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Updates of recruitment and harvesting scenario for the future projection of Pacific bluefin tuna

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SUMMARY

This document provides an example of the updated recruitment and harvesting scenario for the future projection which is compatible with the management measures implemented by WCPFC and IATTC, and the latest survey results about recruitment. Results showed that the recent possible low recruitments never work positively for the stock rebuilding, although the test run estimated to result in achieving the interim rebuilding target of WCPFC. It is getting further important to monitor the each year's recruitment and reflect it timely to the projection.

INTRODUCTION

The latest stock assessment for Pacific bluefin tuna *Thunnnus orientalis* (PBF) was conducted in 2014 by ISC Pacific bluefin tuna working group (PBFWG) with the best available life history parameters and the fishery data from July 1952 to June 2013. Although the base case stock assessment model was unable to reconcile all of the key data sources, base case model and several sensitivity runs commonly depicted large long-term fluctuations in spawning stock biomass (SSB) and a highly depleted stock that has been declining for over a decade. Model estimates that the terminal biomass were at or near the lowest level and that there might be a sign of decrease of the recruitment (ISC PBFWG, 2014). Since the fishing mortality is still very high, it was advised that the fishing effort towards the PBF needs to be regulated to avoid the recruitment overfishing and ensure the stock rebuilding.

In 2014, to ensure the sustainability and the rebuilding of stock, the WCPFC and IATTC members requested future projections with several harvesting and recruitment scenarios, and ISC and also IATTC conducted it (ISC PBFWG 2014; Maunder & Aires-da-Silva, 2014). Having considered the possible low recruitments in recent years, the probability of the stock rebuilding had been evaluated under the assumption of low recruitment scenario in the both RFMOs. Taking the stock assessment result and these projection results into account, WCPFC and IATTC had adopted new management measures, which would be enforced from 2015, to reduce the fishing mortality of PBF (WCPFC CMM2014-04, IATTC Resolution C-14-06). It is notable that the new management measures were slightly different from any of quantitatively evaluated harvesting scenarios by the ISC or IATTC scientific meetings. Therefore, it is important to evaluate afresh the effectiveness of the new management measures actually implemented.

Also, the new information on the level of recruitment is added from 2014 assessment. Since one of the concerns over the probability of the stock rebuilding would be the level of recruitment, WCPFC CMM encouraged the members in particular those catching juvenile PBF to take measures to monitor and obtain prompt results of recruitment of juveniles each year. Japan therefore started a troll vessel monitoring survey program using a GPS and data transmitting system to monitor the

abundance of age-0 PBF earlier and more regulatory than usual stock assessment time frame (Oshima et al., 2015). The latest survey report (hereafter troll survey CPUE) showed sign of an very low recruitment of 2014 year class; the troll survey CPUE of 2014 year class was lower than that of 2012 year class, which was considered to be at or near the lowest level after 1980 by the standardized CPUE time series (Fujioka et al., 2014; Oshima et al., 2015). If the 2014 year class was actually at the historical lowest level, it may impact the current rebuilding projection results.

To comprehend the effectiveness of the management measures in force in light of the new recruitment information, it is necessary to conduct the future projection with a scenario updated from the ISC2014 scenario 6. In this document, we provide an updated projection based on a minimally updated recruitment and harvesting scenario as an example of a revised future projection scenario reflecting the management measures in force and the latest survey results more accurately.

METHODS

The all methods for the future projection followed the ISC 2014 stock assessment report and the revised projection was based on the ISC 2014 base case stock assessment model (ISC PBFWG, 2014). The software used for the future projection is distributed as an R-package named 'ssfuture', and is described in Ichinokawa (2012). This software has been validated as being capable of generating highly similar results on numbers-at-age and catch weight by fleets with deterministic future projections generated by Stock Synthesis (Ichinokawa 2012).

Because there are some retrospective trend in the terminal year's recruitment and fishing mortality, the future projection was set up from the second half of 2012 in calendar year (from 2012 fishing year), although the last stock assessment period was until the first half of 2013 (end of 2012 fishing year). In this document, years refer to calendar years unless otherwise specified.

The harvesting scenario in years 2012, 2013 and 2014 were set up to approximate WCPFC CMMs and IATTC Resolutions reflecting the measures implemented in the respective years. As for the 2012 and 2013, WCPFC CMM 2010-04 and IATTC Resolution C-12-09, which determined upper limit of the fishing effort in the WPO and total catch limit in the EPO, were imitated (Table 1). Note that it includes the unilateral management measures by Japan to determine the catch limit for the Japanese purse seiners (4,500 mt for <30 kg PBF and 2,500 mt for >30kg PBF). The catch by the EPO commercial fisheries (Fleet 12) were allocated into the above and below 30kg based on the proportion of 2010-2012 average catch at size estimated by the base case stock assessment model. As for the 2014, WCPFC CMM 2013-09 and IATTC Resolution C-12-09, which reduces (by 15%) the catch of <30 kg PBF from 2002-2004 average level in the WPO, were imitated (Table 2). As for the 2015 and after, WCPFC CMM 2014-04 and IATTC Resolution C-14-06, which reduces (by 50%) the catch of fish <30 kg PBF and determine the upper limit of >30 kg PBF catch at 2002-2004 average level in the WPO and further reduction of total catch in the EPO, were imitated (Table 3).

As for the EPO sports fisheries, as there is no specific provision targeting fishing mortality or regulating catch limit in the IATTC resolutions, we set to average fishing mortality of 2009-2011 level.

The basic recruitment scenario was derived from the scenario 6 of ISC 2014 stock assessment report; recruitments in 2012 and 2013 year class in projection were resampled from estimated recruitments in 1986-1988, which was low recruitment 3 years, because the recruitment of those past 2 years were estimated to be low by the standardized CPUE and troll survey CPUE, although the recruitment is yet to be estimated formally by the stock assessment process. Then future recruitment is randomly resampled from the low recruitment period (1980-1989) (Fig. 1, Table 4). The only difference from ISC2014 scenario 6 is the value of year 2014. As for the 2014 year class, the troll survey CPUE suggested that the abundance of this year class might be lower than 2012. Although we did not have any information about 2014 year class other than survey nominal CPUE, we proposed to use the estimated historical lowest recruitment year class occurred at 1958 (18% of the historical average) for the 2014 recruitment in projection, as a precautional approach (Fig. 1, Table 4).

RESULTS and DISCUSSION

Under above proposed scenario, the probability achieving to the historical median SSB (42,592 mt), which is the interim rebuilding target of WCPFC, at 2024 (10 years after the implementation of the current management measures) was around 70% (Table 5), where it was around 90 % in ISC2014 scenario 6. The trajectory of median SSB showed a gradual decline and marked minimum value at 2018 (Fig. 2). The risk to decline historically lowest level observed at least one time within 10 years was about 35%, where it was about 25% in ISC2014 scenario 6.

The projection results with updated scenario indicated that the currently enforced management measures will probably contribute to the stock rebuilding when it is implemented properly. It estimated to result in achieving the interim rebuilding target of WCPFC (historical median SSB with at least 60% by 2024). However, the negative impact of the possible very low recruitment in 2014 to the stock rebuilding was not negligible. Even though the reason for the recruitment variability is not fully understood, the possibility that PBF might be entering a low recruitment period needs to be duly noted and therefore it is getting further important to monitor the each year’s recruitment and reflect it timely to the projection. For the coming full stock assessment of this stock, it is also needed to review the life history parameters such as the stock recruitment relationship, growth, and natural mortality as well as the fishery data for the improvement of the modelling for the stock assessment and future projection. Since the proper implementation of the management measures is essential for the stock rebuilding, to estimate fishing mortality and check it against the management measures needs to be done in the coming stock assessment.

LIITARATURE CITED

Oshima, K., Tsuruoka, I., and Suzuki, N. 2015. Quarterly catch, length frequencies and CPUE from troll fishery for farming. Working paper submitted to the ISC PBF Working Group Meeting, 20-25 April 2015, Shizuoka, Japan. ISC/15/PBFWG-1/##.

Ichinokawa, M. 2012. Operating manual and detailed algorithms for conducting stochastic future projections with R packages of 'ssfuture'. Nat. Res. Inst. Far Seas Fish., Shimizu, Shizuoka, Japan, Available at: http://cse.fra.affrc.go.jp/ichimomo/Tuna/projection_manual_v0.4.pdf

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. Working paper submitted to the ISC PBF Working Group Meeting, 17-22 February 2014, La Jolla, USA. ISC/14/PBFWG-1/07.

Maunder, M. N. and Aires-da-Silva, A. 2014. Developing conservation measures for Bluefin tuna in the eastern and western region of the Pacific ocean: Factors to consider and fishery impact analysis. Document paper submitted to the IATTC Commission Meeting, 27 October to 1 November 2014, La Jolla, USA. DOCUMENT IATTC-87 INF-B.

PBFWG. 2014. Stock assessment of Pacific Bluefin Tuna 2014. Available at: http://isc.ac.affrc.go.jp/pdf/2014_Intercessional/Annex4_Pacific%20Bluefin%20Asstmt%20Report%202014-%20June1-Final-Posting.pdf

Table 1. Harvesting scenario in 2012 and 2013 based on WCPFC CMM 2010-04 and IATTC Resolution C-12-09.

Area	Fishery	Target	Catch limit for fish less than 30kg (mt/yr)	Catch limit for fish more than 30kg (mt/yr)	Fishing mortality coefficient	Fleet No.
WPO	Japanese longline	Adult	0	-	F02-04	1
	Purse seine in the East China Sea	Juvenile	5,500	2,500	F02-04	2
	Japanese tuna purse seine fisheries in the Sea of Japan	Adult			F02-04	3
	Japanese purse seine off the Pacific coast of Japan	Both			F02-04	4
	Japanese troll	Juvenile	-	-	F02-04	5
	Japanese pole and line	Juvenile			F02-04	6
	Japanese set net	Both			F02-04	7, 8, 9, 10
	Other fisheries in Japan	Both			F02-04	14
	Taiwanese longline	Adult	0	-	F02-04	11
EPO	East Pacific Ocean commercial fishery	Both	4,129	1,371	Quota	12
	East Pacific Ocean sport fishery	Both	-	-	F09-11	13

Table 2. Harvesting scenario in 2014 based on WCPFC CMM 2013-09 and IATTC Resolution C-12-09.

Area	Fishery	Target	Catch limit for fish less than 30kg (mt/yr)	Catch limit for fish more than 30kg (mt/yr)	Fishing mortality coefficient	Fleet No.
WPO	Japanese longline	Adult	0	-	F02-04	1
	Purse seine in the East China Sea	Juvenile	4,716	2,500	F02-04	2
	Japanese tuna purse seine fisheries in the Sea of Japan	Adult			F02-04	3
	Japanese purse seine off the Pacific coast of Japan	Both			F02-04	4
	Japanese troll	Juvenile	2,950	-	F02-04	5
	Japanese pole and line	Juvenile			F02-04	6
	Japanese set net	Both			F02-04	7, 8, 9, 10
	Other fisheries in Japan	Both			F02-04	14
	Taiwanese longline	Adult	0	-	F02-04	11
EPO	East Pacific Ocean commercial fishery	Both	4,129	1,371	Quota	12
	East Pacific Ocean sport fishery	Both	-	-	F09-11	13

Table 3. Harvesting scenario in 2014 based on WCPFC CMM 2014-04 and IATTC Resolution C-14-06.

Area	Fishery	Target	Catch limit for fish less than 30kg (mt/yr)	Catch limit for fish more than 30kg (mt/yr)	Fishing mortality coefficient	Fleet No.
WPO	Japanese longline	Adult	0	1,317	F02-04	1
	Purse seine in the East China Sea	Juvenile	2,718	2,500	F02-04	2
	Japanese tuna purse seine fisheries in the Sea of Japan	Adult			F02-04	3
	Japanese purse seine off the Pacific coast of Japan	Both			F02-04	4
	Japanese troll	Juvenile	2,007	467	F02-04	5
	Japanese pole and line	Juvenile			F02-04	6
	Japanese set net	Both			F02-04	7, 8, 9, 10
	Other fisheries in Japan	Both			F02-04	14
	Taiwanese longline	Adult	0	1,700	F02-04	11
EPO	East Pacific Ocean commercial fishery	Both	2,437	863	Quota	12
	East Pacific Ocean sport fishery	Both	-	-	F09-11	13

Table 4. Recruitment scenario in the 2014 stock assessment and additional recruitment scenarios with the low recruitment in 2014 and 2015.

	2012	2013	2014	2015	2016	2017	2018	2019-
Scenario in the 2014 stock assessment	Resampling from recruitments in 1986-1988[*1]		Resampling from recruitments in 1980-1989[*2]					
Updated scenario	Resampling from recruitments in 1986-1988[*1]		The lowest recruitment in 1958[*3]	Resampling from recruitments in 1980-1989[*2]				

[*1] The low three years in the low recruitments period (1980-1989).

[*2] The low recruitment period in 1980-1989.

[*3] The historical lowest recruitment occurred in 1958.

Table 5. Projection in the 2014 stock assessment and tentative projections based on additional recruitment scenarios.

	Probability that SSB falls below SSB_{loss} even once from 2015 to 2024.	Probability that SSB is more than SSBmed in 2024.
Scenario 6 in the 2014 ISC stock assessment	24%	89%
Updated scenario	34%	72%

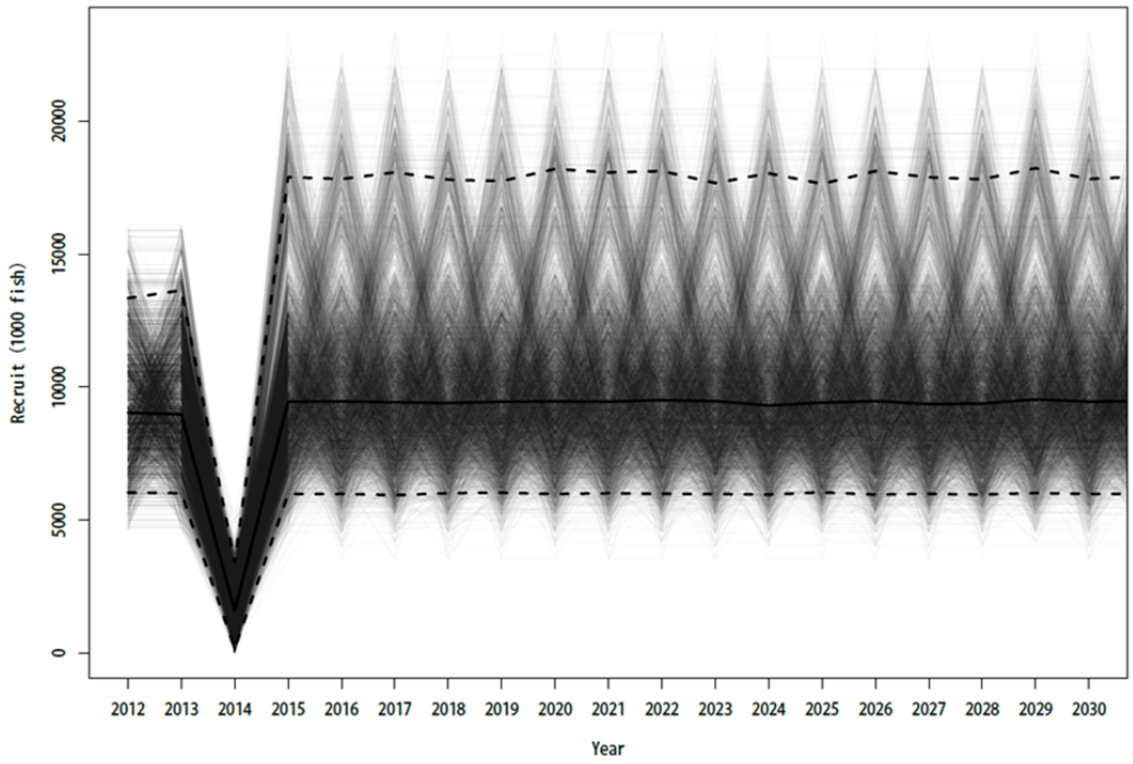

Fig. 1 Future recruitment trajectories in updated future projection scenarios under 19 years (2012-2030). A thin line indicates each recruitment trajectory conditioned by the bootstrap replicates (300 times) followed by stochastic resampling of recruitment (20 times). Dashed and bold lines represent 90% confidence interval and median of each projection, respectively.

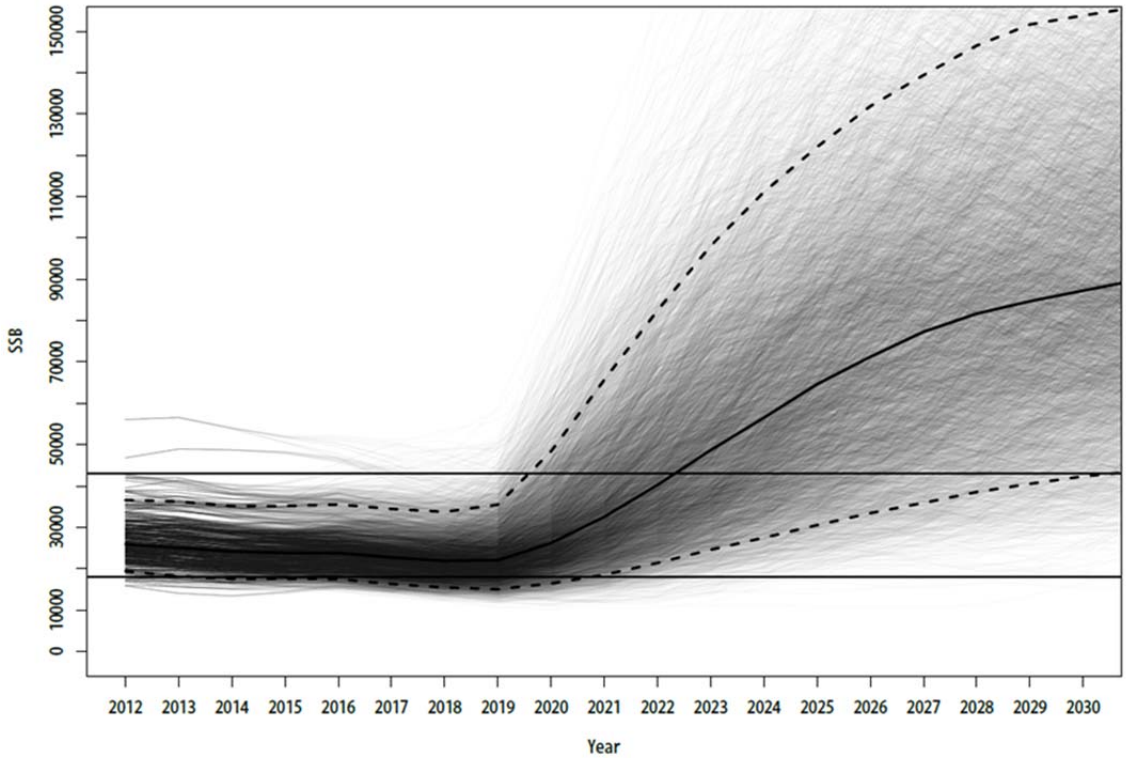

Fig. 2 Future SSB trajectories in updated future projection scenarios under 19 years (2012-2030). A thin line indicates each projection conditioned by the bootstrap replicates (300 times) followed by stochastic resampling of recruitment (20 times). Dashed and bold lines represent 90% confidence interval and median of each projection, respectively. Horizontal 2 lines indicate the historical median and lowest values.