Annex 6

REPORT OF THE PACIFIC BLUEFIN TUNA WORKING GROUP WORKSHOP

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

31 January – 7 February 2012
La Jolla, California, USA

1.0 OPENING AND INTRODUCTION

1.1 Welcome and introduction

The ISC Pacific Bluefin Tuna *(Thunnus orientalis)* Working Group (ISC PBFWG) Workshop met at the National Marine Fisheries Service's (NMFS) Southwest Fisheries Science Center (SWFSC), in La Jolla, California, USA from January 31 to February 7, 2012, under the Chairmanship of Yukio Takeuchi. The Chair opened the workshop and Kristen Koch, the Deputy Director of the SWFSC, welcomed all the participants.

Scientists from Japan, Korea, Taiwan, the USA, and the IATTC participated in the workshop (List of participants in Appendix 2).

1.2 Adoption of agenda

The tentative Agenda previously distributed by the Chair was discussed and adopted (Agenda in Appendix 1).

1.3 Appointment of rapporteurs

Rapporteurs were appointed for each agenda item.

1.4 Distribution, numbering and determination of paper availability of working papers

Nineteen working papers and eleven oral presentations were presented at the workshop (List of papers in Appendix 3). Those papers and presentations were assigned to relevant agenda items and their summaries and following discussions appear in this report under the respective Agenda Items[1]. Please, note that some papers are referred to in more than one Section, in which case, only discussions are included in the second time it is referred to. Working paper authors were

[1] When a paper is referred to more than once, titles are repeatedly included but the summary and discussions appear only in the first place.

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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 SUMMARY AND REVIEW OF 2010 UPDATE AND JANUARY 2011 WORKSHOP, WITH EMPHASIS TO FISHERIES DEFINITION

The past works by this Working Group (WG) has been summarized and reviewed by the Chair, Yukio Takeuchi.

The latest stock assessment (update from 2009 assessments) was conducted in 2010 to extend data coverage for two more years to cover July 1952 through June 2008, using SS 3.10b with the same configuration as used at 2009 assessment. The results were reported at ISC10 (Anonymous, 2010).

The 2010 update included an assessment of the uncertainties of stock status by performing 300 parametric bootstrap runs to assess statistical uncertainties and more than 50 sensitivity runs to assess its structural uncertainties. The WG concluded through sensitivity analyses that adult natural mortality (M) was a major source of uncertainty in absolute biomass size. Nevertheless the WG also concluded that trend of biomass in relative scale is robust, given the result of more than 50 sensitivity runs including change of adult Ms.

Current (in 2008) spawning stock biomass (SSB) declined since 2006, which was estimated to be within 40-60th percentile of historical observed SSBs. Average fishing mortality in 2004-2006 ($F_{2004\text{-}2006}$) had increased from $F_{2002\text{-}2004}$ by 6% for age-0, approximately 30% for ages 1-4, and 6% for ages 5+. For future outlook of the stock, at $F_{2004\text{-}2006}$, median SSB is likely to decline to levels around the 25th percentile of historical SSB, with approximately 5% of the projections declining to or below the lowest previously observed spawning biomass. At $F_{2002\text{-}2004}$ median SSB is likely to decline in subsequent years but recover to levels near the median of the historically observed levels. In contrast to $F_{2004\text{-}2006}$, $F_{2002\text{-}2004}$ had no projections (0%) declining to the lowest observed SSB. In both projections, long-term average yield is expected to be lower than recent levels.

The Chair also briefly summarized the findings at the last workshop in January 2011 (ISC/11/PBFWG-1). That workshop reviewed fishery data improvement including Japanese purse seine and Japanese set net data that will be reviewed at this workshop again. ISC/11/PBFWG-1 also reviewed and tested several new ideas for stock assessment models including Hybrid-VPA, Hockey-stick Stock Recruit Relationship in SS.

The Chair suggested that the key issue at the current meeting would be documentation of data, description on each index and specifications.

Referring to the major findings of the independent review of the ISC North Pacific Albacore stock assessment conducted by the Center for Independent Experts (CIE) in 2011, Gerard DiNardo, ISC Chair, discussed potential implications of these findings to the upcoming Pacific bluefin tuna assessment. He elaborated on the rationale for the review, the review process, and the outcome. In general, the reviews stressed three areas of concern, including quality of data, catch-per-unit-of-effort (CPUE) standardization techniques, and sufficiency of sensitivity runs. While concerns regarding CPUE standardization techniques and sensitivities runs can be addressed through better documentation and planning, data quality concerns will likely require a different approach to the review process. The current review procedure employed a table-top process, which is inadequate for reviewing data quality. This is important given that the upcoming ISC Bluefin stock assessment will be reviewed independently.

WG participants requested additional clarification on the CIE review process, in particular the selection process of reviewers. It was pointed out that the CIE process provides an opportunity for the organization seeking the review to accept or reject reviewers, albeit this window of opportunity is rather short. The WG discussed potential benefits stemming from the different review approaches (table-top, face-to-face, etc.) and it was suggested that face-to-face reviews be adopted, thus allowing for necessary interaction between the WG and reviewers.

3.0 FISHERY DATA FOR INPUT OF THE STOCK ASSESSMENT MODEL

3.1 Western Pacific

- Update of Japanese quarterly catch for Pacific bluefin tuna (oral presentation #7, K. Oshima)

Summary

The Japanese quarterly catches by fisheries, reported to the ISCPBFWG, are calculated, using four main catch data sources. New quarterly catches were provided at this time, for a period of the 3rd qt. of 2008 through the 2nd qt. of 2011. Quarterly catches of longline in 2007 and those of two kinds of purse seine for a period of 2002 through the 2nd quarter of 2008 were modified following the updates and partially due to changes of data sources.

<u>Discussion</u>

No discussion.

- Recent update of Pacific bluefin tuna catch in Korean waters (ISC/12/PBFWG/19, J.T. Yoo)

Summary

PBF in the Korean waters are caught by Korean domestic purse seiners, but PBF are not the main target species of this fishery. At the Busan Cooperative Fish Market, the weight of a wooden box containing tuna for the auction was defined as 18.0 kg, while the actual average weight of a box containing PBF (< about 90 cm in fork length) was 22.7 kg in 2011. The catch from 2009 to 2011 had been estimated based on the number of boxes put to the auctions, using the official weight of 18.0 kg/box. These estimates were revised using actual average weight of a box (22.7 kg) and the catch for 2000 to 2008 were also estimated, (using 22.7kg). The annual catch of PBF tended to increase until 2010, but markedly decreased in 2011. The number of the offshore purse seine vessels has gradually decreased since 1994. Although annual mean fork length (FL) of PBF during 2000-2010 tended to increase, but dropped sharply in 2011. The fishing ground of PBF was mainly formed around Jeju Island mainly in spring.

Discussion

The WG inquired if the decrease in Korean catch had been caused by changes in fishery operations or in fishing grounds. The authors inferred that the decrease of catch in 2011 may be related to low water temperatures resulting from the extension of Yellow Sea Bottom Cold Water to the north East China Sea. The WG also asked whether the PBF landing data were of round or processed fish. It was believed that fish under 20 kg were in round condition. However, it seems that fish larger than 20kg were either gilled and gutted or dressed (head off). The authors explained that the PBF larger than about 90 cm FL that exported to Japanese market are gilled and gutted, but whether the submitted catch data of these large PBF were in round or processed weight is not clear. Therefore, the authors proposed that they would survey this subject and, if necessary, convert the weight of catch into round weight and provide the correct current catch data before the deadline of data submission.

- Estimation of catch at size of Pacific bluefin tuna caught by Japanese longline fishery (ISC/12-1/PBFWG/01, A. Mizuno, M. Ichinokawa, K. Oshima & Y. Takeuchi)

Summary

Catch at size was estimated for JLL fishery by weighting length composition by corresponding catch. No obvious difference was found between catch at size and actual length composition of fish sampled throughout the years; i.e. no difference in temporal shifts of peaks or in appearance of different peaks was shown between these two sets. Two sets of catch at size, estimated with two methods, one weighting by year/month strata and another by year/month/5x5 area strata, also showed similar tendencies. The comparisons of quarterly sample size compositions with two series of quarterly catch at size (raised by the two different methods) did not show significant differences, with a few exceptional cases.

Discussion

The WG inquired whether length frequencies used for Fleet 1 in the previous stock assessment were raised by catch or not. The authors responded that the length frequencies used in the previous stock assessment were not raised to the catch. The WG questioned reasons of the absence of catch at size from 1969 through 1993. The authors responded that it was due to the insufficient amount of available size data during that period.

- Reconsideration of estimation of catch at size for young Pacific bluefin tuna caught by Japanese small pelagic fish purse seine fisheries (ISC/12-1/PBFWG/02, K. Oshima, M. Kai, S. Iwata & Y. Takeuchi)

Summary

In response to the recommendations for Oshima and Takeuchi (ISC/11-1/PBFWG/07) by the ISC PBFWG, procedures of estimating quarterly catch at size were re-examined, focusing on data substitution. Through the GLM analysis differences in mean length were clarified among possible effects, such as years, seasons and box-categories, a revised data substitution procedure was developed and applied in estimation of catch at size. It was recommended that this modified data substitution procedure be used for estimating catch at size fore years before 2002, when length measurements had never been conducted from this fishery.

<u>Discussion</u>

The WG suggested an alternative method of data substation to be used for years before 2002; catch of each box category be entered into the SS model as an independent fleet, and the selectivity of each box category be estimated from length data after 2002. The drawback is that this would result in the model having a large number of fleets. It may also be possible to apply this method but combining several box-categories into a single box-category, in order to minimize number of fleets.

- Update of estimated catch at size by Purse Seiner in the Japan Sea (ISC/12-1/PBFWG/07, M.Kanaiwa, I. Tsuruoka, A. Shibano, T. Shimura, R. Uji, Y. Ishihara & Y. Takeuchi)

Summary

This is an update of the study by Kanaiwa *et al*. (2011), providing with catch at size for 2010. Weighted catch at size in 2010 resulted in more fish of smaller size than the result by the method previously used. This trend of increasing proportion of small sized fish has been observed since 2003. Larger variances are observed on larger fish (Fig. 2 of the paper) compared with estimated variances by assumption of multinomial distribution. The estimated catch at size and effective sample size (Shibano *et al.* 2008) are provided for each year. The WG recommended that these updated data be used in next stock assessment.

<u>Discussion</u>

The WG enquired about the data selecting procedure according to size categories. The authors replied that fish smaller than 60cm, which was called "Yokowa" were removed from the analysis and these catches were added to the catch of the fleet defined as small purse seiners. The authors further explained about the proposed effective sample size, referring to ISC/08-2/PBFWG/06 and Pennington et al. (2002) for detailed explanations. The WG noted some differences between variances estimated by bootstrapping and those under the assumption of multinomial distribution, on larger sized fish for recent years. In SS multinomial distribution is assumed for the likelihood function of catch at size. The authors further noted that the differences may not be a big issue because the ratios of bootstrap variances are theoretically multinomial in the catch at size, for larger sized fish, which is more stable than for smaller sized fish. The WG noted that this study may help to explore more appropriate distributions for the length composition likelihood, e.g. using the Dirichlet distribution, and recommended the research be conducted as future work.

- Estimation of catch at size of Pacific bluefin tuna, *Thunnus orientalis,* caught by Japanese tuna purse seine operated in Pacific Ocean (ISC/12-1/PBFWG/03, eM. Abe, M. Kanaiwa, K. Oshima & Y, Takeuchi)

Summary

Length data collected from tuna purse seine fishery operating in the Pacific Ocean are summarized and estimating catch at size was discussed. Because length data for fish of less than 10kg ("meji") are missing in many year-quarter strata, length data substitutions were required. Length measurement of "meji" PBF was not carried out in many cases after 1993. Annual weighted length distributions of "meji" PBF were considerably different from the actual sample length distributions for the period, 1993-2010, if the weighting procedures in the past were applied. Therefore, it may be preferable that length data of "meji" PBF are excluded after 199f from Fleet 3, or "super year" or "super season" size frequencies are applied as substitutions for that period.

Discussion

There was no discussion.

- Update and re-examination of the estimation of catch at size of Pacific Bluefin tuna *Thunnus orientalis* caught by Japanese set-net fishery (ISC/12-1/PBFWG/05, M. Kai & Y. Takeuchi)

Summary

This paper provides update of the catch at size of PBF caught by Japanese set-net fishery for the stock assessment. The procedures of estimating catch at size were re-examined to improve the accuracy through reducing the sampling bias. Catch at size is calculated based on size sampling data and catch data from three sources for the years 1994 - June 2011. Two data sources were added for wider geographical coverage of catch data. The data used in the analysis are stratified according to the results of generalized linear model (GLM) into prefecture, year, month, and brand name (market size categories), in principle. For the stratum without size sample data, pooled size data set was used as a substitute. The order of the factors for pooling is determined by the GLM. The length compositions of samples are weighted by estimated catch in number by stratum, and then are combined altogether to make the catch at size by year and quarter. In order to evaluate reliability of the estimation of catch at size, two indices were defined: Index I (ratio of number of fish sampled to estimated total catch in number) and Index II (Proportion of catch requiring substitution to the total catch in number). The reliability of the estimation method is also discussed using sensitivity analysis. The estimated catch at size had two modes and both of them had been found at smaller sizes. This result may suggest that Japanese set-net fishery mainly catches relatively small sized fish between 20 and 90 cm and that size sampling data by year and quarter have a large sampling bias. In addition, the estimated catch at size by year and area was substantially different between "West area" in the Sea of Japan and "any other areas". Moreover, a concern was expressed on the uncertainty in estimation due to the substitutions, even after the filtering of data. In conclusions, the authors proposed to: (1) remove the unreliable estimated catch at size for certain year-quarter strata based on the Index I (e.g. less than 3%) and Index II (e.g. more than 50%), if set-net fishery is defined as a single fleet in Stock synthesis (SS) model as past; (2) separate the set-net fishery into two fleets (i.e. catch at size in quarter 3 and 4 in the "West area", and any other quarters and areas together) for the SS model and define two fleets for the Japanese set-net fishery.

Discussion

The WG proposed that the estimated catch at size in the "North area" (i.e. "Aomori" and "Hokkaido") be removed from the set-net fishery and assigned as a new fleet in the SS model, in addition to the author's proposals. The WG also noted the uncertainty in the length frequency estimated from the weight frequency in the "North area". Furthermore, the WG advised the authors to do a simple simulation to examine the uncertainty in the bin intervals when the weight is converted into length using a weight-length relationship. The authors proposed that wide weight bin intervals be avoided for small sized fish. The WG also commented that the current version of SS allows for weight frequency data input, and hence converting data from weight to length may not be necessary.

- Estimation of catch at size of young Pacific bluefin tuna caught by Japanese troll fisheries (ISC/12-1/PBFWG/04, H. Fukuda & K. Oshima)

Summary

This document adopted a new stratification scheme for estimating catch at size of Japanese troll fisheries. The new scheme matches more catch data to corresponding length data than the scheme used previously. The unbalanced sampling rates among prefectures, which had been pointed out at the previous PBF WG, were corrected well with this procedure. The significant differences between weighted catch at size and raw length frequency were found often when 'Nagasaki' had a large amount of catch while only a few size samplings were made (i.e., 1997-3rd & 4th quarter, 2002-1 quarter, and 2005-4 quarter) . These differences became quite insignificant for recent years (after 2007-4th quarter). This result indicates the success of the intensive size sampling, which started in November, 2007, to minimize the unbalanced sampling rates among prefectures.

Discussion

The WG enquired about the coverage rate (number of fish measured from total quarterly catch) in Yamaguchi Prefecture and conversion factors used for total catch in weight into catch in number. The authors responded that about 30% of the landings in Yamaguchi are measured, and confirmed that an average weight of fish is used for conversions. The WG questioned whether seasonal changes within each area have an effect on estimated catch at size. The authors explained that; catch at size in Nagasaki significantly affects estimates of overall catch at size, as Nagasaki accounts for a large portion of total catch. It was suggested that data substitution should be made, if necessary, in order to minimize loss of size information.

- Preliminary analysis of length frequency for Pacific bluefin tuna, *Thunnus orientalis,* landed by Other fishery (Fleet 10) (ISC/12-1/PBFWG/06, M. Abe, I. Yamazaki & M. Kanaiwa)

Summary

This document summarized presently available size data sampled from fisheries operated in Tsugaru area and reviewed quantity and quality of the data in details. Length data did not have so high coverage rate of the total landing in number, whereas weights of individual fish of PBF landed were recorded well in most of ports in Tsugaru area. Consequently, the weight frequency distributions are considered to be more reliable than the length frequency distributions and they do not require raising to the total catch because of their high coverage rates. The authors highly recommend that the weight frequency distributions be used as the size data for Fleet 10 at the next stock assessment.

<u>Discussion</u>

The WG inquired whether or not the weights of larger PBF, which appear to be gilled and gutted were converted to the round weight. The authors replied that all the processed fish weights were converted into round weights with a conversion factor of 1.15. The author added that the samplers have a tendency to select larger fish for easy measurements; and this biased sampling practice explains the lower frequencies of smaller fish in observed length measurement data than those obtained through conversions from the weight data. In agreement with the authors the WG recommended using weight frequency distributions for this fleet.

- Re-estimation of standardized CPUE of Pacific bluefin tuna caught by Japanese offshore longline fisheries operated during 1952-1974 (ISC/12-1/PBFWG/10, K. Fujioka, M. Ichinokawa, K. Oshima & Y, Takeuchi)

Summary

In this document, in order to verify and improve the standardized CPUE previously reported for PBF caught by Japanese longliners during 1952-1974, procedures reported previously was critically reviewed and revised, as these standardized CPUEs had been used as important tuning parameters in the past stock assessments of PBF. The new standardized CPUE calculated using very similar procedures and assumptions as previous studies (Yokawa et al., 2007a; Yokawa 2007b; Yokawa 2007c; Yokawa 2008) showed similar trends with the CPUE calculated previously, indicating that the revised standardized CPUE can be a candidate for the stock analysis.

<u>Discussion</u>

The WG requested that the authors provide a detailed description of the GLM model used to standardize CPUE in a single document when it is finalized, by the next WG meeting. The WG also asked clarification of the data screening procedures for the data set used in CPUE standardization. The authors explained that catch and effort data in a strata (5x5 month cell) where the ratio of PBF catch (in number) to the total catch of all species is larger than 0.2 or where the CPUE of PBF is larger than 1.5 per 1000 hooks were excluded, in order to avoid unrealistic data. The WG recommended sensitivity analyses with different thresholds for data filtering be made by the authors. In addition, the WG suggested replacing reported CPUEs larger than 1.5 per 1000 hooks with 1.5, rather than eliminating the entire record. The WG enquired about the proportion of data eliminated from the data set, using these filtering criteria. The WG also enquired about the time periods for which the CPUE is standardized, particularly the reason of the division of the period at 1974. The authors explained that it is difficult to provide a single CPUE time series from the 1950s through 1990s due to the large historical changes in the operational pattern of Japanese longline, particularly, in Japanese coastal waters.

- Standardized CPUE of North Pacific bluefin tuna caught by Japanese coastal longliners: updates until 2011 (ISC/12-1/PBFWG/08, M. Ichinokawa & Y. Takeuchi)

Summary

The catch-and-effort data are derived from logbook of Japanese coastal longliners, and delta-type two step model is used for standardization. While the data and model used in this analysis are basically the same as those used in the previous study (Abe et al. 2010), fishing area definitions and explanatory variables have been slightly changed. The estimated CPUEs are similar with those in the previous study, and newly added CPUEs of 2009-2011 show constant declines until 2011. Consequently, the standardized CPUE series in Japanese coastal longline fishery tends to decline from the highest value of 1.5 in 1994 to the lowest of 0.15 in 2011, fluctuating annually with 3 local peaks at 1997, 2005 and 2007. Sensitivity analysis for selection of the data used for standardization shows robust annual trends of CPUE to the changes. Skewed distribution of residuals indicates that the model for standardizing CPUE could be improved further to some extent in future studies.

<u>Discussion</u>

The WG pointed out that the ANOVA table in this paper should include the test of main effects as well as interaction effects, so that the model used to standardize CPUE be understood better. The WG noted that after 2000, the defined fishing area had been extended from the previous analysis to the Kuroshio extension and Yaeyama Islands. The WG inquired whether seasonal changes in fishing area were considered or not. The authors explained that the seasonal changes were incorporated by the interaction term between area and 10-days. The WG also confirmed that logbook data from coastal longliners used in this study had been available only since 1993. The WG suggested application of zero inflated negative binomial (ZINB) model for CPUE standardization. The authors indicated that the application will be done in future studies.

- CPUE analysis for Japanese Purse seine in Sea of Japan (ISC/12-1/PBFWG/09, M. Kanaiwa, T. Shimura, R. Uji, Y. Ishihara & Y. Takeuchi)

Summary

Purse seine is one of the major PBF fisheries in Japan. Nominal CPUE of PBF by purse seiners in the Sea of Japan is updated for the years, 1987 - 2010. Since the confidence intervals are wide, it is difficult to see any trend. The figure is almost flat except for 1994, in which year, a high CPUE was observed, due to the increased CPUE for age 4 fish. Regression analysis is conducted between stock abundance estimated by the former stock assessment and the nominal CPUE series derived by this study for each age. All coefficients of regressions are positive, suggesting that these indices had no conflicts with the former stock assessment, even though R^2 was not high.

Discussion

The WG pointed out that the flat annual trend of CPUE of purse seiners in the Sea of Japan estimated through this study may be stemmed from purse-seine-CPUE specific problems. Additionally the WG was concerned that fishing effort used in the CPUE calculation did not consider the search time for the fish schools. Hence, the CPUE might represent only the size of a school of fish, which is known not to be proportional to the abundance of the stock. The authors explained that number of landings was used as effort, because in ISC/8-2/PBFWG/05, the authors compared the catch divided by number of landings with some indices estimated using effort including search time, (e.g. catch divided by the intervals between landings,) and confirmed that there is little differences between them. The authors emphasized the difficulties to calculate indices using landing intervals prior to 2004, due to the low frequency of landings per vessel.

The WG inquired of representativeness of the CPUE for abundance of ages 3-4 fish. The authors indicated that the representativeness will be ensured if age specific CPUEs are estimated accurately. The WG also noted that ages 3-4 fish appear only in the catches of purse seiners operating in the Sea of Japan. The WG noted that a new management regulation had been introduced to this fishery in 2011, influencing the estimates of effort. The WG also noted that the cohort-slicing technique to obtain age-specific CPUEs assumes the fish grow according to the growth equation by Shimose (2012,ISC/12/PBFWG-1/12). But there appears to be some misfits between the Shimose growth model and observed modes in the length composition data. The WG suggested that the authors consider those suggestions by the WG in the future works. After a substantial h discussion, the WG decided that this index not be used in the base case model but be used in a sensitivity run.

- Abundance indices of young Pacific bluefin tuna, derived from catch-and effort data of troll fisheries in various regions of Japan (ISC/12-1/PBFWG/11, M. Ichinokawa, K. Oshima & Y. Takeuchi)

Summary

ISC/12-1/PBFWG/11 presents standardized CPUEs of Japanese coastal troll fisheries from Kochi, Wakayama and Nagasaki prefectures. Catch-and-effort data have been collected mostly from 6, 4 and 5 fishing ports in Kochi, Wakayama and Nagasaki prefectures, respectively. Unit of efforts in the catch-and-effort data is number of landings, which is nearly equivalent to number of trips of troll vessels, because most operations are conducted by one-day trip. Because effort data in Kochi and Wakayama prefectures include landings without PBF catch (zero-catch data), zero-inflated negative binomial model is applied for standardization of CPUE. On the other hand, because effort data in Nagasaki prefecture don't include landings without PBF catch, log-normal model is applied.

The estimated standardized CPUEs from Kochi and Wakayama prefectures show larger magnitudes of annual fluctuations (CV=0.91 in Kochi and CV=0.98 in Wakayama) than those in Nagasaki prefecture (CV=0.35). Since average catches (in weight) recorded in the catch-and-effort data are 517, 62 and 21 mt in Nagasaki, Kochi and Wakayama prefectures, respectively, CPUE in Nagasaki prefecture can be considered as more representative than those in the other prefectures. Combined CPUE of weighted means by corresponding catch in weight would also be a possible candidate for this troll fishery. CV of root of mean squared error (RMSE) from troll CPUE expected in the current stock assessment model is smallest in the combined CPUE of Kochi and Nagasaki prefectures (0.25), and second smallest in the CPUE of single Nagasaki prefecture (0.27). Consequently, single CPUE of Nagasaki prefecture, or combined CPUEs of Nagasaki and Kochi prefectures could be recommended for the use in the next stock assessment, with respect to representativeness and consistency with population dynamics estimated in the current stock assessment model. In either case, the index from troll fishery would be useful to give reasonable information on recruitments at the forthcoming stock assessment of PBF.

Discussion

The WG pointed out that the Nagasaki CPUE may be hyper-stable because it uses only positive trips. The WG proposed an approach to test the effect of non-zero catch data in Nagasaki prefecture, that is to compare standardized CPUEs for Kochi and Wakayama Prefectures, between the original ones with zero-catch data and those without zero-catch records. The authors responded that analysis of this type is not appropriate; the effort data of Nagasaki do not include zero-catch landings, while effort in Kochi and Wakayama prefectures include both zero-catch and non-zero-catch landings, but they can't be separated.

Instead the authors presented the result of log- linear regression between Nagasaki CPUE and estimation by SS without recruitment index. The coefficient of bias parameter was significantly less than 1, which indicates the possibility of hyper-stability in the Nagasaki CPUE index. When updated data become available, the analysis will be conducted again. The WG suggested that catch in number is more appropriate than catch in weight as the weighting factor to combine CPUEs from three prefectures. The author explained that catch in number are not available for this fishery and then some uncertainties will arise when the catch in number is estimated from the catch in weight using mean weights. The WG discussed the ability to estimate CPUE separately Pacific-origin and Sea-of-Japan-origin groups of age-0 fish. The authors showed preliminary results to separate CPUE in Nagasaki prefectures into the two groups. However, it was confirmed that incorporation of assumption of 2 recruitment groups into SS is currently difficult because of impossibility to separate whole troll catch into two groups, and the possible difference in growth curves of the two hatching groups. The WG pointed out natural mortality and increase in weight during fishing season cannot be ignored because of high M value (1.6 /year) and high growth rate for age 0 fish. The discussions at the WG on this paper will be reflected in future works.

- Current situation of Taiwanese longline PBF CPUE data (Oral presentation #6: C-.C Hsu)

Summary

Oral presentation was made to describe Taiwanese small scale longline fleet harvesting PBF in the southeastern, eastern and northeastern waters off Taiwan. indicating that the fishery is targeting giant PBF spawners Almost all PBF caught by this fishery are larger than 165 cm in fork length. The presenter pointed out that the standardized catch per unit effort of PBF for this fleet is important as an abundance index of spawners in stock assessment. Taiwanese PBF fishery is composed of only small scale longliners (<100 GRT) with a long history, first as by-catch species and later, since1993, as the target species. Other fisheries such as set net, may catch a few PBF incidentally. This longline fleet can change their target species easily toward yellowfin or bigeye tunas, billfish and swordfish depending on the fishing season and market prices. Catches are mainly unloaded at ports of Tungkang, Suao and Hsinkang. A trip lasts for about 1 week on an average, the duration depending upon the fishing condition; and they make either 1 or 2 set(s) per day according to number of hooks used per set. Salted or fresh squid bait are used. The fishing season of PBF is extended from March to September, but most of PBF catches are mainly taken in May and June when giant PBF migrate and aggregate for spawning in the waters off Taiwan. Currently almost 60% of PBF landed are domestically consumed and the rest are exported. Collections of catch and effort data of PBF for this fleet were initiated in 1999 and continued until 2008: catches being collected from auction records at fish markets; and efforts being estimated by records of Port Security Inspection Station for fleet dynamics. Since 2008 logbook system has been established instead of collecting fishery data for this fleet. Accordingly, a time series of standardized catch per unit effort was estimated by applying general linear model with year, month and vessel's pattern as fixed factors assuming the Gaussian error structure. The standardized catch per unit effort showed a steep declining trend, i.e. a sharp decline from 1999 to 2002, recovered and remained steady in 2003 and 2004; dropped to another low level in 2005 and remained there until 2008, then decreased again in 2009 to the historical lowest level of this series in 2010 and 2011.

Discussion

To accurately assess the stock status of PBF, the WG recommended that the PBF fishery by Taiwanese fleet be described in much more details, and that the two different sets of catch/effort data used in standardization be verified. The catch/effort data from 2009-2010 logbooks should be re-examined to maintain consistency with the method used for 1999-2008. In order to accommodate the large number of records with zero catches, the WG recommended using a Delta log-normal model in standardizing the abundance index.

The WG revisited the discussion on Taiwanese longliners at a subsequent point. Various questions were raised by the WG, relating to whether all the efforts by longliners in March to July were targeting bluefin tuna or not, and whether or not a screening process was used to filter for bluefin-targeted effort. The WG recommended that a working document describing Taiwanese longline fishery and data in details be submitted at the next workshop.

3.2 Eastern Pacific Fisheries (A. Aires da Silva, S. Teo)

- Historical review of the bluefin fishery in the eastern Pacific Ocean.(Oral presentation #1; G. Compean-Jimenez)

Summary

The PBF fishery in the eastern Pacific Ocean (EPO) has historically exploited a juvenile (mainly age-1 and age-2 fish) segment of what seems to be a highly-migratory northern Pacific wide PBF stock. Purse seining for bluefin tuna in the EPO was initiated in about 1914. Prior to 1930 fishing took place only off California; from about 1930 to 1948 there was considerable fishing effort off both California and Baja California, Mexico; and since about 1948 fishing has taken place mostly off Baja California. The catches were taken predominantly by U.S. and Mexican purse seiners. Annual catches have fluctuated considerably since the early days of exploitation, with an historical peak at about 16,000mt in 1966.

There have been major fluctuations in the production of the PBF fishery in the EPO, and these have apparently been related to marked management events. Two major historical events occurred in the fishery. First, beginning the early 1980s, increasingly effective measures by the Mexican government to enforce its Exclusive Economic Zone resulted in a gradual exodus of U.S. boats from the fishery. Secondly, beginning in 1996, bluefin farming trials had initiated in northern Baja California, and since 2002, many Mexican vessels began to direct their effort toward PBF off Baja California during the summer and early fall, to provide for farming needs, which started commercial operations in that year The fish are transported to holding pens, where they are fattened for several months before being slaughtered for the production of sashimi, considered to be a delicacy in Asia and other parts of the world.

Discussion

There was no discussion.

- A description of PBF field sampling from commercial and recreational fisheries in EPO (Oral presentation #2; E. Everett)

The presenter was available to answer questions about the size sampling of PBF onboard purse seiners and at ports, and recreational fishery boats in the eastern Pacific Ocean.

Discussion

There were substantial enquiries about the size samples of PBF collected by IATTC in the EPO, especially the PBF from purse seiners that transfer majority of the PBF catch to pen operations. Scientists from IATTC clarified that typically some PBF dies before transfer to the pens and since 100% of these vessels have onboard observers, the observers are able to measure these fish that died. In addition, IATTC measure fish samples from canneries where some PBF are unloaded as well as from the recreational fishery. There was also some discussion about whether better length estimates could be obtained from pen operators, as sizes of fish that were dead and/or landed in canary might be biased. The WG felt that the IATTC was doing a good job obtaining currently available length samples but the length compositions for the EPO would likely be improved if size data could be obtained on fish in pens. However, it was noted that the size data from pen operations are private data and pen operators have not released these data, but may do so in the future.

- Brief overview of methods for estimation of pacific bluefin (PBF) total catch and length composition for recreational and commercial surface fisheries in the EPO (Oral presentation #3; C. Lennert-Cody)

Summary

The presentation was made on an overview of methods for estimation of PBF total catch and length composition for recreational and commercial fisheries in the EPO. Annual estimates of total catch and length composition of catch by month are made for both the recreational fishery and the commercial surface fisheries (purse-seine and pole-and-line) operating in the EPO. Estimates of length composition of the catch are computed only for those EPO strata (2 fishery types x 12 months) for which sample data are available.

The following data are available in the EPO. For the recreational fishery, the California Department of Fish and Game (CDFG) provides monthly estimates by year of the total PBF recreational catch in numbers of fish. In addition, IATTC staff sample the recreational catch, and for each sampled trip, length measurements are obtained for a sample of fish, as well as the total amount of PBF caught (in numbers of fish). For commercial fisheries, data on catches from canneries, or recorded by observers or in vessel logbooks (all in metric tons) are compiled for all trips. In addition, IATTC staff sample the catches of individual commercial vessel trips for length-frequencies and total PBF catch (in metric tons).

For both fishery types, a two-stage sampling scheme is used. The first stage unit is a trip for the recreational fishery and a vessel well for the commercial fishery. For the commercial fishery, PBF are sampled only from a vessel well where all the catch loaded into the well came from the same month, the same sampling area and the same type of purse-seine set (for more information on general IATTC port-sampling procedures see the Appendix of http://www.iattc.org/PDFFiles2/SpecialReports/SpecialReport18.pdf, however, note that species composition sampling is not done for PBF). The second stage unit is a fish within a trip for the recreational fishery and a fish within a well for the commercial fishery.

A general description of the method of estimation of the monthly length composition of both the recreational catch and the commercial catch can be found in Tomlinson et al. (1992) (http://www.iattc.org/PDFFiles2/Bulletins/Bulletin-Vol.20-No.6.pdf).

Discussion

The WG enquired about the number of areas sampled by IATTC for catch and length composition and how that affects the estimates. It was clarified that only one or two IATTC fishery areas have PBF catches and length samples so changes in area should not affect estimates. There were additional questions about the need to estimate species composition at the canneries. The IATTC scientist responded there was no need to do so since PBF schools tend to be monospecific and species identification is easy.

The WG further enquired if comparisons have been made between length compositions of catches by recreational and commercial fisheries in the EPO. The presenter responded that not much has been done to compare the two size compositions. It was further clarified that wells on purse seine vessels are only sampled if the well meets certain criteria like fish within a well must be from the same area and month, which improves the representativeness of the size samples.

- Updated standardized catch rates for Pacific bluefin tuna caught by United States and Mexican-flag purse seine fisheries in the eastern Pacific Ocean (1960-2011) (ISC/12-1/PBFWG/18; A. da Silva & S. Teo)

Summary

Updated standardized catch rates for PBF in the EPO were presented. The previous estimates submitted for the 2008 PBF assessment were obtained based on a vessel-based criterion to define PBF-targeted effort. Following a suggestion by the PBF-WG, the new analysis provides updated estimates using an alternative criterion for PBF data selection. Specifically, the proportions of PBF catch by trip rather than proportions of PBF positive trips by vessel are used along with constraints for the PBF optimal habitat to select the PBF data.

Standardized catch rates are presented for four fisheries: (1) the developed phase of the US PBF-targeted fishery (1960-1982); (2) the extinction phase of the US fishery (post-1982); (3) the Mexican opportunistic fishery (1960-1998); and (4) the Mexican PBF-targeted fishery post-1999). Estimates of the coefficient of variation (CV) obtained through jackknifing showed that the precision for both US and Mexican PBF-targeted fisheries were very poor.

Due to complex spatial processes not accounted for in the Stock Synthesis model, coupled with the high variability and low precision of the EPO indices, the authors recommended not using PBF indices for the EPO in the assessment. If the WG desires otherwise, the authors provided three options for including the PBF indices for the US and Mexico PBF targeted fisheries: 1) include the indices in the model so the model fit can be evaluated, but not include them in the objective function; 2) include the indices in the model while using the CVs estimated by the jackknife procedure; 3) include the indices in the model with a moderate CV while modeling inter-annual changes in catchability.

Discussion

Members of the WG enquired about how the ‘opportunistic’ periods were defined and whether that resulted in changes to the criteria used to extract PBF effort. It was clarified that the ‘opportunistic’ period is due to changes in the operation of the fishery like the start of pen operations rather changes in the criteria used to extract data. There was also a suggestion that the post-1998 Mexico index looked similar to the Japan Troll index from Kochi and Wakayama, albeit with a slight lag. It would therefore be a good idea to test this hypothesis by including the index within the assessment model but not including it in the objective function.

The WG also observed that for the US fishery, variability increased substantially after 1982, when effort decreased. However, for the Mexican ‘opportunistic’ fishery before 1999, the variability did not appear to be higher than the post-1999. The authors offered to look into the reason for this observation in the future. The WG also enquired if there was any change in the number of sets per day in the time series. The authors responded that they did not have the information available since the analysis used days fished as a measure of effort and not numbers of sets.

- Time series from US commercial and recreational fisheries for the PBF stock assessment. (Oral presentation #8; S. Teo)

Summary

A description of the time series (catches and length compositions) of US commercial and recreational fisheries of PBF was presented for use in the upcoming assessment. In addition, observations from US spotter plane logbooks were also investigated to determine if an abundance index for the EPO could be developed from the data. Preliminary analysis of the spotter plane data suggested that they could be used to develop an index of presence/absence in time-area strata in the EPO but it was unclear how to use that in the assessment model. This was because the presence of PBF was noted in the spotter plane logbooks but school sizes were recorded inconsistently. School sizes were often not recorded or recorded in either numbers or tons. It was likely that school sizes were recorded in numbers when fish were larger or when school sizes were small. Mixed schools were also recorded with unknown species compositions. In addition, there was substantial rounding of recorded school sizes (e.g., 50 mt, 2000 fish). Overall, due to these issues, an abundance index derived from spotter plane logbook data is not recommended for this upcoming assessment. However, if used in conjunction with purse-seine vessels logbook, it may be possible to develop an improved index in future assessments.

Discussion

The WG enquired about when catches from the US recreational fishery would be available. The author responded that the recreational catches may be available by the end of March and almost certainly by May. Other discussion centered on the potential use of spotter plane logbook data for an abundance index. It was suggested that it may be possible to develop a multinomial index with broad school size categories but it was unclear to the WG how to use such an index in an assessment model. The WG recommended that US scientists continue this work in conjunction with IATTC scientists to further investigate this data source.

4.0 BIOLOGICAL PARAMETERS AND DATA FOR THE STOCK ASSESSMENT

- Updated sex specific growth parameters for Pacific bluefin tuna *Thunnus orientalis*. (ISC/12-1/PBFWG/12. T. Shimose & Y. Takeuchi)

Summary

Sex specific growth parameters for PBF were presented at ISC/11/PBFWG workshop using 351 female (≥100 cm fork length), 364 male (≥100 cm), and 117 young (<100 cm) specimens. After the workshop, otolith ageing was repeated with the same specimens for verification purpose, and updated growth parameters were obtained. In this paper, updated sex specific as well as for sex combined growth parameters are reported. For stock assessment the updated growth parameters with combined sex should be used, because sex-specific parameters apparently under-estimate mean length at age 0 females.

<u>Discussion</u>

The WG enquired about the reasons for the large difference between young sex-specific sizes at recruitment. The authors responded that these sizes were not directly measured due to lack of sex information at these small sizes. Rather, these were estimated from sex-specific growth equations derived from larger fish. The authors recommended the use of the sex-combined growth model. The WG noted the differences in age-at-length between the results of 2011 and those of 2012 even though the same otoliths were aged. The authors responded that this was due to a slight change in counting protocol and to the difficulties in counting annuli. The WG recommended that future aging work include multiple readers, ideally from different laboratories, and that future collaborations among laboratories be established. The authors also reported that radiocarbon dating of PBF otoliths is currently being studied in an attempt to validate the age and growth of PBF. The WG also enquired about possible differences in growth between PBF from the Sea of Japan and the Pacific side of Japan. The authors responded that this subject had not yet been explored yet, but studies using daily otolith rings will be conducted in the future.

Current estimations of sex specific growth parameters provide different values of length at recruitment between sexes: calculated size at recruitment of female is to be 9.68 cm on the 1st of July (assumed date of recruitment), which is much smaller than observed size of fish at recruitment (ca. 15 to 20 cm). The WG s recommended that the sex specific growth parameters should not be used for stock assessment until these discrepancies are resolved.

Currently, age specific age-length relationships are not assumed,. Difference in growth between the Pacific and the Sea of Japan is under investigation for age-0 fish, using otolith daily growth increment analysis. This study will possibly resolve the misfit between calculated lengths and actual observed length at recruit.

- Modeling growth while fitting simultaneously to direct aging and tag-recapture data. (Oral presentation # 9 A. da Silva, P. Maunder, K. Schaefer & Fuller).

Summary

The results of a recent study integrating direct aging and tag-recapture increment to estimate bigeye tuna growth in the eastern Pacific was orally presented. Ages for the tag-recaptured fish are estimated as random effects following the original approach proposed by Laslett et al. (2002) and Eveson (2004). In the bigeye tuna case, the approach helped to reduce the uncertainly on the asymptotic size by incorporating tag-recapture increment data with new information on larger (older) fish for which otolith readings were not available. Application for PBF could be the development of a seasonal growth model integrating the otolith and tagging data.

Discussion

The WG highlighted that it is best to have more tag recoveries with long times-at-large, but it will also be useful to have many tag recoveries with short times-at-large. The authors reiterated that the otolith derived data anchors the sizes at age for the model, and then the tag recapture gives a single parameter into the model. The authors also commented that a benefit of the penalized likelihood approach is that it can be integrated directly into the stock assessment model (stock synthesis). The WG also noted that opportunistic tagging may not adequately incorporate the entire life history, so proper sampling design is needed to incorporate ontogeny & geography. The WG also commented that Bill Bayliff's old work showed growth variability within a growth curve (i.e., linear, VB like) but the authors responded that this model is highly flexible and can deal with this variability. There is also great flexibility in this model to try seasonal growth or incorporate other growth models.

- Reconsideration on the parameters to be used in the analysis of Mark-Recapture experiment in Tosa Bay, Kochi. (ISC/12-1/PBFWG/14 S. Iwata, K. Fujioka, H. Fukuda, & Y. Takeuchi)

Summary

This paper revisits tag shedding parameters of PBF in order to improve estimation of natural and fishing mortalities of PBF. Takahashi (2000), Takahashi and Takeuchi (2002), derived the tag shedding parameters directly from the data of Marine ranching Project (1980-1989) and of IATTC mark recapture project (1980-1982) by adapting the double tag method described in Kirkwood and Walker (1984). On the other hand, tag shedding parameters applied in Takeuchi and Takahashi (2006), Iwata et al. (2011) came from the combination of past mark recapture experiments and a tuna culture experiment, both of which were held in summer 2004 in Tosa Bay by Kochi Prefectural Fisheries Experimental Station (KPFES), as a part of the project of the 'Research of Japanese tuna (RJB)', funded by the Government and lead by National Research Institute of Far Seas Fisheries (NRIFSF). Takeuchi and Takahashi (2006) and, Iwata et al. (2011) adopted the procedures described by Adam and Kirkwood (2001). However, both of the above papers used data on fish of all size classes, even though the recovery rates for the fish less than 20 cm are expected to be very low. Therefore, this paper revisits the analysis to re-estimate tag shedding rate by data of fish over 20 cm only, at the time of releases, for all the estimations made in this report.

Discussion

The WG enquired about size range of fish at tagging in the experiment. The authors responded that the mode was approximately at 19-20 cm. The WG further enquired about whether the fish were held for a while to account for initial mortality due to capture. The authors responded that in the most recent experiments, fish were held for 3-5 days prior to tagging but in the earlier experiments this was not done. In addition the WG noted that there were enough data to estimate precision of the parameter estimates and recommended that the authors pursue the issue.

- Reconsideration of natural mortality of age-0 Pacific bluefin tuna and its variability relative to fish size. (ISC/12-1/PBFWG/1 S. Iwata, K. Fujioka, H. Fukuda, and Y. Takeuchi)

Summary

This paper presents a revised result of estimated natural mortality rate of fish of age 0, PBF; applying a tag-attrition model by using mark-recapture data of conventional tags. In Iwata et al. (2011), natural mortalities were estimated by using updated tagging data set used in Takeuchi and Takahashi (2006). Updating involved mainly adding new data of 1996-1999. In Takeuchi and Takahashi (2006) and Iwata et al. (2011), estimates were made for two cases: with data for recaptured fish of all size classes; and those only for the fish of 20 cm or larger, at the time of releases. Iwata et al. (2012) revised the estimates of tag shedding rate, based on the updated tagging base. This paper estimates natural mortality rates for fish over 20 cm in fork length at releases, using revised tag shedding rate by Iwata et al. (2012). Besides, following the recommendation made by the ISC PBF WG, 2011, size dependent natural mortalities were also examined. The natural mortality rate estimated at this time seems to be lower than those by previous workers. Additionally, ranges of 90% confidence intervals are narrower than those of previous works. The natural mortality of age-0 fish currently used in the stock assessment (i.e. 1.6) seems to be appropriate.

Discussion

The WG noted that the estimated natural mortality had decreased from previous estimates but was still relatively high. It was also noted that estimated natural mortality is from relatively small fish (~ 20 cm) and the fish are growing very rapidly during this period. It may therefore not be appropriate to assume that natural mortality was 1.6 throughout the first year. However, the WG also recognized that due to the current constraints of SS3, it is not yet possible to use rates of natural mortality that changes with size or by season. Acknowledging this shortcoming in the assessment, the WG recommended to perform a series of sensitivity analyses with other values of M for age-0.

5.0 ALTERNATIVE MODELING APPROACH (E.G. NEW SELECTIVITY FUNCTION, HYBRID-SS, HOCKEY-STICK SRR ETC)

- Exploratory application of SS incorporating conditional age at length data from otolith aging (ISC/12-1/PBFWG/16; Y. Takeuchi and T. Shimose)

Summary

The paper presented preliminary results of SS runs estimating growth curve parameters with conditional age at length for unisex model and sex structured model as well as runs without conditional age at length. Use of ageing data within model has limited ability to improve growth curve estimate compared with runs without ageing data. Nevertheless growth curve estimates within the ex-structured model has an effect to keep length at age 0 within feasible length while length at age 0 tend to be underestimated with only ageing data.

Discussion

The WG considered that the problem of sparse conditional size at age will not affect the result because SS assumes the multinomial distribution as the likelihood distribution of length composition. The authors pointed out that in the parametric bootstrap trial to evaluate variance, this may increase the variance. The WG thought that including the sex specific length composition will improve the accuracy of estimation of growth curve but will make another problem on selectivity curve and that it will require another assumption for selectivity curve. The WG requested the authors make a figure to compare this estimated growth curve and SS estimated length composition (for peaks). The WG recommended trying the Richards growth equation as a sensitivity run. Now SS has the the option to estimate ageing error matrix and will be useful to check this estimated result.

- A hybrid SS3-VPA model for examining trends in young fish selectivity and recruitment （Oral presentation # 10; A. MacCall & S. Teo）

Summary

The WG was informed of a newly developed “hybrid” SS3-VPA assessment, 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 PBF 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 a half. Expected recruitment is constant (steepness h=1) in both models, and estimated recruitments from the two models are nearly identical.

Discussion

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 WG pointed out the selectivity curve of age 2 has bias because hybrid model assumed flat selectivity - 1 for ages 0 and 1. Author mentioned this is common problem for VPA however, on SS III we can set the selectivity curve under this hypothesis of hybrid model and may moderate this problem. In same time, changing the age range for VPA part to only 0 and/or from age 0 to 2 will be able to become sensitivity runs to evaluate this effect.

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.

6.0 BASE CASE MODEL CONFIGURATION

6.1 Review of base case model configuration at 2010 update and discussion in January

- Review of the setting of SS3 in previous PBF stock assessment meetings. (ISC/12-1/PBFWG/17 S0 Iwata & Y. Takeuchi,)

Summary

The paper discusses SS setup for the upcoming ISC 2012 PBF full stock assessment meeting. Especially, the fleet definitions, CPUE series, biological parameters (e.g. growth parameter, natural mortality for all age classes, steepness) and catch error settings are reviewed. Finally, the version of SS is updated from the 2010 WG meeting, Nanaimo, Canada. The update includes several new options for consideration, for the stock assessment in the next PBF stock assessment model.

Discussion

The WG noted that the setting of natural mortality has two categories: the seasonal M for age 0 group (M_0); and the natural mortality of older age groups (M_1 and M_{2+}). In the previous PBF assessment M_0=1.6, M_1=0.3864 and M_{2+}=0.25 were assumed. For M_0, the authors considered applying a seasonal M. For the M_{2+} the authors examined the plausibility of the current setting by comparing the natural mortality of other tuna and tuna like species for older age groups and values of natural mortality estimated from the tagging work of Whitlock et al. (2012). The WG will use the same method of calculating effective sample size as was used in the previous assessment. Based on the discussion of Iwata et al (working paper #15), steepness could be set at 0.999 or at 1.

6.2 Tentative base case model configurations

6.2.1 Growth

- Modeling growth while fitting simultaneously to direct aging and tag-recapture data. (Oral presentation # 9: A. da Silva, M. Maunder, K. Schaefer, Fuller,)

See section 4.

- Updated sex specific growth parameters for Pacific bluefin tuna *Thunnus orientalis* r: (ISC/12-1/PBFWG/12 T. Shimose & Y. Takeuchi,)

See section 4.

General Discussion

In the previous assessment the growth curve was fixed at that estimated by Shimose et. al. (2007). This growth curve was updated in 2011 and again at the current workshop. The externally estimated growth curve is for combined sex. Sex specific growth curves are also available, but their use in the assessment is limited by insufficient observations of sex-specific landings and ages. Alternatives are to estimate the growth curve inside the model, either with or without including the conditional age at length data.

The growth rate appears to be different between the Sea of Japan and the EPO, through observation of length composition data, particularly for ages zero and one. It is doubtful that the current version of SS can adequately accommodate these differences. It might be possible to use a spatial model with growth morphs to accommodate the different growth rates.

The "new" otolith data reported by Shimose show differences between 2011 and 2012 readings, particularly for younger individuals. The difference is probably due to a change, presumably an improvement, in methods used for counting bands. A suggestion was made to estimate growth using only the new data because of the presumably improved technique. The "old" data (ageing of samples collected in earlier time) was not re-examined.

6.2.1.1 Internal Growth Estimation

General discussion

The WG previously tried to estimate the variation of length at age internally and estimated a large CV for age zero, probably due to the effects of two distinct spawning seasons and rapid growth. After age 3 the estimated CV was assumed to be constant at a lower value. WG chose CV values that were a compromise between estimates outside the model and those estimated internally. The SS constraints on specification of the CV (which is high at young ages, but lower and constant above age 3) required that the growth curve be defined using an upper reference age of 3, which otherwise would have been set at a much older age.

6.2.1.2 External Growth Estimation

General discussion

Use of the Richards growth curve should be explored for estimation both inside and outside the model. Stock Synthesis now has age specific K that allows for fixing the length at age, allowing use of more flexible growth models estimated outside the assessment.

A smoother applied to the otolith data shows that the growth curves underestimate mean length at ages 15-20. This suggests that a Richards growth curve may be more appropriate. Previous fits of a Richards growth curve did not show differences at older ages. This may have been due to the influence of the mean length at young ages. It might be better to fit the Richards curve while leaving out ages zero and one.

If the hybrid VPA method is used with catch in numbers, then we may not need to deal with the difference in growth for ages zero and one. These alternatives could be presented in a sensitivity analyses.

A small ad-hoc group was formed and assigned the task to formulate a small set of alternative growth curve estimation scenarios. (Members to be Aires da Silva, Kai, Teo, and Maunder).

6.2.2 Natural mortality

6.2.2.1 Natural mortality of older fish

- Overview of natural mortality for Pacific Bluefin Tuna - age 2+ group- (Oral Presentation # 5 H. Fukuda & S. Iwata,)

Summary

Various scenarios of natural mortality rate (M) have been used for tuna stock assessments, including genus of *Thunnus orientalis* (PBF). In this presentation, those scenarios of natural mortality of the old age group (age 2+), which have been used in stock assessments or published in peer-reviewed papers, were reviewed. In the case of PBF, a relatively high value scenario of M was used in the previous PBF stock assessment but a recent published paper by Whitlock et al. 2012 suggested possible relevance of lower values of M. Properties of alternative M scenarios were discussed.

<u>Discussion</u>

The WG discussed the setting of natural mortality for ages 2+, based on the natural mortalities in this presentation. For tuna living in the temperate zone, the current value of M is appropriate. The natural mortality estimates of Whitlock et al. (2012) were discussed extensively (see general discussion).

<u>General Discussion</u>

The WG noted that values presented for YFT and BET in EPO are quarterly rates, so comparisons should recognize different time units. It was suggested that Ms for PBF should not necessarily be the same as thoseas those for southern bluefin tuna (SBT) because the life history parameters are not the same. The differences in natural mortality by sex and age assumed for tropical tunas are not expected to be the same for temperate tunas, because temperate tunas make extended migrations and only spawn once a year, unlike tropical tunas that spawn continuously and don't make extended migrations. The changes by sex and size assumed in tropical tunas are based on change in sex ratio by size, and have no analog in the available PBF data. It was noted that South Pacific albacore show a domination of male at large sizes similar to tropical tunas. If sex specific natural mortality is used, a sexually explicit model is needed, with informative data. The rationale for the current values of M was given in a previous WG paper by Alex Da Silva et al(2008).

In the absence of direct estimates of M for PBF beyond age-0 (1+ years), the WG adopted a natural mortality vector for the PBF 2008 assessment based on assumptions made for SBT. This choice was later on revised considering the differences that exist between the life-history of PBF and SBT (see ISC/08/PBF-2/04 for details). The adoption for PBF of the SBT estimate of $M=0.12\ yr^{-1}$ for the 4+ year old adult fish seemed the most problematic. This assumption was based on the long life-span of SBT (maximum age of 42) which does not seem to be the case for PBF (maximum observed age around 25 years). In addition, while the mean age at maturity for SBT varies from age 8 to age 12 years, PBF begins to mature at age 3 and are fully mature at age 5. It seems reasonable to assume that such an early investment on reproduction would result in higher natural mortality levels for mature PBF. An alternative M estimate (M=0.25) for the adult fish (3+ year) obtained across a large suite of life-history based methods was used in the last assessment. A comparative analysis of reproductive value conducted at the WG meeting in Ishigaki (Dec. 2008) showed that PBF had a similar reproductive value with Atlantic bluefin and southern bluefin tunas under the new assumed level of adult natural mortality (M=0.25).

Several issues were noted regarding the recently published analysis of Whitlock *et al*. (2011) to estimate natural mortality using archival tag data. The results of the analysis are unusually sensitive to the assumed prior probability distribution. When a uniform prior is used for natural mortality, the posterior probability for M_{5+} is about five times higher than their best estimate of $M_{5+} = 0.15$. The data (as opposed to the priors) have a strong mode at M=0, which indicates probable model mis-specification. In addition, the PBF in the EPO are comprised mostly of ages 1 and 2, with very few older fish on which to base an estimate of M_{5+}. These details are unclear in the paper.

The WG agreed to keep the natural mortality values used in the previous assessment, based on the previous arguments of Da Silva, which are unchanged by Whitlock et al, and agreed to use the Whitlock et al. estimates as a sensitivity analysis.

6.2.2.2 Age zero natural mortality

- Reconsideration on the parameters to be used in the analysis of mark-recapture experiments in Tosa Bay, Kochi. (ISC/12-1/PBFWG/14; S. Iwata, K. Fujioka, H. Fukuda & Y. Takeuchi)

See Section 4.

- Reconsideration of natural mortality of age-0 Pacific bluefin tuna and its variability relative to fish size. (Paper #13: S. Iwata, K. Fujioka, H. Fukuda & Y. Takeuchi)

See Section 4.

General Discussion

Based on tagging studies, previous assessments have assumed an annual natural mortality (M_0) of 1.6 for age-0 PBF. However, the WG recognized that M_0 likely decreases with size, and age-0 PBF grow very rapidly. The WG therefore recommended using a seasonal M_0 in the upcoming assessment. The current SS version is able to use a linear interpolation of annual M to approximate seasonal M. The WG recommended that the tagging data described in ISC/12-1/PBFWG/13 and ISC/12-1/PBFWG/14 be used to estimate seasonal M. One option is to estimate M_0 at quarter 1 and/or 2 and linearly interpolate to M at age-1. Another option is to assume a linear seasonal change in M and estimate the slope of the change.

The WG considered to try estimating seasonal M inside a tagging model, using the same assumption as SS.

6.2.3 Steepness

- Estimation of steepness of PBFT - By using biological features. (ISC/12-1/PBFWG/15 : S. Iwata, H. Fukuda, O. Abe & Y. Takeuchi,)

Summary

By using biological features, Mangel *et a*l. (2010) presented a method for direct estimation of steepness from biological information. In the current paper, steepness of Pacific Bluefin tuna is calculated using the deterministic part of Mangel's procedure, which would provide a basis for discussing steepness to be used in the stock assessment model. The calculated steepness of PBF is close to one. In application of this method, a problem arises relating to uncertainties in biological parameters, especially those in the early life period. The duration of "early life period" comes from the growth parameter (a_0) in the Mangel *et al*. procedure. The definition of the early life period in the model has many uncertainties and ambiguities. It is recommended to use steepness ranging, 0.8-1.0 for PBF sensitivity analysis, to compare our results with the results of Mangel *et al*. (2010).

Discussion

The WG discussed the assumption of exponential growth during early life, a period which is defined by the parameters of the growth curve, especially a_0. The authors agreed that the current definition does not fit precisely to the biological meaning of "early life." The WG focused on density dependence during the early life stages. The Beverton-Holt stock recruitment relationship implicitly assumes an intra-cohort density dependent effect. However it is difficult to relate that density dependence to the current method.

General Discussion

The duration of early life mortality is the major issue in the Mangel et al. method. It is unlikely that the density dependence is the same function of cohort size for whole early life history. For example, there may be critical early life history periods.

Zhu *et a*l. (2012) showed that relative loss in equilibrium yield is greater when steepness is overestimated than when it is underestimated. Therefore, they suggest that a lower value of steepness should be chosen. However, if fishing mortality has to be reduced from present levels then there may be a short term loss in yield. One possibility would be to use the lower bound of the 95% profile likelihood confidence interval.

The WG suggested using a hockey stick model to see if there is evidence for reduced recruitment at low spawning stock biomass, which would provide a reason to change steepness.

The WG agreed that the value of steepness should be set to 0.999 for the upcoming assessment..

6.2.4 Data weighting and effective sample size (ESS)

- How to calculate sample size for reconstructed data (Oral Presentation # 11: A. MacCall)

Summary

This method was suggested as a possible solution when there is no clear underlying sample size, such as in the case of length compositions reconstructed from unsampled box-count compositions. The sample ESS values provided by SS can be regressed against a nominal sample size index (e.g., the sum of boxes * count/box). The initial ESS are obtained from a SS run where those samples are assigned zero sample size, so the data do not influence the model. A first approximation of the reconstructed ESS values is given by the regression means for the corresponding samples. A second iterative approximation would begin by using estimated ESS from a second SS run where samples are assigned their first stage ESS values and are fitted by the SS model. These two iterations should be sufficient.

- Estimation of effective sample size for catch-at-length data of Pacific Bluefin tuna (Oral Presentation #4; A. Mizuno, K. Oshima & Y. Takeuchi,

Summary

The authors reviewed methods of estimating ESS. There are three types: (1) the ratio of multinomial to empirical variance (McAllister and lanelli 1997), (2) variance with assumption of normal distribution (Pennington 2002), and (3) Dirichret multinomial likelihood (Hulson 2011). We obtained the conventional ESS used in SS with method (1). From the results of previous study, we found no substantial difference between the effective sample sizes estimated by method (1) and method (3).

<u>Discussion</u>

The WG discussed how to determine the ESS for use with SS. The usefulness of ESS is to measure the uncertainty under an assumed multinomial distribution. The WG noted that there was some difference in understanding regarding ESS. The WG agreed to try the method of MacCall at the same time. The third method is similar to the first method as like ad-hoc method. So the WG agreed to use the effective sample size by using the Dirichret multinomial method as a possible sensitivity analysis.

<u>General Discussion</u>

The previous base case gave more weight to all longline CPUE (lambda of 5). This was to help stabilizing the biomass estimates. Removing the EPO CPUEs might be a better alternative to reduce the instability.

Also in the previous base case, the CV from standardization was used, but CV<0.2 were replaced with CV=0.2. The Student T with df = 30 was used as the likelihood function. Asymptotic selectivity was used for all longline fisheries; however it might be useful to try Taiwan longline as being asymptotic and allow Japan longline selectivity to be slightly dome-shaped.

For the length composition sample size, the previous assessment initially set the EPO commercial sample size to number of wells sampled and made the average sample size of other fleets equal to the average of the EPO, followed by one step reweighting.

There were some different opinions regarding use of lambda. Formally, lambda and ESS values are interchangeable due to mathematical equivalence. It may be best to follow conventional use and avoid manipulating values of lambda (keeping them at unity) and adjust the CVs and effective sample sizes directly. Also it was suggested ti change the CPUE error structure to log normal and to add variance if it is justified.

There are several ways to deal with problematic length composition data. It is important to account for the catch, but not allow the problematic data to be influential. If the fishery is small we may be able to drop the composition data and "mirror" selectivity. If the fishery is large, the size composition data are good, but selectivity is variable, we may be able to use the VPA approach.

Regarding treatment of the EPO length compositions, the WG noted that the migration rate of PBF from the WPO to the EPO is variable, which would result in a time-variable proportion of age-classes in the EPO relative to the stock as whole. Therefore, the WG recommended that the upcoming assessment use time-varying length selectivity for the EPO fisheries, which would account for the variable proportion of age-classes through time. An alternative option suggested by the WG was to use cohort-slicing to estimate catch-at-age for the EPO fisheries and subsequently, input the catches at different ages as separate fisheries in a similar manner as the SS3-VPA hybrid approach (ISC/11-1/PBFWG/01).

The WG agreed to treat the EPO recreational fishery the same as in the previous assessment. The WG can include the EPO CPUE indices in the model, but uses a lambda of zero and look at the fit. Effective sample size will be dependent on the model structure used.

The WG noted that bootstrap is better for calculating the sampling error for the proportions. But in raising compositions to total catch, the length composition error probably does not follow the multinomial distribution. However, SS only uses the multinomial. The ESS includes both sampling and process error. Iterative reweighting should use the regression method, perhaps using some form of asymptotic curve such as the Beverton-Holt "shape". The proportional ESS function used inside SS may not have the proper regression shape.

The WG considered that perhaps initial runs during model development should limit the maximum sample size (e.g. 200) in any composition data set to ensure no data set has too much influence prior to model tuning.

The WG recommended that the seasonal weight-length key will be calculated by the end of March, 2012. A system for weight bins will be developed for possible application to the northern Japan samples that are based on weight. It should be possible to optimize the number and size/pattern of weight bins. There is potential local variability in weight–length relationships, but the nature and severity of the problem need to be investigated.

6.2.5 Summaries

Fleet definitions and summary of model structures to be used at the next assessment session is listed in the Appendix 4.

7.0 SENSITIVITY ANALYSIS

7.1 Review of sensitivity analysis scenarios used in 2010 update

- Reconsideration on the parameters to be used in the analysis of mark-recapture experiments in Tosa Bay, Kochi. S. Iwata, K. Fujioka, H. Fukuda & Y. Takeuchi

See Section 4

- Reconsideration of natural mortality of age-0 Pacific bluefin tuna and its variability relative to fish size. (Paper #13: S. Iwata, K. Fujioka, H. Fukuda & Y. Takeuchi)

See Sect 4.

7.2 Tentative sensitivity analysis scenarios

For size compositions of Japanese Longline (JLL), the WG decided to postpone the decision on the maximum age in the model until the decision about growth is made. The WG can use the old model to test the sensitivity of changing from Age 20 to 25. WG noted that the JLL CPUE series for 1952-1974 in the base model is to be modified according to the working paper #12 (Fujioka *et al*.) and that the JLL CPUE series previously calculated by Yokawa will be examined in a sensitivity analysis.

The WG noted that the base case CV of length at age is 0.25 at age 1 and 0.08 at age 3. It is interpolated between ages 1 and 3, and is constant above 3. Whether the interpolation is a function of length or a function of age could make a difference, and should be examined. The WG agreed that this can be tested on the old model, and the likelihoods should indicate which interpolation is better. A function of length makes more sense. The WG may need to reconsider A_{max} if the growth curve is estimated inside the model.

Analogously to the use of effective sample sizes, the WG agreed to evaluate the need for additional variance in each CPUE index, using one iteration. In both cases this tuning is needed so that the ability of the model to fit the data is consistent with the precision of the data points.

The WG agreed that in addition to sensitivity analyses, model precision can also be estimated by the delta method (MacCall 2012 submitted to *Fisheries Research*). The delta method estimates additional variance from fixed parameters (e.g., M and sigma-R). The additional variance is estimated by the square of the product of the standard error in the fixed parameter and the partial derivative of an estimated quantity with respect to that parameter. The partial derivatives are estimated numerically by small changes in the parameter value. In the case of PBF, steepness would not be included in the delta method estimate because it is at an upper bound where the derivative is not defined.

Table 1. Lists of sensitivity analyses to be conducted

Categories	Base case	Sensitivity
Biological Parameters (growth)		
CV at age-0 (L1)	fixed, 0.25	0.15
CV at age-0 (L1)	fixed, 0.08	
L at Lmin	fixed, 21.5	
L_inf & k	fixed, Shimose et al. (2008)	Lower K
		Higher K
		Shimose et al. (2009)
Bioloical Parameter		
Mature at age	fixed, 0.2 for age 3, 0.5 for age 4	0.2 for age 4, 0.5 for age 5 and 1 for >6 ages
Biological Parameters (M)		
Natural Mortality	Fixed, 1.6 for 0-age, 0.386 for 1-age, 0.25 for >1 age	Ms>3 years old is 0.27
		Ms>3 years old is 0.2
		Ms>1 years old is 0.29
		Ms>1 years old is 0.31
		Ms>1 years old is 0.23
		Ms>1 years old is 0.21
		Ms>1 years old is 0.19
		Ms of 0-1 year old is 1.80 and 0.46
		Ms of 0-1 year old is 1.30 and 0.30
		2008M
		Adult M=0.15 (Witllock's M)
		likelihood profile
		Seasonal M if annual M is base case, or vice versa
		Michael's M
		Ray's M
		Ms used in 2008 stock assessment
Assumption of Recruitment		
S-R function form	Beverton - Holt	
steepness	0.999	1,0.8,value determined from likelihood profile with hockey-stick,
Sigma R	fixed, 0.6	Fixed, 1
Term for estimating recruitment deviations	1946-2009	Estimated from 1951 to 2009
		Estimated from 1941 to 2009
CPUE		
Weighting factors	1 for all CPUEs	different weight
Survey data of CPUE series		
JLL(1952-1974)	Fujioka 2012	Yokawa 2007
JLL(1994-)	Ichinokawa 2012	
JPN Troll	Nagasaki, combined Kochi and Wakayama	
TWLL	Hsu (-2011)	
EPO Comm	US Target(lamda=0)	US Target(lambda=1)
	Mexican Target(lambda=0)	Mexican Target(lambda=1)
Jpn PS(SOJ)	lambda=0	lambda=1
Additional CV	Estimate additional variance	no extra variance
Equilibrium catch		
Assumption of equilibrium catch	No eqC	Fixed referring Mu to et al. 2008.,Twice of all equilibrium catch
	The fisheries with equilibrium catch are FL 1, FL 3 and FL 4.	Half of all equilbirium catch
		Twice of purseseine fisheries
		Half of purse seine fsheries
		Twice of troll fisheries
Length data	all lambda=1(except for EPO SPO=0)	
Effective sample size multiplier	Reweight once	All effective sample size multiplier is 1
		Reweight according to D-M by Mizuno
lambda	Details are shown in Table 1	Length lambda is re-weighting one time
		Removelength data (Jp-LL)
		Removelength data (Jp-smallPS)
		Removelength data (Jp-tunaPS)
		Removelength data (Jp-troll)
		Removelength data (Jp-PL)
		Removelength data (Jp-SetNet)
		Removelength data (Tw-LL)
		Removelength data (EPO-PS)

8.0 FUTURE PROJECTION SCENARIO AND BRPS

Ichinokawa has developed an R package called 'SSFuture' for forward projections. It can be found at:

http://cse.fra.affrc.go.jp/ichimomo/Tuna/ssfuture.html

- Compare current F (2007-2009 period) with best F scenario during 2002-2004

The WG suggested to plot F against biomass, looking at potential changes in slope (this can be checked at the May meeting). The WG also recommended to use the geometric mean because it is more robust and consistent with previous methods.

- Set catch limit to 2002-2004 for WPO and 1999-2008 for EPO

Expected changes from 2011 conservation and management measures (CMM) of WCPFC (and other RFMO's) should be considered. Current CMM of the Northern Committee/WCPFC states a F target at 2002-2004 levels. The WG recommended that it would explore effects of WCPFC CMM (2010/04) on projections, using CMM from ISC northern committee. It was suggested to do impact analysis on how much less F is required to maintain longline effort at historical levels. This is the kind of question likely to come from managers and the SC of the WCPFC. The WG also suggested to explore current scenarios under high-risk situations. The Northern Committee might like to see a risk-scenario table. The WG considered that a Kobe matrix is a common scenario output, and recommended to produce a table, regardless to the consideration of NC/WCPFC. However, no more than 5 or 6 scenarios should be presented, as more than that might be ignored by managers. Below is an example of the information that could be included in the risk-scenario table.

	ExpectedC				Benchmark	Risk	
	2013	2014	2015	2025	$SSB(_{year=y})/SSB_{current}$	$Prob(SSB_{year}=z<SSB_{min})$	$Prob(SSB_{year}=z<SS_{Bath})$
10%*xF	13,000	12,000	10,000	5,000	0.7	4%	2%
100%*xF	12,000	11,000	9,000	6,000	0.8	3%	1%
90%*xF	10,000	9,000	8,000	8,000	1	2%	0%
80%*xF	8,000	7,500	7,000	10,000	1.3	1%	0%

The above table could be constructed using base-case or from weighted averages of sensitivity analyses. The WG noted that the last stock assessment concluded that natural mortality was a major source of uncertainty. It was also pointed out that this table structure is a non-traditional output from other assessment groups like IATTC.

WG considered that Future projections could start from 2010. The same procedure for creating confidence intervals as the last assessment should be used (minimum 300 bootstraps x 20 simulations).

For the SSR, 1) Resampling from estimated recruits; 2) high-risk scenarios with lower steepness should be considered (2 x likelihood); 3) the discussed hockey-stick analysis can be a helpful diagnostic, and it was agreed to implement this in the SSFuture package.

Biological reference points for consideration by the WG can include F_{msy} (no estimate, with a suggestion of keeping all fleet F's the same), F_{max}, $_{F0.1}$, F_{med}, F_{-loss}, Adjusted F_{loss} (no estimate), F_{ssb} (min-5%, ATHL-5%, 25lower-5%, min-50%,ATHL-50%,25% lower-0.5).

The WG recommended lastly, an impact analysis for the WPO vs. EPO fisheries on stock biomass be conducted.

9.0 RECOMMENDATIONS

9.1 Seasonal natural mortality for Age-0

Based on tagging studies, previous assessments have assumed an annual natural mortality (M) of 1.6 for age-0 PBF. However, the WG recognized that M likely changes with size and age-0 PBF are growing very rapidly. The WG therefore recommended using seasonal M in the upcoming assessment. The current SS3 version is able to use a linear interpolation of annual M to approximate seasonal M. The WG recommended that the tagging data described in ISC/12-1/PBFWG/13 and ISC/12-1/PBFWG/14 be used to estimate seasonal M. One option is to estimate age-0 M at quarter 1 and/or 2 and linearly interpolate to M at age-1. Another option is to assume a linear seasonal change in M and estimate the slope of the change. The WG requests this be completed by 1 March 2012.

9.2 EPO length compositions

The WG noted that the migration rate of PBF from the WPO to the EPO is variable, which would result in a time-variable proportion of age-classes in the EPO relative to the stock as whole. Therefore, the WG recommended that the upcoming assessment use time-varying length selectivity for the EPO fisheries, which would account for the variable proportion of age-classes through time. Another option suggested by the WG was to use cohort-slicing to estimate catch-at-age for the EPO fisheries and subsequently, input the catches at different ages as separate fisheries in a similar manner as the SS3-VPA hybrid approach (ISC/11-1/PBFWG/01).

The WG recommended conducting exploratory analysis to decide if growth should be estimated internally or externally by May 2012 stock assessment. Details of work is given in Appendix 4.

9.3 Future work for growth modeling

An exploratory analysis should be conducted before the May meeting in order to decide if PBF growth should be fixed to externally derived estimates (Shimose's work) or estimated internally in Stock Synthesis;

Task 1: A reference Stock Synthesis model run will be build which incorporates the most recent age-at-length otolith reading data from Shimose. This model will be the starting point to develop a series of model (sensitivity) runs.

Task 2: Do series of model runs in which growth is estimated internally.

- Use the more flexible Richard's model;
- Do run in which age 0 and maybe 1 otolith data are excluded from the growth fit. This will help the growth curve to inflect during the latter part of the curve rather than at juvenile ages (linear juvenile growth followed by minimal growth rates in older ages is desired);
- Variability of the size at age should be estimated internally;
- Do run in which Shimose's externally derived mean lengths are used as priors using a penalized likelihood approach.
- It will be necessary to decide on an effective sample size scheme before doing the growth estimation internally. Maybe apply threshold for all data sources (N=200?).

10.0 WORK PLAN FOR 2012 STOCK ASSESSMENT

The WG agreed with the following schedule to conduct the full stock assessments of PBF.

- Small Group for modeling May 23-29 @ NRIFSF, Shizuoka, Japan

To construct and set up the base case scheme

- Stock assessment WORKSHOP May 30 – June 6 @ NRIFSF, Shizuoka, Japan

Discuss and produce draft statement on stock status on PBF and draft conservation advice

- Deadline March 1 for submission of all the data

Required data are： Catch by quarters； size compositions； by quarter and fisheries. It was emphasized by the WG to:

- Make clear if the data are in calendar year or fishing year.
- Length class should be expressed by the lower limits of each class.
- Size compositions should be weighted where necessary, and
- Sample size, substitution procedures should be clearly described.

Mr. Iwata will be responsible for compiling and preparing all the data foe input and hence all the data must be forwarded to him.

Deadline of March 15-20 to distribute final version of assessment input data to members July 16-17 ISC meetings Sapporo. PBFWG should have a meeting in prior to the Plenary.

The WG proposed an update of the assessment occurs in 2014, but this is to be decided at 2012 ISC Plenary.

11.0 OTHER MATTERS

No other matters were discussed.

12.0 CLEARING OF THE REPORT

The draft report was presented and approved. It was agreed that the report would be finalized through correspondence by the end of February, 2012.

13.0 ADJOURNMENT

The meeting of the Workshop was adjourned on February 7, 2012.

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Appendix 1. Agenda

(Rapporteurs for each chapter are given in parenthesis)

1.0 Opening and Introduction (Takeuchi, Miyake)
- 1.1. Welcome and introduction
- 1.2. Adoption of agenda
- 1.3. Appointment of rapporteurs
- 1.4. Distribution, numbering and determination of paper availability of working papers

2.0 Summary and review of 2010 update and Jan 2011 WORKSHOP, with emphasis to fisheries definition (Takleuchi, Miyake)

3.0 Fishery data for input of the stock assessment model
- 3.1. Western Pacific Fisheries (Oshima, Fujioka, Kai, Hsu)
- 3.2. Eastern Pacific Fisheries (Aires-Da-Silva, Teo)

4.0 Biological parameters and data for the stock assessment (Shimose, Fukuda, Kohin)

5.0 Alternative modeling approach (e.g. new selectivity function, Hybrid-SS, Hockey-stick SRR etc) (Kanaiwa)

6.0 Base case model configuration (Maunder, Iwata)
- 6.1. Review of base case model configuration at 2010 update and discussion in Jan. 2011 WS
- 6.2. Tentative base case model configuration

7.0 Sensitivity analysis (Maunder, Iwata)
- 7.1. Review of sensitivity analysis scenarios used in 2010 update
- 7.2. Tentative sensitivity analysis scenarios

8.0 Future projection scenario and BRPs (Kai, Sippel)
- 8.1. Review of future projection scenarios and BRPs at 2010 update
- 8.2. Tentative future projection scenarios and BRPs

9.0 Recommendations (Takeuchi, Miyake)

10.0 Work plan for 2012 stock assessment (Takeuchi, Miyake)

11.0 Other matters (Takeuchi, Miyake)

12.0 Clearing of the report

13.0 Adjournment

Appendix 1 Agenda
Appendix 2 List of Participants
Appendix 3 List of
Appendix 4 Fleet definition for 2012 Stock Assessment

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Appendix 3. List of Documents

Working papers

No	Title	Author
ISC/12-1/PBFWG/01	Estimation of catch at size of Pacific bluefin tuna caught by Japanese longline fishery	Akiko Mizuno, Momoko Ichinokawa, Kazuhiro Oshima and Yukio Takeuchi
ISC/12-1/PBFWG/02	Reconsideration of estimation of catch at size for young Pacific bluefin tuna caught by Japanese small pelagic fish purse seine fisheries	Kazuhiro Oshima, Mikihiko Kai, Shigehide Iwata and Yukio Takeuchi
ISC/12-1/PBFWG/03	Estimation of catch at size of Pacific bluefin tuna ,*Thunnus orientalis*, caught by Japanese tuna purse seine.sperated in Pacific Ocean	Masayuki Abe, Minoru Kanaiwa, Kazuhiro Oshima and Yukio Takeuchi
ISC/12-1/PBFWG/04	Estimation of catch at size of young Pacific bluefin tuna caught by Japanese troll fisheries	Hiromu Fukuda and Kazuhiro Oshima
ISC/12-1/PBFWG/05	Update and re-examination of estimation of the catch at size of Pacific bluefin tuna *Thunnus orientalis* caught by Japanese setnet fishery	Mikihiko Kai and Yukio Takeuchi
ISC/12-1/PBFWG/06	Preliminary analysis of length frequency for Pacific bluefin tuna, *Thunnus orientalis*,landed by Other fishery (Fleet 10).	Masayuki Abe, Izumi Yamazaki and Minoru Kanaiwa
ISC/12-1/PBFWG/07	Update of estimated catch at size by Purse Seiner in Japanese sea	Minoru Kanaiwa, Isana Tsuruoka, Ayumi Shibano, Tsuyoshi Shimura, Ryosuke Uji, Yukio Ishihara, Yukio Takeuchi
ISC/12-1/PBFWG/08	Standardized CPUE of North Pacific bluefin tuna caught by Japanese coastal longliners: updates until 2011	Momoko Ichinokawa and Yukio Takeuchi
ISC/12-1/PBFWG/09	CPUE analysis for Japanese Purse seine in Sea of Japan	Minoru Kanaiwa, Tsuyoshi Shimura, Ryousuke Uji, Yukio Ishihara and Yukio Takeuchi
ISC/12-1/PBFWG/10	Re-estimation of standardized CPUE of Pacific bluefin tuna caught by Japanese offshore longline fisheries operated during 1952-1974.	Ko Fujioka, Momoko Ichinokawa, Kazuhiro Oshima, Yukio Takeuchi
ISC/12-1/PBFWG/11	Abundance indices of young Pacific bluefin tuna, derived from catch-and-effort data of troll fisheries in various regions of Japan	Momoko Ichinokawa, Kazuhiro Oshima and Yukio Takeuchi
ISC/12-1/PBFWG/12*	Updated sex specific growth parameters for Pacific bluefin tuna *Thunnus orientalis*	Tamaki Shimose and Yukio Takeuchi
ISC/12-1/PBFWG/13*	Reconsideration of natural mortality of age -0 Pacific bluefin tuna and its variability relative to fish size	Shigehide Iwata, Ko Fujioka, Hiromu Fukuda and Yukio Takeuchi
ISC/12-1/PBFWG/14*	Reconsideration on the parameters to be used in the analysis of mark-recapture experiment in Tosa Bay, Kochi.	Shigehide Iwata, Ko Fujioka, Hiromu Fukuda and Yukio Takeuchi
ISC/12-1/PBFWG/15	Estimation of steepness of PBFT -By using biological features	Shigehide Iwata, Hiromu Fukuda, Osamu Abe and Yukio Takeuchi

▪ ISC/12-1/PBFWG/16	▪ Exploratory application of SS incorporating conditional age at length data from otolith aging	▪ Yukio Takeuchi and Tamaki Shimose
▪ ISC/12-1/PBFWG/17	▪ Review of the setting of SS3 in previous PBFT stock assessment meetings	▪ Shigehide Iwata and Yukio Takeuchi
▪ ISC/12-1/PBFWG/18*	▪ Updated standardized catch rates for Pacific bluefin tuna caught by United States and Mexican-flag purse seine fisheries in the eastern Pacific Ocean (1960-2011)	▪ Alexandre Aires-da-Silva and Steve Teo
▪ ISC/12-1/PBFWG/19	▪ Recent update of Pacific bluefin tuna catch in Korean waters	▪ Joon Taek Yoo, Zang Geun Kim, Sung-Il Lee, In Ja Yeon, Sang Chul Yoon and Dong Woo Lee

*WP#12, 13, 14 and 18 will be title and contact address only, remaining working papers will be available from ISC web site

Oral presentations

▪ #1	▪ Historical review of the bluefin fishery in the eastern Pacific Ocean.	▪ Guillermo Compean-Jimenez
▪ #2	▪ A description of PBF field sampling from commercial and recreational fisheries in EPO	▪ Ed Everett
▪ #3	▪ Brief overview of methods for estimation of Pacific bluefin (PBF) total catch and length composition for recreational and commercial surface fisheries in the EPO	▪ Cleridy Lennert-Cody
▪ #4	▪ Estimation of effective sample size for catch-at-length data of Pacific bluefin tuna	▪ Akiko Mizuno, Kazuhiro Oshima and Yukio Takeuchi
▪ #5	▪ Overview of natural mortality for Pacific Bluefin Tuna - age 2+ group-	▪ Hiromu Fukuda and Shigehide Iwata
▪ #6	▪ Current situation of Taiwanese longline PBF CPUE data	▪ Chien-Chung Hsu
▪ #7	▪ Update of Japanese quarterly catch for Pacific Bluefin tuna	▪ Kazuhiro Oshima
▪ #8	▪ Time series from US commercial and recreational fisheries for the PBF stock assessment	▪ S. Teo
▪ #9	▪ Modeling growth while fitting simultaneously to direct aging and tag-recapture data.	▪ Alex da Silva Pl, Maunder, K. Schaefer, Fuller
▪ #10	▪ A hybrid SS3-VPA model for examining trends in young fish selectivity and recruitment	▪ A. MacCall and S. Teo
▪ #11	▪ How to calculate sample size for reconstructed data	▪ A. Mc Call

Appendix 4. Fleet definition for 2012 Stock Assessment

Table Appendix 4-1 Fleet definition defined in this workshop

Serial number	Fleet	Short Name	Correspondin	Descriptions (selectivity patterns, data sources etc.)	Renumbered	Short Name	Corresponding	Descriptions (selectivity patterns, data sources etc.)	Weighting factor	Variance adjustme
1	FL1	JLL		Flat top selectivity	F1	JLL		Flat top selectivity	1	3.27
2	FL2	SPSS		Double normal Selectivity	F2	SPSS		Dome shape Selectivity	1	2.1
3	FL3	TPS		Double normal selectivity, share length data with FL4	F3	TPS		Sea of Japan after 1982(L), Dome shape selectivity	1	1.83
4	-	-	-	-	F4	TPS		Pacific ocean "after 1993(L)", "before 1994(W)" Dome shape selectivity	1	1.83
5	FL4	TR		Double normal selectivity, share length data with FL4	F5	TR		Dome shape selectivity	1	3.58
6	FL5	PL		Double normal selectivity	F6	PL		Dome shape selectivity, share length data with FL6	1	1.08
7	FL6	SN		Flat top selectivity	F7	SN		(W)Northern part of Japan, Dome shape selectivity	1	1.74
8					F8	SN		(L)Western part of Japan (Q3&Q4), Dome shape selectivity	1	1.74
9					F9	SN		(L)Other areas, Dome shape selectivity	1	1.74
10	FL7	TWLL		Double normal selectivity	F10	TWLL		Dome shape selectivity	1	6.46
11	FL8	EPOCOM		Doublr normal selectivity	F11	EPOCOM		Dome shape selectivity	1	1
12	FL9	EPOSP		Mirror selectivity in FL9	F12	EPOSP		Mirror selectivity in FL9	0	1
13	FL10	OTH		Lenear segment	F13	OTH		(W)	0.01	2.11
14	S1	JpCLL	JLL	Japanese coastal long line conducting spawning area and season (April to June) (WP 18 in PBF07-2)	S1	JpCLL	JLL	Japanese coastal long line conducting spawning area and season (April to June) (WP 18 in PBF07-2)	5	1
15	S2	JpnDWLLOshima60to80	JLL	CPUEs with set by set data in Japanese offshore longlines from 1960's to 1980's (WP 16 in PBF07-2)	-	-	-	-	-	-
16	S3	JpnDWLLOshima80to00	JLL	CPUEs with set by set data in Japanese offshore longlines from 1980's to 2000's (WP 17 in PBF07-2)	-	-	-	-	-	-
17	S4	JpnDWLLYokawaRevto74	JLL	CPUEs with aggregated data in Japanese offshore and distant water longliners using all quarters and area until 1974 (Yokawa WP "25+26", revisited)	S2	JpnDWLLFujiokaRevto74	JLL	CPUEs with aggregated data in Japanese offshore and distant water longliners using all quarters until 1974	5	1
18	S5	JppDWLLYokawaRevfrom75	JLL	CPUEs with aggregated data in Japanese offshore and distant water longliners using all quarters and area until 1975 (Yokawa WP "25+26", revisited)	S3	JppDWLLYokawaRevfrom75	JLL	CPUEs with aggregated data in Japanese offshore and distant water longliners using all quarters and area until 1975 (Yokawa WP "25+26", revisited)	5	1
19	S6	JppDWLLYokawaOrgto74	JLL	CPUEs with aggregated data in Japanese offshore and distant water longliners using 1 st, 3rd and 4th quarters until 1974 (Yokawa WP "25+26", original)	-	-	-	-	-	-
20	S7	JppDWLLYokawaOrgfrom75	JLL	CPUEs with aggregated data in Japanese offshore and distant water longliners using 1 st, 3rd and 4th quarters from 1974 (Yokawa WP "25+26", original)	-	-	-	-	-	-
21	S8	JppDWLLYokawaWP27to74	JLL	CPUEs with aggregated data in Japanese offshore and distant water longliners using 3rd and 4th quarters and selected regions until 1974 (WP 26 in PBF07-2)	-	-	-	-	-	-
22	S9	JppDWLLYokawaWP27from75	JLL	CPUEs with aggregated data in Japanese offshore and distant water longliners using 3rd and 4th quarters and selected regions from 1974 (WP 26 in PBF07-2)	-	-	-	-	-	-
23	-	-	-	-	S4		TPS	Sea of Japan after 1982(L), Dome shape selectivity, share length data with FL4		
24	S10	JpnTrollChinaSea	TR	CPUEs of Japanese troll fisheries in Nagasaki prefecture (Sea of Japan and east china sea) from 1980 to 2007	S5	JpnTrollChinaSea	TR	CPUEs of Japanese troll fisheries in Nagasaki prefecture (Sea of Japan and east china sea) from 1980 to 2010	1	1
25	S11	JpnTrollPacific	TR	CPUEs of Japanese troll fisheries in Kochi prefecture (Pacific side) from 1980 to 2005	S6	JpnTrollPacific	TR	CPUEs of Japanese troll fisheries combine with Kochi and Wakayama prefecture (Pacific side) from 1980 to 2010	0	1
26	-	-	-	-	S7			CPUEs of Japanese troll fisherieswith Kochi prefecture (Pacific side) from 1980 to 2010		
27	-	-	-	-	S8			CPUEs of Japanese troll fisheries with Wakayama prefecture (Pacific side) from 1980 to 2010		
28	S12	JpnTrollAverage	TR	Simple average of S10 and S12 from 1980 to 2005	-	-	-	-	-	-
29	S13	TWLL	TWLL	CPUEs of Taiwanese longline from 1998 to 2007	S9	TWLL	TWLL	CPUEs of Taiwanese longline from 1998 to 2007	5	1
30	S14	USPSto82	EPOCOM	CPUEs in US purse seine until 1982	S10	USPSto82	EPOCOM	CPUEs in US target purse seine until 1982	1	1
31	S15	MexPSto98	EPOCOM	CPUEs in Mexico purse seine from 1963 to 1998		-	-	-		
32	S16	MexPSto06	EPOCOM	CPUEs in Mexico purse seine from 1999 to 2006	S11	MexPSto06	EPOCOM	CPUEs in Mexico purse seine from 1999 to 2006	0	1
33	S17	Ussports	EPOSO	CPUEs in US sports from 1995 to 2005	-	-	-	-	-	-

Table Appendix 4-2 Tentatively agreed base case model configuration

Categories	Base case	Sensitivity	
Biological Parameters (growth)			
CV at age-0 (L1)	fixed, 0.25	0.15	
CV at age-0 (L1)	fixed, 0.08		
L at Lmin	fixed, 21.5		
L_inf & k	fixed, Shimose et al. (2008)	Lower K	
		Higher K	
		Shimose et al. (2009)	
Bioloical Parameter			
Mature at age	fixed, 0.2 for age 3, 0.5 for age 4	0.2 for age 4, 0.5 for age 5 and 1 for >6 ages	
Biological Parameters (M)			
Natural Mortality	Fixed, 1.6 for 0-age, 0.386 for 1-age, 0.25 for >1 age	Ms>3 years old is 0.27	
		Ms>3 years old is 0.2	
		Ms>1 years old is 0.29	
		Ms>1 years old is 0.31	
		Ms>1 years old is 0.23	
		Ms>1 years old is 0.21	
		Ms>1 years old is 0.19	
		Ms of 0-1 year old is 1.80 and 0.46	
		Ms of 0-1 year old is 1.30 and 0.30	
		2008M	
		Adult M=0.15 (Witllock's M)	
		likelihood profile	
		Seasonal M if annual M is base case, or vice versa	
		Michael's M	
		Ray's M	not converged
		Ms used in 2008 stock assessment	
Assumption of Recruitment			
S-R function form	Beverton - Holt		
steepness	0.999	1,0.8,value determined from likelihood profile with hockey-stick,	no possitive define
Sigma R	fixed, 0.6	Fixed, 1	
Term for estimating	1946-2009	Estimated from 1951 to 2009	
recruitment deviations		Estimated from 1941 to 2009	
CPUE			
Weighting factors	1 for all CPUEs	different weight	
Survey data of CPUE series			
JLL(1952-1974)	Fujioka 2012	Yokawa 2007	
JLL(1994-)	Ichinokawa 2012		
JPN Troll	Nagasaki, combined Kochi and Wakayama		
TWLL	Hsu (-2011)		
EPO Comm	US Target(lamda=0)	US Target(lambda=1)	
	Mexican Target(lambda=0)	Mexican Target(lambda=1)	
Jpn PS(SOJ)	lambda=0	lambda=1	
Additional CV	Estimate additional variance	no extra variance	

Table Appendix 4-2 Continued

Categories	Base case	Sensitivity	
Equilibrium catch			
Assumption of equilibrium catch	No eqC	Fixed referring Mu to et al. 2008.,Twice of all equilibrium catch	
	The fisheries with equilibrium catch are FL 1, FL 3 and FL 4.	Half of all equilbirium catch	
		Twice of purseseine fisheries	
		Half of purse seine fsheries	
		Twice of troll fisheries	
Length data	all lambda=1(except for EPO SPO=0)		
Effective sample size multiplier	Reweight once	All effective sample size multiplier is 1	
		Reweight according to D-M by Mizuno	
lambda	Details are shown in Table 1	Length lambda is re-weighting one time	
		Removelength data (Jp-LL)	
		Removelength data (Jp-smallPS)	
		Removelength data (Jp-tunaPS)	
		Removelength data (Jp-troll)	
		Removelength data (Jp-PL)	
		Removelength data (Jp-SetNet)	
		Removelength data (Tw-LL)	
		Removelength data (EPO-PS)	