Annex 6

REPORT OF THE SHARK WORKING GROUP WORKSHOP

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

13-18 January 2014
La Jolla, California, USA

1.0 INTRODUCTION

The Shark Working Group (SHARKWG or WG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) held a 6-day meeting at the NOAA Southwest Fisheries Science Center in La Jolla, CA, USA, January 13-18, 2014. The primary goals of the workshop were to finalize the choice of abundance indices for the revised North Pacific blue shark assessment; finalize all other input data for the assessment; review the draft Stock Synthesis (SS) assessment of blue shark; and decide on final parameterization and model specifications for the assessment, sensitivity runs and future projections to be completed at the June meeting.

Suzanne Kohin, SHARKWG Chair, opened the meeting. Participants included members from Chinese Taipei, Japan, United States of America (USA), Inter-American Tropical Tuna Commission (IATTC), and Secretariat of the Pacific Community (SPC) (Attachment 1). Dr. Russ Vetter, Director of the Fisheries Resource Division of the NOAA Southwest Fisheries Science Center, welcomed SHARKWG participants to the new La Jolla facility and gave some opening remarks. Dr. Vetter expressed his appreciation for the work of the group and the efforts to complete the first collaborative ISC North Pacific shark assessment since the SHARKWG was formed in 2011. He acknowledged the challenges faced by the group, due to the data poor nature of the stocks, and the difficulty in satisfying all scientists and managers in the ISC, Western and Central Pacific Fisheries Commission (WCPFC) and IATTC arenas. He wished the group a productive meeting in finalizing the data for the revised blue shark assessment. Dr. Vetter also said he hopes that the group will continue to move forward in a collaborative manner such that the conclusions of the revised blue shark assessment and the shortfin mako assessment planned for next year be reached by consensus in order to provide the best available information on these important and vulnerable stocks to fishery managers.

2.0 DISTRIBUTION OF MEETING DOCUMENTS

Seven working papers were distributed and numbered (Attachment 2). Several oral presentations were also made during the meeting. All papers were approved for posting on the ISC website where they will be available to the public with the exception of **ISC/14/SHARKWG-1/06**.

3.0 REVIEW AND APPROVAL OF AGENDA

The draft meeting agenda was reviewed and adopted with minor revisions (Attachment 3).

4.0 APPOINTMENT OF RAPPORTEURS

Rapporteuring duties were assigned to S. Teo, N. Takahashi, K. Piner, Y. Semba, S. Oshimo, T. Sippel, A. Aires-da-Silva, S. Harley, M. Kanaiwa, and M. Kai. The approved agenda (Attachment 3) indicates the rapporteurs for each item in parentheses.

5.0 REPORT OF THE SHARKWG CHAIR

The Chair of the SHARKWG provided summaries of the activities of the SHARKWG from July 2013 to present. During the July 2013 meeting in Busan, Korea, the WG developed consensus stock status and conservation information for north Pacific blue shark and completed other work for the ISC Plenary. The WG also spent several days reviewing size and sex composition information for shortfin mako sharks to begin to understand the dynamics of that species in the North Pacific in preparation for the upcoming shortfin mako assessment. The WG developed a work plan to complete the shortfin mako assessment prior to the Plenary in 2014. The blue shark assessment was accepted by the ISC Plenary as the best scientific information on the stock. In August, the blue shark Bayesian Surplus Production (BSP) assessment was presented to the Scientific Committee (SC) of the WCPFC along with the north Pacific blue shark SS3 assessment conducted by SPC. While the base case assessments showed similar trends in estimated biomass, the SC did not accept the assessments due to the fact that the biomass trajectory was highly sensitive to the abundance index used for the late period. The SC requested that SPC work with the ISC SHARKWG to redo the assessment prior to the next SC meeting. The ISC Chairman subsequently tasked the ISC SHARKWG to revisit the abundance indices and redo the assessment prior to the next Plenary. A workshop attended by some SHARKWG members was convened in December in Honolulu, HI for members to closely examine the set-by-set fishery data used in the abundance indices. The objectives of the workshop were to identify the greatest sources of uncertainty in the indices, to understand how representative the various data sources are of the stock, and to improve the indices. Several interesting outcomes of the CPUE workshop will be discussed as the WG reviews each of the indices during this meeting.

The ISC SHARKWG held its second Shark Age and Growth Workshop in La Jolla, CA January 9-11, 2014 (see Attachment 4). The group of age and growth specialists from Chinese-Taipei, Japan, Mexico and the U.S. reviewed progress on age and growth studies of blue and shortfin mako sharks and discussed collaborative studies initiated at the first ISC Shark Age and Growth Workshop. The group focused on addressing uncertainties regarding shortfin mako age and growth given that the ISC SHARKWG will be conducting a shortfin mako assessment in the coming year. There are a few hypotheses about band pair deposition rates in shortfin makos and only one validation study for juvenile shortfin makos in the North Pacific. The group came up with a work plan and timeline to provide the ISC SHARKWG with updated information by their fall shortfin mako data meeting.

6.0 REVIEW CPUE INDICES FOR UPDATED BLUE SHARK STOCK ASSESSMENT

Update of Japanese abundance indices and catch for blue shark Prionace glauca in the North Pacific (ISC/14/SHARKWG-1/02)

Summary

This working paper provides an update of the Japanese offshore longline abundance index from 1994 to 2012 for north Pacific blue shark (*Prionace glauca*), with particular emphasis on the evaluation of the impact of targeting. Some errors in a small number of log-books were also corrected before the calculation of CPUE, but the influence was quite small on the CPUE standardization. The methodology of CPUE standardization and catch estimation by Hiraoka et al. (2013) were basically followed in this work. The CPUE in the most recent two years were standardized separately from that before 2011 because the Japanese offshore surface longliners largely changed their operational pattern due to the fact that all shark processing facilities were lost by the tsunami of 11th March, 2011. The correction of erroneous logbooks, which reported number of hooks per basket information in the column for total hooks deployed, produced a somewhat more pessimistic trend in the abundance indices for 2006 – 2012, but resulted in slightly narrower confidence intervals. The estimated annual catch from 1994 to 2012 was slightly decreased by the correction of logbook data, but the revision of the conversion factor created overall higher estimates of historical Japanese longline catch from 1971 to 2012.

Discussion

The WG raised the question of how the effect of small-scale areas (5x5) was included in the GLMs presented. Latitude and longitude were included in the GLMs as categorical factors, with interactions between latitude and longitude. However, interactions between that and other factors (e.g., year, season) were not included. Also it was mentioned that the target factors are already included in the model with year and season interactions because of treating the spatial and temporal changes in effort.

At the previous meeting in December 2013 (CPUE workshop in Honolulu), some members of the WG were interested in the CPUE trends in the area where this fishery overlapped with the Hawaii longline fishery in order to better understand the influence of spatial effects on the CPUE trends. It was reported that some analyses demonstrated that for the subset of data in the overlapping area, the graph of the trend for the Japanese fishery visually showed a pattern more similar to the Hawaii longline index, thus suggesting that smaller areas may show regional differences in abundance trends.

Some members of the WG enquired on possible improvements in understanding the effect of targeting on the observed CPUE trends, possibly looking at individual vessel and larger scale trends. The authors confirmed that SWO catch ratio is binned by 10% percentiles of SWO CPUE, and not SWO:BSH ratio.

The WG concluded that the revised index and estimated catch currently represent the best available information for the Japanese offshore longline fishery and is reliable for use in the north Pacific blue shark assessment.

Blue shark catch and effort data collected by Japanese research and training vessels (ISC/14/SHARKWG-1/03)

Summary

In the spring of 2010, limited information from the secretariat of the research and training association provided information that at least part of Japanese research and training vessels do not report all of their shark catches. Questionnaire surveys to each vessel conducted right after that supported this information, though only less than half of vessels answered the survey. The nominal CPUE trends of blue shark of each vessel in their main fishing grounds shows apparently unnatural large variations or unnatural low CPUE values observed for some vessels since early 2000. The CPUE of blue shark standardized with the effect of vessels started to decline and its CV increased in the 2000s. The increase of CV that occurred in the 2000s is supposedly caused by the fact that Japanese research and training vessels underreported the catch of blue shark in the 2000s and the degree of underreporting is different among vessels, which causes the increase of CV. The results of analysis of catch and effort data of blue shark indicates the fact that the under reporting activity started small scale in the early 2000s and it gradually expanded in terms of the number of vessels and/or areas. By the mid 2000s, the under reporting activity becomes more apparent.

In Japan, there are two types of research vessels; one is operated by prefectural fishery laboratories. They are conducting research to offer the information about fishing and sea conditions to fishers, and they are members of part of the research and training association and subject of this study. Other research vessels are operated by the national research institutes. In the 2000s, the information by research vessels operated by national research institutes could only be used for the CPUE analysis of blue shark in the north Pacific.

Discussion

The WG discussed the concerns about the observed changes in reporting rate by the vessels that suggest under-reporting by some vessels. Some members of the WG suggested that the presented index (after standardization) is possibly an improvement over the previously suggested indices using this dataset, due to the comparison of the biological and logbook data. However, the authors suggested that the indices presented are not appropriate for use in the assessment due to unresolved issues with the reporting of these data, and are presented only to illustrate the problems with the data. The authors stated that they are continuing to work with the fishing industry to obtain better records for the past effort and catch, but at this time strongly recommended that if the WG decided to use this dataset, that only the data prior to 2000 be used. The authors offered to run analyses to provide updated indices for the research and training vessels including data from both WCPFC regions 2 and 4 before a final decision was made regarding their value.

Abundance indices of blue shark reported by Japanese research and training vessel during 1993-1999 and 1993-2011 (Powerpoint Presentation)

Summary

Standardized CPUE indices were re-estimated using Japanese Research and Training Vessel records (RTV) operating around the Hawaiian Islands during 1993 to 1999. Similar data filtering were conducted based on the methods mentioned in the document by Clarke et al. 2011. Since there were some questionable approaches used in the prior delta-lognormal analysis (e.g. the exploratory variable of logarithm hook is modeled as spline curve, and vessel is not given as a random effect, etc.), an alternative model (negative binomial model) was used with more preferable explanatory variables as follows:

number of blue shark ~ year + trimester + lon5 + area + trimester * area + offset(log(hooks))

year: (1993-1999), trimester: (Dec-Mar, Apr-Jul, Aug-Nov), lon5: (5 degree of longitude), and area: (area 2 (20N≧) and 4 (20N<).

An additional run used all data through 2011. The estimated standardized CPUEs showed more or less stable trends throughout the periods examined.

Discussion

The WG decided that due to the evidence of potential changes in reporting since 2000, past and revised indices developed using these data are not reliable for use in the current north Pacific blue shark assessment. Continued efforts to improve the reliability of the data and derive more accurate indices for the research and training vessels are recommended.

Updated and revised historical catch and standardized CPUE series of the blue shark by Taiwanese large-scale tuna longline fisheries in the North Pacific Ocean (ISC/14/SHARKWG-1/07)

Summary

In the present study, the blue shark catch and effort data from observers' records of Taiwanese large longline fishing vessels operating in the North Pacific Ocean from 2004-2012 were analyzed. Due to the large percentage of zero shark catch, the catch per unit effort (CPUE) of blue shark, as the number of fish caught per 1,000 hooks, was standardized using the delta lognormal approach. The analysis of standardized CPUE showed an increasing trend for blue sharks. The results suggested that the blue shark stock in the North Pacific Ocean seems at the level of optimum utilization. Estimated blue shark bycatch in weight ranged from 1 ton in 1973 to 1,357 tons in 2002. The results obtained in this study can be improved as longer time series of observer data become available.

Discussion

Some members of the WG enquired if the discard data from this fishery was reliable and the author responded that the discard data are considered to be reliable. However, the WG noted that the number of observed sets is small and the time series is relatively short compared to the other time series, as was noted in previous meetings. It was requested that the authors develop separate abundance indices for the Areas 1 (north) and 2 (south). The WG also noted that the size of blue shark caught by the fishery appeared larger than other fisheries and enquired if the size of blue shark caught were different in the two areas. The author responded that it was previously noted that the Taiwan longline fishery appeared to catch the largest fish and that the size of blue shark was similar for both areas.

After examining the size composition and separate indices by both areas, **the WG noted that there were no apparent differences in size composition and CPUE trends in both areas, and recommended combining the data for both areas.** The authors also produced additional diagnostics and revised their working paper at the request of the WG. **The WG concluded that**

although the sample sizes were relatively low, that the updated Taiwan large longline index is reliable for use in the north Pacific blue shark assessment.

CPUE standardization for blue sharks in the North Pacific Ocean based on SPC-held observer data (Powerpoint Presentation)

Summary

Documents ISC/14/SHARKWG-1/INFO02 and SPC_questions_with_responses_131213 were presented which outlined the analysis of the SPC held observer data for use as an index of abundance for blue shark in the North Pacific. The presentation showed analysis of the entire data base holdings as well as analyses without the Hawaiian Observer program data. The presentation concluded with a review of the responses to the questions from the December workshop.

Discussion

Some members of the WG enquired if the authors had any recommendations as to which of the indices described in the paper should be used in the assessment. The authors suggested that the WG can either use the SPC-HI combined index (SPC-held together with Hawaii longline) or that the SPC and HI data be used in separate indices so as to not double count the HI data provided the U.S. provides an index for the HI fishery. In addition, the authors and **WG recommended that the U.S. scientists provide a standardized abundance index for the Hawaii longline data and that SPC scientists provide an index for the SPC data**, because the datasets are from different regions and operate differently, and that the respective scientists would understand their own data best. Given the recommendation to not include the HI data, the SPC revised their index to include both shallow and deep set operations.

Observer coverage and observed catch of the longline fleets was noted by the WG to be relatively low across fleets during some periods and may not properly represent the small coastal longline fisheries potentially contributing to some of the variation in standardized CPUE. The authors indicated that for the SPC observer program, it is mandatory for a vessel to accept an observer if selected and the data are representative of the longline fisheries in the SPC observer program. In addition, the WG recommended that program code and flag be used as factors in the standardization.

The WG recommended that the time period for the SPC observer data index should be 1993-2009 due to large reductions in observer coverage after 2009 associated with the shift to 100% observer coverage in the tropical purse seine fishery. The WG requested an updated paper be produced which includes the full set of diagnostics before the June assessment meeting. The index was revised and **the WG concluded that the revised index is reliable for use in the stock assessment.**

Description of the Hawaii longline observer program (ISC/14/SHARKWG-1/05)

Summary

Due to the expansion of pelagic longline fisheries based out of Hawaii in the 1980s and concerns about interactions with protected species, an observer program was initiated in the early 1990s to monitor the fishery's catch and bycatch. The scope of the program has changed through time, including a shift from voluntary to mandatory participation, increased levels of observer coverage, and improvements in sampling design. The observer program operates in both the shallow-set, swordfish targeting longline fishery as well as the deep-set, tuna targeting longline fisheries. This paper focuses on the deep-set fishery observer coverage since an index of abundance based on the observer data for this fishery was used by the SHARKWG in the ISC north Pacific blue shark stock assessment in 2013. The distribution of observer coverage in the deep-set fishery has changed through time: prior to 2001 coverage was approximately 4%, but has since been very close to 20% with the spatial footprint of observer coverage being more representative of the entire fishery since 2001. Sampling design of the observer program is considered to be robust since approximately 2001-2002, but prior to that there is concern about bias and lack of representativeness of the data. While some misreporting of data in logbooks was identified in this analysis, and other previous studies, the level of compliance with logbook submission requirements is still considered to be high.

Blue shark catch rates in the Hawaii-based pelagic longline fishery in 2000–2012: a re-evaluation of observer catch data and standardizations for both fishery sectors (ISC/14/SHARKWG-1/06)

Summary

The observer program for the HI-based longline fishery was limited and not of a robust statistical design before 2000. Thus the indices were re-evaluated using only data from 2000 forward. Revised standardized and nominal blue shark catch rates in this fishery do not lead to new conclusions. These results do not demonstrate a more optimistic population scenario than previous work.

Discussion

Some members of the WG enquired about which index was recommended since two standardized indices were presented (see Fig. 1 in paper 06). The authors recommended the WG to use the index using deep-set data from all regions (not presented in Fig. 1 but the coefficients can be found in the document). The WG also discussed whether the CPUE for 2000 should be included in the index because coverage was lower for that year (~10% for 2000 vs 20% for 2001-2012). The authors and other members of the WG responded that 10% coverage was adequate and spatial and seasonal coverage appeared reasonable. **The WG concluded that the Hawaii deep-set longline index is reliable for use in the north Pacific blue shark assessment. However, the WG noted that the paper submitted does not contain the output for the recommended index nor the CV estimates. The Chair will follow up with the U.S. scientists to obtain the correct values for the assessment. A complete document with adequate diagnostics and analysis descriptions should be provided in June to support the stock assessment report.**

6.1 COMPARISON OF CANDIDATE ABUNDANCE INDICES

The WG considered all of the abundance indices brought forward and summarized the information in the following table. The criteria selected in the left column were used to evaluate the reliability of each index for use in the north Pacific blue shark stock assessment.

Table 1. Characteristics of candidate abundance indices proposed to represent relative abundance of north Pacific blue shark and criteria used to evaluate the indices.

Source	**Hawaii**	**Hawaii**	**Taiwan**	**Taiwan**	**Japan**	**Japan**	**Japan**	**SPC**
Gear	**Deep set**	**Shallow set**	**Large-scale**	**Small-scale**	**Early offshore shallow Hokkaido&Tohoku**	**Late offshore & distant water Hokkaido&Tohoku**	**RTV region 2 index-Clarke et al.**	**Longline observer index**
Quality of Observations	Good because using observer data and has 10-20% coverage and discards recorded.	Good because using observer data with 100% coverage and discards recorded.	Good because based on observer data but the number of sets observed is low.	Catch data are representative but effort data were estimated. Based only on landed catch and not discards.	Relatively reliable because 94.6% filtered data applied, logbook data were more reliable after filtering. Data are based on self-reported information and blue shark catch was derived from aggregated shark catch.	Relatively reliable because 94.6% filtered data applied. Logbook reporting rates were validated using available research data.	Species ID good until 2000, quality declining since; after 2005-2006 discarding underreported and data quality considered bad.	Good because it was observer measured, but coverage low.
Spatial distribution	Relatively small (Areas 4 & 5)	Relatively Small (Areas 2 & 5)	Large geographic area (Areas 1-5)	Large geographic area (Areas 1-5)	Medium (Area 1 & 3)	Large (Area 1, 2, 3 and 4)	ISC area 2, and some area 4	Southwest North Pacific (140-180E, 0-15N)
Maximum size	207 PCL (F); 225 PCL (M)	207 PCL (F); 225 PCL (M)	302 PCL (M and F)	240 PCL	no information	170 PCL	180 PCL	181 PCL
Minimum size	132 PCL (M and F)	76 PCL (M and F)	40 PCL (F); 52 PCL (M)	68 PCL	no information	90 PCL	120 PCL, median 160 PCL	114 PCL
Statistical soundness	Not yet known. Awaiting further diagnostics to be provided in the working paper.	Not yet known. Awaiting further diagnostics to be provided in the working paper.	Yes. Reasonable based on diagnostics provided. Not many concerns were raised.	Yes. Diagnostics provided.	Yes. Diagnostics provided.	Yes. Diagnostics provided.	No. Strong patterns in residuals and departure from normality in qq plot; not enough information provided (e.g. deviance table, CV's).	Yes. Some diagnostics provided.
Temporal coverage	2000-2012	2004-2012	2004-2012	2001-2010 (except 2004)	1976-1993	1994-2010	1993-2008	1993-2009
Q Changes (due to management, fishing practices, etc.)	Not likely because no major regulatory changes after the ban on finning in 2000.	Likely due to the regulatory requirements to avoid reaching turtle take caps.	Ban finning from 2005 (probably limited effect on Q)	Ban finning from 2005 (probably limited effect on Q)	No regulation or gear changes.	No regulation, gear and targeting change.	Opportunistic fishing effort, so changes in catchability are hard to determine.	Not likely.

Table 1. continued

Relative catch contribution	<1500 to 2000 mt annually (for deep and shallow sectors combined)		<500 mt/yr before 1999, ~800 mt annually since	>10000 mt/yr from 2004	19000-55000 mt/yr	13000-24000 mt/yr	~50 mt annually	low
Comments				No discard data; more confidence in late than early time series due to higher coverage.	Blue shark was a part of target species which may have changed over time but the standardization and filtering addressed these concerns.	Blue shark is a primary target species. Some concerns about the high number of parameters estimated to address targeting.	Region 4 CPUE index not estimated reliably; Gulland index seems to indicate the vessels were avoiding the high CPUE areas for blue sharks.	In area of relatively lower blue shark density.
Supporting Working Papers or Publications:								
Fishery description/ data description	ISC/11/SHARKWG-1/05, ISC/11/SHARKWG-2/02, ISC/12/SHARKWG-1/02, ISC/14/SHARKWG-1/05	ISC/11/SHARKWG-1/05, ISC/11/SHARKWG-2/02, ISC/12/SHARKWG-1/02, ISC/14/SHARKWG-1/05	ISC/11/SHARKWG-4/06, ISC/13/SHARKWG-1/07, ISC/14/SHARKWG-1/07	ISC/12/SHARKWG-1/15, ISC/13/SHARKWG-1/08	ISC/11/SHARKWG-2/10	ISC/11/SHARKWG-2/11	SC7 Clarke et al. paper; ISC/14/SHARKWG-1/03	ISC/14/SHARKWG-1/INFO02
Analysis description	ISC/11/SHARKWG-2/02, ISC/12/SHARKWG-1/02, ISC/14/SHARKWG-1/06	ISC/11/SHARKWG-2/02, ISC/12/SHARKWG-1/02, ISC/14/SHARKWG-1/06	ISC/13/SHARKWG-1/07	ISC/13/SHARKWG-1/08	ISC/12/SHARKWG-1/07, 08, 09 ISC/12/SHARKWG-2/02 ISC/13/SHARKWG-1/03	ISC/12/SHARKWG-1/08, 09, 06 ISC/12/SHARKWG-2/02, ISC/13/SHARKWG-1/03, ISC/14/SHARKWG-1/02		ISC/14/SHARKWG-1/INFO02
Treatment of outliers or filtering	ISC/11/SHARKWG-2/02, ISC/12/SHARKWG-1/02	ISC/11/SHARKWG-2/02, ISC/12/SHARKWG-1/02	ISC/13/SHARKWG-1/07, ISC/14/SHARKWG-1/07	ISC/13/SHARKWG-1/08		ISC/14/SHARKWG-1/02	SC7 Clarke et al. paper	
Appropriate diagnostics			ISC/14/SHARKWG-1/07			ISC/14/SHARKWG-1/02		

The WG selected 5 indices (Japan longline early, Japan longline late, Hawaii deep-set longline, Taiwan large longline and SPC observer longline) as indices for inclusion in the assessment. The WG noted the differences in trends among some of the CPUE series (Figure 1). The WG attempted to provide a relative weighting of the indices (based on the reliability, plausibility, and/or expert opinion of the WG). The aim of the relative weighting is to provide a relative probability to model runs using a particular index with respect to model runs using other indices. There was substantial discussion on the relative pros and cons of each of the accepted indices as shown in Table 1. The WG **could not come to a consensus** on the relative weighting of each of the accepted indices for the upcoming assessment modeling. **Therefore, the WG will move forward on the modeling without considering the relative weights of the indices.**

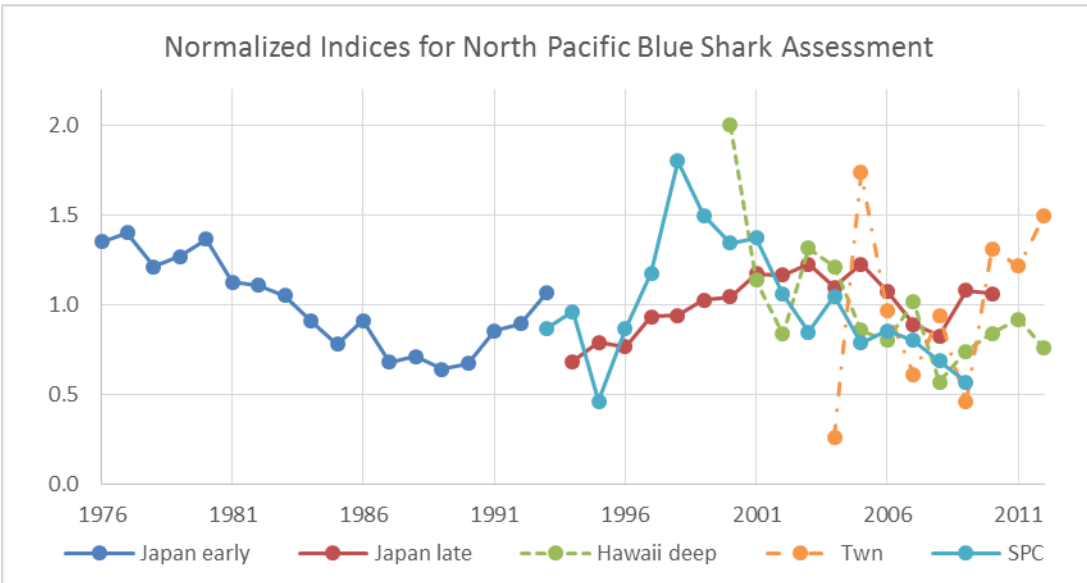

Figure 1. Indices selected for use in the North Pacific blue shark assessment.

7.0 REVIEW OTHER DATA FOR UPDATED BLUE SHARK STOCK ASSESSMENT

7.1 CATCH AND DISCARD DATA

The WG discussed changes to catch estimates that were used in the 2013 stock assessment. The WG reviewed new catch estimates for the Japanese longline fleet based on a new conversion metric (see working paper 02) and a change in the Japanese deep-set longline total catch estimates based upon using a revised analysis of the RTV with data only through 1999. **The WG accepted the new proposed catch estimation procedure for the Japanese deep longline fishery for the stock assessment. Because the data could not be provided by the end of the meeting, the Japan deep-set catch time series will be sent to the Chair by January 25, 2014.** The WG discussed new catch estimates of the Taiwanese large longline fleet (see working paper 07). It was noted that the 2012 catch is incomplete due to low coverage rate. **The WG accepted the new estimates of the Taiwanese large longline fleet for through 2011 for the stock assessment and will carry forward the 2011 value to complete the time series**.

The WG continued discussions focusing on whether catch estimates for 2011 should be updated if the original estimates were uncertain or based on partial data. The WG also discussed extending the catch series to more recent years after noting that the last year in the stock assessment is already several years old. **The WG requested that members submit, if possible, the catch data through 2012 for use in the assessment, and all recent catch data to potentially use in projection estimates**. The WG also discussed potential catch from Central American countries and possibly South American countries that are not included in the WG catch estimates. It was noted that some effort had been made to account for this catch and the missing catch is likely to be relatively small compared to the total North Pacific catch. **The WG recommends that the Chair work with IATTC and Central and South American countries to improve catch estimates**.

7.2 SIZE DATA

Recovered data on size and sex of blue shark collected by Japanese driftnet surveys in the 1980s (Powerpoint presentation)

Japanese scientists have recovered some historical drift net catch and size data from the high seas drift net surveys that may be useful to assign sizes to the historical high seas drift net fisheries.

<u>Summary</u>

<u>Discussion</u>

The WG noted that the data from the small mesh squid driftnet fishery supports size/sex-specific spatial patterns in the North Pacific. The WG discussed how much of this complexity needs to be included in the age-structured model. The WG also noted that the Japanese small mesh size composition data used in the current SS model were taken from the Kleiber et al. 2009 assessment report. Therefore the WG recommended replacing with the small driftnet size data with the new data provided by Japan. However, after further examination of the new Japan data, the Japanese scientists recognized that further editing is necessary to remove some suspicious data, thus the Kleiber et al. data should be used. **The Japanese will check the Kleiber et al. data by January 25, 2014 to confirm that they are correct because some very small sizes were observed and they will provide updated size data if corrections are found warranted.**

The WG continued the size data discussion by examining the Chinese data in the current SS model. The WG noted the size data representing China is from tropical longline fishery observer samples collected by SPC member country observers. The WG noted that there are no size data for China after 2008, as the observer effort shifted to the purse seine vessels from the longline fleet. **The WG recommends that more information on the observer program and location of observed vessels be provided but that it is appropriate to use the China size data in the stock assessment**. It was also noted that the Taiwanese small longline size composition data are sparse but the fishery is important in recent years. The Taiwanese small longline data represent two types of fisheries, one that is based in Taiwan and the second based in FFA island countries. Those two sectors may catch different size sharks. It is impossible to break out the fishery data and size data at this time. The WG noted that the large Taiwanese longline size data was initially reported aggregated across years, but **recommended that the size composition be disaggregated into the appropriate years**. The Taiwanese delegation provided the disaggregated size data. The WG also discussed SPC member nation data associated with

Taiwanese vessels which were not included in the SS assessment. The SPC indicated that at this time they could not provide the fine scale observer data necessary to allow combining these data with the other Taiwanese data**. The WG agreed to use the size data provided by the Taiwan delegation for their longline fleets in the assessment.**

7.3 FISHERY DEFINITIONS

The WG discussed fleet definitions for the SS model, noting that significantly changing fleet definitions at this time is not feasible. **The WG recommended that despite small differences in the Hawaiian deep and shallow longline aggregate size composition data, a single Hawaiian longline fleet should be used in the updated stock assessment as in the 2013 assessment**.

7.4 HISTORICAL CPUE

Comparison of CPUE level of blue shark in Japanese longline research activities before and after the World War II (ISC/14/SHARKWG-1/04)

<u>Summary</u>

The level of standardized CPUE of blue shark between the period before and after World War II was compared using blue shark specific catch and effort data, to offer more concrete information for the stock assessment of the north Pacific blue shark. The results of CPUE analysis shows that the levels of CPUEs were not different between 1937 – 1939 and 1975 – 1977 for the night shallow sets in the higher latitudinal area, and between 1937 - 1939 and 1967 – 1970 for the day sets in the tropical area. In all analyses, the effects of years or periods were not significant. Though the models used for the CPUE standardization were simpler than those used for the estimation of abundance indices, these results clearly indicate the fact that the level of abundance in 1975 – 1977 is not largely different from that in 1937 – 1939 when the north Pacific blue shark stock was believed to be only exploited slightly. Thus the level of abundance in 1975 – 1977 should not be so much different from B_0.

<u>Discussion</u>

The WG discussed how the historical trends in CPUE presented could be used in the current stock assessment. Two approaches were discussed, including using the information in the stock assessment formally (e.g. prior or likelihood component) or as a methods to subjectively judge of the assessment results.

8.0 REVIEW DRAFT SS3 BLUE SHARK ASSESSMENT

Progress on the updated Stock Synthesis stock assessment of Blue Shark in the North Pacific Ocean *(ISC/14/SHARKWG-1/04)*

<u>Summary</u>

A review of the model and results from the SC9 SS stock assessment for blue shark, as well as a preliminary update on the SS model based on revised data submitted for the December workshop (in Hawaii) was presented. The input data are CPUE series, size data (mainly for longline fisheries) and total catches by fleet. The time frame is 1976-2011. The model was started in 1976 which was when the Japanese longline CPUE series started. Biological parameters were taken from the literature and alternatives used in the sensitivity analysis. Eighteen fisheries were defined. North Pacific longline effort trends from 1950 to 2010 were also presented, which showed a steady increase until the 1980s, with a leveling off and a recent increase. It was noted that this effort series includes all the North Pacific Ocean including the tropical zone, which is outside the expected core area of the blue shark population and that the congruence of catch and effort should be examined on a regional basis. The model is an age structured, one-area, two-sex model with 18 fisheries. A model grid approach was implemented which considers different data inputs and model structural assumptions. Reference models were chosen based on the best likelihood among the grid.

Discussion

A participant inquired about the catch time series trends which show a steady decline. A decline in both the Japanese longline and high seas drift gillnet fishery were noted. A question was raised about how each sex contributes to the stock assessment model. The sex ratio of the pups was set at 0.5, from sex-specific length-composition data. Recruitment was estimated from both the low fecund species stock-recruitment relationship and the Beverton-Holt SRR. The shapes were specified to approximate B_{msy}/B_0 at 0.5 which is close to that chosen for the BSP model and is probably appropriate for blue shark. However, some participants felt that some of the shapes obtained for the low fecundity S-R functions were not likely, given the biology of the blue shark, particularly when biomass levels are high (the recruitment decreases as in the Ricker model due to the decrease in the survival of the pups).

Sigma R was fixed at 0.3. A participant inquired about how the initial conditions were modeled. Initial Fs were estimated for two fleets (one for small fish and one for larger fish). The model is not fitted to an equilibrium catch assumption, and initial recruitment deviates are constrained based on the SR relationship but detached from the equilibrium assumption. A question was raised about the confidence intervals in the time series of spawning biomass. It is narrower in the early 1980s and increases afterwards. More is known at the beginning of the series; uncertainty in recruitment comes later on. Spawning biomass for models fitting to different CPUE series were shown. For most scenarios, the trends were consistent. However the trends are very different across some scenarios and these may be due to some internal inconsistences that need to be improved after changing the data and model structures in the grid. Kobe plots for the output using the Japan early and late series were shown. The final state for the different scenarios was shown with the diameter of the dots reflecting assigned weights. The likelihood cannot be used to compare the models because the sample sizes are different among scenarios.

Results from a SS age-structured production model (ASPM) were compared with the reference case. It is based on the reference case but with the contribution of length compositions turned off.

A comment was made on the influence of the spawner-recruit model assumptions on the initial depletion. It was clarified that the spawner-recruit relationship, CPUE series and catch all influence the initial depletion level.

When you remove all extra model structure (taking catch at the right ages with fixed reasonable selectivities), does the surplus production function (from the biological and S-R assumptions) and historic catch series allow for a good model fit to the CPUE data? The SS ASPM was put forward to obtain more consistency with the assumptions of the BSP model. The main objective being not to let the size composition data drive absolute scale. It was suggested to let catchability change through time in the ASPM and try not fitting to the late index. Table 3 in WP01 was presented to summarize the results over all scenarios.

Some participants expressed concern that this table can portray the wrong message to managers since it does not include the weighting of the scenarios. The response was that the table is for the WG only and that the criteria defining uncertainty shall be discussed at a later stage and reflected in the final assessment results to be presented to managers.

The WG Chair also reminded the group that the blue shark assessment is a collaborative effort and the WG should take advantage of SPC's assessment work. A participant asked for clarification about the objective of using the SS model in addition to the BSP model. The WG Chair pointed out that there are relevant uncertainties such as stock structure issues that could be better addressed with SS. **The WG has decided that an alternative age-structured model should be used concurrently with the BSP model.**

There were not many differences in the absolute trends between SS3 and the BSP assessments; the biggest uncertainty was due to the choice of abundance indices. Results from both models were similar if the same indices were used. A participant added that there is size and sex structure of blue sharks in the ocean and the surplus production model assumes homogeneity whereas the fleets operate in different areas. In addition, the production function can change over space and time. The surplus production model has process error, but it will not change the fundamental production function. Sigma R ranges in SS3 were selected to capture the range of uncertainty in productivity. Some members expressed concern about the low quality of size data and the flat recruitment trend in the SS3 results suggesting no need for an age-structured model. Other members of the WG responded that BSP and SS3 both provide valuable insights, and the choice of model is relatively less important than the effect of CPUE index choice.

Concern was raised about the initial depletion levels estimated by the SS model. Improvements could be made. Future work could look at historic catches to help define equilibrium catch assumptions which could be used to better estimate the initial conditions. Diagnostics were proposed to investigate what is influencing the estimated initial depletion levels, which includes:

1) likelihood profile for the initial F.
2) or estimate the initial F while fitting to different assumed values for the equilibrium catch.

Differences between the two models may be further reduced. Sigma-R and size composition weighting are important but considered secondary at this time, not as important as understanding initial conditions. Size compositions are not the big driver of initial conditions. It was pointed out that the length frequency data may still be very informative in the SS model although it was down weighted. The WG has accepted moving forward with the SS3 model and will take some time in the future to more thoroughly review the composition data

9.0 STOCK ASSESSMENT APPROACHES

The WG noted that two assessment approaches had been used for the previous assessment: the BSP and the integrated age and sex-structured model, SS. The WG proposed to again proceed with two assessments for this re-assessment and recalled that it had previously agreed that the primary purpose of the SS model was to assist in validation/verification and to gain an improved understanding of the BSP model results and conclusions.

The WG noted that different approaches had been used with each assessment model to portray uncertainty. The BSP modeling was undertaken with a single 'base case model' and a range of sensitivity runs and the SS modeling was undertaken with a full grid of model runs across major axes of uncertainty. The WG noted the challenge in presenting results when some of the input data were contradictory and recommended further discussion of this issue.

9.1 BAYESIAN SURPLUS PRODUCTION MODELING APPROACHES INCLUDING THE CHOICE OF INPUT PARAMATERS AND PRIORS

Table 2 describes proposed model specifications (i.e., data, parameter values, priors, and model assumptions) for the BSP modeling. It was noted that some of the model runs would be only undertaken to better understand the model, not necessarily to be included in the development of stock status and management advice. The WG carefully considered the specification of priors in light of the SC9 observation (based on the 'prior only run') that some priors were informative for important stock status quantities and this was not considered ideal.

The WG was not able to resolve during the meeting which priors were having the greatest influence, so **it was recommended that work on the sensitivity of the priors continue and be presented at the next assessment meeting.** The WG noted that the catch data were also included in the prior-only run **and recommended that some very different catch trajectories and magnitudes (e.g. reversed and doubling and halving of catch) also be examined to see if the catch is also very influential in the prior-only run.**

Projections will be conducted on key model runs using the most updated catch data available. As in the prior assessment, projections will be carried out for 20 years and will be run assuming status quo catch and F as well as ±20% of those status quo values, and F_{msy}.

Table 2. Bayesian Surplus Production model run specifications and key input parameter choices.

Specifications/Parameters	Reference Value	Alternative Runs	Description/comments
K	Uniform distribution on log(*K*)		Range: [50, 2000] x 1000 MT
r prior mean	0.34	mean = 0.14 mean = 0.43	Reference value based on Cortés (2002) and Kleiber et al. 2009; lower alternative based on Babcock and Cortés 2009; higher alternative from Cortés (2002).
r prior SD	0.5	SD = 0.3 SD = 0.7	
B_{init}/K (*alpha.b0*) prior mean	0.8	mean = 0.5 mean = 1.0	The prior was developed, by expert opinion, after considering the work of Oshimo et al. (ISC/14/SHARKWG-1/04), Matsunaga et al. (2005), Ward and Myers (2005), and reported longline effort in the North Pacific Ocean since 1950.
B_{init}/K (*alpha.b0*) prior SD	0.5	SD = 0.7 SD = 0.9	
Surplus production function	B_{msy}/K = 0.47	B_{msy}/K = 0.3 B_{msy}/K = 0.6	Fletcher-Schaefer model -- reference value corresponds to n = 1.71; alternative values correspond to n = 0.68 and n = 3.39.
Process error	SD = 0.05		

Table 2. continued

Catch		Total dead removals estimated by WG members (for details see prior assessment report).
Abundance indices	Japanese offshore shallow longline (Hokkaido and Tohoku fleets) for 1976-1993 Japanese offshore and distant water longline (Hokkaido and Tohoku fleets) for 1994-2010 Hawaii Deep-set longline (2000-2012) SPC longline (1993-2009) Taiwan large longline (2004-2012)	For details, see CPUE index section of this report.
CV's for abundance indices	0.2 for all indices to start and change if needed by iterative reweighting for Japanese offshore shallow longline CPUE index for 1976-1993	Considering that total CV for CPUE index is treated as the square root of ((observation error CV)^2+(process error CV)^2) in the BSP2 software and the observation error CV for index is quite small, the total CV is dominated by the process error CV for index. To set the total CV for CPUE index properly, inputted CV for index was repeatedly adjusted (iterative reweighting) with an initial value of 0.20 until the ratio of inputted CV to outputted CV got roughly equal to 1.1-1.5 assuming that the CV for index is constant across years, while SD of the process error for the biomass dynamics equation is fixed at 0.05 (M. McAllister, pers. comm.).

9.2 STOCK SYNTHESIS MODELING APROACHES AND THE CHOICE OF INPUT PARAMETERS

Table 3 shows the proposed model specifications (i.e., data, parameter values, priors, and model assumptions) for the SS model. The WG carefully considered model assumptions related to the initial conditions due to the differences observed between the BSP and SS model runs. Major proposed changes to the previous assessment included the starting of the model in 1971 to use the earlier catch data and specifically examining different levels of equilibrium initial catches.

A further important consideration for the SS modeling was how to treat selectivity for fleets for which size data was missing or considered unreliable. **The WG recommended the following:**

- **Mirror Fishery 9 to Fishery 8**
- **Mirror Fishery 13 to Fishery 3**
- **Estimate selectivity for Fishery 17 using new data**
- **Estimate selectivity for Fishery 18 using the aggregated data provided or mirror to a fishery with similar size compositions**

Noting the proposed ‘grid’ approach for the SS modeling, the WG stressed the importance of ensuring internal consistency within the model when this was done.

Table 3. Stock Synthesis model run specifications and key input parameter choices.

GROUP	Variable	Reference case	Alternatives	Notes / Comments
CPUE	CPUE Series	JPN Early and Late	Japanese early with each of the 4 late series (JP, HW, TWN, SPC), Late series without the early Japanese series; and Japanese early only	It might be preferable to also show full diagnostics for the runs using each series.
M	Natural Mortality	Peterson and Wroblewski (using Nakano’s (1994) growth curve)	Peterson and Wroblewski (using Hsu et al.’s (2011) growth curve)	Analyses based on Pacific specific growth curves were initiated at this meeting and provide sex-specific natural mortality ogives.
LF	Sample size for length frequency data	Scalar of 0.2	Scalar of 0.2,& 0.5 & 1.0	Also use the ASPM to determine the most appropriate weighting.
SR	Stock Recruitment Function	LFSR (Sfrac 0.35, Beta=2)	SFRAC=c(0.10, 0.20 , 0.30, 0.40 , 0.50); BETA= c(1,2,3,4)	
	Sigma R (SD on the recruitment deviations)		SigmaR =c(0.1, 0.3)	Previously fixed at 0.3
Initial conditions			Three scalars of 1971 catch levels assumed for equilibrium initial catches.	Investigation of this was initiated, but not concluded at this meeting. The assessment documentation will detail this work.
Catches/Fisheries		1 catch time series with 18 fisheries	1 catch time series with 18 fisheries	
Region Structure		1 region		
Time Frame		1971-2012		
Selectivity	Length Based	Mirrored for those fisheries without length comps.	Mirrored for those fisheries without length comps.	

10.0 ESTABLISH WORK PLAN AND FINAL DATA SUBMISSION DEADLINE FOR UPDATED BLUE SHARK STOCK ASSESSMENT

The final data submission deadline was set as the end of the present meeting. An exception was made for **any corrected small driftnet fishery data (from Kleiber et al. 2009) and the final catch estimated for the Japan deep longline fleet which will be provided to the Chair by January 25, 2014.** The modelers will proceed based on the agreed upon data and the specifications described above.

11.0 OTHER MATTERS

Conservation information will be derived from examining the results of both assessments in order to ensure that all potential uncertainty is considered.

There will be a strict deadline of 10 days before the June meeting for all WG papers to be submitted to the Chair.

12.0 FUTURE SHARKWG MEETINGS

A tentative schedule for upcoming WG meetings was adopted:

June 3-10, 2014 Keelung, Chinese Taipei	Blue shark assessment meeting
July 2014, 1 day At ISC Plenary venue	Finalize blue shark stock status and conservation information; conduct work for the Plenary
Fall/Winter 2014 Location TBD, tentatively Mexico	Shortfin mako data prep meeting

13.0 CLEARING OF REPORT

The Report was reviewed and the content provisionally approved by all present. The Chair will make minor non-substantive editorial revisions and circulate a revised version to all WG members within 2 weeks. The report will be finalized within 30 days.

14.0 ADJOURNMENT

The Chair thanked all participants for attending and expressed her gratitude to Nicole Nasby-Lucas and support staff in the SWFSC Fisheries Division for their assistance with meeting logistics and drafting the report throughout the week. She said she looks forward to seeing everyone again at the next SHARKWG meeting in Keelung, Chinese Taipei. In addition, she encouraged all members to work collaboratively by email over the next few months to conduct the blue shark model runs.

The meeting was adjourned at 1:36 pm on January 18, 2014.

15.0 LITERATURE CITED

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Attachment 1: List of Participants

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Attachment 2. Meeting Documents

WORKING PAPERS

ISC/14/SHARKWG-1/01	Progress on the updated Stock Synthesis stock assessment of Blue Shark in the North Pacific Ocean. Joel Rice and Shelton Harley (joelr@spc.int)
ISC/14/SHARKWG-1/02	Update of Japanese abundance indices and catch for blue shark *Prionace glauca* in the North Pacific. Mikihiko Kai, Ko Shiozaki, Seiji (kaim@affrc.go.jp)
ISC/14/SHARKWG-1/03	Blue shark catch and effort data collected by Japanese research and training vessels. Kotaro Yokawa, Mikihiko Kai, Ko Shiozaki and Seiji Ohshimo (yokawa@fra.affrc.go.jp)
ISC/14/SHARKWG-1/04	Comparison of CPUE level of blue shark in Japanese longline research activities before and after the world war II. Seiji Ohshimo, Ko Shiozaki, Mikihiko Kai, and Kotaro Yokawa (oshimo@affrc.go.jp)
ISC/14/SHARKWG-1/05	Description of the Hawaii Longline Observer Program. Tim Sippel, Nicole Nasby-Lucas and Suzanne Kohin (Tim.Sippel@noaa.gov)
ISC/14/SHARKWG-1/06	Blue shark catch rates in the Hawaii-based pelagic longline fishery in 2000−2012: A re-evaluation of observer catch data and standardizations for both fishery sectors. William A. Walsh and Gerard T. DiNardo (William.Walsh@noaa.gov)
ISC/14/SHARKWG-1/07	Updated and revised historical catch and standardized CPUE series of the blue shark by Taiwanese large-scale tuna longline fisheries in the North Pacific Ocean. Wen-Pei Tsai and Kwang-Ming Liu (kmliu@mail.ntou.edu.tw)

INFORMATION PAPERS

ISC/14/SHARKWG-1/INFO01	Stock assessment of blue sharks in the north Pacific Ocean using Stock Synthesis. Joel Rice and Shelton Harley (joelr@spc.int)
ISC/14/SHARKWG-1/INFO02	Standardization of blue shark catch per unit effort in the North Pacific Ocean based on deepset longline observer data for use as an index of abundance. Joel Rice and Shelton Harley (joelr@spc.int)

Attachment 3: Meeting Agenda

SHARK WORKING GROUP (SHARKWG)

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

INTERCESSIONAL WORKSHOP AGENDA

13 – 18 January, 2014
NOAA Southwest Fisheries Science Center
8901 La Jolla Shores Dr.
Pacific Conference Room
La Jolla, CA

Meeting begins at 10:00 am on Jan 13, and 9:00 am all other days.

1. Opening of SHARKWG Workshop
   - Welcoming remarks
   - Introductions
   - Meeting arrangements

2. Distribution of documents and numbering of Working Papers

3. Review and approval of agenda

4. Appointment of rapporteurs

5. Summary of the July 2013 Working Group Meeting, WCPFC SC Meeting, December 2013 CPUE Workshop and January 2014 Age and Growth Workshop

6. Review CPUE indices for updated blue shark stock assessment – (Teo, Takahashi)

7. Review other data for updated blue shark stock assessment – (Piner, Semba, Oshimo)
   - Catch and discard data and total catch estimation procedures
   - Size data
   - Finalize fishery definitions for fully integrated model

8. Review draft SS3 blue shark assessment – (Sippel, Aires da Silva)

9.1 Discuss Stock Bayesian Surplus Production modeling approaches including the choice of input parameters and priors– (Harley, Kanaiwa, Kai)

- Decide on base case configurations
- Decide on tentative sensitivity analyses
- Discuss future projection scenarios

9.2 Discuss Stock Synthesis modeling approaches including the choice of input parameters – (Harley, Kanaiwa, Kai)

- Decide on base case configurations
- Decide on tentative sensitivity analyses
- Discuss future projection scenarios

10. Establish work plan and final data submission deadline (goal of Saturday this week) for updated blue shark stock assessment

11. Other matters

12. Future SHARKWG meetings

13. Clearing of report

14. Adjournment

Attachment 4: Age and Growth Workshop Report

REPORT OF THE SECOND SHARK AGE AND GROWTH WORKSHOP SPONSORED BY

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

9-11 January, 2014
La Jolla, CA, USA

1. Introduction

During meetings of the Shark Working Group (SHARKWG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC), Working Group members have highlighted the need for better information on age and growth of the pelagic sharks of interest to the ISC. In particular, there is a high degree of uncertainty about key parameters associated with age and growth of many species including shortfin mako and blue sharks. The uncertainty stems largely from the range of methods used to assess shark ages, a lack of samples across all regions and size classes, minimal interaction and corroboration among shark ageing labs, and lack of standard protocols for sample collection and processing. Assumptions regarding age and growth for sharks, given their K-selected life history characteristics, can be highly influential in assessment modeling. The goal of the first ISC sponsored shark age and growth workshop, held in November 2011, was to bring together specialists from ISC member nations to discuss methodologies and regional studies on age and growth of shortfin mako and blue sharks and develop collaborative plans. At this second meeting, the objectives were to: 1) review recent developments on age and growth of shortfin mako, blue and other pelagic sharks; 2) discuss progress on archiving reference collections and developing standards for processing reference samples and collecting ageing data; 3) review progress on cross-validation studies; and 4) develop plans for deriving the best growth curve(s) for shortfin mako in the North Pacific for use in the upcoming ISC assessment.

2. Opening of Age and Growth Workshop

Dr. Cisco Werner, Science Director, NOAA Southwest Fisheries Science Center welcomed workshop participants. He acknowledged that the work proposed by this group is quite challenging and very important work.

Ten scientists from Chinese Taipei, Japan, Mexico, and USA participated (Attachment 1).

Suzy Kohin, Chair of the ISC SHARKWG opened the meeting by reviewing the previous workshop and describing the goals for the current workshop. A draft agenda was reviewed and finalized (Attachment 2). Attachment 3 provides a list of papers and presentations. The agenda captured topics to be covered during the 3-day workshop, but in order to keep an open discussion, the sequence of presentations and discussions did not necessarily adhere to the sequence of topics on the agenda. In general, the group heard updates from participants about regional age and growth studies on shortfin mako and blue sharks, discussed how to move forward with the examination of the reference collection, and spent several hours in the laboratory examining samples and demonstrating methods interactively.

3. Presentations by Participants on Ongoing and New Studies
A number of participants made presentations updating previous results and describing new results and methods. Attachment 3 provides a list of working papers and presentations.

Mikihiko Kai (Japan) described an analysis of shortfin mako growth curve using length composition data of juveniles in the western and central North Pacific Ocean (WCNPO). The objective was to estimate the growth curves for young sharks (0-3 years) based on length-frequency modal progression, including sex specific growth curves, and to validate the consistency of the growth rates estimated in this study with those from previous studies. They used port sampling data of 138,604 measured individuals collected throughout the year from 2005-2013. Length compositions by month were fit to Gaussian distributions and assigned ages. The results showed monthly changes in length composition as a transition of the 0 age class mode with birth month assumed to be in February, and the size at birth assumed to be 67.7 cm precaudal length (PCL). They generated the simulation data from mean and SD of the Gaussian distributions to generate the data up to 3 years of age. Growth curves were estimated by fitting to simulated length at age data using a nonlinear least-squares method with the Von Bertalanffy Growth Function (VBGF). The curves were compared to that of Semba et al. (2009) and were found to indicate faster growth rates.

The group agreed that the age decomposition analysis used in this study is believed to be rather reliable. The results showed the peak in births may occur around February and March however, which is earlier than previously reported in Semba et al. (2009). They also showed that juvenile shortfin makos smaller than 70 cm PCL are mostly caught in area west of 160 E and between 30 – 40˚ N in the 1st quarter. The length at 3 years was found to be around 163 cm PCL for combined sexes while for Semba et al. (2009) it was between 124-128 cm PCL. Overall they concluded that the species grows faster than previously reported in the WCNPO, and consequently may mature earlier and have a shorter life span.

Yasuko Semba (Japan) provided a progress report on the re-examination of growth of juvenile shortfin mako in the North Pacific Ocean. Five studies are publically available, 3 from the EPO and 2 from the WCNPO, and there is some variation between them. Differences in growth may be due to physiological or environmental factors, with periodicity of band pair deposition and methodology as well as size range and sample size providing different results. They looked at the difference of growth of juvenile (<150 cm PCL) in the WCNPO and considered the following effects: difference of decimal age, difference of periodicity of band pair deposition, and the lack of centrum edge analysis for juveniles. The vertebrae of juvenile (<150 PCL) in Semba et al. (2009) was examined and age was recalculated using various scenarios along with newly added samples. The effects of decimal age were examined as well as the effect of band deposition periodicity. The effect of decimal age (difference in birth - February vs. May) appeared to be small. The effect of periodicity of band pair deposition was examined and found that it may partly explain the difference in growth curves. Recalculated growth curves with a biannual deposition assumption showed the Semba et al. (2009) data fit well with Kai et al. (2013) and Pratt and Casey (1983), especially for females. CEA analysis for samples of juveniles >100 and <150 cm PCL indicated annual periodicity, while for fish <100 cm PCL, results were inconclusive due to a small sample size. At this time for the WCNPO, lacking an age validation, they can neither accept nor deny biannual band deposition for juveniles.

The group identified a number of priorities given the new information from the Japan fisheries:

- Validation for all size classes is an urgent issue for vertebrae analysis, particularly determining the switching point from biannual to annual periodicity, based on the validation of two band pairs per year for juveniles in the eastern Pacific (EPO) (Wells et al. 2013) and the indirect validation of one band pair per year in the WCNPO (Semba et al. 2009).
- Cross-reading is important and urgent for the examination of difference between the western and eastern North Pacific.
- The effect of differences in the analyses should be established. (i.e. comparison of methods, assumptions of the size data analysis, etc.)
- Evaluation of periodicity for juveniles based on vertebrae band counts.
- Stable isotope analysis and tagging research for the investigation of habitat use by juveniles.
- Further collection of size data especially for neonates by observers and port samplers.

Yasuko Semba (Japan) presented results of cross-reading between USA and Japan and showed that the counts were similar between Semba and Wells for juvenile shortfin makos with a larger discrepancy at the larger sizes. The US provided 10 samples but only 4 were read because the surfaces of many were damaged. The general finding was that the US scientists were counting more bands in the early years but fewer bands in the later years than the Japanese.

Lisa Natanson (USA) reported on a recent study of vertebral bomb radiocarbon suggesting extreme longevity in white sharks (Hamady et al. 2014). They had 4 males and 4 females with the oldest male estimated at 73 years of age (493 cm FL) and the oldest female at 40 years of age

(526 cm FL). They examined male and female samples that were very close in size (493 vs. 495 cm FL) and the male was estimated at 73 years and the female at 32.

In concurrent ongoing work, they plotted growth curves based on the bomb carbon data and found that they were very different from previously calculated growth curves. The new calculated curves would put age of maturity for both males and females at about 30 years old. They also plotted fork length (FL) vs. vertebral radius, and looked at the number of bands for different vertebrae along the body showing that they got different counts along the column (a discrepancy as large as 5 between the head and tail). On smaller fish there was a smaller difference along the column, but could be as high as 3, which is a significant difference for the younger sharks. Because of this, when possible, they use vertebrae near the abdomen.

Hua Hsun Hsu (Chinese Taipei) presented information on the reference collection samples collected of blue and shortfin mako sharks from the Taiwan fisheries. He also discussed growth modeling of shortfin mako data from the northwestern Pacific Ocean. For comparison, he estimated growth assuming 2 band pairs per year from age 1-6 and 1 band pair per year after that and compared them to the models developed assuming a single band pair per year. Models did not fit the data well when assuming 2 bands per year for the younger sharks, thus one band per year for all ages was most plausible. He found that it is important to refine the age of juvenile fish based on the assumption that makos in the region pup from December through July. The first opaque band after the birth band is deposited between July and Aug. So, the time following birth until the first opaque band is laid could be anywhere from 1 to 9 months. For older fish, that difference is not as important, but for young fish it is significant.

Natalie Spear (USA) provided a brief summary of the Wells et al. (2013) study on age validation of shortfin mako sharks in the Northern EPO (NEPO). Sharks are tagged during a summer juvenile shark survey in the Southern California Bight. When these fish are recaptured, fishers are offered a reward to take vertebrae samples near the head for shortfin mako or blue shark, and near the tail for threshers. In reality it is unknown from what part of the vertebral column the samples come. Wells et al. (2013) used X-ray methodology to image and validate band pair counts on 29 OTC tagged sharks. Using MULTIFAN and MIXDIST, they estimated growth using length frequency modal progression for the first two age classes. Counts validated two band pairs per year during the time-at-liberty post-injection of OTC. This indicates that 1) juvenile shortfin makos in this region are half the ages previously estimated, 2) thus, makos may have a shorter life span, faster growth rates, and reach sexual maturity at younger ages, and 3) this implies an overall stock productivity greater than previously thought.

Yuuki Fujinami (Japan) presented information on reading band in blue shark vertebrae using the burn method. Nakano (1994) used silver nitrate staining in a previous growth study of blue sharks in the North Pacific. The goal of the current study is to re-estimate growth of North Pacific blue sharks with new samples. The burn method is beneficial because it is easy, fast and low cost. Briefly, optimal processing was found when centra were alkalai cleaned and then burned in an oven at 250°C for approximately two hours. The burn method allows for preparation of 100 samples at once with low cost and clear reading. Samples were collected by Japanese research vessels and commercial longline vessels. Samples were alkali processed, burned, cut and read. The effect of the soaking time in the alkali solution is important for clear reading. Size is also important and soaking time should be adjusted by size, using a weaker solution for smaller sized vertebrae. Smaller sized vertebrae should also be burned for a shorter time period. They validated counting with two readers and with burned and non-burned samples. Unburned samples had an underestimation by 1 of the readers, whereas readings of the burned samples were consistent between readers. Counting errors were smaller with the burn method than the unburned. Work with the burn method is preliminary, and future plans are to 1) determine the clear protocol of the burn method, and 2) estimate the growth parameters of blue sharks in the North Pacific Ocean using the burn method.

Natalie Spear (USA) reported on OTC age validation in blue sharks. They tried several different methods for enhancement (e.g. X-ray, histology) and ended up simply cleaning them and using light microscopy on whole vertebrae. They examined vertebrae of 26 OTC-tagged sharks (9 females, 17 males) of sizes at tagging ranging from 73-231 cm FL (average 105 cm FL) with times-at-liberty of 22-587 days (average 234 days). Although the time-at-liberty for most of the samples was rather short, their results showed that there was 1 band per year deposited through all age classes, which agrees with other validation studies using OTC and bomb carbon.

Natalie Spear (USA) also reported briefly on a common thresher shark OTC validation study. The preliminary results suggest an annual deposition rate for the size classes studied (54 OTC vertebrae returned, average time-at-liberty of 342 days, size range from 63-145 cm FL).

4. Demonstrations in the Lab

On the final day, there were demonstrations on band pair reading, vertebrae sectioning, light microscopy imaging, and X-ray imaging. A blue shark vertebra was processed, X-rayed and the band pairs were read testing the draft data recording worksheet (see below). All reference vertebrae provided by national scientists were relabeled with a random reference collection number and sets of vertebrae were redistributed to each nation for future processing. Vertebrae for Mexico will be sent to the appropriate investigators at a later date.

5. Work Plan for Collaborations

Age and growth specialists from the ISC members present (Japan, Mexico, Taiwan, USA) agreed to continue to collaborate to improve the information available for shortfin mako and blue shark stock assessments.

The group focused near term plans on shortfin mako age and growth in order to help reduce uncertainties for the upcoming ISC SHARKWG North Pacific shortfin mako stock assessment.

One of the first steps, as identified in the first ISC Shark Age and Growth Workshop is to verify that all readers visualize and count the same bands. Since the first meeting, members have collected vertebrae to provide for blue and shortfin mako reference collections so that reading among labs can be compared to identify interlab variability in reading bands.

Variation between labs may be attributable to several things, but the group focused on 1) variation that is due to differences in the reading of band pairs by different individuals, and 2) variation that may be due to the different methodologies used among labs to enhance bands. In order to address variation that is due to differences in the reading of band pairs by different individuals, the group agreed to all read the images from the age validated samples analyzed by Wells et al (2013) and corroborate on readings.

The Wells et al. (2013) paper represents the set of validated vertebrae. Those images will be distributed so that all scientists agree they can count the same band pairs as Wells et al. for those specific OTC validated vertebrae images. Subsequently that method and the US team's counts of the reference collection will be considered the "standard" for comparison among all labs' counts.

Once each lab has demonstrated they count the same number of bands in the validated samples, all labs will read the reference vertebrae images as processed by the US. This will allow for control of the variation between readers without adding additional variation that may be associated with different processing and enhancement methods. The group will then be able to produce size vs. band pair curves for the reference collection based on a single method.

Finally, variation that may be due to the different methodologies used among labs to enhance bands will be addressed by having each lab process the reference vertebrae according to their lab's established method. Each lab's counts will be examined and if consistent differences between labs exist, that may be attributed to differences in enhancement methodologies, then conversions may be needed to derive counts similar to the standard counts

Regarding shortfin mako age and growth, prior and new information suggest there is strong evidence for sex specific growth, thus different curves for males and females are needed.

In the NEPO the OTC validation study (Wells et al. 2013) indicates that juveniles up to 4-5 years old deposit two vertebral band pairs (BP) per year. In the WCNPO, new length frequency analyses (Kai et al. 2013) point toward rapid growth, greater than would be estimated from vertebral band counting and ageing assuming a single band pair per year deposition rate. However, there is no validation of band periodicity in juvenile fish in the WCNPO. For larger sharks, greater than 100 cm PCL, Semba et al. 2009 indirectly validated by CEA analysis with statistical validation a periodicity of 1 band pair per year.

Given the prior and new information, the group came up with two sets of hypotheses.

Hypotheses regarding regional differences:

1) growth in NEPO is the same as WCNPO; 2) growth in NEPO differs from WCNPO.

Hypotheses regarding band periodicity in the NPO:

1) 2 BP/year forever; 2) ontogenetic switch from 2 to 1 BP at some stage; 3) 1 BP per year forever

Studies to address regional growth differences and banding periodicity:

- Compile all existing information and collect more information on behavior, ecology, and oceanography
- Try to find old vertebrae for bomb carbon validation
- Wait and hope for longer term OTC recoveries

- Continue OTC tagging in NEPO, and in particular try to increase OTC tagging of larger individuals
- Examine vertebrae for another means of chemical validation
- Re-examine studies on indirect validation methods (e.g. statistical validation of marginal increment analysis)

Shortfin mako and blue shark reference collections

Scientists from the representative nations brought with them samples for the reference collection of shortfin mako and blue sharks. These samples were assigned an ISC ID by the ISC Chair and distributed or will be sent to the participating labs for inter-lab corroboration. A worksheet for recording readings was developed.

Tag or ID Number	Diameter (mm)	Radial Measures (mm)					Complete Band Pair Counts	BP Count Inlcluding Edge (+?)	Marginal Edge Reading	Confidence Score	Reader Initials	Notes
		Total	Poximal edge of BB	Distal edge of BB	BP number	Distal edge of each BP						

Data to be recorded include:

1) ID number of the sample
2) Diameter of the sample. All measurements should be made in mm to two decimal places.
3) The diameter should be measured across the coronal/frontal axis due to the fact that the sagittal axis is known to experience compression. Measurements should be made on fresh and minimally cleaned vertebrae.
4) Distance to the proximal edge of the birth band. (Note that all band measurements will also be made along the coronal axis.)
5) Distance to the distal edge of the birth band.
6) Distance to the distal edge of each band pair.
7) Complete band pair counts (not including the birth band).
8) Total band pair count which includes the number of band pairs plus the edge. If the marginal edge is opaque, the number of band pairs will be a whole number with the opaque band completing the band pair. If the marginal edge is translucent, it will be considered only a partial band and the number of band pairs will be the number of complete band pairs followed by "+" to represent some fraction of a period of growth.
9) The marginal edge reading, indicating if it is translucent or opaque.
10) A confidence score which indicates if the reader felt it was difficult to read, using a score of 1-5 with 1 being unreadable, 2 being not very confident and 5 being confident. If it's a 1, then it is considered unreadable and the reason why should be indicated in the notes.
11) The reader's initials.
12) Record notes which may include recommendations for reprocessing, checks (specify location on vert), comments on processing issues, if one region is easier to read, etc.

Once the vertebrae from the reference collection have been read, there will be corroboration on the counts of vertebrae across a range of sizes and, for shortfin makos, the group will have to come up with a consensus on 1 vs. 2 band pairs/year and a time of transition between these band counts, if applicable. The group will need to come to a consensus on the readings of the reference library before using the data for a growth curve. Based on the prior workshop, the group will compare band counts between labs statistically using APE, and minimum bias analyses.

Additional action items
The following are additional priorities identified by the group.

1. Take a look back at studies that have been done in the past and come up with a plan so that in the near future we can have reasonable growth curves to give to the assessment scientists.
2. Continue to update the life history table as knowledge becomes available, particularly in regards to regional differences in life history parameters for individual species.
3. For the studies that have had large sharks in them, it would be good if we can pool the data.
4. It was requested that Dave Wells put together an estimated growth curve based on the vertebral counts for the OTC validated samples.
5. Collection of additional tagging and movement data throughout the Pacific Ocean.

5. Proposed Timeline
The group prioritized work on shortfin mako ageing and came up with a work plan to provide growth curves to the ISC SHARKWG group by their mako shark data prep meeting in the late fall.

By the end of February - All reference collection verts and the Wells et al. images will be distributed to the national scientists.
By the end of April - Have all Wells et al. images read, and spreadsheets provided to ISC SHARKWG Chair. Chair will compile the results.
By the end of April – US team processes shortfin mako reference vertebrae and distributes images to the other age and growth specialists.
By the end of May – Have all US processed reference images read and spreadsheets provided to ISC SHARKWG Chair.
By the end of July - ISC SHARKWG Chair compiles results and compares results with APE and bias analyses, etc.
By one month prior to the fall 2014 shortfin mako assessment prep workshop - Results will be reviewed and summarized by age and growth specialists in order to prepare a paper for the workshop.

6. Close of Workshop
Suzy Kohin thanked everyone for their participation and contributions to a very productive meeting. She indicated she looks forward to further progress on age reading corroboration and development of growth curves for shortfin makos. A draft of the workshop report will be circulated shortly for review and will be finalized as an attachment to the January ISC SHARKWG meeting.

7. Literature Cited
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Attachment 1. List of Participants

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Attachment 2. Agenda

SECOND SHARK AGE AND GROWTH WORKSHOP

SPONSORED BY

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

9-11 January 2014

Pacific Conference Room
NOAA Southwest Fisheries Science Center
8901 La Jolla Shores Drive
La Jolla, CA USA

Opening of Age and Growth Workshop: 9 January 2014, 10:00

- Welcoming Remarks – Dr. Cisco Werner, Science Director, NOAA Southwest Fisheries Science Center
- Introductions
- Meeting Arrangements

Overview of Meeting Objectives

Summary of 1st Workshop and work assignments

Presentations on pelagic shark age and growth studies by national scientists

- Japan
- Chinese-Taipei
- Mexico
- USA

Summary of published age and growth studies of shortfin mako sharks (see spreadsheet and archived documents)

Plans for reference collection distribution and processing (see template for data recording)

Develop collaborative studies and work assignments

Other matters

Hands on demonstrations and methods sharing in the lab

Review of draft report

Attachment 3: List of Papers and Presentations

Mikihiko Kai (Japan) oral presentation:

Update of estimation of growth curve from length composition of juvenile shortfin mako, *Isurus oxyrinchus*, in the western and central North Pacific Ocean

Yuuki Fujinami (Japan) presentation and working paper:

Preliminary report for development of "burn method" for the blue shark, *Prionace glauca*, in the North Pacific Ocean

Yasuko Semba (Japan) presentation and working paper:

Progress report on the re-examination of growth of juvenile shortfin mako (*Isurus oxyrinchus*) in the western and central North Pacific Ocean

Yasuko Semba (Japan) presentation:

Results of cross-reading of USA and Japan shortfin mako vertebrae

Hua Hsun Hsu (Chinese Taipei) presentation:

Update on reference sample collection and shortfin mako growth modeling

Natalie Spear (USA) presentations:

Summary of the Wells et al. (2013) shortfin mako (*Isurus oxyrinchus*) OTC validation and growth paper

Progress on OTC validation of blue sharks (*Prionace glauca*)

Progress on OTC validation and age and growth of common thresher sharks (*Alopias vulpinus*)

Lisa Natanson (USA) oral presentation:

Summary of the Halmay et al. (2014) study on the longevity of white sharks in the northwest Atlantic determined from bomb carbon analysis

Other findings on the age and growth of white sharks in the northwest Atlantic