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Re-estimation of length frequency for Pacific Bluefin tuna caught by Japanese coastal longliners

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Abstract

There are clear differences in length frequencies of Pacific bluefin tuna in northern and southern prefectures landed by Japanese coastal longline fishery. However, only the influence on length frequencies by month was considered to estimate the catch at size data during 1994-2013 in the latest stock assessment. Therefore, we re-estimated the catch at size considering the influence on length frequency by prefecture/quarter and prefecture/month. There is no clear difference between the catch at size data used in the latest stock assessment and the re-estimated catch at size in the second quarter of calendar year (April-June) during 1994-2014 in the present study. This may be due to the proportional shift in the main sampling ports and the effort for measurement from Wakayama prefecture to Okinawa prefecture corresponding to the shift of main fishing ground from south of the main island (off Honshu) to off Okinawa and Yaeyama islands.

Introduction

Length frequency of Japanese longline fishery is one of the important information in the stock assessment of Pacific bluefin tuna (PBF) because it is used for estimation of selectivity for spawning population. In the last stock assessment, the estimation of the catch at size described in ISC/12-1/PBFWG/01(Mizuno et al., 2012) had been used. Although some studies mentioned that the clear differences were found in length frequencies of PBF by region, especially north and south (Itoh, 2006, Ichinokawa, 2007), the influence on length frequencies by month was only considered to estimate the catch at size during 1994-2013 in ISC/12-1/PBFWG/01(Mizuno et al., 2012). Therefore, we re-estimated the catch at size considering the influence on length frequency by prefecture/quarter and prefecture/month in the second quarter of calendar year (April-June) during 1994-2014.

Materials and Methods

Data sources

1) RJB data

   1-1. RJB size measurement data

   Research project on Japanese bluefin tuna (RJB) have been conducted to measure body size of PBF directly at main landing ports in Japan since 1994 (Fig. 1). Year, month, date, prefecture, landed port, brand name, product status (e.g. round or gilled and gutted), fishing gear, fishing area, length and/or weight data are included in this database.

   1-2. RJB catch data

   RJB have been also conducted to correct the catch amount of PBF based on sales slips at main landing ports around Japan since 1994. Year, month, date, prefecture, landed port, brand name, product status (e.g. round or gilled and gutted), fishing gear, fishing area, catch in weight and catch in number (if available) data are included in the database.

2) Port sampling data in Kesennuma, Katsuura, Tomari and Ishigaki

   In order to complement RJB, National Research Institute of Far Seas Fisheries (NRIFSF) have conducted the size sampling at several fishing ports where the catch of PBF was large but the sampling effort was scarce.

The sampling at Kesennuma Port in Miyagi prefecture have the same kind of data since 1998 and the data in Tomari port and Ishigaki port (Okinawa prefecture) have been provided since 2007. In addition, the sampling project for female gonads in Katsuura port (Wakayama prefecture) has been started since 2010, so we included these size data of this project in the analysis. To prevent the use of duplicated data, the shaded data in Table 1 were utilized in this study.

Estimation of catch at size

According to Ichinokawa (2007), the number of fish (n_{it}) that the fish at the length bin of i occurred in the population at a time stratum t can be described by the following equations:

$$n_{it} = \sum_{k=1}^{K} n_{ikt}/r_{kt}$$

where K is total number of special stratification; r_{kt} is relative catch "in weight" in prefecture k at time t. In this study, we used catch "in weight" because 33% of total amount of RJB catch and 24% of catch observation did not include catch in number. If average weights were used to estimate the catch in number for each stratum, the results should be consistent with those estimated by catch in weight. This equation described the simplest stratum considering the spatial stratum as a prefecture and the temporal stratum as a quarter. If the temporal stratum was considered as a month, catch at size in quarter could be estimated by summing up three months.

Two kind of catch at sizes were estimated to investigate the influence of stratification difference as follows; i) the spatial stratum as a prefecture and the temporal stratum as a quarter, ii) the spatial stratum as a prefecture and the temporal stratum as a month. Finally, we compared these results with the previous result (input data of the 2014 stock assessment) estimated by ISC/12-1/PBGWG/01(Mizuno et al., 2012).

Results and Discussion

There is no clear difference between the catch at size used in the 2014 stock assessment and the re-estimated catch at size in the fourth quarter of fishing year between 1994 and 2013 in the present study (Figs 2-3). This may be due to the proportional shift in at main sampling ports and the effort for measurement from Wakayama prefecture to Okinawa corresponding to the shift of main fishing ground from south of the main island (off Honshu) to off Okinawa prefecture and Yaeyama Islands. The high proportion of catch amount in Wakayama prefecture and Miyazaki prefecture were observed until the beginning of 2000's, after that the catch proportion in Okinawa prefecture has been increased, especially since 2007 (Table 1; Fig. 4). The yearly proportion of size measurement by prefecture also showed the similar trends as catch proportion (Table 2; Fig. 4).

Both methods, that is i) quarter/prefecture strata and ii) month/prefecture strata, showed the similar size frequency (Figs 2-3) and similar amount of catch (Table 3) using for estimation of catch at size (i) 92.2% and ii) 91.4%; Table 3). The stratum which have no observation of size measurement were not considered in this method. About 10% of not-considered catch amount would be derived from the prefectures aggregated as "Others". Alhtough the size frequencies in "Others" were not considered, the data of catch at size in this study were estimated for over 90% of catch amount. Therefore it is suggested that the results in this study would be the bset available information on the catch at size of spawning stocks.

References

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Table 1 Total number of size data caught by Japanese longliners by data source, region (prefecture or fishing port) and quality (measured by weight, length or both) during 1994-2013 in April-June.

A) RJB measure

	Only weight						Only length						Both					
	Miyagi	Chiba	Wakayama	Miyazaki	Okinawa	Others	Miyagi	Chiba	Wakayama	Miyazaki	Okinawa	Others	Miyagi	Chiba	Wakayama	Miyazaki	Okinawa	Others
1994	0	0	1209	0	44	0	15	0	0	0	0	0	71	0	1814	942	498	0
1995	0	0	828	0	0	0	0	0	0	0	0	0	26	0	1061	597	83	0
1996	0	0	209	0	104	0	2	0	1	0	1	0	43	0	2781	903	426	1
1997	0	0	155	0	191	0	0	0	0	0	0	0	90	0	3851	895	357	0
1998	0	0	222	0	97	0	1	0	1	0	2	0	53	0	3042	1125	356	0
1999	0	0	140	0	73	118	0	0	0	0	20	0	40	0	2235	1276	786	0
2000	0	0	546	0	14	0	0	0	0	0	0	0	350	0	905	559	465	1
2001	0	0	335	0	0	0	0	0	0	0	0	0	171	0	639	685	218	0
2002	0	0	749	0	1	0	0	0	0	0	0	0	14	5	620	586	175	0
2003	0	0	0	0	1	0	0	0	0	0	0	0	0	35	684	768	371	0
2004	0	0	3	0	0	0	0	0	0	0	0	0	0	0	894	797	629	0
2005	0	0	0	2	0	0	0	0	1	0	0	0	0	0	1252	632	888	0
2006	0	0	0	0	0	0	0	0	0	0	3	0	0	40	385	338	608	0
2007	0	0	37	0	720	0	0	0	10	0	0	0	0	0	692	372	863	0
2008	0	0	0	0	0	0	0	0	0	0	0	0	0	39	298	244	428	0
2009	0	0	0	0	0	0	0	0	1	0	3	60	0	28	57	147	691	0
2010	0	0	0	0	0	0	0	0	0	0	2	0	0	5	66	107	302	0
2011	0	0	1	0	0	0	0	0	0	0	0	0	0	118	32	0	192	0
2012	0	0	0	0	2	0	0	0	0	0	0	0	0	32	34	58	115	0
2013	0	0	3	0	4	0	0	0	4	0	0	0	0	35	81	78	214	0

B) Port Sampling

	Only weight				Only length				Both			
	Kesennuma	Katsuura	Tomari	Ishigaki	Kesennuma	Katsuura	Tomari	Ishigaki	Kesennuma	Katsuura	Tomari	Ishigaki
1998	10				0				54			
1999	27				0				22			
2000	283				0				141			
2001	197				0				0			
2002	81				0				0			
2003	45				0				104			
2004	6				0				118			
2005	9				0				118			
2006	14				0				24			
2007	1		0	27	100		14	10	58		386	655
2008	0		7	9	73		0	7	50		267	308
2009	0		19	11	0		15	8	16		224	509
2010	0	0	0	31	34	0	2	0	42	77	159	252
2011	0	0	0	8	0	0	2	6	0	66	161	130
2012	−	0	1	2	−	0	9	7	−	94	166	166
2013	−	5	1	0	−	0	2	2	−	27	136	352

Table 2 Total amount of RJB catch (t) caught by Japanese longliners during 1994-2013 in April-June.

	Miyagi	Chiba	Wakayama	Miyazaki	Okinawa	Others
1994	12.3	0.0	376.9	280.9	68.3	141.2
1995	7.9	0.0	250.1	198.3	22.4	30.2
1996	12.5	0.0	359.2	255.8	78.5	44.4
1997	13.5	0.0	540.7	257.7	84.9	47.9
1998	9.2	0.0	515.0	382.6	76.9	106.7
1999	5.7	0.4	361.2	292.3	145.2	45.1
2000	57.0	14.9	237.9	197.6	150.4	16.7
2001	61.8	8.0	154.5	175.9	60.9	18.7
2002	9.8	18.2	217.6	182.7	49.9	18.2
2003	47.8	64.4	246.0	236.1	122.8	11.6
2004	9.9	45.3	316.1	212.3	263.1	45.7
2005	41.7	102.8	466.6	185.9	223.0	39.7
2006	5.9	51.2	160.9	110.1	171.6	24.7
2007	7.1	40.7	228.0	88.0	347.4	103.3
2008	20.3	53.7	115.9	54.2	177.9	36.9
2009	5.4	32.3	50.0	33.7	149.0	33.9
2010	2.5	5.5	34.3	34.9	107.6	39.5
2011	3.8	14.0	30.1	29.9	96.9	14.3
2012	1.7	9.8	25.3	19.1	68.3	8.5
2013	1.7	16.5	36.5	16.4	101.5	15.3

Table 3 Proportion of catch amount using for estimation of catch at size by year and method.

	i) year/qt		ii) year/month		Total amount of RJB catch
	Catch	Ratio	Catch	Ratio	
1994	738.4	83.9%	738.4	83.9%	879.6
1995	478.6	94.1%	478.6	94.1%	508.8
1996	750.4	100.0%	714.3	95.2%	750.4
1997	896.8	94.9%	896.8	94.9%	944.7
1998	983.7	90.2%	981.5	90.0%	1090.3
1999	804.3	94.6%	804.3	94.6%	849.9
2000	659.6	97.8%	652.1	96.7%	674.5
2001	453.1	94.4%	453.1	94.4%	479.8
2002	478.2	96.3%	466.3	93.9%	496.4
2003	717.1	98.4%	717.1	98.4%	728.7
2004	846.7	94.9%	846.7	94.9%	892.4
2005	917.1	86.6%	917.1	86.6%	1059.6
2006	499.7	95.3%	494.8	94.4%	524.3
2007	670.4	82.3%	666.2	81.8%	814.4
2008	422.0	92.0%	422.0	92.0%	458.9
2009	304.2	100.0%	271.4	89.2%	304.2
2010	184.9	82.4%	184.1	82.1%	224.3
2011	141.0	74.6%	141.0	74.6%	189.0
2012	124.2	93.6%	123.8	93.3%	132.7
2013	170.9	90.9%	170.9	90.9%	187.9
Total	11241.3	92.2%	11140.6	91.4%	12191.1

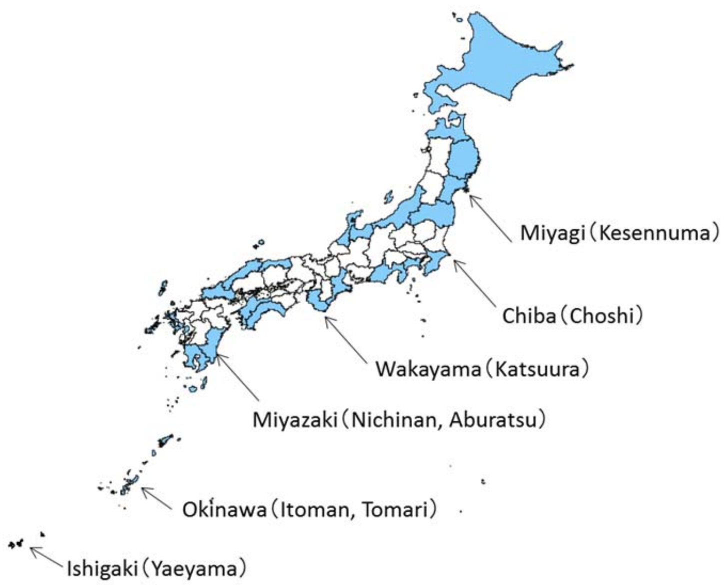

Fig. 1 Location of main sampling prefecture and port by RJB around Japan. Shaded area indicates the 22 prefectures participating the RJB.

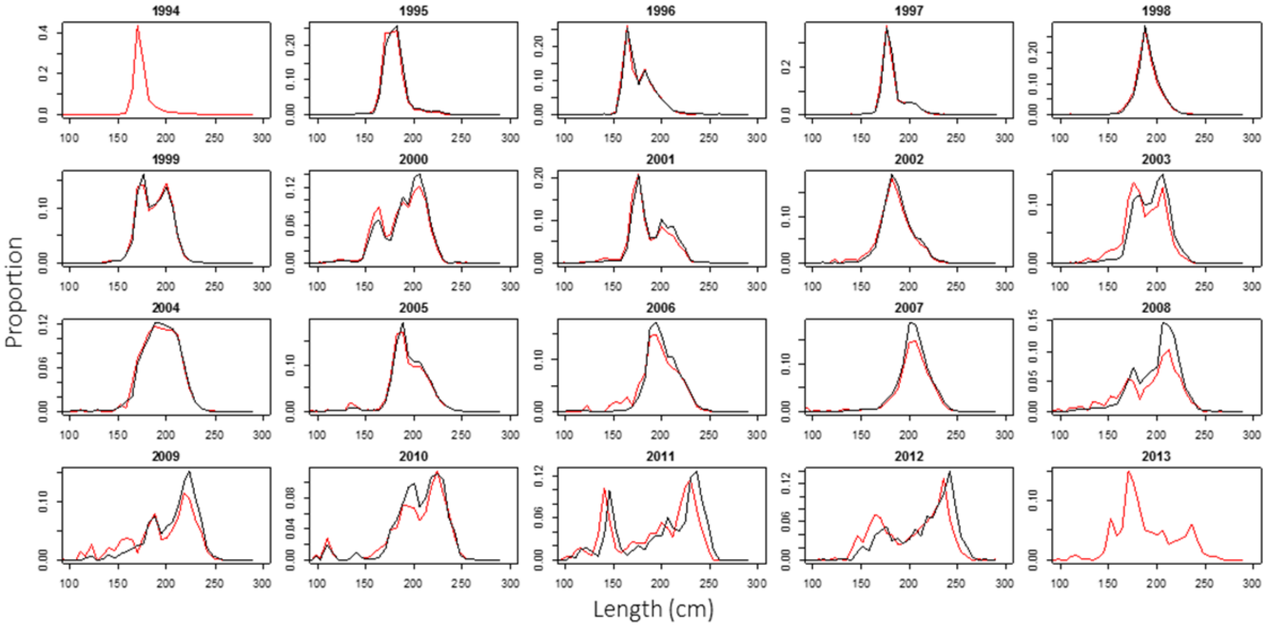

Fig. 2 Comparison of estimated catch at size considered prefecture and quarter (red line) and previous study (black line) in quarter 2 (April-June) during 1994-2013.

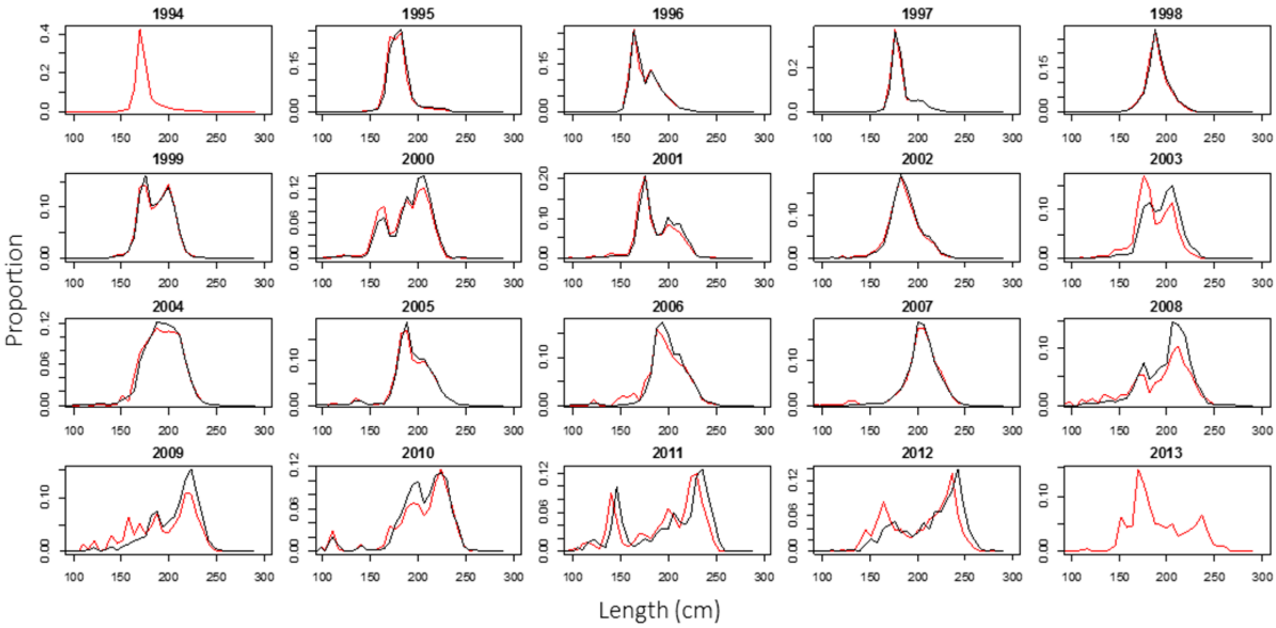

Fig. 3 Comparison of estimated catch at size considered prefecture and month (red line) and previous study (black line) in quarter 2 (April-June) during 1994-2013.

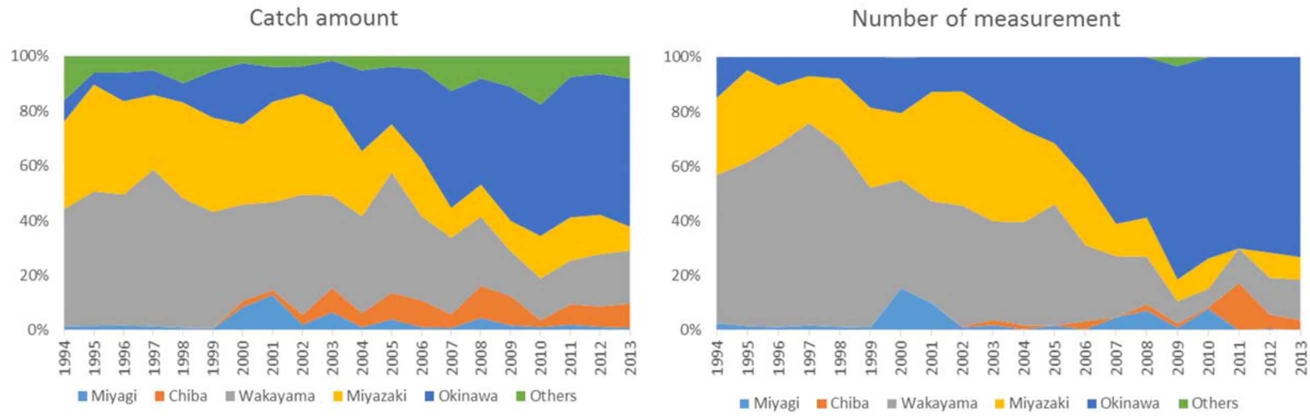

Fig4. Proportion of catch amount of RJB (left) and number of size measurement (right) by year and prefecture in quarter 2 (April-June) during 1994-2013.