FINAL

ISC/21/ANNEX/04

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

ANNEX 04

21st Meeting of the
International Scientific Committee for Tuna
and Tuna-Like Species in the North Pacific Ocean
Held Virtually
July 12-20, 2021

REPORT OF THE SHARK WORKING GROUP WORKSHOP

July 2021

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ANNEX 04

REPORT OF THE SHARK WORKING GROUP WORKSHOP

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

22-26 February 2021
Virtual Meeting

1. INTRODUCTION

The Shark Working Group (SHARKWG or WG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) held a 5-day online meeting from February 22-26, 2021. The primary goal of the workshop was to conduct an indicator analysis of the North Pacific shortfin mako shark and to recommend whether a benchmark assessment should occur prior to the scheduled benchmark stock assessment in 2024.

Mikihiko Kai, SHARKWG Chair, opened the meeting at 9:00 am on February 22, 2021 (Japan time). Participants included members from Canada, Chinese Taipei, Japan, Mexico, and United States of America (USA) (**Attachment 1**). SHARKWG Chair welcomed all participants. He wished for all to stay safe and keep healthy conditions during COVID-19 pandemic and to have a productive meeting and for good work on the indicator analysis of North Pacific shortfin mako shark.

2. DISTRIBUTION OF DOCUMENTS AND NUMBERING OF WORKING PAPERS

Ten working group papers and 5 information papers were distributed and numbered (**Attachment 2**). All working group papers were approved for posting on the ISC website where they will be available to the public.

3. REVIEW AND APPROVAL OF AGENDA

The draft meeting agenda was reviewed and the agenda was adopted with minor revisions (**Attachment 3**).

4. APPOINTMENT OF RAPPORTEURS

The following participants served as rapporteurs for each item of the approved agenda.

Item	Rapporteurs
1-5.	M. Kai
6a.	M. Kinney (Lead), M, Kanaiwa
6b.	J. King (Lead), J.L. Castillo-Geniz
6c.	K.M., Liu (Lead), L.V. González-Ania
6d.	Y. Semba (Lead), G. Ramírez-Soberón
7.	F. Carvalho,
8.	J. King (Lead), Y. Fujinami
9-10.	M. Kai

F. Carvalho volunteered to lead the writing of the indicator analysis report. Y. Fujinami and Y. Semba where tasked with compiling the figures of catch, cpue, and size data.

5. REPORT OF THE SHARKWG CHAIR

The WG Chair summarized the outcomes of the last online SHARKWG meeting, held in September 2020. Meeting participants included 17 members from Canada, Japan, Mexico, the Secretariat of the Pacific Community (SPC), Republic of Korea, Taiwan, and USA. The main objective of the webinar was to determine the method for conducting an intermediate stock assessment after the ISC 20 Plenary approved the schedule change for benchmark stock assessments of North Pacific blue shark and North Pacific shortfin mako from 3 to 5 years. The WG discussed and decided to conduct an indicator analysis for North Pacific shortfin mako with the goal of tracking a few key fisheries indicators (catch, CPUE, size frequency from the base case benchmark assessment [ISC, 2018]) in order to determine if any major changes had occurred which would warrant concerns about the time span between benchmark assessments. The results of this analysis are to be reported at the ISC 21 Plenary. Templates were circulated to members to collect data for these indicators and members were asked to provide the finalized time series data in advance of this meeting so that the WG could review and discusses the planned indicator analyses.

6. REVIEW OF SHORTFIN MAKO DATA

6.1. CPUE

6.1.1. *Updated standardized CPUE and historical catch estimate of the shortfin mako shark caught by Taiwanese large-scale tuna longline fishery in the North Pacific Ocean (ISC/21/SHARKWG-1/01)*

In the present study, the shortfin mako shark catch and effort data from the logbook records of the Taiwanese large-scale tuna longline fishing vessels operating in the North Pacific Ocean from 2005-2019 were analyzed. Due to large percentage of zero shortfin mako shark catch, the catch per unit effort (CPUE) of shortfin mako shark, as number of fish caught per 1,000 hooks, was standardized using a zero inflated negative binomial model. Both nominal and standardized CPUE of shortfin mako shark showed an inter-annual fluctuation with two peaks (2013-2014 and 2018-2019). Estimated shortfin mako shark catch in weight from the Taiwanese large-scale tuna longline fishery ranged from 0 metric tons (MT) in 1973 to 156 MT in 2015, and it decreased thereafter and increased again to 142 MT in 2019.

Discussion

The WG commented that both area and lat/long were used in the standardization model, which means spatial data is used twice, with no interaction term. This assumes that the effect of lat/long is same and constant in each area. It is understood that this meeting is just an update, and that changing the standardization approach used for the Taiwan CPUE is not in the scope of this meeting, however, such considerations should be maintained for future work prior to the next shortfin mako benchmark assessment. **The WG agreed that this model was used for consistency and that future work should look to update it during the next benchmark stock assessment.** It was also commented that the reason for the "double use" was due to the WG's concern that spatial variability within the areas would be missed if lat/long was not included, some progress on this has been made by defining more areas, but again, for consistency, the model should remain as is for the update.

The WG asked how species composition was used in the estimation of historical catch and answered that historical effort data (which has spatial information), along with estimates of historic logbook reporting rates (in terms of both catch and effort), were used with current catch composition to estimate historical catch by area.

The WG also commented about the small scale longline, which is reported entirely from landing data, and so there is no need to estimate catch in the same way for that fishery.

6.1.2. Updated CPUE of shortfin mako, Isurus oxyrinchus, caught by Japanese shallow-set longliner in the northwestern Pacific from 1994 to 2019 (ISC/21/SHARKWG-1/04)

This working paper provides with an updated standardized CPUE of shortfin mako caught by Japanese offshore and distant-water shallow-set longline fishery from 1994 to 2019 in the northwestern Pacific Ocean. The author basically used the same estimation methods used in the previous analysis. Two filtering methods were used to remove the misreporting and inappropriate data. Since the zero-inflated negative binomial model had an issue of model convergence, negative binomial model with the same explanatory variables as used in the previous analysis was used as the best model to standardize the CPUE for the filtered data. The annual standardized CPUE indicated that the historical population trend of shortfin mako had gradually increased until 2011, and then a stable trend was observed except in 2016. The author considered that (1) the increase trends until 2004 was caused by the gradual increase of catch number with a slight increase of fishing effort, (2) the steep increase from 2004 to 2011 was mainly caused by the continuous decrease of the fishing effort with stable annual catches, and (3) the stable trends in recent years were caused by the constant catch and fishing efforts.

Discussion

The WG asked why the confidence interval for the CPUE has expanded in recent years. The WG responded that there are likely two main reasons, one, the number of hooks in the Kinkai shallow fishery are declining, and two, data filtering has been used to remove some data that was considered unreliable, which means less data was available for analysis, which in turn leads to greater uncertainty. **The WG indicated that this current filtering method needs to be looked at again in the next benchmark stock assessment.**

A point of clarification was made to indicate that the zero inflated negative binomial model used in the last benchmark assessment was not used here due to convergence issues, instead a negative binomial model was used.

The WG asked if the CPUE spike in 2016 was considered real, the WG responded that the same spike does not appear in the observer data, and so is likely not real but needs further investigation.

6.1.3. Updated CPUE of shortfin mako, Isurus oxyrinchus, caught by Japanese research and training vessels in the western and central North Pacific (ISC/21/SHARKWG-1/03)

This working paper presents updated annual standardized catch per unit of effort (CPUE: catch number per 1,000 number of hooks) for shortfin mako caught by longline fishery of Japanese training and research vessels during 1992 and 2019 in the North Pacific Ocean. The author used the same estimation methods used in the previous analysis. Since the reporting rates of sharks during 2001 and 2013 are clearly lower than those before 2000, the author removed the data with lower reporting rates using the filtering method based on the prediction of the binomial generalized linear model. Then we standardize the nominal CPUE using two-step model (binomial model for presence/absence and Poisson model for positive catch) in consideration of the characteristics in the data with high zero catch ratio and small over-dispersions. The annual trends in the standardized CPUE slightly increased with large fluctuations until 2007, and then its gradually decreased until 2013. Thereafter, the annual trends in the CPUE sharply increased associated with the lower fishing effort. The CVs of the standardized CPUE were smaller than 0.16 over the years. These results suggested that the recent abundance of shortfin mako in the western and central North Pacific is likely to be on the rise due to the reduction of fishing effort.

Discussion

The WG indicated that the reduction in CPUE peaks in the current model is confusing, since reducing model complexity should not lead to CPUE trends shifting down as they seem to have done in the present analysis. The WG suggested that due to the sensitivity of analysis run on this dataset, conclusions drawn from it should be considered with skepticism (specifically the current upward trends). The WG indicated that the data in 2019 had very few numbers of hooks compared to previous years, and it may be that the data for that year is not complete, which would mean that 2019 data perhaps should be removed from the current indicator analysis.

The WG noted that there were several differences between the current and previous analysis, specifically in 2010 and 2012. In the previous model, SST was included, but not in the present analysis. This was due to time constraints, and it is likely the reason for these differences. The WG also indicated that including SST back into this CPUE analysis could be done in order to remain consistent with what had been done in the last benchmark stock assessment. The WG asked how SST was included in the original CPUE model. The WG responded that SST was added to the binomial model as a sensitivity analysis using a quadratic equation. There was some discussion about the assumptions related to including SST in the model or not, basically, if the WG believes that SST will affect the fishery efficiency or the ratio of zero catch. Based on the WG's belief in such an assumption, the WG should considered, in the future, whether an index with SST should continue to be used. For the moment however, the WG suggested that consistency should be maintained between base case models and updates. The WG finally updated the standardized CPUE using the same model as used in the benchmark assessment, (i.e., SST included). However, the abundance trend indicated the same reduction in peak in 2010 and 2012. The WG asked why the spike in CPUE from 2010-2012 (seen in the Japanese research and training vessel CPUE from the assessment) was not apparent in the presented trend. The WG answered that the dataset used in this analysis was updated (larger), and so different from the one used in the last assessment, which is why the 2010 and 2012 spike does not appear in the presented standardized CPUE trend.

6.1.4. Updated stock abundance indices for shortfin mako (Isurus oxyrinchus) estimated by Japanese longline observer data in the North Pacific Ocean (ISC/21/SHARKWG-1/08)

In this paper, the updated standardized CPUEs between 2011 and 2019 estimated using the observer data set of Japanese longline operated in the North Pacific Ocean were provided. The same statistical model with previous analysis was used. The estimated annual CPUE showed a flat trend between 2011 and 2016 and slightly decreased after 2016.

Discussion

The WG indicated that the CPUE trend of Japanese longline observer data (downward) differs from both the CPUEs for Kinkai shallow and the JRTV, likely due to the limited coverage of the observer data and the shift in spatial coverage year to year. The WG explained that a model with annual spatial distribution was investigated but was not indicated as the best model (from BIC). This is likely due to the limited spatial coverage, and limited amount of total data, in the observer dataset. Since this index was not used in the benchmark stock assessment, the WG suggested that it should not be used in the current indicator analysis.

6.1.5. Update on standardized catch rates for mako shark (Isurus oxyrinchus) in the 2006-2019 Mexican Pacific longline fishery based upon a shark scientific observer program (ISC/21/SHARKWG-1/07)

Abundance indices for shortfin mako shark (*Isurus oxyrinchus*) in the northwest Mexican Pacific for the period 2006-2019 were estimated using data obtained through a pelagic longline observer program, updating similar analyses made in 2014 and 2017. Individual longline set catch per unit effort data, collected by scientific observers, were analyzed to assess effects of environmental factors such as sea surface temperature, distance from mainland coast and time-area factors. Standardized catch rates were estimated by applying two generalized linear models (GLMs). The first model (using a quasi-binomial likelihood and a complementary log-log link function) estimates the probability of a positive observation and the second one estimates the mean response for non-zero observations, using a lognormal error distribution. The importance of factors included in the models is discussed. The results of this analysis point at the abundance index trends being close to stability in the analyzed period.

Discussion

The WG asked what the meaning of “variable coverage” was, sample coverage, or area coverage. The WG responded that sample coverage was variable year to year due to the fact that participation in the observer program is voluntary and not mandatory, and that sampling is variable month to month and year to year.

The WG commented that the binominal model quantile-quantile (QQ) plot is difficult to interpret and that perhaps a randomized quantile plot should be used for model diagnosis instead.

The WG also commented that the environmental factors used in the model are often strongly correlated, if that is true, then perhaps those terms should not be used in the model, since they could have a negative effect on the standardization of the CPUE. The WG indicated that they had investigated the correlations and did not see any strong collinearity. The WG suggested that a spatio-temporal generalized linear mixed model could perhaps be used to better deal with any correlation issues that may arise in the future.

6.1.6. Standardized Catch Rates of Shortfin Mako Shark caught by the Hawaii-based Pelagic Longline Fleet (1995-2019) (ISC/21/SHARKWG-1/10)

Catch and effort data from the Hawaii-based pelagic longline fishery operating in the North Pacific Ocean were analyzed to estimate indices of abundance for the shortfin mako shark between 1995 and 2019. The data come from the records of the Pacific Islands Regional Observer Program (PIROP) submitted to the Pacific Islands Fisheries Science Center (PIFSC). Nominal CPUEs were calculated separately for shallow-set (target: swordfish) and deep-set (target: bigeye tuna) sectors, and standardized with Generalized Linear Models (GLM), separately for each sector. Model validation was carried out with residual analysis. The best-fit models included variables year, quarter of the year, region, sea surface temperature, bait type, and interactions between quarter of the year and region. Overall, the standardized CPUE for the deep-set sector showed a stable trend from 1995 to 2016, followed by an increase in the last three years, while the standardized CPUE in shallow-set sector showed a slightly decrease up to 2012, followed by an increase in 2013.

Discussion

The WG confirmed that the standardization approach is the same as that used in 2018. The WG also asked if there were any differences in the trends presented here and those from the previous analysis in 2018, the WG responded that the trends were very similar. There was some confusion over which index (shallow or deep) was used in the last assessment. The WG clarified that it was the shallow set fishery (deep set was used for the benchmark assessment of blue sharks), and so that will be the index used in the indicator analysis.

The WG asked if SST was an important factor in the model. The WG indicated that SST is highly variable around Hawaii and that most pelagic indices (including those for shortfin mako) include STT in this area for that reason. The WG mentioned that, for shortfin mako, SST was an influential factor in the standardization model. The WG mentioned that SST had a significant impact on the Japanese research and training vessel index as well, a fishery that has a very similar operational area to the Hawaii longline fleets.

6.2. Catch

6.2.1. Updated standardized CPUE and historical catch estimate of the shortfin mako shark caught by Taiwanese large-scale tuna longline fishery in the North Pacific Ocean (ISC/21/SHARKWG-1/01)

Catch data are available from logbooks from Taiwanese large-scale tuna longline fishing vessels operating in the North Pacific Ocean from 2005-2019. The logbook data contain basic information on fishery dynamics (fishing time, area, number of hooks) and the catches of 18 species such as tunas, billfishes and sharks including shortfin mako. Prior to 2005, logbook catch data only recorded a "sharks" group, therefore the shortfin mako catch data are back-estimated by multiplying nominal CPUE with logbook effort and divided by the logbook coverage rate (by year and area). Since weight records are incomplete, catch in weight was estimated by using annual mean weight applied to the annual back-estimated catch. Overall, the catch of shortfin mako in the Taiwanese tuna longline fleet is considered limited. In 2017, the logbooks became electronic, which has improved the data quality for shortfin mako shark catch.

Discussion

See the Discussion in CPUE (*ISC/21/SHARKWG-1/01*).

6.2.2. Estimation of catches for shortfin mako, Isurus oxyrinchus, caught by Japanese offshore and distant water fisheries (ISC/21/SHARKWG-1/05)

Shortfin mako are incidentally captured in Japanese pelagic longline fisheries that are targeting tuna and swordfish. Since the market value of shortfin mako is lower than these other species, the total catch data of shortfin mako are frequently underestimated. Total catches (retained and released) are estimated by multiplying annual CPUE by fishing effort (number of hooks). The catches of shallow-set longline fisheries (hooks per basket < 6) were estimated from the standardized CPUE of Japanese commercial Kinkai shallow fisheries (1994-2019). The catches of deep-set longline fishery (hooks per basket >5) were estimated from the standardized CPUE of the Japanese Research and Training Vessel data (1992-2019). The total number of hooks were derived from set-by-set logbook data for Japanese offshore and distant water longline fisheries (1992-2019) and were summed by year, quarter, area (4 areas demarcated by 180°E and 30°N) and depth (shallow-set or deep-set). The total catch weight by area and quarter was calculated using the mean body weight by area and quarter. When the annual landed catch was larger than the annual estimated total catch, the annual landed catch was used. Total catches of shortfin mako shark in both fisheries has been increasing since 1992 with a peak in 2007 of 1144 tonnes, with a gradual decrease thereafter.

Discussion

Once the CPUE for the JRTV is updated with SST, the deep-set catch reported will also be updated. There have been changes in the spatial dynamics of the fleet which could account for the decrease in catch. In 2011 the Great East Japan Earthquake, and subsequent tsunami, impacted the shallow-set fishing fleet and the catch that year. Since then, this fleet has operated in coastal waters instead of the far seas and does not really operate east 180°E (i.e., Areas 3 and 4 used in the estimation procedures). For the deep-set fishery, a decrease in effort, specifically a shift to other species and also to areas outside of the North Pacific, do account for decreases in this fishery's catch.

After the WG revised the standardized CPUE of JRTV, the annual catch of deep-set was revised and there was no large difference between previous and revised one.

6.2.3. Updated catches of shortfin mako, Isurus oxyrinchus, caught by Japanese coastal fisheries. (ISC/21/SHARKWG-1/06)

The total catch estimation of shortfin mako shark from different coastal fisheries using different data sources: 1) Japanese fishery statistical yearbooks; 2) Research project on Japanese Bluefin tuna and 3) Commercial logbook data. Shortfin mako are caught in five different coastal fisheries in Japan: coastal longline fisheries; other longline fisheries; large mesh driftnet fishery; trap net; other fisheries. The gear-specific annual catch weight is commonly used in the estimation of the total catch for shortfin mako. The working document paper provided the five methods used to calculate the catch in each of the five coastal fisheries. Annual total catches have fluctuated between 161 and 638 tons. Recently it has decreased from 494 tons in 2016 to 213 tons in 2019. About 90% of the annual catch of shortfin mako in coastal fisheries comes from the two longline fisheries and the large-mesh driftnet fishery.

Discussion

The 2016 catch is high, driven by the catch of the coastal drift net fishery. This peak is concomitant with the 2016 peak observed in the shallow-set longline CPUE. However, there is no information on the spatial operation of coastal drift net fishery to determine if this reflects a change in shortfin mako distribution.

6.2.4. Pelagic longline fisheries of Republic of Korea (no supporting document)

Major shark species were separately identified in catch statistics of Korean longline fishery in the North Pacific Ocean from 2013 to 2019 with 100% observer data coverage. These data are considered to be reliable. The catch amount in recent years is near zero, due to conservation measures strengthened for Korean longline fisheries; sharks are now released prior to bringing on board the vessel. This is a new catch time series and was not included in the 2018 benchmark stock assessment. In future work, the estimation of blue shark catch will be conducted after reviewing and analyzing the data on the estimation method of catch.

Discussion

The WG inquired about the amount of discard because there was no information about it, although the recent catch is almost zero from 2017 to 2019. The SHARKWG Chair requested for Korean researcher to answer this question via e-mail. The WG responded that the discard data could be provided in the ISC 21 Plenary or future ISC SHARKWG meeting.

6.2.5. United States (no supporting document)

The catch for the Hawaiian longline shallow-set and deep-set fisheries were compiled as per the previous assessment. The recreational fisheries and the drift net fisheries will be updated from the Southwest Fisheries Science Center of NMFS; but were not available for the meeting for discussion.

6.2.6. WCPFC (no supporting document)

Fleet-specific catch statistics of shortfin mako in the North Pacific between 1950 and 2020 in western and central Pacific Ocean (WCPO) area was provided by SPC. In the previous stock assessment in 2018, the catch statistics provided by Republic of Kiribati, PNG, Republic of Palau, and Solomon Islands were not used as input data, but these data were included in this indicator analysis because they were deemed to be from the North Pacific Ocean.

6.2.7. Mexico (no supporting document)

The WG updated and provided total annual catches for shortfin mako sharks during 2017-2019 split by regions in the Pacific Ocean: North (States of Baja California and Baja California Sur, Mexico) and South (Sinaloa, Nayarit and Colima, Mexico). The catch data were provided by the official Mexican fisheries agency, the National Commission for Aquaculture and Fisheries (CONAPESCA). Since 2006 CONAPESCA reports the total catches of the main shark species.

6.3. Size/sex

6.3.1. Updated size composition of shortfin mako shark caught by the Taiwanese tuna longline fishery in the North Pacific Ocean (ISC/21/SHARKWG-1/02)

There are two types of Taiwanese tuna longline vessels, namely the large-scale tuna longline vessels (LTLL, ≧100 GRT) and the small-scale tuna longline vessels (STLL, < 100 GRT). In the present study, the size data of the shortfin mako shark caught by these two fisheries are presented. All size data recorded in other measurements were converted to pre-caudal length (PCL) by using the converting equations available. The size of shortfin mako caught by the Taiwanese STLL from 1989-2019 in the North Pacific ranged from 61 to 338 cm PCL for females (n = 116,281), and 60–262 cm PCL for males (n = 108,505). The sizes of 11,173 individuals (sexes combined) recorded in the logbook of LTLL from 2005-2019 ranged from 61 to 303 cm PCL. Two modes (mostly 100 and 150 cm PCL) were observed in the size distribution of shortfin mako shark caught by the STLL in the North Pacific Ocean. This also implied that the catches comprised mostly immature fish (female < 228, male < 172 cm PCL). The capture of high proportion of immature sharks may have serious impact on the sustainability of the fishery.

Discussion

The WG discussed whether the large proportion of small individuals in the catch indicated a decreasing trend for the shortfin mako population in the North Pacific Ocean. The WG replied that no clear evidence supported this point from the size data.

The WG also discussed whether the fishing seasons are different for different sizes of STLL vessels. The WG answered that the fishing season is similar but fishing grounds (within and outside EEZ) are major differences for different sizes of STLL vessels.

The WG commented that the large proportion of immature shortfin mako was similar to what is seen in the catch data from Mexican waters. The WG discussed whether the biased sex ratio is related to gear selectivity. The WG suggested that the sex ratio biased to female was probably due to sexual dimorphism in growth and longevity for shortfin mako.

6.3.2. Length frequency of shortfin mako (Isurus oxyrinchus) reported in the Japanese observer program between 2011 and 2019 (ISC/21/SHARKWG-1/09)

This document paper summarizes the length frequency data of shortfin mako collected by the Japanese observer program between 2011 and 2019. Majority of size data was collected in the area north of 30°N and west of 175°E, which is part of main ground of shallow-set longline fishery targeting swordfish and blue shark. The annual median and quartile percentiles of catch at size of shortfin mako in PCL indicated that remarkable temporal change of body size was not clearly observed and relatively stable in the main fishing ground of offshore shallow-set longline fishery where juvenile dominates. Although coverage of observer data is not high, combined with the abundance index estimated based on shallow-set logbook data and current result, it is suggested that population decrease is unlikely to occur after the last year (i.e., 2016) of stock assessment conducted in 2018.

Discussion

The WG discussed the larger sample size in the 3rd quarter. The WG replied that the amount of size data generally reflects the number of sets observed. The deployment schedule of observer is decided by the industry group and thus the amount of data is not homogeneous across seasons.

6.4. Inventory of all data for analysis

CPUE

After reviewing reported annual CPUE documents, the WG created the table and figures of 7 longline CPUE (i.e., Hawaii-Shallow set LL, Hawaii-Deep set LL, Taiwan-Large-scale LL, Mexico-commercial LL, Japan-RTV LL, Japan-offshore and distant-water shallow-set LL, Japan-observer LL) for consideration in the indicator analysis.

Catch
After reviewing reported annual catch of each country/organization (Mexico, IATTC, Japan, Taiwan, Republic of Korea, USA, and WCPFC), the WG created the table and figures for use in the indicator analysis.

Size data
After reviewing reported size frequency data of Taiwanese commercial data (STLL and LTLL) and Japanese observer data, the WG summarize the size data to show the annual change in the length frequency distribution and mean/median of size data.

<u>Discussion</u>

The WG carefully reviewed all available data (**Attachment 4**). The WG discussed the informative indices and reasonable time period to be used for a judgement on whether major shifts had occurred in either the catch, CPUE, or size frequency for shortfin mako shark that would warrant a shift in the benchmark assessment time schedule.

The WG pointed out that the description of recent annual catch trend is also important. After 2016, the last year of benchmark stock assessment, the catch amount in 2019 reached the 2nd highest in the available time period. The remarkable catch might be a signal of increase of fishing pressure, while the large amount of catch may be caused by an increase in population size. Therefore, **the WG agreed not to describe the stock status based on the increase of the recent catch.**

The WG agreed that the size frequency information is used as supplementary information in the indicator analysis.

The WG also discussed the threshold to judge whether a shift in any of the reviewed indicators would signal a "red flag" warning where action would need to be taken. As the specifics of this threshold had never been discussed in the past meeting, **the WG agreed to explore the threshold in the future SHRAKWG meeting** but for now the goal is to track the important fisheries indicators (as identified in the last benchmark assessment) and present their most recent trends to the ISC 21 Plenary.

7. INDICATOR ANALYSIS

<u>Discussion</u>

The WG reviewed the past indicator analyses in 2015 and 2018 (Carvalho *et al*., 2018; ISC 2015, 2018). The WG discussed the methodology of indicator analysis. **The WG agreed to use all of the information provided at this meeting that related to the data included in the last benchmark assessment (ISC, 2018) as indicators** in order to determine whether we will conduct the benchmark stock assessment of North Pacific shortfin mako earlier than the scheduled in 2024.

The WG also agreed not to give a conclusion about the stock status based on our indicator analysis because our information is insufficient to determine the stock status, unlike the simulation study in 2015 (Lee *et al*. 2015) and benchmark stock assessment in 2018 (ISC 2018). Instead, **the WG agreed to examine visually the annual trends of three indicators (catch, CPUE, size frequency)**.

Further, the WG determined to use a 5-year moving average (e.g., the moving average in 2019 is a mean value between 2015 to 2019) and percent change of annual CPUE from both long-term (i.e., whole period of each CPUE) and short term (i.e., recent 5 years from 2015-2019) in order to evaluate the historical and recent changes in the abundance indices.

Regarding the key indicators whether the stock is showing any major "red flags" or not, **the WG agreed to use 4 abundance indices (i.e., Hawaii-Shallow set LL, Taiwan-Large-scale LL, Mexico-commercial LL, Japan-RTV LL) based on the selection of CPUE in the benchmark stock assessment in 2018.**

The WG also discussed the use of the CPUE from the last year of the analysis, 2019, because it is typical that such data is only preliminary owning to as of yet unreported months during the year. The WG decided not to use the last year's data for the calculation of percent change of CPUE for JRTV in line with the discussion of CPUE section.

After inspecting the fishery indicators provided by the member nations, **the WG found no obvious signs to indicate the need to revise the schedule the next benchmark assessment in 2024.**

The WG recommended that at the next benchmark assessment, discussion is held to identify the most appropriate threshold values to use in future interim indicator analysis.

8. FUTURE SHARKWG MEETINGS

8.1. ISC Plenary – July 2021

This meeting was originally planned to take place in Hawaii, but due to COVID-19, it will be held virtually. The announcement regarding this change will be made soon. This does mean that all SHARKWG members can attend if they wish to. At the ISC 21 Plenary meeting, the SHARKWG will present the Indicator Analysis Report and any recommendations from this interim assessment meeting. The lead authors of indicator analysis report will be Mikihiko Kai, Mike Kinney and Felipe Carvalho; the report will be completed by March 31, 2021.

8.2 Blue Shark Data Preparatory for Stock Assessment Meeting

This meeting will be held in fall (Oct. or Nov. or Dec.) of 2021. A location has not yet been identified, but it will likely take place in Japan or Taiwan. Each member nation is expected to update blue shark catch statistics, sex and length data from fisheries and standardized indices of abundance.

8.3 Blue Shark Pre-Stock Assessment Meeting

This meeting will be held in winter (Dec. 2021 to Feb 2022), and will be held online. This meeting will review the issues identified by the SHARKWG with the previous blue shark stock assessment (WCPFC, 2017) with suggestions and implementations for the upcoming assessment. Briefly, the methodological issues identified in the 2017 blue shark benchmark assessment included:

a) Catches: improvement to methods estimating catch; identification of additional fisheries that encounter blue shark.
b) Abundance indices: consider spatial-temporal modelling approaches to improve the standardization methods; Kinkai shallow fleet of Japan has shifted the target focus and exploration on how to adjust the standardization should be undertaken.
c) Biological parameters: aside from field studies or expanded collection of samples from large male and females, biological parameter estimates in the stock assessment model might be improved with a meta-analysis similar to the one conducted by the SHARKWG for shortfin mako.
d) Stock-recruitment relationship: the assessment model could not adequately estimate the parameters of the stock-recruitment relationship because of insufficient information on the stock depletion; it is necessary to improve the accuracy of the estimation of the steepness

outside of the assessment model until better information on age-specific natural mortality and stock depletion are available.

8.4 Blue Shark Stock Assessment Meeting

This meeting will be held in spring (March to May) of 2022. A location has not yet been identified, but it will likely take place in La Jolla, USA because it may be possible to get helpful comments from the stock assessment scientist there.

9 OTHER MATTERS

Genetic study of blue shark

The WG introduced the plan of genetic study of blue shark. Regarding blue shark, Japan is going to launch a mitogenome analysis this year and the experiment and analytical work will be conducted by scientists at Tokai University with collaborative scientists from the Japanese delegation. Japan inquired with the members of the WG about permission to use a master student from Tokai University to conduct this work as his master thesis. **The WG agreed that the master student can use the tissue samples collected by the WG** to clarify the genetic population structure of blue shark in the Pacific Ocean.

10 CLEARING OF REPORT

A draft of the report was reviewed by the WG and the content accepted. The Chair will make minor editorial changes and circulate a draft for comments before finalizing the report.

11 ADJOURNMENT

The WG Chair thanked everyone for a productive meeting. The meeting was adjourned at 12:03 on Friday 26, 2021 (Japan time).

LITERATURE CITED

ISC. 2015. Indicator-based analysis of the status of shortfin mako shark in the North Pacific Ocean. Report of the SHARK WG, Annex 12. ISC Plenary meeting in Hawaii, USA.

ISC. 2018. Stock assessment of Shortfin Mako Shark in the North Pacific Ocean Through 2016. ISC/18/ANNEX/15.

Lee, H.H., Carvalho, F., and Piner, K. 2015. Simulation testing of stock indicators. ISC/15/SHARKWG-1/06.

WCPFC. 2018. Stock assessment of Shortfin Mako Shark in the North Pacific Ocean Through 2016. WCPFC-SC14-2018/SA-WP-11.

WCPFC. 2017. Stock assessment and Future Projections of Blue Shark in the North Pacific Ocean through 2015. WCPFC-SC13-2017/SA-WP-10.

F Carvalho, HH Lee, K Piner, M Kapur, S Clarke. 2018. Can the status of pelagic shark populations be determined using simple fishery indicators? Biological Conservation 228, 195-204

ATTACHMENT 1: LIST OF PARTICIPANTS

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ATTACHMENT 2. MEETING DOCUMENTS AND INFORMATION PAPERS

WORKING PAPERS

ISC/21/SHARKWG-1/01	Updated standardized CPUE and historical catch estimate of the shortfin mako shark caught by Taiwanese large-scale tuna longline fishery in the North Pacific Ocean. **Kwang-Ming Liu, Wen-Pei Tsai, and Kuan-Yu Su** (kmliu@mail.ntou.edu.tw)
ISC/21/SHARKWG-1/02	Updated size composition of shortfin mako shark caught by the Taiwanese tuna longline fishery in the North Pacific Ocean. **Kwang-Ming Liu, Wen-Pei Tsai, and Kuan-Yu Su** (kmliu@mail.ntou.edu.tw)
ISC/21/SHARKWG-1/03	Updated CPUE of shortfin mako, *Isurus oxyrinchus*, caught by Japanese research and training vessels in the western and central North Pacific. **Mikihiko Kai** (kaim@affrc.go.jp)
ISC/21/SHARKWG-1/04	Updated CPUE of shortfin mako, *Isurus oxyrinchus*, caught by Japanese shallow-set longliner in the northwestern Pacific from 1994 to 2019. **Mikihiko Kai** (kaim@affrc.go.jp)
ISC/21/SHARKWG-1/05	Estimation of catches for shortfin mako, *Isurus oxyrinchus*, caught by Japanese offshore and distant water fisheries. **Mikihiko Kai** (kaim@affrc.go.jp)
ISC/21/SHARKWG-1/06	Updated catches of shortfin mako, *Isurus oxyrinchus*, caught by Japanese coastal fisheries. **Mikihiko Kai and Toshikazu Yano** (kaim@affrc.go.jp)
ISC/21/SHARKWG-1/07	Update on standardized catch rates for mako shark (*Isurus oxyrinchus*) in the 2006-2019 Mexican Pacific longline fishery based upon a shark scientific observer program. **Luis Vicente González-Ania, José Ignacio Fernández-Méndez, José Leonardo Castillo-Géniz, Georgina Ramírez-Soberón, and Horacio Haro-Ávalos** (thunnus@ciencias.unam.mx)
ISC/21/SHARKWG-1/ 08	Updated stock abundance indices for shortfin mako *(Isurus oxyrinchus*) estimated by Japanese longline observer data in the North Pacific Ocean. **Minoru Kanaiwa,Yasuko Semba, and Mikihiko Kai** (kanaiwa@bio.mie-u.ac.jp)
ISC/21/SHARKWG-1/ 09	Length frequency of shortfin mako (*Isurus oxyrinchus*) reported in the Japanese observer program between 2011

	and 2019. **Yasuko Semba** (senbamak@affrc.go.jp)
ISC/21/SHARKWG-1/10	Standardized Catch Rates of Shortfin Mako Shark caught by the Hawaii-based Pelagic Longline Fleet (1995-2019). **Felipe Carvalho** (felipe.carvalho@noaa.gov)

INFORMATION PAPERS

ISC/21/SHARKWG-1/ INFO-01	ISC. 2015. Indicator-based analysis of the status of shortfin mako shark in the North Pacific Ocean. Report of the SHARK WG, Annex 12. ISC Plenary meeting in Hawaii, USA.
ISC/21/SHARKWG-1/ INFO-02	Lee, H.H., Carvalho, F., and Piner, K. 2015. Simulation testing of stock indicators. ISC/15/SHARKWG-1/06.
ISC/21/SHARKWG-1/ INFO-03	WCPFC. 2018. Stock assessment of Shortfin Mako Shark in the North Pacific Ocean Through 2016. WCPFC-SC14-2018/SA-WP-11.
ISC/21/SHARKWG-1/ INFO-04	WCPFC. 2017. Stock assessment and Future Projections of Blue Shark in the North Pacific Ocean through 2015. WCPFC-SC13-2017/SA-WP-10.
ISC/21/SHARKWG-1/ INFO-05	F Carvalho, HH Lee, K Piner, M Kapur, S Clarke. 2018. Can the status of pelagic shark populations be determined using simple fishery indicators? Biological Conservation 228, 195-204

ATTACHMENT 3. DRAFT AGENDA

SHARK WORKING GROUP (SHARKWG)
INTERNATIONAL SCIENTIFIC COMMITTEE FOR TUNA AND TUNA-LIKE SPECIES IN THE NORTH PACIFIC
WEBINER DRAFT AGENDA
February 22-26, 2021
Meeting Hours: 09:00-13:00 (Japan time).

1. Opening of SHARKWG Workshop (Webiner)
    a. Opening remarks (SHARK WG Chair)
    b. Introductions
    c. Meeting arrangements (Confirmation of internet-access via Microsoft Teams)
2. Distribution of documents and numbering of working papers.
3. Review and approval of agenda
4. Appointment of rapporteurs
5. Report of the SHARKWG Chair
    a. Summary of the 2020 webinar
    b. Current meeting objectives
6. Review of shortfin mako data
    a. CPUE
    b. Catch
    c. Size/Sex
    d. Inventory of all data for analysis
7. Indicator analysis
8. Future SHARKWG meeting
    a. ISC Plenary (Hawaii, July in 2021)
    b. Data preparatory meeting for blue shark（Autumn in 2021）
    c. Pre-stock assessment meeting for blue shark（Winter in 2022）
    d. Stock assessment meeting for blue shark (Spring in 2022)
9. Other matters
10. Clearing of report
11. Adjournment

ATTACHMENT 4. SUMMARIZED OUTPUTS OF INDICATOR ANALYSIS

Tables

Table 1. The percent change of moving average of CPUE for four major fleets used in the benchmark stock assessment in 2018. The moving average was calculated using the mean value of CPUE for five years. The last year for Japanese RTV was removed from the calculation due to the preliminary result. The percentage indicates the positive and negative changes in the moving average of CPUE between start and end of the period.

	US	Taiwan	Japan	Mexico
Percent change	**Hawaii shallow-set**	**Taiwanese large-scale LL**	**Japanese RTV**	**Mexican commercial fishery**
Whole period	16% (2010-2019)	39% (2010-2019)	93% (1997-2018)	10% (2010-2019)
Recent five years	23% (2015-2019)	-13% (2015-2019)	47% (2015-2018)	-5% (2015-2019)

Figures

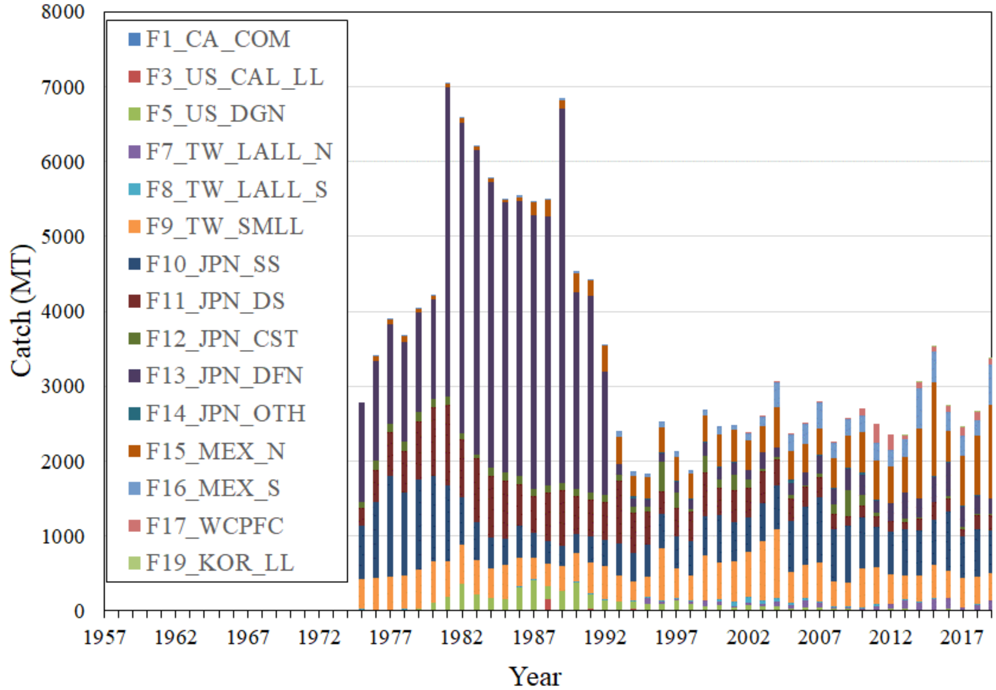

Fig.1 Fleet-specific annual catch in weight (tonnes, MT) of shortfin mako from 1957 to 2019.

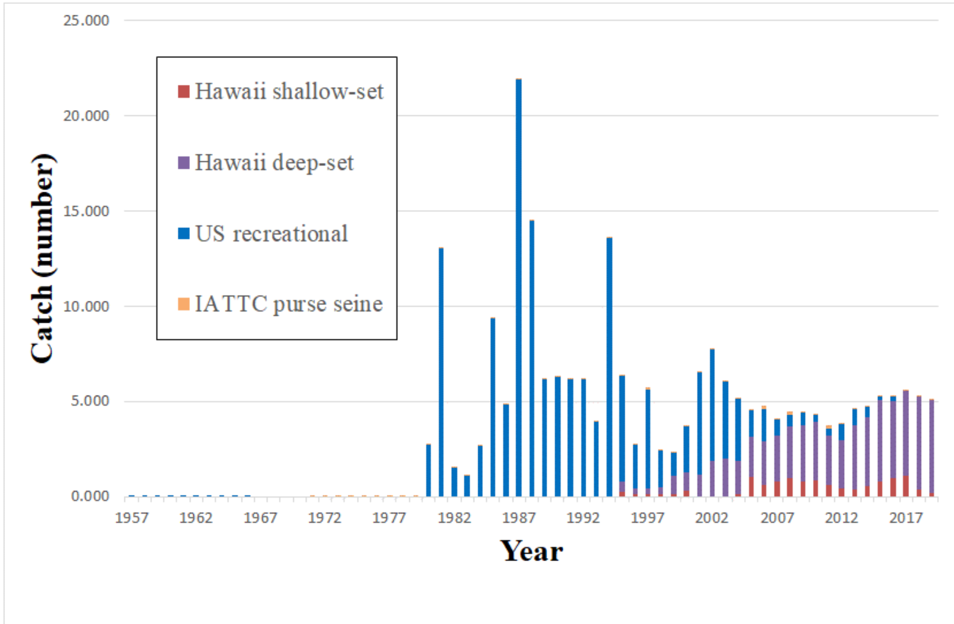

Fig. 2. Fleet specific annual catch in number (1000 fish) of shortfin mako from 1957 to 2019.

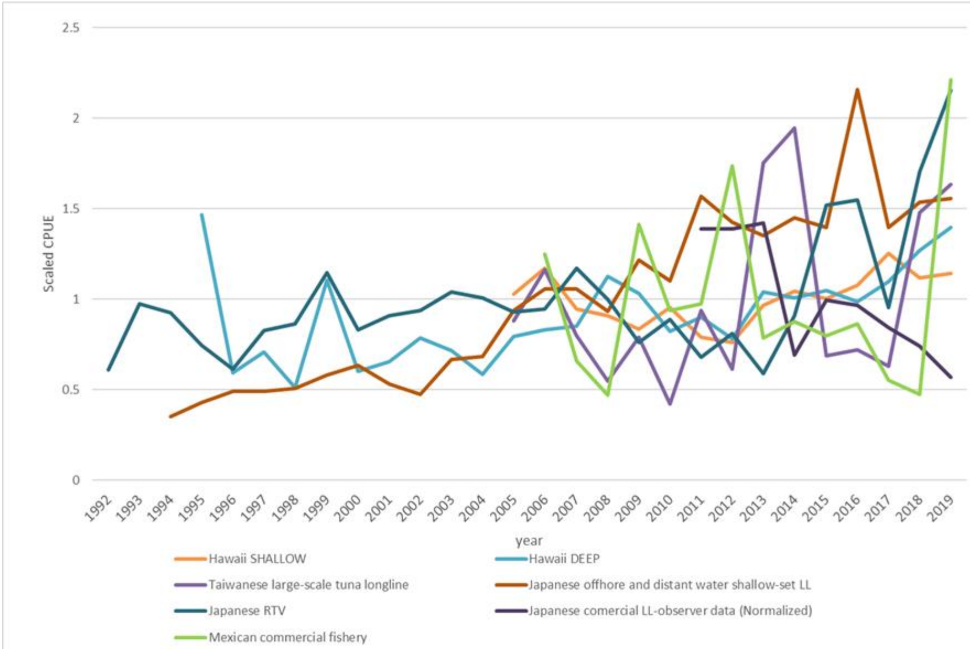

Fig. 3. Fleet specific annual CPUE of shortfin mako between 1992 and 2019 for all fleets presented in this indicator analysis. CPUE is scaled by mean value of annual CPUE.

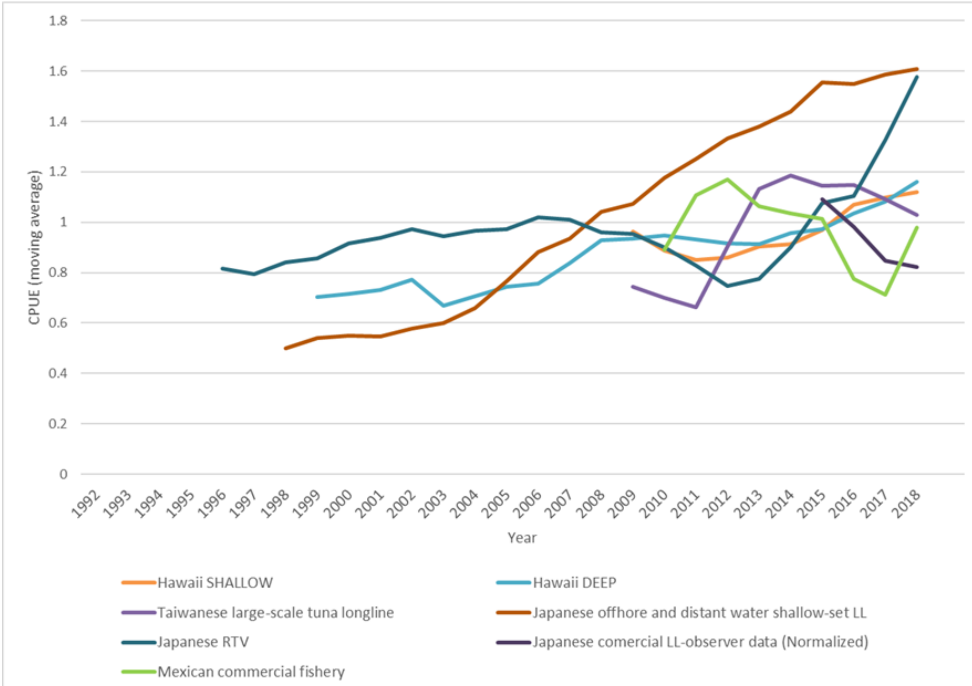

Fig. 4. Moving average of fleet specific annual CPUE of shortfin mako between 1997 and 2018 for all fleets presented in this indicator analysis.

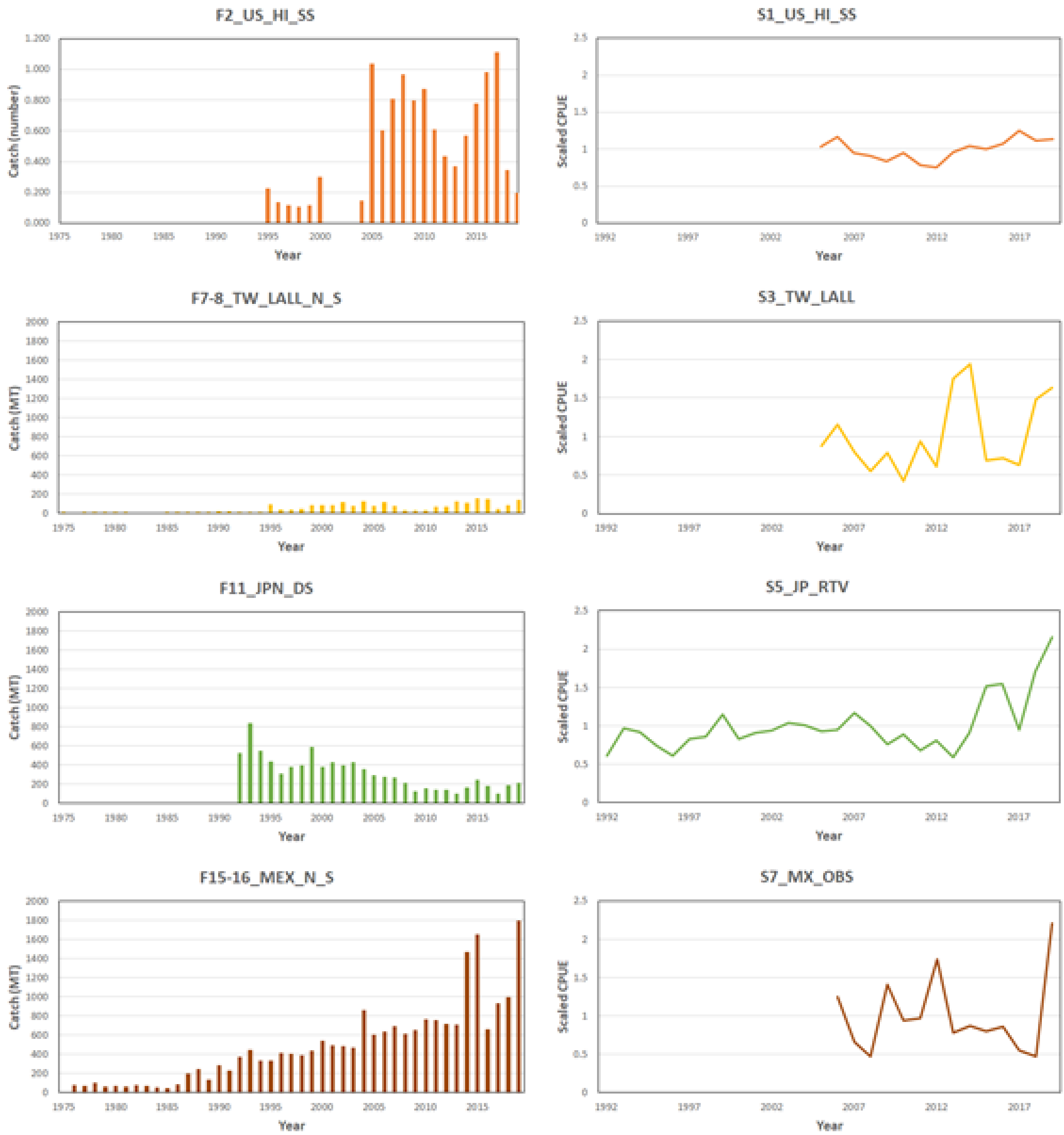

Fig. 5. Annual catch (tonnes; MT) and CPUE of shortfin mako for four major fleets used in the benchmark stock assessment in 2018.

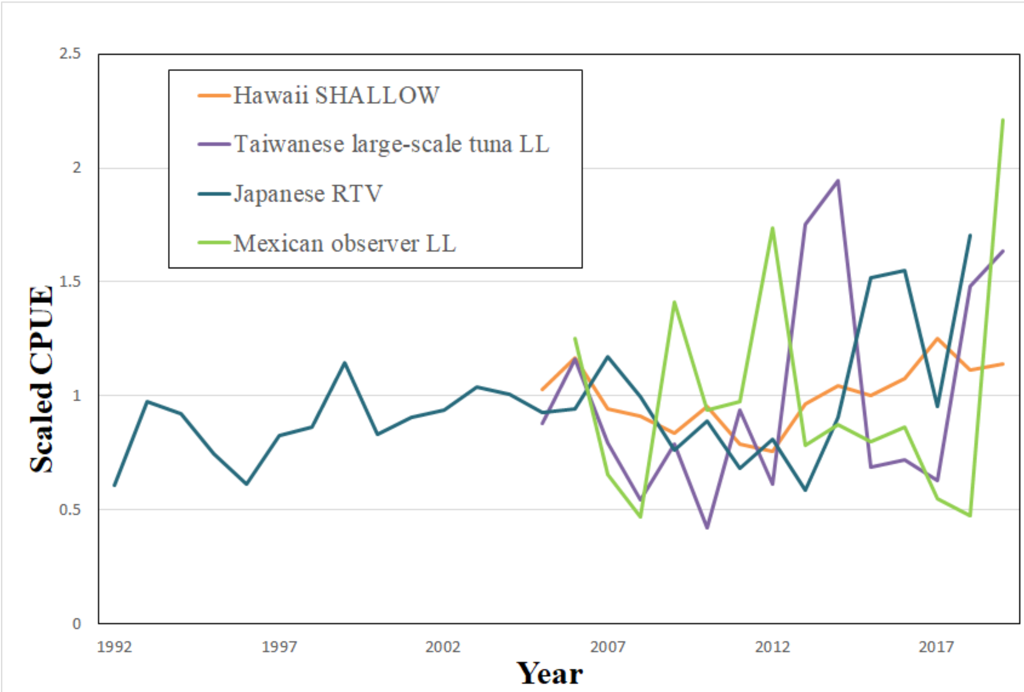

Fig. 6. Fleet specific annual CPUE of shortfin mako between 1992 and 2019 for four major fleets used in the benchmark stock assessment in 2018. The last year for Japanese RTV was removed from the calculation due to the preliminary result. CPUE is scaled by mean value of annual CPUE.

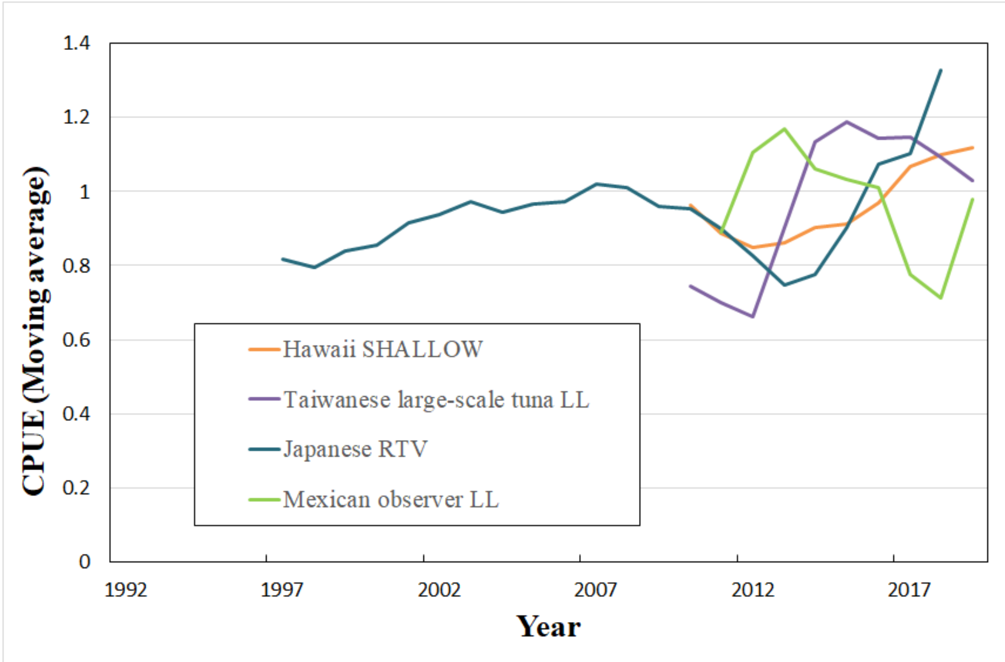

Fig. 7. Moving average of fleet specific annual CPUE of shortfin mako between 1997 and 2019 for four major fleets used in the benchmark stock assessment in 2018. The last year for Japanese RTV was removed from the calculation due to the preliminary result.

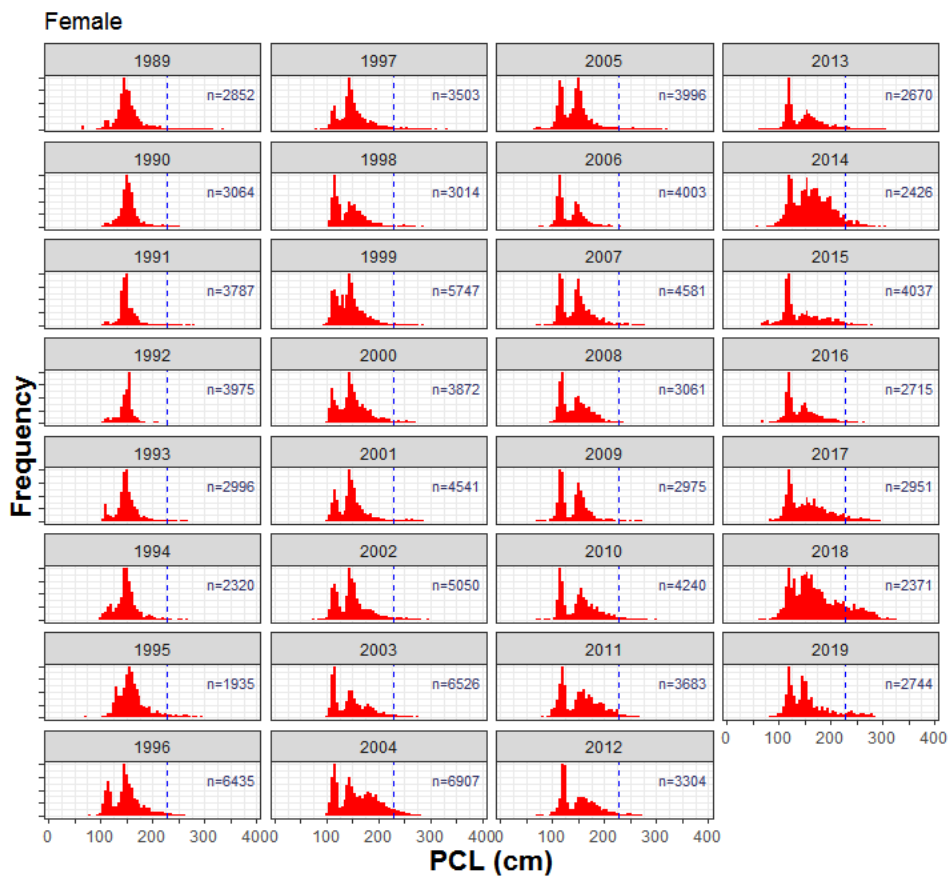

Fig. 8. Length frequency of female SMA caught by STLL. Sex was estimated using weight-specific sex ratio derived from subsample dataset (1,137 females and 807 males) (*ISC/21/SHARKWG-1/02*).

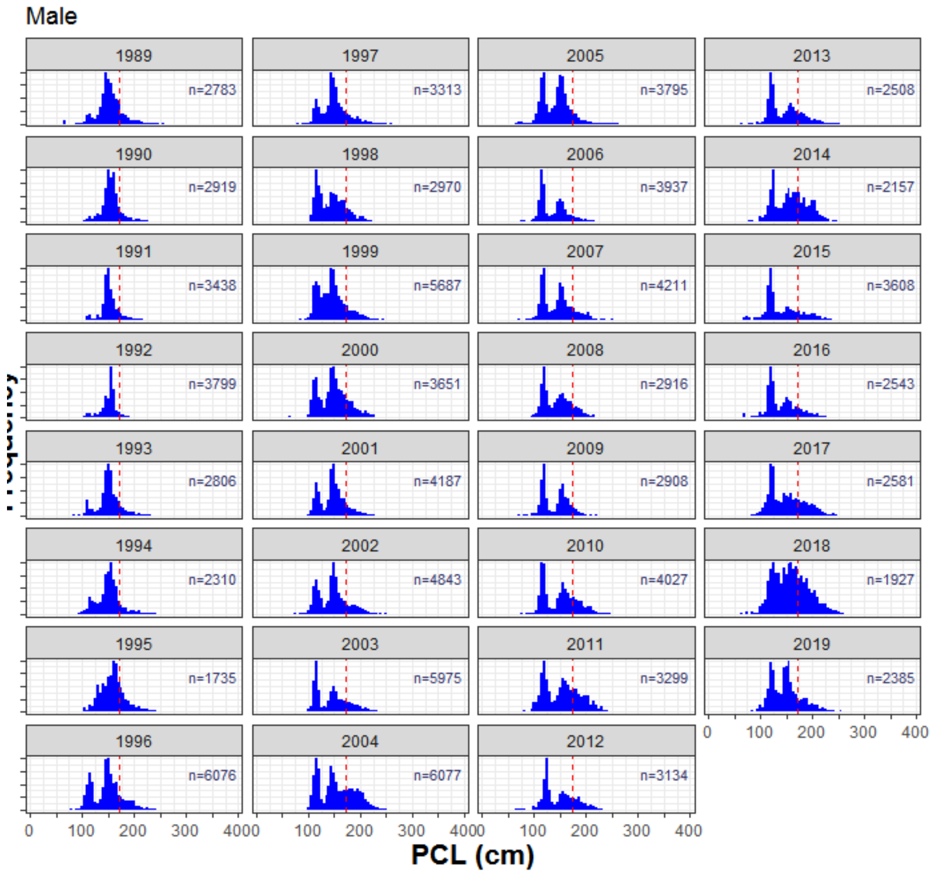

Fig. 9. Length frequency of male SMA caught by STLL. Sex was estimated using weight-specific sex ratio derived from subsample dataset (1,137 females and 807 males) (*ISC/21/SHARKWG-1/02*).

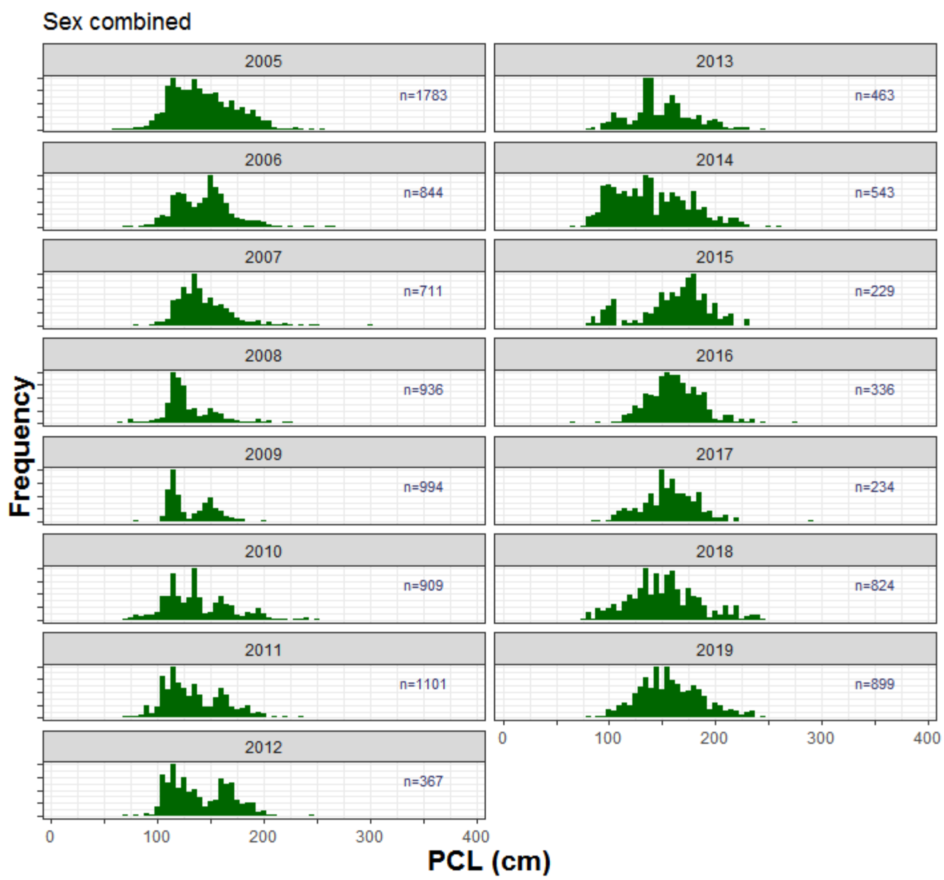

Fig. 10. Length frequency of sex-combined SMA caught by LTLL.

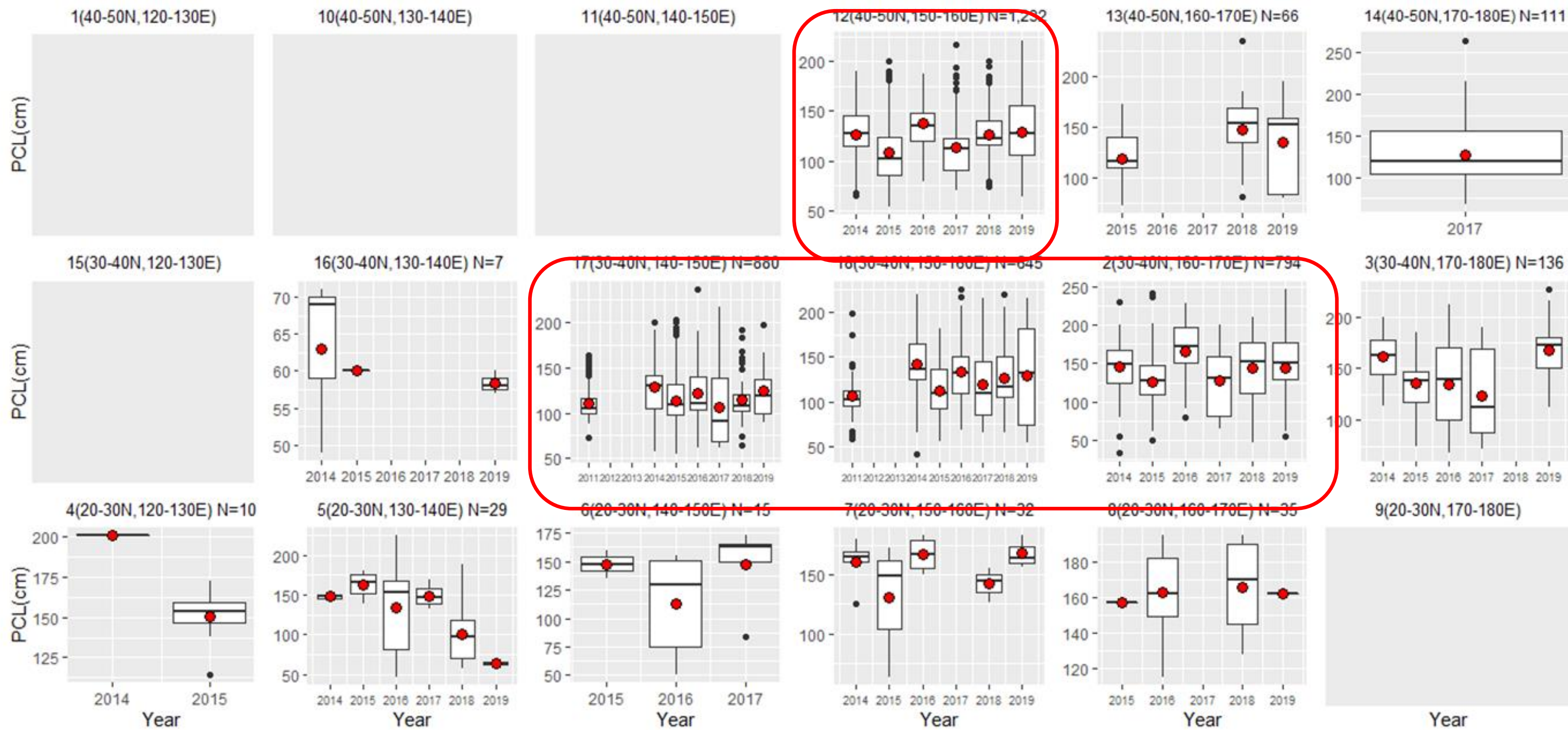

Fig. 11. The annual median and quartile percentiles of catch at size of shortfin mako in PCL by 10° by 10° degrees grid. Red circle is mean PCL in each year and grid. (Note. Grid 2,12,17, and 18 corresponds to the main fishing ground of shallow-set LL). Japan provided the annual median and quartile percentiles of catch at size of SMA based on LL observer data. 91% of size data was collected from shallow-set LL targeting swordfish and blue shark. The annual trend of median and quartile percentiles of PCL, derived from main fishing ground of shallow-set LL (grid 2, 12,17, and 18 in Figure2 in original document) indicated no clear trend of decreasing trend (*ISC/21/SHARKWG-1/09*).