FINAL

ISC/23/ANNEX/10

ANNEX 10

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

July 2023

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ANNEX 10

REPORT OF THE BILLFISH WORKING GROUP WORKSHOP

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

11-17 April 2023 (HST)
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 North Pacific Ocean (NP) swordfish stock assessment meeting. This workshop also discussed the conservation information for the Western and Central North Pacific Ocean (WCNPO) striped marlin. Participating scientists were from Chinese Taipei (TWN), Japan (JPN), United States of America (USA), and the Inter-American Tropical Tuna Commission (IATTC). The 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 WG will formulate recommendations about conservation measures for this stock. The WG also address NP swordfish stock assessment and discuss base case scenario, stock status, future projections, and sensitivity analysis results.

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 as follows.

11 April Yi-Jay Chang, Carolina Minte-Vera and Mikihiko Kai

12 April Yi-Jay Chang, Carolina Minte-Vera and Mikihiko Kai

13 April Carolina Minte-Vera and Jon Brodziak

14 April Yi-Jay Chang, Jon Brodziak and Mikihiko Kai

15 April Yi-Jay Chang and Mikihiko Kai

3. NUMBERING WORKING PAPERS AND DISTRIBUTION POTENTIAL

Five working papers were submitted (Attachment 3). **The WG agreed to post these working papers on the ISC website and make them publicly available.**

4. STOCK ASSESSMENT REPORT OF WCNPO STRIPED MARLIN

The assessment report was sent by email and reflects the decisions taken by the working group in the December 2023 meeting. An updated version was circulated.

4.1. Working papers

Deterministic Constant Catch Projections in SS3.30 for the 2023 WCNPO striped marlin assessment. (ISC/23/BILLWG-01/01)

A set of constant catch projections are provided for the 2023 Western and Central North Pacific Ocean striped marlin stock assessment.

Discussion

The goal of the working paper was to provide catch projections done in the SS3 platform with the 2023 assessment model to fulfill a request done by the ISC Northern Committee. The projections were done for 20 years assuming that the future recruitment would be the same as the average recruitment for the last 20 year (2001-2020). Because the recruitment is in a decreasing trend, the WG clarified that using of the 20-year time window from 2001 to 2020 produces a recruitment that is larger than the more recent recruitment, showing a trend in recovery in the population in almost all constant catch scenarios. The WG explained that the WG conducted recent five years average scenario of recruitment in the past and there is a plan to conduct a full recovery analysis in 2024 with 5-year recruitment window among other scenarios. It was mentioned that the constant-F scenario is more suitable for the bycatch species than the constant-catch scenario, those will be added to the 2024 analysis.

A question arose about which the reference points: 20%$SSB_{F=0}$ and SSB_{MSY} shown in the future projections is the actual limit reference point. It was mentioned that limit reference points have not been established by the WCPFC yet. The WCPFC requested that the 20%$SSB_{F=0}$ be the rebuilding target. This means that the WG need to show both SSB_{MSY} and the 20%$SSB_{F=0}$ in the figures. A comment was made that showing two reference points for the management advice may confuse the stakeholders. The WG decided that for future projections only the 20%$SSB_{F=0}$ should be shown in the figures and in the stock status figures and text, both reference points will be shown.

The WG clarified the definition of the 20%$SSB_{F=0}$, which is the 20%SSB at the dynamic B0 from 2001 to 2020.

The WG noticed that when the population was projected using MSY catches it did not converge to the SSB_{MSY}, and this should be checked.

The WG requested that the author compare results with projections with constant F, but show figures of catch corresponding to those F, so that its comparable with the constant catches results.

Impact of parameter uncertainty on striped marlin stock assessment in the Western Central North Pacific Ocean. (ISC/23/BILLWG-01/02)

Striped marlin is a species subject to commercial and recreational fishing in the western-central North Pacific Ocean. However, assessing the stock state accurately has proven difficult. Here, we analysed the differences in the von Bertalanffy growth curves and model settings between two stock assessments conducted in 2022 and 2023, to identify sources of uncertainty in the model predictions and their potential impact on stock assessment results. Our analysis showed that the initial mortality multiplier parameter (*f*) significantly affected the assessment results. While a smaller value of *f* in the 2022 assessment led to a larger spawning stock biomass and lower fishing mortality, a larger value of *f* in the 2023 assessment led to a severely overfished stock. However, the estimate of *f* had significant uncertainty, highlighting the need for continued improvement in striped marlin stock assessment. Our findings emphasise the importance of accurately estimating the *f* parameter and call for future research to address sources of error and bias in the data used for model parameter estimation.

Discussion

The WG noted that estimated initial Fs for both models were not significantly different. The large difference in model results come from the different growth curves, especially for the effect of differences for the large sized fish. The WG also mentioned that the same phenomenon was observed for the assessment of the bigeye tuna in the eastern Pacific Ocean. The WG noted that the two models compared may have more differences that just the growth curve, a better comparison would be a one-off difference. This is presented in the assessment report as the sensitivity run Model 15, which only differs from the 2023 base-case model by the growth curve. The impact in the results is also evident (Figure 31 in the assessment report). To better visualize the effect of the difference in growth in the spawning biomass, the WG requested a plot of the spawning biomass by age class for the two models. To assess whether the initial-F has an impact in the results, a run was shown fixing the initial F in the 2023 model to the MLE of the initial F from the model done in 2022. No difference were found.

The WG also mentioned that the catch of Japanese drift net fishery also has a large issue on the operational area in the 1970s. Sensitivities using different catch scenarios should be done to evaluate the impact of this issue. In the past, those sensitivities were done, and there was not effect of changing driftnet catch on stock status (2019 WCNPO MLS)

Reducing uncertainty in a parameter critical for striped marlin (Kajikia audax) stock assessment in the Western Central North Pacific Ocean. (ISC/23/BILLWG-01/03)

Fish stock assessments, which estimate the abundance and productivity of fish populations, play a crucial role in managing fishery resources by providing reliable information on the status of fish populations and guiding policymakers in making informed management decisions. However, the results of the stock assessment for striped marlin in the Western Central-North Pacific Ocean critically depend on a parameter that had been estimated with high uncertainty. The parameter in question, the initial mortality multiplier (*f*), caused the 2023 stock assessment to estimate that the stock was overfished, while the 2022 assessment did not. The present study redid the 2023 stock assessment by removing the potentially unreliable Japanese drift-net dataset prior to 1994. The redone assessment found that the value of *f* was substantially smaller and the accompanying 95% confidence interval was substantially narrower compared to the 2023 assessment, indicating that the stock is within reference limits. These findings highlight the importance of ensuring the quality and reliability of datasets used in stock assessments to improve their accuracy, particularly by addressing inconsistencies in catch data, sampling methods, and modelling assumptions.

Discussion

The WG noted that starting the model in 1994 has been a discussion of many years in the working group. The main drawback would be to lose the large depletion that occurred before 1994.

4.2. Conservation recommendation for WCNPO striped marlin

Discussion

The WG noted that the assessment model has been adopted in the December 2023 meeting. The working group recognize that there is a lot of uncertainties of the fishery data as well as biological parameters of striped marlin, but the assessment has been done with the best possible information. Biological studies in growth are underway and should be considered in the future.

Following a lengthy discussion, the WG reached an agreement to revise the text of the conservation information and stock status. **Although the WG agreed on a base-case model for WCNPO MLS to provide stock status information, there was not a unanimous consensus among the members to use this model for conservation information due to one member's concern about the strong sensitivity of the results to plausible alternative configurations and data that are not yet fully understood. In light of this uncertainty, the WG recommends maintaining catch levels at or below the current historically low level.** The WG has clarified that the 2022 model is included in the sensitivity runs shown in the executive summary.

5. NORTH PACIFIC SWORDFISH STOCK ASSESSMENT MODELING

5.1. Base case model development

A preliminary base-case model in SS3.30 for the 2023 North Pacific Swordfish Assessment. (ISC/23/BILLWG-01/05)

A preliminary base-case model in Stock Synthesis 3.30 for North Pacific (NP) swordfish (*Xiphias gladius*) is described for consideration as the 2023 base-case model. The base-case model covers the Western and Central North Pacific north of the Equator and the Eastern Pacific Ocean north of 10°N from 1975 to 2021. It includes data from three International Scientific Committee for the Conservation of Tuna and Tuna-like Species (ISC) countries and other countries in aggregate from the Western and Central Pacific Fisheries Commission (WCPFC) and the Inter-American Tropical Tuna Commission (IATTC). This paper describes the data available for inclusion and the proposed base-case model. The model converges and appears to fit the data well. Initial diagnostics do not indicate major problems. Preliminary results suggest the North Pacific swordfish stock is being not fished above F_{MSY} and spawning stock biomass is above SSB_{MSY}.

Based on this analysis, the WG done several runs for the development of the base-case North Pacific swordfish base case model (Table 1).

The WG reviewed the model development for the WCNPO swordfish stock assessment. An initial reference model and its diagnostics were presented. The model was fit to all available indices of abundance and length composition data. Several model runs were performed to refine the model and produce a base-case model. The rational for the decisions taken are described below.

Indices of abundance: It was noted that likelihood profiles on R0 showed that the CPUE indices for fleets S4 and S8 scaled differently from other CPUE indexes. This suggested that there were differences in the information content of these CPUE indices. Discussion followed regarding the representativity of each index and decisions:

S4<u>JPN_Area2:</u> It was noted that in Area 2 there was some reduction for Japanese longline fishing effort targeting swordfish through time, as well as a contraction of the area of operation of the Japanese fleet. It was decided that the Japanese index in area 2 may not be an adequate index of abundance and should not be used in the base-case model. The WG also noted that there was a general a pattern of smaller juvenile swordfish observed in Japanese CPUE area 2 versus larger adult swordfish in area 1. In particular, the size composition data clearly showed that area 1 has a higher percentage of adult swordfish than area 2 (Ijima and Kanaiwa 2018). The WG noted that it would be helpful to better understand the reasons for these differences and that collecting some bioeconomic data from the swordfish fishery may provide some insight. For example, it was suggested that some Japanese longline vessels have changed their targeting of swordfish in recent years because of variability in winter season.

This led to the suggestion that the CPUE index for fleet S4 be excluded from the model structure because this fleet was not fishing in a primary habitat area for swordfish and their catch of swordfish consisted of small juvenile swordfish relative to primary habitat areas.

S8_USA_Shallow set: This index is based on the US longline fishery that operated North of Hawaii, in a localized area, for which swordfish is a bycatch species. The trend in this index conflicted with the other indices. The question arose to whether this trend may reflect local abundance/availability, rather than population abundance. To explore that hypothesis, the trends on nominal CPUE for the Japanese longline fishery for the same area of operation of the USA fleet was inspected.

For the USA longline shallow-sector fleet, it was noted that temporal closures may affect CPUE and that such seasonal changes in fishing effort could produce larger residuals for the model fits to observed CPUE. Changes in local availability to USA shallow-set fishery was also considered to be important for modeling this CPUE index, noting that local availability of swordfish was varying through time. The trend showed decrease in northerly regions (Figure 1). To inspect whether that decrease could have been an artifact of the decreasing effort on that particular area, the trend of the nominal CPUE in the areas south of the Hawaiian islands was also inspected. That area, despite showing similar decrease in effort than the northern area, showed an increase in nominal CPUE. This led to the conclusion that the decrease trend seen in the USA index maybe reflective of local conditions. The WG discussed that there may be spatiotemporal changes in distribution of swordfish.

In conclusion, the WG agreed to investigate excluding the USA longline CPUE index for fleet S8 for three reasons: (i) the small spatial extent of its fishing grounds, (ii) the decreasing CPUE trend for S8 did not match CPUE in other longline fleets with more substantial spatial coverage of swordfish habitat, but matched the decreasing trend of the nominal CPUE for Japan in a similar area, and (iii) the impacts of USA swordfish fishery closures on CPUE for fleet S8 was probably important but difficult to quantify.

It was also noted that there was an increasing trend in mean size of swordfish for fleet S8 and that the USA fishery is catching a higher percentage of older adult swordfish during 2000-2020. The WG noted that this trend in the size of USA swordfish catches may also reflect changes in the spatial distribution of swordfish or changing fishing fleet behavior. The WG also concluded that it would be potentially useful to consider methods to further standardize swordfish size composition data for assessment applications.

S6: recruitment index. Is was decided that the recruitment index should be modelled as a special survey (option 31 in SS3) rather than a forcing function (option).

Taiwan index: The WG also noted that the Taiwanese longline fishing grounds were reported to have shifted to a more northerly distribution in area 2 around 2010.

Early part of the series – main fishing ground in the northern part. The later years the nominal CPUE is less than the standardized CPUE, which is OK because SWO is a by catch of ALB fishery. Taiwanese index – area 2 – length frequency is consistent, with a slight increase after 2010: there is a time block in selectivity.

Fishing ground changed to northern areas after 2010, time block in sel. The WG decided that a time block in catchability should be added for this index to be consistent with the block in selectivity. The WG discussed that the estimation of standardized size data to represent the indices should be explored in the future.

Length frequencies: The LF data set that fit the worst in the initial reference model was the F9 deep set. This fishery operates in the tropical areas around the spawning grounds. The length distribution shows a strong bimodal pattern with a prominent mode at about 50 cm sitting on a narrow distribution, corresponding to the young-of-the-year fish, a wide distribution over the large sizes, corresponding to the spawning adults. The initial reference model predicts that the first mode should be at about 80 cm. Exploratory runs were made that 1) split the fisheries in 4 fisheries, one for each quarter, 2) split the length frequency of this fleet into small and large fish, the large fish would be used to estimate the selectivity for the fishery while the small fish would represent the recruitment index. That was done by using the run where the fishery was split into 4, one for each quarter, and putting the small sizes in the quarters when the young fish settle, in quarters 2 and 3 and the large fish in quarters 1 and 4. 3) change the Amin from 1 year to 0.5 years, this will make the growth curve to be applied from age 0.5 on, while the linear growth will be assumed from age 0 (length equal to first length bin in the population) to age 0.5 (length at L1), additionally it was decided that the settlement data would be changed to 0.25 years (3 months).

The results showed that: (1) the exploratory model run that split the USA deep-set longline size data into 4 fleets did not fit the observed data well and did not converge to a single solution, (2) the run that separated the size composition fail to converge as well, (3) decreasing the Amin and settlement date fits the F9 data better but degrades the fits to length composition from other fleet, most likely due to changes in the selectivity curve. The WG decided to try runs that remove this length frequency data altogether and mirror the 9_US_WCNPO_LL_deep selectivity to that of F8_US_WCNPO_LL_shallow_early (Model 12).

Asymptotic selectivity: The WG noted that the selectivity for F2_TWN_WCNPO_DWLL_late was estimated to be asymptotic in the initial reference modeling, even when the model assumption was double normal. It was also noted that the fishery F4_IATTC had the largest proportion of large fish. The WG decided to try runs where those too fleets were assumed to have asymptotic selectivity (Model 13).

Other decisions:

Mean body weight X Port sampling data: JPN – divided areas using mean body weight (about 40 kg in Area 2, about 100 kg for area1) , but port sampling data shows no differences. Need to explore why there is difference in the patterns (e.g coverage of the sampling). For the target species (ALB the two data set match). (In area 1-JPN targets ALB, in area 2 – ALB in the north and BET in the south).

The WG compared the results of the model diagnostics for the Model 12 (size data of) and Model 13 (Model 12 with decrease of post-settlement Age from 1.0 to 0.5).

The results of runs test for F4_IATTC indicated that the Model 12 was better than Model 13, however, the total likelihood of Model 13 was significantly smaller than Model 12. The WG noted that Amin = 0.5 had a large effect on the catch number of small sized fish because of weight-length relationships. The WG also confirmed that substantial changes were observed for the estimation of selectivity curves for F4_IATTC and F6_JPN_WCNPO_OSDWLL_early_Area1, but the effect on the CPUE fitting was small.

The WG concluded that Amin = 0.5 is more suitable compared to the Amin=1.0 considering the total likelihood.

In addition, it is rational that the published empirical growth curves of swordfish in the Pacific Ocean clearly showed that the mean body length at 0.5 year is around 80 cm (Demartini et al., 2007; Farley et al., 2022), which is consistent with this assumption.

The WG also compared the R0 profiles of model 12 and 13 (Double normal selectivity for F2_TWN_WCNPO_DWLL_late and F4_IATTC) with Model 7 (Asymptotic selectivity for F2 and F4). The R0 profile of Model 7 showed that the likelihood of length composition was remarkably increased as the increase of the R0, while the Model 12 and 13 showed a slightly increase trend. The WG recognized that the asymptotic selectivity is more reasonable than double normal to explain the large sized fish caught by these fisheries. The results of runs test indicated that the fitting to the IATTC size data of model 7 was inferior to those of model 12 and 13.

The WG noted that the model 14 (13 plus fixation of initial equilibrium catch which was used in the 2018 assessment) showed a decrease trend in the spawning stock biomass in the 1970s, but it had no large impact on the overall fittings and model diagnostics.

The WG finally concluded that model 13 plus Asymptotic selectivity for F2_TWN_WCNPO_DWLL_late and F4_IATTC is the most suitable as base-case model due to the model fitting to the data and shape of R0 profile, and ASPM.

5.2. Sensitivity analysis

The WG discussed additional scenarios of sensitivity analyses and the seven new scenarios (NO13~19) were added to the scenarios (No1~12) agreed in the data preparatory meeting in the last December (Table2).

5.3. Future projection

The estimation uncertainty of the last year is not considered in the future projection in SS3. Also, uncertainty in recruitment is not implemented in SS3. In the past, a future projection software was used to incorporate those sources of variability. Since no specific configuration for future projection were requested, the WG decided to provide projections using deterministic recruitment scenarios using SS3, for illustration purposes (Table 3).

5.4. The proportion of catch and effort north and south of 20^{o}N

The WG confirmed the catches north and south of 20N that was request from the WCPFC Northern committee as follows.

The NC requests that the ISC BILLWG conduct an analysis of how catch and effort for NPS varies spatially in the North Pacific, with the aim of estimating the proportion of catch and effort north and south of 20o N in the Convention and including this information in the 2023 stock assessment for NPS.

The WG summarized catch of swordfish and longline effort using WCPFC and IATTC public domain data (Figure 2).

5.5. Research recommendations

The WG listed several areas of the assessment that could be improved with future research, as follow:

1. *Fisheries definitions*: explore the use of tree analysis to define fisheries based on areas that have the similar size composition, at least for the fisheries of Japan and Taiwan. The size data to use should be explored, for example the size measured or the average body weight per set (catch in weight/ catch in numbers in a set).

2. *Indices of abundance*: explore indices for the whole area using spatiotemporal models, explore standardizing size composition associated with the indices of abundance using spatiotemporal model. If this is not possible, at least explore weighting the size composition data by the density estimated by spatiotemporal models used to standardize the CPUE.

3. *Catches:*
Driftnet: Investigate better estimates of driftnet catches. Driftnet do not seem to be completely accounted for in the model. Japan had large mesh drifnet and squid drifnet. The driftnet fisheries started in the 1950's. In the 1970's the driftnet fisheries expanded from near Japan to the EPO and south Pacific. Large mesh drifnet fisheries used to target swordfish and billfishes, then changed to albacore in the early 1980. In the assessment there is no estimate of catch of swordfish in squid driftnet Also, there may be partial reporting of the driftnet fisheries from other nations. It is possible that the catches were larger. An international initiative to estimate the catches for all species in the driftnet fishery should be done.

WCPFC catches: improve estimate catches and size composition of swordfish for gillnets in the EEZ of within the South China Sea catches taken into account that the migration of swordfish may include the South China Sea.

IATTC catches: improve estimate of catches for EPO coastal nations.

4. *Length composition:*

IATTC: Inspect the data that composed the IATTC length frequency data set to understand the aliasing pattern.

All fisheries: Improve the sampling for length frequency for some fisheries.

5. *Growth*: Continue supporting the IBBS[1], including adding new partners. Explore the otolith annual aging (and validation). Explore the use of other growth curves such as the growth cessation curve. Explore adding tagging and otoliths data in the fitting of growth curve.

6. Maturity and fecundity: Continue supporting the IBBS, including adding new partners.

7. *Length – weight relationship*: obtain updated relationships, measure weight and length over time and space, as fish conditions may change over time. Explore data that is already collected.

8. *Stock structure*: Support popup and archival tagging studies associated with genomic analysis to elucidate stock structure

9. *Alternative abundance estimations*: explore the feasibility of doing a close-kin mark recapture estimation of abundance sampling the catches of fisheries that catch both young-of -the-year and spawning adults (for example the USA deep sets and the TWN fishery in some locations).

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6. OTHER ITEMS

Conceptual model for NP SWO

The WG discussed some ideas that may constitute a conceptual model for the stock (Figure 3):

The current system may be used by the SWO to move: Gyre goes clockwise– western Area 1 – adults in area most likely feeding in the productive Kuroshio current

Spawning in tropical areas

Nursery grounds around Hawaii towards the south of Eastern Area 2.

Hawaiian archipelago, maybe the boundary of the nursery area smaller fish – juvenile nursery area.

The swordfish spawning aggregation changes position with the ocean (Wells et al., 2021).

Some large fish around the equator may be part of another stock, depending on the longitude, this maybe a mixing area.

There is sex-specific dynamic: there seems to be segregation, males maybe associated with the warmer and tropical waters, females may be associated with more productive colder areas.

Movements and vertical habitat of black marlin (Istiompax indica) and swordfish (Xiphias gladius) in the northwestern Pacific Ocean. (ISC/23/BILLWG-01/04)

Understanding the movements and ecology of billfish is critical to improving management and understanding the basic life history of these migratory predators. The traditional harpoon and longline gears were utilized to deploy pop-up satellite archival tags (PSATs) on black marlin (Istiompax indica) and swordfish (Xiphias gladius) in the waters of southeastern Taiwan (Taitung) to examin their movement patterns. Pop-up satellite archival tags (PSATs) recorded depth, temperature and ambient light data. In total, 14 black marlin and 3 swordfish were tagged from December 2008 to November 2021 and PSATs remain affixed on the animals ranging from 13 to 360 days. Linear displacements ranged from 279 to 1,605 km from deployment to pop-up locations with average speeds of 3 to 107 km/day. Black marlin exhibit discernible seasonal movement patterns, as evidenced by the analysis of horizontal movement tracks obtained via Kalman filter calculation. Specifically, fish tagged during spring and summer displayed a tendency to move northwards towards the East China Sea, whereas those tagged during winter exhibited a southerly direction of movement towards the South China Sea. However, swordfish did not exhibit clear seasonal movement patterns, as indicated by the analysis of tagging locations in eastern Taiwan and subsequent pop-up locations spanning a range that extended northwards to the East China Sea, southwest to the South China Sea, and southeast of the Philippines. Diving depths (water temperature) ranged from the surface to ~258 m (14.5°C to 30.3°C) for black marlin, and surface to ~915 m (4.9°C to 32.9°C) for swordfish. The distributions of time spent at depth significantly differ between daytime and night-time diving activity. Tagged black marlin spent the majority of daytime in the surface mixed-layer to ~50 m and exhibited basking behavior, and at nighttime they were confined exclusively to the surface. Swordfish demonstrated pronounced diel vertical movement patterns reaching daytime of depths >400 m and occupying the surface mixed layer <100 m at night-time. Like the other istiophorid billfish, black marlin is susceptible to surface fishing gears due to their preference for surface water and diving behavior. Swordfish spent considerable time in the mesopelagic zone during the day, and the duration of time grows with the size of the fish. Because of their unique physiological and morphological adaptations (such as vascular counter-current heat exchangers), swordfish can search for food resources more effectively in cooler temperatures and exploit more water column resources than other fishes.

Discussion

During the WG discussion, the possibility of taking muscle tissue during the tagging procedure was raised and a question regarding combining genomic tagging results was also brought up. The presenter acknowledged the possibility of taking muscle tissue during the tagging procedure (e.g., TISSUEGRABTM Biopsy Dart) and mentioned checking references for future work.

One member noted that the daily behavior of swordfish is an interesting area of study. There was a suggestion to compare the behavior across different regions or areas. The presenter reported that the results of their study revealed that the behavior of swordfish in the northwestern Pacific was similar to that observed by Dewar et al. (2011). Swordfish in the eastern Pacific, central Pacific, and western North Atlantic-Caribbean exhibited pronounced diel vertical movements, with daytime hours spent mainly below the thermocline and nighttime hours spent in warmer waters. The depth of nighttime movements in the Pacific Ocean was found to be influenced by temperature, whereas in the warm tropical Atlantic, this was not observed. The Fisheries Research Institute of Taiwan plans to continue tagging more swordfish individuals to gather additional information about their behavior in relation to sea conditions in the near future.

During the meeting, the working group had a question about the practicality of using the traditional harpoon method for tagging black marlin. The presenter replied that a modification was made to the traditional triple tag forks, which resulted in the use of double forks instead. The modified harpoon had applicator tips that accommodated the surgical-grade nylon tag head, which was augmented with flopper blades. The barbs were replaced with these applicator tips to allow for the attachment of the tag heads.

7. CIRCULATE WORKSHOP REPORT

The WG Chair drafted and distributed the workshop document to the WG members. The WG members reviewed and revised the draft via e-mail until 28th April. **The WG agreed NP SWO stock assessment report will distribute 15th May and review two weeks.**

8. ADOPTION

The WG adjourned the Western and Central North Pacific Ocean striped marlin conservation information and North Pacific swordfish stock assessment at 14:53 on May 31, 2023 (JST).

9. References

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Table 1. SS3 model list to develop the base-case model.

No	Name	Note
1	Divide F9 size data	Split F9 size data
2	Drop S4 and S8	Drop S4 and S8 indeces
3	Both 1 and 2	Both 1 and 2
4	Change Lmin	Drop S4 and S8, split F9, change Amin to 0.5 (80cm), lognormal selectivity on TWN and IATTC
5	Chang esttlement month	Change settlement month
6	Increase CV Lmin	Increase CV Lmin
7	Longnormal selec	Lognormal selectivity, F9 one fleet, drop S4 and S8 – like model 2
8	Both 4 and 7	Lognormal selectivity, F9 one fleet, change Amin to 0.5
9	Both 3 and 7	Drop S4 and S8, split F9, lognormal selectivity
10	All 3, 4, 7 and 6	Split F9, Drop S4 and S8, change Amin to 0.5, increase Lmin CV, lognormal selectivity
11	Drop F20 decrease Amin	Split F9, drop Q3/4 size, change Amin to 0.5, drop S4 and S8, lognormal selectivity
12	Mirror F9	Mirror F9 catch to F8, change IATTC selectivity to logistic, drop S4 and S8
13	Mirror F9 decrease Amin	Mirror F9 catch to F8, decrease Amin to 0.5, change IATTC selectivity to logistic, drop S4 and S8
14	Mirror F9 decrease Amin Fix eqcat	Mirror F9 catch to F8, decrease Amin to 0.5, change IATTC selectivity to logistic, drop S4 and S8, Fix initial equilibrium catch at 2018 base case levels
15	TWN selec (**Base case model**)	Mirror F9 catch to F8, decrease Amin to 0.5, change IATTC and TWN selectivity to logistic, drop S4 and S8

Table 2. The list of sensitivity analysis

RUN	NAME	DESCRIPTION
Alternative Life History Parameters: Natural Mortality		
1	base_case_highM	Alternative natural mortality rates are 10% lower than in the base case
2	base_case_lowM	Alternative natural mortality rates are 10% higher than in the base case
Alternative Life History Parameters: Stock-Recruitment Steepness		
3	base_case_h070	Alternative lower steepness with h=0.70
4	base_case_h081	Alternative lower steepness with h=0.81
5	base_case_h099	Alternative higher steepness with h=0.99
Alternative Life History Parameters: Growth Curves		
6	base_case_large_Amax	Alternative growth curve with a 10% larger maximum size for each sex
7	base_case_Sun_Growth	Alternative growth curves using growth parameters from Sun et al. (2002)
Alternative Life History Parameters: Maturity Ogive		
8	base_case_high_L50	Alternative maturity ogives with L50 set 10% higher than base case
9	base_case_low_L50	Alternative maturity ogives with L50 set 10% lower than base case
10	base_case_Wang2003	Alternative maturity ogives with converted L50 from Wang et al. (2003)
Alternative catch assumption		
11	Drop_VNCN_catch	Drop the Vietnam and Chinese catch
12	NP_all_catch	Use all catches in North Pacific Ocean
13	Orphan	Use the catch of unclaimed areas among 3 Pacific sword fish stocks
Alternative model setting assumption		
14	Change Amin to 1.0	Alternative setting of Amin
15	Fit to S6	Lambda of US Deep CPUE change to 0
16	Alternative selectivity of TW	Alternative selectivity of Taiwanese to double normal
17	Add F9 of size data	Add the size data of US Deep LL
18	Single CPUE scenario	Use only single CPUE including the dropped CPUE in the base case candidate
19	All CPUE scenario	Use all CPUEs including the dropped CPUE in the base case candidate

Table 3. List of proposed future projection scenarios.

No	Management scenario	Years	Recruitment scenario
S1	**$F_{20\%SBF=0}$ Scenario (F_{Btgt}):** Apply the estimate of F which produces 20%$SSB_{F=0}$ based upon the average of the last five years dynamic B0, which roughly corresponds to	10	Deterministic
S2	**2008-2010 F Scenario ($F_{2008\text{-}2010}$)**: Use the average fishing intensity (SPR) from 2008-2010 and apply the corresponding fishing mortality rate to the stock estimates beginning in 2022; this corresponds to the proposed NP SWO CMM	10	Deterministic
S3	**Low F Scenario (F_{Low})**: Apply an $F_{SPR30\%}$ fishing mortality rate to the stock estimates beginning in 2022.	10	Deterministic
S4	**F_{MSY} Scenario (F_{MSY})**: Apply the estimate of the F_{MSY} fishing mortality rate to the stock estimates beginning in 2022.	10	Deterministic
S5	**Status Quo F Scenario ($F_{StatusQuo}$)**: This is the average F (age 1-10) during 2019-2021.	10	Deterministic

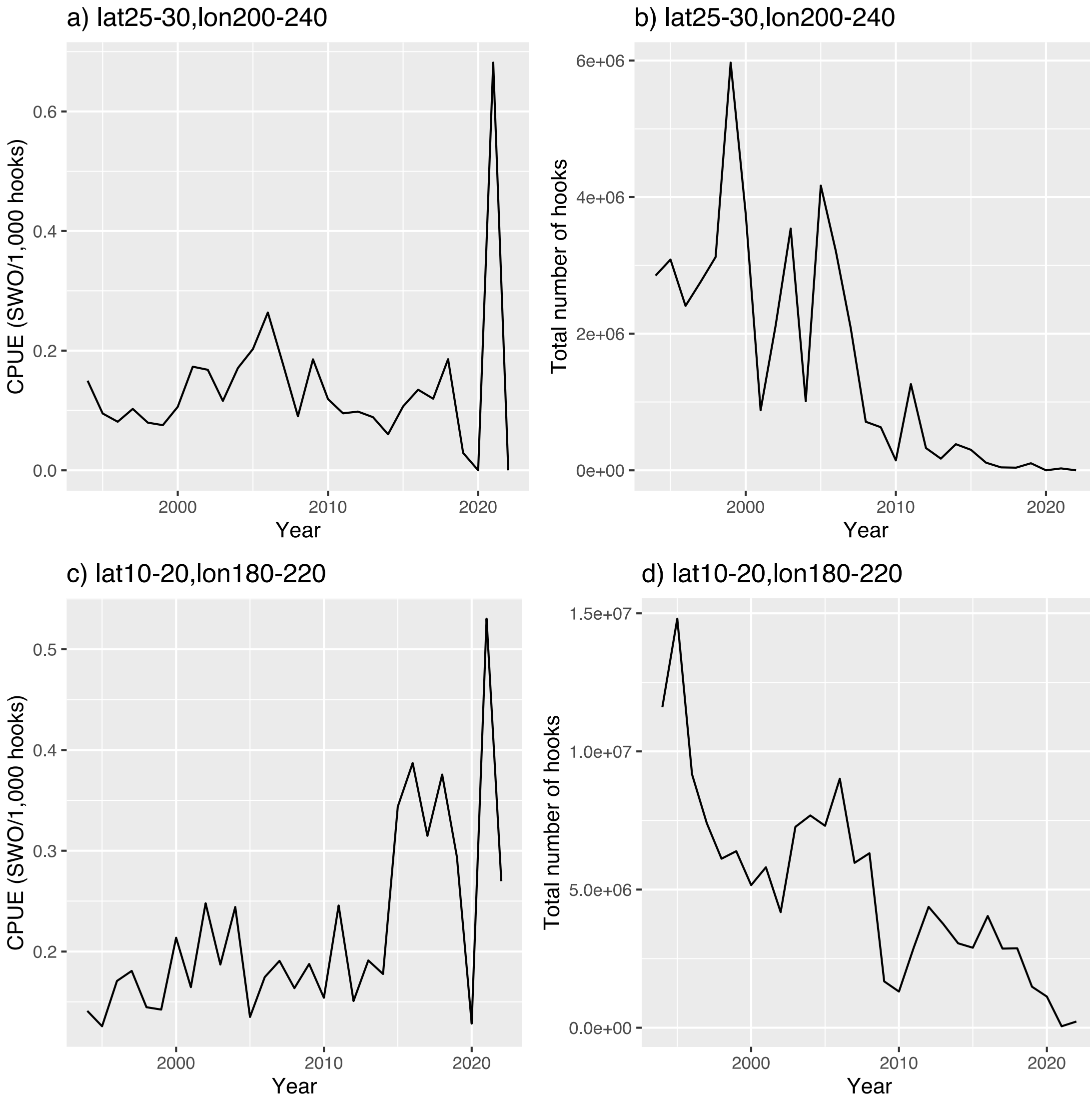

Figure 1. Japanese longline vessel operations and CPUE for swordfish in the U.S. longline operation area. Japanese logbook data were used to tabulate the two areas (North area: 25-30N, 120-160W, South area: 10-20N, 140-180W).

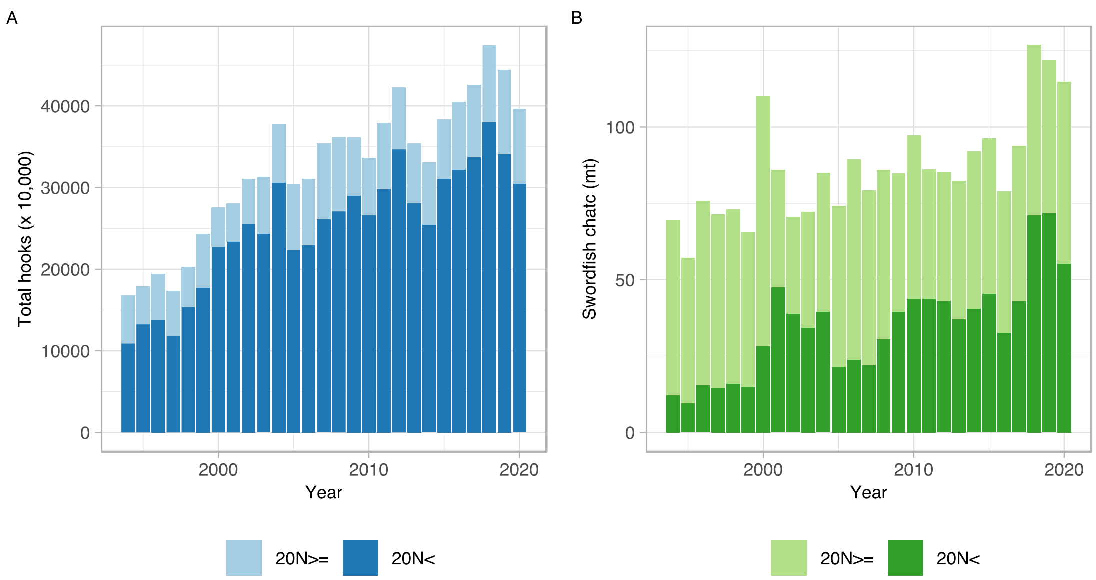

Figure 2. The proportion of swordfish catch and effort north and south of 20° N.

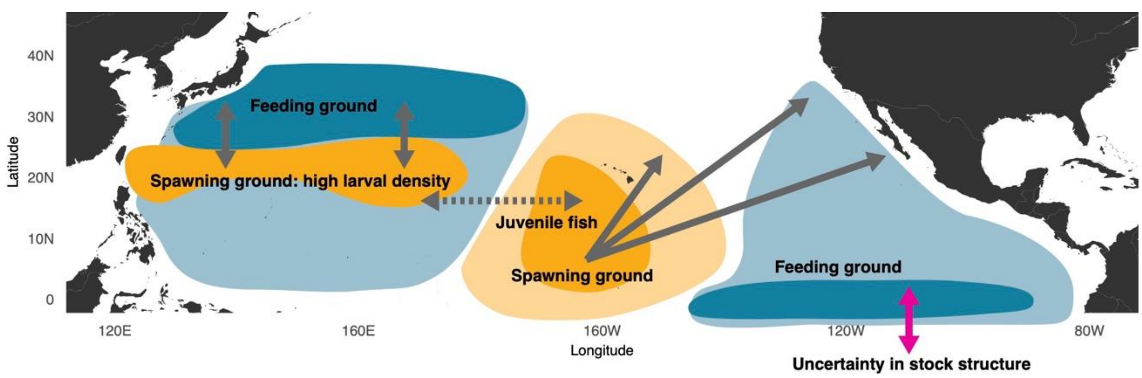

Figure 3. A conceptual model for North Pacific swordfish.

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

BILLFISH WORKING GROUP (BILLWG)

INTERSESSIONAL WORKSHOP ANNOUNCEMENT and AGENDA

Meeting Style:	Hybrid meeting using Microsoft TEAMS The WG chair will inform the link on the day before the meeting.
Meeting venue:	NOAA training room, pier 38. 1139 N Nimitz Highway, Suite 220, Honolulu, Hawaii, 96817, United States.
Meeting Dates:	13:00-18:00, 11th - 17th April 2023 (US Hawaii Time)
Meeting Goals:	1. Based on the stock assessment of WCNPO striped marlin results, the BILLWG will formulate conservation information. 2. The ISC BILLWG will conduct the stock assessment for NP swordfish 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 (Email: ijima_hirotaka69@fra.go.jp) if you plan on attending this meeting
Working Papers:	Submit working papers to Hirotaka Ijima by April 5th.
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: +81-045-788-7925

AGENDA

April 11th (Tuesday), 13:00 - 15:30

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. Stock assessment report of WCNPO striped marlin

April 12th (Wednesday), 9:00 - 15:30

5. North Pacific swordfish stock assessment modeling

a. Base case model
b. Sensitivity analysis
c. Future projection
d. The proportion of catch and effort north and south of 20ºN

April 13th (Thursday), 9:00 - 15:30

5. North Pacific swordfish stock assessment modeling
    a. Base case model
    b. Sensitivity analysis
    c. Future projection
    d. The proportion of catch and effort north and south of 20ºN

April 14th (Friday), 9:00 - 15:30

5. North Pacific swordfish stock assessment modeling
    a. Base case model
    b. Sensitivity analysis
    c. Future projection
    d. The proportion of catch and effort north and south of 20ºN

April 15th (Saturday), 9:00 - 15:30

5. North Pacific swordfish stock assessment modeling
    a. Base case model
    b. Sensitivity analysis
    c. Future projection
    d. The proportion of catch and effort north and south of 20ºN

April 17th (Monday), 9:00 - 15:30

6. Other items
7. Circulate workshop report
8. Adoption

Attachment 3. The list of working papers

ISC/23/BILLWG-01/01)	Deterministic Constant Catch Projections in SS3.30 for the 2023 WCNPO striped marlin assessment. Michelle Sculley michelle.sculley@noaa.gov
ISC/23/BILLWG-01/02)	Impact of parameter uncertainty on striped marlin stock assessment in the Western Central North Pacific Ocean. Marko Jusup jusup_marko00@fra.go.jp
ISC/23/BILLWG-01/03)	Reducing uncertainty in a parameter critical for striped marlin (*Kajikia audax*) stock assessment in the Western Central North Pacific Ocean. Marko Jusup jusup_marko00@fra.go.jp
ISC/23/BILLWG-01/04)	Movements and vertical habitat of black marlin (*Istiompax indica*) and swordfish (*Xiphias gladius*) in the northwestern Pacific Ocean. Wei-Chuan Chiang wcchiang@mail.tfrin.go.tw
ISC/23/BILLWG-01/05)	A preliminary base-case model in SS3.30 for the 2023 North Pacific Swordfish Assessment. Michelle Sculley michelle.sculley@noaa.gov