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THE BR CMP AS SUBMITTED TO THE SEPTEMBER 2022 BLUEFIN SPECIES GROUP MEETING

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SUMMARY

Results are provided for BR CMP variants retuned under the specifications developed by the early September 2022 Bluefin MSE Technical Group meeting. They do not differ greatly from those for the BR variants tabled at that early September meeting.

RÉSUMÉ

Ce document présente les résultats pour les variantes de la CMP BR dans le cadre des spécifications développées par la réunion du Groupe technique sur la MSE pour le thon rouge de début septembre 2022. Ils ne différaient pas beaucoup de ceux des variantes de BR présentés à la réunion de début septembre.

RESUMEN

Se proporcionan los resultados de las variantes de CMP BR recalibradas en función de las especificaciones desarrolladas por la Segunda reunión del Subgrupo de trabajo técnico sobre la MSE para el atún rojo de principios de septiembre de 2022. No difieren mucho de los de las variantes de la BR presentadas en esa reunión de principios de septiembre.

KEYWORDS

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

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Introduction

The most recent BR CMP results are reported in summary form and in terms of the specifications provided by the early September 2022 Bluefin MSE Technical Group meeting. These have been calculated using the equations in Appendix A of this document.

The BR CMP has been tuned to the five baseline tunings as advised at that Technical Group meeting; all five use the catch variance adjustment parameter varCadj=0.5:

- BR5a: Tuned to PGK = 60% with a 2-year management cycle, where allowable TAC adjustment is +20/-30%
- BR5b: Tuned to PGK = 60% with a 3-year management cycle, where allowable TAC adjustment is +20/-30%
- BR6a: Tuned to PGK = 70% with a 2-year management cycle, where allowable TAC adjustment is +20/-30%
- BR6b: Tuned to PGK = 70% with a 3-year management cycle, where allowable TAC adjustment is +20/-30%
- BR5c: Tuned to PGK = 60% with a 3-year management cycle, where allowable TAC adjustment is +20/-35%

Results for the following CMPs are also shown:

- BR7b: Tuned to LD*15% = 0.4 with a 3-year management cycle, where allowable TAC adjustment is +20/-30%
- BS5a: VarCadj=0.7, Tuned to PGK = 60% with a 2-year management cycle, where allowable TAC adjustment is +20/-30%
- BT5a: VarCadj=0.4, Tuned to PGK = 60% with a 2-year management cycle, where allowable TAC adjustment is +20/-30%

Results

Table 1 lists the BR CMP variants presented here, with their control parameter values[2]. They are compared to the final results from Butterworth and Rademeyer (2022), which are first repeated to assist comparisons. Note that compared to those earlier results, these new BR CMP variants have not only been retuned in terms of the specifications set out by the early September 2022 Bluefin MSE Technical Group meeting, but have also adjusted the value of the VarCadj control parameter used previously to reduce resource risk somewhat (though consequently at the expense of some increase in VarC values).

The stochastic Br30, PGK, 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 a number of the CMP tunings and variants considered

Discussion

In brief, the following points seem worth noting:

- For this new default BR CMP, the 3-yr 60% PGK variant is the only one that fails to meet the LD*15% >= 0.40 criterion, and only for the East (BR5b).
- It passes this criterion when the max TAC decrease constraint is increased from 30 to 35% (BR5c). Nevertheless, performance after the 30-year management period remains poor for this variant (see **Figure 1b**).
- Staying with the 30% maximum TAC decease constraint and adjusting control parameters to meet the LD*15% constraint (BR7b), leads to a slight increase only of PGK to 63% for the eastern population and 61% for the western. Other performance statistics are little affected: for the East, AvC30 drops by about 3%, while AvC30 in the West increases by about 1%.

Compared to the BR results submitted to the recent MSE technical meeting:

[2] Note that the value of $\Delta\beta$ for BR5c has been changed marginally from that used to provide the results reported in Butterworth and Rademeyer (2022), so as to meet the LD*15% threshold when minimum TAC change constraints are included in this CMP.

- VarC (as to be anticipated) increases.
- However, other performance statistics do not change very much:
  - The median Br30 values for the eastern stock change slightly
  - The long term TACs (AvC30) increase by 7% for the East but are down 1% for the West
  - The starting TAC (C1) is up 2% in the East but hardly changed in the West

Furthermore:

- C1 is hardly changed from the 2022 TAC in the West but is up by about 4500 mt in the East. With most indices increasing in recent years, this is nevertheless arguably not unreasonable, as the West was awarded a substantial TAC increase for 2022, whereas the East TAC has been held fixed for the last three years.

- If the LD* criterion was changed from 15% to 10%, this is met only for one case: the eastern population for a 2-year interval and PGK = 70%. It falls well short for the western population especially. Retuning to meet this criterion would lead to PGK much greater than 70% and substantial reductions in the TAC over the longer term (AvC30).

- There is perhaps a case for adjusting the value of 0.5 chosen for VarCadj down slightly to reduce VarC values without too much increase in resource risk. Results shown in **Table 2** indicate that if this value is reduced to 0.4 (BT5a), there is little deterioration in measures of resource risk, but the gain in TAC stability is not that great (median VarC values decrease by about 1%).

Reference

Butterworth DS and Rademeyer RA: 2022. The BR CMP as at end August 2022. ICCAT Document SCRS/2022/154.

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

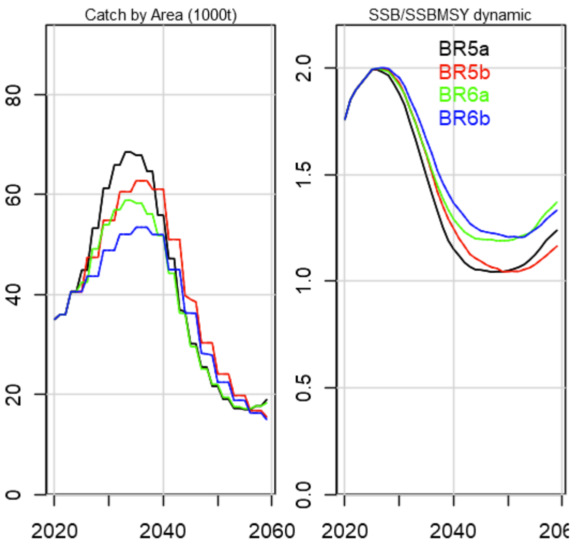
CMP name	TAC intervals (years)	Tuned to	α_0	$\Delta\alpha$	β_0	$\Delta\beta$	Maximum change in TAC		Notes
							Up	Down	
BR5d	2	PGK=0.6	1.235	0.145	0.81	-0.0218	20%	10 then 30%	Carruthers TAC variation reduction adjustment, VarCadj=0.5
BR5e	2	PGK=0.6	1.235	0.113	0.81	-0.0280	20%	10 then 30%	Carruthers TAC variation reduction adjustment, VarCadj=0.3
BR5f	3	PGK=0.6	1.235	0.071	0.81	-0.0340	20%	10 then 30%	Carruthers TAC variation reduction adjustment, VarCadj=0.3
BR6e	2	PGK=0.7	1.235	0.045	0.81	-0.0420	20%	10 then 30%	Carruthers TAC variation reduction adjustment, VarCadj=0.3
BR6f	3	PGK=0.7	1.235	0.013	0.81	-0.0480	20%	10 then 30%	Carruthers TAC variation reduction adjustment, VarCadj=0.3
New package									
BR5a	2	PGK=0.6	1.235	0.218	0.81	-0.0296	20%	10 then 30%	Carruthers TAC variation reduction adjustment, VarCadj=0.5
BR5b	3	PGK=0.6	1.235	0.188	0.81	-0.0346	20%	10 then 30%	Carruthers TAC variation reduction adjustment, VarCadj=0.5
BR6a	2	PGK=0.6	1.235	0.130	0.81	-0.0435	20%	10 then 30%	Carruthers TAC variation reduction adjustment, VarCadj=0.5
BR6b	3	PGK=0.7	1.235	0.096	0.81	-0.0475	20%	10 then 30%	Carruthers TAC variation reduction adjustment, VarCadj=0.5
BR5c	3	PGK=0.6	1.235	0.204	0.81	-0.0320	20%	10 then 35%	Carruthers TAC variation reduction adjustment, VarCadj=0.5
BR7b	3	LD*15%=0.4	1.235	0.157	0.81	-0.0335	20%	10 then 30%	Carruthers TAC variation reduction adjustment, VarCadj=0.5
BT5a	2	PGK=0.6	1.235	0.202	0.81	-0.0308	20%	10 then 30%	Carruthers TAC variation reduction adjustment, VarCadj=0.4
BS5a	2	PGK=0.6	1.235	0.240	0.81	-0.0280	20%	10 then 30%	Carruthers TAC variation reduction adjustment, VarCadj=0.7

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 the CMPs reported in this paper across 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 PGK) are those to which the corresponding CMP has been tuned. The first large block in the table repeats results from SCRS/2022/154, with updated results in the following blocks.

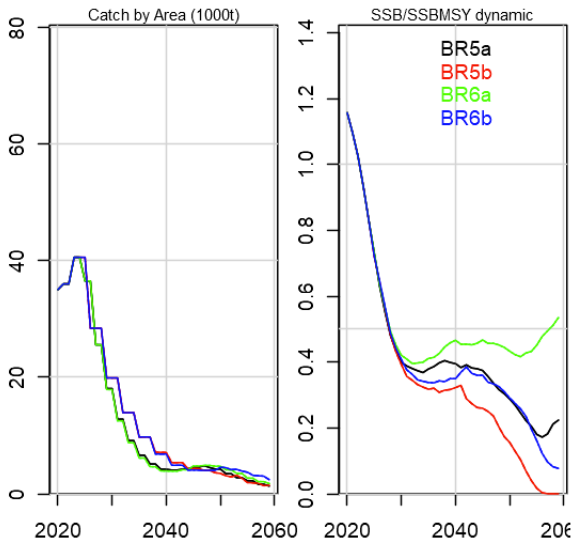
	TAC inter.	PKG	Br30	LD*15%	LD*10%	AvC30	C1	VarC
EAST								
End August results								
BR5d	2	**0.60**	1.24 (0.52; 2.26)	0.51	0.44	38.07 (11.68; 70.08)	39.47 (35.33; 43.20)	14.98 (7.85; 22.71)
BR5e	2	**0.60**	1.27 (0.49; 2.30)	0.48	0.40	37.59 (11.92; 65.92)	38.04 (35.60; 40.43)	11.93 (5.57; 21.52)
BR5f	3	**0.60**	1.32 (0.60; 2.49)	0.43	0.34	36.54 (12.88; 59.62)	38.04 (35.60; 40.43)	13.56 (5.87; 24.39)
BR6e	2	**0.70**	1.41 (0.49; 2.30)	0.54	0.46	34.83 (11.27; 59.09)	38.04 (35.60; 40.43)	11.39 (4.54; 22.15)
BR6f	3	**0.70**	1.46 (0.39; 2.42)	0.47	0.39	33.69 (12.38; 54.11)	38.04 (35.60; 40.43)	12.69 (4.53; 24.35)
New package - 0.6 vs 0.7 PKG and 2 vs 3 yr intervals								
BR5a	2	**0.60**	1.17 (0.44; 2.15)	0.45	0.38	41.42 (12.29; 75.35)	40.57	15.60 (8.73; 22.76)
BR5b	3	**0.60**	1.17 (0.25; 2.22)	0.38	0.30	41.17 (13.20; 71.21)	40.57	17.96 (10.00; 25.71)
BR6a	2	**0.70**	1.32 (0.58; 2.34)	0.51	0.43	38.13 (11.77; 68.21)	40.57	14.63 (7.55; 22.58)
BR6b	3	**0.70**	1.34 (0.42; 2.42)	0.44	0.36	37.20 (12.73; 64.07)	40.57	17.14 (8.29; 25.78)
New package - 30% vs 35% max down								
BR5b	3	**0.60**	1.17 (0.25; 2.22)	0.38	0.30	41.17 (13.20; 71.21)	40.57	17.96 (10.00; 25.71)
BR5c	3	**0.60**	1.17 (0.33; 2.19)	0.41	0.33	41.28 (12.64; 72.24)	40.57	18.65 (10.30; 27.40)
New package - 0.6 PKG vs LD*15% tuning								
BR5b	3	**0.60**	1.17 (0.25; 2.22)	0.38	0.30	41.17 (13.20; 71.21)	40.57	17.96 (10.00; 25.71)
BR7b	3	0.63	1.22 (0.31; 2.28)	**0.40**	0.32	39.82 (13.02; 69.07)	40.57	17.68 (9.50; 26.11)
New package - different varCadj values								
BT5a	2	**0.60**	1.17 (0.43; 2.17)	0.44	0.37	41.12 (12.30; 74.00)	39.61	14.23 (7.85; 22.24)
BR5a	2	**0.60**	1.17 (0.44; 2.15)	0.45	0.38	41.42 (12.29; 75.35)	40.57	15.60 (8.73; 22.76)
BS5a	2	**0.60**	1.17 (0.45; 2.12)	0.44	0.37	41.50 (12.30; 77.22)	42.56	17.12 (10.23; 23.49)
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)
End August results								
BR5d	2	**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)
BR5e	2	**0.60**	1.25 (0.46; 2.36)	0.41	0.28	2.57 (0.90; 3.74)	2.72 (2.63; 2.85)	6.29 (3.28; 19.06)
BR5f	3	**0.60**	1.29 (0.36; 2.44)	0.37	0.26	2.53 (0.96; 3.57)	2.72 (2.63; 2.85)	7.26 (3.36; 21.82)
BR6e	2	**0.71**	1.41 (0.54; 2.54)	0.44	0.30	2.34 (0.88; 3.40)	2.72 (2.63; 2.85)	5.99 (3.14; 20.16)
BR6f	3	**0.71**	1.46 (0.43; 2.60)	0.41	0.26	2.29 (0.94; 3.22)	2.72 (2.63; 2.85)	6.91 (3.14; 22.00)
New package - 0.6 vs 0.7 PKG and 2 vs 3 yr intervals								
BR5a	2	**0.60**	1.25 (0.46; 2.37)	0.42	0.29	2.43 (0.90; 3.60)	2.69	8.81 (4.95; 21.38)
BR5b	3	**0.60**	1.28 (0.38; 2.40)	0.40	0.27	2.40 (0.94; 3.53)	2.69	10.37 (5.51; 24.16)
BR6a	2	**0.71**	1.41 (0.54; 2.53)	0.45	0.30	2.20 (0.87; 3.27)	2.69	8.21 (4.72; 21.07)
BR6b	3	**0.70**	1.45 (0.46; 2.57)	0.43	0.28	2.18 (0.91; 3.20)	2.69	9.75 (5.20; 24.86)
New package - 30% vs 35% max down								
BR5b	3	**0.60**	1.28 (0.38; 2.40)	0.40	0.27	2.40 (0.94; 3.53)	2.69	10.37 (5.51; 24.16)
BR5c	3	**0.60**	1.25 (0.44; 2.37)	0.40	0.27	2.45 (0.89; 3.59)	2.69	10.45 (5.53; 24.32)
New package - 0.6 PKG vs LD*15% tuning								
BR5b	3	**0.60**	1.28 (0.38; 2.40)	0.40	0.27	2.40 (0.94; 3.53)	2.69	10.37 (5.51; 24.16)
BR7b	3	0.61	1.28 (0.39; 2.40)	**0.41**	0.27	2.43 (0.94; 3.58)	2.69	10.22 (5.42; 24.14)
New package - different varCadj values								
BT5a	2	**0.60**	1.25 (0.46; 2.37)	0.42	0.28	2.44 (0.92; 3.61)	2.70	7.61 (4.03; 20.35)
BR5a	2	**0.60**	1.25 (0.46; 2.37)	0.42	0.29	2.43 (0.90; 3.60)	2.69	8.81 (4.95; 21.38)
BS5a	2	**0.60**	1.25 (0.47; 2.37)	0.43	0.29	2.42 (0.90; 3.60)	2.68	10.76 (6.64; 21.71)

EAST

Median

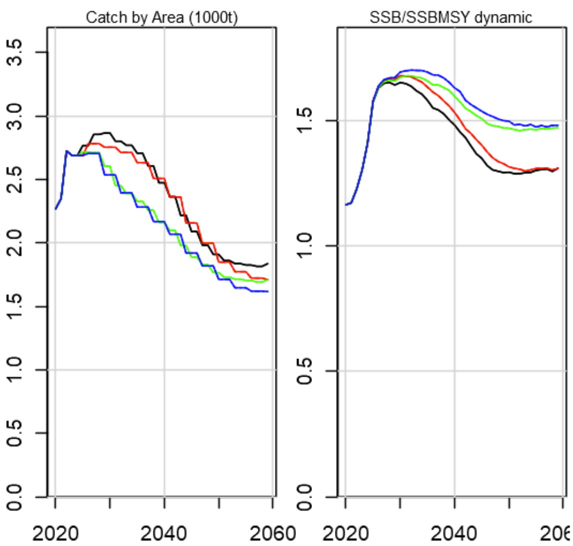


Lower 5%ile



WEST

Median



Lower 5%ile

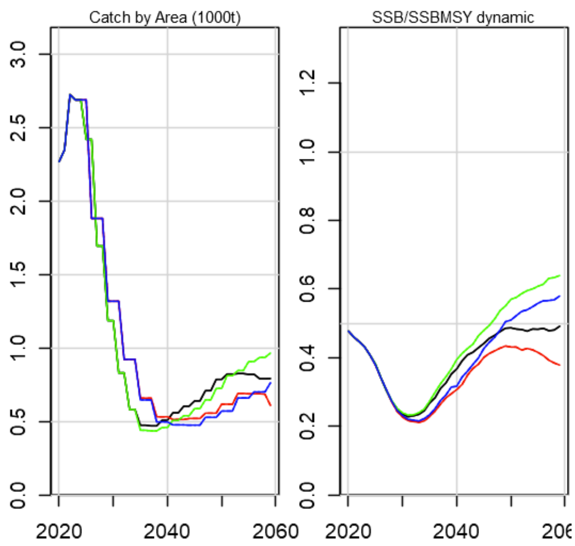


Figure 1a. Median (LHS) and lower 5%ile (RHS) catch (by area) and SSB (by population) projections averaged over all OMs in the grid and the replicate simulations for BR5a, BR5b, BR6a and BR6b (2 vs 3 yr intervals, 0.6 vs 0.7 PGK).

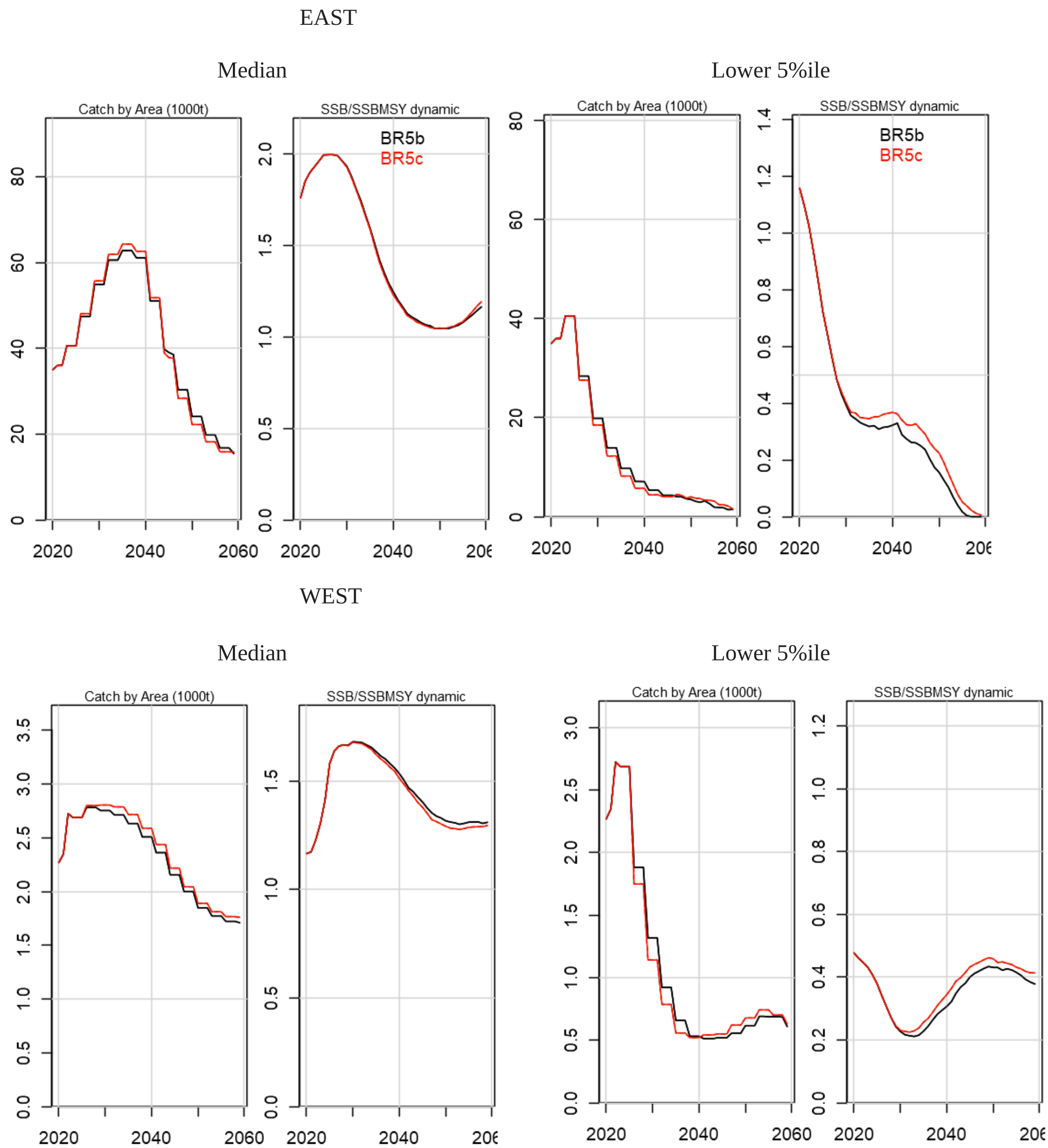


Figure 1b. Median (LHS) and lower 5%ile (RHS) catch (by area) and SSB (by population) projections averaged over all OMs in the grid and the replicate simulations for BR5b and BR5c, (3yr intervals, 0.6 PGK, 30% vs 35% max down).

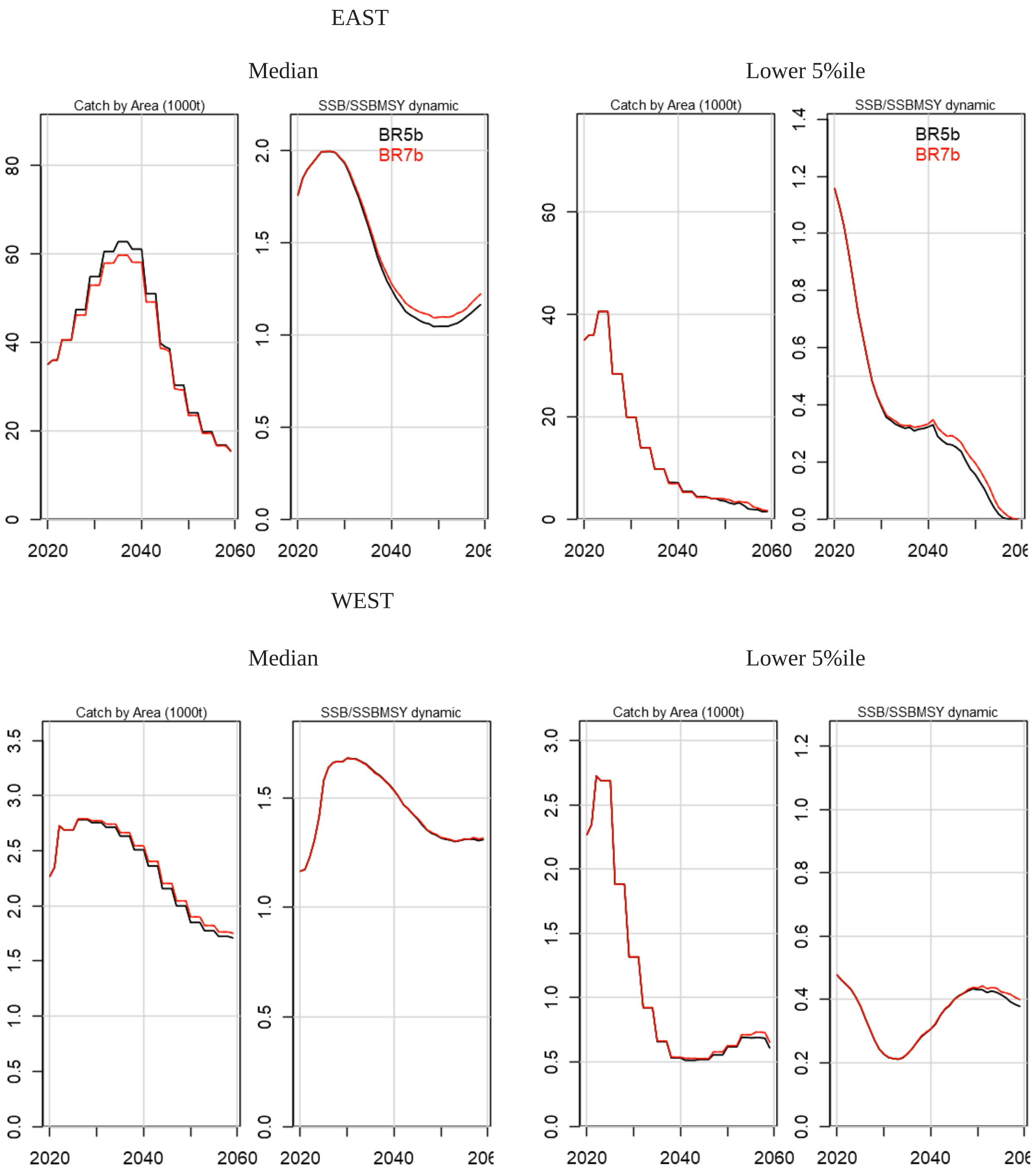
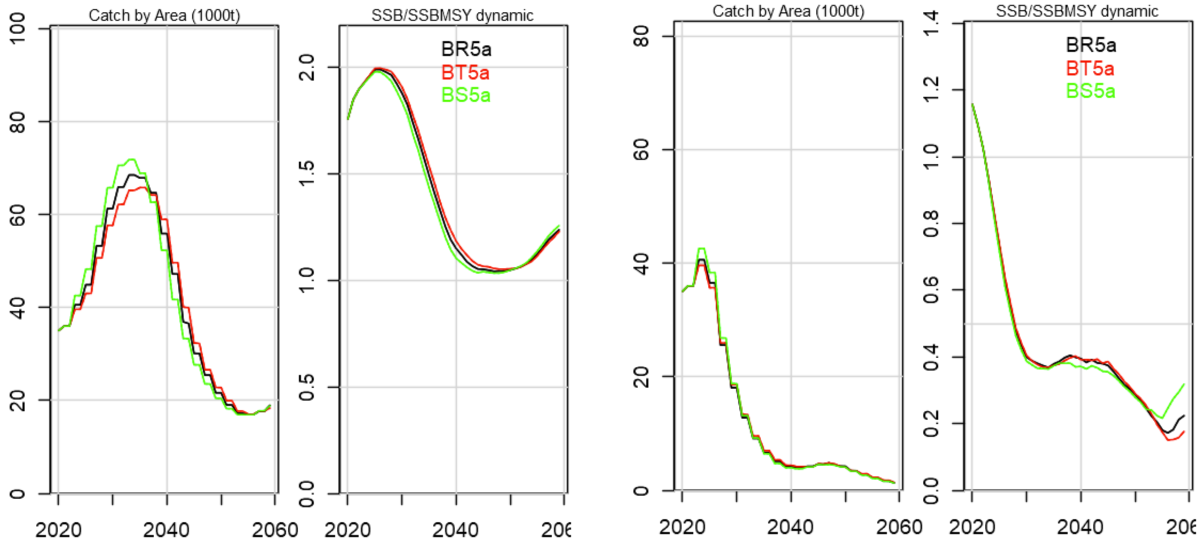


Figure 1c. Median (LHS) and lower 5%ile (RHS) catch (by area) and SSB (by population) projections averaged over all OMs in the grid and the replicate simulations for BR5b and BR7b (3yr intervals, 0.6 PGKvs LD*15%).

EAST

Median | Lower 5%ile



WEST

Median | Lower 5%ile

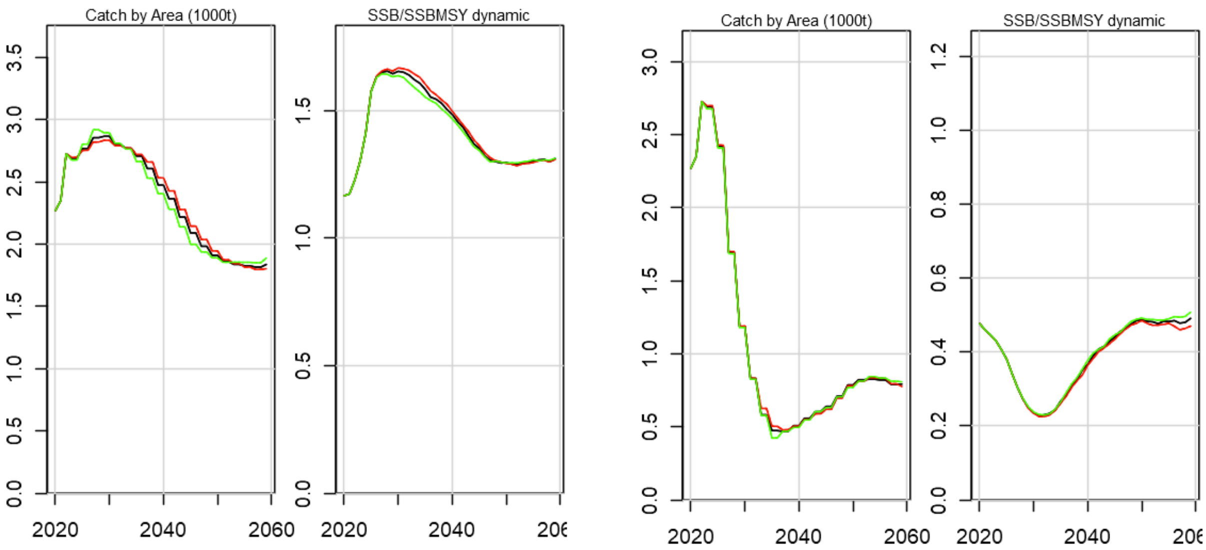


Figure 1d. Median (LHS) and lower 5%ile (RHS) catch (by area) and SSB (by population) projections averaged over all OMs in the grid and the replicate simulations for BT5a, BR5a and BS5a (2yr intervals, 0.6 PGK, 0.4 vs 0.5 vs 0.7 varCadj)

Appendix A

BR CMP Mathematical Descriptions (TAC calculation)

The BR 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 or for the West areas as appropriate (Table A1, 5 indices in each management area), 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.

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, and then taking a weighted average of the results for each index, where the weight is inversely proportional to the variance[3] 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.

The indices, I_y^i, are first standardised to an average value of 1 over the past years for which the index appeared reasonably stable:

$$I_y^{i*} = \frac{I_y^i}{\sum_{y_1^i}^{y_2^i} I_y^i \Big/ (y_2^i - y_1^i + 1)} \quad \text{(A1)}$$

where y_1^i and y_2^i specify the period to which each index (i) is standardised (Table A1).

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

$$J_y^{E/W} = \frac{\sum_i^n w_i \times I_y^{i*}}{\sum_i^n w_i} \quad \text{(A2)}$$

where $w_i = \frac{1}{\sqrt{\sigma^i}}$ (i.e., effective inverse variance to the power ¼ weighting). 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 A1 lists these values for w_i.

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.

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.

The actual index used in the CMPs, $J_{av,y-2}^{E/W}$, is the average over the last three years for which data would be available at the time the MP would be applied, hence:

$$J_{av,y-2}^{E/W} = \frac{1}{3}\left(J_{y-2}^{E/W} + J_{y-3}^{E/W} + J_{y-4}^{E/W}\right) \quad \text{(A3)}$$

where the $J_{av,y-2}^{E/W}$ applies either to the East or to the West area.

CMP specifications

The BR Fixed Proportion CMP variants set the TAC (in mt) every management cycle simply as a multiple of the J_{av} value for the area at the time (**Figure A1**), but subject to the change in the TAC for each area being restricted to a maximum of 20% up and 30% down (10% down for the phase-in period, and 35% down only for PGK 60% with a 3-year management cycle).

[3] This is modified somewhat in a few cases to provide the smoother TAC trend over time., as explained further below.

For the East area:

$$TAC_{E,y} = \begin{cases} \left(\frac{35032.31}{J_{2017}^{E}}\right) \cdot \alpha_y \cdot J_{av,y-2}^{E} & \text{for } J_{av,y-2}^{E} \geq T^{E} \\ \left(\frac{35032.31}{J_{2017}^{E}}\right) \cdot \alpha_y \cdot \frac{\left(J_{av,y-2}^{E}\right)^2}{T^{E}} & \text{for } J_{av,y-2}^{E} < T^{E} \end{cases} \tag{A4a}$$

$$\alpha_y = \begin{cases} \alpha_0 + \Delta\alpha(y-2021) & \text{for } 2021 \leq y \leq 2025 \\ \alpha_0 + 4\Delta\alpha & \text{for } y > 2025 \end{cases}$$

For the West area:

$$TAC_{W,y} = \begin{cases} \left(\frac{2269.362}{J_{2017}^{W}}\right) \cdot \beta_y \cdot J_{av,y-2}^{W} & \text{for } J_{av,y-2}^{W} \geq T^{W} \\ \left(\frac{2269.362}{J_{2017}^{W}}\right) \cdot \beta_y \cdot \frac{\left(J_{av,y-2}^{W}\right)^2}{T^{W}} & \text{for } J_{av,y-2}^{W} < T^{W} \end{cases} \tag{A4b}$$

$$\beta_y = \begin{cases} \beta_0 + \Delta\beta(y-2021) & \text{for } 2021 \leq y \leq 2028 \\ \beta_0 + 7\Delta\beta & \text{for } y > 2028 \end{cases}$$

The values $35032.314\ mt$ and $2269.362\ mt$ used in equations A4a and b respectively are the ICCAT Task1 catch by management area in 2020 as at April 2022.

Note that in equation (A4a), setting $\alpha_y = 1$ would amount to keeping the East area TAC the same as the corresponding catch in 2020 (as explained above) if the abundance indices stayed at their 2017 level. If α_y or $\beta_y > 1$ harvesting would be more intensive than at that time, and for α_y or $\beta_y < 1$ it would 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 BR CMP, the choices of $T^E = 1$ and $T^W = 1$ have been made.

Constraints on the extent of TAC increase and decrease

$$\Delta TAC^{E/W} = \frac{TAC_y^{E/W}}{TAC_{y-1}^{E/W}} \tag{A5}$$

with $TAC_y^{E/W}$ from equation A4. $\Delta TAC^{E/W}$ is then modified as follows:

$$\Delta TAC^{E/W\prime} = \exp\left(\ln(\Delta TAC^{E/W}) VarCadj\right) \tag{A6}$$

with a control parameter, *VarCadj*, taken for the BR CMP to be 0.5.

$\Delta TAC^{E/W\prime}$ is then constrained to a maximum of 20% up and 30% down (10% down for the phase-in period[4], and 35% down only for PGK 60% with 3-year management cycle)

if $\Delta TAC^{E/W\prime} > (1 + maxUp^{E/W})$ then $\Delta TAC^{E/W\prime} = (1 + maxUp^{E/W})$, or

if $\Delta TAC^{E/W\prime} < (1 - maxDown^{E/W})$ then $\Delta TAC^{E/W\prime} = (1 - maxDown^{E/W})$

The TAC is then computed as:

$$TAC_y^{E/W\prime} = TAC_{y-1}^{E/W} \cdot \Delta TAC^{E/W\prime} \quad \text{(A7)}$$

If minimum TAC change constraints are accepted, the following revisions to these TACs apply:

$$\text{if} \quad \left|TAC_{y-1}^{E/W} - TAC_y^{E/W\prime}\right| < min\Delta TAC^{E/W} \quad \text{(A8)}$$

$$\text{then} \quad TAC^{E/W\prime\prime} = TAC_{y-1}^{E/W}$$

where values suggested for $min\Delta TAC^{E/W}$ have been 100 mt for the West and 1000 mt for the East.

[4] This is for two cycles if the cycle period is two years, but only one cycle if this period is three years.

Table A1. The index periods y_1^i and y_2^i (equation A1).and w^i weights used when averaging over the indices to provide composite indices for the East and the West areas (equation A2).

	East				West			
i	Index	y_1^i	y_2^i	w^i	Index	y_1^i	y_2^i	w^i
1	FR_AER_SUV2	2014	2017	1.33	GOM_LAR_SUV	2006	2017	1.33
2	MED_LAR_SUV	2012	2016	1.66	US_RR_66_144	2006	2018	2.55
3	GBYP_AER_SUV_BAR[5]	2015	2018	1.06	MEXUS_GOM_PLL2	2006	2018	1.39
4	MOR_POR_TRAP	2012	2018	1.43	JPN_LL_West2	2010	2019	3.96
5	JPN_LL_NEAtl2	2012	2019	1.33	CAN_SWNS	2006	2017	2.88

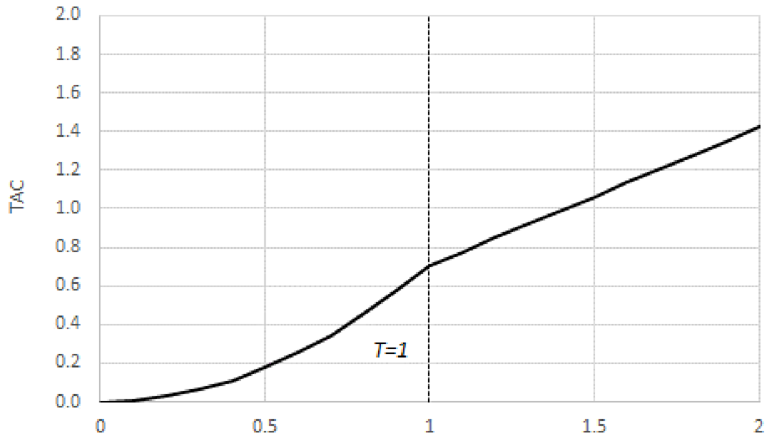


Figure A1. Illustrative relationship (the "catch control law") of *TAC* against $J_{av,y}$ for the BR CMPs, which includes the parabolic decrease below *T*.

[5] For the GBYP aerial survey, there is no value for 2016 and that year was therefore omitted from this averaging.