Annex 5

REPORT OF THE PACIFIC BLUEFIN TUNA WORKING GROUP WORKSHOP

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

6-13 January 2011
Shizuoka, Japan

1.0 INTRODUCTION

1.1 Welcome and Introduction

The ISC Pacific Bluefin Tuna *(Thunnus orientalis)* Working Group (ISC PBFWG) workshop met at the National Research Institute of Far Seas Fisheries (NRIFSF), Shizuoka, Japan, on January 6 to 13, 2011. The meeting was opened by the Chair, Yukio Takeuchi. Dr. Yuji Uozumi, the Director of NRIFSF, welcomed all the participants. Scientists from Japan, Taiwan, the U.S.A. and the IATTC participated in the workshop. Also two more scientists participated in the meeting as invited scientists (Appendix 1). The tentative Agenda previously distributed by the Chair was discussed and adopted with minor changes (Appendix 2). Appointment of rapporteurs Rapporteurs were appointed for each agenda item (shown in parentheses in Appendix 2). Makoto Miyake was given the task of leading rapporteurs and assembling the Workshop report.

Thirteen working papers[1] and seven oral presentations were presented at the workshop. Those reports and presentations were assigned to relevant agenda items (Appendix 3). Working paper authors were asked by the Chair if they wished to make the full paper available through the ISC website and responses are recorded in Appendix 3.

2.0 FISHERY DATA FOR THE STOCK ASSESSMENT

2.1 Approaches for estimation of catch at age of young Pacific bluefin tuna caught by Japanese small purse seine fisheries by Alec MacCall and Steve Teo (ISC/11-1/PBFWG/07)

As a part of process to improve input data for stock assessment, catch at age of PBF caught by Japanese small purse seine fishery, one of the fisheries targeting young PBF, was directly calculated with catch and size data. Length frequency distributions were made by market size categories (box size categories) assuming that the length frequency did not change by year and by season. Subsequently the length frequency distributions by the size category were raised by

[1] Thirteen working papers were presented January workshop. In addition, at the PBF WG meeting held in July 16, 2011, Korea presented a working paper on revision of Korean purse seine catch. The WG recognized it useful and decided to register it as one of working papers of the workshop.

monthly total landing in number in the corresponding category. Two modes of length class corresponding to ages 0 and 1 were observed in monthly catch at size. The von Bertalanffy growth function currently used in the stock assessment failed to explain seasonal growth pattern of young PBF observed in modal progression due to changes in growth rate. Catch at age was calculated by visual slicing applied for the catch at size. The 2004 year class expected as a strong cohort recorded the highest cumulative catch in the year classes of 2004 to 2008. There were discrepancies between observed catch at age and estimated one by the SS3 model. This document clearly showed that the current SS3 model cannot duplicate the actual length frequency distributions of young PBF caught by the small purse seine fishery. It was recommended that direct calculation of catch at age is applied for construction of catch at age of this fishery.

Discussion

The WG was primarily concerned about the representativeness of the length samples within each box category and the sample sizes within each category. The author showed that the length distribution within each box category remained relatively consistent for most years, which is the key assumption of this study. The WG noted that this method provided a reasonably representative catch-at-size for this fishery. However, the WG recommended that the author continue monitoring the length distribution in each box category to ensure the future consistency of length distributions within box categories. The WG suggested that the author use otolith-derived ages to estimate the uncertainty in converting estimated lengths to ages as well as box categories to ages. The WG also recommended that the author provide the following analyses at the data preparation workshop: 1) derive length compositions without data substitution, 2) derive length compositions with data substitution and identifying the substitution, and 3) develop a probability transition matrix for converting box category to age.

Potential methods of using box category or other types of size categories within the SS3 framework were demonstrated to the WG. There was concern that no data prior to 2004 were analyzed nor presented, although data since the beginning of fishery in 1990 were available. The WG recommended that the author analyze all the available data for this fishery and present that analysis at the next data preparation meeting. Some members of the WG suggested that since no abundance index in the SS3 model is linked to this fishery, the main modeling concern for this fishery is that the correct numbers of fish at age be removed from the population by this fishery. Therefore, simply using catch in numbers rather than catch in weight may alleviate the majority of the problems with this fishery.

2.2 Estimation of the length and age compositions of Pacific bluefin tuna caught by Japanese set-net fishery by Mikihiko Kai (ISC/11-1/PBFWG/05)

This paper provides: summary of the catch of Pacific bluefin tuna (PBF) by set-net fishery in Japan; estimation of the length compositions in number of fish calculated on catch and size sample data since 1994; and estimation of age compositions in number of fish through the maximum likelihood method for the Gaussian mixture distribution. The data used in the analysis are stratified into four main fishing areas and then by months. The estimated length compositions in number by area, month, year have frequently two modes within the length range corresponding to age-0 fish. This result indicates that two different birth groups are included in the data. The estimated age composition of the catch clearly showed that age-0 and age-1 fish make up a main component of PBF caught by Japanese set-net fishery. However, the seasonal change in the estimated catch in number of age-0 was inconsistent with that estimated by the preliminary stock assessment in 2010 (SS model). This result indicates that there may be a problem in the estimations of seasonal catch by SS model. Therefore, it is better to estimate age-compositions in number using a model independent method such as that provided in this study, even though it still has some problems. In conclusion, further study is required for improving the accuracy of the estimation of age-composition.

<u>Discussion</u>

The WG suggested discussing the three parts of this study in sequence: 1) derivation of length compositions, 2) conversion of length compositions to age compositions, and 3) deriving age-segregated indices from derived age composition data. The author clarified that the estimated length compositions in this study are quite different from data used in previous assessments. In particular, the estimated proportions of small fish have increased substantially. In response to an inquiry, the author showed the sampling coverage in each category and the effect of data substitution on the estimated compositions for the Hokkaido-Aomori set nets. The WG noted that some categories had very low sampling coverage and required substantial data substitutions, and that the data substitutions resulted in inconsistent length compositions. However, the amount of catch affected by data substitutions, have been relatively minor (~10%). The WG noted that this method may result in improved catch-at-size data for the assessment but the method is relatively complicated and the uncertainties are poorly understood. The WG recommended that more work be put into understanding and determining the uncertainties in the length compositions derived by this method. The WG agreed to postpone discussion of parts 2 and 3 until the uncertainties of this method are better understood.

2.3 Preliminary analysis of length frequency and amount of catch data for Pacific bluefin tuna *(Thunnus orientalis)* landed by Tuna Purse Seine Fleet (Fleet 3) in different sea area by Masayuki Abe and Yukio Takeuchi (ISC/11-1/PBFWG/09)

Length frequency and catch data of tuna purse seine fishery operating in both, the Pacific and the Sea of Japan, areas were reviewed, using Tuna Purse Seine fleet (Fleet 3) data in the Stock Synthesis model. In both areas, fishing seasons have been mainly 1st and 4th quarters in fishing year. After 2003, quarterly catch in 4th qt in the Sea of Japan increased. Sample sizes in both areas were sufficient for using in the Stock Synthesis model. However, sample size observed in the Pacific Ocean side decreased dramatically in recent years and that from the Sea of Japan side increased extremely starting in the early 1990s. The fork length modes in samples collected on the Pacific Ocean and the Sea of Japan sides were 106cm and 116cm, respectively. The differences in quarterly mode between areas were little, but the variability in quarterly modes by area and year were large. The average fork length of the Sea of Japan side of 1st quarter was larger than that of the Pacific Ocean side between 1980 and 1993. However the average fork length of fish from the Tuna Purse Seine Fleet was almost outweighed by that of landing on Pacific Ocean side, because of relatively small sample size from the Sea of Japan side.

Discussion

The WG noted that this study illustrated that the selectivity of this fishery has changed over 3 periods: Pacific-dominated, mixed, and Sea of Japan-dominated periods. A suggestion was made that different selectivity curves be used during those three periods, or alternatively, share selectivity but have different retention curves. The lack of <100cm fish in the Sea of Japan fishery was noted, and a suggestion was made that sets by this fishery with small PBF (<100cm) are assigned to small pelagic PS fishery instead of the tuna purse seine fishery in the current stock assessment, because operations catching small PBF is distinct. The WG enquired if the changes in catch between Pacific Ocean and Sea of Japan fisheries were due to changing number of vessels. However, the authors showed that the number of vessels in each area have remained relatively stable. The WG discussed the possibility of separating the Sea of Japan fishery from the Pacific Ocean, and agreed that it is possible to separate the data between the two areas but will discuss if that is the preferred approach in the model in the next workshop.

2.4 Estimation of length distribution for landing data of Pacific Blue Fin tuna in Sakai-minato port by Minoru Kanaiwa, Ayumi Shibano, and Yukio Takeuchi (ISC/11-1/PBFWG/04)

In the previous stock assessments, the length distribution of sampled individuals is used for estimating catch at size. However, the sampling coverage ratio and number of fish in each landing are different among landing. To account for these factors, the sum of length distributions weighted by numbers of fish in each landing is proposed. We compare results from this method with results derived from the previous method. The positions of modes of length distribution are almost the same but the heights are different. Heights of smaller bins estimated by the proposed method are larger than that by the previous method and that of larger bins are smaller. The variation by the proposed method is larger than that by the previous method and this results suggests that the proposed method results in a better characterization of catch by the purse seine fishery.

Discussion

It was noted that the previous assessment data series started in 1994 but this study used data from 1987. The current method (with the weighting by catch in number) would likely result in a more representative catch-at-size distributions for the purse seine fishery operated in the Sea of Japan. In particular, since 2009, because of a revision of sampling protocol, approximately 200 fish are measured per landing, and hence the number of fish measured is not proportional to the number of fish caught. In addition, since 2004, catches in the Sea of Japan have become much larger and the proportion of sampled catch has become smaller and less proportional. It is therefore important to weight the samples by catch in numbers in order to derive a representative catch-at-size. The WG recommended that this method be used for the length compositions for the Sea of Japan tuna purse seine fishery. However, the WG noted that if length composition data from Pacific Ocean and Sea of Japan fisheries are combined, this method cannot be used due to different sampling methods in the two areas. Therefore the WG will examine both ways of running the model and decide whether to separate the Pacific Ocean and Sea of Japan tuna purse seine fisheries (same as WP#09). It was noted that this study illustrated the potential sampling errors in the length compositions used in previous assessments for this fishery, which was not weighted. It was also suggested that performing simulation studies of sampling protocols be used to determine if the Pacific Ocean fishery length compositions are biased, especially for smaller fish.

3.0 STOCK ASSESSMENT MODELS

3.1 Sensitivity of Estimated Spawning Biomass to Natural Mortality Assumptions in Pacific Bluefin Tuna Assessments by Steve Teo (ISC/11-1/PBFWG/10)

This study systematically evaluated the sensitivity of estimated Pacific bluefin tuna spawning biomass with respect to natural mortality assumptions. In the PBF base model (i.e., model used for status update in July 2010), natural mortality at age-0 (M0), age-1 (M1), and age-2+ (M2+) were assumed to be 1.6, 0.386, and 0.25 respectively. In this study, we fixed M0 at 1.6 but varied M1 and M2+ systematically. For each run of the model, M2+ was changed from 0.05 to 0.45 in 0.01 steps, and M1 was modified such that (M0-M1)/(M0-M2) remained constant for all runs. Estimated spawning biomass increased relatively smoothly from M2+ = 0.15 to 0.25 but when M2+ was assumed to be >0.25, the rate of change of estimated spawning biomass increased substantially. This showed that sensitivity of spawning biomass increased substantially in the PBF base model, when M2+ is >0.25. In addition, spawning biomass ratio and other quantities also showed large increases in sensitivity when M2+ is >0.25. Therefore, it is suggested that adult natural mortality should not be in excess of 0.25, unless there is biological data that suggests otherwise. This study suggests that the PBFWG should be cautious in assuming high levels of natural mortality.

<u>Discussion</u>

The WG discussed what constitutes an unusually sensitive result in a likelihood profile analysis over a range of M. Two possibilities were discussed. The first was large changes in the scale of derived quantities (e.g. spawning biomass and F). The second was a change in the pattern of results that indicated non-linear scaling above a specific M level. The WG generally believed that in this example, the unusual relative scaling of derived quantities resulting from a change in adult M constituted the unusually sensitive result. The WG noted that the profile indicated that the model fits better at higher M levels. It was suggested that length-based models often fit better at higher M levels due to over-fitting of size composition data. Thus the results of the profile may not represent information regarding the best relative likelihood of M. The WG requested additional model runs with finer scale changes in adult M between 0.25 and 0.3 and provides a table of likelihoods for each model component. Results indicated that the unusual profile results were influenced by the fits to the EPO CPUE data.

3.2 Introduction of a spatially-structured model of Pacific Bluefin Tuna by Kevin Piner, Hui-hua Lee, Ian Taylor, Alexandre Aires-da-Silva, and Steve Teo (ISC/11-1/PBFWG/06)

A two-area spatially structured model is introduced for Pacific bluefin tuna. Movement is estimated to explain the proportion at length and CPUE from the Eastern Pacific area. A series of increasingly more complex and realistic models were developed with all model results indicating similar population dynamics. The most parsimonious model results are compared to those of the current stock assessment. Although a full range of diagnostics was not reviewed for the spatially structured model, the limited set of diagnostics indicated it was reasonably well behaved. Results of the spatially structured model were similar to the current stock assessment. The spatially structured model was not sensitive to small changes in juvenile M and changes to adult M were consistent with changes to population productivity. A spatially structured model appears to be possible with the current data; however parsimony may favor the existing stock assessment model.

Discussion

It was clarified if there was evidence of spawning in the EPO that might indicate a resident PBF subpopulation in that area. It was generally agreed that there is no significant evidence of spawning in the EPO, although there are records of periodic catches of very large bluefin in the region. The WG wondered if this might indicate there may have been a resident subpopulation in the EPO that was fished down and thus not apparent today. However if that were the case、then the size of fish caught at the start of the US purse seine fishery should have been larger than observed. The WG also questioned the authors about where information on scaling of the EPO area is derived in their two area model. The authors answered that the scaling is probably most influenced by the magnitude of the EPO catch and trends in the EPO CPUE. The WG suggested that author's estimates of EPO exploitation rates could be compared to those derived from other studies (e.g. tagging) as a method of qualitatively assessing model performance.

The WG questioned the estimated movement rate from the model. It was answered that the current movement rate estimate may include both movements to the EPO and retention rate so that current estimates may be misinterpreted. The authors indicated that a model designed to provide separate estimates of movement and retention would be more appropriate and could be provided at a future meeting.

3.3 Summary of EPO data presented by Alexandre Aires-da-Silva (Oral Presentation only)

The EPO indices will be updated by IATTC along with the catch and size composition for the next stock assessment. This work will be done in collaboration with Mexican and US scientists.

Discussion

The WG noted that there are two distinct issues in regards to using the EPO CPUE for stock assessment. The first is that the CPUE series are derived from purse seine fisheries which are often thought to have ill-defined effort metrics. The authors explained that vessel search time was included into the analysis and that this was a reasonable measure of the true effort. The second issue is that availability of Pacific bluefin to EPO fisheries is likely variable due to trans-Pacific movement. Thus using the CPUE index in a single area stock assessment model with an assumption of a constant proportionality between index and biomass is not recommended. Additional assessment model process beyond that used in the WGs prior assessments (e.g. spatial structure/movement or changing catchability) is needed to adequately use this data. These same concerns may apply to the assumption of a constant selectivity pattern for EPO fisheries. The authors of the EPO CPUE series made it clear that the CPUE series is not appropriate for use in the stock assessment model unless appropriate model process is incorporated. WG agreed with the author's view; however a final decision about inclusion of EPO CPUE will wait until the WG decides on the model structure to be used in the next assessment. The WG emphasized the need to continue to develop and improve all EPO data (catch, size composition and CPUE) so that all modeling options would be available.

During the meeting the WG performed a model run using the 2010 base model incorporating additional 3 time-blocks for EPO selectivity. Results indicated a trend of higher selectivity on larger fish with each more contemporaneous time-block. The increase of six parameters improved model fit by approximately 100 likelihood units, with both CPUE and size compositions showing improvement.

3.4 A hybrid SS3-VPA model for examining trends in young fish selectivity and recruitment by Alec MacCall and Steve Teo (ISC/11-1/PBFWG/01)

A new "hybrid" SS3-VPA assessment was developed, where ages 0 and 1 are disconnected from the selectivity curves for older fish. Catches of ages 0 and 1 are removed from the landings, and are combined to form two "artificial" single-age fisheries with unit selectivity so that fishing mortality rates can be estimated directly. Applying this model to Pacific bluefin tuna indicates that recent (since 1990) fishing mortality rates may be higher than are estimated by the 2010 base model, and that current biomass is substantially lower by nearly half. Expected recruitment is constant (steepness h=1) in both models, and estimated recruitments from the two models are nearly identical.

<u>Discussion</u>

It was noted that the results of the hybrid VPA were very similar to results that down-weighted the EPO data contribution to the total likelihood. Some participants thought this implied that mis-fitting to EPO data was the major issue. In response to a question regarding how some data and parameters were developed for this paper, the authors clarified that for this study they attempted to maintain continuity with the base model. The base model selectivity pattern of the Troll fleet was assumed to be the selectivity pattern of the Troll CPUE series in the hybrid model. In order to apply the hybrid VPA approach to this fishery in the future, a method of providing a selectivity pattern for this CPUE series will need to be developed. The WG questioned why the authors chose to apply the VPA approach only to ages 0 and 1. The authors clarified that those age groups have clear modal structure in the length data and thus can be more easily split into age-classes outside of model. The authors also noted a potential pattern of changing of targeting of ages 0-1 in the recent years that this method may prevents this from misinforming the assessment model. A participant pointed out that changes in targeting in some fisheries may already accounted for by the division of fisheries.

In regards to model results, it was also clarified the reason why the derived time series of F's changed relative to the base model when recruitments were nearly identically estimated and assumed catches at age of ages 0 and 1 must be identical. It was noted that estimated catches at age in the base model from fisheries which are supposed to catch mostly ages 0 and 1 (e.g. troll and EPO PS) contain substantial amount (sometime more than a half) of age 2 and older catch. Thus it was suggested that the results presented in the WG provided the validation of concept but it is difficult to derive a conclusion on the current application of the hybrid VPA. The authors are investigating the cause of this result but think it is related to selectivity pattern changes. In regards to a question on some recruitment estimates in the hybrid VPA model, the authors clarified that in a VPA approach there is little information on the most recent recruitments due to the backward calculations. The authors pointed out that one advantage of a forward simulation approach (such as stock synthesis) is that model process informs estimates near terminal year.

In order to better understand potential differences between the hybrid VPA and the base model, the WG requested a comparison of catches at age and numbers at age in BASE model and hybrid by quarter. Results of that analysis showed some differences in results, which included differences in catch at age-0, trends in age 20 fish, estimated selectivity patterns, F's and the proportion of catches (in weight) of ages 0 and 1. It was also noted that there were very few large fish in the equilibrium conditions. The WG recognized that the Hybrid model is very useful modeling framework to derive more information on the stock status, if more reliable catch at age data is available.

3.5 Evaluation of uncertainty in the terminal year's parameters estimated from SS in the Pacific bluefin tuna assessment by Momoko Ichinokawa (ISC/11-1/PBFWG/14)

It is generally known that terminal year's parameters estimated from any stock assessment models have relatively large uncertainties, because of lack of adequate fisheries information. In the stock assessment of PBF, a clear negative bias in estimation of terminal year recruitment has been observed regardless of CPUE of troll fisheries that are given as a recruitment abundance index. This document investigated why such negative bias occurred in estimating terminal year recruitment in the current stock assessment model. To accomplish this, an experimental run of SS was conducted with a sample data set minus 3 years from the current data. In the experimental run, parameters estimated by maximizing total likelihood were modified by replacing terminal year recruitment deviation originally estimated with a value adjusted to follow observed troll CPUE. Likelihood components calculated from the modified parameters revealed two main forcing factors causing the negative bias in the terminal year recruitment. One is simply from miss-specification of the model on the selectivity of Taiwanese longline CPUE, and another is possibly biased length composition in set-net fishery. The latter result suggests that size composition from the set-net fishery, with a relatively wide range of selectivity from 0 age fish, are treated as one of most important sources to judge strength of terminal year recruitment. Base on the observation, the recruitment in the terminal year can be easily underestimated, if the data is biased to underestimate proportion of smaller fish. It would be important to conduct weighting of fishery information in the terminal year specifically, in order to prevent non-representative data from affecting model results unexpectedly.

Discussion

The WG discussed several proposals for eliminating the underestimation of terminal year recruitment identified in the paper. One suggestion was to reduce the influence of the set-net size composition data by reducing the assumed effective sample size in the terminal year. An appropriate reduction in effective sample size may be approximated by using the results of the retrospective analysis. Other participants suggested that the best option was to correct the bias by eliminating potential model misspecification which may be causing the bias. However it is not yet known if the issue is a result of process or observation error. In regards to the author's findings of a mismatch of the age selectivity settings for the Taiwanese longline CPUE and fishery, the WG agreed to continue using the base case setting for model exploration in this meeting but also agreed to revise in the next stock assessment

3.6 Re-consideration of assumptions applied to Japanese longline fishery in the stock assessment of Pacific bluefin tuna by Momoko Ichinokawa (ISC/11-1/PBFWG/13)

This document re-considered definition of Japanese longliners for use in the assessment model Stock Synthesis (SS), and explores alternative parameterization of its selectivity. While the current base case assumed fixed flat top selectivity for the Japanese longline fishery, the estimated dome shape selectivity improved model total likelihood, especially the likelihood contribution from the size composition data in Japanese longline fishery. In addition, separation of the fishery into two fisheries conducted in spawning and non-spawning season also attained better fits to the size composition data. Those results indicate that dome shape selectivity and assumption of two fisheries with different selectivity in Japanese longline fishery are more plausible than the current base case settings; flat top and single fishery. However, estimated dome shape selectivity had large influence to the estimation of R0 and resultant absolute SSB. Large uncertainty of absolute biomass has been a big issue in the stock assessment of PBF. Incorporation of dome shape selectivity will increase the uncertainty, and decrease model stability. It is generally difficult to judge which assumption of dome shape or flat top is plausible inside the model, because selectivity shape estimated in the model is confounded with the assumption of natural mortality of adult fish. In future, scientific evidence outside from the model, such as intensive aging of older fish, might be needed to solve this problem.

Discussion

The WG noted that incorporating a dome-shaped selectivity process improved fit to length composition but degraded fit to many of the CPUE series. It was also pointed that it may result in an unrealistic increase in the number of older fish. It was noted that estimation of the descending limb of a dome-shaped selectivity pattern is confounded with M and often poorly estimated. The working group requested clarification for investigating the seasonally separated Japanese longline fishery. In response, it was explained that fishing during the spawning season occurs in southern areas whereas in the non-spawning season it occurs in northern areas. The difference in fishing location results in a difference in the size composition observed. It was also suggested that spatial structure may be needed to fully explain the data.

3.7 Hockey Stick SRR in Stock Synthesis by Alec MacCall and Yukio Takeuchi (Oral Presentation only)

MacCall and Takeuchi made an oral presentation on the Hockey Stick stock recruitment relationship which is the newly introduced alternative Stock recruit relationship of Stock

Synthesis. This model was implemented in a beta version of SS3. A number of likelihood profiles were run and the general results supported the current model of h=1.0. It was also pointed that current implementation of the new SRR used ratio of hinge point SSB relative to B0. This implementation may be less effective compared with absolute biomass level of hinge point as the parameter.

Discussion

The authors noted the importance of likelihood profiling to help understanding of model performance and appropriate parameter ranges for this Spawner-Recruit (SRR) relation. It was noted that the current assessment model was tuned to h=1 and likelihood profile may not be the evidence of h=1. It was asked if the development of this proposed SRR relation means that the Beverton and Holt SRR relation is inappropriate for PBF. The authors indicated that the proposed SRR relation was meant as an alternative to the Beverton and Holt function. Other participants questioned how to specify or estimate Bhinge (one parameter of the proposed SRR relation). It was suggested to look at the range of estimated spawning biomass in the 2010 assessment, to guide the specification of Bhinge. The authors noted that with this SRR relation there is no objective reason for Rmin to be less than Rmax. Further testing of this SRR structure is advisable.

4.0 BIOLOGICAL PARAMETERS FOR THE STOCK ASSESSMENT

4.1 Natural mortality

4.1.1 Natural mortality of adult Pacific bluefin tuna estimated with Pauly's equation and its confidence intervals by Kazuhiko Oshima (ISC/11-1/PBFWG/08)

A value of 0.25 -yr is as the current assumption of natural mortality (M) for adult PBF, derived from Pauly's equation. Adult PBF's M was estimated with Pauly's equation and examined for its potential confidence intervals in this study. An L∞ of 245.4 cm and K of 0.195 /year of the von Bertalanffy growth parameters used in the current stock assessment on PBF was applied for estimation of M. The estimated M increased from 0.21-yr to 0.34-yr as mean environmental temperature T increased from 10°C to 30°C. The estimate of M was0.29-yr at 21°C, which corresponds to the mean temperature of the habitat of adult PBF based on the logbook data. Width of 95% confidence interval was 0.12 on average and was considered to be influential for the SSB estimate by the SS3 model, because change of adult M by 0.02 increase SSB twice by this model (Ichinokawa et al. 2010). This suggests that M estimated with Pauly's equation implies potential uncertainty of SSB estimate.

Discussion

The working group noted that Pauly's weight-infinity version was not investigated. It was noted that Pauly's original equation used total length rather than fork length. A concern was expressed about error and correlations in the estimated parameters K and L_{inf} of the growth curve that influence the Pauly estimate of M.

Tags provide another useful source of information on water temperature for possible use in Pauly's equation. Tag-based temperatures are about 18-20 degrees, but internal PBF temperature is 2-10 degrees higher, and it is unclear which value should be used. Tuna physiology is different from other fishes in Pauly's data, and the temperature influence in his equation may not be modeled correctly for bluefin.

There was a concern that both Pauly's and Hoenig's methods are based on surface age determinations which are now known to give lower ages and therefore estimates of M are biased high, but nobody has updated the underlying data. The present value of adult M = 0.25 used in the assessment is based on results from many different methods, including Pauly, Hoenig and others, giving a range of about 0.17 to 0.41.

4.1.2 Updated natural mortality and seasonal movement rates from a spatially-structured mark-recapture model for PBFT by Rebecca Eleanore Whitlock (Oral Presentation only)

Witlock made an oral presentation on "Updated natural mortality and seasonal movement rates from a spatially-structured mark-recapture model for PBFT" Direct empirical estimates of M for 2 age classes from analysis of tagging data were presented, comprising an update of results presented in ISC/10-1/PBFWG/05. Using uniform priors for age-class specific M resulted in higher estimates: posterior means of 0.58 (standard deviation 0.22) for age class 1 (ages 1-3) and 0.15 (standard deviation 0.14) for age class 2 (ages 4+), posterior medians 0.47 age class 1, 0.11 age class 2. 79% of the posterior probability for age class 2 M (uniform prior) was associated with M<0.25, the value currently used in the PBFT stock assessment (94% for the default prior). Sensitivity analyses indicated that estimates of M were fairly robust to the prior used for the archival tag reporting rate. Deviance Information Criterion (DIC) values for sensitivity analyses showed that the use of the alternative priors did not result in a large enough DIC difference (5 or more) that would warrant use of an alternative prior. The results from this model indicate that a separate value of M for older fish (e.g. ages 4 and older) may be appropriate as estimated M was higher for age class 1, with a fairly small overlap between estimated posterior probability distributions for age classes 1 and 2.

Discussion

Migration rates tended to be 0.08 to 0.2 from the eastern Pacific to the west. Seasonal fishing mortality rates probably reflected prior information for quarters 1 and 4. There was some concern about the interpretation of ages in the EPO relative to the nominal birth dates in the western Pacific. It was noted that upper bound for M was mistakenly set up for 1. This may influence the estimate for age class 1.

4.2 Age and growth

4.2.1 Estimation of the sex specific growth parameters for Pacific bluefin tuna Thunnus orientalis by Tamaki Shimose and Toshiyuki Tanabe (ISC/11-1/PBFWG/11)

Sex specific growth of wild captured Pacific bluefin tuna *Thunnus orientalis* was investigated using specimens landed at fishing ports in Japan and the data set used in the previous work. As pointed out in the previous work and confirmed for other tunas, fork length (FL) of males was larger than that of females in older age classes (>10 years old). Conversely, females showed larger FL during early years (ca. 6 years old). Sex ratio was not biased from 1:1 in all age classes, and mortality rate is thought to be similar between sexes. Estimates of the length at infinity from the von Bertalanffy growth formula using the standard method were small compared to the results of the previous work, suggesting that this method may not be appropriate for estimating the growth curve of the species using the present data set. Length infinities estimated by the newly established "sample size-equalized method" were more stable, and the new method is possibly more useful to estimate growth parameters for the species. Estimated growth parameters by the new method were $L\infty = 242$ cm, $k = 0.20$, $t0=-0.11$ for females and 260 cm, 0.17, −0.22 for males.

Discussion

Use of sex-specific growth is promising for future modeling. There was some concern about validating the age determinations, and determining the precision. The author clarified that double reading on his otoliths provides an estimate of within reader precision.

The SS model has difficulty fitting the growth curve internally under current configurations of Amax =3. The WG noted that Amax=3 was used in current model configulation to improve model fit by increasing CV of age <3. It would be useful to fit the data to the parameterization of the growth curve used in SS3, with careful attention paid to describing the CV of length at age which is influential in length-based models. It was noted that the distribution of numbers at age is quite similar for the two sexes, suggesting that there is probably no sex-related difference in mortality rates. One member noted that sex-specific models are used for other tunas such as bigeye in EPO on the basis of less information than available for PBF. Comparing outputs of a sex-specific SS3 model using alternative parameter estimates (nonlinear least squares, equalized weighting) could determine the sensitivity to choice of fitting methods.

4.3 Analyses of tag recapture data

4.3.1 Mark-recapture experiments of Juvenile Pacific Bluefin Tuna in Tosa Bay by Yoshio Hiiya, Shigehide Iwata, and Kazuhiro Oshima (Oral Presentation only)

Japan had conducted mark-recapture experiment of Juvenile Pacific bluefin tuna from 1996 to 2007. Niiya made an oral presentation on the experiments. The results of tagging experiments during 1996 to 2007 are reported. In the experiments, 13,427 fish was released and 1,242 recaptured. From the tagging experiments, almost all recaptures were made within 6 month after the releases. Furthermore, tag loss seemed to increase until 80 days after release and then after the tag loss seemed to have decreased. The released fish in Tosa bay go eastwards, along the Pacific coast of Japan. Off the coast of Chousi, the emigrated fish appeared to be divided into two groups. One group would go to the west coast of the Americas and the other group would go to the off Sanriku, Japan.

Discussion

The data presented is a rich data set for studies of mortality and growth. Reporting rate is thought to be good, over 90%. However, a tag "seeding" experiment would help to estimate reporting rates and strengthen the analysis. . It would be useful to see a graph of cumulative recaptures by fishery and area over time. Most tags are recovered in a short period after releases in Tosa Bay. Flesh of larger fish grow around the tag, reducing its visibility—tags are sometimes returned by the market where they were discovered. This tag disappearance process probably could be quantified.

4.3.2 Updated estimates of natural mortality rate of age 0 Pacific bluefin tuna by using conventional tagging data by Shigehide Iwata, Momoko Ichinokawa, and Yukio Takeuchi (ISC/11-1/PBFWG/02)

This paper presents updated estimates of natural mortality rate of age 0 Pacific bluefin tuna (PBF) from a tag-attrition model by mark-recapture data of conventional tags、 incorporating recent data into estimation. Recent tagging data for 2000 and thereafter were sequentially added to the tagging data base used in the previous study made during 1996-1999. By sequential addition of the data, effects of recent data since 2000 are examined. The updated estimates of natural mortality rate seemed to be lower than that estimated in the previous work, whose estimates ranges 2.4-3. Additionally, ranges of 90% confidence intervals are narrower than those of previous work. Our results suggest that the natural mortality of age 0 PBF would be similar to or might be higher than the value currently used (i.e. 1.6) in respect to the average M for age 0 PBF.

Discussion

A value of M=1.6 is used because fish are possibly at a higher risk for less than 12 months, and are growing. Type I rate (initial shedding/mortality) was determined by cage experiments. Alternatively Type I loss rate could be calculated based on analysis of the first month at liberty. The analysis estimated an extra parameter for first month mortality. Emigration might have confounding effects with estimated natural mortality; therefore it was advised that emigration effect be included in the analysis, although it was pointed out that most recaptures were made in less than 6 months, presumably before emigration occurred. It would be useful to stratify the total tagged fish data by size groups, i.e. smaller and larger fish, groups, or otherwise stratify by size. This might help to determine size-related differences. It would be worth investigating models of variable tag retention probability, because a single remaining tag is likely to be better anchored than the one that was lost—the shedding rate of the two tags is different (this could possibly be supplemented by captive experiments). Archival tags are thought to have very high reporting rate (assumed to be 100%) because fishers are interested in the migration path, and form a basis for statistically estimating reporting rate of conventional tags. It would be good to include double tagging information in model to estimate tag loss rate.

4.4 Reproductive biology and larval studies

4.4.1 Review of the Pacific bluefin tuna necropsy reports dating from 1998 through 2010 from the Tuna Research and Conservation Center and Monterey Bay Aquarium by Charles

Farwell (Oral Presentation only)

Farwell made an oral presentation on PBF necropsy. One-hundred thirty seven necropsy reports from a total of two-hundred eighty were selected for this report based on completeness of the individual reports. Each report contains the individual fish identification number (AVID) which is implanted at time of capture and introduction into our research center or aquarium display. This allows each specimen to be accounted for as to length of time in our facilities and aids in captive growth estimates. All sampled bluefin were kept at 20oC and received a mixed diet of sardines and squid for a daily diet ration of 32kcals/kg/day.

At time of necropsy the following data are taken: date of death, length and mass, individual organ weights which include stomach, ceceum, spleen, liver intestine and gonad. Selected organs are sampled for histology and sent to a laboratory for histology preparation These data were sorted to sex if known, size, age and GSI values determined. The males (N=60) ranged from 2 to 10 years of age with a maximum mass of 223kg. The GSI values for the males ranged between 0.01 for the 2-year olds sampled and 1.10 for an 8-year old individual The female samples (N=38) ranged from 2 to 11 years and a maximum mass of 277kg. GSI values were found to range from 0.01 to 1.10. A temperature effect on increasing the gonad size was noted in 3 females after a 3-month time period being kept at 23oC.

An increase in the GSI values for both sexes occurred at ages 5-6 years and remained high for ages greater than 6 years. In a third group of bluefin, (N-39) sex could not be determined, the ages were 1.5 to 3 years and their GSI values ranged from 0.01 to 0.14 Selected histology slides for each group are included for both lower and the higher GSI values and are paired to show differences in maturation levels.

Pacific bluefin tuna tagging results indicate that the younger ages, 2, 3, and 4-year olds prefer water temperatures 16-18oC which raises the question if sexual maturity can be reached by individuals at these lower water temperatures?

<u>Discussion</u>

The WG agreed that histological examination of gonads is required to identify maturity. The WG noted that the histological slides presented suggest the fish are likely mature but not in spawning condition. The WG agreed that water temperature, and changes in temperature and day-length are important for regulation of spawning.

4.4.2 Skip spawning and spawning frequency of Pacific bluefin tuna around Japan by Sho Tanaka (Oral Presentation only)

Tanaka made an oral presentation on skipped spawning and spawning frequency of Pacific bluefin tuna around Japan. The objectives are to estimate the spawning interval and the rate of fish skipping spawning based on the histological observations. A total of 5215 ovaries of PBF caught around the Nansei Islands and in the Sea of Japan during 1994-2006 were observed. Based on the histological observations, spawning frequency (SF) was estimated and the occurrence of skipped spawning was identified. Around the Nansei Islands, spawning starts in

May. In the Sea of Japan, spawning occurs simultaneously in a school. Spawning starts in the middle of June at the latest, and extends to the end of August. Occurrence rate of skipped spawning by PBF over the 13 years was 4.6 % around the Nansei Islands and 0.2 % in the Sea of Japan. This rate may have minimal influence on estimates of spawning stock biomass. SF was shortened from 13.1 to 2.6 days with the advance of the season around the Nansei Islands. On the other hand, mean SF was 1.2 days in the Sea of Japan, suggesting that PBF spawns almost every day in the Sea of Japan. This may relate to energy accumulation of spawning PBF.

Discussion

The WG enquired about the cause of difference in spawning interval between Nansei Islands and Sea of Japan. Author hypothesized that the difference may be due to different food resources available in the two areas. Lower food availability and quality in the Nansei Islands area may have led to longer spawning intervals in the area. The WG noted that it may be difficult to relate condition factor to feeding availability. The WG also noted the Sea of Japan bluefin start spawning in SST of ~20 deg C, which is cooler than previously noted in studies of other scombrids.

4.4.3 Evaluation of spawning history of fish from ovarian histology by Akio Shimizu (Oral Presentation only)

Shimizu made an oral presentation of spawning history of fish from ovarian histology.

Discussion

Enquiries were made about the length of time that POF and POF residue last? The author replied that POF with cells inside basement membrane does not last long, maybe at most a few days. However, POF residue, after phagocytosis, may last several months. The WG recommended that some bluefin spawning in captivity should be used to verify that post-spawning fish can be identified using this technique. The WG noted that this technique is very promising and will be useful to better determine the age of maturity of PBF and other species.

4.4.4 Annual change of abundance of the Pacific bluefin tuna larvae from 2007 to 2010 around the Ryukyu archipelago by Nobuaki Suzuki, Wataru Doi, Hiroshi Ashida, Toshiyuki Tanabe, and Yoshimasa Aonuma (ISC/11-1/PBFWG/12)

In order to understand natural reproduction of Pacific bluefin tuna (PBF), research surveys for PBF larvae have been conducted around the Ryukyu archipelago. During the sampling period from 2007 to 2010, annual changes in abundance of sampled PBF larvae were observed. Five larval patches each were found in 2007 and 2009, whereas none in 2008 and only one in 2010. Collection of PBF larvae was intensive from 24 to 26ºN along 126 º E lines between Okinawa and Miyako islands. Oceanographic condition with poor larval collection in 2008 and 2010 was characterized by elevated sea surface region in the south of Ishigaki and Miyako islands. Contrastingly, patches in 2007 and 2009 were observed from larger area across in early to late June, of which distribution suggested advection into the Kuroshio from the south of spawning area through the pathway between Okinawa and Miyako islands. Marked collection of PBF larvae around the eastern region of Miyako Island might be caused by the shallow reef (< 100 m in depth), and then here will be a candidate area to monitor northward advection of PBF larvae.

Discussion

The WG noted that this study will be useful in improving our understanding of the reproductive and recruitment processes of bluefin tuna. The WG enquired if this study may be used to develop a larval abundance index. The author considered that the current study is likely not suitable for developing a larval abundance index but is more useful for monitoring and understanding the reproductive and recruitment process in the area. The WG noted that this study is being replicated in the Sea of Japan. The WG recommended that this study be continued to monitor the bluefin reproductive biology and recruitment processes in the area. In addition, the WG recommended that high resolution eddy-resolving ocean models with accompanying ocean observations and particle tracking methods be used to better understand the ocean dynamics in the area. The WG also recommended that the study be extended to better understand the links between larval fish and recruits in the fishery.

4.4.5 Biological research plan presented in ISC9 related topic

The WG also discussed revisions of the biological research plan (insert reference) presented in ISC9 and proposed to WCPFC Northern Committee. The WG Chair noted that, although the plan was not accepted at the WCPFC Commission meeting in Dec. 2010, it is likely to be proposed again recognizing importance of improvement of biological parameter for stock assessment. While the WG recognized the importance of further improvement of 1) age and growth parameters, in particular on younger age and older age by sex, 2) reproductive parameter such as maturity ogive, the WG agreed that the current biological research plan on PBF should be suffice for this objective as biological sampling plan.

5.0 WORK PLAN FOR 2012 STOCK ASSESSMENT

Four PBF WG meetings are planned before the ISC12, where results of full stock assessment of PBF are to be presented. The first one is 1-day meeting before ISC11 for updating Table 1 (16th July, 2011), the second is data preparatory workshop, the third is for full stock assessment, and the forth will be held in conjunction with ISC12. The US made an official invitation to host the 2012 Stock Assessment meeting in La Jolla, which received the support of the IATTC delegate. The IATTC requested that the 2012 stock assessment meeting not be held before its Scientific Advisory Committee 3 in May 2012, not to overlap with the staff's preparatory work for IATTC assessments Dates and places for the latter 3 WGs will be re-visited and officially determined at the next ISC Plenary in July 2011. Work plans, before the next data preparatory meeting are listed as follows.

5.1 Work plan before ISC11 (July 2011)

Updates of catch table (Table 1)

5.2 Work plan before the data preparatory meeting (Nov 2011/Jan 2012)

Fishery data

Category I

Quarterly catch by fleet (up to June 30, 2010) should be submitted as a minimum requirement.

Category II

The WG agreed that standardized CPUE from Japanese offshore longline (before 1992), Japanese coastal longline (after 1993), Taiwanese longline, Japanese troll, and EPO purse seine (including attempt to obtain US/Mexico spotter plane data) be submitted
The WG also agreed that two potentially new abundance indices: Japanese-Purse Seine in Sea of Japan and Japanese-set-net may be submitted.
The WG also agreed that for offshore longline: separate CPUE indices to non-spawning and spawning seasons in the case that JLL is to be separated into two, conditional on the decision of separation of fisheries.

Category III

The WG agreed to estimate catch at length for the fisheriesthat are feasible to do so, and provide effective sample size (or, estimation error, or qualitative information at least)
For the tuna Purse Seine, the WG agreed to explorer to use weight frequency data, because their unit of size sampling was weight until 1993 for Pacific side, and inputted as weight composition data (conditional on decision of separation of fisheries).

Year definition

Some discussion took place concerning the definition of year (e.g. fishing year vs. calendar year), which often divides the peak of fishing seasons into two years. However, the WG found there is no solution to satisfy all the cases. The WG decided to re-visit this problem at the next meeting and possibly try some models with alternative year definitions.

Model configuration

Table 1 shows current base case model configurations and candidates for the next full stock assessment in 2012. Candidates listed in Table 1 are to be examined before next data preparatory meeting and discussed.

Table 1. Model configurations for current updated base case and candidates for next full stock assessment in 2012.

	2010 update	Available options	Full stock assessment in 2012
Year definition	July to June	July to June calendar year	July to June
Time step	Quarter	quarter	quarter
Stock(spawning population)	Single spawning population		Single spawning population
Area	Single	Single 2areas (E&W)	Single for assessment; two area for research
Number of age class	21(0-20)	21(0-20) ?	21(0-20) -default; 21-25 lumped
Ngender	Single sex	Single sex 2 sex	Single sex; explore two-sex model
Fishery definition	See other sheet	separate tuna PS separate JLL	separate tuna PS, separate JLL # of fisheries could be reduced: JPN-PL & JPN-troll
Natural mortality	Age specific, year is time step Age0 =:1.6 Age 1=0.386 Age2+=0.25	Age specific, year is time step Age specific, linear interpolation Sex specific	Age specific, year is time step Explore Age specific, linear interpolation Sensitivity run with direct estimate (Rebecca's) Further updated analysis will be made at the next WS
Maturity	Age specific Age3=0.2 Age4=0.5 Age5+=1.0	?	Age specific Age3=0.2 Age4=0.5 Age5+=1.0 Sensitivity
Growth curve	Shimose et al 2008	?	Shimose et al 2009 for single sex model Shimose et al (WP11) for two-sex model Prepare conditional A@L input vectors

Table 1. Model configurations for current updated base case and candidates for next full stock assessment in 2012.

	2010 update	Available options	Full stock assessment in 2012
			Explore seasonal change in K
#of growth patterns	1	?	1
#of morphs, sub-morphs	1	1,3,5	1
Functional form of Cvgrowth	CV=F(A)	CV=F(A),F(L),	Postpone decision
Amin Amax	0 3		0 3 (revisit this choice)
Length-Weight relationship	Kai et al 2007		Kai et al 2007
Length bin definition	see other sheet		Explore wider pop. length bin for younger ages
Catch unit	Weight		Weight/numbers ex: EPO-sport (numbers), fraction of JP-LL Fleet 2 may have possibility
Catch error	assumed to be exact		assumed to be exact Sensitivity run with error in catch
F-method	3 (solve catch eq)		3 (solve catch eq) - catch exact 2 - sensitivity run
iteration	5	5 7 or 3	5
Upper bound of F	5	5 smaller F is better?	Explore reason for high F estimates in EPO commercial fleet(around 5, first quarter)
CPUE likelihood	t(df=30)	t(df=30) lognormal	t(df=30) explore lognormal
CPUE lambda	5 for LL 1 for other	5 for LL 1 for other 1 for all	Postpone decision
CPUEcv effN for LenComps	Lowest CV is set as 0.2 scale to have same effN to FL8		Revisit input CV Postpone decision, exploratory work new data

Table 1. Model configurations for current updated base case and candidates for next full stock assessment in 2012.

	2010 update	Available options	Full stock assessment in 2012
SRR	B-H	B-H, 2-line	B-H, explore H-S model, retune model w different h values explore Sheperd S-R (to be available soon v3.2)
R0	Estimated	estimated	estimated
Steepness	1 (with sensitivity tests)		1 (with sensitivity tests), run estimate h, profile
σR	0.6		0.6, run estimate
1st year of main Rdev	1946	1946	revisit
R0 offset	Estimated	extend earlier year ?	estimated
SR auto correlation	No	w/Auto correlation	
Initial F	LL(FL1), tuna PS(FL3), troll(FL4) with equilibrium catch	LL(FL1), tuna PS(FL3), troll(FL4) with equilibrium catch no initial equilibrium catch	Estimate initial year F without fitting to equilibrium catch
Diagnostics of the model	Bootstrap, retrospective analysis, sensitivity analysis for fishery data and biological parameters		Same method will be used, and try MCMC.

6.0 RECOMMENDATIONS

Under each presentation in the previous Agenda Items, some specific recommendations relating to the pertinent papers are included, to which a due attention should be paid. Aside of these recommendations, more general and important recommendations are summarized in this section.

6.1 Fishery Data

i. For WP#7, the WG recommended that the author present the following analyses of the length composition data of the small purse seine fishery at the data preparation workshop: 1) derive length compositions without data substitution, 2) derive length compositions with data substitution and identifying the substitution, and 3) develop a probability transition matrix for converting box category to age. This analysis should be extended to all available data, including pre-2004.

ii. The WG recommended continued monitoring for any changes in length distribution within each box category to ensure length distributions within box categories remain consistent.(WP#7)

iii. The WG recommended that more work be put into understanding and determining the uncertainties in the length compositions of the Japanese set net fishery, and that further analyses be presented at the data preparation workshop. The WG agreed to postpone discussion of how to use the set net length composition data in the assessment model until the uncertainties of this method are better understood.(WP#5)

iv. The WG recommended that an analysis be performed on the effects of separating or combining the Sea of Japan and Pacific Ocean purse seine fisheries in the assessment model.(WP#4 and WP#9)

6.2 Stock Assessment model

i. The WG recommended developing an approach to deal with the influential model misfit to data from EPO by 1) disconnecting EPO size composition and CPUE from influencing model process (use only as catch-at-age) or 2) add more appropriate process to the model (spatial structure or flexible and time varying catchability and selectivity).

ii. The WG recommended that IATTC, U.S. and Mexican scientists investigate alternative data sources to develop EPO CPUE series (e.g. spotter plane).

iii. The WG recommended Investigation of selectivity assumptions: both shape (domed vs. asymptotic) and changing selectivity patterns (especially fisheries with CPUE broken into blocks) (short term and long term).

iv. The WG recommended Investigation splitting some current fisheries into more homogeneous units (tuna purse seine, set net and JPN longline).

v. The WG recommended Investigating disaggregating some fisheries into seasonal fisheries.

vi. The WG recommended investigating methods to improve model fit to the size composition data especially younger ages (e.g. try other growth option, hybrid model, two sex model etc).

vii. The WG recommended Investigating improved parameterization of the hockey stick model (estimate parameters as absolute values and not as offsets to enable profiling) and continue testing for potential use in the stock assessment.

viii. The WG recommended development of ways to quantify uncertainty in the SRR relation and incorporate this uncertainty into projections and reference points.

ix. Consider the ways to reduce complexity of fleets by combining fleets with the very similar or mirrored selectivity patterns.

6.3 Biological Parameters

i. Natural mortality

a. The WG agreed to continue exploration of alternative methods of estimating natural mortality rate

ii. Age and growth(WP#11)

a. The WG recommended to begin exploration of a two-sex model in SS3. Compare increase in run time with improvement in model precision.
b. The WG recommended to contact the SS3 author to determine if the CV of length at age can be parameterized without requiring the upper age Amax to be set at 3 to achieve a constant CV.
c. The WG recommended to explore alternative larger size data bins for young ages. Due to rapid growth, fish may grow through small bins in less than a model time-step (quarter), which distorts expected length compositions
d. The WG recommended to use the ageing data as conditional age at length observations in SS3 and estimate growth curve and CV of L at age.
e. The WG recommended to enhance sampling of hard parts (e.g. otolith, vertebrae) for ageing to improve parameter estimate in SS3

iii. Tagging

a. The WG recommended to standardize age classifications for eastern Pacific studies relative to western Pacific studies. Use of decimal (rather than integer) ages relative to a standardized birthdate may help in this regard.
b. The WG recommended parameterizing seasonal fishing activity at monthly resolution in models used to estimate mortality and movement rates from tagging.
c. The WG recommended using existing information such as from the Tosa Bay double-tagging cases to improve tag shedding rate estimates.

d. The WG recommended that Tosa Bay tagging studies should consider modified experimental design, using single and multiple tagging, captive experiments, etc. The purpose is to improve estimates parameters in the analytical models.
e. The WG recommended considering developing a model of apparent tag "loss" due to overgrowth hiding the tag.
f. The WG recommended stratifying the Tosa Bay tagging analysis by size at initial capture. This would help determine the relationship between size and estimated natural mortality.
g. The WG recommended considering doing some tag "seeding" experiments to help estimate reporting rates.
h. The WG recommended incorporating tagging data in growth studies.

iv. Reproductive biology and recruitment process

a. The WG suggested examining how changes in environmental conditions (i.e., daytime length) affect spawning timing and maturity.
b. The WG recommended standardizing the histological techniques and staging of histological structures for the labs involved in these gonadal studies.
c. The WG recommended that some bluefin tuna spawning in captivity should be used to verify if post-spawning fish can be identified using this technique of ovarian histology of Dr. Shimizu presented in item 4.4.
d. The WG recommended considering the use of the granularity (numerical density of granular structures) as the indication of the history of spawning a measure of cumulative spawning activity near the beginning of the season.
e. The WG recommended that this study presented in ISC/11-1/PBFWG/12 be continued to monitor the bluefin reproductive biology and recruitment processes in the spawning areas (Nansei Islands area and Sea of Japan).
f. The WG recommended that the study presented in ISC/11-1/PBFWG/12 also be extended to better understand the links between larval fish and recruits in the fishery.
g. The WG recommended that high-resolution eddy-resolving ocean circulation models with accompanying ocean observations and particle tracking methods be used to better understand the ocean dynamics in the area.

7.0 ADMINISTRATIVE MATTERS

The future meeting schedule is discussed in the Agenda Item 5. No other business was discussed.

8.0 ADJOURNMENT

The Chair thanked collaboration by all the participants and efforts of rapporteurs. The participants praised the performance of the Chair.

The meeting was adjourned in the afternoon of January 13, 2011.

APPENDIX I

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APPENDIX II

Agenda

1. Introduction (Miyake and Takeuchi)
    a. Welcome and introduction
    b. Adoption of agenda
    c. Appointment of rapporteurs
2. Fishery data for the stock assessment (Teo, Oshima and Fujioka)
3. Stock Assessment models (Pinner and Ichinokawa)
4. Biological parameters for the stock assessment
    a. Natural mortality (MaCall and Kai)
    b. Age and growth (MaCall and Kai)
    c. Analyses of tag recapture data (MaCall and Iwata)
    d. Reproductive biology and larval studies (Teo, Okochi and Kaeriyama)
5. Work plan for 2012 stock assessment (Aires-Da-Silva and Ichinokawa)
6. Recommendations (Teo and Takeuchi)
7. Administrative matters (Miyake and Takeuchi)
8. Adjournment.

APPENDIX 3

List of presentations

Document Number	Title and authors	Availability	Contact Details
ISC/11-1/PBFWG/01	A hybrid SS3-VPA model for examining trends in young fish selectivity and recruitment, Alec MacCall and Steve Teo	Full paper on ISC website	Alec MacCall NOAA/NMFS , Southwest Fisheries Science Center Santa Cruz, CA, USA Alec.MacCall@noaa.gov
ISC/11-1/PBFWG/02	Updated estimates of natural mortality rate of age 0 Pacific bluefin tuna by using conventional tagging data , Shigehide Iwata, Momoko Ichinokawa and Yukio Takeuchi	Contact details only	Momoko Ichinokawa National Research Institute of Far Seas Fisheries Shizuoka, Japan ichimomo@fra.affrc.go.jp
ISC/11-1/PBFWG/03	Withdrawn		
ISC/11-1/PBFWG/04	Estimation of length distribution for landing data of Pacific Blue Fin tuna in Sakai-minato port, Minoru Kanaiwa, Ayumi Shibano and Yukio Takeuchi	Full paper on ISC website	Ayumi Shibano Tokyo University of Agriculture Abashiri, Hokkaido, Japan ayumi.shibano@gmail.com
ISC/11-1/PBFWG/05	Estimation of the length and age compositions of Pacific bluefin tuna caught by Japanese set-net fishery, Mikihiko Kai	Contact details only	Mikihiko Kai National Research Institute of Far Seas Fisheries Shizuoka, Japan kaim@affrc.go.jp

ISC/11-1/PBFWG/06	Introduction of a spatially-structured model of Pacific Bluefin Tuna, Kevin Piner, Hui-Hua. Lee, Ian. Taylor, Alexandre Aires-da-Silva and Steve Teo	Full paper on ISC website	Kevin Piner NOAA/NMFS Pacific Islands Fisheries Science Center Hawaii, USA Kevin.Piner@noaa.gov
ISC/11-1/PBFWG/07	Approaches for estimation of catch at age of young Pacific bluefin tuna caught by Japanese small purse seine fisheries, Kazuhiko Oshima and Yukio Takeuchi	Contact details only	Kazuhiro Oshima National Research Institute of Far Seas Fisheries Shizuoka, Japan oshimaka@affrc.go.jp
ISC/11-1/PBFWG/08	Natural mortality of adult Pacific bluefin tuna estimated with Pauly's equation and its confidence intervals, Kazuhiko Oshima	Contact details only	Kazuhiro Oshima National Research Institute of Far Seas Fisheries Shizuoka, Japan oshimaka@affrc.go.jp
ISC/11-1/PBFWG/09	Preliminary analysis of length frequency and amount of catch data for Pacific bluefin tuna (*Thunnus orientalis*) landed by Tuna Purse Seine fleet (Fleet 3) in different sea area, Masayuki Abe and Yukio Takeuchi	Contact details only	Masayuki Abe National Research Institute of Far Seas Fisheries Shizuoka, Japan, abemasa@fra.affrc.go.jp
ISC/11-1/PBFWG/10	Sensitivity of Estimated Spawning Biomass to Natural Mortality Assumptions in Pacific Bluefin Tuna Assessments., Steven L. H. Teo	Full paper on ISC website	Steven Teo NOAA/NMFS Southwest Fisheries Science Center La Jolla, CA USA steve.teo@noaa.gov

ISC/11-1/PBFWG/11	Estimation of the sex specific growth parameters for Pacific bluefin tuna *Thunnus orientalis* , Tamaki Shimose and Toshiyuki Tanabe	Contact details only	Tamaki Shimose Seikai National Fisheries Research Institute, Fisheries Research Agency Ishigaki, Okinawa, Japan, shimose@affrc.go.jp
ISC/11-1/PBFWG/12	Annual change of abundance of the Pacific bluefin tuna larvae from 2007 to 2010 around the Ryukyu archipelago ¸Nobuaki Suzuki, Wataru Doi, Hiroshi Ashida, Toshiyuki Tanabe and Yoshimasa Aonuma	Contact details only	Nobuaki Suzuki Seikai National Fisheries Research Institute, Research Agency, Ishigaki, Okinawa, Japan, suzunobu@affrc.go.jp
ISC/11-1/PBFWG/13	Re-consideration of assumptions applied to Japanese longline fishery in the stock assessment of Pacific bluefin tuna, Momoko Ichinokawa	Contact details only	Momoko Ichinokawa National Research Institute of Far Seas Fisheries Shizuoka, Japan ichimomo@fra.affrc.go .j
ISC/11-1/PBFWG/14	Evaluation of uncertainties in terminal year's parameters estimated from SS in the Pacific bluefin tuna assessment, Momoko Ichinokawa	Contact details only	Momoko Ichinokawa National Research Institute of Far Seas Fisheries Shizuoka, Japan ichimomo@fra.affrc.go .j

ISC/11-1/PBFWG/15	Update of Pacific bluefin tuna catch in Korea waters, Yoo, Joon-Taek, Zang Geun Kim, Kwangho Choi, Sukyung Kang, Jae Bong Lee, Sung IL Lee, Doo-Nam Kim , Kyu-Jin Seok, Dae-Yeon Moon and Dong-Woo Lee	Full paper on ISC website	Joon-Taek Yoo National Fisheries Research and Development Institute (NFRDI) Busan, Republic of Korea
Oral only	Updated estimates of natural mortality and seasonal movement rates from a spatially-structured mark-recapture model for PBFT., Rebecca Eleanore Whitlock		Rebecca Whitlock Hopkins Marine Station Stanford University Pacific Grove, CA, USA rewhitlo@stanford.edu
Oral only	Mark-recapture experiments of Juvenile Pacific Bluefin Tuna in Tosa Bay, Yoshio Niiya, Shigehide Iwata and Kazuhiro Oshima		Yoshio Niiya National Research Institute of Far Seas Fisheries Kochi, Japan niiyay@affrc.go.jp
Oral only	Evaluation of spawning history of fish from ovarian histology , Akio Shimizu		Akio Shimizu National Research Institute of Fisheries Science, FRA Kanagawa, Japan aneko@affrc.go.jp
Oral only	Review of the Pacific bluefin tuna necropsy reports dating from 1998 through 2010 from the Tuna Research and Conservation Center and Monterey Bay Aquarium, Charles Farwell		Charles Farwell Monterey Aquarium Monterey, CA,USAcfarwell@mbayaq.org

Oral Only	Skip spawning and spawning frequency of Pacific bluefin tuna around Japan, Sho Tanaka	Sho Tanaka Tokai University Department of Marine Biology School of Marine Science and Technology Shizuoka, Shizuoka, Japan sho@scc.u-tokai.ac.jp
Oral Only	Summary of EPO data, Alexandre Aires-da-Silva	Alexandre Aires-da-Silva Inter-American Tropical Tuna Commission (IATTC) La Jolla, CA,USA alexdasilva@iattc.org
Oral Only	Hockey Stick SRR in SS, Alec MacCall and Yukio Takeuchi	

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