FINAL

ISC/20/ANNEX/09

ANNEX 09

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 ALBACORE WORKING GROUP WORKSHOP

July 2020

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ANNEX 09

REPORT OF THE ALBACORE WORKING GROUP WORKSHOP
Stock Assessment Workshop

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

5-14 April 2020 (Eastern Pacific)
6-15 April 2020 (Western Pacific)
Webinar

1. OPENING AND INTRODUCTION

1.1 Welcome and Introduction

An intersessional workshop of the Albacore Working Group (ALBWG or WG) of the International Science Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) was scheduled for 16 – 23 March 2020 at the Southwest Fisheries Science Center (SWFSC), La Jolla, CA, USA. However, the WG decided that it would not be possible to conduct the workshop in person due to the global coronavirus pandemic. The workshop was changed to an electronic meeting that was rescheduled for 5 – 14 and 20 April 2020 (Eastern Pacific time) and 6 – 15 and 21 April 2020 (western Pacific time). Twenty-one participants (**Attachment 1**) attended the WS. The objectives of this workshop were to: (1) complete a new assessment of the North Pacific albacore tuna stock, and (2) to provide scientific information on current stock status, future trends and research needs of North Pacific albacore tuna.

This report is a record of discussions and decisions of the ALBWG during the workshop in which the 2020 stock assessment of North Pacific albacore was conducted. The 2020 stock assessment model structure and assumptions, results, interpretation, scientific advice and recommendations are documented in a separate assessment report available from the ISC website at: http://isc.fra.go.jp/reports/stock_assessments.html.

2. MEETING LOGISTICS

2.1 Meeting Protocol

The ALBWG Chair noted that the efforts of the WG at this meeting would be collegial and follow the scientific method with an emphasis on empirical testing, open debate, documentation and reproducibility, reporting uncertainty, peer review, and constructive feedback to authors and presenters.

2.2 Review and Adoption of Agenda
The draft agenda was circulated prior to the meeting, reviewed and adopted at the workshop. Once discussion began on base case model development, the agenda was revised according to the progress in model development. This revised agenda is shown as **Attachment 2.**

2.3 Assignment of Rapporteurs
Rapporteuring duties were assigned to Kevin Piner and Desiree Tommasi.

2.4 Distribution of Documents and Working Paper Availability
Nine (9) working papers (WP) were submitted and assigned numbers for the workshop (**Attachment 3**). Working papers will be publicly available through the ISC website (http://isc.fra.go.jp/) and author contact details will be provided for the other related materials.

3. INPUT DATA REVIEW
The WG briefly reviewed data sources and preparation methods because those decisions had been agreed upon during the data preparation meeting in Shizuoka, Japan (**ISC/20/ANNEX/04**). Presentations and discussion highlighted issues for members who were not at data preparation meeting.

3.1 Catch
North Pacific albacore catch provided by the WCPFC and IATTC. ***Kiyofuji, H.*** **(ISC/20/ALBWG-01/04)**

In this document, catch data provided by the SPC and IATTC submitted by non-ISC members were described as a record for future assessment. The data were also compared to data used in the 2017 stock assessment. Data used in this document were provided by the SPC and IATTC . Although there is a relatively large difference in the catches of China and Vanuatu longline fleets between 2017 and 2020, we could not identify the cause. To reduce any data discrepancies between stock assessment, the WG chair needs close communication with the data managers of SPC and IATTC.

Discussion
The WG agreed that the most recently compiled catches were the best available science and will be used for the current stock assessment. It was recommended that a sensitivity analysis should be conducted comparing model results using both 2017 and 2020 input catch series, which could be used to understand the importance of this issue.

3.2. CPUE indices
Estimation of adult and immature abundance indices of North Pacific albacore caught by Japanese longline fisheries over a long period of time, from 1976 to 2018 . ***Fujioka, K., Ochi, D., Ijima H. and Kiyofuji, H.*** **(ISC/20/ALBWG-01/01)**

In this document, we attempted to develop adult and immature abundance indices (i.e. standardized CPUEs) using Japanese longline fisheries data over a long period of time from

1976 to 2018. The standardized CPUE was calculated separately for two periods of 1976-1993 and 1994-2018, based on the information about historical operational patterns and albacore catch-availability of the fisheries. In the recent period (1994-2018), the operational patterns and catch-availability of adult and immature albacore were mostly stable, and the three-year-time lags between prominent peaks of the immature and adult abundance indices were observed regularly, thus the indices in the period would be reasonable to input to the model for the stock analysis in 2020. Further investigation on the validity of the abundance indices obtained from the early period (1976-1993), on the other hand, may be needed as the fishery information during the period still remain largely unstudied.

Discussion

It was noted that the adult abundance index in the assessment data file begins in 1996. Authors reminded the WG that the years 1994-1995 were a period when a change in the data submission format was started, and fleet operations were still changing and that starting the index in 1996 provides a more reliable index. More specifically, the number of hooks per basket, the proportion of zero albacore catches and the species composition of catch became more consistent starting in 1996. It was also noted that the index could potentially be improved further by the use of geostatistical approaches for future stock assessments. In addition, the early index of 1976-1993 needs further investigation before it can be used in future assessment.

Standardized CPUE for North Pacific albacore caught by the Japanese pole and line data from 1972 to 2018. ***Matsubara, N., Aoki, Y. and Kiyofuji, H.*** **(ISC/20/ALBWG-01/02)**

The index of standardized CPUE (i.e., relative abundance index) of north Pacific albacore caught by the Japanese pole-and-line distant water fishery (JPN DWPL) was summarized in this document. Standardized CPUE was analyzed by PL logbook data from 1972 to 2018 using the same methodologies as for the analysis of CPUE standardization in the 2017 albacore tuna stock assessment (Kinoshita et al., 2017). Updated CPUE showed annual variations. In 1972 – 1992, CPUE was confirmed to be from 0.4-1.0, but it switched to a high index (>1.5) in 1993-2003. On the other hand, it returned to the low Index within a range of 0.5-1.0. Particularly, the last years of CPUE (2018) showed the historically low index of around 0.5.

Discussion

It was noted that the ALBWG had agreed not to use this index because the size composition data show large interannual and quarterly variability, which suggests that availability, targeting, and/or catchability of different age and size classes of albacore may be changing substantially on a quarterly time scale. It was therefore likely that a substantial amount of catchability variability remained in the standardized index. The ALBWG also noted that this index was not consistent with other sources of information in preliminary models. The WG also noted that further development is necessary for the index of the JPN LL in the northern area and EPO surface fisheries.

4. BASE CASE MODEL DEVELOPMENT

Teo et al. (ISC/20/ALBWG-01/06) performed an analysis of the 2020 assessment model and made some recommendations to improve the assessment model. The WG noted that two alternative models (A: a base case model beginning from 1994, and B: a sensitivity model which is similar to the model A but start year is 1966) were agreed to at the data preparatory meeting and that model B would be separated from the base case model development (**See section 7**).

Prior to reviewing the assessment model development, a brief overview of current age-length information was presented (ISC/20/ALBWG-01/07).

Review of current status of North Pacific albacore (*Thunnus alalunga*) age and growth. James, K., Dewar, H. and Teo, S. (ISC/20/ALBWG-01/07)

Accurate age and growth parameters are essential to adequately manage a fish stock. The past several North Pacific albacore stock assessments have identified age and growth as a key uncertainty. We reviewed the available age and growth data and determined that the sex-specific von Bertalanffy growth model generated by Xu et al. (2014) and currently used in the albacore stock assessment is still the best available science. We also examined patterns in mean fork length (FL) between sex, region, and year and mean length-at-age between sex and region. Male and female growth was not different up to age 5 or after age 8, however ages 8-14 strongly overlap in length, which may limit our ability to detect statistical differences at current sample sizes. Regional analyses detected overall differences in mean FL between the Western, Central, and Eastern regions, however mean length-at-age data were too patchy to determine if differences were real or an artifact of the sampling design. Annual differences in mean FL were likely a product of sampling design for the age and growth studies rather than representative of any annual variation because most years were sampled by one fishing fleet in one region. These analyses identify current data gaps and can inform research needs to improve future stock assessments of the North Pacific albacore.

<u>Discussion</u>

The author concluded that the currently used sex-specific growth model is the best available science and recommended its use in this assessment. The WG agreed to use the same growth model used in the 2017 assessment. It was noted that data currently used were collected in different areas and by different fleets, indicating that they are not robust enough to represent growth differences among areas. It was also noted that a Pacific-wide sampling plan should be carried out to better characterize growth patterns for future assessments. The ALBWG discussed the Pacific-wide sampling plan during discussion of the research recommendations (**See section 11**).

Development of a preliminary model for the 2020 North Pacific albacore tuna stock assessment. Teo, S.L.H., Piner, K., Lee, H.- H. and Kuriyama, P.T. (ISC/20/ALBWG-01/06)

The objective of this working paper is to describe the development of the preliminary model for the 2020 assessment of NPALB. We developed the model in a stepwise fashion by incorporating the data submitted by ALBWG members, the previously agreed upon model structure and biological parameters, and the best features of the previously suggested improvements. The model is expected to have a main model period of 1994 – 2018. Three types of data were used in this study: fishery-specific catches, size composition, and abundance indices. The geographic area and spatial stratification of this study followed that of the 2017 assessment (Pacific Ocean north of the equator (0°) to 55°N and from 120°E to 100°W). Thirty-five (35) fisheries were defined for this study on the basis of gear, fishing area, season, and unit of catch (numbers or weight), and all catch and effort data were allocated to these fisheries. Catch was reported and compiled in weight (metric tons) or 1000s of fish. Catch for most fisheries were almost identical to the 2017 assessment but there were non-negligible differences in catch for some fisheries. The abundance index from the Japanese longline fishery in Area 2 and Quarter 1 (F9; 1996 - 2018) was used as the index of adult albacore abundance. Quarterly length composition data from 1994 through 2018 were used in this assessment. Length data were available for 22 of the 35 fisheries and were compiled into 2-cm size bins. Similar to previous assessments, we used the Stock Synthesis (SS) modeling platform in this study. The biological parameters used in this study were the same as for the 2017 assessment. Similarly, selectivity curves were largely based on the selectivity curves in the 2017 assessment, but this study investigated several improvements. The major steps in the development of the preliminary model were as follows:

1) Update data from 2017 to 2020, using the 2020 fishery definitions but otherwise similar to the 2017 assessment (e.g., mirrored selectivities for fisheries that were combined in the 2017 assessment, 2017 size data weightings).
2) Selectivity of fisheries that were split into seasonal fisheries (F10-F12; F14-16; F20-F21; and F22-F23) were allowed independent selectivities (using 2017 size data weightings).
3) Japan pole-and-line fleets in Q2 (F21) and Q3 (F22), which are the largest source of removals, are allowed to have annually varying age selectivity (if data are available).
4) Used alternative weighting scheme such that the weighting per sample was relatively equal between fisheries. Sample size multiplier of 0.1626 for all fisheries.
5) Evaluate conflicts between fishery-specific size composition data and the primary adult index; and evaluate the relative influence of the fishery-specific size composition data on the estimated population scale. Size composition data for specific fisheries were down-weighted or additional model processes incorporated, where appropriate.

Overall, we believe that the preliminary model is a reasonable starting point for the ALBWG to develop the 2020 assessment of NPALB. The preliminary model was found to have a reasonably well observed production function, which means that the catch time series and estimated productivity can explain much of the changes in the observed population and adds confidence that the estimated population scale is approximately right. In addition, the minima of the R0 profile for the adult abundance index is approximately in the right region as the maximum likelihood estimate of the R0 of the model.

Discussion

The WG reviewed and discussed a preliminary model developed by the authors and forwarded to the WG prior to the assessment workshop. During development of the base case model, the "preliminary model" presented in the document was used as the "reference case model" or "reference case" for the base case model.

The WG noted that observed size composition data for all fleets were raised statistically to represent the fleet catch in numbers, which represents a theoretical improvement beyond the 2017 assessment. Similarly, the inputted sample sizes for each observed composition (statistical weight in the model) were allowed to vary between fleets representing the different levels of fish sampled. The WG questioned why the reference model did not include a CPUE series representing juveniles. The authors clarified that investigations of Age-Structured Production Models (ASPM) that included a juvenile index (F1 index) failed to converge, which suggests that the production function of the juvenile index was inconsistent with the adult index (F9 index).

The WG further examined conflicts between F1 index and other data using a series of model runs where the F1 index was given more weight (lambda=1, 5 and 10). The WG noted where fit to other data degraded. Size composition from the EPO, F10 and JPN PL were degraded. F1 size composition and F3 size composition improved. Notably, when the F1 index was fitted with a lambda of 1, it caused modest improvement to the F9 index model fit. However, when the F1 index was fitted with larger weights, the fit to the F9 index degraded. This result was consistent with the new ASPM analysis. A new ASPM with recruitment (ASPMr) model was created with recruitment deviations fixed at levels consistent with the F1 index. This ASPMr model degraded fit to the F9 index. However, fitting both the juvenile and adult index with equal weight and estimating recruitment improved the fit to the F9 index. The WG concluded that the F1 fishery likely represents a mixture of two fleets. This was also apparent in the size composition data of F1, which showed a mode of juvenile fish and a mode for adult fish. **The WG recommended not fitting to the F1 index for this assessment. Furthermore, it was recommended that the assessment team should investigate ways to deal with the two modes in the F1 size composition. The WG also recommended that the F1 index and the fleet definition of F1 should continue to be investigated for potential use in future assessments**.

The WG examined the results of model runs investigating alternative ways to improve fit to the F1 size composition data. The reference case uses a time-invariant non-parametric spline selectivity. Different ways to handle misfit of this data were investigated, including use of time-varying selectivity (spline, age-specific) or down-weighting. The WG agreed that including addition selectivity parameters improved fit and likely better represented catch-at-age, but this fleet is not a major source of removals. All the investigated options allowed the model to scale biomass higher, which was expected based on the R0 profile of the reference model. The WG considered further runs that build on these approaches to dealt with misfit to F1 composition.

The WG also investigated conflicts between the adult index (F9 index) and other sources of data in the models. The WG found that in down-weighting the size composition of the US deep set longline (F26) and Japanese pole and line fleets (F21 and F22) fisheries that these fisheries had a relatively large influence on the estimated population scale. Given these results, the WG agreed that the size composition data of those fleets have undue influence on model scale and somewhat degraded the fit to the F9 index.

The WG discussed how to deal with the relatively strong influence of size composition data of various fleets relative to the limited signal from the F9 index on estimates of population scale. The ASPM analysis of the reference case model indicated that the F9 index had good information on the production function of the stock that was consistent with the observed catch. However, the amount of information was limited because the R0 profile showed that the F9 index had about <1 log-likelihood (logL) units of contrast on the R0 parameter within the range of R0 explored. The goal of the WG was to find a model configuration that fits the composition data well but aligns with the population scale as depicted by the F9 index. The WG was reminded that the Japanese pole and line (F21 and 22) fleets have the largest catches and down-weighting their composition causes the size composition data of some years to have large misfit. This misfit could induce errors in the expected catch-at-age. It was noted that there are interactions between data components so that dealing with the misfit to the size data of one individual fleet by down-weighting will simply result in the increased misfit to other size composition data becoming more influential on the estimated population scale. Such a situation would be problematic because sequentially down-weighting different sources of size data would simply be repeatedly trading misfit to one source of data for misfits to other sources (i.e., the Whack-A-Mole problem). Because of the difficulty in dealing with the influence of the composition data, the WG considered choosing a base case model that estimates population scale that is similar to an ASPM. Based on that discussion, the WG concluded that no new model runs have been demonstrably better than the reference case. The WG acknowledged that the reference model had down-weighted the Taiwanese longline (F27) composition data for similar abovementioned reasons that the WG had considered for the other fleets and decided not to proceed with the down-weighting. **Therefore, the WG recommended changing the reference model so that it did not down-weight the Taiwanese longline so that all fleets are treated similarly**. At this point in time, **the WG recommended investigating using time blocks for F1 size selectivity to try to capture the separate fleets included in that fleet. Conditioned on the review results and diagnostic, this model became a candidate base case model.**

The new runs started with full weighting of the F27 composition data. This run had marginal effects of the model relative to the reference run, with the main difference being higher estimated biomass around the 2010 period. Other runs then included the addition of a time-block to the selectivity of F1 which separated the first 3 years into a common selectivity process. A subsequent run added another time block from 1997-1999. All the models with additional process added to the selectivity of F1 had the effect of increasing abundance especially in the first 5 years. The increase in biomass was notable but not large and accompanied by a similar magnitude of increase in R0. It was noted that adding more process to fitting F1 composition degraded fit to the F9 index and changed the initial depletion level at the start of the model. ASPM runs of each of these alternative models gave highly similar, estimated population scales. Management implications are similar for all the models with regard to terminal year depletion. **The WG agreed that it is important to prioritize information from the F9 index on the estimated population scale (R0) and initial depletion (via equilibrium F) through the production relationship. The WG is also prioritizing the F9 index as the measure of population trends during the modelling period**. In choosing a base case the WG will consider this prioritization. **The WG recommended that the first 5 early (prior to 1994) recruitment deviations do not need to be included in the model as there was no information informing them. The WG focused on 3 models from which to choose the base case:**

Model1: reference model;

Model2: reference model with F27 composition given full weight; and

Model3: reference model with F27 composition full weight and additional selectivity process (two additional time blocks) added to F1.

The WG also recommended R0 profiles be completed for each candidate model.

It was noted that the Francis weighting method was applied to any fleets with inputted sample sizes larger than expected based on model fits to the size data (i.e., Francis multiplier <1). Dropping 5 recruitment deviations from the initialization of the model had no effect on model results. Iteratively estimating sigma-r (penalty on recruitment) brought recruitment up in 2014 and lowered the recruitment penalty. It was noted that the F1 time-block model (Model 3 from the list above) had an unusual R0 profile (more information on high side) and difficulties in getting many R0 profile models to converge.
Choice of final base case model: The WG discussed the options for a base case. It was generally agreed that model with time-blocks to F1 did not addres the two-fleet issue appropriately and may have convergence issues. It was noted that it fit the F1 composition better, but this model degraded fit to the F9 index. Therefore, the WG decided to exclude Model 3, because of degraded fit to F9 index and had potential convergence issues. The WG also agreed that the original reference model used subjective down-weighting which, in retrospect, appears hard to justify. **Therefore, the WG selected Model 2 as a base case. Francis weighting was recommended to down-weight fleet composition with inputted sample sizes that exceeded the calculated Francis weights. Furthermore, because of the large number of selectivity parameters estimated, the WG agreed it would need to see convergence testing before the base case would be accepted.** The WG recommended all 3 candidate models and the ASPM be carried forward in graphs to show that the candidate models all produced similar answers.

The WG received a presentation of model results, diagnostics and convergence tests for the base case model. Convergence testing (jitter of initial parameter values and phases) showed potential areas of local negative log likelihood minimum. It was shown that F21 composition data was what improved in runs at or near the global likelihood minimum. In addition, some age selectivity parameters for F22 and F33 were at the low bounds and potentially causing some of this instability as they appeared poorly informed by data, and those parameters were fixed at values indicating negligible selection for size/ages not caught by the fleet. Composition data for fleets F1, 23 and 27 were reweighted by the Francis method. Sigma-r was iteratively fixed at 0.3 to be consistent with the data given this models structure. **The WG agreed to use this version of the model as the base case model and its results to characterize the stock dynamics.**

The WG agreed to use a base case model with the following structural characteristics:

1. Period: 1994 – 2018
2. Fitting to one index: F9 index (the JPN LL from 1996 to 2018)
3. Age- and sex-specific M vectors
4. Steepness of the Beverton-Holt stock-recruitment relationship is 0.9
5. Dome shaped length selectivity curves for all fisheries
6. age-based selectivity for ages 1 – 5 for surface fleets (troll and pole-and-line)
7. annually varying age-based selectivity for the two most important JPN PL (F21 and F22) fleets

The agreed upon base case model represents three important advances compared to the previous assessment in 2017:

1. Size composition data that were fit in the model were raised statistically to represent the catch in numbers, which is an improvement in data preparation. Based on this improvement, the input sample sizes were allowed to vary between fisheries and over time, depending on the sampling that occurred;
2. The primary Japan pole-and-line fisheries were subdivided into seasonal fisheries, and the selectivity of the two most important Japanese pole-and-line fisheries were allowed to vary annually, if data were available. This substantially improved the model fits to the size composition data of these important fisheries;
3. The Japan longline fisheries that caught albacore in the main spawning area were also subdivided into seasonal fisheries with separate selectivity patterns, which improved fit to the size composition data.

5. DIAGNOSTIC ANALYSES

The WG recommended that the same diagnostic analyses in the 2017 assessment be used for the 2020 assessment during the data preparation workshop: (1) Model convergence (jitter analysis), (2) Age-Structured Production Model (ASPM) diagnostic, (3) Likelihood profile on virgin recruitment (R_0), (4) Residual analysis, (5) Retrospective analysis.

The WG reviewed the above analyses for the base case model. Base on the convergence test, the base case model appeared to be the best maximum likelihood estimate (MLE). ASPM diagnostic showed that the estimated catch-at-age and fixed productivity parameters were able to explain the trend in the F9 index. The R0 profiling showed that the F9 index influences population scale on the low side and that size composition data influence the high side of population scale. There was no retrospective pattern in SSB when 1-5 years of data are removed. The WG agreed that diagnostic results satisfactorily meet the conditions that the base case model provide the best representation of north Pacific albacore population dynamics.

6. SENSITIVITY ANALYSES

The WG agreed at the data preparatory meeting that similar sensitivity analyses would likely be performed for the 2020 assessment. However, the exact sensitivity analyses would depend on the model structure of the base case model. Following sensitivity runs to assess either model performance or the range of uncertainty associated with a particular parameterization:

1. Natural mortality (M): constant M of 0.3 across sexes and ages (same as 2014 assessment); constant M of 0.48 and 0.39 for female and male of all ages, respectively; and estimated M based on prior from Kinney and Teo (2017).
2. Stock-recruitment steepness (*h*): alternative values for the steepness parameter (*h*=0.75; 0.80 and 0.85) and with prior based on Brodziak et al. (2011).
3. Growth: CV of L_{inf} is fixed at higher (0.06 or 0.08).
4. EPO catch: assume catches in EPO over the last 3 years (2016-2018) were double the observed catches.
5. Changes in catch from non-ISC members: replace observed catch to the 2017 assessment
6. Start year of adult index: start year from 1994 rather than 1996
7. Size composition weighting: F9 fleet with natural weight, downweighing of most fleet using 0.1 multiplier
8. US longline asymptotic selectivity: assume that the US longline fishery in Area 2 and 4 has an asymptotic size selectivity.
9. Same model structure as in 2017 stock assessment.

The WG reviewed the sensitivity results. Constant and sex specific natural mortality runs produced a lower biomass scale as compared to the base case model run. Estimated M based on prior from Kinney and Teo (2017) showed higher population scales because the model estimated larger Ms. Different steepness had no impact on model outputs because the stock level is relatively high on the flat part of the Beverton-Holt curve. Increasing the CV of L_{inf} led to the model expecting a higher proportion of larger fish, which in turn led to the estimation population scale decreasing. When EPO catch during 2016 – 2018 was assumed to be double of observed catch, the fishing intensity during the period increased and the depletion decreased relative to the base case outputs. Sensitivity model runs of the change in catch from non-ISC members and assuming asymptotic selectivity for the US deep-set longline fishery (F26) did not show any large differences in model results.

The WG had a discussion on what sensitivity analyses to include in the reference points table for managers and in the executive summary. The WG agreed that growth is one of the major uncertainties in this assessment and that the L_{inf} CV=0.06 scenario should be included in the table. The WG agreed that the steepness and natural mortality scenario would not be included in the table because results by different steepness values show no differences as compared to the base case model and there is poor scientific support for a constant M=0.3 y^{-1} scenario. The

WG decided to include the results from a model with model structure that is highly similar to the 2017 assessment model structure for reference purposes and a clear description of model structure.

7. ALTERNATIVE MODEL DEVELOPMENT

The alternative model (1966-2018; Model B) was being developed as an exploratory model to help understand the changes reflected in the data prior to the 1990s. The WG noted that the development of this model is still incomplete, but initial results appeared similar as the base case model for the period 1994-2018. The following model developments occurred during the WS and brief results were described;

1. Start year from 1966 with the inclusion of data from 1966 – 1993. The JPN LL index (F13; 1976 - 1992) was fitted. This model did not fit the size compositions and index very well. It also showed that data quality was poorer in the early period. Selectivity parameters for F9 and F26 reached the boundary.
2. To improve fit to index, a time block for the JPLL for the 1976-1993 were applied, when a large proportion of larger fish (>100 cm) were observed in the samples from the JPLL fisheries. This improved fit to the later index (F9 index), but the fit to the early one (F13 index) remained poor. Also, there is a large misfit of the JPPL size compositions in the early period with JPPL as well as boundary issues.
3. Same as 2 but with time varying age selectivity for JPPL. The fit for the early period index (F13 index) improved as well as the JPPL misfit, but selectivity boundary issues remain.

The best model produced results that were relatively consistent with the base case model results. The ALBWG agreed that the analysis was useful to understand the problems with the early data and provide support to the decision of starting the current model in the mid-1990s. The WG also noted that it might be necessary to consider incorporating the annual fluctuations of size into the CPUE standardization. **The WG concluded that there are difficulties in finding a well-behaved model that starts in 1966 and more research is needed to develop a model that the WG would be comfortable putting forward**. As such, **the ALBWG recommended that these qualitative model results be presented in a section of the assessment report**.

8. FUTURE PROJECTIONS

The test run of future projection for North Pacific albacore stock using the SS future C++ and the multivariate normal distribution. ***Ijima, H.*** **(ISC/20/ALBWG-01/03)**

This working paper shows the preliminary results of a stochastic future projection using SSfuture C++. For the uncertainty of the initial condition, the multivariate normal distribution generated the 1,000 number at age. The additional SS3 outputs ("ss.cor") file are available for the multivariate normal distribution. Lognormal distribution makes stochastic recruitment in this projection. In terms of the management options, we set the constant catch and the constant F scenario that the ISC albacore working group will use in the 2020 stock assessment. In comparison with the 2017 stock assessment result, the initial values of the future projection were improved. Also attached are the original Rcpp cord of the SSfuture C++ and a simple example in the Appendix.

Discussion

Although this projection software was approved by the WG at the data preparatory meeting, the WG discussed (1) correlation between abundance of year classes in the terminal year and (2) proportion of negative numbers at age which may cause bias in estimated spawning biomass. The author responded that (1) was the result of the model estimate of the population age structure (N-at-age) in the terminal year of the model; and (2) was due to resampling from a multivariate normal distribution. The author also noted that zeros replaced the negative numbers in the N-at-age vectors but the negative bias from was relatively small. It was also noted that the initial age-1+ population structure was randomly generated from a multivariate normal distribution with means, variances, and covariances estimated by the base case model, while recruitment deviates were sampled from a lognormal distribution consistent with the base case model, logN (0, sigma-r).

The WG also reviewed the results of projection model runs. Two scenarios, constant F (recent 3 years average: 2015-2017) and constant catch (recent 5 years average: 2013-2017) over 10-yr period to 2028, were presented. Data from 2018 were provisional and were not included in the estimation of F or average catch. It was pointed out that the uncertainty, especially in the constant-F runs, decreased over time. The author responded that, especially in the constant-F runs, there are only the two sources of uncertainties in the projections: 1) the initial N-at-age; and 2) the projected recruitment. In the constant-F scenario, the F-at-age vector was assumed to be invariant at the average of 2015 – 2017. In the constant catch scenario, the shape of the F-at-age vector was assumed to be invariant but a variable multiplier is applied to the F-at-age vector so that the catch remains constant under different population dynamics. The WG recommended that the limitations in the projected probabilities of exceeding reference points in the projection software be clearly stated, and recommended that area for future improvements. Under the current fishing intensity ($F_{2015\text{-}2017}$) scenario, the female SSB is expected to increase to 62,873 t (CI: 45,123 - 80,622 t) by 2028, with a 0.2 % and <0.01 % probability of being below the LRP by 2020 and 2028, respectively. Similarly, employing the constant catch harvest scenario is expected to lead to an increased female spawning biomass of 66,313 t (CI: 33,463 - 99,164 t) by 2028. The probability that female SSB will be below the LRP in the constant catch scenario is higher than the constant $F_{2015\text{-}2017}$ scenario but is still below 0.5% for all years. It should also be addressed that the constant fishing intensity scenario for longline fisheries would be unrealistic to archive in the real world as effort changes (number of hooks or vessels) may not result in changes in fishing mortality.

9. REFERENCE POINTS AND KOBE PLOTS

The WG discussed the reference points that would be estimated and presented in the assessment and agreed to estimate the same as in the 2017 assessment using the SPR approach.

The WG also discussed Kobe plots briefly and agreed to prepare two plots (one is for the base case model with annual trajectory; another combined the terminal year of the base case and two sensitivity results out of 9 analysis) that are the same as in the 2017 assessment.

10. STOCK STATUS AND CONSERVATION INFORMATION

The WG reviewed the text describing current stock status and conservation information for the Executive Summary and stock assessment report. **The WG recommends the following for stock status:**

1. The stock is likely not overfished relative to the limit reference point adopted by the Western and Central Pacific Fisheries Commission (20%$SSB_{current, F=0}$), and
2. No F-based reference points have been adopted to evaluate overfishing. Stock status was evaluated against seven potential reference points. Current fishing intensity ($F_{2015-2017}$) is likely at or below all seven potential reference points (see ratios in Table ES1).

The WG recommends the following conservation information:

1. If a constant fishing intensity ($F_{2015-2017}$) is applied to the stock, then median female spawning biomass is expected to increase and there will be a low probability of falling below the limit reference point established by the WCPFC by 2028.
2. If a constant average catch ($C_{2013-2017}$ = 69,354-t) is removed from the stock in the future, then the median female spawning biomass is also expected to increase and the probability that SSB falls below the LRP by 2028 will be slightly higher than the constant fishing intensity scenario.

The WG agreed that the report should provide some explanations regarding recent lower catches while the stock status is not overfished nor overfishing. The WG noted that the lower estimated recruitment for 2014 and 2015 would have resulted in lower biomass for the ages targeted by the surface fleets in 2017 and 2018. A plot of total biomass or biomass for the range of ages targeted by the surface fleets might be useful for this explanation. It was also noted that recruitment estimates in the last three years are very uncertain due to the lack of information prior to age 3.

11. RESEARCH RECOMMENDATIONS INCLUDING BIOLOGICAL SAMPLING PLAN

The WG reviewed and discussed research on sex identification of fish using genetics methods (ISC/20/ALBWG-01/08) and biological sampling plan (ISC/20/ALBWG-01/09). There was generally support for more age and growth research.

PCR-based sex determination for North Pacific Albacore (*Thunnus alalunga*). Craig, M.T. and Hyde, J.R (ISC/20/ALBWG-01/08)

Albacore (*Thunnus alalunga*) is a pelagic tuna species that supports a lucrative fishery worldwide. Like all tuna species, albacore are not sexually dimorphic. This means that accurate identification of sex in albacore is only possible through direct observation of gonads. This process is costly, time consuming, and lethal, often necessitating histological confirmation of sex due to the large numbers of immature animals captured in some fisheries. Previous work has shown that a genetic approach to determine sex in albacore is possible. To explore this, we examined sequence data in albacore and modified previous genetic assays in an attempt to decrease phenotype/genotype mismatches in a PCR-based method. The modified assay presented herein, when combined with previous data, demonstrates that sex of albacore can be determined with a 3.3% error rate, and that increased sample size will help to refine this.

Discussion

There is a small mismatch between the histology and genetics. The authors clarified that with continued development of the method they expect that sex assignment reliability may improve.

Ideas for future sampling programs of North Pacific Albacore (*Thunnus alalunga*). James, K., Dewar, H. and Teo, S. (ISC/20/ALBWG-01/09)

Age and growth parameters have been identified as a key uncertainty in the albacore stock assessment. Addressing this uncertainty requires that additional samples be collected. Any new sampling program needs to be scientifically rigorous and to consider potential biases, resource requirements, logistics, and the questions being addressed. Three sampling programs are outlined here as options for future sampling, noting that these are not the only options: 1) age-stratified, 2) proportional, and 3) random. The current length-at-age data were analyzed to inform potential future sampling for both the proportional and age-stratified designs. Mean lengths-at-age were used to define appropriate length bins: 0-60 cm fork length (FL), 60-70 cm, 70-80 cm, 80-90 cm, 90-100 cm, 100-110 cm, and >110 cm. These length bins were used to determine the number of samples that need to be collected for an age-stratified sampling program. These options could be applied at various scales from one-time collection to annual, fleet-specific operational ageing. Current programs should be reviewed to leverage sampling already in place as a starting point prior to starting any new sampling program.

Discussion

The WG agreed that developing sampling program for albacore is difficult given the movement, migration and different selectivities of the fleets operating in different seasons and areas. It was suggested that the sampling plan and what it estimates should be coordinated with the approach for the stock assessment. The WG recognizes that given that there is limited contrast in the data, more information on age might be useful for improving the assessment model. If the goal is to develop a fisheries-specific age-length key (ALK) for a future age-based stock assessment model, the ALK would need to be developed for each year because the age structure for each fleet would change every year. If the aim is to improve the growth curve, collection of more sex-specific samples for the older ages for which growth is more uncertain might be warranted, while samples of younger fish from different regions might be still useful to better assess the potential for region-specific growth curve. It was noted that the age-stratified sampling may be difficult to implement for the distant water longline fleets such as Taiwan and Korea, as the catch is often landed in foreign ports or albacore is not the main target species. Canadian scientists are considering the collection of samples for age and growth determination but will need to talk to the fishers' association to develop a sampling plan. They might be able to have a plan in place for 2021. Japan is also planning to collect age-length data as well as continue to work on the genetic sex identification and otolith measurement procedures. The WG noted that the goal of the paper is to describe the importance for designing a sampling strategy and the document provides a starting point for future discussion. **The WG supports developing a basin wide sampling program and agreed that there should be coordination between the sampling and model development as well as coordination among different countries.** The WG also noted that consistent sampling procedures (collection, store and processing) should be shared among member countries. For further reference, there was a workshop for PBF and ALB ageing in 2013 (http://isc.fra.go.jp/pdf/ISC14/Annex5-Tuna_Ageing_Workshop_Report(Nov2013).pdf).

The WG identified the following recommendations to improve the stock assessment model:

1. Further investigation of the F1 fishery because there appears to be a mixture of two fleets in this fishery;
2. Evaluate adult indices from the JPN LL in southern areas, especially with respect to incorporating size data into the standardization process using a spatiotemporal and/or data from alternative seasons;
3. Evaluate potential juvenile indices from the JPN LL in northern areas, the JPN PL and/or EPO surface fisheries;
4. Collect of sex-specific age-length samples using a coordinated biological sampling plan to improve current growth curves, and examine regional and temporal differences in length-at-age;
5. Collect of sex ratio data by fleet; and
6. Evaluate and document historical high seas drift gillnet catch by member countries.

The WG also noted that followings are general recommendations to understand North Pacific albacore biology and ecology:

7. Explore the utility of conventional and electronic tagging data to inform growth, catchability, and spatial dynamics to improve the conceptual model of this species;
8. Explore age and growth at early stage from larvae and juvenile collected by research vessel; and
9. Explore ocean productivity as drivers of albacore trends and dynamics.

12. MANAGEMENT STRATEGY EVALUATION

Desiree Tommasi (MSE specialist) provided an update on progress of the MSE after the second MSE WS.

Relationship between the effort of longline and surface fleets in the North Pacific and Albacore Fishing Mortality. ***Tommasi, D. and Teo, S.L.H*** **(ISC/20/ALBWG-01/05)**

In the first round of the North Pacific Albacore (NPALB) Management Strategy Evaluation (MSE), effort was not modeled explicitly as the number of hooks, fishing days, or vessels. It was modeled as fishing intensity. One of the recommendations from managers and stakeholders following presentation of the first round of MSE results during the 4th NPALB MSE Workshop was that the relationship between how effort is modelled in the MSE operating models and effort in the real world should be examined by the ALBWG and included in the future round of MSE to help managers and stakeholders, if possible. To that end, members of the ALBWG compiled effort data from their respective country on number of vessels, number of hooks (for longline vessels) or number of fishing days (for surface fleets). Here we show temporal trends in the effort data and assess if fishing mortality as estimated by the base case operating model is correlated with changes in effort. Japanese effort, both for the longline and surface fleet, has decline from 1993 to present. Effort of the U.S. and Canadian surface fleet has remained relatively stable. Chinese Taipei's longline effort has been relatively stable since the mid-2000s. U.S. longline effort, Korean longline effort, Vanuatu longline effort, and China's longline effort (numbers of hooks, quarter 1) have increased from 1993 to present. However, albacore fishing mortality showed an increasing trend only for the Japanese surface fleet in the northern area during April-June and for the Japanese longline fleet operating in Area 2. Longline effort was often found not to be representative of albacore fishing mortality, possibly because many longline vessels are not targeting albacore. Implications of these results for the second round of NPALB MSE are also discussed and a workplan for the second round of NPALB MSE is presented.

Discussion

The WG sought clarification on the relationship between fishing effort and F. The authors clarified that the relationship between effort and F is uncertain and thus it may take large reduction in effort to actually produce a reduction in F given variability in movement, catchability, and species targeted. It was noted that the recent changes in the projections methods and resulting uncertainty may affect the MSE analysis. The 5th MSE workshop is currently scheduled for 2021. **The WG is considering a WG webinar in August 2020 to review the ongoing work on MSE and expects a complete report in December 2020. The WG recommends the 5th MSE workshop be held in person rather than by webinar. It was explained that it is difficult to explain MSE results and a face to face meeting is strongly recommended. The timing of this workshop should be in February or March 2021, contingent on resolution of current travel issues.**

13. ADMINISTRATIVE MATTERS

13.1 Workplan for Completing Assessment Report

The WG is required to submit its stock assessment report to the Office of the ISC Chair no later than June 1. In order to meet this deadline, Steve Teo will be responsible for drafting the stock assessment report. A first draft report of the assessment report with the executive summary will be circulated to WG members by May 15.

13.2 Update National Contacts for ALBWG
The following were confirmed as national contacts for ALBWG matters:

Canada – Zane Zhang
Chinese Taipei – C. -Y. Chen
Japan – Hidetada Kiyofuji
Korea – Mi Kyung Lee
Mexico – Michel Dreyfus
USA – Steve Teo, Desiree Tommasi
IATTC – Carolina Minta-Vera
SPC – Graham Pilling
Data Manager – TBD

13. 3 Time and Place of Next Meeting
The WG developed a work plan for the stock assessment scheduled for 2020 and second round of MSE (**Attachment 4**). **The WG agreed with the proposed work plan.**

13.4 Other Matters
The WG discussed presenting provisional stock assessment results at the upcoming IATTC Science Advisory Committee (SAC) meeting in May 2020. However, the logistics and agenda for the IATTC SAC is currently unclear due to coronavirus pandemic. Nevertheless, the WG agreed to presenting the preliminary results of the 2020 assessment at the SAC, if the IATTC requests a presentation of the preliminary results and the ISC Chair agrees.

The WG also noted that the status of the peer review for the assessment is uncertain but will be discussed with the ISC Chair and Plenary. Results of the consultation will be forwarded to WG members later.

The WG Chair reported that an election for a new WG Chair is scheduled for the ISC20 Plenary meeting. However, the WG decided to conduct election at this meeting because the Plenary meeting will be held as a webinar focusing on specific topics such as the new PBF and ALB benchmark assessments. The result of the election was that the current WG chair (Hidetada Kiyofuji, Japan) and vice-Chair (Steve Teo; USA) were both re-elected for another three-year term (2020 – 2023).

14. CLEARING OF THE REPORT
The WG Chair prepared a draft of the report, which was reviewed by the WG prior to adjournment of the workshop. After the workshop, the WG Chair evaluated and incorporated suggested revisions, made final decisions on content and style and distributed a second draft via email for approval by WG members. The final report will be forwarded to the Office of the ISC Chair for review and approval by the ISC20 Plenary.

15. ADJOURNMENT

The ALBWG meeting was adjourned on 20 and 21 April 2020 (Eastern and Western Pacific Date, respectively). The WG Chair thanked the scientists participating in the workshop for their attendance and contributions on albacore matters.

16. LITERATURE CITED

Kinney, M.J., and Teo, S.L.H. 2016 Meta-analysis of north Pacific albacore tuna natural mortality. ISC Albacore Working Group Intercessional Workshop, 8-14 November 2016, Pacific Biological Station, Nanaimo, BC, Canada. Working Paper ISC/16/ALBWG-02/08, 9 p.

Attachment 1

List of Participants

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Attachment 2
ALBACORE WORKING GROUP (ALBWG)
INTERNATIONAL SCIENTIFIC COMMITTEE FOR TUNA AND TUNA-LIKE SPECIES IN THE NORTH PACIFIC OCEAN
STOCK ASSESSMENT WORKSHOP
5-14 April 2020 (Eastern Pacific)
6-15 April 2020 (Western Pacific)

Webinar

Agenda (revised)

Time:

JAPAN and KOREA:	09:00 – 13:00 (break: 10:30)
CHINESE TAIPEI:	08:00 – 12:00 (break: 09:30)
NOUMEA:	11:00 – 15:00 (break: 12:30)
CANADA, USA and MEX ICO: **HI (USA):**	17:00 – 21:00 (break: 18:30) 14:00 – 18:00 (break: 15:30)

* Note that 11 April is Saturday in western Pacific time, but we will have the WS in accordance with progress on Base case Model development

<u>April 5 & 6 (Sun & Mon)</u>

1. Opening of Albacore Working Group (ALBWG) Stock Assessment Workshop
   1.1 Welcoming remarks
   1.2 Introductions
   1.3 Scheduling
2. Meeting Logistics
   2.1 Meeting Protocol
   2.2 Review and Adoption of Agenda
   2.3 Assignment of Rapporteurs for Workshop Report
   2.4 Working Paper distribution and availability
3. Stock Assessment Report and Section Assignments
4. Input Data Review
   5.1 Catch
   5.2 CPUE indices

<u>April 6 & 7 (Mon & Tue) – 14 & 15 (Tue & Wed)</u>

5. Basecase Model Development
6. Basecase Model Initial Conditions

7. Diagnostic Analyses
8. Sensitivity analyses
9. Alternative Model development
10. Future projection
11. Biological Reference Points and Kobe Plots
12. Stock status and Conservation information
13. Research Recommendations including biological sampling plan

April 20 & 21 (Mon & Tue)

14. Clearing of Executive Summary
15. Clearing of Meeting Report
16. Administrative Matters
    - 16.1 Workplan for Completing Assessment Report
    - 16.2 Progess of MSE
    - 16.3 Time and place of next meeting
    - 16.4 Update national contacts for ALBWG
    - 16.5 Other matters
17. Adjournment

Attachment 3
List of Working Papers and Presentations

Number	Title and Authors	Availability
ISC/20/ALBWG-01/01	Estimation of adult and immature abundance indices of North Pacific albacore caught by Japanese longline fisheries over a long period of time, from 1976 to 2018. Fujioka, K., Ochi, D., Ijima, H. and Kiyofuji, H.	Public
ISC/20/ALBWG-01/02	Standardized CPUE for North Pacific albacore caught by the Japanese pole and line from 1972 to 2018. Matsubara, N., Aoki, Y. and Kiyofuji, H.	Public
ISC/20/ALBWG-01/03	The test run of future projection for North Pacific albacore stock using the SSfuture C++ and the multivariate normal distribution. Ijima, H.	Public
ISC/20/ALBWG-01/04	North pacific albacore catch provided by the WCPFC and IATTC. Kiyofuji, H.	Public
ISC/20/ALBWG-01/05	Relationship between the effort of longline and surface fleets in the North Pacific and Albacore Fishing Mortality. Tommasi, D. and Teo, S.L.H.	Public
ISC/20/ALBWG-01/06	Development of a preliminary model for the 2020 North Pacific albacore tuna stock assessment. Teo, S.L.H, Piner, K., Lee, H.-H. and Kuriyama, P. T.	Public
ISC/20/ALBWG-01/07	Review of current status of North Pacific albacore (*Thunnus alalunga*) age and growth. James, K., Dewar, H. and Teo, S.	Public
ISC/20/ALBWG-01/08	PCR-based sex determination for North Pacific Albacore (Thunnus alalunga). Craig, M.T. and Hyde, J.R.	Public
ISC/20/ALBWG-01/09	Ideas for future sampling programs of North Pacific albacore (*Thunnus alalunga*). James, K., Dewar, H. and Teo, S.	Public

Attachment 4
Workplan

Date	Location	Task/Event
April 5 – 14, 20 2020	CAN, USA	ALBWG: stock assessment by webinar
April 6 – 15, 21 2020	JPN, KOR, TWN	
TBD	TBD	IATTC SAC
July 2020	Webinar	ISC20
August 11 – 20 2020	TBA	SC16
August 2020	Webinar	ALBWG: MSE progress
September 2020	Japan	NC16
December 2020	Webinar	ALBWG: review on MSE progress and completed report
February or March 2021	TBD	5th ISC MSE workshop: review results from 2nd round of MSE