FINAL

ISC/19/ANNEX/05

ANNEX 5

19th Meeting of the
International Scientific Committee for Tuna
and Tuna-Like Species in the North Pacific Ocean
Taipei, Taiwan
July 11-15, 2019

REPORT OF THE BILLFISH WORKING GROUP WORKSHOP

July 2019

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Annex 05

REPORT OF THE SHARK WORKING GROUP WORKSHOP

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

January 14-21, 2018
Honolulu, Hawaii, USA

1. OPENING OF THE WORKSHOP

1.1 Welcome and Introduction

An intercessional workshop of the Billfish Working Group (BILLWG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) was convened in Honolulu, Hawaii, USA, during January 14-21, 2019. The goal of this workshop was to prepare fishery data for the stock assessment of Western and Central North Pacific striped marlin in 2018 including catch by quarter data, standardized catch-per-unit effort (CPUE), size composition data by quarter, tagging data, and life history parameters.

Hirotaka Ijima, Vice Chair of the BILLWG, welcomed participants from Chinese Taipei, Japan, and the United States of America (USA). (Attachment 1). The Vice Chair noted that Jon Brodziak, the Chair of the BILLWG, Annie Yau and Felipe Carvalho of the USA delegation and Shane Griffiths of the IATTC were not be able participate in this meeting due to the USA federal government funding lapse. The Vice Chair also noted that there were no meeting participants from China or Korea. Canada and Mexico did not participate because their catches of WCNPO striped marlin were considered to be negligible.

1.2 Adoption of Agenda and Assignment of Rapporteurs

Rapporteuring duties for the working group (WG) were assigned to Yi-Jay Chang, Hirotaka, Ijima, Minoru Kanaiwa, Akira Kurashima and Michelle Sculley. The meeting agenda was adopted on January 14, 2019 (Attachment 2).

1.3 Computing Facilities

Computing facilities included a Google drive named "ISC BILLWG" for the distribution of working papers (WPs) and other meeting documents and the transfer of other information as well as a Wi-Fi wireless network access point for connection to the Internet.

1.4 Distribution of Working Papers and Status of Assignments

Working papers were distributed and numbered (Attachment 3) and it was agreed that all finalized working papers would be posted on the ISC website and made available to the public, except for working papers 9 and 11 (Attachment 3) by Ijima and Kanaiwa and Kurashima et al. which were considered to be novel research that could be publishable as journal articles.

The work assignments to be addressed at the January 2019 workshop were as follows:

- Submit all outstanding catch, CPUE, and size composition data for the Western and Central North Pacific striped marlin stock assessment to the BILLWG Chair.

- Provide draft working papers, noting that all working papers submitted at this meeting will need to be finalized by February 15, 2019.

- Prepare information, as needed, to make any corrections to the Western and Central North Pacific striped marlin catch, CPUE, and size composition data table for the April 2019 BILLWG stock assessment meeting.

The ISC BILLWG Chair reported that the assignments for submitting all catch, CPUE, and size composition data for the Western and Central North Pacific striped marlin assessment were mostly completed, to the extent practicable, through working paper presentations and personal communications. The Vice Chair noted that Japan and Taiwan would need to submit their finalized fishery catch, CPUE, and size composition data in electronic format to the BILLWG Chair by February 15, 2019. The Vice Chair also noted that some ISC member countries did not submit any new striped marlin fishery data for 2014-2017. **The WG noted that all data and working papers were expected to be submitted to the Chair and uploaded to the Data folder Google drive in electronic format by February 15, 2019.**

2. REVIEW OF RECENT BILLFISH FISHERIES

Two working papers and two oral presentations on the topic of a review of recent billfish fisheries were presented to the WG by Sculley, Kurashima, Chang and Ijima. The WG reviewed the working papers and presentation and discussed the information with each presenter.

U.S. commercial fisheries for marlins in the North Pacific Ocean. Michelle Sculley (ISC/19/BILLWG-1/1)

This report summarizes historical trends and recent developments for U.S. commercial fisheries taking marlins and related billfish species (*Istiophoridae*) in the North Pacific Ocean. Five species of marlins are caught by U.S. commercial fisheries in the North Pacific Ocean. These are striped marlin (*Kajikia audax*), blue marlin (*Makaira nigricans*), shortbill spearfish (*Tetrapturus angustirostris*), sailfish (*Istiophorus platypterus*), and black marlin (*Istiompax indica*). The first two species are predominant in the commercial landings. The description of fisheries in this report will serve as background information for stock assessment and standardization models developed in the ISC Billfish Working Group.

Category I catch statistics refer only to the quantity of fish kept and landed. Catch that was discarded or released was not included. Several sources of fisheries dependent data for the longline, troll, and handline fisheries are collected by Federal, State of Hawaii, and Pacific Island agencies from Guam and CNMI and used in combination by staff of the NOAA Pacific Islands Fisheries Science Center. The duration and coverage (i.e., percent of catch reported) varied amongst the different data sources.

Estimated catches are reported in this paper as whole weights. Some fish were landed whole while others were processed out at sea, e.g., headed and gutted or gilled and gutted. The recorded weight of individual processed fish was adjusted by applying a conversion factor depending on the degree of processing. This step increased the nominal weight of processed catch to an estimate whole weight to account for the weight loss. Likewise, to account for missing market sample days, the sample data were extrapolated to represent full coverage to estimate total landings.

Discussion

The WG noted that the U.S. catch of striped marlin was predominantly caught as bycatch in the Hawaii longline fishery targeting tunas. Effort in this fishery has shifted slightly eastward in recent years.

The WG discussed the treatment of striped marlin discards in the Hawaii longline fishery. It was noted that Walsh et al. (2007) found that discards accounted for about 11% of the striped marlin catch by weight and also that species misidentifications of striped marlin as blue marlin accounted for about 18% of the catch weight. The WG discussed how to account for discards and misidentifications in the benchmark stock assessment. It was suggested that the corrected U.S. catch data from the previous WCNPO striped marlin assessment be used in the 2019 assessment and that more recent catch data be adjusted to account for discarding and misidentifications. **The WG agreed to conduct some sensitivity analyses to account for the probable range of discarding and misidentifications of striped marlin for all fleets, noting that while U.S. catches were underreported other fleets may be over-reporting catch.**

The WG recommended that discarding and species misidentification data for striped marlin and other billfishes be collected.

The WG discussed the differences in striped marlin size distribution among the longline, troll and handline fishing gears. The WG thought that the existing differences might come from differences in sample size or seasonality by fishing gear. **The WG agreed that only the U.S. longline size composition data will be used in the assessment.**

Preliminary genome-wide population analysis of swordfish Xiphias gladius Linnaeus, 1758. Akira Kurashima (ISC/19/BILLWG-1/11)

Swordfish is an important aquatic resource, and knowledge about genetic population structure is necessary for its stock assessment and management. Many genetic studies have been conducted for this species using a small number of genetic markers but there is no consensus on their population structure. This discordance has resulted from the effect of sampling bias owing to insufficient genetic marker sampling. Therefore, genome-wide single nucleotide polymorphism analysis was performed in this study to eliminate potential sampling bias. A total of 460 loci were obtained in this analysis. Three ancestral genetic factors were found in swordfish genome. Atlantic individuals mostly had a single genetic factor. Another two genetic factors were mainly found in Indo-Pacific waters but there were no geographical patterns. These results showed that the population structure of swordfish breaks between Indo-Pacific and Atlantic waters and no genetic difference exists in Indo-Pacific water. Since single specimens caught from Pacific waters had more than half of the Atlantic factor, it may be that Atlantic-factor individuals infrequently migrate to Indo-Pacific waters. For robust stock assessment, it is necessary to understand the population structure based on fine-scale analysis.

<u>Discussion</u>
The WG noted the individual swordfish may undertake long distance feeding migrations. The WG also noted there is a difference of population structure between the Indo-Pacific and the Atlantic waters. The WG discussed the sampling design for this study and noted that the areas sampled for genetic analyses in this study differed from that of Lu et al. (2016).

The WG noted that the results of this preliminary study indicated that there was no significant genetic heterogeneity in the Pacific. The WG recommended that additional sampling be conducted to provide better spatial coverage and resolution in the Atlantic, Pacific and Indian Oceans.

Summary of striped marlin discussions at WCPFC15. Yi-Jay Chang (Presentation Only)

This presentation summarized discussions on striped marlin that occurred at WCPFC 15 this past December. It was noted that WCPFC 15 discussed the issue of whether striped marlin in the North Pacific was a "northern stock". The delegates at WCPFC 15 could not reach agreement on this issue. WCPFC 15 also noted that the WCNPO stock was considered to be overfished and to be experiencing overfishing. As a result, WCPFC 15 recommended that a rebuilding plan be developed for WCPFC 16 and that the CMM 2010-11 for WCNPO striped marlin be updated if necessary.

<u>Discussion</u>
The WG noted the recent information on striped marlin discussed at WCPFC 15. In particular, the WG noted that it would be important to conduct stochastic projections to develop a set of rebuilding scenarios for WCNPO striped marlin in the 2019 benchmark stock assessment. The WG noted that the WCPFC Northern Committee requested a specific set of projections to assist in developing a rebuilding plan.

Definition of the WCNPO striped marlin management unit. Hirotaka Ijima (Presentation Only)

New and existing information to determine the stock definition to be used for the benchmark stock assessment of Western and Central North Pacific striped marlin was presented and reviewed by the WG. This information was based on the presentation made by the WG Chair during the October 30, 2018, BILLWG teleconference call. At this meeting, the WG noted that recent information from genetic analyses (McDowell and Graves 2008, Purcell and Edmands 2011), tagging data (Ortiz et al. 2003, Domeier 2006, Sippel et al. 2007, Sippel et al. 2011, Lam et al. 2015), and life history information (Bromhead et al. 2004, Gonzalez et al. 2006, Hyde et al. 2006, Kopf et al. 2005, Kopf et el. 2011, Kopf et al. 2012, Shimose et al. 2013, Chang et al. 2018, Shimose and Yokawa *In press*, Su et al. 2013, Su et al. 2015) indicated that the striped marlin population in the Pacific was a metapopulation comprised of subpopulations linked through migration.

The striped marlin metapopulation was expected to be comprised of at least three genetically distinct breeding groups based on independent genetic studies (Graves and McDowell 1994, McDowell and Graves 2008, Purcell and Edmands 2011) with one breeding group in the Western and Central North Pacific, one in the Eastern Pacific and one in the Southwest Pacific Ocean. It was noted that these groups likely mixed on feeding grounds, but the extent of mixing was unknown. Pop-up satellite tagging information on movement indicated that some long-distance migrations (>1000 km) do occur (e.g., Sippel et al. 2011) but such migrations appear relatively infrequent relative to localized movements (Ortiz et al. 2003, Domeier 2006). Differences in growth were also apparent between the Western and Central North Pacific, the Eastern Pacific and the Southwest Pacific Ocean breeding groups (Melo-Barrera et al. 2003, Gonzalez et al. 2006, Kopf et al. 2005, Kopf et al. 2011, Sun et al. 2011a). Overall, the new and existing information on the stock structure of striped marlin in the North Pacific (Brodziak 2010, Ichinokawa and Yokawa 2009, Hinton 2008, Hosono et al.2010, Kanaiwa and Yokawa 2009a, Kanaiwa and Yokawa 2009b, Sun et al. 2009) confirmed that there was uncertainty in the probable location of a boundary between the western and eastern breeding groups in the North Pacific. Given the need to develop a rebuilding plan for WCNPO striped marlin management unit at the request of the Northern Committee of the Western and Central Pacific Fisheries Commission, the WG chose to move the eastern boundary of WCNPO striped marlin from 140°W to 150°W to conform to the WCPFC Convention Area boundary. This decision was based on the WGs review of all available information on striped marlin stock structure, spawning areas and movement patterns and the practical need to develop a rebuilding plan for the striped marlin resource consistent with the WCPFC convention area in the North Pacific. This change in the boundary of the WCNPO striped marlin management unit was consistent with the best available biological information and aligned with the provision of management information needed to conserve striped marlin in the Western and Central North Pacific Ocean.

<u>Discussion</u>
The WG noted that several independent studies show consistent spatial patterns in population genetic structure of striped marlin. In particular, the data suggest that there are genetically distinct breeding groups in the Western and Central North Pacific, the Eastern Pacific, and the Southwest Pacific, with another possible breeding group around the Hawaiian Archipelago. The

WG also noted that striped marlin exhibited spatial differences in growth and maturity between the Southwest Pacific and the North Pacific regions.

The WG discussed the genetic study by Purcell and Edmands (2011). It was noted that there was some uncertainty about the specific locations where the genetic samples were collected in the Purcell study and that this lack of information made it more difficult to interpret the degree of separation between sampling groups. For example, it was noted that the Japanese genetic samples were apparently collected from waters around Japan (Purcell and Edmands 2011, Figure 1) but it was not known how far these samples were collected from the Hawaii genetic samples.

The WG discussed the rationale for changing the WCNPO stock boundary from 140°W to 150°W. **The WG reached consensus that the new information about genetic population structure and seasonal migration patterns indicated the existence of at least two stocks in Northern Pacific but also agreed that it was not clear where to separate the stocks based on longitude. As a result, the WG chose to use the eastern longitudinal boundary of the WCPFC Convention Area in the North Pacific as the eastern longitudinal boundary of the WCNPO striped marlin stock to be consistent with the RFMO region.**

3. FISHERY STATISTICS FOR WESTERN AND CENTRAL NORTH PACIFIC STRIPED MARLIN

Eight working papers on the topic of fishery statistics for Western and Central North Pacific striped marlin were presented to the WG by Chang, Ijima and Sculley. The WG reviewed the working papers and discussed the information with each presenter.

Japanese catch statistics of Western Central North Pacific Striped Marlin (Kajikia audax). Hirotaka Ijima (ISC/19/BILLWG-1/2)

This paper compiled Japanese catch data for use in the stock assessment for striped marlin in the Western and Central North Pacific Ocean. Ijima used the yearbook and the logbook data to compile the catch data. Aggregation was done based on the fleet definitions for Stock Synthesis 3. Japanese offshore and distant water longline catch amounts decreased because the area of stock assessment was scaled down. In addition, some of the catch from the Japanese driftnet fleet before the moratorium needed to be excluded because the early period data included some catch from the South Pacific. The influence of the excluded catch on the stock assessment was considered to be important because the driftnet catches were relatively large and the average fish size was also relatively large.

Discussion

The presenter noted that the driftnet catches in the early time period (1975-1993) had limited logbook data and likely contained catch data from the South Pacific driftnet fishery and potentially the EPO. In the 2015 assessment, all of the driftnet catch data was assumed from the North Pacific data. However, this assumption was likely incorrect and it was noted that some of the reported striped marlin driftnet catch was actually from the South Pacific and not the North Pacific.

The group discussed how to address the issue and developed several options for treating the Japanese drift net catches of striped marlin. These were:

- Option 1. Remove driftnet catch data prior to 1994 and place a large equilibrium catch on the driftnet fleet.
- Option 2. Use the nominal driftnet catch as reported with a higher CV on the early period catch.
- Option 3. Use the nominal driftnet catch as reported and include sensitivity runs with decreases in driftnet catch from 10% to 50%.
- Option 4. Estimate the annual proportion of driftnet catch from the South Pacific using logbook data.

The WG discussed the four options. It was suggested to use either the average, maximum or annual percentage of effort from the available logbook data as an indicator of the minimum amount of South Pacific catch for the base case model. Sensitivity runs with decreases in the early catch from 10% to 50% would be used to show the impacts of larger South Pacific catches. The presenter noted that there was an effort to estimate the proportion of albacore caught in the North and South Pacific using the logbook data for the driftnet fleet and that these proportions may also be an option to quantify striped marlin catches as well, noting that albacore was a target species for the driftnet fishery in the 1980s and early 1990s. The WG noted that if there was no accounting for the South Pacific catch of striped marlin in the driftnet fishery then the estimated depletion rate from the assessment model would likely be biased. As a result, the WG agreed that options 2 and 3 would not be appropriate. **Overall the WG agreed to use option 4 where the annual percentage of logbook catch in South Pacific is used to correct the total WCNPO striped marlin Japanese driftnet catch for input to the base case model.**

It was also noted that there is significant variation in the proportion of catch by quarter in the driftnet fishery and this variation may be due to changes in reporting rates from the fleet. Rather than using the reported proportions of catch by quarter, the presenter recommended calculating the average seasonal ratio of the catch and using that to divide the catch into quarters. **The WG agreed with this approach to allocating annual drift net catches by quarter.**

The WG noted that the Japanese catch statistics did not include estimates of discards or species misidentifications of striped marlin and that uncertainty about the amount of underreported striped marlin catch could be addressed through sensitivity analyses.

Catch and size data of striped marlin (Kajikia audax) by the Taiwanese fisheries in the western and central North Pacific Ocean during 1958-2017. Yi-Jay Chang (ISC/19/BILLWG-1/3)

Catch data of striped marlin by the fisheries of Taiwan during 1958-2017 were obtained from the Oversea Fisheries Development Council (OFDC) of Taiwan. Recent five-years, the total catches of striped marlin in the western central North Pacific Ocean (WCNPO) showed a decreasing and then slightly increasing trend overtime. Lower jaw-to-fork length (LJFL, cm) and round weight (kg) data of striped marlin collected from the Taiwanese distant-water longline fishery in the WCNPO were summarized using violin plots during 1981-2017 and 2014-2017, respectively.

For consistency of size data among various fleets for the stock assessment model, LJFL and weight were converted into eye-to-fork length (EFL).

Discussion

The WG noted that the Taiwanese length frequency data would need to be converted to units of eye-fork length for use in the 2019 stock assessment. This conversion was completed during the meeting.

The WG also noted that the length frequency data were gathered from the 2015 WCNPO stock area. The WG requested that the length frequency data be taken from the 2019 WCNPO stock area with the stock boundary at 150°W. This change to the Taiwanese length frequency data was completed during the meeting. The WG noted that the fraction of the distant-water longline catch coming from the region between 140°W and 150°W varied by year and was up to 60% of the total distant-water longline catch. The WG noted that the total distant-water longline catch amount was much lower than the small-scale tuna longline catch of striped marlin.

The WG agreed to use the Taiwanese length frequency data from 2004-2017 for the distant water longline fleet in the stock assessment. Prior to 2004, the length data had low sample sizes and high variability in the sampled lengths.

The WG requested that the presenter provide quarterly plots of the Taiwanese longline length frequency data for comparison with the Japanese size data. This comparison was completed during the meeting and showed that the Taiwanese and Japanese longline size composition data were generally similar and showed consistent spatial patterns on a quarterly basis.

The WG also discussed the possible use of striped marlin weight frequency data for 2014-2017 in the stock assessment, noting that it was not clear whether the weight measurements were whole wet weights or semi-dressed weights. **Overall, the WG concluded that it would be better to use the length frequency data to represent the Taiwanese longline size composition because the time series was longer and the measurement units were consistent.**

Striped Marlin (Kajikia audax) length data available from 1995-2017 in the Hawaii-based longline fishery. Michelle Sculley (ISC/19/BILLWG-1/4)

Striped marlin (*Kajikia audax*) size frequency data are summarized for the Hawaii-based longline fishery from the Pacific Islands Regional Observer Program data set. Details on the spatial and temporal changes in mean lengths are presented, as well as a frequency table of the number of striped marlin measured per 5-cm length bin by year in 1995-2017. Results show relatively consistent annual mean lengths for striped marlin. The deep-set sector tends to catch the smallest age 0 and 1 individuals, although both deep-set and shallow-set sectors primarily catch fish smaller than the length at 50% maturity (181 cm). Striped marlin caught north of the Hawaiian Islands in quarters 2 and 3 tend to be the largest while fish caught to the south and west of the Hawaiian Islands in quarters 1 and 4 tend to be the smallest.

Discussion

The WG discussed whether to use the revised definition of deep-set trips prior to 2004. In particular, prior to 2004 a deep-set trip was defined as a longline trip using 10 or more hook per float. **Overall, the WG agreed to use the revised definition prior to 2004 to better match the reported hooks per float with the reported target species by set, noting that for this assessment the combined deep- and shallow-sector data will be used.**

The WG noted that the aggregate length frequency distributions for quarters 1 and 4 were bimodal. This indicated that there was likely a recruitment signal in these quarters. In contrast, length frequency distributions in quarters 2 and 3 were unimodal.

The presenter clarified the definitions of deep-set and shallow-set sectors and showed plots of the reported hooks per basket (HPB) distribution by set type. The WG discussed the cover rates of deep-set and shallow-set, as well as the sample sizes. The WG also discussed the alternative options of treating the two different gear types as two fleets or using the deep-set fleet only, which could be explored as the sensitivity analysis in the stock assessment. **Overall, the WG agreed to use the combined shallow- and deep-set length frequency data because the length distributions overlapped and the sample sizes and sample coverages were larger and more informative.**

Japanese length frequency data of Western Central North Pacific Striped Marlin (Kajikia audax). Hirotaka Ijima (ISC/19/BILLWG-1/5)

This paper compiled length frequency data obtained by Japanese longline and driftnet fisheries for the WCNPO striped marlin stock assessment. Although the ISC billfish working group used Japanese longline size data in the past stock assessment, Japanese size data sets were confirmed to have low area coverage and the possibility of bias in the training vessel data. Thus, this paper focused on logbook data. In the longline fishery, striped marlin is a bycatch species, and individual catch weights were recorded in the logbook data. This weight data is then converted to body length and the effective sample size is estimated. Use of the converted longline size data improved the coverage of areas that had not been sampled, and also reduced several biases. The converted size data were used as the input longline length frequency data set for SS3 where fleet definitions followed from the analytical results of finite mixture model analyses (flexmix). For the driftnet length frequency data, the size data set was aggregated by year and quarter. Given the seasonal patterns in the driftnet size data, it was appropriate to define the Japanese driftnet fishery as consisting of two fleets operating in two different time periods (first and fourth quarter, and second and third quarter).

Discussion

The WG discussed the representativeness of the Japanese length data. The length data comes from both training vessels and commercial vessels but differs in spatial distribution, temporal distribution and configuration of longline fishing gear. After 1999, the majority of the port sampling data came from a single port. The presenter recommended using the semi-dressed weight data converted into eye-fork length. These data are from the logbook data where one striped marlin was caught. It was shown that the proportion of the records with a single fish caught was consistent through time.

Due to changes in the spatial distribution and the vessels reporting length data over time, the presenter recommended using the semi-dressed weight from the logbook data converted to length data for the length frequency information rather than the length data from port sampling. It was noted that this conversion needed to occur prior to inclusion in the assessment model as the assessment model only has parameters for total weight not semi-dressed weight. The WG noted that there was a conversion factor for the Japanese semi-dressed weight to length data from paired weight-length sampling data.

The WG noted that the highest quality length data in terms of spatial coverage and representativeness of sampling was available for 1994-2017. The available length data from 1975-1993 was converted from semi-dressed weight data and had low spatial resolution, had limited sample sizes, and may be of low quality. However, it was suggested that this data set be included in the assessment model and only removed if it caused problems with fitting or convergence. Five DWLL fleets had lower quality length data. It was suggested to include those data and try to estimate selectivity, but to remove the data and mirror the fleets to other Japanese fleets with similar overall length compositions if there were problems with model convergence or diagnostics.

The WG agreed with the recommendation that the driftnet fleet be split into two fleets: one fleet operating in quarters 1 and 4 and one fleet operating in quarters 2 and 3 to reflect the differences in length composition between the two periods.

The WG asked the presenter to clarify why it was expected that the Japanese length frequency data would be biased. It was explained that this was not bias in measuring fish lengths. Instead, the expected bias was due to a lack of coverage of fishing ports by port samplers. It was noted that almost all length samples collected since 1999 were collected from only one Japanese fishing port (Kesennuma) and the resulting lack of spatial coverage reduced the representativeness of the length samples.

Standardization of the striped marlin (Kajikia audax) catch per unit effort data caught by the Hawaii-based longline fishery from 1994-2017 using generalized linear models. Michelle Sculley (ISC/19/BILLWG-1/6)

This working paper provides the standardization of the Hawaii-based longline fishery striped marlin (*Kajikia audax*) catch per unit effort (CPUE) data. Three different distributions with up to 14 different explanatory variables were explored for the combined dataset. The delta-lognormal generalized linear mixed model (DL-GLMM) provided the best fit to the data based upon percent deviance explained. Using this best-fit model, standardizations with the shallow-set and deep-set sectors were conducted separately and compared. Results showed that the deep-set sector standardized CPUE was very similar to the combined dataset. The shallow-set CPUE series was higher than the other CPUE time series and was flat and highly variable making it a poor candidate for inclusion in the assessment model. The diagnostics of the combined dataset do not suggest any problems with poorly fitted data; therefore, it was recommended to use the combined dataset DL-GLMM standardized CPUE for the 2019 striped marlin base-case assessment model.

Discussion
The WG noted that the number of longline sets with 40 or more HPB was relatively low and as a result, it may be better to aggregate all sets with 40 or more HPB into a single factor level.
The WG asked whether the expected relationship between latitude and longitude and striped marlin CPUE was linear. It was noted that the estimated degrees of freedom from the GAM analysis was roughly 1. This suggested that the linearity assumption in the model was not problematic although the WG did note a slight patterning in the model residuals.

The WG asked which environmental variables produced the largest reductions in deviance and the presenter noted that all of the environmental variables had weak correlations with CPUE.

The WG noted that the target species by set type might be used directly as an alternative explanatory variable instead of the reported HPB. It was mentioned that this approach could be considered in future analytical work.

The WG requested to see a comparison of the AIC for the CPUE standardization model using all data and the combined AIC of the CPUE standardization model applied separately to the deep- and shallow-set sector data sets. The comparison was made during the meeting and showed that the combined AIC from separate deep- and shallow-set sector analyses was smaller than the AIC using all data. However, the difference was relatively small (<2%). The WG suggested that the combined data would provide more information on relative abundance and better spatial coverage than by analyzing the CPUE data separately by sector. Therefore the WG accepted the use of the combined deep- and shallow-set sector data for CPUE standardization. However, the WG also noted there were differences in target species and regulations for the shallow- and deep-set sectors and recommended to continue monitoring changes in the sectors through time. In particular, it was important to account for the effects of regulatory changes on CPUE standardization, especially the effects of seasonal closures for the shallow-set sector.

The WG asked why the standardized CPUE series were similar when estimated with and without the shallow-set sector data. It was explained that the series were similar because the proportion of observed sets with striped marlin in the shallow-set sector was minor (about 10%) and the shallow-set catch amounts were low.

Japanese longline CPUE of striped marlin (Kajikia audax) in the WCNPO. Hirotaka Ijima (ISC/19/BILLWG-1/7)

We standardized CPUE of striped marlin caught by Japanese longline vessel in the WCNPO. We standardized CPUE for two fleets that depended on the analysis results of the finite mixture model. Also, these two fleets were divided into two time series in the year when the format of Japanese logbook statistics changed (early series: 1976-1993, late series: 1994 - 2017). In this analysis, we tested three candidate models for goodness-of-fit to the CPUE data: (i) negative binomial distribution GLMM (NB), (ii) zero-inflated Poisson GLMM (ZIP), and (iii) zero-inflated negative binominal GLMM (ZINB). For the model diagnostics, we used Bayesian information criterion (BIC), model deviance explained and randomized quantile residuals. For all four fleets, the lowest BIC was produced by the NB model and followed by the ZIP. The most complicated ZINB model did not converge or became under dispersed and as a result was eliminated as a candidate model. Randomized quantile residuals showed generally good dispersion in both candidate models (NB and ZIP). There is a possibility that the operational pattern of Japanese longline fishery in the later period had gradually changed. However, there were no data to confirm such a change. To address this issue, we attempted to estimate the true zero catch using the ZIP model. However, the ZIP model could not incorporate the change of fishing operation entirely. In future work, it may be necessary to consider a more complex hierarchical random effects model.

<u>Discussion</u>

The WG noted that the model structure (covariates included) for each ZIP model was not the same over the four model cases, which consisted of two life stages (adults and juveniles) by two time periods (early and late periods). It was also noted that the model structure of NB models was the same over the four cases. The presenter clarified that the blank value in the deviance table represented the best fitting model of the candidate models. The WG noted that the NB models had much smaller BIC values than the ZIP models and that the NB models provided the best fit to the CPUE data over the four model cases (Table 1).

The WG discussed how the HPB was grouped into set-type (shallow and deep) and was treated as a factor in the GLMM. The WG noted that this was consistent with the treatment of the deep-set and shallow-set sectors in the Hawaii longline fishery CPUE standardization.

The WG noted that different time block periods were used in the WP in comparison to the last assessment. The presenter also explained that there were two spatial resolutions of the gridded CPUE data. These were 5x5 degree blocks and 1x1 degree blocks which were used as the mesh sizes of the 2-dimensional spatial grid used for random effects in the GLMM.
The WG discussed the definition of adult index, and noted that the index may represent both sub-adults and adults as an abundance index.

The WG also discussed the CPUE standardization results for the NB and ZIP models. Indices of both adult and juvenile of the ZIP model for the late time period were suggested to be better than the NB model because the ZIP model accounted for some of the changes in the variability of Japanese longline hook depth after 2005. The WP noted that the reported HPB values may not be as representative of the actual gear depth in recent years. The WG noted there was no data to document recent changes in gear depth for deep sets apart from the anecdotal information obtained by interviewing fisherman.

The WG requested additional information on model residuals and diagnostics for both ZIP and NB models over the four cases. This was provided during the meeting. The WG also requested additional information on the percent deviance explained and BIC values for each model and this was also provided during the meeting (Table 1).

Table 1 Comparison of negative binomial (NB) and zero-inflated Poisson (ZIP) model fits to standardize the Japanese adult and juvenile longline CPUE data by time period using percent deviance explained by model, BIC values, and BIC differences.

Percent deviance explained by model			
		Early	Late
Adult	NB	28.0%	26.0%
	ZIP	27.0%	26.0%
Juvenile	NB	42.0%	41.0%
	ZIP	37.0%	35.0%

BIC values by model			
		Early	Late
Adult	NB	75584.14	39772.39
	ZIP	76573.07	40193.96
	BIC Difference	988.93	421.57
Juvenile	NB	156180.94	96717.7
	ZIP	170177.13	106160.82
	BIC Difference	13996.19	9443.12

The WG discussed the scales and units of various standardized CPUE and the presenter explained how CPUE was re-scaled for the comparison of annual trends. The WG noted that the seasonal distribution of striped marlin catch has changed through time and that historic areas of high catch rates have decreased in recent years.

The WG requested to see a comparison of the standardized CPUE estimates from this analysis and the previous assessment in 2015, noting that this was a coarse comparison because the areas used for standardization differed. The comparison was provided and showed some strong positive correlations between the standardized CPUE series across similar areas. In particular, there were strong positive correlations between the coastal and distant-water longline CPUE series in 2015 and the juvenile CPUE series for area 1 and quarter 3 in the 2019 analysis. The WG also reviewed the annual differences in CPUE relative to its mean and noted that there was a substantial increase in the NB adult index for area 1 and quarter 3 during 2013-2016 with a 130% increase in standardized CPUE during 2015-2016.

The WG proposed using the CPUE standardizations from the NB models for the assessment because the NB models provided substantially better fits to the longline CPUE data. However, the WG noted that the ZIP models may provide a better fit to some of the observed CPUE in recent years which appears to have substantial variability due to changes in the realized hook depths by reported HPB value.

Catch rate standardization of striped marlin in the Western and Central North Pacific Ocean by the Taiwanese tuna longline fisheries during 1989-2017. Yi-Jay Chang (ISC/19/BILLWG-1/8)

This report provides annual estimates of standardized catch rates of striped marlin caught by Taiwanese distant-water tuna longline fishery (DWLL, 1989-2017) and small scale tuna longline fishery (STLL, 2008-2017) in the Western and Central North Pacific Ocean. Catch rates were standardized using delta lognormal generalized linear models (GLM) with year, month, latitude, and longitude as predictors. Step plots and coefficient–distribution–influence (CDI) plots are provided to show the relative impacts of the explanatory variables included in GLMs. Results showed that the standardized catch rates for the DWLL has fluctuated overtime; recent peaks were observed in 2012-2013 and 2016-2017, respectively. The standardized catch rate of STLL increased in 2012, then decreased in 2013 and has stayed stable since then.

Discussion

The WG noted that the use of a delta-lognormal CPUE standardization model was an improvement over the use of a lognormal model in the 2015 stock assessment.

The WG discussed the time period of the CPUE standardization analysis for the distant-water longline fleet which began in 1989. It was noted that the quality of the DWLL CPUE data during 1989-1994 was lower than from 1995-2017. As a result, the WG requested that a revised CPUE standardization for the distant-water longline fleet beginning in 1995 be conducted. This revised CPUE standardization analysis was completed during the meeting. The WG reviewed the revised analysis and accepted it as the best available information for the 2019 stock assessment.

The WG noted that the additional diagnostic CDI plots were useful for evaluating the influence of various factors and covariates on the annual changes in standardized CPUE.

The WG noted that the percent deviance explained by the CPUE standardization model was relatively low, about 13%. The WG discussed why the operational or set-by-set CPUE data was used instead of aggregated CPUE data as in the 2015 assessment. The presenter explained that the set-by-set data were more informative because these data had higher resolution. As a result, the variability in in operational data was higher and this led to a lower fraction of the total CPUE variability being explained by the GLM.

The WG noted that HPB was included as an explanatory variable in the 2015 assessment but HPB was not included in this GLM analysis. The presenter explained that the DWLL operational data had limited information on HPB in some years with high fractions of missing HPB values. The presented also noted that HPB did not have an important impact on standardized CPUE in the 2015 assessment. Therefore, HPB was not used as explanatory variables in this GLM analysis.

The WG requested to see a comparison of the 2015 and the 2019 standardized CPUE series for the DWLL. This comparison was completed during the meeting and showed that the 2015 and 2019 standardized CPUE series had generally similar trends.

The presenter noted that the Taiwanese STLL CPUE data quality has improved substantially in recent years. The WG noted that the STLL CPUE was now considered to be acceptable for standardization as a relative abundance index.

For future CPUE standardization work, the **WG suggested it may be useful to investigate the inclusion of random vessel effects and other operational variables like HPB to increase the percentage of deviance explained.**

Size-dependent distribution of Pacific Striped Marlin (Kajikia audax): The analysis of Japanese longline fishery logbook data using the finite mixture model. Hirotaka Ijima (ISC/19/BILLWG-1/9)

The size selectivities by fishing gear and CPUE are essential information for the proper configuration of integrated stock assessment models such as Stock Synthesis 3. However, the fishery selectivity and CPUE need to account for spatiotemporal changes because the fishing operations correspond to fish life-history such as growth and migration or distribution. Here, to clarify the spatial distribution pattern of the Pacific striped marlin (*Kajikia audax*), we explored the finite mixture model analysis using the R software package "flexmix". In this analysis, we used the Japanese longline operational data that report operating area, catch number, effort (number of hooks) and catch weight. Regarding model assumption, we set 2 to 12 clusters with two-dimensional GLMs that responses are mean body weight and CPUE. We used several covariates for these GLMs (e.g., year, quarter and gear effects). We also set the area-seasonal grouping factor. We used BIC for the model selection and from this BIC selected complex nine cluster model for the entire Pacific. Considering with spatial cluster and trends of mean-body weight, we recommend using 11 Japanese longline fleets for the model configuration of Stock Synthesis 3.

Discussion

The WG noted that there was no clear boundary in the cluster analysis between the east and western areas of the WCNPO but there was a clear boundary between the North and South around 20°N. The 11 fleets presented are for catch and length data, the presenter suggested that only two of the fleets would have standardized CPUE: Area 1 Quarter 1 (primarily age-3+) and Area 1 Quarter 3 (primarily age-1 fish).

The WG noted that the flexmix model used aggregated data rather than set-by-set data because individual sets with zero catch had zero body weight. In this case, the lognormal model for body weight could not handle zero weights. A year effect was included in the CPUE model but not in the weight model because this factor was not significant. This suggested that the mean weight patterns were consistent through time, although there was some quarterly variation which was expected to be driven by seasonal movements. The CPUE trend was also expected to change annually, as it should reflect changes in relative abundance.

The WG discussed the finite mixture analyses and agreed that the clustering approach captured the quarterly patterns in longline selectivity. As a result, the WG agreed to the 11 fleet definitions by quarter and by area within quarter for the Japanese longline fishery.

4. REVIEW OF LIFE HISTORY PARAMETERS AND ASSESSMENT MODEL STRUCTURE FOR WESTERN AND CENTRAL NORTH PACIFIC STRIPED MARLIN

Two working papers on the topic of life history parameters and assessment model structure were presented to the WG by Fitchett and Sculley. The WG reviewed the working papers and discussed the information with the presenters.

Estimating age and growth of Central North Pacific striped marlin using tagging data and direct observations of age. Mark Fitchett (ISC/19/BILLWG-1/12)

Age and growth of Central North Pacific striped marlin was modeled by fitting von Bertalanffy growth functions (VBGF) to direct observations of age at size and by utilizing tagging data to further estimate VBGF parameters by using a Fabens-type methodology. Models were fit using 134 observations of age at size read from striped marlin fin spines or by incorporating mark-recapture histories from 35 tagged striped marlin. Nine VBGF models are presented based on inclusion of fin spine data, tagging data, inclusion/exclusion of estimates of age 0 at size, and on estimation of coefficient of variation (CV) for expected size at age. Modeling efforts incorporating tagging data rendered VBGF parameters consistent with those generated by independently incorporating fin spines. Maximum expected size (L_∞) was on average estimated to be approximately 181.7 cm eye-fork length, annual growth coefficient (K) was estimated to be on average 0.7 yr^{-1}, the average CV was estimated to be 0.12, and age at size 0 (t_0) was estimated on average to be -1.09 yr. Expected sizes at age from this study depart moderately from those by Sun et al. (2011a) from ages 0 to 6, but have significantly different L_∞ . L_∞ estimates from this study render maximum expected sizes that are near or below a 50% maturity ogive from the Western North Pacific used to assess the entire stock. This may be due to possible differences in life history characteristics by region and reinforces the need to collect and/or update regional life history information for Central North Pacific striped marlin.

Discussion

The WG noted that this study provided some preliminary growth information for striped marlin on the fishing grounds of the Hawaii longline fleet, which has limited direct observations of size at age and growth. **The WG recommended that further ageing samples be collected to increase the sample size to estimate growth parameters.** The WG noted that the oldest fish in the fin spine ageing sample was aged to be 5 years old which emphasizes the need to collect more samples to characterize the size-at-age of older fish.

The WG suggested that the tagging data may have some bias in the observed size at age because tag-recovered striped marlin were not random samples from the population. In particular, each tag-recovered fish had to survive to be recaptured and it would be expected that fish with higher growth rates and fitness or in better condition would be more likely to survive the tagging process and then survive to be recaptured.

The WG noted that nine alternative growth models were fit but that model selection techniques were not applied to compare models. **The WG recommended that model selection techniques be applied to objectively compare the fits of the alternative growth models, perhaps using k-fold cross validation.**

The WG noted that including the juvenile data may important for estimating the growth curve and noted that age-0 fish were excluded as outliers in some models. **The WG recommended using otoliths micro-increment for juveniles and using decimal ages for the fin spine ageing samples. The WG also recommended investigating 2-stage growth models which may better account for the patterns of early life history stage and juvenile-adult growth.**

The WG noted that the preliminary results from this study differed from the growth curve used in the 2015 stock assessment (Sun et al. 2011a). The results show a faster growth pattern with a smaller asymptotic size than that in Sun et al. (2011a) In particular, the WG noted that the average Linf was 181 cm which is low relative to the estimated length at 50% maturity (L_{50}) of around L_{50}=181 cm (Chang et al. 2018).

Comparison of the results of the 2015 ISC Striped Marlin Stock Assessment Base-Case Model using Stock Synthesis versions 3.24f and 3.30. Presented by Michelle Sculley (ISC/19/BILLWG-1/10)

The ISC BILLWG provided an assessment of Western and Central North Pacific striped marlin in 2015 using Stock Synthesis version 3.24f. In preparation for the 2019 assessment, this model was run in the updated SS version 3.30 to ensure that any changes in the model results in 2019 would not be due to the updated assessment model. This working paper provides the estimated log-likelihood and figures showing the estimates produced from the 2015 assessment run in both SS versions. Based upon these results, the parameter estimates and derived stock status for the 2015 assessment were identical. This confirms that the 2019 assessment run in SS3.30 will be consistent with the results from the 2015 assessment run in SS3.24f.

Discussion

The WG discussed the results of the comparison and agreed that the two SS3 versions produced the exact same result using the same input data. As a result, the WG concluded that using SS version 3.30 would have no impact on the assessment modeling for the 2019 stock assessment.

5. FINALIZE PACIFIC WESTERN AND CENTRAL NORTH PACIFIC STRIPED MARLIN FISHERY STATISTICS

5.1 Fishery Catch

The WG discussed and agreed upon the fishery catch statistics to be used for the stock assessment of Western and Central North Pacific striped marlin by fishing fleet. The WG produced a summary of the current status of the fishery catch, CPUE, and size composition data by country and fleet (Table 2). The acronyms in the fleet names are defined as follows:

- JPN, US, TWN, and WCPFC indicate the countries Japan, Taiwan, United States, and member countries of the WCPFC, respectively;
- LL, DN, OTHER, DWLL, and STLL indicate the fishing gears longline, drift net, assorted other gears, distant-water longline, and small-tuna longline, respectively;
- Q1, Q2, Q3, and Q4 indicate quarters 1, 2, 3, and 4 in the calendar year, respectively;
- A1, A2, A3, and A4 indicate quarter-specific areas 1, 2, 3, and 4, respectively;
- Early is the early time period, 1975-1993 and Late is the late time period, 1994-2017.

Annual Catch of WCNPO Striped Marlin by Country and Fleet

- **China:** Chinese catch data were not provided by China at this meeting. Catch tables for China were to be updated from fishery statistics submitted to the WCPFC (pers. comm., SPC).
- **Taiwan:** Catch tables for Taiwan were described in WP-03 by Hsu et al. (2019).
- **Japan:** Catch tables for Japan were updated from catch statistics using new quarter-specific area definitions described in WP-02 by Ijima (2019) and in WP-09 by Ijima and Kanaiwa (2019b).
- **Korea:** Korean catch data were not provided by Korea at this meeting. Catch tables for Korea were to be updated from fishery statistics submitted to the WCPFC (pers. comm., SPC).
- **Mexico:** Mexican catches of WCNPO striped marlin are negligible.
- **USA:** Catch tables for the USA were described in WP-01 by Ito (2019).
- **Canada:** Canadian catches of WCNPO striped marlin are negligible.
- **Non-ISC Countries**: Catch tables for non-ISC countries in the WCPFC region were updated by correspondence (pers. comm., SPC).

Discussion

It was noted that two ISC member countries, China and Korea, did not provide updated catch data in 2014-2017 for WCNPO striped marlin at this meeting.

For non-ISC countries in the WCPFC, the WG agreed to use the Category I catch data (aggregated across all areas in the WCPFC) for the stock assessment. However, some WCPFC countries only report Category II catch data (catch by area) and do not report Category I data. **In these cases, the WG agreed to use the Category II data north of the equator as the best estimate of the WCNPO striped marlin catch by non-ISC countries.**

Overall, the WG accepted the updated WCNPO striped marlin catch time series as the best available scientific information to conduct the 2019 stock assessment.

Table 2 Fishing fleet definitions for the WCNPO striped marlin stock assessment with fleet code, flag (JPN is Japan, TWN is Taiwan, US is United States, WCPFC is Western and Central Pacific Fisheries Commission), fleet name, catch time period, temporal resolution of catch data, catch units, standardized CPUE and size composition data availability.

Fleet Code	Flag	Fleet Name	Catch Time Period	Temporal Resolution	Catch Units	Standardized CPUE Available ?	Size Composition Data Available ?
F1	JPN	JPN_LL_Q1_A1_Early	1975-1993	Quarter	Numbers	Yes, 1976-1993	Yes, 1976 - 1993
F2	JPN	JPN_LL_Q1_A1_Late	1994-2017	Quarter	Numbers	Yes, 1994-2017	Yes, 1994 - 2017
F3	JPN	JPN_LL_Q1_A2	1975-2017	Quarter	Numbers	No	Yes, 1976 - 2017
F4	JPN	JPN_LL_Q1_A3	1975-2017	Quarter	Numbers	No	Yes, 1976 - 2017
F5	JPN	JPN_LL_Q1_A4	1975-2017	Quarter	Numbers	No	Yes, 1976 - 2017
F6	JPN	JPN_LL_Q2_A1	1975-2017	Quarter	Numbers	No	Yes, 1976 - 2017
F7	JPN	JPN_LL_Q2_A2	1975-2017	Quarter	Numbers	No	Yes, 1976 - 2017
F8	JPN	JPN_LL_Q3_A1_Early	1975-1993	Quarter	Numbers	Yes, 1976-1993	Yes, 1976 - 1993
F9	JPN	JPN_LL_Q3_A1_Late	1994-2017	Quarter	Numbers	Yes, 1994-2017	Yes, 1994 - 2017
F10	JPN	JPN_LL_Q3_A2	1975-2017	Quarter	Numbers	No	Yes, 1976 - 2017
F11	JPN	JPN_LL_Q4_A1	1975-2017	Quarter	Numbers	No	Yes, 1976 - 2017
F12	JPN	JPN_LL_Q4_A2	1975-2017	Quarter	Numbers	No	Yes, 1976 - 2017
F13	JPN	JPN_LL_Q4_A3	1975-2017	Quarter	Numbers	No	Yes, 1976 - 2017
F14	JPN	JPN_LL_OTHER	1975-2017	Quarter	Weight	No	No
F15	JPN	JPN_DN_Q1_Q4	1975-2017	Year	Weight	No	Yes, 2005-2017
F16	JPN	JPN_DN_Q2_Q3	1975-2017	Year	Weight	No	Yes, 2005-2017
F17	JPN	JPN_OTHER	1975-2017	Year	Weight	No	No
F18	US	US_LL	1987-2017	Year	Weight	Yes, 1995-2017	Yes, 1995-2017
F19	US	US_OTHER	1987-2017	Year	Weight	No	No
F20	TWN	TWN_DWLL	1967-2017	Year	Weight	Yes, 1995-2017	Yes, 2004-2017
F21	TWN	TWN_STLL	1958-2017	Year	Weight	Yes, 2008-2017	No
F22	TWN	TWN_OTHER	1958-2017	Year	Weight	No	No
F23	WCPFC	WCPFC_OTHER	1975-2017	Quarter	Weight	No	No

5.2 Fishery CPUE

The WG produced a summary of the standardized CPUE time series that were available for the 2019 benchmark stock assessment of WCNPO striped marlin (Table 3) along with the source.

Table 3 Available standardized indices of relative abundance (CPUE) for WCNPO striped marlin. See Table 2 for fleet codes and acronyms.

Fleet Code	Fleet Name	Time Series	Source
F1	JPN_LL_Q1_A1_Early	1976-1993	Ijima and Kanaiwa. (WP-07)
F2	JPN_LL_Q1_A1_Late	1994-2017	Ijima and Kanaiwa (WP-07)
F8	JPN_LL_Q3_A1_Early	1976-1993	Ijima and Kanaiwa (WP-07)
F9	JPN_LL_Q3_A1_Late	1994-2017	Ijima and Kanaiwa (WP-07)
F18	US_LL	1995-2017	Sculley (WP-06)
F20	TWN_DWLL	1995-2017	Chang et al. (WP-08)
F21	TWN_STLL	2008-2017	Chang et al. (WP-08)

<u>Standardized CPUE time series for WCNPO striped marlin by country and fleet</u>

- **China:** Standardized CPUE series for China were not provided at this meeting.
- **Taiwan:** Standardized CPUE series for the Taiwanese distant water longline fleet (1995-2017) and the Taiwanese small-scale tuna longline fleet were provided in WP-08.
- **Japan:** Standardized CPUE series for the Japanese distant water longline fleets in quarter 1 and areas 1 and 3 (1976-1993, 1994-2017) were provided in WP-07.
- **Korea:** Standardized CPUE series for Korea were not provided at this meeting.
- **USA:** The standardized CPUE series for the Hawaii fleet was provided in WP-06.
- **Non-ISC countries:** Standardized CPUE series from non-ISC countries were not available.

<u>Discussion</u>

It was noted that China and Korea did not provide any standardized CPUE time series for the 2019 BILLWG stock assessment of WCNPO striped marlin.

Overall, the WG accepted the standardized CPUE series as the best available scientific information to conduct the 2019 stock assessment.

5.3 Fishery Size Composition

The WG produced a summary of the fishery size composition data that were available for the 2019 benchmark stock assessment of WCNPO striped marlin (Table 4) along with the source.

Table 4 Available size composition data for WCNPO striped marlin by fishery. See Table 2 for fishery acronyms and codes.

Fleet Code	Fleet Name	Time Series	Source
F1	JPN_LL_Q1_A1_Early	1976-1993	Ijima (WP-05)
F2	JPN_LL_Q1_A1_Late	1994-2017	Ijima (WP-05)
F3	JPN_LL_Q1_A2	1976-2017	Ijima (WP-05)
F4	JPN_LL_Q1_A3	1976-2017	Ijima (WP-05)
F5	JPN_LL_Q1_A4	1976-2017	Ijima (WP-05)
F6	JPN_LL_Q2_A1	1976-2017	Ijima (WP-05)
F7	JPN_LL_Q2_A2	1976-2017	Ijima (WP-05)
F8	JPN_LL_Q3_A1_Early	1976-1993	Ijima (WP-05)
F9	JPN_LL_Q3_A1_Late	1994-2017	Ijima (WP-05)
F10	JPN_LL_Q3_A2	1976-2017	Ijima (WP-05)
F11	JPN_LL_Q4_A1	1976-2017	Ijima (WP-05)
F12	JPN_LL_Q4_A2	1976-2017	Ijima (WP-05)
F13	JPN_LL_Q4_A3	1976-2017	Ijima (WP-05)
F15	JPN_DN_Q1_Q4	2005-2017	Ijima (WP-05)
F16	JPN_DN_Q2_Q3	2005-2017	Ijima (WP-05)
F18	US_LL	1995-2017	Sculley (WP-04)
F21	TWN_DWLL	2004-2017	Hsu et al. (WP-03)

<u>Size composition data for WCNPO striped marlin by country and fleet</u>

- **China:** Chinese size composition data were not provided at this meeting.
- **Chinese Taipei:** Size composition data for the Taiwanese distant water longline fleet (2004-2016) were provided in WP-03.
- **Japan:** Size composition data for the Japanese offshore and distant water longline fleets were provided in WP-05 using new quarter-specific area definitions described in WP-09 by Ijima and Kanaiwa (2019b). Size composition data for the Japanese drift net fisheries in quarters 1 and 4 and in quarters 2 and 3 were provided in WP-05.
- **Korea:** Korean size composition data were not provided at this meeting.
- **USA:** USA size composition data for Hawaii longline fleet were provided in WP-04.
- **Non-ISC countries:** No size composition data (Category III) for longline fleets was received from the WCPFC prior to the meeting. It was noted that further analyses of data quality and consistency were needed to include the WCPFC size composition data in a structured assessment model.

<u>Discussion</u>
The size composition data provided by ISC countries and submitted at this meeting were accepted.

Overall, the WG considered the new set of fishery statistics information to be the best available scientific information and finalized the set of input data for the base case assessment model.

The WG noted that updated fishery statistics were provided in several working papers. **The WG agreed that all striped marlin catch by country and fleet, standardized CPUE, and size composition data, would be provided in electronic format to the Chair by the end of this meeting or by February 15, 2019 via email.**

6. FINALIZE WESTERN AND CENTRAL NORTH PACIFIC STRIPED MARLIN LIFE HISTORY PARAMETERS

The WG discussed and reached consensus on the set of life history parameters to be used for the stock assessment of the Western and Central North Pacific striped marlin stock. **The WG accepted the growth parameters, length-weight relationship, natural mortality, and stock-recruitment relationship as summarized in Kapur et al. (2017) and listed here (Table 5). The WG also agreed to update the striped marlin maturity ogive based on the results of Chang et al. (2018) which revised the length at 50% maturity (females, eye-fork length [EFL]) to be L_{50} = 181 cm from the previous value of L_{50} = 177 cm in Sun et al. (2011b). As a result, the life history parameters used in the 2015 stock assessment were agreed to be the same as those used in the 2019 stock assessment with the exception of the revised L_{50} and slope for the maturity ogive.**

6.1 Growth

Growth parameters for WCNPO striped marlin were taken from the study of Sun et al. (2011a), which was considered the best available scientific information by the WG. The growth model used for striped marlin was refit (Sun et al. 2011a, ISC 2015) and parameterized for the Stock Synthesis model with mean length at age (*L*(age)) parameterized as:

$$L(age) = L_\infty + \left(L(A_{\min}) - L_\infty\right)\exp\left(-k\left(age - A_{\min}\right)\right)$$

$$\textit{where } L_\infty \textit{ is calculated from } L(A_{\min}), L(A_{\max}), \textit{and } k \textit{ via}$$

$$L_\infty = L(A_{\min}) + \frac{L(A_{\max}) - L(A_{\min})}{1 - \exp\left(-k\left(A_{\max} - A_{\min}\right)\right)}$$

where $L(A_{\min})$ and $L(A_{\max})$ are the predicted lengths for the minimum $A_{\min} = 0.3$ years and maximum $A_{\max} = 15$ years reference ages for the growth model, L_∞ is the theoretical maximum length, and *k* is the Brody growth coefficient. For the WCNPO striped marlin assessment model, $L(A_{\min})$ was 104 cm at $A_{\min} = 0.3$. The $L(A_{\max})$ value was 214 cm at age $A_{\max} = 15$. The *k* value was $k = 0.24$.

Table 5 Key life history parameters and model structures for striped marlin from the Western and Central North Pacific Ocean used in the stock assessment update including values, comments, and sources. Comments describe parameters that are expected to be estimated within the assessment model (Estimated), fixed at a specific value, i.e., not estimated (Fixed parameter), or represent model structure (Structure).

Parameter	Value	Comments	Source
Gender	1	Structure	ISC (2012)
Natural mortality	0.54 (age 0) 0.47 (age 1) 0.43 (age 2) 0.40 (age 3) 0.38 (ages 4-15)	Fixed	Piner and Lee (2011)
Reference age (A_{min})	0.3	Structure	ISC (2012)
Maximum age (A_{max})	15	Structure	ISC (2012)
Length at A_{min} (cm, EFL)	104	Fixed	Refit from Sun et al. (2011a); ISC (2012)
Length at A_{max} (cm, EFL)	214	Fixed	Refit from Sun et al. (2011a); ISC (2012)
Growth rate (k)	0.24	Fixed	Refit from Sun et al. (2011a); ISC (2012)
CV of Length at A_{min}	0.14	Fixed	ISC (2012)
CV of Length at A_{max}	0.08	Fixed	ISC (2012)
Weight-at-length	$W=4.68e\text{-}006\times L^{3.16}$	Fixed	Sun et al. (2011a)
Size-at-50% Maturity	181	Fixed	Chang et al. (2018)
Slope of maturity ogive	-0.082	Fixed	Chang et al. (2018)
Fecundity	Proportional to spawning biomass	Structure	ISC (2012)
Spawning season (quarter)	2	Structure	Sun et al. (2011b)
Spawner-recruit relationship	Beverton-Holt	Structure	ISC (2012)
Spawner-recruit steepness (*h*)	0.87	Fixed	Brodziak et al. (2011); Brodziak et al. (2015)
Logarithm of Recruitment at virgin biomass log(R_0)	-	Estimated	ISC (2012)
Recruitment variability (σ_R)	0.6	Fixed	ISC (2012)
Initial age structure (5 yr)	-	Estimated	ISC (2012)
Recruitment deviations 1975-2017	-	Estimated	ISC (2012)

6.2 Length-Weight Relationship

Length-weight parameters for WCNPO striped marlin were taken from the study of Sun et al. (2011a), which was considered the best available scientific information by the WG. The length-weight relationship was an allometric model where mean weight (kg) at length (cm, EFL) was given by

$$W(L) = 4.68 \cdot 10^{-6} L^{3.16}$$

where $W(L)$ is the predicted fish weight at length L. These length-weight relationships were used as fixed inputs for the base case Stock Synthesis model.

6.3 Maturity at Length

Maturity at length parameters for WCNPO striped marlin were taken from the article by Chang et al. (2018), which was an extension of the study of Sun et al. (2011b) and considered the best available scientific information on maturity by the WG. The probability of maturity at length ($P_{mature}(L)$) was modeled using a logistic curve as

$$P_{mature}(L) = \frac{1}{1 + e^{\beta(L - L_{50})}}$$

where L_{50} is the length at 50% maturity (cm, EFL) and β is the slope parameter where

$$\beta = \frac{-\ln(19)}{L_{95} - L_{50}} \ .$$

For WCNPO striped marlin, the maturity ogive parameters (females) were: $L_{50} = 181, L_{95} = 217$ *and* $\beta = -0.082$. The WG noted that the L_{50} of 181 cm corresponded to an age of 50% maturity (A_{50}) of $A_{50} =$ 5 years based on the fixed growth curve used in this stock assessment.

For the stock assessment model, spawning timing for WCNPO striped marlin was set to occur in the second quarter (April-July) based on Sun et al. (2011b).

6.4 Natural Mortality Rate

Natural mortality at age parameters for WCNPO striped marlin were taken from the study of Piner and Lee (2011), which were derived in a metaanalysis of alternative natural mortality estimators based on empirical and life history methods. These estimated natural mortality rates at age for WCNPO striped marlin were considered the best available scientific information by the WG and were:

$$M_0 = 0.54,\ M_1 = 0.47,\ M_2 = 0.43,\ M_3 = 0.40,\ M_{4+} = 0.38\ .$$

6.5 Stock-Recruitment Resilience

The WG agreed to use a Beverton-Holt stock-recruitment curve as the basis for predicting expected recruitment as was done for recent billfish stock assessments conducted by the ISC. The WG also discussed whether to use the value of steepness was set to the median estimate of steepness of $h = 0.87$ for North Pacific striped marlin from Brodziak et al. (2015).

No new information about recruitment variability (σ_R) was available, so **the WG agreed to use a Beverton-Holt stock-recruitment curve with a suggested initial input value of $\sigma_R = 0.6$ and with the σ_R value iteratively rescaled in the base case model to match the predicted variability in recruitment.**

6.6 Life History Parameter Summary Table

Overall, the WG agreed that the table of striped marlin life history parameters to be used in the 2019 stock assessment was the best available scientific information (Table 5).

7. WORK ASSIGNMENTS FOR NORTH PACIFIC STRIPED MARLIN

7.1 Base Case Model Inputs

The WG discussed the input data for the base case stock synthesis model that will be used to assess WCNPO striped marlin. **The WG consensus was to use the fishery statistics and information agreed upon in agenda item 8 and the life history information agreed upon in agenda item 9 for the base case assessment.** The WG also noted that these additional work assignments be undertaken as soon as possible:

- Adjust the U.S. catches during 2010-2017 to account for discards and species misidentifications.
- Adjust the Japanese drift net catches to account for catches that occurred in the South Pacific.
- Estimate the quarterly distribution of Japanese drift net catches.
- Obtain WCPFC catch data and size composition data.
- Request striped marlin catch and size data during 2014-2017 for China and Korea.

7.2 Base Case Model Structure for the Benchmark Assessment

The WG noted that the 2019 WCNPO striped marlin stock assessment is to be a benchmark assessment. The WG discussed the work needed to construct a base case model. **After these discussions, the WG concluded that the base case model would incorporate the following features:**

- Use a 1-area model for the WCNPO striped marlin using areas-as-fleets to estimate fishery selectivity by fleet (i.e., Waterhouse et al. 2014).
- Use a 1-gender model given the apparent lack of sexual dimorphism in WCNPO striped marlin.
- Use a 4-season model to account for seasonal variation in size composition and spatial distribution of WCNPO striped marlin.
- Use the best available catch data for WCNPO striped marlin through 2017.
- Use the best available standardized CPUE for WCNPO striped marlin through 2017.
- Use the best available size composition data for WCNPO striped marlin through 2017.
- Use best available life history parameters for WCNPO striped marlin.

7.3 Sensitivity Analyses for the Base Case Model

The WG discussed what sensitivity analysis needed to be conducted for the 2019 benchmark WCNPO striped marlin stock assessment. The WG considered the input striped marlin catch data to be an important source of uncertainty. **As a result, the WG agreed to conduct sensitivity analyses to account for uncertainty in the fraction of the annual Japanese drift net catches that occurred in the South Pacific and to account for uncertainty in the amount of unreported catches across international longline fleets due to discarding and species misidentifications of striped marlin (Table 6). The WG also agreed to conduct a standard set of sensitivity analyses for life history parameters as in other billfish stock assessments**. In this case, the standard set of sensitivity analyses for billfish life history parameters included sensitivity analyses for natural mortality at age, stock-recruitment steepness, growth, and maturation (Table 6).

Table 6. Sensitivity analyses to characterize the effects of alternative assumptions about input data and life history parameters used in the base case model for the 2019 model assessment of WCNPO striped marlin.

Sensitivity Analyses for Input Catch Data
1. **Japanese driftnet fleet catch**. Fit the model to alternative annual proportions of driftnet catch occurring in the South Pacific.
2. **Longline fleet catch mispreporting**. Fit the model to alternative annual misreporting fractions for international longline fleets in the WCNPO.
Sensitivity Analyses for Life History Parameters
3. **Alternative natural mortality rates (M)**. Fit the model using higher and lower adult natural mortality at age vectors relative to the base case model.
4. **Alternative stock-recruitment steepness (h)**. Fit the model using higher and lower steepness values relative to the base case model.
5. **Alternative growth curves**. Fit the model using alternative growth curve parameters relative to the base case model.
6. **Alternative maturity ogives**. Fit the model using alternative maturity curve parameters (L_{50}) relative to the base case model.

7.4 Stock Projections for the Base Case Model

The WG discussed conducting stock projections to show the probable impacts of alternative harvest strategies on the WCNPO striped marlin stock. **The WG agreed that there was a need to account for uncertainty in both the terminal stock size estimates from the assessment and future recruitment.** The WG noted that the projections conducted in the 2015 WCNPO striped marlin stock assessment included three alternative states of nature for future stock-recruitment dynamics. These alternative states of nature for future recruitment were:

- Medium-term average recruitment. Resample the distribution of recruitment during 1994-2011.

- Recent average recruitment. Resample the distribution of recruitment during 2007-2011.
- Long-term average recruitment. Resample the estimated stock-recruitment relationship for 1975-2011.

It was suggested that the WG consider a similar approach for forecasting alternative states of nature of future recruitment in the 2019 benchmark stock assessment.

The WG agreed to conduct a standard set of stochastic 5-year projections using constant fishing mortality rate scenarios. The alternative fishing mortality scenarios for the standard projections were:

1. Scenario 1. F = the status quo F or average fishing intensity during 2013-2015.
2. Scenario 2. F = FMSY.
3. Scenario 3. F = F to produce 20% of unfished spawning biomass or $F_{0.2*SSB(F=0)}$.
4. Scenario 4. F = the highest 3-year average F during 1975-2017.
5. Scenario 5. F = Low F (e.g., $F_{50\%}$).

The WG also discussed the need to address the 2018 request for developing stock projection scenarios to rebuild WCNPO striped marlin from the Northern Committee of the WCPFC. In particular, the Northern Committee made the following statement to request projections analyses for WCNPO striped marlin from the ISC at the NC14 meeting held in Fukuoka, Japan (NC 14):

"70. NC14 agreed to request ISC to conduct projections examining rebuilding scenarios for North Pacific striped marlin that cover a range of rebuilding targets (20%SSBF=0, FMSY, and 0% to 50% reductions in increments of 10% from current catch limits), timelines (10, 15 and 20 years) and probabilities of each scenario to reach each target within different timelines. ISC should produce additional scenarios of catch reduction if the probability of reaching the rebuilding target in 10, 15, and 20 years is not at least 60%.

71. NC14 expressed concern over the status of NP striped marlin and urged the Commission to develop a rebuilding plan for the stock as a matter of priority. NC members are encouraged to submit a draft CMM, if possible."

The WG agreed to work on this request for rebuilding scenario analyses using stochastic projections based on the base case assessment model for WCNPO striped marlin. It was suggested that the WG consider using the AGEPRO (Brodziak et al. 1998, available at: https://www.nefsc.noaa.gov/nft/AGEPRO_Model.htm) or SSFuture (Akita et al. 2016) software for conducting the standard projections and rebuilding scenario analyses.

7.5 Working Subgroup for Assessment Modeling

The WG identified members of the Modeling Subgroup for the 2019 WCNPO striped marlin assessment which included Felipe Carvalho, Michelle Sculley, Hirotaka Ijima, Yi-Jay Chang, Jon Brodziak and other interested WG members. The role of the Modeling Subgroup is to produce the base case assessment model and stochastic future stock projections.

8. OTHER BUSINESS

The WG discussed other business, including future assessments, future meetings, and other issues.

8.1 Future Assessments

The WG discussed planning for the next billfish stock assessment to be conducted. The Vice Chair suggested that a Pacific blue marlin stock assessment update would be the next stock assessment for the WG. It was also suggested that the WG consider developing an approach for management strategy evaluations of billfish stocks.

The WG agreed that the Pacific blue marlin stock assessment would likely be conducted in 2021 and that the WG would conduct basic research on billfish population dynamics and fishery analyses in 2020.

8.2 Future Meetings

The next meeting of the ISC Billfish Working Group is planned for May 8-15, 2019, in Honolulu, Hawaii. The purpose of this meeting is to conduct the work needed to complete the assessment modeling for the WCNPO striped marlin stock. The Vice Chair noted that there would also be an election for a new WG Chair and also possibly a new Vice Chair at the May meeting.

The Vice Chair also noted that the WG would need to hold several conference calls prior to the next intercessional meeting to discuss work assignments and progress on the WCNPO striped marlin stock assessment modeling efforts.

The WG also discussed the location and dates for their next intersessional meeting in 2020 for ISC20. The Vice Chair noted that Taiwan had tentatively offered to host the next BILLWG meeting in 2020 in Taipei.

9. ADJOURNMENT

The workshop was adjourned at 3:33 PM on January 19, 2019. The Vice Chair expressed his appreciation to the rapporteurs and to all participants for their contributions to completing a successful BILLWG meeting.

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Attachment 1. - List of Participants

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Attachment 2. - Meeting Agenda

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

ISC BILLFISH WORKING GROUP (BILLWG)

INTERCESSIONAL WORKSHOP AGENDA

Meeting Site:	Jefferson Hall (East-West Center Imin Conference Center) 1777 East-West Rd, Honolulu, HI 96848
Meeting Dates:	January 14-21, 2019
Goals:	The BILLWG is holding an intercessional meeting to complete data preparation for the Western and Central North Pacific Ocean marlin stock assessment including catch by quarter data, CPUE standardization, size frequency data, tagging data, and life history parameters. The goal is to finalize all striped marlin stock assessment data for a 2019 benchmark stock assessment at this meeting.
Working Paper Deadline:	Working papers must be submitted to Hirotaka Ijima (ijima@affrc.go.jp) by **Monday, January 14, 2019.** Authors who submit a working paper on January 14th must provide 12 hard copies of that working paper on the first day of the meeting.
Local Contact:	Hirotaka Ijima, ISC BILLWG Vice Chair ijima@affrc.go.jp Michelle Sculley, NOAA scientist michelle.sculley@noaa.gov

January 14 (Monday) 9:15-10:00 – Registration and Opening of Meeting

1. Opening of Billfish Working Group (BILLWG) Workshop
    a. Welcome and Opening of Meeting
    b. Introductions

January 14 (Monday) 10:30-15:30

2. Meeting Logistics

  a. Standard Meeting Protocols
  b. Computing Facilities

BILLWG Google Drive URL and Access Information: ISC BILLWG

  c. Adoption of Agenda
  d. Assignment of Rapporteurs

3. Numbering Working Papers and Distribution Potential

4. Status of Work Assignments

5. Review of Recent Fisheries
   a. Review of Recent Developments and Issues
   b. Review of Availability of 2015-2017 Fishery Data
   c. Review of Information on BILLWG Web Page:
      i. http://isc.ac.affrc.go.jp/working_groups/billfish.html

6. Fisheries Statistics for North Pacific Striped Marlin and Other Billfishes, as Time Permits
   a. Fishery Data and Fleet Definitions
      i. ISC Countries
      ii. Non-ISC Sources
   b. Western and Central North Pacific Striped Marlin Catch by Fishery
      i. ISC Countries
      ii. Non-ISC Sources
   c. Standardized Striped Marlin CPUE by Fishery
      i. ISC Countries
      ii. Non-ISC Sources
   d. Other Biological Information

January 15 (Tuesday) 9:30-16:00

7. Fisheries Statistics for Western and Central North Pacific Striped Marlin and Other Billfishes
   a. Fishery Data and Fleet Definitions
      i. ISC Countries
      ii. Non-ISC Sources
   b. Western and Central North Pacific Striped Marlin Catch by Fishery
      i. ISC Countries
      ii. Non-ISC Sources
   c. Standardized CPUE of WCNPO Striped Marlin by Fishery
      i. ISC Countries
      ii. Non-ISC Sources
   d. Size Composition of WCNPO Striped Marlin by Fishery
      i. ISC Countries
      ii. Non-ISC Sources
   e. Other Biological Information
      i. Sex Ratios

ii. Tagging

January 16 (Wednesday) 9:30-16:00

8. Review Life History Parameters for WCNPO Striped Marlin and Other Billfishes
    a. Growth
    b. Length-Weight Relationship
    c. Maturity and Fecundity
    d. Natural Mortality Rate
    e. Stock-Recruitment Relationship

January 17 (Thursday) 9:30-16:00

9. Finalize Summaries of WCNPO Striped Marlin Fishery Statistics
    a. Catch Table
    b. Standardized CPUE Table
    c. Size Composition Table

10. Finalize Life History Parameters for WCNPO Striped Marlin
    a. Growth
    b. Length-Weight Relationship
    c. Maturity and Fecundity
    d. Natural Mortality Rate
    e. Stock-Recruitment Relationship
    f. Life History Parameter Summary Table

January 18 (Friday) 9:30-16:00

11. Finalize Summaries of WCNPO Striped Marlin Fishery Statistics, as Needed
    a. Catch Table
    b. Standardized CPUE Table
    c. Size Composition Table

12. Finalize Life History Parameters for WCNPO Striped Marlin, as Needed
    a. Growth
    b. Length-Weight Relationship
    c. Maturity and Fecundity
    d. Natural Mortality Rate
    e. Stock-Recruitment Relationship
    f. Life History Parameter Summary Table

January 19 (Saturday) 9:30-17:00

11. and 12. Complete All Work, as Needed

13. Work Plan and Assignments
    a. Benchmark Assessment Models for WCNPO Striped Marlin

b. Benchmark Assessment Models of Sensitivity runs for WCNPO Striped Marlin
c. Benchmark Forecast Models for WCNPO Striped Marlin
d. Benchmark Approaches for BILLWG WCNPO Striped Marlin Assessment
e. Identification of Work Group for Assessment Modeling

14. Other Business
    a. Future Meetings
    b. Group Photo
    c. Other Issues

15. Rapporteurs and Participants Complete Report Sections

16. Complete Workshop Report and Circulate; WG Reviews Report

17. Clearing of Report

18. Adjournment

January 20 (Sunday) No meeting

Attachment 3 - Working Papers

ISC/19/BILLWG-1/01	U.S. commercial fisheries for marlins in the north Pacific Ocean. Russell Y. Ito russell.ito@noaa.gov
ISC/19/BILLWG-1/02	Japanese catch statistics for western and central north Pacific striped marlin (*Kajikia audax*). Hirotaka Ijima ijima@affrc.go.jp
ISC/19/BILLWG-1/03	Catch and size data of striped marlin (*Kajikia audax*) by the Taiwanese fisheries in the western and central north Pacific Ocean during 1958-2017. Jhen Hsu, Yi-Jay Chang, Chi-Lu Sun and Su-Zan Yeh yjchang@ntu.edu.tw
ISC/19/BILLWG-1/04	Striped marlin (*Kajikia audax*) length data available from 1995-2017 in the Hawaii-based longline fishery. Michelle Sculley michelle.sculley@noaa.gov
ISC/19/BILLWG-1/05	Japanese length frequency data of western central north Pacific striped marlin (*Kajikia audax*). Hirotaka Ijima ijima@affrc.go.jp
ISC/19/BILLWG-1/06	Standardization of the striped marlin (*Kajikia audax*) catch per unit effort data caught by the Hawaii-based longline fishery from 1994-2017 using generalized linear models. Michelle Sculley michelle.sculley@noaa.gov
ISC/19/BILLWG-1/07	Abundance indices of western and central north Pacific striped marlin from Japanese longline and other fisheries. Hirotaka Ijima and Minoru Kanaiwa ijima@affrc.go.jp
ISC/19/BILLWG-1/08	Catch rate standardization of striped marlin in the Western and Central North Pacific Ocean by the Taiwanese tuna longline fisheries during 1989-2017. Yi-Jay Chang, Shu-Yu Yeh, Jhen Hsu, and Chi-Lu Sun yjchang@ntu.edu.tw

ISC/19/BILLWG-1/09	Size-dependent distribution of Pacific Striped Marlin (*Kajikia audax*) : The analysis of Japanese longline fishery logbook data using the finite mixture model. Hirotaka Ijima and Minoru Kanaiwa ijima@affrc.go.jp
ISC/19/BILLWG-1/10	Comparison of the results of the 2015 ISC striped marlin stock assessment base-case model using Stock Synthesis versions 3.24f and 3.30. Michelle Sculley michelle.sculley@noaa.gov
ISC/19/BILLWG-1/11	Preliminary genome-wide population analysis of swordfish *Xiphias gladius* Linnaeus, 1758. Akira Kurashima, Satoru Chiba, Hirotaka Ijima Yasuko Semba ijima@affrc.go.jp
ISC/19/BILLWG-1/12	Estimating age and growth of central north Pacific striped marlin using tagging data and direct observations of age. Mark Fitchett mark.fitchett@wpcouncil.org