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FURTHER REFINEMENTS OF THE BR CMP

D.S Butterworth, and R.A Rademeyer[1]

SUMMARY

Imposition of a cap on the East area TAC and introduction of a downward adjustment of West area TACs if abundance indices show a downward trend leads to what are considered to be two trade-off improvements in the BR CMP performance. Respectively these are higher West area TACs (though at the expense of lower East area TACs), and improved final abundances for the Western stock for especially the most "difficult" R3 OMs. However, a concern that still needs to be addressed is cases for the R2 scenario where the TACs for the East area can drop to levels in the 10 kt vicinity; this is although the Eastern stock status has climbed to generally well above B_{MSY} *after 30 years, and hence catches would not seem to need to have been reduced so low.*

RÉSUMÉ

L'imposition d'un plafonnement du TAC de la zone Est et l'introduction d'un ajustement à la baisse des TAC de la zone Ouest si les indices d'abondance montrent une tendance à la baisse conduisent à ce qui est considéré comme deux améliorations des performances de la CMP BR. Il s'agit respectivement de TAC plus élevés de la zone Ouest (mais au détriment de TAC plus faibles de la zone Est), et d'abondances finales améliorées pour le stock occidental, notamment pour les OM R3 les plus "difficiles". Toutefois, il reste encore à dissiper la préoccupation concernant les cas pour le scénario R2, où les TAC pour la zone Est peuvent chuter à des niveaux proches de 10 kt, même lorsque l'état du stock de l'Est a atteint un niveau généralement bien supérieur à B_{PME} *après 30 ans, et donc les captures ne sembleraient pas avoir besoin d'être réduites aussi bas.*

RESUMEN

La imposición de un tope en el TAC de la zona este y la introducción de un ajuste a la baja de los TAC de la zona oeste si los índices de abundancia muestran una tendencia a la baja conducen a lo que se consideran dos mejoras del desempeño del CMP BR. Respectivamente, se trata de TAC más elevados en la zona occidental (aunque a expensas de TAC más bajos en la zona oriental), y de una mejora de las abundancias finales del stock occidental, especialmente para los OM R3 más "difíciles". Sin embargo, una preocupación que aún debe abordarse es la de los casos del escenario R2, en el que los TAC de la zona oriental pueden descender a niveles cercanos a 10 kt; esto es así a pesar de que el estado del stock oriental ha subido hasta situarse, en general, muy por encima del RMS después de 30 años y, por lo tanto, no parecería necesario que las capturas se redujeran tanto.

KEYWORDS

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

[1] Marine Resource Assessment and Management Group (MARAM), Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch 7701, South Africa

Introduction

This document describes the outcome of some attempts to improve the performance of the BR CMP compared to that of the version presented in SCRS/2020/160.

The key areas of poor performance where improvement has been sought have been:

a) Increasing the average catch in the West area.
b) Not depleting the Western stock as much for the most pessimistic scenarios amongst the R3 recruitment OMs which involve a future regime shift.

Description of the BR CMP

The full description of the BR CMP is given in **Appendix 1**. The refinements applied since the version specified in SCRS/2020/160 are summarized below:

1. An update of the East average historical (2017) index computation (see equation A2).
2. A 45 000t cap on the annual TAC in the East.
3. A quadratic instead of cubic form for the catch control law.
4. Adding an abundance index trend term to the West TAC computations (informed by the success of this approach for the Carruthers CMP).

Note that refinement 2 targets objective A) above: reducing the maximum catch in the East area keeps abundance of the Eastern stock higher, resulting in larger numbers of the Eastern stock in the West area. This enables larger catches to be taken in the West area without jeopardizing the Western stock because a greater proportion of these West area catches comprise Eastern origin bluefin.

Refinement 4 targets objective B) by enabling a faster reduction of TACs following a regime shift to a less productive scenario for the Eastern stock through detection of a downward trend in abundance in the West area (where the Eastern origin bluefin are contributing to that abundance).

Results and Discussion

Table 1 lists the CMPs presented here, with their control parameter values. The deterministic Br30 and AvC30 values (medians and 90%iles across the full interim grid of OMs) for each of the CMPs are given in **Table 2. Figure 1** is a visual representation of these results, which is separated for each of the three recruitment scenarios as the results for each are qualitatively different in important ways.

The deterministic Br30 values under BR_1 and BR_6 for each of the 96 OMs of the interim grid are compared in **Figure 2. Figure 3** compares median (**Figure 3a**) and lower 5%ile (**Figure 3b**) catch and biomass projections for BR_1 and BR_6, for each of the three recruitment scenarios.

Table 2 indicates how successful placing a cap on the East area TAC has been in addressing objective A) of increasing catches in the West area. Changing from BR_0 to BR_1, which includes suggested cap of 40 kt for the East area TAC, increases the mean AvC30 in the West area from 1.74 to 2.25 kt. The latter is more in line with recent decisions for the West area TAC, but this increase comes at the expense of a reduction of about 10 kt to AvC30 for the East area. The current final CMP suggestion, BR_6, includes an increase in the suggested East area cap to 45 kt, which compared to BR_1 results in an increase of AvC30 for the East area from about 35 to 38 kt, but a related decrease for the West area from 2.25 to 2.05 kt.

The results shown in **Figure 1** illustrate key differences amongst the three recruitment scenarios. Lower AvC30 values might have been expected for the R3 compared to the R1 scenario for both the East and West areas as a result of the regime shift to lower recruitment for the Eastern stock. Importantly also though, this Figure shows a major difference between results for the R1 and R2 scenarios. For both stocks, Br30 values are lower for the R2 scenarios, and for these the East area AvC30 values drop below 20 kt, which is some 50% or more less than for the R1 and R3 scenarios.

Figure 2 speaks to how well introducing the extra abundance index slope term in the TAC formula for the West area has addressed poor conservation performance for some R3 OMs – objective B). For BR_6 compared to BR_1, there is an appreciable increase in Br30 values for the Western stock under problematic R3 scenarios OM9 (3AII—L) and OM24 (3BII-+L). There is a co-incident decrease in the corresponding values for the Eastern stock, but all remain above about 0.7. This seems a reasonable trade-off, though a few R3 OMs still reflect Br30 values below 0.5 for the Western stock.

Notwithstanding these seeming improvements in trade-off performance, there remains an unsatisfactory aspect of the performance of BR_6, which is the low 5%-ile for AvC30 for the East area of some 12kt (lower still if only R2 scenarios are considered) – see **Table 2 and Figure 1b**. This low East area catch seems unnecessary for the R2 scenarios for which Br30 values for the Eastern stock are above (and many well above) 1 for all the OMs concerned. **Figure 3** (both part a for medians and part b for lower 5%-iles) provides some insight into the reason. From the start of CMP implementation, abundance decreases; **however** East area catches increase for a few years before being reduced dramatically. Nevertheless, it takes time before the abundance trend for the Eastern stock, which has been driven to a low and less productive level, reverses and eventually allows TACs in the East area to increase again back towards levels in the neighbourhood of 20 kt. Priority for further refinement of this CMP will be to ameliorate this potentially large drop in the TAC for the East area.

Table 1. Parameter values for each of the CMPs presented here. The tuning is for West median Br30 = 1.

CMP name	α	β	γ	$s^{threshold}$	Note
BR_0	1.500	0.600			=BR_1 of doc160
BR_1	1.500	0.768	-	-	40 000t cap in East (=BR_4 of doc160)
BR_2	2.000	0.760	-	-	as BR_1 but 2017 East av. index updated
BR_3	2.000	0.735	-	-	as BR_2 but with 45 000t cap in East
BR_4	2.000	0.705	-	-	as BR_3 but quadratic instead of cubic
BR_5	2.000	0.735	5	0	as BR_4 but with extra trend component
BR_6	2.000	0.750	10	0	as BR_4 but with extra trend component

Table 2. Deterministic Br30 and AvC30 values (median of the RS) for each of the CMPs. AvC30 values are in '000 mt.

		Br30	AvC30
EAST			
Zero catch		3.41 (2.10; 4.13)	0.00 (0.00; 0.00)
BR_0	=BR_1 of doc160	1.52 (0.48; 2.14)	44.54 (9.85; 63.13)
BR_1	40 000t cap in East (=BR_4 of doc160)	1.81 (0.98; 2.85)	34.70 (9.30; 39.73)
BR_2	as BR_1 but 2017 East av. index corrected	1.81 (1.01; 2.85)	34.17 (9.30; 39.73)
BR_3	as BR_2 but with 45 000t cap in East	1.80 (0.93; 2.69)	36.37 (9.74; 44.28)
BR_4	as BR_3 but quadratic instead of cubic	1.49 (0.80; 2.69)	38.33 (12.45; 44.28)
BR_5	as BR_4 but with extra slope comp. (γ=5)	1.49 (0.80; 2.69)	38.34 (12.44; 44.28)
BR_6	as BR_4 but with extra slope comp. (γ=10)	1.50 (0.80; 2.69)	38.34 (12.44; 44.28)
WEST			
Zero catch		2.78 (1.49; 3.31)	0.00 (0.00; 0.00)
BR_0	=BR_1 of doc160	1.00 (0.35; 1.90)	1.74 (1.28; 2.59)
BR_1	40 000t cap in East (=BR_4 of doc160)	1.00 (0.30; 1.90)	2.25 (1.52; 3.30)
BR_2	as BR_1 but 2017 East av. index corrected	1.00 (0.32; 1.91)	2.24 (1.51; 3.30)
BR_3	as BR_2 but with 45 000t cap in East	1.00 (0.32; 1.92)	2.16 (1.46; 3.16)
BR_4	as BR_3 but quadratic instead of cubic	0.99 (0.31; 1.94)	2.09 (1.46; 3.04)
BR_5	as BR_4 but with extra slope comp. (γ=5)	1.00 (0.34; 1.92)	2.06 (1.48; 3.12)
BR_6	as BR_4 but with extra slope comp. (γ=10)	1.00 (0.36; 1.91)	2.05 (1.49; 3.16)

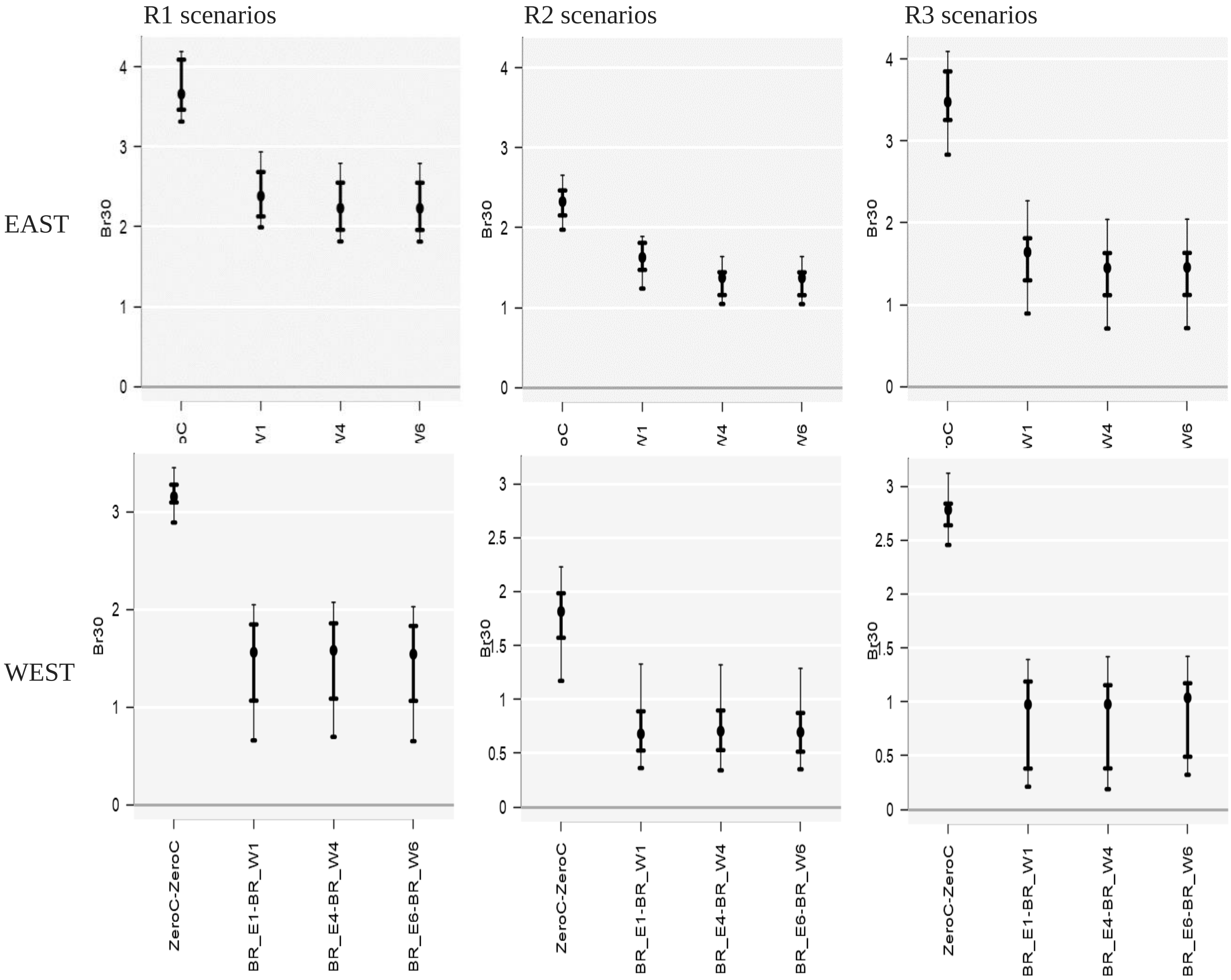

Figure 1a. Deterministic Br30 values for three of the CMPs considered over the interim grid of OMs for each of the recruitment scenarios separately, showing median, interquartile and 90%-ile range.

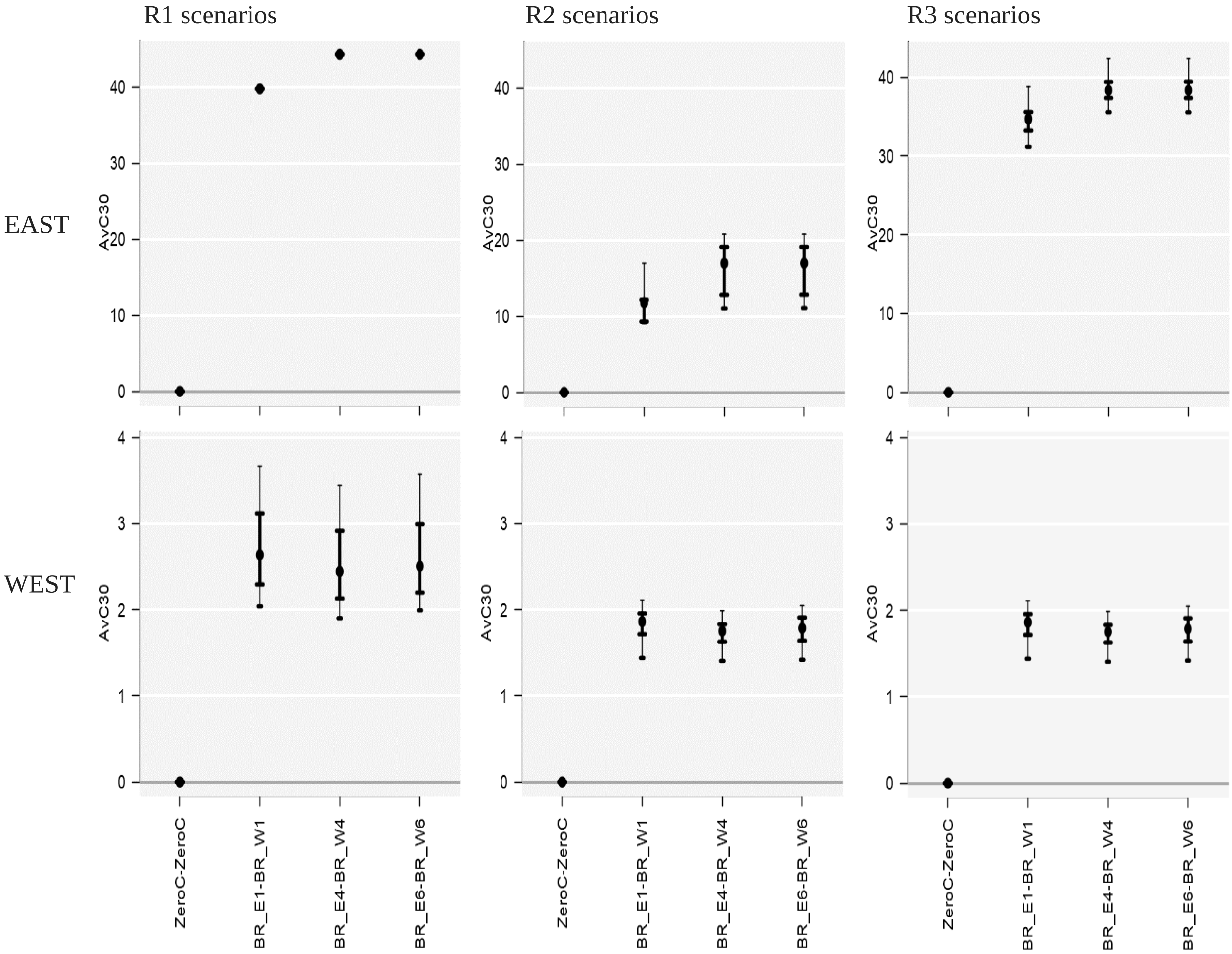

Figure 1b. Deterministic AvC30 values for zero catch and three of the CMPs (BR_1, BR_4 and BR_6) considered over the interim grid of OMs for each of the recruitment scenarios separately, showing median, interquartile and 90%-ile range.

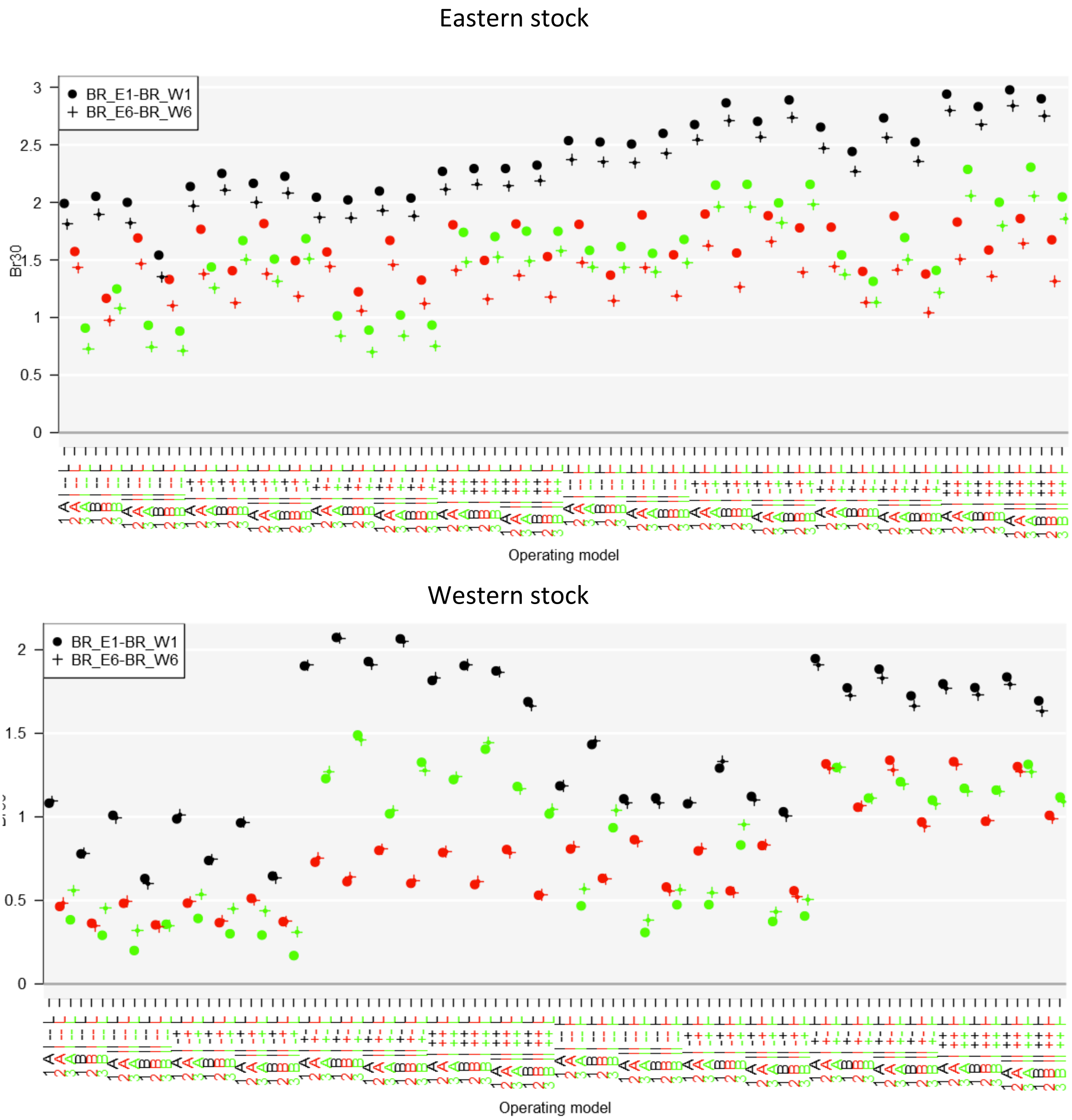

Figure 2. Deterministic Br30 results for BR_1 and BR_6. The three colours correspond to the three recruitment scenarios: black, red and green to R1, R2 and R3 respectively.

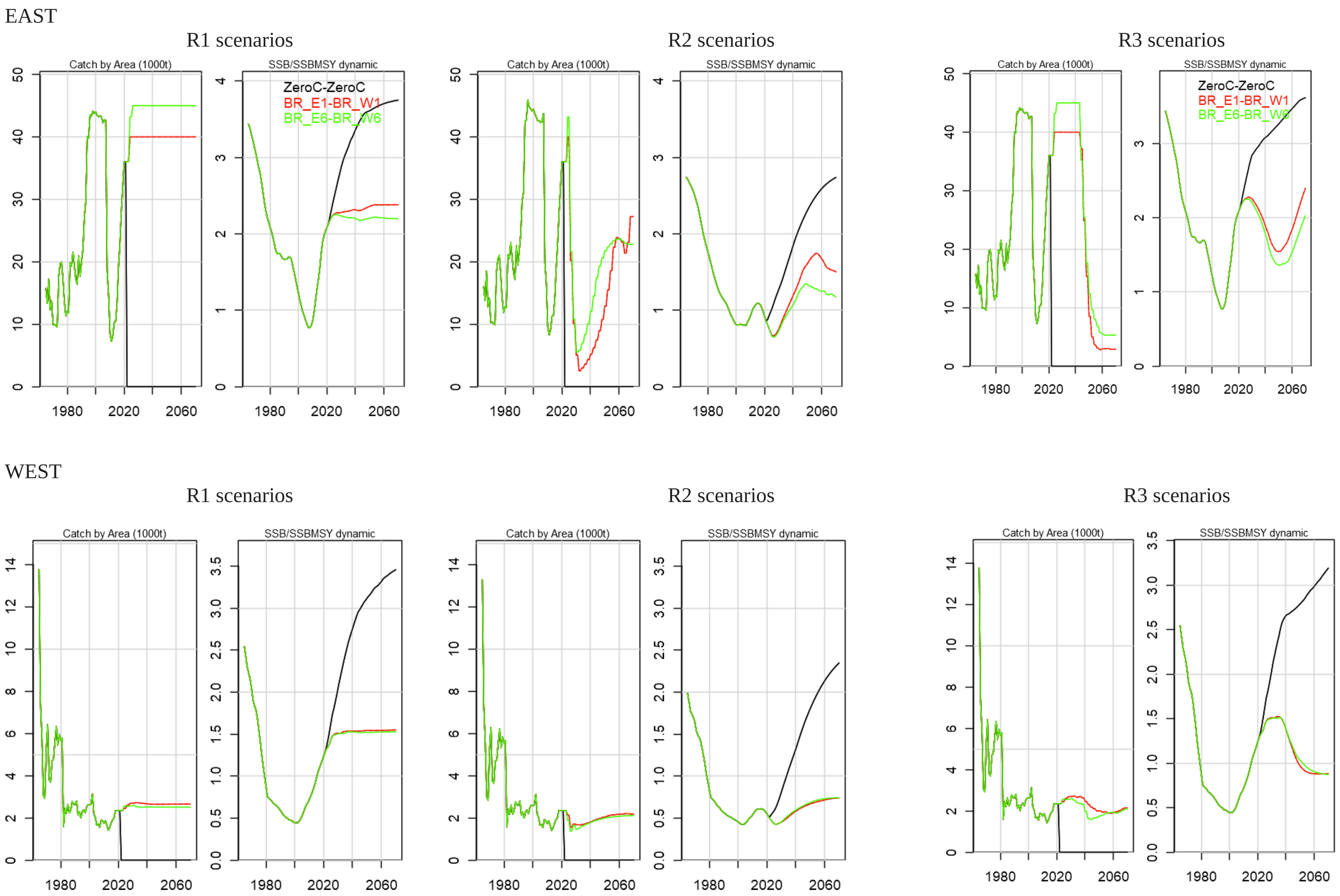

Figure 3a. Median catch and SSB/SSBMSY projections under zero catch and BR_1 and BR_6, for each of the three recruitment scenarios separately.

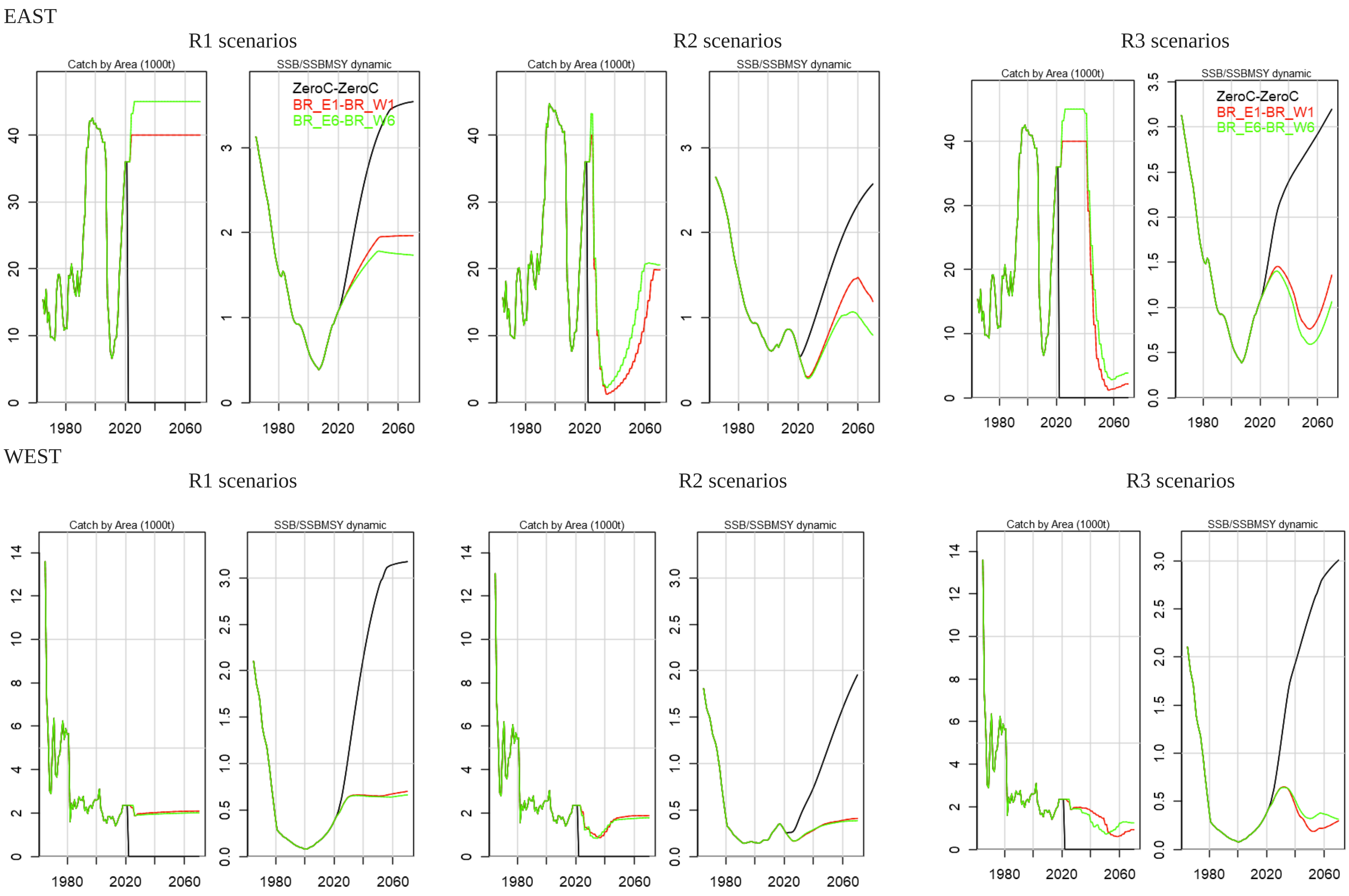

Figure 3b. Lower 5%ile catch and SSB/SSBMSY projections under zero catch and BR_1 and BR_6, for each of the three recruitment scenarios separately.

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 is an average index over *n* series (*n*=5 for the East area and *n*=7 for the West area)[3]:

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

Where

$$w_i = \frac{1}{(\sigma^i)^2}$$

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.

2017 is used for the "average of historical I_y^i". For the East, the 2017 Mediterranean larval survey index value was not previously available, but is now and so has been included in the computation.

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

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

where the *J* applies either to the East or to the West area.

[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 US_GOM_PLL2 indices, 2010-2019 for JPN_LL_West2 and 2006-2017 for CAN_SWNS.

[3] For the aerial surveys, there is no value for 2013, 2018 and 2019 (French) and 2017-2019 (Mediterranean). For GBYP aerial survey there is no value for 2012, 2014, 2016 and 2019. For MOR_POR_TRAP survey, there is no value for 2019. These years were omitted from this averaging where relevant.

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 or down). The formulae are given below.

For the East area:

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

(A4a)

For the West area:

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

(A4b)

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

Maximum increase:

If $TAC_{i,y} \geq 1.2 * TAC_{i,y-1}$ then $TAC_{i,y} = 1.2 * TAC_{i,y-1}$ (A5)

with the subscript *i* corresponding to either East or West area.

Maximum decrease:

If $TAC_{i,y} \leq 0.8 * TAC_{i,y-1}$

then $TAC_{i,y} = (1 - maxdecr) * TAC_{i,y-1}$ (A6)

where

$$maxdecr = \begin{cases} 0.2 & J^{i}_{av,y-2} \geq J_{i,2017} \\ \text{linear btw 0.2 and } D & J_{i,2017} < J^{i}_{av,y-2} < J_{i,2017} \\ 0.5 & J^{i}_{av,y-2} \leq 0.5 J_{i,2017} \end{cases} \quad \text{(A7)}$$

where *D* has been set to 0.5 or 0.3 in implementations to date.

Maximum TAC

A cap on the maximum allowable TAC is set. This can potentially improve performance, particularly in the event of a shift to a lower productivity regime. By ensuring that TACs have not risen so high that they cannot be reduced sufficiently rapidly following such an event to adjust for the lower resource productivity. In investigations to date, this has been found to be useful to implement only for the East area, where TACs can otherwise rise to in excess of 70 kt.

New trend-based term in the West

The TAC in the West is further adjusted if a measure of immediate past trend in the indices is below a threshold value:

If $s_y^W \leq s^{threshold}$

$$TAC_{W,y} \rightarrow \left[1 + \gamma\left(s_y^W - s^{threshold}\right)\right]TAC_{W,y} \quad \text{(A8)}$$

where
s_y^W is a measure of the immediate past trend in the average index J_y (equation 1), and
γ and $s^{threshold}$ are control parameter values.

This trend measure is computed by linearly regressing lnJ_y *vs* year y' for y'=y-6 to y'=y-2 to yield the regression slope s_y^W.

Table A1. σ^i values used in weighting when averaging over the indices to provide composite indices for the East and the West areas (see equation A1).

EAST		WEST	
Index name	σ^i	Index name	σ^i
MOR_POR_TRAP	0.56	GOM_LAR_SUV	0.58
JPN_LL_NEAtl2	0.45	JPN_LL_West2	0.62
FR_AER_SUV2	1.00	US_RR_66_114	1.47
GBYP_AER_SUV_B.	0.56	US_RR_115_144	0.71
MED_LAR_SUV	0.56	US_RR_177	1.29
		US_GOM_PLL2	0.89
		CAN SWNS	1.71

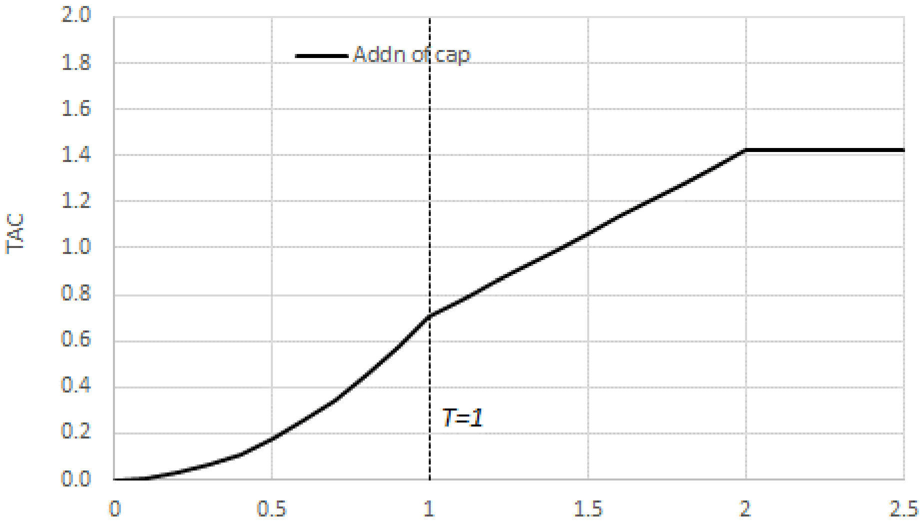

Figure A1. Illustrative relationship (the "catch control law") of *TAC* against $J_{av,y}$ for the BR CMP, which includes the parabolic decrease below T and the capping of the TAC so as not to exceed some maximum value.