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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 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

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

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 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.

[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.

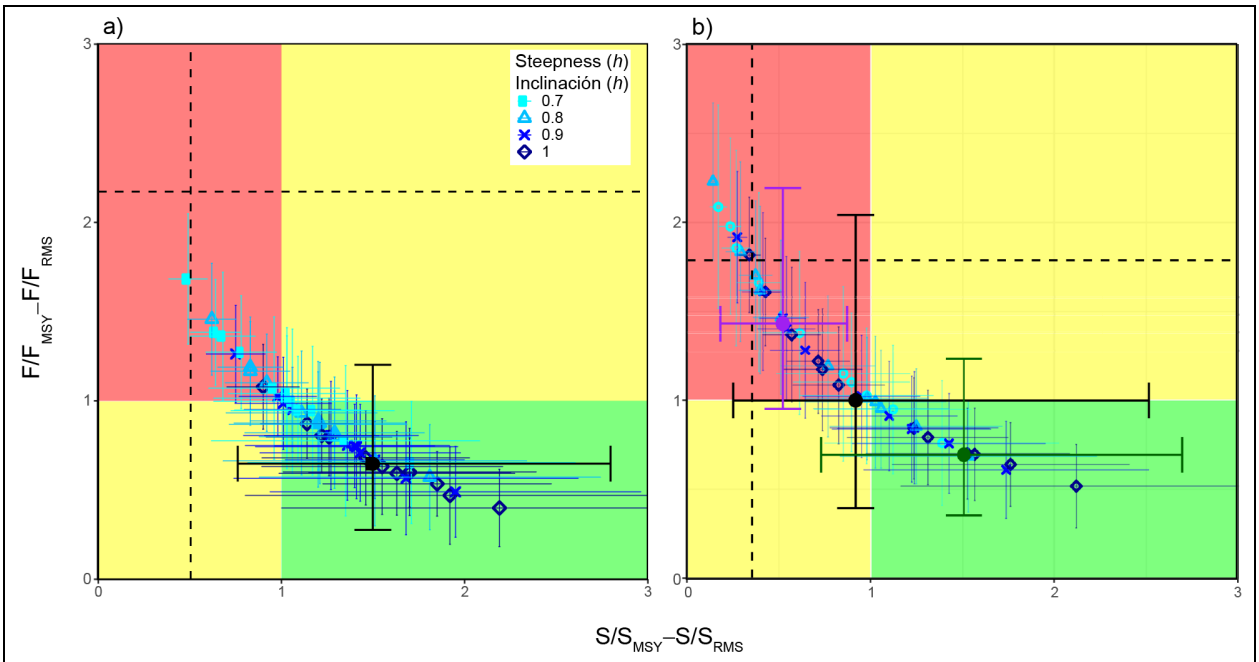

FIGURE 1. Kobe (phase) plot showing the current estimates of spawning stock size (*S*) and fishing mortality (*F*) of **(a) yellowfin** and **(b) bigeye tuna** relative to their MSY reference points. The colored panels are separated by the target reference points (S_{MSY} and F_{MSY}) and limit reference 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} 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

[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.

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 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).

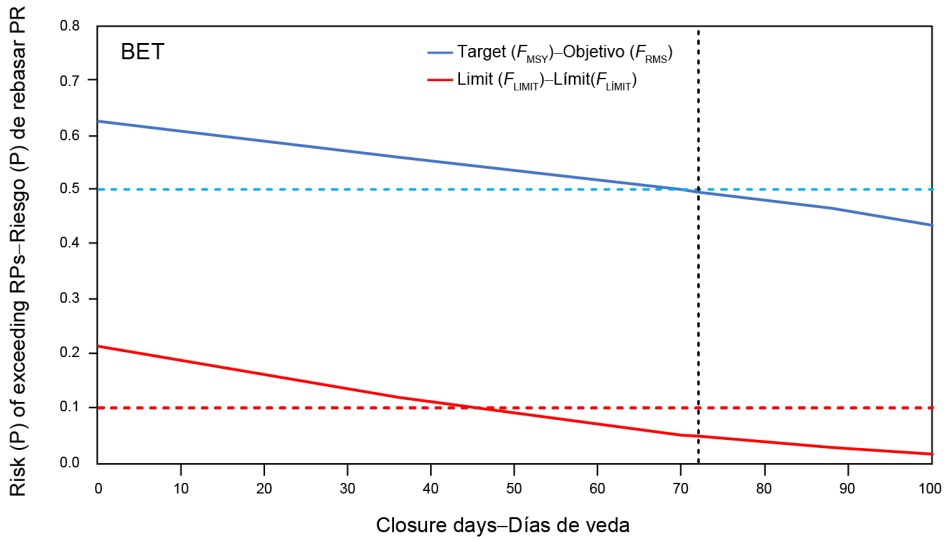

FIGURE 2. Risk curves for bigeye, showing the probability of exceeding the target (solid blue line) and limit (solid red line) *F* reference points (RPs) for different durations of the temporal closure. The blue dashed line represents an arbitrary 50% probability of exceeding the target, and the red 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.

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].

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.

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

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.

1.3. 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 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.

[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.

2. NON-TARGET SPECIES

2.1. Silky sharks

The indices for large silky sharks, based on data from the purse-seine fishery on floating objects, have been updated through 2020 for the north and south EPO (BYC-10 INF-C). Previous analyses (SAC-08-08a(i)) identified a correlation between north EPO indices, particularly those for small and medium silky sharks, and interannual variability in oceanographic conditions, and thus the indices for those size categories, and for all silky sharks, were not updated because of concerns about bias. Because of recent increases in the live release of silky sharks, two sets of indices for large silky sharks were computed, one including live release data and the other not. Taken together, the two sets of indices likely bracket the trend that would have resulted in both the north and south EPO if "finning"[10], shark handling, and data recording practices had continued unchanged since 1994. The real trend is considered to be closer to the index based on dead + live releases because sharks recorded as released alive in recent years would probably have been recorded as dead previously, and thus the dead + live release is likely a more consistent indicator. The terminal point of these indices suggests a relatively stable abundance level for over a decade, with the 2020 values at, or slightly below, the 2019 values, and thus no changes to management measures are recommended. However, the stock status is uncertain, and an assessment has not been possible due to the paucity of data, especially for the longline fleets of coastal nations, which are believed to have the greatest impact on the stock (SAC-05-11a). The staff has made recommendations for data collection as part of its work plan for addressing the stock assessments of sharks (see Section 4.1).

Paragraph 7 of Resolution C-19-05 requires CPCs to implement a three-month prohibition on the use of steel leaders in certain longline fisheries, and paragraph 8 requires the IATTC staff to present, at the SAC meeting in 2021, an analysis of the available data, including the shark fishery sampling program in Central America, with recommendations for improvement of the resolution, including adjustment of the prohibition period in paragraph 7. Resolution C-19-05 also directs the staff to consider the efficacy of the limits established by the resolution and if necessary, recommend revisions. However, the improved species-level catch and composition data required for this analysis are not yet fully available, so the staff could not perform these analyses for SAC-12.

Such persisting data limitations, among others, which apply to both target and non-target species, motivated the staff to review current Resolutions pertaining to data provision that underpin all of its research, in particular, the Resolution on data provision, C-03-05. To this end, the staff has prepared Document SAC-12-09 (see Section 3) with the overarching goal of creating a revised Resolution C-03-05, which will improve the scope and quality of data provided for science, conservation and management, of both target and non-target species.

As part of additional steps taken by the staff to address data limitations, significant progress has been made in recent years in developing the foundations for a sampling program for shark fisheries in Central America (see Section 4.1, SAC-11-13). Made possible through recent funds provided by the European Union, the sampling program in Central America has recently been extended to 2021. The results will support a proposal to be presented at the 2021 annual meeting of the Commission to establish a long term sampling program in Central America. If the sampling design of the current sampling program is expanded to other regions in the EPO (*e.g.* South America, Mexico), both data collection and stock assessments for sharks in the EPO should improve. Such expansion is being considered under a phase 2 of the ABNJ project.

The management of silky sharks is impeded by the lack of a reliable stock assessment due to the lack of reliable time series of data tyically used in stock assessment (catch, CPUE, and sex/size composition).

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

Management of silky sharks could therefore be greatly improved by implementing a close-kin mark-recapture study that would provide estimates of absolute adult abundance and adult natural mortality (SAC-12-14).

RECOMMENDATIONS:

Considering the recent improvements in shark fishery data collection in Central America (SAC-11-13), as well as the potential expansion of the data collection program into other coastal states:

1. Extend Resolution C-19-05 for another biennial period (2022-2023).

CPCs should enhance their compliance with the following provisions of Resolution C-19-05 (to be extended in the new resolution):

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

Considering the potential benefits of Close Kin Mark-Recapture:

4. Fund a workplan for Close-Kin Mark-Recapture starting with Project H.7.e: Feasibility and sampling design for close-kin mark-recapture analysis of stocks in the EPO

2.2. Seabirds

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

RECOMMENDATION:

Revise Resolution C-11-02 consistent with the current state of knowledge regarding seabird mitigation techniques.

B. DATA COLLECTION

3. GENERAL DATA PROVISIONS

The scope of research conducted by IATTC's staff has broadened since the Antigua Convention entered into force over a decade ago, and data provision has not kept pace. This has severely hampered the staff's work, ultimately impacting the types and quality of research that can be undertaken to provide management advice. For example, the Antigua Convention explicitly mandates the consideration of impacts by EPO tuna fisheries on associated and dependent species. However, ecological analyses have been hampered by a lack of reliable data on bycatch species, with limited to no data available for fisheries other than large purse-seine vessels (IATTC Class-6; fish carrying capacity > 363 t) that carry observers onboard for each trip.

Such limitations led the staff to review the Resolution on data provision (C-03-05), which mandates the submission of the majority of fisheries data required by the staff to undertake their research. The staff concluded that Resolution C-03-05 requires updating to align with mandates of the Antigua Convention,

the IATTC's Strategic Science Plan (SSP) and to harmonize with the Food and Agriculture Organization (FAO) and other tuna Regional Fisheries Management Organizations. To this end, the staff has prepared Document SAC-12-09 with the overarching goal to revise Resolution C-03-05 to improve the scope and quality of data submitted by CPCs for science, conservation and management. The document is intended to serve three purposes: 1) to provide background information on the rationale for improved data collection, and outline the data deficiencies for the various fisheries that must be resolved in order for the staff to perform the research necessary to meet its diverse responsibilities; 2) to form a basis to initiate discussions with CPCs on data collection improvements, and associated resources and capacity building requirements; and, 3) to provide a draft of proposed revisions to Resolution C-03-05 pertaining to fisheries known to catch species under the purview of the IATTC in the EPO for which data provision is not addressed under other resolutions.

RECOMMENDATION:

Through a series of workshops planned and facilitated by the staff, revise resolution C-03-05 in consultation with CPCs, taking into consideration the elements presented in SAC-12-09. These workshops will be organized by main fishery with the purpose of discussing improvements in data collection, any required additional resources and capacity building activities.

4. DATA FOR LARGE LONGLINERS

Recent challenges with the assessments of the target tuna fisheries demanded the use of sophisticated analyses that required fine-scale spatial and temporal resolution catch, effort and size data (SAC-11-06; SAC-11-07; IATTC-95-05) from the longline fleets operating far from the coasts and particularly in the high-seas, which in some cases, are not routinely available to the staff. Challenges are also encountered by the staff when producing assessments for tuna-like species, such as swordfish (SWO-01), due to a lack of data. CPUE data from Japan forms the basis for the index of abundance used in the current assessments of bigeye and yellowfin tunas and it is key to address hypotheses of spatial structure for yellowfin tuna in the EPO. However, the magnitude and spatial extent of effort by the Japanese fleet has decreased markedly in the EPO, thereby deteriorating the quality of the indices of abundance. Recent collaborative work with Japan, Korea, Chinese Taipei and China has improved the understanding of their logbook data for developing new indices of abundance. Data for this work were only made available to the staff via multiple MoUs between the IATTC and each CPC, which are renewed annually. The data regularly submitted by the CPCs related to the Resolution C-03-05 on data provision are aggregated spatially (1° x 1° or 5° x 5°) and contain little or no gear configuration information, and no vessel identifiers, which are important factors for better understanding changes in catchability and species targeting (OTM-30), both of which influence abundance indices. Operational-level data (high resolution 'level 1' catch and effort data as defined in C-03-05) with corresponding size information are necessary to improve the indices of abundance routinely used in the stock assessments for bigeye and yellowfin tuna, and will become increasingly important for other commercially important species such as swordfish, other billfish and sharks. These data already exist for most, if not all, large longline fleets (and for some coastal longline fleets), and are currently submitted to other t-RFMOs by IATTC CPCs (WCPFC13), and are similar to the data available to the staff for the purse-seine fishery. Therefore, these equivalent longline data should be expected to be made available to staff on an annual basis for the purposes of improving the quality of data reporting and research to facilitate fulfillment of mandates by the Antigua Convention.

The staff has prepared an extensive workplan to address several uncertainties in the stock assessment of yellowfin, bigeye tuna and other species that will require high-resolution CPUE data with corresponding size information. The staff has routine access to high-resolution data for most of the purse-seine fleet, but not for the longline fleet from which indices of abundance are mostly derived. The quality of stock assessments of tuna and tuna-like species undertaken by the staff will therefore continue to be severely

compromised without access to these high quality existing data.

The staff proposes that submission of current and historic high-resolution, operational-level catch, effort and size ("TASK II") data, by sex, be required for the high-seas longline to improve stock assessments of tuna and tuna-like species. This will allow the scientific staff to fulfil its mission detailed in the SSP to "undertake state-of-the-art scientific research to inform sound management advice, aiming at the conservation and sustainable use of the marine species and ecosystems covered by the Antigua Convention" additional to completing the proposed workplan (SAC-12-01). The staff will continue to be mindful of data confidentiality as demonstrated by the handling of the purse-seine data in strict accordance with Resolutions C-04-10, C-15-07 and IATTC Rule of Procedure XIII.

RECOMMENDATIONS:

Each CPC to submit in 2021 to the IATTC set-by-set catch and effort (TASK II 'level 1' data) and ancillary operational information, from longline logbooks for both historical and current periods, and updates thereafter. All data fields requested are listed in SAC-12-09 Annex 1, Appendix 2 TASK II. However, at a minimum, the following fields must be provided (unless unavailable): Vessel unique identifier, date and time of start and end of set, latitude and longitude of start and end of set, number of hooks used, number of floats used, maximum fishing depth of the hooks, number of light sticks used, length of the mainline, material of the mainline, length of the branchline, material of the branch line, length of the float line, material of the floatline, bait, species caught (all), number of fish (by species).

Each CPC to submit to the IATTC size composition data by sex with date of collection and fine-resolution location information, both historical and current periods.

5. DATA FOR PURSE-SEINE VESSELS WITHOUT ON-BOARD OBSERVERS

The catch information of the portion of the purse-seine fleet that operates without observers aboard, consistent with the rules and procedures adopted by the Commission and the rules of the AIDCP and related instruments, is essential to ensure full compliance with Resolution C-03-05 and the assembling of the best scientific evidence needed to inform the consideration and adoption of conservation and management measures. In this respect, it should be recalled also that, as established in the Resolution, CPCs are directly responsible for the collection of the catch information specified in the resolution and its submission to the Director. In the interests of obtaining complete and timely data, the staff considers that the best way forward would be for each CPC to ensure that its competent authority collect this information (mainly logbook data, but also any other relevant data) at the end of each fishing trip, and provide it to the IATTC staff as soon as possible thereafter, without prejudging its further compilation and provision to the Director on an annual basis.

RECOMMENDATION:

Each CPC should ensure that its competent authority collects the logbook and other pertinent data from every fishing trip made without an observer aboard at the end of the trip, and provides them to the IATTC staff as soon as possible afterwards.

6. SHARKS AND RAYS

6.1. Improving data collection and stock assessments for sharks

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

There are continuing data deficiencies for three fishery components that catch silky and/or hammerhead sharks in the EPO: 1) coastal (*i.e.* 'artisanal') longline and gillnet fisheries (SAC-07-06b(iii); SAC-08-07e); 2)

high-seas longline fisheries (SAC-08-07b; SAC-08-07e); and 3) small[11] purse-seine vessels (SAC-08-06a). In particular, without data from a properly designed long-term sampling program of Mexican, Central American, and South American artisanal fisheries (a significant part of component (1)), the IATTC staff will not be able to meet this requirement of Resolution C-16-05.

As a first step toward developing sampling designs for catch and size composition in artisanal fisheries, and for size composition in industrial longline fisheries, a wealth of information has been collected in five Central American countries under Project C.4.a, funded by FAO-GEF through March 2019, and through March 2020 by the IATTC capacity-building fund (SAC-11-13). A total of 676 artisanal landing sites for shark catches were identified in five countries, and information on fishing effort and on catch rates by species and life stage were obtained in interviews with fishers. The data were used to make order-of-magnitude estimates of shark catches by site, and for the region, which will be used to inform decisions on resource allocation for future sampling programs. In addition, exhaustive sampling data on catch size composition, by species and taxon, were collected from 90 unloadings by longline vessels in Costa Rica and Panama. Simulations were conducted with those data to determine parameters for size composition sampling protocols that will be tested in 2020, and further simulations are currently being conducted.

With funding from the European Union, in April 2020 the staff initiated Phase 1 of the long-term sampling project (Project C.4.b). To date, sampling technicians have been hired and plans have been developed to implement the sampling designs. The data collected in Project C.4.a has been invaluable for informing decisions on sampling priorities and allocation of resources. Field testing of the sampling methodology developed as part of Project C.4.a has been delayed due to the COVID-19 pandemic, but despiste this the sampling technicians began this work in late summer 2020. It will include sampling designs for estimating the composition of shark catches by coastal longline and gillnet fisheries and by the industrial longline fisheries of EPO coastal nations. Made possbile through recent funds provided by the European Union, the sampling program in Central America has been extended beyond to complete the year of 2021. Based on the results of this sampling program, a proposal will be presented by the staff at the 2021 annual meeting of the Commission for the establishment of a long term sampling program in the region. If the sampling program is expanded to other regions in the EPO, both data collection and stock assessments for sharks in the EPO should improve. Such expansion is being considered under a phase 2 of the ABNJ project.

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

RECOMMENDATION:

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

As regards fishery component (2), Resolution C-12-07 requires that vessel captains record all shark catches transshipped, but not by species. Species data are needed for accurate estimates of species-specific catches, so the staff recommends that vessel captains record transshipments of sharks by species.

RECOMMENDATION:

Require all vessel captains to complete the transshipment declaration forms of Resolution C-12-07 by species, for all shark catches.

Previous recommendations by the staff on data collection by observers on longline vessels and Class 1-5 purse-seine vessels are reiterated in Section 8.

[11] IATTC classes 1-5; carrying capacity ≤ 363 t.

7. ECOSYSTEM CONSIDERATIONS

7.1. Development of a fishery-dependent ecological sampling program for EPO tuna fisheries

Accurate depictions of trophic connections, based on data from trophic ecology studies, are fundamental to the ecosystem models that the IATTC staff develops and uses to assess the ecological impacts of fishing, and to forecast potential changes in ecosystem structure due to fishing and/or climate change, such as the impact of increasing fishing effort on floating objects in the EPO (see SAC-12-13). However, the most recent trophic data used in the recently updated version of Olson and Watters (2003) ETP7 ecosystem model of the EPO, now called "ETP-21", were collected in the early 1990s. Since then some of the strongest El Niño events on record have occurred, with potentially significant effects on the diets and abundance of key predators, and the subsequent trophic pathways throughout the ecosystem. This program may also help meet the data needs of other IATTC projects, such as the collection of revised length-weight, length-length, and other morphometric relationships.

RECOMMENDATION:

In collaboration with CPCs and relevant stakeholders, develop a fishery-dependent ecological sampling program to collect stomach and tissue samples from key predators for ecological analyses of contents, stable isotopes and fatty acids.

8. FISH-AGGREGATING DEVICES (FADs)

The recommendations in this section are based on document FAD-03 INF-A; some of them were endorsed by the *ad-hoc* working group on FADs, SAC-09 and SAC-10.

8.1. Timely provision of FAD data

Resolution C-19-01 requires that CPCs provide data on FADs recorded by captains of purse-seiners without observers aboard for the previous calendar year "*no later than 90 days prior to each regular meeting of the SAC*", and that the IATTC staff present a preliminary analysis of that information to the SAC. However, given the variety of formats received and many other tasks required of the staff in preparation for SAC meetings, this does not allow sufficient time for a thorough analysis of the data, and therefore more timely provision of data is desirable.

RECOMMENDATION:

CPCs should provide the FAD data from each fishing trip without an observer aboard to the IATTC staff as soon as possible after the trip terminates.

8.2. Standard reporting format

Resolution C-19-01 requires all CPCs "*to ensure their vessel owners and operators record and report to the appropriate national authorities any interaction with FADs, using a standard format to be developed by the Commission staff*". Since 1 January 2020, on purse-seine vessels without an observer aboard, the captain is responsible for recording FAD data, and it is important that all captains use only the form developed by the IATTC staff (FAD form 9/2018; available here in pdf or MS Excel format), to ensure that all necessary data are collected in a standard format.

RECOMMENDATION:

For purse-seine vessels without an observer aboard, data related to interactions with FADs should be recorded exclusively on the standard form developed by the IATTC staff (FAD form 9/2018).

8.3. Provision of detailed buoy data

Under Resolution C-17-02, now C-20-06, CPCs are required to provide "daily information" on their active

FADs, which is interpreted to mean a single data point per FAD per day, the selection criteria for which are unclear (*e.g.* no acoustic biomass information is required by the Resolution). This combination of low resolution and uncertain selection criteria means that these data are of limited scientific utility. Also, CPCs can report data in different formats, sometimes highly summarized (without any information on FAD identification or trajectory), which again are of little use for science. Moreover, Resolution C-19-01 allows CPCs to use different methods for marking and identifying FADs. As a result, the data currently provided are inadequate even for analyses to determine the level of data resolution required for an assessment of the FAD fishery, since the various FAD-related IATTC datasets cannot be matched and combined. As noted by voluntary pilot studies using raw buoy data, including both trajectories and acoustic biomass information, at regional (*e.g.* FAD-05-INF-E) and global (*e.g.* IOTC-2020-WPTT20-14, SCRS/2019/075) level, scientific studies require high-resolution, standardized data, and the staff therefore recommends that CPCs provide the raw buoy data in order to conduct the appropriate scientific analyses.

RECOMMENDATION:

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

9. FISHING GEAR CONFIGURATIONS

Describing changes in gear configurations is important for monitoring changes over time in fishing strategies, to improve stock assessments and management advice (Strategic Science Plan, Target J.1).

RECOMMENDATION:

Require that vessels submit the purse-seine and longline gear description forms appended to Document SAC-05-05. Any significant modifications made to the gear subsequently should be reported on these forms prior to departing port with the modified gear.

10. OBSERVER COVERAGE

10.1. Purse-seine fishery

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

No formal, fleet-wide on-board observer program exists for Class 1-5 purse-seine vessels, and as a result, trips by many small[12] purse-seine vessels are never sampled by observer programs (SAC-08-06a; SAC-12-09). Vessel logbooks and cannery unloading records are the principal sources of data on the activities of these vessels. However, they generally do not contain information on tuna discards, and the data are less complete and detailed that those collected by observers. In addition, bycatch information is only rarely recorded in logbooks, which hampers efforts to conduct assessments for such species. Electronic monitoring (EM) for this fleet component is currently being explored (Project D.2.a; SAC-10-12), and some capabilities of EM detected in the pilot study are detailed in Appendix 2 of SAC-11-11; however, EM data collection is not likely to begin at any significant level prior to January 2025, given the steps that need to be completed for implementation of an EM System in the EPO (SAC-12-10; SAC-12-11). Therefore, a fleet-wide observer program is needed to obtain the data necessary for estimating the quantity and species composition of bycatches by these vessels and to understand the strategies and dynamics of their operations. Based on a previous study of EPO data for Class-6 vessels fishing on floating objects (IOTC Proceedings WPDCS-01-09, 4: 48–53), an initial sampling coverage of 20% of all trips of the small-vessel fleet component is recommended.

[12] Carrying capacity ≤ 363 t.

RECOMMENDATION:

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

10.2. Longline fishery

10.2.1. Observer coverage

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

RECOMMENDATION:

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

10.2.2. Data standards and reporting

In 2019, the Commission replaced Resolution C-11-08 on scientific observers on longline vessels with Resolution C-19-08. Annex B to C-19-08 formalizes the minimum data standards for longline observer data collection approved by SAC-08 in 2017. Under these measures, all CPCs with qualifying longline vessels fishing in the EPO are required to report all operational data collected by their respective observer programs since 2013. However, several CPCs have not yet reported data for all years, nor responded to the Director's letter of February 2020 requesting information on the status of the missing data.

RECOMMENDATIONS:

CPCs should submit all operational longline observer data collected from 1 January 2013 to present, consistent with the minimum data standards contained in Annex B of C-19-08, or provide a clear and complete explanation as to why the missing datasets have not been submitted.

11. ELECTRONIC MONITORING

11.1. Implementing an electronic monitoring system for the tuna fisheries

Electronic monitoring (EM) is increasingly being used worldwide to record the activities of fishing vessels, to complement human observer programs, and where on-board observer coverage is too low or non-existent. Resolution C-19-08 requires the IATTC staff, in consultation with CPCs, to "*prepare a draft proposal for the development of minimum standards for the implementation of an [electronic monitoring system] for the longline fleets, taking into account the experience of CPCs that are implementing EMS on longline vessels and progress made in other tuna RFMOs, to be submitted to the SAC meeting of 2020*". The resolution also requires that the SAC, in consultation with the IATTC staff, "*present recommendations on this proposal to the Commission for its consideration at its annual meeting in 2020*". The IATTC staff has developed, in consultation with experts on the matter, documents SAC-11-10, EMS-01-01, and EMS-01-02, which outline the objectives and standards for an EM system (EMS) for the tuna fisheries in the EPO, provide a series of recommendations and actions to be taken in the short, medium and long term,

and propose a roadmap for the implementation of the EMS in the region. Document SAC-11-10 was presented at the 11th meeting of the SAC, in October 2020. However, during this virtual meeting it was not possible for members to provide appropriate feedback due to time constraints. Thus, an EM workshop was organized in April 2021 to further discuss some of the elements contained and summarized in document SAC-11-10 and EMS-01-01, respectively, as well as discuss a proposed workplan for the implementation of an EMS in the EPO (document EMS-01-02).

During the workshop, where a diverse type of stakeholders participated, the staff presented a detailed account of all the recommendations described in EMS-01-01, with special emphasis on the importance for the adoption by the Commission, at least in a provisional basis, of the definitions provided in the Annex 1 of the same document. In addition, substantial efforts were focused on discussing the proposed workplan for the EMS implementation, which outlined the timeline and steps needed to be taken by the Commission, the staff, and other stakeholders to successfully implement an EMS in the EPO. The workplan received positive feedback from the participants of the workshop. Finally, and because the workplan contemplates a series of workshops to discuss each component and subcomponent of the EMS, and there are no guidelines to govern this process yet, it was noted that the terms of reference (TOR) for these workshops and other related activities should be developed and adopted, as needed. These TOR are needed to provide structure for the various steps of the EMS implementation process, similar to the function of the TOR put in place for the Management Strategy Evaluation workshops that were adopted by the Commission in 2019 through Resolution C-19-07.

RECOMMENDATIONS:

1. Adopt, at least on a provisional basis, the definitions in Annex 1 of the document EMS-01-01.
2. Adopt the EMS workplan detailed in document EMS-01-02.
3. Task the staff, in consultation with the members and other relevant stakeholders, with the development of a draft for the Terms of Reference for the EM workshops, for potential adoption by the Commission at its annual regular meeting in 2021.