REPORT OF THE 2019 ICCAT WHITE MARLIN STOCK ASSESSMENT MEETING

(Miami, USA 10-14 June 2019)

"The results, conclusions and recommendations contained in this Report only reflect the view of the Billfish Species 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 in Miami at the Rosenstiel School of Marine and Atmospheric Science, Cooperative Institute of Marine and Atmospheric Studies, at the University of Miami, from 10 to 14 June 2019. Fambaye Ngom (Senegal), the Species Group ("the Group") rapporteur and meeting Chair, opened the meeting and welcomed participants. Dr. Miguel Neves dos Santos (ICCAT Assistant Executive Secretary) adressed the Group on behalf of the ICCAT Executive Secretary, welcomed the participants and thanked the United States for hosting the meeting and Dr. David Die for making all the necessary local arramegements. He also highlighted the importance of the meeting, since white marlin is one of the two stocks being assessed in 2019 and with a rebuilding plan in place. The Chair proceeded to review the Agenda, which was adopted with a few minor 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 presented at the meeting are included in **Appendix 4**. The following participants served as rapporteurs:

Sections	*Rapporteur*
Items 1	M. Ortiz
Item 2.1	A. Norelli, M. Ortiz
Item 2.2	F. Forrestal
Item 2.3	K. Ramirez, B. Gibbs
Item 2.4, 2.5	M. Ortiz
Item 3	M. Lauretta, B. Mourato, K. Ba
Item 4	A. Kimoto, D. Die, M. Schirripa, B. Mourato
Item 5	A. Kimoto, G. Diaz
Item 6	F. Sow, R. Coelho, C. Brown
Item 7	D. Die, M. Willis
Item 8	F. Ngom, M. Neves dos Santos
Item 9	M. Ortiz

2. Summary of updated data submitted after the Data Preparatory meeting and before the assessment data

2.1 Catches

The Secretariat provided the reported Task I NC (nominal catches) available as of 5 June 2019 (**Table 1**). It was noted that for 2018 there were very few reports submitted by CPCs and catches for that year are considered highly incomplete. The Group agreed to used 2017 as the last year for the assessment model inputs. As indicated at the data preparatory meeting, few CPCs had officially reported estimates of dead discards and live releases of white marlin.

Following the recommendations and workplan adopted by the Group during the data preparatory meeting (SCRS/2019/004), the Secretariat summarized the Task I and Task II updates for white marlin received from CPCs. The Group was reminded that the reported catches represent both white marlin (*Kajikia albida*) and roundscale spearfish (*Tetrapturus georgii*) due to the difficulty of distinguishing one species from the other. Although, previous genetic studies indicated a low proportion of roundscale spearfish compared to white marlin (Shivji, *et al*., 2006), it was noted that assessment results and recommendations will include the complex of the two species.

The low reporting of both dead discards and live discards by CPCs was discussed. Of 68 CPCs or fishing entities that have historically reported catches of white marlin only 7 CPCs had reported dead discards of white marlin since 1990, and 6 CPCs had reported live discards since 2000, even though data reporting obligations do require to provide these estimates for all billfishes. During the data preparatory meeting, the Group agreed and recommended national scientists to review the estimates of dead discards and live releases, and to report to the Group updates of these estimates based primarily on data from national observer programs, with a dateline of 31 March 2019 for submission. The Group was informed that only one CPC provided such information, thus preventing further analysis. Alternative estimates were developed and presented by the Secretariat, based on annual proportions of dead discards for the longline fishing gear with the assumption that other CPCs that have longline fisheries should have similar rates of white marlin dead discards. **Figure 1** shows the total catch of WHM from longline fleets that reported dead discards and the component of catches from non-reporting fleets. It was noted that although total catches have been decreasing since 1995, the catch proportion from the non-reporting dead discard fleets has increased since the 1990s accounting up to 80% in recent years. The Group suggested this could be due to an increase in dead white marlin being kept instead of discarded.

Table 2 shows the estimated annual discard rates by LL fleets and the corresponding running average of 3 years, with a range between 0% and 2.4% (**Figure 2**). This running average estimate was applied to the LL fleets that haven't reported dead discards. It was noted that the estimates of dead discards from the Observer Program of EU_Portugal were comparable to those estimated by the Secretariat (0.8% to 6.2%). It was noted that most of the EU_Portugal catches were shallow sets at night [swordfish target fishery]. The Secretariat also estimated the live discards by all fleets that haven't reported WHM live discards in the period 2000-2017. Based on scientific studies, an average of post-release mortality for billfish of 24% (Horodysky and Graves, 2005; Kerstetter and Graves, 2006; Musyl and Gilman, 2019) was applied to the live discards. However, the Group considered that the average of live releases from different fisheries/gears was not appropriate to apply to the rest of the fleets, as it does not take into account changes in local/national regulations, gear type and other factors that could affect survival of releases such as fishing area and seasonal effects. The Group concluded that the estimates of mortality from live discards should not be included in the matrix of total removals for the assessment inputs. The Group recommended that a study of time, area and gear configuration variation for discards using observer data should be conducted in the future to improve dead discard estimates and that tagging studies should also be conducted to improve our understanding of post-release mortality.

Table 3 presents the final estimates of the total removals adopted by the Group as input for the stock assessment models.

2.2 Indices of abundance

The Group discussed the standardized CPUE index for EU_Spain longline landings of white marlin and roundscale spearfish presented in SCRS/2019/046. The authors recommended the last three years contained in the index be removed to account for regulations that might bias the index. Recent domestic regulations went into force beginning in 2015, potentially influencing the reported landings used in the index.

It was noted that an earlier version of the EU_Spain LL index was submitted within the timeframe for inclusion in the stock assessment. However the earlier version differed significantly from the index presented in this paper, and both differed from the previous version of the index presented in 2012 (**Figure 3**). The Group confirmed that this index is potentially useful because of the spatial and temporal extent of the data, and that the analysis and diagnostics were appropriate given the small proportion of positive trips in the data set. Furthermore, this index was used in the 2012 assessment (Anon. 2013). The Group was concerned, however, that SCRS/2019/047 reported much higher proportion of positive sets for those sets monitored by scientific observers than the percentage of positive sets for trips reported in SCRS/2019/046. Additionally, there was a concern that Task I reports from the EU_Spain longline for that same fishery in 2015-2017 had large catches in comparison to previous years, even though SCRS/2019/046 reports very low CPUE at landing for that same period.

Given this combination of facts: the changes in the index that were made available by the deadline for analysis, the discrepancies in proportion of positives sets and catch and CPUE for the recent period, and the authors acknowledgement that regulations may have impacted the quality of the data, the Group determined that the EU_Spain LL index should not be used in the stock assessment models used to develop management advice. However, the Group determined that the CPUE index contained within SCRS/2019/046 should be used in the sensitivity analysis for the production model with the three most recent years removed (2015-2017), as recommended by the authors. Including this index in the sensitivity analysis will aid the Group's understanding of the level of potential uncertainty in assessment results resulting from the inclusion or exclusion of the EU_Spain index. Furthermore, the Group agreed that in cases where CPUE data for certain years is determined to be inappropriate for CPUE standardization due to changes in monitoring or management measures, such data should not be included in the analysis. Therefore, the Group recommends that future standardization of EU_Spain longline CPUE should not contain the years 2015-2017. The Group acknowledged that given the length of the time series exclusion of the data for year 2015-2017 may not affect the result of the analysis very much, and that using the index estimates from SCRS/2019/046 for the period 1988-2014 was still useful for the purposes of sensitivity analysis.

The Group discussed the need for clarity with regards to indices containing dead discards and live discards. There were concerns that this information may not have been collected or recorded in the historical catches, potentially inflating or deflating the reported catches. It was noted that consistency in how this issue was treated across billfish assessments was needed as this discussion has arisen across recent assessments. The Group agreed that observer data was the data source most likely to contain such information.

The Group discussed the issues related to standardizing the US recreational index and other indices that rely on tournament data, specifically the Brazilian recreational index. Concerns were raised that the data provided to standardize these indices do not include enough information to account for gear changes that have the potential to increase catchability. However, the Group decided to include these two indices in the assessment models.

The Group decided to use the following indices for the assessment (**Table 4** and **Figure 4**):

1. Brazil, longline, 1978-2010
2. Brazil, recreational, 1996-2017
3. Chinese Taipei, longline, 1968-1989, 1990-2000, 2001-2017
4. Japan, longline, 1959-1975, 1976-1993, 1994-2000, 2001-2017
5. USA, longline, 1993-2017
6. USA, recreational, 1974-2017
7. Venezuela, gillnet, 1991-2010
8. Venezuela, longline, 1991-2010

2.3 Biology

Document SCRS/2019/047 updated the data from scientific observers in the EU_Spain surface longline fishery that targets primarily swordfish in the Atlantic.

The Group discussed the importance of information related to the fate of catches (landed, dead or alive discards). Of particular interest were the reports of the proportion of dead and live discards throughout the time series. This proportion changed from year to year and was greater than what has been reported for other fleets. Another issue raised by the Group was the inclusion of data from experimental longline trials in the analysis, including the proportion of such data and the potential effect on the results presented.

The SCRS/2019/106 document discussed status of fish at set retrieval (haul-back) and sex ratios of white marlin caught by the Chinese Taipei longline fishery in the Atlantic Ocean. The "survival ratio" calculated in this document was the number of alive individuals divided by all alive and dead individuals recorded at hauling.

The Group agreed that the term "survival ratio" is really an alive-at-haulback ratio and recommended using this term to avoid confusion with the normal use of survival rates (e.g. proportion of fish that survive a fishing interaction after release). The Group also suggested that the degree of injury and the condition at the time of release in conjunction with electronic tagging could be used to obtain better estimates of post-release-mortality rates.

2.4 Length compositions

The Secretariat provided updated Task II size information. Following the data preparatory meeting, updates of size samples for white marlin were provided by Mexico (1993-2017) and Venezuela (2015 -2017) for white marlin. The new information was incorporated in the size frequency data analysis and inputs for the stock synthesis model. With the inclusion of the new size data, size frequency samples were consistent with the data presented in SCRS/2019/036. It was noted there were few size samples for white marlin from sport fisheries in recent years. This was mostly due to the changes in the recreational fisheries where catch-and-release is mandatory for most recreational fishing tournaments. Therefore, the measurements are not representative of the total catch including releases fish.

2.5 Other relevant data

No other relevant data for the white assessment was discussed or presented during the meeting.

3. Methods relevant to the assessment

3.1 Production models

The most recent version Bayesian surplus production model, JABBA (v1.5Beta) available online (www.github.com/henning-winker/JABBAbeta), was applied to the time series of white marlin landings and fishery dependent indices to assess the stock status. The development of prior distributions on population growth rate (r) for the model was based on an algorithm developed by Winker *et al*. 2019 (SCRS/2019/103). The approach applied an age-structured equilibrium model to approximate a functional distribution of r approximated from the set of life history parameters selected for Stock Synthesis (size-at-age, natural mortality, maturity, stock recruitment steepness). The effects of key input parameters, including steepness parameter h of the spawning recruitment relationship on the production model parameters *r* and *m* were demonstrated. Simulation test results indicated that biomass estimates, and benchmarks should be calculated as total exploitable biomass, as a large proportion of the landings are immature fish (SCRS/2019/103). Based on the three steepness scenarios modeled (h = 0.5, h = 0.6 and h = 0.7), alternative priors for *r* were approximated based on lognormal distribution as input on JABBA (**Figure 5**).

The Group reviewed the provisional parameterization and results from JABBA, as well as the results of simulation testing of the statistical model (SCRS/2019/104). Initial set of parameters and data input were reviewed in the meeting and some of them modified, so the final list was as follows:

- Natural mortality = 0.2 (CV=30%)
- Length-at-50% maturity = 160.4 cm LJFL (Arocha and Barrios, 2009; SCRS/2019/103)
- Growth parameters (Linf=172.0 cm and 160.6 cm, k = 0.32 and 0.54 for females and males respectively and t0=-1) were inferred from (Arocha and Barrios, 2009).
- Size-at-age parameters were adapted from (SCRS/2019/103), these parameters were used to estimate the appropriate priors for JABBA.
- Steepness was assumed equal to 0.6 to be consistent with estimates from SS, which corresponds *r* prior as ($\log(r) \sim N(\log(0.181), 0.180)$ and a fixed input value of $B_{MSY}/K=0.39$, $m=1.12$).
- Removals should include reported landings and dead discards estimated by the Group (see Section 2.1).
- The EU_Spain longline CPUE was excluded from model input (see Section 2.2).

3.2 Length-based age-structured models: Stock Synthesis

Document SCRS/2019/110 provided a description of the provisional Stock Synthesis (SS) parameterization and results. The range of observational data used in the base model is shown in **Figure 6**. The Group reviewed the SS set-up, diagnostics, and sensitivities and recommended a reference case model to include:

- Removals should include reported landings and dead discards estimated by the Group (see section 2.1).
- Exclusion of the EU_Spain longline CPUE from model input (see section 2.2)
- Natural mortality = 0.2 (fixed)
- Length-at-50% maturity = 160.4 cm LJFL (Arocha and Barrios, 2009)
- Growth parameters (Linf=172.0 cm and 160.6 cm, k = 0.32 and 0.54 for females and males respectively and t0=-1) were inferred from (Arocha and Barrios, 2009).
- Three fleets: (1) gillnet, (2) longline, and (3) recreational rod & reel.
- For models that estimated a catch multiplier, the parameter was estimated for the time block 1998-2017, since the implementation over management regulations by the Commission in 1998-1999.

Diagnostics

The Group outlined a set of standardized model diagnostics to be presented and reviewed for reference models, which included:

- Model fits to indices of abundance and size compositions
- Retrospective analysis of biomass and fishing mortality estimates, and calculation of Mohn's rho for each model run
- Indices jackknife to evaluate the influence of each CPUE on model results
- Likelihood profiles of steepness, R0, and catch multipliers
- Run tests for randomness of CPUE residuals (Carvalho *et al.* 2017).

3.3 Other methods

No other methods were applied.

4. Stock status results

4.1 Production models

The Group reviewed the results obtained with JABBA a surplus production model. JABBA model runs included one base case scenario and two sensitivity scenarios as follows: (S1) sensitivity run 1; included 13 CPUEs (excluding only EU_Spain longline index), (S2) sensitivity run 2; included all 14 CPUEs, and (S3) base case; same setting as S1 but removed data for 1959-1961 in early Japanese longline index. JABBA models converged adequately, and diagnostics indicated no model misspecifications. Outputs showed very similar trends and results across scenarios. The Group concluded that scenario S3 is the best representation of the Atlantic white marlin stock dynamics and it was selected as base model.

JABBA-residual plots showed that the exclusion of EU_Spain longline index improved model fit by reducing RMSE from 58% to around 53% (S1). The exclusion of the first three years of early Japanese longline index showed a slight decrease in RMSE (**Figure 7**), and it estimated the initial biomass ratio (1956) to a more reasonable estimate (0.86) compared to initial runs. The longline fleets from Chinese Taipei and Brazil seem to be the most influential and exhibited the highest discrepancies between CPUE series and model predictions. The predicted CPUE indices fits were compared to the observed CPUE for each scenario (**Figure 8, 9** and **10**). The model fits for white marlin CPUEs indicated that there was a lack of fit from longline fisheries of Chinese Taipei and Brazil, in the third time block period (2001-2017) of Japanese fleet, and US recreational fishery. Plots of process error deviates are shown in **Figure 11,** values of process error have declined more or less continuously since 1995. It is important to note that process error represents annual changes in the indices of abundance that are not explained by the dynamics of the stock production model and the observed catches.

Plots of posterior densities together with prior densities for the three models are depicted in the **Figures 12** to **14** and summaries of posterior quantiles for parameters and management benchmarks are presented in **Table 5**. The trajectory of B/B_{MSY} showed a sharp decrease in the mid-1970s to an overfished status followed by a continuing decreasing trend until 2000. Since the early 2000s the relative biomass showed a slight recovery but remained at levels below B_{MSY} to the end of the time series (base case B_{2017}/B_{MSY} = 0.463). The F/F_{MSY} trajectory showed an overall increasing trend from the beginning of the time series until mid-1990s, followed by a decreasing trend after 2000s with no overfishing (base case F_{2017}/F_{MSY} = 0.606) in recent years (**Figure 15**). The slow rebuilding in the biomass estimated in recent years is explained by the fact that fishing mortality remained above F_{MSY} until 2011 and partially because of the persistent decline in the process error since 1995. A retrospective analysis for eight years was also presented, which showed no evidence of strong retrospective patterns and was very consistent among scenarios (**Figure 16, 17, 18**). All runs indicated that results were robust in terms of similar stock status (F/F_{MSY}; B/B_{MSY}) and MSY (**Table 5**).

The Kobe plot overlaid with the production model revealed a typical anti-clockwise pattern with the stock status moving from underexploited level through a period of unsustainable fishing to the overexploited phase since mid-1970s for all scenarios (**Figure 19** and **20**). The stock status results for 2017 showed that Atlantic white marlin stock has a 99 % probability of being overfished but not suffering overfishing (**Figure 19**).

4.2 Length-based age-structured models: Stock Synthesis

After the Group reviewed Document SCRS/2019/110, the following 4 additional runs (model 4 to 7) were provided to discuss final base case model for Stock Synthesis.

- Model 4: Use all index except EU_Spain longline, without a catch multiplier, without variance reweighting,
- Model 5: Use all index except EU_Spain longline, estimate a catch multiplier, without variance reweighting,
- Model 6: Use all index except EU_Spain longline, without a catch multiplier, with variance reweighting,
- Model 7: Use all index except EU_Spain longline, estimate a catch multiplier, with variance reweighting.

The Group agreed to use models 6 and 7 as final SS3 base case models. The Group carried out variance reweighting which estimates an additional parameter for each CPUE index. These parameters are an additive constant which are added to the input standard deviation of each index. Reweighting was suggested by SCRS/2019/110, and it has the end result of reducing the influence of CPUE series which are not in agreement with predicted trends in stock size. The Group acknowledged that reweigthing improved the model diagnostics, thus it was agreed to use variance reweighting for the final model setting (retrospective analysis: **Figure 21** for models 4 and 5, and **Figure 22** for models 6 and 7). The estimated additive constants from reweighting are shown in **Figure 23**.

The Group continued to have concerns on the accuracy of the white marlin reported catch and the estimates of dead discards as a consequence of the implementation of management measures since1998-1999. The total catch removals matrix used in the assessment models for both JABBA and SS3 analysis (see Section 2.1) may not fully account for all removals from the stock. In the 2012 assessment, the Group decided to use alternative vectors of removals as an approach to evaluate this uncertainty. At this assessment, the Group evaluated the use of a catch multiplier parameter in the SS3 model for the period 1998-2017. This assumed that catch removals are not perfectly known since 1998 but that they were known without error prior to that. Furthermore, this assumes that the under-reported removals for 1998-2017 are a constant proportion of the reported catch. It was noted that estimating a catch multiplier within the SS3 model is a different technique that can be used to account for unaccounted IUU catches, while alternative catch series, as those developed in the 2013 assessment are tipically estimated outside the model.

The Group agreed that a reliable estimate of removals is essentially to ensure the quality of the assessment results, and that there are some under reported removals of white marlin. There were a number of concerns discussed by the Group concerning the catch multiplier approach. Among these concerns were 1) the assumption of a constant under-reporting for the period considered, 2) the assumption that prior to 1999 there was no under-reporting, and 3) that the estimates of underreporting (~27%) were much greater than the values reported by current observer programs. Estimating a catch multiplier did reduce the estimates of recruitment deviations (**Figure 24**), however, it did not eliminate or reduce significantly other data conflicts. As a result, the Group recommended that in order to reduce the uncertainty in removal estimates further improvements of CPUEs and catch data collection are required, especially with respect to monitoring of discards (see Section 6). The Group agreed to use both models 6 and 7 as the final SS3 base case models. The Group agreed that the use of the catch multiplier was a promising approach, and that work should continue to explore its further use.

All parameter values and standard deviations for the final SS3 base models (models 6 and 7) are given in **Table 6**. The model estimated R0 using a noninformative prior, for steepness (*h*) a normal distribution prior with mean of 0.5 and standard deviation of 0.05 was used. The resulting posterior distributions of the parameters encompassed the predetermined values agreed upon for the sensitivity analyses. The estimated values of steepness were 0.557 (SD = 0.018) and 0.617 (SD = 0.018) in the models 6 and 7, respectively. These values were slightly smaller than the one estimated in the 2012 assessment which was 0.654 (SD = 0.032). The estimated catch multiplier in the model 7 was 0.734 (SD =0.080).

The estimated maximum sustainable yield (MSY) in the models 6 and 7 were 1,371 t (1,288-1,453 t), and 1,467 t (1,372-1,562 t), respectively. These values were smaller than the one in the 2012 stock assessment (Anon. 2013) 1,604 t (SD = 28 t). The estimated B/B_{MSY} and F/F_{MSY} showed very similar trend in the both models 6 and 7 (**Figure 26**). The trend B/B_{MSY} has shown a significant decreasing trend in the 1960s, and a continuous downward trend until the late 1980s. After 1990s, the B/B_{MSY} remained below 1.0. The estimated values of B/B_{MSY} in 2017 were 0.60 (0.40-0.80) and 0.66 (0.44-0.88) in the models 6 and 7, respectively. These values are larger compared to the estimated biomass level B_{2010}/B_{MSY}=0.322 (SD = 0.046) in the 2012 stock assessment. The trend in F/F_{MSY} showed immediate increase in early 1960s, and gradually increased around 1.5 in the late 1960s to 2.5 in the early 2010s except some years. After 2010 the F/F_{MSY} showed a continuous decreasing trend up to 2017, and the estimated values of F/F_{MSY} in 2017 were 0.60 (0.42-0.78) and 0.68 (049-0.87) in the models 6 and 7, respectively. The estimated B/B_{MSY} and F/F_{MSY} were such that the current stock status is overfished but is not undergoing overfishing (**Figures 27** and **28**). A Kobe plot was calculated by combining the results from 5000 MVN (multivariate normal approach) runs of models 6 and 7 (**Figure 19**). In 2017, the probability of overfishing and overfished was 0.5%, the probability of overfished but not overfishing 99% and the probability of being neither overfished nor overfishing 0.3%.

4.3 Other methods

No other methods were applied.

4.4 Synthesis of assessment results

During this meeting, JABBA (version 1.5 beta) and Stock Synthesis (version 3.30) were applied. The Group agreed to use a combination of results from JABBA (model S3) and SS3 (models 6 and 7) to develop the advice on stock status and outlook. The combination of results would reflect more of the uncertainty associated with the estimates of stocks status. One model is based on aggregated biomass (JABBA) and uses less data, and the other model uses more data and considers changes in the age distribution of the population (SS3). Using results from both models therefore provides a better representation of some of the process error in the assessment. The Group also agreed that all three models would be given equal weight in such combination.

The trajectories of B/B_{MSY} and F/F_{MSY} from three models (JABBA S3 in **Figure 15**, and SS3 models 6 and 7 in **Figure 26**) were overlaid in **Figures 29** and **30**, respectively. It was noted that B/B_{MSY} was calculated using spawning stock biomass for SS3, and biomass for JABBA. Generally, all models estimated similar annual trends and values of both B/B_{MSY} and F/F_{MSY}. The estimated B/B_{MSY} declined rapidly from the mid-1950s to the mid-1970s, and continued to decrease slightly until 2010 (**Figure 29**). In the recent years, an increasing trend in B/B_{MSY} was observed by SS3, while JABBA showed a flat trend. These differences are associated to the different treatment of CPUEs in each model: SS3 used variance reweighting (see Section 4.2) while JABBA did not incorporate it. It should be noted that the results of SS3 without variance reweighting (models 4 and 5) showed the same flat trend as JABBA.

The estimated F/ F_{MSY} values rapidly increased in the 1960s, and fluctuated between 1.0 and 2.0 in the 1970s and 1980s (**Figure 30**). The values were further increased in 1990s and fluctuated between 2.0 and 3.0 where JABBA estimated higher fishing mortality (3.0) than SS3 (2.0-2.5). Since the late 1990s, it showed a continuous decreasing trend increased until the last year considered in the assessment, 2017.

The Group agreed to calculate uncertainty in Kobe plot by combining 5000 MCMCs iterations from JABBA (model S3), and iterations from SS3 using MVN (multivariate normal) approach. 5000 iterations were also used for each of the SS3 models 6 and 7. Those iterations were randomly extracted from 10000 initial iterations from JABBA and 6000 initial iterations from SS3. The median of the current (2017) biomass ratio and fishing mortality ratio with 95% confidence intervals are 0.58 (0.27-0.87) and 0.65 (0.45-0.93), respectively (**Figure 31**). This implies that in 2017 the stock of Atlantic white marlin was being overfished but not undergoing overfishing. The probability of being in the red quadrant of the Kobe plot was estimated to be 1%. The probability of being in the yellow quadrants of the Kobe plot was estimated to be 99% and that of being in the green quadrant less than 1%. The estimated MSY was determined to be 1,495 t with 95% confidence intervals (1,316 t – 1,745t).

5. Projections

Note that for both models, biomass projections refer to the biomass at the beginning of the year while fishing mortality refers to the entire year. Therefore, biomass reported for 2020 is only affected by catches prior to 2020, while fishing mortality of 2020 is determined by catches in 2020. The Group agreed that projections be conducted for constant catch scenarios starting at 0 t and up to 1600 t at 200 t intervals and for a period of 10 years (2020 to 2029). The catch for years 2018 and 2019 was set to 458 t which corresponds to the carryover of the catch in 2017 (reported landings + dead discards estimated by the Group). To calculate uncertainty, 5000 MCMCs iterations from JABBA, and iterations from SS3 using MVN (multivariate normal) approach were used for the projections.

5.1 Production models

Projections of future stock status with JABBA were conducted for the base model (S3) and they were similar to and less optimistic (**Figure 32**) than those conducted with stock synthesis model (**Figure 33**). However, at high catch levels (TAC > 1,000 t), some iteractions predicted exteremly small biomass ratios and exteremly high F ratios indicating basically a stock collapse. To summarize this trend, the probability of the biomass being less than 10% of B_{MSY} was calculated for each projection year and catch scenario. This probability (**Table 7**) increased with high TAC levels and year, reaching a 24% probability of biomass falling below 10% of B_{MSY} in 2029 with a constant catch of 1,600 t. For the projection figures, the extreme F/F_{MSY} values, that were reached over 400, were replaced to 9.

The projections with JABBA (**Figure 32**) showed that with catches as high as 800 t the stock can recover to B_{MSY} by 2025 and that with catches as high as 1,000 t the stock will not experience overfishing. The Group discussed that these results are inconsistent with the history of the dynamics of the stock. In other words, the stock has shown slow increases in biomass with catches in the order of 400-500 t and, therefore, the Group considered that it is unlikely that catches as high as 1,000 t can rapidly rebuild the stock as suggested by the projections. The Group noted that the JABBA assessment runs showed that in the last several years of the assessment period, there was a period of negative values (2005-2017) in the process error. However, since process error can not be included in the JABBA projections, the predicted increases in stock biomass may be overly optimistic. As such, these projections should be interpreted with caution.

5.2 Length-based age-structured models

Stock synthesis projections were conducted with model 6 and by assuming the average recruitment level from the Beverton–Holt stock recruitment model. Like the JABBA projections, they also showed that the stock can quickly recover even with catches that are substantially higher than currently reported levels (**Figure 33**), and the projections of future stock status with Stock synthesis were slightly more optimistic than those with JABBA. For example, 1,000 t can recover the stock to the spawning stock biomass level that can support MSY by 2025. The Group discussed that the projections assumed that recruitment will be as expected given the stock recruitment parameters, but in fact recruitment estimates were below the expected values for the period 2002- 2015. If low recruitment continues in the future, the forecasted result might be overestimated by this deterministic recruitment approach.In summary, these optimistic projections should also be interpreted with extreme caution.

5.3 Synthesis of projections

For the results of projections, the Group agreed to use a combination of projection results from JABBA (S3) and SS (model 6) to produce the advice outlook, including the Kobe strategy matrices. As was the case for the stock status results, the Group agreed that both models would be given equal weight in such combination. The projection for both models showed very similar results in the median, but JABBA provides wider range of values compared to SS3 (**Figure 34**). The projections with SS3 using MVN approach and assuming the average recruitment level from the Beverton–Holt stock recruitment model may not capture all uncertainties in the projections.

According to these projections (**Figure 35** and **Table 8**: Kobe II matrix), the current 400 t TAC will provide 93% probability of being in green quadrant by 2029. The results show that with a constant 1,000 t catch will achieve the stock status of being in the green quadrant in 2029 with 68% probability, however the Group considered that these estimates predicted increases in stock biomass may be overly optimistic in both JABBA and SS3. It was strengthened that these projections should be interpreted with caution.

6. Recommendations

6.1 Research and statistics

Need for CPCs to report discards: The Group noted that to date only 7 CPCs (out of 68 CPCs or fishing entities) have ever reported billfish discards and using such limited information the estimates of dead discards are around 2-3%. On the other hand, by using statistical analysis within the stock assessment models it was noted that unaccounted IUU catches, including dead discards may reach values of around 27% of the reported catches. Having the total catches, including dead and live discards, and estimates of post-release mortality is important for stock assessment purposes. As such, the Group emphasized the need for all CPCs to comply with the mandatory requirements to report discards (both dead and alive) for billfishes.

Sports fisheries CPUEs: There may still be issues related with increasing catchability in sports fisheries over time that are not fully taken into account in the CPUE standardization. As such, the Group recommends that work be conducted to collect and incorporate any data which informs on the historical evolution of fishing practices which could affect catchability.

Joint CPUE: The Group recommended that joint CPUE indices for longline fleets be developed for future billfish stock assessments using fine scale operational level data. Due to the fact that marlins are, in general, by-catch species, they are often not accurately reported in logbooks. Observer data should therefore be used to assure that all catches, including live and dead discards, are included.

Compare observer and logbook data CPUEs indices: National scientists should develop both observed data and logbook CPUEs indices within their fleets.

Size data analysis: CPUEs indices developed from catches with high proportion of juveniles specimens are often more variable than those developed from catches with higher proportion of adults. As such, the Group recommended that CPUE standardization documents include information on the size distribution of the catches used to develop the indices.

Stock assessment diagnostics: The Group recommended that the Working Group on Stock Assessment Methods develop a standardized set of stock assessment model diagnostics which should include standardized figures, tables and statistics.

Develop estimates of billfish discard mortality: The Group recommended that national scientists collaborate in a study of the effect of time, area and gear configuration variations for discards using observer data to improve discard estimates.

6.2 Recommendations with financial implications

Enhanced Program for Billfish Research (EPBR): The Group recommends continuing funding for the EPBR research activities for future years, to further improve the biological information for the species and areas prioritized. The details for the EPBR workplan are provided in section 8.

Given the misidentification of roundscale spearfishes as white marlin in the data, the Group reiterates its concern regarding uncertainty in stock assessment results and enforcement related problems and maintains its recommendation that research to address this problem should continue to be supported by the Commission.

6.3 Management

In 2012, the Commission adopted Rec. 12-04, intended to reduce the total harvest to 400 t in 2013-2015 to allow the rebuilding of the white marlin stock from the overfished condition. Subsequently, the Commission extended the 400 t annual catch limit to 2016-2018 (Rec. 15-05), and 2019 (Rec. 18-04). Although there is some evidence of slow rebuilding in recent years, the Group noted that catches have exceeded the 400 t TAC in every year since its initial implementation and warns that if catches continue to exceed the TAC, the rebuilding of the stock will proceed more slowly, or be put at risk of further declines. Further reductions in fishing mortality are likely to speed up the rebuilding of the stock. Unfortunately, the inability to accurately estimate fishing mortality will continue to compromise the Group's ability to predict and monitor the stock's recovery period. This is due to the inadequate reporting of discards, as well as the lack of reports from some artisanal and recreational fisheries that take marlin species.

- Measures should be taken to ensure that monitoring and reporting of all landings and discards, including live releases, are appropriate, accurate, and complete. This will likely require improvements to the observer programs of many CPCs, as well as the implantation of discard estimation methods using those data.

- Efforts should be made, building on previous work, to fully account for the catches of artisanal and all recreational fisheries.

Given the overfished status of the stock and the uncertainties in the data, including for both total removals and indices of abundance:

- The Commission, at the minimum, should ensure that catches do not exceed current TAC until the stock has fully recovered.

To reduce the chance of exceeding any established TAC, the Commission should require:

- The release of all marlins that are alive at haul back in ways that maximize their survival.

- The use of circle hooks as terminal gear. Experimental research has demonstrated that in longline fisheries the use of circle hooks resulted in a reduction of marlin catch rates and haulback mortality. Currently, four ICCAT Contracting Parties (Brazil, Canada, Mexico, and the United States) already mandate the use of circle hooks on their pelagic longline fleets.

7. Responses to the Commission

The only active requests from the Commission to the SCRS appear in Rec. 2018-04 which states:

"10.… The SCRS shall review the data and determine the feasibility of estimating fishing mortalities by commercial fisheries (including longline and purse seine), recreational fisheries and artisanal fisheries. The SCRS shall also develop a new data collection initiative as part of the ICCAT Enhanced Program for Billfish Research to overcome the data gap issues of those fisheries, in particular artisanal fisheries of developing CPCs, and shall recommend the initiative to the Commission for its approval in 2019."

The original plan (1986) for EPBR included the following objectives: (1) to provide more detailed catch and effort statistics, particularly for size frequency data; (2) to initiate the ICCAT tagging programme for billfish; and (3) to assist in collecting data for age and growth studies. See section 8 of this report for the status of initiatives within the EPBR. In terms of ongoing effort to close the data gap in artisanal fisheries, there will be intersessional work to finalise a draft EPBR work plan for discussion at the Group meeting in September. The draft work plan will be led by the Rapporteur of the Group and will include the EPBR coordinators, David Die and a representative of the secretariat. The authors of the review reports of the artisanal fisheries of West Africa and Caribbean will be invited to contribute to the draft. All members of the Group are welcome to provide input to the draft work plan as it is being developed intersessionally.

"13. At its next assessments of blue marlin and white marlin/spearfish stocks, the SCRS shall evaluate progress toward the goals of the rebuilding programs for blue marlin and white marlin/spearfish."

Section 6.2 provides management recommendations which includes the evaluation of previous measures.

8. Other matters

8.1 Enhanced Program for Billfish Research (EPBR)

The Secretariat provided a brief explanation on the procedures to fund the activities to be conducted within the EPBR in 2019, since a contract recently ended on 31 May 2019. In addition, the Secretariat noted the difficulties faced by some of the members of the working teams responsible for collecting billfish hard structures in the eastern Atlantic and emphasized the need to overcome the administrative issues and enhance coordination.

Two possible approaches were suggested to move forward the aging study for the three billfish species (blue and white marlin, and sailfish) in the eastern Atlantic: 1) launch a new Call for tenders; or 2) sign a new contract with the consortium led by IFAN and give the opportunity for other teams to join as a partner or sub-contractor/collaborator.

The Group highlighted the importance of the ongoing study and the work carried out over the past 12 months and reiterated the need for such activities to be maintained. The Group also recognized the difficulties faced over the past 12 months and the need to further enhance coordination and the engagement of new teams that could help on the collection of hard structures to conclude the age and growth study more rapidly. The Group noted the availability of Gabon and the European Union (Portugal and Spain) to join this collaborative study by providing samples and helping on the processing and analysis of these. Finally, the Group suggested that the best and fastest approach would be for the Secretariat to sign a new contract with the Consortium, once new partners/sub-contractors could agree to join this cooperative study.

A suggestion was made to include in EPBR the collection of otoliths and tissue samples for genetics. Regarding genetics, the Group noted that a study on the differentiation of white marlin and roundscale spearfish has been ongoing for a number of years, though no results have been made available to the Group yet. In this regards the previous coordinator of EPBR for the western Atlantic was contacted and the Group was informed that a relatively low number of samples have been sent back in recent years and that a minimum number 50 should be collected before being analyzed. The Group urged that a database with the available samples and distributed kits be developed in order to plan future sample collection.

The Group was informed that Dr. John Hoolihan (USA) will no longer act as coordinator of the EPBR for the western Atlantic. The Group expressed its gratitude to Dr. Hoolihan for his role and work over the past years as EPBR coordinator. The Group also agreed that he will be replaced by Karina Ramírez-López (Mexico). Dr. Fambaye N'gom will remain as overall and eastern Atlantic EPBR coordinator.

The Secretariat also informed that the Terms of Reference for the *Atlantic blue marlin Gulf of Mexico reproductive biology study*, were received from the rapporteur (**Appendix 5**), as agreed during the White Marlin Data Preparatory meeting (Anon. in press). Furthermore, the Secretariat informed the Group that a budget quotation request has been sent to experts in the field working in the area, aiming a 12 months contract. The work is expected to start in July 2019 as the necessary funds have already been made available.

The Secretariat also reiterated to the Group that funds had been secured to allow continuing support of sampling fishing activities to improve the quality of data on billfish collected from artisanal fisheries in the Eastern Atlantic. Funding is available for Senegal, Côte d'Ivoire and São Tomé e Príncipe. In order to proceed these CPCs were urged to formally request to the Secretariat the reimbursement related to these activities.

The Group also agreed to work intersessionaly on an EPBR workplan proposal for 2020 that will be discussed at the Group meeting in September 2019.

8.2 Western Central Atlantic Fishery Commission (WECAFC)

The Secretariat provided a brief overview on recent exchanges of correspondence between ICCAT and WECAFC, and on the developments regarding the transformation of WECAFC into a Regional Fisheries Management Organization. A key issue being discussed is "*whether to include a general provision relating to "all fishery resources in the Area of Competence of the Commission" or specific stocks, such as straddling fish stocks, deep sea, and highly migratory species not covered under ICCAT's mandate as well as some transboundary stocks such as sharks…*".

The Group was informed that ICCAT was represented at an WECAFC Working Group on FADs meeting held in April 2019. The meeting provided progress on the science in support of management of moored FADs in the WECAFC area. It discussed some information relevant to billfish and particularly to blue marlin, which dominates billfish catches made on FADs. Given that most species caught around FADs are managed by ICCAT, efforts on data collection and analysis related to FADs made by this WECAFC Working Group are of clear benefit to ICCAT. The Group highlighted the importance to continue to strengthen the coordination and collaboration of activities between ICCAT and WECAFC.

9. Adoption of the report and closure

Due to the limited time, the text report regarding agenda items 4.4 (Synthesis of assessment results) and 5.3 (Synthesis of projections) could not be reviewed prior to the closure of the meeting and therefore were adopted by correspondence. The remainder of the report was adopted during the meeting by the Group. The meeting was adjourned.

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Table 1. Reported Task 1 Nominal Catches (t) of Atlantic white marlin by area, gear and flag.

WHM-Table 1. Reported Task 1 NC catches (t) of Atlantic white marlin (*Kajikia albida*) by area, gear and flag. (v1, 2019-06-10)

				1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981
TOTAL	Stock			0	0	0	0	0	0	19	160	161	112	313	830	2064	2614	3735	4906	3513	1427	2049	2272	2147	2266	2289	1868	1775	1761	1839	1150	975	1039	976	1241
	A+M			0	0	0	0	0	0	19	160	161	112	313	830	2064	2614	3735	4906	3513	1427	2049	2272	2147	2266	2289	1868	1775	1761	1839	1150	975	1039	976	1241
1-Landings			Longline	0	0	0	0	0	0	19	160	161	112	253	763	1985	2548	3661	4827	3425	1335	1949	2171	2027	2153	2171	1750	1645	1634	1680	1011	837	900	822	1011
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	6	9	9	15	16	45	28	27	28	42	158
			Sport (HL+RR)	0	0	0	0	0	0	0	0	0	0	60	67	79	66	74	79	87	91	98	98	116	107	109	109	115	111	114	111	111	111	112	72
3-Discards			Longline	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Other surf.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1-Landings		CP	Barbados	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Belize	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Brazil	0	0	0	0	0	0	0	0	0	0	0	60	34	17	17	17	17	9	21	24	54	17	33	18	32	32	68	275	175	133	58	100
			Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			China PR	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Curaçao	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Côte d'Ivoire	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU.España	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU.France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU.Portugal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			El Salvador	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Gabon	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Ghana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	45
			Grenada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Guatemala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Honduras	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Japan	0	0	0	0	0	0	19	160	161	112	253	692	1915	2418	3495	4631	3002	668	1088	843	703	980	440	355	390	418	543	106	41	57	106	143
			Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	8	109	169	209	381	570	560	545	271	229	180	284	182	38	40	18	85
			Liberia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Maroc	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Panama	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26	123	36	26	76	51	9	3	0	0
			Philippines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			S. Tomé e Príncipe	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			South Africa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			St. Vincent and Grenadines	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Trinidad and Tobago	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			U.S.A.	0	0	0	0	0	0	0	0	0	0	60	60	74	64	70	76	76	81	87	76	104	95	99	104	108	107	109	109	109	110	116	78
			U.S.S.R.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	7	7	7	4	7	16	24	3	7	0	3	2	0	0	1
			UK.Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			UK.British Virgin Islands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Uruguay	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
			Vanuatu	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Venezuela	0	0	0	0	0	0	0	0	0	0	0	18	35	57	82	66	104	114	118	290	27	94	268	175	121	117	112	110	129	183	113	142
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	6	14	6	4	61	181	385	583	612	438	713	599	537	507	519	163	277	217	250	310
			Costa Rica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NCO	Argentina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	14	0	0	20	100	57	0	2	2	2	0	0	0	0
			Cambodia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Cuba	0	0	0	0	0	0	0	0	0	0	0	0	0	44	62	102	141	194	118	65	69	49	40	133	304	349	106	124	170	273	282	305
			Mixed flags (FR+ES)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	3	4	6	9	9	15	16	20	25	25	23	27	31
			NEI (BIL)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			NEI (ETRO)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Sta. Lucia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Togo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3-Discards		CP	Brazil	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Canada	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			EU.France	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Korea Rep.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			U.S.A.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			UK.Bermuda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		NCC	Chinese Taipei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

*Data for 2018 is preliminary and show only reports provided by 5 June 2019.

1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018*
1100	1780	1213	1730	1689	1612	1472	1923	1739	1743	1557	1680	2201	1879	1679	1513	1945	1786	1535	1078	1012	844	841	767	611	738	700	742	502	528	462	639	436	479	438	417	7
1100	1780	1213	1730	1689	1612	1472	1923	1739	1743	1557	1680	2201	1879	1679	1513	1945	1786	1535	1078	1012	844	841	767	611	738	700	742	502	528	462	639	436	479	438	417	7
990	1512	1054	1619	1548	1424	1105	1677	1545	1575	1389	1528	2065	1720	1535	1367	1717	1638	1403	970	834	756	757	689	532	629	603	630	418	414	371	456	357	433	396	364	6
65	189	94	68	108	88	278	123	88	59	59	56	64	36	56	62	189	85	89	86	139	71	55	60	65	81	84	95	68	85	62	56	61	34	33	41	0
45	79	66	44	32	38	29	17	25	19	22	30	30	22	24	14	6	6	2	4	6	1	1	1	2	1	2	2	6	4	6	116	7	3	4	5	
0	0	0	0	0	62	60	107	81	90	88	66	42	100	65	70	32	57	41	17	29	17	27	17	11	26	10	13	10	25	22	10	11	10	5	7	1
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	4	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0
0	0	0	0	0	0	117	11	39	17	24	29	26	43	15	41	33	25	25	24	15	15	18	16	33	22	24	26	6	3	5	6	6	10	14	**17**	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
76	81	61	87	143	93	149	204	205	377	211	301	91	105	75	105	217	158	106	172	407	266	80	244	90	52	55	53	35	75	71	352	102	121	67	47	
0	0	0	0	0	1	0	0	0	0	0	0	4	4	8	8	8	5	5	3	2	1	2	5	3	2	2	1	2	1	2	3	5	3	1	2	
0	0	0	0	0	0	0	0	0	0	0	0	9	11	9	11	15	30	2	20	23	8	6	9	6	10	5	9	8	3	4	2	0	0	0	3	
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0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	5	1	2	2	3	1	1	1	1	3	2	1	1	0	1	1	1	1	1	
0	0	9	14	8	10	62	13	12	26	23	26	26	36	151	93	101	119	186	61	6	22	64	58	51	46	32	16	111	4	34	37	93	113	89	110	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	5	19	30	22	2	35	40	11	18	25	10	9	7	11	**13**	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
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21	142	54	15	22	6	88	68	31	17	14	22	1	2	1	3	7	6	8	21	2	1	1	1	0	1	4	4	3	1	1	1	1	1	1	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	15	8	14	33	10	12	11	17	14	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
111	44	76	126	129	134	144	146	126	122	248	82	92	57	112	58	56	40	83	56	16	33	36	34	39	21	34	43	41	31	42	24	6	8	9	10	
69	15	62	372	71	27	19	135	81	57	10	8	43	23	59	23	35	39	0	0	0	11	40	7	0	113	96	78	43	43	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	8	4	3	4	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	1	7	11	3	1	3	6	11	13	16	15	28	25	16	14	14	19	20	28	36	30	20	26	20	12	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	12	0	0	0	0	0	0	0	0	1	1	2	2	1	2	2	0	0	0	
0	0	0	0	0	0	14	16	19	26	24	17	21	21	30	45	40	36	37	37	37	37	21	33	29	35	36	37	38	39	40	41	42	17	15	13	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	
0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	44	0	0	0	0	0	0	0	0	0	0	0	0	0	8	
0	8	13	2	28	61	29	7	6	3	6	1	11	18	8	32	10	13	4	2	5	12	6	6	5	12	10	11	15	14	39	33	38	32	20	**0**	
57	81	81	75	116	124	42	10	17	13	11	19	13	7	12	8	5	5	1	3	6	1	1	1	1	0	2	2	2	2	1	4	2	2	1	2	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**0**	
0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	**0**	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**0**	
10	13	65	44	16	6	1	1	1	1	3	2	3	0	1	24	22	16	21	20	1	9	2	5	9	3	6	5	5	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
113	234	155	155	193	204	119	141	159	163	276	362	236	286	270	177	310	228	178	182	215	168	136	156	190	131	63	128	116	160	121	75	89	119	172	165	
361	290	220	300	515	766	565	983	895	803	598	616	1350	907	566	441	506	465	437	152	178	104	172	56	44	54	38	28	20	28	15	7	7	10	10	5	6
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	14	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
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0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
250	840	394	512	417	92	37	43	20	10	10	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
32	31	22	23	25	25	25	27	37	11	10	12	11	9	7	7	9	8	12	13	12	13	13	11	10	9	10	12	12	37	0	0	0	0	0	0	
0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	34	77	4	30	134	42	37	170	204	199	0	11	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	114	214	237	285	359	526	498	322	180	11	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	1	0	1	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	19	1	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	62	60	107	81	90	88	66	42	100	64.68	70.46	33	57.51	40.75	17.96	32.78	16.71	27.42	17.347	9.513	7.722	9.702	14.484	8.26	23.275	21.355	10.052	11.012	7.839	2.606	4.975	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2	2	1

Table 2. Annual series of White marlin and roundscale spearfish catch landed, dead discards and live-releases reported by CPCs. This information was used to estimate the annual proportions of discards and the 3-year running average for the LL fleets.

Decade ONLY WHM and RSP
spp WHMS

Sum of Qty_t			YearC																												
GearSS	**Flag**	**CatchType(**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**Grand Tota**
LL	Brazil	**Catch**	201	377	211	301	91	101	70.4	105	101.5	157.58	105.8	171.5	341.9	265.632	80.2937	243.444	85.457	44.4568	40.4818	31.955	28.78371	73.94793	66.56884	240.7045	98.46243	121.2053	66.93418	46.5811	3870.588
		DeadDisc																	1.564	18.757	0.78										21.101
		LiveDisc																	14.779	24.428	5.84										45.047
	Brazil Total		201	377	211	301	91	101	70.4	105	101.5	157.58	105.8	171.5	341.9	265.632	80.2937	243.444	101.8	87.6418	47.1018	31.955	28.78371	73.94793	66.56884	240.7045	98.46243	121.2053	66.93418	46.5811	3936.736
	Canada	**Catch**					4	4	8	8	8	4.8	5.336	3.151	1.645	1.319	1.411	4.243	3.185	2.095	1.503	0.627	1.605	0.757	2.038	2.492	4.582	2.516737	1.015891	1.908783	78.23041
		DeadDisc																											0.121	0.109	0.23
		LiveDisc																											0.09	0.34	0.43
	Canada Total						4	4	8	8	8	4.8	5.336	3.151	1.645	1.319	1.411	4.243	3.185	2.095	1.503	0.627	1.605	0.757	2.038	2.492	4.582	2.516737	1.226891	2.357783	78.89041
	Korea Rep.	**Catch**	81	57	10	8	43	23	59	23	35	39	0.411			11	40	7		113	96	77.667	43.43251	43.43251			0.15			0.1428	810.2358
		DeadDisc																					1.583	1.583							3.166
		LiveDisc																					0.198								0.198
	Korea Rep. Total		81	57	10	8	43	23	59	23	35	39	0.411			11	40	7		113	96	77.667	45.21351	45.01551			0.15			0.1428	813.5998
	Mexico	**Catch**				0.696	7.344	10.894	2.724	1.274	3.381	5.964	10.684	13.402	15.91	15.057	28.002	24.832	16.353	13.569	13.871	19.24	19.985	28.215	36.287	30.442	19.875	25.867	19.659	11.935	395.462
		DeadDisc				0.01							0.079		0.006	0.026	0.041	0.092	0.064	0.06	0.015	0.197	0.093	0.138	0.147	0.06	0.114	0.03	0.035		1.207
		LiveDisc											0.339	0.084	0.681	0.227	0.298	0.097	0.025	0.428	0.3	0.291	0.227	0.16	0.039	0.048	0.075	0.06	0.399	0.217	3.995
	Mexico Total					0.706	7.344	10.894	2.724	1.274	3.381	5.964	11.102	13.486	16.597	15.31	28.341	25.021	16.442	14.057	14.186	19.728	20.305	28.513	36.473	30.55	20.064	25.957	20.093	12.152	400.664
	U.S.A.	**Catch**	1				2																								3
		DeadDisc	81	90	88	66	42	100	64.68	70.46	32	57.45	40.75	16.89	29.28	16.57	27.02	17.1	9.324	7.568	9.306	12.778	8.2	23.275	20.193	10.052	11.012	7.839	2.606	4.955	966.308
		LiveDisc																					14.763		14.516	3.424	5.622	1.095	3.054		42.474
	U.S.A. Total		82	90	88	66	44	100	64.68	70.46	32	57.45	40.75	16.89	29.28	16.57	27.02	17.1	9.324	7.568	9.306	12.778	22.963	23.275	34.709	13.476	16.634	8.934	5.66	4.955	1011.782
Grand Total			364	524	309	375.706	189.344	238.894	204.804	207.734	179.881	264.794	163.399	205.027	389.422	309.831	177.0657	296.808	130.751	224.3618	168.0968	142.755	118.8702	171.5084	139.7888	287.2225	139.8924	158.613	93.91407	66.18868	6241.673

GearSS	**Flag**	**CatchType(**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
LL	**Brazil**	**Catch**	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	83.95%	50.73%	85.95%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
		DeadDisc	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	1.54%	21.40%	1.66%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		LiveDisc	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	14.52%	27.87%	12.40%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Brazil Total		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	Canada	**Catch**					100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	82.80%	80.96%
		DeadDisc					0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	9.86%	4.62%
		LiveDisc					0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	7.34%	14.42%
	Canada Total		0.00%	0.00%	0.00%	0.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	Korea Rep.	**Catch**	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%			100.00%	100.00%	100.00%		100.00%	100.00%	100.00%	96.06%	96.48%			100.00%			100.00%
		DeadDisc	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%			0.00%	0.00%	0.00%		0.00%	0.00%	0.00%	3.50%	3.52%			0.00%			0.00%
		LiveDisc	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%			0.00%	0.00%	0.00%		0.00%	0.00%	0.00%	0.44%	0.00%			0.00%			0.00%
	Korea Rep. Total		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.00%	0.00%	100.00%	100.00%	100.00%	0.00%	100.00%	100.00%	100.00%	100.00%	100.00%	0.00%	0.00%	100.00%	0.00%	0.00%	100.00%
	Mexico	**Catch**				98.58%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	96.23%	99.38%	95.86%	98.35%	98.80%	99.24%	99.46%	96.53%	97.78%	97.53%	98.42%	98.95%	99.49%	99.65%	99.06%	99.65%	97.84%	98.21%
		DeadDisc				1.42%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.71%	0.00%	0.04%	0.17%	0.14%	0.37%	0.39%	0.43%	0.11%	1.00%	0.46%	0.48%	0.40%	0.20%	0.57%	0.12%	0.17%	0.00%
		LiveDisc				0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	3.05%	0.62%	4.10%	1.48%	1.05%	0.39%	0.15%	3.04%	2.11%	1.48%	1.12%	0.56%	0.11%	0.16%	0.37%	0.23%	1.99%	1.79%
	Mexico Total		0.00%	0.00%	0.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
	U.S.A.	**Catch**	1.22%	0.00%	0.00%	0.00%	4.55%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
		DeadDisc	98.78%	100.00%	100.00%	100.00%	95.45%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	35.71%	100.00%	58.18%	74.59%	66.20%	87.74%	46.04%	100.00%
		LiveDisc	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	64.29%	0.00%	41.82%	25.41%	33.80%	12.26%	53.96%	0.00%
	U.S.A. Total		100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
Avg percent of WHMS dead discards to total removals for		**% Dead Di**	0.00%	0.00%	0.00%	0.47%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.18%	0.00%	0.01%	0.04%	0.04%	0.09%	0.67%	5.91%	0.46%	0.25%	0.99%	1.00%	0.13%	0.07%	0.14%	0.04%	3.45%	1.20%
		3 Yr MovAv	0.00%	0.00%	0.00%	0.16%	0.16%	0.16%	0.00%	0.00%	0.00%	0.00%	0.06%	0.06%	0.06%	0.02%	0.03%	0.06%	0.27%	2.23%	2.35%	2.21%	0.57%	0.75%	0.71%	0.40%	0.11%	0.08%	1.21%	1.57%

Table 3. White marlin estimates of total landings (t) and dead discards by main fishing gear type. Estimates of dead discards from LL non-reported CPCs are included for the 1990-2017 period.

Year	LL	GN	OT	PS	RR	Total
1956	19	0	0	0	0	19
1957	160	0	0	0	0	160
1958	161	0	0	0	0	161
1959	112	0	0	0	0	112
1960	253	0	0	0	60	313
1961	763	0	0	0	67	830
1962	1985	0	0	0	79	2064
1963	2548	0	0	0	66	2614
1964	3661	0	0	0	74	3735
1965	4827	0	0	0	79	4906
1966	3425	0	0	1	87	3513
1967	1335	0	0	1	91	1427
1968	1949	0	0	2	98	2049
1969	2171	0	0	3	98	2272
1970	2027	0	0	4	116	2147
1971	2153	0	0	6	107	2266
1972	2171	0	0	9	109	2289
1973	1750	0	0	9	109	1868
1974	1645	0	0	15	115	1775
1975	1634	0	0	16	111	1761
1976	1680	0	25	20	114	1839
1977	1011	0	3	25	111.3	1150.3
1978	837	0	2	25	111.2	975.2
1979	900.1	0	5	23	111	1039.1
1980	822	5.955	9.4	27	112	976.355
1981	1011	44.9	82	31	71.9	1240.8
1982	990	20.82	12	32	45.4	1100.22
1983	1512.468	141.8	16	31	78.5	1779.768
1984	1053.589	55.053	17.3	22	65.5	1213.442
1985	1618.574	15.626	29	23	43.6667	1729.867
1986	1547.939	22.328	61.1	25	32.2	1688.567
1987	1486.438	6.414	57	25	37.6	1612.452
1988	1178.783	112.357	127	25	29	1472.14
1989	1799.573	68.557	11	27	16.6	1922.73
1990	1645.368	30.737	1	37	24.5	1738.605
1991	1691.435	21.689	0	11	19.1	1743.224
1992	1500.833	16.969	8.1	10	21.5	1557.402
1993	1612.055	25.96139	1	12	29.7	1680.717
1994	2128.642	12.76282	19.4	11	30.1	2201.905
1995	1841.804	6.96	0	9	22	1879.764
1996	1629.187	6.155715	13	7	24	1679.343
1997	1482.344	9.389479	0.178	7	14	1512.911
1998	1789.23	24.96337	116	9	6.2	1945.394
1999	1731.105	37.82089	3.06	8	6.2	1786.186
2000	1481.605	25.80658	14.1	11.999	1.7	1535.211
2001	1024.968	34.96148	0.715	14.018	3.5	1078.163
2002	900.7958	24.54608	68.848	11.54	6.149	1011.879
2003	810.0766	19.40182	1.253	13.065	0.754	844.5505
2004	805.0067	21.286	0.9	12.703	1.246	841.1417
2005	739.31	15.086	1.093	10.608	1.43	767.527
2006	573.3523	21.5	4.494	10.239	2.142	611.7273
2007	699.9044	29.441	7.950819	9.013	1.269	747.5782
2008	663.9183	22.77729	15.494	9.94	2.039	714.1686
2009	693.5517	24.653	23.00351	12.187	2.02	755.4152
2010	469.1456	11.4388	10.35617	11.801	2.834	505.5756
2011	480.6852	7.553	1.943	37	2.644	529.8252
2012	437.6003	16.363	10.0106	0.087	1.431582	465.4924
2013	516.895	13.947	112.3446	0.043	3.926961	647.1566
2014	427.2874	17.34153	5.2062	0.16	2.211	452.2062
2015	471.5647	16.30558	0.238852	0.174	3.070484	491.3536
2016	443.353	15.8325	3.604338	0.329	1.619207	464.7381
2017	432.4832	15.63458	4.624296	3.835301	2.158	458.7354

Table 4. Standardized CPUE series used in the 2019 White Marlin stock assessment. Spanish longline index* is used only for sensitivity analysis by JABBA.

Document	SCRS_2019_034		SCRS_2019_035		SCRS/2019/037						SCRS/2000/081		SCRS/2019/038						SCRS/2019/039		SCRS/P/2019/011		SCRS/2019/046		SCRS/2011/034		SCRS/2011/033	
Name	BRARR		BRALL		CTPLL1		CTPLL2		CTPLL3		JPNLLprior		JPNLL1		JPNLL2		JPNLL3		USARR		USALL		SPALL*		VENGL		VENLL	
Num / Wg	N fish		N fish		N fish		N fish		N fish		N fish		N fish		N fish		N fish		N fish		N fish		N fish		N fish		N fish	
Year	CPUE	CV	CPUE	CV	CPUE	CV	CPUE	CV	CPUE	CV	CPUE	CV	CPUE	CV	CPUE	CV	CPUE	CV	CPUE	CV	CPUE	CV	CPUE	SE	CPUE	SE	CPUE	SE
1959											0.39																	
1960											0.66																	
1961											1.54																	
1962											3.28																	
1963											3.12																	
1964											2.46																	
1965											2.21																	
1966											2.63																	
1967											2.26																	
1968					0.20	0.13					1.86																	
1969					0.17	0.11					1.90																	
1970					0.11	0.10					1.52																	
1971					0.14	0.10					1.06																	
1972					0.09	0.12					1.35																	
1973					0.15	0.14					0.78																	
1974					0.11	0.10					1.01								0.72	0.33								
1975					0.08	0.12					0.67								0.80	0.42								
1976					0.02	0.17							0.34	0.16					0.78	0.38								
1977					0.01	0.16							0.19	0.20					0.64	0.40								
1978			0.18	0.28	0.02	0.14							0.38	0.11					0.63	0.39								
1979			0.30	0.34	0.03	0.15							0.30	0.15					0.76	0.38								
1980			0.25	0.35	0.04	0.11							0.32	0.09					1.19	0.37								
1981			0.40	0.38	0.04	0.11							0.38	0.09					0.87	0.35								
1982			0.06	0.40	0.02	0.10							0.26	0.09					1.12	0.36								
1983			0.09	0.39	0.03	0.12							0.20	0.10					1.06	0.35								
1984			0.06	0.28	0.02	0.12							0.27	0.09					0.95	0.35								
1985			0.02	0.38	0.02	0.11							0.28	0.09					0.63	0.35								
1986			0.25	0.28	0.05	0.10							0.24	0.09					0.63	0.37								
1987			0.16	0.27	0.08	0.11							0.33	0.09					0.54	0.41								
1988			0.09	0.30	0.08	0.17							0.20	0.09					0.45	0.43			1.52	0.88				
1989			0.06	0.31	0.09	0.17							0.17	0.08					0.29	0.54			1.48	1.00				
1990			0.19	0.40			0.04	0.16					0.15	0.09					0.35	0.45			0.50	0.37				
1991			0.15	0.27			0.04	0.20					0.14	0.08					0.31	0.54			0.76	0.43	2.54	0.74	0.69	0.52
1992			0.10	0.28			0.06	0.18					0.15	0.09					0.31	0.55			0.43	0.27	1.46	0.47	0.45	0.28
1993			0.13	0.39			0.15	0.12					0.14	0.09					0.26	0.67	1.38	0.12	0.25	0.15	1.94	0.59	0.64	0.36
1994			0.08	0.27			0.16	0.11							0.12	0.18			0.41	0.56	0.68	0.15	0.30	0.17	7.17	1.90	0.59	0.36
1995			0.07	0.26			0.10	0.11							0.11	0.18			0.50	0.47	1.35	0.13	0.54	0.28	3.63	1.01	0.96	0.41
1996	2.56	0.27	0.33	0.26			0.10	0.11							0.09	0.18			0.50	0.48	0.91	0.16	1.86	0.90	1.30	0.45	0.35	0.20
1997	3.66	0.19	0.11	0.26			0.08	0.10							0.08	0.18			0.37	0.53	1.06	0.15	1.18	0.55	1.22	0.41	0.50	0.26
1998	2.97	0.24	0.13	0.25			0.05	0.13							0.12	0.18			0.91	0.45	0.89	0.17	1.81	0.91	3.10	0.88	0.57	0.29
1999	1.10	0.67	0.19	0.25			0.03	0.10							0.08	0.19			0.42	0.56	1.60	0.15	0.58	0.32	5.39	1.46	0.45	0.29
2000	3.33	0.20	0.14	0.26			0.03	0.10							0.07	0.19			0.36	0.74	1.22	0.15	0.61	0.43	3.70	1.03	0.20	0.14
2001	1.15	0.59	0.17	0.25					0.05	0.12							0.05	0.39	0.46	0.57	0.49	0.17	1.71	0.96	2.30	0.68	0.14	0.11
2002	3.35	0.20	0.04	0.26					0.04	0.12							0.04	0.40	0.66	0.48	1.00	0.15	0.08	0.11	3.22	0.91	0.20	0.13
2003	2.61	0.26	0.06	0.29					0.03	0.13							0.03	0.41	0.15	1.09	0.55	0.15	1.17	0.75	3.51	0.99	0.46	0.22
2004	1.65	0.41	0.11	0.27					0.02	0.12							0.04	0.39	0.58	0.49	0.97	0.13	1.67	1.01	5.28	1.43	0.42	0.23
2005	2.17	0.33	0.07	0.32					0.03	0.12							0.04	0.39	0.65	0.49	1.24	0.14	1.45	0.85	5.34	1.44	0.34	0.20
2006	1.99	0.37	0.05	0.32					0.03	0.13							0.07	0.39	0.78	0.46	0.80	0.15	1.40	0.85	5.12	1.39	0.28	0.16
2007	2.22	0.31	0.05	0.32					0.02	0.15							0.05	0.40	0.34	0.72	0.61	0.14	1.43	0.87	5.86	1.57	0.60	0.35
2008	1.85	0.43	0.04	0.33					0.01	0.21							0.03	0.41	0.57	0.57	0.59	0.14	1.17	0.92	4.21	1.16	0.65	0.43
2009	0.77	0.91	0.03	0.33					0.03	0.11							0.03	0.39	0.48	0.62	1.02	0.13	0.14	0.16	3.58	1.00	0.20	0.20
2010	2.89	0.24	0.11	0.34					0.02	0.11							0.02	0.40	0.66	0.54	0.66	0.14	0.56	0.48	2.29	0.68	0.61	0.35
2011	2.67	0.26							0.03	0.11							0.03	0.40	1.33	0.44	1.64	0.13	0.10	0.15				
2012	2.97	0.25							0.02	0.11							0.02	0.41	1.06	0.49	1.52	0.13	1.00	0.89				
2013	3.62	0.19							0.01	0.23							0.04	0.42	0.69	0.50	0.92	0.13	3.79	3.05				
2014	2.95	0.23							0.01	0.21							0.03	0.42	0.60	0.57	0.98	0.13	1.86	1.76				
2015	3.30	0.21							0.01	0.19							0.02	0.43	0.88	0.49	1.03	0.13						
2016	3.01	0.22							0.01	0.20							0.02	0.41	0.74	0.54	0.99	0.13						
2017	3.55	0.19							0.01	0.21							0.01	0.43	0.45	0.80	0.90	0.14						

Table 5. Summary of posterior quantiles denoting the 95% credibility intervals of parameters for the Atlantic white marlin JABBA models: (S1) sensitivity run 1; included 13 CPUEs (excluding EU-Spain longline index), (S2) sensitivity run 2; included all 14 CPUEs, and (S3) base case; same setting as S1 but removed data for 1959-1961 of the early Japanese longline CPUE index

	S3 (base case)			*S1 (sensitivity run 1)*			*S2 (sensitivity run 2)*		
Estimates	*Median*	*2.50%*	*97.50%*	*Median*	*2.50%*	*97.50%*	*Median*	*2.50%*	*97.50%*
K	29,249	21,026	43,041	26,230	18,853	37,395	26,604	19,261	38,197
r	0.163	0.122	0.215	0.17	0.125	0.225	0.168	0.126	0.223
y (psi)	0.863	0.667	1.024	0.759	0.557	1.019	0.735	0.493	1.008
σ_{proc}	0.158	0.105	0.205	0.17	0.11	0.207	0.17	0.114	0.207
F_{MSY}	0.144	0.108	0.191	0.151	0.111	0.2	0.149	0.112	0.198
B_{MSY}	11,409	8,202	16,789	10,232	7,354	14,587	10,378	7,513	14,900
MSY	1,646	1,290	2,222	1,535	1,208	1,977	1,549	1,211	2,046
B_{1956}/K	0.862	0.667	1.023	0.759	0.558	1.016	0.734	0.492	1.007
B_{2017}/K	0.181	0.1	0.304	0.206	0.126	0.349	0.203	0.116	0.331
B_{2017}/B_{MSY}	0.463	0.257	0.778	0.529	0.322	0.895	0.52	0.297	0.849
F_{2017}/F_{MSY}	0.606	0.386	0.932	0.566	0.351	0.866	0.575	0.364	0.897

Table 6. Summary of posterior quantiles denoting the 95% confidence intervals of parameters for the Atlantic white marlin Stock synthesis models 6 and 7.

	Model 6				**Model 7**			
	Estimate	**LCI**	**UCI**	**CV**	**Estimate**	**LCI**	**UCI**	**CV**
SSB/SSBmsy (2017)	0.599646	0.397	0.802	17%	0.662	0.442	0.883	17%
F/Fmsy (2017)	0.60003	0.423	0.777	15%	0.683	0.493	0.873	14%
MSY	1,371	1,288	1,453	3%	1,467	1,372	1,562	3%
Catch_multiplier	1				0.734			
SR_ln(R0)	5.511				5.445			
SR_BH_steepness	0.557				0.617			

Table 7. Percent of JABBA base model runs that resulted in biomass levels < 10% of B_{MSY} during the projection period in a given year for a given catch level (t) for Atlantic white marlin.

TAC	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
200	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
400	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
600	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
800	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.1%	0.2%	0.2%	0.3%
1000	0.0%	0.0%	0.0%	0.0%	0.1%	0.3%	0.5%	0.7%	0.8%	1.1%	1.3%
1200	0.0%	0.0%	0.0%	0.1%	0.2%	0.5%	1.1%	2.0%	3.2%	4.3%	5.5%
1400	0.0%	0.0%	0.0%	0.3%	1.1%	2.3%	3.9%	5.7%	7.7%	10.3%	12.8%
1600	0.0%	0.0%	0.1%	0.5%	1.7%	4.5%	7.8%	12.1%	16.1%	20.0%	24.1%

Table 8. Estimated probabilities of the Atlantic white marlin stock (a) being below F_{MSY} (overfishing not occurring), (b) above B_{MSY} (not overfished) and (c) above B_{MSY} and below F_{MSY} (green zone) in a given year for a given catch level (0 – 1,600 t), based upon the combined projections of JABBA (S3) and stock synthesis (model 6) from the 2019 assessment outcomes.

a) Probability that $F \leq F_{MSY}$

TAC | Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
0	100	100	100	100	100	100	100	100	100	100
200	100	100	100	100	100	100	100	100	100	100
400	100	100	100	100	100	100	100	100	100	100
600	97	98	98	99	99	99	100	100	100	100
800	89	92	93	94	95	96	96	97	97	98
1000	69	75	80	83	85	87	89	90	91	92
1200	37	42	47	51	54	58	60	63	65	67
1400	15	17	20	22	24	25	26	27	28	29
1600	7	8	9	11	11	12	13	14	14	15

b) Probability that $B \geq B_{MSY}$

TAC | Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
0	10	32	60	76	84	88	92	94	96	97
200	10	28	52	70	80	85	89	91	93	95
400	10	25	45	63	75	82	86	88	91	93
600	10	21	37	53	65	73	80	84	87	89
800	10	18	29	41	52	61	70	75	79	82
1000	10	16	23	31	38	46	52	58	63	68
1200	10	14	18	22	26	30	34	37	41	44
1400	10	12	14	16	17	19	21	22	24	24
1600	10	10	11	12	12	13	13	14	15	15

c) Probability that $F \leq F_{MSY}$ and $B \geq B_{MSY}$

TAC | Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
0	10	32	60	76	84	88	92	94	96	97
200	10	28	52	70	80	85	89	91	93	95
400	10	25	45	63	75	82	86	88	91	93
600	10	21	37	53	65	73	80	84	87	89
800	10	18	29	41	52	61	70	75	79	82
1000	10	16	23	31	38	46	52	58	63	68
1200	10	14	18	22	26	30	34	37	41	44
1400	8	10	13	15	17	18	20	21	22	23
1600	5	6	7	8	9	10	10	11	12	12

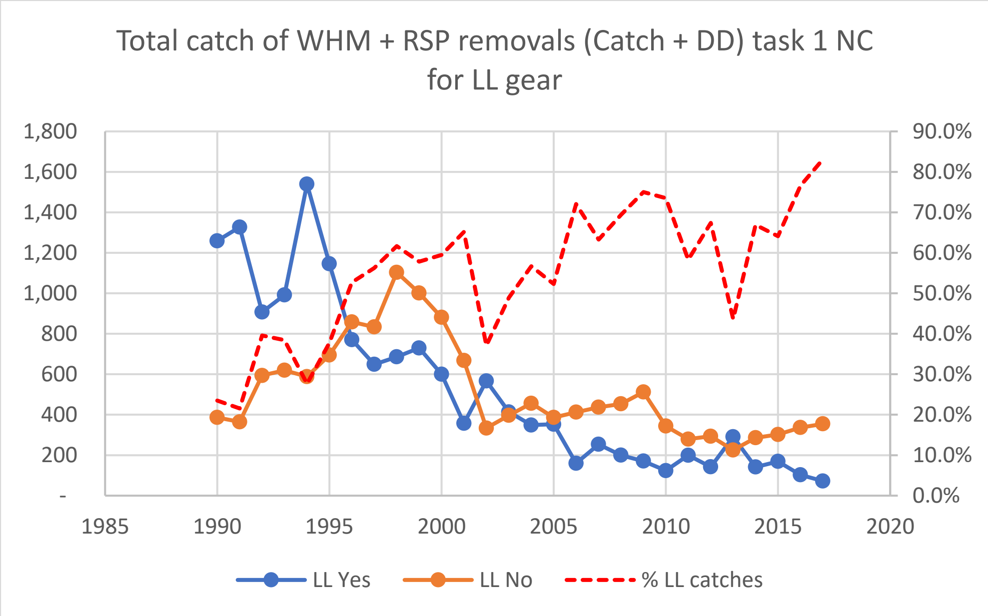

Figure 1. Total catch of WHM complex (WHM and RSP) by CPCs that have reported dead discards (blue line) and those that have not reported (Orange line LL No). Broken red line shows the proportion of the total catch (LL gear) for the fleets that did not report dead discards.

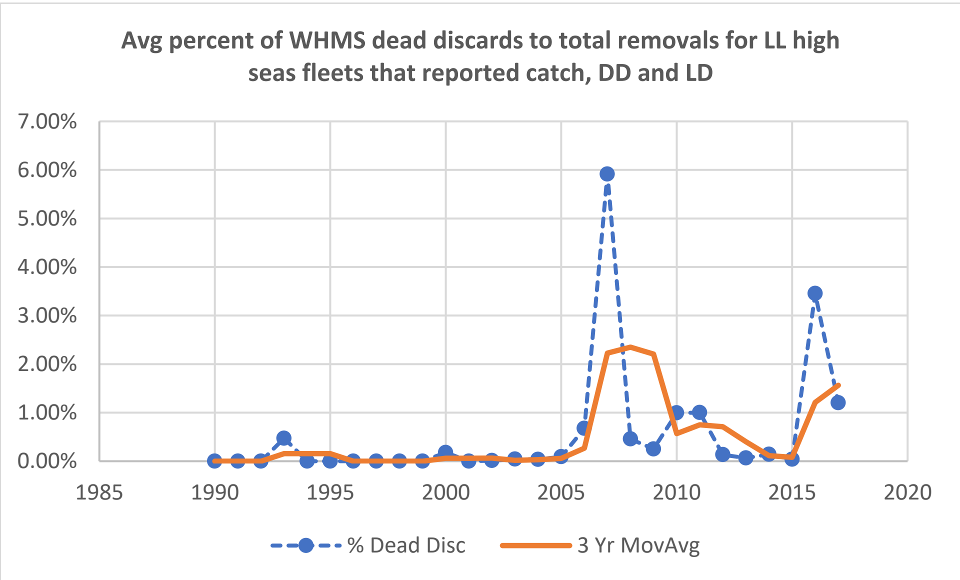

Figure 2. Average annual (dotted line) percent of white marlin and roundscale spearfish (WHMS) dead discards of the total landings for longline fleets 1990-2017. Solid line is the 3-year running average.

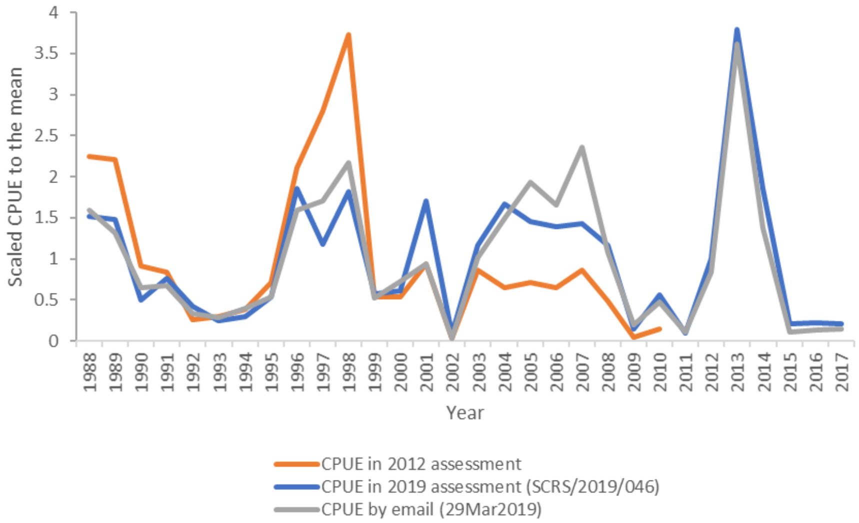

Figure 3. Comparison of standardized EU_Spain longline CPUE; CPUE used in 2012 stock assessment (orange), CPUE used in 2019 stock assessment (SCRS/2019/046, blue), and CPUE provided by e-mail before the deadline (29 March 2019).

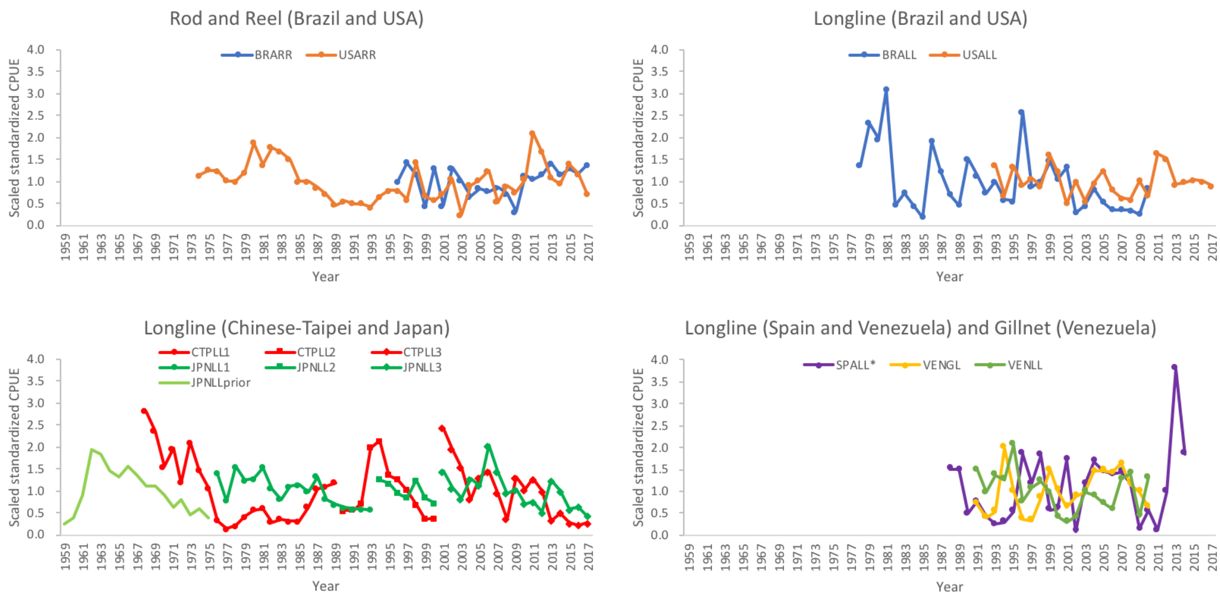

Figure 4. Standardized CPUE series used in the 2019 White Marlin stock assessment. EU_Spain longline index* is used only for sensitivity analysis by JABBA.

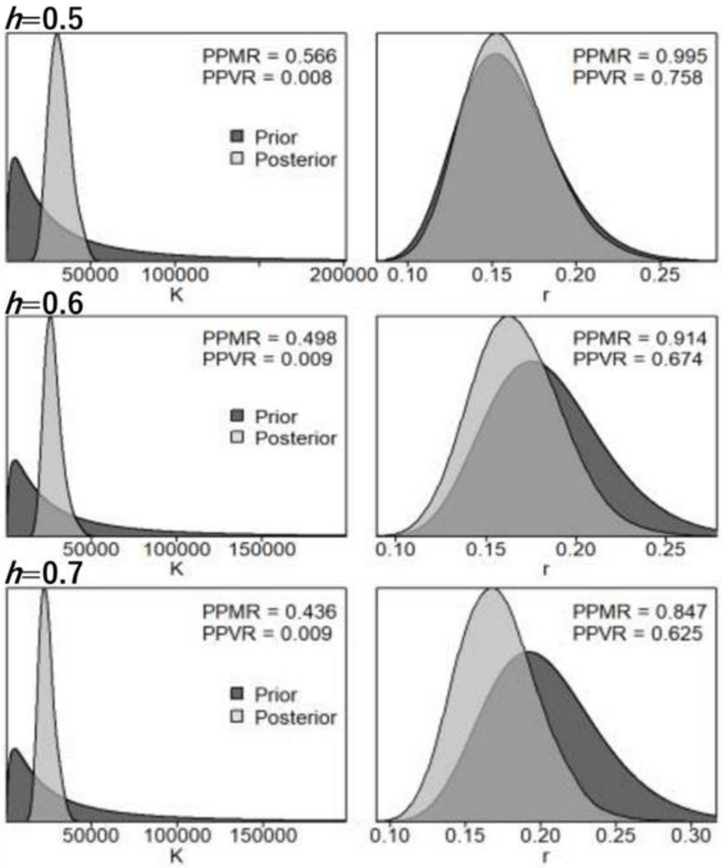

Figure 5. Figure of priors of r based on 3 steepness values h = 0.5,0 .6, 0.7 from JABBA.

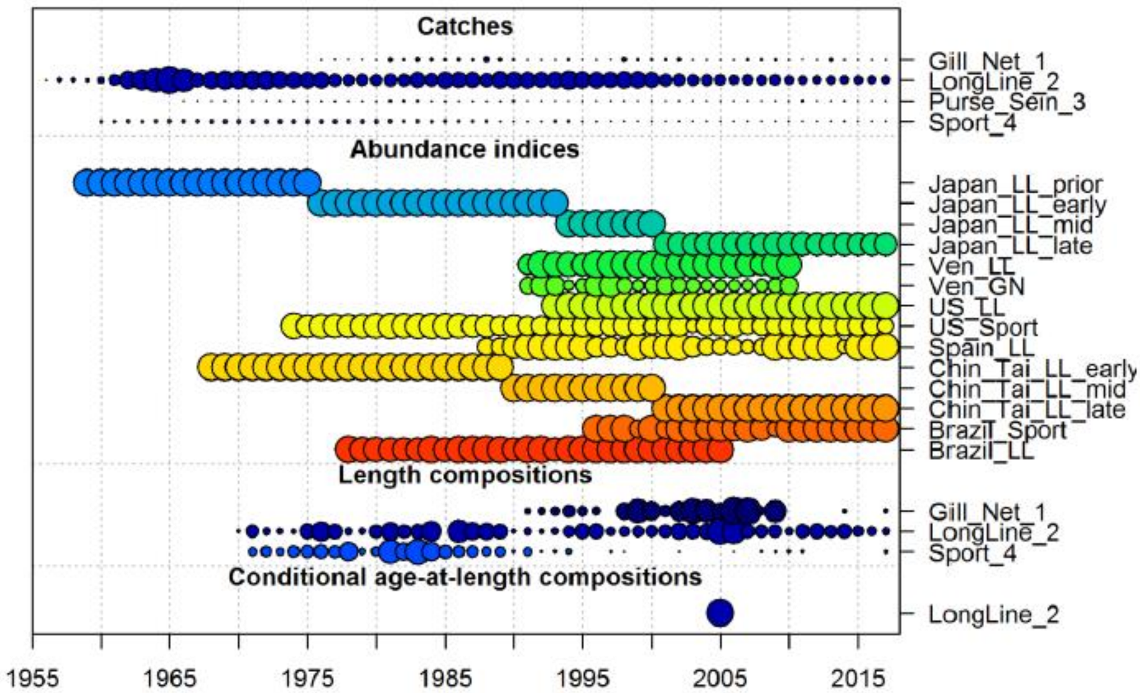

Figure 6. Stock Synthesis range of white marlin observational data used in the models.

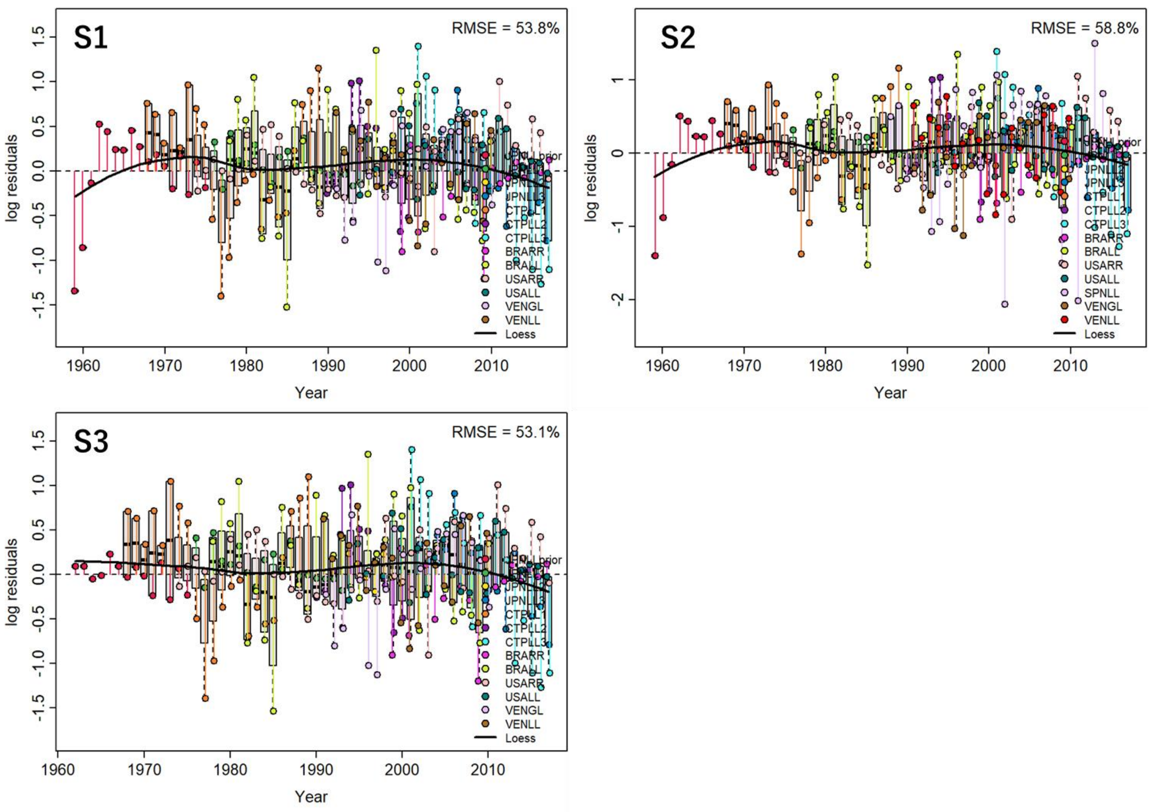

Figure 7. JABBA residual diagnostic plots for alternative sets of CPUE indices examined for each scenario (S1- sensitivity run 1, included 13 CPUEs with the exclusion of EU_Spain longline index; S2 - sensitivity run 2, included all 14 CPUEs, and; (S3 - base case; same setting as S1 but removed data for 1959-1961 from the early Japanese longline CPUE index) for the Atlantic white marlin.

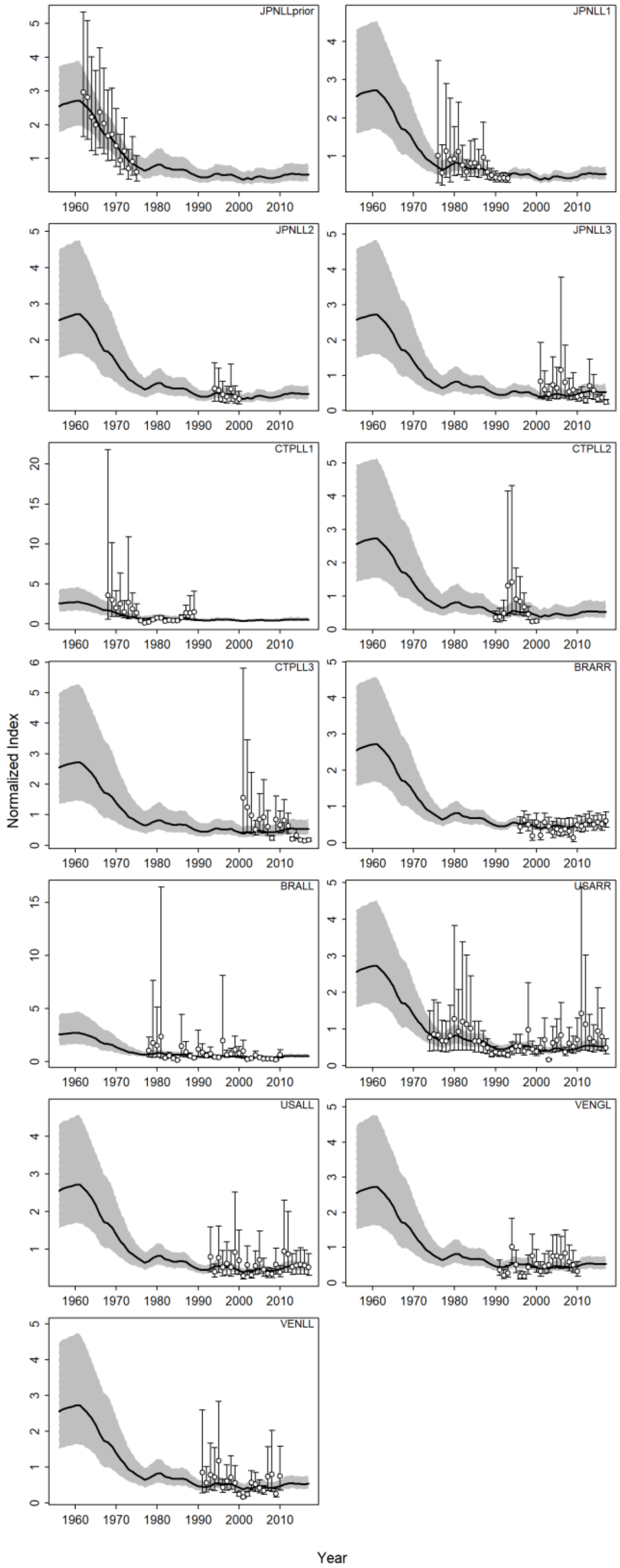

Figure 8. Time-series of observed (circle and SE error bars) and predicted (solid line) CPUE of white marlin in the Atlantic Ocean for the JABBA base case model (S3). Shaded grey area indicates 95% credibility intervals.

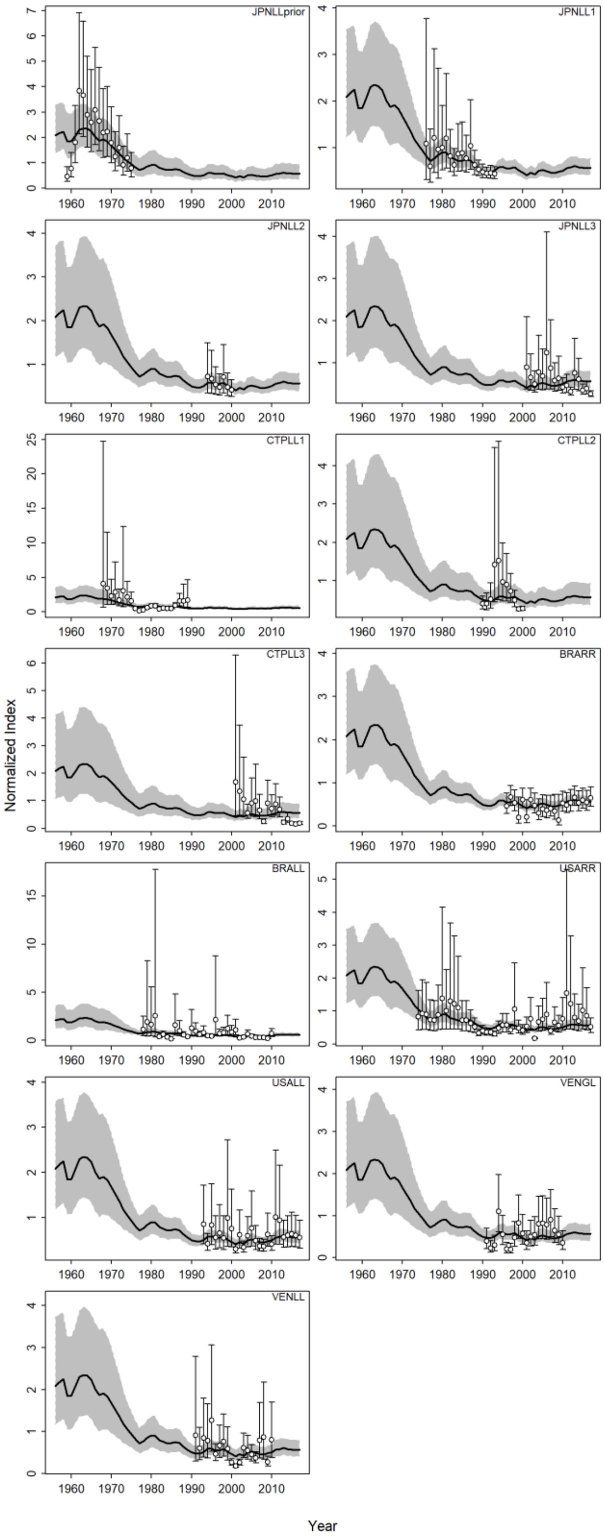

Figure 9. Time-series of observed (circle and SE error bars) and predicted (solid line) CPUE of white marlin in the Atlantic Ocean for the JABBA sensitivity run 1 (S1). Shaded grey area indicates 95% credibility intervals.

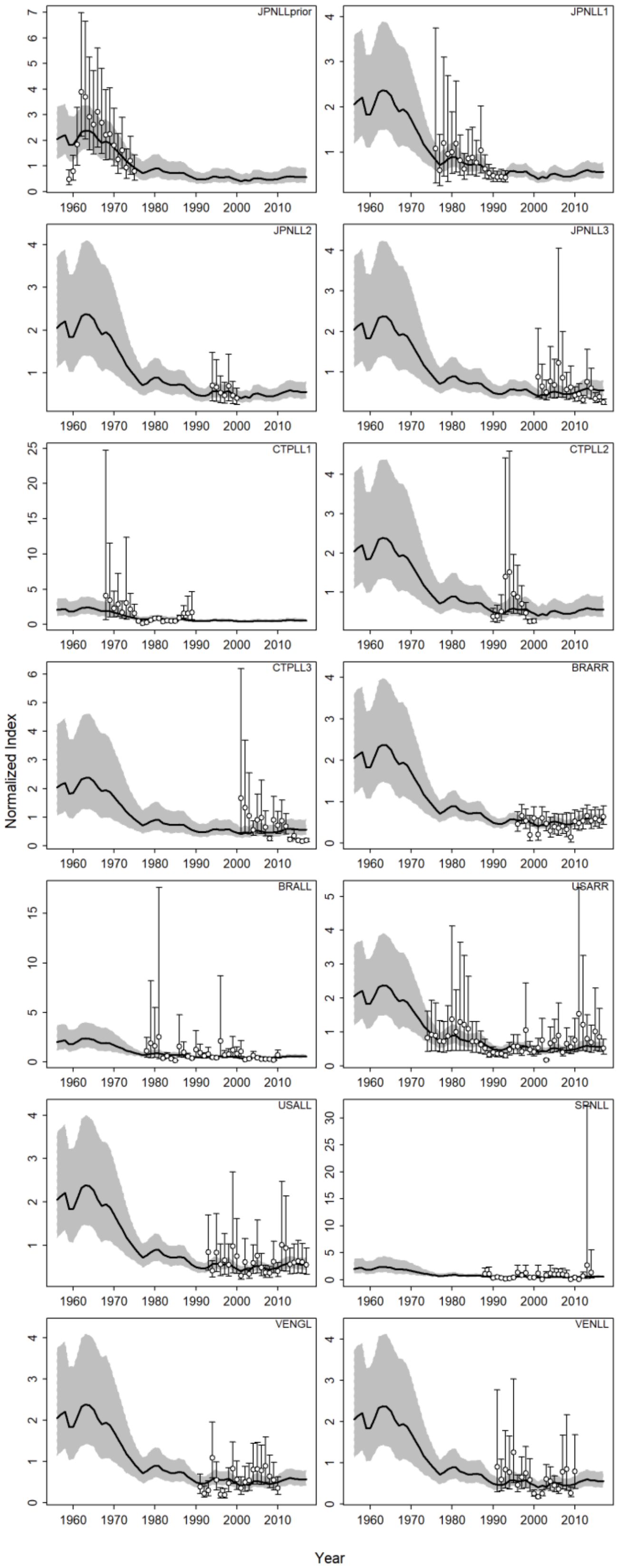

Figure 10. Time-series of observed (circle and SE error bars) and predicted (solid line) CPUE of white marlin in the Atlantic Ocean for the JABBA sensitivity run 2 (S2). Shaded grey area indicates 95% credibility intervals.

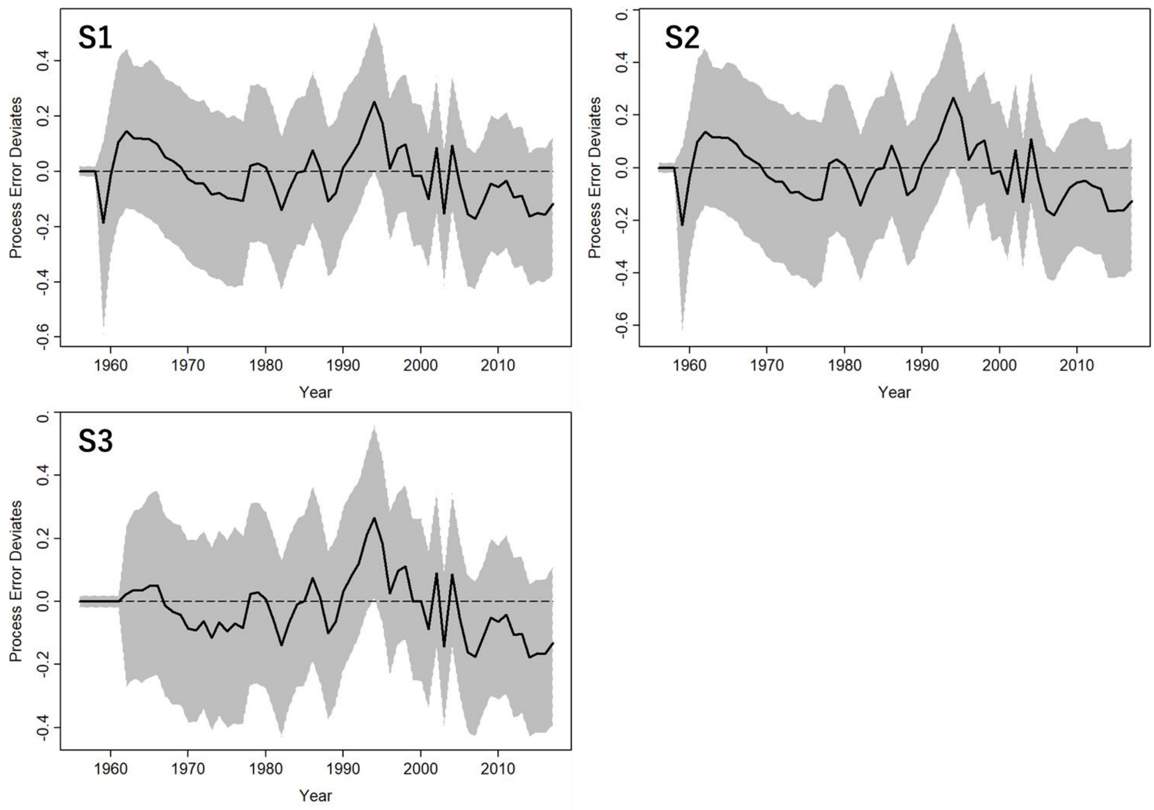

Figure 11. Process error deviates (median: solid line) of white marlin in the Atlantic Ocean for each JABBA model (S1- sensitivity run 1, included 13 CPUEs with the exclusion of only EU_Spain longline index; S2 - sensitivity run 2, included all 14 CPUEs, and; S3 - base case; same setting as S1 but removed data for 1959-1961 from the early Japanese longline index). Shaded grey area indicates 95% credibility intervals.

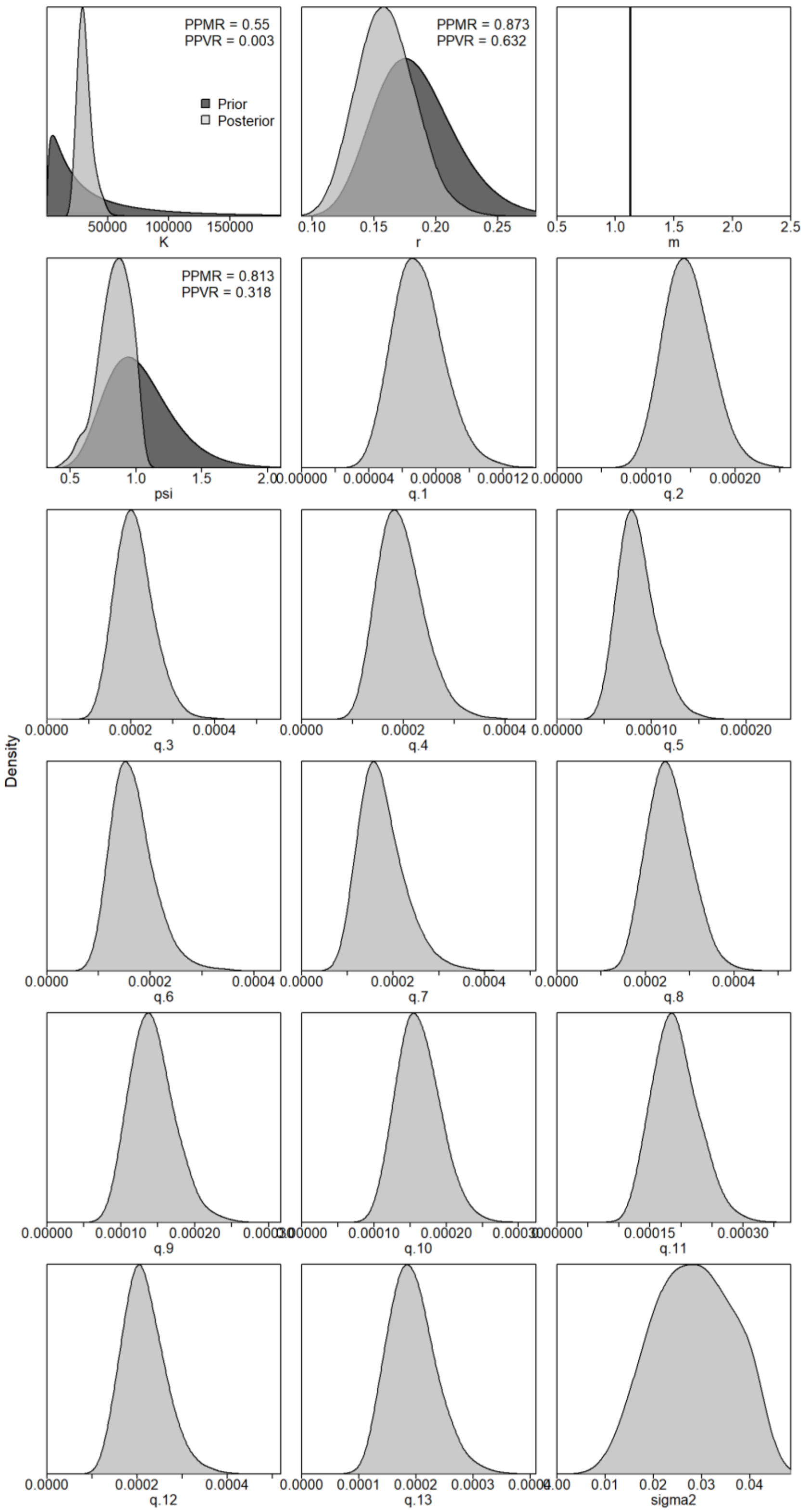

Figure 12. Prior and posterior distributions of various model and management parameters for the JABBA base case model (S3) for white marlin in the Atlantic Ocean.

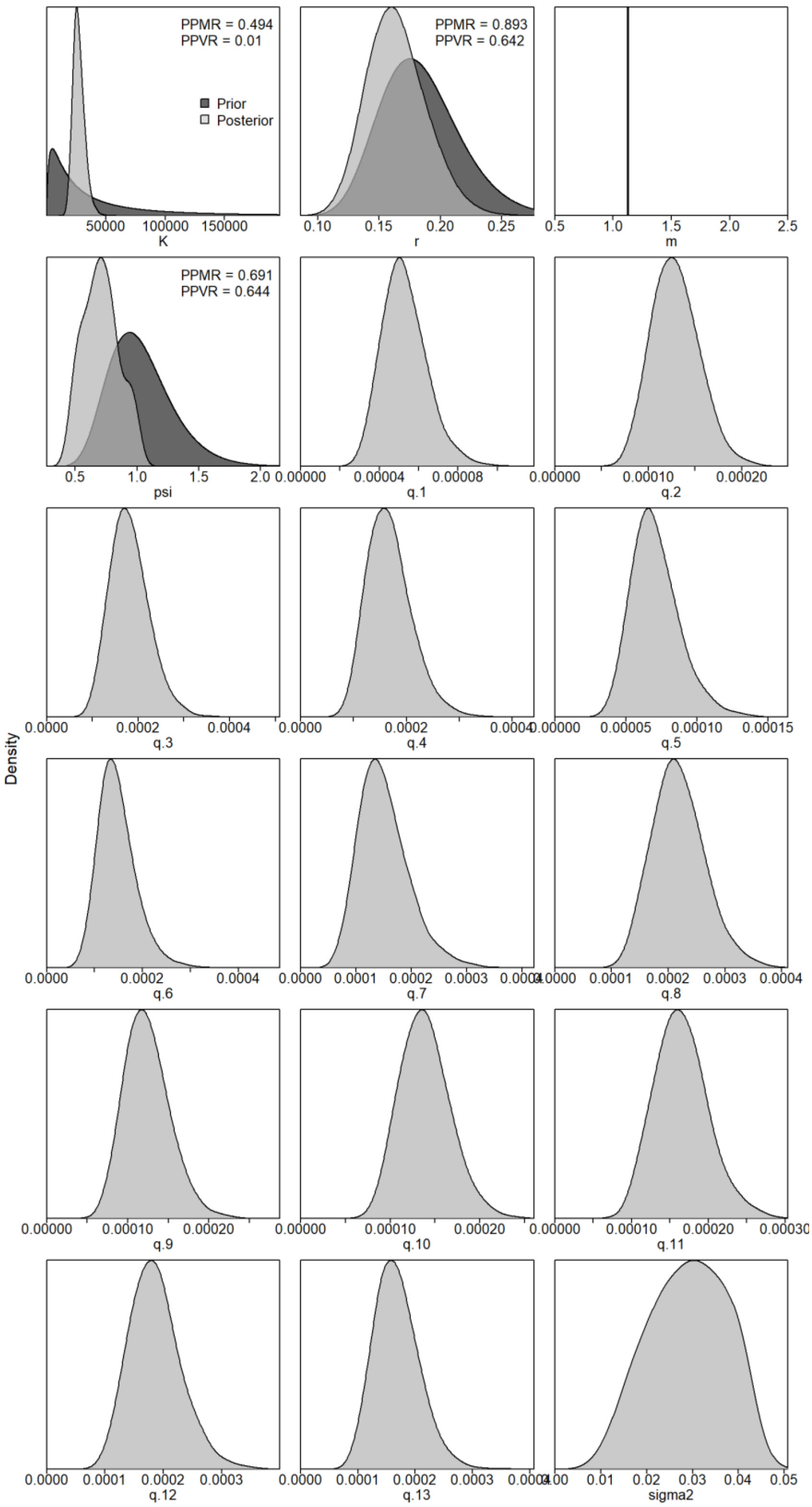

Figure 13. Prior and posterior distributions of various model and management parameters for the JABBA sensitivity run1 (S1) for white marlin in the Atlantic Ocean.

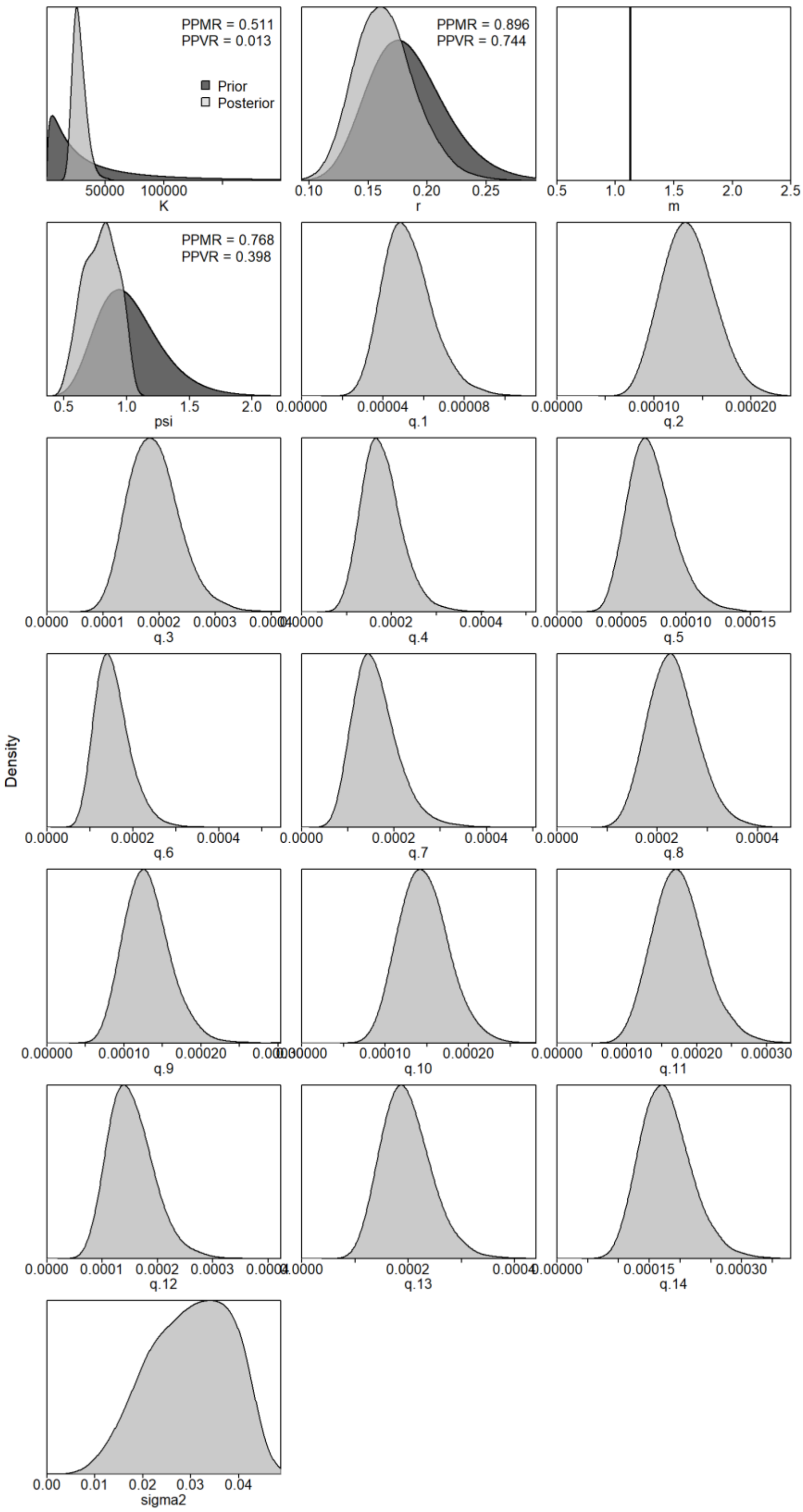

Figure 14. Prior and posterior distributions of various model and management parameters for the JABBA sensitivity run2 (S2) for white marlin in the Atlantic Ocean.

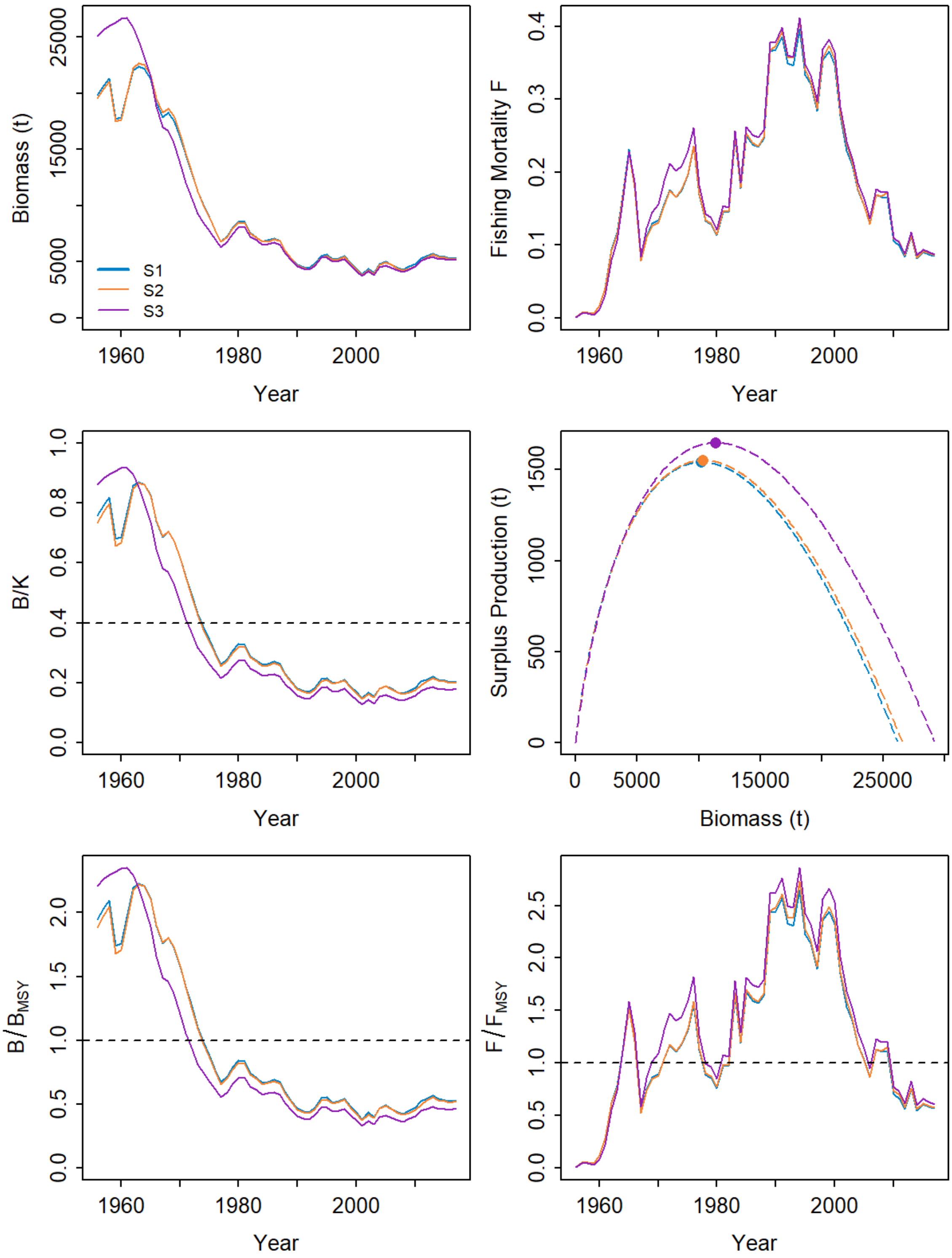

Figure 15. Comparison of biomass, fishing mortality (upper panels), biomass relative to K (B/K) and surplus production curve (middle panels), and biomass relative to B_{MSY} (B/B_{MSY}) and fishing mortality relative to F_{MSY} (F/F_{MSY}) (bottom panels) among JABBA scenarios (S1- sensitivity run 1, included 13 CPUEs with the exclusion of only Spanish longline index; S2 - sensitivity run 2, included all 14 CPUEs, and; S3 - base case; same setting as S1 but removed data for 1959-1961 in early Japanese longline index) for Atlantic white marlin.

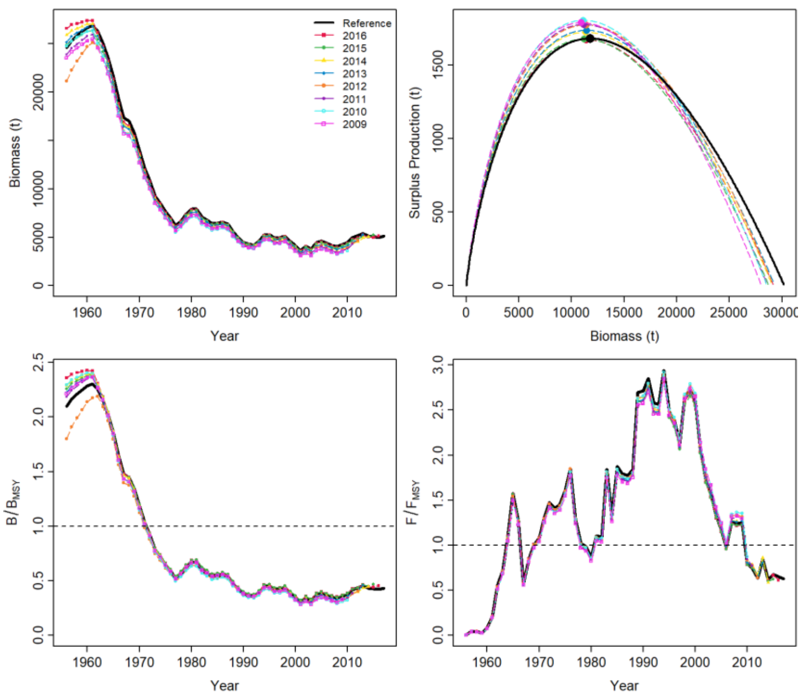

Figure 16. Retrospective analysis for stock biomass (t), surplus production function (maximum = MSY), B/B_{MSY} and F/F_{MSY} for the JABBA base case final model (S3) for Atlantic white marlin. The label "Reference" indicates the base case model fits to the entire time series 1956-2017. The numeric year label indicates the retrospective results from the retrospective 'peel', sequentially excluding CPUE data back to 2009.

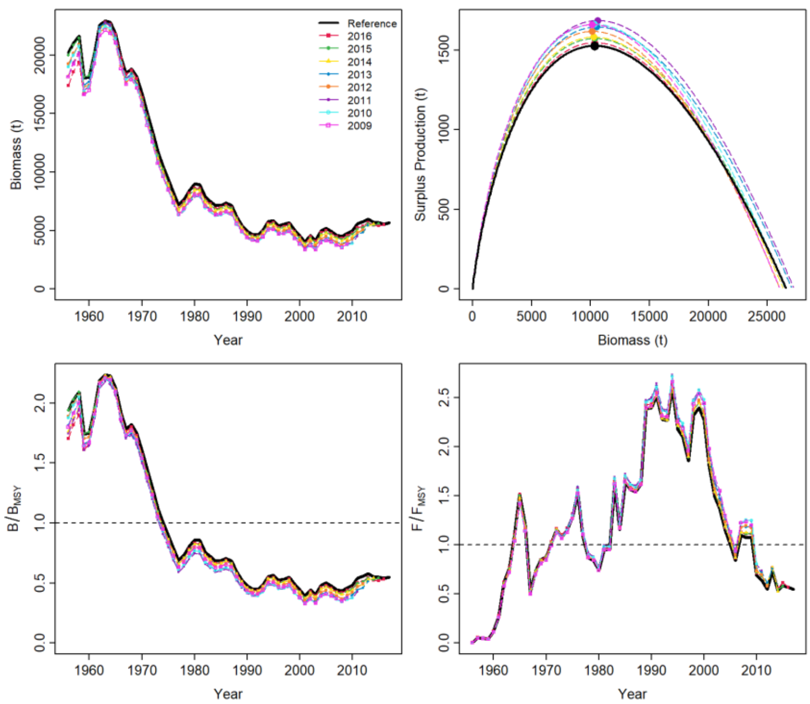

Figure 17. Retrospective analysis for stock biomass (t), surplus production function (maximum = MSY), B/B_{MSY} and F/F_{MSY} for the JABBA sensitivity run1 (S1) with EU_Spain longline index for Atlantic white marlin. The label "Reference" indicates the base case model fits to the entire time series 1956-2017. The numeric year label indicates the retrospective results from the retrospective 'peel', sequentially excluding CPUE data back to 2009.

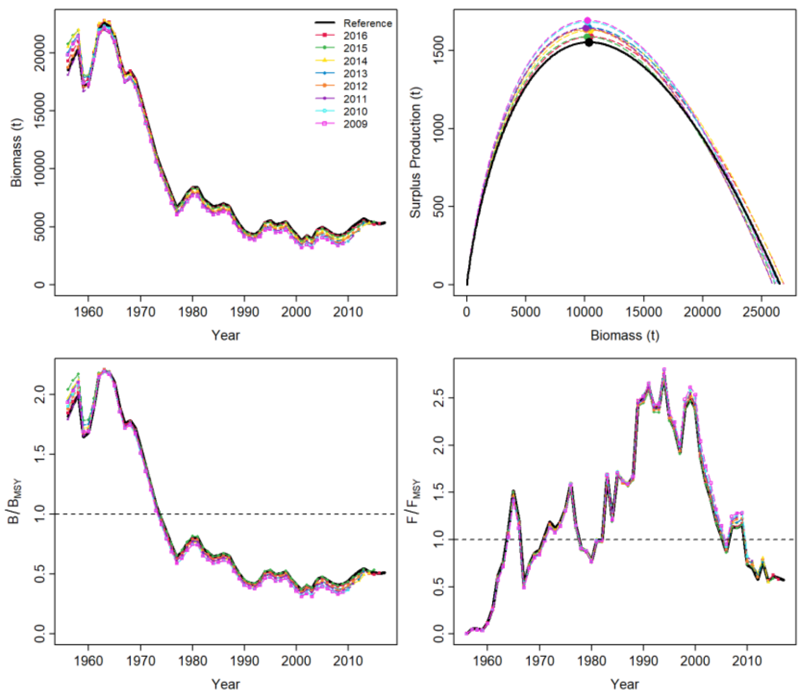

Figure 18. Retrospective analysis for stock biomass (t), surplus production function (maximum = MSY), B/B_{MSY} and F/F_{MSY} for the JABBA sensitivity run2 (S2) included all 14 CPUE indices for Atlantic white marlin. The label "Reference" indicates the base case model fits to the entire time series 1959-2017. The numeric year label indicates the retrospective results from the retrospective 'peel', sequentially excluding CPUE data back to 2009.

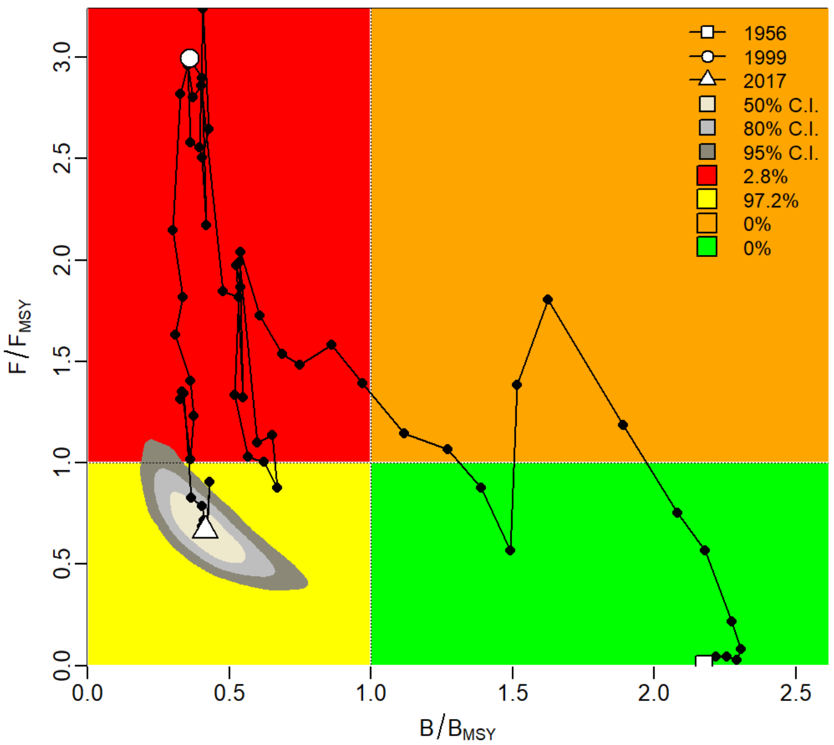

Figure 19. Kobe phase plot showing estimated trajectories (1959-2017) of B/B_{MSY} and F/F_{MSY} for the JABBA base case model (S3) for the Atlantic white marlin. Different grey shaded areas denote the 50%, 80%, and 95% credibility interval for the terminal assessment year. The probability of terminal year points falling within each quadrant is indicated in the figure legend.

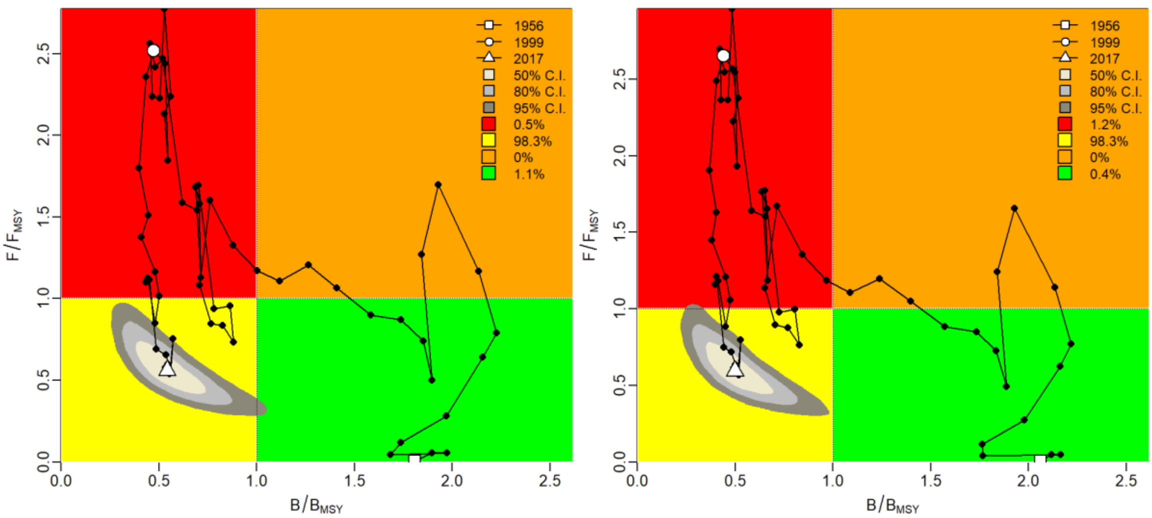

Figure 20. Kobe phase plots showing estimated trajectories (1959-2017) of B/B_{MSY} and F/F_{MSY} for the JABBA sensitivity runs 1 (S1, left) and 2 (S2, right). Different grey shaded areas denote the 50%, 80%, and 95% credibility interval for the terminal assessment year. The probability of terminal year points falling within each quadrant is indicated in the figure legend.

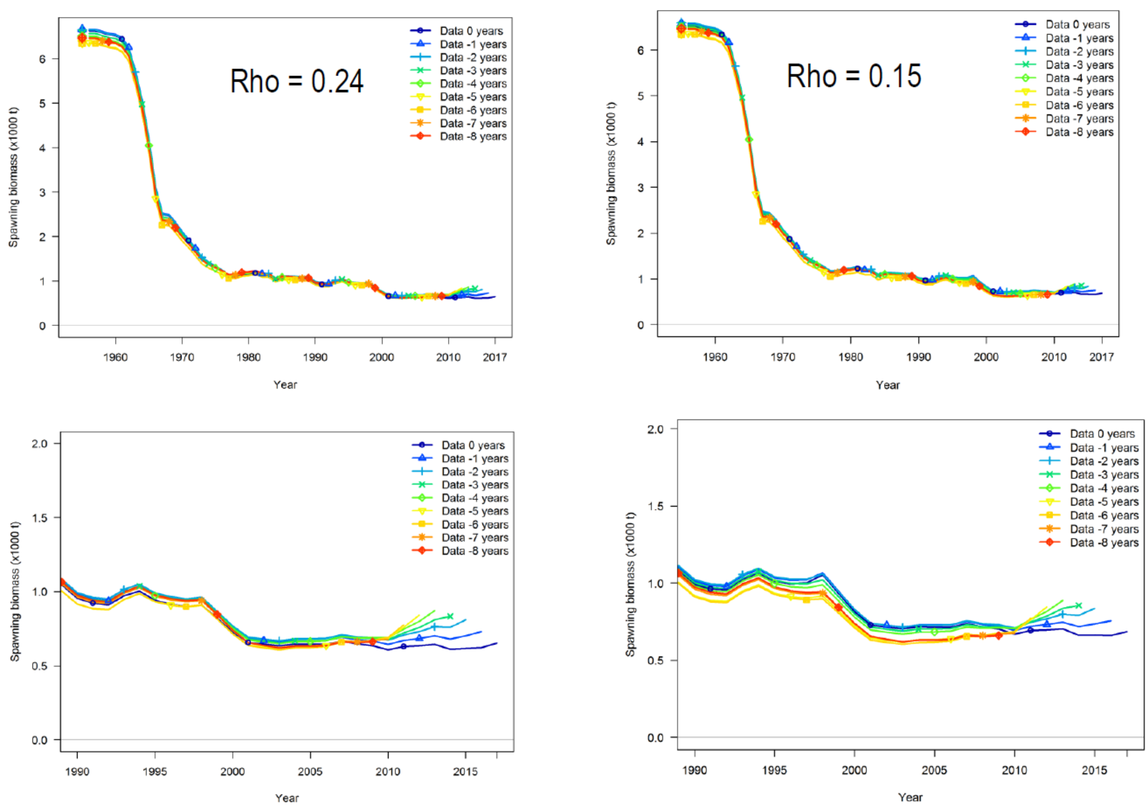

Figure 21. Retrospective pattern by stock synthesis models 4 (left panels) and 5 (right panels) of spawning stock biomass (upper panels: entire time series 1956-2017, lower panels: only after 1990).

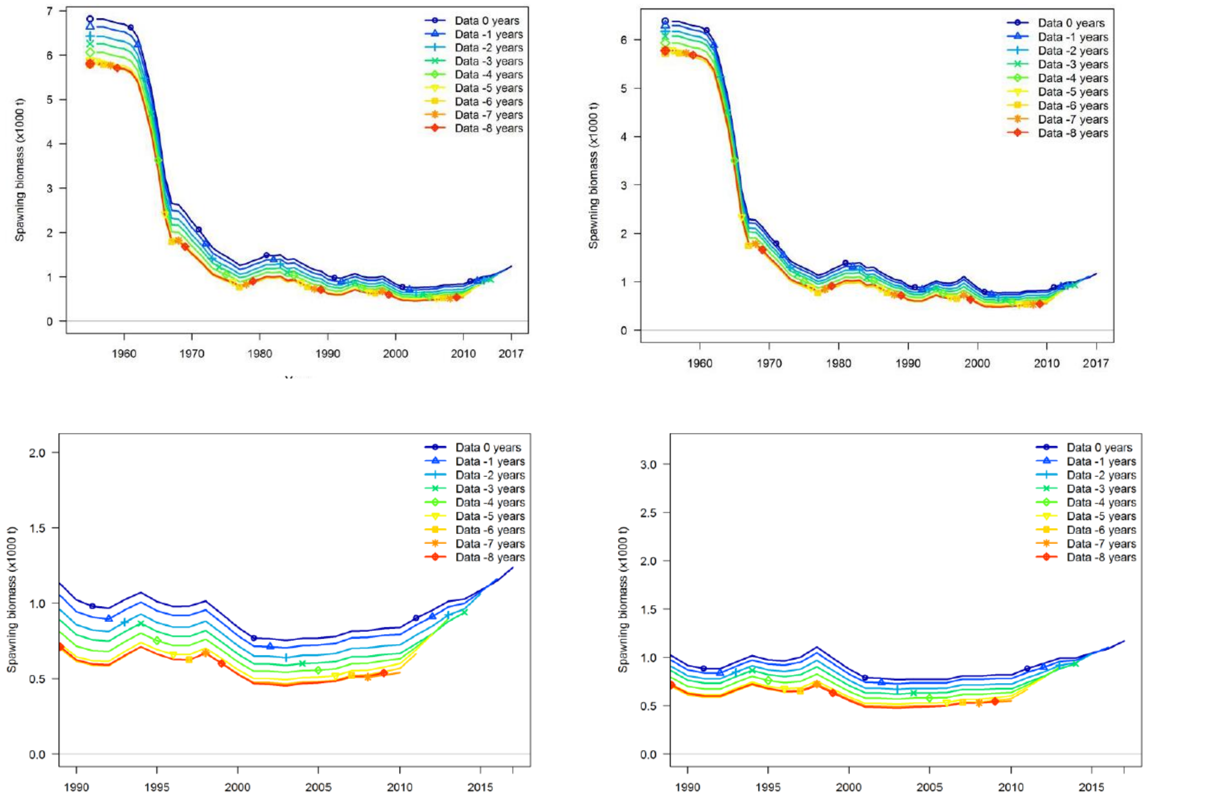

Figure 22. Retrospective pattern by stock synthesis models 6 (left panels) and 7 (right panels) of spawning stock biomass (upper panels: entire time series 1955-2017, lower panels: only after 1990).

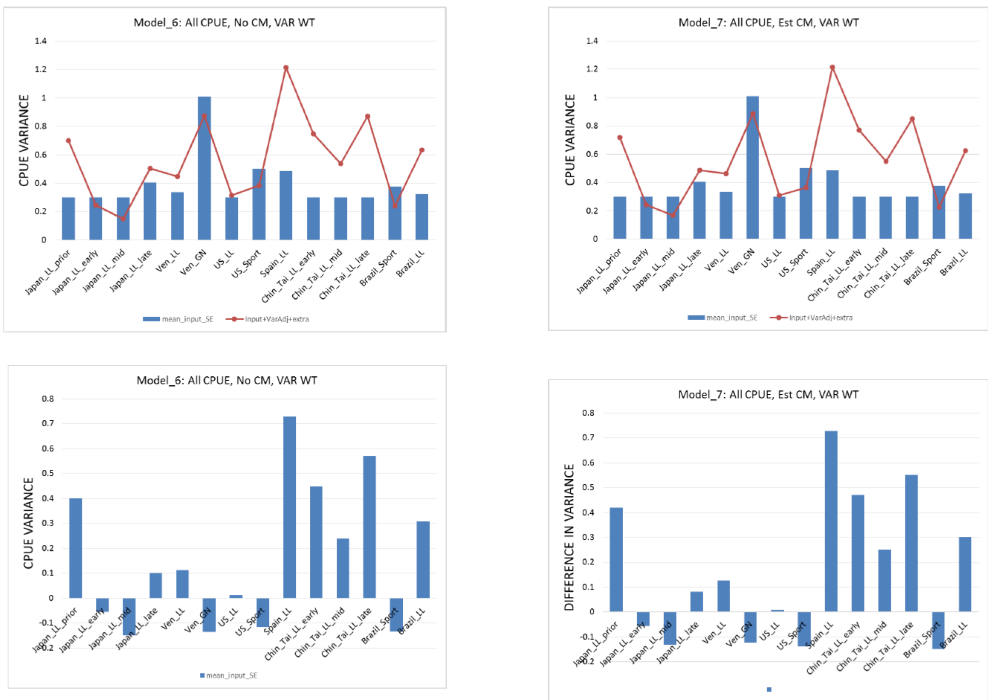

Figure 23. The estimated additive constant from reweighting CPUE indices in stock synthesis values in models 6 and 7.

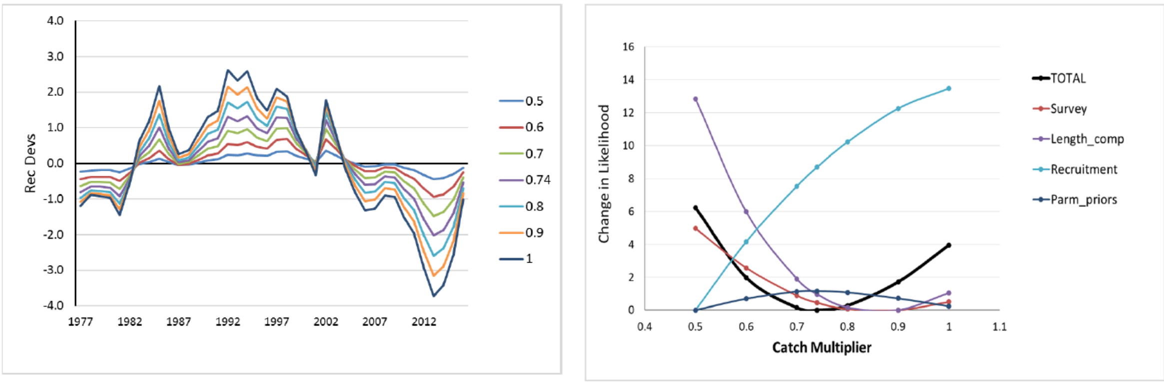

Figure 24. Trends of the estimates of recruitment deviations in stock synthesis run 2 assuming different levels of catch multiplier values from 0.5 up to 1 (left). Right plot shows the changes in overall likelihood fits in each scenario.

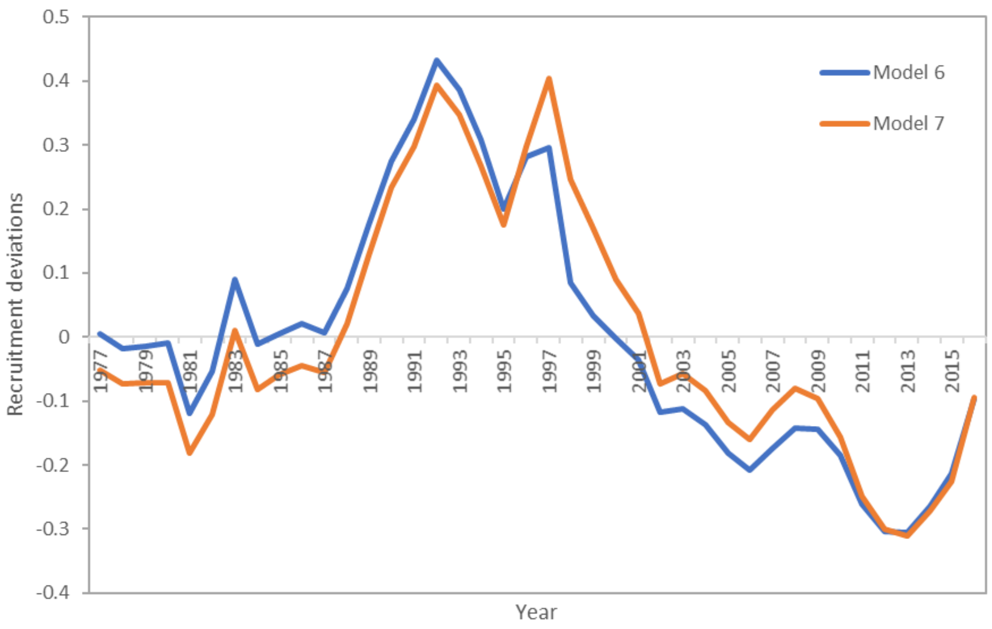

Figure 25. Recruitment deviations from stock synthesis runs model 6 and 7.

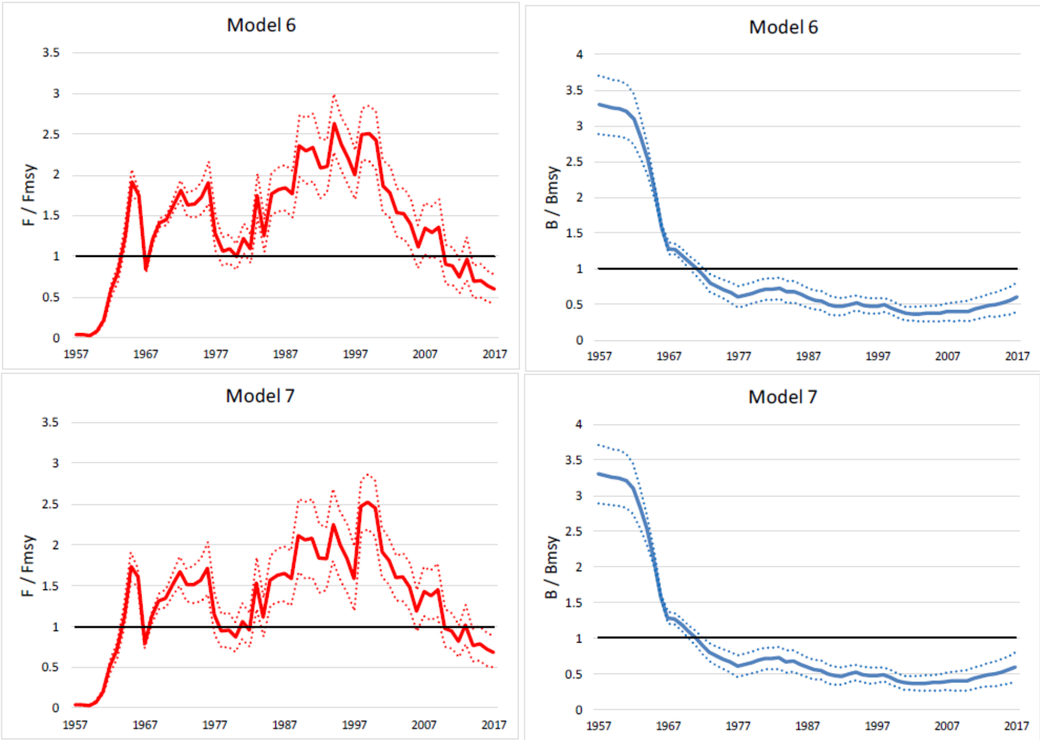

Figure 26. Estimated annual trends of F/F$_{MSY}$ and B/B$_{MSY}$ from the stock synthesis runs models 6 and 7 with 95% confidence bounds for Atlantic white marlin.

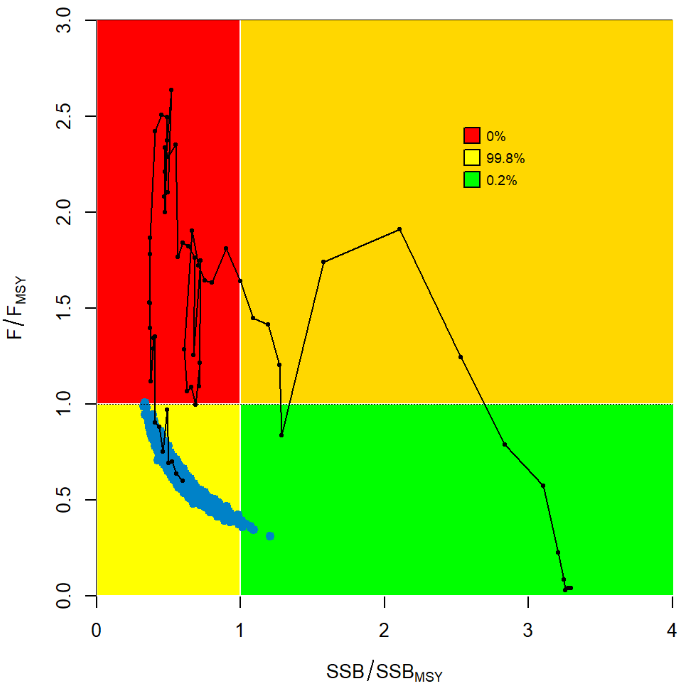

Figure 27. Kobe phase plot showing estimated trajectories (1959-2017) of B/B$_{MSY}$ and F/F$_{MSY}$ for the Stock Synthesis model 6 for the Atlantic white marlin. The probability of terminal year points falling within each quadrant is indicated in the figure legend.

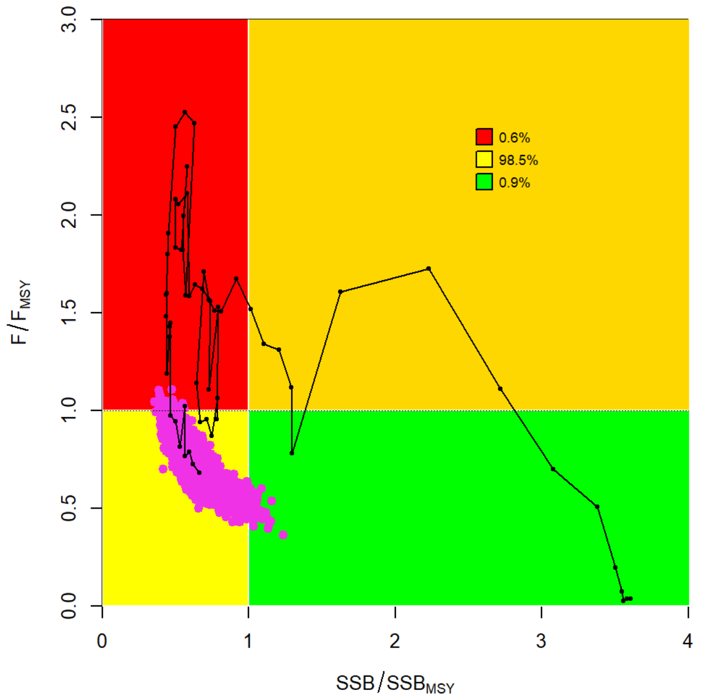

Figure 28. Kobe phase plot showing estimated trajectories (1959-2017) of B/BMSY and F/FMSY for the Stock Synthesis model 7 for the Atlantic white marlin. The probability of terminal year points falling within each quadrant is indicated in the figure legend.

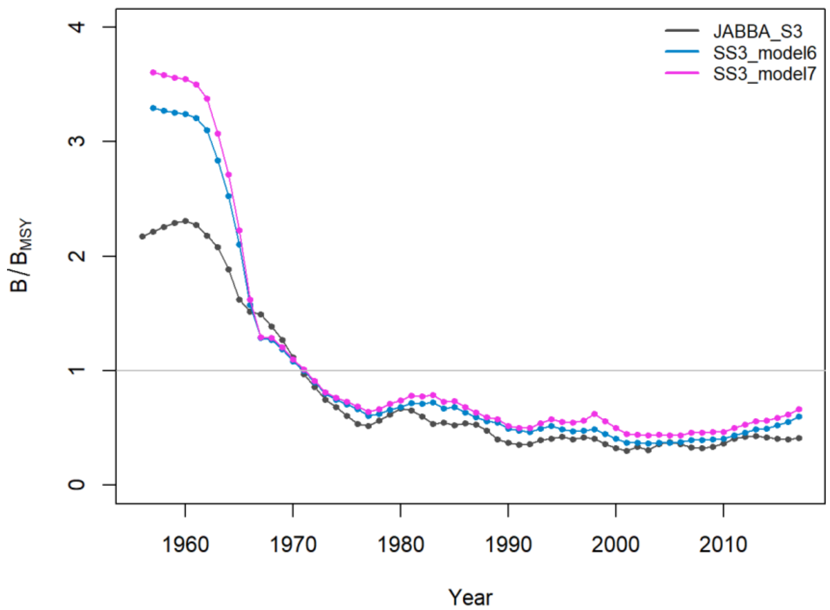

Figure 29. Biomass relative to BMSY (B/BMSY) for the final base cases of JABBA (S3, black) and Stock Synthesis (models 6 and 7, blue and pink, respectively) models for the Atlantic white marlin.

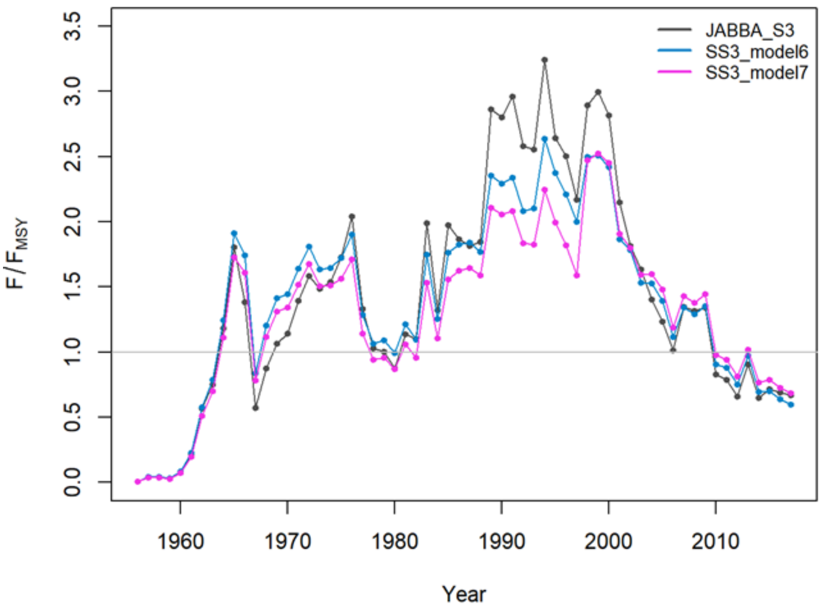

Figure 30. Fishing mortality relative to FMSY (F/FMSY) for the final base cases of JABBA (S3, black) and Stock Synthesis (models 6 and 7, blue and pink, respectively) models for the Atlantic white marlin.

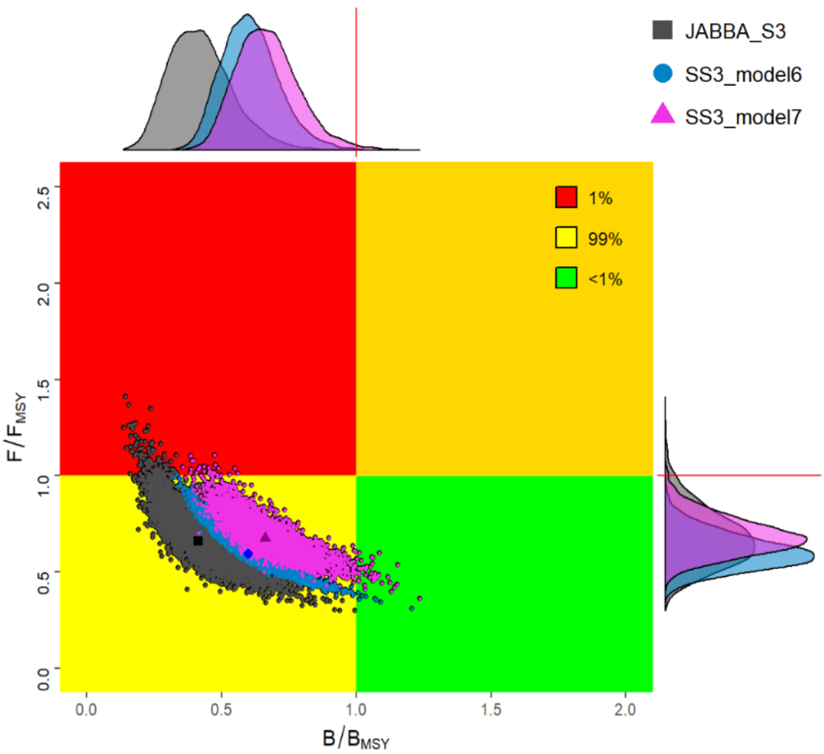

Figure 31. Combined Kobe plots for the final base cases of for the final base cases of JABBA (S3, grey) and Stock Synthesis (models 6 and 7, blue and pink, respectively) models for the Atlantic white marlin.

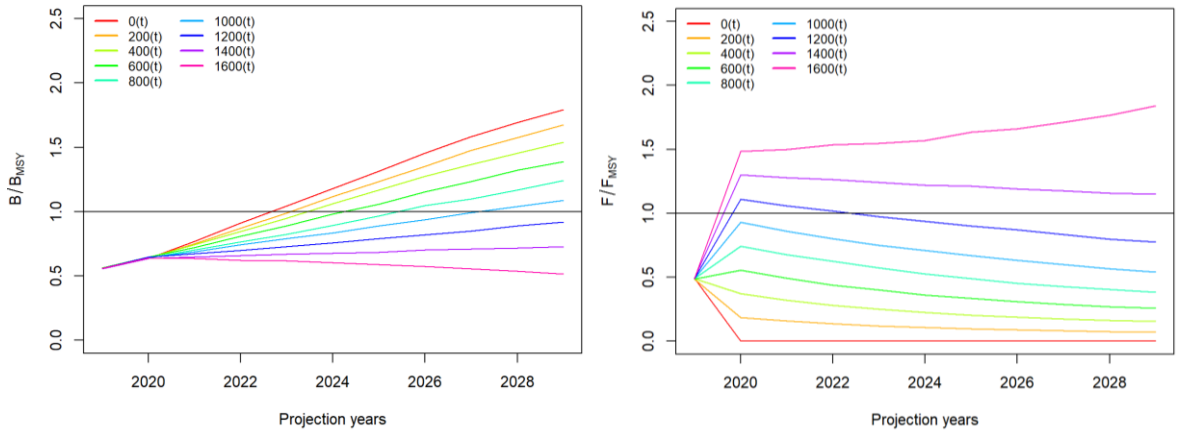

Figure 32. Trends of projected relative biomass (left panel, B/B_{MSY}) and fishing mortality (right panel, F/F_{MSY}) of Atlantic white marlin under different TAC scenarios (0 – 1600 t) from JABBA final base model (S3). Each line represents the median of 5000 MCMC iterations by projected year. The iterations where fishing mortality levels exceeded 9 for F/FMSY were replaced to 9 (only JABBA).

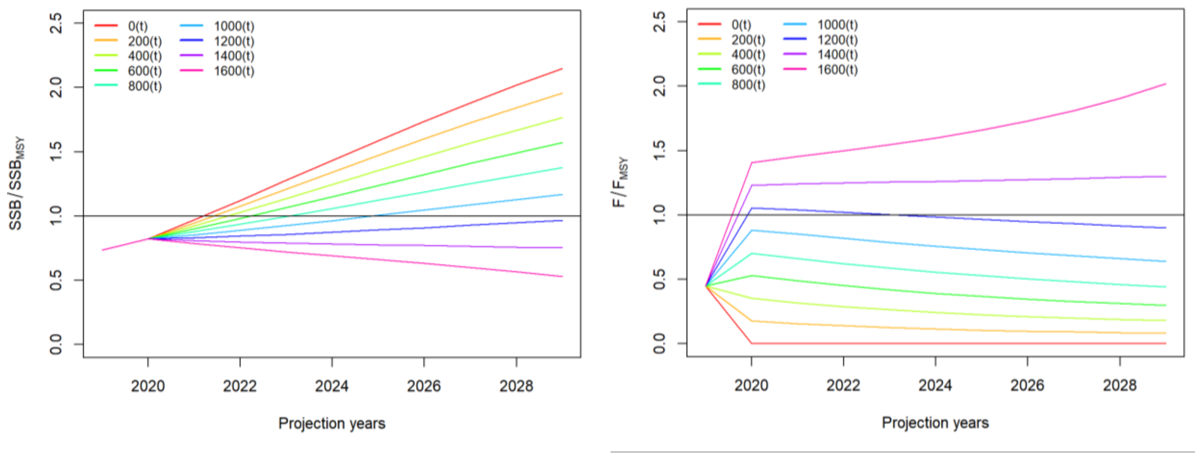

Figure 33. Trends of projected relative spawning stock biomass (left panel, SSB/SSB_{MSY}) and fishing mortality (right panel, F/F_{MSY}) of Atlantic white marlin under different TAC scenarios (0 – 1600 t) from SS3 final base model (model 6). Each line represents the median of 5000 MVN iterations by projected year.

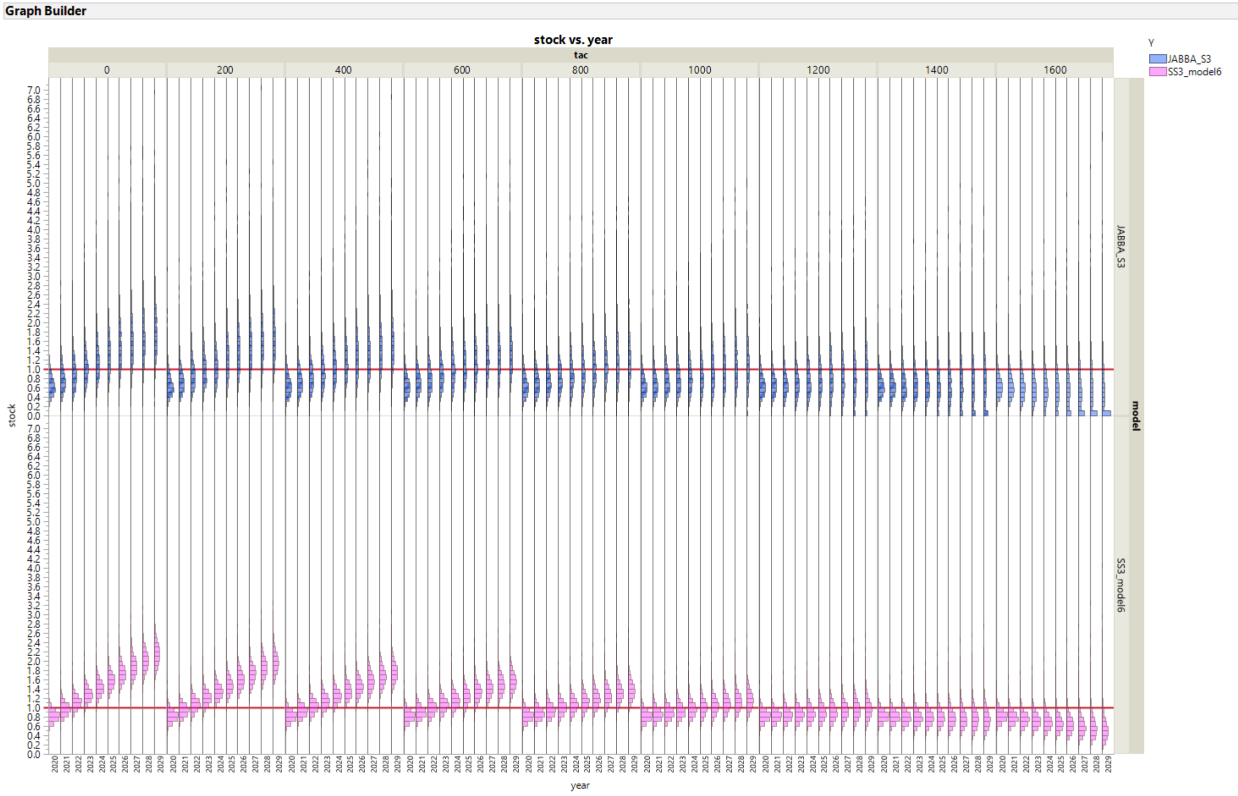

Figure 34. Histogram of B/B_{MSY} by year, constant catch scenario, and stock assessment method (top panels for JABA S3, and bottom panels for SS3 model 6). The plots show the histograms for the projections scenarios of constant catch of 0 - 1600 t by each assessment model in the 2019 Atlantic white marlin assessment.

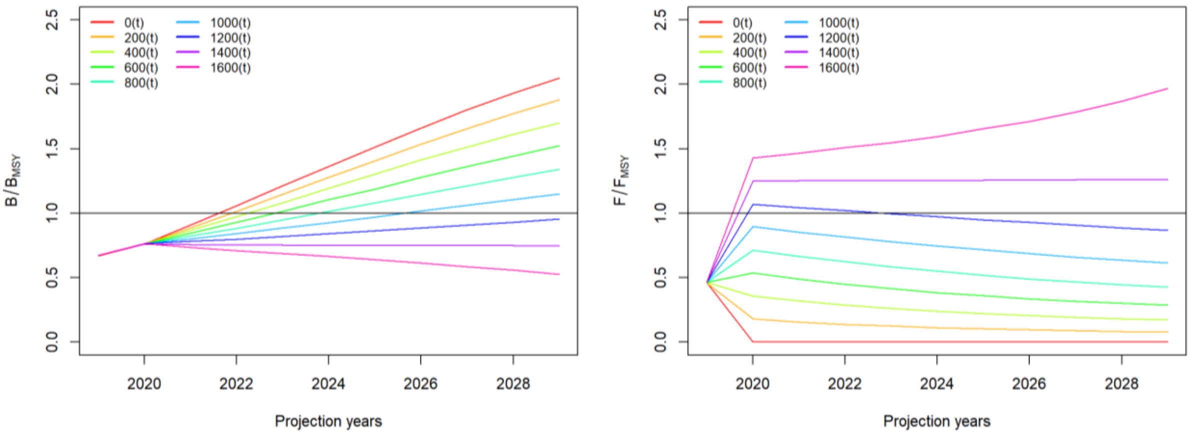

Figure 35. Combined trends of projected relative biomass (left panel, B/B_{MSY}) and fishing mortality (right panel, F/F_{MSY}) of Atlantic white marlin under different TAC scenarios (0 – 1600 t) from JABBA final base model (S3) and SS3 (model 6) for the period between 2019 and 2029. Each line represents the median of combined 5000 MCMC (JABBA) or MVN (SS3) iterations at the beginning of each calendar year. The projection used 458 t which corresponds to the carryover of the catch in 2017 for the catches in 2018 and 2019. The iterations where fishing mortality levels exceeded 9 for F/F_{MSY} were replaced to 9 (only JABBA).

Appendix 1

Agenda

1. Opening, adoption of Agenda and meeting arrangements
2. Summary of updated data submitted after the Data Preparatory meeting and before the assessment data
   - 2.1. Catches
   - 2.2. Indices of abundance
   - 2.3. Biology
   - 2.4. Length compositions
   - 2.5. Other relevant data
3. Methods relevant to the assessment
   - 3.1. Production models
   - 3.2. Length-based age-structured models: Stock Synthesis
   - 3.3. Other methods
4. Stock status results
   - 4.1. Production models
   - 4.2. Length-based age-structured models: Stock Synthesis
   - 4.3. Other methods
   - 4.4. Synthesis of assessment results
5. Projections
   - 5.1. Production models
   - 5.2. Length-based age-structured models
   - 5.3. Synthesis of projections
6. Recommendations
   - 6.1. Research and statistics
   - 6.2. Recommendations with financial implications
   - 6.3. Management
7. Responses to the Commission
8. Other matters
9. Adoption of the report and closure

Appendix 2

List of Participants

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Appendix 3

List of Papers and Presentations

SCRS/2019/046	Standardized yields of the white marlin (*Kajikia albida*) and the roundscale spearfish (*Tetrapturus georgii*) caught as bycatch of the Spanish surface longline fishery targeting swordfish (*Xiphias gladius*) in the Atlantic Ocean.	Ramos-Cartelle A., Garcia-Cortes B., Fernandez-Costa J., and Mejuto J.
SCRS/2019/047	Update of scientific observations of white marlin (*Kajikia albida*) in the Spanish surface longline fishing fleet targeting swordfish in the Atlantic in the period 1993 - 2018.	Garcia-Cortes B., Ramos-Cartelle A., Fernandez-Costa J., and Mejuto J.
SCRS/2019/103	Unifying parameterizations between age-structured and surplus production models: an application to Atlantic white marlin (*Kajika albida*) with simulation testing	Winker H., Mourata B., and Chang Y.
SCRS/2019/104	Developing of Bayesian state-space surplus production model JABBA for assessing Atlantic white marlin (*Kajikia albida*) stock	Mourato B., Winker H., Carvalho F., and Ortiz M.
SCRS/2019/106	Survival and sex ratio of white marlin (*Kajikia albida*) caught in the Taiwanese longline fishery in the Atlantic Ocean	Su N.J., and Lu J.L.
SCRS/2019/110	Current status of the white marlin (*Kajikia albida*) stock in the Atlantic Ocean 2019: predecisional stock assessement model	Schirripa M.

Appendix 4

SCRS Document Abstracts

SCRS/2019/046 Standardized yields of *Kajikia albida+Tetrapturus georgii* were obtained from 27,481 recorded trips (887.86 x106 hooks) by the surface longline fleet targeting swordfish in the fishing areas of the Atlantic during the period 1988-2017. The observations represent about 95% of the total fishing effort of this fleet during the combined period. Roughly 4.64% of the trips recorded showed a positive catch of these species. Because of their low prevalence in this fishery, the standardized yields were calculated using a Generalized Linear Mixed Model, assuming a delta-lognormal error distribution. An overall flat trend was predicted for the whole period considered, with some annual fluctuations. The very low values predicted for the last three years were caused by the implementation of drastic domestic regulations. Some other considerations are also discussed, such as a high inter-annual variability, considered biologically unlikely, and uncertainty in the data, possibly caused by factors such as dead discards, live releases, species misidentification and current regulations.

SCRS/2019/047 A description of 1710 individuals recorded as white marlin during the period 1993-2018 is presented. 21% of the fishing sets were positive for the capture of at least one specimen for those areas considered. The overall prevalence of this species over all fish species combined was 0.65% in number and 0.52% in weight. The overall prevalence over Istiophoridae was 25.12% and 12.61% in number and weight, respectively. A discussion on the applicability of these values is included. Sizes were between 95 and 285 cm LJFL but catches of individuals smaller than 145 cm are very rare. The overall sex-ratio of females was 42.5%. Sex-ratio at size indicates an increase in the percentage of females in sizes larger than 165 cm. Only 7 females of the total 170 females with gonads analyzed presented a high gonadosomatic index. Overall nominal CPUE in weight was higher for males (2.7 kg DW/1000 hooks) than females (1.81 kg DW/1000 hooks). For the whole period analyzed, 16.3% of the specimens observed were discarded and 7.5% were released alive, although different patterns can be discerned over time.

SCRS/2019/103 Integrated Age-structured models (e.g. Stock Synthesis), and surplus production models (e.g. JABBA) are increasingly run in parallel during stock assessments of tuna and tuna-like species. Yet, the choice of parameterization for the two different model types may not always be compatible, which can violate the validity model comparison and consequently inferences about the stock status. Here, we use simulation testing to evaluate an approach that aims to unify the model parameterization between Stock Synthesis and JABBA. Central to this approach is the application of an age-structured equilibrium model (ASEM) to translate a set of typical Stock Synthesis input parameters into the intrinsic rate of population increase r and the shape parameter m of the Pella-Tomlison SPM. We apply this approach using the age- and sex-specific stock parameters for Atlantic white marlin (*Kajikia albida*) and approximate the functional form of a 16-parameter yield curve for an age- and sex-structured stock to approximate by the 3-parameter Pella surplus production curve. We use an age-structured simulation framework to compare the performance of JABBA fitted to the simulated data with priors that were approximated as a function of (1) spawning biomass (SB-model) or (2) exploitable biomass (EB-model). Results from our simulations showed that the SB-model produced positively biased estimates of the stock status, which could be fairly accurately estimated with EB-model, while both models slightly underestimated MSY on average. The satisfactory confidence interval coverage for the true stock status quantities SB/SBMSY and F/FMSY for the EB-model, suggests that a correctly specified JABBA model provides, in principle, a parsimonious framework for billfish assessments with comparable population dynamics. Considering three alternative steepness h scenarios (h = 0.5, h = 0.6 and h = 0.7) and admitting reasonable uncertainty about M, we propose three sets steepness-specific priors for r and m input values for consideration in 2019 JABBA assessments scenarios for Atlantic white marlin.

SCRS/2019/104 Bayesian State-Space Surplus Production Models were fitted to Atlantic white marlin (*Kajikia albida*) catch and CPUE data using the open-source stock assessment tool JABBA. Three initial scenarios are presented based on three considered 'steepness-specific' r input priors. A fourth scenario is developed that only includes those candidate CPUE series that had passed the Runs residual diagnostic test. The results for the four alternative scenarios showed no evidence of strong retrospective patterns and provided fairly consistent estimates of MSY between 1.431 to 1.562 metric tons. Stock status trajectories showed a typical anti-clockwise pattern, moving from initially underexploited through a period of unsustainable fishing, leading to a > 95% probability of stock biomass in 2017 being below levels that can produce MSY. The 2017 fishing mortality rate estimates were below of the sustainable exploitation levels that would be required to achieve rebuilding to biomass levels at MSY in the short- to medium term. Based on multi-model inference from all scenarios, there is a 99.6% probability that the stock is not currently subject of overfishing and 96% probability that stock is still overfished.

SCRS/2019/106 Sex ratios and the condition (alive or dead) of Atlantic white marlin (*Kajikia albida*) reported by onboard observers were summarized for the Taiwanese distant-water longline fishery targeting tunas in this study. The sex ratio ranged between 0.381 and 0.538 from 2007 to 2017, with an overall sex ratio estimated at 0.414. Survival ratios of fish alive when hooking were estimated at 0.713 and 0.615 for two periods of 2007-2009 and 2014-2017, respectively. Lower values (0.182 and 0.286) were derived for particular years due to small sample sizes. The survival ratios were almost identical between sexes (0.655 for females and 0.671 for males). High survival ratios of Atlantic white marlin around 0.650 for commercial tuna longline fishery in this study suggest that alive discards could be an effective measurement to reduce bycatch mortality of the species because high probability of releasing the fish alive could be expected.

SRCS/2019/110 Pre-decisional stock assessment configurations, diagnostics and results are described for the 2019 fully integrated assessment model for Atlantic white marlin (*Kajikia albida*). Three alternative models were studied, each with progressively more complexity. Diagnostics included profile analysis, run tests on CPUE fits, examination of residual trends, and retrospective analysis. Of the three models considered Model_3 (estimated catch multiplier and variance reweighting used on CPUEs) performed the best with regard to diagnostics. Estimates of maximum sustainable ranged from 1,355 t-1,397 t. Estimates of F/F_{MSY} for 2017 ranged from 0.768 to 0.990. Estimates of SSB/SSB_{MSY} for 2017 ranged from 0.411 to 0.512. All three models indicated that the stock is overfished but that overfishing is not occurring.

Appendix 5

Terms of Reference

COLLECTION OF BIOLOGICAL SAMPLES FOR THE STUDY OF GROWTH OF BILLFISH IN THE EASTERN ATLANTIC

Background and objectives

The main objectives of this project are to collect biological data on growth for billfish (BIL) in the eastern Atlantic, to supplement collections of such data conducted elsewhere in the Atlantic Ocean. This growth data are necessary to improve the growth parameters used in the assessment of billfish, and to help the SCRS to provide scientific advice to ICCAT for their management.

The project in 2019/2020 aims continuing the 2018/2019 collection of biological data and further develop the growth studies for billfish from the eastern Atlantic.

This ToRs include two specific objectives:

- The first objective is to collect hard parts (otoliths and spines) and associated information for marlins and sailfish caught off West Africa from all fisheries in the ICCAT Convention area, either from billfish fisheries or from those catching these species as by-catch.

- The second objective is to support the analysis of data on length and age for estimating the growth parameters of the main billfish species that occur in the eastern Atlantic:

    - ✓ *Makaira nigricans* (BUM)
    - ✓ *Tetrapturus albidus* (WHM)
    - ✓ *Istiophorus albicans* (SAI)

As part of this biological samples collection and growth studies, scientific institutes and public or private entities are requested to put forward a consortium and submit an offer for the project. All the samples collected, and the results obtained under the Enhanced Program for Billfish Research (EPBR), shall be used only for scientific purposes and in accordance with ICCAT rules. Any other use of these data should be specifically authorized by ICCAT.

Contractor tasks

The Contractor will work in close consultation with the ICCAT Secretariat.

The Contractor will provide the Secretariat with a detailed description of the biological sampling scheme explaining how the biological activities should be conducted (species to be sampled, spatio-temporal strata of biological sampling, number of fish to be sampled, type of biological samples to be collected, etc.). It must be noted that for biological sampling and analysis, which are meant to represent the entire stock, studies that have a small temporal and spatial scale will not meet the project objectives. As such, tenders should be made on a **regional and collaborative basis**. It is clear, however, that given the timing of this Call for tenders, and the date of completion of the project, proponents will only be expected to collect samples for a 12 months project (from July 2019 to June 2020).

The tender should be responsible for the following:

a) The Contractor must provide the Secretariat with a detailed description of the biological sampling scheme, including aspects on the: biological sampling (e.g. ports/landing places and on board), type of biological samples to be collected and analyzed (otoliths and spines), number of fish to be sampled by month, biological parameters to be estimated, etc. The number of samples to be collected by species shall be balance and take into consideration the samples collected throughout the previous phase of the EPBR (throughout 2018 and first semester of 2019).

b) The Contractor must strictly follow the protocols in the ICCAT Manual for the collection and analysis of the growth data.
c) The Contractor shall provide a detailed report summarizing the preliminary growth parameters estimated to ICCAT.

Contractor minimum qualifications

- Documented multi-year experience in billfish tuna's research and/or research on large pelagic species with experience on fishery data collection.
- University degree in one of the following: fisheries science, marine biology, statistics, natural sciences, biological sciences, environmental sciences or closely related fields (in case of individual scientists).
- Excellent working knowledge of one of the three official languages of ICCAT (English, French or Spanish). A high level of knowledge of English is desirable.

Project proposal

The engaged entities should submit an offer by **21 June 2019**, including:

a) The detailed description of the biological sampling scheme (as specified in the item *(a)* of the contractor tasks), the full cost of the collection of biological samples and the estimation of the growth and maturity parameters.
b) The *curriculum vitae* of the tender (in case of individual scientists) and of any collaborator.
c) The *curriculum vitae* of the institution (if an institution is the tenderer), with any documented experience in research on small tunas, or other large pelagic species or in data collection, to include recent and relevant contracts for the same or similar items and other references (including contract numbers, points of contact with telephone numbers and other relevant information).
d) The name, address, and telephone number of the tendering body.
e) The institutional and administrative background of the tendering body (e.g. statutes, type of institution, annual budget, budget control procedures, etc.) if applicable.
f) A detailed list of any subcontracting activities.
g) The declaration that the offering entity shall follow the ICCAT procedures and formats for data to be provided.
h) A declaration that all the comments eventually made on data and/or documentation reported will be incorporated prior to submission to the ICCAT SCRS.
i) A statement specifying the extent of agreement with all terms, conditions and provisions herein included.

If the offer fails to furnish the required documentation and information, or reject the terms and conditions of these ToR, it will not be considered.

The Contractors can be either research institutes as government or private laboratories, universities, or private consultancy firms or individual scientists or other entities having the qualifications required.

The Contractor should be available to report to any meeting requested by ICCAT.

Deliverables

1. A **SCRS document or a power point presentation** of the preliminary results to the ICCAT SCRS 2018 Billfish Species Group meeting.
2. A **SCRS document and a power point presentation** of the preliminary results to the ICCAT SCRS 2019 Billfish Species Group meeting.
3. Labelled hard structure samples are to be shipped according to instructions determined by the Billfish Species Group and the protocols in the ICCAT Manual for the collection and analysis of the age and growth data strictly followed.

4. The **draft report** to be submitted **at the latest by 15 June 2019**, and shall include:
    a) Executive summary;
    b) Full description of the work carried out;
    c) Preliminary description of the length at age and growth parameters;
    d) References and literature cited.

5. The **final report** shall be updated taking into account the comments provided by the ICCAT Secretariat or SCRS and be submitted **by 30 June 2019** at the latest.

Payment details

Disbursement will be made according to the following schedule:

- 30% of the total amount of the contract within 30 days after signature of the contract and after receiving a regular invoice for the advance payment;
- 20% of the total amount of the contract upon reception of the SCRS document or a power point presentation of the preliminary results to the ICCAT SCRS 2018 Billfish Species Group meeting and after receiving a regular invoice;
- 20% of the total amount of the contract upon reception of the SCRS document and a power point presentation of the preliminary results to the ICCAT SCRS 2019 Billfish Species Group meeting and after receiving a regular invoice;
- 15% of the total amount of the contract upon reception by ICCAT of the draft final report and receiving a regular invoice;
- 15% after the approval of the final report by ICCAT upon incorporation of comments made by ICCAT and receiving a regular invoice.

Logistics

All documents provided by the contractor must be in open format ODF 1.2 (click here) such as MS word or "*.odf" de Apache OpenOffice y LibreOffice, figures must be in excel format or compatible, figures and pictures must be in JPEG or TIFF format or compatible. All documents submitted must be in English, French or Spanish.

Data must be provided in the standard ICCAT format for statistics. The biological data must be submitted in a format to be defined by the ICCAT Secretariat.

Copyright

All the material produced by the Contractor will remain the property of ICCAT, will be kept confidential, and cannot, in any case, be circulated by the Contractor selected. The scientific use of the data by the Contractor shall always be notified to ICCAT in advance for clearance.

For information concerning this Call for tenders, please contact the ICCAT Secretariat at the following address: info@iccat.int