Collect. Vol. Sci. Pap. ICCAT, 79(3): 587-597 (2022)

BR CMP AS AT JUNE 2022

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SUMMARY

The BR CMP is further adjusted in a few respects, especially as regards the relative weights given to the different indices of abundance to secure improved median TAC trajectories. Results are provided for the four basic development tunings, plus variants for one of those tunings in relation to TAC change constraints and the period between TAC changes. Furthermore, the CMP is tuned to the most aggressive option possible under the Blim constraint at 15% and at 10% conservation performance for the eastern population seems too poor for the former, as is catch performance for the West area for the latter.

RÉSUMÉ

La CMP BR est ajustée plus avant, à plusieurs égards, en ce qui concerne notamment les poids relatifs donnés aux différents indices d'abondance pour garantir l'amélioration des trajectoires médianes du TAC. Les résultats sont fournis pour les quatre calibrages de développement de base, plus des variantes pour l'un de ces calibrages en lien avec les contraintes de changement du TAC et la période entre les changements du TAC. En outre, la CMP est calibrée par rapport à l'option la plus agressive possible, dans le cadre de la contrainte de B_{lim} de 15% et de 10%, la performance de conservation pour la population de l'Est semble trop faible pour la première tout comme la performance de capture pour la zone Ouest pour la deuxième.

RESUMEN

El procedimiento de ordenación candidato de la biomasa reproductora (BR CMP) se ajusta aún más en algunos aspectos, especialmente en lo que se refiere a las ponderaciones relativas dadas a los diferentes índices de abundancia para garantizar unas mejores trayectorias medias del TAC. Los resultados se proporcionan para las cuatro calibraciones básicas de desarrollo, más variantes para una de esas calibraciones en relación con las restricciones de cambio al TAC y el periodo entre los cambios de TAC. Además, el CMP está ajustado a la opción más agresiva posible con la restricción de Blim al 15 % y al 10 %. El desempeño de conservación para la población oriental parece demasiado pobre para la primera, al igual que el desempeño de las capturas de la zona occidental para la segunda.

KEYWORDS

Management Strategy Evaluation, Candidate Management Procedure, Operating Model grid, Atlantic bluefin tuna, development tuning

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Introduction

The current latest package ABTMSE v7.6.6 has been used to generate the results reported in this document.

The following change has been made to the RB CMP from the CMP presented in May 2022 (Butterworth and Rademeyer, 2022) to provide a new Baseline BR CMP) (note that the RB CMP was a reweighted variant of the BR CMP):

1. Upweighting ($w_i \rightarrow 3w_i$, see equation A1 and Table A1) of indices US_RR_66_144, JPN_LL_West2 and CAN_SWNS,

This change has been implemented to avoid a steep drop in the median TAC for the West area during the 2030s, as evident in the results reported in Butterworth and Rademeyer (2022).

A full technical description of this refined BR CMP is provided in **Appendix A**.

Results are provided for:

1) The four standard tunings: BR1a, BR2a, BR3a, BR4a;
2) Tuning to 0.4 LD* 15% (BR5a) and 0.4 LD* 10% (BR6a); and
3) A series of variants for tuning 2:
    - BR2b: The first two TAC settings are constrained to a maximum of 20% up and 10% down;
    - BR2c-e: The TAC is set at three year intervals instead of two year ones, with a maximum downward change in TAC of 30, 35 and 40% respectively,
    - BR2f: The maximum downward change in TAC is set to 20% but is allowed to drop to 30% down, as a function of index level (see equation A5),
    - BR2g: The TAC changes are constrained to a maximum of 20% up and 20% down; and
    - BR2h: The first two TAC settings are constrained to a maximum of 20% up and 0% down.

Results

Table 1 lists the BR CMP variants presented here, with their control parameter values.

The stochastic Br30, AvC30, C1 (TAC in 2023/2024) and AAVC (now termed VarC) results for all these CMPs are given in Table 2.

SSB and TAC projections (medians) are shown in **Figure 2** for the CMP tunings and variants considered.

Some comments:

- For BR5a (tuned to 0.4 LD* 15%), lower 5%ile Br30 is only 0.24 in the East (and leads to extinctions at the lower 5%ile later). It is increased to 0.43 when tuned to 0.4 LD* 10% instead (BR6a).
- There is a large difference in the West between BR5a and BR6a of about 800 t in median AvC30.
- BR2c (three year TAC intervals) is notably poor for the Br30 lower 5%ile this is improved when changing to allow a maximum 35% down in BR2d.
- BR2g (+-20% maximal TAC changes) results are notably worse for the Br30 lower 5%ile for the eastern population.

Future plans

Further work will focus on performance tuning and adjusting the ranges for starting TACs and future TAC trends in the light of feedback from the meetings at which these results will be reported.

Reference

Butterworth DS and Rademeyer RA: 2022b. Update of BR CMP to include intended indices weights. ICCAT Document SCRS/2022/090.

Table 1: Control parameter values for each of the CMPs presented in this document. For variants BR5a to BR2h, the changes from the baseline tuning (BR2a) are shown in bold.

	Tuned to weighted median Br30						Maximum change in TAC		Notes
CMP name	East	West	α_0	$\Delta\alpha$	β_0	$\Delta\beta$	Up	Down	
BR1a	1.25	1.25	1.235	0.160	0.81	-0.020	20%	30%	
BR2a	1.50	1.25	1.235	0.030	0.81	-0.019	20%	30%	
BR3a	1.25	1.50	1.235	0.160	0.81	-0.046	20%	30%	
BR4a	1.50	1.50	1.235	0.030	0.81	-0.045	20%	30%	
BR5a	**LD15% = 0.4**		1.235	0.350	0.81	-0.006	20%	30%	
BR6a	**LD10% = 0.4**		1.235	0.250	0.81	-0.050	20%	30%	
BR2b	1.50	1.25	1.235	0.028	0.81	-0.020	20%	30%	**First two TAC settings 20%up/10%down**
BR2c	1.50	1.25	1.235	0.030	0.81	-0.019	20%	30%	**Three year TAC intervals**
BR2d	1.50	1.25	1.235	0.030	0.81	-0.020	20%	**35%**	**Three year TAC intervals**
BR2e	1.50	1.25	1.235	0.039	0.81	-0.019	20%	**40%**	**Three year TAC intervals**
BR2f	1.50	1.25	1.235	0.028	0.81	-0.020	20%	20/30%	**30% down a function of index level**
BR2g	1.50	1.25	1.235	0.010	0.81	-0.020	20%	**20%**	
BR2h	1.50	1.25	1.235	0.028	0.81	-0.020	20%	30%	**First two TAC settings 20%up/0%down**

Table 2: **Stochastic** Br30, AvC30, C1 (TAC in 2023/2024) and AAVC values (weighted medians and 90%iles for the OM grid across all simulations) for all 11 CMPs reported in this paper for all OMs in the grid. AvC30 values are in ‘000 mt. Note that the TACs for 2022 are 36000 mt for the East, and 2726 mt for the West area. The values in bold (either weighted median Br30, LD 15% or LD 10%) are those to which the corresponding CMP has been tuned.

All scenarios

	Br30	LD15%	LD10%	AvC30	C1	VarC
EAST						
Zero catch	2.77 (1.46; 4.03)	**1.30**	1.18	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)
Different tunings						
BR1a	**1.26** (0.56; 2.24)	0.55	0.48	37.91 (11.66; 71.07)	43.20 (34.68; 43.20)	17.78 (11.15; 23.88)
BR2a	**1.50** (0.73; 2.50)	0.66	0.58	32.65 (10.36; 58.84)	43.20 (34.68; 43.20)	16.56 (9.22; 23.98)
BR3a	**1.27** (0.57; 2.24)	0.55	0.49	37.98 (11.68; 71.22)	43.20 (34.68; 43.20)	17.78 (11.15; 23.88)
BR4a	**1.50** (0.73; 2.51)	0.67	0.58	32.71 (10.39; 58.98)	43.20 (34.68; 43.20)	16.54 (9.21; 23.94)
BR5a	1.03 (0.24; 1.93)	**0.38**	0.31	43.31 (13.12; 83.69)	43.20 (34.68; 43.20)	19.67 (13.46; 25.14)
BR6a	1.15 (0.43; 2.09)	0.48	**0.40**	40.87 (12.46; 78.14)	43.20 (34.68; 43.20)	18.80 (12.24; 24.46)
Variants on % change						
BR2a	**1.50** (0.73; 2.50)	0.66	0.58	32.65 (10.36; 58.84)	43.20 (34.68; 43.20)	16.56 (9.22; 23.98)
BR2b	**1.49** (0.71; 2.50)	0.61	0.52	32.47 (10.85; 58.62)	43.20 (34.68; 43.20)	16.51 (9.17; 23.87)
BR2f	**1.49** (0.73; 2.50)	0.66	0.57	32.53 (10.37; 58.82)	43.20 (34.68; 43.20)	16.46 (9.15; 24.07)
BR2g	**1.49** (0.59; 2.54)	0.55	0.46	32.38 (12.08; 56.64)	43.20 (34.68; 43.20)	14.53 (8.83; 20.00)
BR2h	**1.49** (0.69; 2.52)	0.56	0.46	32.45 (11.37; 58.61)	43.20 (34.68; 43.20)	16.40 (9.16; 23.57)
Two vs. three year TAC intervals						
BR2a	**1.50** (0.73; 2.50)	0.66	0.58	32.65 (10.36; 58.84)	43.20 (34.68; 43.20)	16.56 (9.22; 23.98)
BR2c	**1.47** (0.57; 2.54)	0.52	0.44	32.88 (11.96; 58.31)	43.20 (34.68; 43.20)	18.29 (10.08; 26.16)
BR2d	**1.50** (0.67; 2.56)	0.58	0.50	32.35 (10.29; 60.52)	43.20 (34.68; 43.20)	19.14 (9.03; 28.94)
BR2e	**1.50** (0.71; 2.56)	0.62	0.54	32.29 (9.61; 61.58)	43.20 (34.68; 43.20)	19.70 (9.30; 30.14)

All scenarios

	Br30	LD15%	LD10%	AvC30	C1	VarC
WEST						
Zero catch	2.66 (1.40; 4.04)	**0.96**	0.81	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)
Different tunings						
BR1a	**1.24** (0.51; 2.34)	0.47	0.37	2.58 (0.88; 3.85)	2.71 (2.41; 3.15)	12.76 (8.57; 22.64)
BR2a	**1.25** (0.54; 2.35)	0.49	0.38	2.72 (0.95; 4.05)	2.71 (2.41; 3.15)	12.61 (8.44; 22.27)
BR3a	**1.49** (0.64; 2.60)	0.52	0.39	2.06 (0.79; 3.13)	2.71 (2.41; 3.15)	12.62 (8.37; 23.03)
BR4a	**1.51** (0.66; 2.61)	0.53	0.40	2.16 (0.83; 3.27)	2.71 (2.41; 3.15)	12.47 (8.22; 22.49)
BR5a	1.07 (0.41; 2.17)	**0.40**	0.32	2.70 (0.86; 4.03)	2.71 (2.41; 3.15)	13.56 (9.12; 22.78)
BR6a	1.50 (0.64; 2.62)	0.52	**0.38**	1.93 (0.74; 2.96)	2.71 (2.45; 3.15)	12.84 (8.46; 23.30)
Variants on % change						
BR2a	**1.25** (0.54; 2.35)	0.49	0.38	2.72 (0.95; 4.05)	2.71 (2.41; 3.15)	12.61 (8.44; 22.27)
BR2b	**1.25** (0.51; 2.36)	0.47	0.32	2.69 (0.92; 4.01)	2.71 (2.45; 3.15)	12.57 (8.42; 22.10)
BR2f	**1.26** (0.53; 2.36)	0.47	0.35	2.70 (0.95; 4.03)	2.71 (2.41; 3.15)	12.20 (8.36; 21.91)
BR2g	**1.24** (0.45; 2.36)	0.46	0.32	2.71 (0.96; 4.05)	2.71 (2.41; 3.15)	12.15 (8.39; 19.08)
BR2h	**1.25** (0.43; 2.36)	0.43	0.27	2.69 (0.93; 4.01)	2.71 (2.41; 3.15)	12.53 (8.34; 22.14)
Two vs. three year TAC intervals						
BR2a	**1.25** (0.54; 2.35)	0.49	0.38	2.72 (0.95; 4.05)	2.71 (2.41; 3.15)	12.61 (8.44; 22.27)
BR2c	**1.23** (0.45; 2.35)	0.45	0.31	2.72 (0.92; 4.00)	2.71 (2.45; 3.15)	14.57 (9.09; 23.73)
BR2d	**1.25** (0.51; 2.36)	0.46	0.33	2.71 (0.89; 3.97)	2.71 (2.41; 3.15)	14.64 (9.06; 25.71)
BR2e	**1.26** (0.53; 2.35)	0.47	0.35	2.72 (0.83; 3.99)	2.71 (2.41; 3.15)	14.72 (9.06; 26.60)

Note: The VarC values for the CMP with three year TAC intervals (BR2c, BR2d and BR2e) have been multiplied by 1.5 from the values in the Shiny app to make them comparable in terms of effective change per two-year interval.

BR1a-BR4a: standard tunings, +20/-30%
BR5a: Tuned to LD*15%=0.4, +20/-30%
BR6a: Tuned to LD*10%=0.4, +20/-30%
BR2b: -10% for the first two TAC settings, then -30%
BR2c: three year TAC intervals+20/-30%
BR2d: three year TAC intervals+20/-35%
BR2e: three year TAC intervals+20/-40%
BR2f: +20/-20 to -30% down as a function of index level
BR2g: +20/-20%
BR2h: 0% down for the first two TAC settings, then -30%

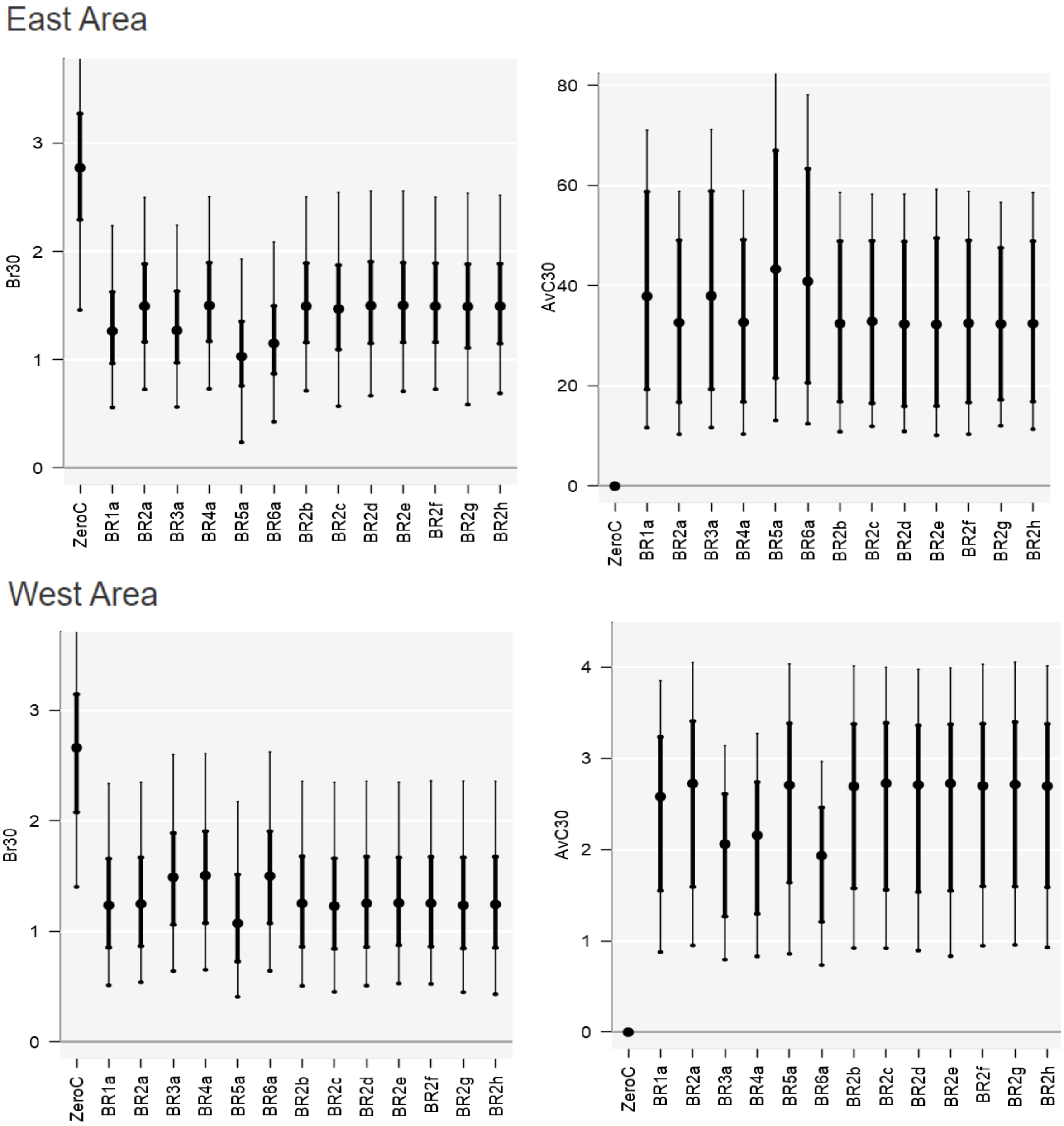
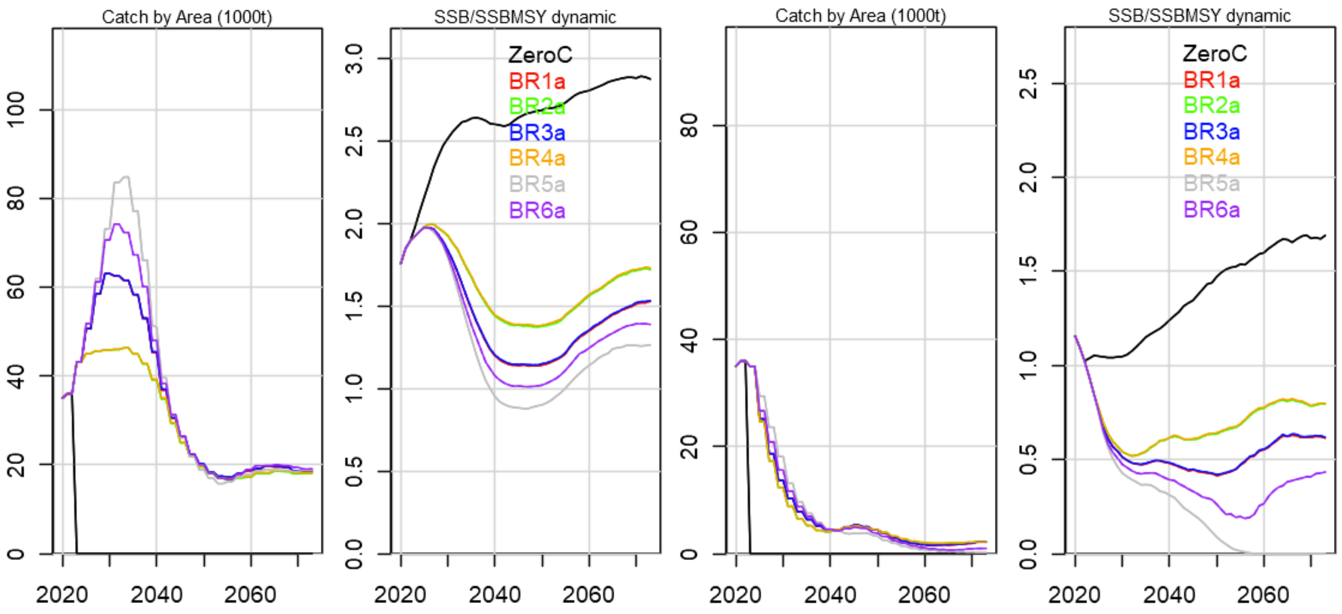


Figure 1: Br30 and AvC30 values for the 13 CMPs considered over the grid of OMs, showing the full distribution as well as the median, interquartile and 90%-ile ranges.
BR1a-BR4a: standard tunings, +20/-30%
BR5a: Tuned to LD*15%=0.4, +20/-30%
BR6a: Tuned to LD*10%=0.4, +20/-30%
BR2b: -10% for the first two TAC settings, then -30%
BR2c: three year TAC intervals+20/-30%
BR2d: three year TAC intervals+20/-35%
BR2e: three year TAC intervals+20/-40%
BR2f: +20/-20 to -30% down as a function of index level
BR2g: +20/-20%
BR2h: 0% down for the first two TAC settings, then -30%

EAST

Median Lower 5%ile



WEST

Median Lower 5%ile

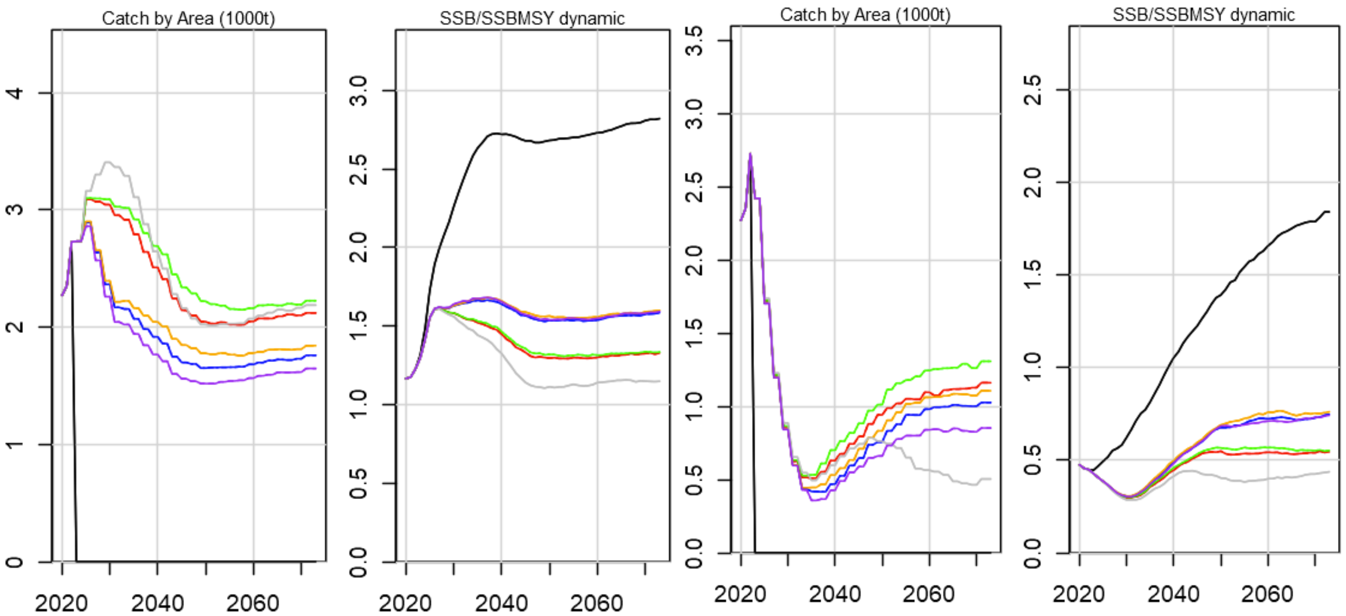
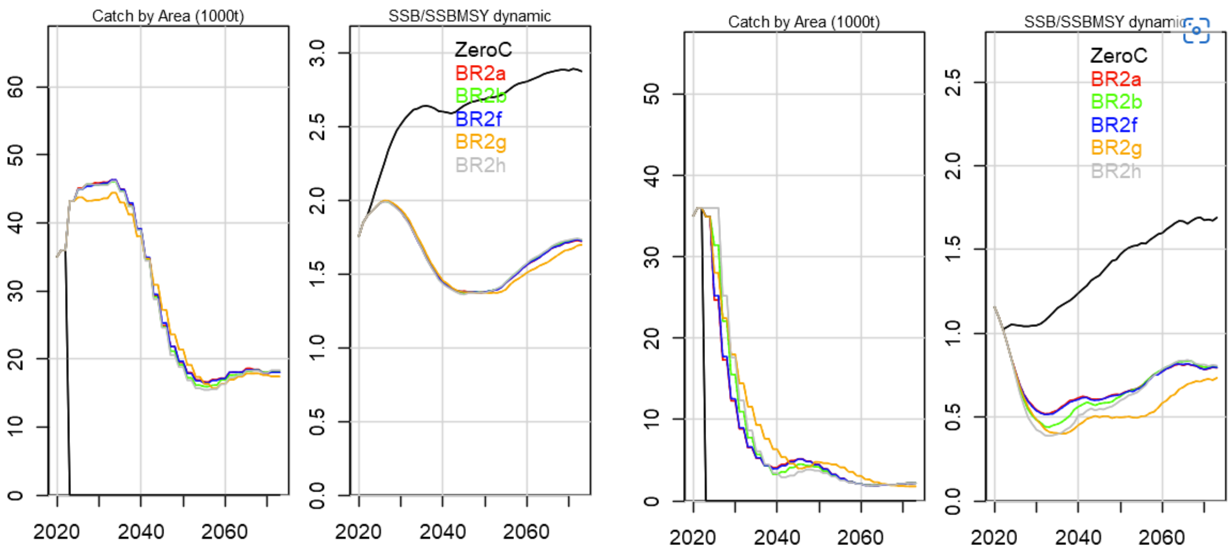


Figure 2a: Median (LHS) and lower 5%ile (RHS) catch (by area) and SSB (by stock) projections averaged over all OMs in the grid and the replicate simulations for BR1a to BR6a.

BR1a-BR4a: standard tunings, +20/-30%
BR5a: Tuned to LD*15%=0.4, +20/-30%
BR6a: Tuned to LD*10%=0.4, +20/-30%

EAST

Median | Lower 5%ile



WEST

Median | Lower 5%ile

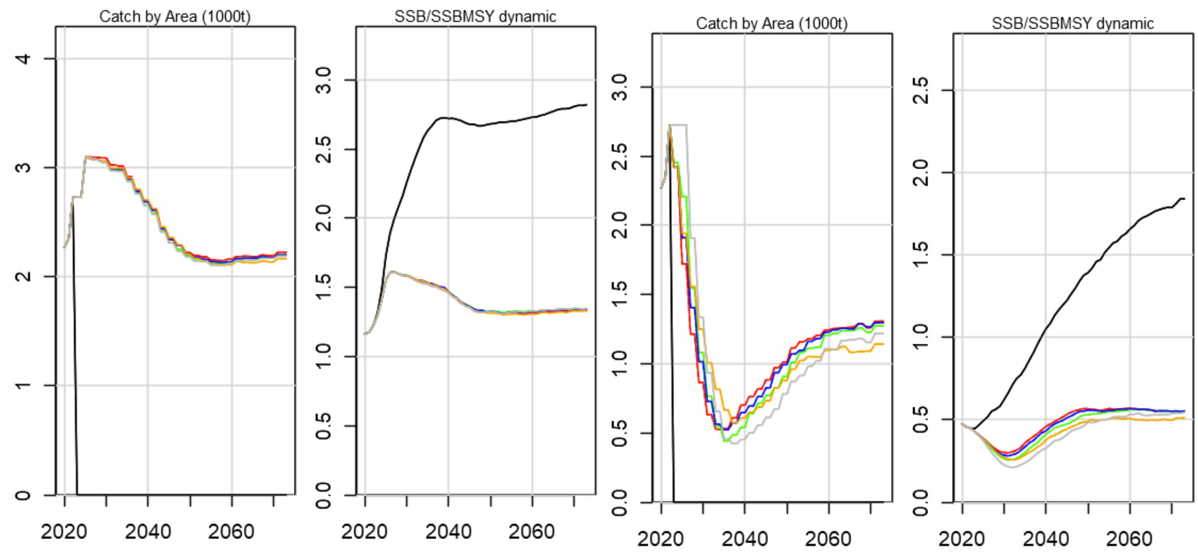


Figure 2b: Median (LHS) and lower 5%ile (RHS) catch (by area) and SSB (by stock) projections averaged over all OMs in the grid and the replicate simulations for BR2a and variants on the percentage change BR2b, and BRf to BR2h.

BR2b: -10% for the first two TAC settings, then -30%
BR2f: +20/-20 to -30% down as a function of index level
BR2g: +20/-20%
BR2h: 0% down for the first two TAC settings, then -30%

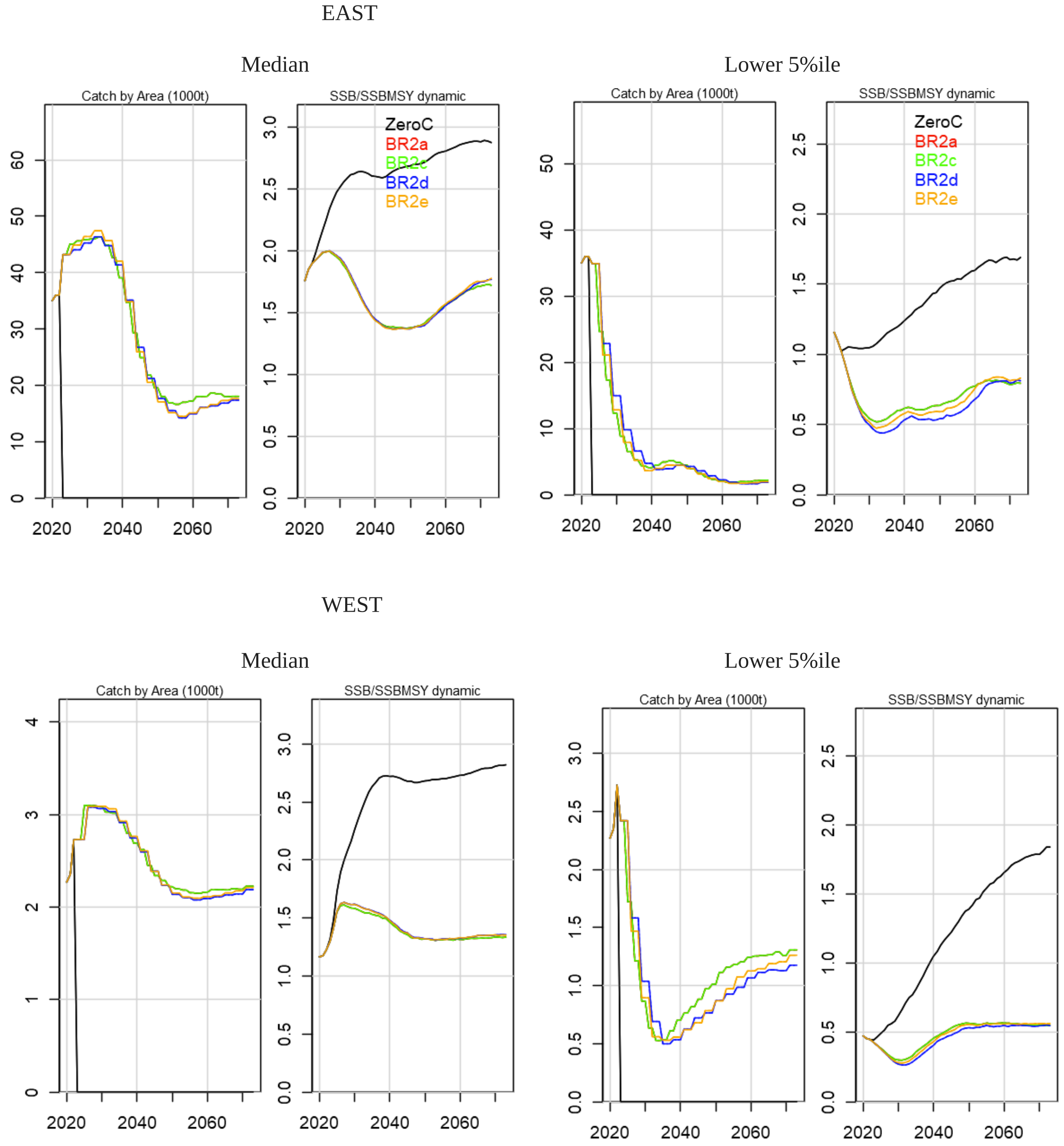


Figure 2c: Median (LHS) and lower 5%ile (RHS) catch (by area) and SSB (by stock) projections averaged over all OMs in the grid and the replicate simulations for BR2a and variants BR2c to BR2e (two vs three year TAC intervals).

BR2c: three year TAC intervals+20/-30%
BR2d: three year TAC intervals+20/-35%
BR2e: three year TAC intervals+20/-40%

Appendix A

The CMP is empirical, based on inputs related to abundance indices which are first standardised for magnitude, then aggregated by way of a weighted average of all indices available for the East and the West areas, and finally smoothed over years to reduce observation error variability effects. TACs are then set based on the concept of taking a fixed proportion of the abundance present, as indicated by these aggregated and smoothed abundance indices. The details are set out below.

Aggregate abundance indices

An aggregate abundance index is developed for each of the East and the West areas by first standardising each index available for that area to an average value of 1 over the past years for which the index appeared reasonably stable[2], and then taking a weighted average of the results for each index, where the weight is inversely proportional to the variance of the residuals used to generate future values of that index in the future modified to take into account the loss of information content as a result of autocorrelation. The mathematical details are as follows.

$J_y^{E/W}$ is an average index over *n* series (*n*=5 for the East area and *n*=5 for the West area)[3]:

$$J_y^{E/W} = \frac{\sum_i^n w_i \times I_y^{i*}}{\sum_i^n w_i} \quad \text{(A1)}$$

where

$w_i = \frac{1}{\sqrt{\sigma^i}}$ i.e. inverse effective variance to the power ¼ weighting.

For the west, the weights computed above for US_RR_66_144, JPN_LL_West2 and CAN_SWNS have been multiplied by 3 i.e. $w_i \rightarrow 3w_i$. This change has been implemented to avoid a steep drop in the median TAC for the West area during the 2030s, as was evident in the results reported in Butterworth and Rademeyer (2022

and where the standardised index for each index series (*i*) is:

$$I_y^{i*} = I_y^i \Big/ Average\ of\ historical\ I_y^i \quad \text{(A2)}$$

σ^i is computed as

$$\sigma^i = \frac{SD^i}{1 - AC^i}$$

where SD^i is the standard deviation of the residuals in log space and AC^i is their autocorrelation, averaged over the OMs, as used for generating future pseudo-data. Table 1 lists these values for σ^i.

In case of a missing index value in year *y*, $J_y^{E/W}$ is computed by setting w_i to zero, i.e. that index is disregarded when averaging over indices for that year only.

2017 is used for the "average of historical I_y^i".

The actual index used in the CMPs, $J_{av,y}^{E/W}$, is the average over the last three years for which data would be available at the time the MP would be applied, hence:

$$J_{av,y}^{E/W} = \frac{1}{3}\left(J_y^{E/W} + J_{y-1}^{E/W} + J_{y-2}^{E/W}\right) \quad \text{(A3)}$$

where the $J_{av,y}^{E/W}$ applies either to the East or to the West area.

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[2] These years are for the Eastern indices: 2014-2017 for FR_AER_SUV2, 2012-2016 for MED_LAR_SUV, 2015-2018 for GBYP_AER_SUV_BAR, 2012-2018 for MOR_POR_TRAP and 2012-2019 for JPN_LL_NEAtl2; and for the Western indices: 2006-2017 for GOM_LAR_SURV, 2006-2018 for all US_RR and MEXUS_GOM_PLL indices, 2010-2019 for JPN_LL_West2 and 2006-2017 for CAN_SWNS.

[3] For the aerial surveys, there is no value for 2013, (French) and 2018 (Mediterranean). These years were omitted from this averaging where relevant. Note also that the GBYP aerial survey has not been included at this stage.

CMP specifications

The BR Fixed Proportion CMPs tested set the TAC every second year simply as a multiple of the J_{av} value for the area at the time (see **Figure 1**), but subject to the change in the TAC for each area being restricted to a maximum of 20% up and 30% down. The formulae are given below.

For the East area:

$$TAC_{E,y} = \begin{cases} \left(\frac{TAC_{E,2020}}{J_{E,2017}}\right) \cdot \alpha_y \cdot J^E_{av,y-2} & \text{for } J^E_{av,y} \geq T^E \\ \left(\frac{TAC_{E,2020}}{J_{E,2017}}\right) \cdot \alpha_y \cdot \frac{\left(J^E_{av,y-2}\right)^2}{T^E} & \text{for } J^E_{av,y} < T^E \end{cases}$$

(A4a)

For the West area:

$$TAC_{W,y} = \begin{cases} \left(\frac{TAC_{W,2020}}{J_{W,2017}}\right) \cdot \beta_y \cdot J^W_{av,y-2} & \text{for } J^W_{av,y} \geq T^W \\ \left(\frac{TAC_{W,2020}}{J_{W,2017}}\right) \cdot \beta_y \cdot \frac{\left(J^W_{av,y-2}\right)^2}{T^W} & \text{for } J^W_{av,y} < T^W \end{cases}$$

(A4b)

With, for the East:

$$\alpha_y = \begin{cases} \alpha_0 + \Delta\alpha(y - 2023) & \text{for } 2023 \leq y \leq 2027 \\ \alpha_{y-2} & \text{for } y > 2027 \end{cases}$$

and similarly for the West:

$$\beta_y = \begin{cases} \beta_0 + \Delta\beta(y - 2023) & \text{for } 2023 \leq y \leq Y_\beta \\ \beta_{y-2} & \text{for } y > Y_\beta \end{cases}$$

α_0, β_0, $\Delta\alpha$ and $\Delta\beta$ are control parameters. $Y_\beta = 2027$ for tuning levels 1 and 2 and 2030 for tuning levels 3 and 4.

Note that in equation (A4a), setting $\alpha_y = 1$ would amount to keeping the TAC the same as for 2020 until the abundance indices change. If α_y or $\beta_y > 1$ harvesting will be more intensive than at present, and for α_y or $\beta_y < 1$ it will be less intensive.

Below *T*, the law is parabolic rather than linear at low abundance (i.e. below some threshold, so as to reduce the proportion taken by the fishery as abundance drops); this is to better enable resource recovery in the event of unintended depletion of the stock. For the results presented here, the choices $T^E = 1$ and $T^W = 1$ have been made.

Constraints on the extent of TAC increase and decrease

Unless otherwise specified, maximum increase and decrease in TAC from one TAC setting to the next are fixed to 20% and 30%, both in the East and the West.

In variant BR2f, the maximum decrease allowed from one TAC to the next is a function of the average index: $J^i_{av,y}$,

$$maxdecr = \begin{cases} 0.2 & J^i_{av,y-2} \geq J_{i,2017} \\ \text{linear btw 0.2 and } D & 0.5J_{i,2017} < J^i_{av,y-2} < J_{i,2017} \\ D & J^i_{av,y-2} \leq 0.5J_{i,2017} \end{cases} \quad \text{(A5)}$$

where *D*= 0.3 in this implementation.

Table A1: w^i weights used when averaging over the indices to provide composite indices for the East and the West areas (see following equation A2).

	w_i
FR_AER_SUV2	1.33
MED_LAR_SUV	1.66
GBYP_AER_SUV_BAR	1.06
MOR_POR_TRAP	1.43
JPN_LL_NEAtl2	1.33
GOM_LAR_SUV	1.33
US_RR_66_144	2.55
MEXUS_GOM_PLL2	1.39
JPN_LL_West2	3.96
CAN_SWNS	2.88

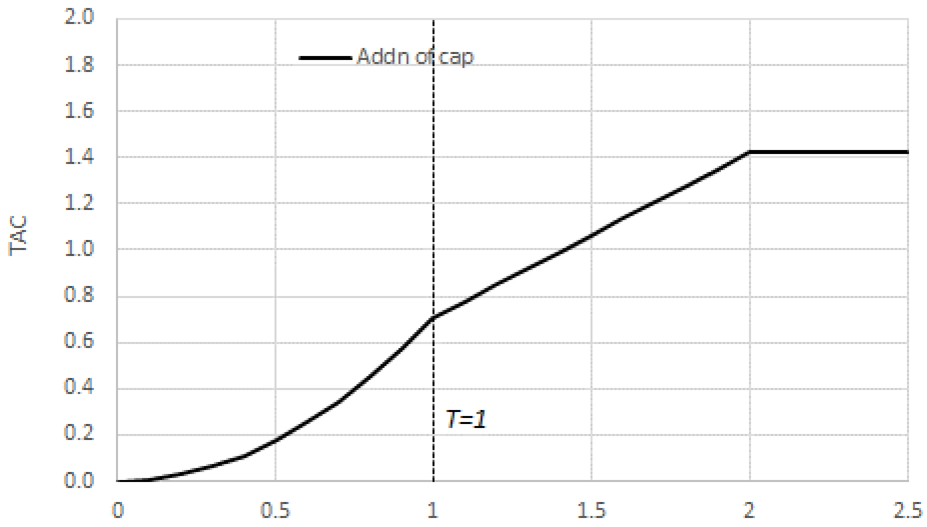

Figure A1. Illustrative relationship (the "catch control law") of *TAC* against $J_{av,y}$ for the BR CMPs, which includes the parabolic decrease below T and (if implemented) the capping of the TAC so as not to exceed some maximum value.