Annex 8

REPORT OF THE SHARK WORKING GROUP WORKSHOP

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

16-24 April , 2013
Shizuoka, Japan

1.0 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 National Research Institute of Far Seas Fisheries (NRIFSF) in Shizuoka, Japan from 16 - 24 April, 2013. The primary goal of the workshop was to complete a Bayesian Surplus Production (BSP) stock assessment for blue sharks in the North Pacific and develop tentative conservation information for the ISC Plenary. Other goals included 1) developing plans for a preliminary age-structured assessment of blue sharks in the North Pacific that will be completed by the next SHARKWG meeting in July and 2) gathering information and discussing assessment plans for shortfin mako shark.

Dr. Hitoshi Honda, the Deputy Director of NRIFSF, welcomed SHARKWG participants. Meeting participants included Canada, Chinese Taipei, Japan, Secretariat of the Pacific Community (SPC), United States of America (USA) and the ISC Chairman (Attachment 1). In his address, Dr. Honda announced that the NRIFSF has a new Director, and that research on tuna and tuna-like species continues to be a focus of the Shimizu lab. He thanked the participants for their continued dedication to the ISC and this working group. Sharks are important in the fisheries of Japan, in particular in Miyagi prefecture where Kesennuma fishing port has historically been the major unloading and processing port for sharks. The port was mostly destroyed during the Great East Japan Earthquake, but the fisheries operating out of that port are beginning to recover. Dr. Honda wished the group success in completing the blue shark assessment and the other planned work. He acknowledged the need for the working group to work hard through the weekend in order to achieve the meeting goals, but he also said he hoped participants will have some time to enjoy the spring in Shizuoka. Now is the time for the first harvest of green tea which is considered very special in this region.

2.0 DISTRIBUTION OF MEETING DOCUMENTS

Seven working papers and one information paper were distributed and numbered (Attachment 2) as well as a number of background papers. Several oral presentations were also made during the meeting. Most authors who submitted a working paper agreed to have their papers posted on the ISC website where they will be available to the public. The authors of working paper ISC/13/SHARKWG-2/03 declined posting on the ISC website because the paper is being prepared for publication elsewhere.

3.0 REVIEW AND APPROVAL OF AGENDA

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

4.0 APPOINTMENT OF RAPPORTEURS

Rapporteuring duties were assigned to nearly all participating WG members. The approved agenda (Attachment 3) indicates the rapporteurs for each item in parentheses.

5.0 SUMMARY OF THE JANUARY 2013 WORKSHOP

Suzanne Kohin, Chair of the SHARKWG, provided a summary of the January 2013 workshop held in La Jolla, California USA. The workshop was the final data preparatory meeting for the BSP assessment of blue shark in the North Pacific. Goals of the workshop were to agree to the data to be used in the north Pacific blue shark assessment, finalize all time series provisionally, establish an assessment data submission deadline, estimate catch of fleets that have not provided data, and conduct some exploratory Bayesian Surplus Production (BSP) runs with the provisional data. Participants included WG members from Japan, Chinese Taipei, IATTC and USA, and a scientist from Mexico. Nine Working Papers and one Information Paper were submitted.

The WG reviewed all the previously submitted catch data as well as some updates to several fishery time series for the USA and Chinese Taipei. Catch time series were developed for the longline fisheries of Korea and China, members that were not in attendance. Two time series of catch for the Mexico fisheries were reviewed and the WG agreed upon a method to estimate Mexico's catch based on research provided by the USA and the scientist from Mexico. The WG established a table of criteria to use for evaluating abundance indices being considered for use in the assessment. After examining the candidate indices and their diagnostics, the WG decided to use the two Japan Kinkai shallow longline indices (early and late) in the base case assessment and to use the Hawaii deep-set longline fishery index in place of the Japan late index as a sensitivity run. Other input parameters were discussed and values for the base case assessment were established. The WG finalized plans for the blue shark assessment to be completed at the April meeting.

The SHARKWG Chair also noted that since the January meeting, several members of the WG have decided to move forward with a collaborative preliminary age-structured assessment of blue shark in the North Pacific Ocean with efforts being led by Joel Rice of SPC and Kevin Piner of NOAA Southwest Fisheries Science Center (SWFSC). The preliminary assessment will be a collaborative ISC SHARKWG product and presented to the SHARKWG in July.

6.0 BAYESIAN SURPLUS PRODUCTION MODELING OF NORTH PACIFIC BLUE SHARK

6.0.a Outstanding issues with catch time series

At the January 2013 SHARKWG workshop, the north Pacific blue shark catch for Korea and China were estimated and were reported in the Workshop Report. The BSP assessment report will use text from the January 2013 Workshop Report summarizing the methods since Working Papers were not produced. An information paper was received describing the methods used to estimate Mexican blue shark catch.

Unofficial blue shark catches estimations for the Mexican Pacific (1976-2011) (ISC/13/SHARKWG-2/INFO-01)

<u>Summary</u>

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 1976 to 2011. Mexican shark catch statistics by species were not available until 2006, so past blue shark catches have to be estimated. Here an unofficial estimation using different sources of information is suggested. This estimation assumes that blue shark has been represented in total catches with different proportions through time and those proportions are based on species composition data obtained from 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 longline fisheries and the drift gill net fisheries were taken into consideration to construct the historical series. Historically, blue shark was not an important species in past catches; however, catches have increased from levels of less than 500 t in the 1970s to around 1,000 t in the 1990s, and to around 4,000 t recently. Estimates indicate that blue sharks are caught mainly off the western coast of the Peninsula of Baja California. Also, in order to facilitate the assessment by the SHARKWG, information from blue shark size frequencies in the catches is added, from information of studies analyzing, mainly, the artisanal fisheries in the region. The results of these studies suggest that a large proportion of the catch is represented by juvenile sharks.

<u>Discussion</u>

At the January 2013 SHARKWG workshop, preliminary estimates of blue shark catch by Mexico based on analyses similar to those in this Information Paper were reviewed and provisionally accepted. Shark aggregated landings data were provided by INAPESCA but further work was needed to derive blue shark catch. Catches estimated in January and for this revised time series were not official submissions, and were not collated by INAPESCA scientists; however, they were considered to represent the best available estimates. The data presented in January 2013 was further amended to include estimated discards from midsize vessel driftnet fisheries and catch from Joint Venture foreign longline fleets. The discard data and Joint Venture longline data were sourced from published documents and confirmed with O. Sosa-Nishizaki as reasonable estimates.

The SHARKWG received the revised landing estimates in the Information Paper provided for this meeting. Although past the deadline for data submission, the WG agreed to consider them for use in the assessment. These revised estimates result in lower landings from 1996 onwards, although the differences are minimal. The revised landings estimates are well documented in the Information Paper, while the preliminary estimates were only presented orally at the January 2013 workshop. **In order to have documented, best estimates, the SHARKWG agreed to**

use the new revised landings estimates along with the additional drift net discard data and Joint Venture longline catch derived from the published documents. It is important to note that these independent estimates are unofficial, but are considered the most complete and current estimates. Updating the Mexico catch based on these estimates for the BSP model will not dramatically change the assessment results since the difference between preliminary and revised landings are minimal, and the Mexico catch represents only 4.8% of the total north Pacific blue shark estimated catch.

The SHARKWG Chair noted that some blue shark data were received from INAPESCA and that they hoped to have a scientist in attendance at the current meeting, although his travel fell through at the last minute. INAPESCA has indicated that they are working on estimating blue shark catch for all fleets and ports, and are also collating shortfin mako catch, so the WG should have improved data for the next stock assessments. **The SHARKWG appreciates the efforts of Mexico to join the WG meetings and provide shark data and endorsed continued collation of Mexico blue and shortfin mako shark data.**

WCPFC non-ISC Member Longline Catch

Summary

The Chair raised the issue about potential double counting between longline data provided to the WCPFC for non-ISC members and Taiwan's reported small longline fishery catch. This is because Taiwan has reported landings into their ports that include some from foreign flagged longline vessels, which may have also been reported to the WCPFC by the foreign fleets directly. At present there is no evidence to suggest significant double counting, although this issue is largely intractable given the current information regarding landings by vessel.

Discussion

It was clarified that the WCPFC catch data provided, which includes discards, are specifically only catch in the north Pacific and likely only for the Federated States of Micronesia, Kiribati, Marshall Islands, Papua New Guinea and Vanuatu. There was concern that these data might be included in the Taiwan catch, either from Taiwanese vessels fishing under the non-member nation flags and landing catch in Taiwan or from non-member nation vessels landing in Taiwan. There is not information on what flags the Taiwanese vessels are using, so filtering of the WCPFC data is not possible. There is also no information on the relative effort on foreign flag landings compared to Taiwan flag landings in Taiwan. The WCPFC data are not port-specific so these data cannot be filtered to address the concern of Taiwan landings.

It was noted that even if all the catch provided by WCPFC is double-counted, it in most years would be less than 15% of the catch provided by Taiwan. The SPC representative, based on his knowledge of the non-ISC member nation's fisheries, believes that very little of the WCPFC data is likely to come from Taiwan landings and it was suggested that both the submitted Taiwan and WCPFC data be used in the BSP base case. **The SHARKWG agreed to use both the WCPFC and Taiwan data in the BSP base case, and to continue to investigate the problem of teasing out foreign fleet landings from the Taiwan data for future assessments.**

Catches of blue sharks from U.S. West Coast recreational fisheries during 1971-2011 (ISC/13/SHARKWG-2/01)

Summary

Recreational fishing is popular in the USA, and effort is directed at many of the same species targeted in commercial fisheries. Various fishing modes contribute to both targeted and non-targeted catch of shortfin mako and blue sharks, but the predominant method used by recreational anglers to target sharks is rod and reel fishing with trolling lures. Recreational fishing activity is monitored and regulated at the state-level, but surveys, data collection, and catch and effort estimation are also coordinated at the Federal-level. Surveys are conducted across many species, fishing modes, locations and times. This is an update to preliminary estimates of blue shark catches from recreational fisheries on the US West Coast provided in 2012 to the SHARKWG to provide a US recreational catch time series for the ISC North Pacific blue shark assessment.

Discussion

The SHARKWG acknowledged that the methods presented in this Working Paper were agreed to at the January 2013 workshop. This paper provides documentation for the additional methods used to expand the time series to the early years and to include estimates of additional mortality of discarded sharks. **The SHARKWG reiterated that it accepted these data for use in the BSP base case.**

6.0.b Outstanding issues with CPUE time series

Analysis of North Pacific Shark Data from Japanese Commercial Longline and Research/Training Vessel Records (Clarke et al. 2011)

Summary

The SPC representative presented an overview of the methods and results of this WCPFC Working Paper. The presentation and discussion focused on the standardized CPUE time series developed from Japanese Research Training Vessel (RTV) records, since the index for WCPFC Region 2 was put forward to the SHARKWG for consideration for the blue shark assessment. The North Pacific longline operational data from research and training vessel surveys (1992-2009) were provided by Japan for onsite analysis in Shimizu in early 2011. Both sets required filtering to remove records believed to under-report actual shark catches. The analysis was based on 7,974 sets representing 10 vessels in the research and training vessel surveys. Application of different filtering methods could result in larger sample sizes, but this benefit would need to be weighed against the probability of increasing the presence of under-reported catches in the filtered database. When considering the selection and application of data filters it is important to recall that if vessels began releasing/discarding (and not reporting) sharks in recent years, filtering may not fully correct for this effect, and declining catch rate trends would thus potentially be exaggerated. On the other hand, if reporting practices do not change but shark stock abundance actually does diminish over time, declining catch rates would be expected. The challenge is to apply a filter which removes those catch records which are under-reported, but retains those which are low but accurate. Filtered data were examined in terms of five potential indicators of fishing pressure: distribution, catch composition, catch rate, targeting and size. Blue sharks showed declining standardized catch rates (in Region 2) using RTV data.

Discussion

The RTV data (1993-2009) are from WCPFC Regions 2 and 4, and have previously been reviewed by the SHARKWG (Takahashi et al. 2012; ISC/12/SHARKWG-1/06) and not considered for use as an index to be included in the BSP. The majority of observed RTV sets are in Region 4, but in the later part of the time series there are increased observations in Region 2. There is a seasonality to Region 2 data, with most sets occurring August-November. The SHARKWG was concerned that despite having the majority of observed RTV sets in Region 4 and indication that there are substantial effort and catch in that Region in all years, that the standardized CPUE based on filtered data show that the model did not adequately fit the data. This result casts serious doubt on the filtering and standardization methods, and based on this the SHARKWG expressed reservations about accepting the results in Region 2 for interpretation since it is based on the comparable analyses. The SHARKWG noted that Clarke et al. (2011) acknowledge that the filtering and standardization models presented here should be considered a starting point for further analysis, implying that these are preliminary results only and should not be used as an abundance index in any assessment. The document outlined that additional improvements (i.e. alternate definitions of covariates and combinations) need to be are explored.

The SHARKWG discussed problems with interpreting and analyzing RTV data. The RTV have different behavior than the commercial fishing fleets; the RTV avoid commercial vessels and fish either before or after the commercial vessels. Also based on the Gulland Index, where values well below 1.0 are typical when avoidance of a species is occurring, the fleet appears to avoid sharks. The RTV have unique strategies to deal with safety concerns for high school students, and the target destination is often Hawaii. These elements suggest that the RTV data cannot be viewed analogous to a survey, or fishery-independent survey. Another issue is that the RTV data come from an area that is a mixing area, where in one season the area is occupied by sub-adults and in another season it is occupied by adults. The treatment of this index will be difficult in a size-based model. Overall, the utility of the RTV sets as abundance indices in these Regions is questionable, and they should not be used for this purpose.

The SHARKWG discussed the implications of the declining trend in the standardized CPUE time series in Region 2. The RTV sets in both Region 2 and 4 are deep sets. The SHARKWG has already reviewed standardized CPUE time series from the Hawaiian longline fisheries for these Regions. The Hawaiian deep set longline fleet operates in Region 4, while the Hawaiian shallow set longline fleet operates in Region 2. Both standardized CPUE time series show decreases, so the decrease in the RTV data for Region 2, if it were representative, could reflect a central Pacific trend. The Hawaiian deep set CPUE time series has been selected by the SHARKWG to include in the BSP as a sensitivity run. So this regional trend is already captured, which also suggests that there is no need to utilize the RTV data given the concerns regarding the methods of filtering and standardization.

The SHARKWG noted that the WCPFC background document itself notes that if changes in data recording and/or discard rates changed in recent years, then the declining trend would be an exaggeration. Japan confirmed that there have been changes in the pattern of recording, including reporting of discards with species identification and in the number of discards. In the 1990s the catch by species would have been more reliable than it is now. The precision of identification of species has deteriorated since 2000, mainly because discards (mostly live releases) without species identification, increased. In addition, due to national regulations relating to finning bans, fewer sharks are now brought on board. All of these changes in behavior and practices would result in a decline in reported catch, and would account for the apparent decline in CPUE.

The diagnostics reported in the background document were not comprehensive, and elements such as deviance tables and CVs were not provided. For the diagnostics that were provided, the SHARKWG expressed concerns of the lack of linearity in the q-q plots, residual patterns, which coupled with small sample sizes, all suggest that these should be treated as preliminary analyses only and not used in any assessment models. The SPC noted that in an age-structured model (specifically SS3 model), the Region 2 RTV index could still be useful in an alternative run since it indexes a somewhat different area from the Hawaiian deep set index, and it can be down weighted. The SHARKWG noted that a fully integrated model would require the catch and size data from the RTV fishery as well. Some RTV size data have already been compiled by the SHARKWG, and it was further suggested that the selectivity could be assumed to be similar to the Hawaiian deep set data for the same region.

The SHARKWG decided to examine the RTV CPUE index using the same criteria as established at the January workshop, and thus tabulated information about the index along with the other 6 indices that had been considered (Table 1). **Based on the selection criteria, and the lack of time to properly evaluate the index, the WG rejected the RTV indices for use in the BSP model. It was also noted that indices for consideration should have been provided in time for the final data prep meeting.**

Table 1. Characteristics of candidate abundance indices proposed to represent relative abundance of north Pacific blue shark and criteria used to evaluate the indices. This table was created during the January 2013 meeting and updated at this meeting to include the proposed RTV index.

	Hawaii Deep-set Longline	Hawaii Shallow-set Longline	Taiwan Large-scale Longline	Taiwan Small-scale Longline	Japan Early Offshore Shallow (Hokkaido & Tohoku)	Japan Late Offshore & Distant Water (Hokkaido & Tohoku)	Japan Research Training Vessel Region 2 Index
Quality of Observations	Good because observer data is used with ~5-20% observer coverage and discards are recorded	Good because observer data is used with ~5-100% observer coverage and discards are recorded	Good because observer data is used but recorded discard data may not be representative	Catch data are representative but effort data were estimated	Relatively reliable because 94.6% filtered data applied, logbook data more reliable by filtering	Relatively reliable because 94.6% filtered data applied and logbook were validated by training vessel and observer data	Species ID believed good until 2000, quality declining since, after 2005-2006 discarding may be underreported and data quality considered bad
Spatial distribution	Relatively small (Areas 4 & 5)	Relatively small (Areas 2 & 5)	Large (Areas 1-5)	Large (Areas 1-5)	Medium (Area 1 & 3)	Large (Area 1, 2, 3 & 4)	ISC area 2, and some area 4
Size/age distribution	90% of catch from females: 175-275 cm TL; males: 175-300 cm TL	90% of catch from females: 100-275 cm TL; males: 100-300 cm TL	60 to 340 cm TL	90 cm to 320 cm TL	no information	90-170 cm PCL	120-200 PCL, median 160
Statistical soundness	Yes. Delta-lognormal model was used and model diagnostics were good	Yes. Delta-lognormal model was used and model diagnostics were good	Some diagnostics provided	Diagnostics provided	Yes	Yes	No. Strong patterns in residuals and departure from normality in qq plot; not enough information provided (e.g. deviance table,

							CV's)
Temporal coverage	1995-2011	1995-2001; 2004-2011	2004-2010	2001-2003; 2005-2010	1976-1993	1994-2010	1993-2008
Catchability Changes (due to management, fishing practices, etc.)	Finning ban from 2000 (probably limited effect on Q)	Ban in shark finning from 2000 (probably limited effect on Q); Shallow-set longline ban from 2001-2004 (likely affects Q); hooks and bait requirements after 2004; limits on turtle bycatch	Ban in finning from 2005 (probably limited effect on Q)	Ban in finning from 2005 (probably limited effect on Q)	No regulation, gear or targeting change	No regulation, gear or targeting change	Opportunistic fishing effort, so changes in catchability are hard to determine
Relative catch contribution	~1500 to 2000 mt annually	~1500 to 2000 mt annually	<500 tons from 2003	>10,000 tons from 2004	19,000-55,000 mt	13,000-24,000 mt	~50mt annually
Decision	Use in sensitivity run	Not used	Not used	Not used	Used in base-case model	Used in base-case model	Not to use in BSP modeling; not to use for SS3 reference case
Decision reason	Use in sensitivity run because it has some desirable characteristics and has different trend from others, but area too small to be primary index	Multiple management changes likely affected catchability	Time-series is relatively short and some questions remain about the representativeness of recorded number of discards	Time-series is relatively short, especially since the index in the early period (2001-2003) should not be used due to incomplete sampling of effort	Large spatial and temporal coverage	Large spatial coverage	Too late to evaluate properly; overlapping in area and operation with HI index that shows similar trend; very small proportion of overall catch

Working papers need to include the following elements:

Fishery description	ISC/11/SHARKWG-1/05, ISC/11/SHARKWG-2/02, ISC/12/SHARKWG-1/02	ISC/11/SHARKWG-1/05, ISC/11/SHARKWG-2/02, ISC/12/SHARKWG-1/02	ISC/11/SHARKWG-1/06, ISC/13/SHARKWG-1/07	ISC/12/SHARKWG-1/15, ISC/13/SHARKWG-1/08	ISC/11/SHARKWG-2/10	ISC/11/SHARKWG-2/11	SC7 Clarke et al. paper
Analysis description	ISC/11/SHARKWG-2/02, ISC/12/SHARKWG-1/02	ISC/11/SHARKWG-2/02, ISC/12/SHARKWG-1/02	ISC/13/SHARKWG-1/07	ISC/13/SHARKWG-1/08	ISC/12/SHARKWG-1/07, 08, 09 ISC/12/SHARKWG-2/02 ISC/13/SHARKWG-1/03	ISC/12/SHARKWG-1/08, 09 ISC/12/SHARKWG-2/02 ISC/13/SHARKWG-1/03	SC7 Clarke et al paper
Treatment of outliers or data filtering	ISC/11/SHARKWG-2/02, ISC/12/SHARKWG-1/02	ISC/11/SHARKWG-2/02, ISC/12/SHARKWG-1/02	ISC/13/SHARKWG-1/07	ISC/13/SHARKWG-1/08			SC7 Clarke et al paper
Remarks			Discard rate is suggested to be higher than recorded by observers because CPUE is unexpectedly low	Negligible discard rate; more confidence in late compared to early time series due to higher coverage of effort sampling in the late period			Region 4 CPUE index seems unreasonable, so concern was raised about the methods as applied to region 2; Gulland index seems to indicate the vessels were avoiding the high CPUE areas for blue sharks

Population Trends in Pacific Oceanic Sharks and the Utility of Regulations on Shark Finning (Clarke et al. 2012)

Summary

This scientific paper was tabled as a background document for discussion by the SHARKWG. A long-term record of species-specific catches, sizes, and sexes of sharks collected by onboard observers in the western and central Pacific Ocean from 1995 to 2010 was analyzed. Relative to blue shark, the authors used generalized linear models to estimate population-status indicators on the basis of catch rate and biological indicators of fishing pressure on the basis of median size to identify trends. Standardized catch rates of longline fleets declined significantly for blue sharks in the North Pacific (by 5% per year [CI 2% to 8]). Combined, these results and evidence of targeted fishing for sharks in some regional fisheries heighten concerns for sustainable utilization. Regional regulations that prohibit shark finning (removal of fins and discarding of the carcass) were enacted in 2007 and are in many cases the only form of control on shark catches. The authors found little evidence of a reduction of finning in longline fisheries. The authors argue that finning prohibitions divert attention from assessing whether catch levels are sustainable and that the need for management of sharks should not be addressed by measures that are simple to implement but complex to enforce and evaluate.

Discussion

The WG recognized that the blue shark index for the north Pacific developed in this paper is delineated at the equator and is largely based on US longline data from Hawaii. The results presented in this paper are not inconsistent with the results that the SHARKWG has observed in the Hawaiian longline data. There is overlap with the data that the SHARKWG has used to develop one of the indices used in the BSP model, so it would be redundant to include more than one index based on the same data in any model runs. The other data contained in this paper are blue shark length data. From 1995-2010 there has been a decrease in size in some of the fisheries. However, the change in size cannot be interpreted without consideration of changes in catchability or selectivity.

Estimation Process of Abundance Indices for Blue Shark in the North Pacific (ISC/13/SHARKWG-2/02)

Summary

In this working paper (WP), we summarized previous WG papers (ISC/11/SHARKWG-2/09, ISC/12/SHARKWG-1/08, ISC/12/SHARKWG-1/07, ISC/12/SHARKWG-1/09, ISC/12/SHARKWG-2/02, and ISC/13/SHARKWG-1/03) relating to the estimation of abundance indices of blue shark in the North Pacific because there were many discussions under the ISC SHARKWG before agreement on the final indicies. The last WP which described the accepted abundance indices for stock assessment cited many WPs of studies conducted before the final one. The objective of this WP is to provide the estimation process of the time series of abundance indices including data preparation and standardized CPUE. The detail of each analysis was described in the original papers.

The abundance indices of blue shark were estimated for the period between 1976 and 2010 using logbook data of shallow sets of Japanese longliners registered to Hokkaido and Tohoku prefectures, which actively target blue sharks. Because only species aggregated shark catch data is available for the period before 1994, blue shark specific catch data is estimated for this period by the species specific catch data after 1993. In this estimation, season-area specific ratio of blue shark catch to the total shark catch is assumed to be the same for the period before 1994 and after 1993. The standardizations of CPUE were conducted separately for the period before 1994 and after 1993 as the quality of data are different between two periods. Japanese shallow longline operations target both swordfish and blue shark using the same gear configuration (hooks per basket), thus the annual percentile of swordfish CPUE of each set is incorporated into the model of CPUE standardization as an explanatory variable. Although the annual trend of the estimated abundance index was decreasing during the period of 1980 to 1989, a continuous increasing trend was observed during the subsequent period except in 2007 and 2008.

Discussion

The SHARKWG had already accepted the analyses outlined in this document and the derived indices for use in the BSP base case model. The WP paper had been requested in order to have a document that contained all the necessary details about developing the indices in order to support the assessment report. As an additional request, the WG asked that the nominal CPUE time series be added to Figure 4 in the WP. The SHARKWG also requested an additional figure with step-plots of the nominal and final standardized CPUE time series and all intermediary series, produced with sequential inclusion of predictor variables. The WP was updated and finalized by the end of the meeting.

Updated historical catches and standardized CPUE series of blue shark by Taiwanese tuna longline fisheries in the North Pacific Ocean (ISC/13/SHARKWG-2/05)

Summary

In the present study, the blue shark catch and effort data from observers' records of Taiwanese large longline fishing vessels operating in the North Pacific Ocean from 2004-2011 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 by a zero inflated negative binomial model. The best model for CPUE standardization included the predictors: year, quarter and area. The analysis of standardized CPUE showed a stable increasing trend for blue sharks. The standardized CPUE is multiplied by logbook effort to estimate historical catch prior to 2004.

Discussion

Based on presentations and papers describing methods for estimating the Taiwan's large longline catch at prior meetings, the calculated estimated catch had already been accepted by the WG. However, some suggestions were made that should be explored to improve the index and catch estimation for future assessments. The histogram of residuals for 2005 and 2011 had a bimodal distribution which might reflect area or season differences. An annual interaction term with area might remove this but it is not a critical or required improvement. Future research could investigate the dramatic spike in the catch per set that occurs in 2011. The SHARKWG requested histograms of residuals in addition to box plots for each predictor in Figure 5 of the Working Paper and a revised version was provided by the end of the meeting. The WG concluded the WP was good for describing the catch estimation procedures in support of the stock assessment.

6.0.c Parameterization issues

Priors for r and n in the BSP model: food for thought (Powerpoint presentation)

Summary

The priors for *r* (intrinsic rate of population growth) and *n* (shape parameter, which is directly related to B_{msy}/K) are highly influential in the BSP model and, in the preliminary base case model, were identical to the priors used in Kleiber et al. (2009). However, the WG should document that these priors are derived from Atlantic blue shark demographic analyses by Cortés (2002). If demographic analysis on north Pacific blue shark were available, the WG could review and consider using these as the priors instead of using values from Atlantic blue shark. Similarly, the current assumption that $B_{msy}/K = 0.5$, in the Schaefer model is a strong assumption that the WG should review, discuss, and document. Fowler (1988) presented a relationship between B_{msy}/K and *r* and *T* (generation time), which can be used to provide an initial parameterization for B_{msy}/K, albeit with uncertainty. Based on the values for *r* and *T* presented in Cortés (2002), the B_{msy}/K for blue shark in this assessment might be better represented by 0.47 instead of 0.5. However, since these values are relatively close, the WG would not be amiss to use 0.5 as the base case value but should document that demographic analysis suggests a highly similar value (0.47).

Estimate of the intrinsic rate population increase for the blue shark in the North Pacific (ISC/13/SHARKWG-1/04)

Summary

The intrinsic rate of increase (*r*) is an important and crucial parameter in fish stock assessment especially using the production model. In this study, the *r* of the blue shark in the North Pacific Ocean was estimated using a demography approach. The input parameters, collected from 3 studies, include the growth coefficient, longevity, fecundity, age at maturity, reproduction cycle, and natural mortality. The results of demographic analysis indicated that the *r* of blue shark ranges from 0.162 to 0.356 with standard error from 0.038 to 0.103. The results derived from this study can be used as the prior of Bayesian surplus production model of blue shark in the North Pacific Ocean.

Discussion

Using the Euler-Lotka model to estimate *r* for Pacific blue shark using biological parameter estimates and growth curve parameters for different regions of the north Pacific, the values of *r* were 0.35 (Northwest Pacific) to 0.162 (Northeast Pacific) and 0.356 (central North Pacific) if assuming a 2 year reproductive cycle. These estimates change to 0.453, 0.245 and 0.468, respectively, if a 1 year reproductive cycle is assumed. The California and central north Pacific growth curves are published, and the northwest Pacific growth curve was presented at the SHARKWG Age and Growth Workshop (Hsu et al. 2011, ISC/11/SHARKWG-2/INFO-02) and is being prepared for publication. These estimates of *r* fall within the range of inputs chosen for the base case and sensitivity runs. **The SHARKWG recommends that future research should investigate *r* estimations specific to the North Pacific once the northwest Pacific blue shark growth curve estimation is finalized and also include a range of methods to estimate natural mortality (*M*) and encompass the range of uncertainty in the biological parameters.**

Reliable growth curve estimates are required for estimating *M* and *r*, both of which are important parameters required for stock assessment models. **As such, the SHARKWG recommends continued research into resolving differences between growth curve estimates in the north**

Pacific and developing reliable growth curve estimates, particularly in the eastern Pacific region. In addition, given the differences in *r* estimates depending on the assumed reproductive cycle (i.e. 1 year vs. 2 years), **the SHARKWG recommends that future research focuses on collecting monthly samples of adult females to address this knowledge gap**. One source of samples might be the Hawaiian fishery observer program since that fishery typically encounters larger females.

At the January 2013 workshop the SHARKWG decided that $r = 0.34$ would be used in the BSP model to be consistent with the previous north Pacific production model assessment. This value is based on Cortés (2002) and is derived for north Atlantic blue shark. Use of this value in the north Pacific BSP model assumes that our north Pacific blue shark has similar demographics to the Atlantic blue shark. This assumption needs to be explicitly stated in the BSP model assessment document. Preliminary research with north Pacific blue shark life parameters (ISC/13/SHARKWG-1/04) confirms that 0.34 is a reasonable value. There is inadequate time to investigate the full range of growth curve estimates and life history parameter estimates in the north Pacific for calculating *r* using Euler-Lotka method or alternates (e.g. McAllister et al. 2001). **The SHARKWG recommends that future research should attempt to investigate alternate approaches using north Pacific life history parameter for *r* estimation. The SHARKWG confirms the use of 0.34 (SD 0.3) as the *r* priors for the BSP model since it is published in Cortés (2002); *r* sensitivity runs should use the range of uncertainty provided in Cortés (2002) and Babcock and Cortés (2009) which are from 0.14 to 0.43.**

Currently the BSP model is using $B_{msy}/K = 0.5$ as a Schaefer model to be consistent with the previous assessment. The SHARKWG agreed that using a shape parameter derived from a demographic analysis was an improvement, and decided that the base case of the BSP model will assume $B_{msy}/K = 0.47$ (derived from $r = 0.34$ and T). **Using the range for *r* in Cortés (2002) results in a calculated range of B_{msy}/K of 0.39 to 0.56, therefore the SHARKWG recommended that BSP sensitivity runs should use $B_{msy}/K = 0.3$ and 0.6.** In addition, a matrix comparison with B_{msy}/K and r varying concurrently was included in the sensitivity runs.

6.0.d Examination of model diagnostics and suggested further analysis

<u>Summary</u>

Results of the BSP stock assessment modeling conducted during the intercession were presented. Base case and all sensitivity runs were based on specifications in the January 2013 meeting report. The results indicated that the north Pacific blue shark stock decreased between the mid 1970's and the beginning of 1990s, turned to increasing afterwards, and recovered by the early 2000s to a level similar to that of the mid-1970s. Current stock level is well above B_{msy}, and current fishing mortality rate is less than F_{msy}. The results were relatively or modestly sensitive to some alternative assumptions: shape parameter (less than 2); low *r*; maximum and minimum catch scenarios; and Hawaii longline CPUE. All other sensitivity runs resulted in similar stock status to the base case. Future median projected blue shark biomass is above B_{msy} under status quo, +20% and -20% harvest policies.

<u>Discussion</u>

The WG thanked the lead modelers and Dr. McAllister for all their work conducted in advance of the workshop. It was noted that these preliminary results were based on an early base case definition, which has changed after the discussion in **Section 6.0.c** (priors for *r* and *n*). **The WG agreed to use an *r* prior with mean of 0.34 and SD = 0.3, and B_{msy}/K fixed at 0.47.**

Several improvements to the documentation were suggested. For example:

1) Tables of projection results for 5, 10, and 20 years should be produced in the report in addition to the figures shown;
2) The initial input CVs (CV = 0.2) of the indices before reweighting should be noted in the document;
3) The bounds on the uniform prior for log(*K*) should be noted;
4) There should be a comparison of the model fit between the base case model and the sensitivity run using the Hawaii LL index.

In addition, the WG suggested several additional sensitivity runs to do:

1) A grid of sensitivity runs that vary both *r* and B_{msy}/K at the same time should be performed using the following values: mean *r* = 0.34 (base), 0.14, and 0.43; and B_{msy}/K at 0.47 (base), 0.3 and 0.6, for a total of 8 sensitivity runs (excluding the base case run). These runs would replace the Fletch1, Fletch2, Fletch3, R1, and R1b sensitivity runs;
2) There should be a sensitivity run that only uses the priors and catch (i.e., not fit to the indices) in order to show the effect of using only the priors;
3) More runs were conducted and presented in subsequent days.

Some members of the WG proposed that a fishery impact analysis be performed. However, after some discussion, **the WG agreed not to perform a fishery impact analysis because it was difficult to separate the catch data into useful fishery components**. It was possible to separate the catch into Longline, Drift Gillnet, and Other fisheries. But since **it was obvious that the longline fisheries dominated the catch, the fishery impact would obviously be dominated by the longline fisheries.**

6.0.e Finalize model results, sensitivities and projections

<u>Discussion</u>

The WG reviewed and discussed the preliminary model results, sensitivities, and projections. After some discussion, three additional analyses were suggested: 1) provide statistical evidence on whether model fits degrade when using the Hawaii longline index instead of the Japanese longline late index; 2) retrospective analysis; and 3) model runs that are not fit to abundance indices (i.e., a priors only run).

It was suggested that a comparison of the root mean square error (rmse) of the fit to indices could be used as an indicator of model fit and estimated process error. However, the base case and the Hawaii sensitivity runs had different input CVs due to the reweighting process. Therefore, additional model runs using input CVs of 0.2 for all indices were performed on the base case and Hawaii sensitivity runs. For these additional runs, the rmse of both indices in the Hawaii sensitivity run were substantially larger than the base case run. This indicates that model fit was degraded, given the model structure, when the Hawaii longline index was used instead of the Japanese longline late index. **The WG therefore agreed that the Japanese longline late index is more statistically consistent than the Hawaii index.**

The WG suggested that a retrospective analysis be performed to investigate possible biases resulting from the terminal data and to support the choice of years to average for catch and F in the projections. Five retrospective model runs were performed, using the same model structure as the base case. For each run, an additional terminal year of data was removed prior to the model run, resulting in 1 to 5 years of data being removed. The retrospective analysis indicated that there was a slight overestimation of terminal biomass, but it was not substantial.

The WG discussed the referenced current year (2011) and whether that should be the starting year for projections because catch and effort during 2011 should be lower than normal due to the Great East Japan Earthquake. The BSP can technically only output the CV of parameters for the last year. The retrospective analysis results did not show substantial differences. In addition, the WG expects the influence of the earthquake to affect catch and effort for several years and that should be considered in the projection. **The WG agreed to use the average of years 2006-2010 for projections of status quo catch and F.**

The WG also recommended that a model run be performed using only the input priors and catch, without fitting to the abundance indices. This will allow the WG to evaluate the influence of priors by estimating the biomass trajectory of the model given only the priors and catch data. However, technical difficulties were encountered that would need the help of Dr. McAllister in order to overcome. **The WG recommended that the main modelers consult with Dr. McAllister to do this and complete this analysis before the ISC Plenary in July 2013.**

The WG drafted the assessment executive summary and all members agreed to the content provisionally. The conservation information may be modified based on the age structured model runs. The WG also reviewed several versions of the draft assessment report and agreed to the content. Some sections still need minor work, but the report will be completed by June 29, 2013.

7.0 AGE STRUCTURED MODELING OF NORTH PACIFIC BLUE SHARK

7.0.a Review of fishery data

The WG had previously reviewed 6 candidate indices for use in the BSP model and produced a table that compared the pros and cons of each index. This table was used to make the decision on which indices to use for the BSP base case and sensitivity runs. The WG revisited the table to discuss the indices to use in the age structured modeling (Table 1).

A**fter much discussion, the WG recommended that for the sensitivity runs, the SS model should use the entire range of candidate indices for various runs (not in the same run), so as to incorporate the entire range of uncertainty in the indices.** Care should be taken to not use indices together that have overlapping data.

The WG recommended that the SS model only use the Japan LL early and Japan LL late indices in the reference case run. These are the indices considered to be the most representative indices for the north Pacific blue shark stock and would maintain consistency with the BSP model, thus making it easier to compare the results of both models.

7.0.b Review of size data

The WG reviewed the size and sex data by fishery. The WG considered whether there were size and sex data for each fishery, and if not, which fishery was most similar to the fishery without size and sex data. **Based on this review, the WG assembled a table (Table 2) that provided the SS model with the representative size composition data to use for each fishery.**

Table 2. Size composition data available for the age structured modeling.

Fisheries	Size Data? (Y/N)	Fishery To Mirror
Mexico	some	
Canada: groundfish LL	N	avg size 21 kg applied
Canada: groundfish Trawl	N	avg size 21 kg applied
Canada: Salmon troll, Gillnet and Seine	N	avg size 21 kg applied
China	Y (some WCPFC data)	
Japan: Kinkai shallow (offshore; smaller boats)	Y	
Japan: Kinkai deep (offshore; smaller boats)	N	Enyo Deep
Japan: Enyo shallow (distant water; larger boats)	N	Kinkai Shallow
Japan: Enyo deep (distant water; larger boats)	Y	
Japan: large mesh driftnet EEZ	Y	
Japan: coastal longline	N	Kinkai Shallow
Japan: other longline	N	Kinkai Shallow
Japan: bait fish	N	Kinkai Shallow
Japan: trap net	N	Kinkai Shallow
Japan: other	N	Kinkai Shallow
Japan: squid driftnet	N	Kleiber Squid
IATTC	N	average wt by year provided
Korea	Y	
SPC non-ISC longline	Y	
USA: drift gillnet	Y	
USA: sport total	N	USA Drift Gillnet
USA: longline	Y	
Taiwan: large longline	Y (+ some WCPFC Data)	
Taiwan: offshore small longline	Y	
Driftnet (Kleiber): DF large mesh (Japan and Taiwan)	Y (no sex data)	
Driftnet (Kleiber): DF small mesh (Japan and Taiwan)	Y (no sex data)	(same as Japan Squid Driftnet)

It was reported that there was a source of blue shark size composition data from Japanese experimental longline cruises targeting salmon shark and driftnet cruises targeting pomfrets. Preliminary size compositions from this data source were presented to the WG. This presentation showed that there might be unrepresentative size data included in this data source. In addition, since the operations of these experimental cruises are likely different from commercial operations, and that there was not enough time for review and quality control of these data, **the WG recommended that these size data should only be used for sensitivity runs if they can be provided, after some examination by the Japan scientists, and should not be used for the reference case run.** Sex is not available in the Kleiber data for the high seas squid driftnet fishery, so these experimental data could be useful.

Size composition data from WCPFC members (e.g., China, South Korea) were reported to the WG and examined. **After some discussion, the WG recommended that the SS modelers use any additional size and sex data that the WCPFC observer program holds and that those data should be distributed with all the other input data to WG members interested in helping with the SS modeling. The WG also requests regular updates of relevant progress**

from the SS modelers. Correspondence should include WG members Takahashi, Kai, Sippel, Kanaiwa, Tsai, Chin, Liu, King, Rice and Piner.

7.0.c Reference case parameterization

The WG reviewed and discussed the parameterization to be used in the age-structured model, especially the life history parameters. Because the BSP model used a productivity assumption based on the previous assessment that was shown to be consistent with the current state of knowledge of blue sharks in the North Pacific, the WG had not decided on specific values for some of the life history parameters needed for the age structured modeling. The WG acknowledged there is still uncertainty in many of the life history parameters.

The WG reviewed an analysis of the length-weight, and total length-alternate length conversion models, that takes into account seasonal and gender effects. The analysis showed that there were statistically significant seasonal and gender effects but the resulting models were not biologically significantly different with the previously agreed models. **The WG therefore agreed to use the current length-weight and length-length conversion models for the SS model**.

The WG also reexamined the growth curves to be used in the SS model. After reviewing multiple available growth models, **the WG agreed to use either growth model by Nakano (1994) or Hsu et al. (2011) for the reference case, and in addition choose alternative L_{inf} values for sensitivity runs.**

Table 3. Recommended blue shark life history parameters to use in the SS3 reference case and for sensitivities.

Blue Shark Life History Characteristics	SS3 input assumption	SHARKWG most/more plausible	Cortés (2002) – to mimic BSP model reference case
Gestation	1 yr		
Breeding frequency	1 or 2		biennial
Sex ratio at birth	1 to 1		
Litter size	1 to 54	25-30, with no relationship between number of pups and female size	37 (SD 14.6) range 4-75 pups per litter
Length at birth	40 to 50 cm FL		
Length at 50% maturity	F: 185-212 TL	193 cm TL	
Age at 50% maturity	F: 5-7 years		5 (triangular distribution 4-6; age at maturity)
Maximum length	380 cm TL		327 cm TL
Longevity	20		16 (empirical); 21 (empirical +30%)
Length conversions	PCL=0.748*TL+1.063, n=497, R^2=0.94, size range = 98-243 cm PCL; PCL=0.894*FL+2.547, n=497, R2=0.98		

Length-weight relationship	Wt=4.2x10^{-6}*PCL$^{3.1635}$, where weight is in kg and PCL in cm		
Growth models	Nakano 1994 and Joung, Hsu, Liu and Wu 2011 (use one with a lower L_{inf} for sensitivity)		
Natural mortality (M)	0.06 to 0.39	0.2	1-(0.76 to 0.85); survivorship calculated based on 4 methods - age specific survivorship range 0.61-0.94

The WG reviewed the map showing the spatial extent of fisheries to determine their accuracy. Some discrepancies were noted and **the Chair agreed to provide a revised version for the assessment report that has some boundary changes for Taiwan small longline, Hawaii longline and Japan Kinkai longline fisheries.**

While reviewing information for the age structured modeling, it was apparent that there remain many uncertainties regarding blue shark life history characteristics. The WG identified the following high priority research needs.

Blue Shark Research Recommendations

- Continue research on temporal, spatial and environmental effects on historic and current blue shark catch rates in order to improve CPUE and catch estimation procedures.
- Improve documentation of catch for foreign flagged vessels landing in member nation ports to ensure accurate accounting of all catch.
- Determine post-release survival for different fleets, seasons and areas based on available information and prioritize new studies if needed in order to accurately estimate dead removals.
- Continue age and growth studies to resolve apparent regional differences.
- Continue research on female reproductive maturity to resolve uncertainty in breeding frequency.
- Prioritize monthly collections of adult females that represent the greatest gap in data needed for age and growth and maturity studies.
- Investigate *r* estimations specific to the North Pacific; include a range of methods to estimate *M* and encompass the range of uncertainty in biological parameters.

7.0.d Potential sensitivity runs and projections

The WG agreed that the SS modeling team should include and document any additional sensitivity runs and information that is important.

7.0.e Plan for use of SS3 model and WG paper

There was much discussion about the appropriate use of the WG data for a fully integrated stock assessment model of north Pacific blue shark. The WG had not prepared the assessment data with the intent of using them for a fully integrated model, thus the definition of fisheries and a careful examination of the size and sex specific catch has not been conducted. Similarly, all potential abundance indices were not evaluated for use in a more complex model. Results of the SS modeling should be treated as preliminary and exploratory until the group has a chance to carefully review the size and sex compositions of the catch by fishery, area and season with a plan to define fisheries for use in a future age structured model.

Some members of the WG expressed concern that the possible inconsistency in the assessment results between the BSP and the SS model. If there are large differences in the results, the WG may find it difficult to explain the results. **As was previously agreed, the WG reiterated that it is important to base the conservation advice primarily upon the BSP model. Results of the SS3 model will be reviewed in July and the conservation information developed can take into account any new information based on the SS modeling. In addition, the WG also agreed that the Chair and WG participants of the ISC Plenary and SC meetings will make their best effort to ensure that the results of stock assessments complement each other with respect to conservation information.**

There is the possibility of use of the output data from the assessment in projections to evaluate harvest strategies, but **the WG agreed that the SS input data are not to be used for further analysis outside the ISC SHARKWG.**

The SPC representative stated his understanding of the process around the development and finalization of the SS3 assessment for North Pacific blue shark. The reference case model would include CPUE and catch inputs chosen so that the SS model is comparable to the BSP model. The life history parameters chosen would aim to approximate the shape parameter of the base BSP model. SPC would also undertake a range of sensitivity analyses, in particular, several model runs relating to alternative CPUE abundance series and life history parameters reviewed by the ISC SHARKWG. The reference case model would be used for the purpose of presenting results and diagnostics. SPC noted that the WCPFC Scientific Committee would likely take its own decision as to which model(s) and run(s) to use to develop its management advice (referred to as base case model(s)) as it has done with other assessments. Finally SPC will work within the ISC SHARKWG to have a single paper describing the SS3 assessment to be submitted as both an ISC SHARKWG document and for the WCPFC SC meeting.

8.0 SHORTFIN MAKO SHARK INFORMATION GATHERING

8.0.a Review life history matrix, identify information gaps and high priority work assignments

The WG life history specialists updated the latest version of the Life History Matrix for shortfin mako sharks and presented the findings to the WG. Although the WG is not aware of any new papers on shortfin mako shark life history, additional information was reported about the validation of growth band pair deposition.

The progress of age and growth studies in the North Pacific was introduced and discussed. Wells et al. (2013), which was previously reviewed by the WG (ISC/11/SHARKWG-2/06), provided the information of the age validation of juvenile shortfin mako tagged and marked with OTC off southern California and supportive information from analysis length frequency and tag-recapture data. In comparison with the study from central and western North Pacific, the difference in the interpretation of growth band pair potentially due to different enhancement techniques was discussed. There are discrepancies in the interpretation of the periodicity of growth band pair deposition i.e. 1 vs. 2 bands annually. Studies that previously validated 1 annual band pair deposition (Natanson et al. 2006; Ardizzone et al. 2006) included larger size sharks, hypothesizing ontogenetic changes in the deposition of bands. **It was ascertained that progress of cross-reading using samples from USA and Japan is urgent for clarification of this problem.** Cross validation is occurring in these age studies, and the results will hopefully be presented in July.

Several shortfin mako shark growth curve problems were discussed. The growth curves cited from each existing paper were put into one figure after being standardized to PCL. It was suggested that the original data would be needed and should be converted to PCL to develop directly comparable error distributions. Problems arising from converting existing growth curves to PCL were acknowledged as well as complications due to the use of various enhancing methods. **The SHARKWG endorsed a shortfin mako ageing workshop to address outstanding issues. The Chair will follow up with the national age and growth specialists regarding participation, prioritization and scheduling.**

Other discussion revolved around the priorities for determining the reproductive cycle and other life history characteristics.

The WG asked that if the most important thing was the collection of larger sharks, and large females in particular, would each nation be able to request samples through existing observer and research programs. It was agreed that **a sampling collection protocol for shortfin mako shark gonads and vertebrae should be developed in order to insure standardization across fleets**.

Discussion of the length-length and length-weight relationships are very close based on the data presented. A data exchange and comparison will take place and the conclusions will be distributed within 30 days.

Table 4. Key life history parameters for shortfin mako sharks in the North Pacific. The information below represents what was identified by WG participants as of April 24, 2013 as the best available information, although uncertainties and omissions were highlighted for further work. More comprehensive tables including references, regions, and sample sizes among other details of the studies will be maintained by the SHARKWG Chair for use by WG members.

Shortfin Mako Shark Life History Characteristics	A: Known with high confidence	B: Known with moderate confidence	C: Highly uncertain
Reproduction	Aplacental viviparity with oophagy - A mother gives birth to live young that initially develop in a yolk sac then feed on a continuous supply of uterine eggs after yolk is depleted.		
Gestation			9-25 months
Breeding frequency			2 or 3 years
Sex ratio at birth	1 to 1		
Litter size	range 4-25; average 12 (there's some evidence of increasing number with female size)		
Length at birth	70-74 cm TL		
Length at 50% maturity		Males: 180-210 cm TL	Females: 278-307 cm TL
Age at 50% maturity			Males: 5-9 years, Females: 17-21 years; depends upon band deposition periodicity
Maximum length	378 cm TL		
Longevity			Males 9-31 years, Females 18-41 years; depends on band deposition periodicity
Length conversions	TL=(FL+0.397)/0.913 AL=(FL-9.996)/2.402 TL=(PCL-0.784)/0.816 TL=(FL-0.952)/0.89		
Length-weight relationship *	All: $Wt(kg)=1.103 \times 10^{-5}\ FL^{3.009}$ All: $Wt(kg)=1.1 \times 10^{-5}\ TL^{2.95}$ M: $Wt(kg)=2.8 \times 10^{-5}\ TL^{2.771}$ F: $Wt(kg)=1.9 \times 10^{-5}\ TL^{2.847}$		
Growth models *			All: $FL_t= 292.8[1-e^{-0.072(t+3.75)}]$ All: $FL_t = 375.4[1-e^{-0.05(t+4.7)}]$ M: $FL_t= 321.8[1-e^{-0.049(t+6.07)}]$ F: $FL_t= 403.62[1-e^{-0.040(t+5.27)}]$ M: $TL_t= 332.1[1-e^{-0.056(t+6.08)}]$ F: $TL_t= 413.8-[(413.8-74)e^{-0.05t}]$ M: $PCL_t=231.3[1-e^{-0.156t}]$ F: $PCL_t=308.6[1-e^{-0.090t}]$

* a number of studies have been conducted in the North Pacific and these will be compared to choose the appropriate ones for use by the SHARKWG

Global genetic population structure and demographic history of shortfin mako (Isurus oxyrinchus) inferred from mitochondrial DNA. (ISC/13/SHARKWG-2/03)

Summary

Global genetic population structure of shortfin mako was examined using a total of 649 whole sequences in mitochondrial cytochrome b region of shortfin mako to contribute the decision of management unit of this species in the North Pacific Ocean. Five population genetic analyses, SAMOVA, AMOVA, pairwise conventional F_{st} and Φ_{st} estimates, and an exact test of haplotype frequency, indicated the genetic structure of shortfin mako with a maximum genetic differentiation between the North Atlantic, and the Indian and Pacific Ocean. These analyses also showed at least two sub-stocks, the Indian Ocean and the Pacific Ocean, within the Indian and Pacific Ocean group. Additionally, pairwise conventional F_{st} and an exact test of haplotype frequency suggested a weak genetic structuring of this species within the Pacific Ocean with at least three genetic stocks, the western and eastern South Pacific and North Pacific Ocean. Furthermore, three phylogeographic analyses, parsimony network of haplotypes, neutrality tests and mismatch distribution analysis, inferred the range expansion of shortfin mako from the Pacific to the North Atlantic Ocean through the Indian Ocean with sudden population growth in the past. Overall results suggested that the population history of this species should be one of the factors which had an influence on their genetic population structure as well as other marine taxa.

Discussion

These preliminary results confirm previous studies that suggest that there is a single north Pacific stock. The stock structure in the south Pacific may be defined as two stocks, east and west. The results presented based on mtDNA (which reflects maternal lineage) confirm previous studies that suggest an east-west delineation in the south Pacific. However, preliminary results presented here based on nuclear DNA did not detect this same delineation. Taken together these suggest that males might move more widely throughout the Pacific than females. The SHARKWG concluded that stock management of shortfin mako in the Pacific could benefit from a 3 area management perspective. **The SHARKWG recommends using a stock boundary between the north and south Pacific and that the assessment would be conducted on the NPO stock. This is most consistent with the genetics and tagging information and reflects appropriate stock units for management.** One issue that may be difficult is that there is significant shortfin mako shark catch around the equator in the EPO, which may not have a clear definition of a north-south boundary.

8.0.b Review fishery metadata table

After review, the SHARKWG noted that the majority of the fisheries will have similar data to those used for blue shark. The SHARKWG discussed the potential movement of fishery effort from west to east due to changing the target from swordfish (winter) to blue shark (summer).

8.0.c Discuss fishery and size data availability

Preliminary review of catch and effort data of shortfin mako shark caught by Japanese offshore and distant-water longliners in the period between 1994 and 2012. (ISC/13/SHARKWG-2/06)

Summary

Japan mandated a new logbook system for Japanese offshore and distant-water longliners in 1994 which requires reporting of shortfin mako shark landings. Though this information does not contain information on discards, some useful information about this species could be extracted. This study summarized the information of shortfin mako shark in this logbook data. The results of analysis in this study suggest that continuous data are available in the subtropical/temperate region in the northwest Pacific and some better coverage of data exists in the central North Pacific. The quality and quantity of catch and effort data are better in the earlier years, but it is not as good as those of blue shark.

Discussion

The most consistent catch has been in the north off of Japan, although the effort distribution has changed. Catch and effort data differs by area with the majority of the catch occurring in the Eastern Tropical Pacific. The effort has declined over twenty years. In the north, the majority of the catch is by surface fisheries (3-4 hooks between floats; HBF) while previously it was a bit deeper (7 HBF), but further south most of the catch is deeper. Some catch and effort data exists but operational changes in space overtime may complicate the utility of this data.

The SHARKWG wondered if there was a high level of retention of shortfin mako, and if so was the logbook data in need of filtering due to poor record keeping. Japan replied that the shortfin mako is mostly a bycatch species, not a target species, and most are retained because of high market value. The data in this Working Paper only contains information on unloaded fish, so just landings and not discards. The coverage rate is quite high, almost 100%. In 2013 the logbook catch includes landings and discards, and skipper notes describing the catch and discards also began in recent years.

Distribution pattern of shortfin mako (Isurus oxyrinchus) caught by Kesennuma offshore longline fleets (ISC/13/SHARKWG-2/07)

Summary

The distribution pattern of shortfin mako was examined in relation to the environmental factors, on the basis of the size data collected by the Kesennuma offshore longline fleet. Size and sex data, with location and date, were collected between 2005 and January 2013 and data from 60,769 individuals were used. It was suggested that the main component of catch was individuals smaller than 200 cm (PCL) and these individuals were extensively distributed in the Kuroshio Current, Kuroshio Extension and the Transition area. An ontogenetic shift of distribution was suggested to occur - from waters off Japan (<100 cm) to western or southern areas (≥100 cm). Strong evidence of a sexual difference in the distribution pattern and environmental preference was not found within the size range used here. However, considering that the number of records of adult females was very small, segregation of this component outside the fishing ground of this fleet and/or an ontogenetic change of catchability may occur. Further investigation is necessary to clarify the distribution pattern of this species throughout its life span.

Discussion

The SHARKWG considers these very valuable size and sex data for shortfin mako shark. The SHARKWG wondered if there was adequate information to relate to the hypothesized size and sex distribution model with regards to identifying pupping and mating grounds and pregnancy areas. Japan clarified that these data are limited to 20°N and higher, and are based on skipper notes. Combining this information with data from the Taiwan fisheries that operate in the lower latitudes will be valuable. Hypotheses on shortfin mako shark size and sex distribution could be addressed through ongoing tagging studies and further collections of catch by size and sex in lower latitudes. A Pacific-wide size and sex distribution study would also be useful.

The WG recognized that previous WG papers describe fishery information on shortfin mako sharks but that once the focus shifted to completing the blue shark assessment, the WG did not routinely carry out further shortfin mako shark data compilation. **The Chair agreed to prepare a metadata table regarding the working papers for shortfin mako sharks to help the group review the information previously provided and minimize requests to submit redundant information.**

8.0.f Develop shortfin mako shark assessment workplan

The Chair introduced a draft workplan for completion of a north Pacific shortfin mako assessment prior to the 2014 ISC Plenary.

Some WG members questioned the 'ambitious schedule' given the fact that the BSH SS model is not yet complete and the priority in July is now to finalize the BSH conservation information for the Plenary after reviewing the SS model. After much discussion about the scheduling, the WG decided to focus on the spatial pattern of shortfin makos by size and sex at the July meeting. This will help the WG see the amount of size data available and whether there are strong patterns that may need to be taken in account. The WG could then make a decision about the potential modeling approach to be used and establish data submission needs. The draft workplan was amended to reflect this.

Shortfin Mako Shark Assessment Work Plan (April 24, 2013)

In advance of the July 2013 meeting:

1. Compare prior L-L and L-Wt conversions with raw data submitted. *(Tsai)*
2. Each nation compile summarized size and sex data in PCL for review at July meeting *(all WG members and observers)*
3. Life history specialists continue to update life history matrix based on prior studies and continue work on high priority biological studies including cross validation of vertebrae from the Wells et al. (2013) and Semba et al. (2009) studies (*Semba, Liu, Kohin*)
4. Chair works with SPC and IATTC, other national delegation leads, and other species WG Chairs to come up with effort, catch and/or size data for fisheries with non-reported catch (*Kohin*).
5. Chair to contact national age and growth specialists about progress on collecting reference vertebrae for blue and shortfin mako sharks and interest in follow-up Age and Growth Workshop (*Kohin*).
6. Chair to review prior WG papers and prepare a meta-data spreadsheet identifying papers that contain fishery information on shortfin mako sharks *(Kohin)*

July 6-8 and 11, 2013 meeting (Busan, Korea)

1. Review information on the size and sex composition of shortfin mako sharks
2. Review progress on biological studies and prioritize studies based on assessment needs and greatest uncertainty
3. Tentatively decide on modeling approach given information on stock structure

4. Decide on area stratification to use for submission and compilation of catch and size data.
5. Develop data submission templates and establish submission deadlines
6. Develop plans and assignments for Second Age and Growth Workshop
7. Revise assessment workplan if needed

ISC SHARKWG Second Age and Growth Workshop (tentative objectives)

1. Compare results of cross validation for shortfin mako vertebral counts (*Semba, Wells*)
2. Compare results of reference vertebrae collection readings for shortfin mako and blue shark (prioritizing shortfin mako work for upcoming assessment)
3. Develop process for combining raw data given the results of the reference collection comparisons
4. Combine raw data based on regional and/or sex-specific growth hypotheses
5. Propose candidate growth curve(s) for shortfin makos for use in the stock assessment

Winter 2013/2014: final data prep meeting (tentatively in Mexico or the US)

1. Review and agree upon all data and procedures to estimate catch and abundance indices.
2. Review and accept catch estimation procedures for non-reporting fleets.
3. Finalize life history parameters to use for assessment.
4. Review and accept size data and definition of fisheries.
5. WG modelers provide proposal(s) for base case run, sensitivities, and projections.
6. Conduct and review preliminary runs.

Late April 2014: shortfin mako shark assessment meeting (location TBD)

1. Conduct and review base case assessment modeling (subgroup meeting in advance of WG meeting if needed).
2. Conduct and review sensitivity results.
3. Conduct and review future projections.
4. Develop stock status conclusions and conservation information.
5. Prepare assessment report.

The WG also discussed ongoing research priorities in the context of the shortfin mako shark life history data gaps and stock assessment needs and came up with the following list of research recommendations.

Shortfin Mako Shark Research Recommendations

- Conduct/continue research on the temporal and spatial distribution of shortfin makos by size and sex.
- Conduct tagging studies to help determine the movements and distribution of mature individuals since few are caught.
- To address differences in age and growth studies, conduct cross-reading of vertebrae samples from USA and Japan.
- Convene the second ISC sponsored shark age and growth workshop.
- Continue research on female reproductive maturity to resolve uncertainty in breeding frequency.
- Develop a sampling collection protocol for shortfin mako shark gonads and vertebrae in order to insure standardization across fleets.

- Prioritize monthly collections of adult females that represent the greatest gap in data needed for age and growth and maturity studies, particulary from lower latitudes.
- Continue genetics studies.
- Continue studies on size conversions.

9.0 FUTURE SHARKWG MEETINGS

The next WG meeting will be held July 6-8, and 11 in Busan, Korea during which the blue shark SS3 model will be reviewed and the conservation information finalized for the Plenary. Additional goals are to finish other work for the Plenary and to review shortfin mako shark size and sex composition information to help plan for the shortfin mako shark assessment. The WG has tentatively agreed to a winter meeting for shortfin mako shark data prep and a spring meeting to complete the shortfin mako shark assessment. The meeting schedule will be revisited at the July meeting after plans for the shortfin mako shark assessment are further developed.

10.0 OTHER MATTERS

10.0.a Data submission

The Chair expressed frustration regarding the failure in many cases of WG members to submit data and other requested information by the deadlines agreed to and within the templates provided. While delays in submitting data may be unforeseeable given the challenges associated with the need to recreate catch due to the lack of reliable shark data, she requested that members make every effort to respond to WG requests using the templates provided and make every effort to adhere to the deadlines. Complications associated with some of the delays and the short decision to conduct the SS modeling have resulted in an extraordinary schedule this year including the need to meet for many days in July. The WG does not want to continue with such a scheduling situation in coming years.

11.0 CLEARING OF REPORT

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

12.0 ADJOURNMENT

The Chair thanked all participants for attending and contributing to a very productive meeting. She also thanked the NRIFSF hosts their generous hospitality and for assisting with logistics throughout the meeting.

The meeting was adjourned at 14:50, April 24, 2013.

13.0 LITERATURE CITED

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Attachment 1: List of Participants

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Attachment 2. Meeting Documents

WORKING PAPERS

ISC/13/SHARKWG-2/01	Catches of blue sharks from U.S. West Coast recreational fisheries during 1971-2011. Tim Sippel and Suzy Kohin (tim.sippel@noaa.gov)
ISC/13/SHARKWG-2/02	Summary of estimation process of abundance indices for blue shark in the North Pacific. Yuko Hiraoka, Minoru Kanaiwa and Kotaro Yokawa (yhira@affrc.go.jp)
ISC/13/SHARKWG-2/03	Global genetic population structure and demographic history of shortfin mako (*Isurus oxyrinchus*) inferred from mitochondrial DNA. Mioko Taguchi and Kotaro Yokawa (tagu305@affrc.go.jp)
ISC/13/SHARKWG-2/04	Estimate of the intrinsic rate population increase for the blue shark in the North Pacific. Chien-Pang Chin and Kwang-Ming Liu (kmliu@mail.ntou.edu.tw)
ISC/13/SHARKWG-2/05	Updated historical catches and standardized CPUE series of blue shark by Taiwanese tuna longline fisheries in the North Pacific Ocean. Wen-Pei Tsai and Kwang-Ming Liu (kmliu@mail.ntou.edu.tw)
ISC/13/SHARKWG-2/06	Preliminary review of catch and effort data of shortfin mako shark caught by Japanese offshore and distant-water longliners in the period between 1994 and 2012. Kotaro Yokawa (Yokawa@fra.affrc.go.jp)
ISC/13/SHARKWG-2/07	Distribution pattern of shortfin mako (*Isurus oxyrinchus*) caught by Kesennuma offshore longline fleets. Ko Shiozaki, Yasuko Semba and Kotaro Yokawa (senbamak@affrc.go.jp)

INFORMATION PAPERS

ISC/13/SHARKWG-2/INFO-1	Unofficial blue shark catches estimations for the Mexican Pacific (1976-2011). Oscar Sosa-Nishizaki (ososa@cicese.mx)

Attachment 3. Meeting Agenda

16-24 April, 2013
National Research Institute of Far Seas Fisheries
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Meeting will start at 10:00am on April 16 and at 9:00am everyday thereafter unless otherwise arranged.

1. Opening of SHARKWG Workshop
    a. Welcoming remarks
    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 the January 2013 Workshop (*Kohin*)
6. Bayesian Surplus Production Modeling of north Pacific blue shark
    a. Outstanding issues with catch time series (*King*, *Semba*)
        - Review of Mexico catch time series paper
    b. Outstanding issues with CPUE time series (*King, Semba*)
        - Review of Clarke et al. abundance index
        - Review of Clarke et al. Cons. Bio. paper
    c. Parameterization issues (*King*, *Kai*)
    d. Examine model diagnostics and conduct further analyses if needed (*Teo, Hiraoka*)
    e. Finalize model results, sensitivities and projections (*Teo, Hiraoka*)
    f. Formulate conservation information considering model uncertainty
    g. Develop/finalize assignments to complete assessment report
    h. Finalize all supporting WG papers for assessment time series
7. Age-structured modeling of north Pacific blue shark (*Semba, Kai*, *Teo*)
    a. Review fishery data
    b. Review size data
    c. Discuss base case parameterization
    d. Discuss potential sensitivity runs and projections
    e. Develop plan for use of SS3 model and WG Report
8. Shortfin mako shark information gathering (*Rice, Tsai*, *Chin*)
    a. Review life history matrix, identify information gaps and high priority work assignments
    b. Review fishery metadata table
    c. Discuss fishery and size data availability

d. Discuss preliminary model choices
e. Establish data submission templates and deadlines
f. Develop shortfin mako shark assessment workplan
g. Age and growth progress, planning

9. Future SHARKWG meetings (*Kohin*)

10. Other matters (*Kohin*)
a. Data submission

11. Clearing of report

12. Adjournment