FINAL

ISC/22/ANNEX/08

ANNEX 08

22nd Meeting of the
International Scientific Committee for Tuna
and Tuna-Like Species in the North Pacific Ocean
Kona, Hawai'i, U.S.A.
July 12-18, 2022

REPORT OF THE PACIFIC BLUEFIN TUNA WORKING GROUP INTERSESSIONAL WORKSHOP

July 2022

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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 8-18, 2022
Webinar

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 an update stock assessment of PBF in 2022 and the present meeting is the stock assessment meeting. The objectives of this meeting were 1) to complete an update assessment and future projections, 2) to develop draft stock status and conservation information, and 3) to prepare responses to RFMOs. Due to the COVID-19 pandemic, the meeting was held online.

1.2. Adoption of Agenda

The draft agenda was adopted without change. The adopted agenda is attached as Appendix 1. The list of participants is provided in Appendix 2. The list of documents reviewed at the meeting is provided in Appendix 3.

1.3. Appointment of Rapporteurs

Rapporteurs were assigned by the Chair as follows: Item 2: D. Tommasi, Item 3: K. Piner, Item 4: M. Maunder, Item 6: M. Dreyfus, Item 7: S.K. Chang.

2. ASSUMPTION OF POPULATION DYNAMICS AND INPUT DATA

2.1. Fishery data for input into the stock assessment model

Japanese Longline Index

The fishery data used to develop the Japanese longline index of abundance were not available for the fishing year 2020 at the time of the data preparatory meeting in December 2021. An additional one-day webinar was held online in January 2022 to review the information. The standardized Japanese longline CPUE index was presented and the WG decided that the index should be standardized until 2019 FY as catchability changed in 2020 resulting from an Individual Quota (IQ) management starting in 2020, which cannot be easily standardized at this stage. The WG needs to approve the standardization results during this assessment meeting.

Standardized CPUE for Pacific Bluefin tuna caught by Japanese coastal and offshore longline in 2022 update assessment (ISC22/PBFWG-01/01)

Y. Tsukahara presented ISC22/PBFWG-01/01. This document presented a standardized CPUE up to the 2019 fishing year using fishery data for Japanese coastal longline fisheries. The procedure for standardization was the same as the one for the previous assessment. However, the additional data filtering process to exclude the small-sized fish was applied based on the WG decision made in the last data preparatory meeting. The standardized CPUE showed a consistent trend with the previous one used in the last assessment and hence can be an appropriate abundance index in the 2022 update assessment.

Discussion

A WG member asked for clarification on how the large numbers of small fish present in fishing years 2019 and 2020 were treated. The data provider clarified that because of the change in fisheries operations caused by the introduction of the IQ management system, no data for the fishing year 2020 was included in the analysis. The index of abundance is up to the fishing year 2019. For this index, catch records of fish smaller than 60 kg were filtered out prior to CPUE standardization but this catch information is included in the assessment model (see also the section below). The WG agreed to adopt this Japanese longline index of abundance in the 2022 update assessment (Fig 1.).

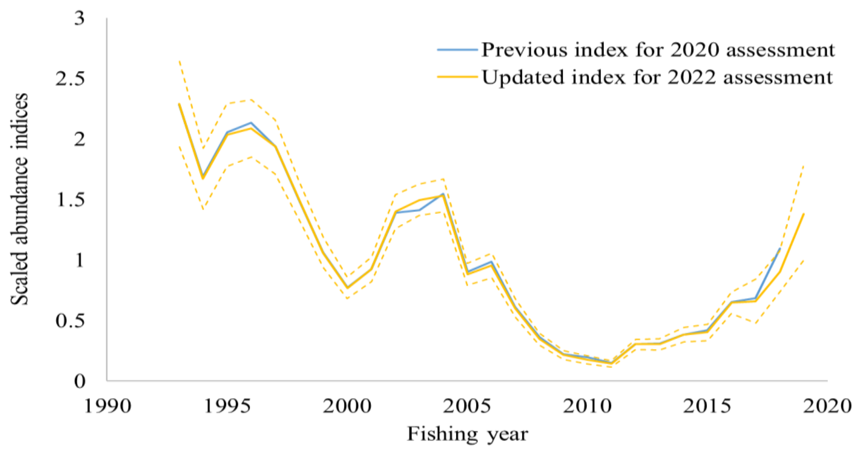

Figure 1. Standardized CPUE of Japanese longline 1993-2019 FY used for the assessment.

Input data of Pacific bluefin tuna fisheries for stock assessment model, Stock Synthesis 3; Update for 2022 assessment (ISC22/PBFWG-01/02)

K. Nishikawa presented a summary of the input data of the PBF stock assessment model (ISC/22/PBFWG-1/02). For the assessment, the input data file including quarterly catch, quarterly size frequency, and annual catch per unit of effort (CPUE) based abundance indices have been revised and updated up to the fishing year 2020 (up to June in the 2021 calendar year). This presentation was based on the tentative model circulated to the PBFWG on the 2nd of March 2022. Data in recent years were slightly modified to treat the size frequency suitably (e.g., recent Japanese longline fleet). Abundance indices from Japanese longlines and Taiwanese longlines were updated.

<u>Discussion</u>

A question was raised about which fleet the size observations for fish smaller than 152 cm removed from Fleet 1 were added to. The presenter clarified that catch and size composition data for season 3 in 1993-2020 has been assigned as Fleet 23 since the 2020 assessment. Additionally, from this assessment, catch and size compositions for season 4 in 2017-2020 were also moved to Fleet 23.

The chair asked if the WG agreed with the suggestion from the presenter to not to use size composition data for the Japanese set net data for 2019-2020 for this update assessment due to the limited data coverage because of changes in fisheries operations caused by COVID-19. **The WG agreed to not to use the 2019-2020 size composition data from the Japanese set net fleet for this update as suggested by the data provider.**

A WG member asked for clarification on the use of the S12 recruitment monitoring index in the assessment. The WG agreed to use the compiled data for the assessment but to leave the decision to include or exclude the recruitment monitoring index to later in the meeting during the model setting discussion.

The chair stated that no changes in the biological assumptions used in the stock assessment have been proposed. **The WG agreed to use the same biological assumptions as the last assessment.**

The WG had an early discussion on recent observations from the fishery. The Mexico fishery has already almost exhausted their quota for 2022 with fish appearing early in the season. The Korean purse seine fishery quota for 2022 has also almost run out and 70-80% of the catch consisted of large fish. The Japanese fishing season started also earlier. While the Japanese longline fishery season is usually April-June, fishing started in January in 2022. However, in Chinese Taipei and the US, the main fishing season has not yet started.

3. MODEL SETTING AND RESULTS

This assessment is an update of the 2020 benchmark assessment model. The ISC has not defined what constitutes an 'update'. The WG generally considers an assessment an update if there are minimal changes to data, data analysis, or assessment model structure.

3.1. Confirmation of Key Model Settings

Preliminary Population Dynamics Models for the 2022 Updated Stock Assessment of Pacific Bluefin Tuna (ISC22/PBFWG-01/03)

H. Fukuda presented the configuration of the preliminary assessment models (ISC/22/PBFWG-1/03). The catch and size compositions were added only for two additional years (2019 and 2020 FY) and updated for the terminal year of the previous assessment (2018 FY). Because of the nature of the CPUE standardizations, the whole time series of the CPUE based abundance indices from the Japanese and Taiwanese longline fleets were re-standardized with the additional data for the period agreed by the WG. The CPUE based abundance index from the Japanese troll fishery was not updated based on the WG decision made in the data meeting in December 2021. The 2018 observation, which had been used in the 2020 assessment, was excluded from the model because there was an unstandardized factor affecting the catchability of the fleet, and thus was not representative. A newly prepared recruitment index based on the Japanese recruitment monitoring survey was input as Survey 12 of the model, and the effect of the inclusion of this index was evaluated. Since the 2022 PBF assessment is the data update, the model structure was maintained as it was in the 2020 benchmark assessment.

The model was diagnosed through the ASPM, retrospective analysis, likelihood profiles over fixed log R0, and residual analyses. They overall showed positive diagnostic results, although there was a small but persistent underestimation trend in the terminal SSB through the retrospective analysis. The full data model could fit the main data source of the relative trend of the adult fish (longline indices). This underestimation trend might be a result of the retrospective period covering a rapid recovery of the spawning stock.

The estimated population dynamics were very consistent with the previous assessments. The relatively high recruitment that occurred in 2016 was confirmed as a good recruitment year class in this model as well, and the maturation of this cohort by 50% in 2020 (4 years old) contributed to the further rapid recovery of the spawning stock. Although there are differences in the terminal 2 years recruitment estimates between the models that included (or not) the recruitment monitoring index, overall results besides the terminal two years recruitment were consistent.

In conclusion, although the updated model showed some negative diagnostics such as a minor retrospective pattern, the model still maintained a good relationship between the productivity assumptions, catch at age, and abundance indices, and the model results showed consistency with the previous assessments. Considering that this is a data update assessment, the authors recommend using this (or those) model(s) for the 2022 stock assessment for the Pacific bluefin tuna.

<u>Discussion</u>

As noted in Section 2, after 2016 the size composition of Fleet 23 included the data from season 4 due to the appearance of smaller sized fish. Including these smaller-fish resulted in some misfitting due to the inflexibility of the selectivity parameterization in Fleet 23 (time-invariant). It is not clear if the sharp peak in small fish were the result of sampling issues, changes in selectivity, or represented the increasing abundance of younger fish for this fleet. The WG discussed two potential base case models that differed in the use of a new real-time JPN Troll recruitment index. The inclusion of this new recruitment index had almost no effect on SSB near the terminal years. The WG noted that the model that did not include the new recruitment index produced nearly identical results as the 2020 benchmark in the overlapping years. The WG also discussed potentially presenting results from both models (including and excluding the new index).

3.2. Selection of Base Case Model

The WG discussed if the updated assessment should include the new real-time recruitment index. It was recognized that there is insufficient information to evaluate its consistency with the other information in the model because these observations of recruitment have not grown into adults. Including the real-time index has the advantage of providing more certainty on the recent recruitments but potentially could provide biased information. Excluding the real-time recruitment index is unlikely to cause bias but makes estimates of recent recruitment more uncertain. As previously noted, the updated model without the real-time recruitment index estimated nearly identical dynamics as the 2020 assessment in the overlapping years. **Therefore, the WG considered it more scientifically defensible to be correctly vague rather than incorrectly accurate and agreed to a base case update model without including the real-time recruitment index.** The real-time monitoring recruitment index will continue to be evaluated in future assessments as more information becomes available for validation.

3.3. Final Model Diagnostics

A series of model diagnostics were presented (R0 profiles, ASPM, retrospective, hindcast, and residual analysis) to evaluate the reliability of the updated assessment. The WG considered the results of the diagnostics to be similar to the 2020 base case model. The WG noted that there continues to be a minor retrospective pattern which may be a result of relatively strong cohorts entering the fisheries. It was suggested that future work could examine retrospective patterns over time periods when other strong cohorts entered the fisheries. The estimated dynamics continue to be driven by the fishing intensity and the production function which gives good hindcasting and R0 profile diagnostic results. **The WG concluded the diagnostics results supported the update model for the determination of the stock condition and future prospects.**

3.4. Final Base Case Model Results

The WG noted that model results confirmed that rebuilding of SSB continued to take place in the two years since the 2020 assessment. The model estimated that SSB surpassed the initial rebuilding target in 2019. **The WG recommends that rebuilding projections should now focus on the probabilities of rebuilding to the 2nd rebuilding target.** The WG also concluded that the current fishing intensity (terminal year) is less than most fishing mortality reference points examined. It was noted that this result was somewhat influenced by excluding the new recruitment index which resulted in recent recruitments being estimated near the average level. The WG evaluated the fishing intensity of the model including the new recruitment index. Although the results are somewhat pessimistic, the WG concluded that fishing intensity is below most reference points and this conclusion is robust even in the model including the new recruitment index.

It was also noted that the current bootstrapping procedure used for projections does not fully accommodate the large uncertainty in recent recruitments due to the lack of a recruitment index. The WG discussed methods to better incorporate the full uncertainty of those recent recruitments into the projection software.

3.5. Final Sensitivity Analysis

A suite of sensitivity analyses with full data (1952-2020) were conducted to investigate the influence of different model assumptions or data on the current stock status. Four sensitivity runs were discussed in the meeting: 1) a model applying different data weighting in size composition data, 2) a model assuming the doubled amount of unseen catch, 3) a model assuming the dome-shaped length selectivity on fleet 12 (Taiwanese longline fleet), and 4) a model introducing recruitment monitoring index after 2016 as an alternative abundance index. The result of those sensitivity runs showed only slight differences from the base case model, suggesting that the estimation in the base case model is robust against the different model assumptions or data, while the inclusion of the recruitment monitoring index made the recent recruitments lower than those in the base case model.

Update of the PBF population dynamics model using short time series data (1983-) and the sensitivity runs for the robustness test (ISC22/PBFWG-01/06)

H. Fukuda presented the model configuration of the short time-series data (ISC/22/PBFWG-1/06). Since an equivalent model performance and results of the short time series model with the assessment base case were confirmed in the previous model

(ISC/21/PBFWG-2/12), the short time-series model was updated. This model configuration was also used to evaluate the sensitivity of the assessment results to the alternative assumptions about productivity (growth, natural mortality, and steepness).

The short time-series model was developed for the shortened modeling period from 1952-2020 fishing year to 1983-2020. Most of the model parameterizations were maintained from the base case assessment model. A different setting was made in the initial equilibrium fishing mortality (initial F), which has been estimated for two fleets (Japanese longline and Set-net fleets) in the base case model, but only the initial F for the Japanese set-net was estimated in the short time-series model to make the model simpler. In addition to that, the size composition data of Fleet 13 (EPO commercial fishery) in 1983, which was not used in the base case model, was included in the likelihood function of the model to estimate the selectivity of that fishery during 1983-2001.

For the sensitivity analyses, five percent higher and lower length at age 3, which are almost identical with the difference in asymptotic length at the same percentage, 20% higher and lower natural mortality for fish at age 2 and older, and 0.85 of the steepness for Beverton-Holt stock-recruitment relationship were tested.

All the models estimated the positive-definite Hessian matrix and the variance-covariance matrix could be estimated. The short time-series model fits all input data generally well as the full time-series model did. The estimated SSB, recruitment, and spawning potential ratio by the full time-series model and the short time-series model were almost identical.

Although there are some differences between the short time-series base case model and the sensitivity runs, those differences could be a typical response of the dynamics (i.e., Higher biomass levels were estimated when the model assumed a smaller asymptotic length / higher natural mortality). All the models suggested the recovery of the stock for the recent 10 years.

There are still some remaining issues, for example, the evaluation of the plausibility of the model assumptions (model weighting). Those sensitivity runs could be useful as the operating model of the Management Strategy Evaluation in the near future or the grid approach (robustness test) for this stock assessment.

Discussion

The WG agreed to use two versions of the updated assessment to conduct sensitivity analyses that differed in the length of the time period modeled. A shortened number of years version of the assessment will be used to conduct sensitivity analyses for M, growth, and steepness changes. The full model will be used for sensitivity analyses for data weighting, selectivity assumptions, discard levels, and inclusion of the new recruitment index. The shortened model allowed sensitivity analysis to lower levels of steepness, which had been difficult to converge in prior assessments. **The WG concluded the results of the sensitivity analyses did not indicate concerns about the reliability of the updated assessment.** Furthermore, the WG recommended that the sensitivity run using the new recruitment index be used to conduct additional analyses (Kobe plot and projection).

Hindcasting Diagnostics

HH. Lee presented a 10-years hindcasting diagnostics on the base case model. This diagnostic assesses the prediction quality of stock assessment for PBF using the hindcasting approach. We retrospected 10-years of stock dynamics (i.e., peeling off 10-years of data sources) and made a 10-years past prediction. We chose the 10-years because the rebuilding measure for PBF uses the

10-years' timeline. This work can be thought of as if we conducted the assessment ten years ago using data only up to that year and forecast forward with the catches by fleets as did occur in the next ten years, could we have predicted what happened to the stock? The result showed that the PBF assessment is a reliable assessment for prediction using the full dynamic model and age-structured production model. It is because our production function accurately describes, on average, the effects of removing catches at age. We argue a model with this predictive ability is likely capturing a reasonable approximation of the dynamics.

Discussion

The WG agreed that hindcasting diagnostics demonstrated the good predictability of the current PBF assessment model.

Bootstrapping

Y. Tsukahara presented the analysis on the bootstrapping. The bootstrap replicates model dynamics to figure out the uncertainty of estimation in stock assessment and to take into account uncertainty of the stock status at the starting point of the future projection based on the parameter estimation errors by observation error. In the previous assessment, the point estimation in the base case model was much closer to the lower confidence interval rather than being around the center of confidence interval of the bootstrapped distribution. In order to address the issue, the procedure which multiplies all of input sample size by 10 and set the adding constant for fleet 10 to 0.0001 was applied when generating the data replicates to resample the size composition data sufficiently and appropriately (Lee et al., ISC/21/PBFWG-1/07). As a result, the point estimation in this assessment was much less biased and it was closer to the median of bootstrap replicates than that in the previous assessment.

Discussion

The bootstrapping procedure is used to evaluate the uncertainty of the model and to conduct the rebuilding projections. The WG discussed a bootstrapping bias that appeared up to the 2020 benchmark assessment and the relative merits of alternative methods to deal with that bias. It was noted that the 2020 procedure used to reduce the bias was an ad hoc median adjustment. A new procedure has been proposed (Lee et al., ISC/21/PBFWG-1/07) which is not ad hoc but addresses the underlying issues causing the bias. It was noted that the bootstrapped median bias using the new procedure is less than 5%, which the WG considered acceptable. It was also noted that both the ad hoc method and new method resulted in similar probabilities of rebuilding when applied to the 2020 assessment results. **The WG agreed to use the new procedure proposed by Lee et al. 2021 to do the bootstrapping.**

4. FUTURE PROJECTIONS

4.1. Confirmation of Projection Scenarios

There was extensive discussion on what years of recruitment should be estimated or replaced by resampled values in the bootstrap forward projections. It was explained that years that have little information about recruitment in the data will be calculated by the bootstrap to be average with a level of uncertainty related to the uncertainty in the virgin recruitment and this underestimates the uncertainty. Due to the elimination of the recruitment index based on monitoring data, there are several years with little or no information on recruitment. Due to the combination of fishing mortality limits and catch limits, it is not possible to replace years of recruitment during the historical period with resampled recruitment. Instead, the bootstrap has to be started in an earlier year. However, this approach ignores data about the current age structure and produces the catch that differs from the observed catch in years after the start of the bootstrap procedure.

A method to overcome this problem was suggested that involved producing dummy data for a recruitment index with the appropriate level of uncertainty to trick the bootstrap into fitting the data and estimating recruitment with the appropriate distribution. However, despite the WG showing interest in this approach, they considered it too much work for the current assessment and that it should be considered for future research. The issue may be resolved in a few years when there may be sufficient data to validate the recruitment index based on monitoring data. It was also suggested that since this was an update assessment, introducing a new approach to do the bootstraps may not be appropriate.

Bootstrap projections were presented starting in both 2018 and 2020 to determine which starting time would be most appropriate and the possible biases. Starting in 2020 had lower mean biomass and smaller confidence intervals for the early years of the projection. Starting in 2018 resulted in high variation and slightly less mean recruitment in recent years (starting in 2020 had biased low uncertainty due to lack of information as explained above). However, the probability of achieving the second rebuilding target was about the same. The catch in 2024 was about the same, but the catch for the historic period (2018-2020) was different. **The WG agreed to start projection from 2020 FY as done in the previous assessment.**

Sensitivity analyses of the projections to model assumptions were conducted using the short-term model. The projections were insensitive to all the assumptions except the steepness of the stock-recruitment relationship. However, it was pointed out that the steepness sensitivity underestimated the rebuild because the recruitment (not the deviates) is resampled around the stock-recruitment relationship and average recruitment should increase as the stock rebuilds.

To respond to the request from the WCPFC NC and IATTC, the WG also discussed the assumptions about future recruitment. It was suggested to confirm if there is autocorrelation of the recruitment, which implies other drivers of recruitment change besides the spawning biomass. The WG confirmed there is no significant recruitment autocorrelation during 1980-2016 (Fig. 2). Since the current (2020) stock level is higher than that of the historical average level, it was considered that resampling the future recruitment from the entire assessment period is appropriate. **The WG agreed to apply the same assumption for the recruitment in future projections.**

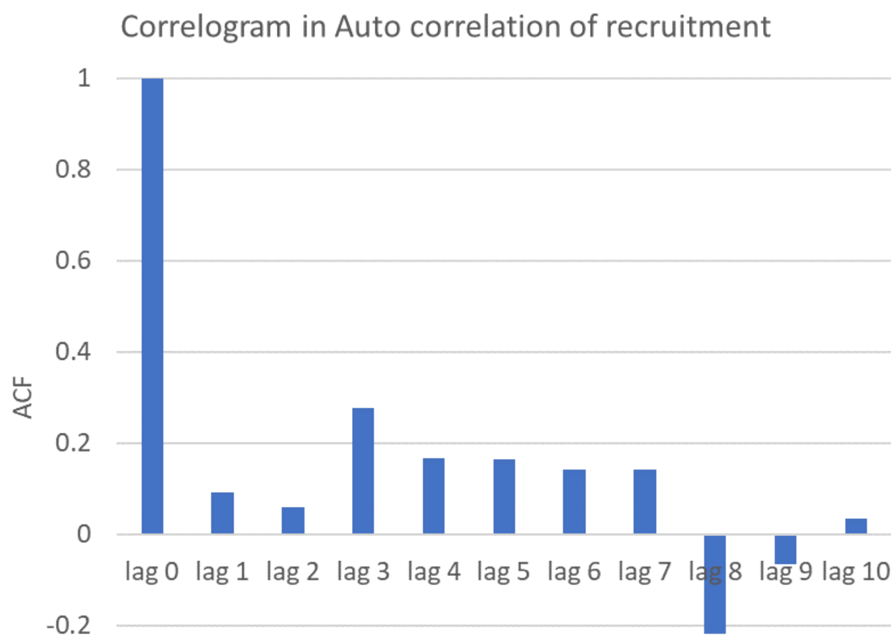

Figure 2. Correlogram in autocorrelation in recruitment estimates (1980-2016) from the base case model. Lag 1 corresponds to the autocorrelation of two consecutive years' recruitment.

4.2. Projection Results

The WG confirmed the projection results. One clarification was made about the definition of a year in performance indicator, namely "10 years after achieving initial rebuilding target". The presenter responded that it is the defined time limit for the second rebuilding period by the RFMOs, and it was the 2029 fishing year for the projections since the initial rebuilding target has been achieved in the 2019 fishing year. Another clarification was made for the definition of "the Risk to breach the initial rebuilding target at 2024". It was responded that because a limit reference point has not been formally adopted for this species, this was calculated to evaluate the risk of each harvesting scenario breaching a certain level of the biomass. It was suggested to use the same performance indicator used in the past assessment, which was the risk of breaching the historical lowest biomass at least once in the future ten years, to evaluate the risk for each of the scenarios.. The WG agreed to this suggestion. **The WG confirmed the projection results to be used for conservation information.**

4.3. Robustness Test

The WG reviewed the projection results from the model including the new recruitment monitoring. It was confirmed that the results were very similar and the WG considered that the inclusion/exclusion of the new recruitment index does not influence the management advice.

The WG also confirmed the results of the future projections based on the sensitivity analyses of the assessment model against the alternative assumptions about the growth (larger asymptotic length), natural mortality (lower M for age 2 and older fish), and lower steepness (h=0.85). Although the relative biomass at the starting point of the projection or expected recruitment relative to the R0 were pessimistic for those sensitivity runs, the WG confirmed that the second rebuilding target would be achieved in each projection. One clarification was made about the future recruitment of the lower steepness projection if those were resampled from the recruitment in the assessment period or calculated from the resampled recruitment deviation around the assumed stock-recruitment deviation. The presenter responded that to maintain the consistency of the analysis method, those were resampled from the assessment recruitment time series. The WG confirmed that this could be a more pessimistic assumption about the future recruitment than an assumption of the future recruitment being produced by the assumed stock-recruitment relationship, and this needs to be carefully written in the assessment report and also conveyed to the outside of the PBFWG.

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

The WG reviewed the results of the agreed base case model, sensitivity tests, and future projection. The WG concluded that the 2022 assessment model represents the population dynamics satisfactorily 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 WG prepared a draft Executive Summary of Stock Assessment Report based on the results.

6. WORK PLAN AND RECOMMENDATIONS

- The WG identified areas of improvement for the stock assessment and future projection in the 2020 assessment as follows. The WG reviewed the list and provided comments for each point. Some issues were addressed during this assessment as follows. As for others, the WG will discuss prioritization and work plans in future meetings.
- <u>Underestimate retrospective pattern</u>: needs to be addressed in the future.
- <u>Residuals in composition data in some fleets</u>: resolved some but needs to be addressed continuously.
- <u>Steep slope of selectivity in some fleets</u>: needs to be addressed in the future.
- <u>Asymptotic selectivity in the model</u>: checked and confirmed not influential.
- <u>Bootstrap for the super year observations</u>: addressed in this assessment.
- <u>R1 penalty</u>: checked and confirmed not a serious issue.
- <u>Skewed distribution of bootstrapped biomass in recent years</u>: much improved.
- <u>Biological assumptions in the model</u>: needs to be reviewed continuously.
- <u>Model convergence</u>: addressed through short-term models.

The WG was also concerned that, although PBF assessment models up to now have been reliable, management intervention is apparently altering the nature of some data, which may degrade the quality of future assessments. The WG needs to continue to monitor the quality of input data.

7. OTHER MATTERS

7.1. New Scientific Information Relevant to PBF

Distribution of juvenile PBF off the Nansei Islands in relation to Kuroshio Current (ISC22/PBFWG-01/05)

Y. Tanaka presented document ISC21/PBFWG-02/05. This presentation showed the results of 6 years surveys for juveniles off the Nansei Islands area from 2016 to 2021. The presenter reported that 345 juveniles PBF were caught in 2021 which is the first record of mass collection, and their distribution were related to the Kuroshio Current where the velocity of water current was fast (>1.5 knots).

Discussion

The author responded to questions that the juvenile fish were likely spawned in waters near Taiwan and that no surveys were conducted there, and so the survival process of the juvenile fish is difficult to know. However, the larvae tended to distribute in the current with low velocity in the survey area.

Preliminary results of migration patterns for adult Pacific bluefin tuna in the northwestern Pacific (ISC22/PBFWG-02/04)

Y. Hiraoka presented document ISC21/PBFWG-02/04 " To examine the post-spawning migration and habitat use of adult Pacific bluefin tuna (PBF), pop-up satellite archival tags were deployed on 15 adult PBF with an estimated fork length of 166-257 cm (roughly 150-200 kg), and released off Ishigaki Island, where known as main spawning ground of PBF, between May 25 and June 11 in 2021. A total of 14 tags were successfully transmitted data after being deployed on adult PBF. We focused on four individuals for which long-term (24-97 days), long-distance migration (over 2,500 km) from the tag-deployed area were obtained and described the spatio-temporal changes in their vertical behavior. After their release, these four PBF moved linearly about 2,500 km to the northern Kuroshio-Oyashio transition zone or subarctic regions, and then frequently repeated short-distance movements in the east-west direction. Also, tagged PBF showed regional differences in their diving behavior, reflecting the thermal habitat of the vertical temperature structure.

Discussion

It was explained that many short-term recoveries of tags were due to the use of early pop-up tags.

7.2. PBF MSE

The WG recognized the expectation of RFMOs for ISC to complete MSE work for PBF by 2024. The ISC also informed the RFMOs of two conditions to start the work, i.e., that a sufficient source of expertise is made available for the work and that the management objectives have been clearly defined. Regarding the first one, there is one expert from the USA and another one from Japan ready to support MSE work. As to the second one, although two workshops, one in the USA and another in Japan, were held by the ISC for developing management objectives, it was decided in the NC-IATTC JWG that the JWG will lead the MSE process, including the provision of the management objectives for the development of MSE. The JWG has yet to provide management objectives to the ISC.

The schedule of MSE was discussed. It was agreed at the PBFWG-2 of 2021 (December 2021) that the stock assessment of PBF should be conducted every three years after 2022 (the pre-scheduled 2024 benchmark assessment will thus be postponed to 2025) to give time for conducting MSE. However, considering that some uncertainties existed in the current assessment which need to be addressed in the near future (e.g., validation of some abundance indices for most recent years) and that the most important target for the managers at present is to make sure the stock recovered to the second rebuilding target, the WG agreed that the stock assessment work is the priority, reconfirming the original schedule to conduct the next benchmark assessment in 2024. Thereafter, the WG can focus on MSE work and provide advice on long-term management for the stock once the management objectives are available. Therefore, the WG is of the view that MSE discussion will be prioritized after 2025. In the meantime, the WG considers it appropriate to construct operating models (OMs) based on the short-term model presented during the meeting, which allows more flexible model settings. The exact uncertainty grid to be incorporated in the OMs will need to be further discussed in the WG.

7.3. Others

In response to the query from the Plenary regarding the necessity of close-kin mark-recapture (CKMR) research in PBF assessment, the WG reconfirmed its following observation from the previous (December 2021) meeting at the present assessment. "**While the strength of CKMR is to provide information on the absolute biomass of fishery resource, the WG is confident that the current PBF assessment provides a reasonable and appropriate level of absolute biomass estimate based on various model diagnostic results and thus considers that the need for CKMR is currently low for the stock. However, CKMR can potentially provide useful information on absolute biomass or the biology of the stock and may become valuable in the future assessments or MSE of PBF. Therefore, while currently there is no plan to include CKMR into the stock assessment, the WG encourages its members to continue CKMR research and exchange information at future WG meetings for further collaboration."**

7.4. Future meeting

The WG discussed the future meeting plan in 2022-2023. The WG considered that two meetings are necessary: one for technical development of MSE and the other for research on improving the 2024 benchmark stock assessment. Therefore, the WG agreed to hold meetings in fall 2022 and spring 2023.

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

After intensive review, the WG adopted the executive summary of the stock assessment report. The executive summary will be forwarded to the ISC Chair for approval before it is submitted to the IATTC SAC in May 2022. The assessment report is tasked to complete by the end of April 2022. The sections of the report are assigned to each member as follows; biology: biology group in Japan, input data: Nishikawa, model description: the USA, model results: Fukuda, future projection: Fukuda, major issues: Fukuda, the USA, and Maunder.

9. ADOPTION OF THE WORKSHOP REPORT AND STOCK ASSESSMENT REPORT

The WG reviewed the draft meeting report, made necessary changes, and adopted the report.

10. ADJOURNMENT

The meeting was adjourned on March 18, 2022.

APPENDIX 1: AGENDA

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 (desiree)
- 2.1 Fishery data for input of the stock assessment model
  - 2.1.1 Catch and unseen mortality time series
  - 2.1.2 Abundance index
  - 2.1.3 Size composition data
- 2.2 Review of Biological assumptions for the stock assessment

3 Model setting and results (kevin)
- 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 (mark)
- 4.1 Confirmation of projection scenarios
- 4.2 Projection Results
- 4.3 Robustness test

5 Drafting Stock status and conservation information for Pacific bluefin tuna

6 Work plan and recommendations (michel)

7 Other matters (eric)
- 7.1 New scientific information relevant to PBF
- 7.2 PBF MSE
- 7.3 Others
- 7.4 Future meeting

8 Adoption of the executive summary of the stock assessment report

9 Adoption of the workshop report and stock assessment report

10 Adjournment

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APPENDIX 3. LIST OF DOCUMENTS

Index	Related Agenda	Title	Author	Contact	Website availability
ISC22/PBFWG-01/01	2.1	Standardized CPUE for Pacific Bluefin tuna caught by Japanese coastal and offshore longline in 2022 update assessment	Yohei Tsukahara, Hiromu Fukuda and Shuya Nakatsuka	tsukahara_y@affrc.go.jp	Yes
ISC22/PBFWG-01/02	2.1	Input data of Pacific bluefin tuna fisheries for stock assessment model, Stock Synthesis 3; Update for 2022 assessment	Kirara Nishikawa, Hiromu Fukuda and Shuya Nakatsuka	kiraranishi@affrc.go.jp	Yes
ISC22/PBFWG-01/03	3	Preliminary population dynamics models for the 2022 updated stock assessment of Pacific bluefin tuna	Hiromu Fukuda, Yohei Tsukahara, Kirara Nishikawa	fukudahiromu@fra.affrc.go.jp	No
ISC22/PBFWG-02/04	7.1	Preliminary results of migration patterns for adult Pacific bluefin tuna in the northwestern Pacific	Yuko Hiraoka, Ko Fujioka, Hiromu Fukuda	yhira415@affrc.go.jp	No
ISC22/PBFWG-01/05	7.1	Distribution of juvenile PBF off the Nansei Islands in relation to Kuroshio Current	Yosuke Tanaka, Taiki Ishihara, Atsushi Tawa, Hiroshige Tanaka, Hiroshi Ashida, Masanori Kawazu, Yuko Hiraoka, Hirohiko Takeshima, Kenji Nohara	yosuket@affrc.go.jp	No
ISC22/PBFWG-01/06	3	Update of the PBF population dynamics model using short time series data (1983-) and the sensitivity runs for the robustness test	Hiromu Fukuda, Yohei Tsukahara, Kirara Nishikawa	fukudahiromu@fra.affrc.go.jp	No