INTER-AMERICAN TROPICAL TUNA COMMISSION

SCIENTIFIC ADVISORY COMMITTEE

FIFTH MEETING

La Jolla, California (USA)
12-16 May 2014

MEETING REPORT

Chairman: Guillermo Compeán

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APPENDICES

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The 5th Meeting of the Scientific Advisory Committee was held in La Jolla, California, USA, on 12-16 May 2014. The attendees are listed in Appendix A.

1. Welcome, introductions, meeting arrangements

The meeting was called to order on 12 May 2014 by the Chairman, Guillermo Compeán, Director of the IATTC, who thanked the attendees for coming to the meeting. The Scientific Advisory Committee (SAC) was established by the Antigua Convention, and is composed of one representative designated by each member of the Commission. This year, 15 representatives were present at the meeting[1], and the required two-thirds quorum was therefore met. Pursuant to Article 10 of the IATTC Rules of Procedure, Alain Fonteneau (EU) was designated rapporteur. It was suggested that he might be assisted in his task by SAC members serving as rapporteurs for different topics during the meeting. Nobody from the SAC volunteered to serve however, so the IATTC staff continued to provide the necessary support.

2. Consideration of agenda

During the meeting, additional items were presented, including:

1. Other business (17): Discussion of a European project developed recently dealing with tropical tunas ;
2. Bigeye tuna (8d): Discussion of a proposal for determining sex of bigeye and yellowfin tunas ;
3. Other business (17): Discussion of the spatial distribution of effort in Pacific for tuna and sharks.
4. Other business (17): Spatial distribution of fishing effort in FADS (foreign fleet) in the Colombian Pacific - Preliminary results

3. Bycatches

a. Seabirds: recent studies (SAC 05 INF-E)

Marco Favero (ACAP) introduced document SAC-05 INF-E submitted by the Agreement on the Conservation of Albatrosses and Petrels and BirdLife International. The document presented (1) an updated best practice advice to reduce seabird bycatch in pelagic longline fisheries, and (2) latest information on at-sea distribution of most threatened seabirds in the East Pacific Ocean.

Current scientific evidence shows that a number of mitigation measures contained in Resolution C-11-02 are not effective and that the conservation measure should be revised to be consistent with the current state of knowledge regarding seabird bycatch mitigation, considering the three methods proven to be effective in mitigating seabird bycatch: line weighting, night setting and bird scaring lines used in combination. Other mitigation measures included in C-11-02 should not be endorsed as comparable substitutes for this suite of measures because their effectiveness remains unproven. The three recommended mitigation measures should specify the following minimum standards:

a. Branchline weighting: configurations should consist of weights greater than 45 g attached within 1 m of the hook or, weights greater than 60 g attached within 3.5 m of the hook or, weights greater than 98 g weight attached within 4 m of the hook. Positioning the weight farther than 4 m from the hook should not be deemed adequate.

b. Night setting: All settings should occur between nautical twilight and nautical dawn.

c. Bird scaring lines: On longliners greater than 35m overall length, two bird scaring lines should be deployed in a manner that maximizes their aerial extent, but with a minimum aerial extent of 100m. A bird scaring line should run from a high point 8m above the water at the stern of the vessel to a device or mechanism that creates drag at its terminus. Streamers should be brightly colored, a mix of long and

[1] China, Colombia, Costa Rica, Ecuador, El Salvador, European Union, Guatemala, Japan, Korea, Mexico, Nicaragua, Panama, Peru, Chinese Taipei, United States

short streamers (at least 1m in length), placed at intervals of no more than 5m. Long streamers should be attached to the line with swivels that prevent streamers from wrapping around the line, and should reach the sea surface in calm conditions. Baited hooks shall be deployed within the area bounded by the two bird scaring lines.

On vessels shorter than 35m overall length, a single bird scaring line should be deployed with a minimum aerial extent of 75m. Lines should be attached to the vessel such that it is suspended from a height of at least 7m above the water at the stern. Streamers should be brightly colored and attached to the line with swivels that prevent streamers from wrapping around the line. Short streamers (at least 1m in length) should be placed at 1m intervals along the entire length of the aerial extent. The addition of longer streamers at 5m intervals along the first 55m of aerial extent to complement the short streamers could be used at the vessel's discretion. Long streamers should reach the sea surface in calm conditions.

The authors suggest that the Commission should take note of the updated seabird density information. Although in general terms high-density areas for seabirds are covered by the application area in the South Pacific, there are important waters in the North Pacific not covered by the Resolution C-11-02. The Committee should analyze the merits of revising these boundaries in view of latest information provided.

The SAC noted that there are areas outside of the shaded areas of the map that have longline effort.

b. Hammerhead sharks: updates (SAC 05-3b)

Marlon Roman presented a summary of information on *Sphyrna* collected in the EPO by different tuna fisheries, and some details on the evolution of the data collecting of *Sphyrna* in the tuna purse seine fishery in the last two decades.

On the first point: species of the genus *Sphyrna* are caught by the tuna purse-seine, the longline and the artisanal fisheries in the eastern Pacific Ocean (EPO). Captures by the artisanal fishery are not detailed enough for statistical analyses. It is known that pupping grounds may be coastal, and it's also known that adults and juveniles are targeted by small-scale coastal artisanal fisheries in the EPO, using different gear types, which could cause an impact to these populations, therefore capture data of *Sphyrna* in this fishery may be necessary to better understand the potential impact to these populations. Capture data of industrial longline is scarce, but two studies have reported that captures of *Sphyrna* are low. On tuna purse-fishery, the *Sphyrna* data have been collected by observers since 1993. Total length recorded by three size categories: small (<90cm TL); medium (90 – 150 cm TL) and large (>150 cm TL) and identifications were down to a group level, but in 2005 they started collecting the information to species level and the total length was recorded to nearest centimeter. The sex was also recorded. The dominant captures by this fishery are the *S. zygaena* and *S. lewini*. It's assumed that there were misidentification issues between these two species between 2005 and 2009. *Sphyrna* are captured in the three sets types, but sets made on floating objects report higher captures. The spatial distribution of *Sphyrna* captured in these three set types indicates that they are more concentrated on the eastern margin of the EPO.

During the discussion, the following suggestions were made:

1. Examination of the hammerhead catch stratified between FADs and natural floating objects. There may be too few sets on natural objects in recent years to statistically compare with FADs, although past data could be examined.
2. Examination of the hammerhead catch stratified by season and distance from coast.
3. Examination of the hammerhead catch stratified by vessel class. It was suggested that changes in 2005 could have been due to regulations by countries on shark finning.
4. Review the spatial distribution of *Sphyrna zygaena* (more pelagic) and *S. lewini* (more coastal).

SAC participants expressed concern about those fisheries about which little is known about shark

bycatch. Data are available only from a few publications for other fisheries. However, additional data on shark bycatch (hammerhead, blue and mako sharks) will be available from the Japanese longline fleet, and China and Korea have reported on catch rates. Mexico has been cooperating with an ISC analysis of shark fisheries and is working on assessments of shark stocks. Guatemala, in collaboration with the OSPESCA and the IATTC, is planning improved data collection by the end of the year and improved export controls, and would be appreciative of further IATTC collaboration. El Salvador has been working with the IATTC to standardize data collection.

Through collaborative work with Latin countries, mainly Ecuador and Mexico, the IATTC staff is aware that artisanal fisheries in tropical areas of the EPO catch substantial numbers of these sharks. Iimprovement of data collection programs is important because these fisheries probably have important effects on these species and they overlap with pupping and nursery grounds. While the impact of artisanal net fisheries could be significant, those fisheries are not under IATTC management purview. The staff appreciates the data and cooperation in research on these species.

c. Handling of bycatches of sea turtles and manta rays (SAC-05-03c)

Martin Hall presented proposals for additional guidelines for the safe release of sea turtles and manta rays. For sea turtles caught by tuna longline fisheries in the eastern Pacific Ocean the following guidelines are proposed:

1. Require every longline vessel operating in an area where sea turtles may be hooked or entangled to carry: a) a dipnet to safely lift sea turtles aboard the vessel, b) a line cutter that is long enough to reach the turtle without lifting it from the water, c) dehookers (both inverted-V-shaped and a pigtail-shaped), d) a bolt cutter capable of cutting hooks, and e) equipment capable of safely keeping the sea turtle's mouth open.
2. Prohibit lifting of turtles from the water using the fishing lines in which the turtles are hooked or entangled. If a turtle must be removed from the water, an appropriate basket lift or dipnet should be used. If a hooked turtle cannot be safely removed from the water, any remaining line should be cut as close as possible to the hook without inflicting additional harm on the turtle. In no case should the length of line left attached to the hook exceed the length of the turtle's carapace.
3. Prohibit attempts to remove swallowed hooks from turtles, and instead require that the hook be left in place and the line cut as close to the hook as possible without further injury to the animal.
4. Vessel crew should be encouraged to assess the condition of any sea turtle brought aboard the vessel prior to releasing them. To the extent practicable, injured or unresponsive turtles should be kept on board and assisted in a manner consistent with methods described in the FAO's *Guidelines to Reduce Sea Turtle Mortality in Fishing Operations* and in the materials on the IATTC website.

For manta rays caught in purse-seine sets, the following guidelines are proposed:

1. Prohibit the gaffing of rays.
2. Prohibit lifting rays by the gill slits or spiracles.
3. Prohibit the punching of holes through the bodies of rays (*e.g.* to pass a cable through for lifting the ray).
4. Prohibit the retention of Manta and Mobula rays caught incidentally during fishing operations.
5. Require that, to the extent possible, rays too large to be lifted safely by hand be brailed out of the net using methods such as those recommended in document WCPFC-SC8-2012/ EB-IP-12 (Poison *et al*. 2012, Good practices to reduce the mortality of sharks and rays caught incidentally by the tropical tuna purse seiners).
6. Require that large rays that cannot be released safely before being landed on deck, be returned to the

water as soon as possible, preferably utilizing a ramp from the deck connecting to an opening on the side of the boat, or if no such ramp is available, lowered with a sling or net.

Martin Hall also noted the need to collaborate with veterinarians to assess safe handling techniques.

The SAC discussed the spatial differences in fisheries that may require different handling guidelines. For example, coastal longliners may encounter many more sea turtles than distant-water longliners; those fisheries with longer soak times may result in mortalities rather than injured animals that require safe release. One participant stated that any guidelines adopted should be harmonized with those already adopted by the WCPFC

4. FADs

a. FADs: patterns (SAC-05-04a)

Martin Hall presented information on spatial and temporal patterns in FAD use and development.

FADs characteristics and dynamics were discussed including the increasing use of technology, and the consequences of this increase, especially the use of sonar buoys with the FADs. The numbers of sets by type, and their diel occurrence were shown. The patterns of FAD deployment in the eastern Pacific were described on a monthly basis, showing the main regions utilized in the different season. The summary, a simplified picture, can be described as: 1st quarter off Peru, 2nd quarter around Galapagos, and 3rd-4th quarter offshore in the Equatorial region west of Galapagos. The annual cycles of FAD deployments were presented for several regions, together with observer records on the size compositions (in three categories) of the different species. From the beginning of the FAD fishery, pieces of webbing, usually old netting materials, have been added under the FADs to increase their attractiveness. It appears that the medians are increasing after many years of stability.

The SAC discussed the decreasing trend of discarded fish. Potential reasons for this trend can be due to the increased prices for tunas, making the retention of smaller tunas (including skipjack) more profitable, regulations by countries that restrict discards, and the development of markets for bycatch species.

The SAC also discussed the changes in the numbers of FADs deployed and recovered over time, the different slopes of these two variables. There were questions about why there was a recent difference in the ratio of FADs deployed, FADs recovered and why catches on FADs have remained constant while the number of FADs deployed greatly increased. Possible answers to the first question may be that FADs are being left to drift longer, particularly during closures, or increased cooperation among vessels. The possible answers to the second question include vessels switching areas with their FADs, counting unit deployments rather than number of FADs at sea, or due to smaller vessels replaced by larger vessels. It was suggested that when the FADs remain at sea for longer periods of time, that this can increase the fishing effort.

b. FADs: marking (SAC-05-04b)

Martin Hall presented proposals for marking FADs to obtain trajectories and catch data.

The SAC discussed the requirements of IATTC C13-04 which initiated these proposals and the 2016 deadline for implementation. There has been deferral of a decision due to the high costs of some alternatives (parallel satellite systems to those already deployed by the fishermen) and lack of movement toward less expensive methods (sharing of data already being collected by fishing companies). Director Compeán noted that resolution C13-04 states that the responsibility is with the flag states, so flag states must require that vessels identify their FADs, and it says that there should be electronic identification. There was one suggestion that the SAC urge the IATTC to ensure that the 2016 deadline be met.

There was also a discussion about the difference between identifying satellite buoys *vs*. the FADs because a FAD can have different buoys throughout its lifetime. If the properties of a particular FAD are important, then both the FAD and the satellite buoy must be identified in some way. If it is the FAD

trajectories that are most important then the satellite information is more important. It depends on what are objectives of management. It was noted that the number of FADs is hard to control; reducing capacity could be better accomplished by reducing the number of sets.

5. Standardized fishing gear descriptions for scientific purposes (SAC-05-05)

Martin Hall presented proposals for standardized fishing gear descriptions. Because fisheries are dynamic and can change rapidly, it is necessary to create forms that capture these changes.

6. The fishery in 2013 (SAC-05-06)

Nick Vogel reviewed the information on the fishery for tunas in the eastern Pacific Ocean (EPO) in 2013. He discussed EPO tuna catch statistics for 2013, including: total catches by species and by flag, purse-seine catch distributions for yellowfin, skipjack and bigeye, and size compositions of the three species. The catches of yellowfin, skipjack, bigeye, and Pacific bluefin tunas by purse-seine, pole-and-line, and recreational gear in 2013 of 550,000 metric tons (t) were about 23% less than the record catches in 2003, and about 15,000 t lower than the 15-year average of catches. Ecuadorian vessels caught about 42% of the total EPO tuna, including 62% of the skipjack and 66% of the bigeye. Mexican vessels caught about 25% of the total EPO tuna, including 47% of the yellowfin and nearly all of the bluefin.

The majority of the yellowfin catches in 2013 were taken in sets associated with dolphins from two general areas: north of 10°N between 115°W and 105°W longitude, and north of 5°N and east of 100°W longitude. Offshore catches of yellowfin in association with dolphins were found further north than in the previous 5-year average.

Yellowfin catches on unassociated schools in 2013 were concentrated mainly in the inshore areas south of the Baja peninsula, with lesser amounts south of Galapagos. Inshore catches around the equator were lower than the 2008-2012 average. Smaller amounts of yellowfin were caught south of the equator throughout the EPO, mostly in association with floating objects.

Yellowfin catches in 2013 of 217,000 t were very close to the 2008-2012 average.

The 2013 skipjack catches in the inshore area east of 100°W longitude were similar to those of previous years, although the percentage of catch in association with floating objects increased. Most of the skipjack caught in unassociated tuna sets occurred in the area around the Galapagos Islands and, to a lesser extent, off the coast of Ecuador and Peru. Offshore catches of skipjack were almost exclusively in association with floating objects, and we can see an overall decrease in the 2013 offshore skipjack catches compared to the previous 5-year average, especially in the area between 120°W and 140°W longitude.

Skipjack catches in 2013 of 279,000 t were 36,000 t higher than the 2008-2012 average, a 15% increase.

The bigeye catch distributions in 2013 were very similar to the average annual distributions for 2008-2012 throughout the EPO. The majority of the bigeye catches occurred between 10°N and 15°S on floating objects. Bigeye catches in 2013 of 49,000 t were 17,000 t lower than the 2008-2012 average, a 26% decrease.

Nick Vogel also showed the length-frequency and species-composition sampling areas, and described the areas defined for stock assessments, along with statistics of the number of wells sampled. Of the 819 wells sampled for length frequency and species composition in 2013, 604 contained yellowfin, 505 contained skipjack, and 130 contained bigeye. The average sizes of yellowfin in 2013 were less than those of 2012 and 2011. The average sizes of skipjack were greater than those of any of the previous five years. With the exception of 2010, the average size of bigeye in 2013 was the lower than any of the previous 5 years.

It was noted that average weights of fish are not included in the summary of the fishery, and it was suggested that including average weights would be helpful to highlight trends in the fishery. This type of information could be included in future presentations but data on average weights are included in the

staff's full stock assessment reports.

The SAC discussed the possibility that catches from coastal longline fisheries could be underestimated in the IATTC's data. Guillermo Compeán indicated that the IATTC receives reliable information from small longline companies verifying how much fresh tuna is exported, and this information confirms that the amount of tuna caught is relatively small. A participant noted that the average sizes of bigeye had decreased in the last two years, and expressed the opinion that this could be a management concern. Nick Vogel explained that the 2013 data are too preliminary to draw conclusions on trends in average size, and noted that in previous years the final average sizes of fish change after all the data are compiled.

7. Yellowfin tuna (SAC-05-07)

Carolina Minte-Vera presented the most current stock assessment of yellowfin tuna (*Thunnus albacares*) in the eastern Pacific Ocean (EPO). An integrated statistical age-structured stock assessment model (Stock Synthesis Version 3.23b) was used in the assessment, which is based on the assumption that there is a single stock of yellowfin in the EPO. This model is the same as that used in the previous assessment.

Yellowfin are distributed across the Pacific Ocean, but the bulk of the catch is made in the eastern and western regions. Purse-seine catches of yellowfin are relatively low in the vicinity of the western boundary of the EPO at 150ºW. The majority of the catch in the EPO is taken in purse-seine sets on yellowfin associated with dolphins and in unassociated schools. Tagging studies of yellowfin throughout the Pacific indicate that the fish tend to stay within 1800 km of their release positions. This regional fidelity, along with the geographic variation in phenotypic and genotypic characteristics of yellowfin shown in some studies, suggests that there might be multiple stocks of yellowfin in the EPO and throughout the Pacific Ocean. This is consistent with the fact that longline catch-per-unit-of-effort (CPUE) trends differ among areas in the EPO. However, movement rates between these putative stocks, as well as across the 150°W meridian, cannot be estimated with currently available tagging data.

The stock assessment requires substantial amounts of information, including data on retained catches, discards, indices of abundance, and the size compositions of the catches of the various fisheries. Assumptions have been made about processes such as growth, recruitment, movement, natural mortality, fishing mortality (*F*), and stock structure. The assessment for 2013 is identical to that of 2012 except for new and updated data.

The catch data for the surface fisheries have been updated and new data added for 2013. New or updated longline catch data are available for China (2012), Chinese Taipei (2010-2012), Japan (2010-2012), Korea (2012), the United States (2011-2012), French Polynesia (2012), Vanuatu (2012), and other nations (2007-2013). Japanese longline catch data for 2013 are available from the monthly report statistics. For longline fisheries with no new catch data for 2013, catches were assumed to be the same as in 2012. Surface fishery CPUE data were updated, and new CPUE data added for 2013. New or updated CPUE data are available for the Japanese longline fleet (2010-2012). New surface-fishery size-composition data for 2013 were added and data for 2012 were updated. New or updated length-frequency data are available for the Japanese longline fleet (2011-2012).

In general, the recruitment of yellowfin to the fisheries in the EPO is variable, with a seasonal component. This analysis and previous analyses indicate that the yellowfin population has experienced two, or possibly three, different recruitment productivity regimes (1975-1982, 1983-2002, and 2003-2011). The most recent recruitments (2012 and 2013) were estimated to be above average, but these estimates are highly uncertain. The productivity regimes correspond to regimes in biomass, with higher-productivity regimes producing greater biomass levels

Substantial levels of fishing mortality have been estimated for the yellowfin fishery in the EPO. These levels are highest for middle-aged yellowfin. Historically, the dolphin-associated and unassociated purse-seine fisheries have the greatest impact on the spawning biomass of yellowfin, followed by the floating-object fisheries. In more recent years, the impact of the floating-object fisheries has been slightly greater

that that by unassociated fisheries. The impacts of the longline and purse-seine discard fisheries are much less, and have decreased in recent years.

The spawning biomass ratio (the ratio of the spawning biomass to that of the unfished population; SBR) of yellowfin in the EPO was below the level corresponding to the maximum sustainable yield (MSY) during 1977-1983, coinciding with the low productivity regime, but above that level during most of the following years, except for the recent period (2005-2007 and 2010-2011). The different productivity regimes may support different MSY levels and associated SBRs. The SBR at the start of 2014 was estimated to be 0.26, slightly below the MSY level (0.27). The effort is estimated to be below the level that would support the MSY (based on the current distribution of effort among the different fisheries), and recent catches are below that level. The curve relating the average sustainable yield to the long-term fishing mortality is flat around the MSY level. Moderate changes in the long-term levels of effort will change the long-term catches only marginally, while changing the biomass considerably. Maintaining the fishing mortality below the MSY level would result in only a marginal decrease in the long-term average yield, with the benefit of a relatively large increase in the spawning biomass. In addition, if management is based on the base case assessment (which assumes that there is no stock-recruitment relationship), when in fact there is such a relationship, there would be a greater loss in yield than if management is based on assuming a stock-recruitment relationship when in fact there is no relationship.

The MSY has been stable during the assessment period (1975-2013), which suggests that the overall pattern of selectivity has not varied a great deal through time.

If a stock-recruitment relationship is assumed, the outlook is more pessimistic, and current effort is estimated to be above the MSY level. Previous assessments have indicated that the status of the stock is also sensitive to the value assumed for the average size of the oldest fish, and more pessimistic results are obtained when higher values are assumed for this parameter. At current (2011-2013) levels of fishing mortality and average levels of recruitment, the spawning biomass is predicted to increase above the MSY level. However, the confidence intervals are wide, and there is a moderate probability that the SBR will be substantially above or below this level. In addition, the spawning biomass is predicted to remain below the MSY level if a stock-recruitment relationship is assumed. If fishing effort continues at recent levels, both the spawning biomass and the catches of surface fisheries are predicted to increase, assuming average recruitment and no stock-recruitment relationship (base case). Slightly higher catches are predicted if in fact such a relationship exists

Key Results

1. There is uncertainty about recent and future levels of recruitment and biomass. There have been two, and possibly three, different productivity regimes, and the MSY levels and the biomasses corresponding to the MSY may differ among the regimes. The population may have switched in the last ten years from a high to an intermediate productivity regime.
2. The recent fishing mortality rates are below the MSY level, and the recent levels of spawning biomass are estimated slightly below the MSY level. As noted in IATTC Stock Assessment Report 14 and previous assessments, these interpretations are uncertain, and highly sensitive to the assumptions made about the steepness parameter of the stock-recruitment relationship, the average size of the older fish, and the assumed levels of natural mortality. The results are more pessimistic if a stock-recruitment relationship is assumed, if a higher value is assumed for the average size of the older fish, and if lower rates of natural mortality are assumed for adult yellowfin.

The SAC discussed why the stock assessment F multiplier of the base case is very optimistic compared to the last assessment. To explore the reasons for this several runs were performed to test for the effect of the recent data added to the model. The results are more pessimistic when the new and updated size composition was excluded. It was learned from previous assessments that the size composition strongly influences in the model results. When the recent purse-seine size composition data is excluded the estimates of fishing mortality are higher. This is due to instability in the estimation of the selectivity of

the floating object fisheries, which is fixed curve for the whole time period. There is indication of time-varying dynamics that should be modeled as time-varying selectivity, as recent research has shown. Results are less optimistic when fitting to the new longline South CPUE without the 2013 PS CPUE. It was noticed that the model seems relatively insensitive to an addition of another year of data, as only the final years of series were changing with the new data.

The SAC discussed future work to be done for next year's full Stock Assessment. The growth and natural mortality estimates will be revised to include the most recent tagging and sex-ratio data. The hypothesis of sex-specific growth will also be explored, as suggested, by estimating how much differences in growth between sexes is needed to account for the observed differences in sex-ratios of large animals.

The SAC discussed the concern that fishing on FADs would impact smaller fish and thus affect recruitment. It was noted, however that the effect on fishing on FADS would be greater on the spawning biomass than the effect of unassociated sets that had a greater influence in the past, as shown in the fishery impact plot. However one participant stated that the average weight of yellowfin tuna, and the fishing mortality of juveniles, in the purse-seine catch has remained relatively constant over the last 40 years.

The SAC also discussed the factors that made this a special year for the analysis. Several countries such as Ecuador, Panama and other Central American countries have updated their longline data. The longline data is available to be used in the stock assessment only in July of each year. This year, Japan provided monthly reports of catches in compliance with IATTC Resolutions on yellowfin tuna. The purse-seine data is available sooner as it is in part collected by the IATTC staff and monthly reports of catches are submitted by countries. The longline trips are also longer.

A participant suggested that a map with the distribution of catches of both surface fisheries and longline vessels be included in future stock assessment reports. It was noticed that the fishing area of those two types of fisheries overlaps in the Indian Ocean and is distinct in the EPO. In the EPO, the longline fleet may be avoiding FAD areas because of potential entanglements. Also, the FADs are deployed in areas with strong currents, where the longline fleet does not operate, possibly to avoid the shear of opposing surface and subsurface currents found along the Equator.

8. Bigeye tuna

8a. Bigeye Assessment for 2013 (SAC-05-08a)

Alexandre Aires-da-Silva presented the most current stock assessment of bigeye tuna (*Thunnus obesus*) in the eastern Pacific Ocean (EPO). An integrated statistical age-structured stock assessment model (Stock Synthesis 3.23b) was used in the assessment.

Bigeye tuna are distributed across the Pacific Ocean, but the bulk of the catch is made to the east and to the west. The purse-seine catches of bigeye are substantially lower close to the western boundary (150ºW) of the EPO; the longline catches are more continuous, but relatively low between 160ºW and 180º. Bigeye are not often caught by purse seiners in the EPO north of 10ºN, but a substantial portion of the longline catches of bigeye in the EPO is made north of that parallel. It is likely that there is a continuous stock throughout the Pacific Ocean, with exchange of individuals at local levels. The assessment is conducted as if there were a single stock of bigeye in the EPO, and there is minimal net movement of fish between the EPO and the western and central Pacific Ocean. Its results are consistent with the results of other analyses of bigeye tuna on a Pacific-wide basis. Data from recent tagging programs, which will help to provide estimates of movement between the EPO and the western and central Pacific Ocean, are being collected and analyzed, and will help to improve the spatial structure assumptions in the next full assessment of bigeye.

This model is the same as that used in the previous full assessment conducted in 2013 (IATTC Stock Assessment Report 14) which included several improvements. First of all, a new Richards growth curve

estimated externally from an integrated analysis of otolith age-readings and tag-recapture observations was introduced. This curve reduced the uncertainty about the average size of the oldest fish (L_2 parameter). In addition, the parameters which determine the variance of the length-at-age were also taken from the new externally-derived growth estimates. Diagnostic analyses with the previous base case model configuration indicated a dominant influence of the size-composition data in determining the productivity (the R_0 parameter) of the bigeye stock, and conflicts among datasets were also found. As a result, improvements were made in the previous full assessment on the weighting assigned to the different datasets. Specifically, the size-composition data of all fisheries were down-weighted. In addition, the number of catch per unit of effort (CPUE) data series used as indices of abundance was reduced in order to minimize conflict trends among data sets. Rather than fitting to a total of ten CPUE series (two purse-seine indices and eight longline indices), a reduced set of indices of abundance was chosen to best represent the bigeye stock trends (the early and late periods of the Central and Southern longline fisheries).

The stock assessment requires a substantial amount of information. Data on retained catch, discards, CPUE, and size compositions of the catches from several different fisheries have been analyzed. Several assumptions regarding processes such as growth, recruitment, movement, natural mortality, and fishing mortality, have also been made. Catch and CPUE data for the surface fisheries have been updated, and include new data for 2013. New or updated longline catch data are available for China (2012), Chinese Taipei (2010-2012), Japan (2010-2012), Korea (2012), the United States (2011-2012), French Polynesia (2012) and Vanuatu (2012). Longline catch data for 2013 are available for China, Chinese Taipei, Japan, and Korea from the monthly report statistics. New or updated CPUE data are available for the Japanese longline fleet (2010-2012). New purse-seine length-frequency data are available for 2013 and updates are available for 2012. New or updated length-frequency data are available for the Japanese longline fleet (2011-2012).

A prominent feature in the time series of estimated bigeye recruitment is that the highest recruitment peaks of 1983 and 1998 coincide with the strongest El Niño events during the historic period of the assessment. There was a period of above-average annual recruitment during 1994-1998, followed by a period of below-average recruitment in 1999-2000. The recruitments were above average from 2001 to 2006, and were particularly strong in 2005. More recently, the recruitments were below average during 2007-2009, and have fluctuated around average during 2010-2013. The most recent annual recruitment estimate (2013) is at about average levels. However, this estimate is highly uncertain, and should be regarded with caution, due to the fact that recently-recruited bigeye are represented in only a few length-frequency data sets.

There have been important changes in the amount of fishing mortality caused by the fisheries that catch bigeye tuna in the EPO. On average, since 1993 the fishing mortality of bigeye less than about 15 quarters old has increased substantially, and that of fish more than about 15 quarters old has also increased, but to a lesser extent). The increase in the fishing mortality of the younger fish was caused by the expansion of the purse-seine fisheries that catch tuna in association with floating objects. The fishing mortality of juvenile bigeye, particularly of fish 9-12 quarters of age, declined in 2013, mainly due to the 27% reduction in the catches of juvenile bigeye by the surface fisheries. It is clear that the longline fishery had the greatest impact on the stock prior to 1995, but with the decrease in longline effort and the expansion of the floating-object fishery, at present the impact of the purse-seine fishery on the bigeye stock is far greater than that of the longline fishery. The discarding of small bigeye has a small, but detectable, impact on the depletion of the stock.

Over the range of spawning biomasses estimated by the base case assessment, the abundance of bigeye recruits appears to be unrelated to the spawning potential of adult females at the time of hatching.

Since the start of 2005, the spawning biomass ratio (SBR; the ratio of the spawning biomass at that time to that of the unfished stock) gradually increased, to a level of 0.30 at the start of 2010. This may be

attributed to a combined effect of a series of above-average recruitments since 2001, the IATTC tuna conservation resolutions during 2004-2009, and decreased longline fishing effort in the EPO. However, although the resolutions have continued to date, the rebuilding trend was not sustained, and the SBR gradually declined to a low historic level of 0.19 at the start of 2014. This decline could be related to a period dominated by below-average recruitments that began in late 2007 and coincides with a series of particularly strong La Niña events.

At the beginning of 2014, the spawning biomass of bigeye tuna in the EPO appears to have been about 5% below S_{MSY}, and the recent catches are estimated to have been about 24% lower than the maximum sustainable yield (MSY). If fishing mortality is proportional to fishing effort, and the current patterns of age-specific selectivity are maintained, F_{MSY} is about 4% higher than the current level of effort.

According to the base case results, the most recent estimate indicates that the bigeye stock in the EPO is slightly overfished ($S<S_{MSY}$) but that overfishing is not taking place ($F<F_{MSY}$) . In fact, the current exploitation is very close to the MSY target reference points. Likewise, the current base case model indicates that the proposed limit reference points of 0.38 S_{MSY} and 1.6 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, have not been exceeded. These interpretations, however, are subject to uncertainty, as indicated by the approximate confidence intervals around the most recent estimate in the phase plots. Also, they are strongly dependent on the assumptions made about the steepness parameter of the stock-recruitment relationship, the assumed levels of adult natural mortality, the growth curve, and the weighting assigned to the size-composition data.

The MSY of bigeye in the EPO could be maximized if the age-specific selectivity pattern were similar to that of the longline fisheries, because they catch larger individuals that are close to the critical weight. Before the expansion of the floating-object fishery that began in 1993, the MSY was greater than the current MSY and the fishing mortality was much less than F_{MSY}.

At current levels of fishing mortality, and if recent levels of effort and catchability continue and average recruitment levels persist, the SBR is predicted to remain stable at about 0.19 until 2017. After that, the SBR is predicted to gradually increase, and stabilize at about 0.21 around 2019, slightly above to the level corresponding to MSY (0.20) . If a stock-recruitment relationship is assumed, it is estimated that catches will be lower in the future at current levels of fishing effort, particularly for the surface fisheries.

These simulations are based on the assumption that selectivity and catchability patterns will not change in the future. Changes in targeting practices or increased catchability of bigeye as abundance declines (*e.g.* density-dependent catchability) could result in differences from the outcomes predicted here.

Key Results

1. The results of this assessment indicate a recovery trend for bigeye tuna in the EPO during 2005-2009, subsequent to IATTC tuna conservation resolutions initiated in 2004. However, the decline of the spawning biomass that began at the start of 2010 persisted through 2013, and reduced both summary and spawning biomasses to their lowest historic levels at the start of 2014. This decline may be related to a series of recent below-average recruitments which coincide with a series of strong la Niña events. However, at current levels of fishing mortality, and if recent levels of effort and catchability continue and average recruitment levels persist, the SBR is predicted to stabilize at about 0.21, very close to the level corresponding to MSY.
2. There is uncertainty about recent and future recruitment and biomass levels.
3. The fishing mortality of juvenile bigeye, particularly of fish 9-12 quarters of age, declined in 2013, due to the 27% reduction in the catches of juvenile bigeye by the surface fisheries.

Both the recent fishing mortality rates and levels of spawning biomass are estimated to be slightly below the level corresponding to MSY. These interpretations are uncertain and highly sensitive to the

assumptions made about the steepness parameter of the stock-recruitment relationship, the assumed rates of natural mortality for adult bigeye, the growth curve, and the weighting assigned to the size-composition data, in particular to the longline size-composition data. The results are more pessimistic if a stock-recruitment relationship is assumed, if lower rates of natural mortality are assumed for adult bigeye, if the length of the oldest fish is assumed to be greater, and if a greater weight is assigned to the size-composition data, in particular for the longline fisheries.

Following Alexandre Aires-da-Silva's presentation, the SAC discussed the uncertainty of past and present use of the boundary of 150°W longitude in the assessment of bigeye. A participant noted that the boundary is artificial and that the assumption of no net movement of bigeye between the east and west in the equatorial Pacific is weak. Alexandre Aires-da-Silva explained that there were important tagging and movement data to be presented by Kurt Schaefer in a subsequent presentation (Section 8c) that would address the equatorial movements of bigeye. A participant suggested that it would be helpful to include changes in average weight of bigeye from purse seine and longline combined in both fishery reports and stock assessments of the IATTC, and the IATTC staff took note of that suggestion.

The SAC discussed the possible relationship between ocean water temperature and bigeye abundance. Alexandre Aires-da-Silva noted that the relationship between bigeye recruitment and the environment is not clear. However, past assessments of bigeye have indicated that anomalies such as the strongest El Niño events (such as those occurring in 1983 and 1998) have had very strong positive associations with bigeye recruitments, and that recruitments have often decreased during La Niña years, while in other years the relationship has broken down. He indicated that previous attempts have been made to include environmental covariates in the bigeye assessment, but that this did not improve the assessment model. When available, environmental data are included along with operational variables in catch-per-unit-effort standardization. This is not done for bigeye since the longline CPUE data are not available at a fine temporal and spatial resolution (aggregated). A participant expressed concern that the bigeye spawning biomass ratio (SBR) estimated for 2013 is at a historically low level, and inquired about possible reasons for the decrease in this index since 2010, after an apparent increase during 2004-2010. Alexandre Aires-da-Silva indicated that since 2010 there has been a period of lower bigeye recruitment, and although IATTC conservation measures are in place, these reduced recruitments did not allow further rebuilding of biomass. However, the SBR is projected to stabilize slightly above the level corresponding to MSY under current fishing mortality and average recruitment conditions. One participant expressed concern that the historical low catch of bigeye in 2013 and the historical high number of purse-seine sets on floating objects in 2013 suggest that the recruitment level is low, and that, as a result, the projection may overestimate the future SBR trend.

8b. Updated operational-level indices for Japanese longline fisheries (SAC-05-08b)

Cleridy Lennert-Cody presented collaborative research with scientists at the National Research Institute of Far Seas Fisheries of Japan. The purpose of the project was to evaluate the effect of differences in fishing efficiency among vessels on standardized trends for bigeye tuna from the Japanese longline fishery in the EPO. The work was based on the analysis of operational-level Japanese longline data from 1979-2012. Standardized trends in each of the four bigeye tuna stock assessment areas were computed from the operational-level data using negative binomial regression models, with and without vessel effects. Results suggested that when differences in fishing efficiency among vessels were taken into consideration, the long-term trend in the index was slightly more pessimistic, depending on the area. It was also found that, with exception of the last few years, both operational-level standardized trends were generally similar to the indices currently used in the bigeye tuna stock assessment model, which are based on aggregated data. For the most recent few years in the Central and Southern areas, both operational-level indices were slightly more optimistic than the index computed from aggregated data. A simple comparison of stock assessment model results was also shown, comparing the summary biomass and spawning biomass from an assessment model run with the aggregated-data index to those of an assessment model run with the operational-level index that included vessel effects. The model run with

the operational-level index gave a more optimistic perception of the current stock state. However, it was noted that the confidence intervals about these biomass trends are quite large and the results would be unlikely to be statistically different. Development of more complex standardization models from operational-level data that might improve model fit was initiated but not completed due to computational challenges associated with analysis of large data sets.

The SAC discussed an apparent contradiction between the comparison of stock assessment model results and the comparison of the operational-level trends, which showed that the trend based on the generalized linear model with a vessel effect was actually more pessimistic. The differences in stock assessment results could be a combination of effects, the effect of fitting to aggregated *versus* operational-level data, and the addition of a vessel effect to the operational-level model, the former possibly being the more influential. Further analyses would have to be done to tease apart these confounding effects.

8c. Movements and stock structure across the equatorial Pacific, based on tagging data (summary of results: SAC-05-08c)

Kurt Schaefer presented a summary of tagging studies of bigeye in the equatorial Pacific. Bigeye tagging experiments conducted in the eastern and central Pacific Ocean were successful in releasing 49,941 fish with plastic dart tags (PDTs) and 772 fish with archival tags (ATs).

PDT and AT returns are about 43% and 50%, respectively, for fish released near 95°W, and 32% and 16%, respectively, for fish released between 140°W and 180°. The median and 95% of the days at liberty were 146 and 549 d, respectively, for fish released near 95°W, and 164 and 515 d, respectively, for fish released between 140°W and 180°. The median and 95% of the linear displacements, from release to recapture positions, for fish at liberty for >30 d, were 259 and 1,016 nmi, respectively, for fish released near 95°W, and 1,013 and 3,677 nmi, respectively, for fish released between 140°W and 180°. 99.4% of those linear displacements were confined to between 10°N and 10°S. The linear displacements were predominantly westward (80.4%), from releases near 95°W, and predominantly eastward (71%), for fish released between 140°W and 180°. The data indicate significant differences in the linear displacements by release locations, days at liberty, and fish length at release.

Analyses of AT data, utilizing the unscented Kalman filter model with sea-surface temperature measurements integrated (UKFsst), enabled the reconstruction of the most probable tracks (MPTs) of individual fish, the estimation of 95% volume contours for all positions along MPTs, by release longitude, and the estimation of movement parameters by release longitude. Considerable variation was observed in movement patterns among individuals, both within and between release longitudes. The movement patterns for the releases along 155°W illustrate fairly strong regional fidelity to release location, but those for the releases along 140°W and 170°W illustrate less regional fidelity, and extensive eastward movements. In comparison, for releases at 95°W, the predominant movement patterns indicate strong regional fidelity to release location, with restricted westward movements.

These analyses of PDT and AT data suggest that three putative stocks (eastern, central, and western) occur across the equatorial Pacific Ocean, between 10°N and 10°S, with stock boundaries at about 120°W and 180°.

The SAC discussed why the archival tag recovery rate was higher in the eastern Pacific, and higher than the recovery rate of conventional tags. Kurt Schaefer explained that the high recovery rate of archival tags was related to the higher $250 reward offered for archival tags versus only $10-$15 for conventional tags. In the central Pacific, the archival tag recovery rates were much lower, due to a high rate of tag shedding and presumed higher mortality after tag surgeries in the smaller fish tagged in that region. A participant inquired about the low number of recoveries of bigeye in regions north of 15°N latitude and asked about the origin of bigeye caught in the Hawaii fishery. Kurt Schaefer indicated that there is protracted spawning of bigeye between 15°N and 15°S latitude, but that seasonally the spawning habitat extends northward and southward including Hawaiian waters. The stock assessment is based on the assumption of

mixing between northern and southern areas.

A question was asked about the possible association between FAD distribution and distribution of tagged bigeye during the studies. Kurt Schaefer noted that the bigeye distribution was not strongly associated with FAD density, but instead was more related to regional fidelity due to forage conditions in the eastern and western Pacific, and that movement in the central Pacific was related to both forage conditions and oceanography of the region.

One participant noted that the tagging program was quite recent (2008-2012) and that the recoveries of bigeye can be expected over the next several years which may provide information on movements and growth. Kurt Schaefer noted that the tagging data are only representative of the sizes and ages of the fish tagged and recaptured, but that the data included fish up to 8 years at liberty.

8d. On the great scientific interest to sample the sex of adult tuna recoveries with a reference to the adult tunas

Alain Fonteneau presented a review and a discussion of the results obtained from the Indian Ocean tagging program on the sex of large yellowfin and large bigeye recoveries. These results are based on a small sample of 75 bigeye and 100 yellowfin recovered during 5 years in the entire western Indian Ocean. All of these recoveries were measured and their time at liberty is well known. Both species show marked differences in growth rates and in the asymptotic sizes of male and female: males have higher growth rates and larger asymptotic sizes. The natural mortality of female yellowfin is moderately greater than males, and nearly identical for both sexes of bigeye tuna. These results are probably valid in the Indian Ocean, and perhaps valid in other oceans. It is recommended that WCPFC and IATTC should start a similar sampling program of their recoveries of large bigeye and yellowfin, especially those caught by purse seiners that are easily identified and sampled by observers. Future work should also be developed to incorporate better the complexity of these results in future tuna stock assessment models.

The SAC discussed the importance of including sex-specific data in EPO fishery management and the difficulty of obtaining growth data from very large yellowfin (>150 cm). The IATTC had looked at sex-specific growth rates in the past. In previous IATTC studies, Alex Wild found from age determination of otoliths a 4-cm difference between large male and female yellowfin, and Pat Tomlinson found that this difference was insufficient to create an observed difference in sex ratio at size.

8e. Workshop on Selectivity: Theory, Estimation and Application in Fishery Stock Assessment Models (no background document)

Mark Maunder presented a summary of a stock assessment workshop of interest to the SAC. The Center for the Advancement of Population Assessment Methodology (CAPAM) conducted a Workshop on Selectivity: Theory, Estimation, and Application in Fishery Stock Assessment Models in March 2013. In addition a special issue in Fisheries Research, containing 20 papers from the workshop, has been published. The output from the workshop will be used by CAPAM to create a guide for good practices on modelling selectivity. The main recommendations from the workshop related to selectivity parameterization, time varying selectivity, spatial structure, data weighting, and diagnostics. The IATTC staff will use these recommendations when conducting future assessments.

8e. IATTC work plan for bigeye and yellowfin tunas

Mark Maunder presented a summary of model improvements being planned for yellowfin and bigeye. Both the Yellowfin and Bigeye tuna stock assessments have been reviewed by independent experts. The yellowfin tuna review made the following main recommendations: a) conduct two assessments separated at 5°N, b) standardize the dolphin-associated CPUE, c) separate fisheries based on the analysis of Lennert-Cody, d) use growth estimates from the integrated age-length and growth increment data, and e) model floating object fishery using time varying selectivity. The bigeye tuna review made the following main recommendations: a) identify the issues with the Japanese length composition data, b) analyze gear

factors for longline CPUE, c) reevaluate the longline fishery definitions, d) consider spatial population dynamics and the inclusion of tag data, e) re-evaluate the length composition sample sizes, f) start the model in 1955, g) consider a more flexible growth curve, h) consider allowing selectivity to change over time, i) consider selectivity as a function of age rather than length, j) use sex-specific composition data where available, and k) re-evaluate fishery definitions.

The yellowfin and bigeye tuna assessments will be completely re-evaluated and improved during 2014 using data available in the stock assessment presented at SAC5. These analyses will be used to select a new base case model and this model will be updated with new data and presented at SAC6 in 2015. The sensitivity analyses conducted using the SAC5 data will also be presented at SAC6. The improvements will focus on the following components of the model: stock and fishery structure, growth, selectivity, data weighting, and longline composition data.

The SAC discussed the future incorporation of the new movement data. This will likely take more time as Pacific-wide assessment is necessarily more complex, the location of stock boundaries are not clear, and the assumptions underlying the movement patterns still need to be tested. A preliminary study showed no large differences in management advice between models using a boundary of 150°W *vs*. 170°W.

9. Skipjack tuna

9a. Indicators of stock status (SAC 05-09)

Mark Maunder presented the status of skipjack. Eight data- and model-based indicators were presented. The purse-seine catch has been increasing since 1985, and has fluctuated around the upper reference level since 2003. The floating-object CPUE has generally fluctuated above the average level since 1990 and was at the upper reference level in 2011. The unassociated CPUE has been higher than average since about 2003, and was at its highest level in 2008; it declined in 2010, then increased to above the upper reference level in 2013. The standardized effort indicator of exploitation rate increased starting in about 1991, but decreased in 2009 and 2010. The average weight of skipjack has been declining since 2000, and in 2009 was below the lower reference level, but has increased slightly since then. The biomass, recruitment, and exploitation rate have been increasing over the past 20 years, and have fluctuated at high levels since 2003. The biomass and recruitment were close to the upper reference level in 2013.

The main concern with the skipjack stock was the constantly increasing exploitation rate. However, this appears to have leveled off in recent years. The data- and model-based indicators have yet to detect any adverse consequence of this increase. The average weight was below its lower reference level in 2009, which can be a consequence of overexploitation, but can also be caused by recent recruitments being greater than past recruitments or expansion of the fishery into areas occupied by smaller skipjack. Any continued decline in average length is a concern and, combined with leveling off of catch and CPUE, may indicate that the exploitation rate is approaching, or above, the level associated with MSY.

A SAC participant made one suggestion to map skipjack tuna size in the catch to verify the assumption that the size of skipjack is smaller in the western EPO.

10. Other tunas

A. Pacific bluefin tuna (SAC-05 INF A)

Report of ISC Working Group (SAC-05 INF A)

Yukio Tekeuchi, former chair of the ISC[2] Pacific Bluefin Tuna Working Group, on behalf of Ziro Suzuki, the Working Group chair, presented the results of the latest stock assessment update of Pacific bluefin tuna, conducted in February 2014 by the Pacific Bluefin Tuna Working Group and adopted by the ISC

[2] International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean

plenary in March 2014. The February 2014 update updated the latest full stock assessment conducted in 2012 with two additional years (July 2011-July 2013) of data. The results of latest stock assessment update indicated current spawning stock biomass (SSB) (26,324 t) is near the historical lowest level. It was also pointed out that in recent six years (2008~2013) average recruitment level is likely lower than the historical average. The stock is experiencing overfishing and is overfished. He also indicated that, based on the results of examinations of seven candidate future harvest scenarios provided by WCPFC NC9 in September 2013 , if current management measures by both IATTC and WCPFC continue into the future, the stock is not expected to increase from the current historical low level if the low recruitments of recent years continue into the future. Among the candidate harvest scenarios only scenario 6, which is the strictest one, can achieve an increase to the historical median level of SSB with high probability under a low recruitment scenario.

a. Stock status of Pacific bluefin tuna and the urgent need for management action (SAC-05 INF, SAC-05-10a)

Mark Maunder presented an alternative method for examining the stock assessment of Pacific bluefin tuna. The stock assessment of Pacific bluefin tuna (by the ISC is unsatisfactory because the model does not adequately fit the data. The lack of fit to the main indices of spawning abundance is particularly concerning. Exploratory analysis identified a single main mode in the Japanese and Chinese Taipei longline length frequency data. Analysis of these data external to the model were used to estimate absolute abundance and trends in abundance. The results support the management advice based on the ISC model. The stock is highly depleted and experiencing overfishing. The analysis of the data shows that the spawning biomass is supported by a single cohort that is nearing the end of its life. Future projections predict that the population will not increase under the low recruitment scenario, which is consistent with recent recruitment estimates, unless catches of juveniles are reduced by 25-50%. Similar cuts are needed to ensure a high probability of reaching 10% of the unexploited biomass in 10 years, assuming average recruitment. In conclusion, urgent management action is needed to ensure the sustainability of the Pacific bluefin fisheries.

Yuko Hiraoka presented a critique of Document SAC-05-10a. The critique presented Japan's summary explanation of two points of objection to SAC-05-10a. . The first point of objection was the statement of "The current spawning biomass could be less than 10,000 t." The calculation was conducted based on the following assumptions; 1) the Japanese CPUE-based index of abundance represents a single cohort, and 2) all spawning Pacific bluefin tuna, essentially one cohort, are fully vulnerable to the longline fishery. It is agreed that the strong cohorts (1990 & 1994 year classes) have constituted the main part of the Japanese longline catch. However, this catch has never been composed of only the 1994 year class, as is clearly shown in Figure 5 of SAC-05-10a. Japan strongly recommends that an age composition analysis should be based on information of direct age determination from otoliths for older Pacific bluefin tuna. Japan's conclusion was that these results are based on an unrealistic single cohort assumption and could be unreliable. In addition, the single cohort assumption did not consider the younger spawners which were not caught by the longline fishery, thus the current spawning stock biomass estimated in Document SAC-05-10a was an underestimate. The second point of objection was the statement that "The CPUE data for the Chinese Taipei longline fishery (…) should be omitted from the analysis until the reasons for the inconsistencies are identified." It was considered the nature of these fisheries that there were some differences in CPUE and body size composition between Japanese and Chinese Taipei longline fisheries data, because these data were collected in different fishing grounds, *i.e.*, the waters off southeastern Japanese and Okinawa Islands and the waters off southeastern Taiwan, respectively. To provide a better understanding of the above two points, Japan presented some ideas for future work to include plausible estimates of age-length keys based on the direct age determination of Pacific bluefin from otoliths and methods for the estimation of the length composition for Japanese longline fishery.

The SAC discussed the three presentations above and suggested various measures that might reduce pressure on wild populations such as increased supply of juveniles artificially bred to farm bluefin (not

likely to have a large impact), increased cooperation among individual countries, and closures. It was noted that some of the Taiwanese offshore and coastal longline vessels have moved to the Indian Ocean. One participant asked if the longline vessels fishing in the spawning grounds target Pacific bluefin tuna, to which the answer was that some do and some don't, but they also catch other species of tunas like yellowfin and albacore. About half of the longline catch of Pacific bluefin tuna comes from the spawning grounds, and the longline CPUE is higher in the spawning grounds than outside, but both are very low. One participant cautioned that the future projections with different catch restrictions on juveniles were conducted considering all fish of less than 30 kg juveniles.

The SAC agreed that the situation is critical for Pacific bluefin tuna, the current takes are not sustainable, and that strong measures are needed. Disappointment was expressed that there is an imbalance in the measures taken in the eastern Pacific *vs*. western Pacific, although it was suggested that needed management should improve in the western Pacific once Japan institutes the 50% cut in catch of juvenile bluefin (< 30 kg) to levels below the 2002-2004 annual average catch due to begin in 2015. There is currently collaboration within the ISC, but joint management was recommended to harmonize the conservation measures needed. The point was made that there are neither good nor bad fisheries; all fisheries that take juvenile bluefin (including sports fisheries) need to significantly reduce their catches. Further, those fisheries that take adult bluefin should reduce catches as much as possible.

b. Management Strategy Evaluation (MSE) implementation in Stock Synthesis: Application to Pacific bluefin tuna (SAC-05-10b)

Mark Maunder presented a description of Management Strategy Evaluation (MSE) using the Stock Synthesis (SS) general stock assessment program as the operating model. Samples from the posterior distribution of a Bayesian application of SS using Markov Chain Monte Carlo (MCMC) are used to represent the possible states of nature, allowing for uncertainty in parameters used in typical stock assessment models. The bootstrap procedure built into SS for generating random observations is used to include observation uncertainty in the future data used in the harvest control rule. Process error is included by extending the "estimation" period of the stock assessment used to create the operating model to include the period over which the MSE will be conducted. Priors can be put on model parameters that are usually fixed (*e.g*., natural mortality), and the parameters estimated to more accurately represent uncertainty. R code is developed to communicate between the SS-based operating model and the management procedure that is being evaluated. The advantage of using SS is that assessments using SS are already available for many stocks, and these can easily be converted into SS-based operating models to conduct an MSE. The procedure is applied to Pacific bluefin tuna based on the stock assessment carried out by the ISC, which was conducted in SS. The management procedure, comprised of simple harvest rates applied to two CPUE-based indices of abundance, one for spawners and one for recruits, is compared to a simple catch-based management procedure similar to that evaluated by the ISC's working group on Pacific bluefin tuna. The harvest rate procedure produced lower uncertainty in biomass projections. A management strategy that seeks MSY, which is the unofficial target reference point of the IATTC, may be desirable. Future work includes improvement of the stock assessment model used for the operating model, identification of other candidate management procedures, and development of appropriate performance criteria.

The SAC noted that under the constant harvest rate rule, the fisheries having catch based on the spawning biomass abundance index will increase as the population rebuilds, but those based on the recruitment index of abundance will just fluctuate around the average level. It was also noted that estimated biomass size from the operating model used for the example MSE, differs from the latest stock assessment of Pacific bluefin tuna by the ISC. This may be due to the potential problem of convergence of the MCMC distribution used for the MSE.

B. Northern albacore tuna (no background document)

Carolina Minte-Vera made a presentation (no document) to report the most updated information regarding

the North Pacific albacore stock. Monitoring of the effort in the EPO and of the stock status is required by IATTC Resolutions C-05-02 and C-13-03. Recent effort (2010-2012 average) for the fisheries targeting North Pacific albacore in the EPO was compared to historic levels. No baseline is currently defined for historic levels; two periods were computed for illustration. The average number of vessels during recent years (2010-2012) was 721 for the United States and 171 for Canada; the 10-year average (2002-2011) was 667 and 185 , and the 2002-2004 average was 689 and 215, respectively). The increase in the average number of US vessels was a result of the 802 boats that operated in 2012. The recent effort, in vessel-days, was 30,014 (US) and 7,301 (Canada); the historical levels were 24,849 and 7,301 (10-year average), and 24,364 and 8,898 (2002-2004 average), respectively. In April 2014, a stock assessment workshop was held in La Jolla by the ISC Albacore Working Group . The stock assessment report will be completed during the first semester of 2014 and will be available online. The model developed by the Albacore Working Group is an age and sex-structured Stock Synthesis seasonal model that covers the period from 1966 to 2012. The model is fitted to CPUE and length-frequency data and includes updated catch data for ISC, IATTC and WCPFC countries. A Kobe plot was produced by the IATTC staff with a run from the model developed by the Albacore Working Group. The assumed steepness of the stock-recruitment curve was 0.9, and the assumed natural mortality was 0.3. Uncertainties about the estimation of the stock status and the fishing mortality rate are high. The results show that the stock is well above the proposed IATTC limit biomass reference point (SAC-05-14). The fishing mortality is well below the proposed IATTC limit fishing mortality reference point.

The SAC acknowledged the current limitations on reporting ISC assessment results. Until the ISC Working Group stock assessment report is approved by the ISC plenary, only limited conclusions can be drawn at this time. It was noted that most of the northern albacore catch comes from the WPO (more than twice that of the EPO).

11. Assessments of other species

a. Silky shark (SAC-05-11a)

Alexandre Aires-da-Silva presented potential stock status indicators for silky sharks in the eastern Pacific Ocean.

The results of two recent genetics studies support assessing and managing the populations of silky sharks (*Carcharhinus falciformis*) in the western and eastern Pacific Ocean separately. One of the studies suggests a further division of silky sharks in the eastern Pacific Ocean (EPO) into two stocks, approximately along the Equator.

An attempt to assess the status of the silky shark in the EPO using conventional stock assessment models has been severely handicapped by major uncertainties in the fishery data, mainly regarding catch levels in the early years, which may be why the model is unable to explain the population declines observed in the early period of the assessment (1994-1998) (Document SAC-05 INF-F). Although this stock assessment attempt has produced a substantial amount of new information about the silky shark in the EPO (*e.g.*, absolute and relative magnitude of the catch by different fisheries and their selectivities), the absolute scale of population trends and the derived management quantities are compromised. Therefore, an alternative scientific basis for management advice is urgently needed. This document presents a suite of possible stock status (or stability) indicators (SSIs) which could be considered for managing the northern and southern stocks of silky sharks in the EPO.

Indices based on standardized catch-per-unit-effort (CPUE) in purse-seine sets on floating objects (CPUE-OBJ) are proposed as the best indicators for representing trends in the silky shark populations in the EPO, mainly on the basis of their wider spatial coverage of the floating-object fishery compared to other set types. However, indicators for other set types are also presented as a potential means to verify the trends of the CPUE-OBJ indicators.

For the northern stock, the CPUE-OBJ indicator shows an initial sharp decline over a wide spatial range

(1994-1998), followed by a period of stability (1996-2006), and possibly increase (2006-2010). However, there are indications that any such increase has been reversed in recent years (2010-2013). These trends are corroborated by a different type of indicator (presence/absence) produced from other set types (dolphin and unassociated).

For the southern stock, the CPUE-OBJ indicator shows a sharp decline during 1994-2004, followed by a period of stability at much lower levels. These trends are also corroborated by presence/absence indicators based on other gear types.

No stock status target and limit reference points have been developed for silky sharks based on these indicators. In addition, no harvest control rules have been developed and tested. At this point, the indicators cannot be used directly for determining the status of the stock or for establishing catch limits: they should be used in combination with other information for those purposes. In terms of management, it is critical that precautionary measures be implemented immediately to allow silky shark populations to rebuild in the EPO.

With respect to future research on SSIs for silk sharks, priority should be given to management strategy evaluation (MSE) work to identify the reference points and harvest control rules that will achieve the conservation goals for silky sharks in the EPO.

The SAC discussed the inability of the model to fit the early sharp decline of the CPUE data used as the main indicator of abundance for the silky shark. It is not known what risk there is to the ecosystem due to this species' decline. Alexandre Aires-da-Silva indicated that studies to-date have placed the silky shark among a medium productivity group among sharks, but recent downward trends in abundance of silky sharks require immediate action to promote recovery of the stock. A concern was expressed that the sampling program may not be sufficiently developed to monitor the recommended measures, in particular the 20% juvenile limit.

b. Dorado (SAC-05-11b)

Alexandre Aires-da-Silva presented an update on the preliminary results from IATTC collaborative research activities on dorado (*Coryphaena hippurus*) fisheries by IATTC staff and scientists of coastal Member States (Document SAC-05-11b).

Requests have been made by some EPO coastal Member States for collaborative research with IATTC staff on dorado and assistance with the design of data collection forms and data-entry programs for dorado fisheries. The work done so far includes: analysis of available catch statistics and trade records, improvement of field data collection programs, investigation of seasonal trends, and identification of fishery units. In addition, available fishery data on dorado from IATTC members and other nations are being analyzed to develop stock status indicators (SSIs) which could potentially provide a basis for advice for managing the species in the EPO. All data for 2013 shown in the report are preliminary. Finally, a proposed IATTC Stock Assessment Group research plan for low-information and bycatch species, including dorado, is outlined.

The SAC confirmed the importance of these preliminary assessments of dorado to the EPO coastal Member States. Ecuador announced the first workshop for assessing dorado in the EPO; the workshop will be held in Manta, Ecuador from October 6-10, 2014. The SAC recommended that further collaboration among countries is currently needed to assess dorado at a level similar to that directed at silky sharks. Guillermo Compeán thanked all participating countries in these preliminary analyses.

c. Indicators of stock status (SAC-05-11c)

Michael Hinton presented information on stock status indicators. The IATTC staff has conducted full assessments of the principal species of tunas, as well as of blue marlin, sailfish, striped marlin, and swordfish, but not of any bycatch species other than dolphins. Stock Status (or Sustainability) Indicators (SSIs) fill the void when data are insufficient for an assessment. They can also be used in harvest-control

rules developed for management. The demand for SSIs has increased with the increased emphasis on ecosystem management and with efforts to manage the tradeoffs between conservation and economic benefits, but the resources necessary for obtaining the basic biological and life history data required for full assessments for the multitude of bycatch species are not available. A triage system is needed to determine on which species to focus. To that end the IATTC has developed productivity and susceptibility analyses (PSAs) to help gauge the vulnerability of bycatch species to fishing. The development of indicators will require identifying the management advice needed and the data that are available and suitable for the purpose. Candidate SSIs should be the subject of extensive testing as that conducted in management strategy evaluation.

Summary of points and recommendations

1. Indicators should be developed, and evaluated for performance and reliability prior to adoption. Standards for these evaluations need to be established.
2. The IATTC Productivity and Susceptibility Analysis (PSA), which identifies species expected to be vulnerable to fisheries, such as most of the sharks taken in the purse-seine fisheries, should be taken into account when establishing priorities for developing indicators.
3. Priority should be given to changes in the experimental design of the purse-seine observer program in order to obtain data needed for developing indicators; for example, collecting data on whether species are present rather than on the size of discarded fish.
4. Observers should be assigned tasks on an ad hoc basis in order to obtain the data necessary for indicators.
5. The spatial and temporal structure and distribution of pelagic resources in the EPO should be considered when developing indicators.

The SAC suggested that additional factors could be included as indicators, such as physical conditions of the fish or environmental factors. It was stressed that the capability of the observers to collect data is finite, that our past experience has shown that training in species identification is critical when instituting a new sampling or monitoring study, and that greater support is required, not only to maintain the current program, but to meet the increased demands for data on a wider range of species required under the Antigua Convention. Focusing on the well-observed tuna purse-seine fishery hides the fact that there are unobserved fisheries that can have significant bycatches. The IATTC staff has been working with coastal longline fisheries and has put some observers on small purse seiners. It was suggested that experiments with electronic sampling or monitoring devices be conducted as well.

d. Index of relative abundance for dolphins (SAC-05-11d)

Cleridy Lennert-Cody presented a progress report on renewed research on the development of an index of relative abundance for dolphins from data collected by observers aboard large purse-seine vessels. The work focused on data from 1990-2012 for the northeastern stock of offshore spotted dolphin. A description of the data processing and calculations used for computing search effort in kilometers was presented. It was explained that the calculation of search effort is based on movement of the purse-seine vessel. A description of heterogeneity in search behavior inferred from sighting characteristics was also presented.

It was demonstrated that there have been changes over the years in the relative use of the three main sighting methods for dolphin herds (binoculars, radar, and helicopter), and that the percentage of dolphin sightings that led to sets by these sighting methods differs. It was noted that these changes through time in search behavior are consistent with the findings of previously published work. It was concluded that this heterogeneity in search behavior has the potential for loss of sighting information from helicopter and radar search, relative to the level of information available from search by binoculars.

The present work also identified potential changes within a trip in search tactics, depending on whether the vessel was in transition between fishing areas or searching at a fishing area. It was explained that this

heterogeneity in searching behavior needs to be accounted for in any model for trend estimation, but that at present such models are still under development. Nonetheless, in order to provide further insights for future model development, a preliminary trends modeling attempt was presented. It was explained that CPUE-type models are being considered at present, instead of line transects methods, because of previously-identified concerns about sighting bearing data quality. The preliminary model fitted to the data was a delta-lognormal generalized additive model (GAM), with a logistic regression component for the presence/absence of dolphins in a trip-day-1° area and a lognormal component for the total number of dolphins per kilometer searching in a trip-day-1° area. To try to control for differences in sightings characteristics by sighting method, which cannot be explicitly included in this simple GAM, models were fitted to two different subsets of the data. In addition, two different approaches were taken for weighting when computing the standardized trends from the GAM results. All model terms were highly significant but simple diagnostics indicated that fit to the data needs to be improved.

The preliminary standardized trends estimated with these procedures were decreasing over the 1990-2012 period, with trends from the two different subsets of the data more similar to each other than the trends estimated with different weighting strategies. In order to provide insights on further model development, these preliminary trends were compared to previously-published indices for dolphins and for yellowfin tuna. It was found that the current preliminary trends were similar to other trends estimated from purse-seine observer data, even though different subsets of data and different methods of estimation were used. It was noted that none of these trends adequately corrects for the possible loss of sightings information for sighting methods other than binoculars.

By contrast, it was noted that there is little correspondence between any of the purse-seine trends and the indices of absolute abundance computed from NMFS survey data. In addition, it was noted that the current preliminary trends for dolphins show a striking similarity to those for yellowfin tuna. It is believed that the purse-seine yellowfin tuna index tracks yellowfin abundance because of similarities in the yellowfin indices computed for the purse-seine fishery and the longline fishery, keeping in mind that the two fisheries catch different sized (age) fish and the trend will be lagged accordingly. It is plausible that the similarity between the indices for the two species reflects fishermen's ability to locate areas where dolphins are associated with tunas, instead of indexing changes in the absolute abundance of dolphins, highlighting inadequate treatment of the issue of non-random search in the present analyses.

It was concluded that while data collected by purse-seine observers represent an extensive data resource, the issues of non-random search and time-varying biases due to temporal changes in fishing behavior will need to be adequately addressed if these data are to be used for? trend estimation for dolphins. The presentation concluded with a summary of the next phase of dolphin trends model development that is presently being undertaken.

The SAC suggested that additional analyses could potentially be done such as a) examining the sensitivity of the results, currently based on vessels with $\geq$5% dolphin sets, to using vessels with 50-70% dolphin sets, b) including sightings initially made by the observer rather than just those made from the crew using the helicopter, radar, or high-power binoculars, and c) stratifying the data to track the technology changes that have occurred in the fishery. One participant suggested that a probable cause for the correlation between the index and the yellowfin CPUE is because the primary tuna-dolphin sighting method for much of this period was the helicopter, and 80% of these sightings led to sets. Another participant, while rejecting the trends from these analyses, suggested that this index could perhaps be used as a measure of tuna accessibility. The SAC also expressed the importance of continuing fishery-independent surveys. It was noted that the request from the ISSF to conduct this study was an attempt to combine both the observer data with the NMFS survey data to produce a hybrid abundance index; the current analysis has not yet surmounted the biases in the data to the point that this can be done.

The SAC stressed that this was a preliminary study and some participants expressed concern that its contents could be taken out of context. The results are based on non-random searching, subject to biases

that vary with time, and follow the abundance of yellowfin. The trends do not track the trends from fishery-independent surveys, the population dynamics that would be expected of a dolphin species, nor the low observed mortality rates that have occurred since 1992. Therefore, they should not be used to determine trends in the dolphin abundance. It was noted that despite the failure to develop a reliable index of dolphin abundance, the presentation of the results were important because rejection of a null hypothesis (that sightings per search time from observed purse seiners have no bias or have a constant bias) is how science progresses, and that the purpose of the SAC is to use its expertise to provide scientific feedback to the IATTC staff, and that the SAC needs to be aware of both the successes and setbacks in the IATTC's research.

12. Evaluation of the relationship between active purse-seine fishing capacity and fishing mortality in the EPO (SAC-05-12)

Mark Maunder presented an analysis of the relationship between active purse-seine fishing capacity and fishing mortality in the EPO. The IATTC limits the total capacity of the purse-seine fleet as a management measure to control effort. The capacity limits allow the use of temporal closures (and a small spatial closure) to control fishing effort in an attempt to keep fishing mortality at or below levels that correspond to the maximum sustainable yield (MSY). The capacity limits do not specify what type of purse-seine set (on floating objects, on yellowfin tuna associated with dolphins, and on unassociated schools) the vessels can make, although vessels that set on yellowfin associated with dolphins are required to have a dolphin mortality limit (DML). In this analysis, we correlate estimates of fishing mortality from the yellowfin and bigeye tuna stock assessments with the capacity limits to evaluate how effective the capacity limits are at controlling effort. The yellowfin tuna exploitation rate generally follows the total effective capacity from 1975 to 1993, but the relationship breaks down after 1993. The exploitation rate for bigeye tuna was low until 1993, so it does not correlate with the total effective capacity; after 1993 there is a vague relationship between exploitation rate and total effective capacity. The fishing capacity of vessels with DMLs has changed over time. For yellowfin, the correlation between exploitation rate and effective capacity was not improved when capacity was restricted to vessels with DMLs, whereas for bigeye it was improved when capacity was restricted to vessels without DMLs. The combined relative exploitation rate of all three species did not correlate as well as the exploitation rate for bigeye only, but the regression is statistically significant ($P<0.01$). The current combined exploitation rate is above the MSY level, but the current capacity is at the MSY level.

One participant recommended that the yellowfin tuna analysis be repeated using the shorter time period that was used for the bigeye tuna analysis. Mark Maunder commented that, based on visual inspection of the correlation, the r-square would be lower.

13. Ecosystem considerations (SAC-05-13)

Leanne Duffy presented an overview of ecosystem considerations for tuna fishing in the EPO, focusing on studies of trophic interactions, ecosystem metrics, and ecological risk assessments. Investigating fisheries effects on ecosystems requires accurate representations of pelagic food webs in ecosystem models.

A brief overview of a recently published diet study of yellowfin tuna was provided. A novel, modified classification tree approach was used to analyze spatial, temporal, environmental, and biological covariates explaining the predation patterns of over 3300 yellowfin tuna sampled across the tropical EPO during two time periods separated by a decade. The classification tree revealed that a major diet shift had transpired in the heart of the tropical EPO. Epipelagic fishes, most notably bullet and frigate tunas, declined markedly, and were replaced by a suite of mesopelagic species and a crustacean that apparently shifted its distribution further south. Simultaneously, widespread reductions in biological production, changes in phytoplankton community composition, and a vertical expansion and intensification of the oxygen minimum zone were factors considered capable of affecting food webs in the tropical and subtropical EPO.

Trophic levels (TLs) are used in food-web ecology to characterize the functional role of organisms, to facilitate estimates of energy or mass flow through communities, and for elucidating trophodynamics aspects of ecosystem functioning. The mean TL of the organisms taken by a fishery is a useful metric of ecosystem change and sustainability because it integrates an array of biological information about the components of the system. Mean TLs were estimated and presented for a time series of annual catches and discards by species from 1993 to 2010 for three purse-seine fishing modes and the pole-and-line fishery in the EPO. The mean TLs of the summed catches of all purse-seine and pole-and-line fisheries were fairly constant from year to year, varying by less than 0.1 TL.

A preliminary Ecological Risk Assessment (ERA) was made to evaluate the vulnerability to overfishing of several components of the ecosystem by the purse-seine fishery in the EPO. The vulnerability to overfishing of many of the stocks incidentally caught in the EPO tuna fisheries is unknown, and biological and fisheries data are severely limited for most of those stocks. To examine the utility of productivity and susceptibility indices to assess vulnerability of incidentally-caught fishes, mammals, and turtles to overfishing in the EPO, IATTC staff made a preliminary evaluation using productivity and susceptibility analysis (PSA) of three purse-seine fisheries. In general, the PSA shows promise as a tool to rank species that are in most need of attention. However, there is no indication from the PSA whether or not the catches of the species that score the highest in vulnerability are unsustainable. The staff plans to continue the work on a full ERA for the EPO.

One participant suggested that tuna trophic level may vary by area because their prey in different areas may be the same yet occupy different trophic levels. One participant noted that the trophic level (estimated at 5.2) for bigeye tuna is the highest of any tuna. Another offered additional data and collaboration. Another participant urged caution about the use of the term “vulnerability” since it is subjective.

14. Options for reference points and harvest rate control rules (SAC-05-14)

Mark Maunder presented a summary of options for reference points and harvest rate control rules. Limit reference points (LRPs) have been traditionally set on biological grounds to protect a stock from serious, slowly reversible, or irreversible fishing impacts, which include recruitment overfishing and genetic modification. In practical terms, this generally means determining the effect of exploitation on recruitment, typically through evaluating the stock-recruitment relationship. The IATTC staff has historically based its conservation recommendations on an informal decision rule that is based on adjusting effort to correspond to the fishing mortality (F) corresponding to the maximum sustainable yield (MSY; F_{MSY}), implying that F_{MSY} is an LRP (also used as trigger reference points). The use of F_{MSY} as an LRP is unreasonable, particularly if the required probability of exceeding the LRP is very low. Four main points should be kept in mind when developing LRPs:

1. given that management is implemented to achieve the target reference point (TRP), there should be a very low, but not zero, probability of exceeding the LRP;
2. the LRP should be based on biological grounds to protect a stock from serious, slowly reversible or irreversible fishing impacts;
3. the TRPs will often be at, or close to, MSY-related quantities; and
4. the decision about which LRPs are appropriate should be made in the context of the management action to be applied if the limit is exceeded.

Biomass (B) and fishing mortality LRPs are developed based on the predicted reduction in recruitment compared to virgin recruitment. A simplified version is developed for practical implementation of biomass and fishing mortality LRPs using a conservative steepness (h) value for the Beverton-Holt stock-recruitment relationship. The x%R_0 reference point can be converted into a biomass reference point based on the depletion level Bx%R_0 and F x%R_0. A conservative value of h ensures that if the reference point is

triggered there is a low probability that recruitment < x%R_0. A fishing mortality reference point can be determined by finding the equilibrium fishing mortality corresponding to the depletion level. We suggest using 50%R_0 as the definition of the reference point. Issues of the approach include that the 50% is arbitrary, h = 0.75 is semi-arbitrary, should the depletion and F calculations be based on the base case assessment or the conservative value of steepness, and should dynamic depletion, which infers dynamic R_0, be used. The actions when the LRP is exceeded needs to be defined and evaluated using a management strategy evaluation.

The SAC discussed how reference points are to be defined, how these definitions hinge on the harvest control rule that results from the triggering of a reference point, and what management action is to be done when in between a TRP and an LRP. A participant suggested the necessity for clarifying the definition of LRPs because an LRP may be used to close the fishery when it is exceeded or act as a trigger for other management action. It was noted that there could be explicit action applied when an LRP is exceeded or further analysis conducted and appropriate management action determined to ensure recovery in a reasonable amount of time. Support was expressed for the inclusion of uncertainty into the evaluation of the current status relative to the reference points. It was suggested that the LRP would likely be appropriate if it is no lower than the level of the lowest spawning stock size for a species that then subsequently recovered.

15. Staff activities and research plans (SAC-05-15)

Rick Deriso presented the document on staff activities and research plans.

The SAC discussed the stock assessment for bigeye tuna and how the staff will proceed in the future. The SAC discussed the extension of the analysis to include the central and western Pacific. It was noted that other issues such as the separation of the northern and southern stocks, growth, and selectivity are more important and that the new tagging data, which are needed to infer movement, are more difficult to incorporate into the model and will require more time than is available before the next assessment. The SAC also discussed the data collection for Pacific bluefin tuna and the delays in studies such as length composition of sport-caught tuna in the EPO imposed by the lack of funding and the retirement of personnel. It was suggested that the staff focus on sex and length of tunas. While Kurt Schaefer's study on growth will look at this, there is neither staff nor resources to do more at this time.

16. Review of Resolution C-13-01 and staff conservation recommendations for 2014 (SAC-05-16) (Appendix B)

A. Conservation of tunas

1. Yellowfin, skipjack, and bigeye tunas

The SAC discussed whether a longer closure is warranted because if, as expected, the capacity increases and if a midway point between the base-case model scenario and the precautionary scenario is adopted, an additional 30 days may be necessary for bigeye, whereas for yellowfin, no change in current management actions would be called for. The staff indicated that the calculation of closure days for the base case is 51 days, however the staff did not recommend decreasing the number of days from the current 62 days as a precautionary measure. Because it is not certain that a capacity increase will occur, the SAC will review this issue again in 2015 and the staff will take note of these comments. One participant stated that fishing effort, in particular the number of FAD sets, should not increase beyond the current level.

The SAC also discussed whether there was new information available to evaluate the effectiveness of the "*corralito*" closure. The staff will follow up on the suggestion to examine the effects on effort due to the westward shift of the fishery.

2. Pacific bluefin tuna

Concern was raised that Pacific bluefin tuna is a shared stock with WCPFC region and the impact of the EPO fishery is relatively minor with respect to the fisheries of the western Pacific. Therefore any measure

approved in the EPO should be linked to measures in the WCPFC that must be equivalent in its benefits for the rebuilding of the stock. Some participants urged the need to have meetings of major countries participating in the fishery in order to promote measures in both RFMOs that would achieve the conservation benefits to be expected for the Pacific bluefin tuna stock.

Because this is a more political question, this discussion will need to be continued at the meeting of the IATTC. It was suggested C-13-02 should be referenced in SAC 05-16 instead of C-12-09.

3. Northern albacore tuna

One participant suggested specifying the unit of weight mentioned.

B. Reference points

The SAC suggested that additional explanation about reference points be included in the recommendations. One participant stated a recovery plan should be developed before adopting reference points on over-fished species.

C. Harvest control rule

It was suggested that the phrase "further action" be replaced with "immediate and substantial action."

D. Conservation of silky sharks

Some participants considered that a prohibition to retain silky sharks on purse-seine vessels would not be a conservation measure because most of the evidence suggests that sharks are already dead. One participant noted that scientific research in the Indian and Pacific Oceans has demonstrated that up to 20% of the silky sharks caught in purse-seine fisheries can survive with proper release handling practices. Another participant said that the amount of catch is small compared to the other components of fishing mortality, so that these guidelines would provide no real benefit for the conservation of this species. A participant mentioned that there are other fisheries using steel leaders that do not target silky sharks and should be excluded from this measure; another participant disagreed.

E. Seabirds

The SAC discussed the expansion of the limits of the management area. The SAC requested that BirdLife International present more-detailed information at the meeting of the IATTC to better inform the Commissioners.

F. Handling of mobulid rays in purse-seine fisheries

It was suggested that this issue should be discussed based on data from the EPO. It was noted that this is a Best Practices recommendation, not a management action.

G. Handling of sea turtles in longline fisheries

It was suggested that measures adopted by the FAO and other RFMOs all be considered. It was noted that this is a Best Practices recommendation, not a management action.

H. Fishing gear configurations

It was noted that some captains may be reluctant to provide very detailed information about their gear despite the assurances that it will be confidential. It had been argued previously however that such forms are necessary to capture the rapid changes that can occur in fisheries. Without timely knowledge of these changes, effective management can be difficult.

I. Non-entangling FADs

It was suggested that the species to be protected be specified and the following wording be used:

"Hanging any entangling materials, such as loose net webbing, that may entangle any large fauna (*e.g.*

sharks and turtles) under FADs deployed in the EPO should be avoided. Any non-entangling materials, such as ropes, may be used, and observer records will be used to verify their performance. The Commission should support research on the effectiveness of various materials and designs."

It was also noted that this recommendation may not be flexible enough; very fine-mesh nets or nets tied into bundles may attract fish while not posing a risk for entanglement.

J. Identification and marking of FADs

One participant argued that visual marking is redundant if the satellite data are acquired; another argued that both the FAD and the buoy should be tagged because the satellite buoy and FAD can be separated.

L. Observer coverage of longline vessels

It was suggested that the recommendation not include the number of countries that have submitted reports as this is the competence of the Review Committee.

17. Other business

a. Catch, effort, and ecosystem impacts of FAD-fishing (CECOFAD)

Javier Ariz presented a summary of the CECOFAD program. The overall objective of the CECOFAD project will be to provide insights into the fishing effort units (for both fishing modes: FADs and free schools) to be used in the calculation of purse-seiner CPUEs in the Atlantic as well as in the Indian and the Pacific Oceans, where European purse-seiners also operate, to ultimately obtain standardized indices of abundance for juveniles and adults of tropical tunas. With regards to the Ecosystem Approach of Fisheries, the CECOFAD project will provide new knowledge on the impact of FAD-fishing on the epipelagic ecosystem and will be of high relevance to support the decision-making to implement proper future regulations of tuna and by-catch resources.

Bearing in mind the multispecies nature of the tropical tuna purse seine fishery and the regular requests expressed by tuna RFMOs to European tuna scientists to provide reliable estimates of abundance indices and accurate indicators on the impact of FAD-fishing on juveniles of bigeye and yellowfin tunas and on bycatch species, the main objectives of the project are:

1. to define a unit of fishing effort for purse-seiners using FADs that accounts for different factors influencing catchability
2. to standardize catch-per-unit-effort series of the EU purse seine fleet, for juveniles and adults of the three tropical tuna species and
3. to provide information on catch composition around FADs and estimate impacts on other marine organisms (*e.g.*, bycatch of sharks).

This project is co-funded under European Fisheries Policy.

Participants: Scientists from AZTI, IEO and IRD. Stakeholders: ANABAC, OPAGAC and ORTHONGEL.

A question was asked about the geographic coverage of the CECOFAD program. Javier Ariz explained that the program will be conducted in three oceans, in the Atlantic, Indian and Pacific. Rick Deriso inquired about potential differences in catch/day between non-entangling FADs and traditional FADs. Javier Ariz noted that that type of analysis is planned during the CECOFAD study. Some potential differences have been observed informally, but specific quantitative data are needed to make further conclusions.

b. Spatial distribution of fishing effort in FADS (foreign fleet) in the Colombian Pacific - Preliminary results

Carlos Polo presented a summary of a Colombian study on the spatial distribution of fishing effort on

FADs. On the basis of the Pilot Program of on-board Observers implemented by the Colombian Fisheries Authority from the City of Tumaco on foreign-flag tuna vessels from 2009 to 2011, information was taken on the fishing effort made on FADs in national jurisdictional waters. The preliminary results show varied effectiveness among set types, with the school sets being greatest (60%) during the last months of 2009 and beginning of 2010, but between July 2010 and January 2011 this effectiveness increased in sets on FADs (37%). The most abundant species caught were yellowfin tuna, bigeye tuna, skipjack tuna and other fish such as billfishes, wahoo and some species of sharks. The spatial distribution of yellowfin tuna and bigeye is closely related to thermal anomalies in temperature, with a greater affinity for areas with positive anomalies between 0.5 and 1.0, with school sets being the ones where the greatest percentage of yellowfin tuna was caught with 71%, while bigeye is more associated with sets on FADs (52%). The preliminary analyses of the spatial distribution of pilot sharks shows a greater abundance to the south and center of Colombian waters, with sets on FADs being where the greatest frequency of capture occurs (90%). Furthermore trophic analyses showed high values of trophic levels (4.0 and 4.4) for the species caught incidentally in each type of set, showing no variability over the years. Similarly, yellowfin tuna and bigeye showed a high frequency of occurrence with wahoo and dorado in school sets, while in FAD sets the high frequency was observed by high abundances of wahoo and pilot shark.

A participant asked about the current status of the fleet under study, and Carlos Polo indicated that it is currently fishing. There was a question about similarities in bycatch between this program and IATTC's bycatch data. Carlos Polo noted that there are both similarities and differences in the bycatch patterns between the programs, and that this will be examined in further detail. Both Guillermo Compeán and Alexandre Aires-da-Silva indicated that these types of bycatch data from small purse-seine vessels are very valuable since the IATTC's bycatch data are derived from only larger purse-seine vessels.

c. Summary of Japanese bigeye size data (SAC-05-INF-D)

The SAC discussed the source and type of Japanese size data on bigeye that is reported to the IATTC. It was explained that both lengths and weights of bigeye are reported to the IATTC by Japanese scientists, and that the original lengths and weights are measured by commercial fishermen at-sea. A participant cautioned that variability can be introduced through this type of cascading measurement system, and recommended that estimates be made of the uncertainty associated with length estimates based on weight data.

d. Japan observer program annual report 2013

Observer coverage is designed to achieve 5% coverage. There is a need to identify sharks to species.

e. China observer program annual report 2013

Observers were aboard 6 trips but the coverage cannot yet be calculated without complete effort data. It was recommended that the deadline for submission of observer coverage be delayed so that it is in synch with catch and effort data.

f. United States observer program annual report 2013

No presentation was made.

g. Korea observer program annual report 2013

Preliminary reports indicate that there were 132 observed days and 124 observed sets. The goal for 2014 is to achieve 5% coverage.

The SAC had the following comments about the national observer reports: 1) observers must identify tagged fish and record the tag number, length, and sex; 2) standardized forms for longliners should be designed to record information beyond the standard AIDCP data; 3) national reports should include maps of the area covered.

18. Recommendations of the Scientific Advisory Committee

The following are recommendations and endorsements made by the meeting participants (in no particular order):

1. National reports describing national fisheries and research should be provided to the SAC on a voluntary basis, and summaries from these reports should be included as an annex of the SAC reports and posted on the IATTC website. Appendix C presents sample guidelines for preparing such reports.
2. It is preferable that all documents and presentations prepared for the SAC should be available one week before the SAC.
3. All the SAC documents should include a summary of their content.
4. Improve the budget and IATTC effort targeting capacity building of developing countries for obtaining fishery statistics and conducting research.
5. The IATTC should conduct a feasibility study for routine sampling of lengths and sexes of the catches of adult tunas (bigeye, yellowfin, and large skipjack) in the canneries and during observed cruises on longline vessels.
6. It would be desirable if all the detailed results obtained by national observers on longline vessels were combined into a central IATTC data base to allow quantitative analysis.
7. The IATTC staff, in collaboration with those of the SPC and WCPFC and other fisheries agencies, should conduct an analysis of the movement patterns of bigeye tuna from Pacific-wide tagging programs and report the results to the SAC.
8. All possible efforts should be made to obtain sex and size of tagged adult tunas recovered from purse-seine and longline vessels.
9. The IATTC staff should report to the SAC on future stock assessment models that incorporate Pacific-wide stock structure, tuna movements, and sex-specific growth.
10. The IATTC staff should report species-specific Ecological Risk Assessment studies, in particular, for silky and hammerhead sharks in the EPO.
11. Establish observer programs for capacity class 1-5 vessels, with technical assistance from IATTC staff, at a level of observer coverage adequate to reliably monitor silky shark bycatches.

19. Meeting report

The meeting report was adopted.

20. Adjournment

The meeting was adjourned at 1455 on 16 May 2014

Appendix A. List of attendees

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Appendix B. Staff conservation recommendations (SAC-05-16)

INTER-AMERICAN TROPICAL TUNA COMMISSION

SCIENTIFIC ADVISORY COMMITTEE

FIFTH MEETING

La Jolla, California (USA)
12-16 May 2014

DOCUMENT SAC-05-16

RECOMMENDATIONS BY THE STAFF FOR CONSERVATION MEASURES IN THE EASTERN PACIFIC OCEAN, 2014

IATTC Resolution C-13-01 on the conservation of tunas, paragraph 14, calls for the IATTC scientific staff to "…propose, if necessary, appropriate measures to be applied in future years."

A. CONSERVATION OF TUNAS

The staff's recommendations are based on its assessment of bigeye tuna (Document SAC-05-08a) and yellowfin tuna (Document SAC-05-07), which are updates of the 2013 assessments.

For bigeye, the staff's conclusion from this year's assessment is that fishing mortality (F) is slightly below F_{MSY}, the level corresponding to the maximum sustainable yield (MSY), as is indicated by the base-case point estimate for the F multiplier[3] of 1.04 (SAC-05-8a, Table 1), and that the measures established in Resolution C-13-01 have had the intended effect of reducing the fishing mortality of bigeye to a level not exceeding the MSY . However, there is a considerable overlap between the target F multiplier of 1.0 and the 95% confidence intervals for the F multiplier of 1.04, indicating that the evidence supporting a conclusion that fishing mortality is below the level of F_{MSY} is not definitive. Nonetheless, the staff considers that the results support the continuation of Resolution C-13-01. Another factor supporting this is the stock assessments of yellowfin and bigeye, which conclude that the base-case point estimate for the spawning stock is below the MSY level for both yellowfin and bigeye (Table 1 of SAC-05-07 and SAC-05-8a, respectively).

[3] The ratio of the current fishing mortality ($F_{current}$, defined as the average fishing mortality for the three most recent years (2010-2012)) to the fishing mortality that will produce the maximum sustainable yield (F_{MSY}). An F multiplier of 1.0 means that $F_{current} = F_{MSY}$; if it is below 1.0, fishing mortality is excessive ($F_{current} > F_{MSY}$)

As of 2 May 2014, the capacity of the purse-seine fleet operating in the eastern Pacific Ocean[4] (EPO) was 215,608 cubic meters (m^3) of well volume, which is close to the three-year (2011-2013) average of 214,337 m^3 . Consequently, the duration of closures of the fishery cannot be reduced on the basis of a reduction in fleet capacity.

YELLOWFIN, SKIPJACK, AND BIGEYE TUNAS

The staff recommends maintaining Resolution C-13-01 for 2015. The offshore temporal and spatial closure ("*corralito*") can be maintained as in the resolution because it has the effect of reducing bigeye catches by an amount equivalent to a three-day closure of the entire fishery (Appendix I).

PACIFIC BLUEFIN TUNA

A new assessment of Pacific bluefin tuna was completed during the last year. Projections in which Resolution C-12-09 was extended into the future, with some reductions of catches in the western Pacific, indicate that it would likely lead to increases in stock abundance provided recruitment continues at average levels. For a low-recruitment scenario, more similar to the most recent years of recruitment estimates, juvenile catches in the EPO lower than those specified in C-12-09, and greater reductions in juvenile catches in the western Pacific, are required. The staff therefore recommends that the commercial catches in 2014 be limited below 3,154 t, which was the estimated commercial catch in 2013, and that the non-commercial catches in 2014 be limited below 208 t, which is based on the same method that was applied to commercial catch to determine that recommended limit.[5]

NORTHERN ALBACORE TUNA

The staff considers that the new assessment of northern albacore tuna, completed in April 2014, supports Resolution C-05-02, and recommends the continuation of Resolutions C-05-02 and C-13-03.

B. PROVISION OF DATA

Catch-composition data provided to the IATTC should be disaggregated by the original unit of measurement (*e.g.* weight and length), fleet (including commercial and training vessels), and sex if available.

C. REFERENCE POINTS

The staff recommends that the Commission adopt the following target and limit reference points[6], based in part on document SAC-05-14, which defines two limit reference points, $F_{0.5R0}$ and $S_{0.5R0}$:

Stock	Target reference point	Limit reference point
Albacore tuna	B_{MSY}; F_{MSY}	$F_{0.5R0}$ and $S_{0.5R0}$, where h = 0.75
Bigeye tuna	B_{MSY}; F_{MSY}	$F_{0.5R0}$ and $S_{0.5R0}$, where h = 0.75
Skipjack tuna	B_{MSY}; F_{MSY}	$F_{0.5R0}$ and $S_{0.5R0}$, where h = 0.75
Yellowfin tuna	B_{MSY}; F_{MSY}	$F_{0.5R0}$ and $S_{0.5R0}$, where h = 0.75
Bluefin tuna	B_{MSY}; F_{MSY}	$F_{0.5R0}$ and $S_{0.5R0}$, where h = 0.75

D. HARVEST CONTROL RULE

The staff has consistently recommended the harvest control rule that, if fishing mortality exceeds the level

[4] Defined as the IATTC Convention Area, established in Article III of the Antigua Convention

[5] The commercial catch quota is a 1 - 3,154 / (10,000/2) = 37% reduction from the previous quota, which was already reduced in 2012-2013 (Resolution C-12-09)

[6] F_{MSY}: fishing mortality rate corresponding to the maximum sustainable yield; B_{MSY}: spawning biomass corresponding to the maximum sustainable yield; $S_{0.5r0}$: spawning biomass corresponding to that which produces a 50% reduction in recruitment as calculated in a Beverton-Holt spawner-recruit model with steepness of 0.75; $F_{0.5R0}$: fishing mortality that causes spawning biomass to be reduced to $S_{0.5r0}$; see SAC-05-14 for details.

corresponding to MSY, it be reduced to that level. The staff recommends that the Commission adopt this rule.

In addition to that F_{MSY}-based management action, if the abundance of a stock falls below its limit reference point, further action should be taken to promote the rebuilding of the population towards its target reference point.

E. CONSERVATION OF SILKY SHARKS

An attempt to assess the status of the silky shark in the EPO using conventional stock assessment models has been severely handicapped by major uncertainties in the fishery data, mainly regarding catch levels in the early years. An alternative scientific basis for management advice is urgently needed and, for that purpose, a suite of stock status indicators (SSIs) are used (Document SAC-05-11a). For the northern stock, catch per set, the main indicator, shows an initial sharp decline over a wide spatial range (1994-1998), followed by a period of stability (1996-2006), and possibly increase (2006-2010). However, there are indications that any such increase has been reversed in recent years (2010-2013). For the southern stock, this indicator shows a sharp decline during 1994-2004, followed by a period of stability at much lower levels. The staff considers the above estimates reported in SAC-05-11a sufficient to warrant recommending the following precautionary measures, to promote the rebuilding of silky sharks stocks in the EPO:

1. For purse-seine vessels:
    a. Prohibit retention of silky sharks by all vessels, and require that the sharks be promptly released unharmed, to the extent feasible.
    b. Establish observer programs for capacity class 1-5 vessels, with technical assistance from IATTC staff, at a level of observer coverage adequate to reliably monitor silky shark bycatches.
    c. Record, through observer programs for purse-seine vessels of all capacity classes, the number and status (dead/alive) of silky sharks caught and released.
2. For vessels other than purse-seiners, require that all silky sharks captured in fisheries that do not target this species be released as soon as they are seen in the net, on a hook, or on deck, to improve their chances of survival.
3. Close fisheries directed at silky sharks for a three-month period each year[7], preferably during the first semester[8]. Fisheries not directed at silky sharks, but which catch the species incidentally, may continue to operate during the closure, but should not be allowed to use steel leaders on longlines for the duration of the closure.
4. Limit the catch of silky sharks of less than 100 cm total length during a trip to 20% of the total number of silky sharks caught during that trip.
5. Identify silky shark pupping grounds and prohibit fishing (with steel leaders) in them.
6. Change Paragraph 12 of Resolution C-05-03 to read "Paragraphs 2-10 of this resolution apply to sharks caught in association with fisheries operating in the EPO" so that reporting of shark catches, by species, and of fishing effort, required by paragraph 11 of the resolution, is mandatory for all vessels.
7. Conduct experiments on mitigating shark catches, especially in longline fisheries, and on the

[7] The three-month closure is based on the ratio of the best measure of average catch in 2008-2009 to that in 2011-2012.
[8] The distribution of catches suggests that the predominant period of silky shark catch is the first half of the year.

survival of sharks captured by all gear types, with priority given to those gears with significant catches. Survival experiments should include studies of the effects on survival of shorter sets and of the use of circle hooks.

8. Support research on mitigation of shark bycatches and data collection projects.

F. SEABIRDS

The Commission should revise Resolution C-11-02 consistent with the current state of knowledge regarding seabird mitigation techniques, as described in document SAC-05 INF-E[9]. The two-column menu approach in C-11-02 should be replaced by a requirement to use at least two of the following three mitigation methods in combination: line weighting, night setting. and bird-scaring lines. Other mitigation methods should not be endorsed as until their effectiveness is proven. The three recommended mitigation measures should, at the very least, specify the minimum standards in Appendix II).

The Commission should take note of the updated seabird density information and consider expanding the area of application of measures to include additional waters in the North Pacific

G. HANDLING OF MOBULID RAYS IN PURSE-SEINE FISHERIES

The Commission should :

1. Prohibit the gaffing of rays.
2. Prohibit lifting rays by the gill slits or spiracles.
3. Prohibit the punching of holes through the bodies of rays (*e.g*. to pass a cable through for lifting the ray).
4. Prohibit the retention of Manta and Mobula rays caught incidentally during fishing operations.
5. Require that, to the extent possible, rays too large to be lifted safely by hand be brailed out of the net using methods such as those recommended in document WCPFC-SC8-2012/ EB-IP-12 (Poison *et al*. 2012, Good practices to reduce the mortality of sharks and rays caught incidentally by the tropical tuna purse seiners).
6. Require that large rays that cannot be released safely before being landed on deck, be returned to the water as soon as possible, preferably utilizing a ramp from the deck connecting to an opening on the side of the boat, or if no such ramp is available, lowered with a sling or net.

H. HANDLING OF SEA TURTLES IN LONGLINE FISHERIES

The Commission should encourage the use of the videos and other educational materials, such as those available on the IATTC website, to train captains and crews of longline vessels on when and how to dehook or disentangle a turtle and familiarize them with the correct methods for doing so, illustrated in these materials. Fishermen should be provided with educational materials for identifying leatherback, loggerhead, and hawksbill turtles.

The Commission should also adopt the following additional measures:

1. Require every longline vessel operating in an area where sea turtles may be hooked or entangled to carry: a) a dipnet to safely lift sea turtles aboard the vessel, b) a line cutter that is long enough to reach the turtle without lifting it from the water, c) dehookers (both inverted-V-shaped and a pigtail-shaped), d) a bolt cutter capable of cutting hooks, and e) equipment capable of safely keeping the sea turtle's mouth open.
2. Prohibit lifting of turtles from the water using the fishing lines in which the turtles are hooked or

[9] Prepared by ACAP and Birdlife International

entangled. If a turtle must be removed from the water, an appropriate basket lift or dipnet should be used. If a hooked turtle cannot be safely removed from the water, any remaining line should be cut as close as possible to the hook without inflicting additional harm on the turtle. In no case should the length of line left attached to the hook exceed the length of the turtle's carapace.

3. Prohibit attempts to remove swallowed hooks from turtles, and instead require that the hook be left in place and the line cut as close to the hook as possible without further injury to the animal.
4. Vessel crew should be encouraged to assess the condition of any sea turtle brought aboard the vessel prior to releasing them. To the extent practicable, injured or unresponsive turtles should be kept on board and assisted in a manner consistent with methods described in the FAO's Guidelines to Reduce Sea Turtle Mortality in Fishing Operations and in the materials on the IATTC website.

I. FISHING GEAR CONFIGURATIONS

The Commission should require that vessels submit the purse-seine and longline gear description forms appended to Document SAC-05-05. The information provided will be treated as confidential by IATTC staff, and used only for scientific purposes. Any significant modifications made to the gear subsequently should be reported on these forms prior to departing port with the modified gear.

J. NON-ENTANGLING FADS

Hanging any materials, such as net webbing, that may entangle any fauna under FADs deployed in the EPO should be avoided. Any non-entangling materials, such as ropes, may be used, and observer records will be used to verify their performance. The Commission should support research on the effectiveness of various materials.

K. IDENTIFICATION AND MARKING OF FADS

Vessels should authorize the companies the operate the satellite systems used to track the FADs to provide to the IATTC, directly or through whatever mechanism the governments and vessel owners consider suitable, the positions of each buoy from the time of deployment until it is recovered, with a time lag of four months to protect the owner's proprietary information.

FADs with satellite buoys deployed after 1 January 2015, shall be marked on the upper surface with a five-digit numeric code, at least 50 mm high, in such a way as to avoid covering the solar cells used to power the equipment while allowing the best visibility possible by the observer on the vessel. If the observer cannot read the code from the vessel, a crew member should provide the code to the observer. IATTC staff at the port of departure will assign the codes for each trip, with enough notice to allow for the painting of the buoys. The observer will record the location of deployment and code of each marked buoy.

The information provided will be treated as confidential by IATTC staff, and used only for scientific purposes.

L. OBSERVER COVERAGE OF LONGLINE VESSELS

Four Member countries provided summary reports of their observer programs. The information provided is insufficient for a rigorous evaluation of the adequacy of 5% coverage for their longline fisheries. The data show that 5% is too low a level of coverage to allow accurate estimates of the catch of species caught infrequently in those fisheries. In other studies in which large amounts of information has been collected, a 20% level of coverage has been calculated to be adequate to provide reliable estimates of the infrequently-caught species.

The staff recommends 20% observer coverage of large longline vessels until sufficient information is available to justify a revision.

APPENDIX I: EFFECT OF THE *"CORRALITO"* CLOSURE ON BIGEYE TUNA CATCHES

Document IATTC-77-04 evaluated the effect of a proposal for the conservation of bigeye and yellowfin tuna in the EPO.

For the purse-seine fishery in the EPO during 2008, 2009, and 2010, the proposal consisted of two components: a 12-week closure in the entire EPO from 20 June through 11 September, and a closure of an offshore area very similar to the "corralito" (Figure 1; proposal D2A in Document IATTC-76-04) during 12 September through 31 December (110 days).

Figure 5 of the document shows the impact of 12- and 6-week temporal closures at different times of the year (not including the effect of a closure of the area in Figure 1).

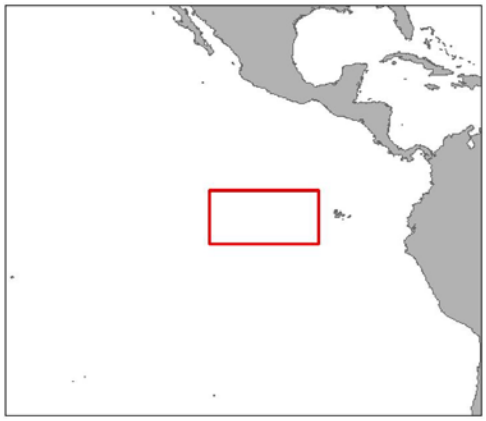

FIGURE 1. Offshore closure area between 94° and 110°W and from 3°N to 5°S

Table 1 of that document shows that, during 1995-2003, the proposal would have reduced the average purse-seine catch of bigeye by 29%. The 12-week closure starting on 20 June would have reduced the catch by 26%. Therefore, the estimated reduction in catch due solely to the 110-day *corralito* closure amounts to 3% or, over the 31-day period specified in Resolution C-13-01, about 0.85%, the equivalent of a three-day closure of the entire fishery (0.03% per day; 0.85%*365).

APPENDIX II: MINIMUM STANDARDS FOR SEABIRD BYCATCH MITIGATION MEASURES FOR LONGLINE VESSELS

1. Branchline weighting configurations should consist of weights greater than 45 g attached within 1 m of the hook, or weights greater than 60 g attached within 3.5 m of the hook, or weights greater than 98 g weight attached within 4 m of the hook. Positioning the weight further than 4 m from the hook should not be deemed adequate.
2. All setting of longlines should be started and completed between nautical twilight and nautical dawn.
3. On longline vessels greater than 35 m length overall, two bird-scaring lines should be deployed in a configuration that maximizes their aerial extent, but with a minimum aerial extent of 100 m. Lines should be attached to the vessel at a height of at least 8 m above the water at the stern. Streamers should be brightly colored, a mix of long and short (<1 m), placed at intervals of no more than 5 m, and attached to the line with swivels that prevent streamers from wrapping around the line. All long streamers should reach the sea surface in calm conditions. Baited hooks should be deployed within the area bounded by the two bird-scaring lines, and.bait-casting machines should be set so that the

baited hooks hit the water within that area .

4. On vessels of less than 35 m length overall, a single bird-scaring line should be deployed in a manner that maximizes its aerial extent, but with a minimum aerial extent of 75 m. Lines should be attached to the vessel at a height of at least 7 m above the water at the stern. Streamers should be brightly colored and attached to the line with swivels that prevent streamers from wrapping around the line. Short streamers (<1 m) should be placed at 1-m intervals along the entire length of the aerial extent. Longer streamers at 5-m intervals along the first 55 m of aerial extent, to complement the short streamers, could be added at the vessel's discretion. All long streamers should reach the sea surface in calm conditions.

Appendix C. Guidelines for national fishery reports

GUIDELINES FOR THE PREPARATION OF ANNUAL REPORTS

1. Introduction

The purpose of Annual Reports is to provide a mechanism for the submission of relevant information on the tuna-related activities of Contracting Parties and Cooperating non-Contracting Parties, Entities or Fishing Entities during the preceding year.

2. Submission process

Annual Reports should be submitted to the SC one week before the start of the meeting

3. Report sections

Annual Reports should contain specific, separate sections on National fisheries that are active on the species covered by the IATTC Antigua convention, statistics and research. They may optionally include appendices containing additional information pertinent to these topics.

The overall structure of these reports should be as follows:

Summary

A summary (not to exceed 20 lines, or half a page) must be included with the report.

National fisheries information and information on research and statistics should be concise. Detailed information of a more scientific nature, or for discussion by individual species working groups, should be presented to the SC as scientific papers.

Section 1: Annual fisheries information

This report section should provide complementary information relating to the data submitted to ICCAT on total catches, effort, CPUE and size-frequency data and briefly describe trends in tuna fisheries during recent years. Attention should be given to changes in fishing patterns or new developments in fisheries, as well as socio-economic factors which influence or explain such changes and developments.

Section 2: Research and statistics

This report section should provide a description of the statistical data collection systems implemented to monitor tuna fisheries, with an indication of the degree of coverage of catch, effort and size data for fishing operations in local and distant waters. Attention should be given to problems, changes and improvements in such statistical systems and, where possible, the coverage of retained catches of target and by-catch species, and of discarded catches.
This section should also present summarized information on tuna-related research activities and results of particular interest to IATTC, such as research related to stock delineation, stock assessment, migration

and environmental factors. A brief description and summarized results or observer programs may also be included in this section.

Tables should be placed after the text, followed by the figure(s);

Figures should be placed after tables.

Appendices, if any, should be placed after figures, and following the standardized headings.