Collect. Vol. Sci. Pap. ICCAT, 82(4), SCRS/2025/154: 1-10 (2025)

BR MP RUNS UNDER THE OPERATING MODELS FOR ATLANTIC BLUEFIN TUNA MSE RE-CONDITIONED TO INCLUDE THE CLOSE-KIN MARK RECAPTURE ESTIMATE OF WESTERN STOCK SCALE

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SUMMARY

*The current BR MP for ABFT is retuned using re-conditioned OMs provided by Carruthers, which take the west close-kin mark recapture scale estimate for the western stock into account. Of the re-tunings considered, BRn3 is the most comparable to the current MP with a PGK value for the western stock of 0.60, but slightly higher for the eastern stock to ensure that LD*15% for that is not less than 0.40. The resultant tuning parameters are more positive for the East and especially for the West area. Preliminary (not all indices are available yet) calculations indicate that using BRn3 in place of the current MP, the values the 2026 TAC for the East area would remain unchanged with a 20% increase, but for the West area would change from a 6% decrease to a 5% increase. In an Addendum, an alternative re-tuning is considered that sets the West Area control parameter Db=0, and instead changes the value of the b parameter. In the short term, TACs for the West Area are somewhat greater under this alternative MP than for BRn3.*

RÉSUMÉ

*La MP BR actuelle pour le thon rouge de l'Atlantique est recalibrée en utilisant les OM reconditionnés fournis par Carruthers, qui tiennent compte de l'estimation de l'échelle de marquage-récupération de spécimens étroitement apparentés pour le stock de l'Ouest. Parmi les recalibrages étudiés, BRn3 est celle qui est la plus comparable à la MP actuelle avec une valeur de PGK pour le stock de l'ouest de 0,60, mais légèrement supérieure pour le stock de l'Est pour s'assurer que LD*15% n'est pas inférieur à 0,40. Les paramètres de calibrage en résultant sont plus positifs pour l'Est et notamment pour la zone Ouest. Les calculs préliminaires (les indices ne sont pas encore tous disponibles) indiquent que si l'on utilise BRn3 à la place de la MP actuelle, les valeurs du TAC de 2026 pour la zone Est resteraient inchangées avec une augmentation de 20%, mais pour la zone Ouest elles passeraient d'une réduction de 6% à une augmentation de 5%.* Dans un *Addendum, un recalibrage alternatif est étudié qui fixe le paramètre de contrôle de la zone Ouest D*b*=0, et modifie plutôt la valeur du paramètre b. À court terme, les TAC pour la zone Ouest sont légèrement supérieurs dans le cadre de cette MP alternative que pour BRn3.*

RESUMEN

*El actual MP BR para el atún rojo del Atlántico se recalibró utilizando los OM recondicionados proporcionados por Carruthers, que tienen en cuenta la estimación de la escala del estudio de marcado y recaptura de individuos estrechamente emparentados occidental para el stock occidental. De los MP recalibrados considerados BRn3 es el más parecido al MP actual con un valor PGK para el stock occidental de 0,60, pero ligeramente superior para el stock oriental para garantizar que LD*15% no sea inferior a 0,40. Los parámetros resultantes de la calibración fueron más positivos para la zona este y, sobre todo, para la oeste. Los cálculos preliminares (aún no se dispone de todos los índices) indican que utilizando la BRn3 en lugar del actual MP, los valores producidos por el TAC para 2026 para la zona este permanecerían inalterados con un aumento del 20 %, pero para la zona oeste pasarían de una disminución del 6 % a un aumento del 5 %. En una adenda, se plantea una recalibración alternativa que fija el parámetro de control de la zona oeste Db=0, y en su lugar cambia el valor del parámetro b. A corto plazo, los TAC para la zona occidental son algo mayores en este MP alternativo que en el MP BRn3.*

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KEYWORDS

Atlantic bluefin tuna; CKMR estimate; management procedure; performance

Introduction

Following the recent re-conditioning by Tom Carruthers of the ABFT OMs to include the CKMR estimate of western stock scale (these are termed "new OMs" hereafter), results are presented here for a series of MPs based on the BR MP:

1) BR: the original BR MP which was used to provide TAC recommendation for 2023-2025 (tuned to Western and Eastern stock PGK values of 0.60);
2) BRn1: as BR, but with tuning parameter *Db* adjusted so that the Western stock PGK=0.60 for the new OMs;
3) BRn2: as BR but with tuning parameters *Db* and *Da* adjusted so that the Western AND Eastern stock PGK=0.60 for the new OMs; and
4) BRn3: as BR but with tuning parameters *Db* and *Da* adjusted so that the Western stock PGK=0.60 AND the Eastern stock LD*15%=0.40 for the new OMs.

For the BR MP, results are also compared between those for the old OM with the original weights, and the version with the "CKMR" weights (see Butterworth and Rademeyer, 2025) – the latter was a first approximation approach to take account of the effect of the west CKMR estimate on the conditioning.

Results and Discussion

Histograms of the 2016 SSB/SSBMSY values for the Western stock under the old and new OMs are shown in **Figure 1**. The old Reference Set includes 32 fitted OMs (two scale values for the West), while the new Reference Set has only 16 fitted OMs only (one scale value for the West); hence for easier comparison, the frequencies for the new OMs have been doubled. Whereas in 2016, the median SSB/SSBMSY over the old OMs was 0.75, i.e. the western stock was broadly considered to be below its MSY level and hence as needing to recover further, for the new OMs this value increases to 1.12 (above the MSY level). Consequently, catches can be set higher than was previously thought necessary to achieve management targets, and the MP tuning parameter for the West area (*Db*) changes from negative (tending to decrease TACs for the West) to positive, with the opposite effect on those TACs.

The results for the primary MP performance statistics are shown in **Table 1**. Values for the tuning parameters *Da* and *Db* are also given (there are no changes to the other MP parameters compared to those for the current BR MP). The following points are perhaps worth noting.

- Using the new OMs yields fairly similar results to those for the simple approach of Butterworth and Rademeyer (2025) (Old OMs*CKMR weights) (under BR) for the West, but ones that are slightly more positive for the East, particularly in terms of LD*15%.
- The median PGK for the Western stock increases from 0.60 to 0.87 (compared to 0.85 for the earlier simple approach) and Br30, LD10% and LD15% are all higher for this stock.
- Median PGK for the Eastern stock is slightly improved (to 0.66), with LD*10% and LD*15% basically unchanged.
- When tuned to a PGK value of 0.60 for both the Western and Eastern stock (BRn2), the LD*15% statistic for the Eastern stock is slightly below the 0.40 threshold requirement. Consequently, BRn3 has been developed, being tuned so that the Eastern stock LD*15% = 0.40.
- When the BR MP is tuned with the new OMs, AvC30 in both the East and the West are increased, with the latter by a greater proportion.

C1 values under BR (as at present) and BR3n (potential for the future) MPs are listed in **Table 2**, with the index values used for these calculations given in **Table 3**. Note that the most recent values shown there have yet to be confirmed by the SCRS (and a few values are not yet available), so that these results are shown as illustrative examples only and are NOT final/definitive. These illustrative calculations indicate that using BRn3, C1 for the East area would remain unchanged with a 20% increase, whereas that for the West area would change from a 6% decrease to a 5% increase.

References

Butterworth DS and Rademeyer RA. 2025. A brief initial analysis of 'does the west CKMR estimate matter for the ABFT MSE'?. Doc SCRS/2025/049.

Table 1: Stochastic Br30, AvC30, LD*15%, LD*10% and VarC values (weighted medians with 5%- and 95%iles for the OM grid across all simulations) for a series of MPs across all OMs in the grid, for the "old OMs" with original weights, the "old OMs" with WCKMR weights (see Butterworth and Rademeyer, 2025) and the new OMs. AvC30 values are in '000 mt. The tuning parameters Δα and Δβ are also shown (the other tuning parameters are all as for the BR MP).

			PGK	Br30		LD*15%	LD*10%	AvC30		VarC	
EAST		$\Delta\alpha$									
Old OMs*original weights	BR	0.204	**0.60**	1.17	(0.33; 2.20)	0.41	0.33	41.35	(12.38; 72.23)	19.23	(10.26; 30.30)
Old OMs*CKMR weights	BR	0.204	0.60	1.25	(0.13; 2.45)	0.29	0.21	48.08	(11.43; 72.46)	19.57	(10.80; 33.67)
New OMs	BR	0.204	0.66	1.27	(0.33; 2.25)	0.42	0.34	43.49	(12.25; 70.77)	19.16	(10.21; 27.99)
	BRn1	0.204	0.65	1.25	(0.31; 2.23)	0.41	0.33	43.40	(12.18; 70.60)	19.23	(10.23; 28.06)
	BRn2	0.250	**0.60**	1.17	(0.24; 2.15)	0.38	0.28	45.10	(12.66; 73.57)	18.63	(10.68; 28.03)
	BRn3	0.220	0.63	1.23	(0.29; 2.20)	**0.40**	0.31	44.00	(12.35; 71.70)	18.99	(10.29; 28.31)
	WEST	$\Delta\beta$									
Old OMs*original weights	BR	-0.0320	**0.60**	1.25	(0.43; 2.37)	0.40	0.27	2.46	(0.86; 3.60)	11.07	(4.89; 32.07)
Old OMs*CKMR weights	BR	-0.0320	0.85	1.71	(0.84; 2.69)	0.65	0.60	2.33	(1.17; 2.90)	9.98	(5.15; 25.21)
New OMs	BR	-0.0320	0.87	1.63	(0.78; 2.80)	0.68	0.61	2.33	(1.20; 3.03)	9.47	(5.10; 22.59)
	BRn1	0.0272	**0.60**	1.20	(0.57; 2.24)	0.58	0.52	3.31	(1.50; 4.31)	10.98	(6.34; 19.86)
	BRn2	0.0243	**0.60**	1.21	(0.57; 2.24)	0.58	0.52	3.24	(1.44; 4.24)	11.20	(6.26; 19.91)
	BRn3	0.0270	**0.60**	1.20	(0.57; 2.24)	0.58	0.52	3.29	(1.48; 4.29)	11.05	(6.38; 20.61)

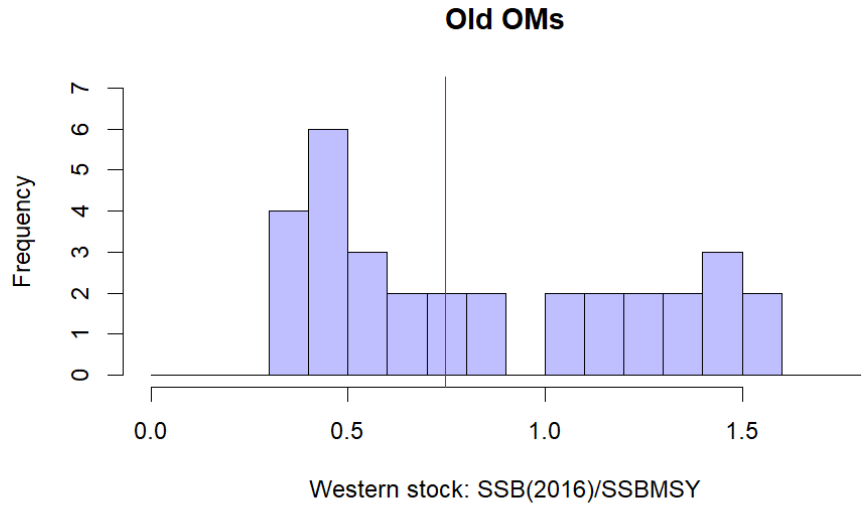
Note: Results for the old OMs are based on the OMs in version 7.7.1 of the ABTMSE package (as used for the development of the current MP in 2022, and therefore identical to those results on which the current MP was selected). Results for the new OMs are based on Carruthers' lite-reconditioned OMs in version 8.0.4 of the ABTMSE package.

Table 2. West and East C1 (2026 TAC) values (in thousand tons) under BR and BRn2. The % changes are with respect to the current TACs. (West 2.726 and East 40.57 thousand tons).

	West C1	East C1
BR	2.556 (-6%)	48.684 (+20%)
BRn3	2.855 (+5%)	48.684 (+20%)

Table 3. Indices used in the C1 computations (recent values kindly provided by J Walter). For some indices their 2024 values are not yet available. Calculations of C1 have assumed those instances being treated as set down in the MP prescription for dealing with missing index values.

	EAST					WEST				
	FR_AER_ SUV2	MED_LAR_ SUV	GBYP_AER _SUV_BAR	MOR_POR_ TRAP	JPN_LL_ NEAtl2	GOM_LAR_ SUV	US_RR_ 66_144	MEXUS_ GOM_PLL	JPN_LL_ West2	CAN_SWNS
2006	-	-	-	-	-	0.562	0.667	0.810	-	1.016
2007	-	-	-	-	-	0.459	0.636	0.470	-	0.728
2008	-	2.293	-	-	-	0.337	0.631	0.750	-	0.804
2009	0.018	-	-	-	-	0.605	0.504	0.640	-	1.246
2010	0.014	-	1659	-	2.214	0.300	0.800	0.470	0.553	1.470
2011	0.026	10.894	1392	-	3.754	1.149	0.711	0.910	1.879	1.170
2012	0.018	31.314	-	101.6	8.229	0.269	0.773	1.560	2.476	1.074
2013	-	49.742	2393	139.7	6.807	0.983	1.225	0.720	1.987	0.709
2014	0.063	24.029	-	68.8	7.747	0.267	0.733	1.330	2.126	0.939
2015	0.027	41.620	4766	106.3	6.241	0.391	0.353	1.980	1.320	0.973
2016	0.107	36.934	-	104.3	5.772	2.389	0.541	1.580	3.287	1.101
2017	0.069	83.684	9300	118.8	7.034	0.989	0.856	1.240	3.668	1.019
2018	0.031	-	15569	78.7	8.412	2.022	0.627	1.530	6.771	0.927
2019	0.063	54.592	13797	108.4	8.074	1.484	1.161	1.720	5.682	1.231
2020	0.136	118.557	-	113.0	5.944	-	1.570	1.350	4.375	1.429
2021	0.097	-	5325	172.0	6.138	1.953	2.020	1.780	3.616	1.563
2022	0.054	52.086	10375	139.6	4.696	-	0.944	2.320	3.552	1.498
2023	0.101	109.587	10597	-	2.940	3.076	0.744	1.890	2.425	1.562
2024	-	-	2200	356.9	5.400	1.550	2.249	-	7.123	1.408



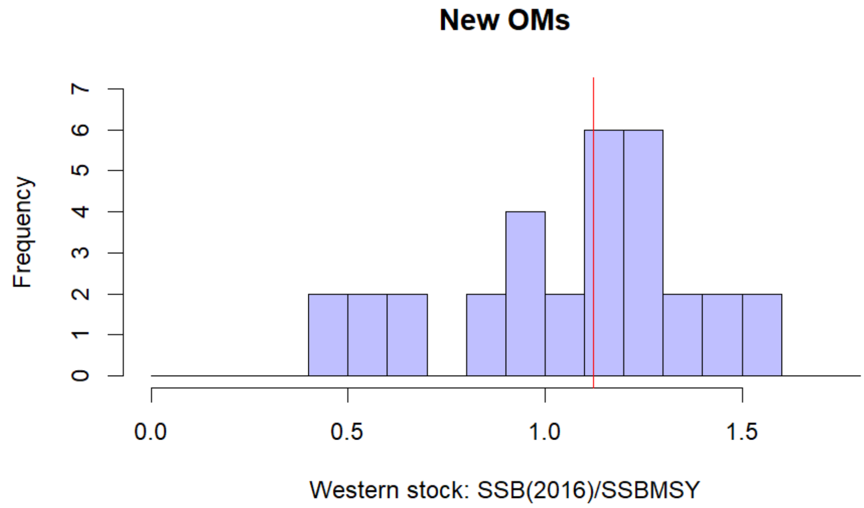


Figure 1. Western stock 2016 SSB/SSBMSY estimates across OMs for the old and new Reference Sets. The old Reference Set includes 32 fitted OMs (two scale values for the Western stock), while the new Reference Set has 16 fitted OMs only (one scale value for the Western stock). For ease of comparison, the frequencies of the new OMs have been doubled. The vertical red lines indicate medians. The SSB/SSBMSY values have been extracted from the OM report files provided by Carruthers.

Addendum 1

Introduction

BR, BRn1, BRn2, BRn3 are as described in the main document. In BRn4 and BRn5, for the West Area TAC, the *Db* parameter is set to 0 and the MP is tuned for the west using the *b* parameter only

1) BRn4: as BR but with tuning parameters *Db*=0, and *b* and *Da* adjusted so that for the Western and Eastern stocks PGK=0.60 for the new OMs that include the west CKMR estimate.

2) BRn5: as BR but with tuning parameters *Db*=0, together with *b* and *Da* adjusted so that for the Western stock PGK=0.60 AND for the Eastern stock LD*15%=0.40 for the new OMs that include the west CKMR estimate.

The original BR MP was developed in a situation when the Western stock was considered to be below B_{MSY}, This necessitated the introduction of the *Db* parameter into the MP to reduce TACs in the short term to secure rebuilding, while avoiding very large TAC reductions. Now that the OMs updated with the west CKMR information suggest instead that the Western stock exceeds B_{MSY}, this may no longer be necessary, and may impede optimal MP performance. This motivates the consideration of MPs fixing *Db*=0.

Results and Discussion

The results for the MP performance statistics are shown in **Table Add1**. Values for the tuning parameters *a, Da*, *b* and *Db* are also given (there are no changes to the other MP parameters compared to those for the current BR MP).

SSB and TAC projections (medians and lower 5%iles) are shown in Figure Add1 for BR3n and BR5n. Both of these meet the same performance thresholds in terms of PGK and LD*15% than were met by the original BR MP for the earlier OMs. Note that in the short term, TACs for the West Area are somewhat greater under BRn5 than for BRn3.

The Appendix provides a full specification of the BR MP approach.

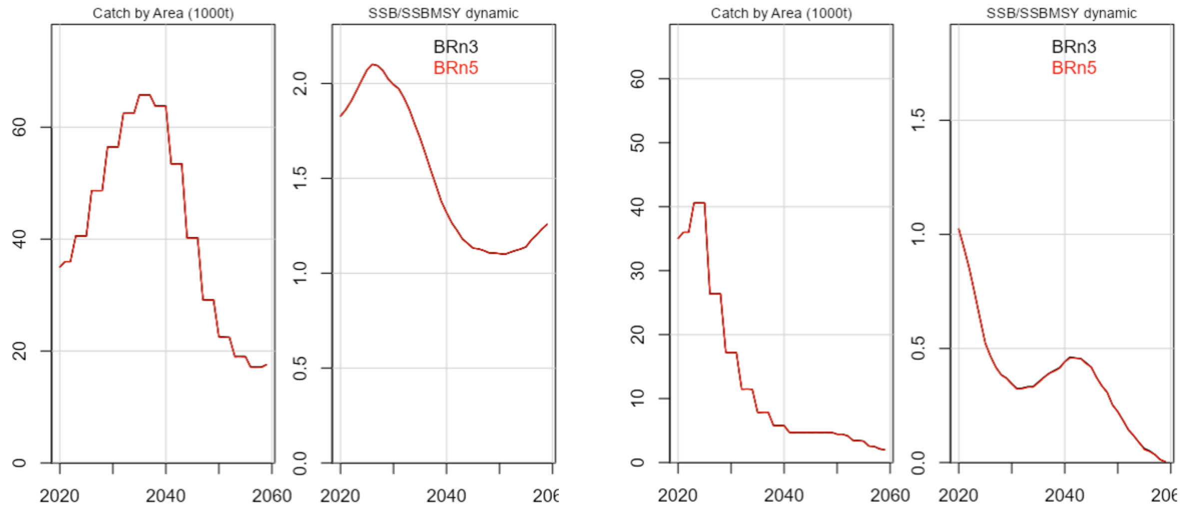
Table Add1: Stochastic Br30, AvC30, LD*15%, LD*10% and VarC values (weighted medians with 5%- and 95%iles for the OM grid across all simulations) for a series of MPs across all OMs in the grid, for the new OMs. AvC30 values are in '000 mt. The tuning parameters *a, Da*, *b* and *Db* are also shown (the other tuning parameters are all as for the BR MP).

				PGK	Br30	LD*15%	LD*10%	AvC30	VarC
EAST		α	$\Delta\alpha$						
New OMs	BR	1.235	0.204	0.66	1.27 (0.33; 2.25)	0.42	0.34	43.49 (12.25; 70.77)	19.16 (10.21; 27.99)
	BRn1	1.235	0.204	0.65	1.25 (0.31; 2.23)	0.41	0.33	43.40 (12.18; 70.60)	19.23 (10.23; 28.06)
	BRn2	1.235	0.250	**0.60**	1.17 (0.24; 2.15)	0.38	0.28	45.10 (12.66; 73.57)	18.63 (10.68; 28.03)
	BRn3	1.235	0.220	0.63	1.23 (0.29; 2.20)	**0.40**	0.31	44.00 (12.35; 71.70)	18.99 (10.29; 28.31)
	BRn4	1.235	0.250	**0.60**	1.17 (0.23; 2.14)	0.38	0.28	45.08 (12.64; 73.53)	18.91 (10.76; 28.11)
	BRn5	1.235	0.220	0.63	1.23 (0.29; 2.21)	**0.40**	0.31	43.99 (12.34; 71.68)	18.88 (10.28; 28.16)
	WEST	β	$\Delta\beta$						
New OMs	BR	0.81	-0.0320	0.87	1.63 (0.78; 2.80)	0.68	0.61	2.33 (1.20; 3.03)	9.47 (5.10; 22.59)
	BRn1	0.81	0.0272	**0.60**	1.20 (0.57; 2.24)	0.58	0.52	3.31 (1.50; 4.31)	10.98 (6.34; 19.86)
	BRn2	0.81	0.0243	**0.60**	1.21 (0.57; 2.24)	0.58	0.52	3.24 (1.44; 4.24)	11.20 (6.26; 19.91)
	BRn3	0.81	0.0270	**0.60**	1.20 (0.57; 2.24)	0.58	0.52	3.29 (1.48; 4.29)	11.05 (6.38; 20.61)
	BRn4	0.97	**0.0000**	**0.60**	1.20 (0.57; 2.24)	0.56	0.50	3.28 (1.44; 4.31)	11.37 (7.19; 20.88)
	BRn5	0.98	**0.0000**	**0.60**	1.21 (0.57; 2.24)	0.56	0.50	3.32 (1.47; 4.36)	11.32 (7.14; 20.84)

Note: Results for the new OMs are based on Carruthers' lite-reconditioned OMs in version 8.0.4 of the ABTMSE package.

EAST

Median   Lower 5%ile



WEST

Median   Lower 5%ile

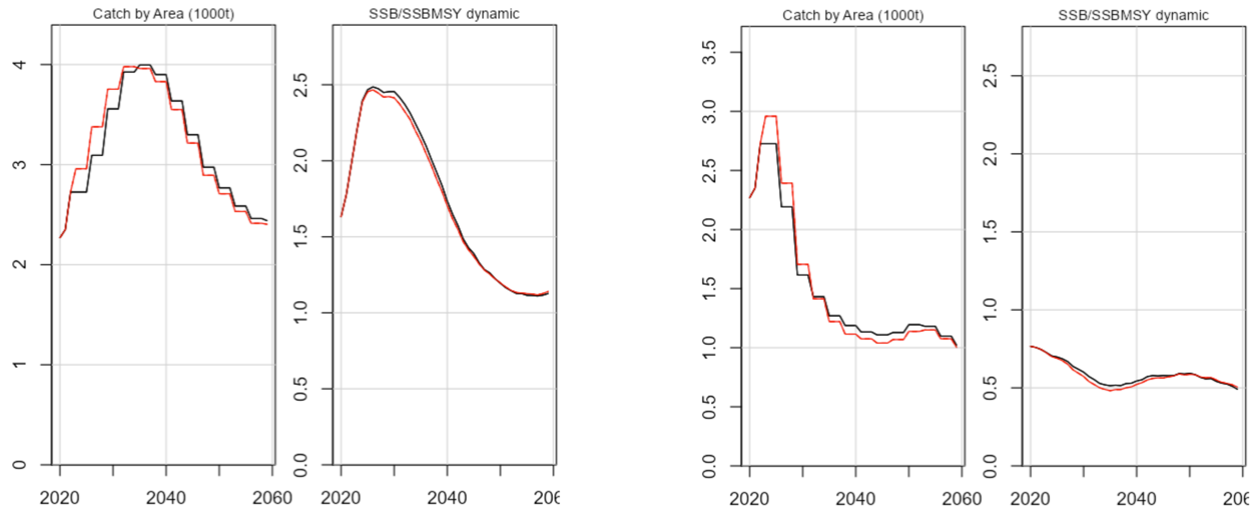


Figure Add1. Median (LHS) and lower 5%ile (RHS) catch (by area) and SSB (by population) projections averaged over all new OMs in the grid and the replicate simulations for BRn3 and BRn5.

Appendix 1

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[2] 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:

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

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):

$$J_y^{E/W} = \frac{\sum_i^n w_i \times I_y^{i*}}{\sum_i^n w_i} \tag{A2}$$

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:

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

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).

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

For the East area:

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

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

For the West area:

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

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

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[3], 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:

$$TAC_y^{E/W\prime} = TAC_{y-1}^{E/W} \cdot \Delta TAC^{E/W\prime} \tag{A7}$$

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

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

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

[3] 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[4]	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

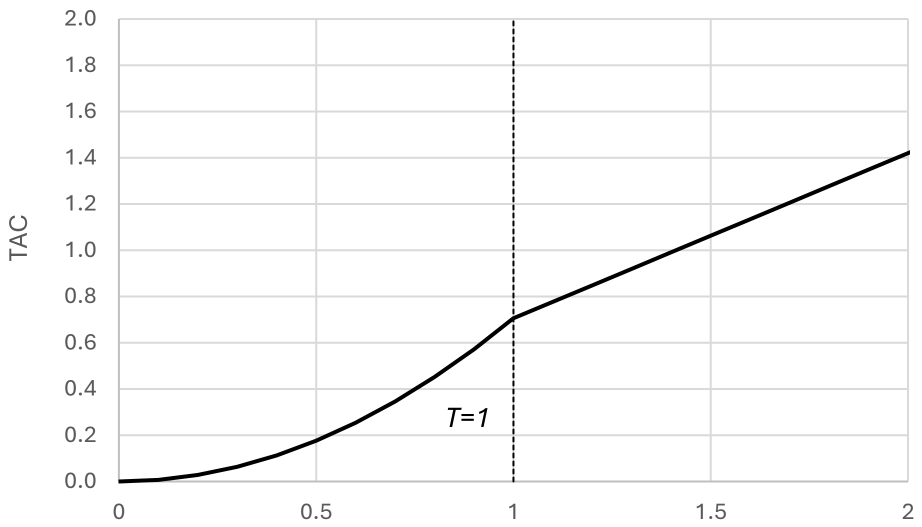


Figure A1. Illustrative relationship (the "catch control law") of *TAC* against $J_{av,y}$ for the BR CMPs, which includes the parabolic decrease below *T*.

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