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REFINEMENTS OF THE BR CMP AS OF APRIL 2022

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SUMMARY

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

RÉSUMÉ

La CMP BR est ajustée à quelques égards, principalement en autorisant une dépendance temporelle limitée des valeurs des paramètres de contrôle au cours des premières années de gestion, afin de permettre des transitions plus douces des TAC de 2022 à 2023. Cette modification s'est avérée nécessaire, notamment en raison de l'augmentation du TAC de la zone Ouest pour 2022 inclus dans le paquet actualisé. Les résultats sont fournis pour les quatre calibrages de développement de base, plus une variante pour l'un de ces calibrages où la contrainte de diminution maximale du TAC par défaut est réduite de 30% à 20%. Des suggestions sont faites quant aux domaines susceptibles d'améliorer les performances, ce qui nécessiterait d'autres améliorations de cette CMP.

RESUMEN

El CMP de la BR se ha ajustado en algunos aspectos, sobre todo permitiendo una dependencia temporal limitada en los valores de los parámetros de control durante los primeros años de ordenación, para permitir transiciones más suaves en los TAC de 2022 a 2023. Esto fue necesario, especialmente debido al aumento del TAC de la zona occidental para 2022 incluido en el paquete actualizado. Los resultados se proporcionan para las cuatro calibraciones básicas de desarrollo, más una variante para una de esas calibraciones en la que la restricción de disminución máxima de TAC por defecto se reduce del 30 % al 20 %. Se sugieren áreas de posible mejora en el desempeño, que requerirían algunas mejoras adicionales de este CMP.

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 v7.5.2 has been used to generate the results reported in this document.

The changes made to the BR CMP from the CMP presented in January 2022 (Butterworth and Rademeyer, 2022) include (for the Baseline CMP):

1. No cap on the TAC;
2. Maximum decrease in the TAC of 30% (instead of 20%);
3. Time-dependent α and β control parameters (see equation A4);
4. In the East area, the maximum increase allowed from one TAC to the next is no longer a function of the immediate past trend in the indices.

The first two of these changes are in accordance with the defaults requested. The third was implemented to avoid large reductions in TACs in the first two years in the West and to avoid large increases in TACs in the first two years in the East (otherwise often followed by sharp reductions in these TACs). The fourth was found to be no longer necessary.

The updated BR CMP is described in full detail in **Appendix A**.

Results

Results for various BR CMP variants are presented, including especially coverage of all the four basic development tunings. **Table 1** lists the BR CMP variants with their control parameter values. These include one variation to the default specifications, which is to show the consequences of changing the maximum allowable decrease in the TAC from 30% to 20%.

The stochastic Br30, AvC30, C1 (TAC in 2023/2024) and AAVC results for all these CMPs are given in **Table 2**, both for all the OMs in the grid (with a visual representation in **Figure 1**), and then separately for the R1, R2 and R3 sets of recruitment scenarios.

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

Discussion

The following is a list of a few features of the results which would seem of importance.

- The updated package introduced a problem as with the increased 2022 TAC in the west, it was difficult to achieved tuning targets and avoid low values for the 5%ile of Br30 without needing a large TAC reduction in the West area from 2022 to 2023. This problem has been essentially solved by allowing for simple time dependence in the values of the α and β control parameters, though some further refinement of the control parameter values to ensure a smoother transition (though without any undue increase in risk-related parameters) seems desirable (particularly for tunings 3 and 4).

- Note (**Figure 2**) that median TACs generally increase in the short term, but eventually asymptote to lower values in both the East and West areas in the longer term. This is as a result of the CMP taking short-term advantage of the current high recruitment in the eastern stock, which also benefits West area catches; however, this high recruitment is not projected to continue.

- For all four basic development tuning targets, the key risk statistic (the lower 5%ile for Br30) seems sufficiently high not to give rise to concern: from 0.59 to 0.74 for the eastern stock, and 0.57 to 0.70 for the western stock. Roughly speaking, the more conservative of the tuning targets results in a loss of average catch of 5000 mt in the East, and 600 mt in the West area. R1 scenarios lead to no serious risk for these CMPs, for which the R2 scenarios present the greatest difficulties.

- Note the bimodality of the AvC30 plots in **Figure 1**. This reflects the ability of the CMP to distinguish and react appropriately to the more productive R1 and the less productive R2 scenarios.

- Restricting the maximum TAC decrease to 20% rather than to 30% results in a consequential decrease of the lower 5%ile for Br30 of about 0.08 for the eastern, and 0.05 for the western stock. This needs to be balanced against the lower 5%iles on the cumulative catch AvC30 not dropping as low for the 20% as for the 30% choice.

- Annual average variability in TACs in fairly high throughout (medians in the 13 to 19% range for all scenarios combined), and especially so for the R2 scenarios.

Summary and future plans

Future refinements will be guided by discussion in the BFT WG meeting, but is likely to focus on:

- Adjusting control parameters to achieve median TACs for 2023/24 (C1) closer to the current TACs for 2022.
- Considering tighter restrictions (than 20 or 30%) for the TAC change from 2022 to 2023/24 for a smoother transition.
- Rather than a 30% maximum decrease allowed in all situations, phasing this down from 20 to 30% as the value of the aggregate abundance index drops.
- Checking trade-off implications for variants which may be suggested in discussions in the BFT WG.

Reference

Butterworth DS and Rademeyer RA. 2022. Refinements of the BR CMP as of January 2022. Document presented at the February 2022 BFT MSE TT meeting.

Table 1. Control parameter values for each of the CMPs presented here.

	Tuned to weighted median Br30						Maximum change in TAC		East cap
CMP name	East	West	α_0	$\Delta\alpha$	β_0	$\Delta\beta$	Up	Down	
BR1a	1.25	1.25	1.10	0.300	0.80	-0.038	20%	30%	
BR2a	1.50	1.25	1.10	0.150	0.80	-0.030	20%	30%	
BR3a	1.25	1.50	1.10	0.300	0.80	-0.078	20%	30%	No cap
BR4a	1.50	1.50	1.10	0.150	0.80	-0.080	20%	30%	
BR2b	1.25	1.25	1.10	0.100	0.80	-0.039	20%	**20%**	

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 5 CMPs reported in this paper, first for all OMs in the grid ("All scenarios"), and then for each recruitment scenario separately (R1 then R2 then R3). 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.

All scenarios

	Br30	AvC30	C1	AAVC
EAST				
Zero catch	2.77 (1.46; 4.03)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)
BR1a	1.27 (0.59; 2.22)	37.17 (11.77; 73.30)	37.51 (31.86; 43.20)	18.54 (12.04; 23.74)
BR2a	1.48 (0.73; 2.46)	32.27 (10.55; 61.74)	37.51 (31.86; 43.20)	17.22 (10.22; 23.51)
BR2a	1.28 (0.59; 2.23)	37.26 (11.79; 73.44)	37.51 (31.86; 43.20)	18.51 (12.02; 23.71)
BR4a	1.49 (0.74; 2.47)	32.37 (10.60; 61.98)	37.51 (31.86; 43.20)	17.19 (10.22; 23.47)
BR2b	1.51 (0.65; 2.53)	31.29 (11.51; 57.41)	37.51 (31.86; 43.20)	14.96 (9.23; 19.67)
WEST				
Zero catch	2.66 (1.40; 4.04)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)
BR1a	1.26 (0.58; 2.33)	2.59 (0.86; 3.90)	2.52 (2.26; 2.88)	13.91 (9.64; 22.38)
BR2a	1.24 (0.57; 2.30)	2.81 (0.91; 4.21)	2.52 (2.26; 2.88)	13.92 (9.58; 22.18)
BR2a	1.50 (0.69; 2.57)	2.08 (0.76; 3.16)	2.52 (2.26; 2.88)	13.68 (9.43; 22.58)
BR4a	1.53 (0.70; 2.61)	2.13 (0.79; 3.24)	2.52 (2.26; 2.88)	13.59 (9.38; 22.55)
BR2b	1.26 (0.52; 2.33)	2.74 (0.94; 4.14)	2.52 (2.26; 2.88)	13.19 (9.38; 18.76)

R1 scenarios only

	Br30	AvC30	C1	AAVC
EAST				
Zero catch	2.98 (2.29; 4.16)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)
BR1a	1.51 (0.94; 2.35)	62.16 (31.55; 76.92)	39.60 (35.00; 43.20)	14.93 (11.13; 19.94)
BR2a	1.74 (1.12; 2.63)	53.51 (27.10; 64.65)	39.60 (35.00; 43.20)	12.91 (9.29; 18.55)
BR2a	1.51 (0.94; 2.36)	62.37 (31.62; 77.12)	39.60 (35.00; 43.20)	14.92 (11.10; 19.93)
BR4a	1.74 (1.13; 2.64)	53.65 (27.17; 64.83)	39.60 (35.00; 43.20)	12.88 (9.26; 18.56)
BR2b	1.81 (1.21; 2.75)	49.40 (25.98; 59.79)	39.60 (35.00; 43.20)	11.75 (8.45; 16.34)
WEST				
Zero catch	3.15 (2.38; 4.49)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)
BR1a	1.48 (0.92; 2.69)	3.24 (2.17; 4.10)	2.63 (2.41; 2.95)	12.39 (9.12; 16.04)
BR2a	1.44 (0.89; 2.65)	3.51 (2.35; 4.43)	2.63 (2.41; 2.95)	12.49 (9.15; 16.16)
BR2a	1.76 (1.17; 2.96)	2.60 (1.71; 3.33)	2.63 (2.41; 2.95)	12.08 (8.69; 15.62)
BR4a	1.79 (1.20; 3.00)	2.67 (1.75; 3.42)	2.63 (2.41; 2.95)	12.02 (8.74; 15.69)
BR2b	1.49 (0.92; 2.71)	3.45 (2.27; 4.39)	2.63 (2.41; 2.95)	12.02 (9.04; 15.42)

R2 scenarios only

	Br30	AvC30	C1	AAVC
EAST				
Zero catch	2.25 (1.22; 3.91)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)
BR1a	1.05 (0.56; 2.08)	17.69 (10.11; 33.11)	34.51 (30.87; 38.80)	19.95 (15.37; 23.96)
BR2a	1.20 (0.64; 2.23)	15.68 (9.15; 29.49)	34.51 (30.87; 38.80)	20.00 (15.43; 24.30)
BR2a	1.06 (0.56; 2.08)	17.73 (10.11; 33.12)	34.51 (30.87; 38.80)	19.94 (15.34; 23.95)
BR4a	1.21 (0.64; 2.24)	15.70 (9.19; 29.55)	34.51 (30.87; 38.80)	20.01 (15.40; 24.30)
BR2b	1.20 (0.57; 2.21)	15.69 (10.56; 28.91)	34.51 (30.87; 38.80)	17.88 (13.74; 20.00)
WEST				
Zero catch	1.96 (1.18; 2.89)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)
BR1a	1.03 (0.51; 1.94)	1.30 (0.71; 1.80)	2.36 (2.22; 2.56)	17.51 (10.97; 24.00)
BR2a	1.01 (0.50; 1.92)	1.38 (0.76; 1.89)	2.36 (2.22; 2.56)	17.12 (10.70; 23.57)
BR2a	1.16 (0.58; 2.11)	1.09 (0.63; 1.46)	2.36 (2.22; 2.56)	18.19 (11.89; 24.20)
BR4a	1.17 (0.59; 2.13)	1.10 (0.66; 1.47)	2.36 (2.22; 2.56)	18.02 (11.88; 23.84)
BR2b	1.00 (0.42; 1.93)	1.38 (0.79; 1.83)	2.36 (2.22; 2.56)	15.59 (10.28; 19.66)

R3 scenarios only

	Br30	AvC30	C1	AAVC
EAST				
Zero catch	3.00 (2.11; 3.91)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)
BR1a	1.17 (0.25; 1.82)	46.27 (23.16; 58.95)	39.40 (34.91; 43.20)	20.51 (16.98; 24.93)
BR2a	1.44 (0.64; 2.13)	39.56 (19.60; 50.09)	39.40 (34.91; 43.20)	18.39 (14.64; 22.84)
BR2a	1.18 (0.27; 1.83)	46.40 (23.19; 59.25)	39.40 (34.91; 43.20)	20.50 (17.00; 24.91)
BR4a	1.45 (0.65; 2.13)	39.68 (19.64; 50.30)	39.40 (34.91; 43.20)	18.37 (14.61; 22.82)
BR2b	1.42 (0.51; 2.19)	38.34 (19.76; 47.66)	39.40 (34.91; 43.20)	14.87 (12.03; 17.92)
WEST				
Zero catch	2.79 (2.22; 3.57)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)	0.00 (0.00; 0.00)
BR1a	1.02 (0.58; 1.93)	2.95 (2.02; 3.89)	2.65 (2.42; 2.94)	13.26 (9.63; 17.17)
BR2a	1.01 (0.54; 1.91)	3.19 (2.21; 4.14)	2.65 (2.42; 2.94)	13.27 (9.44; 17.26)
BR2a	1.32 (0.83; 2.17)	2.39 (1.60; 3.18)	2.65 (2.42; 2.94)	12.59 (9.24; 16.61)
BR4a	1.37 (0.87; 2.23)	2.46 (1.67; 3.24)	2.65 (2.42; 2.94)	12.47 (9.15; 16.36)
BR2b	1.04 (0.56; 1.95)	3.15 (2.16; 4.08)	2.65 (2.42; 2.94)	12.58 (9.27; 15.69)

EAST

WEST

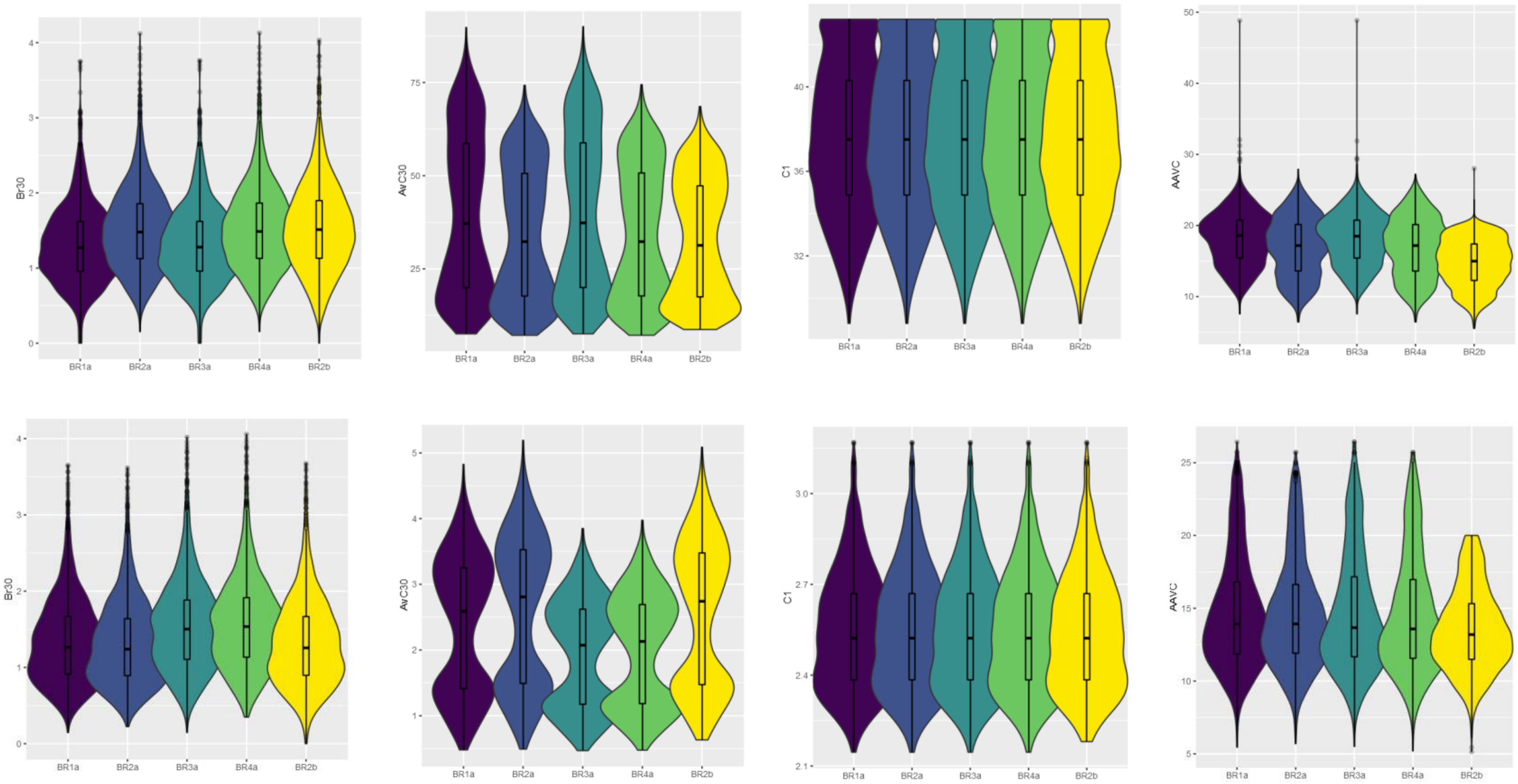

Figure 1. Br30, AvC30, C1 and AAVC values for the five CMPs considered over the grid of OMs, showing the full distribution as well as the median, interquartile and 90%-ile ranges.

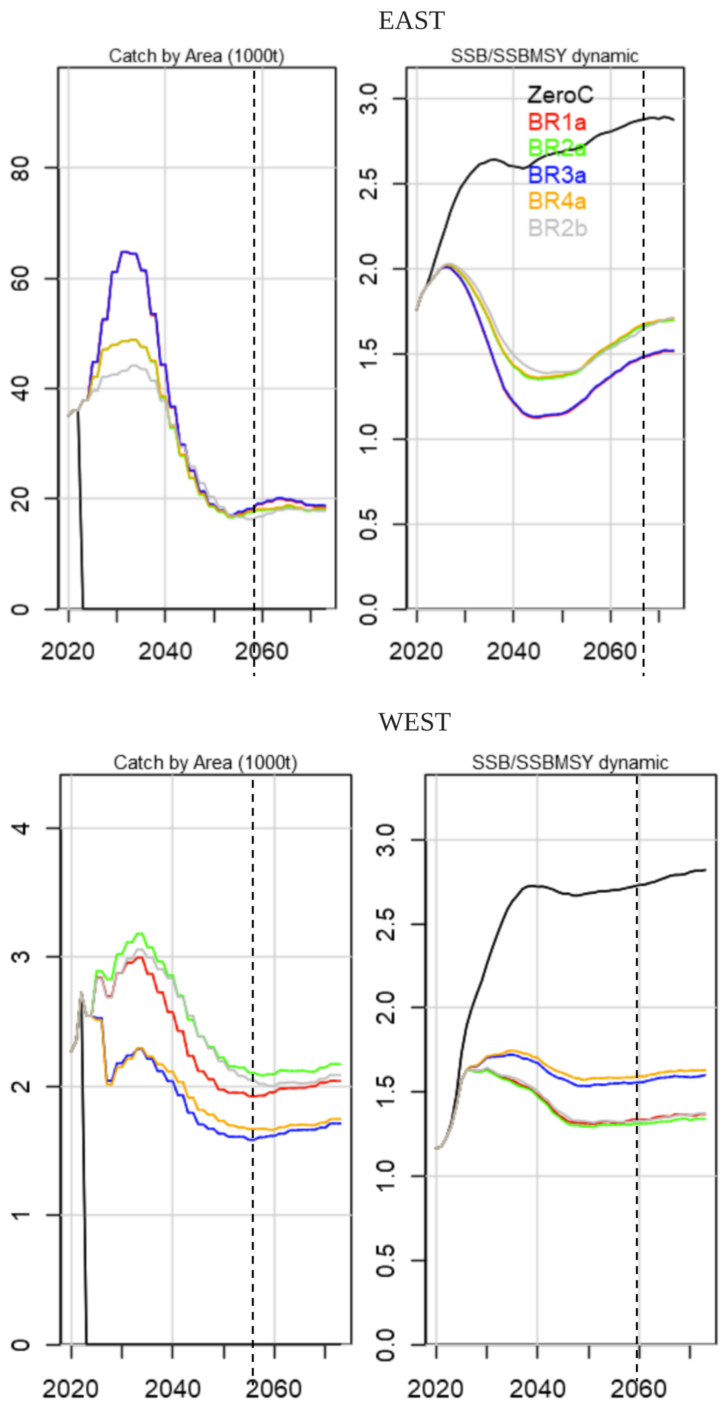

Figure 2. Median catch (by area) and SSB (by stock) projections averaged over all OMs in the grid and the replicate simulations for each. The dashed vertical lines show the end of the 3-year management period considered.

Appendix A

Note: *Changes from the previous version have been yellow highlighted. Certain specifications no longer needed have been deleted; these referred to the maximum increase allowed from one TAC to the next being a function of the immediate past trend in the indices in the East, and to phasing the maximum decrease allowed from 20 to 30% as the value of the aggregate abundance index drops.*

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

$w_i = \frac{1}{(\sigma^i)^2}$ for the west and i.e. inverse effective variance weighting)

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

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.

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

[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.

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

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

where the $J^{E/W}_{av,y}$ 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:

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

(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:

$$\beta_y = \begin{cases} \beta_0 + \Delta\beta(y - 2023) & \text{for } 2023 \leq y \leq 2027 \\ \beta_{y-2} & \text{for } y > 2027 \end{cases}$$

α_0, β_0, $\Delta\alpha$ and $\Delta\beta$ are control parameters.

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.

Table A1. σ^i (averaged over the OMs) values used in weighting when averaging over the indices to provide composite indices for the East and the West areas (see following equation A2).[4]

EAST Index name	σ^i	w_i $(=\frac{1}{\sqrt{\sigma^i}})$	WEST Index name	σ^i	w_i $(=\frac{1}{(\sigma^i)^2})$
FR_AER_SUV2	0.49	1.43	GOM_LAR_SUV	1.48	0.46
MED_LAR_SUV	0.57	1.33	US_RR_66_144	0.57	3.12
GBYP_AER_SUV_BAR	0.99	1.01	MEXUS_GOM_PLL2	0.88	1.28
MOR_POR_TRAP	1.37	0.85	JPN_LL_West2	1.09	0.84
JPN_LL_NEAtl2	3.49	0.54	CAN_SWNS	0.36	7.57

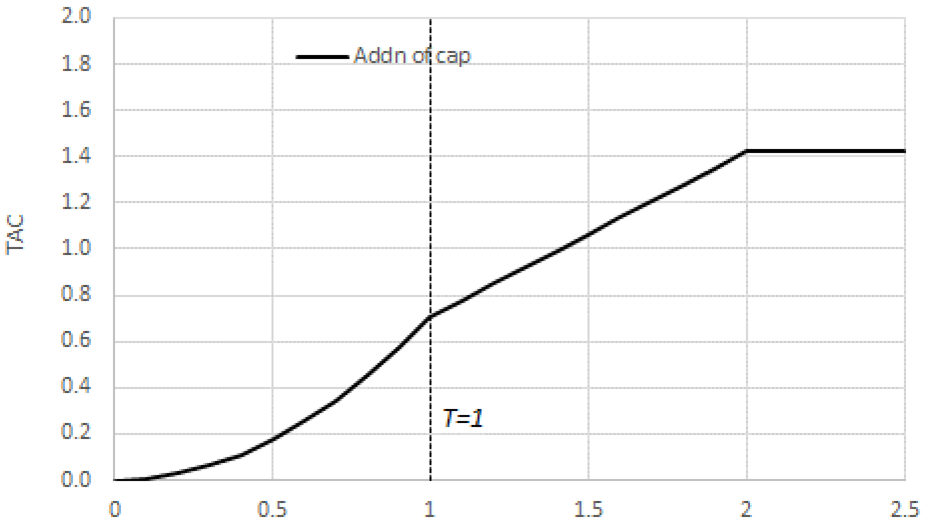

Figure A1. Illustrative relationship (the "catch control law") of *TAC* against $J_{av,y}$ for the BR CMPs, which includes the parabolic decrease below T and (if implemented) the capping of the TAC so as not to exceed some maximum value.

[4] Subsequent to the meeting at which this paper was presented, it was discovered that the weightings for the various East and West abundance indices given in Table A1 had inadvertently been mis-ordered, so that the calculations reported in this and some previous papers had not been carried out exactly as intended.