*Annex 6*

# *REPORT OF THE PACIFIC BLUEFIN TUNA WORKING GROUP WORKSHOP*

*International Scientific Committee for Tuna and Tuna-like Species*
*In the North Pacific Ocean*

29 February – 11 March 2016
La Jolla, California, USA



## 1. INTRODUCTION

### 1.1. Welcome and Introduction

Gerald DiNardo, ISC Chair and Director of the Fisheries Resources Division, NOAA Southwest Fisheries Science Center, opened the meeting on 29 February 2016. He welcomed participants and explained administrative and logistical arrangements. He also emphasized the importance of completing the assessment of Pacific bluefin tuna. The Chair of the Pacific Bluefin Tuna Working Group (PBFWG), H. Nakano, highlighted the main objectives of the meeting.

### 1.2. Adoption of Agenda

The Chair introduced the draft agenda for the meeting. The WG made several modifications and adopted the revised agenda (Attachment 1). A list of participants is provided as Attachment 2.

### 1.3. Appointment of Rapporteurs

S. Nakatsuka was appointed as the lead rapporteur for the meeting and support rapporteurs were assigned by the Chair as follows: Item 2 - N. Suzuki and K. Piner, Items 3.1. and 3.2. – O. Sakai and S. Teo; Items 3.3. and 3.4. - K. Oshima and M. Maunder; Item 4. H. Fukuda and H.H. Lee; Item 5. - H. Nakano; Item 6. – S.K. Chang and M. Dreyfus; Item 7. – Y. Kwon.

## 2. REVIEW OF STOCK ASSESSMENT INPUT DATA

### 2.1. Biological Parameters and Data for Stock Assessment

The Chair noted that most of the biological parameters were agreed at the previous PBFWG meeting in November 2015 and asked participants if anything needs to be discussed under this agenda item. It was suggested that, except for growth curve, all the biological parameters were agreed and growth curve could be discussed under agenda item 3 (Model setting). However, there was a question about the data and method used for the revised growth curve being suggested by Japan and H. Fukuda made a presentation as follows in response.

In the previous assessment, the WG used the growth curve by Shimose et al., 2009, which was updated in 2012 (Shimose and Takeuchi, 2012). However, the study did not include data of age-0 fish and the estimated length at the time of recruitment by the growth curve did not match the observations, thus in the last (2014) assessment the WG decided to increase length at age 0 (L1) to 21.5 cm from 15.5 cm which the growth model suggested. As more than 80% of PBF is caught at age 0 or 1, it was considered a priority for PBFWG to improve the understanding of growth of age-0 fish. The ISC held aging workshop, which produced a manual for aging PBF, and as a result, age-at-length data reviewed and improved became available. In the previous PBFWG meeting in Taiwan, the presenter had shown that age-0 PBF exhibits seasonal growth by growing very rapidly from July to December but then hardly growing during winter (Fukuda et al., 2015; ISC/15/PBFWG-2/03). The data used to estimate the new growth curve were annual ring data from fish aged 1-28 from Japanese and Taiwanese vessels, re-calculated based on the new manual, and daily ring data for fish aged 51-453 days after hatching (n=228). The data have been collected continuously since 2005 and possible outliers outside of 2xSD were excluded from the analysis (4.6% of total data) due to possible incorrect reading.

It was asked if seasonal growth is observed for fish older than age 0. The presenter responded that although there are some studies suggesting the existence of seasonal growth in age 1, seasonal growth has been confirmed only for age 0 fish through observations. It was suggested that large cohorts might grow faster and the variance in growth might cause conflicts in the models and that one possible approach to address the matter is to use time-varying growth curve. In response, it was noted that due to the fishery dependent sampling process, current otolith information should be more influenced by large cohorts even if there is a difference in growth between cohorts.

The WG noted that data previously available only as a growth model is now available as individual paired age-length observations. This data can be treated as random at length or random at age, and the assumptions behind each approach should be considered. Appropriate modelling choices will be discussed in the modelling section. Given the importance and uncertainty in growth, **the WG agreed that the age-length data should be available for use in the stock assessment model or outside the model to re-estimate growth if appropriate**.

## 2.2. Fishery data for input of the stock assessment model

2.2.1 Standardized catch per unit effort of Pacific Bluefin tuna (*Tunnus orientalis*) Japanese coastal longline CPUE for Pacific bluefin tuna: Re-update up to 2014 fishing year for stock assessment; presented by O. Sakai (ISC/16/PBFWG-1/01)

Japanese coastal longline CPUE from 1993-2014 (fishing year) was presented. The CPUE was standardized using the procedure agreed in the November meeting of ISC PBFWG. In the standardization, the effect of target shift was addressed by the indicator from cluster analysis. Cluster indicator was based on the species composition (except for PBF) by fishing trip, and it was used for the explanatory variable of the standardization model. Zero inflated negative binomial (ZINB) model was applied as the model to standardize the CPUE which was based on the aggregated data in fishing trip resolution. The final model selected by the Bayesian information criterion (BIC) included the main effect and some 1st order interactions of cluster indicator. The authors considered that this analysis was conducted using sufficient data-set which included the updated data for 2014 fishing year.

**Discussion**

The Chair clarified that the only new aspect the CPUE is the inclusion of updated data. It was suggested that plots of trends in CPUE by cluster would be useful to see if a cluster might behave differently. It was also questioned what caused a sharp increase in number of trips in 1999 while the PBF catch by Japanese longline for years between 1997 to 1999 was rather stable at around 1,000 t. It was clarified that all the available data is used for the standardization. **The WG agreed to use the most recent 2014 CPUE information in an update of the Japanese Coastal longline CPUE series for the stock assessment**, noting that the CPUE standardization methodology was agreed to in the November 2015 meeting.

2.2.2 Update of Standardized PBF CPUE Series for Taiwanese Longline Fishery; presented by SK. Chang (ISC/16/PBFWG-1/02)

Only market landing data with small coverage of logbooks were available before 2010. Therefore, non-traditional procedures were performed to estimate standardized PBF CPUE series for 2001-2014 in the paper submitted to the second intersessional PBFWG in 2015 (ISC/15/PBFWG-2/10), taking advantage of voyage data recorder (VDR) data, as well as landing data from fish markets and trip information data from the Coast Guard. The works were updated for this meeting by (1) including the data of 2015 (2014 fishing year) and (2) improving the estimation of fishing days by a refined approach based on more complete VDR data. In addition, the trip data with only one fishing day were deleted for 2013 – 2015 to eliminate the bias caused by vessels acting as carriers bringing back PBF catch for landing that were caught by other fishing vessels. Four major works were performed: (1) Estimating PBF catch in number from landing weight for 2001-2003 based on an MCMC simulation; (2) Deriving fishing days information for 2007-2009 from VDR data of 2010-2014; (3) Deriving fishing days information for 2001-2006 from vessels trip information based on linear relationships between fishing days and at-sea days for a trip, by vessel size and fishing port, during 2007-2014; (4) Standardizing the CPUE for 2001-2015 using generalized linear models (GLMs) with delta lognormal assumption. Result of the updated analyses shows similar trend as the previous: declined from 2001 to 2012 with annual fluctuations, increased substantially during 2013 and 2014, and then slightly declined in 2015.

**Discussion**

It was clarified that the amount of fishing effort excluded from the analysis as the result of deleting the trip data with only one fishing day were 6, 4 and 7% for years 2013, 14 and 15, respectively. The trend of fishing effort by Taiwanese longliners was also presented in response to a request; the effort declined to about one half from 2009 to 2011 due to high fuel prices and poor catch rate and then stayed relatively stable. **The WG agreed to use the revised CPUE for Taiwanese longline that excluded the possible transfer vessel trips.** (See 3.2. for further discussion about the treatment of Taiwanese CPUE.)

2.2.3 Input data of Pacific bluefin tuna fisheries for stock assessment model, Stock Synthesis 3; Update for 2016 assessment; presented by O. Sakai (ISC/16/PBFWG-1/03)

In the presentation, the input data for PBF fisheries for the stock assessment were summarized. Compared to the previous assessment, the fleet definition was modified to treat the size frequency adequately (e.g. definition of new fleet for Japanese troll for farming, combination of Japanese set-net fisheries, division of EPO commercial purse seine fisheries). Quarterly catch data were updated up to fishing year 2014 (up to June in 2015 calendar year). Among the 16 fleets, USCOMM (Fleet 13) and TPSPO (Fleet 5) were largest fisheries in eastern and western side of Pacific Ocean until the 1990s, respectively. JPSPPS (Fleet 2) and TPSJS (Fleet 4) have become relatively larger since the mid-2000s in the western side, and MXCOMM (Fleet 14) has a large amount of PBF catch in eastern side since 2000s.

Some size frequency data were updated using improved estimation method (e.g. Japanese troll and set-net) during the intersessional WG meeting. Abundance indices (CPUE) from Japanese longliners, Japanese troll, and Taiwanese longliners were updated up to the 2014 fishing year, of these, the CPUE standardization methods for Japanese and Taiwanese longline were improved.

**Discussion**

The Chair noted that the treatment of CPUE will be revisited in the discussion of model setting. The author noted that in the current data set Mexican purse seine size composition data before 2004 and of 2007 is not included as in the case of the previous assessment. The WG discussed if those same years should not be included in the current assessment model and **agreed to exclude composition data before 2004 and of 2007 from the Mexican PS fleet from the data to be used in the stock assessment**.

The WG noted that the CV associated with the middle years of the JPN LL index were very small and asked if there were differences in the fishery between early, middle and recent periods. It was clarified that the vessel size was different during the middle period, but fishing ground was the same as recent period. The WG is not clear why the start CV were small, but the WG is using a CV=0.2.

K. Oshima presented catch and recruitment trend of PBF in Japan in 2015. In terms of recruitment in 2015, monitoring survey results showed that CPUE of vessels targeting early hatching group is slightly better than 2014 and similar to 2012 while harvesting of late hatching group for farming fry was highest in the recent three years. Thus, it is possible that the recruitment in 2015 is better than that of 2014. Regarding the 2015 PBF catch, the 2010 cohort is observed as a strong cohort in purse seine catch in the Sea of Japan and western Pacific Ocean as well as handline catch in Tsugaru Strait, suggesting that the 2010 cohort is relatively abundant. This could be confirmed by the model results.

With regard to the level of abundance of 2010 cohort, it was pointed out that the catch in Mexican purse seine in 2013 was slightly larger than usual and that might have also been caused by the strong 2010 year class. In response, it was noted that Mexican purse seiners sometimes target larger fish. It was also pointed out that the increase of size in EPO catch could be a result of more abundance of larger fish or targeting shift, which should be addressed by modeling discussion.

## 3. MODEL SETTING AND RESULTS

### 3.1. Confirmation of Key Model Setting

3.1.1. Development of a Pacific Bluefin Stock Assessment; presented by HH. Lee (ISC/16/PBFWG-1/06)

This paper presents objective criteria by which a stock assessment model was developed for Pacific bluefin tuna. The goal of the work was to create an internally consistent model that follows objective criteria using a series of CAPAM workshops on population modelling as guideline. We assert that agreed data should be considered true. Unacceptable diagnostic for model fit to data or conflict between data series is indicative of model misspecification. Misspecification was addressed using either additional model process in the form of flexible and time-varying selectivity patterns or by adding the un-modelled process to the observation error. To keep the model parsimonious, prioritization criteria were developed to determine which data sources would be addressed by time-varying selectivity and which would be addressed by data weightings.

**Discussion**

With regard to the poor fit of the initial model to Taiwanese longline size composition data for small fish, it was questioned if all the Taiwanese data were included and the author clarified that all the data were included. It was further pointed out that despite that fishery does not change, the catch of small fish is increasing in recent years and that may be causing the poor fit, particularly in recent two years. The authors acknowledged that the analysis conducted was to see a general picture of model fit and detailed analysis such as to see the fit on an annual/quarterly basis is necessary in further discussion. The reason for the poor fit to middle-period Japanese longline CPUE when Taiwanese CPUE is included was also questioned but it was noted that the cause was not investigated. With regard to the use of both age and length selectivities, it was pointed out that the change of age selectivity should be more smooth, given that it should reflect biological information.

The prioritization among fleets with large catch was discussed and the authors noted that in order not to have too many parameters to estimate, they chose certain fleets to add model process and for historical EPO commercial fishery weighting analysis was used to focus more on to have recent trend accurately. In response, it was questioned if recent EPO commercial catch should be prioritized and the authors agreed that it needs to be explored.

With regard to Japanese longline size composition data, it was suggested to test time-varying selectivity for the fleet. It was also noted that the misfit of its early 2000 trend may be caused by selectivity change or misspecification of growth thus it could be addressed by a new growth curve.

3.1.2 Preliminary Population Dynamics Model for the 2016 Stock Assessment of Pacific Bluefin Tuna; presented by H. Fukuda (ISC/16/PBFWG-1/07)

The preliminary analysis of the population dynamics model for the 2016 assessment was presented. The authors explained their method to estimate the seasonal growth parameters using the stock assessment model. The authors also focused on the explanation about the setting of selectivity parameters in each fleet.

The seasonal growth, which was estimated using stock assessment model, showed rapid growth from beginnings of season 1 to ends of season 2, and slow growth from beginnings of season 3 to ends of season 4.

The preliminary assessment model could generally fit to the most of the data sources. The fits to the CPUEs are generally improved from the last stock assessment while some misfits are still observable (i.e. latest two years of the Taiwanese longline CPUE). The preliminary results generally showed that the trend of SSB is similar with that of the last stock assessment. The highest SSB occurred in early 1960’s and the second highest peak was in the mid-1990's. After that, the SSB is continuously declined until around 2010 and the SSB are leveling off thereafter. The recruitments were largely fluctuated throughout the estimation period.

**Discussion**

It was clarified by the author that time blocks were set for fleets with large sample size and the period was determined by the trend of size composition.

With regard to the initial F at the beginning of assessment, the WG noted that more flexibility is needed for the treatment of troll fleet because its initial F frequently hit the upper boundary. It was suggested that the impact on recent trend by different treatments of initial F should not be significant. However, it was also pointed out that, given that the current recovery target by WCPFC is set based on historical stock status, drastic change in historical data would be undesirable.

With regard to the proposed seasonal growth curve, it was pointed out that the method places heavy weights on age composition data. It was further suggested that conventional method to estimate growth based on length at age could be biased if there is a selectivity bias and a different approach to estimate age at length was suggested as an alternative. Another approach suggested was to apply time-varying growth curve. Regarding time-varying growth, it was pointed out that the size data for adult fish may not be clear enough to detect the change and that the data were available only after 2005.

As a possible indication of bias in growth estimation, a comparison of the size of dominant cohort and estimated size was presented, which indicated underestimate by the model. In response, it was pointed out that the data used to estimate the model largely came from dominant cohorts, thus the model should fit the observations of dominant cohorts, particularly after the revision using data reviewed based on the new aging manual.

The WG decided to discuss the growth model further in the model setting section.

3.1.3 Configurations of selectivity curve: learned from Japanese set net fleet; presented by S. Iwata (ISC/16/PBFWG-1/04)

The effectiveness of applying cubic spline, age selectivity and time block to length composition data for Japanese set net are considered. Cubic spline is powerful tool to fit the length composition data. But the difficulty of configuration gradually increases as increasing the number of nodes as well as optimal location of nodes for the Japanese set net. For the age selectivity, length composition data of Japanese set net concentrated about age 0 to 2. Therefore it is not effective to apply age selectivity to obtain good fit. For the time block, we found the period to incorporate time block appropriately by using the median values for annual combined length composition data. Authors summarized that the median values are helpful to decide time block period. Applying both dome-shaped selectivity and time block are effective approaches to obtaining good fit of the data by comparison with three methods. Furthermore, the median values for annual combined length composition data are useful to decide time block period.

**Discussion**

It was noted that Japan set net is a passive fishing gear and its capacity has been basically constant. The study indicated that an approach using cubic spline was very difficult to converge due to high correlation among parameters. An approach using constant gear selectivity and flexible age selectivity may work.

## 3.2. Model Setting

**Discussion**

The WG discussed various model setting based on the results of documents presented. With regard to the initial F, the WG agreed to see the impact of deleting the initial F on Fleet 6 (JPTroll). Other options could be to include initial F on other fleets or to set higher boundary for Fleet 6.

With regard to the treatment of the selectivity of Fleet 6 (JPTroll), the WG considered that the first option should be to use cubic spline to estimate size composition rather than splitting it into two fleets by season, given that it is an index fleet. It was emphasized that extraction of fish by the fleet should be correctly estimated given the magnitude of the fishery.

The WG also discussed the prioritization of fitting to size composition data among fleets. The WG generally agreed that fleets with abundance index or large catch in number should be prioritized. In that regard, fleets with abundance index (JPLL, TWLL, JPTroll), JP TPSJS and MXCOMM were considered to have high priority. USCOMM was also a dominant fishery in the past but it was considered not as important as fisheries currently catching PBF in a large number. However, it was also noted that a poor fit to USCOMM should not cause poor fits of CPUE and the WG considered it to be with medium priority. The WG also discussed sampling quality. Based on information provided by members, the WG agreed the priorities among fleets as Attachment 4.

The WG also discussed options for selectivity assumptions for each fleet. All fleets were given default setting and alternative setting(s). The WG agreed to first try the model based on the default settings and then revise the model by testing alternative approaches to improve the fit, starting from more important fleets.

The WG also reviewed the growth models which are constructed using several options. Conditional age-at-length approach was found to be difficult to have a reliable conclusion due to seasonal nature of PBF fisheries. Examination of age-specific variance of size was conducted and the results of age-specific CVs were provided, which were similar to those currently used in the assessment model. The WG agreed that the current approach on growth is not unreasonable and decided to use the new growth function and externally estimated age-specific CVs by the assessment model using the updated otolith information as a default for the assessment.

Based on above discussions, the WG constructed and evaluated a simple model ("prototype-1 model") as a starting point to see which fleets needed improvements. Based on the review of the results of prototype 1 model, several revisions were proposed and changes were made as fleet-by-fleet basis for important fleets by introducing options such as time-varying selectivity, time block, age-based selectivity, etc. Based on the those results, the WG decided to construct prototype-2 model that incorporated all the first improvements to see if the model can function properly when the independent improvements were combined.

In response to poor fit of the initial model to Taiwanese CPUE data in particular the terminal 2 years, SK. Chang presented CPUE indices for the northern fishing ground and southern fishing ground separately. The CPUE in the southern fishing ground showed slight increase in the terminal years while the one in the northern fishing ground showed a big jump in the terminal two years. It was also noted that southern fishing ground has been the main fishing ground for Taiwanese longliners, accounting for more than 75% of catch on average and that the size composition data before 2010 were only available for the landing from the southern fishing ground. Based on the information, the WG agreed to separate Taiwanese longline fleet into northern fleet and southern fleet assuming a dome-shaped selectivity for northern fleet and an asymptotic selectivity to southern fleet in the prototype-2 model and to examine the performance of the model to include and/or exclude two CPUE series.

The WG then evaluated the performance of prototype-2 model. The WG noted that the model fit has been improved and additional options for further improvements were discussed. A relatively poor fit of size composition data for Fleet 2 (JPSPPS) was investigated and the WG agreed to split the fleet to two fleets; season 2 fleet, when age-0 and 1 may be caught, and the fleet with rest of the seasons, when only age-0 fish is caught. Also, options to improve the fit to the size composition data of Fleet 6 (JPTroll) were discussed and it was suggested not to fit the size composition data for season 1, when the size of fish and catch amount is small. The WG members decided to try several options for this fleet.

M. Maunder then made a presentation about the growth in which he concluded that SD of length apparently fairly constant over ages and suggested to use a SD as a function of length rather than CVs as function of length as currently done. The WG also discussed possible causes of variance of growth such as seasonal growth, different birth date, different growth patterns among years, etc. but the WG considered that the actual variance could be the result of mix of many factors and it would be difficult to be accurately explained by a model. Nonetheless, the WG agreed to test an approach to use a constant SD for the length to see the effect. Other growth scenarios such as seasonal growth or two growth models for different birth date could be addressed by fine-tuned selectivities in the model but were considered to be future tasks.

The WG then evaluated the results of various options. Based on the trial results presented by K. Oshima and O. Sakai, the WG agreed to split Fleet 2 (JPSPPS) to season 2 fleet and the fleet with the rest of the seasons. With regard to Fleet 6 (JPTroll), it was noted that, even though the catch weight in season 1 is small, due to the small size of the fish in the season, the number of fish caught in season 1 accounts for about 30% of total catch and that losing the information of such number is not desirable. Japanese scientists showed that the data used for CPUE standardization for Fleet 6 contain very few data from season 1, thus suggested to split season 1 from the fleet. The WG agreed to this approach and revised the model to incorporate those changes. In addition, the WG decided to test a time-varying selectivity for Fleet 1 (JPLL) after 2000 in order to see the effect of possible targeting to a large cohort.

The revised model with time-varying selectivity for JPLL exhibited a very good fit to the Japanese CPUE. However, the WG also noted the disadvantage of this approach by losing the information from the long lasting series of abundance from the fleet. After further discussions, the WG decided not to use time-varying selectivity for JPLL for the base-case model but test the approach in the sensitivity run. The WG also discussed the issue of the initial F. The WG concerned that the initial F for Fleet 6 (JPTroll) hit the boundary frequently. It was suggested to use initial F on Fleet 8 (JPSetnet Season 1-3) instead, which also has a very long history of operation. The WG agreed to test the approach.

### 3.3. Model Diagnostics and Results

**Discussion**

The WG reviewed the results of the 3rd generation model in detail. The group reviewed the fits to the data and residual patterns by season and also conducted diagnostic tests such as jitter, likelihood profile, and retrospective analyses. As the result of those analyses, the WG considered the updated model fit very well to all the abundance indices , which was not the case in the previous assessment, although some misfits to CPUE and size data were still observed. Among them the misfit to recent JPLL CPUE and misfit to size composition data of age-0 fish were considered most important and the WG hope to address them in the future assessments. Overall, the WG was satisfied with the performance of the model and agreed to use the model as the base-case to provide management advice for the current assessment. The detailed settings of the base-case model is provided in Attachment 4.

### 3.4. Sensitivity Runs

**Discussion**

In order to see the robustness of the base-case model, following sensitivity runs were conducted; alternative assumptions for natural mortality, growth, steepness of Beverton-Holt stock recruitment relationship, re-weighting of the composition data, and time-varying selectivity for JPLL.

Sensitivity runs with different natural mortality assumptions (10% increase/decrease from the base-case model for age 2 and older) showed that the base-case model is robust to different assumptions for natural mortality.

The results of sensitivity runs with re-weighting of size-composition data were evaluated. The WG considered that, although the approach could be informative, the specific method to implement the approach requires further study and discussion, including how to decide the level of re-weighting of the size-composition data.

The WG also examined the results of sensitivity analysis on lower steepness. The base-case model does not converge for lower steepness, indicating that the model is fine-tuned to explain data under current assumption of steepness. The WG considered the issue needs to be further investigated in future.

The results of placing time-varying selectivity for JPLL after 2000 were presented, showing a better fit to JPLL CPUE series. The WG noted this could be an alternative hypothesis and agreed to study further as a priority, taking the note of possible issues related to the approach raised in the discussions under agenda item 3.2. The age structure of terminal year for the base-case model and this sensitivity run were also compared and the WG noted difference between them. This could have impact on projection and the WG considered a projection of alternative run might be necessary in future.

The WG also reviewed the results of analyses using two different assumptions on variance of length at age. Both models indicated that different assumptions may improve the assessment and reaffirmed the WG's view that studying finer scale growth information is the highest priority task for the WG for coming intersessional work.

# 4. FUTURE PROJECTIONS

## 4.1. Future Projection Software

4.1.1 Update of a projection software to represent a stock-recruitment relationship using flexible assumptions; presented by K. Oshima (ISC/16/PBFWG-1/05)

The detailed description of the updated software for stochastic future projection was provided. The newly featured option allows the Beverton-Holt stock-recruitment relationship with arbitrary value of steepness (*h*) and estimated value of unfished recruitment ($R_0$) for conducting projections, which met the request from ISC-PBFWG in 2015. Furthermore, based on the 2014 stock assessment for PBF, projections under this option are demonstrated. It was found that smaller *h* leads to i) higher estimated value of $R_0$; ii) upward bias of recruitment in resampling of past deviances; iii) lower level of recruitment and slower rebuilding of SSB in the short terms; and iv) higher risk of decreasing in SSB below the historical lowest level. These conservative results in the short terms indicated that the usage of this option may be beneficial for considering a precautional approach targeted for the stock showing both a higher steepness and bad status.

**<u>Discussion</u>**

The WG noted that there is an inconsistency in the method which calculates the stock-recruitment curve for $h$=0.9, using the recruitment values calculated by a model which assumes $h$=0.999. However, the WG considered the method is sufficient to evaluate the risk of possible existence of a stronger stock-recruitment relationship. **The PBFWG agreed to use the stock-recruitment relationship using the proposed method as one of recruitment scenarios for projection.**

## 4.2. Projection Results

The PBFWG discussed the harvest as well as recruitment scenarios for the projection. With regard to the harvest scenarios, the WG agreed to add 20% reduction from the current CMMs' catch limits to the scenarios agreed at the WG meeting in November 2015, in case that the current scenarios might not provide a desired recovery. The WG further agreed to examine the effect of two options of moving the current threshold of the definition of small fish to age 4.0 and age 5.0[1]. The details of the harvest scenarios are summarized in the Attachment 5.

In terms of the recruitment scenarios, the WG discussed what would be the most appropriate periods to re-sample the recruitment value for the projection. Although the WG noted that the recruitment value would be more reliable since the 1980's, it was agreed that using the whole assessment period (1952-2014) as "historical average" and the 1980' (1980-1989) as "low recruitment period" as the previous assessment do not undermine the projection results and the WG decided to use the same approach. Given the large number of harvest scenarios, the WG decided to conduct projections by all the harvest scenarios for the low recruitment scenario. For other two recruitment scenarios (historical average and stock-recruitment relationship), selected harvest scenarios were examined for comparison. The WG noted that the projection will be conducted by starting from the current status of bootstrapped results and by resampling from the bootstrapped

[1] In the actual projection, 50kg and 80kg were used to approximate the weight of fish age-4.0 and age-5.0, respectively.

recruitment values.

## 5. DRAFT STOCK STATUS AND CONSERVATION ADVICE FOR PACIFIC BLUEFIN TUNA

After extensive discussions, the WG agreed to provide the following Stock Status and Conservation Advice for the discussion of ISC Plenary. The WG decided to separate WPO purse seine into those targeting small fish and the rest in the impact analysis.

**(Copied and pasted from Executive Summary)**

## 6. WORK PLAN AND RECOMMENDATIONS

The PBFWG discussed its future work plan. The WG considered that it would be appropriate to plan the next assessment in 3 years (2019) and in the meantime, the WG would review the catch and abundance indices prior to the annual ISC Plenary meetings. If the WG considers something unexpected is happening from such review, it will conduct an update assessment in the following year. Given the robustness of the new base-case model, annual update assessment using updated data seemes unnecessary.

With such understanding the WG proposes the following schedule for its future meetings:

- July 2016 – review of 2015 catch, Benchmark Stock Assessment presented to ISC16 Plenary
- July 2017 – conduct indices review and present results to ISC17 Plenary
- July 2018 – conduct indices review and present results to ISC18 Plenary
- Early 2019 – Benchmark Stock Assessment
- July 2019 – Benchmark Stock Assessment presented to ISC19 Plenary

In addition to the planned meetings, the WG may hold additional meetings to discuss priority research areas as identified under agenda item 7.1.

## 7. OTHER MATTERS

### 7.1. Research Priorities

The ISC Chair introduced that a domestic US meeting will be held with participants from academia, government scientists, and NGOs to discuss research priorities for PBF and these stakeholders seek for input from ISC members on the current research activities and research priorities to advance its assessment.

YR. An noted that Korea has been collecting PBF catch data opportunistically from 2004 and systematically since 2011. He further noted that they collect biological data such as otolith, stomach content, body length and weight since 2009 for about 2,000 fish, although the otoliths were not read for aging yet. In addition, 150 DNA samples have been collected for close-kin analysis. Larval survey was conducted in 2015 in possible spawning ground but no PBF larvae has been found so far. The Chair noted that the result of ISC aging WS can be provided if necessary since Korea did not participate the WS.

N. Suzuki reported the research activities by Japan. Japan has conducted research cruises, modeling for cruise data, stomach content analysis, tagging and close-kin analysis. With regard to research cruise results, it was noted that the sampling data suggest the increase of relative importance of the spawning grounds in the Sea of Japan recently compared with the 70-80'. As for close-kin analysis, although the ISC collaborative work plan requested Japan to obtain about 1,500 DNA samples annually from adult fish, the actual number of adult fish caught in spawning area and landed in Japan is about 700 in total annually thus the ISC request may not be achievable. The initial goal of research cruises was to locate spawning grounds accurately and now Japan is moving towards the second stage, which is to identify factors affecting survival rate of larvae. Estimating the rate and annual variance of proportion of fish making transpacific migration is also an important research topic. Further, proportion of contribution between two spawning grounds is important.

The ISC chair cautioned that tagging research will require a long term investment and it should be statistically designed. He further emphasized the importance of international collaboration in the EPO side given the trans-Pacific migration pattern of PBF. He is also interested in conducting micro chemistry analysis of otolith from Korean samples to determine the area where PBF were born.

SK. Chang reported that Taiwan will continue to collect size data and otoliths. They will enhance sampling to gather information on sex and improve CPUE estimation from CDS. DNA samples for close-kin analysis will be collected from about 1/3 of the total landing. However, DNA analysis in Taiwan is much more expensive than those in the U.S. and he is unclear if they can secure enough budget to conduct the analysis of all the samples. In addition, he further questioned who will conduct the close-kin analysis, supposing DNA analysis could be completed.

The ISC Chair reminded the WG that ISC members in July 2015 only agreed to collect samples for DNA analysis but not on how to analyze the samples and to use the results. However, it was pointed out that many members are having trouble securing resources to conduct DNA analysis and he is currently trying to work it out. It was also pointed out that any results need to go through PBF WG and best way to move the work forward might be to hold a WS to discuss close-kin analysis. Japanese experience such as efficient primers could be shared there.

The U.S. is putting its effort in developing spatial modeling and is supporting international WS for collaboration in that regard. As for future research, dramatic change of stomach content of PBF was noted recently, which may be the result of climate change or dramatic change in oceanic condition such as El Nino. Collection of fishery independent information as well as catch of recreational fisheries are important topics. They are interested in collaboration with countries in WPO to study about trans-Pacific migration.

M. Maunder noted that no research plan on PBF is established in IATTC. However, he noted that research priorities for PBF should base on the priorities of assessment, which in his view are; more efforts should be focused to investigate the cause of change in the trend of Japanese longline CPUE, possibility of geo-statistical model, improving estimates of growth, population structure, and migration.

M. Dreyfus noted that Mexico will continue to collect size composition data of its fleet.

In addition, samples for close-kin analysis will be collected through cooperation with industry and the financial resources to conduct the analysis are discussed. In case of yellowfin tuna, its recruitment forecasting is in progress noting the strong correlation of yellowfin recruitment to oceanographic conditions and a similar approach may be applicable to PBF.

The PBFWG agreed that research activities that improve the assessment should be most prioritized. In order to better estimate the catch at age in number, the improvement on the knowledge on growth is critical. To ensure the abundance indices properly reflect the true trend of abundance, the improvement of standardization methods of CPUE series, including geo-statistical model is important. After further discussions, the WG agreed its research priority as Attachment 6.

### 7.2. Other Matters

S. Iwata presented the results of trial runs incorporating CPUE of TPSJS (Fleet 4) (Kanaiwa et al., 2015; ISC/15/PBFWG-1/05) into the base-case model. He reported that the run which has incorporated CPUE of age-4 did not converge while that with age-5 did converge. The WG looks forward to further investigation to be reported in the future meetings.

## 8. ADOPTION OF THE REPORTS

The PBFWG reviewed, discussed and amended the draft Working Group meeting report prepared by the rapporteurs. The report was adopted by consensus.

The draft Assessment Report, which describes the assessment method and results in detail, will be prepared by compiling contributions from members by May 1 and will be distributed for review and be finalized by June 1. The draft Executive Summary of the Assessment Report, which was agreed by the PBFWG and subject to change based on the discussion at the ISC Plenary in July 2016, will be provided to IATTC before its SAC meeting. The draft Executive Summary will  be treated as a publically available document after it appears on IATTC website.

Meeting Report, Assessment Report and its Executive Summary need to be approved by the ISC Plenary to be finalized and become publically available as such.

## 9. ADJOUNMENT

The meeting was adjourned on 11 March 2016.

## 10. REFERENCES

Fukuda H., Uyama, H., and Oshima, K. 2015. A minor change in the estimation of length composition data of Japanese troll fisheries. Working paper submitted to the ISC PBF Working Group Meeting, 18-25 November 2015, Kaohsiung, Taiwan. ISC/15/PBFWG-2/03

Shimose, T., Tanabe, T., Chen, K.-S., and Hsu, C.-C. 2009. Age determination and growth of PBF, *Thunnus orientalis*, off Japan and Taiwan. Fish. Res. 100: 134-139.

Shimose, T. and Takeuchi, Y. 2012. Updated sex-specific growth parameters for PBF *Thunnus orientalis*. Working paper submitted to the ISC PBF Working Group Meeting, 31 January-7 February 2012, La Jolla, California, USA. ISC/12/PBFWG-1/12.

Kanaiwa, M., Yamamoto, A., Ishihara, Y., Tsuruoka, I., Oshima, K., Fukuda, H., and Takeuchi, Y. 2015. Estimation of annual stock indices for Pacific bluefin tuna using catch data at Sakai-minato Port. Working paper submitted to the ISC PBF Working Group Meeting, 20-24 April 2015, Shizuoka, Japan. ISC/15/PBFWG-1/05

## Attachment 1. Meeting Agenda

INTERNATIONAL SCIENTIFIC COMMITTEE FOR TUNA AND
TUNA-LIKE SPECIES IN THE NORTH PACIFIC OCEAN (ISC)

PACIFIC BLUEFIN TUNA WORKING GROUP
WORKING GROUP MEETING

February 29 – March 11, 2016

Southwest Fisheries Science Center, La Jolla, California, USA

1. Opening and Introduction
    1.1. Welcome and introduction
    1.2. Adoption of agenda
    1.3. Appointment of rapporteurs
2. Review of stock assessment input data
    2.1. Biological parameters and data for the stock assessment
    2.2. Fishery data for input of the stock assessment model
3. Model setting and results
    3.1. Confirmation of key model setting
    3.2. Model setting
    3.3. Model diagnostics and results
    3.4. Sensitivity runs
4. Future projections
    4.1. Software
    4.2. Projection results
5. Stock status and conservation advice for Pacific bluefin tuna
6. Work plan and recommendations
7. Other matters
    7.1. Research priorities
8. Adoption of the report
9. Adjournment

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**Attachment 3. List of Documents**

| No. | Title | Author | Contact | Publication |
|---|---|---|---|---|
| ISC/16/PBFWG-1/01 | Japanese coastal longline CPUE for Pacific bluefin tuna: Re-update up to 2014 fishing year for stock assessment | Osamu Sakai, Yuko Hiraoka, and Kazuhiro Oshima | sakaios@affrc.go.jp | Available when assessment is available |
| ISC/16/PBFWG-1/02 | Update of Standardized PBF CPUE Series for Taiwanese Longline Fishery | Shui-Kai Chang and Hung-I Liu | skchang@faculty.nsysu.edu.tw | Not Available |
| ISC/16/PBFWG-1/03 | Input data of Pacific bluefin tuna fisheries for stock assessment model, Stock Synthesis 3; Update for 2016 assessment | Osamu Sakai, Shuya Nakatsuka, Yukimasa Ishida, Kazuhiro Oshima, and Hiromu Fukuda | sakaios@affrc.go.jp | Available when assessment is available |
| ISC/16/PBFWG-1/04 | Configurations of selectivity curve: learned from Japanese set net fleet | Shigehide Iwata and Hiromu Fukuda | siwata0@kaiyodai.ac.jp | Available when assessment is available |
| ISC/16/PBFWG-1/05 | Update of a projection software to represent a stock-recruitment relationship using flexible assumptions | Tetsuya Akita, Isana Tsuruoka, and Hiromu Fukuda | akitatetsuya1981@affrc.go.jp | Available when assessment is available |
| ISC/16/PBFWG-1/06 | Development of a Pacific Bluefin Stock Assessment | H.H. Lee, K. Piner, M.Maunder, A. Aires-da-Silva | huihua.lee@noaa.gov | Available when assessment is available |
| ISC/16/PBFWG-1/07 | Preliminary Population Dynamics Model for the 2016 Stock Assessment of Pacific Bluefin Tuna | Hiromu Fukuda, Osamu Sakai, Tetsuya Akita, Isana Tsuruoka, Yaoki Tei, Shigehide Iwata, Kazuhiro Oshima | fukudahiromu@affrc.go.jp | Available when assessment is available |

**Attachment 4. Summary Table of Fleets Definition, Priority, Sampling Quality and Base-case settings.**

| Fleet | Name | Priority for fit to size data | Unit | sampling quality | index | Catch in Number | Base-Case Selectivity | Selectivity const/time-varying |
|---|---|---|---|---|---|---|---|---|
| 1 | F1JLL | High* | Length | Good | o | Low | Double normal | Constant |
| 2 | F2JSPPS (Season 1, 3-4) | Medium* | Length | Good | - | High | Length and Age | Constant |
| 3 | F3KOLPS | Medium** | Length | Fair (sampling has been conducted since 2004 opportunistically, systematically from 2010) | - | Med | Mirror Fleet 2 | Mirror Fleet 2 |
| 4 | F4TPSJS | High* | Length | Very Good | - | High | Length and Age | Time varying |
| 5 | F5TPSPO | Medium* | Length | Fair | - | High-historic | Length and Age | Time varying |
| 6 | F6JTroll (Season 2-4) | High* | Length | Good | o | High | Length | Constant |
| 7 | F7JPL | Low | Length | Bad | - | Historic | Mirror Fleet 6 | Mirror Fleet 6 |
| 8 | F8JSN (Season 1-3) | Low* | Length | Fair | - | Med | Length and Age | Constant |
| 9 | F9JSN (Season 4) | Low* | Length | Fair | - | Low | Length and Age | Constant |
| 10 | F10JSN (HK_AM) | Medium* | Weight | Good | - | Low | Length and Age | Constant |
| 11 | F11JOthers | Medium** | Weight | Good | - | Low | Mirror Fleet 10 | Mirror Fleet 10 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | F12TWLL 'S | High* | Length | Very Good | o | Low | Asymptotic | Constant |
| 13 | F13USCOMM (-2001) | Medium* | Length | Fair (many samples but not sure) | - | High-historic | Length and Age | Time varying |
| Fleet | Name | Priority for fit to size data | Unit | sampling quality | index | Catch in Number | Base-Case Selectivity | Selectivity const/time-varying |
| 14 | F14MEXCOMM (2002-) | High* | Length | Fair (improvement in the recent years due to the stereo-camera; after 2013 calendar year) | - | High | Length and Age | Time varying |
| 15 | F15EPOSports | Low | Catch in # | Fair (Good samples are available only for recent years) | - | Low | Mirror Fleet 13 | Mirror Fleet 13 |
| 16 | F16JTroll4Pen | - | Catch in # | Size comp data are not available while Catch in # of Age-0 fish are available | - | Med | Age-0 only | Constant |
| 17 | F12TWLL 'N | Low* | Length | Fair | - | Low | Length | Constant |
| 18 | F2JSPPS (Season 2) | Medium* | Length | Good | - | High | Length and Age | Time varying |
| 19 | F6JTroll (Season 1) | Medium* | Length | Good | - | High | Length | Constant |

* Fleets whose size data were fitted.
** The size data was combined with another Fleet and was fitted.

## Attachment 5. Harvest Scenarios for Projection

| Harvesting Scenario # | Fishing mortality | Catch limit | | Threshold of Small/Large | actual catch limit | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Japan | | Korea | | Taiwan | | EPO commercial | | EPO sports | |
| | | Small PBF | Large PBF | | Small PBF | Large PBF | Small PBF | Large PBF | Small PBF | Large PBF | Small PBF | Large PBF | Small PBF | Large PBF |
| Scenario1 | F2002-2004 | scenario 6 in 2014 assessment | | 30 kg | 4,007 | - | 718 | - | - | 1,700 | 2,750 | | - | - |
| Scenario2 | | 50% of 2002-2004 average catch for WPO fisheries, 3,300 tons for EPO commercial fisheries | 2002-2004 average catch | | 4,007 | 4,882 | 718 | - | - | 1,700 | 3,300 | | - | - |
| Scenario3 | | 50% of 2002-2004 average catch for WPO fisheries, 2,750 tons for EPO commercial fisheries | | 50 kg | 4,284 | 4,327 | 718 | - | - | 1,700 | 2,750 | | - | - |
| Scenario4 | | | | 80 kg | 4,590 | 3,718 | 718 | - | - | 1,700 | 2,750 | | - | - |
| Scenario5 | | 90% of scenario 2 | same as Scenario 2 | 30 kg | 3,606 | 4,882 | 646 | - | - | 1,700 | 2,193 | 863 | - | - |
| Scenario6 | | same as Scenario 2 | 90% of scenario 2 | | 4,007 | 4,385 | 718 | - | - | 1,530 | 2,437 | 777 | - | - |
| Scenario7 | | 90% of scenario 2 | | | 3,606 | 4,385 | 646 | - | - | 1,530 | 2,970 | | - | - |
| Scenario8 | | 80% of scenario 2 | same as Scenario 2 | | 3,206 | 4,882 | 574 | - | - | 1,700 | 1,950 | 863 | - | - |
| Scenario9 | | same as Scenario 2 | 80% of scenario 2 | | 4,007 | 3,906 | 718 | - | - | 1,360 | 2,437 | 690 | - | - |
| Scenario10 | | 80% of scenario 2 | | | 3,206 | 3,906 | 574 | - | - | 1,360 | 2,640 | | - | - |
| Scenario11 | F2011-2013 | same as Scenario 2 | same as Scenario 2 | | 4,007 | 4,882 | 718 | - | - | 1,700 | 3,300 | | - | - |

**Attachment 6. PBF WG Research Priorities**

| Item | Specific plan | Priority | Time frame |
|---|---|---|---|
| Stock-recruitment relationship | | high | short term |
| Population structure | Genetic population structure inferred from Close-Kin data | high | short term |
| Better understanding of fishery data | New CPUE indices for intermediate age between recruit and large adult | high | short term |
| | cause of change in the trend of Japanese longline CPUE with focus on geostatistical modeling | highest | short term |
| | Improve Taiwanese index with focus on spatio-temporal change | high | short term |
| | Improvements of recruitment index | high | short term |
| Independent estimate of spawning biomass | Close-kin genetics | high | longer term |
| Evaluation of growth to improve length frequency fitting | Seasonal timing, annual variation, regional and sex-specific change of growth | second highest | short term |