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SCIENTIFIC ADVISORY COMMITTEE

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DOCUMENT SAC-12-16

STAFF RECOMMENDATIONS FOR MANAGEMENT AND DATA COLLECTION, 2021

The staff's recommendations for conservation of non-target species and data collection will be added to this document shortly

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A. MANAGEMENT

1. TUNAS

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

Summary

The IATTC staff's 2020 risk analysis (SAC-11-08) for the tropical tuna fishery in the EPO indicates that the recent management measures (C-17-02), which expired at the end of 2020 and were extended for 2021 (C-20-06), will be adequate within the recommended 3-year management cycle (2022-2024), as long as the *status quo*[1] conditions are maintained. To ensure that the *status quo* is maintained, the staff reiterates

[1] Defined as the average fishing mortality (*F*) during the most recent 3-year period (2017-2019) of the bigeye and yellowfin assessments.

its previous recommendation for additional precautionary measures, for seven reasons:

1. If the pessimistic scenario from the bigeye risk analysis reflects the true state of nature, the probability that the limit reference points are being breached is 10%, or slightly higher.
2. There is a long-term, increasing trend in the number of floating-object sets (SAC-12-05), and in other FAD-related activities (*e.g.* deployments and encounters; FAD-05 INF-C), and a potential for increase in the future.
3. A direct link between fishing mortality of bigeye tuna and the number of floating-object sets has been established (FAD-05 INF-D).
4. Other stock status indicators for the floating-object fishery (SAC-12-05), such as catch per set and average length for all three tropical tuna species, also indicate a long-term, increasing trend in fishing mortality.
5. The increased number of floating-object sets, and potentially FADs at sea, may jeopardize the desired effect of the current measures for the purse-seine fishery (*i.e.* maintaining fishing mortality at or below the level corresponding to MSY).
6. Given the lack of a stock assessment, or an alternative harvest strategy which does not require a stock assessment, for skipjack, stock status will be uncertain if fishing mortality increases beyond the *status quo* levels.
7. Perpetual increases in the purse seine fisheries on FADs, coupled with the impacts of other fisheries and a changing climate, is likely to continue changing the structure and dynamics of the eastern tropical Pacific ecosystem (SAC-12-13).

In 2021, the staff maintains its 2020 recommendation that **additional precautionary measures are needed to ensure that the *status quo* fishing mortality will not be exceeded**. There are several types of management measures that could be considered (*e.g*. measures summarized in SAC-12 INF-B). The staff reviewed the advantages and disadvantages of each option, as well as potential solutions to mitigate or compensate the disadvantages (*e.g.* SAC-11 INF-M). The staff also weighed the management benefits against data and infrastructure shortcomings (*i.e.* for monitoring compliance) and concluded that an extended temporal closure, based on the previous year's number of OBJ sets (only to be implemented if the *status quo* is exceeded), combined with individual-vessel daily active FAD limits, would be the best option for maintaining the *status quo* and thus prevent an increase in *F* within the management cycle. The closure would be for both OBJ and unassociated (NOA) set types, and apply to all purse-seine vessels, except those that in recent years made mostly NOA sets (vessels that have made 75% or more of their sets on unassociated schools in each of 3 of the past 5 years (2015-2019)). In addition to the measures already established in C-17-02, and extended through C-20-06, these two additional precautionary measures would help control the two remaining aspects of the fishery that are not sufficiently constrained (number of OBJ sets and FADs at sea), which, if left unconstrained, will allow fishing mortality to increase (FAD-05 INF-D). The detailed rationale for these recommended measures along with the description of the methodology used to obtain the best scientific estimate (BSE) of the total number of FAD sets is provided in Document SAC-12-08.

The staff is recommending the adoption of the additional measures in a multi-year (3-year, 2022-2024) conservation package for tropical tuna in the EPO. A multi-year package is desirable because it would provide stability in the conservation measures, allow time to improve the stock assessments for bigeye and yellowfin, complete the workplan to develop an assessment for skipjack, improve the risk analysis for the tropical tuna before new management advice is needed, and to complete assessments for other stocks. In addition, a multi-year package would allow time for the Commission, its staff and stakeholders to focus on the ongoing Management Strategy Evaluation (MSE) process for tropical tunas.

1.1.1. Background

In 2020, the staff conducted new benchmark assessments for bigeye and yellowfin (SAC-11-06, SAC-11-07). These assessments represent a fundamental change from the staff's previous 'best assessment' approach: they are the basis for a 'risk analysis', in which a variety of reference models are used to represent plausible alternative assumptions about the biology of the fish, the productivity of the stocks, and/or the operation of the fisheries, thus effectively incorporating assessment uncertainty into the management advice as it is formulated.

The staff's 2020 risk analysis (SAC-11-08) for the tropical tuna fishery in the EPO indicated that the recent management measures (C-17-02, extended through 2021 with C-20-06) were adequate in the short term (see Document SAC-11-15). Although the staff did not recommend changes in the numbers of closure days, the staff recommended additional measures to prevent fishing mortality from increasing beyond the *status quo* levels due to precautionary reasons (see Document SAC-11 INF-M). From November 30 to December 4, 2020, the 95th Meeting of the IATTC produced no consensus on the adoption of additional precautionary measures recommended by the staff, which prevented the adoption of conservation and management measures for the tropical tunas in 2021 and beyond. An extraordinary 96th meeting of the Commission was held on December 22, 2020, and Resolution C-20-05 was adopted to extend the validity of the measures established in C-17-02 for the year of 2021, without adopting the additional precautionary measures recommended by the staff, to be recorded as Resolution C-20-06.

Three main goals were captured in C-20-05: 1) review the management measures for 2022 and beyond no later than the annual meeting of 2021, with a view to ensuring long-term conservation of fish stocks in the Convention Area; 2) continue working on the development of comprehensive measures including, but not limited to, the management of FADs based on scientific advice and the precautionary approach; 3) to engage intersessionally in order to facilitate agreement at an extraordinary meeting of the Commission to be held at the latest in June 2021, and likewise at the annual meeting of the Commission in August of 2021, on comprehensive additional measures for the sustainable management of the tropical tuna fishery based of scientific advice.

In 2021, the staff is putting forward the following scientific work for consideration at the intersessional work planned under C-20-05 to produce comprehensive additional measures for the sustainable use of the tropical tuna fishery in 2022 and beyond:

- The two 2020 **benchmark stock assessment reports**, for bigeye (SAC-11-06) and yellowfin (SAC-11-07), presenting the results from all reference models for each species (model fits, diagnostics, derived quantities and estimated parameters that define stock status in 2020);
- The 2020 **risk analysis** (SAC-11-08) specific for tropical tunas, using the methods described in SAC-11 INF-F, which assesses current stock status and quantifies the probability (risk) of exceeding target and limit reference points specified in the IATTC harvest control rule, as well as the expected consequences of alternative management measures in terms of closure days;
- **Stock status indicators** (SAC-12-05) for all three tropical tuna species (yellowfin, bigeye, and skipjack);
- Scientific evidence of a **positive and statistically significant relationship between fishing mortality (*F*) for bigeye and the number of floating-object sets** (FAD-05 INF-D);
- A **review of alternative conservation measures** (SAC-12 INF-B) which could be considered as additional measures for the tropical tuna in the EPO.
- A document on **additional precautionary measures for the floating object-fishery** (SAC-12-08), providing rationale for the staff's recommended measures and technical details for the operational rule associated with their implementation.

- The following **recommendations** by the staff for the conservation of tropical tunas which take into consideration all the above.

1.1.2. Rationale for staff recommendations

The technical rationale underlying the staff's recommendations for the conservation of tropical tunas after the current resolution (C-20-06) expires at the end of 2021 is summarized below.

1.1.2.a Stock status

Yellowfin and bigeye: The overall results of the risk analysis, expressed in terms of the probabilities of exceeding the reference points specified in the HCR, are presented in **Table A**.

Table A. Stock status[2] of yellowfin, bigeye, and skipjack tunas, expressed in terms of the probabilities[3] of exceeding the reference points specified in the HCR.

	Probability (%) of exceeding RP		
Target RP	**Yellowfin**	**Bigeye**	**Skipjack[4]**
$F_{cur}>F_{MSY}$	9	50	<50
$S_{cur}<S_{MSY}$	12	53	<53
Limit RP			
$F_{cur}>F_{LIMIT}$	0	5	<5
$S_{cur}<S_{LIMIT}$	0	6	<6

For **yellowfin**, the overall results of the risk analysis, which include all 48 reference models, indicate only a 9% probability that the fishing mortality corresponding to the maximum sustainable yield (F_{MSY}) has been exceeded[5] (**Figure 1a**). There is a 12% probability that the spawning stock biomass corresponding to the maximum sustainable yield (S_{MSY}) has been breached. The probability that the *F* and *S* limit reference points have been exceeded is zero.

For **bigeye**, the overall results of the risk analysis, which include 44[6] reference models, indicate a 50% probability that F_{MSY} has been exceeded and a 53% probability that S_{cur} is below S_{MSY} (**Figure 1b**). The probabilities that the *F* and *S* limit reference points have been exceeded are not negligible ($P(F_{cur}>F_{LIMIT})$ = 5%; $P(S_{cur}<S_{LIMIT})$ = 6%), but they are below the 10% threshold for triggering an action specified in Resolution C-16-02.

Skipjack: Due to the high and variable productivity of skipjack (*i.e.* annual recruitment is a large fraction of the total biomass, and is strongly environmentally driven), it is difficult to detect the effect of fishing on the population with standard fisheries data and stock assessment models. The last attempt at evaluating the stock status of skipjack in the EPO was by Maunder (2012), in which a variety of methods were

[2] Defined as the spawning biomass (*S*) at the start of 2020 or the average fishing mortality (*F*) during the most recent three years (2017-2019).

[3] These results are based on the 'current' status, and thus relate to fleet capacity during 2017-2019. As of 10 May 2020, the capacity of the purse-seine fleet operating in the EPO, 262,213 cubic meters (m^3) of well volume, is 1% less than the "current" (2017-2019) average of 223,923 m^3. If this reduction is taken into account, the results for bigeye change slightly: $P(F_{cur}>F_{MSY})$ = 0.49. Adjustments for capacity are not available for stock status based on spawning biomass.

[4] A conventional stock assessment is not available for skipjack. Results inferred from PSA analysis indicate that the status of skipjack should be more optimistic than bigeye (see skipjack section below). Therefore, the probability of exceeding the reference points for skipjack should be lower than for bigeye.

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

[6] Four of the 48 models did not converge for bigeye.

applied (fishery and biological indicators, analysis of tagging data, a length-structured stock assessment model, and a Spatial Ecosystem and Population Dynamic Model (SEAPODYM)). The key results of the assessment were that: 1) there is uncertainty about the status of skipjack in the EPO; 2) there may be spatial difference in the status of the stock among regions; 3) there is no evidence indicating a credible risk to the skipjack stock(s). One of the major uncertainties is to whether the catch per unit effort (CPUE) of the purse-seine fisheries is a reliable index of abundance for skipjack. The CPUE data are problematic because it is difficult to identify the appropriate unit of effort, in particular when the fish are associated with fish-aggregating devices (FADs). Without greatly improved age-composition and tag-recovery data, skipjack in the EPO will remain particularly difficult to assess, thus making any evaluation relative to traditional reference points (*e.g*. MSY-based) a challenge.

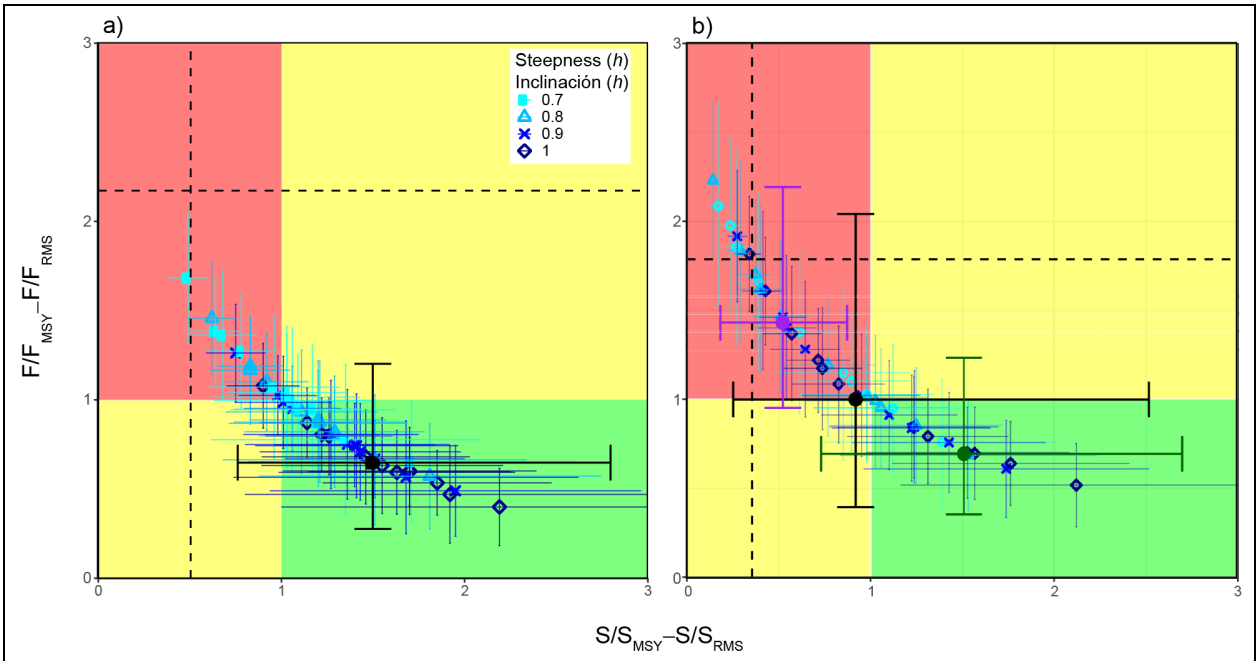

FIGURE 1. Kobe (phase) plot showing the current estimates of spawning stock size (*S*) and fishing mortality (*F*) of **(a) yellowfin** and **(b) bigeye tuna** relative to their MSY reference points. The colored panels are separated by the target reference points (S_{MSY} and F_{MSY}) and limit reference points (dashed lines). The center point for each model indicates the current stock status, based on the average fishing mortality (*F*) over the last three years. The solid black circle represents all models combined. For bigeye (b), the purple and green solid circles represent, respectively, the stock status for the 'pessimistic' and 'optimistic' states related to the bimodal pattern in the risk analysis (see section 1.1.2.c). The lines around each estimate represent its approximate 95% confidence interval.

In 2021, the staff is putting forward a new methodology and workplan to develop a stock assessment for skipjack in the EPO (see Document SAC-12-06). The new spatio-temporal approach is based on the recently available tagging data obtained by the IATTC multi-year Regional Tuna Tagging Program in the EPO (RTTP-EPO 2019-2020, Project E.4.a). The workplan proposes to present preliminary results at the 2022 SAC, an exploratory model at the 2023 SAC, and a benchmark assessment at the 2024 SAC. In addition to these stock assessment developments, an MSE workplan is already ongoing at IATTC (see recent Workshops) funded from 2021 to 2023, with an initial focus on bigeye and moving to the other tropical tuna towards the end of the current plan.

Productivity and Susceptibility Analysis (PSA; Duffy *et al*. 2019) for the tropical tuna fishery in the EPO

indicated that skipjack and bigeye have about the same susceptibility to purse-seine fishing gear, and that skipjack is more productive than bigeye. Taking the 2020 risk analysis results for bigeye (SAC-11-08) as a basis to determine the status of the skipjack stock in the EPO, the staff infers the following (**Table A**):

1. There is less than 50% probability that F_{MSY} has been exceeded ($P(F>F_{MSY})<50\%$), and a less than 53% probability that S_{cur} is below S_{MSY} ($P(S<S_{MSY})<53\%$),
2. There is less than 5% probability that F_{LIMIT} has been exceeded ($P(F>F_{LIMIT})<5\%$), and less than 6% probability that S_{LIMIT} has been breached ($P(S<S_{LIMIT})<6\%$).

While the skipjack assessment workplan is underway, the staff continues to consider that inferences about the stock status of skipjack based upon the Productivity and Susceptibility Analysis (PSA) rationale remain valid on an *interim* basis. That would be the case if management measures are adopted to ensure that the bigeye stock will remain in a healthy status. The linkage regarding the PSA related inferences between SKJ and BET must not be broken (*e.g.* due to management changes or fisher behavior) and additional precautionary measures are needed to prevent fishing mortality from increasing beyond the *status quo* conditions (see section 1.1.2.c).

As a supplementary means to monitor the stock status of tropical tunas, the staff has used stock status indicators (SSIs) to compare current and historical values of these indicators. The indicator values for 2020 were impacted by the COVID-19 pandemic, and therefore cannot be interpreted in the context of long-term trends. For skipjack in particular, the SSIs show recent catches at high historical levels, while catch per set and the average size of the fish in the catch are at low historical levels (SAC-12-05). The continuation of these recent trends raises concerns about increasing exploitation rates, which are mainly due to the increase in the number of floating-object sets (FAD-05 INF-D), and their future impact on the sustainability of the skipjack stock.

1.1.2.b Duration of the temporal closure of the purse-seine fishery

At the core of the conservation measures for tropical tunas in the EPO is the temporal closure of the purse-seine fishery, which currently lasts 72 days per year, either during July-October or November-January (Resolution C-17-02). In order to evaluate the consequences of alternative management actions, specifically through different durations of the closure, the staff conducted a risk analysis (SAC-11-08), which quantifies the probability (risk) of exceeding the reference points specified in the harvest control rules for tropical tunas in the EPO established in Resolution C-16-02.

Paragraph 3a of Resolution C-16-02 specifies that "***the scientific recommendations*** *for establishing management measures in the fisheries for tropical tunas, such as closures, which can be established for multiple years,* ***shall attempt to prevent the fishing mortality rate (F) from exceeding*** *the best estimate of* ***the rate corresponding to the maximum sustainable yield (F_{MSY}) for the species that requires the strictest management***."

The staff's determination about whether the duration of the closure needs to change is based on the overall results[7] of the risk analysis for bigeye, which requires the strictest management of the three species. The overall results (Figure 2) take into account 44 reference models (alternative hypotheses) and their assigned relative weights in the combined distributions for the management parameters.

Assuming that the *status quo* conditions are not exceeded in the next management cycle, in 2021 the staff is not recommending changes in the number of closure days, for three reasons.

1. The overall results of the 2020 risk analysis for bigeye tuna indicate a 50% probability that F_{MSY}

[7] The "overall results" of the risk analysis include the results of all the models (hypotheses) used in the analysis and are obtained by computing the weighted average of the combined probability distributions of the management quantities.

has been exceeded, and a 53% probability that S_{cur} is below S_{MSY}. Although Resolution C-16-02 does not specify the acceptable level of probability of exceeding the target reference points, these probabilities are at about a reasonable arbitrary reference level of 50%, considering that, at F_{MSY}, S will fluctuate around the target reference point (S_{MSY}) due to interannual recruitment fluctuations. F will also fluctuate around the target reference point (F_{MSY}) under the days of closure management due to interannual fluctuations in catchability and distribution of purse-seine effort among set types.

2. The overall results of the risk analysis for bigeye indicate that, although the probabilities that the F and S limit reference points have been exceeded are not negligible ($P(F_{cur}>F_{LIMIT})$ = 5%; $P(S_{cur}<S_{LIMIT})$ = 6%), they are below the 10% threshold for triggering an action specified in Resolution C-16-02.

3. The COVID-19 pandemic has impacted the operations of the tropical tuna fishery in the EPO in 2020. In particular, there was an observed 9% decrease in active fishing capacity operating in the EPO, along with a 28% decrease in the total number of floating-object sets compared to the *status quo* levels. For this reason, it is most likely that fishing mortality in 2020 has not exceed the *status quo* levels and the management measures adopted under C-20-06 for 2021 were adequate. Therefore, advice presented in 2020 on the duration of the temporal closure based on the overall results of the risk analysis do not need to be revised.

1.1.2.c Additional precautionary measures to prevent further increases in fishing mortality

As mentioned above, **assuming that the *status quo* conditions are maintained in the next management**

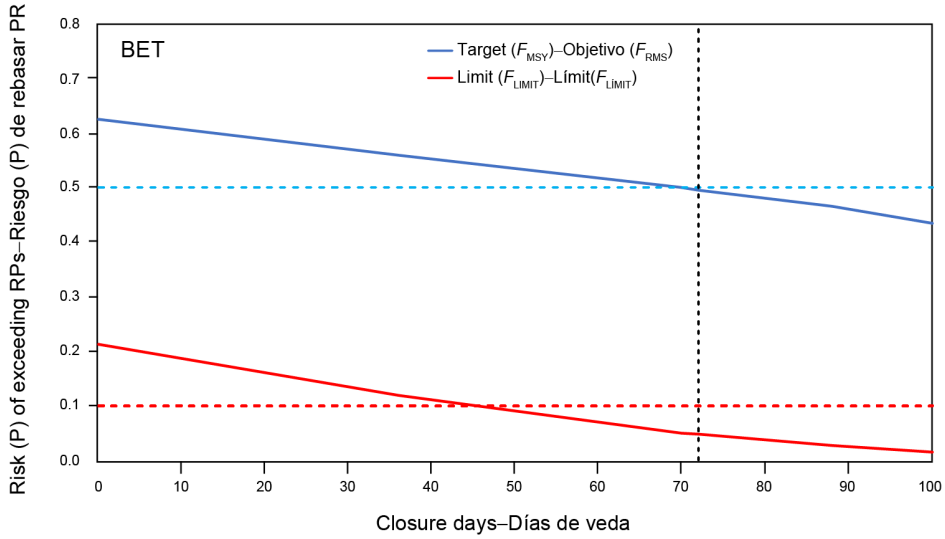

FIGURE 2. Risk curves for bigeye, showing the probability of exceeding the target (solid blue line) and limit (solid red line) F reference points (RPs) for different durations of the temporal closure. The blue dashed line represents an arbitrary 50% probability of exceeding the target, and the red dashed line a 10% probability of exceeding the limit, specified in the harvest control rule. The dashed black line indicates the current 72-day closure.

cycle, the staff based its determination that no changes are needed in the current duration of the temporal closure of the purse-seine fishery on the overall results of the 2020 risk analysis for bigeye. However, the distribution of the management quantities for bigeye is bimodal (Figures 7-10, SAC-11-08), with marked differences in the management quantities estimated by two distinct groups of models (the

'pessimistic' and 'optimistic' states), unlike the unimodal distribution of yellowfin (Figures 1-4, SAC-11-08). This bimodal pattern indicates that the stock is either well below or well above the target reference points (Figure 14, SAC-11-08), and the staff urges caution in interpreting these results for management purposes. The duration of the closure is based on the average of all models, pessimistic and optimistic, but the possibility that either the pessimistic or the optimistic scenario reflects reality needs to be considered. In particular, if the pessimistic scenario is correct, the probability of exceeding the limit reference points with the current closure is 10%, or slightly higher (Figure 15, SAC-11-08).

The staff also considered stock status indicators (SSIs; SAC-11-05) and floating-object fishery indicators (FAD-05-INF-A, FAD-05 INF-C) in the formulation of its management advice for tropical tunas. Based on this information, the staff is concerned with the strong potential for fishing mortality (*F*) increases beyond the *status quo* levels in the near furture, in particular that associated with the floating-object fishery. To ensure that the *status quo* is maintained, the staff reiterates its previous recommendation for additional precautionary measures, for the following seven reasons:

1. If the pessimistic scenario from the bigeye risk analysis reflects the true state of nature, the probability that the limit reference points are being breached is 10%, or slightly higher.
2. There is a long-term, increasing trend in the number of floating-object sets (SAC-12-05), and in other FAD-related activities (*e.g.* deployments and encounters; FAD-05 INF-C), and a potential for increase in the future.
3. A direct link between fishing mortality of bigeye tuna and the number of floating-object sets has been established (FAD-05 INF-D).
4. Other stock status indicators for the floating-object fishery (SAC-12-05), such as catch per set and average length for all three tropical tuna species, also indicate a long-term, increasing trend in fishing mortality.
5. The increased number of floating-object sets, and potentially FADs at sea, may jeopardize the desired effect of the current measures for the purse-seine fishery (*i.e.* maintaining fishing mortality at or below the level corresponding to MSY).
6. Given the lack of a stock assessment, or an alternative harvest strategy which does not require a stock assessment, for skipjack, stock status will be uncertain if fishing mortality increases beyond the *status quo* levels.
7. Perpetual increases in the purse seine fisheries on FADs, coupled with the impacts of other fisheries and a changing climate, is likely to continue changing the structure and dynamics of the eastern tropical Pacific ecosystem (SAC-12-13).

In 2021, the staff maintains its 2020 recommendation (SAC-11-15) that additional precautionary measures are needed to ensure that the *status quo* fishing mortality is not exceeded. There are several types of management measures that could be considered (*e.g*. measures summarized in SAC-12 INF-B). The staff reviewed the advantages and disadvantages of each option, as well as potential solutions to mitigate or compensate the disadvantages (*e.g.* SAC-11 INF-M). The staff also weighed the management benefits against data and infrastructure shortcomings (*i.e.* for monitoring and compliance) and concluded that an extended temporal closure, based on the previous year's number of OBJ sets (only if the *status quo* is exceeded), combined with individual-vessel daily active FAD limits, would be the best option for maintaining the *status quo* and thus prevent an increase in *F* within the management cycle (SAC-12-08). The closure would be for both OBJ and unassociated (NOA) set types, and apply to all purse-seine vessels, except those that in recent years made mostly NOA sets (vessels that have made 75% or more of their sets on unassociated schools in each of 3 of the past 5 years (2015-2019)). In addition to the measures already established in C-17-02, and extended through C-20-06, these two additional precautionary measures would help control the two remaining aspects of the fishery that are not sufficiently constrained (OBJ sets and

FADs at sea), which, if left unconstrained, might allow fishing mortality to increase. The detailed rationale for these recommended measures along with the description of the methodology used to obtain the best scientific estimate (BSE) of the total number of FAD sets in provided in Document SAC-12-08.

1.1.2.d Triennial management cycle

SAC-10 Recommendation 1.b states:

> *"The SAC recognizes that the current schedule of annual benchmark or update assessments of bigeye and yellowfin tunas makes it difficult for the IATTC staff to perform the necessary research to improve those assessments, as well as to develop assessments for other stocks requested by the Commission. Indicators are available every year to make any needed adjustments.*
>
> *Therefore, the SAC recommends that the IATTC staff develop, and present to the SAC, an alternative assessment schedule, with benchmark or update assessments scheduled in coordination with the management schedule, and indicator analyses in the intervening years to assess whether additional management measures are required."*

In 2021, the staff is recommending a triennial management cycle (2022-2024) for the new measures, for the following reasons:

a. Conducting annual risk analyses is an inefficient use of staff time; a three-year management cycle would increase the time available to improve existing assessments and the risk analysis, develop assessments for other stocks, in particular, but not limited to skipjack, and particularly to focus on the ongoing tropical tuna MSE process;
b. The staff has developed an operational rule allowing for adjustments on the duration of the temporal closure within the management cycle, if required, based on a best scientific estimate (BSE) of the total number of floating-object sets in the previous year (see Document SAC-12-08);
c. Major changes in the management recommendations are unlikely within the management cycle, since this would require substantial new data, research and improvements in the assessments and risk analysis.
d. The Scientific Advisory Committee supports transitioning to a multi-year assessment cycle.

1.1.3. Management advice

Based on the rationale presented above, in 2021 the staff makes the following recommendations for the conservation of tropical tunas:

RECOMMENDATIONS:

1. Establish a triennial management cycle for the tropical tuna fishery in the EPO (2022-2024).
2. Maintain the provisions of the current resolution (C-20-06), except paragraph 8, which will be modified per item 4.
3. Within the management cycle (2022-2024), adopt the operational rule described in SAC-12-08 to implement, if needed, an extension of the temporal closure for both floating-object and unassociated set types, to apply to all purse-seine vessels, except those that historically made mostly unassociated sets (vessels that have made 75% or more of their sets on unassociated schools in each of 3 of the past 5 years (2015-2019)).
4. Establish individual-vessel limits (IVL) on the daily number of active FADs, computed independently for each vessel from its active FAD data for 2018-2019[8].

[8] Data prior to 2018 have not been provided to the IATTC staff.

1.1.4. Future research

Future research should focus on: 1) continuing to improve the risk analysis and the stock assessment models, which also involves their data inputs, 2) develop an assessment for skipjack tuna based on recently collected tagging data, and 3) evaluate management strategies that are shown to be robust to the main uncertainties, including the bigeye bimodality, using MSE.

1.1.4.a Improving the risk analysis and the stock assessment models

Matters that require investigation and/or improvement include the bimodal pattern in the risk analysis of bigeye, more objective and transparent scoring in the risk analysis, continuing the collaborative work to improve the longline indices of abundance, the ability to estimate yellowfin absolute abundance, the two-stock hypothesis for yellowfin, estimates of growth, selectivity, and natural mortality through tagging data, and a stronger involvement of industry stakeholders in the tagging program (*e.g.* facilitating access to tagging operations in offshore areas, aggregations on FADs, etc.). Implementation of Close Kin Mark Recapture should be evaluated as a way of resolving uncertainties in the stock assessments and be implemented as soon as practical if appropriate.

1.1.4.b Develop an assessment for skipjack tuna based on recently collected tagging data

A new tag-based stock assessment as outlined in SAC-12-06 will be developed for skipjack. The goal is to use this assessment to provide explicit management advice for skipjack.

1.1.4.c Management Strategy Evaluation

The staff acknowledges that there may always be unresolved issues in knowledge, their impact on taking appropriate management action, and the inherent limits of modelling complex and changing natural systems and their fisheries. Management Strategy Evaluation for tropical tunas will focus on including additional sources of uncertainty (implementation uncertainty, management/institutional uncertainty, sampling uncertainty, projection uncertainty) and refining elements of the current strategy, along with alternatives (types and estimation of reference points, specificity of the current HCR, performance metrics, etc.), that are important for evaluating the robustness of the management advice and the likelihood of strategies achieving desired management objectives. The models and their weighting developed in the risk analysis could be used to inform the development of operating (simulation) models for MSE. The MSE process could be used to evaluate setting management actions based on simpler models or empirical HCRs that rely on trends in data, as an alternative or complement to the recent (best-assessment) or current (risk analysis) approaches while both data and stock assessments are improved. An MSE workplan is already ongoing at IATTC (see recent Workshops) funded from 2021 to 2023, with an initial focus on bigeye and moving to the other tropical tuna towards the end of the current plan.

RECOMMENDATIONS:

In collaboration with CPCs and relevant stakeholders:

1. Continue improving stock assessments and risk analysis for tropical tunas.
2. Develop an assessment for skipjack tuna based on recently collected tagging data following SAC-12-08.
3. Continue support for MSE for tropical tunas, following guidelines from C-16-02 and C-19-07.

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 new benchmark assessment of the species in 2020.

Projections into the future, in which Resolution C-18-01 was extended, predict that, even under a low-recruitment scenario up to the first rebuilding target, the stock will rebuild to the interim rebuilding targets. The optimistic results are due to the above-average 2016 recruitment, which is now better estimated in the stock assessment. Projections predict that catch could be increased while still maintaining a high probability of meeting the rebuilding targets. However, it should be noted that the projections assume that recruitment reverts to average after the first rebuilding target is met.

The assessment includes several catch scenarios, with different increases in catch and different distributions of the catch between small and large fish, which follow the harvest strategy prepared by the joint t-RFMO working group. In most scenarios, catching larger fish increases the total catch in weight for a given level of rebuilding. The staff considers that the most precautionary approach is to maintain the catch limits and other provisions of Resolution C-18-01, and extended by C-20-02 for 2021, through 2022; however, some increases are possible without posing a danger to the rebuilding of the stock, as described in Resolution C-18-02. If one of the scenarios is chosen as the basis for future catch limits, the choice should take into account both the desired rebuilding rate and the distribution of catch between small and large bluefin.

RECOMMENDATIONS:

1. Extend the provisions of Resolution C-18-01, and extended by C-20-02, through 2022.
2. Increased catches based on the scenarios analyzed are possible under the harvest strategy prepared by the joint tRFMO working group. The choice of catch scenario should take into account the desired rebuilding rate and the distribution of catch between small and large bluefin.

1.1. North Pacific albacore tuna

A benchmark stock assessment was completed in 2020 by the Albacore Working Group (ALBWG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC). The spawning biomass was at 46% of the dynamic virgin spawning biomass in 2018, the last year in the assessment, and the fishing mortality during 2015-2017 ($F_{2015\text{-}2017}$) is below the level corresponding to the maximum sustainable yield ($F_{2015\text{-}2017}/F_{MSY}$ =0.60) Ten-year projections with either constant catch (2013-2017 average, 69,000 t) or constant fishing mortality (at the $F_{2015\text{-}2017}$ level) predicted an increase in the female spawning biomass. The Working Group noted that there was no evidence that fishing had reduced the spawning stock biomass below thresholds associated with most potential biomass-based reference points. The Working Group concluded that the north Pacific albacore stock is healthy, and that the productivity was sufficient to sustain recent exploitation levels, assuming average historical recruitment in both the short and the long term.

The Working Group finished the Management Strategy Evaluation (MSE) for the North Pacific albacore stock. The first round of the MSE was reported in March 2019 (ISC/19/ANNEX/06), and a second round was completed during 2020. In the context of the MSE process, management and conservation objectives were agreed[9] and endorsed by the Commission in 2020. During 2021, several regional workshops took place to present and discuss the results of the MSE to the stakeholders. Those discussions will be summarized by the

[9] The following management objectives for North Pacific albacore tuna were developed in the context of the MSE process, given the overarching objective of maintaining the viability and sustainability of the current North Pacific albacore stock and fisheries, agreed upon in the process:

- Maintain spawning biomass above the limit reference point.
- Maintain total biomass, with reasonable variability, around the historical average depletion of total biomass.
- Maintain harvest ratios by fishery (fraction of fishing impact with respect to SSB) at historical average.
- Maintain catches by fishery above average historical catch.
- If a change in total allowable effort and/or total allowable catch occurs, the rate of change should be relatively gradual.
- Maintain *F* at the target value with reasonable variability.

ALBWG in its next meeting to be held at the end of May 2021.

The current conservation and management measures for North Pacific albacore (IATTC Resolutions C-05-02, C-13-03 and C-18-03; also WCPFC CMM 2005-03) are based on maintaining the fishing effort below the 2002-2004 levels. The effort levels in eastern Pacific Ocean for 2017-2019 are 72% and 69% of those in 2002-2004, for vessel-days and number of vessels, respectively.

Given the relative stability in the biomass and fishing mortality in recent years, and in view of the MSE, the staff considers that the current resolutions should be continued. The staff also recommends that CPCs use the results of the concluded MSE process to establish reference points and a harvest control rule (HCR) for North Pacific albacore tuna.

RECOMMENDATIONS:

1. CPCs should continue to implement Resolutions C-05-02, C-13-03, C-18-03, presently in force.
2. CPCs should use the results of the concluded MSE process to establish reference points and a harvest control rule (HCR) for North Pacific albacore tuna.