Estimation of length frequency of Pacific bluefin tuna caught by Japanese coastal longliners: Updated up to 2014 fishing year

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Summary

The catch at size data for Japanese coastal longline catch was updated using revised method which was approved by ISC PBF WG in April meeting; the estimation methods using "Month & Prefecture strata" and "Quarter & Prefecture strata". Updated catch at size data in 2nd quarter of 1994-2015 calendar year shows that the main part of the longline catch have been constituted by some strong cohorts, but this has not been composed of only a single cohort. In 2014 fishing year, the length frequencies indicate the strong year classes of 182-260 cm FL and a new mode of small fish between 146 and 158 cm FL in the catch. The next step is the consideration whether to use "Month & Prefecture strata" or "Quarter & Prefecture strata" as the reference method.

Introduction

Pacific bluefin tuna (PBF) starts spawning in May and peak in late May to early June in south-western North Pacific Ocean (Chen et al. 2006). Japanese coastal longliner operates on the spawning ground and/or the migration route to/from there. Obtaining an accurate estimate of the size composition of PBF landed by the Japanese longliner is vital for population modeling and stock assessment, and to monitor changes in the spawning population over time.

Since 1994, the size structure of the PBF caught by Japanese costal longliner has been monitored through a "Research Project on Japanese bluefin tuna (RJB)" and port sampling research in several landing ports by National Research Institute of Far Seas Fisheries (NRIFSF). The RJB program also monitors the catch and landing of PBF at major ports. In addition, these research activities are not designed only to record fishing data, but also collect biological sample for PBF (e.g. Otoliths, gonads, muscles, etc.).

The length frequency information has allowed us to understand the size composition of Japanese longline catch. These data have shown that the spawning stock of PBF has mainly consisted by some strong cohorts, which provide to dominate the catch and sustain the fishery over several years. Recently, it was suggested the new recruitment of 2007 and/or 2008 year classes into the Japanese longline fishery contribute to slight increase of the CPUE in 2013 (Hiraoka et al. 2014).

In the stock assessment of PBF, the size composition of Japanese longline catch is one of the important information which used for estimation of the selectivity for the spawning stock. The size composition only in 2nd quarter of calendar year (4th quarter of fishing year) was used as the catch-at-size of Japanese costal longliner in the previous assessment, because most of catch in this fishery are reported in April-June and the measurement number in the other season is not many. In previous ISC PBF workshop (2015 April), the revised method to estimate the catch-at-size was proposed, which was used "Month & Prefecture strata" and "Quarter & Prefecture strata" (Hiraoka et al. 2015) changed from "month only stratum" (Mizuno et al. 2012). The WG considered the new method is an improvement and supported the method to be used in the upcoming stock assessment scheduled in next February (ISC 2015).

This document presents an update of catch-at-size information for 2nd quarter of calendar year including the most recent length data available for the Japanese coastal longliners. The length

frequency data are presented up to the 2014 fishing year (2015 calendar year).

Materials and Methods

Data sources

1) Data from "Research project on Japanese bluefin tuna (RJB)"

RJB has been conducted to collect the catch amount and size data for PBF since 1994. In this document, we used sales slips at main landing ports (37 ports) in 13 prefectures to aggregate the catch amounts for 2nd quarter of calendar year (Fig. 1). In the RJB database, year, month, date, prefecture, landed port, brand name, product status (e.g. round or gilled and gutted), fishing gear, fishing area, weight, and number (if available) are included.

Size measurement of PBF landed from Japanese coastal longliners was conducted at 13 main ports (7 prefectures) in 2nd quarter of calendar year (Fig. 1). Fork length was directly measured using caliper in principle. Year, month, date, prefecture, landed port, brand name, product status (e.g. round or gilled gutted), fishing gear, fishing area, length and/or weight data are included in this database.

In RJB database, some longline catch and size data for the other prefectures are also recorded (e.g. Hokkaido and Aomori Prefecture), but we didn't use these data because these fisheries are defined as "other fisheries" in current stock assessment model.

2) Data from "Port sampling by National Research Institute of Far Seas Fisheries (NRIFSF)"

NRIFSF has conducted the size measurement at several fishing ports where the catch of PBF was large but the sampling effort was insufficient. In particular, there are size measurement data from Kesen-numa port (Miyagi Prefecture) since 1998, Tomari and Ishigaki port (Okinawa Prefecture) since 2007, and Kii-katuura port (Wakayama Prefecture) since 2010. We included these size data to estimate the catch-at-size.

Estimation of catch at size

We used the revised method which was proposed by Hiraoka et al. (2015) to estimate the catch-at-size. In this method, the length frequency was estimated by "number" of actual measured fish with relative "weight" for measured fish and total catch. This can be described by the following equations:

$$N_{i\,y} = \sum_{k=1}^{K} \left(n_{i\,ykt} \times c_{ykt} / w_{i\,ykt} \right)$$

where N_{iy} is the fish at the length bin of i occurred in the population at 2nd quarter of calendar year y. K is total number of special stratification. n_{iykt} is number of measured fish at the length bin of i in prefecture stratum k at time stratum t for year y. w_{iykt} is weight of them. c_{ykt} is total catch weight in prefecture stratum k at time stratum t for year y. We used 6 groups as the prefecture strata (Miyagi, Chiba, Wakayama, Miyazaki, Okinawa, and Others). As the time stratum, month (3 strata: April, May, and June) and quarter (1 stratum: only 2nd quarter of calendar year) was used

for the method of "Month & Prefecture strata" and "Quarter & Prefecture strata", respectively.

When fish weight was not measured for the size measurement, the weight of measured fish was estimated from measured length using existing weight-length relationship (Kai 2007).

Results and Discussion

Japanese coastal longliner has caught PBF mainly 2nd quarter of calendar year, and the size measurement data has been also collected mainly same season (Fig. 2). This situation did not change in most recent year, thus size measurement data in 2nd quarter would still remain representing majority of the catch at size information of this fishery.

Most of size measurement data has both length and weight (Table 1). Almost all size data were measured in Miyagi, Chiba, Wakayama, Miyazaki, and Okinawa. As previously reported by Hiraoka et al. (2015), the estimation results from both methods, "Month & Prefecture strata" and "Quarter & Prefecture strata", showed the similar size frequencies (Fig. 3). Moreover, the ratio of catch amount using for the estimation of catch at size was also similar between two methods; 91.3% and 91.9% by "Month & Prefecture strata" and "Quarter & Prefecture strata", respectively (Table 2).

Estimated catch at size data shows that the main part of the Japanese coastal longline catch have been constituted by some strong cohorts (e.g. 1990, and 1994 year classes), but this catch has not been composed of only a single cohort. In 2014 fishing year, the main size of PBF caught by Japanese coastal longliner were 182-260 cm FL which would be 2007 and/or 2008 year classes—these year classes have been shown since 2011. In addition, the length frequencies indicate a new mode of small fish between 146 and 158 cm FL in the catch.

The ISC PBF WG agreed to use the estimation method using in this document for the catch at size data of Japanese coastal longliner (ISC 2015). The updated data for 2014 fishing year, where the strong cohorts were able to be detected continuously, were consistent with those before 2014 fishing year, thus there is no need to change that decision. The next step is the consideration whether to use "Month & Prefecture strata" or "Quarter & Prefecture strata" as the reference method. The difference between the results of these two methods were very small, but the estimated length frequencies from "Quarter & Prefecture strata" method were somewhat smoother than that of "Month & Prefecture strata" method in some years (e.g. for 2003 and 2009). This would suggest that the results from "Quarter & Prefecture strata" method possibly have relatively higher compatibility with those used in the present stock assessment model.

References

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Table 1 Total number of size data caught by Japanese longliners used for the catch-at-size data, which was based on RJB database and port sampling, but dropped their duplicated data. Data was aggregated by region (prefecture) and measurement quality (only length data or length & weight data) in 2nd quarter (April-June) of 1994-2015 calendar year (1993-2014 fishing year).

Calendar	Only length measurement (number)						Both length and weight measurement (number)						
Year	Miyagi	Chiba	Wakayama	Miyazaki	Okinawa	Others	Miyagi	Chiba	Wakayama	Miyazaki	Okinawa	Others	Total
1994	15	0	0	0	0	0	71	0	1814	942	498	0	3340
1995	0	0	0	0	0	0	26	0	1061	597	83	0	1767
1996	2	0	1	0	1	0	43	0	2781	903	426	1	4158
1997	0	0	0	0	0	0	90	0	3851	895	357	0	5193
1998	1	0	1	0	2	0	53	0	3042	1125	356	0	4580
1999	0	0	0	0	20	0	40	0	2235	1276	786	0	4357
2000	0	0	0	0	0	0	350	0	905	559	465	1	2280
2001	0	0	0	0	0	0	171	0	639	685	218	0	1713
2002	0	0	0	0	0	0	14	5	620	586	175	0	1400
2003	0	0	0	0	0	0	36	35	684	768	371	0	1894
2004	0	2	0	0	0	0	9	31	894	797	629	0	2362
2005	0	0	1	0	0	0	47	0	1252	632	888	0	2820
2006	0	0	0	0	3	0	5	40	385	338	608	0	1379
2007	100	0	10	0	24	0	47	0	692	372	1887	0	3132
2008	73	0	0	0	7	0	50	39	298	244	996	0	1707
2009	0	0	0	0	26	0	16	28	151	147	1410	0	1778
2010	34	0	0	0	4	0	42	5	66	107	709	0	967
2011	0	0	0	0	8	0	0	118	86	0	469	0	681
2012	0	0	0	0	15	0	4	32	85	58	436	0	630
2013	0	0	0	0	4	0	0	35	139	78	686	0	942
2014	0	0	0	0	10	0	0	35	80	88	770	0	983
2015	0	3	0	0	7	0	0	46	125	88	568	1	838
Total	225	5	13	0	131	0	1114	449	21885	11285	13791	3	48901

Table 2 Total amount of Japanese longline catch which was recorded in RJB database during 1994-2015 in April-June (Quarter 2), and proportion of catch amount which was used for estimation of Catch-at-Size in this document.

Calendar	Total amount of RJB catch (t)							Catch amount used for estimation (t)		Ratio (%)	
Year	Miyagi	Chiba	Wakayama	Miyazaki	Okinawa	Others	Total	"Month & Prefecture" strata	"Quarter & Prefecture" strata	"Month & Prefecture" strata	"Quarter & Prefecture" strata
1994	12.3	0.0	376.9	280.9	68.3	141.2	879.6	738.4	738.4	83.9	83.9
1995	7.9	0.0	250.1	198.3	22.4	30.2	508.8	478.6	478.6	94.1	94.1
1996	12.5	0.0	359.2	255.8	78.5	44.4	750.4	714.3	750.4	95.2	100.0
1997	13.5	0.0	540.7	257.7	84.9	47.9	944.7	896.8	896.8	94.9	94.9
1998	9.2	0.0	515.0	382.6	76.9	106.7	1090.3	981.5	983.7	90.0	90.2
1999	5.7	0.4	361.2	292.3	145.2	45.1	849.9	804.3	804.3	94.6	94.6
2000	57.0	14.9	237.9	197.6	150.4	16.7	674.5	652.1	659.6	96.7	97.8
2001	61.8	8.0	154.5	175.9	60.9	18.7	479.8	453.1	453.1	94.4	94.4
2002	9.8	17.9	217.6	182.7	49.9	18.2	496.2	466.0	477.9	93.9	96.3
2003	47.8	64.4	246.0	236.1	122.8	11.6	728.7	717.1	717.1	98.4	98.4
2004	9.9	45.3	316.1	212.3	263.1	45.7	892.4	846.7	846.7	94.9	94.9
2005	41.7	102.8	466.6	185.9	223.0	39.7	1059.6	917.1	917.1	86.6	86.6
2006	5.9	51.2	160.9	110.1	171.6	24.7	524.3	494.8	499.7	94.4	95.3
2007	7.1	40.7	228.0	88.0	347.4	103.3	814.4	666.2	670.4	81.8	82.3
2008	20.3	53.2	115.9	54.2	177.9	36.9	458.4	421.5	421.5	91.9	91.9
2009	5.4	31.3	50.0	33.7	149.0	33.9	303.2	269.0	269.4	88.7	88.8
2010	2.5	5.4	34.3	34.9	107.6	39.5	224.2	184.0	184.7	82.1	82.4
2011	3.8	13.3	30.1	29.9	96.9	14.3	188.3	140.3	140.3	74.5	74.5
2012	1.7	9.5	25.3	19.1	68.3	8.5	132.3	123.5	123.8	93.3	93.6
2013	1.7	9.0	36.5	16.4	101.5	15.3	180.3	163.3	163.3	90.6	90.6
2014	0.8	12.6	30.5	30.7	102.6	17.4	194.6	176.4	176.4	90.6	90.6
2015	17.0	18.3	28.3	19.1	57.7	6.3	146.7	123.7	129.7	84.3	88.4
Total	355.1	498.2	4781.7	3294.2	2726.6	866.1	12521.9	11428.9	11503.1	91.3	91.9

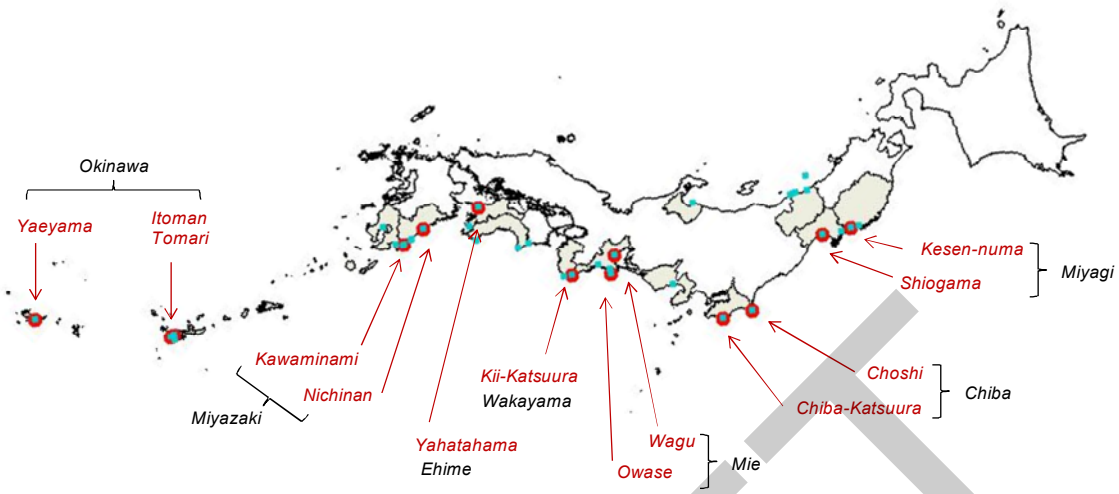

Fig. 1 Location of fishing ports and prefectures where costal longliners have landed Pacific bluefin tuna (PBF) in April-June. Blue points show the fishing ports where the landing of PBF was recorded in RJB database. Red points show the locations that Japan has been correcting size measurement data. There are very few measurement data at some ports in 2nd quarter (e.g. Mie and Ehime).

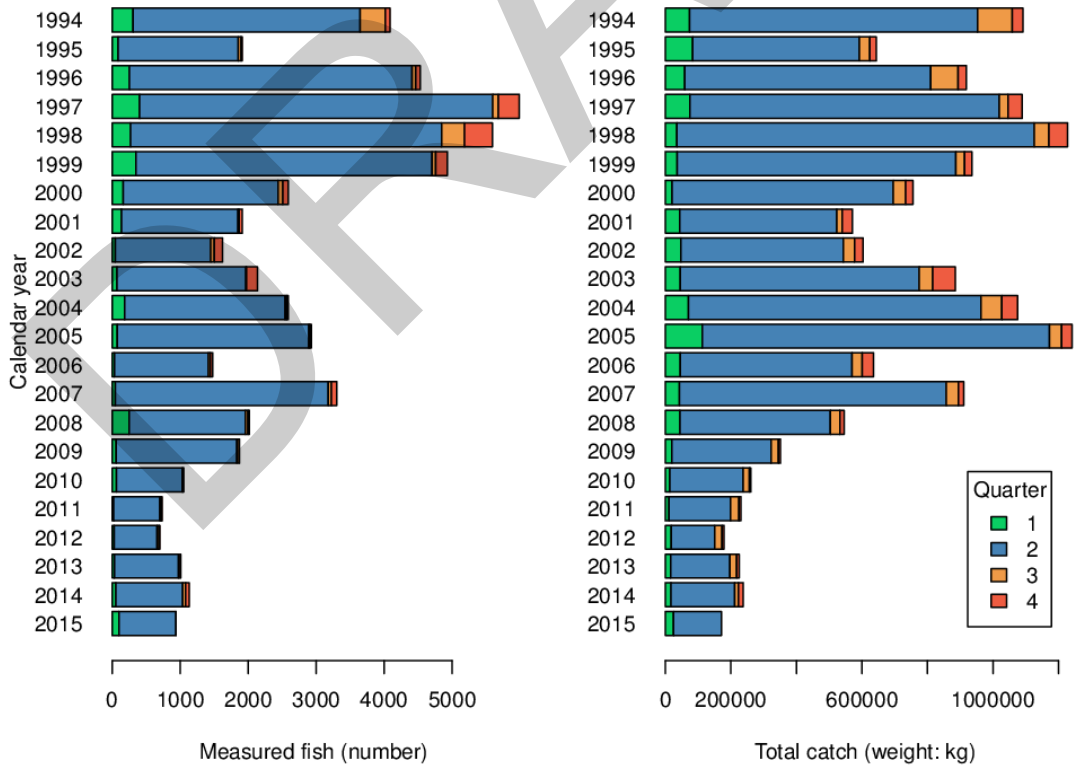

Fig. 2 Number of measured PBF and recorded total catch weight in RJB database. Each color shows the recorded seasons (Quarter) of size measurement and PBF landing.

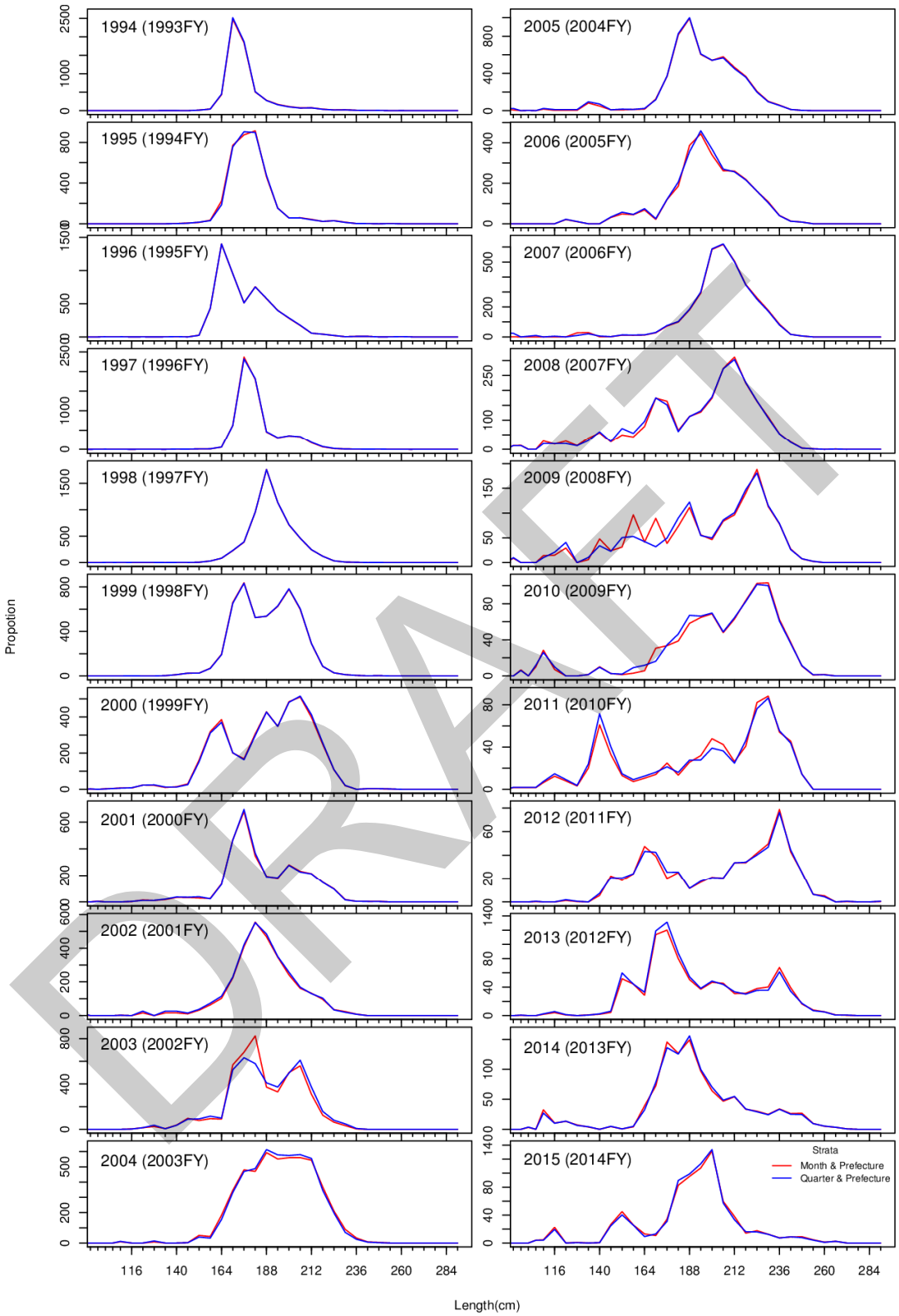

Fig. 3 Estimated catch-at-size of PBF caught by Japanese coastal longliner in 2nd quarter of calendar year. Red and blue lines show the estimation using "Month & Prefecture" and "Quarter & Prefecture" strata, respectively.