FINAL

ISC/20/ANNEX/08

ANNEX 08

20th Meeting of the
International Scientific Committee for Tuna
and Tuna-Like Species in the North Pacific Ocean
Held Virtually
July 15-20, 2020

REPORT OF THE PACIFIC BLUEFIN TUNA WORKING GROUP INTERSESSIONAL WORKSHOP

July 2020

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ANNEX 08

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 2-12, 2020
National Research Institute of Far Seas Fisheries, FRA
Shimizu, Japan

1. OPENING AND INTRODUCTION

1.1 Welcome and Introduction

S. Nakatsuka (Japan), Chair of the ISC Pacific bluefin tuna Working Group (PBFWG or WG), welcomed the participants from Japan, Korea, Mexico, Taiwan, the United States of America, and the Inter-American Tropical Tuna Commission (IATTC) and opened the meeting. The PBFWG has been tasked with completing a benchmark stock assessment of PBF in 2020 and the present meeting is the stock assessment meeting. The objectives of this meeting were 1) to complete a benchmark assessment and future projections, 2) to develop draft stock status and conservation information, and 3) to prepare responses to RFMOs. Due to the epidemic threat of the COVID-19 infection, the Chair of PBFWG and the host country (Japan) established an option for remote participation and all international participants opted for the remote option. The Chair of PBFWG acknowledged online attendance during a difficult time.

1.2 Adoption of Agenda

The adopted agenda is attached as Appendix 1 and a list of participants is provided in Appendix 2. A list of documents reviewed during the meeting is provided in Appendix 3.

1.3 Appointment of Rapporteurs

Rapporteurs were assigned by the Chair as follows: Item 2.1: Y. Tsukahara, Item 2.2: S.K. Chang, Items 3.1-3.3: M. Maunder, Item 3.4 and 3.5: K. Piner, Item 4: M. Dreyfus, Item 5: M. Miyagawa.

2. ASSUMPTION OF POPULATION DYNAMICS AND INPUT DATA

2.1 Review of Biological Assumptions for the Stock Assessment

H. Fukuda presented a summary of the basic structure and input of the biological assumptions for the new stock assessment model. Chair clarified that the PBFWG agreed not to change biological assumptions from the previous (2018) assessment in the November 2019 meeting. The WG agreed with the basic structure of the model as presented by H. Fukuda.

2.2 Fishery Data for Input of the Stock Assessment Model

2.2.1 Abundance Index

The WG reviewed updated abundance indices (Japan longline CPUE index, Japan troll CPUE index, and Taiwan longline index) to be included for the new assessment. Korean purse seine

CPUE index provided in the November 2019 meeting was included in the assessment data file to evaluate the consistency with the other data sources without fitting to the model. While several standardization methods (GLM, GLMM and spatio-temporal models) were present, **the WG noted that the CPUE index from the standardization methods used in the previous stock assessments should also be presented in future meetings for the purpose of comparison if standardization is changed.**

Standardized CPUE by spatiotemporal model for Pacific Bluefin tuna (Thunnus Orientalis) caught by Japanese coastal and offshore longline. *Presented by Y. Tsukahara (ISC/20/PBFWG-1/02)*

Y. Tsukahara presented results of standardized CPUE using spatiotemporal models for Japanese longline fisheries. The standardized CPUE was revised from the preliminary results, which were presented at the Nov. 2019 meeting. Major revisions were 1) to expand the criteria of removal of data in the suspension period in accordance with the factor of Day10, 2) to exclude the locations used for calculation where standard deviations were quite high. The index from spatio-temporal model showed a consistent trend with that predicted by the traditional GLM. The CPUE index continues to increase since 2012 (2011 fishing season).

Discussion

It was clarified that the standardization method was refined to treat data more appropriately based on the discussion in the November meeting. After reviewing an additional plot showing a comparison of the new series with the old one presented in 2019, **the WG agreed that the new series has better performance and was accepted to be used in the new stock assessment (Fig. 1).**

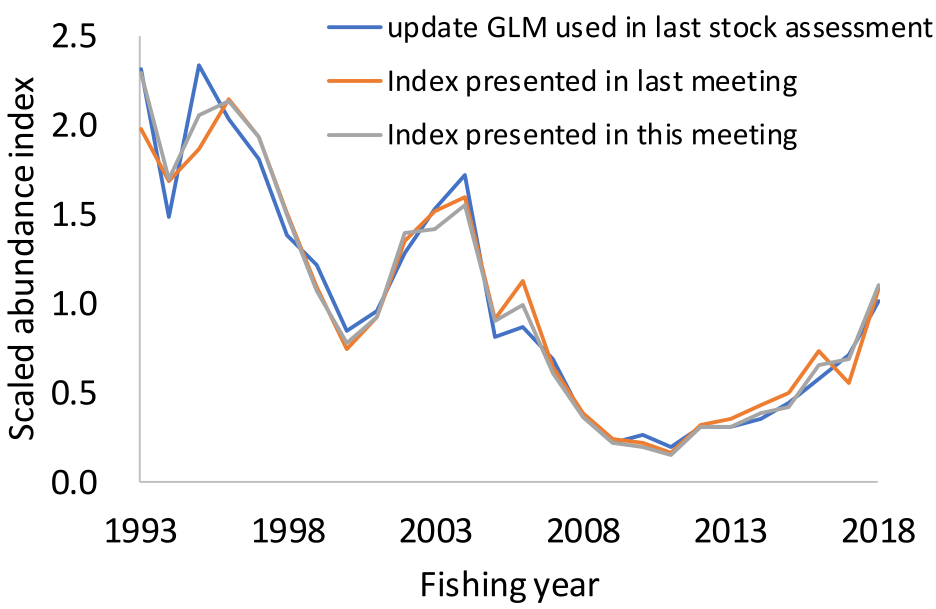


Fig. 1. Japanese CPUE indices presented. The index in grey line was included in the assessment.

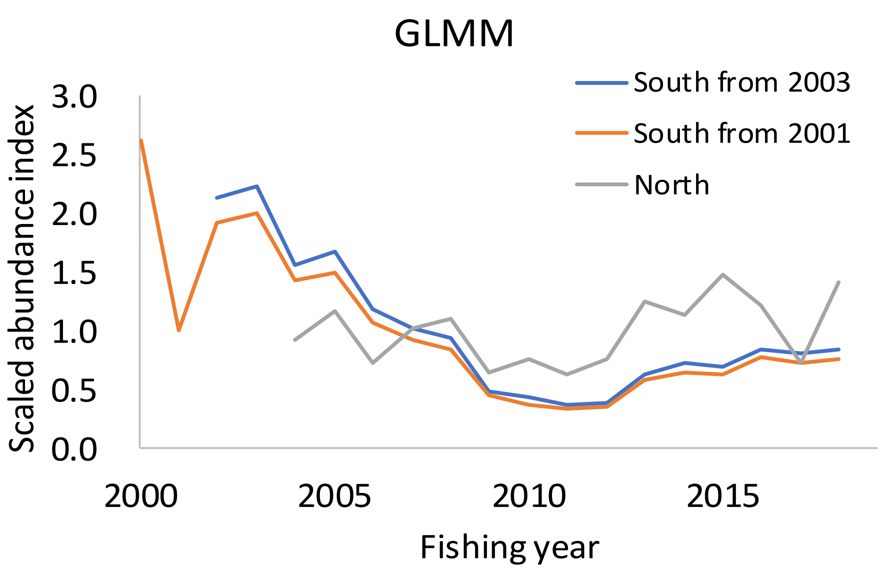
Abundance index of Taiwanese PBF fisheries based on traditional and spatiotemporal delta-generalized linear mixed models. ***Presented by S.K. Chang (ISC/20/PBFWG-1/03)***

Standardized CPUE series for Taiwanese longline fishery was presented. The major difference from previous work presented in the 2019 data preparation meeting was the update of the recent data (slightly updated 2018 data and added 2019 data). Four CPUE series including two from the non-spatial models and two from the spatiotemporal models were presented.

<u>Discussion</u>

The WG reviewed the requests from the 2019 data preparation meeting, which were (1) to provide the standardized series for the south area using the non-spatial model and to exclude less reliable data in 2001-2002; and (2) to provide the standardized series using the spatiotemporal model for the south area and north area separately and the CPUE from the north will not be included in the likelihood function used to fit the data in the assessment model. A question was raised regarding the variables used in the VAST standardization model for Taiwanese catch/effort data. It was responded that they were Year, Area (0.1-degree square), Vessel Id, and interaction of Year and Area.

After reviewing the results presented, **the WG agreed to adopt the new index for the south area from the non-spatial model on 2003-2019 data for the new stock assessment.** It also agreed to include additional four indices but excluding for the likelihood function in the assessment model, which were the new index for the north area from the non-spatial model on 2003-2019 and the three new indices for the north, south, and combined whole area from the spatiotemporal model on 2007-2019 data (Fig. 2).



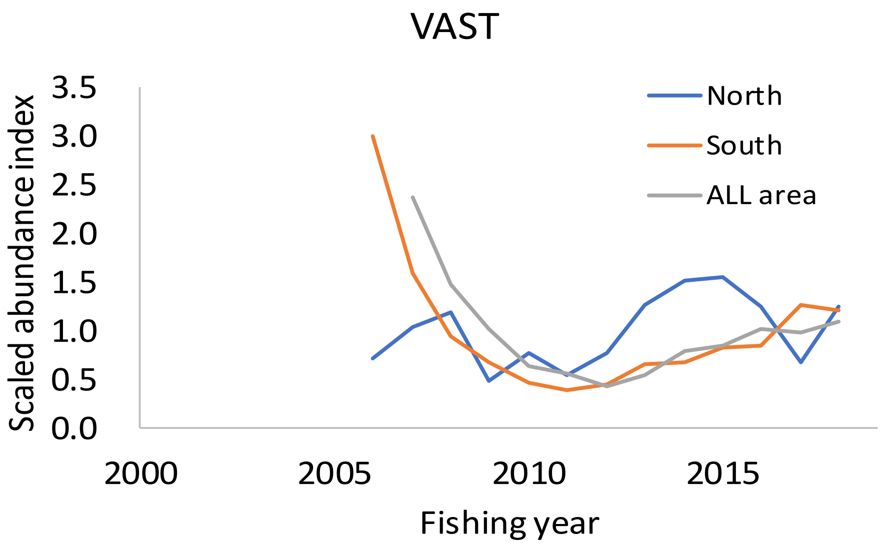


Fig. 2. Taiwanese CPUE indices presented in the meeting. Index from GLMM South from 2003 (blue line in the top panel) was included in the assessment.

Re-updated standardized CPUE for 0-age Pacific bluefin tuna caught by Japanese troll fisheries: Updated up to 2018 fishing year. ***Presented by K. Nishikawa (ISC/20/PBFWG-1/03)***

K. Nishikawa presented a document of CPUE standardization on Japanese troll fishery. It was updated to exclude the 2017 data due to incomplete data collection as agreed at the Nov. 2019 data preparatory meeting. **The WG agreed to adopt the result of the standardized series as the recruitment index for the new stock assessment (Fig. 3).**

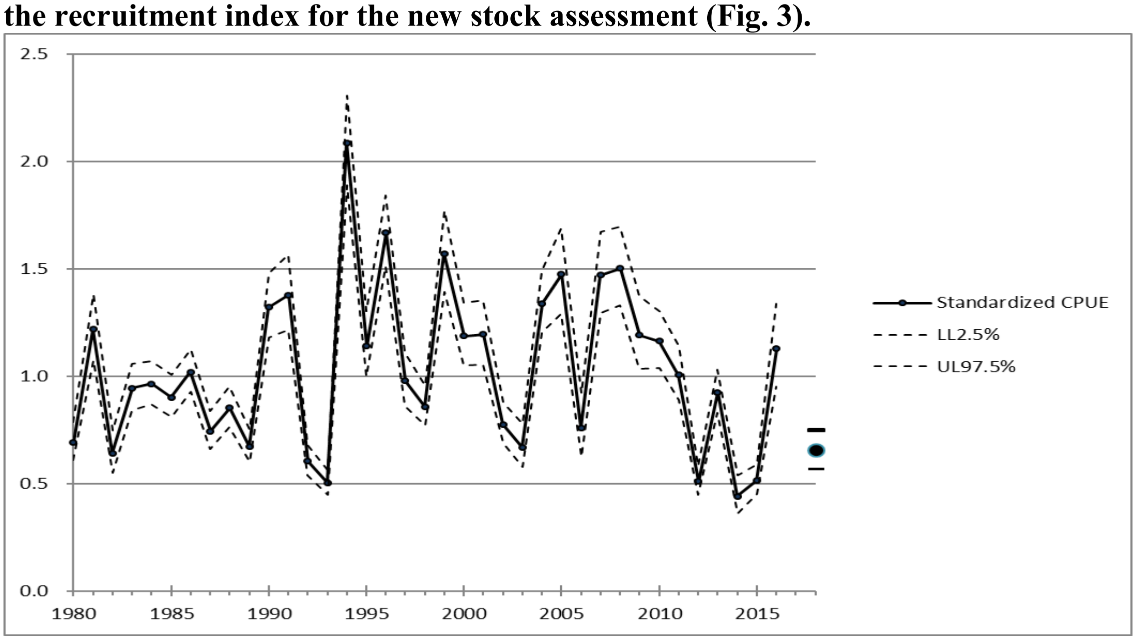


Fig. 3. Standardized CPUE for Japanese troll fisheries to be included in the stock assessment (S4).

2.2.2 Catch Time Series

S. Nakatsuka presented the estimation of unaccounted mortality in Japanese fisheries (ISC/20/PBFWG-1/08). K. Piner presented the estimation of unaccounted mortality in US sports fisheries (ISC/20/PBFWG-1/07). The USA clarified that the mortality was mainly caused by marine mammals. The discard data have been reported in the logbook but were not counted in the catch in the past. Also, there was no estimate from the private boat fishery, but it is not considered to be significant. Korea stated that there is no good information on the PBF discards. However, considering the importance of including discard estimates in the stock assessment, Korea considers it appropriate to apply the 5% discarding ratio for Korean purse seine fishery, which was assumed for Japanese fishery. The WG agreed to include the estimated/assumed unaccounted mortality in the new stock assessment. The WG also notes the importance to obtain reliable estimates of unaccounted mortality and encouraged members to continue their efforts for better data collection of discard information.

2.2.3 Size Composition Data

K. Nishikawa presented the initial setting of input data for the stock assessment (ISC/20/PBFWG-1/08). Input file, quarterly catch, size frequency, and abundance indices (CPUE) have been revised and updated up to fishing year 2018 (up to June in 2019 calendar year). This presentation was based on the tentative model circulated to PBFWG on 28th February 2020. Fleet definition was modified to treat the size frequency suitably. Discard catch data was added newly. Some size frequency data were revised and updated using improved estimation method (Japanese tuna purse seine fishery off the Pacific coast of Japan and Korean offshore large purse seine fishery). Abundance indices (CPUE) from Japanese longline, Japanese troll, and Taiwanese longlines were updated up to the 2018 fishing year where the CPUE standardization methods for Japanese and Taiwanese longlines were revised

S.I. Lee presented a document on the PBF size distribution for purse seine fishery in Korea (ISC/20/PBFWG-1/06). Pacific bluefin tuna (PBF) size data collected from Korean offshore large purse seine were measured by researchers and observers at Busan Cooperative Fish Market where most of PBF caught by Korean purse seine are unloaded. The measurements were recorded in fork length and weight at intervals of 1 cm and 1kg, respectively. Representativeness of the population was raised to sample size data, based on the amount of catch of large size of 30 kg or more and small size less than 30 kg. As a result, the large size was commonly caught in the 1st and 2nd quarter (in calendar year).

3. MODEL SETTING AND RESULTS

3.1 Confirmation of Key Model Settings

H. Fukuda presented the assessment results of the initial model setting (ISC/20/PBFWG-1/09). The WG discussed areas of further improvements as shown below.

Unaccounted mortality

Unaccounted mortality from discards is now included in the new assessment. The USA does not have composition data from the discards for their sport fishery unaccounted mortality, but the length compositions are assumed to be close to those from the retained catch. It was therefore recommended that they be added as a new fishery with the selectivity mirrored to the retained catch of US sports fishery rather than mirrored to the Japanese setnet unaccounted mortality. A revised model was run, and the results were essentially the same.

The high CV (at 0.3) for the unaccounted mortality allows flexibility for the model not to fit the unaccounted mortality but may compensate for some other model misspecifications. Therefore, it was suggested to have a lower CV even though it may not represent the uncertainty. The model fits the unaccounted mortality well and the results were not sensitive to the values of the CV. Therefore, it was agreed that the CV should remain at 0.3 for unaccounted mortality. It was recommended that better data for unaccounted mortality should be collected in the future.

Japanese purse seine in Pacific (F5)
A clarification was made on modeling selectivity for Japanese purse seine fishery during the low catch years 2011-2014. Since there was no composition data in 2011-2013, the selectivity based on 2014 composition data was used for 2011-2013. For years before 2011 and after 2015, time-varying selectivity is used. It was suggested that time blocks should be used rather than random deviations because this creates too many parameters. It was agreed that the time blocks for each fishery need to be described more thoroughly. It was also suggested that this fishery need to be changed to be a high priority because the catch is increasing in recent years.

US sports fishery (F15)
A decision needed to be made about which selectivity to use for the years with missing composition data for the US sports fishery. The US recently began to collect sport fishery composition data, and some additional data is available from the IATTC in prior years. However, there is no comprehensive description of how the early IATTC collected composition data was sampled. A report from the 2006 assessment meeting described how the data were raised, but not how they were sampled. It was agreed that the IATTC data would not be used in the model until the group knows more about how they were sampled. Selectivity for this period needs to assume selectivity from another period or fleet. The early commercial composition data averages 60-80 cm which is slightly smaller than recreational sizes. It was suggested that the decision should be based on why the change in selectivity occurred, was it a change in migratory patterns or a change in targeting. If former, then the commercial fishery should be mirrored. If latter, then the 2014 recreational composition data used. It was agreed that the selectivity would be mirrored to the 2014 NMFS sampled data because the size is similar to the IATTC samples. Selectivity should be estimated as time-varying after 2014 using the observed US sport fishery compositions.

Other
It was noted that the selectivity for fleet 28, the size frequency of Japanese longline catch outside the survey season, differed from that of surveyed season; The length frequency has multiple modes and some years have smaller average lengths. The catch is low for this fishery, but increasing in last couple of years. There is potential for more future catch earlier in the season. Seasonal variation in selectivity might need to be considered.

It was suggested to consider sharing the selectivities of some fleets to make the model to run faster due to reduced number of parameters. But this might delay the results for a day to determine what selectivities are appropriate to share and may not be needed if a satisfactory base case is obtained with the current model. After further investigation, it was found that the model with shared selectivities did not show expected benefit (longer run time) despite a reduced number of parameters to be estimated. Thus, the WG decided not to take this option at this juncture and to investigate the approach further in the future. In the case of continued convergence problems, selectivities could also be simplified to reduce the number of parameters.

It was decided that the unaccounted mortality would not be included in the projections. This means that the managers have to include unaccounted mortality in the quota or assume discard mortality is zero. This will be made explicit in the assessment report.

3.2 Model Diagnostics

H.H. Lee presented the results of the application of the age-structured production model (ASPM) to the input data for the 2020 stock assessment. The ASPM is a diagnostic that helps to understand if catches mediated by the models production function can predict changes in the longline CPUE. It was clarified by the authors that the analysis is also useful because it eliminates dealing with misfit from the composition data. Although some misfit to index was observed, it was noted that overall this simplified model can predict secular changes in abundance trends well. Two versions of the ASPM model were shown: 1) recruitment determinate (taken from the SR relationship), 2) fixed variable recruitments corresponding to the Japanese troll index (ASPM-R). The ASPM predicted the last years of the Japanese longline CPUE well, while the ASPM-R predicted a lower level of terminal abundance than observed. It was shown that misfit to the most recent observation of Japanese longline CPUE could be caused by the lower than average recruitment in 2012 and 2014. It was also noted the effort of the troll fishery has decreased to 10% from historic high, so CPUE may have lost some of its ability to predict recruitment.

With regard to the misfit of ASPM-R estimation to the Japanese longline CPUE index in recent years, it was noted that the composition for the longline index is based on catch weighting, but the index is based on area weighting, and therefore there is an inconsistency. In addition, the composition data comes from a larger area than the data used for the index. Unfortunately, there is no location information from the composition data. The weight frequency data, which has location information, indicates that the smaller fish come from outside the area used for the index.

It was suggested to conduct a sensitivity test using dome shape selectivity for all fleets, perform the ASPM diagnostic and an extensive jitter analysis for the final base case model.

3.3 Selection of the Base Case Model

When evaluating preliminary models, it was noted that there were several fisheries with length-based selectivities that had steep ascending or descending slope, which may be causing the convergence issues. Using 1cm bins for all lengths did not resolve the steep selectivities for all the descending limb and took considerably longer to run. For fleet with a steep descending pattern, the selectivity was estimated for the largest length bin, but this did not solve the issue. The US commercial and Mexico commercial fishery selectivity was modified from time-varying length to time-varying age, but the fit to the length composition data was considerably worse. It was finally concluded that some of the parameters relating to the very steep selectivities would have to be fixed. The detailed explanation of the specific selectivities which were fixed is provided in the assessment report.

The Japan longline CPUE fleet (F1) sometimes catches some small fish, which causes big residuals in several years. Three additional runs were conducted to try and resolve this issue: 1) estimate smallest length selectivity, 2) remove the length composition data below 150 cm after 1993, and 3) increase the additive constant to the composition likelihood. Increasing the positive constant value for composition likelihood provided no improvement in residuals. Estimating the selectivity for the smallest fish caused some changes in the biomass. Setting the composition data to zero for fish less than 150cm removed the residual problem but had little impact on the results. The small fish are probably outside the core area used for the index (weight frequency shows that 150cm (50Kg) would not delete many fish from the core area) and there are a small amount of these. But RMSE fit of the index is slightly degraded. After a lengthy discussion, the WG decided not to change the model as evaluated options did not seem to provide justifiable benefit.

A residual pattern was noted in the fits to composition data from the Japan longline fleet in seasons 1-3 (F28). The current age-based selectivity allowed the capture of age zero fish. The model was changed to exclude the capture of age 0 fish. This change improved the fit, but the results were similar. It was agreed that this would be used in future runs. A run was also conducted estimating the selectivity of smallest fish, which improved the fit, but had little impact on results.

It was noted that the size in the last three years in the south area for Taiwanese longline fishery has decreased. Because every fish is sampled, the decrease of average size is not a sampling problem. The reason for this drop in size is not known.

A run was made that share the age-based selectivity between Japanese (F18) and Korean purse seine (F3) and among Japanese set net (F8, F9, F10, and F11), while maintaining individual length-based selectivities to be estimated. The degradation in likelihood was only two units. However, the shared selectivity run had a longer run time. It was pointed out that the increased run time was probably due to not using an optimized par file with good initial parameter values. The WG decided not to take this option at this stage.

The WG also reviewed the original reference run estimating time-varying length-based selectivity for US commercial (F13), Mexican commercial (F14), and US sport (F15) fisheries and a proposed model estimating age-based time-varying selectivity for each of these fisheries. The proposed model removed the effect of length selection changing within a single length bin resulting in a steep increase or decrease in selectivity. The steep increase or decrease may cause the model failed to converge. This model reduced the number of parameters by 20, but it did cause some degradation of fit to those fleets length composition. Changes (reduces) the spawning biomass estimated in the early period but less influential in the most recent decades. The WG chose the option of specifying the length selection parameters that were problematic based on visual examination of parameters resulting in large changes in selection within a single size bin.

3.4 Base Case Model Results

A possible base case model was chosen that was nearly identical in results and model structure as that presented in the WP ISC/20/PBFWG-1/09. The major changes from the WP-09 were specification of selection parameters associated with steep changes in estimated selectivity that occurred within a single composition bin. Before accepting the proposed base case model, a series of model diagnostics were requested:

1. Comparison to previous assessment: determines how new data, fisheries definitions and changes to the model structure affected historical estimates.
2. Fit to discard: Fisheries with the potential for the largest unseen mortality (discard) were assumed a fixed level of unseen catch. Those catches were fit in the model with large CVs and the WG wanted to see how well the model estimated those unseen catches.
3. ASPM: There is a strong relationship between catches and abundance changes in the longline fleets given the model's production function (natural mortality, growth, spawner-recruitment relationship). This allows the model to estimate a population scale that is consistent with that relationship. The ASPM diagnostic helps evaluate if the inclusion of the composition data obscured that understanding.
4. R0 profile: The profiles help to understand what data sources are providing information on the population scale.
5. Retrospective analysis: The analysis examines if there are systematic patterns in error in the assessment.
6. Jitter (random perturbation of initial parameter value and estimated phases): The primary diagnostic for model convergence to a global best fit.

The initial round of diagnostics of the proposed base case potentially indicated some concerns. The ASPM diagnostic shows that reference model R0 estimate is similar to ASPM estimate, especially when recruitment variability is considered (ASPM-R). The differences in model results between the ASPM, ASPM-R and reference case may indicate some fine scale conflict between data series. Additional years of data will be needed to evaluate if there is data conflict in the most recent index values. Similarly, the retrospective analysis indicates a small pattern in the underestimation of biomass in the recent period. The WG did not consider the retrospective pattern to be serious. The WG was most concerned with the R0 profile which indicated that fleet 13 size comp (early US commercial) has more information than expected on the R0 parameter. Similarly, fleet 14 (Mexican commercial late) also indicated some unexpected strong information. It was noted that this may be due to some misspecification of the selection pattern or perhaps model convergence issues. Because of those concerns, the WG suggested re-doing the R0 profile using smaller changes in fixed R0.

The re-analysis of the R0 profile with finer changes in R0 resulted in a better-behaved profile. However, the WG noted that fleet 12 (Taiwanese LL in south area) composition data was informative about scale. It was noted that this fleet is the only fleet that assumed asymptotic selection and therefore this result was not surprising. It was noted that allowing fleet 12 to have a domed shaped selection did not generally change the results or improve the minimal retrospective pattern in the base case. The WG concluded that although there remains some conflict among data sources on the estimate of R0, the majority of likelihood components were consistent with respect to R0. The WG agrees that the base case on 03/08/2020 will be accepted to characterize stock dynamics.

3.5 Sensitivity Analysis

A suite of sensitivity analyses (changing one assumption in the model and re-estimating parameters) were conducted. Sensitivity analyses fell into 2 broad categories:

1) Model assumptions and structure:
   a) M, lower h, alternative maturity schedule
   b) Data weighting
   c) No assumption of asymptotic selection for any fleet
2) Data:
   a) High and low discard.
   b) Fit to the Japanese longline size comps F1 in last two years.

<u>**Results**</u>

Maturity

Two alternative schedules introduced into the model (mature earlier and later). Changes in the maturity schedule did not affect fit or estimated dynamics because steepness is specified at 0.999. Only the calculation of SSB is affected by the change in maturity schedule (as we sum across different ages) which will affect reference points such as depletion levels (older maturation results in lower depletion ratio and vice versa). The WG concluded this is not an important uncertainty in the stock assessment although it could potentially influence the calculation of management quantities.

Natural Mortality

Lower (-10%) and higher (+10%) M schedules after age 2 were introduced into the model. Small changes in estimated dynamics were observed as the WG expectations. The WG concluded the model is robust to M changes.

High and Low Discard Catch

Catch in fleet 26 (discard in WPO) was assumed to be doubled and set to 0. Because discard is only in the last two years, it doesn't affect model results or fit. The WG concluded that uncertainty in the discard level is not important for this assessment but could be meaningful in future assessments.

Data Weighting

Alternative data weighting for composition data of F13 in accordance with the Francis method was applied and the WG confirmed that there is no difference between the base-case and alternative assumption.

Fit to Discard Catch

The model predicted discard catches that matched the observed catches. The WG concluded that there is not much information in the model to inform the discard catches at the end of the model.

Comparison to the Previous Assessment

Historic spawning biomass estimates were similar to the previous assessment. The WG concluded that the changes in model structure and data did not greatly alter the estimation of the dynamics covered by the previous assessment.

Fit to the 2017 and 2018 size composition fleet 1 (Japanese longline) that were omitted in the base case due to changes in fishery practices
The 2017-18 compositions were included in the total likelihood calculation. Inclusion of the data minimally impacted the fit to the longline CPUE but did not affect the estimated dynamics. The WG concluded the decision to exclude this data did not significantly impact the assessment results.

No Asymptotic Fleet
The WG reviewed a result of a run allowing fleet 12 to have dome shape selectivity. Model results in an estimated selection pattern that is nearly asymptotic and dynamics similar to the reference case. The WG concluded that this assumption was not overly influencing model results.

Steepness
Only alternative steepness of 0.99 had positive definite hessian. Values of lower steepness had non-positive definite hessian. The WG concluded that the high steepness is consistent with the estimates of spawning biomass and recruitment. The WG recommends that further research be focused on understanding this sensitivity result.

3.6 Other Issues

Fit to Unfit Indices
The WG reviewed the fit of indices which were not included in the likelihood function. The Taiwanese spatio-temporal models in the south and all area fit reasonably well. It was clarified that all area model assumed selectivity of the south area. On the other hand, Taiwanese spatio-temporal model as well as GLM in the north did not fit well. Korean purse seine CPUE appeared to capture some of the signal but not others. Regarding Japanese recruit monitoring indices, both indices in summer and winter seem to capture signal until 2016, but some departure was observed thereafter. The WG agreed to review the results towards the next assessment to consider possible modification of abundance indices.

Bootstrap Issue
The super year is being used for some length-frequency data, which have relative weighting number < 1 in the input sample size field of data file to represent the proportion of sample size, and this appeared to cause issues in the bootstrap module for projections due to the latest version of SS (SS3.30) not properly bootstrapping super years. The super years are used for fisheries whose fishing season spans over two fishing years (e.g., Japanese purse seine in Pacific Ocean (F5) US commercial (F13) and Mexican commercial (F14) fisheries). The options to deal with the bootstrapping issues are to re-programming the projection software or to revert to older version of SS (SS3.24) to do the bootstraps once the final model has been developed. The programming option was investigated and the WG considered the option is most consistent with the past approach for bootstrapping while it was noted that the issues should be communicated to the SS developers.

4. FUTURE PROJECTIONS

It was noted that future projections should use low recruitment period values until reaching the first rebuilding target with 60% probability. After that we need to use average recruitment as it has been established in joint IATTC-WCPFC meeting and resolution. According to the projections, PBF SSB will reach the first rebuilding target in 2020 in most scenarios and therefore starting the following fishing year (mostly 2021) , average recruitment is used in projections forward.

As in the previous case, it was agreed to start projection from the terminal year of the assessment, i.e. 2018. The projections start from the bootstrap results in the terminal year, not point estimate so as to capture the uncertainty of stock assessment. It was also agreed that fishing mortality for certain fleets were increased so as to fully utilize increased allocations.

It was noted that the bootstrap distribution is positively biased compared to point estimate in recent years, which will possibly result in optimistic probability for achieving rebuilding targets. The WG confirmed that the recruitment distribution is not biased between the base case and bootstrap replicates except for the terminal two years. The WG also reviewed the difference between the base case and bootstrap replicates (Fig. 4) and agreed to adjust the bias by deducting annual difference from each projection results as suggested in (ISC20/PBFWG-1/15xx) to provide projection results.

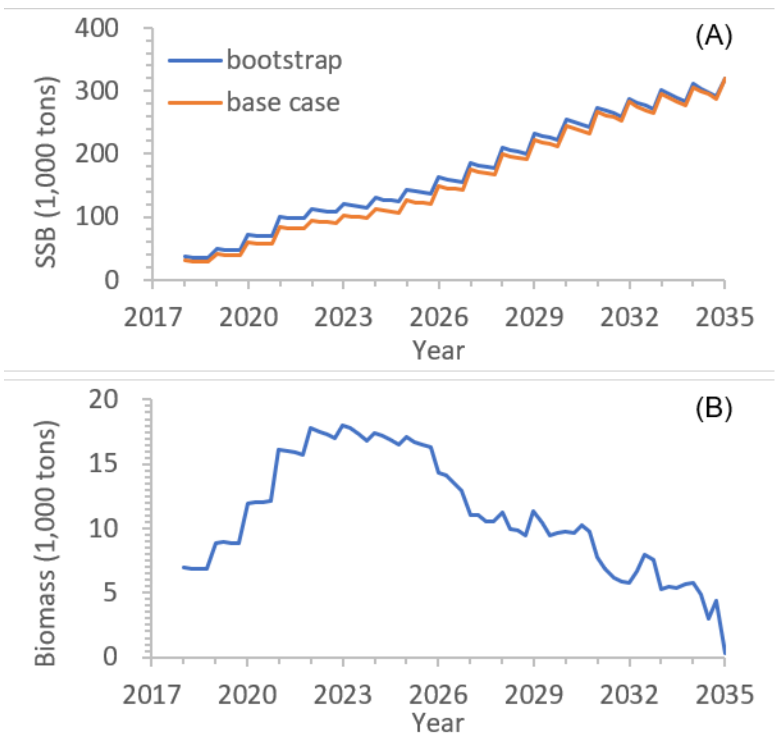
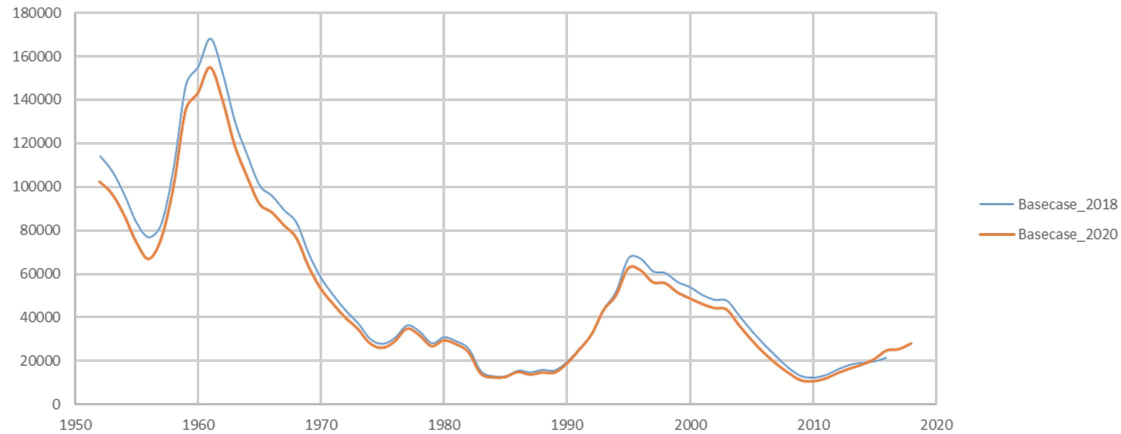


Fig. 4. Median estimates of projected future SSBs based on the bootstrap replicates and base case assessment model (A), and difference between the median estimates of projected future SSBs based on the bootstrap replicates and base case assessment model (B).

5. DRAFTING STOCK STATUS AND CONSERVATION INFORMATION FOR PACIFIC BLUEFIN TUNA

The WG reviewed the results and diagnostics of agreed base case run and sensitivity tests as well as future projection. The base case model is consistent with the previous model (Fig. 5). The WG concluded that the 2020 assessment model represents the population dynamics satisfactory and is the best available scientific information for the stock. The base-case model fits well the data which is considered reliable and is internally consistent among most of the sources of data. The PBFWG prepared a draft Executive Summary of Stock Assessment Report based on the results.



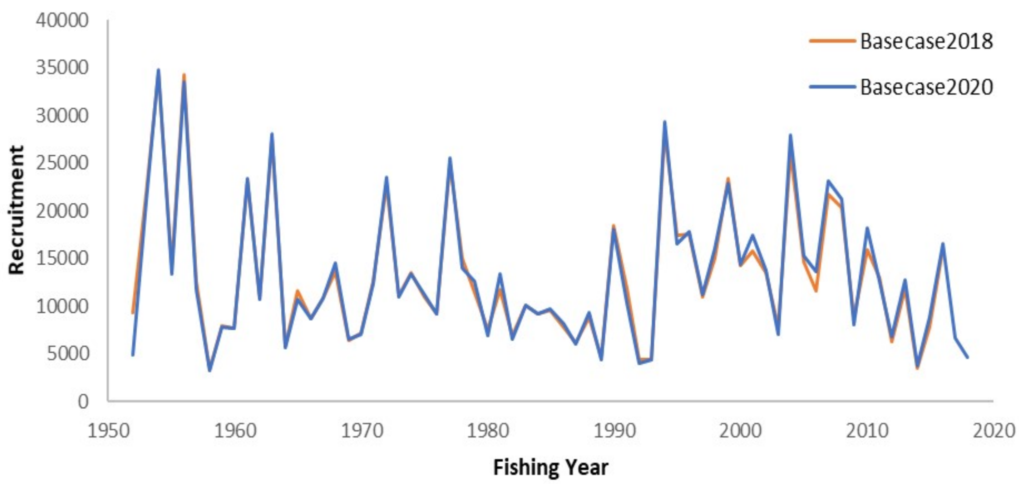


Fig. 5. Comparison of SSB and recruitment of base-case model for 2018 assessment and 2020 assessment.

6. WORK PLAN AND RECOMMENDATIONS

The WG identified areas of improvements for stock assessment and future projection including the followings. The WG will discuss prioritization and work plan in future meetings

- Underestimate retrospective pattern
- Residuals in in composition data in some fleets
- Steep slope of selectivity in some fleets
- asymptotic selectivity in the model
- Bootstrap for super year (need to be communicated to developers of SS)
- R1 penalty
- Skewed distribution of bootstrapped biomass in recent years
- Biological assumptions in the model
- Model convergence

The WG also noted that after completing the benchmark assessment, the work related to MSE has to commence in response to the request from RFMOs. The WG agreed to discuss the meeting schedule further in the half-day session in conjunction with the Plenary meeting.

7. OTHER MATTERS

7.1 Request from RFMOs

IATTC – WCPFC NC Joint WG request ISC to provide a matrix of conversion values across age classes. The WG provides the following table, which is based on the comparison of expected asymptotic SSB which unit weight of PBF of respective age will produce based on biological assumption of the stock assessment (ISC20/PBFWG01/14).

Table 1. Relative impact of catching a unit weight of certain age of PBF

Age	Body weight at half of age (kg)	Relative fishing Impact to Age 6
0	1.42	8.8
1	9.3	3.6
2	24.5	1.9
3	46.0	1.3
4	71.6	1.1
5	99	1.0
6	126	1.0

7.2 A Series of Presentation on the Biology of PBF

Japanese scientists presented summary of researches on biology of PBF conducted in the National Research Institute of Far Seas Fisheries.

Differences in size distribution, maturity status and batch fecundity of Pacific bluefin tuna *Thunnus orientalis* among three fishing areas in the Sea of Japan. *Presented by H. Ashida (oral presentation)*

H. Ashida presented the differences in size distribution, maturity status, and batch fecundity of Pacific bluefin tuna three fishing areas in the Sea of Japan. The presentation showed that the size distribution of specimens, spawning season and batch fecundity, were different among fishing areas and that the reproductive output of Pacific bluefin tuna changed depending on the seasonal variation of SST and fork length.

Estimation of natal origin of PBF by fishing areas using vertebral first annulus. *Presented by Y. Uematsu (oral presentation)*

Y. Uematsu presented estimation of natal origin of PBF by 6 fishing areas (4 in WPO, 2 in EPO) and 2 age classes. This presentation showed the proportion of the group hatched in the Sea of Japan and in Nansei Island area using method of Uematsu et al. (2018). Both groups were observed in all fishing areas and age classes. In WPO, the ratio of the group hatched in Nansei Island area increased with age, on the other hand, that of the group hatched in the Sea of Japan increased with age in PO. The change in the proportion in both groups would be caused by the different timing of trans-Pacific migration.

Detecting the trans-Pacific eastward migratory record of the Pacific bluefin tuna *Thunnus orientalis* by otolith δ13C and δ18O analysis. *Presented by M. Kawazu (oral presentation)*

M. Kawazu focused on a stable isotope ratio of carbon and oxygen (δ13C and δ18O) of PBF otolith. The presentation showed that the profiles of δ13C and δ18O values in otolith trajectories were significantly different between trans-Pacific migrated and no trans-Pacific migrated fish, which were recorded during the trans-Pacific migration at age 1-2 period. The presenter indicated that δ13C and δ18O values in otolith were valuable tools to detect trans-Pacific migratory records of PBF.

Horizontal distributions and habitat associations of tuna larvae off the Nansei Islands, Japan. *Presented by A. Tawa (oral presentation)*

A. Tawa presented the surface horizontal habitats of multiple tuna larvae off the Nansei Islands and the environmental factors. The presentation showed the horizontal larval distributions of the 5 species were largely influenced by the Kuroshio Current. The presenter also suggested that the larvae of 3 species (PBF, YFT, and SKJ) could be different in other habitats, including their vertical distributions and feeding habits in order to avoid overlapping their ecological niches.

Growth and survival of the Pacific Bluefin Tuna larvae in the main spawning ground around Japan, comparison between the south-western North Pacific and the Sea of Japan. ***Presented by T. Ishihara (oral presentation)***

T. Ishihara presented the larval growth of Pacific bluefin tuna in two main spawning areas, the Sea of Japan and the south-western North Pacific. This presentation reviewed 5 papers concerning about the growth, development and feeding habits of Pacific bluefin tuna larvae. The presenter suggested that the larval survival depending on their growth in both areas and the environmental factors affecting the larval growth were e.g. SST and the prey availability.

Prey availability for PBF larvae and juveniles in relation to their piscivory estimated by the mouth gape size. ***Presented by Y. Tanaka (ISC/20/PBFWG-1/11)***

Y. Tanaka presented the prey availability for PBF larvae and juveniles in relation to their piscivory estimated by the mouth gape size of laboratory-reared PBF. The presenter focused on piscivorous feeding habit in the early life stages of PBF, which greatly influence larval growth. The presenter estimated prey availability for PBF larvae and juveniles and suggested the importance of piscivory in the early life stages of PBF for their recruitment processes and interannual variability in recruitment.

Progress report for Close-kin research in Japan. ***Presented by Y. Tsukahara (oral presentation)***

Y. Tsukahara presented recent work for Close-kin (CK) analysis conducted by Japanese scientists. The technics for kin recognition, which were presented in last CK workshop held in Jeju, were preliminarily applied to some actual age-0 PBF samples caught around Japan. As a result, there are several sibling pairs in some cohorts. This study is on-going and requires further investigation.

Hatch date of Pacific bluefin tuna *Thunnus orientalis* juveniles with close kinships. ***Presented by H. Tanaka (oral presentation)***

H. Tanaka reported analyses on the hatch date of PBF juveniles which were estimated to have close kinships (full-siblings or half-siblings) by CK analysis. Differences in hatch dates within each sibling pair, which also mean the differences in spawning dates for adult individual, were reported and compared between full-siblings and half-siblings, and between maternal and paternal half-siblings. Although the sample size is limited so far, these analyses are considered to give new insights into the reproductive biology of PBF at an individual level.

Feeding ecology of adult Pacific bluefin tuna in the Sea of Japan. ***Presented by Y. Hiraoka (ISC/20/PBFWG-1/12)***

Y. Hiraoka presented the diet of adult Pacific bluefin tuna in the Sea of Japan during the spawning season (June to July) assessed from stomach contents. Values of %IRI showed that the top prey for the size classes >125 cm folk length (FL) and 100–125 cm FL were Japanese common squid and small teleost fishes (mostly Japanese anchovy and sailfin sandfish), respectively. Feeding intensity and prey composition differed by size and fluctuated interannually. In particular, feeding intensity corresponded to differences in relative condition factor. The presenter indicated that the feeding habit of adults could influence reproductive success because females of a better condition will spawn larger eggs.

8. ADOPTION OF THE EXECUTIVE SUMMARY OF THE STOCK ASSESSMENT REPORT

The draft executive summary of the stock assessment report was reviewed and adopted. Stock assessment report will be prepared through correspondence.

9. ADOPTION OF THE REPORT

The WG reviewed and revised the draft meeting report and adopted it.

10. ADJOURNMENT

The meeting was adjourned on March 12, 2020.

Appendix 1 - Agenda

THE PACIFIC BLUEFIN TUNA WORKING GROUP INTERSESSIONAL WORKSHOP

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

March 2-12, 2020
National Research Institute of Far Seas Fisheries, FRA
Shimizu, Japan

1 Opening and Introduction
    1.1 Welcome and introduction
    1.2 Adoption of agenda
    1.3 Appointment of rapporteurs
2 Assumption of population dynamics and input data
    2.1 Review of Biological assumptions for the stock assessment
    2.2 Fishery data for input of the stock assessment model
        2.2.1 Abundance index
        2.2.2 Catch time series
        2.2.3 Size composition data
3 Model setting and results
    3.1 Confirmation of key model setting
    3.2 Model diagnostics
    3.3 Selection of the base case model
    3.4 Base case model results
    3.5 Sensitivity analysis
4 Future projections
5 Drafting Stock status and conservation information for Pacific bluefin tuna
6 Work plan and recommendations
7 Other matters
8 Adoption of the executive summary of the stock assessment report
9 Adoption of the report

Adjournment

Appendix 2 - List of Participants

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Appendix 3 - List of Documents

Index	Related Agenda	Title	Author	Contact
ISC/20/PBFWG-1/01	2.2	Input data of Pacific bluefin tuna fisheries for stock assessment model, Stock Synthesis 3; Update for 2020 assessment	Kirara Nishikawa, Hiromu Fukuda and Shuya Nakatsuka	kiraranishi@affrc.go.jp
ISC/20/PBFWG-1/02	2.2.1	Standardized CPUE by spatiotemporal model for Pacific Bluefin tuna (Thunnus Orientalis) caught by Japanese coastal and offshore longline	Yohei Tsukahara, Hiromu Fukuda, and Shuya Nakatsuka	tsukahara_y@affrc.go.jp
ISC/20/PBFWG-1/03	2.2.1	Abundance index of Taiwanese PBF fisheries based on traditional and spatiotemporal delta-generalized linear mixed models	Shui-Kai Chang, Tzu-Lun Yuan, Hung-I Liu and Haikun Xu	skchang@faculty.nsysu.edu.tw
ISC/20/PBFWG-1/04	2.2.1	Re-updated standardized CPUE for 0-age Pacific bluefin tuna caught by Japanese troll fisheries: Updated up to 2018 fishing year without 2017 fishing year	Kirara Nishikawa, Yohei Tsukahara and Shuya Nakatsuka	kiraranishi@affrc.go.jp
ISC/20/PBFWG-1/05	2.2.3	PBF catch size-composition of the Mexican purse seine fishery from data collected at pen rearing operations during 2018-2019	Michel J. Dreyfus-Leon	dreyfus@cicese.mx
ISC/20/PBFWG-1/06	2.2.3	Size distribution of Pacific bluefin tuna, *Thunnus orientalis* caught by Korean offshore large purse seine fishery	Sung Il Lee, Doo Nam Kim, Mi Kyung Lee and Heon Ju Jo	k.sungillee@korea.kr
ISC/20/PBFWG-1/07	2.2.2	Estimates of Recreational release Mortality for the US Commercial Passenger Vessel Fleet (2000-2019).	Piner, K., H.H. Lee, E. Hellmers and S. Stohs	kevin.piner@noaa.gov
ISC/20/PBFWG-1/08	2.2.2	Estimation of Unaccounted Mortality in the Japanese Fisheries	Shuya Nakatsuka and Hiromu Fukuda	snakatsuka@affrc.go.jp
ISC/20/PBFWG-1/09	3	Assumption of the Population Dynamics Model for the 2020 Stock Assessment of Pacific Bluefin Tuna	Hiromu Fukuda, Huihua Lee and Kevin R. Piner	fukudahiromu@affrc.go.jp
ISC/20/PBFWG-1/10	3	New data tests age-structured production model (ASPM) for Pacific bluefin tuna	Huihua Lee, Kevin R. Piner, Mark N. Maunder and Hiromu Fukuda	huihua.lee@noaa.gov
ISC/20/PBFWG-1/11	7	Prey availability for PBF larvae and juveniles in relation to their piscivory estimated by the mouth gape size	Yosuke Tanaka, Hiroshige Tanaka, Atsushi Tawa, Hiroshi Ashida, Taiki Ishihara, Etsuro Sawai, Masanori Kawazu, Takuya Sato, Hiroshi Hashimoto and Kazunori Kumon	yosuket@affrc.go.jp
ISC/20/PBFWG-1/12	7	Feeding ecology of adult Pacific bluefin tuna in the Sea of Japan	Yuko Hiraoka, Yosuke Tanaka, Shuuyou Watanabe and Seiji Ohshimo	yhira415@affrc.go.jp
ISC/20/PBFWG-1/13	2.2.2	Status and future plans for information on discard mortality rates of Korean fisheries for Pacific bluefin tuna, *Thunnus orientalis*	Mi Kyung Lee, Doo Nam Kim, Sung Il Lee and Doo Hae AN	ccmklee@korea.kr
ISC/20/PBFWG-1/14	7	Calculation of conversion value matrix of relative fishing impact across age classes	Hiromu Fukuda, Shuya Nakatsuka	fukudahiromu@affrc.go.jp
ISC/20/PBFWG-1/15	4	A review of the issues associated with the Bootstrap calculations and future projections	Hiromu Fukuda, Yohei Tsukahara, Kirara Nishika	fukudahiromu@affrc.go.jp