

THE STANDARDIZED LONGLINE CPUE OF NORTH AND SOUTH ATLANTIC ALBACORE*K. Uosaki**National Research Institute of Far Seas Fisheries,
5 chome, 7-1 Orido, Shimizu-shi, Shizuoka 424, Japan***SUMMARY**

The CPUEs of the Japanese longline fisheries on both the north and south Atlantic albacore stocks during 1975-1991 were standardized by General Linear Model (GLM). A declining trend of CPUE in the north Atlantic was found, but in the south Atlantic no such trend was found.

RESUME

La CPUE des pêcheries palangrières japonaises sur les stocks de germon de l'Atlantique nord et sud durant la période 1975-91 ont été standardisées par le Modèle linéaire généralisé (GLM). On a noté une tendance à la baisse de la CPUE dans l'Atlantique nord, mais pas dans l'Atlantique sud.

RESUMEN

Las CPUE de las pesquerías de palangre de Japón de los stocks de atún blanco del Atlántico norte y sur durante 1975-1991 se estandarizaron mediante el Modelo Lineal Generalizado (GLM). Se halló una tendencia descendente de la CPUE en el Atlántico norte, no hallándose tal tendencia en el Atlántico sur.

INTRODUCTION

The Japanese longline fishery in Atlantic Ocean commenced in 1956, then expanding fishing ground and increasing fishing effort made albacore catch more than 40,000 metric tons in the mid-1960s. After that as the target species were shifted to bluefin, southern bluefin, bigeye tunas from albacore, the catch of albacore had drastically decreased to 1,000-3,000 metric tons since the early 1970s.

Standardization of CPUE using General linear model (GLM) was studied for Atlantic albacore caught by Taiwanese longline fishery by Hsu and Chang (1993). In this study, CPUE of Japanese longline fishery on both North and South Atlantic albacore were standardized using GLM, accounting the effects of the area, time and gear configurations.

MATERIAL AND METHOD

Catch and effort data used in the analysis were obtained from the Japanese longline fishery statistics compiled at the National Research Institute of Far Seas Fisheries (NRIFSF) for 1975-1991. The database were aggregated by month of the year, 5° square area and the information on the number of branch lines between floats. CPUE was calculated as catch in number per 1,000 hooks. Observation with less than 5,000 hooks were excluded, but observation with no catch of

albacore were remained in the analysis.

The model includes main effects of year, fishing season, area, gear and interaction terms. Quarter of the year was selected as fishing season. Based on the distribution of albacore catch and CPUE, subareas were selected as Fig. 1. Based on the distribution of albacore CPUE by gear configuration, these were categorized to 4 levels e.g. 1-4, 5-8, 9-13 and 14-18 for the North Atlantic, 1-6, 7-9, 10-14 and 15-19 for the South Atlantic. The model is shown below;

$$\text{LOG}(1000 \cdot \text{CPUE} + 1.0) = \mu + Y_i + Q_j + A_k + G_l + \text{interaction} + e_{ijkl}$$

where LOG : natural logarithm
CPUE : catch in number per 1000 hooks
 μ : overall mean
 Y_i : effect of year
 Q_j : effect of quarter
 A_k : effect of subarea
 G_l : effect of gear
 e_{ijkl} : error term with $N(0, \sigma)$
Interaction : any combination of two way interaction except for year term

The best model was selected by AIC (Akaike's Information Criterion, Akaike 1973, 1974 and 1985, Nakano 1993) among the test models.

RESULT AND DISCUSSION

As the result of the test run with any combinations of two way interaction, model $\text{LOG}(1000 \cdot \text{CPUE} + 1.0) = \mu + Y_i + Q_j + A_k + G_l + Q \cdot A_{jk} + A \cdot G_{kl} + e_{ijkl}$, which indicated the least AIC among the models, was chosen for both North and South Atlantic stock (Table 1).

The analysis of variance (Table 2) revealed that all main effects and interactions were significant at 0.1% level. The R square value of the final model were 0.53 for North Atlantic stock, and 0.45 for South Atlantic stock. The histogram of standardized residuals for the model were not so far from normal distribution. (Fig. 2)

The standardized CPUEs were shown in Table 3, and these CPUEs with upper and lower 95% confidence limit were plotted in Fig. 3. The relative CPUE indicated decreasing trend from 1975 to the mid-1980s, but it became stable from the late 1980s to the most recent year for North

Atlantic stock. For the South Atlantic stock, the relative CPUE decreased in the late 1970s, but it became higher level from the early of 1980 to mid-1980s, then it became lower level again in the late 1980s and it has been stable in the recent 5 years.

LITERATURE CITED

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Table 1. Summary of ANOVA for the tested with AIC.

North						
model	No. of parameter	R-square	C.V.	MSE	F Value	AIC
Y,Q,A,G	36	0.4626	92.89	0.346	208.58	-3519.27
Y,Q,A,G,QA	80	0.5111	88.77	0.316	130.24	-3737.97
Y,Q,A,G,AG	80	0.4926	90.43	0.328	120.96	-3612.57
Y,Q,A,G,QG	52	0.4809	91.34	0.334	175.03	-3600.74
* Y,Q,A,G,QA,AG	124	0.5332	86.91	0.303	95.51	-3800.85
Y,Q,A,G,QA,QG	96	0.5193	88.07	0.311	117.40	-3759.40
Y,Q,A,G,AG,QG	96	0.5029	89.57	0.322	109.91	-3645.48
Y,Q,A,G,QA,AG,QG	140	0.5352	86.78	0.302	87.60	-3771.54

No. of observation = 7787

South						
model	No. of parameter	R-square	C.V.	MSE	F Value	AIC
Y,Q,A,G	31	0.4143	126.49	0.300	149.29	-2929.98
Y,Q,A,G,QA	55	0.4387	123.99	0.289	105.76	-2981.16
Y,Q,A,G,AG	55	0.4328	124.65	0.292	103.27	-2955.78
Y,Q,A,G,QG	47	0.4210	125.87	0.297	114.95	-2923.29
* Y,Q,A,G,QA,AG	79	0.4531	122.55	0.282	82.38	-2991.15
Y,Q,A,G,QA,QG	71	0.4421	123.72	0.287	88.20	-2961.17
Y,Q,A,G,AG,QG	71	0.4387	124.09	0.289	86.99	-2946.06
Y,Q,A,G,QA,AG,QG	95	0.4567	122.26	0.281	72.09	-2972.24

No. of observation = 5728

Table 2. Analysis of variance for final model for the North and South Atlantic stoks

North					
Source	Degree of Freedom	Sum of Square	Mean Square	F Value	Pr > F
Model	92	2660.14	28.91	95.51	0.0001
Error	7694	2329.21	0.30		
Corrected Total	7786	4989.35			

R-square = 0.533164

Source	Degree of Freedom	Sum of Square	Mean Square	F Value	Pr > F
Y	16	311.56	19.47	64.32	0.0001
Q	3	282.03	94.01	310.55	0.0001
A	10	1710.73	171.07	565.1	0.0001
G	3	45.24	15.08	49.81	0.0001
Q*A	30	226.72	7.55	24.96	0.0001
A*G	30	83.83	2.79	9.23	0.0001

South					
Source	Degree of Freedom	Sum of Square	Mean Square	F Value	Pr > F
Model	57	1324.08	23.22	82.38	0.0001
Error	5668	1598.23	0.28		
Corrected Total	5725	2922.31			

R-square = 0.453094

Source	Degree of Freedom	Sum of Square	Mean Square	F Value	Pr > F
Y	16	115.58	7.22	25.62	0.0001
Q	3	69.94	23.31	82.68	0.0001
A	5	1019.07	203.81	722.81	0.0001
G	3	6.17	2.05	7.31	0.0001
Q*A	15	71.25	4.75	16.85	0.0001
A*G	15	42.04	2.80	9.94	0.0001

Table 3. Standardized CPUEs of the North and South Atlantic albacore for Japanese longline fishery, 1975-1991.

North		unit:No./1000 hooks	
year	CPUE	95% upper limit	95% lower limit
75	1.971	2.044	1.899
76	1.892	1.968	1.816
77	1.528	1.616	1.440
78	1.270	1.348	1.193
79	1.049	1.127	0.971
80	1.016	1.082	0.949
81	1.200	1.257	1.142
82	0.839	0.897	0.781
83	0.887	0.960	0.813
84	0.819	0.887	0.750
85	0.903	0.963	0.842
86	0.559	0.627	0.492
87	0.462	0.533	0.392
88	0.704	0.771	0.637
89	0.697	0.752	0.643
90	0.621	0.680	0.562
91	0.682	0.742	0.622

South		unit:No./1000 hooks	
year	CPUE	95% upper limit	95% lower limit
75	0.845	0.996	0.694
76	0.756	0.928	0.585
77	0.661	0.811	0.512
78	0.629	0.759	0.499
79	0.488	0.606	0.369
80	1.020	1.121	0.920
81	1.295	1.392	1.199
82	1.224	1.317	1.130
83	0.866	0.966	0.766
84	0.844	0.935	0.752
85	1.087	1.173	1.002
86	1.126	1.215	1.038
87	0.670	0.767	0.573
88	0.638	0.722	0.554
89	0.614	0.697	0.532
90	0.622	0.699	0.545
91	0.607	0.689	0.525

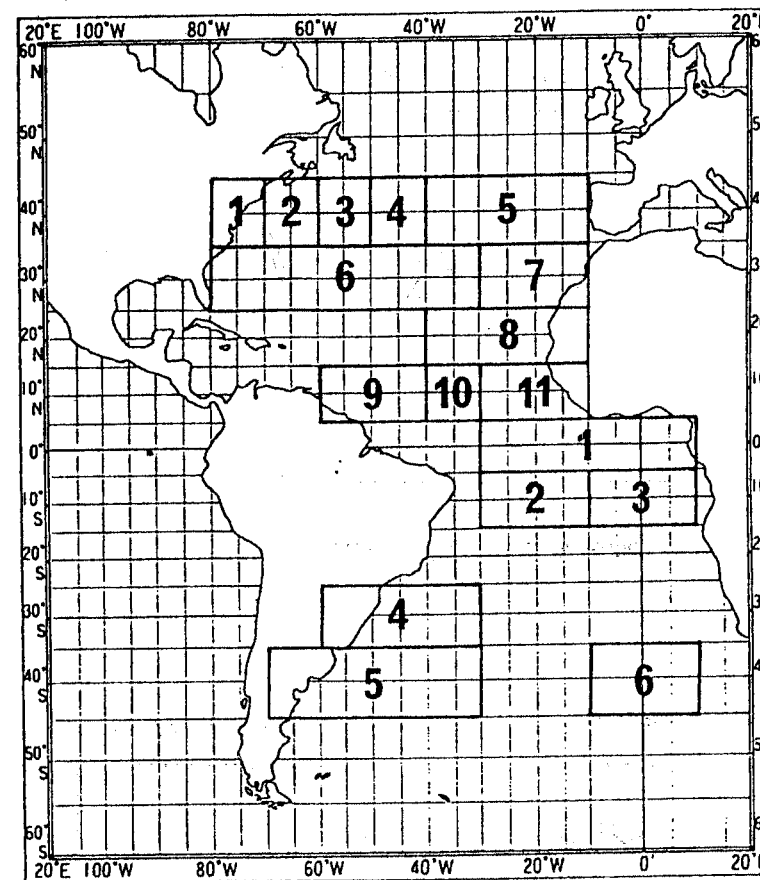


Fig. 1. Subareas used for GLM analysis.

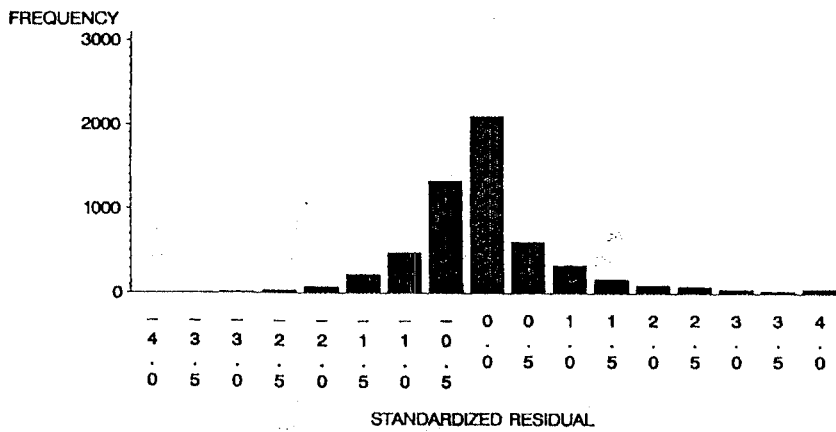
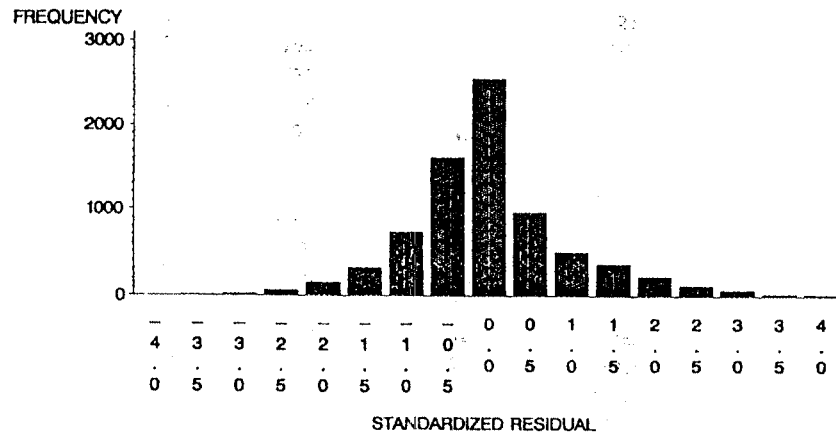
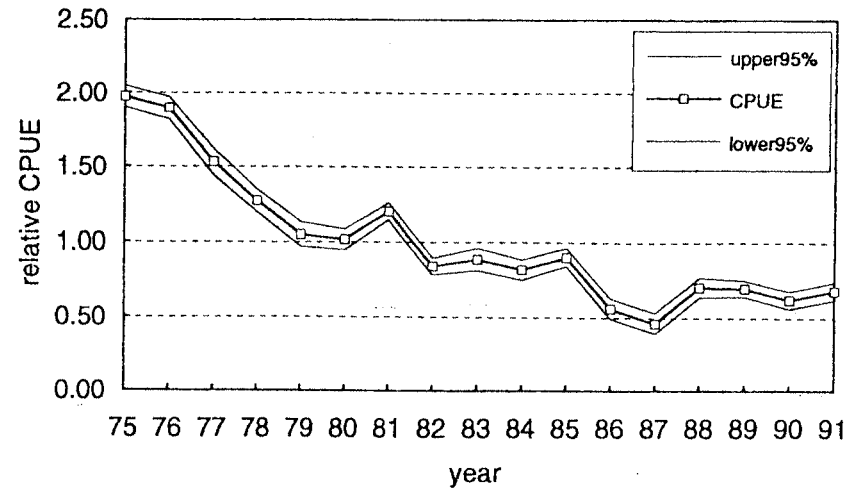


Fig. 2. Distributions of standardized residuals of the final model for North (top) and South (bottom) Atlantic.

standardized CPUE in North Atlantic



standardized CPUE in South Atlantic

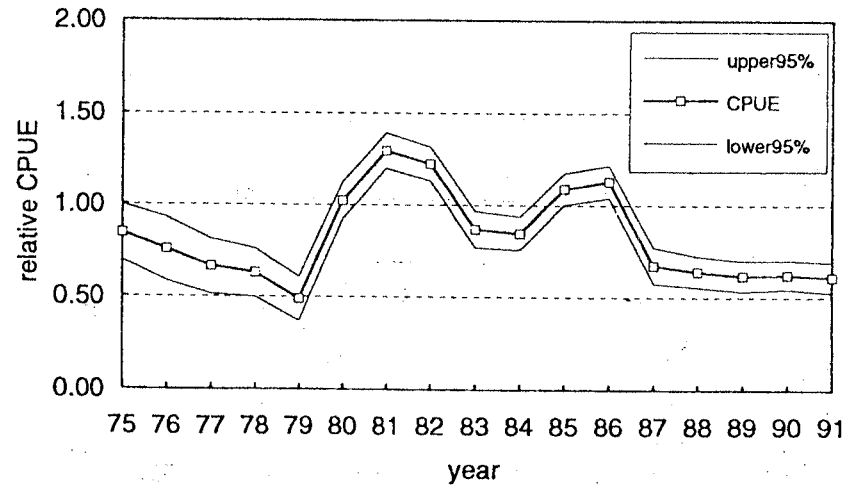


Fig. 3. Standardized CPUE by year for North (top) and South (bottom) Atlantic albacore. Upper and lower line indicate 95% confidence limits.