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SCIENTIFIC ADVISORY COMMITTEE

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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.

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

In 2024, the staff is recommending the extension, for three additional years, of the provisions under Resolution C-21-04 with two outcomes that would trigger re-opening of management package related to future work improving the status determination of yellowfin tuna:

- 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 exploratory analysis estimated that the current fishing mortality is below the level corresponding to MSY and the spawning biomass is near the dynamic level corresponding to MSY for all scenarios except when the steepness of the stock-recruitment relationship h = 0.8 (**Figure 3**). In addition, the spawning biomass does not have a 10% or more probability of exceeding the limit point for any of the scenarios.

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: a) 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 b) 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 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 to strengthen the development of harvest strategies at IATTC. The staff and/or the SMD WG 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. 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. 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 include 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**).

[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.

- 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](C-23-06).

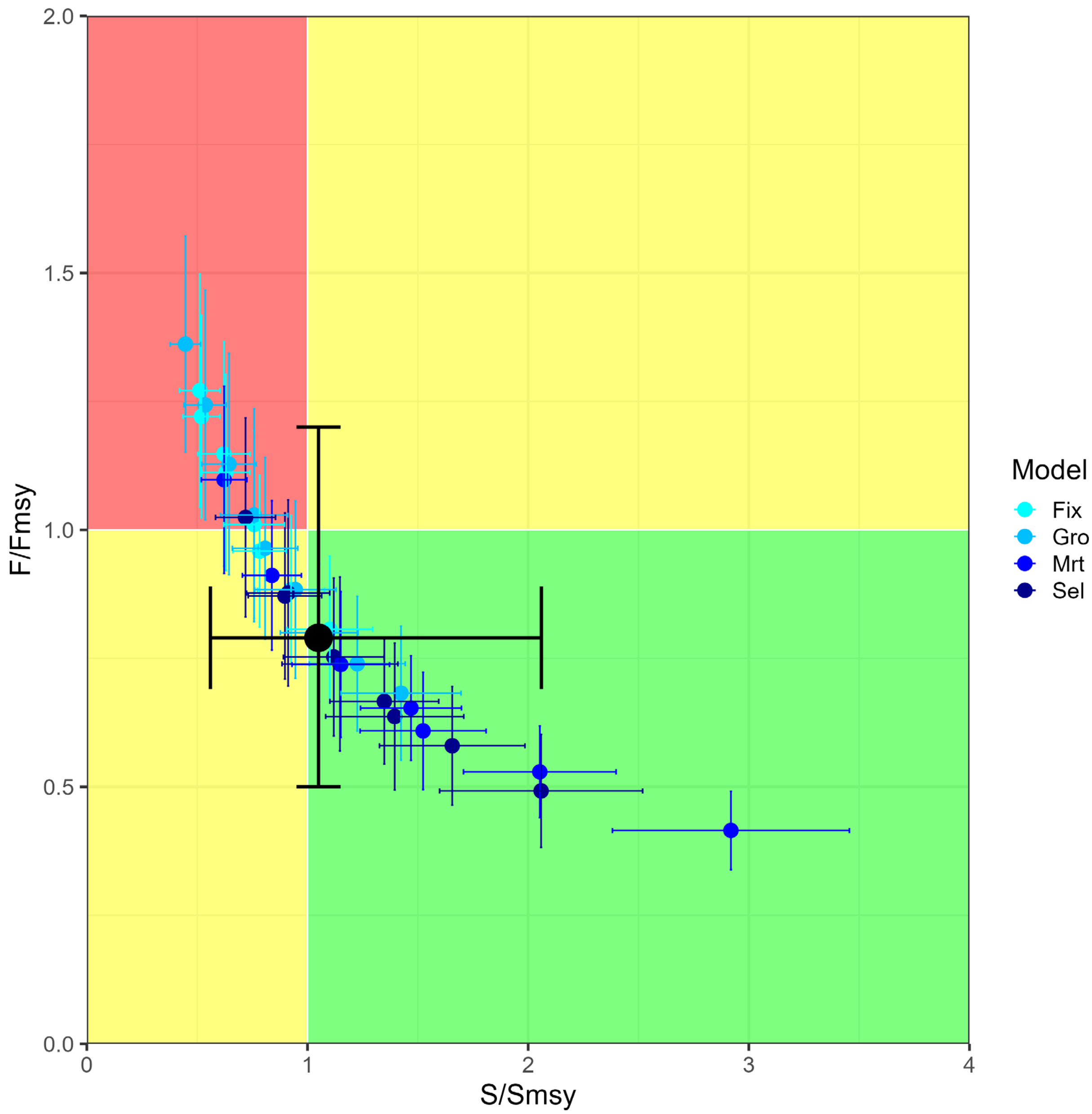

FIGURE 1a. Kobe plot of the most recent estimates of spawning biomass (*S*) and fishing mortality (*F*) relative to their target reference points (*SMSY_d* and *FMSY*) from the thirty-three reference models for bigeye tuna. Each dot is based on the average *F* over the most recent three years, 2021-2023, 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.

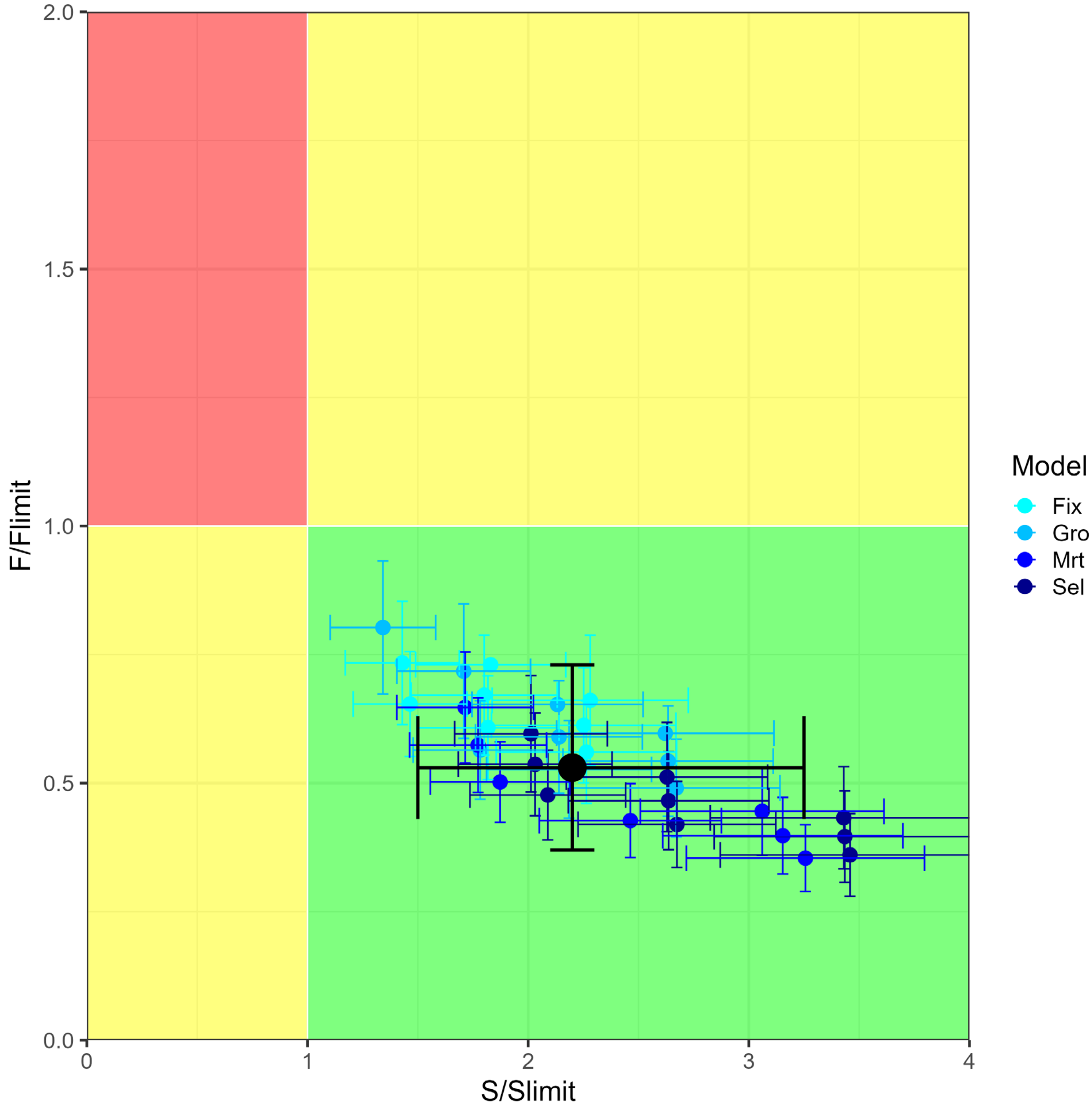

FIGURE 1b. Kobe plot of the most recent estimates of spawning biomass (*S*) and fishing mortality (*F*) relative to their limit reference points (*Slimit* and *Flimit*) from the thirty-three reference models for bigeye tuna. Each dot is based on the average *F* over the most recent three years, 2021-2023, 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

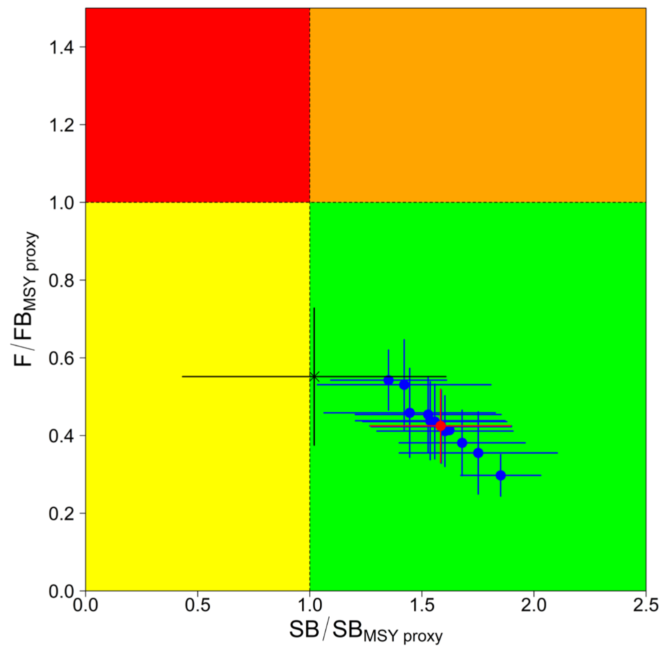

FIGURE 2. Kobe plot showing the most recent stock status estimates from all the models. The x-axis is SB_{currnt}/0.3*dynamic SB_0. Each dot is based on the average *F* over the most recent three years, 2021-2023, and the error bars represent the 80% confidence intervals of model estimates. The red dot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

Several uncertainties in the stock assessment remained including the spatial structure and fits to the composition data for the index and dolphin associated fishery that are assumed to have asymptotic selectivity. Therefore, substantial research was conducted to improve the assessment. Improvements were made to the modeling of spatial structure/stock structure, natural mortality, individual growth, and fisheries. However, uncertainty still remains in the spatial structure/stock structure and additional research is necessary

[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.

for the staff 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.

Based on the analyses above, the staff concludes that the yellowfin stock and the possible sub-stocks are likely to remain healthy and around the level corresponding to MSY, and are unlikely to have exceeded the limit reference point. Although, the scenario with the steepness of the stock-recruitment relationship h = 0.8 estimates that F is greater then F_{MSY} and S is less than S_{MSY}. Therefore, 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.

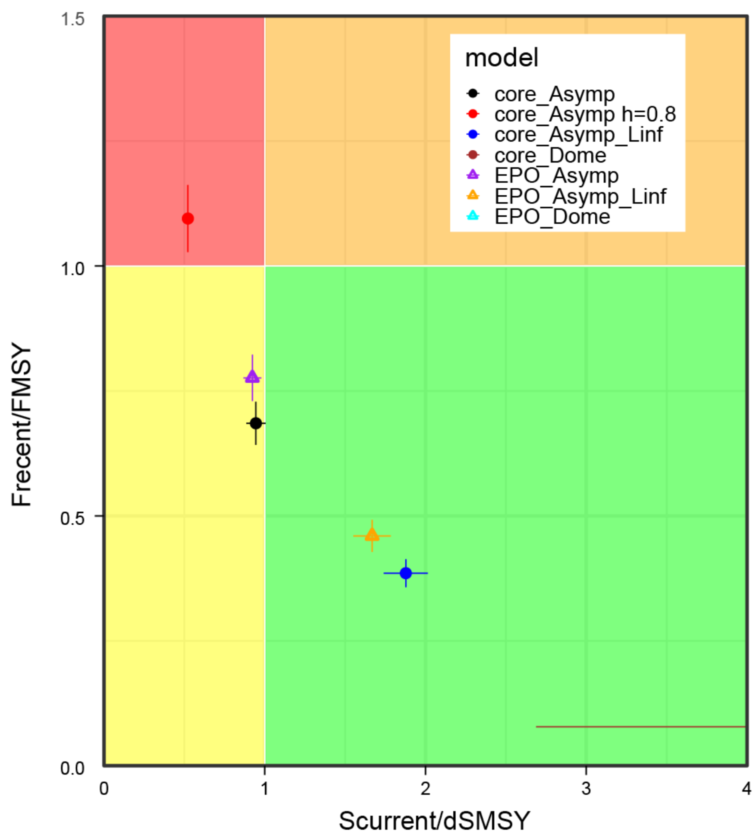

FIGURE 3a. Kobe plot of the most recent estimates of spawning biomass (*S*) and fishing mortality (*F*) relative to their target reference points (*SMSY_d* and *FMSY*) for the exploratory models for yellowfin tuna. Each dot is based on the average *F* over the most recent three years, 2021-2023, and the error bars represent the 80% confidence interval of model estimates. The uncertainty for the Asymp h=0.8 model was not possible to estimate and it was assumed to be the same as Asymp h=1. Models with dome shape selectivity estimate Scurrent/dSMSY>4 and are not shown.

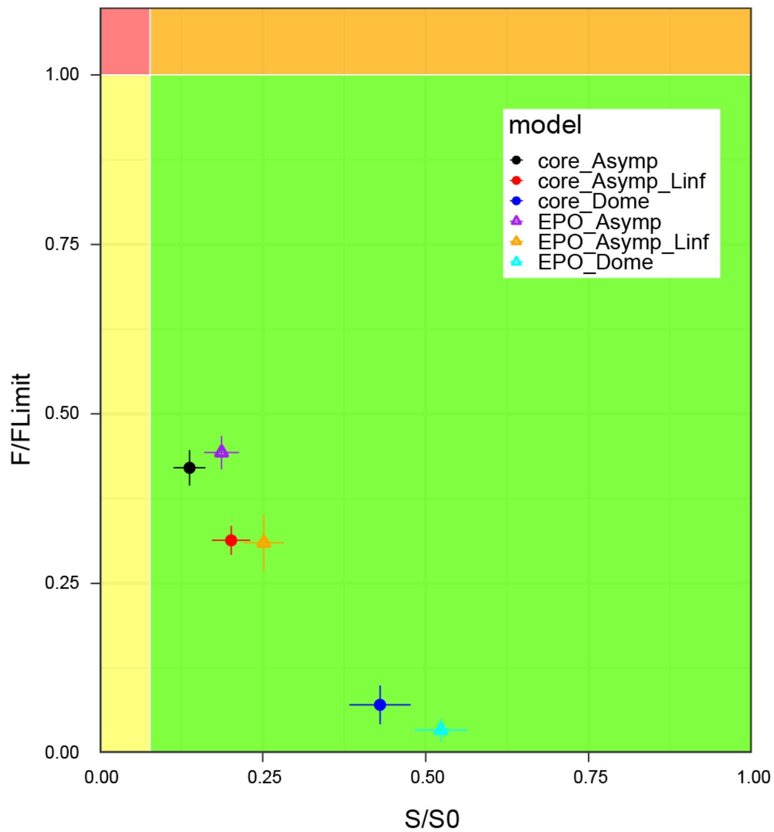

FIGURE 3b. Kobe plot of the most recent estimates of spawning biomass (*S*) and fishing mortality (*F*) relative to their limit reference points (*Slimit* and *Flimit*) for the exploratory models for yellowfin tuna. Each dot is based on the average *F* over the most recent three years, 2021-2023, and the error bars represent the 80% confidence interval of model estimates. The uncertainty for the Asymp h=0.8 model was not possible to estimate and it was assumed to be the same as Asymp h=1.

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).

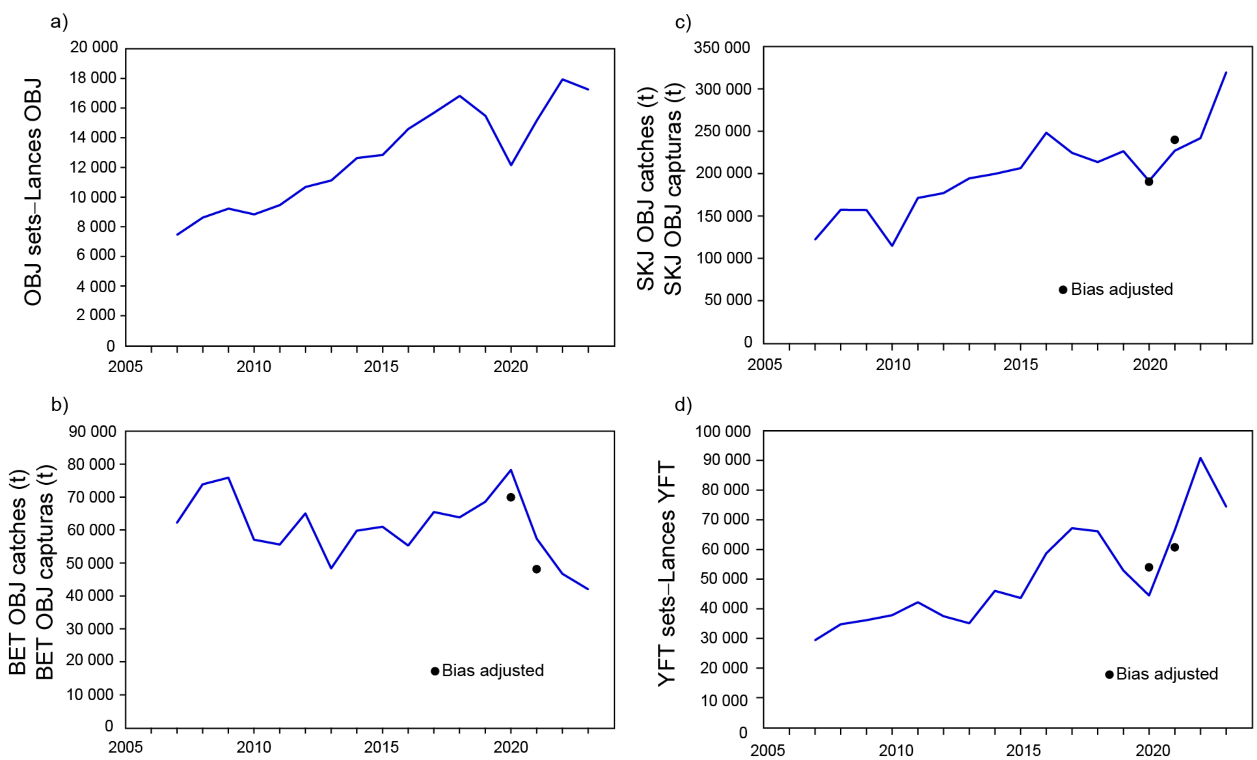

FIGURE 4. Number of sets on floating objects (a) and retained purse-seine catches for (b) bigeye, (c) skipjack and (d) yellowfin tuna (in metric tons). The black dots represent the catch estimates adjusted for bias caused by the effect of the COVID-19 pandemic during 2020 and 2021 (SAC-14 INF-D).

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).

[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).

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 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-14-INF-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)

[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.

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 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 ($SB_{2016\text{-}2019}/SB_{F=0}$) was 0.52 with a 10th to 90th 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 ($F_{2015\text{-}2018}/F_{MSY}$) was 0.24 with a 10th to 90th 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).

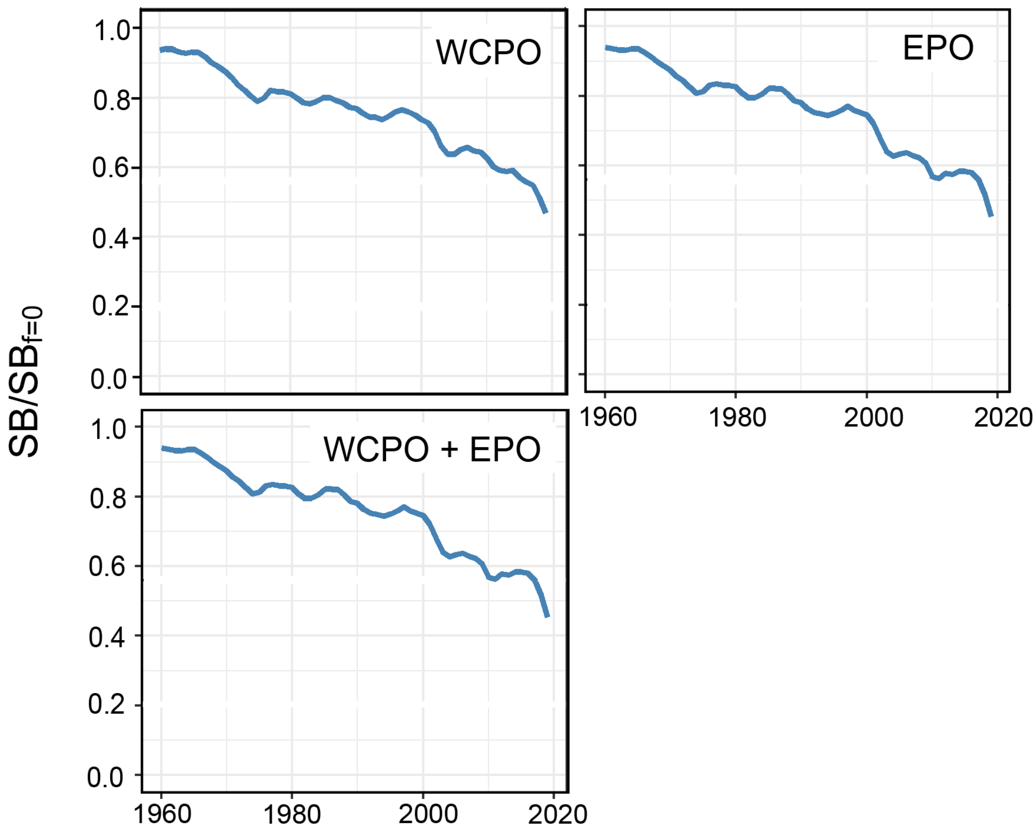

FIGURE 5. Estimated spawning biomass ratio for south Pacific albacore by management regions. This figure is modified from Figure 32 in SAC-13 INF-S.

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).

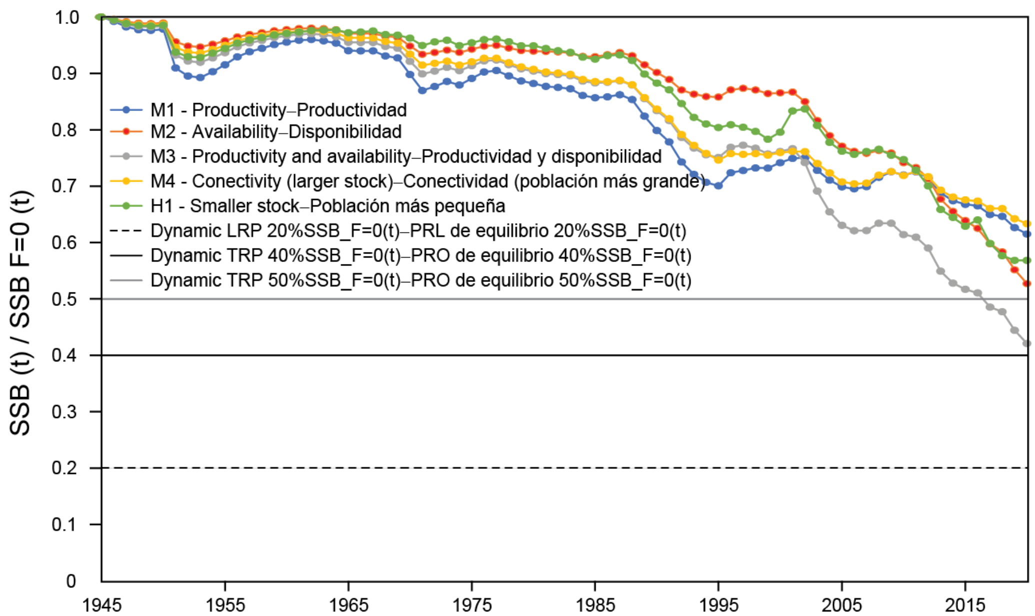

FIGURE S1. Ratio of the estimated spawning stock biomass and spawning stock biomass with no fishing (dynamic) for the models corresponding to the four hypotheses that explain the simultaneous increase in indices of abundance and catches and the model corresponding to the stock structure hypothesis H1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

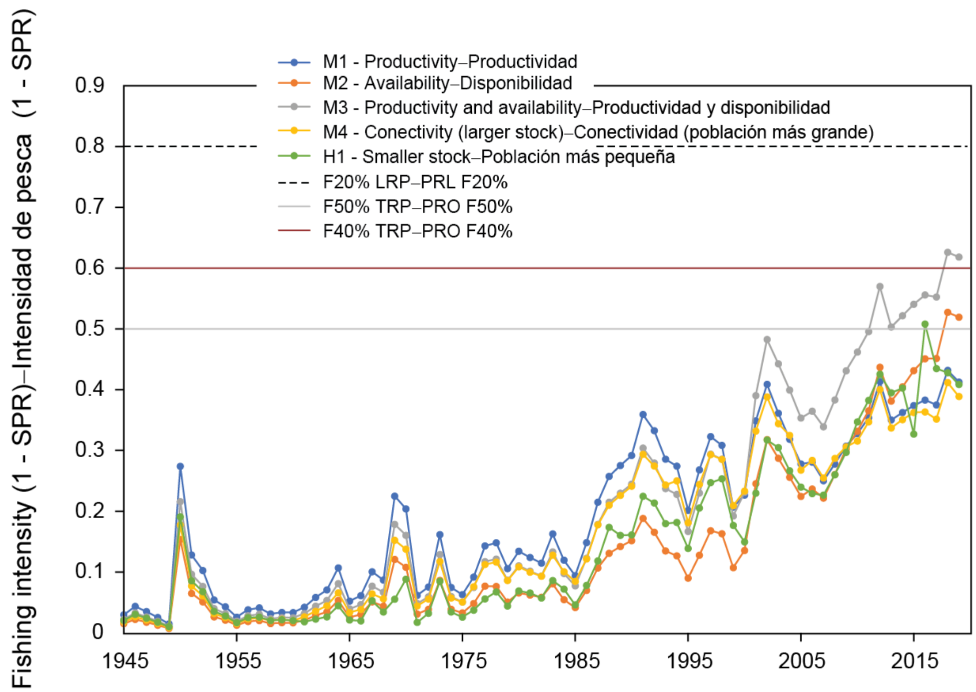

FIGURE S2. Fishing intensity (1-SPR) for the models corresponding to the four hypotheses that explain the simultaneous increase in indices of abundance and catches and the model corresponding to the stock structure hypothesis H1 (north boundary at 5° S). Note that M4 corresponds to the stock structure 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.