Candidate Managment Procedures for Indian Ocean skipjack tuna

8th Session of the IOTC Technical Committee on Management Procedures

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Background and motivation

Overall objective

Develop a Management Procedure for Indian Ocean skipjack tuna that has been fully tested using a Management Strategy Simulation framework.

Specific objectives defined at the 6th and 7th Sessions of the TCMP include:

- Propose a set of candidate Management Procedures to the TCMP (2024) for potential adoption by the Commission.

Time frame: October 2023 to June 2024

Current management (Res. 16/02 & 21/03)

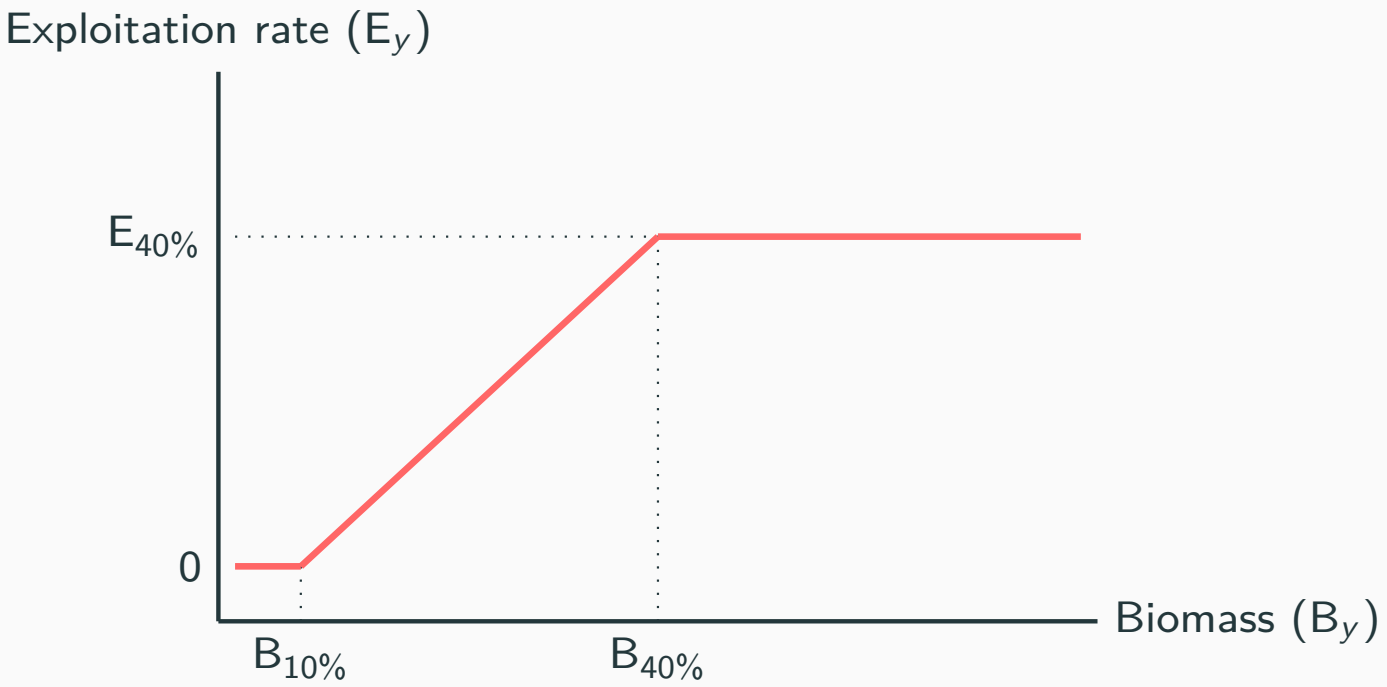

Figure 1: Schematic representation of the current Harvest Control Rule (Resolution 16/02 & 21/03).

Input estimated spawning stock biomass (B_y) to recommend an exploitation rate (E_y). The exploitation rate is multiplied by B_y to calculate C_y^{TAC}.

Current management (Res. 16/02 & 21/03)

Table 1: Recommended catch from current HCR and realised catches used by Fu (2023) in tonnes. *Note that the 2023 catch is predicted by the stock assessment based on current exploitation rates and is not an empirical value.

Year	Recommended catch	Realised catch	Overcatch
2018	470,029	606,134	29%
2019	470,029	590,388	26%
2020	470,029	547,258	16%
2021	513,572	655,115	28%
2022	513,572	648,697	26%
2023	513,572	*596,511	*16%
2024	628,606	–	–
2025	628,606	–	–
2026	628,606	–	–

Candidate Empirical MP for SKJ (TCMP-06)

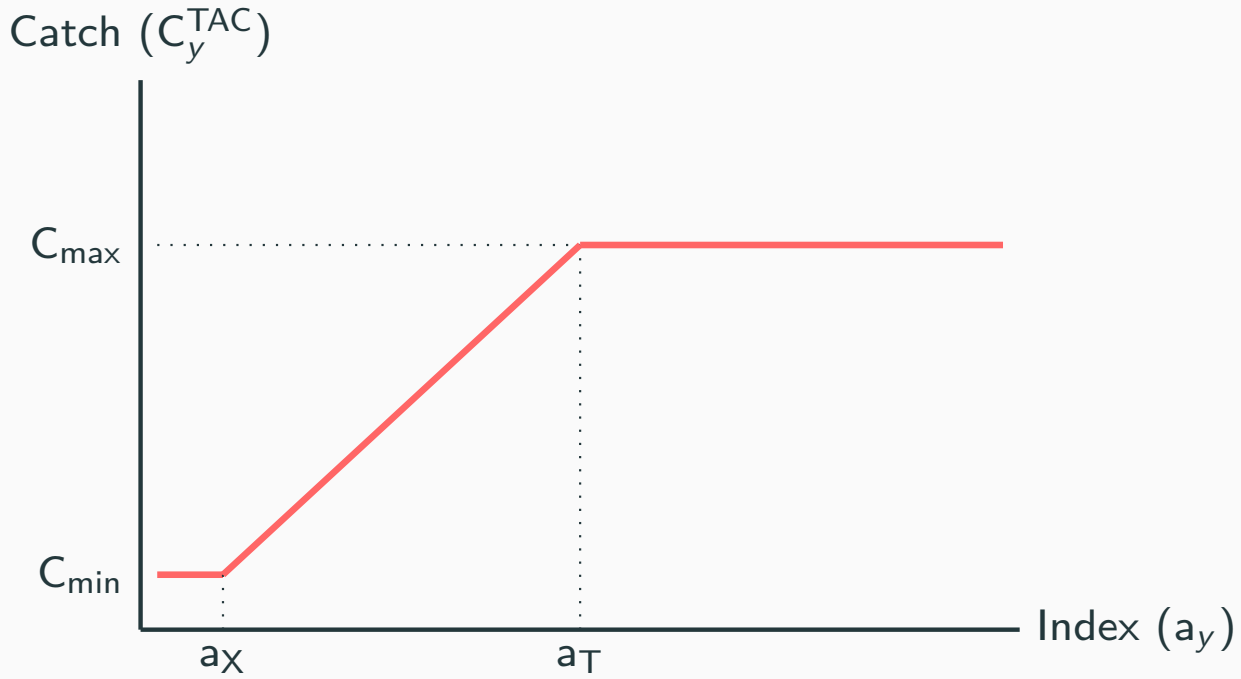

Figure 2: Schematic representation of the empirical Harvest Control Rule proposed as part of a data-based MP.

Input a CPUE-based index of depletion to calculate a recommend a C_y^{TAC}.

Data inputs

Index is calculated from the log of standardised PL and PSLS catch rates. The re-scaled log of these catch rates show similar dynamics.

Figure 3: Time series of the log-trasformed PL and PSLS indices between 1995 and 2021, offset by the mean value.

Data inputs

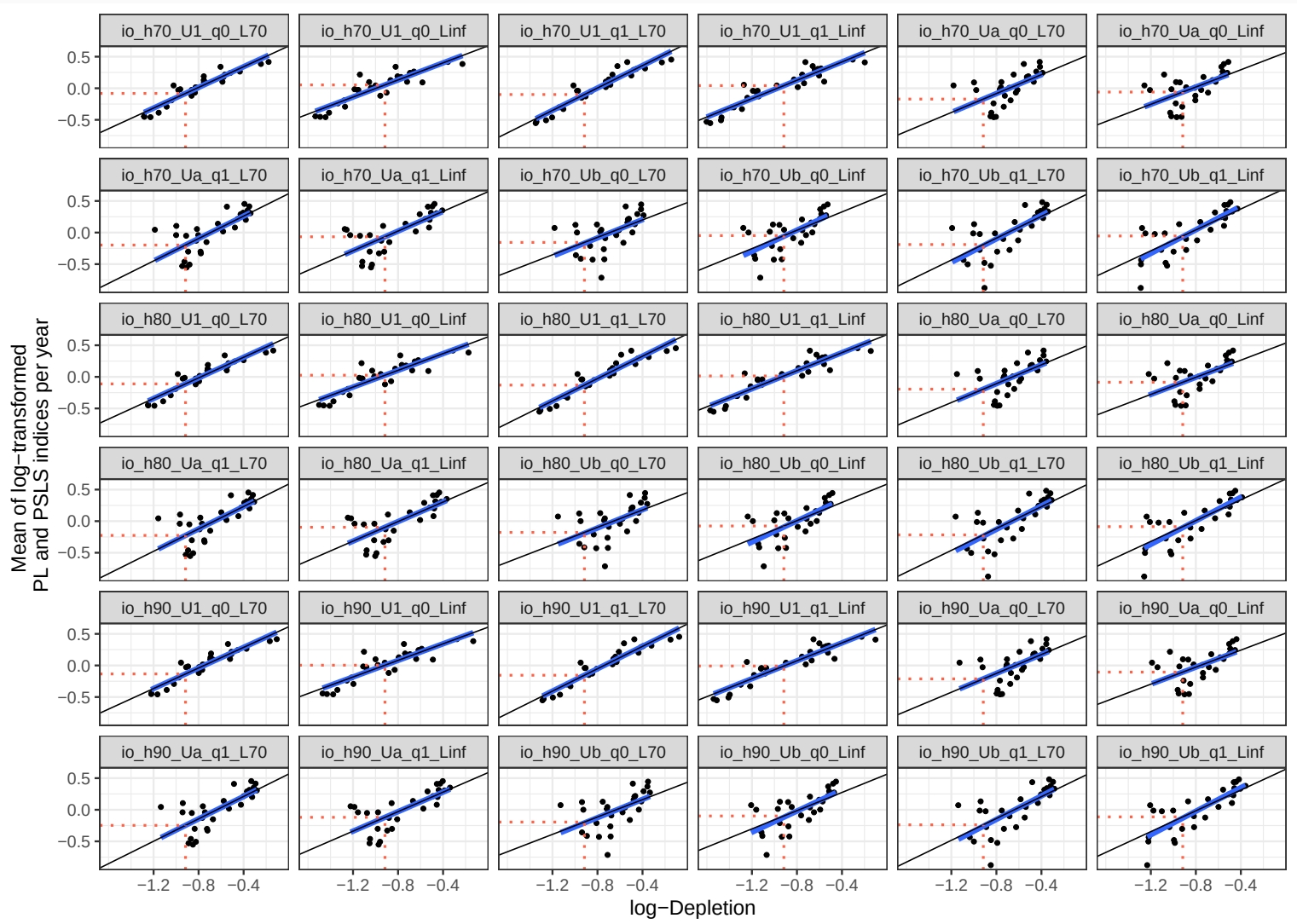

Figure 4: Relationship between the mean of the log-transformed PL and PSLS indices (a_y) and log-depletion.

Data inputs

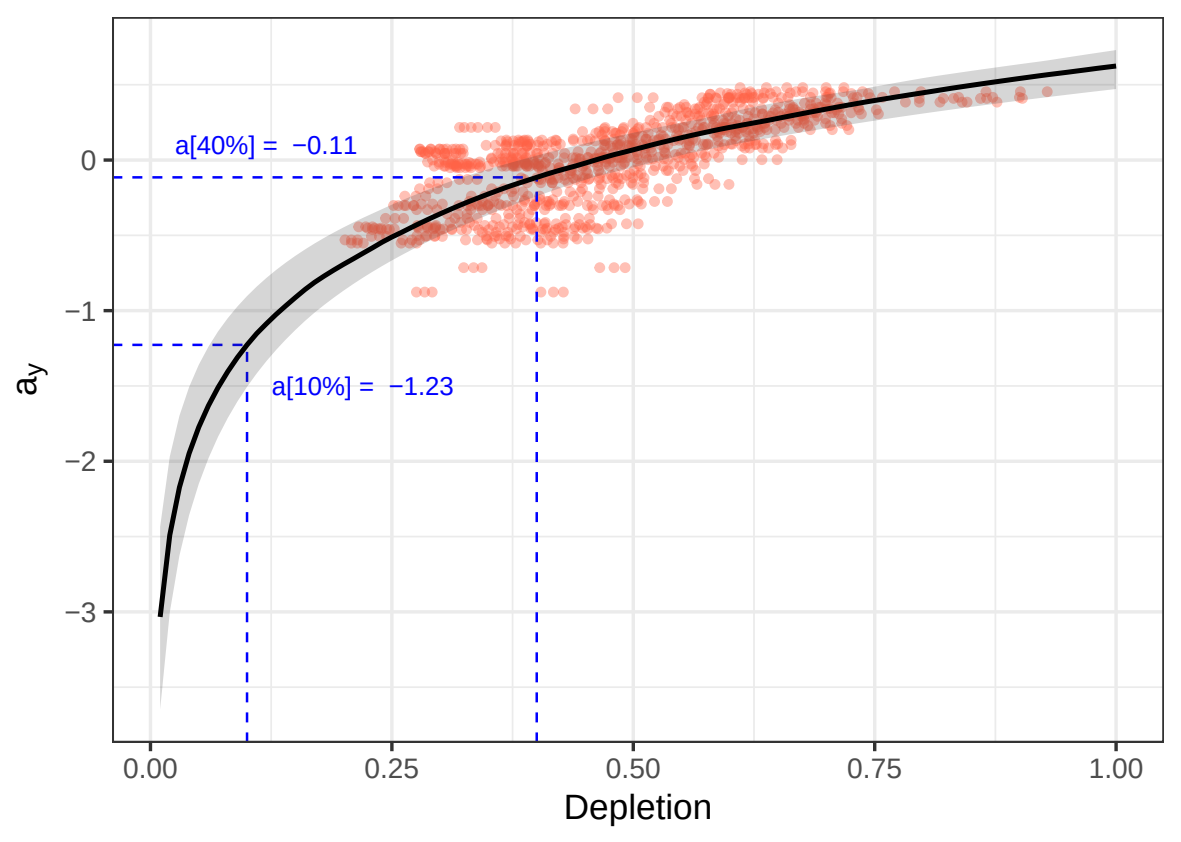

Figure 5: Relationship between the mean of the log-transformed PL and PSLS indices (a_y) and biomass depletion. Each data point (red) represents a value for a_y estimated from the empirical data, and the depletion estimated by the stock assessment.

Tuning

	TARGET-SYM	TARGET-ASY	STABLE-SYM	STABLE-ASY
a_X (% B)	-1.2 (10%)	-1.2 (10%)	-1.4 (8%)	-1.4 (8%)
a_T (% B)	-0.1 (40%)	-0.1 (40%)	-0.3 (32%)	-0.3 (32%)
C_{min}	66	66	66	66
C_{max}	Tuning	Tuning	Tuning	Tuning
TAC down	15%	10%	15%	10%
TAC up	15%	15%	15%	15%

Tuned using C_{max} to a target quadrant:

$$\text{Target Quadrant} = B > B_{40\%} \text{ and } E < E_{40\%}$$

Retained MPs with 50%, 60% or 70% probability of being in target quadrant.

Tuning

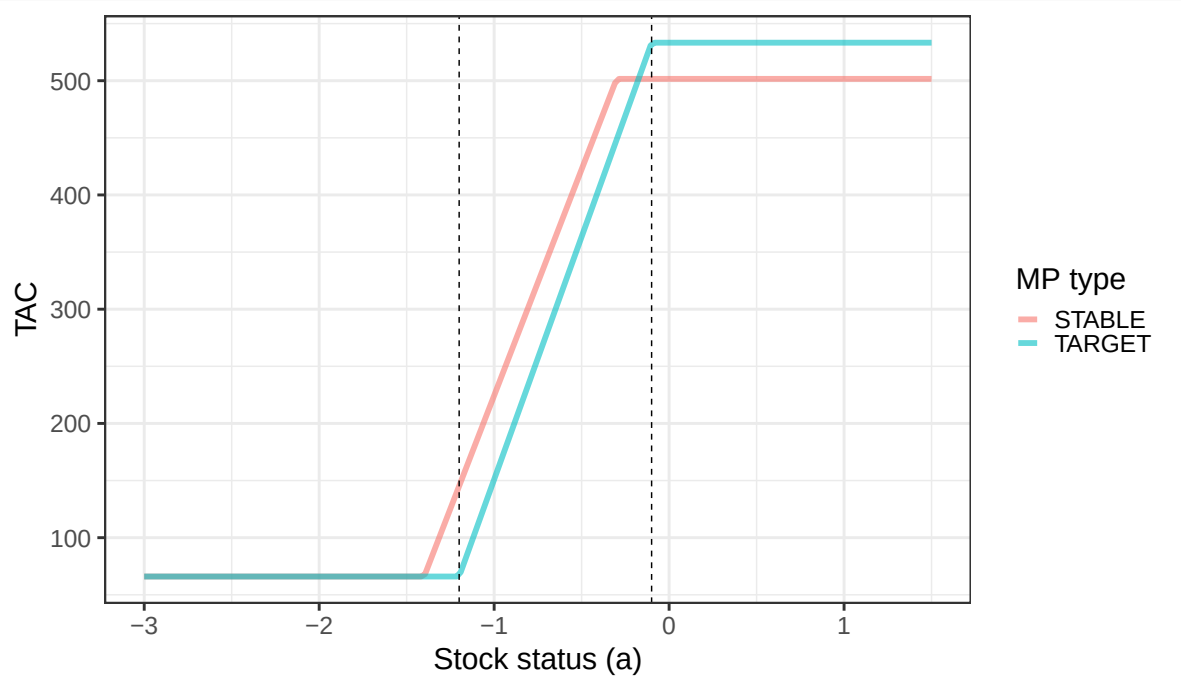

Figure 6: TARGET and STABLE MP types. Verticle lines correspond to 10% and 40% depletion.

Tuning

Table 2: Tuning parameters.

	TARGET-SYM	TARGET-ASY	STABLE-SYM	STABLE-ASY
a_X (% B)	-1.2 (10%)	-1.2 (10%)	-1.4 (8%)	-1.4 (8%)
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Tuned using C_{max} to a target quadrant:

$$\text{Target Quadrant} = B > B_{40\%} \text{ and } E < E_{40\%}$$

Retained MPs with 50%, 60% or 70% probability of being in target quadrant.

Tuning

Tuning used a set of 36 operating models, equivalent to the 36 models used in stock assessment.

All OMs:

- Assumed a 3-year managment cycle;
- Set the first TAC in 2027;
- Assumed a 2-year total lag between the data and the TAC year.

Robustness testing was performed that included a 20% or 30% overcatch of the recommended TAC (consistent with previous observations).

Simulated properties

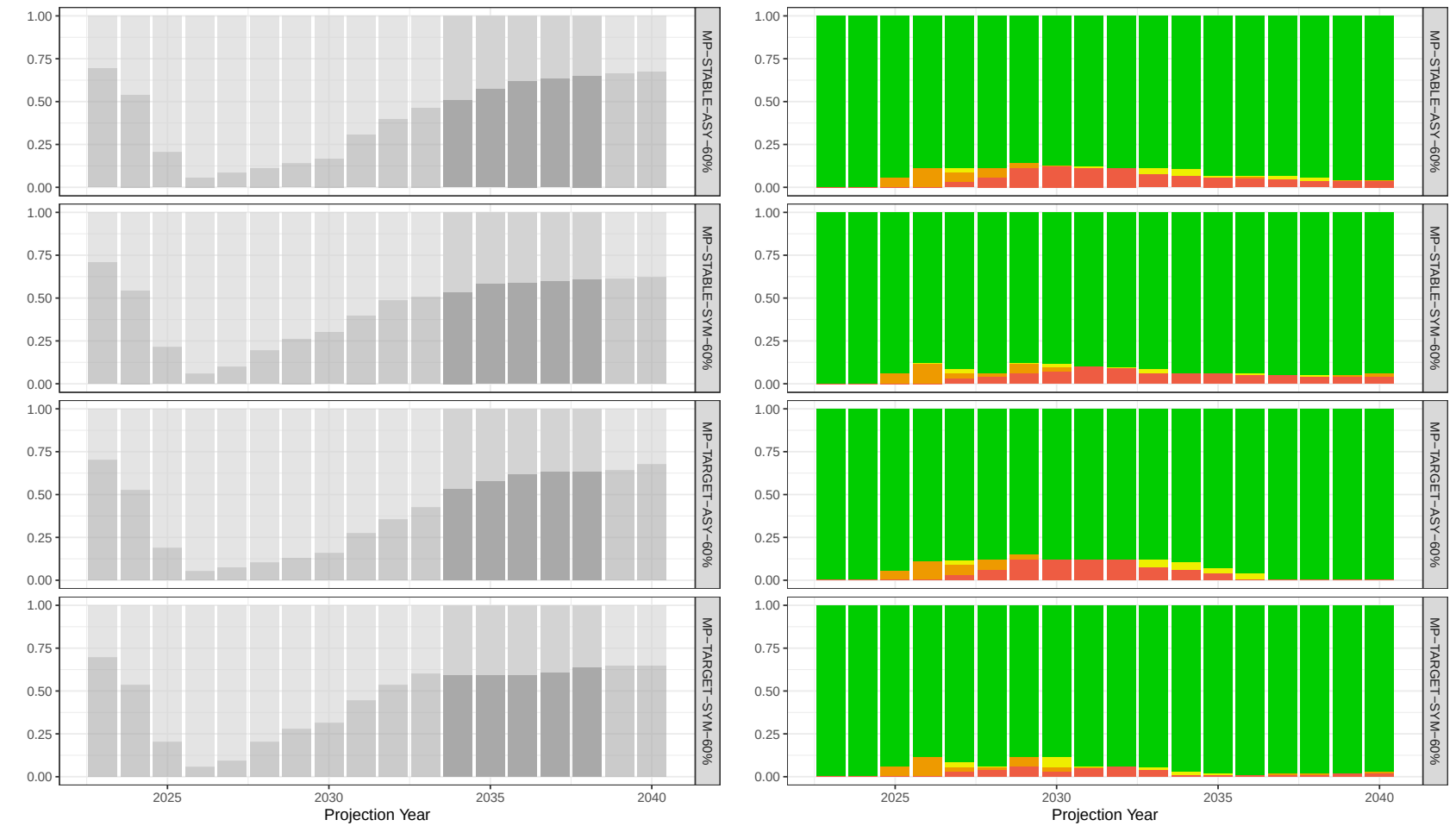

Figure 7: Simulated properties (reference case with 60% tuning probability).

Simulated properties

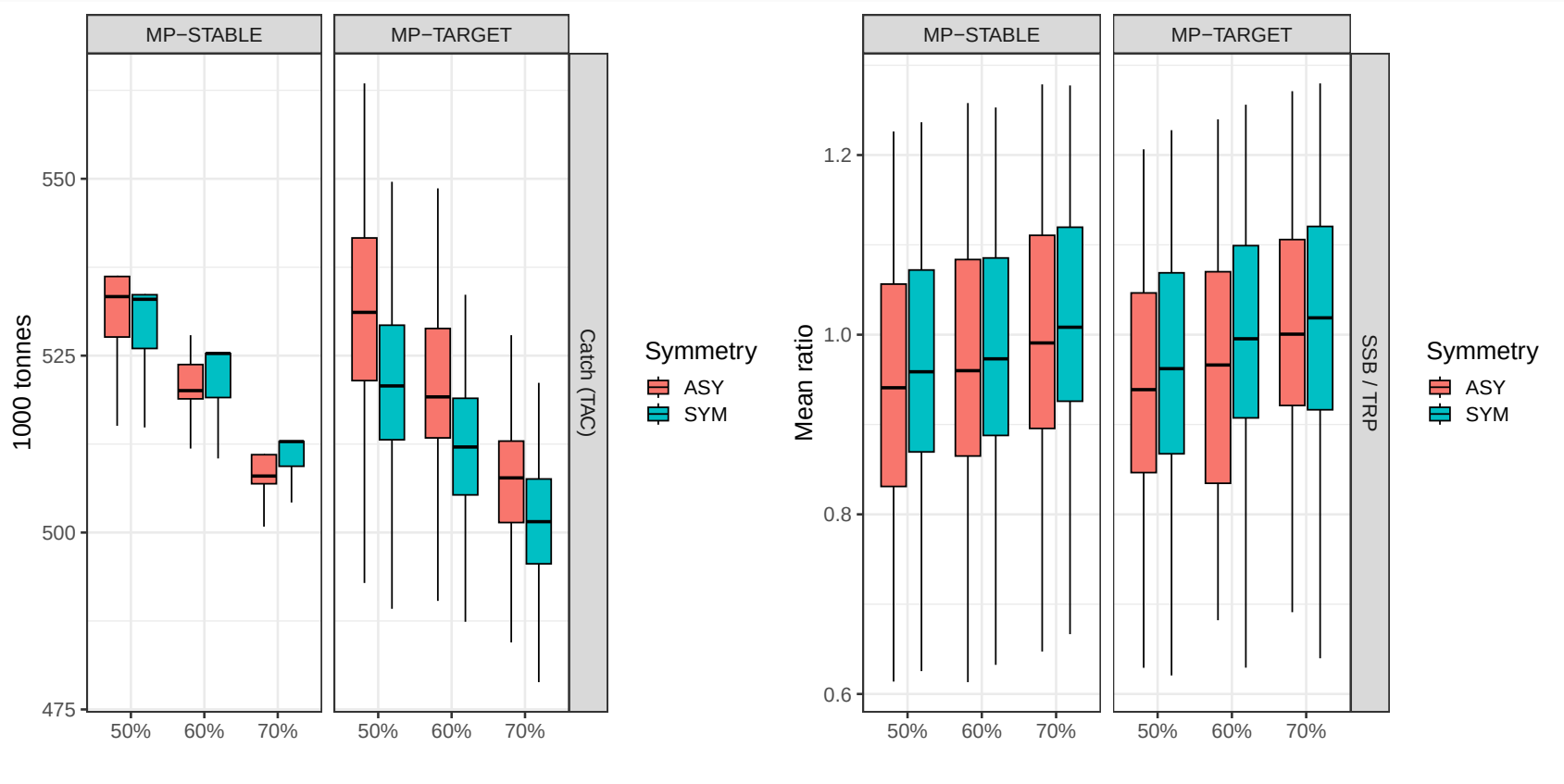

Figure 8: Simulated properties (reference case TAC and SSB).

Simulated properties

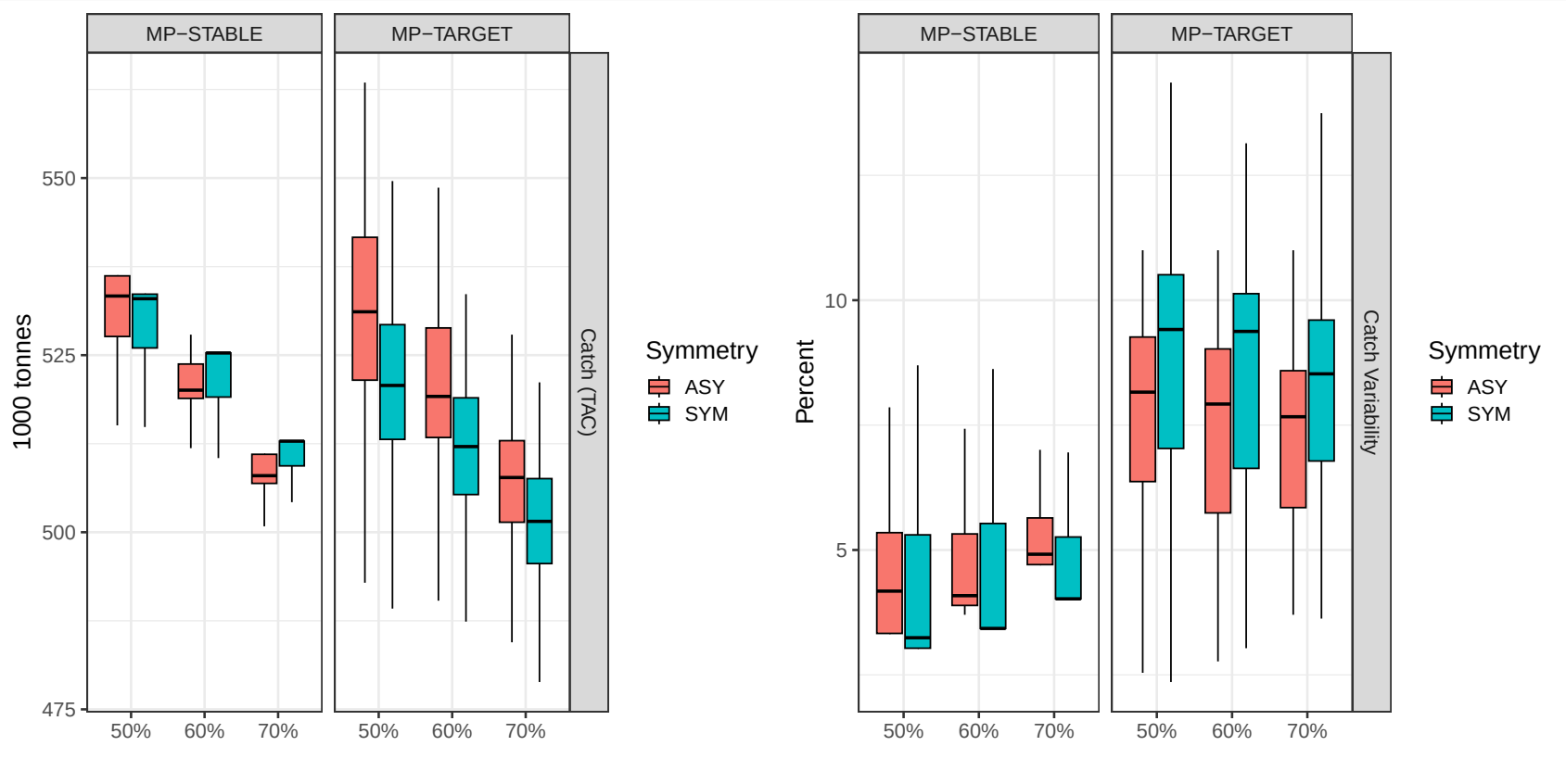

Figure 9: Simulated properties (reference case TAC and target quadrant probability).

Simulated properties

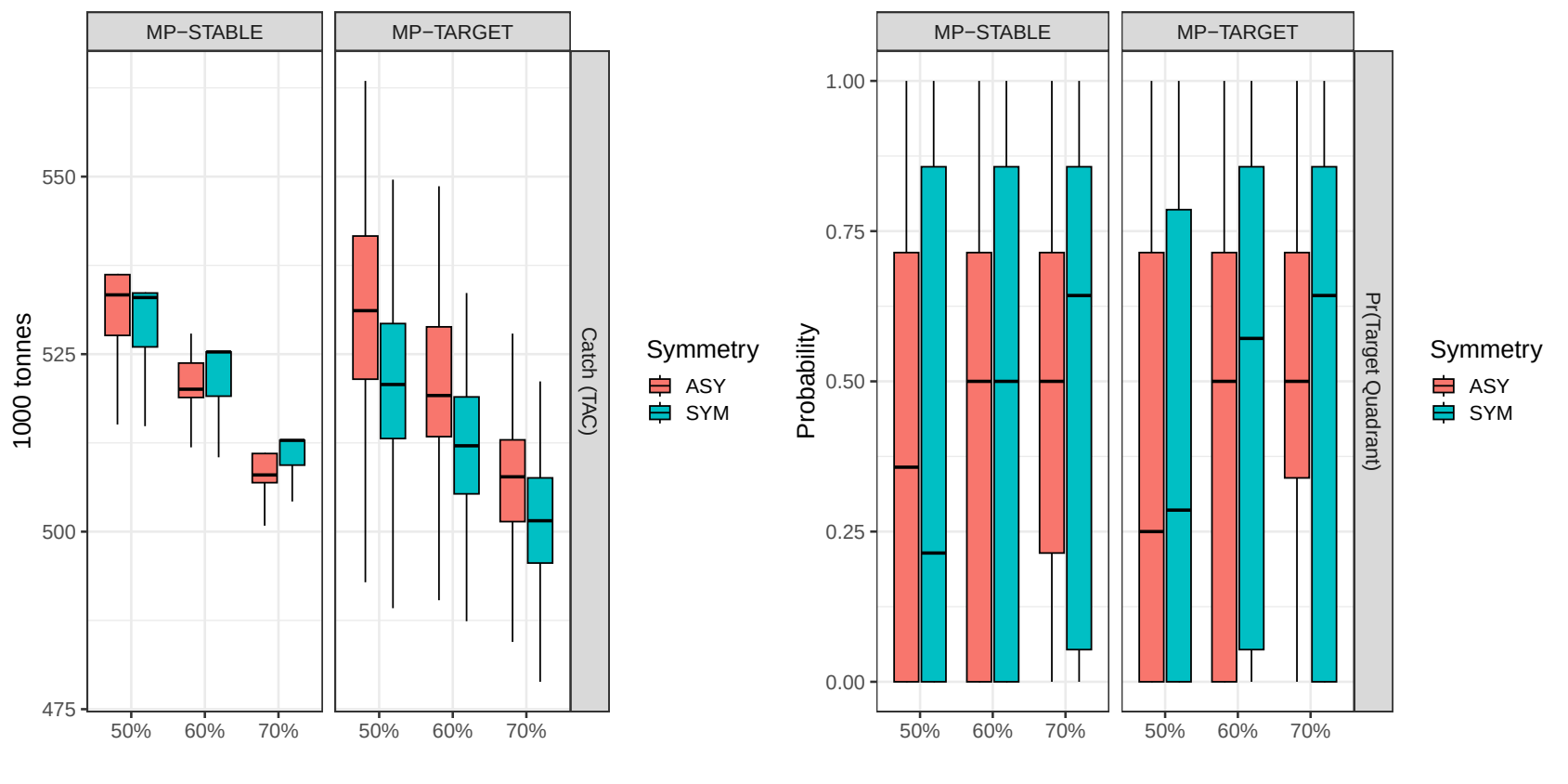

Figure 10: Simulated properties (reference case TAC and TAC variability).

Simulated properties

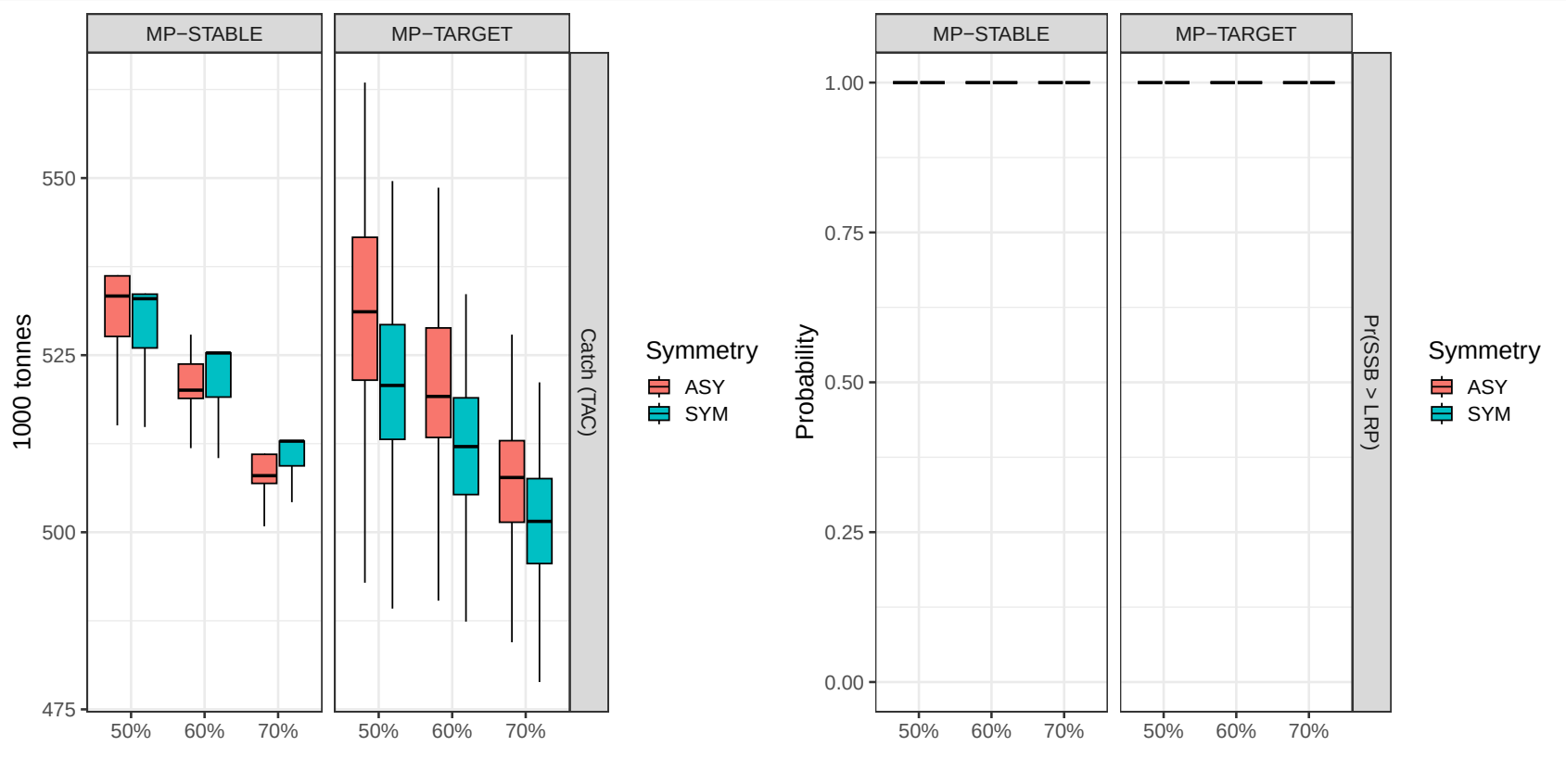

Figure 11: Simulated properties (reference case TAC and proximity to LRP).

Simulated properties

Overall MP properties:

- Overall stock status and average catch are primarily determined by tuning to 50%, 60% or 70% criteria, not by the MP-type or TAC change limit;
- The STABLE MP-type is more stable and can have a higher average TAC;
- The TARGET MP-type has a higher possible TAC;

Simulated properties

Overall MP properties:

- The ASY TAC change limit led to more frequent TAC changes but can improve overall stability;
- Overall, the TAC change limit had the smallest effect on outcome. Stock status and catch stability were primarily determined by the tuning criteria and MP-type.
- In all cases there is expected to be a large reduction in the TAC in the first year of MP implementation (2027);

Simulated diagnostics

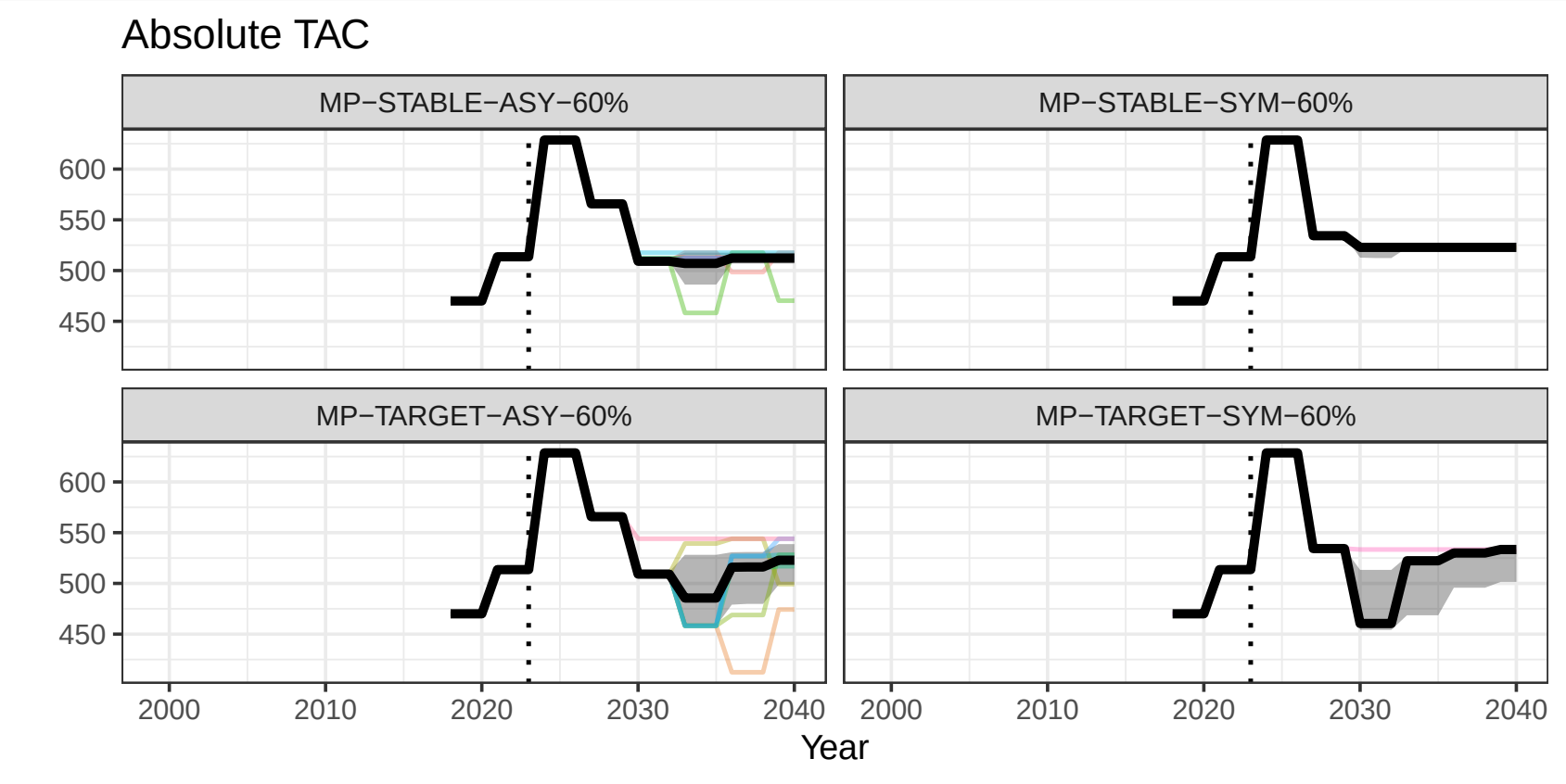

Figure 12: Simulated TAC timeseries for MPs tuned to 60% probability of being in the target quadrant.

Simulated diagnostics

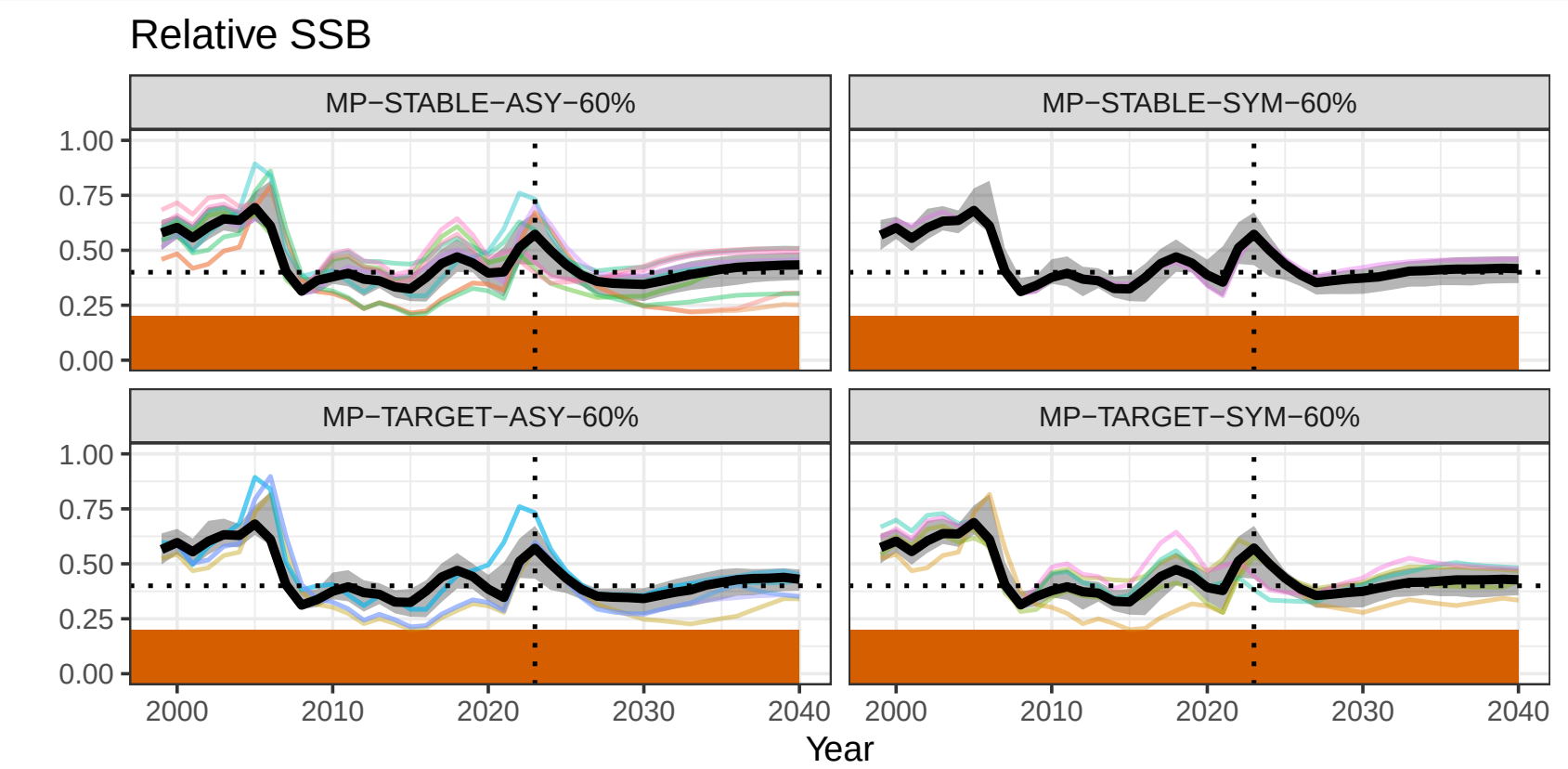

Figure 13: Simulated relative biomass timeseries for MPs tuned to 60% probability of being in the target quadrant.

Simulated properties (with overcatch)

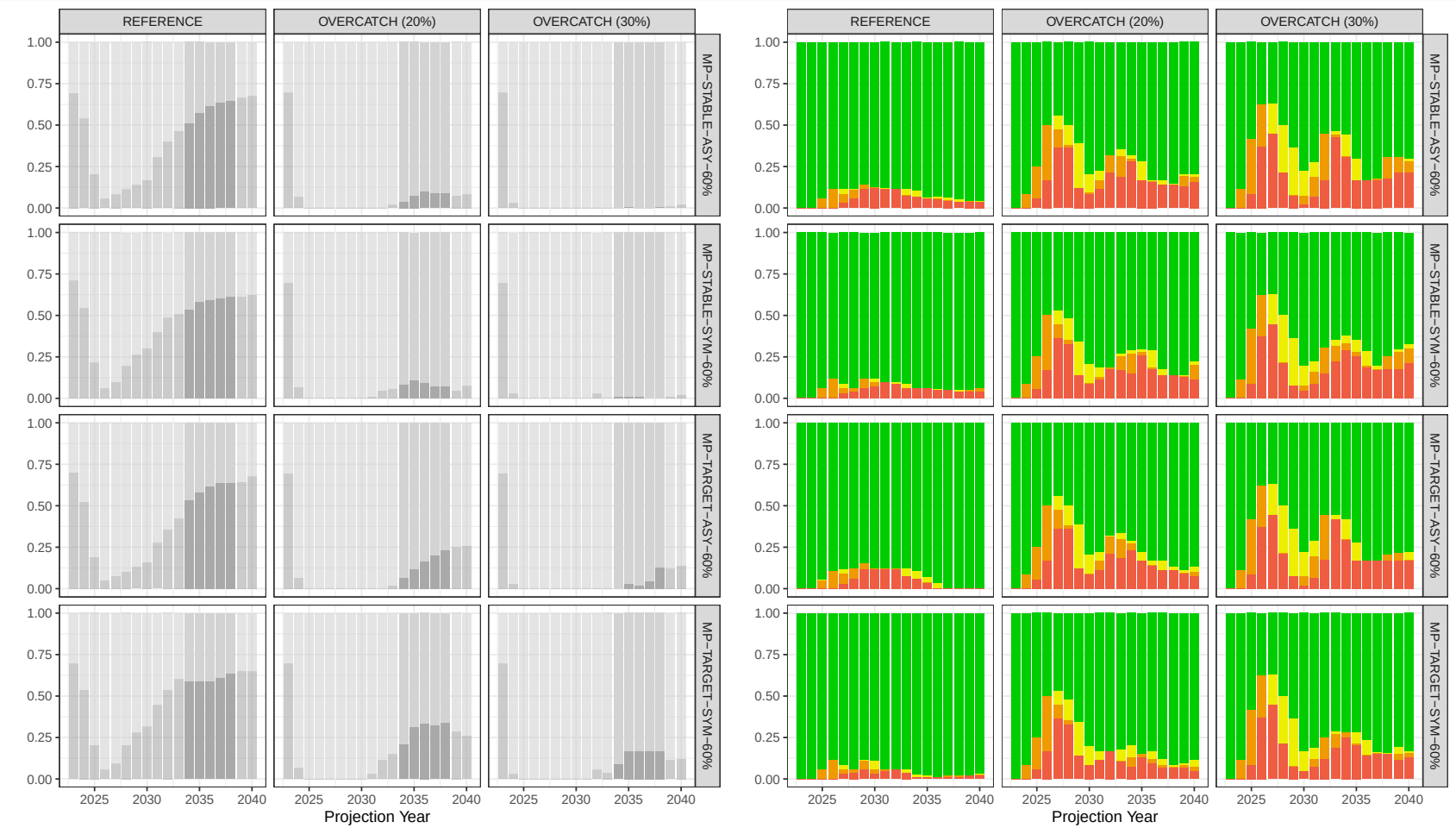

Figure 14: Simulated TAC timeseries for MPs tuned to 60% probability of being in the target quadrant.

Simulated properties (with overcatch)

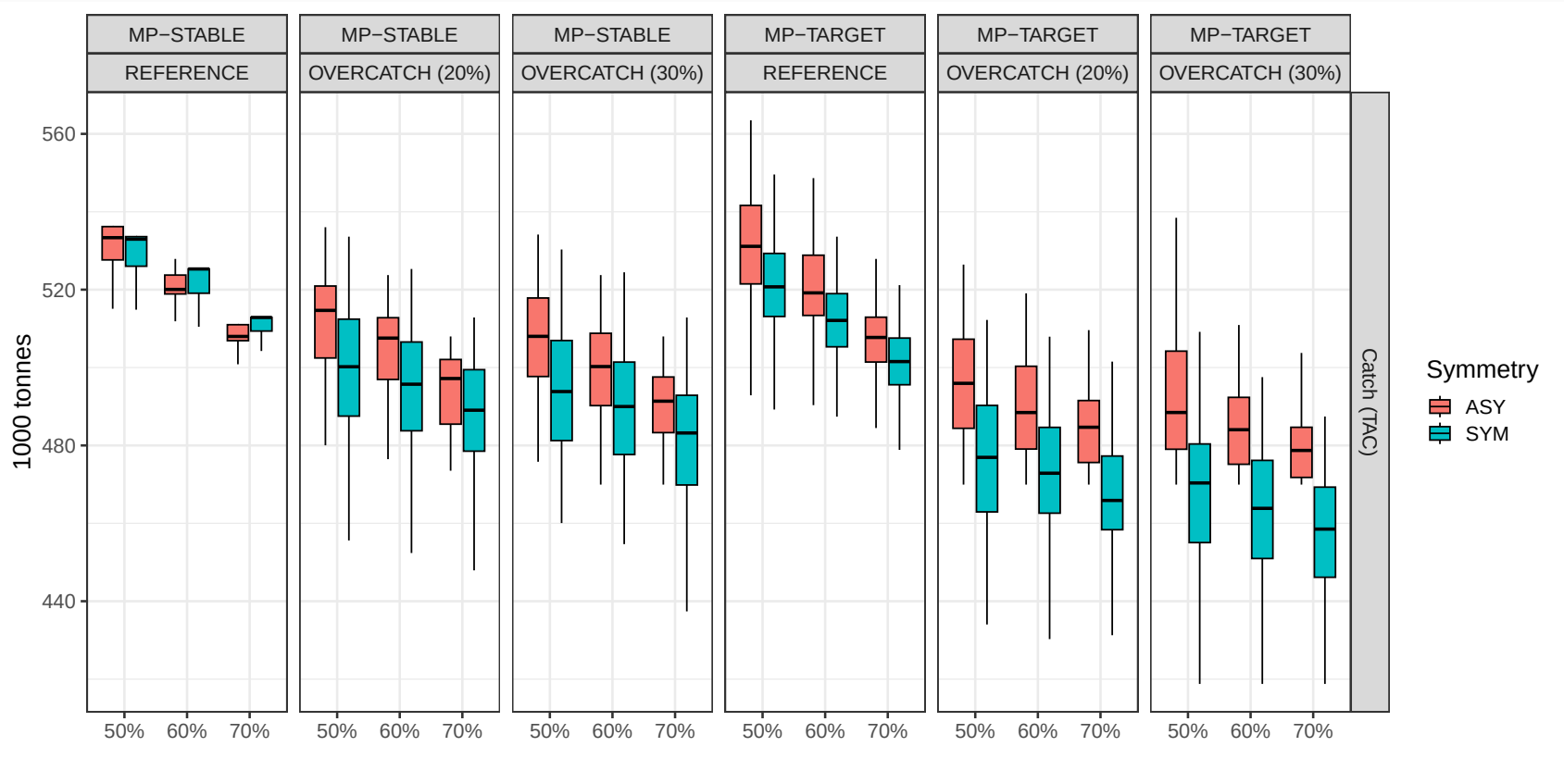

Figure 15: Simulated properties (overcatch TAC).

Simulated properties (with overcatch)

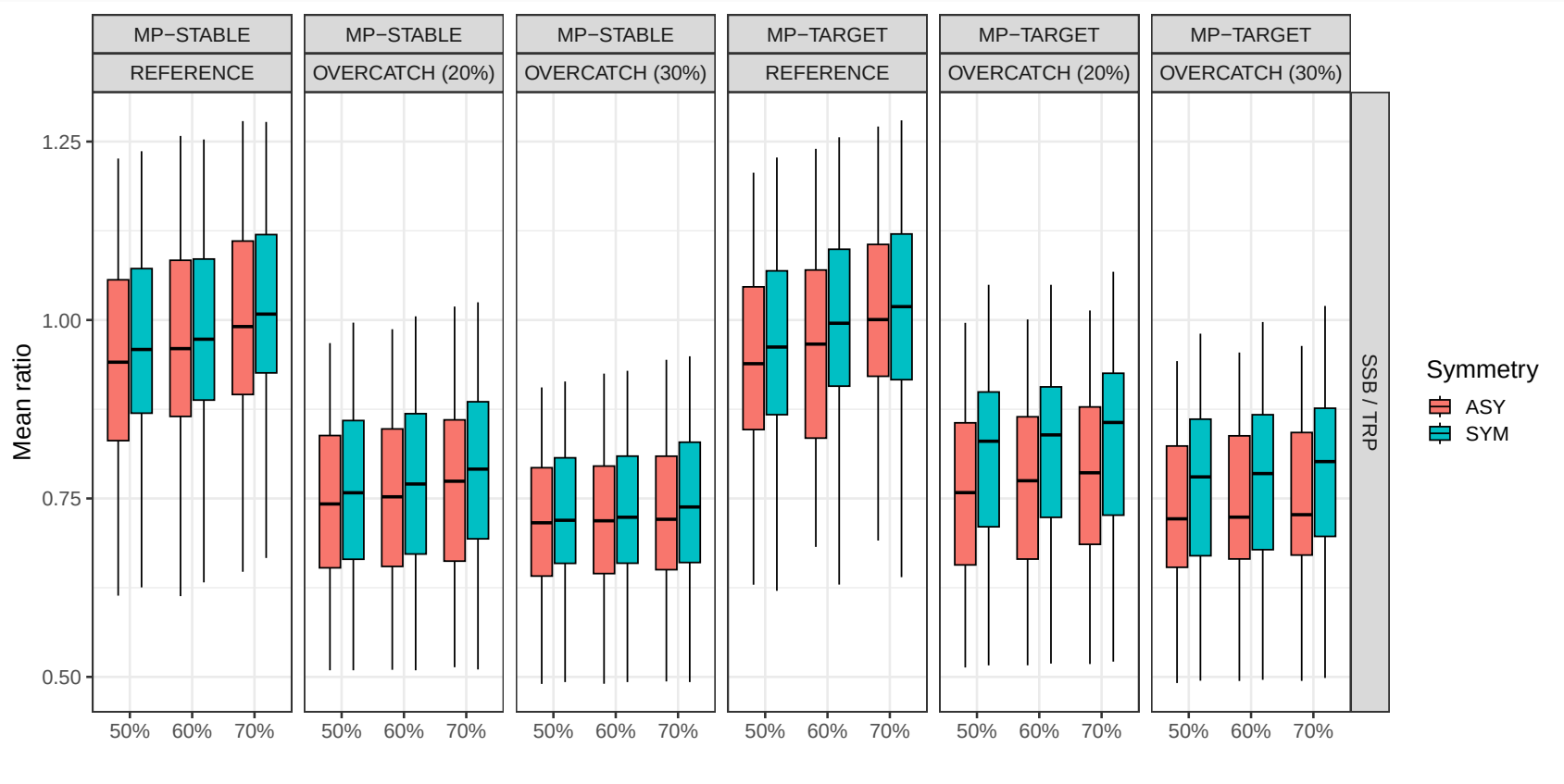

Figure 16: Simulated properties (overcatch SSB).

Simulated properties (with overcatch)

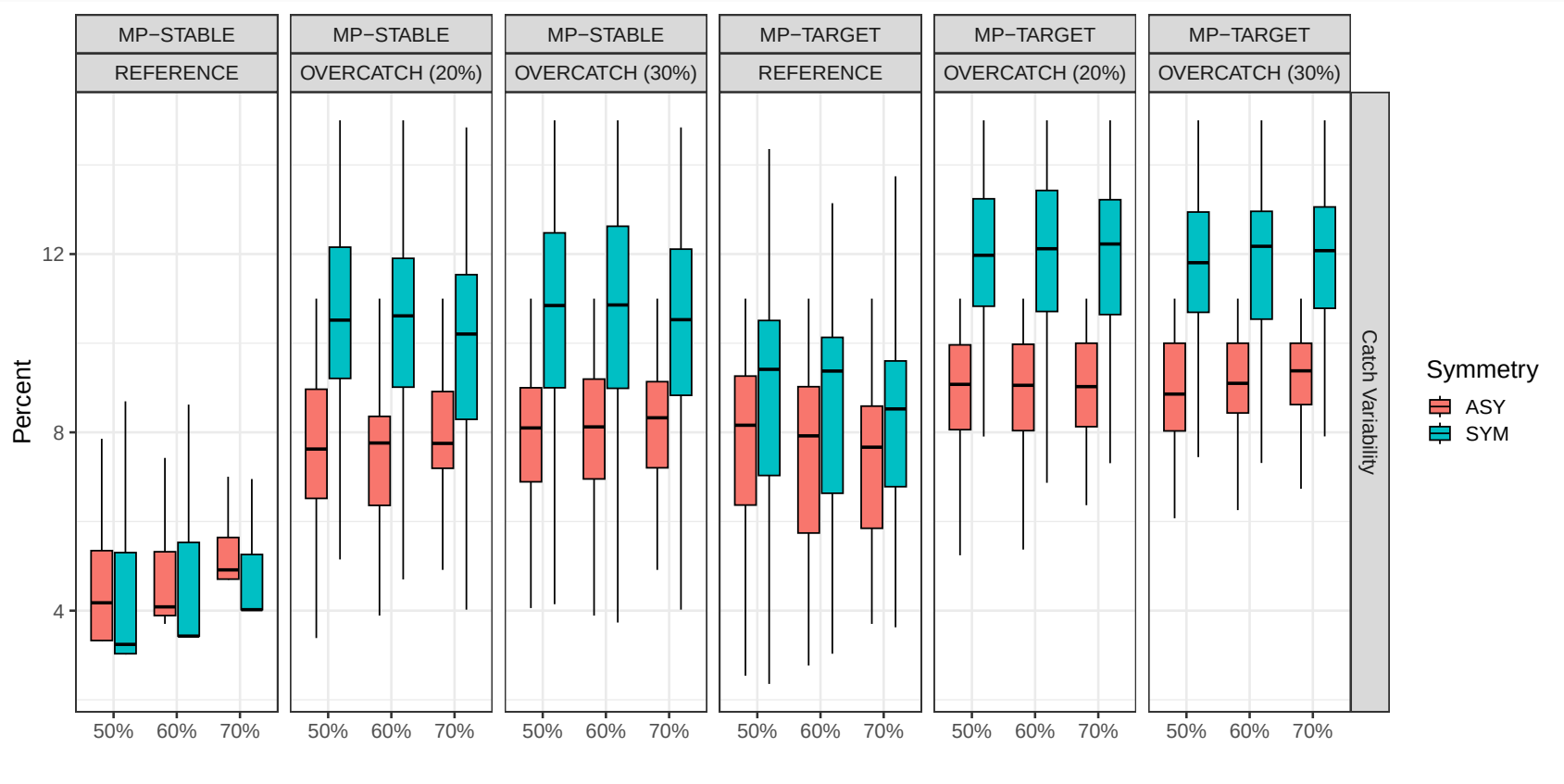

Figure 17: Simulated properties (overcatch TAC variability).

Simulated properties (with overcatch)

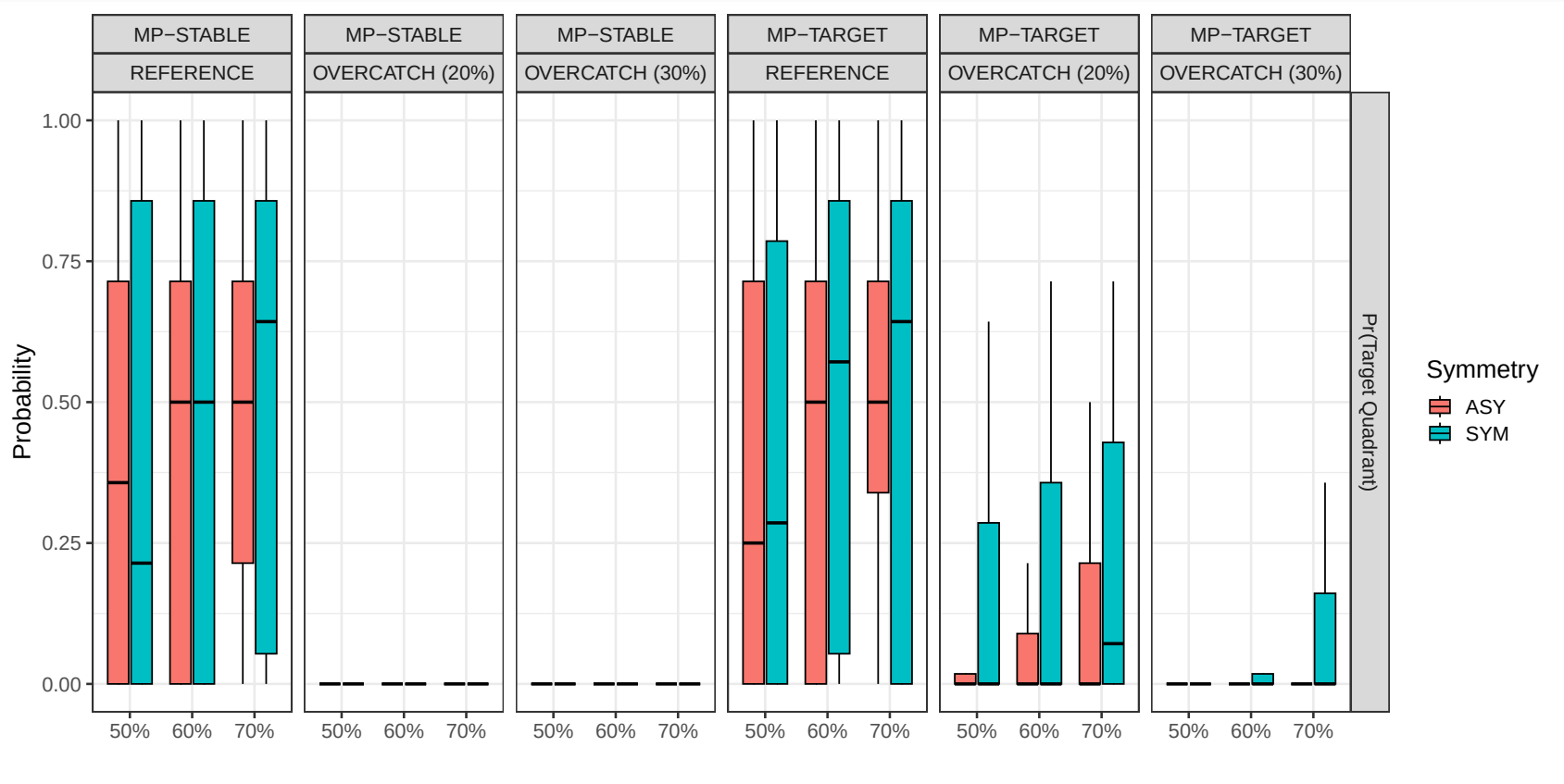

Figure 18: Simulated properties (overcatch target quadrant probability).

Simulated properties (with overcatch)

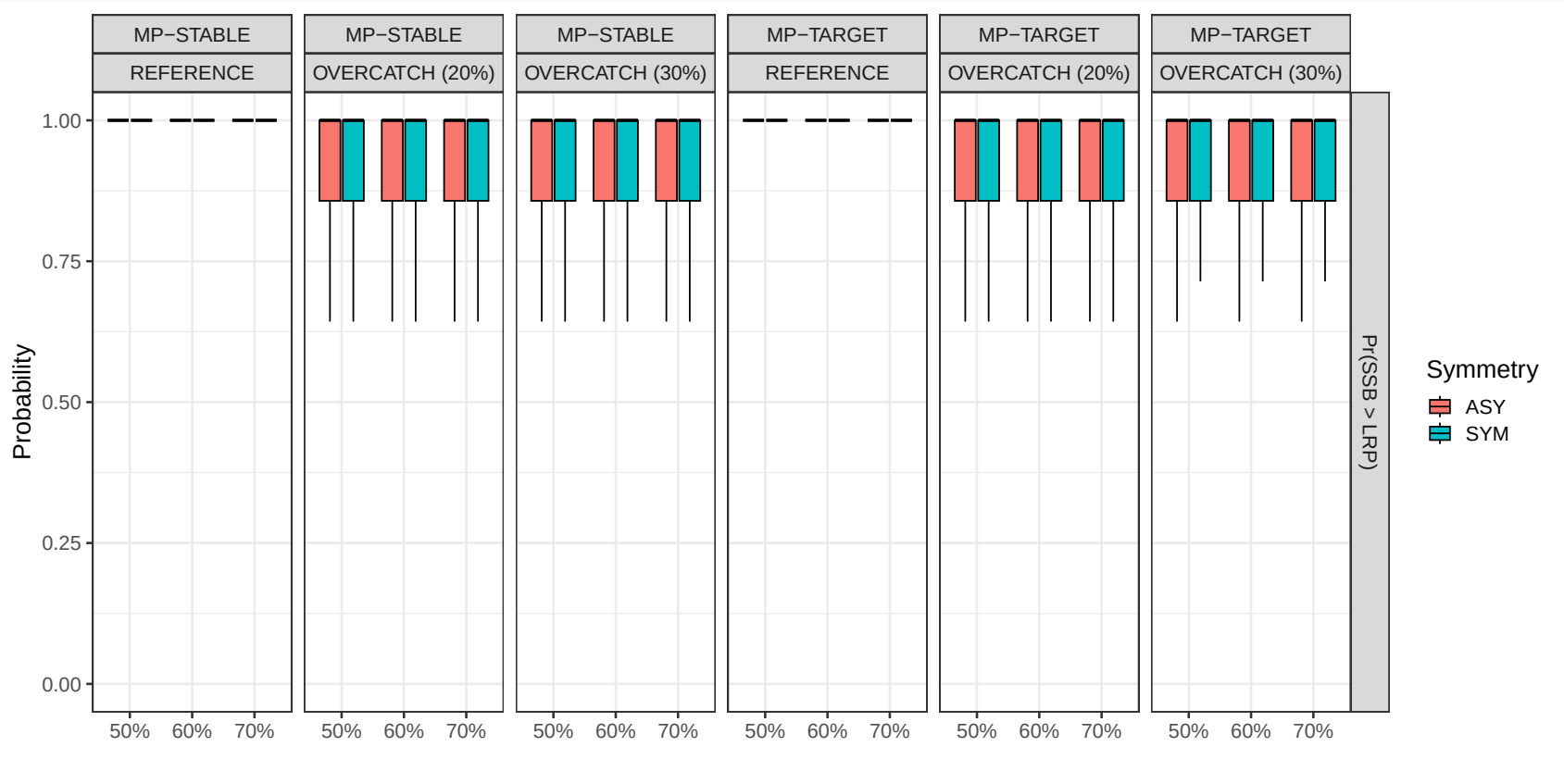

Figure 19: Simulated properties.

Qualitative performance

Table 3: Qualitative performance criteria and recommendations for MP design considering the reference set and overcatch robustness testing.

Criteria	MP-type	TAC change limit	Tuning objective (50%, 60%, 70% prob. of being in the target quadrant)
Maximum possible catch	TARGET	–	50%
Maximum average catch	STABLE	–	50%
Catch stability	STABLE	ASY	70%
Stock status	TARGET	SYM	70%

Decisions

Possible decisions for the Commission include:

1. Selection of the management objective that the MP will be tuned to: a 50%, 60% or 70%, probability of meeting the management target. This will determine the stock status and overall catch;
2. Selection of either the TARGET or STABLE MP-type. This will determine whether stabilty of the TAC over time should be given preference over the maximum allowable catch;
3. Selection of a 10% or 15% limit to the reduction of the TAC. This will have a small impact on TAC stability, with a more restrictive change limit likely leading to more frequent TAC changes.

Selection from these alternate options will identify which of the twelve candidate MPs should be preferred.

Acknowledgements

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