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Standardization of Yellowfin tuna CPUE by Korean longline fishery in the Western and Central Pacific Ocean (1978-2011)

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Abstract

Standardization of yellowfin tuna CPUE by Korean longline fisheries in the Western and Central Pacific Ocean was conducted using General Linear Model for 1978-2011. The data used were catch (number), effort (number of hooks) and number of hooks between floats (NHF) by year, month and 5°x5° block. Explanatory variables for the GLM analysis are year, quarter, area and NHF. From the results, it was suggested that area quarter was the largest factor affecting the nominal CPUE. Standardized CPUEs were generally in declining trend and stable in recent years. This is the first attempt to estimate the standardized CPUE of yellowfin tuna by the Korean tuna longline fisheries in the Western Central Pacific Ocean.

1. Introduction

Yellowfin tuna has been the second highest catch species following bigeye tuna by Korean longline fishery in the WCPFC convention area. Korean longline fishery commenced in the late 1950s but the catch data have been available since the mid-1980s. The catches were fluctuated between the lowest of 7,841 t in 1991 and the peak of 15.497 t in 2002 and stayed below the average in the recent years. It was shown slightly increasing trend prior to 2002 showing the highest catch amount, while slightly decreasing thereafter and no further decline in the recent years (Fig. 1). In this study, yellowfin CPUE standardization of the Korean longline fisheries in the WCPFC convention area (1978-2011) was conducted using Generalized Linear Model (GLM) to assess the proxy of the abundance index.

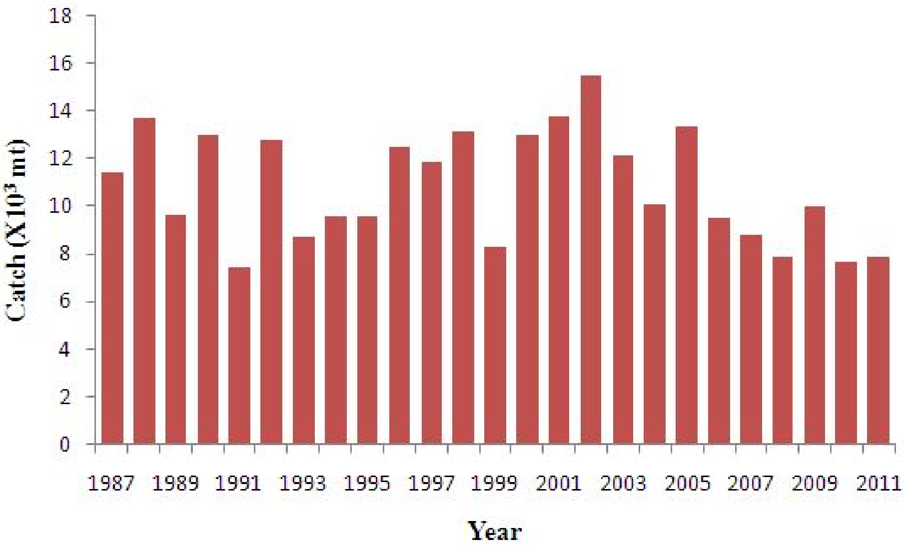

Fig. 1. Annual catch of yellowfin caught by the Korean tuna longline fisheries in the WCPFC convention area.

2. Data and Methods

2.1 Area

The WCPO stock assessment model for yellowfin tuna is stratified into six regions (1-6) (Hoyle, 2010), but only two areas were used for yellowfin CPUE standardization of the Korean tuna longline fisheries, i.e., area 1 (regions 1, 3 and 5) and area 2 (regions 2, 4 and 8) (Fig 2). This was because there were insufficient number of fisheries data in regions 1, 2, 5 and 6.

2.2 Catch and effort data

Yellowfin tuna catch (number) and effort (number of hooks), NHF (number of hooks between floats) by year, month and 5°x5° area for the Korean tuna longline fisheries (1978-2011) were used for the CPUE standardization. The data before 1977 were not used in this study because they did not have data enough to carry out this analysis. Also the fishing information was not available in 1988-1989, hence the data in these two years were not included in this study. The NHF was divided into 4 classes (class 1 : below 9, class 2 : 10-15, class 3 : 16-21, class 4 : above 22) based on the operating characteristics of the Korean tuna longline fisheries (Fig. 3).

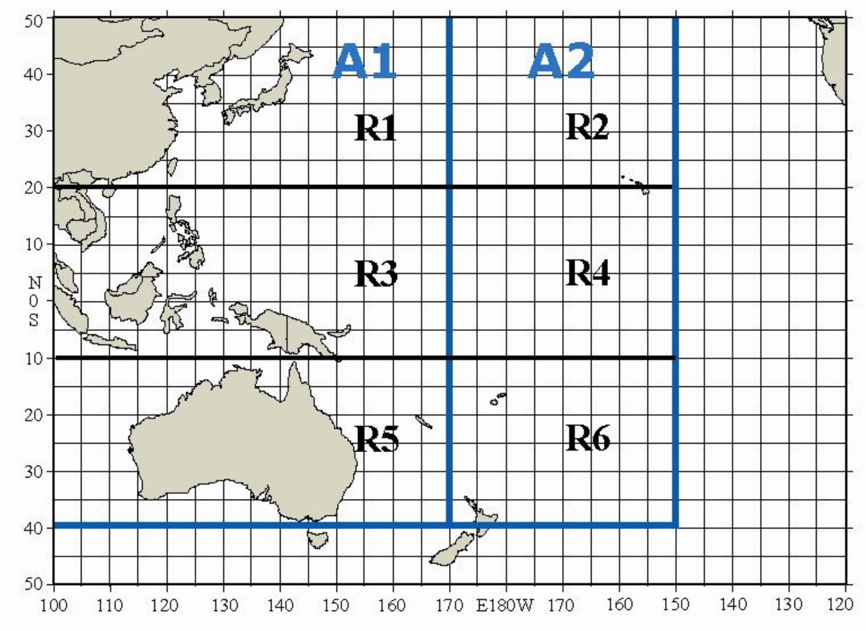

Fig. 2. Map showing two areas (Area 1=regions 1+3+5 and Area 2=regions 2+4+6) used for the yellowfin CPUE standardization of the Korean longline fisheries in the WCPO.

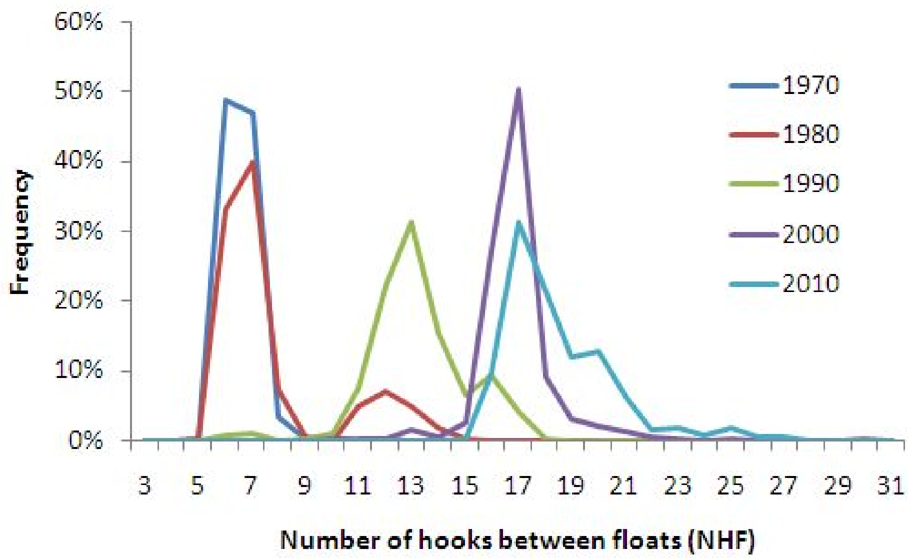

Fig. 3. Changes in the number of hooks between floats used to the Korean tuna longline fisheries by decade.

2.3 Generalized Linear Model (GLM)

Generalized Linear Model (GLM) used for yellowfin tuna CPUE standardization is as follows, and we used SAS program (ver. 9.2) to obtain the results.

$$\ln(CPUE + c) = \mu + Y + Q + A + NHF + Y \times A + error$$

where, CPUE : catch in number of yellowfin per 1,000 hooks
c : 10% of average overall nominal CPUE
Y : effect of year
Q : effect of quarter (season)
A : effect of area (area 1 and 2)
NHF : effect of targeting (4 classes)
Y×A : interaction term between year and area
error : error term

3. Results and Discussion

Table 1 shows the ANOVA (type 3) for the GLM results which suggest that effects of all explanatory variables are significant, and quarter and area effects are the largest factors affecting the nominal CPUE.

Table 1. ANOVA table of GLM for yellowfin CPUE standardization

	DF	Sum of Squares	Mean Square	F	Pr > F
Model	66	1210.0002	18.333336	30.97	<.0001
Error	9540	5647.668	0.591999		
Corrected Total	9606	6857.6682			

R-Square	Coeff Var	Root MSE	Mean CPUE
0.176445	54.27919	0.769415	1.417513

	DF	Type III SS	Mean Square	F Value	Pr > F
YR	30	258.64052	8.6213508	14.56	<.0001
Q	3	175.72026	58.573419	98.94	<.0001
AREA	1	39.572339	39.572339	66.85	<.0001
NHF	3	14.048282	4.6827607	7.91	<.0001
YR*AREA	29	92.05105	3.1741741	5.36	<.0001

Fig. 4 shows the estimated STD CPUE with 95% confidence interval which suggest that STD CPUE (1972-2011) generally shows the declining trend, and stable trend since the mid-2000 years.

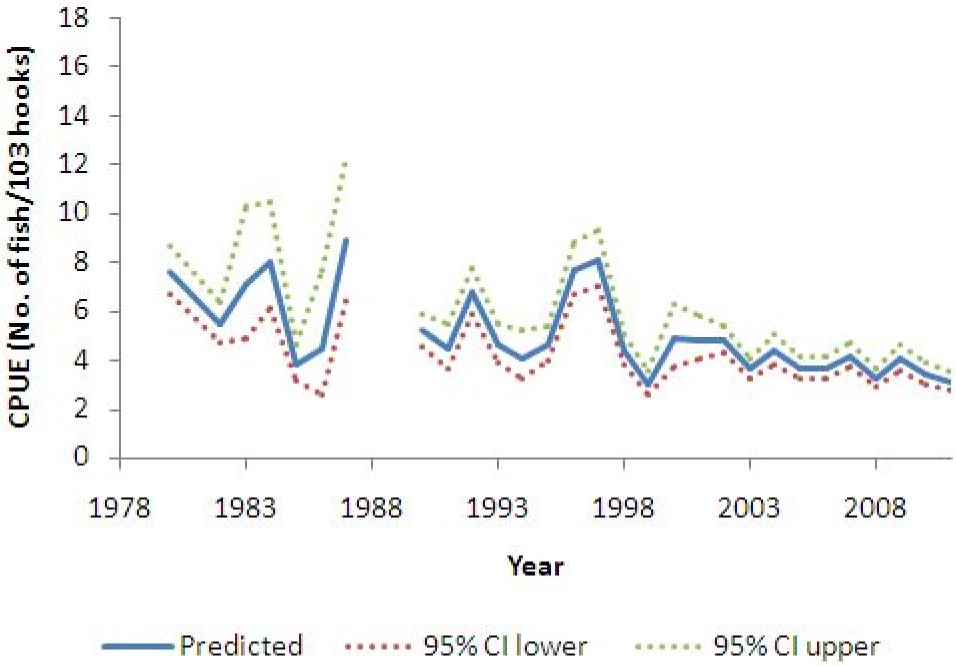

Fig. 4. Standardized CPUE with 95% confidence interval for yellowfin tuna of the Korean tuna longline fisheries in the WCPO (1978-2011).

Figs. 5-7 show the diagnostics for the GLM analyses that is percent frequency distribution, QQ-plots and box plot of the standardized residuals respectively, and they suggested the data fit to the GLM fairly well.

This is the first attempt to estimate the WCPO yellowfin tuna STD CPUE of the Korean tuna longline fisheries. As we have some difficulty in finding out the whole trend for changes in yellowfin tuna CPUE due to no information before 1977, and for 1988-1989, we would like to check and review operational data for the Korean longline fisheries, and to run the GLM model using the operational data in the future.

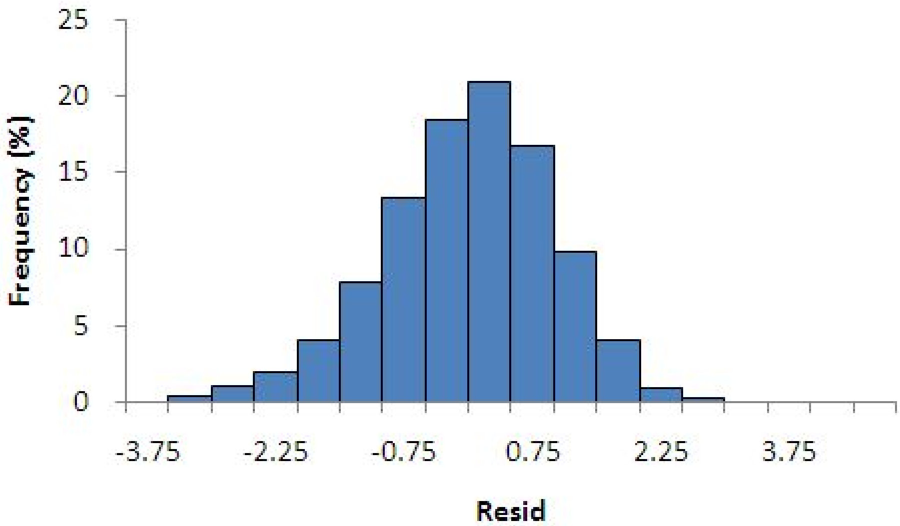

Fig. 5. Frequency distribution of the standardized residual for the GLM analysis.

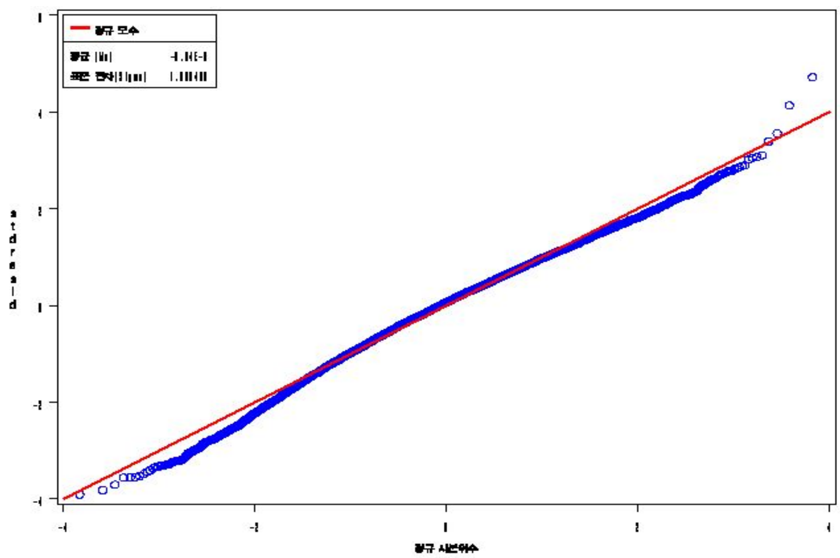

Fig. 6. QQ-plots of standardized residual for the GLM analysis.

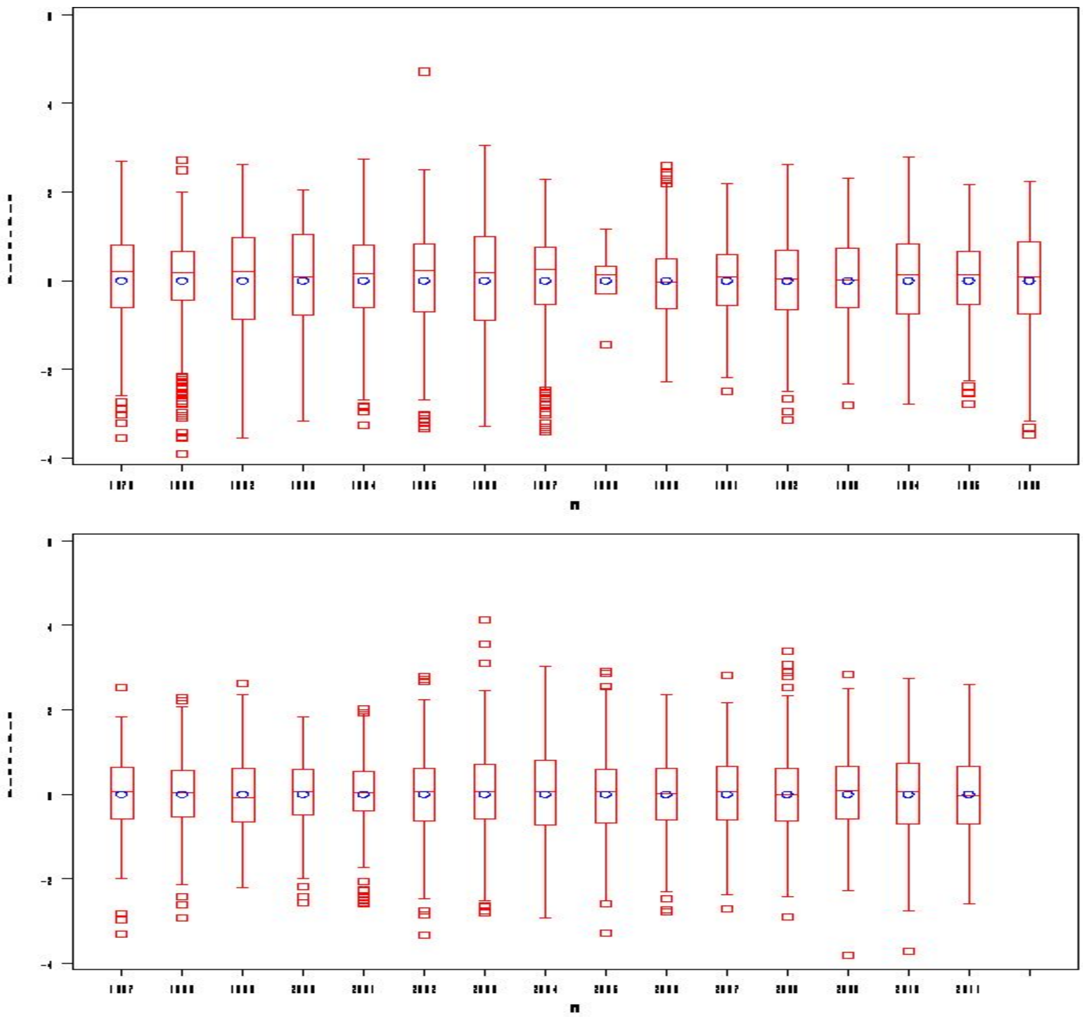

Fig. 7. Box plot of the stnadardized residual by year for the GLM analysis. Circle: mean, box: 25th and 75th percentile, horizontla line in the box: median, bars: maximum and minimum observation between 1.5 IQR (interqurtile range) above 75th percentile and 1.5 IQR below 25th percentile, squares: outliers.

References

Hoyle, S., 2010. Cpue standardization for bigeye and yellowfin tuna in the Western and Central Pacific Ocean. WCPFC-SC6-2010/SA-WP-03.