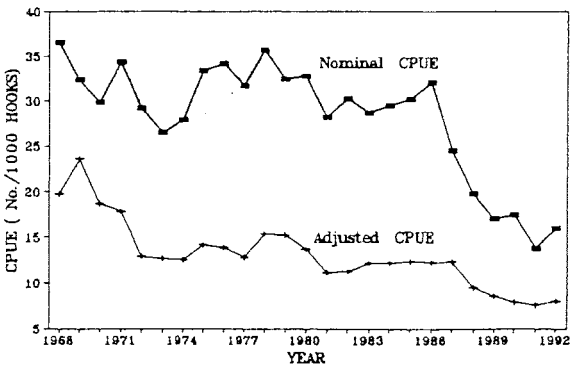

Fig. 4. GLM adjusted South Atlantic albacore CPUE trend based on Taiwanese longline fisheries data set.