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DEMONSTRATION OF CMP DEVELOPMENT TUNING FOR ATLANTIC BLUEFIN TUNA

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SUMMARY

When evaluating Candidate Management Procedures (CMPs), a fundamental trade-off exists between catch performance (what is taken from a fish stock) and biomass performance (what remains after catches). CMPs typically include control parameters that alter how management advice is calculated from data, for example providing higher catches at the cost of less biomass in the long-term. The control parameters of two functionally different CMPs were tuned so that the CMPs obtained comparable biological performance outcomes. In doing so, the performance of the CMPs could be more clearly evaluated on a 'level playing field' at the same location on the catch-biomass performance trade-off axis.

RÉSUMÉ

Lors de l'évaluation des procédures de gestion potentielles (CMP), il existe une compensation fondamentale entre la performance des prises (ce qui est prélevé sur un stock de poissons) et la performance de la biomasse (ce qui reste après les prises). Les CMP comprennent généralement des paramètres de contrôle qui modifient la façon dont l'avis de gestion est calculé à partir des données, par exemple en fournissant des prises plus élevées au détriment d'une diminution de la biomasse à long terme. Les paramètres de contrôle de deux CMP fonctionnellement différentes ont été calibrés de manière à ce que les CMP obtiennent des résultats comparables en matière de performance biologique. Ce faisant, les performances des CMP pourraient être évaluées plus clairement sur un « terrain de jeu égal » au même endroit sur l'axe de compensation entre les performances de capture et la biomasse.

RESUMEN

Al evaluar procedimientos de ordenación candidatos (CMP) existe una compensación de factores fundamental entre el desempeño de la captura (lo que se captura de un stock de peces) y el desempeño de la biomasa (lo que queda después de las capturas). De manera típica, los CMP incluyen parámetros de control que alteran la forma en que se calcula el asesoramiento de ordenación a partir de los datos, por ejemplo, facilitando capturas más elevadas a costa de menos biomasa a largo plazo. Se calibraron los parámetros de control de dos CMP funcionalmente diferentes para que los CMP tuvieran resultados de desempeño biológico similares. Al hacerlo, el desempeño de los CMP podría ser evaluado de forma más clara en «igualdad de condiciones» en la misma ubicación, en el eje de compensación de factores del desempeño entre biomasa-captura.

KEYWORDS

Atlantic bluefin tuna, CMPs, tuning

Introduction

MPs typically include multiple control parameters, for example averaging relative abundance indices over a certain number of years or setting TACs given a prescribed slope with respect to relative abundance indices. It follows that every structural form for an MP encompasses a very large number of nested MPs for various values of the control parameters. For example, consider a comparison between a CMP that recommends incremental changes to the TAC to achieve a target index level by a certain time, with a CMP that aims to maintain a constant exploitation rate (the TAC is a fixed fraction of vulnerable biomass). There are an infinite number of target index levels (the control parameter for the first CMP) and exploitation rates (the control parameters for the second CMP). The performance of these CMPs is likely to vary substantially across the range of these control parameter values. How can one evaluate which structural form of CMP is superior (index target or fixed exploitation rate), given that the selection is confounded with the particular selection of control parameters?

Development tuning addresses this problem and is designed to better understand the performance of the structure of various CMPs on a 'level playing field'.

Although many performance metrics can be envisaged in an MSE process, a central and major trade-off exists between yields (removals from the stock) and biological outcomes (what is left after removals). In order to draw comparisons across CMPs it is standard practice in MSE processes elsewhere to ensure that all CMPs obtain the same result with respect to one of these outcomes, and then to evaluate/compare other performance metrics given this standardized outcome. This helps to provide an initial ranking of CMPs; more particularly at this early stage of the process, it assists developers to see the strengths and weaknesses of their CMP compared to other CMPs, and to use this information to refine their CMPs further. Development tuning may be performed over one or several representative OMs (in which case the tuning would have to relate to achieving a value of the metric averaged over the OMs concerned), but is not designed to provide the actual tuning (that will be the subject of the later "finalization tuning" exercise) that would eventually be applied in the MP adopted to set TACs.

The purpose of this document is to set out the methods and results of a demonstration of development tuning to facilitate collaboration among CMP developers and to provide a framework for comparing CMP performance.

This is intended to be a conceptual demonstration: these CMPs and hence their performances are preliminary and may be improved substantially following further refinement.

Methods

In this document we present an example of (initial) development tuning for two MPs (MPx and FXP). The mathematical description of each type of MP is included in SCRS/2020/150 (MPx) and SCRS/2020/147 (FXP). In each case the MPs were tuned to achieve three outcomes relating to the Br30 performance metric (biomass relative to dynamic BMSY after 30 projection years) in deterministic runs for the OM1 member of the interim grid of 96 OMs (see SCRS/2020/148):

(1) Br30 = 0.75 for deterministic OM1 for both West and East stocks (referenced below as MPx075 or FXP075)
(2) Br30 = 1.00 for deterministic OM1 for both West and East stocks (referenced below as MPx100 or FXP100)
(3) Br30 = 1.25 for deterministic OM1 for both West and East stocks (referenced below as MPx125 or FXP125)

The tuning control parameter values for these MPs are provided in Appendix A and B.

Results

The plots below illustrate the following for Br30 and AvC30 for Eastern/Western stock and East/West area respectively for the following comparisons:

Figure 1a and b: Eastern stock a) Br30 and East area b) AvC30: MPx and FXP for 075 vs125 tuning under OM1 for all 96 interim grid OMs

Figure 2a and b: Western stock a) Br30 and West area b) AvC30: MPx and FXP for 075 vs125 tuning under OM1 for all 96 interim grid OMs

Figure 3a and b: a) Eastern stock/East area and b) Western stock/west area Br30 and AvC30 respectively: MPx100 vs FXP100 tuning under OM1 for all 96 interim grid OMs

Figure 4: Br30 results for MPx100 tuning under OM1 for all 96 interim grid OMs, with colour coding to distinguish recruitment level 1, 2 and 3 OMs.

Figure 5: A comparison of MPx and FXP for all three tunings with a distribution of results across all 96 interim grid OMs

Discussion

Ultimately it is plots such as those above, especially **Figure 5**, that provide guidance to developers on where their CMPs need improvement. Note the following:

- These plots can be extended to include results from other CMPs
- The primary focus in refining a CMP is to narrow the range of Br30 values for both the Eastern and Western stocks that is shown in **Figure 5**
- In particular, there needs to be focus on preventing instances where the stock is rendered extinct (Br30=0)
- Furthermore, for cases where Br30 is well below 1, catches should be such that the stock is increasing at that time 30 years hence
- Hence, in the examples above, FXP needs to focus first on refinement to achieve improvements by way of increasing the lowest values of Br30 for the Western stock, and MPx for the Eastern stock
- In due course, these results need to be extended to stochastic runs of the Oms
- At a later stage, in moving from development tuning to finalization tuning, the grid of OMs will need to be finalized, and some plausibility weighting perhaps incorporated in providing Figures such as **Figure 5** which integrate over grid OMs

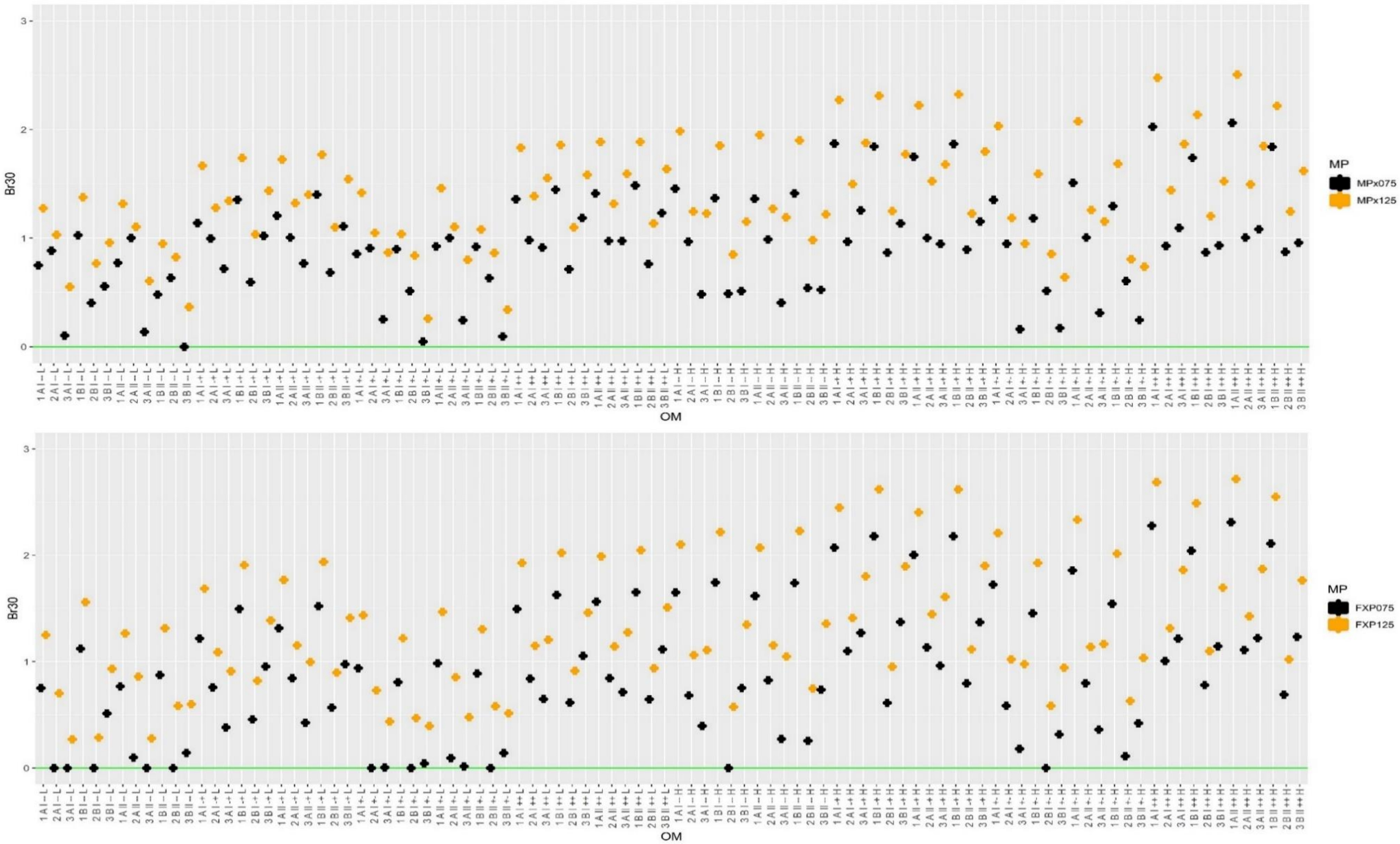


Figure 1a. Eastern stock deterministic Br30 values for all 96 interim grid OMs under MPx (top plot) and FXP (bottom plot) for 075 (black dots) vs 125 (yellow dots) tuning.

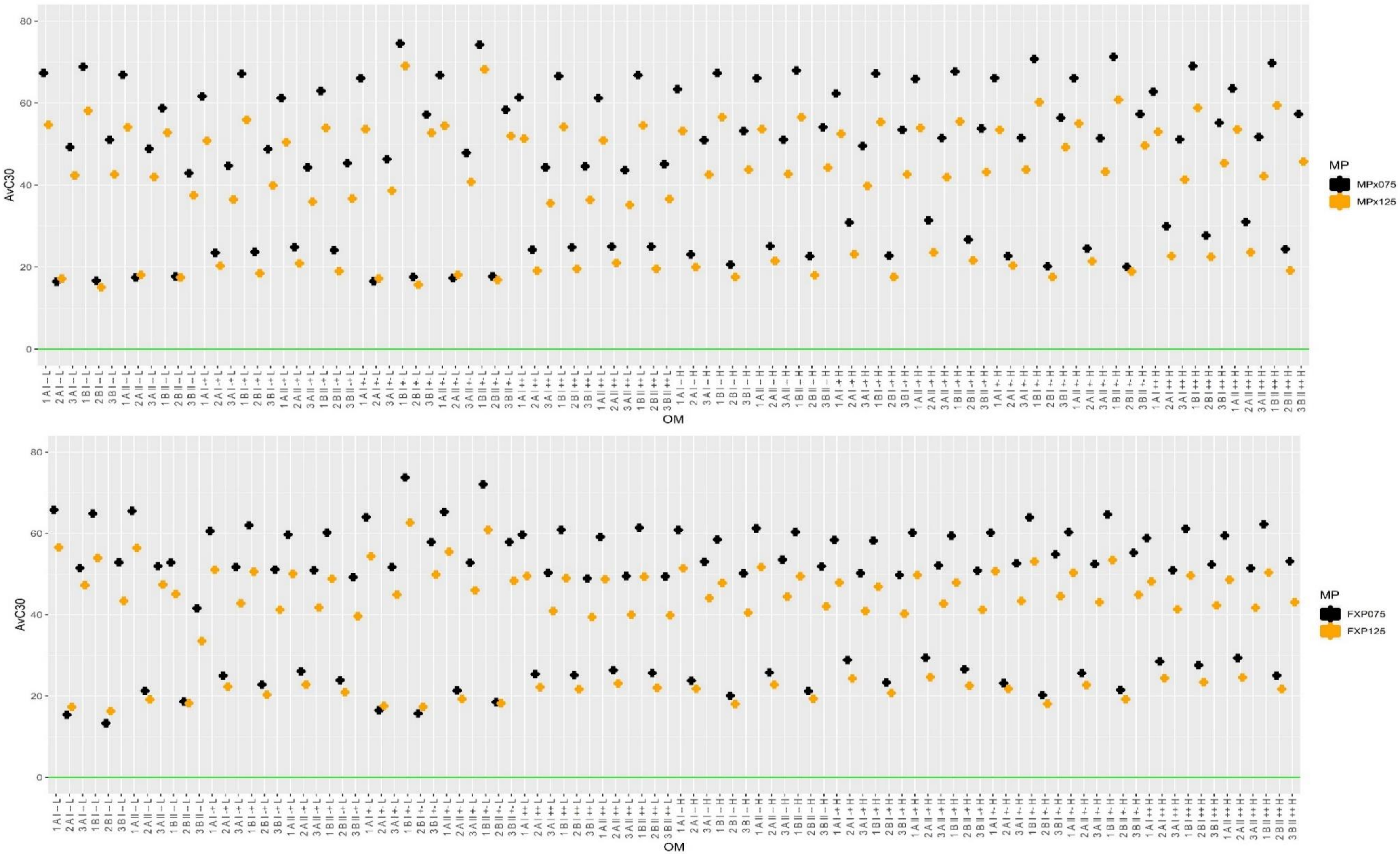


Figure 1b. East area deterministic AvC30 values for all 96 interim grid OMs under MPx (top plot) and FXP (bottom plot) for 075 (black dots) vs 125 (yellow dots) tuning.

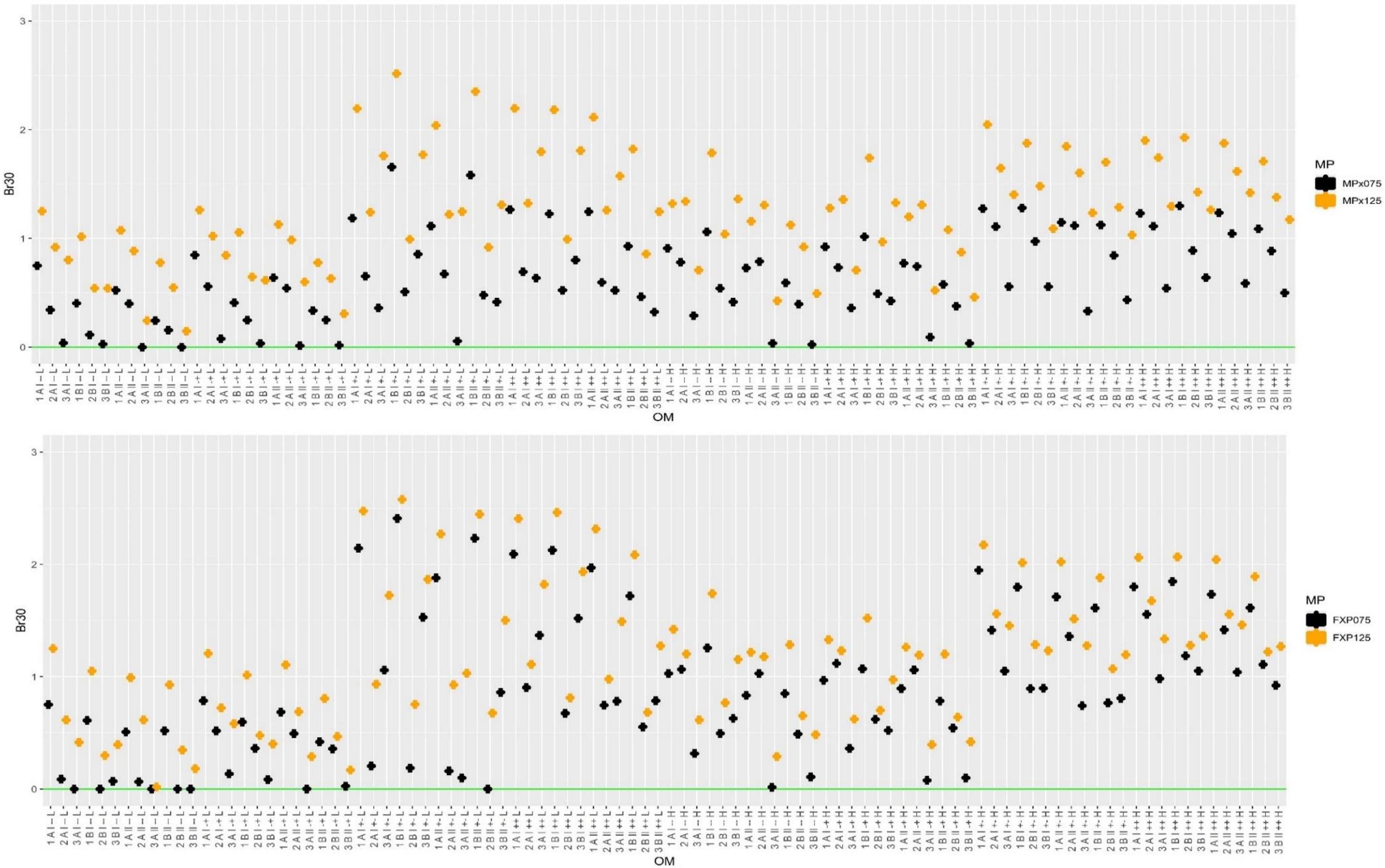


Figure 2a. Western stock deterministic Br30 values for all 96 interim grid OMs under MPx (top plot) and FXP (bottom plot) for 075 (black dots) vs 125 (yellow dots) tuning.

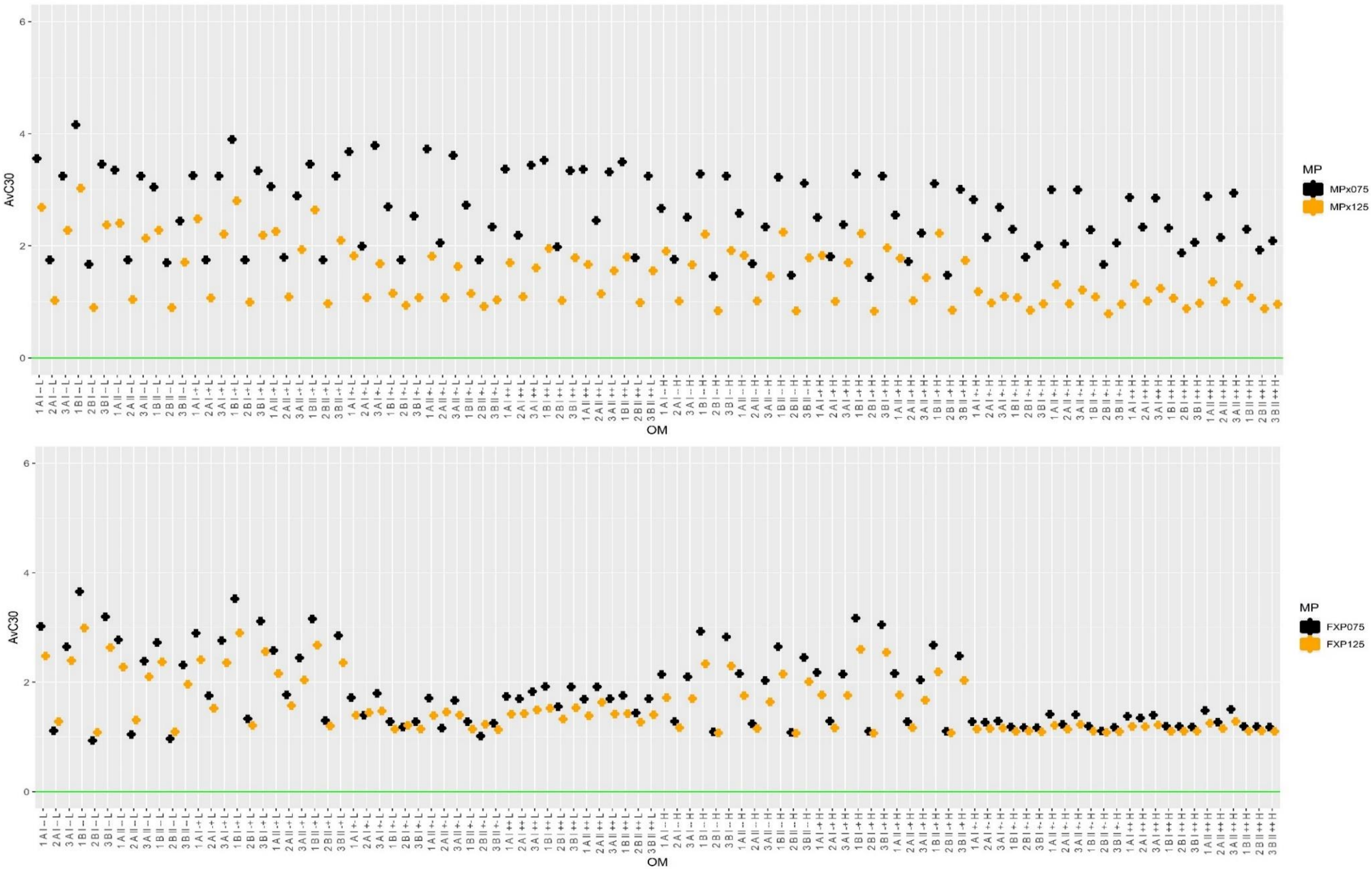


Figure 2b. West area deterministic AvC30 values for all 96 interim grid OMs under MPx (top plot) and FXP (bottom plot) for 075 (black dots) vs 125 (yellow dots) tuning.

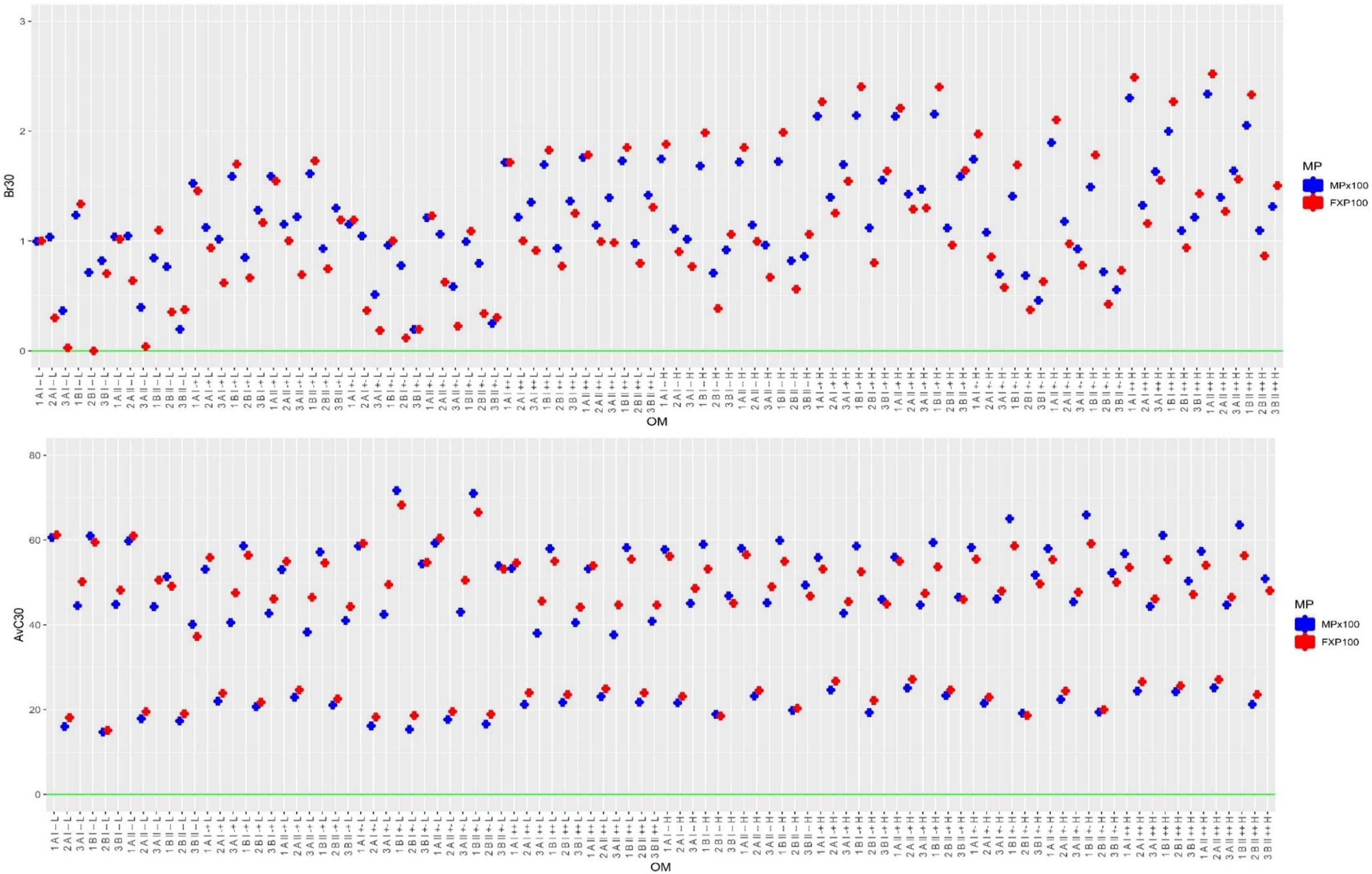


Figure 3a. Eastern stock deterministic Br30 (top plot) and East area AvC30 (bottom plot) values for all 96 interim grid OMs under MPx (blue dots) and FXP (red dots) for 100

tuning.

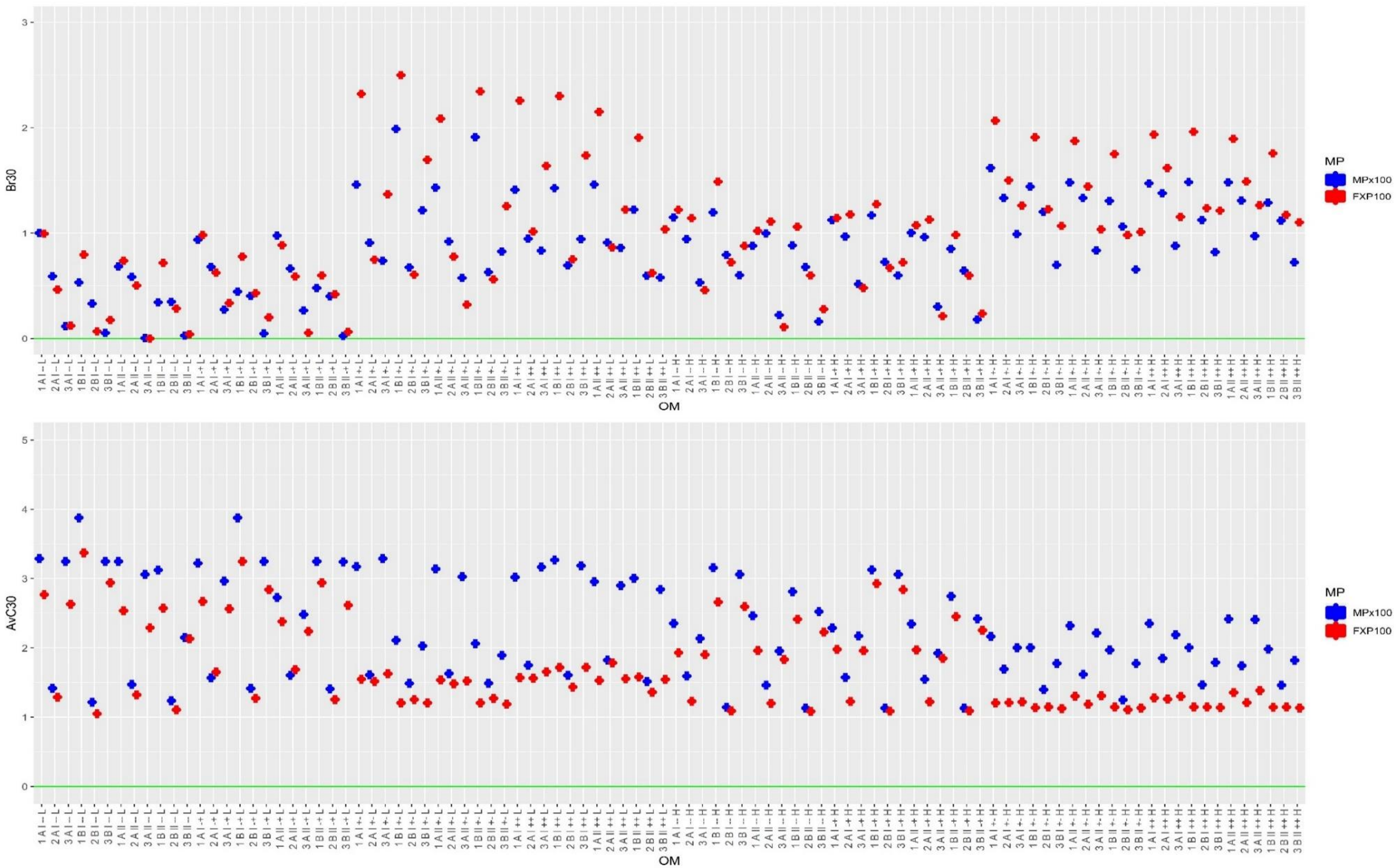


Figure 3b. Western stock deterministic Br30 (top plot) and West area AvC30 (bottom plot) values for all 96 interim grid OMs under MPx (blue dots) and FXP (red dots) for 100 tuning.

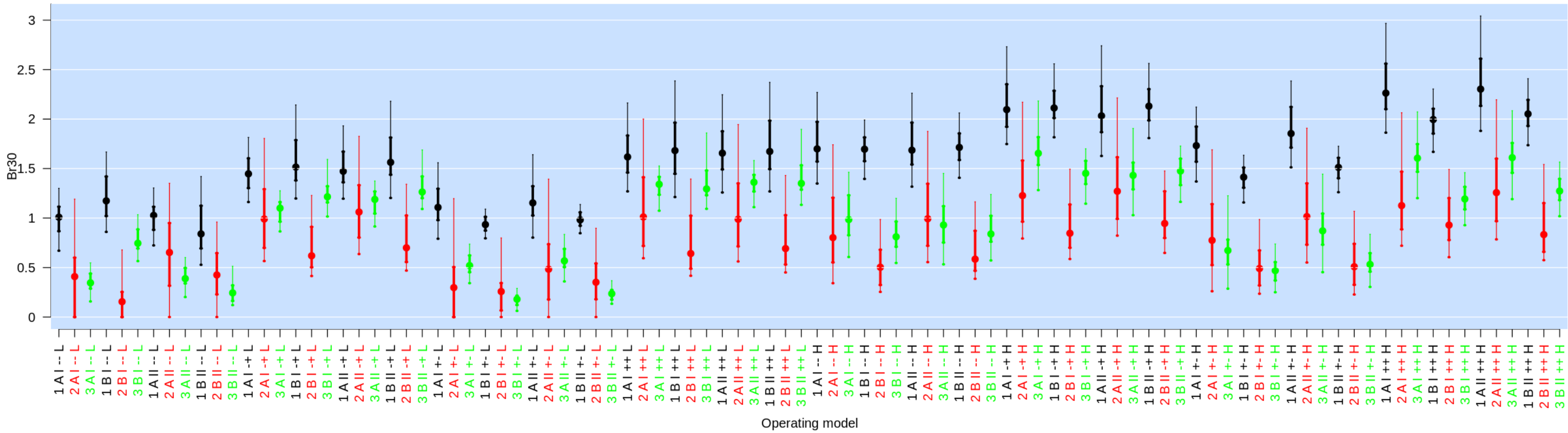


Figure 4a. Eastern stock biomass relative to BMSY (Br30) for MPx100 color coded by recruitment scenarios (black is recruitment level 1 – historical regime shift, red is recruitment level 2 – no historical shift in regime, green is recruitment level 3 – future regime shift).

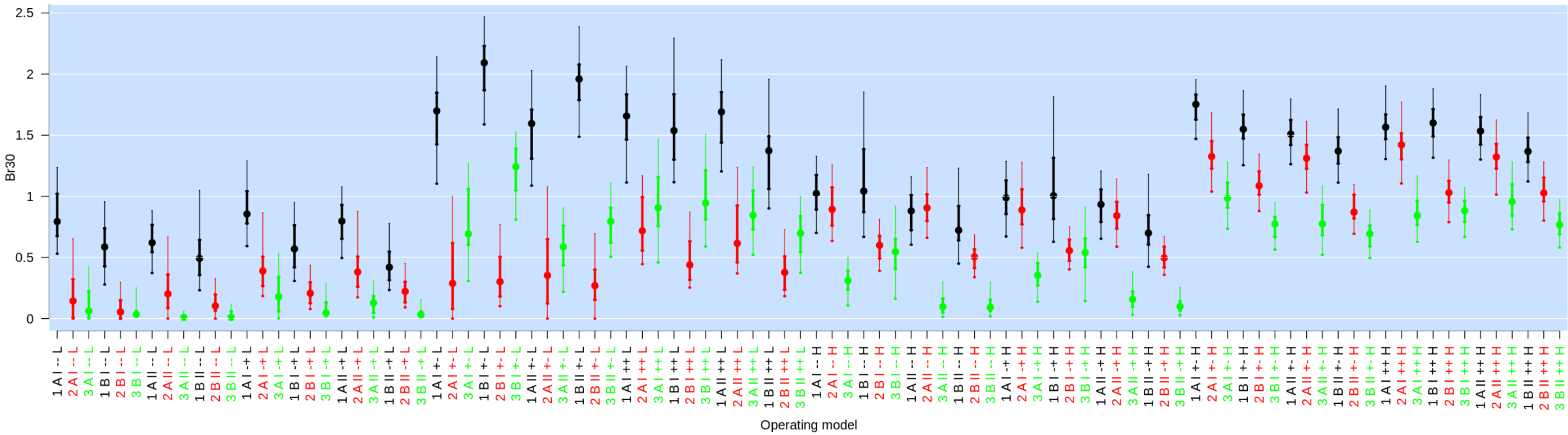
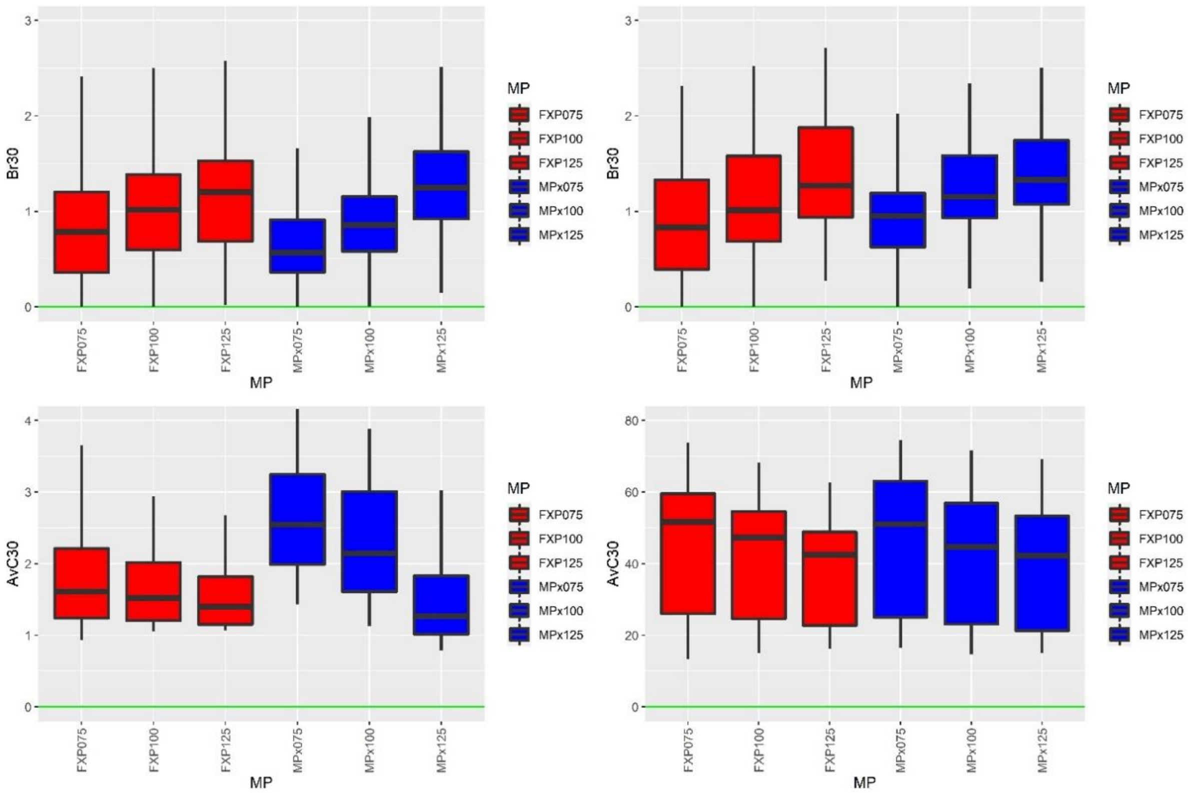


Figure 4b. As Figure 4a but for the Western stock.

West Area / Western Stock East Area / Eastern Stock



West Area Western Stock

Figure 5. AvC30 and Br30 performance metrics among all 96 OMs for the interim grid under deterministic projections for the six CMPs tuned to OM1. The bars show ranges including 25%-, 50%- (i.e. median) and 75%iles.

Appendix A

MPx tuning control parameter values

Three derivatives of the MPx CMP were developed for demonstration purposes. These tuned the θ^{FMSY} parameters in order to achieve Br30 (biomass relative to B_{MSY} after 30 projection years) for both stocks given the deterministic operating model #1 (**Table 1**).

Table A1: Parameter values for each of the three tunings.

Tuning	**CMP name**	$\boldsymbol{\theta^{FMSY}_{West}}$	$\boldsymbol{\theta^{FMSY}_{East}}$
Br30 = 0.75 (both stocks)	MPx075	0.0713	0.0865
Br30 = 1.00 (both stocks)	MPx100	0.0325	0.0641
Br30 = 1.25 (both stocks)	MPx125	0.0094	0.0551

Appendix B

FXP CMP tuning control parameter values

Table B1: Parameter values for each of the three tunings.

Tuning	CMP name	a	β
0.75	FXP_E155nomax-FXP_W0685nomax	1.550	0.685
1.00	FXP_E13nomax-FXP_W057nomax	1.300	0.570
1.25	FXP_E109nomax-FXP_W0463nomax	1.090	0.463