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Re-estimation of standardized CPUE of Pacific bluefin tuna caught by Japanese offshore longline fisheries operated during 1952-1974

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Summary

In this document, in order to verify and improve the standardized CPUE previously reported for Pacific bluefin tuna (PBF) caught by Japanese longliners during 1952-1974, we replicated the procedures reported previously. These standardized CPUE were used as tuning parameters in the past stock assessments of PBF. Our standardized CPUE calculated based on the same procedures and assumptions as previous studies (Yokawa *et al*., 2007a; Yokawa 2007b; Yokawa 2007c; Yokawa 2008) showed similar trends with the previous CPUE, indicating that the re-estimated standardized CPUE can be a candidate for the stock analysis.

Introduction

Japanese longliners have been operating fisheries around coastal, offshore and distant waters off Japan in the northwestern Pacific. ISC PBF WG tentatively agreed to use PBF catch per unit of efforts (CPUE) for the Japanese offshore longline fishery as an abundance index in its stock assessments. The standardized CPUE series for this fishery has been revised a few times (Yokawa *et al*., 2007a; Yokawa 2007c; Yokawa 2008) and the last results by Yokawa (2008) were used in the previous ISC PBF assessments. The reported procedures used for calculating standardized CPUE are very complicated, while the index is very important for the assessments. For this reason, the estimating procedures previously used were re-examined in the current paper for its validity. One of the major consideration in selecting a preferable time series of CPUE is the coverage of data used in the estimation. Wider coverage of data would yield larger information on the dynamics of the stock, and more reliable index. From this point of view, the original series of standardized CPUE for 1952-1974 used data for all quarters and areas 2-4 (see Fig. 1) (Yokawa 2008). PBF is known to spawn around the southwestern Japan in spring. Since the fisheries targeting this spawning stock is not included in the definition of fleet 14, the data from area 1 where the major spawning occurring is excluded (Yokawa *et al*., 2007a; Yokawa 2008). In the future, better definitions for area and sets targeting PBF would be essential to improve the standardization of CPUE. Longline sets targeting PBF are currently defined by the proportion of PBF catch to the total catch of other species, but those process should be critically reviewed. Evaluation of effects of sea surface temperature on the fisheries may also be studied.

In this document, as the first step for formulating future standardization, we attempted to replicate the process to estimate previous standardized CPUE, which were used as the index for the fleet 14 in the Stock Synthesis III. With the results of this

replication, reliability and availability of a new series of CPUE was discussed.

Materials and Methods

The data for offshore longliners operated in Northwest Pacific off Japanese coasts were obtained from the Japanese longline fishery statistics recorded by the National Research Institute of Far Seas Fisheries during 1952-2005, in which catch and efforts are aggregated into 5x5 areas and months. In this study, the data for 1952-1974 were extracted from this data base, that correspond to the period for which the previous standardized CPUE was developed (Yokawa *et al*., 2007a; Yokawa 2008).

The fishing ground was divided into nine areas by Yokawa *et al*., (2007a) (Fig. 1). Details of the number of 5x5 and monthly records, total accumulated catch of the PBF in number of fish, number of hooks deployed, nominal CPUE (PBF catch per 1000 hooks) and standardized CPUE are given in Table 1. Standardizations of CPUE were made by the GLM method with SAS software (version 4.2; Inc., Cary, NC, USA) under the same caveat as Yokawa (2008) (using data from in all quarters (Qt1: January-March, Qt2: April-June, Qt3: July-September, Qt4: October-December) and from areas 2-4). Criteria for the data screening had been arbitrarily decided. The 5x5/month strata where the ratio of PBF catch to the total catch of other species in number is larger than 0.2 or that the CPUE of PBF is larger than 1.5 were defined as PBF target. Those strata were excluded from the CPUE analyses (Yokawa *et al*., 2007a; Yokawa 2008), since the CPUE of PBF target operations are highly variable and opportunistic.

In order to see the precisions of input index preliminary projections were tried using Stock Synthesis III (SSIII) where the re-estimated standardized CPUE were input for fleet 14, while all the other structures were kept the same as the previous basic runs.

Results and Discussions

Nominal CPUE

The trends of nominal CPUE by quarter for each area (Fig. 1) show large fluctuations for some years (Fig. 2). In the previous CPUE analysis (Yokawa 2008) data from 3 areas (areas 2-4) only were used in the standardization. Yokawa *et al*., (2007a) showed quarterly nominal CPUE in the areas 3 and 4 during 1952-1974. Results of this new study showed similar fluctuations with the previous studies, although absolute values of nominal CPUE were quite different between previous and current studies. The cause of such differences in absolute value between two series is not known, as both series used the same data base and procedures. No nominal CPUE was given for area 2 in the previous documents and hence no comparison was made for that area.

Standardized CPUE

Re-estimated standardized CPUE using areas 2-4 in all quarters during 1952-1974 are compared in Figure 3 with previous standardized CPUE, and the distribution pattern of the residuals which is bit skewed to negative (Fig. 4). The re-estimated CPUE trends were similar to the previous results, decreased from 1952 to 1956, rapidly increased from 1957 to 1959, gradually decreased from 1960 to 1974. It is notable that low values of CPUE in the previous series, observed in 1955 and 1956 are sifted by one year to 1956 and 1957, respectively in new CPUE series. In addition, high CPUEs observed in 1958 and 1961 were 0.23 and 0.22 respectively in the previous analysis, while those were changed to 0.16 and 0.19 in this analysis (Table 1 and Fig. 3). In general, the new series is similar to the previous series by Yokawa (2008), with minor differences.

Performance of the new standardized CPUE on SSIII

Figure 5 shows time series of total biomass (top), total SSB (middle) and recruitment (low), comparing two cases, one using previous and another using new series in SSIII analysis. The observed and expected CPUE for previous (original) and current (new) series are compared in Figure 6. Our results of biomass and SSB during 1952-1974 were estimated annually lower than the case using original CPUE in SSIII (Fig. 5). As a result, expected standardized CPUE by SSIII also decreased (especially during 1956-1960) for the new data series compared with original series (Fig. 6). For the period after 1975, the differences between two series are very minor.

Even there were some differences in output of the SSIII analysis between these two series of indices. We can conclude that the re-estimated CPUEs would produce stock assessments results compatible to those by the previous CPUE series. Further investigation for the reason of the differences between these two series is recommended.

References

Yokawa K, Ichinokawa M, Oshima K (2007a) Estimation of the abundance indices of Pacific bluefin tuna using data of Japanese offshore and distant-water longliners. ISC/07/PBF03/25

Yokawa K (2007b) Some considerations of the abundance index of Pacific bluefin tuna estimated by the data of Japanese offshore and distant-water longliners. ISC/07/PBF03/26

Yokawa K (2007c) Workshop CPUE analysis – response to questions and extending the standardization of WP-25. ISC/07/PBF03/Info-4.

Yokawa K (2008) Correction of the standardized CPUE of Pacific Bluefin tuna caught by Japanese offshore and distant-water longliners. ISC/08/PBF-1/05

Table 1 Total number of PBF catch by Japanese offshore longline, nominal CPUE and re-estimated standardized CPUE (named by 'New') from 1952 to 1974. Previous results of the analysis (Yokawa 2008) are also shown (named by 'Original').

Year	No. of records	No. of PBF	No. of hooks	Nominal CPUE (PBF catch / 1000 hooks)	Standardized CPUE	
					Original	New
1952	559	23,960	107,599,115	0.1822	0.0141	0.0140
1953	661	22,289	115,289,587	0.1819	0.0131	0.0126
1954	729	24,311	115,074,572	0.1092	0.0107	0.0112
1955	945	23,158	128,464,923	0.0880	0.0063	0.0085
1956	963	21,414	126,157,726	0.0998	0.0072	0.0058
1957	922	10,739	137,626,415	0.0599	0.0112	0.0067
1958	951	6,561	152,236,977	0.0284	0.0232	0.0160
1959	1,010	27,962	174,604,864	0.0895	0.0254	0.0263
1960	1,090	50,689	196,286,526	0.1051	0.0194	0.0197
1961	1,197	51,327	219,932,010	0.1084	0.0222	0.0193
1962	1,367	43,511	192,836,306	0.1044	0.0151	0.0175
1963	1,527	41,218	210,920,047	0.0540	0.0130	0.0123
1964	1,689	20,023	186,243,446	0.0443	0.0130	0.0128
1965	1,745	16,192	203,144,796	0.0368	0.0114	0.0100
1966	1,617	8,070	192,740,968	0.0224	0.0079	0.0128
1967	1,808	5,983	234,357,667	0.0136	0.0070	0.0062
1968	1,800	3,715	218,051,048	0.0113	0.0056	0.0056
1969	1,734	2,705	219,306,018	0.0108	0.0054	0.0065
1970	1,843	1,748	202,899,593	0.0099	0.0036	0.0046
1971	1,642	1,754	185,060,094	0.0054	0.0026	0.0029
1972	1,514	655	192,026,625	0.0042	0.0030	0.0028
1973	1,584	684	192,165,920	0.0036	0.0034	0.0019
1974	1,662	658	209,583,087	0.0032	0.0030	0.0066

Table 2 Statistical results of GLM analyzed with SAS software in assuming lognormal distribution.

Effects	DF	Type III SS	Mean Square	F Value	Pr > F
Year	22	674.14	30.64	18.12	<.0001
Quarter	3	102.93	34.31	20.29	<.0001
Area	2	233.96	116.98	69.18	<.0001
Quarter*area	6	305.24	50.87	30.08	<.0001

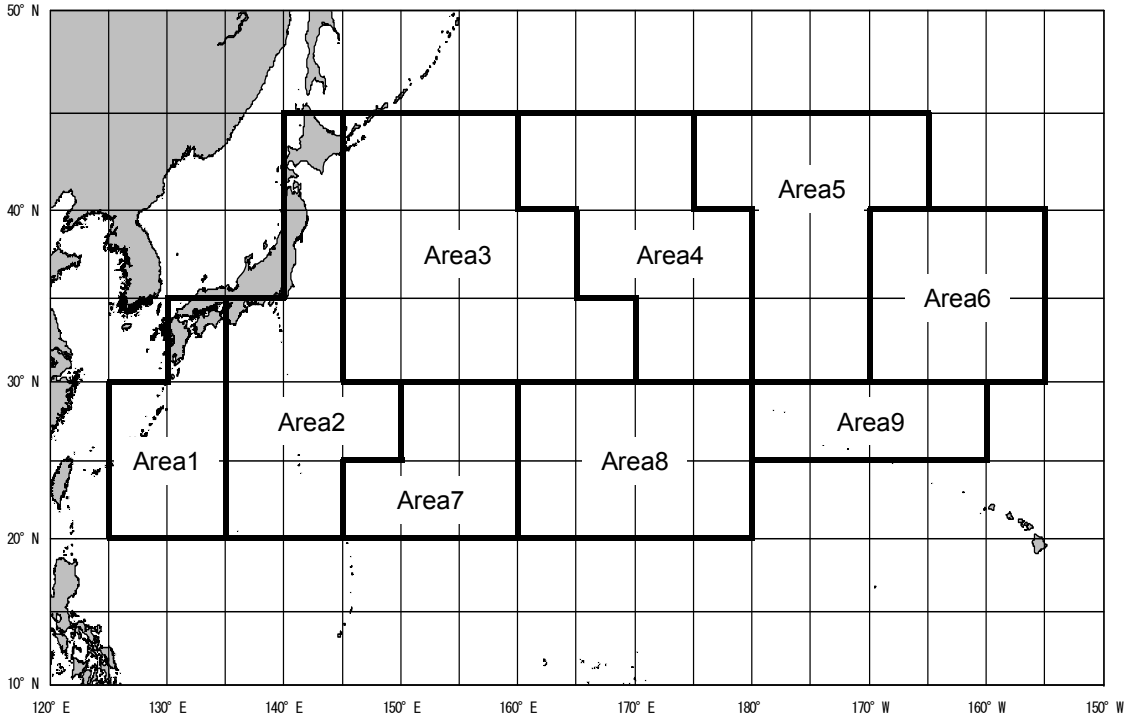

Figure 1 Area classification used in this study, according to Yokawa *et al*., (2007a). All quarterly data in area between 2 and 4 (fleet 14 on SSIII) were used in the re-estimation for standardized CPUE based on the previous study.

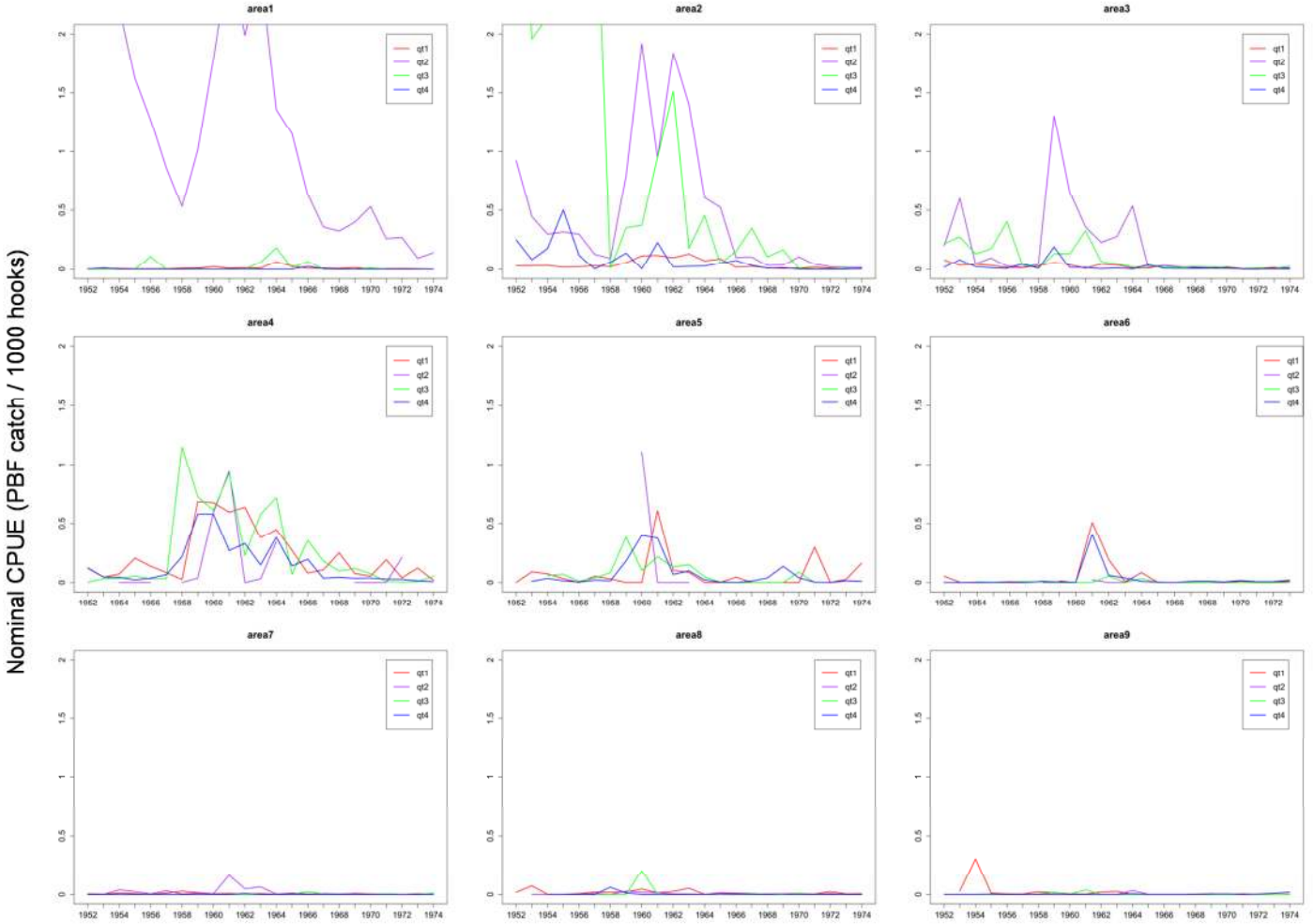

Figure 2 Nominal CPUE (PBF catch / 1000 hooks) in all areas by quarter caught by Japanese offshore longlines in the period between 1952 and 1974.

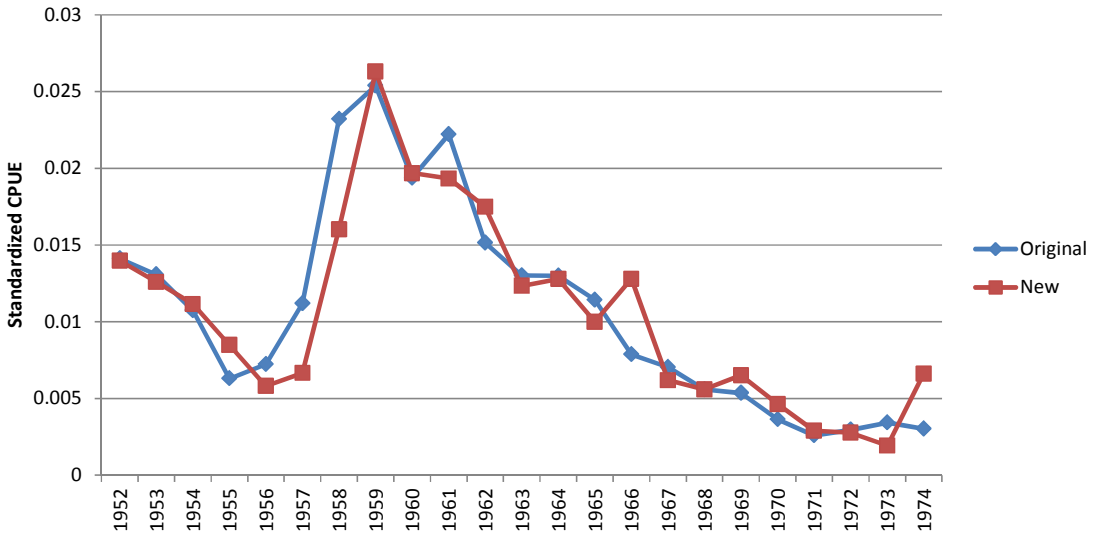

Figure 3 Standardized CPUE for the period between 1952 and 1974 are represented by original standardized CPUE (Yokawa 2008) (blue line) and new standardized CPUE (red line). Both CPUEs were calculated using data for all quarters and area 2-4.

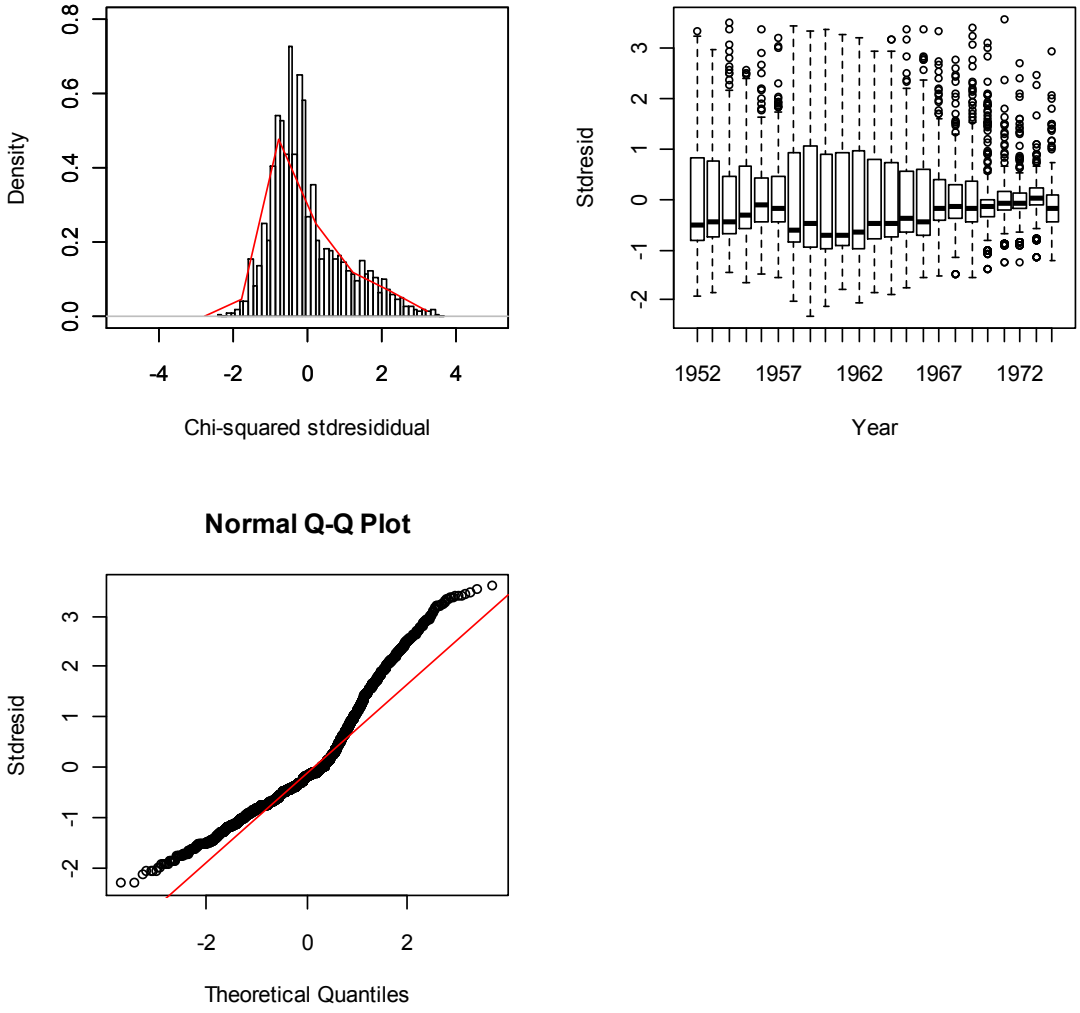

Figure 4 Residual distributions of GLM models of re-estimated CPUE standardization (left), boxplots (light) and normal Q-Q plot (low) of the studentized residual during 1952-1974.

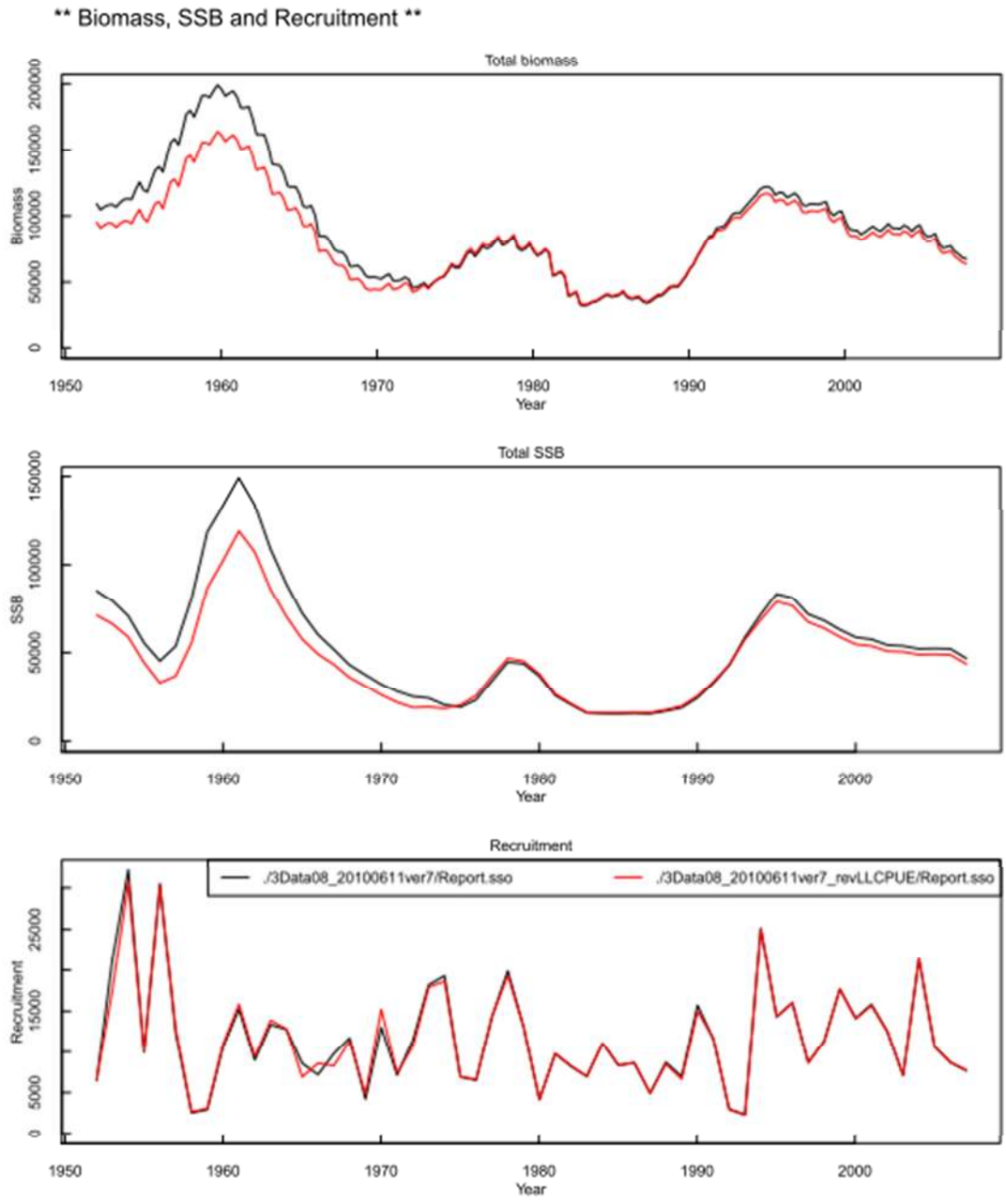

Figure 5 Estimated total biomass (top), total spawning stock biomass (middle), recruitment (low) based on the "Original (black line)" and "New (red line)" CPUE.

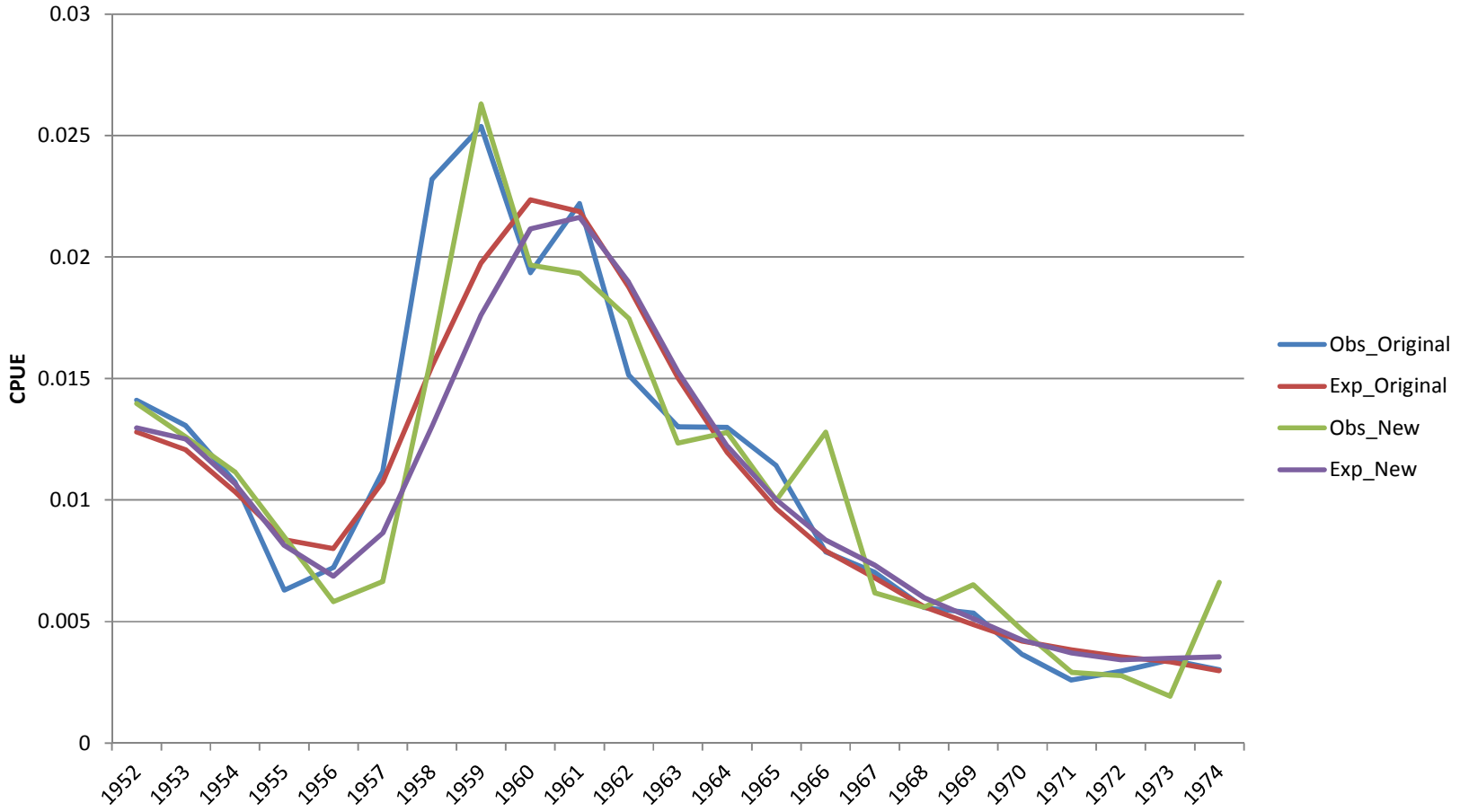

Figure 6 Annual trends of observed (Obs) and expected (Exp) standardized CPUE on SSIII calculation during 1952-1974. "New" means re-estimate values and "Original" means ones presented by the previous analysis by Yokawa (2008).