Annex 5

REPORT OF THE SHARK WORKING GROUP INTERSESSIONAL WORKSHOP

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

November 14-21, 2016
Busan, Republic of Korea

1. OPENING AND INTRODUCTION

1.1 Welcome and Introduction

An intercessional workshop of the Shark Working Group (SHARKWG or WG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) was convened at the Haeundae Grand Hotel in Busan, Republic of Korea. from 14-21 November, 2016. The SHARKWG will be conducting a north Pacific blue shark assessment (BSH) in spring 2017 to present to the ISC17 Plenary. The primary goal of the workshop was to examine new blue shark life history information and their relevance for use in productivity parameterization in the assessment, finalize the input data and methodologies used to derive catch and abundance indices, review size data and their collection programs, establish a final assessment data submission deadline, and decide on parameterizations for the Bayesian Surplus Production and Stock Synthesis models.

Dr. Seok-Gwan Choi, Senior Scientist of Fisheries Resources at the National Institute of Fisheries Science welcomed SHARKWG participants. Meeting participants included fourteen members from Chinese Taipei, Japan, Korea, United States of America (USA) and the Western and Central Pacific Fisheries Commission (WCPFC) (Attachment 1). In his address, Dr. Choi acknowledged the important goal of the meeting - to verify the quality of the data for the blue shark assessment. He indicated that sharks have globally received much attention and the need for better understanding is highlighted by the recent CITES listings in Appendix II for silky and thresher sharks. He wished the group a productive meeting and hopes that the analyses of the group will provide adequate information for improved management recommendations. Despite the difficult work, he hopes the group will have some leisure time to enjoy Busan's local offerings.

1.2 Distribution of Meeting Documents

Twenty five working papers were distributed (Attachment 2). The authors of working papers 02, 03, 04, 05, 07, 08, 09, 17 and 23 declined posting on the ISC website due to either data confidentiality concerns and the preliminary nature of the results, or because the paper was being prepared for publication elsewhere.

1.3 Review and Approval of Agenda

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

1.4. Appointment of Rapporteurs

Rapporteuring duties were assigned to K.-M. Liu, F. Carvalho, M. K. Lee, M. Kai, A. Shibano, N. Takahashi, M. Kanaiwa and S. Kohin. The approved agenda (Attachment 3) indicates the rapporteurs for each item in parentheses.

2. SUMMARY OF THE SEPTEMBER 2016 WEBINAR

S. Kohin, Chair of the SHARKWG, provided a summary of the key outcomes of the September 26-27, 2016, Webinar. Participants from Canada, China, Chinese-Taipei, Japan, Korea, Mexico, and USA joined. Some participants had issues connecting initially, and timing of the webinar is not ideal for all participants given differences in time zones between Mexico City and Taiwan, but in general, response to the Webinars has been very positive. The Webinars have provided the Working Group opportunities to share information and report on progress and work assignments between Working Group meetings.

The objectives of the webinar were to: 1) review some analyses examining the size compositions and potential fishery definitions for the major fleets; 2) come to a preliminary decision on the type of model/models to use for the upcoming assessment given the size data, other fishery data and biological information available; and 3) define a work plan and data submission deadline in advance of the fall meeting.

There were a number of presentations by members. Felipe Carvalho demonstrated a Bayesian State Space Surplus Production Model (BSSPM) he developed in JAGS for a blue shark assessment in the South Atlantic (Carvalho and Winker 2015). The model was coded in R and showed that there are a number of desirable features including producing direct estimates of parameter uncertainty. A preliminary model using the ISC's 2014 blue shark data was shown to demonstrate that this model reproduced the results from the BSP2 model of McAllister and Babcock (2006). Felipe also demonstrated some work he has been doing exploring the 2014 data and assessment results using a catch-only analysis, which enables him to understand the influence of the CPUE indices. He planned to prepare working papers on using the BSSPM with the 2014 data and the parametrizations set up to mimic the BSP2 model and on the catch only modeling efforts for the November meeting. Tim Sippel demonstrated the work he, Yasuko Semba and others had done to explore the size and sex data submitted by all nations. Spatial patterns are apparent and they proposed that fishery definitions should be based on the observed spatial patterns. Semba also showed some work she and her colleagues had been doing to improve the fishery definitions of the Japanese longline fishery based on the size data. The group examined selectivity patterns for all the fisheries based on all the size data submitted and discussed preliminary fishery definitions. The Working Group was also informed that Kai is working on estimating steepness, using some updated biological information, and deriving parameters for the LFSR which may be useful for a Stock Synthesis (SS) model. Finally, the group was updated on several Japanese research projects including some PAT tagging of blue and mako sharks in the central and western north Pacific and a blue shark maturity study.

The WG tentatively decided to move forward with two models for the 2017 assessments, a Bayesian Surplus Production model using BSSPM and a SS model. The final decision on the modeling will be made at the November meeting after review of the BSSPM run to mimic the

2014 BSP2 assessment and work on the LFSR. Final data and paper submission deadlines were agreed upon.

3. BIOLOGICAL INFORMATION

3.1 Review of Blue Shark Biological Data for the Assessment

Reproductive biology of the blue shark, Prionace glauca, in the western North Pacific Ocean, presented by Y. Fujinami (ISC/16/SHARKWG-1/01)

The reproductive biology of the blue shark, *Prionace glauca*, in the western North Pacific Ocean was investigated to provide updated for future stock assessments of this population because of limited number of study after Nakano (1994) and lack of reliable estimate on reproductive cycle. Reproductive data were obtained from 484 males (precaudal length [PCL], 33.4–252.0 cm) and 432 females (PCL, 33.4–243.3 cm). Size at 50% maturity was estimated to be 160.9 cm for males and 156.6 cm PCL for females. Litter size based on the number of embryos and placentas varied from 15 to 112 (mean, 35.5) and was positively correlated with maternal PCL. Parturition, ovulation, and mating occurred sequentially from spring to summer, and parturition took place after an 11-month gestation. The ovarian follicles of pregnant females developed synchronously throughout the gestation period along with embryonic growth, indicating that females reproduce annually. Our results indicate that productivity of North Pacific blue shark is higher than previously thought based on larger fecundity and a shorter reproductive cycle than previously thought. These reproductive parameter estimates will be useful for stock assessments and fisheries management decisions regarding of this population.

<u>Discussion</u>
The group questioned if during the study period any pregnant females were sampled in the months of August and September. The group discussed the influence of these new results regarding the reproductive biology of north Pacific blue shark on the parameters used in the stock assessment, especially *r* and the stock recruitment relationship. This study proposes that the north Pacific blue shark is more productive than previously thought, and that a one year reproductive cycle is recommended. Although further research to understand potential spatial variation on reproductive traits was recommended, **the group acknowledged the quality of the study and accepted its use in the next stock assessment.**

Age and growth estimation of the blue shark, Prionace glauca, in the western North Pacific Ocean, presented by Y. Fujinami (ISC/16/SHARKWG-1/02)

The ISC Shark Working Group indicated there is high uncertainty of the asymptotic length derived from the growth model for blue shark, *Prionace glauca*, in the North Pacific. Here we estimated the growth parameters of the North Pacific blue shark using new information. We sampled vertebral centra of 1,279 individuals (659 males and 620 females), and the range of precaudal length (PCL) was between 33.4 and 258.3 cm. The maximum number of counted growth bands was 18 for males and 17 for females. Based on the centrum edge analysis and verified by statistical analysis, growth bands were shaped once a year during December and February. We assumed the von Bertalanffy growth function for the blue shark growth and that estimated growth parameters were $L\infty$ = 284.8 cm PCL, K = 0.117 years^{-1}, t_0 = –1.34 years for males, and L_∞ = 256.3 cm PCL, K = 0.147 years^{-1}, t_0 = –0.97 years for females. The 50% age at maturity was estimated to be 5.9 years for males and 5.3 years for females. The coverage of area and size was larger than previous studies. Hence, the parameters are believed to be suitable for future stock assessments. There was a statistically significant difference in growth between sexes. Especially, the mature female growth was slower than the mature male. Adult females need high energy for reproduction; thus, the sex-different growth might derive from the sexually-dependent dynamics of the energy budget.

Discussion

The group asked about the model selection process used to choose the best growth curve. This study has a larger sample size overall than other studies, as well as more individuals of the smallest and largest sizes, but the small sample size for older individuals was still pointed out as a potential problem with the model. However this is a problem encountered in all growth studies available for blue sharks. It was requested that the AIC for the combined growth curve and the sex-specific ones be compared. The analyses were completed and the results showed the sex-specific curves produced lower AICs. The maximum age (Tmax) observed in this study is older than in previous work by Nakano (1994), and the group was unsure if these differences could have been caused by differences on reading criterion or that larger individuals were collected in the presented study. The group welcomed the new information and **decided that growth parameters for both male and female north Pacific blue shark were the best available for use in the assessment model.**

Migration pathways for adult female blue shark, Prionace glauca, in the western North Pacific Ocean, presented by Y. Fujinami (ISC/16/SHARKWG-1/04)

The blue shark, *Prionace glauca*, is a top predator and the most abundant pelagic sharks in the world oceans. This species is an important fishery resource, however, little is known about the movement patterns in the North Pacific. Pop-up satellite archival tag (PSAT) was used to investigate the migration pathways of adult female in the western North Pacific. The datasets of five adult females, released at southern waters off Japan in October, were used to show the migration pathways because the PSATs were popped off in a long period after 80-242 days. All of them except one tended to travel in a northeastward direction from warmer to colder water regions. One of them further travelled along the Kuroshio-Oyashio transition zone and reached to the coldest water region (14.1 °C around 35°N and 166°E) in April. The adult female stayed at the region for one week in the surface shallower than 200 m without regular day-night vertical movement. Then, the adult female returned in a southwest direction to warmer region with a regular vertical movement. Our results indicated that migration pathway of adult female blue sharks in the western North Pacific might be related to their parturition because the pregnant females were supposed to migrate to pupping grounds between 30° and 40°N during Boreal summer in the past study (Nakano 1994). Our results also indicated that the pupping of blue sharks might occur at offshore and epipelagic of Kuroshio-Oyashio transition zone.

Discussion

It was clarified that this tagging study was specifically developed to improve the understanding of the reproductive cycle of blue sharks in the north Pacific. The movement pattern seems to match the proposed reproductive cycle off the coast of Japan, however only one individual retained the tag for a long period of time (242 days). Further investigation is recommended given the low sample size. It was brought up the usefulness of such information for development of habitat-based CPUE standardization as well as to understand potential selectivity patterns of the fisheries that operate in the same area. The use of ultrasound to verify pregnancy is a great addition to this study. **The WG recommended continued tagging efforts on blue sharks.**

Conversion factors between specific body parts for blue shark in Pacific Ocean, presented by A. Yamamoto (ISC/16/SHARKWG-1/03)

We provided the conversion factors between several measured parts for blue shark in the Pacific Ocean. These would be useful to treat several data as same measured parts. For most pairs, the linear regressions using log-transformed was performed better than the one using actual values for this species.

Discussion

The group acknowledged the usefulness of the study, especially to assist with expanding the use of size-data available that are not in AL, DL, PCL, FL, or TL. The group discussed the values of the conversion factors found in this study and those used by the Working Group. The differences seemed to be minor, a further comparison was requested and later confirmed that the currently used conversions factors and those found in this study are very similar. Some discussion was also conducted about the argument that log transformed values produced better fits than the actual measurements. **It was decided not to change from the previously agreed upon linear relationships for use by the SHARKWG to standardize length data.**

Estimation of population growth rate of the blue shark (Prionace glauca) using two-sex age-structure matrix model, presented by H. Yokoi (ISC/16/SHARKWG-1/05)

Population growth rate, which depends on several biological parameters, is valuable information for the conservation and management of pelagic sharks, such as the blue shark. However, reported biological parameters for estimating the population growth rate of these sharks differ by sex and display large variability. To estimate the appropriate population growth rate and clarify the relationships between growth rate and relevant biological parameters, we developed a two-sex age-structured matrix population model and estimated the population growth rate using combinations of biological parameters. We addressed the sensitivity analysis of the population growth rate. The population growth rate of the blue shark was estimated to be 0.195–0.533 (median = 0.387). The maturity age of male sharks had the largest impact for blue sharks. The hypotheses for the survival process of sharks also had the large impact on the population growth rate estimation.

Discussion

The group acknowledged the improvement in developing a two-sex age structured model to calculate values of *r*. The group highlighted that the results of the analysis were not included in the working paper, only in the presentation, and requested further documentation. The results showed a higher median value for *r* based on a range of life history scenarios (0.387) than the one adopted by the working group for the previous assessment. A number of questions were raised about the parameter values assumed when developing this two-sex model. It was not clear if the life history information (i.e. parameter values) used in this analysis were consistent with the new life history information presented to the Working Group, consequently the group recommended recalculation of the values for *r* based on the newly accepted life history parameter values. It was also suggested to conduct sensitivity analysis to investigate the impact of assuming one or two year's reproductive cycle in the *r* estimates. **The WG decided to use the *r* value based on Fujinami et al. (2016a) growth (ISC/16/SHARKWG-1/02) and Fujinami et al. (2016b) maturity (ISC/16/SHARKWG-1/01) with a one year reproductive cycle and sex-specific Tmax based on Taylor's (1958) theoretical estimate of longevity (F=19, M=24) for the reference case.** The grid below shows the derivation of the proposed *r*'s for use in alternative runs and the methods used to derive them.

Scenario	Tmax		Reproductive cycle		Productivity (r)	Equation
	Male	Female	1year	2year		use 0.34 as high alternative
1	30	24	yes		0.193464	Fabens
2	30	24		yes	0.159657	Fabens
3	24	24	yes		0.210619	Fabens with assuming male lower (don't use)
4	24	24		yes	0.173269	Fabens with assuming male lower (don't use)
5	24	19	yes		0.221422	Taylor (use as base case)
6	24	19		yes	0.187083	Taylor (use as low alternative)
7	19	16	yes		0.247034	observed
8	19	16		yes	0.211014	observed

Update of age and sex specific natural mortality of the blue shark (Prionace glauca) in the North Pacific Ocean, presented by H. Yokoi (ISC/16/SHARKWG-1/06)

This document updated age and sex-specific natural mortality (*M*) used in the past stock assessment of North Pacific blue shark. Specifically, (1) recalculation of *M* based on the correct coefficient for the estimator of Peterson and Wroblewski (1984), (2) application of length-based estimator by Walter et al. (2016) and new growth curve by Fujinami et al. (2016a, ISC/16/SHARKWG-1/02), and (3) application of other weight and length-based estimator were conducted and compared among the estimates. A length-based estimator based on regression analysis for various species caused unrealistic *M* especially for early ages, while length-based estimator with theoretical approach provided relatively reasonable estimates. The weight-based estimator tended to provide lower estimates among all estimators and some of them were lower than *M* estimated for other shark species with lower productivity. Although there is some room for discussion regarding the parameter in the estimator, it was suggested that age and sex-specific *M* based on Method 2 in Walter et al. (2016) is worth discussing as input parameters for the Stock Synthesis modelling.

Discussion

It was highlighted that the age and sex-specific *M* that was adopted in the 2014 stock assessment was based on the assumption of maximum age of 30. This study showed that for the calculation by Rice and Semba (2014), the coefficient assigned for the dry weight (1.92) was mistakenly applied to wet weight shark, instead of that for the wet weight (1.28). Thus, those *M* schedules were incorrect. A new method using Walter et al. (2016) Method 2 is proposed as more relevant than the Peterson and Wroblewski (1984) that was derived from small teleosts and plankton, so it may not be useful for all species. **The group acknowledged and accepted the new age and sex-specific *M* for north Pacific blue shark based on the length-based method (i.e. Method 2) proposed by Walter et al. 2016 as applied to the Fujinami et al. (2016a, ISC/16/SHARKWG-1/02) growth curves for the reference runs.**

Stock recruitment relationships of North Pacific blue shark, presented by M. Kai (ISC/16/SHARKWG-1/07)

This working paper provides stock-recruitment relationships of blue shark (*Prionace glauca*) in the North Pacific. We developed a pre-recruit survival model for the early life history of blue sharks and combined it with an existing model for the reproductive ecology of teleost species. We used biological data collected from wide areas of the western North Pacific between 2010 and 2016 to estimate key biological parameters. The model provides a point estimate for steepness, which is a fraction of unfished recruitment when spawning stock biomass is 20% of the species' unfished spawning stock biomass. We conducted numerical simulations to incorporate uncertainties in the biological parameters. The mean values and their standard deviations for steepness were 0.68 (standard deviation = 0.073) for the Beverton-Holt (B-H) model and 1.17 (standard deviation = 0.314) for the Ricker model. The curves showed a steep slope around the lower spawning biomass for both models and a slight decline of recruitment at high spawning stock biomass for the Ricker model. These results suggest that the stock-recruitment relationship in North Pacific blue shark was highly density-dependent and that its productivity is higher than that of other pelagic sharks. We discuss the plausibility of these estimates as stock-recruitment relationships of blue shark.

<u>Discussion</u>
The group discussed the relationship between S-R at low spawning biomass condition and the difficulties to estimate such relationship. The impact of assuming 1 or 2 year reproductive cycle in the estimate of the S-R relationship was also discussed. The B-H was viewed as better than Ricker for estimating shark S-R relationships since there is little information on cannibalism of newborn sharks. **The methodology developed to estimate the S-R relationship parameters for the LFSR was approved by the group.** However, it was recommended to re-estimate those parameters using the new life history information presented to the Working Group during this meeting. In addition, it was recommended to develop sensitivity runs to evaluate the impact of different Tmax (19, 24, and 30) in the estimates of the S-R relationship parameters. **The working group agreed that the presented method should be used to calculate values for the S-R relationship parameters used in the 2017 stock assessment with the new accepted life history information.**

Size and sex structure of blue sharks in the North Pacific Ocean, presented by S. Kohin (ISC/16/SHARKWG-1/14)

An updated stock assessment for blue sharks (*Prionace glauca*) in the North Pacific Ocean (NPO) is being developed by the ISC Shark Working Group. The SHARKWG requested that spatially explicit size and sex data be submitted to aid in understanding of fleet dynamics and stock structure. This analysis focuses on the spatial dynamics of blue shark by size and sex, both overall for understanding stock structure and by fleet for understanding fleet dynamics and gear selectivity. Overall, the smallest mean size of females and males (< 145 cm PCL) is found in the northwestern Pacific Ocean (NWPO) and the northeastern Pacific Ocean (NEPO), while sexually mature females and males are found throughout the remaining distribution. Relatively larger sample sizes (>100 observations per 5 x 5 degree block) are found in the north central Pacific

Ocean (NCPO) and NWPO, while relatively lower sample sizes (<20 observations per block) are found mostly below 15^0N latitude, and above 30^0N latitude in the CPO. Immature females and males are found in the NEPO (≤ 100 cm) and NWPO (≤ 145 cm) during all four quarters, and mature females and males are found in the NCPO during all four quarters. The largest (≥200cm) females and males were observed in the tropical NWPO during the 3rd quarter. This working paper and the data used within it are included in another working paper for the meeting to understand gear selectivity and propose an approach to fleet aggregations. Overall, the sample size of data available for this study is substantial with 669,388 observations, although some fisheries were sampled much more than others. Seasonal movement of males and females was discussed.

<u>Discussion</u>
The working group acknowledged the effort to develop a north Pacific wide spatial analysis for the size composition available. Although some spatial patterns were identified, it was highlighted that such analysis will not be directly included in the stock assessment. However, **the Working Group recommended continuation of the spatial analysis using blue shark size composition data in order to improve the overall understanding of the species biology** in the north Pacific.

3.2 Update on Mako Shark Biological Studies

A potential method for meta-analysis of growth curve for shortfin mako in the North Pacific, presented by N. Takahashi (ISC/16/SHARKWG-1/08)

This document is a discussion paper for considering a potential method that effectively utilizes all age and growth data provided by the ISC Shark Working Group members to estimate a growth curve for shortfin mako sharks in the North Pacific Ocean. A possible method of meta-analysis to estimate a growth curve is reviewed and usefulness of this method is briefly examined using simulated age and growth data for hypothetical fish species. Characteristics of the raw age and growth data currently compiled and shared are also overviewed, and points/issues to be considered or resolved for applying the method to these data are raised.

<u>Discussion</u>
Questions were raised about which data from the U.S. must be used when developing the growth curves (i.e. readings of Wells et al. (2013) or those by M. Kinney of the Wells et al. (2013) images). Also a question on how to classify the Mexico data (e.g. study location, institute, etc.?) was raised. The WG asked to clarify what data exactly is needed to develop the simulation. The author said that all that is needed are the raw data from the different growth studies (band pair counts versus length). The lack of consensus on how to translate band pair counts from the different studies into ages was discussed. Through several workshops, the subgroup of ISC shark age and growth specialists has developed a work plan to advance research on this topic but progress has been slow. **The Working Group acknowledged the importance of this issue and the necessity of keeping this project moving forward. It was recommended that the Chair contact the delegations and request the data suitable for the meta-analysis.** Taiwan mentioned they may be able to provide data, which include large females, but they want to wait until after their study is published.

3.3 Size Data and Size Data Collection Protocols

In this section, several presentations addressed both size data collection and catch estimation procedures. In those cases, the summary and discussion addressing both are included in this section.

<u>Taiwan</u>

Catch, size and distribution pattern of blue sharks by Taiwanese small-scale longline fleets in the North Pacific in 2001-2015, presented by K.-M. Liu (ISC/16/SHARKWG-1/20)

This study presented the catch, size, and distribution pattern of the blue shark by Taiwanese small-scale tuna longline (STLL) fishery in the North Pacific. Catch estimated was based on the landing data from the three major fishing ports for STLL fishery. The estimated annual catch of blue sharks by Taiwanese small-scale tuna longline fisheries ranged from 6983 mt in 2013 to 14707 mt in 2011, with the mean of 11179 mt in 2001-2015. The mean size of females was 219.7 cm TL and that was 220.9 cm TL for males. Juvenile females and males were found in the equatorial waters but adults were more often found in the subtropical waters. Seasonal variations in the mean size for both sexes and the smallest mean sizes for both sexes were found in season 2. The sex ratio was significantly different from 0.5 for every season except season 4.

<u>Discussion</u>
The size data will be provided for the SS modeling. The WG requested that the difference between the previous and current catch time series be shown. The estimates provided were only from 2011 onward and show roughly similar magnitudes to the recent data. The WG asked about the coverage of logbook data. It was answered that there is no information about the coverages. The WG had a question about the number of vessels. It was responded that the number of vessels is probably decreasing. **The WG accepted the updated catch estimates for the Taiwan small scale longline.**

Size and spatial distribution of the blue shark, Prionace glauca, caught by Taiwanese large-scale longline fishery in the North Pacific Ocean, presented by K.-M. Liu (ISC/16/SHARKWG-1/21)

The size and spatial distribution of the blue shark, *Prionace glau*ca, were described based on 3942 specimens that were collected by scientific observers on-board Taiwanese large-scale tuna longline fleets in the North Pacific between June 2004 and December 2014. Size segregation was found, and the mean size of blue sharks in the tropical and subtropical area (0-30 °N) was significantly smaller than those in the temperate area (north of 30 °N). No significant sex segregation was found. Males predominated in the size range of 210-290 cm TL in the temperate area and in the range of 230-310 cm TL in the tropical and subtropical area.

<u>Discussion</u>
These size data were provided for the spatial analysis and for use in the SS modeling. It was noted that in the northern area higher mean size was observed which differs from the pattern seen in most other fisheries. It was explained that the observer coverage differs by area and time each year so that may affect the mean sizes.

Korea

Catch and size data of blue shark by Korean tuna longline fishery in the North Pacific Ocean, presented by Y. Kwon (ISC/16/SHARKWG-1/23)

This paper introduces Korean historical catch of sharks caught by longline fisheries and size data of blue shark collected by scientific observers in the North Pacific Ocean. The catches of sharks of last 10 years caught by Korean tuna longline fishery in the NPO about 300 mt, but the catches were almost “0” during 2005-2009. The catches of blue shark from 2013 to 2015 were about 80 mt, 100 mt, and 50mt, respectively. Korean catches of blue shark were 0.2~0.3% of the reported total catches of blue shark to ISC. About 600 individual size data of blue shark for 6 years (2005-2008, 2013- 2014) were collected by 14 scientific observers. Average length was ranged from 152 cm to 225cm, and the biggest length was 267cm in 2005.

<u>Discussion</u>
The WG was concerned about the reliability of the catch rate of blue shark in recent years presented in this meeting because the species composition data don’t show the expected catch ratio of blue sharks, and the total catch amount of sharks was very small compared to the data of other nations submitted to the WCPFC. The WG recommended estimating the catch considering the catch rates from the Taiwanese (ISC/16/SHARKWG-1/22) and Japanese fleets (Hiraoka et al. 2012). The Japanese or Taiwanese CPUEs could be applied to the Korea effort data. Korea has a long time series data of unspecified “sharks” catch since 1970s even though the catch is relatively low. The **WG encouraged Korea to try to submit catch data of blue shark including not only retained but also discard and release.**

It was noted that to catch sharks including blue shark is not common in Korea, the fishing vessels sometimes reported the incorrect species name of sharks because the pronunciation of the Korean word for “porbeagle” is a quite similar to the word for “other sharks”. It was also noted that the number of hooks between floats is about 17 and those fisheries are targeting bigeye and yellowfin tunas. Thresher sharks were not identified by species.

USA

Catch and Size of Blue Sharks Caught in U.S. Fisheries in the North Pacific, presented by S. Kohin (ISC/16/SHARKWG-1/15)

The objective of this working paper is to describe blue shark catch and size time series for U.S. fisheries in Hawaii and along the U.S. West Coast (California, Oregon and Washington) and provide updates of blue shark catch estimates (i.e. dead removals) for the period 1971-2015 for use in the upcoming ISC north Pacific blue shark stock assessment. Fisheries are characterized as commercial (longline, drift gillnet, troll), recreational (private or rental vessels, and commercial passenger fishing vessels), and research. Two fisheries for which blue shark catch was not previously estimated are included herein: a troll/pole-and-line fishery targeting albacore that operates primarily out of Oregon and Washington, and a recreational charter boat fishery in Oregon and Washington. Blue shark size/sex data, collected through observer programs and during research surveys, are also described. Some relatively minor changes to catch estimation methodology for some fleets have been made. Estimates of U.S. north Pacific blue shark dead removals average 361 mt annually over the recent 10 years, down from a peak in 1993 of 4007 mt. The estimate of U.S. dead removals of north Pacific blue shark derived with improved methodologies and including some previously undescribed catch is approximately 14% higher than estimated for the previous assessment (1971-2011). The most significant change results from applying a post-release mortality estimate of 9.8% to blue sharks released live from the Hawaii-based longline fisheries. Observers and researchers measured 17420 blue sharks between 1990 and2015. The size data show that west coast fisheries catch predominately juvenile blue sharks while the Hawaii-based fisheries tend to catch larger sharks in the central North Pacific, and some juveniles in the transition zone. These data update previous catch estimates and provide size/sex data for use in the assessment and to examine the population dynamics of blue sharks in the North Pacific.

Discussion

For this presentation only the size data were shown and discussed.
The WG discussed potential effects of changes in regulations for the driftnet fishery on the sampled blue shark length distribution. Size compositions were not specifically studied before and after major regulatory changes to look for an effect, however, from the paper on spatial distribution (ISC/16/SHARKWG-1/14) it appears that the mean size and sex ratio is relatively similar throughout the entire area of operation along the U.S. West Coast. **The WG concluded that these data are suitable for use in the stock assessment.** Size data for the juvenile shark survey may not be useful for the assessment given there is no associated fishery, but they are valuable for the spatial distribution study.

Mexico (***ISC/16/SHARKWG-1/24***, discussed in Section 4)

4. CATCH AND DISCARD DATA AND TOTAL CATCH ESTIMATION PROCEDURES

In this section, several WG papers addressed both CPUE models and catch estimation procedures since estimating catch depended upon applying CPUE to a time series of effort. In those cases, the summary and discussion addressing both are included in this section. In order to set the stage for the relative importance of catch (and indirectly indices) to biomass estimation in a Bayesian Surplus Production model, F. Carvalho began the session with an example of a catch-only model.

Stock Assessment of North Pacific Blue Shark (Prionace glauca) Using a Catch Based Method, presented by F. Carvalho (ISC/16/SHARKWG-1/18)

In this study I use a catch-based method (i.e. CMSY) to investigate the productivity and historical harvest rates of the north Pacific blue shark. We use the catch data available for the last ISC blue shark stock assessment, conducted in 2014. The CMSY posterior median estimate for the current (2011) stock biomass was 816,048 mt, while the posterior median estimate for the maximum sustainable yield (MSY) was 75,718 mt. The median ratio of the 2011 biomass to that at MSY (B_{2011}/B_{MSY}) was 1.52. The posterior median for the ratio of fishing mortality rate in 2011 to that at MSY (F_{2011}/F_{MSY}) was 0.35. The median estimate for maximum population increase (*r*) was 0.28. In the present study CMSY estimates for *r* and *K* were different to those obtained in the 2014

BSP2 stock assessment JEJL_Ref. However, the estimates for management quantities were similar. Results suggest that historical catch is within the estimated limits of the capacity of the blue shark stock to replace the amount of biomass harvested.

Discussion

The WG asked for clarification on the parameterization of the *K* and *r* priors. It was answered that for a non-depleted stock is possible to use the value as a prior 0.3-0.8 for *K*. The WG discussed how much information about the productivity is in the catch only model, and how do we consider the uptrends in early 1970s and sharp decline in the 1980s. The WG recognized that the catch information is essential data and with enough contrast can help understand the productivity of the stock. For the initial population level, the WG conducted a range in initial depletion for the sensitivity analyses in the past and it didn't show a large impact because of the wide ranges of the prior. The information on recruitment is limited due to only the short time series in recent years. The WG noted that *K* has a large impact if the catch is exactly correct. The WG had a question about how these results compare to the previous BSP2 prior only run for this model. It was answered that it showed similar results The BSP2 prior only run produced no crashed population trajectories because the catch provided some information about population trends. The WG noted that the Schafer model has no age-structured information about the population dynamics. The WG discussed the relation of the fishery with a peak and decline in the time series: one is a peak in 1980 and another one is a sharp decline from 1989 to 1990. The WG confirmed that the catch of blue shark had started in 1894. It was noted that it is possible to estimate the productivity because of the prior, even if the information of the initial stock level is lacking. The drawback of the production model is a difficulty in the estimations of the trends by the size classes because it is assumed that the body size is the same. Because the productivity is largely changed, a hierarchical model was applied to the production model. The WG acknowledged that reliable estimates of catch are important to provide information about the population productivity.

Japan

Update of Japanese catches for blue shark caught by Japanese offshore and distant water longliner in the North Pacific, presented by Mikihiko Kai (ISC/16/SHARKWG-1/11)

This working paper provides updates of Japanese catches of blue shark (*Prionace glauca*) caught by Japanese offshore and distant-water longline fishery between 1994 and 2015 in the North Pacific. Since the landings of sharks is frequently underestimated due to lower value than any other teleost species such as tunas and billfishes, total catches including retained and discard/released catches were estimated using a product of the yearly changes in standardized CPUEs and the fishing effort. The methods were almost similar to those used in the previous analyses. The results showed that the total catches of blue shark in the North Pacific caught by Japanese offshore and distant-water longline fishery had been decreasing since 1995 until 2015 due to the reduction in the fishing effort. The estimated catches in the recent five years varied between 11,532 and 18,692 tons.

Discussion

It was asked why discards from Enyo-shallow longline fishery were not estimated. The author explained that results from comparison of CPUEs between the commercial vessels and Japanese research vessels indicated only small difference suggesting that discards from this fleet were assumed to be negligible.

There was some concern about the average weight (27.3 kg) applied to estimate catch in weight from catch in number. The weights in the Japan database may contain a mixture of dressed and whole weights to which further conversions were applied. Also, average weights by area or fishery sector (shallow/deep) may be better to apply. **Further work is recommended to verify the appropriate average weight to apply to this fishery. The estimated annual catches were almost similar to those used in the previous stock assessment and were accepted by the WG.**

Update of catches for North Pacific blue shark caught by Japanese coastal fisheries, presented by M. Kai (ISC/16/SHARKWG-1/12)

This working paper provides an update of Japanese catches of blue shark (*Prionace glauca*) caught by Japanese coastal fisheries during 1994 and 2014. Since the species-specific shark's data is not included in Japanese official coastal landing data, the catches of coastal fisheries are estimated using the available species-specific data (i.e. a ratio of blue shark to sharks). Estimated catches of blue shark by coastal fisheries by year showed that the total annual catches of longline fisheries as well as large mesh drift net were accounted for more than 99% of annual total catches. Yearly changes in the estimated total catches had a decreasing trend from 2,071 tons in 1994 to 1,094 tons in 1997, and then it had gradually increased and reached to the maximum value at 4,124 tons in 2007. Thereafter, the trends in the estimated catches tended to decrease. In 2011, the total catches were very small due to a reduction of the coastal longline due to the influence of the huge earthquake of the Pacific coast of Tohoku.

Discussion

The WG requested clarification about the conversion factors applied to the calculation of the coastal and other longline fisheries because the conversion factors for processed to whole weight of blue shark, shortfin mako shark, and porbeagle shark were calculated using the data in the other tuna-RFMO areas (ICCAT, CCSBT). The WG agreed to use those values because it was only used to calculate the catch ratio among the shark species. The WG had a question about the fleet definition of the coastal longline fishery because offshore and distant water longliners both land the blue shark at the same fishing port where the coastal longliners unload the blue shark. It was answered that the Japanese longline fishery are categorized by the vessel tonnages. Vessels of 10-20 tons are categorized as the coastal longline fishery. The WG requested a comparison of the time series of the annual catch with those in the previous stock assessment. The comparison indicated a slight difference between them due to the changes in the conversion factors as well as the update of the catch ratio of the Japanese driftnet fishery data. **The estimated annual catches were accepted by the WG.**

Taiwan

Catch, size and distribution pattern of blue sharks by Taiwanese small-scale longline fleets in the North Pacific in 2001-2015, presented by K.-M. Liu (ISC/16/SHARKWG-1/20)

Discussed in Section 3.3 (Size Data and Size Data Collection Protocols)

Catch estimate and CPUE standardization of the blue shark based on observers' records of Taiwanese large-scale tuna longline fisheries in the North Pacific Ocean, presented by K.-M. Liu (ISC/16/SHARKWG-1/22)

In the present study, the blue shark catch and effort data from observers' records of Taiwanese large-scale longline fishing vessels operating in the North Pacific Ocean from 2004-2015 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 delta lognormal approach. The analysis of standardized CPUE showed a stable 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 by-catch in weight ranged from one ton in 1973 to 1,658 tons in 2002.

Discussion

It was clarified that the CPUE index was estimated from observers' data only. Taiwanese catch was estimated by using nominal CPUE and effort data. The WG noted that Taiwanese catch could also be estimated by using standardized CPUE and effort data. The WG recommended the author try to estimate Taiwanese catch by multiplying standardized CPUE by effort for each time/area stratum, and then multiplying the ratio of logbook coverage. The group raised a concern about inclusion of the latitude and longitude terms with the area term into the CPUE standardization model (collinearity issue). A coefficient table for explanatory variables estimated from the standardization model was requested. It was discussed that inclusion of latitude and longitude into the CPUE standardization model might capture some of the spatial dynamic of the fleet, which can potentially have an effect on the catch estimate as well. It was noted that the area-quarter interaction term in the standardization model could capture the same spatio-temporal effect. The WG also recommended the author standardize CPUE using logbook data which were appropriately filtered because logbook data records were greater than observer records. **The WG accepted the area-combined standardized CPUE index, as presented in the paper, for use in the assessment model.**

For the purpose of estimating catch, it was requested to re-estimate catch by using both nominal CPUE by Area and standardized CPUE by Area because Area stratification is necessary when estimating catch from catch rate. The paper was revised and **the WG accepted the revised catch time series developed using the standardized CPUE for each area multiplied by the effort within each area.** The area specific standardized CPUE in the northern area in particular smoothed out the high nominal CPUE for 2015 that is believed to be an artifact of low observer coverage that year.

USA

Catch and Size of Blue Sharks Caught in U.S. Fisheries in the North Pacific, presented by S. Kohin (ISC/16/SHARKWG-1/15)

Discussed in Section 3.3 (Size Data and Size Data Collection Protocols)

Discussion
For this presentation only the catch data were shown and discussed.

The WG had a question about the value of post-release mortality assumed (6.3%) because the value seems to be underestimated in comparison to more recent studies. The WG noted that the handling of sharks by fishers may differ from those selected by researchers for tagging studies because researchers may select sharks in good condition if they want to also examine the data for habitat use studies. Furthermore, some fishers may cut the line without bringing the sharks onboard. **The WG recommended using a value of 9.8% for post-release mortality for the Hawaii longline fishery**, based on a recent study in the Atlantic pelagic longline fishery (Campana et al. 2016), to compute the dead removals. The WG felt that using 6.3% post-release mortality for the sport and pole-and line fisheries is probably fine. The time series for Hawaii was re-estimated and new U.S. total catch estimates were presented to the group. Because the majority (estimated at >99%) of sharks are released from the Hawaii longline fishery, applying 9.8% post-release mortality to the live releases noticeably changed the time series. **The revised U.S. catch estimates were accepted for use in the stock assessment.**

The WCPFC secretariat announced that the WCPFC is holding a workshop on post-release mortality of sharks in New Zealand in January 2017. The WG stressed the importance of understanding post-release mortality rates by fishery and species in order to get better estimates of total dead removals. **Further studies are recommended to address shark post-release mortality, in particular for shortfin mako and blue sharks** since those are the species assessed by the SHARKWG.

Canada

Blue Shark (Prionace glauca) bycatch statistics in Canadian Fisheries, J.R. King and A.M. Surry (ISC/16/SHARKWG-1/19)

The catch statistics reported here replace all previous catch data supplied by Canada for Blue Shark incidental catches in King (2011, ISC/11/SHARKWG-2/01). Since the last report, effort has been made by DFO to improve shark catch statistics, including verification of species codes in databases. In addition, catch recorded in the experimental squid fisheries were not previously included in total annual catch estimates.

Discussion
The WG accepted these updated estimates as the best available data for Canadian north Pacific BSH catch.

Mexico

Blue shark catches estimations for the Mexican Pacific (1976-2014), Oscar Sosa-Nishizaki and José Leonardo Castillo-Géniz (ISC/16/SHARKWG-1/24)

This document presents estimates for the blue shark catches landed at ports or fishing camps in the coasts of five Mexican states, located in the Pacific, for the period of 1975 to 2014. From 1975 to 2011 the estimates are the same as reported by Sosa-Nishizaki (2013). Mexican shark catch statistics by species were not available until 2006, so past blue shark catches have to be estimated. For the period of 1975 to 2006 estimations assume that blue shark has been represented in total catches with different proportions through time. And the values of the proportions were obtained from published papers in the scientific literature or by using more detailed local statistics. In Mexico, blue sharks are caught mainly by the artisanal and middle size long-line fisheries, which target pelagic sharks or swordfish. Catches that were landed in the past by the former large size vessel long-line fisheries and the drift gill net fisheries were taken into consideration to construct the historical series. For the period of 2006-2014 we used official statistics that report specifically blue shark catches. Historically, blue shark was not an important species in past catches; however, catches have increase from levels of less than 500 t in the 1970s to around 1,000 in the 1990s, and to around 4,000 t in the second half of the 2000s, reaching the highest catch reported in 2014 (5,500 t). Estimates indicate that blue sharks are caught mainly in the western coast of the Peninsula of Baja California, and recent years off of the Revillagigedo Islands.

Discussion

The WG noted that for the last assessment there were some historical catch estimates for joint venture longline operations and swordfish fishery discards that are not included in this paper. The Chair contacted the Mexican scientists to confirm that the historical estimates are still considered reliable and should be used in the current assessment. The response was “yes”. **The WG accepted these updated estimates, including the historical fishery data, as the best available for Mexican north Pacific BSH catch.**

China ***(no paper)***

China provided annual effort and catch by species data that were submitted to the IATTC and WCPFC (2011-2015) to meet annual data reporting requirements. The data type is the same that the WG used for the prior assessment to develop estimated China longline catch. The catch data for 2011-2015 were considered directly as a preliminary updated catch time series. The preliminary estimates appear to be on the order of what was estimated for the most recent years in the last assessment. The Chair will verify the analyses and contact the China correspondent to clarify some questions about the submitted data. For example, the WG thinks that the estimated BSH catch seemed to be underestimated and that discards are not accounted for. **The WG agreed with the Chair’s plan to update the China time series based on their submission.**

<u>IATTC</u> ***(no paper)***

The WG Chair requested updated blue shark catch for the IATTC purse seine fishery. In this fishery the bycatch rate was quite low, below 5 mt through the last 15-20 years. The WG Chair noted that in addition to the purse seine data, IATTC could be an important data source for several time series on coastal fisheries as well as the Spanish longline fleet targeting swordfish operating in EPO. The WG Chair noted that IATTC has been working on building a variety of time series data on coastal fisheries for a long time for the stock assessment of silky shark, and perhaps information on blue shark could be extracted from those data. **The Chair will work with IATTC scientists to get their non-ISC member BSH catch for the EPO.**

<u>SPC</u> ***(no paper)***

The WG Chair indicated she sent a request to WCPFC and SPC for updated catch for longline fisheries of non-ISC member countries. The WG chair noted that the ISC STATWG has a data sharing agreement with the WCPFC and IATTC in order to obtain the relevant data, but it is obvious that the STATWG does not obtain all shark landings and discard data by species since the ISC database has almost no blue and shortfin mako shark records. It was pointed out that the WCPFC and IATTC data should be publically available through their websites. The Chair was concerned that the publically available data may not be inclusive if some data are confidential. **The WG Chair will work with the WCPFC/SPC reps to get the updated time series** and inquire about the policies of each RFMO for posting data in case the websites can provide the necessary data in the future.

5. REVIEW CPUE INDICES FOR BLUE SHARK STOCK ASSESSMENT

<u>Japan</u>

Performance of methods used to estimate abundance indices for a longline fishery targeting two species, with consideration of target change, presented by Ayumi Shibano (ISC/16/SHARKWG-1/09)

Target change of a fishery from one species to another species is an essential factor in CPUE standardization. Conventional approaches currently used to standardize target effect include modelling with a target indicator as an explanatory variable. In recent years, several studies proposed application of finite mixture modelling to fisheries, showing improvement in CPUE standardization. However, performance evaluation of these approaches is insufficient. In this study, we simulated catch datasets assuming a variety of fishery and stock conditions. Using the simulated datasets, we tested the accuracy and precision of CPUEs estimated by each of the candidate models. We compared the performance of each model and discussed appropriate models for CPUE standardization considering the annual change of target species.

<u>Discussion</u>
The WG generally agreed with the potential for cluster analysis to help address changes in fishing strategies, as in the use of finite mixture modelling, and recommended further analysis. Although the WG discussed use of cluster analysis (i.e. the k-means method, or others) to address potential

targeting changes, the results should be viewed with caution because they will not account for temporal changes in population abundances. The WG also discussed further analysis on targeting strategies such as targeting all species, increasing the number of species in the model to more than two, or adding an area effect to conduct simulations more similar to the real fishery. However, the essentials of this study were to simplify the reality and investigate the model performance of standardizing target effect. The WG therefore concluded further analysis on alternative scenarios were not necessary at this time. Finally, the WG recognized the value of this study to help understand the impact of the swordfish ranking factor when deriving indices of abundance.

Update of Japanese abundance indices for blue shark caught by Japanese offshore and distant water shallow-set longliner in the North Pacific, presented by Mikihiko Kai (ISC/16/SHARKWG-1/10)

This working paper provides an update of Japanese abundance indices of North Pacific blue shark (*Prionace glauca*) for 1994 to 2015. Catch per unit of effort (CPUE) was standardized using the generalized linear model with negative binomial distribution errors. A continuous time series of data was used to standardize the CPUE without separation of the data after the Tsunami of 2011. A comparison of the standardized CPUEs showed that an annual trend of combined CPUE was almost similar to that of separated CPUE except for the magnitudes of the CPUEs from 2011 to 2015. The annual trends of the combined CPUEs with narrow confidence intervals suggested that the abundance indices of blue shark in the western North Pacific had gradually increased since 1994 to 2005, decreased from 2005 to 2008, and again increased in the recent 5 years.

<u>Discussion</u>

It was questioned whether the Japanese CPUE index was representative for stock dynamics of North Pacific blue shark because the data for an area around the Hawaiian islands (i.e., Area 4) were limited in certain quarters. The authors explained that the data used had already gone through filtering processes, and information of this area was not necessary because there was no difference in CPUE trend by year and area in examination of year-area interaction. It was recalled that the method for filtering the data and the approach of incorporating targeting effect into CPUE standardization were already well documented before. The authors explained that the purpose of filtering is to exclude data for vessels that appear to not report or under report blue shark catch.

It was asked whether there was possible risk of deleting data with true zeros from the dataset by using the filtering applied if in fact the blue shark population was in dramatic decile compared to when the filter was developed. The author responded that blue shark abundance was considered great compared to tunas and thus catchability might be higher. The filter allows for up to 5 sets with zero BSH catch during any given trip, and **the WG agreed that given our knowledge of the existing condition of the BSH population in this high abundance area, the risk of deleting data with true zeros would be low and the filter is likely appropriate to reduce non-reporting.**

The WG questioned whether geostatistical modeling approach currently being developed by the author could be an alternative to this CPUE modeling. The author responded that the geostatistical modeling is a potential alternative but it is not ready yet and there were several issues to be resolved before being considered for standardizing blue shark CPUE in this fishery. **The WG considers the geostatistical modeling as a promising approach and recommended the author to further develop the approach for future blue shark CPUE analysis.**

The group raised a concern regarding incorporating the targeting effect in the CPUE standardization process. The use of swordfish catch in both explanatory and response variables of the standardization model could be problematic. The author explained that because of such potential problem, ranking of swordfish CPUE was used. Some WG members continued to question the use of swordfish rank as a target factor and whether in fact the fishery shows a signal consistent with a shift in targeting. See more on targeting below.

It was asked why CPUE did not change markedly after the Tsunami in 2011. The author explained that the Tsunami only destroyed the main shark processing port (Kesennuma) but did not affect the vessels. This prevented high shark landings during the main shark season (summer) in 2011, but the fishery quickly began to make landings in other ports (e.g., Choshi port). The WG pointed to differences between the combined CPUE and separated CPUEs for 2012-2015 and requested a comparison of the AICs resulting from standardizing the combined and separated CPUEs. During the meeting, the author confirmed that the separated CPUE standardization model had a smaller AIC than the combined one suggesting some effect of the 2011 Tsunami on the CPUE trend. There was a discussion of whether it was appropriate to use the separated CPUE indices. To utilize information contained in longer, continuous CPUE series as much as possible, **the WG agreed to use the combined CPUE index without the 2011 data.** The reason of the removal was that the 2011 Tsunami affected the summer quarter, the major fishing season for the Tohoku fleet.

The WG extensively discussed how to deal with potential targeting in the CPUE standardization. Some participants requested Japan try to apply a cluster analysis using species compositions for examining change in fishing strategy and to compare the result from the cluster analysis with that obtained from the current ranking approach. Reasons why they preferred use of cluster analysis was that this approach had been widely used in other RFMOs for examining changes in fishing strategy (e.g., porbeagle shark in the South Pacific) and that this approach was simpler and more understandable than the current ranking method. Other participants indicated, as discussed for the simulation analyses above, that there are statistical problems concerning use of a cluster analysis and considered the current ranking approach was more appropriate to deal with targeting effect in standardization. The WG recommended that the author conduct a cluster analysis for examining potential changes in fishing strategy. If there were no yearly change in cluster proportion detected (i.e., no change in fishing strategy), then use of the current ranking approach should not be a problem. A preliminary effort to cluster the data and show CPUE by species by cluster was shown and some patterns were observed but not fully understood. **The WG recommended further examination of the data to help understand and account for potential targeting and ultimately improve the standardization.** It was noted that the target issue does not affect the catch estimates because the catch is derived based on the average standardized CPUE for the entire fishery by year applied to effort for each specific time and area stratum.

The WG agreed that this is the best available index to represent this fishery, after removing the 2011 value, for use in the stock assessment.

General WG recommendations on accounting for targeting in the Japan Kinkai-shallow CPUE standardization

The Working Group recommended that for every CPUE standardization, there needs to be consideration of whether fishing strategies have shifted and whether this may have affected the abundance index.

1. Potential Changes in Strategy for Japan's Kinkai Shallow Fishery
   Participants discussed (in this and other meetings of the Working Group) that Japan's Kinkai shallow fleet has probably shifted its fishing strategy over time including:

   a. Possibly in the late 1990s (in response to growth in the shark fin trade);
   b. Possibly in the early 2000s (as noted by fishermen in Kesennuma (per Yokawa));
   c. Possibly in 2011 in response to the Tohoku earthquake and the shift in landings to processing plants in Choshi (Chiba prefecture).

   Since the Japan Kinkai shallow CPUE series is instrumental in the stock assessment, **the WG recommended investigating if there is any clear evidence of changes in fishing strategies in the data, and how to treat them properly in the standardization.**

2. Prior Treatment of the Issue
   In previous standardization of the CPUE index from Japan, a factor has been included in the model which is based on the rank (percentile) of the catch of SWO relative to the distribution of SWO catches, on the assumption that if the catch of SWO is low, the vessel is more likely to be targeting BSH. Although, this method has been published in a peer-reviewed paper (Hiraoka et al. 2016), the WG expressed some concerns about the appropriateness of this approach, including:

   a. The catch of other species is not accounted for;
   b. Targeting of SWO and targeting of BSH may not be discrete strategies (i.e. there may be a varying mixture of strategies and/or fishermen may not be able to control their catches at such fine at scale);
   c. If the abundances of SWO and BSH are changing over time, the factor might reflect the abundance changes rather than a shift in targeting. Although the simulation analyses presented in ISC/16/SHARKWG-1/09 showed that this may not be a significant issue, there are a number of assumptions underlying the CPUE standardization model which complicate understanding the direct effects.

3. Alternative approaches
   a. The simulation study presented above (ISC/16/SHARKWG-1/09**)** suggests that there were shifts in fishing strategies in the late 1990s. One advantage to the approach (which is based on clustering) is that year, season and area factors are taken into account thus correcting (if necessary) for temporal influences on changes in relative species abundances. Overall, there were slight differences in the standardized CPUE indices between the method investigated in

ISC/16/SHARKWG-1/09 and the current method used to standardize the Japanese index.

b. Clarke et al. (2011) used Gulland's concentration index to examine whether relatively more effort was spent in areas of higher than average BSH CPUE for the Kinkai fishery from 1993-2008. This analysis showed evidence of targeting of BSH from 2002 onward in the area off Tohoku (north of 20°N and east to 180°). This approach indicates whether fishing strategies were shifting, however, it does not directly provide an explanatory variable to be used in CPUE standardization models.
    i. The group noted that Japan has identified 13 vessels as targeting sharks in its shark management plan submitted to the WCPFC. However, the plan indicates that these vessels targeted sharks in 2015 but it does not indicate when they started operating and when they might have shifted to this fishing strategy. The WG suggested that it would be interesting to plot CPUE for these 13 vessels as a group as compared to other vessels or the Kinkai fleet as a whole, in order to see whether these named vessels have higher catch rates or any other diagnostic differences.
    ii. Japan conducted a hierarchical clustering method (h-clustered with the Ward method as distance factor) at the trip level on catch composition for the Kinkai fleet. This analysis was set to identify three clusters. One of these clusters had markedly higher CPUE for blue shark (than SWO or BET) and another cluster had notably higher CPUE of bigeye tuna. A third cluster had low CPUE for blue shark, and relatively higher CPUE for both SWO and BET depending on year. This analysis suggested that there is a distinct fishing strategy for BSH, and there were some apparent shifts in the proportion of effort associated with each cluster over time which may indicate changes in strategy. In addition, for the cluster associated with high blue shark CPUE, the group noted increasing CPUEs in the late 1990s and the mid-2000s, at times when the fishery was reported by various sources to have increased targeting (see Figure A2 in ISC/16/SHARKWG-1/10).

4. Conclusion
    a. There was consensus that targeting/fishing strategy shifts have probably occurred in the Kinkai shallow fleet, but the timing and magnitude of these shifts remains unclear.
    b. The WG acknowledged the concerns regarding the existing standardization model's explanatory variable for targeting; however, an alternative model that better addresses targeting has not yet emerged. The WG agreed that the currently accepted available alternative to address this issue needs further work.
    c. Pending further research on a robust explanatory variable representing fishing strategy, **the Working Group agreed to proceed with the Kinkai shallow standardized index as it currently stands.**
    d. Further study of the influence of changing Kinkai fishing strategies should be a priority for future work.

Taiwan

Catch estimate and CPUE standardization of the blue shark based on observers' records of Taiwanese large-scale tuna longline fisheries in the North Pacific Ocean, presented by K.-M. Liu (ISC/16/SHARKWG-1/22)

Discussed in Section 5: Catch and Discard Data and Total Catch Estimation Procedures

USA

Standardized CPUE for Blue Shark (Prionace glauca) Caught by the Longline Fisheries Based in Hawaii (1994 – 2015), presented by Felipe Carvalho (ISC/16/SHARKWG-1/16)

Catch and effort data from the Hawaii-based pelagic longline fishery operating in the North Pacific Ocean were analyzed to estimate indices of abundance for the blue shark between 1995 and 2015. The data come from the records of the Pacific Islands Regional Observer Program (PIROP) submitted to the Pacific Islands Fisheries Science Center (PIFSC). Nominal CPUEs were calculated separately for shallow-set (target: swordfish) and deep-set (target: bigeye tuna) sectors, and standardized with Generalized Linear Models (GLM), separately for each sector. Blue shark CPUE standardizations were conducted using generalized linear models (GLMs) by the Delta-lognormal method (DLN) for each fishery sector separately. Model validation was carried out with residual analysis. The standardized CPUE trend from the deep-set fishery sector was consistent with the trend observed in the nominal CPUE. Overall, the standardized CPUE showed declining and increasing trends between 2000 and 2008, followed by an increase until 2015. The standardized CPUE trend from the shallow-set fishery sector was also consistent with the trend observed in the nominal CPUE. The standardized CPUE showed a steep decline between 2006 and 2009, followed by an increase in 2010, and another steep decline until 2012. The last two years of the time series showed an increase in the standardize CPUE, with the value in 2015 being the highest since 2007.

Discussion

It was asked whether vessel ID was considered in standardization. The author advised that he treated the vessel ID either as random effect or fixed effect, and the AIC was larger when the vessel ID was treated as a fixed effect. A question was raised about the residual distribution in diagnostic plots. Ordinarily for a binomial model, the residuals will not follow a normal distribution and thus the histogram becomes bimodal, and also the q-q plot is usually not linear. In the current analyses the bimodal pattern was not pronounced. The author responded that a reason for obtaining the residual distributions presented was that most data had positive catch.

The estimation method for variance was discussed. In a two-step delta-lognormal approach, if proportion of positive catch and positive catch are independent, then the method used is appropriate. However, in this case, these two are not independent, so it was suggested to use the bootstrap approach described in Shono (2008) by which bias is small. Some WG members noted that the bootstrap method could provide artificially small confidence intervals in some cases.

It was noted that area weighting was necessary for standardized CPUE. If patterns of CPUE trends between areas are different, they may represent dynamics of different components of stock. The author was requested to provide figures of yearly changes of nominal CPUE by operation areas. The highest variability was observed in the earliest years of the time series. **It was recommended that further investigation be conducted on the possibility to standardize the index from the fishery using data from both fishery sectors combined, including the set-type as a covariate in the model. In addition, the WG recommended looking for evidence of a potential change in strategy that may have affected CPUE during the closure of the shallow-set fishery.**

The WG considered the potential for regulatory changes to affect the shallow-set CPUE, with closures imposed in 2006 and 2011 due to turtle interactions. Given the shorter time series for the shallow-set index and the fact that there quite a bit of overlap with the deep-set fishery that tends to catch larger animals, **it was agreed that the deep-set index be used in the 2017 assessment, but not the shallow-set index.**

Mexico

Standardized catch rates for blue shark (Prionace glauca) in the 2006-2015 Mexican Pacific longline fishery based upon a shark scientific observer program, José Ignacio Fernández-Méndez, Luis Vicente González-Ania, José Leonardo Castillo-Géniz (ISC/16/SHARKWG-1/25)

Abundance indices for blue shark (*Prionace glauca*) in the northwest Mexican Pacific for the period 2006- 2015 were estimated using data obtained through a pelagic longline observer program. Individual longline set catch per unit effort data, collected by scientific observers, were analyzed to assess effects of environmental factors such as sea surface temperature, distance to the nearest point on the continental coast and time-area factors. Standardized catch rates were estimated by applying generalized linear models (GLMs). Sea surface temperature, distance to the coast, year, area fished and quarter were all significant factors included in the model. The results of this analysis show a descending trend in the standardized abundance index in the period considered. This trend could be explained in terms of recent oceanographic events like the ENSO of 2014-2015.

Discussion

The WG questioned why the gamma distribution was applied as the error distribution for the CPUE standardization. The gamma distribution was selected by lower AIC values relative to the other error distributions tried. Perhaps the choice was made because the distribution of CPUE data was skewed closer to 0 or skewed to more positive side than lognormal distribution. The WG also discussed the importance of considering this index in the stock assessment, especially because it is the only index in the EPO. **The WG accepted this index for use in the 2017 BSH assessment.**

General WG conclusions on the CPUE indices

The WG also discussed the non-ISC longline index prepared by SPC for the last assessment. Although not updated, the WG decided to use it again in the 2017 assessment. Table 1 shows characteristics of the indices considered and their use in the 2017 assessment.

Table 1: CPUE selection table for 2017 blue shark assessment.

	Hawaii Deep-set Tuna Longline	Hawaii Shallow-set Swordfish Longline	Taiwan Large-scale Tuna Longline	Taiwan Small-scale Longline	Japan Early Offshore Shallow Longline (Hokkaido & Tohoku)	Japan Late Offshore & Distant Water (Hokkaido & Tohoku)	Japan Research and Training Vessel (Region 2)	SPC Observed Longline	Mexico Longline
Use in 2017	**yes**	**no**	**yes**	**no**	**yes**	**yes**	**no**	**yes**	**yes**
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% reporting ratio filter applied; logbook data were more reliable after filtering. Data are based on self-reported information and blue shark catch was derived	Relatively reliable because 94.6% reporting ratio filter applied. Logbook reporting rates were validated using available research data.	Concerns about reporting rate post 2000 addressed by filtering.	Good because it was observer measured, but coverage low.	Good because it was observer measured, but coverage not uniform over time.

					from aggregated shark catch.				
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)	Relatively Small (Areas 2)	Southwest North Pacific (140E-180, 0-15N)	Relatively Small - Northeast Pacific off Baja California
Size range (approx. upper)	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	190 PCL
Size range (approx. lower)	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	70 PCL
Statistical soundness	Yes. Diagnostics provided.	Yes. Diagnostics provided.	Yes. Diagnostics provided.	Yes. Diagnostics provided.	Yes. Diagnostics provided.	Yes. Diagnostics provided.	No. Strong patterns in residuals and departure from normality in qq plot; lacking some diagnostics (e.g. deviance table, CV's).	Diagnostics provided but some concerns raised.	Yes. Diagnostics provided.

Temporal coverage	2000-2015	2005-2015	2004-2015	2001-2010 (except 2004) - not updated	1976-1993	1994-2015 excluding 2011	1993-2008 - not updated	1993-2009 - not updated	2006-2015
Q Changes (due to management, fishing practices, etc.)	Not likely great because no major regulatory changes after the ban on finning in 2000. Shallow-set closure may have affected some deep-set fishery effort during 2000-2003.	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 notable regulation and gear changes; potential targeting change.	Uncertain, changes in catchability are hard to determine.	Not likely but catchability changes hard to determine.	Not likely, but there was a summer closure imposed starting in 2012 that covers ~30% of the high blue shark catch season.
Fishery 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/yr	low	Ensenada: ~1500 mt/yr

Comments		Closures in 2006, 2011 due to turtle take caps.	2015 observer coverage low in northern area.	No discard data; more confidence in late than early time series due to higher coverage.	Blue shark targeting may have changed over time. Standardization and filtering may have addressed these concerns.	Blue shark is a primary target species. Continued research recommended about capturing targeting practice in the CPUE.	Filtering may have addressed data quality issue. Spatio-temporal coverage may have been patchy. Further efforts to develop an index for this fishery are recommended.	In area of relatively lower blue shark density.	Spatio-temporal observer coverage could affect data quality and should be explored. Considered best EPO index available. NEPO had anomalous warm conditions in 2014 and 2015.

6. DISCUSS MODELING APPROACHES FOR USE IN THE BLUE SHARK ASSESSMENT

The WG discussed the types of models to use for the BSH assessment.

During the September webinar, the WG tentatively agreed to run a Bayesian Surplus Production model but expressed reservations about using the BSP2 model of McAllister and Babcock (2006) again given that not all the workings of BSP2 were fully understood. A Bayesian State-Space production model approach developed in R (BSSPM) used for BSH in the South Atlantic (Carvalho and Winker 2015) was considered promising as an alternative. The WG had asked that a paper be produced to see the results of running BSSPM parameterized to closely match the 2014 BSP2 assessment so as to identity any potential differences in performance before agreeing to use the new modeling approach.

During the September webinar, the WG also tentatively agreed to run an age-structured Stock Synthesis model pending review of the work on stock recruitment relationships and a preliminary examination of the size data by fleet.

Stock Assessment and Future Projections for the North Pacific Blue Shark (Prionace glauca): An Alternative Bayesian State-Space Surplus Production Model, presented by F. Carvalho (ISC/16/SHARKWG-1/17)

This working paper presents a comparison between the previous north Pacific blue shark stock assessment using the BSP2 model and an alternative Bayesian State-Space production model approach developed in R (BSSPM). In this assessment, five CPUE indices, Japan offshore shallow longline CPUE for 1976 to 1993 (JE), Japan offshore and distant water logline CPUE for 1994 to 2010 (JL), Hawaii deep-set longline CPUE (HW), SPC longline CPUE (SP) and Taiwan large-scale longline CPUE (TW), were used to account for a full range of uncertainties associated with stock dynamics. The data and prior distribution for key parameters were the same used in the 2014 BSP2 stock assessment. Historical stock dynamics as well as the stock status in 2011 were similar between the two assessment approaches. The results for both BSP2 and BSSPM stock assessment models suggest optimistic stock status for north Pacific blue shark in 2011.

<u>Discussion</u>

The study showed that BSSPM run with the 2014 data and parameterizations set to mimic the 2014 BSP2 assessment produced remarkably similar results to the previous assessment. The model is set up to run in R using JAGS and the R code is well documented. Although all parameters were fixed in the 2014 assessment, it was noted that some parameters can be estimated in the BSSPM model which may be preferable. The WG asked the reason why the estimated K and r (posteriors) were different than in the 2014 assessment. There may be several reasons including the value of process error and the weighting of indices. The WG continued to discuss weighting and CVs for indices and agreed that **weighting of the indices (through application of CVs) needs to be carefully considered**. As currently parameterized, the model appears to be heavily influenced by the catch, but is that due to underweighting the indices? A higher value for process error might provide better fitting to CPUE but could produce unrealistic stock dynamics. Retrospective analyses could help identify indices that are highly influential and thus guide selection of appropriate CVs. **The Francis (2011) method was recommended for use in determining appropriate CVs.** The paper provided other recommendations regarding model diagnostics including examination of residuals and retrospective analysis. **The WG agreed that examination of residuals and retrospective analysis is important and should be conducted in 2017.** Further information on model diagnostics is included in section 10.

The WG agreed to use BSSPM rather than McAllister's BSP2 for the 2017 assessment. Felipe is the author of the code and a WG member and will work closely with the modeling team to make sure all parameterizations are run correctly and that the results are fully understood.

Direct Estimates of Gear Selectivity for the North Pacific Blue Shark Using Catch-at-Length Data: implications for stock assessment, F. Carvalho (ISC/16/SHARKWG-1/13)

Understanding the size-selectivity characteristics of fishing gear is fundamental to interpreting catch data accurately, determining the size structure of fish populations, and assessing the effects of fishing on exploited stocks. Selectivity is one of the main processes modeled in contemporary statistical stock assessments, but its influence on management advice has been under-appreciated. We fitted the logistic size selectivity model to blue shark catch-at-length data from the different fleets operating in the NPO. Further, we compared the catch-at-length frequency distributions and selectivity estimates for the different fleets. In this document, catch-at-length data submitted to the SHARKWG was summarized using the Data-prep tool developed in R (DPT). Length frequency distribution for each fleet was summarized using 5 cm bins. In addition, logistic selectivity curves were developed for each fishery separately. Results presented here will assist the SHARKWG to appropriately define fleets to be used in an SS3 assessment, if it chooses that approach.

Discussion

As part of this presentation, it was explained how these size data are used in an age-structured model and some of the benefits of a fully integrated model versus a production model.

It was clarified that the smallest sizes recorded in Korea came from survey vessels in the transition zone area (30-40°N) but the fishery effort is centered in the subtropical waters. The WG discussed how to aggregate some of the submitted size compositions into the fleets identified in the last assessment. It was noted that for some fleets, the submitted data may come from different sampling programs for the same fleet, in effect double counting. For example, for the Kinkai-shallow longline fishery, both skipper notes and port sampling data were submitted. Each delegation was asked to identify to which fleets their submitted size data apply. For those fleets for which there were no size data, the WG made a proposal about mirroring those to others based on the selectivities estimated in this study. A table of selectivity assignments appears in section 11 below.

The WG considered all the available information including the new life history information, work on estimating the low fecundity stock recruitment relationship from life history information, the abundance of size data, and the lessons learned from the 2014 BSP and SS assessments and **agreed to run both Stock Synthesis and BSSPM for the 2017 assessment.**

7. DISCUSS STOCK BAYESIAN SURPLUS PRODUCTION MODELING APPROACH INCLUDING THE CHOICE OF INPUT PARAMETERS

The WG reviewed the parameter specifications (i.e., data, parameter values, priors, and model assumptions) from the last assessment BSP assessment and tentatively decided on the specifications in Table 2 below for the reference cases and alternative runs. The prior values for *r* and B_{msy}/K were selected based on a grid of life history information to capture what is believed to be the range of plausible values for BSH in the North Pacific. New studies reviewed at this meeting on reproductive biology, growth and natural mortality have reduced the uncertainty relative to our understanding going into the last assessment. The parameter values used in the last assessment will also be used again in alternate runs for comparison purposes.

Projections will be conducted on key model runs based on the average selectivities and *F*s during the 3 year period 2012-2014. Projections will be carried out for 10 years and will be run assuming status quo *F*, higher and lower *F* (±20% of status quo), and F_{msy}.

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

Specifications / Parameters	**Reference Values**	**Alternatives**	**Description / Comments**
K	Uniform distribution on log(*K*)		Range: [100, 20000] x 1000 MT
r prior mean	0.287	0.226, 0.34	Reference value based on Fujinami et al. (2016) with 1 yr breeding periodicity and Walter et al. (2016) method II for M; higher alternative based on Cortés (2002) and Kleiber et al. 2009 as in 2014; lower alternative based on Fujinami et al. (2016a) with 2 yr breeding periodicity and Walter et al. (2016) method II for M. (see grid in report)
r prior SD	0.5	0.3 0.7	
B_{init}/K (*alpha.b0*) prior mean	0.8	0.5 1.0	The priors were developed, by expert opinion, after considering the work of Ohshimo et al. (2014), Matsunaga et al. (2005), Ward and Myers (2005), and Okamoto (2004), and reported longline effort in the North Pacific Ocean since 1950.
B_{init}/K (*alpha.b0*) prior SD	0.5	0.7 0.9	
Surplus production function	$B_{msy}/K = 0.55$	$B_{msy}/K = 0.47$ $B_{msy}/K = 0.59$ try to estimate	Fletcher-Schaefer model - reference value estimated based on Fowler (1988) with r=0.287, 1 yr breeding periodicity and T=5.5; high alt value assumes r=0.226 with 2 yr and T=5.5; low alt value assumes 2 yr and T=7 as in 2014 assessment.

Process error	SD = 0.07	try to estimate	
Catch	1 catch time series of total dead removals, 1971-2015	Replace WG Korean estimates with Korean submitted time series	Total dead removals estimated by WG members (for details see catch section of this report, working group papers and prior assessment report)
Abundance indices	Japanese early with each of the 5 late series (JP, HW, TWN, SPC, MX)	Each late series without the early Japanese series	For details, see CPUE index section of this report
CV's for abundance indices			CV's will be estimated from the catch and indices outside the model by the Francis (2011) method
r vs *Binit/K* grids			Pair combinations as before on the 5 reference runs
r vs *Bmsy/K* grids			Pair combinations as before on the 5 reference runs
Diagnostics	Retrospective analysis (10 yr), residual analysis, Bayes' Factor		

8. DISCUSS STOCK SYNTHESIS MODELING APPROACH INCLUDING THE CHOICE OF INPUT PARAMETERS AND PRIORS

The WG reviewed the parameter specifications from the last SS assessment and tentatively decided on the specifications in Table 3 below for the reference cases and alternative runs. There was lengthy discussion on how to parameterize the LFSR relationship to be consistent with the BSP runs. A grid of candidate life history values needed to estimate the LFSR relationship was created and runs were proposed that had *r*, B_{msy}/K and LFSR coefficients all estimated based on the same life history assumptions. Those that produced parameters on the high and low end, relative to the selected reference case parameters, were chosen for alternative runs.

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

GROUP	Variable	Reference values	Alternatives	Description / Comments
CPUE	CPUE Series	Japanese early with each of the 5 late series (JP, HW, TWN, SPC, MX)	Each late series without the early Japanese series	CV's will be estimated from the catch and indices outside the model by the Francis (2011) method.

M	Natural Mortality	Walter et al. (2016) method II using Fujinami et al. (2016) growth with Tmax=24	Walter et al. (2016) method II using Fujinami et al. (2016a) growth with Tmax=20, and Tmax = 30; Peterson and Wroblewski (1984) method using Nakano (1994) growth and Tmax=24	Sex specific
LF	Sample size for length frequency data	Scalar of 0.2	Scalar of 1.0 and from Francis 2011.	5 cm precaudal length bins; numbers indicate lower limits of bin (i.e., put fish of 24.9 cm into 20 cm bin).
SR	Stock Recruitment Function	LFSR calculated using base case r and base case LH parameters	LFSR calculated for the 8 variations in life history parameters	Kai (2016)
	Sigma R (SD on the recruitment deviations)		SigmaR =c(0.1, 0.3)	
Initial conditions		40,000 mt	20,000 mt, 60,000 mt	Developed, by expert opinion, after considering the work of Ohshimo et al. (2014), Matsunaga et al. (2005), Ward and Myers (2005), Okamoto (2004), and reported longline effort in the North Pacific Ocean since 1950.
Catches/Fisheries		1 catch time series with 18 fisheries	Replace WG Korea estimates with Korean submitted time series	Total dead removals estimated by WG members (for details see working group papers and prior assessment report)
Region Structure		1 region		
Time Frame		1971-2015		
Selectivity	Length Based	Estimated by fishery from submitted size data. Mirrored for those fisheries without length comps		
Plus Group		24		
Length-weight relationship		F: $Wt=5.388x10^{-6}PCL^{3.102}$ M: $Wt=3.293x10^{-6}PCL^{3.225}$		Nakano (1994)

Litter Size		15-112, with positive relationship between # pups and female size	as in Cortés 2002	Fujinami et al. (2016)
Breeding Periodicity		1 yr	2 yr	Reference from Fujinami et al. (2016b); alternative as in Cortés 2002
Tmax	Longevity	24	20, 30	Tmax of 30 from Fabens using Fujinami et al. (2016a) growth for males, and 24 is Fabens on Fujinami for females; 20 is based on Taylor's equation and Hsu et al. (2011) growth.
Maturity	Length at 50% maturity	F: 156.6 cm PCL	from Nakano 1994 as in last assessment	Logistic maturity; reference case from Fujinami et al. (2016b)
	Age at 50% maturity	F: 5 years		
	Length at first maturity	F: 141 PCL		
	Age at first maturity	F: 4 years		
Diagnostics		retrospective analysis (10 yr), residual analysis, neg-logliklihood profiles		

The WG proposed the following treatment of selectivities for fleets for which size data was missing or considered unreliable:

Fishery Size Data	**2014 Fleet Assignment**	**Selectivity**	**Comment**
México (Ensenada and San Carlos SSLL combined)	F1_MEX	Estimate	
	F2_CAN	Mirror to F14	Beginning in 2013 with a selectivity time block
China - LL	F3_CHINA	Estimate	Use the former data for earlier and may need a time block
Japan SSLL (Kinkai shallow and small shallow)	F4_JPN_KK_SH	Estimate	
Japan DSLL (JRTV and observer deep)	F5_JPN_KK_DP	Estimate	Only through 2012
	F6_JPN_ENY_SHL	Mirror to F4	

	F7_JPN_ENY_DP	Mirror to F5	
Japan - Driftnet	F8_JPN_LG_MESH	Estimate	Also use the former data from 2014 deleting the 2011 data
	F9_JPN_CST_Oth	Mirror to F5	
2014 assessment small mesh gillnet data	F10_JPN_SM_MESH	Estimate	
	F11_IATTC	Mirror to F1	
Korea - longline	F12_KOREA	Keep 2005 & 2007,otherwise mirror to F17 from 0-15N	
	F13_NON_ISC	Mirror to F3	
USA - DGN	F14_USA_GILL	Estimate	
	F15_USA_SPORT	Mirror to F14	
Hawaii (DSLL & SSLL combined)	F16_USA_Longline	Estimate	
Taiwan - large longline	F17_TAIW_LG	Estimate	
2014 assessment Taiwan small longline data	F18_TAIW_SM	Estimate	

Projections will be conducted on key model runs based on the average selectivities and *F*s during the 3 year period 2012-2014. Projections will be carried out for 10 years and will be run assuming status quo *F*, higher and lower *F* (±20% of status quo), and F_{msy}.

9. ESTABLISH WORK PLAN FOR THE ASSESSMENT AND FINAL DATA SUBMISSION DEADLINE

<u>SHARKWG Members</u>

- All outstanding final assessment data for the base case are to be sent to the SHARKWG Chair by December 12, 2016.
- All outstanding final assessment data for the alternative runs are to be sent to the SHARKWG Chair by December 19, 2016.
- All members conduct updated analyses or prepare supporting documentation based on requests made during this meeting. Ensure that working group reports describing any data used in the assessment adequately describe estimation methods with appropriate detail and diagnostics.
- Japanese modelers will take the lead on the BSP modeling. BSP correspondents are M. Kai, H. Yokoi, N. Takahasi, M. Kanaiwa (Japan), K.-M. Liu (Chinese Taipei), F. Carvalho, J. Brodziak and T. Sippel (U.S.).
- Conduct base case and sensitivity runs in advance of assessment workshop.
- Conduct projections in advance of the assessment workshop.

- U.S. modelers will take the lead on Stock Synthesis modeling. SS correspondents are F. Carvalho and T. Sippel (U.S.), M. Kai and M. Kanaiwa (Japan), K.-M. Liu (Chinese Taipei), and A. Aires da Silva (IATTC).
- Conduct base case and sensitivity runs in advance of assessment workshop.
- Conduct projections in advance of the assessment workshop.
- Webinar to discuss final data for the assessment (for modeling and data subgroups) tentatively the week of Dec 19 and 20 (EPO), Dec 20 and 21 (WPO)
- Small modeling subgroup meeting, tentatively in January (La Jolla)

SHARKWG Chair

- Contact SPC to obtain updated information on non-ISC longline fleets reporting blue shark catch in the north Pacific and finalize SPC data by the data submission deadline Dec 12.
- Contact China correspondents for further information on their submitted data (i.e. have they accounted for discards) and finalize China data by the data submission deadline of Dec 12.
- Contact IATTC to obtain updated information on non-ISC fleets reporting blue shark catch in the north Pacific and finalize IATTC data by the data submission deadline Dec 12.
- Calculate recent Korea catch using methods agreed upon for the last assessment using data from the ISC data archive and finalize Korea base case data by the data submission deadline Dec 12.
- Compile and distribute final assessment base case data by Dec 19.
- Organize webinar for week of Dec 19.

10. OTHER MATTERS

The Chair reminded all members that an election for a new SHARKWG Chair will be held in July.

11. FUTURE SHARKWG MEETINGS

The next SHARKWG Meeting will be held 17-24 March, 2017, in La Jolla, CA, USA, to complete the blue shark assessment. The Chair has requested a 2-day meeting in July (dates TBD) prior to the ISC Plenary.

12. 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 the revised version to all WG members.

13. ADJOURNMENT

The Chair thanked all participants for attending and contributing to a very productive meeting. She also thanked the Korean delegation for the incredible hospitality, for their support with logistics in advance of the meeting and throughout the week, and for the wonderful excursion and banquet dinner. The meeting was adjourned at 17:01, November 21, 2016.

14. LITERATURE CITED

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Attachment 1 - List of Participants

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Attachment 2 - Meeting Documents

WORKING PAPERS

ISC/16/SHARKWG-1/01	Reproductive biology of the blue shark, *Prionace glauca*, in the western North Pacific Ocean. Yuki Fujinami, Yasuko Semba, Hiroaki Okamoto, Seiji Ohshimo, and Sho Tanaka (fuji925@affrc.go.jp)
ISC/16/SHARKWG-1/02	Age and growth estimation of the blue shark, *Prionace glauca*, in the western North Pacific Ocean. Yuki Fujinami, Yasuko Semba, Hirotaka Ijima, and Sho Tanaka (fuji925@affrc.go.jp)
ISC/16/SHARKWG-1/03	Conversion factors between specific body parts for blue shark in Pacific Ocean. Atsuya Yamamoto, Ayumi Shibano, Yasuko Semba, Yuko Hiraoka, Minoru Kanaiwa and Mari Kobayashi (a3yamamo@bioindustry.nodai.ac.jp)
ISC/16/SHARKWG-1/04	Migration pathways for adult female blue shark, *Prionace glauca*, in the western North Pacific Ocean. Ko Shiozaki, Yuki Fujinami, and Mikihiko Kai (kaim@affrc.go.jp)
ISC/16/SHARKWG-1/05	Estimation of population growth rate of the blue shark (*Prionace glauca*) using two-sex age-structure matrix model. Hiroki Yokoi, Hirotaka Ijima, Seiji Ohshimo, and Kotaro Yokawa (ijima@affrc.go.jp)
ISC/16/SHARKWG-1/06	Update of age and sex specific natural mortality of the blue shark (*Prionace glauca*) in the North Pacific Ocean. Yasuko Semba and Hiroki Yokoi (senbamak@affrc.go.jp)
ISC/16/SHARKWG-1/07	Stock recruitment relationships of North Pacific blue shark. Mikihiko Kai and Yuki Fujinami (kaim@affrc.go.jp)
ISC/16/SHARKWG-1/08	A potential method for meta-analysis of growth curve for shortfin mako in the North Pacific. Norio Takahashi, Mikihiko Kai, and Yasuko Semba (norio@affrc.go.jp)
ISC/16/SHARKWG-1/09	Performance of methods used to estimate abundance indices for a longline fishery targeting two species, with consideration of target change. Ayumi Shibano, Minoru Kanaiwa, Ranta Watari, Mio Shibuya, Atsushi Yamamoto, Mari Kobayashi, and Mikihiko Kai (ayumi.shibano@gmail.com)
ISC/16/SHARKWG-1/10	Update of Japanese abundance indices for blue shark caught by Japanese offshore and distant water shallow-set longliner in the North Pacific. Mikihiko Kai and Ko Shiozaki (kaim@affrc.go.jp)
ISC/16/SHARKWG-1/11	Update of Japanese catches for blue shark caught by Japanese offshore and distant water longliner in the North Pacific. Mikihiko Kai (kaim@affrc.go.jp)

ISC/16/SHARKWG-1/12	Update of catches for North Pacific blue shark caught by Japanese coastal fisheries. Mikihiko Kai and Toshikazu Yano (kaim@affrc.go.jp)
ISC/16/SHARKWG-1/13	Direct Estimates of Gear Selectivity for the North Pacific Blue Shark Using Catch-at-Length Data: implications for stock assessment. Felipe Carvalho and Tim Sippel (felipe.carvalho@noaa.gov)
ISC/16/SHARKWG-1/14	Size and sex structure of blue sharks in the North Pacific Ocean. Tim Sippel, Yasuko Semba, Ko Shiozaki, Felipe Carvalho, Jose Leonardo Castillo-Geniz, Wen-Pei Tsai, Kwang-Ming Liu, Youjung Kwon, Yan Chen, Suzanne Kohin (tim.sippel@noaa.gov)
ISC/16/SHARKWG-1/15	Catch and Size of Blue Sharks Caught in U.S. Fisheries in the North Pacific. Suzanne Kohin, Tim Sippel, Felipe Carvalho (suzanne.kohin@noaa.gov)
ISC/16/SHARKWG-1/16	Standardized CPUE for Blue Shark (*Prionace glauca*) Caught by the Longline Fisheries Based in Hawaii (1994 – 2015). Felipe Carvalho (felipe.carvalho@noaa.gov)
ISC/16/SHARKWG-1/17	Stock Assessment and Future Projections for the North Pacific Blue Shark (*Prionace glauca*): An Alternative Bayesian State-Space Surplus Production Model. Felipe Carvalho, Henning Winker, and Jon Brodziak (felipe.carvalho@noaa.gov)
ISC/16/SHARKWG-1/18	Stock Assessment of North Pacific Blue Shark (*Prionace glauca*) Using a Catch Based Method. Felipe Carvalho and Henning Winker (felipe.carvalho@noaa.gov)
ISC/16/SHARKWG-1/19	Blue Shark (*Prionace glauca*) bycatch statistics in Canadian Fisheries. J.R. King and A.M. Surry (jackie.king@dfo-mpo.gc.ca)
ISC/16/SHARKWG-1/20	Catch, size and distribution pattern of blue sharks by Taiwanese small-scale longline fleets in the North Pacific in 2001-2015. Kwang-Ming Liu, Kuan-Yu Su, Chien-Pang Chin (kmliu@ntou.edu.tw)
ISC/16/SHARKWG-1/21	Size and spatial distribution of the blue shark, *Prionace glauca*, caught by Taiwanese large-scale longline fishery in the North Pacific Ocean. Kwang-Ming Liu, Kuang-Yu Su, and Wen-Pei Tsai (kmliu@ntou.edu.tw)
ISC/16/SHARKWG-1/22	Catch estimate and CPUE standardization of the blue shark based on observers' records of Taiwanese large-scale tuna longline fisheries in the North Pacific Ocean. Wen-Pei Tsai and Kwang-Ming Liu (kmliu@ntou.edu.tw)
ISC/16/SHARKWG-1/23	Catch and size data of blue shark by Korean tuna longline fishery in the North Pacific Ocean. Doo Nam Kim, Youjung Kwon, Sung Il Lee, Hun Ju Cho, Jeong Eun Ku and Mi Kyung Lee (kwonuj@korea.kr)

ISC/16/SHARKWG-1/24	Blue shark catches estimations for the Mexican Pacific (1976-2014). Oscar Sosa-Nishizaki and José Leonardo Castillo-Géniz (leonardo.castillo@inapesca.gob.mx)
ISC/16/SHARKWG-1/25	Standardized catch rates for blue shark (*Prionace glauca*) in the 2006-2015 Mexican Pacific longline fishery based upon a shark scientific observer program. José Ignacio Fernández-Méndez, Luis Vicente González-Ania, José Leonardo Castillo-Géniz (leonardo.castillo@inapesca.gob.mx)

Attachment 3 – Workshop Agenda

SHARK WORKING GROUP (SHARKWG)

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

14 – 21 November, 2016
Haeundae Grand Hotel
Busan, Republic of Korea

Meeting begins at 9:00 am Monday.

1. Opening of SHARKWG Workshop
    a. Welcoming remarks – Dr. Seok Gwan Choi, senior scientist at Distant Water Fisheries Resources Research Division, NIFS
    b. Introductions
    c. Meeting arrangements
2. Distribution of documents and numbering of Working Papers
3. Review and approval of agenda
4. Appointment of rapporteurs
5. Summary of September webinar and outcomes
6. Biological information *(Liu, Carvalho)*
    a. Review of blue shark biological data for the assessment
    b. Update on mako shark biological studies
    c. Size data and size data collection protocols
7. Catch and discard data and total catch estimation procedures *(Kai, M. K. Lee)*
8. Review CPUE indices for blue shark stock assessment *(Takahashi, Shibano)*
9. Discuss modeling approaches for use in the blue shark assessment *(Kanaiwa, Kohin)*
10. Discuss Stock Bayesian Surplus Production modeling approaches including the choice of input parameters *(Kanaiwa, Kohin)*
    a. Decide on base case configurations
    b. Decide on tentative sensitivity analyses
    c. Discuss future projection scenarios
11. Discuss Stock Synthesis modeling approaches including the choice of input parameters and priors *(Kanaiwa, Kohin)*
    a. Decide on base case configurations
    b. Decide on tentative sensitivity analyses
    c. Discuss future projection scenarios
12. Establish work plan for the assessment and final data submission deadline
13. Other matters
14. Future SHARKWG meetings
15. Clearing of report
16. Adjournment