Updated standardized CPUE for 0-age Pacific bluefin tuna caught by Japanese troll fisheries: Updated up to 2015 fishing year

Yoshiaki Fukuda and Osamu Sakai

National Research Institute of Far Seas Fisheries,
Fisheries Research and Education Agency
5-7-1, Orido, Shimizu-ku, Shizuoka 424-8633, JAPAN

February 2017

Information paper submitted to the ISC Pacific bluefin tuna Working Group, International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC), 15-20 February 2017, Shimizu, Shizuoka, Japan.
Document not to be cited without author's permission.

Summary

To estimate the time series of abundance index from Japanese troll fishery operated in the East China Sea (coastal area around Nagasaki Prefecture) were standardized for the period of 1980-2015 fishing year. Generalized liner model (GLM) with lognormal error distribution was applied for the standardization which was authorized and used for the stock assessment 2016. The standardized CPUE of 2015 fishing year is slightly larger than 2014 fishing year, but is at a low level.

Introduction

The index of juvenile Pacific bluefin tuna (PBF) abundance based on catch and effort data of a troll fishery is one of the important indices available for monitoring and assessment of the PBF stock. Ichinokawa et al. (2012) provided three CPUE series of troll fisheries from Kochi, Wakayama, and Nagasaki Prefectures, and ISC PBFWG decided to fit only Nagasaki's series in the assessment model due to representativeness (ISC 2014). This troll fishery is targeting age-0 PBF which comes from both two major spawning grounds (in waters near the Ryukyu Islands to the east of Taiwan, and in the southern portion of the Sea of Japan), thus their CPUE would reflect the whole annual recruitment strength of PBF population.

This document presents an update of the standardized CPUE of troll fishery of Nagasaki Prefecture. The catch-and-effort data used in this document have been collected and archived by National Research Institute of Far Seas Fisheries with cooperation from local fishery institutes, as a part of the Marine Ranching Project during 1980's (Secretariat of Forestry and Fisheries Research Council 1989) and Research Project on Japanese bluefin tuna (RJB) since 1994 (Ichinokawa et al. 2012).

Methods

Troll CPUE was based on the catch-and-effort data which have been collected at the 5 main fishing ports in Nagasaki Prefecture since 1980s; i.e. Izuhara-Are, Kami-tsushima, Kami-agata, Ojika and Tomie. These ports located in Goto Islands and Tsushima Island of western part of Japan (Fig. 1). These data were based on the sales slips which were collected under the RJB. The catch data is total PBF weight of sales per day in each fishing port, which include landing weight for fresh market and fry weight for farming. The effort data is number of ship sold per day in each fishing port.

Generalized liner model (GLM) with lognormal error distribution was applied to standardize the CPUE, because the effort data was not recorded for zero-catch trip. The following three effects were used for the standardization;

1) FISHING YEAR (FY); 1980-2015… Fishing year is starting from July and ending to June.
2) FISHING MONTH (FM); 1-12… Fishing months are aligned with fishing year.
3) PORT; five ports… Izuhara-Are, Kami-tsushima, Kami-agata, Ojika and Tomie.

Objective variable was log(CPUE) and explanatory variables were the three effects listed above and all possible first-order interactions. The GLM was carried out through GLM procedure of SAS 9.4. The best model was determined based on BIC. The standardized CPUE was calculated from least square mean of 'FY' effect.

Results and Discussions

Catch-and-effort data by each landing port are summarized in Table 1. In 2015 fishing year, total catch weight and efforts were smaller than previous years in Tomie and Ojika. On the other hand, they were larger than previous years in Are, Kami-tsushima and Kami-agata. Catch for farming was started 2012 in this area. The ratio catch for farming was increased in 2015 fishing year (about 20% of total catch) compared to the recent 3 year (Fig. 2).

The best model selected by BIC was a combination of “FY”, “FM” and “PORT” (Table 2), and this was the same as the previous study (Sakai and Oshima 2015). Residuals distributed centrally around zero, although those distributions showed slightly left-skewed shapes (Figs 3 and 4). The standardized CPUE, CV and 90% confidence limits are shown in Table 4. Range of CV of standardized CPUE was 0.03-0.06. The time series of standardized CPUE trend shows similar with the previous study (Sakai and Oshima 2015, Fig 5). The nominal and standardized CPUE from 2013 to 2014 were decreased, but increased again in 2015 fishing year. The standardized CPUE of 2015 fishing year is slightly larger than 2014, but is at a low level.

The increment of catch for farming in recent years could be due to the increase in needs of PBF for farming and implementation of strict catch restriction for small fish. It is still unknown how this would impact the behavior of troll fishery on this area and quality of their catch data, therefore continuously monitoring of this changes would be necessary.

References

Fujioka, K., Oshima, K., Tei, Y., Ichinokawa, M., and Takeuchi Y. 2014. Recruitment abundance indices of young Pacific bluefin tuna revealed by Japanese Troll Fisheries. ISC/14/PBFWG-1/07.

Ichinokawa, M., Oshima, K. and Takeuchi Y. 2012. Abundance indices of young Pacific bluefin tuna, derived from catch-and-effort data of troll fisheries in various regions of Japan. ISC/12-1/PBFWG/11.

ISC 2014. Stock assessment of bluefin tuna in the Pacific Ocean in 2014. Report of the Pacific bluefin tuna working group. 121p.

ISC 2015. Report of the Pacific bluefin tuna working group intersessional workshop. Annex 9 of Report of the fifteenth meeting of the international scientific committee for tuna and tuna-like species in the North Pacific Ocean, plenary session. 24p.

Oshima, K., Fujioka, K., Ichinokawa, M., and Takeuchi Y. 2013. Updated Japanese troll CPUE targeting age 0 PBF through 2011. ISC/13/PBFWG/Appendix C.

Sakai, O. and Oshima, K. 2015. Japanese troll CPUE targeting age-0 Pacific bluefin tuna: Updated up to 2014 fishing year. ISC/15/PBFWG-2/08.

Table 1 Total catch (mt), effort (number of landing per day, excluding zero PBF catch) and CPUE (kg/landing) by year and by fishing port, recorded in catch-and-effort data used for standardization of CPUE in Nagasaki Prefecture.

Fishing year	Catch (mt)						Effort (Number of landing)						CPUE (kg / landing)					
	Tomie	Are	Kami-tsushima	Kami-agata	Ojika	Total	Tomie	Are	Kami-tsushima	Kami-agata	Ojika	Total	Tomie	Are	Kami-tsushima	Kami-agata	Ojika	Total
1980	210.4	7.2	11.2	18.2	11.4	258.3	5330	670	142	339	723	7204	39.5	10.7	78.7	53.7	15.7	35.9
1981	423.0			118.1	125.7	666.8	9740			1633	2952	14325	43.4			72.3	42.6	46.5
1982	62.5	14.3	8.9	45.9	17.9	149.5	1301	694	274	1503	725	4497	48.1	20.7	32.4	30.5	24.7	33.3
1983	242.9	51.3	153.4	350.9	102.4	900.9	6264	1756	2012	3958	2278	16268	38.8	29.2	76.2	88.7	45.0	55.4
1984	482.2	72.8	63.5	355.0	132.6	1106.2	12383	1591	1130	6715	3381	25200	38.9	45.8	56.2	52.9	39.2	43.9
1985	182.7	78.3	85.0	130.8	91.4	568.1	6932	1753	1035	2470	1787	13977	26.4	44.6	82.1	53.0	51.1	40.6
1986	378.5	67.0	24.0	130.5	77.3	677.2	11457	1729	338	2420	2367	18311	33.0	38.7	70.9	53.9	32.6	37.0
1987	115.1	14.3	23.2	132.3	15.1	300.0	4406	500	447	2502	658	8513	26.1	28.6	51.8	52.9	23.0	35.2
1988	281.2	6.0	37.3	150.3	51.1	525.9	9115	283	555	2465	1079	13497	30.8	21.1	67.3	61.0	47.3	39.0
1989	119.5	17.4	36.1	81.2	24.8	279.0	5744	776	696	1583	868	9667	20.8	22.4	51.8	51.3	28.6	28.9
1990	240.9	46.3	145.4	173.2		605.8	6733	903	1537	1739		10912	35.8	51.3	94.6	99.6		55.5
1991	79.0	44.0	95.5	111.7	127.1	457.3	1546	865	1008	1603	2195	7217	51.1	50.9	94.7	69.7	57.9	63.4
1992	66.4	1.9	23.1	12.9	15.1	119.4	2416	234	630	446	953	4679	27.5	8.0	36.7	29.0	15.9	25.5
1993	42.4	17.8		60.1	4.9	125.2	1810	986		2040	487	5323	23.4	18.0		29.4	10.1	23.5
1994	464.1	105.3		874.2	426.3	1869.9	5363	1343		5719	3668	16093	86.5	78.4		152.9	116.2	116.2
1995	104.6			243.4	41.0	389.0	2981			2055	1116	6152	35.1			118.4	36.7	63.2
1996	340.5	104.5		507.1	127.6	1079.8	6134	1543		4793	2065	14535	55.5	67.7		105.8	61.8	74.3
1997	90.4	23.4	59.1	138.8	39.5	351.2	2334	761	690	2605	767	7157	38.7	30.7	85.6	53.3	51.6	49.1
1998	234.3	45.4	196.0	268.8	21.5	766.0	4525	1236	2348	3908	399	12416	51.8	36.7	83.5	68.8	53.9	61.7
1999	202.0	101.8		355.9	74.7	734.4	4294	1167		2691	833	8985	47.1	87.3		132.3	89.6	81.7
2000	48.4	113.4	207.2	318.3	48.2	735.5	2571	1213	1353	2216	668	8021	18.8	93.5	153.1	143.6	72.2	91.7
2001	87.5	76.4	163.8	159.3	48.0	535.1	1582	1111	1682	1729	776	6880	55.3	68.8	97.4	92.2	61.8	77.8
2002	105.5	34.5	44.4	69.1	24.6	278.2	2725	902	951	1495	806	6879	38.7	38.3	46.7	46.2	30.5	40.4
2003	18.0	30.0	68.5	8.1	13.0	137.6	853	631	842	239	357	2922	21.2	47.6	81.3	33.8	36.4	47.1
2004	117.5	83.4	188.2	324.1	40.0	753.3	2304	923	1478	3101	692	8498	51.0	90.4	127.3	104.5	57.7	88.6
2005	22.5	15.2	125.9	68.2	23.6	255.4	550	365	1014	721	354	3004	40.9	41.8	124.1	94.6	66.5	85.0
2006		9.5	30.7	20.0	0.4	60.7		231	437	490	28	1186		41.3	70.4	40.8	16.0	51.2
2007	5.3	22.6	91.8	163.8	29.8	313.3	64	376	753	1920	393	3506	82.6	60.1	121.9	85.3	75.9	89.4
2008	179.7		142.0	53.8	60.9	436.3	2668		854	760	792	5074	67.3		166.3	70.8	76.9	86.0
2009	97.3	35.7	75.6		5.3	213.9	1339	743	693		175	2950	72.7	48.0	109.1		30.1	72.5
2010	115.3	14.7	76.7	171.9	6.5	385.1	2119	439	806	2350	135	5849	54.4	33.4	95.1	73.2	48.4	65.8
2011	28.7	13.2	96.9	216.6	1.7	357.0	979	195	665	2286	55	4180	29.4	67.4	145.7	94.7	31.2	85.4
2012	7.7	18.9	0.6	62.2	3.2	92.6	234	767	19	1526	94	2640	32.9	24.6	33.6	40.8	33.6	35.1
2013	98.0	77.9	6.8	179.7	12.0	374.4	1240	1048	148	1742	179	4357	79.0	74.4	45.9	103.1	67.1	85.9
2014	8.2	3.9	0.0	0.1	0.7	12.9	312	196	4	5	37	554	26.4	19.7	11.5	16.7	18.7	23.3
2015	5.5	20.1	0.3	12.1	0.6	38.7	177	806	16	184	23	1206	31.2	25.0	20.9	65.8	25.3	32.1

Table 2 Values of BIC (Bayesian Information Criterion) calculated for all models of possible combinations of main effects and first-order interaction terms. The first best model "a)" (shaded) is used for base case.

Model	BIC
a) fy+fm+port	30021.1
b) fy*fm+port	30138.9
c) fy*port+fm	30286.8
d) fy+fm*port	30043.7
e) fy*fm+fy*port	30594.4
f) fy*fm+fm*port	30152.3
g) fy*port+fm*port	30279.9
h) fy*fm+fm*port+fy*port	30515.2

Table 3 Type 3 analysis of the explanatory variables in the final model for CPUE standardization.

Efffects	df	Type III SS	Mean squire	F value	Pr > F
Model	50	2605.3	52.1	53.33	<.0001
Error	10462	10222.1	1.0		
Corrected Total	10512	12827.3			
				R squared value	0.203

Efffects	df	Type III SS	Mean squire	F value	Pr > F
fy	35	1353.9	38.7	39.6	<.0001
fm	11	262.0	23.8	24.4	<.0001
port	4	863.9	216.0	221.0	<.0001

Table 4 Standardized troll CPUE in Nagasaki Prefecture, comparing with previous study (Sakai and Oshima 2015) and nominal CPUE. All CPUEs are normalized by each average.

Fishing year	Nominal CPUE	Record Number	Standardized CPUE				Sakai and Oshima (2015)	
			Estimation	CV	Lower 5%	Upper 5%	Estimation	CV
1980	0.59	255	0.67	0.04	0.53	0.85	0.66	0.03
1981	0.90	265	1.18	0.03	0.94	1.48	1.16	0.03
1982	0.57	183	0.62	0.04	0.49	0.79	0.61	0.04
1983	0.89	328	0.92	0.04	0.74	1.15	0.91	0.03
1984	0.75	396	0.94	0.03	0.76	1.17	0.93	0.03
1985	0.83	375	0.88	0.04	0.70	1.09	0.87	0.03
1986	0.72	492	0.99	0.03	0.80	1.23	0.98	0.02
1987	0.60	310	0.72	0.04	0.58	0.90	0.71	0.03
1988	0.72	356	0.83	0.04	0.66	1.03	0.82	0.03
1989	0.52	351	0.66	0.04	0.53	0.82	0.65	0.03
1990	1.18	333	1.29	0.03	1.03	1.61	1.28	0.02
1991	1.11	271	1.33	0.03	1.06	1.68	1.31	0.03
1992	0.49	308	0.59	0.04	0.47	0.73	0.58	0.03
1993	0.41	330	0.49	0.04	0.39	0.61	0.49	0.03
1994	1.80	439	2.04	0.03	1.64	2.53	2.02	0.02
1995	0.96	243	1.10	0.04	0.88	1.39	1.08	0.03
1996	1.21	448	1.63	0.03	1.31	2.02	1.61	0.02
1997	0.95	251	0.95	0.04	0.76	1.20	0.95	0.03
1998	0.98	350	0.84	0.04	0.67	1.05	0.83	0.03
1999	1.49	286	1.54	0.03	1.23	1.92	1.52	0.02
2000	1.58	273	1.17	0.03	0.93	1.47	1.16	0.03
2001	1.31	265	1.17	0.03	0.93	1.47	1.16	0.03
2002	0.74	275	0.76	0.04	0.61	0.95	0.75	0.03
2003	0.81	184	0.66	0.04	0.52	0.84	0.65	0.03
2004	1.51	369	1.31	0.03	1.05	1.63	1.29	0.02
2005	1.69	230	1.44	0.03	1.14	1.82	1.42	0.03
2006	1.06	106	0.74	0.05	0.57	0.97	0.73	0.04
2007	1.60	244	1.43	0.03	1.14	1.81	1.41	0.03
2008	1.69	285	1.45	0.03	1.16	1.82	1.43	0.02
2009	1.01	206	1.17	0.04	0.92	1.48	1.16	0.03
2010	1.10	324	1.13	0.03	0.91	1.42	1.12	0.03
2011	1.39	266	0.98	0.04	0.78	1.23	0.96	0.03
2012	0.49	245	0.51	0.05	0.40	0.64	0.50	0.03
2013	1.35	350	0.90	0.04	0.73	1.12	0.84	0.03
2014	0.34	99	0.44	0.06	0.34	0.58	0.42	0.05
2015	0.67	225	0.52	0.04	0.42	0.65		

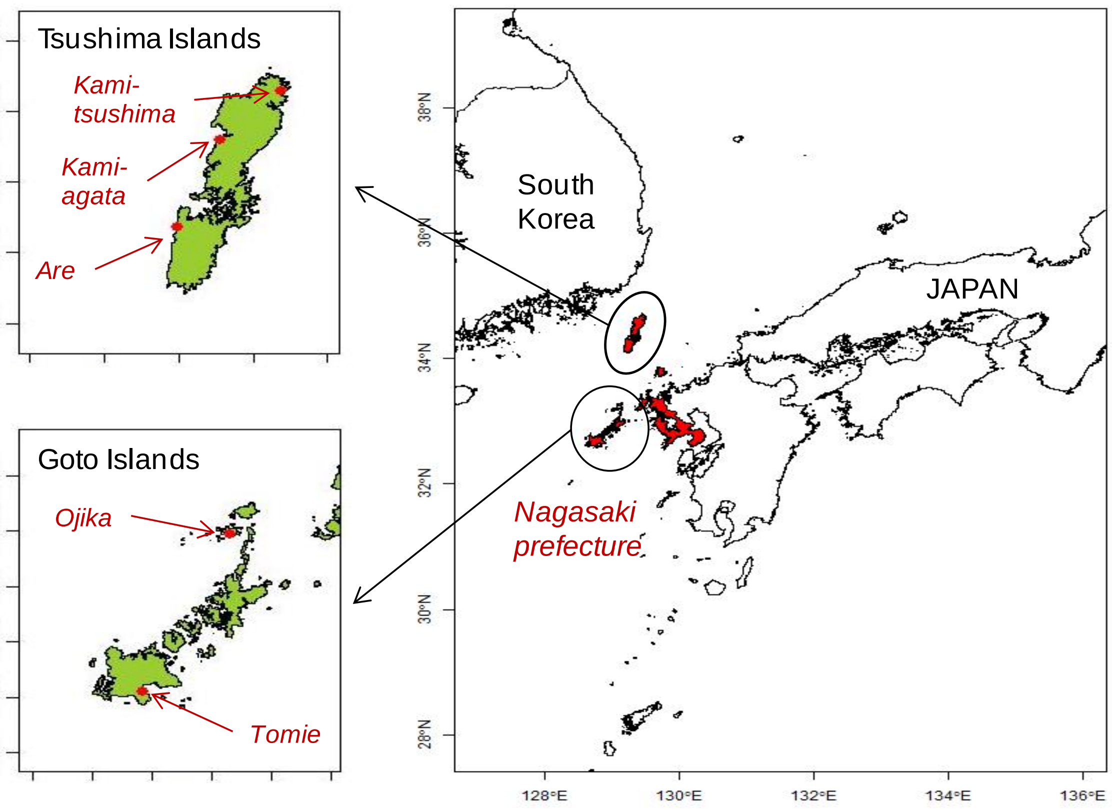

Fig. 1 Location of fishing ports where catch-and-effort data of troll fisheries have been collected in Nagasaki Prefecture.

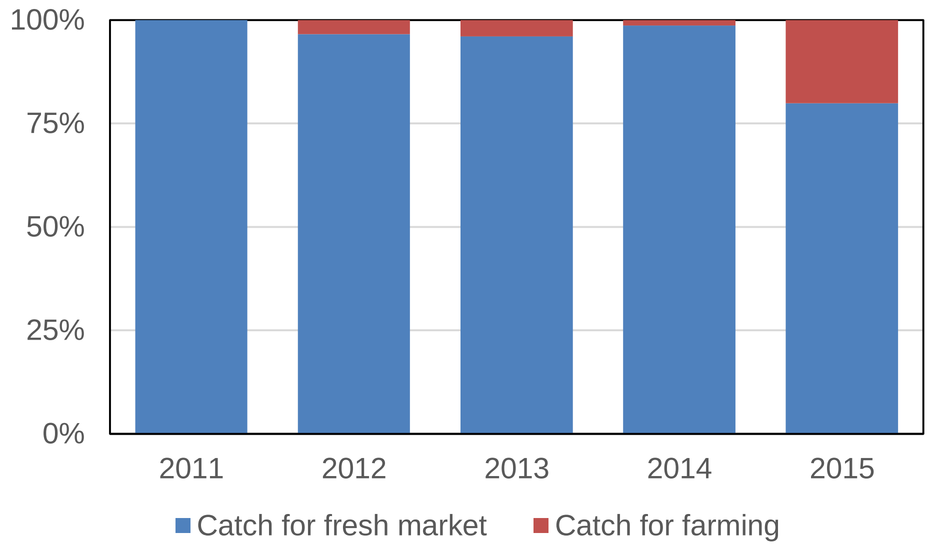

Fig. 2 Ratio of catch for fresh market and for farming. Catch for farming was not recorded before 2011.

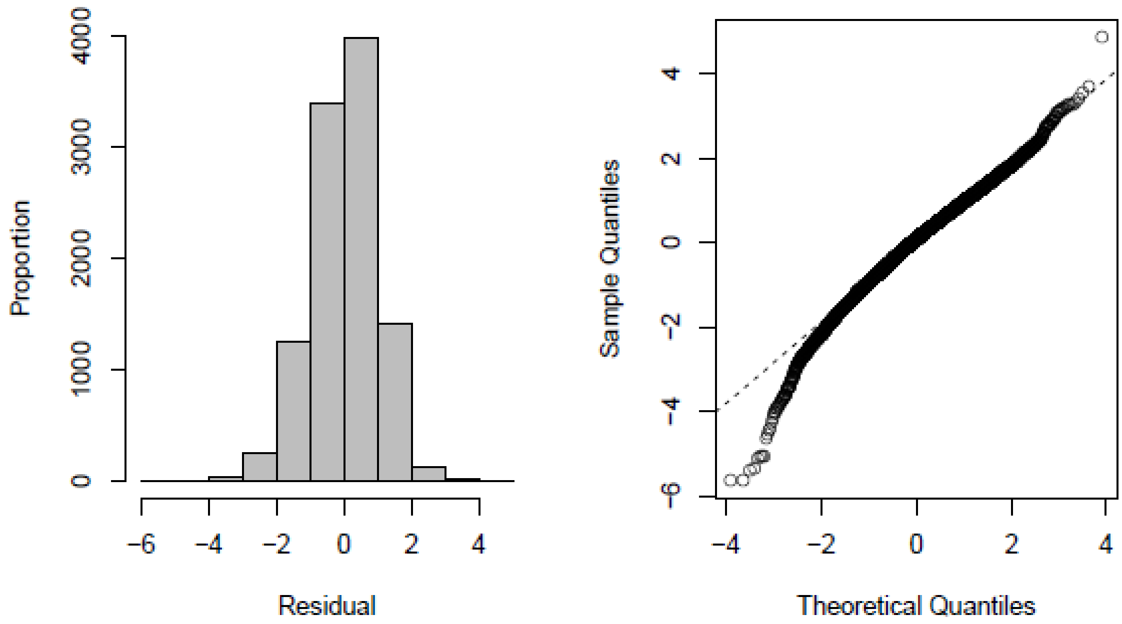

Fig. 3 Standardized residuals (left panel) and Q-Q plot of them (right panel).

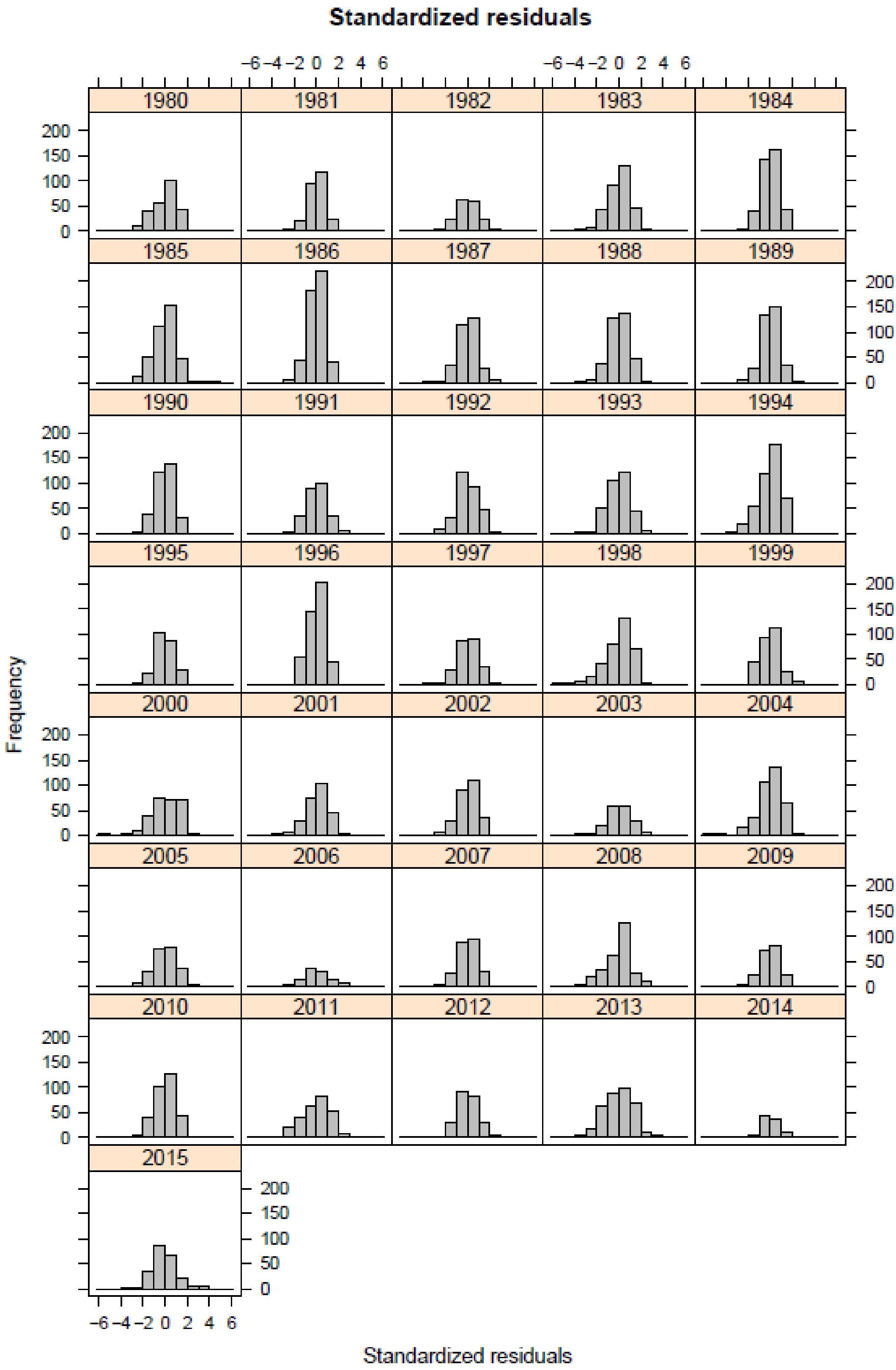

Fig. 4 Standardized residuals by year.

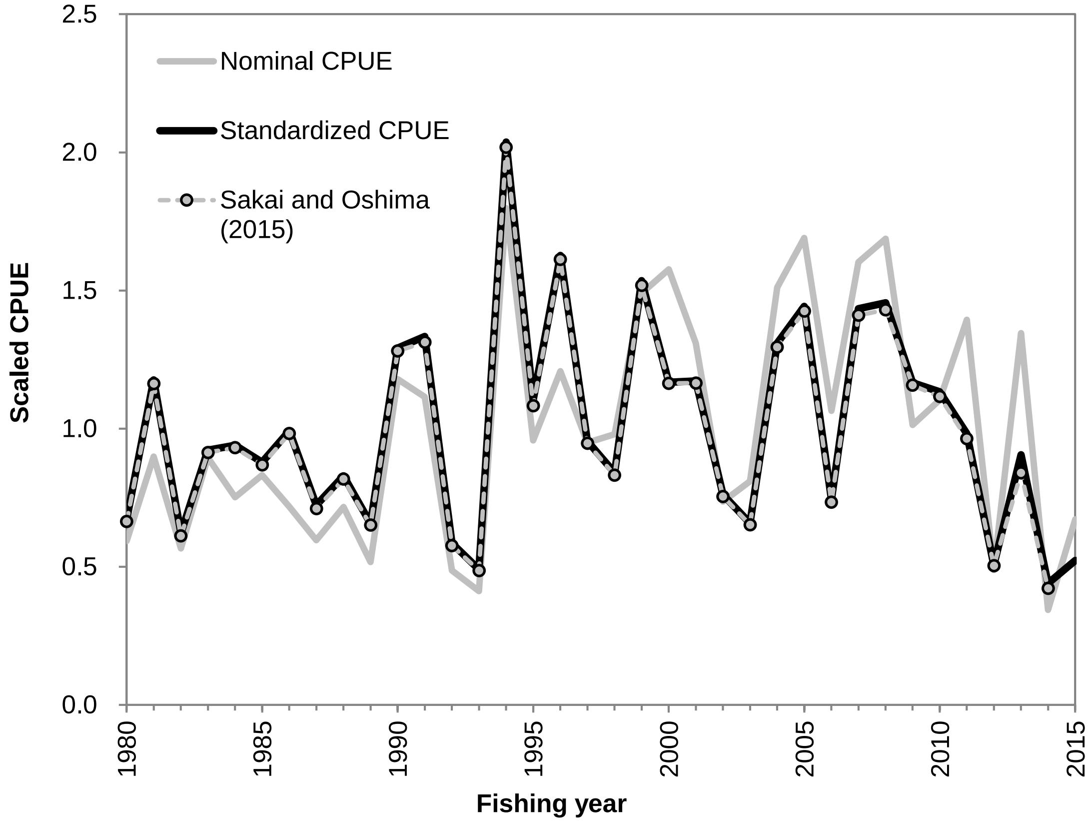

Fig. 5 Comparison of time series of CPUE. Gray and black lines indicates nominal and standardized CPUE from 1980 to 2015 fishing year. Dash line and circles show the previous standardized CPUE estimated by Sakai and Oshima (2015).