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STAFF RECOMMENDATIONS FOR MANAGEMENT AND DATA COLLECTION, 2024

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A. MANAGEMENT

1. TUNAS

1.1. Conservation of tropical tunas: bigeye, skipjack, and yellowfin

Summary

Resolution C-21-04, which establishes the conservation measures for tropical tunas in the eastern Pacific Ocean and seeks to prevent fishing mortality from exceeding the *status quo* conditions[1] during the triennial management cycle of 2022-2024, is about to expire on 31 December 2024. A new resolution is needed to establish conservation and management measures for the tropical tunas in the EPO in 2025 and beyond.

In 2024, the staff evaluated the status of the stocks relying upon various sources of scientific information. For bigeye and skipjack, benchmark stock assessments are used to evaluate current stock status (SAC-15-02, SAC-15-04). The stock assessment of yellowfin tuna in the EPO remains challenged by major uncertainties in stock structure and a benchmark assessment is not available in 2024 as initially planned. For yellowfin, the staff is providing an exploratory assessment for the "core area", which is extended to the EPO in some scenarios, and also stock status indicators for yellowfin in other areas of the EPO (SAC-15-03).

In 2024, the staff is recommending the extension, for three additional years, of the provisions under Resolution C-21-04:

- For bigeye tuna, with respect to the target reference points, there is a 25% probability that F_{MSY} has been exceeded and a 47% probability that S_{cur} is below S_{MSY} (**Figure 1a**). Regarding the limit reference points, the risk analysis estimates that there is very low probability that the F and S limit reference points have been exceeded ($P(F_{cur}>F_{LIMIT}) = 0.1\%$; $P(S_{cur}<S_{LIMIT}) = 0.2\%$), both below the 10% threshold for triggering an action specified in resolution C-23-06.
- For skipjack tuna, the reference model estimated that the current fishing mortality is below the level corresponding to the MSY *proxy* and the spawning biomass is above the dynamic level corresponding to the MSY *proxy* (**Figure 2**). In addition, the spawning biomass does not have a 10% or more probability of exceeding the limit point. This is also true for all the sensitivity models.
- For yellowfin tuna, the results of the exploratory analysis indicate that the yellowfin stock and the possible sub-stocks are likely to be near or above the level that corresponds to dynamic MSY and not likely to have exceeded the spawning biomass limit reference point. However, these conclusions are uncertain and dependent on the assumed steepness of the Beverton-Holt stock-recruitment relationship. Immediate data collection and research efforts are warranted to reduce the persisting uncertainties, improve stock assessments, and secure reliable management advice for yellowfin in the EPO.

The staff considers important that two outcomes would trigger re-opening of the management package within a multi-year management cycle related to future work improving the status determination of yellowfin tuna dependent on continuing to improve the assessment and complete a benchmark assessment for yellowfin. These outcomes include:

1) Completion and acceptance of a stock assessment for yellowfin that finds the stock(s) to be in a condition that requires additional management measures and;
2) A stock assessment for yellowfin that is not reliable enough to use for management advice and indicators showing reasons for concern.

Development of harvest strategies is also important. It is important to finalize the Management Strategy

[1] Defined as the average fishing mortality (F) during the period 2017-2019.

Evaluation (MSE) for bigeye based on the new operating models available from the 2024 benchmark assessment. The establishment of a Science-Management Dialogue (SMD) Working Group would strengthen the development of harvest strategies at IATTC. The staff and/or the SMD WG should organize a series of workshops (fall 2024 and spring 2025) to finalize the MSE for bigeye, and discuss management objectives and revised reference points for the tropical tuna at the IATTC.

Finally, the staff is facing challenges with the tropical tuna assessments, primarily due to the continuous decrease in spatial coverage and fishing effort (number of hooks) of the most informative longline index of abundance. Fortunately, through an external collaboration, the staff has developed a methodology that can provide alternative indices of absolute abundance from tagging data (SAC-15 INF-G). The value of these estimates for improving stock assessments has been demonstrated this year in the skipjack benchmark assessment. To mitigate the challenges faced in the tropical tuna assessments, the staff recommends the continuation and enhancement of the Regional Tuna Tagging Program, as well as other tuna tagging activities in collaboration with CPCs and relevant stakeholders. It is also important to get vessel-level data from the distant water longline fleet on a permanent basis to improve the spatial coverage of the longline data used to create the longline CPUE based index of abundance.

1.1.1. Background

Resolution C-21-04 establishes the conservation measures for tropical tunas in the eastern Pacific Ocean (EPO) during the triennial management cycle of 2022-2024. The resolution consists of a package of management measures designed to prevent fishing mortality from exceeding the *status quo* conditions, which are defined as the average fishing mortality (F) during the period 2017-2019. According to the overall results of the 2020 risk analysis for the management of the tropical tuna fishery in the EPO, the stocks of yellowfin, bigeye and skipjack were all assessed to be in a healthy condition at the start of 2020. To maintain the healthy status of these stocks, additional precautionary measures to prevent fishing mortality from exceeding the *status quo* conditions were recommended by the IATTC staff and the Scientific Advisory Committee (SAC), in particular measures related to the management of the floating-object fishery. Following these recommendations, Resolution C-21-04 extended most provisions of Resolution C-20-06 onto 2022-2024 (*e.g.,* 72-day closure for the purse-seine fishery, catch limits on the longline fishery), adjusted some related to the fishery on fish-aggregating devices (FADs) and added new ones. The new measures were: 1) thresholds on individual purse-seine vessel annual bigeye tuna catch that, when breached, trigger additional closure days for a vessel; the adjusted measures were: 2) reduced limits on active FADs by vessel size-class, and 3) new FAD data provisions.

The measures described above under Resolution C-21-04 are applicable until 31 December 2024, except for the second closure period of the purse-seine fishery, which extends until 19 January 2025, and the additional days of closure that would be added to that second closure period pursuant to paragraph 5. Therefore, a new resolution is needed to establish conservation and management measures for tropical tunas in the EPO for 2025 and beyond.

Paragraph 35 of the resolution tasks the staff to analyze the effects on the stocks of the implementation of these measures, and previous conservation and management measures, and will propose, if necessary, appropriate measures to be applied in future years. In 2024, the staff evaluated the status of the stocks relying upon various sources of scientific information. New benchmark stock assessments are available for bigeye and skipjack (SAC-15-02, SAC-15-04). The status of yellowfin is evaluated based on an exploratory stock assessment (SAC-15-03). Stock status indicators are also available for all three species as complementary information (SAC-15 INF-F). The staff has also evaluated the effects on the stocks of the individual vessel threshold (IVT) program (SAC-15 INF-K) and also the corralito (SAC-15 INF-M).

1.1.2. Rationale for staff recommendations

The technical rationale underlying the staff's recommendations for the conservation of tropical tunas in 2024 is summarized below.

1.1.2.a Stock status

The results below summarize the stock status[2] for the tropical tunas (bigeye, skipjack and yellowfin) at the start of 2024. The reported status of the stocks is associated with the average fishing mortality (F) conditions estimated in the 2024 assessments for the tropical tuna in the EPO during 2021-2023.

Bigeye:

The 2024 benchmark assessment of bigeye tuna in the EPO continues to use a risk analysis approach to provide management advice (SAC-15-02). Two great improvements are achieved in the 2024 benchmark assessment for bigeye. The first one is resolving the prominent regime shift in recruitment coinciding with the expansion of the floating-object fishery in the mid-1990s. The second one is resolving the bimodal pattern in estimated management quantities which resulted from two distinct groups of models, optimistic and pessimistic, in the previous 2020 benchmark and risk analysis (SAC-11-06, SAC-11-08).

For bigeye, the risk analysis includes 33 reference models. The overall results, expressed in terms of the probabilities of exceeding the reference points specified in the harvest control rule (HCR) under Resolution C-23-06, indicate the following:

- With respect to the target reference points, a 25% probability that F_{MSY} has been exceeded and a 47% probability that S_{cur} is below S_{MSY} (**Figure 1**).
- Regarding the limit reference points, the risk analysis estimates that there is very low probability that the F and S limit reference points have been exceeded ($P(F_{cur}>F_{LIMIT}) = 0.1\%$; $P(S_{cur}<S_{LIMIT}) = 0.2\%$), both below the 10% threshold for triggering an action specified in resolution C-23-06.

[2] In this report, the terms "overfished" and "overfishing" are not used, because the Commission has not defined the threshold probabilities associated with those terms.

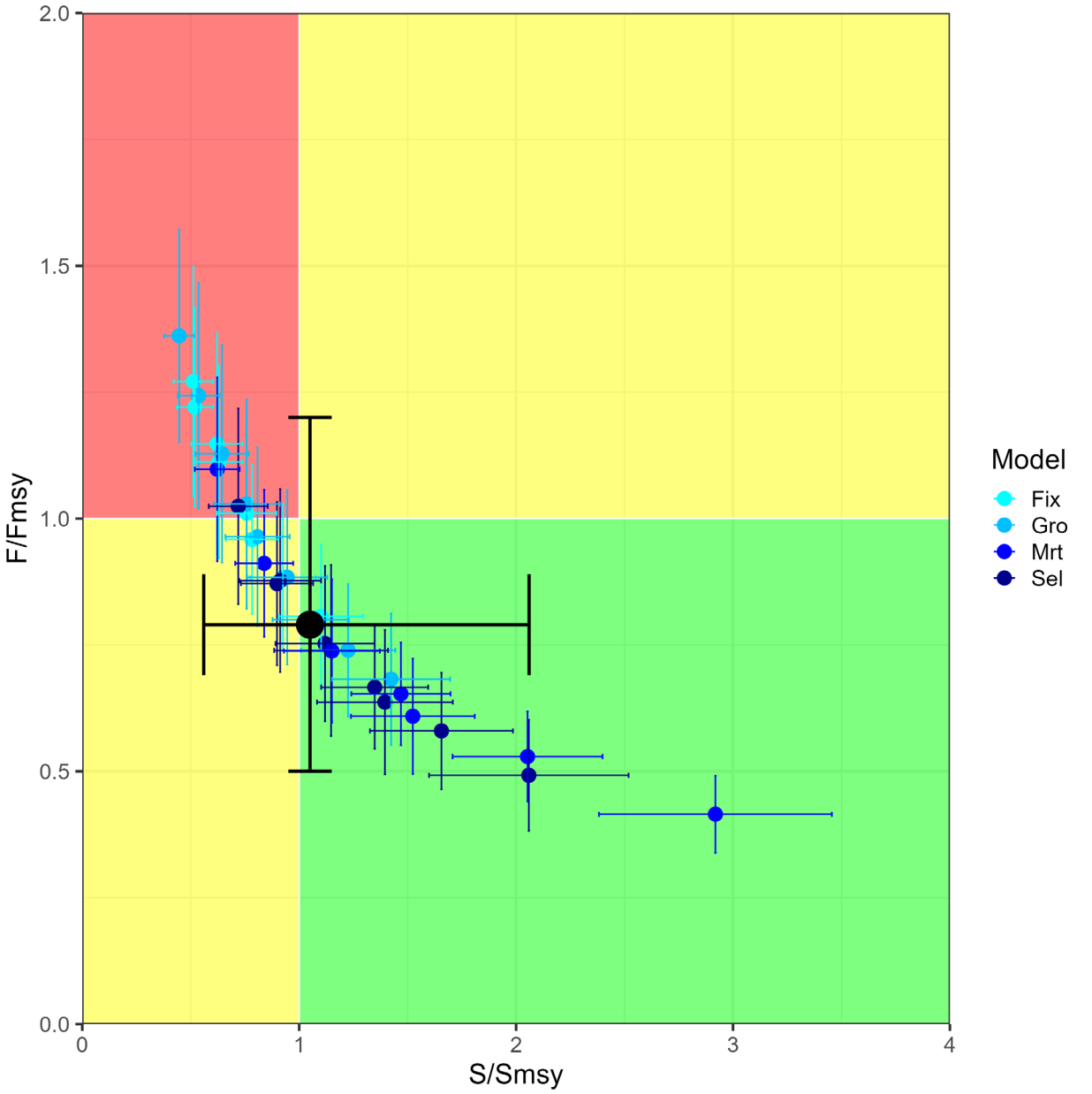

FIGURE 1a. Kobe plot of the most recent estimates of spawning biomass (*S*) and fishing mortality (*F*) relative to their target reference points (*SMSY_d* and *FMSY*) from the thirty-three reference models for bigeye tuna. Each dot is based on the average *F* over the most recent three years, 2021-2023, and the error bars represent the 80% confidence interval of model estimates. The black dot and error bars represent the medium and 80% confidence interval of combined values, respectively.

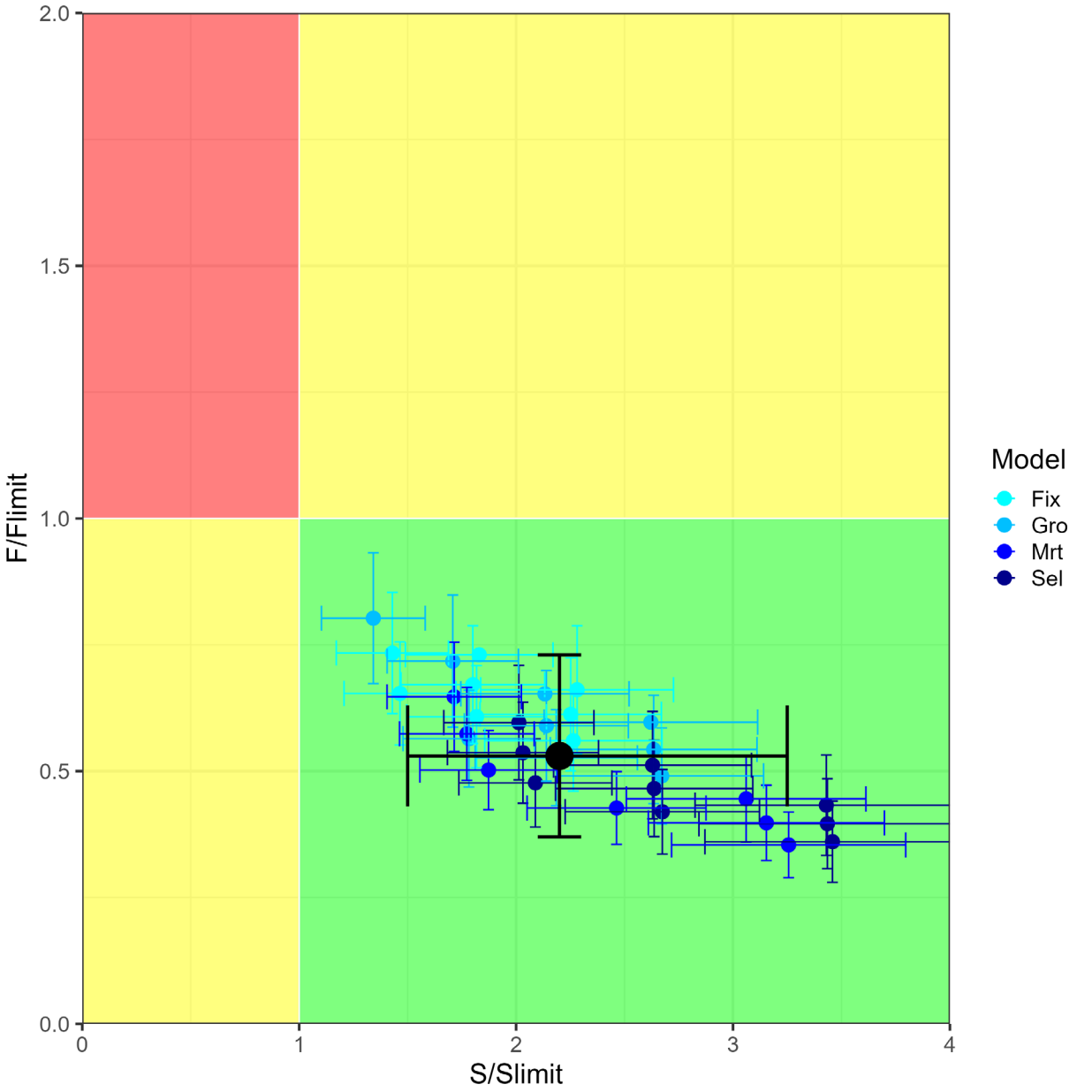

FIGURE 1b. Kobe plot of the most recent estimates of spawning biomass (*S*) and fishing mortality (*F*) relative to their limit reference points (*Slimit* and *Flimit*) from the thirty-three reference models for bigeye tuna. Each dot is based on the average *F* over the most recent three years, 2021-2023, and the error bars represent the 80% confidence interval of model estimates. The black dot and error bars represent the medium and 80% confidence interval of combined values, respectively.

Skipjack:

In 2024 the staff completed the first benchmark assessment for skipjack tuna in the EPO. This assessment represents a significant improvement from the *interim* assessment conducted in 2022. It reflects major advancements in the assessment methodologies and incorporates new data sets, including an updated index of relative abundance based on recently developed echosounder buoy data (FAD-08-02), and an absolute biomass estimate derived from the tagging data collected under the Regional Tuna Tagging Program in the EPO (SAC-15 INF-G). There is substantial uncertainty about several model assumptions and sensitivity analyses were conducted and determined that the management advice is robust to the uncertainty.

For skipjack, MSY-based quantities cannot be estimated because the tradeoff between growth and natural mortality, in combination with the assumption that recruitment is independent of stock size, implies that fish should be caught at the youngest ages to maximize yield, implying that the optimal fishing mortality should be infinite. Under these circumstances Resolution C-23-06 allows for the consideration of MSY *proxies*. Therefore a conservative *proxy* for the target biomass of SBR[3] = 0.3 is proposed, and the fishing mortality corresponding to that biomass, are used as the target reference points (SAC-14-09).

The reference model estimated that the current fishing mortality is below the level corresponding to the MSY *proxy* and the spawning biomass is above the dynamic level corresponding to the MSY *proxy* (**Figure 2**). In addition, the spawning biomass does not have a 10% or more probability of exceeding the limit point. This is also true for all the sensitivity models.

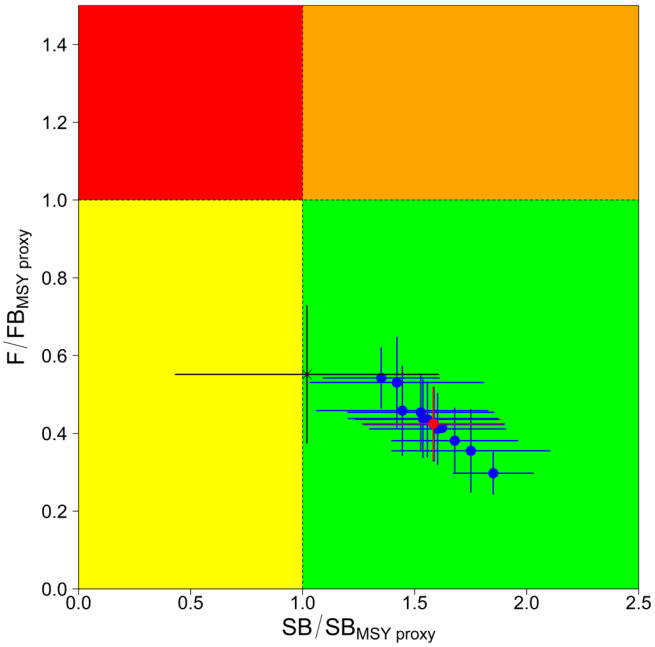

FIGURE 2. Kobe plot showing the most recent stock status estimates from all the models. The x-axis is $SB_{currnt}/0.3$*dynamic SB_0. Each dot is based on the average F over the most recent three years, 2021-2023, and the error bars represent the 80% confidence intervals of model estimates. The red dot and error bars represent the estimates from the reference model. The black cross and error bars represent the estimates from the model that removed the ECHO index.

Yellowfin

The previous benchmark assessment for yellowfin in the EPO was carried out in 2020 (SAC-11-07), and the results were included in a risk analysis for management[4] (SAC-11-08). An attempt to conduct a new benchmark assessment for yellowfin tuna in the EPO in 2024, as initially planned, was unsuccessful because the stock assessment remains challenged by major uncertainties.

Substantial research was conducted to improve the yellowfin assessment. Improvements were made to the modeling of spatial structure/stock structure, natural mortality, individual growth, and fisheries. However, uncertainty remains in the spatial structure/stock structure and additional research is necessary for the staff

[3] Spawning biomass ratio: SBR; spawning biomass divided by the spawning biomass in the unfished state.

[4] The overall results of the 2020 risk analysis, which included 48 reference models, indicated only a 9% probability that the fishing mortality corresponding to the maximum sustainable yield (F_{MSY}) had been exceeded, and there was a 12% probability that the spawning stock biomass corresponding to the maximum sustainable yield (S_{MSY}) had been breached. The probability that the F and S limit reference points had been exceeded was zero.

to complete a benchmark assessment for yellowfin in the EPO. Meanwhile, the staff is putting forward an exploratory stock assessment (SAC-15-03) implementing the improvements made primarily focusing on data from the "core area" of the dolphin-associated fishery (between 5 and 20°N, east of 130°W). Sensitivities to the assumptions made about stock structure were also carried out (e.g., including catch for the whole EPO). In addition, stock status indicators are also evaluated for five additional geographical areas to investigate the possibility of local depletion.

The results of the exploratory analysis indicate that the yellowfin stock and the possible sub-stocks are likely to be near or above the level that corresponds to dynamic MSY and not likely to have exceeded the spawning biomass limit reference point. However, these conclusions are uncertain and dependent on the assumed steepness of the Beverton-Holt stock-recruitment relationship. Immediate data collection and research efforts are warranted to reduce the persisting uncertainties, improve stock assessments, and secure reliable management advice for yellowfin in the EPO.

1.1.2.b Recent trends

Although the 2024 stock assessments for bigeye, skipjack, and yellowfin provide the best scientific information available on the current status of the stocks (see section 1.1.2.a above), this section identifies some prominent trends, both historical and recent, that are noteworthy in the context of the discussions on management advice. In general, for the tropical tuna fishery in the EPO, the staff notes the following recent trends:

1. The staff remains concerned about the resuming of the general increasing trend in the number of floating-object sets observed since 2005. Although this increasing trend had been interrupted with the onset of the COVID-19 pandemic in 2020, this trend has resumed in 2021 and 2022, when the effects of the pandemic on fishery operations gradually diminished. In 2022, the number of sets on floating objects reached its highest historic value since 2000 (~18 thousand sets, SAC-15-01**, Figure 4a**). The increasing trend did not continue in 2023, possible due to the high availability (catch-per-set) of skipjack leading in 2023 to the record catches of skipjack on the floating-object fishery (SAC-15 INF-F, SAC-15 INF-L). In the ongoing development of harvest strategies for the tropical tunas in the EPO, it is important to consider that if this generally increasing trend in the fishing effort on floating objects remains unrestricted, the desired benefits of future measures may potentially be compromised in multi-year management resolutions.

For bigeye:

2. Bigeye is caught mainly in the floating-object fishery for which the catch-per-set and the average length have shown a consistent decline over time (SAC-15 INF-F), while the catch has been somewhat stable, except in recent years where catches reached low historical levels in 2022 and 2023 (**Figure 4b**). An evaluation of the impact of the individual vessel threshold (IVT) scheme confirmed that it likely had a positive effect on reducing bigeye catches in 2022 and 2023 (SAC-15 INF-K, additional details on section 1.1.2.c).

For yellowfin:

3. The 2022 yellowfin catches on floating-object sets were at approximately 91 thousand t. This recent increase in the catch of yellowfin on floating-object sets in 2022 was particularly strong, which was at the highest level since 2000 (increase of ~50% from 2021 to 2022, in bias adjusted weight). In order to better understand the effect of long-term environmental processes on tuna catches, the staff investigated the changes in yellowfin and skipjack tuna catch in the purse-seine floating-object fishery relative to El Niño Southern Oscillation (ENSO) events (SAC-15 INF-L). The analysis suggests the positive impact La Niña events may have on yellowfin recruitment into the fishery. In addition to the increased number of floating-object sets, this relationship may have contributed to the strong increases in yellowfin catches in the floating-object fishery in 2022.

For skipjack:

4. In 2023, the catch for skipjack in floating-object sets was at the highest historic level since 2000 (approximately at 320 thousand t, **Figure 4 c**). This represented a 32% increase relative to the 2022 skipjack catches on floating objects despite a reduction in the number of floating-object and unassociated sets (4% and 11%, respectively). The staff environmental analysis indicates that two years prior to the increase in skipjack catch and catch-per-set in 2023, a La Niña event was weakening towards a neutral phase, which may be a contributing factor for higher catches, despite a slight decrease in effort in 2023 (SAC-15 INF-L).

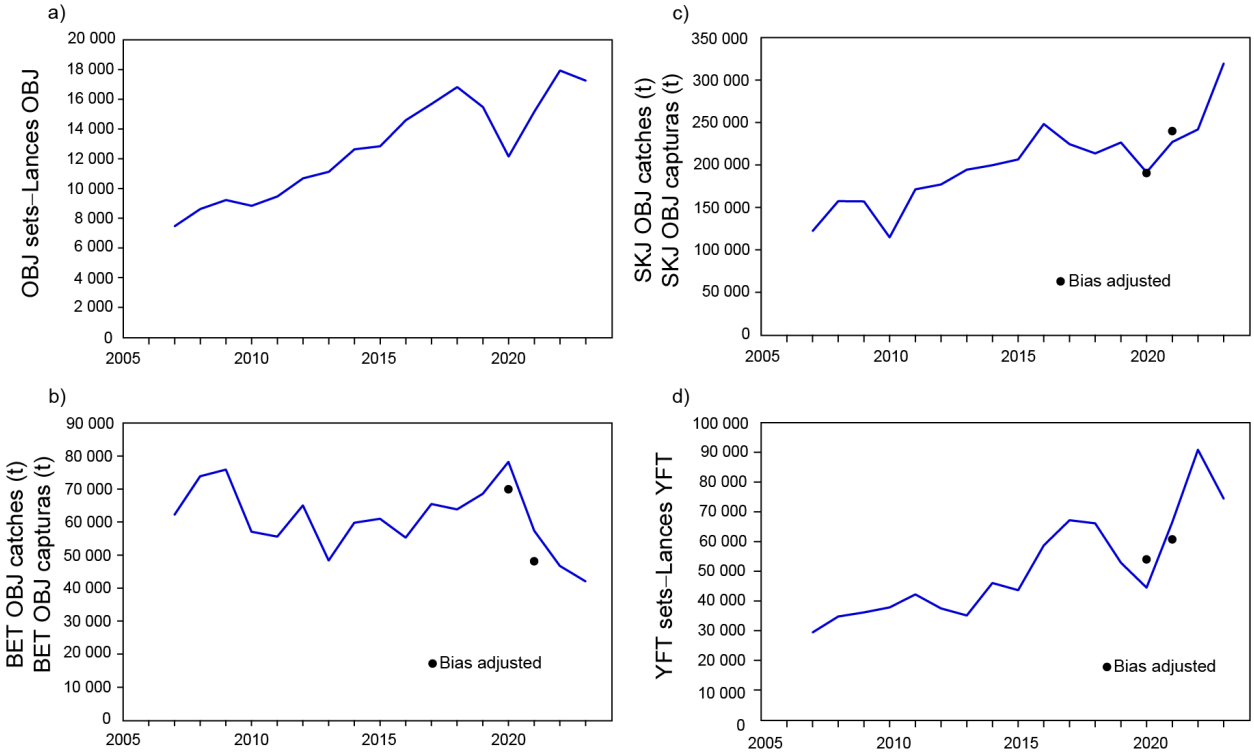

FIGURE 4. Number of sets on floating objects (a) and retained purse-seine catches for (b) bigeye, (c) skipjack and (d) yellowfin tuna (in metric tons). The black dots represent the catch estimates adjusted for bias caused by the effect of the COVID-19 pandemic during 2020 and 2021 (SAC-14 INF-D).

1.1.2.c Evaluation of conservation measures

This section summarizes the results of two analyses requested to the staff. The first is a study in response to a research recommendation made by the IATTC's Scientific Advisory Committee (recommendation 3.1 in SAC-14-16), for the staff to evaluate evidence for the impacts of the IVT program on the fleet's behavior and catches of tropical tunas, particularly bigeye, in the EPO in 2022 and 2023. The second is a response to a request under Paragraph 11 in Resolution C-21-04 for the staff to evaluate the effects of the "corralito".

Individual Vessel Threshold (IVT) program for bigeye catches

The conservation measures for tropical tunas in Resolution C-21-04 implemented what has come to be known as an "Individual Vessel Threshold" (IVT) program for bigeye tuna catches in the EPO. This IVT program went into effect in 2022. Under this program, applicable purse-seine vessels receive increased closure days in the following year provided that they exceed certain annual catch values, with the amount of closure days increasing as a function of the amount by which a vessel exceeds the threshold. As part of the IVT program, an enhanced port-sampling program ("Enhanced Monitoring Program", EMP) for estimation of trip-level bigeye catch was mandated by Resolution C-21-04, to support member countries and their purse-seine vessels in their conservation efforts. The EMP began data collection in March 2023, and

sampling will continue through December 2024. Results from EMP for 2023, as well as a summary of scientific research currently being conducted with EMP data, can be found in SAC-15 INF-H.

The staff conducted a comprehensive evaluation of the impacts of the IVT program on tropical tuna catches and fleet behavior in the EPO (SAC-15 INF-K). In summary, the staff estimated that the IVT meaningfully decreased catches of bigeye in floating-object sets by class 6 purse seine vessels. This change appears to have been driven largely by a decrease in catch-per-unit-effort of floating-object sets, as opposed to a decrease in the number of total sets or a shift from floating-object to unassociated sets. This estimated reduction in bigeye catches caused by the IVT takes into account the effects of best available estimates of underlying bigeye abundance. These results are further supported by results showing that highliner vessels[5] appeared to have decreased their probability of catching ≥ 10 t of bigeye in a floating-object set relative to other background trends in this rate.

The "corralito"

The IATTC has utilized a spatiotemporal closure known as "the corralito" as part of its conservation and management measures package for many years. The corralito has been in the same location since 2009, but the exact dates of the closure have varied slightly (most recently from Oct 9 to Nov 8 within 2017 through 2024). In response to a request from Resolution C-21-04, the IATTC staff assessed evidence for the effects of the corralito on a range of outcomes of the purse-seine fishery in the EPO (SAC-15 INF-M).

The new analysis did not find clear empirical effects of the corralito on the evaluated metrics (catch, effort, catch-per-unit effort, mean length of tropical tunas, and catches of sharks and other vulnerable non-target taxa). This is not surprising, given the expected effect sizes of the corralito previously predicted by the staff (IATTC-77-04 REV, Section 3.1) which are confirmed in the new analysis. As such, while the staff cannot point to clear empirical evidence confirming the predicted impacts of the corralito, this is entirely consistent with the predicted levels of impact, on average 3 days of closure for bigeye but with substantial year-to-year variation, on which the original decision to implement the corralito was based. Therefore, this new study should not be considered to substantially change the staff's previous evaluation of the potential benefit of the corralito as a tropical tuna management measure (i.e. equivalent to, on average, to 3 days of EPO purse-sein closure for bigeye).

1.1.2.d Opportunities and challenges related to management advice

Opportunities: Enhanced species composition port-sampling program (EMP)

The management measure for bigeye tuna catch thresholds per vessel (IVT), established in Resolution C-21-04, utilizes the Enhanced Monitoring Program (EMP) as a science-based support tool. This program implements a data collection protocol during catch unloading in port that allows for the estimation of the BET caught by a vessel during a fishing trip and a measure of precision on that catch estimate.

Between March and December 2023, the EMP sampled 75 trips from 30 purse-seine vessels, with a total of 529 wells sampled. The bigeye catch estimates per trip ranged from 2 to 519 t, with a decreasing temporal trend in the estimated bigeye catch per trip over the 9-month period. Meanwhile, the coefficients of variation (CVs) obtained for the trip-level bigeye catch estimates ranged from 0.05 to 0.88, with a median value of 0.19, and an increasing temporal trend over the 9-month period. The increase in CVs at a time when catches were decreasing reflects the fact that, for a number of sampled trips, only a few of the sampled wells contained significant amounts of bigeye catch, while most sampled wells had little or no bigeye catch. At the same level of sampling coverage of wells, such variability in bigeye catch among wells leads to higher estimated variance on the trip-level catch, and hence higher CVs. To better understand vessel-specific patterns, EMP and observer estimates of the proportion of bigeye in the catch, at the level of individual wells, are being analyzed. The 2024 EMP data will be very beneficial for these well-level comparisons because they will increase the number of trips sampled per vessel, for many of the vessels sampled by the

[5] Vessels that historically caught levels of bigeye that could put them at risk of exceeding the IVT (see SAC-15 INF-K for details).

EMP, leading to better statistical models, and thus, a better understanding of the relationship between the two data sources.

The data collected by the EMP have created significant research opportunities, enabling studies that focus on maximizing the scientific benefits of data from other sources (observers, logbooks, and processing plants) not only for estimation of bigeye catch per trip, but also for the estimation of fleet-level species catch composition; furthermore, the IATTC staff has prepared a proposal included in SAC-15 INF-H in which the EMP could continue to implement the sampling protocol in support of the IVT, and in addition: 1) collect morphometric data to update the morphometric relationships used in the stock assessments; and, 2) collect high-frequency species composition sampling data for use in simulation studies to evaluate improvements to the traditional port-sampling protocol. Both of these activities would address recommendations of the 1st External Review of data used in stock assessments of tropical tuna in the EPO. All these components would establish a foundation that can be expanded to collect additional types of data for scientific research, including but not limited to biological data for both tuna and non-tuna species (see Unfunded Project B.3.b).

Challenges: Tropical tuna stock assessments

Developing the yellowfin tuna benchmark assessment faced serious challenges and only an exploratory analysis was possible in 2024. There is evidence of strong spatial structure of yellowfin in the EPO and some form of a spatially structured assessment or separate assessments for different sub-stocks may be needed. Further research and model development will be conducted in 2024-25 and a benchmark assessment is rescheduled for presentation at SAC-16 in 2025. This benchmark assessment will be used to update management advice, which may require additional management actions. However, it is not guaranteed that a reliable assessment for yellowfin be produced in this time frame or without additional data. Therefore, in the case that a reliable yellowfin assessment is unavailable, other information, such as stock status indicators, will need to be used to determine if additional management action is needed to ensure the sustainability of yellowfin.

In the bigeye tuna assessment, due to the pronounced decrease in the spatial coverage and fishing effort (number of hooks) of the Japanese longline fleet in the EPO, the precision of the Japanese longline index of abundance has rapidly deteriorated since 2020 (SAC-15-02). Consequently, the longline index of abundance does not provide precise information on the temporal change of population abundance over the recent period. If this trend persists, the reliability of the bigeye stock assessment may become compromised in the near future considering that the Japanese index is the primary index informing the abundance trend of large bigeye. Although the staff intends to continue its collaboration with distant-water longline CPCs to improve the longline index of abundance for bigeye tuna, there are other challenges with the data available. Although there is a reliable dolphin-associated index of abundance for yellowfin in the northern EPO (the "core" region; SAC-15-03), the indices available for the southern region of the EPO based on the longline data may not be reliable.

Fortunately, in collaboration with external scientists at Technical University of Denmark (DTU), the staff has developed a spatiotemporal approach to derive estimates of absolute abundance from tagging data (SAC-13-08, SAC-14 INF-E). The potential of this approach and its benefits for stock assessment are shown for the first time in the 2024 benchmark assessment for skipjack (SAC-15-04). Although the spatiotemporal tagging model is currently only available for skipjack (SAC-15 INF-G), the staff is planning to apply a similar approach to overcome some of the challenges faced in the bigeye and yellowfin assessments. For this purpose, it is critical that the IATTC continues to support the continuation and enhancement of the Regional Tuna Tagging Program (RTTP) as well as other tagging research activities planned by the staff in collaboration with CPCs and relevant stakeholders.

1.1.3. Management advice

Based on the rationale presented above, and taking into consideration the expressed preference during the SAC-15 meeting for a multi-year (3 years) management plan[6], in 2024 the staff makes the following recommendations for the conservation of tropical tunas:

RECOMMENDATIONS:

1. Extend the provisions under Resolution C-21-04 for three additional years with the following two outcomes that would trigger re-opening of management package:
   a. Completion and acceptance of a stock assessment for YFT that finds the stock(s) to be in a condition that requires additional management measures;
   b. A stock assessment for YFT that is not reliable enough to use for management advice and stock status indicators showing reasons for concern.
2. Continue the Enhanced Monitoring Program (EMP) for bigeye catches for three additional years, expanded for scientific value in 2025 (see the proposal in SAC-15 INF-H for details).
3. Adopt provisions to make operational level longline data routinely available for scientific purposes: At a minimum data aggregated at a 1 by 1 by month by vessel and HBF level (SAC-14INF-Q).
4. To ensure reliable stock assessments for management advice, continue and enhance the IATTC Regional Tuna Tagging Program (RTTP) and implement opportunistic tagging studies in collaboration with CPCs and relevant stakeholders (see section 3 on Tuna Tagging and unfunded project E.4.b).
5. Continue to support the development of harvest strategies for the tropical tuna in the EPO (see recommendations in section 1.3.a)

1.1.3.a Development of harvest strategies for the tropical tunas in the EPO

The staff acknowledges that there may always be unresolved issues in knowledge, and inherent limits of modelling complex and changing natural systems and their fisheries, which may impact the scientific advice for taking appropriate management actions. There is a need for refinement and further specification of harvest strategy elements already in place at IATTC (e.g., full specification of the harvest control rule, HCR), along with alternative ones (with different reference points and/or ways of estimating them), devising performance metrics, etc, with the goal of evaluating the robustness of the management advice and the likelihood of alternative strategies achieving desired management objectives.

The evaluation of harvest strategies can be conducted using Management Strategy Evaluation (MSE), a process that uses computer simulations to test the robustness of alternative management strategies (designed using stakeholder's input) to different sources of uncertainty. An MSE process for tropical tunas (SAC 15-07) is ongoing at IATTC, with an initial focus on bigeye given that it has been historically the tropical tuna driving management measures. The MSE for tropical tunas is focusing on including additional sources of uncertainty (implementation uncertainty, management/institutional uncertainty, sampling uncertainty, projection uncertainty) to those included currently on the assessments.

Implementing reliable stock assessments to act as operating models is an essential part of the MSE process. The bigeye assessment has been evolving over time with several substantial improvements being made recently. The 2020 bigeye assessment still had substantial uncertainties, including a bimodal pattern in management quantities (one group of models with estimates of biomass above the level corresponding to

[6] The initial staff recommendations proposed a one year roll over of the current management due to the absence of a YFT benchmark assessment and BET MSE, but SAC participants expressed preference for the need of a muli-year management plan. Therefore, the staff revised their proposal to a 3-year plan with triggers within the timeframe to modify the management action based on the future YFT benchmark assessment or other information in the case a reliable benchmark assessment is not attainable for YFT.

maximum sustainable yield (B_{MSY}), another group below B_{MSY} with little probability in between) along with a suspect apparent regime shift in recruitment coincidental with the increase of floating object purse seine catches in the 1990s. Although the 2020 assessment models covered the range of uncertainties, this led to operating models that may not result in the best strategy being selected had a better set of operating models been available. Recently, substantial changes in modeling of bigeye tuna (SAC-15-02) related to data, biology, and model specifications following panel recommendations of the two recent stock assessments external reviews (RVDTT-01-RPT and RVMTT-01-RPT) removed the apparent regime shift in recruitment estimates and the bimodal pattern in management quantities. Since the 2024 assessment has resolved many of the structural issues of previous bigeye assessments, using that assessment for the operating models in the update of the MSE should result in a better strategy being selected.

Staff revisited target reference points for tropical tunas in 2024 (SAC-15-05) following concerns about the definition of the target reference point and estimated highly depleted stock levels at MSY ($B_{MSY}/B_0 = 0.17$) for some scenarios of the 2024 bigeye tuna assessment given recent changes in the assumptions about age-specific natural mortality. A more global approach to defining MSY, which is designed to support a range of proportioning of catch among the fleets, supports a less depleted biomass ($B_{MSY}/B_0 = 0.3$). The staff has proposed to consider $B_{MSY}/B_0 = 0.3$ as interim target reference point until discussions under a comprehensive Management Strategy Evaluation framework process determine target reference points based on a variety of objectives.

These changes prompted the staff to revise the workplan for the bigeye tuna MSE work by replacing the original set of operating models with a new set of operating models derived from the 2024 bigeye tuna benchmark assessment, as well as incorporating proposed alternative HCRs and reference points. The staff's organized MSE dialogue component has included a series of educational and stakeholder input workshops (see recent Workshops). There have been requests by stakeholders for the establishment of a dedicated dialogue Working Group, which could enhance or replace the staff's organized workshops. Recommendations during SAC-14 stated that the Commission consider the Science-Management Dialogue (SMD) or informal workshops approach to continue the MSE process (SAC-15 INF-D).

The MSE process at IATTC has been funded by the European Union between 2021 and 2023. A newly established (2024) IATTC staff harvest strategies permanent position has secured continuation of the MSE work. The revised timeline includes bigeye MSE work during 2024 and 2025, with plans to expand the MSE work to the other tropical tunas (likely skipjack next and then yellowfin) now that funding has been secured for continuation of the MSE work for EPO tropical tunas.

RECOMMENDATIONS:

1. That the Commission considers the establishment of a Science-Management Dialogue (SMD) Working Group, following recommendations from SAC-14.
2. That the staff or SMD Working Group organizes a series of Workshops:

   - A Fall 2024 workshop to discuss and finalize elements of the MSE for bigeye tuna.

   - A Spring 2025 workshop for staff to present preliminary results of the MSE for bigeye to CPCs and relevant stakeholders and gather feed-back necessary to prepare the final MSE to be presented at SAC-16.
3. That the Commission agree and adopt management objectives (SAC-15-07, SAC-15-08) and revised reference points for tropical tunas (SAC-15-05).

1.2. Pacific bluefin tuna

The Pacific bluefin tuna working group of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) completed a benchmark assessment of the species in 2024 (SAC-15 INF-N). The stock achieved the second rebuilding target of 20%$SSB_{F=0}$ in 2021, 13 years earlier than originally scheduled. The working group is also conducting a Management Strategy Evaluation (MSE), which is scheduled for completion in 2025.

IATTC Resolution C-21-05 establishes management of Pacific bluefin tuna in the EPO for the period 2021-2024 defining total commercial catches and biennial catch limits for each CPC.

The assessment evaluates several catch scenarios, with different increases in catch and different distributions of the catch between small and large fish and between the eastern and western Pacific Ocean. Catching larger fish increases the total catch in weight for a given level of rebuilding. While most catch increase scenarios maintain the probability of spawning biomass being above the second rebuilding target 20%$SSB_{F=0}$ by 60% or more, some of the scenarios have a 10% or higher probability of being below the interim limit reference point of 7.7%$SSB_{F=0}$, at least once by 2041, and high probability of exceeding potential target reference points, including the 30% proxy proposed by the staff for tuna, billfish and other highly migratory fishes (SAC-14 INF-O). The Joint IATTC-WCPFC-NC Working Group has requested additional scenarios that are likely to reduce these probabilities. However, without specific target and limit reference points defined for the IATTC, these scenarios cannot be evaluated appropriately.

Target and limit reference points have not been defined for Pacific bluefin tuna. Preferably, permanent or interim reference points would be defined so that catch scenarios can be appropriately evaluated. For example, a target proxy reference point of 30%$SSB_{F=0}$ (dynamic), and associated F, as proposed by the staff for highly fecund pelagic spawning species managed by the IATTC, and the limit reference point 7.7%SSB_0 (equilibrium) currently used for tropical tunas in the EPO, should be considered (SAC-14 INF-O; SAC-15-05). This recommendation is related to Harvest Control Rules 11 and 12 requested for MSE evaluation by the JWG. However, the staff recognizes that adopting reference points is challenging and the in progress MSE process will identify reference points and evaluate harvest control rules in context of these reference points. Therefore, the staff supports adopting, in the short term, one of the catch scenarios requested by the Joint IATTC-WCPFC-NC Working that satisfies potential future reference points.

RECOMMENDATIONS:

1. Preferably, interim reference points should be adopted. In the absence of adopted reference points, choose one of the catch scenarios requested by the Joint IATTC-WCPFC-NC Working Group, considering performance relative to the possible future reference points for bluefin tuna (e.g. the reference points proposed in SAC-14 INF-O).
2. Continue the MSE work.

1.3. North Pacific albacore tuna

The North Pacific albacore tuna is assessed routinely by the Albacore Working Group (ALBWG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC). The ALBWG completed a benchmark stock assessment in 2023. The assessment results indicate that:

1. The spawning biomass in 2021 (54% of $SSB_{current, F=0}$[7]) was higher than the threshold and limit reference points (30% $SSB_{current, F=0}$ and 14% $SSB_{current, F=0}$, respectively).
2. The average fishing mortality during 2018-2020 ($F_{59\%SPR}$; the fishing intensity that results in the stock producing a SPR[8] of 59%) was below the target reference point ($F_{45\%SPR}$; the fishing intensity that results in the stock producing a SPR of 45%).
3. The Working Group concluded that the north Pacific albacore stock is likely not overfished relative to the threshold and limit reference points adopted by the WCPFC and IATTC and is likely not experiencing overfishing relative to the target reference point.

In 2023, the Commission adopted a harvest control rule with elements specified in Resolution C-23-02. The harvest control rule parameters define the relationship between stock status and fishing intensity.

The staff has collaborated with the ISC to develop criteria for identifying exceptional circumstances for north Pacific albacore tuna that would result in suspending or modifying the application of the adopted harvest strategy, and potentially may require updated Management Strategy Evaluation simulation work (SAC-15 INF-S). Three general elements will be considered when evaluating possible exceptional circumstances for north Pacific albacore: stock and fleet dynamics, application, and implementation.

The staff has also collaborated with the ISC to provide scientific advice on interpreting the fishing intensity metric from the harvest strategies in terms of catch and effort management measures. The ALBWG recommends that the change in fishing intensity required by the harvest strategy can potentially be translated into catch reductions for all fleet groups and effort reductions for surface fleet groups. Effort management is less precise than catch management in terms of changing the fishing intensity for surface fleet groups.

[7] Dynamic spawning biomass in 2021 under no fishing.
[8] Spawning potential ratio is the female spawning stock biomass per recruit (resulting from a fishing mortality pattern) relative to the female spawning biomass per recruit in the unfished population. The fishing intensity can be measured as 1-SPR.

RECOMMENDATIONS:

1. Based on the adopted harvest control rule (C-23-02) and the 2023 assessment result that there is more than 50% probability that $SSB_{current}/SSB_{current, F=0}$ is above the threshold reference point, fishing intensity should be maintained at or below the target fishing mortality reference point.
2. The change in fishing intensity required by the harvest strategy is potentially translated into catch and effort measures according to the relationships described in SAC-15 INF-T.
3. CPCs should consider the criteria developed by the ALBWG for identifying exceptional circumstances for north Pacific albacore tuna (SAC-15 INF-S).

1.4. South Pacific albacore tuna

In collaboration with the IATTC, the Pacific Community (SPC) conducted a benchmark stock assessment for South Pacific albacore tuna in 2021. It is based on a spatially-explicit stock assessment model in which the South EPO is considered as a single area due to the lack of tagging data. Several axes of the structural uncertainties were explored in this benchmark assessment, including steepness, movement, size data weighting, recruitment distribution, and the combination of growth and natural mortality. The final structural uncertainty grid for this assessment consisted of 72 models. Results suggest that the movement scenario (tagging vs. SEAPODYM informed movement rates) is the major source of uncertainty among those uncertainty axes.

Based on the weighted grid of the 72 models, the estimated reference points for albacore tuna in the South Pacific are:

1. The median value of relative recent (2016-2019) spawning biomass depletion ($SB_{2016-2019}/SB_{F=0}$) was 0.52 with a 10^{th} to 90^{th} percentile interval of 0.41 to 0.57.
2. There was a 0% probability (0 out of 72 models) that the recent (2016-2019) spawning biomass had breached the limit reference point (0.2) adopted by the WCPFC.
3. The median of relative recent fishing mortality as a ratio of that corresponding the MSY ($F_{2015-2018}/F_{MSY}$) was 0.24 with a 10^{th} to 90^{th} percentile interval of 0.15 to 0.37.
4. There was a 0% probability (0 out of 72 models) that the recent (2015-2018) fishing mortality was above F_{MSY}.

In summary, the benchmark assessment suggests that the South Pacific albacore stock is healthy and the recent fishing mortality is much lower than the fishing mortality at MSY. Nevertheless, it should be noted that the spawning biomass of South Pacific albacore was estimated to have decreased sharply since 2017 due likely to the continuing increase in the amount of longline catch in recent years (see SAC-13-03). For albacore in the south EPO, the spawning biomass ratio (spawning biomass divided by spawning biomass in an unfished condition) is estimated to have decreased from above 0.9 in 1960 to less than 0.5 in 2019 (Figure 4).

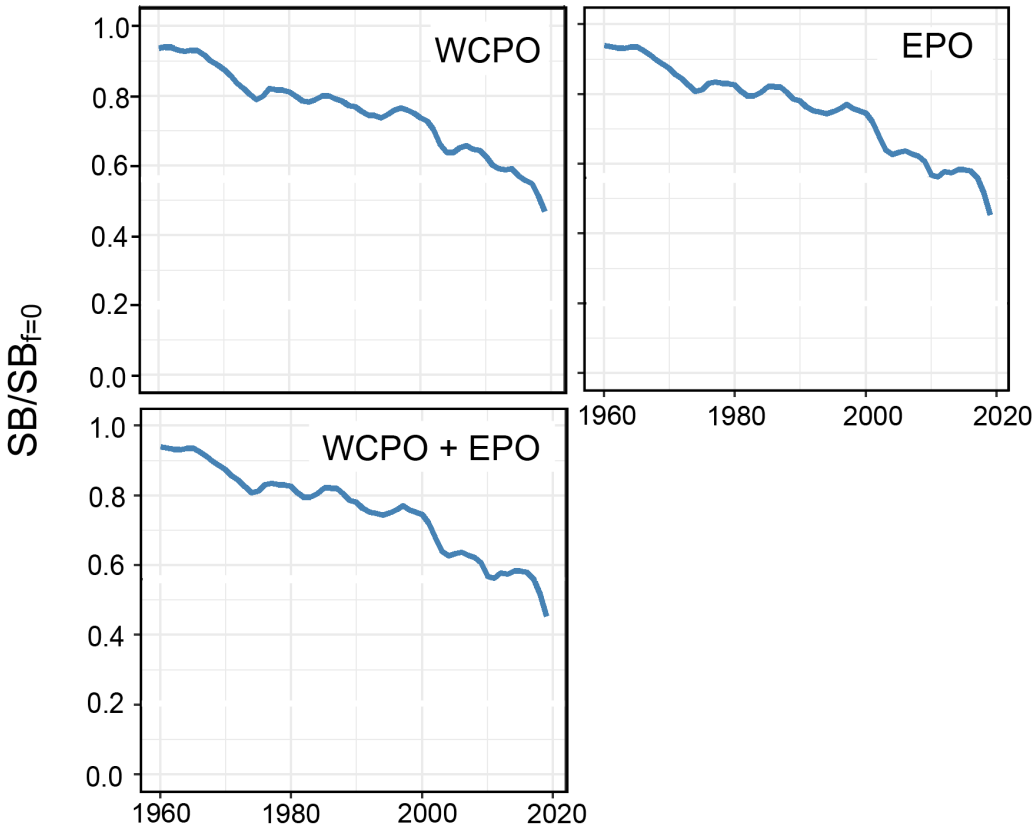

FIGURE 5. Estimated spawning biomass ratio for south Pacific albacore by management regions. This figure is modified from Figure 32 in SAC-13 INF-S.

RECOMMENDATION:

1. Continue collaborating with the Pacific Community (SPC) to monitor the stock status of South Pacific albacore tuna (*e.g.*, using sock status indicators and conducting another benchmark assessment in 3-4 years).
2. That the Commission request the WCPFC to plan a joint effort between IATTC scientific staff and SPC to explore management strategies for South Pacific Albacore tuna.

1.5. South Pacific swordfish

The IATTC staff have finalized the benchmark assessment for south EPO swordfish (SAC-14-15), which was possible due to the collaboration with several CPCs, national scientists and other colleagues (SWO-01-REP). The data up to 2019 was included. There is uncertainty in the stock structure, and three hypotheses were proposed. The initial reference model considered the hypothesis that all catches in the EPO south of 10°N are part of the S EPO stock, as there is support for connectivity between equatorial area and the area south of 5°S, which was the 2011 assessment stock structure assumption, and one of the hypotheses considered. The third stock structure hypothesis was that the stock extends to 170°W and 10°N, including the area of high catches in the central Pacific Ocean. The catch data compiled for the EPO south of 10°N showed a dramatic increase since the mid-2000s. The average catch per year from 2000 to 2009 was about 15,000 tons, while the average catch per year for 2010 to 2019 almost doubled to about 29,000 tons. In the last three years of the compilation (2017 - 2019) the average catch was about 34,000 tons a year. The fleets that are currently the most important are the Spanish longline fleet, which catches about 30% of the total catches in weight, followed by the Chilean gillnet fleet with 22%, and the Ecuadorian longline fleet with 20%.

Associated with the increase in catches, there was a clear increase in the indices of abundances, which was a

continuation of the trends already apparent in the 2011 assessment. To inspect the possibility that the increasing trend was not real but an artifact of a particular index (for example because of changes in target), several indices were constructed using catch and effort data from different longline fleets and from gillnets. No index was considered ideal to represent the stock due to a range of limitations of each one, but all shared the increasing trend in the last 20 years. Four hypotheses were proposed to explain the simultaneous increase of catches and indices of abundance, which included both the possibilities that the increase is either real or not (increase in availability). Dynamic reference points used only for illustrative purposes, indicated that the stock is approaching the hypothetical biomass TRP (of 40% unfished biomass) for one of the hypotheses and is larger for the other hypotheses (SSBcurrent/SSBF=0> 0.5). In any case, the stock is not approaching the hypothetical limit reference point (20% unfished biomass), which is also only to illustrate the stock status (Figure S1). All models estimate a strong increase in fishing mortality since the start of the fishery in the 1950's. The fishing intensity is slightly above the fishing intensity target reference point for one of the hypotheses and below for the other models (Figure S2).

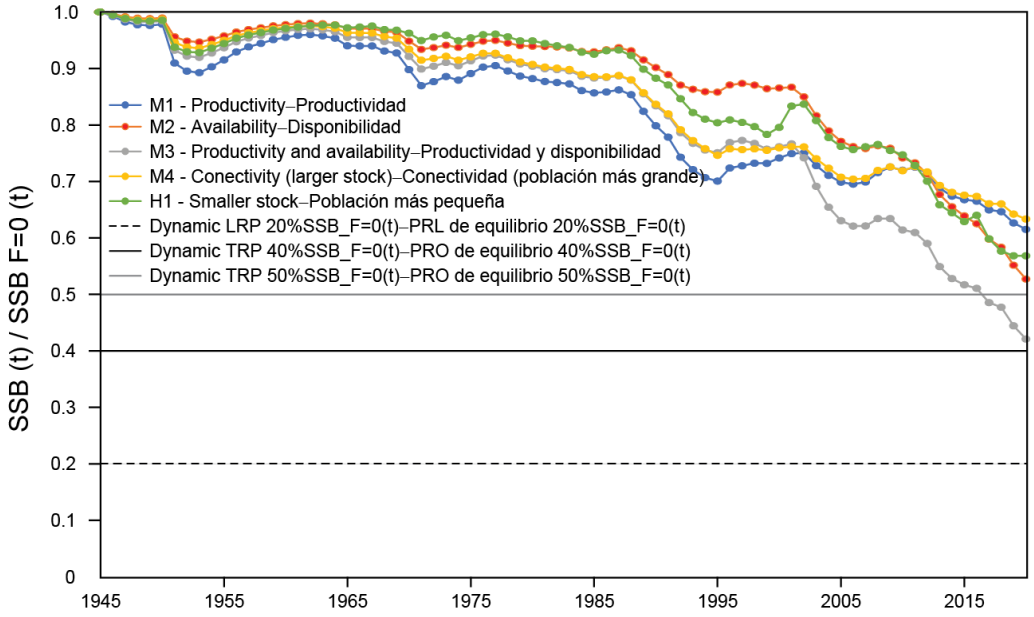

FIGURE S1. Ratio of the estimated spawning stock biomass and spawning stock biomass with no fishing (dynamic) for the models corresponding to the four hypotheses that explain the simultaneous increase in indices of abundance and catches and the model corresponding to the stock structure hypothesis H1 (north boundary at 5°S). Note that M4 corresponds to the stock structure hypothesis H3 (western boundary at 170°W).

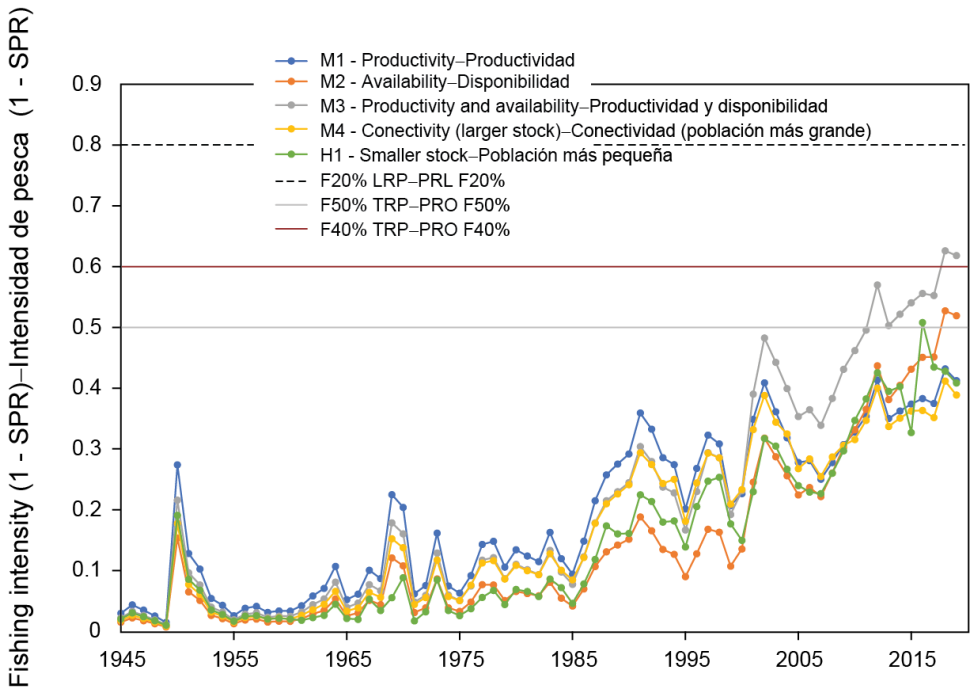

FIGURE S2. Fishing intensity (1-SPR) for the models corresponding to the four hypotheses that explain the simultaneous increase in indices of abundance and catches and the model corresponding to the stock structure hypothesis H1 (north boundary at 5°S). Note that M4 corresponds to the stock structure hypothesis H3 (western boundary at 170°W). Fishing intensity is a proxy for fishing mortality, based on SPR (proportion of the spawning biomass produced by each recruit with fishing relative to biomass per recruit in the unfished condition, Goodyear 1993). Large SPR are indicative of low fishing mortality, thus a proxy for fishing mortality is 1-SPR.

There is not enough information in the current data to determine the relative plausibility of the different hypotheses that may explain the simultaneous increases in catch and indices of abundance. There is external evidence that an increase in productivity of the stock may be plausible due to increase in the main prey of swordfish in the South EPO, the jumbo squid. If this is the case, management of the stock should account for potential decreases in productivity if the prey species decreases in abundance. Nevertheless, the other hypotheses are also plausible and should be considered.

Due to the large uncertainties in both stock structure and the effect of fishing on the stock, the staff recommends that the stock be closely monitored though indicators and assessment, and that CPCs should continue to report operational level (set-by-set) catch and effort data to IATTC, size and age composition, as well as other pertinent data towards this end. The staff also recommends that future research should focus on information that could help discriminate among these hypotheses such as genomics, close-kin mark-recapture studies, electronic tagging studies, habitat modelling and changes in habitat over time and investigating changes in fishing strategies. Finally, the staff recommends that reference points be adopted for the stock, for example those suggested in SAC-14-INF-O.

RECOMMENDATIONS:

1. Continue to monitor the stock (e.g., using stock status indicators and conducting benchmark assessments in 3-5 years).
2. Adopt interim reference points for the stock taking into consideration those proposed in SAC-14 INF-O.

2. NON-TARGET SPECIES

2.1. Silky sharks

The indices for large silky sharks, based on data from the purse-seine fishery on floating objects, have been updated through 2023 for the north and south EPO (**Figure 5**). Previous analyses (SAC-08-08a(i), Lennert-Cody et al., 2019) identified a correlation between north EPO indices, particularly those for small and medium silky sharks, and interannual variability in oceanographic conditions, and thus the indices for those size categories, and for all silky sharks, were not updated because of concerns about bias. Because of recent increases in the live release of silky sharks, two sets of indices for large silky sharks were computed, one including live release data and the other not. Taken together, the two sets of indices likely bracket the trend that would have resulted in both the north and south EPO if "finning"[9], shark handling, and data recording practices had continued unchanged since 1994. The real trend is considered to be closer to the index based on dead and live releases because sharks recorded as released alive in recent years would probably have been recorded as dead previously, and thus the dead and live release is likely a more consistent indicator. The terminal point of these indices suggests a relatively stable abundance level for over a decade, with the 2023 values slightly lower in both the south and north relative to the 2022 value, and thus no changes to management measures are recommended (**Figure 5**). However, the stock status is uncertain, and an assessment has not been possible due to the paucity of data, especially for the longline fleets of the EPO coastal nations, which are believed to have the greatest impact on the stock (SAC-05 INF-F, SAC-14 INF-L). Insufficient data for stock assessment is also a common problem for almost all shark species with which EPO fisheries interact. Therefore, in 2022 the staff used the ecological risk assessment method EASI-Fish to conduct the first comprehensive quantitative vulnerability assessment for 32 shark species caught in industrial and artisanal fisheries in the EPO (SAC-13-11). The assessment showed silky shark to be classified as "most vulnerable", having the second highest vulnerable rank among the 32 shark species assessed. In 2023, a focused EASI-Fish assessment was undertaken on silky shark and three hammerhead shark species to explore the potential efficacy of hypothetical conservation and management measures (CMM) (SAC-14-12), such as EPO-wide closures, and prohibition of the use of wire leaders. The assessment showed that the majority of measures reduced the vulnerability of silky sharks but no single CMM, or combined use of up to four CMMs in concert, resulted in silky shark being classified as "least vulnerable". As a result of handicapped stock assessment attempts and EASI-Fish outcomes, the staff has made recommendations for data collection as part of its work plan for addressing the stock assessments of sharks (see Section 6.1).

[9] Cutting the fins off sharks and discarding the carcass.

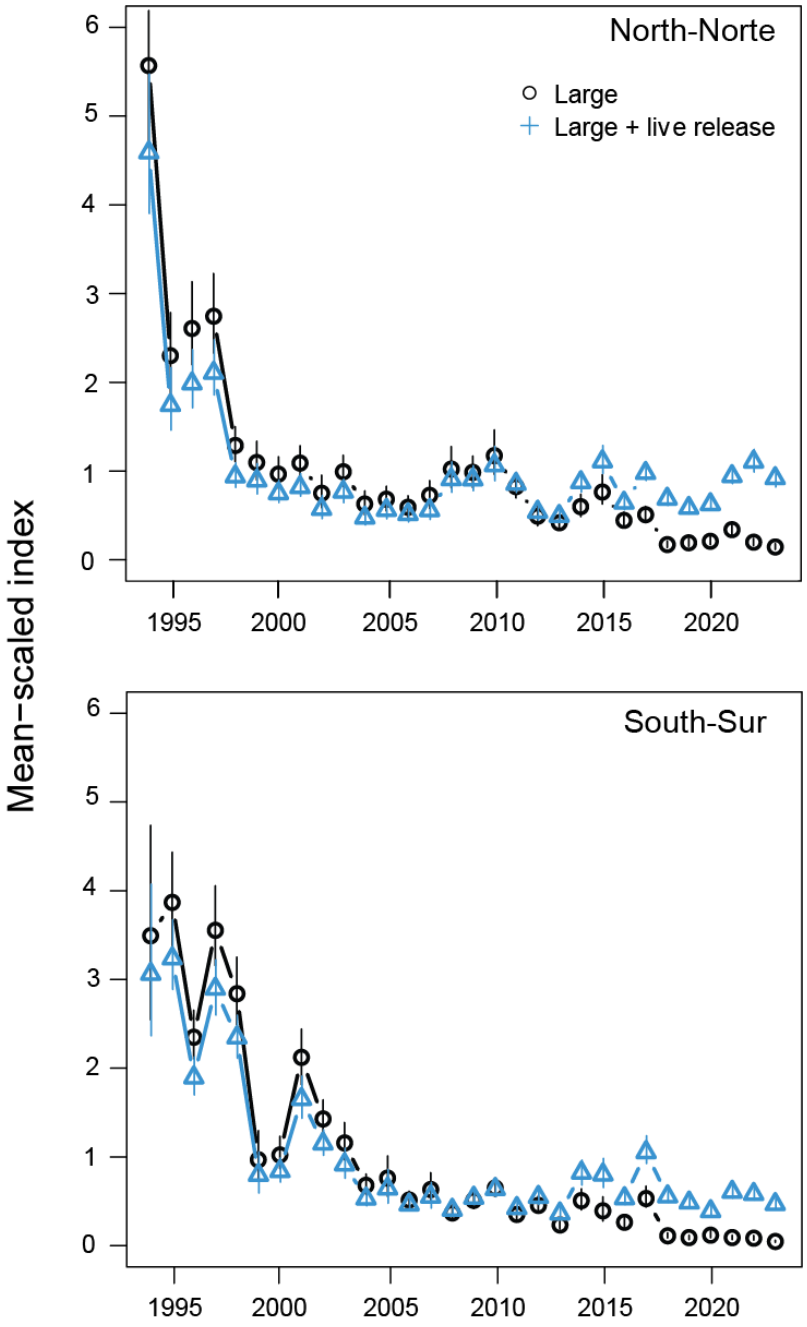

FIGURE 5. Mean-scaled standardized bycatch-per-set (BPS; in numbers of sharks per set) of large silky sharks in sets on floating objects, with and without live release, in the north (top) and south (bottom) EPO.

Paragraph 7 of Resolution C-23-08 , which extends Resolution C-19-05 for another biennial period (2024-2025), requires CPCs to implement a three-month prohibition on the use of steel leaders in certain longline fisheries, and paragraph 8 requires the IATTC staff to present, at the SAC meeting in 2025, an analysis of the available data, including the shark fishery sampling program in Central America, with recommendations for improvement of the resolution, including adjustment of the prohibition period in paragraph 7. Resolution C-23-08 also directs the staff to consider the efficacy of the limits established by the resolution and if necessary, recommend revisions. However, the improved species-

level catch and composition data required for this analysis are not yet available, so it remains a challenge for the staff to evaluate the efficacy of the limits.

Such persisting data limitations, among others, which apply to both target and non-target species, motivated the staff to review current Resolutions pertaining to data provision that underpin all of its research, in particular, the Resolution on data provision, C-03-05. To this end, the staff prepared Document SAC-12-09 (see Section 3) with the overarching goal of creating a revised Resolution C-03-05 to broaden the scope and improve the quality of data provided for science, conservation and management, for both target and non-target species. An outcome from this work was a staff recommendation to the SAC to hold a series of workshops, by gear type, on data provision (SAC-12-16 see Section B.3. "General Data Provisions"). This recommendation was endorsed by the SAC and the first data improvement workshop was organized in January 2023, addressing the industrial longline fishery. A background document (WSDAT-01-01) and workshop report (WSDAT-01-RPT) were produced. Recommendations from this workshop are included in Section 3 of this document.

As part of additional steps taken by the staff to address data limitations, significant progress has been made in recent years in developing the foundations for a sampling program for shark fisheries in Central America (see Section B.4.1, SAC-11-13, SAC-14 INF-L). Made possible through funds provided by the FAO-GEF ABNJ ("Tuna 1) project, the European Union and theIATTC's capacity building, the sampling program in Central America has reached its completion in December 2021. The results supported a proposal that was presented at the 2021 98th Meeting (resumed) meeting of the Commission to establish a long term sampling program in Central America (IATTC-98-02c). Unfortunately, the necessary funds to implement the program are not available yet. If the sampling design of the current sampling program is expanded to other regions in the EPO (*e.g.,* South America, Mexico), both data collection and stock assessments for sharks in the EPO should improve. Very recently, resources to expand the Central American shark data collection improvements into other EPO coastal nations have been made available under a second part of the ABNJ project, the "Tuna 2" project (SAC-14 INF-M). Based on past and current experiences, and as a follow-up to a request made on paragraph 14 under Resolution C-23-07, the staff has prepared SAC-15-10 to provide CPCs with the necessary background on developing a sound shark sampling program in the region.

The management of silky sharks is hindered by the lack of a reliable stock assessment due to the absence of reliable time series of data typically used in stock assessment (catch, CPUE, and sex/size composition). Management of silky sharks could therefore, be greatly improved by implementing a close-kin mark-recapture study (CKMR) that would provide estimates of absolute adult abundance and adult natural mortality (SAC-12-14, SAC-14 INF-M). With funds provided by the ABNJ "Tuna 2" project and the European Union, the staff recently began exploring the feasibility of CKMR approaches for sharks in the region, including a simulation study and a conceptual model for silky sharks (Talwar et al. 2024; presentation EB-02 5.c.2). These efforts will continue in the coming years (SAC-14 INF-M). Until a reliable stock assessment can be undertaken, the staff plans to continue its use of data-limited assessment methods, such as EASI-Fish, to explore the potential efficacy of CMMs to guide managers in the intervening period (*e.g.,* CMMs specified under Resolution C-23-08) (SAC-14-12).

RECOMMENDATIONS:

Considering the recent improvements in shark fishery data collection in Central America (SAC-14 INF-L, SAC-15-10), as well as the upcoming opportunity to expand these data collection improvement efforts into other coastal states (SAC-14 INF-M, SAC-15-10):

CPCs should enhance reporting regarding their implementation of the following provisions of Resolution C-23-08:

1. Paragraph 7, prohibiting the use of steel leaders during a period of three consecutive months of each year for the relevant portions of their national fleets.
2. Paragraphs 11 and 12, which require notifying the Commission of the period of the prohibition, the number of vessels subject to the prohibition, and how compliance with the prohibition will be monitored.

Considering the potential benefits of Close-Kin Mark-Recapture:

3. Fund the development a conceptual model for hammerhead sharks, similar to the one described in Talwar et al. (2024; presentation EB-02 5.c.2) for silky shark.

2.2. List of shark species under the IATTC purview

There has been discussion among CPCs as to what shark species are under the purview of the IATTC. At its 101st meeting, the IATTC adopted Resolution C-23-07 "Conservation measures for the protection and sustainable management of sharks" which, among other things, requires *"…the IATTC scientific staff, in consultation with the SAC and EBWG, shall develop a draft list of shark species under the purview of the Commission in the Convention Area for its consideration"*. The IATTC staff prepared document SAC-15-09, which drew upon the results from IATTC's 2022 shark vulnerability assessment (SAC-13-11) and incorporated ancillary ecological and conservation information to present a range of options for the SAC and the EBWG to consider in developing a proposed interim list of species for potential adoption by the IATTC in 2024. The IATTC scientific staff present for consideration for adoption by the IATTC, at a minimum, a list of 19 oceanodromous and epipelagic species caught in the major industrial and artisanal pelagic fisheries in the EPO (list C of SAC-15-09).

RECOMMENDATIONS:

1. Adopt as an interim list of shark species under purview of IATTC, the list that includes the 19 oceanodromous and epipelagic species caught in the major industrial and artisanal pelagic fisheries in the EPO (list C of SAC-15-09).

2. Given no single organization is currently responsible for sharks in the EPO, the staff notes that additional species could warrant special attention due to their ecological importance, and suggest to cooperate in relevant research and data collection efforts, to the furthest extent possible.

2.3. Seabirds

Resolution C-11-02 should be revised to be consistent with the current state of knowledge regarding seabird mitigation techniques, as described in document SAC-08 INF-D. In addition, the two-column menu approach in C-11-02 should be replaced by a requirement to use at least two of three mitigation methods (line weighting, night setting, and bird-scaring lines) in combination, in a way that will meet the minimum standards recommended by the Agreement on the Conservation of Albatrosses and Petrels (ACAP) and BirdLife International. Other mitigation methods should not be approved until their effectiveness is proven.

BHRP guidelines for seabirds captured in IATTC longline and other hook and line fisheries have been developed (EB-01-01 Annex 1; also available in Annex 1 of document EB-02-03). These BHRP guidelines, recommended by the staff to be used to revise Resolution C-11-02 in 2023, were based on adopted guidance from the ACAP, NOAA Fisheries, and New Zealand Fisheries and have been reviewed by ACAP staff. In the absence of BHRP guidelines for seabirds in the IATTC convention area, the approval of these interim BHRP guidelines is warranted and timely.

RECOMMENDATIONS:

1. Revise Resolution C-11-02 to be consistent with the current state of knowledge regarding seabird interactions and mitigation techniques as described in SAC-08-INF-D and Gianuca et al. (2023)).

2. Adopt interim best handling and release practice guidelines available in Annex 1 EB-02-03.

2.4. Sea turtles

A revised resolution on sea turtles (C-19-04) entered into force on 1 January 2021 requiring EPO tuna fisheries to implement various measures designed to reduce the bycatch of sea turtles, in particular the use of circle hooks and finfish baits in shallow longline sets. The low encounter rates of sea turtles by fishing vessels make these 'rare event' data difficult to analyze using conventional approaches for assessing the status of sea turtle populations. Therefore, a collaborative research project (BYC-11-01) between the IATTC, the Inter-American Convention on the Protection and Conservation of Sea Turtles (IAC), and international sea turtle experts employed the EASI-Fish approach as an alternative means to assess vulnerability status and to simulate conservation and management measures (CMMs) that may mitigate fishery-imposed risks to the critically endangered East Pacific population of leatherback sea turtle. This project was extended in 2021-2022 with several model improvements (*e.g.,* a new species distribution model and updated fishing effort data for artisanal fisheries) (BYC-11-02). Proxies for fishing mortality ($\tilde{F}_{2019}$) and the breeding stock biomass per recruit (BSR_{2019}) exceeded precautionary biological reference points ($F_{80\%}$ and $BSR_{80\%}$), classifying the EP leatherback turtle stock as "most vulnerable" in the reference year (2019). Of the 70 CMM scenarios, use of circle hooks, finfish bait, and to a lesser extent best handling and release practices were each predicted to decrease vulnerability when examined individually, by far the most effective scenarios involved using these three measures in concert, followed by using circle hooks with either finfish bait or best practices.

Following Resolution C-19-04, the IATTC organized a workshop to discuss the minimum hook size that would reduce sea turtle mortality. The workshop also addressed the ecosystem-level concerns and potential trade-offs regarding the expanded use of circle hooks in longline fisheries and discussed the potential impacts of gear types on various taxa, including sea turtles. However, a final agreement was not reached on a recommendation to the Commission for a minimum hook size as well as a schedule for implementing this recommended minimum hook size through a revision to the Resolution C-19-04 (WSHKS-01). As such, the EBWG recommended that the IATTC staff co-host a follow-up workshop with the goal of exploring/expanding on topics of interest/data-knowledge gaps identified by the Working Group to mitigate bycatch of sea turtles and to complete the outstanding requirements of Resolution C-19-04.

RECOMMENDATIONS:

1. Revise Resolution C-19-04 consistent with the simulated efficacy of CMMs assessed in BYC-11-02.

2. Conduct a follow-up workshop to reevaluate available data on circle hooks and reach an agreement on a recommendation for the adoption of a specific shape or minimum size of circle hook.

2.5. Best handling and release practices (BHRP) of vulnerable[10] species

Concerns about the incidental capture (*i.e.*, bycatch) of vulnerable marine species, including marine mammals, seabirds, sea turtles, and elasmobranchs, have resulted in increased efforts to develop conservation and management measures. These measures often require that no retention takes place and that the best handling and release practices (BHRP) are employed to reduce the impacts of fishing on these populations. However,

[10] Unless specified otherwise, including but not limited to citations to vulnerability assessments and any qualitative/quantitative scores (e.g. BYC-10 INF-B; SAC-13-11), the staff's definition of "vulnerable species" refers to the species that, in the *sensu latu*, and due to their low-productive life-history traits (i.e. K species in r/K selection theory), are more vulnerable to the impacts of fisheries and other anthropogenic activities on these species or their habitat and ecosystem. This includes the marine mammals, seabirds, sea turtles and the elasmobranchs.

developing safe and effective BHRP guidelines is often a complex and iterative process that involves understanding fishery characteristics, handling and discard methods, and post-release survival rates. The IATTC staff are working towards creating BHRP guidelines that are safe, effective and practical for vulnerable species captured by the various fishing gears across the convention area. A workplan with phases, components, and activities (including a list of research priorities), as well as a framework, and a timeline towards BHRP adoption have been developed by the staff (EB-02-03).

At its 101st meeting, the IATTC adopted Resolution C-23-07 "Conservation measures for the protection and sustainable management of sharks" which, among other things, requires, "….*The IATTC scientific staff, in collaboration with the IATTC SAC and EBWG, shall develop and recommend to the Commission a set of best handling guidelines for the safe release of sharks for inclusion in this measure in 2024*". The IATTC staff, in collaboration with subject matter experts, developed BHRP for sharks in document SAC-15-11. The document compiles all scientific evidence in support of the recommended BHRPs for sharks.

The following are the IATTC staff recommendations reagarding the development of BHRPs for vulnerable species:

RECOMMENDATIONS:

Specifically on sharks:

1. Adopt the shark BHRP guidelines described in SAC-15-11.

Regarding the nature of BHRP guidelines for vulnerable species:

2. The Commission, in addition to endorsing the development of the guidelines and adopting them, should consider making their content legally binding, in part or in whole, through their incorporation in appropriate instruments, such as, among others, a general resolution with annexes covering all BHRPs, or individual resolutions on specific BHRPs.

Regarding the collection of data to support devolpment of BHRP guidelines for vulnerable species:

3. CPCs suport the staff in the collection of all relevant information on, among others, vessel and gear configuration details by target species and fishing gear, ongoing PRS studies, stranding networks, or other relevant activity.

B. DATA COLLECTION

3. TUNA TAGGING

Conventional tagging experiments (capture-mark-release) are a useful tool in fisheries science for obtaining important biological information on exploited fish populations. This can range from routine data, such as movements, stock structure, and growth, to more complex information, such as exploitation rates, natural mortality, and, in some cases, abundance estimates. By including electronic archival tags (ATs) in these experiments, researchers can gain insights into daily movements (horizontal and vertical), behavior, and habitat preferences. Combining information from both conventional and electronic tagging in stock assessments can reduce uncertainty, thus providing policymakers with more robust data for making management decisions.

Through financial support provided by the European Union and the IATTC, the multi-year Regional Tuna Tagging Project in the EPO was conducted by the IATTC during 2019-2023 (RTTP-EPO 2019-2020, Project E.4.a, SAC-14-07). The program consisted of a series of three tuna tagging cruises and aimed at advancing the biological information currently used in stock assessments and to help inform management decisions for the tropical tuna fishery in the EPO. The tagging data collected under the RTTP-EPO allowed for the development of a novel spatiotemporal Petersen-type model for skipjack tuna in the EPO. The model provides estimated absolute biomass utilising available tag recapture and catch data as well as movement patterns estimated by a tagging movement model (SAC-13-08, SAC-14 INF-E, SAC-15 INF-G). These estimates have been incorporated into the 2024 skipjack benchmark assessment (SAC-15-04).

Although the spatiotemporal tagging model is currently only available for skipjack (SAC-15 INF-G), the staff is planning to apply the approach to the other tropical tuna. This is particularly important at a time when the bigeye and yellowfin tuna assessments are facing serious challenges. In the bigeye tuna assessment, due to the pronounced decrease in the spatial coverage of the Japanese longline fleet in the EPO, the precision of the Japanese longline index of abundance has rapidly deteriorated since 2020 (SAC-15-02). Consequently, the longline index of abundance does not provide precise information on the temporal change of population abundance over the recent period. If this trend persists, the reliability of the bigeye stock assessment may become compromised in the near future considering that the Japanese index is the primary index informing the abundance trend of large bigeye. Although the staff intends to continue its collaboration with Asian CPCs to improve the longline index of abundance for bigeye tuna, there are other challenges with the data available. With respect to yellowfin tuna, there is evidence of strong spatial structure of yellowfin in the EPO and some form of a spatially structured assessment or separate assessments for different sub-stocks may be needed. Although there is a reliable dolphin-associated index of abundance for yellowfin in the northern EPO (the "core" region; SAC-15-03), the indices available for the southern region of the EPO are not reliable. Estimates of absolute abundance, such as those just developed from the spatiotemporal model for skipjack, will help overcome the challenges with the bigeye and yellowfin assessments.

RECOMMENDATIONS:

1. Conduct at least one tagging cruise every three years to coincide with the tuna assessment and management cycle.

2. Support the development of a framework to strengthen collaboration and participation of CPCs and the tuna fishing industry in the implementation of the tagging project:

    a. Facilitate the negotiation of dFAD sharing agreements with vessels and companies;

    b. Conduct tagging in partnership with CPCs using pole-and-line vessels fishing from coastal states;

    c. To address deficiencies in key biological parameters, conduct opportunistic tagging in collaboration with the recreational sector.

3. Investigate the feasibility of using sea cages for holding purse-seine captured tunas as a tagging method.

4. DATA FOR LARGE LONGLINERS

Recent challenges with the assessments of the target tuna fisheries demanded the use of sophisticated analyses that required fine-scale spatial and temporal resolution catch, effort and size data (SAC-11-06; SAC-11-07; IATTC-95-05) from the longline fleets operating far from the coasts and particularly in the high-seas, which in some cases, are not routinely available to the staff. Challenges are also encountered by the staff when producing assessments for tuna-like species, such as swordfish (SWO-01), due to a lack of data. CPUE data from Japan forms the basis for the index of abundance used in the current assessments of bigeye, yellowfin, and for the first time, skipjack (SAC-13-07), and it is key to address hypotheses of spatial structure for yellowfin tuna in the EPO. However, the magnitude and spatial extent of effort by the Japanese fleet has decreased markedly in the EPO (SAC-15-02), thereby deteriorating the quality of the indices of abundance. Recent collaborative work with Japan, Korea, Chinese Taipei and China has improved the understanding of their logbook data for developing new indices of abundance. Data for this work were only made available to the staff via multiple MoUs between the IATTC and each CPC, which are renewed annually. The data regularly submitted by the CPCs related to the Resolution C-03-05 on data provision are aggregated spatially (1° x 1° or 5° x 5°) and contain little or no gear configuration information, and no vessel identifiers, which are important factors for better understanding changes in catchability and species targeting (OTM-30), both of which influence abundance indices. Operational-level data (high resolution 'level 1' catch and effort data as defined in C-03-05) with corresponding size information are necessary to improve the indices of abundance routinely used in the stock assessments for bigeye and yellowfin tuna, and will become increasingly important for other commercially important species such as swordfish, other billfish and sharks. These data already exist for most, if not all, large longline fleets (and for some coastal

longline fleets), and are currently submitted to other t-RFMOs by IATTC CPCs (WCPFC13), and are similar to the data available to the staff for the purse-seine fishery. Therefore, these equivalent longline data should be expected to be made available to staff on an annual basis for the purposes of improving the quality of data reporting and research to facilitate fulfillment of mandates by the Antigua Convention.

The staff has prepared an extensive workplan to address several uncertainties in the stock assessment of yellowfin, bigeye tuna and other species that will require high-resolution CPUE data with corresponding size information. The staff has routine access to high-resolution data for most of the purse-seine fleet, but not for the longline fleet from which indices of abundance are mostly derived. The quality of stock assessments of tuna and tuna-like species undertaken by the staff will therefore continue to be severely compromised without access to these high-quality existing data.

Additionally, the Antigua Convention entered into force over a decade ago and expanded the mandate of the Commission to include non-target, dependent and associated species, and the effects of the fishery on the ecosystem. The data provision has lagged both in pace and types of data reported to the IATTC. This in turn has affected the staff's ability to adequately fulfill its obligations under the Convention and objectives under IATTC's Strategic Science Plan (2019–2023, IATTC-93-06a). Therefore, the staff—under the direction of a SAC- and Commission-endorsed staff recommendation (see SAC-12-16, General Data Provisions)—planned and facilitated the 1st workshop on improvements in data collection and provision with a focus on the industrial longline fishery (WSDAT-01) taking into consideration elements from SAC-12-09 on data gaps pertaining to all gear types. Preliminary staff recommendations to improve data collection and provision for the industrial longline fishery were presented at the workshop (WSDAT-01-01) to stimulate discussions on recommendations to revise resolution C-03-05. Input from workshop participants (WSDAT-01-RPT) was used to revise the staff's recommendations provided in SAC-14 INF-Q.

The SAC, in general terms, endorsed the recommendations on tunas presented by the staff in SAC-14-14 (SAC-14-16, paragraph 1d) as well as a recommendation that the Commission review and update Resolution C-03-05 on "Data Provision", taking into consideration document SAC-14 INF-Q (SAC-14-16, paragraph 7.1). Therefore, the importance of updating this resolution is reiterated by the IATTC staff.

RECOMMENDATIONS:
Following the SAC-endorsed staff recommendation to review and update Resolution C-03-05:

Encourage CPCs to update the data provision resolution (C-03-05) to guarantee the provision of scientific advice, based on indices of abundance derived from longline data, for management of tuna and tuna-like stocks and to better align data provision and submission requirements with the Antigua Convention's mandate to include non-target, dependent and associated species, and the effects of the fishery on the ecosystem.

Consider the following recommendations summarized from SAC-14 INF-Q – see document for detailed recommendations:

The Commission amends resolution C-03-05 to mandate the submission of set-by-set level, vessel specific, catch and effort longline data, both current and historical, ideally from the year the fleet began operating in the EPO to the most recent year possible, and updated annually thereafter, by March every year, to the scientific staff for scientific purposes pursuant to the objective, rules, and relevant provisions of the Antigua Convention and measures adopted by the IATTC.

Until the coverage of the operational-level logbook data provided to the Commission is 100%, catch and effort data aggregated at a 1° by 1°-degree spatial resolution by vessel, month, hooks-per-basket and species should be provided.

On a case-by-case basis, where necessary according to domestic laws and regulations, CPCs may work with the Director to conclude Memorandums of Understanding or other equivalent instruments, subject to periodic renewal, in order to provide IATTC with continuous or near continuous access to these data for scientific use.

The technical specifications on data provision pursuant to resolution C-03-05 shall be posted to IATTC's website under the "Resources" tab, "Reports and provision of data" and updated annually.

5. SHARKS AND RAYS

5.1. Improving data collection and stock assessments for sharks

Paragraph 1 of Resolution C-16-05 requires the IATTC staff to develop a workplan for completing full stock assessments for silky and hammerhead sharks. As noted in SAC-05 INF-F, SAC-05-11a, and SAC-07-06b(iii), improving shark fishery data collection in the EPO is an essential prerequisite.

The first comprehensive quantitative ecological risk assessment for sharks in the EPO was completed in 2022 (SAC-13-11) using the EASI-Fish approach, which identified 20 of the 32 species assessed exceeding biological reference points, thus rendering these species "most vulnerable". Of the 20 most vulnerable species, silky shark and three species of hammerheads were ranked highest. In 2023, an EASI-Fish assessment was undertaken on four of the most vulnerable shark species, silky shark and three hammerhead shark species, to explore the potential efficacy of hypothetical conservation and management measures (SAC-14-12), among others, EPO-wide closures, and prohibition of the use of wire leaders. The assessment showed that the majority of measures reduced the vulnerability of silky sharks but no single CMM, or combined use of up to four CMMs in concert, resulted in the species being classified as "least vulnerable". The EASI-Fish assessment and previous shark research undertaken by the staff have identified significant data deficiencies for vulnerable shark species, including silky and/or hammerhead sharks, in the EPO: 1) reliable catch and size composition data for coastal (*i.e.* 'artisanal') longline and gillnet fisheries (SAC-08-07b; SAC-08-07e), high-seas longline fisheries (SAC-08-07b; SAC-08-07e) and small[11] purse-seine vessels (SAC-08-06a), 2) basic biological information to parameterize EASI-Fish and stock assessments, such as length-weight and length-length relationships, maturity ogives and growth curves, and 3) species-specific and fishery-specific estimates of post-release survival. In particular, without data from a properly designed long-term sampling program for artisanal fisheries across EPO coastal States

(a significant part of component (1)), the IATTC staff will not be able to meet this requirement of Resolution C-16-05.

As a first step toward developing sampling designs for catch and size composition in artisanal fisheries, and for size composition in industrial longline fisheries, a wealth of information has been collected in five Central American countries under Project C.4.a, funded by FAO-GEF through March 2019, and through March 2020 by the IATTC capacity-building fund (SAC-11-13). Made possible through recent funds provided by the European Union, the sampling program in Central America has reached its completion in December 2021. The results supported a proposal that was presented at the 2021 98th Meeting (resumed) meeting of the Commission to establish a long term sampling program in Central America (IATTC-98-02c). Unfortunately, the necessary funds to implement such long-term program are not available to date. If these funds to initiate the long-term sampling program in Central America are secured and these efforts are expanded to other regions in the EPO (*e.g.,* South America, Mexico), both data collection and stock assessments for sharks in the EPO could improve. Resources to expand the Central American shark data collection improvements into other EPO coastal nations have recently made available under part 2 of the ABNJ project (SAC-13-12, SAC-14 INF-M, SAC-15-10).

RECOMMENDATIONS:

1. Establish, or strengthen, data collection programs for artisanal fisheries in EPO coastal States to obtain reliable catch and size composition data and biological information for assessments of vulnerability and stock status.

2. Resume the IATTC Technical Meetings on Sharks to gather existing data and expert knowledge on data-poor sharks and fisheries, with the goal of improving population and ecological risk assessments (e.g., EASI-Fish) that can inform management decisions.

Given the scale and importance of the shark fisheries in Central America (SAC-14 INF-L, SAC-15-10) and the lack of fishery/biological sampling data from shark landings in that region (SAC-07-06b(iii)), the staff reiterates the following recommendation:

RECOMMENDATION:

Establish an IATTC field office in Central America near the port or ports where most shark landings occur.

Previous recommendations by the staff on data collection by observers on longline vessels and Class 1-5 purse-seine vessels are reiterated in Section 9.

5.2. Improving data collection and stock assessments for Mobulid rays

Resolution C-15-04 paragraph 6 requires the Commission, no later than in 2017, to establish a species-specific Mobulid ray data-collection program for all fisheries. With the development of a new field guide by the IATTC staff and partners for the identification of mobulid rays to species for Pacific Ocean fisheries now freely available to all CPCs, observer programs and fishing agencies, on the IATTC website, the ability to identify bycaught mobulid rays to species level has been greatly improved.

RECOMMENDATION:

CPCs should ensure that the new species identification field guide for manta and devil rays in Pacific Ocean fisheries, posted on the IATTC website, is used.

6. ECOSYSTEM CONSIDERATIONS

6.1. Feasibility study to develop a sampling program for updating morphometric relationships and collecting biological samples for priority species in EPO tuna fisheries

Length-weight (L-W) relationships are the foundation to a variety of research projects including stock assessments, ecological risk assessments (*e.g.,* EASI-Fish) and for converting catch reported in numbers to weights, and vice versa. These relationships can vary markedly in space and time and can greatly influence stock and risk assessment model outcomes. Despite this, L-W relationships for tunas are outdated (*e.g.,* yellowfin: 1986, bigeye: 1966 and skipjack: 1959) or inadequate for many priority species (see SAC-13-11, SAC-09-12, IATTC Special Report 25). Catch estimations are also affected by imprecise and/or outdated L-W relationships. Furthermore, species and size composition of the catch and fishing strategies differ significantly between longline (LL) and purse-seine (PS) fisheries (*e.g.,* see IATTC-98-01). Additionally, basic life history data for assessment models are absent or inadequate for most bycatch species. A proposed feasibility study (Project F.3.a) addresses these issues and a background paper (SAC-14 INF-J) summarizes the staff's internal discussions, provides background information, describes data deficiencies in morphometric relationships and biological sampling, and identifies potential sampling opportunities in 3 gradual phases. In SAC-14 INF-J, the staff built upon Project F.3.a and developed a hierarchical phased-based approach to update morphometric relationships and biological sampling for tunas, billfishes, and prioritized bycatch species, through the collaboration of staff, CPCs, industry and other relevant stakeholders. This project is complementary to other data improvement projects (SAC-12-09, WSDAT-01-01, WSDAT-01 Report) and also aims to align with work conducted in the Western and Central Pacific Ocean through SPC's Oceanic Fisheries Programme on the collection of morphometric data to build a comprehensive database on various length and weight types and to establish collection of biological samples. Concerns over the outdated morphometric relationships for tunas were discussed at the 1st external review of data used in stock assessments of tropical tunas in the eastern Pacific Ocean (RVDTT-01), and this inadequacy contributes to considerable uncertainty in catch estimates and the tuna stock assessments. Accordingly, the external review panel recommended the implementation of Project F.3.a (RVDTT-01).

RECOMMENDATION:

1. In collaboration with CPCs and relevant stakeholders, develop a feasibility study (Project F.3.a)—which may be upscaled using a hierarchical phase-based approach (see SAC-14 INF-J)—for a fishery-dependent sampling program to collect morphometric measurements and biological samples from tunas and other prioritized species.

7. FISH-AGGREGATING DEVICES (FADs)

The recommendations in this section are based on documents FAD-08-01, FAD-08-02 and FAD-08-03; some of them were endorsed by the *ad-hoc* Working Group on FADs, SAC-09, SAC-10, SAC-14 and IATTC-97-01, among others.

7.1. Provision of detailed historic buoy data

Under Resolution C-17-02 and C-20-06, CPCs were required to provide "daily information" on their active FADs, which was interpreted to mean a single data point per FAD per day, the selection criteria for which are unclear (*e.g.* no acoustic biomass information is required by the Resolution). This combination of low resolution and uncertain selection criteria meant that these data were of limited scientific utility. Also, CPCs were allowed to report data in different formats, sometimes highly summarized (without any information on FAD identification or trajectory), which again were of little use for science. Moreover, Resolution C-19-01 allows CPCs to use different methods for marking and identifying FADs. As a result, the data provided under C-17-02 and C-20-06 were inadequate even to allow connection of the various FAD-related IATTC. In recent years, the IATTC staff, the FAD-WG and even the SAC itself recommended the provision of raw buoy data as received by original users (*i.e.*, vessels, fishing companies), including both trajectories and acoustic biomass information. Therefore, starting in 2022, under Resolution C-21-04, CPCs began to report this data following the format specified in Annex IV of C-21-04.

Although Resolution C-21-04 reduces the active FAD limits in 2022 and 2023, compared to the 2018-2021 period, analysis of raw buoy data for 2022-2023 (FAD-07-01, FAD-08-01) has shown an increase in the number of active FADs used by the fleet. However, the data available to the staff before and after 2022 are inconsistent in reporting rate and quality, and thus, the exact reasons for this increase remain unclear, but may range from improved data to actual increases in FAD usage.

Moreover, as noted by voluntary pilot studies using raw buoy data, including both trajectories and acoustic biomass information, at regional (*e.g.*, FAD-05-INF-E, FAD-06-03, FAD-07-03, SAC-13-07, FAD-08-02) and global scale (*e.g.*, IOTC-2020-WPTT20-14, SCRS/2019/075, SCRS/2024/044), scientific studies, including improved stock assessments of tropical tuna, require high-resolution, standardized long-time series data. Therefore, the staff recommends that CPCs provide the historic raw buoy data in order to conduct the appropriate scientific analyses, and in particular, to continue improving staff's understanding of FAD fishery dynamics and the assessment of skipjack (SAC-15-04) and other tropical tuna species.

RECOMMENDATION:

CPCs should provide to the IATTC staff the historic raw buoy data received by original users (*i.e.,* vessels, fishing companies), including both trajectories and acoustic biomass information.

7.2. Remote identification of FADs

The quantification of FAD impacts requires efficient high-quality data collection methods, including accurate tracking and monitoring methods for individual FADs throughout their lifetime. Currently, FADs are identified using satellite-buoy identifiers (see Resolution C-19-01), and appropriately obtaining buoys' alphanumeric serial numbers has traditionally been difficult for observers, and not possible with current electronic monitoring (EM) capabilities (Legorburu et al. 2018). However, this information is key to merge and connect different IATTC databases and support scientific advance and the development of science-based management recommendations. The staff, the FAD Working Group and the SAC have reiterated the importance to access FAD/satellite buoy identifiers and repeatedly recommended to explore efficient ways to mark and track FADs (e.g., FAD-03-INF-A, SAC-11-INF-M). As such, the IATTC staff, in collaboration with industry partners, tested and evaluated the suitability of the LoRaWAN technology, with different configurations, to remotely and electronically identify FADs (i.e., satellite-linked echo-sounder buoys) in real conditions.

This technology, as described in document FAD-08-03, can reliably transmit information between a transmitter and a receiver at short-medium distances (i.e., 500 m) (e.g., satellite-buoy identification to vessels approaching the FAD), potentially addressing issues related to data collection of observers, both human and electronic, and satellite-buoy serial numbers. Moreover, this promising technology could be explored to be used in various fisheries data collection needs, such as using electronic scales to record tuna catches remotely and automatically in purse seiners, transshipments, or other systems, enhancing data accuracy and reliability.

With these elements into consideration, the IATTC staff makes the following recommendations:

RECOMMENDATION:

1. Consider the LoRaWAN technology for the development of sensors transmitting the FAD buoys' serial number to receivers located at distances no greater than 500 m.
2. Consider exploring the LoRaWAN technology for applications with other fishing activities that require remote and automatic data collection (e.g., electronic scales for weight estimates).

7.3. Regional data collection program on stranding FADs

At present, the characteristics and magnitude of the loss or abandonment of FADs in the EPO fisheries are not well known and neither its potential impacts on the environment and ecosystems, such as ghost fishing, impacts on sensitive habitats, and more generally marine pollution, although there is a generalized awareness and concern regarding the consequences of their stranding and the resulting damage to ecosystems.

In this context, the IATTC recognized the importance and urgency of the issue and adopted measures "*to prevent loss or drifting*" of FADs (Resolution C-23-03, paragraph 3) in addition to approving the recommendation that the *Ad Hoc* Working Group on FADs (FADWG) (FAD-07-05) had adopted and the SAC (IATTC-101-03) endorsed afterwards. This recommendation reads as follows:

> "3. *On stranding FADs*
>
> *3.1. Consider alternative mechanisms to continue monitoring buoys that are leaving the convention area or the fishing grounds and that are susceptible for deactivation, taking into account the implications with regard [to] the limits on active FADs per vessel.*
>
> *3.2. To the extent possible, provide data to the Secretariat on the entire trajectory of FADs, even when transiting outside the convention area or the fishing grounds, monitored through new FAD marking systems, the FAD's buoy or other systems.*
>
> *3.3. Consider putting in place a set of best practices for optimizing FAD retrieval.*
>
> *3.4. Promote FAD recovery programs, both from the land and from the sea, and establish standards to ensure the effectiveness of these programs.*
>
> *3.5. Create awareness of FAD strandings and encourage the expansion of the in-country data collection efforts on FAD strandings in the EPO to harmonize with SPC-WCPFC efforts in the WCPO.*
>
> *3.6. Develop solutions to process/recycle FAD materials in ports*."

To this end, CPCs were invited to participate in the development and implementation of an IATTC regional data collection program on FAD strandings (Memorandum Ref.: 0008410) aimed at (i) facilitating a better understanding of the extent of environmental impacts of drifting or stranded FADs both in the EPO, and in the WCPO, when crossing over to that area and (ii) contributing to improved management advice on FADs. Development of this program will harmonize IATTC's efforts with those already established by the WCPFC's data collection program described in FAD-07 INF-A. Harmonization of data collection in the WCPO and the EPO will foster Pacific-wide research as recommended by the SAC ("*Increase Pacific-wide collaboration on drifting FAD research…*" See document IATTC-101-03, recommendation 5.1); it will also foster and facilitate collaboration on FAD stranding events as well as guidance of potential management options, particularly for events that span both regions.

To date, five CPCs have responded to the memorandum and expressed interest in participating in a regional data collection program to harmonize with SPC-WCPFC's efforts. The initial interest by these CPCs, as well as the success of the eventual data collection program on stranding FADs, could significantly benefit from the participation of other CPCs in the region and from increasing awareness by local communities.

RECOMMENDATIONS:

1. CPCs participate in a regional data collection program on FAD strandings originating from EPO fisheries—following, to the extent possible, the system of data collection and dedicated data forms already established by the WCPFC and described in FAD-07 INF-A—to improve our understanding of the extent of environmental impacts of drifting or stranded FADs and to guide potential management options.

2. CPCs create awareness of FAD strandings by engaging local communities to communicate and disseminate information (e.g., through posters, radio and television broadcasts, and public speaking) and improve reporting of lost and abandoned FADs data found by fishers and/or local communities.

8. OBSERVER COVERAGE

8.1. Purse-seine fishery

8.1.1. Observer coverage of purse-seine vessels of less than 364 t carrying capacity

No formal, fleet-wide on-board observer program exists for Class 1-5 purse-seine vessels, and as a result, trips by many small[12] purse-seine vessels are not sampled by observer programs (SAC-08-06a; SAC-12-09, SAC-14-11). However, data collection has been improving due to a voluntary observer program, established in 2018. Initially, observer coverage was low due to the voluntary nature of the program. Therefore, vessel logbooks and cannery unloading records are the principal sources of data on the activities of these vessels. However, these data sources generally do not contain information on tuna discards, and the data are less complete and detailed than those collected by observers. In addition, bycatch information is only rarely recorded in logbooks, which hampers efforts to conduct assessments for such species. Electronic monitoring (EM) for this fleet component is currently being explored (Project D.2.a; SAC-10-12), and some capabilities of EM detected in the pilot study are detailed in Appendix 2 of SAC-11-11; however, EM data collection is not likely to begin at any significant level prior to January 2025, given the steps that need to be completed for implementation of an EM System in the EPO (SAC-12-10; SAC-12-11, EM-02-01). Therefore, a formal, non-voluntary, fleet-wide observer program is recommended to routinely obtain the data necessary for estimating the quantity and species composition of bycatches by these vessels and to understand the strategies and dynamics of their operations. Based on a previous study of EPO data for Class-6 vessels fishing on floating objects (IOTC Proceedings WPDCS-01-09, 4: 48–53), an initial sampling coverage of at least 20% of all trips of the small-vessel fleet component is recommended.

RECOMMENDATION:

Establish a formal, non-voluntary, fleet-wide observer program for purse-seine vessels of less than 364 t carrying capacity, with a sampling coverage of at least 20%.

8.2. Longline fishery

8.2.1. Observer coverage

Resolution C-19-08 requires that at least 5% of the fishing effort by longline vessels greater than 20 m length overall (LOA) carry a scientific observer. However, recent analyses undertaken by IATTC staff with the new operational-level data collected by observers onboard large longline vessels showed that, at such a low level of coverage, the data are not representative of the fishing activities of the entire fleet and cannot even be used to produce accurate estimates of total catch of target species such as bigeye tuna and yellowfin tuna (BYC-10 INF-D). Therefore, the staff concludes that 5% coverage is too low for calculating accurate estimates of the total catches of bycatch species caught by these vessels, particularly those species caught infrequently, such as sea turtles, seabirds and some sharks of conservation concern. In fact, several studies of sampling coverage for other longline fisheries have shown that 20% coverage is considered the minimum level required for estimating total catch of bycatch species. Both the staff and the SAC have recommended that this level of coverage be adopted for longline vessels over 20 m LOA (SAC-10 INF-H).

RECOMMENDATION:

The staff maintains its recommendation of at least 20% observer coverage of longline vessels over 20 m length overall.

9. ELECTRONIC MONITORING

9.1. Implementing an electronic monitoring system for the tuna fisheries

Electronic monitoring (EM) is increasingly being used worldwide to record the activities of fishing vessels, to complement human observer programs, and where on-board observer coverage is too low or non-existent.

[12] Carrying capacity ≤ 363 t.

Accordingly, per request of the Scientific Advisory Committee during its 10th meeting in 2019, and pursuant to paragraphs 9 and 10 of Resolution C-19-08, the IATTC staff, at the 11th meeting of the SAC in 2020, presented the document SAC-11-10, containing information on the potential of an Electronic Monitoring System (EMS), a description and evaluation of the minimum standards of its components, and the actions that would be required for its implementation. To further discuss the elements contained in document SAC-11-10, the *1st Workshop on Implementation of an EMS in the EPO* was held in April 2021. Presented at this workshop, the document EMS-01-01 recommended several actions for endorsement by the Commission. Among these was a workplan formulated by IATTC staff (EMS-01-02-Rev), which proposed a series of workshops to consider and analyze the EMS components and subcomponents in a hierarchical and chronological order. The associated Terms of Reference of these EMS workshops and a set of definitions were adopted through the Resolutions C-21-02 and C-21-03, respectively, during the 98th Meeting of the IATTC. In observance of Resolution C-21-02, and according with the workplan adopted for the implementation of an EMS in the EPO, the staff organized in fall 2021 the 2nd Workshop of an EMS in the EPO to discuss aspects on the institutional structure, goals and scope of the EMS (see EMS-02-01 and EMS-02-02 Rev.). A 3rd Workshop was organized in spring 2022 to discuss considerations related to the management of an EMS for the EPO (see EMS-03-01). During SAC-13, the staff presented a compilation of workshop participants' comments and concerns, revising its preliminary recommendations of the 2nd and 3rd workshop as necessary (SAC-13-INF-D). Subsequently, during the 100th IATTC Meeting, Resolution C-22-07, established an *Ad Hoc* working group on EM (EMWG), which creates a forum for Members to discuss and make recommendations on issues that could not be addressed in the EM workshops. However, the workplan, now with a more educational approach, continued with the planned workshops (EMS-02-01). A 4th Workshop took place in December 2022 to discuss matters related to technical standards and data collection priorities of an EMS (see EMS-04-01 and EMS-04-02). A 5th Workshop took place in Spring 2023 to discuss the financial considerations of an EMS (see EMS-05-01). The staff has compiled all the comments and concerns of the 4th and 5th workshop participants and revised its preliminary recommendations as necessary (SAC-14-INF-H). The 6th and final workshop of this workplan was held in December 2023, focusing on the logistical and data analysis and reporting standards of an EMS (see EMS-06-01). In parallel, the 1st meeting of the *Ad Hoc* EMWG was organized in Novermber 2023, where the best approach for implementing an EMS in the EPO to be adopted by the Commission was discussed. After deliberation, the EMWG decided to first focus on the preparation of a set of draft of interim minimum standards on EMS for the Commission's consideration and potential adoption. The first draft set of interim standards (WGEM-02-01), prepared in coordination with the IATTC staff, were presented by the EMWG co-chairs and discussed at the 2nd meeting of the *Ad Hoc* EMWG in April 2024. Based on the comments and suggested edits received, the draft interim standards, , will be further revised and considered by the 2nd meeting of the *Ad Hoc* EMWG (resumed), before the annual meeting of the Commission.

RECOMMENDATION

Without prejudging the future work of the EM working group as defined in its terms of reference, the Commission should adopt interim minimum standards for an EPO EMS, based on the draft prepared by the Working Group, and taking into consideration, as appropriate, the recommendations of the IATTC staff and the results of the six EM workshops (SAC-15 INF-Q).