Annex 8

REPORT OF PACIFIC BLUEFIN TUNA WORKING GROUP WORKSHOP

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

30 May – 6 June 2012
Shizuoka, Japan

Executive Summary

The PBF Working Group (WG) met to conduct an assessment of the stock status of Pacific bluefin tuna (*Thunnus orientalis* - PBF) using fishery-associated data through 1st half of 2011. This assessment was conducted using length-based, age structured population dynamics models developed within the Stock Synthesis software (version 3.23b), based on the assumption that there is a single stock of PBF in the entire Pacific Ocean. The model used quarterly catch-at-length data: 13 fisheries defined by gear, location and season; and six abundance indices.
The WG recognized the substantial uncertainty in input data, including fishery data and biological parameters. After considering a wide range of model configurations, including input data as well as model parameterizations, the WG could not reach consensus on a base model describing the stock status of the species. Under these circumstances the WG cannot offer a clear view on its stock status or conduct future projections.

Although there is no new quantitative description of stock status, the exercise to develop a base case model and the fishery-associated data (e.g. longlines and troll CPUE indices) suggested that: the SSB may have continued declining since the last stock assessment (2010), as was projected at that occasion; whilst current recruitments may have fluctuated yearly without any specific trends. Therefore, until a new stock assessment result becomes available, the WG decided to carry over the previous advice on stock status on PBF, albeit with the precautionary note that the uncertainty in the stock status has increased through the passage of time. The advice on stock status is as follows.

"Given the conclusions of the July 2010 PBFWG workshop (ISC/10/ANNEX/07), the current (2004 -2006) level of F relative to potential biological reference points, and the increasing trend of F, it is important that the level of F is decreased below the 2002-2004 levels, particularly on juvenile age classes."

However, given that SSB may have continued to decline since the last stock assessment, the WG noted it is even more important that the above conservation advice be followed even though uncertainty in the stock status has increased.

Noting that the PBF stock assessment had not been completed at this session, the WG proposed that it hold another session in November 9-16, 2012 in Honolulu, USA and submit the final report to the ISC plenary by mid December 2012 for its adoption.

Research recommendations are given in Section 10 of the report and are summarized below:

1. To evaluate size composition of the catch by the purse seine fishery in the Sea of Japan and determine if “time block” to the modeling of selectivity function to this fleet be applied;
2. To collect and review information to characterize effectively Japanese purse seine fishery operating in Pacific ocean;
3. To review current size- and age- ranges of fish caught by the EPO commercial fishery and to improve size sampling from the fish kept in the farming pens;
4. WG holds a Workshop focusing on “cubic spline selectivity function” feature in Stock Synthesis software;
5. Korea submits the size composition data of catches from their offshore large purse seiner fishery to the WG. WG would consider a separation of the Korean offshore large purse seine fleet from the Japanese purse seine fleet in the stock assessment fleet definitions.
6. Korea will present the management measures enacted in 2011 as well as proposed harvest scenarios desired for evaluation in the future projections.
7. To investigate a more reliable growth curve by the next stock assessment is planned (not including the new one proposed in the nearest future to complete the work of this session).
8. To investigate the other age characters such as annual rings of vertebrae, scales, daily rings of otolith, and to consider validation of current ageing results by using multi-method. The Plenary Meeting would seek an opportunity to hold a special Workshop for age determination of tunas in the North Pacific.
9. To collect PBF otolith samples from different PBF fisheries/regions and to communicate and share the otolith samples among the ISC members.
10. To plan a joint survey to identify spawning grounds in the areas not known at present (e.g. Korean waters and Chinese Taipei waters etc.).

1.0 OPENING AND INTRODUCTION

1.1 Welcome and introduction

The meeting was opened by its Chair, Y. Takeuchi.

Dr. H. Nakano, the director of the Temperate Tuna Research Division of National Research Institute of Far Seas Fisheries welcomed all the participants. He stressed the importance of the bluefin tuna fishery for Japan and showed his keen interest in the results of the WG. He considered that scientific work would be most important for the development of well managed tuna fisheries.

The participants introduced themselves. The list of the participants is attached as Appendix 2.

1.2 Adoption of agenda

The tentative Agenda previously circulated was adopted with some modifications and is attached as Appendix 1.

1.3 Appointment of rapporteurs

Appointed rapporteurs are given for each agenda item in Appendix 1.

1.4 Distribution, numbering and acceptance of working papers presented to the Working Group

All the papers, presented and reviewed are listed in Appendix 3.

2.0 REVIEW OF RECENT FISHERIES AND ANNUAL PBF CATCH

2.1 Japanese Pacific bluefin tuna catch updates (ISC/12-2/PBFWG/01, K. Oshima, M. Abe, and S. Uematsu)

Japanese catches of Pacific bluefin tuna (PBF) were updated up to and including 2010 and presented in this paper. Total annual catch of PBF increased from 8.561 mt in 2010 to 13,342 mt in 2011. The annual nominal catches of tuna purse seine, small pelagic fish purse seine, troll and set net fisheries showed increases. That of the coastal longline fisheries have declined possibly reflecting a lower abundance of spawning stock. On the other hand, increase in the catch of the small pelagic fish purse seine fishery might indicate high abundance of recruitments of the 2010 year class

Discussion

A question was asked about the fishery in Tohoku Region, particularly how the 2011 disaster affected fishing effort. It was responded that there have been very little changes in total fishing effort due to the disaster, except for set net fisheries. It was further clarified that the decline of longline catch in 2011 was not due to the effects of the disaster but may be the result of a decline in catch of large fish. It was noted that the purse seine fishery in the Eastern China Sea, which catches age 1 fish, doubled its catch in 2010 (relative to 2009) which may indicate that recruitment had not declined. .

2.2 Activities and data collection of Pacific Bluefin tuna by Taiwanese fishery (ISC/12-2/PBFWG/13, Overseas Fisheries Development Council)

Up to early 1990s, there were BFT fisheries by purse seine and other gears, together with longline. Thereafter however, all PBF catches in Taiwan have been taken only by the longline fishery. In 2000, it attained the highest level of about 3,000 mt. Thereafter, it showed a rapid decline until recent years, to less than 1,000 mt. Area of catch is east of Taiwan. In 2002, almost 1,500 mt of PBF were exported but the quantity of export has declined very rapidly in recent years. Size sampling and otolith collections started in 2010 as a part of government research.

Discussion

It was enquired if there is any change in fishing area which related with the recent decrease in the catch. It was clarified that there have been no change in area. It was also clarified that the fishing effort data have mostly come from interviews of the vessel captains.

2.3 US fishery

It was reported that preliminary estimates of U.S.A. catches of PBF in 2011 were 99 mt for the purse seine fishery, 456 mt for the recreational fishery, and 18 mt for other fisheries.

2.4 Mexico

It was reported that the Mexican purse seine catch of PBF in 2011 was 2730 mt, all all in the Mexican EEZ

2.5 Korea

It was reported that the Korean catch of PBF by Korean offshore large purse seiners in 2011 was 670 mt. Korea also reported that there were modifications in quarterly and total catches reported for previous years. Korea also clarified that the catches were reported in round weight.

2.6 Revisions of input data for stock assessment on Pacific bluefin tuna (ISC/12-2/PBFWG/18, K. Oshima)

After the data for assessments had been updated and distributed among the WG members, some errors were found in the data and were revised. Those revisions were in the quarterly catch data of Fleet 2 and in size data for Fleet 11.Those errors in Fleet 2 involved that Korean purse seine catches of small bluefin tuna were double counted in the 3rd quarter (Jan.-Mar.) of 2001 to the 4th quarter (Apr.-Jun.) of 2007 and the 3rd and 4th quarters of 2010. Also past Korean catches reported for the period between the 3rd quarter of 1999 and the 2nd quarter (Oct.-Dec.) of 2004 had errors and were corrected. The length frequency data for Fleet 11 during the period between the 4th quarter of 1999 and the 4th quarter of 2010 were revised after the IATTC staff reported a bug in the algorithm used to produce the data previously submitted and hence the WG approved all these changes.

Discussion

Participants from Korean suggested to separate Korean purse seine fleet from currently defined fleet 2 because, in particular, the new minimum size limit (20 kg) of PBF catch applied to Korean purse seine from 2011. The WG will consider the separation of Korean purse seine from current fleet 2 for future stock assessment (see recommendation 5). A correction made on the size composition data for fleet 11 (E. Pacific commercial) was approved.

2.7 Strength of 2010 year class observed in catch information (ISC/12-2/PBFWG/04, by K. Oshima and Y. Takeuchi)

Estimates of PBF recruitment strength in the most recent years provide with a projection for future population size. To enhance precision of the PBF recruitment strength estimate for 2010, the authors explored catch-related information (i.e. CPUE and catch during the last two decades) from three fisheries: Japanese troll, Japanese small pelagic fish purse seine, and EPO commercial fishery. The three fisheries target different age classes of PBF: Japanese troll targets ages 0 and 1 fish; small seine targets mainly age 1 fish; and EPO commercial fishery targets age 2 fish. The catch trends from the three fisheries together postulated three strong year classes: 1994, 2004, and 2007.

For the 2010 year class, while Japanese troll catch in 2010 was low, the purse seine catch in 2011 was relatively high (i.e., 2011 catch in weight was the second highest during 2000-2011). Thus, the 2010 year class strength may be above the average.

Discussion

The authors used the SS3 model-generated recruitment time series to verify the 2010 recruitment strength. The WG recommended also using observational data for validation. For example, there are juvenile survey data (referring to Abe’s Oral Presentation #2). In addition, the authors referred to the ongoing juvenile survey plans for 2008-2011.

WG also noted spatial differences in recruitment patterns. For example, the model-generated recruitment patterns appeared to fit better to the troll abundance index data from the East China Sea but not to the troll data from the Pacific side. The East China Sea CPUE was also higher than that of the Pacific, indicating higher recruitment in the East China Sea. Presumably, different oceanic conditions resulted in different recruitment strengths between these areas. The WG suggested conducting juvenile surveys in the East China Sea. The authors responded that there are future plans for surveys in the East China Sea.

3.0 REVIEW OF BIOLOGICAL STUDIES

3.1 A manual for age determination of Pacific bluefin tuna *Thunnus orientalis* (Oral presentation #1. T.Shimose,)

The Seikai National Fisheries Research Institute and National Research Institute of Far Seas Fisheries are preparing a manual for age determination of PBF. The draft of "A manual for age determination of Pacific bluefin tuna" (by T. Shimose) was distributed as an information paper. This manual aims at increasing objectiveness in age determination of PBF, as requested by the PBF and other WGs. The contents in each section of the manuscript were explained.

Discussion

WG agreed that age determinations provide valuable information for quantifying individual growths. As the growth curve is an important component in the stock synthesis model, age determination procedures should be consistent. The author explained that the past work on ageing PBF was conducted by only one researcher. This might have resulted in bias in age-reading. Furthermore, the author indicated that the key to ageing PBF lies in precision in identifying and validating formation of otolith opaque zones.

The WG, recognizing the difficulty in age determination of PBF, suggested the followings:

- The use of daily rings may help validation of annuli. However, presence of sub-daily rings could make ageing difficult.
- The use of different hard structures (e.g., vertebrae, fin spines, scales etc.) and use of different methods (e.g., radio isotopes) to validate the annuli.

As similar difficulties in age determination may occur with other species of tuna, the WG considered that it may be beneficial to suggest the ISC Plenary to organize an ageing Workshop, to provide an opportunity to communicate on the age determination procedures among researchers for different tuna species. It was hoped that someone in the WG participants may wish to develop such a proposal.

3.2 Pacific bluefin tuna larval/Juvenile surveys (Oral presentation #2, M. Abe)

The past and ongoing surveys conducted by the Fisheries Research Agency of Japan (FRA) demonstrated two major spawning grounds for the PBF near Japan: 1) near the Nansei Islands during May-June; 2) in the Sea of Japan (SOJ) during July-August. As the past surveys gave a higher priority to the spawning ground near the Nansei Islands, information for the SOJ is relatively scarce. As the purse seiners target spawning fish of PBF in the SOJ, it is important to investigate spatial and temporal variations in the spawning ground in the SOJ, based on the fishery-associated data of the purse seine. Furthermore, juvenile surveys in this area may help understanding migratory patterns and size structures of fish, which are important in estimating recruitment strength.

Based on data from the Marine Ranching Project (1979-1988) and on results of the current spawning ground survey (2011), it was found that the larval patch near the Nansei spawning ground moved northeastward during May-June. Recently, the highest larval abundance was found east of Miyako Island. Some larval appearances coincided with the longline fishing grounds. The larval survey data from the SOJ showed that larvae scattered off Wakasa Bay. Survey data also showed northward movement of juvenile fish from the Nansei Islands, possibly generated by the northbound Kuroshio current.

Discussion

The WG noted that the larval and juvenile data can provide with background information (e.g., spatial and temporal extents of spawning grounds) as well as information useful in the recruitment estimates for the SS simulations. Given the proximity between the Nansei spawning ground and waters off Taiwan, the WG questioned if similar larval/juvenile surveys were conducted by Taiwanese researchers. It was responded that a 2-year survey was conducted during the late 1990s. A suggestion was made of exchanging information between Japanese and Taiwanese researchers.

The WG inquired the relationship between the two major PBF spawning grounds. For example, if the spawning stocks as well as fish in larval stages are different between the two PBF spawning grounds near Japan. The presenter responded that ages of spawning fish in the SOJ are mainly age 3+, whereas those around the Nansei Islands are mainly age 5+. This may indicate segregation of spawning fish by ages. The WG was informed that PBF can spawn over a wide area form north to south near Japan if the sea conditions are favorable. WG considered that it may be reasonable to assume a single spawning stock for PBF.

The WG discussed variations in spawning stock characteristics. It was recognized that a mature PBF may skip spawning. Also, the WG noted that sex-ratio tends to skew to male only for the large-sized fish (as common in Albacore). PBF year class strengths often display spiky patterns, presumably suggesting the influence of variable environmental conditions on larval abundance. The WG suggested that temperature may be an important determinant for larval growth and survival. The presenter responded that the larval growth rates were lower in the Sea of Japan in 2011 than usually observed in the Nansei Island area. WG considered that the temperature effects on larval survival as well as information on spawning stock characteristics should be incorporated in the SS analysis to account for uncertainty in estimation. Another suggestion was using SS-surveyed CPUE for comparisons of larval/juvenile abundance levels among years and areas.

3.3 Abundance index of Pacific Bluefin tuna (*Thunnus orientalis*) by Taiwanese small-scale longline fleet in the southwestern North Pacific Ocean (ISC/12-2/PBFWG/14. C.-C. Hsu and H.-Y. Wang)

Taiwanese small scale longline fleet is the main fishery harvesting PBF in the southeastern, eastern and northeastern waters off Taiwan. This fishery targets giant PBF spawners (> 165 cm FL) during April to June, each year. The standardized PBF CPUE series of this fishery serves as an abundance index for spawners in the SS model.

The Taiwanese PBF catch and effort data were derived from a standard sampling scheme. Prior to sample collection, researchers identified individual fishing boats which targeted PBF, and obtained information on number of hooks deployed per day for these boats. Then, researchers quantified fishing effort of these boats as: number of hooks per day * number of fishing days (assumed as number of days-at-sea less 2 days),. Number of days-at-sea data were obtained from the security checking stations of the harbor. The catch data were estimated from the auction records.

Two statistical models were applied to the annual PBF CPUE in 1999-2011: a GLM (with 3 factors: Year, Month, and vessel types) and a GLMM (with interaction terms Year*Month and Year*vessel type as random effects). Both model fits showed that CPUE sharply declined from1999 to 2002, slightly increased in 2003 and 2004, dropped to a low level in 2005 and remained there until 2008, and then decreased again in 2009-2010. There was a small increase in CPUE in 2011. Further, given the similar fits but different levels of complexity between the two models, the GLM fit should be used as input data to the SS analysis.

Discussion

The WG confirmed that the simple GLM model was used in the current trial SS analysis, based on the authors' recommendation. In addition, the WG was concerned with the sharp declining trend in 1999-2002. Similar sharp declines were found in other species as well. The reasons were unknown for PBF. During this time period, fishers did not change fishing grounds, and number of fishing vessels was relatively constant. Catch increased in 1993-1999 and then declined. It was not known if the catch trend is indicative of changes in stock abundance.

Regarding Figure 5 in ISC/12/PBFWG-2/14, the WG suggested modifying this figure to include data before 2000.

3.4 Strength of 2010 year class observed in catch information (ISC/12-2/PBFWG/04, K. Oshima and Y. Takeuchi)

This paper was referred to in this section but already introduced in Section 2. For details, please see Section 2.

4.0 REPORT AND RECOMMENDATIONS FROM THE MODELING SMALL GROUP MEETING

The Chair informed the WG that the modeling small group had met in the preceding week and reviewed the model structures but that the work had not been completed. His intention was that some session during WG week would be devoted to the modeling small group to reach consensus on modeling for the base case run.

Also he noted that major part of the work done by the modeling small group would be presented at this session, and would be covered by the WG report, and hence there would be no detailed report of the small group.

The recommendations came out of modeling small group were discussed and accepted. Those are included in the section of Recommendations (Section 10).

5.0 REVIEW OF STOCK ASSESSMENT INPUT DATA FOR SS MODEL

WG reviewed the annual nominal catches by fleet (Fig. 1), CPUE (Fig. 2, Table 2) and length and weight compositions by fleet (Fig. 3) submitted to this session of the WG. Definitions of fleet are summarized in Table 1.

5.1 Abundance indices

Basically, the CPUE indices presented in the Data Preparatory Meeting in January-February 2012 are used in this assessment. However, ISC/12-2/PBFWG/14 contains Taiwanese longline CPUE, which had been revised from what was submitted to the data preparatory meeting. The WG evaluated the revised CPUE, and decided to use the updated ones included in this paper. The paper presents two series of CPUE standardized by GLM and GLMM, and the one standardized by GLM is used by this stock assessment according to recommendation by authors (see Section 2 of this report). All available CPUEs are given in Table 2 and Fig. 3. According to the decision at the Data Preparatory Meeting, CPUE series from Japanese coastal longline (S1/F14), Japanese distant water longline (S2/F15-S3/F16), Japanese troll in East China Sea (S5/F18), Japanese troll in the Pacific (S6/F19), and Taiwanese longline (S7/F20) were to be used for the base case of this stock assessment. Other indices from Japanese purse seine in the Sea of Japan (S4/F17) and EPO purse seine (S8/F21, S9/ F22) are to be used only for the sensitivity analysis.

5.2 Length composition data

Using catches at size (length and weight) for some fisheries were discussed and agreed at the Data Preparatory Meeting and those series were estimated to be used at this assessment. During the meeting of the modeling small group, some inconsistencies between model assumption and length composition data were found; especially in F3, F4 and F11. Because the inconsistencies caused miss-fit of the stock assessment model to the size composition data, having resulted in unstable estimation of parameters, the length composition data were re-evaluated for the use of this stock assessment. Consequently, it was decided to exclude the catch at size estimates of F4 for the period prior to 1994.

In addition, the modeling small group, recognizing a possibility of time-varying selectivity in F3 and F11, discussed as to how and whether or not to incorporate time blocks when assuming different selectivity among the periods. Details of the discussion are described below for each fishery. In addition, catch at size data in the 1st quarter of 1996 for F4 were excluded from the analysis, because an extremely unbalanced size sampling caused unrealistic estimates of catch at length for this quarter.

A) Purse seine fishery in the Sea of Japan (F3)

There were substantial discussions on the possible incorporation of time blocks for this fleet. Spatial-temporal distributions of fishing locations of the fleet were provided during the meeting. The distributions suggested that fishing grounds had shifted toward north since 2004. On the other hand, catch at length showed annual variability and the fish caught apparently became smaller in 2007 and thereafter than in the previous period. Since the number of fish sampled was considered to be sufficient to estimate the catch at size, the annual variability in catch at length might have reflected either the modal progression of strong cohorts, yearly changes in availability of fish, or change of selectivity. However, any further evidence to determine a real cause could not be provided during this meeting. It is therefore recommended that a detailed description of the fishing operation, including selectivity and fishing locations be provided for this fishery.

B) Japanese purse seine fishery in the Pacific (F4)

The estimated catch at size (in number) in this fishery was apparently changed after 1993: proportion of fish smaller than 78 cm to the total fish caught was 72 (±27) % during 1973-1993 and 15 (±17) % during 1994-2010. In addition, length composition before 1994 showed unrealistically narrow spikes in most of years.

WG was informed of the historical evolution in the procedures of size sampling and catch data collection, as follows.

- Before 1987: weight data were derived from sales slips mostly Tokyo Metropolitan fish market (Tsukiji market) and then were converted to length using an equation of weight-length relationship. The length compositions were estimated independently for two size categories of ≦10kg and >10kg, and were raised by catches (in weight) reported in the log-books, for corresponding two size categories.
- From 1987 to 1993 (both years inclusive): weight of fish were collected by weight measurements at the main fishing ports (Shiogama and Ishinomaki) by NRIFS. Then the weight data were converted into length compositions, using a weight-length relationship. Catch at size was estimated by raising the length compositions by catches (reported in log-books), for each size category of ≦10kg and >10kg.
- Since 1994: length compositions were derived from length measurements at the main fishing ports, of fish presorted in two size categories (“Meji” ≦20kg, “Maguro” >20kg). The length compositions were raised to catch-at-size for each of the size categories “Meji” and “Maguro”, using estimated catches (in weight) collected from the market sales slips.

After reviewing the above, the WG agreed to exclude catch-at-size for the period until 1993 from the analysis; because the conversion of weight frequencies to length frequencies might have caused the apparent difference between estimated catch-at-size for the two periods, until 1993 and since 1994. In addition, WG agreed to exclude the data since 2007, because catches were extremely small (367.5, 0.6, 862.9 mt in 2007-2009, respectively), which caused insufficient length sampling.

The WG reviewed catch at length from 1994 to 2006, which also showed annual variations. The WG recognized 3 different types in catch at length: a) including both small (<100cm) and large (>100cm) fish; b) including only small fish; and c) including only large fish. These different types of length compositions appeared randomly among years, possibly since the fishers changed target size of fish, year by year. Three different types of selectivity were estimated within the model which revealed that length compositions of both large and small fish and those of only small fish can be explained by a single selectivity with annual modal progressions. However, the length composition with only large fish in 1994 and 1995 can't be explained by this selectivity. Considering parsimony of the model, the WG decided to exclude the data for 1994 and 1995, and to apply single selectivity estimated from the length composition data during 1996-2006 to this fishery for the entire period. The final decisions by the WG on length compositions of this fishery are summarized below.

1. Exclude size compositions before 1994 because of uncertainty on conversion from weight to length composition data
2. Exclude size compositions from 2007 to 2010 because of insufficient size sampling due to low catches.
3. Exclude size compositions in 1994-1995 because the size compositions included only extremely large fish.

C) EPO Purse Seine (F11)

Oral presentation #3 (see details in Section 6.5) was made to the WG. The presentation denoted that length compositions of purse seine catch in the eastern Pacific Ocean (EPO) historically changed, so that an assumption of a single selectivity pattern for the entire time period may be a model misspecification, which would cause a misfit to size composition data being unduly influenced. It was proposed to establish appropriate time blocks with different selectivities in this fishery.

WG summarized historical changes of this as following.

- 1952-1986 (US PS dominant)
- 1987-1998 (Opportunistic catches by US and Mexico PS)
- 1999-2001 (Mexico PS dominant)
- 2002-present (Mexico PS for farming)

However, actual observed changes of length compositions did not match with this history, especially during 1987 to 2001. The WG recognized that it is difficult to define a time block, consistent with history of this fishery. The WG also recognized that availability of fish for this fishery can vary substantially by year and/or decade, because this fishery catches young fish migrating from the western Pacific. The time-varying changes of length compositions may therefore reflect the changes in availability. In addition, sampling procedures could have changed, associated with the drastic changes of fishery. Tentatively, the WG decided to down-weight length composition data of this fishery by a factor of 0.1, in order to avoid model instability caused by misfit to the length composition data in this fishery.

After the decision of down-weighting to this fishery, the necessity for the incorporation of time blocks assuming different selectivities was discussed. One proposal was to use a separate time block from 2002 to 2010, which is corresponding to the period when fisheries for providing fish for the farming have been operating. In addition, it was proposed that the selectivity estimated for 2002-2010 to be applied for the period of 1996-2001 (when length composition data are more uncertain). Because implementation of the two proposals are equivalent to establishing a single time block from 1996-2010, the time block during 1996-2010 have been incorporated into some trial runs. However, because it is recognized that length composition since 1996 can't be explained well with the current model configuration, establishment of time blocks is still open for discussion.

Table and Figures for Section 5

Table 1. Definition of fisheries in the stock assessment using SS

Serial number	Nuber of fleet	Short Name	Data type	corresponding fisheries and mirroring	Size data type (fishery) or mirroring (CPUE)
1	F1	JLL	Fishery	Japanese coastal longline	length
2	F2	SPSS	Fishery	Small pelagic fish purse seine	length
3	F3	TPS	Fishery	Tuna purse seine (Sea of Japan)	length
4	F4	TPS	Fishery	Tuna purse seine (Pacific ocean)	length
5	F5	TR	Fishery	Japanese Coastal Troll	length
6	F6	PL	Fishery	Japanses Pole-and-line	length
7	F7	SN	Fishery	Japanese Set net (Northern part of Japan)	weight
8	F8	SN	Fishery	Japanses Set net (Q3&Q4 Hokuriku, Japan)	length
9	F9	SN	Fishery	Set net (Other area)	length
10	F10	TWLL	Fishery	Taiwanese long line	length
11	F11	EPOCOM	Fishery	Eastern Pavific Ocean commercial fishery	length
12	F12	EPOSP	Fishery	Eastern Pavific Ocean Sports fishery	length
13	F13	OTH	Fishery	Others	weight
14	F14(S1)	JpCLL	CPUE	Japanese coastal long line conducting spawning area and season (April to June) (WP 8 in PBF12-1)	JLL
15	F15(S2)	JpnDWLLRevto74	CPUE	CPUEs with aggregated data in Japanese offshore and distant water longliners using all quarters until 1974 (WP 10 om PBF-WG 12-1)	JLL
16	F16(S2)	JppDWLLRevfrom75	CPUE	CPUEs with aggregated data in Japanese offshore and distant water longliners using all quarters and area until 1975 (Yokawa WP "25+26", revisited)	JLL
17	F17(S3)		CPUE	Sea of Japan after 1982(L), Dome shape selectivity, share length data with FL4	TPS
18	F18(S3)	JpnTrollChinaSea	CPUE	CPUEs of Japanese troll fisheries in Nagasaki prefecture (Sea of Japan and east china sea) from 1980 to 2010	TR
19	F19(S4)	JpnTrollPacific	CPUE	CPUEs of Japanese troll fisheries combine with Kochi and Wakayama prefecture (Pacific side) from 1980 to 2010	TR
20	F20(S4)		CPUE	CPUEs of Japanese troll fisherieswith Kochi prefecture (Pacific side) from 1980 to 2010	TR
21	F21(S5)		CPUE	CPUEs of Japanese troll fisheries with Wakayama prefecture (Pacific side) from 1980 to 2010	TR
22	F21(S5)	TWLL	CPUE	CPUEs of Taiwanese longline from 1998 to 2007	TWLL
23	F22(S6)	USPSto82	CPUE	CPUEs in US target purse seine until 1982	EPOCOM
24	F23(S6)	MexPSto06	CPUE	CPUEs in Mexico purse seine from 1999 to 2006	EPOCOM

Table 2. CPUE series provided for this stock assessment.

	F14 (S1)	F15 (S2)	F16 (S3)	F17 (S4)	F18 (S5)	F19 (S6)	F20 (S7)	F21 (S8)	F22 (S9)	F23 (S10)	F24 (S11)
1952		0.0140									
1953		0.0126									
1954		0.0112									
1955		0.0085									
1956		0.0058									
1957		0.0067									
1958		0.0160									
1959		0.0263									
1960		0.0197								1.04	
1961		0.0193								1.54	
1962		0.0175								1.40	
1963		0.0123								1.75	
1964		0.0128								1.05	
1965		0.0100								1.20	
1966		0.0128								1.93	
1967		0.0062								1.55	
1968		0.0056								0.58	
1969		0.0065								0.82	
1970		0.0046								0.99	
1971		0.0029								0.92	
1972		0.0028								1.35	
1973		0.0019								0.65	
1974			0.0016							0.61	
1975			0.0011							1.25	
1976			0.0026							0.82	
1977			0.0029							0.51	
1978			0.0035							0.98	
1979			0.0023							0.72	
1980			0.0030		0.64					0.62	
1981			0.0035		1.11		0.82			0.34	
1982			0.0020		0.57		0.25			0.38	
1983			0.0012		0.87		0.21				
1984			0.0013		0.88		1.14				
1985			0.0012		0.82		0.77				
1986			0.0014		0.93		0.28				

Table 2. (Continued)

	F14 (S1)	F15 (S2)	F16 (S3)	F17 (S4)	F18 (S5)	F19 (S6)	F20 (S7)	F21 (S8)	F22 (S9)	F23 (S10)	F24 (S11)
1987			0.60	1.02	0.67		0.18				
1988			0.69	0.51	0.76		0.63				
1989			1.05	0.86	0.61		0.35				
1990			1.05		1.20		0.71				
1991			1.68	0.42	1.29		0.63				
1992			1.81	0.70	0.55		0.32				
1993	1.77			0.86	0.46		0.56				
1994	1.28			3.45	1.93	2.36	3.52	1.40			
1995	1.60			1.68	1.05	0.84	1.15	0.78			
1996	1.65			1.01	1.57	0.85	0.99	1.26			
1997	1.46			0.66	0.89	0.46	0.53	0.71			
1998	1.04			0.79	0.81	1.11	1.69	0.55	2.54		
1999	0.80			1.10	1.47	0.25	0.36	0.18	2.11		
2000	0.62			1.08	1.14	0.32	0.36	0.53	1.24		
2001	0.71			0.63	1.15	1.56	2.33	0.94	0.78		
2002	1.18			0.66	0.73	0.67	0.91	0.62	1.11		
2003	1.27			0.68	0.64	0.32	0.44	0.30	1.07		
2004	1.51			1.08	1.27	3.17	3.82	4.37	0.57		
2005	0.74			1.23	1.35	0.87	1.09	1.08	0.67		
2006	1.06			0.56	0.70	0.82	1.02	1.04	0.57		
2007	0.58			1.24	1.38	1.27	1.62	1.51	0.75		
2008	0.37			1.08	1.41	0.68	0.73	1.20	0.58		
2009	0.19			0.84	1.09	0.08	0.09	0.13	0.36		
2010	0.17			0.87	1.07	1.35	2.16	0.40	0.66		

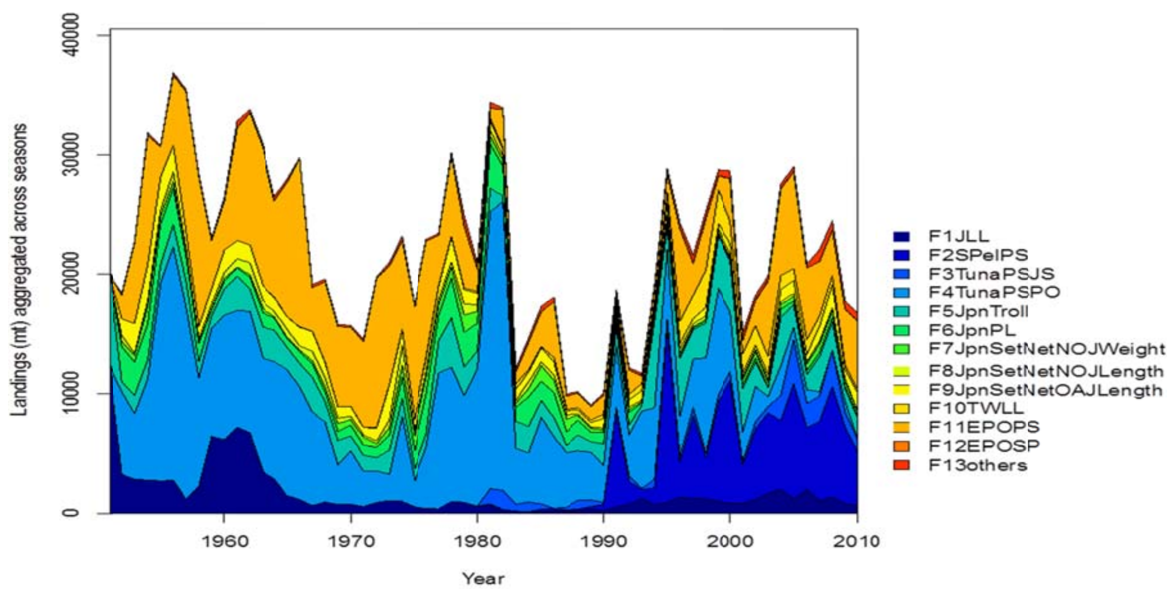


Fig. 1. Total annual catch by defined fleets used in SS model.

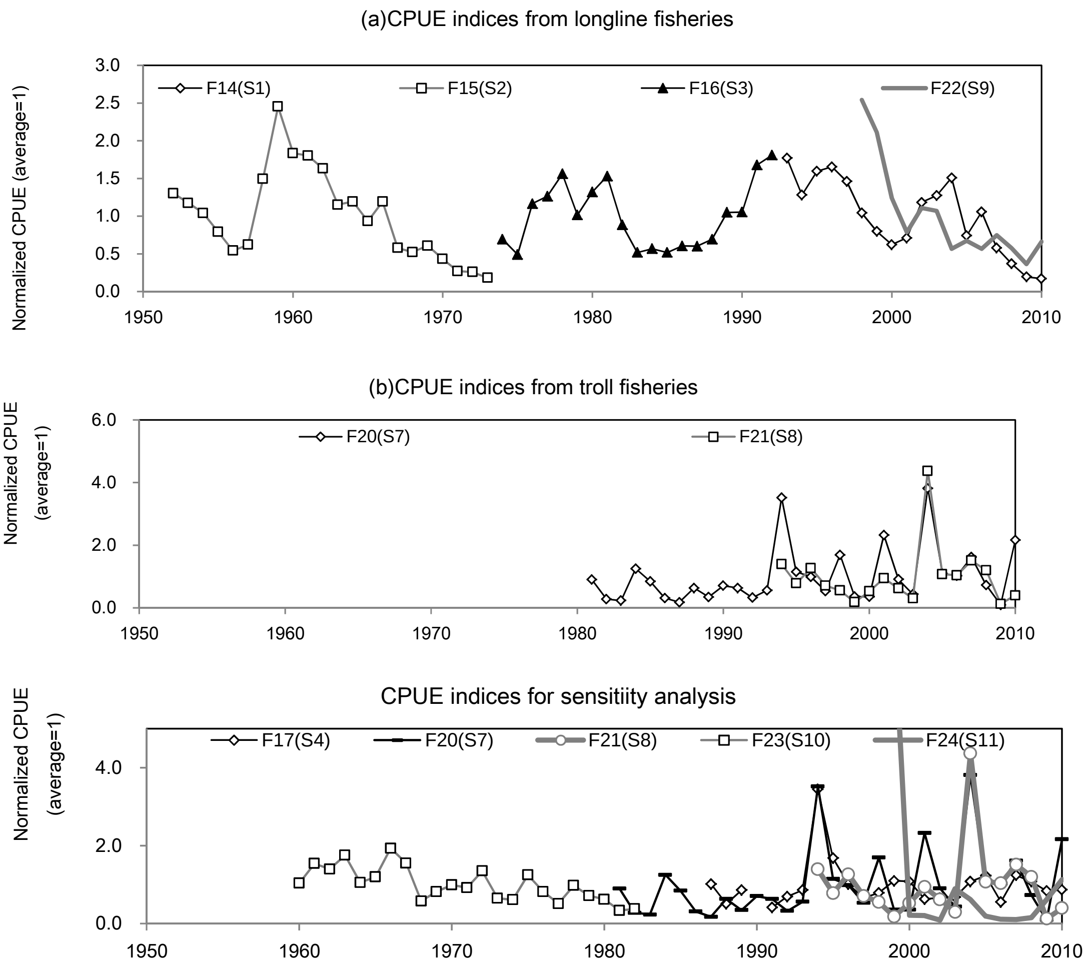


Fig. 2. Input data of CPUE time series from longline (a) and troll fisheries (b) which are agreed to be used for the base case assessment. Other CPUEs from purse seine and troll fisheries (c) are not to be used for the base case, but for sensitivity.

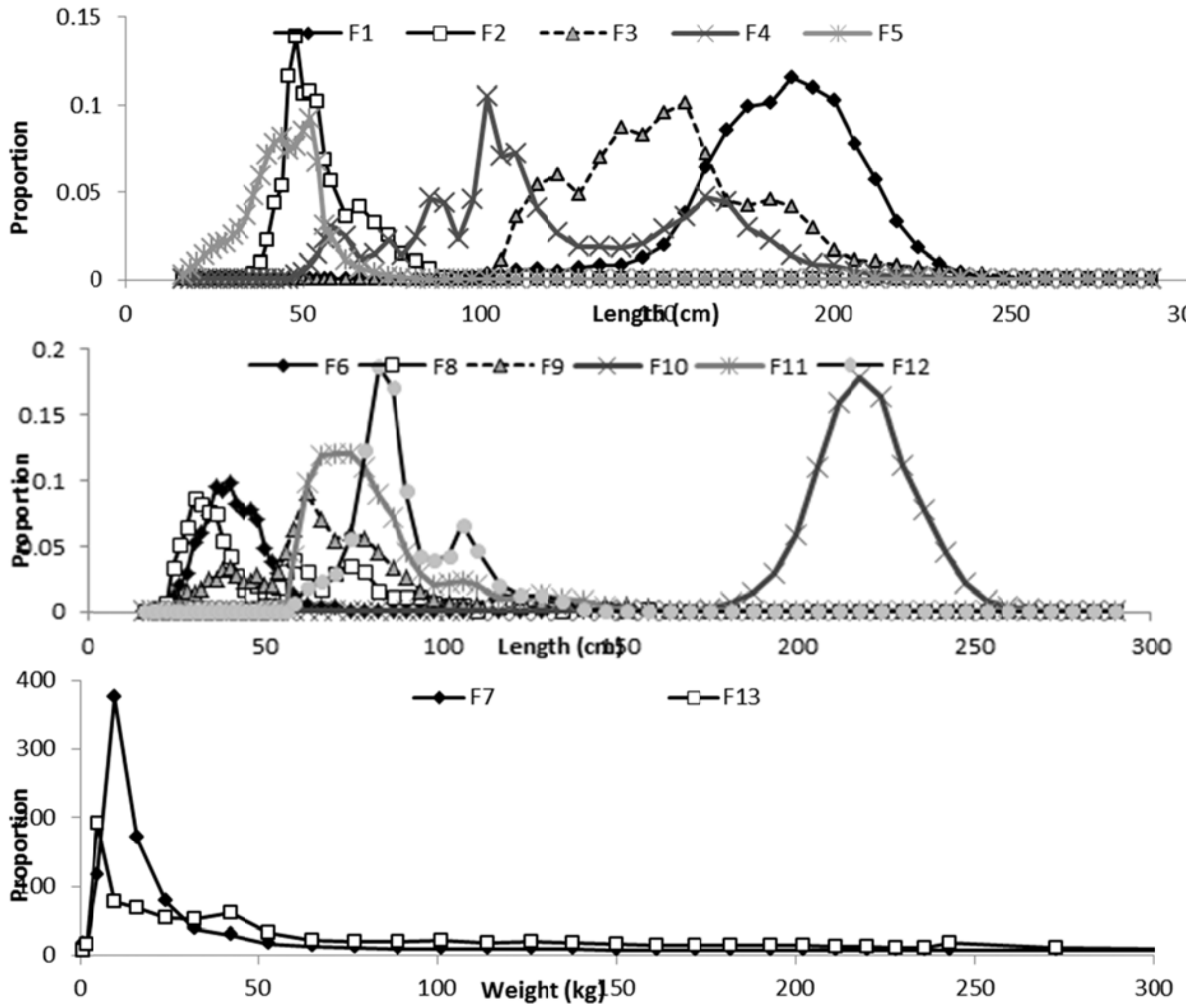


Fig. 3. Length and weight composition data aggregated by fleet submitted to this WG for the stock assessment.

6.0 DEFINITION AND REVIEW OF THE SS BASE CASE RUN AND SENSITIVITY RUNS FOR PBF

The WG discussed the SS configuration for the PBF assessment based on diagnostics and results from the configuration given in ISC/12/PBFWG-2/6 and ISC/12/PBFWG-2/7 (See Section 6.5 for details), and the data revised according to the agreements by the WG described in section 4 (e.g. revised small pelagic PS catch and EPO length data). The WG realized that in the model configuration, important issues are the growth parameters (6.1) and definition of selectivity (6.2). In addition, diagnostics using likelihood profiles were conducted (6.3), which were followed by the discussion on relative weighting to various fisheries data (6.4).

6.1 Growth curve

ISC/12/PBFWG-2/7 and ISC/12/PBFWG-2/11 (See Section 6.5 for details) raised the issue on choice of growth parameters for the use of this assessment. Previous assessment used a fixed growth curve estimated by Shimose (2008). This study has been updated by Shimose et al (2011) and Shimose et al. (2012). Because the most recent study by Shimose et al (2012) used more than 1000 readings of otolith, the WG considered that this study would provide the most reliable information on growth of this species, especially for older ages. However, length at age 0 (July 1st in SS) estimated using growth curve by Shimose et al (2012) is 15.47 cm (for a sex-combined curve), which is smaller than that actually observed in length frequency of age-0 PBF caught in July (Fig 4). This caused extremely high CV of length at age 0 (more than 0.4) estimated in SS, in order to explain observed length frequency in the model. ISC/12/PBFWG-2/11 suggests that length at age 0 is estimated to be around 24 cm, if SS estimates all parameters of a growth curve.

The WG decided to use growth parameters of K and L infinity estimated with Shimose's otolith data by fixing a plausible value of length at age 0. Table 4 showed results of estimated K and L at age 3 with various fixed lengths at age 0 and Shimose's otolith data. Maximum likelihood method assuming normal error distribution and parameterization of growth curve in SS are used in this estimation. Bootstrap analysis was conducted to estimate 90% confidence interval of the estimated parameters. Based on the actual catch compositions shown in Fig 4 (20-23 cm), SS estimation of L_{min} (Paper #11) (24 cm), and previous estimation by Shimose et al. (2008) (21.54 cm), the WG decided L_{min} to be 21.5 cm, and corresponding parameters of K and length at age 3 were estimated, The WG agreed to use fixed growth parameters in SS: L at age 0 = 21.5 cm; L at age 3 = 109.2 cm; and K=0.157 (Fig. 5).

6.2. Functional type of Selectivity

The latest version of SS (3.23b) implemented a new selectivity function of cubic spline. This selectivity function can estimate relatively flexible shapes of selectivity such as bi-modal. The preliminary run by ISC/12/PBFWG-2/6 used the cubic spline function for all fleets with an exception for Taiwanese longline, for which a logistic selectivity function was assumed. However, various problems were raised during modeling small group, such as difficulty in estimating gradient parameters in the terminal node and in determining appropriate number and positions of nodes. Some trial runs conducted during the small group indicated that the number and positions of nodes sometimes influence the estimated shape of selectivity and resulting stock status. Therefore, the WG agreed that cubic spline functions should be incorporated only after enough sensitivity analyses on the way to define positions and number of nodes.

The WG decided to use parametric selectivity curves for this stock assessment rather than cubic spline. Double-normal functional type selectivity curves were used for all fleets, except for F10 (Taiwanese longline). As for F101, it was agreed to assume flat-top selectivity according to ISC/12/PBFWG-2/15.

6.3. Likelihood profile on R_0 (What determine scale of recruitment and biomass?)

Likelihood profile on R_0 (log average recruitment) produced by the preliminary run with configuration given in document #6, and with revised input data, indicated that length compositions of specific purse seine fleets (F4 and F11) have large impacts on estimation of R_0 (Fig. 6). It was suggested that the large impacts of these fleets on R_0 might be caused by misfit of the model to the length data, because the length composition data for these fisheries seemed to vary over time (Oral presentation #03). F3 and F11 are purse seine fleets that opportunistically target or non-target PBF, which would cause changes in length composition by year. In general, the WG agreed to avoid letting the misfit caused by an assumption of a single selectivity pattern during the whole period in these fisheries overly influence the population dynamics.

Based on those findings, the WG took the following approaches to solve this problem:

- Re-examination of length composition data (see Section 5.2),
- Adjustment of parameterization of selectivity function (see Section 6.2)
- Application of proper weighting (see Annex)
- Establishment of time blocks (a part of discussions is in Section 5.2).

6.4 Further model fitting to length and CPUE data

Modification of selectivity parameters and elimination of unreliable catch at length data and estimation of CVs of CPUEs were suggested which achieved a realistic model behavior of likelihood profile on R0: gradients of likelihood components on R0 had similar scale for length composition and CPUE (Fig. 7). However, the WG could not come to consensus as to whether this model configuration was appropriate or not. The WG discussed whether further adjustment of the model is needed to achieve an improved fit to CPUE data such as Japanese coastal longline, by incorporating time block assumption to some fisheries or not. The WG discussed the reliability and model fit of each CPUE index, and the appropriateness of incorporation of time block for some fisheries. However, the WG could not come to a consensus on the base case scenario for this stock assessment, because of the model is highly sensitive to a slight change in time blocks. Table 3 shows tentative configurations on what the WG had agreed and what the WG still had to decide.

6.5. Presentations of relevant documents to this Section and specific discussions not covered in previous subsections

The following Working Papers were presented and discussed in the Section 6. Discussions related to these papers are included in the texts of the previous Sub-Sections with references and therefore not included after the summary of each paper. However, discussions not included in the previous texts are included under each paper.

6.5.1 Input data for stock assessment model, Stock Synthesis 3, on Pacific bluefin tuna, Thunnus orientalis （ISC/12-2/PBFWG/02, S. Uematsu, K. Oshima, M. Kanaiwa, M. Ichinokawa, M. Kai, M. Abe, S. Iwata, K, Fujioka, H. Fukuda, A. Mizuno, J.-T. Yoo, S. C. Yoon, C. C. Hsu, S. Teo, A. Aires-da-Silva, M.Dreyfus and Y. Takeuchi）

This paper presents summary of the input data for the Stock Synthesis 3 model (SS3) to be used in stock assessment of PBF. The main contents are as follows: quarterly catch and length data of PBF up to 2010 fishing year (July 1st to June 30) by fleets (increased to thirteen fleets from ten); length composition data weighted by respective catch quantity; 11 CPUE time series to be used as input data (6 series for the base case and 5 for sensitivity analysis).

Discussion

All the data updated and prepared for the use at the assessment session were distributed. The WG confirmed that the latest data modifications referred to in the ISC/12/PBFWG-2/18 have been reflected in the final edition of the data files distributed at this time. The WG inquired on a very high spike found at the 212-218cm bin in the size composition histogram for quarter 1 of 1950s for Fleet 1. It was clarified that the spike resulted from having a single fish measured on August 1956 being raised to the high catches in that month. Comparisons between runs including and excluding this observation indicated no major impact on the results. Therefore, the WG agreed to exclude this observation from the assessment.

6.5.2 Modification of input fishery data for Stock Synthesis III model from the 2010 Pacific bluefin tuna stock assessment (ISC/12-2/PBFWG/03, K. Fujioka, H. Fukuda, K. Oshima, M. Abe, S. Iwata, M. Kai, and Y. Takeuchi)

In last 2010 stock assessment, fork length frequency distributions in “Northern part of set net fishery (F7)” and “Other fishery (F13)” were used as input data into Stock Synthesis 3 model. The WG, at its Data Preparatory session for the 2012 assessment, agreed to use weight frequencies for the above two fleets, instead of length frequencies, because weight data are more abundant than length data. Therefore, definition of weight bin size was needed. In this paper, definition of weight bin sizes was proposed as had been recommended by the WG. In addition to these modifications, all input fishery data were reviewed and some changes were made on “Japanese purse seine fishery catching adult PBF operated in Pacific Ocean (F4)” and “Troll fishery (F5)”.

Discussion

The WG inquired on the impact of changes made on growth on the assumed weight-at-age relationship. The WG was advised that the revised growth curve would not have an impact on the weight-at-age relationship to be used.

A comment was made on the troll data. Fish over 170cm were excluded in size studies, because they overrepresented in catch compositions, as sampling location is biased. The WG agreed that these samples are not representative of the troll catch and that the exclusion of these frequencies is appropriate.

6.5.3 Abundance index of Pacific bluefin tuna (Thunnus orientalis) by Taiwanese small-scale longline fleet in southwestern North Pacific Ocean, (ISC/12-2/PBFWG/14, C.C.Hsu and H. Y Wang

The paper was referred to in Section 3.

6.5.4 Size of Pacific bluefin tuna catches in the Eastern Pacific by Mexican purse seiners, estimated from Catch Document System (CDS); ISC/12-2/PBFWG/20、K. Oshima, P.M. Miyake & Y. Takeuchi）

"Catch document system" has been in effect by ICCAT for all bluefin tunas (Pacific and Atlantic), since 2008. All the bluefin tuna caught are immediately registered and traced with registered serial numbers throughout the transactions of fish. The "catch documents" include information on catch in terms of number of fish and of weight. Such information are gathered from the catch documents attached to PBF imported to Japan from Mexico and frequencies of average sizes per catch are presented in this paper.

There are some reservations in interpreting the results but it gives some good indications on size of the majority of fish caught by the Mexican purse seiners in recent years (2008-2011). It appears that the majority of catches by this fishery is consisted of ages 1 and 2 fish in most recent years.

Discussion

The WG agreed that this paper support intensified research particularly in getting accurate size data from Mexican purse seine fishery. The Mexican participant commented on their intention to improve the size data, e.g. using underwater cameras. It was also suggested that catch document system could be new source of information for checking the catch and size of PBF caught by these fisheries. Some more arguments followed on whether the recent size data for this fishery contained a bias or not, which showed almost 40% (in number) of fish were age 3+, while the data before 2002 and this paper suggested most of the catches in the EPO were of ages 1 and 2.

6.5.5 Preliminary stock assessment of Pacific Bluefin Tuna through Stock Synthesis 3 (ISC/12-2/PBFWG/06, S. Iwata, S. Uematsu, K. Oshima, M. Ichinokawa, Mi. Kai, M. Abe, K. Fujioka, H. Fukuda, A. Mizuno, & Y.Takeuchi)

The paper introduces result of a run of base case candidate model, based on the agreements at the WG Data Preparatory meeting in February, 2012. In the preliminary model description, three new functions of Stock Synthesis 3.23b were used; a) "Generalized Size Composition", b) "Cubic Spline", and c) "Super period". These three functions were appropriate to describe the data of PBF. However, since the "cubic spline" is hard to adjust it has to be further investigated.

6.5.6 A Sensitivity Analysis of Stock Assessment 2012 for Pacific bluefin tuna (ISC/12-2/PBFWG/07, H. Fukuda, M. Kai, S. Iwata, M. Abe, A. Mizuno, S. Uematsu, K. Fujioka, K.Oshima & Y. Takeuchi)

The WG noted that uncertainties in the SS3 base case candidate model (Iwata et al., 2012 (ISC/12/PBFWG-2/) for PBF regarding some biological parameters, input data and model settings were evaluated by sensitivity analyses for each parameter. The results suggested that the base case candidate used in this paper was quite sensitive to the growth parameters such as von Bertalanffy K, and $L@A_{min}$, $L@A_{max}$, and CV for those parameters. On the other hand, old age M that was considered as a significant source of uncertainties (ISC11/PBFWG/10) did not have as large impact on the result as growth. Some of the changes in fishery definitions such as fleet 4, 7, 8, and 9 had significant effects on results. The function of the selectivity curve of each fleet also had significant effects on conclusions. The WG should be careful in using those data and settings, if any further changes on them are considered.

6.5.7 Estimation of growth curve using conditional age at length data from otolith aging (ISC12/PBF02/11, M. Kai & Y.Takeuchi)

This paper compares the growth curve estimated externally with that estimated internally with and without conditional age at length data. The result showed that the use of conditional age at length: a) decreased the length infinity from 249.6 to 240.5 cm; b) decreased the growth coefficient (Brody's k) in relation to the growth rate from 0.173 to 0.160; and c) increased the fork length at age-0 from 15.8 to 23.7 cm. Therefore, there were inconsistencies between the growth curves estimated externally and internally. In particular, it seems that the growth curve with conditional age at length underestimates the length at older ages in comparison with observed length at age. Nevertheless growth curve estimates within the age structured model has an effect to maintain length at age 0 within feasible length, while length at age 0 tends to be underestimated if only ageing data are used. Therefore, two possible suggestions were made; (i) estimate all the growth parameters internally in the SS model: and (ii) estimate the parameters externally, while fixing the length at age-0 as estimated in the SS model or as assumed empirically within a reasonable observed range. The above (i) is not recommendable because of an increased uncertainties in growth curve at older ages.

6.5.8 Estimation of effective sample size for PBF caught by Japanese longline with bootstrap resampling method (ISC12/PBF02/9, A. Mizuno)

Effective sample size (ESS) was estimated for length data of catches by Japanese longline: i.e. the sample size sufficient for random sampling, using resampling data through bootstrap method. Effective sample size is estimated using ratio of the coefficient of variation between frequency from bootstrap and observations. The ESSs were lower than real sample sizes (average of sample size was 996.2 whilst average of ESSs was 258.68).

6.5.9 Consideration of effective sample size and weighting for length frequency of PBF (ISC12/PBF02/10, A. Mizuno)

Firstly, the paper describes scaling of sample sizes and weighting method of length compositions, using stock assessment given in ISC/12-2/PBFWG/06, and effects of changing criterion value on the result of stock assessment. Secondly, it clarifies the changes in weight determined by the estimated ESS of length composition, for Japanese longline catches. Thirdly, it reviewed the McCall's method to determine weight of length compositions.

6.5.10 Selection of an asymptotic selectivity pattern (ISC12/PBF02/15, K. Piner)

An analysis was conducted with PBF fishery data to determine which fleet (gear/area combination of catch and size composition) is most consistent with the strong assumption of an asymptotic selectivity pattern. Evidence of consistency with the asymptotic assumption is based on consistency of the model fit to the size composition data of other fleets. Both the Taiwanese longline fleet and "Japanese other" fleet showed evidence of consistency with the asymptotic selectivity pattern assumption. Given that the Taiwanese longline fleet operates only for a short duration, in a limited spatial range targeting large spawners, it is the best choice for the strong selectivity pattern assumption.

6.5.11 Time varying selectivity of fisheries in the Pacific Bluefin tuna stock assessment (Oral Presentation #3, S.Teo)

In preparation for the 2012 PBF stock assessment, a preliminary stock assessment model (Stock Synthesis v3.23b) was developed with data from the ISC PBF WG (PBFWG) (data dated April 27, 2012 – with modifications on May 17, 2012). Analysis of this model suggested that several data sources conflicted with the model fits to the Japan Coastal Longline abundance index (S1) and the Taiwan Longline abundance index (S9). The main sources of this conflict appeared to be the size compositions from the Japan Purse Seine in the Japan Sea (F3) and the eastern Pacific Ocean (EPO) Purse Seine (F11); and to a lesser extent Japan Purse Seine in Pacific Ocean (F4). Visual inspection of these size compositions and their model residuals suggested that selectivity of these three fisheries were likely to have been changing over time. A series of models were therefore developed that included time varying selectivity for these fisheries using selectivity time blocks. These models with time varying selectivity resulted in substantially improved fits to the S1(F14) and S9(F22) indices, indicating that it is important for the WG to further investigate time varying selectivity in this stock assessment model, especially for F3, F4 and F11.

6.6. Base case model

During the session, very prolonged discussions were carried out among the participants on the selection of a base case model. Unfortunately, the WG could not come to consensus on the base case model. The following elements were key issues;

- Model fit to abundance indices, especially the longline indices in the recent period (i.e., S1 – Japan coastal longline, and S9 – Taiwan longline)
- Weighting among likelihood components
- Selectivity parameterization including establishment of time-block to specific fleets

See section 8 for further discussion.

Table 3. Model configurations

	Setting in 2010	Agreement at the WG February in 2012	ISC/12-2/PBFWG/06 (distributed to WG at 14th May)	Agreement in this WG
Model Structure				
SS version	SS-V3.10b	SS-V3.23b	SS-V3.23b	SS-V3.23b
Year definition	July to June	July to June	July to June	July to June
Period	1952-2007	1952-2010	1952-2010	1952-2010
Time step	Quarter	Quarter	Quarter	Quarter
Number of stock, area, gender, growth pattern and growth morphs (spawning population)	Single	Single	Single	Single
Number of age class	21(0-20)	21(0-20)	21(0-20)	21(0-20)
Fishery definition	10 fleets for catch and 5 surveys of CPUE	13 fleets for catch and 5 surveys of CPUE	13 fleets for catch and 5 surveys of CPUE	13 fleets for catch and 5 surveys of CPUE
Popo length bin			2 cm bin (16 cm - 222 cm and 252 cm - 290 cm), 1 cm bin interval (224 cm-251 cm)	2 cm bin (16 cm - 222 cm and 252 cm - 290 cm), 1 cm bin interval (224 cm-251 cm)
Biological parameters				
Natural mortality	Age specific,year is time step	Age specifc, year is time step	Age specific,year is time step	Age specific,year is time step
	Age0 =:1.6		Age0 =:1.6	Age0 =:1.6
	Age 1=0.386		Age 1=0.386	Age 1=0.386
	Age2+=0.25		Age2+=0.25	Age2+=0.25
Maturity	Age specific		Age specific	Age3=0.2
	Age3=0.2		Age3=0.2	Age4=0.5
	Age4=0.5		Age4=0.5	Age 5+=1.0
	Age 5+=1.0		Age 5+=1.0	
Growth curve	Shimose et al. 2008	Shimose et al. 2009, Shimose et al. 2012, Richards, conditional catch at age, seasonal K	Shimose et al. (2009)	Estimate K and Lmax from otolith data in Shimose (2012) by fixing length at age 0 to be 21.5 cm.
Functional form of CV growth	CV=F(A)	CV=F(L)	CV=F(L)	CV=F(L)
Amin	0	0	0	0
Amx	3	3 (revisit this choice)	3	3
L-W	Kai et al. 2007	Kai et al. 2007	Kai et al. 2007	Kai et al. 2007
Assumption of recruitment				
SRR	B-H	B-H, explore H-S model, retune model w different h values(estimate H by hockey-stick)	B-H	B-H
R0	Estimated	Estimated	Estimated	Estimated
Steepness	1	0.999	0.999	0.999
sigmaR	0.6	0.6, run estimate	0.6, run estimate	0.6, run estimate
1st year of main Rdev	1946	Tune later	1946	1946
R0 offset	Estimated	Estimated	Estimated	Estimated
SR auto correlation	No	No	No	No

Table 3 (continued)

	Setting in 2010	Agreement at the WG February in 2012	ISC/12-2/PBFWG/06 (distributed to WG at 14th May)	Agreement in this WG
Fishery & fishing				
Catch unit	Weight	Weight/numbers	Weigth	Weight
Catch error	0.1	0.1	0.1	0.1
Initial catch	Equilibrium catch (3 years average of catch or actual catch) for LL, tuna PS and troll	Equilibrium catch (3 years average of catch or actual catch) for LL, tuna PS and troll	Equilibrium catch (3 years average of catch or actual catch) for LL, tuna PS and troll	Equilibrium catch of F4 is set to be zero, becasue initial F of F4 hits lowe bound of the parameter (0).
Initial F	LL, tuna PS, troll with eqC	Estimate Finit without fitting to EqC. if unsuccessful LL, tuna PS, troll with eqC	Estimate initial F for F1, F4 and F5	Estimate initial F for F1 and F5
F-method	3 (solve catch eq)	3 (solve catch eq)	3 (solve catch eq)	3 (solve catch eq)
iteration	5	5	5	5
upperF	5	Explore reason for high F estimates in Epo (aroud 5, first qrt)	10	10
CPUE assumption				
CPUE likelihood	t(df=30)	lognormal	lognormal	lognormal
CPUE lambda	5 for coastal longline, 1 for others (Nagasaki troll, EPO PS and TWLL)	1 for all CPUE, but 0 for EPO PS	1 for F14, F15, F16, F18, F19, F22 and 0 for F17, F20, F21	1 for F14, F15, F16, F18, F19, F22 and 0 for F17, F20, F21
CV of CPUE	Lowest CV is set as 0.2	Lowest CV is set as 0.2	Lowest CV is set as 0.2	Lowest CV is set as 0.2
Length comps & Selectivity				
Data structure	Only length composition wiht single definition of length bin	Only length composition wiht single definition of length bin. Explore wider pop. length bin for younger ages	Generalized size composition (bin definition is different among fleets) Details are in ISC/12-2/PBFWG/02 for lengthbin and ISC/12-2/PBFWG/03 for weight bin)	Generalized size composition (bin definition is different among fleets) Details are in ISC/12-2/PBFWG/02 for length bin and appendix XX for weight bin)
effN for LenComps	Scale to have same effN to FL8	Scale to have same effN to FL8,FL3(SOJ)	Scale to have same effN to FL11,FL3(SOJ)	Scale to have same effN to FL11,FL3(SOJ)
ESS	Reset length lambda=1, then re-weight	Reset length lambda=1, then re-weight	Reset length lambda=1 except Fleet12 (lambda=0), then re-weight	(Reset length lambda=1, then re-weight)
Selectivity	Flat top for JPLL and TWLL, and dome-shape (double normal) other fisheries	Flat top for JPLL and TWLL, and dome-shape other fisheries	F1 Cubic Spline	F1 Double normal, Eliminate data in 1st quarter of 1956 as outlier
			F2 Cubic Spline	F2 Double normal
			F3 Cubic Spline	F3 Double normal, super period combining q1 and q4
			F4 Cubic Spline	F4 Double normal, Eliminate data before 1993 and after 2007
			F5 Cubic Spline	F5 Double normal
			F6 Cubic Spline	F6 Mirror F5 selectivity
			F7 Cubic Spline	F7 Double normal
			F8 Cubic Spline	F8 Double normal
			F9 Cubic Spline	F9 Double normal
			F10 Flat top	F10 Flat top
			F11 Cubic Spline	F11 Double normal, down weight=0.1
			F12 Mirror F11 selectivity, weight=0	F12 Mirror F11 selectivity, weight=0
			F13 Cubic Spline	F13 Double normal, down weight=0.1

Table 4. Estimated growth parameters using aging data by Shimose et al (2012) with fixing parameter of length at age 0 (L_{min}). The parameters of length at age 3 (L_{max}) and K were estimated.

Lmin	Lmax (Amax=3)	K	Comment
10	106.7	0.172	
11	106.9	0.171	
12	107.1	0.169	
13	107.3	0.168	
14	107.5	0.167	
15	107.7	0.166	
16	107.9	0.164	
17	108.2	0.163	
18	108.4	0.162	
19	108.6	0.161	
20	108.8	0.159	Average size of toll catch in July
21	109.1	0.158	
21.5	109.2	0.157	Determined value
21.54	109.2	0.157	Estimation by Shimose (2008)
22	109.3	0.157	
23	109.5	0.156	
23.07	109.6	0.155	Estimation in SS (Kai 2012)
24	109.8	0.154	
25	110.0	0.153	
26	110.2	0.152	
27	110.5	0.15	
28	110.7	0.149	
29	111.0	0.148	
30	111.2	0.147	

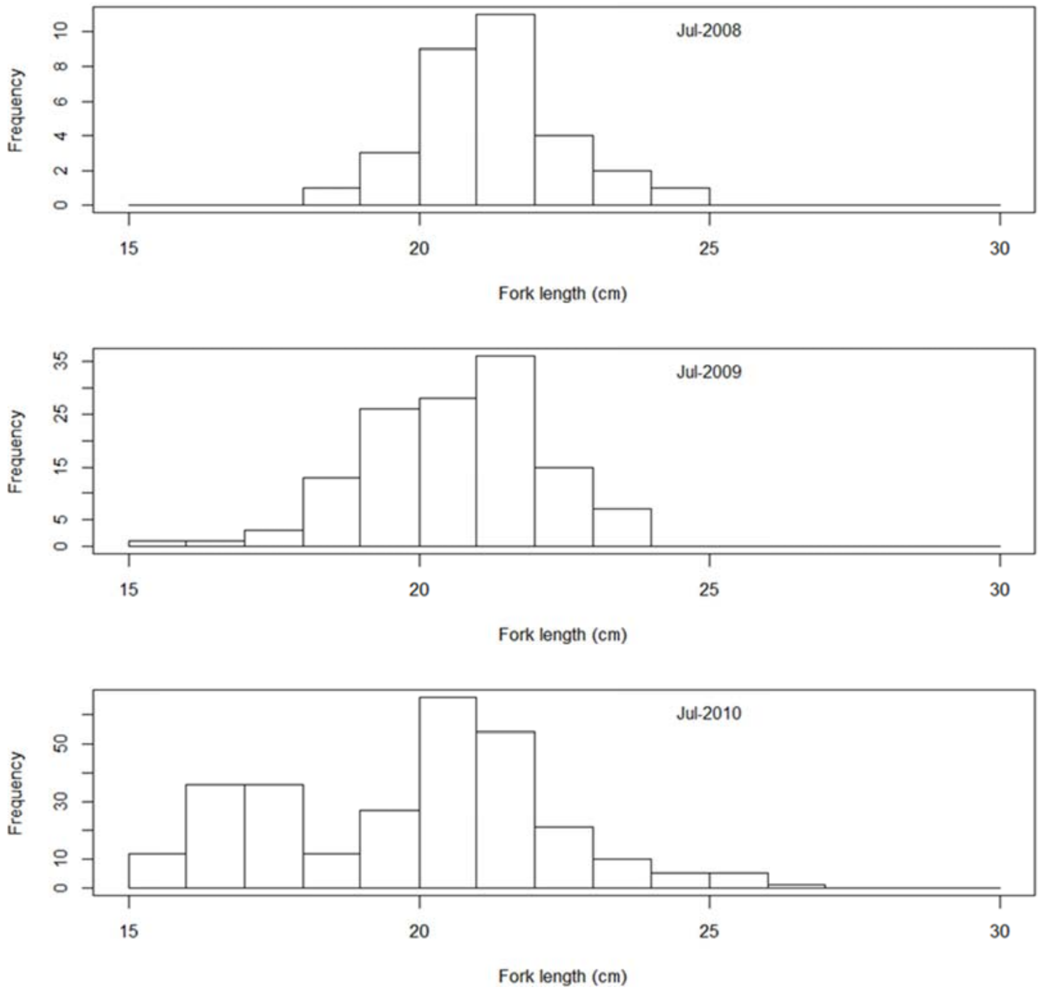


Fig. 4. Size composition data of Japanese troll fishery at Tosa-bay in July 2008-2010.

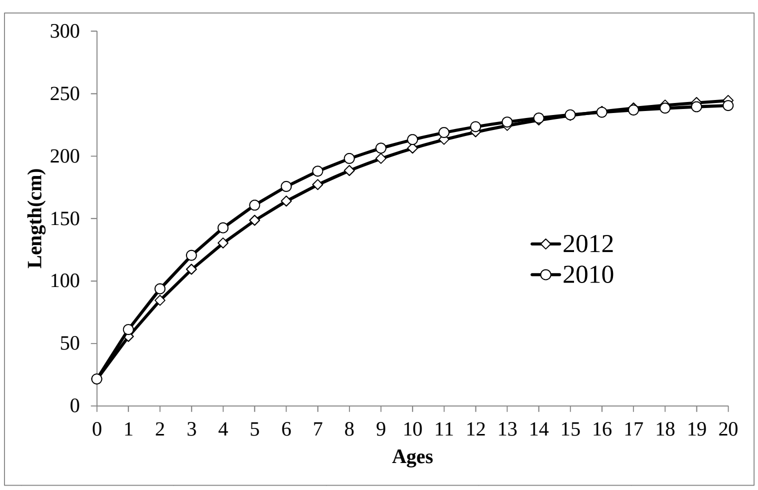


Fig. 5. Growth curves the WG agreed to use in this assessment (labeled as 2012), compared with the growth curve used in 2010 Update (labeled as 2010)

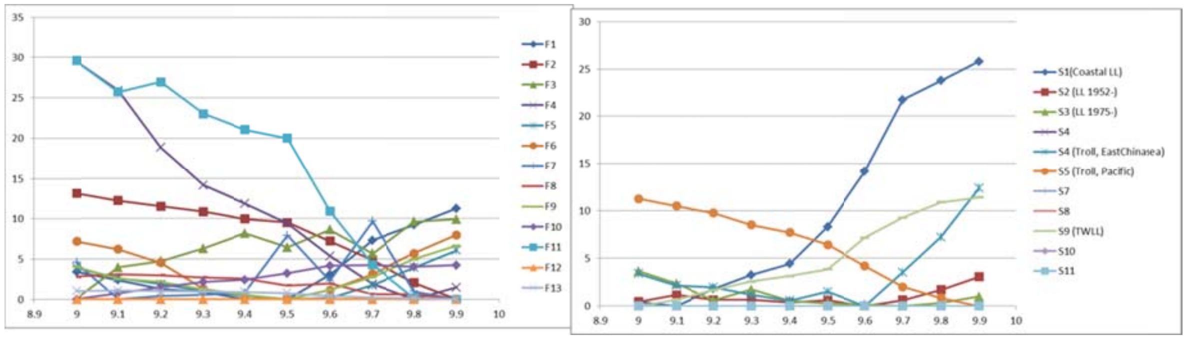


Fig. 6. Likelihood profiles on R_0 (log of average recruitment) by ISC/12-2/PBFWG/06, using the configuration distributed before this meeting.

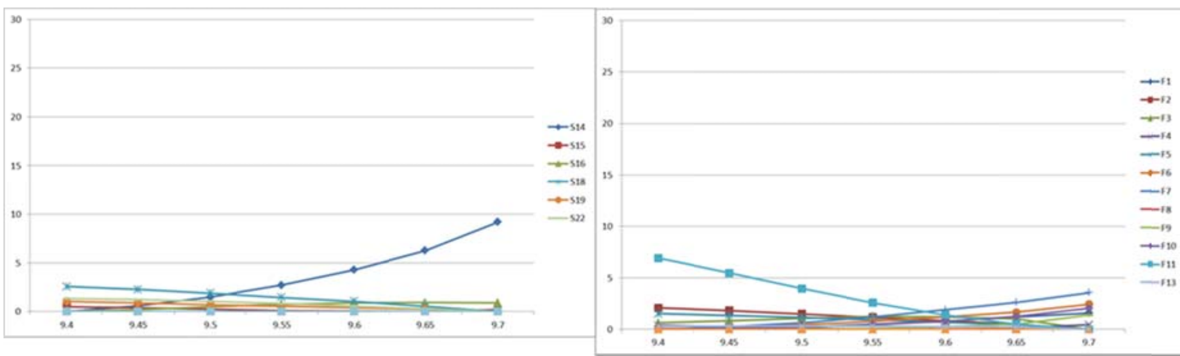


Fig. 7. Likelihood profiles on R_0 with configuration after modification of selectivity function (parametric)(run 1 of Annex 2), estimation of CVs of CPUEs improve misfit to length composition data, and elimination of uncertain catch at length.

7.0 DEFINITION AND REVIEW OF FUTURE PROJECTION AND REFERENCE POINT

7.1 Biological reference points and Future projections of Pacific bluefin tuna (ISC/12-2/PBFWG/08, M. Kai, M. Ichinokawa & Y.Takeuchi)

This paper presents a list of biological reference points (BRPs) and results of future projection using a preliminary stock assessment result of PBF. The stock status in relation to estimated BRPs suggests that fishing mortality on this stock during 2007-2009 exceeded those during 2002-2004. Empirically based BRP suggested that current F exceeds F_{med} by 20-30%. Future projection indicates that future spawning stock biomass (SSB) can be recovered to the historical median level under $F_{2002\text{-}2004}$, while current F ($F_{2007\text{-}2009}$) causes future SSB to further decline to 30-40% of historical median level of SSB.

Evaluation of the effectiveness of five future harvesting scenarios, with the current conservation and management measure (CMM) and with Japanese regulation of purse seine fisheries, was conducted by using performance index on SSB and total catch. For most of the scenarios, it was very clear that the trade-off for increasing SSB is reduction of the catch. However, the trajectory of a scenario ($F_{2007\text{-}2009}$ with catch regulation on Japanese purse seine fishery) showed that SSB can sharply recover with steadily increasing catch. These results mean that the balance of the performance index is better than the others. The results of the risk assessment demonstrated that the risks of future SSB to decline below the benchmarks (Minimum SSB, Average ten historical level (ATHL), historical lowest 10 %, and historical lowest 20%) are very low for all scenarios.

Discussion

The WG discussed if it was appropriate to discuss the settings and scenarios of future projection before the outcome of the stock assessment. It was noted that the results of the assessment are needed to determine the projections, but it was also noted that any proposed changes in the current projection software will need advance notice.

7.2 Future projections

The WG considered the options for developing future recruitment and it was thought that resampling recruitment from some time period was likely the best option. It was also suggested that resampling from high and low recruitment periods could serve to bracket uncertainty. Resampling deviations from a S-R relationship is also possible with both a Beverton and Holt (h=1) and a hockey-stick relationship is available in the current software.

The WG noted that the assessment period ends in 2011 and that projections begin in 2013 and thus a decision about how control the intervening years is needed. Two options were discussed: Use harvest level from CMM 10-04 or current F. No decision was reached.

The WG noted that a comprehensive list of fishing intensities evaluated could include Biological Reference Points. It was also noted that the following two options should be included:

1. Status-quo ($F_{2007\text{-}2009}$)
2. $F_{2002\text{-}2004}$

IATTC requested that a set of Eastern Pacific Ocean harvest options be evaluated in the projections. Although further clarification from IATTC will be needed, the options will include the following fishing intensities in the EPO:

1. Status-quo (2007-2009)
2. 25% of Status-quo (2007-2009)
3. Average F of 1994-2007

and the following fishing intensities in the WCPO:

1. Status-quo (F2007-2009)
2. $F_{2002\text{-}2004}$

It was noted that some members of the WG requested projections with harvest options specific to the Japanese fisheries:

1. 4500MT for small pelagic PS (part of fleet 2, as currently defined)
2. 2000MT for tuna PS (fleet3)
3. 500MT for PS in Pacific (fleet4)

The WG discussed creation of a decision table based on the projections. The WG agreed to include indicators (e.g. average SSB, catch etc.) of future stock status (short and long period) by changing F in the decision table,

7.3 Reference point

It was suggested to list a suite of commonly used reference points, due to the lack of an official identification of the reference point to be used, from the WCPFC NC. The WG decided to leave the discussions still open for the WG members.

8.0 OVERVIEW OF THE STOCK ASSESSMENT WORK CONDUCTED AT THE WORKSHOP

During the stock assessment workshop, there were lengthy discussions about the model configurations and model fit to data. Main configurations were introduced from the agreement at the ISC PBFWG February in 2012 (see Annex 6 Table 1), but some of configuration details were still on the table. The major change after PBFWG February 2012 was in the selectivity curve. The WG initially implemented cubic spline function to estimate it for all Fleets except for Taiwanese longline (fleet 10) which is assumed to have an asymptotic selectivity for this stock assessment. During this Workshop, however, because of high sensitivity of spline function to the small changes of the setting such as the number of the knots or their positions, PBFWG decided not to use spline curves but use parametric curves until model sensitivity to the spline curve configuration is better understood.

The WG also discussed the high sensitivity of the average level of recruitment (log of R0), which indirectly can determine the scale of biomass, by likelihood component of size composition, and generally agreed that these effects need to be reasonably minimized or balanced. For resolving the problems, several approaches (e.g. elimination of uncertain length data, modification of parameterization of selectivity functions, incorporating time-varying selectivity and arbitrary down-weighted to length likelihood components) have been explored by the WG.

Importantly, there was substantial discussion among the WG about the importance of model fit to the data, especially the fit to the abundance indices (see Comment 2 below). Different approaches to this were evident among the WG (cf. Comment 1 & 2). Nevertheless, the WG agreed to continue working on this problem and resolve this issue for the next meeting.

Typical runs discussed during the session (Runs 1 and 2) are given in the Annex which appears to show a reasonable range of stock trends. The following opinions were expressed on the floor.

Comment 1 (on Run 1)

“After re-examination of parameterization in selectivity functions and elimination of uncertain length composition data in some fisheries, we made sure that likelihood profiles on R0 have greatly improved to show consistent trends between CPUE and length composition data. We think that the effect of size composition data to R0 was reasonably reduced by those modifications, without incorporating “time block” in the selectivity.

“Therefore, although there remains one major difference to realize the concept above on the use of “time block”, we came up with the simpler idea that “Time block” is not necessary; to keep a fair balanced weighting among the size compositions data and CPUE data. The reason to choose the simple way of modeling is that the most of all data were discussed well during the data preparatory meeting in last February. Currently we can’t provide enough scientific evidences to establish time varying selectivity. Also we note that the WG recommend further studies on this matter (see recommendation section)

“Then, most of the data, which contain uncertainties, were already excluded or down-weighted. Consequently effects of size composition data to the level of R0 as were reasonably reduced without “time block” in the selectivity and with keeping “fair and balanced” weighting. Accordingly, we proposed a model configuration, which has no “Time block”, all size composition lambda=1 except Fleet 11 to 13. In addition, we considered a possibility to allow extra CV for CPUE data. ”

Comment 2

“Data: This statement assumes that fishery definitions and time-series of data have been developed and adopted and that only credible data is made available for the stock assessment modeling. Thus we accept that all data is relevant and that we need to achieve the best representation of all data in the modeling. Furthermore we assume that the precision of the data is reflected in the reported variance used in the modeling.

“Modeling approach: We generally assume catch is estimated with minimal error and should be treated as known or estimated precisely unless this assumption is shown to be false. We accept that standardized indices of abundance (typically CPUE or better fishery independent surveys) are the best available representation of trends in the abundance of the segment of the population sampled and that biological composition (size/age frequency) best describes that segment of the populations size or age structure. Attempts should be made to reduce the inevitable conflict between biological composition information and CPUE through the use of appropriate additional model process if applicable. Serious irresolvable conflicts in trends in indices of abundance may require alternative models to reflect the different trends. Generally, we recommend re-weighting the input variances to be consistent with model expectation in a final model so that our model results match the statistical assumptions.

“Model choice: Attempts should be made to insure that fit to the data and not the misfit of data is influencing the model results using traditional diagnostics and model exploration. Adequate representation of the indices of abundance in the model results are a primary diagnostic of model performance. Model results, such as biomass or F trends should be evaluated for implausibility but with care so that model outcome does not represent our belief. Final model choices should be achieved without consideration of the potential management considerations."

Run 3

Noting differences in the model configurations between Runs 1 and 2, another run (Run 3) which falls between Runs 1 and 2 was presented on the final day, This run reflects the idea with eliminating estimation of extra CV to CPUE (as in the case of Run 2) but eliminating time blocks for F4 and F11 (as in the case of Run 1). However, the WG did not have enough time to review this run and agreed to include it as the third run (see Annex).

9.0 STOCK STATUS AND CONSERVATION ADVICE FOR PBF

9.1 Stock status and conservation advice

Since the WG could not select a base case run, no future projections were developed. Under the circumstances, the WG cannot offer a clear view on the stock status for PBF.

Although there is no new quantitative description of stock status, the exercise to develop a base case model and the fishery-associated data (e.g. Fig. 2) suggested that: the SSB may have continued declining since the last stock assessment (2010), as was projected at that occasion; whilst current recruitments may have fluctuated yearly without any specific trends. Therefore, until a new stock assessment result becomes available, the WG decided to carry over the previous conservation advice, albeit with the precautionary note that the uncertainty in the stock status has increased through the passage of time. The conservation advice is as follows.
"Given the conclusions of the July 2010 PBFWG workshop (ISC/10/ANNEX/07), the current (2004-2006) level of F relative to potential biological reference points, and the increasing trend of F, it is important that the level of F is decreased below the 2002-2004 levels, particularly on juvenile age classes."

However, given that SSB may have continued to decline since the last stock assessment, the WG noted it is even more important that the above conservation advice be followed even though uncertainty in the stock status has increased.

9.2 Completion of the stock assessment

Noting that PBF stock assessment had not been completed at this session, the WG proposed that it hold another session in the very near future and report stock status of PBF to the 2013 ISC Plenary. The date and venue of the proposed session should be decided at the meeting of WG or ISC Plenary in July 2012 in Sapporo.

At the WG meeting in July 2012, the ISC Chair emphasized importance of completing the assessment work and adopting the final report by the end of 2012, by the WG and by the ISC Plenary.

The WG, realizing that the ISC Plenary has to adopt the final WS report by the end of 2012 and by back calculating from this deadline, proposed that the WG hold the stock assessment workshop on 9-16 November 2012 in Honolulu, USA.

In order to develop a Work Plan for this proposed workshop. WG reviewed research recommendations (See Section 10).

The proposed WS will review studies which would be useful in interpreting and understanding data already presented and their uncertainties, particularly those relating to the modeling configurations. However, the change to the base data will not be accepted, unless errors are identified and agreed by the WG.

Taking into consideration of this possible new information, the WG will decide the configurations to be used in the base case. Sensitivity runs as well as future projections will be made basically according to the procedures agreed upon in May-June meeting. The final conclusion of the WG will include conservation advice.

10.0 RESEARCH RECOMMENDATIONS*

The WG reviewed at its July session, the list of research recommendations prepared at its May-June Workshop.

1. Recognizing the importance of obtaining some new information on the points of conflicts in interpreting fishery related data and associated uncertainties, the WG made some minor modifications on text and on the time frame considered for each recommendation. Noting that after 2007 size composition data from Japanese purse seine fishery operating in the Sea of Japan suggested a decline of upper limit of size/age range of target fish, it is recommended that the evaluation of size composition data be continued, in order to investigate if this decline of upper limit of size/age range of target fish continues. It is also recommended that WG consider introducing "time block" to the modeling of selectivity function to this fishery to better parameterize the apparent shift in size/age of fish target by this fishery.
   (time frame : possibly at 2012 WS or otherwise next WS).

2. Noting that Japanese purse seine fishery operating in the Pacific ocean opportunistically catches variety of size/age of PBF, while their main target species is skipjack, also noting that their size/age of fish caught by this fishery varies year by year, and also noting that background information of this fishery (including the historical changes) is insufficient, it is recommended that information to efficiently characterize this fishery be collected and reviewed.
   (time frame : if possible by 2012 WS or otherwise next WS)

3. Noting that a Mexican project to improve size sampling from farming in EPO is ongoing, and also noting that size composition data from EPO commercial fishery suggested the size of fish captured shifted to the larger fish after 1998, and noting that the data from Catch Documentation System (CDS) (see ISC/12/PBFWG-2/20) received by the

Japanese Government are conflictive with this observation, it is highly recommended that the current size and age range of fish caught by EPO commercial fishery be evaluated with special attention to the improvement of size sampling from the fish designated to pen.
(time frame : next WS)

4. The 2012 stock assessment tried the cubic spline selectivity function feature in Stock Synthesis software; this new feature demonstrated its high flexibility, although it revealed its complexity and high sensitivity to configurations. It is recommended that the WG will hold a Workshop focusing on this issue. Involvement of expertise might be the appropriate way to determine the configuration of the selectivity function of the Stock Synthesis software.
(time frame : if possible by 2012 WS or otherwise by 2014)

5. Noting that the current fisheries definition of the stock assessment input data, combines Korean offshore large purse seine fleet with Japanese purse seine fleet operating in the East China Sea in Fleet 2 because of the similarity in operating area, and recognizing that Korea started their own size regulation on Korean PBF catch from 2011, it is recommended that Korea submit a working paper to the WG, at the WS planned in advance to the next stock assessment, evaluating possible changes in size of fish caught by its fleet in response to its new regulation and explain the fishery specifications. In addition, noting that Korea has submitted size composition data to ISC data base, and recognizing that in ISC, each species WG holds its own stock assessment data apart from ISC data base, it is recommended that Korea submit the size composition data of its offshore large purse seine catches to the WG, to enable SS estimate the selectivity curve of this fleet. It is also recommended, that the WG consider, based on the above data, the separation of Korean offshore large purse seine fleet and Japanese purse seine fleet in the stock assessment fleet definition.
(time frame : if possible by 2012 WS but otherwise well before the next stock assessment)

6. Noting that it is recommended that Korea submit a working paper to the WG, at the WS planned in advance to the next stock assessment, evaluating possible changes in size of fish caught by its fleet in response to its new regulation and explain the fishery specifications in recommendation 5, the stock assessment to be conducted in November 2012 will separate in the data file the Korean offshore large purse seine fleet from the Japanese small pelagic purse seine fleet operating in the East China Sea. This separation allows evaluation of changing management measures in the Korean fleet in the future projections. At the stock assessment in November 2012, the Korean offshore large purse seine fleet will share the selectivity pattern with the Japanese small pelagic purse seine fleet operating in the East China Sea for the purpose of the estimation of dynamics in the assessment model. It is recommended that Korean members submit a paper describing the management measures enacted in 2011 as well as proposed harvest scenarios desired for evaluation in the future projections.
(time frame: next stock assessment November 2012 if possible, otherwise next full stock assessment)

7. During the meeting of modeling small group, it appeared that population size estimates including levels of recruitment as well as of biomass are highly sensitive to the growth curve function parameters to be used. It also appeared that, in particular, size of fish at the time of the recruitment to the fishery is highly influential to the recruitment estimates. In addition, it appeared that implied length at age from the Stock Synthesis estimates differs from the length at age estimates (e.g. Shimose et al 2009, 2012) obtained externally out of the Stock Synthesis. it is highly recommended that more reliable growth curve estimates be investigated by the next stock assessment is planned.
(time frame : by ISC 14)

8. To accomplish the above, it is also recommended to investigate the other age characters such as annual rings of vertebrae, scales, daily rings of otolith, and to consider validation of age readings by using multi-methods, such as otolith micro chemicals and radio-isotopes. It is recommended that the Plenary Meeting would seek an opportunity to hold a special Workshop for age determination of tunas in the North Pacific (PBF and North Pacific albacore) to polish and to revise the age-determination manual of PBF.
(time frame : by ISC13 or ISC14)

9. Noting that the highly diverse fisheries targeting different PBF size groups, the WG encourages that age and growth studies be conducted to estimate more reliable growth parameters. The WG recommends collecting PBF otolith samples from different PBF fisheries/regions; and to communicate and share the otolith samples among the ISC members.
(time frame : by ISC14)

10. Noting that assumed spawning area of PBF spreads very widely and no definite spawning grounds are well defined, it is recommended to exchange and to share information for larval/juvenile survey methods and results for PBF among the ISC scientists. To accomplish this it is recommended to plan a joint survey to identify spawning grounds in the areas not known at present (e.g. Korean waters and Chinese Taipei waters etc.).
(time frame : by ISC 15)

11.0 OTHER MATTERS

No other matters were discussed.

12.0 CLEARING OF THE REPORT

The WG agreed to review the draft report through correspondence and finally adopt it at the WG meeting in prior to the 10th ISC meeting in July, 2012 in Sapporo.

The draft report, which included various comments received after the May-June session, edited and reformatted was presented at the WG meeting on July 16-17, 2012, at Sapporo in prior to the ISC 12. It was confirmed that this draft was distributed for the final comments a few days before the WG session at Sapporo. After reviewing the draft, the WG adopted the entire report with further modifications.

13.0 ADJOURNMENT

The meeting was adjourned

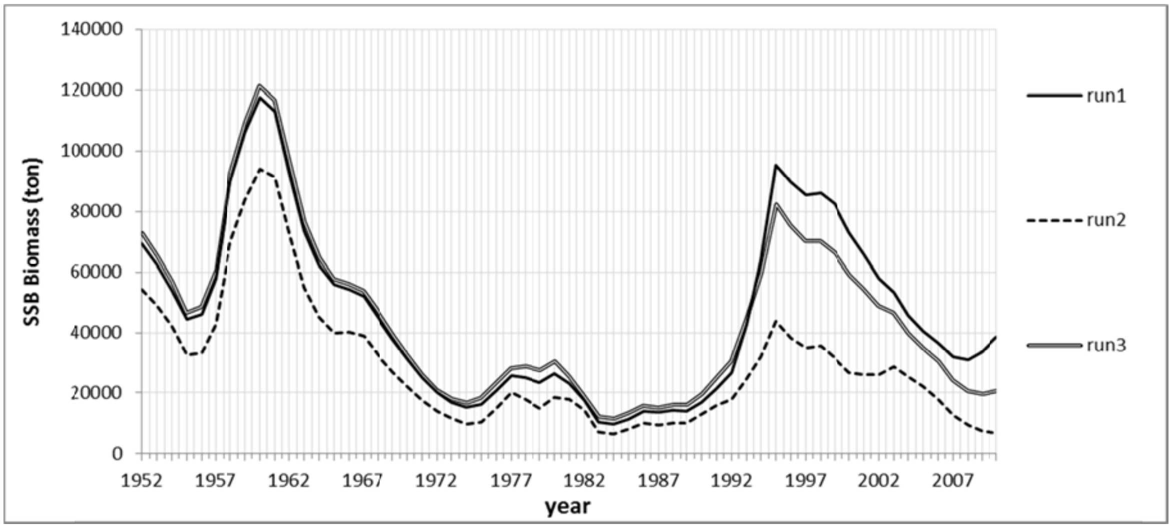
Annex. Descriptions of typical three runs

As explained in the texts of the WG report, the WG made lengthy discussions about the model configurations. Main configurations were introduced from the agreements at the ISC PBFWG in February, 2012 (see Annex-Table), but some of these configuration details were still left open for discussion. The WG has explored several approaches (e.g. elimination of uncertain length data, modification of parameterization of selectivity functions, incorporating time-varying selectivity and arbitral down-weight to length likelihood components). After the discussions of the WS, the WG minimized differences on the model configurations (see left two columns of Annex -Table 1). On the last few days of the WS, two typical runs (runs 1 and 2, see Annex-Figure for trends of spawning stock biomass) were presented. These runs appear to show a reasonable range of stock trends. Also at the last day of the meeting another run which falls between these two runs was presented (run 3, see Annex-Figure) Differences between models are explained in Annex table 1.

Run 3

Noting the differences in the model configurations between Runs 1 and 2, another run (Run 3) which falls between Runs 1 and 2 was presented on the final day, This run reflects the idea with eliminating estimation of extra CV to CPUE (as in the case of Run 2) but eliminating time blocks for F4 and F11 (as in the case of Run 1). However, the WG did not have enough time to review this run and agreed to include it as the third run (see Annex).

Annex -Figure. Spawning stock biomass trends of runs 1-3.



Annex-Table. SS model configurations agreed by the WG (2nd column, also see in table 3 in main text) and remaining differences in configurations (bolds in 3rd -5th columns). Blanks in 3rd to 5th columns indicate that there was no difference.

	Agreement in this WG	run 1	run 2	run 3
Model Structure				
SS version	SS-V3.23b			
Year definition	July to June			
Period	1952-2010			
Time step	Quarter			
Number of stock, area, gender, growth pattern and growth morphs (spawning population)	Single			
Number of age class	21(0-20)			
Fishery definition	13 fleets for catch and 5 surveys of CPUE			
Popo length bin	2 cm bin (16 cm - 222 cm and 252 cm - 290 cm), 1 cm bin interval (224 cm-251 cm)			
Biological parameters				
Natural mortality	Age specific,year is time step Age0 =:1.6 Age 1=0.386 Age2+=0.25			
Maturity	Age3=0.2 Age4=0.5 Age 5+=1.0			
Growth curve	Estimate K and Lmax from otolith data in Shimose (2012) by fixing length at age 0 to be 21.5 cm.			
Functional form of CV growth	CV=F(L)			
Amin	0			
Amx	3			
L-W	Kai et al. 2007			
Assumption of recruitment				
SRR	B-H			
R0	Estimated			
Steepness	0.999			
sigmaR	0.6, run estimate			
1st year of main Rdev	1946			
R0 offset	Estimated			
SR auto correlation	No			
Fishery & fishing				
Catch unit	Weight			
Catch error	0.1			
Initial F	Equilibrium catch of F4 -> zero, not estimate initial F of F4			
F-method	3 (solve catch eq)			
iteration	5			
upperF	10			
CPUE assumption				
CPUE likelihood	lognormal			
CPUE lambda	1 for all CPUE, but 0 for EPO PS			
CV of CPUE	Lowest CV is set as 0.2	Estimate CV	Lowest CV is set as 0.2	Lowest CV is set as 0.2
Length comps & Selectivity				
effN for LenComps	Scale to have same effN to F11,F3(SOJ)			
Length bin definition	Use wider weight bin			
ESS	Reset length lambda=0.1 for F11 and F13, 0 for F12 and 1 for ather fleets, then re-weight	no reweight	no reweight	no reweight
Selectivity	F1 Double normal, Eliminate data in 1956 (outlier)			
	F2 Double normal			
	F3 Double normal	No time block	Time block (1987-1989, 1995-1997, 2000-2002)	No time block
	F4 Double normal, Eliminate data before 1993 and after 2007			
	F5 Double normal			
	F6 Mirror F5 selectivity			
	F7 Double normal			
	F8 Double normal			
	F9 Double normal			
	F10 Flat top			
	F11 Double normal	No time block	Time block (1996-2010)	No time block
	F12 Mirror F11 selectivity			
	F13 Double normal			

Appendix 1. Agenda

ISC Pacific Bluefin Tuna Workshop

May 30-June 6, 2012

1.0 Opening and Introduction

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 Review of recent fisheries and annual PBF catch

3.0 Review of biological Studies

4.0 Report and recommendations from the modeling small group meeting

5.0 Review of stock assessment input data

6.0 Definition and review of the SS base case run and sensitivity runs for PBF

7.0 Definition and review of future projection and reference points

8.0 Overview of the stock assessment work conducted at the Workshop

9.0 Stock status and conservation advice for PBF

10.0 Research Recommendations

11.0 Other matters

12.0 Clearing of the report

13.0 Adjournment

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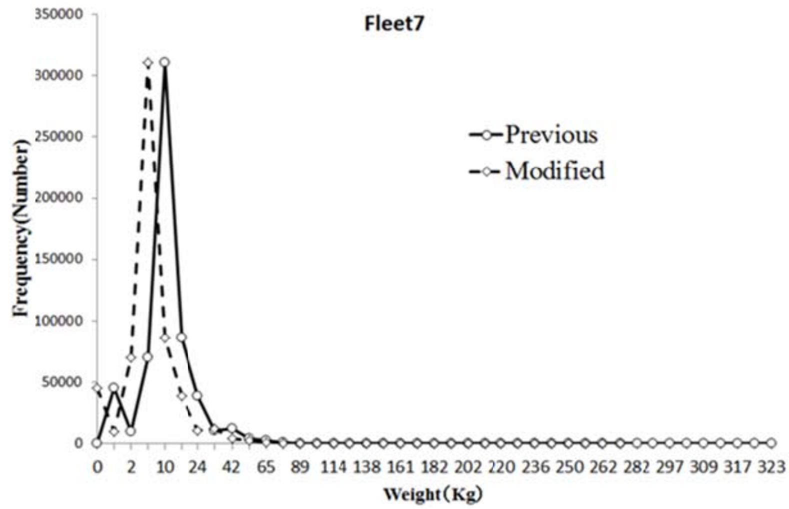
Appendix 2. Lists of Documents

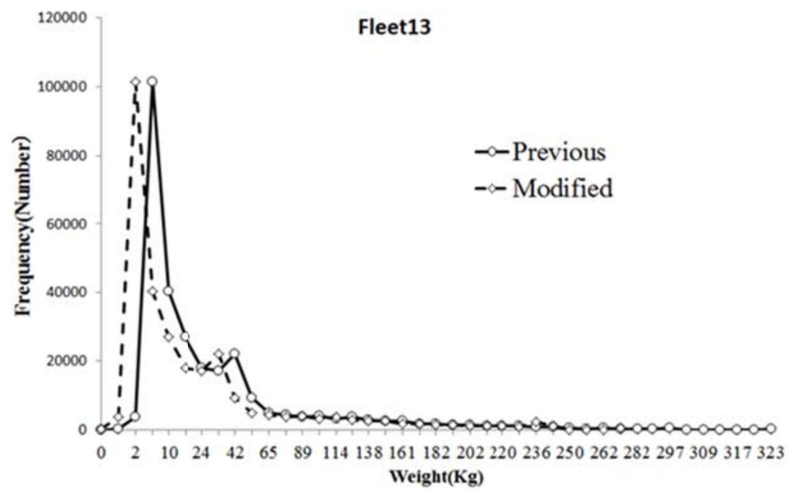
No	Title	Author
ISC/12-2/PBFWG/01	Japanese Pacific bluefin tuna catch updates	Kazuhiro Oshima, Masayuki Abe, Shuhei Uematsu
ISC/12-2/PBFWG/02	Input data for stock assessment model, Stock Synthesis 3, on Pacific bluefin tuna, *Thunnus orientalis*	Shuhei Uematsu, Kazuhiro Oshima, Minoru Kanaiwa, Momoko Ichinokawa, Mikihiko Kai, Masayuki Abe, Shigehide Iwata, Ko Fujioka, Hiromu Fukuda, Akiko Mizuno, Joon-Taek Yoo, Sang Chul Yoon, Hsu Chien-Chung, Steven Teo, Alexandre Aires-da-Silva, Michel Dreyfus and Takeuchi Y
ISC/12-2/PBFWG/03	Modification of input fishery data for Stock Synthesis III model fromthe 2010 Pacific bluefin tuna stock assessment	Ko Fujioka, Hiromu Fukuda, Kazuhiro Oshima, Masayuki Abe, Shigehide Iwata, Mikihiko Kai, Yukio Takeuchi
ISC/12-2/PBFWG/04	Strength of 2010 year class observed in catch information	Kazuhiro Oshima
ISC/12-2/PBFWG/05	Withdrawn	
ISC/12-2/PBFWG/06	Preliminary stock assessment of Pacific Bluefin Tuna through Stock Synthesis 3	Shigehide Iwata, Shuhei Uematsu, Kazuhiro Oshima, Momoko Ichinokawa, Mikihiko Kai, Masayuki Abe, Ko Fujioka, Hiromu Fukuda, Akiko Mizuno, and Yukio Takeuchi
ISC/12-2/PBFWG/07	A sensitivity analysis of stock assessment 2012 for Pacific bluefin tuna	Hiromu Fukuda, Mikihiko Kai, Shigehide Iwata, Masayuki Abe, Akiko Mizuno, Shuhei Uematsu, Ko Fujioka, Kazuhiro Oshima and Yukio Takeuchi
ISC/12-2/PBFWG/08	Biological reference points and Future projections of Pacific bluefin tuna	Mikihiko Kai, Momoko Ichinokawa and Yukio Takeuchi
ISC/12-2/PBFWG/09	Estimation of effective sample size for PBF caught by Japanese longline with bootstrap resampling method	Akiko Mizuno
ISC/12-2/PBFWG/10	Consideration of effective sample size and weighting for length frequency of PBF	Akiko Mizuno
ISC/12-2/PBFWG/11	Estimation of growth curve using conditional age at length data from otolith aging	Mikihiko Kai and Yukio Takeuchi
ISC/12-2/PBFWG/12	Withdrawn	

ISC/12-2/PBFWG/13	Activities and data collection of Pacific Bluefin tuna by Taiwanese fishery	Oversea Fisheries Development Council
ISC/12-2/PBFWG/14	Abundance index of Pacific Bluefin tuna (Thunnus orientalis) by Taiwanese small-scale longline fleet in the southwestern North Pacific Ocean -	Hien-Chung Hsu, Hui-Yu Wang
ISC/12-2/PBFWG/15	Selection of an asymptotic selectivity pattern y	K. Piner
ISC/12-2/PBFWG/16	Withdrawn	
ISC/12-2/PBFWG/17	Withdrawn	
ISC/12-2/PBFWG/18	Revision of input data for stock assessment on Pacific bluefin tuna	Kazuhiro Oshima
ISC/12-2/PBFWG/19	Withdrawn	
ISC/12-2/PBFWG/20	Size of Pacific bluefin tuna catches in the Eastern Pacific by Mexican purse seiners, estimated from Catch Document System (CDS)	Kazuhiro Oshima, Makoto Miyake and Yukio Takeuchi
ISC/12-2/PBFWG/21	Withdrawn	
Oral Presentation #1	A manual for age determination of Pacific bluefin tuna Thunnus orientalis	T. Shimose
Oral Presentation #2	Pacific bluefin tuna larval/Juvenile surveys	O. Abe
Oral Presentation #3	Time varying selectivity of fisheries in the Pacific Bluefin tuna stock assessment	S. Teo

Appendix 3. The correction of the definitions of weight bins for fleet 7 and 13

In SS model, the interval of size bin is defined as left-closed and right-open intervals. However, the weight bins for fleet7 (Northern part of set-net fishery) and 13 (Other fishery) were incorrect definitions with right-closed and left-open and given as follows; 1 (kg),2,5,10,…. Hence, we corrected the definitions of weight bins for fleet7 and 13 as follows; 0 (kg),1,2,5,…. Previous and corrected weight frequencies are shown in below.





Appendix 4. Pacific bluefin tuna catch table by fisheries (metric tons) during 1952-2011

Year	Western Pacific States																Eastern Pacific States						Out of ISC members		Grand Total
	Japan[1]									Korea[3]		Taiwan				Sub Total	United States[4]			Mexico		Sub Total			
	Purse Seine		Dist. & Off. Longline		Coastal Longline	Troll[2]	Pole and Line	Set Net	Others	Purse Seine	Trawl	Longline	Purse Seine	Distant Driftnet	Others		Purse Seine	Others	Sport	Purse Seine	Others		NZ[5]	Others[6]	
	Tuna PS	Small PS	NP	SP																					
1952	7,680		2,694	9		667	2,198	2,145	1,700							17,094	2,076		2			2,078			19,172
1953	5,570		3,040	8		1,472	3,052	2,335	160							15,636	4,433		48			4,481			20,117
1954	5,366		3,088	28		1,656	3,044	5,579	266							19,027	9,537		11			9,548			28,575
1955	14,016		2,951	17		1,507	2,841	3,256	1,151							25,739	6,173		93			6,266			32,005
1956	20,979		2,672	238		1,763	4,060	4,170	385							34,268	5,727		388			6,115			40,383
1957	18,147		1,685	48		2,392	1,795	2,822	414							27,302	9,215		73			9,288			36,590
1958	8,586		818	25		1,497	2,337	1,187	215							14,666	13,934		10			13,944			28,610
1959	9,996		3,136	565		736	586	1,575	167							16,760	3,506	56	13	171	32	3,779			20,539
1960	10,541		5,910	193		1,885	600	2,032	369							21,531	4,547	0	1			4,548			26,079
1961	9,124		6,364	427		3,193	662	2,710	599							23,078	7,989	16	23	130		8,158			31,236
1962	10,657		5,769	413		1,683	747	2,545	293							22,107	10,769	0	25	294		11,088			33,195
1963	9,786		6,077	449		2,542	1,256	2,797	294							23,201	11,832	28	7	412		12,280			35,481
1964	8,973		3,140	114		2,784	1,037	1,475	1,884							19,406	9,047	39	7	131		9,224			28,631
1965	11,496		2,569	194		1,963	831	2,121	1,106			54				20,334	6,523	77	1	289		6,890			27,224
1966	10,082		1,370	174		1,614	613	1,261	129							15,243	15,450	12	20	435		15,918			31,161
1967	6,462		878	44		3,273	1,210	2,603	302			53				14,825	5,517	0	32	371		5,920			20,745
1968	9,268		500	7		1,568	983	3,058	217			33				15,634	5,773	8	12	195		5,989			21,623
1969	3,236		313	20	565	2,219	721	2,187	195			23				9,479	6,657	9	15	260		6,940			16,419
1970	2,907		181	11	426	1,198	723	1,779	224							7,448	3,873	0	19	92		3,983			11,432
1971	3,721		280	51	417	1,492	938	1,555	317			1				8,773	7,804	0	8	555		8,367			17,140
1972	4,212		107	27	405	842	944	1,107	197			14				7,854	11,656	45	15	1,646		13,362			21,216
1973	2,266		110	63	728	2,108	526	2,351	636			33				8,821	9,639	21	54	1,084		10,798			19,619
1974	4,106		108	43	1,069	1,656	1,192	6,019	754			47			15	15,010	5,243	30	58	344		5,675			20,685
1975	4,491		215	41	846	1,031	1,401	2,433	808			61			5	11,332	7,353	84	34	2,145		9,616			20,948
1976	2,148		87	83	233	830	1,082	2,996	1,237			17			2	8,716	8,652	25	21	1,968		10,666			19,381
1977	5,110		155	23	183	2,166	2,256	2,257	1,052			131			2	13,335	3,259	13	19	2,186		5,477			18,811
1978	10,427		444	7	204	4,517	1,154	2,546	2,276			66			2	21,645	4,663	6	5	545		5,218			26,863
1979	13,881		220	35	509	2,655	1,250	4,558	2,429			58				25,595	5,889	6	11	213		6,119			31,715
1980	11,327		140	40	671	1,531	1,392	2,521	1,953			114			5	19,693	2,327	24	7	582		2,940			22,634
1981	25,422		313	29	277	1,777	754	2,129	2,653			179				33,532	867	14	9	218		1,109			34,641
1982	19,234		206	20	512	864	1,777	1,667	1,709	31		207		2		26,228	2,639	2	11	506		3,159			29,387
1983	14,774		87	8	130	2,028	356	972	1,117	13		175	9	2		19,670	629	11	33	214		887			20,557
1984	4,433		57	22	85	1,874	587	2,234	868	4		477	5		8	10,655	673	29	49	166		917			11,573
1985	4,154		38	9	67	1,850	1,817	2,562	1,175	1		210	80	11		11,975	3,320	28	89	676		4,113			16,089
1986	7,412		30	14	72	1,467	1,086	2,914	719	344		70	16	13		14,157	4,851	57	12	189		5,109			19,266
1987	8,653		30	33	181	880	1,565	2,198	445	89		365	21	14		14,474	861	20	34	119		1,033			15,507
1988	3,583	22	51	30	106	1,124	907	843	498	32		108	197	37	25	7,562	923	50	6	447	1	1,427			8,989
1989	6,077	113	37	32	172	903	754	748	283	71		205	259	51	3	9,707	1,046	21	112	57		1,236			10,943
1990	2,834	155	42	27	267	1,250	536	716	455	132		189	149	299	16	7,067	1,380	92	65	50		1,587			8,653
1991	4,336	5,472	48	20	170	2,069	286	1,485	650	265		342		107	12	15,262	410	6	92	9		517	2		15,781
1992	4,255	2,907	85	16	428	915	166	1,208	1,081	288		464	73	3	5	11,896	1,928	61	110	0		2,099	0		13,995
1993	5,156	1,444	145	10	667	546	129	848	365	40		471	1		3	9,825	580	103	298			981	6		10,811
1994	7,345	786	238	20	968	4,111	162	1,158	398	50		559				15,795	906	59	89	63	2	1,118	2		16,916
1995	5,334	13,575	107	10	571	4,778	270	1,859	586	821		335			2	28,248	657	49	258	11		975	2		29,225
1996	5,540	2,104	123	9	778	3,640	94	1,149	570	102		956				15,066	4,639	70	40	3,700		8,449	4		23,519
1997	6,137	7,015	142	12	1,158	2,740	34	803	811	1,054		1,814				21,720	2,240	133	156	367		2,897	14		24,632
1998	2,715	2,676	169	10	1,086	2,865	85	874	700	188		1,910				13,277	1,771	281	413	1	0	2,466	20		15,763
1999	11,619	4,554	127	17	1,030	3,387	35	1,097	709	256		3,089				25,919	184	184	441	2,369	35	3,213	21		29,153
2000	8,193	8,293	121	7	832	5,121	102	1,125	689	2,401	0	2,780			2	29,665	693	61	342	3,019	99	4,214	21		33,900
2001	3,139	4,481	63	6	728	3,329	180	1,366	782	1,176	10	1,839			4	17,103	292	48	356	863		1,559	50		18,712
2002	3,922	4,981	47	5	794	2,427	99	1,100	631	932	1	1,523			4	16,467	50	12	654	1,708	2	2,427	55	10	18,959
2003	956	4,812	85	12	1,152	1,839	44	839	446	2,601	0	1,863			21	14,671	22	18	394	3,211	43	3,689	41	19	18,419
2004	4,934	3,323	231	9	1,616	2,182	132	896	514	773	0	1,714			3	16,326		11	49	8,880	14	8,954	67	10	25,357
2005	4,034	8,783	107	14	1,818	3,406	549	2,182	548	1,318		1,368			2	24,129	201	7	79	4,542		4,830	20	7	28,986
2006	3,644	5,236	63	11	1,058	1,544	108	1,421	777	1,012		1,149			1	16,024		2	96	9,928[8]		10,026	21	3	26,074
2007	2,965	3,875	83	8	2,004	2,385	236	1,503	1,209	1,281		1,401			10	16,960	42	2	14	4,147		4,205	21[9]	3[9]	21,189
2008	3,029	7,192	19	8	1,476	2,074	64	2,358	1,192	1,866		979			2	20,259		1	93	4,392	15	4,501	21[9]	3[9]	24,784
2009	2,127	5,950	8	7	1,304	1,875	50	2,236	913	936		877			11	16,294	410	5	176	3,019		3,610	21[9]	3[9]	19,928
2010	1,122	2,620	4	6	904	1,301	83	1,603	918	1,196		373			36	10,166		0	122	7,745		7,867	21[9]	3[9]	18,057
2011	2,194	6,137	-[7]	-[7]	727	1,688	63	1,957	572	670		292			24	14,324	99	18	456	2,730		3,303	21[9]	3[9]	17,651

Appendix 4. (continued)

1 Part of Japanese catch is estimated by the WG from best available source for the stock assessment use.
2 The troll catch for farming estimating 10 - 20 mt since 2000, is excluded.
3 Catch statistics of Korea derived from Japanese Import statistics for 1982-1999.
4 US in 1952-1958 contains catch from other countries - primarily Mexico. Other includes catches from gillnet, troll, pole-and-line, and longline.
5 Catches by NZ are derived from the Ministry of Fisheries, Science Group (Compilers) 2006: Report from the Fishery Assessment Plenary, May 2006: stock assessments and yield estimates. 875 p. (Unpublished report held in NIWA library, Other countries include AUS, Cooks, Palau and so on. Catches derived from Japanese Import Statistics as minimum estimates.
6 Other countries include AUS, Cooks, Palau and so on. Catches derived from Japanese Import Statistics as minimum estimates.
7 The catch for Japanese coastal longline in 2011 includes that for the distant water and offshore longliners.
8 Revision of annual catch was made for Mexican PS in 2006 due to observer information that was not considered before.
9 Catches in New Zealand and Other countries since 2007 are carry-overs of those in 2006.
10 Catches in shaded cells are provisional.