FINAL

**ISC/18/ANNEX/09**

# ANNEX 9

*18th Meeting of the*
*International Scientific Committee for Tuna*
*and Tuna-Like Species in the North Pacific Ocean*
*Yeosu, Republic of Korea*
*July 11-16, 2018*

# Report of the Pacific Bluefin Tuna Working Group Intersessional Workshop

**July 2018**

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**Annex 09**

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

*International Scientific Committee for Tuna and Tuna-Like Species In the North Pacific Ocean (ISC)*

**March 5-12, 2018**
Southwest Fisheries Science Center
La Jolla, California USA

## 1. OPENING AND INTRODUCTION

### 1.1. Welcome and Introduction

An intercessional workshop of the Pacific Bluefin Tuna Working Group (PBFWG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) was convened in La Jolla, California, USA, 5-12, March 2018. H. Nakano, the PBFWG Chair, welcomed the participants and opened the PBFWG meeting. He introduced the goals of the PBFWG meeting as to update the stock assessment and conduct projections according to the requests from the Western and Central Pacific Fisheries Commission (WCPFC) and the Inter-American Tropical Tuna Commission (IATTC).

G. DiNardo, the local host, welcomed PBFWG members and underscored the importance of the work of the PBFWG.

### 1.2. Adoption of agenda

The draft agenda was revised and adopted (Attachment 1). The list of participants is provided as Attachment 2. The list of documents is provided as Attachment 3.

### 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 3. (H. Fukuda); Item 4. (K. Piner); Item 5. (H.H. Lee), Item 6. (O. Sakai); Item 9. (S.K. Chang).

## 2. REVIEW THE HARVEST STRATEGY ADOPTED BY WCPFC

S. Nakatsuka introduced the Harvest Strategy adopted by the WCPFC at its annual meeting held in December 2017, which includes management objectives, reference points, acceptable levels of risk, monitoring strategy, decision rules, and performance evaluation of PBF (Appendix A of ISC/18/PBFWG-1/09 (WCPFC Harvest Strategy 2017-02 (https://www.wcpfc.int/doc/hs-2017-02/harvest-strategy-pacific-bluefin-tuna-fisheries)). He emphasized that the decision rule in the Harvest Strategy stipulates the expectation of the WCPFC and IATTC regarding what kind of advice to be provided from the current meeting when projection results show either higher or lower probability achieving the rebuilding targets than certain specified levels.

**Discussion**
It was reiterated that the Harvest Strategy is based on the recommendations from the WCPFC NC-IATTC Joint Working Group. It was confirmed that the PBFWG should do the best to respond to the requests from the WCPFC, and may ask for clarification from the WCPFC and IATTC if the request is unclear. It was also pointed out that the requested calculation of the second rebuilding target, 20%SSBF=0, which is based on "average recruitment conditions", is different from the R0 based calculation conducted in the ISC. The PBFWG noted the difference should be conveyed, although the actual impact on the result may not be substantial. While the Harvest Strategy was developed at the Joint WCPFC NC-IATTC meeting, it was pointed out that the IATTC may request for additional advice from the ISC.

## 3. REVIEW OF STOCK ASSESSMENT INPUT DATA

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

*Input data of Pacific bluefin tuna fisheries for stock assessment model, Stock Synthesis 3; Simple update for 2018 assessment; presented by O. Saki (ISC/18/PBFWG-1/06):*

O. Sakai presented updated input data of PBF fisheries for stock assessment, which was shared by the working group members in advance of the meeting. For the "simple update" of the stock assessment, quarterly catch, size frequency, and abundance indices (CPUE) were updated up to fishing year 2016 (up to June in 2017 calendar year). Estimation method and procedure of the size frequency and CPUE were exactly the same as used for the previous assessment. The presenters reviewed fleet structure which was assumed in previous assessment model (19 fleets) and described sharing of size composition data and/or mirroring of selectivity information by some fleets (e.g. Fleet 2 and 3, Fleet 10 and 11, etc.). In addition, it was mentioned that the fish size of some fleets' catch became bigger in recent years (e.g. Fleet 3 Korean PS, Fleet 14 Mexican PS, and Fleet 15 EPO sports fishery).

**Discussion**
It was noted that there appear some changes in the updated size composition data in recent years for Korean purse seine fleet and the US recreational fleet. Korea explained that no technological change is observed for the fleet and the fishing grounds remain the same. No information is available regarding fishing strategy. Korea further noted that observer coverage to monitor the size of landing was increased since 2015 to ensure wide coverage. It was also noted that the size of PBF in 2018 is also larger than previous (63cm -> 74cm in mean size). The cause of change in size is unclear. For the US recreational fleet, it was informed that fishermen report more larger fish in the fishing grounds in recent years. It was noted that fishermen would prefer to catch easy target, the most abundant group of fish. The PBFWG noted that the size information should continue to be monitored carefully and that the cause of any changes should be investigated. In future assessments the issue may need to be addressed if these changes in size persist. **The PBFWG endorsed the updated data.**

*Size composition of the PBF catch by Mexican purse seine vessels 2015-2017; presented by M. Dreyfus (ISC/18/PBFWG-1/05):*

PBF catch size-composition data for the 2015 to 2017 fishing seasons was prepared and send to be included in the PBF update assessment. Size data is based on length measurements taken from stereoscopic underwater cameras during pen transfer operations of live PBF. PBF average size increased from previous 2013 and 2014 fishing seasons from 103 cm and 104 cm, to 115 cm, 114 cm and 137 cm for the years 2015 to 2017, respectively. All fishing activities is concentrated in northern Baja California for logistics and economic reasons compared to fishing in the early stages of farming activities that was distributed all over the west coast of Baja California Peninsula.

**Discussion**

It was noted that all the farming companies are now cooperating for the monitoring and that the monitoring coverage of sets increased substantially from 25% in 2015. It was also noted that the sampling size ranges about 200 – 500 per set. It was questioned if the change in size is the result of targeting or change in availability. The author responded that it is difficult to confirm either but fishermen generally prefer to catch larger fish for economic reasons. However, it is also the case that they cannot wait for large fish too long as there is competition. It was noted that the first peak of the size composition would be age-3 fish. **The PBFWG agreed to use updated size information for the Mexican purse seine fleet.**

*Japanese coastal longline CPUE and catch-at-length for Pacific bluefin tuna: Update up to 2016 fishing year; presented by O. Sakai (ISC/18/PBFWG-1/01):*

O. Sakai presented updated Japanese coastal longline CPUE and catch-at-length from 1993-2016 (fishing year). The CPUE was standardized using the model which was used for the previous stock assessment in February 2016. In addition, “best model” was explored based on BIC as reference. In the standardization, the effect of target shift was addressed by the indicator from cluster analysis. The 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. Both CPUEs which were standardized by previous model and best model showed similar trend overall. Thus, the presenters considered not to be a problem using the previous model as “simple update”. The updated CPUE showed a consistent increase after 2011 fishing year. Catch-at-length indicated a new mode of smaller fish in the catch. The presenters concluded that these results are positive information for the adult stock population of PBF.

**Discussion**

The PBFWG underscored the cause of the change in the index in the past even using the same method; because of the clustering method used, the number of operations included in the analysis increased due to “at least one PBF catch for10 years” rule on the selection of grids and clustering results changed including the past by adding data from the recent period as well as from newly added grids. Although noting the benefit of having a formal policy on what should constitute

"update assessment" within the ISC, **the PBFWG agreed to use the updated CPUE series for the update assessment.**

*Standardized PBF CPUE Series and size frequency for Taiwanese longline fishery up to 2017 calendar year; presented by S.K. Chang (ISC/18/PBFWG-1/02):*

SK Chang reported an update of Taiwanese CPUE series. Same procedures as in ISC/16/PBFWG-1/02 (revised) and ISC/17/PBFWG-1/02 were used for reconstruction of catch and effort data and standardization of CPUE, with updates of 2015 and 2016 data and new addition of 2017 data. The CPUE were standardized separately by north and south fishing grounds using delta-generalized linear mix model (delta-GLMM). Standardized CPUE series for the south fishing ground is recommended for representing the abundance index of PBF in this region which showed similar trend as the previous work presented in the 2017 ISC PBFWG meeting. In general, the CPUE declined continuously from 2001 to 2012 and then started to increase since 2014. The PBF catch were all large size fish (>225 cm) in general, however the proportion of medium sized fish (<225 cm) increased since 2014 and was over 50% since 2015 in the southern fishing ground.

**Discussion**
A question was raised, given the difference in trend in CPUE in south vs north, if it might be prudent to include both indices in the assessment rather than using only one from the south. The author clarified that the fishing grounds in the north is relatively new, and operations there have not been consistent. Because of that, it was agreed not to use the index from the north in the previous assessment. It was also clarified that fishing gear is the same in the north and south grounds and no apparent change in the fishing areas in the south ground, suggesting the appearance of the smaller cohort is due to the change of availability rather than targeting. **The PBFWG agreed to use the updated CPUE from the south ground for the update assessment.**

*Updated standardized CPUE for 0 age Pacific Bluefin Tuna caught by Japanese troll fisheries: Updated up to 2016 fishing year; presented by Y. Tsukahara (ISC/18/PBFWG-1/03):*

To estimate the recruitment abundance index for Pacific bluefin tuna, Japanese troll CPUE in the East China Sea (coastal waters of western Kyusyu) was standardized for the period of 1980-2016 fishing year. Generalized liner model (GLM) with lognormal error distribution was applied for the standardization, which was exactly the same method as used for the previous stock assessment. The "best model" was exactly the same model as used in the previous assessment. The standardized CPUE of 2015 was larger than that of 2014 and the standardized CPUE of 2016 fishing year exceeded the historical average.

**Discussion**
It was clarified that the index uses the data covering the whole fishing year but main fishing season is from 2$^{nd}$ and 3$^{rd}$ quarter (Oct – March). **The PBFWG agreed to use the updated CPUE for the update assessment.**

## 4. MODEL SETTING AND RESULTS

### 4.1. Confirmation of key model setting from the 2016 base-case Model

*A preliminary population dynamics model for the 2018 updated stock assessment of Pacific bluefin tuna; presented by H. Fukuda (ISC/18/PBFWG-1/07):*

H. Fukuda presented the model setting of the 2016 assessment model as well as the preliminary model for the update assessment 2018. An annual time step length based, age-structured, forward simulation population model was implemented using Stock Synthesis Version 3.24f. The model assumes a single well-mixed stock for Pacific bluefin tuna (PBF), and does not consider a spatially explicated structure. The time period modeled in the updated assessment was 1952-2016 including the updated recent two fishing years (2015-2016). The model parameters of the population scale (e.g. virgin recruitment), stock recruitment offset, initial condition (e.g. initial F and recruitment deviation during 1942-1952), annual recruitment deviates (from 1953 to 2016), and time-varying/invariant selectivity parameters were estimated. Most of the biological and demographic assumptions were not changed from the 2016 stock assessment. For the fleets assuming time-varying selectivity (Fleets 4, 14, and 18), the last years of the selectivity parameter estimates were extended to the terminal year. The size selectivity parameter of Fleet 13 in 1956, which has been fixed at a given value in the previous assessment to avoid hitting to the lower boundary of the range of parameter estimates, was estimated in the update assessment since this parameter was estimable without hitting to the boundary given the current model.

**Discussion**

**The PBFWG endorsed the proposed model setting for the update assessment.**

### 4.2. Model diagnostics and results

H. Fukuda continued his presentation on the model diagnostics and assessment results. Most of the parameters were estimated well by the updated model and the assessment results did not drastically change from the previous assessment. The retrospective diagnostics and likelihood profile over the fixed population scale parameter suggested the model kept its internal consistency among most of the sources of data and assumptions, which has been confirmed in the previous assessment. The updated model fitted generally well to the size composition data although there were some misfits to the recent year's data. Those misfits were considered to be occurred by the un-modeled process such as variability in the migration patterns, the local availability/fishing activity, and/or the growth patterns. The model fits to the updated abundance indices were also generally well, although the root mean square error for a terminal longline index were higher than the previous assessment. The unfished SSB (SSB0) was estimated to be almost identical with the previous assessment. SSB estimates exhibited long term fluctuations, and in the most recent two years, SSB continued to show a tendency of slight increase which has been appeared since 2011. The depletion ratio (SSB/SSB0) of the terminal year (2016) corresponded 3.3%. The recruitment estimates were almost identical with the previous assessment. The recent two years (2015 and 2016) of the recruitments were lower and higher than the estimated unfished recruitment, respectively. A proposal was made to combine the two examples of the Kobe plot shown in the previous assessment report into a single plot.

**Discussion**
The PBFWG inquired as to what new information caused the change in SSB0 in the update model relative to the previous benchmark. The author noted that the differences were minor, with update model estimates of abundance slightly higher that previous benchmark in the dynamic period since 1952 but slightly less in the unfished. The authors further clarified that this change was likely from the changes in the updated TWNLL and JPNLL CPUE estimates resulting from the addition of new data in the filtering and standardization methods.

A small retrospective pattern in SSB was noted in the updated model. This pattern was discussed and it was concluded that it was the result of the retrospective period covering a population inflection period. Removal of the most recent years provided the model with no information on the recent period of increasing biomass and this caused the small retrospective bias in biomass. The PBFWG concluded this was not indicative of significant model misspecification.

The PBFWG discussed the influence of the recruitment penalty in the R0 profile. It was noted that the penalty provides significant information on the low side of LNR0 as displayed by the R0 profile. It was also noted that the penalty on the offset of unfished recruitment also contributes to the total likelihood. It was suggested that in future reports this influence be better documented, including the relative contributions of the R1 offset and recruitment deviation to the total likelihood.

**The PBFWG accepted the updated results as sufficient for use in determining stock status and updating projections. The PBFWG further recommended that these updated results provide a better measure of the current status and future stock trends than results from previous assessments.**

A proposed version of the Kobe plot that depicts the WCPFC rebuilding targets and associated spawning potential ratio measures of fishing intensity was discussed. The PBFWG supported the idea of using spawning potential ratio to describe fishing intensity as the group considered it is a better approach than using F (fishing mortality), which is difficult to compare when selectivity changes. The PBFWG also noted that using spawning potential ratio is a general trend in ISC to represent fishing intensity. It was suggested that the PBFWG should indicate that spawning potential ratio was used as a proxy of F. The PBFWG agreed that this depiction of the Kobe plot, whose construction is basically the same as one of the previous version, could replace the multiple Kobe plots used in previous assessment reports.

## 5. FUTURE PROJECTIONS

### 5.1. Confirmation of Software
*On the latest updates of R package "ssfuturePBF" and the representation of the stock assessment results; presented by S. Nakayama (ISC/18/PBFWG-1/08):*

S. Nakayama introduced the latest updates of "ssfuturePBF" program. Two updates were added to ssfuturePBF, the R package for future projections of Pacific bluefin tuna stock. These updates

enabled to; (1) introduce arbitrary amount of recruitment; and (2) introduce arbitrary age-specific fishing coefficient by the exploitation of a certain fleet.

**Discussion**
The PBFWG was reiterated for the reasons why these new functions for ssfuturePBF were requested previously; In the previous meeting, it was considered that these functions might be needed to evaluate situations where an unprecedented, in particular low, recruitment occurs or a fleet changes its selectivity from its historical pattern. The new functions can be used in the projection in this meeting if deemed necessary.

The PBFWG acknowledged the development of Kobe plot of future trajectory. The group considered it a useful tool to present projection results and suggested to present it in the projection section. The PBFWG considered that it would be useful to have impact plots of future projection.

**5.2. Projection results**
*Future Projection with requests from WCPFC-IATTC joint working group; presented by H. Fukuda (oral presentation only):*

H. Fukuda presented the model specifications for the future projection such as the demographic assumptions, future recruitment, rebuilding targets, harvesting scenario, and evaluation criteria. Two rebuilding targets of the SSB med (1952-2014) and 20%$SSB_{F=0}$ were defined based on the WCPFC CMM which was prepared by the WCPFC-NC and IATTC joint working group. The future recruitment during the initial rebuilding period, which was the initial condition of the projection until the stock meets the initial rebuilding were specified to be low recruitment (random resampling from the low recruitment period; 1980-1989). Those for the second rebuilding period (from the next year of the stock achieving initial rebuilding target until to the stock achieves second rebuilding target), the future recruitment were assumed to be similar with the whole of the assessment period (resampled from the whole recruitment period). The author suggested that if the ISC provided relevant information about the possible increase of the catch limit according to the CMM of WCPFC by future projection analysis, projection scenario for that might need to be specified as “catch control scenario” not the “catch and effort control scenario” to see the effect of catch limit increase adequately.

**Discussion**
The PBFWG discussed about the harvest scenarios of projection based on the proposal from H. Fukuda. The projection program (ssfuture PBF) can simulate the future harvesting using fishing mortality (F) and catch limit. According to the CMMs of WCPFC, the harvesting is controlled based on the fishing mortality in 2002-2004 to reflect the effort management and catch limit for small and large sized fish (i.e. <30kg or ≥30kg) for the fisheries in western Pacific. Because there is no resolution for effort management in IATTC, the harvesting by eastern Pacific fisheries is simulated by F2002-04 x2 to reach their catch limit. For the simulation of future recruitment, “low recruitment” scenario (resample from 1980-89 recruitment) is used until the spawning stock biomass is achieved to the initial rebuilding target, then “average recruitment” is used from the following year (resample from whole historical recruitment) according to the instruction from WCPFC-NC and IATTC joint meeting. The PBFWG was informed that

Japanese WCPFC Commissioner notified the PBFWG Chair that Japan will continue the transfer of 250 t of the catch limit of small fish to large fish for 2017 to 2020. The PBFWG agreed to include the transfer into the future projection.

It was noted that, as WCPFC requested to use either the low recruitment scenario or recent 10 years' recruitment, whichever is lower for the projection against the initial rebuilding target, the PBFWG needs to inform WCPFC which situation applies. It was confirmed that low recruitment scenario is more precautionary than the recent 10-year recruitment. The PBFWG suggested to provide the projected year when the SSB reaches the initial rebuilding target in the result. It was also pointed out that the probability of achieving the initial rebuilding target under the low recruitment scenario needs to be confirmed to surpass 70% for all the scenarios. The PBFWG also discussed the risk level used in the initial rebuilding target. The 60 percent probability allows more uncertainty in projection than the 50 percent probability.

Some considered that arbitral change of recruitment from low recruitment to historical average in the following year of achieving the initial rebuilding target is not scientific. It was also pointed out that it is unrealistic to assume the same measures to remain until the 2nd rebuilding target being achieved when assessments will be conducted periodically and the measures will be modified accordingly. The PBFWG was of the view that historical average recruitment will be most appropriate to be used for evaluating the probability to achieve 2nd rebuilding target. However, the PBFWG agreed to use the recruitment scenario as prescribed by WCPFC Harvest Strategy for projection, that is low recruitment scenario until the first rebuilding target being achieved and historical average recruitment from the following year.

The PBFWG prepared the scenarios of 5, 10, and 15% increase of catch limit for all fisheries, except for EPO sports fishery. It was advised that there is "bag limit" domestic regulation for US sports fishery, but the PBFWG didn't have best way to address it for projection because of the difficulty to set explicit catch limit. Therefore, the PBFWG continued the previous projection setting (using F2009-2011) to simulate the harvesting by EPO sports fishery.

Some PBFWG members requested to evaluate the impact by the increase of catch limit for small and large sized fish separately. For that reason, the PBFWG divided their catch limit into that of small and large sized fish for Korea and Mexico fleets using their catch ratio in 2014-2016 based on the quarterly catch-at-age and weight-at-age form base-case assessment results: the catch ratio which was applied was 50:50 and 70:30 (small: large) for Mexican PS fishery and Korean fishery, respectively.

## 6. STOCK STATUS AND CONSERVATION ADVICE FOR PACIFIC BLUEFIN TUNA

*Preparation of draft stock status and management recommendation*

The PBFWG discussed the structure of the draft of executive summary of assessment report. According to the "draft template" which was proposed by US in ISC17, it was pointed out that major changes to the data and model structure for last assessment should be highlighted at very first part of summary by separate paragraph.

The PBFWG considered that given the difficulty of comparing fishing mortality (F) among years when selectivity changes, it was more appropriate to use spawning potential ratio (SPR) as a measure of fishing intensity rather than F. It was also noted that using SPR is becoming a standard approach in ISC WGs. In this assessment, it was agreed that the value of SPR was used as proxy of F to indicate fishing intensity. Therefore, the table of relative values of F-based reference points was replaced by the table based on the rebuilding targets and corresponding SPR values. In addition, the Kobe plot was also replaced by new one which was based on SPR value (Y-axis) and relative biomass of rebuilding targets (X-axis). It was pointed out that there are no limit reference point and target reference point for PBF. Moreover, it was also pointed out the final rebuilding target after reaching second rebuilding target has not been agreed. Thus, the PBFWG agreed not to fill any colors in Kobe plot which indicate overfishing and overfished. It was noted that the MSY based reference point has not been used for PBF because of the difficulty to calculate due to steepness value.

Based on the discussion, the PBFWG prepared the draft stock status and management recommendation for the discussion at ISC18. The PBFWG also agreed to request ISC Chair to forward the draft Executive Summary to IATTC Scientific Advisory Committee held in May for information.

**(to be copied and pasted from Executive Summary)**

*Preparation of assessment report*

The PBFWG discussed about the structure of assessment report based on an oral presentation by H. Fukuda. In the presentation, it was noted that most part of the assessment report need not to be changed from the previous assessment report in 2016 although several components should be rewritten and highlighted especially for the new results and updated parts.

The PBFWG discussed the following ideas considering the implications of “simple update” from the experience in Billfish working group: 1) Updated parts should be highlighted in a way that a reader can understand what new information from the updated assessment is, 2) Additional section should be considered, if necessary, and 3) Model diagnostics and sensitivity tests (for M, steepness, selectivity, and re-weighting) should be included in the report to confirm whether the updated model worked well. It was also suggested to include the detailed information for projection, including one under F=0 scenario.

The PBFWG agreed to finalize the assessment report through correspondence in about a month and forward the final version to ISC18.

## 7. NEW SCIENTIFIC INFORMATION

*To evaluate recruitment indices using PBF as example; presented by HH. Lee (oral presentation only).*

H.H. Lee presented a summary of new study to evaluate recruitment indices of PBF. Reliable estimates of recruitment are important for recreating the population dynamics of exploited stocks. The 2016 stock assessment of Pacific bluefin tuna, *Thunnus orientalis*, (PBF) estimates that spawning biomass is currently near the lowest level observed in the last 50 years. Compounding the low abundance, an age-0 CPUE index derived from troll fisheries predicts recent recruitment to have fallen below the historical average. However, there is little additional information to confirm the recruitment estimates. The high fishing mortality over the last 20 years has produced catches that have impacted stock trajectories as measured by the adult indices of abundance. This connection between catch and indices allows for determination of the presence of relationship among catch, stock trends, and the shape of the production function. We expanded the existing connection using an age-structured production model diagnostic to evaluate alternative fishery-dependent indices of abundance for age-0 recruits. The age-0 index that is consistent with other data types is considered to provide information on the process variability in the existing production function. The results showed that adding recruitment indicated by the age-0 index from the western side of Japan in the analysis refined the production relationship (scales, population trends, and the shape of production function); however, the relationship was degraded by adding recruitment indicated by the age-0 index from the western side of Japan. The consistency of the western age-0 index provided indirect evidence on validating the data and spatial aspects of the basis biology of PBF recruitment.

**Discussion**

It was noted that the results indicate the production relationship matches better with the age-0 troll CPUE from the western side of Japan which is currently used in assessment, rather than one from the eastern side. It was also noted that the misfit between model estimation and observation on the cohorts from 2000-2005 may be due to the targeting effect on large cohorts from those years. A question was raised if this method can be used to check the reliability of the most recent recruitment index. It was clarified that it cannot be used directly for such a purpose but the results show a strong connection between recruitment index and adult index thus demonstrate that the recruitment index can be used to predict recruitment. This is the case even when a recruitment is at a moderate level.

*CPUE standardization of Pacific bluefine tuna caught by Korean offshore large purse seine; presented by S.I.Lee (ISC/18/PBFWG-1/04):*

Pacific bluefin tuna, *Thunnus orientalis* (PBF) has been mostly caught by the Korean offshore large purse seine fishery (KOPS) in Korean waters. The main fishing ground of PBF of this fishery is around Jeju Island, however, it expands to the west to the Yellow Sea, north to coastal of Busan and east to the East Sea depending on PBF migration patterns by season. The catch in 2016 was 1,024 mt, which was higher than in 2015 and lower than in 2014. The CPUE standardization of PBF was conducted using Generalized Linear Model (GLM) to assess the proxy of the abundance index. The data used for the GLM were catch (in weight), effort (no. of hauls), PBF catch ratio, moon phase by year, quarter and area. The standardized CPUE from

2004 to 2011, except for 2003 and 2010, showed a steady trend, and then increased until 2014. The CPUE in 2015 decreased, and in 2016 was higher than in 2015.

**Discussion**
It was clarified that all the size information was included for the analysis. It was questioned if the analysis can be done separately for small fish and large fish. The author responded that the size of target fish was not considered in the current analysis but can be done if information is available. Also, in response to a question author clarified that the main target of purse seine fleet is mackerel but they also catch PBF using the same fishing gear. A question was raised if good PBF catch is a result of targeting. Author responded at this stage he is unsure what is causing good PBF catch vs. poor catch.

The PBFWG noted that three new CPUE series (Korean purse seine, JPLL using new clustering (see Agenda 7), and Japan's recruitment monitoring (see Agenda 9.4)) were presented in the current meeting and their performance can be evaluated by conducting sensitivity test to compare expected values for these indices without fitting them in the assessment model. It may provide useful information for their further development. It was also noted that the assessment results and new analysis by H.H. Lee demonstrate a strong consistency among indices, thus that the PBFWG should be very critical for evaluating new indices to include into the assessment.

*Simultaneous estimation of target effect and abundance index from a multi-species catch dataset of Japanese coastal longliners; presented by A. Shibano (oral presentation only):*

A. Shibano presented an attempt to standardize target effect using finite mixture modeling for Japanese coastal longline CPUE. In the current standardization for this CPUE, the output of hierarchical clustering is used as the explanatory variable indicating target species. In comparison, this study applied finite mixture modeling as an alternative. The recent studies using finite mixture modeling for CPUE standardization reported that simultaneous estimation of target species and abundance index by this approach showed high performance of standardizing target effect. In the results, some improvements in the residual distribution were observed by finite mixture modeling. Yearly trends of standardized CPUE estimated by finite mixture modeling and current standardization method were similar, thus the presenter concluded that the current method would be able to treat target effect appropriately to some extent.

**Discussion**
No Discussion.

*Patchy distribution in a parasitic copepod Euryphorus brachypterus, inferred from its morphological variations between fishing grounds of Pacific bluefin tuna; presented by H. Katahira (ISC/18/PBFWG-1/11):*

To evaluate the usability of the parasitic copepod *Euryphorus brachypterus* as an indicator of local migration in Pacific bluefin tuna off the coast of Japan, body size of this parasite was compared between the hosts caught from main fishing grounds near Matsumae, Sakaiminato and Ishigaki Ports. As a remarkable result, size polymorphism was found in this survey. Body sizes in both male and female copepods were increased latitudinally from north to south; especially in

the southernmost area (i.e. Ishigaki), bimodal size distributions were found due to the presences of extremely large males and females. Although further verifications are needed, the present finding suggests a possibility that *E. brachypterus* has consisted of sub-populations representing patchy distribution with different body size despite the host's high mobility, and moreover that the body-size trait itself can be useful to discriminate migratory history of the preceding weeks in PBF.

**Discussion**
A question was raised how the difference in size of parasites can be considered as a result of the existence of subpopulation of the parasite rather than the result of different surrounding temperature, when the parasite is known to grow larger in warmer waters. The author responded that he considers that the bimodal structure of size distribution supports a hypothesis that these two groups have different biological characteristics. It was also clarified that the longevity of the parasite may be less than one month, so it may possess information regarding the recent past of the host. PBFWG members welcomed to cooperate with the author for the sampling and analysis of the parasite in respective countries.

## 8. WORK PLAN AND RECOMMENDATIONS

To fulfill the WCPFC and IATTC request, the PBFWG also discussed its work plan to prepare for the next stock assessment in 2020. In the past, the PBFWG updated and review indices in the year prior to a bench mark assessment. The PBFWG considered the Monitoring Strategy in the WCPFC Harvest Strategy, which refers to coping with drastic drop in recruitment to conduct projection in 2019. Given the positive information regarding the recent recruitment, the PBFWG agree to proceed as follows:

In 2019, the PBFWG will review the available indices to see if anything unexpected is happing. In addition, the PBFWG will discuss the possible areas of improvements towards the 2020 benchmark assessment. As the current model is internally consistent among data, the PBFWG does not expect a major overhaul of the assessment model in 2020. However, the PBFWG will need to review the standardization of indices, size-information, impact of the management measures, and any other model settings as necessary to add flexibility.

In early 2019 the PBFWG plans to hold the 2019 meeting possibly in Shimizu, Japan. The PBFWG will consider additional meeting in 2019 if needed for the 2020 benchmark assessment.

July PBFWG meeting (half-day) is expected to be chaired by the newly elected PBFWG Chair. Main goal is to update latest catch and review other new information. The report of the MSE Workshop may be provided.

## 9. OTHER MATTERS

### 9.1. Research priorities

The PBFWG discussed its research priorities. It was noted that research related to improvement of the assessment model and other biological research should be included. It was also noted that research priorities should have clear timeline, and the PBFWG should identify those responsible for completing task.

A preliminary result of evaluation of Japan's recruitment monitoring index was presented. It demonstrated that a model, which was not fit to any recruitment index, showed a fairly good fit to the recruitment monitoring index from the western side of Japan. The PBFWG considered it a useful exercise and included a further evaluation in the research priority table.

The progress on close-kin research, which has been undertaken by PBFWG members, was discussed. Japan reported that they continue sampling at landing ports and are developing a software to estimate absolute biomass using close-kin information. It was noted that US intends to convene a workshop this year involving scientists from ISC member countries and outside experts to develop protocols for processing tissue samples and the strategy to complete the task.

After further discussion, the PBFWG adopted its research priority as Attachment 4.

**9.2. Preparation for Management Strategy Evaluation Workshop**
*Planning of PBF MSE Workshop; presented by S. Nakatsuka (ISC/18/PBFWG-1/09):*

During the 13th Meeting of the WCPFC-Northern Committee (WCPFC-NC) in August 2017 the ISC agreed to initiate development of a management strategy evaluation (MSE) for Pacific Bluefin tuna (PBF) in 2019 with the goal of completing it by 2024. To support development of the MSE the WCPFC-NC agreed to provide 1) funding to ISC for two MSE experts if possible, 2) target and limit biological reference points, and a harvest control rule (HCR) by 2019. Furthermore, without the requested funds to hire the experts and information (reference points and HCR), ISC would not engage in the MSE process for PBF. To initiate the PBF MSE process, the ISC also agreed to host a workshop in 2018. This document summarizes past activities considered germane to developing a PBF MSE and future plans agreed to by ISC and WCPFC.

**Discussion**
It was questioned whose responsibility PBF MSE will become. It was clarified that in the case of North Pacific albacore, the ALBWG takes the responsibility. However, the MSE is primarily conducted by a designated person who was newly recruited to the group. Although the PBFWG recognized the need to become more involved in MSE, current resources are limited and completing the task will require two new MSE experts.

It was noted that MSE work involves scientific aspects as well as managerial aspects. Scientific aspects are relatively manageable if appropriate experts were identified for the coding of necessary programme. However, gathering the necessary information from stakeholders is expected to be time-consuming. G. DiNardo has been identified to chair the May 2018 MSE Workshop in Yokohama Japan and will remind the WCPFC-NC of their responsibility to provide funds to secure additional experts for MSE development and provide necessary input information such as selecting candidate limit reference points (LRPs) and harvest control rules (HCRs).

However, it was also emphasized that ISC should not postpone even though the apparent increases in 2016 recruitment.

The PBFWG considered that it may be possible to form a some sort of "core group" for technical work of MSE from some of its members for the time being. For example, H.H. Lee may be able to construct a preliminary programme for MSE by expanding the current assessment model. Also, it may be more efficient to collaborate with other MSE projects such as for northern albacore in the ISC or IATTC bigeye. However, it was also noted that given the very complex nature of PBF fisheries and management, MSE based on the current assessment model may not be sufficiently sophisticated to reflect managerial needs. It was also noted that the primal responsibility of the PBFWG is to conduct assessments in a responsible manner and that conducting MSE without additional resources may jeopardize the current two year assessment interval plan.

It was also considered important to have a leader of MSE work in the PBFWG. Technical core group would not be sufficient to move the demanding MSE process. The PBFWG further discussed how and when to start MSE related work. It was agreed to wait for further input from the WCPFC and IATTC after the May Workshop and following discussions in Commission meetings. **The PBFWG endorsed the proposed agenda to be on ISC website for public announcement (attachment 5).**

**9.3. Election of new Chair**

Alex Aires-da-Silva of IATTC was elected to be the new Chair of the PBFWG. Shuya Nakatsuka will continue to serve as Vice Chair.

**9.4. Other**

*Real-time recruitment monitoring for Pacific bluefin tuna using CPUE for troll vessels; presented by Y. Tsukahara (ISC/18/PBFWG-1/12):*

Japan is conducting a real-time monitoring of the CPUE from troll fisheries for strengthening the recruitment monitoring to comprehend the trend of most recent recruitment of Pacific bluefin tuna in a timely manner. The operation and catch information are recorded by data logger equipped on fishermen's boats participating the survey. These data are sent to the National Research Institute of Far Seas Fisheries (NRIFSF) on a real-time basis. The catch data per day by each boat were used as nominal CPUE and those were standardized for two regions harvesting recruits from the two spawning grounds, respectively. The both results of standardization show the levels of recruitment in 2017 were above those in 2016. These results were published on the Japan Fisheries Agency's web-site.

**Discussion**

It was noted that due to management measures and/or limited demand for farming, fishing seasons for recruits are becoming shorter particularly from 2017 and Japanese scientists are concerned that recruitment indices may become more uncertain. The PBFWG discussed what recommendation can be drawn from the information provided in the document. It was clarified that no detailed analysis of the performance of these indices to predict recruitment had yet to be performed partly because of the shortness of the time series to date but it was pointed out that as

the current assessment adds two more years that can be compared and that sensitivity analysis can be conducted to evaluate its performance as recruitment indicator (see also 9.1).

*Reference points*
The PBFWG was reminded that ISC17 suggested the PBFWG to review the list of candidate reference points prepared in 2010. It was noted that currently two rebuilding targets have been adopted by both Commissions and the PBFWG can evaluate management actions against those targets. Although it was noted that the PBFWG can provide further information on other candidate reference points, this work will need to be considered with the current workload in the PBFWG.

*Reporting of assessment results*
The assessment results will be presented at the IATTC SAC (May, La Jolla) by H. Fukuda, MSE Workshop (May, Yokohama Japan) by S. Nakatsuka, ISC18 (July, Korea) by H. Fukuda or S. Nakatsuka, WCPFC SC (August, Busan) by the new Chair (to be confirmed in the ISC18 meeting), WCPFC NC (September, Japan) by the new Chair (to be confirmed in the ISC18 meeting), and possibly in WCPFC15 (December, Federated States of Micronesia).

## 10. ADOPTION OF REPORT

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

**ATTACHMENT 1. AGENDA**

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

PACIFIC BLUEFIN TUNA WORKING GROUP
INTERSESSIONAL WORKSHOP
March 5-12, 2008
La Jolla, CA

Agenda

1. Opening and Introduction
    - 1.1. Welcome and introduction
    - 1.2. Adoption of agenda
    - 1.3. Appointment of rapporteurs

2. Review the harvest strategy adopted by WCPFC

3. Review of stock assessment input data
    - 3.1. Fishery data for input of the stock assessment model

4. Model setting and results
    - 4.1. Confirmation of key model setting from the 2016 base-case Model
    - 4.2. Model diagnostics and results

5. Future projections
    - 5.1. Confirmation of Software
    - 5.2. Projection results

6. Stock status and conservation advice for Pacific bluefin tuna

7. New scientific information

8. Work plan and recommendations

9. Other matters
    - 9.1. Research priorities
    - 9.2. Preparation for Management Strategy Evaluation Workshop
    - 9.3. Election of new Chair
    - 9.4. Other

10. Adoption of the report

11. Adjournment

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## ATTACHMENT 3. LIST OF DOCUMENTS

### 3.1 Working Papers

| Index | Agenda | Title | Author | Contact | Website availability |
|---|---|---|---|---|---|
| ISC/18/PBFWG-1/01 | 3.1 | Japanese coastal longline CPUE and catch-at-length for Pacific bluefin tuna: Update up to 2016 fishing year | O. Sakai and Y. Tsukahara | sakaios@affrc.go.jp | yes |
| ISC/18/PBFWG-1/02 | 3.1 | Standardized PBF CPUE Series and size frequency for Taiwanese longline fishery up to 2017 calendar year | S. K. Chang and H. I Liu | skchang@faculty.nsysu.edu.tw | yes |
| ISC/18/PBFWG-1/03 | 3.1 | Updated standardized CPUE for 0 age Pacific Bluefin Tuna caught by Japanese troll fisheries: Updated up to 2016 fishing year | Y. Fukuda, Y. Tsukahara, and O. Sakai | yoshif@affrc.go.jp | yes |
| ISC/18/PBFWG-1/04 | 7 | CPUE standardization of Pacific bluefine tuna caught by Korean offshore large purse seine | S.I. Lee, D.N. Kim and M.K. Lee | k.sungillee@gmail.com | yes |
| ISC/18/PBFWG-1/05 | 3.1 | Size composition of the PBF catch by mexican purse seine vessels 2015-2017 | Michel Dreyfus Leon | dreyfus@cicese.mx | yes |
| ISC/18/PBFWG-1/06 | 3.1 | Input data of Pacific bluefin tuna fisheries for stock assessment model, Stock Synthesis 3; Simple update for 2018 assessment | O. Sakai, K. Nishikawa, H. Fukuda, and S. Nakatsuka | sakaios@affrc.go.jp | yes |
| ISC/18/PBFWG-1/07 | 4.2 | A preliminary population dynamics model for the 2018 updated stock assessment of Pacific bluefin tuna | H. Fukuda, O. Sakai | fukudahiromu@fra.affrc.go.jp | yes |
| ISC/18/PBFWG-1/08 | 5.1 | On the latest updates of R package ossfuturePBF”sfuturePBFst updates of R package odel for the 2018 upda | S. Nakayama, T. Akita, H. Fukuda, S. Nakatuka | shinichironak@affrc.go.jp | yes |
| ISC/18/PBFWG-1/09 | 2 and 9.2 | Planning of PBF MSE Workshop | S. Nakatsuka and G DiNardo | snakatsuka@affrc.go.jp | yes |
| ISC/18/PBFWG-1/10 | | Withdrawn | | | |
| ISC/18/PBFWG-1/11 | 7 | Patchy distribution in a parasitic copepod *Euryphorus brachypterus*, inferred from its morphological variations between fishing grounds of Pacific bluefin tuna. | H. Katahira, K. Ito, M. Kanaiwa and N. Suzuki | paraparaparasites@gmail.com | no |
| ISC/18/PBFWG-1/12 | 7 | Real-time recruitment monitoring for Pacific bluefin tuna using CPUE for troll vessels | Y. Tsukahara, O. Sakai, K. Oshima and S. Nakatsuka | tsukahara_y@affrc.go.jp | yes |

**ATTACHMENT 4: PBF WG Research Priorities**

| Item | Specific plan | Priority | Time frame |
|---|---|---|---|
| Stock-recruitment relationship | | high | Long term |
| Recruitment index review | Evaluate performance of existing index as well as recruitment monitoring index. | high | By next assessment |
| Evaluation of contribution from two spawning grounds | Cohort based analysis of annual contribution from two fishing grounds | high | Long term |
| Catch information of China | WG Chair to contact China<br>Check Japanese import data | high | short term |
| Population structure | Genetic population structure inferred from Close-Kin data | high | long term |
| Better understanding of fishery data | New CPUE indices for intermediate age between recruit and large adult | high | long term |
| | cause of change in the trend of Japanese longline CPUE with focus on geostatistical modeling | highest | by next assessment |
| | Improve Taiwanese index with focus on spatio-temporal change | high | short term |
| | Investigation of CUPE related size information | high | By next assessment |
| Independent estimate of spawning biomass | Close-kin genetics | high | longer term |
| MSE | WCPFC requested complete by 2024.<br>Review published MSE studies on PBF.<br>Wait for further instruction from Commissions. | high | Long term |

| | | | |
|---|---|---|---|
| Evaluation of growth to improve length frequency fitting | Seasonal timing, annual variation, regional and sex-specific change of growth | second highest | by next assessment |
| Reference points | | high | Short term |
| Monitoring of fisheries | Investigate impact of regulation on fishery dependent data. | high | forever |

**ATTACHMNET 5**

# Pacific Bluefin Tuna
# Management Strategy Evaluation Workshop

***Queens Forum, Queens Tower B 7th Floor (in Queen's Square)***
***Yokohama, Japan***

***May 30-31, 2018***

**May 30, 2018（10:00 am – 5:00 pm）**

**Registration (10:00-10:30) – Coffee Service**

1. Welcome-Japan (10 minutes) – 10:30–10:45

2. Opening Remarks – G. DiNardo (10 minutes) - 10:45-10:55

3. Review and Adoption of Agenda – G. DiNardo (5 minutes) – 10:55-11:00

4. MSE Presentations
   a. Management Strategy Evaluation – Realizing its Full Potential – G. DiNardo (60 minutes) – 11:00-12:00

**Lunch 12:00-1:30**

   b. MSE Application Case Studies – G. DiNardo (60 minutes) – 1:30-2:30
   c. MSE Application to Pacific Bluefin Tuna: Requirements for Implementation – S. Nakatsuka (60 minutes) – 2:30-3:30

**Break 3:30-3:45 coffee service**

5. Towards Development of a Pacific Bluefin Tuna MSE - Open Discussion – Moderator: S Nakatsuka – (60 minutes) - 3:45-4:45

**Recap Summary 4:45-5:00**

**May 31, 2018（9:30 am – 2:00 pm）**

**Coffee Service – 9:30-10:00**

5. Towards Development of a Pacific Bluefin Tuna MSE - Open Discussion – Moderator: S Nakatsuka (60 minutes) – 10:00-11:00

6. Future Work Plan and Expectations- Moderator: G. DiNardo (30 minutes) – 11:00-11:30

7. Open Discussion – S. Nakatsuka and G. DiNardo (30 minutes) – 11:30-12:00

**Lunch 12:00-1:30**

8. Other matters: latest information about Pacific Bluefin Tuna (30 minutes) – 1:30-2:00

9. Closing remarks – G.DiNardo

**Adjourn**