ANNEX 13

23rd Meeting of the
International Scientific Committee for Tuna
and Tuna-Like Species in the North Pacific Ocean
Kanazawa, Japan
July 12-17, 2023

REPORT OF THE BILLFISH WORKING GROUP WORKSHOP[1]

July 2023

[1] Prepared for the 23rd Meeting of the International Scientific committee on Tuna and Tuna-like Species in the North Pacific Ocean (ISC) held July 12-17, 2023 in Kanazawa, Japan. Document should not be cited without permission of the authors.

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ANNEX 13

REPORT OF THE BILLFISH WORKING GROUP WORKSHOP INTERSESSIONAL WORKSHOP

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

2-3, 5 December 2022 (JST)

Hybrid Meeting

1. OPENING AND INTRODUCTION

1.1. Welcoming Remarks

Hirotaka Ijima, the International Scientific Committee for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC) Billfish Working Group (WG) chair opened the Western and Central North Pacific Ocean (WCNPO) striped marlin stock assessment meeting. Participating scientists were from Chinese Taipei (TWN), Japan (JPN), United States of America (USA), and the Inter-American Tropical Tuna Commission (IATTC). A list of participating scientists is in Attachment 1.

1.2. Introduction

The WG revised the growth curve for WCNPO striped marlin. Using the revised growth curve, the WG conducted a stock assessment for the WCNPO striped marlin and agreed on stock status, future projections, and sensitivity analysis results. Based on these results, the BILLWG will formulate recommendations about conservation measures for this stock.

1.3. Standard Meeting Protocols

The WG chair introduced protocols for the hybrid meeting. The WG used Microsoft Teams for this meeting, and working papers on the agenda were presented and discussed.

2. ADOPTION OF AGENDA AND ASSIGNMENT OF RAPPORTEURS

The WG adopted the meeting agenda before the stock assessment meeting (Attachment 2). The WG chair also assigned the rapporteurs J Brodziak, M Kai, and M Jusup.

3. NUMBERING WORKING PAPERS AND DISTRIBUTION POTENTIAL

Three working papers and one presentation were submitted (Attachment 3). However, one working paper entitled "*Parameterization conversions for some von Bertalanffy growth curves*" was not presented during the meeting but it was part virtual meetings held on the striped marlin growth curve. **The WG agreed to post these working papers on the ISC website and make them publicly available**.

4. GROWTH CURVE OF WCNPO STRIPED MARLIN

Conversion of Richards Growth Curve Parameters for Western and Central North Pacific Ocean Striped Marlin. Jon Brodziak (ISC/22/BILLWG-03/01)

The goal of this working paper is to show how to convert the parameters of the best-fitting 4-parameter Richards growth curve used in the Sun et al. (2011) ISC Billfish WG working paper on striped marlin to the parameters of the Richards curve used in the SS3 assessment software. The working paper begins with a description of the asymptotic form of the Richards curve and parameter estimates from Sun et al. (2011). The parameters of the asymptotic Richards curve are

then converted to those of the modified form used in the SS3 software where the modified form includes length at minimum and maximum length at reference age parameters, in comparison to an asymptotic length parameter in the asymptotic form. We convert the parameters based on direct calculation of the minimum and maximum length at reference age parameters. We then show that the converted parameters are numerical solutions of necessary conditions for the modified Richards growth curve using Newton's method and provide a summary of the working paper results.

Discussion

The WG agreed that including the information on L_∞ based on data from the southwest Pacific to inform L_∞ in the WNCPO is the best scientific approach given that there are no data beyond age 6 for the north Pacific stock. The WG emphasized the need to document the process, especially in view of the decision to use the von Bertalanffy (or the Richards 3-parameter) growth curve when the original plan was to use the Richards (4-parameter) curve.

Updated estimate of the growth curve of the western and central north Pacific Ocean striped marlin: a Bayesian approach. Yi-Jay Chang, Jon Brodziak, Marko Jusup, Hirotaka Ijima, and Chi-Lu Sun (Presentation 1)

Using the 4-parameter (L_1, L_2, k, β) Richards curve yields an estimated growth rate $k \approx 0$, which implies that the available information is insufficient to reliably estimate all four parameters. Attempts to replicate the Richards curve by Sun et al. (2011) failed. Reducing the number of parameters by fixing beta=1 yielded a growth rate $k>0$, but the estimate of L_∞=198 cm EFL is inconsistent with available biological information and the recommended L_∞=263 cm LJFL (228 cm EFL) of Sun et al. (2011). Consequently, a Bayesian estimation approach was adopted by using three different prior assumptions. The model using prior 3 produced a consistent result with the observed mean length at age.

Discussion

The WG agreed to use the 3-parameter curve using prior 3 and compared it to the growth curve used in the 2022 assessment. The 2022 growth curve was input directly from Sun et al. (2011), and the 2023 growth curve is the 3-parameter Richards whose parameters have been re-estimated by the BILLWG.

A WG member asked why the posterior distribution did not differ between models using priors 1 & 2. It was also noted that prior distribution 3 is subjective, but was produced based on the expert knowledge of the WG members. The model using prior 3 achieved better prediction accuracy for mean length at ages 5 and 6. Models using priors 1 & 2 contradicted available biological information that fish can grow beyond ≈200 cm. The WG acknowledged that using a combined prior for k and L_2 or L_∞, but given the time constraints and benefits of the model using prior 3, this is the current best information available.

A WG member asked whether the L_∞ value should be revised. It was suggested that it may be better to use the growth curve from the south Pacific because the value for L_∞ is better aligned with the largest sizes of fish caught in the WCNPO (up to ≈300 cm EFL) and that Sun et al. (2011) data give an incomplete picture of striped marlin life history since they aged fish up to age 6 (200 cm EFL). It was noted that SS3 diagnostics were very poor when the WG tried to use information from the south Pacific for the 2022 assessment. The von Bertalanffy growth parameter k for the south-Pacific stock is very high and the WG considered it unlikely that this value would be valid

in the north Pacific.

5. WCNPO STRIPED MARLIN STOCK ASSESSMENT MODELING

An alternative base-case model for the 2022 WCNPO MLS stock assessment. Michelle Sculley (ISC/22/BILLWG-03/02)

Based upon discussions of the ISC billfish working group and the ISC Plenary at their meeting in July 2022, the working group agreed to continue exploring the growth curves used in the 2022 western and central North Pacific Ocean striped marlin (WCNPO MLS) stock assessment. This document presents the alternative base-case model (2023 growth) using a refitted Von Bertalanffy curve that the working group agreed was the best information available from the original growth curve in Sun et. al, 2011. The growth curve uses the data in that paper as well as information on the range of sizes of fish caught in the WCNPO and southwest MLS fisheries to produce a new growth curve. In addition, a comparison is presented to show the result of the assessment using the growth curve from the 2019 WCNPO MLS assessment for comparison (2019 growth) and the growth curve used in the original 2022 base-case model (2022 growth).

Discussion

The WG clarified setting that the sum of the recruitment deviations was set to zero, which was a change from 2022 base case model. It was noted that when recruitment deviations are allowed to vary freely, they tend to be more positive, and there is more data conflict. The setting reduces the number of parameters, which is a good idea when dealing with parameter-rich models.

The WG asked why the F value was higher in the 1990s considering the Japanese high-seas drift net fishery was banned in 1993, after which time total catches decreased. It was noted that the largest contributor to *F* after 1993 is the Japanese longline fleet primarily catching smaller fish in Q4, compared to the larger fish during spawning season (Q2) caught by the Japanese high-seas drift net fishery. This results in the mean *F* over ages 3-12 increasing after the closure of the high-seas drift net fishery. When the SPR time series is considered there is no similar increase after 1993, which supports this hypothesis.

The WG had an extensive discussion about the diagnostics from the new model, particularly about the hindcast diagnostic. The WG compared the hindcast diagnostic results to the 2022 results. There are improvements, but CPUE hindcast and retrospective errors look better in the previous assessment. It was indicated that poor hindcasting performance is likely to occur if the stock is not production driven, if the production function is not estimable from the data, and if the production function is not stationary over time, which is likely what is happening in this stock assessment based on the ASPM diagnostic. The WG asked why the result of hindcast cross-validation seems optimistic because it over-predicts CPUE. It was noted that there is still a somewhat limited understanding of how to interpret hindcast results. The WG noted that there is a question on whether the WCNPO striped marlin stock is recruitment driven, as the ASPM diagnostic suggests. It was suggested that an option is not to provide the hindcast diagnostic because of the problems with interpreting the results. The WG agreed to drop the hindcast results but include the ASPM results.

The WG discussed the possibility of applying an ensemble approach. It was mentioned that if the 2023 growth curve is the best available information, it is the only one that should be used. **The WG agreed to use the 2023 growth curve as the base case model.** It was noted that the problem with using the currently available length-at-age data is the lack of information on 7+ year old fish.

A somewhat subjective view, perhaps supported by data, is that most large fish should be ±10% of the estimated size.

Considering the model diagnostics result, the WG discussed which sensitivities should be run**. The WG agreed upon the same sensitivity runs as in the 2022 assessment, with the addition of two extras based on the model used in the 2022 stock assessment (Table 1).**

The stock status was presented relative to the dynamic reference point, $20\%SSB_{F=0}$, which is calculated as the average over the last 20 years. A WG member asked whether the results were presented relative to the MSY reference points. The WG noted that MSY based reference points were shown the last time around, and it could be done again. **The WG agreed that the results would be presented in terms of both the dynamic and MSY reference points.** The dynamic reference point will likely be adopted for future assessments.

A WG member suggested confirming the period for dynamic reference points. It was noted that setting the period was requested by the WCPFC NC, and the WG suggested 20 years. Any change needs to be discussed with the WCPFC NC. However, the WG recognized the importance of the period for the dynamic reference point, and the **WG agreed that this topic would be put on the list of future work.**

A jitter analysis was produced using 100 runs following the procedures outlined by the diagnostics recommended in Carvalho et al. (2020) and its associated cookbook. It was noted that the base case NLL was the minimum over 100 jitter analyses, and the model runs tests and R0 profile results were considered an improvement from the 2022 model. However, some problems remain with this model. Specifically, the fits to the US and TWN length composition data have large residuals, which may have affected the sensitivity of the model estimation. The group also noted the ASPM results indicate the catch data and the production function alone cannot explain the trajectories depicted in the CPUEs. This can have several causes, including that the stock is recruitment-driven. The WG further noted that very different values of initial F produce nearly the same NLL, indicating a large uncertainty with respect to this parameter. **The WG agreed to document the current model's uncertainty and issues in the assessment report.**

Following these discussions, the **WG finally agreed to use the current base-case model as the stock assessment model.**

6. WCNPO STRIPED MARLIN STOCK ASSESSMENT SENSITIVITY ANALYSIS

16 alternative sensitivity runs were conducted. Compared to the 2022 assessment, two scenarios were added, including a scenario with the recruitment deviation option set to 2. Larger steepness, lower L50 values, and 2019 growth curve led to substantially more optimistic results. The WG discussed the differences between the 2019 growth curve sensitivity run and the 2023 base case model, concluding that the differences may arise due to a number of model settings including the values of lengths L_1 and L_2 at ages a_1 and a_2. It was argued that changing the growth curve requires additional tuning of the model, which could change the results substantially even if the growth curve seemingly changes only a little. The WG reviewed the output of all sensitivity runs at the meeting.

7. WCNPO STRIPED MARLIN STOCK ASSESSMENT FUTURE PROJECTION

The WG discussed 10 future projection scenarios, most of which end below SSB equaling $20\%SSB_{F=0}$. These results suggest the need for a rebuilding plan. The WG will organize a rebuilding plan meeting if managers request it.

8. OTHER ITEMS

The WG discussed the need to have a rebuilding plan meeting. It was suggested that simple catch scenarios be put forward such that there is a 60% probability of reaching 20%$SSB_{F=0}$ in 5-year increments into the future. The chair also emphasized the need to inform the managers of the large uncertainty in the current results.

The chair suggested two additional sections to the final stock assessment report:

- The progression to develop the 3-parameter Richards growth curve vs. the 4-parameter Richards curve.
- The major sources of model uncertainty and a research plan to explore those uncertainties.

9. CIRCULATE WORKSHOP REPORT

The WG Chair made a draft of the workshop document and distributed it to the WG members. The WG members reviewed the draft.

10. ADOPTION

The WG adjourned the Western and Central North Pacific Ocean striped marlin stock assessment meeting at 15:47 on December 5, 2022 (JST).

11. REFERENCES

Sun, C.L., Hsu, W.S., Chang, Y.J., Yeh, S.Z., Chiang, W.C. and Su, N.J., 2011. Age and growth of striped marlin (*Kajikia audax*) in waters off Taiwan: A revision. Working paper submitted to the ISC Billfish Working Group Meeting, 24 May-1 June 2011, Taipei, Taiwan. ISC/11/BILLWG-2/07: 12p. Available at: http://isc.ac.affrc. go.jp/pdf/BILL/ISC11BILLWG2_WP07. pdf.

Carvalho, F., Winker, H., Courtney, D., Kapur, M., Kell, L., Cardinale, M., Schirripa, M., Kitakado, T., Yemane, D., Piner, K.R. and Maunder, M.N., 2021. A cookbook for using model diagnostics in integrated stock assessments. Fisheries Research, 240, p.105959.

Table 1. The list of sensitivity runs.

RUN	NAME	DESCRIPTION
Alternative Life History Parameters: Natural Mortality		
1	base_case_highM	Alternative natural mortality rates are 10% higher than in the base case
2	base_case_lowM	Alternative natural mortality rates are 10% lower than in the base case
Alternative Life History Parameters: Recruitment Variability (σ_R)		
3	base_case_large_σ_R	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_S1975	Start the assessment model in 1975 instead of 1977
Alternative catch assumption		
11	Drop_VNCN_catch	Drop the Vanuatu and Chinese catch
Alternative Life History Parameters: Growth curve		
12	SWPO_SA9	SW Pacific Growth model
13	Growth_2019	Use biological parameters from 2019 base-case model
14	Growth_2022	Use biological parameters from 2022 SA
15	Growth_2022_recdev2	Use biological parameters from 2022 SA with recruitment deviation option=2.
Alternative selectivity assumption		
16	base-case_DFselec	Alternative mirroring for F24 (F13) and F25 (F14)

Table 2. The list of future projection scenarios.

Projection	Scenario		Years	Recruitment Scenario
1	F-Based	$F_{status\ quo}$ (Average F 2018-2020)	20	S/R Curve
2	F-Based	F_{MSY}	20	S/R Curve
3	F-Based	Highest F (Average F 1998-2000)	20	S/R Curve
4	F-Based	Low F ($F_{30\%}$)	20	S/R Curve
5	F-Based	$F_{20\%SSBF=0}$	20	S/R Curve
6	F-based	FstatusQuo	20	Last 20yrs recruitment
7	F-Based	$F_{20\%SSBF=0}$	20	Last 20yrs recruitment
8	F-Based	F_{MSY}	20	Last 20yrs recruitment
9	F-Based	Highest F (Average F 1998-2000)	20	Last 20yrs recruitment
10	F-Based	Low F ($F_{30\%}$)	20	Last 20yrs recruitment

APPENDIX 1. LIST OF PARTICIPANTS.

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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)

INTERSESSIONAL WORKSHOP ANNOUNCEMENT and AGENDA

Meeting Style:	Hybrid meeting using Microsoft Teams The WG chair will inform the link at the day before the meeting
Meeting Dates:	December 2-3, 5 2022 10:00-17:00 (JST)
Meeting Venue:	Japan Fisheries Research and Education Agency. 2-12-4 Fukuura, Kanazawa-ku, Yokohama, Kanagawa, 236-8648, JAPAN
Meeting Goals:	The ISC BILLWG will conduct the stock assessment for Striped marlin in the Western and Central North Pacific Ocean (WCNPO) and agree on stock status, future projections, and sensitivity analysis results. Based on these results, the BILLWG will formulate conservation information.
Meeting Attendance:	Please respond to Hirotaka Ijima if you plan on attending this meeting. (Email: ijima_hirotaka69@fra.go.jp)
Working Papers:	Submit working papers to Hirotaka Ijima by November 25th.
BILLWG Contact:	Hirotaka Ijima (Ph.D, ISC BILLWG Chair) Highly Migratory Resources Division, Fisheries Stock Assessment Center, Fisheries Resources Institute (FRI), Japan Fisheries Research and Education Agency. 2-12-4 Fukuura, Kanazawa-ku, Yokohama, Kanagawa, 236-8648, JAPAN E-mail: ijima_hirotaka69@fra.go.jp TEL: +81-543-36-6044

DRAFT AGENDA

December 2nd (Friday), 10:00 - 17:00 (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. Growth curve of WCNPO striped marlin
5. WCNPO striped marlin stock assessment modeling

December 3rd (Saturday), 10:00 - 17:00 (JST)

6. WCNPO striped marlin stock assessment sensitivity analysis
7. WCNPO striped marlin stock assessment future projection

December 5th (Monday), 10:00 - 17:00 (JST)

8. Circulate workshop report
9. Adoption

APPENDIX 3. THE LIST OF WORKING PAPERS

ISC/22/BILLWG-03/01	Conversion of Richards Growth Curve Parameters for Western and Central North Pacific Ocean Striped Marlin. Jon Brodziak Jon.Brodziak@noaa.gov
ISC/22/BILLWG-03/02	An alternative base-case model for the 2022 WCNPO MLS stock assessment. Michelle Sculley michelle.sculley@noaa.gov
ISC/22/BILLWG-03/03	Parameterization conversions for some von Bertalanffy growth curves. Jon Brodziak Jon.Brodziak@noaa.gov
Presentation 1	Updated estimate of the growth curve of the western and central north Pacific Ocean striped marlin: a Bayesian approach. Yi-Jay Chang, Jon Brodziak, Marko Jusup, Hirotaka Ijima, and Chi-Lu Sun. yjchang@ntu.edu.tw