ISC/13/ALBWG/08

Preliminarily analysis for the standardized albacore CPUE for Japanese longline fisheries by vessel type in the northwestern Pacific Ocean[1]

H. Ijima, T. Matsumoto and H. Okamoto

National Research Institute of Far Sea Seas Fisheries
Fisheries Research Agency
5-7-1 Orido, Shimizu-ku, Shizuoka-shi
424-8633 Japan

E-mail: ijima@affrc.go.jp

[1] This working paper was submitted to the ISC Albacore Working Group Stock Assessment Workshop, 19-26 March 2013, Shanghai Ocean University, Shanghai, China. Document not to be cited without author's permission.

Preliminarily analysis for the standardized albacore CPUE for Japanese longline fisheries by vessel type in the northwestern Pacific Ocean

Hirotaka Ijima[1], Takayuki Matsumoto[1], Hiroaki Okamoto[1]

[1]National Research Institute of Far Seas Fisheries, 5-7-1 Shimizu-ku, Shizuoka 424-8633, Japan.

SUMMALY

To understand effects between large and small longline fishery for albacore abundance index, we attempted analyses for standardizing abundance indices of Japanese albacore longline CPUE using GLMs separately by two fisheries. Annual changes for catch and effort and spatial distribution for these fisheries show different trend. Several explanatory variables are year-quarter, fishing gear effect, and fishing area effect. Trend of standardized CPUE was similar to that of nominal CPUE and all explanatory variables were significantly correlated for the analyses of both fisheries.

1. INTRODUCTION

In the previous albacore stock assessment, Japanese longline fishery definition was decided by fish size in each area and season (Anonymous. 2010). This definition could show realistic catch at size trend. However, to operate stock synthesis 3 (SS3), it is difficult to understand an effect of each fishery's condition such as distant water and offshore (large) or coastal (small) longline fishery. Thus, size-dependent fishery data set was aggregated by large and small longline fishery data. In order to recognize this difficulty, we attempted analysis for the Japanese longline CPUE in which fishery was divided only by vessel type (large and small longline).

2. MATERIALS AND METHODS

2.1. Catch and effort data

In our statistics, longline fishery is divided into large and small longline fishery. Large (distant water and offshore) longline is operated by vessels over 20 ton. In contrast, small (coastal) longline is operated by vessels less than 20 ton. Using these fisheries' logbook data, we made data set that was aggregated by 5 X 5 degrees latitude/longitude spatial block, month and number of hooks per basket. Available logbook data period for large and small longline is 1966 to 2011 and 1994-2011, respectively. During 1966-1974, number of hooks per basket is not available. Consequently, we assumed 5 hooks per basket for that period.

2.2. Fishery definition and analysis area

Japanese longline fishery definition for SS3 for north Pacific albacore is based on fish length data in each area and season (Ichinokawa 2009a b; Matsumoto 2010a b). These analyses aggregated the large and the small longline fisheries. However, these fishery's catch and effort show different trend (Figure 1), and operating area for these fisheries is quite different (Figure 2 and Figure 3). To comprehend each fishery's effect, we attempted CPUE standardization for the large and the small longline fishery separately.

In the previous albacore stock assessment, sub area classification was defined based on catch distribution (Matsumoto 2010a b). Area for CPUE was limited to northwestern Pacific Ocean (15-40N, 120-180W). It is because although Japanese longliners have been operating in the northeastern Pacific Ocean historically, recent CPUE changed drastically due to the spatial shift of longline operation. In this analysis, we chose the northwestern Pacific Ocean (Figure 4). This area covers almost entire albacore catch (Figure 2 and Figure 3) and so we did not use the data for northeastern Pacific for the similar reason to that for the previous study.

2.3. Standardization of CPUE

A generalized linear model (GLM) was used for standardizing CPUE based on the dataset and fishery definition mentioned above. We chose three main effects: a combination effect of year-quarter, a fishing gear effect and a fishing area effect. We did not use interaction term because there was a lot of missing interactions. The model examined for standardization of CPUE is,

$$\ln\left(CPUE_{ijk} + const\right) = X + YQ_i + G_j + A_k + \varepsilon_{ijk}$$

where $CPUE_{ijk}$ is the catch in number of the fish per 1,000 hooks in year-quarter i, fishing gear j, and area k. *Const* is 10% value of overall nominal CPUE, X is the intercept, YQ_i is the combination effect of year-quarter, G_j is the fishing gear effect, A_k is the fishing area effect, and ε_{ijk} is the random error term that was assumed to follow normal distribution $\varepsilon_{ijk} \sim N(0, \sigma^2)$. In this GLM, we treated all data sets as categorical data. Fishing gear effect was stratified into five categories (5-6, 7-9, 10-13, 14-17 and 15-19 hooks per basket). A standardized annual CPUE was obtained by calculating the least squares mean. All statistical analysis results were provided by R-2.15.2.

3. RESULTS AND DISCUSSIONS

Table1 and 2 show summary of ANOVA in this analysis. All explanatory variables are significantly correlated for the two fisheries ($p<0.001$). For the adjusted (type III) SS, the year-quarter effect is the largest for both large and small longline. Figure 5 and 6 show analysis results for CPUE standardization using GLMs. Compared with nominal CPUE, annual trends are generally similar for both fisheries. These residual plots show relatively equal distribution and the QQ plots show the expected linier pattern. Based on this analysis, it is considered that large and small longline abundance indices are able to be used separately. However, there are two difficulties in using for SS3. First, we couldn’t trace the change of large longline operating area. Second, we have not considered zero-catch effect. To clear up the zero-catch problem, it may be effective to use delta-lognormal model.

4. REFERENCES

Anonymous. 2010. Report of the ISC - Albacore Working Group Workshop. National Research Institute of Far Seas Fisheries 5-7-1 Orido, Shimizu-Ku Shizuoka 424-8633 Japan. 20 - 26 April 2010. 37pp.

Ichinokawa, M. 2009a. Rearrangement of Japanese fisheries for applying length-based SS-3 to the stock of North Pacific albacore I: offshore longline. ISC/09-1/ALBWG02.11pp.

Ichinokawa, M. 2009b. Rearrangement of Japanese fisheries for applying length-based SS-3 to the stock of North Pacific albacore II: coastal longline. ISC/09-1/ALBWG03.8pp.

Matsumoto, T. 2010a. Standardization of north Pacific albacore CPUE by Japanese longline corresponding to newly defined fishery definition for SS3 analyses. ISC/10-2/ALBWG/04. 7pp.

Matsumoto, T. 2010b. Abundance indices of north Pacific albacore by Japanese longline for SS3 and VPA analyses. ISC/10-3/ALBWG/04. 12pp

Table 1. Summary of ANOVA (large longline).

	Type III SS	Df	F	Pr(>F)
Year / Quarter	11749.5	183	85.811	<0.001
Fishing gear (number of hooks per basket)	1887.4	4	630.635	<0.001
Fishery area (5 x 5 spatial block)	3659.5	47	104.063	<0.001
Residuals	30122.4	40259		

Table 2. Summary of ANOVA (small longline).

	Type III SS	Df	F	Pr(>F)
Year / Quarter	89534	71	1784.415	<0.001
Fishing gear (number of hooks per basket)	53	4	18.818	<0.001
Fishery area (5 x 5 spatial block)	57205	38	2130.18	<0.001
Residuals	292089	413317		

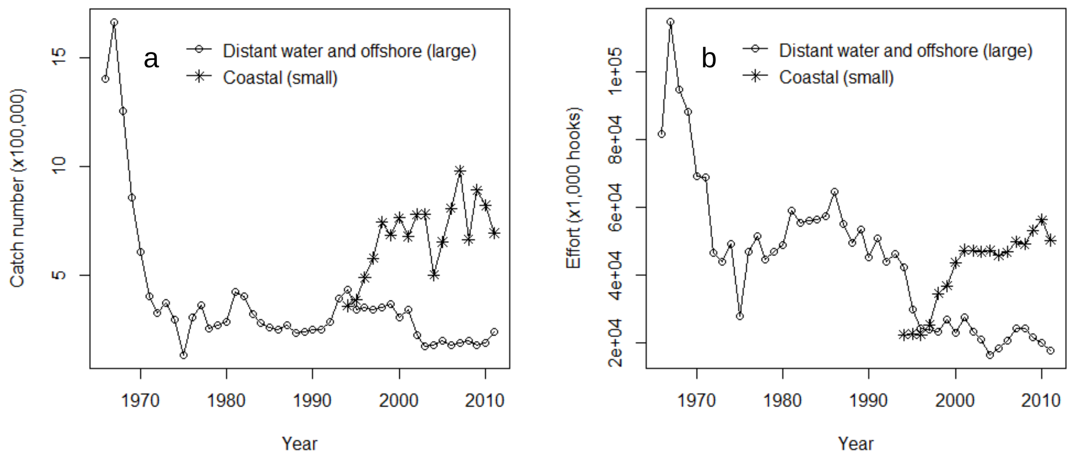

Figure 1. Available time series data set a) catch in number b) fishing effort (hooks). Catch and effort for coastal longline are not raised.

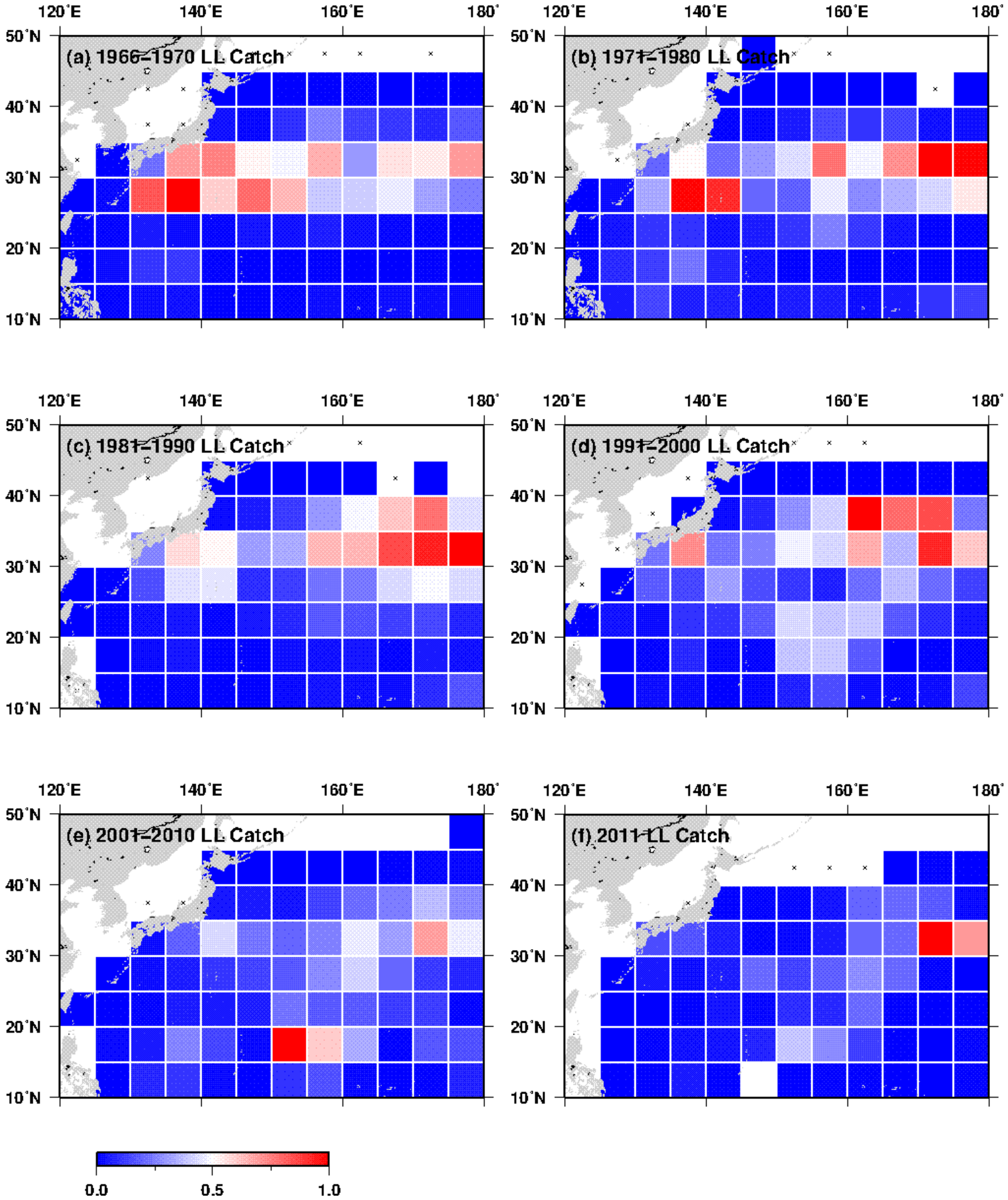

Figure 2. Spatial distribution of albacore catch (large longline).

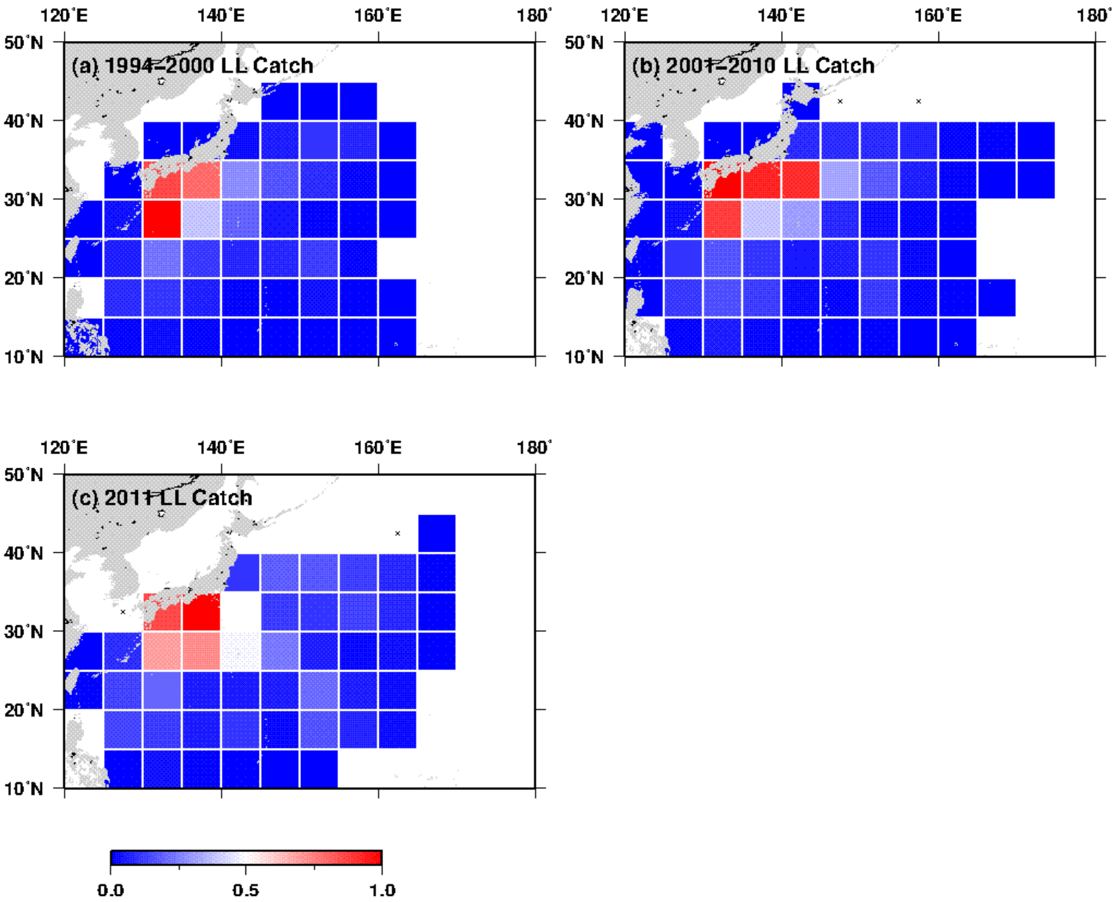

Figure 3. Spatial distribution of albacore catch (small longline).

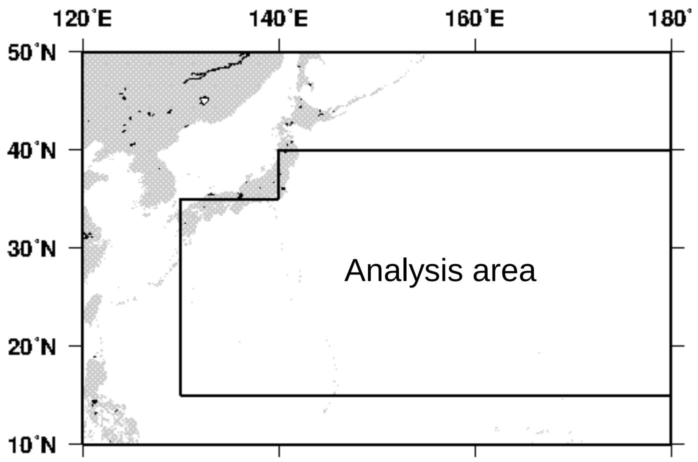

Figure 4. Area definition of Japanese longline fishery CPUE analysis.

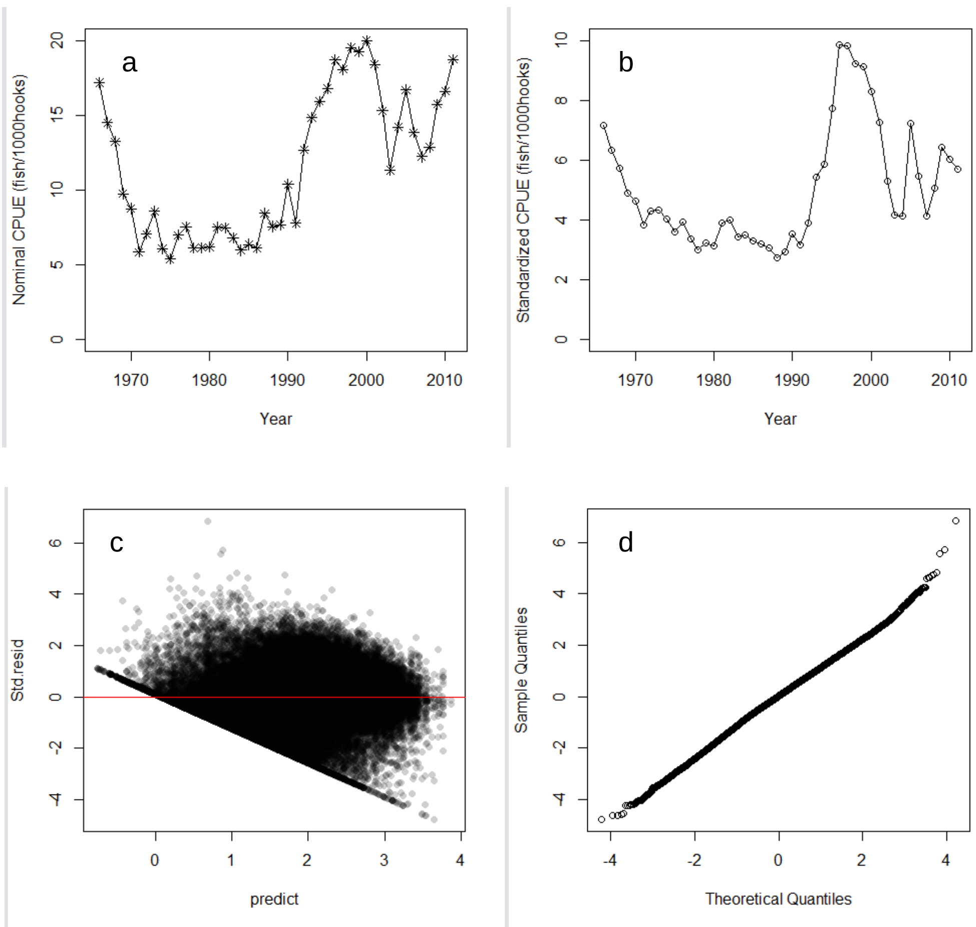

Figure 5. Analysis results for Japanese albacore large longline CPUE, a) nominal CPUE, b) standardized CPUE, c) residual plots and d) QQ plots.

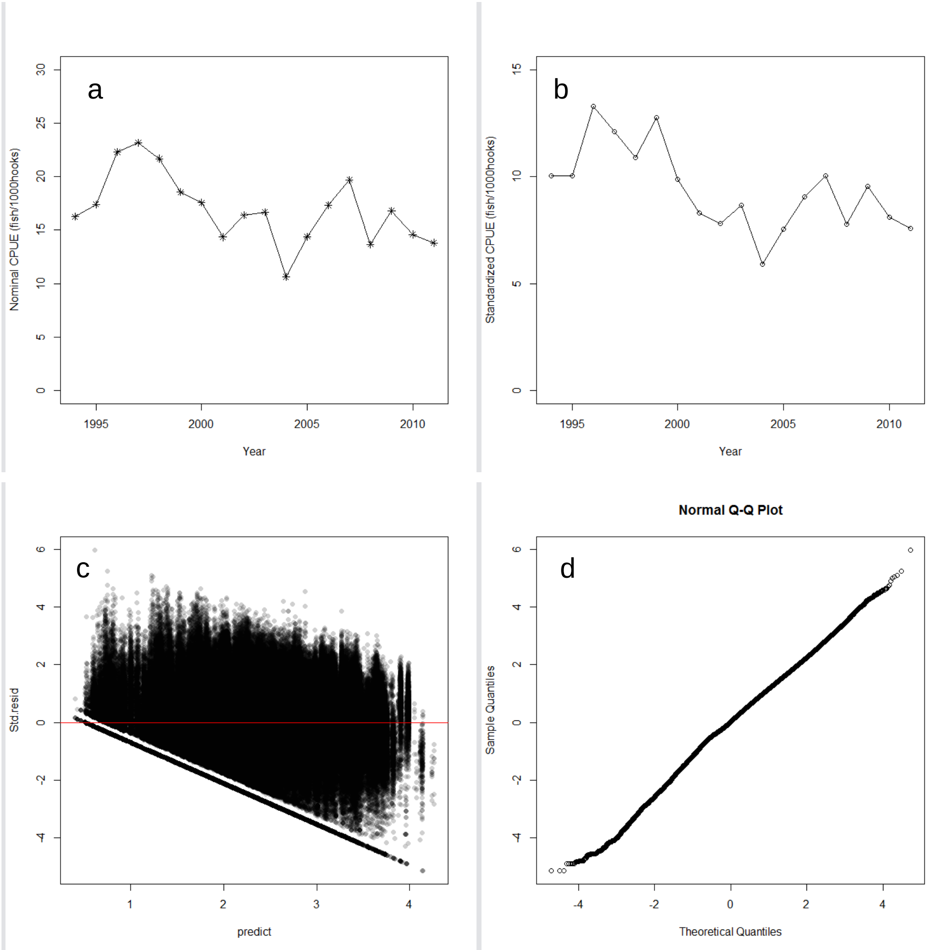

Figure 6. Analysis results for Japanese albacore small longline CPUE, a) nominal CPUE, b) standardized CPUE, c) residual plots and d) QQ plots.