INTER-AMERICAN TROPICAL TUNA COMMISSION

SCIENTIFIC MEETING

La Jolla, California (USA)
9-12 May 2011

MEETING REPORT

Chairman: Dr. Guillermo Compeán

CONTENTS

AGENDA

		Documents
1.	Opening of the meeting	
2.	Consideration of agenda	
3.	Rules of procedure for the Committee	SAC-02-03
4.	The fishery in 2010	SAC-02-04
5.	Review of 2010 staff conservation recommendations and IATTC Recommendation C-10-01	
6.	Assessment of yellowfin tuna	SAC-02-06
7.	Assessment of bigeye tuna:	SAC-02-07
8.	Assessment of skipjack tuna	SAC-02-08
9.	Assessment of swordfish	SAC-02-09
10.	Poststratified estimators of total catch for port-sampling data	SAC-02-10
11.	Evaluation of the Kobe plot and matrix and their application to tuna in the EPO	SAC-02-11
12.	Ecosystem considerations	SAC-02-12
13.	FAD research activities	SAC-02-13
14.	Research project on mitigating bycatch in the purse-seine fishery	SAC-02-14
15.	Summary of recent activities and planned future activities	SAC-02-15
16.	Conservation measures for bluefin tuna in the eastern and western Pacific Ocean	SAC-02-16
17.	Discussion of planned stock assessment methods workshop in fall 2011: "Integrating fisheries oceanography into stock assessment and management"	
18.	Other business	
19.	Recommendations	
20.	Meeting report	
21.	Adjournment	

APPENDICES

A. List of attendees
B. Proposal of Colombia for genetics studies in the EPO

The 2nd Meeting of the Scientific Advisory Committee was held in La Jolla, California, USA, on 9–12 May 2011. The attendees are listed in Appendix A.

1. Welcome, introductions, meeting arrangements

The meeting was called to order on 9 May 2011 by the Chairman, Dr. Guillermo Compeán, Director of the IATTC, who thanked the attendees for coming to the meeting. The Scientific Advisory Committee (SAC) is established by the Antigua Convention, and is composed of one representative designated by each member of the Commission. The required two-thirds quorum was not present, and the meeting proceeded as an informal meeting at the invitation of the Director. The recommendations from the attendees will be forwarded to the Commissioners through the Director.

2. Consideration of agenda

Dr. Compeán reviewed the provisional agenda. An additional item on conservation measures for bluefin

tuna had been added as Item 16 a few days prior to the meeting, and two additional contributions to Item 18, Other business, were mentioned. The agenda was approved without further changes.

3. Rules of procedure for the Committee (SAC-02-03)

At the first meeting of the SAC in August 2010 a request was made to examine the rules of procedures for the SAC. Dr. Compeán noted that the SAC is established by the Antigua Convention and there are rules set forth in the Convention and its annexes for the operation of the Committee. He noted that the Commission needs to instruct the SAC about some aspects of the meetings, including how to proceed when the quorum specified in the Convention is not reached. A participant asked about participation by observers from non-governmental organizations (NGOs). Dr. Compeán noted that the Antigua Convention defines members and observers, and that observers must be approved by the Commission. All approved observers may participate, including those from other organizations such as the WCPFC and ISC. Clarification of the participation of NGOs pursuant to the Convention is needed in the rules of procedure, A participant further noted that under Rule 3 of the rules of procedure proposed in Document SAC-02-03 only governmental members may participate in decision-taking. Clarification was requested as to whether this means decisions on both scientific and procedural issues. Scientific decisions made by the SAC will be made by consensus, or with a majority and minority view if consensus was not reached.

A participant asked if scientific documents may be submitted to the SAC. Dr. Compeán noted that in previous years documents were contributed and posted on the IATTC website. The Convention contains stipulations about documents for the Committee, and the staff welcomes documents from scientists. If many documents are submitted, the staff will not be able to translate them; however, there will be simultaneous translation of the presentations during the meeting. It was noted by a participant that the rules of procedure should establish a time deadline for documents to be submitted.

4. The fishery in 2010 (SAC-02-04)

Mr. Ed Everett reviewed the information on the fishery for tunas in the eastern Pacific Ocean (EPO) in 2010. He discussed tuna catch statistics for 2010: total catches by species and by flag, distributions of purse-seine catches of yellowfin, skipjack, and bigeye, and size compositions of the three species. The catches of yellowfin (251,670 metric tons (t)), skipjack (147,240 t), bigeye (57,752 t), and Pacific bluefin tuna (7,857 t) by purse-seine, pole-and-line, and recreational gear in 2010 were about 35% less than the record catch of 715,000 t in 2003, and about 14% lower than the 15-year average.

Together, Ecuadorian-, Mexican-, Panamanian-, and Venezuelan-flag vessels caught about 79% of the total catch of yellowfin, skipjack, and bigeye in the EPO during 2010. Mexican, Panamanian and Venezuelan vessels caught about 64% of the yellowfin, and Ecuadorian vessels caught about 56% of the skipjack. The yellowfin catch distributions for 2010 showed an increase in catches on dolphins in the inshore areas off southern Mexico and Central America, while yellowfin catches were lower in the inshore areas off Ecuador and Peru compared to the 2005-2009 average. Yellowfin catches in 2010 were 22% higher than the 2005-2009 average. Catches of skipjack in 2010 were lower in the areas north of 10°N, and in the inshore areas off Ecuador and Peru as compared to the five-year average of catches. Slightly higher catches of skipjack were observed on floating-object sets in the offshore equatorial area from about 130°W to 150°W. Skipjack catches in 2010 were 112,000 t (43%) lower than the 2005-2009 average. Bigeye catches in 2010 were similar to the 2005-2009 average, with the exception of slightly greater catches in the offshore equatorial area from about 140°W to 150°W, and considerably lesser catches in the equatorial area from 90°W to 110°W.. Catches in 2010 were about 20% lower than the 2005-2009 average.

Mr. Everett described the length-frequency and species composition sampling areas and the areas defined for stock assessments. Of the 723 wells sampled for length-frequency and species composition in 2010, 555 contained yellowfin, 326 contained skipjack, and 163 contained bigeye. The average sizes of yellowfin in 2010 were considerably less than those of 2009. The average sizes of skipjack were slightly

greater than those of 2009, but less than during the previous four years. The average size of bigeye in 2010 was less than those observed during 2007-2009.

One participant requested confirmation that the samples taken are related to the total catch. Mr. Everett confirmed that they are.

5. Review of 2010 staff conservation recommendations and IATTC Recommendation C-10-01

Dr. Richard Deriso reported that recommendations made by the IATTC staff to the 2010 Annual Meeting of the Commission (Document IATTC-81-06b), were largely supported by the Commission, and led to the approval of Recommendation C-10-01 on conservation measures. The two other Recommendations approved by the Commission, were C-10-02 on mitigating bycatches of seabirds and C-10-03 on prohibiting setting near data buoys.

Dr. Compeán indicated that the four major purse-seine fishing countries, and most other countries as well, have already informed the IATTC as to which closure they will follow. The few countries that have not yet informed the IATTC regarding this matter have until July 2011 to do so. A participant asked if this referred to the 62-day closure, and Dr. Compeán confirmed that it did.

6. Assessment of yellowfin tuna (SAC-02-06)

Dr. Alexandre Aires-da-Silva 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 3.20b) was used in the assessment, which is based on the assumption that there is a single stock of yellowfin in the EPO.

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 catch data for the surface fisheries have been updated, and new data added for 2010. New or updated longline catch data are available for French Polynesia (2008), Japan (2008-2010), Korea (2009) and the United States (2008-2009). Surface fishery catch per unit of effort (CPUE) data were updated, and new CPUE data added for 2010. New or updated CPUE data are available for the Japanese longline fleet (2008-2010). New surface fishery size-composition data for 2010 were added. New or updated length-frequency data are available for the Japanese longline fleet (2007-2009).

In general, the recruitment of yellowfin to the fisheries in the EPO is variable, with a seasonal component. This analysis and previous analyses have indicated that the yellowfin population has experienced two, or possibly three, different recruitment productivity regimes (1975-1982, 1983-2002, and 2003-2010). The productivity regimes correspond to regimes in biomass, with higher-productivity regimes producing greater biomass levels. A stock-recruitment relationship is also supported by the data from these regimes, but the evidence is weak, and this is probably an artifact of the apparent regime shifts. A sharp decline in the levels of spawning biomass since 2009 follows a series of below-average recruitments from the second quarter of 2007 through the last quarter of 2008.

The average weights of yellowfin taken from the fishery have been fairly consistent over time, but vary substantially among the different fisheries. In general, the floating-object, northern unassociated, and pole-and-line fisheries capture younger, smaller yellowfin than do the southern unassociated, dolphin-associated, and longline fisheries. The longline fisheries and the dolphin-associated fishery in the southern region capture older, larger yellowfin than the northern and coastal dolphin-associated fisheries.

Significant levels of fishing mortality have been estimated for the yellowfin fishery in the EPO. These levels are highest for middle-aged yellowfin. The dolphin-associated and unassociated purse-seine fisheries have the greatest impact on the spawning biomass of yellowfin, followed by the floating-object

fisheries. The impact of the longline and purse-seine discards is much less.

There is a large retrospective pattern of overestimating recent recruitment. This pattern, in combination with the wide confidence intervals of the estimates of recent recruitment, indicates that these estimates and those of recent biomass are uncertain.

Historically, 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 1975-1983, coinciding with the low productivity regime, but above that level during most of the following years, except for the recent period (2004-2007 and 2010). The 1984 increase in the SBR is attributed to the regime change, and the recent decrease may be a reversion to an intermediate productivity regime. The two different productivity regimes may support two different MSY levels and associated SBR levels. The SBR at the start of 2011 was estimated to be at 0.18, below the level corresponding to the MSY (0.25). The effort levels are estimated to be less than those that would support the MSY (based on the current distribution of effort among the different fisheries), and recent catches are below MSY.

It is important to note that the curve relating the average sustainable yield to the long-term fishing mortality is very flat around the MSY level. Therefore, changes in the long-term levels of effort will change the long-term catches only marginally, while changing the biomass considerably. Reducing fishing mortality below the level at MSY 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 were 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 calculations indicate that, theoretically at least, catches could be increased if the fishing effort were directed toward longlining and purse-seine sets on yellowfin associated with dolphins. This would also increase the SBR levels.

The MSY has been stable during the assessment period (1975-2010), which suggests that the overall pattern of selectivity has not varied a great deal through time. However, the overall level of fishing effort has varied with respect to the level corresponding to MSY.

If a stock-recruitment relationship is assumed, the outlook is more pessimistic, and current effort is estimated to be above the level corresponding to the MSY. The status of the stock is also sensitive to the value assumed for the average size of the oldest fish. If the CPUE of the northern dolphin-associated fishery, rather than that of the southern longline fishery, is assumed to be the most reliable index of abundance, the current spawning stock biomass is estimated to be at about the level corresponding to MSY.

Under current levels of fishing mortality (2008-2010), the spawning biomass is predicted to rebuild and remain above the level corresponding to MSY. However, the confidence intervals are wide, a retrospective pattern exists in recent recruitment, and there is a moderate probability that the SBR will be substantially above or below this level. Fishing at F_{msy} is predicted to reduce the spawning biomass slightly from that under current effort and produces slightly higher catches.

Key Results

1. There is uncertainty about recent and future levels of recruitment and biomass, and there are retrospective patterns of overestimating recent recruitment;
2. The recent fishing mortality rates are lower than those corresponding to the MSY;
3. The recent levels of spawning biomass are below those corresponding to the MSY;
4. Increasing the average weight of the yellowfin caught could increase the MSY.

5. There have been two, and possibly three, different productivity regimes, and the levels of MSY and the biomasses corresponding to the MSY may differ among the regimes. The population may have recently switched from a high to an intermediate productivity regime;
6. The results are more pessimistic if a stock-recruitment relationship is assumed;
7. The results are sensitive to the average size assumed for the oldest fish.

Following Dr. Aires-da-Silva's presentation, a participant expressed concern that the longline data may not adequately represent the longline fishery in recent years, due to the reduction in effort related to high oil prices. Dr. Aires-da-Silva agreed that effort is lower, and perhaps changes in fishing efficiency (catchability) have occurred. To better characterize these changes and improve the longline catch-effort standardization, access to fine-scale longline operational data is needed. The IATTC staff offered to work in collaboration with Japanese scientists on this issue. Another participant pointed out that defining purse-seine fishing effort is problematic, and that longline effort is more reliable.

Another participant agreed that changes in productivity regimes are possible, but that many fishing vessels had lower fishing power in earlier years than in recent years. Dr. Aires-da-Silva acknowledged the importance of taking into account changes in fishing efficiency. The observed abrupt decline in recruitment and subsequent biomasses in the more recent years may be a combination of a lower productivity regime and higher fishing mortalities. The assumption of higher natural mortality rates for female yellowfin was questioned, and that sex ratios may not be as skewed as indicated. Dr. Aires-da-Silva indicated that the mortality schedule was developed using empirical data (sex ratios and maturity), but it is necessary to continuing exploring alternative hypotheses and sensitivity analyses.

A participant mentioned that the yellowfin stock assessment gives a mixed result, and would like more interpretation. The spawning stock size is low with respect to the level corresponding to the MSY, and he believes that steepness is actually below 1.0. He stated that every assessment is overly-optimistic for the current years when analyzed retrospectively, so the yellowfin stock is likely below target and fishing mortality is likely above target, and there may be a need for more stringent conservation measures Another participant mentioned that perhaps more stringent conservation measures are not needed, but fishing effort that does not exceed current levels. Dr. Aires-da-Silva stated that the management quantity taken into consideration in the staff's management recommendations is not spawning stock size but the *F* multiplier, which has not been subject to high retrospective bias. With respect to a lower steepness, although the yellowfin model fits better with a lower steepness, this may be due to the different productivity regimes. There is as yet no solid basis among the regional fishery management organizations (RFMOs) to use a lower steepness. In addition, the staff uses a steepness value less than 1.0 as a floor for precautionary management.

Another participant discussed the *F* multiplier within the context of steepness. The likelihood profile on steepness indicated that steepness appears to be less than 1.0 (at about 0.70). This can be explained by the different regimes of productivity. Accordingly, the hypothesis of different productivity regimes should be incorporated in the future projections. Dr. Aires-da-Silva welcomed this suggestion. The participant suggested that estimates of MSY and the biomass corresponding to MSY do change depending on what regime is assumed to calculate average recruitment. Therefore, the current status of the stock may change depending on the regime used to calculate the reference points.

Dr. Deriso mentioned that the staff's conservation recommendations are more conservative than those corresponding to a steepness value of 1.0.

A participant suggested that it would be helpful if the RFMOs could jointly resolve the common issue of using CPUE as an index of abundance. Another participant indicated that large-scale changes in the movements of fish can affect stock assessments, and asked whether yellowfin tagged recently in the western Pacific had been recovered in the eastern Pacific, since that might influence the stock assessment. The staff reported that there are some recent data for yellowfin tagged in the central Pacific, but that those

data have not yet been considered in the yellowfin assessment. The tagging has been primarily directed to bigeye, and fewer yellowfin have been tagged.

A participant offered the opinion that technical information from the assessments needs to be understandable to the Commissioners. More analysis of the fishery for yellowfin on fish-aggregating devices (FADs) was suggested, as well as more analysis of the effects of oceanographic conditions on yellowfin abundance. Dr. Aires-da-Silva indicated that the assessment of yellowfin is based on the best information available to date and although the yellowfin projections contain uncertainty, the *F* multiplier (the quantity used for management) is more robust across sensitivities. Dr. Compeán stated that the staff always presents precautionary recommendations in its assessments (*e.g.* lower steepness), and that in the yellowfin fishery, the recommended catches have been less than MSY estimates. He added that estimates of relative abundance of yellowfin have been consistent since the 1970s because the fishery has been consistent, thus providing some level of confidence for the yellowfin abundance estimates.

Another participant questioned the time periods used to partition cold and warm periods in the EPO in the analysis of yellowfin recruitment, and suggested an alternative partitioning of cold and warm periods which extends the start of a warm period from the early 1980s back to the mid-1970s, which then extends through 1998. The participant agreed that warm periods of ocean temperatures favored higher yellowfin recruitments and that very high recruitments directly followed very strong ENSO years. Dr. Aires-da-Silva indicated that the staff's analysis had noted these general associations between recruitment and ocean temperature patterns and ENSO events for both yellowfin and bigeye, and he agreed that there is subjectivity in the fine partitioning of cold and warm periods in the yellowfin assessment. The definition of cold/warm periods is not clear cut.

Clarification was requested about the future direction of the yellowfin assessments. Dr. Aires-da-Silva indicated that the yellowfin analysis could benefit from more flexibility in the treatment of selectivity (changes over time). Another participant suggested the possible exclusion of the most recent quarterly estimates of recruitment of yellowfin in the projections, since those recent estimates are the most uncertain and could propagate bias in the analysis. Dr. Aires-da-Silva noted that the staff will continue to address the retrospective pattern in recruitment, and has considered the exclusion of the most recent quarterly recruitment estimates in the projection analysis, if necessary.

6.1. Yield per recruit and MSY of longline fisheries for yellowfin in the EPO

Dr. Alain Fonteneau presented a brief paper, prepared by himself and Dr. Javier Ariz, questioning the conclusion of various IATTC stock assessment reports on yellowfin that MSY of the longline fishery could be larger than 400,000 t in the EPO. Based on the analysis of fishery and environmental data in the Pacific Ocean and in the EPO, the paper reaches the conclusion that the real potential MSY of longliners on the EPO yellowfin stock is probably very low, much lower than in the western Pacific Ocean, for instance. This low potential MSY is due to the fact that this resource is not significantly available to longliners, even if their yield per recruit is high. This very low catchability of the EPO yellowfin stock to the past and present longline fisheries is probably explained by the low levels of oxygen concentration observed in this area at the traditional fishing depth of longliners.

Dr. Deriso pointed out that the staff's reports state that the longline fisheries are not efficient enough to catch the full MSY that is predicted. Another participant agreed that this point is clearly stated in the Commission documents. Dr. Fonteneau believes that the estimates for longline are misleading and should be omitted, but it is not necessary to remove the calculations for the dolphin and floating-object fisheries. Dr. Deriso agreed that the staff could eliminate the longline only MSY in Table 5.2a in the report or alternatively the table caption can be modified to make it clear that the results pertain to changes in the age selectivity corresponding to each of the types of fishing.

7. Assessment of bigeye tuna (SAC-02-07)

Dr. 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 Version 3.20b) was used in the assessment. This model is the same as the base case model used in the previous assessment (IATTC Stock Assessment Report 11).

The stock assessment requires a substantial amount of information. Data on retained catch, discards, catch per unit of effort (CPUE), and age-at-length data 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 (see IATTC Stock Assessment Report 11). Catch and CPUE for the surface fisheries have been updated to include new data for 2010. New or updated longline catch data are available for French Polynesia (2009), Japan (2008-2010), the Republic of Korea (2009) and the United States (2008-2009). Longline catch data for 2010 are available for China, Chinese Taipei and Vanuatu from the monthly reporting statistics. New or updated CPUE data are available for the Japanese longline fleet (2008-2010). New purse-seine length-frequency data are available for 2010. New or updated length-frequency data are available for the Japanese longline fleet (2007-2009).

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 increased to a much 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. 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 population 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.

There are several important features in the estimated time series of bigeye recruitment. First, estimates of recruitment before 1993 are more uncertain, as the floating-object fisheries were not catching significant amounts of small bigeye. There was a period of above-average annual recruitment in 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 high in 2005 and 2006. The 2009 recruitment was below average, but the recruitment in 2010 appears to have been particularly high. However, this recent estimate is very uncertain and should be regarded with caution, due to the fact that recently-recruited bigeye are represented in only a few length-frequency samples.

Since the start of 2005, when the spawning biomass ratio (the ratio of the spawning biomass (S) at that time to that of the unfished stock; SBR) was at its historic low level of 0.16, the bigeye stock has shown a recovery trend, to an SBR of 0.24 at the start of 2011. According to the base case model, this most recent SBR is about 21% higher than the maximum sustainable yield (MSY) level. This recent recovery trend is subsequent to the IATTC tuna conservation resolutions initiated in 2004.

Recent catches are estimated to have been 8% greater than those corresponding to the MSY levels. If fishing mortality (F) is proportional to fishing effort, and the current patterns of age-specific selectivity are maintained, the level of fishing effort corresponding to the MSY is about 93% of the current (2008-2010) level of effort.

According to the base case results, the two most recent estimates indicate that the bigeye stock in the EPO is probably not overfished ($S>S_{MSY}$), but that fishing mortality slightly exceeds the level corresponding to the MSY (overfishing is taking place, $F>F_{MSY}$). This interpretation, however, is subject to uncertainty as indicated by the approximated confidence intervals around the most recent estimate in the Kobe plot. The addition of new data for 2010 and updated data for earlier years lowered the SBR compared to the

previous assessment. Similar retrospective patterns also occurred in previous assessments when adding new and updated data. The changes are generally within the confidence intervals of the estimated quantities and well within the ranges estimated under different sensitivity analyses from the previous assessment.

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 less than F_{MSY}.

Under the current levels of fishing mortality, recent spikes in recruitment are predicted not to sustain the increasing trend observed for SBR since 2004. Both the base case and the assessment assuming a stock-recruitment relationship indicate that the population is likely to drop below the level corresponding to MSY under average recruitment conditions. It is estimated that catches will be lower in the future at current levels of fishing effort if a stock-recruitment relationship is assumed, 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 increasing 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 recent recovery trend for bigeye tuna in the EPO (2005-2010), subsequent to IATTC tuna conservation resolutions initiated in 2004. However, under the current levels of fishing mortality, recent spikes in recruitment are predicted not to sustain this increasing trend;
2. There is uncertainty about recent and future recruitment and biomass levels;
3. The recent fishing mortality rates are estimated to be slightly above the level corresponding to MSY, and the recent levels of spawning biomass are estimated to be above that level. As described in IATTC Stock Assessment Report 11, 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, the assumed levels of natural mortality for adult bigeye, and the historic period of the bigeye exploitation used in the assessment. 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, if lower rates of natural mortality are assumed for adult bigeye, and if only the late period of the fishery (1995-2009) is included in the assessment;
4. The results are more optimistic if a lower value is assumed for the average size of the older fish, and if higher levels of natural mortality are assumed for adult bigeye.

Following Dr. Aires-da-Silva's presentation, a participant asked about an apparent contradiction that the bigeye stock is making a recovery, but that there is also overfishing. Dr. Aires-da-Silva commented that although there are signs of population rebuilding since 2004 after IATTC resolutions, the current levels of fishing effort (fishing mortality) are still above those corresponding to the MSY, and this is the information that matters for management recommendations. However, there is uncertainty in the assessment, and sensitivity analyses are done to address uncertainty. Dr. Compeán remarked that fishing mortality is above the level at MSY. If it continues above MSY, it cannot be guaranteed that the recovery will continue. There is a trend for growth in biomass, but no guarantee that it will continue. Participants expressed support for continuing strict management measures.

Clarification was requested about the results of forward projections which are more pessimistic in comparison to last year's assessment (SAC-01-08a). Dr. Aires-da-Silva indicated that this result is due to the combined effect of lower recent recruitments and higher fishing mortality rates (lower *F* multiplier).

Discussion followed about the 150°W limit of the EPO, and that there is bigeye movement across the line toward the west and east, and whether the SAC should recommend the preparation of a comprehensive report about movement across the frontier of the EPO, to include fish tagged in the west. Dr. Aires-da-Silva pointed out that the staff fully recognizes that the bigeye stock is viscous and movements occur across the 150°W meridian, but that the net movement should be minimal.

Dr. Deriso presented release and recovery locations for bigeye tuna tagged during joint SPC/IATTC tagging studies near 150°W longitude in 2008-2009. The results indicate limited movement, similar to the pattern shown by earlier tagging in the EPO, but also that 150°W longitude is not a barrier to movement of bigeye. There was agreement that 150°W longitude is not a barrier to bigeye movement, and that bigeye have plenty of time for movements during their life history. Dr. Deriso explained that the IATTC and SPC will be conducting more joint tagging studies in the central Pacific, and in addition, archival tag data already collected by the IATTC staff, will provide a more robust analysis of bigeye movements across 150°W longitude.

Dr. Deriso also explained that one problem in analyzing the tag recovery data is the uncertainty in assigning the proper well from which the tags originated after unloading in port. Tags are often handed in at a local IATTC field office sometime after their removal from a well, and this sometimes creates uncertainty as to the proper assignment of the well, and therefore the probable capture location and date. Dr. Deriso stressed the need for more funding to employ tag return staff at the docks at vessel unloading.

A participant noted that the recommendation made by the "External Review of IATTC Bigeye Tuna Assessment," that "The Panel recommends that future model runs should start in about 1955 and use as much of the historical data as possible," should be followed by the IATTC staff for the bigeye stock assessments in the future. Dr. Aires-da-Silva replied that the Commission staff believes that working with data that are representative of the recent mix of fisheries and selectivities in the EPO is preferable: this avoids encountering other major shifts, such as increased recruitments observed after the expansion of the FAD fishery, which have been of concern for some participants. Another issue is that data on the number of hooks per basket used in longlines are available for the period after 1975 only. The same participant mentioned that changes in the number of hooks per basket before that year were minimal. Dr. Michael Hinton, of the IATTC staff, pointed out that an analysis published by Dr. H. Okamoto showed that there was significant variation in hooks-per-basket in various regions prior to 1975, but that the publication is available only in Japanese.

One participant expressed concern about whether the recovery trend since 2004, indicated in the EPO bigeye assessment, is robust enough that it does not contradict the pessimistic trend in the *F* multiplier compared to that of the last assessment, and asked whether this pessimistic trend was derived from the decline in longline CPUE in 2010. Dr. Aires-da-Silva indicated that the longline trend is highly influential in the model fit, but there are other data sets contributing to the overall fit (indices of abundance from other fisheries and size-composition data). Another participant suggested that the report include graphs with model fits to the CPUE data.

Dr. Deriso mentioned that the IATTC conservation recommendation C-10-01 states that the SAC should review the management measure for bigeye and advise whether it should be modified. In recent years, longer time closures were used, increasing from 42 days to 59 days to 62 days. Dr. Deriso's preliminary calculations indicate that a 77-day closure would now be required, but that estimate requires an adjustment downward to account for the recent decline in operational capacity of the purse-seine fleet in the EPO, and when adjusted downward, the estimate is approximately 62 days, which is very close to what the current resolution calls for. However, another participant noted that if there were improvements in fishing efficiency, then the adjustment should be upwards. Another participant agreed that one important aspect of this committee's work is to evaluate the management measures for the EPO stocks.

A participant pointed out that the closure in 2004 was a time-area closure by country, but that the current system is an *a la carte* closure for each vessel, and asked whether it would be more efficient to

recommend a single closure period instead of the current two. Dr. Compeán indicated that the recommendations are made based on a series of assumptions and that the management negotiations are sometimes challenging.

A participant suggested the inclusion of the retrospective analysis results in the bigeye update assessment document, and Dr. Aires-da-Silva indicated that, if the likelihood profile on steepness was conducted, these analyses will be updated in subsequent full assessments of bigeye.

8. Assessment of skipjack tuna (SAC-02-08)

Dr. Mark Maunder presented the indicators of stock assessment for skipjack tuna in the EPO. Skipjack tuna is a notoriously difficult species to assess. Due to its high and variable productivity, it is difficult to detect the effect of fishing on the population with standard fisheries data and stock assessment methods. Since the stock assessments and reference points for skipjack in the EPO are so uncertain, developing alternative methods to assess and manage the species that are robust to these uncertainties would be beneficial. Maunder and Deriso (2007. IATTC, Stock Assessment Report, 8: 229-248.) investigated some simple indicators of stock status based on relative quantities. Rather than using reference points based on MSY, they compared current values of indicators to the distribution of indicators observed historically. They also developed a simple stock assessment model to generate indicators for biomass, recruitment, and exploitation rate. We update their results to include data for 2007-2010. To evaluate the current values of the indicators in comparison to historical values, we use reference levels based on the 5th and 95th percentiles, as the distributions of the indicators are somewhat asymmetric. The purse-seine catch has been increasing since 1985, and has fluctuated around the upper reference level since 2003, but declined in 2010. Except for a large peak in 1999, the CPUE for floating-object sets has generally fluctuated around an average level since 1990. The CPUE for unassociated sets has been higher than average since about 2003 and was at its highest level in 2008, but declined in 2010. The standardized effort indicator of exploitation rate has been increasing since about 1991 and has been above the upper reference level in recent years, but dropped below it in 2009 and 2010. The average weight of skipjack has been declining since 2000, and in 2009 was below the lower reference level, but increased in 2010. The recent trend is consistent among the floating object fisheries, but is not seen in the unassociated fisheries. The expansion of the fisheries to the west might partially explain the reduction in mean weight and a more detailed spatial analysis of mean weight is needed. The biomass, recruitment, and exploitation rate have been increasing over the past 20 years, and have fluctuated at high levels since 2003, but declined in 2010.

The main concern with the skipjack stock is the constantly increasing exploitation rate. However, 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 it can also be caused by recent recruitments being greater than past recruitments. The 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. The trend in many of the indicators changed in 2010, however it is uncertain what this implies.

Following Dr. Maunder's presentation, a participant noted that skipjack now comprises more than half of the world catch of tuna, yet none of the RFMOs can perform consistent stock assessments of the species. Dr. Maunder explained that several organizations, such as WCPFC and SPC, use tagging data in their assessments, but that those data are not available for the EPO. He noted that the IATTC plans a full and potentially more robust assessment of skipjack in 2012.

A participant asked if spatial structure is possible in the skipjack analysis. Dr. Maunder explained that the sampling areas used were designed for sampling yellowfin tuna and therefore they may not be adequate for sampling skipjack in the western area of the EPO, thus limiting spatial analyses. The postratification analysis presented later in the meeting will facilitate spatial analysis. A discussion also developed regarding the decline in average weight of skipjack and whether it could be related to overexploitation. A

participant asked if there was recent evidence of increased recruitment of skipjack, which could contribute to lower average weights of fish. Dr. Maunder indicated that a decline in average weight of skipjack would require a trend in recruitment, rather than large random spikes in recruitment levels. He suggested that it appears difficult to overfish the stock due to maximum yield per recruit occurring at a size less than the sizes of fish caught in the fishery, but that there are some recent indicators for the stock that are cause for concern in the assessment.

Another participant suggested that the variation in skipjack abundance could be related to fluctuations in environmental factors. Dr. Maunder indicated that the staff's past analyses have indicated no strong correlations between environmental variables and skipjack recruitment. He added that the IATTC will host a workshop in fall 2011 which will address the integration of oceanographic variables into stock assessment.

Dr. Deriso commented that one of the dominant features of the skipjack fishery is the spatial expansion west of the Galapagos Islands after 1994, and he indicated that the best approach in any assessment is to reflect the expansion in the fishery by dividing the analysis into pre- and post-1994 time periods.

Dr. Fonteneau presented a series of maps showing skipjack catches in the EPO during 1960-2010. Dr. Compeán commented that the catches offshore during the 1960s and 70s were due to fishing outside the Commission Yellowfin Regulatory Area (CYRA) during yellowfin closures.

9. Assessment of swordfish (SAC-02-09)

Dr. Michael Hinton presented the assessment of the stock of swordfish (*Xiphias gladius*) in the southeast Pacific Ocean.

The assessment was conducted using Stock Synthesis (Version 3.20b). The model is not a spatially structured model (there is no substructure within the model with parameters governing movement among subareas); however, two subareas were identified for data compilation, selectivity definitions, and development of catch rate (CPUE) indices. These two areas were those lying east and west of 90°W, and were based on regression-tree analyses of size-frequency data from the longline fisheries of Japan.

Key results of the assessment and the sensitivity analyses, conducted by varying the values of fixed model parameters, were:

1. The swordfish stock in the southeast Pacific Ocean is not experiencing overfishing and is not overfished;
2. The spawning biomass ratio (SBR) is about 1.45, indicating that the spawning biomass is about 50 percent above the carrying capacity, and substantially above the level which is expected to produce catch at the level of maximum sustained yield (MSY);
3. Recent annual catch levels (~14,300 t) are significantly below the estimated MSY (~25,000 t);
4. Recent recruitments to the swordfish stock have been high;
5. Assuming that recruitment decreases to levels seen before the recent high annual recruitments, catch rates and catches under current levels of fishing effort and fleet configurations will tend to decrease over the coming decade, as the high-recruitment cohorts pass through the fishery.

It was noted that, while the *F* multiplier (the factor by which effort would need to be increased to reach that expected to produce MSY catch) from the assessment was very high (17), the yield curve approaching MSY was very flat, while the *F* multiplier for a principal sensitivity analysis with steepness of 0.75 was about 7, with a decreasing yield expected at higher levels of fishing effort.

Following the presentation, a participant requested a map of swordfish catches by 5-degree square by each fleet. The stock boundary line of 5°S seems to be in the middle of the fishing area of the Japanese longline fleet. Dr. Hinton reviewed again the map showing fishing regions of Chile by swordfish life

stage. There is no separation between the fisheries of Japan and Chile at the north of the identified spawning area.

A participant pointed out that the Kobe plot presented for swordfish is very optimistic and he had never seen such a "perfect" result for any swordfish stock in the world. He asked if this could be artificial due to CPUE giving an impression of increasing biomass, while effort is increasing. Dr. Hinton said that he and his colleagues on the staff questioned their results shown in the Kobe plot, and found few signals identifying increases in effort. Dr. Maunder pointed out that the Kobe plot is distorted somewhat due to the low SBR at MSY, which is probably caused by the fast growth of age-0 fish. The recent stock assessment conducted by Chile estimated the stock to be above 50% of the virgin level. Another participant agreed with the previous participant that the CPUE data are very optimistic, and a comparative analysis across fleets would be helpful.

Dr. Robert Olson, of the IATTC staff, noted that a large-scale range expansion, especially off Chile, and an apparent increase in abundance of jumbo squid occurred after the mid-1990s. Swordfish are major predators of cephalopods, and increased squid production could be supporting increased abundance of swordfish.

10. Poststratified estimators of total catch for port-sampling data (SAC-02-10)

Dr. Cleridy Lennert-Cody presented a method to create poststratified estimators of catch. Although the goals of stratification for stock assessment and data collection are often in agreement, it is useful to be able to consider different stratifications for the two, particularly when the characteristics of the fisheries have changed over time. In order to do this, it is necessary to develop an estimator for fishery totals based on the post-data-collection strata. Two candidate poststratified estimators for catch species and size composition for the recent purse-seine fishery data were presented. An approach for selecting between the two was also discussed. Application of these methods to purse-seine data from 2000 to present will be undertaken in the future.

Following Dr Lennert-Cody's presentation, a participant expressed interest in this methodology for post-sampling stratification, noting that scientists are struggling with similar problems in the Atlantic and Indian Oceans. He recommended collaboration on this work among the scientists working in all oceans, and Dr. Lennert-Cody agreed that collaboration would be useful.

Another participant expressed interest in this method, and noted the difficulty of defining strata for fisheries. He commented that a Japanese scientist has developed a method for determining optimal stratifications with fisheries data, and expressed interest in collaborating with the IATTC on this issue.

Dr. Lennert-Cody pointed out that there are in the literature methods for poststratification from other disciplines, but that typically these methods were developed for studies with strict sampling protocols, and they can be difficult to implement in practice for fisheries because fishery data may be collected largely opportunistically due to logistic constraints.

Dr. Deriso asked about the possibility to use the sampling data to develop a classification algorithm to estimate the species composition of the pre-2000 catch data. Dr. Lennert-Cody said this was not something that had been considered yet, but certainly would be worth undertaking.

11. Evaluation of the Kobe plot and matrix and their application to tuna in the EPO (SAC-02-11)

Dr. Mark Maunder presented an evaluation of the Kobe plot and matrix and their application to tuna in the EPO. The first joint meeting of the tuna RFMOs recommended standardizing the presentation of stock assessment results and management advice. Stock assessment results should be presented using the four-quadrant, red-yellow-green Kobe plot. The second joint meeting of the tuna RFMOs (Kobe II) recommended the Kobe strategy matrix, which provides alternative options for meeting management targets. The construction of the Kobe plot and Kobe strategy matrix are not straightforward. Dr. Maunder, working in collaboration with Dr. Aires-da-Silva, presented a critical evaluation and outlined the

application of this analysis for the EPO in Document SAC-02-11.

The Kobe strategy matrix requires the following considerations (based on Adam Langley pers. com.): 1) selecting the appropriate models to undertake projections; 2) sampling from the uncertainty envelope of accepted models; 3) assumptions regarding future recruitments; 4) the level of catches or effort for the various fisheries; and 5) re-evaluation of the reference point definition with temporal changes in the F-at-age matrix. Dr. Maunder's presentation focused on a) temporal changes in the target reference points and b) calculation of uncertainty.

The reference points F_{MSY} and B_{MSY} are a function of both biological and fishery characteristics. These quantities will differ depending on what type of gear is used or on the mix of effort among the gears. Therefore, the quantities should be either calculated each year based on the effort mix (age-specific F) in that year or based on a single selectivity that has some desirable characteristic.

MSY quantities are dependent on the stock-recruitment relationship. The form and parameters of the stock-recruitment relationship are often highly uncertain. Proxies are often used (*e.g.* 35% or 40% of the unexploited biomass are often used for groundfish). Alternatively, the stock-recruitment relationship could be fixed based on external information. The steepness of the Beverton-Holt stock-recruitment relationship could be set at a conservative level (*e.g.* 0.75), which only provides a small loss in equilibrium yield when under-specifying steepness.

Recruitment variation should be taken into account when calculating B_{MSY}. This can be done by projecting the population over the historic period under F_{MSY} using the estimated annual recruitment deviates. Alternatively, regime shifts can be taken into account by basing the calculation of B_{MSY} on average recruitment for the appropriate regime.

There are several sources of uncertainty: 1) parameter uncertainty; 2) model or structural uncertainty; 3) statistical assumptions; 4) process variation; and 5) implementation error (for management strategies). There are several different methods to calculate uncertainty (*e.g.* normal approximation, profile likelihood, bootstrap, and Bayesian MCMC), which differ depending on their accuracy and computational demands.

Model structural uncertainty is usually greater than parameter uncertainty. Model structure uncertainty is usually investigated by conducting sensitivity analyses. In general, probability statements need to be given to the different sensitivity analyses to make them useful for management advice.

Process variation is important for projections. Most processes are assumed to be constant over time, except recruitment. Rigorous statistical procedures are available to include process variability, but they are computationally demanding, and approximations are often used. Variability in future recruitment can be based on distributional assumptions or resampling from the historic recruitment estimates. Regime shifts need to be taken into consideration, and recruitment probabilities can be based on the current regime or computed separately for different regimes.

The main uncertainties in the EPO tuna assessments are steepness of the stock-recruitment relationship, natural mortality, mean size of old individuals, the assumption of proportionality between the index of abundance and stock size, and temporal variation in selectivity. In general it is not possible to estimate the steepness of the stock-recruitment relationship from the available data and there is inherent bias in the estimates. Therefore, analyses should be conducted for different values of steepness. Stock Synthesis should be configured so age-specific natural mortality is easier to implement and appropriate priors can be used. More flexible growth curves should be included in Stock Synthesis and appropriate priors implemented, or growth increment data based on tagging integrated into the model. Temporal variation in selectivity for some fisheries should be modeled. MCMC Bayesian analysis for the EPO tuna stocks is computationally demanding, but initial results appear promising.

Initial analyses should be based on sensitivity analyses with the possibility of combining the results and

associated uncertainty across the different sensitivity analyses. Several modifications to Stock Synthesis are required to improve the implementation of the assessments and the calculation of the Kobe plot and strategy matrix. Future research should focus on developing the MCMC Bayesian analysis and including priors and/or integrated data.

Following Dr. Maunder's presentation, a participant commented on the long time required to make the MCMC analysis, and suggested that a default approach might be to make the model runs prior to the meeting. Dr. Maunder replied that the staff receives the data late and that the analyses are completed just prior to the meeting, so that changes in either the timing of the meeting or computational approaches would be helpful. Dr. Deriso added that it may be necessary for the Commissioners to see what they are requesting in this type of analysis, and he expressed some concerns as to the added value of the probability statements produced by this type of analysis.

A participant suggested that the request for the Kobe analysis results in a cascading group of uncertainties, and also cautioned that the uncertainties in the stock structure hypothesis also introduces additional uncertainties in the projection, especially for long-lived species such as bigeye and bluefin. Another participant offered the opinion that the purpose of the Kobe plot was to simplify stock assessment for the novice, but that the analysis can be difficult to understand and interpret.

Another participant observed that the Kobe plot analysis can be difficult to explain to decision-makers, since data points used in the analysis can move location in the plot from year to year, and stressed the importance of communication between those performing the Kobe analysis and decision-makers in order to highlight the dynamic nature of the analysis. A precautionary approach to management may be required, based on parameters such as fishing mortality, even though the Kobe plot may not reflect this condition of the stock.

A discussion developed regarding potential misconceptions in interpreting results from the Kobe plot. One participant suggested that relative changes in F_{MSY} and B_{MSY} occur in relation to different selectivity patterns, and that this may cause some confusion in interpreting the Kobe plot. Dr. Aires-da-Silva explained that the Kobe plot results need not be in the red area for there to be a need for management efforts on a stock. Dr. Compeán suggested that fishing mortality can be addressed by management measures, but that the spawning biomass was based on biology and is out of control of management. He summarized this discussion by observing that the Kobe matrix is useful but that it needs some revision and careful interpretation.

12. Ecosystem considerations (SAC-02-12)

Dr. Robert Olson presented an overview of ecosystem considerations for tuna fishing in the EPO, focusing on contemporary signs of ecosystem changes. Species dependencies and critical links are only understood by continued studies of the structure and function of the food web in the EPO.

Ecosystem change was reviewed at three scales. As noted by Dr. Aires-da-Silva, the current stock assessment of yellowfin tuna in the EPO suggests that the population may have switched from a higher to a lower productivity regime in the early 2000s. Satellite telemetry measurements of surface chlorophyll showed that large regions of the Pacific Ocean became progressively more oligotrophic between 1998 and 2006. Simultaneously, phytoplankton cell size declined in the north and south Pacific, with the potential to reduce the efficiency of energy transfer to the upper trophic levels.

Two diet studies, in which yellowfin tuna stomachs were sampled during two three-year periods about 10 years apart, were described. A classification tree analysis of the pooled data from both studies showed a marked shift in the diet composition over the decade, from predominately epipelagic fishes to predominately small mesopelagic fishes and squid. Prey size and daily ration also declined considerably over the decade. All indications point to reduced productivity in the EPO after 2003.

The key assumption is that yellowfin tuna, a ubiquitous highly-active predator, is a non-selective

predator, and therefore its stomach contents can provide samples for effectively monitoring change at the middle trophic levels in pelagic open ocean ecosystems. Recommendations were made to establish a low-level monitoring program of tuna stomach contents and to develop more and better ecosystem models for the EPO.

Following Dr. Olson's presentation, a participant noted that changes made in Document SAC-02-12 concerning the Productivity and Susceptibility Analysis (PSA) presented at last year's SAC meeting were appreciated. He asked about other types of ecological risk assessments (ERA) that may be investigated as part of this analysis. Dr. Olson replied that other methods of ERA, although similar to PSA, have been developed, especially in Australia.

Another participant asked if last year's PSA was based only on the purse-seine fishery. Dr. Olson responded that the analysis was based on data from the three types of purse-seine fishing, and that the analysis could be improved by adding other types of fishing to the assessment, but that data for those other types were not readily available.

A participant noted that in the susceptibility diagrams, turtles exhibited greater susceptibility in unassociated sets compared to the floating object fishery, and inquired as to the basis for this result. Sea turtles are very infrequently killed in purse-seine sets. Dr. Olson responded that in coastal areas, where unassociated sets are mostly distributed, turtles are returning to their nesting areas and are therefore more vulnerable to capture in those sets. He acknowledged that attribute scoring related to interaction with a certain gear should be better adjusted for the probability that the animal-gear interaction results in mortality.

A participant mentioned that in Colombia some regional studies of the feeding habits of yellowfin tuna in the coastal fishery zone were conducted in 1991 and 1996, and studies of skipjack in 1995, and the resulting data could be provided to supplement the diet data sets of the Commission. Dr. Olson indicated that these data would be useful to add to a global database and to supplement his analyses.

Dr. Compeán asked if the frequency of empty stomachs of tunas had increased with time in the diet analysis. Dr. Olson indicated that the number of empty stomachs had increased overall during the 2003-2005 period, and also considering each set type separately.

13. FAD and bycatch research activities (SAC-02-13)

Dr. Martín Hall presented an overview of purse-seine bycatch and mitigation issues in the EPO. Recent NOAA surveys showed estimates of increasing abundances of the major dolphin stocks that were impacted primarily in the 1960s by the tuna purse-seine fishery. A simple model fitted to the abundance data showed a high likelihood of positive population growth rates, with means of 2.8% for the northeastern stock of spotted dolphins, and 3.4% for the eastern spinner stock.

Recent activities to mitigate sea turtle bycatches by longline gear were described. These included a program with the Overseas Fishery Cooperation Foundation (OFCF) of Japan to study the gear and hooks used in the small-scale longline fisheries of the EPO. A catalog of hooks in use in the coastal region of the EPO was developed, and a comparative study of longline gear is being prepared by Dr. T. Mituhasi, OFCF. The regional program sponsored by the World Wildlife Fund (WWF) has made sustained progress. The program is active in most of the countries bordering the eastern Pacific, and circle hooks have been placed on close to 600 vessels for testing. More than 2200 observer trips have been completed and the data entered into a common database.

At a recent Circle Hook Symposium, studies comparing the performance of J hooks with circle hooks for turtles and target species, including the location of the hooks on the longline, were presented by WWF and OFCF researchers, with cooperation from IATTC staff.

Gear description forms for longlines, gillnets, trammel nets, and purse seines have begun to be used in small scale fisheries in the region to collect detailed fisheries and bycatch data that will allow the

standardization of effort estimates.

Following Dr. Hall's presentation it was pointed out that bycatches by longline gear are caused by a mixture of factors, *e.g.* hook type, bait type, line configuration, and others. Addressing a combination of factors is needed for bycatch reduction and not one factor alone. Dr Hall pointed out that the goal for target species is management and the goal for non-target species is mitigation. Appropriate management and mitigation measures may differ by region, depending on the characteristics and status of the species involved.

A participant asked if the model for the dolphin stocks fitted to the NMFS abundance surveys is published. Dr. Hall answered no, but the modeling work has been initiated.

Further information was requested about the study done at the University of Washington on shark hot spots in the EPO. The study identified areas where relatively few sets but relatively large shark bycatches were made. This work has been published (Watson, J.T., T.E. Essington, C.E. Lennert-Cody, and M.A. Hall. 2008. Trade-offs in the design of fishery closures: management of silky shark bycatch in the eastern Pacific Ocean tuna fishery. Conservation Biology 23 (3): 626-635).

A participant asked for an opinion about whether the decreasing catch rates of pelagic sharks are due to a decline in their populations. Dr. Hall does not doubt that the oceanic whitetip shark has undergone a very large population decline in the EPO, with catch rates reduced as much as 90% relative to those in the early years of IATTC's bycatch program. He stated that immediate action is needed, and that the evidence of trends in the spatial frequency over the years is unquestionable (see maps in Shark Technical Meeting, La Jolla 2010). The silky shark does not show such a steep decline, but a significant decline in all areas and fisheries except for the purse-seine fishery in the western Pacific. Bycatch data for the longline fishery in the eastern Pacific are not available to compare with those in the western Pacific. The data for the western Pacific show that the bycatch of silky sharks in purse seine sets is around 10% of the total with the remaining in longline sets, but there are many fisheries unaccounted for. Following-up, the participant asked if the steep declines in all areas happened during the decade of the 2000s, and if so why the declines happened in that decade. Dr. Hall replied that the declines have been in the last decade in the EPO, but he is unsure about the western Pacific. The reason may be due to "mixed targeting" or changes in targeting.

Dr. Aires-da-Silva stated that population dynamics models for silky and oceanic whitetip sharks are urgently needed to help detect the cause of the known population declines. A workshop on shark stock assessment is scheduled to follow this SAC meeting. Data are needed for smaller vessels in addition to the class-6 boats carrying observers. Dr. Hall added that stock assessments are very important, but that precautionary actions should be taken urgently.

Mr. Marlon Román presented information on the activities of the IATTC Bycatch and Dolphin Conservation Programs. Bycatch data collected by observers at sea have been summarized and analyzed in several ways, providing a variety of insights into fishing activities and fishing impacts on a variety of species. For example, the species composition of tunas and other fishes varied for the different types of FADs, by FAD soak times since deployment, and by time of day. Mr. Román summarized data for consecutive sets on floating objects and temporal patterns of tuna catches on days following initial FAD deployments. Particular attention was given to the spatial bycatch patterns of oceanic whitetip sharks by size composition, and the spatial distribution of manta rays and pelagic sting rays in the bycatch.

The Bycatch program has also worked with tuna boat captains with the intention of reducing bycatches. Some individual captains have provided ideas for gear modifications and novel maneuvers during sets that hold promise of reducing or releasing non-target animals from the purse seine. In addition, methods have been proposed by IATTC staff for releasing large pelagic fishes from the deck. For example, Mr. Román presented a schematic describing a method to release large manta rays

A participant asked if the data on the catch composition by time of day on floating objects are reliable,

noting that the same species compositions are apparent in the Atlantic. Mr. Román stated that those data were from thousands of observer records, and are of good quality.

It was pointed out that, in studies of successive sets on the same floating object in the Atlantic, after about 7 days only bigeye remained associated with the objects, while on previous days yellowfin were also associated. Dr. Hall noted that the same pattern was apparent in the EPO. At a workshop in 1989, it was shown that consecutive sets were enriched with yellowfin followed by bigeye, although few data exist because most FADs receive only 2-3 consecutive sets.

14. Research project on mitigating bycatch in the purse-seine fishery (SAC-02-14)

Dr. Deriso presented a brief summary of the current research cruise on a chartered purse-seine vessel, on which Mr. Kurt Schaefer is Chief Scientist. During the 65-day cruise, which is financed by the International Seafood Sustainability Foundation (ISSF), five major projects will be addressed:

1. **Ecological FADs:** *i.e.* fish-aggregating devices that do not entangle turtles and sharks;
2. **Catch prediction:** improve the methods followed by captains for making pre-set estimates of the species composition, sizes, and quantities of tuna aggregations;
3. **Behavior of tunas within mixed-species aggregations associated with FADs, and targeting single-species skipjack schools with a purse-seine vessel:** develop new purse-seine fishing practices that will reduce the fishing mortality of bigeye tuna and other species of concern by avoiding their capture;
4. **Behavior of tunas and sharks within a purse-seine net:** explore modifications to normal fishing practices by purse-seine vessels targeting tuna aggregations associated with FADs, with the aim of isolating and releasing alive in good condition bigeye tuna and sharks captured in the net;
5. **Survival of released sharks and assessment of capture stress:** minimize both initial and post-release mortality by improving handling and release practices for sharks captured during purse-seine fishing operations.

Following his presentation, Dr. Deriso asked Dr. Victor Restrepo, of ISSF, if he had any further comments about the project. Dr. Restrepo thanked the IATTC and Mr. Schaefer for their cooperation. He pointed out that the idea is to have cruises in other oceans as well as the Pacific, but the decision to begin in the EPO was made because of the highest catch rates of bigeye on FADs. Sharks will be the focus of work in the Indian Ocean because of higher bycatch rates. The research cruises are a part of the bycatch component of ISSF. The second part is a scientific approach to reducing bycatch by actions such as changes to gear and training fishing captains.

Dr. Hall, who chaired the ISSF bycatch committee, stated that this operation in the EPO is preliminary, with more work later in other areas. Studies of behavior inside the net are a high priority. The fishing captains were not very positive about separating skipjack inside the net.

15. Summary of recent activities and planned future activities (SAC-02-15)

Dr. Deriso presented a summary of the recent and future activities of the IATTC staff described in Document SAC-02-15, indicating that the document is an update from 2010, with some changes.

Regarding the schedule for stock assessments and reviews, there are some changes planned for 2012. The original schedule called for a full assessment of bigeye in 2012, but the staff now proposes to conduct update-assessments for both bigeye and yellowfin in 2012, which will allow the staff to focus on other research items. Dr. Aires-da-Silva and Dr. Maunder each indicated that the revised schedule will allow for additional important projects such as producing a Kobe matrix or a spatial model of bigeye, in addition to full assessments of skipjack, silky sharks, and sailfish.

There was general support for an independent review of yellowfin by an external panel in 2012. Dr.

Compeán noted that the yellowfin peer review is being planned for 2012, and solicited suggestions for participants.

A discussion developed regarding planned research by the staff on sharks. Dr. Aires-da-Silva explained that a research plan would be developed for silky sharks first and then for oceanic whitetip sharks. Dr. Hall observed that, since the oceanic whitetip is encountered in the fishery, its abundance will continue to decline and an assessment is not required. He expressed the opinion that management action is required now for the oceanic whitetip and subsequently for the silky shark.

A participant noted that neither northern albacore nor northern bluefin tuna were listed on the schedule for stock assessments and reviews, and inquired whether the IATTC will participate in the assessments of those stocks by the ISC. Dr. Deriso indicated that the IATTC would participate with the ISC in assessment activities for both, as well as for marlins and sharks.

A participant suggested the need for a Pacific-wide, integrated assessment of bigeye, as well as expedited analysis of tagging data. Dr. Maunder indicated that there were no plans to conduct a Pacific-wide assessment of bigeye, since the available information has indicated similar results between the western and eastern Pacific. He also explained that the IATTC staff will wait for more tagging data before considering an integrated approach to bigeye assessment.

A participant expressed concern about the adequacy of current data on sailfish for proper assessment. Dr. Compeán indicated that there are good Mexican data on sailfish and good bycatch data on sailfish at the IATTC. Dr. Hinton explained that the staff recognizes the problems with the acquisition of data for sailfish, but indicated that the planned assessment of sailfish would still be a valuable exercise, even if the analysis could not be completed. Dr. Hall noted that sailfish do not constitute a large portion of the billfish catch of artisanal coastal fisheries, and participants from Ecuador agreed. One participant indicated that the main billfish effort in the Ecuadorian artisanal coastal fisheries is directed at blue marlin and striped marlin, and expressed the opinion that, in addition to the silky shark, hammerhead sharks are also species of concern in those fisheries.

A participant asked for a clarification of the plan for assessment of sharks. Dr. Compeán indicated that the plan is to work with the data that currently exist for both silky and oceanic whitetip sharks. This work will be done differently from that of tunas, in that it will be conducted in a working group with input from different countries, much like ICCAT. Dr. Compeán expressed the hope that much progress could be made during the shark meeting later in the week to facilitate the analysis of sharks. Dr. Aires-da-Silva explained that the IATTC's overall research approach is proactive on two fronts: (1) in the short term, through the mitigation program headed by Dr. Hall, and (2) in the longer term, through the stock assessment program directed by Dr. Maunder.

Dr. Deriso concluded the discussion with a general summary of planned research activities by the IATTC staff. The general plans include some important research initiatives, such as: tagging studies directed by Kurt Schaefer around the 150°W boundary area; collaborative studies between the IATTC's early life history group, directed by Dr. Daniel Margulies, and Kinki University on comparative research of the reproductive biology and early life history of yellowfin and Pacific bluefin; ecosystem studies directed by Dr. Olson, including isotope analyses and diet studies; and automation of length frequency information by Alejandro Pérez. Finally, Dr. Deriso praised the work and career of Mr. Pat Tomlinson of the IATTC staff, who will be leaving the IATTC this coming year. Dr. Compeán added a tribute to Mr. Tomlinson and his many contributions to the research programs of the IATTC.

16. Conservation measures for bluefin tuna in the eastern and western Pacific Ocean (SAC-02-16)

Dr. Mark Maunder presented a summary of conservation measures for bluefin tuna in the eastern and western Pacific Ocean. Maunder et al. (2010. IATTC Stock Assessment Report, 11: 262-270.) developed a management "indicator" for bluefin tuna that is based on calculating the impact of fisheries on the stock.

The fisheries in the WCPO have had a greater impact than the EPO fisheries, and their rate of increase in recent years is higher. In the EPO, the impact of the fisheries was substantially lower during 1994-2007, with an average catch of 4,221 metric tons, than it was during 1970-1993, when the stocks were depleted to a much lower relative size. Maunder et al. (2010) recommended that catch levels should be set based on those years when the impact was low until the uncertainty in the assessment is reduced.

WCPFC Conservation and Management Measure 2010-04 limits total fishing effort and catches of juveniles (age 0-3) during 2011-2012 by vessels fishing for Pacific bluefin tuna north of 20°N to below the 2002-2004 levels, except for artisanal fisheries.

Furthermore, during 2002-2004 the average catch in the EPO was higher than during 1994-2007, whereas in the WCPO it was lower. Therefore, using the same years for determining catch limits in the EPO and WCPO may not be appropriate.

Following Dr. Maunder's presentation, a participant noted that the ISC has not renewed their stock evaluation of bluefin, other than an update last July of the previous evaluation, but an in-depth evaluation is scheduled for 2012. He pointed out that cross-Pacific migrations are important, and suggested that for this year, the Committee should not give any specific recommendations while waiting for the full evaluation to be conducted by the ISC in 2012.

Another participant requested more information on old and new mortality rates used in bluefin analyses. Dr. Aires-da-Silva explained that there has been a long debate regarding the level of adult natural mortality for bluefin, and that a low mortality estimate used in the 2008 ISC assessment was more recently judged to be more appropriate for southern bluefin and Atlantic bluefin. A new mortality schedule has been adopted by the ISC Pacific bluefin working group that assigns a higher natural mortality estimates than the estimates previously used for adult northern bluefin. Another participant asked about catch-at-age of bluefin in the WPO and the EPO. Dr. Aires-da-Silva indicated that the WPO fishery catches mostly age 0-1 fish while the EPO catch is dominated by age 1-2 fish, and it is assumed that a large proportion of the fish occurring in the EPO return to the WPO.

A discussion developed regarding the fishery impact on spawning biomass in the EPO and the WPO. Several participants discussed the data sets utilized in these analyses of bluefin. One participant urged a broader timeframe, examining fishery data for earlier years. Dr. Aires-da-Silva indicated that the analysis presented by Dr. Maunder extended back to 1955 and that the ISC model includes all of the historical catch. Dr. Compeán urged the participants to refer to Document SAC-02-04 for a listing of catches of bluefin by country. It was noted that the impact from the western and eastern fisheries was not proportional to catch, and this was related in part to the age composition of the catch.

Another participant noted that in the WCPO there is overall effort restriction on all ages, not just juveniles, and characterized the recruitment dynamics in bluefin as perhaps the most complex of all tuna stocks; in future impact analyses, emphasis should be placed on reducing fishing mortality of young fish. Another participant suggested that the fishery structure has changed, and that the age composition of the fishery has changed in the EPO. Dr. Maunder pointed out that mostly age-1 and -2 fish comprise the catch in the EPO, so probably the age structure of the catch has not changed so much. He indicated that it is difficult to implement restrictions of effort in this fishery, which is why the staff prefers catch-based management recommendations.

17. Discussion of planned stock assessment methods workshop in fall 2011: "Integrating fisheries oceanography into stock assessment and management"

Dr. Maunder presented a summary of a workshop planned for fall 2011 in La Jolla, which will address the integration of fisheries oceanography into stock assessment and management.

One participant noted that the proposed dates of October 11-14 for the workshop are very close to the October 19 meeting of the AIDCP. Dr. Compeán indicated that the staff would reconsider the proposed

date for the workshop.

18. Other business

Dr. Deriso discussed Document CAP-11-05 on target capacity that was prepared for the meeting of the working group on capacity, two weeks ago in Costa Rica, which showed that estimates of target capacity were made that are consistent with the staff's last two conservation recommendations, presented in documents IATTC-78-06b and IATTC-81-06b. The document provides details of the methods employed in the calculation along with detailed results. The existing recommendation of 158,000 m^3 for purse-seine capacity in the EPO is supported by the new analysis. The longline target capacity based on hooks fished far exceeds that actual reported number of hooks being fished because bigeye longline catches for some countries, notably Japan, are far less than the catch limits recommended for that gear.

After Dr. Deriso's presentation, a participant said that cubic meters of fish well volume is not a good measure of fishing capacity, because there has been a constant increase in fishing power over time; for example, two small boats are more efficient that one large boat twice the size. Dr. Deriso agreed that the calculations assume that fleet characteristics are proportional to those of the current fleet, and that reductions would also be proportional. A previous analysis showed a significant correlation between numbers of sets and cubic meters of well capacity. According to Dr. Hall, fishing power has changed in recent years due to changes in net length and depth and the use of acoustic equipment on FADs. The goal is not to manage fishing mortality directly but to have an overall limit on capacity, and these estimates are suitable for that purpose.

Dr. Deriso went on to present the results in document SAC-02-INF A. of eight scenarios based on different combinations of the capacity increases requested by several countries. The evaluation centered on calculations of the number of additional closure days required for each scenario consistent with the fishing mortalities on which the last two IATTC conservation recommendations are based.

A discussion ensued concerning the possibility that any new capacity could consist of vessels with more sophisticated equipment and therefore higher fishing power, and an estimate that each 1000 m^3 increase in capacity adds 1.2 days to the closure period seemed appropriate. Some participants shared the concern that added capacity could be more effective at catching fish than is existing capacity, and it was suggested that the recommendations of the SAC to the Commission could include a statement to this effect.

One participant expressed concern about the lack of data availability from the IATTC, and urged the IATTC staff to explore ways to improve this situation with respect to member countries, in particular estimates of catch and effort stratified into one or five-degree areas by gear and country. Dr. Compeán stated that the IATTC staff shared the concern over data availability, and suggested that it be reflected in a recommendation from this meeting.

Dr. Vladimir Puentes, from Colombia, presented a proposal for a genetics research project (link to proposal on website), to be carried out by Colombian scientists, that would contribute proactively to the technical aspect of the IATTC's activities. The proposal, summarized in Appendix B, outlines genetics sampling designed to verify stock structure, contribute to species identifications, and examine genetic diversity in the following groups: tunas, dorado, sharks, billfishes, wahoo, turtles, and marine mammals.

A participant commented that the proposal was interesting on a scientific level, but questioned its usefulness to improve stock assessment; tagging studies may be more useful than genetics for determining mixing rates and stock structure of tunas. However, several participants expressed support for the research proposal, and it was agreed that the proposed work would be useful and could provide supplemental information to the IATTC.

Another participant recommended that the IATTC participate in the effort agreed at the Kobe II meeting to develop strategy matrices for application to tuna stocks in the EPO.

Regarding capacity building, Dr. Aires-da-Silva stated that the IATTC scientific staff is always interested

in providing technical training in member countries. However, the development of training courses and workshops are subject to approval by the Commission, and funding is sometimes difficult to obtain. Dr. Compeán confirmed that historically many of the IATTC staff have contributed to training and capacity building in member countries, and will continue to participate in these activities.

19. Recommendations and endorsements

The following are recommendations and endorsements made by the Scientific Advisory Committee, in no particular order. The participants understand that some are more important than others.

1. That the chair of the SAC develop a working document for this year's annual meeting of the Commission, outlining recommendations for rules of procedure, clarification of the participation of NGOs as observers, and establishing a time deadline for documents to be submitted prior to the SAC meetings. Other elements that might be included, such as how to work without a quorum, were mentioned in the report of the first meeting of the Committee in 2010.
2. That the staff conduct a full assessment of the yellowfin and bigeye tuna stocks in the EPO every third year, and these assessment shall be independently reviewed periodically.
3. The SAC generally supports the Commission staff's conservation recommendations for 2011 to 2013, but some participants believed that they should be strengthened. Furthermore, the recommendations should be reviewed every year, in view of the new stock assessments, as called for in IATTC Recommendation C-10-01, paragraphs 18a and 18b.
4. That a comprehensive report about movement of fish across the western boundary of the EPO, including fish tagged in the western Pacific, be produced.
5. Encourage collaboration among the scientists working in all oceans on the issue of post-stratification, as described in Document SAC-02-10.
6. That the Commission staff prepare a report about FAD research activities, based on the information discussed during this meeting, given that bycatch mitigation is not adequately covered in Document SAC-02-12
7. That the IATTC join the effort established at the Kobe II meeting in April 2009 to develop strategy matrices for application to the tuna stocks in the EPO.
8. The SAC supports the analysis presented in Document SAC-02-INF A. However, some participants believe that newly-built purse seiners are likely to be more efficient than current vessels, and therefore added capacity will not be equivalent to existing capacity.
9. That the Commission adopt rules for the availability of fisheries data of a similar standard as the other tuna RFMOs.
10. To support the genetics research project proposed by Colombia.
11. To support programs for building scientific capacity, in the framework of the Antigua Convention, in coastal states. The SAC recognizes that this may require additional staff for the IATTC.
12. That the Commission strengthen Resolution C-05-03 by clarifying the mitigation measures, especially for shark species of concern.
13. That, within the Bycatch Working Group, Recommendation C-10-02 on seabird bycatch be reviewed, taking into account the latest information.

Finally, the SAC recognized the invaluable contribution of Patrick Tomlinson to fisheries science, and recommends that the Commission officially acknowledge his 50-year continuous service at the IATTC.

Dr. Compeán stated that at the annual meeting of the Commission in July the staff will reiterate the conservation recommendations made to the last annual meeting in document IATTC-81-06b, excluding the recommendation for northern albacore. The staff's final recommendations will be submitted to the IATTC members through the Director, and are separate from any recommendations of the SAC. The opinions of everybody, however, are taken into account.

A participant expressed concern that the calculation of the staff's recommended number of closure days was not presented, noting that is was difficult to provide advice to the respective delegations without more explicit information on which to base strong conclusions. Dr. Deriso presented those calculations to the group. There was some discussion that the calculations could result in too short a closure for various reasons, for instance that additional capacity could consist of vessels that are more efficient on average than those currently fishing in the EPO. Drs. Compeán and Deriso commented on several considerations that support the recommendation, for instance that additional capacity may be similar in efficiency to the existing fleet. In general, there seems to be more respect now for the conservation measures.

At the request of a participant, Dr. Compeán briefly reviewed the legal aspects of the Antigua Convention as it applies to recommendations versus resolutions. The participant expressed concern that the recommendation on bycatches of seabirds was too general, in that it applies to all longline fishing boats. In more than 15,680 monitored sets by small coastal longline vessels from Ecuador not one albatross was caught. Mitigation measures (*e.g*. tori lines) should be recommended for specific types of vessels and not for all longline vessels. The seabird recommendation and other pending issues from last year can be brought up again as resolutions at the 2011 annual meeting. Several technical issues were left pending from the first seabird meeting. The recommendation on sharks will be presented this year, as it was last year.

20. Meeting report

The meeting report was adopted.

21. Adjournment

The meeting was adjourned at 1:15 pm on 12 May 2011.

Appendix A.

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Appendix B. Proposal of Colombia for genetics studies in the EPO

Genetic characterization of the main tuna species (yellowfin, bigeye and skipjack tunas) and tuna bycatch species (sharks, mahi-mahi, wahoo, sea turtles, marine mammals and billfishes) regulated by the Inter-American Tropical Tuna Commission - IATTC - in the eastern Pacific Ocean

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ABSTRACT

This research project aims to contribute to the management of the main tuna species and bycatch species in the eastern Pacific Ocean, managed by the Inter-American Tropical Tuna Commission (IATTC), in terms of the genetic characterization of these populations, in order to have more reliable management tools which, together with stock assessments, will give the IATTC staff better scientific information to support conservation measures for these species. The project aims to work with strategic stakeholders of the scientific community in Colombia and other countries of the region, in order to obtain tissue samples of yellowfin tuna (*Thunnus albacares*), bigeye tuna (*T. obesus*), skipjack tuna (*Katsuwonus pelamis*), mahi-mahi (*Coryphaena hippurus*), some shark species such as the thresher shark (*Alopias pelagicus*), hammerhead shark (*Sphyrna lewini*) and silky shark (*Charcharhinus falciformis*), among others. Other species include wahoo (*Acanthocybium solandri)*, striped marlin (*Tetrapturus audax*) and blue marlin (*Makaira nigricans*), sea turtles (*Chelonia mydas*, *Caretta caretta*) and marine mammals such as several dolphin species or whales that may be captured as bycatch in the tuna fisheries. The research work will include the scientific staff of the IATTC, universities, research institutions, NGOs and government staff involved with this kind of work

RESUMEN

Este proyecto de investigación pretende contribuir a la ordenación de las principales especies de atunes y especies de captura incidental en el Océano Pacífico Oriental, gestionados por la Comisión Interamericana del Atún Tropical – CIAT – , en términos de la caracterización genética de estas poblaciones, a fin de contar con herramientas de ordenación más fiables que, junto con las evaluaciones de las poblaciones, brindará al personal de la CIAT una mejor información científica para apoyar las medidas de conservación de estas especies. El proyecto pretende trabajar con los actores estratégicos de la comunidad científica en Colombia y otros países de la región, a fin de obtener muestras de tejido de atún aleta amarilla (*Thunnus albacares*), atún patudo (*T. obesus*), atún barrilete (*Katsuwonus pelamis*), dorado (*Coryphaena hippurus*), ciertas especies de tiburones tales como el tiburón zorro (*Alopias pelagicus*), cornuda (*Sphyrna lewini*) y tiburón sedoso (*Charcharhinus falciformis*), entre otros. Otras especies incluyen el peto o sierra wahoo (*Acanthocybium solandri)*, marlín rayado (*Tetrapturus audax*) y marlín azul (*Makaira nigricans*), tortugas marinas (*Chelonia mydas*, *Caretta caretta*) y mamíferos marinos tales como varias especies de delfines o ballenas que podrían ser capturadas incidentalmente en las pesquerías atuneras. El trabajo de investigación incluirá el personal científico de la CIAT, universidades, instituciones de investigación, ONG, y personal del gobierno relacionado con este tipo de trabajo.