Indian Ocean swordfish Management Procedures Evaluation

8th Session of the Technical Committee on Management Procedures

10-11 May 2024

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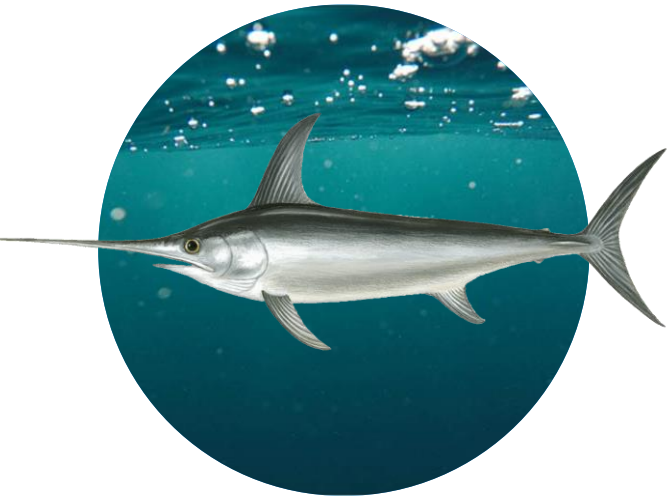

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Overview of the SWO MSE work

- OM based on 2020 WPB SS3 assessment and covered the dynamics of the swordfish until the year 2018.

→updated to the year 202**3**, by projecting the stock forward based on the reported catches for 2019 to 2022 and assuming constant fishing mortality in 2023 at the 2022 level.

- Comparison with new 2023 WPB SS3 assessment, differences not substantial
- Candidate MPs evaluated
  - Model-based (surplus-production model JABBA using Japanese and Taiwanese LL CPUE)
  - Data-based (empirical rule based on Japanese LL CPUE)
- Tuning objectives set in TCMP-04 (2021)
- Robustness tests conducted
- Work conducted at WMR under contract with IOTC, with support of WPM/ MSE taskforce

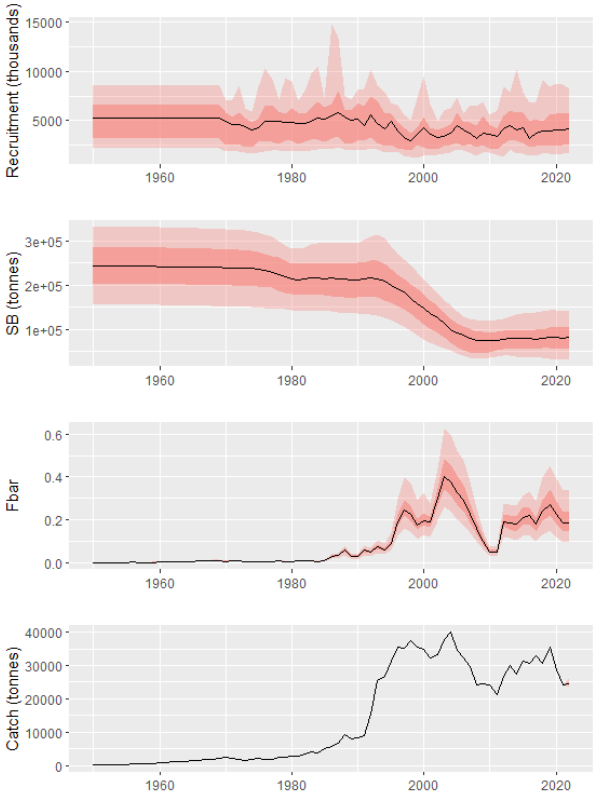
Swordfish OM : OM construction

structural uncertainty grid

- to account for uncertainty in 9 parameters used in the configuration of the stock assessment
- 648 possible combinations reduced to 175 relevant combinations (factorial design optimisation)
- Resulting 130 acceptable SS3 runs

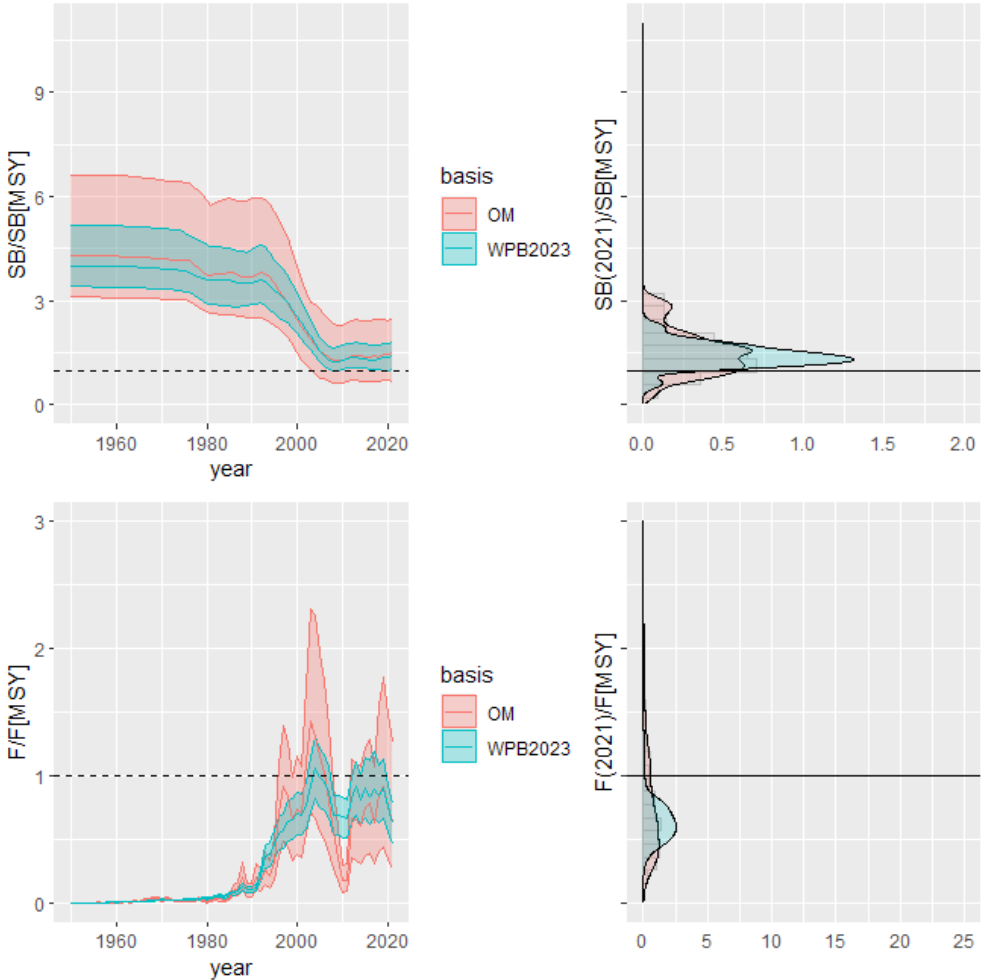
Selectivity	Double Normal		
Steepness	0.6	0.75	0.9
Growth + Maturity	Slow growth, late maturity (Wang et al.,2010)	Fast growth, early maturity (Farley et al., 2016, otoliths)	
M	Low = 0.2	High = 0.3	Sex-specific Lorenzen M (Farley et al. (2016), otoliths)
Sigma R	0.2	0.4	0.6
ESS	2	20	
CPUE scaling schemes			Biomass
CPUEs	JPN late + EU.PRT	JPN late	TWN + EU.PRT
Catchability increase	0%	1% / year	

Stock metrics



Swordfish OM

Stock status and comparison Operating Model vs. WPB 2023 assessment



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Management procedures tested :

Model Based MP

MODEL BASED MP :

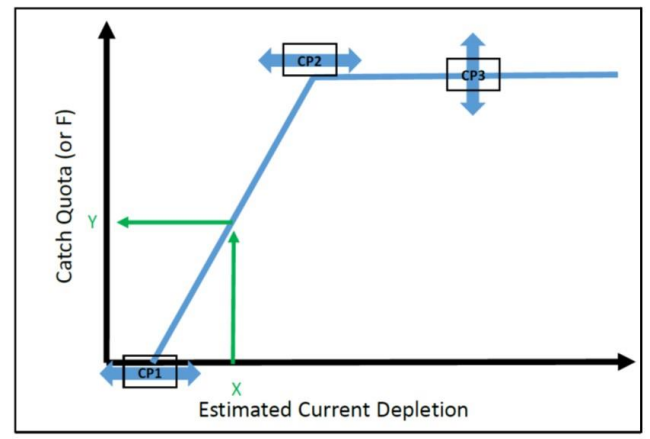
1)Estimator

- Current stock depletion (SB/SB0) estimate
- model : Jabba (Schaefer form)
- input data (as provided by WPB 2023):
  - Total annual catches
  - CPUE indices (UJPLL_NW & UTWLL_NW)

2)Harvest control rule :

- Catch based hockey-stick HCR

INPUT : Total annual catches
CPUE (UJPLL_NW & UTWLL_NW)
Model (JABBA) ➔ Current depletion SB/SB0
HCR ➔ TAC



CP1 : Set at SB/SB0 = 0.1
CP2 : Set at SB/SB0 = 0.4
CP3 : Estimated by tuning

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Management procedures tested :

Data Based MP

DATA BASED MP :

1)Estimator

- One CPUE index (UJPLL_NW) as provided by WPB 2023

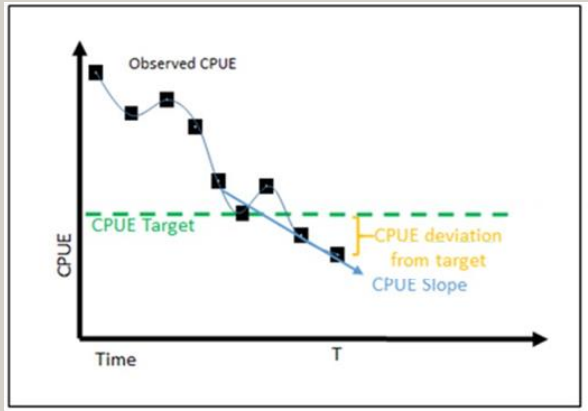
2)Harvest control rule :

- TAC multiplier calculated based on :
  - recent slope (last 5 years) in the CPUE
  - distance between recent average (last 3 years) and the $CPUE_{target}$

INPUT : CPUE (UJPLL_NW)

MP ➔ % change in the TAC

$$TAC_{mult} = 1 + k_a Sl + k_b D$$



Responsiveness to CPUE slope and deviation from target : set

CPUE target : Estimated by tuning

Management procedures tested :

Data Based MP

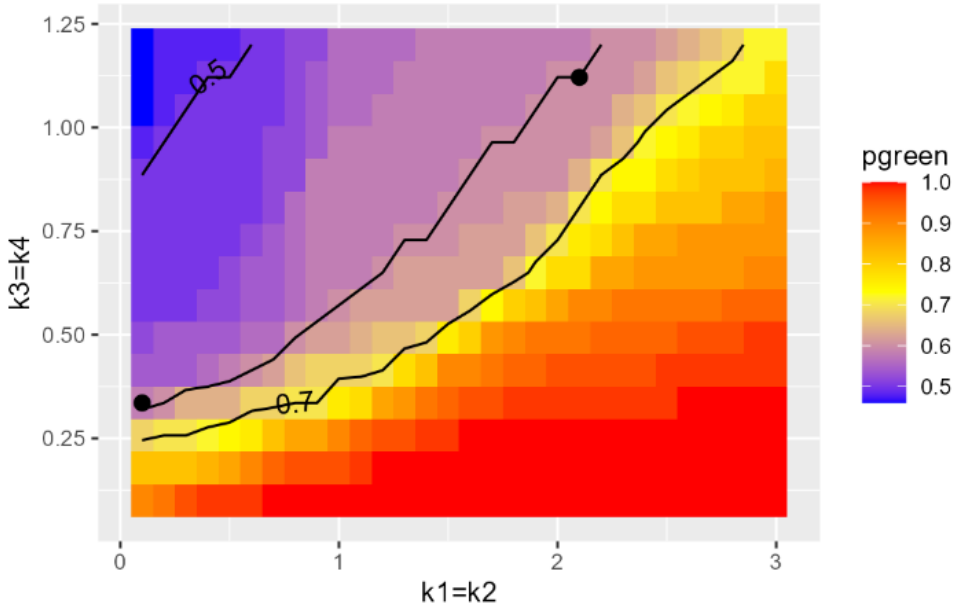
Two versions of the data-based MP : **slow** and **fast** reaction to CPUE index

$$TAC_{mult} = 1 + k_a\, Sl + k_b\, D$$

Slow reaction data-based MP:
- k_a : k_1 & k_2 = 0.1
- k_b : k_3 & k_4 = 0.3

Fast reaction data-based MP :
- k_a : k_1 & k_2 = 2.1
- k_b : k_3 & k_4 = 1.2

For both, tuning done for **$CPUE_{target}$**



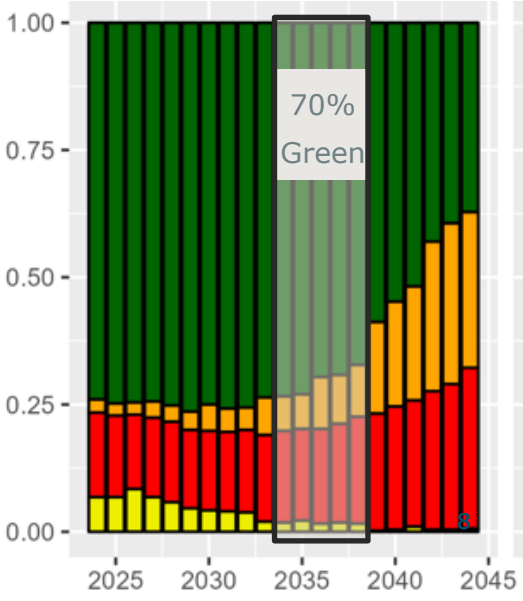
Candidate MPs

- MP constraints and implementation
  - TAC stabilizer (max +15% and -10%)
  - 3-year advice (first TAC set for 2024-2026)
  - 2-year lag (1 data, 1 management) : 2022 data used in 2023 assessment to set TAC for 2024-2026

- Tuning
  - For Target catch (model-based MP) and target CPUE (data-based MP)
  - Tuning separately for

    p(Kobe Green) 2034-2038 = 60% or 70%

    (11 to 15 year to model terminal year)



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Candidate MPs

List of requested tuned MPs

MP	Name	MP type	Tuning objective p(Kobe Green$_{2034\text{-}38}$)	TAC stabilizer (max % change up-down)
MP1	CPUE_Fast_60%_15-10	Data based	60%	15-10
MP2	CPUE_Fast_70%_15-10	Data based	70%	15-10
MP3	CPUE_Slow_60%_15-10	Data based	60%	15-10
MP4	CPUE_Slow_70%_15-10	Data based	70%	15-10
MP5	Hockeystick_60%_15-10	Model based	60%	15-10
MP6	Hockeystick _70%_15-10	Model based	70%	15-10

Robustness tests

- **Catches exceeding TAC**

  Additional runs were conducted to test the robustness of the tuned MPs to different scenarios in which the catches exceed the TACs delivered by the MP. Two scenarios are considered :

  - An overcatch of 10% consistently applied over the whole simulation period, fixed rate
  - An overcatch of 15% for the first management cycle (2024, 2025 and 2026)

- **Management lag**

  MP tuned assuming a 1 year management lag are also run with a 2 year management lag.

- **Recruitment failure**

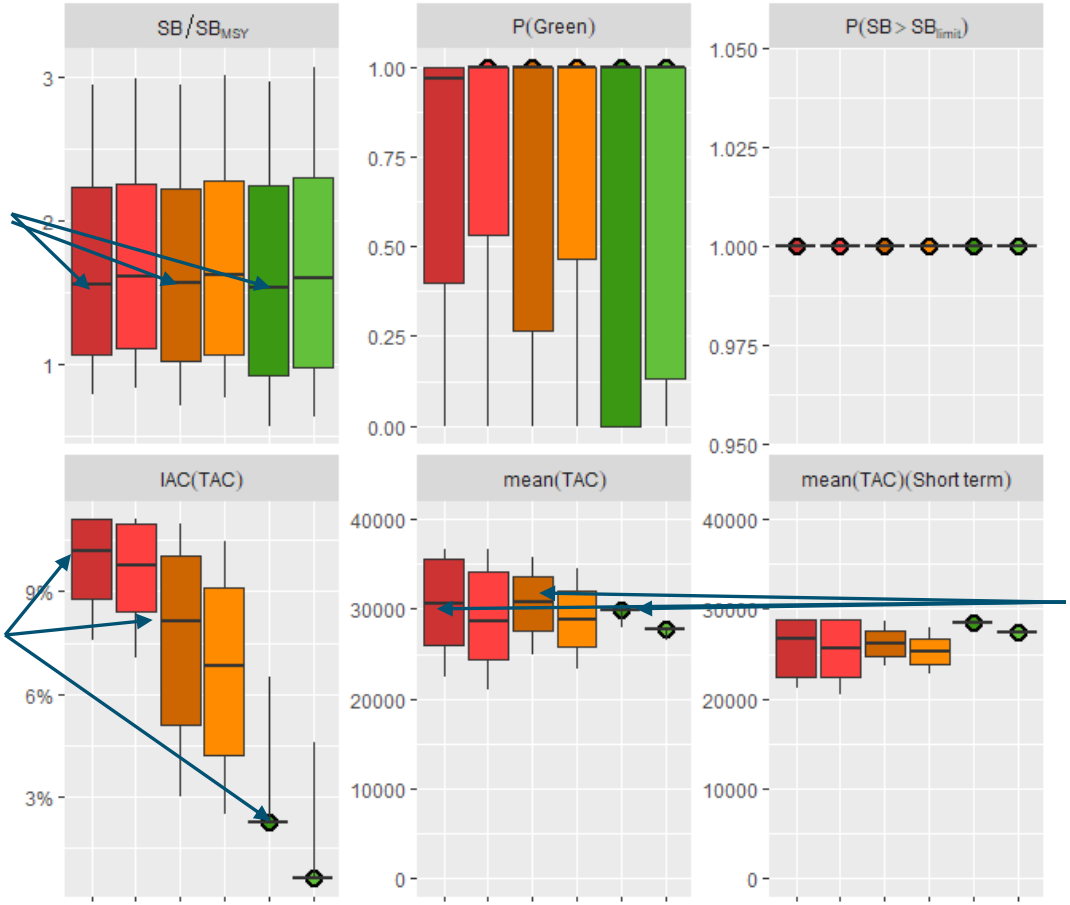
  Performance of the tuned MPs under a 3 year recruitment failure (2024-2026)

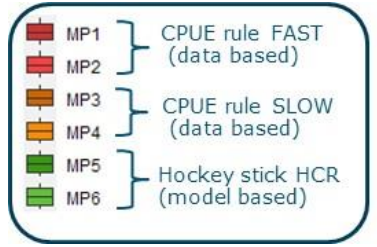
  Fictional scenario aiming at comparing MPs robustness

MP performance (2024-2038)

More impact of tuning objective than MP type
Large uncertainty in future stock size but slightly larger for model-based MPs)

Stable catches for model-based MP, more variable for data-based MP





High probability of $SB>SB_{lim}$

High probability of being in Kobe green

Higher TAC for data-based MP with wider distribution, but opposite for the short-term

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MP performance

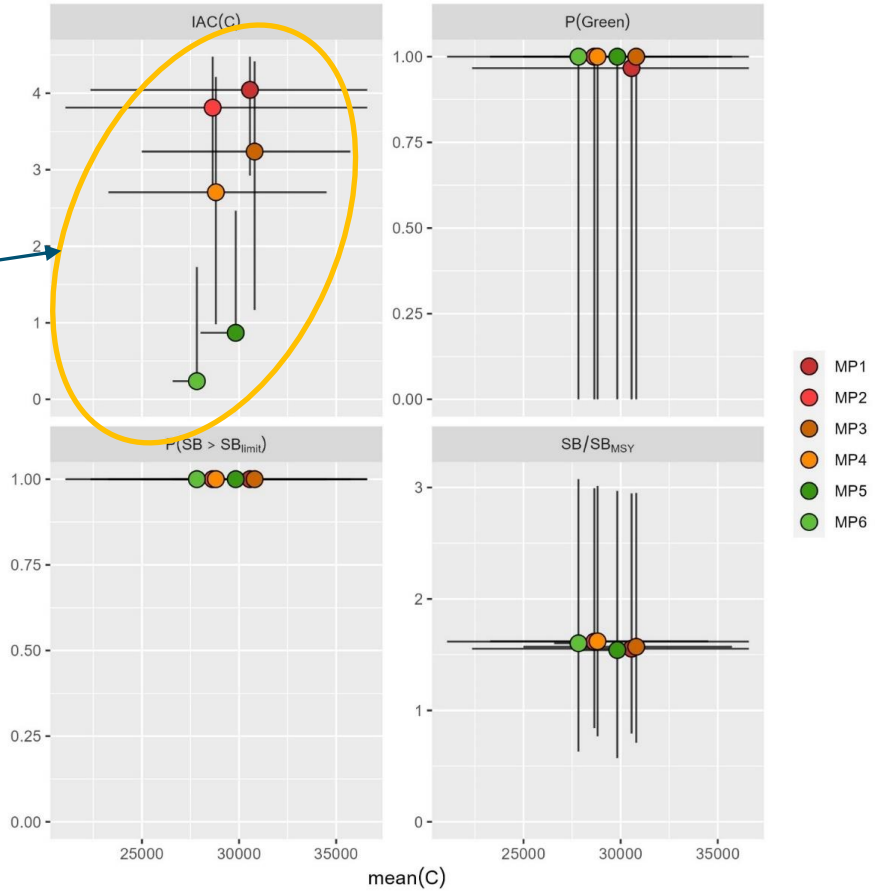
MP	SB/SBMSY	p(SB>=SBMSY)	p(SB>SBlim)	p(Green)	mean(TAC)	C/MSY	IAC(TAC)
MP1	1.55 (0.79-2.95)	1 (0.00-1.00)	1 (1.00-1.00)	0.61 (0.00-1.00)	30561 (22351-36599)	0.95 (0.71-1.15)	10.16 (7.55-11.11)
MP2	1.62 (0.84-2.99)	1 (0.00-1.00)	1 (1.00-1.00)	0.69 (0.00-1.00)	28643 (21062-36599)	0.9 (0.69-1.10)	9.75 (7.07-11.11)
MP3	1.57 (0.71-2.95)	1 (0.00-1.00)	1 (1.00-1.00)	0.59 (0.00-1.00)	30802 (24993-35728)	0.97 (0.70-1.15)	8.13 (3.03-10.96)
MP4	1.62 (0.77-3.01)	1 (0.00-1.00)	1 (1.00-1.00)	0.7 (0.00-1.00)	28809 (23277-34506)	0.92 (0.66-1.08)	6.84 (2.52-10.48)
MP5	1.54 (0.57-2.97)	1 (0.00-1.00)	1 (1.00-1.00)	0.62 (0.00-1.00)	29828 (28012-29828)	0.93 (0.60-1.20)	2.25 (2.25-6.52)
MP6	1.6 (0.63-3.07)	1 (0.00-1.00)	1 (1.00-1.00)	0.69 (0.00-1.00)	27828 (26580-27828)	0.87 (0.56-1.12)	0.62 (0.62-4.57)

Median values (10% and 90% quantiles)

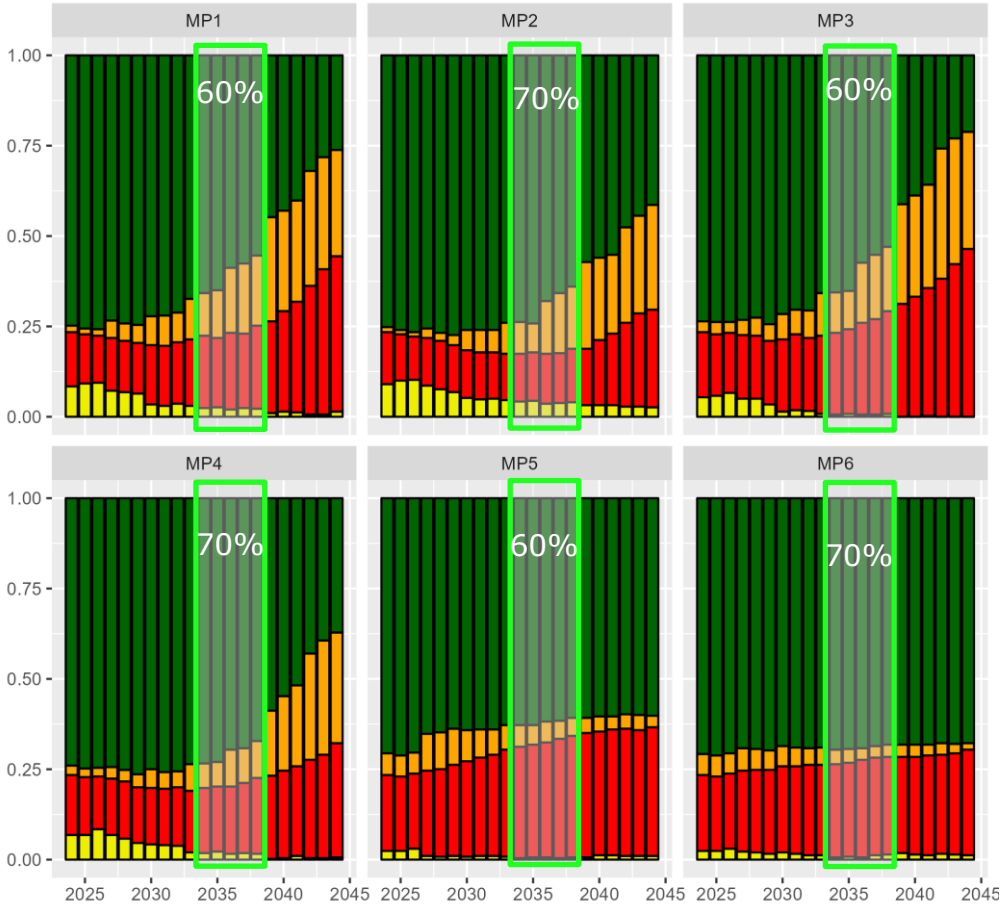
Performance over the period 2024-2038

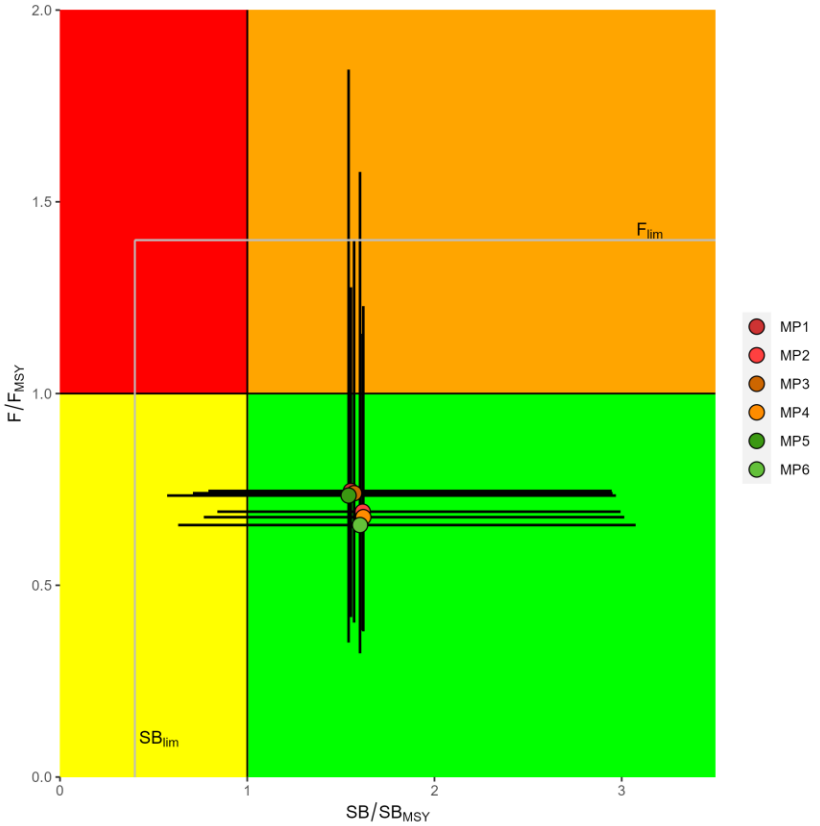
Trade-offs (2034-2038)

higher catches but larger interannual variation and overall uncertainty for the data-based MP

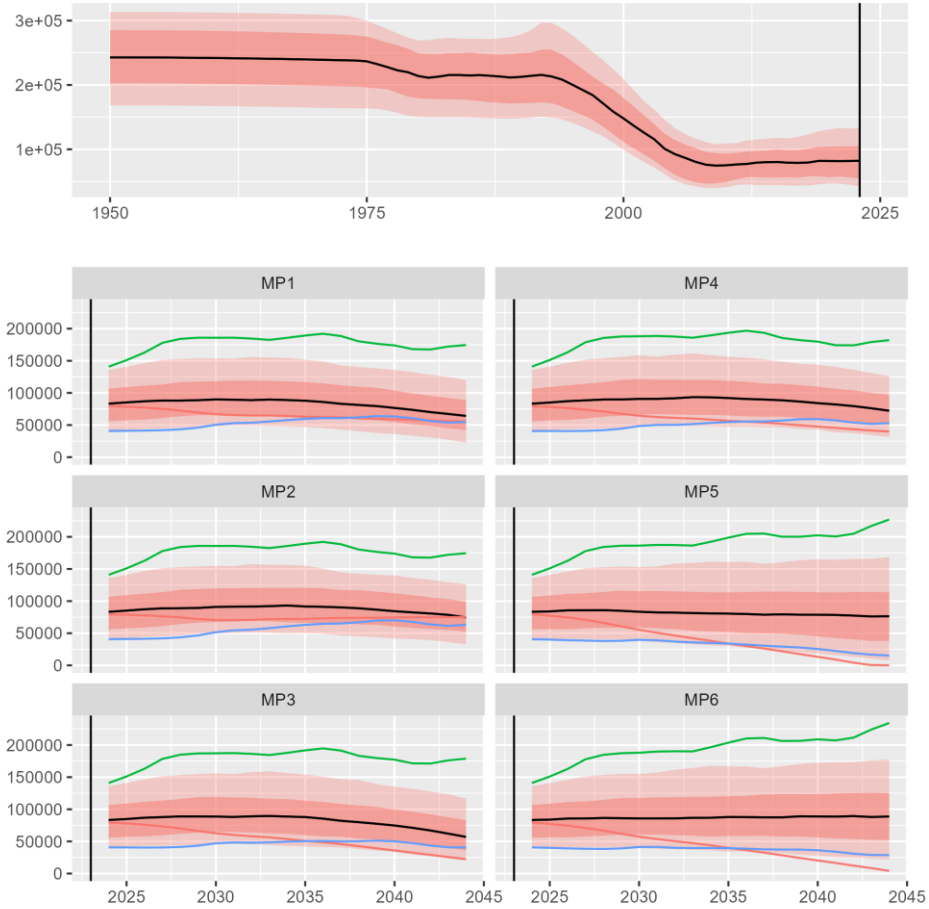


Kobe quadrants probabilities





Spawning biomass trajectories (OM and simulated)



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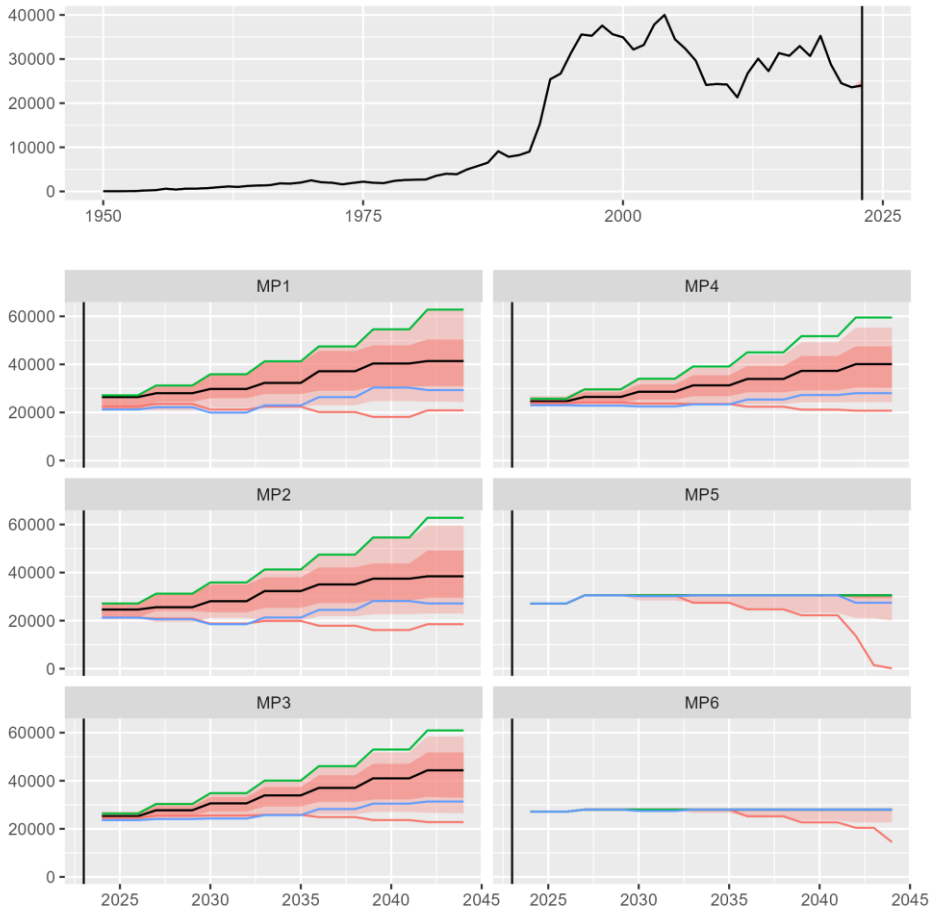
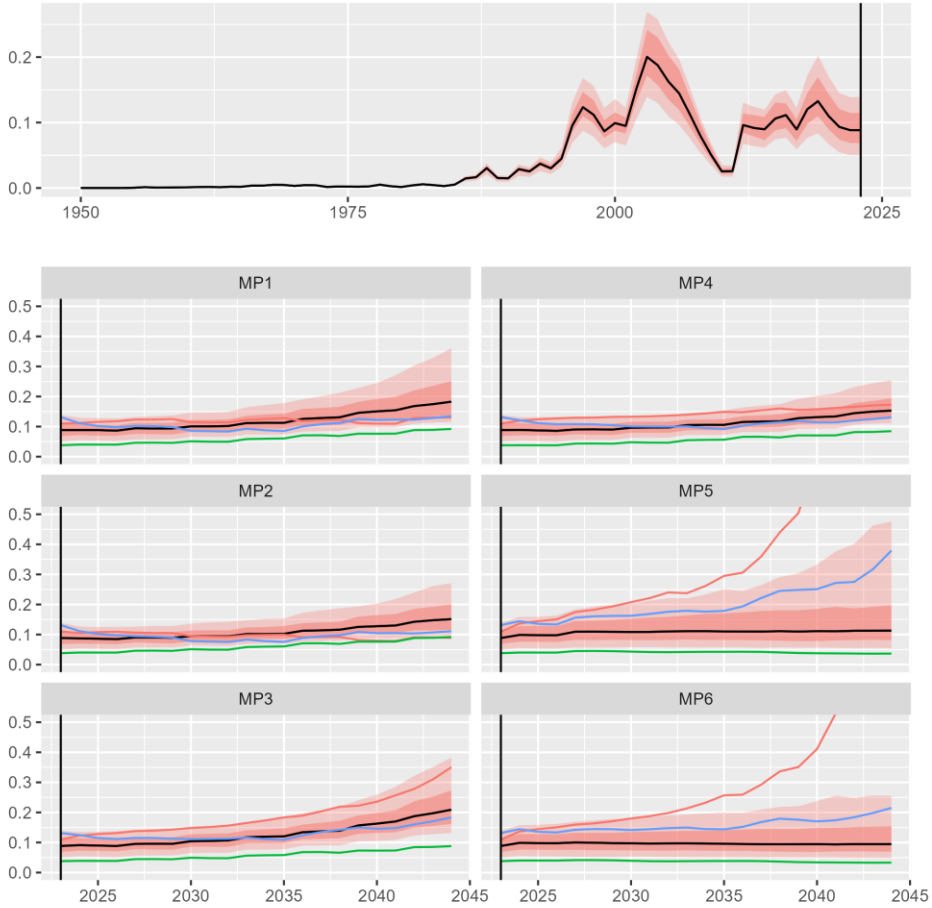
TAC trajectories (OM and simulated)



Fishing mortality trajectories (OM and simulated)

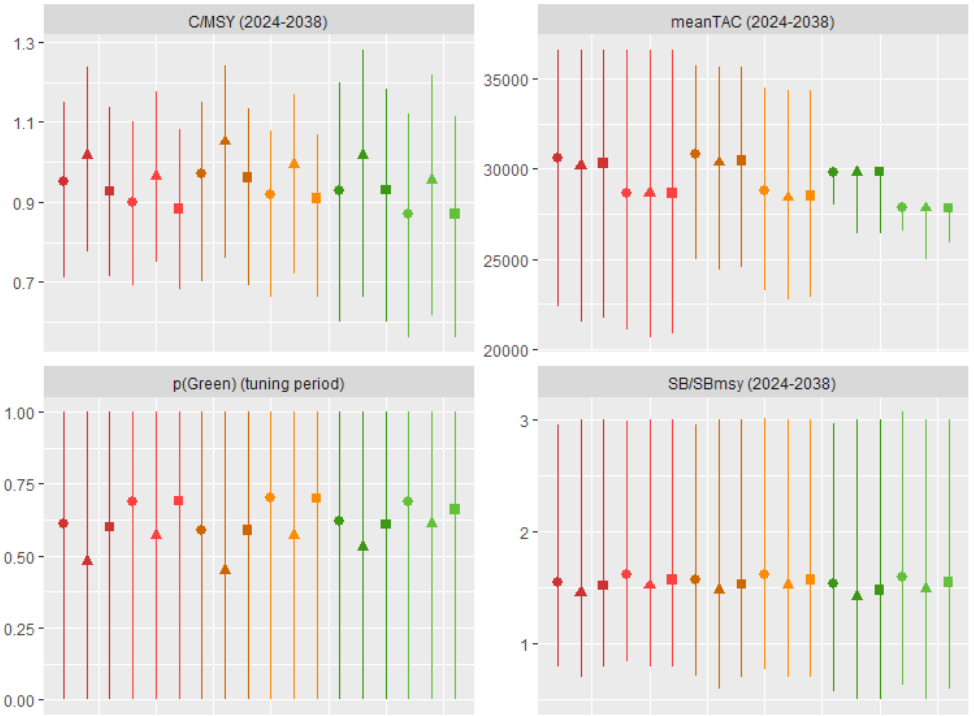


Impact of overcatching the TAC

10% constant overcatch leads to :

- higher catches
- small TAC decrease
- lower stock biomass
- manag. objectives not met

Lesser impact on manag. Objectives for Model-based MPs



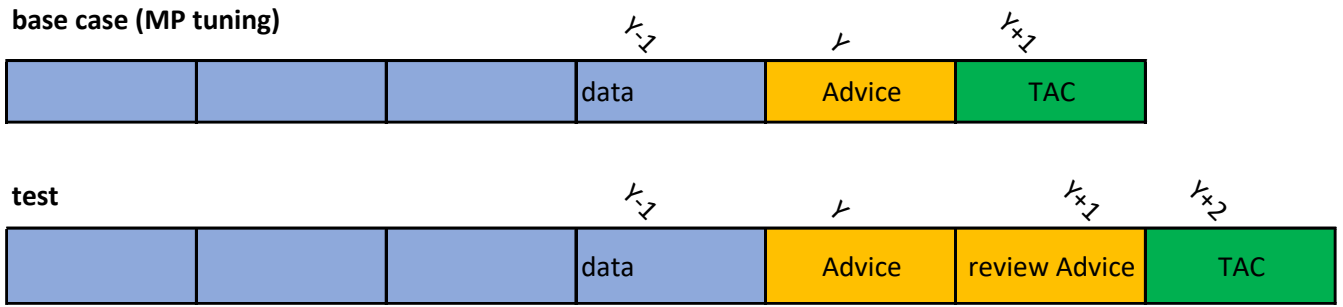
Impact of overcatching the TAC

15% overcatch over three years leads to :

- only minor differences

in performance metrics

Implementing TACs with a 2-year lag

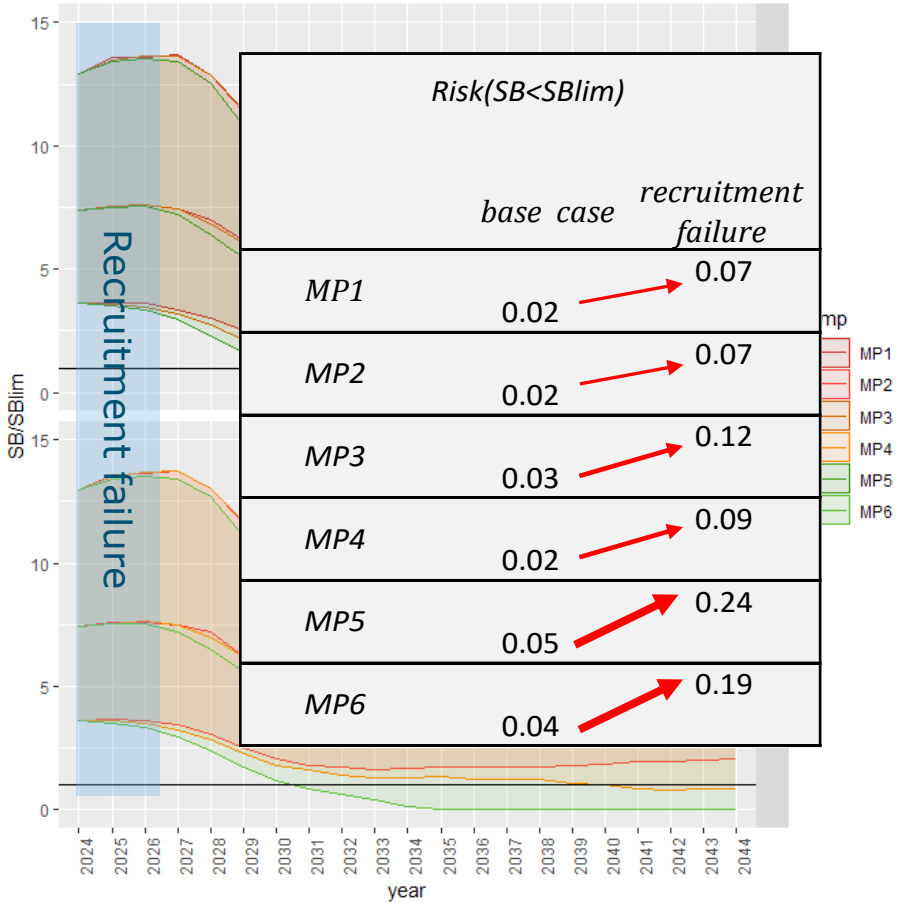


- Lower catches (increase in TAC postponed)
- above target for the tuning criteria (e.g. p(Green) > objective
- Slightly less impact for data-based MPs

Recruitment failure

Model-based MP least robust

Fast reacting data-based most robust MP



Summary

- Future stock size :
  - All MPs maintain the stock well above SB_{lim} and SB_{MSY}
  - Little difference between the 6 MPs
  - Management objective has more impact than MP type

- Future TACs :
  - Slightly higher but more uncertain for data-based MPs
  - Management objective has more impact than MP type

Summary

- TAC variability
  - Very stable for model-based MPs, most variable for fast reacting data-based MP
  - More impacted by MP type than management objective
- Impact of overcatch or additional lag to implement the TAC:
  - Similar change in performance of all MPs (slightly less for model-based MP)
- Robustness to poor recruitment
  - Lower risk of $SB<SB_{lim}$ with data-based MP (especially fast reacting one)

Model based PROs

- Predictability of the outcome (TAC)
- Stability in TAC
- Long term stock trajectory
- Minor difference in Catches
- Based on an assessment model integrating different data sources

Data-based Pros

- Minor gain in TAC
- Robustness to recruitment failure (fast reacting MP)

Model based CONs

- Less robust to recruitment Failure

Data based CONs

- long term stock trajectory
- High uncertainty in future TACs
- larger TAC variability
- Dependency on a single CPUE index

Thank you for your attention

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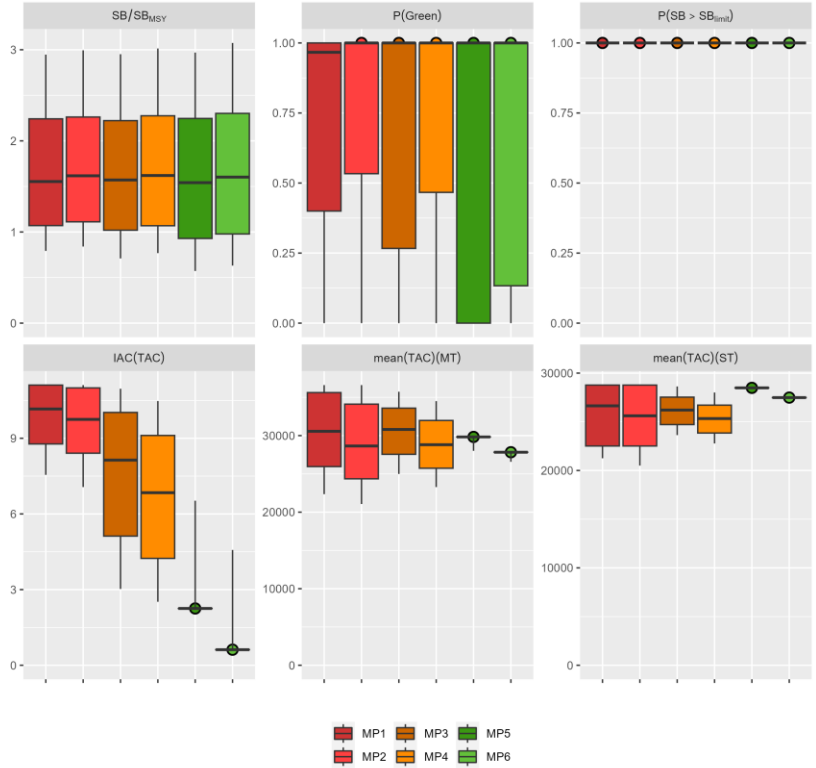
Model based : alternative Jabba configuration

Tuned MP presented above used Schaefer $SB_{MSY}/SB_0 = 0.5$



Tuned again with Jabba configured so that $SB_{MSY}/SB_0 = 0.4$