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STANDARDIZED CPUE TREND OF TAIWANESE LONGLINE FISHERY FOR NORTHERN ATLANTIC ALBACORE FROM 1968 TO 1996 BY USING GLM AND GENMOD

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SUMMARY

The generalized linear model (GLM) and the generalized linear model with Poisson error structure (GENMOD) were used to standardize the North Atlantic albacore CPUE series compiled from Chinese Taipei 1968-1996 longline fisheries data provided by the Overseas Fisheries Cooperation Council. The factors used in GLM and GENMOD are year, season, fishing area, by-catch effort of bigeye and interaction between area and season. Three major areas, mainly based on real-time species composition characteristics, were identified and designated in this study. Values of CPUE were relatively adjusted to the year of 1996 for unity.

The results so far obtained show that: (1) all factors incorporated in GLM and GENMOD model analysis are highly significant; (2) GLM adjusted CPUE trends indicated that although it appeared that CPUE declined sharply at the beginning of the fisheries (early 1968 to 1971), CPUE remained rather stable until the early 1990s; (3) GLM standardized CPUE trends appeared to decline since 1992; and (4) the general pattern of GENMOD results are quite similar to those from GLM, although its fluctuation between the mid-1980s to the early 1990s seems higher.

RÉSUMÉ

Le modèle linéaire généralisé (GLM) et le modèle linéaire généralisé avec structure de l'erreur de Poisson (GENMOD) ont servi à standardiser la série de CPUE du germon nord-atlantique compilée d'après la pêche palangrière 1968-1996 du Taïpei chinois fournie par l'Overseas Fisheries Cooperation Council. Les facteurs utilisés dans le GLM et le GENMOD sont l'année, la saison, la zone de pêche, la prise accessoire de thon obèse et les interactions zone/saison. Trois principales zones ont été définies, en se fondant essentiellement sur les caractéristiques spatio-temporelles de la composition spécifique, et sont citées dans cette étude. Les valeurs de la CPUE ont été ajustées relativement à l'année 1996 en tant qu'unité de base.

Les résultats obtenus jusqu'à maintenant montrent que : 1) les facteurs incorporés à l'analyse des modèles GLM et GENMOD sont tous très significatifs ; 2) la tendance de la CPUE ajustée par GLM montrait que, malgré une baisse brusque lors des débuts de la pêcheries (début 1968 à 1971), la CPUE est restée assez stable jusqu'au début des années 1990 ; 3) la tendance de la CPUE standardisée par GLM semble baisser depuis 1992 ; 4) le mode général des résultats du GENMOD sont assez semblables à celui du GLM, mais ses fluctuations du milieu des années 1980 au début des années 1990 semblent plus accusées.

RESUMEN

Se utilizó el Modelo Lineal Generalizado (GLM) y el Modelo Lineal Generalizado con estructura de error de Poisson (GENMOD) para estandarizar las series de datos de CPUE de atún blanco compiladas a partir de las series de datos de palangre de Taipei Chino en 1968-1006, aportados por Overseas Fisheries Cooperation Council, de la República China. Los factores utilizados en GLM y GENMOD son: año, temporada, área de pesca, esfuerzo secundario de patudo e interacción entre áreas y temporadas. Se identifican y mencionan en este estudio tres áreas, que se basan principalmente en las características espacio-temporales de la composición por especies. Los valores de CPUE se ajustaron en relación al año 1996, que se eligió como unidad.

Los resultados obtenidos hasta ahora muestran que: (1) todos los factores incorporados en el análisis GLM y GENMOD son altamente significativos; (2) la tendencia de CPUE ajustada con GLM indicó que aunque parecía haber un fuerte declive en la CPUE a comienzos de las pesquerías (a principios de 1968 a 1971, la CPUE permaneció bastante estable hasta comienzos de los años 90; (3) la tendencia de la CPUE estandarizada con GLM pareció declinar desde 1992; (4) el esquema general de los resultados con GENMOD es bastante similar al que se obtiene con GLM, aunque la fluctuación que se produjo entre mediados de los 80 hasta comienzos de los 90 parece ser superior.

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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 separate 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 and Lin, Chang and Yeh, 1997). Factors, such as: year, season and fishing area block are commonly to consider 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 and GENMOD methods to adjust CPUE trend of northern albacore stock.

METERIALS AND METHODS

Taiwanese 1968-1996 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 effort data were identified and split into northern stock by 5 ° N. The resolution of the data, which were complied from recovered logbooks of Taiwanese longline vessels, is by monthly, by 5×5 block, and by species.

Generalized linear model (GLM) and Generalized linear model with Poisson error structure (GENMOD) were used to adjust the CPUE series of northern Atlantic Albacore stock. Main factors used in GLM and GENMOD are year(YR), season(QT), fishing area(AREA), bycatch effort of bigeye tuna(BET) and interaction between season and fishing area (QT*AREA). Three major areas, mainly based on areal-time species composition characteristics, were identified and designated in this study (Fig. 1). An interaction term between area and season was also included in the model. Therefore,

(1)the formula of GLM is followed:

$LN(cpue+1.0)= \mu+YR+QT+AREA+BET+QT*AREA+E$

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

(2) the formula of GENMOD is followed:

$E(C)=H \exp(\mu+YR+QT+AREA+BET+QT*AREA)$

Where E(C) is expected value of catch in number, H is number of hooks used in a monthly assigned sub-area and μ is intercept or overall mean.

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. Table 2 shows the ANOVA table of GENMOD analysis of northern Atlantic stock. All the factors considered in this study are significant and effective in GENMOD model. Table 3 shows the standardized CPUEs of north Atlantic albacore compiled from GLM and GENMOD procedures respectively.

The least-square adjusted CPUE and its 95% confidence interval along with the nominal CPUE by using GLM method are plotted in Fig.2. GLM adjusted CPUE trend indicated that: although it appeared sharply CPUE decline at the beginning of the fisheries (early 1968 to 1971), CPUE remained rather stable until early 1990s; GLM standardized CPUE trend appeared a decline since 1992. The general pattern of GENMOD results are quite similar with those from GLM, although its fluctuates between mid-1980s to early 1990s seems higher (Fig. 3).

Reference

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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	42	4462.329083	106.24593054	194.46	0.0001
Error	4265	2330.294306	0.54637616		
Corrected Total	4307	6792.623389			
		R-square	0.656938		

Source	DF	Type I SS	Mean Square	F Value	Pr>F.
YR	28	1854.923709	66.247275	121.25	0.0001
QT	3	90.838558	30.279519	55.42	0.0001
AREA	2	1883.797714	941.898857	1723.90	0.0001
BET	3	571.346705	190.448902	348.57	0.0001
QT*AREA	36	61.422397	10.237066	18.74	0.0001

Source	DF	Type III SS	Mean Square	F Value	Pr>F.
YR	28	312.271403	11.152550	20.41	0.0001
QT	3	34.747307	11.582436	21.20	0.0001
AREA	2	499.721576	249.860788	475.31	0.0001
BET	3	524.997974	174.999325	320.29	0.0001
QT*AREA	36	61.422397	10.237066	18.74	0.0001

Table 2. ANOVA table of the GENMOD model of the North Atlantic albacore.

Criteria For Assessing Goodness Of Fit

Criterion	DF	Value	Value/DF
Deviance	4265	2860386.0201	670.6650
Scaled Deviance	4265	4265.0000	1.0000
Pearson Chi-Square	4265	3315359.4722	777.3410
Scaled Pearson X2	4265	4943.3916	1.1591
Log Likelihood	.	133356.1738	.

LR Statistics For Type 1 Analysis

Source	Deviance	NDF	DDF	F	Pr>F	ChiSquare	Pr>Chi
YR	6028010.10	28	4265	140.6115	0.0001	3937.1208	0.0001
QT	5763410.14	3	4265	131.5113	0.0001	394.5338	0.0001
AREA	3493893.61	2	4265	1691.9898	0.0001	3383.9796	0.0001
BET	2905339.37	3	4265	292.5227	0.0001	877.5682	0.0001
QT*AREA	2860386.02	6	4265	11.1713	0.0001	67.0280	0.0001

LR Statistics For Type 3 Analysis

Source	NDF	DDF	F	Pr>F	ChiSquare	Pr>Chi
YR	28	4265	27.1056	0.0001	758.9575	0.0001
QT	3	4265	5.2838	0.0012	15.5814	0.0012
AREA	2	4265	378.2971	0.0001	756.5943	0.0001
BET	3	4265	256.8335	0.0001	770.5004	0.0001
QT*AREA	6	4265	11.1713	0.0001	67.0280	0.0001

Table 3: Standardized CPUEs of north Atlantic albacore compiled from GLM and GENMOD procedures respectively.

	Absolute			Relative	
Year	CPUE	Lower95%	Upper95%	CPUE-GLM	CPUE-GENMOD
1968	13.3828	11.5086	15.5378	1.8550	1.7463
1969	13.4204	11.8321	15.2053	1.8568	1.8116
1970	10.4445	9.3770	11.6219	1.6960	1.3151
1971	5.4369	4.7605	6.1927	1.2956	0.9238
1972	7.2040	6.1101	8.4663	1.4644	1.1600
1973	8.2404	6.9844	9.6939	1.5471	1.2863
1974	9.0315	7.9875	10.1967	1.6043	1.2392
1975	7.0736	6.1710	8.0900	1.4532	1.3072
1976	8.9104	7.8284	10.1251	1.5958	1.0250
1977	7.8185	6.9222	8.8161	1.5146	0.8708
1978	8.2177	7.1404	9.4375	1.5454	0.9718
1979	8.1176	6.7820	9.6823	1.5378	1.2344
1980	9.8454	8.4842	11.4019	1.6586	1.2630
1981	8.7068	7.5736	9.9898	1.5814	1.1505
1982	9.3121	8.1834	10.5794	1.6235	1.3862
1983	9.8360	8.6957	11.1104	1.6580	1.2488
1984	8.3508	7.4447	9.3541	1.5554	1.0824
1985	7.2744	6.4864	8.1453	1.4703	0.9183
1986	6.1293	5.4596	6.8686	1.3667	0.7899
1987	6.2012	5.3207	7.2044	1.3737	0.6589
1988	9.8161	7.2053	13.0860	1.6565	1.0415
1989	6.6789	4.6594	9.4190	1.4183	0.8680
1990	4.8971	3.8686	6.1429	1.2346	0.5877
1991	9.3432	8.0906	10.7684	1.6256	0.8045
1992	6.9389	5.6294	8.5071	1.4415	1.1015
1993	6.3829	5.3285	7.6130	1.3910	0.8163
1994	4.8183	4.1691	5.5491	1.2253	1.0858
1995	5.1175	4.4044	5.9248	1.2602	1.1130
1996	3.2090	2.7749	3.6930	1.0000	1.0000

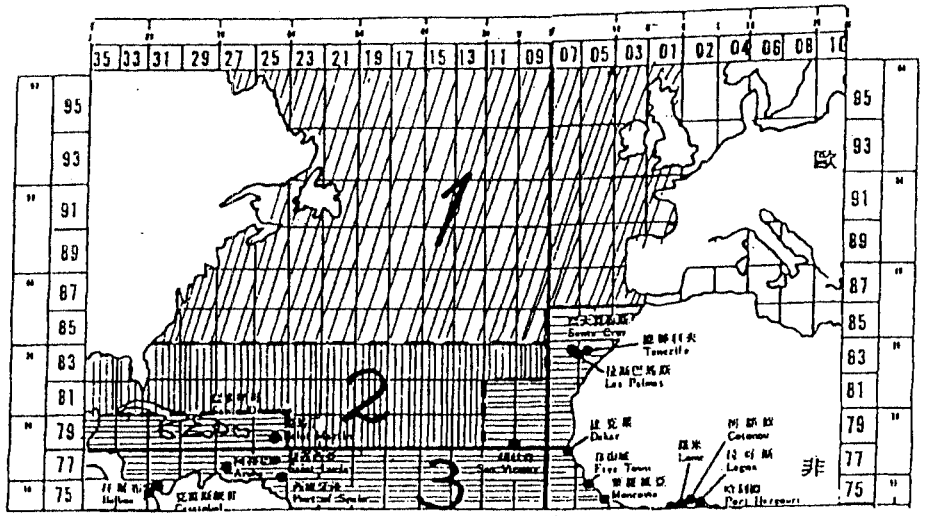

Fig. 1 Map shows the definition of subarea in the north Atlantic used in the GLM and GENMOD analysis in this study.

Fig. 2 The CPUE estimated by GLM procedures for the north Atlantic albacore by Taiwanese longline fishery.

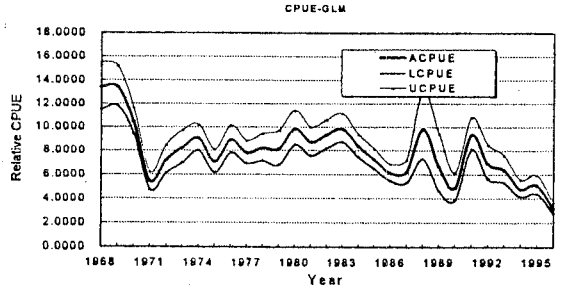

Fig. 3 Standardized CPUEs, estimated by GLM and GENMOD procedures respectively, for the north Atlantic albacore by Taiwanese longline fishery. Values of CPUE were relatively adjusted to year of 1996 at which values were set to 1.0.