REPORT OF THE 2022 EASTERN ATLANTIC AND MEDITERRANEAN BLUEFIN TUNA DATA PREPARATORY MEETING (INCLUDING BFT MSE)
(Online, 18-26 April 2022)

The results, conclusions and recommendations contained in this Report only reflect the views 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 revises 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, meeting arrangements and assignment of rapporteurs

The 2022 Eastern Atlantic and Mediterranean Bluefin Data Preparatory Meeting (including BFT MSE) of the Bluefin Tuna Species Group (BFT-SG) ("the Group"), was held online from 18 to 26 April 2022. Drs John Walter (USA) and Enrique Rodríguez-Marín (EU-Spain), the Rapporteurs for the western Atlantic and eastern Atlantic and Mediterranean bluefin tuna stocks (W-BFT and E-BFT) respectively, opened the meeting and served as Co-Chairs.

On behalf of the Executive Secretary, Dr Mauricio Ortiz, and the SCRS Chair welcomed the participants to the meeting. The Group Co-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 and Presentations provided at the meeting is attached as **Appendix 3**. The abstracts of all SCRS documents and presentations provided are included in **Appendix 4**. The following served as rapporteurs:

Sections	*Rapporteur*
Items 1, 9	A. Kimoto
Item 2	N.G. Taylor and C. Peterson
Item 2.10	T. Rouyer and E. Andonegui
Item 2.11	M. Lauretta and J. Walter
Item 2.12	T. Carruthers
Item 3	J.J. Maguire and H. Arrizabalaga
Item 4.1	A. Hanke and A. Gordoa
Item 4.2	M. Ortiz
Item 4.3	C. Palma
Item 4.4	A. Kimoto and M. Ortiz
Item 5	T. Rouyer, P Sampedro and S. Cadrin
Item 6	T. Rouyer and E. Rodriguez-Marin
Item 7	F. Alemany and S. Tensek
Item 8	S. Deguara

2. Summary of developments on ABFT-MSE

2.1 Report on the 2022 March Intersessional Meeting of Panel 2 on BFT MSE

The W-BFT Rapporteur summarised the discussions at the March 2020 Intersessional Meeting of Panel 2. The final report of Panel 2 was not yet complete but should be available soon. He noted that Panel 2 is considering the material presented by the BFT-SG very carefully and had requested that an additional day be added to the May 2022 Second Intersessional Meeting of Panel 2 on Bluefin Tuna Management Strategy Evaluation (BFT MSE). He also advised the Group that a number of matters would need to be addressed in collaboration with Panel 2 including: finalization of operational management objectives, selection of Candidate Management Procedures (CMPs), a biomass Limit Reference Point (B_{LIM}), performance statistics, and a fishing mortality (F) statistic. Panel 2 had additional requests that included: increasing and decreasing TAC change (+20/-30%) as well as increasing and decreasing TAC changes of +20/-20; +20/-10; +∞/-∞. He summarized a number of criteria requested for CMP tuning and performance statistics notably: a biomass Limit Reference Point (B_{LIM}), and a probability of being in the green quadrant of the Kobe Matrix. Panel 2 had also requested that the management cycle interval be evaluated, but the W-BFT Rapporteur had responded that this could be considered only should time permit. Finally, he noted that one initiative of the BFT-SG has been to capture the effects of the initial application of a number of CMPs that will demonstrate how TACs are likely to vary during the initial period of MP implementation. Rather than reviewing two or three key CMPs, Panel 2 requested seeing the data inputs and performance of all CMPs to ensure that there was transparency.

2.2 Report of the informal BFT Technical Sub-group on MSE, 14-16 February 2022

The W-BFT Rapporteur provided a summary of the "Report of the Bluefin Tuna Technical Sub-group on Management Strategy Evaluation" (SCRS/2022/076). This included the progress by each CMP developer and an overall summary of the performance statistics. Importantly, the package had been adjusted to take account of the most recent TACs and the most recent indices; this required that CMPs be re-tuned. One important result in the interim is that refined CMPs could largely abandon use of TAC caps because CMP performance was generally adequate without them. The Sub-group reviewed the quilt plot performance metrics table to compare CMPs and discussed corresponding methods for CMP ranking, other performance statistics, and the desire for an overfishing metric. Finally, it was noted that tuning is now much more difficult and time-intensive with the newly reconditioned ABFTMSE package. This puts a heavier burden on CMP developers and the practical consequences of this burden should be considered in moving forward.

2.3 Review of the scientific papers/presentations relevant to MSE

SCRS/P/2022/013 provided a summary of CMP results. The MSE software has a new application that allows users to summarize CMP performance, view metrics, filter and rank CMPs. This application will allow users to explore performance in more detail than could possibly be presented in a document or in a presentation. Eight CMPs were reviewed. The naming convention for CMPs had to be modified to reflect tuning levels and percent TAC change requirement. The presentation was confined to tuning to levels 1 (West 1.25 – East 1.25) and 2 (West 1.25 – East 1.50) only.

CMP tuning had varying degrees of success at the target Br30 tuning levels for depletion (spawning biomass SSB relative to dynamic SSB_{MSY}) after projection year 30 at a tolerance level of 0.05 (**Figure 1**). The presentation was largely focused on stochastic tuning at level 2: West 1.25 – East 1.50 with no TAC caps, a max 20% up, and a) a max 30% downward adjustment or b) a max 20% downward adjustment. The updated 2022 W-BFT TAC, higher than the one previously used in conditioning of operating models (OMs), made tuning difficult across a large number of CMPs. With respect to yield, AvC30 statistics (mean catches over first 30 projected years) showed important performance differences across CMPs in expected yield. When CMPs are capable to adjust TACs given the biomass that is available (i.e. can catch a high amount when biomass is high, and reduce catches when biomasses are lower), then they tend to have higher long-term yields. Conversely those that are not responsive to biomass changes, or with lagged responses do not always ramp down catches in step with the biomass reduction, so that there is reduced long-term yield. Violin plots in the presentation and the application demonstrated how performance statistic distributions vary within and across CMPs. Similarly, there was large variability in performance across CMPs as measured by average variation in TAC each time these are set (VarC: average annual variation in catches). Median performance in CMPs varied from approximately 6% to 17%. As is the case with most MSEs (Hall *et al*., 1988, Hicks *et al*., 2016, Forrest *et al*., 2018, Mardle and Pasco, 1999, and Taylor *et al*., 2014) the trade-offs span yield, biomass and yield variability with clear tradeoffs between variability in catch and stability.

An additional analysis had been requested by Panel 2. This was to compare the trade-off between the eastern and the western catch and will be compiled by the BFT Technical Sub-group on MSE.

The MSE Consultant provided a summary of the effects of tuning with max TAC decreases. In broad terms, when CMPs did not allow for more rapid TAC declines, there was a high frequency of occasions when the stock declined to very low levels. For example, when tuned to Br30 at the 1.25 level for the western stock and 1.50 for the eastern stock, allowing only a 20% downward adjustment showed a much higher frequency of runs dropping below 40% SSB_{MSY}. The magnitude of the impact of this downward adjustment was not consistent among CMPs. For example, there was a much bigger impact on the average catch over 30 years (AvC30) and the 5th percentile of Br30 for the TC CMP than for the FZ and LW CMPs. Permitting TAC declines of up to 30% allowed for faster recovery and higher long-term yields for recruitment level 2 and 3 (R2 and R3) operating models, because CMPs were able to respond more appropriately to rapid simulated biomass declines.

The presentation showed a candidate quilt performance metric table that provided a summary of the key statistics (**Table 1**).

SCRS/2022/078 evaluated the effects of the alternative recruitment assumptions in the BFT MSE on the performance of the PW CMP. This paper is important as a number of stakeholders have raised the concern that, at least for the West, 60% of the OM weightings have the 'high' recruitment relationship for years 11-30 (R1 and R3) and that this emphasis may bias the tuning to favor high recruitment. To address this the PW CMP was deterministically tuned to each individual recruitment level separately (R1, R2, R3), then all recruitment levels (RA), and finally, recruitment levels 1 and 2 only (R1 and R2). Tuning to each scenario separately had the expected results; R1 levels perform satisfactorily for the most aggressive CMP, R2 was satisfactory only for the least aggressive, and R3 gave intermediate results. Most critically, tuning to only R1 and R2 (the traditional high/low dichotomy for western BFT) gave nearly identical tuning performance as tuning to all 3 recruitment levels. This indicated that the suggestions of biased performance resulting from tuning including R3 levels are not a major concern, at least for the PW CMP.

SCRS/2022/080 reviewed the plausibility of OM Index Projections. The paper considered simulated indices on a case-by-case basis, looking at how the indices change over future projected years. The paper called for a closer examination of how indices are modelled in the future; noting that on first examination, the indices appear to have some very large values in the future (trap gears for example), that might be implausible given the likelihood of gear saturation.

The Group discussed the presentation, noting that one reason that index values into the future are very high is because the stock is rebuilding to levels to which had not been seen recently. It was noted that if there are underlying gear or fleet dynamics that might give rise to hyperstability, then considering them will require that there be some quantitative characterization of the hyperstability to design a scenario to test for such effects. Several of the robustness tests incorporating time varying catchability and non-linearity in the indices may address several of the concerns raised in SCRS/2022/080.

SCRS/2022/081 reconstructs three of the currently active CMPs using the mathematical formulae submitted to the SCRS to:

1. allow managers and harvesters to understand easily how changes to the indices will impact resulting TACs for the various CMPs

2. help in informing managers and stakeholders on the differences between the CMPs

3. confirm that the "mathematical re-creation" of the CMP is possible and that the mathematical descriptions of the CMPs are fulsome and accurate (making sure that the CMPs are indeed reproducible is an important step)

4. confirm that the data available outside of the MSE-CMP testing environment are sufficient to run the CMP

The reconstructed CMP performance was provided to the Group in the form of an Excel workbook that SCRS members could use to explore CMP behavior.

The Group had some questions about what indices were being used in the reconstructed CMP performance. The Group noted that CMPs would be changing very rapidly in the course of the next two months so the question was raised about how such a tool will be managed to ensure that it remains accurate. Moreover, it was noted that in the existing MSE framework, a CMP simply needs to be provided with a data object, and it will then return the catch. The MSE Consultant noted that such an application could be developed in a short period of time.

The Group discussed how MPs would be curated once they are implemented. This topic will be addressed by the Group at subsequent meetings.

2.4 Round-robin from CMPs and changes to CMPs based on Panel 2/Commission input

CMP developers provided concise status summaries of their CMP tunings. Where no documents were provided, developers gave verbal summaries. In general, there were: only minor changes to the AI CMP and no changes as yet to the EA CMP because some delays had been experienced in tuning it for the new package. For practical reasons, the NC CMP will no longer be supported by developers, so is the first CMP to be culled for subsequent evaluation. The Group emphasized that *it is imperative that CMP development tuning across levels 1-4 be finalized at the May 2022 Meeting of the BFT Technical Sub-group on MSE* (**Appendix 5**).

SCRS/2022/074 presents a CMP for BFT using only the indices of Japanese longline in each area. The simple MP ensures the use of indices likely to be consistently available in the future and also promotes understanding among managers and stakeholders. This paper presents results of the CMP tuned to the target discussed by the Intersessional Meeting of Panel 2 in March 2022.

SCRS/2022/082 summarized changes to BR CMP. Importantly, the new version allows limited temporal dependence in control parameters values over the first few years of the projection period, to allow for smoother transitions in the TACs from 2022 to 2023. The key changes from the previous version were as follows:

- No cap on the TAC,
- Maximum decrease in the TAC of 30% (instead of 20%),
- Time-dependent alpha and beta control parameters (see equation A4 of the document SCRS/2022/082),
- In the East area, the maximum increase allowed from one TAC to the next is no longer a function of the immediate past trend in the indices.

Results were provided for the four basic development tunings, plus one variant for one of those tunings where the default maximum TAC decrease constraint is reduced from 30% to 20%. Suggestions made for possible improvement in performance were:

- Adjusting control parameters to achieve median TACs for 2023/24 (termed C1: catch in first projection year) closer to the current TACs for 2022,
- Considering tighter restrictions (than 20 or 30%) for the TAC change from 2022 to 2023/2024 for a smoother transition,
- Rather than a 30% maximum decrease allowed in all situations, phasing this down from 20 to 30% as the value of the aggregate abundance index drops.

A question arose about the extent to which this CMP had some degree of omniscience. In response the authors explained that the procedure was essentially a constant fishing mortality policy, except that early in the projection period the control parameters were adjusted so that predicted catches closely matched those at present, but that later these control parameters were changed so as to meet long-term tuning targets. Accordingly, there was not any omniscience in the CMP.

Some additional clarifications were requested about the so-called superman effect. In response, it was explained the superman effect is caused by the recent increase in the western Mediterranean larval index in the East area that resulted in a large positive recruitment anomaly being present when conditioning the OMs.

The LW CMP had undergone minor changes, while changes to the PW CMP were documented in an updated mathematical description. Briefly, the relative eastern index value was converted into a multiplier which was applied to the current western index level, thereby accounting for eastern biomass in the West area.

2.5 Summary of CMP performance metrics based on Panel 2/Commission input

The MSE Consultant summarized CMP performance statistics (see definitions in Anon., 2022 Appendix 6 TSD Table 10.1) for those updated CMPs that had been run on the new package with the first two tuning levels.

The Group discussed whether additional statistics should be reported in the main quilt plot performance metrics table other than median C1 (catch in first projection year), AvC10 (mean catches over first 10 projected years), AvC30 (mean catches over first 30 projected years) and VarC (average annual variation in catches), LD (Lowest Depletion) (5% and 15%, lowest depletion (SSB relative to dynamic SSB_0) over the 30 years), and Br30 (depletion after projection year 30) (5%). Since, with the exception of C1, the statistics listed are basic performance statistics that had already been agreed in the course of several earlier meetings. To provide additional statistics requested, a second table will be created.

The merits of including C1 to show what catches would be in the first year that a CMP was applied was discussed. While there were some concerns that this statistic could receive undue attention and that CMP selection should be guided primarily by longer-term performance, short-term TACs are important to stakeholders. Further, substantial reductions in catch relative to 2022 TACs on the first application of a CMP could be difficult to justify and explain, especially given the recent generally high indices. Time series of projected catches indicated that, while some CMPs had immediate large reductions in the West TAC, others did not, and that they all achieved long-term performance goals (**Table 1**). This indicates that such reductions were not critically necessary to maintain the stock but were more indicative of individual features of different CMPs that could be altered to achieve short and long-term operational objectives. If longer-term performance is not substantially reduced, some form of short-term stability may be desirable, and the Group agreed that CMP developers should explore a phase in periods of +20/-10 % change in TAC for the first two MP applications as a way of phasing in any large reductions in TAC indicated by the CMPs. The Group agreed to try three levels: a) *status quo* +20/-30 %, b) +20/-10 % (for the first two MP applications, i.e. first four years); then +20/-30 % subsequently, and c) at the discretion of the developer.

The Group agreed that it would be essential to all involved in the MSE process to review plots of the catch and SSB time series for each CMP as part of their examination of CMP performance to see how it varies over time and to check aspects of CMP performance that would not be readily apparent from merely reviewing the performance statistics alone.

The Group proposed the following statistics be added to a second quilt plot performance metrics:

- Lowest depletion (LD) 10%
- AvC20 (Mean catches over first 20 projected years)
- 50% percentile of the exploitation rate in year 30 (or some representative statistic for F relative to F_{MSY})
- Probability being in green zone
- Br10/C10
- Br20/C20
- Proportion of distribution of LD that is below B_{LIM}=0.4B_{MSY}

While Panel 2 requested that the summary score not be provided, the Group agreed that they would retain the capacity to provide it for inspecting CMP. The BFT Technical Sub-Group on MSE will continue to work on alternative color schemes including a key to be included explaining what the colors mean.

2.5.1 Key figures and plots

The Group discussed what might be a key set of figures and plots to summarize the results from the MSE. One of the key figures that was adopted for use was the quilt plot (discussed above). The decision was to present quilt plots for i) the main performance metrics and ii) an additional quilt plot for the secondary performance metrics. In addition, the Group asked to review so-called worm plots; these are a set of replicates of time series of the distribution of simulation outcomes (of biomass for example) for a given CMP.

The Group elected not to represent CMP performance on radar plots at the present time with the large number of CMPs and key performance statistics. They may be revisited when the number of CMPs get reduced. In practice, many performance axes to plot on a radar plot for CMP performance and, in particular, too many CMPs to plot; both make for a daunting plot for readers to interpret. Given the above, the Group elected not to present radar plots to represent CMP performance at the present time, but radar plots are available in the Shiny App.

2.6 Update performance statistics based on initial operational management objectives

2.6.1 Request from Panel 2 to provide a B_{LIM}

SCRS/2022/077 proposes a biomass Limit Reference Point (B_{LIM}) for the BFT MSE. Biomass Limit Reference Points (LRPs) provide lower bounds on biomass; a management body would want a high probability of avoiding biomass falling below such bounds. B_{LIM}, or the biomass LRP, is usually defined as the stock size below which recruitment has a high likelihood of being impaired. Given the nature of Atlantic bluefin tuna, use of B_{LIM} as a hard trigger would be difficult, both because of the challenge which assessment models have in estimating biomass reference points, and also because the empirical management procedures being considered do not have a clear basis for evaluating biomass status. Hence, the current BFT MSE can really use B_{LIM} only as a passive statistic to evaluate and eventually tune CMP performance so as to achieve desired safety objectives.

While noting that assessment models for BFT cannot reliably estimate B_{MSY} but that it is known for each OM, the paper proposes a B_{LIM} of 40% of dynamic SSB_{MSY} as defined in the OMs for the purposes of the BFT MSE for CMP testing and performance tuning. Such a B_{LIM} reflects the individual production dynamics of each OM in the MSE, reflects temporal variability in production dynamics, and provides the best representation of the potential consequences of stocks falling below it. Such a B_{LIM} is consistent with Panel 2 decisions for the northern albacore stock, the northern swordfish stock and approaches in other Regional Fisheries Management Organizations (RFMOs).

The Group discussed the document. It noted that it would need to be repeatedly stressed to Panel 2 that this reference point be defined only in the context of this MSE. While it provides a pragmatic fix for this MSE, it will not be useable in a best assessment context or for other MSEs. In addition, the time frame (years 11-30) was discussed. The Group questioned why this time frame was appropriate for B_{LIM} in this case but not for other stocks. In addition, the Group asked if this performance statistic should be produced across all projection years.

B_{LIM}

The Group highlighted the conceptual difference between utilization of biological reference points within a best assessment paradigm (Butterworth, 2007) and with MSE. Within a best assessment context, the assessment model is treated as a best approximation of the current dynamics, where uncertainty should be relatively low. In contrast, MSEs are designed to robustness test CMPs, thereby ensuring that the chosen MP will be suitable for application. It was also noted that B_{LIM} can be an active or a passive concept. An active B_{LIM} would trigger some management action if stock biomass fell below that B_{LIM}, whereas a passive B_{LIM} threshold can be breached without triggering management action. In the current MSE application, relative biomass is not measured by the CMPs, so that the B_{LIM} to be considered is necessarily passive. The proposed B_{LIM} for the current MSE is intended to serve as an operational performance statistic, where CMPs that fail to meet a B_{LIM} threshold and its associated probability as determined by Panel 2 may be excluded from further consideration (this is an example of the use of a satisficing criterion).

A performance statistic related to LD is proposed as a measure of B_{LIM}. The performance statistic LD (**Figure 1**) is calculated as the lowest depletion (spawning biomass relative to dynamic SSB_{MSY}) for a simulation replicate across all replicates and all, plausibility-weighted OMs during the management period (years 1-30). The calculation of the statistic to be used, LD* which considers only years 11 to 30, is specified below:

$$LD^{*}=\left\{\left\{\min\left\{\frac{SSB_i}{SSB_{MSY}}\right\}_{i=11}^{30}\right\}_1^j\right\}_1^k \qquad eq(1)$$

where i years 11-30 only are taken into account (see rationale, below). This provides a single minimum SSB_i/SSB_{MSY}, over j=48 simulations of one operating model, and k =48 OMs this gives a set of 2304 values. Then, a weighted percentile is obtained using the OM plausibility weights using the R function wtd.quantile in the Hmisc package (Harrell, 2021). This gives a probability across the weighted OMs of any CMP giving biomass below B_{LIM} in any of the years in the evaluation period of years 11-30. The rationale for this is that the operational management objective related to safety for the Commission states: "There should be no more than a X% chance of the stock falling below B_{LIM} at any point during the 30 year evaluation period. A definition of B_{LIM} should be recommended by SCRS."

The previous presentation of CMP results above had several discussion points related to a potential B_{LIM}. These are best recorded in this section. The Group noted that $0.4SSB_{MSY}$ had been adopted for the northern albacore stock (Rec. 21-04), and for the northern swordfish stock (Rec. 17-02, Taylor *et al*., 2021). It was further noted that in ICCAT, the value of $0.4B_{MSY}$ incorporates the concept that the reference point needs to be set at a value such that even with variability in recruitment, the stock is protected from reaching very low levels of abundance by chance. The Group discussed how different choices of steepness affect choices of the fraction of B_{MSY} that would define a Limit Reference Point. It noted that while different values of steepness would result in very different absolute values of $0.4B_{MSY}$, the ratio of B/B_{MSY} does not vary greatly.

The Group asked how different stock productivity might affect the choice of different ratios of SSB_{MSY} as Limit Reference Points. Different OMs have different productivities as captured by the full reference grid of OMs. If B_{LIM} is defined as the point at which recruitment success is impaired, then what most determines recruitment impairment is steepness (with growth and mortality also having impacts). Given that the set of OMs captures a range of plausible scenarios for steepness, then this B_{LIM}, is appropriate over the range of plausible biological parameters. The Group agreed that plain language summary of the decisions about how the range of steepness values and stock recruitment scenarios was be chosen would be helpful. This description is provided in Section 2.8.3.1 of this report.

Rationale for years to calculate LD*

The rationale for calculation of LD* over years 11-30 is that 4 of the OMs for the western stock start the future 30-year management period below 40% of B_{MSY}, with most others well above. Hence it would not be particularly meaningful to use these early years to evaluate CMP performance relative to B_{LIM} as SSB levels then are primarily determined by the starting conditions, rather than by CMP performance. For the OMs that start below B_{LIM}, these CMPs would require rebuilding that could reasonably occur only after several years of CMP application. For Atlantic bluefin tuna, it turns out that the first 10 years of management provide a reasonable opportunity for that rebuilding to occur – hence the proposal to consider years 11-30 only in evaluating performance in terms of avoiding the stock dropping below B_{LIM}.

Probability of falling below B_{LIM}

The decision regarding the probability of falling below a biomass Limit Reference Point is fundamentally a question of risk and hence the purview of Panel 2 and the Commission. Panel 2 has provided preliminary guidance of not greater than a 15% probability of the stock falling below B_{LIM}. While ICES (2017) and Preece *et al*. (2011) suggest that there should be a very low probability of falling below B_{LIM} (e.g. 5-10%), such low probabilities need to be balanced by practical considerations regarding the modeling and characterization of uncertainty. For Atlantic bluefin tuna, a probability lower than 15% would be more prone to poorly estimated tail behavior and could be unduly influenced by only a few of the OMs.

To assist Panel 2 in making such a decision the quilt plot tables (**Table 1**) will indicate LD* at both the 5% and 15%tiles for B_{LIM} and the second table will show probabilities at 10%. Lower probabilities (5%) imply less risk and higher (15%) greater risk. Initial results indicated that at a LD* threshold of 40% of SSB/SSB_{MSY} (the proposed B_{LIM}), most CMPs could pass a criterion at a 15% probability level, but that at a 5% probability this would be more difficult and would require reduced fishing intensity. As there are risk-reward tradeoffs with this decision, the Group considers the quilt plot tables to be useful tools to convey this trade-off to Panel 2 for their eventual decision.

In conclusion, the BFTSG recommends a B_{LIM} *of 40% of dynamic* SSB_{MSY} *for the purposes of this MSE for CMP testing and performance tuning. Performance with respect to* B_{LIM} *would be calculated based on the percentile of the lowest depletion (spawning biomass relative to dynamic* SSB_{MSY}*) over years 11-30 for which the CMP is applied across the plausibility-weighted operating models in the grid (eq(1)).*

2.6.2 Fishing mortality metric

There are many problems in specifying F for the multi-stock, multi-area, variable mixing situation being considered here (Appendix 4 in SCRS/2022/076). Nevertheless, SCRS/P/2022/014 provides an exploitation rate proposal for an appropriate MSE performance metric relating to fishing mortality. It is not straightforward to estimate an instantaneous F_{MSY} given the complexity of the BFT OMs. This is because overall asymptotic age-selectivity (across all fleets) is difficult to characterize in any year because cohort strength interacts with seasonal, age-specific movement, and because of multiple fleets that fish in varying seasons and areas. Because it is challenging to calculate the selectivity required both for MSY type calculations and to characterize overall vulnerable biomass, a proposal was made to calculate a new performance statistic U/U_{MSY} where U is annual catch (in tonnes) divided by the total annual biomass (in tonnes) and U_{MSY} is the fixed harvest rate U corresponding with SSB/SSB_{MSY} = 1 at year 50.

U_{MSY} is used in some other ICCAT assessments (*Report for Biennial Period 1998-1999, Part II (1999), Vol. 2*; *Report for Biennial Period 2020-2021, Part I (2020), Vol. 2*). Since the MSE computations already keep track of catch in weight and total biomass, it is straightforward to calculate U relative to U_{MSY} for any projection year.

The advantages of the U_{MSY} statistic are that it:

- Is simple to calculate and numerically stable
- Meets conventional requirements of an F-based metric (overfishing leads to overfished status)
- Can be used for probability of overfishing and related Kobe quantities such as 'probability of being in the green quadrant of the Kobe plot'
- Is already available in ABTMSE package version v7.6.0 +

The proposal highlighted that CMPs may quite reasonably be designed to operate close to U_{MSY} and B_{MSY}. In such scenarios the probability of being in the green quadrant of the Kobe Matrix could be quite low. The MSE Consultant consequently drew attention to the possibility to include a metric summarizing the probability of not being in the red quadrant of the Kobe Matrix.

The Group discussed the proposed U_{MSY} statistic. One question was why the projections were run out to 50 years and another was whether this statistic was redundant. In regard to the former, using the longest available projected time period in the MSE (50 years) mitigates against transient behavior over the shorter term. With regard to the latter, this will have to be checked against other statistics. It was noted that if this statistic is strongly correlated with other statistics, then it might be possible to eliminate it. An additional question related to how B_{MSY} had been presented in previous reports. In response, it explained that this had been calculated using an approximation of asymptotic selectivity and it had been insensitive to alternatives.

CMPs will need to be re-run to calculate U/U_{MSY} to be able to evaluate its utility and to develop the most appropriate performance statistic. This was not possible to complete at this meeting and will be conducted for the upcoming meeting of the BFT Technical Sub-group on MSE in May 2022. *In the interim, the Group recommends U/U_{MSY} in principle but leaves it to the BFT Technical Sub-group on MSE to provide an appropriate statistic for its calculation.*

2.6.3 Other statistics

One other outstanding statistic remains the 'status' statistic(s) or those that reflect probability of being in the green quadrant of the Kobe plot. While awaiting guidance on the F statistic for the time being, this could be split into separate biomass and fishing mortality objectives. Two existing performance statistics could be used for biomass status depending upon if the objective was the probability of B>dynamic B_{MSY} after 30 years (Br30) or over the years 1-30 (AvgBr). The Group recommends that Br30 be used for this MSE.

The Group discussed the management period over which performance statistics are to be reported. A list of final performance statistics was agreed as outlined in *Table 10 of the trial specification document* (**TSD, Appendix 6**); bolded statistics will be used/considered for quilt plot.

2.7 Specification of final MSE robustness trials

The Group reviewed the existing set of robustness trials. The main outstanding trial is for a hyperstability index, where it had not been possible to get OMs to converge with indices with these properties. While it was not possible to characterize hyperstability dynamics in the past, the MSE Consultant noted that it was possible to project these dynamics into the future. But it was noted that having projections into the future with such dynamics when it was not possible to infer that such dynamics had occurred historically, was logically problematic, and that the results for such a scenario would need to be considered carefully. Otherwise, all of the robustness trials across the standard four OMs are complete. Additional robustness trials, notably probabilistic movement, a step-change in catchability, and a split western Mediterranean larval survey index may be considered if time permits.

The Group asked about considering a possible fourth recruitment scenario with recruitment increasing at some point in the future; this may be considered if it is put forward in the form of a detailed proposal. Some concerns were expressed regarding the timeframe for MSE reconditioning which is likely to occur about 5-6 years hence.

The Group focused on robustness tests that might reflect inadequate CMP performance by focusing on the lower 5th percentile of Br30. The increasing catchability scenario had the greatest effect on performance, with lower Br30 (5%) results for both western and eastern stocks, although with the more pronounced performance declines in the western stock.

The first round of robustness tested revealed the following scenarios of potentially large effect:

- Increases in catchability
- TAC overages made a difference to some CMPs but not to others. Those that use the reported catch series to make a recommendation (e.g. TC), tend to be the ones that are affected most because overages/overruns are not reported
- Time varying mixing (TVmix) mattered for some CMPs but not others
- The persistent change in mixing scenario affects some CMPs (LW and PW) but not others, with larger effects on the eastern stock size
- Difference in the time-varying regime shift in the future (flipping and flipping back) did not appear to be important for robustness, but it would nevertheless be important to continue to include this trial to capture the performance of some CMPs that have time-varying components (such as BR)
- Intermediate parameter value trials needed further attention to check that that they were functioning correctly
- The zero eastern stock mixing scenario affected some CMPs notably, but others less so

One important conclusion of the robustness testing to date is that many CMPs that pass the tuning criteria for the reference set are also largely able to navigate robustness tests. The Group noted that the OM reference grid provides a strong filter to test and develop CMPs.

The Group inquired about how robustness tests will be used to select MPs and whether CMPs need to pass (i.e. provide satisfactory performance for) robustness tests in order to be considered acceptable. The short answer was no: they do not need to pass all robustness tests, though CMPs that do may be preferable to others, other things being equal. Instances where performance seems less than satisfactory then provide key additional information to be considered in moving towards MP selection.

A more detailed comparison method across robustness tests will be developed to readily flag CMPs that perform differentially. This examination will occur once the top performing CMPs have been identified. At that time, the Group will have to determine which robustness tests should be presented to the Commission, focusing on how performance of the robustness tests will form part of selecting a final set of MPs.

2.8 Decision process for CMP development and performance tuning and eventual selection

2.8.1 Process for development tuning and performance tuning

The SCRS proposes a two-step tuning process for facilitating CMP selection and seeks Panel 2 approval on the approach.

Step 1: *Development tuning* for CMP comparison

- CMPs are being tested on a common Br30 performance level (currently 1.0, 1.25 or 1.5, for each stock)
- SCRS will then rank CMPs across the remaining performance statistics corresponding to yield, status, safety, and stability objectives
- Panel 2 may then be able to evaluate relative performance of the CMPs to select several leading CMPs

Status: Development tuning is nearly complete. Because relative CMP performance initially seems to be the same across the candidate tuning levels, *specific tuning levels do not need to be selected by Panel 2 at this time. The poorest performing CMPs could be recommended for removal by Panel 2, at this stage.*

Step 2: *Performance tuning* of retained list of CMPs to determine the final CMP specifications

- Once top performing CMPs are selected in Step 1, they may be *performance tuned* to best achieve Commission objectives. The control parameter values best reflecting the Commission's preferences will be fixed for the MP adopted.
- All CMPs include at least one setting for each area that can be adjusted to determine how heavily or lightly it applies fishing pressure to achieve desired performance on the risk-reward trade-off (i.e. catch vs. biomass) for each of the East area/eastern stock and West area/western stock.
- In other words, the median Br30 target level can also be tweaked at this point to test additional values (e.g. 1.36, 1.42) to achieve the preferred trade-off between operational management objectives.
- Performance tuning may impact how aggressive or conservative the final MP will be, but the associated median Br30 tuning value is not a value specified in the MP itself, but rather an output from that MP when applied over the grid of OMs.

Status: *Performance tuning* has not yet begun. It will occur following the May 2022 Intersessional Meeting of Panel 2. Performance tuning will continue throughout the months leading up to the October 2022 Meeting of Panel 2. The SCRS will provide feedback on the process at its July and September meetings in 2022. Panel 2 may first select a CMP and then will select a tuning level from within a range of tested performance tuning settings during the October 2022 meeting.

The SCRS proposes the following process for narrowing down the list of CMPs and seeks Panel 2 input and approval on the approach.

- At its May 2022 meeting, Panel 2 plans to agree to a minimum standard for CMP performance, which may include, for example:

  - A less than X% chance of breaching B_{LIM}
  - The stock should have a greater than Y% probability[1] of being above SSB_{MSY} in year 30
  - To be considered - a proposal from the BFT Technical Sub-group on MSE for U/U_{MSY} and the probability of occurring in the green quadrant of the Kobe matrix after 30 years

- At its 2022 May meeting, Panel 2 may choose to exclude any CMPs that are considered to have unacceptable performance or structure.

- Panel 2 may agree to a common set of performance statistics and descriptive tables (e.g. quilt plot tables) for CMP decision making.

- At its July and September 2022 meetings, the BFT-SG will review performance tuning results for all CMPs and compare them to the minimum performance standards set by Panel 2 in May 2022. Any CMPs that do not meet the minimum standards may be not recommended by the SCRS to Panel 2 with results and rationale nevertheless still provided.

- CMP developers can also withdraw their CMPs from consideration at any time if they are not performing as desired.

2.8.2 Satisficing

The Group discussed a process for illustrating how the Group might choose CMPs which might be to examine all the CMPs on a quilt plot table. In so doing, it would be evident which CMPs performed poorly across multiple performance criteria.

[1] For a given development tuning this probability (POF or probability SSB > SSB_{MSY} in year 30) is one of the output statistics provided.

The Group reviewed a presentation from September 2021 (Appendix 7 in Anon. 2021). In broad terms, satisficing (see also Schwartz *et al*., 2011, Miller and Shelton, 2010) involves defining an ordered set of criteria, and for each a required performance level. Then the process is to go through each criterion stepwise to eliminate CMPs that fail at each step. The Group noted that there were some practical difficulties in implementing such a system, because it requires a thorough understanding of the trade-offs associated with managing the stocks (e.g. satisficing too aggressively based on the first performance metric might result in unacceptable performance of the remaining CMPs for competing management objectives). In the BFT MSE situation, there is not much time remaining to finalize analyses; therefore, applying satisficing would result in stakeholders not having much opportunity to review which CMPs were eliminated and why.

The general conclusion of the Group was that developing objective criteria for satisficing would be a time consuming and intensive process on which to attempt to reach agreement; time would be better spent simply engaging Panel 2 in the decision process across the CMPs. Panel 2 members are well-versed in decision making. Provided the SCRS and the BFT Technical Sub-group on MSE can give clear information on the trade-offs associated with each CMP; Panel 2 should be able to decide upon an MP. *The BFTSG recommends against developing a further (to* B_{LIM}*) formal satisficing exercise.*

2.8.3 Other considerations

The W-BFT Rapporteur noted that Dr Levontin will be involved in a project to poll CPCs on their approaches to stakeholder engagement in the MSE process. This will start after the adoption of an MP by the Commission.

2.8.3.1 Description of stock recruitment relationships in operating models

For the western stock, the stock recruitment relationships reflect the two historical assumptions. The first axis is the 'low' or 'two-line' stock recruitment relationship which assumes a recruitment regime shift from a large, but less productive stock to a smaller but more productive one, often hypothesized to be due to some change in the environment. (Note that "productive" here is used in a relative sense, i.e. production per unit biomass.) The second axis assumes that no regime shift occurred and that the stock retains its initial demographics. Both the early period for recruitment axis 1 and the full time period for axis 2 assume a Beverton-Holt recruitment and a strong relationship between the number of spawners and the number of recruits (steepness =0.6). The third axis mimics the first but assumes a regime shift back to Beverton-Holt recruitment 10 years into the future. This is in line with the hypothesis that if a regime shift happened in the past, then it is possible that it could occur (reverse perhaps) in the future.

For the eastern stock, the first stock recruitment axis also assumes a regime shift, but only in the absolute level of recruitment. The first time period (1950-1987) represents low recruitment, and the second time period (1988+) has high recruitment. Both cases assume a Beverton-Holt recruitment form with a weak relationship between spawning stock and recruitment (steepness of 0.98). The second axis assumes that no regime shift occurred, and that recruitment follows a Beverton-Holt recruitment form, but with a stronger relationship between spawners and recruits (steepness of 0.7). The third axis mimics the first, but assumes a regime shift back to low recruitment 10 years in the future, again in line with the hypothesis of a future regime shift given that one occurred in the past. These scenarios reflect the traditional high/medium/low recruitment assumptions for eastern origin bluefin where these three stanzas of recruitment come from specific years: the 'high' corresponding to the recent period; and low to the earlier period. The OMs do not have a 'medium' time period modeled; however, they do explicitly entertain, in recruitment level 2 (R2), the concept of a stronger stock recruitment relationship. This uses recruitment as estimated over the entire time period, hence reflecting the 'medium' recruitment scenario and the usual assumption that there is some form of dependence between the size of the spawning stock and recruitment.

The various recruitment levels were plausibility weighted by the BFT-SG based on expert knowledge (Anon., 2020a). Levels 1 and 2 were given weights of 40% while the regime shift (level 3: R3) was deemed less plausible (20%).

The Group discussed an additional robustness test that would entertain a differential weighting of the recruitment scenarios to effectively create equal weighting of the high and low western recruitment in the long term (years 11-30 and beyond in the projection). The technical details will be addressed by the BFT Technical Sub-group on MSE.

2.9 Initial cull of CMPs

The Group reviewed methods that could be used to select CMPs in section 2.8, above. In addition, some CMPs might not be supported for practical reasons (e.g. too susceptible to problems in implementation if a single abundance index was not available for one year) and therefore would effectively be culled. At this time, however, only one CMP has been removed from the initial 9 (NC).

2.10 Communications material

There was not a specific time slot dedicated to cover this agenda item, but some interesting discussion points have been gathered by the Rapporteurs.

As a general remark, with regards to the material to be developed by the Communication Team to facilitate the dialogue with stakeholders in general and Panel 2 in particular, it was noted that there is very little time left between the Meeting of the BFT Technical Sub-group on MSE (3-6 May, 2022) and the Second Intersessional Meeting of Panel 2 on BFT MSE (9-10 May, 2022), which should prevent the Group from preparing a lot of new material for the ambassador and Panel 2 meetings. It was agreed that the Communications Team will work on updating the existing material (1- and 4- pagers, and the PowerPoint document) for those meetings and present it to the Meeting of the BFT Technical Sub-group on MSE for discussion. The need to provide accurate information, which should be adequately presented to stakeholders and PA2, was also noted as key in making the MSE process appeal to them and providing them with the option to interact and feel part of the process. The new role of stock assessments should also be clarified for them.

2.10.1 Key plots and outputs

The material produced and available through the two APPs developed by the MSE Consultant, including the new Application with the quilt plot tables (https://apps.bluematterscience.com/ABTMSE/; https://apps.bluematterscience.com/ABTMSE_Performance/) was considered key for being able to evaluate the performance of existing CMPs and applying the satisfying criteria to rank CMPs. Information from all existing CMPs will be provided in the Second Intersessional Meeting of Panel 2 in May 2022. The Group agreed that quilt plot tables should be updated with the most up-to-date information during the Meeting of the BFT Technical Sub-group on MSE in May 2022 and also once feedback from PA2 is provided. It was also noted that current quilt plot tables contain several premature values, since CMP tuning work is still a work in progress and, if they are to be included in the report, CMP names would need to be replaced by a more general naming pattern (i.e. CMP1, CMP2, CMP3, etc.) until near-final CMP results are available for the Second Intersessional Meeting of Panel 2 in May 2022, at which points specific CMPs will be identified by name. Color-codes used by these plots also need to be agreed on (after discussion with Panel 2).

With regards to the plots produced from the CMPs (trade-off plots, worm plots, etc.), the Group agreed on the need to use additional values to complement the median values used in trade-off plots, since the plots with medians might cause some misinterpretation from stakeholders; the impression given may be different to the one conveyed by the actual results. Using violin plots and even worm plots representing the actual time series of CMPs results could help understanding on how different recruitment scenarios might affect the results and would then need to be taken into consideration for communication purposes. Radar plots were not considered useful to be used at this stage of the process, although they are available in the Application.

In terms of the performance statistics to be used, and since the Group accepted the proposed B_{LIM}, defined as 40% of the dynamic SSB_{MSY}, the percentile of the Lowest Depletion (LD) statistic to be used as the statistic to assess the performance of the different CMPs in terms of safety should be discussed and provided by Panel 2. The adoption of the F metric (U/U_{MSY}) will need to be further discussed by the BFT Technical Sub-group on MSE, before being presented to Panel 2.

2.10.2 Develop presentation to Panel 2 on progress

The W-BFT Rapporteur presented a short communications document that outlines key information and decision points for Panel 2 (**Appendix 7**). This material will be further discussed during the next Meeting of the BFT Technical Sub-group on MSE.

2.10.3 BFT-MSE Ambassadors programme

The Group agreed on the relevance and value of continuing with the ambassadors programme to provide plain-language information to stakeholders and facilitate the dialogue with Panel 2 at a later stage. Having acknowledged their value, two additional ambassador meetings were proposed for 2022, probably one in July and the next in October, before the Third Intersessional Meeting of Panel 2, which is scheduled for 14 October 2022. Concerns about the ability of Panel 2 to carry out the large amount of work to be developed between May and October were expressed by different participants, but the Group recognizes that this is the only way to make progress. If Panel 2, in its May 2022 meeting, considers that additional Panel 2 meeting time might be useful, it can make that request for additional meeting time either in October or before (July/September), depending upon the purpose and need.

2.11 Path forward for the BFT MSE process

The path forward for the MSE for the remainder of this year is outlined in **Table 2**.

The path forward for beyond the MP adoption involves outlining a number of key future steps that will include:

1. Routine application of the MP on pre-specified time frames (currently 2 years).
2. Specification of Exceptional Circumstances provisions that specify situations when the MP can be overridden, e.g. analysis of indicators, indices are outside ranges tested, inability to update an index for multiple years, natural disasters, or other situations, both foreseen or unforeseen, that preclude implementation of the MP. As has been standard practice, the BFT-SG will consider annual reviews of the abundance indices.
3. Less frequent "stock assessments" will occur on a predetermined interval as 'health' or 'status' checks and to inform reconditioning for MP review. The exact format and nature of these assessments are still to be determined, but they will not be critically necessary for setting TACs.
4. Management procedure review/revision and MSE reconditioning which includes refitting to new data, and incorporation of new information or new methodology such as ground-breaking science. This would also possibly be triggered by Exceptional Circumstances coming into play.

Possible timeframes for the above events could resemble **Table 3** with the exact timing of stock assessments and MSE reconditioning being a decision point for the Commission under advice of the SCRS.

2.12 Update of trial specification document (TSD)

During the meeting, the MSE Consultant updated TSD (**Appendix 6**), which is mainly a list of final performance statistics (see section 2.6). TSD might be further updated at the Meeting of the BFT Technical Sub-group on MSE in May 2022.

3. Review of the scientific papers relevant to E-BFT stock assessment

The E-BFT Rapporteur opened this agenda item noting that since 1999, when only the western stock was assessed, both stock components have been assessed at the same time. In 2021, only the western stock was assessed (Anon., 2021). Considering the heavy workload associated with the BFT MSE, the East Atlantic and Mediterranean component is assessed separately in 2022.

The draft Terms of Reference (ToRs, **Appendix 8**) for the assessment were reviewed. The Group agreed to follow the ToRs as closely as possible, but noted that some flexibility may be necessary, as the ToRs involve a very similar model structure and data as used in the 2020 assessment which was not accepted as a basis to provide advice. It was suggested to test in a sensitivity run how Close Kin Mark Recapture could help reduce uncertainty in scale in the East Atlantic and Mediterranean bluefin tuna stock assessment. The Group agreed the ToRs as drafted.

SCRS/2022/067 presented data inputs and initial model setup for the 2022 E-BFT Virtual Population Analysis (VPA) stock assessment, noting that the purse seine (PS) fishery in the Mediterranean was mostly fishing on large fish since the early 2010s while both large and small bluefin tunas were caught in the past.

Problems identified in the previous assessment include: i) a large and rapid increase in biomass since the early 2010s, ii) uncertainty regarding total catch and estimated catch at age (CAA), specifically during 1998-2007, iii) a significant shift in perception of stock size between the 2014 and 2017 stock assessments, iv) sensitivity of the results to the F_{RATIO} between the age+ and the next younger age group, v) large, estimated recruitment in recent years and instability in retrospective patterns.

The Group recognized that selectivity on ages 10 and older is not necessarily flat-topped but agreed that assuming F16+=F15 was a sensible assumption.

SCRS/2022/070 presented data inputs and initial model setup for the 2022 E-BFT Age Structured Assessment Program (ASAP) stock assessment. There are reasonable correlations (r= 0.5 – 0.83) for adjacent ages up to age 15/16+. ASAP does not assume that catch (or catch at age) are known exactly. It is suggested to investigate total catches in the period 1998 to 2007 when total catch was estimated from fishing capacity in the Mediterranean and a WWF report about underreporting. This could be done by assuming that the reported catches are a lower limit and estimating underreporting as dead discards. Or simply increasing the coefficient of variation (CV) on the reported catch allowing for over and underreporting. Illegal catches have also been identified in 2018 and investigations are ongoing, but the tonnage involved remains unknown.

For the ASAP configuration it was agreed to use a fleet structure similar to that used in Stock Synthesis, and in the MSE, but this may be done iteratively, adding the most important fleets first. Blocks for selectivity may also need to be adjusted.

SCRS/2022/079 presented data inputs and initial model setup for the 2022 E-BFT Stock Synthesis stock assessment. The Group noted that the stock size indices for comparison purposes should be scaled to the average of common years. Total catches from the ICCAT database for 1864-1949 will be used as supportive information for the initial equilibrium catch in the Stock Synthesis configuration.

The Group noted the need to revise the input data used in Stock Synthesis, as in the case of the baitboat fleet where relatively large size samples where available in recent years when the fishing activity was low. The purse seine fleet in the Mediterranean accounts for the bulk of the removals, so it is important to characterize this selectivity properly. It was suggested to further split this fishery to take into account the different behavior after 2010, clearly focused on large fish. The Group also suggested to give low weight to historical purse seine size data, given that they were not based on individual measurements.

While the authors had used double normal and cubic splines in order to better fit size data, the Group suggested to also consider more common dome shape and asymptotic selectivities. The Group also proposed that sample sizes of length compositions must reflect the differences of sampling intensity between years and gears.

4. Presentation of initial data inputs

4.1 Biology and age data

SCRS/2022/075 describes the current length at age database available for the E-BFT management area. A total of 8,500 spines and 5,000 otoliths were read from specimens caught from 1984 to 2017 in both the Atlantic Ocean and Mediterranean Sea. Obtaining ALKs for this species is difficult, as it has a wide length range and spatial distribution, and sampling is costly. Unfortunately, there are practically no contributions to this database from the East Atlantic and Mediterranean Sea countries, and only thanks to the initiative of the GBYP has it been possible to increase the number of samples in the ICCAT database in the last 10 years. As a result, the current ICCAT length-at-age database has incomplete spatial, temporal and size range coverage. The authors suggested that the conditional age-at-length data be included in the Stock Synthesis model.

The Group discussed whether the data are already included in Stock Synthesis, if the age determination errors are the same for spines and otoliths and whether the errors are kept separate in Stock Synthesis. It was clarified that the errors are different and that an error matrix should be investigated in future evaluations for both structures. It was also indicated that both structures provide similar age results up to age 13 at which point the error for spines increases.

On the issue of contributions to the ageing database, the Group noted that samples have been collected from Portuguese traps since 2017 but these samples have yet to be processed due to a lack of resources. Further, the Group was reminded of EU supported sampling of caught BFT that occurs every 2 to 3 years. However, it was unclear where the associated data to BFT sampling programs reside and whether they are in a common format. It was recognized that many of the samples not contributing to the ALK may not have been aged following the recommended protocol and that effort should be focused on ensuring that those involved in the processing and ageing of hard parts should work in a coordinated way. While a complete list of the samples available for processing is not known, the GBYP, through its work on the Task 3 database for biological samples, can identify at least some sources.

Noting that there has been insufficient support for coordinating the collection, processing and ageing of samples and that these data could reduce uncertainty in the advice provided to managers, it was suggested to identify the data limitations.

It was suggested that in order to fill gaps in the ALK in the short term, size at age could be estimated from the aged ALK samples using back calculation (Stewart *et al*., 2022) and/or the existing ALK data could be combined with the 24,181 back calculated size at age values provided in the paper. A consideration with this approach is accounting for fleet specific selectivities.

Presentation SCRS/P/2022/011 reviewed the outcomes of a study that fit mixed effects growth models to back calculated BFT size at age data (Stewart *et al*., 2022). The modified-Fry function produced the best correspondence between estimated size at age and observed size at capture of younger fish and a nonlinear mixed effects formulation of the von Bertalanffy growth model provided the best prediction of the future size of individual BFT. This model yielded population level estimates for t0, L_{INF} and K of -0.47, 300.41 cm and 0.119, respectively and did not vary by stock of origin. However, it was demonstrated that while K was identical by gender, the L_{INF} for males (305.24 cm) was 13.5 cm greater than females.

The Group recognized the balanced nature of the data and that, due to stock of origin work, the northwest Atlantic could provide age data for larger eastern stock fish. It was also recognized the effect that single versus repeated observations on individual fish and the model fitting approach has on the population level estimates of the growth parameters.

Presentation SCRS/P/2022/012 provided progress on a study to estimate BFT age at maturity using biphasic growth models applied to back-calculated size at age data. Neither a segmented regression modeling approach nor a Lester model could support that the age of maturity differed between stocks. The better fitting Lester model suggested a modal age of maturity of ~ 3 years for both stocks but with some fish reaching maturity as early as age 2 and as late as age 8. Further work will involve testing for gender and cohort effects as well as checking model estimates against observational data.

The Group discussed the potential to validate the model results using farmed fish or captures in the Gulf of Lions which are 2 to 5 years old. It was noted that observational data from the Croatian farms agree with the model results. It was also noted that there are many past studies and a 2018 workshop on BFT reproduction that could provide the data to inform the model fit and/or validate the model results. Also, the Group indicated that using back-calculated data to estimate the age at maturity would be useful for providing estimates of the proportions of the population that are mature at each age and that this is relatively hard to achieve by other methods. There was general support to continue the work as it addressed unresolved issues affecting the assessment and provided results consistent with what one would expect for closely related sub populations of a species.

Lastly, it was suggested to extend the analysis to include size-at-age data from individuals of eastern origin caught in the Mediterranean Sea in order to help validate the results based on eastern origin fish caught in the Atlantic Ocean.

A summary of the current assumptions concerning life history attributes for the West Atlantic and East Atlantic and Mediterranean bluefin tuna stocks is provided in **Table 4**, and these will be used in the 2022 assessment models.

4.2 Size and age composition, update stereo-camera data through to 2020

The Secretariat presented a summary of the input Task 2 size-frequency data (T2SZ) by fleet ID for the 2022 assessment models, data were provided well in advance of the meeting to the modelers following the 2022 Bluefin tuna workplan. The size frequency data was compared to the 2021 input size-frequency data provided for the reconditioning of the BFT MSE OM (Kimoto *et al*., 2021), following the recommendation of the Group to use the same fleet structure between MSE OMs and the 2022 assessment models.

Figure 2 shows the comparison of the overall size-frequency distribution by fleet ID. Overall the size information is similar between data versions. Most of these changes correspond to historical updates on bluefin size samples provided by CPCs in 2020 and 2021 as reported in the Secretariat Report on Statistics and Coordination of Research (*Report for Biennial Period 2021-2022, Part II (2021), Vol. 4*). In the case of the size data from the trap/other fisheries, it was identified that new information from Portuguese and Spanish traps reported catches of larger size fish compared to the Italian trap size information previously available for this period (2010-2020). A further review noted that historically Italian trap size information shows a large variation in BFT size caught (**Figure 3**), likely related to the active trap and the location of the catch as well as the size data provided. National scientists indicated that Italy Sardinian traps normally catch smaller fish while the Sicilian traps catch larger fish, however, this trap ceased activity in 2000. Finally, the case of other gears fleet (FL16_OTH) includes BFT size from diverse gears (handlines, gillnets, harpoon, rod & reel, and unknown) and fleet CPCs, with no consistent sampling through the years and by gear, and represent small overall catches. The Group may recommend not to use this information.

The Group also informed that following its recommendations from 2018, the BFT size distributions provided from stereoscopic cameras measurements by Turkey from the period 2015-2020 were revised (Ortiz *et al*., 2021) and confirmed the increased proportion catch of bluefin tuna of about 120-125 cm straight-fork-length (SFL) in 2017, 2018 and 2019. These data were included in the updated 2021 MSE-OMs reconditioning (**Figure 2** FL15_PSOTH) showing the bimodal size distribution of this fleet in the recent period. The Secretariat informed the Group that all stereoscopic camera information has been integrated into the size-frequency data for the purse seine fleets and some trap catches. It was however noted that some of the historical (1970-2010) size distribution from the purse fleet of Spain and France, was based on an estimate of the mean weight per set operation rather than direct size sampling of fish (Gordoa *et al*., 2019). The BFT Group in the 2017 assessment (Anon., 2018a) reviewed and adopted these size estimates as the best information available for this important fishery, however, compared to actual size measurements it is recommended that this data have relative a lower weight in the 2022 assessment models.

CAS and CAA estimations

The Secretariat updated the catch at size (CAS) covering the entire series 1950-2020. Between 1950 and 2018, very minor updates were made to the existing CAS estimations used in the 2020 E-BFT stock assessment. The major update was the inclusion of the Gibraltarian rod and reel (RR) catch series (2015-2020) recently added to Task 1 (the size samples of Spanish handline fishing in the western Mediterranean Sea used). The remaining changes are negligible and mostly linked to re-raising a few catch series of recent years (EU-Croatia handline 2015 and 2016, EU-Greece handline 2015 and 2016, Tunisia 2016-2018 PS dead discards addition) resulting from minor corrections in Task 1. The estimated CAS in 2019 and 2020 incorporated the revisions by various CPCs on Task 2 size samples and Task 2 catch at size (estimated/reported by CPCs). Some revised or new PS size samples obtained from the stereoscopic cameras are also reflected in the CAS. No changes were made to the methodology (an extrapolation process) and the same substitution rules were used (Anon., 2018a) with a new rule added for the Gibraltar recreational fishery without size information available. The mean weights (kg) obtained from the CAS are presented in **Figure 4**. The AgeIt software was used to obtain the catch at age.

4.3 Catch estimates

The Secretariat has made available to the Group the most recent statistical datasets (T1NC: Task 1 nominal catches; T2CE: Task 2 catch & effort; T2SZ; T2CS and conventional tagging information on bluefin tuna). This information already contains all the statistical information (yearly catches, catch-and effort, and actual size) recovered by the GBYP Programme (historical data recovery). Overall, there are only minor updates when compared with the information adopted by the SCRS in 2021 during its annual meeting (Anon., 2021).

4.3.1 Task 1 Nominal Catches

The bluefin tuna nominal catches (T1NC) for E-BFT, as presented in **Figure 5**, comprise the eastern Atlantic region (sampling areas: BF53, BF54, BF57, BF58, BF59, BF62, BF65, BF66) and the Mediterranean region (BF59) including the Black Sea. ICCAT has recorded historical catches of E-BFT since the 15th century (1512) with the majority linked to the trap fisheries (Spanish since 1500s, Italy since 1600s and Portugal and Tunisia since 1800s). This historical information, recovered under the GBYP programme, only covers partially the total removals of the E-BFT stock. Only around the beginning of the 19th century are the E-BFT catches considered reasonably complete. Since the 1950s, about 80% of the total catches were made in the eastern Atlantic region and 20% made in the Mediterranean. The importance of eastern Atlantic catches declined beginning in the 2000s when 81% of the E-BFT catches were made in the Mediterranean region. This inversion (large increase in the Mediterranean catches after the 1970s) coincided with the increase of the purse-seine fisheries in the Mediterranean region. In the last decade (2010), the Atlantic region catches have partially recovered their weight (31% of E-BFT total catches), and similar ratios in the order of 30% were observed in 2020 and 2021. **Figure 6** presents the total E-BFT historical catches by year and region, between 1512 and 2020. The total E-BFT catches by year between 1950 and 2020 with the corresponding Total Allowable Catch (TAC) series, are presented in **Figures 7** (by region) and **8** (by major gear). Only from 2004 onwards, the E-BFT catches contain the dead discard component. **Table 5** presents the total E-BFT catches (landings plus dead discards) by year, region and major gear.

The Secretariat also gave a brief overview of the update status of other statistics, including the recently updated CATDIS (T1NC catch distribution by trimester and 5x5 squares) of bluefin tuna covering the period 1950-2020. These estimates (**Figure 9** presents the maps by decade: 1960-2020), published on the ICCAT Statistical Bulletin series Vol. 47 (Anon., 2022), contain the most recent T1NC and T2CE updates made since September 2021. The Task 2 datasets (T2CE, T2SZ, and T2CS) were also briefly reviewed (SCRS catalogues presented in **Tables 6** and **7** for the Atlantic and Mediterranean regions, respectively), focusing mostly on the missing gaps observed. The Group invited all CPC scientists to review those catalogues, covering the period 1992 to 2021, and report to ICCAT the missing datasets identified. The updated BFT conventional tagging dataset (represented in **Figures 10-12**) was also made available to the Group.

4.3.2 Assumptions about catches in 2021 and 2022 for projections

For the projections, the Group adopted the TAC of 36,000 t of E-BFT as the yield indicator for the total catches expected for 2021 and 2022. The flag/gear combination catch ratios of 2020 were used to allocate the catches by gear and flag. The Group noted that 2021 total catches could be slightly below the 36,000 t, considering the potential impact of COVID-19 on E-BFT fishing activities. This possibility was observed with a preliminary evaluation of the 2021 catches, and their distribution by flag, region, and gear. For this study, the Secretariat presented two Commission related auxiliary data sources (all anonymized) to estimate 2021 catches: i) the BFT weekly catch reports, by flag, region, and gear; ii) the eBCD (electronic Bluefin Catch Documentation scheme) catch data. The 2021 catches of E-BFT ranged between 32,600 t in (i) and 35,000 t in (ii). When completing the 2021 T1NC preliminary statistics (6 flag CPCs have already reported 2021 catches in Task 1) with both (i) and (ii) auxiliary data sources and applying carry overs (last year) to the remaining flag/gear combinations without statistics, the total E-BFT preliminary estimated catches were about 35100 t in 2021. The Group agreed to replicate this exercise at the stock assessment meeting (with more complete information in (i) and (ii) for 2021 and 2022), aiming to compare the results with the adopted 2021 and 2022 catch projections of 36,000 t (TAC).

4.3.3 Assumptions regarding past inflated catch and recent IUU

Historical estimated non-reported IUU (Illegal, Unreported and Unregulated) catches covering the period 1982-2007, were adopted by the Group over several years and included in T1NC, under four distinct NEI (not elsewhere included) flags mainly to distinguish different estimation approaches over time. **Table 8** presents these NEI catch series for both regions between 1982 and 2007. The table below characterizes the four NEI flags used by the Group:

Flag	*Characteristics*	*Origin/Source*
NEI (ETRO)	ATE only, 1984-1991, unknown flag/gear	Japanese market (direct imports) (*Report for Biennial Period 1992-1993, Part II (1993), Vol. 2*)
NEI (Flag related)	ATE & MED, 1991-2000, LL, known flag	Task 1 versus Trade (ICCAT CDS) direct comparison (Anon., 2003)
NEI (combined)	MED only, unknown flag - LL (old NEI-MED) 1982-1992; - PS (1994-2004)	LL: Task 1 versus Trade (ICCAT CDS) direct comparison CDS with the methodology adopted at 2002 GFCM-ICCAT meeting (Anon., 2003)
NEI (inflated)	MED only, 1998-2007, PS only, unknown flag	SG-BFT estimations based on the estimated PS fleet structure and fishing potential (number of PS vessels) (Anon., 2018b)

The flag "NEI (inflated)" represents the largest portion of NEI estimated catches reaching 30 to 40% of the total E-BFT catches between 2000 and 2007. The high amounts of estimated NEI catches in the total catches, lacking a proper flag/gear/area allocation, may have large effects on the stock assessment results at several levels, e.g. the uncertainty arising from not allocating properly the partial catches to the fleet structure defined by the Group. Another example is the uncertainty resulting from choosing/adopting size samples used to produce the CAS/CAA estimations (VPA models).

For the stock assessment, the Group agreed to update the CAS/CAA intersessionally by replacing the "NEI (inflated)" partial catches component (1998-2007) with a new set of combined Mediterranean size samples (various gears and Flags).

For the most recent years, possible illegal, unreported and unregulated (IUU) catches in the Mediterranean are under investigation and, until more information is available on the magnitude and timing of these catches, the Group cannot speculate on their impact on the assessment or assessment advice.

4.4 Indices of abundance

As indicated in section 5, the Group considered that the default approach for this assessment should be similar to previous assessments (*Report for Biennial Period 2016-2017, Part II (2017), Vol. 2*); *Report for Biennial Period 2020-2021, Part I (2020), Vol. 2*) unless there is a strong rationale for changes due to the limited time available and the commitment to the MSE process. The Group also recognized the importance of the use of the best available information for the stock assessment, therefore effort might be taken to harmonize the input data for this stock assessment and the current OMs in the BFT MSE. In this section, the Group reviewed all available indices and decided on the indices to be used for the 2022 stock assessment. All indices applied to the 2020 stock assessment and the OMs were available before the meeting.

The Group accepted to apply to the 2022 stock assessment the series of indices used in 2020: Spanish (1952-2006) and Spanish-French (2007-2014) baitboat indices, Moroccan-Spanish (1981-2011) and Moroccan-Portuguese (2012-2020) trap indices, Japanese longline indices in the East Atlantic and Mediterranean (1975-2009) and in the Northeast Atlantic (1990-2009/2010-2020), French aerial survey index (2000-2003/ 2009-2021). The Group decided to use the revised indices of the western Mediterranean larval survey index used in the OMs for inclusion in the assessment models. The Group recommended using the revised GBYP aerial survey index for the Balearic region. Several other indices were available but were not considered for inclusion in the models. The Group encouraged continued efforts to develop indices to inform the E-BFT stock abundance.

The table and figure of available indices are shown in **Table 9** and **Figure 13**. The Group also reviewed the CPUE Evaluation table for both W-BFT and E-BFT stocks (**Table 10**).

Document SCRS/2022/066 presented a summary of the acoustic-based fishery independent bluefin tuna index in the Bay of Biscay. The main objective of this survey is to develop an acoustics-based, fishery independent abundance index in the Bay of Biscay that continues the historical baitboat index, based on catch rates, used in the E-BFT stock assessment, that stopped in 2015. An acoustic survey covering the summer feeding area for bluefin tuna was conducted in the Bay of Biscay from July 2015 to 2021 on-board a baitboat fishing vessel, using acoustic technology. The survey followed systematic zig-zag transects defined according to historical baitboat catch locations. All bluefin detections by sonar and echosounder were recorded. In each aggregation, species identification and size sampling were conducted through no-kill fishing events, stereoscopic cameras, and/or multibeam sonar. The index presented is available for consideration for the E-BFT stock assessment.

The authors asked the Group about the utility and potential future use of this fishery independent index for the evaluation and management advice of E-BFT by the SCRS as well as to justify its continuation and to warrant appropriate funding. The SCRS strongly supports the development and continuation of this type of fishery independent indices of abundance, highlighting the modern acoustic methodology and additional scientific information collected by the survey. The need to increase the duration of the survey from the current 10 days, to allow for more coverage of the area in the Bay of Biscay, as well to measure the variability of oceanographic conditions that determine the migratory patterns of bluefin tuna in this feeding area in the summer months was noted. It was also noted the sequential arrival of age classes to the Bay with larger fish present during early June/July and smaller fish arriving later, even in September. Therefore, there may be a need to extend the number of surveys within the summer period to monitor the different age groups properly.

It was further suggested integrating survey information with other surveys in the area such as the French Marine mammal survey, and/or with the associated bluefin commercial fisheries in the Bay of Biscay. The Group also inquired about the feasibility of combining the acoustic survey with aerial surveys or even satellite high-resolution imaging. The authors indicated that this option was considered in the initial years, however, the oceanographic and climatological conditions of the Bay were not optimal for aerial detection of the bluefin tuna schools at the time of surveying, plus the potential misidentification with albacore schools present at this time in the Bay was problematic. In summary, the Group supports the continuation of the Bay of Biscay Acoustic based survey. The Group also recommends that the survey be extended in time and that additional financial support from different research programs including the GBYP, be sought.

Document SCRS/2022/068 presented the update of the French aerial survey index used in the MSE and in the stock assessment. The strict update was applied to the second time-period of the time series (2009-2021), with no change in methodology compared to what was used since the 2017 E-BFT assessment. It showed a slight decrease in 2021 compared to 2020, but still remains the third highest in the time series. The effort remained comparable to previous years. Future work will improve the methods to account for environmentally driven changes in availability.

The Group inquired about the index standardization methodology and if environmental factors have been incorporated. The authors indicated that following the recommendations of the BFT-SG in 2020/2021, the index is a strict update of the 2020 index, noting that ongoing research is evaluating the impact of environmental (wind speed) and oceanographic conditions on the index, but the results are expected only to be available in early 2023. *It was further noted that the Group agreed to use this index in the 2022 assessment and that it has been included in the BFT MSE as well as in the 2017 and 2020 stock assessments.*

Document SCRS/2022/071 presented an update of the retro-calculated larval abundance index of Atlantic bluefin tuna in the Western Mediterranean Sea 2001-2020.

The Group inquired about methodological changes in the update of the larval index. The authors indicated that changes were from a generalized additive model (GAM) in the earlier versions to a two-stage generalized linear mixed model (GLMM) using the marginal means product of the probability of larvae presence times mean larvae density by year as the standardized index. This model version was used in the BFT MSE in 2021. It was further shown that the overall trends were similar among standardization models. The authors indicated that the index represents the estimated number of larvae at 2.5 cm using a mortality function and the standardization model included a correction for the changes on the sampling gear between 2001-2005 and 2012-2019. The Group requested the size distribution of sampled larvae by year and inquired about the inclusion of environmental factors in the standardization. The authors indicated that oceanographic conditions affecting BFT larvae distribution were considered including salinity, mixed layer depth, and residual temperature. The Group noted that in 2019-2020 the index indicates a large increase in the series from about 46 to 107 (e.g. two-fold increase), and enquired on the potential explanations for this increase. The authors pointed that several sensitivity analyses provided identical indices including the high value in 2020 showed. It was noted that the larval survey index and the GBYP aerial survey index for the Balearic Sea showed similar increasing trends in recent years. *The Group recommended use of the revised larval index for the assessment and noted that the increased CV of the index likely is a better reflection of the variability inherent in larval surveys and larval dynamics.*

SCRS/2022/073 describes the abundance indices of bluefin tuna for the Japanese longline fishery in the West and Northeast Atlantic up to fishing year 2021 both for the purposes of the MSE and the assessment of the E-BFT stock. While the indices were standardized with a delta-lognormal model with random effect with the SAS (previously, "Statistical Analysis System") software for the sake of simple update, this document introduced alternative indices using 'lme4' and 'VAST' packages in R. The simply updated CPUE both in the East and West Atlantic remained at a relatively high level, although those in the most recent 2 years, fishing years 2020 and 2021, showed a somewhat decreasing trend. The alternative indices showed similar trajectories and the simple update with small differences. The authors suggested the use of the indices standardized by 'lme4' for MSE purposes and the use of indices standardized by 'VAST' for the stock assessment in the East Atlantic.

The Group acknowledged the authors for the comprehensive and extensive work done on this index, highlighting the application of the VAST spatial standardization model to the catch and effort of a longline fishery that has shown a large spatial variation in distribution throughout the years. This modeling approach will help to better address some of the limitations of traditional generalized linear model (GLM) standardization models. It was indicated the GLM models showed a bimodal distribution of the residuals, a feature that was corrected with the VAST model.

The authors' proposal of using the VAST model for the assessment was discussed at length by the Group. It was noted that there are significant changes in the treatment of data and standardization models between the versions of indices presented for both East and West BFT and although the overall trends of the standardized CPUE series were similar, the application of the VAST model may warrant further evaluations. The Group asked about the split of the index in 2009-2010 for the VAST model. The authors indicated that in 2010 the individual quota (IQ) management measure implemented affected the fishing operations of the fleet, and a similar approach was implemented in the previous assessments (2017 and 2020) by splitting the index into two series. It was also noted that the VAST index lost the initial 5 years (1990-1994) of the series for E-BFT and requested the authors to redo the standardization with the whole time series. The authors provided the updated VAST index for the period 1990-2020 during the meeting.

The Group also noted the desire the consistency of the index trend replication with the addition of new data for the BFT MSE process, a feature that is less likely with the VAST model standardizations. The additional time and effort required for the VAST standardization updates compared to traditional GLM models was also noted. *The Group recommended to use the indices standardized by SAS that have been included in the BFT MSE and in the 2017 and 2020 stock assessments. The Group supported continuous efforts on the development of the standardized indices by VAST model for the future uses in the MSE and assessments.* The Group encouraged the authors to shift the software to R 'lme4' from SAS, and agreed to apply them once it is completed in the near future.

The GBYP Coordinator provided a presentation SCRS/P/2022/018 comprising first an overview of the GBYP aerial survey index and then a summary of the current situation and next steps. The GBYP Coordinator detailed the actions taken towards full standardization of methodologies, as well those directed to the refinement of the data base and analytical procedures to address inconsistencies detected in the revision carried out in 2018. Next, the recommendations from the external experts who carried out in 2020 a further complete revision of the GBYP aerial survey programme were explained. This led to a second complete reanalysis of the available data in 2021 by the CREEMs team from the University of St Andrews. The results from this second complete reanalysis of data provided both a revised aerial index time series for the Balearic Sea and a new one for the Western and Central Mediterranean areas. It was pointed out that the revised aerial index for the Balearic Sea was not significantly different from the one in the 2019 complete reanalysis and that it showed a similar trend to the western Mediterranean larval index. Finally, the pilot survey carried out in 2021 in the Balearic Sea area over an extended area and incorporating digital systems for automatic recording of BFT schools, as recommended by the external experts, was described in the presentation as well as a summary of the activities to be carried out in 2022.

The Group acknowledged the efforts by the GBYP to review and update the aerial survey indices of the Balearic Sea (western Mediterranean) and the West and Central Mediterranean Areas together (which includes the Balearic Sea index) following the Group's previous recommendations. It was clarified that the Balearic Sea index has been included in the list of available indices for CMPs in the MSE process, however, it is not currently used in the MSE OM reconditioning (e.g. zero weight) pending the revision of the index. The Group inquired about the overlapping of the two indices, and the authors indicated that in 2019 the Group decided to use temporarily the Balearic Sea index only, since it was based on a more consistent standard survey compared to the rest of the areas covered and was not affected by some of the problems affecting other areas. The complete 2021 revision has fixed these problems, and it is also possible to provide the combined West and Central Mediterranean index. However, it has been noticed that Balearic Sea and the West and Central Mediterranean indices may not cover fully the potential spawning areas in the Mediterranean for E-BFT, since unfortunately the available data from the eastern Mediterranean survey cannot be used to get an index representative of spawning stock biomass (t) in that region. It was indicated that these indices, if included in the assessment models, could potentially duplicate the information provided by the western Mediterranean larval index, as they would be associated with the spawning component of the BFT population even though the data source for each index is different. *The Group recommended that only the Balearic Sea index be used for the 2022 assessment models and that the West and Central Mediterranean index be presented as auxiliary information for the management advice*. The Group recommended that it should outline a series of model runs, with a clear set of tests to objectively choose the best performing run.

Document SCRS/2022/072 presented a review of the available information for the eastern Atlantic bluefin tuna from the Chinese longline observer data for the period 2013-2019. During this period, two Chinese fishing vessels target bluefin tuna in the North Atlantic operating between 50°-55° N and 23°-26° W areas from September through November. A summary of fishing effort i.e. the number of hooks deployed, fishing days, catch and nominal catch rates, as well the size and weight distribution of the catch, was provided.

The Group recognized and welcomed the information provided by the Chinese scientists and recommended continuing observer data collection, exploring standardization of the catch rates, and extending collaboration/participation with other national scientists and the SCRS bluefin tuna scientific programmes within the biological, tagging and other research projects currently ongoing.

5. Detailed ToRs for E-BFT stock assessment (VPA, Stock Synthesis, and ASAP)

5.1 Specify runs

Details of the preliminary stock assessment runs are provided below, as well as the related Group discussion. In addition to the areas for investigation and/or revision identified here, the BFT Technical Sub-group on Assessment may consider additional modifications to improve the diagnostic performance of the models.

VPA

A presentation on a preliminary continuity run for VPA was presented to the Group (SCRS/P/2022/015). It used input data and specifications that were as close as possible to those used for the 2017 assessment and the 2020 update assessment. The objective was to present initial results to seek feedback from the Group on the path forward for the VPA. Results showed similar problems as identified during the 2020 update assessment: a strong instability in scale, strong retrospective patterns and a strong sensitivity to the indices, which were likely linked to the F-ratio estimates.

Several ways were suggested to improve the VPA modeling, a key objective being to try to provide stability to the model with an emphasis on the F-ratios estimate. Suggested approaches for improving the VPA included:

- to investigate the estimate of F-ratio through different options. For instance, using an empirical basis to fix the F-ratios empirically for time blocks for which the rationale for F-ratio=1 could be deemed reasonable could be considered

- a random walk approach to constrain the F-ratio estimate for the different time blocks, whereas more flexibility could be left for the 1996-2007 time block during which the uncertainty on size structure is important
- to attempt a run only including the reported catch as most of the uncertainty was linked to the inflated catch structure
- a penalized function for the scale, whose implementation details would have to be discussed
- to extend the age-structure from age 10+ to age 16+ to assume F-ratio=1, which would also mirror the modeling choices for the western stock
- since other platforms do not make the same assumptions about the catch at age, the initial results from other modeling platform could help understanding issues encountered with the VPA (e.g. using the CAA estimated by SS3 as an input for VPA) or pointing to potential solutions

The Group also identified that the age-structure of the inflated catch series (1998-2007) did not include large fish (mainly 1998-2004), whereas there is evidence that large individuals were caught, specifically by purse seiners, during this period. the Group put forward the proposal that the age structure of the inflated catch during the 1998-2007 period was not realistic as it was largely composed of young fish, whereas the general assumption during that period is that it was an increase in the targeting of large fish. The Group recommended to investigate catch at size and formed a small group to address it, which would allow catch at size to be revised and used in the 2022 assessment.

Stock Synthesis

SCRS/P/2022 /016 showed the results of the preliminary Stock Synthesis model for E-BFT for 2022 with the data input and model settings presented in SCRS/2022/079. The presentation focused on the evaluation of the performance of the model. The model converged and it was possible to invert the hessian matrix to get the covariance matrix. The joint residual analysis indicated that there are not trends in the residuals of indices but for two indices (SPNBB_5006 and W-Med Larval Survey) some years have high residuals. The mean length residual tests showed a non-random trend in length residuals that need to be explored. The retrospective analyses with 5 peels indicated a moderate consistency and stability of the model for SSB and F estimates.

The Group considered the initial model setup and identified some issues to be addressed in the models. The Group recommended i) solving the problem of selectivity parameters being estimated at parameter constraint boundaries and ii) also trying to simplify the selectivity functions with the use of dome-shaped and logistic selectivity curves. None of the fleets in the model used a logistic selectivity and this could be a matter of concern (Crone *et al*., 2013). The inclusion of a fleet selectivity forced to be logistic should be considered.

The Group indicated that the effective sample sizes for the length composition by fleet and year have to be included in the model as specified by using the log(N) of the number of observations. The authors of Japanese longline indices requested that the JPNLL_NEAtl indices estimated by VAST model (1995-2009/2010-2020) be included in the model but excluded from the likelihood components by setting weighting for this index (lambda= 0). This exercise can reveal the consistency of the estimated biomass trend in these indices without any disturbance of fit in the base case model. Once the concern on this standardization by VAST is solved, the Group can discuss the use of this index in the future meeting based on the result of this exercise.

The initial equilibrium catch used in the preliminary model would be checked based on the available records of catches for years before 1950 that were provided by the ICCAT Secretariat. The Group recommended using features included in the Stock Synthesis software (i.e. *catch multiplier* feature) to deal with uncertainty in catch values of the inflated period (1998-2007).

The Group suggested some modifications in the fleet structure, because the CAA of the inflated catch (1998-2007) will be reconsidered for the VPA and ASAP inputs. The Group suggested considering separating the inflated catch as one new fleet and applying the associated size compositions for CAS/CAA matrix estimation. The size frequency for the other PS fleet showed two modes (around 120 cm and 200 cm) recently. It was suggested to consider the shift in the fleet structure if necessary.

The Group recommended consideration be given to the growth parameters, particularly revising the prior distribution on L_{INF} (currently 340 cm) to one closer to existing growth model estimates and less influential. Once this is done, the resulting growth estimates can be evaluated to see if they are reasonable and do not have high correlation with other parameters. If high correlations exist and/or estimates of growth change substantially in retrospective peels, modelers can consider fixing the growth parameters with those estimated in the terminal year of the Stock Synthesis model. If growth estimates still prove to be problematic, external estimates similar to those used in the MSE could be used, although it would be preferable to estimate internally to utilize the extensive hard part data that have been collected to estimate growth, variability in growth and to inform cohort structure. The ramp for reduction of bias in estimating standard deviations of recruitment should be updated based on protocols outlined in Methot and Taylor (2011).

The Group recommended revisiting all the data inputs to be consistent with what is being used in the BFT MSE. Also, it recommended obtaining relative precision estimates before performing extensive model diagnostics and potential re-weighting schemes.

The non-random residuals detected for mean length should be explored to identify possible misspecification of the model related to growth and/or selectivity. The Group suggested evaluating the plausibility of the model means a wide set of diagnostics, most of them available in the R library *ss3diags*:

- Model convergence: goodness-of-fit, Hessian matrix invertibility, jittering, and individual residuals and joint residuals analysis
- Model consistency: profiling of *h*, sigmaR and R0, age structured production model (ASPM) and retrospective analysis
- Model prediction skills: hindcasting cross-validation

ASAP

A continuity run for ASAP was presented to the Group (SCRS/P/2022/017) to seek feedback on preliminary model diagnostics as well as proposed data and model revisions. ASAP methods and recent applications to E-BFT are described in SCRS/2022/070, with example input data (1968-2020 catch at ages 1-10+ by fleet and stock indices). Input data and specifications of the continuity run were as close as possible to the one used for the 2020 update assessment (Anon., 2020b), with a slightly different age range (single fleet, ages 1-16+). Results of the continuity run were similar to those from the 2020 update assessment: the model generally fit the data well, with some residual patterns and higher residual variance of some indices than their input CVs, but the retrospective pattern was relatively small (Mohn's rho was +0.13 for SSB and -0.08 for F).

Several alternative ASAP applications were also presented that had revised input data based on Group decisions and initial model explorations. An alternative run with revised indices recommended by the Group had similar variance as input CVs, suggesting more appropriate influence of each index on model estimates. Increasing the input CV for the 1998-2007 inflated catch allowed model estimates of catch to vary within a lower constraint of reported catch. An additional selectivity period for 2015-2020 improved age composition residuals, but did not entirely resolve residual patterns, suggesting further selectivity modeling is needed. A revised ASAP with all three revisions (revised data, increased catch CVs for inflated catch, and additional selectivity period) had better model fit than the continuity run and greater retrospective consistency (Mohn's rho was +0.04 for SSB and -0.03 for F).

An exploratory ASAP run did not fit the western Mediterranean GBYP aerial survey (WMED_GBYP_AER) well but had similar goodness of fit to other data, as well as similar estimates of SSB and F. The proposed plan for ASAP includes further model exploration to improve fit to age composition and indices, with alternative selectivity models and perhaps adding fleet structure. Modeling fleets separately and specification of index selectivity are expected to improve selectivity estimates. The Group suggested adopting the fleets defined for BFT MSE and Stock Synthesis (SCRS/2022/079) if fleet structure is explored.

6. Working plan leading to the July 2022 stock assessment meeting

Following the presentations of initial data and preliminary results for three modeling platforms, discussions during the meeting allowed for identification of several aspects that will have to be addressed and/or explored by the July stock assessment. Some aspects were common to the three platforms, whereas others were more specific.

The workplan for the July stock assessment meeting will build on the investigation of these different aspects by the modeling teams. The workplan will include two informal online meetings leading up to the July stock assessment meeting:

- 1st informal meeting of the BFT Technical Sub-group on Assessment: advances and transversal issues
- 2nd informal meeting of the BFT Technical Sub-group on Assessment: diagnostics and finalization, preferably 2 weeks before the assessment meeting (4-9 July 2022)

Before the first informal meeting, the following transversal issues will be addressed:

- Update of the CAS/CAA data including new size/age composition for the inflated catch period (1998-2007) by May 13
- Hindcasting, if time permits, to be evaluated at the 1st informal meeting

For each modeling platform, the following aspects were identified for further investigation. These aspects will be addressed and/or discussed during the first informal meeting, so that most of them will be addressed by the second meeting. The BFT Technical Sub-group on Assessment may identify additional aspects for investigation and possible revision.

- VPA
  - Catch at age
    - Explore extending the age structure from 10+ to 16+
    - Run with reported catch only e.g. exclude the NEI-inflated 1998-2007
  - Model stability, F-ratios
    - Empirically fixed values
    - Random-walk estimates
    - Penalty function for the scale or the prior distribution of the scale estimate, if time permits and if a scale estimate proposal is forthcoming
- Stock Synthesis
  - Data issues
    - Update the length composition and indices in the model
    - Set appropriate sample sizes for length composition and standard error for indices
    - Define the ramp for recruitment deviations
    - Evaluate size at age data and ability to estimate growth in Stock Synthesis
  - Model Selectivity
    - Try more simple functions (dome-shaped and logistic) or directly all Double Normal (as in MSE)
    - Evaluate size compositions over time and consider time block(s) by Fleet, for example the PS_MED after years 2010
  - Inflated catch period 1998-2007
    - address different features available in Stock Synthesis to deal with uncertainty in catch
  - Estimate growth without prior distribution on L_{INF}, test correlation of growth parameters with other leading parameters and estimates across retrospective runs. If growth remains problematic, fix growth parameters at values estimated by the model, provided they are realistic or published external growth model parameters including the accepted model for E-BFT
  - Analysis of JPNLL_NEAtl-Vast: include the index JPNLL_NEAtl-Vast with Lambda = 0 and check the fit
  - Profiling key parameters
  - Balance the weight of different input data
  - Penalty function for the scale or the prior distribution of the scale estimate, if time permits and if a scale estimate proposal is forthcoming
- ASAP
  - Further model exploration to improve fit to age composition and indices
  - Alternative selectivity models
  - Adding fleet structure to improve selectivity estimates and specification of index selectivity
  - Profile key parameters- R0, steepness

- Evaluate age composition over time and consider time block(s) by Fleet

7. General discussion of GBYP matters

The GBYP Coordinator gave presentation SCRS/P/2022/019 to inform the Group about the recent GBYP activities and results, as well as the future plans. GBYP is currently running the Phase 11, which has been extended until the end of August 2022, while the proposal for the new Phase 12 has already been submitted to the major sponsor. The Coordinator informed the Group that, with respect to data management, there have been joint efforts ongoing in the Secretariat to develop both an electronic tagging database and a biological database. Approximate 200 new electronic tagging data sets shortly be acquired by the data recovery program. Electronic tagging deployments have ultimately been achieved by formal collaboration with national teams, both in the Atlantic and in the Mediterranean, which significantly lowered the operational costs. Future campaigns will be planned shortly, and the Group was asked to provide the inputs for defining the tagging priorities. It was noted that there have been important improvements observed in tag retention times and tag recovery rates, which will allow improvements in movement matrices used in MSE. The Group was informed that a global workshop on electronic tagging methodologies and joint use of databases will be organized soon.

Regarding biological studies, the sampling in farms has finished, while other biological sampling and analyses are still ongoing; the final results will be provided by September 2022. The Group was asked for its guidance in defining the research priorities for future studies. It was also informed about the workshop for coordination of efforts on biological sampling, which will be organized in 2022. As for the close-kin related studies, the Coordinator informed about its progress and reminded the Group of a series of agreed steps and the associated time frame. It was stressed that the immediate goal is to elaborate a concrete and realistic workplan, including cost analysis, to be presented to the SCRS Plenary and Commission for approval. With respect to the fishery independent indices, a larval survey workshop is planned in the second part of the year, while aerial survey campaigns will be resumed this year in the Western and Central Mediterranean. The work on habitat modelling to allow a model-based analysis of the overall results from aerial surveys will continue this year as well. More details on aerial surveys have already been provided in SCRS/P/2022/018. Regarding modelling approaches, the GBYP continues to provide its support to MSE process and has funded the external review of the E-ABFT stock assessment. Future plans also include support for the development of alternative/improved stock assessment models. Finally, the Coordinator provided an outline of possible mid-term activities, in order to improve GBYP efficiency and adapt it to a probable future scenario of decreased funding. They include a progressive shift from basic data provision to data management/analysis and coordination of the activities, in close cooperation with CPCs as main data providers.

With respect to future funding, the ICCAT Assistant Executive Secretary informed the Group that, up to now, science in ICCAT has mainly been funded by voluntary contributions from various CPCs, the EU being the main sponsor. Given that the EU has informed ICCAT that they will be progressively reducing the budget, the Commission will have to find alternative ways to continue financing the scientific programmes, such as increasing available funds through the ICCAT regular budget, which in 2022 only accounts for 17% of the total science budget.

8. Other matters

The E-BFT Rapporteur presented Document SCRS/2022/069 that provided the current electronic tagging information available for management strategy evaluation. The information also allows to identify gaps in sizes and geographical areas that should be considered to plan future tagging activities. It also describes the status of current electronic tag databases, advantages and disadvantages of electronic tags used on Atlantic bluefin tuna and outlines the technological advances that will allow the use of different types of tags (pop-up satellite archival, archival internal and acoustic tags) to improve the description of movements of BFT. The authors summarize, in the conclusions section, the needs for improvement in the use of electronic tagging for this species.

The Group was informed that efforts have been made to collect biopsy samples from all recently tagged fish to identify stock-of-origin of those fish, and to recover some data in order to fill the gaps in knowledge through the GBYP. It was also announced that a second GBYP workshop on electronic tagging, would be held within the next GBYP phase 12, where further discussion on the needs highlighted in this document would be possible.

8.1 BFT Technical Sub-group on Growth in Farms

Following the presentation of preliminary alternative updated growth tables during the SCRS meeting in 2021 (*Report for Biennial Period 2020-2021, Part I (2020), Vol. 2*), Section 21.26 (Responses to the Commission), the SCRS agreed that the completion of the finalized tables requires additional analyses of the data available. As these further analyses are completed, the objective was to have definitive tables by 2022. The Secretariat is currently analysing the data available, considering also the information obtained within the different GBYP funded studies on individual or specific cohort growth rates, based on tagging and Modal Progression Analyses, by applying alternative models to fit the data. However, the new analysis has not yet been completed and is not ready to be presented for discussion. Once this analysis has been completed, a meeting of the BFT Technical Sub-group of Growth in Farms will be immediately convened to discuss and agree on a final set of tables and to develop a workplan to formulate a draft final answer to the Commission.

In the 2021 Commission plenary meeting (*Report for Biennial Period 2021-2022, Part II (2021), Vol. 4*), there was a request (PA2_608/2021) that the SCRS establish a length-weight relationship (L-W) for fattened bluefin tuna. This request cannot be resolved by estimating a generic L-W relationship from fish harvested on the farms, as doing so would ignore the gain in weight (of a particular cage/whole farm) as a function of time on the particular farm and the initial size. This means that the Commission's request becomes an extension of the farm weight increase (after the harvesting has stopped) which could be possible if sufficient observations from the harvest are available and the updated growth tables are finalized.

9. Adoption of the report and closure

The Report of the 2022 Eastern Atlantic and Mediterranean Bluefin Tuna Data Preparatory Meeting (Including BFT MSE) was adopted. Drs Rodríguez-Marín and Walter, and the SCRS Chair thanked the participants and the Secretariat for their hard work and collaboration to finalize the report on time. The meeting was adjourned.

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Table 1. 'Quilt' plot for the West and East for tuning level 2. Color scale represents relative performance from yellow (best) to green to purple (worst). The seven statistics and associated percentiles are C1: catch (kt) in the first year of MP application (median or 50% percentile), AvC10: average catch (kt) over years 1-10 (50%tile); AvC30: average catch (kt) over years 1-30, VarC: Variation in catch (kt) between MP applications (50%tile); LD*(5%): lowest depletion over years 11-30 (5th percentile); LD*(15%): 15%tile of lowest depletion; BR30(5%): 5%tile of SSB/SSB_{MSY} in year 30. CMPs have been given an anonymous number 1-N as some are still being further refined. The May Panel 2 meeting will receive specific, named CMPs.

West

	C1 (50%)	AvC10 (50%)	AvC30 (50%)	VarC (50%)	LD (5%)	LD (15%)	Br30 (5%)
CMP_9	2.523	2.882	2.811	13.92	0.313	0.497	0.569
CMP_8	2.82	2.864	2.595	16.397	0.327	0.544	0.669
CMP_13	2.206	2.658	2.792	18.716	0.369	0.52	0.567
CMP_14	2.509	2.644	2.534	15.645	0.286	0.505	0.499
CMP_17	2.682	2.831	2.637	6.708	0.182	0.402	0.35
CMP_16	1.908	2.052	2.256	18.124	0.337	0.528	0.545
CMP_12	1.676	1.948	2.167	19.355	0.311	0.511	0.521
CMP_18	3.271	3.452	2.639	18.585	0.051	0.281	0.107
CMP_11	2.695	3.383	2.338	21.424	0.098	0.264	0.197

East

	C1 (50%)	AvC10 (50%)	AvC30 (50%)	VarC (50%)	LD (5%)	LD (15%)	Br30 (5%)
CMP_8	34.84	43.753	39.157	16.85	0.363	0.612	0.394
CMP_9	37.509	39.017	32.269	17.221	0.496	0.668	0.734
CMP_11	43.2	51.804	32.538	20.575	0.24	0.424	0.515
CMP_12	43.2	33.819	28.568	19.05	0.357	0.552	0.505
CMP_13	43.2	33.188	28.256	19.06	0.373	0.57	0.53
CMP_14	43.2	35.02	30.441	17.231	0.43	0.59	0.547
CMP_16	43.2	35.337	30.848	17.26	0.427	0.59	0.543
CMP_17	37.261	33.432	29.209	8.18	0.369	0.538	0.52
CMP_18	39.829	41.518	28.647	16.465	0.228	0.413	0.357

Table 2. Detailed listing of meetings of the BFT-SG, BFT Technical Sub-group on MSE and Panel 2 for 2022.

Date		**Meeting (virtual or hybrid)**	**Objectives**
2022	March 4	1st Panel 2 meeting on BFT MSE (virtual)	1. SCRS to present updated MSE framework and CMPs. 2. Panel 2 to provide feedback and guidance on additional changes to the CMPs. 3. Panel 2 to refine initial operational management objectives.
	March/April	SCRS BFT Tech. Sub-group on MSE informal meeting (virtual)	1. Address Panel 2 feedback. 2. Prepare material for BFT-SG.
	April 18-26	E-BFT Data Prep including MSE	1. BFT-SG to update performance statistics based on initial operational management objectives, if necessary. 2. BFT-SG to provide feedback and approval of final MSE robustness trials. 3. BFT-SG to develop presentation to Panel 2 on progress.
	May 3-6	SCRS BFT Tech. Sub-group on MSE meeting (virtual)	1. BFT Tech. Sub-group on MSE to present changes to CMPs based on Panel 2/Commission input.
	May 9-10	2nd Panel 2 meeting on BFT MSE (virtual)	1. SCRS to present final MSE framework and draft suggestions for selecting of CMPs. 2. Panel 2 to provide feedback on MSE and guidance on additional changes to the CMPs. 3. Panel 2 to agree on final operational management objectives.
	July 4-9	E-BFT Assessment including MSE (hybrid)	1. Some elements of MSE will likely be discussed.
	July (TBD)	SCRS BFT Tech. Sub-group on MSE informal meeting (virtual)	1. BFT Tech. Sub-group on MSE to collate and address Panel 2 feedback. 2. CMP developers to present revised results, incorporating feedback.
	Late July (TBD)	Ambassador meetings (3) (virtual)	
2022	September 5-8	SCRS BFT Tech. Sub-group on MSE meeting (hybrid)	1. CMP developers to present revised performance tuned results, incorporating feedback from PA2. 2. BFT Tech. Sub-group on MSE to recommend up to three CMPs but will provide SCRS/BFT-SG with all results.
	September 19-24	SCRS BFT Species Group (hybrid)	1. BFT-SG & SCRS to review and endorse final CMP results. 2. BFT-SG & SCRS to select several final CMPs for presentation to Panel 2.
	September 26-30 Sep	SCRS Plenary (hybrid)	1. SCRS to recommend up to three CMPs but will provide PA2 with all results.
	Early Oct (TBD)	Ambassador meetings (4) (virtual)	

	October 14	3rd Panel 2 meeting BFT MSE (hybrid)	1. SCRS to present final CMPs, with all final specifications, for review. 2. Panel 2 to select a CMP to recommend for Commission adoption. Panel 2 will also select final performance tuning settings.
	November 14-21	Annual Commission meeting (hybrid)	10. Commission to adopt a fully specified MP, including final operational management objectives.

Table 3. Possible timeline of events for future advice framework for BFT using the example of a 2-year MP setting cycle.

Year	Event
2022	E- BFT Stock Assesssment Management Procedure Sets 2-year East and West TACs for 2023 and 2024
2023	Define Exceptional Circumstances Provisions
2024	Management Procedure Sets 2-year East and West TACs
2025	Stock Assessment - health check (exact timing TBD)
2026	Management Procedure Sets 2-year East and West TACs
2027	MSE reconditioning, possible start in 2026 (TBD)
2028	(Possibly revised) Management Procedure Sets 2-year East and West TACs
2029	TACs as set in 2028
….	…….

Table 4. A summary of the current assumptions concerning life history attributes for the West Atlantic and East Atlantic and Mediterranean Bluefin tuna stocks will be used in the 2022 assessment models.

Life history attribute	***Assumption used by the SCRS***	***Source (see also ICCAT Manual)***	***Notes***
Growth (length at age)	West: Richards model A_1=0; A_2=34; L_1=33.0; L_2=270.6; K=0.22; p=-0.12 East & Med.: Von Bertalanffy model K= 0.093; L_∞=319 cm; t_0=-0.97	Ailloud *et al*. (2017) Cort (1991)	For the west, the SCRS adopted the growth curve of Ailloud *et al.* (2017) in 2017.
Growth (length-weight)	Area and season specific conversions are used, overall equations: West: $W=0.0000177054*L^{3.001251847}$ East & Med.: $W=0.0000350801*L^{2.878451}$	Rodriguez-Marin *et al*. (2015)	The seasonal specific conversions by area are in *ICCAT Manual* (BFT-Table2, conversion factor)
Natural mortality	West and East & Med.: Starting at age 1: 0.38, 0.30, 0.24, 0.20, 0.18, 0.16, 0.14, 0.13, 0.12 (ages 9-10), 0.11 (ages 11-13), and 0.10 yr^{-1} (ages 14 plus)	Lorenzen (1996) mortality vector based on the growth model (Ailloud *et al*., 2017) and rescaled to have a value of 0.1 at age 20	Lauretta (2018) (This natural mortality has been used for both stocks sincethe 2017 stock assessments.) Size-weight relationship (Rodriguez-Marin *et al.*, 2015)
Longevity	West: 32 yr East &Med.: > 20 yr	Neilson and Campana (2007) Fromentin and Fonteneau (2001)	Based on radiocarbon traces. Based on tagging data.
Spawning-at-age	West older spawning: Starting at age 1: 0 (ages 1-8), 0.2, 0.6, 0.9, 1(ages12plus) West younger spawning: Same as East Atlantic	Porch and Hanke (2018)	Porch and Hanke (2018) estimated spawning fraction oogive based on age composition data from the U.S. longline fishery in the Gulf of Mexico 2009-2014. Recent findings indicate fish were mature at age 5 (Knapp *et al*., 2013).

	East & Med.: 50% spawning at age 4 (115 cm / 30 kg). Starting at age 1: 0 (ages 1-2), 0.25, 0.5, 1 (ages 5 plus)	Anon. (1997)	M_{50} at 105cm, (age 3.5) from Corriero *et al*. (2005).
Spawning area	West: Gulf of Mexico and Slope Sea. East & Med.: Around Balearic Islands, Tyrrhenian Sea, central Mediterranean and Levantine Sea, and Bay of Biscay.	Multiple sources, see Hernández *et al*. (2022), Rodriguez *et al*. (2021), Reglero *et al*. (2018), Rooker *et al.* (2007), Fromentin and Powers (2005), Mather *et al.* (1995) for reviews.	Other spawning areas have been identified, but not yet demonstrated to be important.
Spawning season	West: April to mid-June GOM, add Slope Sea July-Aug. East & Med.: eastern Med.: mid-May to mid-June western Med.: mid-June to mid-July	As above.	Timing of the spawning season can change from year to year due to environmental conditions.

Table 5. E-BFT total catches (t) by region and major gear between 1950 and 2020.

	BFT-E (AE)						BFT-E (MD)						BFT-E
Year	Bait boat	Longline	Other surf.	Purse seine	Sport (HL+RR)	Traps	Bait boat	Longline	Other surf.	Purse seine	Sport (HL+RR)	Traps	TOTAL
1950	2975		452	2200	1142	13400			607	1390	400	4246	26812
1951	3872		1790	6728	1724	8906			916	1191	400	4684	30211
1952	4685		1004	14752	2734	9471			1066	1667	400	3228	39007
1953	4135		2202	10217	1167	13553			999	1796	800	4405	39275
1954	5500		312	12145	1658	9669			900	2283	600	4090	37157
1955	6559		1921	13394	2316	12593			889	1583	1200	3637	44092
1956	3409		55	5313	1046	14784			474	1215	900	2988	30186
1957	4017	33	1004	6437	2030	14949			721	1097	500	5084	35873
1958	4241	2		6399	623	15150			433	1032	700	4773	33353
1959	3800	56		6727	1828	7927			487	755	700	4054	26334
1960	1374	481		6501	536	10951			501	674	900	4197	26113
1961	1597	223		11547	454	7835			699	816	1100	3811	28083
1962	1702	2484		10358	370	9165			323	595	1000	3460	29457
1963	1554	1618		1586	3	4553		800	814	1605	1200	2624	16357
1964	1263	645		3520	44	5391		300	1058	1306	600	3081	17208
1965	1984	438		3412	23	5189		400	507	470	700	3972	17095
1966	3557	91		2778	2	3221		500	100	1897	500	2438	15084
1967	2018	141		4063	15	4582		300	100	2937	600	4978	19734
1968	1585	208		1206	8	2072		600	100	3355	500	3911	13545
1969	2056	201		1520	1	2475		400	0	3638	500	4233	15024
1970	3017	274	5	876	14	1820		69	20	2396	100	2216	10808
1971	3055	254	105	683	1	713		129	2	3906	100	2237	11185
1972	3032	261	101	961	6	469		236	4	4084	100	1575	10830
1973	3316	91	14	933	2	506		520	56	4324	100	1149	11012
1974	2385	2243	4	1459	0	78		2408	14	8119	100	2476	19285
1975	3193	2923	4	3612	0	448		1400	39	8065	114	1666	21465
1976	1868	2048	12	860		490		1243	21	13970	100	1756	22368
1977	3055	1806	5	1426	300	561		639	64	9563	188	1373	18980
1978	4126	733	2	257	451	633		179	24	7299	191	1219	15115
1979	2216	748	1	266	1024	600		222	11	6103	204	1040	12435
1980	1707	1002	2	437	38	817		253	4	8541	60	1198	14059
1981	1479	575	2	266	72	1186	100	390	66	8529	52	1388	14105
1982	987	2715	0	650	27	2309	53	1587	45	12131	122	1794	22421
1983	3128	2626	85	262	2	1956	391	980	10	10485	224	1550	21699
1984	2949	1557	88	373	158	2302	1699	1380	250	10624	603	2490	24473
1985	2364	576	150	86	1	1630	278	1396	795	12460	1007	1320	22063
1986	2253	1008	80	276	13	1057		966	527	11116	811	1153	19260
1987	2129	1026	0	255	3	1040		974	620	10032	810	1382	18271
1988	2682	1187	255	202	1	2624		1435	431	12566	1210	1537	24129
1989	2685	962	163	147	2	1492		1364	923	10883	826	1714	21161
1990	1993	1510	252	54	1	2504	25	1178	344	11797	1559	2382	23599
1991	1653	3196	126	46		1522	148	3057	356	13805	769	1711	26389
1992	1422	3618	523	462	7	1365	158	3145	447	18580	952	1152	31831
1993	3884	2802	976	24		1631	48	2470	371	20065	1238	749	34258
1994	2284	2311	590	213	25	1630	0	6993	776	27948	2307	1691	46769
1995	3093	4522	555	458		1152	206	8469	545	23799	3562	942	47303
1996	5369	4212	273	323		1921	5	9856	417	26021	2149	951	51497
1997	7215	4057	60	828	237	3982	4	7313	282	24279	2340	613	51211
1998	3139	3789	387	700	28	3586	11	4117	284	31792	1092	1074	50000
1999	1554	3570	404	726	33	3960	4	3338	228	33798	1533	852	50000
2000	2032	3736	509	661	126	2996	38	3424	728	33237	1773	739	50000
2001	2426	3303	558	153	61	3585	28	4144	354	33043	1167	1177	50000
2002	2635	2896	631	887	63	3235	1	3234	340	34044	1520	515	50000
2003	1409	2748	521	490	109	2116	9	3484	198	37291	1404	221	50000
2004	1902	2064	290	1078	89	1978	17	3036	197	37869	1325	154	50000
2005	2282	2700	424	1197	11	2408	5	3427	175	36639	619	112	50000
2006	1263	2033	831	408	99	2895		3408	81	38363	494	125	50000
2007	2436	1705	502	0	11	3788	0	3269	85	48994	117	93	61000
2008	2393	2491	181	0	12	3166	0	2376	0	13540	149	152	24460
2009	1260	1951	297	2	11	3164	38	1344	0	11448	160	144	19818
2010	725	1194	124	1	44	2292	1	1242	1	4986	448	281	11338
2011	636	1125	35	0	51	2137	0	962	1	4306	356	165	9774
2012	283	1139	49	0	53	2311	2	587	1	6183	202	125	10934
2013	243	1167	141	2	46	2564	2	605	20	7992	240	222	13243
2014	95	1194	210	0	43	2376	9	588	29	8195	289	232	13261
2015	172	1467	193		104	2905	25	784	3	9994	373	192	16214
2016	1085	1829	261	42	35	2716	0	1523	37	11349	297		19175
2017	1195	2214	295	49	101	3362	50	1184	90	14503	351	272	23665
2018	692	2738	340	11	118	4258	56	1518	34	17134	582	300	27782
2019	845	3186	320	56	92	4594	72	1436	51	19519	611	353	31134
2020	936	3321	381	190	155	5885	103	1824	282	20877	713	366	35032

Table 6. E-BFT standard SCRS catalogue on statistics (Task 1 and Task 2) for the eastern Atlantic region, by major fishery (flag/gear combinations ranked by order of importance) and year (1992 to 2021). Only the most important fisheries (representing ±97.5% of Task 1 total catch) are shown. For each data series, Task 1 (DSet = "t1", in t) is visualised against its equivalent Task 2 availability (DSet = "t2") scheme. The Task 2 colour scheme, has a concatenation of characters ("a" = T2CE exists; "b" = T2SZ exists; "c" = T2CS exists) that represents the Task 2 data availability in the ICCAT-DB. 2021 still incomplete. Shaded blue cells in Task 1 (DSet = t1) could indicate missing catches.

Species	Stock	Status	FlagName	GearGrp	DSet	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Rank	%	%cum
				T1 Total (t)		7396	9317	7054	9780	12098	16379	11630	10247	10061	10086	10347	7394	7402	9023	7529	8441	8243	6684	4379	3984	3834	4163	3918	4841	5968	7216	8157	9093	10868	5946			
BFT	ATE	CP	Japan	LL	t1	3350	2484	2075	3971	3341	2905	3195	2690	2895	2425	2536	2695	2015	2598	1896	1612	2351	1904	1155	1089	1093	1129	1134	1386	1578	1911	2270	2524	2782	2780	1	28.1%	28%
BFT	ATE	CP	Japan	LL	t2	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	ac	1		
BFT	ATE	CP	EU-España	BB	t1	1046	3718	1999	2878	4979	6634	2605	1278	1939	2319	2478	1278	1847	2207	1190	2307	2326	1197	641	562	197	163	92	130	983	1109	617	754	788		2	20.8%	49%
BFT	ATE	CP	EU-España	BB	t2	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	ac	ac	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc		2		
BFT	ATE	CP	Maroc	TP	t1	94	387	494	210	699	1240	1615	852	1540	2330	1670	1305	1098	1518	1744	2417	1947	1909	1348	1055	990	960	959	1176	1433	1703	2164	2476	3089	2884	3	17.9%	67%
BFT	ATE	CP	Maroc	TP	t2	-1	-1	-1	-1	-1	-1	-1	a	a	a	-1	-1	-1	-1	bc	abc	ab	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	3		
BFT	ATE	CP	EU-España	TP	t1	1271	1244	1136	941	1207	2723	1926	3106	1416	1240	1548	784	862	880	1126	1348	1194	1209	887	902	1106	1370	1173	1466	968	1299	1764	1892	2421		4	16.7%	84%
BFT	ATE	CP	EU-España	TP	t2	ab	ab	ac	ab	ab	ab	ac	ac	ab	ac	ac	c	c	abc	b	a	abc	abc	abc	abc	abc	abc	ab	abc	abc	abc	abc	abc	ac		4		
BFT	ATE	CP	EU-France	TW	t1	441	436	224	400		57	259	247	394	456	599	518	289	423	829	501	180	295	122	28	36	120	118	166	211	228	315	309	358		5	3.5%	87%
BFT	ATE	CP	EU-France	TW	t2	-1	-1	-1	-1		-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	abc	abc	ab	ab	abc	abc	ab	ab	b	ab	ab	a	ab	ab		5		
BFT	ATE	CP	Maroc	PS	t1	462	24	213	458	323	828	692	709	660	150	884	490	855	871	179																6	3.2%	90%
BFT	ATE	CP	Maroc	PS	t2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1																6		
BFT	ATE	CP	EU-France	BB	t1	372	164	66	181	310	134	282	270	91	105	150	130	47	69	65	128	67	62	83	74	85	74	2	42	99	77	71	88	133		7	1.5%	92%
BFT	ATE	CP	EU-France	BB	t2	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	a	a	a	a	a	a	ab	ab	b	ab	a	a	ab	a		7		
BFT	ATE	CP	EU-Portugal	TP	t1				1	15	19	45	2	40	15	17	27	18	9	25	23	24	46	57	180	215	233	243	263	315	361	330	225	375		8	1.3%	93%
BFT	ATE	CP	EU-Portugal	TP	t2				b	abc	ac	ac	ab	ab	ab	ab	ab	b	b	b	b	b	b	ab	ab	b	ab	ab	ab	ab	ab	ab	ab	ab	b	8		
BFT	ATE	CP	EU-Portugal	LL	t1	124	89	143	134	97	246	18	404	398	383	160	33	1	66	72	6	12	5			8	0		0	9	13	112	237	136		9	1.2%	94%
BFT	ATE	CP	EU-Portugal	LL	t2	a	-1	a	-1	-1	a	a	-1	-1	a	a	a	a	ab	a	a	a	a	a		a	a		b	ab	ab	ab	ab	ab		9		
BFT	ATE	CP	Korea Rep	LL	t1			4	205	92	203			6	1		0	3		1										161	181	208	232	247	242	10	0.7%	95%
BFT	ATE	CP	Korea Rep	LL	t2			-1	-1	a	a			a	a		a	a		-1										abc	abc	abc	abc	abc	a	10		
BFT	ATE	NCC	Chinese Taipei	LL	t1		6	20	4	61	226	350	222	144	304	158			10	4																11	0.6%	96%
BFT	ATE	NCC	Chinese Taipei	LL	t2		-1	-1	ab	ab	ab	ab	ab	ab	ab	ab			ab	ab																11		
BFT	ATE	CP	China PR	LL	t1							85	103	80	68	39	19	41	24	42	72	119	42	38	36	36	38	37	45	54	64	79	89	101		12	0.6%	96%
BFT	ATE	CP	China PR	LL	t2							-1	a	a	a	a	a	a	a	a	ab	a	a	a	ab	a	a	abc	ab	abc	abc	abc	abc	abc		12		
BFT	ATE	CP	EU-España	HL	t1						162	28	33	126	61	63	109	87	11	4	10	6	2	21	19	25	21	16	59	35	101	107	82	77		13	0.5%	97%
BFT	ATE	CP	EU-España	HL	t2						ab	ac	ac	ab	ac	ac	c	c	ab	ab	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc		13		

Table 7. E-BFT standard SCRS catalogue on statistics (Task 1 and Task 2) for the Mediterranean region, by major fishery (flag/gear combinations ranked by order of importance) and year (1992 to 2021). Only the most important fisheries (representing ±97.5% of Task 1 total catch) are shown. For each data series, Task 1 (DSet = "t1", in t) is visualised against its equivalent Task 2 availability (DSet = "t2") scheme. The Task 2 colour scheme, has a concatenation of characters ("a" = T2CE exists; "b" = T2SZ exists; "c" = T2CS exists) that represents the Task 2 data availability in the ICCAT-DB. 2021 still incomplete. Shaded blue cells in Task 1 (DSet = t1) could indicate missing catches.

Speci	Sto	Stat	FlagName	GearG	DS	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	Rank	%	%cum
			T1 Total			24435	24941	39715	37523	39399	34831	38370	39753	39939	39914	39653	42606	42598	40977	42471	52559	16217	13133	6959	5790	7100	9080	9343	11372	13206	16450	19624	22041	24164	3653			
BFT	MED	NCO	NEI (inflated)	PS	t1							9471	16893	16458	15298	15880	18873	18376	14164	18343	28234															1	21.6%	22%
BFT	MED	NCO	NEI (inflated)	PS	t2							-1	-1	-1	-1	-1	-1	-1	-1	-1	-1															1		
BFT	MED	CP	EU-France	PS	t1	7346	6965	11803	9494	8547	7701	6800	5907	6780	6119	5810	5549	6339	8328	7438	9543	2536	2918	1546	678	678	1940	1944	2299	2763	3320	3930	4374	4714		2	19.3%	41%
BFT	MED	CP	EU-France	PS	t2	b	b	b	b	b	b	bc	bc	bc	bc	bc	bc	bc	bc	bc	ab	abc	abc	abc	ab	ab	abc	abc	b	ab	abc	ab	ab	abc		2		
BFT	MED	CP	EU-Italy	PS	t1	3846	4162	4654	3613	7060	7068	3334	1859	2801	3256	3246	3849	3752	3961	4006	4311	1854	2339	2	752	1374	1474	1539	1678	2050	2409	2885	3347	3538		3	11.3%	52%
BFT	MED	CP	EU-Italy	PS	t2	-1	-1	-1	ac	-1	-1	b	b	b	-1	b	b	b	b	b	a	ab	abc	-1	abc	-1	-1	b	b	b	b	b	b	b		3		
BFT	MED	CP	Turkey	PS	t1	2817	3084	3466	4219	4616	5093	5899	1200	1070	2100	2300	3300	1075	990	806	918	879	665	409	528	536	551	544	1091	1324	1515	1273	1761	2256		4	7.1%	59%
BFT	MED	CP	Turkey	PS	t2	b	b	b	b	b	b	b	b	b	b	b	b	b	b	b	ab	ab	ab	ab	ab	ab	ab	abc	abc	bc	ab	ab	ab	ab		4		
BFT	MED	CP	Tunisie	PS	t1	975	1997	2523	1617	2147	1992	1662	2263	2134	2432	2510	740	2266	3245	2542	427	2679	1932	1042	852	1017	1057	1057	1248	1491	1788	2101	2378	2651	2728	5	7.0%	66%
BFT	MED	CP	Tunisie	PS	t2	-1	-1	-1	-1	-1	-1	-1	a	a	a	-1	-1	-1	a	b	abc	abc	ab	ab	ab	abc	ab	ab	b	abc	ab	abc	ab	abc	abc	5		
BFT	MED	CP	EU-España	PS	t1	1366	1431	1725	2896	1657	1172	1573	1504	1676	1453	1686	1886	1778	2242	2013	1649	1645	1167	804	877	1034	917	1122	1169	952	1523	2433	2457	2549		6	5.8%	72%
BFT	MED	CP	EU-España	PS	t2	ab	ab	ab	ab	ab	ab	abc	abc	ab	ab	ab	ab	ab	ab	ab	bc	ab	ab	ab	ab	b	ab	ab	ab	ab	b	b	ab	a		6		
BFT	MED	CP	Libya	PS	t1	300	568	470	495	598	32	230	195	503		200	512	872	730	1140	1200	1267	1047	645		763	933	933	1153	1368	1631	1792	2052	2228		7	3.0%	75%
BFT	MED	CP	Libya	PS	t2	b	-1	-1	-1	-1	-1	-1	a	a		-1	-1	-1	-1	-1	a	-1	-1	-1		ab	ab	b	ab	ab	b	b	b	ab		7		
BFT	MED	CP	EU-Croatia	PS	t1	1076	1058	1410	1220	1360	1088	889	921	914	890	975	1137	827	1017	1022	817	821	609	370	366	367	380	378	438	436	587	679	751	829		8	3.0%	78%
BFT	MED	CP	EU-Croatia	PS	t2	a	a	a	-1	-1	-1	-1	-1	-1	a	ab	a	ab	ab	ab	ab	ab	ab	ab	ab	a	a	ab	abc	abc	abc	ab	abc	abc		8		
BFT	MED	CP	Algerie	PS	t1	773	768	1092				900	1056	778	917	922	640	753	623	850	650	972				69	244	244	370	448	1038	1300	1437	1649		9	2.3%	80%
BFT	MED	CP	Algerie	PS	t2	-1	-1	-1				-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1				ab	abc	ab	ab	b	b	b	abc	abc		9		
BFT	MED	CP	EU-Italy	LL	t1	78	135	1018	2103	2100	1620	674	515	287	260	395	475	302	310	286	217	216	193	521	670	256	180	115	312	434	411	528	566	563		10	2.0%	82%
BFT	MED	CP	EU-Italy	LL	t2	a	b	ab	ab	ab	a	ab	a	ab	a	a	ab	b	b	ab	ab	abc	abc	abc	abc	abc	abc	ac	abc	abc	abc	bc	abc	abc		10		
BFT	MED	CP	EU-España	LL	t1	371	187	245	435	416	871	253	418	493	644	436	583	529	484	668	745	804	590	240	58	26	24	34	57	490	126	232	56	41		11	1.3%	84%
BFT	MED	CP	EU-España	LL	t2	ab	ab	ab	abc	ab	ab	ab	ac	ab	ac	ac	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	ac		11		
BFT	MED	CP	Libya	LL	t1	372	67	802	865	656	925	920	900	1002	1867	331	170	393	318	187	158	51	34													12	1.3%	85%
BFT	MED	CP	Libya	LL	t2	-1	-1	-1	-1	-1	-1	-1	ac	a	a	-1	-1	-1	-1	-1	a	b	b													12		
BFT	MED	CP	Maroc	HL	t1			373	816	541	455	634	600	650	195	407	570	597	80	187	19		2		78	120	130	134	138	140	185	265	265	365	372	13	1.0%	86%
BFT	MED	CP	Maroc	HL	t2			-1	c	-1	-1	-1	abc	ab	abc	b	b	b	b	b	b		b		abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	13		
BFT	MED	CP	Algerie	LL	t1					482	672	175	179	801	503	806	706	501	712	748	754	339														14	0.9%	87%
BFT	MED	CP	Algerie	LL	t2					-1	-1	-1	-1	b	b	b	b	b	-1	b	ab	ab	b													14		
BFT	MED	CP	EU-Greece	HL	t1	348	339	766	915	784	1127	279	233	597	341	394	245	73		6	7	93	66	135	52	39	35	78	90	34	45	69	78	32		15	0.9%	88%
BFT	MED	CP	EU-Greece	HL	t2	-1	-1	-1	-1	-1	-1	-1	a	a	-1	-1	a	-1		-1	-1	a	a	a	a	a	a	a	a	a	a	-1	-1	-1		15		
BFT	MED	CP	EU-Malta	LL	t1	80	251	572	587	399	393	407	447	376	219	240	255	264	321	263	144	165	263	136	92	137	89	91	49	97	115	127	80	387	185	16	0.9%	89%
BFT	MED	CP	EU-Malta	LL	t2	-1	-1	-1	-1	-1	-1	-1	ac	ac	ac	-1	-1	-1	abc	bc	ab	ab	ab	ab	ab	abc	abc	abc	abc	abc	abc	abc	abc	abc	abc	16		
BFT	MED	CP	Japan	LL	t1	123	793	536	813	765	185	361	381	136	152	390	316	638	378	556	466	80	18													17	0.9%	89%
BFT	MED	CP	Japan	LL	t2	abc	abc	abc	abc	abc	ac	abc	ac	ac	ac	ac	ac	ac	abc	ac	abc	a	abc													17		
BFT	MED	CP	Panama	LL	t1	484	467	1499	1498	2850	236																									18	0.9%	90%
BFT	MED	CP	Panama	LL	t2	-1	-1	-1	-1	-1	-1																									18		
BFT	MED	CP	EU-Italy	TP	t1	364	249	201	255	491	225	419	308	353	427	364	145	119	69	125	93	149	144	281	165	125	222	231	192		272	300	353	360		19	0.9%	91%
BFT	MED	CP	EU-Italy	TP	t2	c	b	bc	bc	b	b	b	b	b	b	b	b	b	b	b	ab	ab	ab	ab	abc	ac	-1	-1	-1		b	-1	-1	b		19		
BFT	MED	NCO	NEI (combined)	PS	t1	49		773	211		101	1030	1995	109	571	508	610	709																		20	0.8%	92%
BFT	MED	NCO	NEI (combined)	PS	t2	-1		-1	-1		-1	-1	-1	-1	-1	-1	-1	-1																		20		
BFT	MED	CP	EU-France	LL	t1				60	580	500	300	246				300	130	309	226	614	134	131	184	112	112	232	234	238	259	289	368	426	448		21	0.8%	93%
BFT	MED	CP	EU-France	LL	t2				-1	-1	-1	-1	-1				-1	-1	-1	-1	-1	-1	a	a	a	a	a	a	b	ab	ab	a	ab	ab		21		
BFT	MED	CP	EU-Italy	RR	t1	336	470	775	766	277	235	9	245	217	229	340	284	284	283	157		17	58	165	66	8	10	10	11		15	18	20			22	0.7%	94%
BFT	MED	CP	EU-Italy	RR	t2	-1	-1	-1	b	b	-1	-1	-1	-1	-1	-1	-1	b	b	b		-1	-1	b	-1	-1	-1	-1	-1		-1	-1	-1			22		
BFT	MED	NCC	Chinese Taipei	LL	t1		328	709	494	411	278	106	27	169	329	508	445	51	267	5																23	0.5%	94%
BFT	MED	NCC	Chinese Taipei	LL	t2		-1	-1	b	b	ab	ab	ab	ab	ab	ab	ab	ab	ab	ab																23		
BFT	MED	CP	EU-Italy	HL	t1	189	152	179	226	205	301	5	340	171	184	283	229	241	229	133	16	12	14	93	130	25	51	50	79			128				24	0.5%	95%
BFT	MED	CP	EU-Italy	HL	t2	b	-1	b	b	-1	-1	b	b	b	b	-1	b	b	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1			-1				24		
BFT	MED	NCO	NEI (Flag related)	LL	t1			427	639	171	1058	761	78	17																						25	0.4%	95%
BFT	MED	NCO	NEI (Flag related)	LL	t2			-1	-1	-1	-1	-1	-1	-1																						25		
BFT	MED	CP	Algerie	TP	t1	331	329	468	156	156	157	399	367	290	366	41																				26	0.4%	95%
BFT	MED	CP	Algerie	TP	t2	b	-1	-1	-1	-1	-1	-1	-1	-1	-1	-1																				26		

Table 8. E-BFT estimated catch series adopted by this Group, and included in T1NC as NEI flags, by eastern stock region, flag, fleet, gear and year. The “NEI (inflated)” flag catches (1998-2007), is the most representative NEI catch series reaching 30 to 40% of the total E-BFT catches.

	BFT-E (ATE)				BFT-E (MED)						TOTAL (NEI flags)	% of BFT-E Total
	NEI (ETRO)	NEI (Flag related)			NEI (combined)		NEI (Flag related)			NEI (inflated)		
	NEI.001	NEI.071-HN	NEI.081-GQ	NEI.094-GW	NEI.COMB		NEI.081-GQ	NEI.105-GN	NEI.134-BZ	NEI.INFLT		
Year	UN	LL	LL	LL	LL	PS	LL	LL	LL	PS		
1982					1						1	0%
1983											0	0%
1984	6				19						25	0%
1985	3										3	0%
1986	4				168						172	1%
1987					183						183	1%
1988	5				633						638	3%
1989	6				757						763	4%
1990	74				341	19					434	2%
1991	4	85			1750	49					1888	7%
1992		144			1349	49					1542	5%
1993		223									223	1%
1994		68				773		282	145		1268	3%
1995			189			211		240	399		1039	2%
1996			71					171			242	0%
1997			208			101	659	399			1367	3%
1998				66		1030	333	428		9471	11328	23%
1999						1995	78			16893	18966	38%
2000						109	17			16458	16584	33%
2001						571				15298	15869	32%
2002						508				15880	16388	33%
2003						610				18873	19483	39%
2004						709				18376	19085	38%
2005										14164	14164	28%
2006										18343	18343	37%
2007										28234	28234	46%

Table 9. Abundance indices used for East Atlantic in 2022 stock assessment. GBYP aerial survey for the West and Central Mediterranean (*) will be used as auxiliary information.

series	SPN BB		SPN-FR BB		MOR-SPN TRAP		MOR-POR TRAP		JPN LL Eatl&Med		JPN LL NEAtl1		JPN LL NEAtl2	
age	2-3		3-6		6+		10+		6 - 10		4 - 10		4 - 10	
indexing	Weight		Weight		Number		Number		Number		Number		Number	
area	East Atlantic		East Atlantic		East Atl and Med		East Atl and Med		East Atl and Med		NEast Atl		NEast Atl	
method	Delta lognormal RE		Delta lognormal RE		no.		no.		Delta Lognormal RE		Delta Lognormal RE		Delta Lognormal RE	
time of the year	Mid-year		Mid-year		Mid-year		Mid-year		Mid-year		Begin-year		Begin-year	
source	SCRS/2014/054		SCRS/2015/169		SCRS/2014/060		SCRS/2018/165		SCRS/2012/131		SCRS/2022/073		SCRS/2022/073	
Year	Std. CPUE	CV	Std. CPUE	CV	Std. CPUE	CV	Std. CPUE	CV	Std. CPUE	CV	Std. CPUE	CV	Std. CPUE	CV
1952	179.22	0.43												
1953	184.74	0.53												
1954	226.46	0.41												
1955	187.01	0.42												
1956	470.53	0.43												
1957	315.05	0.41												
1958	252.25	0.41												
1959	506.79	0.41												
1960	485.16	0.43												
1961	327.29	0.41												
1962	180.12	0.46												
1963	312.09	0.49												
1964	457.40	0.42												
1965	228.91	0.41												
1966	349.10	0.42												
1967	345.89	0.41												
1968	447.00	0.42												
1969	610.62	0.40												
1970	594.66	0.43												
1971	744.71	0.40												
1972	525.63	0.41												
1973	535.63	0.40												
1974	245.39	0.44												
1975	484.22	0.41							1.90	0.15				
1976	483.96	0.41							2.15	0.12				
1977	547.56	0.41							3.53	0.14				
1978	705.26	0.41							1.50	0.15				
1979	623.01	0.41							2.70	0.14				
1980	634.81	0.45							1.69	0.16				
1981	510.66	0.42			768.36	0.57			1.63	0.17				
1982	503.78	0.42			1038.12	0.35			3.32	0.13				
1983	625.14	0.43			1092.05	0.35			2.12	0.13				
1984	331.71	0.45			1200.27	0.35			1.62	0.12				
1985	1125.74	0.41			814.46	0.35			1.75	0.15				
1986	751.21	0.42			394.33	0.28			1.32	0.14				
1987	1008.43	0.42			433.53	0.28			2.16	0.13				
1988	1394.68	0.42			1014.56	0.28			1.35	0.14				
1989	1285.60	0.40			531.45	0.26			1.05	0.16				
1990	986.51	0.41			614.37	0.23			1.41	0.14	0.46	0.32		
1991	901.20	0.42			727.86	0.23			1.21	0.13	0.54	0.26		
1992	695.16	0.43			313.95	0.23			1.03	0.14	0.83	0.17		
1993	2093.55	0.40			325.36	0.23			1.04	0.14	0.76	0.14		
1994	1007.03	0.42			341.90	0.23			1.12	0.16	1.01	0.15		
1995	1235.91	0.41			223.43	0.23			1.42	0.15	1.02	0.14		
1996	1739.29	0.40			375.22	0.25			0.50	0.22	2.50	0.12		
1997	2246.41	0.40			992.41	0.25			0.53	0.21	1.56	0.13		
1998	879.51	0.41			925.14	0.25			0.71	0.17	0.85	0.15		
1999	339.77	0.44			1137.45	0.25			0.64	0.22	1.20	0.14		
2000	960.44	0.40			739.23	0.23			0.74	0.20	1.11	0.12		
2001	704.49	0.45			1284.62	0.23			0.96	0.17	1.42	0.12		
2002	687.42	0.42			1130.42	0.23			2.05	0.15	0.96	0.13		
2003	444.91	0.48			662.66	0.24			1.70	0.13	1.05	0.15		
2004	1210.46	0.42			332.36	0.23			0.82	0.18	0.93	0.13		
2005	2383.57	0.40			677.39	0.23			0.88	0.15	0.73	0.13		
2006	850.09	0.48			633.94	0.23			1.91	0.15	0.86	0.13		
2007			2179.98	0.31	1000.60	0.23			0.94	0.19	0.92	0.13		
2008			2154.01	0.30	634.18	0.23			1.22	0.17	1.05	0.13		
2009			955.38	0.30	876.71	0.23			1.04	0.24	1.61	0.12		
2010			2126.20	0.31	1042.24	0.24							2.35	0.13
2011			2785.47	0.30	674.97	0.23							4.01	0.15
2012			2306.99	0.39			95.37	0.34					8.59	0.20
2013			1569.13	0.44			126.73	0.37					7.22	0.16
2014			678.29	0.41			62.88	0.36					8.06	0.21
2015							98.23	0.38					6.40	0.21
2016							94.29	0.39					5.77	0.18
2017							110.34	0.39					7.27	0.21
2018							71.90	0.39					8.70	0.22
2019							99.88	0.38					8.33	0.21
2020							104.13	0.36					6.84	0.19
2021													6.65	0.19

Table 9. Continued.

series	French Aerial survey 1		French Aerial survey 2		WMed Larval Survey		WMed GBYP Aerial Survey		W+CMed GBYP Aerial Survey*	
age	2-4		2-4		Spawners		Spawners		Spawners	
indexing	Number of schools		Number of schools				Total weight (t)		Total weight (t)	
area	West Med		West Med		West Med		Balearic Sea		W+C Med	
method										
time of the year	Mid-year		Mid-year							
source	SCRS/2022/068		SCRS/2022/068		SCRS/2022/071		SCRS/P/2022/018		SCRS/P/2022/018	
Year	Index	CV	Index	CV	Index	CV	Index	CV	Index	CV
2000	0.02	0.38								
2001	0.01	0.37			4.58	0.42				
2002	0.01	0.49			9.58	0.49				
2003	0.01	0.31			2.67	0.54				
2004					10.86	0.42				
2005					2.27	0.40				
2006										
2007										
2008					1.96	0.79				
2009			0.02	0.35						
2010			0.01	0.53			1659	0.55	4956	0.36
2011			0.03	0.25	9.92	0.40	1392	0.43	9581	0.31
2012			0.02	0.27	26.57	0.22				
2013					40.32	0.30	2393	0.42	13585	0.28
2014			0.06	0.27	20.10	0.30				
2015			0.03	0.24	36.61	0.24	4766	0.47	16754	0.39
2016			0.11	0.20	32.41	0.28				
2017			0.07	0.25	73.03	0.25	8001	0.45	20635	0.28
2018			0.03	0.17			13344	0.31	22149	0.24
2019			0.06	0.14	46.16	0.23	11548	0.38	16654	0.30
2020			0.14	0.15	107.15	0.23				
2021			0.10	0.14						

* GBYP aerial survey for the West and Central Mediterranean will be used as auxiliary information

Table 10. Criteria table for available abundance indices in East and West Atlantic bluefin tuna stocks in 2022.

Available index years	1995-2021	1993-2021	1980-1992	1983-1992	1994-2020	1974-2021	1976-2009	2010-2021
Stock	**West**	**West**	**West**	**West**	**West**	**West**	**West**	**West**
Used in the latest stock assessment/MSE?	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
SCRS Doc No:	SCRS/2021/034	SCRS/2021/038	SCRS/1993/067	SCRS/1993/067	SCRS/2021/035	SCRS/P/2018/055	SCRS/2022/073	SCRS/2022/073
Index Name:	US RR 66-144cm	US RR >177cm	US RR<145cm	US RR>195cm	MEXUS GOM LL	GOM Larval Survey	JPN LL1	JPN LL2
Data Source (state if based on logbooks, observer data etc.):	Dockside observer survyes of fishing trips	Dockside observer survyes of fishing trips	Dockside observer survyes of fishing trips	Dockside observer survyes of fishing trips	Longline Onboard Observer Collected Data	Fishery Independent Scientific Survey	Logbooks	Logbooks
Do the authors indicate the percentage of total effort of the fleet the CPUE data represents?	No	No	No	No	Yes	NA	Yes	Yes
If the answer to 1 is yes, what is the percentage?	0-10%	11-20%	0-10%	11-20%	91-100%		31-40%	91-100%
Are sufficient diagnostics provided to assess model performance?	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
How does the model perform relative to the diagnostics	Well	Well	Well	Well	Well	Well	Mixed	Mixed
Documented data exclusions and classifications?	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes
Data exclusions appropriate?	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes
Data classifications appropriate?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographical Area	Atl NW	Atl NW	Atl NW	Atl NW	Atl NW	Atl NW	Atl NW	Atl NW
Data resolution level	trip	trip	trip	trip	Set	Set	Set	Set
Ranking of Catch of fleet in TINC database (use data catalogue)	6-10	1-5	6-10	1-5	6-10		1-5	1-5
Length of Time Series	longer than 20 years	longer than 20 years	11-20 years	6-10 years	longer than 20 years	longer than 20 years	longer than 20 years	11-20 years
Are other indices available for the same time period?	None	Few	None	None	Few	Few	Few	Many
Are other indices available for the same geographic range?	None	Few	None	None	Few	Few	None	None
Does the index standardization account for Known factors that influence catchability/selectivity? (e.g. Type of hook, bait type, depth etc.)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Estimated annual CVs of the CPUE series	Medium	Medium	Medium	Medium	Medium	High	Medium	Medium
Annual variation in the estimated CPUE exceeds biological plausibility	Possible	Possible	Possible	Possible	Possible	Possible	Possible	Possible
Are data adequate for standardization purposes?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Is this standardised CPUE time series continuous?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
For fisheries independent surveys: what is the survey type?						Larval		
For 19: Is the survey design clearly described?	Yes	Yes	Yes	Yes	Yes	Yes		
Other comments	Only juvenile index in the W Atlantic, based on dockside trip surveys of the US. Rec rod and reel fishery. Survey documentation available online (search NOAA Large Pelagics Survey)	Based on dockside trip surveys of the US. Rec rod and reel fishery. Survey documentation available online (search NOAA Large Pelagics Survey)	Based on dockside trip surveys of the US. Rec rod and reel fishery. Survey documentation available online (search NOAA Large Pelagics Survey)	Based on dockside trip surveys of the US. Rec rod and reel fishery. Survey documentation available online (search NOAA Large Pelagics Survey)	Joint CPC-analysis of Mexico and US longline scientific observer collected data in the Gulf of Mexico. 100% observer coverage of the MEX fleet, 50% coverage of the US fleet during bluefin spawning season.	Larval survey of the Northern Gulf of Mexico during April and May. Long-term time series since 1977 with few years missing data. 2020 survey did not occur.	Only areas 4 and 5 (40-50N, 45-55W) are used. The value for 1986 was not used in the assessment models	

Table 10. Continued.

Available index years	1974-1981	1994-2017	2018-2019	1988-2020	1996-2020	1952-2006	2007-2014	1981-2011
Stock	**West**	**West**	**West**	**West**	**West**	**East & Med**	**East & Med**	**East & Med**
Used in the latest stock assessment/MSE?	Yes/Yes	Yes/Yes	No/No	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes
SCRS Doc No:	SCRS/1991/071	SCRS/2021/036	SCRS/2021/036	SCRS/2021/025	SCRS/2021/025	SCRS/2015/169	SCRS/2015/169	SCRS/2014/060
Index Name:	JPN LL GOM	CAN Acoustic survey1	CAN Acoustic survey2	CAN GSL RR	CAN SWNS RR	SPN BB	SPN-FR BB	MOR-SPN TRAP
Data Source (state if based on logbooks, observer data etc.):	Logbooks	survey	survey	logbooks	logbooks	Trips	Logbooks	scientific observers; data provided by trap owners
Do the authors indicate the percentage of total effort of the fleet the CPUE data represents?	Yes	NA	NA	Yes	Yes	Yes	Yes	No
If the answer to 1 is yes, what is the percentage?	91-100%			91-100%	91-100%	91-100%	91-100%	
Are sufficient diagnostics provided to assess model performance?	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
How does the model perform relative to the diagnostics	Mixed	Well	Well	Well	Well	Well	Well	Mixed
Documented data exclusions and classifications?	Yes	Yes	Yes	Yes	Yes	Yes	NA	NA
Data exclusions appropriate?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Data classifications appropriate?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Geographical Area	Atl NW	Atl NW	Atl NW	Atl NW	Atl NW	Localised (< 10 x 10 degrees)	Localised (< 10 x 10 degrees)	Atl NE
Data resolution level	Set	OTH	OTH	OTH	Set	trip	OTH	OTH
Ranking of Catch of fleet in TINC database (use data catalogue)	11 or more			1-5	1-5	6-10	6-10	6-10
Length of Time Series	6-10 years	longer than 20 years	0-5 years	longer than 20 years	longer than 20 years	longer than 20 years	6-10 years	longer than 20 years
Are other indices available for the same time period?	Few	Few	Few	Few	Few	Few	Many	Few
Are other indices available for the same geographic range?	Few	None	None	None	None	None	None	None
Does the index standardization account for Known factors that influence catchability/selectivity? (e.g. Type of hook, bait type, depth etc.)	Yes			Yes	Yes	Yes	Yes	No
Estimated annual CVs of the CPUE series	Medium	Low	Low	Variable	Medium	Medium	Medium	Variable
Annual variation in the estimated CPUE exceeds biological plausibility	Possible	Unlikely	Unlikely	Unlikely	Unlikely	Possible	Possible	Possible
Are data adequate for standardization purposes?	Yes			Yes	Yes	Yes	Yes	Yes
Is this standardised CPUE time series continuous?	Yes			Yes	Yes	Yes	Yes	Yes
For fisheries independent surveys: what is the survey type?		Acoustic	Acoustic					
For 19: Is the survey design clearly described?		Yes	Yes					
Other comments								

Table 10. Continued.

Available index years	2012-2020	1975-2009	1990-2009	2010-2021	2000-2003	2009-2021	2001-2019	2010-2019	2010-2019
Stock	**East & Med**	**East & Med**	**East & Med**	**East & Med**	**East & Med**	**East & Med**	**East & Med**	**East & Med**	**East & Med**
Used in the latest stock assessment/MSE?	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes	Yes/Yes (only projection)	No/No
SCRS Doc No:	SCRS/2018/165	SCRS/2012/131	SCRS/2022/073	SCRS/2022/073	SCRS/2022/068	SCRS/2022/068	SCRS/2022/071	SCRS/P/2022/018	SCRS/P/2022/018
Index Name:	MOR-POR TRAP	JPN LL Eatl&Med	JPN LL NEAtl1	JPN LL NEAtl2	French Aerial survey 1	French Aerial survey 2	WMed Larval Survey	GBYP Aerial Survey Balearic Sea	GBYP Aerial Survey West and Central Med
Data Source (state if based on logbooks, observer data etc.):	scientific observers; data provided by trap owners	Logbooks	Logbooks	Logbooks	scientific spotters	Scientific Spotters	Fishery Independent Scientific Survey	Professional and scientific spotters	Professional and scientific spotters
Do the authors indicate the percentage of total effort of the fleet the CPUE data represents?	No	Yes	Yes	Yes	NA	NA	NA	NA	NA
If the answer to 1 is yes, what is the percentage?		91-100%	81-90%	91-100%					
Are sufficient diagnostics provided to assess model performance?	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient	Sufficient
How does the model perform relative to the diagnostics	Well	Well	Mixed	Mixed	Well	Well	Well	Well	Well
Documented data exclusions and classifications?	NA	Yes	Yes	Yes	Yes	Yes	Yes	No	No
Data exclusions appropriate?	NA	Yes	Yes	Yes	Yes	Yes	Yes	NA	NA
Data classifications appropriate?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Geographical Area	Atl NE	Atl NE	Atl NE	Atl NE	Med	Med	Med	Med	Med
Data resolution level	OTH	Set	Set	Set	OTH	OTH	Set	OTH	OTH
Ranking of Catch of fleet in TINC database (use data catalogue)	6-10	11 or more	1-5	1-5					
Length of Time Series	6-10 years	longer than 20 years	11-20 years	6-10 years	0-5 years	11-20 years	11-20 years	6-10 years	6-10 years
Are other indices available for the same time period?	Few	Many	Many	Many	Few	Few	Few	Few	Few
Are other indices available for the same geographic range?	None	Few	None	None	None	None	Few	Few	None
Does the index standardization account for Known factors that influence catchability/selectivity? (e.g. Type of hook, bait type, depth etc.)	No	Yes	Yes	Yes			Yes		
Estimated annual CVs of the CPUE series	High	Low	Medium	Medium			Medium		
Annual variation in the estimated CPUE exceeds biological plausibility	Unlikely	Possible	Possible	Possible					
Are data adequate for standardization purposes?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Is this standardised CPUE time series continuous?	Yes	Yes	Yes	Yes			Yes		
For fisheries independent surveys: what is the survey type?					Aerial	Aerial	Larval	Aerial	Aerial
For 19: Is the survey design clearly described?					Yes	Yes	Yes	Yes	Yes
Other comments					Only fisheries-independent index for young fish in the Mediterranean	Only fisheries-independent index for young fish in the Mediterranean	For existence of other indices in the area, there is the GBYP aerial survey (accepted yet?); Biological plausibility should be calculated following specific methods	Index ime series for other ares of the Mediterranenan already available CREEM report 2022	Index ime series for other ares of the Mediterranenan already available CREEM report 2022

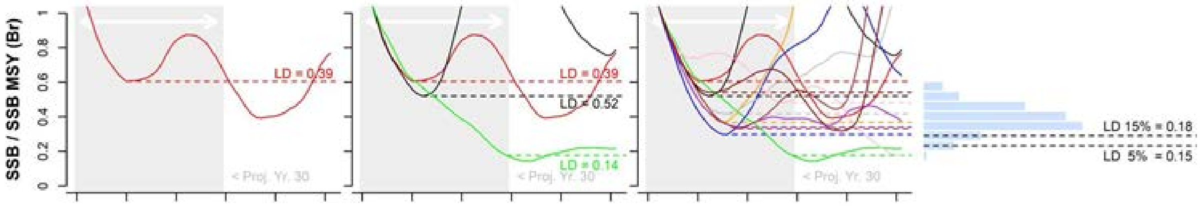

Figure 1. Visual descriptions of the calculation of B_{LIM} performance statistic illustrating one simulation (first column), three simulations (second column) and multiple simulations (3rd column) for one OM and one CMP. B_{LIM} is defined in relation to the performance statistic LD* (lowest depletiononly years 11 to 30) or Lowest depletion (i.e., SSB relative to dynamic SSB_{MSY}) over 30-year projection period. This figure shows LD* for years 1-30 though the Group propose using years 11-30 only for B_{LIM} calculations for reasons explained in the text. LD* is calculated as a weighted average across all OMs in the grid.

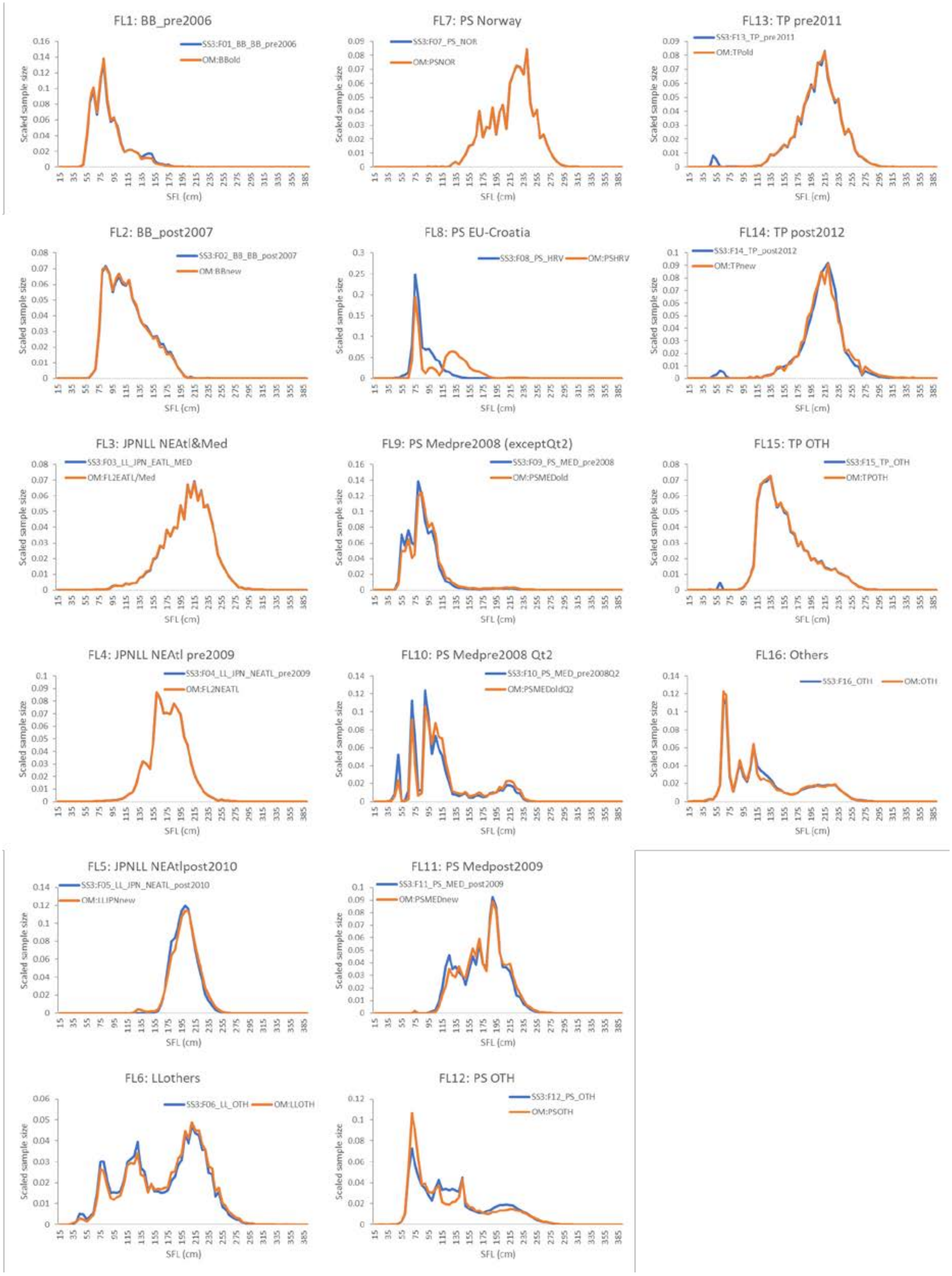

Figure 2. E-BFT size distributions by fleet_ID comparison between 2021 BFT MSE OM recondition (2021 blue line) and the 2022 assessment input (2022 orange line).

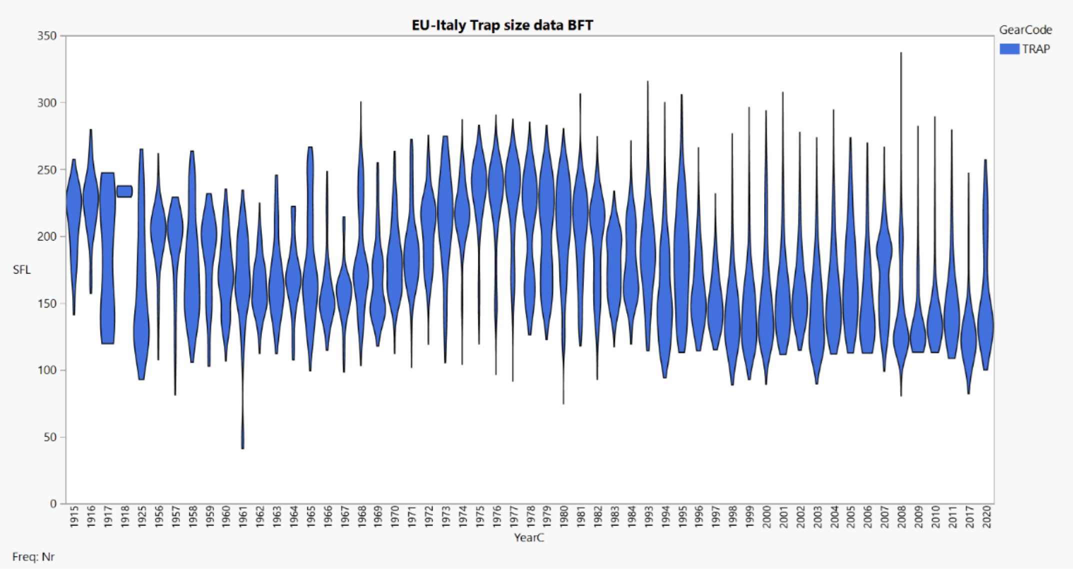

Figure 3. Bluefin tuna size distribution (SFL) by year from EU-Italy traps 1915 - 2020. This plot summarizes data from several traps that have been active and reporting size data for different periods.

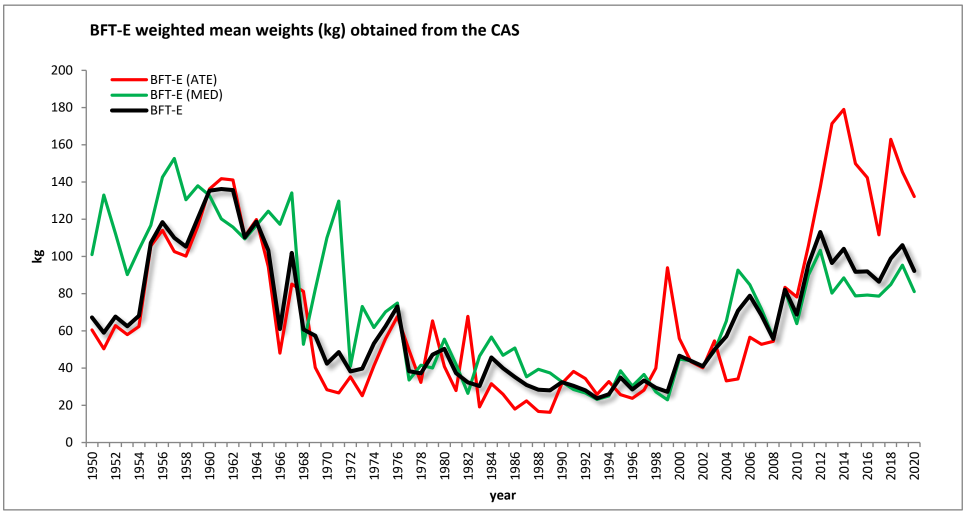

Figure 4. E-BFT weighted mean weights (kg) obtained from the CAS estimations.

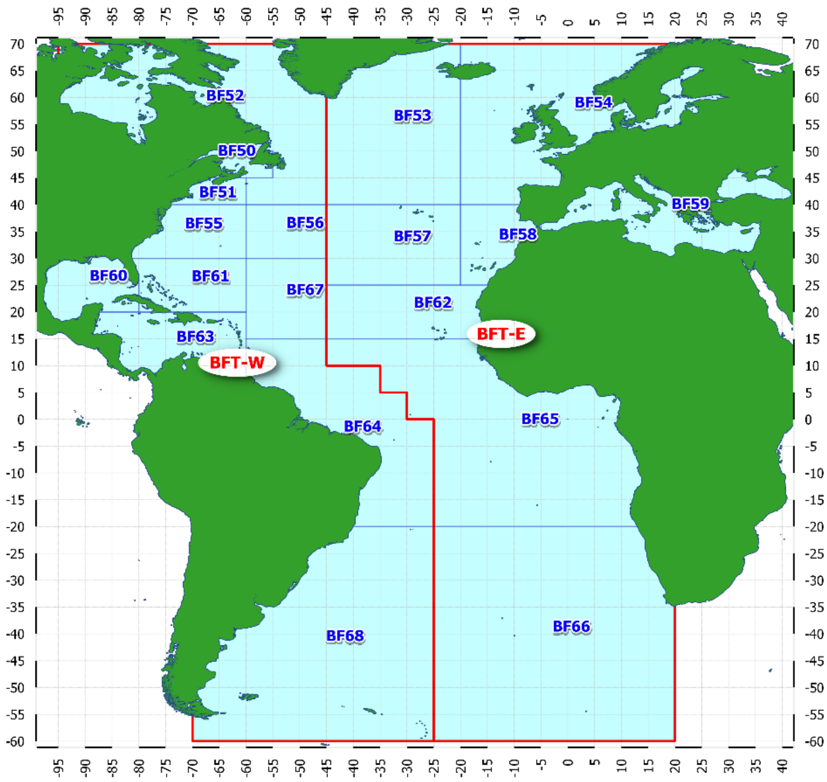

Figure 5. BFT eastern Atlantic (E-BFT) and western Atlantic (W-BFT) stocks, with the corresponding sampling areas, adopted by the SCRS.

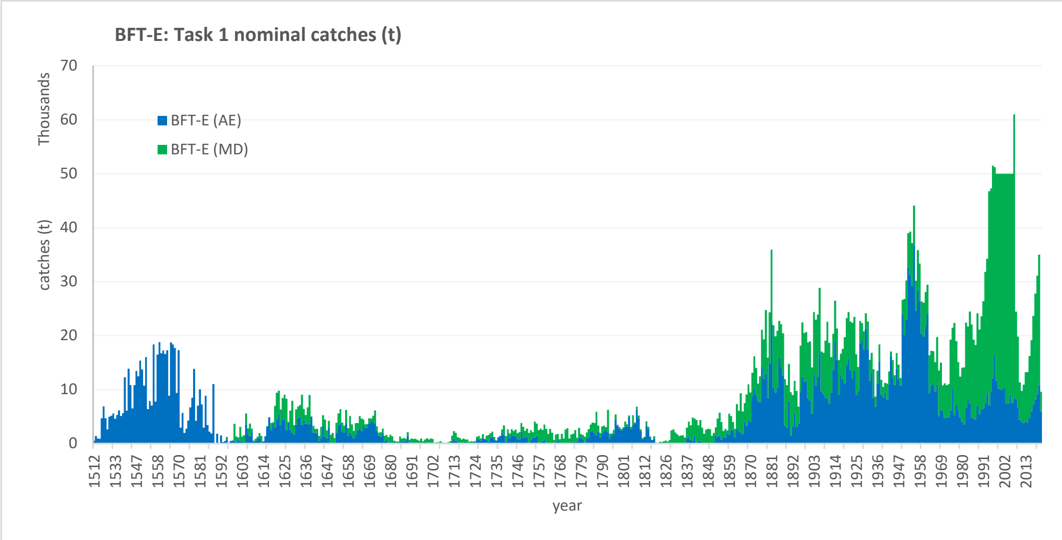

Figure 6. E-BFT total catches (T1NC) for the eastern Atlantic stock (Atlantic and Mediterranean regions), between 1512 and 2020.

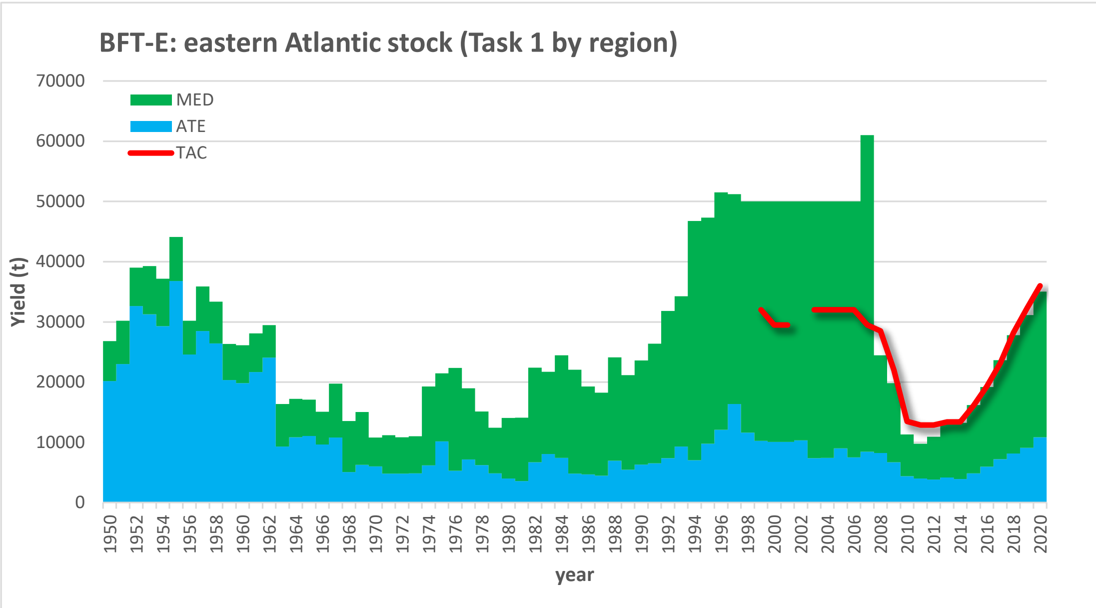

Figure 7. E-BFT total catches (T1NC) (Atlantic and Mediterranean regions), between 1950 and 2020 by region, also showing the TAC (Total Allowable Catch) series by year.

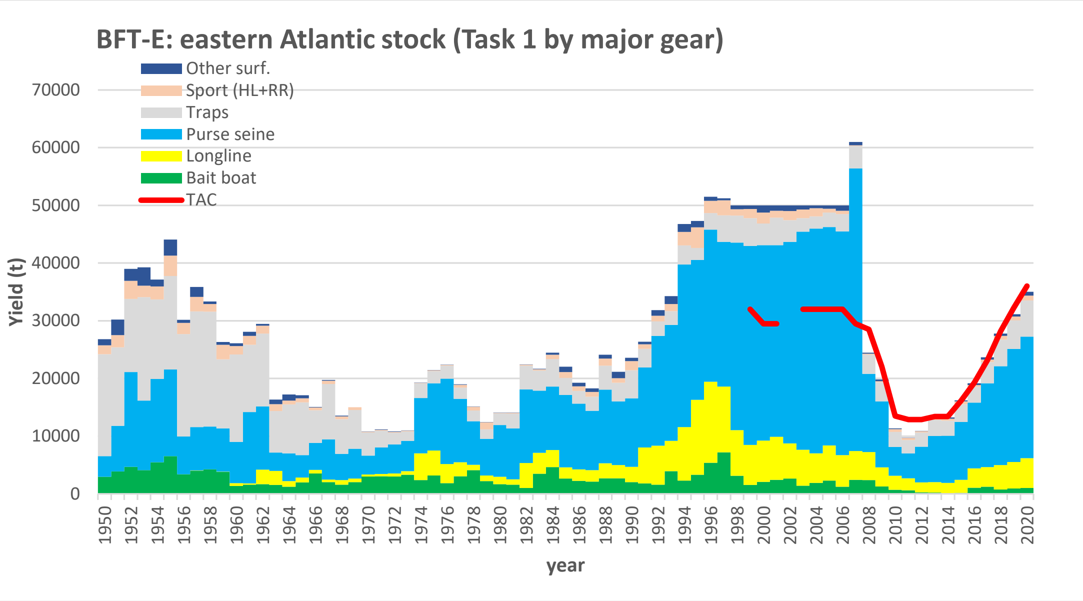

Figure 8. E-BFT total catches (T1NC) (Atlantic and Mediterranean regions), between 1950 and 2020 by major gear, also showing the TAC (Total Allowable Catch) series by year.

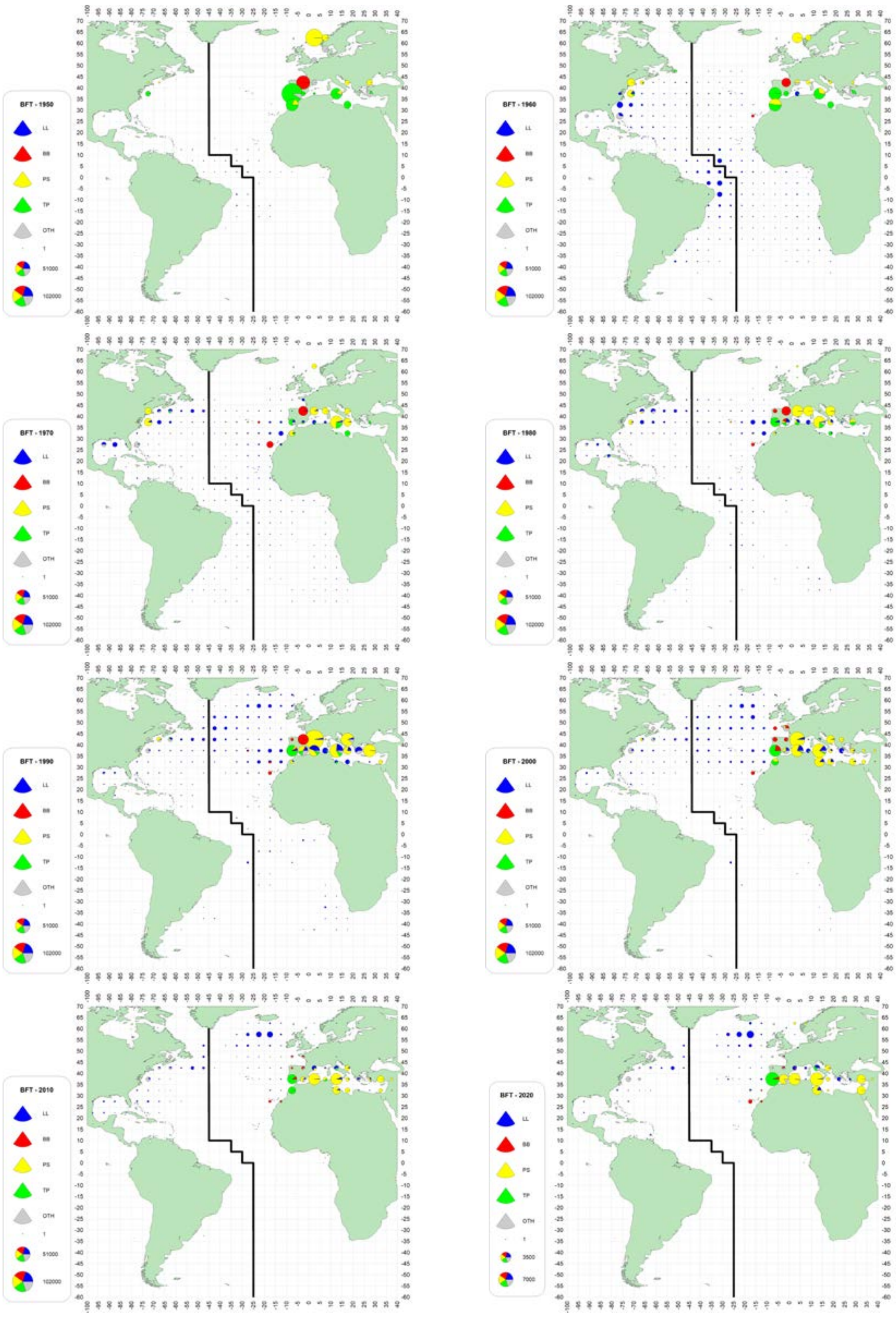

Figure 9. Geographical distribution of BFT catches (t) by decade and major gear (1950 to 2020). Last decade (2020) only contains the first year. Source CATDIS (reflecting BFT Task 1 as of 2022-01-31).

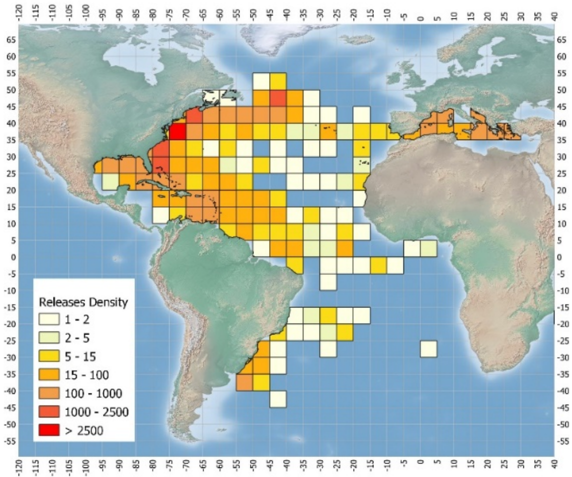

Figure 10. Density of BFT conventional tags released in a 5x5 square grid, in the ICCAT area.

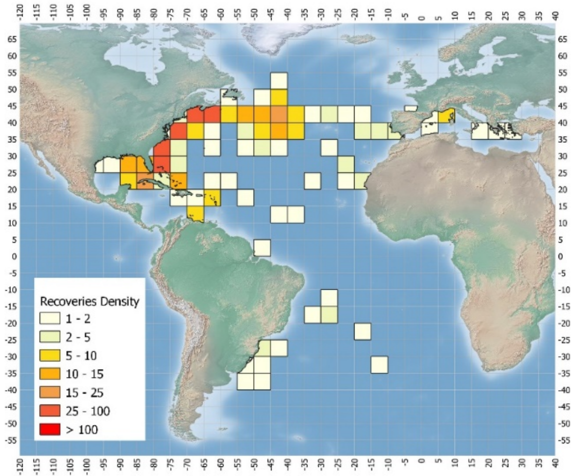

Figure 11. Density of BFT conventional tags recovered in a 5x5 square grid, in the ICCAT area.

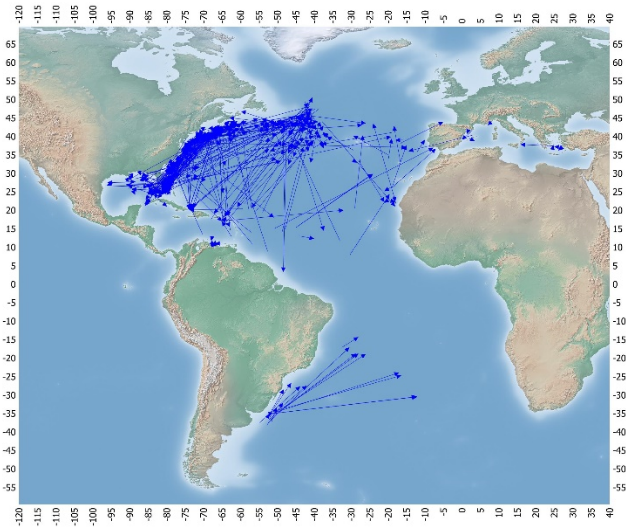

Figure 12. Apparent movement (arrows from the release to recovery position) of the BFT conventional tagging.

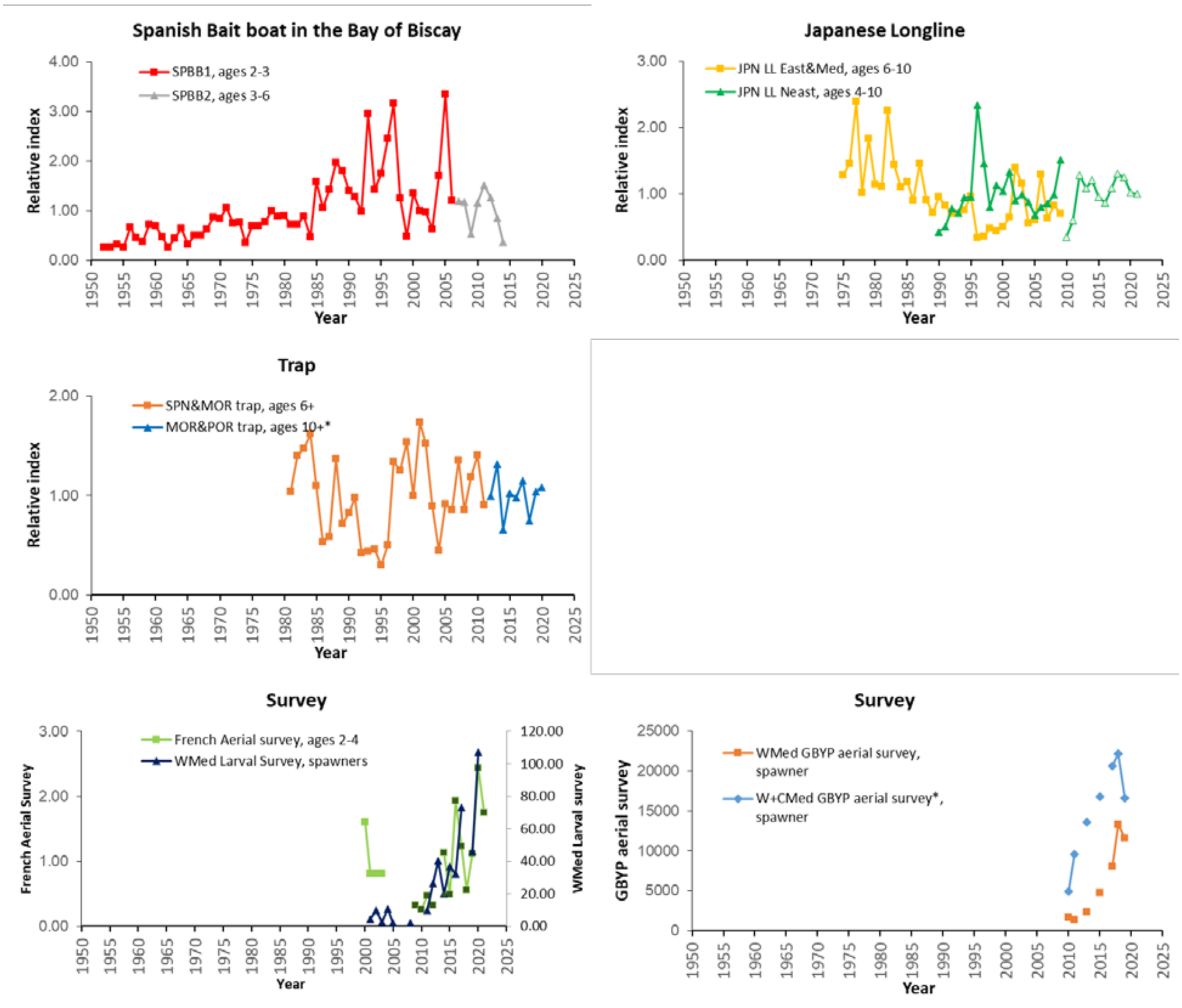

Figure 13. Abundance indices used for East Atlantic in 2022 stock assessment. GBYP aerial survey for the West and Central Mediterranean (*) will be used as auxiliary information.

Appendix 1

Agenda

1. Opening, adoption of agenda and meeting arrangements and assignment of rapporteurs

MSE Process

2. Summary of developments on ABFT-MSE

   2.1 Report on 2022 March Panel 2 meeting on BFT MSE
   2.2 Report of the informal BFT MSE Technical Sub-group February 14-16th, 2022.
   2.3 Review of the scientific papers/presentations relevant to MSE
   2.4 Round-robin from CMPs and changes to CMPs based on Panel 2/Commission input
   2.5 Summary of CMP performance metrics based on Panel 2/Commission input
      2.5.1 Key figures and plots
   2.6 Update performance statistics based on initial operational management objectives
      2.6.1 Request from Panel 2 to provide a B_{LIM}
      2.6.2 Fishing mortality metric
      2.6.3 Other statistics
   2.7 Specification of final MSE robustness trials
   2.8 Decision process for CMP development and performance tuning and eventual selection
      2.8.1 Process for development tuning and performance tuning
      2.8.2 Satisficing
      2.8.3 Other considerations
         2.8.3.1 Description of stock recruitment relationships in operating models
   2.9 Initial cull of CMPs
   2.10 Communications material
      2.10.1 Key plots and outputs
      2.10.2 Develop presentation to Panel 2 on progress
      2.10.3 BFTMSE Ambassadors programme
   2.11 Path forward for the BFT MSE process
   2.12 Update of trial specification document (TSD)

E-ABFT Data Preparatory

3. Review of the scientific papers relevant to E-BFT stock assessment

4. Presentation of initial data inputs

   4.1 Biology and age data
   4.2 Size and age composition, update stereo-camera data through to 2020
   4.3 Catch Estimates
      4.3.1 Task I Nominal Catches
      4.3.2 Assumptions about catches in 2021and 2022 for projections
      4.3.3 Assumptions regarding past inflated catch and recent IUU
   4.4 Indices of abundance

5. Detailed ToRs for E-BFT stock assessment (VPA, Stock Synthesis, and ASAP)

   5.1 Specify runs

6. Workplan leading to the July assessment

7. General discussion of GBYP matters including Close-kin

8. Other matters

   8.1 BFT Technical Sub-group on Growth in farms and other Docs

9. Adoption of the report and closure

Appendix 2

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Appendix 3

List of Papers and Presentations

Number	Title	Authors
SCRS/2022/066	Acoustic-based fishery-independent abundance index of bluefin tuna in the Bay of Biscay: results from the first seven surveys	Onandia I., Goñi N., Uranga J., Arregui I., Martinez U., Boyra G., Melvin G.D., Godard I., Arrizabalaga H.
SCRS/2022/067	Data and initial model set-up for the 2022 VPA stock assessment of the eastern Atlantic and Mediterranean bluefin tuna	Rouyer T., Kimoto A., Zarrad R., Ortiz M., Palma C., Mayor C., Lauretta M., Rodriguez-Marin E., and Walter J.
SCRS/2022/068	Update of the French aerial abundance index for 2021	Rouyer T., Derridj O., and Fromentin J.M.
SCRS/2022/069	Update of electronic tagging data and methodologies for Atlantic bluefin tuna in order to plan future tagging activities	Aarestrup K., Alemany F., Arregui I., Arrizabalaga H., Cabanellas-Reboredo M., Carruthers T., Hanke A., Lauretta M., Pagá A., Rouyer T., Tensek S., Walter J., and Rodriguez-Marin E.
SCRS/2022/070	Data and initial model set-up for the 2022 ASAP stock assessment of the eastern Atlantic and Mediterranean bluefin tuna	Cadrin S.X., Carrano C., and Maguire J.-J.
SCRS/2022/071	Retrocalculated larval abundance index of Atlantic bluefin tuna in the western Mediterranean Sea, 2001-2020	Alvarez-Berastegui D., Tugores M.P., Martín M., Lineth N., Pérez-Torres, A.P., Balbín R., and Reglero P.
SCRS/2022/072	A review of available information for the eastern Atlantic bluefin tuna using Chinese longliner observer data for the period 2013-2019	Feng J., Zhang F., Zhu J., and Wu F.
SCRS/2022/073	The standardized CPUE for Japanese longline fishery in the Atlantic up to 2021	Tsukahara Y., Fukuda H., and Nakatsuka S.
SCRS/2022/074	A simple candidate management procedure using Japanese longline indices	Tsukahara Y., and Nakatsuka S.
SCRS/2022/075	Description of the ICCAT length at age data base for bluefin tuna from the eastern Atlantic, including the Mediterranean Sea	Rodriguez-Marin E., Quelle P., and Busawon D.
SCRS/2022/076	Report of the Management Strategy Evaluation Technical Sub-group February 14-16, 2022	Walter J., and Peterson C.
SCRS/2022/077	A proposal for a Biomass Limit Reference Point (B_{LIM}) for Atlantic bluefin tuna	Walter J., Butterworth D., and Rodriguez-Marin E.
SCRS/2022/078	Effect of tuning a CMP to each recruitment scenario within the Atlantic bluefin tuna MSE	Peterson C., Lauretta M., and Walter J.
SCRS/2022/079	Data and initial model set-up for the 2022 stock synthesis stock assessment of the eastern Atlantic and Mediterranean bluefin tuna	Sampedro P., Kimoto A., Ortiz M., Sharma, R., Fukuda H., Gordoa, A., Lauretta, M., Rouyer T., Sunderlöf, A., Tsukahara Y., Walter J., and Rodríguez-Marín E.
SCRS/2022/080	BFT MSE Operating Model index projections and questions of plausibility: Are these futures possible?	Duprey N.M.T., and Hanke A.R.

SCRS/2022/081	Putting Candidate Management Procedures into practice	Duprey N.M.T., Hanke A.R., Butterworth D.S., Rademeyer R. A., Peterson C., Lauretta M., and Walter J.
SCRS/2022/082	Refinements of the BR CMP as at April 2022	Butterworth D. S., and Rademeyer R.A.
SCRS/P/2022/011	Applying mixed-effects growth models to back-calculated size-at-age data for Atlantic bluefin tuna	Stewart N.D., Busawon D.S., Rodriguez-Marin E., Siskey M., and Hanke A.
SCRS/P/2022/012	Estimating age-at-maturity from biphasic growth models for Atlantic bluefin tuna	Stewart N.D., Busawon D.S., Rodriguez-Marin E., Siskey M., Wilson K., and Hanke A.
SCRS/P/2022/013	Preliminary CMP results April 2022	Carruthers T.
SCRS/P/2022/014	An exploitation rate proposal for an appropriate MSE performance metric relating to fishing mortality	Carruthers T.
SCRS/P/2022/015	The 2022 VPA stock assessment preliminary results of the eastern Atlantic and Mediterranean bluefin tuna	Rouyer T., Kimoto A., Zarrad R., Ortiz M., Palma C., Mayor C., Lauretta M., Rodriguez-Marin E., and Walter J.
SCRS/P/2022/016	The 2022 stock synthesis stock assessment preliminary results of the eastern Atlantic and Mediterranean bluefin tuna	Sampedro P., Kimoto A., Ortiz M., Sharma, R., Fukuda, H., Gordoa, A., Lauretta, M., Rouyer T., Sunderlöf, A., Tsukahara Y., Walter J., and Rodríguez-Marín E.
SCRS/P/2022/017	The 2022 ASAP stock assessment preliminary results of the eastern Atlantic and Mediterranean bluefin tuna	Cadrin S.X., Carrano C., and Maguire J.-J.
SCRS/P/2022/018	GBYP Aerial survey: overview and latest results	Alemany F., Tensek S., and Pagá A.
SCRS/P/2022/019	Updating on GBYP matters	Alemany F., Tensek S., and Pagá A.

Appendix 4

SCRS Document and presentations abstracts as provided by the authors

SCRS/2022/066 The main objective of this survey is to develop an acoustics-based, fishery independent abundance index in the Bay of Biscay that continues the historical one, based on catch rates, used in the EBFT stock assessment, that stopped in 2015.An acoustic survey covering summer feeding area for bluefin tunas was conducted in the Bay of Biscay from July 2015 to 2021 on-board a baitboat fishing vessel, using a medium-range 90kHz sonar and a SIMRAD EK60 scientific echosounder working at three frequencies, of which 38 kHz was used for echointegration. The survey followed systematic transects defined according to historical baitboat catch locations. All bluefin detections by sonar and echosounder were recorded. In each aggregation, species identification and size-sampling were performed through no-kill fishing events, stereoscopic camera and/or multibeam sonar. The spatial distribution of detected bluefin schools is shown, as well as the estimated number and size/age of individuals in the detected schools.

SCRS/2022/067 This document presents the data and initial model set-up for the 2022 stock assessment for the Eastern Atlantic and Mediterranean Bluefin tuna stock. During the 2017 data preparatory meetings, several changes in the data used for previous assessments have been presented, among which the revision of the Task I and Task II statistics and the selection of the indices of abundance. This led to completely revisiting the catch at age matrix and the model specifications for the 2017 assessment. For the present document, the data over the historical period (1968-2015) were nearly identical, whereas the data for the years 2016-2020 and abundance indices were updated. As agreed in previous meetings, the initial model specifications were kept identical to the 2017 assessment as no change has been agreed on since then.

SCRS/2022/068 The French aerial survey over the Gulf of Lions provides an important fisheries independent index for the stock assessment of Eastern Atlantic Bluefin Tuna (EABFT, Thunnus thynnus). The present manuscript reminds the methodology employed for the survey and provides the update of the index for the year 2021 that displays a slight decrease compared to 2020, which was the highest year to date, but remains the 3rd highest value thus confirming the upward trend of the recent years.

SCRS/2022/069 This document presents the current electronic tagging information available for management strategy evaluation. This information also allows to identify gaps that should be taken into account to plan future tagging activities. It also describes the status of current electronic tag databases, advantages and disadvantages of electronic tags used on Atlantic bluefin tuna and outlines the technological advances that will allow the use of different types of tags (pop-up satellite archival, archival internal and acoustic tags) to improve the description of movements of this species.

SCRS/2022/070 The 2020 application of the Age Structured Assessment Program (ASAP) for stock assessment of Eastern Atlantic and Mediterranean Atlantic Bluefin tuna is being revised and updated for the 2022 stock assessment. ASAP is a statistical catch at age model that requires similar data as Virtual Population Analysis (VPA): a time series of observed catches, catch-at-age, and indices of abundance. Model revisions will explore fleet structure and will require catch, catch-at-age, and indices of abundance for each major fleet (trap, Eastern Mediterranean longline, Northeast Atlantic longline, bait boat, purse seine and other). These ASAP input data were derived from VPA input files with partial catch-at-age for index fleets.

SCRS/2022/071 This document presents the update of the Bluefin tuna retrocalculated larval abundance indices from the Balearic Archipelago (Western Mediterranean). The index has been calculated following methods presented in 2020 (SCRS/2020/067) and 2021 (SCRS/2021/033). The abundance index shows an increasing trend with a maximum value in 2020. A previous version of the index (SCRS/P/2019/055) is also provided for comparison.

SCRS/2022/072 A review of available information is presented about the Chinese longline fleet targeting the Eastern Atlantic bluefin tuna for the period 2013-2019. The nominal catch and fishing effort have been increasing steadily in these years. The highest record of nominal catch was 89.0 t in 2019 with the fishing effort 137.879 thousand hooks. The nominal CPUE maintained around 2- 3 (in number) and 500-600 kg per thousand hooks respectively in 2017-2019. Size and weight data show that the average fork length and dressed weight in the observer sampling exceeded 220 cm and 170 kg respectively during 2013 and 2019.

SCRS/2022/073 Abundance indices of bluefin tuna from the Japanese longline fishery in the West and Northeast Atlantic were provided up to 2021 fishing year both for the purposes of the MSE and the stock assessment of the East Atlantic and Mediterranean Bluefin tuna stock. While the indices were standardized with deltalognormal model with random effect with the SAS system for the sake of simple update, this document introduced the alternative indices using 'lme4' and 'VAST' package in the R system. The simply updated CPUE both in the East and West Atlantic remained at a relatively high level, although those in most recent 2 years,2020 and 2021 fishing years, showed somewhat decreasing trend. The alternative indices showed similar trajectories with the simple update with small differences. The authors suggested use of the indices standardized by 'lme4' for MSE purpose and use of indices standardized by 'VAST' for the stock assessment in East Atlantic.

SCRS/2022/074 This paper presents a candidate MP for ABT only using the indices of Japanese longline in each area. The simple MP makes it easy not only to obtain the indices sustainably but also promotes understanding of managers and stakeholders. This paper presents results of the candidate MP tuned to the target discussed by Panel 2 meeting in March 2022 were calculated by R package "ABTMSE" ver. 7.5.0.

SCRS/2022/075 This study aims to describe the current length at age database available for Eastern Atlantic bluefin tuna management area. A total of 8 500 spines and 5 000 otoliths were read from specimens caught from 1984 to 2017 in both the Atlantic Ocean and Mediterranean Sea. Obtaining ALKs for this species is difficult, as it has a wide length range and spatial distribution, and sampling is costly. Unfortunately, there are practically no contributions to this database from the East Atlantic and Mediterranean Sea countries, and only thanks to the initiative of the GBYP has it been possible to increase the number of samples in the ICCAT database in the last 10 years. As a result, the current ICCAT length at age database has incomplete spatial, temporal and size range coverage. However, it can be attempted to be used as conditional age-at-length data in the Stock Synthesis model.

SCRS/2022/076 This document is an informal report of the February 14-16th, 2022 BFT MSE technical team meeting. The report was not adopted by the group and the meeting was not a formal meeting of the SCRS Bluefin tuna working group. Nevertheless the details from and discussions at the meeting are pertinent to the Bluefin Working group. Many of these details will be addressed and included in the material presented to the March Panel 2 meeting.

SCRS/2022/077 Biomass limit reference points (LRPs) provide lower bounds which a management body would want a high probability of avoiding. B_{LIM}, or the biomass limit reference point, is usually defined as the stock size below which recruitment has a high likelihood of being impaired. LRPs can either be active triggers for reductions in fishing mortality, even to the extent of closing the fishery (F=0), or passive statistics to be evaluated. Given the nature of ABFT and the empirical form of the CMPs, we propose the use of B_{LIM} as a passive performance statistic to evaluate CMP performance. We propose a B_{LIM} of 40% of dynamic SSB_{MSY} for the purposes of the ABFT MSE for CMP testing and performance tuning. This would be calculated as the lowest depletion (spawning biomass relative to dynamic SSB_{MSY}) over years 11-30 of the first 30 years for which CMP is applied, as evaluated across the plausibility weighted Operating Models of the grid. Such a B_{LIM} reflects the individual production dynamics of each Operating Model in the MSE, reflects temporal variability in production dynamics, and provides the best representation of the potential consequences of stocks falling below it. Such a B_{LIM} is consistent with Panel 2 decisions for Northern Albacore and approaches in other RFMOs.

SCRS/2022/078 We evaluated the effects of the alternative recruitment assumptions in the Atlantic bluefin tuna MSE on the performance of the PW candidate management procedure. We deterministically tuned the CMP to the 30-year biomass ratio (Br30) estimates to each individual recruitment scenario separately (R1, R2, R3), then all recruitment scenarios (RA), and finally, recruitment levels 1 and 2 only (R12). We found that tuning to recruitment scenario 1 resulted in the most aggressive CMP, while tuning to recruitment scenario 2 resulted in the least aggressive CMP. Notably, the impact of including recruitment level 3 was minimal, as demonstrated by similar performance and outcomes of RA scenario compared to the R12 scenario.

SCRS/2022/079 This document describes the data used for Stock Synthesis assessment for the Eastern Atlantic and Mediterranean bluefin tuna. The initial model configuration, fleet definitions, selectivity modeling and main parameterization are also outlined. The model runs from 1950 to 2020 and is fit to length composition data and pair age-length data treated as conditional age-at-length.

SCRS/2022/080 No text provided by the author.

SCRS/2022/081 No text provided by the author.

SCRS/2022/082 The BR CMP is adjusted in a few respects, most importantly by allowing limited temporal dependence in the values of the control parameters over the first few years of management, to allow for smoother transitions in the TACs from 2022 to 2023. This was necessitated especially by the now higher West area TAC for 2022 in the updated package. Results are provided for the four basic development tunings, plus one variant for one of those tunings where the default maximum TAC decrease constraint is reduced from 30% to 20%. Suggestions are made of areas for possible improvement in performance, which would require some further refinements of this CMP.

SCRS/P/2022/011 reviewed the outcomes of a study that fit mixed effects growth models to back-calculated Bluefin tuna size at age data (Stewart et al. 2022). The modified-Fry function produced the best correspondence between estimated size at age and observed size at capture of younger fish and a non linear mixed effects formulation of the von Bertalanffy growth model provided the best prediction of the future size of individual Bluefin tuna. This model yielded population level estimates for t0, Linf and K of -0.47, 300.41 cm and 0.119, respectively and did not vary by stock of origin. However, it was demonstrated that while K was identical by gender, the L_{INF} for males (305.24 cm) was 13.5 cm greater than females.

SCRS/P/2022/012 provided progress on a study to estimate Bluefin tuna age at maturity using biphasic growth models applied to back-calculated size at age data. Neither a segmented regression modeling approach nor a Lester model could support that the age of maturity differed between stocks. The better fitting Lester model suggested a modal age of maturity of ~ 3 years for both stocks but with some fish reaching maturity as early as age 2 and as late as age 8. Further work will involve testing for gender and cohort effects as well as checking model estimates against observational data.

SCRS/P/2022/013 No text provided by the author.

SCRS/P/2022/014 No text provided by the author.

SCRS/P/2022/015 A presentation on a preliminary continuity run for VPA was made to the Group. It used input data and specifications that were as close as possible as the one used for the 2017 assessment and the 2020 update assessment. The objective was to present intial results to seek feedback from the Group on the path forward for the VPA. Results showed similar problems as identified during the 2020 update assessment: a strong instability in scale, strong retrospective patterns and a strong sensitivity to the indices, which were likely linked to the F_{RATIO} estimates. Several ways were suggested by the authors to improve the VPA modeling, in relationship to the various problems identified in the catch and in the past assessments. Path forward included exploring F_{RATIO} locked to historical estimates or the value of one when there was no reason to use other values. Exploring the reason of problems using the CAA produced by SS3 was also suggested. Finally, using a wider age-structure (16+ instead of 10+) mirroring what is used for the West stock was also suggested as using this age structure allows an easier assumption on Fratios=1.

SCRS/P/2022/016 showed the results of the preliminary Stock Synthesis model for E-BFT for 2022 with the data input and model settings presented in SCRS/2022/079. The presentation was focused on the evaluation of the performance of the model. The model converged and the Hessian matrix inverts. The joint residual analysis indicated that there are not trends in the residuals of indices but for two indices (BB_5006 and W-Med Larval Survey) some years have high residuals. The mean length residual tests showed a non-random trend in length residuals that need to be explored. The retrospective analyses with 5 peels indicated a moderate consistency and stability of the model for SSB and F estimates.

SCRS/P/2022/017 A continuity run for ASAP was presented to seek feedback on preliminary model diagnostics as well as proposed data and model revisions. ASAP methods and recent applications to E-BFT are described in SCRS/2002/079, with example input data (1968-2020catch at ages 1-10+ by fleet and stock indices). Input data and specifications of the continuity run were as close as possible as the one used for the 2020 update assessment with slightly different age range (single fleet, ages 1-16+). Results of the continuity run were similar to those from the 2020 update assessment: the model generally fit the data well, with some residual patterns and higher residual variance of some indices than their input CVs, but the retrospective pattern was relatively small.

SCRS/P/2022/018 provided an overview and the latest results of the GBYP aerial survey. The GBYP Coordinator gave a brief presentation/ overview of the evolution of the sampling and analytical methodologies applied to generate this index and following a summary of the current situation and next steps. The coordinator detailed the actions taken from the very beginning of the program towards the full standardization of survey strategies and sighting methodologies, as well those directed to the refinement of the database used for analyses and further standardization of analytical procedures after an in-depth internal revision carried out in 2018. This included a complete reanalysis to provide a revised index time series in 2019. Next, the recommendations from the external experts who carried out in 2020 a global revision of the GBYP aerial survey program following a request from BFT Species Group were explained., This led to a second global reanalysis of the available data in 2021 by the original developers of the applied aerial surveys methodologies, the CREEMs team from the University of Saint Andrews. The results from this second global reanalysis of data, which has provided both a revised aerial survey spawning biomass index time series for the Balearic Sea and a new aerial survey index time series for the Western and Central Med areas together (the data from Eastern Med surveys were not considered because of the low number of adult fish sightings along the whole period), as requested by the BFT species Group, were presented. It was pointed out that these revised aerial survey indices, which in the case of the Balearic Sea index show a similar trend to that of the Balearic Sea larval index and were not significantly different from those obtained in the 2019 global reanalysis. Finally, the pilot survey carried out in 2021 in the Balearic Sea area over an extended area and incorporating digital systems for automatic recording of BFT schools, as recommended by the external experts, was described, as well the activities to be carried out in 2022.

SCRS/P/2022/019 No text provided by the author.

Appendix 5

Guidance for MSE Developer and CMP Developers

It was noted that one process for tuning CMPs that had proven to be successful was to apply the following procedure:

1. Tune to the target Br30 using the tuning OMs
2. Run the stochastic grid using those same tuning parameters
3. Calculate the ratio of stochastic OMs Br30 to tuning OMs Br30
4. Adjust the tuning target based on the ratio (e.g., stock Br30/tuning Br30 =1.2, adjust tuning target to 1.25/1.2=1.04)
5. Tune to the new target Br30 values
6. Run the full stochastic OMs

Tuning was then carried out first to levels 1 (1.25W/1.25E) and 4 (1.5W/1.5E). The middle tuning levels were simply a combination of the tuning parameters from these scenarios, with a slight adjustment of the West upward or downward when the East target is adjusted. This had proved an efficient way to get close to the targets for the four scenarios.

In terms of the MSE package development, the new package features include:

- AvC20: average catch over first 20 years of projection
- Br20: B/B_{MSY} at projection year 20
- POF: $U/U_{MSY} > 1$
- PNOF: $U/U_{MSY} < 1$
- PGK: $U/U_{MSY} < 1$ & $B/B_{MSY} >1$
- PNRK: $U/U_{MSY} < 1$ | $B/B_{MSY} > 1$

To take advantage of these feature, it will be essential that the **CMP developers**:

1) Install v7.6.1
2) Rerun all stochastic MSE calculations (so that the new U_{MSY} metrics are correctly derived)
3) Recompile and share results

The MSE developer outlined the following tasks that need to be completed to the App before the BFT MSE Technical subgroup meeting in May 2022:

- Add levels to the performance tab app (e.g. ability to specify 40% LD and quantify fraction high than that level)
- Add mean (expected value) to performance app
- Add option to remove summary column
- Add spider diagrams (and better equivalent) to the performance app
- Update TSD (indices from update, new performance metrics)
- Rerun AI and TC MPs for the new package to get U/U_{MSY} metrics
- Consolidate all CMP results submitted
- Propose any specific alternative color schemes and improvement for the quilt plots
- Correspond with Dr Parma to prepare equivalent worm plots to those used in the southern bluefin tuna

Appendix 6

Specifications for MSE Trials for Bluefin Tuna in the North Atlantic
Version 22-1: 25 April 2022

Specifications for the MSE trials are contained in a living document that is under constant modification. The most recent version of the document (Version 22-1: 25 April 2022) can be found here.

Appendix 7

Atlantic Bluefin Tuna MSE – Results, Decisions, & Next Steps (4/27/2022)

Executive Summary

This document presents updated results of the Atlantic bluefin tuna management strategy evaluation (MSE). The intention is to provide sufficient knowledge to facilitate discussion among scientists, fishery managers and stakeholders, as well as decision-makers, at the 9-10 May 2022 meeting of Panel 2.

Candidate Management Procedures

There are currently 8 candidate management procedures (CMPs)[2] under development by 6 different international teams (**Table 1**). All currently assume a 2-year management cycle and calculate separate total allowable catches (TACs) for the West and East management areas. The SCRS rigorously reviewed all western and eastern indices, resulting in several indices being deemed not usable in their present condition by the MSE. After this, the choice of indices used in each CMP has been at the discretion of developers with emphasis placed on whether the indices perform well in the CMPs. Scientific rationale for SCRS consideration of indices in CMPs will be provided to Panel 2. We present results from 8 CMPs to show key performance tradeoffs for management objectives in a 'quilt plot' (**Figure 1**) that ranks CMPs on 7 key performance statistics; a second plot (*forthcoming at the Panel 2 meeting*) will include additional statistics.

The May Panel 2 agenda specifies three main decision points.

- **Decision point 1** (*PA2 Agenda Item 6.a)*: Agreement on operational management objectives percentages (gray sections), timeframes and performance statistics (See **Table 2**).

- **Decision point 2** (*PA2 Agenda Item 6.b)*: Does Panel 2 approve this proposed two-step process for Candidate Management Procedure development and performance tuning?

  Step 1: Development tuning for CMP comparison

  - CMPs are tested on a common Br30 performance level (currently 1.0, 1.25 or 1.5, for each stock)
  - SCRS will rank CMPs across remaining performance statistics corresponding to yield, status, safety and stability objectives
  - Panel 2 will evaluate relative performance of CMPs and may rank CMPs based on performance

  Status: Development tuning is nearly complete. As CMP performance initially seems similar across tuning levels. **Therefore, specific tuning levels do not need to be selected by Panel 2 at this time. CMPs that are poorly performing could be recommended for removal by Panel 2, at this May meeting.**

  Step 2: Performance tuning of retained list of CMPs to determine the final CMP specifications

  - Once top performing CMPs are selected in step 1, they may be performance tuned.
  - All CMPs include at least one adjustable setting to determine how heavily or lightly it applies fishing pressure to achieve desired performance on the risk-reward tradeoff (i.e., catch vs. biomass) for each of the East area/eastern stock and West area/western stock.
  - The setting can be adjusted to achieve different median Br30 (e.g., 1.43, 1.36) across the grid of operating models to achieve higher yields while meeting safety, status, and stability objectives.

[2] While 8 CMPs are under development, not all will be deemed to perform at the level necessary to be eligible candidates for MP adoption. For example, the Canadian development team have withdrawn one of their CMPs (i.e., NC) since the March PA2 meeting to focus their efforts on their other CMP that has better performance (i.e., FZ).

Status: Performance tuning has not yet begun and will occur following the May Panel 2 meeting and continue to the October Panel 2 meeting. The SCRS will provide feedback at its July and September meetings. At its October meeting, PA2 may first select a CMP and then select from within a range of tested performance tuning settings.

- **Decision point 3 (*PA2 Agenda Item 6.c)*: Does Panel 2 approve the following process for narrowing (culling) of CMPs?**

  - Panel 2 (in May) agrees to a set of performance statistics & descriptive tables/figures (e.g., quilt plots)
  - Panel 2 (in May) agrees to minimum standards for CMP performance, which may include:

    - Less than X% chance of breaching B_{lim}, where X is defined by PA2.
    - Stock should have a greater than Y% probability[3] of being above SSB_{MSY} in year 30, where Y is defined by PA2.
    - A (*forthcoming at the Panel 2 meeting*) proposal for an overfishing metric (U/U_{MSY}) & probability of the green quadrant of the Kobe matrix in year 30Are there other specific and measurable objectives would Panel 2 like to use as minimum thresholds?

  - Panel 2 (in May) may choose to exclude CMPs with unacceptable performance or structure.
  - At its July and September meetings, SCRS will review all CMPs and compare them to performance standards set by Panel 2 in May. CMPs not meeting minimum standards might not be recommended to Panel 2 in October, with results and rationale provided.
  - CMP developers may also withdraw their CMPs if they are not performing as desired.

- ***Additional Decision/Discussion points:***

  - Are there other specific and measurable objectives would Panel 2 like to use as minimum thresholds?
  - Are there any CMPs that Panel 2 would like to remove from consideration at this point?
  - Are there any additional features of CMPs that Panel 2 would like to see? CMP performance is not impacted by TAC caps.
  - Does Panel 2 require additional meeting time, either in July or as an extra day in October?

Next steps

After the May 9-10 Panel 2 meeting, there is one remaining meeting of Panel 2 to take place before the Commission Plenary, scheduled for October 14. The Bluefin Species Group will continue with two series of Ambassador meetings (July and September) in English, French and Spanish and materials will be translated into Arabic.

Other resources

Atlantic Bluefin Tuna MSE splash page, including interactive Shiny App (ENG only)
Harveststrategies.org MSE outreach materials (multiple languages)

[3] For a given development tuning, the probability of overfished status (POS), or probability $SSB<SSB_{MSY}$ in year 30, is a performance statistic.

Figure 1. 'Quilt' plot for the West and East for tuning level 2 (i.e., Br30=1.25 for West and Br30=1.5 for East). Color scale represents relative performance from yellow (best) to green to purple (worst). The seven statistics and associated percentiles are C1: TAC (kt) in the first two years of MP application (median or 50% percentile); AvC10: average catch (kt) over years 1-10 (50%tile); AvC30: average catch (kt) over years 1-30 (50%tile); VarC: Variation in catch (kt) between 2-year management cycles (50%tile); LD*(5%): lowest depletion over years 11-30 (5th percentile); LD*(15%): 15%tile of lowest depletion over years 11-30; Br30(5%): 5%tile of SSB/SSB_{MSY} in year 30. CMPs have been given an anonymous number 1-N as some are still being further refined. The May Panel 2 meeting will receive specific, named CMPs. This plot shows the top 7 performance statistics. A second plot [*forthcoming*] will also show LD*(10%), Br10(50%tile), Br20(50%tile), AvC20(50%tile), prob($U<U_{MSY}$)^4(50%tile), P[green zone] and proportion of distribution of LD* below B_{LIM}. See **Table 2** for more detailed descriptions of performance statistics.

West

	C1 (50%)	AvC10 (50%)	AvC30 (50%)	VarC (50%)	LD (5%)	LD (15%)	Br30 (50%)
CMP_8	2.82	2.864	2.595	16.397	0.327	0.544	1.311
CMP_17	2.682	2.831	2.637	6.708	0.182	0.402	1.287
CMP_13	2.206	2.658	2.792	18.716	0.369	0.52	1.26
CMP_9	2.523	2.882	2.811	13.92	0.313	0.497	1.24
CMP_14	2.509	2.644	2.534	15.645	0.286	0.505	1.253
CMP_16	1.908	2.052	2.256	18.124	0.337	0.528	1.262
CMP_12	1.676	1.948	2.167	19.355	0.311	0.511	1.271
CMP_18	3.271	3.452	2.639	18.585	0.051	0.281	1.243
CMP_11	2.695	3.383	2.338	21.424	0.098	0.264	1.281

East

	C1 (50%)	AvC10 (50%)	AvC30 (50%)	VarC (50%)	LD (5%)	LD (15%)	Br30 (50%)
CMP_8	34.84	43.753	39.157	16.85	0.363	0.612	1.442
CMP_9	37.509	39.017	32.269	17.221	0.496	0.668	1.48
CMP_17	37.261	33.432	29.209	8.18	0.369	0.538	1.544
CMP_14	43.2	35.02	30.441	17.231	0.43	0.59	1.494
CMP_16	43.2	35.337	30.848	17.26	0.427	0.59	1.491
CMP_13	43.2	33.188	28.256	19.06	0.373	0.57	1.564
CMP_12	43.2	33.819	28.568	19.05	0.357	0.552	1.548
CMP_18	39.829	41.518	28.647	16.465	0.228	0.413	1.601
CMP_11	43.2	51.804	32.538	20.575	0.24	0.424	1.457

Table 1. Table of candidate management procedures (CMPs), indicating in red where changes have occurred since the March Panel 2 meeting.

CMP	Indices used		Formulae for calculating TACs	References
	EAST	WEST		
FZ	FR AER SUV2 JPN LL NEAtl2 W-MED LAR SUV	US RR 66-144, CAN SWNS RR US-MEX GOM PLL	TACs are product of stock-specific F0.1 estimates and estimate of US-MEX GOM PLL for the West and W-MED LAR SUV for the East.	SCRS/2020/144 SCRS/2021/122
AI	All	All	Artificial intelligence MP that fishes regional biomass at a fixed harvest rate.	SCRS/2021/028
BR	FR AER SUV2 W-MED LAR SUV MOR POR TRAP JPN LL NEAtl2	GOM LAR SUV US RR 66-144 US-MEX GOM PLL JPN LL West2 CAN SWNS RR	TACs set using a relative harvest rate for a reference year (2018) applied to the 2-year moving average of a combined master abundance index. In recent refinement, the weighting range across individual indices has been reduced, resulting in improved performance. More recently still, some limited time dependence has been introduced into the TAC formulae to allow for a smoother transition from current TACs to those to be generated initial years of the MP application.	SCRS/2021/121 SCRS/2021/152 SCRS/2022/082
EA	FR AER SUV2 W-MED LAR SUV MOR POR TRAP JPN LL NEAtl2	GOM LAR SUV JPN LL West2 US RR 66-144 US-MEX GOM PLL	Adjust TAC based on ratio of current and target abundance index.	SCRS/2021/032 SCRS/2021/P/046
LW	W-MED LAR SUV JPN LL NEAtl	GOM LAR SUV MEXUS_LL	TAC is adjusted based on comparing current relative harvest rate to reference period (2019) relative harvest rate.	SCRS/2021/127
~~NC~~	~~MOR POR TRAP~~	~~US-MEX GOM PLL~~	~~No longer supported~~	~~SCRS/2021/122~~
PW	JPN LL NEAtl2 GOM LAR SUV	US-MEX GOM PLL GOM LAR SUV	TAC is adjusted based on comparing current relative harvest rate to reference period (2019) relative harvest rate.	SCRS/2021/155 SCRS/2022/078
TC	MOR POR TRAP JPN LL NEAtl2 W-MED LAR SUV GBYP AER SUV BAR	US RR 66-144	TAC is adjusted based on F/F_{MSY} and B/B_{MSY}.	SCRS/2020/150 SCRS/2020/165
TN	JPN LL NEAtl2	JPN LL West2	Both area TACs calculated based on their respective JPN_LL moving averages, unless drastic drop of recruitment is detected by US_RR index.	SCRS/2020/151 SCRS/2021/041 SCRS/2022/074

East indices: FR AER SUV2 – French aerial survey in the Mediterranean; JPN LL NEAtl2 – Japanese longline index in the Northeast Atlantic; W-MED LAR SUV – Larval survey in the western Mediterranean; MOR POR Trap – Moroccan-Portuguese trap index; GBYP AER SUV BAR – GBYP aerial survey in the Balearics

West indices: US RR 66-144 – U.S. recreational rod & reel index for fish 66-144 cm; CAN SWNS RR – Canadian South West Nova Scotia handline index; US-MEX GOM PLL – U.S. & Mexico combined longline index for the Gulf of Mexico; GOM LAR SUV – U.S. larval survey in the Gulf of Mexico; JPN LL West2 - Japanese longline index for the West Atlantic.

Table 2. Decision points relative to management objectives and performance statistics.

Management Objectives (Res. 18-03)	Current Performance Statistics	Decision Points for Management Objectives	Decision Points for Performance Statistics
The stock should have a greater than [__]% probability of occurring in the green quadrant of the Kobe matrix	**Br30** – Br [i.e., biomass ratio, or spawning stock biomass (SSB) relative to dynamic SSB_{MSY}[3]] after 30 years **U/U_{MSY}-** exploitation rate (U) in biomass divided by exploitation rate at MSY.[4] **OFT** – Overfished Trend, SSB trend if Br30<1.	• Leave as p(Green) or split into separate biomass/fishing mortality objectives (i.e., relative to dynamic SSB_{MSY} and F_{MSY}). • Probabilities (__% after 30 years)	• F-statistic: SCRS will propose an exploitation rate metric • Timeframe over which U/U_{MSY} is calculated.
There should be a less than [__]% probability of the stock falling below B_{lim} at any point during the 30 year evaluation period.	**LD*** – Lowest depletion (i.e., SSB relative to dynamic SSB_{MSY}) over years 11-30 in the projection period. LD* value is evaluated relative to SCRS-proposed B_{lim}(40% of dynamic SSB_{MSY}).[5]	• Is 40% of dynamic SSB_{MSY} over years 11-30 acceptable as B_{lim}? • Probability of falling below B_{lim} (Options: 5%, 10%,15%)	*None, if LD* is acceptable*
Maximize overall catch levels	**C1-** TAC in first 2 years of MP (i.e., 2023-24) **AvC10** – Median TAC (t) over years 1-10 **AvC30** – Median TAC (t) over years 1-30	• Add timeframe to management objective? [For example, "in the medium (5-10 years) and long (over 30 years)" terms]	*None, if existing 3 are acceptable*
Any increase or decrease in TAC between management periods should be less than [__]%	**VarC** –Variation in TAC (%) between 2-year management cycles	• Probabilities (Options: no restriction, ±20, +20/-30) • 'Phase-in' period of +20/-10 for first 2 MP applications (i.e., currently 2023-26), then +20/-30	*None, if **VarC** is acceptable*

[3]Dynamic SSB_{MSY} is a set fraction of dynamic SSB_0, which is the spawning stock biomass that would occur in the absence of fishing, historically and in the future. Dynamic SSB_{MSY} can change over time since it is based on current recruitment levels, which fluctuate due to time-varying dynamics in the models.
[4]The exploitation rate (U) is annual catch (in tonnes) divided by the total annual biomass in tonnes. U_{MSY} is the fixed harvest rate (U) corresponding with SSB/SSB_{MSY}=1 at year 50.
[5]SCRS proposes a B_{LIM} of 40% of dynamic SSB_{MSY} for the purposes of the MSE for CMP testing and performance tuning. This is calculated as the lowest depletion (spawning biomass relative to dynamic SSB_{MSY}) over projection years 11-30 for which the CMP is applied across the plausibility weighted operating models. B_{LIM} is proposed as a performance statistic, not as an 'active' or functional trigger for determining a management action.

Appendix 8

Specifications for 2022 East Atlantic bluefin tuna stock assessment

The Committee outlined the specifications of the stock assessment for East Atlantic bluefin tuna (E-BFT) for the provision of TAC advice. The Committee considers that the default approach for this assessment should be very similar to previous assessments (Anon., 2018; 2020) unless there are strong rationale for changes. The Commission stated that the eastern stock assessment should not interfere with the MSE process. This means that MSE has priority and that efforts related to the stock assessment must be contained within a workload compatible with the MSE tasking for 2022. The general approach is to keep the data used for the assessment as consistent as possible to what is currently used within the MSE. An external reviewer will be engaged to participate in the entire process, from data preparation to the projections of the assessment.

Models to be used for the assessment

Two models, VPA and Stock Synthesis, will be used, but the possibility of using other models remains open, provided that they meet diagnostic criteria and can be fully reviewed by the group.

Model specifications

Model platforms and set-up will follow the previous assessments, with exception of updated indices of abundance and including data through 2020.

- Catches. Last year of data 2020.
- Length data. Update stereo-camera data through 2020. Review length composition of fish destined to farms, particularly in how it is used in Stock Synthesis. Evaluate the input sample sizes for composition data, as input for Stock Synthesis.
- Age data. Will try to use conditional age at length and error matrices. Age data will be available through 2020. Age data will be used in Stock Synthesis as conditional age at length with an error vector. For VPA it may be possible to consider using an inverse age length key to construct the CAA, however the default will be to use the continuity age-slicing.
- Abundance Indices. Same ones as in MSE, strict updates for consistency. Already updated 2020: Mor-Port traps, JPNLL NEAtl, FRA Aerial, W-Med larval index. Updated needed: GBYP aerial with the St Andrews reanalysis (CREEM).
- Biology. Similar biological parameterizations of the models will be used as in previous assessments.

Model diagnostics and assumptions

Diagnostics pertinent to each modeling platform will be used as a basis for considering model utility for advice. These should, depending upon the platform, include:

a. Jittering of starting conditions to evaluate model stability
b. Likelihood profiles of key parameters, particularly R0 and F-ratios
c. Retrospective runs
d. Selectivity assumptions
e. Key assumptions for other parameters or model structure

Further detailed specifications will be described after the E-BFT data preparatory meeting.

Deadlines

March 15, 2022: CAS and CAA available
March 15, 2022: Age data from direct ageing
April 18-26, 2022: E-BFT Data preparatory meeting
July 4-12, 2022: E-BFT Stock Assessment
Sep 18-19, 2022: SCRS species Group
Sep 26-Oct 3, 2022: SCRS

References

Anonymous. 2018. Report of the 2017 ICCAT bluefin stock assessment meeting. ICCAT Collect. Vol. Sci. Pap, 74 (6): 2372-2535.

Anonymous. 2020. Report of the 2020 Second Intersessional Meeting of the ICCAT BFT Species Group (Online, 20-28 July 2020). ICCAT Collect. Vol. Sci. Pap., 77 (2): 441-567.