INTER-AMERICAN TROPICAL TUNA COMMISSION

SCIENTIFIC ADVISORY COMMITTEE

SIXTH MEETING

La Jolla, California (USA)
11-15 May 2015

MEETING REPORT

Chairman: Guillermo Compeán

AGENDA

	Documents
1. Opening of the meeting	
2. Consideration of agenda	
3. a. The fishery in 2014	SAC-06-03
b. National reports	
c. Longline observer program reports	
4. Modelling:	
a. Improved growth estimates for bigeye tuna	SAC-06-04a
b. Time-varying selectivity	SAC-06-04b
c. Stock and fishery structure	SAC-06-04c
5. Assessment of bigeye tuna	SAC-06-05
6. Assessment of yellowfin tuna	SAC-06-06
7. Indicators of stock status for skipjack tuna	SAC-06-07
8. Other species:	
a. ISC assessment of northern albacore tuna	SAC-06-08a
b. Updated indicators for silky sharks	SAC-06-08b
c. Update on shark work under GEF project	SAC-06-08c
d. Hammerhead sharks	
e. Dorado	
f. Update on north Pacific bluefin tuna	
9. Ecosystem considerations	SAC-06-09
10. a. Staff activities and research plans	SAC-06-10a
b. Update on harvest control rules, reference points, and management strategy evaluation	SAC-06-10b
c. Review of research at the Achotines Laboratory	SAC-06-10c
d. CAPAM workshop on growth	SAC-06-10d
e. Extra-budgetary funded research projects	SAC-06-10e
11. Staff conservation recommendations for 2015	SAC-06-11
12. Other business	
a. Capacity scenarios	SAC-06 INF-B
b. Impact of El Niño/La Niña	
c. Virtual working group on capacity	
d. Discussion about FADs	
e. Recruitment models	
13. Recommendations	
14. Meeting report	
15. Adjournment	

APPENDICES

A. List of attendees
B. Staff conservation recommendations

The 6th Meeting of the Scientific Advisory Committee was held in La Jolla, California, USA, on 11-15 May 2015. The attendees are listed in Appendix A.

1. WELCOME, INTRODUCTIONS, MEETING ARRANGEMENTS

Guillermo Compean welcomed the participants to the 6th Meeting of the Scientific Advisory Committee on 11 May 2015 and noted that a quorum had been achieved for the meeting.

Shuya Nakatsuka from the National Research Institute of Far Seas Fisheries of Japan agreed to serve as rapporteur for the 6th Meeting of the Scientific Advisory Committee.

2. CONSIDERATION OF AGENDA

The following additional items were presented and considered:

1. The fishery in 2014 (3): National reports and Longline observer program reports
2. Other species (8): Dorado
3. Other species (8): Update on Pacific Bluefin Tuna
4. 10(c): Review of research at the Achotines Laboratory
5. Other business (12): Capacity Scenarios
6. Other business (12): Effects of Oceanography on tuna fisheries with an emphasis on the Ecuadorian fishery;
7. Other business (12): Results of Capacity Working Group
8. Other business (12): Discussion regarding FADs
9. Other business (12): Mexico presentation on yellowfin recruitment models

The SAC noted that its reports should clearly record its discussions and its advice, if there is a consensus.

3. THE FISHERY IN 2014

The Director, Guillermo Compean reviewed the information on the fishery for tunas in the eastern Pacific Ocean (EPO) in 2014. He discussed EPO tuna catch statistics for 2014, 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 2014 of 560,000 metric tons (t) were about 22% less than the record catches in 2003, and about 5,000 t lower than the 15-year average of catches.

In 2014, Ecuadorian purse seine and pole-and-line vessels caught about about 44% of the total EPO tuna, including 66% of the skipjack and 64% of the bigeye. Mexican vessels caught about 25 percent of the total EPO tuna, including 52% of the yellowfin. EPO Bluefin was caught by Mexican and U.S. Vessels and the USA.

The number and type of purse seine sets was similar to 2013, except for a reduction in the number of sets on free swimming schools around Baja Mexico, and an increase of sets on free swimming schools to the west of Galapagos.

The majority of the yellowfin catches in 2014 were taken in sets associated with dolphins from 3 general areas: offshore between 5°N and15°N latitude and 140°-115°W longitude, inshore north of the 5°N between the 120° and 105°W longitude, and inshore between 5°N and15°N latitude and east of the 105°W longitude. The 2014 offshore catches of yellowfin in association with dolphins were greater than the previous 5 year average.

Yellowfin catches on unassociated schools in 2014 decreased by 27% from the previous 5 year average. This was due in part to decreased catch and effort in the inshore area south of the Baja peninsula. Inshore

catches around the equator were lower than the 2009-2013 average. Smaller amounts of yellowfin were caught south of the equator throughout the EPO, mostly in association with floating objects.

Yellowfin catches in 2014 of 233,000 t were slightly higher than the 2009-2013 average of 222,000 mt.

The 2014 skipjack catches in the inshore areas were similar to those of previous years, though the percentage of catch in free swimming schools decreased and the percentage associated with floating objects increased. Most of the skipjack caught in unassociated tuna sets occurred in the area around the Galapagos Islands and, to a lesser extent, off the coast of Ecuador and Peru. Offshore catches of skipjack were almost exclusively in association with floating objects, and there was an overall decrease in the 2014 offshore skipjack catches when compared to the previous 5 year average, especially in the area between the 145°W and 110°W longitude.

Skipjack catches in 2014 of 262,000 t were 22,000 t higher than the 2009-2013 average, a 15% increase.

The bigeye catch distributions in 2014 were very similar to the average annual distributions for 2009-2013 throughout the EPO. The majority of the bigeye catches occurred between 10°N and 15°S on floating objects. Bigeye catches in 2014 of 60,000 t were slightly lower than the 2009-2013 average, with only a 2% decrease.

The Director also showed the length-frequency and species-composition sampling areas, and described the areas defined for stock assessments, along with statistics of the number of wells sampled. Of the 819 wells sampled for length frequency and species composition in 2014, 625 contained yellowfin, 479 contained skipjack, and 159 contained bigeye. The average size of yellowfin in 2014 was similar to that of 2013. The average size of skipjack was similar to that of the previous five years. The average size of bigeye in 2014 was slightly larger than the previous 5 years average, but still smaller than the 8 and 6.7 kg average in 2011 and 2012 respectively.

PBF catches by purse seine vessels in the EPO in 2014 were 4,900 mt. The catch fluctuated over the last few years due to conservation measures in place which limit yearly catch. Excess PBF catch in 2012 led to a lower limit in 2013. PBF catch is closely monitored in near real time through at-sea reporting by onboard observers, in order to avoid catches which exceed established yearly limits.

Discussion

One Member inquired as to the percent of the total bigeye catch taken by the purse-seine vessels setting on dolphins. The Director noted that although bigeye may be encountered on rare occasion in some years, the amount was so small as to be effectively zero.

The SAC noted that the fishery summary focused primarily on the purse-seine fisheries and reminded the SAC that for logistical reasons, some Members are unable to collect and submit longline data in time for consideration by the SAC each May. The deadline for submission of aggregate longline data from the previous year, as specified in C-03-05, is 30 June, and it typically arrives at mid-year.

The SAC also noted that the catches of tropical tunas thus far in 2015 are trending higher than normal and asked whether the IATTC staff had any thoughts on this and whether there was any indication that this was due to increased capacity operating in the purse-seine fishery, increased abundance, or availability. The Director noted that catches of both bigeye and skipjack are significantly higher than last year at this time, that there has historically been significant variation in the rates of catches among years and that it was too early to hypothesize as to what may be going on in the fishery this year. One Member also noted that in early 2014, waters off Peru and Ecuador were warmer, which tends to lead to lower catch rates, whereas so far in 2015, the water temperatures in this region are comparably colder and so better fishing conditions could explain some of this.

In the context of yellowfin tuna, a Member noted that although most purse-seine caught yellowfin tuna results from dolphin sets, sets on unassociated schools and floating objects also had impacts on yellowfin stocks and requested a figure showing the number of sets, by type for 2014. The Director indicated that

the staff could generate that data, but warned that it would be incomplete because that information is collected from log book data, which has not been fully submitted by this point in the year.

3.1. National reports

The SAC welcomed the submission of national reports by Spain (SAC-06-INF-I), Venezuela (SAC-06INF-K) and Japan (SAC-06-INF-L), which were summarized in brief oral presentations.

The EU gave a brief presentation regarding the national report of Spain. Two types of fisheries are conducted by Spanish-flag vessels in the IATTC area: purse-seine targeting tropical tunas (yellowfin - yellowfin, skipjack-skipjack and bigeye-bigeye) and surface longline targeting swordfish (SWO). This report summarizes the main numbers from these fisheries as well as a summary of the main lines of research conducted on these species. The provision of data to the IATTC has been carried out in accordance with the provisions of Resolution C-03-05 (data provision) as regards both fishing gears. Regarding purse seine, the guidelines established by the AIDCP and the IATTC have also been followed, not only as regards the target species but also including information on compliance and bycatches. The unloadings of the most important tunas and tuna-like species during the year 2014 have been estimated, preliminarily, at about 17,662 t (bigeye: 2,256 t., skipjack: 6,241 t., SWO: 7,847 t., yellowfin: 901 t., unidentified TUN: 130 t). Additionally the catch of about 3,938 t of other pelagic oceanic species has been estimated, preliminarily.

Following the presentation by the EU, a Member asked whether the EU had information on the average size of yellowfin tuna caught by the Spanish fleet in FAD sets. The EU commented that they did not have that data at hand and noted that size sampling is conducted by IATTC staff and that they might be able to provide this information. A follow-up inquiry noted that the report indicated a bycatch of over 1400 silky sharks in 2014 and asked whether all of them were caught in FAD sets. The EU responded that Spanish purse-seine vessels fish almost exclusively on FADs (the report indicates that 1460 of the 1462 silky sharks were caught in sets on floating objects).

The SAC then asked about EU efforts to examine the use of electronic observers on purse-seine vessels. The EU explained that electronic observer data collection can be a powerful tool, but that deployment on purse-seine vessels was more problematic than on longline vessels due to the nature in which the catch is brought on board and stored. The estimation of catch quantities, sizes and composition by species cannot be reliably done at this stage of development of the technology. Models that use high quality images and video are both being examined, but it is still too early to speak definitively to the types and quality of data that can be gathered.

Japan presented summary information of Japan's national tuna fisheries report in EPO. Longline is the only tuna-fishing gear deployed by Japan in the EPO. The total 2014 EPO catch of tunas and tuna-like species by the Japanese longline fishery was still provisional. Coverage rate of logbook for the Japanese longline fishery (distant water license only, 3 Oceans) was estimated to 74% - 100% in recent 5 years. The most dominant species was bigeye representing 54% in weight of the total tuna and tuna-like fish catch in 2014. The bigeye catch shows clear declining trend, from 56 thousand t to 14 thousand t during the mid- 1990s to the mid- 2000s. In recent five years, bigeye catch showed no apparent trend and was 11,336 t in 2014 in logbook base. The next dominant species was swordfish, accounting for 17% and third species was yellowfin (11%). The fishing effort of distant water longline fleets in the EPO showed a peak, 200 million hooks in 1991, decreased to less than 50 million, thereafter. In recent years, the fishing effort was 36 million hooks in 2014, which is the historical lowest.

Venezuela reported that their tuna fleet operating in the EPO is made up of tuna purse-seine vessels of Class-6 type (>425 m^3), the whole capacity is on the IATTC Regional Capacity Register and is 27,846 m^3 (21 vessels), in the last two years only 15 vessels (71.43%) have been operating. This fleet has been operating in the EPO uninterrupted since 1973.

The efforts by the Venezuelan fleet are directed mainly at fishing for tunas associated on dolphins,

followed by floating objects and lastly on pure schools. The catches of predominant tunas are yellowfin (60-65%), followed by skipjack (35-38%) and very little bigeye (1-2%). The data are analyzed and processed by the National Program and with a permanent exchange of all the data collected with the IATTC.

3.2. Observer Program Reports

The SAC also welcomed the submission of observer program reports by Chinese Taipei (SAC-06-INF-E), Japan (SAC-06-INF-F), the United States (SAC-06-INF-G), Mexico (SAC-06-INF-H), China (SAC-06-INF-J), and Korea (SAC-06-INF-M). Mexico, Japan and Chinese Taipei provide brief oral summaries of their reports.

Japan presented summary information of Japan's scientific observer program report in the convention area of IATTC. In 2014 calendar year, eighteen observer trips were conducted on Japanese tuna longline vessels in IATTC area. By 31 March 2015, observer data from thirteen trips was submitted to Fisheries Agency Japan. Total number of the observed fishing operations during those thirteen observer trips was 683 days. Therefore tentative observer coverage of effort is calculated as 4.3% (683/15721 days of operation), but the other five observer data was not included in the calculation at this time. Details of observer trips and tentative catch records were also summarized in the information paper F.

Mexico made a brief presentation and noted that it has, since 1992, the first national on-board scientific observer program for the purse-seine tuna fleet in the framework of the IATTC. It collaborates and constantly exchanges information with the IATTC staff in order to have 100% of the information from the fishery. The Mexican fishery in recent years has caught about 130 thousand tons of tunas. In 2014 it made 84% of its sets on tunas associated with dolphins and a part of the statistics that the national program develops is the determination of the performance of the Mexican fleet in terms of protecting dolphins. In this regard, 95% of the sets associated with dolphins were AIDCP Dolphin Safe. Mexico has a similar program of 100% coverage in its longline tuna fishery in the Gulf of Mexico since 1993 and since 2006 carries out a program of variable coverage of its Pacific shark fisheries. In 2014, the coverage was 5% in accordance with the resolution adopted by the IATTC.

Chinese Taipei reported that they exceeded the mandate for 5% observer coverage of their longline fishing effort.

4. MODELLING

4.1. Improved growth estimates for bigeye tuna

Carolina Minte-Vera presented the paper "Evaluation of including the cost of reproduction in a growth model for bigeye tuna in the eastern Pacific Ocean, and the effect on stock assessment results and management advice" (SAC-06-04a). Growth rate estimates are more important in stock assessments than is generally considered, particularly for assessments that fit to length-composition data. It is therefore important that growth is specified correctly in stock assessment models, in order to avoid bias in estimated management quantities. Tropical tunas typically show linear growth at young ages, after which the growth rate declines rapidly. The traditional von Bertalanffy growth curve, which has been used to model tropical tuna growth, is unable to adequately represent this growth pattern. Therefore, the more flexible Richards growth curve is now often used. In addition, the reduction in growth rates makes determining the age of older individuals problematic, resulting in a lack of length-at-age and maturity-at-age data for older individuals. We evaluate two growth curves for bigeye tuna in the eastern Pacific Ocean that include a proxy for the cost of reproduction. The growth curves are fitted to both age-length data derived from daily increment counts in otoliths and growth increment data from tagging, which together cover nearly the entire range of ages. The estimates of management quantities based on these growth curves are compared to those based on the von Bertalanffy and Richards growth curves as well as those using the current assessment growth assumptions. The growth models that included the proxy for cost of reproduction did not provide a substantial improvement over the currently used Richards growth

model with age-length and tag-increment data included.

Discussion

Following the presentation, a Member asked how the uncertainty in the growth curve affects the assessment and whether a simulation could be used to prioritize factors that add the most uncertainty to the analysis. Carolina Minte-Vera explained that if there is a larger length at L_∞, and there are no individuals of those lengths found in the catch-length frequencies, then the stock will be estimated as more depleted, and vice-versa. Alexandre Aires-da-Silva suggested that growth is not the most problematic factor in the bigeye analysis, but that a prioritized list of important factors (in descending order of importance) would include data weighting, natural mortality, steepness of the stock-recruitment relationship, selectivity, and growth. Carolina Minte-Vera agreed with this prioritized list of important factors for bigeye and indicated that this also holds for the yellowfin assessment.

A Member asked why a Von-Bertanlanffy growth model is not appropriate for yellowfin. Carolina Minte-Vera indicated that the Von-Bertanlanffy growth model does not have the flexibility to provide a good fit to the change in growth rate indicated for tuna species such as yellowfin.

The SAC supported the undertaking of further analysis in preparation for the next full stock assessment.

4.2. Time-varying selectivity

Alexandre Aires-da-Silva presented a summary of time-varying selectivity. Selectivity is one of the main processes modeled in contemporary statistical stock assessments, but its influence on management advice has been under-appreciated. Recent research has shown that selectivity curves can take on much less regular shapes than those commonly used in statistical catch-at-age models, and are likely to change over time due to spatial variation in the age structure of the population or in the fishery. Therefore, it is important to model selectivity correctly (e.g. model time-varying selectivity if highly variable composition data are present).

A good case study to investigate the time-varying nature of composition data and the impact of different selectivity assumptions on stock assessment results is the assessment of yellowfin tuna (yellowfin, Thunnus albacares) in the eastern Pacific Ocean (EPO). For simplicity, the selectivity curves for all fisheries in the yellowfin assessment are assumed to be constant over time; but this is an oversimplification of reality.

This investigation focuses on the yellowfin assessment to illustrate and compare several approaches to modeling selectivity to mitigate potential biases associated with highly variable composition data. The Stock Synthesis (SS) statistical age-structured model is used for this investigation. The methods explored range from a full time-varying selectivity process through allowing for quarterly changes in selectivity (the "process" approach) to the "simplified" approach currently in use, which assumes constant selectivity (ignoring time-varying selectivity). The "truth" (true population dynamics model) is not known in this analysis. It is assumed that using the "process approach" by improving the model fit to the highly variable composition data though time-varying selectivity provides the best "unbiased" description of the population dynamics. The results suggest that assessments of yellowfin tuna and other tuna stocks in the EPO should use time-varying selectivity for some fisheries, particularly the purse-seine fisheries on floating objects, in order to avoid possible biases. It is also shown that a "hybrid" approach, which models only the terminal period of the assessment (6 years, at least) with time-varying selectivity and ignores (is not fitted to) earlier composition data, can replicate modeling temporal variation in selectivity for the whole time period. This hybrid approach offers a compromise between modelling time-varying selectivity and computational demands. The performance of this and other selectivity approaches explored in this document to deal with highly variable composition data should be simulation tested.

Discussion

Following the presentation, the SAC discussed the various methods explored in the analysis. A member commented on the good fits to the size composition data obtained by the time-varying and hybrid

methods. The presenter agreed, but he also mentioned that these fits may be further improved through the use of non-parametric splines and these functions should be explored. A compromise is needed between computation time and numbers of parameters needed to deal with time-varying selectivity. The computational requirements for the full time-varying selectivity approach are quite demanding, therefore, the hybrid approach seems to present a resonable compromise. A Member also suggested that, if time-varying selectivity analysis is used for the assessment, each method requires separate simulation testing, and it was noted that use of time-varying selectivity methods provided a more pessimistic result in the assessment. It was noted that the IATTC staff in collaboration with NMFS staff have conducted preliminary simulation analysis of the time varing selectivity method. A Member asked that if simulation testing is successful, how much time would be required to incorporate this approach into the assessment. Mark Maunder suggested that for the next full assessments of yellowfin and bigeye, time-varying selectivity will probably be introduced into the analysis and a different model may be utilized.

The SAC discussed alternative approaches to deal with time-varying selectivity in the tropical tuna assessments. Alexandre Aires-da-Silva indicated that the choice depends on the quality of the size composition data. At this point, the staff considers that the best approach for yellowfin and bigeye may be the hybrid approach in which time-varying selectivity is allowed for recent years and a constant "average" selectivity is assumed for the early historical data.

The Japanese longline data show differences in size composition, with smaller fish caught prior to 1990 and larger fish after 1990. These data are very influential in weighting, and for this reason the staff downweighted the size composition data of these fisheries. Time-varying selectivity approaches could be implemented to deal with this problem. The staff extended a request for collaborative work with Japan to understand these pending issues with the Japanese longline size composition data. Japan agreed to work jointly to address the problem. Rick Deriso also indicated that potential biases to the Fmultiplier caused by selectivities depend on any shifts in the fishery (e.g. longline versus purse seine/floating object) and shouldn't be systematic (i.e., systematically biased low or high).

4.3. Stock and fishery structure

Carolina Minte-Vera gave a presentation on the stock and fishery spatial structures of yellowfin tuna and bigeye tuna. Determining stock and fishery spatial structure is an essential part of conducting fishery stock assessment. Unfortunately, there is typically insufficient, and often contradictory, evidence on which to base decisions about assumptions on spatial structure. The case of tropical tunas is no different. However, there is accumulating evidence that spatial structure exists, and local depletion might be a concern. There are two types of spatial structure that need to be considered in stock assessments. The first is population or stock structure, which, at a practical level, refers to groups of fish that have limited interaction with other groups of fish. The second type of spatial structure is related to the definition of fisheries. Defining fisheries by space allows the selectivity curve to account for spatial differences in the vulnerability or distribution of different age or size classes. We compiled and evaluated the information available on stock and fishery structures for the main tropical tunas (bigeye, yellowfin, and skipjack) in the eastern Pacific Ocean (EPO), with the goal of restructuring future stock assessment models. Based on this evaluation, along with considerations of data limitations, computational constrains, and the practical constrains of international fisheries management, we proposed stock and fisheries structures for yellowfin and bigeye tuna and conducted preliminary stock assessments. The results showed some differences between the northern and southern stocks of yellowfin and between the new and old stock and fishery spatial structures for yellowfin and bigeye. The results of the stock assessment models, on which the management would be based, also showed high dependence on the relative contribution of the size composition data to the fits (through data-weighting), which may be equal or more important than assumptions on stock structure made about those models. There is still much uncertainty about the population structure and appropriate fishery definitions for tropical tunas in the EPO. The information currently available needs to be further analyzed, and hypothesized structures need to be tested in the stock assessment model to determine whether they improve its performance. Comprehensive tagging studies

designed to test alternative hypotheses on stock and fishery structure are probably the only way to both decrease uncertainty about spatial structures and to estimate movement rates among putative stocks.

Discussion

Following the presentation, a Member characterized this analysis as preliminary and suggested that it should be analysed in depth before adoption due to the large impacts that it could have on assessment. The Member also expressed doubt that the yellowfin status represents more than one stock. Area definitions are important for biomass estimation, and differences between northern and southern areas are not totally convincing in the analysis. Carolina Minte-Vera agreed with this suggestion and stressed that the staff recognizes the uncertainties in the analysis.

Another Member suggested the inclusion of trophic levels by area in the analysis, and also inquired as to the time scale (annual, decadal) of the sea surface temperatures reported and why the 24°C isotherm was used to characterize yellowfin distribution. Carolina Minte-Vera referred to several staff analyses by Robert Olson and Michael Hinton covering trophic levels and oceanography, respectively, that supported this analysis. She indicated that the staff is also mindfull of the temporal variability in the sea surface temperature; and that data shown was only for illustration, and explained that the 24°C isotherm was used as a lower limit on distribution and spawning conditions for yellowfin.

The SAC supported the continuation of the analysis but requested to treat the results with caution in the context of future stock assessments.

5. ASSESSMENT OF BIGEYE TUNA

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

Bigeye tuna are distributed across the Pacific Ocean, but the bulk of the catch is made to the east and to the west. The purse-seine catches of bigeye are substantially lower close to the western boundary (150ºW) of the EPO; the longline catches are more continuous, but relatively low between 160ºW and 180º. Bigeye are not often caught by purse seiners in the EPO north of 10ºN, but a substantial portion of the longline catches of bigeye in the EPO is made north of that parallel. The assessment is conducted as if there were a single stock of bigeye in the EPO, with minimal net movement of fish between the EPO and the western and central Pacific Ocean (WCPO). Its results are consistent with the results of other analyses of bigeye tuna on a Pacific-wide basis. However, a large amount of conventional and electronic tagging data has recently accumulated from the Pacific Tuna Tagging Programme, which has focused its bigeye tagging efforts between 180° and 140°W since 2008. The tag recoveries clearly show that there is extensive longitudinal movement of bigeye across the IATTC's management boundary at 150°W, in particular from west to east. The IATTC staff is collaborating with Secretariat of the Pacific Community (SPC) on an updated Pacific-wide bigeye stock assessment. This research will incorporate the new tagging data in a spatially-structured population dynamics model, which will help to evaluate potential biases resulting from the current approach of conducting separate assessments for the EPO and WCPO.

This model is the same as that used in the last full assessment of bigeye tuna conducted in 2014, which included several improvements. First of all, a new Richards growth curve estimated externally from an integrated analysis of otolith age-readings and tag-recapture observations was introduced. This curve reduced the uncertainty about the average size of the oldest fish (L2 parameter). In addition, the parameters which determine the variance of the length-at-age were also taken from the new externally-derived growth estimates. Diagnostic analyses with the previous base case model configuration indicated a dominant influence of the size-composition data in determining the productivity (the R0 parameter) of the bigeye stock, and conflicts among datasets were also found. As a result, improvements were made in the previous full assessment on the weighting assigned to the different datasets. Specifically, the size-composition data of all fisheries were down-weighted. In addition, the number of catch per unit of effort

(CPUE) data series used as indices of abundance was reduced in order to minimize conflict trends among data sets. Rather than fitting to a total of ten CPUE series (two purse-seine indices and eight longline indices), a reduced set of indices of abundance was chosen to best represent the bigeye stock trends (the early and late periods of the Central and Southern longline fisheries).

The stock assessment requires a substantial amount of information. Data on retained catch, discards, CPUE, and size compositions of the catches from several different fisheries have been analyzed. Several assumptions regarding processes such as growth, recruitment, movement, natural mortality, and fishing mortality, have also been made. Catch and CPUE data for the surface fisheries have been updated, and include new data for 2014. New or updated longline catch data are available for China (2013), Japan (2008-2013), Korea (2013), Chinese Taipei (2011-2013), the United States (2012-2013), French Polynesia (2013) and Vanuatu (2013-2014). Longline catch data for 2014 are available for China, Japan, Chinese Taipei, and Korea from the monthly report statistics. For longline fisheries with no new catch data for 2014, catches were assumed to be the same as in 2013. New or updated CPUE data are available for the Japanese longline fleet (2008-2013). New purse-seine length-frequency data are available for 2014 and updates are available for 2013. New or updated length-frequency data are available for the Japanese longline fleet (2011-2013).

A prominent feature in the time series of estimated bigeye recruitment is that the highest recruitment peaks of 1983 and 1998 coincide with the strongest El Niño events during the historic period of the assessment. There was a period of above-average annual recruitment during 1994-1998, followed by a period of below-average recruitment in 1999-2000. The recruitments were above average from 2001 to 2006, and were particularly strong in 2005. More recently, the recruitments were below average during 2007-2009, and have fluctuated around average during 2010-2013. The most recent annual recruitment estimate (2014) is estimated to be slightly above average levels. However, this estimate is highly uncertain, and should be regarded with caution, due to the fact that recently-recruited bigeye are represented in only a few length-frequency data sets.

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

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

Since the start of 2005, the spawning biomass ratio (SBR; the ratio of the spawning biomass at that time to that of the unfished stock) gradually increased, to a level of 0.30 at the start of 2010. This may be attributed to a combined effect of a series of above-average recruitments since 2001, the IATTC tuna conservation resolutions and decreased longline fishing effort in the EPO during 2004-2009. However, although the resolutions have continued since 2009, the rebuilding trend was not sustained during 2010-2013, and the SBR gradually declined to a low historic level of 0.19 at the start of 2013. This decline could be related to a period dominated by below-average recruitments that began in late 2007 and coincides with a series of particularly strong La Niña events. More recently, the SBR is estimated to have increased slightly, from 0.19 in 2013 to 0.22 at the start of 2015; in the model, this increase is driven mainly by the recent increase in the catch per unit of effort (CPUE) of the longline fisheries that catch adult bigeye.

At the beginning of 2015, the spawning biomass of bigeye tuna in the EPO appears to have been about 6% above SMSY, and the recent catches are estimated to have been about 13% lower than the maximum

sustainable yield (MSY). If fishing mortality is proportional to fishing effort, and the current patterns of age-specific selectivity are maintained, FMSY is about 14% higher than the current level of effort.

According to the base case results, the most recent estimate indicates that the bigeye stock in the EPO is not overfished (S>SMSY) and that overfishing is not taking place (F<FMSY). Likewise, the current base case model indicates that the interim limit reference points of 0.38 SMSY and 1.6 FMSY, which correspond to a 50% reduction in recruitment from its average unexploited level based on a conservative steepness value (h = 0.75) for the Beverton-Holt stock-recruitment relationship, have not been exceeded. These interpretations, however, are subject to uncertainty, as indicated by the approximate confidence intervals around the most recent estimate in the phase plots, which allows F>FMSY). Also, they are strongly dependent on the assumptions made about the steepness parameter of the stock-recruitment relationship, the assumed levels of adult natural mortality, the growth curve, and the weighting assigned to the size-composition data.

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

At current levels of fishing mortality, and if recent levels of effort and catchability continue and average recruitment levels persist, the spawning biomass is predicted to continue rebuilding and stabilize at at an SBR of 0.25 around 2022, above the level corresponding to MSY (0.21). If a stock-recruitment relationship is assumed, it is estimated that catches will be lower in the future at current levels of fishing effort, particularly for the surface fisheries.

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

Key Results

1. The results of this assessment indicate a recovery trend for bigeye tuna in the EPO during 2005-2009, subsequent to IATTC tuna conservation resolutions initiated in 2004. However, the decline of the spawning biomass that began at the start of 2010 reduced both summary and spawning biomasses to their lowest historic levels at the start of 2013, and persisted through 2013. This decline may be related to a series of recent below-average recruitments which coincide with a series of strong la Niña events. More recently, the SBR is estimated to have increased slightly, from 0.19 in 2013 to 0.22 at the start of 2015; in the model, this increase is driven mainly by the recent increase in the CPUE of the longline fisheries which catch adult bigeye. At current levels of fishing mortality, and if recent levels of effort and catchability continue and average recruitment levels persist, the spawning biomass is predicted to continue rebuilding, and stabilize at about 0.25, above the level corresponding to MSY (0.21).
2. There is uncertainty about recent and future recruitment and biomass levels.
3. The recent fishing mortality rates are estimated to be below the level corresponding to MSY whereas recent levels of spawning biomass are estimated to be slightly above that level. These interpretations are uncertain and highly sensitive to the assumptions made about the steepness parameter of the stock-recruitment relationship, the assumed rates of natural mortality for adult bigeye, the growth curve, and the weighting assigned to the size-composition data, in particular to the longline size-composition data. The results are more pessimistic if a stock-recruitment relationship is assumed, if lower rates of natural mortality are assumed for adult bigeye, if the length of the oldest fish is assumed to be greater, and if a greater weight is assigned to the size-composition data, in particular for the longline fisheries.
4. The IATTC staff is collaborating with the Secretariat of the Pacific Community (SPC) on an updated

Pacific-wide wide bigeye stock assessment. This research will incorporate the new bigeye tagging data in a spatially-structured population dynamics model, which will help to evaluate potential biases resulting from the current approach of conducting separate assessments for the EPO and WCPO.

Discussion

Following Alexandre Aires-da-Silva's presentation, the SAC discussed the data sources used in the assessment. Alexandre Aires-da-Silva indicated that the catches reported are based on data available for both purse seine and longline. However, indices of abundance are based on the Japanese longline data only, since the Japanese data include hooks/basket, which is the minimum required for CPUE standardization. A Member pointed out that the CPUE may be influenced by a recent decrease in Japanese longline effort. Alexandre Aires-da-Silva agreed that this is a potential concern, but that the Japanese longline data are still the best and only data available for estimating indices of abundance. The index of abundance could be improved with availability of operational data. The IATTC staff recognizes that there has been contraction in the areas fished which could result in greater efficiency of remaining boats, thus influencing the CPUE. The staff relies on input from Japan for specific information regarding the fleet and this fishery.

A Member asked whether the interim and target reference points were adopted for all species (excluding skipjack) or just bigeye and yellowfin. The staff clarified that the interim reference points were adopted for the tropical tunas (bigeye, yellowfin and skipjack). The SAC discussed IATTC staff collaboration on the Pacific-wide assessment of bigeye which is being conducted at SPC. Alexandre Aires-da-Silva indicated that the SPC is taking the lead on a Pacific-wide assessment, and that the IATTC will be sharing required data on bigeye from the eastern Pacific and collaborating in the work. This is a large undertaking and faces some issues such as differences in biology and other life history parameters between the regions. It is recognized by the IATTC staff that there are spatial aspects of bigeye movements that are not fully accounted for and must be incorporated into the current assessments. The IATTC staff will be looking at the Pacific wide assessment results as a means to evaluate potential biases resulting from conducting bigeye assessments separately for the EPO and WPO. Rick Deriso added that circumstances of IATTC staff and timing had not allowed early participation in the Pacific-wide assessment, but that staff participation would occur prior to the completion of the assessment currently being developed by SPC.

A Member noted that the number of sets on floating objects has been increasing, and that this is a concern for the apparent effects on juvenile bigeye and yellowfin. It was suggested that the SAC recommend a limit on these types of floating object catches and also propose some measures to counteract potential impacts on bigeye. Guillermo Compeán noted that the SAC can make such recommendations to be considered by the staff in their own recommendations, or that such recommendations can be addressed by the SAC if there is consensus.

A discussion developed regarding the use of data from other longline fleets in addition to the Japanese longline data. Alexandre Aires-da-Silva explained that the staff has worked with CPUE data from Chinese Taipei, but that in general there is a lot of variability and changes of operational practices in non-Japanese data sets. A Member inquired about the capacity to coordinate management recommendations with the WCPFC, even though the WCPFC uses a different limit reference point for SSB (20% versus the value of 8% used by IATTC), and urged collaboration and comparison of approaches. Guillermo Compeán noted that the IATTC has good scientific coordination with the WCPFC but has no mechanism for collaboration on conservation recommendations. Mark Maunder added that the IATTC has significant interactions with the SPC at the scientific level and that there has been opportunity for interaction at ISSF scientific meetings. Rick Deriso indicated that the IATTC staff has fundamental disagreements with the SPC and WCPFC over the steepness parameter of the stock-recruitment relationship that is related to different management approaches, but that does not preclude important collaborations.

An Observer suggested that management strategy evaluation work would benefit all of these bigeye analyses. Possible shifting of targets from bigeye to skipjack by some vessels was discussed. Kurt

Schaefer indicated that acoustic discrimination of species in a school is not yet feasible as a method for reducing catch of bigeye in mixed schools.

6. ASSESSMENT OF YELLOWFIN TUNA

Carolina Minte-Vera presented regarding the most recent 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 in 2014.

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

The stock assessment requires substantial amounts of information, including data on retained catches, discards, indices of abundance, and the size compositions of the catches of the various fisheries. Assumptions have been made about processes such as growth, recruitment, movement, natural mortality, fishing mortality (F), and stock structure. The assessment for 2014 is nearly identical to that of 2013, and includes new and updated data. The staff performed substantial investigative analyses in preparation for the external review of its assessment of yellowfin tuna, held in October 2012. The review resulted in a series of recommendations, which are being explored to be incorporated in the upcoming full stock assessment.

The catch data for the surface fisheries have been updated and new data added for 2014. New or updated longline catch data are available for China (2013), Japan (2008-2013), Korea (2013), Chinese Taipei (2011-2013), the United States (2012-2013), French Polynesia (2013), Vanuatu (2013-2014), and other nations (2013). Japanese longline catch data for 2014 are available from the monthly report statistics. For longline fisheries with no new catch data for 2014, catches were assumed to be the same as in 2013. Surface fishery CPUE data were updated, and new CPUE data added for 2014. New or updated CPUE data are available for the Japanese longline fleet (2008-2013). New surface-fishery size-composition data for 2014 were added and data for 2013 were updated. New or updated length-frequency data are available for the Japanese longline fleet (2008-2013).

In general, the recruitment of yellowfin to the fisheries in the EPO is variable, with a seasonal component. This analysis and previous analyses indicate that the yellowfin population has experienced two, or possibly three, different recruitment productivity regimes (1975-1982, 1983-2002, and 2003-2012) (Figure 1). The recruitments for 2011 and 2012 were estimated to be below average. The most recent recruitments (2013 and 2014) were estimated to be above average, but these estimates are highly uncertain. The productivity regimes correspond to regimes in biomass, with higher-productivity regimes producing greater biomass levels. 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.

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

The spawning biomass ratio (the ratio of the spawning biomass to that of the unfished population; SBR) of yellowfin in the EPO was below the level corresponding to the maximum sustainable yield (MSY) during 1977-1983, coinciding with the low productivity regime, but above that level during most of the following years, except for the recent period (2005-2007 and 2010-2014) (Figure 4). 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 SBRs. The SBR at the start of 2015 was estimated to be 0.26, slightly below the MSY level (0.27). The recent (2011-2014) SBRs estimated by the current assessment are less optimistic than those produced by the previous assessment, which indicated a sharp decline in spawning biomass after 2009, followed by an increase in 2012 to above the level corresponding to the MSY (IATTC Stock Assessment Report 15). In the current assessment, the SBRs for 2012, and for 2013 and 2014 as well, are slightly below the MSY level. This result is probably due to the higher fishing mortality of middle-aged yellowfin since 2009 estimated by the current assessment. The effort is estimated to be below the level that would support the MSY (based on the current distribution of effort among the different fisheries), and recent catches are below that level. It is important to note that the curve relating the average sustainable yield to the long-term fishing mortality is flat around the MSY level (Figure 6). Therefore, moderate changes in the long-term levels of effort will change the long-term catches only marginally, while changing the biomass considerably. Maintaining the fishing mortality below the MSY level would result in only a marginal decrease in the long-term average yield, with the benefit of a relatively large increase in the spawning biomass. In addition, if management is based on the base case assessment (which assumes that there is no stock-recruitment relationship), when in fact there is such a relationship, there would be a greater loss in yield than if management is based on assuming a stock-recruitment relationship when in fact there is no relationship.

The MSY 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 SBRs.

The MSY has been stable during the assessment period (1975-2014), 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 MSY level.

If a stock-recruitment relationship is assumed, the outlook is more pessimistic, and current effort is estimated to be above the MSY level . Previous assessments have indicated that the status of the stock is also sensitive to the value assumed for the average size of the oldest fish, and more pessimistic results are obtained when higher values are assumed for this parameter. At current (2012-2014) levels of fishing mortality and average levels of recruitment, the spawning biomass is predicted to increase above the MSY level. However, the confidence intervals are wide, and there is a moderate probability that the SBR will be substantially above or below this level. In addition, the spawning biomass is predicted to remain below the MSY level if a stock-recruitment relationship is assumed. If fishing effort continues at recent levels, both the spawning biomass and the catches of surface fisheries are predicted to increase, assuming average recruitment and no stock-recruitment relationship. Slightly higher catches are predicted if in fact such a relationship exists.

Key Results

1. There is uncertainty about recent and future levels of recruitment and biomass. There have been two, and possibly three, different productivity regimes, and the MSY levels and the biomasses

corresponding to the MSY may differ among the regimes. The population may have switched in the last ten years from a high to an intermediate productivity regime.

2. The recent fishing mortality rates are below the MSY level, and the recent levels of spawning biomass are estimated to be at that level. As noted in IATTC Stock Assessment Report 15 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. This result is due to moderate fishing mortality levels for middle-age yellowfin tuna since 2008, which are estimated by the current assessment.
4. Increasing the average weight of the yellowfin caught could increase the MSY.

Discussion

Following the presentation, Guatemala asked to examine the impacts to the F from the addition of 3000 m3[1] fishing capacity to the fishery. Guillermo. Compean explained that looking simply at mortality, the increase to mortality would be approximately 1.3%, but noted that the estimates of F always involves uncertainty from multiple sources, including the question of how much capacity is active in the fishery at any given time and that under some circumstances, the addition of 3000 m3 of capacity might have no measureable effect. Further examination of this and related questions was deferred to the discussion of conservation recommendations. The SAC discussed the meaning and significance of "discard fisheries" in the analysis presented. These fisheries are more important for the historical period, mostly prior to 2000, when vessel pracitices included discarding smaller tunas that were considered to be of little or no commerical value. That practice was subsequently prohibited by the full retention requirements adopted by the Commission in various conservation and management resolutions.

The SAC also discussed the source of recruitment for projections, as estimates used in the assessment for recent years are not accuratedly estimated. Carolina Minte-Vera explained that the projection used all the estimated recruitment, including those for the most recent years . For future recruitments, the the average recruitment for the whole period is used..

7. INDICATORS OF STOCK STATUS FOR SKIPJACK TUNA

Mark Maunder presented a summary of indicators of stock status for skipjack tuna. Several alternative methods have historically been used to assess the status of skipjack tuna: a) fishery and biological indicators; b) analysis of tag data; c) a length-structured stock assessment model; d) Age-Structured Catch-at-Length Analysis (A-SCALA); and e) a Spatial Ecosystem and Population Dynamic Model (SEAPODYM). The results of all five of these methods are compared when discussing the status of skipjack in the EPO. Only the indicator approach has been updated in this report.

Biomass, recruitment, and fishing mortality are estimated to be highly variable over time. The estimates are uncertain and differ among the alternative assessment methods. A large recruitment appears to have entered the population in 1999, and led to increased biomass in that year, but the increase was temporary, due to the short-lived nature of skipjack. Biomass appears to have been above average in recent years, but this may differ among regions. SEAPODYM estimates annual biomass of skipjack 30cm or larger cycling between 1,800,000 t and 2,350,000 t from 1998 to 2008, but the quality of these estimates has yet to be determined. The average weight of skipjack started declining in 2000, but has stabilized in recent years. Previous assessments using a catch-at-length analysis (A-SCALA) to assess skipjack tuna in the EPO

[1] The full amount of capacity request that has been conditionally approved for Guatemala is 3,762 m3.

were considered preliminary because: 1) it was unknown if catch-per-day-fished for purse-seine fisheries is proportional to abundance; 2) it is possible that there is a population of large skipjack that is invulnerable to the fisheries; and 3) the structure of the EPO stock in relation to the western and central Pacific stocks is uncertain. These issues are also relevant to the other assessments.

Previous assessments estimated that maximum yields are achieved with infinite fishing mortality because the critical weight is less than the average weight at recruitment to the fishery. However, this is uncertain because of uncertainties in the estimates of natural mortality and growth. For this reason, no traditional reference points are available for skipjack tuna in the EPO. Consequently, indicators and reference levels have been used to evaluate the status of the stock. The main concern with the skipjack stock is the constantly increasing exploitation rate. However, exploitation rate appears to have leveled off in recent years. The data- and model-based indicators have yet to detect any adverse consequence of this increase. The average weight was below its lower reference level in 2009, which can be a consequence of overexploitation, but it can also be caused by recent recruitments being greater than past recruitments or expansion of the fishery into areas occupied by smaller skipjack. However, average weight has stabilized in recent years. The tagging analyses, length-structured model, A-SCALA, and the SEAPODYM analyses do not provide any information that indicates a credible risk to the skipjack stock(s).

Susceptibility and productivity analysis (PSA; see IATTC Fishery Status Report 12, p 149) shows that skipjack has substantially higher productivity than bigeye tuna. Biomass and fishing mortality corresponding to MSY are, respectively, negatively and positively related to productivity. Therefore, since skipjack and bigeye have about the same susceptibility, which is related to fishing mortality, the status of skipjack can be inferred from the status of bigeye. The current assessment of bigeye tuna estimates that the fishing mortality is less than *F*MSY; therefore, the fishing mortality for skipjack should also be less than *F*MSY. Since effort and skipjack biomass have been relatively constant over the past 10 years, this also implies that skipjack biomass is above *B*MSY.

Key Results

1. There is uncertainty about the status of skipjack tuna in the EPO.
2. There may be differences in the status of the stock among regions.
3. There is no evidence that indicates a credible risk to the skipjack stock(s).
4. No additional management action is needed above and beyond that implemented for the conservation of bigeye tuna.

Discussion

Following the presentation, the SAC discussed the possible relationship between the number of FADs and skipjack status. A Member expressed concern about a potential increase in the number of FADs and its effects on the skipjack population. Mark Maunder explained that little is known about the number of FADs and how skipjack are distributed among them, and that it would be helpful to know numbers of FADs and how often they are fished.

A Member noted that the SAC may need to call the attention of the Commission for the possible reduction in catch rate even when the stock is above Bmsy.

The SAC also discussed the trend of higher relative recruitment of skipjack starting around 2000 and possible causative factors. Mark Maunder suggested that this could have been caused by environmental factors, but also may be a bias in the stock analysis caused by increased estimates of recruitment as a consequence of increased catch.

8. OTHER SPECIES

8.1. ISC assessment of northern albacore tuna (SAC-06-08a)

Steve Teo presented a summary of the ISC working group assessment of northern albacore tuna for 2014..

The North Pacific albacore tuna (*Thunnus alalunga*) stock area consists of all waters in the Pacific Ocean north of the equator, and all available fishery data from this area were used for the stock assessment. It is assumed that there is instantaneous mixing of albacore throughout the stock area on a quarterly basis (i.e. a single well-mixed stock).

The total reported catch of North Pacific albacore was relatively low in the 1950s and 1960s and increased to a peak of 126,175 mt in the mid-1970s before declining and reaching a secondary peak by the late 1990s. Following a second decline in the early 2000s, the catch has recovered slightly to fluctuate between 69,000 mt and 92,000 mt in recent years (2006–2012). Since the early 1950s, surface gear types (troll, pole-and-line) have accounted for approximately twice as much of the albacore catch as longline gear.

Catch and size composition data were collected from ISC countries (Canada, Chinese Taipei, Japan, Korea and USA) and some IATTC and WCPFC member countries, including China. Standardized CPUE data for eight indices used to measure trends in relative abundance were provided by Japan, USA, Canada and Chinese Taipei. However, based on a closer examination of these abundance indices, the Albacore Working Group concluded that the Japanese pole-and-line (PL) and longline (LL) indices were the indices that best represented the trends in juvenile and adult albacore abundance, respectively, and the base case model was therefore fitted to these indices only. The North Pacific albacore tuna stock was assessed using an age-, length-, and sex-structured Stock Synthesis (Version 3.24f) model fitted to time series of standardized CPUE and size composition data using a 1966 to 2012 time frame. Sex-specific growth curves were used because there is evidence of sexually dimorphic growth, with adult male albacore attaining a larger size and age than female albacore. The value for steepness in the stock recruitment relationship was h = 0.9, based on two separate external estimates of this parameter. The assessment model was fitted to four relative abundance indices (early and late period Japanese PL and LL) and size composition data in a likelihood-based statistical framework. Maximum likelihood estimates of model parameters, derived outputs, and their variances were used to characterize stock status. Several sensitivity analyses were conducted to evaluate changes in model performance or the range of uncertainty resulting from changes in model parameters, including some of the data series used in the analyses, growth curve parameters, natural mortality, stock recruitment steepness, starting year, selectivity estimation, and weighting of size composition data.

Estimates of total stock biomass (age-1 and older) show a long-term decline from the early 1970s to 1990 followed by a recovery through the 1990s and subsequent fluctuations without trend in the 2000s. Female SSB exhibits similar long-term changes, with a decline from the early 1970s to the early 1990s, a recovery in the late 1990s and a leveling off in the late 2000s. Female SSB was estimated to be approximately 110,101 mt in the terminal year of the assessment (2012) and stock depletion is estimated to be 35.8% of unfished SSB. The estimated SPR (spawners per recruit relative to the unfished population) in the terminal year of the assessment is 0.41, which corresponds to a relatively low exploitation level (i.e. 1-SPR = 0.59). While current F-at-age on juvenile fish is lower in the base case model than in 2002–2004, F on adult ages (50% of age-5 and all fish age-6 and older) is higher on average than during 2002–2004. Juvenile albacore age-2 and age-3 are the largest component of the catch as reflected by the larger impact of the surface fisheries (primarily troll, pole-and-line, but including several minor gear types) relative to longline fisheries, which remove adult fish. Average historical recruitment is approximately 42.8 x 10^6 recruits annually, but there are periods where the average recruitment is above or below this at the beginning of the assessment time frame followed by fluctuations around the average since the 1990s. The Albacore Working Group believes that North Pacific albacore recruitment, as with other tuna species, is influenced by changes in environmental conditions and the

stock recruitment relationship. Kobe plots depict stock status in relation to MSY-based and MSY proxy reference points (see below) from the base case model. The Kobe plots are presented for illustrative purposes because biological reference points have not been established for the north Pacific albacore stock, with the exception of the $F_{SSB\text{-}ATHL}$ interim reference point used by the WCPFC's Northern Committee. $F_{SSB\text{-}ATHL}$ is the fishing mortality that results in future SSB, over a 25-year projection period, falling below the average of the 10 historical lowest estimated SSBs (SSB-ATHL) with 50% probability. Based on an evaluation of the estimated current F ($F_{2010–2012}$) against various F-based reference points, including $F_{SSB\text{-}ATHL}$, the North Pacific albacore stock is not currently experiencing overfishing (SAC-06-08a, Executive Summary Table 1) because the ratios for most candidate reference points, except F_{MED} and $F_{50\%}$, are below 1.0. Although no biomass-based reference points have been developed for this stock, there is little evidence from this assessment that fishing has reduced SSB below reasonable candidate biomass-based reference points, so the Albacore Working Group concludes that the stock is likely not overfished at present.

Stochastic stock projections were conducted externally to the Stock Synthesis base case model to evaluate the impact of various levels of fishing intensity on future female SSB for North Pacific albacore. Future recruitment was based on random resampling of historical recruitment for three periods: i) low recruitment (29.1 x 106 recruits), 1983–1989; ii) average recruitment (42.8 x 106 recruits), 1966–2010; and high recruitment (54.8 x 106 recruits), 1966–1975. These calculations incorporate the structure of the assessment model (e.g. multi-fleet, multi-season, size- and age-selectivity) to produce results consistent with the assessment model. Projections started in 2011 and continued through 2041 under two levels of fishing mortality (constant $F_{2010–2012}$, constant $F_{2002–2004}$, constant catch averaged for 2010–2012) and three levels of recruitment (low, average, and high as defined above). Results show projected female SSB for each of the three harvest and recruitment scenarios. Based on these projections, the stock performs better under the constant $F_{2010–2012}$ harvest scenario than under the constant $F_{2002–2004}$ harvest scenario. Assuming average historical recruitment and fishing at a constant current F, median female SSB is expected to remain relatively stable between the 25th and median historical percentiles over both the short- and long-term, with a 13% probability that SSB falls below the SSB-ATHL threshold during a 25-year projection period (2011–2036). In contrast, if a low recruitment scenario is assumed, then median female SSB declines under both harvest scenarios and the probability that it falls below the SSB-ATHL threshold in the 25-year projection period increases to 65%. The high recruitment scenario is more optimistic, with median SSB increasing above the historical median SSB and the estimated probability of breaching the SSB-ATHL threshold is correspondingly low at 3%. The constant catch scenario is inconsistent with current management approaches and it may be unrealistic for this stock because catches of North Pacific albacore are largely dependent on recruitment.

Biological reference points were computed with the base case model (SAC-06-08a, Executive Summary Table 1). The point estimate (± SD) of MSY is 105,571 ± 14,759 mt and the point estimate of spawning biomass to produce MSY (SSB_{MSY}, adult female biomass) is 49,680 ± 6,739 mt. The SSB-ATHL threshold (i.e. the average of the 10 historically lowest SSB estimates) is estimated to be 117,835 mt, which is more than twice the SSB_{MSY} level. The ratio of $F_{2010–2012}/F_{MSY}$ is estimated to be 0.52 and the ratio of $F_{2010–2012}/F_{SSB–ATHL}$ is estimated to be 0.72. $F_{2010–2012}$ ($F_{current}$) is below F_{MSY} and all MSY-proxy reference points except F_{MED} and $F_{50\%}$ (SAC-06-08a, Executive Summary Table 1) and these ratios are lower than ratios estimated using $F_{2002–2004}$, consistent with the intent of previous Albacore Working Group recommendations for conservation.

The $F_{SSB\text{-}ATHL}$ reference point is currently the interim default reference point chosen by the Northern Committee. The ALBWG notes that improvements to the assessment model have altered the biomass trajectory in the current assessment relative to the 2011 model, with a low biomass period occurring at the end of the modeled time frame. Because of these changes, the estimated SSB–ATHL threshold differs from the previous assessment and now includes several recent years (2007–2010) in its calculation. Consideration should be given to determining whether it is appropriate to include recent years in the calculation of this threshold because the threshold is used to evaluate the current status of the stock based

on recent years.

Based on the results of the stock assessment, the North Pacific albacore stock is not experiencing overfishing and is probably not in an overfished condition. The current exploitation level ($F_{2010–2012}$) is estimated to be below that of $F_{2002–2004}$, which had led previously to the implementation of CMMs for the North Pacific albacore stock in the EPO (IATTC Resolution C-05-02 supplemented by Resolution C-13-03) and the WCPO (WCPFC CMM 2005-03). The probability that current F will lead to SSB falling below the SSB-ATHL threshold is well below 50% under both average and high historical recruitment scenarios, but rises to 65% if a low recruitment scenario is assumed. The Albacore Working Group notes that there is no evidence that fishing has reduced SSB below thresholds associated with the majority of biomass-based reference points that might be chosen, and that population dynamics in the North Pacific albacore stock are largely driven by recruitment, which is affected by both environmental changes and the stock recruitment relationship. The Albacore Working Group concludes that the North Pacific albacore stock is healthy and that current productivity is sufficient to sustain recent exploitation levels, assuming average historical recruitment in both the short term and long term.

The Albacore Working Group notes that the lack of sex-specific size data, the absence of updated estimates of important life history parameters (natural mortality, maturity), and the simplified treatment of the spatial structure of North Pacific albacore population dynamics are important sources of uncertainty in the assessment.

Discussion

Following Steve Teo's presentation, Mark Maunder inquired about the use of fishing mortality reference points in the assessment. Steve Teo clarified that the WCPFC adopted a limit reference point of 20% of the virgin spawning biomass (SB0).

8.2. Updated indicators for silky sharks

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

An attempt by the IATTC staff to assess the status of the silky shark in the EPO using conventional stock assessment models has been severely handicapped by major uncertainties in the fishery data, mainly regarding catch levels in the early years, which may be why the model is unable to explain the population declines observed in the early period of the assessment (1994-1998) (Document SAC-05 INF-F). Although this stock assessment attempt has produced a substantial amount of new information about the silky shark in the EPO (e.g., absolute and relative magnitude of the catch by different fisheries and their selectivities), the absolute scale of population trends and the derived management quantities are compromised. Therefore, an alternative scientific basis for management advice is urgently needed. Since a conventional stock assessment was not possible, the staff proposed a suite of possible stock status (or stability) indicators (SSIs) which could be considered for managing the northern and southern stocks of silky sharks in the EPO (SAC-05-11a). The present paper updates the indices based on standardized catch-per-unit-effort (CPUE) in purse-seine sets on floating objects (CPUE-OBJ) with data for 2014.

Spatial distribution maps provide a simple quantitative overview of changes through time in both species occurrence and abundance. For silky sharks, they are available for average bycatch-per-set (BPS) from purse-seine sets on floating objects in the EPO, for small (< 90 cm), medium (90-150 cm), and large (> 150 cm) size classes separately (Figures 1a-c), and all silky sharks (Figure 1d). For all size classes north of the equator, there is an apparent reduction in bycatch rates (transition from predominantly red- and yellow-colored 1° areas to predominantly green- and blue-colored 1° areas). This reduction seems particularly strong in the most recent period (2011-2013), and apparently begins much earlier (around the

mid-2000s) for large sharks. Silky shark catch rates were noticeably higher (red and yellow-colored 1° areas) in 2014. However, this may be the result of increased availability, rather than abundance, of silky sharks due to a transition to a period dominated by positive (warmer than average) SST anomalies, which were felt in 2014 and have become stronger towards 2015.

For the northern stock, the CPUE-OBJ indicator shows an initial sharp decline over a wide spatial range (1994-1998), followed by a period of stability (1996-2006), and possibly increase (2006-2010). However, there are indications that any such increase has been reversed in recent years (2010-2013).

Observers record catches of silky sharks by size class: small (< 90 cm), medium (90-150 cm), and large (>150 cm). The relative trends described above for all sharks generally apply to the individual size categories. However, there is more inter-annual variability in the trends observed for small sharks, which is not surprising since the small shark class can be seen as a proxy indicator for recruitment (ages 0 and 1). The sharp decline seen for medium and large sharks during 1994-1998 is not as marked for small sharks, which suggests that recruitment has not been greatly affected over time. For better comparison of relative trends across size classes, Figure 3b presents the mean-scaled standardized CPUE.

For the southern stock, there is a major decline in bycatch rates (transition from predominantly red- and yellow-colored 1° areas to predominantly green- and blue-colored 1° areas). This decline is particularly marked for medium and large sharks around the early- to mid-2000s. Small individuals are relatively scarce in the southern area. It is uncertain where the recruitment to the southern stock originates. The CPUE-OBJ indicator for the southern stock shows a sharp decline during 1994-2004, followed by a period of stability at much lower levels. The trends for medium and large sharks are similar.

The CPUE-OBJ trends are corroborated by a different type of standardized indicator (presence/absence) produced from other set types (dolphin and unassociated).

An analysis of trends by sub-area in the northern EPO suggests that the recent increases in silky shark trends may be the result of a combination of spatially-distinct factors. Indicators updated with data for 2014, by sub-area, in the north show little to no recent increase for small and medium-sized sharks in the nearshore region (Area 4). Recent increases are apparent for small and medium sharks in the other areas; however, they are only apparent for large sharks in the offshore (Area 2) and far northern (Area 1) areas. Thus, the overall recent increasing trends in the northern area may in fact reflect an integration of spatially-distinct processes, including the effect of fishing pressure closer to the coast, and the arrival of adults from the west, perhaps as a result of recent environmental changes.

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

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

Discussion

One Member noted that the presentation cautioned against considering the recent and large increase in the CPUE index as an indication of a recovery trend because the increase was so great as to be impossible from a biological standpoint, given the life history of the species; suggesting that environmental factors may provide the most likely explanation for the increase. The Member noted, however, that the same cautionary statement was not made regarding the possibility of environmental noise associated with the observed declines in CPUE and wondered what might emerge if the el nino and la nina phenomena were overlaid across the entire CPUE time series. One suggestion was to examine whether catches of other

shark species followed similar trends.

Alex Aires-da-Silva noted that while the staff could examine other species such as oceanic whitetips and hammerhead sharks, these species were so rare in the purse-seine data that they would be difficult to analyze meaningfully.

The SAC also inquired regarding the quite narrow confidence intervals associated with the CPUE trends that were presented, which were unable to explain the uncertainty of the SST anomalies, and the factors that were used to standardize the index, looking for opportunities to improve the standardization. Alex Aires-da-Silva noted that the CPUE standardization author, Cleridy Lennert-Cody, was unable to attend the SAC meeting, but would be happy to discuss the formulation of the index and possible improvements, encouraging interested parties to contact her directly following the meeting. He also explained that she had examined other possible indicators and had not focused exclusively on CPUE for floating-object fisheries. For example, she examined CPUE and presence/absence indicators for other purse seine set types (dolphin, unassociated sets), and these all corresponded very well with the CPUE indicators for floating-objects. Average length indicators were also examined and they didn't show major differences over time, but that quantity did not show corresponding differences over the recent time period.

One Member expressed some concern that IATTC staff were supporting management of the purse-seine fishery for this species when it seemed clear that purse-seine catches represented only a small part of the problem and that the primary sources of over-exploitation lie elsewhere. It was noted that catches on purse seiners by handlining a night might be contributing to the catch.

Another Member noted that when discussing development of CPUE for skipjack tuna, IATTC staff had noted the difficulty presented by the uncertainty in the numbers of sets made, and asked whether this same CPUE methodology could be used to overcome that problem and develop an index for skipjack. The staff noted that CPUE for skipjack tuna is not standardised and standardization of the CPUE would be an improvement. They also noted that data from dolphin sets had also been used in this study, but skipjack tuna data from dolphin sets would not be useful because encounter rates with skipjack are so low in that fishery.

The SAC then discussed the fact that silky sharks were separated into northern and southern components for this exercise and asked whether there was strong and convincing evidence of multiple stocks of silky shark in the EPO. Alex Aires-da-Silva noted that there was some evidence supporting a north/south delineation to be found in genetic data, size data, spatial analysis and oceanographic data. However, he cautioned that the two-stock hypothesis for silky sharks is still viewed by the staff with some reservations and subject to review because much of the genetic supporting information remains unpublished, and thus it is still very much an open question that deserved further consideration. One issue that resulted from the north-south separation is the almost lack of juvenile segment in the south. So, it is uncertain where recruitment to the southern stock originates from.

The SAC also discussed the need to improve data collection by the coastal states in the EPO in support of the conservation and management of silky sharks and other shark species. Many Members expressed strong support for such efforts. There is hope that the shark work conducted under the GEF-FAO project by IATTC staff would result in improvements, but also noted that the effort would require continuity in order to succeed. Highlighted areas of need include the development of standardized data collection forms, training and institutional capacity building. Alex Aires-da-Silva noted that a workshop on shark data collection would take in the next few days and that a second workshop focusing on data analysis for data-poor species would follow in the future.

A Member asked whether the presented indicators included data from smaller class vessels. He noted that Colombia developed a program to deploy observers on smaller purse-seine vessels and that these data could be useful. Alex Aires-da-Silva agreed, acknowledging that IATTC staff concerns have been expressed at recent SAC meetings about smaller vessels operating in predominately coastal areas catching higher numbers of sharks than large-class vessels, including silky sharks.

One Member highlighted the importance that all the Members with fleets catching sharks, skates and rays in the region collaborate with the IATTC Secretariat to provide detailed statistics that will allow for comprehensive ecological risk assessments of main species of pelagic elasmobranches.

On the issue of observer data, a representative of ISSF noted they had found significant differences in the number of sharks recorded by on board observers and scientists enumerating shark bycatch during research cruises on commercial vessels. This may be due in part to the large number of tasks that an observer is responsible for during a set. He also noted that from a management effectiveness perspective, measures requiring purse-seine vessels to release sharks brought on board may be reduced in effectiveness because their research indicates that silky sharks that are sacked and brailed tend to have low survival rates. Thus to be maximally effective, the focus should be on avoiding their capture altogether or on release prior to sack-up.

An observer from Defenders of Wildlife reminded the SAC that CITES had recently sent a notice asking Parties to provide information on fisheries management and shark populations by the end of August 2015. They asked the Commission to consider submitting a regional update along these lines. The Director noted that much of the relevant IATTC shark data officially reported by members was already publicly available. Any response beyond that would require the submission of a formal request by CITES.

8.3. Update on shark work under GEF project

Salvador Siu provided an update on shark activities being conducted under the GEF project. The project was funded due to the worrying situation on the status of populations of sharks, being this regulators group populations of other minor species and its decline would lead several changes to the marine ecosystem. Currently, the information we have of shark resource is registered as a whole, without differentiation of species, so assessments of populations of these species has been difficult to perform. It is to this problem that the FAO-GEF Oceans Commons project has focused on improving the capture of information on those members of the Commission who have difficulty capturing biological and fishery information necessary for the proper assessment of these species, added to capacity building through training and impressions of educational material to these countries. The FAO-GEF project includes four major objectives: 1) Creating a Metadata which includes historical information on fisheries, biological and trade data of this group by species; 2) Improvement in the methodology of capturing biological and fishery information; 3) Using a common database to record information collected in the landings; and 4) Development of information material to support the best species identification and dissemination of research directed at these species.

To date, five IATTC Members (Panama, Belize, Guatemala, Nicaragua, and El Salvador) have been visited, and the following information has been collected:

1. Number of Sharks vessels
2. Shark catches by vessel,
3. Information on exports and imports of shark products
4. Biological data and data from scientific research;
5. Management plans for sharks;
6. Methods for recording field data and data base

Discussion

Following the presentation, a Member asked whether consideration had been given to extending the study area south, to include waters off of Peru and Ecuador. Salvador Siu explained that this project represents a very small part of the GEF project on sharks as a whole and that from its inception it had been designed to focus on the Central American region, which had been identified as a region of high priority. He noted, however, that some aspects of the project such as the workshops, were open to all IATTC Members and

that broad participation is encouraged.

The SAC then discussed the need for continuity of future efforts with the GEF project following its inclusion so that progress and momentum is not lost. Guillermo Compean noted that the IATTC has been conducting workshops and coordinating other work and collaboration in the EPO long before the GEF efforts and would continue to do so. One of the GEF project outputs will be to identify future opportunities for developing infrastructure and future programs that could be implemented following the 3-year GEF project. He also mentioned that IATTC is exploring the possibility of establishing a field office in Central America to focus on data collection in the region.

One Member suggested that data collection on sharks might improve if the IATTC would amend the format of its data collection log books that it provides to smaller vessels to accommodate greater detail on shark captures and interactions. Alexandar Siu noted this suggestion and indicated that this could be discussed further at the workshop taking place May 16 and 17 2015, where the focus will be data collection at landing, because ideas such as this represent an opportunity to improve the type of data gathered on small vessels operating without observers.

8.4. Hammerhead sharks

Marlon Román provided a brief update on hammerhead sharks caught in EPO tuna fisheries. Species of the genus *Sphyrna* are caught by the tuna purse-seine, the longline and the artisanal fisheries in the eastern Pacific Ocean (EPO). Several RFMOs have submitted recommendations and propositions pursuing the prohibition of hammerhead species from international trade, the release of unharmed hammerhead sharks when brought on board, the detailed description of discards and releases records, and the identification of potential nursery areas which shall consider time and area closures. The description of the captures of hammerheads on each of these fisheries, with special emphasis in the tuna purse-seine fishery is presented, and discusses the evolution of the hammerhead shark bycatch in the tuna purse-seine fishery in the last two decades. *Sphyrna zygaena* and *S. lewini* are the predominant species captured in this fishery. Capture of hammerheads represents less than 0.5 individuals per set. Sets on floating objects show the higher capture per set followed by unassociated sets and dolphin sets. The spatial distribution by size category of these two species and their composition according to the distance to the coast are also explored.

Discussion

The SAC noted that the challenges regarding hammerhead conservation may be similar to those presented by silky sharks in that artisanal fleets may dominate in terms of catch and purse-seine catch may represent a relatively small portion of the overall harvest in the region. Members highlighted the urgent need to improve the rates of data collection and data quality in the region as a critical step towards the creation of a clear picture of the relative sources of impacts and the development of sound management advice.

One Member asked about progress on a request made last year to compare the catches of hammerhead species in sets on man-made FADs vs. naturally occurring floating objects. The presenter then showed plots comparing these two categories and also the partitioning the catches of the two hammerhead species based on the distance from the coastline, but noted that catches of hammerheads in FAD sets are not necessarily larger than the catches taken on naturally occurring floating objects because sets on man-made FADs are the dominant aspect of the fishery.

One Member indicated that hammerhead sharks are now all listed in CITES appendix II. This Member suggested that it is therefore desirable that the Secretariat focus on providing advise on hammerhead shark through an ecological risk assessment that considers all the gears impacting on this species.

8.5. Dorado

Alexandre Aires-da-Silva provide an update on dorado collaborative research activates in the EPO. The IATTC held its first technical meeting on dorado in Manta, Ecuador, on 14-16 October 2014. This first

meeting had three objectives: 1) promote synergy in Members of the IATTC for a regional investigation of dorado in the EPO; 2) review the current state of knowledge of dorado and identify available data sets across fisheries/regions in the EPO); and 3) plan a future collaborative research plan.

A report is available that describes the work, discussions, and knowledge generated during the three sections of the meeting: 1) a "mini-symposium" on dorado" (23 presentations); 2) summary identification of the data sources available in the EPO region (preparation of a table of metadata); 3) discussion of research priorities and a plan for future collaborative research on dorado in the EPO.

The diverse range of topics of the talks presented at the meeting is an indicator of the substantial data collection and research efforts that are underway for dorado in EPO coastal nations. This is in contrast with the data-poor situation found for silky shark in recent IATTC collaborative work between IATTC staff and members countries.

The quality of the commercial fishery statistics available for dorado in the EPO has been quite satisfactory since 2000. This information is notably more abundant for the dominant nations in the fishery (Peru and Ecuador), and includes fleet composition data, georeferenced fishery-dependent data, and fishing effort data. There are also reasonable fishery statistics for other EPO nations, such as Colombia and some Central American nations. An additional great amount of information on dorado is available from NGOs, universities, research centers, the industry, and the sport fishing sector operating in the region. These stakeholders are encouraged to stay involved in future collaborative regional work activities.

Information on the life-history of dorado in the EPO is particularly rich, with several studies concluded and ongoing research activities on age and growth, reproductive biology (maturity and fecundity) and feeding ecology. Despite a few population genetic studies already carried out and those that are currently underway in the region, the population structure of dorado in the EPO remains unclear. There are ongoing tagging activities of dorado in the EPO but these are limited to Mexican waters and suggest restricted movements.

Conventional stock assessment modeling methods could potentially be used for dorado in the EPO with the fishery data available. However, lessons learned by the IATTC staff with similar species (*e.g.*, skipjack) indicate that the high productivity of these species (*i.e.* high fecundity, and fast growth rates over a short lifespan) is a handicap for conventional stock assessment analysis. Recruitment seems to be highly variable and strongly influenced by environmental conditions, and it is difficult to separate the exploitation and environmental effects with conventional stock assessment models.

Relying on the existing data available across the region, the IATTC staff proposes that stock status (or stability) indicators (SSIs) are produced for dorado in continuing regional collaborative research activities. The reliability of these indicators to achieve management and conservation goals for dorado in the EPO should be investigated within a Management Strategy Evaluation (MSE) framework. The MSE process should involve scientists and policy makers and lead to decisions about management objectives, harvest control rules, and which fishery indicators should be monitored. The synergies seem to be solid for continuing the regional collaborative work on dorado in the region. A second Technical Meeting on Dorado is tentatively planned to take place in the fall of 2015 in Peru.

Discussion

The SAC welcomed the description of progress being made, emphasized the importance of these efforts and inquired regarding the expected timeline for the development of indicators from which conservation and management measures could be developed. The pace at which this work can proceed depends heavily on timely follow through on the commitments of the relevant nations to collect and provide both historic and current data. The data collection program of Ecuador, which has been in place for 8 years, was highlighted as a great example, noting that IATTC has already produced standardized CPUEs for their fisheries based on their input. Similar results are possible on a regional scale if all nations remain actively engaged in these coordinated efforts. The process has been energized following the last workshop in

Ecuador, so it is hoped that focus can be maintained so that progress can be realized as soon as possible.

Ecuador mentioned that they have biological data and other information available from 1989 that they can make available to further the efforts on dorado.

8.6. Update on north Pacific Bluefin tuna

Alexandre Aires-da-Silva provided an update on pacific bluefin tuna stock assessment research activities. A new stock assessment cycle has just initiated at a recent workshop of the PBF Working of the International Scientific Committee (ISC) for Tuna and Tuna-Like Species in the North Pacific Ocean (ISC). The working group met at the National Research Institute of Far Seas Fisheries, Shimizu, Shizuoka, Japan (April 20-24, 2015). Alexandre Aires-da-Silva participated as IATTC representative at the working group. A second intersessional workshop is tentatively planned for fall 2015 in Chinese Taipei. The next full stock assessment meeting will take place in early 2016, tentatively in La Jolla, CA, USA.

There is new information available on the Japanese CPUE troll fishery indicator which has been updated for 2014. This new information is indicative of a potentially very low PBF recruitment in 2014. Since the possibility of this very low recruitment in 2014 was considered in the stock assessment population projection scenario used for management recommendations, the working group agreed that this new information does not change current conservation advice. PBF management recommendations will be revised after the next stock assessment results become available in early 2016.

Discussion

Some Members expressed concern regarding this timeline, because it would mean that the new assessment will not be available for consideration by the next meeting of the WCPFC Northern Committee in September 2015 or the WCPFC annual meeting in December 2015, making unlikely that WCPFC Members would take additional action to address the high mortality rates of juvenile PBF in the WPO prior to the 2017 fishing year. This concern is heightened, in their view, in light of recent reports suggesting low recruitment levels. Other Members, referring to the conclusion of the ISC PBF WG in April, stated that they were less concerned by this possibility because they considered that the current management approach took into account the possibility of low recruitment in its analysis and projections. Guillermo Compean noted that the current IATTC CMM in place, C-14-06, provides measures for 2016 and that if necessary, additional, voluntary measures could be taken.

The SAC also heard that IATTC staff had recently visited Bluefin pens in Mexico and that the Mexican industry expressed a willingness to share information they collect on the size of PBF at the time of stocking. The industry uses underwater cameras to obtain accurate estimates of sizes at capture and that this data would represent a significant improvement to the size composition data for the EPO.

9. ECOSYSTEM CONSIDERATIONS (SAC-06-09)

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

A brief overview of a recently published diet study of silky sharks was provided. A novel, modified classification tree approach was used to analyze broad-scale spatial and shark size covariates explaining the predation patterns of 289 silky sharks captured in sets on floating objects, primarily drifting fish-aggregating devices (FADs), across the tropical EPO. A strong spatial shift in diet was identified by the tree analysis, with different foraging patterns in the eastern (inshore) and western (offshore) regions. Results showed greater proportions of FAD-associated prey (especially skipjack and yellowfin tunas) than non-FAD-associated prey (e.g., squids, crabs, and flyingfishes) in the silky shark diet. These results indicate that pelagic fishes associated with FADs may be more vulnerable to predation by silky sharks

than prey that do not associate.

Trophic levels (TLs) are used in food-web ecology to characterize the functional role of organisms, to facilitate estimates of energy or mass flow through communities, and for elucidating trophodynamics aspects of ecosystem functioning. The mean TL of the organisms taken by a fishery is a useful metric of ecosystem change and sustainability because it integrates an array of biological information about the components of the system. Mean TLs were estimated and presented for a time series of annual catches and discards by species from 1993 to 2013 for three purse-seine fishing modes and the pole-and-line fishery in the EPO.

A preliminary Ecological Risk Assessment (ERA) was made to estimate the vulnerability to overfishing of several components of the ecosystem by the purse-seine fishery in the EPO. The status of many of the stocks incidentally caught in the EPO tuna fisheries is unknown, and biological and fisheries data are severely limited for most of those stocks. To examine the utility of productivity and susceptibility indices to assess vulnerability of incidentally-caught fishes, mammals, and turtles to overfishing in the EPO, IATTC staff members made a preliminary evaluation using Productivity and Susceptibility Assessment (PSA) of three purse-seine fisheries. The staff of IATTC's Biology and Ecosystem Program had planned to finalize and publish the PSA analysis during 2014, but the retirement of one staff member and budget constraints have prevented the work from being finished. However, three modifications of the analysis have been made since it was reviewed at the SAC meeting in May 2014: 1) the procedures for determining which species to include in the analysis were modified; 2) the susceptibility values for each fishery were combined to produce one overall susceptibility value for each species; and 3) the use of bycatch and catch information in the formulation of susceptibility indices was modified.

The list of productivity attributes remains unchanged, while the list of susceptibility attributes has been revised due to this 3rd modification. These modifications were discussed and three susceptibility measures were presented, two of which use catch data to compute alternate susceptibilities. These susceptibility measures are considered preliminary and provide a means to illustrate alternative concepts for computing susceptibility tailored to the EPO purse-seine fishery. The IATTC staff recognizes that it is difficult to isolate the effect of any one fishery when using catch data as an alternate measure of susceptibility, e.g. some species have low catch rates compared to historical levels, and this may be the result of integrated impacts from other fisheries, not just the purse-seine fishery. The IATTC staff will continue working to improve and refine the productivity and susceptibility analysis during 2015. Future work will focus on evaluation of which of the three susceptibility measures is preferable, and whether further modifications should be made. In addition, a full literature review is in progress to determine if productivity and susceptibility attributes and corresponding scores should be updated as a result of new research. In general, the PSA shows promise as a tool to rank species that are in most need of attention. However, there is no indication from the PSA whether or not the catches of the species that score the highest in vulnerability are unsustainable.

Discussion

The SAC welcomed these efforts as a very positive first step in helping the Commission begin to think about and address ecosystem considerations. Although the preliminary nature of the results were acknowledged, some thought that the results could be refined and improved and that perhaps the future scope of these analyses can be expanded so to consider other fisheries in order to get a clearer representation of true vulnerability. Along those lines, one Member suggested that an informal working group meet on the margins of the SAC to discuss possible refinements and future directions. Another Member was enthusiastic about the use of trophic levels in ecosystem management and indicated a transoceanic working group on how fisheries management can improve ecosystem elements is planned for some time in 2016 or 2017 and encouraged IATTC to participate in those efforts.

One Member expressed concern that terms such as "most vulnerable" and "most susceptible" could be taken out of context and lead more casual readers to conclude that purse-seine fisheries in the EPO represent the greatest conservation threat to some of these species, when that is not the case; other

fisheries may have a greater impact on these species than does the purse-seine fishery. The SAC understands that this is a relativistic comparison among purse-seine set types, but that others could make different interpretations.

Another Member expressed concern regarding the use of IUCN listing criteria in the paper because some consider the use of these categories inappropriate for use in classifying exploited fish stocks.

The SAC also took note that north Pacific bluefin tuna were not considered in this analysis because the scope of the modeling effort was restricted to the tropical EPO.

Finally, the SAC considered the extent to which the Commission is applying an ecosystem management approach. The Director indicated that the Commission is already applying it as an approach, but not as a model. He said that the Commission hoped to address this in the near future by hiring someone who will work on mathematic models in the ecosystem context, and that this work would complement Leanne Duffy's ecology work.

10. STAFF ACTIVITIES AND RESEARCH PLANS (SAC-0610A)

Rick Deriso presented document SAC-06-10a on staff activities and research plans.

Discussion

Following the presentation, one Member asked for an accounting of research to develope technology to reduce bycatch and otherwise increase target selectivity (e.g. to catch skipjack in FAD sets while avoiding or minimizing captures of juvenile bigeye tuna). The Director first mentioned a planned research cruise that will examine the feasability of using the backdown procedure developed to facilitate dolphin release from purse-seine nets to release sharks from FAD sets without first bringing them on board the vessel and subjecting them to the stresses of sack-up and brailing. He also mentoined a FAD project that is planned using extra-budgetary funds provided by the EU which will evaluate biodegrable materials that could be used in FAD construction and non-entangling FAD designs. A number of SAC Members commented that various aspects of similar research and evaluation has already been conducted, including under the auspices of ISSF, and suggested that the planned IATTC project seek to build up what has already been achieved rather than anew from scratch. The staff also mentioned planned projects to evaluate the survival rates of silky sharks caught in longline fisheries. Additionally, planned or completed collarborations with ISSF include projects looking to develop methods for acoustic selectivity pre-set, a search for FAD designs less attractive to bigeye tuna (while remaining attractive to skipjack tuna).

A representative of ISSF recalled that ISSF has been working to address purse-seine bycatch issues through technical solutions since 2009. The program is designed to test potential metigation measures in each ocean due to the varying nature of the fisheries, biology and oceanography that exist. He stressed the importance of establishing and maintaing a two-way dialogue with fishermen in each fishery because they play an important role in assessing feasability and effectivness and also play integral roles in the identifcation of creative and novel solutions. Additionally, he noted that funding for this type of research is not as strong as it was just a few years ago, and this stimulated a SAC discussion on the importance of extra-budgetary funding for research priorities relating to bycatch.

Regarding the status of further research on the use of sorting grids to release juvenile tunas from FAD sets, the SAC heard that while there had previously been general agreement to continue to examine these methods, no specific designs have been suggested for further evaluation.

Korea noted the IATTC plans to conduct assessments of both yellowfin and bigeye tuna in 2016 and expressed its wish to participate in those stock assessment and offered to provide their historical operational longline data. It further noted that those operational data had been incoporated into the pan Pacific bigeye assessment being conducted by SPC and IATTC in 2015.

Regarding the pan-Pacific assessment of bigeye, the SAC encouraged the active participation of IATTC scientists in the assessment beyond the provision of data for the efforts. Rick Deriso confirmed that the

IATTC planned to particiapte in the assessment with SPC.

The SAC also took note that in 2014, IATTC scientific staff put significant resources into investigations of north Pacific bluefin tuna, and that they would be collaborating with ISC in 2015 and 2016 to conduct another assessment of this stock, likely culminating in a final assessment workshop in March 2016, as was previously discussed in detail under agenda item 8(f).

Finally, the SAC inquired about the status of dolphin abundance research efforts and when results might be expected. Rick Deriso noted that SAC-06-11 is a proposal for an experts workshop, funded by the EU, that would bring together relevant expertise to discuss the best options for assessing dolphin abundance and population trends moving forward. He reminded the SAC that previous abundance efforts were conducted by NOAA as part of larger EPO survey efforts, and that such a cruise has not been conducted since 2006. Given that Cleridy Lennert's analysis from last year concluded that using purse-seine data to create an abundance index for dolphins was not very promising because of the bias contained in those data sets. In his opinion, the best options may be abundance survey efforts of some type- whether in collaboration with NOAA or othewise. Rick Deriso also noted that the scoping paper presented at the October 2014 AIDCP meeting highlighted that regardless of how it might be conducted, an abundance cruise or cruises will be expensive and these efforts will have ot rely on extra-budgetary contributions of money and other resources. Without new survey data, their ability to assess dolphin populations in the EPO will remain limited.

10.1. Update on harvest control rules, reference points, and management strategy evaluation

Carolina Minte-Vera (no paper) presented the management strategies evaluation (MSE) activities performed by the staff. These were related to capacity building, scientific meetings, research, working groups, and development of research proposals.

Capacity building activity included the participation in the workshop "Eastern Pacific Ocean Coastal States Tuna Management" of the Areas Beyond National Jurisdiction (ABNJ) Project (FAO-GEF, World Wildlife Fund- WWF) at Gamboa Rainforest Resort, Panama, 24-25 February 2015. The goal of this workshop was to create a better understanding among Eastern Pacific Ocean Coastal States of the precautionary approach, Harvest Strategies (HSs) and management strategy evaluation (MSE) for sustainable tuna fisheries in the context of tuna fisheries. Alexandre Aires-da-Silva gave the presentation "An overview of the harvest strategy and management strategy evaluation process (MSE) at the Inter-American Tropical Tuna Commission (IATTC)". Carolina Minte-Vera gave the presentation "Ejercicio: Evaluación de la estrategia manejo de los atunes tropicales en el Océano Pacífico oriental." Guillermo Compean participated in the discussions.

Contributions in scientific meetings included: (i) International Seafood Sustainability Foundation (ISSF) 2015 Stock Assessment Workshop "Characterizing uncertainty in stock assessment and management advice", 16-18 March at the Monterey Bay Aquarium, with the goal of review recent progress made by the tuna RFMOs towards adopting harvest strategies, with particular emphasis on the methodologies used to quantify and express uncertainty in stock status results. Carolina Minte-Vera gave the presentation "Progress towards implementing harvest strategies and addressing uncertainty in the management of EPO tuna fisheries; (ii) International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC) Management Strategy Evaluation Workshop, April 16-17, 2015, Yokohama, Japan, the review the objective, benefits, and requirements to implement an MSE, as well as recent progress made by tuna RFMOs towards adopting and implementing the MSE process. Discussions related to defining the roles of managers, stakeholders and scientists in the MSE process. Alexandre Aires-da-Silva gave the presentation "Progress towards implementing harvest strategies and MSE in the management of EPO tuna fisheries". The ISC- Albacore Working Group held a Stock Assessment Workshop: Management Strategy Evaluation Mini-Workshop, 20-22 April 2015, Shimizu-ku, Japan, with the aim to develop of a MSE plan. The IATTC staff did not attend but an account was given to the group by Steve Teo (SWFSC/NOAA). The ALBWG members identified two principles guiding MSE workplan development

and framework implementation: (i) delivering the next stock assessment of north Pacific albacore in 2017 is a priority for WG members, scheduling of the MSE process is a secondary priority, and (ii) present resources are not sufficient to develop and conduct an MSE process and the stock assessment process in parallel. If the MSE process is deemed a high priority by managers and stakeholders, then an ISC member country will have to support the hiring or contracting of a scientist to deliver on MSE commitments in collaboration with the ALBWG. The USA (NOAA/SWFSC) has committed to hiring a scientist to work on MSE, which may be insufficient, but given the small number of scientists qualified to perform MSEs, it may be difficult to hire the scientist in a timely manner. The ALBWG scoped out an 'optimistic timeline', assuming that a MSE scientist could be hired by January 2016, which aims to complete the first round of the MSE in 2018. However, the timeline may be delayed depending on when a MSE scientist could be hired. The MSE process is expected to take a minimum of three years and involve a series of interactions between the WG and managers/stakeholders to establish a program that will meet the management goals and objectives of albacore sustainability at prescribed abundance levels.

The staff participated on the following working groups: (i) tRFMO-MSE Working group, organized by Laurie Kell (ICCAT), the groups maintain an online repository of MSE related code and a meeting will be held in 2015 (tentative); (ii) N ALB ISC Working Group chaired by John Holmes (DFO, CA) which plans to continue addressing the MSE subject and (iii) Dorado working group, whose facilitator, Alexandre Aires-da-Silva, commented that MSE is one of the tools to be considered for use by the dorado group and a meeting will be held in the fall of 2015 (tentative).

The publications on MSE done by the staff were (i) Maunder, M.N. 2014. Management strategy evaluation (MSE) implementation in stock synthesis: Application to Pacific bluefin tuna. IATTC Stock Assessment Report 15: 100-117. (Develops a method to implement MSE using existing stock assessment implemented in Stock Synthesis and applies it to north Pacific Bluefin tuna; (ii) Carruthers, T. , Kell, L. , Butterworth, D. Maunder, M.N. Geromont, H. , Walters, C., McAllister,M. , Hillary,R. Levontin, P. Kitakado, T., Davies, C. Performance Review of Simple Management Procedures (Evaluates several simple harvest control rules applicable to data poor species under different sources of uncertainty); Kell,K.T. Levontin,P. Davies, C., Maunder, M.N., Pilling, G. Sharma, R. (In preparation). The quantification and presentation of risk (Book chapter in Management science in fisheries: a practical introduction to simulation-based methods) ; (iv) Maunder, M. N. Zhu, J. , Aires-da-Silva. A. 2015. Preliminary Management Strategy Evaluation to evaluate the IATTC interim reference points and proposed harvest control rule. IATTC Document SAC-06-10b.

The staff developed two research proposals to seek funding for MSE related research: (i) "Simulation testing of reference points" (see SAC-06-10e), time frame: For final presentation at the 2017 SAC and update given at the 2016 SAC; and (ii) "Management Strategy Evaluation", this project will develop simulation analysis to test the HCR and RPs under different sources of uncertainty. A comprehensive plan would comprise several components, as follows: Determine management objectives; Fully describe the sources of uncertainty including the type, magnitude, and probability of the uncertainty; Identify alternative HCRs and RPs; Determine how the HCR and RPs will be used in management including the data collected, assessment methods used, and management actions taken to comprise a full management strategy; Develop performance measures; Conduct the simulation analysis; Compare the performance of the alternative HCRs and RPs. The time frame for final presentation is the 2018 SAC and an update will be given at the 2017 SAC.

Mark Maunder also presented a summary of preliminary management strategy evaluation for IATTC interim reference points and proposed harvest control rules. Harvest control rules (HCRs) and reference points (RPs) have become common in the management of many fish stocks. The IATTC has operated for many years under the unofficial HCR of fishing at FMSY, and recently adopted interim target (TRP) and limit (LRP) reference points. We use management strategy evaluation (MSE) to evaluate the HCR and RPs using bigeye tuna as an example. Stock Synthesis is used as both the operating model (OM) and the assessment model. The analysis is repeated under misspecification of the steepness of the stock-recruitment relationship, the asymptotic length, and natural mortality. Random recruitment deviations are

applied for projection of the OM when testing the management procedure (MP). The results show that the probability of recruitments dropping below 50%R0, which is used to define the LRPs, is generally lower than 10% for the 9-year management period. An over-assumed steepness in the MP can increase the probability of dropping below 50%R0, and an over-assumed steepness or natural mortality can increase the probability of exceeding the fishing mortality-based LRP. Overall, the MP applied in this study works effectively to manage the stock at the MSY level, and avoid a high risk of recruitment being seriously impacted. However, these results are only preliminary, and more analyses are needed.

Discussion

Following the staff presentations, the SAC discussed management strategy evaluation and harvest control rules. One Member expressed concern that the wording and terms used in management strategy evaluation may not be well understood by managers, and that it is important that results of management strategy evaluation be shared with managers and Commissioners. Carolina Minte-Vera agreed with this suggestion and used the work of the northern albacore working group as an example of early sharing and evaluation by managers.

Another Member suggested that harmonization in terminology is needed for management strategy evaluation, particularly for managers. Carolina Minte-Vera agreed, and indicated that the staff had begun the process of harmonization and feedback from managers through the workshop on tuna management held in February 2015 in Panama.

A Member suggested that the conclusion from the analysis on MSE of bigeye that both harvest control rules and reference points were reasonable may not be accurate. Mark Maunder agreed and explained that the reasonableness of the 50%R0 limit reference points is based on general thinking that the reference point would rarely be breached under the current control rule. He also explained that the analysis presented should be considered to have tested the appropriateness of the harvest control rule given the limit reference points and that a different type of analysis might be needed to test the appropriateness of the limit reference points.

10.2. Review of research at the Achotines Laboratory

Dan Margulies presented a summary of the research program conducted at the IATTCs Achotines Laboratory in the Republic of Panama. Achotines Laboratory is the only research facility in the world dedicated to studies of the early life history of tropical tunas.

The early life history research program involves laboratory and field studies of tropical scombrids aimed at gaining insight into the recruitment process and the factors that affect it. Previous research on recruitment of non-scombrid fishes suggests that abiotic factors, such as temperature, light, current patterns, and wind conditions, and biological factors, such as feeding, growth, and predation, can affect recruitment. As the survival of pre-recruit fishes is probably controlled by a combination of these factors, the IATTC research program addresses the interaction between the biological system and the physical environment.

Research on tropical scombrids at the Achotines Laboratory has involved two distinct phases. The first phase of research was directed predominantly at coastal, tropical scombrids, mainly black skipjack (*Euthynnus lineatus*), bullet and/or frigate tunas (*Auxis* spp.), sierra (*Scomberomorus sierra*), and striped bonito (*Sarda orientalis*), during the period from 1984 to 1995. From 1996 to present, the focus of research shifted to the reproductive biology and early life history of yellowfin tuna, utilizing eggs spawned by captive yellowfin broodstock.

Research on coastal tropical scombrids

From 1986-1994, we began our studies of coastal scombrids in the Panama Bight. We developed methods for the collection of large numbers of live early-juvenile scombrids at sea. The fish were collected by dipnet after attraction to an underwater light (24 V DC, 300 W) and transported alive to laboratory tanks. They were fed in the laboratory with wild zooplankton size-graded between 333 and 1000 µm in body

width, predominantly cladocerans, copepodites and adult stages of copepods.

Studies of the early life history and reproductive biology of coastal, tropical scombrids during the first decade of operation of the Achotines Laboratory produced new and important findings on the biology of tropical scombrids. These studies included descriptions of the growth dynamics of larval and juvenile tropical scombrids, estimates for tropical waters of the incidence of starvation in larval and juvenile scombrids, descriptions of the temporal and spatial distribution of larval scombrids in the Panama Bight, validation of daily growth increments in the otoliths of larval and early-juvenile black skipjack and bullet/frigate tuna to determine ages and estimate growth rates, and descriptions of the development of sensory systems in larvae and early-juveniles. Research on yellowfin tuna

Research on reproductive biology and early life history of yellowfin

From 1996 to present, the IATTC has conducted research on the reproductive biology in captivity and early life history of yellowfin. The objective of the research is to develop a more complete understanding of daily mortality processes occurring during pre-recruit life stages (larval and early-juvenile stages) and how mortality is influenced by key environmental and biological factors. The ultimate goal of our experimental program on yellowfin early life history is the contribution of new insights into recruitment variability. The ability to forecast yellowfin recruitment, prior to the age at entry to the fishery (6 months), would be a powerful stock assessment tool.

Yellowfin research at the Achotines Laboratory has focused on important aspects of adult growth, spawning dynamics, genetics of spawning fish, early life stage development, growth dynamics of larvae and early-juveniles (in the laboratory and *in situ*), and the effects of important physical factors on pre-recruit survival and growth. The results of this research are summarized in a series of publications listed on the IATTC website.

Promising links between yellowfin early life research and stock assessment

Laboratory and in situ growth of larval and juvenile yellowfin

We have focused much of our experimental efforts with yellowfin on investigations of growth dynamics during the larval and early-juvenile stages. Since 1997, we have studied growth in the laboratory of yellowfin larvae and juveniles reared from eggs from our yellowfin broodstock. We have investigated the effects of food availability, water temperature, and other physical factors on the survival and growth of yellowfin larvae and juveniles up to 100 days after hatching. Early-larval growth (the first 2 weeks) is exponential in length and weight (<0.35 mm day^{-1} in length and 20 to 35% body weight day^{-1}), but growth increases significantly during the late-larval and early-juvenile stages (>0.6 mm day^{-1} and ca. 30-50% body weight day^{-1}) (Figures 4 and 5). Yellowfin larvae become piscivorous at around 6.5 mm SL, and the timing of the onset of piscivory probably determines, in part, an individual's growth potential. Laboratory cohorts that are early piscivores (ca. 6.0-7.0 mm SL) grow more rapidly, and individuals that remain zooplanktivorous lag in growth and/or are cannibalized.

A juvenile growth index, perhaps estimated quarterly in the Panama Bight, may prove useful as an index of recruitment strength. This type of sampling program to estimate *in situ* juvenile growth could be developed at the Achotines Laboratory via quarterly or seasonal sampling and aging of juveniles collected by nightlighting. We have conducted similar analyses of *in situ* growth during selected years in the Panama Bight, and we found some localized correspondence between high growth rates of larvae and recruitment estimates. Our experimental results have indicated an early onset of substantial density-dependent growth of yellowfin during the first 2.5 weeks after hatching. Increases of 2-4 times in larval density have resulted in growth deficits up to 56% during larval stages. We have also noted strong indirect evidence of density-dependent growth in larval cohorts during certain years in the Panama Bight.

Effects of wind-induced turbulence on yellowfin larval survival

Feeding success of marine fish larvae can be influenced by the levels of wind-induced microscale turbulence in the feeding environment. The probability of prey encounters and feeding success of larvae

may increase with increases in wind-induced microscale turbulence up to an asymptotic wind and turbulence level and then decrease at higher levels of turbulence. We conducted a series of laboratory experiments at the Achotines Laboratory which examined the survival of yellowfin larvae during the first week of feeding under conditions of variable microturbulence. .

Our preliminary analysis of the 1997-2000 data indicates that survival during the first week of feeding is up to 2.7 times higher at intermediate levels of microturbulence (ca. 7.4 x $10^{-9}m^2s^{-3}$ to 2.25 x $10^{-8}m^2s^{-3}$ as an energy dissipation rate) than at lower or higher levels of turbulence (Figure 7). Using a boundary layer model that equates microturbulence levels in the mixed layer of the ocean with wind speed, we have made preliminary estimates of optimal wind speeds for larval yellowfin survival, based on assumed depths for maximum concentration of the larvae at 5-20 m depth (estimated from larval field survey data in the literature). The optimal wind speed estimates range from 2.0 to 4.5 m sec^{-1}.

The estimated wind speeds for larval survival were examined for correlations with historical yellowfin recruitment estimates in the EPO for select 2x2° areas. Wind speed data for the period 1987-2007 were obtained from the Blended Sea Winds Database, National Oceanic and Atmospheric Administration (NOAA), National Environmental Satellite, Data, and Information Service (NESDIS), National Climatic Data Center (NCDC). The percentage of days with optimal wind speeds within a given 2x2° area was estimated and correlations were calculated with IATTC quarterly estimates of yellowfin recruitment (time-lagged 6 months to account for pre-recruit development). A spatial pattern was observed both latitudinally and longitudinally for the areas selected . The areas closer to shore, east of 100° W, showed positive correlation values, while the correlation coefficients became negative further offshore and west of 100° W. All areas south of the equator exhibited positive correlations.

The wind speed – recruitment analysis can be refined and expanded, but this analysis is promising for assessing yellowfin recruitment patterns. The correlation analysis reported here involves different spatial scales of variables (EPO-wide recruitment estimates versus 2x2° estimates of wind speed). More geographical coverage would improve the analysis and future development of spatial components to the IATTC's recruitment estimates would allow the examination of wind speed data and recruitment on the same spatial scale.

Comparative studies of the early life histories of yellowfin and Pacific bluefin

In 2011, the IATTC, Kinki University (KU) of Japan, and the Autoridad de los Recursos Acuáticos de Panama (ARAP) began a 5-year comparative study of the reproductive biology and early life history of yellowfin and Pacific bluefin tuna (Science and Technology Research Partnership for Sustainable Development, SATREPS). The joint research project is funded by the Japan International Cooperation Agency (JICA) and Japan Science and Technology Agency (JST), and is being conducted mostly at the Achotines Laboratory and the Fisheries Laboratories of Kinki University in Wakayama Prefecture, Japan. The studies are the first in the world to investigate important comparative aspects of the reproductive biology, genetics, and early life histories of Pacific bluefin tuna and yellowfin tuna. Although Pacific bluefin are temperate to subtropical and yellowfin are tropical to subtropical in their adult life histories, the early life stages of both species require warmwater ecosystems as nursery grounds, thus providing a common background for comparative studies. Experimental results will also be used to comparatively model mortality processess occurring during the pre-recruit life stages of both species. An additional objective of the project is to develop technologies for the successful aquaculture of juvenile yellowfin, including sea-cage culture.

The effects of ocean acidification on yellowfin eggs and larvae

The 5th Intergovernmmental Panel on Climate Change (IPCC) assessment estimates a global average decline in ocean surface pH of 0.30-0.32 by 2100 due to increasing concentrations of dissolved carbon dioxide (pCO_2) from anthropogenic activities. Across regions of the Pacific Ocean, where yellowfin tuna spawn and develop, mean surface water pH is predicted to decrease between 0.26-0.49 pH units by 2100. Ocean acidification is a concern for its potential effects on the growth, development, and survival of early

life stages of tunas in oceanic habitats and for potential effects on the spatial extent of suitable nursery habitat for tunas.

To advance our knowledge of the potential effects of ocean acidification on yellowfin early life stages, a laboratory study was conducted by multiple collaborating organizations at the Achotines Laboratory in 2011. Two separate trials were conducted to test the impact of increased pCO_2 on eggs, yolksac larvae, and first-feeding larvae. Acidification levels tested ranged from present day to levels predicted to occur in some areas of the Pacific within the next 100 years (near future) to 300 years (long term). The study results were variable between trials, but did indicate the potential for significantly reduced survival and size of larvae and prolonged

egg hatch times at acidification levels that are relevant to near future predicted levels.

Discussion

Following the presentation by Dan Margulies, a Member inquired about the operational stability of the Laboratory. Dan Margulies explained that the Laboratory is operated on a modest, fixed budget that is supplemented by external funding. However, budget for the Achotines Laboratory is not sufficient to address all research needs. The SAC then discussed the challenges of rearing bigeye in captivity, and Dan Margulies indicated that the staff had no knowledge of successful husbandry of bigeye in land-based tanks anywhere in the world. However it may be possible to rear bigeye in a large tank such as the spawning tank at the Achotines Laboratory.

In light of the pre-recruit yellowfin studies conducted at the Achotines Laboratory, a Member inquired about the three apparent regimes for yellowfin recruitment in the EPO. Rick Deriso explained that there was clearly a regime shift in the early 80s, but the underlying mechanisms are unclear. He noted that there is some consensus among researchers that the massive El Niño of 1982-83 permanently changed the ecosystem and allowed for increased recruitment of yellowfin, although that has started to diminish recently. Still, not enough is known about the ecosystems to fully characterize the regime shifts for recruitment in yellowfin.

A Member suggested that since bigeye is a species of high interest in conservation, it might be very helpful to establish a line of research with bigeye at the Achotines Laboratory. Dan Margulies explained that successful husbandry of bigeye might be possible at the Achotines Laboratory, but that it would involve some challenging logistics and modest funding to transport bigeye from offshore waters to the Achotines Laboratory. Guillermo Compeán suggested that bigeye was transported in several occasions in towed cages like those used in Mexico for Pacific bluefin.

A Member described some attempts to rear bigeye in the Canary Islands, and indicated that a small group of bigeye were held in laboratory tanks for about a month. Dan Margulies indicated that yellowfin broodstock begin feeding about 1-3 weeks following collection and stocking in land-based tanks.

10.3. CAPAM workshop on growth

The Center for the Advancement of Population Assessment Methodology (CAPAM) hosted a workshop on Growth: theory, estimation, and application in fishery stock assessment models from November 3-7, 2014 at the Southwest Fisheries Science Center (SWFSC) in La Jolla, CA, USA. The five-day meeting was part of a broader program under CAPAM that focuses on developing guidance for Good Practices in Stock Assessment Modeling. The workshop was sponsored by NOAA/NMFS and the International Seafood Sustainability Foundation (ISSF). Mark Maunder (IATTC) served as chairperson for the technical forum. A diverse body participated in the workshop, including 100 scientists from federal, state, and international fishery institutions, 30 researchers who contributed recent analysis and case studies pertaining to growth, and 5 invited speakers who provided reviews on major topics associated with growth parameterization and considerations in fishery assessment models. Keynote speakers included: biological processes/ontogeny (Kai Lorenzen, University of Florida); specification and estimation: age-structured models (Chris Francis) and length-structured models (André Punt, University of Washington);

spatial/temporal variation (Steve Martell, International Pacific Halibut Commission); and modeling growth in tuna assessments (Dale Kolody, CSIRO Marine and Atmospheric Research). The workshop was structured in a manner that allowed both novice practitioners and experienced analysts to gain insight into growth properties and parameterizations involved in developing robust stock assessment models. Each topic above comprised a review and several research presentations, followed by group discussion that addressed focus questions and outlined priorities for future research. Additionally, two special sessions related to modeling growth in integrated assessment models were held as part of the overall workshop. The first session was based on the widely-used stock statistical modeling framework Stock Synthesis (SS, Methot and Wetzel 2013), with Ian Taylor (Northwest Fisheries Science Center, NWFSC) presenting an overview and tutorial for addressing growth parameter options available in SS. The second session was led by Jim Thorson (NWFSC), who provided an introduction to Template Model Builder, an AD Model Builder inspired R-package for fitting flexible state-space and hierarchical models.

Some general concepts discussed in the workshop include the following. Specification of growth is particularly important for stock assessment models that fit to length composition data, uncertainty in the length-at-maximum age can substantially impact estimates of fishing mortality and abundance. Variation is most pronounced in asymptotic length of a growth relationship. It is recommended that when there is an adequate amount of growth information available, estimation of annual variation in L_{∞} should be the default assumption. The relationship for variation of length-at-age should be a function of mean length. The standard deviation of length at age typically increases with mean length and a constant CV is appropriate in the absence of information, 10% being commonly observed. Growth estimation should be conducted inside the stock assessment to ensure that selectivity, length-bin sampling, and additional information from length composition data are accounted for. If sufficient age composition data are available using empirical weight-at-age data should be considered. Sex-specific growth is likely more common in species than not and differences may be of magnitude to substantially impact population estimates from the assessment model. Growth estimation in integrated stock assessments models should focus primarily on model performance in terms of derived estimates useful to management and not strictly the growth parameter estimates. Growth models that more accurately account for broadly applicable ontogenetic changes exhibited in growth warrant further attention.

The workshop report is available on the CAPAM website.

The 2015 CAPAM workshop will be on "data conflict and weighting, likelihood functions, and process error" and will be held in La Jolla, CA, USA, October 19-23, 2015. The topics and invited speakers are: Data conflict and weighting (Chris Francis), Likelihood functions (Jim Thorson), Temporal variation (Anders Nielsen), Model misspecification (Kevin Piner). A wildlife population assessment (TBA) keynote will also be invited and a session will be held on data weighting considerations using the Stock Synthesis modeling framework (Ian Taylor).

10.4. Extra-budgetary funded research projects

Rick Deriso gave a presentation on the following extra-budgetary funded research projects described in SAC-06-10e:

1. Simulation testing of reference points (60,000 € from EU + 20% matching funds)
2. Dolphin population assessment workshop (60,000 € from EU + 20% matching funds)
3. Estimation of the post-release survival rates of sensitive shark species captured by purse-seine and longline fisheries in the EPO (150,000 € from EU + 20% matching funds)
4. Testing of non-entangling and biodegradable fish aggregating devices (FADs) (180,000 € from EU + 20% matching funds)

Discussion

Following Rick Deriso's presentation, the SAC discussed the summarized projects. There was a discussion of differences in scope between project 1 and the MSE and HCR analysis presented earlier by

Mark Maunder. Mark Maunder indicated that presented research focused more on harvest strategy rather than reference points. Rick Deriso added that the staff has plans to propose a 2-year multiple-species MSE project as well. An Observer reiterated ISSF's support of projects 1 and 3, and suggested that with project 4, the IATTC is in good position to evaluate traditional versus non-entangling FADs, recognizing that substantial research has been conducted in multiple ocean systems on non-entangling FADs. A Member agreed that substantial work has been conducted on non-entangling and biodegradable materials supported by the EU industry, and noted that there had been contact between the IATTC staff and those carrying out this work.

The SAC also discussed the relative impact of entanglement in FADs in the EPO. A Member questioned the relative magnitude of importance of entanglement in FADs compared to the bycatch issue of setting on FADs. Guillermo Compeán indicated that last year the staff presented data on this issue, and regardless of the magnitude of this problem, that the staff already had a recommendation on this topic, and that there were plans to address the issue for the EPO. A Member and an Observer both confirmed that entanglement in FADs has been documented as a significant source of mortality in other regions for silky sharks, and they expressed support for this research effort in the EPO.

11. STAFF CONSERVATION RECOMMENDATIONS FOR 2015

11.1. Conservation of tunas

11.1.1. Yellowfin, skipjack, and bigeye tunas

The SAC considered the current proposed recommendation of no change in the duration of closures for 2015. Some Members noted that the increase in operative capacity for 2015 of 7.5% for the purse-seine fleet could suggest the need for more closure days. Rick Deriso explained that the improvement in the F multiplier would support a reduction in closure days, but that there was an offsetting effect from an increase in capacity of 7.5%, thus resulting in the same recommendation as last year and no change in the duration of closures, taking into account of a large confidence interval of the assessemnt.

Nicaragua asked what will be the effect to the Fmultiplier considered for the conservation measure as recommended by the Secretariat, after adding 7,000 m^3 to the current capacity. Rick Dersio replied that, after calculation, the effect is reaching a level of Fmutliplier = 1.0, that implies no change to the Resolution 13-01 is necessary. The staff recommendation of no change in the duration of closures is explained in the conservation recommendations report which states,

> "For yellowfin, the staff's conclusion from this year's assessment is that fishing mortality (*F*) is below F_{MSY}, the level corresponding to the maximum sustainable yield (MSY), as is indicated by the base-case point estimate for the *F* multiplier[1] of 1.11 (SAC-06-06, Table 1), which is slightly less than the 1.14 *F* multiplier for bigeye. The operative capacity of the purse-seine fleet is estimated to be about 7.5% greater in 2015 compared to the previous three-year average, which means that the yellowfin *F* multiplier, adjusted for capacity, is 1.03, and that the measures established in Resolution C-13-01 have had the intended effect of reducing the fishing mortality of bigeye and yellowfin to a level not exceeding the MSY. However, there is a considerable overlap between the target *F* multiplier of 1.0 and the 95% confidence intervals for the *F* multiplier of 1.03, indicating that the evidence supporting a conclusion that fishing mortality is below the level of F_{MSY} is not definitive. Nonetheless, the staff considers that the results support the continuation of Resolution C-13-01. Another factor supporting this is the stock assessment of yellowfin, which concludes that the base-case point estimate for the spawning stock is slightly below the MSY level for yellowfin (Table 1 of SAC-06-06)."

The Secretariat was asked to produce the calculated closure days corresponding to the adjusted F multiplier of 1.03, and that was found to be 52 days, but the original staff recommendation was intended to retain some buffer against uncertainty.

A Member suggested that the staff should also analyze the impact of the revised F multipliers on longline catch limit for bigeye as well because they are linked. There was also discussion of what to do with the longline limits if the conservation measure is now being driven by yellowfin rather than bigeye, since the catch of yellowfin in the longline fishery is minor. A Member favored careful consideration of the basis for not changing longline limits given an improved bigeye assessment and the fact that the purse seine measures are being driven by yellowfin. Rick Deriso noted that there was not much difference between the bigeye and yellowfin Fmultipliers.

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11.1.2 Pacific bluefin tuna

The SAC considered the 2015 recommendation on catch. One Observer asked for clarification on why the staff recommendation on catch was the same as 2014, even though no new assessment information was available. Rick Deriso explained that all of the staff models, even under a low recruitment scenario, predicted that the stock would begin to recover, barring a total recruitment failure. A Member suggested that the reductions in catch recommended for the EPO during 2014 and 2015 are relatively greater than those recommended for the WPO. In his opinion, there is cause for concern for the stock, given the very low biomass level which may make the likelihood of an increase in recruitment low.

The SAC recognized the importance of the development of integral measures for conservation and management of Pacific bluefin tuna along its entire distribution area in the North Pacific and not only in the EPO. Therefore, some Members highlighted the need to reduce the catch of already depleted adult fish based on the recent information of the possible very low recruitment in 2014 as well as the analysis conducted by the Secretariat in 2014 which suggested that the current adult PBF population could consist of a single cohort, thus vulnerable. In response, a Member noted that there are no adult PBF fisheries under the auspices of IATTC while WCPFC last year has introduced not only a strengthened control measures for juvenile, but also a catch limit for adult fish in addition to effort limit. He further pointed out that the ISC's projection in 2014 concluded that more strict measures to protect juvenile is necessary for the recovery of the stock, which is reflected in the current measures of WCPFC and IATTC. Based on the backdrop, he considered that the SAC was not in a position to make additional recommendations on PBF without new scientific information.

11.1.3 Northern albacore tuna

Rick Deriso indicated that the last assessment for northern albacore was done in 2014 in advance of SAC-05, and no new information was available to inform the staff.

11.2. Provision of Data

The SAC did not comment on this recommendation.

11.3. Harvest Control Rule

One Member indicated that while they agreed that the adoptoin of HCRs should be undertaken, they were concerned that this recommendatoin was premature in light of the fact that it has not been subjected to simulation analysis. However, others pointed out that the proposal was for an interim HCR and that such concern might be misplaced. It was also noted that the proposed HCR is based on the current unofficial operational management strategy. IATTC staff recalled that a similar HCR was proposed last year, but was not because it did not identify actions to be taken if the limit reference point is exceeded. Therefore, adoption this year could be fairly straight forward.

11.4. Conservation of silky sharks

Several SAC Members expressed support for this recommendation, while others had some problems with certain aspects of the recommendation. A couple of Members considered that a purse-seine measure for silky sharks was not warranted given that purse-seine catches were such a small part of the overall threats faced by this species. Additionally, concerns were expressed that the no rentention could not be justified as a conservation measure in the purse-seine fishery because of the low survival rate of silky sharks that have been sacked and brailed. Other Member expressed a different view that a no retention policy was still reasonable given the decline suggested by the available indicators, reasoning that even if only a small percentage of the released sharks survived, it was still a worthy conservation objective.

Some Members also felt that the application of closures to small, coastal vessels would not be politically and operationally viable and might also undermine efforts to secure their cooperation in the collection and provision of data.

Another subset of Members expressed difficulties with the recommendatoin of steel leader bans because such a masure was not focussed on the conservation of the silky sharks and would impact the ability to harvest other species for which elevated concerns do not exist.

Finally, in this context, a Member expressed the opinion that another measure that should be considered is a requirement that all sharks be landed with their fins natuarally attached, as has been discussed at previous Comission meetings. Costa Rica, Guatemala and Nicaragua made a proposal to modify Resolution C-05-03, so that in the fisheries under the aegis of the Convention the unloading of sharks with fins separated from the bodies is prohibited, allowing the unloading of the shark at the first port of unloading, when the sharks have their fins naturally attached, they may have partial cuts without separating them, thus allowing a better identification of the relationship between the body of the shark and its fins at the time of unloading. After the discussions and supports received, a Member expressed that it could not join the consensus since there is not sufficient scientific inofortmation to support such a proposal, resulting that the proposal was not approved.

Deffenders of wildlife congratulated proponents for the fins-attached proposal and presented a brief overview of the status of the silky shark and urged the Members of the SAC to draft a recommendation in accordance with the staff recommendations.

A member noted that the fishing industry had raised concernbs about baning steel leaders because of safety concerns.

11.5. Seabirds

One Member indicated that they could not support the recommendation to expand the area of coverage of the IATTC seabird measure because no information had been reviewed by the SAC that would support such an expansion. The IATTC staff recalled that such information had been provided by ACAP and Birdlife International within an informational paper and presentation considered by SAC05.

Another Member took issue with the recommended minimum standards because they interpreted them as requiring the number of bird scaring lines to two on large vessels and one on smaller vessels. However, it was noted that one streamer line should also be allowed for large vessels according to minimum standard from the ACAP advisory paper as well as minimum standards of other tuna RFMOs.

11.6. Handling of Mobulid rays in purse-seine fisheries

Guillermo Compean noted that this recommendation contained a list of best practices and that they should be forwarded to the Commission to decide how best to deal with them.

One Member stated that they could not support this recommendation because the SAC had not reviewed informaiton on mubulid rays and thus there was no scientific basis for making such a recommendation. The Director reminded the SAC that information on catch data, status and threats had been presented at

SAC5 and the staff considered it unecessary to repeat the same presentations again this year.

11.7. Handling of sea turtles in longline fisheries

The SAC did not comment on this recommendation.

11.8. Fishing gear configurations

The SAC did not comment on this recommendation.

11.9. Non-entangling FADs

The SAC did not comment on this recommendation.

11.10. Identification and marking of FADs

One Member commented that this is an important initiative that is related to two components; scientific and compliance, the latter of which is far from the role of this committee. He recalled that there have been a number of workshops and consultations in various regions exploring how to best accomplish this task and noted that IATTC should, at the very least, look to harmonize a system of FAD ID with WCPFC. This member proposed the creation of an ad hoc working group on FADs to assess the consequences for tuna fisheries and their ecosystems of the increasing number of FADs being utilized in EPO fisheries and other technological developments pertaining to FADs. This ad hoc working group would be of multi-sectorial nature, involving scientists, managers and the fishery sector. The working group would liaise with other tuna RFMOs regarding similar initiatives in other regions and would deliver its findings in time for the 2016 IATTC SAC meeting. The SAC shall develop TOR for this group, along the lines of those already adopted by other tuna RFMOs, for the consideration of the Commission.

A representative of ISSF remarked that they were keen to see this initiative move forward after many years of discussion and to that end could offer funding to the Commission to assissst accomplishing these tasks.

11.11. Observer coverage on longline vessels

Guillermo Compean introduced the recommendation and noted that the initial coverage rate of 5% was a good start, but that the ideal level of coverage would be 20%. Thus, the staff was recommending that the coverage rate be elevated to 20% until such time that enough information is available to justify further revision. The 20% coverage rate was based on the Hawaii longline observer program and the evaluations of NOAA that determine that 20% coverage allowed for the collectoin of good data on species with low encounter rates such as sea turtles.

A couple of Members commented that 20% coverage would be very hard to achieve due to logistical and budgetary constraints, and that even a step-wise increase to 10% coverage would be difficult particularly without a clear analysis of what percent coverage is necessary to improve data quality to a specific level.

Another Member recalled the ecosystem mandate that the SAC had been discussing the past few days and that it seemed imbalanced to have 100% observer coverage on large purse-seine vessels and to contemplate increased monitoring of FADs, but then resist a call for 20% coverage on longline vessels. Additionally, he aslo suggested that the Commission undetake a series of experiments to explore the feasability of using electronic observer equipment to supplement the onboard observer data from longline vessels.

12. OTHER BUSINESS

12.1. Capacity scenarios

Rick Deriso presented document SAC-06 INF-B on capacity scenarios.

Discussion

Following the presentation, one Member noted that that steepness analysis presented seemed very relevant and asked that the staff conduct such an analysis for bigeye tuna and yellowfin tuna and post the results in advance of the Commission meeting, as the impact to change in steepness is significant and might lead, in their opinion, to less pessimistic conclsusions. He also asked whether in formulating the length of closure to be recommended, whether there was consideration of time vessels need to spend in dock and the possibility that they take advantage of the closures to schedule work that would otherwise require them to be tied up. Rick Deriso replied that there was not independent consideration of that. All vessels require maintenance and repair at some time or another and the number of boats is much larger than the space avaialable for vessels needing repair, and so while some vessels no doubt take advantage of the closure to schedule work, many of them must still take additional time outside of the closure.

Colombia inquired whether there would be additional consideration of capacity scenarios relating to other long-term capacity requests that remain pending. Guillermo Compean indicated that while the staff are available to respond to any requests for analysis, this analysis was performed in response to specific direction from the Commission and Colombia additionally asked about the reasons for not analyzing management measures other than these closures in these scinarios presented. The Director responded that it is important that any additional requests must be specific in order to be analyzed, as the staff should not be put in a position to interpret a request which is not provided in a written form.

Kiribati asked if the current capacity analysis by the Secretarit is taking into account the effect el nino phenominon and the Secretariat responded that this year 1 / 4 of one US vessel capacity was added to operative capacty because of documented movement of the US vessel from western Pacific to east for 90 days. The SAC took note of one administrative matter, which is that the case of Guatemala and Venezuela are no longer considered a capacity dispute, but rather a pre-approved request that is now awaiting decisions on conditions for activation. Guatemala asked whether the staff could evauluate the conservation impact of a stipulation that activated vessels not be allowed to set on FADs, setting exclusively on breezes and in association with dolphins. Rick Deriso replied that such an analysis would not be helpful at this time because the conservatoin recommendations are currently being driven by the needs of yellowfin tuna rather than bigeye tuna follwing the most recent assessments. Thus, focussing efforts on dolphins sets would direct more efforts into the most vulnerable fishery. He also took the opportunity to prepare the SAC for the liklihood that the next round of assessments will produce different results because of the new spatial structures that will be used.

One Member expressed surprise some of the increases in vessel capacity that result from measurements of vessels, as in some cases it appears that the recorded capacity of the vessel nearly doubles. The Director recalled the specific s of the implementation of C-02-03 and that the initial cap was intended to reflect the capacity that was active in the fishery at tht point in time. Governments were supposed to work quickly to measure vessels and report confirmed capacities, but in practice, some of these efforts proceeded slowly and in some instances confirmed well volumes are still outstanding. Sometimes we see significant differnces from the original capacity estimates and the effect when the vessel is replaced or transfered their capacity, then the result is a change in the amount of active capacity. Another Member then asked whether the staff could compile a list of all of the capacity changes, increases and vessel substitutions for examination. The Director reminded the SAC that IATTC regularly send out notices of chnages in capacity of various vessels and that Members could reconstruct the histories of various vessels from those notices. He noted that the measure is now 13 years old and that the system of trading, management, splitting, well sealing, and vessel replacement had become extremely complex. Thus compiling a definitive accounting of all of the changes and transactions would be too large of a task for us to undertake.

12.2. Impacts of El Niño/La Niña

The SAC received a presentation on the impacts of climate change and variability on the tuna fisheries of

the EPO by Franklin Ormaza. Skipjack (*Katsuwunus pelamis*), yellow fin (*Thunnus albacares*) and albacore (*Thunnus alulunga*) tunas landed in the Eastern Pacific Ocean (EPO) countries and Ecuador were correlated to the Indexes Oceanic El Niño (ONI) and Multivariate Enso Index (MEI). The temporal series 1983-2012, and 1977-1999 (warm Pacific Decadal Oscillation, PDO), and 2000 – 2012 (cold PDO) were analyzed. Linear correlation showed that at least 11 % of the total landings were associated with the MEI, with a slightly negative gradient from cold to warm conditions. When non-linear regression (n=6), the R^2 was higher up to 0.304 (MEI, r= 0.551). The correlation shows high spread from -0.5 to +0.5 for both MEI/ONI; the highest landings occurred at 0.34-0.45; both indexes suggested that at extreme values <-1.0 and >1.1 total landings tend to decrease. Landings were associated up to 21.9 % (MEI) in 2000-2012, 1983-1999 rendered lower R^2 (<0.09); i.e., during cold PDO periods there was a higher association between landings and oceanographic conditions. For the non-linear regression (n=6) a R^2 of 0.374 (MEI) and 0.408 (ONI) were registered, for the 2000-2012, a higher R^2 was observed in 1983-1999, 0.443 and 0.711 for MEI and ONI respectively, suggesting that is better to analyze split series (198-1999, 2000-2012) than as a whole (2983-2012), due to noise produced by the transition from hot to cold PDOs. The highest landings were in the range -0.2 to 0.5 for MEI/ONI. The linear regression of skipjack landings in Ecuador gave an R^2 of 0.140 (MEI) and 0.066 (ONI) and the non-linear were 0.440 and 0.183 respectively. Total landings in the EPO associated to oceanographic could be used somehow as predictors of the high El Niño o La Niña. In a longer scale of time, the Pacific Interdecadal Oscillation also plays a role, suggesting that during cool period (2000-2030) there should be more tuna biomass in the water column, whilst in a warm period availability and biomass should be less.

Discussion

One Member noted that they had been conducting similar research and inquired about the correlation tests used, noting it seemed the presenter had used Pearson correlation tests, which assumes homogenous data, whereas they had used a Spearman correlation test because they had found their data to be non-homogenous. Franklin Ormaza reported a Pearson value of 0.8 and indicated that he is currently in the process of publishing his results

12.3. Virtual working group on Capacity

The Scientific Advisory Committee, received Bernal Chavarría in his capacity of Coordinator of the Virtual Group on Capacity established by the Commission at its 88th Extraordinary Meeting, with the aim of fulfilling the mandate of initiating the process of communication between that Virtual Group and the SAC. After making a presentation which is attached to the record of this meeting, regarding the nature, subject matter, background and objective of the Group as well as the expectations of the dialogue, in the context of being able to count on the input of the Scientific Advisory Committee in the search for solutions or guidance to the overall problem of capacity combining the effort of all the IATTC's bodies, Bernal Chavarría asked for comments or observations that he could transmit to the Commission on what he presented, without receiving contributions from any of the members of the Committee.

Discussion

There were no questions or comments following the presentation and the Director noted that the requirement for interaction between this working group and the SAC had been fulfilled.

12.4. Discussions related to the FAD fishery

12.4.1. Electronic observer equipment and methodology

A first presentation by EU reported on progress made in applying electronic monitoring systems on board tropical tuna purse seiners. In view of the recent advancements on the use of electronic monitoring systems for at-sea data collections, this initiative proposes that the tRFMOs work towards the definition of minimum standards for Electronic Monitoring Systems given that, according to recent analyses conducted, they can provide very useful information on fishing trips and be a complement to port

sampling and human scientific and compliance observer programs for tropical tuna purse seine fisheries.

Discussion

Guillermo Compean inquired as to who reviews the resulting video output. The presenter indicated that the footage is reviewed by trained personnel, but that they did not review all of the footage but through systematic sampling, as it is fairly straight forward to apply filters that allow reviewers to focus on times of active fishing operations.

The SAC also inquired about the potential for data loss during equipment failure, the costs of equipment and operation, and exactly what types of data could be expected from electronic observer systems. The presenter indicated that it was too early to provide answers to these questions. He noted that estimation of catch volume was pretty straight forward and that this equipment was a great way to monitor vessel activity, but the extent to which this technology will be useful in estimating catch composition, size and other parameters is still uncertain at this stage. He stressed that the EU does not consider this a tool that can potentially replace observers on purse-seine vessels, but rather a supplemental tool that can be used for a limited set of tasks where no observer is assigned.

An Observer from ISSF noted that this is a very active area of development and that there are currently trials in taking place on the WPO on both purse-seine and longline vessels.

12.4.2. Development of a code of good conduct for tuna purse-seine fisheries

A second presentation by EU was related to the common agreement for the application of good practices in the tropical tuna fleet (purse seiners and supply vessels) adopted by EU-Spanish tuna purse seiners organizations ANABAC and OPAGAC in 2012 The goal of this self-imposed initiative is to reduce the mortality by entangling or by incidental catch of FAD-associated sensible species (sharks, rays/mantas whale sharks and sea turtles). The good practices defined comprise the use of non-entangling FADs and the application of release operations for FAD-associated sensible fauna. In order to assess the actual level of application of these good practices in the fleet, a system of verification is being implanted in all the vessels of the ANABAC and OPAGAC fleets – i.e. 59 purse seiners and 19 supply vessels in April 2015, including both Spanish flags and other flags – operating in the Atlantic, Indian and Pacific oceans, in areas corresponding to 4 tuna RFMOs (ICCAT, IOTC, WCPFC and IATTC). This verification is based on in-situ registration of the good practices by observers. This implies a 100% coverage of the fleet by observers. The presentation showed the initial situation (October 2014) in terms of application of good practices, the training for crew and observers, and the first data of good practices observed in the Atlantic Ocean.

Discussion

In response to a question from a Member, the presenter indicated that they have a program that verifies conformity with these good practices through the use of observers who receive additional training for this purpose. They have developed a form that reflects the information they wish to gather and have been careful to not overload observers in this task. In some cases these are EU observers, but in other cases they work closely with the commissions or other fisheries authorities to train observers who may be deployed on EU vessels.

12.4.3. Evaluating biodegradable twines for use in FAD construction

A third initiative was presented by EU on evaluating potential biodegradable twines to attach the bamboo poles or other natural materials traditionally used by the EU fleet to build FADs. The core of the project is searching and testing biodegradable materials for use in drifting FADs. The project includes a study of biodegradable materials available on the market that can be used in floating objects. It will take into account the degree of biodegradability, price and market availability .The project foresees a first phase performing a controlled experiment , with the selected materials , to evaluate the resistance of the different biodegradable materials. And then carry out a real experience at sea.

Discussion

One Member asked what they have discovered in terms of the lifespan and durability of the materials they have tested. The presenter responded that the research has not yet concluded and so they do not yet have any of those statistics.

12.4.4. Acoustic discrimination of multispecies aggregations

The presentation by EU showed initiatives related to tuna species discrimination of echosounders of Fish Aggregating Devices (FADs) used by purse seine targeting tropical tuna, funded by ISSF. Many of FAD buoys are now equipped with echo-sounders in order to provide remote information on the aggregated biomass. Nowadays these biomass estimates are not accurate enough to provide information on species composition. Species discrimination at FADs to provide in situ and remote species composition, by using 3 echo-sounders operating simultaneously at 3 different frequencies (38 kHz, 120 kHz and 200 kHz) was investigated. Target Strength for Bigeye and Skipjack tunas were obtained for the different frequencies used and a frequency response mask created to discriminate between species. This work confirmed the potential of using multiple frequencies to discriminate between fish with swim-bladder (Yellowfin and Bigeye tunas) from fish without swim-bladder (Skipjack). More research is planned in the future to confirm these findings and assess the way in which electronic discrimination can assist purse seiners to minimize the catches of non-target species.

Discussion

A member of the IATTC staff noted that although the use of multifrequency echo-sounders has shown some promise in estimating species composition under FADs, the accuracy of such estimation s has not been validated by comparing to actual catch, and that that task becomes more difficult with large, multispecies schools. Evaluation of size composition is even more challenging and ultimately these tools may not prove to be useful for either purpose.

In response to an inquiry, the presenter said that the determinations of target strength had come from oceanic experiments on single species schools.

12.4.5. ISSF skipper workshops

Dave Itano from ISSF gave a brief presentation. He stressed that these workshops were an important opportunity to open two-way lines of communication with fishermen. In the search for solutions to bycatch problems and other challenges, it is important to not only communicate information to fishermen, but also to provide them with an opportunity to share their experiences regarding what works and what does not, as well as to receive creative ideas they might have on possible solutions to be investigated.

12.5. Recruitment models

An artificial Neural Network (ANN) model of yellowfin recruitment in the EPO was presented by Mishcel Dryfus of Mexico, aiming to understand the importance of PDO and SOI index as well as Spawners Biomass (SB). Quarterly data of those variables was used as input. The ANN was able to represent Recruitment with a correlation of 0.82. A sensitivity analysis showed that SOI index was the most important variable, followed by PDO and SB.

Another model was build based on temperature, current and wind speed but excluding biological data. The model fitted the data at the same level as the previous model. With this model it was possible to predict future recruitment thanks to data from the Geophysical Fluid Dynamics Laboratory that models future oceanographic conditions. In all the different scenarios that this laboratory has produced, the ANN model predicts an increase in average yellowfin recruitment (160-188 thousand tons) for the period 2015-2020 compared to recent past levels.

Discussion

Following the presentation, one Member suggested that the model could be renewed in 5-years time in

order to see how well the predictions hold up and the presenter agreed.

In response to another inquiry, the presenter confirmed that environmental variables in the model were lagged and recruitment estimated on a quarterly basis.

13. RECOMMENDATIONS OF THE SCIENTIFIC ADVISORY COMMITTEE

The Members of the SAC made the following recommendations (in no particular order):

1. The IATTC staff should create a form to guide Members in the submission of national reports.
2. Include in the agendas of future SAC meetings an item for a review of the SAC recommendations from the previous year, thus providing the SAC with an opportunity to track progress and outcomes, where applicable.
3. The IATTC should establish a data collection program for fishing vessels smaller than 24 m length overall.
4. Establish an IATTC program for collecting and processing data in the fisheries covered by the Convention, in order to standardize and systematize the handling of information and enable the reduction of the levels of uncertainty about the impact of the fisheries on species associated with tunas.
5. All documents and presentations prepared for a meeting of the SAC should be available one week before the meeting.
6. The SAC welcomes initiatives such as those pursued under the FAO-GEF project on sharks, and recommends that these efforts continue and be expanded upon in order to improve data collection, cooperation, and capacity building.
7. The Commission should continue and strengthen its cooperation with the WCPFC so as to ensure the recovery of Pacific bluefin tuna through the management of both juvenile and adult fish.
8. The Commission should strengthen the work on FADs by holding a meeting involving managers, scientists, and other stakeholders.
9. The Commission should consider requiring all the Members with fleets catching sharks, skates, and rays in the region to collaborate and cooperate with the staff by providing detailed statistics that will allow the staff to conduct a comprehensive ecological risk assessment of the main species of pelagic elasmobranchs.

14. MEETING REPORT

The meeting report was adopted.

15. ADJOURNMENT

The Meeting was adjourned at 5:00 PM on 15 May 2015.

Appendix A.

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Appendix B.

INTER-AMERICAN TROPICAL TUNA COMMISSION

89TH MEETING

Guayaquil, Ecuador
29 June to 03 July, 2015

DOCUMENT IATTC 89-04d

RECOMMENDATIONS BY THE STAFF FOR CONSERVATION MEASURES IN THE EASTERN PACIFIC OCEAN, 2015

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

A. CONSERVATION OF TUNAS

The staff's recommendations are based on its assessment of bigeye tuna (Document SAC-06-05) and yellowfin tuna (Document SAC-06-06), which are updates of the 2014 assessments.

For yellowfin, the staff's conclusion from this year's assessment is that fishing mortality (F) is below F_{MSY}, the level corresponding to the maximum sustainable yield (MSY), as is indicated by the base-case point estimate of 1.11 for the F multiplier[2] (SAC-06-06, Table 1), which is slightly less than the 1.14 F multiplier for bigeye. The operative capacity of the purse-seine fleet is estimated to be about 7.5% greater in 2015 compared to the previous three-year average, which means that the yellowfin F multiplier, adjusted for capacity, is 1.03, and that the measures established in Resolution C-13-01 have had the intended effect of reducing the fishing mortality of bigeye and yellowfin to a level not exceeding the MSY. However, there is a considerable overlap between the target F multiplier of 1.0 and the 95% confidence intervals for the F multiplier of 1.03, indicating that the evidence supporting a conclusion that fishing mortality is below the level of F_{MSY} is not definitive. Nonetheless, the staff considers that the results support the continuation of Resolution C-13-01. Another factor supporting this is the stock assessment of yellowfin, which concluded that the base-case point estimate for the spawning stock is slightly below the MSY level for yellowfin (Table 1 of SAC-06-06).

[2] The ratio of the current fishing mortality ($F_{current}$, defined as the average fishing mortality for the three most recent years (2012-2014)) to the fishing mortality that will produce the maximum sustainable yield (F_{MSY}). An F multiplier of 1.0 means that $F_{current} = F_{MSY}$; if it is below 1.0, fishing mortality is excessive ($F_{current} > F_{MSY}$)

As of 19 April 2015, the capacity of the purse-seine fleet operating in the eastern Pacific Ocean[3] (EPO) was 236,089 cubic meters (m^3) of well volume, which is above the three-year (2012-2014) average of 219,634 m^3. Consequently, the duration of closures of the fishery cannot be reduced on the basis of a reduction in fleet capacity.

YELLOWFIN, SKIPJACK, AND BIGEYE TUNAS

The staff recommends maintaining Resolution C-13-01 for 2016.

PACIFIC BLUEFIN TUNA

A new assessment of Pacific bluefin tuna was completed in 2014. Projections in which Resolution C-12-09 was extended into the future, as well as the newer forecasts in IATTC-87 INF-B, called for some reductions of catches in the western Pacific, indicating that these would likely lead to increases in stock abundance, provided recruitment continues at average levels. For a low-recruitment scenario, more similar to the most recent years of recruitment estimates, juvenile catches in the EPO lower than those specified in Resolution C-12-09, and greater reductions in juvenile catches in the western Pacific, are required. Resolution C-14-06, adopted in 2014, provides for such a reduction, as does the recent measure adopted by the WCPFC (CMM-2014-04).

NORTHERN ALBACORE TUNA

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

B. PROVISION OF DATA

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

C. HARVEST CONTROL RULE

The staff recommends the following interim harvest control rule:

1. Management measures for the purse-seine fishery, such as closures, which may be fixed for multiple years, will ensure that the fishing mortality rate (F) does not exceed the best estimate of the rate corresponding to the maximum sustainable yield (F_{MSY}) for the species that requires the strictest management.
2. If the probability that F exceeds the limit reference point (F_{limit}) is greater than 10%, management measures that have a probability of at least 50% of reducing F to the target level (F_{MSY}) or lower, and a probability of less than 10% that F will exceed F_{limit}, will be established as soon as is practical.
3. If the probability that the spawning biomass (S) is below the limit reference point (S_{limit}) is greater than 10%, measures will be established that have a probability of at least 50% of rebuilding S to the target level (dynamic S_{MSY}) or greater, and a probability of less than 10% that S will fall below S_{limit} within a period of two generations of the stock or five years, whichever is greater.
4. For other fisheries, management measures will be as consistent as possible with those for the purse-seine fishery.

Further evaluation of this harvest control rule and alternatives will be conducted, so that a permanent harvest control rule can be adopted.

D. CONSERVATION OF SILKY SHARKS

An attempt to assess the status of the silky shark in the EPO using conventional stock assessment models

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

has been severely handicapped by major uncertainties in the fishery data, mainly regarding catch levels in the early years. An alternative scientific basis for precautionary management advice is urgently needed and, for that purpose, a suite of stock status indicators (SSIs) have been proposed (Document SAC-05-11a). For the northern stock, catch per set, the main indicator, shows an initial sharp decline over a wide spatial range (1994-1998), followed by a period of stability (1996-2006), and possibly increase (2006-2010). However, there are indications that any such increase has been reversed in recent years (2010-2013). For the southern stock, this indicator shows a sharp decline during 1994-2004, followed by a period of stability at much lower levels. Updated indicators that include data for 2014 show a recent increase for both northern and southern stocks (SAC-06-08b); However, this may be the result of increased availability, rather than abundance, of silky sharks due to a transition to a period dominated by positive (warmer than average) SST anomalies, which were felt in 2014 and have become stronger towards 2015. The staff maintains its belief that fishing mortality needs to be reduced in order to promote rapid rebuilding of silky shark stocks in the EPO; therefore, it reiterates its previous recommendations:

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

E. SEABIRDS

The Commission should revise Resolution C-11-02 consistent with the current state of knowledge

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

regarding seabird mitigation techniques, as described in document SAC-05 INF-E[6]. The two-column menu approach in C-11-02 should be replaced by a requirement to use at least two of the following three mitigation methods in combination: line weighting, night setting. and bird-scaring lines. Other mitigation methods should not be endorsed until their effectiveness is proven. The three recommended mitigation measures should, at the very least, specify the minimum standards in Appendix I.

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

F. HANDLING OF MOBULID RAYS IN PURSE-SEINE FISHERIES

The Commission should :

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

G. HANDLING OF SEA TURTLES IN LONGLINE FISHERIES

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

The Commission should also adopt the following additional measures:

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

[6] Prepared by ACAP and Birdlife International

board and assisted in a manner consistent with methods described in the FAO's Guidelines to reduce sea turtle mortality in fishing operations and in the materials on the IATTC website.

H. FISHING GEAR CONFIGURATIONS

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

I. NON-ENTANGLING FADS

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

J. IDENTIFICATION AND MARKING OF FADS

In accordance with Resolution C-13-04, FADs with satellite buoys deployed after 1 January 2015 must be marked, and the staff maintains the recommendation submitted to the Commission in 2014, which contained two options:

1. As a first option, vessels should authorize the companies that operate the satellite systems used to track the FADs to provide to the IATTC, directly or through whatever mechanism the governments and vessel owners consider suitable, the positions of each buoy from the time of deployment until it is recovered, with a time lag of four months to protect the owner's proprietary information.
2. A second option would be that FADs with satellite buoys be marked on the upper surface with a five-digit numeric code, at least 50 mm high, in such a way as to avoid covering the solar cells used to power the equipment while allowing the best visibility possible by the observer on the vessel. If the observer cannot read the code from the vessel, a crew member should provide the code to the observer. IATTC staff at the port of departure will assign the codes for each trip, with enough notice to allow for the painting of the buoys. The observer will record the location of deployment and code of each marked buoy.

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

K. OBSERVER COVERAGE OF LONGLINE VESSELS

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

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

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

1. Branchline weighting configurations should consist of weights greater than 45 g attached within 1 m of the hook, or weights greater than 60 g attached within 3.5 m of the hook, or weights greater than 98 g weight attached within 4 m of the hook. Positioning the weight further than 4 m from the hook should not be deemed adequate.
2. All setting of longlines should be started and completed between nautical twilight and nautical dawn.
3. On longline vessels greater than 35 m length overall, two bird-scaring lines should be deployed in a configuration that maximizes their aerial extent, but with a minimum aerial extent of 100 m. Lines should be attached to the vessel at a height of at least 8 m above the water at the stern. Streamers should be brightly colored, a mix of long and short (<1 m), placed at intervals of no more than 5 m, and attached to the line with swivels that prevent streamers from wrapping around the line. All long streamers should reach the sea surface in calm conditions. Baited hooks should be deployed within the area bounded by the two bird-scaring lines, and bait-casting machines should be set so that the baited hooks hit the water within that area .
4. On vessels of less than 35 m length overall, a single bird-scaring line should be deployed in a manner that maximizes its aerial extent, but with a minimum aerial extent of 75 m. Lines should be attached to the vessel at a height of at least 7 m above the water at the stern. Streamers should be brightly colored and attached to the line with swivels that prevent streamers from wrapping around the line. Short streamers (<1 m) should be placed at 1-m intervals along the entire length of the aerial extent. Longer streamers at 5-m intervals along the first 55 m of aerial extent, to complement the short streamers, could be added at the vessel's discretion. All long streamers should reach the sea surface in calm conditions.