

**REPORT OF THE 2019 ICCAT YELLOWFIN TUNA DATA PREPARATORY MEETING***(Madrid, Spain, 22-26 April 2019)*

*“The results, conclusions and recommendations contained in this Report only reflect the view of the Tropical Tuna Working Group. Therefore, these should be considered preliminary until the SCRS adopts them at its annual Plenary meeting and the Commission revise them at its Annual meeting. Accordingly, ICCAT reserves the right to comment, object and endorse this Report, until it is finally adopted by the Commission.”*

**1. Opening, adoption of agenda and meeting arrangements**

The meeting was held at the ICCAT Secretariat in Madrid, 22-26 April 2019. Dr. Shannon L. Cass-Calay (USA), the Yellowfin Tuna Species Group (“the Group”) rapporteur and meeting Chair, opened the meeting and welcomed participants. Mr. Camille Jean Pierre Manel (ICCAT Executive Secretary) welcomed the participants and highlighted the importance of the work to be developed by the Group aiming at the preparation of the stock assessment for the management advice to the Commission. The Chair proceeded to review the Agenda, which was adopted without changes (**Appendix 1**).

The List of Participants is included in **Appendix 2**. The List of Documents presented at the meeting is attached as **Appendix 3**. The abstracts of all SCRS documents and presentations provided at the meeting are included in **Appendix 4**. The following served as rapporteurs:

| <i>Sections</i> | <i>Rapporteur</i>                |
|-----------------|----------------------------------|
| Items 1, 11     | M. Ortiz, A. Kimoto              |
| Item 2          | A. Pacicco, L. Ailloud           |
| Items 3, 4      | M. Ortiz, C. Palma               |
| Item 5          | C. Brown                         |
| Item 6          | A. Rios, S. Hoyle, A. Kimoto     |
| Item 7          | J. Walter, K. Satoh, A. Kimoto   |
| Item 8          | A. Norelli, L. Ailloud, D. Beare |
| Item 9          | D. Die, S. Cass-Calay            |
| Item 10         | S. Cass-Calay                    |

**2. Review of historical and new data on yellowfin biology**

There were 3 documents and 3 presentations on yellowfin tuna biology. The Group was made aware of the recent publication relevant to stock structure (Pecoraro *et al.*, 2018). Further discussion on the importance of this information will occur at the stock assessment meeting in July 2019.

**2.1 Age and growth**

SCRS/P/2019/025 presented an age and growth analysis of yellowfin tuna caught in the US Gulf of Mexico and western Atlantic Ocean using annual increment counts. Results from a <sup>14</sup>C bomb radiocarbon validation study were also presented, showing validation of age estimates up to 18 years with strong support for the annual age reading criteria. The Group saw great value in including these data in the assessment but cautioned that these results will have important ramifications for the estimation of the natural mortality vector, which depends on both growth and maximum age ( $t_{max}$ ) in the population.

The Group questioned why a 2-stanza growth model was not attempted as was done in previous studies for yellowfin growth. The author explained that samples of very small fish (<68cm CFL) were not available to inform the shape of the curve at the youngest ages. A question was then raised regarding the ability of the model to predict growth below than the minimum size observed in the sample. The Group agreed that the lack of samples at the youngest ages was problematic. It was proposed that age estimates obtained from reading daily increments, which are considered reliable for age 0 and 1 fish, be used to anchor the curve and that a growth curve be estimated inside the stock synthesis model. Daily rings age data are available from the Shuford *et al.* (2007) study, Brazil (unpublished data provided by Guelson da Silva) and the AOTTP reference collection. The peak selectivity of the FAD fishery of 50 cm means that having reliable estimates of growth and natural mortality for these smaller length groups is very important.

The Gulf of Mexico dataset is the first comprehensive and reliable set of direct ages that have been made available to the Group (n=3223) from 2004-2017 ranging in sizes from 68 to 191 cm CFL. The Group raised the concern that all the samples used in the growth analysis came largely from the same area and the maximum age of 18 years may not be representative of the whole population. It was pointed out that a separate study exists of annual ageing which has aged fish captured near Ascension Island to be up to 18 years old (Kate Downes, personal communication). Unfortunately, these data could not be made available in time for the data preparatory meeting. The Group raised concerns about the appropriateness of including these age estimates since they were not available for review. It was suggested to have experienced otolith age readers from the western area review the ageing protocol for these samples once these become available. The Group is requesting that these data be made available before the 31 May 2019 data submission deadline and that a working document describing the ageing protocol be submitted to the yellowfin stock assessment meeting.

Males and females both reach older ages (males=18; females=17) but females appear to reach a lower Linf than males. Observing equal numbers of males and females at age would suggest that males and females have equal survival, previous observations of unequal numbers of males and females at size could be explained by the differential Linf.

SCRS/2019/071 presented preliminary results of otolith increment deposition rate validation in AOTTP oxytetracycline (OTC) marked fish. Preliminary results suggest that age estimates based on daily increment counts may lead to underestimation of age, while annual increments appear to be deposited on an annual basis (**Figure 1**). The Group noted that these results were in agreement with the <sup>14</sup>C bomb radiocarbon validation results presented in SCRS/P/2019/025.

SCRS/2019/074 presented current work conducted using historical and recent (AOTTP) conventional and electronic tagging records of yellowfin tagged in St. Helena. Length frequencies and monthly modal progressions in the commercial landings was also presented. The Group was pleasantly surprised to see such clear modes in the fishery. It was remarked that the monthly modes of small fish (50-60 cm) did not appear to increase systematically as the year progressed. This could reflect the influx of smaller fish throughout the year, consistent with a protracted spawning period. A question was raised regarding the selectivity of the gears and potential impact it could have on the observed modes. In addition to the selectivity effect of the gear, it was pointed out that the fishermen discard smaller fish routinely and these are not present in the data. The author pointed out that there are no FADs in St. Helena and that most of the tagging data was from free schools, though a few are from sea mounts.

The Group inquired how the growth information from the tagging data compared to the currently accepted growth curve. The author presented additional plots of growth trajectories plotted against the Gascuel growth curve (Gascuel *et al.*, 1992) (**Figure 2**). The records generally looked in agreement with the curve, though there were very few fish below 50cm CFL to help determine if the slowdown of the Gascuel curve was reflected in the tagging records. The Group suggested it would be helpful to plot these same trajectories onto other growth models being considered.

The Group suggested comparing like to like by comparing the growth information by location of capture (recapture), FAD vs free school, or using the grotag model to obtain estimates of growth rates by size from the tagging data. Plots of mean length (average length between release and recapture) vs. growth were presented to the Group which showed that the 2-stanza growth was apparent in the tagging data caught on FADs but much less apparent in the tagging data of fish caught in free schools (**Figure 3**). However, it was noted that the results were sensitive to the removal of the shortest times at liberty.

Additional analyses were run to explore the question of growth in the tagging data. However, due to the complexity of interpretation of the growth information, the preliminary analyses were not conclusive. We expect that additional tags collected through the AOTTP will shed light on growth. It also noted that tagging and the OTC may affect growth and the fishing mode at recapture (FAD vs free school) could have an effect on the interpretation of growth. It has also been suggested that there may be a slowdown in growth due to the association with FADs.

SCRS/2019/080 evaluated the estimability of growth inside the Stock Synthesis (SS) integrated modeling platform and found that; a) growth is estimable within the integrated models, b) externally fixed growth curves, including the currently ICCAT yellowfin curve result in model misspecification that produces the appearance of a regime shift at the initiation of the purse-seine FAD fishery, c) estimating growth in the models is a way to address this misspecification. Given the results of this analysis, the author favored estimating growth inside the SS model and underscored the fact that, in that way, SS could also be used for hypothesis testing (e.g. functional form of the growth curve).

The author also argued that the flattening of the growth curve at younger ages observed in the Gascuel growth model could be a result of assuming a common birth date of 15 January for all the cohorts, when in fact we know that yellowfin have a much more protracted spawning season in the Atlantic. It was noted that the Gascuel growth curve is in fact a piecewise function and that the younger ages were modelled to follow a linear growth pattern (following inspection of the tagging data which appeared to show slower growth rates at younger sizes) from a prior study by Bard (1984).

Given the complex patterns of gear selectivity of the fisheries for yellowfin tuna, it is important to consider the impact of size selection on observed growth rates.

A concern was raised that we are observing fish larger than the  $L_{inf}$  estimated by SS and SCRS/P/2019/025. The author reminded the Group that the definition of  $L_{inf}$  used in the age structured model is the mean asymptotic size in the population, not the absolute maximum size, and that, as such, it is natural to observe fish falling above and below the estimated  $L_{inf}$ , according to the variability in size at age. A comment was also made on whether it was appropriate to merge the Lang *et al.* (2017) and SCRS/P/2019/025 datasets. The author confirmed that otolith age readers from each laboratory conducted calibration exercises and cross-checked age estimates using a reference collection and found little error between readers (+/-1 year).

The Group saw a benefit in estimating growth within SS to allow for hypothesis testing and account for potential biases (e.g. selectivity). Initial model runs using the Lang *et al.* (2017) otolith annual age readings found no evidence of a two-stanza growth pattern. The estimated  $L_{inf}$  fell close to that estimated in SCRS/P/2019/025 but the  $K$  was higher. Since a minimum size limit (68.6 cm CFL) is present in the Gulf of Mexico recreational fishery, it was recommended to control for this in the integrated approach.

The recommendation for the stock assessment is to use two approaches for modelling the growth:

1. Estimate growth within SS using the annual age estimates from SCRS/P/2019/025 combined with daily age estimates of small fish (< 1 year old) from Shuford *et al.* (2007), the Brazilian collection (Guelson da Silva, unpublished data) and the AOTTP collection.
2. Include the Gascuel length frequency data, which will likely result in the 2-stanza shape but result in a  $L_{inf}$  that is lower and therefore more commensurate with the length data.

## 2.2 Natural mortality

SCRS/P/2019/025 illustrated the impact that a higher  $t_{max} = 18$  would have on the estimates of the natural mortality ( $M$ ) vector by age.

*Baseline natural mortality*; the baseline natural mortality rate is the average mortality across the exploited ages. The Then *et al.* (2015) estimator,  $t_{max}$  based estimator, was used in the 2016 assessment to obtain the baseline  $M$ . The Group will be adopting a similar approach for the 2019 assessment.

The Group was reminded that the previously adopted  $t_{max}$  of 11 was based on the longest time at liberty observed in the ICCAT historical tagging dataset. While the Group does not dispute the new finding that the maximum age is 18, it was questioned whether that maximum age was an appropriate proxy for maximum age of fish found in the equatorial zone where the bulk of the catch is caught. It is possible that the maximum age is lower in the equatorial zone, which would entail a higher  $M$ . It was suggested to scale natural mortality in such a way that it would result in high  $M$  for the lower age classes targeted by the fishery, which would lead to a different shape because there is a concern of the estimation of  $M$  using a high  $t_{max}$  for the lower age classes.

The implied natural mortality based on the  $t_{max}$  of 18 is  $0.35 \text{ yr}^{-1}$ , which is lower than the 2016 assessment assumption of  $0.54 \text{ yr}^{-1}$  based on a  $t_{max}$  of 11 years. As there is variability in the relationship between  $t_{max}$  and natural mortality rates across species (Then *et al.*, 2015), it was suggested to use the prediction standard deviation to obtain a range of baseline  $M$ :  $0.18 - 0.65 \text{ yr}^{-1}$ . This range of mortality estimates for a given age was obtained from the standard deviation of the residuals to the Then *et al.* (2015) regression. The range was obtained as 1.5 standard deviations above and below the estimate for a  $t_{max}$  of 18.

*Scaling of M.* The second component of natural mortality is the scaling according to the growth curves. This can be achieved internally with SS by specifying the baseline M and the age of full selection, and then allowing the internally estimated growth curve to scale M at age. This internal scaling achieves internal consistency between M and growth when growth is estimated. A figure was presented for demonstration purposes, showing the M vector scaled using dataset presented in SCRS/P/2019/025 assuming an age of full selection of 1 and a baseline M of 0.35 (**Figure 4**).

It is generally understood that large (>150 cm FL) yellowfin tuna in the Atlantic tend to be male. The Group has previously entertained two main alternative hypotheses that could account for this: 1) females experience higher M, or 2) there are sex-specific growth curves, with males growing to large sizes. The analyses presented in presentation SCRS/P/2019/025 demonstrate evidence supporting sex-specific growth curves, with males growing larger. Furthermore, baseline M estimates calculated using the maximum age in the samples as  $t_{max}$  (18 years for males, 17 years for females), adjusted accounting for the differing growth curves, indicate little difference in M estimates by sex.

While there may be differences in mortality and growth between the two sexes and the model might be able to capture improved biological realism by modeling separate sexes, the Group does not have enough information regarding the sex ratio in the catches to consider that such a model would result in improved advice at this time.

The recommendation for the stock assessment is to use a  $t_{max}$  of 18 and of 11 (continuity vector from 2016 assessment) for the Then *et al.*, (2015) analysis as the baseline M to test two hypotheses about natural mortality in the stock assessment (see section 7).

### 2.3 Reproduction

SCRS/P/2019/027 presented a histological assessment of yellowfin tuna ovaries sampled in the US Gulf of Mexico and western Atlantic from 2010 to 2017 (n=410). Length at 50% maturity was estimated at 110cm CFL using a maturity threshold of advanced vitellogenesis (V3), with spawning capable females observed in 9 out of 11 months of capture, and batch fecundity estimated to increase with size and age with an observed maximum of 6.2 million eggs per batch. The data showed a sharp increase in gonad weight relative to size starting at around 115 cm CFL.

The author suggests using a length of maturity threshold at advanced vitellogenesis (V3;  $L_{50}$ =110 cm CFL) or at the onset of vitellogenesis (V1; 109 cm CFL). In 2016 the Group recommended the vitellogenic stage for the maturity threshold ( $L_{50}$  = 115.1 cm). Based on the similarity of the current study compared to Diaha *et al.* (2016), the Group did not see any strong reason to change the assumption placed on the maturity threshold but recommended that further collaborative work be conducted between the East and West Atlantic to agree on a maturity estimate that best represents the whole population.

This study supports our general understanding that the peak spawning months in the US Gulf of Mexico occur in May/June, differing from the spawning months observed in the Gulf of Guinea (September/October). The Group was reminded that in other closely related species, older females are known to enter the spawning grounds earlier in the year than younger females, and that this has an influence on the size frequency of spawning females observed. The Group suggested that it would be possible in future work to estimate the size/ages frequency of spawning to see if they differ by region. The Group noted that larger sample size would help with this estimation, and it was also suggested to continue improving estimates of batch fecundity by increasing the sample size.

Presentation SCRS/P/2019/033 described a macroscopic assessment of yellowfin tuna ovaries sampled in the Mexican EEZ of the Gulf of Mexico from 2000 to 2013. The Group acknowledged that the relatively long time series of sex ratio was valuable to improve stock assessment models and was impressed with the large number of samples presented (n=413,961). Regarding the methods, it was suggested to combine pre-spawning and spawning females into the calculation of sexual maturity oogive.

## 3. Review of fishery statistics

The Secretariat presented the most up-to-date information available in the ICCAT database system (ICCAT-DB) for yellowfin tuna (YFT) and to a less extent bigeye (BET) and skipjack (SKJ), namely the fishery statistics datasets (T1NC: Task I nominal catches; T2CE: Task II catch & effort; T2SZ: Task II size frequencies) and conventional tagging data. For 2018, only 11 CPCs provided fisheries statistics out of 39 that have reported catches of YFT in 2017.

### 3.1 Task I (catches) data

The Group revised entirely the T1NC dataset of YFT available and discussed the importance of including 2018 catches in the assessment given the recent increasing trends of catch that have overpassed the Commission current recommended YFT TACs. Therefore, the Group requested that CPCs provide T1NC estimates of YFT for 2018 YFT (including T2CE and T2SZ and T2CS) by 15 May 2019.

The T1NC revision for YFT (1950-2017) aimed to identify and estimate the YFT missing catches, and to improve the gear discrimination by flag across the entire catch series. This work, made whenever possible with the e ICCAT CPC scientists, included:

- The reclassification of unclassified gears (codes SURF, UNCL) of various flags: Argentina 1982-92 to TRAW; Brazil 1976-79 to BB and 1980-09 to LL-surf; Barbados 1974-96 to LL; Colombia 1991-97 to PS; Cuba 1991-97 to LL; EU-France Guadeloupe 2016 to LL-surf; EU-France small catches in the East Atlantic merged as TRAW; EU-Latvia 1991-97 to TRAW; Gabon 1995-1999 to TRAW; Ghana 1978-92 to PS; Grenada 1963-85 to LL; Senegal 1989-91 to HAND; São Tomé e Príncipe to PSS; UK-Bermuda 2014-17 to RR.
- The corrections of various CPC catches by gear (split/merge processes): USSR 1978-81 SURF split into LL (84%) and PS (16%) using 1982 catches; Angola 2007 HAND deletion and SURF 1950-55 split into BB (88%) and TRAP (2%) using 1956 catches; Cabo Verde 1981 SURF merged with BB; EU-Portugal (Mainland) 2009-11 SURF merged with LL-surf; Gabon 2000-01 merged with TRAW; Ghana 1977-92 SURF merged with PS; Guinea Rep. 2009 SURF merged with PS; Venezuela 1979-80 SURF split into PS (71%) and BB (29%) using 1982 catches.
- The estimation of missing catches (series gaps) using carry overs (in its majority the average of the two adjacent years): USSR 1977 PS; Canada PS (1972,1977) and LL (1989); Côte d'Ivoire 2009 GILL; Cabo Verde 2002 BB; Cuba 1972 (PS) and 1973 (LL); Namibia 2012 LL; Panama LL (2011-2015, 2017); Senegal 2017 GILL; São Tomé e Príncipe 2007 PSS; St. Vincent 2005 LL; Venezuela GILL (2015-2017); South Africa 1995-96 RR.
- The T1NC revision of Senegal (Ngom and Fonteneau, 2016) to the BB and PS tropical fisheries (1965-2014 for BET/YFT/SKJ) is now fully included in ICCAT-DB.

All the above changes made to T1NC (a total of about 500 records) were registered in the database system with a reference to this meeting.

The comparison of T1NC for YFT, before and after the revision, is presented in **Table 1**. Overall, the total catches by region (YFT-E and YFT-W) don't have big increases (less than 1% both regions). The major differences are related to the improvement of the gear discrimination (UNCL gear catches decreased from about 5% to less than 1% on both regions). As of today, this updated T1NC estimations for YFT (**Figure 5**) represent the best overall YFT catch estimates for the period 1950 to 2017 (2018 still very incomplete).

For the assessment input of Stock Synthesis, the annual catch of YFT will be disaggregated into a fleet-gear structure, similar as possible to the fleet structure used for the 2018 BET assessment (Anon. 2019). After reviewing the distribution of the size samples for the longline fleets, the modelling team may consider aggregated the longline fleet structure by the 3 regions specified within the joint longline CPUE analyses (see Section 7, **Figure 7** and **Table 7**).

### 3.2 Task II (catch-effort and size samples) data

The Secretariat presented the SCRS catalogues for YFT by region (YFT-E: eastern Atlantic; YFT-W: western Atlantic) for the period 1989-2018 (respectively, **Tables 2** and **3**). As observed, many T2CE datasets (crucial for estimating CATDIS, the YFT data source used as the quarterly catches by fishery in the stock synthesis models) are still missing in ICCAT. The Secretariat has informed that, several CPCs (Mexico, South Africa, EU-Cyprus, etc.) have an ongoing full revision of their corresponding T2CE datasets currently available in ICCAT, and invited all the CPC scientists to use the YFT catalogues to verify the completeness of their series.

SCRS/2019/064 document presented a summary of the YFT size data available in ICCAT-DB and the preliminary size frequency distributions by fishery ID, year and quarter as input for assessment models. The size data was quality control checked and standardized to straight fork length (SFL 2 cm bin size intervals), observations reported in weight units were excluded. From the size data, a size frequency samples were constructed when at least 75 fish measures were available by strata, and the frequency

sample kurtosis and skewness were within their 95% percentile of the overall size frequency samples, respectively. The Group also requested excluding samples from other gears fishery ID that represented mix/unknown fishing gears and the respective catch is less than 5% of the annual YFT catch.

The Group enquired about the size distribution of the Chinese Taipei longline fleet, particularly in recent years, when the mean size of YFT catch has increased since 2005. The Group noted that in other tRFMOs (e.g. Indian Ocean) it was recommended not to use size sampling data from the Chinese Taipei fleets, until problems could be resolved. For bigeye in 2018, Chinese Taipei scientists corrected the catch size distribution data using the observer programme data. There were no scientists present at this meeting to answer questions from the Group. The Group recommended to exclude the size data from Chinese Taipei after 2004 and to seek advice from Chinese Taipei about whether to use size data before 2004.

### ***3.3 Improvements to Ghana statistics (Task I and II, 2006-2018)***

The Secretariat informed that it has recently received the data from Ghana tropical tuna fisheries statistics, though due to time restrictions, it was not able to provide estimates at the meeting. However, the proposed methodology for estimating total removals (T1NC) was presented to the Group, catch composition (CAS), catch & effort by fishing mode (T2CE) and size information (T2SZ). The estimation work will be done intersessional in collaboration with Ghana scientist, following the same procedure as done in 2018 for the bigeye assessment (Ortiz and Palma, 2019).

### ***3.4 Improvements to “faux poissons” estimations (Task I)***

No new estimates of “faux poissons” were presented at the meeting nor provided to the Secretariat. The Group requested to the scientist of the tropical tuna fisheries to update these estimates up to 2018 and to provide them before the deadline for data submission of 15 May 2019.

### ***3.5 Other information (tagging)***

The Secretariat provided a summary of the tagging information of the ICCAT database, including data from the AOTTP programme. See Section 8 for details and discussions on the tagging activities and results for yellowfin tuna.

## **4. Review and update of CAS/CAA**

### ***4.1 Preliminary estimations***

No information on CAS was presented for YFT as most of the 2018 data fisheries statistics were not provided by the CPCs before this meeting. The Group agreed on an intersessional workplan (Section 7) and requested that CPCs provide 2018 fisheries statistics by 15 May 2019. It was noted that the develop of CAA is a low priority for the Group, as no VPA models are scheduled for the assessment. If required, the CAA can be extracted from the stock synthesis model outputs for each fishery and the overall population.

### ***4.2 Improvements needed for a final CAS estimation***

The Group discussed if it was necessary to develop CAS for YFT and noted that it is possible to extract population CAS from the Stock Synthesis model as a product of the model fitting. The Group determined that the model's estimates of mean weight and CAS obtained the Stock Synthesis model were consistent with the trends observed in the fishery.

## **5. Review of fishery indicators**

Several presentations were made describing fisheries indicators, such as trends in fleet components and distribution, effort characterization and quantification, environmental conditions affecting catch rates, etc. Review of such fisheries indicators may assist in the treatment of stock assessment data inputs and interpretation of results, and in the formulation of management advice.

### ***Fisheries Indicators from National Fleets***

SCRS/2019/076 was presented, providing an update on the statistics for the EU-Spain tuna fisheries in the tropical Atlantic. During discussion, it was noted that a substantial increase in sets per day on FADs began in the early 2000s, around the time when sonar equipped FADs increased the efficiency of FAD fishing. However, there was no apparent increase during the 1990s, when it is generally understood that FAD sets began increasing (SCRS/2019/076, Figure 12). It was suggested that the figure showing the trends in FAD and free school sets/day across years be considered for inclusion in the report, potentially in the Executive Summary.

SCRS/2019/077 presented statistics on the EU and associated purse seine and baitboat fleets. The Group was informed that the current EU tropical tuna sampling programme has been modified beginning in 2019. Agreements are in place to ensure continued sampling of the EU fleet, but the situation is unclear currently in the case of the foreign flagged fleet. The Group considered the sampling conducted when purse seine catch is offloaded, as well as in the local markets of Abidjan and Dakar, to be very important because this is essential to characterizing the catch, species composition and size frequency of the PS fishery. The Group therefore recommended that sampling of the foreign flagged component (monitored by the EU sampling programme) continue at recent coverage levels into the future. The Group also recommends that the monitoring and sampling of other PS and BB tropical tuna fleets be carried out at similar levels.

The Group considered that it may be of value to examine potential differences among the fleets. It was suggested that this sampling data should be shared because it is anonymous. The rule is that each country is responsible for collecting its data, but not all data is shared globally.

The Group suggested that showing the number of sets per day by fishing mode (floating object vs free school sets) for the EU and associated fleets would be useful for understanding trends. It was indicated that this could be prepared, if requested, for future discussions.

The Group considered that it would be useful to see the trends in number of vessels, active fishing days and carrying capacity for the total tropical tuna PS and BB fisheries. Information from some PS and BB vessels fishing for tropical tunas in the Atlantic are not covered within available information from the EU and associated fleets. However, all of this information is not currently submitted to the Secretariat because it is optional. Therefore, the Group recommends that the annual submission of number of vessels, active days fishing, and specific vessel characteristics (ST01FC) be mandatory for all CPCs with fisheries on PS and BB tropical tunas in the Atlantic. The Group recommends that the reporting of such data for other fleets also be considered.

SCRS/P/2019/030 provided descriptive statistics of the EU-France purse seiner fleet targeting tropical tunas in the Atlantic Ocean from 1991 to 2018, with the aim to present a global overview of tendencies. These fishery indicator statistics will be updated and made available for the Tropical tunas Species Group meeting in September 2019.

The indicators presented could be separated in four groups: (a) fleet characteristic indicators (number of vessels by volume of wells and carrying capacity over the years), (b) summarization of the activities (activity duration and number of sets by fishing modes), (c) distribution of catches (by fishing mode, mean weight of individuals and biomass by size class for the yellowfin tuna and spatial distribution of catches) and (d) at least nominal CPUE for each major tropical tuna by fishing modes (catches per searching day and catches per positive set).

The Group noted the importance of receiving the Task II information by the deadline established for this year's stock assessment.

SCRS/2019/029 presented an analysis of seasonal trajectories of tuna vessels off Mauritania from VMS data. On average, more than 50 foreign tuna vessels (EU, Japan, Senegal) have worked under free license during the last decade off the coast of Mauritania. This document presented an analysis of VMS data for 32 vessels in 2017, and 28 vessels in 2018. Models were applied to classify the observations by activity type (e.g. search time, set time). One future application planned would involve associating fishing time with catches in order to calculate a catch per unit of effort.

The Group noted that this analysis was conducted for was all gears together. It was suggested that this be done by main gear type, as the characteristics of the various components of fishing related activity are different between the major gears.

### ***Effect of climate variability on catches***

SCRS/P/2019/024 presented an analysis of the effect of climate variability on catches of yellowfin tuna in the southwestern Atlantic Ocean for the period 1982-2010. Results presented confirm that climatic variability caused by different atmospheric and oceanic processes affects the distribution and catches of yellowfin tuna in the southwestern Atlantic Ocean. No direct relationship between the increase in SST and the catches of this species were observed. The optimal SST range defined by the model (16° - 22.5°C) is below the preference ranges reported for the species. ENSO events appear to have a positive effect over CPUE in extreme events of El Niño and La Niña, while moderate events tend to be negative or low effect.

The Group noted that it would be a good input for the model to include a variable that addressed the change in target species of the fishery (which has been related over time to the differing composition of the fleet), as there was concern that could confound the associations with environmental variables that are being tested. For the analysis, targeting strategies for four different species were identified. The Group recommended removing from the analysis those targeting albacore and blue shark and keeping bigeye and swordfish. It was suggested that another way of dealing with target species could be splitting the time series as it has been previously done in the standardization of Uruguayan CPUE index. This approach might not be the best solution, as long temporal series are needed for climate effect analysis.

Also, the Group commented that the optimal SST range defined for the model might not mean that the preferences of the species are different from what is reported in the literature, and that the estimated optimal might be given by the lack of data with higher values of SST. It was clarified that the SST preference in the study reflects the strong association of the species with the thermal fronts occurring in the area. It was noted that electronic tagging data have shown that, despite an apparent preference for warmer waters, yellowfin tuna are somewhat tolerant of much cooler temperatures (e.g. 5-6 °C during deep dives extending over several hours), so the model estimated range of (16° - 22.5°C) did not seem unreasonable, given the conditions. The author noted that YFT were found in the study are at even lower temperature (below 16°), possibly associated with feeding on squid or anchovy, two very abundant prey species in the area. The author was asked if the effect of eddies was specifically examined; it was clarified that this complex topic was not addressed.

The Group noted that these data could be useful for developing an abundance index, although that was not part of the current study. The variable CV-DEPTH explained the highest percent of the deviance in the model. It was suggested that this might in part be explained by the aggregation by month, since cv-depth is constant for each cell (as it is defined by the variability of depth within the cell area, irrespective of where, when and under what environmental conditions the sets occurred), whereas the effect of other variables may be somewhat muted by the averaging.

There was concern that the model may not be able to distinguish annual climate effects from annual abundance changes (given that YEAR effects were included in the model, which can be a proxy for relative annual abundance), although there was discussion as to whether considering the climate effects on a monthly basis is addressing this. This is an important consideration when ultimately the effects of environmental factors are accounted for in abundance indices/stock assessments. There may be a confounding between the environmental factors and the year effect, particularly when using environmental indices compiled on a yearly basis, or when there are long-term environmental trends. The Group cautioned that climate-induced changes in catchability and/or availability that are not included in the development of indices of abundance can lead to false conclusions about population abundance trends.

There was interest in whether or not there will be AOTTP PSAT data from that area. At this time, there are some PSAT results for areas near South Africa and Brazil.

### **6. Review of available indices of relative abundances by fleet and estimation of combined indices**

The Group was provided with standardized longline indices from several CPCs and a multi-national joint standardized index. After reviewing all provided information related to longline fisheries, the Group agreed to use the joint CPUE between Japan, USA, Brazil, Korea, and Chinese Taipei for the 2019 stock assessment. The Group was also provided with a novel abundance index of juvenile yellowfin tuna derived from echosounder buoys, and a refined method for the standardized CPUE of EU free school purse seine fleets. The Group made suggestions to improve and document diagnostics for echosounder and purse seine indices in order to consider them before and during the stock assessment meeting in July 2019. The abundance indices recommended for use in 2019 July assessment are available in **Table 4** and **Figure 6**, and all other available indices are found in **Table 5**. The Group also discussed and completed the CPUE evaluation tables (**Table 6**).



***National longline indices***

SCRS/2019/072 presented standardized Japanese longline CPUE for yellowfin tuna in the Atlantic Ocean up to 2018. The indices were updated using the same GLM model and area (40N-40S) as previously used. There was no discussion on this document.

SCRS/2019/079 presented the standardized catch rate for yellowfin tuna caught by the Brazilian pelagic longline fleet for the period 1978 to 2017. The Group asked why the index was less variable than the one presented in 2016 (Sant'Ana, 2017). The author emphasized that substantial improvements have been made for cleaning the data, resolving conflicting data, and updating the standardized method. Another important point was the inclusion of vessel ID in the model, this new factor in the model associated with targeting accounted well for the big variability observed in fleets from Brazil.

SCRS/2019/078 presented standardized indices, both in numbers and in weight, from the CPUE data of the US pelagic longline fishery up to 2018. The indices were updated using the same GLM model as previously used (Walter, 2017). It was noted that the fleet effort has declined due to fuel costs, regulations on bluefin tuna and other protected species, oil spills and recent hurricanes. The Group asked if the data had been explored to characterize fleet heterogeneity. It was noted that in this study, the presence and number of light sticks was used to differentiate targeting, and that other approaches that incorporate vessel ID (e.g. repeated measures) can also be useful to differentiate targeting.

SCRS/P/2019/032 provided the overview of Korean longline fishery for yellowfin tuna in the Atlantic Ocean. The Group recognized the increase in coverage since 2010 in the index and questioned the reasons. The author explained that Korea has introduced the electronic reporting system that improved the coverage of logbook significantly to 100% coverage. The Group was provided the final index in the region 2 that is the main fishing ground calculated by the same method used for the multi-national longline index (SCRS/2019/081).

SCRS/P/2019/031 presented the regional differences in size data that were used to define boundaries for utilization in CPUE standardization. Defining spatial boundaries is necessary in order to outline regions over which selectivity can be assumed constant in time and space. The information presented provided evidence of larger yellowfin tuna in the equatorial areas. The Group noted that the differences in size of yellowfin tuna that were observed across space could potentially reflect spatial structure in growth or movement across regions. It was also noted that CPUE may vary by season. The Group asked to see seasonal map for yellowfin. The author provided the requested information and it was noted that the distribution of fish sizes changed seasonally, with larger fish in warmer waters.

SCRS/P/2019/028 presented preliminary results of abundance indices by size categories of yellowfin tuna of the Japanese longline fishery in the Atlantic Ocean. It was noted that this work supports the regions defined in SCRS/P/2019/031. The Group noted that the spatial differences could be due to large fish moving to the tropical region or due to gear selectivities that are mainly associated with larger fish. There was a question about the figure showing direction of geometric anisotropy and the author clarified that the figure suggested that similarities in encounter probabilities and in the catch rates were present over a wider range of longitude than latitude.

***Multi-national longline indices***

SCRS/2019/060 presented the comparisons of yellowfin tuna CPUE and fish size from the Chinese-Taipei and Japanese longline fleets and provided a combined index with seven proposed areas. The conflict of CPUE trend between both fleets decreased compared with that in the 2016 stock assessment. After presenting the data, the authors suggested removing 4 temperate areas and retaining 3 tropical areas. The Group noted that the proposed spatial truncation was advantageous due to low catch and lack of targeting of yellowfin tuna in temperate regions but also disadvantageous because of the potential for hyperstability in a central region. The Group inquired about additional variables related to characterizing fishing configuration. The proxy that is currently used to define targeting is hooks per basket (HPB). Other potential variables briefly discussed were vessel and line setting speed, hook type, light sticks, and leader type. However, these additional variables were deemed impracticable for use as they are historically not available in both fleets and a single model was intended to be used on both the Chinese Taipei and Japanese longline data.

SCRS/2019/081 provided the multi-national longline CPUE indices for Japan, USA, Brazil, Korea, and Chinese Taipei developed using the regional boundaries described in SCRS/P/2019/031. The presentation provided two alternatives for dividing the combined data into 3 or 6 spatial regions. The 6 region spatial configuration was similar to the 3 region configuration, with an additional division to define East and West Atlantic components. It was indicated that the joint indices developed using 6 regions provided very limited additional information compared to the indices with just 3 regions.

A spatio-temporal comparison of depletion in abundance within and across regions indicated declines in all regions with more pronounced declines evident in the Tropical region, which is the main central area for yellowfin tuna, compared to the North and South Temporal regions. This does suggest an overall decline in the population, rather than a contraction of habitat range. The author noted that the depletion analysis for region 1 (North temperate area) and region 3 (South temperate area) should be interpreted with caution, as the data in regions 1 and 3 were associated with much less observations than in region 2 (Tropical area).

The Group recommended using the joint index as an indicator of the abundance trend for yellowfin tuna based on the longline CPUE. The joint index is constructed for three regions (**Figure 7**). The Group recommended that the joint index using vessel effects for years 1979-2018 be used. Due to difficulties related to interpretation of the sharply declining trends in the early time period (1960-1978) that may be due to un-modeled changes in targeting, reporting or other unknown reasons the Group recommended that this early time period index not be used in the modeling.

The joint indices are available for the three regions defined as part of the joint CPUE evaluation process (**Figures 6 and 7**). The Group noted that indices for all three regions might be possible to use but as the Stock Synthesis model will not model movement, it may be necessary to consider some type of index weighting procedure to account for conflicting trends across the regions for indices that largely reflect the same population. This could be based on area or biomass weighting, however the Group felt that it would require substantial further work.

Therefore, the Group outlined a series of model runs (Section 7) that use the joint index in area 2 as the initial reference model, but also including a model run with all three region indices as a sensitivity run. The Group further notes that each of these index treatments will be screened before determining which ones will be used in the reference case and the treatment of the number of indices (1 or 3) will be determined through the modelling exercises outlined in Section 7.

### ***Juvenile Indices***

SCRS/2019/075 presented an index of abundance for juvenile yellowfin tuna calculated from echosounder buoys. This index is based on the echosound data collected from the buoys, the authors clarified that the window of time (between 20 to 35 days) within which data were used to estimate densities for each buoy was determined from the literature. This allows time for aggregations to form (at least 20 days) while avoiding exposure to fishing activity.

The Group noted that the species composition data used to estimate the index, Task II catch and effort data, is derived from large spatial area estimates which could imply that species composition proportions are kept constant which will affect the precision and accuracy of the CPUE (e.g. 3 tropical species-specific trends following parallel trends). The Group suggested developing and comparing the juvenile index across the three tuna species (bigeye and skipjack in addition to yellowfin tuna) to check whether the species composition from Task 2CE data affects the specific CPUE trends. It was also suggested that the species composition information should be based on data from fished sets with higher spatiotemporal relevance and that the uncertainty of species composition should be propagated into the final model. Thus, the Group requested the authors to use species composition and size frequencies at a more fine-scale (e.g. 1x1<sup>o</sup> and month) obtained from the EU Tropical sampling programme database.

The Group also suggested an alternative analysis whereby an abundance index from echosounder biomass for all species (skipjack, yellowfin tuna, bigeye tuna) is multiplied by estimates of species composition derived from another GLM model using the EU Tropical tuna sampling programme by the same strata (i.e. 1x1<sup>o</sup> and month).

The authors indicated that the early and current buoys used a single frequency signal echosounder, that was converted into species specific signals using specific target strength parameters. According to the literature there is also some differential vertical segregation among species that may be worth exploring.

Lastly, the Group commented on the potential effects of competing FADs to affect aggregations and the author noted that the FAD density is included in the standardization model.

### ***Indices from Surface Fleets***

SCRS/2019/066 introduced refined methods for standardizing CPUE of the EU purse seine fleet for free schools. The authors clarified the terms used to characterize the first component of the delta lognormal standardization method. The new response variable for this first component was defined as the number of detections, i.e. the total number of sets, thus becoming a Poisson component. Detection of free schools was modeled as a function of several variables, including searching time defined as the total vessel time, independently from the fishing mode, in a cell minus the time spent fishing in that cell. Fishing activity was counted for all sets, including null sets where fishermen failed to catch fish. The Group further discussed the Poisson response variable and how changes in this metric would be interpreted.

It was commented that the dependence of sets should be considered in the analysis, because there is little additional search time when a vessel sets repeatedly on the same school. It was suggested to consider a minimum time between consecutive sets. The Group also suggested that simulations could be used to support the aptness of the methodology for indexing density of free schools. The Group also noted that the method assumes similar composition between null and successful sets.

The Group discussed the types of gear used by the EU purse seine fleet in the eastern Atlantic, highlighting that the vessels use similar technology but that catch changes by vessel size. While the number of sets need to fill the wells of a vessel will vary, the author clarified that vessel age and storage capacity were incorporated in the model.

## **7. Identification of data inputs and specifications for the different assessment models and advice framework (SPM, SS3, Others)**

### ***7.1 General considerations***

The Group agreed to conduct surplus production models and Stock Synthesis models, similar to the previous yellowfin tuna assessments, which would capture a range of model assumptions and complexity. The Group considered that the production models and different configurations of the integrated model would encompass a wide enough range of assumptions regarding data inputs and model structure such that several of the models previously applied to yellowfin (e.g. VPA and ASPM) would not be necessary to run. While this section outlines general recommendations and specifications, we maintain the prerogative of analysts to make necessary decisions to alter certain specifications according to the model performance and more detailed consideration of input data.

SCRS/2019/062 presented a hindcasting approach for the stock assessment for the Atlantic yellowfin tuna. The method is a retrospective cross-validation test, in which virtual prediction over several years ahead by intentionally removing data for such years is conducted and compared with actually observed data. This method is applied to test the prediction skill, which is crucial for management advice, and to compare the models across those with partially different data set. The method has been preliminary applied to several stock assessment exercises such as the Atlantic bigeye tunas, the Indian Ocean yellowfin tunas and the Pacific saury. It was demonstrated that, even when the retrospective patterns do not clearly differentiate performance between models, there can be contrast in prediction skill that help differentiate between models. While evaluation of the performance of the hindcasting method itself via simulation studies is ongoing, it remains valuable to apply the method in this assessment. The Group also noted that the hindcasting is useful not only for diagnostic screening of the sensitivity runs before constructing the grid but also for weighting considerations of the uncertainty grid. However, the method of hindcasting relies upon selectivity and catchability of the fleets used to model the index selectivity, and if selectivity varies over the recent time period the approach may have some limitations. In this case it may be most useful for screening and may not provide clear advice for weighting of the uncertainty grid. In this case equal weighting may be considered.

SCRS/2019/073 presented an outline for the upcoming ICCAT yellowfin tuna stock assessment in July 2019, of which most recommendations have been incorporated into reference model and sensitivity specifications outlined below.

Overall, for all modeling platforms, the time frame will be 1950-2018, assuming near virgin conditions in 1950. The modeling will be conducted by teams as the intention of the Group is to make the modeling process transparent (by routinely posting model input and data files to the Owncloud) and inclusive (any interested parties should contact model leads to participate). Leads, as of the data preparatory meeting, have been identified as follows: SPM (G. Merino), and JABBA (R. Sant Ana, A. Kimoto), SS (J. Walter, H. Yokoi, K. Satoh, T. Matsumoto, A. Urtizberea, T. Kitakado). The Group requests that leads post the reference case input files for each model to allow cross-checking of data files, control files, etc. At least one week prior to the assessment meeting (1 July 2019) all input, data files, code and executables for all model runs will be made available to the Group and each model should have an associated paper provided for the assessment workshop that describes the inputs, model and results as of that date so that the Group can fully evaluate each stock assessment platform.

All models to be considered for the development of management advice should have the full suite of diagnostics.

The Group notes that many essential modeling inputs are still in preparation and that all missing data inputs (primarily task I NC and size composition and several of the index inputs) be provided by 1 June 2019.

## 7.2 Deadlines

15 May 2019: Task I data through 2018 from CPCs  
 1 June 2019: Data deadline for Task I NC inputs to model  
 1 July 2019: Deadline for submission of reference model and sensitivity runs to Owncloud  
 8 July 2019: Start of meeting

## 7.3 Process for building the uncertainty grid starting from a reference case

SCRS/2019/073 presented an outline for the upcoming ICCAT yellowfin tuna stock assessment in July 2019. The process is composed of six steps; 1) developing the reference case, 2) conducting one-off sensitivity analyses based on the reference case, 3) conducting diagnostics for detecting the model mis-specification, understanding goodness-of-fit and model prediction performance, 4) assessing the impact of each parameter alternation, 5) constructing the uncertainty grid, and 6) assemble the results of multiple scenarios. The list of reference models and sensitivity runs are outlined below.

In all models, the reference case is merely the starting point for the subsequent analysis and is likely to change on the basis of diagnostic screening.

*Phase 1.* Develop the reference case. In recent year, diagnostic methodology for the integrated stock assessment model has been developed including the ASPM diagnostic (Minte-Vera *et al.*, 2017) and R0 profile (Wang *et al.*, 2014), which were applied for the tuna species stock assessment. The retrospective analysis and residual plots are useful tools for the diagnosis. Using these tools, an initial reference case should be screened for potential model mis-specification. Full diagnostics, including jitter analysis, retrospective analyses, likelihood profiling of R0, steepness; bootstrapping and simple projections will be conducted on the reference case model.

*Phase 2.* Define one-off sensitivities based as listed above.

*Phase 3.* Diagnostics on sensitivities. Screening of sensitivities runs based on diagnostics using these tools outlined above to identify model mis-specification. Some scenarios may be excluded from further analysis, if they do not pass diagnostic tests. Another screening diagnostic that will be applied is that each model considered for the grid analysis should have a positive definite Hessian matrix. Another criterion for model convergence is the maximum gradient component for which the standard criterion of 0.0001 may need to be relaxed. For the production models the approach of Kell and Merino (2016) serves as general screening of sensitivities to different indices.

*Phase 4.* Developing uncertainty grid. The impact of each parameter alternation will be assessed comparing the difference of the stock status indicators ( $F/F_{MSY}$  and  $B/B_{MSY}$ ) between the reference case and the one-off sensitivity tests. The sensitivity runs with the largest differences have the greatest potential to influence the assessment results and are likely the most important to consider to encompass the range of uncertainty.

*Phase 5. Grid analysis.* After the selection of the previous process, the grid analysis will be conducted using these selected setting items. As an example, if three items (steepness, growth, mortality) are selected to form the sensitivity analysis, the total number of scenarios for the grid analysis are the products of the three items ( $12 = 3 \times 2 \times 2$ ). Such grid would then be constructed for each model platform.

*Phase 6. Ensemble the results of multiple scenarios.* An ensemble of the uncertainty grid will likely be used for developing the management advice. The hindcasting methodology (Kell *et al.*, 2016) to provide advice on how to weight candidate model constructions for the uncertainty grid may be considered. As management advice in ICCAT is based on future predictions using the Kobe 2 matrix, models that show good predictive performance are desirable. Therefore, a scenario, which shows good performance for future prediction, may be a better candidate for a larger weighting in the grid during the ensemble process.

Models to be included in the grid analyses will then be projected for development of management advice. Projection specifications will follow general advice by using likely carrying over preliminary 2018 TACs for 2019. A range of TACs ranging from 0, and 80-140 thousand t for development of Kobe 2 Strategic Matrix. For Stock Synthesis uncertainty will be quantified by use of the multivariate normal approximation similar to that used for bigeye tuna (Walter *et al.*, 2019). For projection advice to be available by the end of the meeting the uncertainty grid must be finalized by the 3rd day of the meeting.

#### **7.4 Stock synthesis specifications**

Similar to the 2016 stock assessment, the integrated assessment modeling platform of Stock Synthesis will be used. Fleet structure (**Table 7**), model set ups and specifications will mostly remain the same as in 2016, though some restructuring of the fleets will be conducted to match the revised spatial structure identified in SCRS/2019/042. Fleet structure will, when possible, also be harmonized to match the structure of the bigeye assessment to facilitate structuring of Stock Synthesis models to inform operating models in the MSE. Specific changes are outlined below:

The reference case will have the following specifications:

1. Convert from SS 3.24 to 3.30
2. Address several parameter bounding issues and high CVs on some selectivity parameters
3. Check the plus group 10+ specifications to determine if a change is necessary
4. Annual indices will be used, though the model retains quarterly time step for length composition and recruitment partitioning. Though juvenile index may be retained as quarterly to reflect quarterly recruitment
5. Model will be one area, with fleets-as areas assigned according to revised 3 area definitions (**Figure 7**)
6. Movement will not be estimated
7. Recruitment estimated quarterly
8. Francis reweighting of composition data (Francis, 2011)
9. Lambda on size composition data =1
10. Reevaluate selectivities for baitboats and purse seine fleets, correcting for some bounded parameters.
11. Reevaluate seasonal selectivity/seasonal fleet structure to match seasonality of movement/availability for purse seine and longline indices.
12. The longline fleets will be initially 6 separate fleets as specified in the bigeye model and consideration of condensing them into three fleets will be based on inspection of the composition data. Selectivity for area two (central) will be estimated with an asymptotic function. Selectivity will be estimated as double normal for regions 1 and 3, based on larger average sizes from longline caught fish in region 2 (SCRS/2019/042).
13. A time block on selectivity for the longline fleet selectivity will be applied starting in 1979; similar time blocks as in the bigeye tuna stock assessment should be incorporated.
14. Growth estimated internally in the model with Richards using otolith data from SCRS/P/2019/025, and daily aged otoliths only up to age 1.
15. Baseline  $M=0.35$  (as estimated from Then *et al.*, 2015 using  $t_{max}$  of 18).
16. Attempt to estimate  $\sigma_R$  (using the bias correction ramping of Methot and Taylor, 2016).
17. Initial size composition data sample size input as  $\ln(N)$ .
18. Brazil handline fleet landings assigned a new fleet, use size information from AOTTP tagging data.
19. Joint index for region 2 from 1979-2018 with vessel ID (one index).
20. Model will start in 1950 and go to 2018 (with preliminary catch used for 2018. This allows for the use of the 2018 index value; likely no composition data will be available for 2018 but it is not needed by the model). Stock status could be determined for 2017 in this case.

21. Beverton-Holt stock recruitment, steepness fixed at 0.8, but profiled as part of the diagnostic evaluation.
22. Joint index will be input with a common CV of 0.2 but with interannual variability to account for differential precision of the index.
23. Chinese Taipei (2005-2014) size composition; recommendation is to remove size composition after 2004 as the reported data may be uncertain and to confirm with National scientists whether the data prior to 2005 is reliable.
24. Evaluate whether the “others” (Oth) fleet can be moved or combined into another fleet.
25. Tagging data will be formatted for input to the data file, but probably not used in estimation.
26. Incorporate size limit and retention function for US RR fishery to account for size selection of samples at 69 cm.

#### *One-off sensitivity analyses*

Based on the reference case, a list of the model specifications for the sensitivity analysis is included below:

1. Baseline  $M=0.55$  (Continuity  $M$  from 2016)
2. High  $M = 0.65$
3. Low  $M=0.18$
4. Growth estimated internally in the model Richards fit to Gascuel *et al.* (1992) data
5. Joint index for regions 1, 2, 3 1979-2018 with vessel ID (3 indices)
6. Steepness 0.7
7. Steepness 0.9
8. Reduce size composition data weights (0.5) with respect to reference case
9. Reference case + purse seine free school index (CV 0.3, scaled according to interannual variability in precision)
10. Reference case + juvenile acoustic index (CV 0.3, scaled as above)
11. Reference case + purse seine free school and juvenile acoustic index (CV 0.3, scaled as above)
12. Incorporate Dirichlet multinomial distribution
13. Best-fit  $M$  value, on the basis of profiling  $M$  in the reference case, above

These sensitivity analyses should get the full diagnostic evaluation.

#### **7.5 Surplus production model**

The SPM/JABBA model requires total landings and at least one index of abundance. One of the key assumptions with a surplus production model is that all fish are fully selected. In previous ASPIC models single indices were used in isolation and full diagnostics similar to Kell and Merino (2016) will be applied to screen models in a process similar to that outlined above. These include evaluating the correlation of indices to determine if there are similarities, profiling of  $r$ ,  $K$  and the shape parameter, retrospective analyses of estimates of  $r$ ,  $K$ , and stock status and evaluation of sensitivity to starting conditions and starting values.

Runs for production models will consist first of a reference case which will use the joint longline index for region 2 (1979-2018 with vessel ID) and then model runs with the other index specifications outlined for Stock Synthesis.

After screening of models, a base case or an uncertainty grid will be developed for projections, the production models are chosen for projections.

For JABBA, three approaches will be taken to consider prior distributions for  $r$ ,  $K$  and shape parameter for the model:

- i) the first, will be aimed at informative priors, based on the same priors used in the past for yellowfin tuna Bayesian SPM models (Anon, 2009).
- ii) the second, as informative priors too, will be based on trying to derive the priors from the life history information.
- iii) the third, as non-informative priors, will be aimed to use flat priors for these parameters.

To facilitate the process of comparison and explore behaviour/sensitivity of the models to distinct index information input, analyses will be conducted using distinct indices into the models one at a time and a posterior analysis will be conducted to evaluate and infer from the answer that these distinctions will provide.

## 8. Review of the progress of AOTTP

There were six documents and one presentation on the progress of the AOTTP.

SCRS/2019/065 provided a progress update of the AOTTP and described the data availability for the yellowfin stock assessment. The Group noted the fish movement in January and March and suggested an improved figure to clarify which direction the fish were moving. Additionally, the Group noted the lack of recoveries in the western Atlantic on the southern coast of Brazil. The author explained that relatively few fish were released in that area and that recovery rates have been low for Brazil.

The Group asked for additional details on the AOTTP hard part collection and analyses. The authors clarified that the hard parts were read using daily rings and were found to be between the ages of 0 and 4. Suggestions included to; have multiple labs analyze the AOTTP otolith references to confirm ages, utilize annual rings instead of daily rings, and encourage longline fishers or canneries to contribute larger fish or fish heads. The Group acknowledged the benefits of otolith references but were concerned about the lack of older fish hard parts.

The AOTTP received a no-cost extension to November 2020, but recoveries will need to continue after that point to ensure as many tag recoveries as possible. A clear recommendation for the Commission is needed, including a budget estimation for continuing recoveries for 2 or 5 years.

SCRS/2019/068 provided estimates of tag shedding from the AOTTP, estimating rates for the various types of tag loss. The Group concluded that future work should focus on explaining why the larger fish are shedding tags at a higher rate. Typically, younger fish have weaker bodies, so the larger fish were expected to lose less tags.

SCRS/P/2019/026 presented preliminary analyses of the AOTTP tagging data to estimate annual total survival rate and year specific tag recovery rate parameters using a traditional Brownie dead recoveries model. These exploratory analyses indicated that the fact that newly tagged fish do not immediately mix in the population is likely to cause problems in the estimation of mortality from tagging data.

The Group proposed that the tagging data could be incorporated into the SS model, however the fact that not all fish are fully mixed into the population must be accounted for. The Group suggested that the level of mixing be further explored using analyses such as those described in Kolody and Hoyle (2015). The Group also suggested that these Brownie type analyses be further explored for the July assessment as they provide a helpful check on estimates resulting from the integrated assessment model analysis.

It was also suggested that post release mortality be explored by comparing return rates from different taggers. This was found to be non-negligible in the Indian Ocean tagging programme (20%+).

SCRS/2019/069 presented a GLM examining factors that affect reporting rate, including four tagger types, three species, three years, and six unloading locations. It was observed that all variables were significant predictors of tag recovery rates and questioned whether this could be a result of overdispersion. The author explained that it was difficult to conduct robust statistical analyses on these data since they were not evenly spread in nature (i.e. species, gear), space and time.

A comment was made regarding the fact that one of the objectives of tag seeding should also be to give us an idea of where along the production line we are most likely to recover a tag. Since the tag seeding takes place at different levels of the production line (on vessel, at unloading, during transshipment, etc.) this can allow for the estimation of the probability of recovering a tag at every stage. Another objective could be to uncover the rate of misreporting of fish location, date, species and vessel/gear. This could in turn help inform uncertainty in estimates of movement and growth obtained from the tagging data.

The author pointed to very low reporting rate in Brazil and Cabo Verde. AOTTP clarified that the tag seeding data from Brazil has since then been invalidated. And, that the data from Cabo Verde had originally contained an error that has since then been corrected, all 10 tags seeded were in fact recovered.

The Group was informed that the protocol for tag seeding experiments was modified six months into the project. Originally, one tag was seeded per seeding event, today five tags are seeded. This should be considered when analyzing the data.

The Group noted the lack of tag seeding effort done on longlines. AOTTP reminded the Group of the difficulty of seeding on longliners. The Group encouraged National scientists to make sure that their longliners know about the programme and declare tags. The Group reiterated the importance and benefit of having tag seeding data for the mark recapture data to be informative. It was noted that these tag seeding exercises ought to be extended in time for the duration of the recovery activities, beyond the life of the AOTTP programme.

SCRS/2019/070 assessed if the data discrepancies in the recapture data of the AOTTP were random across time, space, and fleet. The analyses of recaptures included all tropical species, but only for the purse seine fishery. Concerns over apparent data discrepancies near Mauritania were raised but the author noted that the high number of data discrepancies corresponds with an area of high recaptures and the significance of it depends on the spatial scale used to assess it.

The Group recommended to run this analysis again with updated data since several quality control checks have now been put in place to reduce gaps in data. This type of analysis could allow one to look at randomness of the recovery locations based on release location to identify levels of mixing.

SCRS/2019/067 examined the effectiveness of the FAD moratorium utilizing data from fish tagged inside or outside the moratorium. Fish were 18 times more at risk of being caught when released outside the moratorium area. The Group inquired whether AOTTP tagging data could be used to estimate the appropriate size/time duration of the moratorium based on the mixing rates and movement of tagged fish. The author acknowledged that this could be possible in the future. The Group also suggested that the author try and exclude short times at liberty or look at the recapture rates as a function of distance from the moratorium.

SCRS/2019/074 summarized St. Helena's yellowfin tuna fishery. St. Helena hosts an impressive tagging programme including ~3,000 conventional tags, 30 satellite tags, and 123 internal tags. Electronic tagging data show yellowfin tuna diving to maximum depths between 150 and 400 meters and migrating as far as the Ivory Coast. A Principle Component Analysis revealed five distinct behavioral patterns that vary by month and may have implications for catchability.

Younger yellowfin tuna were seen in St. Helena inshore area with length frequencies demonstrating the formation of yellowfin tuna cohorts that moved offshore (to Bonaparte or Cardno seamounts) as they grow. Concerns about gear selectivity affecting the distribution of fish size from inshore to offshore were raised, but the fish appear to move as cohorts.

## **9. Recommendations**

### **9.1 Biology**

It has been shown that ageing of otoliths can provide accurate and precise estimates of aging, both for the first year of growth (with daily annuli) and for older fish (with annual rings). Current ageing data is overwhelmingly coming from NW Atlantic samples. It is recommended that otoliths from the eastern and southern parts of the distribution of the stock be collected and aged. Such collection and analysis should be coordinated to follow the standardized protocol successfully developed by NW Atlantic scientists. The Group also recommends that the sex of the fish be recorded to allow estimation of sex-specific growth.

The Group noted the value of the information on maturity and fecundity that was presented from the northern Gulf of Mexico, and the extensive collection of information on sex ratio, spawning season and spawning condition that was also available in the southern Gulf of Mexico. Thus, it recommends that National scientists from Mexico and the United States collaborate to continue to improve and expand these valuable programmes.

The Group recommends enhancing the collection of biological samples from tropical tunas throughout the Atlantic but especially in the East and South. The Group recommends that national observer programmes should be considered as a platform for these collections. Biological collections should include samples of ovaries, otoliths and muscle tissue for studies of reproduction, ageing, growth and stock structure. The Group also recommends that National scientists explore options for obtaining biological samples from their fisheries. The Group requests that at least 1,000 otoliths be collected from each of the major gears, using a representative sampling scheme.



## **9.2 Statistics**

Improvements of historical catch and effort data series continue to happen under the leadership of the Secretariat and with the collaboration of some CPCs. There is still a need for CPCs to continue to review historical data series to improve the quality of the reports, especially for data sets which contain gaps that have been temporarily replaced with “carry-overs”.

The Group noted that size frequency from the longline fishery of Chinese Taipei suggests substantial changes in gear selectivity, availability or retention of small yellowfin tuna in the early 2000s. As no scientist from Chinese Taipei attended the data preparatory meeting, it was not possible to obtain answers to the questions raised. The Group recommended that the Secretariat reach out to data correspondents of Chinese Taipei to determine the appropriate use of size frequency data in the yellowfin tuna stock assessment.

The Group was informed that the current EU tropical tuna sampling programme has been modified beginning in 2019. Agreements are in place to ensure continued sampling of the EU fleet, but the situation is unclear currently in the case of the foreign flagged fleet. The Group considered the sampling conducted when purse seine catch is offloaded, as well as in the local markets of Abidjan and Dakar, to be very important because this is essential to characterizing the catch, species composition and size frequency of the purse seine fishery.

The Group therefore recommended that sampling of the foreign flagged component (monitored by the EU sampling programme) continue at recent coverage levels into the future. The Group also recommends that the monitoring and sampling of other purse seine and baitboat tropical tuna fleets be carried out at similar levels.

The Group noted the importance of information on fishing effort from the tropical tuna surface fleets. The Group recommends that the Sub-Committee on statistics considers requesting all CPCs with surface fleet fisheries targeting tropical tuna fleets to provide information on the number of vessels, active fishing days and specific vessel characteristics (STF01FC).

## **9.3 Fishery indicators and indices of abundance**

The estimates of a biomass index obtained from acoustic data from buoys deployed with FADs show a lot of promise. It is recommended that this work continues and is extended to other species of tropical tunas (see Section 6).

The development of a joint index from set by set data from longline fleets was successful in showing the usefulness of joining data sets from different fleets. This analysis provided not only an index more representative of the abundance of yellowfin throughout the entire distribution of the stock, but also a better understanding of the spatial sub-structure of the stock. It is recommended that such joint indices continue to be developed for other ICCAT stocks and that data from other longline fleets, not yet incorporated to the joint index, are added to the data set.

The Group noted the increased contribution of the Brazilian handline fleet to the overall landings of yellowfin tuna. The Group recommends the development of indices of abundance from CPUE data and that additional statistics be reported from that fleet, including fish size and fishing effort data.

## **9.4 Assessment models**

The Group noted the need to follow the timelines specified in Section 7 of this report.

## **9.5 AOTTP**

The success of the AOTTP in improving the capacity of coastal scientists to participate and contribute to the work of the SCRS is obvious from the number of SCRS papers and presentations provided during the meeting. It is recommended that ICCAT continues to support such type of activities in the future to capitalize on the investment success of the AOTTP project.

Most AOTTP-tagged fish were released small and it takes several years for such fish to grow to the large sizes which are more informative for the study of growth and mortality from gears other than surface gears. As a result, dedicated tag recovery activities need to continue for 3-5 years at a minimum to ensure that tagged fish caught in subsequent years are reported. Such activities should partially shift their focus from surface gears to longline gear.

AOTTP has successfully invested in the improvement of data reports for tagged fish. Despite this, there are some records with missing information required for analysis. It is recommended that the analysis of data gaps is used to further improve the quality of reports.

Analysis of tag seeding experiments conducted by the AOTTP has shown that there is still room for improvement of reporting rates for all fleets, and particularly longline fleets. The variability in estimated reporting rates highlights the need to continue such tag seeding experiments in the future, so as to be able to use future tag-returns for stock assessments. It is recommended that awareness programmes are increased or maintained and estimates of reporting rates continue to be obtained into the future.

The Group noted the estimates of tag shedding obtained by analysis of the AOTTP data. Studies from other tRFMOs have shown that tag-release mortality is significant and can be as high as 30%. It is recommended that tag shedding rates, tag-release mortality and the level of mixing of recently tagged fish be considered in the analysis of AOTTP tag returns.

The Group noted the success of the releases of internal tagged fish in St. Helena, where the percentage of tag returns of such fish is at the same level or greater than those from fish released with conventional-tags. The Group recommends that ICCAT scientists releasing fish with satellite tags or internal tags contact the St Helena scientists for advice on the best procedures to be used for handling fish during tagging experiments.

There is some evidence from tag returns that growth of yellowfin tuna may be halted or depressed right after fish are released. It is recommended that further analyses are conducted of the short-term growth of tagged fish, including a review of studies conducted elsewhere.

The Group noted the usefulness of the preliminary work on the movement of fish tagged within the FAD moratorium area and during the moratoria. The Group recommends that such work continues and is expanded to help the SCRS to respond to the Commission request of the effects of the moratoria. Ideally updated results of the expanded work should be presented at both the 2019 yellowfin assessment meeting in July and the 2019 September SCRS species Group meeting.

## **10. Other matters**

The Group was made aware that the final report of work conducted during phase 1 of the tropical tuna management strategy evaluation (MSE) is available (SCRS/2019/033), as well as a description of the observation error model (SCRS/2019/015). The Group asked that a brief plan and budget for the completion of phase 2 activities be presented to the yellowfin tuna assessment meeting in July 2019.

The Group was also made aware that the United States has recently improved their recreational statistical sampling programme, which may result in revised estimates of recreational catch for yellowfin tuna and other ICCAT species. Any revisions to US statistics would be presented and reviewed through typical ICCAT protocols. The potential changes are not expected to be of the magnitude that they would impact the stock assessment results.

## **11. Adoption of the report and closure**

The Chair acknowledged that the successful outcome of the data preparatory meeting was made possible by the substantial efforts of the Secretariat and National scientists to prepare the needed data inputs, to participate in the review of those products, and to make modeling recommendations. The Chair also thanked the rapporteurs who volunteered to prepare the report of this meeting. The Group adopted the report at this meeting and the meeting was adjourned.

## References

- Anon. 2009. Report of the 2008 ICCAT yellowfin and skipjack stock assessments meeting (Florianópolis, Brazil – July 21 to 29, 2008). Collect. Vol. Sci. Pap. ICCAT, 64(3): 1634-927.
- Anon. 2019. Report of the 2018 ICCAT bigeye stock assessments meeting (Madrid, Spain – 23-27 April 2018). Collect. Vol. Sci. Pap. ICCAT, 75(7): 1634-1720.
- Bard, F.X. 1984. Croissance de l'albacore (*Thunnus albacares*) Atlantique d'après les données des marquages. International Commission for the Conservation of Atlantic Tunas. Collect. Vol. Sci. Pap. ICCAT, 20(1):104-116.
- Diaha, N.C., Zudaire, I., Chassot, E., Barrigah, D.B., Irie, Y.D., Gbeazere, D.A., Kouadio, D., Pecoraro, C., Romeo, M.U., Murua, H., Amade, M.J., Dewals, P., and Bodin, N. 2016. Annual monitoring of reproductive traits of female yellowfin tuna (*Thunnus albacares*) in the eastern Atlantic Ocean. Collect. Vol. Sci. Pap. ICCAT, 72(2):534-548.
- Francis, R.I.C.C. 2011. Data weighting in statistical fisheries stock assessment models. Canadian Journal of Fisheries and Aquatic Sciences 68:1124–1138.
- Gascuel, D., Fonteneau, A., and Capisana, C. 1992. Modelisation d'une croissance en deux stances chez l'albacore (*Thunnus albacares*) de l'Atlantique Est. Aquatic Living Resources. 68(5):2059-2075.
- Kell, L.T., Kimoto, A., and Kitakado, T. 2016. Evaluation of the prediction skill of stock assessment using hindcasting. Fisheries Research, 183: 119-127.
- Kell, L.T., and Merino, G. 2016. Stock assessment diagnostics for Atlantic bigeye tuna. Collect. Vol. Sci. Pap. ICCAT, 72(1): 245-265.
- Kolody, D., Hoyle, S. 2015. Evaluation of tag mixing assumptions in western Pacific Ocean skipjack tuna stocks and assessment models. Fisheries Research, 163: 127-140.
- Lang, E. T., Falterman, B. J., Kitchens, L. L., and Marshall, C. D. 2017. Age and growth of yellowfin tuna (*Thunnus albacares*) in the northern Gulf of Mexico. Collect. Vol. Sci. Pap. ICCAT, 73(1): 423-433.
- Nagom, F., and Fonteneau, A. 2016. Historical review: 50 years of tropical tuna fishing by Senegalese fisheries. Collect. Vol. Sci. Pap. ICCAT, 72(3): 725-746.
- Methot, R.D., and Taylor, I.G. 2011. Adjusting for bias due to variability of estimated recruitments in fishery assessment models. Can. J. Fish. Aquat. Sci., 68:1744-1760.
- Minte-Vera, C.V., Maunder, M.N., Aires-da-Silva, A.M., Satoh, K., and Uosaki, K. 2017. Get the biology right, or use size-composition data at your own risk. Fisheries Research, 192: 114-125.
- Ortiz, M., and Palma, C. 2019. Estimation of Ghana tasks I and II purse seine and baitboat catch 2006 – 2017: data input for the 2018 bigeye stock assessment. SCRS/2018/109.
- Pecoraro, C., M. Babbucci, R. Franch, C. Rico, C. Papetti, E. Chassot, N. Bodin, A. Cariani, L. Bargelloni and F. Tinti. 2018. Scientific Reports 8:13890 DOI:10.1038/s41598-018-32331-3
- Sant'Ana R., Hazin H.G., Hazin F.H.V, Mourato B., Andrade H.A., and Travassos P. 2017. Standardized catch rates of albacore (*Thunnus alalunga*) caught by the Brazilian fleet (1978-2012) using Generalized Linear Mixed Models (GLMM) – Delta Log Approach. Collect. Vol. Sci. Pap. ICCAT, 73(4): 1561-1570.
- Shuford, R. L., Dean, J. M., Stéquert, B., and Morize, E. 2007. Age and growth of yellowfin tuna in the Atlantic Ocean. Collect. Vol. Sci. Pap. ICCAT, 60(1): 330-341.
- Then, A.Y., Hoenig, J.M., Hall, N.G., and Hewitt, D.A. 2015. Evaluating the predictive performance of empirical estimators of natural mortality rate using information on over 200 fish species. ICES Journal of Marine Science 72(1):82-92.
- Walter, J. 2017. Standardized catch rate in number and weight of yellowfin tuna (*Thunnus albacares*) from the United States pelagic longline fishery 1987-2015. Collect. Vol. Sci. Pap. ICCAT, 73(1): 323-368.

- Walter, J., Hiroki, Y., Satoh, K., Matsumoto, T., Winker, H., Urtizberea, I.A., and Schirripa, M. 2019. Atlantic Bigeye tuna Stock Synthesis projections and Kobe 2 Matrices. Collect. Vol. Sci. Pap. ICCAT, 75(7): 2283-2300.
- Wang, S-P., Maunder, M.N., Piner, K., Aires-da-Silva, A., and Lee, H-H. 2014. Evaluation of virgin recruitment profiling as a diagnostic for selectivity curve structure in integrated stock assessment models. Fisheries Research, 158: 158-164.







**Table 4.** Recommended abundance indices for reference set in 2019 Atlantic yellowfin tuna stock assessment.

| series | Joint LL- Region1 |               | Joint LL- Region2 |                 | Joint LL- Region3 |                 | PS              |          | series  | Buoy-derived Abundance Index |          |                 |                 |                 |                 |                 |
|--------|-------------------|---------------|-------------------|-----------------|-------------------|-----------------|-----------------|----------|---------|------------------------------|----------|-----------------|-----------------|-----------------|-----------------|-----------------|
|        | units             | Number        |                   | Number          |                   | Number          |                 | Tropical |         | units                        | Tropical |                 |                 |                 |                 |                 |
|        |                   | area          | North Temprate    |                 | Tropical          |                 | South Temprate  |          |         |                              | method   | Delta lognormal |                 |                 |                 |                 |
|        |                   |               | source            | Delta lognormal | Delta lognormal   | Delta lognormal | Delta lognormal |          |         |                              |          | Delta lognormal | Delta lognormal | Delta lognormal | Delta lognormal | Delta lognormal |
|        | SCRS/2019/061     | SCRS/2019/061 | SCRS/2019/061     | SCRS/2019/061   | SCRS/2019/066     | SCRS/2019/066   | SCRS/2019/066   | Year     | Quarter | Std. CPUE                    | CV       | Std. CPUE       | CV              |                 |                 |                 |
| 1979   | 1.12              | 0.10          | 1.29              | 0.08            | 1.35              | 0.20            |                 | 2010     | 1       | 0.44                         | 0.15     |                 |                 |                 |                 |                 |
| 1980   | 0.89              | 0.10          | 1.25              | 0.06            | 0.62              | 0.14            |                 | 2010     | 2       | 0.44                         | 0.15     |                 |                 |                 |                 |                 |
| 1981   | 0.81              | 0.08          | 1.23              | 0.05            | 0.72              | 0.12            |                 | 2010     | 3       | 0.41                         | 0.16     |                 |                 |                 |                 |                 |
| 1982   | 0.74              | 0.09          | 1.18              | 0.04            | 0.90              | 0.10            |                 | 2010     | 4       | 0.63                         | 0.16     |                 |                 |                 |                 |                 |
| 1983   | 1.01              | 0.09          | 1.02              | 0.06            | 0.85              | 0.11            |                 | 2011     | 1       | 0.45                         | 0.16     |                 |                 |                 |                 |                 |
| 1984   | 1.12              | 0.09          | 1.29              | 0.05            | 1.07              | 0.12            |                 | 2011     | 2       | 0.51                         | 0.15     |                 |                 |                 |                 |                 |
| 1985   | 0.86              | 0.09          | 1.15              | 0.04            | 0.86              | 0.10            |                 | 2011     | 3       | 0.37                         | 0.16     |                 |                 |                 |                 |                 |
| 1986   | 1.06              | 0.08          | 1.41              | 0.05            | 0.99              | 0.10            |                 | 2011     | 4       | 0.33                         | 0.16     |                 |                 |                 |                 |                 |
| 1987   | 1.06              | 0.07          | 1.52              | 0.04            | 0.91              | 0.11            |                 | 2012     | 1       | 0.23                         | 0.15     |                 |                 |                 |                 |                 |
| 1988   | 1.19              | 0.07          | 1.37              | 0.04            | 1.35              | 0.10            |                 | 2012     | 2       | 0.34                         | 0.15     |                 |                 |                 |                 |                 |
| 1989   | 1.16              | 0.06          | 1.31              | 0.04            | 1.00              | 0.10            |                 | 2012     | 3       | 0.22                         | 0.16     |                 |                 |                 |                 |                 |
| 1990   | 1.36              | 0.07          | 1.32              | 0.04            | 1.00              | 0.09            |                 | 2012     | 4       | 0.17                         | 0.15     |                 |                 |                 |                 |                 |
| 1991   | 1.23              | 0.06          | 1.11              | 0.04            | 1.03              | 0.07            |                 | 2013     | 1       | 0.12                         | 0.14     |                 |                 |                 |                 |                 |
| 1992   | 1.25              | 0.06          | 0.86              | 0.04            | 1.07              | 0.09            |                 | 2013     | 2       | 0.17                         | 0.14     |                 |                 |                 |                 |                 |
| 1993   | 0.96              | 0.07          | 1.02              | 0.04            | 0.88              | 0.09            |                 | 2013     | 3       | 0.17                         | 0.13     |                 |                 |                 |                 |                 |
| 1994   | 1.22              | 0.07          | 1.07              | 0.04            | 1.06              | 0.07            |                 | 2013     | 4       | 0.22                         | 0.13     |                 |                 |                 |                 |                 |
| 1995   | 1.26              | 0.06          | 1.13              | 0.04            | 1.22              | 0.07            |                 | 2014     | 1       | 0.17                         | 0.13     |                 |                 |                 |                 |                 |
| 1996   | 1.01              | 0.06          | 0.98              | 0.04            | 1.09              | 0.08            |                 | 2014     | 2       | 0.18                         | 0.13     |                 |                 |                 |                 |                 |
| 1997   | 1.04              | 0.06          | 0.88              | 0.04            | 0.98              | 0.08            |                 | 2014     | 3       | 0.22                         | 0.12     |                 |                 |                 |                 |                 |
| 1998   | 1.08              | 0.06          | 0.94              | 0.04            | 1.15              | 0.06            |                 | 2014     | 4       | 0.22                         | 0.12     |                 |                 |                 |                 |                 |
| 1999   | 1.10              | 0.06          | 0.95              | 0.04            | 1.05              | 0.07            |                 | 2015     | 1       | 0.15                         | 0.12     |                 |                 |                 |                 |                 |
| 2000   | 1.07              | 0.05          | 0.94              | 0.04            | 1.08              | 0.06            |                 | 2015     | 2       | 0.17                         | 0.12     |                 |                 |                 |                 |                 |
| 2001   | 1.00              | 0.05          | 0.87              | 0.04            | 1.11              | 0.07            |                 | 2015     | 3       | 0.22                         | 0.09     |                 |                 |                 |                 |                 |
| 2002   | 0.86              | 0.05          | 0.78              | 0.04            | 1.18              | 0.08            |                 | 2015     | 4       | 0.22                         | 0.10     |                 |                 |                 |                 |                 |
| 2003   | 0.93              | 0.05          | 0.82              | 0.04            | 1.16              | 0.07            |                 | 2016     | 1       | 0.14                         | 0.11     |                 |                 |                 |                 |                 |
| 2004   | 1.04              | 0.05          | 0.94              | 0.04            | 1.13              | 0.08            |                 | 2016     | 2       | 0.19                         | 0.12     |                 |                 |                 |                 |                 |
| 2005   | 1.34              | 0.05          | 1.18              | 0.03            | 1.29              | 0.06            |                 | 2016     | 3       | 0.22                         | 0.12     |                 |                 |                 |                 |                 |
| 2006   | 1.14              | 0.06          | 0.98              | 0.03            | 1.07              | 0.05            |                 | 2016     | 4       | 0.21                         | 0.11     |                 |                 |                 |                 |                 |
| 2007   | 0.90              | 0.06          | 0.87              | 0.04            | 1.02              | 0.05            |                 | 2017     | 1       | 0.17                         | 0.12     |                 |                 |                 |                 |                 |
| 2008   | 0.69              | 0.07          | 0.67              | 0.04            | 0.85              | 0.06            |                 | 2017     | 2       | 0.24                         | 0.11     |                 |                 |                 |                 |                 |
| 2009   | 0.77              | 0.07          | 0.69              | 0.03            | 0.81              | 0.06            |                 | 2017     | 3       | 0.34                         | 0.11     |                 |                 |                 |                 |                 |
| 2010   | 0.72              | 0.07          | 0.64              | 0.03            | 0.90              | 0.06            |                 | 2017     | 4       | 0.46                         | 0.11     |                 |                 |                 |                 |                 |
| 2011   | 0.79              | 0.07          | 0.65              | 0.03            | 1.02              | 0.06            |                 |          |         |                              |          |                 |                 |                 |                 |                 |
| 2012   | 0.84              | 0.06          | 0.66              | 0.03            | 1.21              | 0.06            |                 |          |         |                              |          |                 |                 |                 |                 |                 |
| 2013   | 0.87              | 0.06          | 0.72              | 0.04            | 1.24              | 0.05            |                 |          |         |                              |          |                 |                 |                 |                 |                 |
| 2014   | 0.80              | 0.08          | 0.64              | 0.04            | 0.89              | 0.06            |                 |          |         |                              |          |                 |                 |                 |                 |                 |
| 2015   | 0.78              | 0.07          | 0.67              | 0.04            | 0.99              | 0.06            |                 |          |         |                              |          |                 |                 |                 |                 |                 |
| 2016   | 0.86              | 0.07          | 0.64              | 0.04            | 0.98              | 0.06            |                 |          |         |                              |          |                 |                 |                 |                 |                 |
| 2017   | 0.92              | 0.07          | 0.67              | 0.04            | 1.04              | 0.06            |                 |          |         |                              |          |                 |                 |                 |                 |                 |
| 2018   | 0.86              | 0.09          | 0.55              | 0.05            | 0.91              | 0.09            |                 |          |         |                              |          |                 |                 |                 |                 |                 |





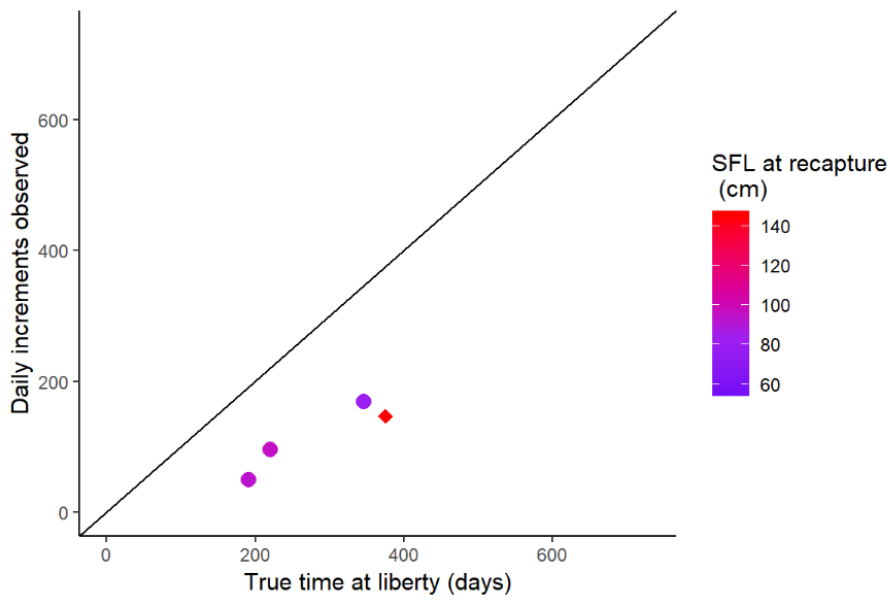


**Table 6.** CPUE evaluation table for abundance indices presented during the meeting.

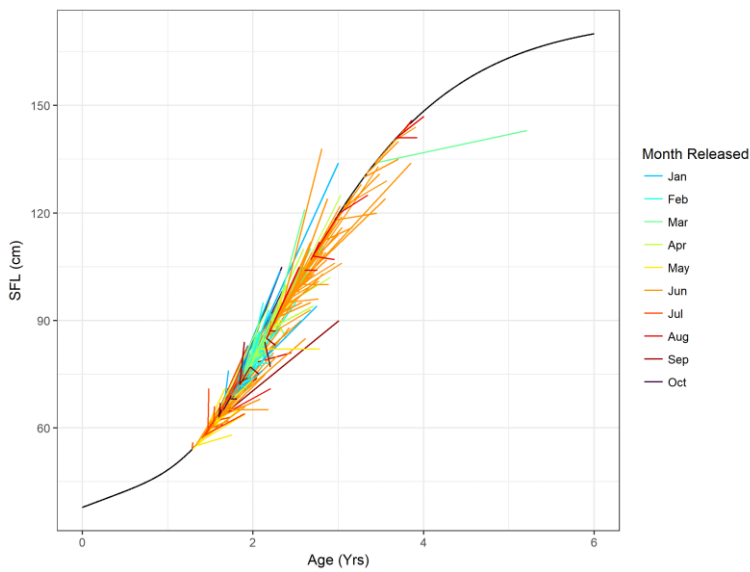
| SCRS Doc No.  | SCRS/2019/072        | SCRS/2019/075  | SCRS/2019/078   | SCRS/2019/079   | SCRS/2019/081  |
|---|----------------------|--|---|-----------------|--|
| <b>Index Name:</b>  | Japan longline       | Buoy-derived Abundance Index   | USA longline  | Brazil longline | Combined longline  |
| Data Source (state if based on logbooks, observer data etc)   | logbooks             | acoustic data from echosunders buoys, TaskII   | logbooks  | logbooks        | logbooks   |
| Do the authors indicate the percentage of total effort of the fleet the CPUE data represents?   | No                   | NA   | No  | Yes             | Yes  |
| If the answer to 1 is yes, what is the percentage?  |                      |  |   | 71-80%          | 91-100%  |
| Are sufficient diagnostics provided to assess model performance??   | Sufficient           | Sufficient   | Sufficient  | Sufficient      | Sufficient   |
| How does the model perform relative to the diagnostics ?  | Well                 | Well   | Well  | Well            | Well   |
| Documented data exclusions and classifications?   | Yes                  | Yes  | Yes   | Yes             | Yes  |
| Data exclusions appropriate?  | Yes                  | Yes  | Yes   | Yes             | Yes  |
| Data classifications appropriate?   | Yes                  | Yes  | Yes   | Yes             | Yes  |
| Geographical Area   | Atlantic             | Tropical   | Atl NW  | Atl S           | Atlantic   |
| Data resolution level   | Set                  | OTH  | Set   | Set             | Set  |
| Ranking of Catch of fleet in TINC database (use data catalogue)   | 6-10                 |  | 11 or more  | 11 or more      | 6-10   |
| Length of Time Series   | longer than 20 years | 6-10 years   | longer than 20 years  | 11-20 years     | longer than 20 years   |
| Are other indices available for the same time period?   | Few                  | Few  | Few   | Few             | Few  |
| Are other indices available for the same geographic range?  | Few                  | Few  | Few   | Few             | None   |
| Does the index standardization account for Known factors that influence catchability/selectivity? (eg. Type of hook, bait type, depth etc.) | Yes                  | Yes  | Yes   | No              | No   |
| Estimated annual CV of the CPUE series  | Low                  | Low  | Low   | Variable        | Variable   |
| Annual variation in the estimated CPUE exceeds biological plausibility  | Unlikely             | Unlikely   | Unlikely  | Unlikely        | Unlikely   |
| Is data adequate for standardization purposes   | Yes                  | Yes  | Yes   | Yes             | Yes  |
| Is this standardised CPUE time series continuous?   | Yes                  | Yes  | Yes   | Yes             | Yes  |
| For fisheries independent surveys: what is the survey type?   |                      | Acoustic   |   |                 |  |
| For 19: Is the survey design clearly described?   |                      | Yes  |   |                 |  |
| Other Comments  |                      | need to revise the catch composition of the 1x1 and month cell using more detailed information; the same with the size data. | The data used for this index are also utilized in the combined index. |                 | multi-national joint longline index from Japan, USA, Brazil, Korea, and Chinese-Taipei |

**Table 7.** Proposed Fleet structure for Stock Synthesis model.

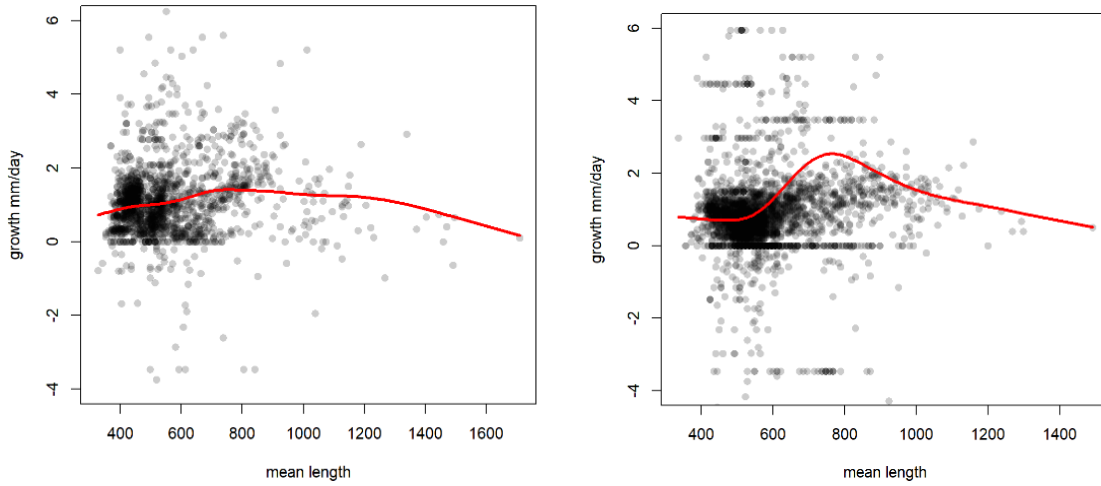
| <b>Model</b> | <b>Fishery</b> | <b>Region</b> | <b>Name</b>                 | <b>Gear</b> | <b>Yr start</b> | <b>Yr end</b> |
|--------------|----------------|---------------|-----------------------------|-------------|-----------------|---------------|
| YFT_2019     | 1              | 2             | Early PS                    | PS          | 1965            | 1985          |
| YFT_2019     | 2              | 2             | Transition PS               | PS          | 1986            | 1990          |
| YFT_2019     | 3              | 2             | Late PS Free Schools        | PS          | 1991            | 2018          |
| YFT_2019     | 4              | 2             | Late PS FAD                 | PS          | 1991            | 2018          |
| YFT_2019     | 5              | 2             | Ghana BB+PS                 | PS / BB     | 1965            | 2018          |
| YFT_2019     | 6              | 2             | TRO BB south Dakar          | BB          | 1962            | 2018          |
| YFT_2019     | 7              | 2             | TRO BB north Dakar<br>Early | BB          | 1965            | 1979          |
| YFT_2019     | 8              | 2             | TRO BB north Dakar Late     | BB          | 1980            | 2018          |
| YFT_2019     | 9              | 1             | North BB Azores             | BB          | 1965            | 2017          |
| YFT_2019     | 10             | 1             | JLL North                   | LL          | 1950            | 2018          |
| YFT_2019     | 11             | 2             | JLL Tropical                | LL          | 1950            | 2018          |
| YFT_2019     | 12             | 3             | JLL South                   | LL          | 1950            | 2018          |
| YFT_2019     | 13             | 1             | Other LL North              | LL          | 1950            | 2018          |
| YFT_2019     | 14             | 2             | Other LL Tropical           | LL          | 1950            | 2018          |
| YFT_2019     | 15             | 3             | Other LL South              | LL          | 1950            | 2018          |
| YFT_2019     | 16             | 1             | RR USA                      | RR          | 1980            | 2018          |
| YFT_2019     | 17             | 2             | HL Brazil north             | HL          | 2014            | 2018          |



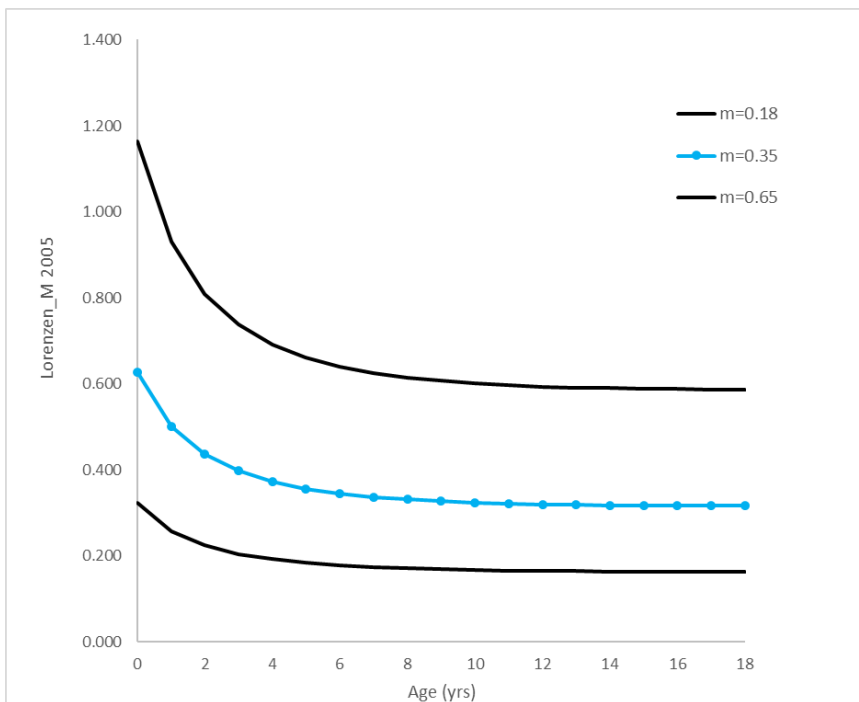
**Figure 1.** Comparison of daily increment counts with true time at liberty. A one-to-one line is drawn in solid black. Points falling below the line indicate that the number of increments counted underestimates the true time at liberty. Different symbols reflect the different age read experts. The colors of the symbols indicate the fish size at recapture. SFL = straight fork length.



**Figure 2.** YFT size increments from tagged and recapture fish off St Helena. The age at release is plotted assuming the Gascuel *et al.* (1992) YFT growth model, colors indicate the month of release.



**Figure 3.** Growth information from AOTTP tagging records of fish recaptures on free schools (left panel) and FAD/Seamounts (right panel). A smoothing spline with a tuning parameter = 0.9 was fitted to the data (red solid line) to show the trend in growth rates. The 2-stanza growth pattern is clearly apparent in the FAD caught fish and much less striking in the free school fish. Note: the y-axis was cropped at -4 and +6 to ease visualization, some data exist beyond these bounds.



**Figure 4.** Reference mortality vector (blue) from the Then *et al.* (2015) model using a  $t_{max}$  of 18, and alternative mortality vectors (black) obtained from the prediction standard error of the Then *et al.* (2015) model at age 18 (0.15).

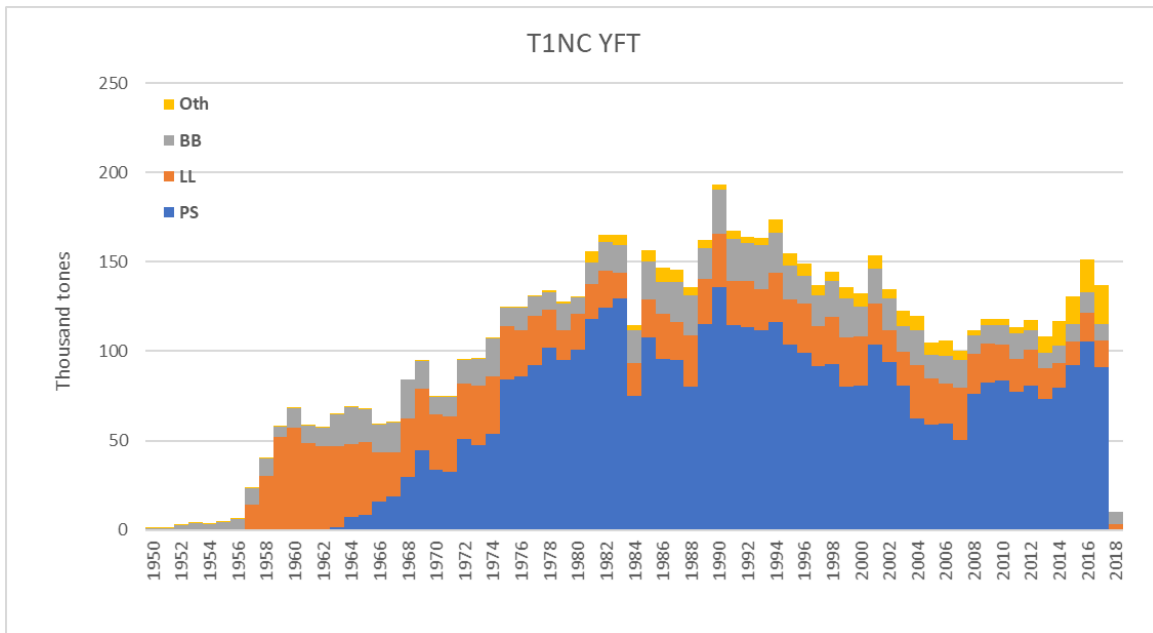
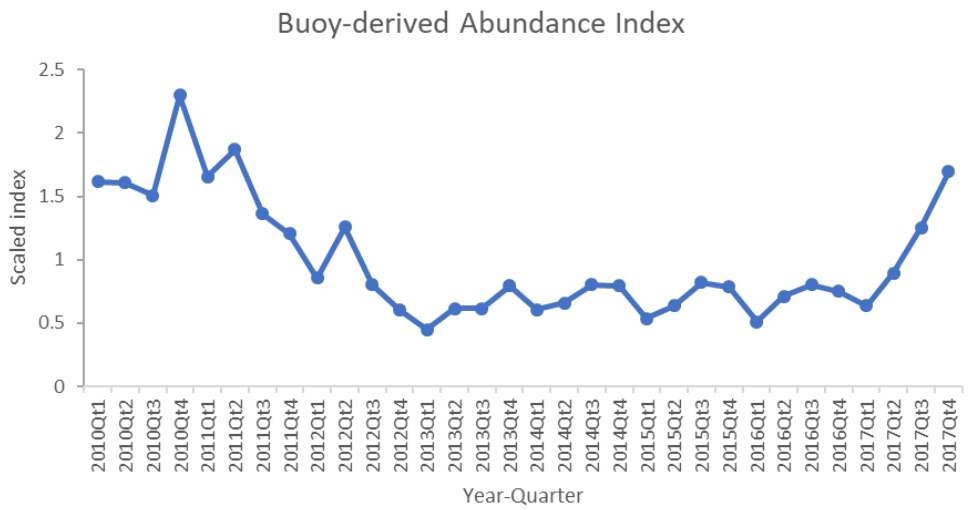
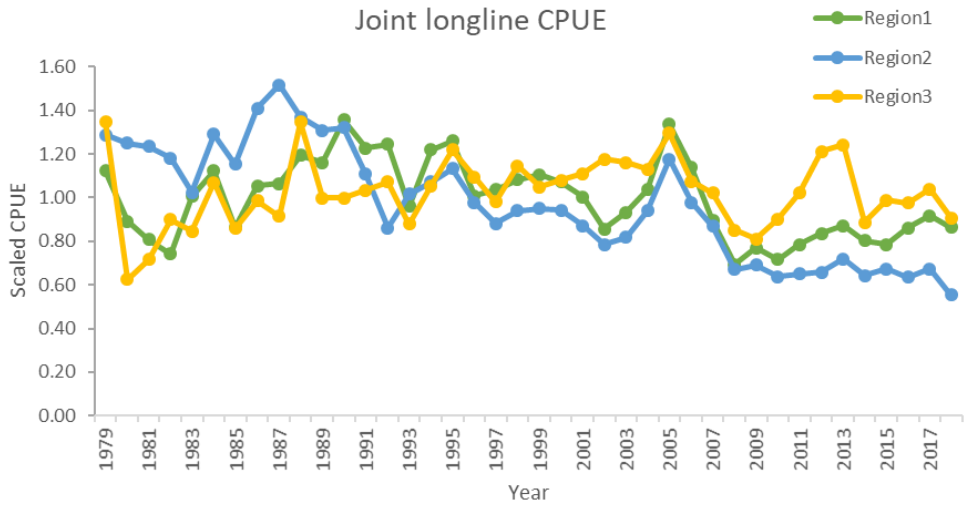
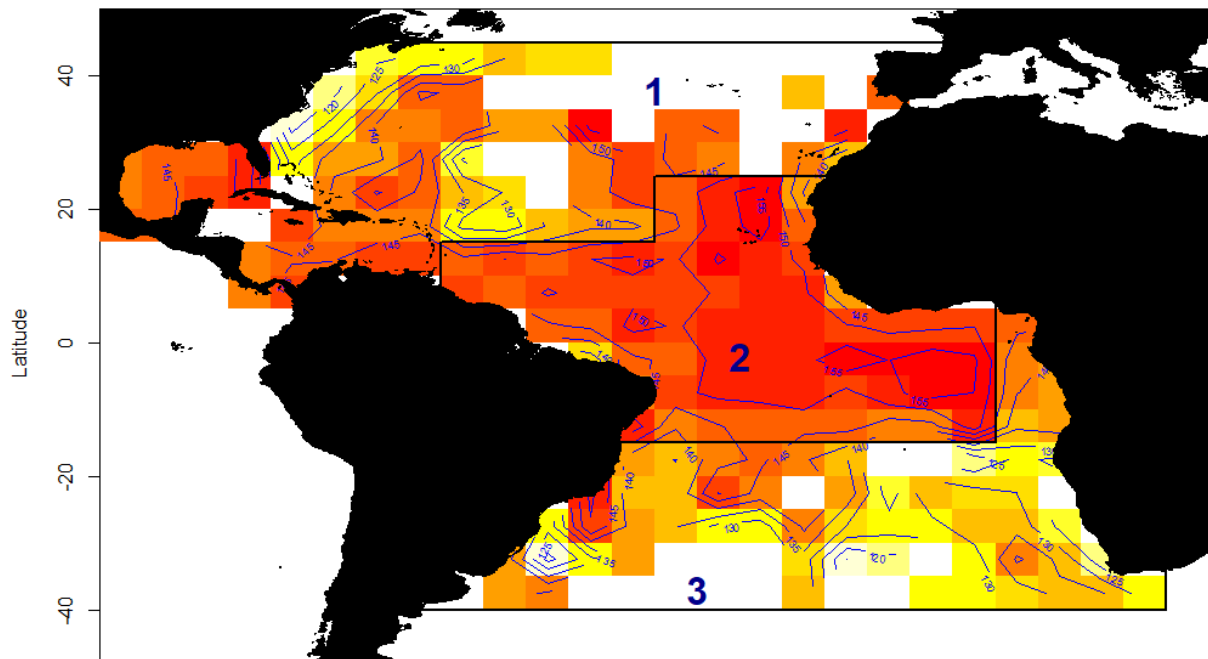


Figure 5. Task I nominal catches of YFT accumulated by main gear type.



**Figure 6.** Recommended abundance indices for reference set in 2019 Atlantic yellowfin tuna stock assessment.





**Figure 7.** Proposed spatial partitioning for assessment model fleet structure.

**Agenda**

1. Opening, adoption of agenda and meeting arrangements
2. Review of historical and new data on yellowfin biology
  - 2.1 Age and growth
  - 2.2 Natural mortality
  - 2.3 Reproduction
3. Review of fishery statistics
  - 3.1 Task I (catches) data
  - 3.2 Task II (catch-effort and size samples) data
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## List of Papers and Presentations

| Number        | Title  | Authors  |
|---------------|--|--|
| SCRS/2019/060 | Comparison of yellowfin tuna CPUE and length composition between the Taiwanese and Japanese longline fisheries in the Atlantic Ocean   | Matsumoto T., Satoh K., Kitakado T., Wang S., Su N., and Yeh Y.  |
| SCRS/2019/062 | Proposal of use of the hindcasting approach for evaluating prediction skill of the stock assessment models   | Kitakado T., Satoh K., Matsumoto T., and Yokoi H.  |
| SCRS/2019/064 | Review and preliminary analyses of size samples of Atlantic yellowfin tuna ( <i>Thunnus albacares</i> )  | Ortiz M., and Palma C.   |
| SCRS/2019/065 | AOTTP yellowfin tuna Tag-recapture data by numbers - an update   | Beare D., Ailloud L., Garcia J., and Seynabou N.   |
| SCRS/2019/066 | Accounting for fishing days without set in the CPUE standardisation of yellowfin tuna in free schools for the EU purse seine fleet operating in the Eastern Atlantic Ocean during the 1991-2018 period | Guéry L., Deslias C., Kaplan D., Marsac F., Abascal F., Pascual P., and Gaertner D.  |
| SCRS/2019/067 | Assessing the effectiveness of the current moratorium on dFADs using conventional tagging data from the AOTTP  | Deledda-Tramoni G., and Gaertner D.  |
| SCRS/2019/068 | First estimate of tag-shedding for yellowfin tuna in the Atlantic Ocean from AOTTP data  | Gaertner D. , Goni N. , Amande J., Pascual Alayon P., N'Gom F., Addi E., Conceicao I., da Silva G. B., Alves Bezerra N., Ferreira Muniz R., Niella Y., Wright S., Beare D., and Ailloud L. |
| SCRS/2019/069 | First estimates of the reporting rate for recaptures of yellowfin, bigeye and skipjack tunas from tag-seeding experiments conducted during the AOTTP program   | Akia S., Amande M., and Gaertner D.  |
| SCRS/2019/070 | Assessing the randomness of unreported recapture data for the Atlantic Ocean tropical tuna purse seine fishery   | Norelli A. P.  |
| SCRS/2019/071 | Preliminary results on AOTTP validation of otolith increment deposition rates in yellowfin tuna in the Atlantic  | Ailloud L., Beare D., Farley J.H., and Krusic-Golub K.   |
| SCRS/2019/072 | Japanese longline CPUE for yellowfin tuna ( <i>Thunnus albacares</i> ) in the Atlantic Ocean standardized using GLM up to 2018   | Yokoi H., Matsumoto T., and Satoh K.   |
| SCRS/2019/073 | Propose of stock assessment model specification of yellowfin tuna in the Atlantic Ocean  | Yokoi H., and Satoh K.   |
| SCRS/2019/074 | Review of St. Helena yellowfin tuna ( <i>Thunnus albacares</i> ) tagging data.   | Wright S., Riley A., Stamford T., Beard A., Clingham E., Henry L., Thomas W., Caswell D., Madigan D., Schallert R., Castelton M., Righton D., Block B., and Collins M.                     |
| SCRS/2019/075 | A novel index of abundance of juvenile yellowfin tuna in the Atlantic Ocean derived from echosounder buoys   | Santiago J., Uranga J., Quincoces I., Orue B., Grande M., Murua H., Merino G., and Boyra G.  |

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| SCRS/2019/076 | Estadística de las pesquerías Españolas atuneras, en el océano Atlántico tropical, período 1990 a 2018  | Pascual-Alayón P., Rojo V., Amatcha H., Sow F.N, Ramos M.L., and Abascal F.J.   |
| SCRS/2019/077 | Statistics Of The European And Associated Purse Seine And Baitboat Fleets, In The Atlantic Ocean (1991-2018)  | Pascual-Alayón P., Floch L., Gom F.N., Dewals P., Irié D, Amatcha A.H., and Amandè M-J.                                   |
| SCRS/2019/078 | Standardized catch rate in number and weight of yellowfin tuna ( <i>Thunnus albacares</i> ) from the United States Pelagic Longline Fishery 1987-2018 | Rios A.   |
| SCRS/2019/079 | Catch Rate Standardization For Yellowfin Tuna Caught By The Brazilian Pelagic Longline Fleet (1978-2016)  | Sant'Ana R., Travassos P., and Hazin F.   |
| SCRS/2019/080 | Integrated modeling of growth for Atlantic yellowfin tuna   | Walter J., Lang E., Falterman B., Pacicco A., Schirripa M., Brown C., Shuford R., Cass-Calay S., Sharma R., and Allman R. |
| SCRS/2019/081 | Collaborative study of yellowfin tuna CPUE from multiple Atlantic Ocean longline fleets in 2019   | Hoyle S.D., Lauretta M., Lee M.K., Matsumoto T., Sant'Ana R., and Yokoi H.  |

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| SCRS/P/2019/024 | Effect of climate variability on catches of yellowfin tuna ( <i>Thunnus albacares</i> ) in the southwestern Atlantic Ocean     | Forselledo R., Ortega L., Jiménez S., and Domingo A.                             |
| SCRS/P/2019/025 | Age validation, growth, and mortality of yellowfin tuna ( <i>Thunnus albacares</i> ) from the U.S Gulf of Mexico and Atlantic  | Pacicco A., Allman R., Andrews A., Lang E., Falterman B., Golet W., and Murie D. |
| SCRS/P/2019/026 | Preliminary estimates of tag shedding and mortality from the AOTTP mark recapture data   | Ailloud L., and Beare D.   |
| SCRS/P/2019/027 | A histological assessment of yellowfin tuna ovaries sampled in the U.S Gulf of Mexico and Atlantic from 2010-2017              | Pacicco A., Allman R., and Murie D.  |
| SCRS/P/2019/028 | Preliminary results of abundance indices by size category of yellowfin tuna of Japanese longline fishery in the Atlantic Ocean | Satoh K., Kitakado T., and Matsumoto T.  |
| SCRS/P/2019/029 | Spatio-seasonal trajectory of tuna vessels in the West African area: case of Mauritania  | Braham C.B., and Bamba D.A.  |
| SCRS/P/2019/030 | Descriptive statistics of the French purse seiner fleet targeting tropical tunas in the Atlantic Ocean (1991-2018)             | Depetris M., Duparc A., Lebranchu J., and Floc'h L.                              |
| SCRS/P/2019/031 | Regional boundaries for Atlantic yellowfin tuna CPUE   | Hoyle S.   |
| SCRS/P/2019/032 | Overview of the yellowfin information by Korean tuna longline fishery in the Atlantic Ocean                                    | Lee M.K.   |
| SCRS/P/2019/033 | Analysis of sexual maturity yellowfin tuna <i>Thunnus albacares</i> in the Gulf of Mexico                                      | López R.K., and Wakida-Kusunoki A.T.   |



**SCRS Document and Presentations Abstracts as provided by the authors**

*SCRS/2019/060* - Comparison of CPUE and fish size of yellowfin tuna for several areas in the Atlantic Ocean was conducted between Taiwanese and Japanese longline fisheries from the concern of conflict of CPUE trend among fleets at the previous stock assessment. The trend of standardized CPUE based on the same method was similar between fleets except for a part of period, and differed depending on the area. Mean length of the catch by area has some similarity between Taiwanese and Japanese longline, although some difference was also observed. These results indicate that area stratification and using the method for standardization is one solution of conflict of CPUE, and that it is possible to create joint yellowfin CPUE for Japanese and Taiwanese longline fishery. This kind of collaborative study is desired to be continued and expanded.

*SCRS/2019/062* - A hindcasting approach is proposed for the stock assessment for the Atlantic yellowfin tuna. The method is a kind of retrospective cross-validation test, in which virtual prediction over several years ahead by intentionally removing data for such years is conducted and compared with actually observed data. This method is applied to test the prediction skill, which is crucial for management advice, and to compare the models even across those with partially different data set. The method has been preliminary applied to several stock assessment exercises such as the Atlantic bigeye tunas, the Indian Ocean yellowfin tunas and the Pacific saury by the leading author of this paper. It was demonstrated that, even when the retrospective pattern tends to be ignorable, prediction is so hard even a short period. However, there is a contrast that some models have some prediction skill in light of medium term prediction. Even the evaluation of hindcasting method itself via simulation studies is on-going by a group consisting of Kitakado, Sharma and Kell, it is worth conducting application of hindcasting method to some models used in stock assessment for the Atlantic yellow tunas.

*SCRS/2019/064* - Size sampling data of Atlantic yellowfin tuna was reviewed, and preliminary analyses performed for its use within the stock evaluation models. Size data is normally submitted to the Secretariat by CPCs under the Task II requirements; for the major fisheries CPCs have also to submit Catch at Size for the major fisheries. The size samples data was revised, standardized and aggregated to size frequencies samples by main fishery/gear type, year and quarter. Preliminary analyses indicated a minimum number of 75 fish measured per size frequency sample, with size information since 1970 for the purse seine, baitboat and longline fishing gears. For Atlantic yellowfin tuna, the size sampling proportion among the major fishing gears is consistent with the proportion of the catch.

*SCRS/2019/065* - The purpose of this working document is to summarise the tagging effort on yellowfin tuna by the AOTTP project. It provides a general overview of the data available to date. AOTTP has been tagging the three main species (bigeye, skipjack, yellowfin) of tropical tuna throughout the Atlantic since June 2016 using a range of different tags and approaches (e.g. conventional tagging, double-tagging, electronic and chemical tagging). Nearly 35,000 yellowfin have been tagged & released (R-1) in the EEZs of 21 different countries, although most have been in the High Seas. Nearly 300 electronic tags (pop-ups and internals) have been deployed on yellowfin which will provide new information on migrations and habitat preferences. Over 6,500 tagged yellowfin have been recovered with conventional tags (yellowfin recovery rate is ca 19%). Tag-seeding experiments are ongoing, and the reporting rate for yellowfin in the purse-seine fleet is ca 70%. Over 4,500 yellowfin have been double-tagged allowing tag-shedding rates to be estimated, and ca 2,600 chemically tagged which improves our ability to age recaptured fish. AOTTP partners from Brazil and Senegal are creating a pan-Atlantic Otolith Reference Set to standardise age-determination, workshops have been held on hard-part procedures, protocols and validation, and two trainees (one in Dakar and one in Abidjan) have been employed to undertake routine ageing of tropical tuna, including yellowfin, into the future.

*SCRS/2019/066* - The time series of EU purse seine fleet catches per unit effort (CPUE) of yellowfin tuna (*Thunnus albacares*) from the Atlantic Ocean were standardized using a new development of the Delta-lognormal generalised linear mixed model. The aim was to depict the trend in abundance for adults yellowfin tuna, i.e. only in free school (FSC). The originality of this work relied on the inclusion of i) null sets, considered as presence of yellowfin tuna FSC, ii) fishing days without set, considered as absence of FSC, iii) EU fishing agreement in the exclusive economic zones driving the EU purse seine fleet presence in these areas, and iv) environmental variables known to affect catchability. CPUE for FSC was thus defined as the catch per sets (positive and null) of large yellowfin tuna (> 10 kg). To detect and include cells with fishing days but without set, all activities recorded in the captain logbooks were used for the period 1991-2018. In addition, we also investigated the use of vessels monitoring system (VMS) data to detect these fishing days when they were available for the French fleet, i.e. period 2000-2018. This new standardization approach of yellowfin tunas CPUE therefore, represents a significant advance over previous efforts. Nevertheless, several avenues for future progress are noted in the discussion.

*SCRS/2019/067* - The objective of this study is to assess the effectiveness of the current dFAD fishing moratorium using tagging data from the AOTTP (2016-2018). Capture - recapture data can be used to assess the efficiency of time-area closure regulation in terms of protection of juvenile tropical tunas. In this study, the effectiveness of the current moratorium Rec [15-01] was assessed for both yellowfin and bigeye juveniles (Fork length <70 cm) by (1) computing the relative risk of recapture which depends on tagged tunas recapture rates inside and outside the moratorium area. Secondly, for both species, (2) shortest distance in kilometers at sea, cardinal directions and time at sea were computed for individuals tagged inside the moratorium area in 2017. The results showed that (1) the recapture rates when juvenile yellowfin tunas were tagged outside the moratorium area is equal to 17 times the recapture rate of tunas which were tagged inside the moratorium area (2017 and 2018 confounded) and that (2) directions patterns can be evidenced with circular diagrams. Finally, this paper proposes several perspectives to better assess the effectiveness of the moratorium in future analyses.

*SCRS/2019/068* - A key objective of the Atlantic Ocean Regional Tuna Tagging Project (AOTTP) was to estimate tag-shedding rates, Type-I (immediate tag shedding) and Type-II (long-term tag shedding) for yellowfin tuna. To assess this, a series of double-tagging experiments (4,518 double tags released with 1,061 recoveries) were conducted as part of the broader tagging program. We used a constant-rate model for characterizing tag-shedding rates of yellowfin, as follows:  $Q(t) = \alpha * e^{-L * t}$ . While the observed percentage in tag loss shows minor differences between the insertion point of the tag according to the body side of the fish, introducing a tag-location effect in Type-1 (i.e.,  $1 - \alpha$ ) and in Type-II tag-shedding did not improve significantly the fit. The estimates of the Type-I (0.026) and Type-II tag shedding ( $L$  (per year) = 0.031) are very close to the values obtained from the Indian Ocean Tuna Tagging Program (0.028 and 0.040, respectively). On the basis of these results, the Atlantic yellowfin shedding rate is about 6% the first year at sea and reaches 17% after 5 years at sea. Preliminary results indicate that tag loss could differ according to the size at release but additional factors must be taken into account before drawing a definitive conclusion. This study suggests however that tag shedding rate should be taken into account with other sources of uncertainty such as the reporting rate in order to estimate exploitation and mortality rates derived from tagging data.

*SCRS/2019/069* - The purpose of this article is to analyse the reported rate of BET, SKJ and YFT using the AOTTP's tag seeding experiment. To achieve this objective, we have adopted the methodology developed by Hillary (Hillary 2008). It consists of using a binomial GLM to identify possible factors that impact the tag reported rate and use them as level of disaggregation to estimate reported rate by stratum in a Bayesian approach. The disaggregation variables analysed are the species, the unloading location, the interaction between year and quarter (time) and the tagger type. However, only the year, the unloading location and the specie were used to estimate reported rate by strata. Some levels of disaggregation such as the tagger type and the quarterly interaction factor were dropped in favour of the three first due to the limited number of the data. The overall results showed that reported rate range from 8% to 93% and is highly dependent on defined strata.

*SCRS/2019/070* - This project aimed to identify data discrepancies in the AOTTP dataset and determine if the data discrepancies were randomly distributed across time space and fleet. Non-random data can cause error in spatially and temporally explicit parameter analysis. Utilizing chi-square tests for independence, the discrepancy-free data was compared to the data with discrepancies. Tests were conducted on time scales of years and months, and location scales of ~650km. Ultimately, the data discrepancies were not randomly distributed across time, space, or fleet. However, the significance of the results rely heavily on the scale at which the data is sorted so there is a chance that the locational and spatial data is actually random. These tests should be conducted again on the full AOTTP dataset at different spatial scales and the same time scales to confirm the results.

*SCRS/2019/071* - The Atlantic Ocean Tropical Tuna Programme (AOTTP) has tagged a total of 3,104 yellowfin tuna with oxytetracycline and has now begun to analyse the hard parts from recaptured fish. To date, a total of 16 OTC marked otoliths have been prepared and analysed for annual increment counts, and four sister otoliths were prepared and analysed for daily micro-increment counts. Increment counts were compared to known times at liberty to validate the deposition rate of ("daily") micro-increments and larger ("annual") increments. Preliminary results suggest that age estimates based on daily increment counts may lead to underestimation of age, while annual increments appear to be deposited on an annual basis. In previous studies, maximum age observed in Atlantic yellowfin tuna based on readings of annual increments in otoliths is 18 years, much higher than the maximum age of 11 years currently used in the assessment. So, although our preliminary results are limited in scope (small sample size, short times at liberty, < 2 years), they should be taken into consideration as they could have implications for the Atlantic yellowfin stock assessment.

SCRS/2019/072 - Japanese longline CPUE in number for yellowfin tuna caught the Atlantic Ocean was standardized in quarter and annual base using GLM (General Linear Model) for the period from 1965 to 2018 in order to provide indicator of the stock. Annual CPUE in weight was also estimated from 1970 to 2018. Catch and effort data from the Japanese longline fishery operating in the Atlantic Ocean from 1965 to 2018 were used to standardize the abundance index of yellowfin tuna (*Thunnus albacares*). Three new indices were presented as 1) annual index from 1971 to 2018 in weight, 2) annual index from 1965 to 2018 in number and 3) quarterly index from 1965 to 2018 in number. As factors in the models, the standardization procedure evaluated year, season (quarter), sub-area, number of hooks between floats, materials of main line, materials of branch line, sea surface temperature and sea floor depth. Model selection was performed according to the reduction in explained deviance, with factors being retained if they result in greater than a 5% reduction in explained deviance.

SCRS/2019/073 - The upcoming stock assessment for yellowfin tuna in the Atlantic Ocean is scheduled at July 2018. The uncertainty of the model specification is always accompanied with assessment results. The ensemble results can be readily changed according to the weighting. Thus, the weighting methodology to ensemble multiple scenario results preferably should be determined in advance.

SCRS/2019/074 - Yellowfin tuna (YFT; *Thunnus albacares*) are commercially the most important species in the waters around St Helena. Since November 2015, YFT have been tagged with conventional and satellite tags around St Helena Island, with the goal of better understanding their movement patterns. Conventional tags have been deployed on 1010 YFT (size range 24-134 cm Fork Length, FL), and electronic tags have been deployed on 12 YFT (size range 95-138 cm FL). Most conventionally tagged YFT (90%) were recaptured close to the release location (within 50 km), though four showed larger-scale movements, providing connections between inshore regions and seamounts and further afield (outside St Helena's EEZ). One tuna (60 cm) was caught in excess of 2000 km 14 days after release close to St Helena Island. All satellite tagged YFT remained within the St Helena EEZ up to 277 days after release. While the results suggest that YFT may spend a large proportion of their time within the STH EEZ, more work is required to disentangle the factors that may affect migratory behaviour, such as size, spawning behaviour, and environmental conditions.

SCRS/2019/075 - The collaboration with the Spanish vessel-owners associations and the buoy-providers companies, has made it possible the recovery of the information recorded by the satellite linked GPS tracking echosounder buoys used by the Spanish tropical tuna purse seiners and associated fleet in the Atlantic since 2010. These instrumental buoys inform fishers remotely in real-time about the accurate geolocation of the FAD and the presence and abundance of fish aggregations underneath them. Apart from its unquestionable impact in the conception of a reliable CPUE index from the tropical purse seine tuna fisheries fishing on FADs, echosounder buoys have also the potential of being a privileged observation platform to evaluate abundances of tunas and accompanying species using catch-independent data. Current echosounder buoys provide a single acoustic value without discriminating species or size composition of the fish underneath the FAD. Therefore, it has been necessary to combine the echosounder buoys data with fishery data, species composition and average size, to obtain a specific indicator. This paper presents a novel index of abundance of juvenile yellowfin tuna in the Atlantic Ocean derived from echosounder buoys for the period 2010-2017.

SCRS/2019/076 - En este documento se presentan datos de la flota española, estrategias de pesca, zonas de pesca, capturas de las especies objetivo, esfuerzos, rendimientos (CPUEs), coberturas de muestreos y distribuciones de talla de las especies objetivos y accesorias de la flota atunera de cerco y de la flota de cañeros de cebo vivo que faena en el Océano Atlántico Tropical. El número de barcos de cerco que operó durante este último año se mantuvo en los mismos términos que durante 2017 y la captura total disminuyó un 15% con respecto al año anterior durante 2018. En éste último año, se realizaron igualmente más lances a objeto que a banco libre. En términos de porcentaje más del 70 % correspondió a Objetos y algo más del 20 % a Banco Libre. Los pesos medios de los ejemplares capturados para el rabil y patudo han aumentado ligeramente con respecto al año anterior, siendo: para rabil 6,7 kg (2,9 kg objeto y 40 kg banco libre); para el listado 1,6 kg (1,62 kg objeto y 1,83 kg banco libre) y para patudo 3,5 kg (3,24kg objeto y 31,7 kg banco libre). El rabil (YFT) presentó una talla modal de captura 42 cm a Objeto (OB) y tres tallas modales de 44 cm, 52 cm, 150 cm para las capturas a Banco libre (FS) en 2018. El listado (SKJ) una talla modal de captura, 44 cm para Objeto (OB) y una talla modal de 48 cm para Banco libre (FS) en 2018. El patudo (BET) una única talla modal de captura 40 cm para Objeto (OB) y dos tallas modales de 44 cm y 146 cm para Banco libre (FS) en 2018.

*SCRS/2019/077* - The document presents an overall summary of the fishing activities of the European and assimilated purse seine and bait boat fleets operating in the eastern Atlantic Ocean over the period 1991-2018. We describe the annual changes in fleet technical characteristics (carrying capacity, size), fishing effort (fishing and searching days), extent of fishing grounds, catches and nominal Catch per Unit Effort by species, as well as the average individual weight by species. Maps are also presented indicating the fishing effort distribution in the Atlantic, as well as the spatio-temporal distribution of European and assimilated purse seine catches in 2018.

*SCRS/2019/078* - Two indices of abundance of yellowfin tuna from the United States pelagic longline fishery are presented for 1987-2018. These are: 1: Entire Atlantic (ATL) and Gulf of Mexico (GOM) CPUE in number; 2: Entire ATL and GOM CPUE in weight. Both indices were updated using the same standardization procedure that was developed previously for the United States pelagic longline indices utilized in 2016 ICCAT Yellowfin Tuna Stock Assessment. The updated indices show identical trends to the indices presented in 2016. The indices have declined since 1987 and were some of lowest on record for 2008-2010 but show some slight increasing trends in the most recent years.

*SCRS/2019/079* - In the present paper, catch and effort data from 99,376 sets done by the Brazilian tuna longline fleet, including both national and chartered vessels, in the equatorial and southwestern Atlantic Ocean, from 1978 to 2017, were analyzed. The fished area was distributed along a wide area of the equatorial and South Atlantic Ocean, ranging from 20°W to 52°W of longitude, and from 011°N to 50°S of latitude. The CPUE of the yellowfin tuna was standardized by a Generalized Linear Model (GLM) using a Delta Lognormal approach. The standardization was implemented in a stratified way concerning the Yellowfin tuna regions as a proxy (Reg 02; Reg03). A comparative standardization using both regions integrated was also implemented. The factors used in the models were: year, quarter, vessels, strategy, hooks per floats, hooks and the lat-long reference for each 5 by 5 spatial squares. Due to some assumptions of the model, principally the structure of the covariates and the presence of vessels that never caught the target species of this analysis, the final index was estimated only for the period between 1999 and 2017. In general, the behaviour of the three indices estimate here, over the Brazilian LL fleet, shows a quite similar pattern with two stables periods, first between 1999 and 2008 and the second among 2012 and 2017. In the period between 2008 and 2012 presents a soft decreasing in the Yellowfin tuna index.

*SCRS/2019/080* - We evaluate the estimability of growth inside of the Stock Synthesis integrated modeling platform. We employ a factorial combination of three different empirical datasets including otolith annual increments (Lang et al., 2016, daily ages (Shuford et al (2007) and modal progression (Gascuel et al., 1992) and evaluate a von Bertalanffy and a Richards model that mimics the current two-stanza growth model used by ICCAT. The integrated modeling approach highlighted that a) growth is estimable within the integrated models b) externally fixed growth curves, including the currently ICCAT curve result in model misspecification that produces the appearance of a regime shift at the initiation of the Purse-seine FAD fishery, c) estimating growth in the models is a possible means to address this misspecification. When estimated,  $L_{inf}$  across all datasets and growth models was  $\sim 155$  cm CFL indicating that many externally derived growth models may have substantially overestimated  $L_{inf}$ . Further,  $L_{inf}$  had substantial impact on estimated management quantities which highlights the importance of correctly specifying this aspect of growth. While this study cannot conclusively exclude it, the modeling and data showed little support for a slow-down in growth at young ages. The appearance of this in the current ICCAT growth model may have been partially an artifact of the assumed birthdate of all cohorts in the modal progression. The approach illustrates the value of an integrated modeling approach for addressing key uncertainties regarding tuna growth.

*SCRS/2019/081* - In April 2019 a collaborative study was conducted between national scientists with expertise in Brazilian, Japanese, Korean, Chinese-Taipei, and USA longline fleets, and an independent scientist. The meetings addressed Terms of Reference covering several important issues related to yellowfin tuna CPUE indices in the Atlantic Ocean. The study was funded by the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the International Seafood Sustainability Foundation (ISSF). The meeting developed joint CPUE indices based on analysis of combined data from the Japanese, Korean, Chinese-Taipei, Brazilian, and US fleets.

*SCRS/P/2019/024* - This study presented an analysis of the effect of climatic variability on the Yellowfin tuna captures over the Southwestern Atlantic Ocean for the period 1982-2010. The study area is characterized by a very complex hydrography, with multiple contrasting water masses. Changes in the trend of SST and wind anomalies is demonstrated. YFT CPUE was modeled using GAM with climatic and environmental variables such as SST, Wind Anomaly, Depth and ENSO events. The results presented confirm that climatic variability caused by different atmospheric and oceanic processes affects the distribution and catches of yellowfin tuna in the Southwestern Atlantic Ocean. No direct relationship between the increase in SST and the catches of this species were observed. The optimal SST range defined

by the model ( $16^{\circ}$  -  $22.5^{\circ}$  C) is below the preference ranges reported for the species. The analysis of the CPUE and the environmental variables indicate a clear association of the species with the thermal fronts that characterize the continental slope area, most likely due to trophic migration as the fronts are characterized by a great abundance of possible preys (squid and anchovy). ENSO events appear to have a positive effect over CPUE in extreme events of El Niño and La Niña, while moderate events tend to be negative or low effect.

*SCRS/P/2019/025* - During 2004-2017, a total of 3,223 yellowfin tuna sagittal otoliths were collected from the US Gulf of Mexico ( $n=3,055$ ) and Atlantic coast ( $n=168$ ). Ages ranged from 1 to 18 years old with 91% of estimates less than 5 years old. Bomb-radio carbon ( $^{14}\text{C}$ ) results validated the maximum age of 18 years. The growth model with the most parsimonious fit to the age data for pooled sex based on the lowest  $\Delta\text{AIC}$  score was the Gompertz ( $L_{\infty}=1,606$ ,  $G_i=0.4$ ,  $\text{tinfl}=-0.11$ ), followed by the logistic, ( $L_{\infty}=1,580$ ,  $G_i=0.5$ ,  $\text{tinfl}=0.7$ ) ( $\Delta\text{AIC}=3.95$ ) and von Bertalanffy (VB) ( $L_{\infty}=1,647$ ,  $k=0.29$ ,  $t_0=-1.44$ ) ( $\Delta\text{AIC}=10.64$ ). Likelihood ratio tests revealed significant differences in sex-specific growth for all three candidate models ( $p<0.001$ ), with males consistently obtaining a greater size than females. Natural mortality was investigated using two different point estimates (Hoenigsh; Then et al. 2015) using a  $t_{\text{max}}$  of 18 and scaled across ages using the Lorenzen type function (Lorenzen 2005) with the estimated VB growth parameters.

*SCRS/P/2019/026* - We conducted preliminary analyses of the AOTTP tagging data to estimate annual total survival rate and year specific tag recovery rate parameters using a traditional Brownie dead recoveries model. The first step was to estimate type I (immediate) and type II (chronic) shedding rates from double tagged fish. Results indicated a 3% immediate tag loss rate and a 4% annual chronic tag loss rate, similar to what has been estimated in yellowfin from the Indian Ocean tagging program. Tag returns were then adjusted for tag shedding in each year and, using the annual tag reporting rate estimates obtained from SCRS/2019/069, we were able to separate the estimated tag recovery rates from exploitation rates. Including all data, regardless of the time spent at liberty, resulted in unrealistic estimates of F and M. This is likely caused by the fact that newly tagged fish do not immediately mix in the population, violating one of the main assumptions of the Brownie model. The issue of mixing must be explored further to be able to properly include tagging data in the assessment.

*SCRS/P/2019/027* - Histological assignment of female reproductive phase ( $n=410$ ) followed the standardized terminology of Brown-Peterson et al. (2011) with specifications made for yellowfin tuna (Schaefer 1996;1998). Length at 50% maturity ( $L_{50}$ ) was estimated for all capture months using three different maturity thresholds; cortical alveolar ( $L_{50}=1,040$  mm CFL), primary vitellogenesis (V1) ( $L_{50}=1,090$  mm), and late-stage vitellogenesis (V3) ( $L_{50}=1,100$  mm). In the Gulf of Mexico, ovaries were observed in the spawning capable phase March-December with peak spawning occurring May-August. Females began actively spawning as early as age 2, but were observed more frequently by age 3. Batch fecundity estimates ranged from 1.3-6.2 million eggs per female and increased with yellowfin tuna size and age.

*SCRS/P/2019/028* - Spatiotemporal delta-generalized linear mixed model of catch rate data are used to produce size specific standardized indices of relative abundance for yellowfin tuna (*Thunnus albacares*) caught by Japanese longline fisheries from 1986 to 2017 in the Atlantic Ocean. The nine size groups, from smaller than 90 cm to larger than 160 cm by 10 cm interval, were modeled. Results show that the density of yellowfin tuna had both pronounced spatial variation across the Atlantic Ocean and annual spatiotemporal variation. Spatial segregation in size was observed. According to the preliminary analysis, smaller fish, less than 130 cm mainly distributed in the coastal area, and the larger fish, larger than 130 cm distributed in the equatorial area. There were differences in annual CPUE trend by the size category.

*SCRS/P/2019/029* - The work presented constitutes the development of a statistical approach to study the trajectory and cartography of the fishing effort of the tuna vessel working in the West African area. Tuna (large pelagic) are highly migratory species that move in very wide areas and over very large areas. The Vessel Monitoring System (VMS) data are retrieved for the period 2012 to 2018. This work is based on the comparison of tuna fishing activity mapping based on the trawl speed classification and the choice of a semi-Markov approach with an estimation by EM (Expectation-maximization) algorithms using nonparametric residence laws. The ultimate goal is the quantification and refined calculation of fishing effort to obtain standardized CPUEs and unbiased indices of abundance by joining these data with catch data per year. It also allows to know the zones of frequentation of the predators (vessels), to map a proxy of abundance of the preys (targeted species). The first results of this work, show a high mobility of vessel in 2018 compared to 2017. The fishing activity is concentrated at the beginning of the year (January-March) in southern Senegal. From April to October, the fishing activity seems to concentrate in the Mauritanian zone. This work did not take into account the distinction between the different nationalities nor the fishing under FADs where a free bank. In the perspective of this work, we plan to:

- Complete the analyses for every month
- Correct the fishing effort of the boats working in the Mauritanian zone
- Use the observer data to validate the model
- Joins catch data by boat with the effort to calculate a catch per unit of effort

*SCRS/P/2019/030* - aims to provide a first batch of several indicators for descriptive statistics of the French purse seiner fleet targeting tropical tunas in the Atlantic Ocean from 1991 to 2018. The idea was to have an overview and global tendencies. A second batch of newer indicators will be available for the next species working groups on tropical tunas in September. For now, indicators presented could be separated in 4 groups: (a) fleet characteristic indicators (number of vessels by volume of wells and carrying capacity over the years), (b) summarize of the activities (activity duration and number of sets by fishing modes), (c) distribution of catches (by fishing mode, mean weight of individuals and biomass by size class for the YFT and spatial distribution of catches) and (d) at least nominal CPUE for each major tropical tuna by fishing modes (catches per searching day and catches per positive set).

*SCRS/P/2019/031* - An analysis of ICCAT and US observer size data was presented that showed spatial patterns in yellowfin tuna size distribution. Fish were larger in equatorial areas and smaller at higher latitudes and closer to coastlines. These spatial patterns were used to propose 2 alternative sets of regional boundaries for CPUE analyses.

*SCRS/P/2019/032* - It was presented the fishing characteristics of Korean tuna longline fishery, with a focus on catch and fishing effort information for yellowfin tuna in the Atlantic Ocean. In the 1970's catches of yellowfin were over 10 thousand mt over that period, especially it recorded the highest about 18 thousand mt in 1975, and sharply declined from 17.6 thousand mt in 1977 to 180 mt in 1993. The average catch from the 1990's to the present is about 355 mt. Most of yellowfin caught in the central part (20°~40°W) of the tropical area (20°N~20°S), however, the areas shown higher yellowfin CPUE were quite different from those of catch. For the joint longline CPUE standardization analysis, fishing data with operational level were used from 1979 to 2018. And data fields consist of vessel id, operation date and location(lat/long), no. of hooks, no. of floats, catch in number of 12 species categories.

*SCRS/P/2019/033* - The objective of this work was to analyze the sexual maturity of yellowfin tuna *Thunnus albacares* through data from the on-board observer program on longline vessels in the Gulf of Mexico. For this purpose, information was analyzed for the period 2000-2013, in which 413 961 individuals with a sexual composition of 224 564 males (54.25%), 166 835 females (40.30%) and 22 562 undetermined (5.49%) were studied. The sex ratio presented a range of 1.20: 1 to 1.57: 1 male: female, the male predominance occurs in an average proportion of 1.35:1. Of the gonadal stages of the females, 32.5% corresponded to Stage IV (pre-spawning and spawning), which presented the largest number of individuals with 53,637 total females with an average of 3 831 females / year. The months of presence of females in Stage IV were May, June, July and August with higher values in June. The furcal length (Lf) of the females in Stage IV registered a range of 80 to 195 cm Lf with mode of 140 cm. The average length of maturity (L50) in females in Stage IV was 142 cm Lf.