BR CMP as at end August 2022

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SUMMARY

The BR CMP is tuned to meet the specifications arising from the July Panel 2 meeting. Of particular note is that the application of the Carruthers TAC variation reduction adjustment reduces the median values for the associated VarC performance statistic by about 25%, with scarcely any deterioration in the values of the other performance statistics.

KEYWORDS

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

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Introduction

This document reports results for the BR CMP (tuned to meet the specifications arising from the July Panel 2 meeting). The most recent package ABTMSE v7.7.1 has been used to generate the results reported.

The BR CMP's mathematical description has not been changed from Butterworth and Rademeyer (2022) (Appendix A below), except for BR5d (see below); only the tuning parameter values have been adjusted as necessary.

As agreed during the July Panel 2 meeting, and unless specified otherwise, all the CMPs presented here include:
- Either 2-year ("a") or 3-year ("b") TAC intervals.
- TAC settings constrained to a maximum of 20% up and 30% down, with the first two (in the case of the 2-year interval) and first one (in the case of the 3-year interval) TAC settings constrained to a maximum of 20% up and 10% down.

Results are provided for five tunings:
"1": 1.25 (W)- 1.25 (E) median Br30,
"2": 1.25 (W)- 1.50 (E) median Br30,
"5": 0.60 (both W and E) mean PKG,
"6": 0.70 (both W and E) mean PKG, and
"7": 0.65 (both W and E) mean PKG.

One further CMP variant includes the "Carruthers TAC variation reduction adjustment" to reduce variance in TAC changes each time these are adjusted, "BR5d". The associated maximum TAC change allowed at a time when this is modified, is computed as follows:

$$\Delta TAC = \frac{TAC_y}{TAC_{y-1}} \quad (1)$$

with TAC_y from equation A4.

ΔTAC is then modified:

$$\Delta TAC' = \exp\left(\ln\left(\Delta TAC \cdot VarCadj\right)\right) \quad (2)$$

with *VarCadj* a control parameter, taken here to be 0.5.

$\Delta TAC'$ is then constrained to a maximum of 20% up and 30% down (10% down for the first one/two TAC settings) and the final TAC, computed as:

$$TAC'_y = TAC_{y-1} \cdot \Delta TAC' \quad (3)$$

Results

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

The stochastic Br30, PKG, LD*15%, LD*10%, AvC30, C1 (TAC for 2023/2024) and VarC results for all these CMPs are given in Table 2.

SSB and TAC projections (medians) are shown in Figure 1 for the CMP tunings and variants considered.

Some comments:
- There is hardly any difference in terms of performance statistics between the 2 and 3 year interval CMPs, apart from a slight increase in VarC for the 3 year intervals.

- Application of the Carruthers TAC variation reduction adjustment (BR5d) reduces the median values of the associated VarC performance statistic by about 25%, with scarcely any deterioration in the values of the other performance statistics, particularly the risk-related ones.

The authors intend to explore this application further by adjusting its *VarCadj* control parameter value.

Reference

Butterworth DS and Rademeyer RA: 2022. BR CMP as at June 2022. ICCAT Document SCRS/2022/126.

Table 1: Control parameter values for each of the CMPs presented in this document.

	Tuned to					Maximum change in TAC		Notes
CMP name		α_0	$\Delta\alpha$	β_0	$\Delta\beta$	Up	Down	
BR1a	Br30 = 1.25E/1.25W	1.235	0.167	0.81	-0.0225	20%	10 then 30%	
BR2a	Br30 = 1.50E/1.25W	1.235	0.023	0.81	-0.0200	20%	10 then 30%	
BR5a	PKG=0.6	1.235	0.180	0.81	-0.0180	20%	10 then 30%	
BR6a	PKG=0.7	1.235	0.097	0.81	-0.0350	20%	10 then 30%	
BR7a	PKG=0.65	1.235	0.137	0.81	-0.0270	20%	10 then 30%	
BR2b	Br30 = 1.50E/1.25W	1.235	0.017	0.81	-0.0205	20%	10 then 30%	
BR5b	PKG=0.6	1.235	0.136	0.81	-0.0220	20%	10 then 30%	
BR6b	PKG=0.7	1.235	0.066	0.81	-0.0360	20%	10 then 30%	
BR7b	PKG=0.65	1.235	0.097	0.81	-0.0295	20%	10 then 30%	
BR5d	PKG=0.6	1.235	0.145	0.81	-0.0218	20%	10 then 30%	Carruthers TAC variation reduction adjustment

Table 2: **Stochastic** Br30, AvC30, C1 (TAC in 2023/2024) and VarC values (weighted medians and 90%iles for the OM grid across all simulations) for all 10 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, or weighted mean PKG) are those to which the corresponding CMP has been tuned.

		Br30	LD15%	LD10%	AvC30	C1	VarC
EAST							
Zero catch	1.00	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, 2 year TAC intervals							
BR1a	0.62	**1.25** (0.54; 2.23)	0.52	0.44	38.20 (11.82; 71.61)	43.20 (34.68; 43.20)	18.31 (11.50; 24.33)
BR2a	0.78	**1.51** (0.72; 2.51)	0.61	0.52	32.17 (10.82; 58.15)	43.20 (34.68; 43.20)	16.83 (9.21; 24.00)
BR5a	**0.60**	1.24 (0.53; 2.20)	0.51	0.43	38.51 (11.90; 72.69)	43.20 (34.68; 43.20)	18.37 (11.52; 24.17)
BR7a	**0.65**	1.30 (0.58; 2.28)	0.54	0.46	37.06 (11.59; 69.19)	43.20 (34.68; 43.20)	17.93 (10.82; 24.00)
BR6a	**0.70**	1.37 (0.63; 2.35)	0.57	0.49	35.55 (11.27; 65.78)	43.20 (34.68; 43.20)	17.46 (10.27; 24.00)
Different tunings, 3 year TAC intervals							
BR2b	0.75	**1.50** (0.59; 2.57)	0.53	0.44	32.19 (11.91; 56.82)	43.20 (34.68; 43.20)	19.52 (10.18; 26.67)
BR5b	**0.60**	1.27 (0.39; 2.30)	0.45	0.37	38.00 (12.45; 67.83)	43.20 (34.68; 43.20)	20.50 (12.61; 26.67)
BR7b	**0.65**	1.34 (0.44; 2.39)	0.49	0.39	36.27 (12.29; 64.89)	43.20 (34.68; 43.20)	20.23 (11.96; 26.36)
BR6b	**0.70**	1.40 (0.50; 2.46)	0.51	0.41	34.91 (12.11; 62.05)	43.20 (34.68; 43.20)	19.96 (11.36; 26.51)
Different variance, 2 year TAC intervals							
BR5a	**0.60**	1.24 (0.53; 2.20)	0.51	0.43	38.51 (11.90; 72.69)	43.20 (34.68; 43.20)	18.37 (11.52; 24.17)
BR5d	**0.60**	1.24 (0.52; 2.26)	0.51	0.44	38.07 (11.68; 70.08)	39.47 (35.33; 43.20)	14.98 (7.85; 22.71)
WEST							
Zero catch	1.00	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, 2 year TAC intervals							
BR1a	0.62	**1.25** (0.49; 2.35)	0.46	0.32	2.53 (0.88; 3.78)	2.71 (2.45; 3.15)	12.92 (8.55; 21.89)
BR2a	0.63	**1.25** (0.51; 2.36)	0.47	0.33	2.70 (0.92; 4.02)	2.71 (2.45; 3.15)	12.76 (8.44; 21.72)
BR5a	**0.60**	1.21 (0.47; 2.31)	0.45	0.32	2.61 (0.89; 3.88)	2.71 (2.45; 3.15)	13.10 (8.65; 22.08)
BR7a	**0.65**	1.29 (0.52; 2.41)	0.47	0.32	2.46 (0.88; 3.69)	2.71 (2.45; 3.15)	12.88 (8.53; 21.99)
BR6a	**0.70**	1.38 (0.55; 2.49)	0.48	0.32	2.32 (0.86; 3.50)	2.71 (2.45; 3.15)	12.70 (8.34; 22.14)
Different tunings, 3 year TAC intervals							
BR2b	0.63	**1.25** (0.46; 2.36)	0.45	0.30	2.69 (0.93; 3.96)	2.71 (2.45; 3.15)	15.18 (9.49; 25.00)
BR5b	**0.60**	1.23 (0.43; 2.35)	0.44	0.30	2.58 (0.93; 3.83)	2.71 (2.45; 3.15)	15.36 (9.69; 25.00)
BR7b	**0.65**	1.31 (0.47; 2.43)	0.45	0.30	2.46 (0.91; 3.66)	2.71 (2.45; 3.15)	15.05 (9.34; 25.00)
BR6b	**0.71**	1.39 (0.50; 2.50)	0.46	0.31	2.33 (0.88; 3.48)	2.71 (2.45; 3.15)	14.94 (9.25; 25.00)
Tom's trick to reduce catch variance, 2 year TAC intervals							
BR5a	**0.60**	1.21 (0.47; 2.31)	0.45	0.32	2.61 (0.89; 3.88)	2.71 (2.45; 3.15)	13.10 (8.65; 22.08)
BR5d	**0.60**	1.22 (0.48; 2.32)	0.43	0.32	2.61 (0.90; 3.86)	2.72 (2.56; 2.93)	8.81 (5.15; 21.67)

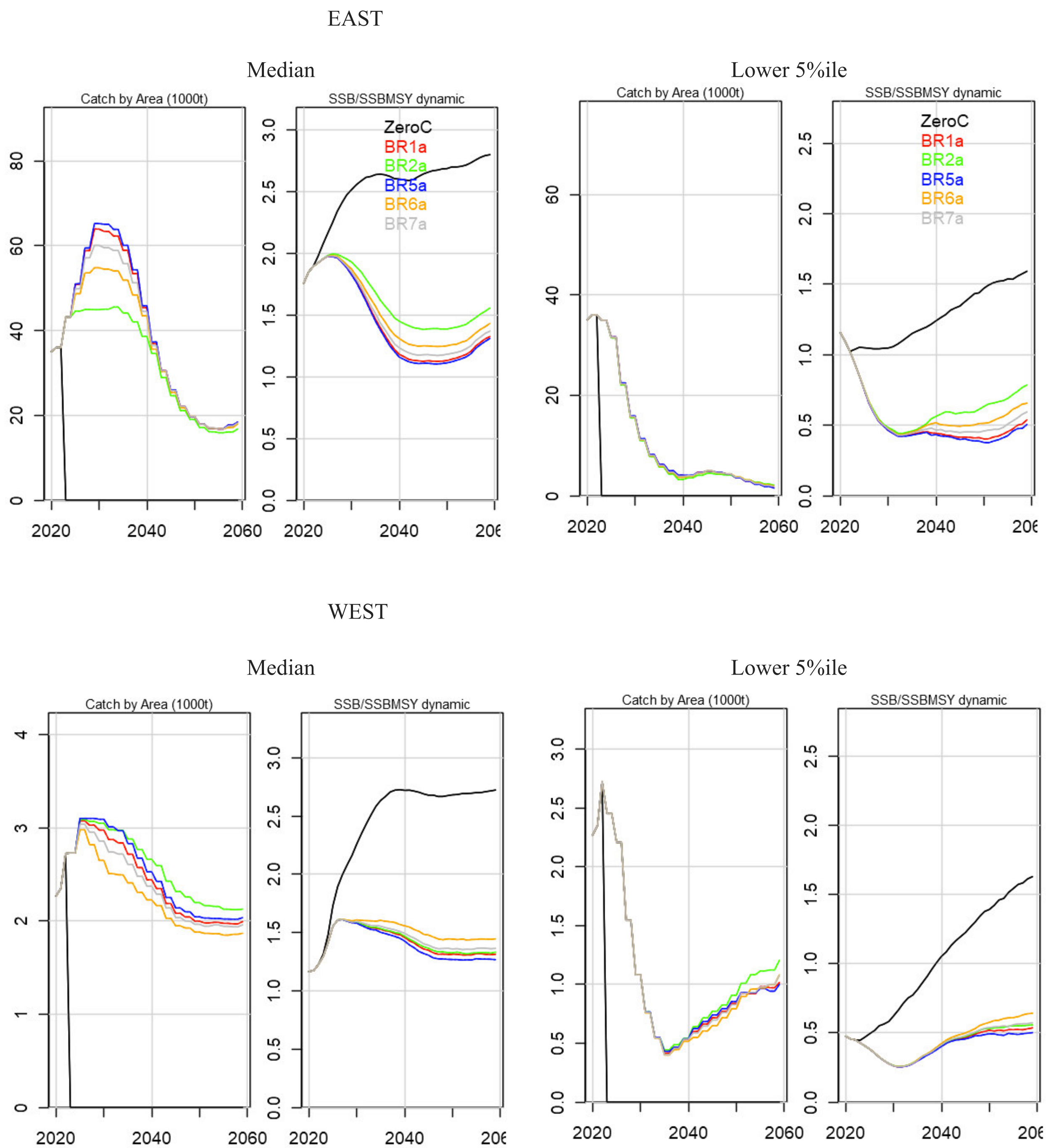


Figure 1a: Median (LHS) and lower 5%ile (RHS) catch (by area) and SSB (by stock) projections averaged over all OMs in the grid and the replicate simulations for BR1a, BR2a and BR5a to BR7a (**2 year TAC interval**, different tunings).

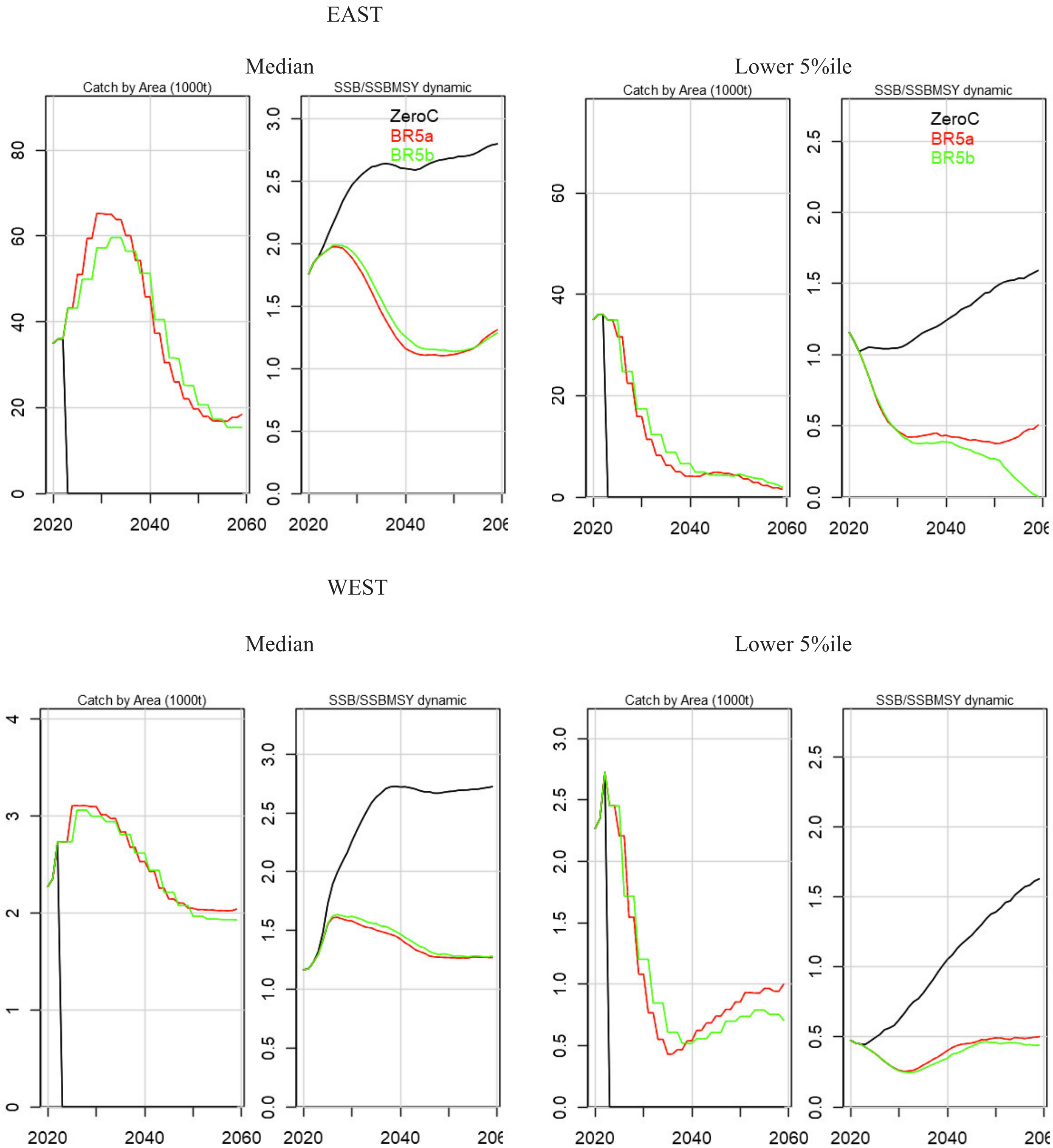
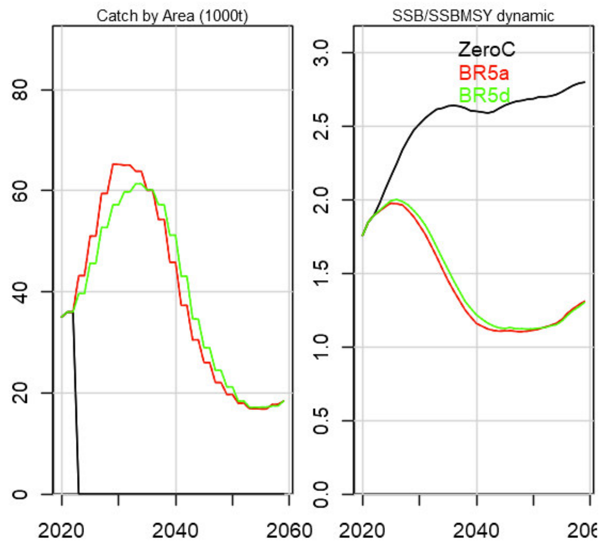


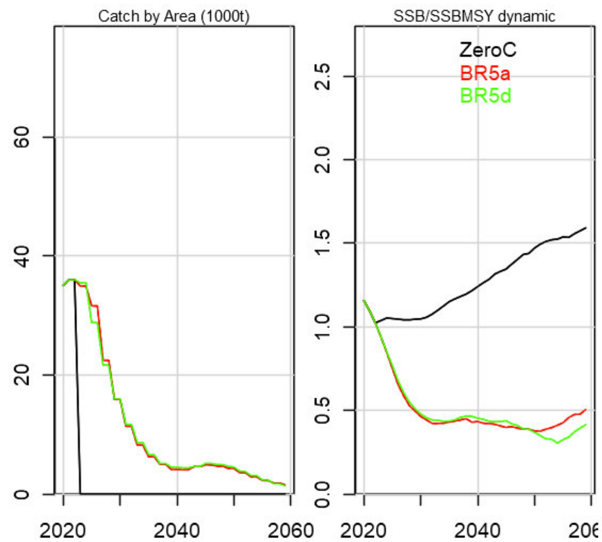
Figure 1b: Median (LHS) and lower 5%ile (RHS) catch (by area) and SSB (by stock) projections averaged over all OMs in the grid and the replicate simulations for BR5a and BR5b (2 vs 3 year TAC interval, PGK=0.6)

EAST

Median

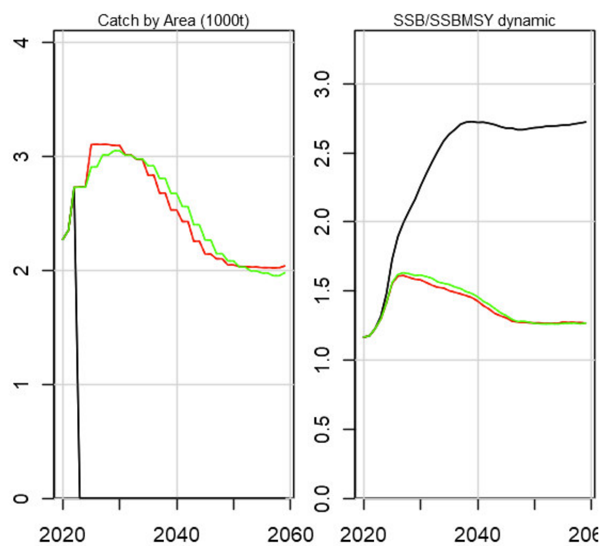


Lower 5%ile



WEST

Median



Lower 5%ile

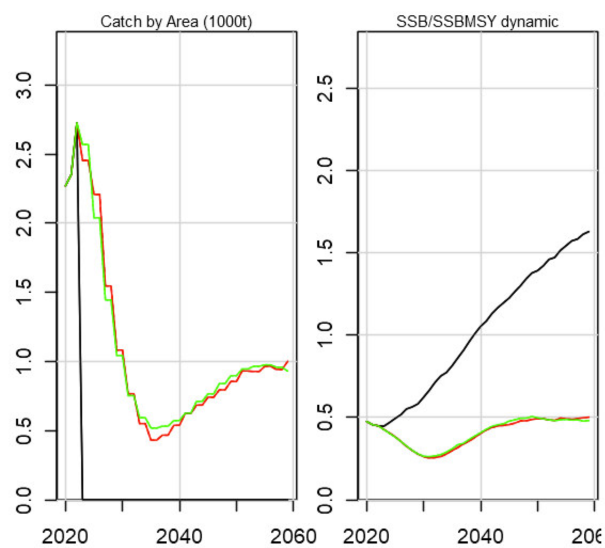


Figure 1c: Median (LHS) and lower 5%ile (RHS) catch (by area) and SSB (by stock) projections averaged over all OMs in the grid and the replicate simulations for BR5a and BR5d (without and with the Carruthers TAC variation reduction adjustment).

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]:

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

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:

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

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:

[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.

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

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

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:

$$TAC_{E,y} = \begin{cases} \left(\frac{TAC_{E,2020}}{J_{E,2017}}\right) \cdot \alpha_y \cdot J_{av,y-2}^{E} & \text{for } J_{av,y}^{E} \geq T^E \\ \left(\frac{TAC_{E,2020}}{J_{E,2017}}\right) \cdot \alpha_y \cdot \frac{\left(J_{av,y-2}^{E}\right)^2}{T^E} & \text{for } J_{av,y}^{E} < T^E \end{cases} \qquad \text{(A4a)}$$

For the West area:

$$TAC_{W,y} = \begin{cases} \left(\frac{TAC_{W,2020}}{J_{W,2017}}\right) \cdot \beta_y \cdot J_{av,y-2}^{W} & \text{for } J_{av,y}^{W} \geq T^W \\ \left(\frac{TAC_{W,2020}}{J_{W,2017}}\right) \cdot \beta_y \cdot \frac{\left(J_{av,y-2}^{W}\right)^2}{T^W} & \text{for } J_{av,y}^{W} < T^W \end{cases} \qquad \text{(A4b)}$$

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: $J_{av,y}^{i}$,

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

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

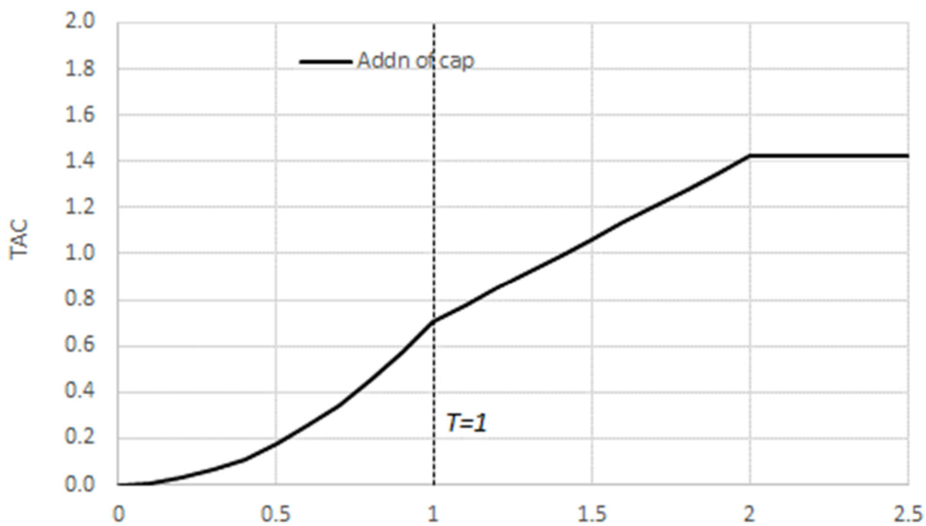


Figure A1. Illustrative relationship (the "catch control law") of *TAC* against $J_{av,y}$ for the BR CMPs, which includes the parabolic decrease below T and (if implemented) the capping of the TAC so as not to exceed some maximum value.