INTER-AMERICAN TROPICAL TUNA COMMISSION

SCIENTIFIC ADVISORY COMMITTEE

SEVENTH MEETING

La Jolla, California (USA)

09-13 May 2016

REPORT OF THE MEETING

CONTENTS

The 7th Meeting of the Scientific Advisory Committee was held in La Jolla, California, USA, on 9-13 May 2016. The attendees are listed in Appendix A.

1. OPENING OF THE MEETING

The Director and Chairman, Guillermo Compean welcomed the participants and noted that a quorum had been achieved for the meeting.

Julio Guevara (Nicaragua) agreed to serve as rapporteur.

2. CONSIDERATION OF AGENDA

The following additional issues were identified for their consideration within the agenda:

- Review of Status of SAC Recommendations from 6th Meeting of the SAC
- Format for submission of longline data pursuant to C-11-08
- Guatemala and Venezuela capacity request

Another issue was also identified but could not be addressed during the meeting (Table of the evolution of SAC recommendations)

3. THE FISHERY:

3.1. The fishery in 2015

Nick Vogel reviewed the information on the fishery for tunas in the Eastern Pacific Ocean (EPO) in 2015. He discussed EPO tuna catch statistics, 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 2015 of 641,000 metric tons (t) were about 14% higher than the average of catches for the previous 15 years. The 2015 catch was the highest in the last 30 years, with the exception of the record catches of 715,000 t in 2003.

Ecuadorian vessels caught about 47% of the total EPO purse-seine tuna, including 64% of the skipjack and 69% of the bigeye. Mexican vessels caught 21% of the total EPO purse-seine tuna, including 43% of the yellowfin and all of the bluefin.

The number and type of purse seine sets were similar to 2014, except for an unusual increase in the number of sets on unassociated schools north of French Polynesia, and an increase of sets on unassociated schools along the coast of southern Peru.

Most yellowfin catches in 2015 were taken north of the 5°N latitude in sets associated with dolphins, and in the area between Galapagos and the coast of the Americas in all three types of sets. Though yellowfin in unassociated schools is typically found closer to shore, moderate catches were found far offshore around the 135°W longitude south of the equator. As in previous years, smaller amounts of yellowfin were caught in the southern EPO mainly in sets on floating objects. The total yellowfin catch of 245,000 t in 2015 was 10% higher than the average of the previous 5 years.

Most of the skipjack catch in 2015 occurred south of the 5°N latitude in sets on floating objects and inshore unassociated schools. The area off the coast of Peru produced the greatest skipjack catches, which were higher than in previous years. The increase in unassociated school sets north of French Polynesia also contributed to the increase of skipjack catch.

Total skipjack catch of 329,000 t in 2015 was 33% higher than the yearly average of the previous 5 years, primarily due to increased catch in unassociated tuna sets.

The bigeye catch distributions in 2015 were very similar to the average annual distributions for 2010-2014 throughout the EPO. The majority of the bigeye catches occurred between 10°N and 15°S latitude from sets on floating objects. Bigeye catches in 2015 of 63,000 t were 9% higher than the 2010-2014 average.

The length-frequency and species-composition sampling program was reviewed, along with a description of the areas defined for stock assessments and statistics of the number of wells sampled. Of the 958 wells sampled for length frequency and species composition in 2015, 686 contained yellowfin, 628 contained skipjack, and 209 contained bigeye. The average weight of yellowfin in 2015 of 9.0 kg was lower than any of the previous 5 years, much less than the high of 13.3 kg in 2012. The average weight of skipjack in 2015 of 1.9 kg was also lower than any of the previous 5 years. The average weight of bigeye in 2015 was also the lowest at 4.7 kg, significantly lower than the highest average weight of 8.0 kg in 2011.

PBF catches by purse seine vessels in the EPO in 2015 were 3,168 t. The catches fluctuated over the last few years due to conservation measures in place which limit yearly catch. Excess PBF catch in one year leads to a lower catch limit in the next year. 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

In answer to a question about whether vessels smaller than 24m length should be included in the scope of data provision requirements, the Director noted that pursuant to Resolution C-03-05, CPCs are required to submit, at a minimum, annual catch data for all vessels fishing for species under the purview of the Commission. The participants discussed the difficulties for some countries to comply with these requirements, given the wide range of size and sophistication among the various vessels and national fleets and the difficulty in recording landing catches at an unknown number of locations throughout IATTC coastal nations. Alexandre Aires-da-Silva noted that the challenges associated with collecting data from small longline fleets will be addressed in detail under Agenda Item 6(b)(ii), and he also highlighted the importance of such data because these vessels are responsible for the majority of shark catches in the EPO. It was suggested that these uncertainties and other data gaps should be addressed in ecological risk assessments.

3.2. National reports

The Director noted that oral presentations regarding national reports remain optional. He noted that the national reports submitted to date are available on the SAC07 meeting web page, and that 10 Members had made annual submissions, mainly of their longline observer programs. The Director then opened to floor to any Members wishing to address the SAC.

The European Union then gave a brief presentation on i national report. In answer to a question about which ports are used by EU longline boats operating in the Pacific and targeting swordfish the European Union responded that these vessels utilize WCPO ports.

Venezuela indicated that it had prepared a national report, but that it was not sent prior to the meeting. It then gave an oral summary of its national report.

3.3. Longline observer program reports

This topic was covered under the previous agenda item regarding national reports. Members proposed that a format for observer forms should be made available so that observers can record data. The Director noted that, pursuant to Resolution C-11-08, paragraph 5, such forms and corresponding manuals were already available on the IATTC website in both English and Spanish and welcomed SAC review and comments on these documents. Members also noted that paragraph 7 of the same resolution also instructs the SAC to create and approve a format for the submission of longline data collected by CPCs to the Commission for incorporation into the Commission database and the Director welcomed SAC comments onsuch format. The Director also indicated that what should be submitted to the Commission is the raw data that has been collected and noted that such data would be protected under the relevant rules of data confidentiality that have been approved by the Commission. The SAC subsequently addressed these matters further under agenda Item 10, Other Business.

3.4. The fishery on FADs in the eastern Pacific Ocean

Martin Hall presented an updated information on the fishery on fish-aggregating devices (FADs) in the EPO.

The effort by Class-6 vessels has continued increasing, and 2015 was a record year. Most of the increase was in the number of FAD sets. The number of FADs retrieved used to follow very closely the number deployed, but in recent years a gap has developed; the difference included both active FADs in the water and lost ones. The use of technology on the FADs is increasing, particularly that of echosounder buoys which are now deployed in almost 70% of the FADs because they produce higher catches. The median number of FADs deployed by the average vessel has remained at about 100, but a few vessels deploy over 500 FADs per year. The vast majority of sets are made very early in the morning, the same pattern observed in previous years. A noticeable change has been the lengthening of the net hanging under the FAD; the median is higher, with some exceeding 60 m. This change might relate to the depth of the thermocline at a given location, so more sets in regions with deep thermoclines may drive the boats to use deeper components, but more investigation into this question was warranted.

The location of FAD deployments through the year continues the patterns observed before, but the seeding of FADs in the Humboldt area, off Peru, now starts earlier than before, in October. Discards of the main target species have almost disappeared due to more utilization, higher prices, and a ban on discarding. Bycatches of the main non-tuna species have also continued to decline with a few exceptions that haven't found a market yet. The changes in areas of deployment of FADs, show three basic regions, that have different catches (in both species and sizes) and seasons. Some additional studies were performed taking into account the regional differences.

Another area of exploration was the change in Catch Per Positive Set, CPPS, (sets with greater than 0.5 t capture), and how it changed over the years and with the increase in the number of FADs. For the total tuna catches (of all three main tropical tuna species), there were clear, significant declines in the Galapagos and Humboldt regions, and a probable decline in the Equatorial region. These declines could be a result of the increase in the density of FADs, of environmental or ecological factors, of changes in soak time (shorter soak times before setting, fewer schools associated), or of real changes in abundance. Several approaches were used to explore these hypotheses, including the simplification of the catches (fewer species, fewer size classes).

<u>Hypotheses for the decline in CPPS</u>

CPPS is not a measure of CPUE in the traditional sense that is used as an index of abundance. It is mostly an "ecological index" perhaps related to prey abundance, productivity, etc., or it could be a measure of the "encounter rate" between tuna schools and FADs.

a. With many FADs in an area, there are many "attractors" for the tuna schools. In the past, perhaps two, three or more schools converged on the same FAD. Now, fewer schools per FAD is the norm.
b. Schools are smaller because of ecological or environmental changes (e.g., prey abundance, thermocline depth)
c. Soak times are shorter. FADs are set on sooner than in the past, so schools don't have time to accumulate.
d. Smaller schools reflect lower abundance of one or more species

There i currently no conclusive evidence in support of any of these hypotheses, and a comprehensive model is needed.

<u>Discussion</u>

If the numbers of FADs deployed and FAD sets continue to increase, one Member asked what implications and trends might this have? For example, does the higher number of FADs mean that the resources are now distributed into a larger number of units, but at a lower density? Does the increase in the number of FADs equate to an increase in the effective fishing effort? Hall responded by noting that a decade ago, the FAD fishery tended to be more distant from shore and boats had to travel long distances from port to fish. The increased number of FADs and the placement of FADs closer to the coast means that vessels could now make more sets per trip without increasing trip duration. However, the corresponding impact is not obvious. Regarding the impact of the increasing number of FAD sets on the resources, especially juveniles, Japan commented that the Commission should adopt measures to limit the number of FAD sets at the current level. It also stated that the uncontrolled number of FAD sets is a serious issue not only for longline fisheries but also for purse seine fisheries targeting large size fish.

Members discussed the increased number of FAD sets in the Humboldt current system off Peru and the ratio of unassociated school sets to FAD sets. Hall suggested that at least part of the explanation likely may lie in the recent El Niño event and the shift towards favorable FAD fishing conditions.

Several Members expressed concern about the impacts to resources resulting from the expansion and evolution of FAD fisheries in the EPO. One Member expressed concern that unless port sampling was able to distinguish between catches resulting from FAD sets and those from unassociated school sets, the true impact of the FAD fishery might not be accounted for. The Director indicated that the sampling method used by IATTC staff was to identify wells for sampling that contained catch from a single set type. Thus the data collected is always set-type-specific. One Member suggested that increasing the sampling of smaller purse-seine vessels should be a priority as most of sampling was conducted on Class-6 vessels, and that finding wells with uniform set content becomes harder with decreasing vessel size. . Another Member reminded the SAC that the total weight of FAD catches, while considerable, does not describe the full conservation impact of this fishery because many of the fish caught are smaller in size, and thus represents the removal of a much larger number of individuals than the corresponding weight taken in other fisheries.

Another Member noted that attempts to reliably determine the relative size species composition of aggregations under FADs using acoustic instruments have not yet been successful. However, it was noted that increasingly, there seems to be some realization that species composition under FADs varies by time, and that some species tend to arrive after 6:00 AM.

In response to SAC requests, the Director presented updated information on purse-seine capacity trends over time and on the sources of recent increases in active capacity in EPO purse-seine fisheries. He first presented figures showing how operational capacity in the EPO varies by month. He then noted that in 2015 there was a further increase in operational purse-seine capacity compared to previous years and that specifically, there has been an increase in the number of Class-6 purse-seine vessels in the EPO since 2013. Since 2013, operational capacity in the EPO has increased from approximately 212,000 cubic meters to approximately 248,000 cubic meters. The Director then described the relative amounts of this increase due to the entry of newly constructed vessels, and re-entry of vessels with a history of EPO fishing. Many Members welcomed this information and asked that the figures presented be updated to reflect what reflect what had been explained and that the result be made available for the meeting of the Working Group on Fleet Capacity immediately following the 7th Meeting of the SAC.

4. MODELLING:

4.1. Correction of longline length-frequency database

Keisuke Satoh (National Research Institute of the Far Seas Fisheries, Japan) presented the paper "An exploration into Japanese size data of tropical tuna species because of a prominent size-frequency residual pattern in the stock assessment model" (SAC-07-03d). Previous stock assessments of bigeye tuna in EPO have shown a prominent residual pattern in size frequency for the Japanese longline fishery. Therefore, collaborative work between IATTC and Japan was carried out to address the issue. In preliminary investigations, similar differences in size composition were also detected for yellowfin tuna. The length-weight conversion procedures used prior to the shift. are described in Appendix B of his paper, but some older conversion tables were never published and are not available.

Three hypotheses to explain this size-composition shift were developed: 1) changes in Japanese longline fishing strategies, such as selection of fishing ground and/or fishing season between the two periods (pre- and post-1990), 2) development of new fishing gear that affected the sizes of tuna caught around 1990, and

3) change in the size data collecting and reporting system around 1990.

Regarding the first hypothesis, the number of hooks of the Japanese longline fishery in the EPO had reached its highest historical level in 1991, after which it decreased, showed some fluctuations, and the effort of the fishery became more concentrated in specific areas. However, the shift of the size composition occurred in all areas for both species, and thus the change in the spatial distribution of effort is not considered to have caused the shift. The difference in the seasonality of the effort between the two periods (pre- and post-1990) was less than 1%, which indicates that the fishing schedule by quarter had not changed around 1990.

As for the second hypothesis, mainlines made of nylon began to be deployed around 1990 by smaller Japanese longline vessels operating in the vicinity of Japan, and their use spread rapidly throughout this fishery. However, the new gear was unlikely to be popular with the larger longline vessels in the EPO around 1990, according to interviews with fishermen and given that logbook data show that the proportion of longline sets using nylon mainlines was only about 50% in 1994. In addition, there was no strong evidence that the material of the main line affects the fish size caught.

Regarding the third hypothesis, there were two items to be investigated, the vessel type (commercial and training vessel) and the unit of fish size (weight and length). Although the average size of fish caught by the commercial vessels was in many cases larger than those of the training vessels, the ratio of sample size by vessel type was similar between the two periods (prior- and post 1990). Therefore, the difference in fish size by vessel type did not directly affect the size composition shift in 1990. However, it is important to update the Japanese longline size data with the information about the vessel type for modeling the fishery's selectivity, since there are clear differences in size composition between the vessel types.

As for the other component of the third hypothesis, until 2010 the raw weight data were converted to length before being submitted to the IATTC from Japan. The average fish lengths converted from the weight group were smaller than those of the length group in many cases, which indicated that the weight-length conversion caused an underestimation of fish size. The number of length measurements increased after 1990 for both species, and exceeded, or was equal to, the number of weight measurements in 1991, and since then the length measurements has predominated. However, the changes of the average weight for both species did not present a clear shift in 1990. This indicates that the shift in size composition in 1990 for both species is unlikely to represent a real change in fish size. The combined effects of the change in the data-collecting system and the underestimation of fish size from the weight-length conversion probably lead to an artificial shift in the size composition. It is important to update Japanese size data with the information about the unit of measurement. The informative size data is useful for investigating the previously-developed stock assessment models with two time blocks, fishery definitions, and selectivity.

Discussion

Members and the IATTC staff expressed appreciation for this successful collaborative effort, and highlighted its importance for assessments of yellowfin and bigeye tuna.

In a discussion about the differences between the Japanese training vessel and commercial vessels, Satoh responded that training vessels operated in a localized area near the Hawaiian Islands, and that this resulted in the difference in length composition when compared to the commercial fleet. One Member noted that prior to 1970, there was no data difference between training vessels and commercial vessels, but that after 1975, differences became apparent, but it was not known with certainty if there were differences among gear used or fishing protocol. It was then recalled that the difference between those two types of vessels would also be addressed in the next presentation. Regarding the possible differences in catches and selectivity between the training and commercial boats, Satoh noted that, on commercial vessels, the procedure was to collect data from five fish per set, whereas on training vessels data was collected from all tuna and that this could have had some impact. Data on catch and effort (with hooks per basket information) that will be provided to the IATTC will only come from the commercial boats and will not include the training vessels. No information was available regarding any changes in the amount or types of bycatch that might have resulted from the changes in fishing gear and materials used.

4.2. Sensitivity of the bigeye and yellowfin models to changes in size -frequency data

Carolina Minte-Vera presented the document "Changes in longline size-frequency data and their effects on the stock assessment models for yellowfin and bigeye tunas" (SAC-07-04a). Integrated statistical age-structured stock assessment models (Stock Synthesis 3 models, SS3) are used to assess the stocks of yellowfin and bigeye tuna in the eastern Pacific Ocean (EPO). Of the many pieces of information that the models require, length-frequency data for the longline fleets are among the most essential. For both species, the main indices of abundance are the standardized CPUE of the longline fleets. The length-frequency data indicate the sizes selected by the longline fisheries. Since there are no age-frequency data, the length-frequencies, via a growth curve, inform the model about the ages that comprise the relative abundance indices. In addition, for bigeye tuna, the longline fisheries were the main fisheries until the mid-1990s, when the purse-seine fisheries on fish-aggregating devices (FADs) commenced.

In recent years, about a third of the bigeye tuna catches is taken by longliners. The IATTC has traditionally used the length-frequency data for the Japanese fleet to represent the longline fleets in the models. A pattern was evident in the length-frequency data, mainly for bigeye tuna, which consisted of smaller fish being caught prior to 1990 and larger fish thereafter. This pattern resulted in positive residuals for smaller fish before 1990 and negative residuals afterwards. Japan and the IATTC staff collaborated to investigate the possible causes of this pattern. The conclusion was that it appeared to be caused by a combination of converting the raw gilled-and-gutted weight data to fork length and complementing the length-frequency data for the commercial fleets with observations taken from training vessels. Subsequently, Japan submitted the unconverted data by vessel type (commercial and training) to the IATTC. The data are available now as originally measured, *i.e.* as fork length or gilled-and-gutted weight.

The document explored the best way to incorporate the new size-frequency data into the stock assessment models for yellowfin and bigeye in the EPO. The provision of raw size-frequency data for the Japanese longline fleets, with information on the type of vessel of origin, represents a great advance towards improving the stock assessments of yellowfin and bigeye in the EPO. The striking residual patterns for bigeye in the former stock assessment models, which consisted of positive residuals for small length classes in the early years and for larger classes in the later years, are very likely to have resulted from the mixture of data types and how the proportion of each type changed over time. The gilled-and-gutted weight data require converting in order to be used in the stock assessment, but any conversion is likely to introduce further bias and uncertainty. The size-composition data was included in the SAC 6 base case models for yellowfin and bigeye tunas. The runs designed to mimic the SAC Base Case models produced the same results as with the new data sets for yellowfin tuna and more optimistic results for bigeye tuna. The converted weight-frequency data do not seem compatible with the length-frequency data for the same fisheries and species. The average weight from the weight-frequency data tends to be lower than expected by the models that also incorporate length-frequency data and assume the same selectivity for both data types.

For yellowfin, the management quantities were more optimistic when the weight-frequency data were excluded or when their effect was minimized by assuming a different selectivity function for them. The biomass trajectories are very similar for all model configurations that had different combinations of size-composition data and selectivity assumptions.

For bigeye, the largest difference in management quantities was obtained when the assumption of two time periods for each longline series was replaced by assuming one series for the whole time period with the same catchability and selectivity. This new assumption was justified by the fact that the residual pattern that motivated the inclusion of the time blocks was likely an artifact of the mixture of incompatible data types used to compose the longline length frequencies that were used in the stock assessment model. The training vessel length-frequency data do not represent the commercial fleet well, and should not be used for that purpose. Since the training-vessel length frequencies are on average smaller those from commercial vessels, it may have information that can be used for estimating temporal variation in recruitment, for example. For bigeye, time blocks for the longline fleets should be removed and the CPUE series be treated as one continuous series from 1975 to the present, as the temporal residual pattern that motivated the inclusion of the blocks is likely artificial. The size-frequency data for the longline fleets should be entered in the stock assessment models for bigeye and yellowfin as follows (1) base-case model: length-frequency of the commercial fleet, and length-frequency of the training vessel fleet treated as a “survey” with its own selectivity function (survey is the term used in SS3 for a fishery with no catch associated with it, which allows flexibility in the modelling of these size-composition data); no time blocks in selectivity or catchability of the standardized CPUE longline series; (2) Sensitivity model: as for the base-case model. Preferably, a conversion factor specific for the EPO should be developed; (3) Data weighting: the weighting for the length- and weight-frequency data should be reevaluated before adopting a model to be used for management advice.

Discussion:

In answer to why a sensitivity analysis using the weight-composition data was not included in the assessments, Minte-Vera replied that there is not a conversion factor from gilled-and-gutted data to weight or length data specific for the EPO at this time and using the Pacific Ocean conversion may bias the results as the fish of both species in the EPO are larger than in the WCPO.

One Member commented that a similar situation was found in the Indian Ocean where the training vessel length-composition data was on average smaller than the commercial length-composition data. It was for a fleet of another flag (not Japan). They found that the data for commercial vessels did not include the smaller sizes for commercial reasons, not due to selectivity. The commercial vessels also caught smaller fish. This possibility could be investigated for the Japanese fleets in the EPO.

5. STOCK ASSESSMENTS:

5.1. Bigeye tuna: assessment for 2015

Alexandre Aires-da-Silva presented a summary of the bigeye tuna assessment for 2015.

1. The assessment of bigeye tuna in the eastern Pacific Ocean (EPO) in 2015 is similar to the previous assessment, except that separate series of length-frequency data for Japanese longline commercial and training vessels are now available, and both were used in the assessment.
2. The results of this assessment indicate a recovering trend for bigeye in the EPO during 2005-2009, subsequent to IATTC tuna conservation resolutions adopted since 2003-2004. However, although these resolutions have continued to be adopted afterwards, the rebuilding trend was not sustained during 2010-2012, and the spawning biomass ratio (SBR) gradually declined to a historically low level of 0.16 at the start of 2013. This decline may be related to a series of recent below-average recruitments which coincided with a series of strong La Niña events. More recently, the SBR is estimated to have increased slightly, from 0.16 in 2013 to 0.20 at the start of 2016; 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. There is uncertainty about recent and future levels of recruitment and biomass. At current levels of fishing mortality (F), and if recent levels of effort and catchability continue and recruitment remains average, the spawning biomass (S) is predicted to continue rebuilding and stabilize at about 0.22, above the level corresponding to the maximum sustainable yield (MSY) (0.21).
3. The recent fishing mortality rates are estimated to be below the level corresponding to MSY, whereas recent spawning biomasses are estimated to be slightly below that level. These interpretations are uncertain and highly sensitive to the assumptions made about the steepness parameter (h) of the stock-recruitment relationship, the weighting assigned to the size-composition data (in particular to the longline size-composition data), the growth curve, and the assumed rates of natural mortality (M) for bigeye.
4. The following topics should be a priority in future research into the bigeye stock assessment:

a. Investigation of the causes of model misspecification responsible for the two-regime recruitment pattern in the bigeye assessment (average length of the oldest fish in the model (L_2), natural mortality, others).
b. Formulation of a growth curve that is more representative of the data.
c. Weighting of the different data sets.
d. Fishery definitions.
e. Stock structure. The IATTC staff will continue collaborating with the Secretariat of the Pacific Community (SPC) on a Pacific-wide assessment of bigeye. This will incorporate 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 the Western and Central Pacific Ocean (WCPO).

Discussion

A Member noted that in the data weighting CPUE for the base case, there was a strong increasing trend which is also mirrored in the WCPO in 2014-2015, reflecting the effects of a strong El Niño. It was suggested that the increasing trend in CPUE could reflect more shallow distribution patterns of bigeye, and thus higher catchability, in response to the El Niño oceanographic conditions. Aires-da-Silva suggested that the increase in CPUE could be a result of both increased catchability and increased recruitment of bigeye. The fine-scale environmental data required to assess the influence on CPUE were not available. There appears to be a strong response between recruitment of bigeye and strong El Niño events, and it is possible that recruitment could increase in response to the most recent strong El Nino of 2015-2016, but the data are not yet available.

Another Member noted that the current analysis is an improvement in the assessment, and asked if other indicators from other fleets, or other sources of information on CPUE, have been used in the assessment. Aires-da-Silva explained that the staff would like to have access to other indicators of relative abundance, such as standardized CPUE for other fleets, but that those data are currently not available. The staff has collaborated with Chinese Taipei to analyze their longline data, but that fishery is dynamic and sometimes switches targets. The Japanese longline data are the best source of information currently available for the IATTC analysis.

The Members discussed how bigeye stock structure would influence management advice. Rick Deriso indicated that there is a paper (SAC-07-07e) to be presented at this meeting that addresses alternative spatial closures and predicted catches of bigeye related to those closures. One Member suggested that the assumption of a single stock for bigeye could cause error in modeling, since recent information indicates the likelihood of multiple stocks of bigeye in the Pacific. Aires-da-Silva agreed that bias could be introduced around biological assumptions on growth or spatial movement. Tagging data indicate movement of bigeye around the management line of 150°W. The staff's approach is to perform sensitivity analyses of their assumptions about spatial movements, as well as working with colleagues at SPC and WCPFC on Pacific-wide assessments of bigeye.

A discussion developed on the need for more information, such as longline data from other countries, to improve the bigeye assessment. Improved data collection is needed, including data on associated species such as sharks, in order to refine scientific recommendations that are requested by the IATTC. Observer coverage on smaller vessels will start at 5%, but the staff's recommendation has always been 20% coverage.

A Member noted that for better assessments of bigeye, there must be estimates of the real fishing efforts of FADs, which affect other age groups in the bigeye population. Aires-da-Silva agreed and indicated that the staff will address this topic in a later presentation on FAD research. It was also noted that a recent paper by Schaefer et al. indicated the likelihood of up to 9 stocks of bigeye in the Pacific, and that these conclusions could influence the bigeye assessment. Aires-da-Silva noted that for incorporation of these new stock structure concepts in the assessment, new tagging data are required. Mark Maunder indicated that to define spatial structure of the bigeye stock, well-designed tagging studies are required that provide improved spatial and temporal coverage of movements of bigeye.

A Member inquired about the IATTC view on the transfer of bigeye catch limits from one Member country to another. The Director indicated that the quantity of transfer is important and whether the transfer is partial or total. Deriso noted that transfers are not provided for within the terms of Resolution C-13-01, paragraph 9 ("*China, Japan, Korea, and Chinese Taipei undertake to ensure that the total annual catches of bigeye tuna by <u>their</u> longline vessels (…)*"). Deriso also indicated that the Staff has consistently concluded that the type of fishery on bigeye influences the MSY, with a mixed fishery producing lower MSY compared to a longline-only fishery.

Aires-da-Silva cautioned that the assessment should not be viewed as overly optimistic. The management measures on closures have worked based on an existing capacity, but due to changes in capacity there must be consideration of revised recommendations. The Director noted that the recommendation made by the IATTC is to maintain F at levels that will produce MSY, and that will again be the recommendation of the staff. This has been accomplished through a given number of closure days, and taking into account the recent increase in capacity, the recommended number of closure days may have to increase in order to maintain the balance.

5.2. SPC Pacific-wide assessment and CPUE analysis

Laura Tremblay-Boyer(Secretariat of the Pacific Community - SPC), presented the main results of the Pacific-wide stock assessment for bigeye tuna undertaken in 2015 by the SPC dos WCPFC. This assessment was performed to address a recommendation by an external review of the 2011 bigeye stock assessment for the Western Central Pacific Ocean (WCPO). The reviewers highlighted that new tagging data indicated considerable movement of individuals between the WCPO and EPO and that, consequently, the predictions of population dynamics for bigeye in the WCPO could be sensitive to the exclusion of EPO dynamics.

Two additional stock assessments were conducted to address this concern. First, an updated WCPO model (WC15) based on the reference case model of the 2014 stock assessment (WC14) with an extra year of data, and, second, a model that represents the bigeye tuna population for the entire Pacific Ocean (PW15). The latter consisted of 12 individual regions and included all available tagging data including IATTC data for the EPO. The WCPO regions matched those of the 2014 assessment and the EPO regions were defined to include longline fisheries only in the north, and a mix of the tropical purse-seine and longline fisheries in the south. Both models were compared to the 2014 reference case model (WC14). New CPUE indices of abundance were also estimated from an extensive dataset of operational-level longline fishing data provided for this purpose by distant-water fishing nations, combined with those held by the SPC, and were included in both models.

Most of the modelling assumptions of WC15 and PW15 followed closely from WC14, with identical parameter settings and structural assumptions for processes such as natural mortality, catchability, effort deviation penalties, and tag reporting rates. The general results of the modelling procedure, and comparisons of WC14, WC15 and PW15 (WCPO regions) results can be summarized as follows:

- Absolute estimates of recruitment, total biomass and spawning potential showed some differences between the WC15 and PW15 models, though larger differences were observed between these 2015 models and the WC14 model, which can largely be attributed to the new CPUE indices used in the 2015 models.
- Estimates of depletion and depletion-based reference points were very consistent among the three models.
- The spawning potential in 2012, as a proportion of the spawning potential in the absence of fishing

(SBlatest/SBF=0), was estimated to be 0.16, 0.15 and 0.14 for the WC14, WC15 and PW15 models, respectively.

- High rates of movement from the WCPO to the EPO were estimated for PW15, with a high proportion of fish in the EPO estimated to originate from the WCPO. Conversely, fish in the WCPO were estimated to comprise mainly fish that originated in the WCPO.
- All models estimated relatively similar growth functions although the estimates of L2 were higher and lower than those estimated from independent data external to the model for the WCPO and EPO, respectively.

The SPC concluded that the dynamics of bigeye tuna in the WCPO estimated using the Pacific-wide model are not substantially different from those estimated using the WCPO-only model, especially with respect to the main stock status indicators used by WCPFC. Therefore, it was suggested that it is reasonable to continue to provide management recommendations to WCPFC on the basis of WCPO regional stock assessment models.

In parallel, IATTC staff also showed that the estimates of spawning biomass depletion produced by the 2016 EPO bigeye stock assessment were very similar to those coming from the EPO component of the 2015 PW assessment. Given the different assessment structures underlying both stock assessments (SS *vs*. Multifan-CL), this finding gives further confidence into the performance of both assessments.

It was acknowledged that a significant potential misspecification of the SPC PW model is the assumption of common growth across the Pacific, where actual growth appears to vary between the WCPO and EPO, with EPO bigeye fish showing L2 estimates that are considerably higher (~25cm) than their western counterparts. This cannot be reliably modelled using currently implemented age-based models and further investigation of spatial variation in bigeye tuna growth is recommended.

Lastly, given the results of the sensitivity analysis, there are currently no formal plans by the WCPFC for further Pacific-wide BET assessments. Future MSE work might use a Pacific-wide operating model, though the MSE work for the WCPO is currently focusing on skipjack and albacore tuna.

Discussion

In answer to a question on the assumed steepness of the stock-recruitment relationship used in the analysis, Trembley-Boyer indicated that a steepness of 0.8 was used in this analysis, taken from the WCPFC assessment conducted in 2014. It was also noted that the steepness values of the stock-recruitment relationship were different between the Pacific-wide assessment (0.8) and the IATTC assessment (1.0). Mark Maunder indicated that a comparison of the stock-recruitment relationships was not valid since the majority of the recruitment in the EPO is coming from the WCPO. In response to a question about the use new tagging data, Trembley-Boyer indicated that tagging data collected through 2014 were used, but that no funding was currently available to undertake new tagging studies. These results will be used as an operational model for looking at biases while continuing to conduct an assessment in the WCPO.

5.3. Yellowfin tuna: assessment for 2015

Carolina Minte-Vera presented the yellowfin tuna assessment for 2015. The assessment of yellowfin tuna in the eastern Pacific Ocean in 2015 is similar to the previous assessment, except that separate series of length-frequency data for Japanese longline commercial and training vessels are now available, and both were used in the assessment. There is uncertainty about recent and future levels of recruitment and biomass. There have been two, and possibly three, different productivity regimes since 1975, and the levels of maximum sustainable yield (MSY) 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. The spawning biomass ratio (SBR) has been below average since 2006, with the exception of 2008-2010, which resulted from a high recruitment in 2006. The recent fishing mortality rates (*F*) are slightly below the MSY level (F_{mult} = 1.02), and the recent levels of spawning biomass (*S*) are estimated to be below that level (S_{recent}/S_{MSY} = 0.95).

These interpretations are uncertain, and highly sensitive to the assumptions made about the steepness parameter (*h*) of the stock-recruitment relationship, the average size of the older fish (L_2), and the assumed levels of natural mortality (*M*). The results are more pessimistic if a stock-recruitment relationship is assumed, if a higher value is assumed for L_2, and if lower rates of *M* are assumed for adult yellowfin. A likelihood profile on the virgin recruitment (R_0) parameter showed that data components diverge on their information about abundance levels. Sensitivity analyses indicated that the results are more pessimistic if the weighting assigned to length-frequency data is changed, using recommended data weighting methods, and more optimistic if the model is fitted closely to the index of relative abundance based on the catch per unit of effort (CPUE) of the northern dolphin-associated purse-seine fishery rather than of the southern longline fishery.

The highest fishing mortality (*F*) has been on fish aged 11-20 quarters (2.75-5 years). The average annual *F* has been increasing for all age classes since 2009, but in 2015 it showed a slight decline for the 11-20 quarter age group.

The following topics should be a priority in future research for improving the yellowfin stock assessment:

(a) implementation of a large-scale tagging program to address hypotheses about stock structure and regional differences in life-history parameters and depletion;

(b) improved estimates of growth, particularly for older fish;

(c) weighting of the different data sets that are fitted to the assessment model;

(d) refinement of fisheries definitions within the assessment model;

(e) implementation of time-variant selectivity, mainly for the purse-seine fisheries on floating objects;

(f) exploration of alternative assumptions about stock structure within the assessment model;

(g) analysis of changes in spatial distribution of effort for the Southern longline fishery, and whether they invalidate the use of the CPUE of this fishery as the main abundance index in the assessment model.

Discussion

The apparent difference in fishery impact between yellowfin and bigeye was discussed, particularly the large impact on bigeye but not yellowfin following the large expansion in FAD fishing in the 1990s. Minte-Vera explained that the yellowfin purse-seine fishery was more constant from the beginning with traditional fishery types, while the floating object fishery caught predominantly bigeye and skipjack and changed from natural floating objects to FADs, which had a greater relative impact on bigeye. There was also a discussion about fishing mortality on juvenile yellowfin, with Minte-Vera indicating that juvenile fishing mortality was depicted for quarters 1-10, with only ages 0-3 months not represented. A request was made to present the mortality of the juveniles ages 0-3 month as a separate component in the future.

In response to questions about the model inputs, Minte-Vera explained that all the recruitments estimated are used, followed by an assumption of average recruitment for the rest of the years. The model is constructed in Stock Synthesis 3, which is a comprehensive stock assessment modeling framework built in the AD model builder, which allows for very complex non-linear analysis using maximum likelihood approaches. Standardization of the CPUEs for the purse-seine fleets used in the model was presented at the SAC 4 meeting (SAC-04-04c). The standardization was done using variables regarding the fishing operation, the indices produced did not make a difference in the results of the stock assessment model, and the standardization did not include environmental variables that may change the availability of the fish. The CPUE of the purse-seine fisheries in the south did not fit to the model however. The length-frequency data for this fishery had shown changes that indicated different sizes being targeted over time, which than complicates the interpretation of the CPUE as an index of relative abundance.

The assumption of one population of yellowfin was questioned in the models. One suggestion was to perhaps divide the population up into at least 3 stocks. Minte-Vera indicated that spatial models would be preferred but that there is insufficient tagging data to develop this approach. Instead, spatial differences are addressed in the model by differentiating the fisheries by gear type and area of operation.

Members and Staff agreed that a large-scale tagging program be conducted. The Members agreed that this study be proposed in a SAC recommendation for the Commission. One Member asked how long it will take to have results from a tagging program that could be used to improve the growth curve. Minte-Vera responded that it depends on the age that the fish were marked. To improve the estimation of the growth model the fish need to be older than 4 years; up until 4 years the age can be estimated using daily rings in the otoliths. She also mentioned that for the bigeye case the time at liberty of the fish recovered last year was 10 years or more. It was also suggested that the large-scale tagging program be made in collaboration with the WCPFC.

Two Members congratulated the staff for making the input and output of the stock assessment models fully available online, as this provides greater transparency to the assessment process and recommended that the Stock Assessment Program staff continue to do so in the future. One Member pointed out that this action is also important because it provides other scientists the opportunity to have a closer look at the model, and it is a capacity building tool, because students can run the model themselves and learn.

It was noted that the yellowfin model is harder to improve than the bigeye model because of the lack of contrast in biomass in the yellowfin model and because there is a lot of pressure on the staff to do the assessments on schedule, leaving little time to explore changes or improvements. It was suggested that the SAC could recommend: (1) that a full assessment not be done for yellowfin for 2017, but rather that time be taken to technically review and improve the model; or (2) “freeze” the fishery database to include data for trip finalized earlier than December to give the staff more time to prepare the assessment. Rick Deriso indicated that there is a schedule for conducting assessments, and that an external review of the yellowfin assessment several years ago provided a number of recommendations that are under consideration. Minte-Vera indicated that one of the goals of having annual stock assessments is to include all the purse-seine fishery data from the previous year to produce the best available science.

5.4. Skipjack tuna: indicators of stock status

Mark Maunder presented a summary of indicators of stock status for skipjack. The main concern with the that stock had been the increasing exploitation rate. However, this appears to have leveled off in recent years. The indicators have yet to detect any adverse consequence of this increase in exploitation rate. The average weight was below its lower reference level in 2015, which can be a consequence of overexploitation, but is likely due to high recruitment in 2015. Susceptibility and productivity analysis shows that skipjack has substantially higher productivity than bigeye tuna. Therefore, since skipjack and bigeye have about the same susceptibility, 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}.

<u>Discussion</u>

A Member asked about the conclusion of no adverse consequences from an increase in exploitation rate, noting that there was no good index of abundance available from the FAD fishery and that a more cautious outlook should be adopted. Maunder agreed that the CPUE from the FAD fishery is not a very good indicator of abundance, but noted that there was nothing in the indicators that suggested a problem with the skipjack population, although decreasing catch/set is of some concern.

5.5. Pacific bluefin tuna: updated assessment and management

5.5.1. ISC assessment

The full stock assessment was conducted in February-March 2016 by the Pacific Bluefin Tuna Working Group (PBFWG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC). Population dynamics were estimated using a fully integrated age-structured model (Stock Synthesis v3.24f) fitted to catch, size-composition and catch-per-unit of effort (CPUE) data from 1952 to 2015, provided by Members of the ISC PBFWG and non-ISC countries.

The 2016 assessment model was developed and refined in the intervening three years based on improvements made by the PBFWG. The improvements include: more accurate historical catch data, a better estimate of size composition by fleet, improved standardization of abundance indices, a revised growth curve based on additional otolith information and standardization of aging techniques, and improved model settings to represent the best input data. Key results were shown below;

a. Model fits diagnostics suggested that the base case model generally could fit well to the CPUE and size composition data, which was not the case in the previous assessment in 2014.

b. A likelihood profile over fixed log R0 parameter, which scales global population, suggested an internal consistency of the base case model assumption and data regarding the population scale estimates.

c. Spawning stock biomass (SSB) fluctuated throughout the assessment period (fishing years 1952-2014) and the SSB steadily declined from 1996 to 2010; and the decline appears to have ceased since 2010, although the stock remains near the historic low.

d. Recruitment estimates fluctuate widely and the 2014 recruitment was relatively low and the average recruitment for the last five years may have been below the historical average level.

e. The 2011-2013 F exceeds the calculated biological reference points except for F_{MED} and F_{loss}, but F has decreased slightly in recent years.

f. Under all examined projection scenarios, the initial goal of WCPFC of rebuilding to SSB_{MED} by 2024 with at least 60% probability, is reached. The projection results indicate that the probability of SSB recovering to the initial WCPFC target (SSB_{MED} by 2024) is 69% if the low-recruitment scenario is assumed and WCPFC CMM (2015-04) and IATTC resolution (C-14-06) are fully implemented and should continue in force.

Discussion

A Member noted that this assessment is greatly improved, although SSB and recruitment are very low and fishing mortality is above reference levels. The level of depletion of the stock is 98%, and the question was posed as to the status of MSY in the assessment. Hiromu Fukuda indicated that the historical median would be about 5-6% of SSB_0. The Kobe plot was used as a proxy in the analysis and the value used was 20% of SSB_0. The Member also asked if there were any suggestions as to alternatives in management resolutions. Mark Maunder replied that additional measures should be taken if the desire to reduce the short term risk of recruitment collapse was considered.

Another Member commented on the definition of small size for Pacific bluefin, noting that the WCPFC defines fish < 30 kg as small. If fish of 50 kg were defined as small, they would be age 4 which is the weight at 50% of maturity, and if 80 kg fish were chosen, they would be age 5 and all would be mature, so perhaps the choice of < 30 kg is a good choice for the definition of small fish.

A Member asked about the use of the terms F_{MED} and SSB_{MED} in the analysis. Hiromu Fukuda explained that SSB_{MED} is the historic median of SSB from the best case model, and F_{MED} is the F which is the average from the stock-recruitment relationship. Another Member asked for the IATTC opinion on the use of F_{MED} and SSB_{MED} in the analysis. Rick Deriso indicated that these terms were commonly used in the analysis of northern fisheries by ICES in the 1980s, where at that time, reference points were not established, and instead, a large number of alternative reference points are used for comparisons.

A Member commented on the conclusion that the effect of fisheries in the EPO is less than that of fisheries in the WPO on Pacific bluefin. The reduction in catch of small fish by 10% would have a larger impact than a reduction of 10% in catches of large fish, and it was suggested that perhaps the focus of conservation efforts should be on WCPFC regulation of the Japanese troll fishery. Fukuda indicated that the troll fishery is included in the WPO coastal fisheries. He indicated that the coastal troll fishery does not contribute large quantities in weight, but does capture a large number of individuals.

5.6. IATTC Pacific bluefin tuna research

Mark Maunder presented the research efforts of IATTC staff. A new assessment has been developed for Pacific bluefin tuna by the ISC bluefin tuna working group. The assessment is a substantial improvement over previous assessments, but the management implications are generally the same: the stock is at very low levels, and the fishing mortality is higher than any reasonable reference point.

Substantial management action has already been taken on both sides of the Pacific Ocean to rebuild the population, and the assessment indicates that these actions are adequate. However, there are still some issues with respect to the adequacy of the model fit to the data and uncertainty about the relationship between recruitment and spawning stock size. Here the robustness of the assessment model results to these issues is investigated and the management implications of the assessment results are discussed.

A strong cohort can be seen entering the Japanese fishery, starting in 2000 and growing through the fishery. However, after 2002, the mode representing this cohort no longer grew, indicating that either the cohort stopped growing, or was no longer selected by the fishery, or was overwhelmed by younger cohorts. From 2002 to 2005, the standard deviation of the normal distribution representing the cohort increases from 8.8 cm to 15.0 cm, indicating that the normal distribution may be representing an increasing number of cohorts. A cohort can be seen moving through the Chinese Taipei longline data starting in 2002, at a size slightly larger than that seen in the Japanese longline data in the same year. However, the mean of the normal distribution representing this cohort does not increase after 2004.

A second strong cohort appears to have entered the Japanese longline fishery starting in 2002, with a mode at about 176 cm, and may have been accompanied by another cohort in 2003, recruited at about the same size of 176 cm. These cohorts appear to grow through the fishery all the way until the last year of data in 2012, with a mode at about 235 cm. A strong cohort can be seen moving through the Chinese Taipei fishery, starting in 2006 at a slightly larger size (217 cm) than seen in the Japanese fishery (207 cm) in the same year. However, the mode in 2012 is about the same for both fisheries.

Other cohorts can be seen entering the Japanese fishery in recent years, including 2007 and 2010. A strong cohort can be seen in the Chinese Taipei fishery in 2014, but it is not clear whether this is the same cohort seen entering the Japanese fishery in 2010.

The large cohorts enter the Japanese longline fishery at around 176 cm, or about six years of age. Mapping the fish back to their year of birth, the strong cohorts of 2000, 2002, and 2003 relate to years of birth of 1994, 1996, and 1997, respectively. The recruitment index shows strong recruitments in 1994 and 1996, but not in 1997. Interestingly, the 1996 cohort that is most strongly seen in the longline composition data is not estimated to be as high as the recruitment index indicates.

An alternative assessment was conducted with a time series that starts in 1980, estimates growth, and uses time-varying selectivity for the Japanese longline fishery. The alternative assessment is more optimistic than the base case assessment but supports the general conclusion that the stock is at very low levels and the fishing mortality is higher than any reasonable reference point.

The main concerns about the stock are (1) the extremely low levels of spawning biomass, (2) uncertainty about how recruitment is related to the spawning biomass, and (3) two out of the last three recruitments are at the lowest levels observed since 1980 according to the index of recruitment based on troll CPUE, which has been shown to be reliable. Therefore, it is recommended that further action be taken to protect the spawning population.

Discussion

The representative of Japan expressed procedural concerns about this exercise, noting that IATTC staff had participated in the ISC PBFWG and had ample opportunity to make comments in the development assessment of Pacific bluefin tuna. He also noted that document SAC-07-05d, which provides advice that differs from that coming from the ISC's assessment, was posted 42 days after the end of the PBFWG. Japan believes that IATTC staff can make a contribution further to the assessment by providing comments in the PBFWG. Japan wishes that the Secretariat will give due consideration to this point.

Japan also expressed concerns about inconsistencies in the assumptions used by the ISC and the IATTC staff. The IATTC staff's analysis was thoroughly discussed at the last ISC assessment meeting. Nevertheless, this document provides a different advice.

Japan noted that the results of this analysis presented by Dr. M. Maunder will be incorporated with the full stock assessment report. The PBFWG recognized that the different assumptions presented could be an alternative assumption. The ISC Pacific bluefin tuna working group will start further investigation about spatial-temporal variation of size of fish caught by Japanese longline and catchability for future assessments. And so far, because this alternative run foregoes some of important information about abundance from the Japanese longline CPUE, which is the main abundance index, the PBFWG, as a whole, chose the current base case.

Japan asked whether the presenter tested the model which applied the time-varying selectivity to the Japanese longline size composition data and does not fit to the Japanese longline CPUE. Dr. Maunder stated that he did not do this type of analysis, but it would be worth investigating.

Japan also pointed out about the cohort analysis from Japanese longline size data. The analysis by the presenter is not based on the age-composition data but length-composition data of the Japanese longline fleet. Because the model process does not include seasonal and annual variation, or regional, sex-specific, and individual differences in growth, using the mode of the length-observation data to define a cohort is uncertain. Japan thinks that further research about age-composition observations will be necessary.

Finally, Japan noted that further actions to protect the spawning stock will contribute to reducing the risk of recruitment collapse, but that such actions were not available solely to WCPFC and the IATTC should contribute to this process. Additionally, any further action to protect the small fish or intermediate-aged fish also contributes to the enhancement of young spawning stock, so there are many options to enhance the spawning stock. This was the logic behind the consideration of 20 different scenarios within the latest ISC assessment.

The Director noted that the landscape of this problem is complex because there are two commissions whose management measures need to be consistent with the conservation advice resulting from assessments. He noted that although the ISC does a good job in their assessments, ISC is a body that makes recommendations to the WCPFC through the Northern Committee. On the other hand, the IATTC receives recommendations based on the work of the IATTC staff and the SAC, and only measures that fall within the competence of IATTC are appropriate for EPO fisheries. Thus, although IATTC scientific staff participates in the work of the ISC, that does not necessarily fully discharge the duty IATTC staff to make recommendations to IATTC Members, nor does it preclude further analysis and additional opinions and advice.

One Member noted that under both the ISC assessment and the IATTC analysis, the actions adopted are adequate to rebuild the stock to target levels. It noted that the rebuilding target for Pacific Bluefin tuna of 6% of estimated virgin spawning stock biomass appears to be lower than the interim limit reference points for tropical tuna species and asked for confirmation of that. Maunder noted that the thrust of the IATTC staff recommendation was the protection of the adult spawning stock in the near-term as an insurance policy against the possibility of recruitment failure. The Director also noted that implementing such a recommendation was not feasible for IATTC because the fisheries for adults occur in the WCPFC Area. Another Member suggested that the target values for Pacific bluefin tuna should be agreed by both commissions, and that cooperation in that effort, as well as in conservation, was essential for success. A third Member proposed that the SAC make a recommendation regarding the need for increased and continued cooperation.

A Member asked whether, given the status of the stock and the fact that its depletion is due mainly to fishing mortality, further reductions in fishing might be warranted. Maunder responded that the answer was dependent on policy goals. The current measures are expected to allow for recovery in the long-term, but if a quicker recovery were desired, the models suggest that further reductions in fishing mortality would need to occur. Further protections of adult fish would also protect against the possibility of recruitment failure. Another Member stated that the conservation outlook would improve if the WCPFC would agree to the necessary reductions in fishing, noting that the IATTC had already done so. Noting this comment, Japan noted the good cooperation to date among Members for rebuilding the stock of PBF, and expressed hope that it would continue so that a new Resolution, based on ISC's stock assessment, could be adopted at the 90th Meeting of the IATTC.

6. OTHER SPECIES:

6.1. Dorado

6.1.1. Assessment

Alexandre Aires-da-Silva presented an exploratory stock assessment of dorado (*Coryphaena hippurus*) in the southeastern Pacific Ocean. Dorado has a wide distribution throughout the tropical and subtropical waters of the world's oceans. It is one of the most important species caught in the artisanal fisheries of the coastal nations of the eastern Pacific Ocean (EPO), ranging from Chile in the south to Mexico in the north.

Available fisheries statistics indicate that the EPO is the dominant region in global production of dorado. The species has been thought of as highly resilient to overfishing due to its high productivity in all the oceans of the world. However, stock assessments are needed to obtain a better picture of the stock status of the species and to evaluate alternative reference points for management.

Coastal Member States of the IATTC have requested regional, collaborative research and guidance from IATTC staff regarding dorado, in particular on stock assessment. Two IATTC Technical Meetings on Dorado have been conducted to date in Ecuador (2014) and Peru (2015). A large and diverse amount of fishery and biological data for dorado available from IATTC Member States was identified; stock structure assumptions were discussed, as were the methodologies and indicators of stock status to use.

This study presents an exploratory stock assessment for dorado in the southeastern Pacific Ocean. The geographical extent of the assessment is the "core region" of the dorado stock in the EPO. In this region, dorado are mainly subject to targeted artisanal longline fisheries in Peru and Ecuador, but the species is also caught incidentally (as bycatch) by the tuna purse-seine fisheries.

The assessment was implemented in the modeling platform Stock Synthesis and covered the fishing years 2007-2014. Dorado catches in the model are those of Peru, Ecuador, and the tuna purse-seine bycatch. The model was fit to the following datasets: dorado CPUE data from Ecuador, and length-composition data from Peru and tuna purse-seine bycatch (sexes combined), as well as length composition from Ecuador (sexes separated). The model uses a monthly time-step which allows depletion caused by the catch to be measured by the CPUE to inform estimates of absolute abundance.

The assessment produces a good fit to Ecuadorean CPUE and size-composition data. Although the fit to size-composition data is good, residual patterns for some months in the Ecuadorean fishery suggest that more work is needed to add processes (e.g., estimating growth inside the stock assessment model, cohort-specific growth, alternative growth curves) that could produce a better fit. Although the assessment results contribute to the knowledge about the population dynamics of dorado and its history of exploitation in the EPO, the IATTC staff is unable to draw conclusions about stock status, because no reference points, target or limit, have been defined for dorado in the EPO. Nonetheless, some management quantities are presented and discussed for consideration.

Recent catches are near MSY estimates from the stock assessment. However, YPR analyses show that the yield curve is very flat, and the fishing mortality required to achieve MSY is poorly defined. Also, a complementary study presents an exploratory management strategy evaluation (MSE) for dorado in the southern EPO. Overall, this study shows that Stock Synthesis is a promising tool for conducting stock assessments of this species in the EPO.

More research is needed to refine the model, the data used, and to prioritize collection of new data for the assessment of dorado. Analyses including data from these fisheries and expanding the spatial extent of this assessment could be considered in the future.

Discussion

A Member noted that in the presented study there are a high level of larva abundance during November to December in the South. Nevertheless, for the northern hemisphere there is evidence that the highest level of abundance occurs during September to November. The staff observed that in the northern region spawning seems to occur throughout the year, but it is unknown if the larvae survives. However for the southern region, there is an increase in survival and better recruitment.

The availability and potential processes affecting the viability of larvae were discussed, particularly the seasonal patterns in different regions.

One Member noted that most have generally assumed, based on the high growth rate of the species and other factors, that reproduction of dorado is continuous or nearly so. They asked whether it was possible, that seasonality and other factors cause large fluctuations in recruitment success on a spatial temporal scale, but reproduction is continuous. Aires-da-Silva replied that they had heard that recruitment for dorado would be highly variable, but that this was one the biggest surprises. He noted that they had tried to work with time-varying catchability, and that helped the model fits to monthly CPUE, but that there is more work to do to improve the model fits. It is possible that future efforts will examine time-varying selectivity, or using a "years as months" model setting (similar to what is done for tuna assessments) to better reflect processes occurring during the year. Juan Valero noted that Jimmy Martinez has worked on the relationship between SST and CPUE for dorado and is examining whether, given that dorado are typically associated with the 23°C isotherm, SST might be used as a covariate for either recruitment of availability.

It was noted that researchers from Chinese Taipei continue to conduct dorado research and have collected tissue samples from the northwestern, central, and eastern Pacific Ocean. This work could help address the question of dorado stock structure. In 2010 an assessment using stock synthesis for dorado was attempted, but there were problems with some of the assumptions and model implementation. . Chinese Taipei is currently reviewing the data to improve quality and would welcome collaboration on Pan-Pacific stock structure research.

One Member noted that dorado are reserved, under Mexican national law, for sport fishing, and asked whether there was any indication as to whether there was any evidence for a distinct Mexican stock of dorado. Carolina Minte-Vera noted that the efforts of WWF had produced some unpublished genetic data comparing samples collected in Peru and Mexico. Those samples exhibited homogeneity for the markers examined, but the results were inconclusive at this stage. Efforts in Colombia have suggested two stocks - a near-shore resident stock and an offshore stock, but a more thorough sampling effort would include more of Central America. Genetic homogeneity at the population level requires very little mixing, with the emigration of only a few individuals per generation being adequate to prevent heterogeneity from accumulating, and which suggests that length-frequency studies may also be a useful tool in these efforts.

The surprising and marked difference in sex ratios among dorado catches was discussed. During the second Meeting on Dorado in Peru (2015) several processes were incorporated into a preliminary Stock Synthesis model to evaluate their potential impact on observed sex ratios. At this stage, however it cannot be determined whether the difference is a result of differential sex-ratio during recruitment, natural mortality, selectivity, or other factors.

Another Member noted the socio-economic importance of dorado in Central America. He noted that data collection needed to be improved so that the status of this important resource could be better understand, but also noted that the fisheries were primarily artisanal, presenting challenges in terms of data collection. Aires-da-Silva noted that the availability of high-quality data in the southern regions - particularly Ecuador, was the reason that the initial investigation focused on that region. However, he noted that, with some additional investment, the scope could be expanded and that he expected the next regional meetings on dorado to focus more on central and northern areas. He also suggested that further developing the assessment model into an operational model for its use to evaluate alternative strategies (similar to the MSE work that followed the assessment presentation) would be useful to develop and evaluate stock indicators in the Central American region (where currently available data seems too sparse to implement similar stock assessments), which would require less comprehensive and sophisticated data collection.

Minte-Vera suggested that tagging research in Central America might also help illuminate population dynamics in the region. Several Members from Central America agreed that they wanted to see data collection and research for dorado in their region expanded so that they can also garner management advice for this important species. However, they also noted that such efforts would also require human capacity building assistance to enhance the resources available and to bridge the technological gaps that exist. Peru noted that data collection for dorado was difficult because their fishery is artisanal in nature, but that they are committed to improving their data efforts and are partnering with Ecuador to that end. Aires-da-Silva noted that improving data collection in EPO coastal nations would be a topic covered in detail during his presentations on sharks, and that the recommendations IATTC staff are making in that respect would also improve data collection for many other species, including dorado.

The inclusion of oceanographic factors in stock assessments was discussed. Using oceanographic factors as proxies in stock assessments is challenging due to the lack of consistent or persistent relationships between population processes and environmental factors, but oceanographic factors could be used in the context of MSE.

Another Member noted that it appeared that natural mortality rates could have been estimated by the investigators and asked whether they had attempted to make this calculation. Valero noted that they had tried unsuccessfully to estimate both natural mortality and growth rates, but encountered a lot of model instability, more work is needed. He suggested that tagging studies are informative for estimating growth, mortalities, movement and that they could be a component of future research efforts.

Members then discussed the 2015 fishery for dorado. It appears that 2015 was the worst year on record for the dorado fishery in Ecuador, with catches of less than 50% of what is typical. A big year for the fishery due to the El Niño conditions had been expected and questions remain. Was this due to environmental factors? Was there reduced recruitment? Were the fish present and simply distributed differently? Aires-da-Silva indicated that environmental factors were suspected to be responsible and that some had suggested that perhaps the fish had been densely concentrated and trapped in a blob of very warm water further to the south. A Member noted that Peru had in fact, experienced a very good fishing year, harvesting an estimated 56,000 tons. Their experience was the fish were found further south and closer to the coast than normal (i.e., predominately Peruvian waters).

6.2. Management Strategy Evaluation (MSE)

Juan Valero discussed an exploratory management strategy evaluation (MSE) for dorado (*Coryphaena hippurus*) in the southern eastern Pacific Ocean (EPO). MSE is a framework used to evaluate management procedures. A management procedure is a set of pre-agreed decision rules that specify what data are to be collected and how the data are to be used to set catches, or determine input controls such as allowable fishing effort or fishing seasons. The evaluation of alternative management procedures is typically done by comparing performance statistics reflecting management objectives and the interests of managers, resource users, and scientists. We conditioned the operating model to all available data used in the current exploratory assessment for dorado, which spans the 2007-2014 period, using the stock assessment modeling platform Stock Synthesis. We projected population and fisheries dynamics for 2015-2019 under alternative harvest strategies and scenarios, including alternative monthly closures and openings, size limits for the fish in the catch, and discard mortality rates. The alternative harvest strategies were also evaluated retrospectively. Yield per recruit (YPR) analyses were conducted to describe expected YPR and spawning biomass ratio (SBR) as a function of age of entry to the fishery and annual fishing mortality. We present tradeoffs between SBR and yield for strategies based on alternative season openings, closures, and minimum size limits with different assumptions regarding discard mortality rates of undersized fish.

We found that alternative season closures and openings have similar general effects on SBR and total yield. However later season openings increase SBR without marked reductions in expected yield, while earlier closures increase SBR but at the expense of reduced catch. YPR analyses show that the age of entry that will produce the maximum YPR is around 10 months, based on the annual fishing mortalities estimated by the assessment. That would mean that openings around October-November would be consistent with YPR considerations. The age of entry consistent with maximum YPR would be higher at fishing mortalities higher than those estimated by the assessment. SBR is expected to increase with minimum size limits, while yield is expected to increase under no or moderate discard mortality and to decrease al greater discard mortality rates. Under an assumed moderate discard mortality, increased minimum size limits are expected to result in increased SBR, but at the expense of reduced yield.

In this study we develop an exploratory MSE for dorado in the EPO. This is not intended in any way as a final MSE to be used for the management of dorado; it is rather the first step in a process of evaluating the utility of MSE for dorado, and is intended to further collaboration between all interested parties in order to continue developing this framework for dorado and, if found useful and appropriate, consider its utility for determining the potential outcome of alternative decisions.

Discussion

Several Central American Members congratulated the staff for this important evaluation and requested further assistance in data collection and analyses for this region as it seems to be different from the information presented in the south.

The staff indicated that success of the evaluation presented was due to the good data presented by two Members, Peru and Ecuador. Valero noted that a combination of assessment and MSE work could help identify what methods could work best for different regions with varying data availability. It could be that for evaluation and management of this species, even a few years of high quality data (e.g. monthly CPUE and size information) could provide enough information. Alternative, less data-dependent methods (e.g., preserving a fraction of initial CPUE at the start of the fishing season) could be evaluated via MSE. The next Dorado meeting will be held in Panama in October of 2016. In addition to help continue gathering information and furthering discussion on dorado, these meetings are helping with building human capacity for Members.

In addition to the quantitative results obtained from the assessment and MSE, both studies can be used to guide research priorities. It was also stressed that when discussing these priorities, the management objectives need to be considered. Because there are multiple fisheries, multiple target species, and multiple coastal states, management is complex.

The Staff indicated that the evaluation was an example of how an exploratory management evaluation can be useful in the management decision making. The Director emphasized that in the Commission there is no agreed-upon management measure, and that with this evaluation there is now a guide in case the members see a need for one.

6.3. Sharks

6.3.1. Indicators for silky shark

Cleridy Lennert-Cody presented on purse-seine indices for the silky shark (*Carcharhinus falciformis*), which have been updated with data from 2015. The index for all silky sharks in the northern area shows an increase in 2015 relative to 2014, but the index for all silky sharks in the southern area remains at the 2014 level. This increase in the index in the northern area may be in part the result of changes in availability, rather than abundance, due to strong El Niño conditions. Differences among trends computed for sub-areas in the north suggest that the overall recent increasing trend in the north may reflect an integration of spatially-distinct processes, including the effect of fishing pressure closer to the coast, and environmentally-mediated movement of individuals into the tropical eastern Pacific Ocean (EPO) from the west.

The IATTC staff does not consider the more optimistic recent trends to be strong enough to offset the urgent need for precautionary management actions, and reiterates its previous recommendations. It is critical that improvements are made in shark fishery data collection in the EPO so that conventional stock assessments and/or other indicators of stock status can be developed and the results made available to better inform the management of silky and other shark species.

Discussion

The Members recommended that, in order to have a better evaluation of stock status in the future, data from other fisheries, such as coastal and high-seas longline fisheries, need to be incorporated into the analyses. The use of only the purse-seine data for developing indices of relative abundance limits the ability to monitor stock status for species that are impacted by a variety of fisheries in different regions within the EPO. Longline data are necessary to create different indices from the purse-seine index. The Members also recommended continuing the silky shark tagging program which can provide spatial movement data. The Members agreed that better data collection is necessary for small purse seiners (<Class-6 vessels), longliners, and coastal artisanal fisheries in order to improve the silky shark evaluation. Many Members reiterated the importance of this species for the Central American region and they are willing to better their data collection but require financial assistance to implement these programs.

In response to a question on the extent of bycatch of silky sharks in the southern EPO, Lennert-Cody noted that the catches of juvenile silky sharks have always been very low in the southern EPO, and have been nearly absent in recent years, and the question is why? One possibility is that recruitment in the southern area comes from other regions. Another possibility might be that catchability in the southern EPO is different from that in the northern EPO for small silky sharks.

6.3.2. Inventory of sources of shark data in Central America

Salvador Siu presented an inventory of sources of data in Central America on shark fisheries operating in the eastern Pacific Ocean.

Central American artisanal fisheries have several common characteristics, the most common being: 1) the use of different types of fishing gear during a single trip; 2) catches of various species in their juvenile stage; 3) seasonal fishing activity; and 4) numerous small-scale vessels. We made 6 trips between 2014-2015 to obtain the follow information: fisheries inspection, sampling programs, biological studies by fisheries institutes and universities, trade records, management arrangement, and anecdotal information.

The main source of shark fishery data available in Central America are the landings inspection programs, conducted mainly for compliance purposes. Such programs have been operating in all Central American countries involved in the fishery since the early- or mid-2000s. The quality of the data varies among programs. Some programs in Central America collect data on shark landings by species and fleet, while others pool all sharks into a single category which may or may not be classified by fleet. The coverage by these programs of artisanal and industrial ports and fleets varies, and is difficult to quantify. Shark trade records are also available for most countries since the mid-2000s, but not at the species level. Fishery and/or biological sampling programs for sharks, conducted mainly for resource monitoring and/or research purposes, are very scarce in Central America, with only a few sporadic pilot programs implemented in the region for very short periods of time.

We surveyed the scientific literature in three categories: 1) descriptions of the fisheries; 2) research by particular species or particular shark fisheries; 3) universities and NGOs. In summary, we found 73 documents, mostly on coastal shark species of Costa Rica and Guatemala. The chronology of life-history studies available for sharks in Central America begins in 1990, with biological and fishery data collected for student theses that have led to investigations of sizes at maturity, growth parameters, trophic analysis, distribution and abundance, breeding areas, pharmaceutical studies, descriptions of shark fisheries, and business analyses of the fishing sector dedicated to sharks.

Central American countries are experimenting with the internal management of their fisheries and legislation is constantly developing on control and management of shark fishery. The main legislation is the shark finning prohibition, started in 2004 with Costa Rica, and followed by Nicaragua, El Salvador, Panama, Guatemala and Belize. All countries have a National Plan of Action but these have not been developed due to a lack of funding in the fisheries institutes. The Central American Fisheries and Aquaculture Sector Organization (*Organización del Sector Pesquero y Acuícola de Centroamérica*; OSPESCA), has developed various strategies for regional fisheries management, in conjunction with the fisheries authorities of the various Central American countries. This regional work has resulted in several projects for the management of shark fisheries, such as the Regional Plan of Action for Sharks (2011), regional pilot sampling plans for sharks (2009-2010), regulation of tourism and fisheries activities on the whale shark (*Rhincodon typus*) stock (2011), and regional bans on shark finning (2011). The international management in the eastern Pacific Ocean, started in 2002 with CITES regulation of commercial trade, follow by resolutions by the IATTC in 2005 and the WCFC in 2010.

IATTC members submit information on the catches and effort in the tuna fishery annually, in accordance with Resolutions C-03-05 (Provision of data) and C-04-05 REV (Bycatch), in the Task I and Task II format used by other regional fisheries management organizations (RFMOs). The requirements on how to submit this information are established by the IATTC scientific staff. The IATTC has received some form of summary catch and effort data at the Task I level from all Central American countries; more-detailed Task II records (*e.g*., catch and effort data by trip, spatial data) have been submitted only by Belize. The IATTC database contains records of bycatches by purse-seine vessels of 28 species of sharks and 9 species of rays reported by on-board observers since 1993. Catches are reported in number of individuals, although prior to 2005 they were also reported in weight.

<u>Discussion</u>

Several Members offered their congratulations and thanks for this important work, but also noting that this is just a first step and that much important and challenging work lies ahead.

A few Central American Members commented on the difficulties of collecting quality data from artisanal fisheries and small longliners. They noted that the IATTC staff have provided them with forms and protocols for data collection, but that financial, capacity and logistical challenges remain. They highlighted that many of the relevant communities face economic and social challenges and that shark fisheries can be a very important source of economic income and food security. It was noted that the recent cooperation and collaboration on dorado could serve as a model for advancing on sharks in the region as well,

One Member suggested that numbers of boats might be used as a proxy for fishing effort if other data proved difficult and asked if this had been considered. Siu responded that even where estimating the number of vessels might be possible, other important factors are missing that would make that number relevant.

Numbers of fishing days or effective fishing days, gear type, numbers of hooks used are all examples. We don't know how frequently each boat goes out or when they do, if they are targeting sharks or not. This makes using numbers of vessels problematic at best.

Finally, Siu noted that in some cases there exists additional challenges with national laws and regulations which may mandate the collection of fisheries data, but at the same time prohibit it use in research efforts.

6.3.3. Results of FAO-GEF shark project 2 (shark data collection challenges in the EPO)

Alexandre Aires-da-Silva presented a summary of the challenges to collecting shark fishery data in the eastern Pacific Ocean along with recommendation for improvement.

Sharks are subject to fishing pressure from a great variety of fisheries in the eastern Pacific Ocean (EPO). They are targeted or caught incidentally (as bycatch) by multi-species and multi-gear fisheries of the coastal nations. In addition, they are also caught as bycatch by the high-seas longline fisheries for tuna and billfish of distant-water (mainly Asian) fleets, as well as by tuna purse-seine fisheries.

The Antigua Convention, which entered into force in 2010, requires that the Inter-American Tropical Tuna Commission (IATTC) "adopt, as necessary, conservation and management measures and recommendations for species … that are affected by fishing for, or dependent on or associated with" the tuna stocks. Sharks are among these species, and there is a critical need for stock assessments to guide shark management and conservation.

Unfortunately, implementing the conservation goals of Antigua Convention for sharks, or any other non-tuna and billfish-like "associated species," for that matter, is presently handicapped by several factors. In addition to the uncertainties with respect to the extent to which shark stocks and fishing vessels operating in the EPO fall under the scope of the Antigua Convention, a number of severe challenges must be faced. There is lack of essential data, which handicaps any attempt to conduct conventional stock assessments and/or produce simple stock status indicators. Although IATTC and national program observers collect shark data aboard large tuna purse-seine vessels, it is estimated that catches from this fishery represent only a small fraction of the total shark removals in the EPO. Other sources of data are urgently needed. Ideally, reliable estimates of species-specific total removals should be obtained. At a minimum, catch and effort and size-composition data by species from the longline fisheries, which are estimated to make the majority of the shark removals in the EPO, should be collected so that indices of relative abundance and/or other indicators can be applied to assess the status of the shark stocks in the EPO.

This report identifies and discusses in detail the main challenges on shark data collection in the EPO. In addition, it includes recommendations by the IATTC staff to overcome each one of these challenges, improve shark fishery data collection in the EPO, and ultimately help to meet the conservation goals of the Antigua Convention for sharks and "other associated species". This work has been made possible through funding from the Food and Agriculture Organization of the United Nations (FAO) and the Global Environmental Facility (GEF) within the framework of the *Common Oceans* program.

<u>Discussion</u>

Challenge 1- Members had a lengthy discussion on the scope of the Antigua Convention, both in terms of the scope of species covered and the scope of the Commission's mandate to recommend and implement conservation and management recommendations. If a species is encountered in EPO tuna fisheries, does Antigua provide a mandate to manage (or even to recommend management) of that species beyond tuna fisheries? Dorado and some species of sharks are good examples of this issue. Where the Commission directs the IATTC staff to assess or otherwise come up with indicators for these species, it can involve the collection and analysis of data from non-IATTC fisheries. Additionally, where EPO tuna fisheries may have some impact on a species, but the majority of the fishing mortality results from non-tuna fisheries, are management measures and recommendations coming from the staff to be limited only to vessels targeting or catching tuna? How much tuna catch by a fleet is enough to provide a sufficient nexus for IATTC management? Members all agreed that these questions of scope need to be addressed by the Commission, so that the role of IATTC scientific staff and their research efforts can be clarified.

Beyond that, Members also reflected that under any interpretation, the scope of Antigua was potentially so large in terms of potential species of interest, that clear prioritization of research efforts of scientific by the Commission is necessary, and that any additional research mandate include the funding necessary to carry out the work.

Challenge 2- The Director noted that Resolution C-03-05 indicates that CPCs only need to report on catches from artisanal vessels annually, but that there is no definition for that classification. Resolution C-15-04 is the first to contain a definition of artisanal vessel (less than 1.99 net tonnage), so perhaps this is at least a starting point moving forward. Martin Hall noted that in many cases, from a scientific perspective, the classification and characteristics of the vessels themselves may be less important than the type and configuration of the fishing gear they are using.

Challenge 3 - Members again discussed the scope of the Antigua Convention as it pertains to sharks with a focus on data collection. They discussed the differences between mandated data collection and recommended data collection, noting that creating more obligatory data collection requirements for developing countries without corresponding capacity building assistance and other help would not be welcome. In that context, many Members again pointed to the recent work on dorado as a good operational model.

One Member expressed the view that much of what was being discussed was beyond the scope of the Antigua Convention, and that the focus should be on deciding what is included in "tuna and tuna-like species," and stop there. The Director noted that a definition of tuna and tuna-like species was already in place, and that the difficulty lies in the interpretation of terms such as "species belonging to the same ecosystem and that are affected by fishing for, or dependent on or associated with, the fish stocks covered by this Convention." Members concluded that it would be helpful for the Commission to provide clearer guidance on the extent of Antigua's mandate with respect to sharks.

Challenge 4- One Member noted that 100% coverage would be both logistically and financially impossible for most Latin American countries, and that the focus should be on a level of sampling adequate to allow for reasonable extrapolations. If the data demand is too large and exceeds the proportional economic importance of some fisheries, then the motivation to comply or cooperate is decreased. IATTC staff noted that where the Commission has identified priorities and recommended the allocation of IATTC resources, staff in IATTC field offices may be able to help with some of these efforts, both in terms of conducting sampling and in building the national capacity to do the same.

Challenge 5- Within the context of this item, Members discussed the possibility of expanding the work of IATTC field offices and the possibility of establishing an additional field office in Central America (Panama and Costa Rica were mentioned as candidates). Several Members from the region agreed that they would be helpful.

Challenge 6- On the topic of species-specific export data, a couple of Members expressed concern about how such data would be treated, noting that they frequently have foreign vessels landing sharks in their countries and that they are reflected as imports, but then when they are re-exported they may get attributed as catches of the importing country. Thus, care must be taken as to how the data is characterized and used.

Challenge 7- Members discussed some of the problems regarding observer coverage and their work. With respect to purse-seine vessels, it was noted that the job of observers and electronic monitoring systems in spotting and identifying shark bycatch becomes difficult when catch is brailed directly into wells and that this problem was relevant to other non-target species as well. One Member noted that this problem may be compounded by the fact that some vessels have started using larger brailers (previously 1-2 tons per scoop, but some now as large as 8 tons per scoop), meaning that larger volumes of catches are entering the wells or hoppers at a faster rate, which makes spotting and identifying non-target catch composition more challenging.

A few Members expressed support for the use of electronic monitoring systems to supplement observer coverage or as a substitute for observer coverage where the size of the vessel may prevent observer deployment (e.g., small longline vessels). They highlighted the successes they have had with their national programs in this regard and noted that one of the only limitations on its use is the expense of the equipment.

Challenges 8 and 9- Members discussed the appropriate level of observer coverage on longline vessels. Most Members expressing views agreed that the current level of 5% coverage was not adequate to meet the scientific needs and several Members expressed a preference for 20% coverage as the next step, until such time as adequate information is available to recommend a different level. One Member noted that data quality from longline observers is also an important consideration and recommended that rather than move immediately to 20%, that coverage should be increased in smaller increments, while also paying close attention to data quality coming from these programs.

Members also discussed the importance of addressing the mandate under Resolution C-11-08, paragraph 7, regarding the establishment by the SAC of a format for the submission of the scientific observers' information to the SAC. The importance of this task was again highlighted, so that the Commission can start to receive observer data more detailed than the summary national reports that are prepared each year. Incorporating the raw/operational data from these observer efforts is critical for the scientific endeavors of the Commission.

6.4. Seabirds

The Inter-American Tropical Tuna Commission adopted Resolution C-11-02 in 2011 to mitigate the impact of fishing on seabirds in the eastern Pacific Ocean (EPO) Since that time, BirdLife International and the Agreement on the Conservation of Albatrosses and Petrels (ACAP) revised best practice mitigation measures; ineffective methods were removed and line weighting, night setting and bird scaring lines became the primary recommended mitigation methods based on tests of effectiveness in reducing seabird mortality in longline fisheries.

These best practice mitigation measures have been adopted by the WCPFC, the ICCAT, and the IOTC. BirdLife International and ACAP provided details with a paper presented at the 2014 IATTC SAC-05 (Document SAC-05 INF-E) and the United States presented at the 2015 Commission Meeting a proposal to amend Resolution C11-02 (see Appendix 3 of the Minutes of the IATTC 89th Meeting Report). That proposal was not adopted due to lack of consensus. Some CPCs requested additional scientific data on occurrence of seabirds in the IATTC region. This paper and associated presentation were designed to provide this additional information.

Seabirds rely on two distinctly different habitats: land for breeding, and the ocean for feeding. When breeding, they are central-place foragers but can range thousands of miles from their colonies in search of food. When not breeding, many cross entire ocean basins to feed in regions far from their breeding locations. The transboundary nature of seabirds means that their distribution often overlaps with fisheries managed by RFMOs. Longline fisheries are of particular relevance because seabird bycatch in these fisheries can be high (upwards of 160,000 birds/year) and have been identified as a primary factor driving precipitous declines in abundance of many seabird populations, especially albatrosses and petrels.

Data from three independent sources (range maps from BirdLife International, individual seabirds fitted with satellite transmitters, and at-sea surveys of seabirds) indicate that many species of albatrosses, petrels, and shearwaters regularly occur within IATTC boundaries.

Resolution C-11-02 needs to be revised to include new best practice seabird bycatch mitigation measures throughout the IATTC a. This revision will further improve benefits to seabirds through harmonization with the WCPFC, which has already adopted these new measures.

Discussion

One Member noted that when considering modification of mitigation measures, it requires not only seabird density, but also what interactions occur where and with which species. It pointed out that information related to bycatch was not included in this document. It noted that observer data could show where the mitigation measures were needed. In its opinion, there was not adequate information in the document to support the mitigation measures that the documents recommended. Specifically, it noted that at the present time, there is a lack of scientific evidence supporting a requirement of two bird-scaring lines, as proposed in the Appendix of SAC-07-08. The definition of density was discussed, and Lisa Ballance indicated that the maps do not reflect density of individual seabirds, but instead species richness or number of species present. Several Members noted that the IATTC has requested seabird data through resolutions, and suggested harmonization of seabird conservation measures with the WCPFC.

One Member asked if the information on sightings was based on dolphin surveys in the Mexican EEZ, and Lisa Ballance confirmed that they were from 2006 surveys in that region as well as more recent surveys near Hawaii. It was noted that the sighting data are nearly 10 years old and that recommendations may be based on dated information.

7. RESEARCH:

7.1. Staff activities and research plans

Rick Deriso reviewed the research activities of the staff presented in SAC-07-07a.

Discussion

A discussion ensued about the IATTC's integrated research plan and the value of the Achotines Laboratory for conducting experimental research on tuna ecology and recruitment while generating outside support. The Director stated that he would prepare a document to create a more-integrated research plan.

7.2. Ecosystem considerations

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 summary of a recently completed global diet study of tunas was provided. Predator-prey data for yellowfin, bigeye and albacore tunas, collected over a 40-year period from the Pacific, Indian and Atlantic Oceans, were used to quantitatively assess broad, macro-scale trophic patterns in pelagic ecosystems. Collation of these data, representing more than 10,000 predators, in a global database, was a critical first step underpinning the analyses. A classification tree approach showed significant spatial differences and partitioning in the principal prey items consumed by all three tuna species, reflecting regional distributions of micronekton. Generalized additive models revealed that diet diversity was mainly driven by regional-scale processes and tuna length. In regions of low primary productivity, the diet diversity of yellowfin tuna was more than double the diversity values in regions of high productivity. Ontogenetic and spatial patterns in diet diversity were found for bigeye tuna. Regardless of size, diversity was greatest in the eastern and central Pacific Ocean and lowest in the western Pacific and north Atlantic Oceans. Diversity of small bigeye (<684 mm fork length) in the western Pacific was lower than for large bigeye tuna in the same region. Diet diversity of albacore tuna was globally higher than that of the other tunas and was uniformly high in all oceans except in the oligotrophic Mediterranean Sea. These results suggest that the current expansion of warmer, less productive waters in the world's oceans may alter foraging opportunities of yellowfin tuna due to changes in the regional abundance of prey resources. Due to the larger depth range across which bigeye and albacore tunas forage, these species are less likely to be affected by changes in temperature and other environmental processes at the surface and within the mixed layer. Well-planned, long-term diet studies for large pelagic ecosystems are needed to test these preliminary hypotheses.

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 2014 for three purse-seine fishing modes in the EPO.

In 2015 a vacancy announcement for an Ecosystem Specialist was posted. The selected appointee, Dr. Shane Griffiths, a senior scientist and recognized expert in Ecological Risk Assessments (ERAs), will join the IATTC staff in August of 2016. He will lead the ERA effort for the EPO. A review of a preliminary ERA using Productivity and Susceptibility Assessment (PSA) prepared for the large purse-seine fishery in 2015 was presented.

In response to requests made by the Members at the 2015 SAC meeting, an effort was made by the IATTC staff to evaluate the possibility of including data for gear types other than large purse seiners in an ERA (described in SAC-07-INF C(d)). Although some information on retained catches of non-target species is reported for small purse-seine (Class 1-5; ≤ 363 metric tons carrying capacity), pole-and-line, and longline fisheries, the information appears to be incomplete, not validated, and/or is of limited use for an ERA because species identifications were not provided or could not be verified. In addition, information on at-sea discards is limited for fisheries other than those of large purse-seine vessels. This lack of fundamental information on species composition and total catches severely compromises our ability to produce a comprehensive EPO ERA. Progressing in the absence of such critical data is likely to lead to inappropriate management action. This review will be addressed with Dr. Griffiths and a plan to progress this work will be devised.

Discussion

The discussion centered on details of the mean trophic levels of the catch, the Ecological Risk Assessment and where the next steps can be taken. Members suggested that an examination of the effects of El Niño on the mean trophic levels would be interesting. One Member proposed that workshops on the productivity and susceptibility assessment should be held to include collaboration with ecosystem scientists and stakeholders.

7.3. Review of research at the Achotines Laboratory

Dan Margulies presented a summary of the research program conducted at the IATTC's 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.

From 1996 to present, the IATTC has conducted research on the reproductive biology in captivity and early life history of yellowfin. 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 Achotines Laboratory section of the IATTC website (http://www.iattc.org/AchotinesLab/AchotinesPublicationsENG.htm).

7.4. Promising links between yellowfin early life research and stock assessment

7.4.1. Laboratory and *in situ* growth of larval and juvenile yellowfin

Much of the experimental efforts with yellowfin at the Achotines Laboratory have focused 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)

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.

7.4.2. 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. A series of laboratory experiments were conducted 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. $7.4 \times 10^{-9} m^2 s^{-3}$ to $2.25 \times 10^{-8} m^2 s^{-3}$ as an energy dissipation rate) than at lower or higher levels of turbulence. 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. 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.

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

In 2011, the IATTC, Kindai 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 has been 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 warm-water ecosystems as nursery grounds, thus providing a common background for comparative studies. Experimental results will also be used to comparatively model mortality processes 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. During 2015, yellowfin early-juveniles were transferred to a sea cage near the Achotines Laboratory for the first time worldwide.

7.4.4. The effects of ocean acidification on yellowfin eggs and larvae

The 5th Intergovernmental 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, yolk-sac 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. Several additional analyses of the study results are ongoing.

Discussion

A Member asked if the larval parameters that have been studied could be extrapolated to explain low catches of yellowfin in the past few years in the EPO. Margulies indicated that the larval parameters studied influence pre-recruit survival and that the research was focused on long-term predictive forecasting. The models of pre-recruit vital rates are not quite at the predictive stage, but they are progressing in the right direction.

A Member asked about the alternative use of variance in growth, rather than mean growth, as an index of pre-recruit survival. Margulies indicated that the approach of the IATTC research group was to examine mean growth, but that an examination of growth variance in larval and early-juvenile yellowfin in relation to recruitment would be an interesting and valid comparison as well.

A Member asked if other environmental variables, such as productivity or water temperature, could be included in the analysis of microturbulence effects on larval survival. Margulies noted that factors such as zooplankton density and water temperature have been studied by the research group at the Achotines Laboratory, and these factors could be added to the microturbulence analysis.

Rick Deriso inquired as to the source of increased larval mortality in response to acidification. Margulies indicated that there are direct lethal and sub-lethal effects of acidification on organ tissues, particularly on those organs involved in acid-base regulation, and there are also apparent effects on organs involved in foraging and prey capture, resulting in a trend of decreasing feeding success with acidification.

7.5. Extra-budgetary funded research projects

Rick Deriso presented on research projects that received extra-budgetary funding (SAC07-07d).

Discussion

Many Members stressed the need to effectively find other sources of funding for these kinds of research projects. The Director clarified that there is no Staff member in charge of looking for outside sources of financial resources and that the implementation of a long-term research plan would enable it to be worked in an more organized manner in this respect.

7.6. Predicting catches of bigeye tuna

Cleridy Lennert-Cody presented preliminary analyses of several options for reducing bigeye tuna catches. The current management measures for bigeye tuna in the eastern Pacific Ocean (EPO) include, in addition to the 62-day general closures of the purse-seine fishery, a 30-day closure of a relatively small area of the EPO west of the Galapagos Islands, known informally as the "*corralito*", from the end of September to the end of October. However, there is the perception that additional management measures may be needed. The document that is presented describes the results of an analysis of areas of high catches of bigeye during 2001-2015, using data from floating-object sets by IATTC size Class-6 purse-seine vessels. The results of this analysis were used in a simulation to explore the potential of spatial closures to reduce catches of bigeye in the purse-seine fishery. The simulation results suggest that an annual closure of the equatorial EPO west of 120°W could potentially yield greater reductions in catch of bigeye than losses of catch of skipjack tuna. Future work should include optimization of the closure area boundaries and more realistic simulations of effort reallocation.

Also presented in this document is an update of analyses of the effect of environmental factors and fishing gear characteristics on the probability of catching bigeye in floating-object sets by large purse-seine vessels, using data from 2012-2013. The results of this analysis are consistent with previous studies, and indicate that the location of fishing and environmental factors may have a greater effect than gear characteristics on the probability of catching bigeye. However, also consistent with previous studies, this analysis found that the probability of catching bigeye was greater with deeper purse-seine nets and with floating objects with greater underwater depth; an updated analysis of spatial patterns in these gear effects has not yet been done. Weekly environmental data for 2014 were used to illustrate the possibility of forecasting areas with high probability of bigeye catches in near real-time. The weekly forecasts show temporal changes in the areas with the highest estimated probability of bigeye catch, within a fairly stationary offshore region of the EPO. Future work should include validation of the forecasting results.

Discussion

Many Members noted the importance to continue carrying out these types of analyses in order to have better and different alternatives of management measures beyond closure date proposals. They also pointed out that similar work should be done for other species, especially for yellowfin tuna and skipjack. It was recommended to include in these analyses other variables such as captain performance and individual vessel catch as well as to collaborate with the work already in progress in other RFMOs, such as in WCPFC.

The staff made known another research project that is undergoing comparing net mesh size with the sinking speed of nets.

Another Member requested that unilateral conservation measures such as the Costa Rica EEZ closure which has been in effect for three years should be analyzed to verify the impacts that they have on small yellowfin tuna catches and recruitment.

7.7. The purse-seine fishery on floating objects:

7.7.1. Indicators

Floating-object sets of both small (Class 1-5) and large (Class-6) purse-seine vessels has increased since 2005 while a decreasing trend has been observed in purse-seine catch-per-floating-object-set, for YFT, BET and SKJ. These changes in the dynamics of the fishery on floating objects have prompted the need for a review of the data available for small vessels. Large vessels are sampled by observer programs, providing detailed information on tuna retention, bycatch and dynamics on floating objects. On the other hand, small vessels are rarely sampled by observer programs, and the fishing data is collected almost exclusively from vessel logbooks, and as available, from cannery records which may not provide full information on species composition of retained catch for non-target species nor provide information on at-sea discards of tuna and non-target species. A lack of detailed information on the fishing activities on floating objects of small vessels may compromise management of the purse-seine fishery. In terms of non-target species, small-vessel fish on unassociated schools of tunas and on tunas associated with floating objects. The effort distribution is more coastal, and overlaps the effort on unassociated and floating objects made by large vessels, and in some periods and areas the effort on small vessels is equal or greater than those from large vessels. It is known that large vessels capture several non-target species as bycatch which may also occur in sets made by small vessels fishing in these overlapped areas. One option that may help with the task of collecting information on FADs and on non-target species composition is that from Electronic Monitoring Systems (EMS). These systems have proven efficient for identifying and quantifying bycatch of large-bodied species, and may also be effective for FAD fishery.

Discussion

Many Members pointed out the lack of data from purse-seine vessels smaller than Class-6 and its possible implications on tuna stocks and other species. From the presentation they noted that the impacts of tuna catches are similar to catches from Class-6 vessels, and proposed to enhance the use of observers on these vessels or the use of electronic monitoring systems, taking into consideration the costs and the viability of its implementation. Obtaining more data will also help in evaluating the impacts on other bycatch species such as sharks as these vessels mostly fish on FADs where there is an increase of incidental catches.

7.7.2. Evaluation of declining catch per set

Mark Maunder gave a brief presentation about the increasing effort in the purse-seine fishery on floating objects in the eastern Pacific Ocean (EPO) and its correlation with reduced catch per set (CPS) for all three major tropical tuna species, particularly bigeye tuna. There are many possible hypotheses that could explain the correlation between increased effort and declining CPS, but we focus on three that we consider most probable: (H1) declining abundance, (H2) declining number of tuna per FAD, and (H3) change of targeting practices. Given the currently available data, it is difficult to determine the cause of the decline in catch per set of bigeye in the EPO floating object purse-seine fishery. There does not appear to be any evidence supporting any one of the three hypotheses over the others. However, the reduction in CPS is unlikely to be due to changes in spatial distribution of the fleet, increase FAD webbing depth, or increased purse-seine net depth. The stock assessment does not estimate an impact of the increased number of FAD sets on the bigeye populations. Research and data collection are needed. The most important piece of data is a measure of the local FAD density at a given time. The reasons why the number of sets is increasing at a faster rate than the capacity of the fleet should also be investigated. The additional sets may have lower catch rates of bigeye.

Discussion

A Member commented that the assessment was good but does not estimate the impact of the increase of FADs used on the tuna population, and the number of sets made using FADs can have an important effect. The staff responded that the stock assessment accounts for the catch but does not account for the reduced catch/set.

Another suggested that the use of echo sounders on FADs results in increasing fishing effort, noting that they are used in approximately 76% of FADs and allow vessels to operate more efficiently because it allows them to evaluate what is under a given FAD without traveling to it.

A Member noted that the average weight of bigeye tuna was 4.7 kg which is smaller than any value in six years, and which is markedly different that the average of 8 kg in 2011, insisting this should be considered in the review of this topic.

It was asked if there is evidence, considering the application of the IATTC operational harvest control rule, to support the assumption that it is unlikely that unforeseen environmental conditions could cause severe decline in SKJ recruitment but not in BET so that management action on BET at least equally protects SKJ?

The staff responded that the management of tropical tunas in the EPO is based on an operational HCR that essentially uses a seasonal closure to ensure that the fishing mortality is no greater than F_{MSY} for all three species. A comprehensive assessment is not available for skipjack tuna, therefore based on their higher productivity than the other species it is assumed that adequate management for bigeye and yellowfin will ensure that skipjack fishing mortality is below F_{MSY}. It is also assumed that recruitment is independent of stock size and we consider dynamic reference points (i.e., B_{MSY} changes with recruitment fluctuations) therefore we focus more on applying F_{MSY} rather than B_{MSY}. F_{MSY} does not change with recruitment variation, it changes with (assumptions about) natural mortality, growth, steepness of the stock-recruitment relationship and selectivity. Therefore, as long as F is proportional to effort and the environment does not change the biology of the species, the logic of F_{MSY} management based on BET or YFT protecting SKJ still holds. There is little information about growth or how it changes over time and we have no information on natural mortality. It is unlikely that temporal changes in skipjack biology will reduce its productivity below that of YFT and BET.

7.7.3. Analysis of implementation of harvest control rules and reference points

The IATTC has used seasonal closures to manage the purse-seine fishery for tropical tunas in the eastern Pacific Ocean since 2002. Interim target and limit reference points based on maximum sustainable yield (MSY) and reductions in recruitment, respectively, have been adopted for these tunas. This analysis evaluates the use of the harvest control rule (HCR) used by the IATTC, which is based simply on limiting fishing mortality (F) to levels that do not exceed the level corresponding to the MSY.

Until 2010, the implemented closures were shorter than indicated by the stock assessments and recommended by the IATTC staff; however, since then they have been consistent with both. The stock assessments, which cover the 1975-2014 period, estimate that for most of that period the fishing mortality of yellowfin and bigeye tuna has been below the level corresponding to MSY. No assessment is available for skipjack tuna, but the fishing mortality increased starting in the early 1990s and leveled out in the late 2000s.

It is currently not possible to evaluate the appropriateness of the limit reference points unless some assumptions are made about the population dynamics of tuna (*e.g.* steepness of the stock-recruitment relationship). Extensive meta-analysis shows no evidence for depensation, and when fishing pressure is reduced, stocks almost always increase in abundance, indicating that hard biomass-based limit reference points can be set at low levels of abundance. (A ‘hard’ reference point demands strict and prompt management action if a stock falls below that point; a ‘soft’ reference point requires only that appropriate action be taken within a reasonable time.) The appropriateness of the HCR with respect to the limit reference points has not been thoroughly tested. A preliminary management strategy evaluation (MSE) for bigeye tuna indicated that the HCR based on F_{MSY} is appropriate and will result in a low probability of exceeding the limit reference point. A more comprehensive MSE is needed to evaluate the HCR. Alternative HCRs that include soft and hard limit reference points, use biomass-based reference points, and establish well-defined management actions when reference points are exceeded, should be considered.

Discussion

The ISSF mentioned that the IATTC has previously discussed harvest control rules, but none have been adopted by the Commission and urged progress on this issue.

A Member stated that each harvest control rule should be fishery specific, and in that way, differences in fishing effort over time can be observed by each fleet.

A Member mentioned that the measure (control rule) restricts only catch but not capacity. Other member underlined that the inclusion of capacity should be considered with careful because the capacity operating in the EPO has increased by fleet (some fleets have not grown) and it can complicate the current model.

A Member pointed out that the current IATTC purse-seine closure is driven by the stock status of yellowfin tuna, while the proportion of longline catch of yellowfin tuna is minor. Nonetheless, they noted that the longline catch limits for bigeye are subsequently linked to the purse seine-closure. In considering future management measures it could be useful that the harvest control rules include fishery-specific fishing mortality and to apply a fishery-fleet specific fishing mortality to reflect the historical changes of effort by fleet.

7.7.4. Research on Management Strategy Evaluation

At its 87th meeting in October 2014, the IATTC adopted interim target and limit reference points for two species of tropical tunas, bigeye (*Thunnus obesus*) and yellowfin (*T. albacares*). The target reference points are the biomass (*B*) and fishing mortality rate (*F*) corresponding to the maximum sustainable yield. The limit reference points are those associated with a 50% reduction in recruitment under a conservative assumption (h = 0.75) about the relationship between stock size and recruitment, expressed as steepness (h; see Maunder and Deriso 2014). The IATTC has operated under the informal HCR of fishing at F_{MSY}, or more accurately, reducing the fishing mortality to F_{MSY} if fishing mortality on bigeye or yellowfin exceeds F_{MSY} for that species, as estimated by the base case stock assessments.

Previous work has included the development of a procedure to conduct management strategy evaluations (MSEs) using *Stock Synthesis* and applied to Pacific bluefin tuna as a "toy" example, and a preliminary MSE on bigeye tuna to investigate the appropriateness of the operational F_{MSY}-based HCR, given the new interim limit RP. During 2015 the IATTC staff, in conjunction with FAO and WWF conducted a workshop "to accelerate the development of tuna harvest strategies within the Eastern Pacific Ocean by assisting IATTC Commissioners and technical advisors to become familiar with the MSE process and the way that scientists and decision makers should work together towards selecting and implementing robust [harvest strategies]." IATTC staff also participated in the 2015 ISSF Stock Assessment Workshop on Characterizing Uncertainty in Stock Assessment and Management Advice and conducted a MSE for dorado. Plans for future work include a preliminary MSE on tunas in the EPO. A Joint MSE Technical Working Group has been established by the tuna RFMOs. Additionally, the ISC has a work plan to develop a process for evaluating the performance of alternative management procedures for north Pacific albacore.

It should be noted that the results of MSE will be highly dependent on the choice of operating models used to represent the states of nature. Stock assessment must be conducted to develop the operating model. Therefore, MSE should not be thought of as a replacement for stock assessment; in fact, it means that additional stock assessment research is needed to ensure that the uncertainty about the assessment is accurately represented, and that arbitrarily-chosen operating models do not influence the results of the MSE.

Discussion

The staff noted that we are operating under harvest control rules (HCR) based on maximum sustainable yield (MSY).

A Member stated that MSE is an important concept, but difficult to explain to stakeholders. He also commented that MSE is similar to full stock assessments in that they can take considerable time to complete and require extensive dialog with scientists and managers which can be challenging. Given that, the SAC should recommend strengthening dialogue with managers and scientists. The Director replied that a project already exists at this respect, but that it could not be fully implemented due to a lack of adequate funding.

8. STAFF CONSERVATION RECOMMENDATIONS FOR 2016 AND BEYOND

The SAC reviewed the conservation recommendations made by IATTC staff and provided the following comments:

8.1. Yellowfin, skipjack, and bigeye tunas

The Members inquired the reason why the increase of the operating capacity was not included in the report for 2015, considering that a lot of that was used in that year. Rick Deriso indicated that as it can be seen in the weekly reports sent to the Parties, the increase in operating capacity occurred gradually and the total numbers were not available until after the calculations were made for last year's recommendations. A discussion followed about the nature of that operation as some of these vessels were able to make a single trip. The Director indicated that the operating capacity increase was the result of Parties using capacity available for them and that was not used until the beginning of 2016. In that year, no vessel indicated in paragraph 12 of resolution C-02-03, made use of its right to make a single trip and the increase in capacity was not the product only of one Party but several, including vessels with a capacity greater than initially indicated, as a consequence of a more recent measurement.

Some Members stated that not being aware of the increase of the operating capacity would create this problem and that the advice to their administrations has been made on the premise that the operational capacity was steady. The Director reminded the Members that all increases were made in accordance with the guidelines in the resolutions as adopted by the Commission.

Some Members inquired if alternative control methods could be included in the recommendations in order to avoid an increase of days of closure which would be difficult to implement due to socio-economic considerations. Among the ideas mentioned were limits on the depth of the net, or the increase of the size of the offshore closure area, or even the development of closure in areas of sensible ecosystem implications as those developed by Costa Rica or even divide a long closure for a single vessel in two different times of the year, so vessels can prepare for operations or even a differentiated closure for the different modes of fishing, on dolphins and FADs specifically.

Another Member indicated that it would be desirable that the staff develop a list of reasonable guidelines of alternatives, based on scientific evidence, for the Commission to evaluate, but other Members indicated that the same exercise, when applied to the capacity workshop in Cartagena, Colombia did not yield viable options.

In accordance with the approved introduction of an item to be considered by the SAC linked to the general question of the capacity of the fleet, the delegation of Guatemala, after an introductory statement to provide background to its claim of capacity and to the decision of the Commission at its 88th meeting (extraordinary) to consider that request favorably without further need for review, asked several questions to the IATTC scientific staff. In response to these questions, the Coordinator of Scientific Research, Rick Deriso reminded Members that these questions had been already considered in previous meetings and that, in addition to a general obligation to follow a precautionary approach, a document had been produced last year, SAC 06 INF B, which contained a series of scenarios corresponding to the increased capacity deriving from the various disputes and claims under consideration of the Commission and their effects in terms of the compensatory conservation and management measures that should be adopted. He called in particular the attention of Guatemala and the other Members to Scenario 7, which describes how the increase of 3762 m^3 requested by Guatemala would be compensated through the establishment of five additional days of closure. He highlighted that this was but one of a total of 11 scenarios, each one leading to a different number regarding the days of closure to be adopted.

Guatemala also referred to the question of the recent activation of 25,000 m^3 and asked more specifically if some of the flag States concerned had informed of conservation and management measures that they would have taken unilaterally to compensate that activation. The Director responded that they had only informed on their intention to activate their respective capacity.

On this basis, Guatemala requested that, in order to allow for the activation of its already approved capacity, five days mentioned by Dr. Deriso be added to the number of days for closure that had been recommended by the scientific staff, from 82 to 87 days, in the understanding that, afterwards, the Commission was free to discuss the adoption instead of other compensatory measures. Venezuela supported the statement made by Guatemala and asked to receive the same treatment since the Venezuelan request has been also considered favorably by the Commission at its 88th meeting (extraordinary) without further need for review, that is increasing the closure by two additional days. In subsequent statements, both Guatemala and Venezuela strongly emphasized that their requests had been already approved and that the only pending issue was the question of the activation of the requested capacity. This was the reason why the SAC should consider, for these two cases only, the impact that the activation would have and the compensatory measures that should be recommended. For the other cases, it would be more appropriate to wait for the Permanent Working Group on the Capacity of the Fleet and the Commission itself to consider them and take a decision in their respect.

Ecuador and Costa Rica expressed that they could not support the consideration of one or two individual cases, and that all cases should be considered jointly regarding the adoption of compensatory measures, with an emphasis on alternate measures of less social and economic impact than merely increasing the number of days of closure.

Nicaragua clarified that the cases put forward by Venezuela and Guatemala were different since their respective claims were already approved by the Commission, why such approval were still pending for the other cases. For that reason, Nicaragua supported the proposal made by Guatemala and Venezuela that the SAC indicate the number of additional days that should be added to those indicated by the IATTC scientific staff in their recommendation if the Commission confirms that it approves the activation of the capacity requested by these two members. Mexico expressed later in the discussion a similar position.

The European Union emphasized that this discussion was entering into an area that was not under the scope of this Committee and was of the competence of the Commission alone.

Costa Rica, while approving that the question of the activation by Guatemala and Venezuela of their request of capacity be considered by the Commission, reminded Members of its own request, also conditioned by the adoption of compensatory measures, not only in terms of closure days but also of other measures. It expressed the wish that the SAC might indicate which other measures would be necessary to compensate its request for 7058 m^3.

The Director clarified that all specific recommendations in this respect should be made by the SAC itself although it could be considered that there was a consensus that the staff could prepare a set of scenarios of alternative measures, beside its original recommendation regarding the increase of the number of days of closure. Peru and Guatemala agreed with that interpretation and approach regarding the need for the SAC itself to reach conclusions and adopt the appropriate recommendations concerning the measures to be taken, including the alternative ones.

Colombia recalled its own request and reiterated that an addendum to the document SAC 06 INF B referred to by Rick Deriso with an additional scenario based on that request be added, as already agreed during the 89th meeting of the Commission.

The SAC then considered several possible recommendations, including, if the Commission decides to activate the capacity of Guatemala and Venezuela, considered favorably at the 88th meeting, an increase in the closure period as recommended in Document SAC-06 INF-B, as a conservation measure that offsets that capacity. The European Union stated that it did not agree with this recommendation because it considers that the process of formulation and its contents go beyond the scientific scope that is the remit of this Committee, and goes into elements that are strictly within the competence of the Commission. The Director indicated that the recommendation would include any alternative options that the staff think would be feasible to apply and monitor and would be presented to the Commission.

8.2. Pacific bluefin tuna

Showing its disagreement, Japan noted that the staff encouraged WCPFC to adopt additional measures to reduce the catch of adults. It wished that cooperative relationship among Members to date will continue for adoption of a new Resolution at the 90th Meeting of the IATTC. Japan also pointed out errors in the characterizations in SAC-07-08, noting that the latest assessment was 2016 rather than 2014 and that the Resolution analyzed in the ISC projections was C-14-06, rather than C-12-09.

8.3. Northern albacore tuna

The Members had no comments on this recommendation.

8.4. Harvest Control Rule (HCR)

Japan showed concern that the recommendation on reference points of Pacific bluefin tunas were not included in the document SAC-07-08 and were showed suddenly in the presentation. Japan announced that the WCPFC Northern Committee is considering and developing reference points and harvest control rules of PBF.

Rick Deriso noted that, indeed, reference control rules had been approved only for tropical tunas. Some Members noted that for HCR could not be applied to bluefin tunas in that case. They also indicated that it did not seem to be logical to use the same HCR as recommended by the northern committee, and that it did not seem correct to only include the purse-seine fishery in this**.**

A discussion followed on the mechanism of the way reference points and HCR are related to the instructions from the Commission either in the minutes or a resolution. Deriso indicated that, indeed, there is no specific approval of the Commission and that the idea of the staff was to rebuild the targets based on changes on the fishery.

One Member indicated that it was desirable that HCR would be applied to the non-tropical tunas as well and that the report should reflect this and maybe include this as a recommendation from the SAC to the Commission.

Japan commented that in considering future management measures it could be useful that the harvest control rules include fishery-specific and fishery-fleet-specific fishing mortality.

8.5. Conservation of sharks and mobulid rays

The staff noted that some of the recommendations were mitigation measures and some were a reorganization of measures already approved by the Commission.

One Member noted that its understanding of the difference of the new recommendations compared with what was presented by the staff last year, was that they were asked to make consultations with the stakeholders to propose different management provisions for directed and non-directed fisheries and reminded that at the beginning there was a proposal for a six-month closure.

The staff indicated that the consultations were made and that the staff identified that the proposal of a three-month closure would have the best chance to be approved by the members and would still provide a reasonable measure of control.

Mexico noted that they already had a three-month closure on the directed fishery from May to June, based on scientific evidence, but mentioned that for non-directed fisheries it did not seem to make much sense to prohibit the retention of all species of sharks, considering that there is scientific evidence that most of the specimens in the catch were mostly dead. Instead, this delegation was in favor to underline the importance of releasing sharks alive to the extent practical. Martin Hall mentioned that still, a considerable proportion was surviving, and that research was needed in post-release survival using improved techniques.

Some Members were concerned that the prohibition of shark lines would be implemented on artisanal vessels that could be affected, and requested that the recommendations make note of the size of the vessels to prevent an unwanted impact on artisanal vessels. Martin Hall replied that shark lines seem to be specific to deeper sets than those used by the artisanal fleets.

One Member indicated that the work of Keisuke Sato included a series of recommendations for vessels targeting big-eyed tuna, to protect silky sharks and they would like to see this included in the recommendations. Besides, it would recommend that the IATTC would implement the guidelines approved by the WCPFC for whale sharks.

Some Members expressed support for prohibit retention, but one noted that on purse seiners, the process of 'brailing' (loading the fish from the surface of the ocean to the wells of the vessels) would make it difficult to prevent dead sharks from being loaded with the fish, particularly if a sorting dispositive is not used, which is what most vessels that fish on dolphins use more often. The use of the hopper would facilitate observation and release of sharks.

The Defenders of Wildlife and other NGOs submitted joint statements (Appendix B).

8.6. Conservation of Seabirds

Japan noted that the first part of document SAC-05 INF-E[1] was aimed at harmonizing measures by all tuna RFMOs, but it offered no scientific evidence for the need for that. It further commented that there were no scientific evidences for that application of two bird-scaring lines, specified in Appendix of SAC-07-08, at the present time, and added that it is not reasonable to apply two bird-scaring lines in the IATTC convention area, as recommended by the staff. Another Member mentioned that the information on the mitigation measures referred in the second section of the document seemed to be out of date and its effectiveness could be questionable.

The Director indicated that the staff accepted the recommendation of ACAP and that is what it was forwarded to this group, but in reality the IATTC staff did not have the expertise of working with this kind of mitigation measures.

Mexico offered to provide information of research made by a Mexican scientist on seabird interactions in the area the west coast of Baja California, in which it is stated that there are no seabird interactions with inshore longline fisheries[2].

8.7. Handling of sea turtles in longline fisheries

The US indicated that their longline vessels have a requirement of using circular hooks and expressed that maybe that should be taken in consideration for the recommendations from this group.

Martin Hall noted that extensive work on using circular hooks in the coastal areas of Central and South America was done in the past by the staff in conjunction with Takahisa Mituhasi, a Japanese scientist with support of the Overseas Fishery Cooperation Foundation, a Japanese agency and WWF. This work included the use of different types of circular hooks, and although these showed in general that the use of circular hooks would reduce the number of turtles, mostly olive ridleys, that would have lethal interactions with the gear, in certain areas and seasons, some of these hooks seemed to increase the catch rate of certain species of shark. In general, olive ridley turtles seem to be in recovery and some of the species of sharks were greatly depleted. Because of this, the decision of the Staff was to provide all the information available to each participating Member in order for them to determine how best to address these situations.

One Member requested that there would be a definition of the size of the vessels impacted by the recommendations in order to prevent undesirable effects on artisanal fisheries.

8.8. Fishing gear configurations

Japan noted that the data to be collected was abundant and requested scientific basis for the requirement item by item. Martin Hall replied that this data should be provided by the vessels because even with an observer, the technical details of the composition of different parts of the net on purse-seine vessels, for example, was very difficult to assess. For instance, analysis showed that for example, nets with larger mesh size may have a faster sinking rate which at the same time may have an effect on catch and bycatch. Also,

[1] Prepared by ACAP and Birdlife International

[2] Brito-Chavarría, M. 2011. Captura incidental de aves marinas por la pesquería artesanal de las costa occidental de Baja California, México. Masters thesis, Centro de Investigación y de EducaciónSuperior de Ensenada, Mexico. 57 pp.

the work mentioned above, on circular hooks, showed the very significant impact of gear characteristics on catch rates. Japan also commented that this information should be collected by a scientific observer concerning the increase of the burden of fishermen.

8.9. Non-entangling FADs

One Member indicated that this is a practice that is being adopted by many purse-seine fleets, voluntarily, and required only that the mesh used be wrapped like a sausage for FADs that are deployed with hanging material, instead of forbidding the use of mesh.

Martin Hall indicated that, although the evidence in the EPO was that entanglements do not seem to be a problem, the idea was that any material that has the potential to entangle fish, should be avoided and alternative materials should be explored.

8.10. Identification and marking of FADs

There was no initial reaction from the Members. Martin Hall mentioned that this request was the alternative to the original recommendation of the staff in the sense that, to make more complete analysis and possible to have a census of FADs, it would be more practical to have the information of the satellite buoys that the data providers have. As some of the Members made the point that these could be considered proprietary commercial data, the staff had recommended that the data would be provided not in real time but with a delay of time to be decided by the Commission. The staff consulted with the stake holders and this recommendation was the result. Nonetheless, this marking depends on the fact that the observer can see and read the marks and this is probably the most challenging part of the work. It also creates a cost that would seem unnecessary considering that the electronic information is available.

The Members decided that a more-detailed discussion should take place in the workshop following the meeting of the SAC.

8.11. Improving the quality of bycatch data from purse-seine vessels

There were no comments from the Members on this.

8.12. Observer coverage of longline vessels

There was a discussion on the basis of the proposed increase coverage and how it was determined that a 5% coverage was too low. Rick Deriso noted that the United States had made extensive analysis on the adequate coverage for the longline fishery and it had determined that the best way to make annual assessments of bycatch would be done with a 20% coverage, but 5% may be adequate, for example, to make an assessment based on a 5-year average. Then, it would be up to the Commission to determine the adequate level, based on the need for an accurate assessment and its periodicity.

One member noted the need for more information on the actual operational capacity of longline vessels in the IATTC Regional Register and their presence in the EPO.

Regarding the staff’s explanation that 5% coverage is too low to allow for accurate estimates of the catch of species caught infrequency in those fisheries, Japan commented that a 5% coverage may be still be sufficient to collect scientific information on target species, as well as comprehensive data on interaction with non-target species.

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

The Members asked about the feasibility of an assessment of costs related to electronic monitoring compared or in addition to using human observers. The Director commented that the staff will ask ISSF to provide information on the costs of the recent deployment of electronic monitoring systems on a small, Ecuadorian purse-seine vessel.

9. STRENGTHENING THE SCIENTIFIC ADVISORY COMMITTEE IN THE PERFORMANCE OF ITS ROLE AND FUNCTIONS:

In addition to taking this opportunity to review briefly the situation regarding the implementation of the 9 recommendations adopted at the 6th meeting of the SAC in 2015, and in spite of the fact that the report on the performance review of the IATTC and the AIDCP was not available yet, the Members did make some comments and suggestions.

Colombia, supported by Nicaragua and Venezuela, proposed that during the next meetings of the SAC matters be grouped in blocks or units and that all matters and questions related to tropical tunas be considered together and first and other species afterwards.

The European Union, which had proposed the inclusion of this item in the agenda, expressed its conviction that the performance review report would certainly contain the developments regarding the work of the SAC and that the Committee could later continue to reflect on these issues. It proposed the following as issues for further reflection:It suggested.

- that a new item be introduced in the agenda for reviewing all the requests put to the SAC by the Commission
- that the organization and publication of the documents be improved in particular in order to give more visibility to the documents submitted by national scientists in addition to the documents prepared by the IATTC scientific staff;
- to ensure that at the end of the meeting of the SAC there is discussion and consensus on the text of the various adopted recommendations; work on the drafting of the other components of the SAC report and its adoption might be done later;
- to ensure a convergence between the recommendations made by the IATTC scientific staff and those adopted by the SAC, the recommendations should be consolidated in the presentation to the IATTC meeting, rather than addressing them separately (this suggestion was supported later by Venezuela).

Colombia insisted that the document containing the recommendations by the scientific staff should be posted, at least one week before the meeting, to be able to carry out the necessary internal consultations. Recognizing the merits of that comment, Rick Deriso stressed that a way forward might be to circulate the set of recommendations on target fisheries before those regarding by-catch and the other species, which in addition require more time to prepare, instead of waiting for sending all recommendations together. This proposal was supported by Venezuela and the United States, the latter taking this opportunity for reminding the Members of the need to address the question of prioritization.

10. OTHER BUSINESS

10.1. Format for reporting under Resolution C- 11-05

The SAC discussed the need to establish a format for the submission to the IATTC of the scientific observers' information on the previous year's fishery pursuant to paragraph 7 of Resolution C-11-08 *on scientific observers for longline vessels*. After some discussion, Members agreed that the work of the IATTC scientific staff and the objectives of the Commission overall would be best served where CPCs submit all of the data collected using the forms and explanatory handbooks drawn up by the Director pursuant to paragraph 5 of C-11-05.[3] The SAC noted that CPCs were not required, *per se*, to use the longline observer forms provided by the IATTC, since they are only provided in two languages which may be different than the languages spoken by longline crews and observers, but rather that these forms represent a minimum set of fields and data to be collected by their programs. In this sense, most Members of the SAC agreed that the contents of these forms represented the minimum level of detail and content of data that CPCs should in

[3] http://www.iattc.org/Downloads/Forms/LonglineNormal-forms-and-manual.pdf

turn provide to the Commission on an annual basis.

The Director also presented a draft format for reporting of metadata for the longline observer programs established under C-11-05. He emphasized that this format was modelled upon a similar format used in ICCAT and that this data complemented the data collected by the observers themselves using the previously mentioned forms published on the IATTC website.

After a few interventions that led to some minor drafting improvements and corrections, the SAC approved: the format (Appendix D) developed by the IATTC staff for collecting and reporting metadata and other details regarding the characteristics of each national longline observer program.

In view of the dissenting opinion of Japan, no consensus could be reached for the approval of the forms and field manual already used by the Commission and reproduced in Appendix C be used for the collection and submission to the Commission of scientific observers' data originating from their respective longline observer programs established pursuant to Resolution C-11-05.[4]

11. RECOMMENDATIONS TO THE COMMISSION

The Scientific Advisory Committee (SAC) makes the following recommendations:

1. That the staff present alternatives for management measures, such as: a single closure to be applied to all fisheries and vessel sizes, or a single closure with two periods during the year, the establishment of more time-area closures (like the *corralito*) where there is a high incidence of catch of juvenile bigeye and yellowfin tunas, individual vessel quotas, capacity reductions, and restrictions on fishing gear deployments, that would apply to fisheries on the basis of their relative impacts and as alternatives to the 87 days of closure proposed by the IATTC scientific staff for tropical tuna species in the years 2017 and 2018.
2. Support the staff's recommendation on Pacific bluefin tuna.
3. Over a five-year period, increase observer coverage of longline vessels over 20 meters length overall to 20% annual coverage.[5]
4. That countries with longline vessels over 20 meters length overall update which vessels are active, inactive, and/or sunk, and if possible inform the IATTC staff of the duration of their fishing operations.
5. Establish observer coverage for purse-seine vessels of less than 364 metric tons carrying capacity, and evaluate the use of electronic monitoring systems.
6. Evaluate the use of electronic monitoring systems with the objective of proposing minimum standards for adoption by the Commission and so augment observer coverage in longline and purse-seine fisheries.
7. Clarify the scope of the Antigua Convention with respect to associated species that are part of the same

[4] Comment by Japan: As provided at the discussion at the development of the recommendations of the SAC at this 7th meeting, Japan did not agree to approve the format for submission by CPCs to the Commission of raw data collected by national longline observer programs under Resolution C-11-08 (draft recommendation 3). Japan recognized that establishing a format for the submission of the scientific observers' information on the previous year's fishery was discussed at the SAC because paragraph 7 of Resolution C-11-05 provides that the format is established by the SAC. As the result of the discussion, Japan agreed to approve a format for reporting of metadata for the longline observer programs but did not agree to approve the format and content of Appendix C of the Report.

[5] Japan stated that it does not agree with this recommendation because it considers that the need of scientific observers described in the preamble of Resolution C- 11-08 can be achieved under the current coverage with an appropriate research plan. China, Korea and Chinese Taipei stated also that they do not agree with this recommendation.

ecosystem and are affected by fishing (e.g., sharks and dorado) in order to facilitate research and management priorities.

8. Build and strengthen the capacity of developing states in data collection, research, and compliance with IATTC measures (e.g., training workshops, data collection, analyses, and standardization of data), with the aim of establishing a data collection program for fisheries and vessels for which a lack of information has been identified
9. Establish a definition of artisanal fisheries (e.g., by vessel size, gear type, well size, etc.) in order to clarify which vessels need to submit data to the IATTC.
10. Strengthen and continue the work and research on FADs with the objective of designing a management plan for FADs as soon as possible.
11. That the staff continue to work on models for predicting catches of bigeye tuna, and expand these efforts to consider other species, particularly yellowfin tuna.
12. If the Commission decides to activate the capacity of Guatemala and Venezuela, considered favorably at the 88th meeting, increase the closure period as recommended in Document SAC-06 INF-B and its *addendum*, as a conservation measure that offsets that capacity.[6]
13. Establish or continue tagging programs for tropical tunas, silky sharks, and dorado, to improve estimates of growth and hypotheses of stock structure.
14. Evaluate unilateral management measures adopted by Members, like Costa Rica within its EEZ, and their impacts on stocks of juvenile bigeye and yellowfin tunas.
15. Strengthen scientific cooperation with the WCPFC and encourage the adoption of harmonized conservation measures for bigeye and bluefin tunas in both organizations.
16. The SAC thanked Japan for providing datasets including samples for its training and commercial vessels, separately. It was noted that, according to the information provided, training and commercial vessels seem to be catching different sizes. In light of these results the SAC recommended that the staff continues working with Japan in order to explore recruitment signals in the training vessel data.
17. The SAC congratulated the IATTC Secretariat for developing a tool to access the results of the assessments through the IATTC web page. It was noted that this tool is very useful and the SAC recommended that the Secretariat continue development of such tool into the future.
18. The SAC thanked the Secretariat for presenting the results of the work undertaken with the coastal countries to assess the status of dorado and capacity-building activities undertaken by IATTC staff. The SAC noted the socio-economic importance that dorado fisheries have in the region and recommended that this work continue in the future.

12. MEETING REPORT

The SAC agreed that the draft meeting report would be prepared by the Rapporteur with assistance from the IATTC staff, and then transmitted to all CPCs for their comments, revised, approved and published pursuant to Articles 45 to 48 of the IATTC Rules of Procedure.

13. ADJOURNMENT

The 7th Meeting of the SAC was adjourned on the evening of May 13, 2016.

[6] The EU states that it does not agree with this recommendation because it considers that the process of formulation and its contents go beyond the scientific scope that is the remit of this Committee, and goes into elements that are strictly within the competence of the Commission.

Appendix A

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Appendix B.

Statements by Defenders of Wildlife, Pew Charitable Trust, Humane Society International and Project Aware

On behalf of Defenders of Wildlife, PEW Charitable Trust, Humane Society International and Project Aware we welcome the Staff recommendations to the SAC.

Silky

We remain concerned over reported declines in silky sharks in the EPO, and strongly support precautionary measures to rebuild this species, now also listed on CMS Appendix II and proposed for listing on CITES Appendix II.

We urge the SAC to not only revisit the population assessment for this species, but also to issue updated advice for managers, including recommendations on the prohibition on the capture of the silky shark.

Hammerheads

CITES Appendix II requirements are also now in effect for scalloped hammerhead (*Sphyrna lewini*), great hammerhead (*Sphyrna mokarran*), and smooth hammerhead (*Sphyrna zygaena*), all of which are classified on the IUCN Red List as globally threatened. The IATTC can greatly aid in the implementation of these listings. We urge the SAC to focus on providing clear advice for hammerhead shark and issue recommendations to prohibit the retention.

Mantas

We applaud the addition of handling measures for sharks and rays which are complementary to the Recommendation adopted last year on Mantas and is consistent with WCPFC Good practices to reduce the Mortality of sharks and rays.

And finally we would like to stress the importance of recommendation 4 on the reporting of shark catches, by species, and of fishing effort, required by paragraph 11 of the resolution, making it mandatory for all vessels engaging in these fisheries.

--

Thank you very much for the presentation and preparation of these important documents, including the last one, which includes recommendations for improving the management of sharks. Defenders of Wildlife, PEW, Humane Society International and Project Aware believe that the lack of data on shark fisheries is one of the main deficiencies in the taking of effective decisions for the benefit of sharks and for compliance with obligations related in international and regional agreements, including RFMOs, CITES and CMS.

We agree this is necessary to obtain trade records on sharks from all countries, but especially for Central America, since this is a region that supplies international trade in fins and that complying with the species identification data is a necessary measure for complying with CITES to prepare DENPs and documents on legal acquisitions.

It is important to take measures as soon as possible due to the fact that sharks are highly susceptible for fishing for tunas and if we wait until we have all the scientific information, it will never be the best moment for taking recommendations. It is necessary to apply the precautionary approach to the subject of sharks since we have seen that for certain species the stocks are collapsing.

Therefore, we urge the Parties to the Commission to consider carefully the recommendations of this report at this meeting and at the annual meeting in this month of June, and that they consider presenting and adopting measures to improve the collection of data on sharks following FAO guidelines for data collection on shark fisheries products with the aim of obtaining data on shark trade and adopting a proposal that requires that all sharks be unloaded with fins attached or partially attached to the body with the aim of facilitating data collection through inspections of unloadings.

Appendix C

LONGLINE GEAR FORM

F2

VESSEL: ______________________________ SAMPLE No:_____ OBSERVER: ______________________________

Registration		Length	m	Fuel capacity	gal	Number of crew	
Company name		Width	m	Fuel used	gal	Water capacity	gal
Captain Name		Draft	m	Type of fuel		Catch conserve method	
Departure date/time		Distance deck to water	m	Type (fibra-mother ship)		If the vessel is a 'fibra', ↓ name of mother ship ↓	
Arrival date/time		Well capacity	MT	Number of fibras			
Departure port		Main motor		Navigation and fishing equipment:			
Arrival port		Aux. motor					

Characteristics	Quantity	Material *	Diameter	Length	Color *
Mainline			mm	Nm	
Upper gangion			mm	fath	
Middle gangion			mm	fath	
Lower gangion			mm	fath	
Floatline / dropline				cm	
Buoy			cm		
Flag					
Float			cm		

Distance btwn. hooks↓	Max. hooks on mainline↓	Number of lights↓	Number of radio buoys↓
bz			

Mainline weights:
Yes ( ) No ( )

Dropline connection to mainline:
Knots ( ) Snaps ( )

Mainline retrieval
By hand ( )
Manual crank ( )
Hydraulic crank ( )
Other __________ ( )

Fishing gear diagram

Hooks	Type (J / C)	Size	J-straight/ J-curved	Material*	Manufac-turer	Offset	Ring (Yes / No)	Other details	Observations
Hook A									
Hook B									
Hook C									

* Use numbers from code tables

F2s v2: 02/2012

F3

LONGLINE SET FORM

VESSEL: ____________________ **SAMPLE No:** _____ **OBSERVER:** ____________________

Set number		SET		RETRIEVAL		Number of hooks in the set by type:	Hook. A	Hook. B	Hook. ©		Type of bait	% of total
		Start	End	Start	End							
↓ Date ↓	LAT									Bait 1		
	LON					**Total** no. of hooks in set:				Bait 2		
	TIME					No. of hooks lost:				Bait 3		
Target Fishery	Set Special? Patrolled?	Yes ☐ ☐	Retrieval direction Start to end ☐ End to start ☐		Sea surf. temp.	No. hooks btwn. floats	Avg. hook depth fath	Bottom longline? Yes ☐ No ☐				
Observations:												

Set number		SET		RETRIEVAL		Number of hooks in the set by type:	Hook. A	Hook. B	Hook. ©		Type of bait	% of total
		Start	End	Start	End							
↓ Date ↓	LAT									Bait 1		
	LON					**Total** no. of hooks in set:				Bait 2		
	TIME					No. of hooks lost:				Bait 3		
Target Fishery	Set Special? Patrolled?	Yes ☐ ☐	Retrieval direction Start to end ☐ End to start ☐		Sea surf. temp.	No. hooks btwn. floats	Avg. hook depth fath	Bottom longline? Yes ☐ No ☐				
Observations:												

Set number		SET		RETRIEVAL		Number of hooks in the set by type:	Hook. A	Hook. B	Hook. ©		Type of bait	% of total
		Start	End	Start	End							
↓ Date ↓	LAT									Bait 1		
	LON					**Total** no. of hooks in set:				Bait 2		
	TIME					No. of hooks lost:				Bait 3		
Target Fishery	Set Special? Patrolled?	Yes ☐ ☐	Retrieval direction Start to end ☐ End to start ☐		Sea surf. temp.	No. hooks btwn. floats	Avg. hook depth fath	Bottom longline? Yes ☐ No ☐				
Observations:												

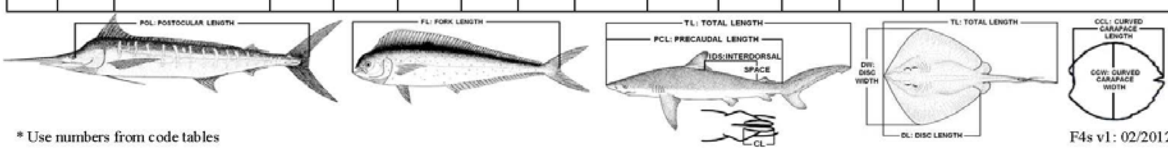
F3s v1: 02/2012

CATCH FORM

F4

VESSEL: ____________________ SAMPLE No: _____ OBSERVER: ____________________

Set No.	Time	Species name	Number caught	Hook A B ©	Hook location *	Dispo-sition *	Sex M=1 F=2	Weight (kg)	LENGTHS (cm)			Male sharks			Observations
									POL-FL-TL-CCL	PCL-*DL*	IDS-*DW*-CCW	CL (cm)	CAL	SEMEN	



* Use numbers from code tables

F4s v1: 02/2012

F5

TURTLE FORM

(Record turtle sightings only for hawksbill, loggerhead and leatherback turtles)

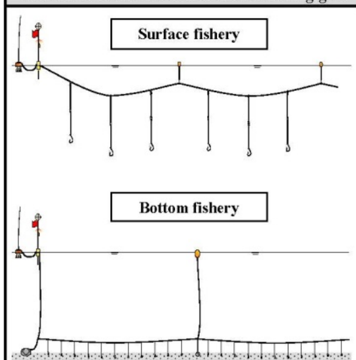
VESSEL: ______________________________ **SAMPLE No:** _____ **OBSERVER:** ____________________________

Date	Time	Set number	Species	Sex	CCL[1] (cm)	CCW[2] (cm)	Tail LTC (cm)	Hook A B C	Color of the nearest float or buoy*

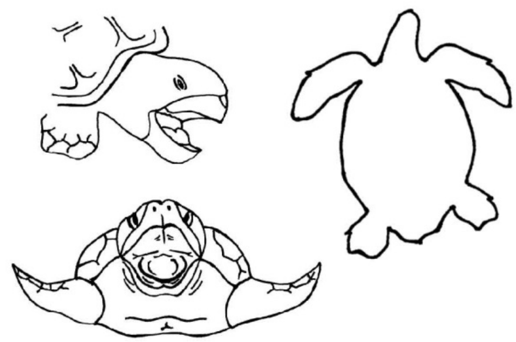
Position:	Latitude		Longitude		

Condition *( )	Entanglement *( )	Hooking *( )	Disposition*( )	Observations:

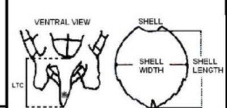
Turtle location in relation to the fishing gear



Hook location and turtle entanglement



Existing tag 1:
Existing tag 2:
New tag 1:
New tag 2:



[1]CCL: Curved carapace length [2]CCW: Curved carapace width

* Use numbers from code tables

F5s v1: 02/2012

BIRD FORM

F6

VESSEL:___________________________ SAMPLE No: _____ OBSERVER:___________________________

Set No.	Date	Time	Species name	Position		Age Immature=1 Adult=2	Sex M=1 F=2	Caught in set Yes/No	Hook A B C	Cond-ition *	Mitig. 1 *	Mitig. 2 *	Dispo-sition *	Photo Yes/No	Observations
				Latitude	Longitude										

* Use numbers from code tables

F6s v1: 07/2014

Longline Observer Program

Field Manual

Last update: July 7, 2014

INDEX

Introduction

This manual is intended to explain the correct method of recording data on the specialized forms which were developed for collecting catch data on longline vessels.

Work and responsibilities

You have been chosen to board a longline vessel for the length of a fishing trip. You will be required to carefully follow the instructions in this manual exactly as they are stated. You are responsible for the accuracy of the data that you collect, and that the required forms are complete. NEVER report information that you do not directly observe, or if for some reason you do need to report unobserved information, be sure to clearly indicate that the data you are recording was not directly observed. If you have any doubt about the data you are recording, it is preferable to document your doubts than record as fact data that might be incorrect. During the trip you will record information related to the fishing activities of the vessel in the following forms:

F2) Longline Gear Form
F3) Longline Set Form
F4) Catch Form
F5) Turtle Form
F6) Bird Form

You should make every effort not to interfere with the fishing activities while performing your duties. **The information that you collect is the property of the observer program, and is highly confidential.** Do not make copies of the forms and other data for your personal use, nor divulge fishing information to others. What happens during a fishing trip should not be discussed with crewmembers on another trip. While you are aboard the vessel, you should not engage in any activities, personal or otherwise, which could interfere with your work as an observer. Given the sensitive nature of the data which you are collecting, it is necessary to conduct your activities in a responsible and professional manner during the entire trip. The abuse of alcohol and use of illegal drugs reduces your credibility as an observer, and will result in immediate dismissal if detected. Your responsibility is limited to observation and registration of data in the appropriate forms provided. You should not interpret laws or regulations or interfere in any way with the normal fishing operations of the vessel, even when the captain or other crewmember solicits your opinion. If this occurs, you should politely remind the crew that you are not qualified for this, and that you have no authority to apply the law or to make exceptions to the law, and that the authorities of the jurisdiction of the vessel should be consulted for any clarification. Even though you know the laws, and observer a violation of them, your only function on the vessel is to collect data carry out any other activities assigned to you by the observer program. HOPEFULLY the observer will make an effort to train the crewmembers of all participating vessels on the best methods to free hooked or entangled turtles, including the use of instruments designed for this purpose. AS A GENERAL RULE: IT IS EXPECTED THAT THE OBSERVER WILL REPORT ONLY WHAT IS SEEN. IF THE OBSERVER CANNOT SEE SOMETHING, OR HAS DOUBTS ABOUT ANYTHING, THEY SHOULD MAKE A NOTE OF THEIR DOUBTS ON THE DATA FORMS AND NOT ATTEMPT TO "GUESS" THE ANSWER.

Before the trip

You should be adequately prepared in a training course before boarding a vessel. Technicians from the observer program will provide training in the identification of fish, turtles and birds, the data forms, personal security measures and the proper protocol to follow while on the vessel. Be sure to have the sample number for the trip, since this number will need to be written on each data form. The observer program staff will provide this number.

During the trip

Familiarize yourself with this *Field Manual*, and consult it often to ensure that you are correctly filling out the data forms. This will help to avoid repeating the same errors. Become familiar with the layout of the vessel and the conduct and "rules" of the crewmembers. Pay particular attention to the location of life vests, fire extinguishers, and first aid supplies. Establish cordial relationships with the crewmembers. Explain your activities to them, and that you it is your responsibility to collect correct data. Always be vigilant of your personal safety, and do not take risks. NO DATA IS MORE VALUABLE THAN THE LIFE OF AN OBSERVER. Never enter the water during fishing operations under any circumstances. Obtain the fishing captains permission before using any of the vessel equipment. If you are injured, it is important to document in detail the circumstances, and to ask the captain to note the event for legal purposes and reimbursement of medical expenses.

After the trip

You should work with the data editors review, complete and correct the data on the forms. The data review is your best opportunity to clarify doubts, explain problems and relate any other items of interest which occurred during the trip. Given your understanding of the objectives of the observer program, hopefully you will discuss any observations not covered in the forms, but which you believe are useful and have documented in the comments sections of the forms, with the data editors during the data review.

INSTRUCTIONS FOR THE COLLECTION OF DATA

Your primary responsibility during the trip is to record the data with the highest precision possible in the manner that you were instructed. The notations should be legible, written in block letters and numbers in the indicated spaces. If you are not sure of a data item, leave the corresponding space blank and write an explanatory note on the form.

Forms

F2 – Longline Gear Form

The Longline Gear Form is designed to record data related to the vessel and the trip. The form is separated into 3 sections:

- Vessel and trip data
- Longline gear characteristics
- Hook characteristics

Fields of the form

Trip data

VESSEL: The name of the vessel which made the sets.

SAMPLE No: The sequential number assigned to this trip. The observer program staff will provide this number before the vessel leaves port.

OBSERVER: The name of the observer recording the data.

Registration The official identification of the vessel.

Company name The name of the vessel owner. Additional useful information includes the company address, telephone numbers, email, etc. Be careful to write the names exactly as they should be to avoid the creation of false duplications.

Captain name The name of the person directing the fishing operations.

Departure / arrival date and time The date and time of the vessel departure / arrival.

Departure / arrival port The name of the departure / arrival port.

Length The length, in meters, of the vessel from the tip of the bow to the stern.

Width The width, in meters, of the vessel at the point where the vessel is widest.

Draft The height of the vessel, in meters, measured at the vessel midpoint from the work deck to the bottom of the hull.

Distance deck to water The distance, in meters, from the work deck to the water surface. The measurement should be taken when the vessel is empty. This measurement is useful for the determination of the length of turtle dehooking tools and dip nets.

Well capacity The maximum capacity, in metric tonnes, of all fish holding wells.

Main motor Details of the main motor, for example the manufacturer, model, year of manufacture, horsepower, inboard vs. outboard, etc.

Aux. motor Details of the auxiliary motor, if there is one.

Fuel capacity The maximum amount of fuel the vessel normally carries, in gallons. If the vessel normally carries portable fuel containers in addition to the main fuel tanks, the capacity of these containers should also be included with an explanation of the details.

Fuel used The quantity of fuel, in gallons, consumed during the trip.

Type of fuel Note the type of fuel used, for example diesel or gasoline.

Number of crew The number of crew members working on the vessel during the fishing trip, including the fishing captain.

Water capacity The maximum volume of water the vessel normally carries, in gallons.

Catch conserve method Describe the method used to conserve the catch, for example ice, ammonia, etc.

If the fishing vessel in this trip works with a mother ship (nodriza) or operates as a mother ship for smaller towed vessels (fibras de remolque) answer:

The questions in this section should only be answered if the catcher vessel operates with the assistance of a mother ship (nodriza) or if the catcher vessel is a mother ship which also provides at-sea support to smaller catcher vessels (fibras).

Type (fibra-mother ship) Indicate whether the catcher vessel is a fibra or mother ship.

Number of fibras If the vessel is a mother ship, indicate the number of smaller towed fibras that accompany the vessel. If the vessel is not a mother ship, leave this cell blank.

If the vessel is a 'fibra', name of mother ship When the catcher vessel is a fibra, write the name of the mother ship. If the catcher vessel is a mother ship, leave this cell blank.

Navigation and fishing equipment: Describe any navigation or fishing equipment (GPS, sonar, thermometers, etc.) on the vessel, including the make, model, range, etc.

Longline gear characteristics

This section is used to record the characteristics of the longline fishing gear. Elements of the longline are listed at the top of each column, with the specific part of the gear listed in the column on the left side. Data should not be recorded in shaded spaces, as these are not applicable and unnecessary. Many of the spaces contain a label for the correct units of the measurement. Be sure to always record the data IN THESE UNITS.

For the Material and Color columns, numeric codes from the corresponding code tables tblMaterial and tblColor should be used (see the annex at the end of this manual). If an element of the longline contains more than one material or color, the numeric codes of all materials or colors should be recorded. Multiple codes should be separated with a dash(-). For example if there are red, brown and yellow floats, in the 'Float' line and 'Color' column the value '4-10-3' should be recorded.

Mainline Record the diameter of the mainline in millimeters, the **total** length in nautical miles, and the distance between hooks in fathoms.

Upper/middle/lower gangion Record the characteristics in each space on the form. If there is not a middle gangion, leave the line blank. If there is a leader on the hook, record the details in the 'Lower gangion' line. A leader is a metal portion of the lower gangion used in the shark fishery.

Floatline/dropline Record the length, in centimeters, and codes for the material and color.

Buoy A buoy is the principal float on the mainline, normally tied to each end. Record the necessary data.

Flag Record the necessary data.

Float Floats are the smaller buoys attached at regular intervals along the length of the mainline. Record the diameter in centimeters along with the rest of the required data.

Distance btwn. hooks The distance between hooks, measured in fathoms.

Max. hooks on mainline Record the **total number** (maximum) of hooks that the entire mainline contains when it is completely rigged.

Number of lights Record the maximum number of lights used during any set of the trip.

Number of radio buoys Record the maximum number of radio buoys or other locating devices used during any set of the trip.

Mainline weights: Indicate whether weights are attached to the mainline.

Dropline connection to mainline: Indicate whether the dropline is connected to the mainline with knots or snaps.

Mainline retrieval Indicate the primary method for hauling in the mainline from the options presented. If an unlisted method is used, indicate 'Other' and describe the method.

Fishing gear diagram Use this space for a simple drawing of the longline gear, with details such as the location of flags, floats, weights, hooks, number of hooks between floats, etc. Indicate distances such as the fishing depth of the hooks, distance between hooks, etc.

Hook characteristics

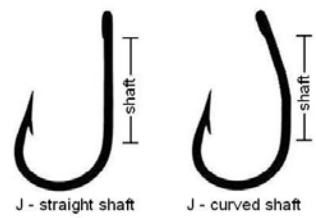
This section is used to record the characteristics of the distinct types of hooks used in the ENTIRE mainline during the trip. If the crewmembers change the configuration of the mainline during the trip, include the characteristics of each type of hook used during the trip.

There is space on the form to record the characteristics of up to 3 different types of hooks. If there are more than 3 different types of hooks used during the trip, you should record the characteristics of the most important hooks.

Record the characteristics of each hook that the vessel uses in the Longline Gear Form F2. Labels $\boxed{A}$, **B**, © are assigned to each of the 3 lines used to describe the hooks. These different labels are used as a reference to the hooks in the Longline Set Form F3 section detailing the percentage of each type of hook used in the set. For example, the hook identified as © in the Longline Gear Form should continue to be identified as © in the Longline Set Form F3.

Type (J/C) Indicate whether the hook is a J hook (write 'J') or a circle hook (write 'C').
Size Indicate the size of the hook. For example, if the hook is a C16 you should write 'C' in the Type column, and '16' in the Size column.

J-straight / J-curved If the hook is a J hook, indicate whether the shaft of the hook is straight or curved. If the hook is a circle hook, leave this space blank.



Material Record the code of the hook material. Consult the table tblAnzMaterial (tblHookMaterial).
Manufacturer Record the manufacturer of the hook, if it is known, for example 'Mustad' or 'Korea'.
Offset Record the offset of the hook. If there is no offset, write '0' (zero).
Ring Indicate with 'Yes' or 'No' the presence of a separate ring on the end of the hook shaft. Do not confuse the ring with the loop that is fashioned from the hook itself.
Other details Record any other characteristics that are not specifically listed in one of the columns dedicated to the description of the hook. For example, if the hook has a wire tied to the barb to minimize turtle hooking, you could write 'barb wire' in this column with a more detailed description in the Observations column.
Observations Note any other data of interest relevant to the hook. This is especially important when the vessel uses a hook with characteristics that are not covered by the columns dedicated to the description of the hook.

F3 – Longline Set Form

The Longline Set Form is designed to record data related to individual sets during the fishing trip. You should only record data for sets which you have directly observed.

Fields of the form

VESSEL: The name of the vessel which made the sets.

SAMPLE No: The sequential number assigned to this trip. The observer program staff will provide this number before the vessel leaves port.

Set number The consecutive set number, starting with 1.

Date The date of the set.

LAT/LON/TIME There are 4 important moments in each set: the start and end of the deployment of the mainline, and the start and end of the retrieval of the mainline. For each moment you should note the latitude and longitude, in degrees and minutes, and the time. Always note the time using the 24 hour clock. For example, 8:35 pm is written 20:35.

Number of hooks in the set by type: Record the total number of each type of hook defined with the symbol $\boxed{A}$, **B**, Ⓒ on form F2 *Longline Gear Form* placed in the water during the initial setting of the mainline.

Total no. of hooks in set: Record the total number of hooks that placed in the water during the initial setting of the mainline. The sum of hooks $\boxed{A}$, **B**, Ⓒ in the previous section should be equal to the total number of hooks in the set.

No. of hooks lost: Record the number of each type of hook lost during the set.

Bait There is space for up to 3 types of bait:

Type of bait - % of total Record the type of bait and the percentage of each type in the space provided. Use tblCarnada (tblBait) for numeric bait codes.

Target fishery Record the target fishery of the set, according to the fishermen (e.g. shark, tuna, etc.) Choose one of the fishery types from the table tblPesca (tblFishery) in the annex.

Set - Special? Indicate with a check mark ☑ if the set is special, for example a 'circle set' or a set in association with dolphins. Document the details in the 'Observations' section.

Set - Patrolled? Indicate with a check mark ☑ if the fishermen removed catch from individual hooks and rebaited the hooks before retrieving the entire mainline.

Retrieval direction Indicate with a check mark ☑ if the fishermen returned to the original end of the mainline to begin the retrieval process (*Start to end*), or if after setting the entire line they began to retrieve the mainline from the end that was the last to enter the sea (*End to start*).

Sea surf. temp. Record the sea surface temperature.

No. hooks btwn. floats Record the number of hooks between floats. If the number of hooks varies, record the number of hooks between floats that is most prevalent.

Avg. hook depth Record the average depth of the hooks, in fathoms.

Bottom longline? Indicate with a check mark ☑ the box labeled 'Yes' if the mainline was configured to rest on the bottom of the sea. If the mainline is configured to fish at the surface or mid-water, mark the box labeled 'No'.

Observations Note any other data of interest related to the set.

F4 – Catch Form

The Catch Form is designed to record the catch of all animals brought on deck. ONLY ANIMALS WHICH ARE BROUGHT ABOARD THE VESSEL ARE CONSIDERED CATCH; IF THE ANIMAL IS LOST FROM A HOOK, ESCAPES OR FALLS BACK INTO THE SEA, DO NOT INCLUDE THE CATCH ON THIS FORM.

All catch should be noted on the Catch Form F4, including fish, turtles, marine mammals and birds. Use the Turtle Form F5 and Bird Form F6 to collect additional turtle and bird data that is not defined on this form. Note that all catch of turtles and birds should always be listed on Catch Form F4, and if additional turtle or bird data is collected this should be recorded on Turtle Form F5 and Bird Form F6. EVERY turtle and bird listed in the Turtle Form and Bird Form should also be listed in the Catch form.

The characteristics of hooks $\boxed{A}$, **B**, © are defined in the Vessel Form. You must use the same label $\boxed{A}$, **B**, © to reference the corresponding hooks in the Catch Form. This label will be used to record which type of hook caught the fish. Be sure to always use the same label for the same hook in each of the forms used in the trip, as defined in the Vessel Form.

Fields of the form

VESSEL: The name of the vessel which made the sets.

SAMPLE No: The sequential number assigned to this trip. The observer program staff will provide this number before the vessel leaves port.

Set No. The set number which corresponds to the sets defined in the Longline Sets Form.

Time The time that the catch was taken on board. It is not necessary to record the date.

Species name Record the scientific name WHENEVER POSSIBLE, the common name, or the alpha code assigned to this species in tblEspecie (tblSpecies). Never use the numeric code, since it is almost impossible to verify its validity.

Number caught Record the number of individual fish caught. Note that the characteristics in the following columns (Hook location, Disposition, Sex) must apply to ALL of the fish counted on a line. For example, if you record 3 mahi-mahi with sex 'male', this means that all 3 fish must be male. If there are 2 male mahi-mahi and one female mahi-mahi, the catch should be separated into 2 lines on the form, with the 2 male mahi-mahi on one line and the single female mahi-mahi on the next line. If you record data with Length and/or Weight measurements, you may not record more than one fish per line and the 'Number caught' will always be '1'.

Hook $\boxed{A}$ **B** © Record on which of the previously defined hooks the fish was caught. The characteristics of hooks $\boxed{A}$, **B**, © are defined in the Vessel Form. Be sure to use the same label $\boxed{A}$, **B**, © to reference the corresponding hooks in the Catch Form.

Hook location Record the location of the hook on the fish, using the numeric code from the Hooking Location table tblEnganche at the end of this manual. Only use codes marked for use with fish, <u>not</u> those applicable to turtles.

Disposition Record the fate of the catch, using the numeric code from the Disposition table tblDestino at the end of this manual. Only use codes marked for use with fish, <u>not</u> those applicable only to turtles and/or birds.

Sex Record the sex of the fish if it is possible to determine. For males, use the letter 'M' or numeric code 1. For females, use 'F' or numeric code 2.

Weight If a reliable measurement is possible, record the weight of the fish, in kilograms.

LENGTHS section

POL-FL-TL-CCL This column is used for the primary length of each animal. Record the length, in centimeters, of the distinct species according to the diagrams at the foot of the form F4. For billfish, measure the postorbital length **POL,** from the posterior edge of the eye socket to the center of the fork in the tail. Tuna and other fish are measured by fork length **FL**, which is from the tip of the jaw or snout with mouth closed to the center of the fork in the tail. Sharks are measured by total length **TL** from the tip of the snout to the tip of the tail. If the tail is damaged or missing, leave this measurement blank. Rays should be measured by total length **TL** from the tip of the disc to the tip of the tail. For turtles, measure the curved carapace length **CCL**, which is the length of the shell over the curve measured from the midpoint of the nuchal scute to the posterior tip of the shell.

PCL-*DL* This column is used for two measurements, according to the species. For sharks, use the column to record the precaudal length **PCL**, from the tip of the snout to the anterior insertion of the caudal fin, according to the diagram in Figure 1 below. For rays, use the column to record the disc length ***DL***. For all other species, leave the cell blank.

IDS-*DW*-CCW This column is used for three measurements, according to the species. For sharks, use the column to record the interdorsal space **IDS**, which is the length from the posterior insertion of the first dorsal fin to the anterior insertion (start) of the second dorsal fin, according to the diagram in Figure 1 below. For rays, use the column to record the disc width ***DW***. For turtles, use the column to record the curved carapace width ***CCW***, which is the width of the shell measured over the curve. For all other species, leave the cell blank.

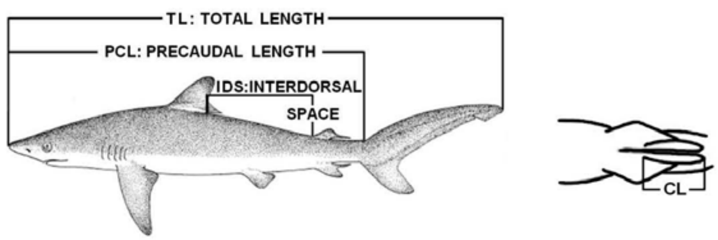


Figure 1: shark measurements

Male sharks section

The three columns in this section are only applicable to male sharks. For female sharks and all other species, the cells should be blank. Sexual maturity of male sharks is determined by the clasper length and condition.

CL This column is used to record, in centimeters, the shark clasper length **CL** (Figure 1).

CAL This column is used to indicate the presence or absence of clasper calcification. Record a 'Y' (yes) or 'N' (no) in the column.

Semen This column is used to indicate the presence or absence of semen. Record a 'Y' (yes) or 'N' (no) in the column.

Observations Note any other data of interest related to the catch, for example if the fish 'escaped' from the circle hook.

F5 – Turtle Form

Every hooked or entangled turtle brought up to the side of the vessel or the deck should be recorded on the Catch Form F4. **If the turtle falls off the hook or disentangles itself, it should not be counted as capture; rather the turtle is considered as a sighting.** The Turtle Form F5 is used to record additional turtle information that cannot be recorded on the Catch Form F4. Each captured or entangled turtle recorded on Turtle Form F5 must also be recorded on Catch Form F4.

Use one sheet of the Turtle Form for each turtle hooked or entangled (all species of turtles) and for sightings of the 3 least common turtle species: hawksbill (*Eretmochelys imbricata*), loggerhead (*Caretta caretta*) and leatherback (*Dermochelys coriacea*). Do not record sightings of olive ridley (*Lepidochelys olivacea*), green/black (*Chelonia mydas mydas, C. mydas agassizii*) and unidentified turtles. **Sightings** of olive ridley, green/black and unidentified turtles are not required since these turtles are common and of less interest than the hawksbill, loggerhead and leatherback turtles.

The characteristics of hooks $\boxed{A}$, **B**, © are defined in the Vessel Form. You must use the same label $\boxed{A}$, **B**, © to reference the corresponding hooks in the Turtle Form. This label will be used to record which type of hook caught the turtle. Be sure to always use the same label for the same hook in each of the forms used in the trip, as defined in the Vessel Form.

Fields of the form

VESSEL: The name of the vessel which made the sets.

SAMPLE No: The sequential number assigned to this trip. The observer program staff will provide this number before the vessel leaves port.

Date / Time The date and time that the turtle arrives alongside the vessel.

Set number The set number which corresponds to the sets defined in the Longline Sets Form.

Species Record the scientific name, common name, or the alpha code assigned to this species in tblEspecie (tblSpecies). Never use the numeric code, since it is almost impossible to verify its validity.

Sex Record the sex of the turtle if it is possible to determine.

CCL Record the length of the turtle, in centimeters, over the curve of the shell (Curved Carapace Length) according to the diagram on the lower right corner of the form.

CCW Record the width of the turtle, in centimeters, at its widest point over the curve of the shell (Curved Carapace Width).

Tail LTC Record the length of the tail, in centimeters, according to the diagram on the lower right corner of the form.

Hook $\boxed{A}$ **B** © If the turtle was hooked, record on which of the previously defined hooks the turtle was caught. The characteristics of hooks $\boxed{A}$, **B**, © are defined in the Vessel Form F2.

Be sure to use the same label $\boxed{A}$, **B**, © to reference the corresponding hooks in the Turtle Form F5.

Color of the nearest float or buoy Record the numeric color code defined in tblColor of the float or buoy closest to the hooked, entangled or sighted turtle . A buoy is a main float, normally located at each end of the mainline.

Position: Latitude / Longitude Record the position of the vessel at the time when the turtle reaches the side of the vessel.

Condition Describe the condition of the turtle (hooked, entangled alive/dead, sighted, etc.) in the space provided. In the space (   ) provided record the corresponding numeric code from the Condition table (tblEstado) at the end of this manual. Only use codes marked for use with turtles, not those applicable to fish.

Entanglement If the turtle was entangled, describe the entanglement, for example the part of the gear that entangled the turtle, or which appendage became entangled. In the space (   ) provided record the corresponding numeric code from the Entanglement table (tblEnredo) at the end of this manual. Only use codes marked for use with turtles, not those applicable to fish. If the turtle was not entangled, leave this section blank.

Hooking If the turtle was hooked, describe where the turtle was hooked. In the space (   ) provided record the corresponding numeric code from the Hooking Location table (tblEnganche) at the end of this manual. Only use codes marked for use with turtles, not those applicable to fish. If the turtle was not hooked, leave this section blank.

Disposition Describe the final state of the turtle after the encounter with the longline in the space provided. In the space (   ) provided record the corresponding numeric code from the Disposition table (tblDestino) at the end of this manual. Only use codes marked for use with turtles, not those applicable to fish. Generally, a light injury is one that the turtle will most likely survive. A grave injury is one that will likely kill the turtle. If the encounter is simply a turtle sighting, use Disposition code '0' (other fate).

Observations Note any other data of interest related to the encounter with the turtle, for example a photo number.

Existing / New tag If the turtle has a tag, record the tag identification (numbers and/or letters) of the tag(s) in addition to other information present. Do not remove tags unless instructions on the tag request that it be removed, or the turtle is dead. If you attach a new tag to the turtle, record the characteristics (tag code and where on the turtle the tag was attached).

Turtle location in relation to the fishing gear If the turtle is entangled, you may sketch the general location of the turtle in relation to the gear, for example in the mainline, a gangion, or close to a buoy or float.

Hook location and turtle entanglement If the turtle is hooked, use the diagrams to indicate where the physical location of the hook, or which part of the turtles body was entangled.

F6 – Bird Form

The Bird Form is designed to record the involvement of all birds in longline sets, along with any mitigation measures and ultimate disposition.

The characteristics of hooks $\boxed{A}$, **B**, © are defined in the Vessel Form. You must use the same label $\boxed{A}$, **B**, © to reference the corresponding hooks in the Bird Form. This label will be used to record which type of hook caught the bird. Be sure to always use the same label for the same hook in each of the forms used in the trip, as defined in the Vessel Form.

Fields of the form

VESSEL: The name of the vessel which made the sets.

SAMPLE No: The sequential number assigned to this trip. The observer program staff will provide this number before the vessel leaves port.

Set No. The set number which corresponds to the sets defined in the Longline Sets Form.

Date / Time The date and time that the bird arrives alongside the vessel.

Species name Record the scientific name WHENEVER POSSIBLE, the common name, or the alpha code assigned to this species in tblEspecie (tblSpecies). Never use the numeric code, since it is almost impossible to verify its validity.

Position: Latitude / Longitude Record the position of the vessel at the time when the bird reaches the side of the vessel.

Age Record the developmental stage of the bird. Write code '1' for an immature bird, and '2' for an adult bird.

Sex Record the sex of the bird if it is possible to determine. For males, use the letter 'M' or numeric code 1. For females, use 'F' or numeric code 2.

Caught in set Record whether the bird was caught by taking a hook. Write Yes or No.

Hook $\boxed{A}$ **B** © Record on which of the previously defined hooks the bird was caught. The characteristics of hooks $\boxed{A}$, **B**, © are defined in the Vessel Form. Be sure to use the same label $\boxed{A}$, **B**, © to reference the corresponding hooks in the Bird Form.

Mitig. 1 – Mitig. 2 Record mitigation measures in place to avoid capture of birds, using the numeric code from the Mitigation table (tblMitigacion) at the end of this manual.

Disposition Record the fate of the bird, using the numeric code from the Disposition table tblDestino at the end of this manual.

Photo Indicate whether photos of the bird were taken.

Observations Note any other data of interest related to the bird involvement in the set.

Code tables

Color (*tblColor*)

ID	Description
0	Other
1	Light Blue
2	Green
3	Yellow
4	Red
5	Blue
6	White
7	Black
8	Orange
9	Grey
10	Brown
11	Transparent

Condition (*tblEstado*)

ID	Description	Use for:
0	Other condition	Turtle and bird
1	Entangled alive	Turtle and bird
2	Entangled dead	Turtle and bird
3	Hooked alive	Turtle and bird
4	Hooked dead	Turtle and bird
5	Sighted	Turtle and bird

Disposition (*tblDestino*)

ID	Description	Use for:
0	Other fate	Fish, turtle and bird
1	Returned to the sea dead	Fish, turtle and bird
2	Commercial sale	Fish, turtle and bird
3	Consumed by the crew	Fish, turtle and bird
4	Utilized as bait	Fish, turtle and bird
5	Returned to the sea alive	Fish, turtle and bird
6	Retained as laboratory specimen	Fish, turtle and bird
12	Released with minor injuries	Turtle and bird
13	Released with grave injuries	Turtle and bird
17	Released with the hook still present	Turtle and bird

Entanglement (*tblEnredo*)

ID	Description	Use for:
0	Other location or unknown	Turtle
1	Alongside float	Turtle
2	Gangion	Turtle
3	Mainline	Turtle
4	Gangion and mainline	Turtle
5	Floatline	Turtle
6	Gangion, mainline and float	Turtle

Hooking Location (*tblEnganche*)

ID	Description	Use for:
0	Other location or unknown	Fish and turtle
1	Swallowed	Fish and turtle
2	Jaw	Fish and turtle
3	External	Fish and turtle
4	Entangled - not hooked	Fish and turtle
11	Head	Turtle
13	Upper jaw	Turtle
14	Lower jaw	Turtle
15	Neck	Turtle
16	Right front flipper	Turtle
17	Right rear flipper	Turtle
18	Left front flipper	Turtle
19	Left rear flipper	Turtle
20	Armpit	Turtle
21	Tongue	Turtle
22	Tail	Turtle
23	Shell	Turtle
25	Epiglottis	Turtle

Materials (*tblMaterial*)

ID	Description
0	Other
2	Nylon multifilament
3	Nylon monofilament
4	Polyethylyne
5	Polypropolyne
6	Steel
7	Bronze
8	Plastic
9	Polystyrine
10	Cloth
11	Bamboo
12	Cork
15	Carbon steel
16	Stainless steel
17	Duratín

Mitigation (*tblMitigacion*)

ID	Description	Use for:
0	Other	Bird
1	Bird scaring lines	Bird
2	Side setting	Bird
3	Night setting	Bird
4	Branchline weighting	Bird
5	Blue dyed bait	Bird
6	Line shooter	Bird
7	Underwater setting	Bird
8	Offal and discard discharge management	Bird

Target Fishery (*tblPesca*)

ID	Description
1	Tuna
2	Dorado, mahi-mahi
3	Grouper
4	Shark
5	Sea catfish
6	Ray
7	Billfish
8	Oilfish
10	Other

Appendix D

Report of the National Observer Programs for pelagic fisheries under the IATTC Convention Area

Observer Program

Reporting CPC: ☐

Name of the program:

Scientific contact:

Email:

Year start:

Vessel type monitored:

Average number of vessels Observed per year:

Observer Program : Data Recorded from interactions with fishing operations

Level data record:

Other:

Frequency record:

Other:

Data recorded please check if the following information is recorded	target species	Non-target commercial spp	Other bycatch spp
Catch estimates (Kg/No)	☐	☐	☐
Dead discards	☐	☐	☐
Releases alive	☐	☐	☐
Species identification	☐	☐	☐

Main taxa groups monitor by Observers	☐ Yes
Fish target spp	☐
All fish species (sharks/rays)	☐
Sea turtles	☐
Seabirds	☐
Mammals	☐
Other taxa (specify)	

Record on conditions of discards and reasons for	☐ Yes
Reason(s) for discard of commercial catches	☐
General state of live discards	☐

Biological sampling and samples collections	target sp	Non-target sp	Bycatch
Species identification (photo)	☐	☐	☐
Size & weight measurement	☐	☐	☐
Sex and/or fecundity status	☐	☐	☐
Hardparts (otoliths, spines)	☐	☐	☐
Tissues (muscle, gonads, blood)	☐	☐	☐
Tagging (release)	☐	☐	☐

Vessel information recorded	☐ Yes
ID, Name	☐
IMO Number	☐
LOA, GRT, HP	☐
Main gear(s) operation	☐
Electronics (GPS, sonar)	☐
Home port	☐

At fishing operation please check if the following information is recorded	☐ Yes	Start operation	End operation
	☐		
Fishing on FADs or not	☐		
Gear type	☐		
Geo-position (lat - lon)	☐	☐	☐
Date/Type operation	☐	☐	☐
Bait type	☐		
Crew number	☐		

Environmental data recorded	☐ Yes
Sea surface temperature	☐
At gear catch sea temp.	☐
Depth of gear operation	☐
Wind speed and direction	☐
Other environmental data	

Observer Program: Qualifications and Training

Observers qualification and training	Before enter obs. program	Eval. during prg.
Minimum qualifications describe		
Training course	☐	☐
Training materials and forms	☐	☐
Observer evaluation(s)	☐	☐
Validation of data recorded	☐	☐
On vessel training/supervision	☐	☐

CPCs	Vessel_type	LevelDataRecord
China	Bait boat	By set or fishing operation
Chinese Tapei	Gillnet	By trip of vessel
Colombia	Hand-line	Other (specify next)
Corea	Harpoon	
Costa Rica	Haul seine	
Ecuador	Longline	
El Salvador	Purse seine	
European Union	Rod-and-reel	
Guatemala	Sport	
Japan	Tended line	
Mexico	Trammel net	
Nicaragua	Trap	
Panama	Trolling	
Peru	Trawl	
United States	Various gears	
Venezuela	Others	