ANNEX 06

21st Meeting of the
International Scientific Committee for Tuna
and Tuna-Like Species in the North Pacific Ocean
Held Virtually
July 12-21, 2021

REPORT OF THE BILLFISH WORKING GROUP WORKSHOP

July 2021

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ANNEX 06

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

3-4, 13 November 2020 (JST)
Virtual Meeting

1. OPENING AND INTRODUCTION

1.1. Welcoming Remarks

Hirotaka Ijima, Billfish Working Group chair opened the meeting. Five members, Chinese Taipei, Japan, United States of America (US), 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 held a three-day meeting by webinar. The purpose of this meetingwas to i) agree on a sampling plan and sampling methods to support biological studies for billfish species in the north Pacifc Ocean, and ii) discuss the blue marlin growth curve to be used in the forthcoming stock assessment.

1.3. Standard Meeting Protocols

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

1.4. Adoption of Agenda and Assignment of Rapporteurs

Prior to the meeting, the WG adopted the draft agenda of the biological workshop (Attachment 2). The WG Chair assigned the rapporteurs for the three items on the agenda as follows:

Item	Rapporteurs
1-3	H. Ijima
4. a	(WP 01) M. Kanaiwa and A. Kurashima
4. b	(WP 02) YJ. Chang
5. c	(WP 03) M. Kinney
6-8	H. Ijima

1.5. Numbering Working Papers and Distribution Potential

The WG chair distributed numbered working papers (Attachment 3). The WG agreed to post the working papers on the ISC website and make them publicly available, except for document ISC/20/BILLWG-02WP03.

2. SAMPLING PLAN AND METHODOLOGY FOR BILLFISHES

2.1. Length-Based Proportional Sampling for Life History Research: Establishing Uniform Sampling for North Pacific Billfish Species. Michael J. Kinney, Yi-Jay Chang, Hirotaka Ijima, Minoru Kanaiwa, Eva Schemmel, Joseph O'Malley (ISC/20/BILLWG-02/01)

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. Here, the United States, as a member of the BILLWG, outlines 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. Our design sets out guidelines for a length-based proportional sampling approach that can be used to sample pelagic species of interest in the North Pacific. We also evaluate the impact of using length frequency data from past years to inform current proportional sampling efforts.

Discussion

This sampling plan matches samples to those in length-frequency data. The WG noted that the two most influential components when fitting a growth curve to length-at-age data are the very small and very large fish. Also, the WG suggested proportionally sampling the largest and smallest size classes that comprise the tails of length-frequency distributions. The author answered that the proposed sampling plan is based on a simulation study and a review of the literature, both of which indicated that supplemental sampling, or additional ad hoc sampling of the smallest and largest fish, can lead to a bias in growth parameter estimates. If the WG targets individuals to fill upper and lower length bins, this kind of bias may result. It was also mentioned that all samples are collected from the fishery, and that there are currently no sources of fishery independent samples. Thus, only fisheries dependent samples are available to the WG.

The author noted differences between the data requirements and sample collection procedures for growth studies and maturity studies. For example, if the WG focused on a maturity study of billfish, specific sampling objectives that are directed only at maturity are required. This may include monthly collection of samples during the year. For Hawaii, there are certain seasons of the year where billfish are infrequently caught by the fishery. Thus, it would be challenging to obtain sufficient samples for all months of the year from each fishing nation across the Pacific. However, the WG considered it was important for the to initiate a well-designed international biological sampling program before considering a more complex monthly sampling protocolthat would require and extremely large sample size. Furthermore, at this early stage, there was no established method for how length-based sampling could be stratified by month across areas and countries.

The WG indicated that the target minimum samples per region was only 300, and 900 combined for the entire North Pacific. This sample size was considered by several working group members to be low and the author was asked how the number of samples was determined. The author answered that previously published and ongoing simulation studies were used to evaluate what the return on increasing sample sizes would be. The simulation results showed a diminishing return appeared a lot sooner than would be generally expected. A sample size of 300 was explained by the author to be more than what the simulations indicated was needed, although the required sample size may vary depending on the variability in growth in space and time. The WG noted that Chang et al. (2019) simulated that the effective sample size for Pacific bluefin tuna was about 500, though most studies of tuna growth typically use more samples.

It was suggested to add the samples collected by the IATTC and WCPFC observers to the program who, under normal circumstances, cover almost 100% of the purse seine fisheries in their respective convention areas. **The WG agreed to investigate a collaboration for this sampling plan with IATTC and WCPFC by including in their length data in the determination of the proportional sampling length bins.** The WG noted that 300 samples would still be the minimum number of samples to be collected per area because additional IATTC and WCPFC samples would be added in future and that there was currently no scheduled end date for the sampling period. In addition, Japan had already collected many samples that contain small individuals and are part of a supplemental sampling plan, but can be used in the new program to investigate its efficacy. Therefore, the WG will likely have more samples than recommended in the sampling plan.

A WG member asked why there are no differences in the target sample size between years and areas in sampling plan since sampling depends on recruitment, which differs by year and the migration pattern which can differ by day. The author answered that for the WG to be able to investigate growth differences across the Pacific a harmonized sampling approach should be used so that comparisons across space are not confounded by different sampling approaches in different areas. It was also indicated that if spatial differences in biological dynamics are evident, it would require a more refined spatial sampling strategy. At the moment, however, there is no clear indication of such spatial variability and setting up area spatially stratified sampling program based on limited information would be inappropriate.

The WG agreed to start the proposed sampling plan. The WG also indicated that the sampling program needed to be periodically reviewed since sampling situation will differ in ISC member countries.

The WG agreed that the WG has an ongoing review of the sampling since the WG can design a database that allows almost real-time tracking of sampling. The authors are currently working to get such a database operational.

The WG chair asked the WG members if there were any sampling issues for each country. Japanese members answered that the issues depend on species. For example, there are commercial vessels for swordfish. Thus, it is possible to conduct seasonal wide-ranging sampling for swordfish using port-based sampling (e.g. at Kesennuma). It may be difficult to conduct monthly sampling for the blue and striped marlin sincee they are non-target species and their availability to the fishery is highly dependent on the stage of their migration at the time of sampling. Most of the gonad samples already collected are frozen, however Japan is trying to improve the collection of fresh samples.

It was asked how Taiwan determined the catch location information for each specimen sampled during their port sampling. Fishing location (in degrees and minutes) from the offshore longline fishery (OSLL) is provided by the vessel captains at the time of sample collection at the port. Since the OSLL fishing trips are short and mainly occur nearby in the waters off Taiwan, the collected spatial information are considered to be reliable.

Taiwan also has an observer program from which it may be possible to obtain samples. However, billfish samples have not previously been obtained from this source, so the quality of samples that may be obtained using this source is unknown. Taiwan is planning to explore sampling using the observer program in the near future. The majority of biological samples have been collected from the fishing ports. However, when specimens are are of high quality for sale, it is difficult to collect biological samples (e.g. otoliths, gonads, and muscle tissue) from these fish as the fishers do not generally gut them.

The US has observers on the longline vessels, however, due to time constraints, they cannot collect biological samples from all species while at sea. The US is working to establish a two-stage sampling approach where the observers collect gonads because the billfishes are typically gutted at sea. Once the billfish is landed, additional samples (e.g. spines and otoliths) would be collected from the same fish. The longline fishery has a distinct seasonality component where it is generally easier to obtain samples during certain months of the year.

The WG discussed the sample database, which the US has been developing, and this work is still ongoing. The WG members recommended that within a specific length bin, no more than two samples be collected from a single set, or lacking set-by-set information, four samples from a single trip. It was also suggested to record vessel information for collected samples. With concerns of sharing confidential information (e.g. fishing locations, vessel identification) the US is working to resolve these issues internally and then share its solutions with the group. Currently the plan is to avoid confidential location information by binning location data into 5x5 degree grid cells. It may also be possible to establish international non-disclosure agreements, which would help with concerns of confidential information. The authors will report back to the WG as more is learned about this aspect of the project.

Noting the confidentiality of fishing trip information, the WG agreed to record the location and vessel information, where possible, in the database.

2.2. Examination of Histological Methods from Frozen Gonad Samples of the Billfishes. Akira Kurashima, Hirotaka Ijima, Yasuhiro Shibasaki and Nobuhiro Mano (ISC/20/BILLWG-02/02)

Histological observation needs high-quality specimens to estimate accurate maturity size. However, collecting good condition specimens for histological observation of billfish species are not easy because they are highly migration fishes and are live far sea. If we can use the frozen specimens for histological observation, the gonad sampling will be facilitating. This study observed histological changes among the paraffin sections and the cryofracture, or among raw, frozen, and defrost condition. We also considered whether we can use frozen specimens to estimate the size at first maturity of the billfishes. As a result, we frequently observed the cell shedding by cryofracture in the thin sections of frozen samples. The paraffin sections had higher morphological retention capacity than cryofracture. In the comparison among preserve condition, shedding and deteriorations is looks like morphologies of follicles. This result suggested the possibility of causing misunderstand maturity stage. Although the detailed maturity stage cannot be determined from the frozen specimens, it might be possible to determine mature or immature by referring to the cell diameter and other factors.

Discussion

The WG recognized that it is difficult for Japan to collect fresh gonad samples. The WG agreed to allowed data from frozen gonad samples to be added to the database. However, the WG encouraged all members to collect fresh gonad samples where possible.

A WG member informed the WG that species like billfishes with asynchronous oocyte development have postovulatory follicles (POF) or atretic oocytes that originate from yolked oocytes during or soon after spawning, which provide the strongest evidence of previous spawning activity. However, these spawning indicators typically disappear immediately or soon after

spawning. These spawning indicators are often indistinguishable when freezing deteriorates the integrity of the cells, which can lead to mis-classification of the ovary as being either mature resting or immature. Consequently, using frozen samples can result in increased uncertainty and/or bias in estimates of size-at-50% maturity and batch fecundity. Although detailed maturity stage cannot be reliably determined from frozen samples, it might be possible to simply distinguish between mature or immature fish by measuring cell diameter or other histological structures. The WG noted that there is value in using frozen samples given the current sampling limitations and recommended that it is important to continue sample collection.

3. GROWTH CURVE OF PACIFIC BLUE MARLIN

Estimation of the two-stanza growth curves with ageing uncertainty for the Pacific blue marlin (Makaira nigricans) Yi-Jay Chang, Tamaki Shimose, Miyuki Kanaiwa, Xu-Bang Chang, Takahito Masubuchi, Atsuya Yamamoto, Minoru Kanaiwa (ISC/20/BILLWG-02/03)

Age-structured stock assessments are dependent on accurate estimates for age and growth rates. In this study, length-at-age data of the Pacific blue marlin (*Makaira nigricans*) collected among various published and unpublished studies were used to construct growth models to describe the overall growth dynamics of the Pacific blue marlin. Sex-specific growth was modeled by means of the traditional von Bertalanffy growth model (VBGM) and the two-stanza growth model (TSGM), respectively, coupled with the ageing uncertainty. The results of model selection criteria support the use of the TSGM over the VBGM for both sexes. This study suggests that the TSGM coupled with the ageing-error approach appeared to be suitable for modelling the growth of the Pacific blue marlin while VBGM tends to underestimate the median maximum size.

Discussion

The WG asked if it was realistic to use a linear form of growth for animals of age 0–1 years. The response was that this was the way it was done in the 2013 blue marlin assessment, although the paper presented a Gompertz curve that seems to better fit the data and was recommended to be used in future assessments. It was suggested that a linear fit to age 1 may be an option that is compatible with Stock Synthesis.

It was suggested that using the five parameter Schnute-Richards model (which has an inflection point that could be used to separate the two growth stages but would also only use a single model) should be explored, rather than combing the Gompertz to the VB after age 1. The author responded that fitting the data was quite difficult even using a two phase growth approach, it might be even more difficult to fit a model with only one stage.

The WG wanted to state that should the stock assessment change the growth curve within the SS model—based on the L_{inf} and other parameter estimates from the growth model—it must be assessed whether it seems reasonable to use a new growth model. The authors indicated that it does seem reasonable.

The WG asked if constraining the model at $t_0 = 0$ resulted in an underestimate of L_{inf}. The authors indicated that they had one sample that showed a t_0 of zero, which is why they used this value, but mentioned there is also ageing error is also incorporated in this study, which allows some fluctuation around t_0—meaning it is not actually fixed.

The WG queried the justification for starting the second growth stage at age 2, and whether other transition points were considered. The authors responded that the transition point is actually at age

1—a fixed value—based on the patterns observed in the growth increments of the otoliths and spines. The authors explored different transition points in their analyses that yielded similar results, indicating that the transition point did not make a marked difference in the model outcome. Therefore, for simplicity, it was treated as a fixed value. There was also a question of how ageing error was introduced. The author indicated that only very simple ageing error terms were used, and that this was just a starting point. Different error structures may be explored in the future. The WG indicated that a two-stanza growth model was not possible to integrate into SS, only a linear approach for age 0 to A_1 and then VB or Richards thereafter. It was responded that the approach presented is likely more suitable but the authors did not have an idea of how to integrate this into SS. Nonetheless, it was explained that there was not a substantial difference between the new and the existing linear refit approach currently used in SS. The WG indicated that additional spines had been aged with multiple reads and that these could be included to help determine ageing error. The author indicated that it would be helpful to obtain these additional samples, and the data be added to the analysis. It was asked if one person can perform multiple reads of otoliths or spines, or if multiple people must perform multiple reads to be useful in terms of understanding ageing error. It was explained that either could be used but there are different assumptions associated with each approach. Considering this response, the WG indicated that more samples can be provided to improve the analysis.

A WG member stated that the WG needs to make a choice of how to proceed, to either use the new growth model in the assessment, or continue with the previous model. Also, the WG asked whether this work is representative across the distribution of this species. It was indicated that the area coverage of this new analysis is better than for the previous analysis and that more work could be done at the request of the WG, but there would be insufficient time to do so before the next assessment. The WG agreed that the new growth curve is the best available information, but it was suggested that all sensitivities need to be considered during the assessment.

It was suggested that an ensemble approach be used in the assessment—run assessment models with different states of nature. However, the WG commented that there are issues with using this approach such as additional modeling complexity and model weighting.

It was suggested that two SS models be built for the development of the base case—one with the old growth model, and one with the new. The fit to the length-frequency data and other model diagnostics can then be used to determine the most appropriate base case model. The WG agreed to adopt this approach.

4. FUTURE MEETING

The WG discussed sharing a spreadsheet to track current progress of biological sample collection while the sampling program database is being developed. Additional meetings will be coordinated via email as needed.

5. CIRCULATE WORKSHOP REPORT

The WG Chair prepared a draft of the report, which was reviewed by the WG members. The provisional report was editorially revised by the WG Chair and distributed via email for WG members to finalize.

6. ADJOURNMENT

The BILLWG workshop was adjourned at 11:15 AM on 13 November 2020 (JTS). The WG Chair expressed appreciation towards the participating scientists for their collaboration in future biology studies.

7. REFERENCES

Chang, Y.J., Hsu, J., Shiao, J.C. and Chang, S.K., 2019. Evaluation of the effects of otolith sampling strategies and ageing error on estimation of the age composition and growth curve for Pacific bluefin tuna *Thunnus orientalis*. Marine and Freshwater Research.

Andrews, A.H., Humphreys Jr, R.L. and Sampaga, J.D., 2018. Blue marlin (*Makaira nigricans*) longevity estimates confirmed with bomb radiocarbon dating. Canadian Journal of Fisheries and Aquatic Sciences, 75(1), pp.17-25.

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)

SECOND BIOLOGICAL STUDY WORKSHOP ANNOUNCEMENT and AGENDA

Meeting Style:	Webinar meeting using Webex
Meeting Dates:	9:00-13:00, 3-4th, 13th November (Japan Time) 8:00-12:00, 3-4th, 13th November (Taiwan Time) 11:00-15:00, 3-4th, 13th November (New Caledonia Time) 14:00-18:00, 2-3th, 12th November (US Hawaii Time) 16:00-20:00, 2-3th, 12th November (US San Diego Time)
Meeting Goals:	The purpose of this meeting is to i) agree on a sampling plan and sampling methods for billfish species and ii) discuss the blue marlin growth curve.
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 October 27th.
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@affrc.go.jp TEL: +81-543-36-6044

AGENDA

November 3rd (Tuesday), 9:00-13:00 (Japan time)

1. Opening of Billfish Working Group (BILLWG) second biological study 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. Sampling plan and methodology of billfishes
    a. Length-Based Proportional Sampling for Life History Research: Establishing Uniform Sampling for North Pacific Billfish Species (ISC/20/BILLWG-02/01)
        1. Discussion of the sampling design.
        2. Individual nation sample collection and sharing.
        3. Database issues.
    b. Examination of Histological Methods from Frozen Gonad Samples of the Billfishes. (ISC/20/BILLWG-02/02)

November 4th (Wednesday), 9:00-13:00 (Japan time)

5. Growth curve of Pacific blue marlin
    c. Estimation of the two-stanza growth curves with ageing uncertainty for the Pacific blue marlin (Makaira nigricans) (ISC/20/BILLWG-02/03)
6. Future meeting

November 13th (Friday), 9:00-13:00 (Japan time)

7. Circulate workshop report
8. Adoption

ATTACHMENT 3. THE LIST OF WORKING PAPERS.

ISC/20/BILLWG-02/01	Length-Based Proportional Sampling for Life History Research: Establishing Uniform Sampling for North Pacific Billfish Species. Michael J. Kinney, Yi-Jay Chang, Hirotaka Ijima, Minoru Kanaiwa, Eva Schemmel, Joseph O'Malley michael.kinney@noaa.gov
ISC/20/BILLWG-02/02	Examination of Histological Methods from Frozen Gonad Samples of the Billfishes. Akira Kurashima, Hirotaka Ijima, Yasuhiro Shibasaki and Nobuhiro Mano akura@affrc.go.jp
ISC/20/BILLWG-02/03	Estimation of the two-stanza growth curves with ageing uncertainty for the Pacific blue marlin (*Makaira nigricans*) Yi-Jay Chang, Tamaki Shimose, Miyuki Kanaiwa, Xu-Bang Chang, Takahito Masubuchi, Atsuya Yamamoto, Minoru Kanaiwa yjchang@ntu.edu.tw