INTER-AMERICAN TROPICAL TUNA COMMISSION

94TH MEETING

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DOCUMENT IATTC-94-03

STAFF RECOMMENDATIONS FOR MANAGEMENT AND DATA COLLECTION, 2019

CONTENTS

A. MANAGEMENT

1. TUNAS

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

In 2019, stock status indicators (SSIs) are being used to monitor all three species of tropical tunas.

In the past, the staff has based its recommendation for the duration of the closure of the purse-seine fishery on the *F* multiplier, a parameter that relates fishing mortality (*F*) to the maximum sustainable yield (MSY) of a stock. However, in 2018 the staff concluded that the **bigeye** tuna assessment model had become overly sensitive to the inclusion of new data and to previously-identified issues in the assessment (SAC-09 INF-B). For this reason, the *F* multiplier derived from the bigeye assessment was considered compromised, and the staff did not recommend using it to define management measures in 2018. The staff is working on resolving these issues, and will conduct a benchmark assessment of bigeye for 2020; in the meantime, SSIs are being used to evaluate the status of the stock (SAC-10-06).

Stock assessments of **skipjack** tuna cannot be conducted with currently-available data, so as in previous years, SSIs are used (SAC-10-09).

The only assessment conducted in 2019 was an update assessment of **yellowfin** tuna (SAC-10-07). Issues similar to those in the 2018 bigeye assessment were identified, so the results of the assessment are not considered reliable, which precludes their use as a basis for supporting changes in the number of closure days currently used for managing tropical tunas in the EPO (SAC-10 INF F). Consequently, SSIs were also produced for yellowfin (SAC-10-08), and are being used to monitor the stock in 2019.

The SSIs suggest that fishing mortality (*F*) is continuing to increase for all three species, due to increases in fishing effort in the purse-seine fishery, specifically in the number of sets on floating objects. Because it is not practical to limit floating-object sets alone, the staff maintains its 2018 recommendation to limit the

total combined number of floating-object and unassociated purse-seine sets.

Rationale

Previously, the staff based its recommendation for the duration of the closure of the purse-seine fishery on the *F* multiplier, a parameter that relates fishing mortality (*F*) to the maximum sustainable yield (MSY) of a stock. The fishery impacts all three major tropical tuna species, and therefore the most restrictive *F* multiplier was used as the basis for management advice. In 2018 bigeye had the most restrictive *F* multiplier, but the staff concluded that the assessment model had become overly sensitive to the inclusion of new data and to other previously-identified issues (SAC-09 INF-B); therefore, its results should not be used as a basis for management measures in 2018. Consequently, the *F* multiplier from the yellowfin assessment was used (SAC-09-15) when considering changes in the duration of the closure established in C-17-02; it was very close to the target of F_{MSY}, so no changes were made.

In 2019, the staff is not recommending changes in the number of closure days based on the *F* multiplier from the yellowfin assessment, for four reasons. First, the issues identified in the yellowfin assessment, which are similar to those identified in the bigeye assessment in 2018, need to be addressed before considering the results of the yellowfin assessment for management advice (SAC-10 INF F). Second, even if it is argued that the yellowfin assessment results should be considered for management advice, population projections under current fishing mortality have less than a 10% probability of exceeding the fishing mortality and biomass limit reference points, for both the base-case and the sensitivity analyses (Appendix 1; Appendix 2, Figures A.1-A.2), and no immediate action would be required based on the yellowfin assessment results (Resolution C-16-02)[1]. Third, since Resolution C-17-02 established management measures through 2020, a closure is already established for 2020. Fourth, substantial progress has been made on the work plan to improve bigeye assessments, and lessons learned will be applied as part of the work plan developed to improve the yellowfin assessment. Results from the improved assessments will be considered to establish management measures for 2021 and subsequent years, since the current resolution (C-17-02) expires in 2020.

Management advice

As noted above, in the absence of reliable stock assessments for tropical tunas in 2019, the staff used stock status indicators to monitor the stocks (SAC-10-06, SAC-10-08, SAC-10-09). The indicators suggest that additional management measures should be considered to address the continuing increase in the number of sets on floating objects that, despite the longer closure since 2017, is a concern for all three species.

In recent years, recommendations for longer closures have been driven mainly by increases in fleet capacity, and it is therefore essential that capacity does not increase further, particularly if the current management measures of Resolution C-17-02 continue unchanged in 2020. However, fleet capacity is not the only factor that can affect fishing mortality; there are at least three others: number of days fished, number of sets, and number of fish-aggregating devices (FADs).

[1] Since the model indicates that the limit reference points have not been exceeded, nor are they projected to be exceeded, no immediate action, as contemplated in paragraph 3b or 3c of Resolution C-16-02, is required. Resolution C-17-02 requires that appropriate measures be applied "if necessary"; however, "necessary" has not been defined except in terms of limit reference points, per paragraph 3b or 3c of Resolution C-16-02.

Currently, for the purse-seine fleet, capacity is restricted (C-02-03), as are the number of days fished and the number of active FADs (C-17-02), so the only one of these factors that remains to be limited is the number of sets (Figure 1), particularly sets on floating objects which continue to increase. It is not practical to limit floating-object sets alone, mainly because accurate real-time monitoring of numbers of sets, by type, necessary to implement such a limit, is challenging.

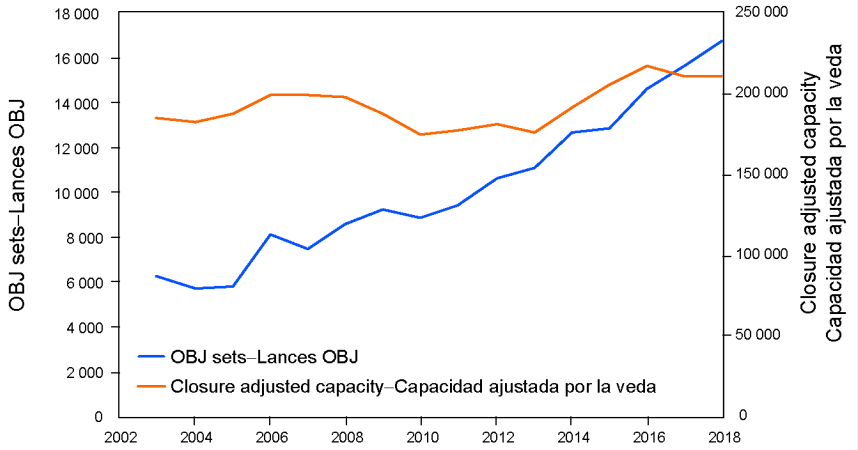

Figure 1. Sets on floating objects and fleet capacity, all purse-seine vessels, 2003-2018

In view of all the above, the staff maintains its 2018 recommendation for a limit on floating-object (OBJ) and unassociated sets (NOA), combined (OBJ+NOA), by Class-6 vessels during 2020. Class 1-5 vessels rarely carry observers, and so cannot be reliably monitored in real time; therefore, the closure would commence when the number of OBJ + NOA sets by Class-6 vessels, which can be monitored in quasi-real time, reached the limit, but would apply to all purse-seine vessels, regardless of capacity.

Improving the assessments

Substantial research is needed to improve both the bigeye and yellowfin assessments. The bigeye situation in 2018 led the staff to develop the work plan to improve the bigeye assessment, and substantial progress has been made (*e.g.* WSLL-01, WSBET-02). A work plan has also been developed for the yellowfin assessment, benefitting from the lessons learned from the bigeye work plan. The staff is on track to deliver improved benchmark assessments for bigeye and yellowfin in 2020. The results, and the staff's consequent recommendations, will be presented at SAC-11 in 2020, and later that year to the IATTC's 95th meeting, when the Commission will consider management measures for 2021 and subsequent years, since the current conservation resolution (C-17-02) expires in 2020.

RECOMMENDATIONS:

1. Maintain the provisions of the current resolution (C-17-02).
2. For the purse-seine fishery, limit the total annual number of floating-object and unassociated sets combined (OBJ+NOA) by Class-6 vessels in 2020 to 15,723. Once the limit is reached, only dolphin-associated (DEL) sets will be allowed during the rest of that year, and all vessels without a Dolphin Mortality Limit must return to port.

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 update assessment of the species in 2018. Projections in which Resolution C-14-06 (and therefore Resolution C-16-08) was extended into the future predict that, even under a low-recruitment scenario, the stock will rebuild to the interim rebuilding targets. The assessment and auxiliary data suggest that the three most recent recruitments (2016-2018) were larger than assumed in the low-recruitment scenario used for projections. Projections that take the 2016 recruitment into consideration predict that catch could be increased while still maintaining a high probability of meeting the rebuilding targets. Given that two additional larger recruitments were not used in the projections, these increased catches appear conservative.

The analysis 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, while the most precautionary approach is to maintain the catch limits in Resolution C-18-01, 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. The current resolution (C-18-01) is adequate and, for this reason, no additional recommendations are made.
2. Increased catches based on the scenarios analyzed are possible under the harvest strategy prepared by the joint tRFMO working group as described in C-18-02. 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

The stock assessment of north Pacific albacore tuna (SA-WP-09), completed in April 2017 by the ISC albacore working group, concluded that the stock was not experiencing overfishing and was probably not overfished. The fishing mortality for the most recent years in the assessment ($F_{2012\text{-}2014}$) is below the level corresponding to MSY ($F_{2012\text{-}2014}/F_{MSY} = 0.61$) and the spawning biomass is above that level ($S_{current}/S_{MSY} = 3.32$), but those results are highly uncertain. 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, and that population dynamics in the stock are largely driven by recruitment, which is affected by both environmental changes and the stock-recruitment relationship (a measure of the degree to which biomass and recruitment are interdependent). 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. A management strategy evaluation (MSE) is in progress.

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. Given the relative stability in the biomass and fishing mortality in recent years, and in view of the ongoing MSE, the staff considers that the current resolutions should be continued.

RECOMMENDATION:

The current resolutions (C-05-02, C-13-03, C-18-03) should be continued.

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 2018 for the north and south EPO (SAC-10-17). 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"[2], shark handling, and data recording practices

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

had continued unchanged since 1994. The real trend is considered to be closer to the index based on dead plus live releases because sharks recorded as released alive in recent years would probably have been recorded as dead previously, and thus the dead plus 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 a decrease in the indices in 2018 to about the 2016 level, following an increase in 2017, 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 (Section 3) as part of its work plan for addressing the stock assessments of sharks.

Resolution C-16-06 directs the staff to consider the adequacy and effectiveness 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 is yet not fully available, so the staff could not perform the analysis.

Paragraph 6 of Resolution C-16-06 requires CPCs to implement a three-month prohibition on the use of steel leaders in certain longline fisheries, and Paragraph 7 requires the IATTC staff, in coordination with the SAC, to recommend the most appropriate period for this prohibition, based upon the analysis of data provided by CPCs. However, those data are not yet fully available, so the analysis could not be conducted. Nonetheless, the longline catch-composition information compiled for the recent dorado assessment (SAC-07-06a(i)) suggests that a prohibition would be most effective outside the dorado fishing season, which typically lasts from October through March. Therefore, the staff recommends that, where appropriate, each CPC prohibit the use of steel leaders during a period of three consecutive months between April and September, and continue the prohibition annually until sufficient data are available to change this recommendation.

RECOMMENDATIONS:

1. CPCs subject to the terms of paragraph 7 of Resolution C-16-06 should implement a prohibition on the use of steel leaders during a period of three consecutive months during April-September of each year for the relevant portions of their national fleets.
2. Pursuant to Paragraphs 9 and 10 of Resolution C-16-06, CPCs should notify 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.

2.2. Seabirds

Resolution C-11-02 should be revised consistent with the current state of knowledge regarding seabird 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. SHARKS AND RAYS

3.1. 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 essential if conventional stock assessments and/or indicators of stock status are to be developed for these species.

There are continuing data deficiencies for three fishery components that catch silky and/or hammerhead sharks in the EPO: 1) coastal 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[3] purse-seine vessels (SAC-08-06a). In particular, without data provided by a properly designed long-term sampling program of Central American artisanal fisheries (a significant part of component (1)), the IATTC will not be able to meet the goal of Resolution C-16-05 of EPO assessments of silky and hammerhead sharks.

The FAO-GEF funding for Project C.4.a, to improve data collection for artisanal fisheries in Central America (component (1)), ended in April 2019, and the work is being continued through December 2019 with IATTC capacity-building funds. The project is generating a wealth of information for developing sampling designs for catch and size composition in artisanal fisheries, and for size composition in industrial longline fisheries (SAC-10-16). However, no funding is available to conduct a long-term sampling program (Project C.4.b) using the methodologies developed under these projects.

Since shark fishery data are essential for an assessment, the staff recommends that funding be secured for implementing **Project** C.4.b, in two phases. **Phase 1** will last one year, and will provide the necessary extensive field testing required to fine-tune sampling methodology and logistical plans. In **Phase 2**, the methodology and plans developed in Phase 1 will be implemented in a long-term sampling program.

RECOMMENDATION:

Implement Phase 1 of the long-term sampling program (Project C.4.b), using sampling methods and logistics developed under Project C.4.a.

In addition, 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 data on quantities of 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 7.

[3] Classes 1-5; carrying capacity ≤ 363 t

3.2. Evaluating post-release survival of Mobulids

Mobulid rays are among the bycatches of the tropical tuna purse-seine fishery, and are of special concern because of their low reproductive rates. There is also uncertainty about many aspects of their life-history (stock structure, migratory patterns, etc.) and their post-release survival rates. A quantitative ecological risk assessment of *Mobula mobular* by IATTC staff (BCWG-09-01) explored various management measure scenarios to reduce the species' vulnerability to the fishery. Improved handling practices have shown as the most promising means of reducing post-release mortality and, as a result, vulnerability.

RECOMMENDATION: Conduct a post-release survival tagging pilot study for Mobulid rays in all purse-seine set types, following the guidelines in Annex I of Resolution C-15-04.

4. ECOSYSTEM CONSIDERATIONS

4.1. 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 has begun to use to assess the ecological impacts of fishing, and to forecast potential changes in ecosystem structure due to fishing and/or climate change. However, the most recent trophic data used in the current version of the ecosystem model of the EPO (Olson and Watters 2003) were collected in the early 1990s. Since then, the floating-object fishery has shown a five-fold increase in effort, impacting a diverse suite of oceanic species. Furthermore, in the past 20 years the EPO has experienced some of the strongest El Niño events on record. Together, these anthropogenic and environmental impacts are likely to have had a significant effect on the diets and relative abundances of key predators and their prey.

RECOMMENDATION:

In collaboration with CPCs, 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.

5. 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 and SAC-09.

5.1. Timely provision of FAD data

CPCs are required by Resolution C-18-05 to provide data on FADs for the previous calendar year "*no later than 60 days prior to each regular meeting of the SAC*", and the staff of the IATTC is required to 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 to the IATTC staff as soon as they receive them at the end of that trip.

5.2. Standard reporting format

Resolution C-18-05 allows CPCs to collect and report the information contained in Annex 1 "*through a dedicated logbook, modifications to regional logsheets, or other domestic reporting procedures*". However, Annex 1 requires CPCs to "*record and report any interaction with FADs, using a standard format to be developed by the Commission staff*". The staff has now developed a FAD data collection and reporting form (FAD form 9/2018; available here in pdf or MS Excel format), which should be used exclusively.

RECOMMENDATION:

CPCs should report any interactions with FADs exclusively on the standard form developed by the IATTC staff (FAD form 9/2018).

5.3. Provision of detailed buoy data

Under Resolution C-17-02, 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. 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-18-05 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. Scientific studies require high-resolution, standardized data, and the staff therefore recommends that CPCs provide position data for buoys, in a standard format to be developed by the staff and the ad hoc Working Group on FADs: (a) at a minimum resolution of one position per day, and (b) for any "search window", when the vessel is communicating more frequently than usual with the buoy in order to locate it.

RECOMMENDATION:

CPCs should provide to the IATTC staff buoy data corresponding to, at a minimum, one position per day, and every "search window" (when the vessel is communicating more frequently than usual with the buoy in order to locate it).

6. 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 (SSP, 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.

7. OBSERVER COVERAGE

7.1. Purse-seine fishery

7.1.1. Observer coverage of purse-seine vessels of less than 363 t carrying capacity

Trips by small[4] vessels are rarely sampled by observer programs (SAC-08-06a), and 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 not always recorded in logbooks, which hampers efforts to conduct assessments for such species. Electronic monitoring is currently being explored (SAC-10-12), but it is not yet known whether this will provide data of sufficient quality; therefore, a full-time observer program is needed to obtain the data necessary for estimating the quantity and species composition of bycatches by small vessels and understanding 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 trips is recommended.

[4] Carrying capacity ≤ 363 t

RECOMMENDATION:

Establish an observer program for purse-seine vessels of less than 363 t carrying capacity, with a sampling coverage of 20%.

7.2. Longline fishery

7.2.1. Observer coverage

Resolution C-11-08 requires that at least 5% of the fishing effort by longline vessels greater than 20 m length overall (LOA) carry a scientific observer. However, 5% coverage is too low for calculating accurate estimates of the catches of species caught infrequently in those fisheries, such as some sharks of conservation concern; 20% coverage is considered the minimum level required for such estimates. 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.

7.2.2. Data standards and reporting

Resolution C-11-08 requires that CPCs submit to the SAC, by 31 March of each year, information collected by observers on longline vessels on the previous year's fishery. The reports submitted by CPCs document compliance with the 5% observer coverage requirement, and include summaries of the data collected in the previous year. In 2017, the SAC recommended minimum standards (Recommendation 14) for collecting and reporting operational-level data by longline observer programs, including a standardized format. Also in 2017, the staff requested the relevant historical data for 2013-2016 (since the entry into force of C-11-08), but the response to date has been very limited. To minimize the reporting burden on CPCs, a simplified version of the proposed format for the annual summary reports, circulated in March 2018 (see SAC-09 INF-A), will be presented at SAC-10 (SAC-10-INF-H).

The staff also reiterates its recommendation that the measure of effort be changed from "effective days fishing" to "number of hooks", to improve the precision of the estimates of effort, and to align with IATTC and WCPFC tuna stock assessments.

RECOMMENDATIONS:

1. CPCs should submit all operational longline observer data collected from 1 January 2013 to present, consistent with the recommendation by SAC-08.
2. Adopt a standardized format for the annual longline observer data reports by CPCs, such as the one proposed in SAC-10-INF-H.
3. Adopt number of hooks as the effort metric for longline fisheries in the EPO.

Appendix 1.

CALCULATION OF CLOSURE DAYS

In order to provide the same information as in previous years, the calculation of the number of days of closure corresponding to the adjusted *F* multiplier for yellowfin is presented below.

The *F* multiplier needs to be adjusted to take into account changes in fleet capacity. As of 14 April 2019, the capacity of the purse-seine fleet operating in the EPO, 263,858 cubic meters (m^3) of well volume, although slightly higher than the 2018 value of 262,226 m^3, represented a 1% increase from the "current" (2016-2018) average of 262,239 m^3 used to calculate the *F* multiplier. The adjusted *F* multiplier is therefore 0.88 for yellowfin.

During the three-year period used as a basis for the calculation of the SAC-10 yellowfin *F* multiplier, two resolutions were in force: C-13-01 during 2016 and C-17-02 in 2017-2018. Calculating the duration of these extended closures is more complicated than in previous years, because in 2016 the closure lasted 62 days, but in 2017 and 2018 it lasted 72 days. With the adjusted *F* multiplier of 0.88, the closure corresponding to F_{MSY} is 103 days for yellowfin. This represents an increase of 31 days with respect to the current 72-day closure.

Thus, the closure corresponding to the *F* multiplier adjusted for capacity increase is as follows:

	Yellowfin
F multiplier from the stock assessment	0.89
Capacity increase	1.0%
F multiplier adjusted for capacity increase	0.88
Days of closure	103

Appendix 2.

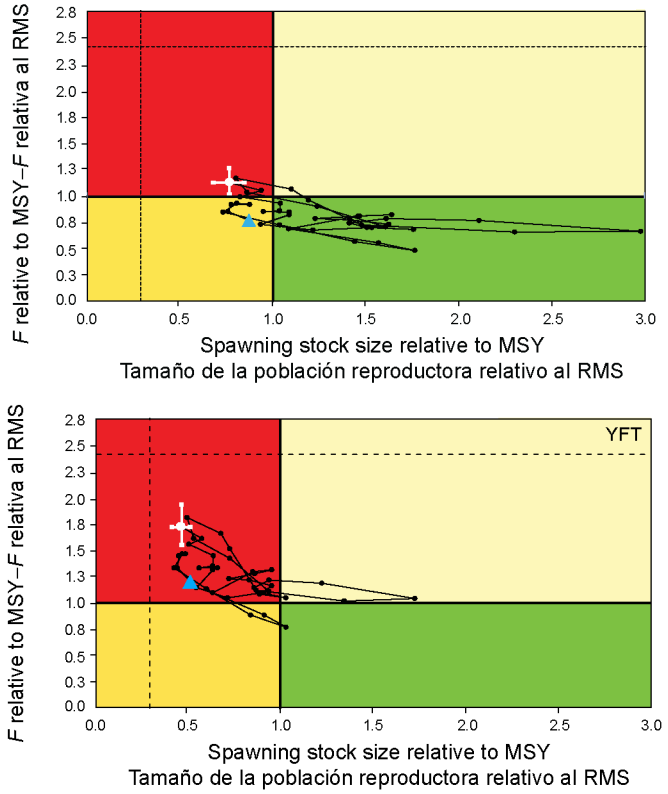

FIGURE A.1. Yellowfin Kobe (phase) plot of the time series of estimates of spawning stock size and fishing mortality relative to their MSY reference points for the sensitivity analysis that assumes h = 1 (current base-case model; top panel) and a stock-recruitment relationship (h = 0.75, sensitivity case; bottom panel). The colored panels represent target reference points (S_{MSY} and F_{MSY}; solid lines) and limit reference points (dashed lines) of 0.28 S_{MSY} and 2.42 F_{MSY}, which correspond to a 50% reduction in recruitment from its average unexploited level based on a conservative steepness value (h = 0.75) for the Beverton-Holt stock-recruitment relationship. Each dot is based on the average fishing mortality rate over three years; the large dot indicates the most recent estimate. The squares around the most recent estimate represent its approximate 95% confidence interval. The triangle represents the first estimate (1975).

FIGURA A.1. Gráfica de Kobe (fase) de la serie de tiempo de las estimaciones del tamaño de la población y la mortalidad por pesca de aleta amarilla en relación con sus puntos de referencia de RMS correspondientes al análisis de sensibilidad que supone h = 1 (modelo de caso base actual; panel superior) y una relación población reclutamiento (h = 0.75, caso de sensibilidad; panel inferior). Los paneles de colores representan puntos de referencia objetivo y (S_{RMS} and F_{RMS}; líneas sólidas) y límite (líneas de trazos) de 0.28 S_{RMS} y 2.42 F_{RMS}, que corresponden a una reducción de 50% del reclutamiento de su nivel no explotado medio basado en un valor cauteloso de la inclinación (h = 0.75) de la relación población-reclutamiento de Beverton-Holt. Cada punto se basa en una tasa de mortalidad por pesca media trienial; el punto rojo grande indica la estimación más reciente. Los cuadrados alrededor de la estimación más reciente representan su intervalo de confianza de 95% aproximado. El triángulo representa la primera estimación (1975).

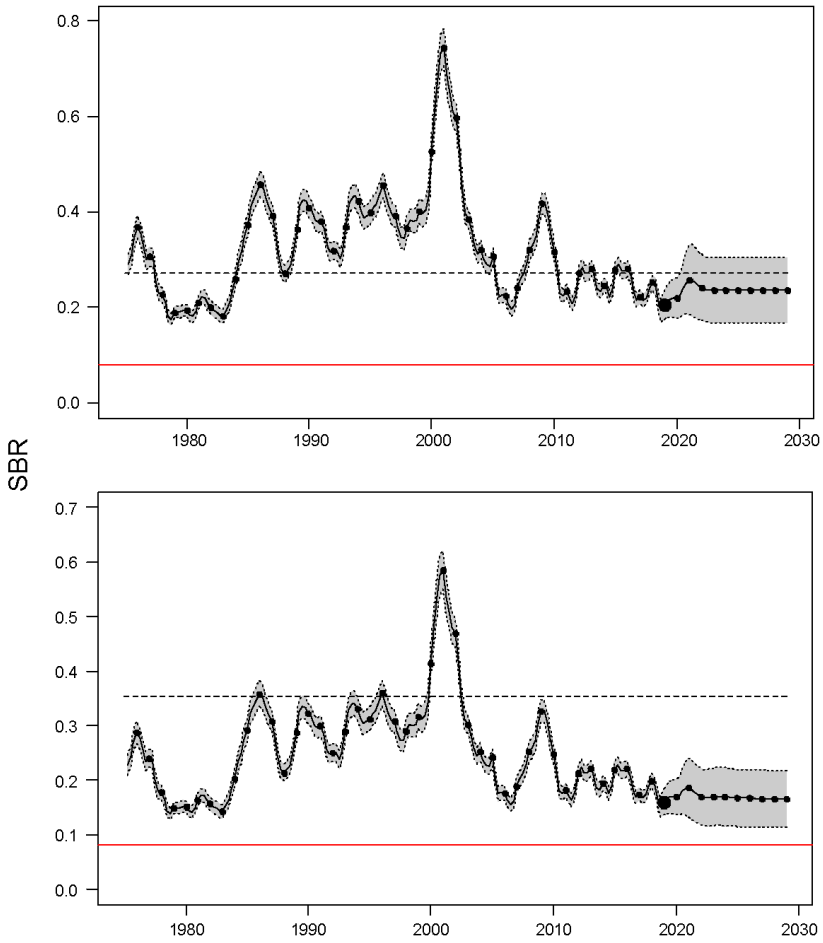

FIGURE A.2. Estimated spawning biomass ratios (SBRs) of yellowfin tuna in the EPO, including projections for 2019-2029 based on average fishing mortality rates during 2016-2018, from the base case (top panel) and the sensitivity analysis that assumes a stock-recruitment relationship (h = 0.75, bottom panel). The dashed horizontal line (at 0.27 and 0.35, respectively) identifies the SBR at MSY. The solid line illustrates the maximum likelihood estimates, and the estimates after 2019 (the large dot) indicate the SBR predicted to occur if fishing mortality rates continue at the average of that observed during 2016-2018, and recruitment is average during the next 10 years. The shaded area represents the 80% confidence intervals, and the solid horizontal line represents the limit biomass reference point (d = 0.077, Maunder and Deriso 2007). If the shaded area extends below that line, the probability of exceeding the limit reference point is at least 10% (Resolution C-16-02).

FIGURA A.2. Cocientes de biomasa reproductora (SBR) estimados de atún aleta amarilla en el OPO, incluyendo proyecciones para 2018-2028 basadas en las tasas medias de mortalidad por pesca durante 2015-2017, del caso base (recuadro superior) y el análisis de sensibilidad que supone una relación población-reclutamiento (h = 0.75, recuadro inferior). La línea de trazos horizontal (en 0.27 y 0.35, respectivamente) identifica SBR_{RMS}. La línea sólida ilustra las estimaciones de verosimilitud máxima, y las estimaciones a partir de 2018 (el punto grande) señalan el SBR que se predice occurrirá si las tasas de mortalidad por pesca continúan en el promedio observado durante 2015-2017 y el reclutamiento es promedio durante los 10 años próximos. El área sombreada representa los intervalos de confianza de 80%, se y la línea horizontal solemne representa el punto de referencia límite de biomasa (d = 0.077, Maunder y Deriso 2007). Si el área sombreada se extiende por debajo de esa línea, la probabilidad de rebasar el punto de referencia límite es al menos 10% (Resolución C-16-02).