REPORT OF THE 2019 INTERSESSIONAL MEETING OF THE ICCAT BLUEFIN TUNA MSE TECHNICAL GROUP
(Madrid, Spain – 7-9 February 2019)

"The results, conclusions and recommendations contained in this Report only reflect the view of the Bluefin MSE Technical Group. Therefore, these should be considered preliminary until the SCRS adopts them at its annual Plenary meeting and the Commission revise them at its Annual meeting.

Accordingly, ICCAT reserves the right to comment, object and endorse this Report, until it is finally adopted by the Commission."

1. Opening

The meeting was held at the ICCAT Secretariat in Madrid, 7-9 February 2019. Drs Douglas Butterworth (Professor Emeritus, University of Cape Town) and Gary Melvin (DFO, St. Andrews Canada) served as co-chairs and opened the meeting, welcoming participants. The ICCAT Executive Secretary, Mr. Camille Jean Pierre Manel, welcomed the participants and highlighted the importance of the ICCAT's Atlantic bluefin tuna Management Strategy Evaluation (MSE) process. He thanked the participants for their work so far and emphasized the importance of this work for the Commission. The co-chairs reminded the Group that the purpose of the meeting was to prepare for next week's species group meeting foreseen from 11-15 February 2019 and that to do so the Group would review MSE work completed to date in order to facilitate discussion of the meeting next week. Many of the items slated for discussion at this meeting will also be discussed at the Intersessional Bluefin Species Group meeting, 11-15 February 2019.

The Group decided that a short report would be prepared for the meeting. Specific changes to operating models (OMs) and candidate management procedures (CMPs) will be captured in the Trial Specifications Document but it was noted that final decisions about the Trial Specifications themselves will be reserved for the BFT Species Group meeting the next week from 11-15 February 2019.

2. Adoption of Agenda

The co-chairs emphasized that the agenda was to be considered as a broad guideline for the meeting discussion and as key priorities to address. An updated draft agenda is provided in **Appendix 1**. The meeting's list of participants is listed in **Appendix 2**.

3. Nomination of the rapporteurs

Day	*Rapporteur*
1-2	Nathan Taylor
3	Nathan Taylor and Carmen Fernandez

4. Review of available documents

See **Appendix 3**.

5. Summary of developments since the September 2018 Bluefin Species Group

The purpose of MSE was briefly reviewed including its purpose, and the role of operating model conditioning and CMPs.

5.1 Operating Model Plausibility

The Group discussed how to select reference sets of operating models and how to consider the plausibility of OMs in general. It was noted that threshold(s) for eliminating some operating models needed to be defined and applied. The usefulness of reviewing model residuals and predicting future data were discussed.

The Group examined worm plots of future stock dynamics with zero catch in order to see if the stock dynamics projected into the future resemble the past and, in particular, to see if having future zero catch resulted in stocks rebuilding relative to the time-varying (dynamic) B0. Specifically, the Group agreed that they would check to see that all projections tended toward dynamic B_0 with no fishing.
The Group discussed what the distinction was between the reference set and the robustness set. The criterion for inclusion in the reference set are those OMs that are both highly plausible given the data and also influential with respect to their effect on the performance of CMPs. Robustness sets consisted of those that are highly plausible though are not influential, or those that are of low plausibility but have large effects.

t-RFMO Report on MSE

The Group also reviewed the t-RMFO report on MSE. See **Appendix 4** for a review of the Group's discussions Report of the 2018 Joint Tuna RFMO Management Strategy Evaluation Working Group meeting (*Seattle, USA – 13-15 June 2018*).

6. Comparative analysis of the results of the different OMs

6.1 Review of the results of different OMS

Several specific problems/queries regarding operating model outputs were identified by the Group:

- Conflicts in the data (abundance indices and Stock of Origin or SOO) indicators
- Genetics vs otolith microchemistry estimates
- Biomasses – trends and absolute values, initial (B_0) biomasses, whether cryptic
- The apparent high biomass in the South Atlantic - is this plausible?
- The realism of the tonnage of total biomass moving from west to east areas being comparable
- Potential bias in electronic tagging
- Clear presentation of movement patterns is needed
- Some indices that had previously been considered good for management procedures now appear to be poor with respect to residuals under the current MSE framework
- Recruitment deviations appear to be highly autocorrelated (in the OM model report recruitment deviations are large blocks of positive and negative residuals)
- Concerns about the operating model hitting parameter bounds
- The seasonal dynamics in the Mediterranean, with a large biomass there throughout the year, does not seem plausible
- The proportion of the western stock biomass that is in the east area (30-70% of the western stock biomass) appears surprisingly high, while the proportion of the east area biomass that is from the western stock was very small (2-3% of the east area biomass).

The Group discussed the challenges in determining the credibility of alternative OMs. To resolve this issue, a set of plots and diagnostics was requested to better understand the reasons underlying the current OM output. It was stressed that the basis for accepting or rejecting OMs would be based on data that have already been agreed upon for model fitting, diagnostics and other empirical criteria, and not on the management consequences of using them for the evaluation of CMPs. In the end a major coding error was discovered, rendering the projection outputs brought to the meeting from all OM's invalid.

A summary of these discussions is laid out below under broad subject headings.

6.2 Genetics vs otolith microchemistry

The current assumption in the model is that both the genetics and microchemistry data are treated as reflecting stock of origin. The main concern was that the microchemistry data may not reflect true stock of origin (like genetics), but rather the location that the fish inhabited for their first few months of life. A large fraction of individuals reared in waters characteristic of the Gulf of Mexico may have an eastern stock ancestry (SCRS/2019/022). It was agreed to explore the possibility of weighting or removing options.

6.3 Potential bias in tagging

Electronic tagging data summaries show that all the western origin fish tagged were greater than 200 cm in length, whereas most the eastern fish were less than 200 cm. This could lead to biases. A plot by size-at-tagging was requested to reveal their vulnerability to fisheries. The western bluefin tuna chair will make a request for these plots.

6.4 Biomasses (trends and absolute values, initial (B0) biomass, whether cryptic)

To review this, plots of biomass by area, stock of origin, quarter and the three age-groups used for movement dynamics would be desirable. For this meeting comparing these plots for five operating models (1A-I, 1A-II, 2A-I, 2A-II, 1B-II, and 1B-III) would be appropriate to start the review of qualitative differences among the operating model predictions. Discussions of OM weighting and elimination were deferred until later.

6.5 Clear presentation of movement

To review movement, the time series of absolute biomass of each stock in each area would be needed. The plot would repeat Fig. 16 of the OM report by stock, but in absolute terms.

6.6 Recruitment deviations

The existing plots of stock recruit plots and residuals are sufficient to visualize what appear to be highly autocorrelated residuals. It was noted that recruitment is generated in 2-year blocks and the OM includes a check that prevents estimates from hitting bounds in converged runs.

6.7 Seasonal dynamics in the Mediterranean

Existing plot were adequate. No additional information was requested.

6.8 Master Index

The Group discussed whether it would be useful to examine the uncertainty in specifying master index. The Group agreed to undertake OM model conditioning with the Master Index down-weighted, for a single operating model.

6.9 Indices that had previously been considered good for management procedures now appear to be poor with respect to residuals

Discussion on this item was deferred.

6.10 Concerns about the operating model fitting behavior

The Group was satisfied that the diagnostics (in relation to the non-linear minimizer convergence and parameter bounds checking) for current OM fitting reflected acceptability.

The Group reviewed a new analysis prepared by the GBYP modelling expert. With respect to conflicts in the data (abundance indices and SOO indicators), the GBYP modelling expert first conducted a series of trials where different data types for the west and the east were down-weighted to explore how this changed the operating model results. These results were summarized in presentation given to the Group. Data series fit in operating model conditioning were down-weighted to 20% relative to base-case levels for the following scenarios:

a) east relative abundance indices (CPUE and fishery independent in the east area);
b) west relative abundance indices (CPUE and fishery independent in the west area);
c) stock of origin data (both otolith microchemistry and genetics);
d) electronic tagging data (e.g. PSATs),
e) otolith microchemistry data.

The sensitivity analysis illustrated the effect of different data weighting procedures on OM model spatial biomass and relative stock composition outputs. One primary tension between the SOO indicators and the indices of abundance was that when index data were down-weighted, the model was better able to fit the SOO data and vice versa. Differential weighting of otolith microchemistry data demonstrated that predicted biomass and stock ratio were sensitive to these weightings. By far the greatest differences occurred when the west area indices were down-weighted, leading to a some three-fold increase in the estimated absolute abundance of the western stock.

However, a critical concern was the need to understand the mixing between the stocks, and to reconcile the model's predictions with observed data that were considered in the sensitivity analysis. The Group reviewed the model's spatial structure which included a mixture analysis of the genetics and otolith microchemistry data (Carruthers T., and Butterworth D.S, 2019). One concern was that the analysis used derived data, rather than the original otolith microchemistry data. Similarly, the genetic data also contained assignment uncertainties. It was suggested that a review of samples used for the baseline in assigning might help resolve some uncertainties about the otolith microchemistry analysis. A further concern was some spatial distribution patterns that seemed to lack realism in indicating large numbers of fish in certain quarter/strata combinations. To resolve some of these concerns, priors will be added to limit biomass in some quarter/strata combinations and to review the stock of origin data. Additional plots were requested from the GBYP modelling expert to visualize some of the stock dynamics that were the subject of the debate.

In compiling the additional plots requested above, the developer discovered errors in the R package code that led to the apparent extirpation of the western stock in some operating models. This was not an error in the OM conditioning software (so that previous conditioning results were not affected), but in the R package used for CMP development projections. This meant that the new/corrected package gives qualitatively different results to the previous package. The Group reviewed the new results in detail seeking some initial clarifications. There is a constraint within the OMs that does not allow the harvest rate (actually, U, i.e. proportion harvested during a three-month period in relation to numbers) to exceed 0.9 in any strata. Concern was raised that this could unrealistically high value. At this stage, the Group decided not to change 0.9 as the ceiling, noting that this could be further considered at the upcoming BFT meeting.

6.11 Correction to version v4.2.15 of ABFT MSE R package:

Results from running the corrected package on a "current catch" MP's were presented to the group for several OMs (document "Investigation of historical and projected stock biomass"), and generally they no longer showed extirpation of the western stock. However, for OM 2AIV, the results for the west area were difficult to understand. The GBYP modelling expert agreed to investigate outputs from the OM and report back to the group. Additional clarification on plots included:

- The graphs labelled "Catch" display the actual catch predicted by the model
- The graphs labelled "Harvest rate" display catch (in biomass) predicted by the model divided by biomass, and were calculated on an annual basis
- To include a similar graph (historical and projected) for recruitment in the future.

7. Collation of results from CMP developers and preparation of their presentation to the Intersessional Meeting of the Bluefin Tuna Species Group

Initial descriptions and results from CMP developers are summarized in **Appendix 4**.

8. Tuning of CMPs to a reference west and an east performance statistic for a specified OM to the extent possible, and preparation of summary results

Rerunning CMPs on corrected ABFT package (including development tuning):

The Group agreed that the CMPs which developers were to put forward for this meeting should be tuned to facilitate comparison. Tuning options used for the CMPs at this stage do NOT imply that they should be used for final candidate MPs eventually put forward for the Commission's consideration. It was agreed that:

- CMP tuning for purpose of the BFT Intersessional Meeting will be based on the results from OM 1AI, using the deterministic OM default settings with no observation or implementation error.
- The performance measure for the tuned CMP will be Br(30) = $B(30)/B_{MSY}$ (CMP's should be tuned to 1 for the western stock, and if possible close to 1 for the eastern stock).

If developers had time, they could also put forward a second CMP where the tuning was conducted based on the eastern stock instead of the western stock.

9. Consideration of the reconditioning of OMs to develop a suggested procedure for their review at the Intersessional Meeting of the Bluefin Tuna Species Group, in particular as regards acceptability

Movement and Stock mixing

The Group discussed several aspects of the internal workings of the OMs that were difficult to understand. Many of those aspects are related to the modelling of movement in the OMs, as well as the impact of the various sources of data that likely can inform on movement and mixing: electronic tagging data, genetics data, otolith microchemistry data and the master index. A subgroup was established to consider these issues and discovered that Caribbean data had been included in the GOM by mistake (which is to be corrected).

An up-to-date version of Figure 2.1 of the trial specification document was requested for each of the three movement age classes, as the Group would like to use this for further understanding and discussion.

The impact of the master index on movement estimates and stock mixing was unclear. In principle, it may be expected that contrary trends in data to those for the master index would tend to supplant the values for the latter, but if there were no data for the stratum-quarter concerned, the master index value would apply by default. It was agreed that sensitives to the specification of the master index will be needed (the actual form for any alternative would need to be determined externally, as the master index does not enter as a likelihood term in the OM conditioning).

Certain movements did not appear to be feasible on the basis of additional objective information not explicitly incorporated in the OM or their conditioning. Restrictions will be imposed using penalties/priors from the actual population in the OM. It was agreed that the OMs should include the following restrictions:

- No fish should be in the GOM in Quarter 3;
- No fish should be in the GSL in Quarter 1 (note: although "few fish" is likely more realistic than "no fish", it was agreed to use "no fish" for pragmatic coding reasons);
- No GOM fish in MED;
- No MED fish in GOM.

A further restriction concerning SATL biomass in Quarter 4 was considered, but as there was no proposal put forward for how to implement this in the OM's, this was deferred for the present.

The GBYP modelling expert explained that conventional tagging data had been used only qualitatively, to constrain what movements could or could not happen. He also explained that for the electronic tagging data, only fish of known stock of origin (i.e. the tag fish which entered the GOM or MED at some point in time) had been used in the model. Information from the remaining tags was not used. Concern was also expressed that short tagging duration could cause bias in the estimation of movement or stock mixing. Moreover, more tags had been deployed in the west area compared to the east area, but the proportion of short tagging durations is higher in the east than in the west. It was suggested that the mixing subgroup should re-convene to consider and carefully specify what sensitivities they would want the GBYP modelling expert to run.

The co-chair noted that in MP development, what matters more is the impact that assumptions may have on trends in biomass projections, in comparison to their impact on historical perspectives. He proposed that when requesting the GBYP modelling expert to undertake additional sensitivity analyses, he should be asked to project these into the future treating constant catches at their current values as a CMP (at least for those sensitivities having the highest priority).

A question was raised about how OMs should be weighted appropriately: for example, if some OMs that seem realistic were to be excluded from the reference set because they result in similar projection outcomes to an OM that is included in that set, might this not lead to bias? The co-chair explained that the OM set on which to base final decisions must be balanced in respect of OMs with differing stock status and productivity, but advised that the weighting issue was to be discussed further and decided by the group at a later stage. Additionally, the final one or two CMPs to be presented to the Commission would always need be checked against more OMs than the members of the reference set, such as those in the robustness set.

The Group also agreed that sensitivities that strongly down-weight each of genetic, SOO and PSAT data sources, down-weighting one data source at a time, should be conducted. This is essentially a rerun, though with extensions and some OM data input revisions, of some of the sensitivity analyses conducted earlier.

10. Initial draft of suggested form of presentation to Panel 2 to assist further development of this at the Intersessional Bluefin Tuna Species Group Meeting

This discussion was deferred to the Bluefin Tuna Species Group meeting.

11. Coding package: possible suggestions for modifications

Correction were made to the ABFT MSE R package during the meeting (see item 6 above).

12. Adoption of the Report

The meeting had insufficient time to consider many of the points on its Agenda, and referred these for discussion at the Species Group meeting the next week but otherwise adopted the report.

References

Carruthers T., and Butterworth D.S. 2019. A mixture model interpretation of stock of origin data for Atlantic bluefin tuna. ICCAT Collect. Vol. Sci. Pap. 75 (6) 1363-1372.

Appendix 1

Agenda

1. Opening
2. Adoption of Agenda
3. Nomination of the rapporteurs
4. Review of available documents
5. Summary of developments since the September 2018 bluefin session
6. Comparative analysis of the results of the different OMs
7. Collation of results from CMP developers and preparation of their presentation to the Intersessional Meeting of the Bluefin Tuna Species Group
8. Tuning of CMPs to a reference west and an east performance statistic for a specified OM to the extent possible, and preparation of summary results (such tunings are to facilitate evaluation of results of different CMPs for comparable recovery vs short-medium term catch trade-offs)
9. Consideration of the reconditioning of OMs to develop a suggested procedure for their review at the Intersessional Meeting of the Bluefin Tuna Species Group, in particular as regards acceptability
10. Initial draft of suggested form of presentation to Panel 2 to assist further development of this at the Intersessional Meeting of the Bluefin Tuna Species Group
11. Coding package: possible suggestions for modifications
12. Adoption of the report

Appendix 2

List of Participants

CONTRACTING PARTIES

ALGERIA
Kouadri-Krim, Assia
Chef de Bureau, Ministère de l'Agriculture du Developpement rural et de la Pêche, Direction Générale de la Pêche et de l'Aquaculture, CTE 800 Logements, Batiment 41, Nº 2 Mokhtar Zerhouni Mouhamadia, 16000
Tel: +213 558 642 692, Fax: +213 21 43 31 97, E-Mail: dpmo@mpeche.gov.dz; assiakrim63@gmail.com

CANADA
Carruthers, Thomas
335 Fisheries Centre, University of British Columbia, Vancouver Columbia V2P T29
Tel: +1 604 805 6627, E-Mail: t.carruthers@oceans.ubc.ca

Duprey, Nicholas
Science Advisor, Fisheries and Oceans Canada - Fish Population Science, Government of Canada, 200-401 Burrard Street, Vancouver, BC V6C 3S4
Tel: +1 604 499 0469, E-Mail: nicholas.duprey@dfo-mpo.gc.ca

Hanke, Alexander
Scientist, St. Andrews Biological Station/ Biological Station, Fisheries and Oceans Canada, 125 Marine Science Drive, St. Andrews New Brunswick E5B 0E4
Tel: +1 506 529 5912, Fax: +1 506 529 5862, E-Mail: alex.hanke@dfo-mpo.gc.ca

EUROPEAN UNION
Arrizabalaga, Haritz
AZTI - Tecnalia /Itsas Ikerketa Saila, Herrera Kaia Portualde z/g, 20110 Pasaia Gipuzkoa, España
Tel: +34 94 657 40 00; +34 667 174 477, Fax: +34 94 300 48 01, E-Mail: harri@azti.es

Biagi, Franco
Directorate General for Maritime Affairs and Fisheries (DG-Mare) - European Commission, Rue Joseph II, 99, 1049 Bruxelles, Belgium
Tel: +322 299 4104, E-Mail: franco.biagi@ec.europa.eu

Gordoa, Ana
Centro de Estudios Avanzados de Blanes (CEAB - CSIC), Acc. Cala St. Francesc, 14, 17300 Blanes Girona, España
Tel: +34 972 336101, E-Mail: gordoa@ceab.csic.es

Fernández, Carmen
Instituto Español de Oceanografía, Avda. Príncipe de Asturias, 70 bis, 33212 Gijón, España
Tel: +34 985 309 804, Fax: +34 985 326 277, E-Mail: carmen.fernandez@ieo.es

Merino, Gorka
AZTI - Tecnalia /Itsas Ikerketa Saila, Herrera Kaia Portualdea z/g, 20100 Pasaia - Gipuzkoa, España
Tel: +34 94 657 4000; +34 664 793 401, Fax: +34 94 300 4801, E-Mail: gmerino@azti.es

Rouyer, Tristan
Ifremer - Dept Recherche Halieutique, B.P. 171 - Bd. Jean Monnet, 34200 Sète Languedoc Rousillon, France
Tel: +33 (0)4 42 57 32 37; +33 (0)7 82 99 52 37, E-Mail: tristan.rouyer@ifremer.fr

JAPAN
Butterworth, Douglas S.
Emeritus Professor, Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch, 7701 Cape Town, South Africa
Tel: +27 21 650 2343, E-Mail: doug.butterworth@uct.ac.za

Miyagawa, Mitsuyo
2-19-4 Uragaoka, Kanagawa Yokosuka 239-0823
Tel: +27 70 7528 6049, E-Mail: mitsuyo.minami@gmail.com

Nakatsuka, Shuya
Head, Pacific Bluefin Tuna Resources Group, National Research Institute of Far Seas Fisheries, Japan Fisheries Research and Education Agency, 5-7-1 Orido, Shizuoka Shimizu 424-8633
Tel: +81 543 36 6035, Fax: +81 543 36 6035, E-Mail: snakatsuka@affrc.go.jp

Tsukahara, Yohei
National Research Institute of Far Seas Fisheries, 5-7-1 Orido, Shizuoka Shimizu-ku 424-8633
Tel: +81 54 336 6035, Fax: +81 54 335 9642, E-Mail: tsukahara_y@affrc.go.jp

MOROCCO
Abid, Noureddine
Chercheur et ingénier halieute au Centre Régional de recherche Halieutique de Tanger, Responsable du programme de suivi et d'étude des ressources des grands pélagiques, Centre régional de L'INRH à Tanger/M'dig, B.P. 5268, 90000 Drabed Tanger
Tel: +212 53932 5134, Fax: +212 53932 5139, E-Mail: noureddine.abid65@gmail.com

Bensbai, Jilali
Chercheur, Institut National de Recherche Halieutique à Casablanca - INRH/Laboratoires Centraux, sidi Abderrhman / Ain Diab, 20000 Casablanca
Tel: +212 661 59 8386, Fax: +212 522 397 388, E-Mail: bensbaijilali@gmail.com

TUNISIA
Zarrad, Rafik
Institut National des Sciences et Technologies de la Mer (INSTM), BP 138 Ezzahra, Mahdia 5199
Tel: +216 73 688 604; +216 97292111, Fax: +216 73 688 602, E-Mail: rafik.zarrad@instm.rnrt.tn; rafik.zarrad@gmail.com

UNITED STATES
Aalto, Emilius
120 Ocean View Blvd, CA Pacific Grove 93950
Tel: +1 203 809 6376, E-Mail: aalto@cs.stanford.edu

Brown, Craig A.
Chief, Highly Migratory Species Branch, Sustainable Fisheries Division, NOAA Fisheries Southeast Fisheries Science Center, 75 Virginia Beach Drive, Miami Florida 33149
Tel: +1 305 586 6589, Fax: +1 305 361 4562, E-Mail: craig.brown@noaa.gov

Lauretta, Matthew
NOAA Fisheries Southeast Fisheries Center, 75 Virginia Beach Drive, Miami Florida 33149
Tel: +1 305 361 4481, E-Mail: matthew.lauretta@noaa.gov

Morse, Molly
University of Massachusetts, School for Marine Science & Technology, 836 S Rodney French Blvd, New Bedford MA 02744
Tel: +1 310 924 5554, E-Mail: mmorse1@umassd.edu

Walter, John
NOAA Fisheries, Southeast Fisheries Center, Sustainable Fisheries Division, 75 Virginia Beach Drive, Miami Florida 33149
Tel: +305 365 4114, Fax: +1 305 361 4562, E-Mail: john.f.walter@noaa.gov

OBSERVERS FROM NON-GOVERNMENTAL ORGANIZATIONS

PEW CHARITABLE TRUSTS - PEW
Cox, Sean
School of Resource and Environmental Management, Simon Fraser University, 8888 University Drive, British Columbia Burnaby V5A1S6, Canada
Tel: +1 78 782 5778, Fax: +1 778 782 4968, E-Mail: spcox@sfu.ca

SCRS CHAIRMAN
Melvin, Gary
SCRS Chairman, St. Andrews Biological Station - Fisheries and Oceans Canada, Department of Fisheries and Oceans, 285 Water Street, St. Andrews, New Brunswick E5B 1B8 Canada
Tel: +1 506 651 6020, E-Mail: gary.d.melvin@gmail.com; gary.melvin@dfo-mpo.gc.ca

*****

ICCAT Secretariat
C/ Corazón de María 8 – 6th floor, 28002 Madrid – Spain
Tel: +34 91 416 56 00; Fax: +34 91 415 26 12; E-mail: info@iccat.int

Manel, Camille Jean Pierre
Neves dos Santos, Miguel
Ortiz, Mauricio
Taylor, Nathan
Kimoto, Ai

Appendix 3

Review of Available Documents

By way of an introduction to CMPs developed each developer provided a quick summary of the CMPs described in more detail in their documents. These and other papers presented are summarized below.
SCRS/2019/P/001 presented a CMP for the eastern and western stocks that is empirical and calculates the relationship between the average value of the available standardized indices in each management period of the simulation with a target, which is set relative to its value at the beginning of the simulation. The TAC is set to be proportional to the ratio between the current value and the target. The CMP uses an average of four indices for the eastern stock (1 fishery and 3 independent) and one survey for the western stock. The four indices used for the east are the Japanese longline index, the French aerial survey, the Mediterranean larval survey and the GBYP aerial survey. For the west, this CMP used the Gulf of Mexico larval index. The CMP aims at two different targets, one for each stock: 0.75 of the current average index in the east and to maintain the current value of the index in the west. In addition, this CMP includes a stability clause that allows only for moderate increases or decreases of TAC in each management period (Irat < ±20%).

SCRS/2019/02 presented some new analysis of otolith chemistry, genetics, integrated analysis, and their significance for MSE hypotheses. It carried outdid a re-analysis of adults (Gulf of Mexico, Mediterranean), and Slope Sea larvae. The analysis showed the following: mixing proportions west and east of 45º N based on otolith microchemistry that show some different rations from year to year; genetic analysis indicated that the Gulf of Mexico, Slope Sea and Mediterranean Sea constitute different populations with a weak genetic differentiation. The project also generated new genetic assignments to two stocks of origin that demonstrated stock composition ratios that were similar to a previous Atlantic-wide sampling projects conducted in previous years. The paper also explored a so-called integrated approach to stock discrimination: this method combines different techniques (genetics and stable isotopes) together; it showed that the integrated approach improves stock discrimination power over using genetics or isotopes alone. However, the paper's most salient conclusion was that using integrated analysis results in a larger proportion of unassigned fish than using one of the methods separately: these fish were classified as GoM using isotopes, and Mediterranean using genetics, so that they could not be assigned to either population using integrated method; when considered jointly, the genetic and stable isotope profile of these fish does not match that of the fish in either spawning area. The groups discussed a variety of uncertainties including early-life population dynamics that might give rise to the otoliths of Mediterranean fish acquiring GOM-like microchemistry and statistical methods used to make the assignments.

The paper discussed the consequences of this work for the AFBT MSE. In particular it stated that the assignment errors might translate into apparently high migration. To address this, the paper identified a number of hypotheses that could be considered in the MSE, specifically as already included in robustness OMs: parameterizing operating models using integrated genetic and otolith chemistry assignments, no mixing, half the inferred level of stock mixing, no western fish in the east, and time varying mixing parameterization of operating models. The paper illustrated how otolith microchemistry and, genetics, and integrated methods can result in very different apparent stock ratios. The presentation concluded with a series of questions about how to proceed on the basis of these results: genetic and integrated analyses suggest more complex population structure than assumed in the current MSE (namely a possible third population or a Mediterranean contingent that migrates into the Atlantic early in life); should this new knowledge, as well as the new SOO data provided (under the current 2 stock hypotheses) be included incorporated into the MSE results? Genetics estimates a smaller western proportion in the east so should genetics alone be used to avoid situations where a large proportion of western fish area available in the east? Should OMs simplify structure with considering fewer areas and/or fewer age and time strata?
The group discussed these issues but did not, as yet, reach any conclusions.

SCRS_P/2019/003 introduced three empirical MPs based on maintaining constant exploitation rates. As catch divided by index can be a proxy for exploitation rate it is possible to find ratios of current catch/index that match a target catch/index value. For all three CMPs a constant exploitation rate CMP is used with the Mediterranean larval index. For the west, the first CMP uses the lagged USRR 115-144 index to reflect recruitment to the fishery. The second CMP uses the Gulf of Mexico larval index for the west and aims for a continued increase in this index, which is consistent with the general aim of historical management. The third CMP uses a constant exploitation rate for the west using the Gulf of Mexico larval index. At the present time, the target levels for both the east and west exploitation rates remain to be fully developed.

SCRS 2019/014 reviewed candidate management procedures for western and eastern Bluefin tuna stocks which were developed and tested on 24 deterministic operating models that differed with respect to recruitment, abundance, spawning potential and natural mortality. The MP used GBYP_AER_SUV and CAN_ACO_SUV to estimate status of the western and eastern stocks, respectively, and trends in US_RR_66_114and CAN_ACO_SUV surveys to determine the TACs in the west and east areas, respectively, based on a three zone stock status framework (Healthy, Cautious, Critical).

SCRS/2019/16 described age and genetic analyses on the Norwegian bluefin tuna were conducted to know more about the Norwegian catch composition in terms of cohorts and origin. Using genetic analysis, the paper's results suggest that the large bluefin tuna individuals that feed in Norwegian waters in summer are predominantly of Mediterranean origin, and similar age classes were observed in 2016 and 2017, ranging between 6 and 14 years old, but mostly of 9 and 10 years old.

SCRS/2019/018 described simple constant (intended) proportion CMPs which was applied to the 16 conditioned OMs and nine robustness test OMs in version 4.2.15 of the Package. The CMP used a set of variance weighted indices to derive a baseline index to input to TAC equations based on two control parameters. The CMP was essentially a constant harvest rate policy subject to a catch variance constraint that limit the extent of TAC changes. In order to avoid extirpating the western stock, an alternative MP applied a threshold criterion to the fixed harvest rate. Further tuning parameters were the harvest rate (slope) and an associated threshold.

SCRS_2019_020 introduced a simple empirical MP that promotes understanding by managers and stakeholders. It used CPUE and accordingly did not incur the additional costs associated with the collection of additional data. A conceptual flow chart of the MP was presented: it used a threshold criterion based upon the GOM larval index and applied a series of conditional statements to JPN longline CPUE to derive TACs in each year.

SCRS/2019/021 updated the 2017 SCRS-agreed VPA assessment for the eastern Atlantic bluefin tuna to include previously unreported catches of age-0 tuna in the Mediterranean. Except for three years in the 1980s, the change in estimates of annual recruitment were negligible. The pattern that indicates a regime shift in the 1980s therefore remains. Consequently, no related change was proposed in the current specifications for the Reference Set of Operating Models for the Atlantic bluefin MSE.

SCRS/2019/022 presented an analysis of bluefin tuna caught in the Canadian EEZ which were assigned to groups based on otolith microchemistry and genetic methods. Otolith microchemistry provides information on the site (close to) where an individual hatched, whereas genetic methods inform on an individual's ancestry. Of the 1413 individuals with paired observations, 720 had assignment probabilities greater than 0.8 and less than 0.2 by both methods. Results indicate that a large fraction of individuals hatched in water characteristic of the Gulf of Mexico have an eastern stock ancestry. The group discussed the results and how they compared to SCRS/2019/02 and discussed how some mechanism such as temperature might give rise to interannual variability in dissolved oxygen ratios.

The group considered re-running the mixture analysis using up-to-date data presented in SCRS papers above.

List of Papers and Presentations

Reference	Title	Authors
SCRS/2019/014	Candidate Management Procedures for Bluefin tuna	A. Hanke
SCRS/2019/016	Origin and age composition of Norwegian catch	Arrizabalaga H., Lastra P., Rodríguez-Ezpeleta N., Rodriguez-Marín E., Ruiz M., Ceballos E., Garibaldi F., and Nøttestad L.
SCRS/2019/018	Application of fixed proportion candidate management procedures for North Atlantic Bluefin Tuna using Operating Model Package Version 4.2.1.5	D S Butterworth, M Miyagawa and M R A Jacobs
SCRS/2019/020	Preliminary Development of a Simple Candidate Management Procedure Using Index of Japanese Longline	Y. Tsukahara and S. Nakatsuka
SCRS/2019/021	Quantifying the Impact of Estimates of Recruitment Trends of Previously Unreported Catches of Age-0 Blufin Tuna in the Mediterranean	T. Carruthers, D. Butterworth
SCRS/2019/022	A Comparison of Stock of Origin Assignment Methods	A.R. Hanke1, D. Busawon, G. Puncher, L. Hamilton, D. Dettman, S. Pavey
SCRS/2019/P/001	Preliminary evaluation of a CMP for Atlantic bluefin using MSE	G. Merino, H. Arrizabalaga, T. Rouyer, A. Gordoa
SCRS/2019/P/002	Population structure and mixing: new information and analyses	H. Arrizabalaga, N. Rodriguez-Ezpeleta, I. Fraile, D. Brophy, N. Diaz-Arce, Y. Tsukahara, D. Richardson, J. L. Varela, E. Rodriguez-Marín, A. Medina, A. Hanke, N. Abid, and P. Lino
SCRS/2019/P/003	Constant exploitation rate candidate management procedures for Atlantic bluefin tuna	J. Walter and M. Lauretta

Appendix 4

Review of t-RMFO Report On MSE

The group reviewed the tRMFO meeting report´s Conclusions and Recommendations on MSE, and in particular reviewed those recommendations which were relevant to the ABFT MSE process. Regarding recommendation 1, it was suggested that the so-called first guillotine that applied to data selection may not have applied to the ABFT MSE as new data were accepted at the April 2018 meeting. However, it was explained that this was because conditioning had not yet occurred. Furthermore, the inclusion of new data that were provided after the September 2018 meeting had required a substantial proportion of the software developer´s time to check these data and recondition the OMs. One exception to violating the restrictions of data guillotine would be a scenario where new data completely transform the perspectives about the state and/or population dynamics of the stock. Recommendations 2, 3 and 4 of the tRMFO report were not considered relevant to the ABFT process at the current juncture. Recommendation 5 that pertains to reviews of the MSE process was discussed in regard to a few salient features. To a certain extent, the process is self-reviewing as technical groups examine the results; nevertheless, for ABFT one item that remains to be examined in more detail is a review of the code; finally, the CMPs themselves need to be consolidated and reviewed.

The group discussed the process for CMP development at some length. For the ABFT MSE, circumstances limited the time available for CMP developers to coordinate and mutually review their results before this meeting commenced. The practical limitations of MP development including the wide use of alternative methods, data and models were discussed: the group expected those limitations to continue especially because the presiding requirement for the current CMP development process was a selected CMP be implementable from a practical perspective within 18 months' time. CMPs that can consider new data types could be considered during future operating model development, once these data types are available for practical use. The group expected that current CMP development will continue iteratively in the short-term future. Indeed, it is possible that CMPs developed separately could be combined in the future.

Item 6, on Marine Stewardship Certification (MSC) was not discussed in great detail save that MSC requirement for a harvest control rule has fed down to the Tuna Commissions' desire for MSE, and that the scoring criteria may require that the performance of a given harvest control rule be tested. Given that the motivation for MSE from some parties is MSC certification, the group may need to consider that the MSC largely rates fisheries from a "best assessment" perspective so that output from the MSE need would need to be presented a way that will allow it to be evaluated in some way that is equivalent to the MSC scoring criteria; the alternative path is that being pursued by the tuna-RFMO MSE group is of seeking a changed approach by the MSC for fisheries managed on an MSE basis.

Conditioning operating models (7-11 of the t-RMFO report) and Computational aspects, including code validation (item 12) were discussed. It was expected that the group would revisit these criteria in some detail when they considered operating model conditioning and code review later.

Dissemination of results (items 13 and 14) was not discussed in great length.

Further Work (item 15) as it applies to ABFT MSE was reviewed very briefly. For the ABFT situation, it was noted that the Commission will need to provide some feedback on their preference for model or empirical CMPs: in order to support these discussions, the relative performance of model-based and empirical MPs will have to be presented. With respect to model-based procedures, it was noted that some management procedures that explore procedures that consider time-varying catchability were under development. Whether model-based or not, it was emphasized that it would be the performance of CMPs that should ultimately determine which is adopted.

The glossary included in the t-RMFO report was also discussed. One challenge in using it is that in different dialects of English, the terms has different meanings. In particular, "plausible" in some dialects denotes a persuasive argument using specious reasoning that it is intended to deceive. It was noted that a remedy for this confusion is in documents using the term to define plausibility as the relative degree of credibility, and further that a specific definition of the term as it is applied in ABFT be developed.

One item that was not addressed in the report is how to present to managers the performance statistics of a given MP across a range of Operating Models. This topic covers several sub-topics including relative weighting of operating models (i.e. how to calculate the mean risk), how to calculate and present risk as the product of probability of events and cost functions, the effect of the use of priors rather than best estimates of various parameters on the perception of risk, and the calculation of mean and median risks. In addition, it was noted that a further issue is how to reconcile the differences between results from the current best assessment approach and the MSE output. The group realized that how to present these risks is a major challenge that they will need work. On all fronts, what the terms mean, and what risk is, will need to be communicated very carefully to decision makers through an intermediary group that communicates with Panel members, handouts with definition of terms in layman´s language, and other measures. It was noted that it would useful to prepare a lay person's glossary based on the t-RMFO glossary. A small group to undertake this work will be appointed to draft such a glossary later in the meeting.

The group discussed the difficulty within the ICCAT community of gaining acceptance for a small group to act as an intermediary between the Commission and the ABFT MSE developers. In the ICCAT world, small groups do not have recommendation power. Having the discussions at Panel 2 was suggested as a better alternative. One key point remains which is that more intense interaction with decision makers would be very helpful. It was noted that within each CPC and in some cases between CPCs, there is also some obligation to consult and discuss any science and decision making. The group agreed that communication between the technical MSE group and stakeholders will need to be discussed in greater detail later at next week's BFT Species Group meeting.