Atlantic Bluefin Tuna MSE – Results, Decisions, & Next Steps (6 May 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. This updated version of the summary is based on discussions at the 3-6 May 2022 Bluefin MSE Technical Team meeting.

Candidate Management Procedures

There are currently 8 candidate management procedures (CMPs)[1] 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 two 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 5 key performance statistics; a second plot (**Figure 2**) includes 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, 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 give advice on ordering CMPs across performance statistics corresponding to yield, status, safety and stability objectives. The SCRS proposes five key performance statistics (**Figure 1**) chosen on the basis of removing duplicative statistics and focusing on the four operational performance statistics of safety, status, stability and yield (both short term and long term). The remaining performance statistics are reported in **Figure 2**.
  - Panel 2 will evaluate relative performance of CMPs and may rank CMPs based on performance.

  Status: Development tuning is nearly complete. CMP performance initially seems similar across four CMPs evaluated at four 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.

[1] 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., EH).

- 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.

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, Panel 2 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 Panel 2. The performance statistic LD* is recommended to evaluate status relative to B_{LIM} (40% of dynamic SSB_{MSY}).
    - Stock should have a greater than Y% probability[2] of being above SSB_{MSY} in year 30, where Y is defined by Panel 2.
    - A proposal for an overfishing metric (U/U_{MSY}) & probability of the green quadrant of the Kobe matrix in year 30.
    - Are 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, the SCRS will review all CMPs and compare them to performance standards set by Panel 2 in May. CMPs deemed by SCRS to not perform satisfactorily may be culled by SCRS and not recommended to Panel 2 in October, with results and rationale provided.
  - SCRS will use scientific rationale (e.g., lack of performance across robustness tests and substantially low ranking across performance statistics) for any decisions to cull CMPs.
  - To assist SCRS to conduct such culling it requests further feedback from Panel 2 on what constitutes more desirable performance for CMPs that already meet minimum criteria.
  - CMP developers may also withdraw their CMPs if they are not performing as desired.

- Decision point 4: Relative weighting of key performance statistics.

  Purely to facilitate discussion, the SCRS puts forward three example weighting schemes for the key statistics of the primary quilt plot (**Table 3**). The ultimate decision to use one of the three examples or other weighting schemes (as well as, for example, selection of the percentage for LD*) is up to Panel 2. PGK is not weighted as the CMPs are tuned to achieve a common Status objective (Br30). The ranking in the quilt plot shown in Table 3 uses the default ranking. The purpose of the relative weightings is to facilitate decision making but is not intended to be the sole criterion for CMP selection. See **Table 2** for more detailed descriptions of performance statistics.

- Additional Decision/Discussion points:

  - Are there other specific and measurable objectives that Panel 2 would 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.

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

- Several CMPs indicate possible initial decreases in TAC which may be due to how CMPs are structured and how they behave during the transition period, and often not a result of underlying stock declines. Would Panel 2 like SCRS to explore a phase in period for those CMPs? Specifically, the SCRS proposes a time frame of the first two MP applications and limits for TAC change (+20 / -10) that may be desirable as constraints to build into CMPs.

- A key aspect of the refinement of CMPs after the May Panel 2 meeting will involve making adjustments to the CMPs to provide anticipated future TAC trajectories in line with stakeholder preferences, both as regards short term stability and longer term trends and variability. This will require dialogue with Panel 2 on how best to obtain feedback from CPCs to the SCRS to inform finalization of CMP development by the end of June to give developers sufficient time to refine CMPs.

- 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 14 October 2022. The Bluefin Species Group will continue with additional Ambassador meetings 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)

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		
~~FZEH~~	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 CAN SWNS RR ~~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~~ W-MED 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**
Status 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. **PGK**: probability of being in the Kobe green quadrant (i.e., $SSB>dSSB_{MSY}$ and $U<U_{MSY}$) in year 30. **U/U_{MSY}**- exploitation rate (U) in biomass divided by exploitation rate at MSY.[4] **Br20** – Br after 20 years. **AvgBr** – Average Br over projection years 11-30 **POF** – Probability of overfishing ($U>U_{MSY}$) after 30 projected years **PNRK** - Probability of not being in the red Kobe quadrant ($SSB > SSB_{MSY}$ or $U < U_{MSY}$) after 30 projected years **OFT** – Overfished Trend, SSB trend if Br30<1.	[…] Probabilities (__% after 30 years)	F-statistic: SCRS proposes an exploitation rate metric (U/U_{MSY})
Safety 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 adopted B_{LIM} (40% of dynamic SSB_{MSY}).[5]	[…] Probability of falling below B_{LIM} (Options: e.g., 5%, 10%,15%)	*None*
Yield Maximize overall catch levels	**AvC10** – Median TAC (t) over years 1-10 **AvC30** – Median TAC (t) over years 1-30 **C1**- TAC in first 2 years of MP (i.e., 2023-24) **AvC20** – Median TAC (t) over years 1-20	None	*None*
Stability 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 adopted a B_{LIM} of 40% of dynamic SSB_{MSY} for the purposes of the MSE for CMP testing and performance tuning. Status relative to B_{lim} 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.

Table 3. To facilitate discussion, the SCRS puts forward three weighting schemes for the five key performance statistics for consideration by Panel 2. Weighting will influence CMP performance ranking.

Weighting scheme	**Status PGK (mean)**	**Short term Yield AvC10 (50%)**	**Long term Yield AvC30 (50%)**	**Stability VarC (50%)**	**Safety LD* (%TBD)**
Default: Equal across yield, stability, and safety	0	0.5	0.5	1	1
Sensitivity 1: Double weighting of safety	0	0.25	0.25	0.5	1
Sensitivity 2: Double weighting of yield	0	1	1	1	1

CMP	West					East					Tot
	PGK (Mean)	AvC10 (50%)	AvC30 (50%)	VarC (50%)	LD (15%)	PGK (Mean)	AvC10 (50%)	AvC30 (50%)	VarC (50%)	LD (15%)	
BR2a	0.63	2.89	2.78	13.85	0.49	0.73	40.83	33.3	17.46	0.65	0.24
AI2a	0.61	2.93	2.67	16.38	0.54	0.69	42.05	38.26	16.53	0.63	0.29
TC2a	0.61	2.83	2.64	6.71	0.4	0.73	33.43	29.21	8.18	0.54	0.39
EA2a	0.62	3.42	2.74	15.87	0.36	0.71	38.77	29.65	15.45	0.48	0.43
EH2a	0.6	2.8	2.73	16.53	0.5	0.68	40.82	31.22	17.86	0.5	0.57
TN2a	0.64	3.42	2.59	18.64	0.28	0.71	42.21	29.79	16.02	0.39	0.62
PW2a	0.66	2.44	2.35	20.51	0.45	0.72	34.8	30.64	17.22	0.6	0.69
LW2a	0.6	2.65	2.54	15.61	0.51	0.72	34.25	30.09	17.15	0.6	0.7

Figure 1. Primary 'Quilt' plot for the West and East for tuning level 2 (i.e., Br30=1.25 for West and Br30=1.5 for East) using the default weighting scheme and ordered relative to the total column. Color scale represents relative performance from dark (best) to light (worst) within a column. This plot shows the top 5 performance statistics chosen on the basis of removing duplicative statistics and focusing on the four operational performance statistics of safety, status, stability and yield. The five statistics and associated percentiles are PGK: probability of being in the Kobe green quadrant (i.e., $SSB>SSB_{MSY}$ and $U<U_{MSY}$) in year 30; AvC10: average catch (kilotons, 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*(15%): 15%tile of lowest depletion over years 11-30. PGK is not weighted in the scoring as all CMPs are tuned to achieve similar biomass status. Ordering is achieved by scaling each column according to its minimum and maximum, within a column, giving a rank order from 0(best) to 1 (worst), weighting columns according to the default weighting, obtaining an average for West and East and then taking the average across East and West (Tot). See **Table 2** for more detailed descriptions of performance statistics. The 'a' for each CMP refers to the +20/-30 stability tuning.

West

CMP	West									
	C1 (50%)	AvC20 (50%)	AvgBr (50%)	Br20 (50%)	Br30 (5%)	LD (5%)	LD (10%)	POF (Mean)	PNRK (Mean)	OFT (P>0)
BR2a	2.68	2.84	1.39	1.29	0.56	0.29	0.4	0.2	0.86	0.87
AI2a	2.82	2.73	1.41	1.34	0.66	0.33	0.43	0.24	0.89	0.89
TC2a	2.68	2.59	1.41	1.41	0.35	0.18	0.27	0.28	0.78	0.86
EA2a	2.83	2.66	1.34	1.21	0.32	0.18	0.27	0.19	0.85	0.88
EH2a	2.21	2.78	1.39	1.29	0.54	0.31	0.41	0.24	0.82	0.86
TN2a	3.27	2.46	1.33	1.24	0.1	0.05	0.17	0.16	0.86	0.9
PW2a	2.36	2.26	1.29	1.16	0.48	0.28	0.37	0.11	0.94	0.94
LW2a	2.51	2.55	1.41	1.31	0.5	0.29	0.38	0.25	0.81	0.84

East

CMP	East									
	C1 (50%)	AvC20 (50%)	AvgBr (50%)	Br20 (50%)	Br30 (5%)	LD (5%)	LD (10%)	POF (Mean)	PNRK (Mean)	OFT (P>0)
BR2a	38.19	34.6	1.53	1.38	0.71	0.48	0.58	0.06	0.98	0.95
AI2a	33.43	40.99	1.54	1.49	0.44	0.4	0.53	0.12	0.89	0.85
TC2a	37.26	28.84	1.63	1.58	0.52	0.37	0.47	0.07	0.94	0.9
EA2a	43.2	29.99	1.56	1.47	0.43	0.31	0.41	0.08	0.93	0.92
EH2a	43.2	30.74	1.51	1.43	0.45	0.33	0.42	0.12	0.91	0.91
TN2a	39.98	27.75	1.55	1.44	0.31	0.21	0.3	0.08	0.92	0.92
PW2a	43.2	30.3	1.57	1.49	0.56	0.44	0.53	0.08	0.95	0.92
LW2a	43.2	29.92	1.57	1.51	0.56	0.44	0.54	0.08	0.95	0.92

Figure 2. Quilt plot #2 depicting C1: catch in the first year of CMP application (50%), AvC20: average catch (kilotons, kt) over years 11-20 (50%tile), Br20: Depletion (spawning biomass relative to dynamic SSB_{MSY}) in projection year 20 (50%), AvgBr: spawning biomass relative to dynamic SSB_{MSY} over projection years 11-30 (50%), LD* (5%): 5%tile of lowest depletion over years 11-30; LD* (10%) 10%tile of lowest depletion over years 11-30, Br30: Depletion (spawning biomass relative to dynamic SSB_{MSY}) in projection year 30 (5%); POF: Probability of Overfishing ($U > U_{MSY}$) after 30 projected years (mean), PNRK: Probability of not Red Kobe ($SSB > SSB_{MSY}$ or $U < U_{MSY}$) after 30 projected years (mean), OFT: Overfished trend, SSB trend over projection years 31 - 35 when Br30 < 1. See **Table 2** for more detailed descriptions of performance statistics. CMPs are ordered according to rank order in Quilt #1. The 'a' for each CMP refers to the +20/-30 stability tuning.