UPDATE ON STANDARDIZATION OF CPUE FOR YELLOWFIN TUNA CAUGHT BY TAIWANESE DISTANT-WATER TUNA LONGLINE FISHERY OPERATE IN THE INDIAN OCEAN

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ABSTRACT

Standarization of CPUE series using catch and effort data from 1968 to 2000 for Taiwanese distant-water tuna longline fishery in the Indian Ocean were reported Factors including year, quarter, areas (with 7 sub-areas) as well as the CPUE of albacore and bigeye tunas (each with 5 different levels), were used as the main factors in the GLM. The model explains about 55% of the variance. Most of the variances can be explained by factors: area, targeting effect of albacore and year. The series of adjusted CPUE showed a sharp decreasing trend from 60's to 70's, but remained relatively stable after 80's. In recent years, the index showed an increasing trend but decrease again if the preliminary data in 2000 was included. It was suggested that the stock of the yellowfin tuna in the Indian Ocean remained to be stable in recent years. However, more studies on fisheryspecific and regional-specific analyses may be necessary as different fisheries may actually target on different life stages of yellowfin tuna, and abundance of yellowfin tuna also is different among areas. There is also a need to further investigate interactions of targeting effect of albacore and bigeye tunas on the catch rate of yellowfin tuna.

INTRODUCTION

Yellowfin tuna is one of the most important targeted species for Taiwanese distant-water tuna longline fishery operate in the Indian Ocean (Fig. 1). Taiwanese longliner started to explore this resource from mid-50's in the north and the eastern Indian Ocean, and subsequently expanded to three major Oceans. Catches during late 60's to early 70's were mainly yellowfin tuna, but shifted to albacore during mid-70's, and then bigeye tuna from 80's as super cold freezer were developed and equipped in larger new-built vessels. For recent years, landing of yellowfin tuna showed a dramatic increase (~5000 mt) from 1997 to 1998, but remained stable at about 17,500 mt during 1999-2000, and increased again (to 18,860 mt) in 2001. Catch in recent years accounted for about 17% of the total yellowfin catch in the entire Indian Ocean.

In this report, we updated Taiwanese standardized CPUE using GLM for distant water tuna longline fishery operate in this ocean by including new catch and effort data for recent years.

MATERIALS AND METHODS

Catch and effort data aggregated by 5^o x 5^o area from 1968 to 2000 for Taiwanese distant-water tuna longline fishery operate in the Indian Ocean were used in this study for standarization of CPUE series. Because stock identification for yellowfin tuna in the Indian Ocean remain to be determined (Kikawa et al., 1970; Morita and Koto, 1970; Huang et al., 1973, Kurogane and Hiyama, 1958, Nishida, 1992), we decided to use the historical catch composition and distribution information for area specification (Fig. 2), and used in the GLM model.

Factors including year, quarter, areas as well as the CPUE of albacore and bigeye tunas, each classified as 5 different levels, were used as the main factors in the GLM model. The GLM model selected is as following:

$$\log(cpue + c) = \mu + year + quarter + area + alb + bet + \varepsilon$$

Where μ is overall mean, ε is error term assumed to be normally distributed with zero mean and σ^2. The Indian Ocean was divided into 7 sub-areas (Fig. 3) according to the catch composition (by no.) and distribution of yellowfin tuna in this region. The constant *c*, as 10% of the overall nominal CPUE was used in the model.

RESULTS AND DISCUSSION

The ANOVA result from GLM was shown in the Table 1. The fitting model explains about 55% of the variance. Most of the variance can be explained by the 「area」,「targeting effect of albacore」and 「year」 factors. The model was accepted by the significant statistical F value and the normal distribution of residuals (Fig. 4). In the model, other explained factors also were statistical significant.

The series of adjusted catch-per-unit-effort (i.e., ACPUE) of the yellowfin tuna showed (Fig. 4) a sharp decreasing trend from 60's to 70's, but remained relatively stable after 80's. In recent years (except 2000), the index actually showed an increasing trend but decrease again if the preliminary data in 2000 was included. In a previous study (not shown here), we also used five sub-areas (separated based on the CPUE level of the yellowfin tuna) for the model run, the CPUE trend was essentially the same as this study (see appendix for detail), but the r^2 is lower and the root MSE is higher.

Based on the result presented here, it is suggested that the stock of the yellowfin tuna in the Indian Ocean remained to be stable in recent years. However, more studies on fishery-specific and regional-specific analyses may be necessary as different fisheries (purse seine, longline, troll …etc.) may actually target on different life stages of yellowfin tuna, and abundance of yellowfin tuna also is very different among areas (as demonstrated in this study). There is also a need to further investigate interactions of targeting effect of albacore and bigeye tunas on the catch rate of yellowfin tuna.

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Table 1: TheANOVA results of the GLM analysis conducted for the yellowfin tuna caught by Taiwanese distant water tuna longline fishery operate in the Indian Ocean during 1968-2000.

Source	**DF**	**Sum of Squares**	**Mean Square**	**F Value**	**Pr > F**
Model	49	13498.06	275.47	453.38	<.0001
Error	18032	10956.00	0.61		
Corrected Total	18081	24454.06			

R-Square	C. V.	RMSE	lcpue Mean
0.55	106.12	0.78	0.73

Source	**DF**	**Type I SS**	**Mean Square**	**F Value**	**Pr > F**
year	32	5707.20	178.35	293.54	<.0001
q	3	141.92	47.31	77.86	<.0001
reg	6	7015.43	1169.24	1924.40	<.0001
acode	4	547.92	136.98	225.45	<.0001
bcode	4	85.59	21.40	35.22	<.0001

Source	**DF**	**Type III SS**	**Mean Square**	**F Value**	**Pr > F**
year	32	4000.07	125.00	205.74	<.0001
q	3	18.66	6.22	10.23	<.0001
reg	6	1743.96	290.66	478.38	<.0001
acode	4	533.53	133.38	219.53	<.0001
bcode	4	85.59	21.40	35.22	<.0001

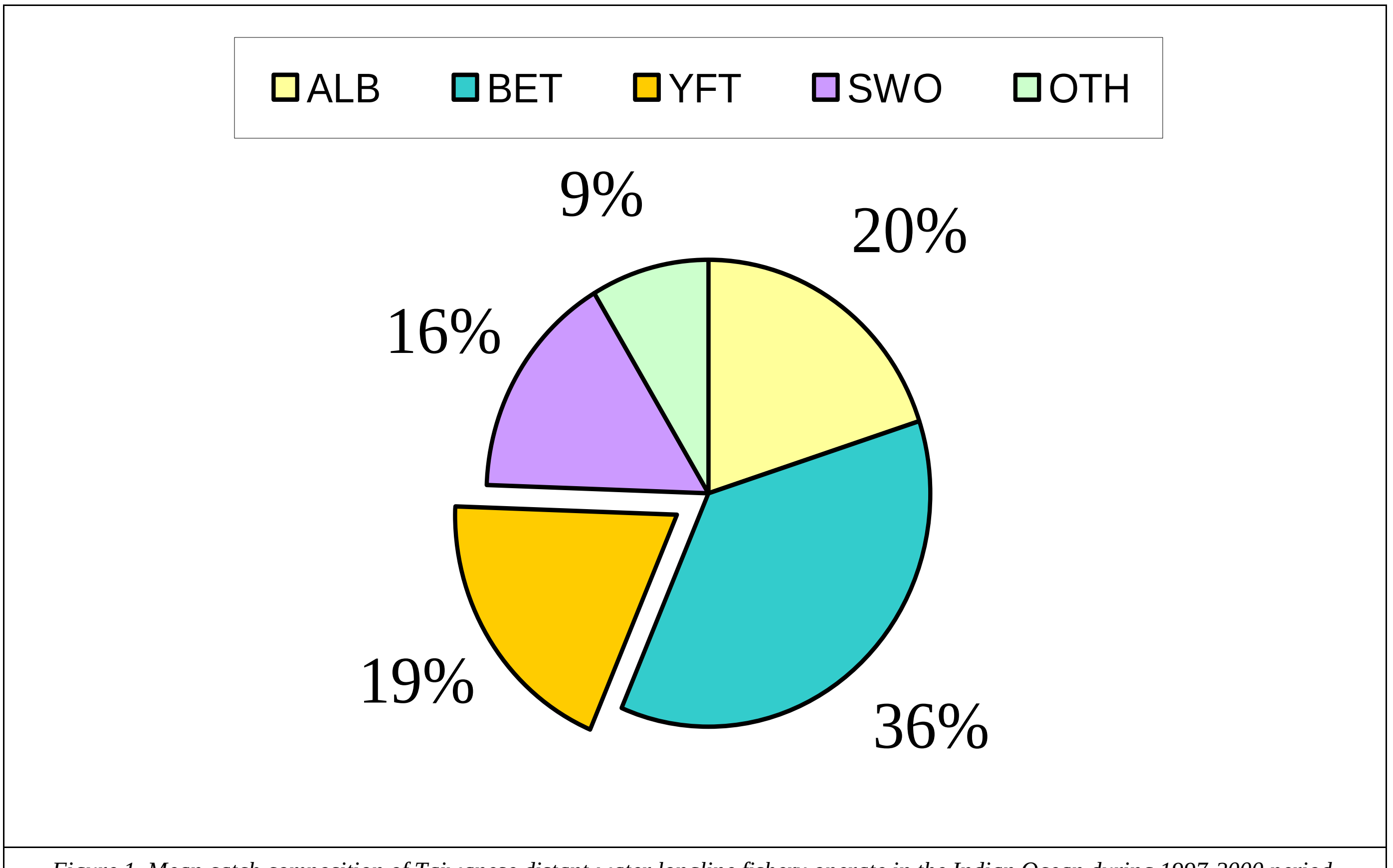

Figure 1. Mean catch composition of Taiwanese distant-water longline fishery operate in the Indian Ocean during 1997-2000 period.

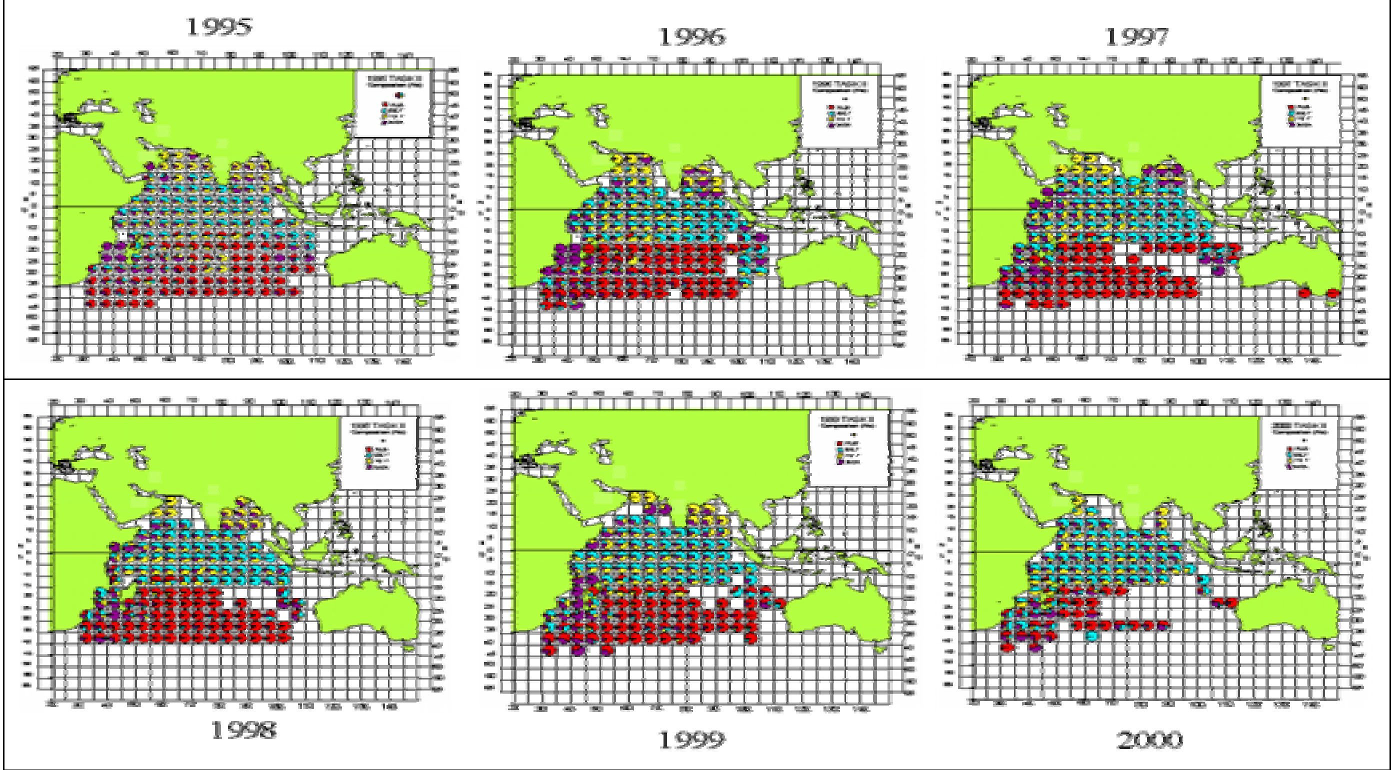

Figure 2. Catch distribution of major tuna species from Taiwanese distant- water longline fishery operate in the Indian Ocean during 1995-2000 periods.

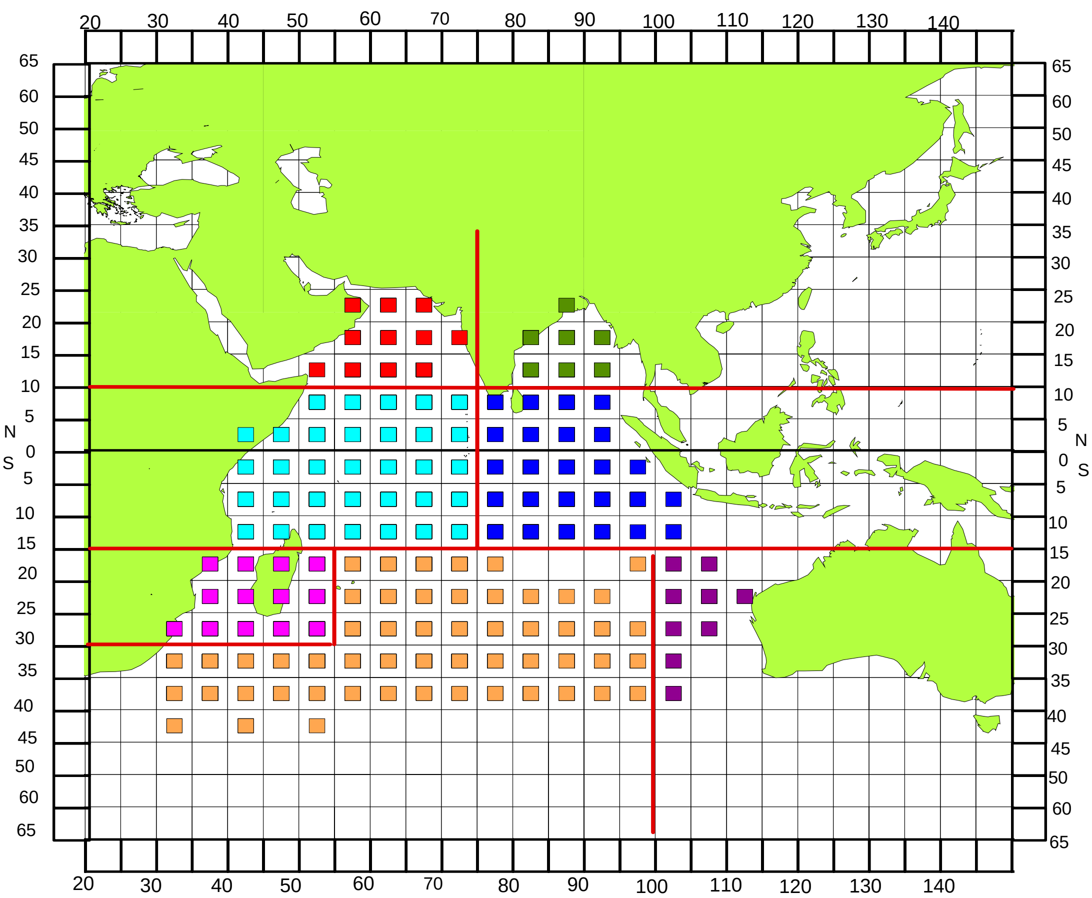

Fig. 3. Sub-areas of the Indian Ocean specified for the GLM analyses in the study.

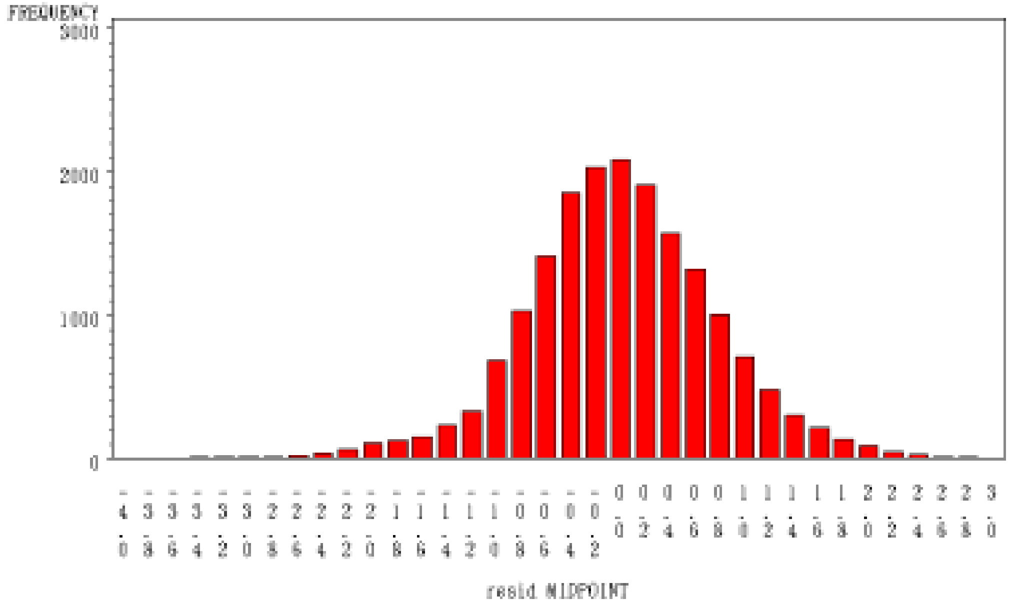

Figure 4. The residual plot of the GLM results conducted for yellowfin tuna caught by Taiwanese distant water longline fishery operate in the Indian Ocean during 1968-2000.

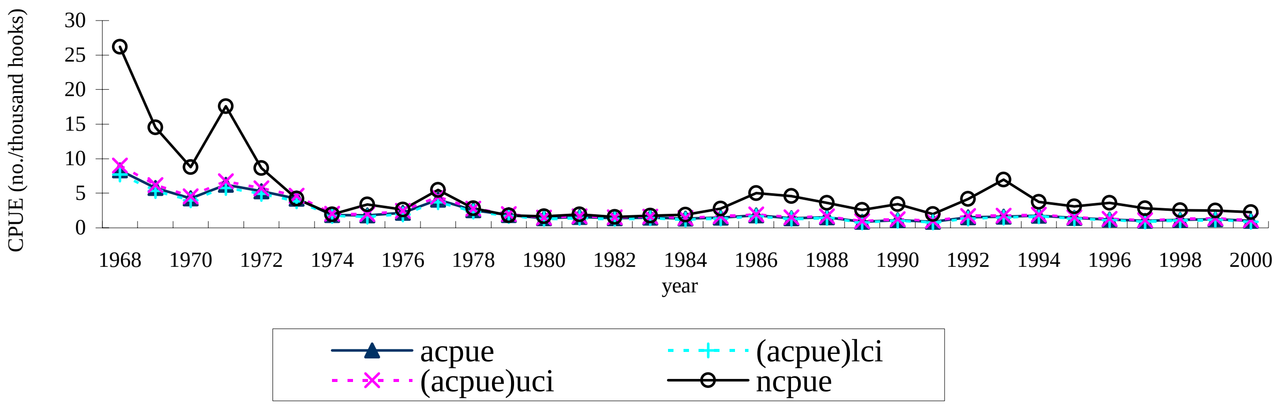

Fig. 5. The nominal and standardized CPUE series of yellowfin tuna caught by Taiwanese distant water longline fishery operate in the Indian Ocean during 1968-2000. Dash lines represented for upper and lower 95% confidence intervals.

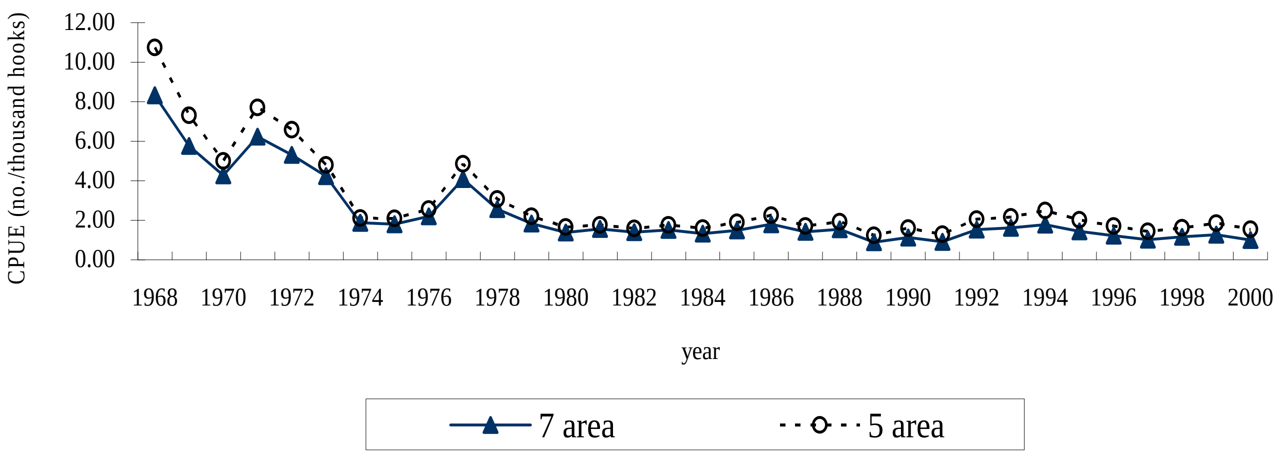

Fig. 6. The standarized CPUE series using different area specifications for yellowfin tuna caught by Taiwanese distant water longline fishery operate in the Indian Ocean during 1968-2000.