FINAL

ISC/22/ANNEX/05

ANNEX 05

22nd Meeting of the
International Scientific Committee for Tuna
and Tuna-Like Species in the North Pacific Ocean
Kona, Hawai'i, U.S.A.
July 12-18, 2022

REPORT OF THE BILLFISH WORKING GROUP WORKSHOP

July 2022

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ANNEX 05

REPORT OF THE BILLFISH WORKING GROUP WORKSHOP

International Scientific Committee for Tuna and Tuna-Like Species
In the North Pacific Ocean (ISC)

December 13, 15-18, 2021
Webinar

1. OPENING AND INTRODUCTION

1.1. Welcoming and Remarks

Hirotaka Ijima, the ISC Billfish Working Group chair, opened the data preparatory meeting for Western Central North Pacific striped marlin. Scientists from Chinese Taipei, Japan, United States of America (USA), Pacific Community Oceanic Fisheries Program, and the Inter-American Tropical Tuna Commission (IATTC) participated in the meeting. The participating scientists are listed in Attachment 1.

1.2. Introduction

The Billfish Working Group (WG) of the International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC) held a virtual five-day meeting by webinar. The goals of the meeting were: i) agree on the data and the model configuration of Stock Synthesis 3 and, ii) report the progress of biological study for billfish species.

1.3. Standard Meeting Protocols

The WG chair introduced protocols for the webinar meeting. Cisco Webex was used for this meeting, and the working papers on the agenda were presented and discussed.

2. ADOPTION OF AGENDA AND ASSIGNMENT OF RAPPORTEURS

Prior to the meeting, The WG adopted the draft agenda of the meeting (Attachment 2). The WG chair assigned the numbers for the working papers (WP) (Attachment 3) and the rapporteurs for the agenda items as follows:

Date	Item	WP	Rapporteur
13th Dec.	Abundance Indices	WP01-03 Presentation 1	M Kanaiwa, H Ijima
15th Dec.	Catch and length frequency data	WP04-06	J Brodziak, M Kanaiwa
16th Dec.	Model configurations	WP07-08	Y-J Chang, H Koike
17th Dec.	Progress of biological study for billfish species	WP09-11 Presentation 2-3	M Kinney, A Kurashima

3. NUMBERING WORKING PAPERS AND DISTRIBUTION POTENTIAL

The WG agreed to post the finalized working papers on the ISC website and make them publicly available.

4. ABUNDANCE INDICES

CPUE Standardization for Striped Marlin (Kajikia audax) using Spatio-Temporal Model using INLA. Hirotaka Ijima and Haruko Koike (ISC/21/BILLWG-03/01)

Using the Japanese logbook data, we addressed to standardize the CPUE of the Western Central North Pacific striped marlin. Before the CPUE standardization, we analyzed the relationship between detailed fishing gear settings and fishing grounds using a geostatistical model. Adding the effect of fishing gear to the geostatistical model did not significantly improve the WAIC. This result indicates that the gear setting also depends mainly on the location, and we did not use gear information for CPUE standardization. The fleet definition was based on the previous stock assessment and assumed that the catch size would change depending on the area and season. We used R software package INLA for these analyses, and model selection was performed using the WAIC and the LOOCV obtained from Bayesian estimation. As a result of model selection, a spatiotemporal model was selected. To standardize CPUE, we estimated spatial CPUE annually, averaged according to the fleet definition. Striped marlin might be migrating seasonally in the North Pacific. In this study, we tried to build a spatiotemporal model considering seasonality. However, most models had technical problems. For example, some models did not converge, and the calculation crashed in the middle. Some converged model indicated that the spatial distribution of latent spatial field fluctuates greatly depending on the season. Thus, it needs to develop a spatiotemporal model considering seasonality for the future.

Discussion

The WG indicated that there was no correlation between nominal CPUE and gear setting because the striped marlin is bycatch species. The WG member also noted that the archival tagging study showed striped marlin distribute shallow water most of the time (Lam et al. 2015). The authors responded that it is a possibility and that it is necessary to confirm in the future whether there is a relationship between gear setting and CPUE in the target species, such as bigeye and yellowfin tuna.

The WG discussed the high zero catch ratio in striped marlin logbook data. The authors have not confirmed the zero catch rate in this study but considered it at least 70-80%. The WG also asked why the negative binomial distribution and the zero-inflated negative binomial distribution were not considered for the excess zeros data. The authors explained that there was time constrain.

The WG asked the method of creating standardized CPUE in INLA. The authors tried to calculate the least square mean in INLA in this study. To calculate the least square mean, INLA needs all combination covariate for the prediction data. This data is input to the program for parameter estimation, which outputs the standardized CPUE simultaneously with the parameter estimation. If the prediction data exceeds a certain level during this calculation, INLA will stop working. Therefore, in this case, the least-squares mean was calculated externally. The inability to calculate estimates has been a problem, and a new R software package, "inlabru" is being developed.

The WG asked to show the residual plots. The authors have calculated the randomized quantile residuals and presented the results. The WG pointed out that the models selected by WAIC still have biases in the residuals, and there is room for improvement.

CPUE Standardization of Striped Marlin Caught by Taiwanese Distant-Water Longline Fishery in the Western and Central North Pacific Ocean During 1995 – 2020. Ke Lee, Jhen Hsu, Yi-Jay Chang (ISC/21/BILLWG-03/02)

This report provides the standardized catch rate of striped marlin caught by Taiwanese distant-water tuna longline fishery (DWLL) during 1995 – 2020 in the Western and Central North Pacific Ocean (WCNPO). Catch rates were standardized using the Vector-Autoregressive Spatio-Temporal model with year, quarter, vessel, spatial, and spatio-temporal effects as explanatory variables. Results indicated that the standardized catch rate of the DWLL for the WCNPO striped marlin has fluctuated overtime, and recently increased from 2018 to 2020.

Discussion

The WG member asked about the target effect in the Taiwanese longline vessel and the possibility of including it in the future. For example, previous analysis was used cluster analysis results for the covariate of the GLMM model. Alternatively, the multispecies model can be available in the VAST model to consider the target effect. The authors answered that is an important matter and will be addressed in the future.

The WG clarified that the distance unit was 5x5 degree and noted that it might be too big for the VAST analysis. This is a point of simplicity vs complexity or bias variance trade off. However, it is difficult to know what the optimal configuration now.

The WG requested to compare the results of this study with the previous results. The WG noted that the previous residual pattern also looks fine and indicated that it is hard to say which model has the advantage for the residual pattern. The WG also noted the previous model has fewer outliers. The authors answered that the previous analysis aggregated data, but the current study used original data.

The WG noted that there is an improvement of the modeling process in the current study compared to the previous study. Current VAST model has a higher value of deviance explained, although the annual CPUE are similar between the two studies.

The WG noted that the new model has adequate residuals and the output results appear a bit smoother than the previous analysis. On the other hand, the initial decline and current status are much lower in the new model, which may affect stock synthesis analysis. However, that is not the reason to reject this analysis.

Standardization of the Striped Marlin (Kajikia audax) Catch per Unit Effort Data Caught by the Hawaii-based Longline Fishery from 1994-2020 Using Generalized Linear Models. Michelle Sculley (ISC/21/BILLWG-03/03)

This working paper provides the standardization of the Hawaii-based longline fishery striped marlin (*Kajikia audax*) catch per unit effort (CPUE) data. Two analyses with 15 different potential explanatory variables were explored for the complete dataset and the deep-set only data. The delta-lognormal generalized linear mixed model (DL-GLMM) has been shown to provide the best fit to the data based upon percent deviance explained in previous standardizations and was used in this work. Results showed that the deep-set sector standardized CPUE was very similar to the combined dataset. The diagnostics of the either models do not suggest any problems with poorly fitted data; therefore, it is recommended to use the combined dataset DL-GLMM standardized CPUE for the 2022 striped marlin base-case assessment model, as it is consistent with previous assessments.

Some Potential Effects of Alternative CPUE Standardizations for Striped Marlin in the Hawaii Longline Fishery. Jon Brodziak (Presentation 1)

In response to a WG question about the possible effects of using a negative binomial distribution to standardize Hawaii longline CPUE, some alternative CPUE analyses were conducted before the data preparation meeting. The initial investigation was based on the USA Hawaii longline fishery observer data during 1994-2019 due to a lack of response time. Here it was noted that the USA longline observer data was comprised of about 90,000 sets in comparison to the USA longline logbook data which totaled about 590,00 sets reported by longline vessel captains. Four types of negative binomial standardizations were considered in the analyses with the fishery observer data using alternative model structures that were similar to that used in the USA CPUE standardization based on the full set of longline logbook data. These were: a zero-inflated negative binomial with fixed vessel effects fitted with the R package "pscl", a zero-inflated negative binomial with random vessel effects fitted with R package "glmmTMB", a standard negative binomial with fixed vessel effects fitted with the function "glm.nb" (glmnb), and a generalized additive negative binomial with random vessel effects fitted with the function "gam" (gamnb). Of these four model types, the glmnb and gamnb provided the best fits to the longline fishery observer data and explained about 30% of the deviation in the striped CPUE data. The time series of standardized CPUE from each of the model types were significantly positively correlated ($\rho > 0.99$). This suggested that the negative binomial distribution may be a useful alternative to the delta-lognormal distribution used to standardize USA longline CPUE for striped marlin. However, when the two best-fitting negative binomial models were applied to the full Hawaii longline logbook data set during 1995-2020 that was used for standardization, it was found that the standard negative binomial with fixed vessel effects and the generalized additive model with random vessel effects explained a lower percentage of the null deviance in the data (17% and 13% respectively). It was also noted that the recent time trends for the two best-fitting negative binomial models differed when fit to the fishery observer data versus the logbook data with the fits to the observer data showing an increasing trend and the fits to the logbook data showing a flat trend despite being highly positively correlated ($\rho > 0.80$). Overall, the negative binomial modeling results suggested that the delta-lognormal CPUE standardization model provided a better fit to the Hawaii longline logbook data for striped marlin. However, the results also suggested that there may be some utility in re-evaluating the longline data sets used for the Hawaii longline CPUE standardization as this data modeling choice may have an impact on the resulting CPUE trends.

<u>Discussion</u>

The WG indicated the difference the Standardized CPUE trend between delta-lognormal model and negative binominal model in the recent years.

The WG noted it is not clear whether this is due to differences in the assumed error distribution or the data, but **it was agreed that the stock index provided in the WP should be used, as the analysis using log-book data is not yet available and this is an update of the method agreed in the previous analysis.** The decision was then made based on the model fitting.

5. CATCH AND LENGTH FREQUENCY DATA

5.1. Catch statistics and length frequency data for ISC member countries

Update Japanese Data Set for Striped Marlin Stock Assessment in the Western and Central North Pacific Ocean. Hirotaka Ijima (ISC/21/BILLWG-03/04)

This paper updated Japanese catch statistics and length composition data required for the Western and Central North Pacific striped marlin stock assessment in 2022. These data sets were prepared the same procedure as the previous stock assessment, assuming that the fishery definition would not be changed. However, a programming error was found in the longline logbook data reading. Some scripts had to fix, and longline catch statistics were changed. For driftnet catches before 1993, new estimate statistics have been submitted. However, this estimated catch is preliminary, and the data unit has changed from the catch weight to the catch number. In addition, the available period will be shorter. Thus, it would need to change the basic assumptions of the stock assessment model, such as the assessment period and the unit of catch data, when the BILLWG would use alternative driftnet catch data in the next stock assessment. The length composition data was almost the same as in the previous stock assessment data. Finally, the data for 2020 is still being compiled due to COVID-19 and should be used with caution.

<u>Discussion</u>

The WG member asked what kind of longline vessels are not required to submit logbooks. The author answered that it is a small-size longline fleet <10t.

The WG asked a lognormal bias correction was applied to the length-weight equation to predict length composition from weight composition and it was noted that this issue would be checked and resolved to account for the expected value of the error term.

The WG also discussed the issue of how to treat the Japanese driftnet catch data in the 2022 assessment and **it was agreed that the revised catch data were likely more precise and that the differences in the catch units in the 1970s could be accounted for by separating the early driftnet catches into separate fleets with units of catch weight or catch numbers.** Overall, the WG noted that the catch and length data prepared for the 2022 stock assessment were similar to the data used in the 2019 assessment.

The author was concerned that starting the stock assessment from 1977 may substantially impact the initial equilibrium catch and R0 estimation. Considering these concerns, **the WG agreed to replace the catch data from 1977-1993**. In other words, a new number-based Japanese driftnet fleet (1977-1993) will be established.

The author noted that, due to the Covid-19 pandemic, there would be some delays in the provision of Japanese fishery statistics for the years 2020 and 2021, and as a result, data for these years may be updated as improved information is collected in the future. The presenter also noted that there was likely an overall reduction in Japanese fishing operations in the year 2020 due to the Covid-19 pandemic.

Catch and Size Data of Striped Marlin (Kajikia audax) by the Taiwanese Fisheries in the Western and Central North Pacific Ocean During 1958-2020. Ke Lee, Cheng-Hao Yi, Wei-Jen Wang, Cheng-Yu Lu, Yi-Jay Chang (ISC/21/BILLWG-03/05)

Catch and size data of striped marlin caught by the Taiwanese fisheries in Western and Central North Pacific Ocean (WCNPO) during 1958-2020 and 1981-2020, respectively, were summarized for the 2022 ISC striped marlin stock assessment. Total catches fluctuated about 600 metric tons from 1950 to 1991, then declined gradually until 2001 at 201 metric tons, and increased sharply at 896 metric tons in 2003. After then, the total catches declined again until 2014 at 202 metric tons. The total catches have stabilized at about 400 metric tons in the past four years. Size data collected by the Taiwanese distant-water longline fishery revealed a relatively stable trend from 2004 to 2020. For the consistency of the data format used in the stock assessment, lower-jaw-to-fork length (LJFL) was converted into eye-to-fork length (EFL) as the input data of the stock assessment model.

Discussion

The WG noted that the samples sizes of the length compositions were generally low prior to 2004 with substantial interannual variation in mean length. In contrast the Taiwanese length compositions from 2004-2020 exhibited a stable trend. **As a result, the WG agreed to only use the Taiwanese length composition data from 2004-2020 in fitting the stock assessment model as was done in the 2019 assessment.**

Withdraw (ISC/21/BILLWG-03/06)

The WG noted that the USA did not provide a working paper on the Hawaii longline catch and length data for striped marlin for this meeting. It was noted that the USA had provided a corrected catch time series through 2017 earlier this year and that the USA would provide the new catch and length data from the Hawaii longline fishery for the years 2018-2020 through correspondence prior to the next stock assessment modeling meeting.

6. CATCH STATISTICS NON ISC MEMBERS

Information on the reported catches of striped marlin from the WCPFC by non-ISC countries was presented by the WG chair. It was noted that the WCPFC catches for Vanuatu and China had increased in the most recent WCPFC catch database. In particular, the catches reported by Vanuatu appeared to be higher than might be expected in 2014-2016 relative to previous reports. **The WG discussed how to treat the revised WCPFC catches and agreed to use the most recent catch data reported to the WCPFC**. However, it was also suggested that there be a model sensitivity run to evaluate the effect of assuming the previous reported catches from Vanuatu and China as used in the 2019 stock assessment.

Revised Analyses of the Reproductive Maturity of Female Striped Marlin, Kajikia audax, in the Central North Pacific off Hawaii. Robert Humphreys and Jon Brodziak (ISC/21/BILLWG-03/07)

Declining trends in the population biomass of striped marlin, *Kajikia audax*, in the western and central North Pacific, have led to recent assessments of this regional stock. As part of the data inputs into these assessments, information on reproductive biology supports the evaluation of stock productivity. The lack of reproductive information for the central North Pacific area led to our first study on female reproductive maturity and spawning dynamics based on gonad histology from observer sampling of the Hawaii-based pelagic longline fleet (Humphreys and Brodziak, 2019). Past genetic studies and recent results from a current study indicate stock intermingling within the fleet's striped marlin catch. In this study, we re-analyze the length distribution and reproductive data to minimize potential external stock individuals in our dataset. Our working hypothesis is that the occurrence of extra-stock females during the central North Pacific spawning season would be best identified as regenerating individuals since they would be reproductively out-of-phase. Logistic regression model runs using standard and robust GLM approaches were applied to all data and portions of the dataset based on spawning/non-spawning season and inclusion/exclusion of regenerating phase females. The robust GLM model approach using length as the single variable provided the two best maturity ogive fits to the data. Our new estimates of female L_{50} (152.2 and 153.6 cm EFL) are based on best fits to portions of the data restricted to the spawning season and exclusion of regenerating females within the spawning season, respectively. These revised L_{50} estimates are lower than our previous estimate of 160.4 cm EFL for the central North Pacific. The central North Pacific around Hawaii represents a very dynamic region that functions as a spawning, nursery, and young adult habitat from which fish emigrate and immigrate to as they grow and mature.

<u>Discussion</u>

In reply to a question regarding about the estimation of spawning frequency, the authors explained that this work has not yet been done, but maybe completed in the future through a series of weekly or biweekly sample collections during the spawning season.

The WG queried whether it is reasonable to exclude the regenerating mature fish when estimating the mature ogive. The authors explained that this was done to exclude potential stock interlopers in the sample since fish from the South Pacific were most likely to be in the regenerating phase as the spawning season is offset by about 6 months relative to the fish in the North Pacific. The authors also pointed out that there is not that much difference in the length composition and L50 when omitting fish in the regenerating phase.

The WG commented that the stable isotope analysis using hard parts (e.g. otoliths), and possible parasites (but noting candidate selection of parasites could be challenging) may be used in the future for identifying individuals that have moved north from the South Pacific or elsewhere. The authors agreed that the otolith micro-chemistry analysis might provide useful information for identifying the origin of the sampled fish.

The WG also discussed previous genetic research for discriminating stocks of striped marlin in the WCNPO.

The WG noted that the new estimates of female L50 (152.2 and 153.6 cm EFL) are based on best fits to portions of the data restricted to the spawning season and exclusion of regenerating females within the spawning season, respectively. Although the revised L50 estimates are lower than previous estimate of 160.4 cm EFL for the central North Pacific, the WG considered the revised estimates to be reliable.

Candidate Biological Parameters for the Western and Central Northern Pacific Ocean Striped Marlin Stock Assessment. Hirotaka Ijima (ISC/21/BILLWG-03/08)

This working paper summarized the biological information required for assessing Western Central North Pacific Ocean (WCNPO) striped marlin stock, including growth curves and natural mortality rate. The growth curves were obtained from several studies in the Pacific Ocean, and these parameters were converted to the parameter in Stock Synthesis 3. Specifically, the lower jaw-fork length was converted to eye-fork length, and the L1 and L2 parameters were associated with age 0.5 and 15, respectively. The natural mortality was estimated by the same meta-analysis method as the previous study using the growth curve reported in the South Pacific Ocean. Furthermore, multiple population assessment model settings were proposed due to the relationship between natural mortality and growth curves.

<u>Discussion</u>

The WG commented that the use of the LJFL-EFL conversion equation of Kopf 2011 et al. (EFL = 0.834 LJFL + 36.01) should be avoided since it can result in LJFL values being smaller than EFL values at a certain size ranges. The author believed that the equation is suitable for use because the unit of measurement is mm rather than cm. However, estimated EFL values were larger than LJFL values for fish less than 20cm which are extremely rare in the catch. **Therefore WG agreed that it is appropriate to apply the conversion equation of Kopf et al. 2011 to the South Pacific growth curve.**

The author explained why and how the sex-combined growth and natural mortality was estimated. **The WG agreed to continue improving biological parameter values of striped marlin (e.g., any sexual difference in growth or mortality) in the future based on the information of the international billfish biological sampling (IBBS) and other collaborative projects**.

A WG member asked for an explanation as to why L1 and L2 parameters are used to characterize growth and not Linf for the L2. The WG explained that L1, L2, and K values are calculated directly from the von Bertalanffy growth function and maximized observed age. Stock Synthesis 3 linearly extrapolates the length between age 0 and minimum reference age (A1) and uses the von Bertalanffy curve to characterize growth after A1. A WG member suggested that moving from an often negative t0 value to a more positive value of t0 of a value around 0 would result in a reduction in the size at age of fish less than A1. However, the **WG agreed that the proportion of fish less than A1 in catches is small and therefore should not significantly impact the stock assessment. The WG also explained that SS3 has capability to use the standard von Bertalanffy growth curve parameterization.**

The WG discussed the value of natural mortality for each growth curve. The author pointed out the problems with the meta-analysis. Using Lorenzen's equation for natural mortality, the slower the growth rate (i.e. high vBGF parameter function K), the higher the age-specific mortality rate. However, when the meta-analysis results are used for scaling, the slower the growth rate, the lower the natural mortality rate.

The WG commented that the current meta-analysis could include the growth uncertainty by randomly sampling the growth parameters for the meta-analysis. The WG noted the comment and will continue to improve the natural mortality rate of striped marlin in the future.

The WG also raised the issue of the estimated maximum age used in the meta-analysis due to the limitations of the dorsal spine sectioned aging methodology. Since it was impossible to resolve these issues at this time, **the WG agreed to apply previously used best estimated natural mortality rates for all growth curves to maintain consistency with the last stock assessment.**

The WG discussed an apparent problem related to the minimum bin size. Minimum bin size corresponds to the size at age 0, **which the WG agreed to explore changing the bin size to 50cm.** However, the author mentioned that SS3 gives the error message that the minimum bin size is too large when using 50 cm as the input value (SS3 requires below 10cm minimum bin). The WG member questioned the necessity of changing the size bins from the original 50cm. The importance of creating the SS3 model without any errors was stressed since it will be considered for the stock rebuilding plan of the WCNPO striped marlin. The author will report on the effect of this bin size error in the first modeler's meeting.

7. MODEL CONFIGURATIONS

7.1. Version of the Stock Synthesis 3

The WG discussed the version of Stock Synthesis 3. **The WG agreed to use the latest version 3.30.18 and the most recent version of the r4ss package**.

7.2. Fleet Definition and Data Sets

The WG discussed the fleet definition for the SS3 model (Table 1). Two new fisheries, F24 and F25, were added to use the re-estimated Japanese driftnet catch data. The US catch and size composition data are simple updates and are not expected to change significantly, but the WG requested a brief document before the stock assessment.

7.3. Combination of Biological Parameters

The WG created an ensemble of parameters based on the three growth curves (Table 2). The same values of natural mortality were used for all models as in the previous study. As there was no evidence for the CVs of the growth curves, the same values were uniformly set. The same assumption was used for all models for the length-weight relationship because the EFL-based function was Sun et al. 2011 only. The WG also set same value for the slope parameter of maturity at length because of the limited information. The WG discussed alternative L50 value in EPO. **The WG agreed to first attempt fitting the model first with an approximate L50 at 181 cm EFL (Gonzalez-Armas et al. 2006, Table 3, Stage 4).** Pending model performance, another alternate female L50 value at 166.5 cm EFL (Sevilla-Rodriguez 2013 MS thesis) will be attempted. Noted this alternate value was converted from LJFL (LJFL = 1.1454 x EFL + 7.3164 mm; S. Ortega-Garcia, pers. comm.)

7.4. Future Projection

The WG addressed stochastic future projections considering various possibilities in the previous stock assessment. However, after the stock assessment, the WG will hold the stock rebuilding plan meeting and implement the detailed future projections. Due to the limited time available for these tasks, the **WG agreed to use SS3 for simple deterministic future projections for this stock assessment (Table 3).** The WG acknowledged that WCPFC has already included specific language for stock rebuilding, which should be considered in the future projection.

7.5. Sensitivity Analysis

The WG discussed the combination of sensitivity analysis. The current stock assessment uses the ensemble approach for uncertainty in the growth curves. Thus, sensitivity analysis on the growth curves can be excluded. However, the **WG agreed to make a final decision on the uncertainty during the stock assessment, as it is often identified during the model building process.** The WG summarized the tentative list of sensitivity runs (Table 4).

8. DATE OF THE STOCK ASSESSMENT MEETING AND MEETING FOR REBUILDING PLAN

The WG noted the workload of rebuilding analysis and discussed the flexible date of the stock assessment meeting and meeting for rebuilding plan. The WG will hold two modeling meetings before the stock assessment. The tentative date for the meetings are listed as below:

Meeting	Date	Venue
Data submission	10th January 2022	-
Modelers meeting 1	7th February 2022	Webinar using WebEx
Modelers meeting 2	1st March 2022	Webinar using WebEx
Stock assessment meeting	28 March-2 April 2022	Webinar using WebEx
Stock rebuilding meeting	25-28 April 2022	Webinar using WebEx

9. PROGRESS OF BIOLOGICAL STUDY FOR BILLFISH SPECIES

Progress of the International Biological Billfish Sampling Project (IBBS). Michael Kinney (Presentation 2)

For highly migratory species such as tuna and billfish, basic biological processes like growth and reproduction are notoriously difficult to estimate accurately. The Billfish Working Group (BILLWG) indicated that improved estimates of these basic biological processes were key components in efforts to reduce model uncertainty in the assessment of billfish in the North Pacific. The United States, as a member of the BILLWG, established a collaborative biological sampling effort with Japan and Taiwan in order to improve estimates of growth, maturity, and stock structure by developing a uniform sampling protocol that can be used across the North Pacific. We have designated this the International Billfish Biological Sampling project (IBBS). At the meeting of the BILLWG we present an update to progress made by all project partners, as well as an introduction to the newly developed cloud-based database which will be available to use by all members of the IBBS project soon.

<u>Discussion</u>

The WG mentioned the SPC tissue bank collection may be a place to look for more information on how to deal with sample collection, storage, and shipping. The WG did not have suggestions of who to contact for such information but it should be possible. It was indicated that much work had been done on these processes in the lead up to the creation of IBBS, but more information is always valuable.

The working group discussed how to deal with sample process time and space. It was mentioned that process time and space for these samples is limited for some members and so there are issues with storing lots of them. The US mentioned that it can store samples for other nations but that requires some form of shipping which can be difficult but was still offered. It was mentioned that 10-20 individuals can be processed in a single day, indicating that it is a time consuming process, and slides take about 1 week to do for 10 individuals. The WG indicated that more resources are needed from human resources and some members suggested having more studies focused on such work to offset the time commitment.

There was some interest in limiting what users could see in the database based on their credentials and authorizations, perhaps masking data with restricted views such that the granular data would not be exposed to all database users. For example, you can input exact lat and long data for the sample collected, but everyone else only will only see the region or a 5°x5° grid cell of where it was collected. This will be investigated further by the US. Japan also indicated that they would check again to make sure that the current sharing of data that has already begun is still OK and if future data will also need to be approved or if the US Japan MOU is enough.

Sampling Progress and Efforts for the Biological Studies of Striped Marlin, Blue marlin and Swordfish in Japan. Akira Kurashima and Hirotaka Ijima (Presentation 3)

The ISC billfish working group members work on the sampling according to the ISC program. However, the sampling of striped marlin, blue marlin, and swordfish is difficult in Japanese fisherman's ports because several parts were already discarded on the board. Hence, we have built 4 types of routes for sampling for ISC sampling in Japan. In this presentation, the sampling progress and effort of Japan report. Sampling was performed using research vessel, training vessel, commercial vessel, and sport fishing. The sampling using commercial vessel was performed in the multiple fisherman's ports because to collect specimens from wide area. As a results, a total of 65 striped marlin, 33 blue marlin and 173 swordfish were collected in the area "W" and "C" until August 2021.

Discussion

It was commented by the WG that Japan had made great progress on sampling and that in the future the IBBS database should include the same information as was given in this presentation about whether gonads had ever been frozen. The presenter indicated that this could be added to the database.

Preliminary Results of Daily Age Estimation for Juvenile Striped Marlin (Kajikia audax) Caught in the Seas around Japan, North West Pacific Ocean. Miyuki Kanaiwa, Ayumu Furuyama, Hirotaka Ijima, Akira Kurashima, Minoru Kanaiwa (ISC/21/BILLWG-03/09)

Striped marlin and swordfish differ in age and growth between the eastern and western Pacific, but the cause of this difference is not known. Since age estimation methods differed between the eastern and western Pacific studies, a unified approach is necessary. Therefore, at ISC/20/BILL WG-01/05, it was agreed that the daily age estimation should first be done using otoliths to determine the body length at one year of age, followed by age estimation using spines (Kanaiwa et al. 2020). The study followed that method to estimate the daily age of striped marlin using otoliths and compared the estimates of daily age between Kopf et al. 2011 and Shimose and Yokawa 2019, which used the same method to estimate the daily age of striped marlin. The 95% confidence interval widened significantly with the addition of this study. Although the results were not necessarily consistent with Shimose and Yokawa (2019) and Kopf et al. (2011), there were no major inconsistencies. This inconsistency may be partly due to the small number of cross-reading sessions and the fact that there are issues with the reader's skill level and reading style. Therefore, the present results are preliminary and will be recounted again.

Discussion

The WG asked that based on the L50 presented in the US talk the day before that some of the individuals in this presentation may be mature. It was responded that that would only be the case if the L50 was the same in the western Pacific as it is in the central Pacific. It is likely that based on the larger L50 values found in studies focused on samples taken from the western Pacific that these animals would likely not be mature.

The working group asked if this information should be used in the assessment base case analysis, no was the response, instead it was suggested that such information may be good to use in a sensitivity run.

The WG questioned if something perhaps was missing from estimates of L50 since as these animals grow and get close to maturity they start putting girth on more than length.

The WG commented that in terms of daily ring counts the difference between reads could be compared if they had saved picture of the otoliths with marks all along them indicating what the reader had marked as a daily rings. The authors responded that this was the way the study was performed, even indicating that slides in the presentation showed just such marks on pictures of otoliths used in the study.

The WG asked if the IBBS database could be used to store information on things like daily ring counts and other various age and growth related data coming from this work. It was responded that this was not part of the current database plan but that something like this would not be very difficult to implement due to the nature of the database and the use of unique database sample ID's. The author indicated that there had been much interest over the development of the project by others to include more and more information and species into this work. The author understood these desires but is more interested in getting this database up and running for the fundamental needs of the IBBS project. Further extension would be a distant second to having the database server the primary needs of the IBBS work.

Preliminary Report on Homology of Cross-Section Position in Fin Spine of Striped Marlin (Kajikia audax) for Age Estimation. Ayumu Furuyama, Miyuki Kanaiwa, Hirotaka Ijima, Akira Kurashima, Minoru Kanaiwa (ISC/21/BILLWG-03/10)

One of the important age phenotypes of striped marlin is the fin spine. In this study, multiple sections of dorsal fin spines from a single spine were prepared and age estimation results were compared in order to test whether spines that had been cut off at the base during sampling could still be used for age estimation. The estimated ages of the 1/2 sections were compared with those of the 2/2 and 3/2 sections, and no significant differences were found between the sections, suggesting that even if a section cannot be made at 1/2 joint width due to cutting at the base of the spine, it can be used for age assessment if a section can be made at 2/2 or 3/2.

Discussion

It was mentioned that when US samples were taken and the fin spines were cut the observers were asked to reach in and pull the base of the spines by hand which allowed the base to be collected. It was unclear how exactly this was done but it is unlikely such a process would be helpful in instances were spines were cut due to time constraints.

The WG also mentioned that other projects are using computer learning technique to estimate the age of these animals. There was also a mention of a working group for Bluefin turn doing the same thing in Australia.

There is also a group in Australia through CSIRO where they are looking to age marlin and swordfish with cross sections but using annual marks in swordfish and striped marlin. What they found was that older ages in otoliths were being counted compared to what was being counted in fin spines of the same swordfish. The chair indicated that this is interesting but at the moment there are no planed collaborative works between the north and south pacific. The working papers for this work will be shared with the group regardless.

Size-Based Spatiotemporal Dynamics of Striped Marlin Movement in the Pacific Ocean: First Observations. (ISC/21/BILLWG-03/11)

Striped marlin, *Kajikia audax*, have been in overfished condition in the western and central North Pacific, and overfishing is still occurring, prompting an urgent need to devise conservation and management measures based on the best, current knowledge on biology and ecology of this species. Movement data is crucial information for the understanding and determination of stock structure, mixing, and ecological relationships of striped marlin. This paper attempts to distill the results available from genetic and tagging studies, and characterize movement patterns from complementary approaches. Broadly speaking, recent genetic and tagging results are in agreement and support the presence of three genetic populations (North, Western South and Eastern Central) in the Pacific Ocean. Furthermore, mixing do occur between distinct populations, and in particular, movement between North Pacific and Western South Pacific could reach 19% or higher. We postulate mixing may be widespread in space and time, and may be observable with better sampling and tagging technologies. Limitations of what genetic and tagging studies were explained in details, and suggestions for future research and funding were explored. Finally, we introduce an approach to utilize fisheries data, namely size information in fisheries logbooks, and be combined with movement insights derived from genetics and tagging and generalize the spatiotemporal dynamics on movement for striped marlin.

Discussion

The WG asked if upwelling or gyres were looked at in comparison to the presented movements. The author indicated that yes this was something they were looking at for future papers, but at the moment they are focusing on other oceanographic features like SST fronts.

The WG asked if the migration patterns presented here had been looked at in terms of individual animal size. The author indicated that this was something they were interested in doing in the future but that tagging was also limited to specific size ranges (as small fish can't really handle having tags put on them, while bigger animals are rarer and harder to sample.).

10. OTHER ITEMS

The WG agreed to discuss a roadmap for a post-sampling biology collaboration study. These works will begin in 2022.

11. CIRCULATE WORKSHOP REPORT

The WG Chair prepared a draft of the workshop report for the data preparation of stock assessment and reviewed it with the WG members. The WG Chair distributed the provisional report that includes the biology study section via email for WG members to finalize.

12. ADOPTION

Using email, the WG adjourned the data preparatory meeting of Western and Central North Pacific striped marlin stock assessment at 12:00 on 10 January 2022 (JTS). The WG Chair expressed appreciation to the participating scientists for their collaboration in the stock assessment work.

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Table 1. Fleet definition for the WCNPO striped marlin stock assessment.

Fleet No	Fleet name	Catch units	Size data	CPUE	Source
F1	F01_JPNLL_Q1A1_Late	N	Y	S01_JPNLL_Q1A1_Late	Ijima and Koike 2021 Ijima 2021a
F2	F02_JPNLL_Q1A2	N	Y	N	Ijima 2021a
F3	F03_JPNLL_Q1A3	N	N (Mirror to F2)	N	Ijima 2021a
F4	F04_JPNLL_Q2A1	N	Y	N	Ijima 2021a
F5	F05_JPNLL_Q3A1_Late	N	Y	S02_JPNLL_Q3A1_Late	Ijima and Koike 2021 Ijima 2021a
F6	F06_JPNLL_Q4A1	N	Y	N	Ijima 2021a
F7	F07_JPNLL_Q1A4	N	N (Mirror to F2)	N	Ijima 2021a
F8	F08_JPNLL_Q2A2	N	N (Mirror to F4)	N	Ijima 2021a
F9	F09_JPNLL_Q3A2	N	N (Mirror to F5)	N	Ijima 2021a
F10	F10_JPNLL_Q4A2	N	N (Mirror to F6)	N	Ijima 2021a
F11	F11_JPNLL_Q4A3	N	N (Mirror to F6)	N	Ijima 2021a
F12	F12_JPNLL_Others	B	N (Mirror to F4)	N	Ijima 2021a
F13	F13_JPNDF_Q14_EarlyLate	B	Y	N	Ijima 2021a
F14	F14_JPNDF_Q23_EarlyLate	B	Y	N	Ijima 2021a
F15	F15_JPN_Others	B	N (Mirror to F4)	N	Ijima 2021a
F16	F16_US_LL	B	Y	S03_US_LL	Sculley 2021 To be detailed
F17	F17_US_Others	B	N (Mirror to F16)	N	To be detailed
F18	F18_TWN_DWLL	B	Y	S04_TWN_DWLL	Lee et al., 2021a Lee et al., 2021b
F19	F19_TWN_STLL	B	N (Mirror to F18)	N	Lee et al., 2021a
F20	F20_TWN_Others	B	N (Mirror to F14)	N	Lee et al., 2021a
F21	F21_WCPFC_Others	B	N (Mirror to F12)	N	WCPFC yearbook
F22	F22_JPNLL_Q1A1_Early	N	N (Mirror to F1)	S06_JPNLL_Q1A1_Early	Ijima and Koike 2021 Ijima 2021a
F23	F23_JPNLL_Q3A1_Early	N	N (Mirror to F5)	S07_JPNLL_Q3A1_Early	Ijima and Koike 2021 Ijima 2021a
F24	F24_JPNDF_Q14_Mid	N	N (Mirror to F13)	N	Ijima 2020
F25	F25_JPNDF_Q23_Mid	N	N (Mirror to F14)	N	Ijima 2020

Table 2. Biological parameters for the Western and Central North Pacific striped marlin stock assessment models.

Parameter	WCNPO (Revised) Sun et al. (2011)	SWPO Kopf et al. (2011)	EPO Melo-Barrera al. (2003)	Reference
Growth_Age_for_L1	0.5	0.5	0.5	Refit Ijima (2021b)
Growth_Age_for_L2	15	15	15	Refit Ijima (2021b)
NatM	0.54 (0) 0.47 (1) 0.43 (2) 0.4 (3) 0.38 (4+)	0.54 (0) 0.47 (1) 0.43 (2) 0.4 (3) 0.38 (4+)	0.54 (0) 0.47 (1) 0.43 (2) 0.4 (3) 0.38 (4+)	Piner and Lee (2011)
L_at_Amin_Fem_GP_1	110	115	74	Refit Ijima (2021b)
L_at_Amax_Fem_GP_1	203	212	184	Refit Ijima (2021b)
VonBert_K_Fem_GP_1	0.34	0.64	0.23	Refit Ijima (2021b)
CV_young_Fem_GP_1	0.14	0.14	0.14	ISC 2012
CV_old_Fem_GP_1	0.08	0.08	0.08	ISC 2012
Wtlen_1_Fem	4.68e-06	4.68e-06	4.68e-06	Sun et al. (2011)
Wtlen_2_Fem	3.16	3.16	3.16	Sun et al. (2011)
Mat50%_Fem	152.2[1]	178.4[2]	181[3] 166.5[4]	[1]Humphreys and Brodziak (2021) [2]Kopf et al. (2012) [3]Gonzalez-Armas et al. (2006) [4]Sevilla-Rodriguez (MS 2013)
Mat_slope_Fem	-0.204	-0.204	-0.204	Humphreys and Brodziak (2021)
Fecunditiy	Proportional to spawning biomass	Proportional to spawning biomass	Proportional to spawning biomass	-
Spawning season	July	July	July	ISC 2012
R0	-	-	-	Estimate
Steepness	0.87	0.87	0.87	Brodziak et al. (2015)

Table 3. List of proposed future projection scenario.

Projection	Scenario		Years	Recruitment Scenario
1	F-Based	$F_{status\ quo}$ (Average F 2015-2017)	20	Deterministic
2		F_{MSY}	20	Deterministic
3		Highest F (Average F 1975-1977)	20	Deterministic
4		Low F ($F_{30\%}$)	20	Deterministic

Table 4. List of tentative sensitivity runs.

RUN	NAME	DESCRIPTION
Alternative Life History Parameters: Natural Mortality		
1	base_case_highM	Alternative natural mortality rates are XX% higher than in the base case
2	base_case_lowM	Alternative natural mortality rates are XX% lower than in the base case
Alternative Life History Parameters: Recruitment Variability (σ_R)		
3	base_case_large_σR	Alternative growth curve with a larger σ_R (0.9).
Alternative Life History Parameters: Stock-Recruitment Steepness		
4	base_case_h095	Alternative higher steepness with h=0.95
5	base_case_h079	Alternative lower steepness with h=0.79
6	base_case_h070	Alternative lower steepness with h=0.70
Alternative Life History Parameters: Maturity Ogive		
7	base_case_L50_177	Alternative maturity ogives with L50 177 cm (Used in the 2015 assessment)
8	base_case_L50_181	Alternative maturity ogives with converted L50 from Chang et al. (2019)
Alternative Model Configuration		
9	Base_case_S1994	Start the assessment model in 1994 instead of 1975
10	Base_case_S1977	Start the assessment model in 1977 instead of 1975
Alternative catch assumption		
11	Drop_VNCN_catch	Drop the Vanuatu and Chinese catch

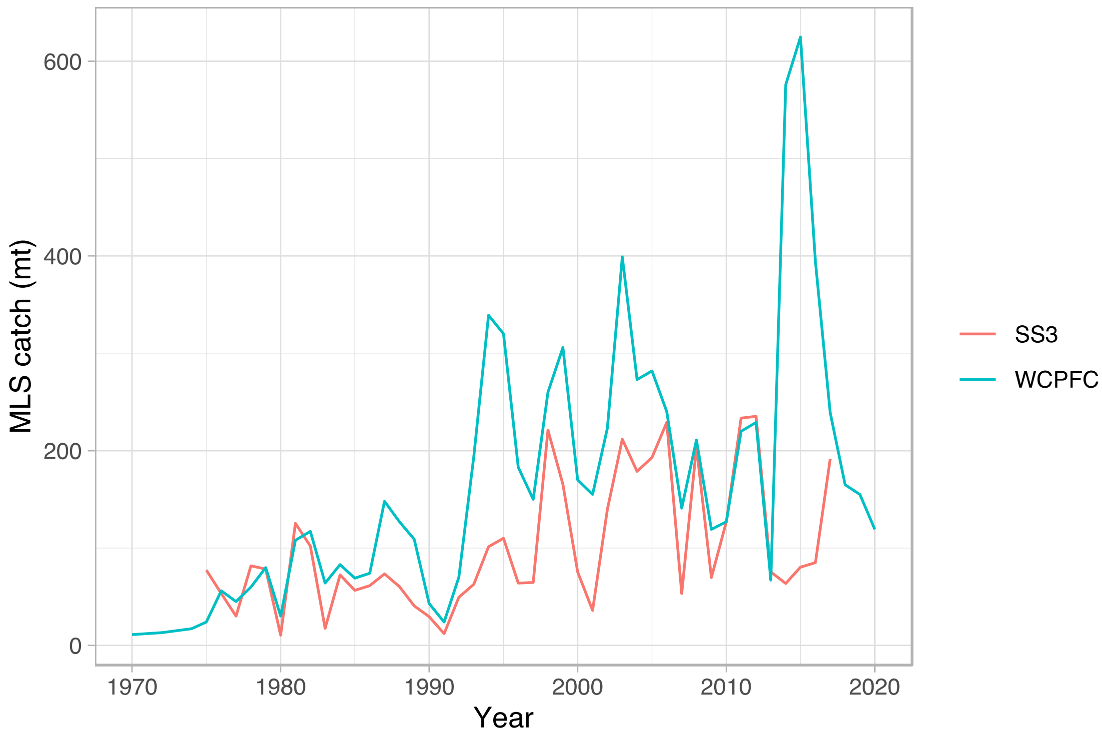

Figure 1. Comparison old and updated striped marlin catch of non ISC members in North Pacific WCPFC convention area.

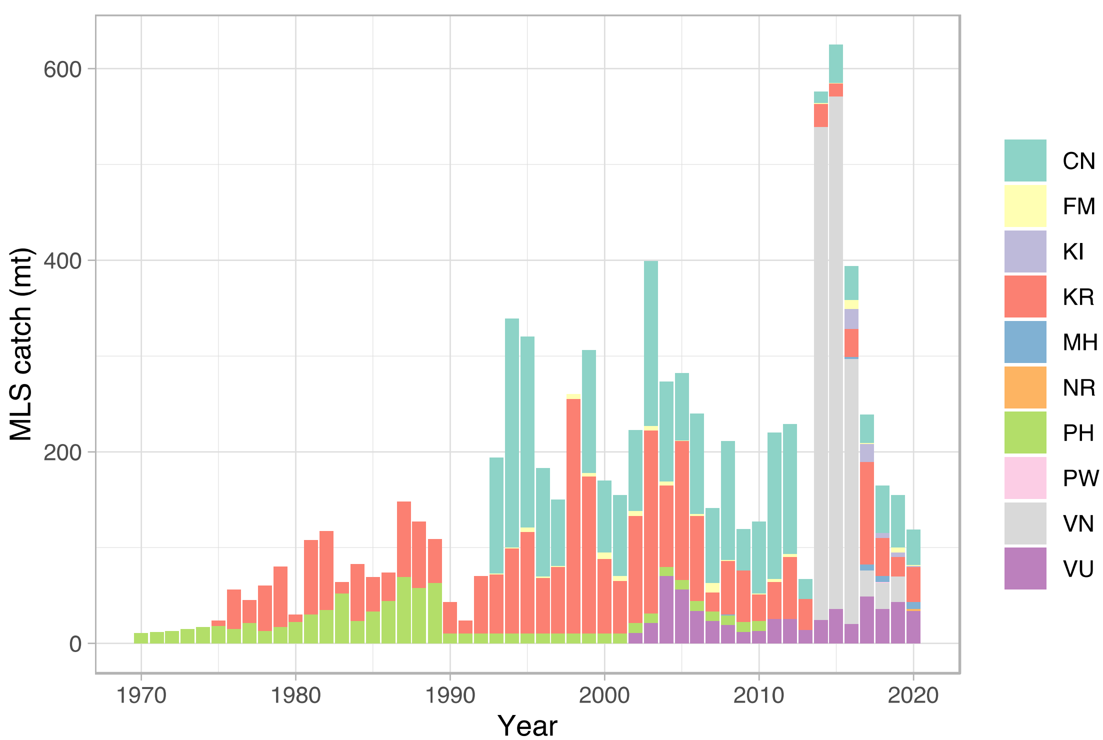

Figure 2. Updated striped marlin catch of non ISC members in North Pacific WCPFC convention area.

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APPENDIX 2. MEETING AGENDA.

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

BILLFISH WORKING GROUP (BILLWG)

DATAPREPARETORY MEETING OF WESTERN CENTORAL NORTH PACIFIC STRIPED MARLIN STOCK ASSESSMENT ANNOUNCEMENT and DRAFT AGENDA

Meeting Style:
Webinar meeting using Webex
The WG chair will inform the link at the day before the meeting.

Meeting Dates:
9:00-13:00, 13th, 15-18th December (Japan Time)
8:00-12:00, 13th, 15-18th December (Taiwan Time)
11:00-15:00, 13th, 15-18th December (New Caledonia Time)
14:00-18:00, 12th, 14-17th December (US Hawaii Time)
16:00-20:00, 12th, 14-17th December (US San Diego Time)

Meeting Goals:
- To agree on the data and the model configuration of Stock Synthesis 3.
- Report the progress of biological study for billfish species.

Meeting Attendance:
Please respond to Hirotaka Ijima (Email: ijima@affrc.go.jp) if you plan on attending this meeting.

Working Papers:
Submit working papers to Hirotaka Ijima by December 1st.

BILLWG Contact:
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DRAFT AGENDA

December 13th (Monday), 9:00 - 13:00 (JST)

1. Opening of Billfish Working Group (BILLWG) workshop
    a. Welcoming remarks
    b. Introductions
    c. Standard meeting protocols
2. Adoption of agenda and assignment of rapporteurs
3. Numbering working papers and distribution potential
4. Abundance Indices
    a. Japanese CPUE (ISC/21/BILLWG-03/01)
    b. Taiwanese CPUE (ISC/21/BILLWG-03/02)
    c. US Hawaii CPUE (ISC/21/BILLWG-03/03, Presentation 1)

December 15th (Wednesday), 9:00 - 13:00 (JST)

5. Catch and length frequency data
    a. Japanese catch and length data (ISC/21/BILLWG-03/04)
    b. Taiwanese catch and length data (ISC/21/BILLWG-03/05)
    c. US catch and length data (ISC/21/BILLWG-03/06)
    d. Other WCPFC fleets

December 16th (Thursday), 9:00 - 13:00 (JST)

6. New information for biological parameters
    a. Maturity at length (ISC/21/BILLWG-03/07)
    b. Ensemble of growth and natural mortality (ISC/21/BILLWG-03/08)
7. Model configurations
    a. Fleet definition and data sets
    b. Combination of biological parameters
    c. Future projection
    d. Sensitivity analysis
8. Date of the stock assessment meeting and meeting for rebuilding plan
9. Other items

December 17th (Friday), 9:00 - 13:00 (JST)

10. Progress of biological study for billfish species
    a. Progress of the International Biological Billfish Sampling Project (IBBS) (Presentation 2)
    b. Sampling progress in Japan (Presentation 3)
    c. Daily age estimation for juvenile striped marlin (ISC/21/BILLWG-03/09)
    d. Homology of cross-section position in fin spine of striped marlin (ISC/21/BILLWG-03/10)
    e. Striped marlin movement in the Pacific Ocean (**ISC/21/BILLWG-03**/11)

March 18th (Saturday), 9:00 - 13:00 (JST)

11. Circulate workshop report
12. Adoption

APPENDIX 3. THE LIST OF WORKING PAPERS AND PRESENTATIONS.

ISC/21/BILLWG-03/01	CPUE Standardization for Striped Marlin (*Kajikia audax*) using Spatio-Temporal Model using INLA. Hirotaka Ijima and Haruko Koike
ISC/21/BILLWG-03/02	CPUE standardization of stripe marlin caught by Taiwanese distant-water longline fishery in the Western and Central North Pacific Ocean during 1995 – 2020. Ke Lee, Jhen Hsu, Yi-Jay Chang
ISC/21/BILLWG-03/03	Standardization of the Striped Marlin (*Kajikia audax*) Catch per Unit Effort Data Caught by the Hawaii-based Longline Fishery from 1994-2020 Using Generalized Linear Models. Michelle Sculley
ISC/21/BILLWG-03/04	Update Japanese data set for striped marlin stock assessment in the Western and Central North Pacific Ocean. Hirotaka Ijima
ISC/21/BILLWG-03/05	Catch and size data of striped marlin (*Kajikia audax)* by the Taiwanese fisheries in the Western and Central North Pacific Ocean during 1958-2020. Ke Lee, Cheng-Hao Yi, Wei-Jen Wang, Cheng-Yu Lu1, Yi-Jay Chang
ISC/21/BILLWG-03/06	Withdraw
ISC/21/BILLWG-03/07	Revised analyses of the reproductive maturity of female striped marlin, *Kajikia audax*, in the central North Pacific off Hawaii. Robert Humphreys and Jon Brodziak
ISC/21/BILLWG-03/08	Candidate biological parameters for the Western and Central Northern Pacific Ocean striped marlin stock assessment. Hirotaka Ijima
ISC/21/BILLWG-03/09	Preliminary results of daily age estimation for juvenile stripede marlin (*Kajikia audax*) caught in the seas around Japan, North West Pacific Ocean. Miyuki Kanaiwa, Ayumu Furuyama, Hirotaka Ijima, Akira Kurashima, Minoru Kanaiwa
ISC/21/BILLWG-03/10	Preliminary report on homology of cross-section position in fin spine of striped marlin (*Kajikia audax*) for age estimation. Ayumu Furuyama, Miyuki Kanaiwa, Hirotaka Ijima, Akira Kurashima, Minoru Kanaiwa
ISC/21/BILLWG-03/11	Size-based spatiotemporal dynamics of striped marlin movement in the Pacific Ocean: first observations. Chi Hin Lam and Hirotaka Ijima

Presentation 1	Some potential effects of alternative CPUE standardizations for striped marlin in the Hawaii longline fishery. Jon Brodziak
Presentation 2	Progress of the International Biological Billfish Sampling Project (IBBS). Michael Kinney
Presentation 3	Sampling progress and efforts for the biological studies of Striped marlin, Blue marlin and Swordfish in Japan. Akira Kurashima, Hirotaka Ijima