Examples of management procedure behaviour changes in response to operating model updating

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Abstract

To date, the evaluation of candidate Management Procedures (MPs) for the SBT stock has been undertaken with an operating model (OM) conditioned with data from 1952-2000. The full assessment undertaken at the CCSBT-SAG in 2004 includes data from 1952-2003, and will be used to decide whether the initial OM is still consistent with our perceptions of SBT dynamics, or whether updated or changed operating models should be used. This paper presents results from four candidate MPs that were developed with the old operating model, (tuned to B2022/B2002 = 1.1) and applied to new OMs: "mechanical" – the original OM updated with 3 additional years of conditioning data, and 2 new OMs proposed by the CCSBT External Advisory Panel in July 2004 "Panel_tag" and "Panel_notag". The candidate MPs were applied to the new OMs, as tuned to the original operating model, and re-tuned to the new operating models (again B2022/B2004 = 1.1). The results suggest that, as expected, the average MP behaviour can change substantially with the updated OMs when tuned to the same level.

Introduction

To date, the evaluation of Candidate Management Procedures (CMPs) for the SBT stock has been undertaken with an operating model (OM) conditioned with data from 1952-2000. There are now 3 additional years of data which will be used for stock assessment at the CCSBT SAG/SC in 2004, and a decision needs to be made about whether or not to initiate another round of MP development in light of the new data. A major goal of Management Strategy Evaluation (the MP process) is the attainment of a framework for making management decisions that are likely to result in reasonable management outcomes irrespective of the major underlying uncertainties about the current status and future production potential of the fish stock. To some extent, the performance of the MPs will depend on how reliably the operating models represent the true stock dynamics. MPs are more likely to be robust if greater uncertainty is admitted in the operating models during development. This paper provides an illustration of the relative performance of several CMPs, when challenged by a range of operating models that will be under consideration at the 2004 SAG/SC. This paper is not intended as an evaluation of either MPs or operating models. It is intended to illustrate how MP performance changes as a result of our changing perceptions of SBT uncertainty (due to the addition of more data and changing model assumptions), and highlights some factors that should be considered in the MP development process.

The following 4 SBT operating models are considered here:

1) "Reference" – the reference set used in the April 2004 CCSBT MP meeting (conditioned with data up to 2000),

2) "mechano" – the original OM updated with 3 additional years of conditioning data

3) "Panel_tag", and

4) "Panel_notag", the latter two OMs were conditioned with 3 additional years of data and proposed by the CCSBT External Advisory Panel in July 2004, as less than ideal, but pragmatic alternatives to "mechano" that would allow CMPs to be retuned in time to allow for a selection to be made at CCSBT Commission meeting in 2004.

Results are presented for 4 CMPs: FXR_01, FXA_71, (two decision rules based on the Fox model) CPU_05 (a CPUE-based rule with no attempt to estimate production dynamics) and CON_01 (constant catch), which have been described in detail at the April 2004 Workshop (Polacheck et al, 2004). The performance of these rules is presented with respect to:

1) The behaviour that would be observed for each OM if the rule was tuned assuming that the Reference OM was correct.

2) The behaviour that would be observed if the CMP was retuned to each specific OM.

We briefly note the extent to which the CMPs developed for the Reference Model appear to provide robust performance under the updated OM scenarios, and speculate about the degree to which Reference case uncertainty is consistent with the perception of uncertainty from updated OMs. Implications for future rounds of MP development and implementation are considered.

Methods

Results are presented for 4 of the CMPs developed by Australia FXR_01, FXA_71, CPU_05 and CON_01, which have been described in detail at the April 2004 Workshop (Polacheck et al, 2004). We were interested in examining a variety of different CMPs to evaluate whether the underlying behaviour of the rule was robust to changes in the OM, and whether the relative performance among rules remained consistent in the different OM scenarios. For this reason, we evaluated two similar rules that were presented at the April workshop (which provided excellent behaviour in terms of minimizing biomass risk), as well as a basic CPUE rule and the constant catch CMP CON_01. Results are available for all tuning levels and TAC stability options, but for brevity, we consider only the central tuning cases, B2022/B2004 (or B2022/B2001 for the Reference case) tuned to 1.1 and 3 year TAC change interval.

A decision rule is defined here as a basic algorithm that can be used to determine the TAC in the next year given available information (e.g. past catches, CPUE trends, etc.). All of the decision rules considered here have "control" parameters, one of which was used as the parameter that was varied to achieve a specified tuning level. We defined a CMP as a decision rule with all of its control parameters specified, except the one that was varied for tuning.

The graphical summaries and associated software initially developed by Eveson and Ricard (2003), modified by Eveson (2003) and further modified by Eveson (and distributed to the CCSBT-MP through e-mail) were used to illustrate the performance characteristics of the different CMPs.

Results

In the following results, we attempt to draw attention to the main differences in the MP performance with respect to the different OMs, particualrly in terms of likely short term changes to TACs, and relative performance with respect to minimizing biomass risk. Biomass risk is only illustrated for CMPs that are tuned to the respective OMs (as opposed to the Reference case).

Figure 1 and Figure 2 provides a brief overview of the performance of the CMPs with respect to the Reference operating model, i.e. the same results presented in Polacheck et al. (2004). The FXR_01 and FXA_71 rules are seen to be similar, and the most attractive in terms of minimizing the risk of attaining low biomass. The constant catch rule, Con_01, has the highest biomass risk, and CPU_05 is intermediate. All 4 decision rules produce a drop in TAC at the first opportunity with a probability of at least 90%.

Figure 3 illustrate how the CMPs performed against Mechano, when tuned to Mechano. Figure 4 illustrates how the CMPs performed against the OM Mechano, when tuned to Mechano vs when tuned to Reference. The most striking observation from these trials is the fact that there is a substantial probability of the TAC increasing at the first opportunity for the FXR and FXA models, followed by several years of quota cuts; the probability/magnitude of the quota increase is considerably greater when these MPs are tuned to the OM Mechano. The CPU model had a high probability of initial TAC decline with the Reference tuning, and a strong probability of TAC increase with Mechano tuning. The relative performance of the MPs with respect to minimizing biomass risk is not as evident as it was in the Reference case

– CON is clearly the worst, but the others are all very similar, with CPU intermediate between FXA and FXR.

Figure 5 illustrates how the CMPs performed against OM panel_tag, when tuned to panel_tag. Figure 6 illustrates how the CMPs performed against the OM panel_tag, when tuned to panel_tag vs when tuned to Reference. In this case, the relative performance of the MPs with respect to biomass risk is consistent with the Reference case (FXR and FXA similarly good, CON the worst and CPU intermediate). These results also show a high probability of a short term TAC increase (followed by decrease) for FXR and FXA, and similarly CPU has a rapid TAC decrease with the Reference tuning, but a high probability of strong increase with the panel_tag tuning.

Figure 7 illustrates how the CMPs performed against OM panel_notag, when tuned to panel_notag. Figure 8 illustrates how the CMPs performed against the OM panel_notag, when tuned to panel_notag vs when tuned to Reference. The relative performance of the CMPs was again consistent with the Reference case with respect to biomass risk. The panel_noTag-tuned FXA and FXR CMPs both had ~50% probabilities of an initial TAC increase, while CPU had a high probability of initial TAC increase. With the Reference tuning, FXA, FXR and CPU all had high probabilities of an initial TAC increase.

Figure 9 provides a comparison of FXA performance against the three new proposed operating models in a single plot. As would be expected, the MP performance is less variable when tuned to each of Mechano, panel_tag or panel_noTag as opposed to Reference. However, the difference is smaller than we might have expected. Additionally, differences among the three proposed OMs is smaller than we might have expected; panel_noTag performance seems to be the least variable OM.

Discussion

From the CMP evaluations, we note the following points for consideration:

- A qualitative comparison of MP performance suggests that the dynamics resulting from the OMs Mechano, panel_tag, and panel_noTag are somewhat different than the Reference OM. But the MPs (particularly FXA and FXR) do seem to avoid ridiculous long term behaviour even when tuned to the wrong operating model.

- The short term behaviour of the adaptive MPs that we examined are sensitive to the selection of the operating model used for evaluation. The three MPs FXA, FXR, and CPU have a high probability of recommending a substantial TAC increase in the short term, despite the depressed status of the simulated stock in the OMs Mechano, panel_tag and panel_noTag. In contrast, these models generally prescribed a drop in TAC for the Reference case.

- Whatever OM is selected for the final set of CMP evaluation trials should encompass sufficient uncertainty that we can be confident of avoiding a recommendation that goes against common sense (i.e. given perceptions about the current depleted status, likely future productivity of the stock and short term industry preferences, it seems unwise to adopt an MP with a high probability of increasing the TAC in the short term, with a subsequent decline). If MPs are selected with initial decision characteristics that are highly sensitive to OM specification, it will presumably be harder to reach a selection

concensus, and the decision process might be iteratively delayed pending additional information under the (probably misguided) assumption that the next assessment will be substantially more reliable than the previous one. It would probably make sense to impose an additional constraint on all MPs to avoid precisely this short term behaviour.

- The relative performance of the selected MPs was fairly consistent across OMs (in terms of biomass risk). This might give us some confidence that we can make meaningful progress in reducing the number of candidate MPs even without a definitive OM. However, we would expect that this would not be the case if other MPs were admitted to this analysis. While FXA and FXR were the lowest biomass risk MPs in the April Reference trials, this was accomplished in part because of the large initial TAC reduction. Presumably other CMPs that were not as risk averse in the April trials (e.g. those that reduce the maximum magnitude of TAC change initially) would actually have lower biomass risk than FXA and FXR in the new OM scenarios.

We also note that the choice of tuning level could contribute to strange behaviour for some MP-OM combinations. e.g. For a productive stock, the MP might be constrained to take catch in an undesirable pattern to prevent excessive rebuilding to meet the tuning objective. However, the same MP could perform much more reasonably with a higher tuning level.

References

Polacheck, T., P. Eveson, J. Hartog, M. Basson, and D. Kolody. 2004. Comparison of the performance of tuned candidate management procedures for southern bluefin tuna based on the final trial specifications and testing procedures. CCSBT-MP 0404/4.

Reference

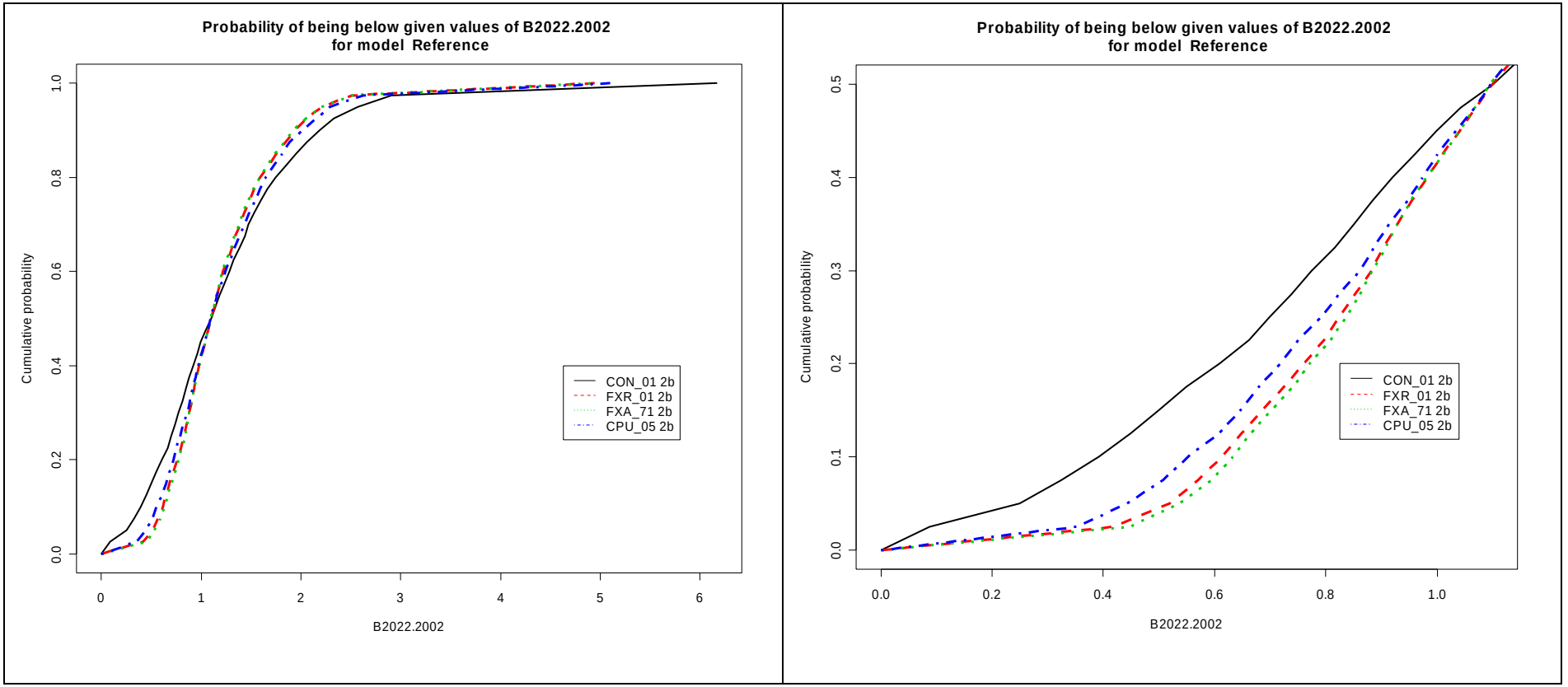

Figure 1 Cumulative probability of the spawning stock in 2022 relative to 2004 (B2022/B2004) being below a given value for CMPs tuned to 1.1 using the Reference set. The upper panel gives results over the entire range of values for B2022/B2002; the lower panel is a close-up for values below 1.1.

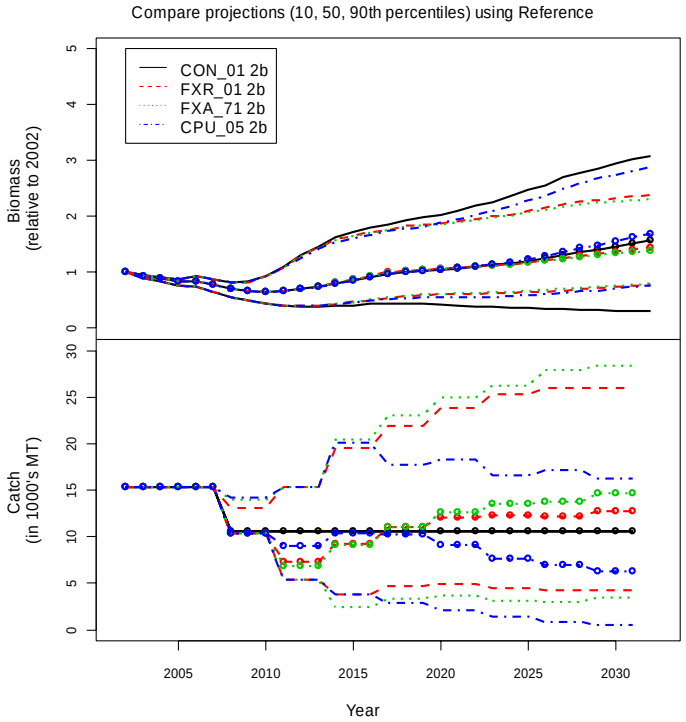

Figure 2 Comparison of the time trajectories for the median, 10th and 90th percentiles for biomass and catch using Reference for the MPs CON_01, FXR_01, FXA_71 and CPU_05.

Mechanical Update

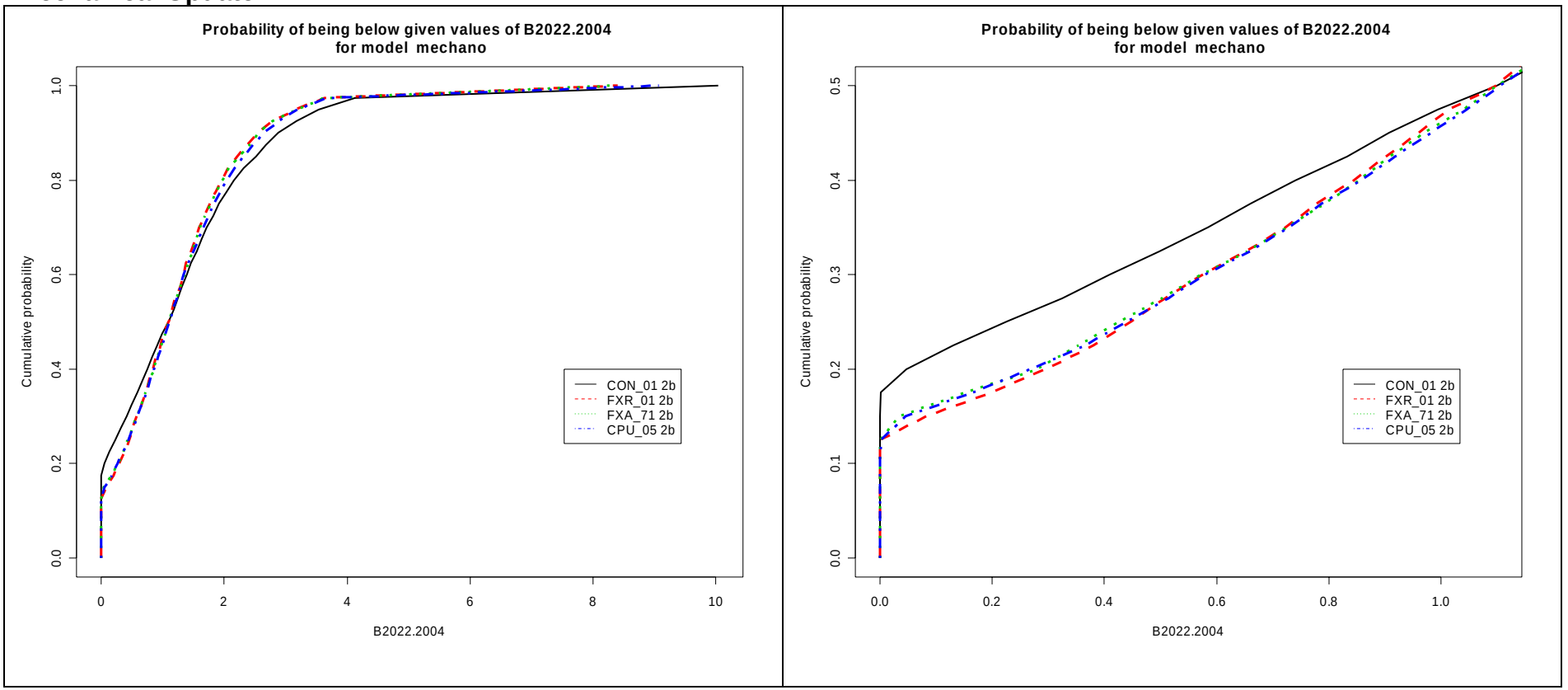

Figure 3 Cumulative probability of the spawning stock in 2022 relative to 2004 (B2022/B2004) being below a given value for CMPs tuned to 1.1 using the Mechanical Update. The left panel gives results over the entire range of values for B2022/B2004; the right panel is a close-up for values below 1.1.

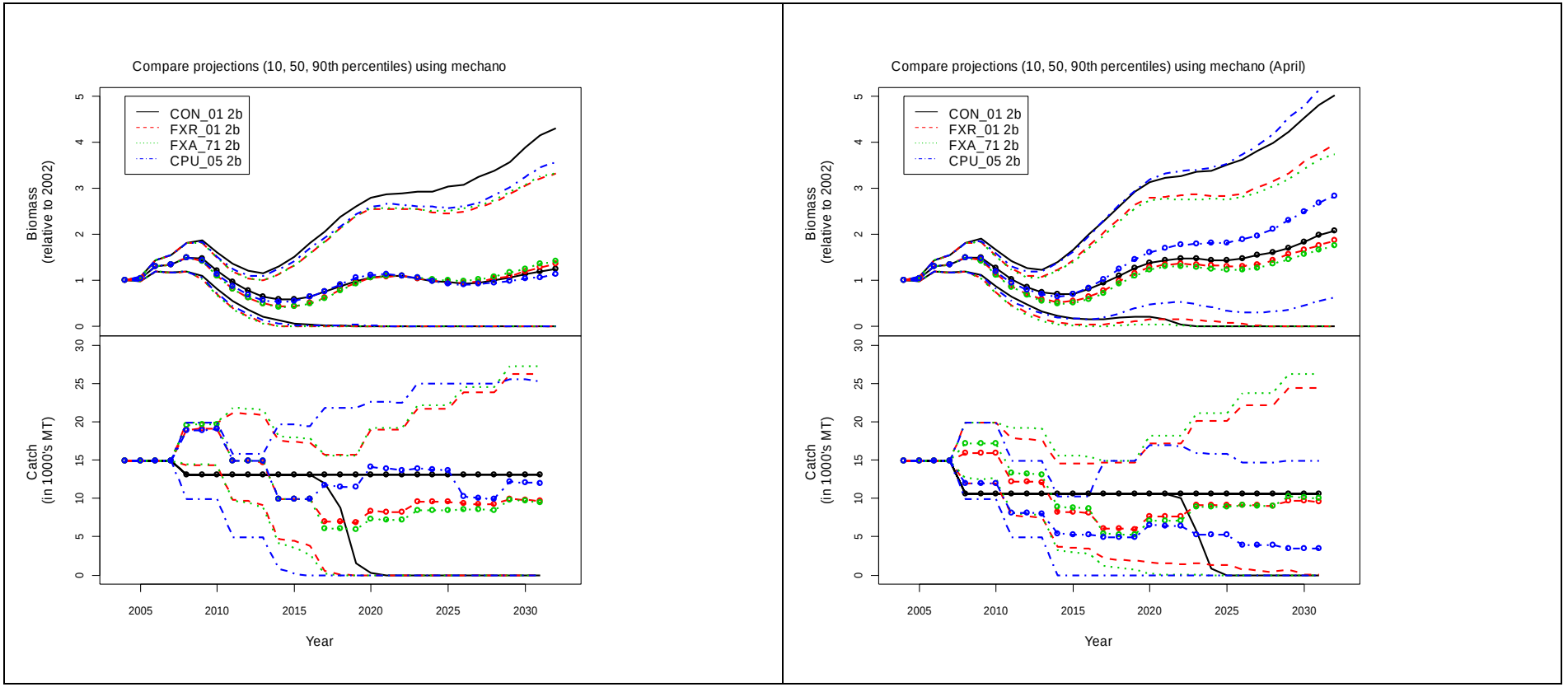

Figure 4 Comparison of the time trajectories for the median, 10th and 90th percentiles for biomass and catch using Mechanical Update for CON_01, FXR_01, FXA_71 and CPU_05. Panel 1 shows the time trajectories when tuned to 1.1, panel 2 uses the tuning parameters from the Reference set (April).

Panel_tag

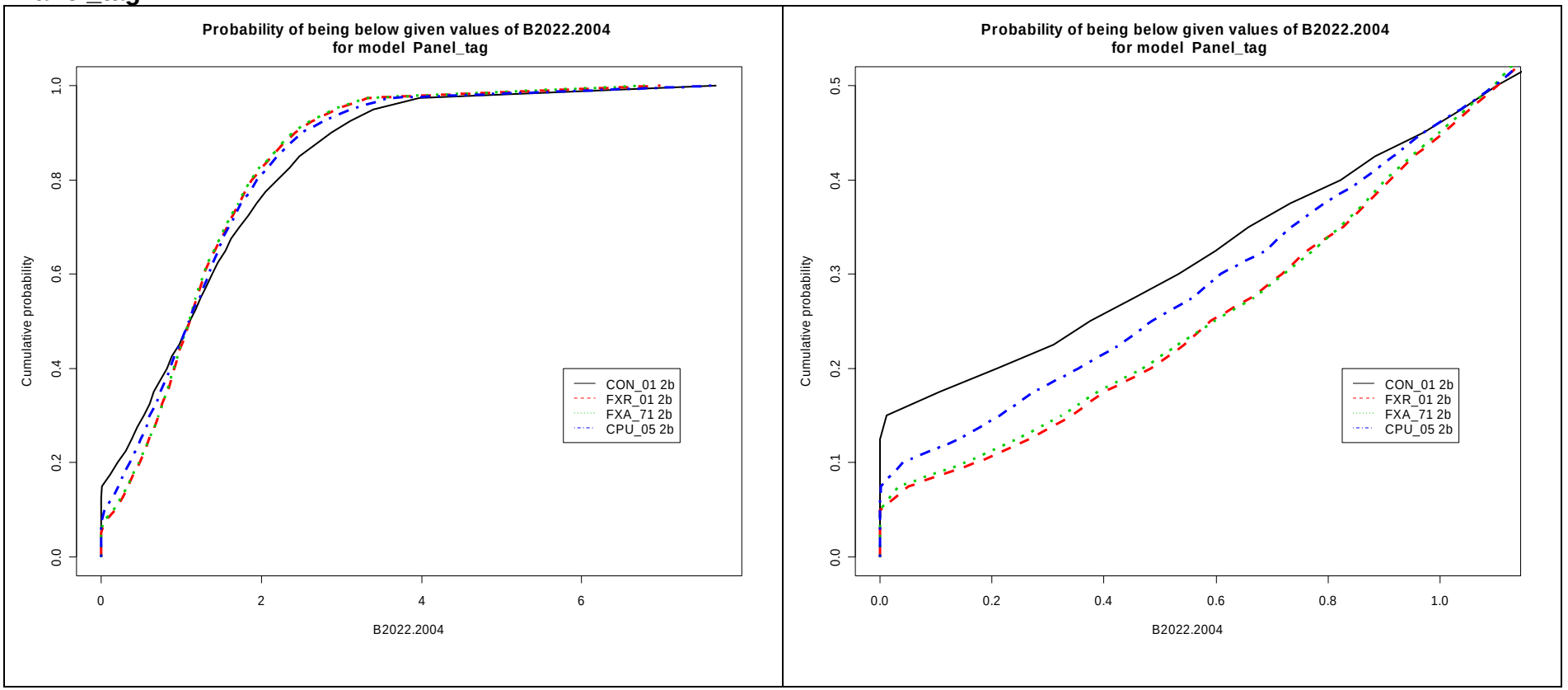

Figure 5 Cumulative probability of the spawning stock in 2022 relative to 2004 (B2022/B2004) being below a given value for CMPs tuned to 1.1 using Panel_tag. The left panel gives results over the entire range of values for B2022/B2004; the right panel is a close-up for values below 1.1.

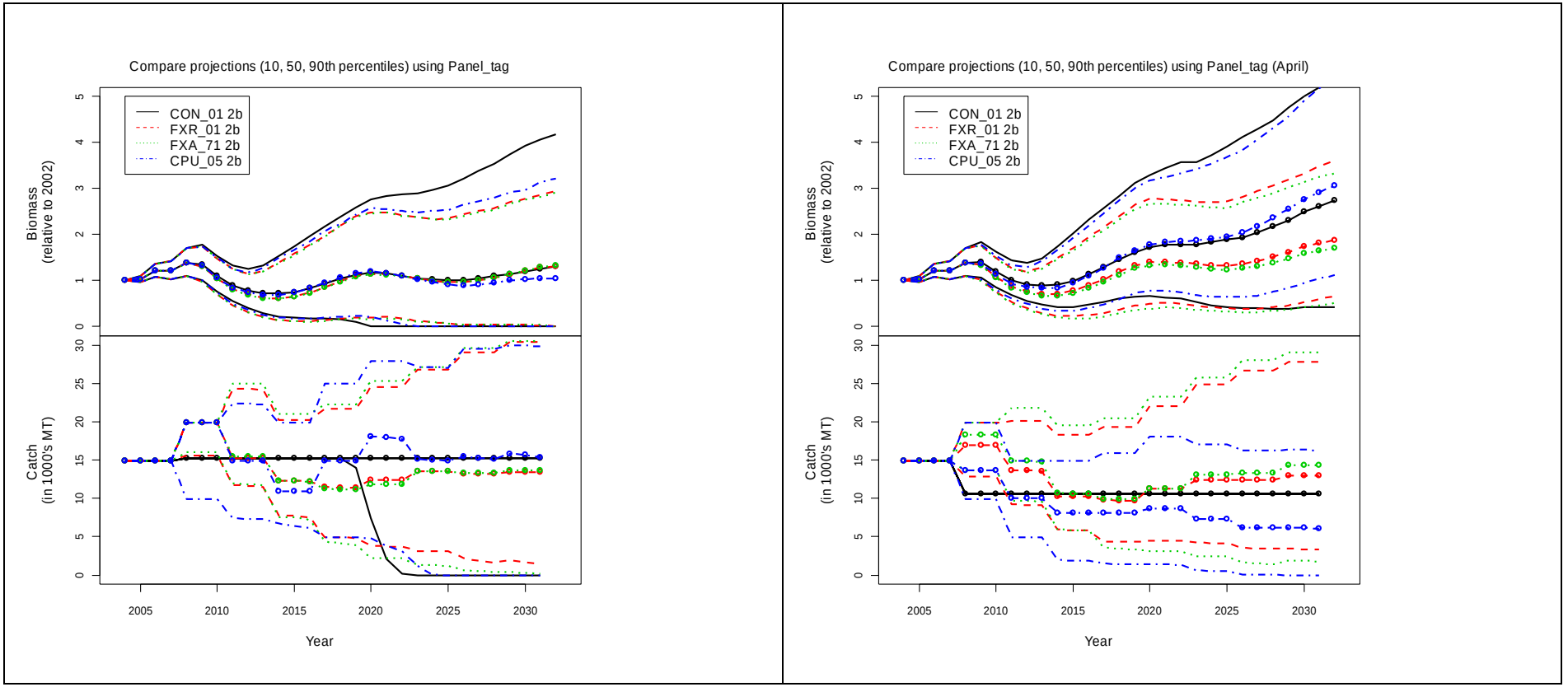

Figure 6 Comparison of the time trajectories for the median, 10th and 90th percentiles for biomass and catch using Panel_tag for CON_01, FXR_01, FXA_71 and CPU_05. Panel 1 shows the time trajectories when tuned to 1.1, panel 2 uses the tuning parameters from the Reference set (April).

Panel_notag

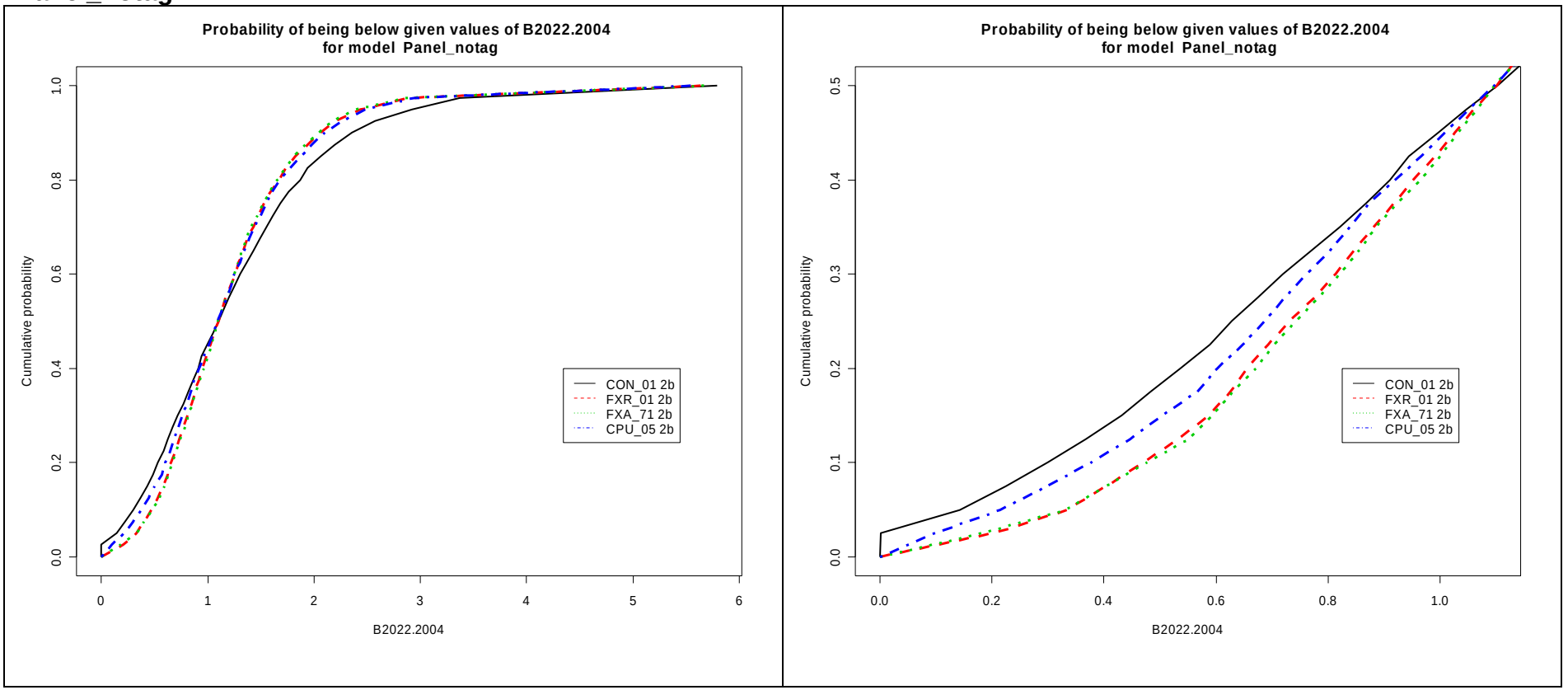

Figure 7 Cumulative probability of the spawning stock in 2022 relative to 2004 (B2022/B2004) being below a given value for CMPs tuned to 1.1 using Panel_notag. The left panel gives results over the entire range of values for B2022/B2004; the right panel is a close-up for values below 1.1.

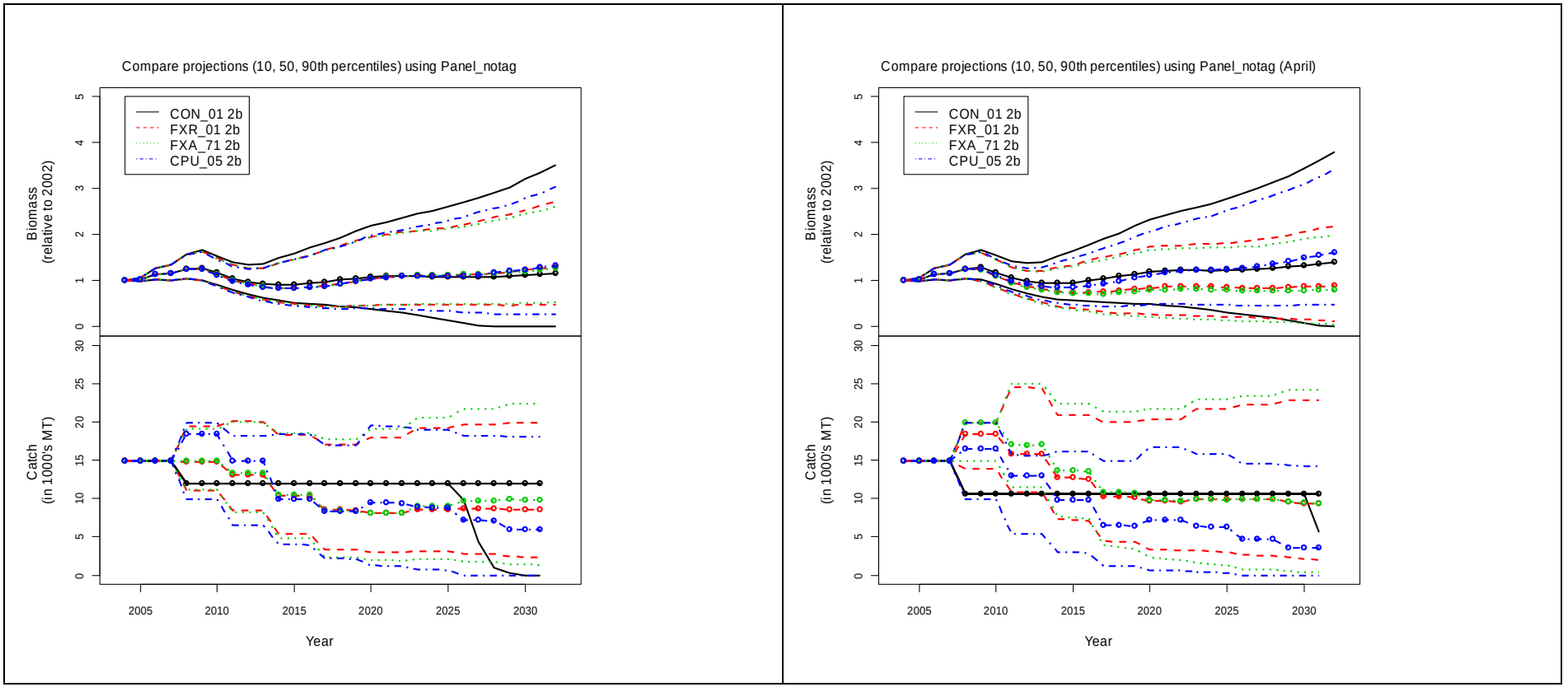

Figure 8 Comparison of the time trajectories for the median, 10th and 90th percentiles for biomass and catch using Panel_notag for CON_01, FXR_01, FXA_71 and CPU_05. Panel 1 shows the time trajectories when tuned to 1.1, panel 2 uses the tuning parameters from the Reference set (April).

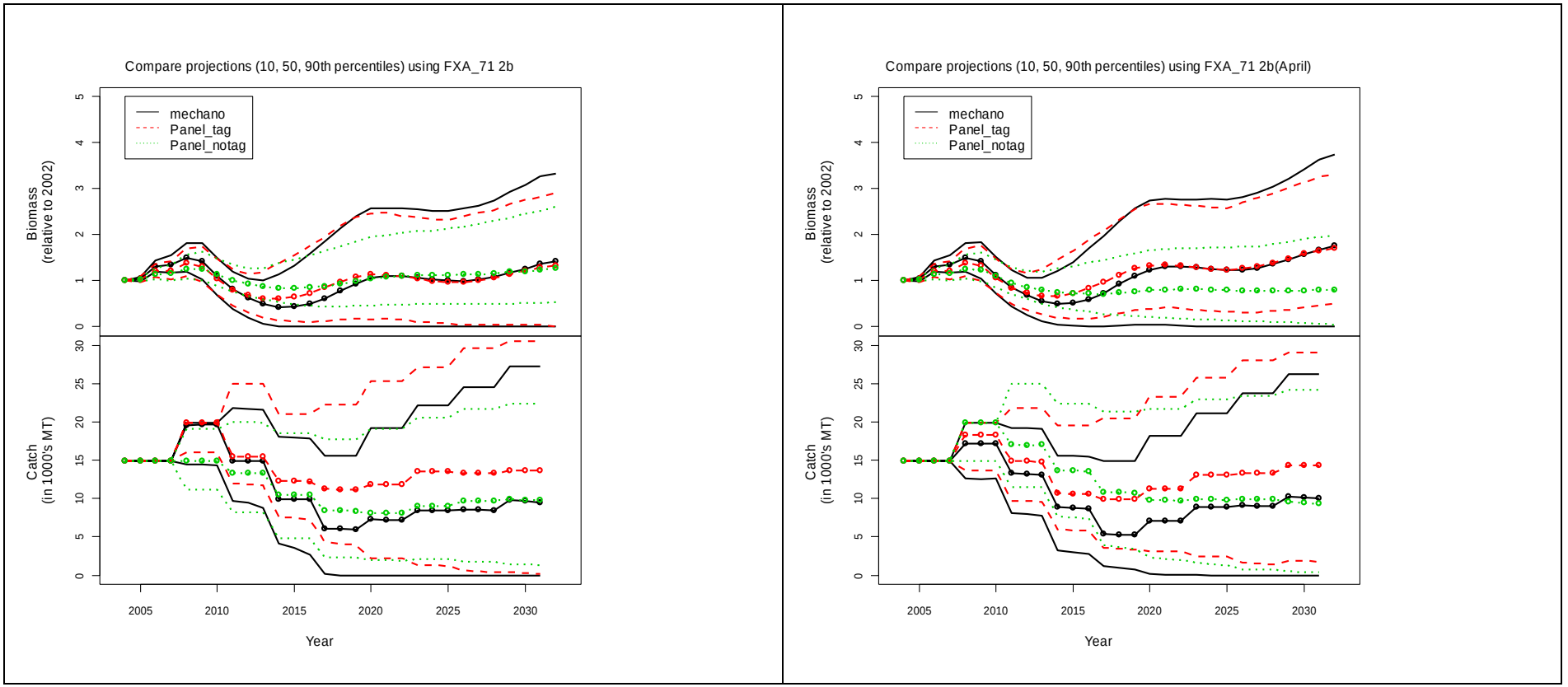

Figure 9 Comparison of the time trajectories for the median, 10th and 90th percentiles for biomass and catch using all the new OMs for FXA_71. Panel 1 shows the time trajectories when tuned to 1.1, panel 2 uses the tuning parameters from the Reference set (April).