REPORT OF THE 2020 SECOND ICCAT INTERSESSIONAL MEETING OF THE BLUEFIN TUNA SPECIES GROUP

(Online, 20-28 July 2020)

The results, conclusions and recommendations contained in this Report only reflect the view of the Bluefin tuna 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 and assignment of rapporteurs

The online second intersessional Bluefin tuna Species Group ("the Group") meeting was held from 20 to 28 July 2020. Drs John Walter (USA) and Ana Gordoa (EU-Spain), the Rapporteurs for the western Atlantic and eastern Atlantic and Mediterranean stocks, respectively, opened the meeting and served as Co-Chairs.

On behalf of the Executive Secretary, the Assistant Executive Secretary welcomed the participants to the meeting. The Chairs proceeded to review the Agenda which was adopted after some changes (**Appendix 1**).

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

Sections	Rapporteur
Items 1, 13	A. Kimoto
Item 2	H. Arrizabalaga
Item 3	M. Ortiz
Items 4, 5	A. Kimoto, N. Duprey, K. Gillespie, E. Andonegi
Items 6, 12	C. Fernandez
Item 7	A. Gordoa, J. Walter, J.-J. Maguire, A. Kimoto
Item 8	A. Pagá, T. Rouyer, G. Melvin
Item 9	S. Tensek
Items 10, 11	A. Kimoto, J. Walter, A. Gordoa

2. Review of the scientific papers relevant to assessment

Four documents were presented in this section.

Document SCRS/2020/110 discussed and analysed the many components that can bias the catch per unit of effort (CPUE) data from purse seine (PS), trap and longline (LL), affecting their meaning and interpretation. The fishing strategies, technological creeping and the effects of regulations are the most important factors biasing the CPUEs and therefore affecting their use as indicators of abundance or fishing capacity.

Presentation SCRS/P/2020/058 presented CPUE of the Balfegó purse seine joint fishing fleet in Balearic waters from 2003 to 2020. The number of boats represented oscillated between 2 and 10 throughout the time series. Since 2013, CPUE remained high, representing fish of average age 9-10. The author mentioned that even if the stock increases, this fleet might not be able to detect it, as they are limited by the maximum number of daily transfers they can do at sea.

Presentation SCRS/P/2020/059 presented an update to the Southern Gulf of Saint Lawrence Acoustic Index. The authors continued investigating the factors affecting the low values of the index in the last two years. They suggested that the low spatial coverage in 2019 is probably not the reason for the low index value in that year and identified further research to see if other factors (data editor, herring biomass or vessel effect) are meaningful. Meanwhile they suggested not using the 2018 data point in the assessment and splitting the index until further research is carried out to help understand the decline. The Group welcomed the update and suggested that environmental as well as trophic issues might be worth exploring.

Document SCRS/2020/128 analysed recent trends in Eastern and Western Bluefin tuna (E-BFT and W-BFT) indices. If assessment models are considered unreliable for projection advice, this empirical approach could provide a rationale to evaluate whether there is evidence to diverge from prior model-based advice, or whether a TAC roll-over might be adequate. The document concluded that if the 2020 E-BFT updated VPA is deemed unreliable for projection advice, evaluation of the indicators provides no clear evidence in the eastern indicators that would preclude a rollover of the 2020 TAC.

The Group welcomed the analysis and agreed to first focus on the assessment results to see whether projection advice would be reliable and, if not, to revisit this analysis. The Group also noted that this kind of analysis can be done in different ways (e.g. statistical significance could have been defined in different ways, variance of the indices could have been used in different ways, etc.), which might affect the results of the study, but in general the overall picture remains unchanged. The Group's view on the conclusions of this paper are reflected in section 7.3.

In this context, the Group also noted that the model used for E-BFT advice in 2017 was not free of concerns, so there is a question about how confident the Group needs to be with the strict update assessment model in order to use it for projection advice again in 2020. Taking this into account, the Group agreed to focus on the performance of the assessment models (see Section 4).

3. Progress to 2020 TAC

During the first BFT intersessional meeting in May 2020 (Anon., 2020b), the Group inquired about the 2020 current fisheries and catch development in 2020, in particular whether the COVID-19 pandemic has impacted the fisheries for bluefin tuna stocks.

3.1 Potential 2020 underages

The Secretariat presented a summary of the catch reports based on the weekly and monthly reports submitted by the CPCs. **Table 1** shows the summary of catches reported by the main flags for E-BFT. Briefly, of an allocated TAC of 36,000 t for 2020 (Rec. 19-04), as of 20 July, about 74.44% of the quota has already been reported. By flag, most of the flags reached over 99% of their quota allocation (Albania, Algeria, Morocco, Syria, Tunisia, and Turkey); the EU has reported 72.4% of the quota being completed, Egypt's adjusted catch for 2020 is 125 t due to overages in 2019, of which 94% has been reported; while Libya has reported 39% of catches. However, from the Compliance reports, all CPCs have indicated that their respective fisheries have been closed for the 2020 fishing season, and it is expected that the catch reports will be submitted very soon. In summary, for E-BFT the TAC has almost been completed and no carry overs are expected to be needed for next year. Scientist familiar with the fisheries indicated that BFT fisheries operations continued in 2020, despite some restrictions associated with the pandemic.

For W-BFT, it was noted that catches are only just starting now for several of the fleets with the main bulk of the fishery activity in the summer and autumn months. Japan informed that their W-BFT catch was completed in 2019, but the fishing season in 2020 has not yet begun. Canada informed the Group that they had little information for this year and fishers have indicated they may have trouble landing all their allocation due to COVID-19 safety measures. In the case of the USA, dealers in general are currently limiting the purchase of fish largely due to low market demand (domestically, as well as from Japan) as a result of the pandemic, as well as the general poor quality of fish caught at this point during each year. Typically, fish condition improves later in the year, but the likelihood that the USA will reach its quota in 2020 may largely depend on whether or not market demand increases. The current measure Rec. 17-06 already allows Mexico, EU-France-Saint Pierre and Miquelon and EU-UK-Bermuda to carry forward 100% of the annual allocations.

3.2 Advice on carryover

In summary, the Group concluded that TACs for 2020 will be completed for the E-BFT stock, while this is not yet known for W-BFT. Due to time constraints, the Group was not able to provide advice on the biological implications of the carry over at this time.

4. Review of model results

4.1 East (VPA)

Document SCRS/2020/111 was presented explaining the up-to-date VPA results for the E-BFT population, including model fits (**Figure 1** showed fits to indices). The presentation showed the 2017 base case using data up to 2015 (Run0); the same model specifications as Run0 with updated data from 1968-2015 (Run83); and the same model specifications as Run0 with updated data from 1968-2018 (Run84) (**Table 2**). The authors re-iterated the differences in SSB and recruits and strong retrospective patterns found between continuity Run83 and Run84 (**Figure 2**). Run135 had the F-ratios (the ratio of F for the age 10 and older group to the age 9 fishing mortality) fixed to those estimated in the 2017 assessment in order to stabilize the model, and was chosen in the first BFT intersessional meeting in May (Anon., 2020b) as the new base case for this assessment update (**Figure 3**, blue line).

With the impact that the catch-at-age (CAA) seems to be having on estimated recruitment, it was questioned whether it is possible to do jackknife plots by peeling out fleet CAA one at a time, similar to how individual indices are removed one by one to see their influence on spawning stock biomass (SSB) and recruits. This could not be done at this meeting, but is something that could be looked at in the future. The VPA assumes that the CAA is known without error. Numerous assumptions are necessary to the development of the CAA, however none of the uncertainty associated with these assumptions are adequately quantified, despite the derivation of the CAA being one of the most influential sources of uncertainty in assessment models (Carruthers *et al.,* 2018).

The results of the base case assessment Run135 brought back the major concern of the steep increase in SSB (e.g. a large and fast increase in biomass), comparable to results from the previous 2012 and 2014 assessments (**Figure 3**). The Group also reiterated the uncertainty in the 2017 VPA assessment and that this uncertainty is even greater in the 2020 update (especially as the modelling time required to tackle these issues was not possible under the strict update). While in Run135 F-ratios were fixed, which helped to improve model stability and removed some scale issues in the historical period, there were also large deviations in scale compared to the 2017 assessment results. Run 135 showed a rapidly increasing SSB in recent years, as observed in the 2012 and 2014 assessments. A retrospective analysis of Run135 showed strong retrospective patterns for recruitment and SSB (**Figure 4-a**). It was also shown that the results were sensitive to the CAA input in the retrospective analysis.

The Group discussed how a strict update to the 2017 VPA was what was agreed in 2020, however, due to model instability, Run135 required a deviation from a strict update (in Run135 the F-ratios were fixed to the values estimated in 2017 rather than estimated; fixing the F-ratios was necessary to stabilize historical estimates of the SSB in the 2020 model). In 2017, the recruitment values for the 4 most recent years (2012-2015) were replaced with an average over the 2006-2011 period. However, in 2020 the Group lacked confidence in the recruitment value since 2007 and moved to replace the last 11 years (2008-2018) with an average over the period (1968-2007) (Anon., 2020b). However, it turned out that replacing 11 years was beyond the length possible for the projection platform due to the fact that the plus group starts at age 10, so only 9 years could be replaced (2010-2018). This kept two large recruitment estimates in 2008 and 2009, and these are likely to be influential for short-term projections.

The remit of the Group was to provide a strict update assessment using exactly the same parameter settings as in 2017. In the VPA this produced unstable results for biomass estimates in the historical period because of variability in the F-ratio. Fixing the F-ratio over time to the values estimated in the 2017 assessment provided stability in historical estimates of SSB, but resulted in a large retrospective pattern (5-year peel) where removing years led to estimates of consistently lower SSB and recruitment (**Figure 4-b**). Changing the F-ratio could not be considered a strict update. The Group concluded that none of the VPA model formulations tested in 2020 provided results which were sufficiently reliable to be used as the basis for projection for management advice.

4.2 West (VPA and Stock Synthesis)

West (VPA)

Document SCRS/2020/119 presented model fits (**Figures 5** and **6** showed fits to indices and retrospective analysis, respectively), and results of the 2020 update, which were compared to those from the 2017 assessment. Both assessments show similar long-term scales and trends, with the main divergences appearing in the recruitment estimates for the period between 2005 and 2009. The most recent recruitment estimates for the 2020 update continued the decreasing trend already shown in the previous assessment following the highest peak (in 2003) since the 1970s. SSB estimates have started to reflect a similar recent decreasing trend, particularly for the early maturity scenario. Differences in trends and magnitudes of SSB values under the different maturity scenarios are consistent with the scaling of abundances by the spawning-at-age assumptions. Since both scenarios necessarily showed exactly the same recruitment estimates, the differences in the stock-recruit plots (**Figure 7**) related exclusively to different SSB scaling by the assumed spawning-at-age. The updated VPA results for SSB and recruitment estimates were a very close match to the 2017 assessment for the historical period from 1974 to 2015 (**Figure 8**).

The $F_{current}$ estimate ($F_{current}$=0.10, **Figure 9**) is defined in terms of maximum F-at-age, averaged over the three most recent years (age 10 showed the highest average F during the 2015-2017 period at F=0.1). This has increased since the 2017 assessment ($F_{current\ in\ 2017}$= 0.08) (**Table 3**). Apical F (defined as the maximum annual F across all ages) has also increased since 2013 with the largest F-at-age shifting from 8 – 11 years old to 4 years old (**Figure 10**). Based on the F values presented, there is a 94% probability that the fisheries are not currently (period 2015 to 2017) overfishing the stock, as estimated by bootstrapping.

There were suggestions that the jack-knife and retrospective analyses indicated that the CAA was the primary information providing the base for recent recruitment estimates (Anon., 2020a). However, there were also counter-arguments that the CAA could not be the only factor driving the current period of recruitment estimates since (and especially for the period from 2005 to 2009) the influence of the various indices on recruitment estimates was apparent from the jackknife analysis (**Figure 11**). The Group concluded that both the USA rod and reel (USRR) juvenile [66–114cm and 115–144 cm] indices and the CAA were providing important information that influenced the model's recent recruitment estimates. The Group drafted a recommendation to examine the potential effect of recent changes in management and adequacy in representatively sampling the fishery for fishery dependent indices.

The Group noted that the protocol used for the updates was exactly the same as for the 2017 assessment (Anon., 2017b), from which a future decline in total biomass and SSB had been predicted under the current TAC. However, the decline was more rapid than projected in 2017 due to lower than assumed recruitment in recent years.

West (Stock Synthesis)

Document SCRS/2020/121 presented model fits (**Figure 12** showed fits to indices) and results for the Western bluefin Stock Synthesis (3.30) base case runs. Input and model settings underwent only slight changes from those used in 2017, commensurate with the strict update. Two model configurations (Run1: late maturity; Run2: early maturity) span from 1950 to 2018 and were fit to length composition data, conditional age-at-length data, 13 indices and 13 fishing fleets. The authors noted that diagnostic results showed similar patterns to those observed in the 2017 assessment. There were minor issues regarding fit to data (e.g. fit to USRR FS (fish small) length comps; fit to final two years of Gulf of Mexico (GOM) larval and Japanese LL indices) and some of the diagnostic results; however, these were also present in the 2017 assessment. The authors noted that 2020 spawning output and recruitment estimates were lower than those estimated in 2017 but maintained a similar trend (**Figure 13**). It should be noted that both model configurations show a retrospective pattern of decreasing biomass scale as additional years of data are added; however the Mohn's rho values were 0.17 and 0.10, respectively, for each model, within generally acceptable criteria (**Figure 14**).

The update of the assessment model resulted in a decrease of approximately 7% in SSB virgin biomass prior to exploitation, and differences in a number of estimated parameters between 2017 and 2020 (**Table 4**). Coupled with differences in estimated recruitment, the resulting scale of SSB from 2000 to 2015 is 20% to 30% lower than estimated in the 2017 assessment (**Figure 13**). While the scale of SSB is now nearly exactly the same as that of the VPA, this change in recent population scale is substantial and occurs sequentially with the addition of new data, as seen in the retrospective diagnostics plots (**Figure 14**).

A number of factors could contribute to this change in scale. The 2020 update maintained the same model settings (e.g. parameters estimated in 2017 were also estimated in 2020), therefore there are some differences in the estimated biological parameters (**Table 4**). Virgin recruitment is ~8% lower than estimated in the 2017 assessment. There are differences in estimated growth parameters that lead to non-negligible differences in size and weight at age (**Figure 15**). The 2020 assessment model has a substantially greater amount of age data as large numbers of fish have been added since 2015 (SCRS/2020/120), much of which has been re-aged according to standardized protocol (Rodríguez-Marín *et al.*, 2019) which obviated the need for the previously used aging bias vector (Anon., 2017b). The previous age bias vector was obtained from assuming that spines give accurate readings up to age 7 and that otoliths give a biased reading due to the counting of a false annulus. In other words, and reading from **Figure 16**, the 2017 assumption was that if an otolith reading was age 8, then the fish was really age 7. The revised reading protocol has eliminated this bias and the reads are now assumed to be accurate. Given the revised reads of the otolith data, the only consistent use of the data in the 2020 models would be to remove the aging bias vector. The resulting inference on growth is that mean size at age is lower for ages 3-8, the years mostly affected by the aging bias vector.

To help explain these differences, two additional sensitivity runs were conducted that used a) all growth parameters fixed at the 2017 model estimates, and b) growth estimated but with the 2017 aging bias vector. These sensitivity runs indicated that the revised inference on growth had a fairly substantial impact on trends in biomass relative to the 2017 assessment, as well as on absolute SSB, though recent recruitment trends and absolute values were very similar (**Figure 17**).

Further explorations were conducted to evaluate the impact of several estimated parameters on the biomass scale. Estimated parameters for the 2020 model configurations were replaced by and fixed to the estimated value in the 2017 model, parameter by parameter. The other parameters are estimated with the 2020 dataset. This sensitivity was done for Run1, late maturity scenario. All of the sensitivity runs affected the biomass scale to different degrees. In particular, when catchability for three index fleets were replaced and fixed with the 2017 values, recent SSB level is similar to that in the 2017 assessment. It should be noted that fixing catchability is a rather artificial result that largely imposes the same total abundance on the two model configurations. It remains a topic of further evaluation whether fixing a scaling parameter such as catchability from one model update to another is advisable as it is generally not standard practice for most modelling approaches. The analysts noted that every sensitivity run had worse fits to the data compared to the current base case, however the exercise identified some potential reasons for the differences in scale between the 2017 and 2020 models.

On basic principles, adding new data for only 3 years should not have a substantial impact upon biological parameters or absolute scale without good justification. However, this can have such an impact when the inference on growth changes. In the most recent ICCAT yellowfin tuna assessment (Anon., 2019b), adding several new years of data, which happened to be the only ones with aging data, substantively changed inference on growth. For W-BFT, the revised aging protocols changed many of the historical readings, hence changing the historical data and not just the additional three years. In this case, the resulting growth estimates are different (**Figure 15**) and appear to have an impact on the estimated population scale (**Figure 13**), at least relative to the run where growth parameters were fixed at the 2017 estimate. However, given that growth only accounts for about 10% of the difference in scale, other changes occurring with the additional years of data as seen in the retrospectives (SCRS/2020/121) are also contributing to the change in scale. Hence, there is always the possibility that updating any models can result in different absolute estimates, making the F-based 'best assessment' TAC approach prone to variability to additional years of data.

One consistent pattern across the retrospective peels and between the 2017 and the 2020 model is that the relative population status relative to a common year has remained relatively consistent. Hence, even if absolute biomass may change from one assessment to another or from one retrospective peel to another, the status relative to a common year such as 1974 could be rather consistent, a common tendency of models where they are challenged in obtaining scale but are fairly consistent over time in relative status (Deroba *et al.,* 2017). It could be possible to evaluate the change in stock status relative to 1974 between the time period 2015 to 2017 to give an indication of how TAC advice might differ in response to a change in relative stock status.

Noting the poor model fit to the final two years of the recent Japanese longline index, the Group requested clarification on the period assumed to have time varying selectivity. The authors noted that the period for time varying selectivity was from 2011 to 2015 and the addition of only three years of data risked producing poor selectivity estimates or selectivity parameters that run up against their bounds. It was requested to re-run models with time-varying selectivity to the end of assessment period, 2011-2018. The authors re-ran the base cases with this modification and then compared likelihood values among models to evaluate whether the modification was appropriate. Changing the period for time-varying selectivity resulted in a very minor improvement to the log-likelihood estimate (<1 log-likelihood unit), and the likelihood value for the index was slightly worse (<1 log-likelihood unit). It was recommended that the model with the same selectivity setting as the 2017 assessment remain as the base case.

Model estimated recruitment deviations are lower than average since 2009 (**Figure 18**). The Group noted that this could require further investigation (see below); this reflects model misspecification, though it was not evident from diagnostic evaluations which, if any, misspecification (e.g. selectivity, growth, mortality, etc) could be the culprit. As similar patterns are seen in the VPA, this could be due to changes in immigration from the Eastern Atlantic stock (Morse *et al*., 2020), or could be the result of actual low recent recruitments. As neither the current VPA nor SS explicitly consider mixing, both could be affected by mixing or variability in mixing from the Eastern stock. The Group also discussed F-at-age patterns among recent years (2013-2018) because of current low recruitment resulting in an increase of F at young age (**Figure 19**). Similar to the W-BFT VPA (**Figure 10**), F on ages 4 increases in recent years, though the fishing mortality metric used to measure F relative to $F_{0.1}$ in Stock Synthesis is the average F over ages 10-20, which is relatively stable.

To further investigate the recent reductions in recruitment relative to the 2017 estimates, the 2020 model was re-run with the actual 2017 deviations fixed. Recruitment deviations from 2017 (which are qualitatively similar but have higher recruitment for several years) were input and deviations not estimated in the 2020 assessment model. The difference in log-likelihood between the model with fixed and estimated deviations were then examined by model component (indices, catch-at-length (CAL), length compositions (Lcomps)). The USRR_115-144 index was a major contributor to the differences in log-likelihood from the fixed 2017 recruitment deviations, with the 2018 data point being highly influential on the lack of fit to the 2017 deviations and on the estimates of lower recruitment from 2012-2014. Furthermore, the Group noted that the primary indicators of small fish abundance in the models are the USRR_66-114 and USRR_115-144 indices, and they can be influential on the model estimation of recent recruitment.

As with many of the indices used in the assessment which have experienced hypothesized changes in catchability or availability of fish, the USRR indices also warrant further examination into potential biases that might degrade their potential to reflect relative abundance. Furthermore, as the 2018 value for the USRR_115_144 was one of the few index values outside of the 80% prediction intervals obtained by projecting the 2017 assessment model forward (Anon., 2019a), it could warrant further exploration. As a minimum, an improved treatment of the index may be to better reflect the interannual precision in estimated values within the integrated model or through some means akin to a robust regression approach. We note that the 2018 USRR_115_144 estimate has a CV that is more than double that of similar years, and this interannual variability in precision should be better accounted for in the future. Nonetheless, this data point and this index is not the only factor contributing to the low recruitments estimated in 2012-2014 as the jackknife analysis that removed the index entirely and an additional model run that removed just the 2018 value did not result in substantially different recruitment estimates (SCRS/2020/122).

4.3 Other models

Document SCRS/2020/125 presented the update of the 2017 Age Structured Assessment Program (ASAP) runs for eastern and western Atlantic bluefin tuna stocks with data through 2018. For both stocks, the base case model agreed by the Group and some sensitivity runs were provided, and the retrospective analyses (**Figures 20** and **21** showed retrospective analysis for E-BFT and W-BFT, respectively) were compared to the VPA results (SCRS/2020/111 and SCRS/2020/119). All ASAP runs generally estimated lower SSB than those by VPA for both stocks (**Figures 22** and **23**). ASAP runs also estimated a steep increase in SSB since around 2010 for the eastern stock, and estimated a moderate increase in SSB since mid-2000s for the western stock.

The Group reviewed the additional updated assessment analysis by ASAP for both stocks. It was questioned why ASAP runs conducted in 2017 showed a steeper increase in SSB compared to ones in 2020 for the eastern stock, whereas SSB by VPA in 2020 showed a steeper increasing trend than in 2017. It might be related to the assumption of the age for plus group, but further investigations were suggested. It was pointed out that, while ASAP did not estimate such a notably different scale of recruitment as the VPA, it did not estimate as strong of a 2003 year class as the VPA (**Figure 24**), even when both models applied the same CAA input. These differences could come from the model assumptions that ASAP does not assume that CAA is perfectly known, as VPA does. ASAP tends to smooth out interannual variability on recruitment and to estimate selectivity at age freely.

5. Review of projections

5.1 East (VPA)

While the Group had little confidence in the VPA - as evidenced by the preference expressed to replace 11 years of recruitment estimations, although it was only possible to replace 9 years - it conducted projections in keeping with the terms of the assessment update. The 2020 projections (**Figure 25-a** and **Table 5-a**) predicted that much larger catches are possible than in the 2017 projections (**Figure 25-b** and **Table 5-b**). The reason for the higher predicted catches is that recruitment in the last 15 years (**Figure 2**) was estimated to be substantially higher than in 2017 and long-term average recruitment was 26% higher than recruitment projected in 2017 (**Figure 2**). The combination of these two factors lead to projected yields at $F_{0.1}$ that are about 30% higher than the projected yields at $F_{0.1}$ for the 2017 assessment.

5.2 West (VPA and Stock Synthesis)

West (VPA)

The Group reviewed the provisional projection assumptions and results documented in SCRS/2020/120. The estimates of recent low recruitments and influence on future recruitment assumption were discussed in great detail. Concern was raised that the most recent estimates appeared to be more precise than expected in the terminal years of the VPA (**Figure 26**). Examination of the variance estimates indicated acceptable model performance, with increasing CV of recruitment estimates to the end of the series and a range of uncertainty similar to estimates for prior years and the 2017 assessment.

The Group evaluated the evidence for the low recruitments in 2013 and 2014, and the influence of particular data on the estimates. Estimates of catch-at-age and juvenile indices of relative abundance both evidenced low cohort effects. As a second inference, the Group reviewed the updated indices of juvenile abundance to evaluate if the low signal continued into the 2019 observations. It was demonstrated that the most recent index showed an increase in both juvenile indices, providing evidence that the terminal year low recruitment may not have persisted to the most recent years (post 2015). The Group outlined a second future recruitment scenario for projection sensitivity, with the period 2008-2013 as the reference period to estimate the mean future recruitment, and the last five years of the VPA recruitments replaced with the mean. **Table 6** lists the mean recruitment estimates for the reference periods, and the mean recruitment assumptions for the alternative recruitment scenarios. For comparison, the mean of the 2017 assessment assumed for projections is shown in **Table 6**. **Figure 26** graphically displays the alternative recruitment scenarios used for stock projections.

The two alternative recruitment proposals were extensively evaluated, pros and cons were outlined, and the influence on the projection results were scrutinized. It was determined that the two scenarios in combination provided a better characterization of model uncertainty for stock forecasting. The Group decided that incorporating both scenarios into the advice was warranted, and integrated the scenarios into the Kobe uncertainty. The final decision was to base the near-term yield advice on the ensemble of four models from both VPA and Sock Synthesis, the two recruitment scenarios combined with alternative spawning-at-age assumptions.

The Group questioned the fishing mortality metric (apical F) used to determine overfishing status in the near future. Specifically, it was questioned whether the metric was heavily influenced by single-cohort effects. It was requested to evaluate whether the probability of overfishing was driven by a low cohort entering the fishery, acknowledging that the contribution of weak cohorts to current stock biomass estimates could be minimal. An alternative analysis based on biomass harvest rate (yield/total stock biomass) demonstrated that the near-term yield advice was similar, whether measured by apical fishing mortality or overall harvest rate. The primary divergence in near-term yield advice from the VPA projections was the mean future recruitment and the number of patching years back to be replaced by the mean recruitment assumption on the recent cohorts.

Estimates of recent low recruitments (**Figure 26**) signalled near-term decline in total stock (**Figures 27** and **28**) and spawning stock biomass (**Figure 29**). The decline occurred under the most constant catch scenarios. The spawning biomass scale and trend under the early maturity scenario matched total biomass, indicating that ages 4 and older comprised the majority of the stock biomass. Older spawner abundance and biomass decreased in all projection scenarios except zero catch due to eleven years of declining recruitment (i.e. between 2004 and 2015) and fewer individuals aging into the older spawner group.

The Kobe matrix integrated across the four scenarios is shown in **Table 7**. Projected yields at $F_{0.1}$ were markedly lower than the current total allowable catch limit (2,350 mt), with annual decreases predicted between 2020 and 2023 (**Table 8**). Yields at the current total allowable catch resulted in a 13% probability of not overfishing in 2021 (**Table 7**).

West (Stock Synthesis)

Document SCRS/2020/122 presented fishery status and a variety of projection scenarios. The low recruitments estimated for 2012-2014 coupled with signs of increasing recruitments in 2015-2017 prompted discussion on how to appropriately project recent recruitment trends. Status quo settings (a recruitment mean from 2010-2015, patching from 2018; option A) assume that recruitment would remain at historically low levels. However, the Group noted that recruitment indicators (e.g. US RR 66_114 and RR 115_144, CAS/CAA) suggest an upward trend for the years 2017 to 2019 and that near-future recruitment could increase and, therefore, it may be appropriate to use a higher mean recruitment (mean of 2007-2012). Furthermore, the Group noted that recent recruitments could well be highly uncertain and that a longer patch, similar to that entertained in the VPA, might be appropriate. In response, the Group decided to consider a second recruitment option using a 5-year patch and a higher mean recruitment using the average from 2007-2012. Both recruitment scenarios were considered equally plausible and used for projection. The resulting recruitment settings are shown in **Table 9** and **Figure 30.**

To create the Kobe 2 matrix, a multivariate lognormal approximation (MVLN) approach that was applied to multiple ICCAT stocks was used, whereas in 2017 a parametric bootstrap approach was used. For a subset of projections, the parametric bootstrap was used alongside MVLN to check for comparability and they were shown to give similar results (SCRS/2020/122). The Kobe 2 matrix was equally averaged across all 4 Stock Synthesis models (**Table 10**). Projections of fixed TACs and $F_{0.1}$ are shown in **Figure 31**.

The Group noted that that Kobe matrices had similarities regardless of the recruitment option used (A or B), although option B resulted in lower probabilities of avoiding overfishing for similar catches. The Group further discussed how recent low recruitment estimates affect recent projections. It was noted that the 2017 assessment also included data for poor 2013 recruitment, but that this was having a stronger effect in 2020 as more data was added to the assessment. It was also noted that a large year class almost 20 years ago (in 2003) is driving transient trends. The combined effect of the strong year 2003 cohort beginning to phase out the population and the recent (2012-2014) poor recruitment result in reduced population growth in the projections. The Group noted that stock biomass and yield decline in the projection years under an $F_{0.1}$ fishing scenario (**Table 11**). Probabilistic projected yields in **Table 7** are allocated by catch in weight and differ from the fixed TACs in **Table 7** due to differences related to allocation of catch based on fishing mortality. As management is predicated on allocating catch by weight, these are the more accurate reflections of TAC advice.

6. Review of OMs performance over different CMPs

The MSE session, which was originally scheduled for days 2 and 7 of the meeting, had to be reduced to one hour only because of an overall meeting delay and the need to prioritize the stock assessments and TAC advice. This only allowed for some presentations by the MSE Contractor, which are summarized below.

Most of the items in the original MSE agenda (**Appendix 5**, items 2-7) were postponed to a later date, thus the Group did not review Documents SCRS/2020/117 and SCRS/2020/127. The following section 6.1 (item 1 in **Appendix 5**) was only covered partially, with consideration of some further documents and detailed discussion also being postponed.

Given the limited time that could be devoted to the MSE workplan, the September 2020 meeting devoted to MSE will provide further specificity for the milestones and meetings planned for later in 2020 and in 2021. At that September meeting, the Group will provide a general outline of the tasks that need to be undertaken to complete the MSE, together with their planned timing and nature. This will include indications of whether certain key decisions needed in the process will require physical meetings or whether they can be achieved at virtual meetings (**Appendix 6**).

6.1 Evaluate OM behaviour that might not match perceptions or that could be difficult to explain

Operating Model investigations

a) Mixing ("An Overview of the Diverse Mixing Scenarios the Interim Grid of Operating Models")

The MSE Contractor provided a presentation on this item. This showed the range of western stock and eastern stock mixing (defined as the proportion of each stock biomass that is found in the opposite area of the Atlantic), which is covered in the interim reference set (or "grid") of OMs (operating models). Previous testing of two example CMPs (candidate management procedures) revealed similar performance, in terms of biomass outcomes after 30 years of CMP application, across the two levels of western stock mixing (1% and 20%) in this interim grid (Butterworth and Rademeyer, 2020), indicating that such mixing was relatively inconsequential. However, the interim grid also includes two levels of weighting of the likelihood component for the length composition data. These two levels also reflect differing estimates of eastern stock mixing that are consequential for the biomass performance of these example CMPs.

The Group concluded that the current interim grid includes a wide range of mixing scenarios, some of which are consequential for CMP performance.

b) Spatial distribution (SCRS/2020/126)

The MSE Contractor provided two presentations on this item.

The first of these focused on OM estimates of spatio-temporal biomass distributions over past years, and the potential impacts of differences in these distributions on CMP performance. After the bluefin tuna meetings of February and May 2020 (Anon., 2020a and 2020b), members of the bluefin tuna Species Group had provided a set of four observations regarding the OM estimates of historical spatio-temporal biomass distributions. These pertained to the fraction of Eastern stock biomass in the Mediterranean and the South Atlantic areas (so-called variants a and b, respectively), the fraction of age class 1 Western fish in the East area (variant c), and the fraction of age class 2 Western fish in the Gulf of Mexico (variant d). In each of these cases, a prior was specified to force the OMs to fit alternative spatio-temporal distributions; six OMs from the interim grid were identified for the exercise. In all cases, using an example CMP, the incorporation of these priors in the OMs was either not particularly consequential for CMP biomass performance or led to substantially worse fits to the historical data. The presentation concluded that a small subset of these OM variants, particularly in relation to variants b and c, might be included in the final set of OMs as low priority robustness tests.

The second presentation related to the three primary robustness tests identified in previous meetings. These refer to the inclusion of senescence, the application of the western growth curve to the eastern stock, and the so-called 'Brazilian catch' test for which certain catches in the South Atlantic during the 1960s are re-assigned from the western to the eastern stock. These modifications were applied to those four OMs, which had been specified in earlier meetings. The historical model estimates (in particular, the time series of SSB/SSB_{MSY}) for the modified OMs did not vary greatly from those for the original OMs. However, for an example CMP, all three robustness tests resulted in notable changes to biomass performance under some OMs, mostly for Recruitment level 2 (single recruitment regime) scenarios. The presentation concluded by raising, albeit not answering, the question of whether the current interim OM grid and set of robustness tests should be reorganized based on these findings, or whether some of the new results should instead be retained as robustness tests without modifying the interim reference grid.

During the meeting, it became apparent that the reassignment of catches for the 'Brazilian catch' test had been incorrect and would require revision, and the associated tests would need to be redone. The small group was appointed to facilitate the process of appropriate specification of these catches.

There was no time for Group discussion of these presentations as the meeting had to be rescheduled to make more time available for the priority assessment option. In the very little time available, only a single comment was possible, related to the first of the two presentations. This comment noted that there was a very large fishery in the Mediterranean some time ago, implying that a substantial quantity of fish (of age class 1, corresponding to ages 1-4) must have been present in that area. The MSE Contractor will respond later to this and to other comments that may be provided offline.

6.2 Possible refinement of interim grid and robustness trials

Discussions were postponed due to the time constraints.

6.3 Obtain as close as possible agreement on an interim grid

Discussions were postponed due to the time constraints.

7. Assessment results

7.1 Stock status

As discussed in section 4 (Review of model results), stock assessments were updated for the eastern and western stocks separately (without mixing) using three different frameworks: VPA-2BOX (SCRS/2020/111 and 112 for the eastern stock and SCRS/2020/119 and 120 for the western stock), Stock Synthesis 3 (for the western stock only, SCRS/2020/121 and 122) and ASAP 3 (SCRS/2020/125). These were intended to be strict updates adding data for the additional years, while using the same parameter settings as in the 2017 assessment. In 2017, only the single-stock VPA for the eastern stock and the single-stock VPA and Stock Synthesis models for the western stock were considered sufficiently advanced for management advice.

This year's assessments for both E-BFT and W-BFT were conducted as strict updates, as proposed by the SCRS and subsequently approved by the Commission in 2019. Accordingly, the Group conducted the assessments reported below as strict updates, where the procedures in 2017 were followed as closely as possible, except for issues where the Group considered that modification was absolutely necessary to avoid scientifically inappropriate results, as is explained in detail in section 4. In turn, this means that the Group did not attempt to improve the assessment models by undertaking further analyses at this time, so that various reservations raised in 2017 concerning these assessment models still remain to be addressed. Furthermore, the models could not be adjusted substantively to take into account new data and information in ways which might have led to improved results. This leads to additional uncertainty in the results obtained compared to those reported to the Commission in 2017. While the process for updating the models was outlined and agreed at the first BFT intersessional meeting in May 2020 (Anon., 2020b), questions remain regarding whether a 'strict update' implies fixing certain parameters estimated in 2017 at the same values or re-estimating them. Particularly for integrated models such as Stock Synthesis where there are many interconnected parameters, it is not entirely clear what should be fixed in a strict update or what should be estimated. Unfortunately, a "strict update" never turns out to be simple.

7.1.1 East

The 2017 VPA stock assessment was updated with three further years of data (2016–2018). Previous concerns regarding the reliability of the VPA results remain (Anon., 2015 and Anon., 2017b). These concerns arise for several reasons, including the fact that the age composition of catches is not well known, particularly because the size composition of catches by many E-BFT fleets remains uncertain. This is particularly significant for a number of years before the implementation of stereo video camera system in 2014, to get the number and size of the bluefin tuna catch going into farms. Nonetheless, even with these cameras now in place, further inconsistencies have been found in the length frequencies for some of the purse-seiner catches since 2014 that require further investigation.

Statistical catch-at-age assessment models (e.g. Stock Synthesis and ASAP) remain under development for this stock, but have yet to reach the stage of acceptance as a basis for the provision of advice on stock status. The ASAP model presented in 2017 was also updated similarly to the VPA (see Section 4.3), i.e. with three additional years of data to 2018; the model structure was unchanged, except to allow for four additional ages (to age 20).

East (VPA)

VPA modelling produced an updated assessment for the East and Mediterranean stock of Atlantic bluefin tuna (E-BFT), as specified in the workplan by SCRS 2019 (SCRS/2020/111). The base case was not a strict update assessment as the F-ratio was fixed rather than estimated to improve estimation stability.

The VPA base case results show a substantial increase in SSB from the late 2000s, reaching 870,000 t in 2018, which is the highest estimate ever and 30% above the maximum in the 1970s (**Figure 32**). Similarly, strong increases in SSB were also estimated in the 2012 and 2014 assessments; the SSBs estimated for 2013 were 650,000 t and 510,000 t for those two assessments, respectively (**Figure 3**). Uncertainty regarding the magnitude of the recent SSB increase estimated by the VPA is even higher than in the 2017 assessment due to considerable instability in the recruitment estimates.

Recruitment (age 1) varied around an average of 0.8 million in the late 1970s, followed by a steady increase towards a "high recruitment period" from the mid-1990s to the mid-2000s when it fluctuated between 3 to 4.5 million. Recruitment then decreased sharply from 2004 to 2007, but again increased rapidly to over 4 million in 2009, and has fluctuated at high levels since then while displaying the two largest recruitments estimated to date. These large recruitment estimates from 2008 onwards constitute a major difference compared to the 2017 base case, which estimated low recruitment values for that same period (**Figure 3**). Note that the last three year-cohorts (2016-2018) are not shown in **Figure 32** because VPA does not provide reliable estimates of very recent recruitment; this is due to limited information about incoming year class strength and uncertainties in the indicators used to track recruitment. Concern also remains regarding the high degree of inconsistency evident in retrospective estimates of recruitment, suggesting that there are conflicting signals in the data as regards the absolute magnitude of recent estimates. Furthermore, the general problem of having to use catch-at-age (CAA) "data" based on the cohort slicing method continues to apply. Particularly as the recruitments from 2007 onward provide the primary basis for the very high estimates of the current SSB, the results from the VPA should be interpreted with caution. This is especially relevant for the 2020 assessment, as the most recent recruitment estimates show a reverse of the trend of those estimated in the 2017 assessment.

The fishing mortality rates estimated for the younger ages (i.e., average F for ages 2 to 5) display a continuous increase until the late 1990s, followed by a sharp decline to reach very low levels after the late 2000s (**Figure 32**). This result was not surprising because the reported catches for ages 2 to 3 have reduced dramatically (i.e., to about 10% or less of what they were prior to 2007) in recent years in response to the new minimum size regulations implemented in 2007. The trend in F for these younger ages was similar to that indicated by the 2014 assessment. The fishing mortality for older fish (i.e. F for the plusgroup of ages 10 and older) in the base case run showed an initial decline from 1968 to 1973 and fluctuated a little below 0.05 thereafter. It then increased sharply in 1994 and continued increasing until 2005 (when F_{10+}=0.26). This period (from the mid-1990s to the mid-2000s) reflects the highest level of fishing mortality in larger fish. Since 2008, there has been a rapid decrease in F_{10+} (as noted in previous assessments); this is associated with regulations, i.e. the drastic reduction of the TAC and enforcement of size regulations from that time. The trend of F for large fish indicated by this updated assessment is similar to that reflected by the 2017 assessment.

Summary of East (VPA) results

In summary, the remit of the Group was to provide a strict update assessment using the same parameter settings as in 2017. For the VPA, this produced unstable results for biomass estimates in the historical period because of variability in the F-ratio. Fixing the F-ratio over time to the values estimated in the 2017 assessment provided stability in historical estimates of SSB, but resulted in a large retrospective pattern (5-year peel) where removing years led to estimates of consistently lower SSB and recruitment. Changing the F-ratio could not be considered a strict update. The Group concluded that none of the VPA model formulations tested in 2020 provided results which were sufficiently reliable to be used as the basis for management advice.

However, the Group notes that, viewed more broadly, the available data do clearly indicate that the biomass of the East Atlantic and Mediterranean bluefin tuna has increased since the late 2000s, is high at present, and that there are no concerns that overfishing may be occurring under the current TAC (36,000 t in 2020).

East (other models: ASAP)

An update of the 2017 Age Structured Assessment Program (ASAP) assessment for eastern Atlantic bluefin tuna stock reported in SCRS/2020/125 also indicated a substantial increase in relative SSB since 2007, though the estimated 2018 absolute biomass value is about 290,000 t smaller for ASAP compared to the VPA (SSB 583,000 t in ASAP and 873,000 t in the VPA, **Figure 22**).

7.1.2 West

Two stock assessment approaches (VPA and Stock Synthesis, detailed in Section 4.2) were considered sufficiently advanced to be considered as the basis for providing management advice for the western stock. In addition, ASAP results were presented (Section 4.3).

West (VPA)

Time series estimates of abundance mirrored the magnitude and trend of the 2017 assessment, with the exception of recruitment estimates from 2005 to 2009 (**Figure 23**). The 2003 year class constituted the largest recruitment event over the last few decades, observed as a distinct peak in estimated abundances-at-age. The recent decrease in abundance of some age classes (ages 5 to 9, in particular) resulted from lower recruitments following this strong 2003 year class.

Estimates of fishing mortality in ages 1 to 7, and ages 13 to 16 for the terminal year (2018), were lower than for historical periods. However, there is an increasing trend in recent fishing mortality estimates for ages 8 to 12, though with terminal year estimates remaining below historical highs. Apical fishing mortality rates (i.e. annual maximum F across all age-classes) declined to a low value in 2013, but have since increased. The Apical F is compared with the average F for ages 10 to 16, or with the exploitation rate (catch in tons divided by total biomass), as shown in **Figure 33**. Higher fishing mortality has occurred in age 4 and ages 10 to 12 compared to other ages, with increases evident between 2013 and 2018 (**Figure 10**). The bootstrap distribution of current F (mean of 2015 to 2017 apical fishing mortality) ranges from approximately 0.07 to 0.16 (**Figure 9**), with a median equal to 0.10.

Recruitment estimates have decreased over the last decade (**Figure 8**). The decrease in spawning biomass (young spawning scenario) during the last two years reflected the recruitment trend. The abundance of old fish in the population (ages 15 and 16+) increased during 2014 to 2018 to the highest abundance since 1980, with the 2003 year class expected to have entered that group in 2019, noting that a lag effect of the recent lower recruitments (2011 to 2015) on the abundance of older age classes will be expected (i.e. a future decline in the abundance and biomass of spawners of age 16 and older). **Figure 7** plots the paired spawner-recruitment estimates.

West (Stock Synthesis)

Estimated selectivities generally reflected the expected patterns for the actual fisheries. The dome-shaped curve of the Japan LL selectivity is fairly steep, but seems rather well determined given the assumption that one fleet has asymptotic selectivity (Canada Rod and Reel) and catches much larger fish on average.

Overall, the time series of SSB and recruitment and other derived parameters are similar between the two model configurations that differ only in their assumptions for maturity at age (Run1 late maturity vs. Run2 early maturity), indicating a relatively limited impact on model results (**Figure 13**). While SSB is scaled higher or lower according to the maturity assumption, the resulting total biomass estimates and relative depletions from virgin levels are similar. Trends of biomass and fishing mortality are shown in **Figures 34** and **35**, respectively. Similar to the projections of the 2017 assessment, recent total biomass has decreased since a peak in 2015 (**Figure 34**).

Summary of West (VPA and Stock Synthesis) results

The Stock Synthesis and VPA runs show relatively consistent patterns in that the SSB was estimated to decline between 1970 and 1985, level off through the 1990s, and increase up to 2016 with decreases in 2017 and 2018 (**Figure 36**). Both models estimate that the fishing mortality rates on fish of age 10 and older have fluctuated around an average of 0.14 yr^{-1} since the 1980s, with a marked decline after 2003 (**Figure 35**). The estimates of recruitment (age 1) fall sharply after 1975 and show smaller inter-annual fluctuations since that period (**Figure 36**). Relatively strong year-classes are estimated for 1988 and 2003, similar to results from previous assessments (e.g. 2012). Stock Synthesis diverges from the VPA in estimating a very strong 1994 cohort and a larger 2003 cohort (**Figure 36**).

West (other models: ASAP)

Generally speaking, ASAP estimated smaller SSB compared to VPA since 1985 with similar trend (**Figure 23**). For recruitment estimates, ASAP did show similar trend until 2004 (except 1993/94), but varied thereafter, with no indication of large recruitments in recent years (**Figure 24**).

7.2 Projection advice

7.2.1 East

The Group concluded that the 2020 VPA assessment could not be used as a basis to provide reliable projections.

The attempt to project the 2020 base case using the Group specifications proved problematic for the projection platform (SCRS/2020/112) and an appropriate solution could not be found in the time allocated. The Group discussed the appropriateness of using the results of the updated VPA, particularly regarding the substantial instability in the recruitment estimates, as evidenced by a retrospective analysis.

As in 2017, given the uncertainty in the absolute value of the then current biomass, the Group considered it was not advisable to use the biomass-related results to evaluate the current status of the stock in relation to biomass-based reference points. Furthermore, the 2020 assessment results point to high uncertainty regarding the recent levels of recruitment to the stock. As the latter is a key input for the projections, the Group considered that short term catch advice based on $F_{0.1}$ from the updated assessment would not be robust. For example, the long term yield under $F_{0.1}$ was estimated to be 33,830 tons (31,762-35,515 t), whereas the Kobe matrix derived from the projections (for which results benefit from the large estimates for recent cohorts) indicates that a catch of 50,000 tons would maintain a 60% probability of F being below $F_{0.1}$ in 2023 (SCRS/2020/112).

The overall uncertainty of the updated assessment and short-term projections was highlighted, and it was noted that the analysis of the indices (SCRS/2020/128) did not provide evidence of any clear trend between the period before and after the 2017 assessment.

7.2.2 West

Each of the two Stock Synthesis and VPA (early and late maturity) models were projected with two recruitment specifications (each pair specific to the respective methodology), leading to eight projection scenarios across a suite of fixed TACs (**Figure 37**). Projection outputs were equally weighted and averaged across the eight models.

While current fishery status as indicated by $F/F_{0.1}$ for the years 2015-2017 was classified as not overfishing (**Figure 38**), projected fishery status in 2020 at the current TAC (2,350 t) would likely result in overfishing (**Figure 37** and **Table 12**). Projections based on fixed TACs indicate that a rollover of the 2020 TAC for 2021 would lead to a 94% probability of overfishing in 2021 (**Table 12**).

Differences between 2017 projections and 2020 projections

The main differences between the 2017 and 2020 projections is that the 2017 projections assumed that recruitment would revert to a higher mean than subsequently estimated by the 2020 models. Projections conducted in 2017 indicated that a large component of the projected catch was comprised of the 2003 year class, whose biomass has decreased with time, causing catches to decline after 2018. Furthermore, the low recruitments estimated for the years 2010-2015 now form a substantial component of the fishable biomass for the 2021-22 TACs. These recruitments were low in the 2017 models but had little impact on yield advice, or were amongst the years replaced with mean values. The subsequent update of the model in 2020 confirmed these low recruitments and estimated it to be lower for 2012-2014 than initially estimated in 2017 (**Figures 26** and **30**). Even when patching several years of these cohorts and using mean recruitment from 2007-2012 to address uncertainty in estimates for these years, the projections still indicate that short-term catches under $F_{0.1}$ would be lower than predicted in 2017 for the same years. For Stock Synthesis, there is the added change that the updated model estimated a total biomass approximately 30% lower in recent years, albeit at the nearly the same magnitude now as the VPA (**Figure 37**).

In 2017 the population was projected to decline by ~7.5% from 2017 to 2020 at current TAC (Anon., 2019). Based on the updated models, the total population biomass is estimated to have experienced a 12% decline over the same time period. Projections indicate that the population is expected to decline in total biomass across all fixed TACs from 1,000-3,000 t and at F0.1 from 2021-2023 (**Table 13**). Viewed overall, it is evident that recent recruitment (and, for Stock Synthesis, population biomass) estimates are now lower than in 2017, and the averages used for projections are lower than the averages assumed in 2017. The combination of these two factors leads to catch limit advice lower than indicated in 2017.

A feature of the $F_{0.1}$ approach is that catch advice changes as it is informed by recruitment. As recent recruitment has remained low and has subsequently been estimated to be lower with updated information, the 2020 projections result in lower catch advice than in 2017.

8. Responses to the Commission

8.1 Progress on growth in farms response

In Rec. 18-02 and Rec. 19-04, the Commission requested that the SCRS update the growth table published in 2009. In this request, the use of individual fish to determine growth was emphasized, as well as the consideration of differences between geographical areas.

The SCRS, on the basis of a standardized protocol to be established by the SCRS for the monitoring of recognizable individual fish, shall undertake trials to identify growth rates including in weight and size gains during the fattening period. Based on the result of the trials and other scientific information available, the SCRS shall review and update the growth table published in 2009, and the growth rates utilized for farming the fish referred to under paragraph 35 c, and present those results to the 2020 Annual meeting of the Commission. In updating the growth table, the SCRS should invite independent scientists who have appropriate expertise to review the analysis. The SCRS shall also consider the difference among geographic areas (including Atlantic and Mediterranean) in updating the table. Farm CPCs shall ensure that the scientists tasked by the SCRS for the trials can have access to and, as required by the protocol, assistance to carry out the trials. Farm CPCs shall endeavour to ensure that the growth rates derived from the eBCDs are coherent with the growth rates published by the SCRS. If significant discrepancies are found between the SCRS tables and growth rates observed, that information should be sent to the SCRS for analysis.

In order to provide an answer to this request, the BFT Group created a specific sub-group and the GBYP started different studies in 2019, which will continue in the coming years. This Sub-group, coordinated by Dr. Simeon Deguara, has met online during 2020 with the objective of compiling and reviewing the current ongoing research activities, in particular on growth tagging studies on farms. Document SCRS/2020/129 presented a summary on the BFT farm growth sub-group status of activities, including 5 main study areas and some preliminary results, and the work plan for 2020 and 2021. Of the current studies, some of the limitations of individual fish growth tagging experiments were highlighted, e.g. handling and tagging effects, limited number of samples and mortality of fish. The presentation also summarized alternative methodologies for estimating growth in farms and made specific recommendations for the compilation and summary of different research studies.

The Group inquired about the decrease in weight after weighing and tagging. It was noted that the fish were in poor condition and aerial exposure probably caused undue stress. After the presentation, clarification about the methodology used in the study area 5, modal analysis for the determination of growth and possible correlations with environmental factors and food supply was requested. It was indicated that Stereo Camera measurements recorded in different months make it possible to detect fish growth in size by length modal progression, and potentially link this to environmental conditions and the food supply in the cages.

8.2 Presentation of work to revise the catch rate table

Presentation SCRS/P/2020/060 presented the steps for an approach to update the catch rates table of East and West BFT by main gear type and vessel size category provided by the SCRS to the Commission in 2009, initiating the work to address a Commission request. The approach proposed integrates a large amount of information available to the ICCAT Secretariat (eBCD, weekly reports, VMS, Vessels registration data, etc.) to provide catch and estimates of fishing effort by main gear type, using vessels with a consistent fishing history for BFT. The Group saluted the great efforts deployed by the Secretariat to tackle such an issue using recent technological improvements in data reporting and collection. Concerns were raised about the specific fishing patterns of purse seine presented, and it was recalled that SCRS/2020/110 presented a number of considerations regarding the interpretation of catch rates and capacity. The Group also noted that catch rates and fishing capacity were not interchangeable concepts, particularly as CPCs can adjust their fishing capacity (i.e. number of boats) but not the catch rates. The Group thus felt that the definition of "catch rates'' still needed clarification from the Commission so that the request could be appropriately addressed. To initiate the work, the Group assumed that the definition was similar to a catch per unit effort. However, doing so, the Group noted that the results of this analysis would not be able to be interpreted in the same way as the catch rates table from 2009.

8.3 Additional responses

The Group noted that the Commission has increased the number of requests to the SCRS, and asks that they be prioritised due to limited time.

Eastern Atlantic and Mediterranean Bluefin Tuna

1. **Rec. 19-04, para. 4** – The SCRS shall annually advise on the TAC.

Background: *The TAC shall be reviewed annually on the advice of the SCRS.*

An update assessment of the eastern BFT stock was undertaken in 2020. No change in the current TAC advice is recommended. A summary of the stock assessment and the TAC advice will be presented in the SCRS 2020 advice to the Commission.

2. **Rec. 19-04, para. 18/19** – SCRS should review catch rates each time that a stock assessment for eastern bluefin tuna is performed, including specific rates for gear type and fishing area.

Background: (para. 18) *Each CPC shall adjust its fishing capacity to ensure that it is commensurate with its allocated quota by using relevant yearly catch rates by fleet segment and gear proposed by the SCRS and adopted by the Commission in 2009. Those parameters should be reviewed by the SCRS no later than 2019 and each time that a stock assessment for eastern bluefin tuna is performed, including specific rates for gear type and fishing area.*

(para. 19) *For that purpose each CPC shall establish, when appropriate, an annual fishing capacity management plan to be analysed and, as appropriate, endorsed by Panel 2 intersessionally. Such plan shall adjust the number of catching vessels to demonstrate that the fishing capacity is commensurate with the fishing opportunities allocated to the catching vessels for the same quota period. Regarding small-scale coastal vessels, the minimum quota requirement of 5 t (catch rate defined by the SCRS in 2009) shall no longer be applicable and sectorial quotas may alternatively be applied to those vessels as follows".*

During 2020, regarding the request to provide specific catch rates for eastern Bluefin tuna fleets, the SCRS has received only one document from a CPC (Norway, SCRS/2020/017) providing information on their fleet(s) catch rates.

The Group once again requests a clarification of the definition of "catch rates" from the Commission. Meanwhile the Group is interpreting the definition of catch rate as catch per unit of effort (CPUE), e.g. catch per day per vessel type. This definition makes the results of the analysis proposed incompatible with the Table of catch rates provided in 2009 by the SCRS. The Group, in coordination with the Secretariat, has started an additional review and update of the BFTCPUE; for this task information from the eBCD, BFT weekly reports, the VMS and Vessels registration data is being compiled by the Secretariat and will be analyzed and reported in 2021.

3. **Rec. 19-04, para. 28** –The SCRS, on the basis of a standardized protocol to be established by the SCRS for the monitoring of recognizable individual fish, shall undertake trials to identify growth rates including in weight and size gains during the fattening period.

Background: *The SCRS, on the basis of a standardized protocol to be established by the SCRS for the monitoring of recognizable individual fish, shall undertake trials to identify growth rates, including in weight and size gains, during the fattening period. Based on the result of the trials and other scientific information available, the SCRS shall review and update the growth table published in 2009 and the growth rates utilized for farming the fish referred to under paragraph 35 c, and present those results to the 2020 Annual meeting of the Commission. In updating the growth table, the SCRS should invite independent scientists who have appropriate expertise to review the analysis. The SCRS shall also consider the difference among geographic areas (including Atlantic and Mediterranean) in updating the table. Farm CPCs shall ensure that the scientists tasked by the SCRS for the trials can have access to and, as required by the protocol, assistance to carry out the trials.*

The Commission has requested that the SCRS update the growth table published in 2009, with particular emphasis on the maximum growth rates. In this request, the use of individual fish to determine growth was stressed, as well as the consideration of differences between geographical areas. As a result, the GBYP launched a series of studies in 2019, which will continue during 2020 and 2021, and established a Sub-Group on growth of BFT in farms within the BFT Species Group in 2020. This Sub-Group was created to ensure that the best scientific data would be provided to the Commission. The Sub-Group has held a number of online meetings to discuss using different approaches and assessing their limitations, so that a scientifically sound updated growth table or tables can be provided. Limitations identified so far by the Sub-Group (financial, logistical and representativeness) affect the feasibility of providing sufficient results based on individual growth to elaborate a complete and fully representative new maximum growth reference table, whilst also considering the impact of physical weighing and tagging on subsequent growth, especially in larger fish. Consequently, the Sub-Group concluded that different methodological approaches, from individual growth studies based on tagging to broader analyses based on the available L/W data from stereo-cameras measurements at caging and harvesting data from eBCD, should be combined to address the Commission's request. There are also concerns that the current L-W relationships (needed to convert stereo-camera length measurements to RWT) does not represent the L-W relationship applicable to certain geographical areas and/or certain size classes.

These and other issues were grouped into five study areas: tagging of individual fish to determine growth; regional L-W equations; modal analysis of available data for the determination of growth and possible correlations with environmental factors and feed supply; analysis of stereo-camera and harvest data held by the Secretariat as well as other datasets; and new methods for determining growth (acoustics and image analysis and AI). Analyses within the individual study areas have been initiated, but considering the current situation and the work required, sufficient results to enable an update of the growth table are not expected to be available before 2021 or, more realistically, 2022. More details and the work plans are presented in SCRS/2020/129. Results from the GBYP ongoing studies are available on the GBYP webpage.

4. **Rec. 19-04, para. 33** – The SCRS should provide advice on the possibility of extending or modifying the fishing seasons for different gear types and/or fishing areas.

Background: *No later than 2020, the Commission shall decide to what extent the fishing seasons for different gear types and/or fishing areas might be extended and/or modified based on the SCRS advice, without negatively influencing stock development and ensuring the stock is managed sustainably.*

The Committee has never provided advice on the appropriate length or timing of fishing seasons in relation to stock development, and the length of current fishing seasons was determined without the Committee's input.

This request is broad in scope considering the diversity of fleets, spatial coverage and seasonality. No information was provided to the Group on this issue. The Group requests more details on the questions to be addressed in order to undertake the appropriate data compilation and analysis. Specific objectives of the request would be helpful given that some CPC fleets couldn't fill their quota during the fishing season. Assuming clarification is provided by the Commission to the SCRS in 2020 a response could be available for 2021.

5. **Rec. 19-04, para. 83** – National observer programmes **-** The SCRS shall report on the coverage level by CPC and provide a summary of the data collected and any relevant findings associated with that data. The SCRS shall provide any recommendations to improve the effectiveness of CPCs observer programmes.

Background: *For the scientific aspect of the programme, the SCRS shall report on the coverage level achieved by each CPC, and provide a summary of the data collected and any relevant findings associated with that data. The SCRS shall also provide any recommendations to improve the effectiveness of CPCs observer programmes.*
…
Each CPC shall ensure coverage by observers, issued with an official identification document, on vessels and traps active in the bluefin tuna fishery on at least:
- 20% of its active pelagic trawlers (over 15 m),
- 20% of its active longline vessels (over 15 m),
- 20% of its active baitboats (over 15 m),
- 100% of towing vessels,
- 100% of harvesting operations from traps.

CPCs with less than five catching vessels of the first three segments defined above authorized to actively fish for bluefin tuna shall ensure coverage by observers 20% of the time the vessels are active in the bluefin tuna fishery.

No later than 2020, CPCs shall present to the SCRS the statistical methodology used to estimate dead and live discards. CPCs with artisanal and small-scale fisheries shall also provide information about their data collection programs. The SCRS shall review these methodologies and if it determines that a methodology is not scientifically sound, the SCRS shall provide relevant feedback to the CPCs in question to improve the methodologies.

The COVID-19 pandemic has had a significant impact on both national and international observer deployment in 2020 and any new information is unlikely representative of what can and will be implemented by CPCs and their fleets. Consequently, it is suggested that the report on coverage be deferred until conditions have returned to near normal.

Given the limitations imposed by the worldwide crises, no new work was initiated/provided in 2020 by the SCRS to review the methodologies used to estimated dead and live discards. This very important issue will hopefully be picked up in 2021.

6. **Rec. 19-04, para. 99** – Measures and programmes to estimate the number and weight of bluefin tuna to be caged – The SCRS should evaluate such procedures and results and report to the Commission by the Annual meeting.

Background: *A programme using stereoscopic cameras systems or alternative methods that guarantee the same level of precision and accuracy shall cover 100% of all caging operations, in order to refine the number and weight of the fish. This programme using stereoscopic cameras shall be conducted in accordance with the procedures set out in Annex 9. In case of the use of alternative methods, those methods should be duly analysed* *by the SCRS, who should present its conclusions regarding their precision and accuracy for endorsement by the Commission during its Annual meeting before an alternative methodology can be considered valid for the purpose of monitoring the caging operations.*

The results of this programme shall be submitted by 15 September annually to the SCRS by all farming CPCs. The SCRS should evaluate such procedures and results and report to the Commission by the Annual meeting.

No new information was presented to the SCRS on this matter in 2020. A program to estimate number and weight of the minimum sample size that is representative of the bluefin tuna being caged could possibly be implemented under GBYP activities in Phase 11. This task may require the analysis of the complete transfer records of several farms and the availability of these data should be ensured.

7. **Rec. 19-04, para. 114** – Safeguards – The SCRS shall provide new advice on the TAC for the following year when the goal of maintaining the biomass around $B_{0.1}$ (to be achieved by fishing at or less than $F_{0.1}$) is not achieved and the objectives of this plan are in danger.

Background: *When, as a result of a scientific evaluation, the goal of maintaining the biomass around B0.1 (to be achieved by fishing at or less than F0.1) is not achieved and the objectives of this plan are in danger, the SCRS shall provide new advice on the TAC for the following year.*

The SCRS could not provide advice based on $F<F_{0.1}$ for the eastern BFT stock due to uncertainty in the assessment and short-term projections. However, the Group concluded that there is no evidence to recommend a change in the current TAC advice for 2021. Details are provided in the 2020 SCRS report Eastern BFT Executive Summary.

8. **Rec. 19-04, Annex 9, item vi -** SCRS shall review the specifications and, if necessary, provide recommendations to modify them.

Background: *The report on the results of the stereoscopical program should include details on all the technical specifications above, including the sampling intensity, the sampling methodology, the distance from the camera, the dimensions of the transfer gate, and the algorithms (length-weight relationship). SCRS shall review these specifications and, if necessary, provide recommendations to modify them.*

No new information was provided to the group on the validation or review of technical specifications of the stereoscopic length measurements prior to each caging operation. The SCRS indicated that to properly review minimum sampling, full raw data from the stereo camera videos is required and should be provided to the Secretariat.

Western Atlantic Bluefin Tuna

9. **Rec. 17-06, para. 4** – The SCRS shall annually advise on the TAC.

Background: *The annual TACs in Paragraph 3 shall be reviewed annually by the Commission on the advice of the SCRS, which would include the review of updated fishery indicators. In support of this work, CPCs shall make special efforts to update abundance indices and other fishery indicators annually and provide them to the SCRS.*

An update assessment of the western BFT stock was undertaken in 2020. A summary of the stock assessment and the TAC advice is presented in the SCRS 2020 report to the Commission.

10. **Rec. 17-06, para. 17, 18** – The SCRS shall advise on appropriate management measures, approaches, and strategies, including, inter alia, regarding TAC levels for those stocks for future years, on potential impacts due to uncertainties.

Background:*17) In 2020, the SCRS will conduct a stock assessment for bluefin tuna for the western Atlantic stock and for the eastern Atlantic and Mediterranean stock, and provide advice to the Commission on the appropriate management measures, approaches, and strategies, including, inter alia, regarding TAC levels for those stocks for future years.*

Stock assessments were undertaken for both the eastern and western Bluefin tuna stocks in 2020.

18) By 2020, the SCRS shall provide the Commission with advice on any potential impacts due to uncertainties (including regarding the spawner-recruit relationship) of implementing an F0.1 strategy, and, for any identified risks, advise how they could be addressed in future management decisions.
Due to time constraints the SCRS was not able to address this request, which will be addressed during the upcoming September meeting.

9. GBYP matters requiring attention of BFT Species Group

In his presentation, the GBYP Coordinator focused only on GBYP matters that require the attention of the Group given that, due to time constraints, the full annual report on GBYP activities could not be presented. Nevertheless, he invited the Group to consult the document SCRS/2020/124, which provides more information on GBYP activities and results in Phase 9 and the first part of Phase 10, as well as detailed activities reports available on the GBYP webpage. Further updates included the status of the electronic tagging activities, which could not be carried out as envisaged (e.g. in the Levantine Sea) due to the logistic limitations caused by the pandemic, and will instead be performed opportunistically in cooperation with national tagging teams.

9.1 Aerial survey external review

The Group was reminded about recurrent issues in the aerial surveys and was informed that it will be reviewed in detail by the external experts. In addition, their report will serve as a basis for the Group to provide advice on the future of this activity.

9.2 GBYP External member

The Group was also informed about contracting a new external member of the GBYP Steering Committee. The post will be covered by Dr. Ana Parma, who is an MSE expert and was recommended for this position by the current members.

9.3 Workshops

The GBYP Coordinator also recalled that the two GBYP workshops planned for March 2020 on electronic tagging and close kin for Eastern BFT stock were cancelled and should be rescheduled for the near future, because future GBYP activities should depend on their inputs. He also asked the Group to provide their direct advice for the readjustment of Phase 10 activities and planning of the ones under the framework of Phase 11.

Given that the immediate advice from the Group is needed before the end of the year, it was recommended that both workshops be held as webinars in the timeframe from October to early December 2020. It was noticed that the majority of CPC scientist already have a busy schedule in that period and the Secretariat will work out the best timing for these meetings with the Group.

The GBYP Coordinator also asked the Group for their specific advice on a number of GBYP matters like the future of aerial surveys, decision on implementation of the close kin approach for the Eastern stock, support to MSE work plan development and identifying research priorities for biological studies and asked if it would be possible to hold an additional meeting on these subjects. The Group acknowledged that GBYP is an important research programme and more time should be dedicated to discussing it and making decisions on its future activities, although it is less likely that the Group could dedicate more time on these issues this year, due to other scheduled meetings.

E-tagging

The Group recommended that the E-Tagging webinar focus on compiling all the data available so far in order to identify the gaps and the priorities for the future campaigns and detailing the future in-person workshop, which should focus on free discussions, data sharing and joint analyses.

Close-kin

The Group recommended proceeding with the organization of the Close-kin webinar, to be held by the end of the year.

10. Workplan and Recommendations

The Group created Recommendations and also reviewed the bluefin tuna workplan proposal for 2021. These items will be finalized during the Species Group meeting in September.

Recommendations with financial implications

1. Meetings devoted primarily to MSE development (two Bluefin tuna MSE Technical Group meetings, coordinated by GBYP, and a Joint BFT/MSE intersessional meeting).
2. Continued funding to support the essential work of GBYP, including funding of the MSE development process, biological studies and the full GBYP work plan, including an external review of MSE.
3. The Group recommends support for workshops in statistical techniques for index standardization and to develop a working network for analysts to facilitate the future sharing of knowledge and tools.

Recommendations without financial implications

4. Habitat and environmental variables represent an important source of variability in existing indices of BFT relative abundance, the Group recommends continued explorations of factors that may account for differential availability or catchability
5. Continuation of the Joint CPUE Standardization work group.
6. Continued work in developing alternative assessment models for E-BFT, notable statistical catch at age/length models.
7. Review of CAS, CAA (especially from 2009 onwards), and direct aging information, for improved characterization of associated uncertainty and incorporation into the modelling framework.
8. The Secretariat work in collaboration with national scientist to carefully review the task 2 stereo-camera size data submitted by the fleet Mediterranean OTHERS purse seine (Anon., 2017a, Table 3) for the 2017-18 years and confirm the correct size distribution of their catch.
9. The Group discussed the concern that the age that F-apical refers to can vary over time, and that F-apical is very sensitive to low recruitments. The use of biomass based exploitation rate or average F over older ages classes, e.g. ages 10-20, as used in SS) should be explored, as it appears that this metric could be more robust.

11. Other matters

The Group revised and updated the Atlantic Bluefin tuna Executive Summary. However, the final version including figures, tables and other additions will be finalized during the Species Group meeting in September.

12. Free discussion of CMP development progress and guidance for further development

Given the limited time, the Group postponed the discussion.

13. Adoption of the report

The Report of the second 2020 ICCAT intersessional meeting of the Bluefin tuna Species Group was adopted. The Group drafted an interim workplan ahead of the September Species Group meeting. This workplan (**Appendix 7**) outlines the process for revising the workplan for 2021, addressing several outstanding sections of the Executive summary text. The 2021 workplan, Recommendations, and Executive Summary will be formally adopted at the September meeting. Drs Gordoa and Walter thanked the participants and the Secretariat for their hard work and collaboration to finalise the assessment and the report on time. The meeting was adjourned.

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Table 1. Summary report by month and flag for the E-BFT 2020 catch and respective TAC allocation (Rec. 19-04) as of 20 July 2020. For Egypt the quota reflects the adjusted TAC 2020. 2020 BFT fishing season indicates the notification sent to the Secretariat compliance department in reference to their fishery operations

Cumulative catches BFT , East stock by month and CPC 2020

	Month	Albania	Algerie	Egypt	European Union	Libya	Morocco	Syria	Tunisia	Turkey	Grand Total
	Jan				81.2						81.2
	Feb				154.4						154.4
	Mar				224.5						224.5
	Apr				437.6						437.6
	May	168.7	-	-	7,688.3	112.3	2,048.0		572.2	606.8	11,196.3
	Jun		1,349.6	122.1	5,430.1	765.5	765.4	79.2	2,016.2	1,645.2	12,173.3
	Jul*		299.0		81.0		223.9		59.8		663.8
	Grand Total	168.7	1,648.7	122.1	14,097.2	877.8	3,037.3	79.2	2,648.1	2,252.0	24,931.1
Rec 19-04	Quota 2020	170.0	1,655.0	125.4	19,460.0	2,255.0	3,284.0	80.0	2,655.0	2,305.0	31,989.4
	% Quota completed	99.3%	99.6%	97.4%	72.4%	38.9%	92.5%	99.0%	99.7%	97.7%	77.94%
	2020 BFT Fishing Season	closed	closed	closed	closed	closed	closed	closed	closed	closed	

Table 2. E-BFT VPA. Descriptions of the various E-BFT VPA runs produced as part of the E-BFT update to the 2017 assessment.

Run name	Run description
Run0 (2017 base case)	Run using the 2017 VPA assessment base case model setting and uses data up to 2015 as available in 2017.
Run83	Run using the 2017 base case with data up to 2015 (Run0), with updates that have taken place up to 2020
Run84	Run using the 2017 base case with data up to 2018, with updates that have taken place up to 2020
Run135 (2020 base case)	Run using the 2017 base case with data up to 2018, with updates that have taken place up to 2020, with F-ratio fixed to the 2017 assessment levels

Table 3. W-BFT VPA. Estimates of $F_{current}$ (averaged over the most recent three years, apical F) and $F_{0.1}$ delivered in the 2020 and 2017 stock assessment with 80% confidence intervals.

Assessment year	Item	Median	80% CI Lower Limit	80% CI Upper Limit
2020	$F_{0.1}$	0.127	0.110	0.151
2020	$F_{current}$	0.103	0.085	0.126
2017	$F_{0.1}$	0.110	0.102	0.120
2017	$F_{current}$	0.078	0.065	0.096

Table 4. W-BFT Stock Synthesis**.** Estimated key parameter values in the 2017 and 2020 Stock Synthesis models for the western stock. Values in parenthesis are standard deviation for each parameter.

		Model 1 (Late maturity)		Model 2 (Early maturity)		Estimation
		2020 model	2017 model	2020 model	2017 model	
Growth	Length at Age 0.5 (L_{young})	42.98 (-)	42.98 (-)	42.98 (-)	42.98 (-)	fixed
	Length at Age 34 (L_{old})	264.07 (0.75)	263.33 (0.79)	264.05 (0.75)	263.278 (0.79)	estimated
	Growth rate K	0.30 (0.0090)	0.25 (0.0066)	0.30 (0.0090)	0.25 (0.0065)	estimated
	Richards coefficients	-0.95 (0.076)	-0.47 (0.056)	-0.94 (0.076)	-0.45 (0.056)	estimated
	CV of length at Age 0.5	0.090 (0.0056)	0.10 (0.0061)	0.090 (0.0056)	0.10 (0.0060)	estimated
	CV of length at Age 34	0.070 (0.0016)	0.067 (0.0016)	0.070 (0.0016)	0.067 (0.0016)	estimated
Stock recrutiment	Ln(R0)	6.38 (0.035)	6.46 (0.038)	6.38 (0.035)	6.47 (0.038)	estimated
	Steepness	0.63 (0.030)	0.55 (0.027)	0.54 (0.029)	0.47 (0.024)	estimated
	Sigma R	0.79 (0.091)	0.71 (0.088)	0.77 (0.090)	0.68 (0.085)	estimated
Initial F	US_TRAP	0.016 (0.0024)	0.013 (0.0020)	0.016 (0.0024)	0.013 (0.0019)	estimated
	USA_CAN_HARPOON	0.0015 (-)	0.0015 (-)	0.0015 (-)	0.0015 (-)	fixed
Ln(Q)	US_RR_GT177	-4.82 (0.070)	-4.51 (0.079)	-4.51 (0.070)	-4.83 (0.079)	estimated
	CAN_GSLNS	-5.12 (0.062)	-5.60 (0.072)	-4.40 (0.062)	-5.13 (0.072)	estimated
	CAN_ACOUSTIC	-5.81 (0.11)	-5.60 (0.13)	-5.60 (0.11)	-5.82 (0.13)	estimated

Table 5-a. E-BFT VPA. The probabilities, estimated in the 2020 assessment, of $F<F_{0.1}$ for quotas from 18,000 to 50,000 t for 2021 through 2025 under the long-term average (1968-2007) recruitment scenario. Shading corresponds to the probabilities of being in the ranges of 50-59%, 60-69%, 70-79%, 80-89% and greater or equal to 90%. For all scenarios, catches for 2019 and 2020 are assumed to be equal to 32,240 t and 36,000 t, respectively. Note that the Group does not have confidence in the projections used to produce this Kobe matrix and it is NOT recommended for management advice.

TAC (mt) \ year	2021	2022	2023	2024	2025
18000	100	100	100	100	100
20000	100	100	100	100	100
22000	100	100	100	100	100
24000	100	100	100	100	100
26000	100	100	100	100	100
28000	100	99	100	100	100
30000	99	99	99	100	100
31000	99	99	99	99	100
32240	99	99	99	99	99
33000	99	99	99	99	99
34000	99	99	99	99	99
35000	99	99	99	99	99
36000	99	98	98	98	98
37000	98	98	98	97	97
38000	98	98	97	97	96
39000	97	96	96	96	95
40000	96	95	95	94	93
45000	88	86	84	81	78
50000	70	65	60	55	51

$P(F < F_{0.1})$: 50 60 70 80 90 100

Table 5-b. E-BFT VPA. The probabilities, estimated in the 2017 assessment, of F<F0.1 for quotas from 0 to 50,000 t for 2018 through 2022 under the recent 6 years (2006-2011) recruitment scenario. Shading corresponds to the probabilities of being in the ranges of 50-59%, 60-69%, 70-79%, 80-89% and greater or equal to 90%. Catches for 2016 and 2017 are assumed to be equal to the 2016 and 2017 TAC in all scenarios.

Catch (t)	2018	2019	2020	2021	2022
18,000	100	100	100	100	100
20,000	99	99	99	99	99
22,000	99	99	98	98	98
23,655	98	98	98	98	98
24,000	98	98	97	98	97
26,000	97	96	96	96	96
28,000	95	94	94	94	94
30,000	93	92	92	90	89
31,000	90	90	89	89	88
32,000	89	88	87	86	83
33,000	86	85	83	81	80
34,000	82	81	79	78	75
35,000	79	77	76	72	70
36,000	75	73	70	68	64
37,000	70	68	65	62	59
38,000	65	63	60	57	54
39,000	59	57	54	52	49
40,000	56	52	49	46	44
45,000	36	35	34	30	28
50,000	24	22	20	18	18

Table 6. W-BFT VPA. VPA recruitment estimates (age-1 abundance) of bluefin tuna in the West Atlantic for the period 2008 to 2015, used to define mean future recruitment scenarios, and projection scenarios and recruitment specifications.

YEAR	MEDIAN	AVERAGE	STD_DEV.	CV
2008	126,050	127,381	18,441	0.14
2009	132,300	134,765	20,116	0.15
2010	103,500	105,655	17,245	0.16
2011	45,025	45,659	6,420	0.14
2012	95,540	97,137	19,712	0.20
2013	60,380	61,296	10,685	0.17
2014	25,125	26,219	6,144	0.23
2015	34,300	34,854	8,246	0.24
Geometric Mean 2010-15	53,392			
Geometric Mean 2008-13	87,484			
2017 Projections	95,562			

model	maturity	recruitment assumption	scenario
VPA	late	status quo	3-year patch: replace recruitment (age1) in 2016-2018 (3 years) with the average recruitment between 2010-2015
VPA	early	status quo	3-year patch: replace recruitment (age1) in 2016-2018 (3 years) with the average recruitment between 2010-2015
VPA	late	5-year patch	replace recruitment (age1) in 2014-2018 (5 years) with the average recruitment between 2008-2013
VPA	early	5-year patch	replace recruitment (age1) in 2014-2018 (5 years) with the average recruitment between 2008-2013

Table 7. W-BFT VPA**.** Probability of Not Overfishing (F apical <$F_{0.1}$) bluefin tuna in the West Atlantic, based on model projections from VPA, averaged across both recruitment and maturity specifications.

TAC	2021	2022	2023	2024	2025
0	100%	100%	100%	100%	100%
1000	100%	99%	98%	97%	96%
1250	96%	93%	87%	82%	80%
1500	82%	73%	66%	61%	58%
1550	79%	69%	63%	57%	55%
1600	74%	65%	59%	54%	50%
1650	70%	59%	52%	47%	44%
1700	65%	53%	47%	41%	39%
1750	59%	49%	41%	37%	35%
1800	54%	42%	36%	33%	31%
1850	49%	38%	32%	28%	28%
1900	45%	33%	29%	26%	25%
1950	40%	29%	25%	24%	22%
2000	35%	25%	23%	21%	20%
2250	17%	13%	12%	10%	9%
2350	13%	9%	8%	7%	6%
2500	7%	5%	3%	3%	2%
2750	2%	1%	1%	1%	1%
3000	1%	1%	0%	0%	0%

Table 8. W-BFT VPA**.** Predicted Yield at $F_{0.1}$ (in metric tons) of bluefin tuna in the West Atlantic in 2021 to 2023, based on VPA projections, averaged across both recruitment specifications.

Year	Predicted Yield at F0.1	80% CI Lower Limit	80% CI Upper Limit
2021	1,840 mt	1,411 mt	2,426 mt
2022	1,728 mt	1,291 mt	2,311 mt
2023	1,646 mt	1,194 mt	2,280 mt

Table 9. W-BFT-Stock Synthesis. Projection scenarios and recruitment specifications.

model	maturity	recruitment assumption	scenario
SS3	late	status quo	no patch, average recruitment between 2010-15 (89,000)
SS3	early	status quo	no patch, average recruitment between 2010-15 (89,000)
SS3	late	5 year patch	replace recruitment (age0) in 2013-2017 (5yr) with average recruitment between 2007-2012 (135,000)
SS3	early	5 year patch	replace recruitment (age0) in 2013-2017 (5yr) with average recruitment between 2007-2012 (135,000)

Table 10. W-BFT-Stock Synthesis**.** Probability of not overfishing bluefin tuna in the West Atlantic, based on integrated model projections from Stock Synthesis, averaged across both recruitment specifications.

TAC	2021	2022	2023	2024	2025
0	100%	100%	100%	100%	100%
1000	100%	100%	100%	100%	100%
1250	100%	100%	100%	100%	100%
1500	100%	98%	93%	92%	86%
1550	98%	96%	87%	84%	78%
1600	97%	88%	76%	68%	63%
1650	94%	74%	61%	50%	46%
1700	86%	60%	44%	36%	31%
1750	75%	47%	30%	20%	18%
1800	60%	31%	19%	14%	11%
1850	43%	18%	10%	5%	4%
1900	31%	13%	6%	3%	3%
1950	19%	5%	2%	1%	1%
2000	12%	3%	1%	0%	1%
2250	0%	0%	0%	0%	0%
2350	0%	0%	0%	0%	0%
2500	0%	0%	0%	0%	0%
2750	0%	0%	0%	0%	0%
3000	0%	0%	0%	0%	0%

Table 11. W-BFT-Stock Synthesis. Predicted yield at $F_{0.1}$ (in metric tons) of bluefin tuna in the West Atlantic in 2021 to 2023, based on Stock Synthesis projections. Predicted yield is calculated differently than for the Kobe matrix, in that the values shown here come from allocations based on fishing mortality, not on catch.

	Value	80% CI Lower Limit	80% CI Upper Limit
$F_{0.1}$	0.091	0.089	0.094

Year	Predicted Yield at $F_{0.1}$	80% CI Lower Limit	80% CI Upper Limit
2021	1,903 mt	1,723 mt	2,082 mt
2022	1,759 mt	1,588 mt	1,930 mt
2023	1,667 mt	1,502 mt	1,8321mt

Table 12. W-BFT. Kobe II matrix giving the probability that the fishing mortality rate (F) will be less than the F reference point (F≤F0.1, overfishing not occurring) over the next 3 years for alternative constant catches, based on two recruitment scenarios and the two maturity schedules equally averaged across the 2020 VPA and SS models, or a total of 8 scenarios.

TAC	2021	2022	2023
0	100%	100%	100%
1000	100%	100%	99%
1250	98%	96%	94%
1500	91%	86%	80%
1550	89%	82%	75%
1600	85%	76%	67%
1650	82%	67%	56%
1700	75%	57%	45%
1750	67%	48%	35%
1800	57%	37%	27%
1850	46%	28%	21%
1900	38%	23%	17%
1950	29%	17%	13%
2000	23%	14%	12%
2250	9%	6%	6%
2350	6%	5%	4%
2500	4%	2%	2%
2750	1%	1%	0%
3000	0%	0%	0%

Table 13. W-BFT. Percentage change in total stock biomass at the middle of the year relative to 2020 under alternative constant catch scenarios from the 2020 assessment, based on the projections from Stock Synthesis and VPA, averaged across 2 recruitment and 2 maturity specifications. Stock Synthesis and VPA projections come from averaging the deterministic model runs.

Catch	2021	2022	2023
1000	-4%	-4%	-4%
1250	-4%	-6%	-7%
1500	-5%	-7%	-10%
1550	-5%	-8%	-10%
1600	-5%	-8%	-11%
1650	-5%	-8%	-11%
1700	-5%	-9%	-12%
1750	-5%	-9%	-12%
1800	-5%	-9%	-13%
1850	-5%	-9%	-13%
1900	-5%	-10%	-14%
1950	-6%	-10%	-14%
2000	-6%	-10%	-15%
2250	-6%	-12%	-17%
2350	-6%	-13%	-18%
2500	-7%	-14%	-20%
2750	-7%	-15%	-23%
3000	-8%	-17%	-25%
F0.1	-5%	-9%	-12%

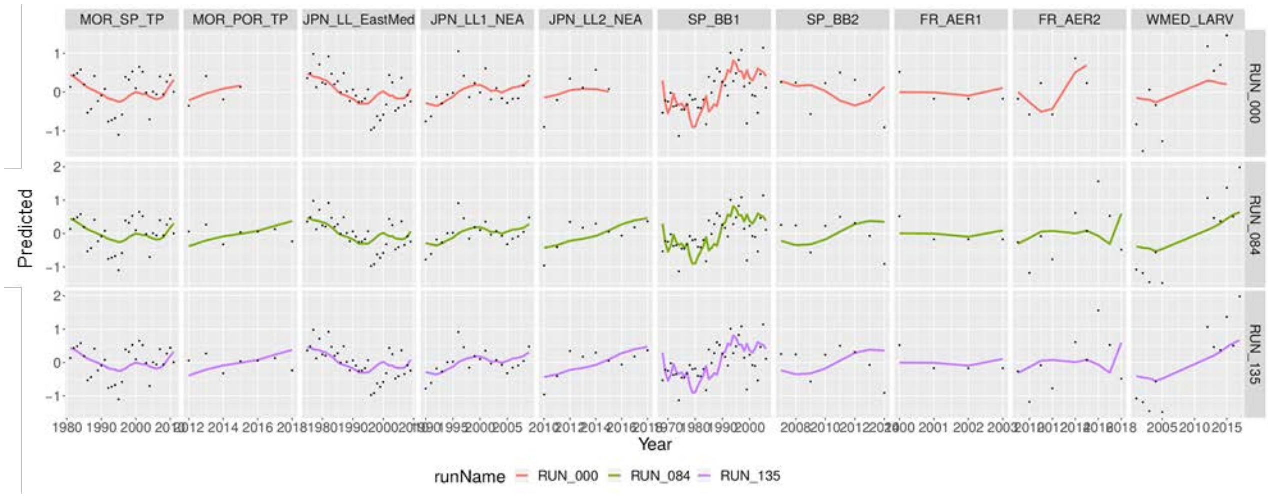


Figure 1. E-BFT VPA. Fit to the Moroccan Spanish trap index (MOR_SP_TP), Moroccan Portuguese trap index (MOR_POR_TP), Japanese longline eastern Mediterranean index (JPN_LL_EastMed), Japanese longline index in the Northeast Atlantic (early and late, JPN_LL1_NEA and JPN_LL2_NEA, respectively), Spanish Baitboat in the Bay of Biscay (early and late, SP_BB1 and SP_BB2, respectively), French aerial survey (early and late, FR_AER1 and FR_AER2, respectively) and Western Mediterranean Larval index (WMED_LARV) for Run 0 (2017 base case, the top row), Run 84 (update over 1968-2018, the middle row), and Run 135 (Model stabilization, the bottom row).

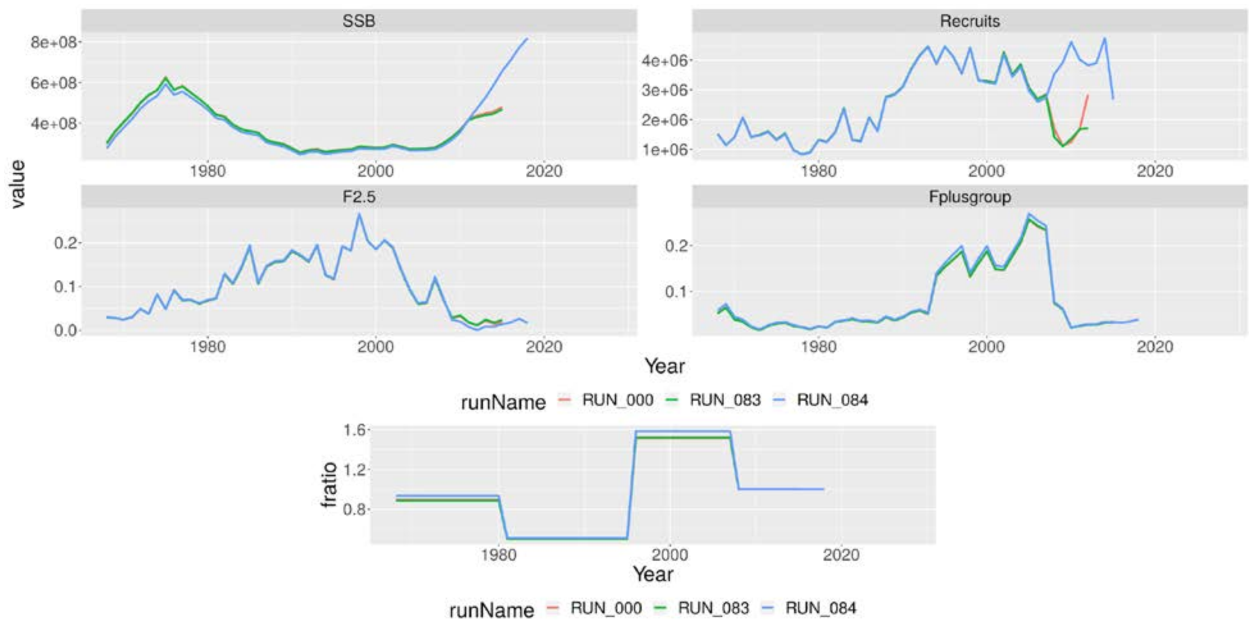


Figure 2. E-BFT VPA. Trends in spawning stock biomass (SSB), Recruitment (Recruits), fishing mortality for ages 2 to 5 (F2.5) and for the plus group (Fplusgroup), and time series of F-ratio obtained for Run 0 (2017 base case in red), Run 83 (update over 1968-2015 in green) and Run 84 (update over 1968-2018 in blue). The last 3 years of recruitment are not shown here, as it is common practice to discard the last years that are badly estimated in VPA.

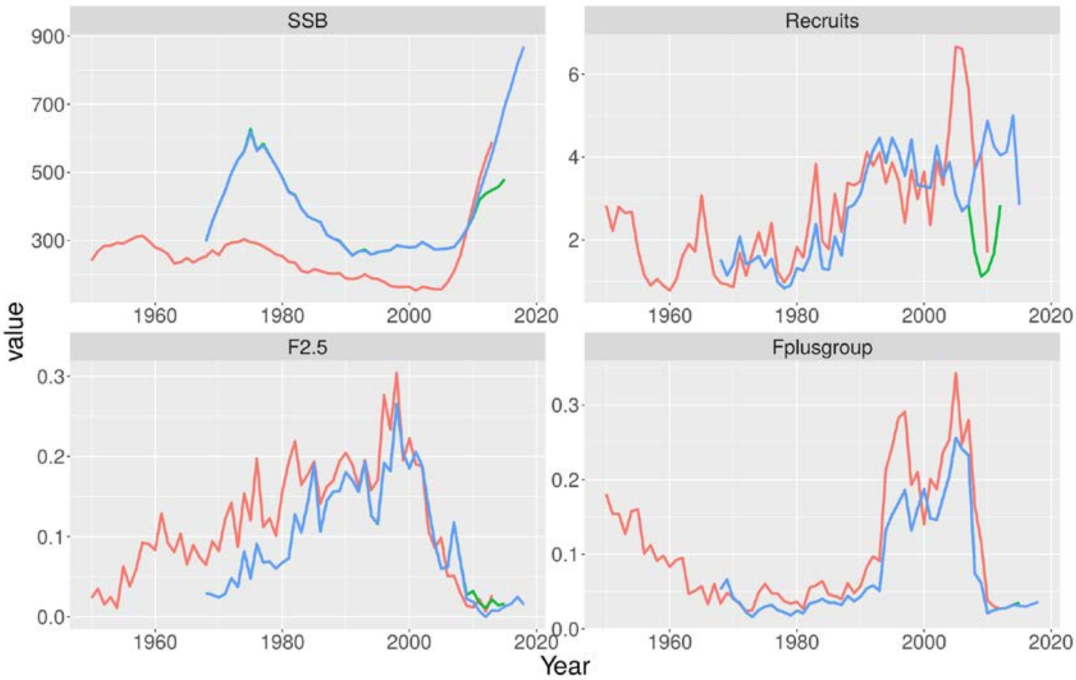
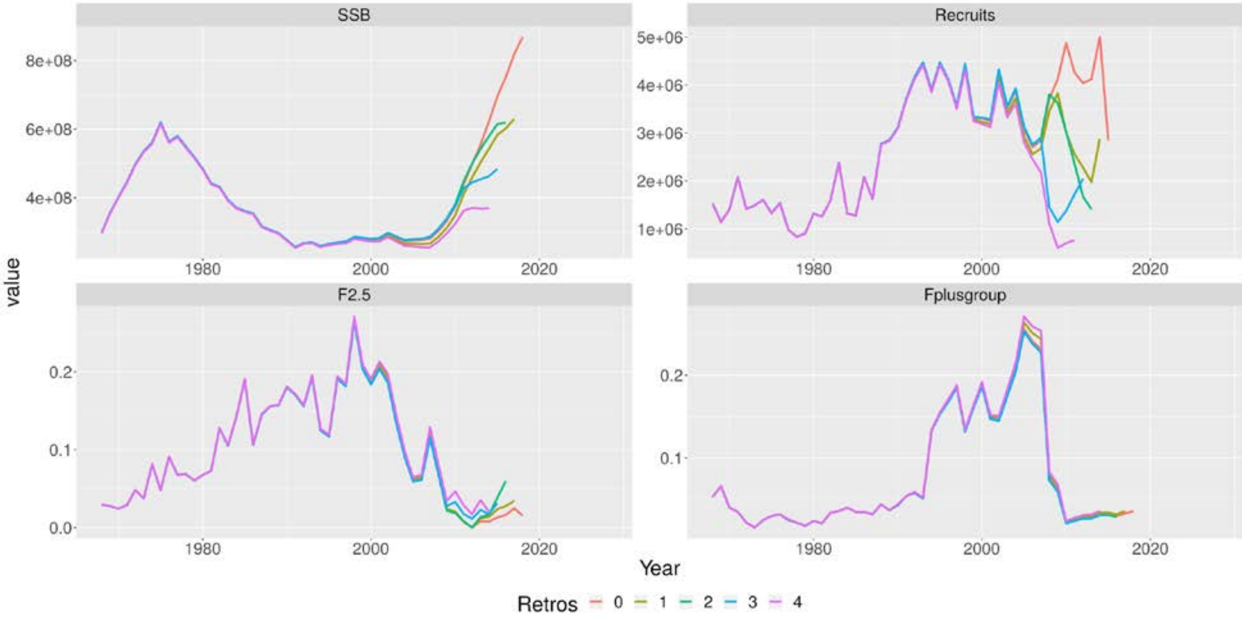


Figure 3. E-BFT VPA. Comparison of the trends in spawning stock biomass (SSB), Recruitment (Recruits), fishing mortality for ages 2 to 5 (F2.5) and for the plus group (Fplusgroup), and time series of F-ratio obtained for the base cases in 2020 (Run135, blue), 2017 (green), and 2014 (red).

a) 2020 base case



b) 2017 base case

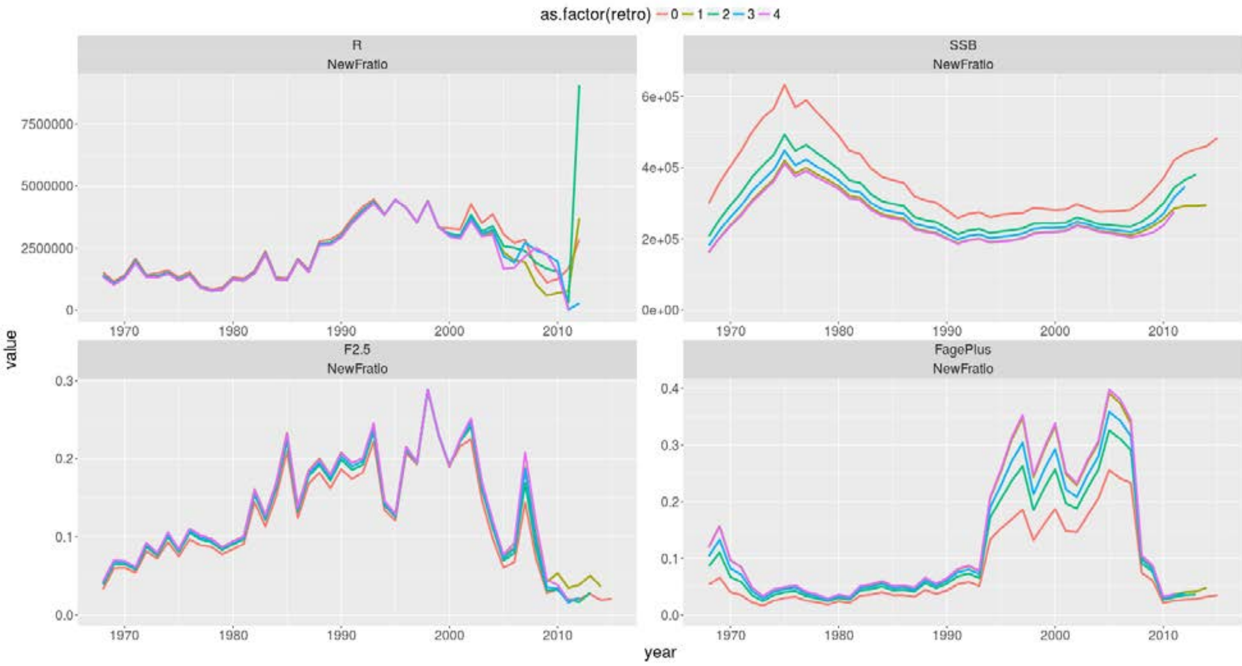


Figure 4. E-BFT VPA. Retrospective analysis obtained by sequentially removing the last 4 years of data for spawning stock biomass (SSB), Recruitment (Recruits), fishing mortality for ages 2 to 5 (F2.5) and for the plus group (Fplusgroup) and the F-ratio, for (a) the 2020 base case (Run 135), and (b) the 2017 base case.

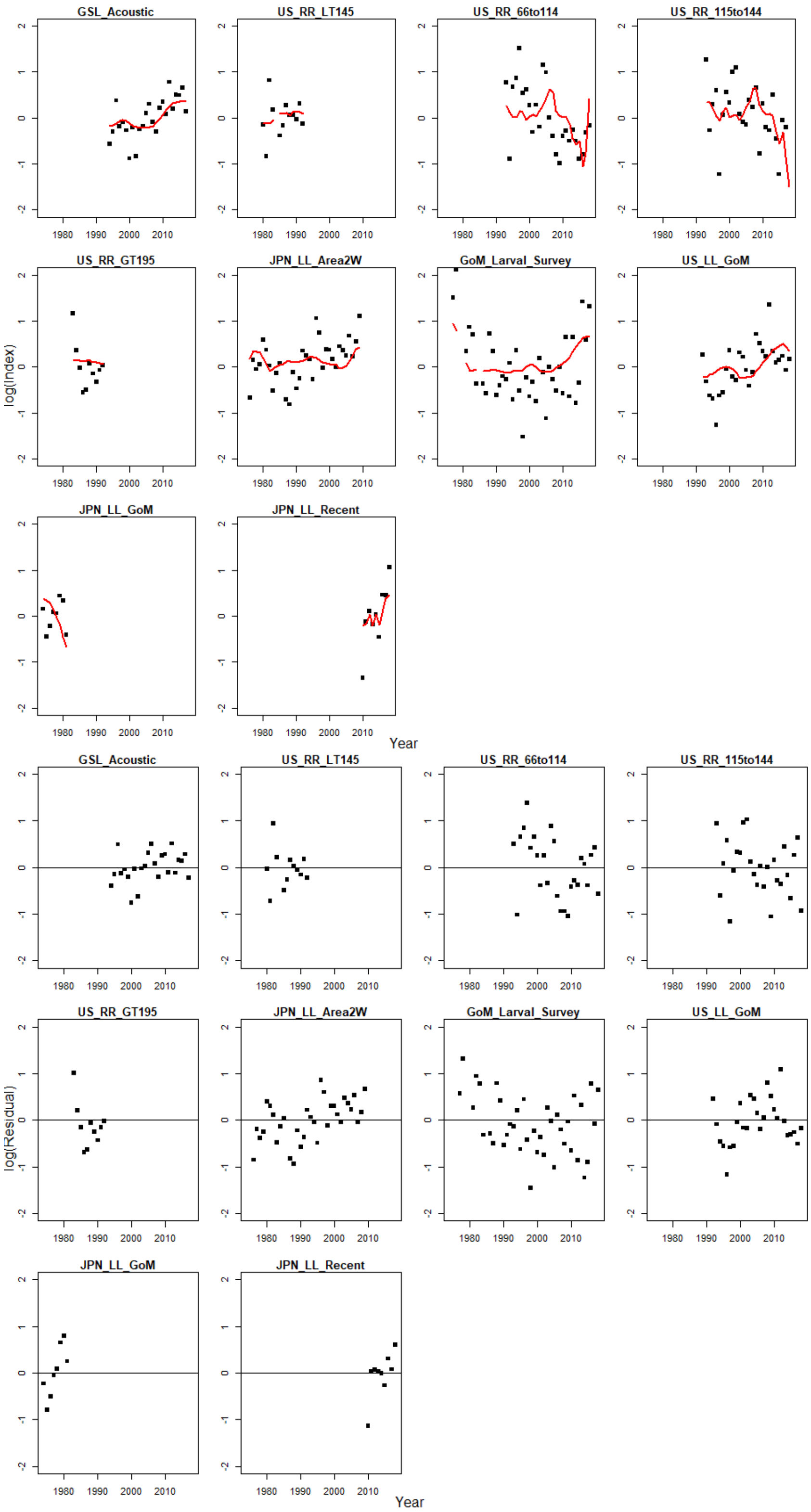
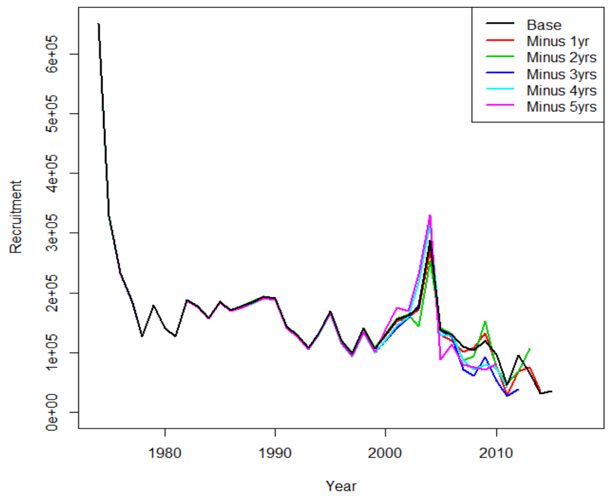


Figure 5. W-BFT VPA. Fits to CPUE indices and model residuals (log-scale) for the VPA base case assessment of the western stock (observed shown as points, model predicted shown as lines).



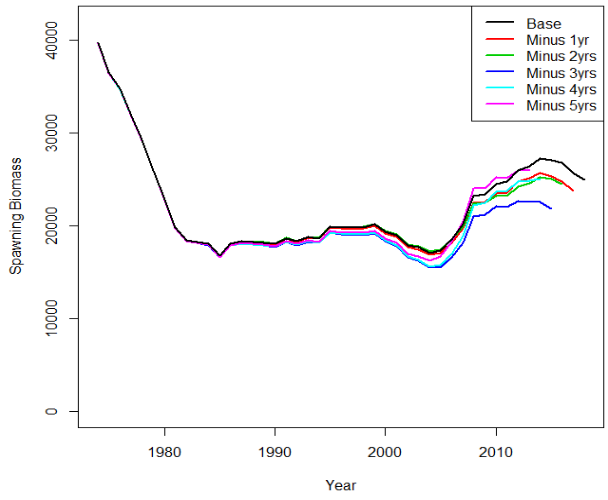


Figure 6. W-BFT VPA. Retrospective estimates of bluefin tuna recruitment (left panel) and spawning stock biomass (early maturity scenario, right panel) in the West Atlantic.

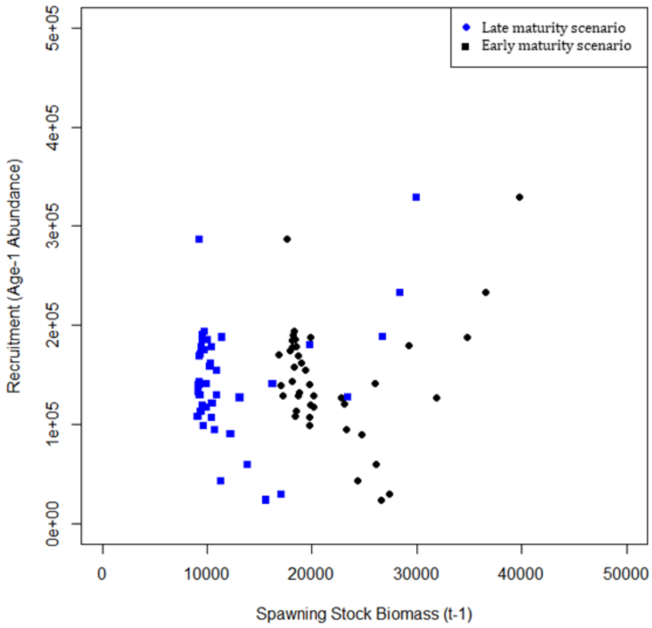


Figure 7. W-BFT VPA. Stock-recruitment estimates. The black points show the early maturity scenario and the blue points show the late maturity scenario.

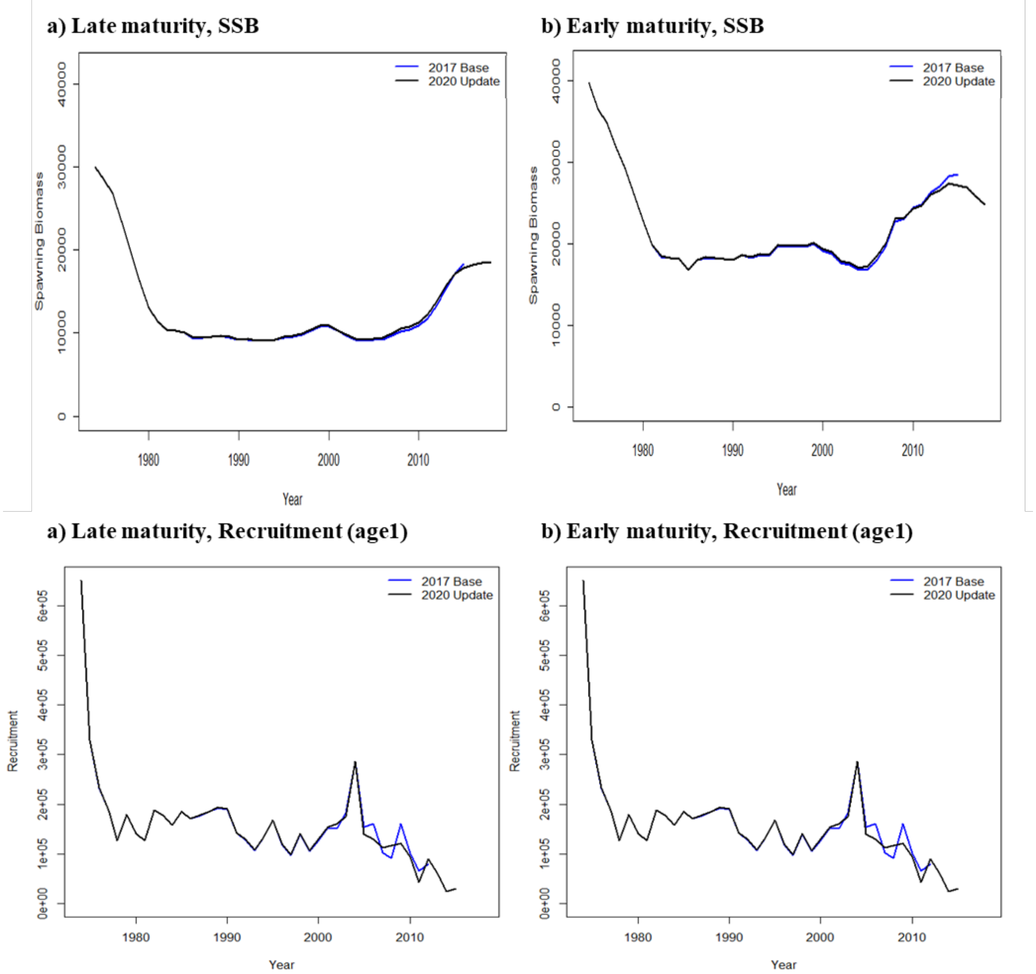


Figure 8. W-BFT VPA. Spawning stock biomass (upper panels) and recruitment estimates (age 1, lower panels) for (a) late (left panels) and (b) early maturity (right panels) scenarios of bluefin tuna in the West Atlantic compared to the 2017 assessment (blue lines).

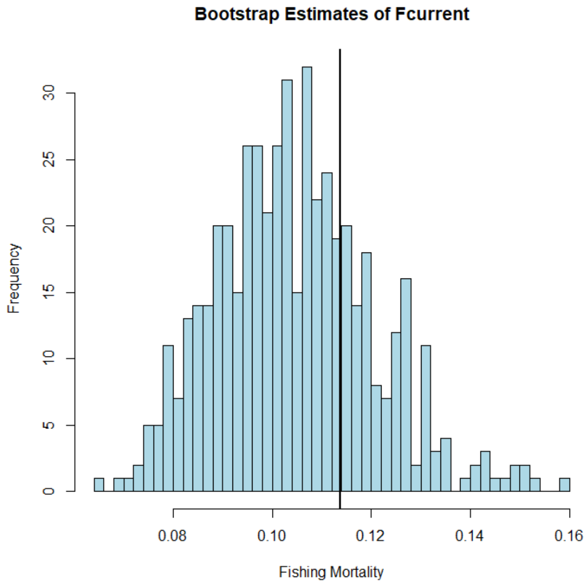


Figure 9. W-BFT VPA. Estimated current fishing mortality (2015 to 2017 mean apical F) of bluefin tuna in the West Atlantic. The blue histogram shows the distribution of estimates across bootstraps, and the vertical black line shows the deterministic run estimate.

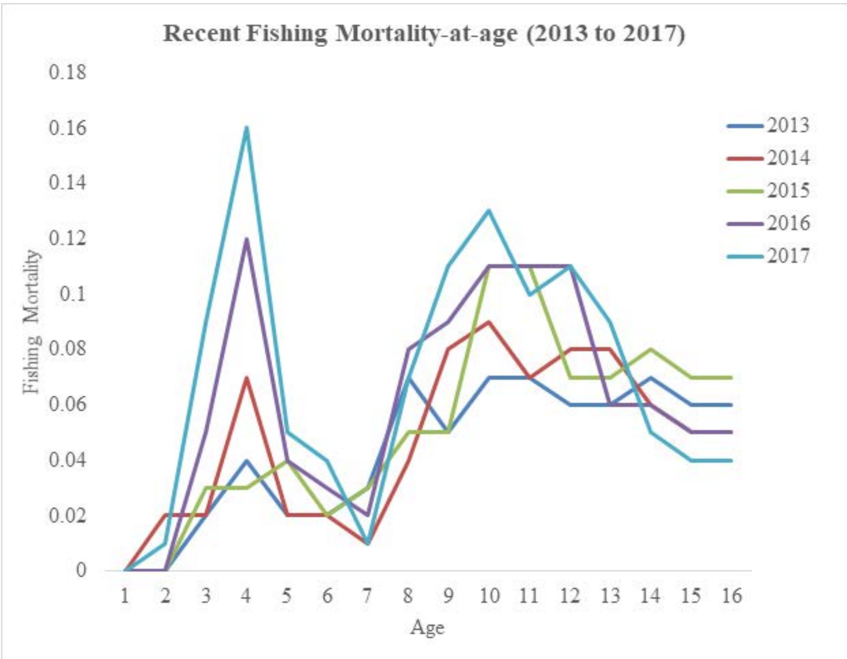


Figure 10. W-BFT VPA. Fishing mortality-at-age estimates of bluefin tuna in the West Atlantic during 2013 to 2017.

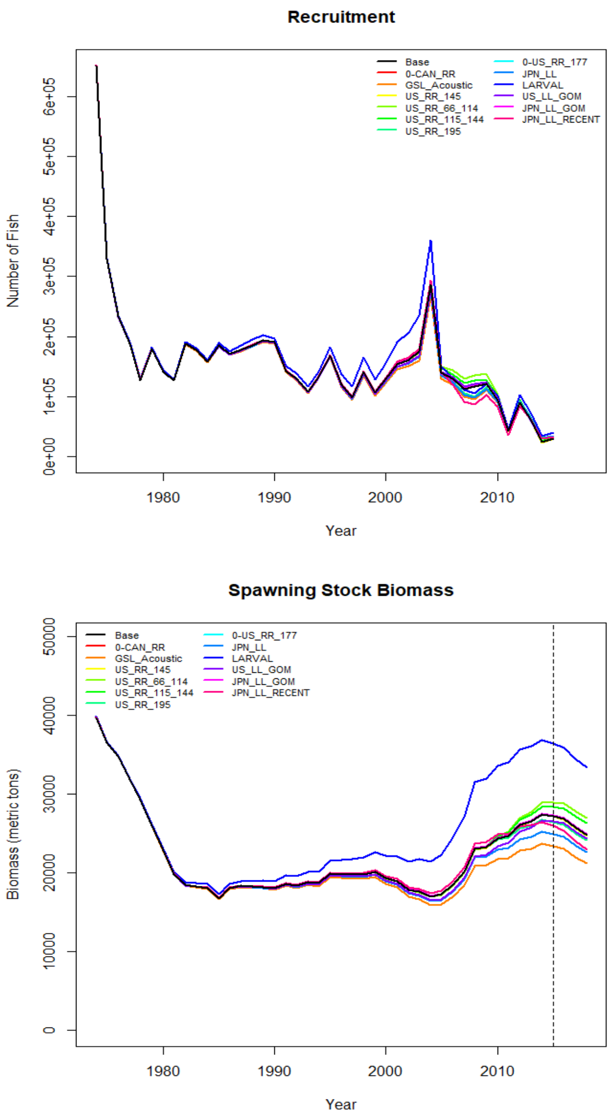
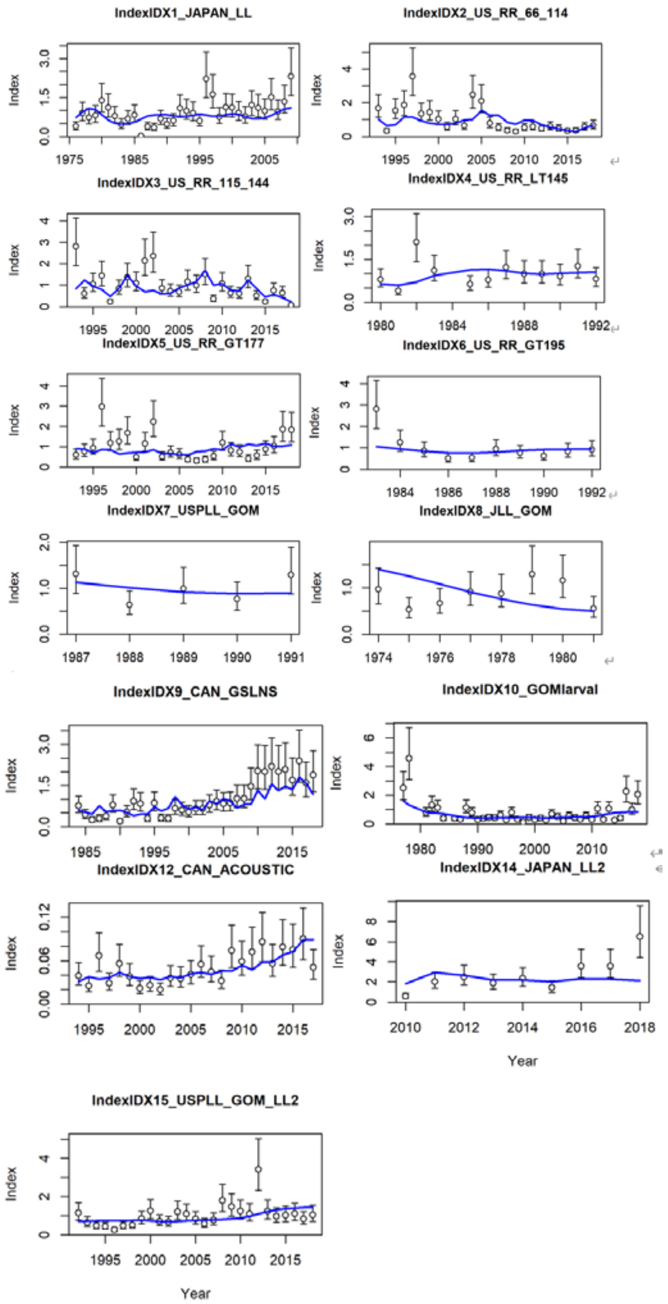


Figure 11. W-BFT VPA. Index jackknife effects on estimates of bluefin tuna recruitment (left panel) and spawning stock biomass (right panel, early maturity scenario) in the West Atlantic.


IndexIDX1_JAPAN_LL
IndexIDX2_US_RR_66_114
IndexIDX3_US_RR_115_144
IndexIDX4_US_RR_LT145
IndexIDX5_US_RR_GT177
IndexIDX6_US_RR_GT195
IndexIDX7_USPLL_GOM
IndexIDX8_JLL_GOM
IndexIDX9_CAN_GSLNS
IndexIDX10_GOMlarval
IndexIDX12_CAN_ACOUSTIC
IndexIDX14_JAPAN_LL2
IndexIDX15_USPLL_GOM_LL2
Index
Year

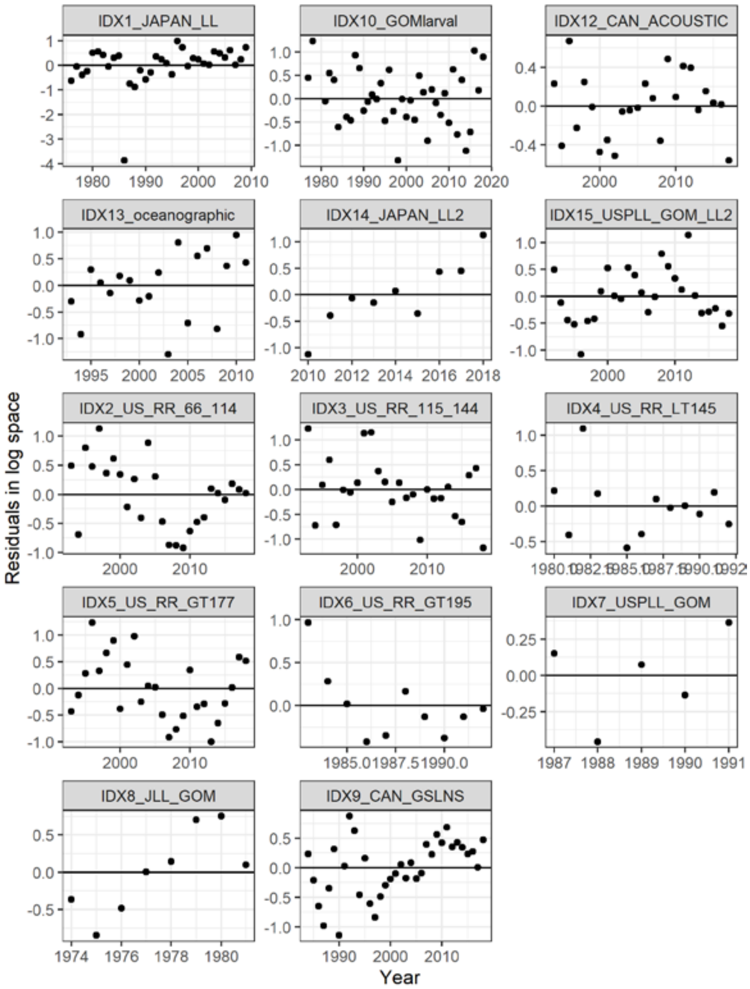


Figure 12. W-BFT Stock Synthesis. Fits to CPUE indices and model residuals (log-scale) for Stock Synthesis Run1 (assuming late maturity, and the results for Stock Synthesis Run2, early maturity, are not shown as they are nearly identical) for the western stock.

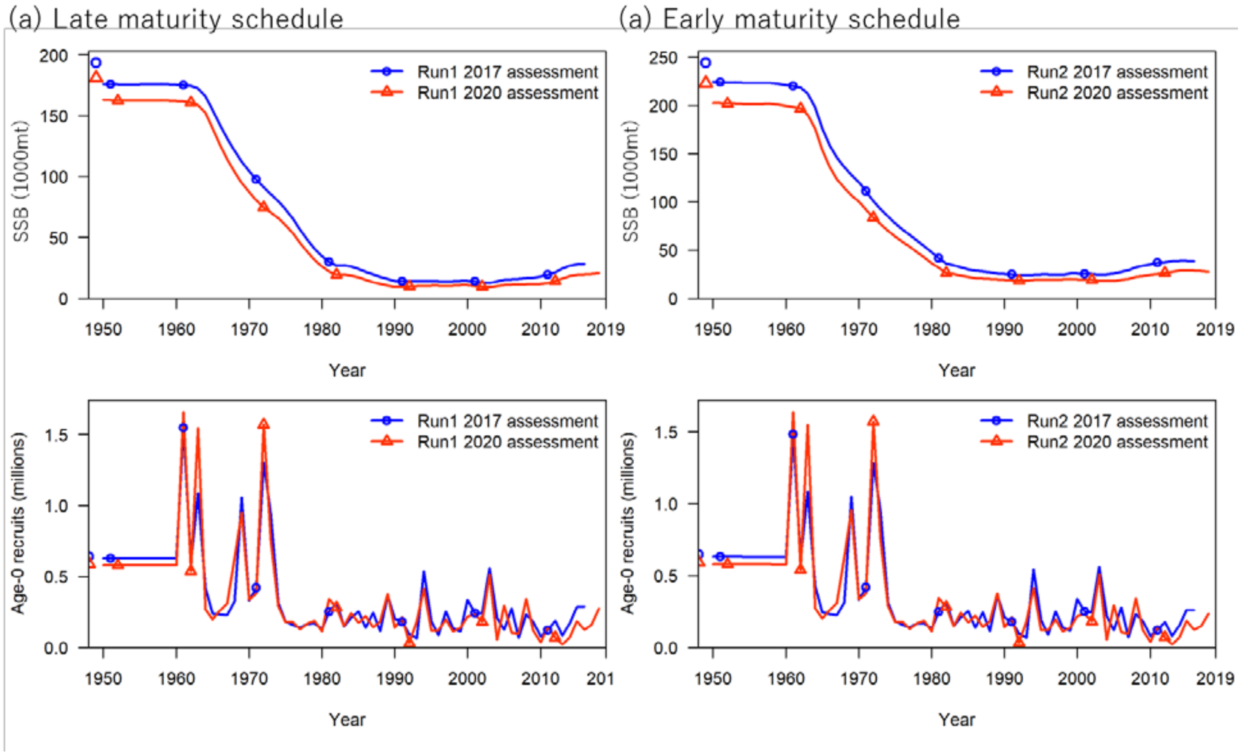
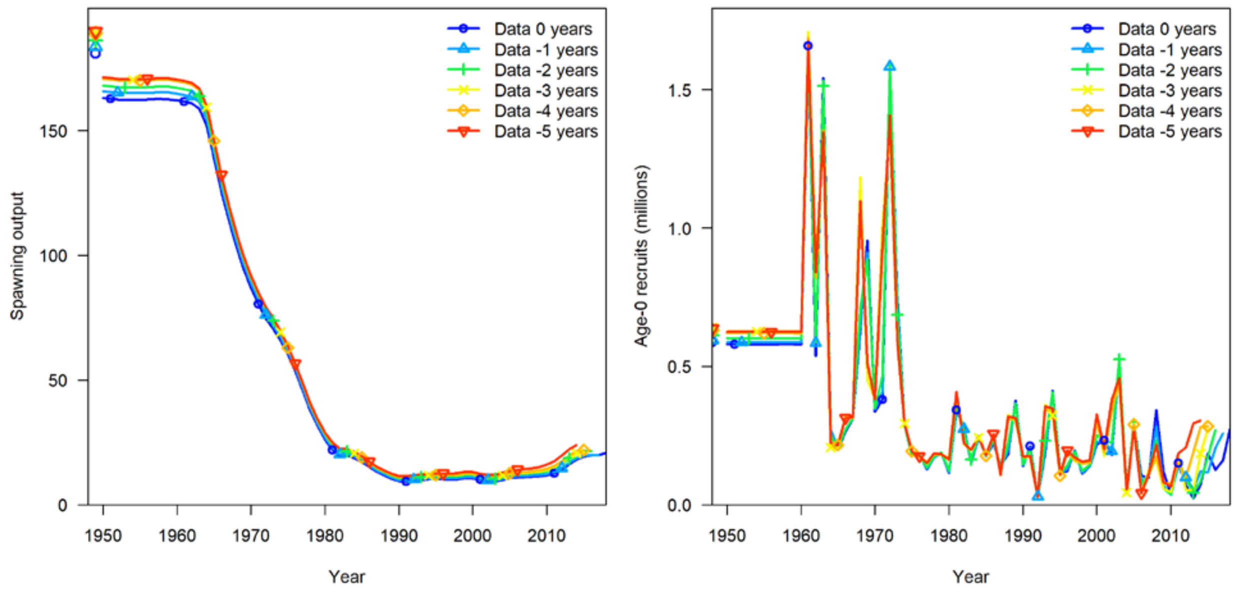


Figure 13. W-BFT Stock Synthesis. Comparison of 2017 (blue lines) and 2020 (red lines) SSB in 1000s mt and recruitment estimates for late and early maturity scenarios.

(a) Run 1 (last maturity)



(b) Run 2 (early maturity)

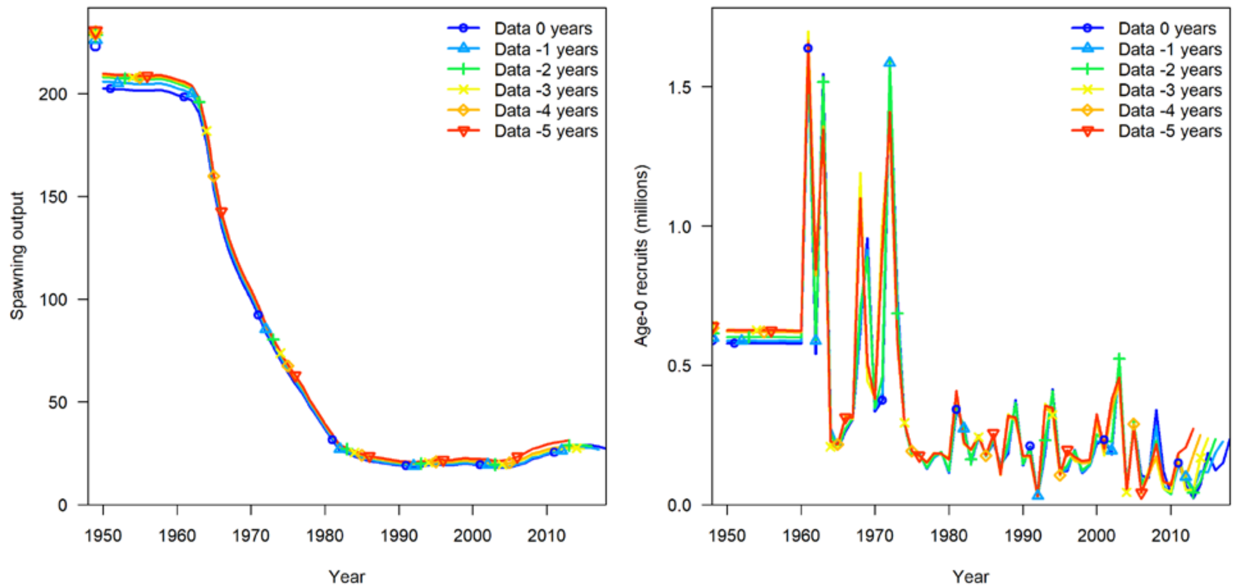


Figure 14. W-BFT Stock Synthesis. Retrospective plots of SSB and recruitment trends for (a) Run 1: late maturity scenario and (b) Run 2: early maturity scenario.

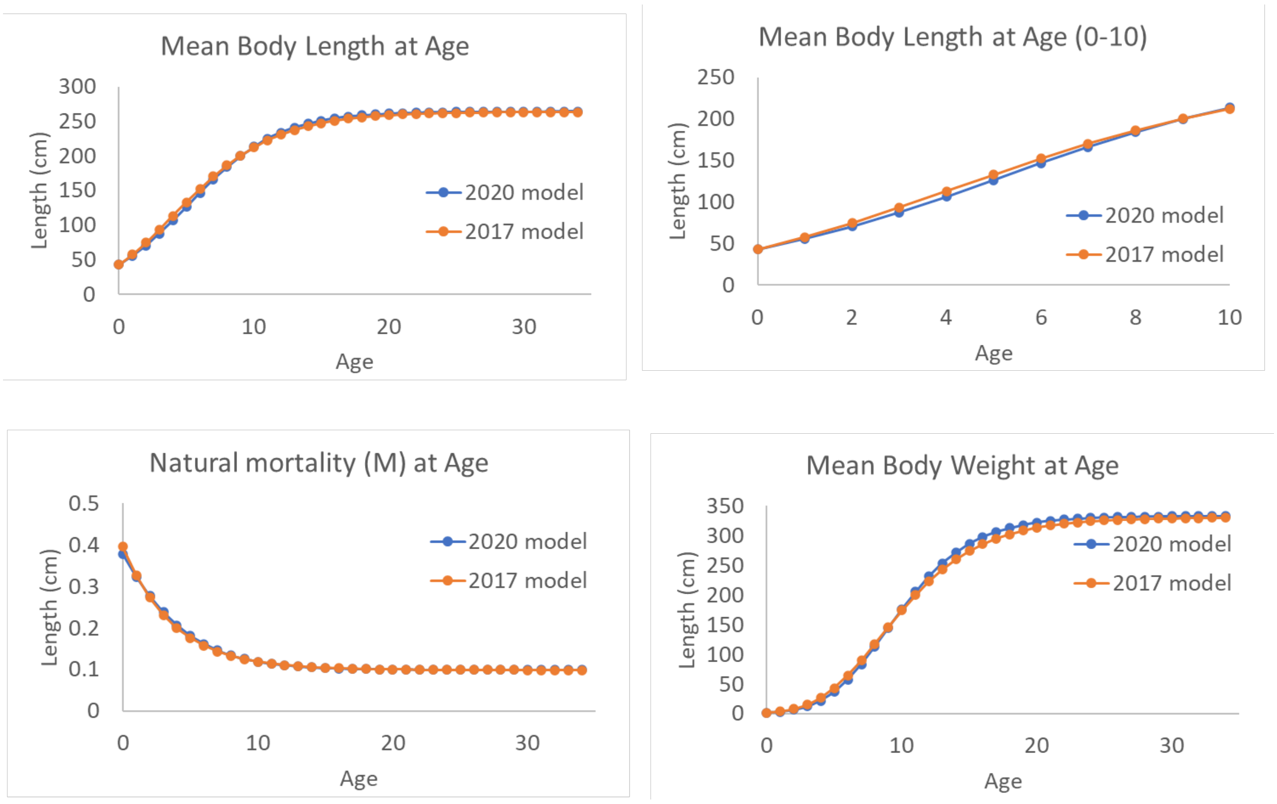


Figure 15. W-BFT Stock Synthesis. Biological parameters for the 2017 and 2020 assessments. Growth parameters were estimated in both 2017 and 2020.

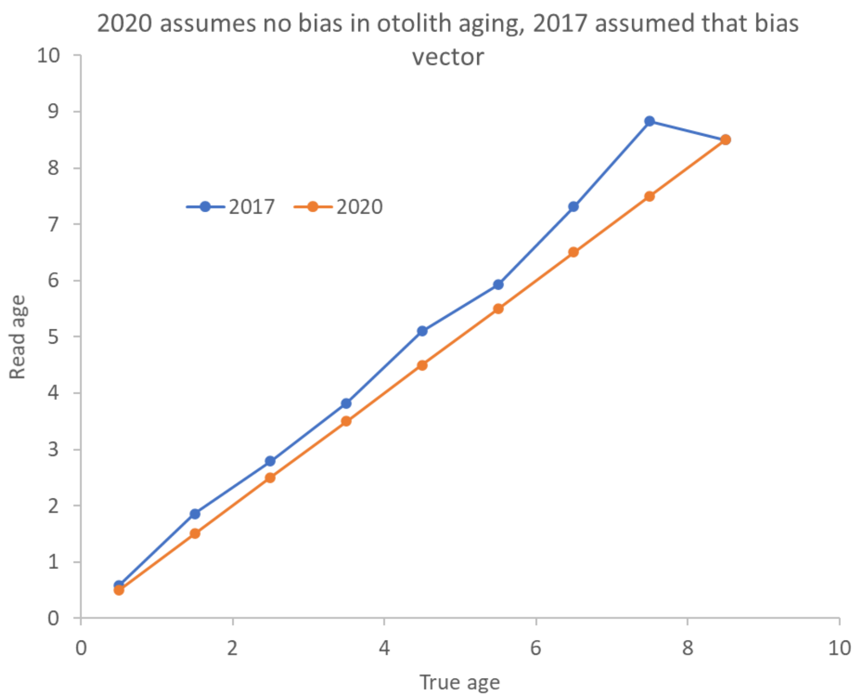


Figure 16. W-BFT Stock Synthesis. Otolith age-true age bias vector. In 2020 due to the revised aging protocol, no aging bias assumption was required.

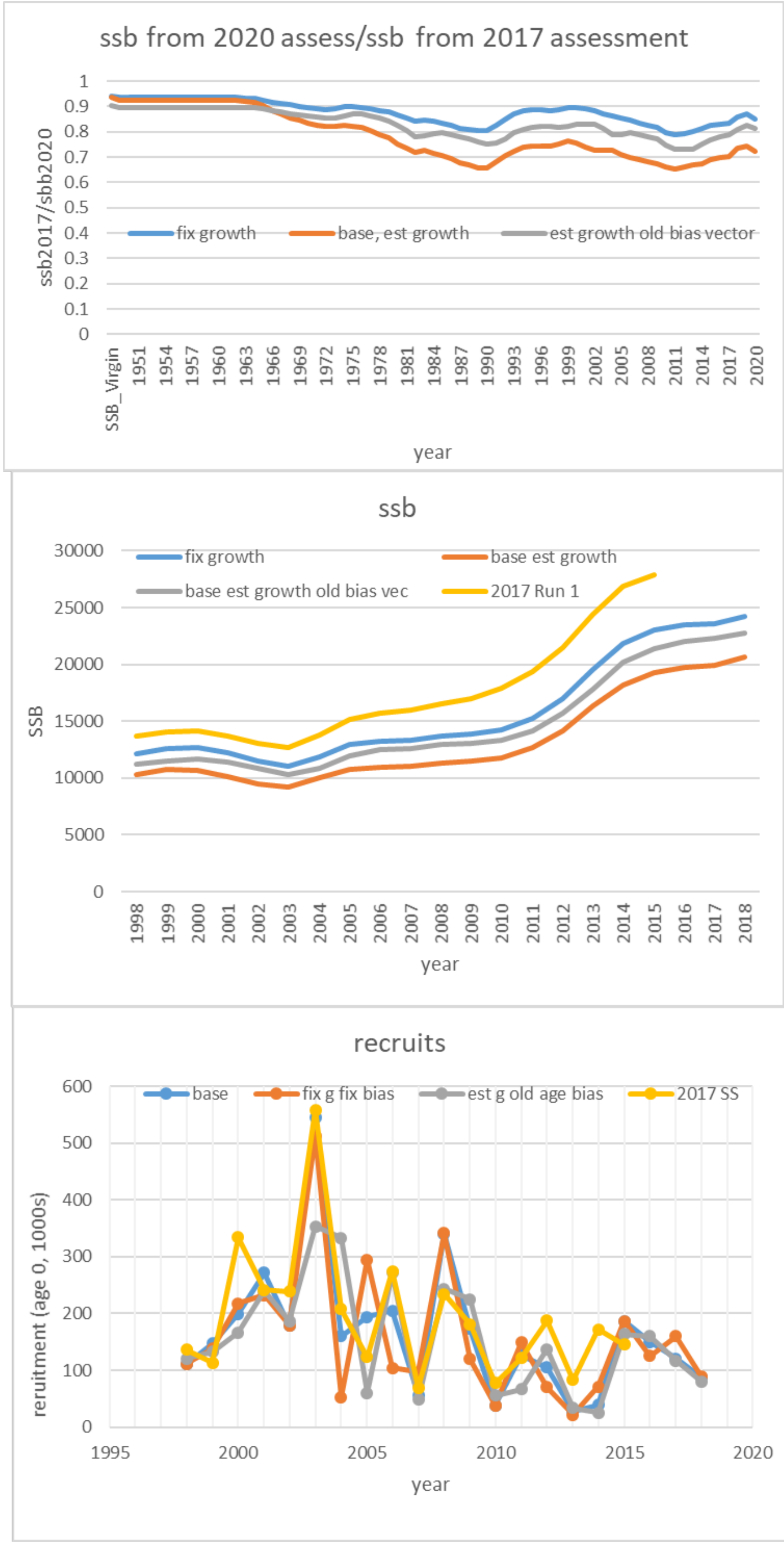


Figure 17. W-BFT Stock Synthesis. Sensitivity runs of 2020 base model (orange) base with fixed growth (blue line) and with estimated growth but with the 2017 bias vector (gray line) for a) ratio of SSB relative to the 2017 model SSB b) absolute SSB, which also shows the 2017 assessment model (yellow) and c) recruitment for the same four model runs. All sensitivities use only the late maturity run.

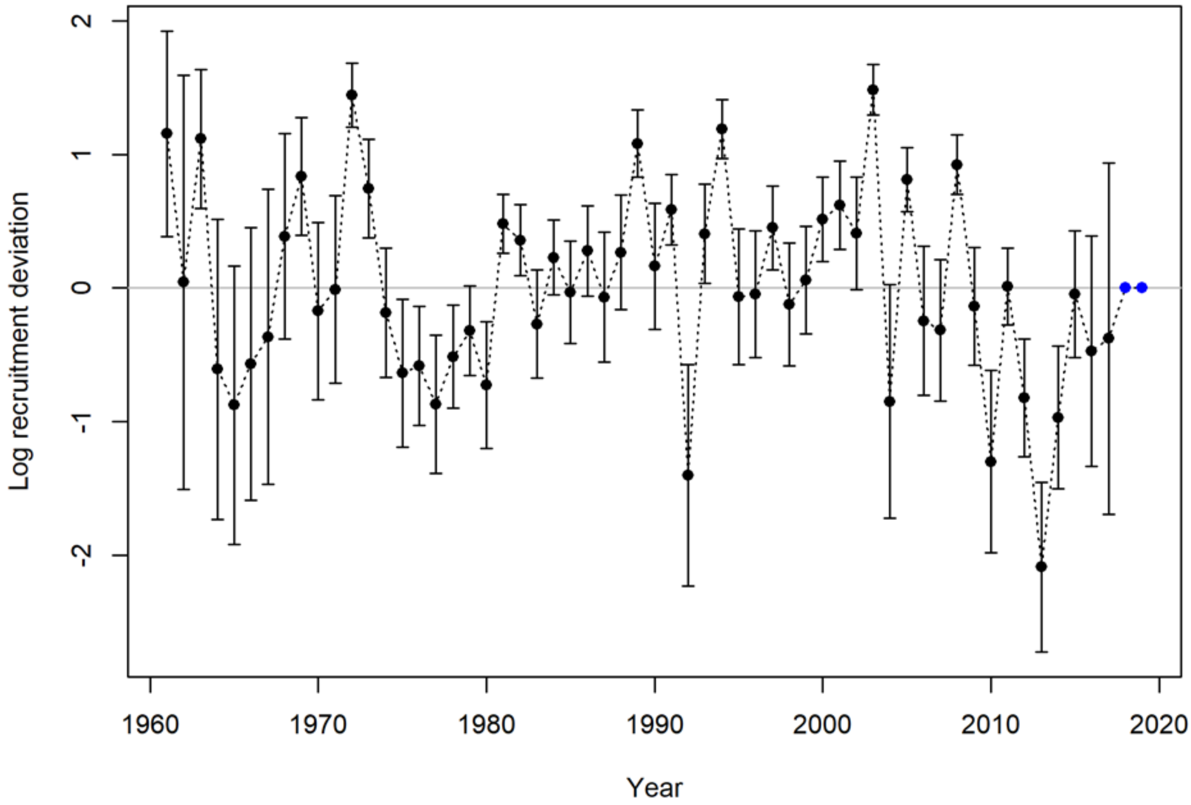


Figure 18. W-BFT Stock Synthesis. Recruitment deviations for W-BFT Stock Synthesis run 1 (late maturity scenario).

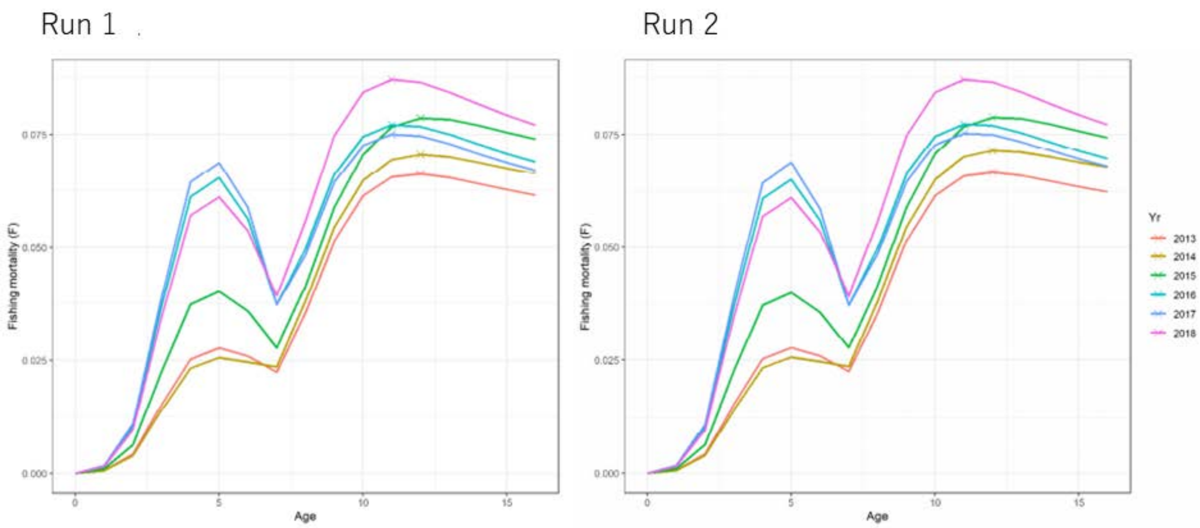


Figure 19. W-BFT Stock Synthesis. Fishing mortality (F) at age during 2013 to 2017 from Stock Synthesis for (a) Run 1: late maturity scenario and (b) Run 2: early maturity scenario.

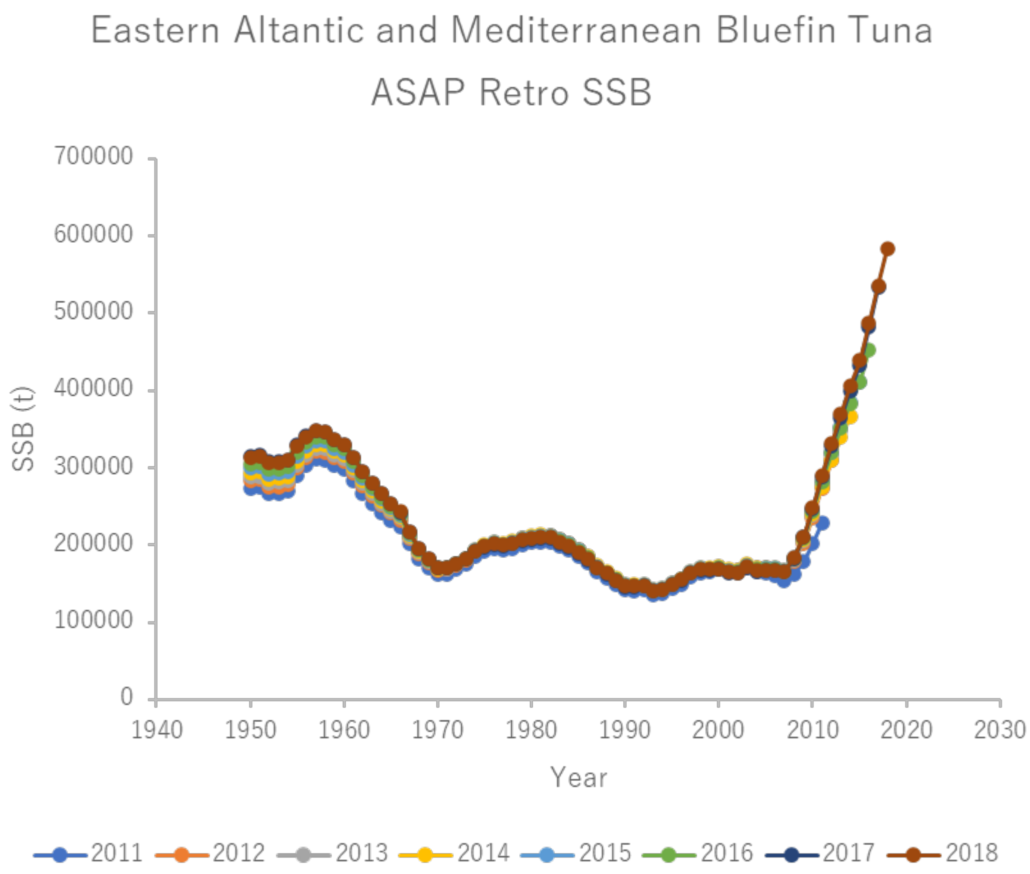


Figure 20. E-BFT ASAP. Retrospective SSB analysis by ASAP for E-BFT.

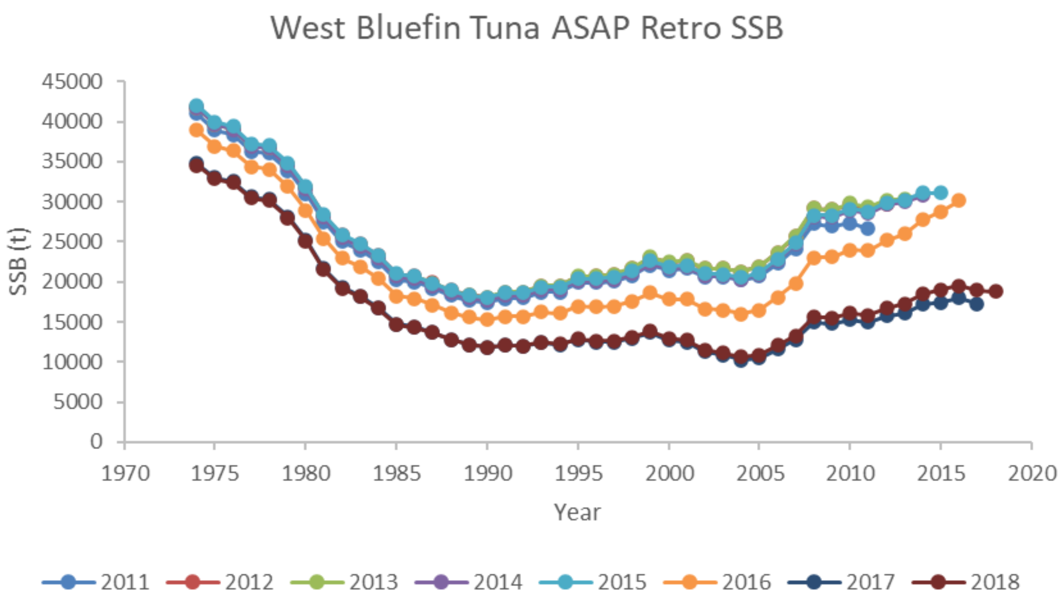


Figure 21. W-BFT ASAP. Retrospective SSB analysis by ASAP for W-BFT.

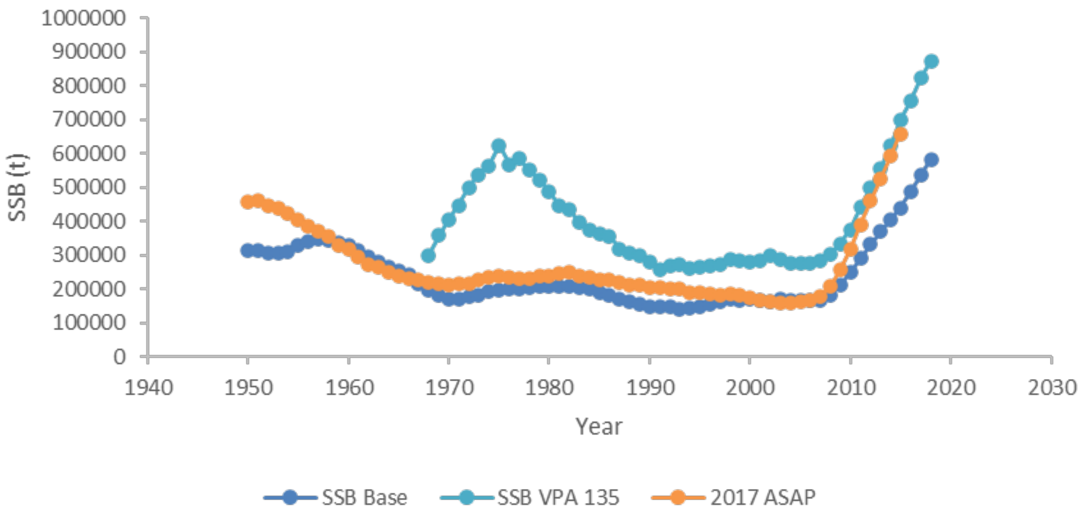


Figure 22. E-BFT ASAP. SSB by ASAP (SSB Base) compared with the VPA base case (Run 135). The orange line is from the 2017 ASAP run.

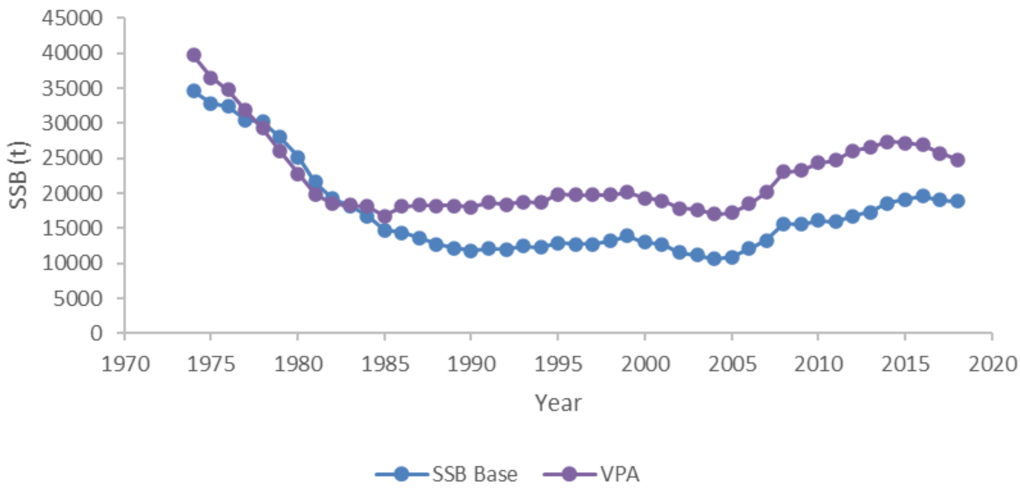


Figure 23. W-BFT ASAP. SSB by ASAP (SSB Base) compared with the VPA base case for early maturity scenario.

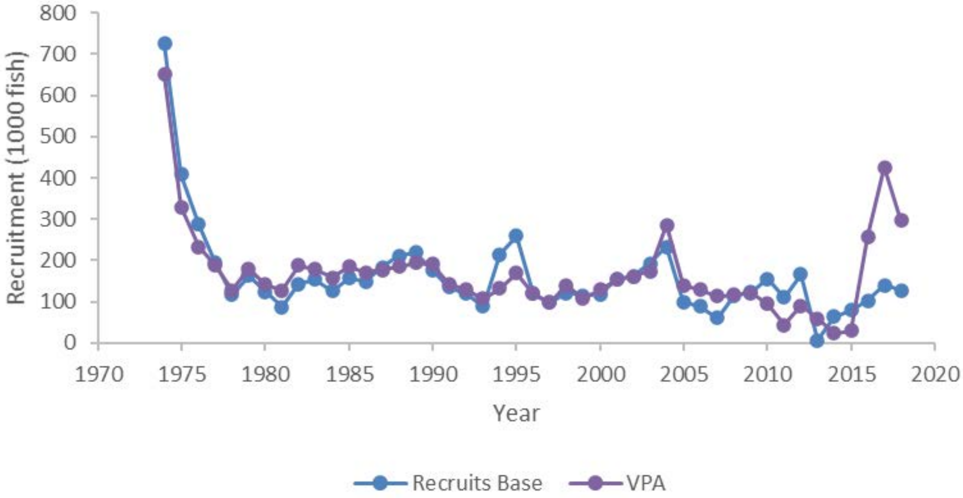


Figure 24. W-BFT ASAP. Recruitment by ASAP (SSB Base) compared with the VPA base case for early maturity scenario. The terminal three recruitments are removed from the VPA, but are shown here for comparison only.

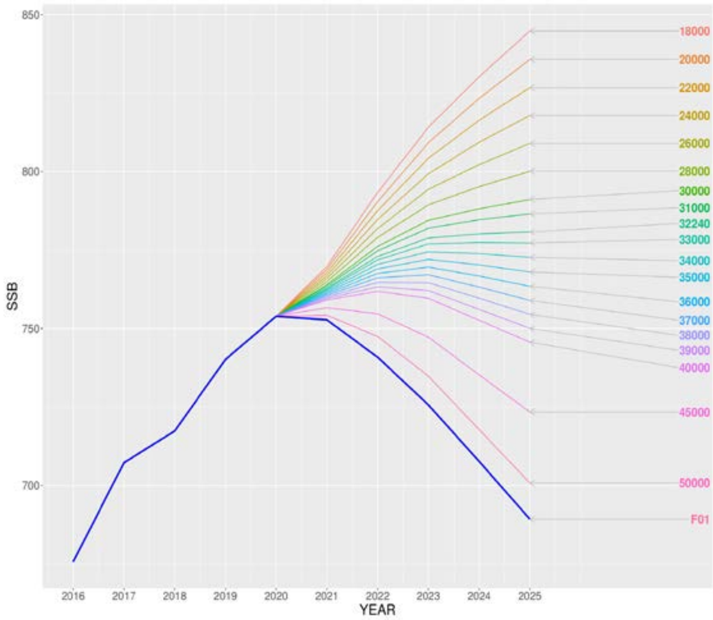


Figure 25-a. The 2020 projections of spawning stock biomass (in 1000s of metric ts) up to 2023 under the long-term average (1968-2007) recruitment scenario with various levels of constant catch starting in 2020. The TAC values for 2019 (32,240 t) and 2020 (36,000 t) were also used for the projections. Note that the Group does not have confidence in the projections and it is NOT recommended for management advice.

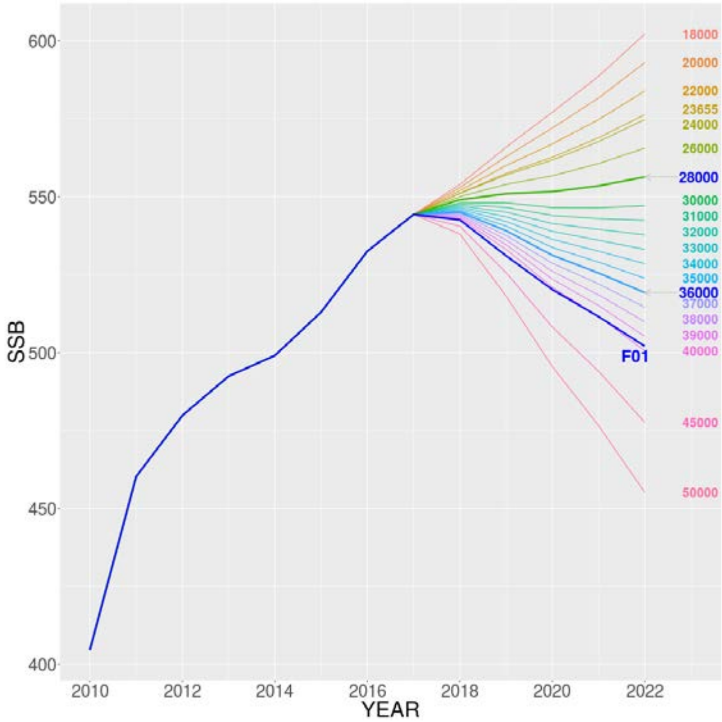


Figure 25-b. The 2017 projections (Anon., 2019a) of spawning stock biomass (in 1000s of metric t) up to 2022 under the recent 6 years (2006-2011) recruitment scenario with various levels of constant catch starting in 2018, assuming TAC is caught in 2016 and 2017. The TAC values for 2016 (19,296 t) and 2017 (23,655 t) were also used for the projection.

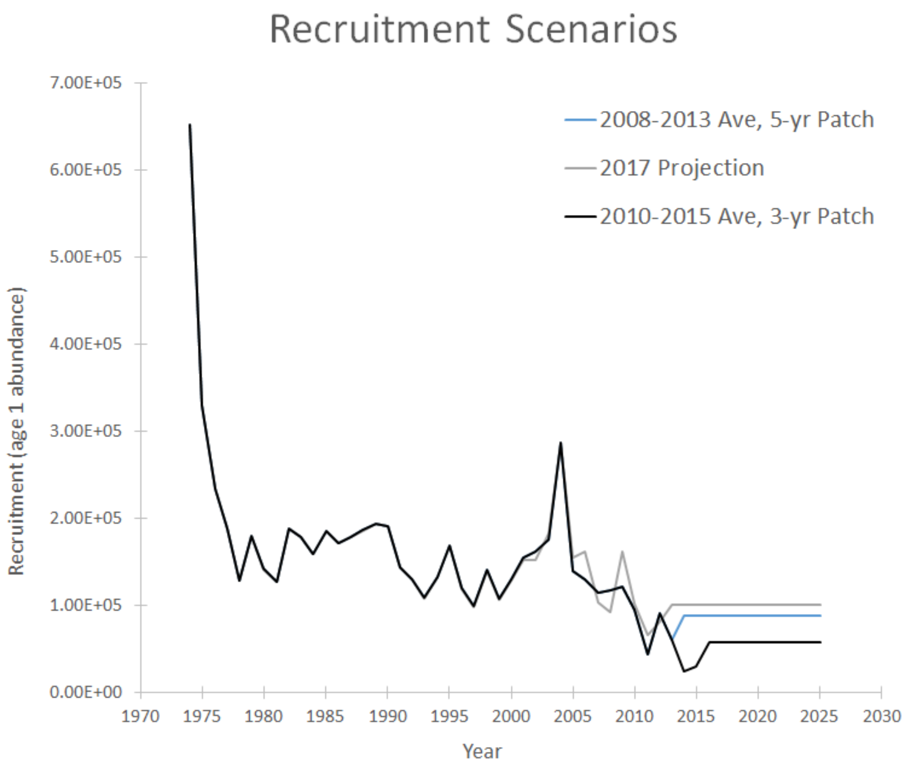


Figure 26. W-BFT VPA. Estimated recruitment of bluefin tuna in the West Atlantic. The black line shows the median of the bootstrap trials, and the gray shaded area shows the 80% confidence intervals (top chart), and alternative recruitment assumptions in stock projections (bottom chart).

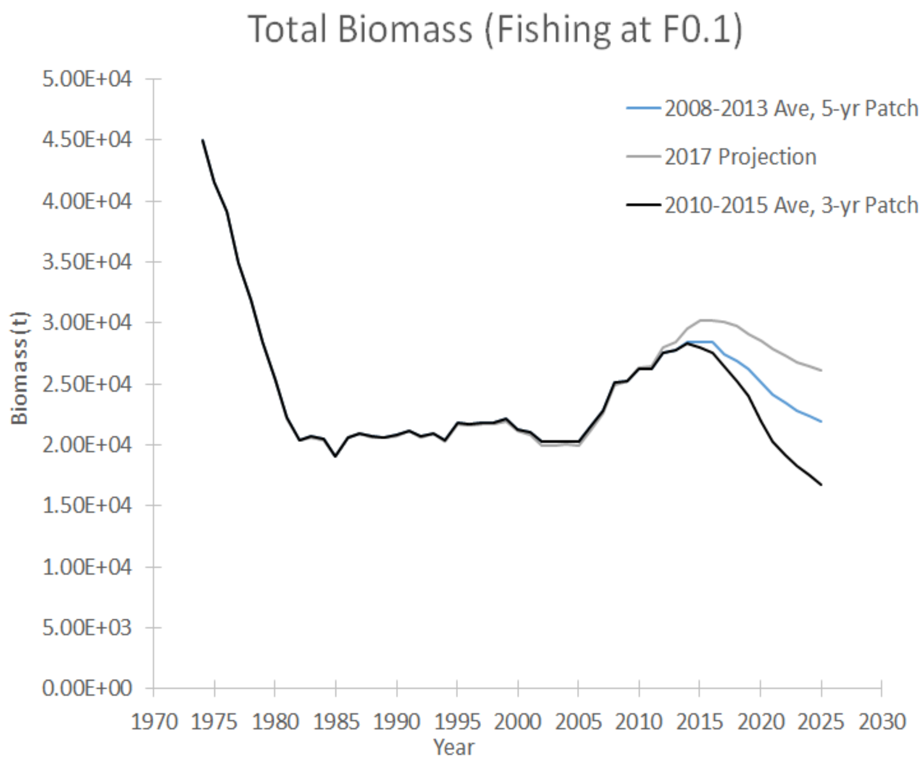


Figure 27. W-BFT VPA. VPA projected total stock biomass of bluefin tuna in the West Atlantic. The two recruitment scenarios (black and blue lines) are compared to the 2017 predictions (grey line).

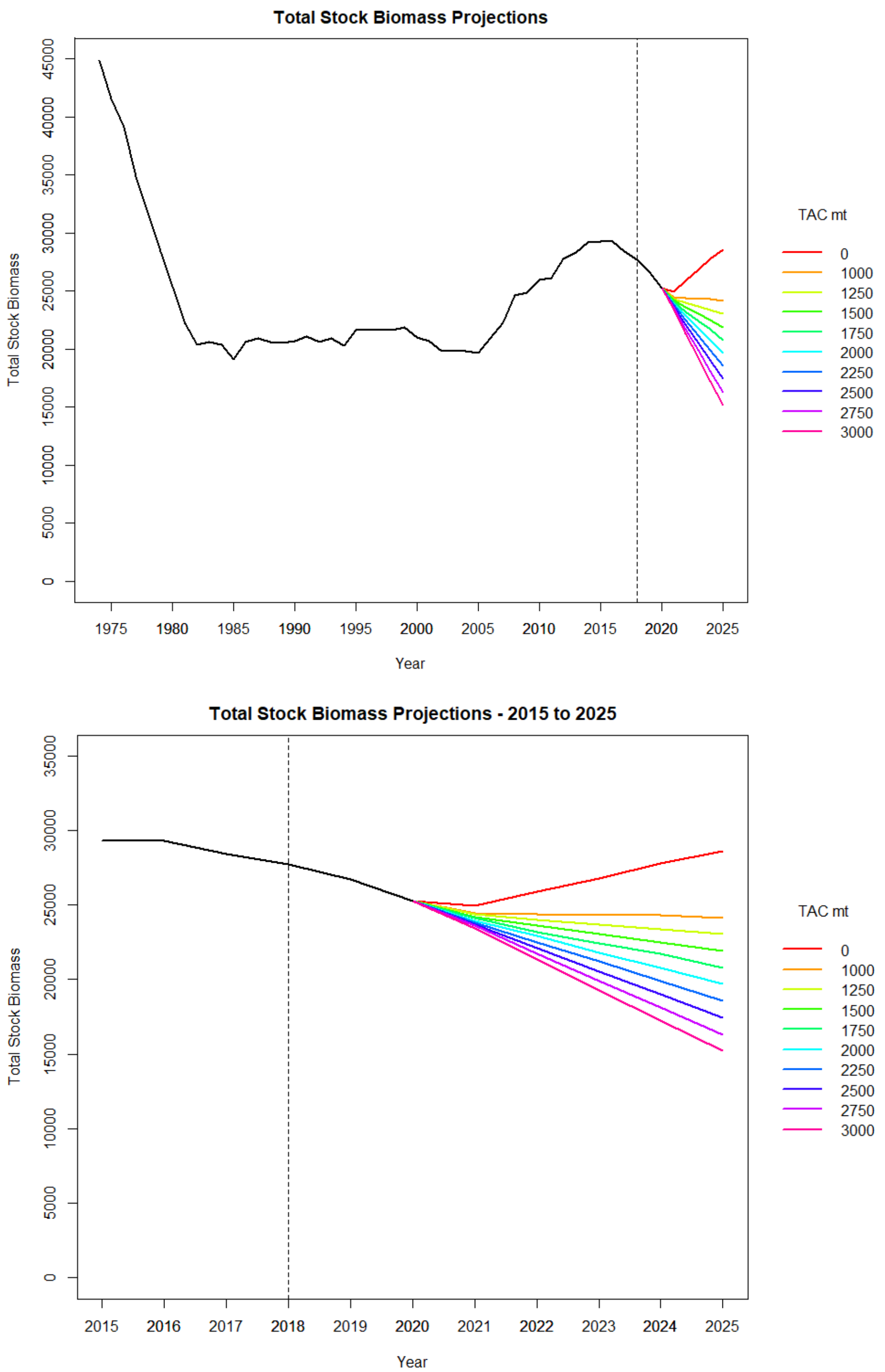


Figure 28. W-BFT VPA. Projected total stock biomass of bluefin tuna in the West Atlantic under alternative constant catch scenarios, averaged across both recruitment specifications. Upper panel: entire time series, Lower panel: zoomed in to 2015 to 2025.

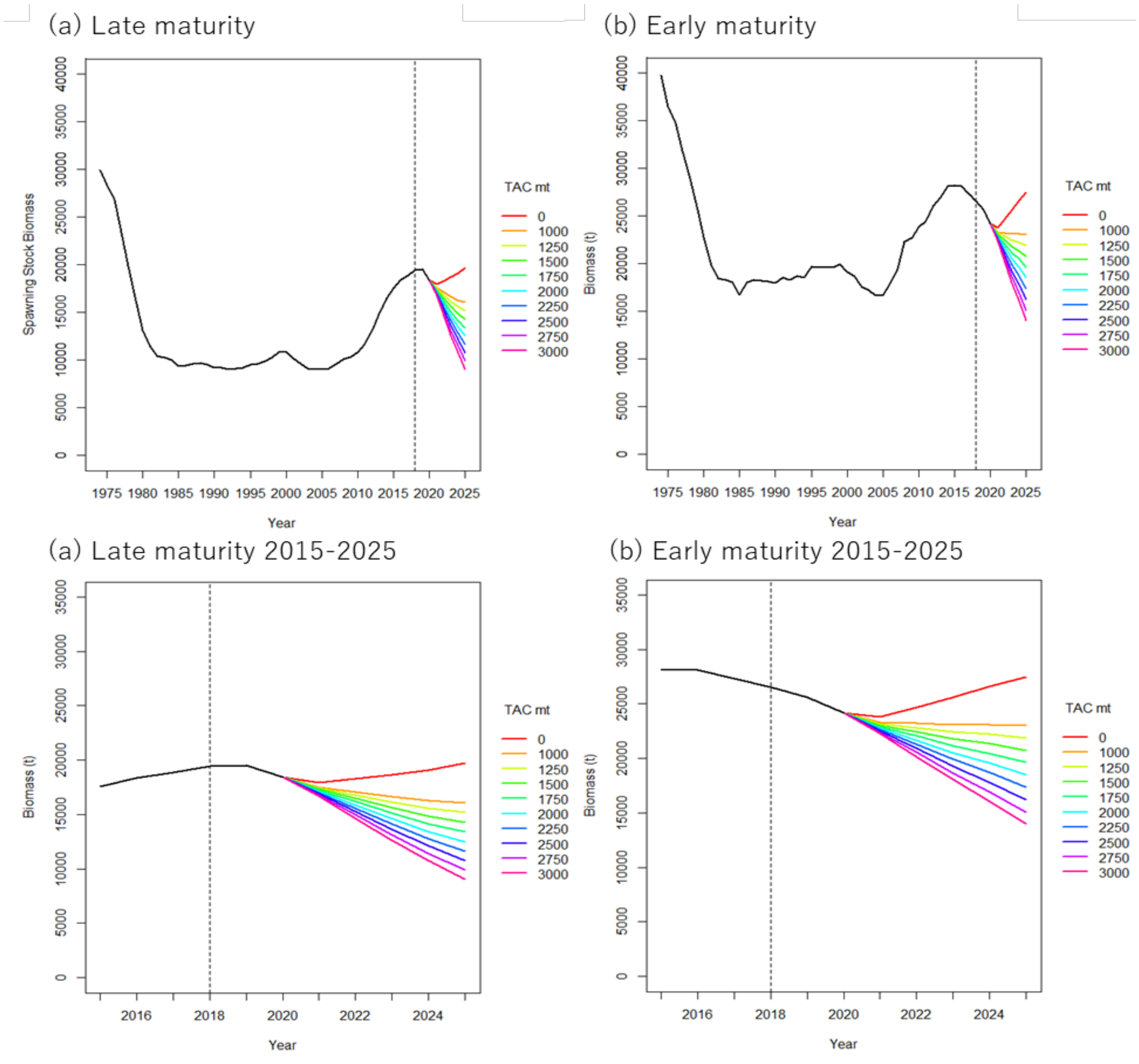


Figure 29. W-BFT VPA. Projected spawning stock biomass (SSB) of bluefin tuna in the West Atlantic under alternative constant catch scenarios, averaged across both recruitment specifications. Upper left: (a) late maturity scenario, upper right: (b) early maturity scenario, lower panels: zoomed in to 2015 to 2025.

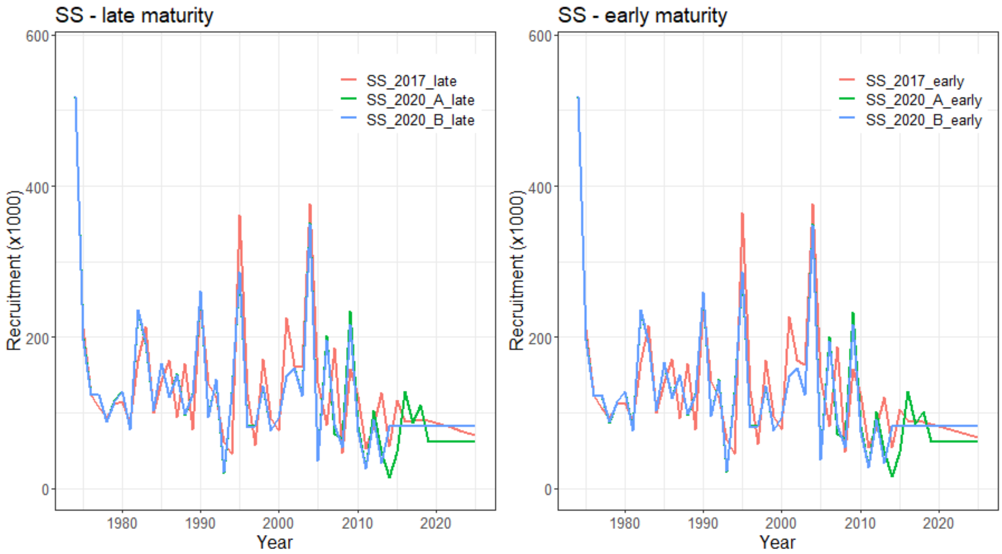


Figure 30. W-BFT Stock Synthesis. Projection settings for recruitment trends with $F_{0.1}$ for two recruitment assumption scenarios (A, status quo 2010-2015 average with only replacing 2018, green lines) and (B, 5-year patch using the 2007-2012 average and replacing years 2013-2018, blue lines) in model Runs 1 (late maturity) and 2 (early maturity). These are contrasted with the 2017 model and its recruitment specifications which was to use constant recruitment deviations (but not exactly constant recruitment) from the 6-year period 2007-2012 (red lines).

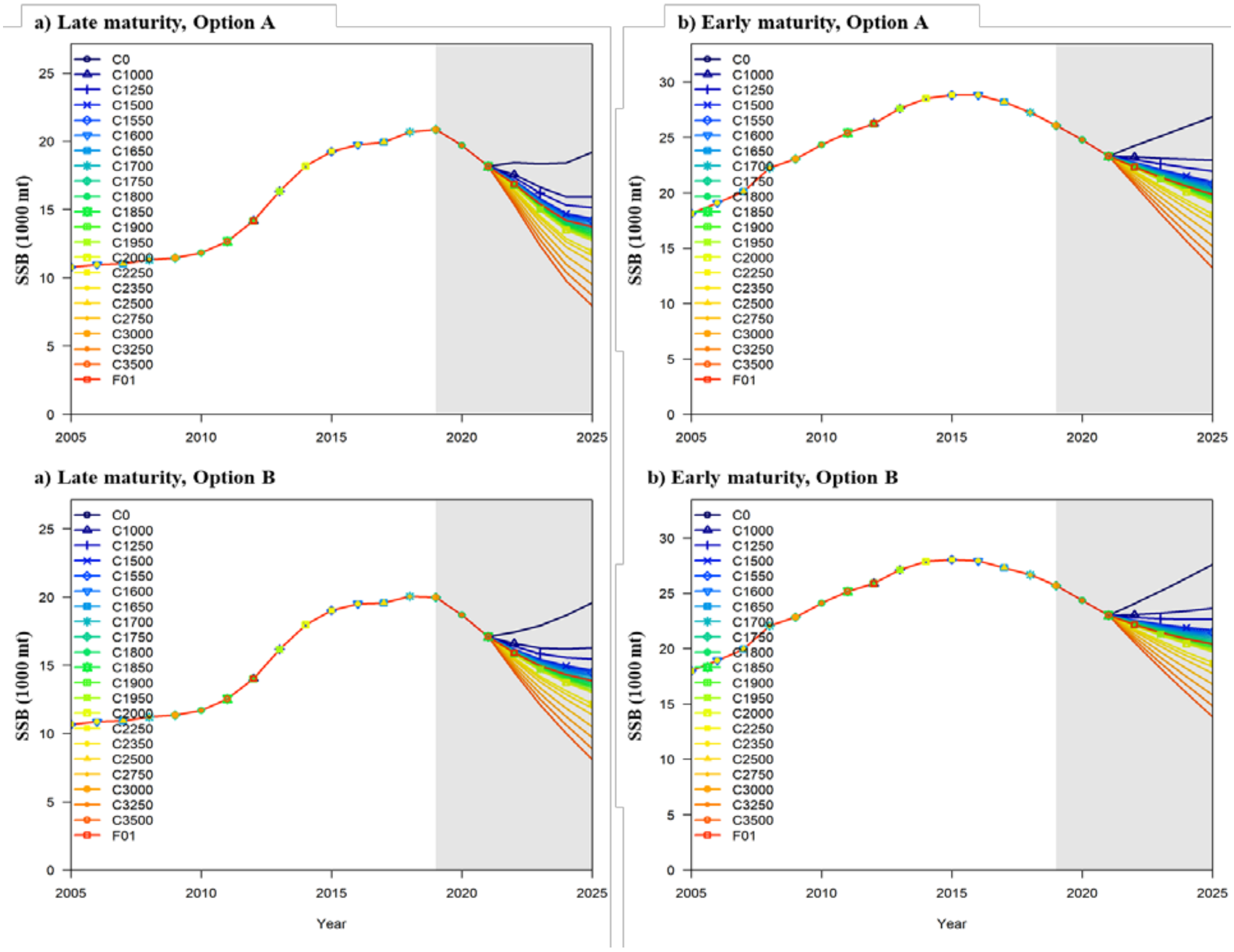


Figure 31. W-BFT Stock Synthesis. Projected SSB with different fixed TAC (0, 1000 to 3500 mt) and $F_{0.1}$ for a) late maturity and b) early maturity, by different recruitment specifications (Option A: status quo 2010-2015 average with only replacing 2018, and Option B: 5-year patch using the 2007-2012 average and replacing years 2013-2018).

Figure 32. E-BFT VPA. Trends in spawning stock biomass (SSB), Recruitment (Recruits), fishing mortality for ages 2 to 5 (F2.5) and for the plus group (Fplusgroup), and time series of F-ratio obtained for the 2020 base case (Run 135). The last 3 years of recruitment are not shown here, as it is common practice to discard the last years that are badly estimated in VPA.

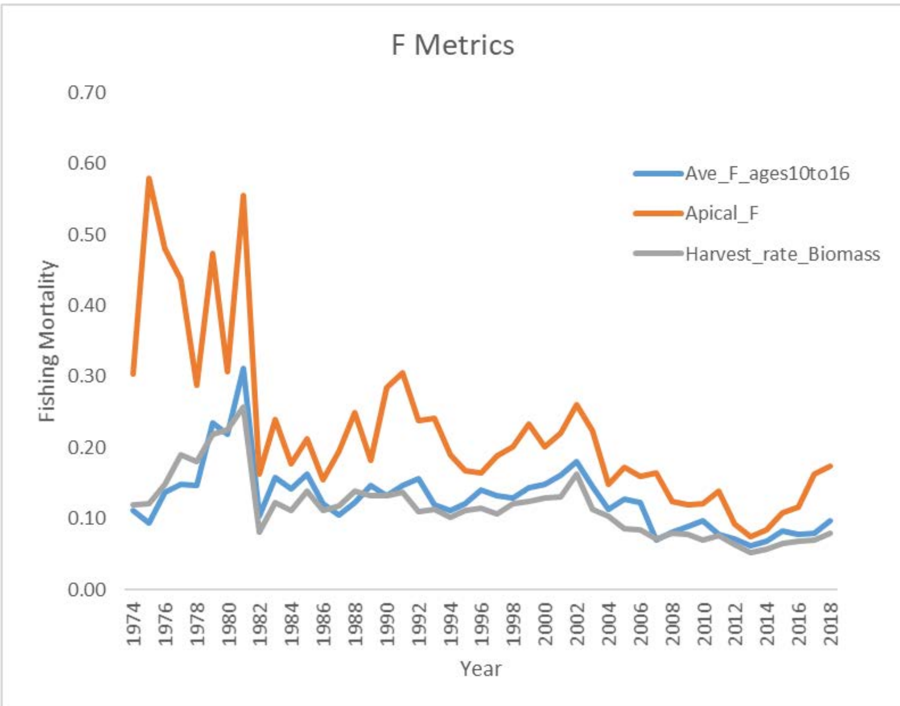


Figure 33. W-BFT VPA. West Atlantic bluefin tuna VPA estimates of average F (10-16), Apical F and harvest rate.

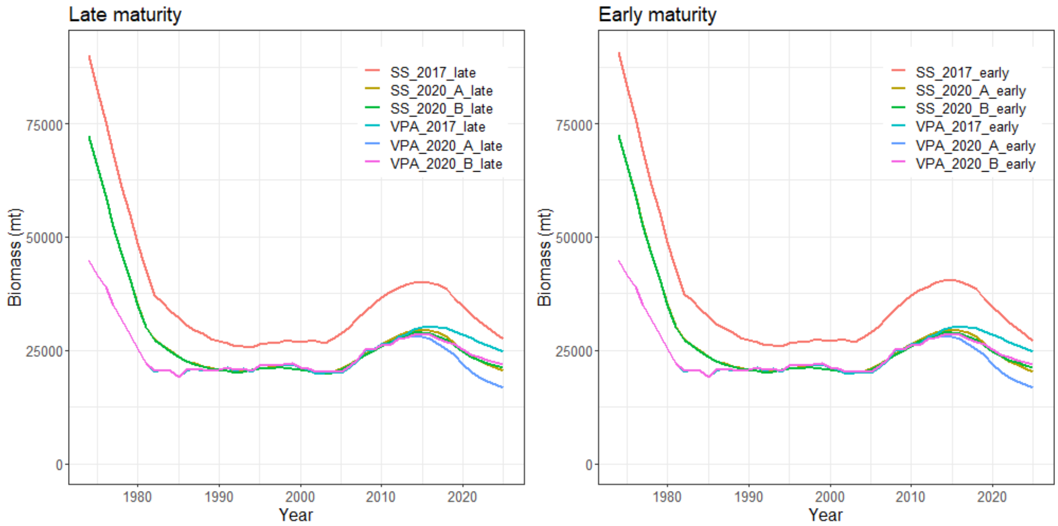


Figure 34. W-BFT. Comparison plot of Stock Synthesis and VPA time series of biomass for the 2017 and 2020 base case models, for two maturity (late and early) scenarios, and two recruitment assumption scenarios (Stock Synthesis, A: status quo 2010-2015 average with only replacing 2018, green lines and B: 5 year patch using the 2007-2012 average and replacing years 2013-2018, blue lines. VPA, A: status quo 2016-2018 average and replacing 2010-2015, red lines and B: 5-year patch using the 2014-2018 average and replacing years 2008-2013, blue lines).

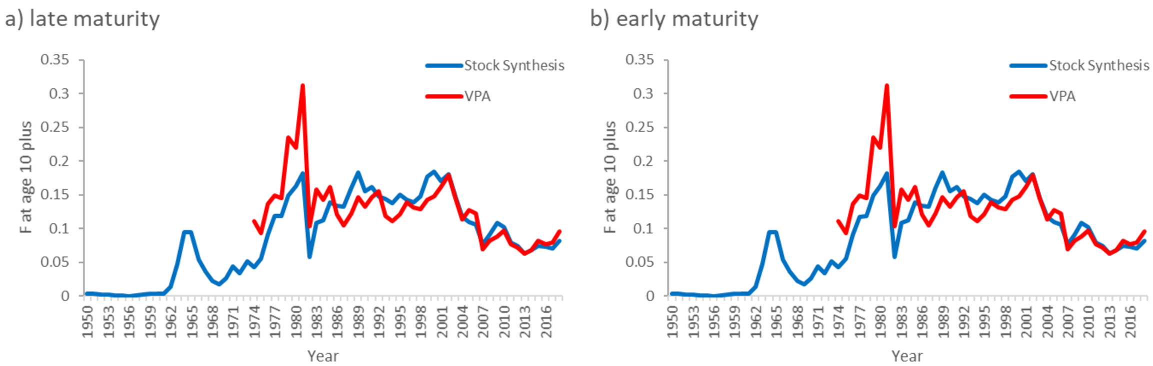


Figure 35. W-BFT. Comparison plot of Stock Synthesis and VPA time series of F at age 10 plus for (a) late and (b) early maturity scenarios.

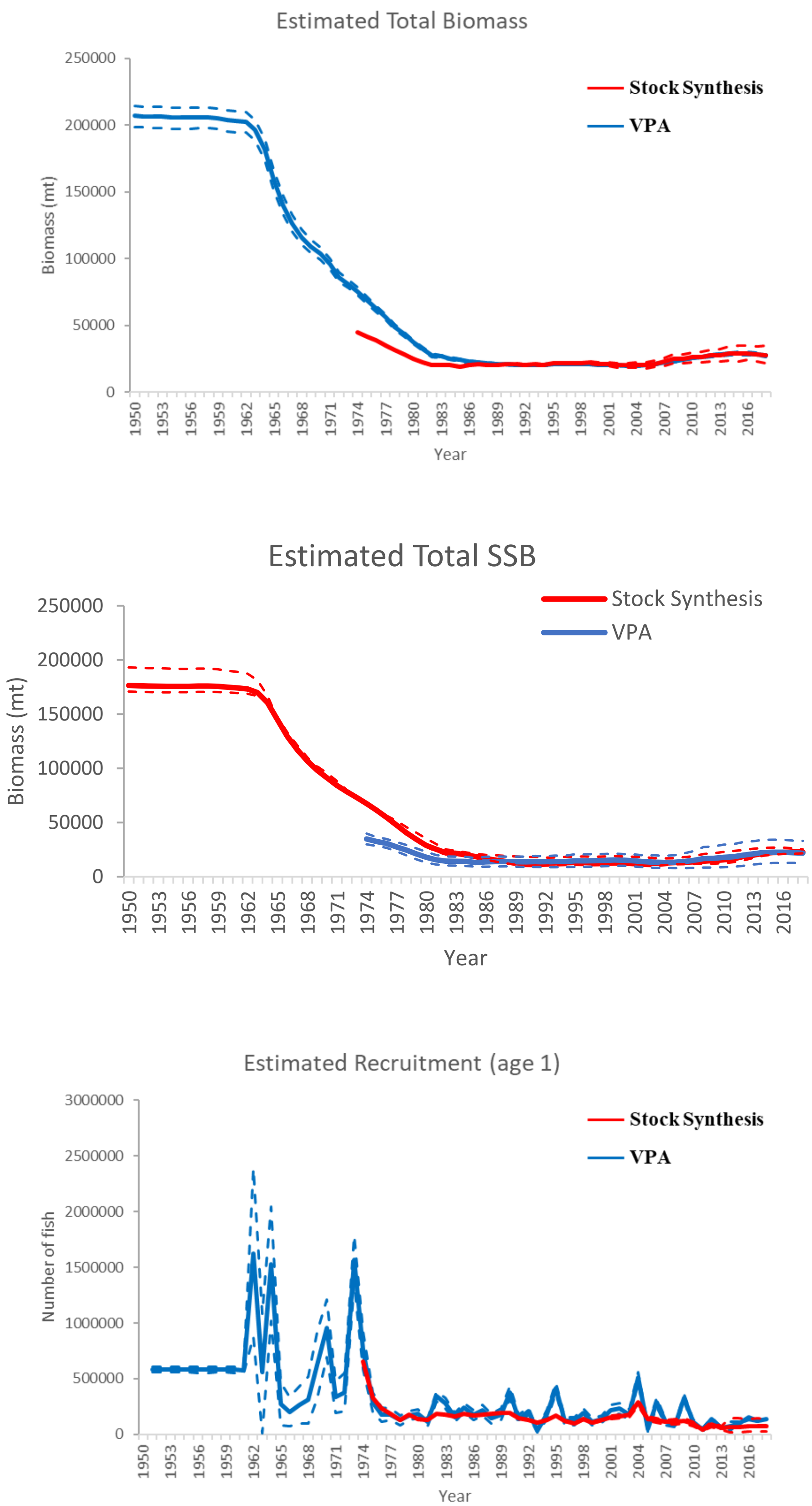


Figure 36. W-BFT. Estimates of total stock biomass, SSB, recruitment for the base VPA (red) and Stock Synthesis (blue) models from the 2020 assessment, averaged across 2 recruitment and 2 maturity specifications. The 80% confidence intervals (the minimum and maximum lower or upper confidence interval among all specifications) are indicated with dashed lines. The recruitment estimates for the recent years (e.g. 2014-2018) have been replaced by the average estimates by specification.

Figure 37. W-BFT. Estimates of recruitment and total stock biomass from the stock assessment (solid lines) and the projections (2019-2023, dotted lines) for the base VPA (red) and Stock Synthesis (blue) models from the 2020 assessment, averaged across 2 recruitment and 2 maturity specifications. The 80% confidence intervals (the minimum and maximum lower or upper confidence interval among all specifications) are indicated with dashed lines. The recruitment estimates for the recent years (e.g. 2014-2018) have been replaced by the average estimates by specification.

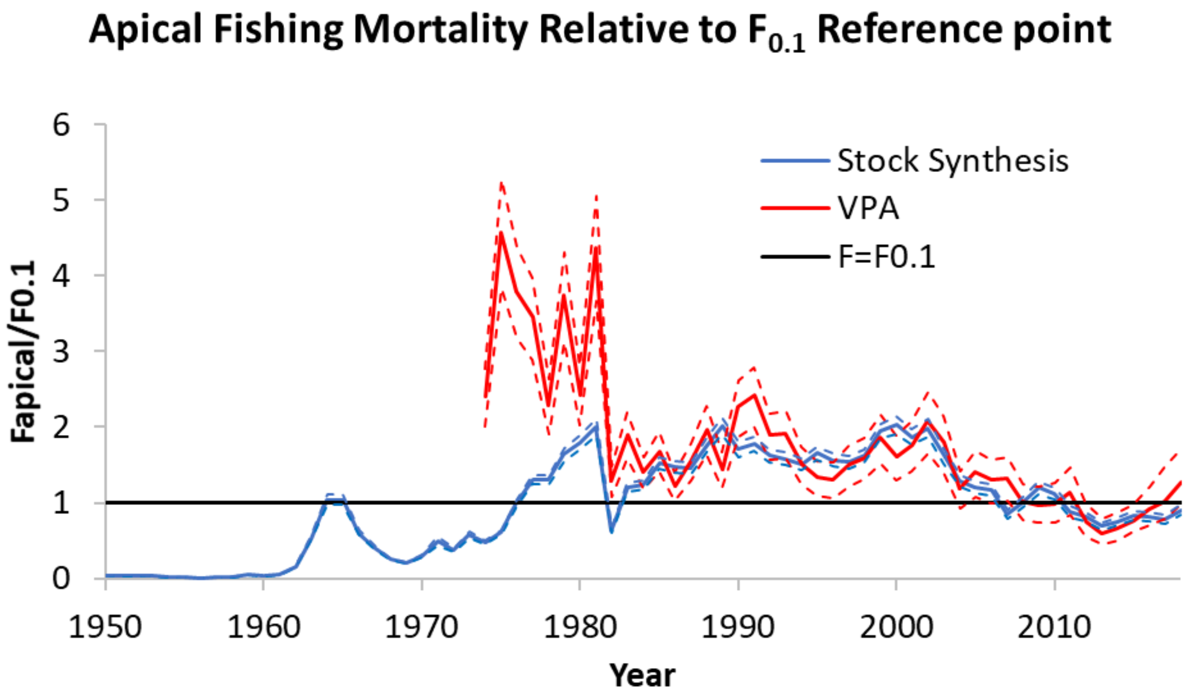


Figure 38. W-BFT. Fishing mortality relative to the $F_{0.1}$ reference point as estimated by VPA (red) and Stock Synthesis (blue) for the 2020 assessment. The 80% confidence intervals are indicated with dashed lines.

Appendix 1

Agenda

1. Opening, adoption of agenda and meeting arrangements and assignment of rapporteurs
2. Review of scientific papers relevant to assessmeny
3. Progress to 2020 TAC
   3.1 Potential 2020 underages
   3.2 Advice on carryover
4. Review of model results
   4.1 East (VPA)
   4.2 West (VPA and Stock Synthesis)
   4.3 Other models
5. Review of Projections
   5.1 East (VPA)
   5.2 West (VPA and Stock Synthesis)
6. Review of OMs performance over different CMPs
   6.1 Evaluate OM behavior that might not match perceptions or that could be difficult to explain
   6.2 Possible refinement of interim grid and robustness trials
   6.3 Obtain as close as possible agreement on an interim grid
7. Assessment results
   7.1 Stock status
      7.1.1 East
      7.1.2 West
   7.2 Projection advice
      7.2.1 East
      7.2.2 West
8. Responses to the commission
   8.1 Progress on growth in farms response
   8.2 Presentation of work to revise the catch rate table
   8.3 Additional responses
9. GBYP matters requiring attention of BFT Species Group
   9.1 Aerial survey external review
   9.2 GBYP External member
   9.3 Workshops
10. Workplan and Recommendations
11. Other matters
12. Free discussion of CMP development progress and guidance for further development
13. Adoption of the report

Appendix 2

List of Participants

CONTRACTING PARTIES

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Appendix 3

List of Papers and Presentations

Number	**Title**	**Authors**
SCRS/2020/110	How fishing strategies and regulations can bias our perception of catch rates and fishing capacities. A discussion paper for bluefin tuna.	Di Natale A.
SCRS/2020/111	VPA models for the 2020 stock assessment update for the eastern and Mediterranean Atlantic bluefin tuna stock.	Rouyer T., Kimoto A., Zarrad R., Ortiz M., Palma C., Mayor C., Lauretta M., Gordoa A., and Walter J.
SCRS/2020/112	Projections for the 2020 stock assessment update for the eastern and Mediterranean Atlantic bluefin tuna stock	Rouyer T., Kimoto A., Zarrad R., Ortiz M., Palma C., Mayor C., Lauretta M., Gordoa A., and Walter J.
SCRS/2020/117	A GLM approach for determining the influence of operating model features on management procedure performance	Hanke A.R., Arrizabalaga H., Andonegi E., and Duprey N.
SCRS/2020/119	Western Atlantic bluefin tuna virtual population analysis base model diagnostics and results	Lauretta M., Kimoto A., Hanke A., Rouyer T., Ortiz M., Palma C., Mayor C., and Walter J.
SCRS/2020/120	Western Atlantic bluefin tuna virtual population analysis stock projections	Lauretta M., Kimoto A., Hanke A., Rouyer T., Ortiz M., and Walter J.
SCRS/2020/121	Western Atlantic bluefin tuna stock assessment 1950-2018 using Stock Synthesis: part II. model diagnostics and results	Tsukahara Y., Walter J., Gillespie K., Kimoto A., and Ortiz M.
SCRS/2020/122	Western Atlantic bluefin tuna stock assessment 1950-2018 using Stock Synthesis: part III projection and fishery status	Tsukahara Y., Walter J., Kimoto A., and Ortiz M.
SCRS/2020/124	ICCAT Atlantic-Wide Research Programme for Bluefin tuna (GBYP) Activity report for Phase 9 and the first part of Phase 10 (2019-2020)	Alemany F., Tensek S., Pagá García A.
SCRS/2020/125	An update of the 2017 ASAP runs for Atlantic Bluefin tuna	Maguire J.-J., and Cadrin S.X.
SCRS/2020/126	PART 1: Investigation of the impact of spatial distribution of mean available biomass on Operating Model projection outcomes	Carruthers T., Butterworth D., and Rademeyer R.
SCRS/2020/127	Atlantic bluefin tuna constant harvest rate and index-based Candidate Management Procedures; tuning to ABT_MSE package 6.6.14	Lauretta M., and Walter J.
SCRS/2020/128	Recent trends in Eastern and Western Bluefin tuna indices	Walter J., and Gordoa A.
SCRS/2020/129	The BFT Farm Growth Sub-Group status and activities	Anon.

SCRS/P/2020/058	Bluefin CPUE time series of the Balfegó purse seine joint fishing fleet in Balearic waters from 2003 to 2020.	Gordoa A.
SCRS/P/2020/059	2019 Update to the Southern Gulf of Saint Lawrence Acoustic Index	Minch T.
SCRS/P/2020/060	Review catch rates BFT by vessel type and size	Ortiz M.

Appendix 4

SCRS Document and Presentations Abstracts as provided by the authors

SCRS/2020/110 - Usually, catch rates and fishing capacity are essential elements for sustainably managing a fishery. In the case of bluefin tuna, both these elements are often strongly biased by the fishing strategies and the regulations, adding uncertainties to already weak data in most cases. This discussion paper tries to describe these uncertainties by gear, pointing out various elements which usually escape from the assessments for several reasons. In particular, there are elements for better understanding what is behind the catch rate of the purse seine fishery, the trap fishery and the longline fisheries (including those targeting bluefin tuna, swordfish tuna and albacore). The problem of domestic observer data is also discussed, as a part of the issue.

SCRS/2020/111 - This document presents the modelling work done for the 2020 update of the 2017 stock assessment for the Eastern and Mediterranean Bluefin tuna stock, during the intersessional Species Group meeting in May 2020. Like the workplan by SCRS 2019, the model specifications were kept nearly identical to the 2017 assessment, so that the runs presented in this document are an update, as strict as possible, of the 2017 base case. Compared to the 2017 base case, the presented update runs displayed an improvement of the model behaviour regarding retrospective patterns of the spawning stock biomass. However, differences were found for the estimated recruitment that displayed higher values than during the 2017 assessment, which was also associated with instability in the recruitment retrospectives. The models also showed a strong increase in spawning stock biomass.

SCRS/2020/112 - This document presents the projections for the stock assessment update of the Eastern and Mediterranean Atlantic bluefin tuna stock. Projection specifications were defined by the BFT Species Group at the May 2020 meeting. One specification (patch length) had to be modified as the software used for projections did not allow for the original one. Results show that the stock is currently reaching the highest level of spawning biomass to date, substantially higher than in 2017. Under the assumptions used, the stock is not subject to overfishing and a substantial catch level still allows the spawning stock biomass to grow. The use of short-term projections for scientific advice are discussed in the context of the model uncertainties.

SCRS/2020/117 - GLMs were fit to the performance metrics generated by management procedures applied to models of the Atlantic Bluefin tuna fishery in a closed loop simulation. The models identified the features of the population model that accounted for the most variability in the average catch and biomass ratio over 30 years of simulated management. The variability in the performance metrics of the alternative management procedures tested was attributed to a differing set of population model features, i.e. the most influential axes of uncertainty in the population model were management procedure dependent.

SCRS/2020/119 - This report documents the 2020 update of the West Atlantic bluefin tuna virtual population analysis. The SCRS Bluefin Tuna Species Group reviewed the assessment model assumptions, results and diagnostics via webinar from 14–22 May 2020. We present the base model diagnostics and results, including time series estimates of spawning stock biomass (both young and older spawning scenarios) for the period 1974 to 2018, and recruitment for the period 1974 to 2015. The 2003 year class showed the largest recruitment event over the last few decades, reflected in the time series of estimated abundances-at-age. A recent decline in abundance resulted from the period of lower recruitment following the 2003 year class. Analysts posted the assessment files and results to the Bluefin Tuna Species Group Meeting cloud-based drive on 15 May 2020.

SCRS/2020/120 - This report documents the 2020 stock projections of West Atlantic bluefin tuna based on the results of the virtual population analysis. The SCRS Bluefin Tuna Species Group reviewed the projection model assumptions and settings via webinar from 14–22 May 2020. Analysts posted the projection files and results to the Bluefin Tuna Species Group meeting cloud-based drive on 27 June 2020. The current fishery status (2015-2017 status) is NOT OVERFISHING (94% probability). However, stock projection at recent recruitments indicated a future decline in abundance and biomass. The projected yields at the target fishing mortality ($F_{0.1}$=0.13) were notably lower than current yields, with annual decreases predicted between 2020 and 2023. Yields at the current total allowable catch (2,350 metric tons) resulted in a high probability of overfishing in 2021 to 2023. We note that the final yield advice will integrate results from both the virtual population analysis and Stock Synthesis models. The Group will complete that task during the 20–28 July 2020 intersessional meeting.

SCRS/2020/121 - This document describes a stock assessment model using Stock Synthesis (version 3.30.14) for the Western Atlantic population of Bluefin tuna. This document describes model diagnostics and initial results derived from settings agreed at the Atlantic bluefin tuna Working Group meeting in May 2020, which were only slightly changed from those used in 2017, commensurate with this being a strict update. The diagnostics result showed relatively good performance with some negative signs, while those problems occurred similarly in last assessment. The two model runs showed very similar behaviour with the stock decreasing during the 1970s, remaining relatively low during the 1980-2000 period and showing a pattern of steady population growth since 2000. The addition of three years of data (2016-2018) indicates a relatively stable population trend. This paper represents the second in a series of three papers that will describe the assessment update process.

SCRS/2020/122 - This document describes a stock assessment model using Stock Synthesis (version 3.30) for the Western Atlantic population of Bluefin tuna. This document describes projection results and stock status based on F reference point F0.1, which is estimated from the YPR curve. Current F during 2016-2018 was below the F0.1, hence the stock was not subject to overfishing. On the other hand, projection results indicate that F will probably overshoot the reference point in the near future under current total allowable catch (TAC) scenarios. We also show the probability that F<F0.1 under several constant catch scenarios for management advice. This paper represents the third in a series of three papers that will describe the 2020 strict update assessment process.

SCRS/2020/124 - The ICCAT GBYP Phase 9 was implemented between 1 January 2019 and 30 April 2020. Phase 10 was initiated on 1 January 2020, with a planned duration of one year, therefore temporarily overlapping with Phase 9. As in previous years, the GBYP programme has promoted and funded several activities in the following lines: (a) data mining, recovery and management, (b) biological studies, (c) stock indices: aerial surveys on spawning aggregations, (d) tagging, including awareness and rewarding campaign and (e) further steps of the modelling approaches. The present report summarizes the final results of the activities carried out in Phase 9 and describes the activities initiated in Phase 10, in addition to their preliminary results, if available. The main achievements were the seventh year of index of abundance obtained through aerial survey; re-analysis of all aerial surveys data to date; deployment of electronic tags; biological sampling and analyses; ageing, including calibration exercise and creation of otolith reference collection; growth in farms studies, including in house compilation of data from stereo-cameras; and development of MSE modelling techniques.

SCRS/2020/125 – The application of the Age Structured Assessment Program (ASAP) to both assessment units of Atlantic bluefin tuna that were developed in the 2017 stock assessment were updated with data through 2018. The results fit the data reasonably well and indicate continued increase of the eastern Atlantic bluefin tuna stock at low fishing mortality, but modest rebuilding of the western Atlantic bluefin tuna stock at relatively low fishing mortality.

SCRS/2020/126 -No text provided by the author.

SCRS/2020/127 - We evaluated three candidate management procedures for Atlantic bluefin tuna using the ABT_MSE package in R. The first procedure applied a constant harvest rate strategy for both the east and west stocks. The second management procedure evaluated juvenile indices of abundance as indicators of future changes in allowable catches. The third procedure evaluated the ability to achieve SSB of the West stock at or above current estimates (measured by stock-of-origin indices). Observations from indices of abundance were assumed proportional to spawning biomass and juvenile abundance for each stock and area, respectively, with observation error (observation model = Good_Obs). Each procedure was compared against zero-catch scenarios for comparison of trade-offs among strategies. The constant harvest rate procedure was tuned across five OMs that characterized the general range of uncertainty in the larger OM grid.

SCRS/2020/128 - In the strict update of the EBFT VPA numerous longstanding issues emerged that may make projection advice unreliable. In situations where strictly updated models are deemed unreliable for projection advice either due to poor diagnostic performance or lack of robustness to updating, an empirical evaluation of the indicators may provide a rationale to evaluate whether there is evidence to diverge from prior model-based advice. We evaluate two hypothesis tests related to mean values of indices and recent slopes to determine whether empirical evidence in the indices provides any reason to diverge from the 2020 TAC advice. We find no clear evidence in the Eastern indicators that would preclude a rollover of the 2020 TAC. For completeness, we evaluate indicators in the West.

SCRS/2020/129 - The Commission has requested that the SCRS update the farmed Atlantic bluefin tuna growth table published in 2009. In this request, the use of individual fish to determine growth was emphasized, as well as the consideration of differences between geographical areas. As a consequence of this request, the GBYP launched a series of studies in 2019, which will continue during 2020 and 2021, and a Sub-Group on growth of BFT in farms was established in 2020 within the BFT Species Group. This Sub-Group was created to ensure the best scientific data would be provided to the Commission. The Sub-Group held several online meetings to discuss how to carry out this request using different approaches and assess their limitations, so that a scientifically sound updated growth table or tables could be provided. To facilitate this process, the analyses required were split into a number of study areas; the action plans of these study areas were presented to the Sub-Group during the last online meeting (17 July 2020).

SCRS/P/2020/058 - This study updated the CPUE series of the Balfegó joint fishing fleet (CPUE) and catch structure. The trend of CPUE experienced important increases from 2011 that peaked in 2014 and relaxed in 2015; since then, it has remained at high values. The average annual fork length estimates from stereo cameras range from 94 to 203 cm, while the range from skippers' visual estimation goes from 185 and 191 cm for the same period (2013-2019). The CPUE is contrasted with the Japanese longline indices and both show a similar time pattern. These results are indicative that CPUE series is consistent with JP LL trends, is reliable as an abundance index of the eastern population, and can be used to correct the lack of fisheries abundance indices in the Mediterranean.

SCRS/P/2020/059 - In 2016, A fishery-independent index of abundance was developed for Bluefin tuna in the Gulf of Saint Lawrence (GSL). For the most part, the GSL acoustic time series has been consistent with BFT catch-per-unit-effort; however, recent updates suggest a significant decline in BFT that does not appear to be consistent with CPUE. This presentation provides an update to the index of abundance using 2019 herring survey data. Bluefin tuna abundance for 2019 is low (0.008 BFT/km stratum area weighted), and similar to the 2018 value. While spatial coverage (# of transects) was lower in 2019 than 2018, detection rates are comparable. Herring biomass was notably low (0.0829 kg/m^2) for the second consecutive year, which may cause tuna to forage in other regions of the GSL when herring reach a critically low biomass. Future work aims to continue investigating the cause of the decline.

SCRS/P/2020/060 -The Secretariat, in collaboration with national scientists, is reviewing and updating the catch rates of East and West BFT by main gear type and vessel size category in order to update the estimates provided by the SCRS to the Commission in 2009. Catch, fishing effort, vessel characteristics and auxiliary information is gathered from different sources, including weekly and monthly catch reports, e-BCD data, Task 1 and 2 fisheries statistics and VMS data, in order to provide a compiled dataset of vessels catching E-BFT from 2008 to 2019. The approach is to provide catch and estimates of fishing effort by main gear type; purse seine, longliners, baitboat and road reel, and size category within main gears. The analyses will focus on vessels with a consistent historic catch and fishing operations for bluefin tuna and evaluate the relative change of nominal catch rates, taking into consideration the changes in fishing practices and management regulations that have impacted the activity of the main fleets during this period. It is expected to provide a preliminary analysis in 2021 to the Group for their review and further evaluation

Appendix 5

Agenda for MSE discussions

1. Operating Model investigations
    a. Mixing ("An Overview of the Diverse Mixing Scenarios the Interim Grid of Operating Models")
    b. Spatial distribution (SCRS/2020/126)

2. Interim grid considerations ("Progress report MSE")
    a. Primary robustness tests (SCRS/2020/126)
    b. "What matters" aspects (SCRS/2020/126; SCRS/2020/117)
    c. Suggested grid revisions (if any)

3. Further CMP results (if any) and progress on shiny app development for results presentation ("Progress report MSE")

4. Guidance on CMP refinement

5. TSD update

6. Development tuning

7. Work plan up to September meeting ("Progress report MSE")

Appendix 6

Towards a BFT MSE Workplan

Ongoing

1. Developers further refine CMPs
2. Consultant refines Shiny app for integrated and comparative presentation of results
3. Consultant codes remaining robustness tests (lower priority than 1. and 2. above)

Preparatory work for September with regard to:

1. "Does it matter" criteria and grid finalisation
2. Proposals for development tuning targets

Key aims for September meeting and immediately beyond

1. Grid finalisation
2. Development tuning targets finalisation
3. Initial (at least) discussions on plausibility
4. Paring down on number of CMPs towards a reduced set for initial presentation of results to stakeholders

Appendix 7

Workplan before the Species Group meeting in September

1. 2021 Workplan (lead by the co-Chairs, small email group is tasked to develop option A and option B, the decision will be made on the basis of what happens with the management advice) – to be finalized between July and September (final adoption in September) (**comments needed before 15 August**)

    a. Decisions points: what degree of assessment (if any) is needed in 2021
    b. Option A (basically focus on MSE) vs. Option B (Assessment in 2021) (decision must be made by September)

2. Recommendations (lead by the co-Chairs) – to be finalized between July and September (final adoption in September) (**comments needed before 15 August**)

3. Executive summary (**comments needed before 15 August**)

    a. Near final versions will be cleaned and distributed (by August 6)
    b. Feedback on preamble
    c. Decision points

        i. East
            1. Nature of advice for 2022 (send to the E-BFT Chair comments specifically related to how we might give advice for 2022)
            2. Nature of assessment (if any for 2021) for 2022 advice

        ii. West
            1. TAC Advice for 2021-2020 (lead by the W-BFT Chair, small email group is tasked to develop)