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Updated abundance indices of north Pacific albacore by Japanese longline fishery[1]

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Updated abundance indices of north Pacific albacore by Japanese longline fishery

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SUMMALY

In this paper, we updated standardized abundance indices of north Pacific albacore by Japanese longline fishery to apply for stock synthesis 3. We used similar method to that for previous stock assessment with updated data set, in which the fishery was separated based on fish size. Data for 2010 to 2011 were added. The standardized abundance indices were approximately the same as previous standardized indices.

1. INTRODUCTION

Abundance indices of north Pacific albacore for stock assessment were employed by standardized catch per unit effort (CPUE). The standardization of Japanese longline CPUE for stock synthesis 3 (SS3) was defined as two types of fisheries based on fish size data, fishery area and fishery season. These analyses were submitted to the ISC albacore working group (ALBWG) in September 2010 and October 8 2010 (Matsumoto 2010a b). For preliminary analyses of the stock, interpretation of sharp decline in CPUE in the northwestern Pacific during late 1960s was described in another paper submitted to the 2010 ALBWG meeting (Matsumoto 2010c). In this paper, we attempted to update standardized Japanese longline CPUE using previous analysis method and compared with the results of previous analysis.

2. MATERIALS AND METHODS

2.1. Catch and effort data

Catch and effort data were obtained from the statistics of Japanese large longline (distant water and offshore, L-LL) and small longline (coastal, S-LL). For these fisheries' logbook database, we aggregated catch and effort data by 5×5 degrees latitude/longitude block, month and number of hooks per basket. We used logbook database for 1966-2011, in which data for 2010-2011 were added and data for 2008-2009 were updated from the last assessment. During 1966-1974, number of hooks per basket is not available, so we assumed 5 hooks per basket during the period.

2.2. Standardization of CPUE

In the previous albacore stock assessment in 2011 using SS3, two types of longline CPUE were defined by ALBWG agreement (Anonymous. 2010). Figure 1 and Table 1 show the fishery definition. The Japanese longline CPUE were standardized only for the western Pacific. The reason is that, in recent years, few Japanese longline vessels have been operating in the eastern Pacific. Fishery definition for SS3 was conducted focusing on fish length in each fishery area and operation season. Albacore mainly distributes around 30°N (approximately between 26°N and 35°N) in the north Pacific. Therefore, subareas were stratified so that they cover distribution area and do not divide distribution area. Fishery 1 is targeting smaller size albacore that is caught at northwest area in the first and second quarters. Fishery 2 is targeting larger size albacore that is caught at the rest of areas and quarters in the western Pacific.

In the statistical analysis, generalized linear model (GLM) was used for CPUE standardization for the two fisheries defined above. For the Fishery 1, GLM includes 5 main effects (year, month, area, fishery and fishing gear) and several interaction terms (area/month, year/area, area/fishing gear, year/month, month/fishing gear). Month and quarter were examined as the effect of fishing season, and month was selected based on AIC. Number of hooks per basket (NHB) was used for gear effect. Small and large long line fisheries were distinguished and used for the effect of fishery. Area stratification was assumed based on distribution of catch and effort (Matsumoto et al., 2010b). For the Fishery 2, season and area irregularities resulted in limitations of using several interactions which may affect standardized CPUE. Hence, we conducted alternative model instead of using interaction month/area; combined effect of month-area (month-area=month*10+subarea number) was incorporated.

The two models examined for standardization of CPUE was,

Fishery 1

$$\ln(CPUE + Const) = \mu + Y + M + A + B + F + Y*A + M*A + A*B + Y*M + M*B + e$$

Fishery 2

$$\ln(CPUE + Const) = \mu + Y + MA + B + F + e$$

where *CPUE* is the catch in number of fish per 1000 hooks, *Const* =10% of overall mean of nominal CPUE, μ is the intercept, *Y* is the effect of year, *M* is the effect of fishing season (month) , *A* is the effect of area, *MA* is the effect of combination of month-area, *B* is the effect of fishing gear (NHB divided into five categories), *F* is the effect of fishery (small or large longline) and *e* is the error term with $N(0, \sigma)$. NHB was categorized as 3-4, 5-6, 7-9, 10-14 and 15-20 hooks per basket. Statistical analyses were operated through the statistic package program “SAS version 9.1.3”.

Area weighting method for calculating overall CPUE was similar to those by Ichinokawa (2009a b) and Matsumoto (2010a). That is, as for the GLMs including the interaction term of year and area (*Y*A*), overall CPUE was calculated using area weighting factors for each subarea *a* (f_a, a=1, 2, …, A) and predicted CPUE in year *y* and subarea *k* ($SCPUE_{yk}$) with the following equation (Punt

2004).

$$SCPUE_y = \sum_{k-1}^{A} f_k \cdot SCPUE_{yk}$$

where $\sum f_k = 1$

The parameter of $SCPUE_{yk}$ is the least squares mean (population marginal mean) of CPUE estimated in year y at subarea k. The area weighting factors of f_k is the ratio of the number of 5x5 degree blocks with ≥1 longline operations in area k to the total number of 5x5 degree blocks considered.

3. RESULTS AND DISCUSSIONS

Tables 2 and 3 show results of ANOVA. All explanatory variables are significantly correlated for the two models (p<0.0001). For the adjusted (type III) SS, the fishing gear effect is the largest in Fishery 1. In contrast, month-area effect is the largest in Fishery 2. These model residual plots show relatively equal distribution (Fig. 2) and the QQ plots for the fishery 2 show the expected linier pattern (Fig. 3). Compared with CPUE for previous study (Figure 5), standardized CPUE for Fishery 1 in the present study is higher than the previous one during 1966-1982, and is lower during 1983-1992. Standardized CPUE for fishery 2 is approximately the same as previous result.

4. REFERENCES

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Table 1. List of the Japanese longline fisheries defined for SS3.

Fishery	For Standardized CPUE				Catch and size for SS3
	L-LL*	S-LL*	Area**	Season	
Fishery 1 Combined L-LL and S-LL	1966-2011	1994-2011	Northwest	Qt 1-2	Qt1 and 4 for Northeast
Fishery 2 Combined L-LL and S-LL	1966-2011	1994-2011	Northwest, Southwest	Qt3-4 for Northwest and Qt1-4 for Southwest	Qt2-3 for Northeast and Qt1-4 for Southeast

*L-LL:large (distant water and offshore) longline, S-LL:small (coastal) longline.

**Boundary of North and South is 25N.

Table 2. Summary of the ANOVA for the Fishery 1.

	DF	Type III SS	Mean SS	F	Pr>F
Year	39	495.274735	12.699352	26.98	<0.0001
Month	5	2654.849534	530.969907	1128.02	<0.0001
Area	5	174.137408	34.827482	73.99	<0.0001
Fishing gear	4	3733.388062	933.347016	1982.86	<0.0001
Fishery	1	103.002566	103.002566	218.82	<0.0001
Year x Area	195	631.035828	3.236081	6.87	<0.0001
Month x Area	25	788.988598	31.559544	67.05	<0.0001
Area x Fishing gear	20	502.491243	25.124562	53.38	<0.0001
Month x Fishing gear	20	375.451464	18.772573	39.88	<0.0001
Residuals	21676	10203.06611	0.47071		

Table 3. Summary of the ANOVA for the Fishery 2.

	DF	Type III SS	Mean SS	F	Pr>F
Year	45	4355.45074	96.78779	119.35	<0.0001
Month-Area	71	37824.42477	532.73838	656.95	<0.0001
Fishing gear	4	5179.2926	1294.82315	1596.72	<0.0001
Fishery	1	294.89488	294.89488	363.65	<0.0001
Residuals	61939	50227.8715	0.8109		

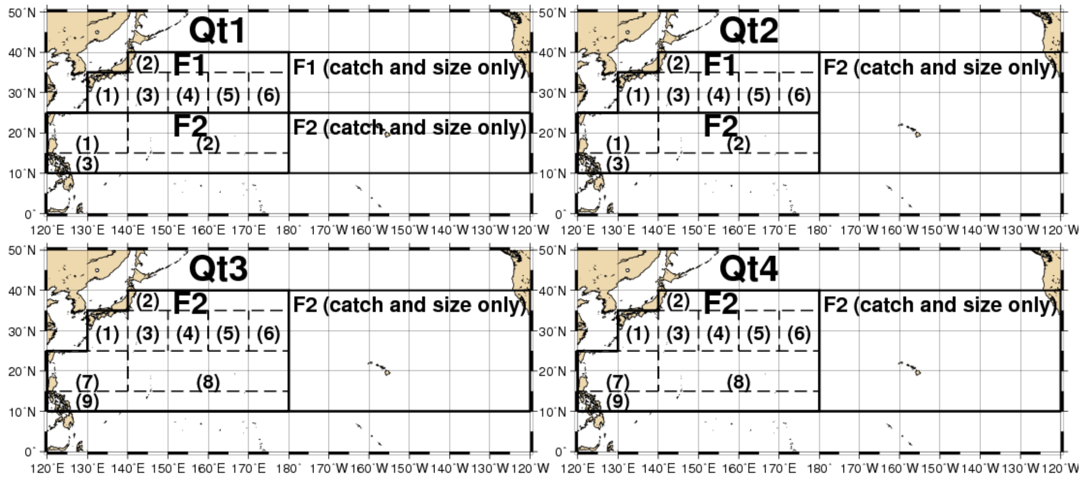

Figure 1. A definition of sub area and division by season.

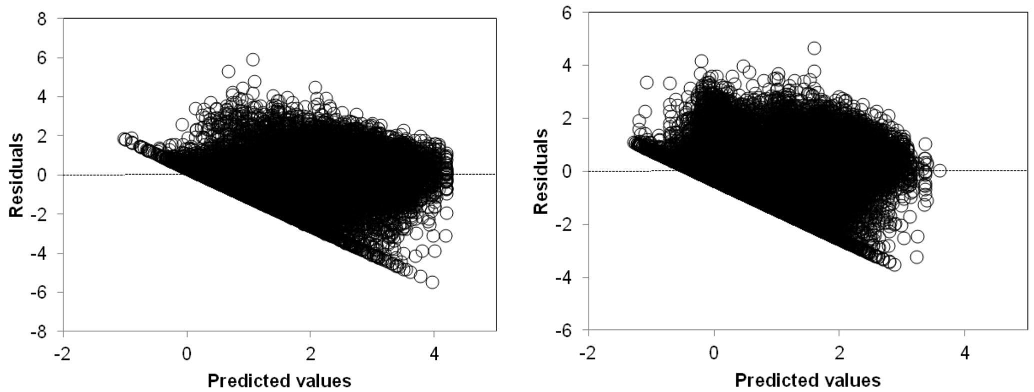

Figure 2. Residual plots of the GLM using Japanese longline fishery data set. Left panel is Fishery 1, and right panel is Fishery 2.

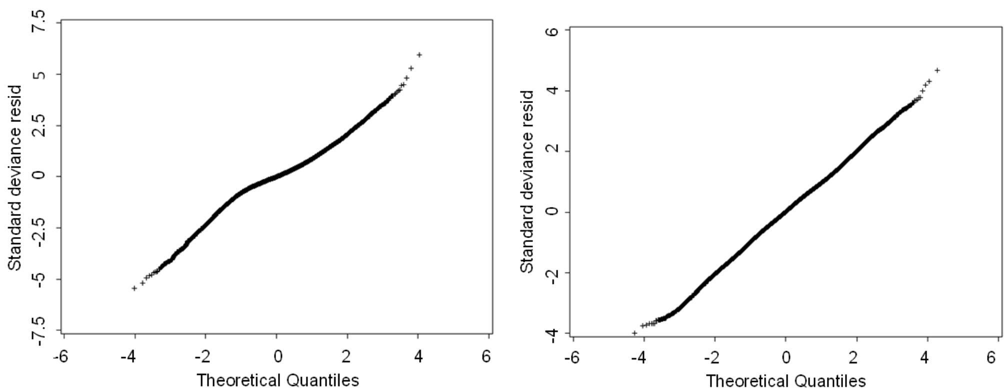

Figure 3. Q-Q plots of the GLM using Japanese longline fishery dataset. Left panel is Fishery 1, and right panel is Fishery 2.

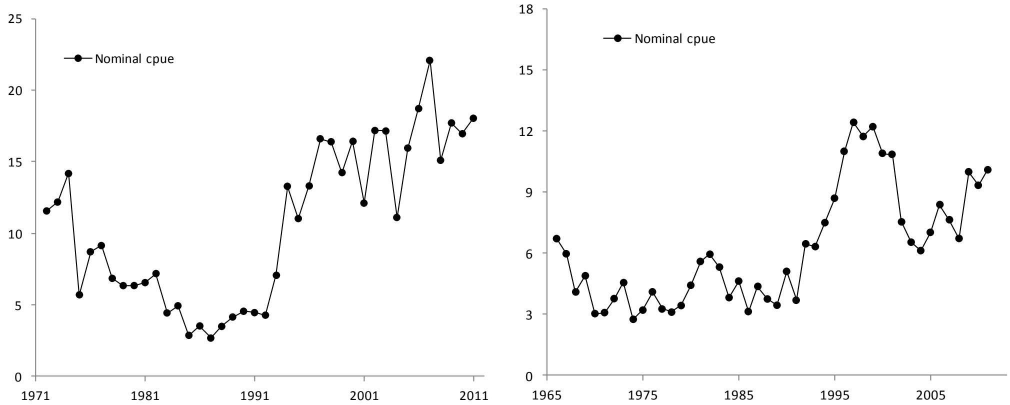

Figure 4. Nominal CPUE for Japanese longline fishery defined for SS3 analyses. Left panel is Fishery 1, and right panel is Fishery2.

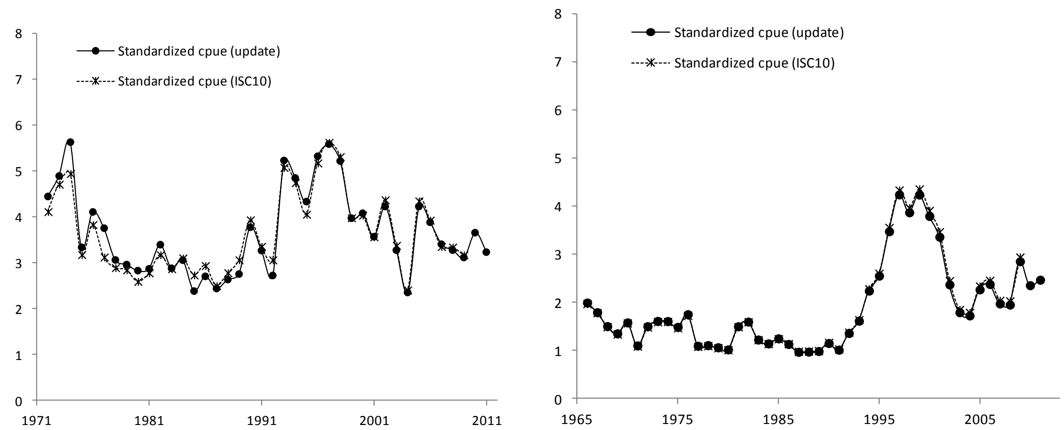

Figure 5. Comparison of standardized CPUE for SS3 between current (left panel) and past (right panel) analysis (Matsumoto 2010a).