EFFECTS OF TUNING TO ALTERNATIVE RECRUITMENT SCENARIOS IN THE ATLANTIC BLUEFIN TUNA MSE ON PERFORMANCE OF THE PW CANDIDATE MANAGEMENT PROCEDURE

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SUMMARY

We evaluated the effects of the alternative recruitment assumptions in the Atlantic bluefin tuna MSE on the performance of the PW candidate management procedure. We deterministically tuned the CMP to the 30-year biomass ratio (Br30) estimates to each individual recruitment scenario separately (R1, R2, R3), then all recruitment scenarios (RA), and finally, recruitment levels 1 and 2 only (R12). We found that tuning to recruitment scenario 1 resulted in the most aggressive CMP, while tuning to recruitment scenario 2 resulted in the least aggressive CMP. Notably, the impact of including recruitment level 3 was minimal, as demonstrated by similar performance and outcomes of RA scenario compared to the R12 scenario.

RÉSUMÉ

Nous avons évalué les effets d'autres postulats de recrutement dans la MSE du thon rouge de l'Atlantique sur la performance de la procédure de gestion potentielle PW. Nous avons ajusté de façon déterministe la CMP sur les estimations du ratio de biomasse sur 30 ans (Br30) pour chaque scénario de recrutement séparément (R1, R2, R3), puis sur tous les scénarios de recrutement (RA) et finalement sur les niveaux de recrutement 1 et 2 uniquement (R12). Nous avons constaté que l'ajustement sur le scénario de recrutement 1 a donné lieu à la CMP la plus agressive, tandis que l'ajustement sur le scénario de recrutement 2 a donné lieu à la CMP la moins agressive. Notamment, l'impact de l'inclusion du niveau de recrutement 3 était minime, comme le démontrent les performances et les résultats similaires du scénario RA par rapport au scénario R12.

RESUMEN

Se han evaluado los efectos de los supuestos alternativos de reclutamiento en la MSE del atún rojo del Atlántico sobre el desempeño del procedimiento de ordenación candidato PW. Se ha calibrado de forma determinista el CMP a las estimaciones de la ratio de biomasa de 30 años (Br30) de cada escenario de reclutamiento individual por separado (R1, R2, R3), luego a todos los escenarios de reclutamiento (RA) y, por último, sólo a los niveles de reclutamiento 1 y 2 (R12). Se halló que la calibración al escenario de reclutamiento 1 tuvo como resultado el CMP más agresivo, mientras que la calibración al escenario de reclutamiento 2 tuvo como resultado el CMP menos agresivo. En particular, el impacto de incluir el nivel de reclutamiento 3 fue mínimo, como lo demuestran el desempeño y los resultados similares del escenario RA en comparación con el escenario R12.

KEYWORDS

ABTMSE, Recruitment scenario, Tuning, CMP, Reference grid, PW

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1. Background

During recent Atlantic bluefin tuna MSE scientific review and discussions of provisional findings, questions were raised about the selected axes of uncertainty and weighting within the reference operating model grid. Specifically, evaluation of the effects of the alternative recruitment assumptions used to tune the CMPs was requested. This included assessing the impact of including versus excluding Recruitment level 3 (Rec3) on the resulting tuning and CMP performance. To address this, we analysed the PW candidate management procedure performance metrics across a range of scenarios, including tuning to individual recruitment scenarios, tuning to all recruitment scenarios, and tuning to recruitment levels 1 and 2 only.

2. Methods

We deterministically tuned PW CMP performance (see Appendix for mathematical description) to the five recruitment scenarios, which included each recruitment level separately (R1, R2, R3), recruitment levels 1 and 2 jointly (R12), and all recruitment levels jointly (RA) to investigate the effect of recruitment level tuning on performance metrics of the full OM reference grid. Using the ABTMSE package (v. 7.4.7), we tuned PW for this analysis. Each CMP was tuned using Br30_wt() to tuning level 2 (1.25, 1.5) using only OMs within each Recruitment level scenario. PW applies a constant relative harvest rate (ConstU, where relative harvest rate = catch/relative abundance) to adjust TAC advice relative to the reference period (2014-2016). Results are presented with the help of the ABT MSE Shiny app (https://apps.bluematterscience.com/ABTMSE_prelim/).

3. Results and Discussion

The effect of tuning to specific recruitment scenarios impacted the aggressiveness of the tuning parameters. As such, the R1 CMPs were the most aggressive, while R2 was the most conservative. R2 was the least similar to the rest of the CMPs (**Figures 1-5**). Similar results could be obtained by adopting alternate tuning targets for the full OM reference grid (**Table 1**).

Overall performance of CMPs was similar, other than the impacts of more/less aggressive tunings, which particularly impacted the minimum observed values and distributions of resulting performance metrics (e.g., see the ‘tails’ in Br30 violins, **Figure 2**).

By comparing tunings and CMP results for RA and R12, we determined that the addition of Recruitment scenario 3 had a relatively minimal impact on the overall tuning of PW, compared to the R12 scenario which excluded Recruitment scenario 3.

References

Tom Carruthers (2022). ABTMSE: Atlantic Bluefin Tuna Management Strategy Evaluation. R package version 7.4.7.

Table 1. Weighted Br30 values in the East and West of the full reference grid when PW was deterministically tuned to each recruitment level (R1, R2, R3), recruitment levels 1 and 2 (R12), and all recruitment levels (RA).

PW CMP	***East Br30***	***West Br30***
RA	1.50	1.25
R1	1.12	1.02
R2	1.93	1.61
R3	1.35	1.43
R12	1.61	1.21

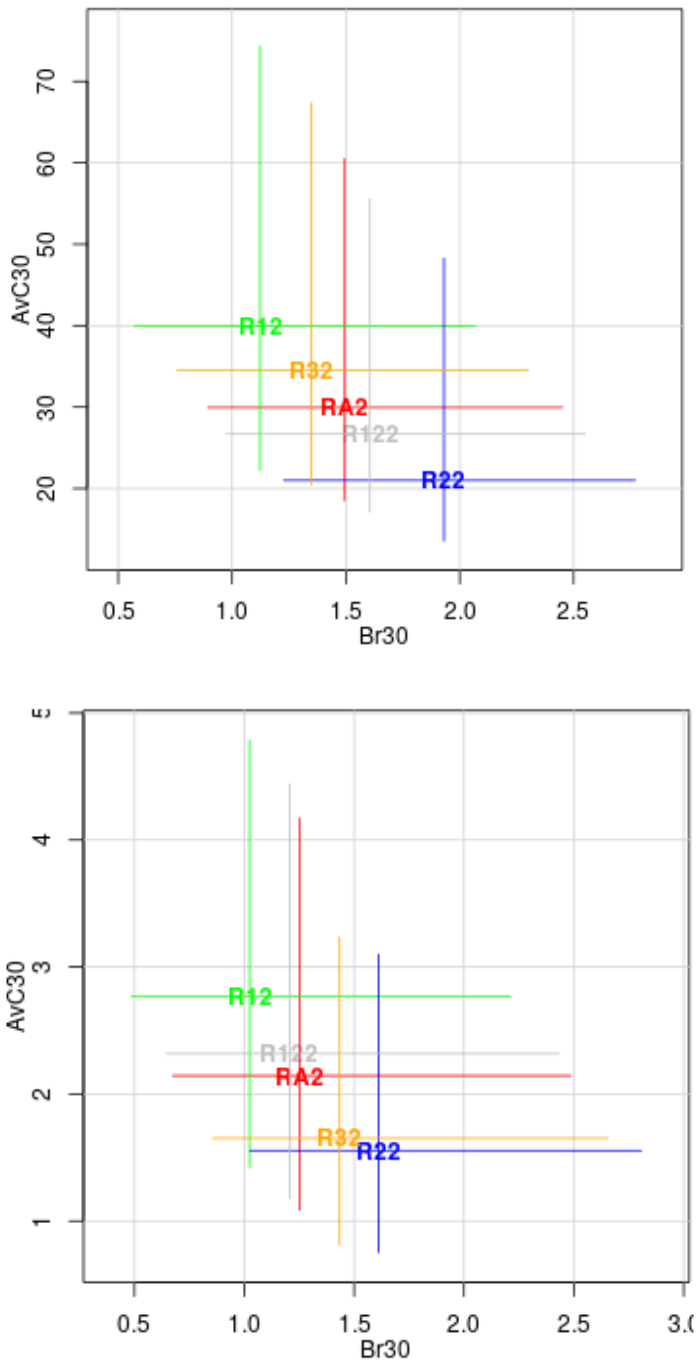

Figure 1. Trade-off plots depicting trade-off space between Br30 and AvC30 for RA, R1, R2, R3, R12 across the reference OM grid as obtained from the ABTMSE Shiny app for the East (top) and West (bottom).

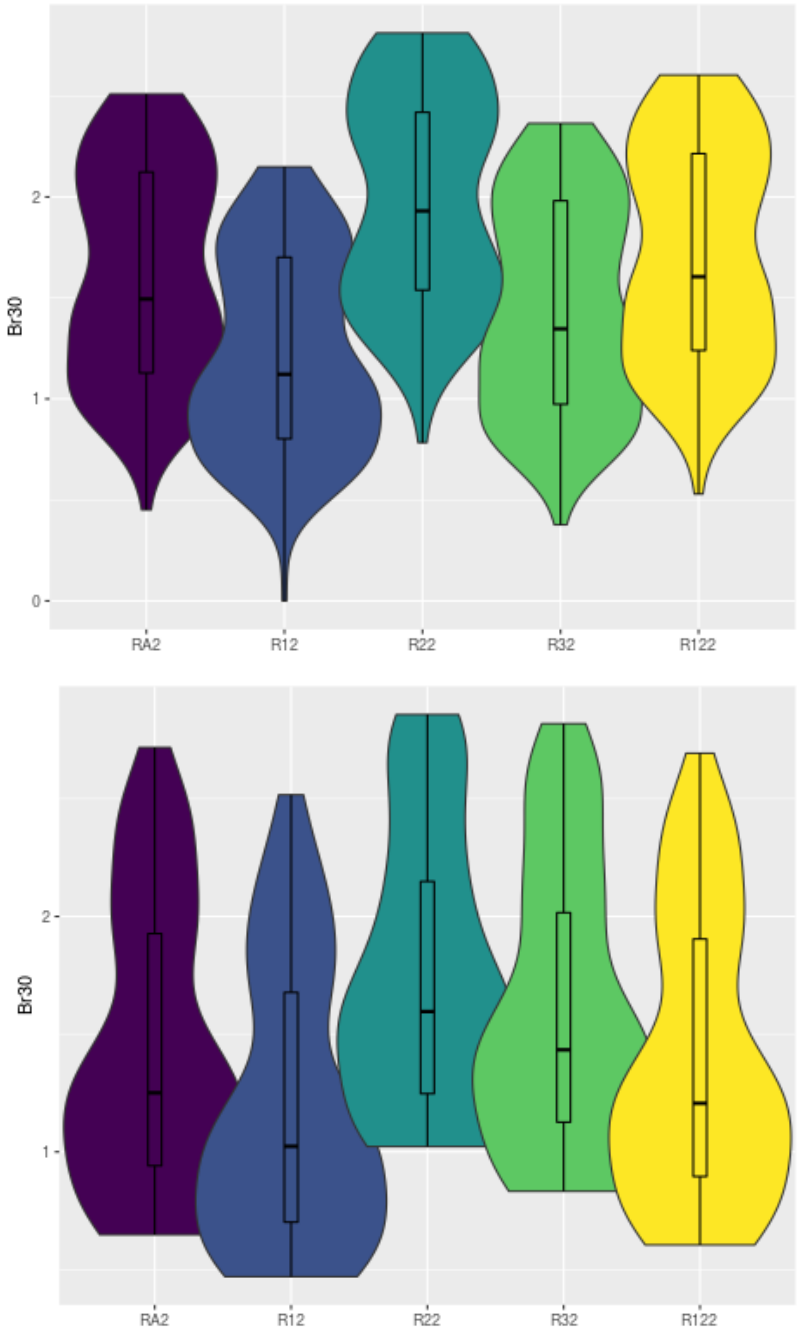

Figure 2. Br30 violin plots for RA, R1, R2, R3, R12 across the reference OM grid as obtained from the ABTMSE Shiny app for the East (top) and West (bottom).

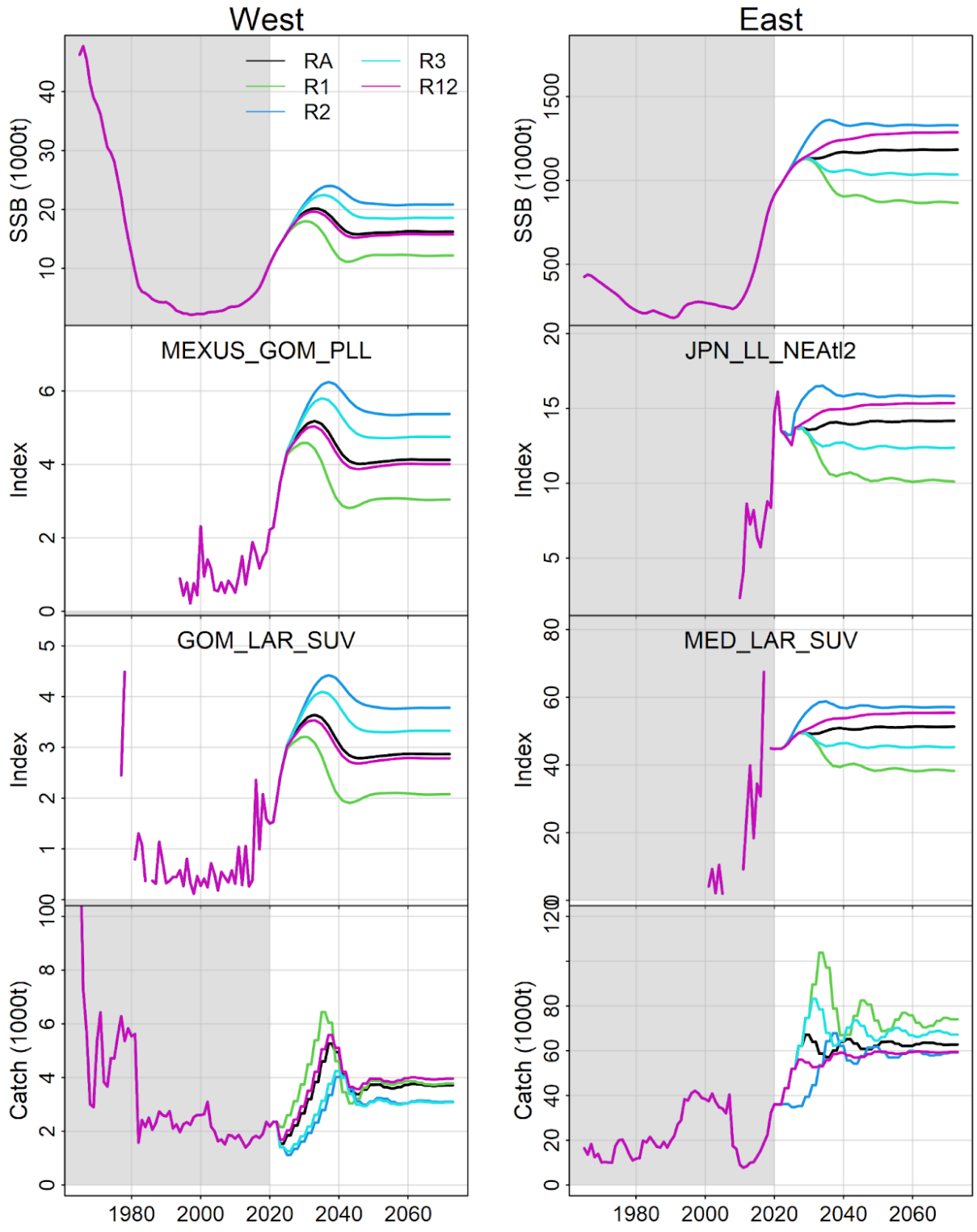

Figure 3. Spawning stock biomass (SSB), indices of abundance, and catch projections for the East and West resulting from CMPs RA, R1, R2, R3, R12, RA on OM1.

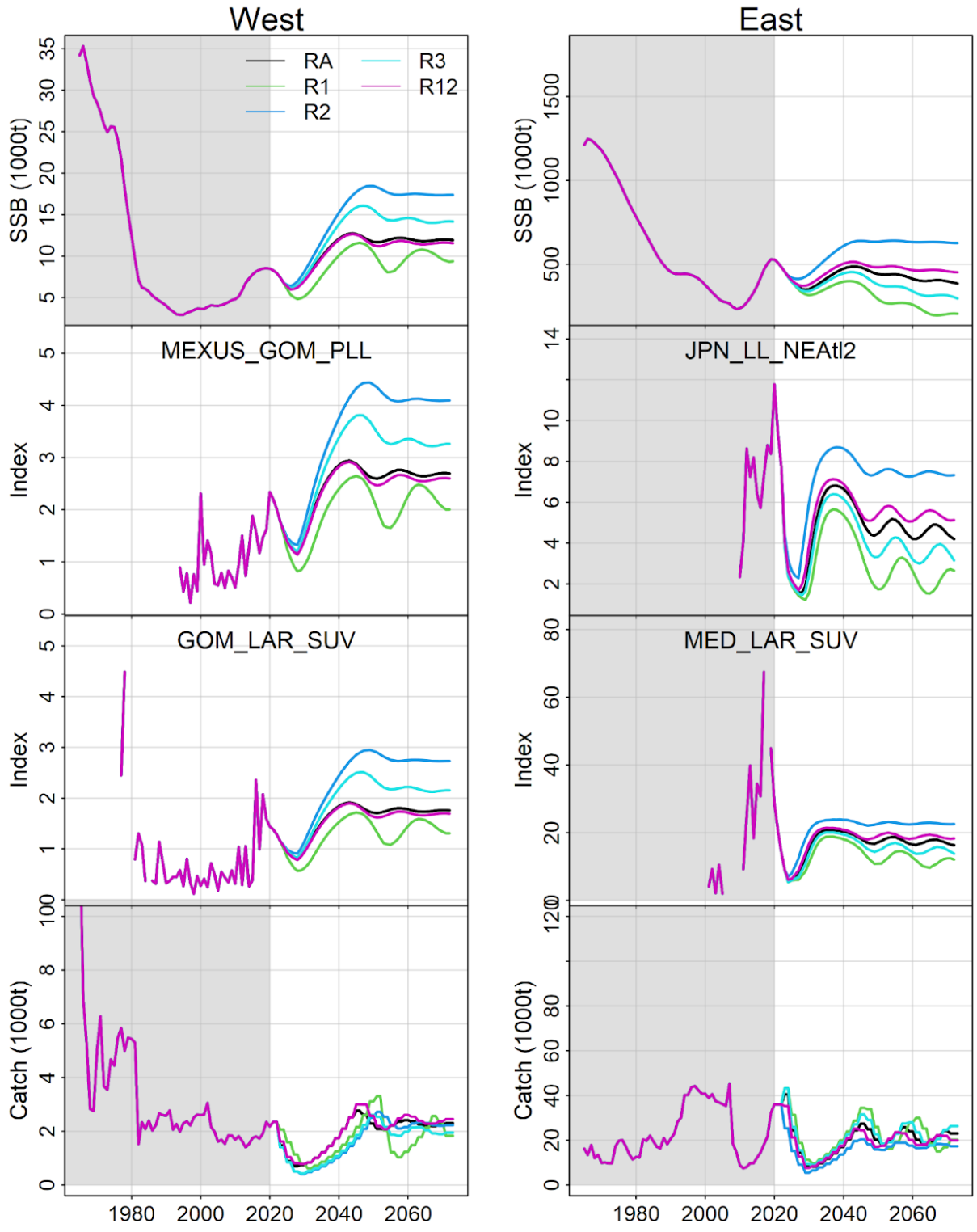

Figure 4. Spawning stock biomass (SSB), indices of abundance, and catch projections for the East and West resulting from CMPs RA, R1, R2, R3, R12, RA on OM2.

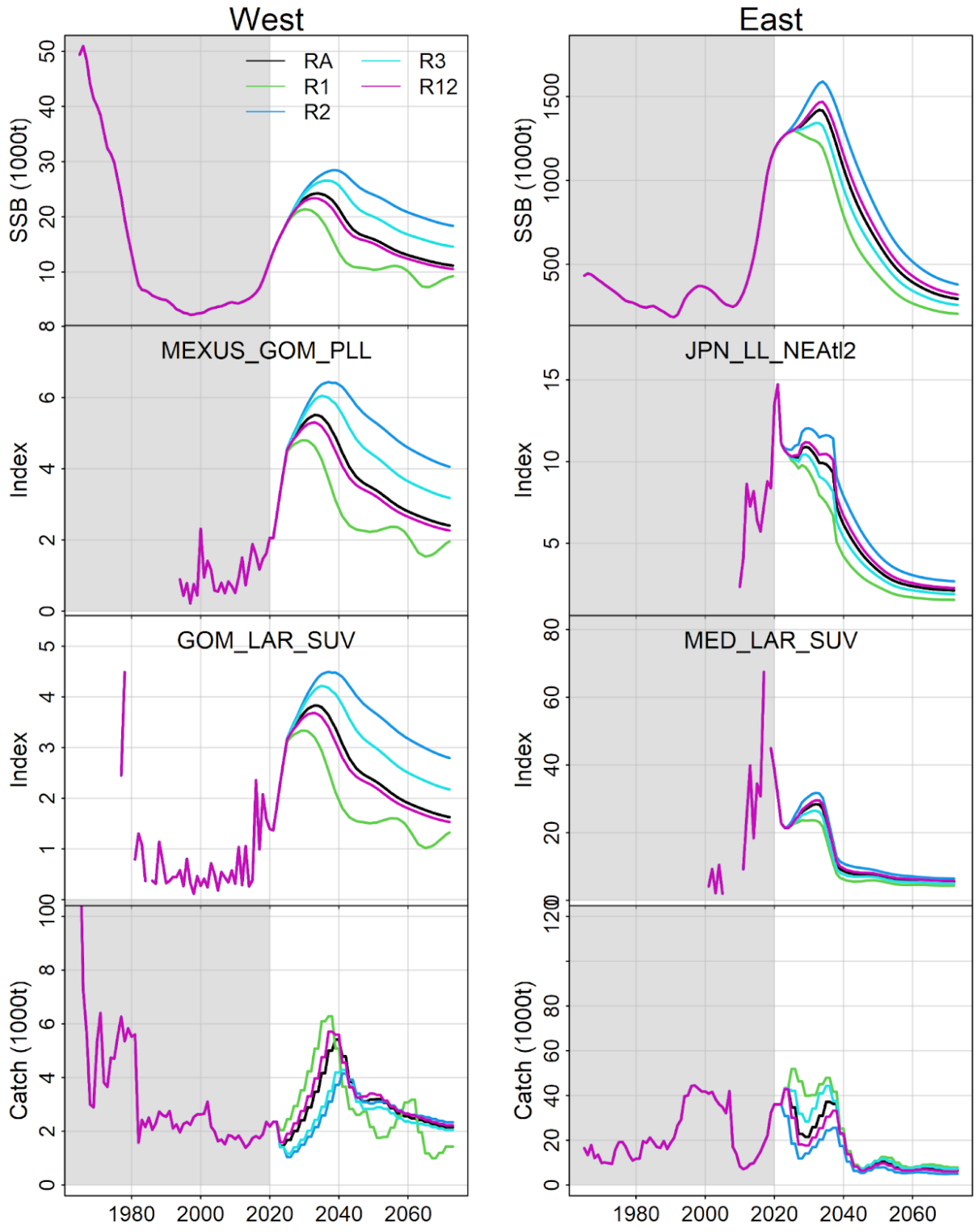

Figure 5. Spawning stock biomass (SSB), indices of abundance, and catch projections for the East and West resulting from CMPs RA, R1, R2, R3, R12, RA on OM3.

Appendix

Mathematical description of PW CMP applied in recruitment scenario tuning analyses.

PW is based on constant harvest rate (ConstU) strategies for both the east and west stocks. In the MSE, the indices of abundance are assumed to be proportional to vulnerable biomass, i.e. the base parameterization assumes time-invariant catchability. Therefore, a relative harvest rate for each stock can be calculated as follows:

$$harvest\ rate = catch/abundance$$

$$relative\ abundance = catchability * abundance$$

$$relative\ harvest\ rate = \frac{catch}{relative\ abundance}$$

Under this approach, management procedures for east and west stocks were designed to apply a constant harvest rate strategy tracking catches and indices of relative abundance.

$$U_{target_i} = \frac{C_{t52:t50}}{\underline{\underline{I_{i,t52:t50}}}} \cdot x$$

where
U=relative harvest rate
C=catch in mt
I=averaged relative abundance index for index i
t=model year, and
x=constant multiplier

$$U_{current_i} = \frac{C_{t-2:t-0}}{\underline{\underline{I_{i,t-2:t-0}}}}$$

$$\Delta_{ratio} = FUN_i\left(\frac{U_{target_i}}{U_{current_i}}\right)$$

where FUN is a function to summarize across ratios for each index (e.g., mean or minimum).

$$TAC_{t+1:t+3} = \Delta_{ratio} \cdot TAC_{t-2:t-0}$$

where
TAC=total allowable catch limit

For the West stock, the GOM_LAR_SUV and MexUS_GOM_PLL indices are used, and for the East stock, the MED_LAR_SUV and JPN_LL_NEAtl2 indices are used. FUN used to summarize across *Δratio*s for each index was minimum. Allowable annual % TAC changes were restricted to 20% upwards and 40% downwards. PW also penalized TACs if $I_{current}$ was below I_{target} by setting

$$TAC_{t+1:t+3} = \{\Delta_{ratio} \cdot TAC_{t-2:t-0}\ if\ I_{current} \geq I_{target}\ p * \Delta_{ratio} \cdot TAC_{t-2:t-0}\ if\ I_{current} < I_{target}$$

where the penalty parameter (p) was set equal to 0.75.