Updated candidate MPs for Indian Ocean skipjack tuna

7th Session of the IOTC Technical Committee on Management Procedures

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19 - 21, February 2024

Online

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 Session of the TCMP include:

1. Re-visit the possibility of using a model-based Management Procedure based on the updated CPUE indices to be presented at WPTT25; ✓
2. Propose a set of candidate Management Procedures to the TCMP (2024) for potential adoption by the Commission.

Item (1) was addressed at the 25th Session of the IOTC-WPTT in October 2023, with evidence presented that a model-based approach to setting management catch limits was not viable.

Time frame: October 2023 to June 2024

Background and motivation

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

What is an MP?

- It calculates a recommended management action based on defined data inputs;
- It has been simulation tested.

Why simulation testing?

- Does it work?
- Under what conditions does it not work?

MPs usually have implicit design features.

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

Harvest control rule: recommends an exploitation rate based on the stock biomass.

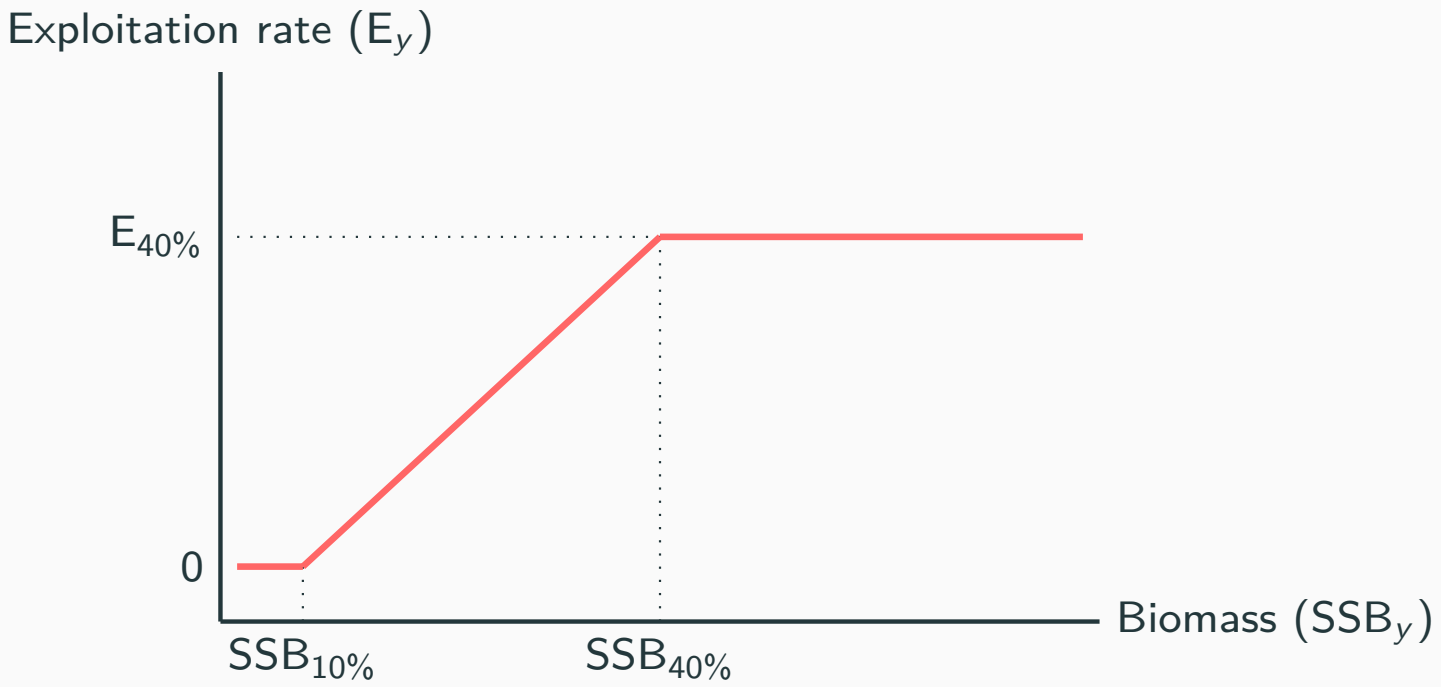

Figure 1: Schematic representation of the current Harvest Control Rule (Resolution 16/02 & 21/03).

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

Design features: stabilise exploitation rate; reduce exploitation rate at biomass below the target.

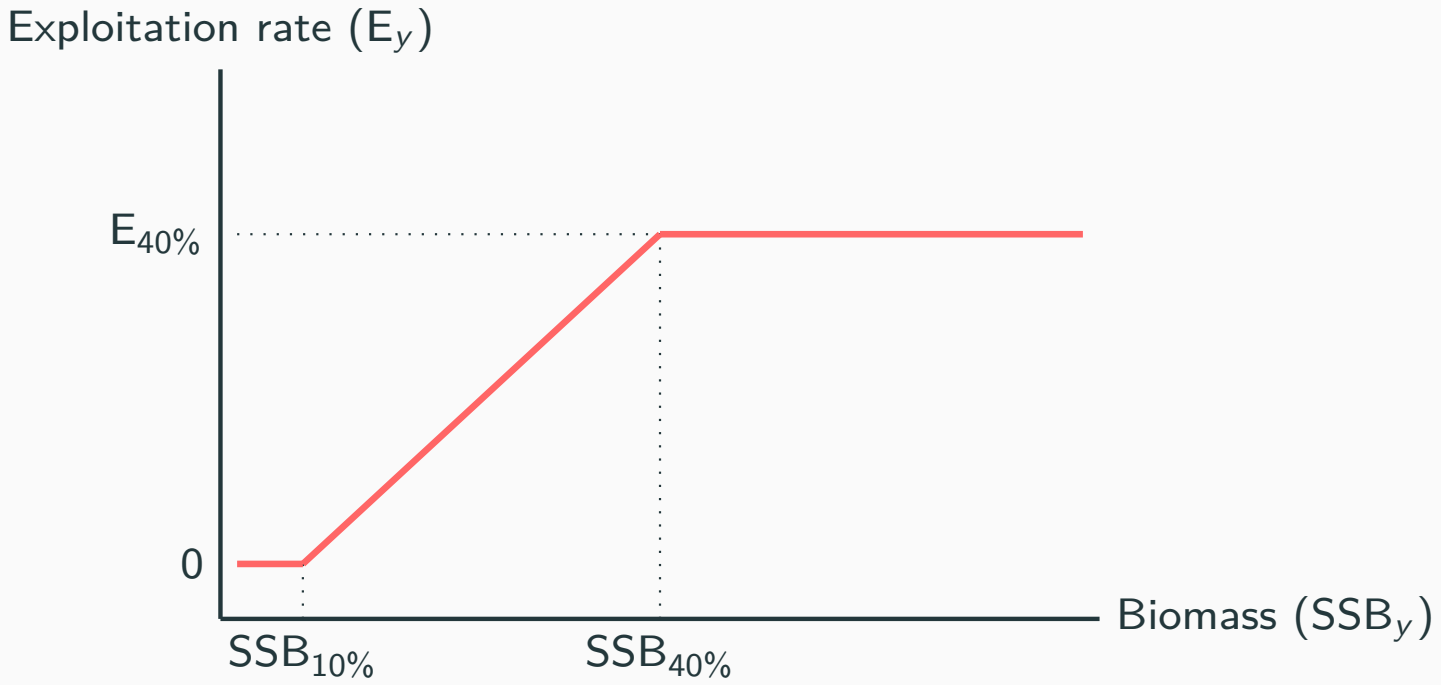

Figure 1: Schematic representation of the current Harvest Control Rule (Resolution 16/02 & 21/03).

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	–	–

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.

Does current management work?

- If biomass is well estimated.
- What happens if it is not well estimated?

What can we do?

- Define an indicator of biomass;
- Build an MP that uses this indicator as input;
- Perform simulation-based evaluation.

In general: the simpler the measure of biomass the easier it is to test.

Background and motivation

Overall objective

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How do we simulate?

- Represent stock dynamics;
- Represent MP implementation

How do we evaluate?

- Generate statistical diagnostic outputs (e.g. total catch);
- Retain MPs that meet pre-defined objectives ("tuning");
- Compare tuned MPs qualitatively.

Background and motivation

Overall objective

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Steps:

1. Define data inputs;
2. Define harvest control rule;
3. Tune to pre-defined criteria;
4. Compare preliminary diagnostic outputs.

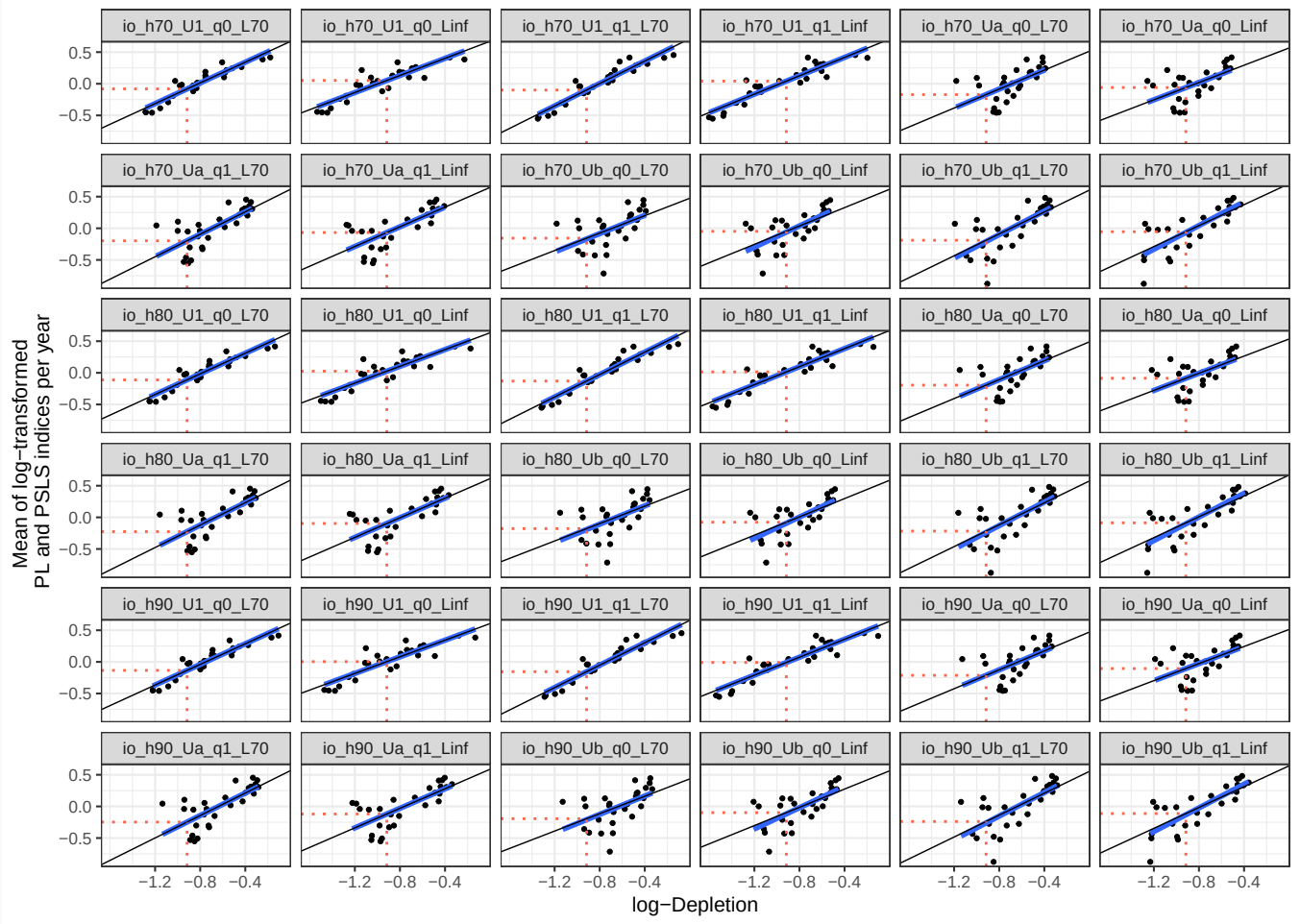
Data inputs

log-transformed PL and PSLS catch rate indices show similar dynamics:

Define a_y as scaled mean of log-trasformed PL and PSLS indices.

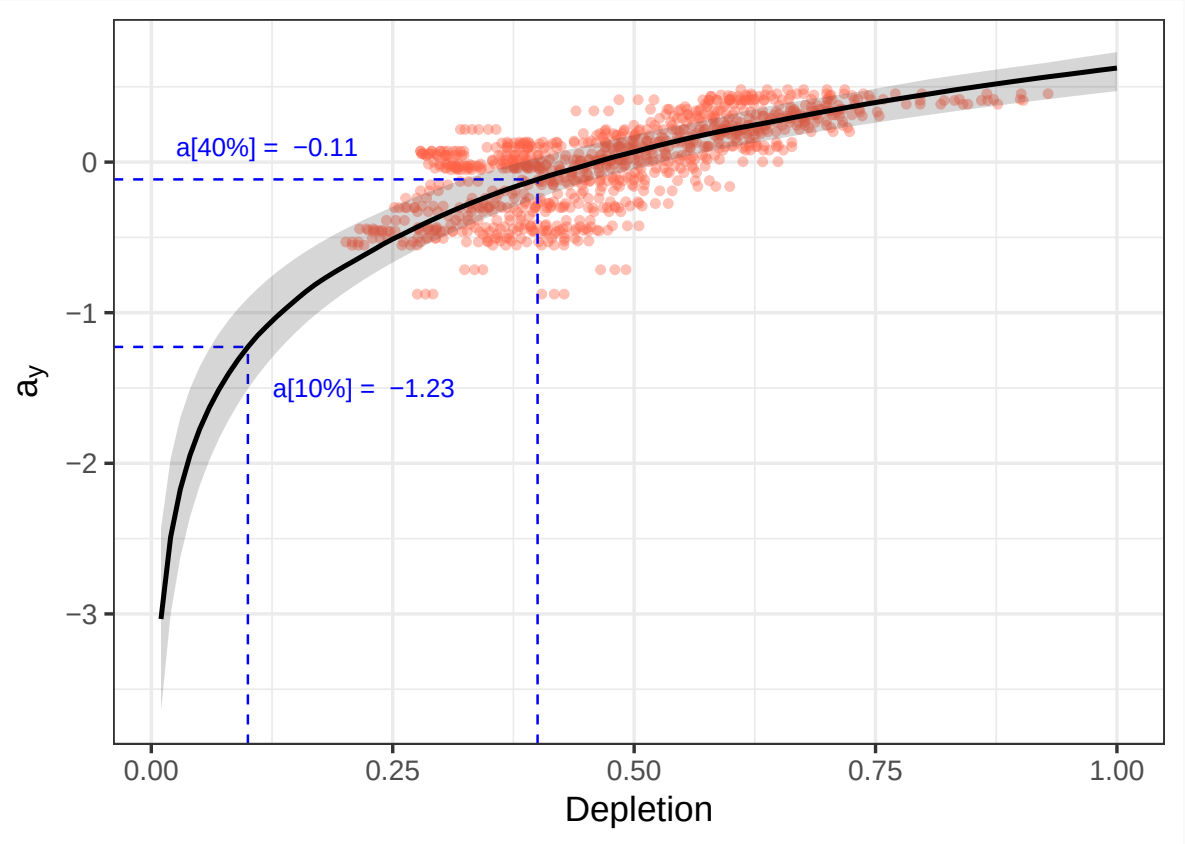
Data inputs

Relationship between (a_y) and log-depletion ($\log(SSB_y/SSB_0)$):



Data inputs

Relationship between (a_y) and depletion (SSB_y/SSB_0):



Harvest Control Rule

Harvest control rule: recommends a total catch based on the stock biomass index.

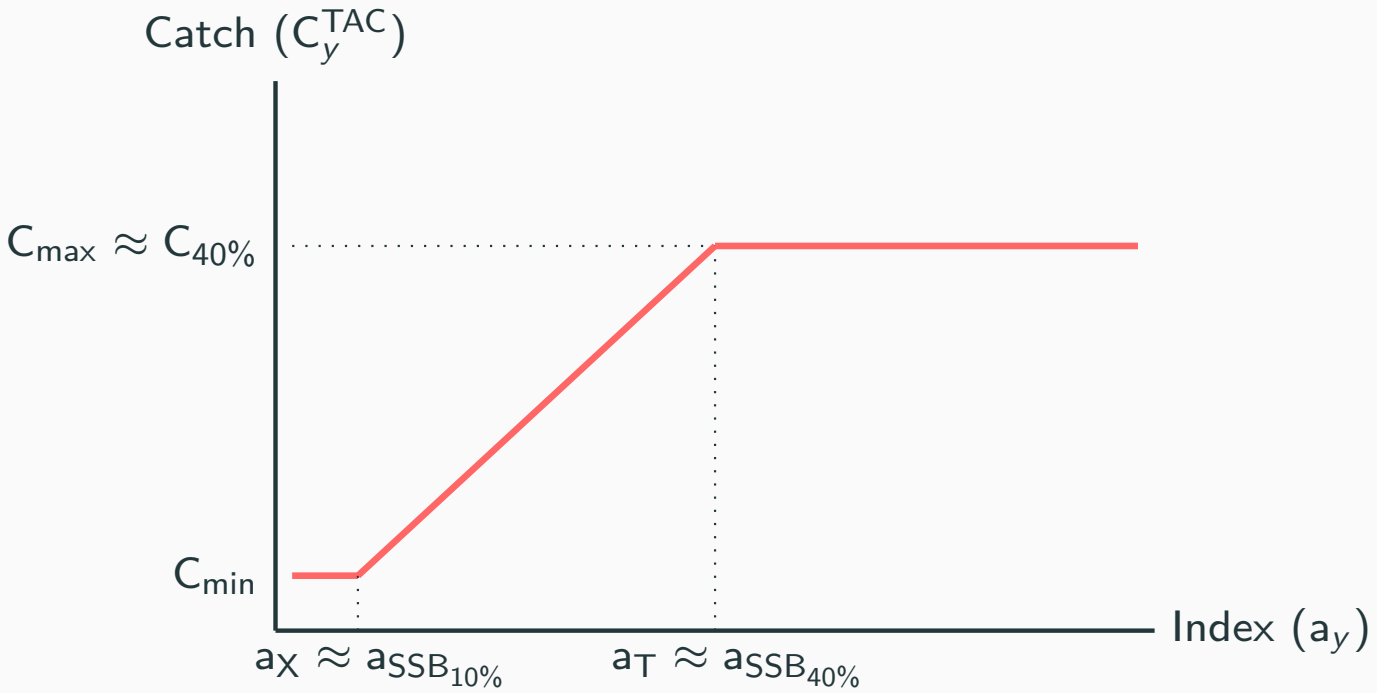


Figure 2: Schematic representation of the empirical Harvest Control Rule proposed as part of a data-based MP.

Harvest Control Rule

Design features: stabilise total catch; reduce catch as biomass declines.

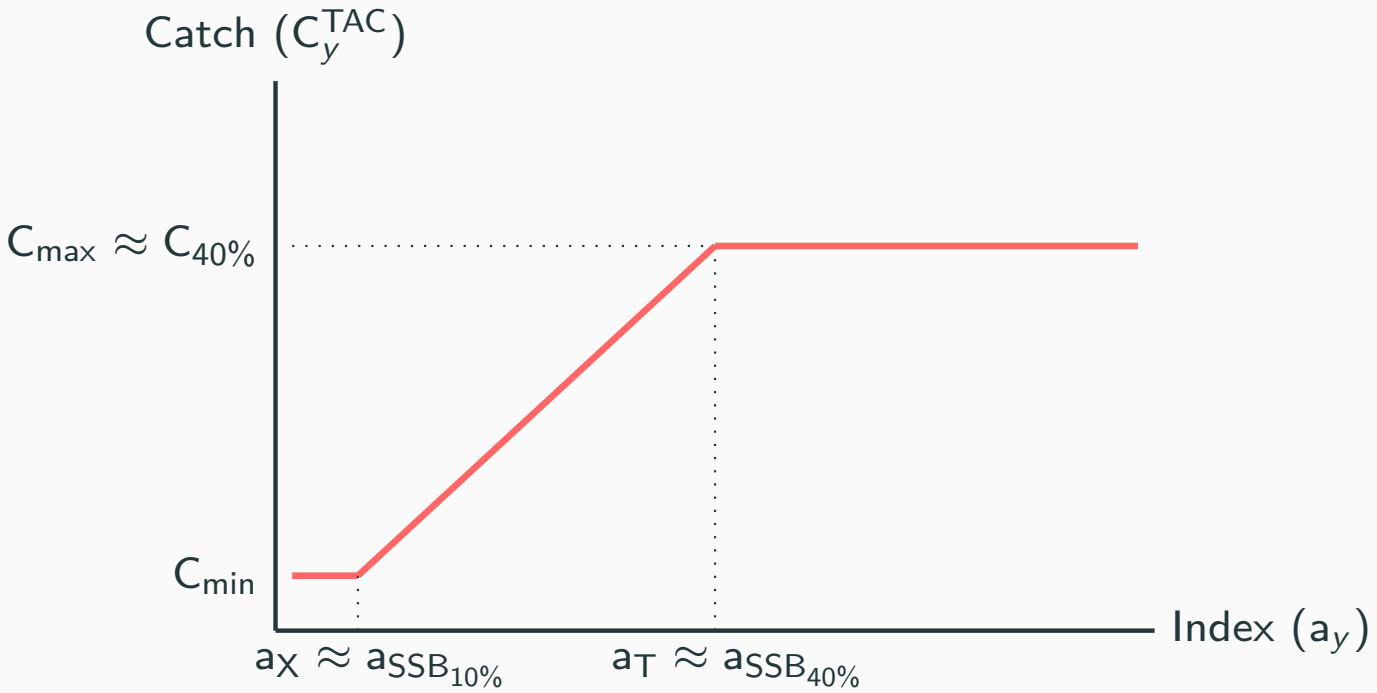
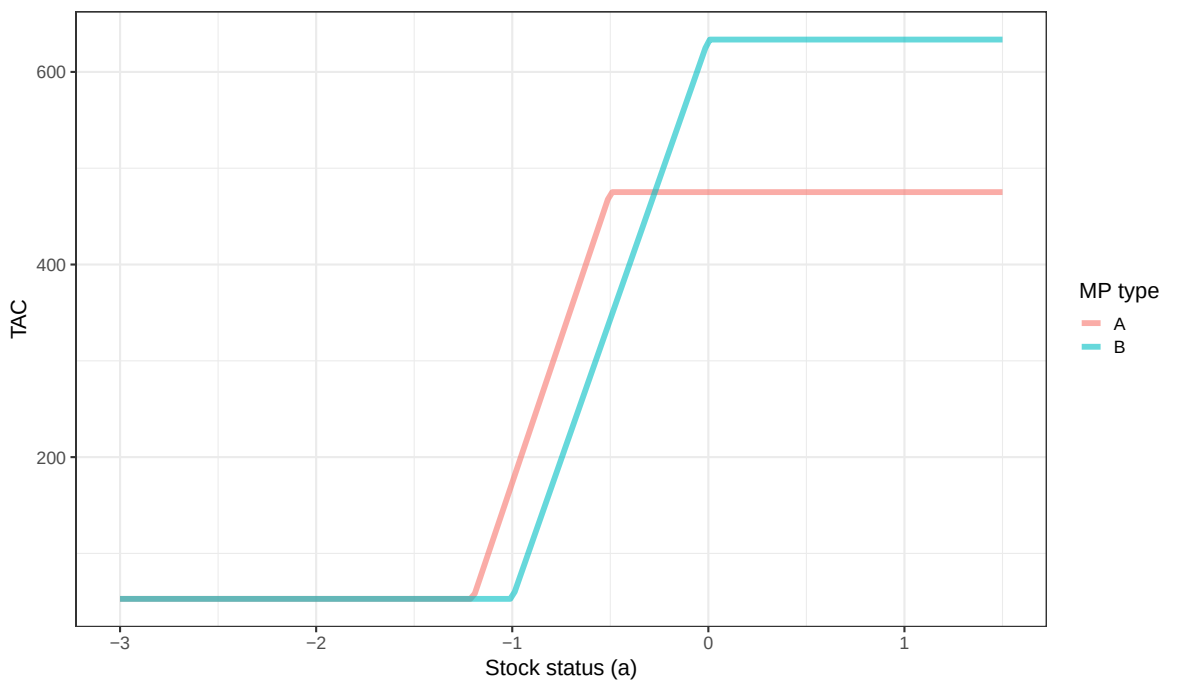


Figure 2: Schematic representation of the empirical Harvest Control Rule proposed as part of a data-based MP.

Tuning

Simulate probability of being in target quadrant:

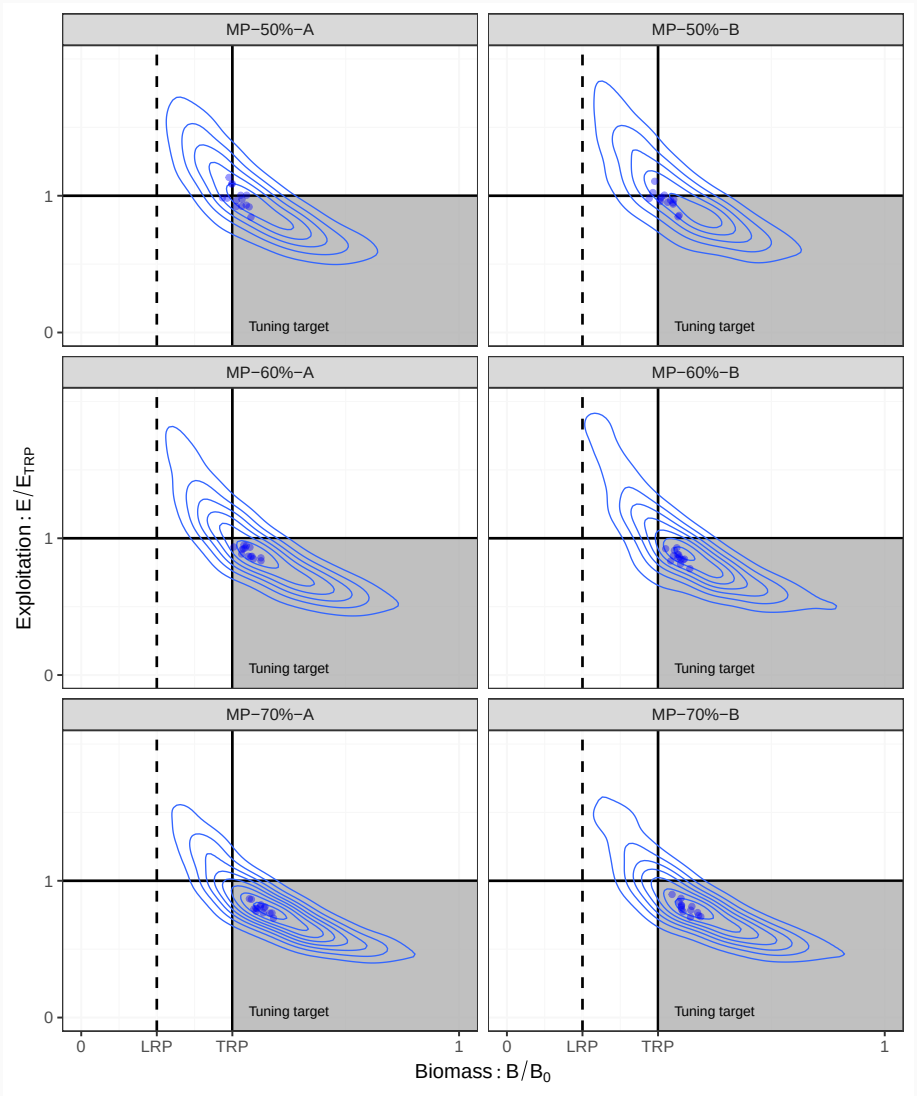
$$\text{Target Quadrant} = \text{SSB} > \text{SSB}_{40\%} \ \& \ \text{E} < \text{E}_{40\%}$$



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

Tuning

Tuning target simulation results:



Tuning

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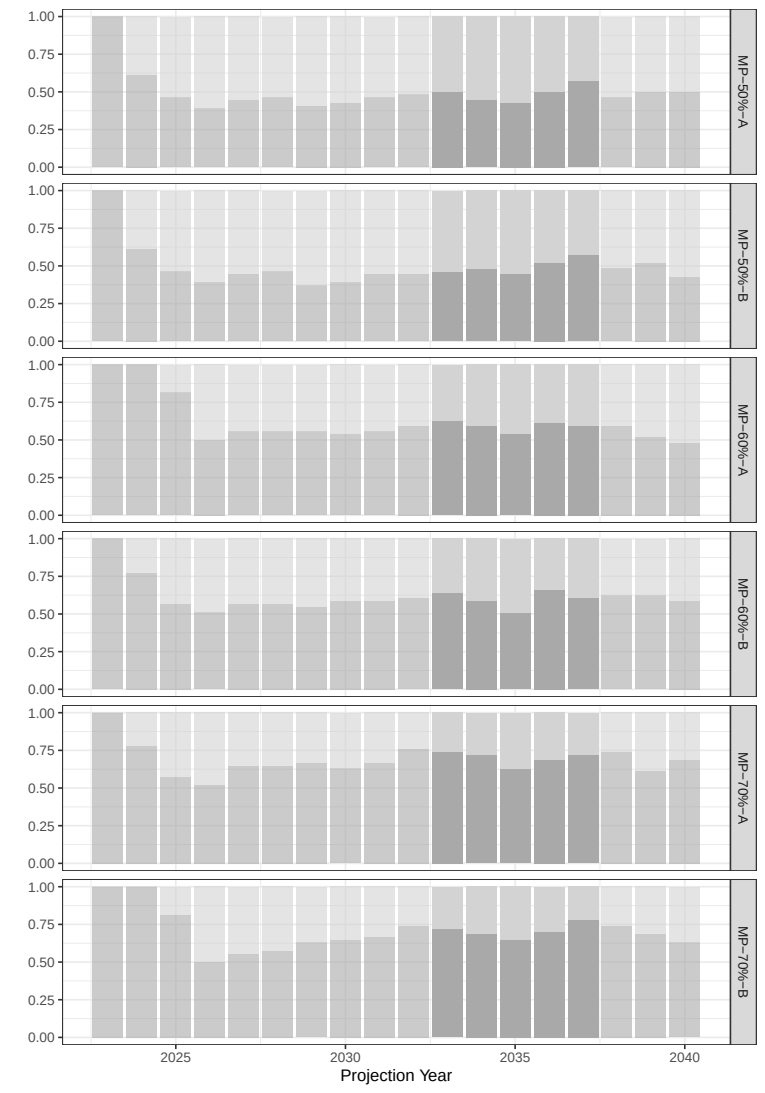
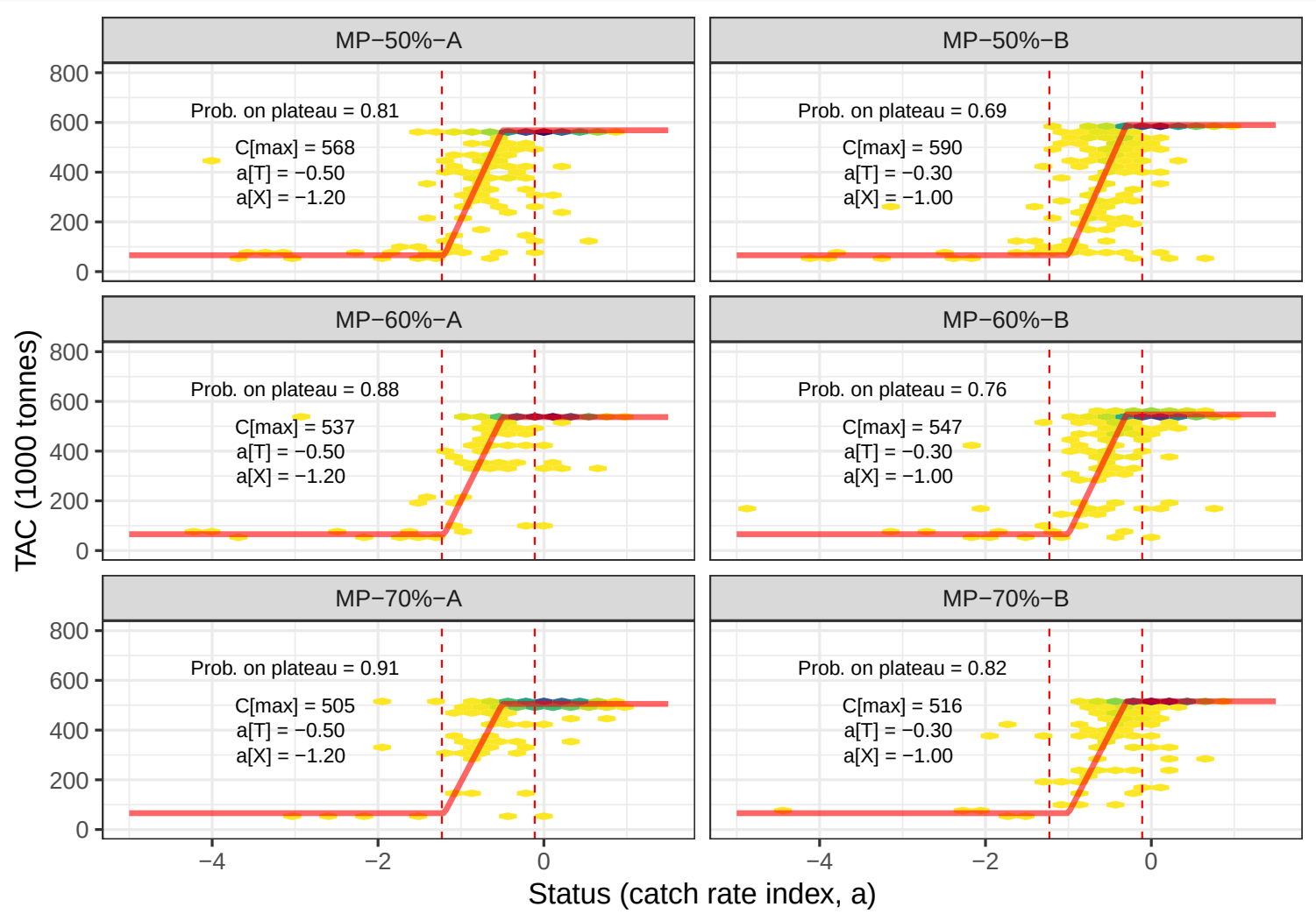
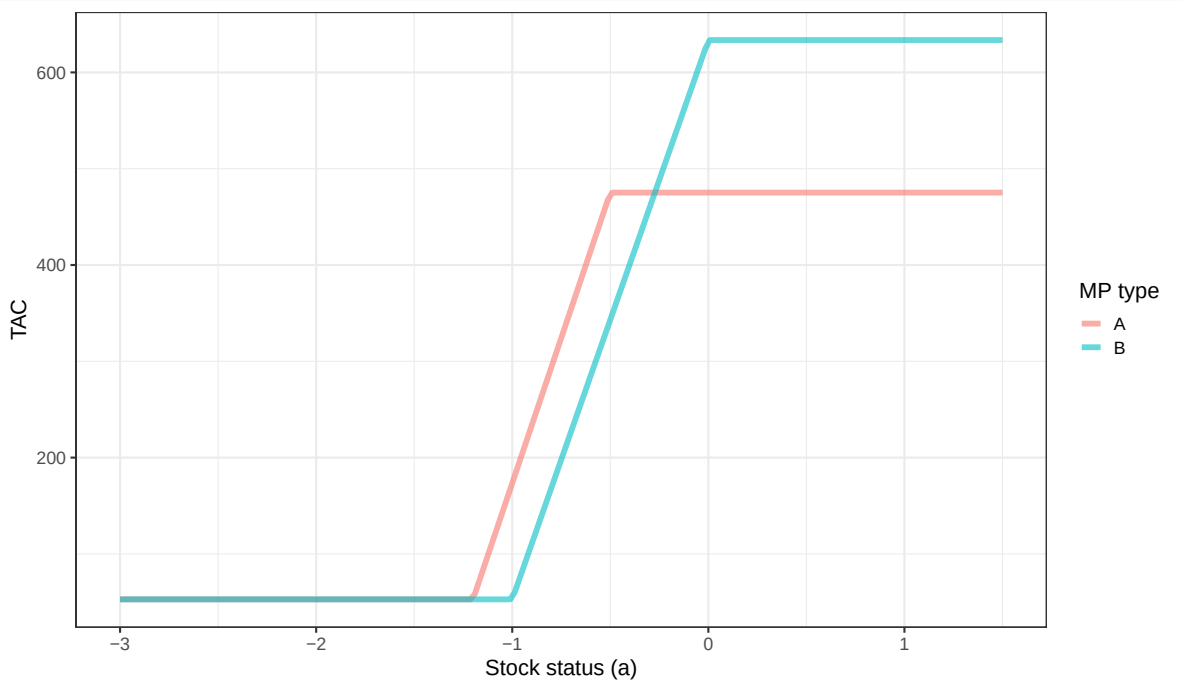


Tuning

Relationship between a_y and the TAC for each MP. Verticle dashed lines illustrate $a_{SSB_{10\%}} = -1.2$ and $a_{SSB_{40\%}} = -0.1$:



Tuning

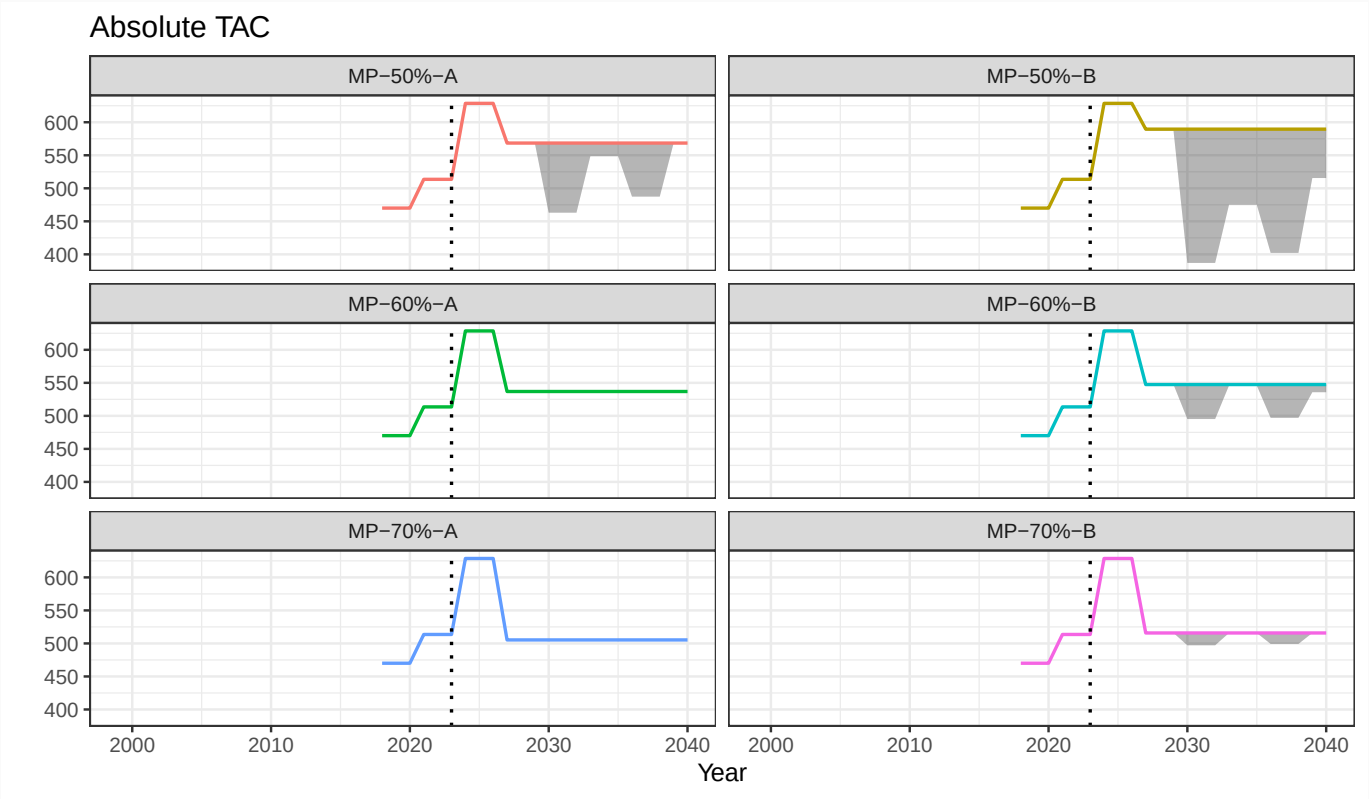


Overall properties:

- Both “A” and “B” type can be tuned to 50%, 60%, 70% criteria.
- Type “A” are more stable with lower maximum catch;
- Type “B” are less stable with a higher maximum catch.

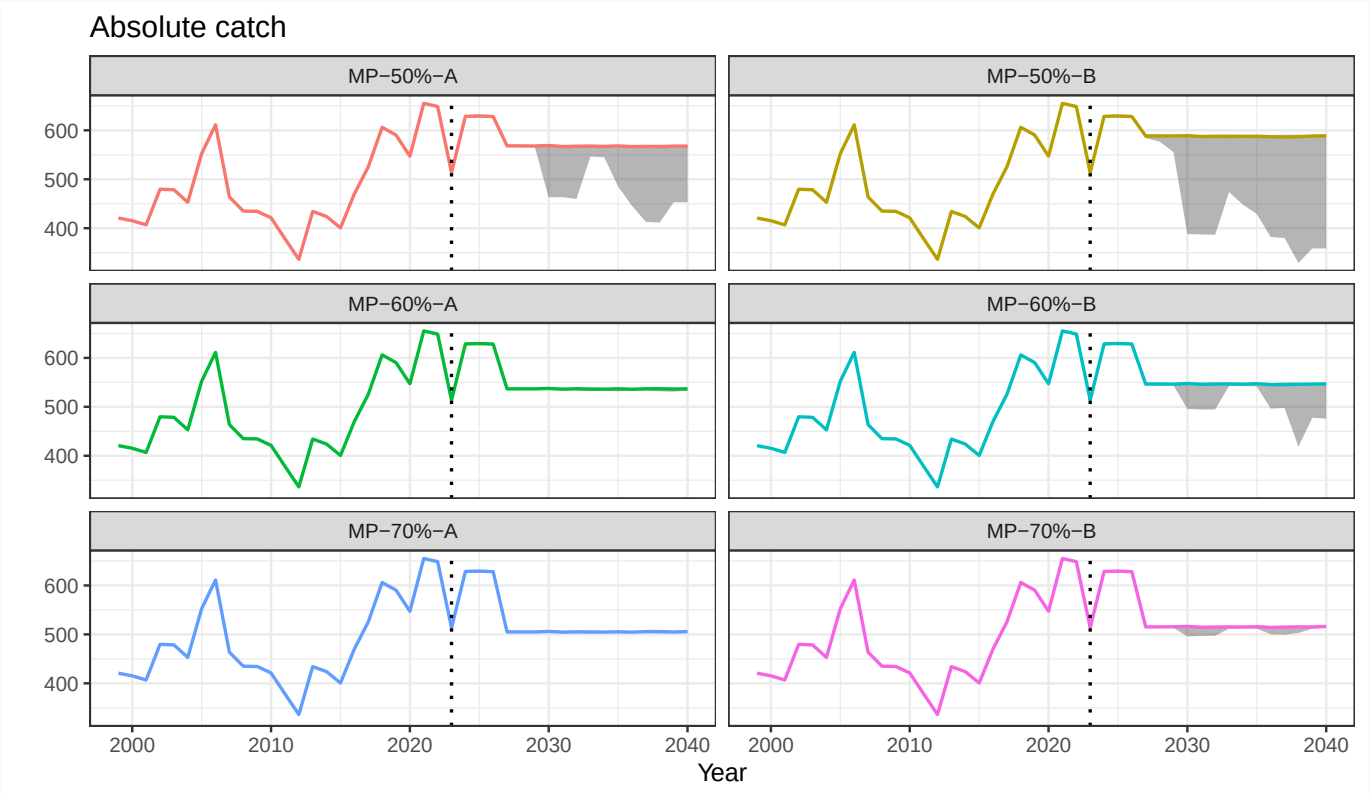
Simulated diagnostics (preliminary results)

Recommended TAC over time for each MP:



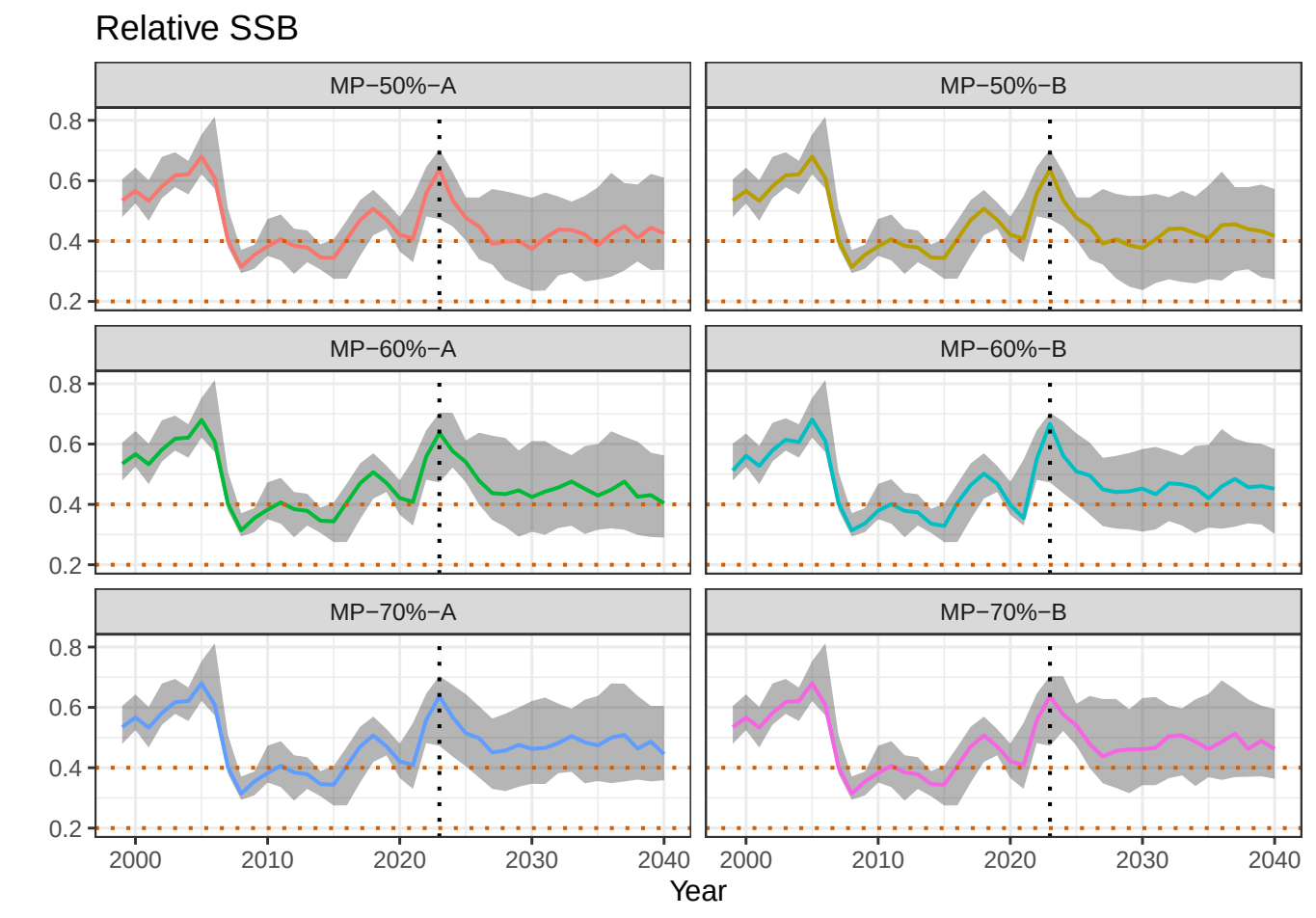
Simulated diagnostics (preliminary results)

Realised catch over time for each MP:



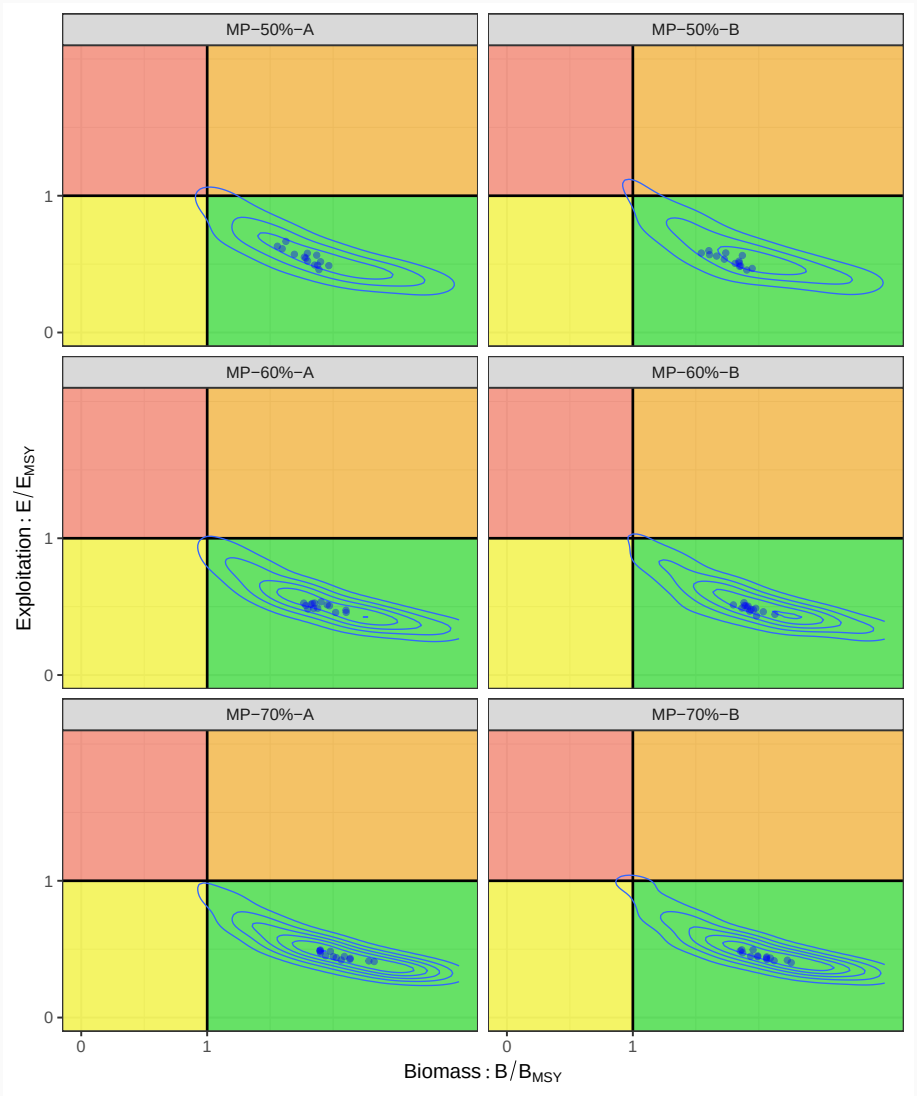
Simulated diagnostics (preliminary results)

Spawning stock biomass depletion SSB_y/SSB_0 relative to the 40% and 20% reference points:



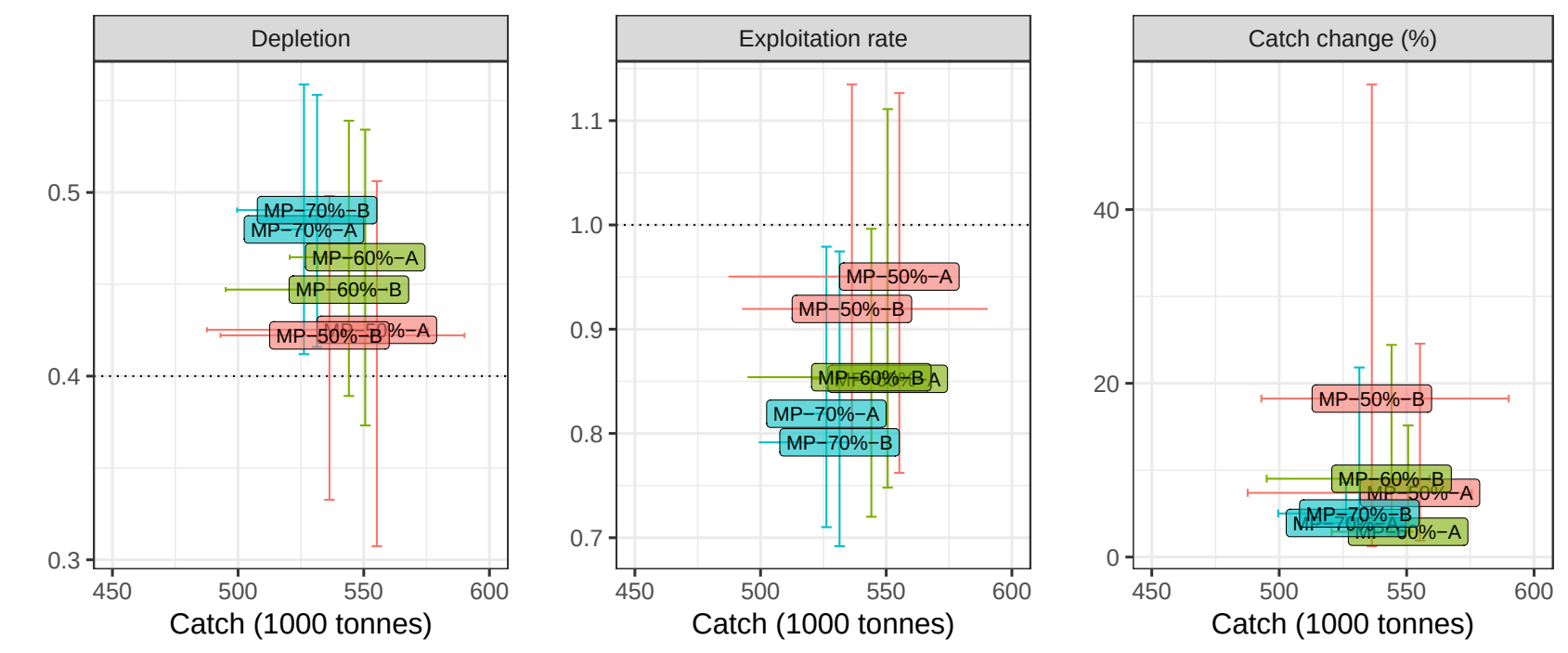
Simulated diagnostics (preliminary results)

Kobe phase plots:

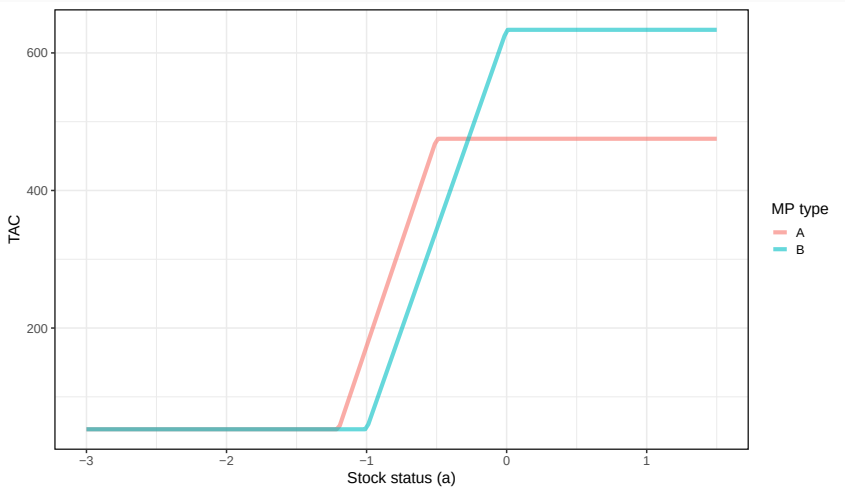


Simulated diagnostics (preliminary results)

Trade off plots:



Qualitative comparison (preliminary results)



Criteria	Type A vs B	Preferred Tuning objective (50%, 60%, 70% prob. of being in the target quadrant)
Maximum possible catch	Type-B	50%
Maximum average catch	Type-A	60%
Catch stability	Type-A	70%
Stock status	Neither	70%

Conclusions

Does the MP work?

Overall MP design:

- data input requires minimal processing;
- will stabalise catch but ensure TAC is reduced when necessary;

Simulated properties (preliminary results):

- can be tuned to provide a reasonably stable catch;
- tuning to target quadrant determines realised depletion;
- selection of Type-A or Type-B determines catch stability;
- probability $P[\mathrm{B} < \mathrm{SSB}_{20\%}] < 10\%$ in all cases.

Further work

Under what conditions does the MP not work?

Robustness testing:

- add temporal correlation in recruitment:
  - reproduce sustained drop in recruitment timeseries for 5 – 10 years at the minimum estimated recruitment value;
- evaluate consequences of overcatch:
  - constant values of 20% and 30%;
- include increasing catchability:
  - increase of 1% per annum for PL and PSLS CPUE;
- consequences of data lag:
  - compare 3-year vs 2-year vs 1-year lag.

Further work

Further MP development:

- Include full assessment grid (36 models);
- Evaluate different catch change limits. Suggestions from WPM-14:
  1. symmetric 15%;
  2. symmetric 25%;
  3. asymmetric 25% (upward) and 15% (downward);
  4. asymmetric 15% (upward) and 10% (downward).
- Include CPUE standardisation methods as part of the MP definition.

Exceptional circumstances:

- as specified in IOTC-2021-SC24-R[E] - Appendix 6A.

Results to be presented at the TCMP-08 in May 2024.

Further work

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Exceptional circumstances:

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Results to be presented at the TCMP-08 in May 2024.

Further work

Decisions for the TCMP:

1. Choose 1 of the 3 alternative tuning objectives: 50%, 60% or 70% probability of being in the target quadrant.
   - A higher probability of being in the target quadrant, i.e. 70% compared to 50%, results in less depleted (better) stock status, but lower long term catches.
   - When one of these is chosen, the MP will be tuned to reach this objective.
2. Choose between two types of MPs.
   - Type-A more stable catches, lower maximum catch.
   - More stable catches means that there can potentially be higher average catch over the time period.
   - Type-B less stable catches, but higher maximum catch potential.

Acknowledgements

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