Annex 10

REPORT OF THE ALBACORE WORKING GROUP WORKSHOP

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

14-28 April 2014

Southwest Fisheries Science Center
La Jolla, CA, United States of America

1.0 OPENING OF THE WORKSHOP

An intersessional workshop of the Albacore Working Group (ALBWG or WG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) was convened at the Southwest Fisheries Science Center (SWFSC), La Jolla, CA, USA. The objectives of this workshop were: (1) to complete a new assessment of the North Pacific albacore tuna stock, (2) to develop scientific advice and recommendations on current status, future trends, and conservation of North Pacific albacore tuna, and (3) to review national fisheries and update the catch table maintained by the WG with 2013 data.

Suzy Kohin, Deputy Director of the Fisheries Resource Division, welcomed 11 participants (Attachment 1) to the Southwest Fisheries Science Center's new building and wished them a productive meeting. Scientists from Canada, Chinese Taipei, Japan, the United States of America (USA), and the Inter-American Tropical Tuna Commission attended the workshop. Members from Mexico and Korea sent their regrets.

This report is a record of discussions and decisions of the ALBWG during the workshop in which the 2014 stock assessment of North Pacific albacore was conducted. The 2014 stock assessment model structure and assumptions, results, interpretation, scientific advice and recommendations are documented in a technical assessment report available from the ISC website at: http://isc.ac.affrc.go.jp/.

2.0 MEETING LOGISTICS

2.1 Meeting Protocol

The ALBWG Chair noted that the efforts of the WG at this meeting would be collegial and emphasize empirical testing, open debate, documentation and reproducibility, reporting uncertainty, peer review and constructive feedback. He recalled the reviews of the 2011 assessment and the WG responses to some of the points raised by the reviewers (see ALBWG 2012) and observed that the WG needed to show progress in addressing high priority issues in the 2014 assessment.

2.2 Review and Adoption of Agenda

A draft agenda circulated prior to the meeting was revised and adopted at the workshop (Attachment 2).

2.3 Assignment of Rapporteurs

Rapporteuring duties were assigned to John Holmes, Hidetada Kiyofuji, Kevin Piner, and Vidar Wespestad. John Holmes had the overall responsibility for assembling the report.

2.4 Distribution of Documents and Working Paper Availability

Seven working papers were submitted and assigned numbers for the workshop (Attachment 3). Six of the working papers will be publicly available through the ISC website (http://isc.ac.affrc.go.jp/) and contact details along with the title and authors will be provided for the seventh working paper.

3.0 STOCK ASSESSMENT REPORT AND SECTION ASSIGNMENTS

The WG reviewed a draft table of contents for the stock assessment report distributed prior to the meeting. Some minor changes were suggested and approved. It was decided that Steve Teo would have primary responsibility for drafting the report and that John Holmes will assist him. The draft report will be circulated to WG members for comment prior to submission of the final version of the report to the Office of the ISC Chair on or around June 1, 2014.

4.0 WORKING PAPER REVIEWS

4.1 Abundance indices of albacore tuna for the Stock Synthesis III by Japanese longline fishery in the north west Pacific Ocean. Hirotaka Ijima and Keisuke Satoh. ISC/14/ALBWG/01

Summary – Area and seasonally dependent abundance indices of albacore tuna in the north west Pacific Ocean were calculated for Japanese longline fisheries. All results are available as alternative abundance indices for use in the upcoming stock assessment.

Discussion – The WG noted that quarters 2-3 had little catch and therefore the CPUE in that period was more variable than in quarters 1 and 4. It was noted that the results support the fishery definitions used in the stock assessment model (see Attachment 4).

4.2 Review of Japanese albacore catch data for the North Pacific albacore stock assessment in April 2014. Keisuke Satoh, Takayuki Matsumoto and Koji Uosaki. ISC/14/ALBWG/02.

Summary – This document reports Japanese albacore catch data and the procedures used to compile these catch data for the north Pacific albacore stock assessment in April 2014. The procedure used to generate the dataset was almost the same as the method applied in preparation for the previous stock assessment (see Matsumoto and Uosaki 2011: ISC/11/ALBWG/08), however, some changes were made as a result of changes in fishery definitions agreed to at the data preparation workshop in November 2013.

Discussion - The WG questioned how catch was calculated for vessels without logbooks. It was noted that effort for vessels with and without logbooks was assumed to be equivalent within each quarter in order to estimate the quarterly catches of vessels without logbook. The WG had no comment on the appropriateness of this assumption. It was also noted that catch for the pole-and-line fleet includes catches from all components of this fleet (coastal, offshore, and distant water) whereas the CPUE index is based on data from distant water vessels only.

4.3 An update of the standardized abundance index of US and Canada albacore troll fisheries in the North Pacific (1966-2012). Yi Xu, Steven L.H. Teo, and John Holmes. ISC/14/ALBWG/03.

Summary - A merged US-Canada albacore troll/pole-and-line (surface) fisheries dataset was used to obtain a standardized abundance index from 1966 to 2011 for the upcoming 2014 stock assessment of North Pacific albacore tuna. This index is based on coastal region data and excludes the 2012 data point as recommended during the November 2013 data preparation workshop. The final standardized abundance index values from GLMs with three time periods (1966-1978, 1979-1998, and 1999-2011) are provided in this paper. In addition, the associated model diagnostics and summaries for the GLM models are reported. We recommend that the standardized coastal ocean CPUE index be used as a sensitivity run for the upcoming stock assessment.

Discussion - The WG questioned the use of data from the open ocean strata relative to coastal strata to calculate CPUE. It was clarified that open ocean data are sparse and were not included in the analysis and that the data from the coastal region are considered more representative of CPUE. It was also noted that Canada's fleet is made up of small salmon vessels operating primarily in coastal areas. The US fleet has larger vessels, but those vessels mainly fished in coastal areas after 2000.

4.4 A comparison study of North Pacific albacore (*Thunnus alalunga*) age and growth among various sources. Yi Xu, Tim Sippel, Steven L.H. Teo, Kevin Piner, Kuo-Shu Chen, and David R.J. Wells. ISC/14/ALBWG/04.

Summary – The objectives of this working paper are to: 1) review two recent studies (Chen et al. (2012) and Wells et al. (2013)) on the age and growth of north Pacific albacore, 2) provide a series of best available sex-specific and sex-combined growth model parameters for the 2014 assessment based on the conditional age-at-length data from these two studies, and 3) compare the size of fish sampled by these studies with commercial catch composition data. We calculated the von Bertalanffy growth parameters (L_{inf}, K, and t_0) using conditional age-at-length data derived from otolith samples from Chen et al. (2012) and Wells et al. (2013). The resulting growth models show differences in the growth of male and female albacore as well as between the different regions of the north Pacific Ocean. Male albacore tend to grow faster than females after age 7-8, resulting in a larger L_{inf} of approximately 119 cm for males (based on combined Chen and Wells datasets) compared to 106 cm for female albacore. Most of the biggest fish were collected in the central Pacific Ocean, and were either male or of unknown-sex. We also studied the size composition of albacore sampled by Wells et al. (2013) relative to the size composition reported by the US longline deep-set fishery. The results suggest that Wells et al. (2013) likely had a bias towards sampling larger fish from this fishery, which may have resulted in more male albacore being sampled since larger fish tend to be male. This sampling in turn may have biased the resulting sex-combined growth model because of the higher proportion of male fish in the samples of large fish. Based on these results, we suggest that the ALBWG consider using sex-specific growth models with reasonable growth parameters, or estimate growth parameters within the stock assessment model.

Discussion – The WG agreed with the authors recommendations to use sex-specific growth models in the 2014 assessment and to estimate the growth parameters externally to the model.

Given the importance of growth in the assessment, the WG recommended that uncertainty about growth be captured by a research recommendation.

4.5 Albacore catch statistics of Taiwanese longline fisheries operated in the North Pacific Ocean, 1995-2011, and preliminary estimates for the year of 2012. Chiee-Young Chen and Fei-Chi Cheng. ISC/14/ALBWG/05.

Summary - This working paper describes Taiwanese albacore catch statistics provided for the 2014 stock assessment of north Pacific albacore tuna. The document highlights a revision to the estimates of catch for the fourth quarter (Q4) in 2000, owing to the low logbook reporting rate for that quarter from the albacore targeting component of the longline fishery.

Discussion - The WG recommended using the new estimates of catch for quarter 4 in 2000 in the base case as it constitutes the best available estimate of catch. In response to a WG question on the size of fish taken by the fleet, the author clarified that the larger fish (>120 cm) are taken in the southern area, but that the albacore catch from the southern area (non-albacore targeting fleet component) is low relative to the northern area.

4.6 Updated standardized CPUE for North Pacific albacore caught by the Japanese pole and line data. Hidetada Kiyofuji. ISC/14/ALBWG/06.

Summary - This document describes the updated abundance index for north Pacific albacore caught by the Japanese distant water pole and line fishery based on key points from the data preparatory meeting and email discussions on whether catchability changed around the late 1980’s and early 1990’s.

Discussion - The WG questioned whether alternative temporal boundaries were explored for CPUE standardization to address the catchability change that seems to have occurred in the late 1980s. The author clarified that several alternative boundaries were explored, but the use of catch levels was thought to be the most appropriate method to split the series at 1989-90 because there is a switch from catch primarily in Q1 and Q2 prior to 1989 to primarily Q3 and Q4 after 1990.

4.7 North Pacific albacore catch and size composition from the Japanese longline fishery. Hidetada Kiyofuji. ISC/14/ALBWG/07.

Summary – We examined the representativeness of Japan longline (JPN LL) size sampling relative to JPN LL catch in the northwestern North Pacific Ocean as a result of poor fits to the size composition data in several preliminary assessment model runs. Poor length fits were especially prevalent among larger-sized fish between 1985 and 1993. In this document, the reasons for the poor fit in these larger sizes during the 1985-1993 period are documented and splitting of the JPN LL fisheries into a northern and southern areas at 20°N is recommended.

Discussion - In response to a question from the WG, the authors noted that the longline fleet is split into separate fleets based on the metrics of the catch (number, weight), season (quarters), and spatial area as well as temporal for the northern region because of selectivity differences. In total, there are 12 JP LL fleets for the assessment. This splitting, including the north-south split at 20°N, was agreed to by the WG during the modeling meeting (Attachment 4). The finer scale definitions of this gear are due to its importance in the estimation of model scale.

5.0 REVIEW OF RECOMMENDED BASE-CASE MODEL

The base-case model developed during the model sub-group meeting (Attachment 4) was presented along with sensitivity runs on key inputs to the model. The catch data were slightly revised to include a change in Q4 2000 data from Taiwan. This change had no impact on the results. An important improvement in this base-case model relative to 2011 is the implementation of a two-sex growth model. Growth parameters for the two-sex model were estimate outside the assessment model by Xu et al. (2014) based on a combined dataset (CW) of sex-specific length-age data published by Chen et al. (2012) and sex-specific length-age data (N = 94) used by Wells et al. (2013). CVs for growth within the model were set at 6% for age 1 and 4% for Li_{nf}. These values are consistent with model estimates of CV and estimates provided in Xu et al. (2014). An additional feature of the model is that catches from several minor fisheries with different gears were included in the defined fisheries that corresponded with respect to season, area, and expected selectivity to improve computational speed of the 2014 model. Fecundity is based on female weight. This base-case model is dated 2014-04-23 and will be archived in the ISC database by the WG.

Twenty-four fleets are defined in the 2014 assessment based on country, gear, season, spatial, catch metric (weight, numbers) and time (one fleet)) and the model is fitted to four CPUE indices, which are used as indices of relative abundance over the 1966-2012 model time frame. Each gear has two indices comprising an early and late period based on operational changes in these fisheries. The JP PL indices are considered representative of juvenile abundance and the JP LL indices are considered representative of adult abundance. A two-sex growth model (CW) was implemented because it best explains the available size and catch data. The model was fitted to size composition from six of eight fleets. The goal in modeling was to develop the best fit to the abundance indices. To achieve this goal, selectivity patterns were estimated flexibly. Process was added through the addition of time blocks (time varying) at changes in fishery practices. All other variability in size composition data is assumed to be sampling error and is handled via statistical weighting of these data. Fleets without size composition data use the same selection pattern (i.e., mirrored) as a fleet that operated in the same area with the same gear. Fleet definitions are described in Table 1 of Attachment 4. The following selectivity patterns were applied in the base-case model:

- F1 PL q1-2 – domed, time-blocked (2 blocks) parametric
- F2 PL q3-4- domed, time blocked (2 blocks) parametric
- F3 JPNSLL q1-2 domed time blocked (3 blocks) parametric
- F4 JPNSLL q3-4 domed time-blocks (2 blocks) parametric
- F5 F6 mirrored to F3 and F4
- F7 EPO time-blocks (4 blocks) parametric
- F8 JPN LLLNW q1-4 domed time-blocks (2 blocks) parametric
- F9 mirrored to F8
- F10 F11 mirrored to F8
- F12 JPN LLNW q-1and2 asymptotic (central period) parametric
- F13, F14, F12 mirrored F12
- F16 JPN LLSW q-1-4 asymptotic (2 blocks) parametric
- F17 JPN LLSW q-2-4 asymptotic (2 blocks) parametric
- F18 F19 mirrored F16
- F20 US LL d asymptotic parametric
- F21 US shallowest domed time-block (2 periods) parametric

- F22 TW domed parametric
- F23 mirrored F20
- F24 domed parametric

Biomass trends in the base-case model are primarily driven by changes in recruitment rather than fishing. Depletion ranges from 0.5 to 0.25-0.30 over the modeled period, 1966-2012. Trends in model estimated total catches appear to be similar to SSB trends. It was noted that the continuous F of the JP LLS fishery increases in the 1980s and early 1990s when the proportion of large fish in the catch increased – this was also a period when SSB was lowest. The WG discussed the size composition data and agreed to include histograms of size compositions aggregated across years by season and fleet (because that is what the model is configured for) and Pearson residual bubble plots for fisheries to which the size composition data were fitted in the stock assessment report.

Results from some diagnostic runs were examined, including convergence tests, retrospective analysis, and R_0 profiling. Twenty-five runs exploring different phasing of estimates and starting values converged on a global negative log likelihood value of 327.493. There was no retrospective pattern to biomass or recruitment estimates when successive years of data were removed except after 5 or more years were removed, which resulted in a change of scale. Based on this finding, the WG agreed to estimated current F as the mean F from 2010 to 2012, $F_{2010-2012}$, and will begin projections in 2011 because recruitment in 2012 is not well estimated. R_0 profiling revealed some sensitivity to scale, depending on the dataset and that the model settled on a comprise log R_0 of about 10.8. The WG concluded that there is little information in the albacore data (CPUE, size composition) that can be used to give the model appropriate scale. Attachment 4 has a more detailed discussion of the base-case model and its development.

6.0 SENSITIVITY RUNS

Several sensitivity runs were conducted and reviewed to assess either model performance or the range of uncertainty associated with a particular parameterization:

1. Growth – corresponding to an alternative stock structure hypothesis in which there is a smaller-bodied northern stock characterized by the Chen et al. (2012) growth parameters, size composition of the large fish in the southern areas is not fitted, and the JP LLLN fishery selectivity is asymptotic;
2. Combined sex vs. two sex growth model, along with a larger CV on L_{inf};
3. Effect of JP PL data on recruitment patterns – compares patterns with and without JP PL data; this was conducted as a diagnostic test, rather than a reportable sensitivity run;
4. Alternative juvenile indices (JP LLS, EPO surface);
5. Stock-recruitment steepness range of 0.75-0.95;
6. Natural mortality, range 0.25 to 0.40 in 0.05 increments;
7. Starting year of the model, 1952 (and fitting to initial catch), 1973, 1993;
8. Estimating the width of the top of the domed selectivity for TWN LL albacore targeting and US LL- shallow-set fisheries; and
9. Using effective sample size to weight size composition data rather than statistically down weighting these data.

The WG reviewed the results of these runs and noted that trends in biomass (total and spawning) and recruitment did not change with alternative assumptions, but there were some changes in the scale of these quantities, i.e., absolute estimates changed. In most cases, the scale of these alternative estimates were within the error associated with the base case model estimates of biomass and recruitment. There were no sensitivity runs in which the base case model results were an outlier relative to the sensitivity results.

7.0 ALTERNATIVE MODELS

Keisuke Satoh briefly discussed the results of a production model implemented with the ASPIC software. The WG agreed to use this model as a diagnostic tool at the data preparation workshop (Attachment 5) . He noted that the model was not converging and that its scale was much lower than the scale of SS base case model approved by the WG, at least when the JP LLL index was fitted separately for early and late periods. Convergence could be achieved only when the JP LLL index was joined into one and some other strong simplifying assumptions were used. The WG discussion focused on the fact that the model was based primarily on the JP LLL index of adult relative abundance, but catch consisted of total removals of juveniles and adults. The WG concluded from this discussion that even a much simpler modeling approach cannot find scale in the albacore data because they contain little information and that scale is derived from asymptotic selectivity assumption.

The WG planned to consider the results of a delay-difference model as well but was unable to complete this task for the present workshop.

8.0 PROJECTIONS

The WG discussed how to conduct future projections. The 2011 assessment used the R-package SSFUTURE (Ichinokawa 2011). This package is configured for a combined sex model, but was reengineered during the workshop to accept two sex model output from SS. Test runs to check the results showed that the historical trends estimated by the base case model could be recreated at the appropriate scale so the WG agreed to use the revised code for projections.

SSFUTURE conducts stochastic future projections on an age-structured population dynamics model based on the results of the base-case model configuration. The WG agreed to base each projection on 100 bootstrap replicates to estimate parameter uncertainty followed by 10 stochastic simulations of future trends. Projections remove catches observed in 2011 and 2012 (observed values are divided by 2 because projections are of female SSB only) and then catch removals are based on constant F or constant catch values as specified below. Projections will begin January 1, 2011 and will be 30 years in length, terminating in 2041.

The WG reviewed the projection scenarios discussed during the data preparation workshop and agreed to the following harvest and recruitment scenarios (nine in total):

1. Constant harvest at Fcurrent ($F_{2010-2012}$) and low, average and high historical recruitment;
2. Constant harvest at F2002-2004 under low, average, and high historical recruitment; and
3. Constant average catch for 2010-2012 under low, average and high historical recruitment.

Recruitment for the projections is estimated by resampling historical recruitment. Based on a review of recruitment in the base case model, low recruitment is defined as the 1983-89 period (29.1×10^6 recruits annually), average recruitment is the 1966-2010 period (42.8×10^6 recruits annually), and high recruitment (54.8×10^6 recruits annually) is the 1966-75 period.

The evaluation of the $F_{SSB\text{-}ATHL}$ reference point was discussed by the WG because it is estimated with the SSFUTURE package. $F_{SSB\text{-}ATHL}$ is the F that will lead to future SSB falling below the SSB-ATHL threshold level with a probability of 50% during a 25-yr projection period. It was noted that the SSB-ATHL threshold can be derived from point estimates of SSB or bootstrap estimates of SSB-ATHL. The WG agreed to use the bootstrap estimates of SSB-ATHL.

9.0 BIOLOGICAL REFERENCE POINTS AND KOBE PLOTS

The WG discussed the reference points that would be estimated and presented in the assessment report and agreed to use the list of reference points provided by the Northern Committee, substituting F_{MSY} for F_{MAX}. The list of reference points consists of F_{MSY}, $F_{0.1}$, F_{MED}, $F_{10\%}$, $F_{20\%}$, $F_{30\%}$, $F_{40\%}$, $F_{50\%}$, and $F_{SSB\text{-}ATHL}$. The WG noted that evaluating current F against $F_{SSB\text{-}ATHL}$ may be problematic because the SSB-ATHL threshold is based on the 10 lowest estimated SSBs in the time series and may change substantially between assessments. In the 2014 assessment, SSB estimates from 2007 to 2010 are among the 10 lowest estimated SSBs in the time series against which Fcurrent will be evaluated. This approach of evaluating $F_{2010\text{-}2012}$ against a reference point in which the same data are used to estimate the reference point is poor practice scientifically.

The WG also discussed Kobe plots and which reference points to provide in these plots. The WG Chair noted that the use of Kobe plots was not optional. However, other than the interim reference point, $F_{SSB\text{-}ATHL}$, no reference points have been identified for north Pacific albacore. The WG discussed a Kobe plot using $F_{SSB\text{-}ATHL}$ and concluded that it would have to be converted to an equivalent SPR value for plotting, but decided not to take this approach because it was considered to indirect to be beneficial to managers. Instead, the WG agreed to present Kobe plots based on F_{MSY}, and $F_{10\%\text{-}50\%}$. A Kobe plot with F_{MED} will not be presented because there is little contrast in the albacore SSB time series so interpretation of this reference point would not be meaningful. It was noted that in the $F_{50\%}$ Kobe plot, overfishing is occurring over much of the 1966-2012 period. The WG considers a conclusion of overfishing based on this reference point to be unreasonable given the model structure and assumptions employed in the assessment. The WG will substitute F_{MSY} for F_{MAX} in its reference point evaluations because it believes that the estimate of the stock-recruitment steepness parameter used in the assessment, 0.9, is sound given current knowledge of stock productivity. However, the WG also notes that recruitment may be influenced by environmental changes so quantities based on MSY may be impacted by both environmental changes and changes in population dynamics that may be difficult to partition. It was also noted that biomass-based reference points have not been developed for the north Pacific albacore stock. It was recommended that text be added to the assessment report to indicate that the Kobe plots are presented for illustrative purposes and that the WG is not endorsing any particular choice of reference point, although it does have comments on the plausibility of some choices.

10.0 PROJECTION SCENARIO RESULTS

After correcting scale issues in some preliminary projection results, the WG noted that the procedure used to down-weight size composition data in the base case model (statistical weighting using a multiplier on the sample size rather than lambda) adversely affects the scale in projections and cannot be used. The WG decided to use lambda of 0.1 to down weight the size composition data (combined with increasing sample sizes by an order of magnitude) for projection purposes, which results in similar weighting for both projection and base case models.

The WG reviewed projection results for the $F_{2002\text{-}2004}$, $F_{2010\text{-}2012}$ and constant catch harvest scenarios and low, average, and high historical recruitment scenarios. It was noted that base case model estimates of historical SSB were biased low relative to the bootstrap estimates, but they were within the range of uncertainty. The projections show that in a constant $F_{2010\text{-}2012}$ and average historical recruitment scenario, future female SSB rises slightly and is relatively stable between the 25th percentile and median historical SSB. If high historical recruitment is assumed, then future SSB increases above the historical median SSB and if low recruitment is assumed, then the stock declines below the SSB-ATHL threshold. When the $F_{2002\text{-}2004}$ scenario is used, similar trends are observed, but stock performance is consistently below the $F_{2010\text{-}2012}$ scenario.

11.0 CURRENT STOCK STATUS AND CONSERVATION ADVICE

The WG briefly reviewed current stock status based on reference point ratios relative to $F_{2010\text{-}2012}$ (Fcurrent) and concluded that overfishing is not occurring. The WG noted that all reference point ratios were calculated by SS except $F_{0.1}$, which was based on yield-per-recruit (YPR) analysis because SS has no calculation option for this reference point. Although no biomass-based reference points have been developed, depletion is about 35% of unfished SSB in 2012 so the stock is likely not overfished given average historical recruitment. Evaluating $F_{2002\text{-}2004}$, the Conservation and Management Measure (CMM) reference level, against the reference points confirmed to the WG that fishing mortality in 2010-2012 is lower than in 2002-2004.

Reference Point	$F_{2002\text{-}2004}/F_{RP}$	SSB(t)	Equilibrium Yield (t)
$F_{SSB\text{-}ATHL}$	0.85	87,164	97,079
F_{MSY}	0.76	47,916	101,429
$F_{0.1}$	0.56	57,140	92,923
F_{MED}	1.34	156,291	69,288
$F_{10\%}$	0.71	22,867	93,303
$F_{20\%}$	0.80	54,530	101,135
$F_{30\%}$	0.92	86,192	94,712
$F_{40\%}$	1.07	117,855	84,296
$F_{50\%}$	1.29	149,517	72,059

Reference Point	$F_{2010\text{-}2012}/F_{RP}$	SSB(t)	Equilibrium Yield (t)
$F_{SSB\text{-}ATHL}$	0.72	100,344	90,256
F_{MSY}	0.52	49,680	105,571
$F_{0.1}$	0.51	73,380	93,939
F_{MED}	1.30	156,291	74,640
$F_{10\%}$	0.63	22,867	96,590
$F_{20\%}$	0.71	54,530	105,418
$F_{30\%}$	0.81	86,192	99,612
$F_{40\%}$	0.94	117,855	89,568
$F_{50\%}$	1.13	149,517	77,429

12.0 RESEARCH RECOMMENDATIONS

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

1. Size composition sampling should be raised to the catch (most of the size composition data in the current assessment were not raised) so that observation (sampling) and process (e.g., movement dynamics) errors can be partitioned and dealt with appropriately;
2. All member countries are encouraged to collect sex ratio information from their fleets;
3. Changes in sex ratio and size by depth should be investigated because the WG suspects that there is either a depth-size-sex or a spatial area-sex-size effect that is important to the population dynamics of this stock;
4. Comprehensive sex-specific age and growth data are needed to improve understanding of growth in the north Pacific albacore stock; and
5. The application of cubic spline functions to estimate selectivity in the assessment model should be investigated. This approach was explored during the 2014 assessment workshop, but their was insufficient time to develop it satisfactorily.

13.0 WORKING GROUP UPDATES

13.1 Catch Table for 2013

The WG updated the annual catch table for 2013 (Attachment 6). Preliminary catch values for the USA and Canadian fisheries were added to the table. Catch estimates from 2012 were rolled over for 2013 for other countries. Japan indicated that preliminary 2013 catch information may be available closer to the ISC Plenary meeting in July 2014. The WG Chair will update the table when these data are available. The WG Chair was also tasked with reminding the STATWG Chair to request 2013 data for non-member countries and China from the IATTC and the WCPFC. The WG discussed and agreed to identify Chinese catches separately in the catch table, given the interest in these catches.

13.2 Issues for STATWG

The WG identified two issues to be forwarded to the STATWG by the WG Chair:

1. Obtaining Chinese and non-member country data from the IATTC and WCPFC; and
2. A need for sex-specific size composition data from fleets catching albacore.

14.0 NC9 REFERENCE POINT INFORMATION REQUEST

The Northern Committee (NC) of the Western and Central Pacific Fisheries Committee (WCPFC) sought information on a list of potential limit reference points (LRPs) for north Pacific albacore tuna (*Thunnus alalunga*) during its Eight Regular Session and requested that the ISC update its responses based on the 2014 stock assessment results during its Ninth Regular Session in September 2013. The WG discussed the request and developed the updated responses, including new calculations of reference points and depletion probabilities, shown in Attachment 7.

15.0 ADMINISTRATIVE MATTERS

15.1 Work Plan for 2014-15

The WG has not planned any inter-sessional workshops between July 2014 and July 2015. Requests for information/advice from the Northern Committee or the ISC Plenary will be handled via email, teleconferencing, and webinar tools. A one-day meeting in advance of ISC15 will be requested. In addition, the WG Chair and Steve Teo, the primary assessment modeller, will attend various science meetings to deliver the new stock assessment results and advice. The following schedule is proposed for the WG:

- SC10 – 6-14 Aug 2014, Majuro, Republic of the Marshall Islands (Teo);
- NC10 – 1-4 Sept 2014, Japan, (Holmes, Piner);
- ISC15 – July 2015 – 1 day to update catch table and conservation advice; and
- 6th SAC, IATTC – May 2015, La Jolla (Holmes).

15.2 National Contacts

The following were confirmed as national contacts for ALBWG matters:

Canada – John Holmes, Zane Zhang
China – X. Dai, Y. Chen
Chinese Taipei - C.-Y. Chen
Japan - Keisuke Satoh
Korea - Sang Chul Yoon
Mexico - Michel Dreyfus, Luis Fleischer
USA – Kevin Piner, Steve Teo
IATTC – Carolina Minte-Vera
SPC – Shelton Harley
Data Manager – John Childers

15.3 Time and place of next meeting

There will be a half-day session to prepare the stock assessment presentation in advance of the ISC14 Plenary in July 2014. This meeting is informal and attendance is neither mandatory nor required.

15.4 Other Matters

WG members thanked Ian Stewart (International Pacific Halibut Commission) and Mark Maunder (Inter-American Tropical Tuna Commission) for their participation and help in defining an improved base-case model for the 2014 assessment and tasked the WG Chair with conferring their appreciation to the Directors of their respective organizations.

16.0 CLEARING OF 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 ISC14 Plenary.

17.0 ADJOURNMENT

The WG meeting was adjourned at 15:05 on 28 April 2014. The WG Chair thanked the hosts (Drs. Kevin Piner and Steve Teo) for their hospitality and overall meeting arrangements, which served as the foundation for meaningful scientific discussion and a productive meeting. He also thanked the scientists participating in the workshop for their attendance and contributions and stressed the need to maintain ongoing communication and cooperation on albacore matters.

18.0 LITERATURE CITED

Albacore Working Group (ALBWG). 2012. Report of the Albacore Working Group Workshop. Annex 11. Report of the Twelfth Meeting of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean. Plenary Session, 18-23 July 2012, Sapporo, Hokkaido, Japan.

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ATTACHMENT 1

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ATTACHMENT 2

ALBACORE WORKING GROUP (ALBWG)

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

INTERSESSIONAL WORKSHOP

14-28 April 2014

SWFSC, La Jolla, CA, USA

DRAFT Agenda

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. Working Paper Reviews
5. Base case model and recommendations for modeling subgroup meeting
6. Sensitivity analyses
7. Alternative Models – Production for diagnostic purposes
8. Projection Scenarios
9. Biological Reference Points and Kobe Plots
10. Review Projection Scenario Results
11. Current status and Conservation Advice
12. Research Recommendations
13. Working Group Updates
    - 13.1 Catch Table for 2013
    - 13.2 Issues for STATWG
14. NC9 Reference Point Information Request
15. Administrative Matters
    - 15.1 Work Plan for 2014-15
    - 15.2 Update national contacts for ALBWG
    - 15.3 Time and place of next meeting
    - 15.4 Other matters
16. Rapporteurs and participants complete assigned sections of workshop report
17. Draft of workshop report circulated for review
18. Clearing of Report
19. Adjournment

ATTACHMENT 3

List of Working Papers

WP Number	Title and Authors	Availability
ISC/14/ALBWG/01	Abundance indices of albacore tuna for the Stock Synthesis III by Japanese longline fishery in the north west Pacific Ocean. Hiortaka Ijima and Keisuke Satoh.	Public
ISC/14/ALBWG/02	Review of Japanese albacore catch data for the North Pacific albacore stock assessment in April 2014. Keisuke Satoh, Takayuki Matsumoto and Koji Uosaki.	Public
ISC/14/ALBWG/03	An update of the standardized abundance index of US and Canada albacore troll fisheries in the North Pacific (1966-2012). Yi Xu, Steven L.H. Teo, and John Holmes.	Public
ISC/14/ALBWG/04	A comparison study of North Pacific albacore (*Thunnus alalunga*) age and growth among various sources. Yi Xu, Tim Sippel, Steven L.H. Teo, Kevin Piner, Kuo-Shu Chen, and David R.J. Wells.	Public
ISC/14/ALBWG/05	Albacore catch statistics of Taiwanese longline fisheries operated in the North Pacific Ocean, 1995-2011, and preliminary estimates for the year of 2012. Chiee-Young Chen and Fei-Chi Cheng.	Contact details
ISC/14/ALBWG/06	Updated standardized CPUE for North Pacific albacore caught by the Japanese pole and line data. Hidetada Kiyofuji.	Public
ISC/14/ALBWG/07	North Pacific albacore catch and size composition from the Japanese longline fishery.	Public

ATTACHMENT 4

REPORT OF THE ALBACORE WORKING GROUP MODEL SUBGROUP MEETING

14-18 April 2014
La Jolla, CA, United States of America

1.0 OPENING OF THE MEETING

An model meeting was convened prior to an intersessional workshop of the Albacore Working Group (WG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) at the Southwest Fisheries Science Center (SWFSC), La Jolla, CA, USA, 14-18 April 2014. The goal of this meeting was to define a base case model for the upcoming assessment, working through issues identified via email amongst participating scientists prior to the meeting.

Suzy Kohin, Deputy Division Director at the Southwest Fisheries Science Center, welcomed 13 participants (Attachment 1) to the Southwest Center and La Jolla and wished them a productive meeting. She noted that this was probably the first time that most of the scientists had visited the new building housing the SWFSC arranged a tour for afternoon of the first day. Scientists from Canada, Japan, the United States of America (USA), the Inter-American Tropical Tuna Commission, and the International Pacific Halibut Commission attended the meeting.

John Holmes, WG Chair, reminded the group that the goal of this subgroup meeting was to identify an acceptable base case model, given the data and model structure and assumptions. He briefly reviewed a draft agenda circulated prior to the meeting and proposed that the group start with an overview of base case modeling results from Steve Teo and use issues identified in this presentation as the basis for further discussion. Meeting participants agreed to this approach.

Steve Teo briefly reviewed the biology and data and then presented some results from the model version forwarded 2014-04-12. He noted that it is likely that there is latitudinal stratification of fish by size, especially in adults (larger fish are found further south) and that this pattern presents some difficulties in a model that is not spatially explicit. It means that greater care must be taken in defining fisheries and CPUE indices. Based on this presentation, the following list of issues was identified for further discussion:

1. Data issues (seasonal, area splits in fisheries, CPUE indices)
2. Growth
3. Estimated selection
4. Initial conditions for the model
5. Weighting of size composition data
6. Weight of CPUE relative to other CPUE

2.0 DATA ISSUES

Data issues revolve mostly around the Japan pole-and-line (JPN PL) and Japan longline fisheries (JPN LLL, JPN LLS) (see Table 1 for a list and description of fishery definitions in the base-case model). Further work between the data preparation workshop and the present meeting led to the conclusion that the JPN PL fishery needed to be split into two time periods (1972-89, 1990 -2012) owing to operational changes in the fishery from Q1+Q2 to Q2+Q3 and into seasonal fisheries (Q1 + Q2, Q3+Q4) owing to operational shifts in fishing. The CPUE index for this fishery is based on Q3+Q4 data. A working paper was prepared supporting these splits and meeting participants agreed with these recommendations.

The JPN LL-S fishery was split into two time periods (1975-1988, 1989-2012) as a result of a shift from shallow-set to deep-set fishing in 1988 and seasonal fisheries were established for each period, Q1+Q2, Q3+Q4. The CPUE index is based on Q1+Q2 and will be used as a sensitivity run. The rationale for these changes is documented in a working paper and they were agreed to by meeting participants.

The JPN LL-L fishery was split into two time periods during the data preparation workshop, 1975-1992, 1993-2012. These time blocks were maintained, but the data were further split into seasonal and area-based fisheries. The main finding is that the largest fish in this fleet are caught south of 20°N and that size sampling is much more extensive in the southern component, so the fishery was split into northern and southern fisheries, JPN LL-L North, JPN LL-L South. Two seasons were established for each area: the primary season is Q1+Q4, secondary season is Q2+Q3. The CPUE index is based on JPN LL-L North Q1+Q4. These new definitions are documented in a working paper and were agreed to by meeting participants. It was recommended that Japanese scientists look into weight frequency data and training vessel data to address size composition sampling deficiencies in the northern fishery.

3.0 GROWTH

The presentation by Steve Teo raised three issues about albacore growth:

1. Combined sex or two-sex growth model?
2. Estimate growth internally within the model or externally and fix it in the model?
3. The data source to use for growth, Chen et al. (2012) and/or Wells et al. (2013)?

There is credible evidence of sexually dimorphic growth in north Pacific albacore (Chen et al. 2012) and that males reach a larger size and live longer than females. It was noted that sampling by Wells et al. (2013) in Hawaii was biased to larger fish in the 110-130cm size which were almost all male. In the 2011 assessment a combined sex growth model was estimated within the model and growth parameters were consistent with parameters estimated externally by Wells et al. (2013). Yi Xu prepared a working paper on growth options, which noted that the there was little sex specific age and growth data in Wells et al. (2013) and that sampling was biased. Meeting participants recommended using a two sex growth model based on the combined sex-specific length-age data published by Chen et al. (2012) and sex-specific length-age data available for the dataset published by Wells et al. (2013) and compiled by Xu et al. (2014: ISC/14/ALBWG/04) because it is consistent with theory and evidence and it is the right process to include in the model. It was noted that only sex-specific age and growth data are available, none of the catch and effort data are sex specific (this was part of the rationale against implementing a two sex model in 2011). It was also recommended that a combined sex growth model (i.e., single or non-specific sex growth model) be used as a sensitivity run.

Meeting participants briefly reviewed Yi Xu's working paper (ISC/14/ALBWG/04) and agreed that growth should be estimated externally and fixed within the model based on data from Chen et al. (2012) only. The advantage of this assumption is it bases growth on fish from the western Pacific and the main longline index is western based as well. It also avoids the implicit data weighting that would occur if the data from Wells et al. (2013) and Chen et al. (2012) were combined. It was recommended that a sensitivity run with Wells/Chen age and growth data combined be conducted.

In order to implement the growth model, CVs need to be provide for age 1 fish and fish at Linf. CV1 is 0.06 (6%) for age 1 fish. Various options were discussed for estimating CV2. Eventually, a table of CVs by age based on a combined Wells and Chen dataset was developed by Yi Xu and included in her working paper (ISC/14/ALBWG/04). After examining this table, meeting participants agreed to use 0.04 (4%) for CV2.

Steve Teo noted that an earlier implementation of a two-sex model required about 3 hours to finish running. Since CPUE indices are mirroring selectivity of their fisheries, it was suggested that they be embedded within the fishery, rather than defining them as survey fleets. This approach would cut the number fleets down and should improve run times.

4.0 SELECTIVITY ISSUES

Several issues associated with selectivity were noted for the Japan LL-L fisheries. The primary issue is that selectivity is not well estimated for the early periods as it seems to have an extremely abrupt descending limb. Selectivity for the later periods is relatively stable and well estimated. It was noted that we would have to come back to this issue and work on it on a case-by case basis.

Japanese scientists noted that a time block from 1966 to 1974 should be applied to the JPN LL-L North Q14 size comp data as the index begins in 1975.

Japan also recommended fitting to the size composition data for JPN LL EPO North in order to estimate selectivity for this fishery.

At the end of the Day 1, the following changes were applied to the preliminary base-case model

1. Compact the model by including CPUE indices within fisheries and test against a fully specified model in which CPUE are identified as survey fleets to ensure that the same results are produced;
2. Apply a time block for 1966 to 1974 on the JPN LL-L North fishery and estimate selectivity for the JPN LL EPO North fishery; and
3. Implement two-sex growth, estimating growth model externally based on data from Chen et al. (2012) and using CV1 = 6% and CV2 = 4%.

5.0 INITIAL CONDITIONS

The initial conditions for the preliminary base-case model are as follows: recruitment deviations are estimated to 1966 and extended back 10 years, F is estimated but not fitted to catches, and initial catches are based on the JPN PL and JPN LL-L fisheries. The advantages/disadvantages of this approach and fitting to initial catches were discussed. It was noted that if catch data prior to 1966 are considered credible, then the model can be fitted to them because they may inform the model. Meeting participants concluded that the current approach of not fitting to initial catches is the most flexible approach to use at this time. It was recommended that a sensitivity run in which the model is fitted to initial catches be conducted.

The changes to the preliminary base-case model recommended at the end of Day 1 were reviewed. It was noted that trends in biomass were similar in both the compact and non-compact model but the full model estimated higher biomass levels relative to the compact model and the compact model fit was better by one likelihood unit. It was also noted that there were some issues with selectivity estimation that needed to be investigated. The difference between compact and non-compact models was traced to the use of 2 cm size bins for the population in the compact model and 1 cm size bins in the non-compact model. This was corrected and it was recommended that 1 cm size bins be used.

It was noted that this assessment has two overriding problems to address: (1) how to provide scale to the model, and (2) bounds on selectivity seem to be affecting the model.

6.0 SIZE COMPOSITION

Size composition data collected by Japan training vessels from 1987 to the present were reviewed. Sample sizes of sexed individuals ranged from about 10 to 300 per year. A plot of proportion male and female by length from longline catches shows that males reach larger sizes than females, but there are some females at 130-140 cm. A table of sex ratio by latitude shows that most of the large fish were sampled south of 25°N, consistent with the commercial fishing data. Based on these data, it was suggested that CV2 on the growth curves should be increased to 5% to give the model some flexibility and allow it to account for the large females.

Size composition data and estimated selectivity were reviewed by fleet to assess how to improve fits to the size composition data. It was noted that the Japan training vessel data provide evidence that larger fish are found in the data. There are three ways to improve fit to the size composition data:

1. Add model process in the form of time varying selectivity, flexible selectivity functions, etc.;
2. Change sample size within each series; and
3. Fine tune size composition weighting via statistical downscaling of sample sizes.

F1 JPN PLQ12 – selectivity looks OK, but size composition data show large misfits. This fleet is linked to an index beginning in 1972. Adding a time block for 1966-1971 and using a spline function to estimate selectivity were recommended. There was discussion on where to insert nodes for the spline function, which concluded that nodes should be placed anywhere that a change in selectivity is thought to be occurring.

F2 JPNPLQ34 – Time block added for 1966-1971 and spline function for estimating selectivity. Size composition is highly variable as some modes appear/disappear from year-to-year. It was speculated that these data may have to be down weighted.

F3 JPNLLSwQ12 (catch units of weight) – large positive residuals at 100 cm between 1982 and 1990. The source of these residuals was not clear but it was noted that these data are not raised to catch so the precision is expected to be lower. It was recommended that any size composition not raised to catch be down weighted since time varying selectivity is not the right process to apply. Three time blocks should be applied to these data: 1972-1982, 1983-1989, 1990-2012.

F4 JPNLLSwQ34 – few size composition data, not much to do.

F5 JPNLLSnQ12 – mirrored to F3.

F6 JPNLLSnQ34 – mirrored to F4.

F7 EPOTR – use spline function to estimate selectivity and three time blocks as agreed to at data preparation workshop.

F8 JPNLLLNwQ14 – main index in model. Selectivity has a sharp descending limb at about 120 cm. Three time blocks were recommended for 1966-1974, 1975-1992, and 1993-2012. This fishery should have asymptotic selectivity and it was suggested that the use of a spline function be explored.

F9 JPNLLLNwQ23 – there are few data, but some very large fish (>120cm) appear in the 1980s through the early 1990s. Applying three time blocks: 1966-1974, 1975-1997, and 1998-2012 was recommended. These time blocks differ from documented changes in the fishery, which occurred in the 1992-1993 period. It was suggested that size composition data from this fishery be down weighted as there aren't a lot of fish and they might be better represented elsewhere.

F10 JPNLLLNnQ14 – mirrored to F8.

F11 JPNLLLNnQ23 – mirrored to F9.

F12 + F13 JPNLLLSnQ14 & JPNLLLSwQ14 – lots of large size fish and large positive residuals at 120 cm. These fish are larger than L_{inf} estimated by the Chen et al. (2012) growth model and after 1985 rise to represent more than 60% of catch. One option is to remove these size composition data from the model and mirror selectivity to F8 and use the growth curve based on northern fish, which is the Chen et al. (2012) curves.

F16 – USALLdCNO (USA deep-set longline plus China and others) - it was recommended that a time block be added for 2005-2012 due to changes in the shallow-set fishery that may have affected the deep-set fishery.

F17 – USALLs – two time blocks for 1995-2000 and 2005 to 2012.

F18 – TWNLLA – TWN longline group A, which targets albacore north of 25 N. No time blocks.

F20 JPNLLEPON –selectivity mirrored to F8 and asymptotic, reflecting a southern growth model or make it dome shaped with the southern growth model. This fishery catches some large fish.

There was discussion about two alternative hypotheses that seem to reflect stock structure or at least regional growth differences: Hypothesis 1 – the majority of catch occurs north of 20°N (northern) and is reflected by lower L_{inf} of the Chen et al. (2012) curves, with selectivity of F8 assumed to be asymptotic and no estimation of selectivity for the southern fisheries (F12, F13, F16). Hypothesis 2 – estimate selectivity for the southern fisheries, with asymptotic selectivity, F8 dome-shaped and use a combined Chen-Wells growth curve with higher L_{inf} for males and females.

Steve Teo was charged with setting up and running models reflecting these hypotheses overnight.

Review of the northern and southern model results showed that there are few differences with respect to fits. Conceptually, the southern model is preferred because it is based on all of the data (using all size composition data) and fits are not degraded much from the northern model. The northern model fits to F8 and F20 size composition data quite well because selectivity was estimated for these fisheries, but there are large misfits to the southern large fish fisheries, as expected since selectivity for these fisheries were mirrored to F8. The results confirmed the WG decision to use a two-sex growth model estimated by Xu et al. (2014: ISC/14/ALBWG/04) based on combined data from Chen et al. (2012) and Wells et al. (2013).

There was general agreement that it was better to use the southern model because it uses all of the data. However some selectivity issues were noted, notably with F12 and F13. It was recommended that the WG move forward with the H2 model, but keep HI (northern influenced model) as a plausible alternative, reflecting something in stock structure or regional growth differences.

Time blocks were added to F12 and F13 at 1985-2012 and these fisheries were split and selectivity estimated separately. Results from a run with these changes implemented showed improved likelihoods by about 30 units on the size composition fits for F12 and F13. It was agreed that this configuration should form the basis for further work on the base case model.

It was noted that fits to the size composition data for F17 and F18 were hitting the upper bound of the width parameter and it was recommended that a fixed width value be used. Estimating selectivity of the middle time block of F8 has proven to be problematic. It is asymptotic but there is little information and the ascending limb is very steep and hitting the upper bound. It was recommended that a logistic function be used to estimate selectivity since it requires only an estimate of the inflection point. Implementing this recommendation means that this time block has to be separated as a separate fishery and CPUE index and as a result the same split must be implemented for F9 as well since one is a number-based and the other a weight-based fishery. The end result is that four new fisheries are created since there are Q14 and Q23 seasonal fisheries along with number and weight based data. The results of these configuration changes were reviewed and found to help with the fitting to the size composition data, especially for F8 and F9. The group agreed that these were improvements and that they should be the basis of the working base case model going forward.

In several previous runs it was noted that the model does not fit the JPN PL indices very well. This is a concern because these are two of the main indices in the model. A run was conducted in which the model was forced to fit to the JPN PL index by changing the lambda to 10, i.e., up weighting. When it was forced to fit to the PL indices, the model seriously degraded the fit to all other data, including the size composition data for this fleet. It was noted that the size composition data are highly variable from year to year across seasons. The majority of data are collected in Q2, but similar variability is observed in Q1. There was discussion of how to deal with this issue. It was noted that the size composition data are not raised to the catch. Two methods of dealing with these data were discussed: (1) observation error, and (2) process error.

If the size composition data in aggregate are believable, but not any one year, then they can treat this variability as observation error. The fact that these data aren't raised to reflect catch is consistent with this approach. From a modeling standpoint, these data should be down weighted so that the model continues to remove fish at the right average size. Alternatively, if the annual size composition data are considered believable, then some sort of process error must be occurring and time varying selectivity should be used to address it in the model. The group looked at the sample data and noted that the use of a maximum sample size of 30 was probably distorting the weight of individual samples. Rescaling sample sizes from 5 to 150 and then statistically down scaling to an average of 30 using a multiplier to better reflect the relative relationships among size composition data, was recommended as a prudent approach for fisheries from which a CPUE index is fitted in the model. Size composition samples for F1 were rescaled to an average of 100 and size samples for F2 (the Q3&4 fishery with less sampling) were rescaled to an average of 50.

It was recommended that this rescaling of the sample range (5-150) followed by the use of a multiplier (0.033) to bring the average back to about 30, be applied to fleet size composition data (JPN PL, JPN LLL, JPN LL EPO N, EPO TR) and that a spline function be used to estimate some of the selectivity functions.

The group reviewed attempts to fit cubic spline functions (time varying selectivity) to F1, F2, F3, F4, F7, and F8; stretching size composition sample sizes was not applied. In most cases, the spline functions produced some odd results, possibly related to node placements. The exception seemed to be F7, where the application of the spline was not considered bad. Based on a review of these results, size composition fits, and residuals for these fisheries, time blocks were recommended for F7 (EPO surface fisheries) at 1966-1974, 1975-1987, 1988-1995, and 1996-2012. A time block was also recommended for F3 (JPN LLSwQ12) at 1966-1974. The group concluded that the application of cubic splines for estimating selectivity needed more work prior to the assessment and so recommended investigating splines as a future research priority. Based on the overall review, it was concluded that splines should not be used in this assessment. A new run was recommended in which the additional time blocks are implemented and rescaling of the size composition sample sizes is implemented.

Runs in which spline fits to F1 and F2 were reviewed. The splines were improved by moving the last node from 90 to 100cm. However, overall fit (likelihood) did not improve much relative to the use of a double normal selectivity curve. The group recommended using the double normal curve for F1 and F2.

A run in which additional time blocks were added to F3, F4 and F7 were reviewed. Adding a fourth time block to the F7 (EPO surface) improved the max residual value and likelihood improved by 20 units. Lots of observation error remains and these size composition data are an obvious candidate for time varying selectivity. Additional blocking on F3 and F4 did not improve the fits to size composition data relative to base case model (2 blocks each). The group recommended the four time blocks on F7 and reverted to the previous configuration of two time blocks on F3 and F4.

A run was reviewed in which size composition sample sizes were rescaled to between 5 and 150 for all fleets and a multiplier (variance adjustment) of 0.03 was used in the model (lambda = 1.0). In most cases this procedure brought the Pearson residuals of the size composition fits into line with expectations with the majority of residuals between values of -2 and 2. It was clear that this procedure overly down weighted some fleets as maximum Pearson residual values were less than 1.0. It was recommended that F16, F17, F20 and F21 size composition data be up weighted through the use of a different multiplier (0.045 or 0.06) for these fleets to bring them more into line with other size composition data.

A brief review of the fits to CPUE indices showed that the fit to F8 (primary longline index) was reasonably good with CV = 0.2. Fit to the F2 (JPN PL in later period) was not as good and it was recommended that a new run using a CV of 0.3 be conducted. A last point is that some fine adjustments to the bias correction ramp were recommended.

Another run was reviewed (F1+F2 double normal, F3 time block 1984-93, bias adjustment corrected, 0.1 added to CV of F2 index, readjusted multipliers for size composition data of some fleets) by the group. Results are generally considered good, but it was noted that size compositions for F16, F17, F21, and F24 should be up weighted further.

7.0 CPUE WEIGHTING

Runs overnight include some fine-tuning and the following:

- A run in which 1 cm population bins are used (we have used 2 cm to date for developmental purposes because model is faster)
- A run in which the extra CV on F2 and F4 are estimated, to check our assumption;
- R_0 likelihood profiling
- A sensitivity run in which the CV on old fish in the growth curve (CV2) is increased from 5%

A run in which 1 cm population size bins were used was reviewed. It showed that trends in relevant quantities were consistent with the base case but with slightly higher absolute values. The group concluded that this run confirmed that using 2 cm size bins for developmental work (to improve computational speed) on the base case was appropriate.

A run in which the extra CV on the PL index was estimated was reviewed. The extra CV estimated for F1 was 0.01 and for F2 it was 0.21. It was concluded that the original CV fixed for F1 was appropriate (0.2) and that the CV for F2 should be 0.4.

A run in which the CV for L_{inf} was estimated was reviewed. The model estimates this CV at 0.04, which is consistent with earlier analysis of length at age. If a CV of 0.06 is forced, it increases Linf and reduces SSB.

R_0 profiling was conducted on the base case model. Results are a bit mixed but support the conclusion that there is little information on scale in any of the indices or size composition data, except the TWN LL size composition. The results show that the northern longline fisheries scale to smaller size and the southern longline scale to larger size. The scale in the model is a compromise between the two, in part because the model was set up to rely on the northern longline for the catch curve and to provide scale since selectivity of the southern fleets is right shifted and only a few age classes are fully selected.

It was recommended that a sensitivity run be conducted in which the current base-case model is configured to reflect the earlier northern hypothesis, i.e., use the Chen et al. (2012) growth curves, do not fit to the southern longline size composition data, and apply asymptotic selectivity to F8.

A run in which F16, F17, F21 and F24 size composition data were up weighted to 0.09, 0.15, or 0.18 was conducted. Results did not change much and it was agreed that the original weighting (0.06) should be used for these data.

The group stepped through and reviewed the putative base case model output and agreed to move forward with this model. No issues were flagged during this review.

8.0 RESEARCH RECOMMENDATIONS

- Japanese scientists should investigate weight frequency data and training vessel data to address size composition sampling deficiencies in the northern longline fishery;

- A closer examination of size composition data in the JPN PL fleet is needed to determine ascertain how much of the apparent variability is sampling error and how much is process error related to moving fish and fleet;
- A comprehensive sex-based age and growth dataset is needed and efforts should be made to assess the utility of sex-ratio of catch on the Japanese training vessel and other fleets; and
- Investigate the use of cubic splines for estimating selectivity in some fisheries intersessionally;

9.0 RECOMMENDED SENSITIVITY RUNS

- A combined sex growth model using Chen-Wells age and growth data;
- Fit model to initial catches, 1952-1965;
- Configure model to reflect the plausible alternative northern hypothesis, i.e., use the Chen et al. (2012) growth curves, do not fit to the southern longline size composition data, and apply asymptotic selectivity to F8;
- Do not fit to the JPN PL size and CPUE data to determine if implied recruitment increases;
- Alter steepness, 0.75 to 0.95;
- Alter M, 0.3 to 0.4;
- Alter starting years in the model, 1953, 1975, and 1993; and
- Fit to JPN LLS and EPO surface indices as alternative juvenile indices to JPN PL.

10.0 LITERATURE CITED

Chen, K.-S., Shimose, T., Tanabe, T., Chen, C.-Y., and Hsu, C.-C. 2012. Age and growth of albacore *Thunnus alalunga* in the North Pacific Ocean. J. Fish Biol. 80: 2328–2344. DOI: 10.1111/j.1095-8649.2012.03292.x

Wells, R.J.D., Kohin, S., Teo, S.L.H., Snodgrass, O.E., and Uosaki, K. 2013. Age and growth of North Pacific albacore (*Thunnus alalunga*): Implications for stock assessment. Fish. Res. 147: 55– 62. DOI: 10.1016/j.fishres.2013.05.001

Table 1. Fleet definitions used in an exploratory model and accepted for the final base case model in the 2014 albacore assessment.

Preliminary Base-case Fishery Definitions		Final Base-case Fleets	Combined Catch Data	Embedded Survey Fleet	Time Period	Description[A]
F1_JP_PL_Q12		F1_JPPL_Q12	Japan, Korea & Taiwan Gillnet and Japan Miscellaneous	S1	1975-1992	Japan Pole-and-Line Quarter 1 &2
F2_JP_PL_Q34		F2_ JPPL_Q34		S2	1993-2012	Japan Pole-and-Line Quarter 3 & 4
F3_JP_LLS_wt_Q12		F3_ JPLLS_W_Q12		S7	1975-1988	Japan Longline Area 1, small-sized fish, Quarter 1 & 2, catch in metric tons
F4_JP_LLS_wt_Q34		F4_JPLLS_W_Q34		S8	1989-2012	Japan Longline Area 1, small-sized fish, Quarter 3 & 4, catch in metric tons
F5_JP_LLS_num_Q12		F5_ JPLLS_N_Q12				Japan Longline Area 1, small-sized fish, Quarter 1 & 2, catch in 1000s of fish
F6_JP_LLS_num_Q34		F6_ JPLLS_N_Q34				Japan Longline Area 1, small-sized fish, Quarter 3 & 4, catch in 1000s of fish
F7_EPO_SF		F7_EPO_SF		S9 (1966-78) S10 (1979-98) S11 (1999-2012)		Can and US troll and pole-and-line fisheries in EPO
F8_JP_LLL_wt_Q14		F8_JPLLL_W_Q14	Korea Longline (1966-1974, 1993-2012)	S3, S4	1966-1974 & 1993-2012	Japan Longline Area 2 & 3, large-sized fish, Quarter 1 & 4, catch in metric tonnes
F9_JP_LLL_wt_Q23		F9_JPLLL_W_Q23			1966-1974 & 1993-2012	Japan Longline Area 2 & 3, Quarter 2 & 3, catch in metric tonnes
F10_JP_LLL_num_Q14		F10_JPLLL_N_Q14			1966-1974 & 1993-2012	Japan Longline Area 2 & 3, large-sized fish, Quarter 1 & 4, catch in 1000s of fish
F11_JP_LLL_num_Q23		F11_JPLLL_N_Q23			1966-1974 & 1993-2012	1 Japan Longline Area 2 & 3, large-sized fish, Quarter 2 & 3, catch in 1000s of fish
F12_US_LL_deep		F12_JPNLLL_W_Q14	Korea Longline (1975-1992)		1975-1992	Japan Longline Area 2 & 3, Quarter 1 & 4, catch in metric tonnes
F13_US_LL_shlw		F13_JPLLL_W_Q23			1975-1992	Japan Longline Area 2 & 3, Quarter 2 & 3, catch in metric tons
F14_TW_LL_ALB		F14_JPLLL_N_N_Q14			1975-1992	Japan Longline Area 2 & 3, Quarter 1 & 4, catch in 1000s of fi

F15_TW_LL_BET		F15_JPLLL_N_N_Q23			1975-1992	Japan Longline Area 2 & 3, Quarter 2 & 3, catch in 1000s of fi
F16_JP_EPOLL_N		F16_JPLLL_S_W_Q14			1966-2012	Japan Longline Area 4, south of 20N, Quarter 1 & 4, catch in metric tonnes
F17_JP_EPOLL_S		F17_JPLLL_S_W_Q23			1966-2012	Japan Longline Area 4, south of 20N, Quarter 2&3, catch in metric tonnes
F18_JP_GN		F18_JPLLL_S_N_Q14			1966-2012	Japan Longline Area 4, Quarter 1 & 4, catch in 1000s of fish
F19_TWKR_GN		F19_JPLLL_S_N_Q23			1966-2012	Japan Longline Area 4, south of 20N, Quarter 2 & 3, catch in 1000s of fish
F20_KR_LL		F20_USLL_D	Japan Longline Area 6 (south of 25N) and China and Others Longline	S5		US Longline Deep-Set
F21_CN_LL		F21_USLL_S				US Longline Shallow-Set
F22_OT_LL		F22_TWNLL_A		S6		Taiwan Longline, north of 25N, albacore targeting
F23_JP_misc		F23_TWNLL_NA				Taiwan Longline, south of 25N, non-albacore targeting
F24_EPO_misc		F24	Japan Longline Area 5			EPO miscellaneous gears other than troll and pole-and-line
Survey Fleet Definitions						
S1_JP_LLL_7592						
S2_JP_LLL_9312						
S3_JP_PL_7289						
S4_JP_PL_9012						
S5_US_LL_deep						
S6_TW_LL_ALB						
S7_JP_LLS_7588						
S8_JP_LLS_8912						
S9_EPO_SF_6678						
S10_EPO_SF_7998						
S11_EPO_SF_9911						

A – See ISC/14/ALBWG/01 for a description of the areas used for Japanese Longline fishery definitions.

APPENDIX 1

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ATTACHMENT 5

Application of surplus production models to the North Pacific Ocean albacore (*Thunnus alalunga*) stock. Keisuke Satoh.

Abstract

As alternative model approach, a non-equilibrium surplus production model (ASPIC version 5.34.9) was applied to catch and CPUE data of the North Pacific albacore. The biomass levels estimated by the production model and integrated model (Stock Synthesis) were compared.

Material and method

Initial parameterization of the ASPIC production model was discussed by the WG during the data preparation meeting in Nov. 2013 (Table 7 of report of the data preparatory meeting; Appendix 1).

Catch and CPUE data

Total North Pacific albacore catches as of July 2013 (in Table 14-1 for ISC plenary report) were used as input catch data. Two annual CPUE indices from the Japanese longline large fleet (Ijima and Satoh 2014) was used for the production model. The indices were composed of two periods (1975-1992 and 1993-2012), which were treated as separate fisheries in the production model (Table 1).

ASPIC program

A non-equilibrium surplus production model - ASPIC program (Prager 1994) was applied to albacore catch and CPUE data. The program was latest version at the instant of the analysis, which was available on the NOAA Fisheries tool box website (http://nft.nefsc.noaa.gov/ASPIC.html).

Results

ASPIC program run

A total of 35 runs were conducted. The initial parameterization for each run is presented in Tables 2 and 3. The settings for the first five runs (Run01 – 05) were comparable to those discussed during the data preparation workshop in Nov 2013. These five runs did not convergence (Table 3) and also failed to fit the CPUE indices (Fig. 1).

A combination of several different initial parameterizations (B1/K; 0.3, 0.5 and 0.7, MSY; 90,000, 180,000, K: 450,000, 900,000 and 1,800,000) were then tested (Runs 06 – 20; Table 2, 3). Only two runs (Run 06 and Run11) converged (Table 3). The CPUE fitting were improved for these two runs (Fig. 2), although there was a discontinuous estimation of CPUE between 1992 and 1993 in Run11. The estimated value for B1/K of Run06 was very low (0.02; Table 3).

In further runs (Runs21-35), one period model was tested with the same combination of initial parameters as Runs 06-20. Total ten runs reached normal convergence (Table 3). Although the fit to the CPUE for these ten runs were not good after 1991, the fit to observed CPUE for early period (1975-1990) was improved (Fig. 3). The estimated total biomass and spawning biomass of the base-case SS and estimated biomass of ASPIC (Run28) were compared (Fig. 4). Run28 represented the lowest value of the total objective function (Table 3). The level of spawning biomass of SS and biomass from ASPIC were similar.

Conclusions

The two period model did not explain the observed CPUE trend well.

The one period model improved fitting to CPUE before 1990, but fits after 1991 were poor.

The level of spawning biomass of SS and biomass from ASPIC was similar.

Reference

Ijima, H., and Satoh, K. 2014. Abundance indices of albacore tuna for the Stock Synthesis III by Japanese longline fishery in the North West Pacific Ocean. ISC/14/ALBWG/01.

Prager, M.H. 1994. A suite of extensions to a non-equilibrium surplus-production model. Fish Bull, 92:374-389.

Table 1. Catch and CPUE for ASPIC model runs for stock assessment of North Pacific albacore.

	JPN LL (1952-1992)		JPN LL (1993-2012)	
year	CPUE	Catch	CPUE	Catch
1975	8.72549	96808.4	-1.00000	0.0
1976	11.41862	126537.7	-1.00000	0.0
1977	11.64574	62469.0	-1.00000	0.0
1978	10.26887	99600.0	-1.00000	0.0
1979	8.94468	70745.0	-1.00000	0.0
1980	8.84259	74931.0	-1.00000	0.0
1981	9.05453	70583.3	-1.00000	0.0
1982	7.79138	73027.1	-1.00000	0.0
1983	7.52255	54950.9	-1.00000	0.0
1984	7.41792	72612.2	-1.00000	0.0
1985	5.73337	59218.0	-1.00000	0.0
1986	6.46911	46144.0	-1.00000	0.0
1987	9.11733	49190.5	-1.00000	0.0
1988	5.92897	45411.5	-1.00000	0.0
1989	6.42342	44039.5	-1.00000	0.0
1990	6.09482	53709.1	-1.00000	0.0
1991	5.67433	37269.2	-1.00000	0.0
1992	6.84461	54801.4	-1.00000	0.0
1993	-1.00000	0.0	7.90853	54319.4
1994	-1.00000	0.0	11.49938	73198.0
1995	-1.00000	0.0	12.27498	67948.5
1996	-1.00000	0.0	16.79564	86221.5
1997	-1.00000	0.0	18.19966	106765.2
1998	-1.00000	0.0	19.70165	98241.9
1999	-1.00000	0.0	19.09054	125602.1
2000	-1.00000	0.0	22.17543	85072.9
2001	-1.00000	0.0	18.70141	90222.9
2002	-1.00000	0.0	14.93520	105236.9
2003	-1.00000	0.0	11.77574	92867.7
2004	-1.00000	0.0	11.17636	90629.0
2005	-1.00000	0.0	16.19175	63279.2
2006	-1.00000	0.0	18.25170	66398.3
2007	-1.00000	0.0	17.33610	92075.5
2008	-1.00000	0.0	14.78281	65496.6
2009	-1.00000	0.0	16.71874	79609.0
2010	-1.00000	0.0	17.52002	68919.1
2011	-1.00000	0.0	15.21057	80209.3
2012	-1.00000	0.0	18.53477	81969.6

Table 2. Parameter specifications used for ASPIC model runs for stock assessment of North Pacific albacore.

		1 - 5	6 - 20	21 -35
	period	two period (1975-1992, 1993-2012)	←	one period (1975-2012)
	CPUEs used	JPN LL-L (1975-1992) JPN LL-L (1993-2012) annual base	←	←
	Year of catch *	1975-2012	←	←
	Model	Generalized (Pella-Tomlinson)	←	←
input file line				
1	Run type (FIT, BOT, or IRF)	FIT	←	←
2	Title of analysis			
3	Model shape and optimization control ・model shape ・optimization mode ・objective function ・genelalized model parameters (min) ・genelalized model parameters (max) ・genelalized model parameters (step size) ・genelalized model parameters (bounds multiple)	GENGRID YLD SSE 20 30 5 8	GENFIT ← ← 15 55 25 ←	← ← ← ← ← ← ←
4	Verbosity	2	←	←
5	Number of bootstrap trials	-	-	-
6	0=no MC search, 1=search, 2=repeated srch; N trials	0 100	←	←
7	Convergence criteria for simplex	1.0E-08	←	←
8	Convergence criteria for restarts N restarts	3.0E-08 8	←	←
9	Convesion criteria for F; N steps/yr for gen. model	1.0E-04 12	←	←
10	Maximum F when cond. on yield	8	←	←
11	Stat weight for B1>K as residual	1	←	←
12	Number of fisheries (data series)	2	←	←
13	Statistical weights for data series	1.0E+00 1.0E+00	←	←
14	B1/K (starting guess)*	0.3 - 0.7 by 0.1 interval	0.3 - 0.7 by 0.2 interval	←
15	MSY (starting guess)*	90,000	(90,000 or 180,000)	←
16	K (carrying capacity) (starting guess)*	900,000	(450,000, 900,000, 1,800,000)	←
17	q (starting guesses)*	1.8E-06 1.8E-06	(1.8E-03, 1.8E-06, 1.8E-7)	←
18	Estimate flags (1 = estimate) (B1/K,MSY,K,q1...qn)	1 1 1 1 1	←	←
19	Min and max constraints -- MSY	9.0E+03 1.8+06	←	←
20	Min and max constraints -- K	9.0E+04 1.8E+07	←	←
21	Random number seed	74321	←	←
22	Number of years of data in each series	38	←	←

* Initial value for each run was presented in Table 3.

Table 3. Parameter estimation for ASPIC model runs of stock assessment of North Pacific albacore.

	Run01	Run02	Run03	Run04	Run05	Run06	Run07	Run08	Run09	Run10
B1/K (initial value)	0.3	0.4	0.5	0.6	0.7	0.3	←	←	←	←
MSY (initial value)	90,000	←	←	←	←	90,000	←	←	←	180,000
K (initial value)	900,000	←	←	←	←	900,000	←	450,000	1,800,000	900,000
q (initial value)	1.8E-06	←	←	←	←	1.8E-03	1.8E-07	1.8E-06	←	←
Program status information	Estimate of MSY is at or near maximum bound.	Estimate of MSY is at or near maximum bound.	Estimate of MSY is at or near maximum bound.	Estimate of MSY is at or near maximum bound.	Estimate of MSY is at or near maximum bound.	Normal convergence	Estimate of MSY is at or near maximum bound.	Minimum SSE found at lowest or highest Bmsy/K in user range.	Estimate of MSY is at or near maximum bound.	Estimate of MSY is at or near maximum bound.
Total objective function	1.79	1.79	1.79	1.79	1.79	1.87	1.79	1.80	1.80	1.79
B1/K; Starting relative biomass (in 1975)	1.44	1.44	1.44	1.44	1.44	0.02	1.43	1.42	1.42	1.43
MSY; Maximum sustainable yield	5.58E+06	5.58E+06	5.58E+06	5.57E+06	5.58E+06	2.63E+05	1.80E+06	1.80E+06	1.14E+06	1.80E+06
K; Maximum population size	5.57E+07	5.50E+07	5.53E+07	5.66E+07	5.48E+07	9.25E+06	1.70E+07	1.37E+07	1.30E+07	1.70E+07
phi; Shape of production curve (Bmsy/K)	0.20	0.20	0.20	0.20	0.20	0.32	0.17	0.15	0.23	0.16
q(1); 1975_1992	1.25E-07	1.27E-07	1.26E-07	1.23E-07	1.28E-07	6.03E-05	4.14E-07	5.23E-07	5.46E-07	4.15E-07
q(2) 1993_2012	2.80E-07	2.83E-07	2.82E-07	2.75E-07	2.84E-07	6.90E-05	9.30E-07	1.16E-06	1.23E-06	9.34E-07
Bmsy Stock biomass giving MSY	1.11E+07	1.10E+07	1.11E+07	1.13E+07	1.10E+07	2.98E+06	2.83E+06	2.06E+06	3.02E+06	2.79E+06
Fmsy Fishing mortality rate at MSY	5.01E-01	5.08E-01	5.05E-01	4.92E-01	5.10E-01	8.85E-02	6.37E-01	8.73E-01	3.77E-01	6.46E-01
n Exponent in production function	0.353	0.353	0.353	0.353	0.353	0.7733	0.2692	0.2337	0.444	0.2654
g Fletcher's gamma	-2.73	-2.73	-2.73	-2.73	-2.73	-10.60	-2.22	-2.03	-3.44	-2.20
B./Bmsy Ratio: B(2013)/Bmsy	4.96E+00	4.96E+00	4.96E+00	4.96E+00	4.96E+00	1.03E-01	5.86E+00	6.48E+00	4.15E+00	5.92E+00
F./Fmsy Ratio: F(2012)/Fmsy	2.96E-03	2.96E-03	2.96E-03	2.97E-03	2.96E-03	3.14E+00	7.77E-03	7.03E-03	1.73E-02	7.69E-03

Table 3 (continued)

	Run11	Run12	Run13	Run14	Run15	Run16	Run17	Run18	Run19	Run20
B1/K (initial value)	0.5	←	←	←	←	0.7	←	←	←	←
MSY (initial value)	90,000	←	←	←	180,000	90,000	←	←	←	180,000
K (initial value)	900,000	←	450,000	1,800,000	900,000	900,000	←	450,000	1,800,000	900,000
q (initial value)	1.8E-03	1.8E-07	1.8E-06	←	←	1.8E-03	1.8E-07	1.8E-06	←	←
Program status information	Normal convergence	Minimum SSE found at lowest or highest Bmsy/K in user range.	Estimate of K is at or near maximum bound, 1.800E+07	Estimate of MSY is at or near maximum bound.	Estimate of K is at or near maximum bound, 1.800E+07	Estimate of q is at program-set bound.	Minimum SSE found at lowest or highest Bmsy/K in user range.	Estimate of K is at or near maximum bound, 1.800E+07	Estimate of K is at or near maximum bound, 1.800E+07	Estimate of MSY is at or near maximum bound, 1.800E+06
Total objective function	2.55	1.79	1.81	1.79	1.79	2.28	1.79	1.79	1.80	1.79
B1/K; Starting relative biomass (in 1975)	0.16	1.43	1.41	1.43	1.43	1.03	1.43	1.43	1.43	1.43
MSY; Maximum sustainable yield	1.70E+05	1.80E+06	9.18E+05	1.80E+06	1.79E+06	4.65E+05	1.80E+06	1.80E+06	1.46E+06	1.80E+06
K; Maximum population size	8.48E+05	1.61E+07	1.80E+07	1.75E+07	1.80E+07	4.65E+05	1.58E+07	1.79E+07	1.80E+07	1.77E+07
phi; Shape of production curve (Bmsy/K)	0.49	0.15	0.42	0.18	0.19	0.31	0.15	0.18	0.26	0.18
q(1); 1975_1992	8.62E-05	4.40E-07	3.94E-07	4.02E-07	3.91E-07	1.800E-05 *	4.47E-07	3.94E-07	3.91E-07	3.98E-07
q(2) 1993_2012	2.59E-05	9.88E-07	8.80E-07	9.03E-07	8.79E-07	3.62E-05	1.00E-06	8.86E-07	8.79E-07	8.94E-07
Bmsy Stock biomass giving MSY	4.14E+05	2.41E+06	7.53E+06	3.10E+06	3.43E+06	1.44E+05	2.37E+06	3.27E+06	4.73E+06	3.19E+06
Fmsy Fishing mortality rate at MSY	4.10E-01	7.47E-01	1.22E-01	5.81E-01	5.21E-01	3.23E+00	7.59E-01	5.51E-01	3.09E-01	5.64E-01
n Exponent in production function	1.8764	0.2337	1.3102	0.2944	0.3278	0.7207	0.2337	0.3094	0.542	0.3025
g Fletcher's gamma	4.39	-2.03	10.09	-2.36	-2.56	-8.34	-2.03	-2.45	-4.51	-2.41
B./Bmsy Ratio: B(2013)/Bmsy	1.77E+00	6.48E+00	2.32E+00	5.51E+00	5.12E+00	2.98E+00	6.48E+00	5.33E+00	3.71E+00	5.41E+00
F./Fmsy Ratio: F(2012)/Fmsy	2.73E-01	7.03E-03	3.84E-02	8.26E-03	8.97E-03	5.91E-02	7.03E-03	8.55E-03	1.51E-02	8.42E-03

Table 3 (continued)

	Run21	Run22	Run23	Run24	Run25	Run26	Run27	Run28	Run29	Run30
B1/K (initial value)	0.3	←	←	←	←	0.5	←	←	←	←
MSY (initial value)	90,000	←	←	←	180,000	90,000	←	←	←	180,000
K (initial value)	900,000	←	450,000	1,800,000	900,000	900,000	←	450,000	1,800,000	900,000
q (initial value)	1.8E-03	1.8E-07	1.8E-06	←	←	1.8E-03	1.8E-07	1.8E-06	←	←
Program status information	Normal convergence	Minimum SSE found at lowest or highest Bmsy/K in user range	Minimum SSE found at lowest or highest Bmsy/K in user range	Minimum SSE found at lowest or highest Bmsy/K in user range	Normal convergence	Normal convergence	Minimum SSE found at lowest or highest Bmsy/K in user range	Normal convergence	Normal convergence	Normal convergence
Total objective function	**2.01**	**2.65**	**6.59**	**6.53**	**2.05**	**2.00**	**2.65**	**1.81**	**1.92**	**1.95**
B1/K; Starting relative biomass (in 1975)	0.20	0.21	0.40	0.51	0.18	0.18	0.21	0.37	0.21	0.18
MSY; Maximum sustainable yield	1.37E+05	1.39E+05	1.07E+06	2.97E+06	1.48E+05	1.47E+05	1.41E+05	9.87E+04	1.20E+05	1.28E+05
K; Maximum population size	1.21E+06	2.46E+06	1.12E+06	4.68E+06	1.35E+06	1.29E+06	2.49E+06	4.82E+05	1.06E+06	1.32E+06
phi; Shape of production curve (Bmsy/K)	0.50	0.55	0.55	0.55	0.50	0.49	0.55	0.51	0.46	0.44
q(1); 1975_2012	5.26E-05	1.800E-05 **	1.02E-05	2.42E-06	5.16E-05	5.69E-05	1.800E-05 **	7.77E-05	5.97E-05	5.65E-05
Bmsy Stock biomass giving MSY	6.03E+05	1.35E+06	6.18E+05	2.57E+06	6.75E+05	6.31E+05	1.37E+06	2.48E+05	4.88E+05	5.86E+05
Fmsy Fishing mortality rate at MSY	2.27E-01	1.03E-01	1.74E+00	1.15E+00	2.19E-01	2.33E-01	1.03E-01	3.98E-01	2.46E-01	2.19E-01
n Exponent in production function	1.9809	2.5952	2.5952	2.5951	1.9932	1.8898	2.5952	2.1519	1.6114	1.5007
g Fletcher's gamma	4.05	2.96	2.96	2.96	4.02	4.34	2.96	3.63	5.75	6.74
B./Bmsy Ratio: B(2013)/Bmsy	7.48E-01	8.72E-01	1.79E+00	1.81E+00	6.89E-01	6.69E-01	8.62E-01	1.21E+00	8.01E-01	7.07E-01
F./Fmsy Ratio: F(2012)/Fmsy	8.40E-01	6.90E-01	4.27E-02	1.53E-02	8.48E-01	8.81E-01	6.91E-01	7.00E-01	8.90E-01	9.44E-01

Table 3 (continued)

	Run31	Run32	Run33	Run34	Run35
B1/K (initial value)	0.7	←	←	←	←
MSY (initial value)	90,000	←	←	←	180,000
K (initial value)	900,000	←	450,000	1,800,000	900,000
q (initial value)	1.8E-03	1.8E-07	1.8E-06	←	←
Program status information	Normal convergence	Estimate of q is at program-set bound	Normal convergence	Normal convergence	Normal convergence
Total objective function	**1.87**	**2.69**	**2.00**	**1.97**	**1.84**
B1/K; Starting relative biomass (in 1975)	0.37	0.06	0.01	0.11	0.34
MSY; Maximum sustainable yield	9.65E+04	3.17E+05	5.09E+05	1.69E+05	1.04E+05
K; Maximum population size	4.74E+05	9.55E+06	2.66E+07	1.98E+06	6.04E+05
phi; Shape of production curve (Bmsy/K)	0.50	0.47	0.33	0.43	0.52
q(1); 1975_2012	7.91E-05	1.800E-05 **	5.62E-05	5.88E-05	6.61E-05
Bmsy Stock biomass giving MSY	2.37E+05	4.47E+06	8.69E+06	8.62E+05	3.14E+05
Fmsy Fishing mortality rate at MSY	4.08E-01	7.09E-02	5.86E-02	1.96E-01	3.32E-01
n Exponent in production function	1.9977	1.6965	0.7934	1.4269	2.213
g Fletcher's gamma	4.01	5.20	-11.77	7.69	3.51
B./Bmsy Ratio: B(2013)/Bmsy	1.22E+00	2.74E-01	4.75E-02	4.71E-01	1.13E+00
F./Fmsy Ratio: F(2012)/Fmsy	7.08E-01	9.76E-01	3.56E+00	1.09E+00	7.17E-01

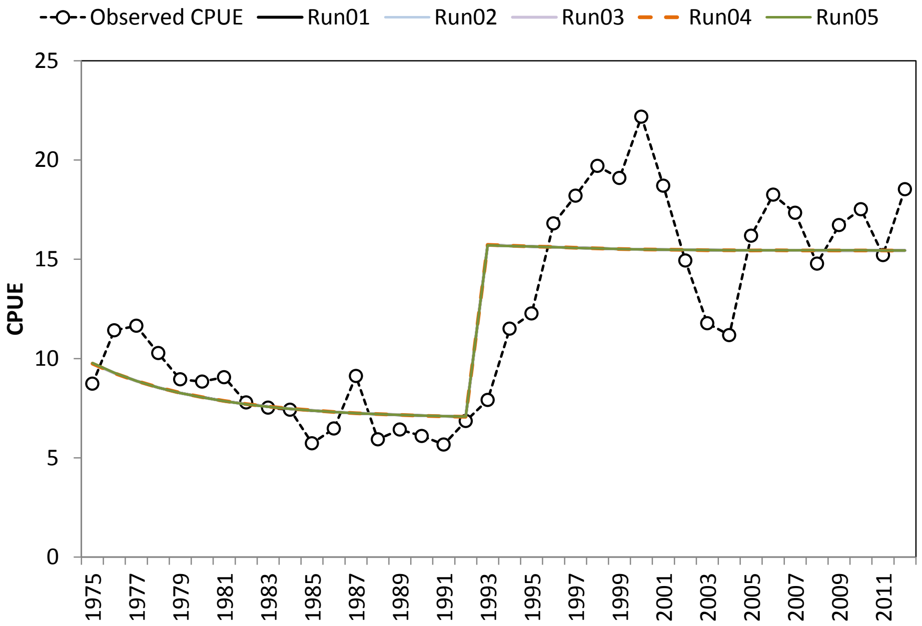

Fig. 1 Comparison between observed CPUE (open circle with dashed line) and estimated CPUE of ASPIC model runs (Run01 – 05) of stock assessment of North Pacific albacore. Model specifications of the five runs were based on the initial parameterizations in ISC ALB data preparatory meeting in Nov. 2013.

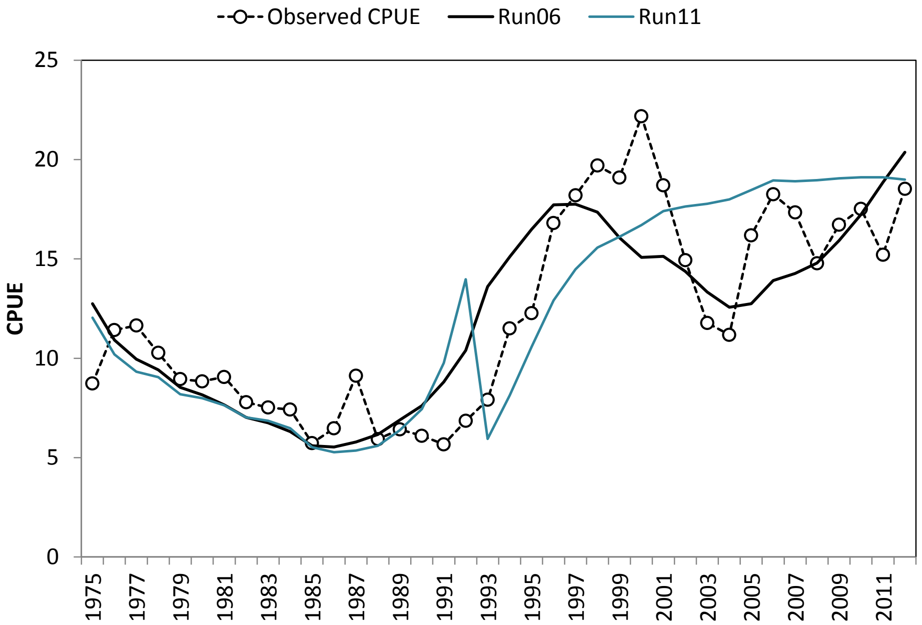

Fig. 2 Comparison between observed CPUE (open circle with dashed line) and estimated CPUE of ASPIC model supposed two periods for CPUE index. The two runs (Run06 and 11) reached the status of normal convergence.

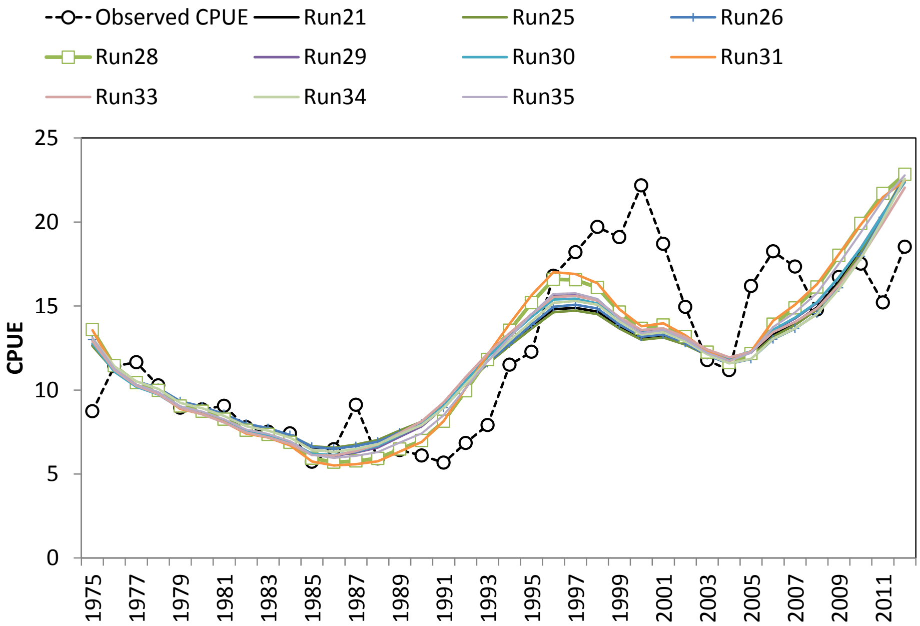

Fig. 3 Comparison between observed CPUE (open circle with dashed line) and estimated CPUE of ASPIC model supposed one period for CPUE index. The ten runs reached the status of normal convergence. The results of Run28 (lowest value of total objective function) was presented open circle with green line.

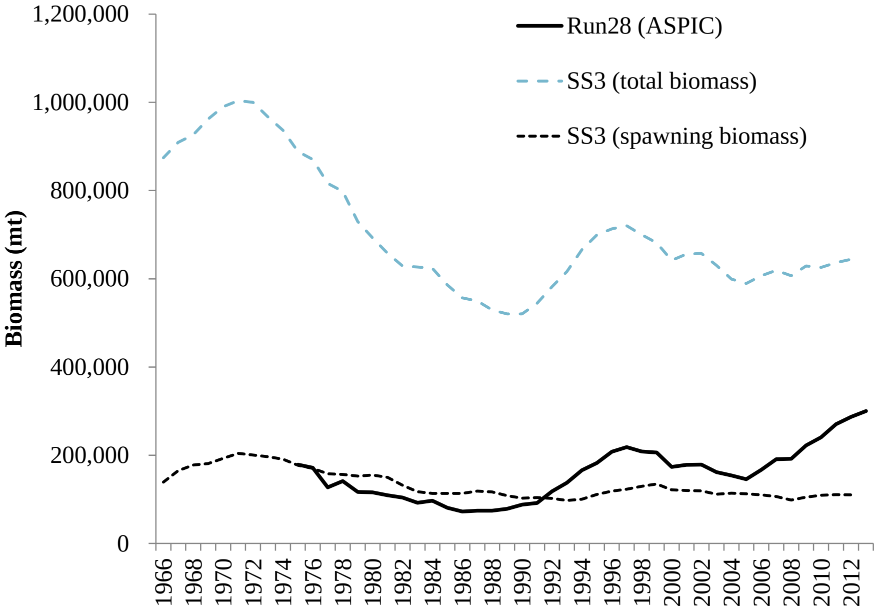

Fig. 4 Comparison between estimated total biomass and spawning biomass of base case of SS and estimated biomass of ASPIC of stock assessment of North Pacific albacore in Apr. 2014.

Table 7. Initial parameterization of the ASPIC production model discussed by the ALBWG.

Parameter	**Parameterization**
First year in model	Two periods: 1975-1992 and 1993-2012
Last year in model	2012
Data series	JPN LL-L1 (1975-1992), JPN LL-L2 (1993-2012)
Program mode	FIT (use in case of single index), and BOT (use after converged in FIT mode)
Model shape	Generalized (Pella-Tomlinson)
Optimization Model	Conditioned on Yield
Objective function	SSE
Generalized Model parameter	PHI MIN (20), PHI MAX (30), PHI step size (5), PHI start value (25) (recommend), PHI = Bmsy/K*100
Bound Multiple	8.0
Monte Carlo	unable
B1/K	0.3, 0.4, 0.5, 0.6, 0.7 for initial value, Estimate
MSY	Value of about 90,000 t for initial value
K	Initial value: 850,000 mt, Estimated
Series type	CC but use number based on CPUE directly.
q	small value (1.8×10^{-6}) for initial value, Estimate

ATTACHMENT 6

Annual Catch Table by Country

Table 1. [1] North Pacific albacore catches (in metric tons) by fisheries, 1952-2012. Blank indicates no effort. -- indicates data not available. 0 indicates less than 1 metric ton. Provisional estimates in ().

Year	Japan							Korea		Chinese-Taipei		
	Purse Seine	Gill Net	Set Net	Pole and Line	Troll	Longline	Other	Gill Net	Longline	Gill Net [2]	Distant Water Longline	Offshore Longline
1952	154		55	41,787	--	26,687	182					
1953	38		88	32,921	--	27,777	44					
1954	23		6	28,069	--	20,958	32					
1955	8		28	24,236	--	16,277	108					
1956			23	42,810	--	14,341	34					
1957	83		13	49,500	--	21,053	138					
1958	8		38	22,175	--	18,432	86					
1959			48	14,252	--	15,802	19					
1960			23	25,156	--	17,369	53					
1961	7		111	18,639	--	17,437	157					
1962	53		20	8,729	--	15,764	171					
1963	59		4	26,420	--	13,464	214					
1964	128		50	23,858	--	15,458	269					
1965	11		70	41,491	--	13,701	51					
1966	111		64	22,830	--	25,050	521					
1967	89		43	30,481	--	28,869	477				330	
1968	267		58	16,597	--	23,961	1,051				216	
1969	521		34	31,912	--	18,006	925				65	
1970	317		19	24,263	--	16,222	498				34	
1971	902		5	52,957	--	11,473	354		0		20	
1972	277	1	6	60,569	--	13,022	638		0		187	
1973	1,353	39	44	68,767	--	16,760	486		5		--	
1974	161	224	13	73,564	--	13,384	891		91		486	
1975	159	166	13	52,152	--	10,303	230		7,051		1,240	
1976	1,109	1,070	15	85,336	--	15,812	270		2,213		686	
1977	669	688	5	31,934	--	15,681	365		501		572	
1978	1,115	4,029	21	59,877	--	13,007	2,073		670		6	
1979	125	2,856	16	44,662	--	14,186	1,139	0			81	
1980	329	2,986	10	46,742	--	14,681	1,177	6	592	--	249	
1981	252	10,348	8	27,426	--	17,878	699	16	5,956	--	143	
1982	561	12,511	11	29,614	--	16,714	482	113	4,874	--	38	
1983	350	6,852	22	21,098	--	15,094	99	233	2,162	--	8	
1984	3,380	8,988	24	26,013	--	15,053	494	516	1,925	--	--	
1985	1,533	11,204	68	20,714	--	14,249	339	576	2,789	--	--	
1986	1,542	7,813	15	16,096	--	12,899	640	726	3,833	--	--	
1987	1,205	6,698	16	19,082	--	14,668	173	817	1,624	2,514	--	
1988	1,208	9,074	7	6,216	--	14,688	170	1,016	800	7,389	--	
1989	2,521	7,437	33	8,629	--	13,031	433	1,023	562	8,350	40	
1990	1,995	6,064	5	8,532	--	15,785	248	1,016	30	16,701	4	
1991	2,652	3,401	4	7,103	--	17,039	395	852	5	3,398	12	
1992	4,104	2,721	12	13,888	--	19,042	1,522	271	2	7,866	--	
1993	2,889	287	3	12,797	--	29,933	897		3		5	
1994	2,026	263	11	26,389	--	29,565	823		3		83	
1995	1,177	282	28	20,981	856	29,050	78		14		4,280	
1996	581	116	43	20,272	815	32,440	127		158		7,596	
1997	1,068	359	40	32,238	1,585	38,899	135		404		9,119	337
1998	1,554	206	41	22,926	1190	35,755	104		226		8,617	193
1999	6,872	289	90	50,369	891	33,339	62		99		8,186	207
2000	2,408	67	136	21,550	645	29,995	86		15		7,898	944
2001	974	117	78	29,430	416	28,801	35		64		7,852	832
2002	3,303	332	109	48,454	787	23,585	85		112		7,055	910
2003	627	126	69	36,114	922	20,907	85		146		6,454	712
2004	7,200	61	30	32,255	772	17,341	54		78		4,061	927
2005	850	154	97	16,133	665	20,420	234		420		3,990	482
2006	364	221	55	15,400	460	21,027	42		135		3,848	469
2007	5,682	226	30	37,768	519	22,336	44		137		2,465	451
2008	825	1,531	101	19,060	549	19,092	15		405		2,490	579
2009	2,076	149	33	31,172	410	21,995	43		101		1,866	512
2010	330	24	42	19,561	588	21,167	37		109		2,281	537
2011	480	12	50	25,705	443	20,956	78		84	3	2,972	462
2012	(480)	(12)	(50)	(27,117)	(443)	(21,315)	(78)		(202)	(3)	(2,055)	(588)
2013	(480)	(12)	(50)	(27,118)	(443)	(21,316)	(78)		(202)	(3)	(2,055)	(588)

1 Data are from the ISC Albacore Working Group,July 12, 2013 except as noted.

2 Chinese-Taipei gill net catches for 2011 include 2 t from Offshore Other gear category.

Table 1. (Continued)

Year	United States of America[2]							Mexico		Canada	China	Other		Grand Total
	Purse Seine	Gill Net	Albacore Troll[3]	Tropical Troll & Handline	Sport	Longline	Other[4]	Purse Seine	Pole and Line[5]	Troll	Longline	Troll[6]	Longline[7,8]	
1952			23,843		1,373	46				71				94,198
1953			15,740		171	23				5				76,807
1954			12,246		147	13								61,494
1955			13,264		577	9								54,507
1956			18,751		482	6				17				76,464
1957			21,165		304	4				8				92,268
1958			14,855		48	7				74				55,723
1959			20,990		0	5				212				51,328
1960			20,100		557	4				141				63,403
1961			12,055		1,355	5	1	2	39	4				52,649
1962			19,752		1,681	7	1	0	0	1				47,264
1963			25,140		1,161	7		31	0	5				68,937
1964			18,388		824	4		0		3				62,393
1965			16,542		731	3	1	0		15				73,033
1966			15,333		588	8		0		44				66,149
1967			17,814		707	12				161				83,096
1968			20,434		951	11				1,028				69,480
1969			18,827		358	14		0		1,365				75,023
1970			21,032		822	9		0		390				68,022
1971			20,526		1,175	11		0		1,746				91,240
1972			23,600		637	8		100	0	3,921				106,716
1973			15,653		84	14		0		1,400				106,841
1974			20,178		94	9		1	0	1,331				115,204
1975			18,932		640	33	10	1	0	111				94,284
1976			15,905		713	23	4	36	5	278				126,175
1977			9,969		537	37		3	0	53				62,511
1978			16,613		810	54	15	1	0	23				99,264
1979			6,781		74	--		1	0	521				70,745
1980			7,556		168	--		31	0	212				75,121
1981			12,637		195	25		8	0	200				76,539
1982			6,609		257	105	21	0	0	104				72,439
1983			9,359		87	6		0	0	225				56,202
1984	3,728		9,304		1,427	2		107	6	50				72,047
1985	26	2	6,415	7	1,176		118	14	35	56				60,819
1986	47	3	4,708	5	196		66	3	0	30				49,054
1987	1	5	2,766	6	74	150	139	7	0	104				50,207
1988	17	15	4,212	9	64	307	76	15	0	155				46,036
1989	1	4	1,860	36	160	248	10	2	0	140				44,574
1990	71	29	2,718	15	24	177	20	2	0	302				53,738
1991		17	1,845	72	6	312	20	2	0	139				37,274
1992		0	4,572	54	2	334	40	10	0	363				54,802
1993		0	6,254	71	25	438	194	11	0	494		0	1	54,302
1994		38	10,978	90	106	544	66	6	0	1,998		0	6	72,995
1995		52	8,125	177	102	882	4	5	0	1,761		94	0	67,948
1996	11	83	16,962	188	88	1185	10	21	0	3,321		469	0	84,487
1997	2	60	14,325	133	1,018	1653	12	53	0	2,166		336	1	103,942
1998	33	80	14,489	88	1,208	1120	15	8	0	4,177		341	0	92,371
1999	48	149	10,120	331	3,621	1542	61	0	57	2,734		228	2	119,297
2000	4	55	9,714	120	1,798	940	24	70	33	4,531		386	46	81,465
2001	51	94	11,349	194	1,635	1295	39	0	18	5,248		230	652	89,404
2002	4	30	10,768	235	2,357	525	13	28	0	5,379	210	466	13	104,760
2003	44	16	14,161	85	2,214	524	8	29	0	6,847	643	431	(14)	91,178
2004	1	12	13,473	157	1,506	361	3	104	0	7,857	504	82	4,113	90,953
2005		20	8,479	175	1,719	296	1	0	0	4,829	453	52	4,184	63,654
2006		3	12,547	95	385	270	0	109	0	5,833	665	1	4,804	66,733
2007	77	4	11,908	98	461	250	0	40	0	6,040	133	7	3,632	92,308
2008	--	1	11,761	29	418	354	0	10		5,464	185	0	2,807	65,676
2009	39	4	12,938	100	677	203	0	17		5,693	77	0	1,616	79,720
2010	--	5	12,634	55	704	421	19	25		6,527	907	0	2,947	68,919
2011	--	5	11,037	88	424	708	37	0		5,415	2,928	(0)	(8,320)	(80,206)
2012	5	8	14,149	280	1,212	659	2	(0)		2,497	6,092		(2,962)	(80,209)
2013		(5)	(12,325)		(839)		()	(1)		(5,097)	(6,092)		(2,962)	(79,666)

2 USA estimates updated July 2013.

3 Albacore Troll estimates include catches caught with Pole-and-Line gear.

4 Other may include catches by Purse Seine.

5 Mexico Pole-and-line catches for 1999 and 2000 include 34 and 4 metric tons, respectively, from Longline.

6 Other Troll catches are from vessels registered in Belize, Cook Islands, Tonga, and Ecuador.

7 Other Longline data are from WCPFC Yearbook 2011 for non-member nations.

8 Catch reported for Other Longline in 2011 requires verification of accuracy as this figure is much higher than the historical record.

ATTACHMENT 7

INFORMATION AND ADVICE ON BIOLOGICAL REFERENCE POINTS FOR NORTH PACIFIC ALBACORE UPDATED WITH 2014 STOCK ASSESSMENT RESULTS

This document updates the information and advice requested by the Eighth Regular Session of the Northern Committee (NC8) using the 2014 stock assessment results (Appendix 1). These updates were developed by the Albacore Working Group (WG) during the assessment workshop, April 14-28, 2014 in La Jolla, USA. The organization of this document follows the questions posed by NC8.

1.0 ASSESSMENT MODEL PARAMETERS

1.1 Stock-recruitment Relationship and Steepness Parameter

The 2014 stock assessment assumed that a Beverton-Holt stock recruitment relationship was representative of stock-recruitment dynamics in the north Pacific albacore stock and that the value of the steepness parameter (h) in this relationship is 0.9. The assumption of a Beverton-Holt stock-recruitment relationship is considered plausible, although the relationship may be weak. Two separate estimates of the steepness parameter based on life history theory provide evidence that plausible values of h are in the range $0.6 < h < 1.0$, with separate estimates reporting peak frequency distribution values of 0.84 and 0.95, respectively (Brodziak et al. 2011; Iwata et al. 2011). The steepness value assumed in the 2014 assessment is the median between these estimates ($h = 0.9$) and is considered reasonable by the WG based on its knowledge of albacore stock productivity relative to other highly migratory species. However, the WG notes that there are likely long-term environmental trends affecting recruitment in addition to the stock recruitment relationship.

1.2 Biological and Fishery Parameters

The age-based maturity schedule used in the 2014 stock assessment is identical to the schedule used in the 2011 assessment: 50% of albacore at age-5 are assumed to be sexually mature and all fish age-6 and older are mature. This age-based maturity schedule is considered reasonable, but it is based on maturity data that are more than 40 years old and there is a need to develop a better description of maturity at age or length for north Pacific albacore since existing information does not capture spatial variation in maturity across the range of the adult component of this stock.

Natural mortality, M, was not estimated in the 2014 assessment model, but was fixed at 0.3 yr^{-1} for all ages. The assumed value was taken from assessments of Atlantic albacore (e.g., ICCAT 2010) and was used in previous assessments. The WG recognizes the need to develop estimates of sex-specific natural mortality for north Pacific albacore because a two sex model was used for the 2014 assessment and there are clear differences in sex ratio with increasing size.

Given the data inputs and model structure, the WG concludes that fishery selectivity for north Pacific albacore is well estimated for the eight fleets for which size composition data are available. Selectivity of fleets for which no size data were available was assumed to be identical to one of the eight fleets based on similarities in operating characteristics.

2.0 CANDIDATE REFERENCE POINTS

2.1 Estimated Yields and Probabilities

Advice on expected future yields and variability under low, average, and high historical recruitment scenarios over a 10-yr projection period was requested by NC8 and NC9 to assist in determining the suitability of candidate reference points. Additional information in the form of the estimated probability of breaching the Interim Management Objective (average of the 10 historical lowest years of SSB) and several biomass depletion levels for each candidate reference point harvest scenario was also requested. The WG developed separate tables to provide these estimates for low, average, and high historical recruitment scenarios (Tables 1 to 3). These estimates are based on the 2014 assessment model, which includes data through 2012.

Methods - Biomass depletion levels are calculated relative to $SSB_{F=0}$, which is estimated as the mean spawning biomass (N = 100) at the terminal year of a 30-yr projection with F=0 for a given level of low, average, or high recruitment, i.e., the mean SSB at 2041. Thus, a different average value of $SSB_{F=0}$ was calculated for each recruitment scenario and applied to the nine harvest scenarios. Estimating $SSB_{F=0}$ was a first and separate step from the projections described below.

A second set of projections to derive estimates of future yield and probabilities that biomass will fall below depletion levels in at least one year of the projection period was performed with the R package "ssfuture" (Ichinokawa 2012,) which was also used for future projections in the 2014 stock assessment. Biological parameter values and initial population number were estimated for 2011 and recruitment was estimated by random resampling of the low, average, or high historical recruitment period data from the 2014 base case model. Projections were conducted for 27 combinations of recruitment (three scenarios) and constant harvests strategies (nine scenarios corresponding to candidate reference points $F_{SSB-ATHL}$, F_{MSY}, $F_{0.1}$, F_{MED}, $F_{10\%}$, $F_{20\%}$, $F_{30\%}$, $F_{40\%}$ and $F_{50\%}$). One hundred (100) bootstrap replicates were used to estimate the mean expected yield (±CV) and the probability that SSB would fall below biomass depletion levels at a constant fishing mortality equivalent to the candidate reference points for each recruitment-harvest combination projection. Mean expected yield is calculated as average harvest at the terminal year of the projection, which is 2021 for 10-year and 2036 for the 25-year projections.

Results - Expected yield for all harvest scenarios increases with increasing recruitment level and the differences between yield in the low and high recruitment scenarios ranges between 50,000 and 72,000 t, depending on the harvest scenario used (Tables 1 to 3). The F_{MSY}, $F_{10\%}$, and $F_{20\%}$ harvest scenarios produce similar large expected yields and while the $F_{SSB-ATHL}$ scenario produces the lowest expected yield regardless of the length of the projection period 10 or 25 years) . Expected yield increases approximately 33% between the minimum and maximum values in all recruitment scenarios.

The WG notes that improvements implemented in the 2014 assessment model affect the $F_{SSB-ATHL}$ reference point. The biomass trajectory in the current assessment has changed relative to the 2011 model, with a low biomass period occurring at the end of the modeled time frame. Because of this change, the estimated SSB–ATHL threshold differs from the previous assessment and now includes several recent years (2007-2010) in its calculation. However, the WG also notes that the point estimate of this threshold is 117,835 t, which is more than twice the SSB_{MSY} level (49,680 t) estimated by the 2014 base case model. Consideration should be given to determining whether it is appropriate to include recent years in the calculation of this threshold since the threshold is used to evaluate the current status of the stock based on those recent years.

The probability of depleting spawning biomass (SSB) to various levels varies with the harvest scenarios, but in general the probabilities for a given harvest scenario are higher when low recruitment is assumed than high recruitment (Tables 1 and 3). Probabilities are highest for the high yield harvest scenarios (F_{MSY}, $F_{10\%}$, $F_{20\%}$) and lowest for the $F_{SSB-ATHL}$ harvest scenario. The probability of depletion decreases as the depletion level increases from $SSB_{40\%}$ to $SSB_{10\%}$ in all recruitment scenarios (Tables 1-3).

2.3 Harvest Scenarios Relative to Reference Points

Estimated F-ratios of candidate reference points for two different constant harvest scenarios ($F_{2002-2004}$, $F_{2010-2012}$) are shown in Table 4 to determine if reference point levels are exceeded. It is important to note that the WG used selectivity for $F_{2002-2004}$ and $F_{2010-2012}$, respectively, for these calculations. The WG also notes that all reference point ratios were calculated by SS except $F_{0.1}$, which was based on yield-per-recruit (YPR) analysis because SS has no calculation option for this reference point. This means that the quantitative basis for the $F_{0.1}$ calculation differs from the other reference points.

$F_{2002\text{-}2004}/F_{RP}$ ratios are consistently higher than $F_{2010\text{-}2012}/F_{RP}$ ratios with a maximum difference of 46% for F_{MSY}. The $F_{50\%}$ and F_{MED} reference point ratios exceeded 1.0 under an F-current ($F_{2010\text{-}2012}$) harvest scenario, the remaining ratios were less than 1.0 for Fcurrent.

2.4 Environmental Influences on Candidate Reference Points

The north Pacific albacore stock is modeled as an recruitment-driven stock in 2014 since there is little evidence at present that fishing has reduced SSB below thresholds associated with the majority of biomass-based reference points that might be chosen. The WG suspects but does not have strong evidence at present supporting the hypothesis that recruitment is “environmentally driven” in addition to the stock-recruitment effect implicit in the assumption of a steepness parameter of h=0.9. Kiyofuji (2013) presented a working paper that provides evidence of cyclic changes in albacore recruitment levels (high, low, average) that seems to fit regime shifts in productivity of the North Pacific Ocean in the 1970s and 1980s. Zhang et al. (2013) showed that stock productivity, when modeled with a logistic surplus production model, was positively affected by the North Pacific Gyre Oscillation (NPGO) and negatively affected by the multi-variate ENSO index (MEI) at a lag period of four years. Hokimoto and Kiyofuji (2013) demonstrated that changes in phytoplankton concentration impact the migration behavior of albacore based on the in-situ data and were able to develop a model to predict albacore location depending on the chlorophyll-a concentration of phytoplankton. Although it is not clear what population process is impacted by large scale climate forcing represented by the NPGO and MEI, Zhang et al. (2013) and the WG speculate that these results could be a latent recruitment effect.

A preliminary assessment of the effects of regime shifts on values of F_{SPR}s can be accomplished by comparing the results for the low and high recruitment scenarios in Tables 1 and 3. The probability of SSB breaching the Interim Management Objective and other depletion levels when harvesting at F_{MSY}, $F_{10\%}$ and $F_{20\%}$ was higher than the other harvests scenarios for both high and low recruitment assumptions. Depletion probabilities were always higher in the low recruitment scenario relative to those of high recruitment scenario and these differences range from 20 to 60%.

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Table 1. Expected future yield at the end of the projection period (± CV) and estimated probabilities that SSB will be lower than several biomass depletion level thresholds in at least one year of the projection period under nine constant harvest scenarios corresponding to candidate reference points and the low historical recruitment scenario. $SSB_{F=0\ xx\%}$ refers to spawning biomass depletion relative to the unfished state. Probabilities highlighted in bold are ≥ 0.50.

Low Historical Recruitment Scenario

				Biomass Depletion Level				
Reference Point	Projection Period (yr)	Future* Yield (mt)	CV	SSB-ATHL	$SSB_{F=0\ 10\%}$	$SSB_{F=0\ 20\%}$	$SSB_{F=0\ 30\%}$	$SSB_{F=0\ 40\%}$
$F_{SSB\text{-}ATHL}$	25	63,111	(0.08)	**0.84**	0.00	0.00	0.15	**0.60**
$F_{SSB\text{-}ATHL}$	10	68,987	(0.07)	**0.71**	0.00	0.01	0.16	0.46
F_{MSY}	10	90,956	(0.10)	**0.92**	**0.51**	**0.69**	**0.79**	**0.86**
$F_{0.1}$	10	74,663	(0.08)	**0.78**	0.00	0.06	0.35	**0.60**
F_{MED}	10	70,294	(0.08)	**0.73**	0.00	0.01	0.19	**0.50**
$F_{10\%}$	10	91,910	(0.11)	**0.95**	**0.68**	**0.79**	**0.85**	**0.91**
$F_{20\%}$	10	90,570	(0.09)	**0.92**	0.47	**0.67**	**0.78**	**0.86**
$F_{30\%}$	10	86,158	(0.09)	**0.88**	0.12	**0.52**	**0.68**	**0.79**
$F_{40\%}$	10	80,337	(0.08)	**0.83**	0.00	0.22	**0.53**	**0.70**
$F_{50\%}$	10	72,115	(0.08)	**0.75**	0.00	0.03	0.25	**0.55**

*Future yield is estimated for females and doubled to account for males.

Table 2. Expected future yield at the end of the projection period (± CV) and estimated probabilities that SSB will be lower than several biomass depletion level thresholds in at least one year of the projection period under nine constant harvest scenarios corresponding to candidate reference points and the average historical recruitment scenario. $SSB_{F=0\ xx\%}$ refers to spawning biomass depletion relative to the unfished state. Probabilities highlighted in bold are ≥ 0.50.

Average Historical Recruitment Scenario

				Biomass Depletion Level				
Reference Point	Projection Period (yr)	Future* Yield (mt)	CV	SSB-ATHL	$SSB_{F=0\ 10\%}$	$SSB_{F=0\ 20\%}$	$SSB_{F=0\ 30\%}$	$SSB_{F=0\ 40\%}$
$F_{SSB\text{-}ATHL}$	25	90,467	(0.09)	**0.50**	0.00	0.00	0.23	**0.72**
$F_{SSB\text{-}ATHL}$	10	97,869	(0.09)	**0.55**	0.00	0.01	0.30	**0.74**
F_{MSY}	10	130,623	(0.12)	**0.92**	**0.57**	**0.78**	**0.88**	**0.96**
$F_{0.1}$	10	106,636	(0.10)	**0.73**	0.00	0.11	**0.53**	**0.84**
F_{MED}	10	99,887	(0.09)	**0.61**	0.00	0.03	0.35	**0.78**
$F_{10\%}$	10	132,641	(0.14)	**0.95**	**0.73**	**0.85**	**0.92**	**0.97**
$F_{20\%}$	10	129,028	(0.12)	**0.92**	**0.53**	**0.76**	**0.88**	**0.95**
$F_{30\%}$	10	123,664	(0.11)	**0.88**	0.16	**0.62**	**0.81**	**0.90**
$F_{40\%}$	10	114,441	(0.10)	**0.81**	0.00	0.31	**0.69**	**0.89**
$F_{50\%}$	10	102,666	(0.09)	**0.66**	0.00	0.05	0.42	**0.81**

*Future yield is estimated for females and doubled to account for males.

Table 3. Expected future yield at the end of the projection period (± CV) and estimated probabilities that SSB will be lower than several biomass depletion level thresholds in at least one year of the projection period under nine constant harvest scenarios corresponding to candidate reference points and the high historical recruitment scenario. $SSB_{F=0\ xx\%}$ refers to spawning biomass depletion relative to the unfished state. Probabilities highlighted in bold are ≥ 0.50.

High Historical Recruitment Scenario

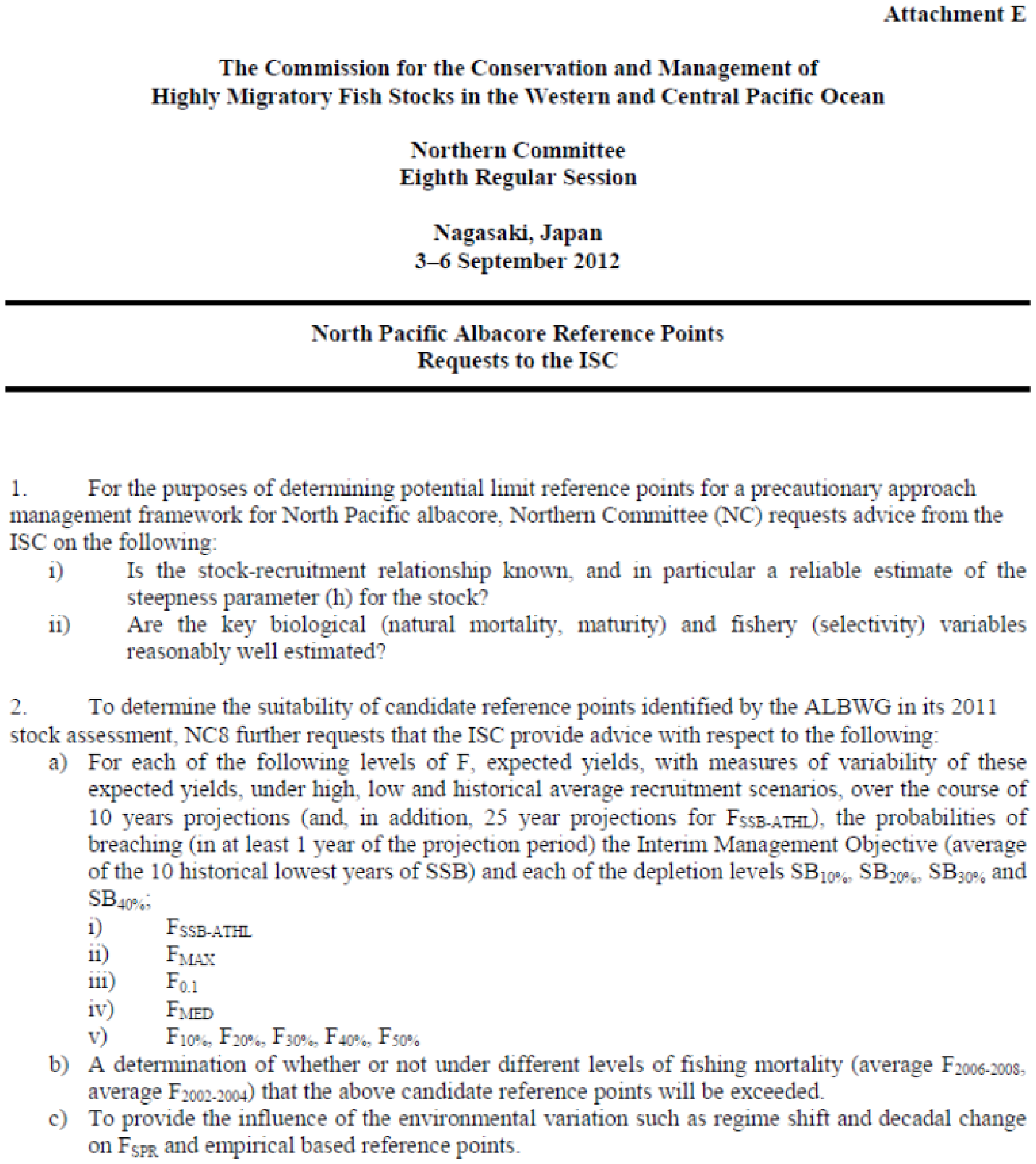
Reference Point	Projection Period (yr)	Future* Yield (mt)	CV	Biomass Depletion Level SSB-ATHL	$SSB_{F=0\ 10\%}$	$SSB_{F=0\ 20\%}$	$SSB_{F=0\ 30\%}$	$SSB_{F=0\ 40\%}$
$F_{SSB\text{-}ATHL}$	25	113,178	0.07	0.20	0.00	0.00	0.27	**0.82**
$F_{SSB\text{-}ATHL}$	10	121,006	0.07	0.38	0.00	0.02	0.45	**0.92**
F_{MSY}	10	162,487	0.09	**0.92**	**0.62**	**0.83**	**0.94**	**0.99**
$F_{0.1}$	10	132,120	0.07	**0.63**	0.00	0.15	**0.71**	**0.94**
F_{MED}	10	123,643	0.07	0.43	0.00	0.03	**0.51**	**0.92**
$F_{10\%}$	10	163,931	0.09	**0.95**	**0.77**	**0.88**	**0.96**	**0.99**
$F_{20\%}$	10	161,209	0.08	**0.92**	**0.58**	**0.82**	**0.93**	**0.99**
$F_{30\%}$	10	153,149	0.08	**0.88**	0.17	**0.70**	**0.90**	**0.99**
$F_{40\%}$	10	142,139	0.07	**0.79**	0.00	0.39	**0.83**	**0.97**
$F_{50\%}$	10	126,947	0.07	**0.51**	0.00	0.07	**0.60**	**0.93**

*Future yield is estimated for females and doubled to account for males.

Table 4. Potential reference points and estimated F-ratios using Fcurrent ($F_{2010\text{-}2012}$) and $F_{2002\text{-}2004}$ (current F in the 2006 assessment that lead to the implementation of CMMs). Ratios ≥ 1.0 are highlighted in bold.

Reference Point	$F_{2010\text{-}2012}/F_{RP}$	$F_{2002\text{-}2004}/F_{RP}$
$F_{SSB\text{-}ATHL}$	0.72	0.85
F_{MSY}	0.52	0.76
$F_{0.1}$	0.51	0.56
F_{MED}	**1.30**	**1.34**
$F_{10\%}$	0.63	0.71
$F_{20\%}$	0.71	0.80
$F_{30\%}$	0.81	0.92
$F_{40\%}$	0.94	**1.07**
$F_{50\%}$	**1.13**	**1.29**

APPENDIX 1



Attachment E

The Commission for the Conservation and Management of
Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Northern Committee
Eighth Regular Session

Nagasaki, Japan
3–6 September 2012

North Pacific Albacore Reference Points
Requests to the ISC

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1. For the purposes of determining potential limit reference points for a precautionary approach management framework for North Pacific albacore, Northern Committee (NC) requests advice from the ISC on the following:
    - i) Is the stock-recruitment relationship known, and in particular a reliable estimate of the steepness parameter (h) for the stock?
    - ii) Are the key biological (natural mortality, maturity) and fishery (selectivity) variables reasonably well estimated?

2. To determine the suitability of candidate reference points identified by the ALBWG in its 2011 stock assessment, NC8 further requests that the ISC provide advice with respect to the following:
    - a) For each of the following levels of F, expected yields, with measures of variability of these expected yields, under high, low and historical average recruitment scenarios, over the course of 10 years projections (and, in addition, 25 year projections for $F_{SSB\text{-}ATHL}$), the probabilities of breaching (in at least 1 year of the projection period) the Interim Management Objective (average of the 10 historical lowest years of SSB) and each of the depletion levels $SB_{10\%}$, $SB_{20\%}$, $SB_{30\%}$ and $SB_{40\%}$;
        - i) $F_{SSB\text{-}ATHL}$
        - ii) F_{MAX}
        - iii) $F_{0.1}$
        - iv) F_{MED}
        - v) $F_{10\%}$, $F_{20\%}$, $F_{30\%}$, $F_{40\%}$, $F_{50\%}$
    - b) A determination of whether or not under different levels of fishing mortality (average $F_{2006\text{-}2008}$, average $F_{2002\text{-}2004}$) that the above candidate reference points will be exceeded.
    - c) To provide the influence of the environmental variation such as regime shift and decadal change on F_{SPR} and empirical based reference points.