NORTHERN COMMITTEE
SIXTH REGULAR SESSION
7-10 September 2010
Fukuoka, Japan

Report of ISC Albacore Working Group for 2010

WCPFC/NC6/IP-02
27 August 2010

ISC

Annex 6

REPORT OF THE ALBACORE WORKING GROUP WORKSHOP

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

20-26 April 2010
Shizuoka, Japan

1.0 INTRODUCTION

A meeting of the *International Scientific Committee for Tunas and Tuna-like Species in the North Pacific (ISC) - Albacore Working Group* (ALBWG or the WG) was held at the National Research Institute of Far Seas Fisheries (NRIFSF) in Shimizu, Japan on 20 – 26 April 2010.

Eighteen (18) participants from Canada, Japan, and the United States participated in the meeting (Appendix 1). The ALBWG regrets that no one from Chinese-Taipei was able to attend the meeting and looks forward to their participation at the July 2010 meeting. John Holmes chaired the meeting. A provisional agenda was circulated prior to the meeting, received minor revisions at the meeting, and was adopted (Appendix 2). John Holmes, Momoko Ichinokawa, Mikihiko Kai, Suzanne Kohin, Hui-hua Lee, Miki Ogura, Steven Teo, Koji Uosaki, and Zane Zhang served as rapporteurs.

1.1 Working Paper Policy

The ALBWG briefly reviewed the ISC policy on working paper availability while working papers were distributed. The ISC working paper policy was revised in July 2009 to improve the transparency and dissemination of scientific results to the public while recognizing the right of authors to withhold releasing a paper publicly for journal publication, confidentiality or other reasons. The revised policy states

> *"Working papers presented at WG workshops, excluding information papers and other non-working paper documents, shall be released publicly through the ISC website or other means only with the authors' permission. If an author chooses not to release the working paper publicly, the title and author's email address only will be released so that interested parties may contact authors directly to request copies."*

Working paper authors were asked by the Chair if they wished to make the full paper available through the ISC website. Eleven working papers were presented at the workshop and several authors agreed to post the full paper on the ISC website (Appendix 3). The WG requested clarification on the procedure for posting full papers: do papers require clearance through the ISC Plenary or can they be posted after the author provides permission at a WG meeting?

1.2 Workshop Goals

The ALBWG has been tasked with completing a new north Pacific albacore (NPALB) stock assessment in early 2011. The goals of the present meeting are: (1) to finalize spatial/temporal re-stratification of catch and effort data for the Japan Pole-and-Line (JPN PL), Japan longline (JPN LL), Taiwan longline (TWN LL), USA longline, (USA LL), and USA/Canada troll fisheries (USA/CAN troll); (2) to develop indicators of spawning biomass or recruitment for use during stock status updates between full assessments; and (3) to develop advice and recommendations on suitable biological reference points for the north Pacific albacore stock.

2.0. REVIEW OF IMPORTANT NATIONAL FISHERY DEVELOPMENTS

North Pacific albacore are a valuable species with a long history of exploitation in the north Pacific Ocean. The WG briefly reviewed oral reports of important fishery developments for 2009 since national fishery reports and updating of the catch table will be agenda items at the July 2010 meeting in Victoria, Canada.

2.1 Canada

John Holmes reported on the 2009 CAN troll fishery. Approximately 5,600 t of albacore was harvested, which is a 4% increase in catch relative to 2008. The Canadian troll fishery was largely coastal in 2009 with more than 85% of the catch and effort occurring within the EEZs of the United States and Canada. No Canadian vessels reported operating west of 142 °W, continuing a pattern that began in 2006. Thirty-eight vessels out of a fleet of 135 vessels (28%) participated in an on-board length sampling program that was implemented in 2009 and turned in 11,717 fork length measurements. This program will be an ongoing licence requirement.

2.2 Japan

Koji Uosaki presented a summary of the annual catch by the JPN PL fishery in 2009. Preliminary catch figures for this fishery are 32,421 t, which is a 66% increase from the 2008 catch (19,577 t). The increase in catch may have resulted from pole-and-line vessels switching between targeting skipjack and albacore. Skipjack fishing was poor in 2009 and very good for albacore during May to June on fishing grounds off Tokyo (32-36°N, 142-153°E). The number of pole-and-line vessels did not change between 2008 and 2009.

2.3 United States

Preliminary figures for United States albacore fisheries were presented by Suzanne Kohin. The biggest USA fishery is the troll/pole-and-line fishery. The troll fishery has averaged 10,000-12,000 t annually over the last 5 years and the preliminary figure for 2009 is 10,938 t. The pole-and-line fishery catches about 1,200 t. Other fisheries contribute small amounts to the total catch. The Hawaii-based USA LL fishery averages about 300 t historically. An update on the albacore catch by the recreational fishery in 2009 is not yet available.

3.0 SPATIAL/TEMPORAL STRATIFICATION OF FISHERIES

The ALBWG reviewed preliminary work to spatially re-stratify the catch, effort, and size data from the JPN LL and JPN PL fisheries in order to improve spatially explicit indices of albacore abundance at its April 2009 meeting (see Annex 6 in ISC 2009). Chinese-Taipei also presented preliminary reanalysis of the TWN LL CPUE focusing on the importance of developing a discriminant function to separate albacore targeted and non-targeted sets. The WG concluded in 2009 that further work on spatial/temporal patterns was necessary to finalize fishery definitions for the these fisheries and that similar reviews should be completed of the USA/CAN troll and USA LL fisheries. Four working papers (ISC/10-1/ALBWG/02, 05, 06, 08) characterizing the reanalyzed fisheries data for the JPN LL, USA LL, and USA/CAN troll fisheries were presented at this meeting. Unfortunately, Chinese-Taipei did not attend the workshop so a review of the TWN LL fishery will deferred to the July 2010 meeting.

3.1 Japan Pole-and-Line

Analyses to examine the temporal and spatial characteristics of the JPN PL fisheries are ongoing. A brief synopsis of the issues surrounding the fisheries was provided. The main issue is the high percentage of zero catch in all areas because the primary target species of this fishery is skipjack. Albacore is targeted when skipjack availability is poor. Various methods are being considered to deal with the zero catch. Consideration will also be given to combining some of the fishery data, for example combining the fishery for areas 1 and 2. Decisions on the fishery definitions for the JPN PL fisheries will be taken up at the July 2010 meeting once the analyses are completed and reviewed by the WG.

3.2 Japan Longline

ISC/10-1/ALBWG/02 describing recent changes in the operation of JPN LL fishery in their northeast Pacific fishing grounds, was presented by Takayuki Matsumoto. The cause of very low albacore catch and CPUE in the northeast Pacific by the JPN LL fishery during the 2003-2007 period was examined based on monthly 1° x 1° plots of catch, effort and CPUE. High albacore catch and CPUE were observed during a limited season and area on the northeast Pacific fishing grounds up to 2002, but little effort was deployed in this area during the 2003-2007 period. This absence of effort was likely caused by a shift in the area of JPN LL operations in the northeast Pacific, and it accelerated the decline in CPUE. Due to this problem, it is suggested that data from the northeast Pacific should be excluded from the JPN LL CPUE index used in the next stock assessment.

The WG discussed the recent JPN LL catch of albacore in the northeast (NE) Pacific area of operation (180° - 120°W and 25°N – 40°N; see Figure 1 of ISC/10-1/ALBWG/02). Since 2003, the fleet has been deploying deeper gear and targeting bigeye tuna in the southern part of the NE area. The decline in CPUE for the offshore/distant water longline fleet in the NE area since 2002 may be a consequence of the change in fishing operations and bigeye targeting. It was pointed out that the USA/CAN troll fishery has also retreated from offshore fishing grounds in the northeastern Pacific due to the high availability of albacore in the coastal waters of North America. ALBWG members were concerned about the absence of recent information on fish abundance in the northeastern Pacific area that was proposed to be eliminated from the CPUE index. Some WG members thought that the TWN LL fishery, which also operates in the NE area, could provide some data. In addition, it was pointed out that the effect on SS3 model output of eliminating the NE area from the CPUE index should be considered by conducting trials with CPUE indices including and excluding the NE area data. An alternative approach to standardizing the CPUE index is to use total catch as a factor so as to remove the effect of recent years on CPUE when catch was low. This CPUE issue was further discussed in the review of working paper ISC/10-1/ALBWG/04.

Takayuki Matsumoto also presented a paper describing the re-examination of JPN large (offshore/distant water) and small (coastal) LL fisheries (L-LL and S-LL) in the north Pacific for standardization of CPUE for Stock Synthesis 3 (SS3) analyses (ISC/10-1/ALBWG/04). Due to the concentration of LL effort and albacore catch in the northwest Pacific and a problem with the CPUE index for the northeast Pacific, the JPN LL fishery was aggregated into two or three sectors based on area and season in which only northwest and southwest areas were used for CPUE standardization. Large and small LL fisheries were aggregated due to the similarities in operations and size of fish caught in the same area. Trends in CPUE are similar among the newly defined fisheries except for a part of period. The results of last year's studies by Ichinokawa (ISC/09-1/ALBWG/02, 03) were also reviewed for discussion about arranging JPN LL fishery for SS3 analyses.

The ALBWG discussed several possible scenarios to combine fisheries by area, season, and size of fish caught to make a final stratification of the JPN LL fisheries. WG members agreed to partition the fisheries based on the size of fish caught since a length-based SS3 model will be used for the next stock assessment. Fishery I catches smaller fish and consists of the northwest region (130°E - 180° and 25°N – 40°N; see Figure 3 in ISC/10-1/ALBWG/04) for quarters 1 and 2 and the northeast region (180° - 120°W and 25°N – 40°N) from quarters 1 and 4. Fishery II catches larger-sized fish and is comprised of the northwest region for quarters 3 and 4, the northeast region for quarters 2 and 3, and all quarters in the southern region (120°E - 120°W and 10°N – 25°N).

The CPUE could be standardized in Fishery I using the data in the northwest quarters 1 and 2 data, and in Fishery II using the southwest data for all quarters of the year and the northwest for quarters 3 and 4. The WG suggested two alternatives for the CPUE index: first, data for the eastern regions are not included in the index because of the inconsistencies described above, and second, the NE area data are used in the standardized CPUE. These two alternatives need to be tested in the SS3 model in order to assess the impacts of eliminating the NE data on the model output. An additional option may be to use the index but estimate it with a greater standard error (SE) for the later years.

Standardized CPUE trends for the JPN LL fisheries in the northwest and southwest were also presented (Figure 5 in ISC/10-1/ALBWG/04). Participants discussed the meaning of the sharp decline of CPUE trend of the northwest fishery during the 1966 – 1970 period, which occurs at the beginning of the time series. One explanation is that this drop reflects a change in targeting from albacore to other tuna species. Work is ongoing to examine the species composition of this fishery and size composition of any other surface fisheries (e.g., the JPN PL) during the beginning of the time series to try to determine the cause of the initial decline in CPUE. Since the drop in CPUE during the early period may not reflect abundance but rather a targeting effect a decision will be made at the October 2010 data preparation meeting on whether to keep or eliminate this part of the time series for the next stock assessment.

The ALBWG explored the impacts of the new Japan LL fishery definitions on fits and biomass, spawning stock biomass (SSB), and recruitment outputs using an existing SS3 base-case scenario. Fits to the CPUE and length-frequency data were good and there were no real differences between outputs of the base case scenario (five JPN LL fisheries) and outputs with the new JPN LL fisheries. Some minor differences were observed at the beginning and end of the time series, but this was expected.

3.3 USA Troll

Working paper ISC/10-1/ALBWG/05 presented by Steven Teo addressed the spatial and temporal characteristics of the USA troll fishery in the northeast Pacific. In view of the transition to SS3, catch,-effort and length-frequency distributions (LFD) were examined, and a time-series of CPUE for stock assessments based on those characteristics was developed. Based on the catch and effort distribution from logbooks, the USA troll fishery was divided into inshore versus offshore (with 130°W as the dividing line), as well as north versus south (with 40°N as the dividing line). The overall albacore LFDs in these 4 areas were found to be relatively similar, especially between offshore and inshore areas. The size ranges for all areas were similar, ranging from approximately 40 to 100 cm, with a major mode at ~65 cm and a secondary mode at ~75 cm. The LFD in the northern area was relatively consistent through time with a strong mode at ~65 cm and the data coverage was high, but the LFD in the southern area showed less consistency, with the size of fish caught varying through cohorts and data coverage was also relatively low. The standardized CPUE indices for all scenarios were comparable, with all indices being highly correlated with each other (r ranged from 0.57 to 0.96, $p << 0.001$ for all correlations). However, there has been minimal catch and effort in the southern area in recent years, which suggests that CPUE indices from the southern area alone may not be representative of fish abundance.

The WG discussed area-specific effort changes. Although real-time satellite oceanographic information might help to increase the catchability of albacore, the concentration of fishing effort off Oregon and Washington in recent years is thought to be caused by an increase in albacore availability in those areas and the contraction of the fishing season from year round to June through October. The decrease in fishing effort in the southern areas might be due to a distributional change caused by oceanographic conditions. Although there was a small difference between length frequency data of northern and southern areas, because of relatively small catch and small number of size data of the southern areas the WG agreed there is no need to separate the troll fishery by areas. Trial SS3 runs with the north and south separated showed no change in the fitting of other fisheries or the overall abundance, recruitment and fishing mortality estimates. The WG also agreed to combine the US and Canada troll fisheries into one fishery, as has been done for the previous assessments.

3.4 Canada Troll

John Holmes described the spatial and temporal characteristics of catch, effort and length-frequency data from the CAN troll fishery, which operates in the northeast Pacific (ISC/10-1/ALBWG/08). Logbook catch and effort data from 1995-2009 were aggregated into monthly 1° x 1° spatial blocks. Length-frequency data from 1981 through 2009 were grouped into 5-year blocks because sample sizes vary interannually and samples were not obtained every year. The CPUE time series was standardized using a lognormal generalized linear Bayesian model using Year, Month, Area, and Vessel as explanatory variables. Only July, August and September were used in the month variable as effort was very low in all other months and the vessel variable was included as a proxy for the length of experience of vessel captains. The CAN troll fishery has changed from a north Pacific fishery in the early 1990s, when more than 60% of the catch and effort was west of 150 °W, to a coastal fishery since 2006 in which more than 85% of the catch and effort occurs within the coastal waters of the USA. Length-frequency distributions consistently show one or two modes between 60 and 70 cm FL and 70-80 cm FL in all time periods. Although these samples suggest that length selectivity has not changed in this fishery, the samples were obtained from fish caught within coastal or adjacent waters of the USA and may not be fully representative of the fishery when it operated on the highseas in the 1990s and early 2000s. Both nominal and standardized CPUEs exhibit consistent trends, peaking in 1998 and 2003, declining substantially in 2005, and then levelling off since 2006 at a relative abundance that is about 20% greater than the reference year (1995) level. If comparisons with standardized CPUE derived from the U.S. troll fishery are favourable, then the standardized CAN CPUE might be a suitable index for monitoring changes in juvenile albacore abundance in the years between formal stock assessments.

The WG discussed the larger fluctuation of the USA troll CPUE compared to the CAN troll CPUE. Both showed similar peaks and trends, but possible explanations include the use of vessel ID in the Canada CPUE to try to account for experience, or the difference between using 1° x 1° monthly strata in the USA troll index versus weight/vessel fishing day in the Canada index. One recommendation was to try using vessel day for the USA CPUE. The ALBWG believes that the USA CPUE index in the past did not include CAN fishery data, but now suggests considering including the Canada logbook data from 1995 since both fisheries overlap. Roughly 90% of Canada effort is in the EEZ of the USA. It was pointed out that some adjustments may be needed to combine CPUE for both fisheries into one index. No decision was made about a suitable recruitment index at this meeting as the CAN time-series is relatively short.

3.5 USA Longline

Steven Teo also presented ISC/10-1/ALBWG/06, which addressed the spatial and temporal characteristics of the USA LL fishery in the Northeast Pacific. In view of the transition to SS3, catch, effort and LFD were examined, and a preliminary time-series of CPUE for stock assessments based on those characteristics was developed. The USA LL fishery in the north Pacific targets bigeye tuna and swordfish and operates primarily from Hawaii. The data were divided into shallow-set (swordfish-target) and deep-set (bigeye-target) LL fisheries based on the target species or trip type recorded by the logbooks and observers. The results clearly show substantial differences in LFDs between the two fisheries and that the deep-set fishery targeting tuna was more appropriate for use as an indicator of SSB. The majority of albacore catch has been landed by the deep-set fishery, which is primarily concentrated around the main Hawaiian Islands while catch and effort in the shallow-set fishery tends to occur in the north Pacific transition zone, especially during winter and spring. The sizes of albacore tuna from the deep-set fishery are relatively large, primarily consisting of large, mature adults while the shallow-set fishery primarily catches a mixture of juvenile and adult fish. The standardized CPUE index of the deep set fishery was relatively high in the 1990s, but the index has been relatively low since 2002. Causes of this recent decline in CPUE are currently under investigation.

The ALBWG discussed whether combining the Hawaii shallow-set (swordfish) catch and size data with the deep-set (bigeye tuna) data as has been done for previous assessments is still appropriate. Combining the two would be inconsistent with the sized-based criterion agreed to for the JPN LL fishery (above). The swordfish fishery operates generally to the north of 25°N and catches smaller fish, whereas the bigeye fishery generally operates to the south and catches larger fish. However, because the swordfish fishery has few landings and only represents approximately 20% of the total combined USA LL fishery, combining the fisheries into one is unlikely to have much effect on the model output. It was recommended that SS3 trials with the data combined and separated should be run and output compared to inform the discussion around this decision. If the fisheries are combined into a single USA LL fishery, then the CPUE index could still be developed following the previous practice of using the deep-set (bigeye) tuna fishery data. The ALBWG asked the USA to determine whether earlier longline data are also available. The CPUE discussion will be further taken up in the next section when discussing possible indices of SSB.

3.6 Taiwan Longline

The ALBWG discussed the TWN LL fishery. There was no documentation available at this meeting about the fishing grounds and size of fish caught in this fishery. Size data collected from the TWN LL fishery are believed to be unrepresentative of the catch because fewer than expected small- and large-sized fish were measured compared to scientific sampling. The ALBWG wondered why the TWN LL fishery used size data from the JPN LL fishery prior to 1990 and the USA LL fishery after 1990. According to the rules defined at NPALBW 19 in Taipei 2004, size data of the USA LL fishery were linked to the TWN LL fishery. However, there was a comment that Chinese-Taipei scientists believe that the TWN LL fishery catches smaller fish than the USA LL fishery. The size of fish caught is linked to the location of the LL fishery (based on Japanese analysis): large fish predominate in catches south of 25 °N and smaller fish are more common north of 25 °N. It was noted that the ALBWG Chair should ask Chinese-Taipei to provide their fishery information at the July meeting. At that time a decision can be made about whether to link the TWN LL fishery to a combined USA LL fishery or to one sector of the USA LL fishery depending upon the time and area of operation, which may serve as a proxy for the size of fish caught. Final decisions concerning stratification of the USA LL fishery are contingent on resolving the TWN LL fishery definition.

The ALBWG also reviewed and updated the fishery definition table in light of discussions at this meeting (Table 1). Several fisheries (JPN PL, TWN LL, and USA LL) require further consideration at the July 2010 meeting, before they can be confirmed. The WG discussed pooling the JPN gillnet (GN) and miscellaneous fisheries into one fishery and concluded that they should remain separate fisheries because they were sufficiently different in their operations. Exploration of the data from these fisheries is ongoing. It was clarified that the high catches in the JPN GN fishery in the 1980s included catches from highseas flying squid driftnet fisheries.

The following fishery definitions were accepted by the ALBWG at this meeting (see Table 1 for spatial and temporal boundaries):

1. JPN LL – Partitioned into two (2) fisheries based on the size of fish caught. Fishery I catches smaller fish (>80 cm), and Fishery II catches larger-sized fish (>100 cm);
2. USA/CAN troll – catch and effort data from the two fleets will be combined and scientists will investigate incorporating CAN logbook data into the CPUE index as these data were probably not used for past stock assessments;

3. USA LL – the ALBWG favours a single USA LL fishery at present, but a final decision concerning two separate USA LL fisheries or a single combined USA LL fishery is contingent on resolving the TWN LL fishery and the size data that will be used for that fishery;
4. EPO miscellaneous – it was clarified that albacore catches from Mexico are placed in this fishery and the ALBWG accepted this definition;
5. JPN GN
6. JPN miscellaneous
7. TWN, KOR GN.

Table 1. Spatial and temporal fishery definitions for the next albacore stock assessment in 2011 developed by the ALBWG at the April 2010 meeting in Shimizu, Japan. Fisheries with an asterisk (*) have definitions requiring further work at the July 2010 meeting. Data needs from each fishery are also shown: ✓ indicates that data are needed from that fishery or that the assessment model will be fitted to those data (biological or CPUE); X indicates that the model will not be fitted to biological or CPUE data from a fishery.

FISHERY	FISHERY DESCRIPTIONS	FISHERY BOUNDARIES AND TEMPORAL COVERAGE	TARGET SIZE	CATCH DATA	BIOLOGICAL DATA	FITTED	CPUE DATA	FITTED	REFERENCE
1	USA/CAN troll (A)	10-55°N latitude by 120°W-180° longitude 30-55°N latitude by 160°E-180° longitude	60-80 cm	✓	✓ 1966-	✓	✓ 1966-	✓	ISC/10-1/ALBWG/05
2*	USA LL	10-35°N latitude by 145°E-175°E longitude	> 100 cm	✓	✓ 1994-	✓	✓ 1991-	X	
3	EPO miscellaneous	E.E.C. zone along US, Canada west coast and Mexico west coast	N.A.	✓	N.A.		N.A.		
4*	JPN PL	25-35°N latitude by 130°E-180° longitude in 2nd quarter,	90 cm	✓	✓ 1966-	✓	✓ 1972-	X	
5*	JPN PL	35-45°N latitude by 140°E-180° longitude in 2nd and 3rd quarter,	60-90 cm	✓	✓ 1966-	✓	✓ 1972-	✓	
6	JPN LL (Fishery I - smaller fish)	offshore and coastal: 25-40°N latitude by 120°E-180° longitude in Q1 and Q2 offshore: 25-40°N latitude by 120°W-180° longitude in Q1 and Q4	80 cm	✓	✓ 1966-	✓	✓ 1966-	✓	ISC/10-1/ALBWG/04
7	JPN LL (Fishery II - larger fish)	offshore and coastal: 25-40°N latitude by 120°E-180° longitude in Q3 and Q4 offshore: 25-40°N latitude by 120°W-180° longitude in Q2 and Q3 offshore and coastal: 10-25°N latitude by 120°E-120°W longitude all year round	100 cm	✓	✓ 1966-	✓	✓ 1966-	✓	ISC/10-1/ALBWG/04
8	JPN gill net	30-55°N latitude by 120°E-180° longitude		✓	✓ 1990-1991	X	N.A.		
9	JPN miscellaneous	E.E.C. zone along Japan coasts		✓	N.A.	X	N.A.		
10*	TWN, KOR, others (TKO) longline	10-40°N latitude by 120°E-120°W longitude		✓	N.A.	X	✓ 1995-	X	
11	TWN, KOR (TK) gill net	30-55°N latitude by 120°E-180° longitude		✓	✓ 1988-1990	X	N.A.		

* Fisheries have not been rigorously reviewed. Definition of these fisheries is tentative based on the report of the meeting of the ISC ALBWG in April 2009.

(A) Includes USA pole and line catch

4.0 INDICATORS OF SPAWNING BIOMASS AND RECRUITMENT

The ALBWG concluded in July 2009 that existing nominal CPUE indices did not provide useful indicators of spawning biomass or recruitment for qualitative updates of stock status between stock assessments. It was recognized that the spatial/temporal restratification of various fisheries in preparation for the might provide improvements. The WG considered whether standardized CPUE indices based on the new fishery definitions are representative of spawning biomass for use in providing qualitative updates on stock status in years between formal stock assessments.

Standardization of age-aggregated and age-specific abundance indices by the JPN large (offshore/distant water) and small (coastal) LL fisheries (L-LL and S-LL) during 1966-2008 was reported by Takayuki Matsumoto (ISC/10-1/ALBWG/03). The goal of this study was to prepare an abundance index for VPA as well as to provide a proposed abundance index for adult fish, i.e., a spawning biomass index. The methods were similar to a previous study (Watanabe et al. ISC/06/ALBWG/07) with minor modifications. The northeast area was eliminated from the analysis due to the problem in CPUE reported in ISC/10-1/ALBWG/02. Effects of area, season (quarter), fishing gear (number of hooks per basket) and several interactions between them were used for standardization. The age-aggregated abundance index was almost stable during 1960s-1980s, increased during 1990s, decreased sharply during 2001-2003, and then has gradually increased since this time. Age-specific indices were also constant during 1960s-1980s and were high during 1990s except for the age 3 index, which was mostly constant except in 2006 and 2008. The age-aggregated index was very similar to the index of adult fish (age 6-9+).

The ALBWG compared the proposed JPN LL age 6-9+ CPUE index to the estimated SSB trends derived from the 2006 VPA results, SS3 preliminary runs (Kai 2009; Lee and Conser 2009), plus projections from 2006 to 2008 from the VPA, and total biomass from a Biomass Production Model (see ISC/10-1/ALBWG/01). The SSB trend of the VPA analysis conducted in 2006 resemble trends in the age 6-9+ JPN LL CPUE index (Figure 1). Based on these comparisons and recognizing the limitations of the data and difficulties with the estimation of SSB at the beginning and terminal years of a time-series, the ALBWG felt that the age 6-9+ JPN LL CPUE has the potential to capture trends in SSB, but more quantitative evaluation should be completed after the next stock assessment.

The USA LL fishery that targets bigeye tuna predominately south of 25°N also catches spawning sized albacore (see ISC/10-1/ALBWG/06). These data show a drop in CPUE during recent years that requires further examination and data verification. It was pointed out that the CPUE trend of the Hawaii deep-set LL fishery in recent years dropped sharply and was similar to that observed in the JPN LL CPUE of the Northeastern region. It was also pointed out that because of the restricted operating area of the Hawaii longline fishery, the CPUE index may not reflect stockwide spawning stock abundance.

The WG consensus was that the age 6-9+ index for the JPN LL fishery is considered of greater potential value for determining relative stock condition between assessments because of the greater coverage of the fishery and longer time series. The USA deep-set LL data should be re-examined in order to understand the mechanisms behind the trends in CPUE before it would be considered for monitoring SSB between assessments.

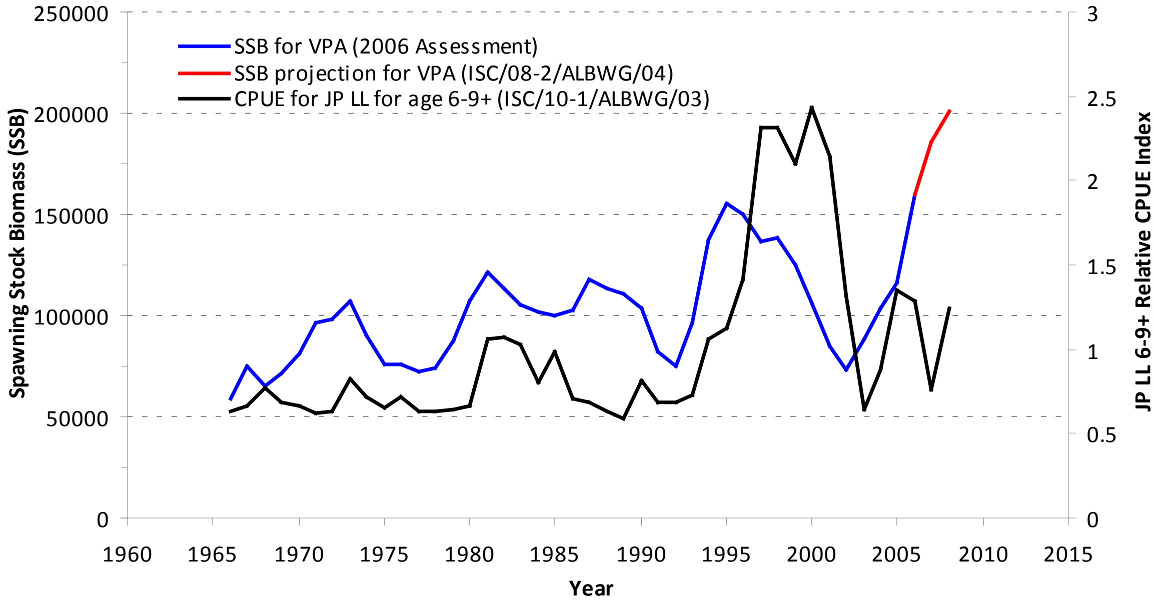

Figure 1. Comparison of the JPN LL age 6-9+ CPUE index with the 2006 VPA assessment results (blue – estimated SSB 1966-2005; red – projected SSB for 2006-2008; black – JPN LL age 6-9+ CPUE index).

The ALBWG recognizes the apparent inconsistency in using an age-specific CPUE index to monitor SSB when the stock assessment modelling will use age-aggregated CPUE indices of abundance. The WG notes that this age-specific index is not intended to be used for modelling purposes, but as a tool for monitoring trends in SSB between formal stock assessments.

5.0 REVIEW OF STOCK ASSESSMENT MODELING DECISIONS

Hui-hua Lee reviewed the specifications for the next stock assessment as defined at the April 2009 meeting of the ALBWG (Table 2). She noted that only the base case scenario would be run with the VPA model; all sensitivity analyses and projections will be obtained from SS3. Discussion focused on the effective sample size and how to estimate this quantity. The effective sample size refers to the number of measurements per time-area-fishery strata. The maximum effective sample size of 10 in Table 2 was used during preliminary analysis with SS3 because the model was not fitting size and catch data well. Using a low effective sample size, down-weights the size data. The WG noted that it will need to revisit the effective sample size and how it should be estimated. One suggestion is to calculate the effective sample size outside of the model for the USA LL, USA/CAN troll, and JPN LL fisheries. The WG also noted that the number of fisheries and CPUE indices for both SS3 and the VPA in Table 2 are subject to change pending the outcome of further review and decisions on fishery definitions that will be made at the July 2010 meeting.

6.0 FURTHER PROGRESS ON LENGTH-BASED SS3 MODELLING

Length-based SS3 modelling was the focus on the April 2009 meeting. At the conclusion of that meeting, suggestions on additional runs were put forward to examine the impacts of binning for samples, selection, changes in effective sample size, and the removal of small seasonal fisheries on model output. No working papers addressing this topic were prepared for this meeting so the ALBWG moved to the next item on the agenda.

7.0 ALTERNATIVE MODELLING APPROACHES

Zane Zhang presented ISC/10-1/ALBWG/01, which continues his work on Bayesian modelling approaches using north Pacific albacore data. Two types of biomass models were fitted to the total catch data from 14 fisheries and catch rate (CPUEs) data from 10 fisheries for the north Pacific albacore stock. In Model 1, the intrinsic population growth rate (*r*) is unchanged over the years, whereas in Model 2, *r* varies in different years reflecting likely changes in recruitment, natural mortality, and possibly somatic growth rates in different years. The models were applied in the Bayesian state-space fashion, so that both the observation and process errors were incorporated. CPUEs from each of the 10 fisheries were individually modeled as biomass indices. Catchability coefficients were assumed to be variable for different years due to some random variations in the distribution of the fish population and effectiveness of fishing. The intrinsic population growth rate (*r*) was modeled with a random walk function. Model fits to the data are assessed using varieties of criteria including Bayesian p-values, AIC, Bayes' factor, coefficient of determination (R^2), and comparison of predicted and observed CPUEs. Both models were well fitted to the observed commercial data. R^2 ranged between 0.47 and 0.79 for nine fisheries, and is less than 0.1 for one fishery. Model 2 behaves better than Model 1 based

Table 2. Model specification for Stock Synthesis 3 (SS3) and virtual population analysis (VPA). Baseline model was based on consensus achieved at the April 2009 ALBWG meeting.

	SS Model Configuration	VPA Model Configuration
DATA		
N. fleets	11	11
N. CPUE	9	9
stderr of log(catch)	small (known without error)	N.A.
catch at age	N.A.	assume know withoue error
initial equil catch	1 surface (fishery 1) & 1 LL (fishery 7) using avg catch (1966-70) from F1 and F5 for surface and avg catch from F6 and F7 for LL	N.A.
variance associated with CPUE	input as SE	input as SE
binning structure	Pop binning: 1cm 10-140cm Data binning: 1cm 26-90cm / 2cm 90-100cm / 4cm >100cm	N.A.
effective sample size	max = 10	N.A.
PARAMETER CONTROL		
Natural mortality	fix at 0.3	fix at 0.3
Maturity at age	fixed	fixed
Growth parameters	fix at Suda's with higher CV for LAA on large fish (CV=0.1) than small fish (CV=0.08)	follow Suda growth
Spawner-Recruitment	h=1 (correspond with the 2006 assessment); sigmaR=0.6 estimate Rdev (1962-2002) assuming non-equil init age comp	steepness=1; sigmaR=0.6
Initial equil F	estimate F1 & F7	N.A.
Terminal-year F	N.A.	estimated and fix F ratio at 1 (ratio of the plus-group to the next younger age)
Catchability	constant	constant
Selectivity patterns	Size selex: asymptotic for LL F2 & F6; dome-shape for others For all dome-shaped LL, estimate largest size	N.A.
Variance adjestment	none	none

*Some fishery definitions are uncertain; resolution of these definitions may change the values of the N.fleets and N.CPUE parameters in this table on the Bayes factor. Estimated values for the intrinsic rate of population growth (*r*) have different magnitudes in different periods. These differences may reflect changes in ocean conditions. The models produce some important biological references points, such as the maximum sustainable yield (MSY), for management of this resource. MSY ± 1 SD was estimated to be 83,270 ± 10,118 and 94,814 ± 12,867 tons by Models 1 and 2, respectively.

The ALBWG discussed how this alternative Bayesian production model could be used to help with the albacore stock assessment. One question concerned how the model accounts for the different CPUE time-series. Catchability is modeled in a flexible manner and is allowed to vary between years and explains a lot of why the expected CPUE fits the observed CPUE. The shape and variability of catchability is determined by data.

Strengths and weaknesses in this production model relative to SS3, such as the lack of age-structure in the production model, were discussed. The production model described by Zhang might be able to provide supplementary information that would be useful for the stock assessment. For example, the MSY estimate from this model is relatively stable compared to that from SS3 or Multifan-CL. A question was asked about how to interpret fisheries in which the estimated CPUE index is fitted with low R^2. One interpretation is that a CPUE time-series with low R^2 is a non-informative time-series for modelling and that this time series should be down-weighted. This interpretation is one possible outcome, but model runs should be done with and without that time-series and compared in order to make a final decision. The catchability time-series also needs to be examined. Zhang agreed with this point and noted that the catchability plots will be presented next time. Additional improvements were suggested including a sensitivity analysis of the estimated MSY by leaving one year out for different runs. In addition, it was mentioned, and the ALBWG agreed, that it would be useful to look at regime change and environmental linkages, based on the *r* time-series. The model will be updated with new fishery definitions and data at the next meeting.

8.0 REVIEW OF 2009 DEVELOPMENTS AT IATTC AND WCPFC RELEVANT TO THE ALBWG

The Antigua Convention of the IATTC is coming into force in August. A Science Advisory Committee will be formed and the first meeting is scheduled 31 Aug – 1 September 2010 in La Jolla, U.S.A. It was suggested that the October meeting be moved to occur immediately after the Science Advisory Committee. However, the ALBWG did not consider changing the timing of its October 2010 meeting.

The SC5 meeting of the WCPFC (August 2009) discussed data issues and gaps and recommended a procedure to address data gaps in the holdings of the ISC and WCPFC: data inventories will be completed and exchanged by ISC10 in July 2010; a process to identify gaps will be completed by October 1, 2010 and data will be exchanged at a future date. The ALBWG identified data gaps at ISC9 related to South Pacific countries fishing north Pacific albacore. In retrospect the timing of this process is poor considering the ongoing preparations for the next stock assessment. The WG data manager, John Childers, will be most heavily involved in this process, but input from WG members may be needed.

The SC5 meeting also proposed modifications to the WCPFC-ISC Memorandum of Understanding (MOU) to have the ISC report to both the SC and NC and respond to requests for information and advice from both the SC and NC. The NC did not recommend this modification and the WCPFC ultimately accepted the NC view at its December 2009 meeting.

The NC proposed revisions to CMM 2005-03 for North Pacific Albacore including defining "current level of effort" as the average effort for the 2002-2004 period and applying the CMM to the Pacific Ocean north of the equator. Other proposed changes may bring on additional data reporting obligations to some members of the WG. The WCPFC deferred further consideration of the revised CMM until next year in order to work toward a measure that applies to the stock throughout its range.

Hideki Nakano reported that Izumi Yamasaki took over as the ISC Data Administrator from Koji Uosaki. He also introduced the newly appointed ISC website administrator Yukiko Hashimoto to the WG. The ISC Chair has been informed about these personnel changes.

8.bis Illegal, Unreported, and Unregulated Fishing

Illegal, unreported, and unregulated fishing (IUU) was added to the agenda at the request of the ISC Chair. Reports are received periodically of net marked albacore and other highly migratory species. It was clarified that IUU refers to activities on the high seas, e.g., driftnets outside the coastal waters of member countries. The WG noted that it considered the issue at a March 2008 meeting in La Jolla, CA, and that the WG has no further information since that meeting.

The following text was excerpted from the March 2008 meeting report of the ALBWG:

> *"Anecdotal evidence confirms hat IUU is occurring, but the level of removals and impact(s) on the North Pacific albacore stock are unknown. At present, no country has a formal program for monitoring IUU or obtaining data for inclusion in Table 1 (catches by country and gear) and it would be speculative of the ALBWG to attempt to estimate an IUU time-series for technical use. The ALBWG recommends the creation of a joint multi-member discussion paper on IUU at the ISC level rather than technical level as a first step in addressing the issue. Since IUU is also an enforcement issue, the ALBWG felt that the Enforcement Committees of the WCPFC and IATTC should be engaged to begin surveillance during the fishing season and perhaps obtain some preliminary data on IUU."*

The WG considered these observations, conclusions and recommendations to be relevant in 2010.

9.0 SUITABLE BIOLOGICAL REFERENCE POINTS FOR NORTH PACIFIC ALBACORE

The ISC was tasked with identifying potential biological reference points (BRPs) for all northern stocks of highly migratory species in the Pacific Ocean at the 5th regular session of the Northern Committee (NC) in Nagasaki, Japan, and asked to report it's findings at the 6th session of the NC in September 2010. The ALBWG needs to substantially complete this assignment at the April 2010 meeting in order for it to be presented and endorsed by the ISC Plenary in advance of the NC6 meeting.

Reference points are part of a precautionary approach to fisheries management and seek to avoid serious harm to a stock while permitting maximum sustained yield or other catch scenario. Limit reference points attempt to constrain harvesting within safe biological limits for a stock. Recruitment overfishing (fishing mortality above which the recruitment to the exploitable stock becomes significantly reduced) and growth overfishing (fishing mortality at which the losses in weight from total mortality exceed the gain in weight due to growth) are often considered to be the major biological risks to the resiliency and productivity of a stock, with recruitment overfishing considered to have the more serious and potentially harmful impacts. Limit reference points are fishing mortality rates or biomass levels which must not be exceeded and are frequently implemented to avoid recruitment overfishing because when a stock falls below the threshold level associated with a LRP, there is a high probability that the resiliency and productivity of the stock will be so impaired that serious harm to the stock will occur. Target reference points are fishing mortality rates or biomass levels which permit long-term sustainable exploitation of a stock and are determined by productivity objectives for the stock, broader biological considerations, and socio-economic objectives. Typically, the biological consequences of exceeding a TRP are not as severe as those incurred if a LRP is exceeded. Working paper ISC/10-01/ALBWG/10 introduces the concept of precautionary reference points into the albacore discussion. Precautionary reference points are buffers from limit reference points that account for modelling uncertainties and the risk strategy of managers for stocks in which data and information are not wholly reliable (Cadima 2003).

The ALBWG agreed that it should focus on limit and precautionary reference points since recruitment overfishing causes more serious harm to a stock than growth overfishing and are more clearly based on scientific evidence. Target reference points may also reflect management and industry goals and risk tolerance/avoidance and so require broader input from managers and stakeholders in order to establish.

The ALBWG has estimated a suite of potential MSY-proxy reference points including $F_{40\%}$, $F_{35\%}$, $F_{30\%}$, $F_{20\%}$, $F_{0.1}$, and F_{MAX}, in stock assessments since 2000. More recently, the WG has developed minimum SSB reference points that are F-based estimators to ensure that SSB will not decline below historically estimated SSB levels for any pre-specified probability. At the NC4 meeting, an interim objective to maintain the spawning stock biomass (SSB) above the average level of its ten historically lowest estimates (ATHL) with a probability greater than 50% was adopted and at ISC9 the ALBWG estimated the associated F-based reference point ($F_{SSB\text{-}ATHL}$) using a 25-yr projection period to be 0.75 yr^{-1}. These F-based minimum SSB reference points, including $F_{SSB\text{-}ATHL}$, are implicitly consistent with a goal of maintaining albacore SSB at levels that historically supported the productive, large-scale fisheries conducted in the North Pacific for more than 50 years (Conser et al. 2005).

To complete the NC task, it was proposed that the ALBWG provide a table (Appendix 4) that describes and characterizes a suite of candidate reference points, including comments on their strengths and weaknesses and applicability to north Pacific albacore. The WG has not identified specific target or limit reference points in this list, but where WG members had knowledge, it has been noted how the reference points in the table have been used by other RFMOs and science-advisory bodies. Since uncertainty (in both model structure and parameter estimates) and risk with respect to the future condition of the stock are important concepts in the use of reference points, the WG also identified a simple framework to illustrate the tradeoffs between uncertainty, risk, threshold levels, and reference point estimates. Three working papers were also reviewed and incorporated into the WG products for this task.

Hidetada Kiyofuji conducted sensitivity analyses of changes in natural mortality rate (*M*) based on the 2006 north Pacific albacore stock assessment and its effects on biological reference points (BRPs) and reported his results in working paper ISC/10-01/ALBWG/11. Natural mortality rate was estimated by several empirical methods. Simulation-based BRPs (F_{SSB}) were more robust to changes in M than reference points based on yield-per-recruit (YPR) or spawning-per-recruit (SPR). If simulation-based BRPs were used as target or limit reference points, there are two quantities that need to be determined: (1) the threshold level above which the SSB should be maintained; and (2) probability level that stock remains above the threshold. Biological reference points that are highly sensitive to M (F_{MAX}, $F_{0.1}$) should not be considered since the choice of M is a key uncertainty of the stock assessment modelling.

The ALBWG raised a question regarding the usage of other natural mortality (*M*) schedules to estimate reference points. A single constant *M* has been used for the North Pacific albacore stock assessment but in reality, *M* changes with age or time, but the available life history information is not sufficient to directly estimate *M*. The WG agreed to include robustness to changes in M as a factor to consider when assessing biological reference points.

Mikihiko Kai presented a paper describing a fishing mortality (F) - based reference point (F_{loss}) and assessing the applicability of F_{loss} as a limit reference point for north Pacific albacore (ISC/10-1/ALBWG/09). F_{loss} is the F corresponding to the expected recruitment value ($\overline{R}_{loss}$) at the lowest observed spawning stock biomass (B_{loss}). The author suggests that F_{loss} derived from recruitment (R) at B_{loss} may be a suitable LRP for North Pacific albacore (NPALB). However, errors in the estimation of SSB and recruitment (R) over the stock assessment period are major uncertainties affecting this reference point. Therefore, it is recommended that the mean value of R or R estimated from the stock-recruitment relationship at B_{loss}, should be used as an estimate of $\overline{R}_{loss}$ to address these uncertainties.

The ALBWG discussed the uncertainties associated with SSB and recruitment (R) estimates derived from the 2006 VPA assessment as these data were used in the assessment of F_{loss}. In particular, the lowest SSB was estimated at the beginning of the time series, and is known to be unreliable since backward projecting VPA models have difficulty estimating older fish at the beginning of the model run. Monte Carlo simulation could be an alternative approach to addressing the uncertainty around estimated R by assuming constant recruitment variability. The ALBWG pointed out that the uncertainties for these estimates also depend on the different assessment models applied. Although F_{loss} is clearly used as a limit reference point, it was suggested that comparison should be made with F_{SSB} regarding sensitivities to errors in SSB and recruitment estimates. This working paper was the first time that the ALBWG has discussed F_{loss} as a potential albacore reference point. It was noted that ICES has considered this reference point. WG members indicated that consideration of the popularity of specific reference points in other Regional Fisheries Management Organizations (RFMO) does not on its own justify adoption for north Pacific albacore. However, the ALBWG agreed to include F_{loss} and B_{loss} in its table of potential biological reference points for north Pacific albacore.

Momoko Ichinokawa presented a paper describing the conceptual and technical characteristics of F_{SSB}, including the concept of precautionary reference points (ISC/10-01/ALBWG/10). F_{SSB} is a simulation based BRP initially proposed in 2005 for the north Pacific albacore stock. This paper provides an interpretation of $F_{SSB-ATHL}$ as a 'precautionary reference point' (as defined by Cadima 2003) with buffers from the B_{loss} or F_{loss} limit reference points. $F_{SSB-ATHL}$ (50%), which was adopted by the NC as an interim BRP for north Pacific albacore, refers to the fishing mortality rate that ensures that SSB does not fall below the average of the ten historical lowest estimated SSB with a 50% probability. Although this objective is similar to the objectives of F_{loss} and B_{loss}, i.e., maintaining SSB above a minimum threshold, $F_{SSB-ATHL}$ (50%) implicitly accounts for various structural and parameter uncertainties. One important uncertainty is non-equilibrium population dynamics caused by recruitment fluctuations, which is incorporated into the reference point by calculating probabilities with which future SSB falls below the threshold level in 'at least one year' in the projection period. In addition, uncertainty in the lowest estimate of SSB estimate (SSB_{min} or B_{loss}) is considered through the use of a higher threshold e.g., SSB_{ATHL}, rather than B_{loss}. Uncertainty in parameter estimates in the terminal year is incorporated into the F_{SSB} reference point by conducting future projections from bootstrapped stock assessment results. Further buffers can also be considered if a higher level of certainty that the future SSB will not fall below the threshold is employed, e.g., 5%. An important advantage of the F_{SSB} approach is that it provides a high level of flexibility to incorporate a variety of management objectives through adjustments in SSB threshold levels and probability levels (certainty of achieving the objective) or by incorporating detailed alternative scenarios (e.g., actual management plans or possible S-R relationship) into the stochastic projection. However, this flexibility in the F_{SSB} calculation could also be a drawback since it requires considerable discussion on the configurations of the future projections used in calculating F_{SSB}.

The fact that terminal year parameter estimates are used in future projections despite being less reliable (i.e., greater variability) than estimates from the prior years in the time series was recognized by the ALBWG. Several scenarios were suggested for the projection and should be analyzed before making a decision on the final configuration. For example, it was suggested that the mean parameter estimates from a 2-3 years period prior to the terminal year be used for future projections. Although the ALBWG agreed that F_{SSB} is a reasonable framework for assessing reference points, it also noted that the F_{SSB} may be sensitive to the configuration of the stochastic simulations such as the number of projection years used or the definition of current fishing mortality, etc. It was also suggested that since a stock-recruitment relationship can not be estimated, autocorrelation in time series data or different noise methods could be investigated as methods for randomizing future recruitment in projection scenarios. Regime-shift can be also taken into consideration and incorporated into the reference points. The WG also noted that uncertainties around recruitment might influence biomass-based reference points and that it is important to consider these uncertainties when biomass-based reference points are provided. Simulation-based F_{SSB} can account for many of these uncertainties and can be used to address different management objectives given different risk strategies that managers may apply to a fishery.

Based on the information compiled in Appendix 4, estimating MSY-based reference points for north Pacific albacore would pose significant challenges for the ALBWG. A single point estimate of MSY requires knowledge of the steepness of the stock-recruitment relationship, which can not be estimated from available data for albacore since these data lack sufficient contrast. MSY proxies based on yield-per-recruit (e.g., $F_{0.1}$, F_{MAX}) or spawner-per-recruit (e.g., $F_{40\%}$, $F_{30\%}$, $F_{20\%}$) considerations can be used when the stock-recruitment relationship is unknown. However, there is no clear way to choose an appropriate MSY-proxy reference point from among the common candidates other than using a trial-and-error process. Furthermore, outdated and under-sampled life history parameters may be a significant contributing factor in the difficulties in establishing reference points for north Pacific albacore. The WG recommends the F_{SSB} framework described in ISC/10-01/ALBWG/10 because it builds on previous work of the WG, it takes into account non-equilibrium dynamics, and hence presents a more realistic picture of stock conditions, and it accounts for both structural and parameter uncertainties in the stock assessment with respect to their impacts on the future condition of the stock.

The schematic in Figure 2 illustrates a simulation framework that considers uncertainty in current stock status (e.g., parameter) and uncertainty in the future condition of the stock (e.g., recruitment variation) to estimate the probability of falling below a given SSB threshold. Users specify a SSB threshold and the appropriate probability (certainty) level and then determine the associated fishing mortality rate value based on the intersection of the SSB threshold with the probability line. Three lines of probability are shown in Figure 2. Line A (the thick grey line to the right) is the 50% probability under equilibrium conditions. Points on this line are interpreted to mean that for given fishing mortality rate, half of the SSBs in future years when equilibrium is achieved will be below the associated threshold. This line is equivalent to the median of future SSB. The other two lines represent non-equilibrium dynamics at 50% (Line B) and 5% (Line C) probabilities. Interpretation of the probabilities presented by these lines differs from Line A: for a given fishing mortality rate (F), there is a 50% chance (Line B) or 5% chance (Line C) that SSB in one or more years of the projection period will fall below the associated SSB threshold. Therefore, Lines B and C are equivalent to the probability that minimum SSB during a given future projection period will fall below the threshold level. Line C represents the highest degree of certainty or a more risk adverse approach for reference points.

An example will illustrate how uncertainty and risk are accommodated in the setting of reference points with Figure 2. Suppose the goal of management is to maintain albacore SSB above the minimum estimated level (broken vertical line to the left on Figure 2). The first decision is a choice between equilibrium or non-equilibrium dynamics in the projection scenario. The advice of the ALBWG is that equilibrium is an unrealistic expectation and that non-equilibrium dynamics should be used. This accounts for Buffer 1, moving from Line A to Line B. The next decision relates to uncertainty in the stock assessment, in this case to the estimate of the lowest observed SSB (B_{loss}). Since this estimate for albacore occurs at the beginning of the stock assessment time-series when the model has difficulty estimating the age structure of older animals, the ALBWG advises that this is one of the least reliable estimates of SSB. A second buffer (Buffer 2) is added, this time to the threshold level, shifting it to the right to the average of the ten historically lowest levels (ATHL), which would be a more robust SSB threshold. A third decision occurs at this point concerning the level of certainty that future SSB will remain above

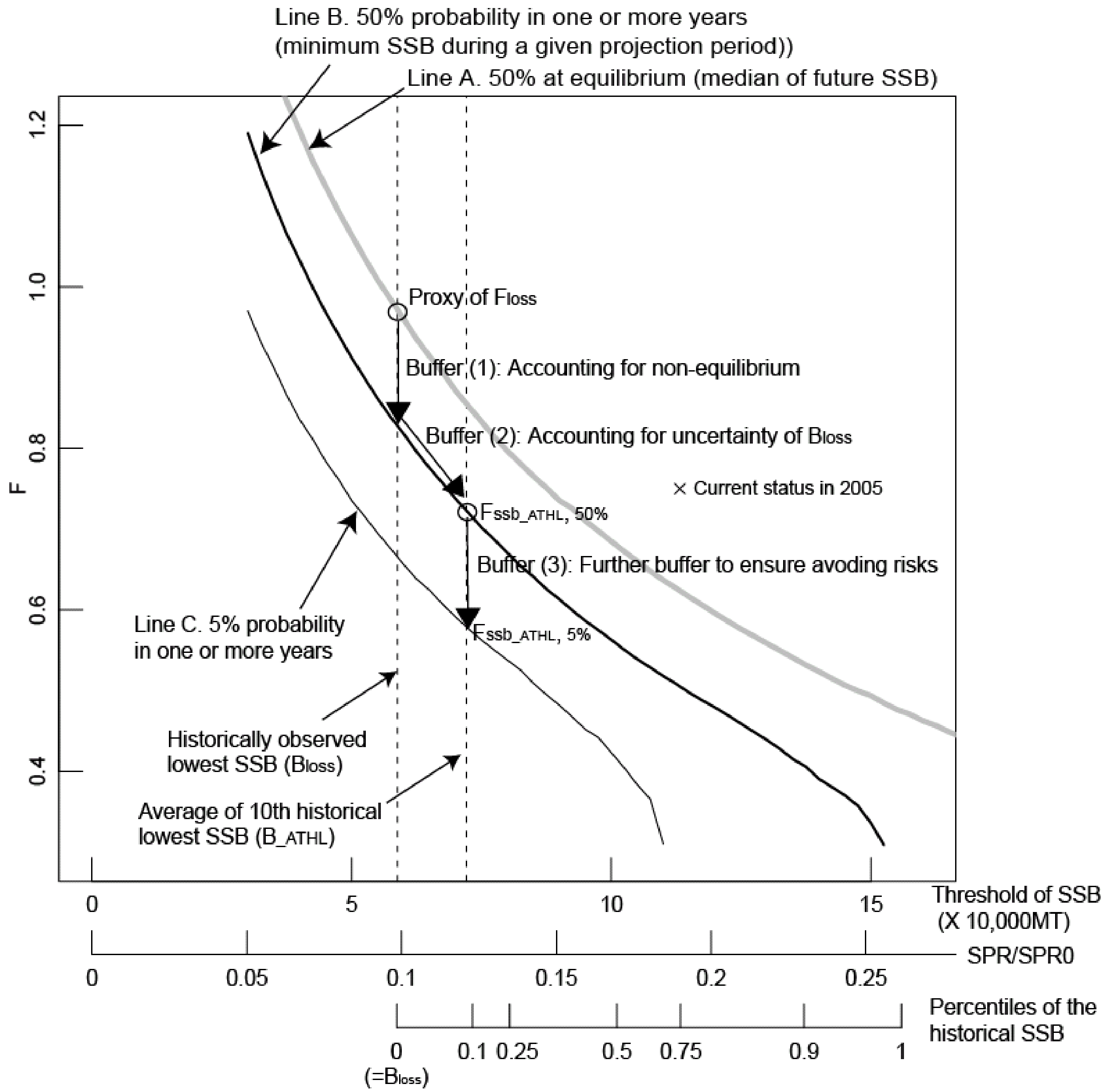

Figure 2. A schematic figure to show implicit buffers assumed in calculating $F_{SSB\text{-}ATHL}$ from F_{loss}. X-axis shows threshold of SSB and corresponding measures of SPR/SPR0 and percentiles of historical SSB, and Y-axis fishing morality rates. These plots were created from the most recent results of future projection by Kiyofuji et al. (2009) using PRO2BOX. A 25-year projection period until 2030 was used. See text for details. Taken from Ichinokawa (2010) (ISC/10-1/ALBWG/10) with minor modifications.

the threshold: the ALBWG advice is that for a limit reference point used to prevent recruitment overfishing, a the probability that future SSB will fall below the SSB threshold should be less than 50% . A third buffer can be added (Buffer 3) to shifting from the 50% (Line B) to 5% (Line C) certainty to accommodate a more precautionary approach. In this example, the cumulative effect of each of the buffers is to reduce the maximum allowable F. It is important to note also, that Figure 2 applies specifically to a 25 year projection and that results would differ under shorter or longer projection periods. Shorter projection periods would shift the probability lines higher and to the right (i.e., a risk tolerant strategy), while longer projection periods would have the opposite effect (i.e., risk averse strategy). Thus, managers need to clearly specify objectives, threshold level, level of certainty concerning future SSB, their risk tolerance/avoidance, and the length of the projection period to use this framework.

The ALBWG is not endorsing these particular reference points of F_{SSB} at this time, but using them to illustrate to managers the impacts that structural and parameter uncertainties may have on the associated F-value and how risk strategies affect the choice of minimum SSB threshold. The F_{SSB} framework includes limit, target and precautionary reference points.

The role of scientists and managers in the establishment of biological reference points was also discussed ALBWG. The role of scientists is to:

1. conduct stock assessment and future projection scenarios,
2. identify candidate biological reference points,
3. characterize the uncertainty associated with current and projected stock dynamics relative to the suite of candidate reference points,
4. conduct simulations and risk analysis to evaluate the risks associated with albacore management using each candidate reference point and appropriate control rules.

The WG suggested that the following inputs to the process of establishing biological reference points are needed from managers:

1. management objectives for the stock, noting that an interim objective is in place for north Pacific albacore,
2. specification of the management strategy, e.g., control rules,
3. specification of the risk management strategy, i.e., risk tolerant, risk adverse,
4. decisions on reference points and control rules for albacore.

Further discussion of reference points provided the following points for communication with managers. First, managers should consider the need for extreme trigger reference points, that is, the reference points that denote the minimum level of SSB (or other relevant measure) below which stock collapse will occur so that they can take into account the risk of collapse and the interpretation of reference points relative to this risk. For example, ICCAT has established an extreme biomass-based trigger for Atlantic bluefin tuna that once reached, triggers a moratorium on fishing, although biomass-based reference points are not normally used by ICCAT. Second, the simple reference points discussed by the ALBWG consider only a single F for control. But some fisheries (e.g., longline) can target different sizes of fish and thus selectivity patterns are not common. This means that a single F may not be easy to evaluate for these fisheries and might not be appropriate.

10.0 UPDATE ON NORTH PACIFIC ALBACORE BIOLOGICAL RESEARCH PLANS

The Chair briefly introduced the albacore biological research plan developed by ISC09 (Table 3). This plan was part of a multi-species, multi-national proposal to collect sex-related age, growth, maturity, and fecundity data , for all north Pacific HMS stocks. Although the proposal was endorsed at the NC5 meeting, funding was not provided. The WG noted that an overall project leader was needed to coordinate planning and collection of the samples and data, however a suitable person was not identified. Since the research plan is broken down to fish contributions by country and gear combination, a contact person for each country x gear combination was appointed as follows; Canada – John Holmes; USA - John Childers; and Japan – Koji Uosaki. Due to the absence of Chinese Taipei, Hsu and Chen were suggested as temporary contacts for the Taiwan longline fisheries. There was a comment on the value of small albacore (< 40 cm) for analysis and that it was difficult to distinguish between young albacore and yellowfin tuna without genetic analysis because the key morphological feature used to identify albacore, length of the pectoral fin, is highly variable in young albacore. Comments were also raised that the collection of young albacore might be valuable for testing stock structure hypotheses in the north Pacific. Furthermore, focusing effort on potential spawning grounds in the EPO may help address the hypothesis that there are two stocks of albacore in the EPO separated by the Mendocino Ridge, as suggested by conventional tag returns and differences in growth rates. Testing of the EPO two-stock hypothesis has been hampered by the lack of sampling effort for eggs and larvae in the EPO. There was a brief discussion of gonad preservation methods with a question as to whether freezing could be used instead of formalin fixation. Formalin fixation is needed for assessing batch fecundity, but the regulations concerning the transport and use of toxic chemicals mean they are difficult to get on North American vessels conducting sampling. Gonadal tissue can be frozen easily on most vessels and might be suitable for simple stage analysis. Bob Humphreys (NOAA/PIFSC/Hawaii) will be consulted on this matter by Suzanne Kohin. The ALBWG believes that the goals of broad biological sampling program are important given the uncertainties in life history parameters for albacore and encourages the ISC to pursue these goals.

Biological research plans in individual member countries were briefly discussed. Canada is planning to sample the 80 fish outlined in the biological research plan in August-September 2010. Suzanne Kohin noted that USA started sampling its troll fleet in 2009 and has been sampling the sport fishery for the last 3 years. Sampling of the Hawaii-based longline fishery will begin soon. A new age and growth biologist specializing on HMS has been hired at the Southwest Fishery Centre. It was commented that Chinese-Taipei has conducted research on albacore fecundity and that age, growth and reproductive research is ongoing. ALBWG members agreed to coordinate their research efforts in order to ensure consistency of methods.

Suzanne Kohin presented a summary of the USA north Pacific albacore archival tagging program through 2009 (ISC/10-1/ALBWG/07). The tagging program was initiated in 2001 to study the migration and behaviour of juvenile (ages 2-5) north Pacific albacore that utilize the waters off the U.S. west coast, and to study their movements and stock structure as they disperse from the U.S. commercial surface fishery grounds. To date 593 archival tags and 43 dummy tags have been deployed off the USA and Mexico west coasts. A total of 22 archival-tagged and

Table 3. Size-stratified sampling design for albacore, *Thunnus alalunga* updated by the ALBWG in April 2010. Shading indicates size range captured by a fleet.

	Fork length bins (cm)														
Fleet	20	30	40	50	60	70	80	90	100	110	120	130	140	150	**Fleet Contact**
CAN-LTN					40	40									John Holmes
JPN-DWLL							40	20	40	20	20	20			Koji Uosaki
JPN-PL			40	40											Koji Uosaki
JPN-PS															Koji Uosaki
JPN-GN	20	20													Koji Uosaki
JPN-SN															
JPN-LTN															
KOR-LL															
MEX-PS															
TWN-DWLL							40	40	20						Hsu or Chen?
TWN-OSLL								20	20						Hsu or Chen?
USA-LL										60	60	60			John Childers
USA-RG															
USA-PL															
USA-LTN			40	40	40	40									John Childers
															Total Samples
Target Samples	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**			**960**
Projected Samples	**20**	**20**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**	**80**			**840**

Data Needs	Date & latitude/longitude of capture	Fork length (cm) Total weight Sex Gonad weight	Otoliths First dorsal fin (whole) Gonad (whole) or tissue subsample Muscle/tissue samples for DNA etc.
Coordinator	To Be Determined at July 2009 meeting	1. Develop sampling SOP 2. Coordinate and monitor implementation of sampling & analyses	
Analysis	Age/growth: CAN/JPN/TWN/USA Reproductive: JPN/TWN/USA		
Sample storage	Gonad – 10% buffered formalin; alternatively frozen but inferior to immediate fixation Otoliths/dorsal fins – dried in appropriate labelled containers (vials + envelopes) Samples to be delivered by fleet contacts to appropriate lab for analysis.		

6 dummy-tagged fish have been recaptured (recovery rate of 4.4%). The majority of fish were recaptured near their tagging locations after periods of 63 to 753 days. The archival tags provide detailed data on vertical and horizontal movements as well as ambient water and peritoneal temperatures. Tagged albacore exhibited five distinct, seasonal migratory patterns; many fish migrated from the eastern North Pacific to the central North Pacific and a single fish migrated to coastal Japan. Several albacore tagged off southern California and northern Baja Mexico remained close to the North American coast. It is apparent that juvenile albacore move between a variety of habitats, including coastal upwelling regions with high primary productivity, transition zone waters, and areas with warmer, less productive surface water. The archival tagging program will continue during 2010. Deployments in the central North Pacific and western North Pacific could help elucidate the structure of the stock throughout its range.

The WG discussion of this paper focused on the implications of these findings with respect to the suitability of CPUE indices used in the stock assessment. Five different migration patterns were described, but these patterns were not related to the size of tagged fish. One implication of the findings is that there may be limited mixing between eastern and western Pacific. If this hypothesis is true, then the interpretation of CPUE indices may have to be revised as presently they are considered representative of the entire Pacific. Northeast Pacific fish from the coast of North America contribute to the northeast area of Japan longline fishery, where the CPUE index declined to very low levels after 2002 (ISC/10-1/ALBWG/02). Conventional tagging in the 1960s and 1970s demonstrated that large numbers of albacore moved east to west across the Pacific Ocean, but were less clear about west to east movements (Ichinokawa et al. 2008). The USA is continuing to deploy archival tags in the northeast Pacific and may supplement this program with tagging of large albacore near Hawaii. Although the WG believes that enhanced coverage of tagging throughout the north Pacific would be valuable in further examining the stock structure of north Pacific albacore, it also noted a concern that a previous Japanese albacore archival tagging project had low tag returns that may not justify the cost of these programs.

11.0 WORK PLANNING, ASSIGNMENTS, AND SCHEDULING FOR 2010

The WG discussed work planning and scheduling as it was clear that the plan devised at the July 2009 meeting required revision, particularly data preparation and exchange for the next stock assessment workshop in March 2011. The following is the revised work plan and scheduling.

July 1 2010 – Catch Data Submission Deadline.

- ALBWG members will submit -preliminary catch data for 2009 and final data through 2008 to the data manager (John Childers) to update catch by nation and gear (Table 1).

July 12-13, 2010 - ISC10, Victoria, Canada

- Update statistics and Table 1
- Finalize spatial/temporal stratification JPN PL
- Finalize spatial/temporal stratification TWN LL
- Finalize USA LL fishery definition, contingent on TWN LL
- Examine re-stratified fishery CPUE abundance indices for indicators of spawning

biomass, i.e., age 6-9+ SSB for NW and SW data only or all areas of operation.
- Complete reference point assignment (if necessary)

September 1, 2010
- Submission of preliminary data up to 2008 for:
  - VPA (CAA, CPUE, Table 1)
  - SS3 (catch, size, CPUE) up to 2008
- All SS3 input data (quarterly catch and size data by fishery; annual CPUE indices and their standard errors) should be emailed to Hui-Hua Lee prior to this meeting. She will prepare an SS3 data file and distribute to all working group members for verification. Once finalized, this data file will then serve as a common baseline for the SS runs that will be made prior to the data preparation meeting.

October 19-26 2010 – Data preparation meeting, La Jolla, USA
- Preliminary VPA base case scenario run
- Preliminary SS3 runs using new fishery definitions and data submitted Sept 1
- Some sensitivity runs
- Decision on standardized CPUE for JPN LL Fishery I and II (compare with and without NE data)
- Decision on standardized CPUE for USA/CAN troll (include or exclude CAN data)
- Projection scenarios, e.g., constant catch, others?
- Discussion on how to proceed if VPA and SS3 base case scenario output trends differ

December 1, 2010 - Deadline to submit finalized data
- Final input data for VPA (CAA, CPUE, Table 1) up to 2009
- all VPA input data (annual catch-at-age by fishery; annual CPUE indices and their standard errors) should be emailed to Takayuki Matsumoto prior to the deadline. He will prepare a VPA data file and distribute to all working group members for verification. Once finalized, this data file will be the common baseline for the VPA run
- Final input data for SS (catch, size, CPUE) up to 2009

March 22-29, 2011 - Stock assessment workshop
- The modeling subgroup may meet 16-21 March at the same location.
- ALBWG members agreed that base-case scenarios will be run with both SS and the VPA-2BOX models, but that sensitivity analysis and projections will be completed with the SS3 model.

External software for stock projections and biological reference point estimation
The WG noted that the SS3 model is not configured to calculate biological reference points for North Pacific albacore nor are the SS3 projection options suitable because of the inability to analyze the probability of achieving biological reference points in a stochastic simulation approach. Yukio Takeuchi demonstrated R-coded software that estimates some of the commonly used biological reference points for North Pacific bluefin tuna and is compatible with SS3 model outputs. He noted that this software was given to an ALBWG member and that it should be available for NPALB (and any other species) as long as there is no change to the format of the output files (.rep file) produced by the SS software. Momoko Ichinokawa

demonstrated R-coded software used to conduct stock projections for North Pacific bluefin tuna using SS model outputs. She stated that this software may be available for NPALB, but she will need to test and ensure the behaviour of the software is stable when some results of SS3 model run for NPALB are available. The ALBWG was pleased that both the reference point and stock projection software were provided for next stock assessment.

The question of whether a constant catch scenario will be included in future projection scenarios in the next stock assessment was raised. This scenario was not part of the 2006 assessment, but if it is used in the next assessment, then this function will need to be incorporated into the future projection software. However, a decision can be made on this point in the October 2010 meeting.

The ALBWG also discussed standardizing the SS model used for the stock assessment, projection, and reference point software. Currently SS Version 3.10b is publicly available, however, the version that will be used for the next stock assessment can be decided at the October 2010 meeting. The projection software developed by M. Ichinokawa uses output from Version 3.03. Some testing will be needed to make sure it is compatible with output from more recent versions, but this was not believed to be time consuming.

12.0 OTHER MATTERS

12.1 Collaboration with WCPFC-SC-SPC on NPALB and SPALB assessments

The ALBWG did not discuss this item as all efforts are focused on the next stock assessment. This item will be added to the agenda of the July 2010 meeting.

12.2 Time and place of ALBWG stock assessment meeting (March 2011)

Japan offered to host the stock assessment workshop in Shimizu and this proposal was accepted with thanks. The ALBWG stock assessment meeting (22-29 March 2011) will be held at the National Research Institute of Far Seas Fisheries in Shimizu, Japan. The modeling subgroup may meet 16-21 March at the same location to prepare for the workshop.

13.0 ADOPTION OF REPORT AND CLOSURE OF THE MEETING

13.1 Procedure for clearing the report

A first draft of the meeting report was prepared by the Chair and circulated by email to all participants. This draft was reviewed by the ALBWG and revisions were incorporated into a second draft prior to adjournment of the meeting. After the meeting, the Chair distributed a third draft of the report containing his edits via email for review, comment, and approval by the participants by the end of May 2010. Subsequently, the WG evaluated suggested revisions, made final decisions on content and style, and provided the report for ISC10 Plenary review.

13.2 Acknowledgments

ALBWG participants thanked the hosts (National Research Institute of Far Seas Fisheries and staff) for their hospitality and overall meeting arrangements, which served as the foundation for meaningful scientific discussion and a successful meeting.

13.3 Adjournment
The ALBWG meeting was adjourned at 16:35 on 26 April 2010. The chair (John Holmes) thanked all of the participants for their attendance and contributions.

LITERATURE CITED

Cadima, E.L. 2003. Fish stock assessment manual. FAO Fisheries Technical Paper. No. 393. Rome, FAO. 161 p.

Conser, R.J., P.R. Crone, S. Kohin, K. Uosaki, M. Ogura, and Y. Takeuchi. 2005. Preliminary research concerning biological reference points associated with north Pacific albacore population dynamics and fisheries. Working paper ISC/ALBWG/05/06 prepared for the International Scientific Committee Albacore Working Group Meeting, NOAA Fisheries, Southwest Fisheries Science Center, 8604 La Jolla Shores Dr., La Jolla, CA 92037, USA, November 28-December 2, 2005.

Ichinokawa, M., Coan, Jr., A.L., and Takeuchi, Y. 2008. Transoceanic migration rates of young North Pacific albacore, *Thunnus alalunga*, from conventional tagging data. Can. J. Fish. Aquat. Sci. 65: 1681–1691.

International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC). 2009. Annex 6. Report of the Albacore Working Group Workshop, 14-22 April 2009, Shimizu, Japan. *In*: Report of the Ninth Meeting of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean. Plenary Session. 15-20 July 2009, Kaohsiung, Taiwan, 63 p.

Kai, M. 2009. Preliminary results of stock assessment of North Pacific Albacore using SS with area aggregated data of Japanese main fisheries. Working document ISC/09/ALBWG/06 submitted to the meeting of the Albacore Working Group Workshop, International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC), April 14 – 21, 2009, Shimizu, Shizuoka, Japan.

Kiyofuji, H., K. Uosakai, and Y. Takeuchi. 2009. Revision of minimum SSB reference points in response to new management objective for the North Pacific albacore. Working paper ISC/09/ALBWG-2/04 prepared for the Ninth Meeting of the International Scientific committee on Tuna and Tuna-like Species in the North Pacific Ocean (ISC), 15-20 July, 2009, Kaohsiung, Taiwan., Kaohsiung, Taiwan.

Lee, H.-h. and R.J. Conser. 2009. Population Analysis of North Pacific Albacore Based on the Stock Assessment Program Stock Synthesis 3. Working document ISC/09/ALBWG/05 submitted to the meeting of the Albacore Working Group Workshop, International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC), April 14 – 21, 2009, Shimizu, Shizuoka, Japan.

APPENDIX 1
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APPENDIX 2

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

MEETING OF THE ALBACORE WORKING GROUP
20-27 April 2010
Shimizu, Japan

AGENDA

1. Opening welcome and meeting arrangements

2. Distribution of documents and review of ISC working paper availability policy

3. Review and approval of agenda

4. Appointment of rapporteurs

5. Review of important national fishery developments

6. Finalize spatial/temporal stratification of the JPN PL & LL, TWN LL, USA LL, & CAN/USA troll fisheries

7. Examine new CPUE indices for indicators of spawning biomass & recruitment

8. Review modeling decisions for upcoming stock assessment

9. Further progress on length-based SS modelling since July 2009 meeting

10. Alternative modelling approaches (if time is available), e.g, Bayesian approaches

11. Review 2009 developments at IATTC, WCPFC (SC and NC) relevant to ALBWG
    11.bis – IUU Fishing

12. List estimates of biological reference points from 2006 assessment & develop recommendations for north Pacific albacore (see attached spreadsheet)

13. Update on NPALB vital rate research and biological research plan

14. Planning of topics and work assignments for upcoming meetings in 2010
    a. July 12-13 meeting in Victoria
        i. Updates of fisheries data through 2009 and up to 01 July 2010
        ii. Updates (if any) of NPALB vital rates
        iii. Updates of standardized CPUE indices

   iv. Complete reference point assignment if necessary
  b. October 2010 ALBWG meeting and review of work assignments
   i. Development of CPUE indices
   ii. Preparation of the final database for stock assessment modeling
   iii. External software for biological reference point estimation

15. Other matters
  a. Collaboration with WCPFC-SC-SPC on NPALB and SPALB assessments
  b. Time and place of ALBWG stock assessment (March 2011)

Adoption of report and closure

APPENDIX 3

List of Working Papers

		Availability
ISC/10-1/ALBWG/01:	Use of A Biomass Production Model to Estimate MSY for the North Pacific Albacore Tuna Stock. Zane Zhang and John Holmes	Abstract and contact details on website
ISC/10-1/ALBWG/02:	Recent change in the operation of Japanese longline fishery in the northeast Pacific. Takayuki Matsumoto	Full paper on ISC website
ISC/10-1/ALBWG/03:	Standardization of age aggregated and specific abundance indices for north Pacific albacore caught by the Japanese large and small longline fisheries, 1966-2008. Takayuki Matsumoto	Full paper on ISC website
ISC/10-1/ALBWG/04:	Reexamination of arrangement and standardization of CPUE for Japanese longline fishery for applying SS3 to north Pacific albacore. Takayuki Matsumoto	Full paper on ISC website
ISC/10-1/ALBWG/05:	Spatiotemporal characterization and critical time series of the US albacore troll fishery in the North Pacific. Steven L.H. Teo, Hui-Hua Lee, and Suzanne Kohin.	Abstract and contact details on website
ISC/10-1/ALBWG/06:	Spatiotemporal characterization and preliminary time series of the US albacore longline fishery in the North Pacific. Steven L. H. Teo, Hui-Hua Lee, and Suzanne Kohin.	Abstract and contact details on website
ISC/10-1/ALBWG/07:	Summary of the U.S. north Pacific albacore archival tagging program through 2009. Suzanne Kohin, John Childers, and Stephanie Synder	Abstract and contact details on website
ISC/10-1/ALBWG/08:	Review of the Canadian Troll Fishery for North Pacific Albacore for the Length-based SS-3 Model. John Holmes and Zane Zhang	Full paper on ISC website
ISC/10-1/ALBWG/09:	Applicability of F_{loss} for north Pacific albacore as a limit reference point (LRP). Mikihiko Kai	Abstract and contact details on website
ISC/10-1/ALBWG/10:	Conceptual and technical characteristics of Fssb. Momoko Ichinokawa, Mikihiko Kai, Hidetada Kiyofuji, and Yukio Takeuchi	Title and contact details on website
ISC/10-1/ALBWG/11:	Examining robustness of biological reference points to natural mortality. H. Kiyofuji, M. Kai, M. Ichinokawa, S. Iwata, K. Uosaki, and Y. Takeuchi	Title and contact details on website

APPENDIX 4

Candidate biological reference points for north Pacific albacore and their characteristics.

BRPs	Recent Estimate (Year)		Description	Data Needs	Model
	50% Prob.	95% Prob.			
F_{MSY}			Fishing mortality rate associated with maximum sustainable yield	Catch, CPUE, life history parameters	Age structured & dynamic-pool models
F_{MED}			Fishing mortality rate corresponding to the median observed recruit/SSB ratio	Catch, CPUE, life history parameters	Age structured & dynamic-pool models
$F_{40\%}$	0.32 (2006)		F that reduces SSB/R to 40% of unfished state	Life history parameters (length-weight, M, size at age, sex ratio)	Age structured model
$F_{35\%}$	0.38 (2006)		F that reduces SSB/R to 35% of unfished state		
$F_{30\%}$	0.45 (2006)		F that reduces SSB/R to 30% of unfished state		
$F_{20\%}$	0.65 (2006)		F that reduces SSB/R to 20% of unfished state		
$F_{0.1}$	0.45 (2006)		F at which slope of Y/R is 10% of value at origin	Life history parameters (length-weight, M, size at age, sex ratio)	Age structured & dynamic-pool models
F_{MAX}	2.07 (2006)		F corresponding to maximum yield per recruit	Life history parameters (length-weight, M, size at age, sex ratio)	Age structured & dynamic-pool models
F_{loss} [A]			Fishing mortality rate expected to keep biomass at Bloss	Catch, CPUE, life history parameters	Age structured model
B_{loss} [A]			Minimum observed biomass (or SSB)	Catch, CPUE, life history parameters	Age structured model
B_{MSY}			Stock biomass associated with maximum sustainable yield	Catch, CPUE, life history parameters	Age structured & dynamic-pool models
SSB_{MSY}			Spawning stock biomass associated with maximum sustainable yield	Catch, CPUE, life history parameters	Age structured & dynamic-pool models

Candidate biological reference points for north Pacific albacore and their characteristics.

BRPs	Recent Estimate (Year)		Description	Data Needs	Model
	50% Prob.	95% Prob.			
F_{SSB}			Fishing mortality rate that ensures future spawning stock biomass (SSB) remains above a specified threshold level with a certain probability.	Configuration of stock assessment model and projection software requires discussion with managers	Age structured & dynamic-pool models
$F_{SSB-10\%}$	0.70 (2006)	0.55 (2006)	Fishing mortality rate that prevents the SSB from declining below the 10th percentile of observed SSB		
$F_{SSB-25\%}$	0.66 (2006)	0.51 (2006)	Fishing mortality rate that prevents the SSB from declining below the 25th percentile of observed SSB		
$F_{SSB-50\%}$	0.56 (2006)	0.39 (2006)	Fishing mortality rate that prevents the SSB from declining below the median (50th percentile) of observed SSB		
$F_{SSB-ATHL}$	0.75 (2009)		Fishing mortality rate that prevents the SSB from declining below the average of the ten historically lowest observed SSB		
$F_{SSB-min}$	0.81 (2006)	0.64 (2006)	Fishing mortality rate that prevents the SSB from declining below the minimum observed SSB		

Candidate biological reference points for north Pacific albacore and their characteristics.

BRPs	USE (target/limit)	Pros	Cons	Robustness to M[B]	NPALB Comments
F_{MSY}	target or limit	Considers both S/R and OY concepts; consistent with goals of many management bodies	Difficult to estimate; sensitive to S/R steepness and other structural assumptions; risk of recruitment overfishing; productivity changes (e.g., regime shifts) may have unpredictable effects		$F_{MSY} = F_{MAX}$ based on previous stock assessment because steepness of S/R relationship = 1 was used.
F_{med}	target		Assumes S/R; may not be robust if number of recruits estimated from narrow range of SSB	Estimates relatively sensitive to M assumption	
$F_{40\%}$ $F_{35\%}$ $F_{30\%}$ $F_{20\%}$	target or limit	Proxies for FMSY; Knowledge of S/R relationship is not required	Difficult to specify which %SPR is an appropriate proxy; advice in literature based on assumptions about stock productivity; not robust to changes in selectivity; does not consider impacts of environmental change on productivity	Estimates relatively sensitive to M assumption	Life history parameter estimates for albacore are old and need updating; may affect estimates of Fx%; difficult to estimate unfished biomass, especially for NPALB exploited historically
$F_{0.1}$		Proxy for F_{MSY}; Knowledge of S/R relationship is not required; Can be estimated if Y/R curve asymptotic in contrast to F_{MAX}; Accounts for changes in life history	Not useful for recruitment overfishing	Estimates highly sensitive to changes in M	Life history parameter estimates for albacore are old and need updating; may affect estimates

Candidate biological reference points for north Pacific albacore and their characteristics.

BRPs	USE (target/limit)	Pros	Cons	Robustness to M[B]	NPALB Comments
		parameters over time and selectivity patterns.			
F_{MAX}	limit	Estimated from Y/R so S/R relationship doesn't need to be known; F > FMAX considered growth overfishing	Difficult to estimate if Y/R curve is asymptotic; not useful for recruitment overfishing	Estimates highly sensitive to changes in M	Life history parameter estimates for albacore are old and need updating; may affect estimates
F_{loss} [A]	limit	Ease of calculation relative to F_{SSB}; easy to understand the concept as a limit	Assume equilibrium dynamics which may not be realistic	Estimates relatively sensitive to M assumption	B_{loss} occurred at beginning of time series when backward simulation models do not estimate well. Robustness of estimate based on previous stock assessment questioned; may not be an issue with implementation of SS3 for upcoming stock assessment but requires further research
B_{loss} [A]	limit	Ease of calculation relative to Fssb; easy to understand the concept as a limit	Assume equilibrium dynamics which may not be realistic	Estimates relatively sensitive to M assumption	B_{loss} occurred at beginning of time series when backward simulation models do not estimate well. Robustness of estimate based on previous stock assessment questioned; may not be an issue with implementation

Candidate biological reference points for north Pacific albacore and their characteristics.

BRPs	USE (target/limit)	Pros	Cons	Robustness to M^B	NPALB Comments
					of SS3 for upcoming stock assessment but requires further research
B_{MSY}	target or limit	Considers both S/R and OY concepts; consistent with goals of many management bodies (straightforward); Accounts for changes in life history parameters over time and selectivity patterns.	Difficult to estimate; sensitive to S/R steepness and other structural assumptions; not robust to change in selectivity; productivity changes (e.g., regime shifts) may have unpredictable effects		
SSB_{MSY}	target or limit	Considers both S/R and OY concepts; consistent with goals of many management bodies (straightforward); Accounts for changes in life history parameters over time and selectivity patterns.	Productivity changes (e.g., regime shifts) may have unpredictable effects		
F_{SSB}	target or limit	Flexibility in way it's calculated; flexible based on management goals; increases need to determine	Flexibility in way it's calculated; increases need to determine risk strategy of management; computer	$F_{SSB-10\%}$: insensitive, $F_{SSB-25\%}$: insensitive,	Flexibility in way it's calculated; increases need to determine risk strategy of management; computer

Candidate biological reference points for north Pacific albacore and their characteristics.

BRPs	**USE (target/limit)**	**Pros**	**Cons**	**Robustness to M[B]**	**NPALB Comments**
$F_{SSB\text{-}10\%}$	Limit/Precautionary	risk strategy of management; Based on concept of avoiding recruitment overfishing Simulation-based; takes into account uncertainties as buffers by quantifying non-equilibrium dynamics, estimates of historical SSB, and parameter estimates in the terminal years.	intensive; Requires specification of: (1) threshold SSB level, (2) probability that stock remains above threshold, and (3) length of projection period. Sensitive to projection period used in simulation, e.g., 5- vs 25-yr.	Sensitivity for $F_{SSB\text{-}50\%}$ was not tested.	intensive; Requires specification of: (1) threshold SSB level, (2) probability that stock remains above threshold, and (3) length of projection period. Based on concept of Avoiding recruitment overfishing
$F_{SSB\text{-}25\%}$	Limit/Precautionary				
$F_{SSB\text{-}50\%}$	Target				
$F_{SSB\text{-}ATHL}$	Limit/Precautionary		Occurs at beginning of time series when VPA does not estimate old fish well; this may not be true with new SS3 model;	Estimates insensitive to M assumption	Consistent with interim objective for NP ALB;
$F_{SSB\text{-}min}$	Limit/Precautionary			Estimates relatively sensitive to M assumption	Occurs at beginning of time series when VPA does not estimate old fish well; this may not be true with new SS3 model;

A – see Kai 2010 - ISC/10-1/ALBWG/09.
B – see Kiyofuji et al. 2010 - ISC/10-1/ALBWG/11.