INTER-AMERICAN TROPICAL TUNA COMMISSION

SCIENTIFIC MEETING

La Jolla, California (USA)
15-18 May 2012

MEETING REPORT

Chairman: Dr. Guillermo Compeán

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The 3rd Meeting of the Scientific Advisory Committee was held in La Jolla, California, USA, on 15-18 May 2012. The attendees are listed in Appendix A.

1. Welcome, introductions, meeting arrangements

The meeting was called to order on 15 May 2012 by the Chairman, Dr. Guillermo Compeán, Director of the IATTC, who thanked the attendees for coming to the meeting. The Scientific Advisory Committee (SAC) was established by the Antigua Convention, and is composed of one representative designated by each member of the Commission. 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. Item 6c (*Kobe plot and matrix and their application to bigeye*) was moved to Item 9. A presentation and document (*Update on mitigation measures for seabirds*) was added as Item 11c. Two additional contributions were added to Item 15, *Other business*: discussion of data confidentiality for longline gear and discussion of research on mahi mahi (dorado). Participants also requested further discussion of FADs under Item 11b and conservation measures on Pacific bluefin tuna under Item 8. The agenda was approved without further changes.

3. The fishery in 2011 (SAC-03-03)

Mr. Ed Everett reviewed the information on the fishery for tunas in the EPO in 2011. He discussed EPO tuna catch statistics for 2011, including: total catches by species and by flag, purse-seine catch distributions for yellowfin, skipjack and bigeye, and size compositions of the three species. The catches of yellowfin, skipjack, bigeye, and Pacific bluefin tunas by purse-seine, pole-and-line, and recreational gear in 2011 were about 24% less than the record catches in 2003, and about 4,000 metric tons (t) lower than the 15-year average of catches.

Colombian, Mexican, Panamanian and Venezuelan vessels caught about 79% of the yellowfin, and Ecuadorian vessels caught about 54% of the skipjack. The yellowfin catch distributions for 2011 showed an increase in catches on dolphins in the inshore areas off southern Mexico. YFT catches were somewhat lower off Central America. Yellowfin catches in 2011 were equal to the five-year average of catches from 2006-2010. Catches of skipjack in 2011 were lower in the inshore areas off Ecuador, but greater in the offshore equatorial areas around the Galapagos Islands. Skipjack catches in 2011 were 43,000 t (18%) higher than the five-year average of catches. Bigeye catches in 2011 were similar to the 2006-2010 average, with the exception of lower catches in the offshore equatorial areas from about 90°W to 110°W. Catches in 2011 were about 20% lower than the five-year average of catches.

Mr. Everett showed the length-frequency and species-composition sampling areas, and described the areas defined for stock assessments. Of the 859 wells sampled for length frequency and species composition in 2011, 582 contained yellowfin, 510 contained skipjack, and 138 contained bigeye. The average sizes of yellowfin in 2011 were greater than those of 2010, but considerably less than those of 2009. The average sizes of skipjack were slightly greater than those of the previous five years. The average size of bigeye in 2011 was greater than those observed during 2006-2010.

One participant asked for clarification about the apparent decrease in catches in 2011 relative to 2010, specifically if effort had decreased west of the EPO. Effort did not diminish much in the west, but catches were lower inshore and effort increased around the Galapagos Islands.

4. Review of 2011 staff conservation recommendations and IATTC Resolution C-11-01

Dr. Richard Deriso gave a short presentation on items in the IATTC resolutions that need SAC or IATTC staff input. The current conservation resolution, C-11-01, calls for staff to evaluate the conservation measures in that resolution in light of new stock assessments. Those evaluations will be discussed later

during the meeting. Resolution C-11-08, about observers on longline vessels, calls for the SAC and the staff to give recommendations about how fishing effort should be measured for the purpose of defining the 5% level of observers required by the resolution. The number of hooks fished is the preferred measure of fishing effort and a lower preference would go to the alternatives of days of operation or number of sets fished. Lowest preference would simply be effort measured by number of vessels. Resolution C-11-02 on seabirds calls for SAC input on effectiveness of conservation measures on seabirds and that may be discussed later in the agenda after the seabird presentation.

Discussion ensued regarding how effort should be measured for estimating observer coverage. The most accurate method is by numbers of hooks, but that method is nearly impossible in a practical sense. Japan prefers to use the number of days fished as the measure of effort. Typically there is one set per day on longline vessels, so there is a good correlation between numbers of days fished and numbers of sets. The SAC will recommend 5% observer coverage on longline vessels, measured by effective days fishing (i.e. excluding transit days).

5. Update of 2010 assessment of yellowfin tuna (SAC-03-05)

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 3.23b) was used in the assessment, which is based on the assumption that there is a single stock of yellowfin in the EPO. This model is the same as that used in the previous assessment (IATTC Stock Assessment Report 12).

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, and stock structure. The assessment for 2011 is identical to that of 2010 except for updated and new data. The catch data for the surface fisheries have been updated and new data added for 2011. New or updated longline catch data are available for China (2010), Chinese Taipei (2008-2010), French Polynesia (2010), Japan (2007-2010), Korea (2009-2011) and the United States (2009-2010). Surface fishery CPUE data were updated, and new CPUE data added for 2011. New or updated CPUE data are available for the Japanese longline fleet (2007-2010). New surface-fishery size-composition data for 2011 were added. New or updated length-frequency data are not available for the Japanese longline fleet.

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 2003-2009). Although the two most recent annual recruitments (2010 and 2011) were estimated at about average levels, these estimates are highly uncertain. 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.

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. Historically, the dolphin-associated and unassociated purse-seine fisheries have the greatest impact on the spawning biomass of yellowfin, followed by the floating-object fisheries. In more recent years, the impact of the floating-object fisheries has been slightly greater

that that by unassociated fisheries. The impact of the longline and purse-seine discard fisheries is much less.

There has been 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 1977-1983, coinciding with the low productivity regime, but above that level during most of the following years, except for the recent period (2005-2007 and 2010-2011). The 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 different productivity regimes may support different MSY levels and associated SBR levels. The SBR at the start of 2012 was estimated to be 0.26, above the level corresponding to the MSY (0.25). The recent SBR levels (2010-2011) predicted by the current assessment are more optimistic than those produced by the previous assessment, which indicated a sharp decline in the levels of spawning biomass since 2009 (IATTC Stock Assessment Report 12). This result is due to a decline in the fishing mortality levels for middle-age and older yellowfin tuna since 2009, which is estimated by the current assessment. 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, moderate 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 is such a relationship, there would be a greater loss in yield than if management is based on assuming a stock-recruitment relationship when in fact there is no relationship.

The MSY 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 (1975-2011), 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. Previous assessments have also indicated that the status of the stock is also sensitive to the value assumed for the average size of the oldest fish, and more pessimistic results are obtained when larger values are assumed for this parameter. Under current levels of fishing mortality (2009-2011), the spawning biomass is predicted to slightly increase 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. In addition, the spawning biomass is predicted to remain below the level corresponding to MSY if a stock-recruitment relationship is assumed. 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. 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.

2. The recent fishing mortality rates are lower than those corresponding to the MSY, and the recent levels of spawning biomass are estimated to be at about that level. As described in IATTC Stock Assessment Report 12 and previous assessments, these interpretations are uncertain, and highly sensitive to the assumptions made about the steepness parameter of the stock-recruitment relationship, the average size of the older fish, and the assumed levels of natural mortality. The results are more pessimistic if a stock-recruitment relationship is assumed, if a higher value is assumed for the average size of the older fish, and if lower rates of natural mortality are assumed for adult yellowfin;
3. The recent levels of spawning biomass predicted by the current assessment are more optimistic than those from the previous assessment (IATTC Stock Assessment Report 12). This result is due to a recent decline in the fishing mortality levels for middle-age and older yellowfin tuna since 2009 which is estimated by the current assessment.
4. Increasing the average weight of the yellowfin caught could increase the MSY.

Following Dr. Aires-da-Silva's presentation, there was a substantial amount of discussion about the steepness parameter of the stock-recruitment relationship. A participant asked if a steepness estimate derived internally by the stock assessment model is available. Dr. Aires-da-Silva commented that, although this was not done in the current update assessment, a likelihood profile on steepness was produced in the previous full assessment of yellowfin (SAC-02-06). This likelihood profile was shown during the presentation, and the maximum likelihood estimate for steepness is at about 0.7. A suggestion was made to report the 0.7 estimate along with corresponding management quantities in the assessment report. Dr. Aires-da-Silva commented that estimating steepness internally is problematic and that the low estimate of steepness is likely the result of a model artifact caused by the different productivity regimes and needs to be regarded with caution. In addition, a standard sensitivity analysis, assuming steepness at 0.75, is presented in the assessment reports as a precautionary measure. However, it was recognized that this assumed value of 0.75 is arbitrary. A steepness value generally accepted by all the tuna regional fisheries management organizations (RFMOs) would be useful if a more conservative assumption than the one assumed by the base case is desired (steepness at 1.0). Dr. Mark Maunder mentioned that a study concluded that steepness cannot be estimated in most cases, and the IATTC staff uses the value of 0.75 to be conservative and to examine the effect of steepness in the model results. It was noted that a workshop sponsored by the International Seafood Sustainability Foundation (ISSF) used meta-analysis for different tuna stocks, but the data could have been biased by different productivity regimes. A participant expressed concern that the hypothesis of a regime shift could be based on a spurious correlation, and recommended that the staff report that the model estimates a steepness value of 0.7. It was recommended that steepness be discussed at the IATTC workshop in the fall. It was further suggested that a precautionary stance be taken for yellowfin in the EPO. Although the base case, with a steepness of 1.0, indicates that fishing can be increased, the staff's recommendations for yellowfin are always precautionary, driven by the more conservative results obtained from the sensitivity to a lower steepness value of 0.75, and also by the recommendations for bigeye.

Concern was expressed about the high natural mortality (*M*) estimate used by the IATTC staff for yellowfin tuna. The assumption of increased natural mortality for adult females based on sex-ratio-at-length information may be incorrect and the sex ratios may be due to differences in growth rates between males and females, as has been observed in the Indian Ocean from the recoveries of sexed adults. Dr. Maunder clarified that the *M* curve was based on several data sources and assumptions, and represents the best scientific information available. *M* was estimated by fitting to *M* estimates from tagging data in the western Pacific and sex-ratio data from the EPO, assuming the same growth rates for males and females and no selectivity or spatial structure. The purse-seine and longline catches have similar sex ratios. IATTC staff tried to estimate *M* for bigeye using tagging data, but the estimates were highly imprecise. There was a recommendation to do research on *M*, and the staff agreed it is an important issue and that

tagging is the only way to adequately estimate *M*. Dr. Deriso suggested this be discussed in the IATTC workshop in the fall.

6. Update on 2010 assessment of bigeye tuna (SAC-03-06)

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 3.23b) was used in the assessment. This model is the same as the base case model used in the previous full 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 2011. New or updated longline catch data are available for China (2010), Chinese Taipei (2008-2010), French Polynesia (2010), Japan (2007-2010), the Republic of Korea (2009-2011) and the United States (2009-2010). Longline catch data for 2011 are available for China, Chinese Taipei and Japan from the monthly reporting statistics. New or updated CPUE data are available for the Japanese longline fleet (2007-2010). New purse-seine length-frequency data are available for 2011. New or updated length-frequency data are not available for the Japanese longline fleet.

There are several important features in the estimated time series of bigeye recruitment. The most obvious pattern is a period of below-average recruitment prior to 1994, which may be a model artifact caused by the expansion of the floating-object fisheries in 1994. 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 2008 and 2010 recruitments were above average, but the recruitment in 2011 appears to have been below average. 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.

There have been important changes in the amount of fishing mortality caused by the fisheries that catch bigeye tuna in the EPO. On average, since 1993 the fishing mortality of bigeye less than about 15 quarters old has increased substantially, and that of fish more than about 15 quarters old has also increased but to a lesser extent. The increase in the fishing mortality of the younger fish was caused by the expansion of the purse-seine fisheries that catch tuna in association with floating objects. 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.

Since the start of 2005, when the spawning biomass ratio (the ratio of the spawning biomass 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 end of 2010. This recent recovery trend is subsequent to the IATTC tuna conservation resolutions initiated in 2004. The SBR is estimated to have declined slightly since the beginning of 2011 to a level of 0.23 at the start of 2012. According to the base case model, this most recent SBR is about 12% higher than the maximum sustainable yield (MSY) level.

Recent catches are estimated to have been 8% less 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 95% of the current (2009-2011) level of effort (Table 1).

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 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 a slight decline of the SBR since the start of 2011 and predict that the population is likely to further 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, an apparent slight decline of the spawning biomass has begun at the start of 2011 and, under the current levels of fishing mortality and average recruitment, recent spikes in recruitment are predicted not to sustain the early observed population rebuilding 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 commented that there appeared to be a slight decrease in the spawning biomass ratio for bigeye since 2010, and suggested that a management goal should be to regain the trend of increasing spawning biomass ratio. Another participant asked if a more comprehensive analysis could be performed which used an earlier time series of data back to at least 1955. Dr. Aires-da-Silva explained that a sensitivity analysis had been done for the SAC 01 meeting that included data back to 1950, and that there had been no impact of that analysis on the staff recommendations. Considering the abrupt change in the mix of selectivities that occurred in the fishery around the mid-1990s with the expansion of the floating object fishery, the staff believes that an emphasis on more recent time periods improves the stock assessment estimates for bigeye.

A participant noted that recruitment of bigeye appeared to increase after 1995 when the FAD fishery started, and stated that the recruitment pattern appears to be positive and real and asked if this represented true regime change. Dr. Aires-da-Silva explained that the staff believes that this result is the effect of a model artifact caused by the abrupt appearance of small bigeye in the data with the expansion of the floating-object fisheries. Patterns like this are a major shortcoming that comes with doing assessments for large periods of time that include major changes of fisheries selectivity, and are difficult to eliminate. In fact, the pattern is also present in other tuna assessments (*e.g*., bigeye in the western and central Pacific Ocean (WCPO)) Again, the staff recommends that an analysis of more recent periods is more reliable, and estimates management quantities better. It was noted by a participant that all of the analysis for bigeye was done under the assumption that the stock boundary is at 150°W, and asked if there were tagging data to support this. Dr. Maunder pointed out that a bigeye assessment review for the western and central Pacific had included tagging data which indicated that there could be substantial movement between the stocks and that there was a recommendation to conduct a Pacific-wide assessment for bigeye. The staff will be collaborating with South Pacific Commission (SPC) on a Pacific-wide assessment for bigeye in the near future.

A discussion developed regarding the staff recommendations for bigeye. A participant suggested the use of alternative management measures besides the current measures of time closures or selective spatial closures such as the high-seas area established in resolution C-11-01. It was suggested that perhaps other measures could be considered, such as limits on small bigeye for certain vessels that seem to dominate on the catch of small bigeye. Dr. Compeán explained that several years ago the staff had proposed to the Commission a recommendation for size limits on bigeye, but that this was not accepted due to problems with the identification of small bigeye and uncertainties regarding the fate of released fish. Therefore, this had become an issue of negotiation. Dr. Compeán also indicated that a resolution was already in force for the Commission regarding bigeye for 2012. Dr. Deriso also pointed out that the current recommendations for purse-seine fishing were rooted in concern over bigeye, but that they have ancillary positive effects on yellowfin and other species such as silky sharks. However, he also agreed that efforts should be made to keep current time closures from increasing.

6a. Integrating tagging and otolith data for bigeye growth estimation

Dr. Aires-da-Silva presented the preliminary results of an ongoing investigation to reduce the uncertainty on the average size of the oldest fish (L_2), a parameter that is highly influential in the bigeye stock assessment results. Growth is one of the most important biological processes that are considered in stock assessment models. Traditionally, a functional form that either a) describes size as a function of age or b) growth as a function of length is fitted to one of three types of data (length-at-age data obtained from age readings on skeletal parts, length increment data from tagging experiments or length-frequency data). However, these two approaches differ when considering the error structure of the observations and therefore the results cannot be easily combined. In addition, there are disadvantages to using either type of data alone. One example is bigeye tuna in the EPO, for which direct ageing data from otolith readings are dominated by the juvenile segment of the population. Fitting a growth model to these data without length-at-age observations for older fish results in unrealistically high estimates of the asymptotic size. To overcome this handicap, bigeye growth was estimated while fitting simultaneously to juvenile length-at-age data and growth-increment data from adult fish using the framework of Everson *et al*. 2004. Three alternative statistical approaches are illustrated: random effects, penalized likelihood and Bayesian analysis. Advantages and disadvantages of the different approaches were discussed.

A participant asked whether bigeye in the EPO show a slow growth stanza between 40-70 cm, similar to that exhibited by juvenile bigeye in the Indian Ocean. Dr. Aires-da-Silva indicated that juvenile bigeye in the EPO exhibited nearly-linear growth during the juvenile phase and did not exhibit slow growth between 40-70 cm. The participant also asked if there were growth differences indicated between adult males and females, and Dr. Aires-da-Silva indicated that Messrs. Kurt Schaefer and Dan Fuller of the IATTC had analyzed growth of juvenile bigeye, by sex, and there were no differences indicated (IATTC

Bulletin 23).

A discussion developed regarding the influence of the new estimates for the asymptotic size (L_2) in the current stock assessment results for bigeye. Dr. Aires-da-Silva recalled that the early bigeye full assessment showed meaningful changes of the F multiplier resulting from minor changes of L_2. Lower estimates of the F multiplier were obtained from assuming higher values of L_2. The staff expected feedback from the SAC regarding this new analysis before incorporating in the stock assessment of bigeye. Several participants suggested that the analysis of direct aging and tag-recapture data seemed to provide a better estimate of L_2 for bigeye that that assumed in previous assessments. Dr. Aires-da-Silva indicated that the staff plans to formalize this work after further workshop feedback and peer review through publication of the analysis.

6b. Spatial modeling of bigeye catch distribution with environmental factors

Dr. Aires-da-Silva presented the preliminary results of an investigation of the potential use of spatial-temporal analysis for near real-time spatial management of large pelagic predators in the eastern Pacific Ocean. The ongoing study is using bigeye as a case study species and aims at predicting (forecast) areas of high bigeye densities ("hotspots") based upon time series of bigeye catch distribution in space and oceanographic data for the EPO. Bigeye catch per set data from logbook and observer data are analyzed on monthly and 1x1 degree square aggregate. The hybrid geostatistical regression-kriging model has two parts: a regression component that explores the correlation with the exploratory oceanographic variables, and an ordinary kriging component the deals with localized spatial-temporal autocorrelation. Generalized additive models (GAMs) are used to investigate the relationship between the bigeye catch distribution and the following environmental variables: sea-surface temperature (SST), sea surface height (SSH), chlorophyll a (Chla), bottom depth and distance to land. Variogram analysis is conducted in space and time to model the small-scale spatial-temporal dependencies. Finally, bigeye catch distributions maps are built from estimates derived from a hurdle model which combines the results from binomial and lognormal GAM models on the presence/absence and bigeye catch per set, respectively. The regression-kriging model shows potential as a tool for spatio-temporal modeling of large pelagics in the EPO. However, improvements are necessary. In particular, the proportion of deviance explained by the oceanographic variables is low. This suggests that the selected aggregation scale used for the oceanographic variables may not be optimal and that a finer spatio-temporal scale may be needed. Future work will include improving the choice of oceanographic variables, challenging the stationary assumptions for the small-scale spatial-temporal covariance structure, cross-validation and applying the model to bycatch species.

A participant asked if a distinction between vessels targeting small bigeye and those targeting skipjack was taken into consideration for the analysis. Dr. Aires-da-Silva indicated that the main intent of the ongoing investigation is to minimize the catch of small bigeye while not affecting skipjack catches. Also sets on floating objects have skipjack as the main target species. For this reason, the full observer data set from the floating-object fisheries was analyzed. Several participants noted that this analysis was promising. Two additional factors were proposed for inclusion in the analysis: taking into account the likely underestimates of bigeye catch by observers, and the inclusion of the density of floating objects. Dr. Aires-da-Silva agreed that the inclusion of the density of floating objects could be helpful in the analysis.

7. Assessment of skipjack tuna (SAC-02-07a-d)

Dr. Maunder presented information on the assessment of skipjack tuna. Four different methods were used to assess the status of skipjack tuna in the EPO: 1) analysis of tag data; 2) a length-structured stock assessment model; 3) a Spatial Ecosystem and Population Dynamic Model (SEAPODYM); and 4) the indicator method used in recent assessments. The EPO is divided into six stocks and each stock is analyzed separately in some cases. Floating object CPUE has been increasing in some areas and mean length has been decreasing in the offshore areas.

Tagging

Tag release and recapture data from eight trips by pole-and-line vessels between 1973 and 1981 and from several trips by pole-and-line vessels between 2000 and 2006 in the EPO were analyzed to estimate fishing mortality rates. Each tagging trip or release month was modeled as a separate population, but sharing parameters. The model includes initial tagging-related mortality and tag shedding as a combined parameter, chronic (long-term) tag shedding and tagging-related mortality as a combined parameter, non-reporting, and initial non-mixing. The fishing mortality by month was modeled as a random effect around an overall mean fishing mortality. The model was fitted to the recaptures using a negative binomial-based likelihood function.

The model fits the recaptures reasonably well. There is a large amount of temporal variability and uncertainty in the estimates of fishing mortality based on the tagging data. Adding effort data did not improve the analysis substantially. This analysis suggests that it is unlikely that the historical tagging data will provide a substantial amount of information on fishing mortality to improve the skipjack stock assessment. Under the assumption that tag shedding, tagging-related mortality, and reporting rates are the same for the historic and recent data, the analysis indicates that recent fishing mortality rates in the area of the recent tagging are lower than the historic fishing mortality rates in the areas of the historic tagging. However, it is likely that reporting rate differs, and the other quantities may as well.

Length-structured model

A length-structured model is developed for assessing skipjack tuna in the EPO. This model differs from the standard age-structured model approach used for assessing yellowfin and bigeye tuna, implemented using Stock Synthesis. The ageing data for skipjack tuna is unreliable, and growth information is based on tagging length-increment data. Growth based on length-increment data is ideally suited for length-structured models, and is problematic for age-structured models. The EPO is divided into six stocks and each stock is analyzed separately. The model is fitted to CPUE-based indices of relative abundance and length-composition data.

There is insufficient information in the CPUE and length-composition data to produce reliable estimates of skipjack stock size. In all but one region (Region B off the coast of Ecuador) the estimates of abundance and exploitation rates were unrealistic. The selectivity or growth rates are sufficiently different among stocks that sharing selectivity information from region B with the other regions also produces unrealistic estimates. Therefore, results from the length-structured stock assessment model are only presented for region B.

The length-structured model for region B estimates highly variable monthly recruitment, with a very large recruitment in 1999. Estimates of biomass are also highly variable with a very large biomass in 1999 and generally increasing biomass since 1980. The estimates of exploitation rates are highly variable. The exploitation rates were estimated to be high in the late 1970s and the early 1980, but considerably lower in recent years.

SEAPODYM

A Spatial Ecosystem and Population Dynamic Model (SEAPODYM), that fits to a variety of data sources (Senina *et al*. 2008), has been applied to skipjack tuna in the Pacific Ocean (see Lehodey *et al*. 2011 for details) (references: see http://www.iattc.org/Meetings2012/May/PDFs/SAC-03-07a-SKJ-assessment-2011.pdf). The analysis differs from Lehodey *et al*. (2011) in that the analysis: 1) used the latest available SODA 2.1.6 variables; 2) switched to MFCL-2010 length-at-age estimates; 3) scaled the Western and Central Pacific Ocean (WCPO) stock to MFCL estimates via fixing recruitment and mortality coefficients; and 4) used asymmetric Gaussian functions for purse-seine selectivities instead of sigmoid selectivities. Biomass estimates for the EPO only are used in this assessment.

The SEAPODYM model is a two-dimensional coupled physical–biological interaction model at the ocean

basin scale, and contains environmental and spatial components used to constrain the movement and the recruitment of tuna. The model combines a forage (prey) production model with an age-structured population model of the fishery target (tuna predator) species. All the spatial dynamics are described with an advection– diffusion equation. Oceanographic input data sets for the model are sea-surface temperature (SST), oceanic currents and primary production that can be predicted data from coupled physical–biogeochemical models, as well as satellite-derived data distributions. Recent improvements include rigorous parameter optimization using fisheries data (size composition and abundance indices), which are based on methods used for contemporary stock assessment models (Senina *et al*., 2008).

The estimates of biomass are less variable than the other methods. Annual exploitation rate is estimated as catch divided by biomass in the EPO, and is moderately low.

Indicators

Eight data- and model-based indicators are used to evaluate the 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. The results are updated to include data up to 2011. 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. Except for a large peak in 1999, the floating-object CPUE has generally fluctuated around an average level since 1990, but was at the upper reference level in 2011. The unassociated CPUE has been higher than average since about 2003, and was at its highest level in 2008; it declined in 2010, then increased to around the upper reference level in 2011. The standardized effort indicator of exploitation rate increased starting in about 1991, and has been above the upper reference level in the mid 2000s, but dropped below it in 2009 and has been declining since. The average weight of skipjack has been declining since 2000, and in 2009 was below the lower reference level, but increased slightly in 2010 and 2011. The biomass, recruitment, and exploitation rate have been increasing over the past 20 years, and have fluctuated at high levels since 2003. The biomass and recruitment were above the reference level in 2011.

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

Summary

There is uncertainty about the status of skipjack tuna in the EPO. There may be differences in the status of the stock among regions. There is no evidence that indicates a credible risk to the skipjack stock(s).

Following Dr. Maunder's presentation, a participant asked about the tagging studies and the level of reporting rates by fishermen. Dr. Maunder indicated that older reporting rates from the 1970s were used. Another participant suggested that the conclusion put forth in the analysis, that tagging data will not improve the skipjack assessment, is too pessimistic and that more time is required to assess the usefulness of tagging data. Dr. Maunder responded that this conclusion was regarding the tagging data currently available, and a more comprehensive tagging program would improve the assessment.

Regarding indicators for skipjack, one participant noted that the trend of increasing recruitment for skipjack could be related to an increase in catch. Another participant suggested that the staff concern over

the decline in average length of skipjack should be revised to indicate that any further decline in average length is a concern. Dr. Maunder agreed with this suggestion.

A discussion developed regarding future analysis of skipjack. One participant asked when the next analysis would take place beyond 2012. Dr. Maunder indicated that an update in the skipjack assessment might coincide with the inclusion of additional tagging data into the analysis. Another participant expressed concern about the decrease in mean size at capture for skipjack related to the FAD fishery and urged a precautionary approach in the management of skipjack. It was also recommended that a higher CPUE for skipjack could be targeted, through either FAD research or tag-recapture studies. Dr. Maunder explained that the staff had requested more information on FADs. He also pointed out that there are uncertainties in managing skipjack, but that resolutions targeting bigeye also have the ancillary effect of protecting skipjack as well.

Another participant asked if longline catches of skipjack had been incorporated into the analysis. Dr. Maunder indicated that this had not been done but cautioned that the skipjack catches by longline were very low and might be unreliable. One participant reported that in the Indian Ocean, an analysis to standardize longline data for skipjack resulted in scattered data and unclear trends.

8. Assessment of other species

8a. North Pacific albacore

Dr. J. Holmes, Chair of the ISC-Albacore Working Group, presented the 2011 assessment of the north Pacific albacore tuna (*Thunnus alalunga*) stock, using fishery data through 2009. This assessment was conducted using a seasonal, length-based, age-structured, forward-simulation population model developed with the Stock Synthesis modeling platform (Version 3.11b) and is based on the assumption that there is a single well-mixed stock of albacore in the north Pacific Ocean. The model uses quarterly catch-at-length data, 16 age-aggregated fisheries defined by gear, location, season, and catch units (weight or number), a new growth curve estimated within the model, and use of conditional age-at-length data not previously available.

Analyses were carried out to assess the sensitivity of the results to assumptions, including data-weighting (both between data types and relative weightings of different sources within a data type), biology (stock-recruitment relationship, natural mortality, growth), and fishery selectivity patterns. Stochastic future projections of albacore stock dynamics were used to assess the impact of current fishing mortality and management on future harvest and stock status. The base-case scenario for projections assumes average recruitment and constant F (at current F level, $F_{2006\text{-}2008}$), but sensitivity of the results to alternative harvest scenarios (constant catch and constant $F_{2002\text{-}2004)}$, two recruitment scenarios (high and low levels), and alternative structural assumptions (down-weighting of the length composition data, stock-recruitment relationship, growth) was investigated. Retrospective analysis to assess the level of bias and uncertainty in terminal year estimates of biomass, recruitment and fishing mortality was also conducted. A reference run of the virtual population analysis (VPA) model configured as in the 2006 assessment, but with updated catch-at-age and CPUE indices, was conducted to compare important estimated quantities for model-related changes.

The base-case model estimates that the spawning stock biomass (SSB) has likely fluctuated between 300,000 and 500,000 t between 1966 and 2009 and that recruitment has averaged 48 million fish annually during this period. The pattern of F-at-age shows fishing mortality increasing to its highest level on 3-yr old fish and then declining to a much lower and stable level in mature fish. Current F (geometric mean of 2006 to 2008, $F_{2006\text{-}2008}$) is lower than $F_{2002\text{-}2004}$ (current F in the 2006 assessment). Future SSB is expected to fluctuate around the historical median SSB (~405,000 t) assuming F remains constant at $F_{2006\text{-}2008}$ and average historical recruitment levels persist. $F_{2006\text{-}2008}$ is well below several MSY proxy reference points (F_{MAX}, $F_{0.1}$, F_{MED}) and is equivalent to a spawning potential ratio of approximately F55%.

Sensitivity and retrospective analyses assessed the impact of alternative assumptions on the assessment

results. These analyses revealed scaling differences in estimated biomass (total and SSB) and, to a lesser extent, recruitment, but few differences in overall trends.

Both the SS3 base-case model and the VPA reference run estimated similar historical trends in SSB and recruitment, but with different scaling for biomass. The scaling difference is largely attributable to the different growth curves used in SS3 base-case model (estimated within the model) and the VPA reference run (growth fixed to externally estimated parameters).

The Working Group concluded that overfishing likely is not occurring and that the stock likely is not in an overfished condition (*e.g.*, $F_{20\text{-}50\%} < 1.0$), although biomass-based reference points have not been established for this stock. The current assessment results confirm that *F* has declined relative to the 2006 assessment and that this conclusion is robust to the different plausible assumptions tested by the Working Group. The lower *F* found by this assessment is consistent with the intent of the previous (2006) Working Group recommendation.

The north Pacific albacore stock is considered to be healthy at the current level of average historical recruitment and fishing mortality ($F_{2006\text{-}2008}$). However, recruitment is a key driver of the dynamics in this stock and a more pessimistic recruitment scenario (25% below average historical recruitment, which is within the estimated variability) will increase the likelihood that the impact of current *F* ($F_{2006\text{-}2008}$) on the stock is not sustainable.

Following Dr. Holmes's presentation, a participant expressed interest in a written report of the albacore assessment, and Dr. Holmes said there is a link to the document on the agenda of this SAC meeting. In addition, the presentation will be on the IATTC website. There was a question about why reference points, which would be a high priority for the next assessment, were not presented. Dr. Ray Conser, the previous ISC-Albacore Working Group chair, was asked to address this matter. Appropriate reference points have been a long-standing issue for north Pacific albacore, and the Working Group has not been comfortable using the nominal MSY reference points. F_{max} is not very reasonable, and there have been requests for other ones. In the working group's analysis, the estimated ratio $F_{max}/F_{current}$ is about 8, which is very large.

8b. Report of technical meeting on silky sharks, December 2011.

Dr. Aires-da-Silva presented an overview of the progress made on stock assessment for the silky shark in the EPO (see the report of the 3rd Technical Meeting on Sharks).

Following Dr. Aires-da-Silva's presentation, a discussion developed regarding existing data availability shortcomings for silky sharks. Dr. Aires-da-Silva indicated that, despite the existing data limitations, assumptions have been made about these gaps and there should be a full preliminary assessment of silky shark by 2013, which the staff could rely on to improve their recommendations to the Commission.

Another participant suggested that the analysis should include data from fisheries that target sharks, such as some components of the industrial longline fishery. This participant also pointed out that silky sharks dominated the shark catch in Ecuador and Colombia in the late 1990s, but now the dominant species is thresher shark, and it is uncertain what caused this switch in catch dominance. The staff was urged to provide some precautionary recommendations to the Commission in the short-term rather than waiting for the full assessment in 2013. Dr. Aires-da-Silva explained that the staff has prepared recommendations for silky sharks for this meeting and these will be discussed later in the agenda.

A participant reported that in Venezuela, measures or resolutions about finning of sharks are being evaluated. One of the proposals is to bring the entire animals to port, while permitting only partial cuts to help in freezing. The purpose is to provide a means to estimate size composition from historical records of numbers of dressed sharks. ICCAT's parameters will be used for size conversion from trunk dimensions to length of the whole animal. Another activity in progress now in Venezuela is to familiarize members of the fishing communities and technicians on accurate in port identification of sharks and other species.

Dr. Aires-da-Silva expressed interest in this work and urged further discussion about these initiatives.

Another participant welcomed the efforts made and commented that it is necessary that the countries that have not yet cooperated with information for this necessary exercise join in, and then the assessment of this species in the EPO can be finished. He also suggested that at the end of this assessment the necessary basis will be in place for making better conservation and mitigation recommendations.

9. a. Options for reference points and harvest rate control rules (SAC-03-09)

Dr. Maunder presented information on this topic. The Antigua Convention commits the IATTC to applying the precautionary approach, in accordance with Annex II of the United Nations Fish Stocks Agreement (UNFSA). UNFSA states that reference points and decision rules should be used, and defines how reference points should be used in decision rules. Specifically, fishery management strategies shall ensure that the risk of exceeding limit reference points is very low. UNFSA provides minimum standards for some reference points and decision rules. Specifically, the fishing mortality rate which generates maximum sustainable yield should be regarded as a minimum standard for limit reference points. By analogy any biomass-based LRP should be at least B_{MSY}, and the TRP should be considerably higher than B_{MSY}. Both UNFSA and the Antigua Convention explicitly state that the amount of uncertainty should be taken into consideration when taking management action, and therefore it should be part of the decision rule.

The IATTC has historically used an informal decision rule that is based on F_{MSY} as a target reference point (TRP). This is inconsistent with the precautionary approach as prescribed in Annex II of the U.N. Straddling Stocks Agreement, which states that F_{MSY} is a limit reference point (LRP), and LRPs should have a low probability of being exceeded. The calculation of MSY and the associated reference points requires knowledge of several biological (*e.g.* growth, natural mortality, stock-recruitment relationship) and fishery (*e.g.* selectivity) related quantities. In particular, the stock-recruitment relationship is difficult to estimate Precautionary reference points have been developed based on spawner per recruit (SPR). An alternative approach is to estimate the MSY based quantities assuming a precautionary value for the steepness of the stock-recruitment relationship recognizing the flat yield curve at high steepness levels. For some stocks, the absolute level of the population size and fishing mortality is difficult to estimate and standard reference points are not appropriate. Reference points based on historical biomass or fishing mortality levels may provide LRPs based on the assumption that those levels occurred in the past and the population remained sustainable, but the outcome is unknown if they are exceeded.

A common decision rule is fishing mortality as a function of biomass, using biomass-based reference points to control changes in the fishing mortality. The minimum standards outlined in the precautionary approach, as prescribed in Annex II of the U.N. Straddling Stocks Agreement, can be used to define a decision rule based on the following guidelines: B_{MSY} should be considered a limit; the risk of exceeding the limit reference point should be very low; fishing mortality should not exceed F_{MSY}. A simple rule could be to set the fishing mortality rate at a precautionary level (*e.g.* F_{MSY} x% or F_{MSY} h=x) independent of the biomass level.

Following Dr. Maunder's presentation, it was noted that science is good for determining limit reference points, but socioeconomic factors come into play for target reference points. For example, in Canada maximum economic yield is important, and reference points based on economic factors are usually lower than if based on F_{MSY}. There was discussion about whether B_{MSY} should be considered a limit reference point. It was noted that the requirement to use F_{MSY} as a limit reference point did not require the use of B_{MSY} as a limit. Dr. Maunder explained that since F_{MSY} implies B_{MSY} in equilibrium, that these two reference points are inherently linked. The conservation measures adopted by the IOTC address target and limit reference points. Although the goal is to follow the precautionary approach as prescribed in Annex II of the U.N. Straddling Stocks Agreement, they recommended a limit reference point of 140% of F_{MSY}, which is inconsistent with the precautionary approach. In the western Pacific and the Atlantic, no target and limit reference points were adopted. It was pointed out that, in the IOTC, reference points are a

recommendation and the precautionary approach as prescribed in Annex II of the U.N. Straddling Stocks Agreement is official. These are specific interim reference points. The IATTC staff's recommendations are based on F_{MSY}, and closures are recommended due to the status of bigeye tuna. In practice, F_{MSY} has been treated as both limit and target reference points.

Although another agenda item, the Director was asked what the staff will recommend to the Commission. The Antigua Convention requires that the stocks be maintained near MSY. The basis for the recommendations is always expressed; this year the yellowfin stock is better off than last year and we continue to see a downward trend in bigeye. The recommendation will be similar to that is previous years, with a warning regarding bigeye. Since this is a multi-species fishery, the measures apply to all vessels fishing tropical tunas. The staff will also make recommendations regarding mitigation measures for incidental species such as sharks. Fisheries that target sharks, for example, must also be included. Of course, the staff's recommendations may not be adopted by the Commission.

There was additional discussion of the complicated nature of managing multispecies fisheries and the need for appropriate decision rules. The need for an ecosystem approach was underscored, to take into account that pelagic species are susceptible to ecosystem and environmental changes.

9b. Kobe strategy matrix and its application to bigeye (SAC-03-06c)

Dr. Maunder presented information on the Kobe plot and matrix. Following the recommendations of the first joint meeting of the tuna regional fisheries management organizations (RFMOs), held in Kobe, Japan, in January 2007, there are ongoing efforts to standardize the presentation of stock assessment results for management advice among the world's RFMOs. One of the main recommendations was to present stock assessment results in the form of "four quadrant, red-yellow-green" format, the so-called Kobe plot (Report of the first joint meeting of the tuna RFMOs). This task has already been implemented with some variants by all tuna RFMOs. The next step is to present a "strategy matrix" for managers, which provides alternative options for meeting management targets (Report of the second joint meeting of the tuna RFMOs). We critically evaluated a series of alternative approaches which could be used to implement the Kobe strategy matrix (bootstrapping, Monte Carlo methods, Bayesian MCMC analysis and the normal approximation method). An application of the normal approximation method is illustrated with the base case assessment model for bigeye tuna in the EPO. The analysis is only an illustration of the construction of the Kobe strategy matrix and the results should not be used for management advice.

The Kobe strategy matrix differs from traditional decision tables. It presents the probability of meeting a target reference point and therefore requires estimates of uncertainty. There are several different sources of uncertainty, but the main ones are: a) parameter estimation uncertainty, b) model structure uncertainty, and c) future process variation. Parameter estimation uncertainty and the main source of future processes variation (recruitment variation) are generally well determined in stock assessment models. However, model structure uncertainty is often poorly represented and sensitivity analyses to model structure assumptions should be conducted. A separate Kobe strategy matrix could be constructed for each model structure assumption. Alternatively, if probability statements can be assigned, the model structure uncertainty could be integrated into a single Kobe strategy matrix.

Stock Synthesis has the facility to estimate parameter uncertainty using Bayesian MCMC analysis, bootstraps, and normal approximation. The bigeye assessment is conditioned on natural mortality, average length of the oldest fish, and steepness of the Beverton-Holt stock-recruitment relationship. These need to be considered in the uncertainty estimates used in the creation of the Kobe strategy matrix. Initial Bayesian without the model structure uncertainty runs took 10 days to converge and are therefore not feasible. A single run to estimate the model parameters takes 3.5, so it is not feasible to run the 200 or more bootstraps needed for the base case as well as the model structure uncertainty runs. There also may be issues with convergence. Therefore we applied the normal approximation method.

Fishing mortality rates relative to the current fishing mortality were chosen as the management action

since it relates to the season closures used in the EPO. We created the Kobe strategy matrix for the 80%, 90%, and 95% probability that the spawning biomass (Sy) is above the spawning biomass corresponding to MSY (S_{MSY}) in 5, 10, and 15 years. We also calculated the Kobe strategy matrix for the 80%, 90%, and 95% probability that the fishing mortality (Fy) is below the fishing mortality that corresponding to MSY (F_{MSY}). The fishing mortality calculations are independent of time.

To ensure that there is a 95% probability that the spawning biomass in five years is greater than the spawning biomass corresponding to MSY, the fishing mortality has to be reduced by 15% under the base case model. The reduction in fishing mortality is less if the time frame is longer or if the desired probability is less. The projections converge to a stable state quickly, so the results are similar for 10 and 15 years. To ensure that there is a 95% probability that the fishing mortality is less than the fishing mortality corresponding to MSY (F_{MSY}), the fishing mortality has to be reduced by 17%. The management quantities are highly sensitive to the model structure uncertainty for natural mortality, average length of the oldest bigeye tuna, and steepness of the stock-recruitment relationship. This model uncertainty greatly reduces the fishing mortality that produces the desired probability of being below F_{MSY}. Assigning equal weight to all sensitivities gives more emphasis to extreme assumptions, increasing the uncertainty and further reducing the fishing mortality that produces the desired probability of being below F_{MSY}. The management actions are more sensitive to the model structure uncertainty than to choosing between the probabilities of exceeding the reference points.

The construction of the Kobe strategy matrix for parameter and data rich models such as those used for assessing tunas in the EPO is computationally intensive, particularly if model structure uncertainty is taken into consideration. The use of the normal approximation method is a practical alternative, as we have shown, but the accuracy of the approximation is unknown. Our results clearly show that ignoring model structure uncertainty or naively including all model structures without appropriately weighting them can substantially bias the management actions presented in a Kobe strategy matrix. The management actions are more sensitive to the model structure uncertainty than choosing between the probabilities of exceeding the reference points.

Following Dr. Maunder's presentation, Dr. Deriso mentioned that risk curves at various *F* scales will be a regular part of the assessments, and asked the SAC for opinions about whether this should be in graph or tabular form, or both. It was noted that a graphical presentation is probably better, and that the SAC should support this idea. Further agreement to use a graphical method was expressed, noting that while the Kobe matrix is becoming a decision tool, the technical foundation must be clear so the decision makers understand how it works. The Director underscored that the staff is currently using the Kobe plot, and at some point in the future may begin using the Kobe matrix. Dr. Maunder's presentation has clearly shown how difficult it is to develop the matrix.

10. Progress report on poststratified estimators of total catch for port-sampling data (SAC-03-10)

Dr. Cleridy Lennert-Cody presented progress in the evaluation of the areas used in stock assessments and in poststratification of the port-sampling data for estimating total catches by species. The focus of the work to date has been on purse-seine sets on tunas associated with dolphins, with emphasis on yellowfin tuna. A multivariate regression tree approach was used to simultaneously analyze spatial-temporal patterns in yellowfin tuna length-frequency distributions (from port-sampling data for 2000-2011) and in annual trends in catch-per-unit-effort (catch per day fishing computed from observer and logbook data for 1975-2011). The four-area stratification that was obtained from this analysis shows similarities to the stock assessment areas currently in use for yellowfin in dolphin sets. The preliminary evaluation of poststratification methods for total catch estimation was based on the use of linear models to study spatial and temporal variability in average weight of yellowfin tuna, and the use of generalized linear models to study spatial variability in species count data for yellowfin and skipjack tuna (no bigeye tuna was present in the port-sampling data for dolphin sets). Both of these analyses used the port sampling data from 2000-2011. The results of these analyses suggest that spatial variability dominated over temporal variability,

and that an estimator of total catch with somewhat fewer strata than that currently in use may be reasonable. Future work, in preparation for the IATTC external review in October 2012, will include a sensitivity analysis of the spatial stratification for stock assessment, additional analysis of poststratification definitions for catch estimation (including additional analyses for skipjack), and estimation of total species catch and variance of total catch for various poststratification definitions.

Following Dr. Lennert-Cody's presentation, clarification was requested about whether the analysis will also consider skipjack and bigeye in addition to yellowfin. The focus has been on dolphin sets only, so bigeye are not in the analysis. A participant mentioned that the dolphin fishery is relatively simple due to the catch of fairly uniform size fish, but the floating-object and unassociated tuna fisheries are more complex in that juvenile yellowfin are also in the catch, and therefore should be included. Dr. Lennert-Cody pointed out that the external review committee for the yellowfin stock assessment recommended concentrating on dolphin sets because most of the yellowfin catch comes from those sets, and floating-object sets can be added later.

It was further noted that temporal and spatial factors in species composition and size frequency are also important. Dr. Lennert-Cody mentioned that spatial and temporal pattern in length frequency distributions were considered, in the present analysis of large areas for the stock assessment. In this particular case, length-frequency data for the other species have not been considered because dolphin set catches are dominated by yellowfin tuna. However, within the large stock assessment areas, an analysis of spatial variability in the species counts in the sampling data was conducted using logistic regression, and spatial-temporal variability in these data will be explored with other types of analyses in the work for the IATTC external review. An analysis of temporal and spatial patter in the average weight data for yellowfin within large stock assessment areas was also presented. This type of analysis also will be applied to the average weight data for skipjack for the external review.

There was a question about whether environmental and oceanographic conditions are considered for the poststratification process. Environmental predictors were not included in the analysis, but Dr. Lennert-Cody pointed out that latitude and longitude are proxies for habitat differences. It was further noted by a participant that seamounts and ridges have important effects on pelagic fisheries, and that the northern area has a relatively stable environment due to reduced ENSO influences. According to Dr. Lennert-Cody, while spatial resolution at the level of the 5° area is used in the analysis at present, this is something that could be considered in future analyses.

11. Ecosystem considerations (SAC-03-11)

11a. Use of Productivity and Susceptibility Analysis (PSA)

Dr. Robert Olson presented information on a preliminary Productivity and Susceptibility Assessment for the purse-seine fishery in the EPO. The vulnerability to overfishing of many of the stocks incidentally caught in the EPO tuna fisheries is unknown, and biological and fisheries data are severely limited for most of those stocks. Many fisheries managers and scientists are turning to risk assessments to evaluate vulnerability to fishing. The IATTC staff is evaluating an established method for determining the vulnerability of data-poor, non-target species. A version of productivity and susceptibility analysis (PSA), used to evaluate other fisheries in recent years, considers a stock's vulnerability as a combination of its productivity and its susceptibility to the fishery.

Productivity and susceptibility indices of a stock are determined by deriving a score ranging from 1 (low) to 3 (high) for a standardized set of attributes related to each index. The individual attribute scores are then averaged for each factor and graphically displayed on an x-y scatter plot. Nine productivity and eight susceptibility attributes were used in this PSA. When scoring the attributes, the data quality associated with each attribute score was assessed, and the attributes were weighted by the data-quality score. Stocks that received a low productivity score (p) and high susceptibility score (s) were considered to be at a high risk of becoming depleted, while stocks with a high productivity score and low susceptibility score were

considered to be at low risk. Vulnerability scores (v) were calculated from the p and s scores as the Euclidean distance from the origin of the x-y scatter plot and the datum point.

The tunas and some of the "large fishes" scored the highest in productivity and the elasmobranchs the lowest in productivity. The olive Ridley turtle, yellowtail amberjack, and bigeye thresher shark scored lowest in susceptibility, while black marlin and bigeye trevally had the highest susceptibility scores. In terms of overall vulnerability to overfishing, the shortfin mako, great hammerhead, bigeye thresher, and the giant manta ray scored the highest.

In general, the PSA shows promise as a tool to rank species that are in the most need of attention. However, there is no indication from the PSA analysis if the species that score the highest in vulnerability are indeed unsustainable. The staff has plans to focus a working group to continue progress on a full PSA for the pelagic eastern Pacific Ocean.

Following Dr. Olson's presentation, a discussion developed regarding the vulnerability of species such as dolphins and tunas that are well studied but still appear vulnerable in the analysis. Dr. Olson explained that species such as dolphins and tunas that are well studied can be helpful in the analysis for comparison with the data-poor species, to validate the analysis.

Another participant reported that a recent risk assessment meeting in Canada identified uncertainty scores as an important component of this type of analysis. If the analysis indicates that a species is highly susceptible, the level of uncertainty around that estimate is important. Dr. Olson agreed that this is an important aspect of the analysis and indicated that he will discuss incorporating uncertainty with the stock assessment group.

A participant commented that the analysis is geared towards analyzing risk for each species, and that species-specific behavior is important. Another participant urged precaution about vulnerability assumptions for species such as dolphins, which are assumed to be well-studied and at low risk for vulnerability. Dr. Olson agreed with both points and indicated that as the analysis is refined, well studied species such as tunas and dolphins will be used as reference points in the analysis. Dr. Martian Hall also noted that designations such as endangered and threatened (according to the IUCN designations) were not uniform among species and should be viewed with caution. Dr. Deriso also noted that the definition of susceptibility, as used in the analysis, may require some reconsideration. The definition, according to the documentation of NOAA's procedure, does not fit well with dolphins and tunas.

11b. Bycatches in purse-seine fisheries (SAC-03-11b-iii and SAC-02-13)

Dr. Martin Hall presented an overview of purse-seine bycatch and mitigation issues in the EPO. His presentation covered FAD research, experimental designs for sorting grids, potential use of pumps in purse-seine fisheries, and an in-press FAO review: *Bycatches and non-tuna catches in purse-seine fisheries of the world.* Dr. Hall introduced some information on a recent feasibility study that took place in Norway, on the use of pumps to bring tunas and other species alive to the vessel, to allow a better selection of the catch. The project was financed by ISSF, and had the participation of gear technologists, an experienced tuna captain, and researchers from the Institute of Marine Research in Bergen, Norway. Norway has a very advanced technology developed to handle live fish in aquaculture operations. The possibility of adapting some of the pump models to a purse seiner is an attractive one, since the pump may have several uses, besides the main one of allowing the live release of unwanted individuals.

Following Dr. Hall's presentation, a participant asked for clarification on the types of sorting grids being tested in at-sea experiments. Dr. Hall explained that there were two types of sorting grids which differed slightly in materials and construction as well as a control with no sorting grid. Retained catch in the control net can be compared to that retained in the nets containing each type of sorting grid to assess effectiveness of the grids. It is important to develop uniformity between grid types and grid location in the net to standardize testing.

A discussion developed regarding the harmonization of data among the RFMOs. One participant indicated that the ISSF supported the meeting held in Sukarrieta, Spain, at AZTI's research center, which was in line with the Kobe process, and urged the Commission, perhaps through the Director, to disseminate the report to all of the RFMOs. The meeting had the participation of managers of observer programs, database managers and some data users from all the tuna purse-seine observer programs in the world. The objectives, list of attendees, and additional description of the meeting are in Dr. Hall's presentation. Dr. Hall responded that the Kobe process has formality but that the aforementioned meeting was a technical meeting that happened to include some coordinators from various organizations. He added that the meeting contributes to the Kobe objectives as well as to those of the tuna RFMOs.

11c. Update on mitigation measures for seabirds

Dr. Marco Favero presented a paper by ACAP and Birdlife International summarizing a research initiative on seabird mitigation. A comprehensive analysis of new research and evidence on seabird bycatch mitigation for pelagic longline fisheries was conducted in 2011 during the annual Meeting of the ACAP Advisory Committee and its Seabird Bycatch Working Group. The review was condensed in a document drafted by ACAP and BirdLife International to the IATTC Scientific Advisory Committee. The document indicates that a combination of weighted branchlines, bird scaring lines, and night setting is the best practice mitigation in pelagic longline fisheries. Options for line-weighting regimes and use of bird-scaring lines for vessels of different size are specified in the document. These measures should be used in the areas of application defined by resolutions designed to reduce the seabird incidental mortality to the lowest possible levels. Currently, no single mitigation measure can reliably prevent the incidental mortality of seabirds in most pelagic longline fisheries. The most effective approach is to use the above measures in combination. Other RFMOs such as ICCAT and IOTC recently reviewed their seabird conservation measures following the ACAP/BirdLife International best practice advice, leaving behind the two column approach and adopting this new concept, calling for the use of two out of three of the above mentioned measures.

Following Dr. Favero's presentation, one participant noted that all of these proposed mitigation measures were included in the seabird mitigation resolution of 2011. Dr. Favero indicated that there was no evidence of the effectiveness of these recommendations in the 2011 resolution. Dr. Compeán noted that, based on the conclusions by ACAP, that the report by the Committee should indicate that it is better to use 2 of the 3 mitigation measures tested, and that this information be taken into account for consideration of possible amendment of the 2011 resolution. Dr. Favero indicated that the latest information on seabird mitigation measures was not available until after the 2011 Annual Meeting of the IATTC, and that most RFMOs have now accepted the use of 2 of the 3 mitigation measures proposed by ACAP. Dr. Compeán suggested that the Committee should recommend that the mitigation measures be reviewed, not revised, based on new information provided at this meeting by ACAP and BirdLife International. However, the decision of whether to amend the 2011 resolution rests with the Commission

11d. ISSF-IATTC purse-seine research cruise in the equatorial EPO in 2011

Mr. Schaefer presented information on a research cruise sponsored by ISSF and IATTC. The 73-day cruise was undertaken by IATTC scientists during the period of 11 May to 23 July 2011 in the equatorial eastern Pacific Ocean aboard the Ecuadorian-flag purse seine vessel *Yolanda L.*, under a charter agreement between the vessel owner and the ISSF. The objectives of the cruise included attempting to reveal practical solutions for reducing the fishing mortality of undesirable sizes of bigeye and yellowfin, sharks, and other species of concern commonly captured during fishing operations by purse-seine vessels setting on mixed-species aggregations associated with drifting fish-aggregating devices (FADs). A focus of the scientific experiments conducted, and the overall research objective, was to elucidate whether the potential exists to modify purse-seine fishing methods to minimize the capture of such species, while optimizing the catches of skipjack tuna associated with drifting FADs.

There were five specific research activities, which the scientific committee of the ISSF by-catch program

agreed fit within the objectives of the overall project, and were undertaken during the cruise:

1. To test different designs of FADs that may not entangle turtles or sharks, potentially using biodegradable materials.
2. To evaluate the accuracy of the fishing captain's catch predictions from sets on tuna aggregations associated with drifting FADs, and the potential for improvements in those estimates through the use of additional complementary equipment and methods.
3. To elucidate spatial and temporal differences in the behavior of skipjack, bigeye, and yellowfin tunas within mixed species aggregations associated with drifting FADs, in order to reveal potential opportunities for avoiding the capture in purse-seine sets of bigeye, yellowfin, and sharks, while optimizing the capture of skipjack.
4. To investigate the behavior of tunas and sharks captured within a purse-seine net, and determine if species-specific segregations occur, and if so the spatial and temporal characteristics of such segregations.
5. Determine the at-vessel mortality, post-release survival, and the physiological, biochemical, and molecular responses of sharks incidentally captured by purse seiners.

The results of each of these five research activities were presented and discussed, in varying degrees of detail.

Following Mr. Schaefer's presentation, a participant inquired about the source of recaptured fish during the tagging experiments conducted during the research cruise. Mr. Schaefer indicated that recapture rates were based on fish onboard the boat (a few) and unloaders in Manta, Ecuador, and that recaptures occurred on the same FAD. Another participant commented on the difficulty of separating species associated with FADs and separating the sampling well, and requested information on the fate of the 40 silky sharks caught during the sampling. Mr. Schaefer noted that of the 40 silky sharks caught, 8 were tagged (2 opportunistically after becoming entangled) and 32 were dead onboard and sampled for biological and physiological analysis.

A participant commented on the high mortality of sharks once they are subject to capture and handling in the nets. It was suggested that the optimal situation is to not set on sharks, and the second option is to remove them from the nets as quickly as possible, while the undesired situation is to brail the sharks, especially in large sets, which will result in almost certain mortality. Dr. Hall noted the large size (avg of 102 t) of the sets during the cruise, compared to the IATTC's estimate of average long term set size on FADs of 42 t. He suggested that to extrapolate to all FAD sets, a series of experiments would be required over a range of catches to estimate fully the effects of set size.

Another participant noted that all silky sharks caught in the experiments were juveniles, and suggested that it would be informative to study the importance of life stage on survival of sharks in the nets. Mr. Schaefer confirmed that all silky sharks captured were juveniles, and he also noted that no other species of sharks were captured during the experimental work.

A discussion developed regarding the quality of advice offered on sharks in recent resolutions of the Commission. One participant noted that based on the experimental evidence of this study and accumulated knowledge of the extremely low survival of sharks once captured in nets, that the recommendation to release all sharks may not be the best advice. It was noted that much remains to be learned in this area of research.

One participant inquired as to the ability to determine the composition of the fish aggregated under a FAD based on this study. Mr. Schaefer indicated that in the study echo sounders were not compared to satellite buoys, but added that several members of the ISSF bycatch committee were experts on separation of tunas and other species by echo sounder images and were conducting research on identification and separation of fishes in association with FADs. Another participant asked about the ability to identify pure

skipjack schools based on target strength. Mr. Schaefer confirmed that it is possible because skipjack do not possess swim bladders. In addition, the depth distributions of bigeye and yellowfin are different from that of skipjack, and this can also be used to distinguish between the species.

11e. Conservation status of sea turtles in the EPO

Dr. Jeffrey Seminoff, of the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC), presented a summary of the conservation status and habitat use of sea turtles in the EPO. At the 5th Conference of the Parties to the IAC in June 2011, a Memorandum of Understanding (MOU) was signed between the IAC and the IATTC. Under this agreement, the IAC believes that a first step to strengthen potential collaborations is to provide the IATTC with information about the conservation status, habitat use, and movements of sea turtles in the EPO. Dr. Seminoff reported on the current state of knowledge regarding the five sea turtle species occurring in the region, including leatherback turtles (*Dermochelys coriacea*), green or black turtles (*Chelonia mydas*), loggerhead turtles (*Caretta caretta*), olive Ridley turtles (*Lepidochelys olivacea*) and hawksbill turtles (*Eretmochelys imbricata*). Information on nesting abundance and trends was presented for each species, and a series of recommendations were given to promote sea turtle conservation and population recovery in the Pacific Ocean. As the IAC recognizes the tremendous efforts on the part of IATTC to reduce sea turtle-fisheries interactions, the recommendations presented by IAC were of general form, and touched on the overall needs for the conservation of sea turtles in the eastern Pacific, and not directed at IATTC as if IAC urged action by this RFMO. It is hoped that the two groups can build off this document to create positive sea turtle conservation action of enduring value.

Following Dr. Seminoff's presentation, Dr. Hall acknowledged the IAC and the excellent collaboration of many research groups studying turtles in the EPO. He noted that the critical situation of some turtle species requires specific action in the short-term rather than just monitoring. There is a lack of information regarding return routes to nesting sites in the EPO. IATTC observer data indicate that the return routes may be more coastal, putting the turtles at risk because they pass through many coastal fisheries. Dr. Hall urged committee members to communicate a sense of urgency to their countries regarding several turtle species, including hawksbill and leatherback.

Dr. Seminoff commented that the popular press characterizes sea turtle populations as doing poorly, yet individual species such as olive Ridleys and greens have increased in numbers, while others are showing serious declines. He indicated that one research need is for better tags and retention times to increase the time durations of tagging information.

A participant noted that under the Antigua Convention, having more and better information on turtle populations is desirable. A question was posed regarding the decrease of loggerhead turtles in both Mexico and Costa Rica, and whether this might be a population change or change in habitat. Dr. Seminoff noted that there appeared to be multiple causes of population declines in the eastern and western Pacific, such as by-catch, loss of nesting habitat in Japan due to seawall construction, dog predation on beaches in Australia, and low hatching success. For this reason, a holistic approach to conservation measures is recommended.

A participant asked how IAC and IUCN would approach the reclassification of species that appear to be doing better, such as the green turtle. Dr. Seminoff indicated that the green turtle is recovering in Mexico due to protection of beaches. He recommended a dialog between IAC and IUCN to promote regional assessments and reclassification in the categories.

Another participant noted that many problems associated with turtles might not lie with the fisheries under IATTC purview, but rather in the nesting areas and with fisheries that are not under the jurisdiction of the IATTC. Dr. Compeán indicated that the IATTC is now looking at coastal shark fisheries, and that there is little knowledge of the effect of shark fisheries, but the issues might be applicable to turtles. He expressed the opinion that the IAC document is a good first step to characterize the status of sea turtles,

and the next step is to identify actions that could reflect the issues identified in the aforementioned document and address specific problems in turtle conservation.

12. Staff activities and research plans (SAC-03-12)

Dr. Deriso provided a general overview of the document and provided clarification on the stock assessment schedule. The bigeye full assessment will be moved from 2014 to 2013, since this corresponds to the final year of the IATTC conservation measure and the staff would like to provide the most recent information on bigeye to the Commissioners. The yellowfin full assessment will be moved to 2014. An assessment of blue marlin will be done in 2013 instead of 2014, and black marlin will be undertaken in 2013 or 2014. The sailfish assessment has been pushed back to 2013. A Pacific-wide assessment of bigeye was not included but may be undertaken in 2013 in collaboration with the SPC. Information from tagging data indicates substantial movement of bigeye across the 150°W boundary, for fish tagged near the boundary, which could result in a very different assessment. There are also differences in growth of bigeye in the far western and eastern Pacific which have caused problems with the Pacific-wide assessment.

Another participant expressed some uncertainty regarding the reported growth differences in bigeye between the western and eastern Pacific, and suggested that the differences might be related to method of analysis rather than actual growth differences. Dr. Maunder indicated that there is strong evidence from otolith analyses and trends in the maximum size of fish from the longline fishery indicating that the growth differences are real.

Dr. Hall encouraged IAC and ACAP to continue to share information with the staff regarding sea turtles and seabirds. Dr. Compeán suggested that, based on previous discussions, the SAC should recommend that the Commission staff undertake an assessment of mahi-mahi. The participants agreed with this recommendation.

13. Discussion of workshop in fall 2011: Integrating fisheries oceanography into stock assesment and management

Dr. Maunder provided an overview of the workshop, held in October 2011. Fisheries scientists are well aware of the role that oceanographic processes play in controlling fish populations. Fisheries stock assessment and management has sometimes been criticized for failing to account for oceanographic processes. This workshop reviewed the use of oceanographic data in fisheries stock assessment and management. The results of the workshop have been developed into a draft manuscript prepared by the IATTC staff for submission to the journal Fisheries Oceanography.

There was no discussion of the workshop, but Dr. Maunder indicated that the draft manuscript was available at this meeting for review and comment.

14. Other business

Assessment of *mahi mahi* (dorado)

A participant proposed that the IATTC staff conduct an assessment of mahi mahi (*Coryphaena hippurus*) in the EPO. The Director said it is in the purview of IATTC to conduct a stock assessment on this species. It is in the same ecosystem as the tunas and is an important species throughout the region. There are good data from the purse-seine fishery and some artisanal data. A staff member expressed concern about not having information on stock structure. A participant informed the meeting that Ecuador is contributing pertinent research on mahi mahi, including genetics work with Mexico. Another participant expressed that, to decide, the Commission will need to know how much fishery activity is under the purview of the IATTC and what portion of the total catch this organization can account for. Several individuals voiced support for an assessment of mahi mahi in the eastern Pacific. The Director pointed out that some members of the Commission have requested an assessment of mahi mahi.

Management of FADs

One of the participants mentioned that an international symposium that was held last year in Tahiti presented information on FADs worldwide. He mentioned that the recommendations from that symposium highlighted many activities that can be done in the EPO, including regulations in the framework of a FAD Management Plan. Several participants focused on that fact that identification of individual FADs is necessary for monitoring and research purposes. The SAC has recommended this to the Commission in the past, but it has not been approved because it has not received the necessary support. The ISSF supports the recommendation and is requesting industry participants to submit FAD logbooks to the RFMOs.

Data availability

SAC participants continue to express concern that scientists cannot obtain adequate fisheries data for research purposes. Longline data especially, and purse-seine data to a lesser degree, are not available to any scientist in the world. Comparisons among oceans are impossible. Data for the EPO should be made available in the public domain, as in other oceans. A participant agreed with the need for better accessibility, but first it is necessary to determine what data should be public as well as non-public and to derive rules for the use the non-public data for scientific purposes. There was general agreement that the SAC should state that the current situation is not satisfactory and that data issues need to be resolved by the Commission.

IATTC reports

A participant repeated his concern that the staff displays relevant information on the fisheries and tuna stocks inadequately in its documents. Dr. Deriso pointed out some of the many types of data presented by the staff, and improvements in the figures in recent years, while there is room for improvement. The recommendation from the SAC will reflect this concern.

Miscellaneous other business

A participant noted the recent verdict reached by the World Trade Organization (WTO) which was in Mexico's favor in a suit brought by that country against the United States, for trade reasons related to tuna labeled as Dolphin-Safe and particularly for AIDCP Dolphin-Safe tuna. He also mentioned that after more than 20 years of a trade dispute, the WTO acknowledged by this action and in a definitive manner that there has been an unjust differential treatment that has restricted trade in the only tuna in the world that is totally certified and guaranteed to be Dolphin-Safe and which is furthermore a contemporary example of sustainability, recognizing it moreover as an outstanding international standard.

The decision of that world body is furthermore a recognition of the high scientific level existing in the IATTC-AIDCP program, which has made it possible to resolve a problem of incidental catch while maintaining appropriate levels of catch. With the WTO decision the environment wins, since it endorses the fishing methods used by the Mexican fleet and thus the result is also a recognition of the sustainability of the fishery for tunas with dolphins in the EPO.

15. Discussion of staff recommendations

Tunas

Dr. Deriso briefly reviewed the staff conservation recommendations for tunas in the EPO during 2012-2013, presented in Appendix B.

Participants expressed concern that overfishing of the bigeye tuna stock continues, as indicated by the results of the stock assessment and projections. In order to eliminate overfishing of the stock, the Commission may in the future look into extending the closure of the purse-seine fishery established in Resolution C-11-01. Alternatively, in part due to the status of yellowfin tuna, that does not require those measures, the Commission could consider other options, such as maintaining the current closure and adopting additional measures aimed specifically at reducing the catch of bigeye, particularly of small individuals associated with floating objects. Such measures could include, for example, annual vessel-

specific limits for bigeye. If effectively implemented, such limits could also result in increased productivity, i.e. a higher MSY. The Director said the staff can prepare the data to explore these alternatives. Further, an individual vessel quota system is difficult to manage, and to better manage, it may be necessary to follow the full retention rule.

Other participants mentioned geographic or temporally extending the fishing closure in the high-seas closure area as another option to manage the bigeye stock.

A participant commented that the necessity of a longer closure for the purse seine fishery is the result of the increase in purse-seine capacity from 208,100 m^3 in May 2011 to 214,422 m^3 in May 2012, and therefore the measure to reduce longline catches in paragraph 7 of the draft staff recommendation, if the existing 62-day closure is lengthened, cannot be considered an equal treatment.

Another participant expressed that the measures adopted by the Commission to end overfishing of bigeye tuna are insufficient, and the closure needs to be longer. Therefore, the staff's recommendations should be more stringent, in his opinion.

A participant mentioned that an increased closure of 74 days in 2012-2013 amounts to a 21% increase, and it is not mathematically consistent with the increase in purse-seine capacity over the past years, which is only 3% (from 208,100 to 214,222 m^3). A closure increase of 3% amounts to 63 days. In addition, if the *F* multiplier suggested for bigeye tuna is 0.95 then an additional increase of 5% in closure could be recommended. A 5% increase of the 63-day closure would amount to 66 days and not 74 as was being suggested.

There was discussion about the staff recommendations on Pacific bluefin tuna. A participant did not agree with the approach used by the staff of fixing the annual catches to the average annual level of catches during 1994-2007. He explained that, during the 1994-2007 period there was low impact on bluefin tuna, and to fix a quota to that average would limit catches in the EPO much below the desired objective. He requested that the IATTC staff analyze other management options, such as a catch limit, that would lead to the average calculated for the low impact period. Another participant expressed that the staff recommendation for Pacific bluefin is appropriate, the minimum needed, and consistent with IATTC's sister commissions. The Director said this was a precautionary approach to take while waiting for a new assessment from the ISC, later this month.

Sharks

Dr. Compeán briefly reviewed the staff conservation recommendations for silky sharks in the EPO during 2012-2013, presented in Appendix C.

A lively discussion ensued both for and against this staff recommendation. Some participants argued against adopting these measures at this time, due to:

- The status of silky shark is not yet known; a stock assessment is planned to be done this year, and we should wait for that assessment. This is a different situation than that of oceanic whitetip sharks, for which the SAC recommended immediate action because it was clear that the species was severely impacted. The declining trend for silky sharks is not thought to be remarkable by some SAC participants.
- The ISSF-IATTC at-sea experiments showed that sharks that had been brailed from the sack and released had a much lower probability of survival than expected under those conditions. Moreover, management measures for the longline fishery targeting sharks, where shark mortality is greater, are not strong enough.

Other participants argued for adopting these measures at this time, due to:

- IATTC data collected since 1993 are of high quality and clearly justifies action. This is a precautionary measure, given the low fecundity and growth rates of carcharhinid sharks. It is a good

start in the conservation of a highly exploited shark species, and similar measures should be proposed for hammerhead sharks.

- The assessments of silky sharks will always be considered preliminary if the IATTC staff is not able to have sufficient data, so there is an urgent need to collect more and better data.
- Data showed that the decrease of silky shark catch is significant, and very similar to the case of the oceanic whitetip shark, for which a resolution was adopted without a full assessment.
- The staff recommendations are mitigation measures that can be reviewed once the full assessment is finished.

In summary, there was not full agreement by the meeting participants for this recommendation at this time, but they would support these measures after the upcoming stock assessment is done, given the results indicate the need for these measure. All participants, however, support staff recommendations 5 and 6 at this time, while there was some support for the recommendations in their entirety.

Seabirds

The recent research results presented by ACAP suggest a move away from the 2-column format for mitigation actions to a single set of measures, which will be provided to the Commission members. Some participants did not support the measures suggested by ACAP, while other participants supported sending forward the recommendations of ACAP to the Commission. The staff will provide the Commission access to the latest information on mitigation measures submitted to this meeting.

Sea turtles

Dr. Compeán briefly reviewed recommendations 6 to 10 because they may be considered applicable to the fisheries under the IATTC framework. Dr. Compean asked if any of the recommendations in the document of the Inter-American Convention for the Protection and Conservation of Sea Turtles should be included in the SAC report. There was insufficient support to include these because there were concerns that these mandates may not be under the purview of the IATTC and they were not prepared for purposes of the IATTC. In addition, some of the IAC recommendations are already included in the IATTC resolution on sea turtles. In summary, the SAC took note of the recommendations by the IAC.

16. Recommendations and endorsements

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

1. That the IATTC staff conduct an assessment of mahi mahi (*Coryphaena hippurus*) in the EPO.
2. That the IATTC staff consider to employ an alternative approach to that in the staff recommendations for the management of Pacific bluefin tuna, and that it be based on a quota higher than the average annual catches during 1994-2007.
3. That identification of individual FADs in the EPO be conducted for research and monitoring purposes, including assessing fishing effort.
4. That the Commission adopt rules for the availability of fisheries data of a similar standard as the other tuna RFMOs. The current situation regarding data availability for research purposes is not satisfactory (this recommendation was also made in 2011).
5. That the IATTC staff establish a clear policy for scientific documents, including the presentation of data (this recommendation was also made in 2010).
6. That the Commission consider the staff's work on reference points and harvest rate control rules in adopting stock-specific targets and limits.

7. That the values for steepness used in yellowfin assessments be discussed at the external review of those assessments in the fall of 2012.
8. That the IATTC staff conduct further research on the natural mortality rate of yellowfin, which is best explored through further tagging studies.
9. That 5% observer coverage on longline vessels, measured by effective days fishing (*i.e.* excluding transit days), be implemented.
10. That research experiments be conducted on the reduction of the incidental mortality of sharks, and on the estimation of survival of sharks captured by all gear types, with priority given to those gears with significant captures. Survival experiments should include studies of the effects on survival of shorter sets and on the use of circle hooks.
11. To establish a fund to support research on mitigation of shark captures and data collection projects.
12. That the Commission consider the relocation of the high-seas closure area, as an adequate conservation measure for bigeye juveniles.

17. Meeting report

The meeting report was adopted.

18. Adjournment

The meeting was adjourned at 13:15 on 18 May 2012.

Appendix A.

ATTENDEES – ASISTENTES

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Appendix B.

STAFF RECOMMENDATIONS FOR THE CONSERVATION OF TUNA IN THE EASTERN PACIFIC OCEAN DURING 2012-2013

BACKGROUND: BIGEYE TUNA

IATTC conservation Resolution C-11-01, in its paragraph 13, calls for the IATTC scientific staff to "…propose, if necessary, appropriate measures to be applied in future years." For 2012, the staff's assessment of bigeye tuna (Document SAC-03-06) is an update of the 2011 assessment; a full assessment of bigeye is planned for 2013. The staff's conclusion from this year's assessment is that fishing mortality of bigeye is excessive, as is indicated by the base case point estimate for the *F* multiplier[1] of 0.95 (SAC-03-06, Table 1), and that the measures established in Resolution C-11-01 have not had the intended effect of reducing the fishing mortality of bigeye to the maximum sustainable yield (MSY) level. Also, the Kobe plot for 2012 (SAC-03-06) is very similar to that of the 2011 assessment, and thus continues to support the staff's conclusions regarding the bigeye stock. However, there is a considerable overlap between the target *F* multiplier of 1.0 and the 95% confidence intervals for the *F* multiplier of 0.95, indicating that the evidence supporting such a conclusion is not definitive. Nonetheless, the staff considers that, as a precautionary measure, the duration of the closures established in that resolution (61 days, on average, during 2009-2011) should be increased. Another factor supporting this is the growing capacity of the purse-seine fleet: as of 8 May 2012 this was 214,422 cubic meters (m^3) of well volume, the highest since 2009. In May 2011, after a year of an apparent declining trend, it was 208,100 m^3; by June it had increased to 211,231 m^3, and by the end of 2011 had reached 213,008 m^3. Consequently, the duration of closures of the fishery cannot be reduced because of a reduction in fleet capacity. Taking into account the *F* multiplier of 0.95 and the increase in fleet capacity, the staff considers it advisable that the closure of the fishery be increased to 74 days in 2012 and 2013, to reduce the fishing mortality of bigeye to the MSY level.

A. YELLOWFIN, SKIPJACK, AND BIGEYE TUNAS

The staff recommends applying the following conservation and management measures for yellowfin, skipjack, and bigeye tunas in the eastern Pacific Ocean[2] (EPO) during 2012 and 2013:

1. Apply these measures in the years 2012-2013 to all CPCs' purse-seine vessels of IATTC capacity classes 4 to 6 (more than 182 metric tons carrying capacity), and to all their longline vessels over 24 meters length overall, that fish for yellowfin, bigeye, and skipjack tunas in the EPO.
2. Exempt pole-and-line, troll, and sportfishing vessels, and purse-seine vessels of IATTC capacity classes 1-3 (less than 182 metric tons carrying capacity) from these measures.
3. All purse-seine vessels covered by these measures must stop fishing in the EPO for a period of 62 to 74 days in each of the two years 2012 and 2013. These closures should be effected in one of two periods in each year as follows:

   2012 – [17][29] July to 28 September, or from [6][18] November to 18 January 2013.

   2013 – [17][29] July to 28 September, or from [6][18] November to 18 January 2014.
4. Notwithstanding paragraph 3, purse-seine vessels of IATTC capacity class 4 (between 182 and 272 metric tons carrying capacity) will be able to make only one single fishing trip of up to 30 days

[1] The ratio of the current fishing mortality ($F_{current}$,defined as the average fishing mortality for the three most recent years (2009-2011)) to the fishing mortality that will produce the maximum sustainable yield (F_{MSY}). An *F* multiplier of 1.0 means that $F_{current} = F_{MSY}$; if it is below 1.0, fishing mortality is excessive ($F_{current} > F_{MSY}$)

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

duration during the specified closure periods, provided that any such vessel carries an observer of the On-Board Observer Program of the Agreement on the International Dolphin Conservation Program (AIDCP).

5. Close the fishery for yellowfin, bigeye, and skipjack tunas by purse-seine vessels within the high-seas area defined in Resolution C-11-01 from 0000 hours on 29 September to 2400 hours on 29 October.

6. China, Japan, Korea, and Chinese Taipei should undertake to ensure that the total annual catches of bigeye tuna by their longline vessels in the EPO during 2012-2013 do not exceed the following levels:

Metric tons	2012-2013
China	2,507
Japan	32,372
Korea	11,947
Chinese Taipei	7,555

7. For 2012 and 2013, adjust the total annual longline catches of bigeye tuna in the EPO appropriately if the existing 62-day closure of the purse-seine fishery is lengthened in those years.

8. All other CPCs should undertake to ensure that the total annual catches of bigeye tuna by their longline vessels in the EPO during 2012-2013 do not exceed the greater of 500 metric tons or their respective catches of bigeye tuna in 2002. CPCs whose annual catches exceed 500 metric tons should provide monthly catch reports to the Director. For 2013, the limits in this paragraph should remain in effect if the conservation measures for purse-seine vessels are maintained, as ratified or adjusted in accordance with paragraph 11.

9. In order to evaluate progress towards the objectives of these measures, in 2013 the IATTC scientific staff should analyze the effects on the stocks of the implementation of these measures, and previous conservation and management measures, and propose, if necessary, appropriate measures to be applied in future years.

10. The IATTC should continue efforts to promote compatibility between the goals and effectiveness of the conservation and management measures adopted by the IATTC and WCPFC.

11. In 2013 the results of these measures should be evaluated in the context of the results of the stock assessments and of changes in the level of active capacity in the purse-seine fleet and, depending on the conclusions reached by the scientific staff, the duration of the closure for 2013 should be ratified or adjusted.

B. PACIFIC BLUEFIN TUNA:

The scientific staff's recommendations concerning Pacific bluefin tuna are as follows :

As a precautionary measure, each CPC with flag vessels that catch Pacific bluefin tuna should take the measures necessary to:

1. Control the fishing mortality of Pacific bluefin tuna by commercial tuna vessels fishing under its jurisdiction during each of the years 2012-2013, to ensure that the annual catches in the EPO by commercial vessels under its jurisdiction do not exceed the average annual level of such catches during 1994-2007.

   Each CPC should take the measures necessary to control the fishing mortality of Pacific bluefin tuna and inform the Director of any such measures.

2. Ensure that the total annual fishing effort for Pacific bluefin tuna in the EPO by sportfishing vessels under its jurisdiction does not exceed the maximum annual level of such effort during 2006-2010.

All CPCs should provide monthly reports of sportfishing catches and fishing effort to the Director.

The above recommendations are subject to revision, depending on the outcome of the ISC working group meeting in May 2012.

C. NORTHERN ALBACORE TUNA:

The 2011 ISC Working Group on assessment of northern albacore concluded that "The north Pacific albacore stock is considered to be healthy at current levels of average historical recruitment and fishing mortality, $F_{2006\text{-}2008}$." The Group therefore recommended "… maintaining present management measure (no increase in effort beyond "current" levels (2002-2004))." The Group found that "In addition, $F_{2006\text{-}2008}$ is consistently lower than $F_{2002\text{-}2004}$ (current fishing mortality in the 2006 assessment) up to age-6, after which both measures of *F* are similar."

Consequently, the scientific staff's recommendations concerning northern albacore tuna are as follows:

1. As discussed during the 80th meeting of the IATTC, establish an *ad hoc* working group to develop an operational definition of the "current levels" of effort specified in paragraph 1 of Resolution C-05-02;
2. Amend Resolution C-05-02 to require that the required six-monthly reports include information on effort as well as catch, and to clarify that data provided should be for the EPO only.

Appendix C.

STAFF RECOMMENDATIONS FOR THE CONSERVATION OF SILKY SHARKS IN THE EASTERN PACIFIC OCEAN IN 2012-2013

Recent information received about trends in catch rates and distribution of catches of silky sharks (*Carcarhinus falciformis*) show that catch rates have declined substantially in the eastern Pacific Ocean[3] (EPO), particularly south of the equator (Figure 1). A formal assessment of silky sharks has not been completed, but there is sufficient information to warrant recommending some precautionary measures.

The staff recommends the conservation and management measures for silky sharks in the EPO set out below;

a. Resolution C-11-10 should be extended to include silky sharks, but apply to purse-seine vessels only.

b. For vessels other than purse-seiners, all silky sharks captured in fisheries that do not target this species should be released as soon as they are seen in the net, on the hook, or on deck, to improve their chances of survival.

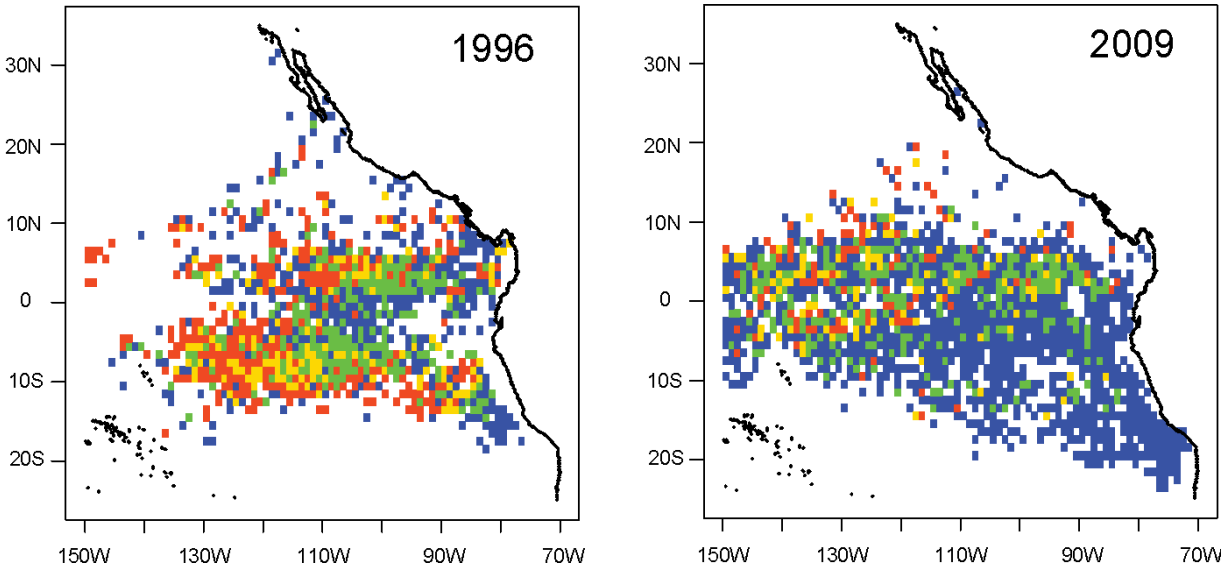
c. Longline vessels that target sharks in the EPO, defined as those whose shark catches for a given trip exceed 50% of their total catch, should not increase their fleet's fishing effort, defined as number of days fishing, beyond the level applied in 2011.

d. Paragraph 11 of Resolution C-05-03 should be changed so that reporting of shark catches by species and of fishing effort is mandatory for all vessels.

e. Research experiments should be conducted on mitigation of shark catches, especially in longline fisheries, and on estimation of survival of sharks captured by all gear types, with priority given to those gears with significant captures. Survival experiments should include studies of the effects on survival of shorter sets and on the use of circle hooks.

f. Establish a fund to support research on mitigation of shark captures and data collection projects.

Figure 1. Average silky shark bycatch per set (BPS), in numbers of sharks, by 1° area for floating-object sets by purse-seine vessels of IATTC capacity class 6 in 1996 and 2009. Blue: BPS = 0; green: 0 < BPS ≤ 1; yellow: 1 < BPS ≤ 2; red: BPS > 2.



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