Second Intersessional Meeting of Panel 4 on North Atlantic Swordfish MSE

30 June 2023

Reference: Swordfish MSE website

ICCAT CICTA CICAA

Objectives

- Review revisions to the operating model structure
- Familiarize PA4 with tools used to communicate management tradeoffs
- Communicate results of CMPs in development
- Identify key performance metrics
- Review tasks still to be completed in 2023 and in subsequent years

Agenda

4. Review of Panel 4 feedback and requests in March 2023
5. Summary of work done since the March 2023 meeting of the Panel
6. Modifications to the OM grid
7. Management objectives and key performance metrics
8. Initial CMPs and their results
9. MSE development timeline for 2023
10. Key decisions to be taken by PA4

Agenda

10. Key decisions to be taken by PA4
    a. Choice of a key performance metrics, timeframes, and minimum/maximum acceptable thresholds (if applicable) for each of the Status, Safety, Stability, and Yield objectives
    b. Choice of tuning objective, including time frame
    c. Definition of minimum threshold for TAC change between management cycles, if desired
    d. Prioritization of robustness and sensitivity tests

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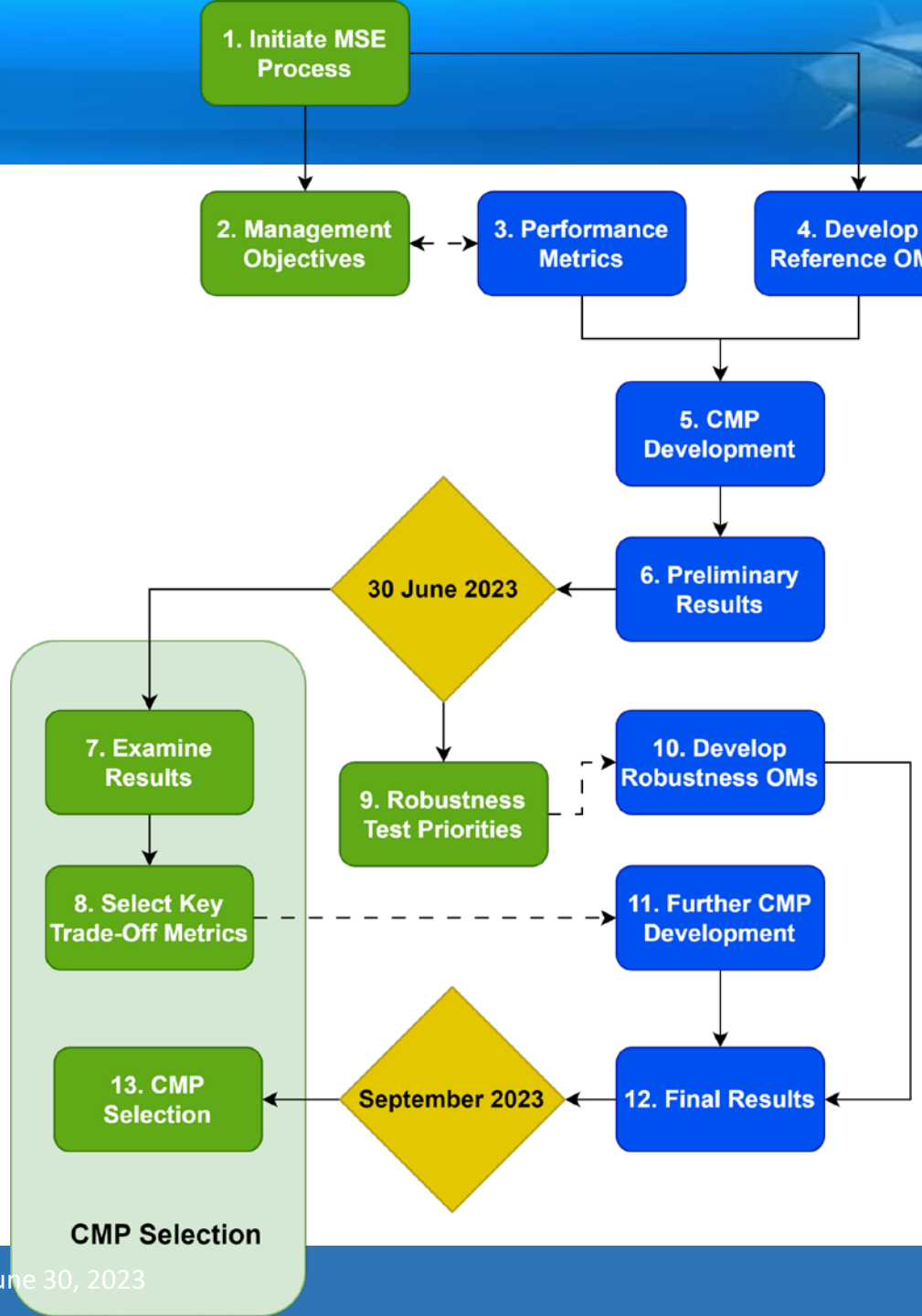
MSE Process: Selection of Management Procedure

Managers

Science



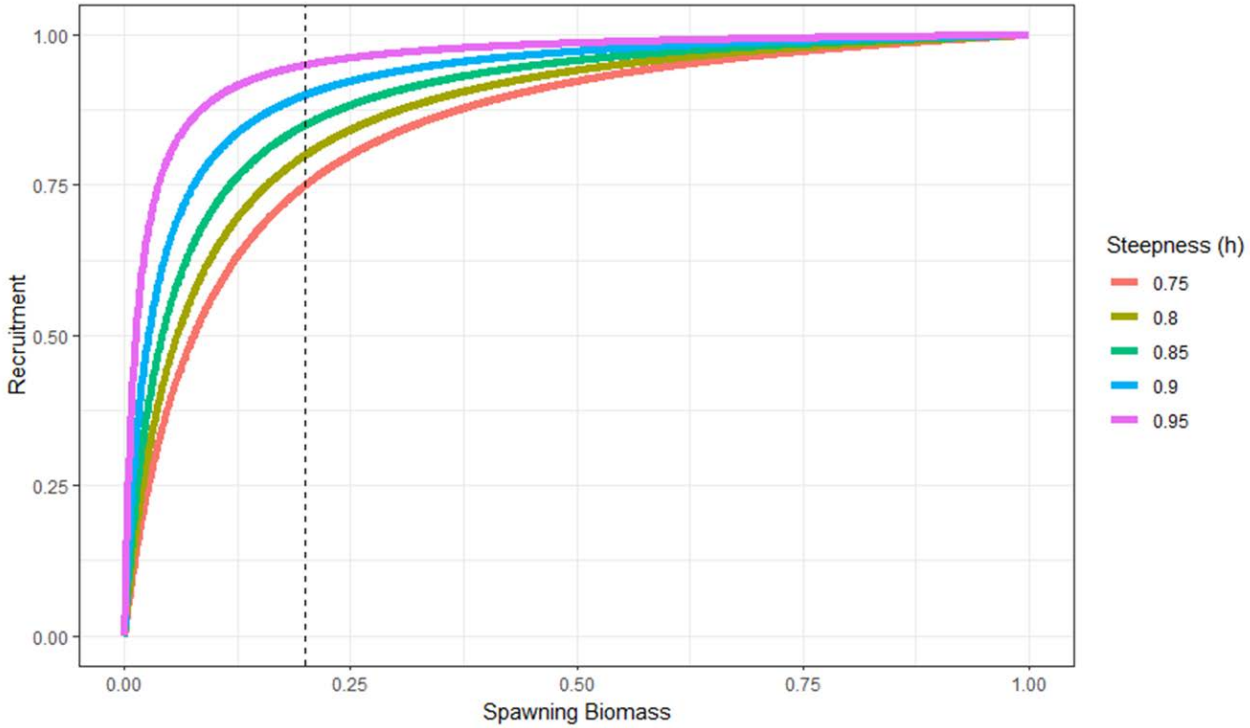
First 2023 PA4 Meeting (March 2023)

- Review of N-SWO MSE framework

- PA4 presented with 5 key decision items:
  1. OM grid and robustness tests
  2. Evaluating the minimum size limit
  3. Management objectives and performance metrics
  4. CMP specifications
  5. Overall process

Operating model grid

- Core uncertainty: stock productivity
  - Ability to recovery from low abundance levels
  - Natural mortality (death rate in the population)



Decision item 1: OM grid

Variable	Stock assessment base case model	Operating model grid		
Steepness	0.88	0.6	0.75	0.9
Natural mortality	0.2	0.1	0.2	0.3
SigmaR (recruitment variability)	0.2	0.2	0.6	
Include CAL	TRUE	TRUE	FALSE	
Catchability increase	0%	0%	1%/year	

- Request for additional analysis on steepness
- Identification of additional robustness tests

Decision item 2: minimum size limit

- **Rec. 90-02**: minimum size limit requiring that swordfish less than 25 kg (or 125 cm lower jaw fork length, LJFL) not be retained in ICCAT fisheries in the Atlantic (with a 15% tolerance in the landed catch).
- Supplemented by **Rec. 95-10**: alternative minimum size limit of 119 cm LJFL (or 15 kg) with no tolerance in the landed catch.

- **Res. 19-14**

"In the development of the operating models, the Commission would like the SCRS to allow for the evaluation of minimum size limits as strategies to achieve management objectives"

- Robustness test allows for feedback to the Commission on effects of retaining minimum size limit (120 cm) versus removal of the minimum size limit in the projection period

Decision item 3: management objectives & performance metrics

Objectives fall into 4 categories:

19-14	SWO
RESOLUTION BY ICCAT ON DEVELOPMENT OF INITIAL MANAGEMENT OBJECTIVES FOR NORTH ATLANTIC SWORDFISH	

1. Safety

   E.g. “There should be a [_]% or less probability of the stock falling below B_{LIM} at any point during the 30-year evaluation period.”

2. Stock status

   E.g. The stock should have a greater than [__]% probability of occurring in the green quadrant of the Kobe matrix

3. Stability

   E.g. Any increase or decrease in TAC between management periods should be less than [__]%

4. Yield

   E.g. Maximize overall catch

Decision item 4: CMP specifications

CMPs

- **Empirical**

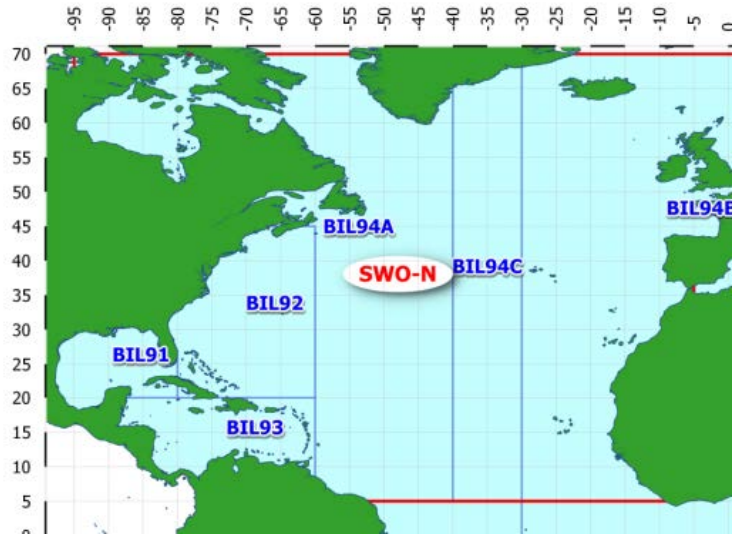
-Index ratio decision rule sets TAC

- **Model based**

-Assessment model output sets TAC

TAC

Whole of N-ATL



Decision item 5: Overall process

- Meeting schedule
  - Ambassador sessions
  - Panel meetings
  - Technical team meetings
- Communications materials
  - Summary document
  - Presentations
  - Website
  - Slick tool
  - SCRS papers
- Multi-year schedule

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Summary of work done since the March 2023 meeting of the Panel

- Reference OM structure reviewed and revised
- Operating models reconditioned
- Robustness and sensitivity tests developed
- Additional CMPs created
- Tradeoff plots developed
- MSE revisions approved by SWO Species Group
- MSE structure communicated via Ambassador Session

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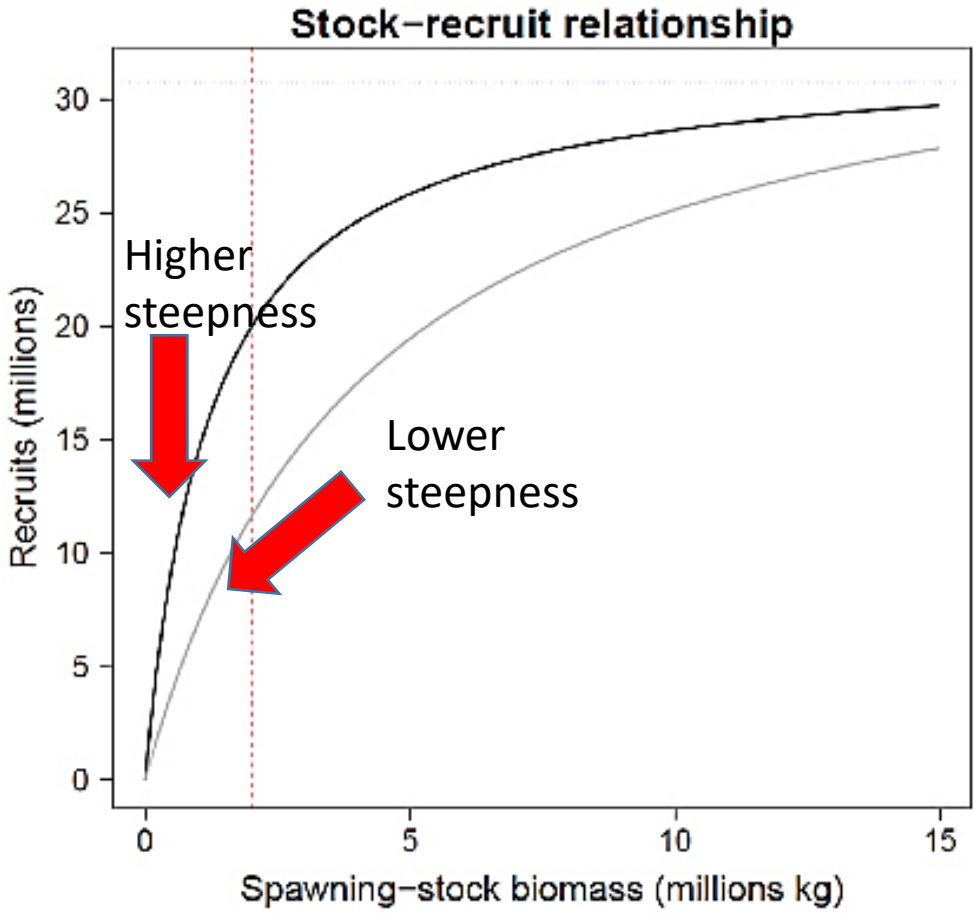
Operating model grid

- Core uncertainty: stock productivity

  - Ability to recovery from low abundance levels

  - Natural mortality (death rate in the population)



Grid as presented to PA4 in March 2023

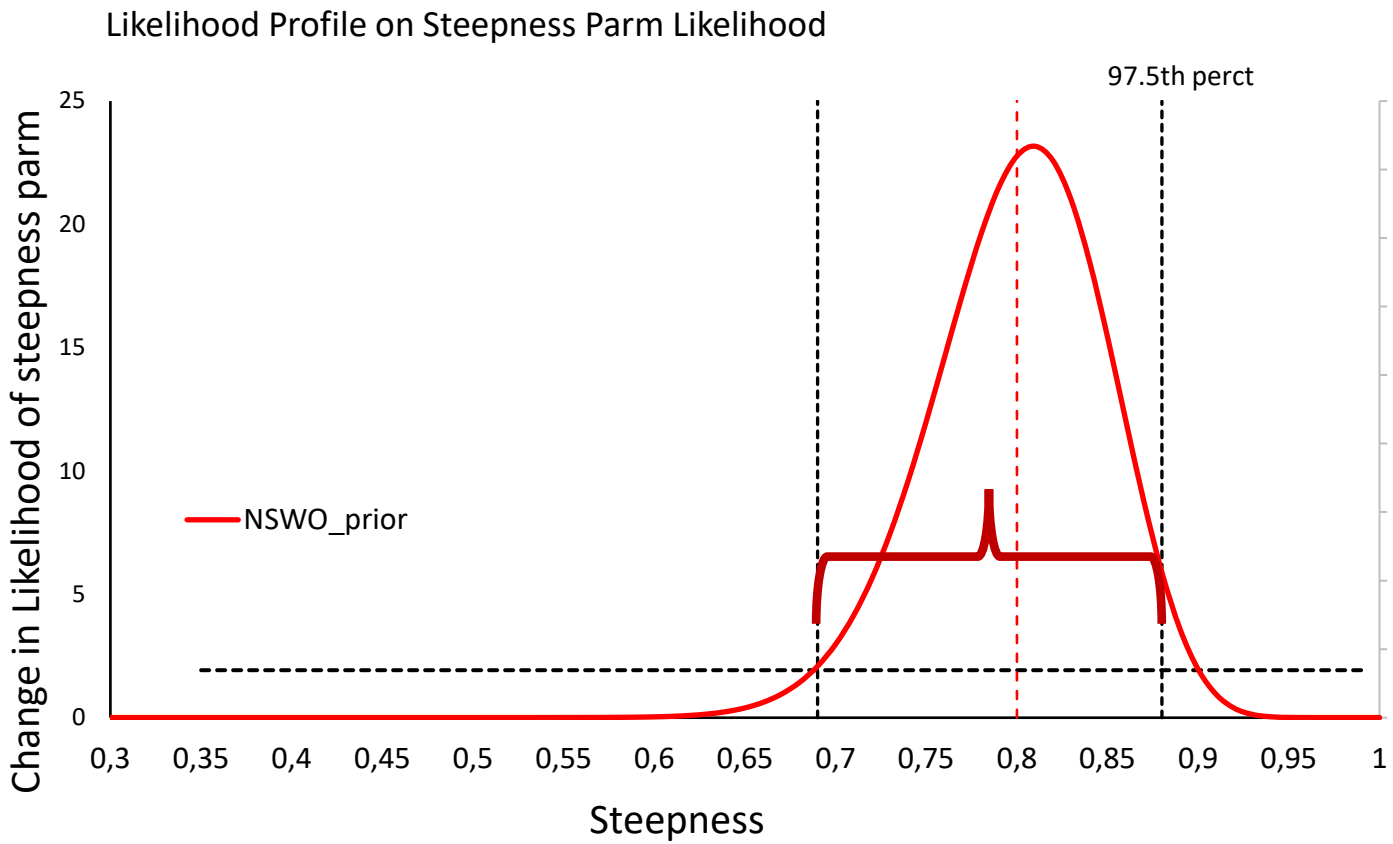
Variable	Stock assessment base case model	Operating model grid		
Steepness	0.88	0.6	0.75	0.9
Natural mortality	0.2	0.1	0.2	0.3
SigmaR (recruitment variability)	0.2	0.2	0.6	
Include CAL	TRUE	TRUE	FALSE	
Catchability increase	0%	0%	1%/year	

- 9 reference OMs
- 27 robustness OMs

} 36 total OMs

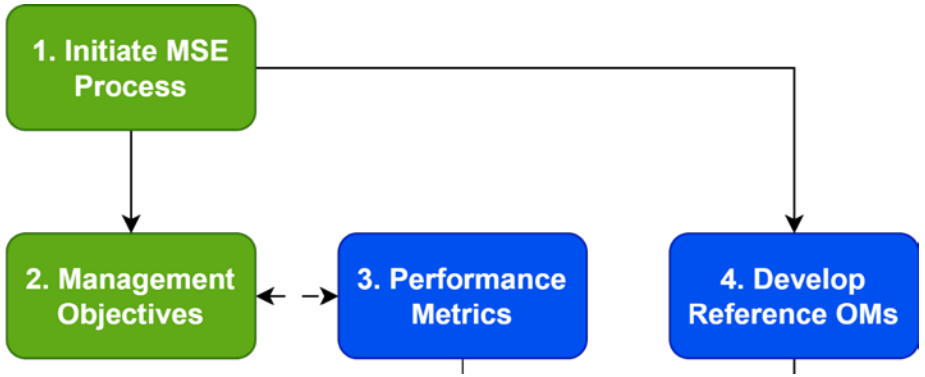
Updates to the OM grid - steepness

- Ability of the stock to recover from low abundance levels
- Original steepness values: 0.6, 0.75, 0.9
- Additional analysis. Plausible range adjusted to 0.69 to 0.88
- Compensation ratio (Goodyear, 1980) used to estimate steepness mid-point (0.8)

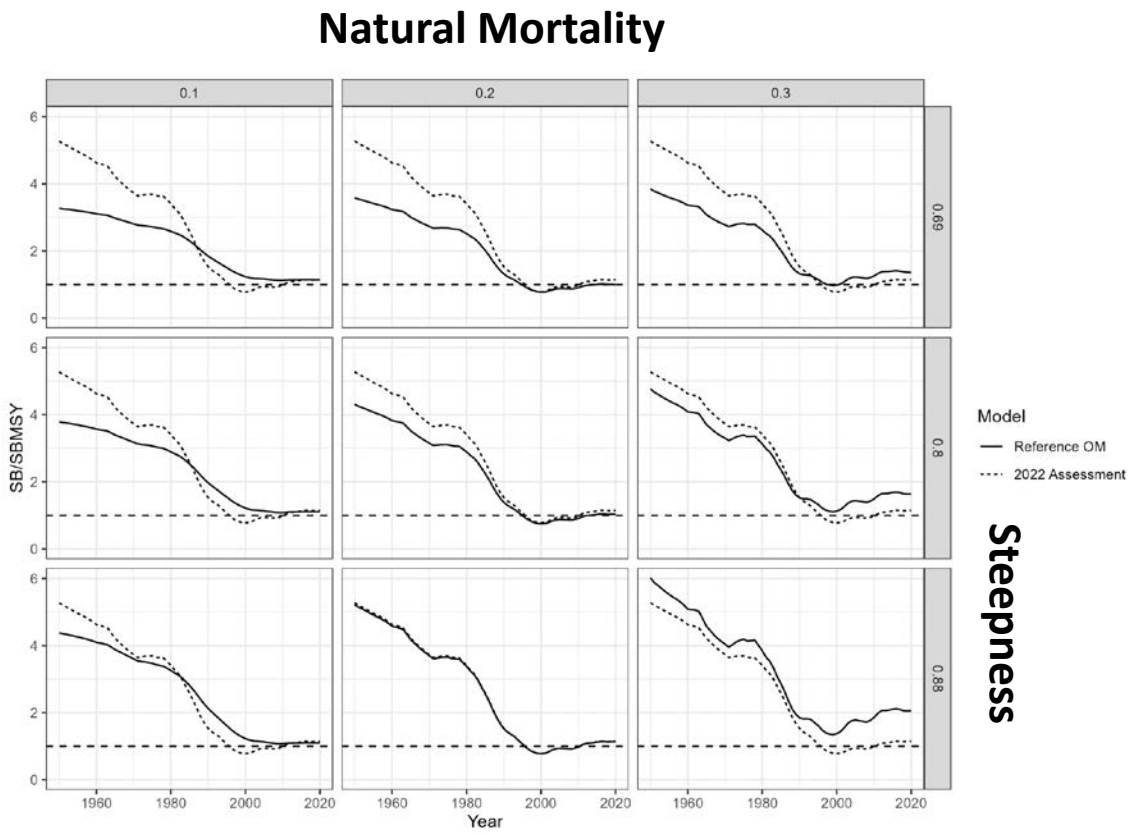


Grid after recalculation of steepness values

Variable	Stock assessment base case model	Operating model grid		
Steepness	0.88	0.69	0.8	0.88
Natural mortality	0.2	0.1	0.2	0.3
Steepness			0.6	
SigmaR (recruitment variability)	0.2	0.2	0.6	
Include CAL	TRUE	TRUE	FALSE	
Catchability increase	0%	0%	1%/year	



1. MSE Process Initiated
2. Management Objectives stated
3. Develop Performance Metrics
4. Develop Reference OMs



Initial Robustness OMs

- Higher recruitment variability
- Exclude length composition data
- 1% annual catchability increase in historical period

Updates to the OM grid – robustness tests

Test	Purpose	Uncertainty type	Analysis requirements
1. Lower steepness	Evaluate sensitivity to stock with low resilience	Conditioning	Low
2. Higher recruitment variability	Evaluate sensitivity to higher variability in recruitment process error	Conditioning	Low
3. Exclude length composition data	Evaluate impact of only using indices of abundance in OM conditioning (i.e. do not include catch at length data in the model fitting)	Conditioning	Low
4/5. Catchability in historical and projection periods	Evaluate impact of an increase in catchability that was not accounted for in the standardization of the indices of abundance	Conditioning/projection	Low
6. a) Climate change recruitment	Evaluate impact of systematic pattern in recruitment deviations in projection periods; a proxy for impact of climate change on productivity	Projection	Medium
6. b) Climate change alternative scenarios	Investigate impacts of climate change on stock biology, distribution; fishing fleets	Projection/management	High
7. Implementation error	Evaluate impact of illegal, unreported, or unregulated catches	Management	Medium
8. Size limit	Evaluate impact of different size limits, including removing all size regulations	Management	Medium
9. Alternative management cycles	Evaluate the impact of a longer management cycle	Management	Low

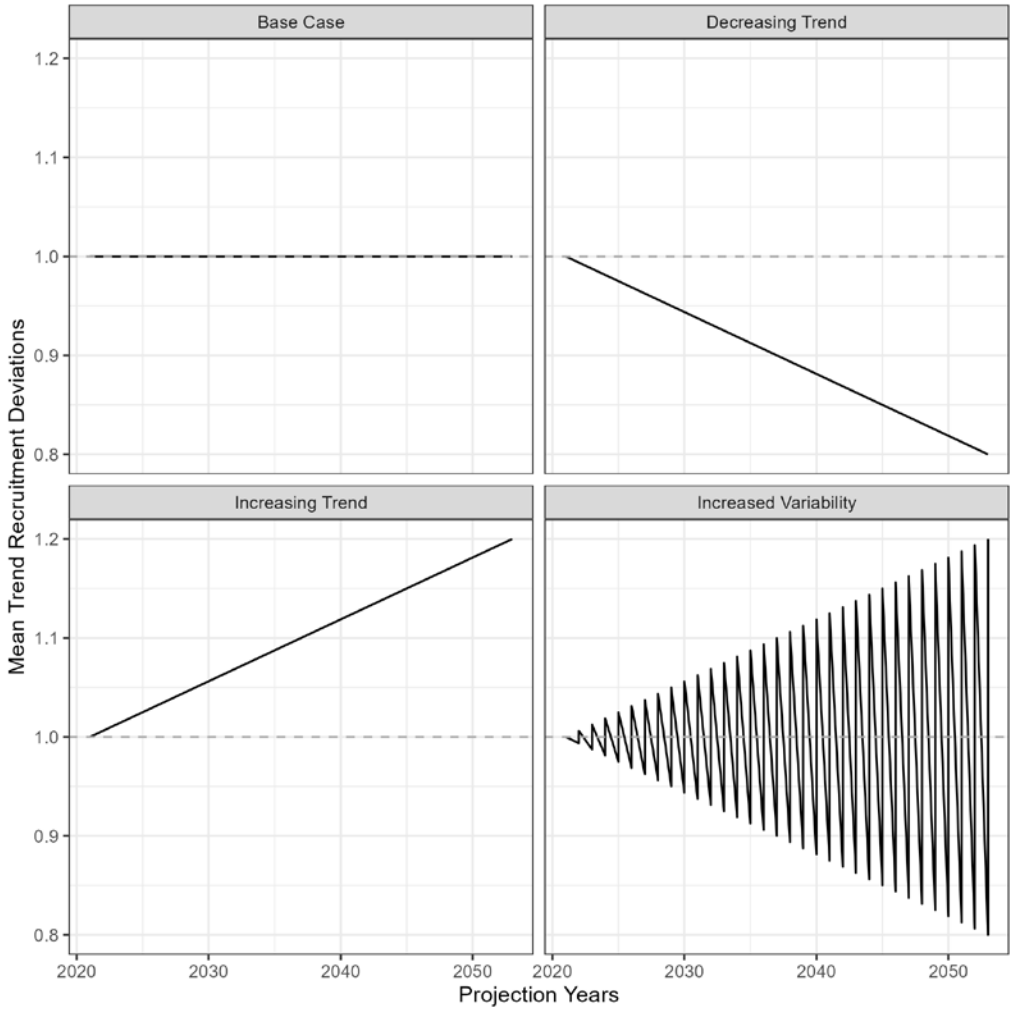
Robustness tests: Climate change

- Climate change may have varying effects on different features of the stock, such as
  - Distribution
  - Reproduction
  - Growth
- Complex scenarios require long term work plan
- Short term proposal: assume effects on stock productivity via recruitment deviations

Robustness OMs: Climate change

- Proposal for work in 2023

- Directional change in the recruitment deviations:
  - Status quo
  - Positive trend
  - Negative trend
  - Increased variability



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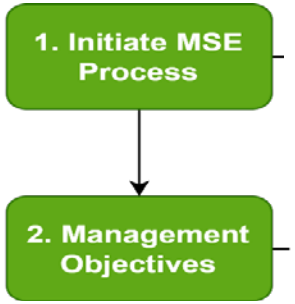


1. MSE Process Initiated
2. Management Objectives stated

Management Objectives fall into 4 categories:

1. Safety

E.g. “There should be a [_]% or less probability of the stock falling below B_{LIM} at any point during the 30-year evaluation period.”

2. Stock status

E.g. The stock should have a greater than [__]% probability of occurring in the green quadrant of the Kobe matrix

3. Stability

E.g. Any increase or decrease in TAC between management periods should be less than [__]%

4. Yield

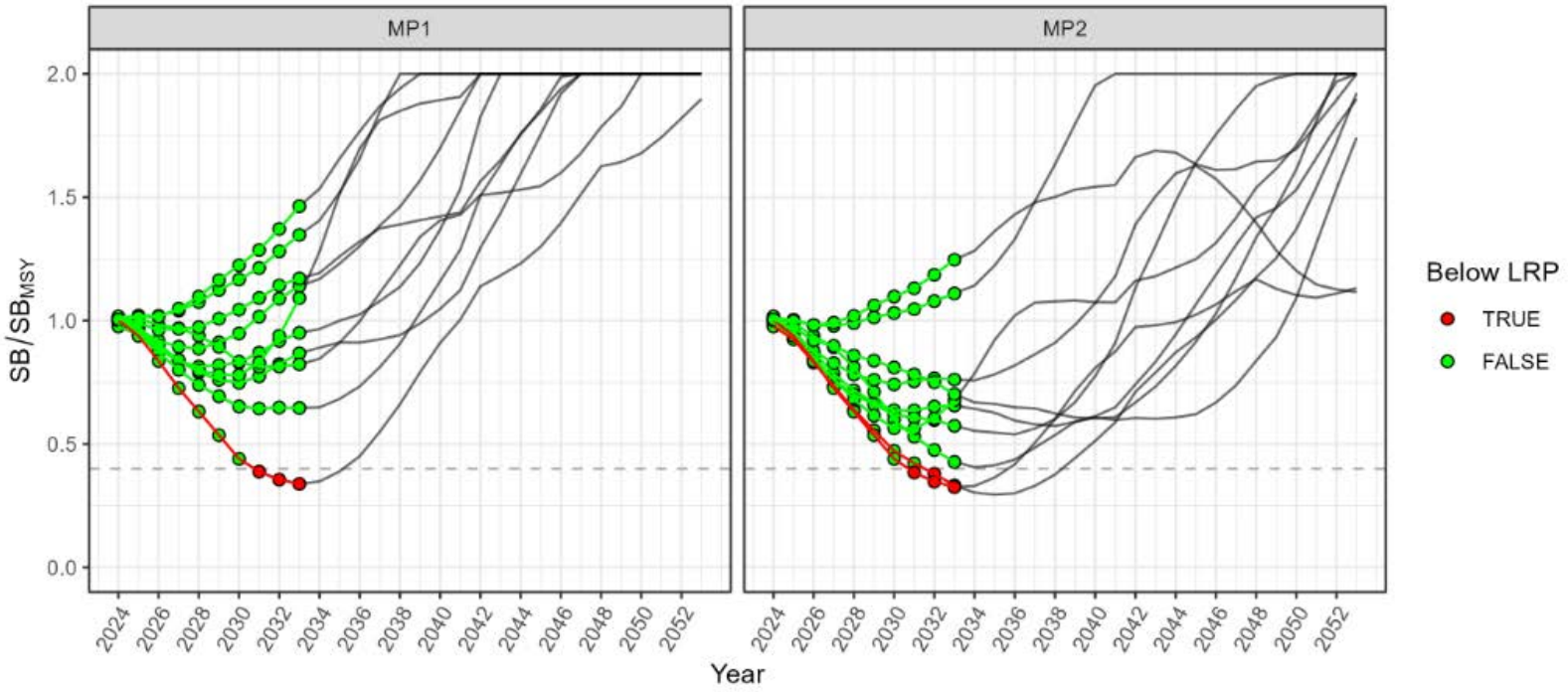
E.g. Maximize overall catch

Management objectives and performance metrics

- Minimum thresholds provided by PA4
  - Status, PGK: 51%, 60%, 70%
  - Safety: 5%, 10%, 15% of breaching LRP ($0.4B_{MSY}$)
  - Stability: 25% and no limitation

Minimum Performance Criteria

Safety: LRP Performance Metric (require <15%)



Example

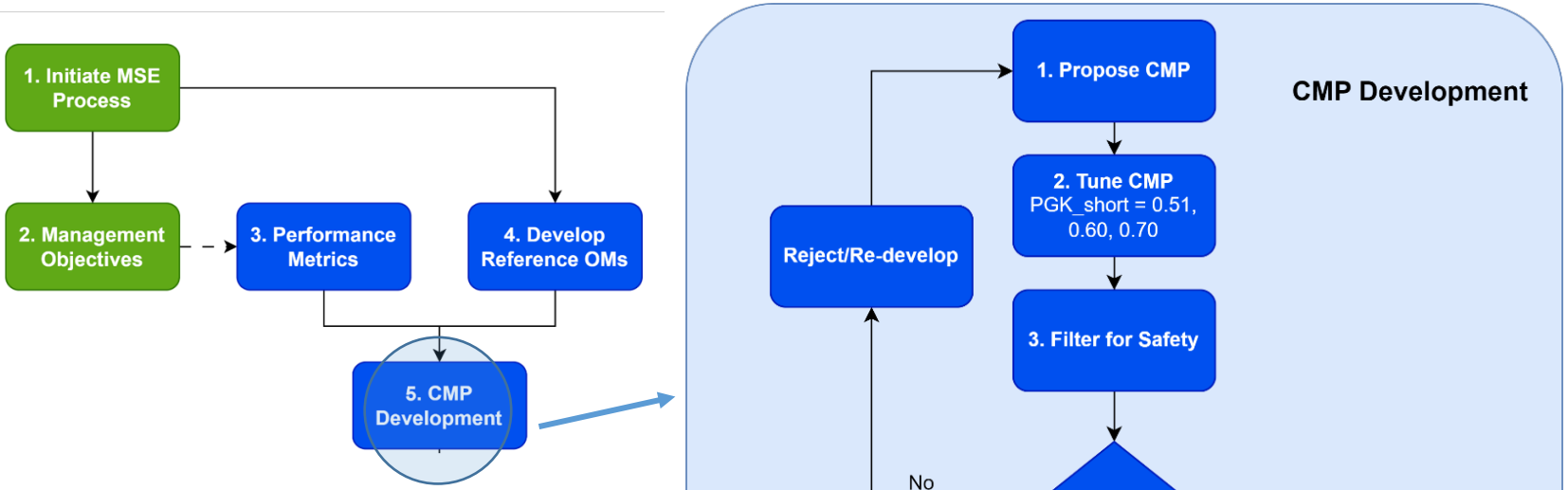
- 10 Simulations
- $B_{LIM} = 0.4SB_{MSY}$

LRP Values:

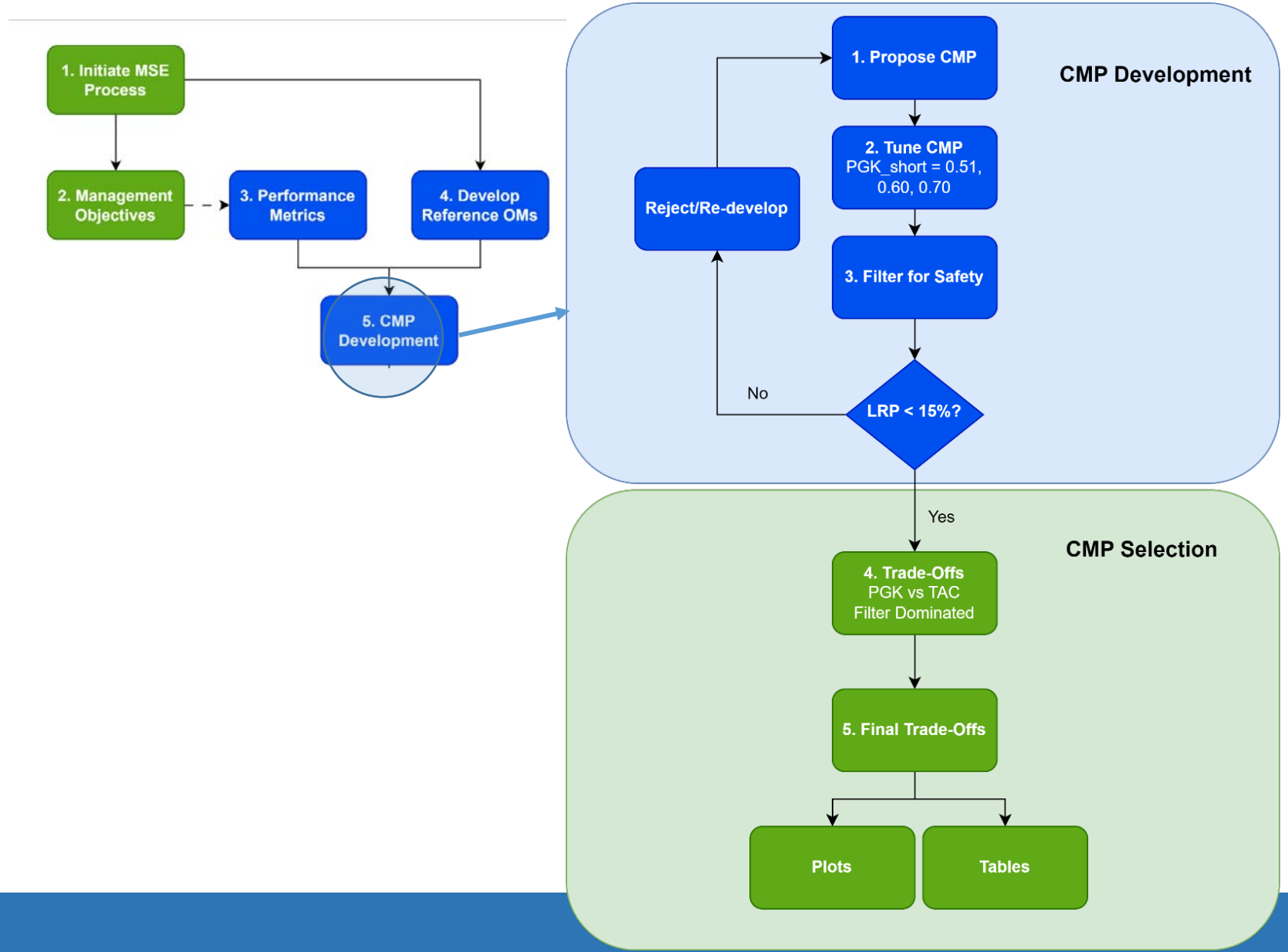
1. MP 1: 10% (1/10 sims)
2. MP2: 20% (2/10 sims)

1. MSE Process initiated
2. Management Objectives stated
3. Develop Performance Metrics

Family	Name	Description	Minimum Acceptable Values
Status	PGK_short	Probability of being in Green Zone of Kobe Space (SB>SBMSY & F<FMSY) in years 1-10 (2024-2033)	51, 60, 70
	PGK_med	Probability of being in Green Zone of Kobe Space (SB>SBMSY & F<FMSY) in years 11-20 (2034-2043)	51, 60, 70
	PGK_long	Probability of being in Green Zone of Kobe Space (SB>SBMSY & F<FMSY) in years 21-30 (2044-2053)	51, 60, 70
	PGK	Probability of being in Green Zone of Kobe Space (SB>SBMSY & F<FMSY) over all years (2024-2053)	51, 60, 70
	PGK_30	Probability of being in Green Zone of Kobe Space (SB>SBMSY & F<FMSY) in year 30 (2053)	51, 60, 70
	POF	Probability of Overfishing (F>FMSY) over all years (2024-2053)	
	PNOF	Probability of Not Overfishing (F<FMSY) over all years (2024-2053)	
Safety	LRP_short	Probability of breaching the limit reference point (SB<0.4SBMSY) in any of the first 10 years (2024-2033)	5, 10, 15
	LRP_med	Probability of breaching the limit reference point (SB<0.4SBMSY) in any of years 11-20 (2034-2043)	5, 10, 15
	LRP_long	Probability of breaching the limit reference point (SB<0.4SBMSY) in any of years 21-30 (2044-2053)	5, 10, 15
	LRP	Probability of breaching the limit reference point (SB<0.4SBMSY) in any year (2024-2053)	5, 10, 15
Yield	TAC1	TAC (t) in the first implementation year (2024)	
	AvTAC_short	Median TAC (t) over years 1-10 (2024-2033)	
	AvTAC_med	Median TAC (t) over years 11-20 (2034-2043)	
	AvTAC_long	Median TAC (t) over years 21-30 (2044-2053)	
Stability	VarC	Median variation in TAC (%) between management cycles over all years	
	MaxVarC	Maximum variation in TAC (%) between management cycles over all years	No minimum value and 25

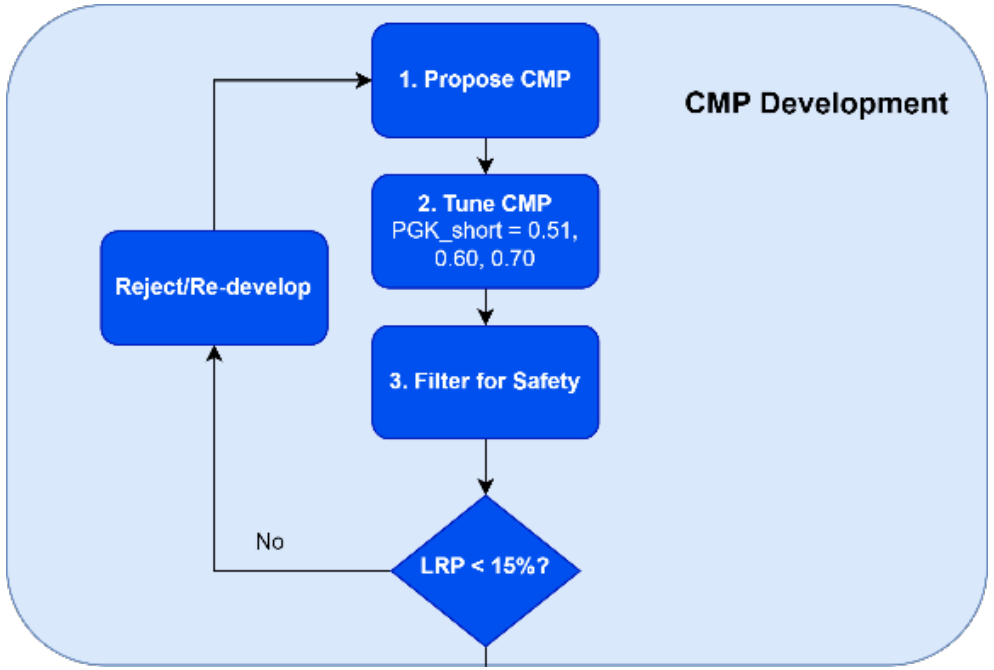


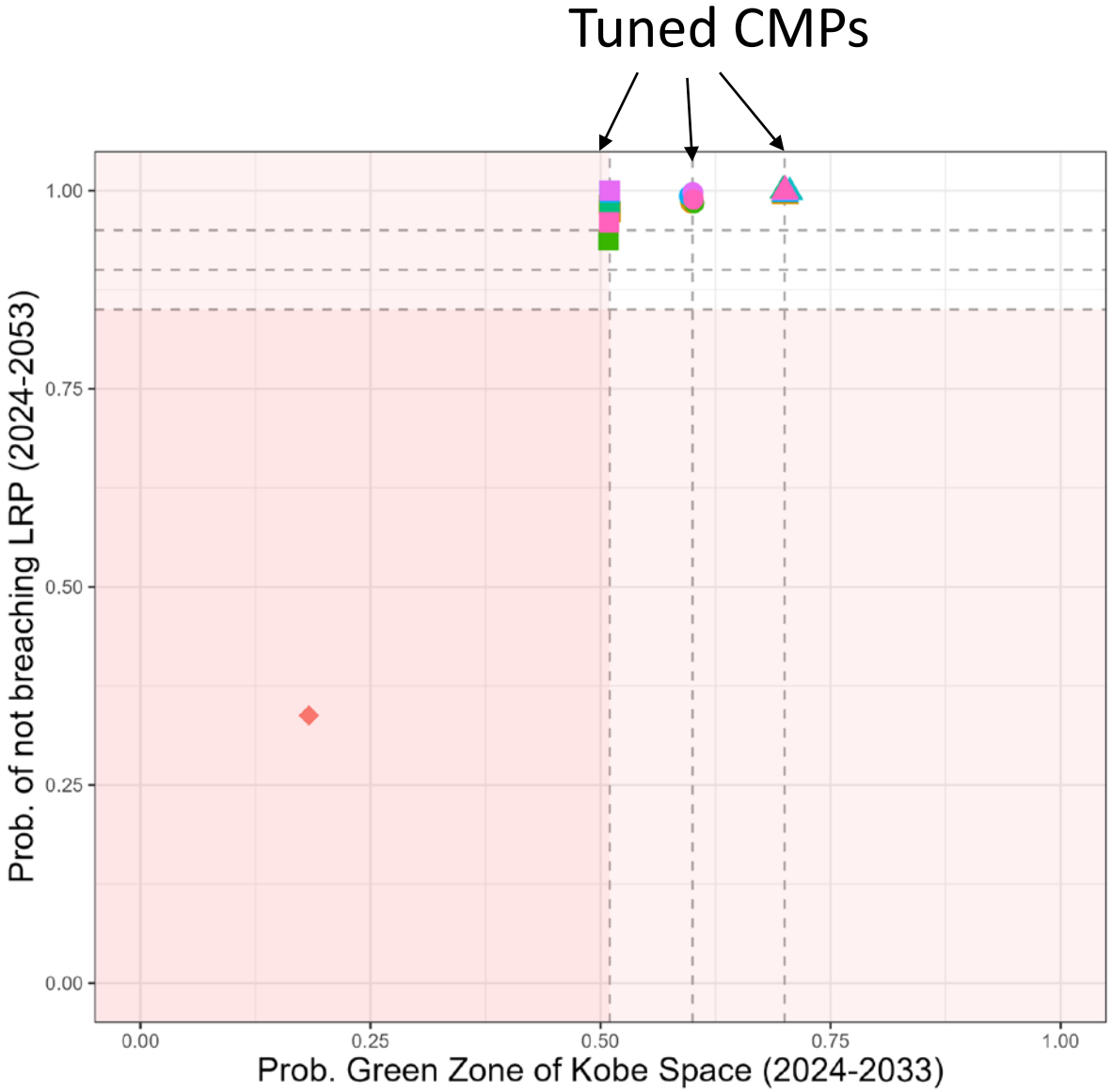
1. Propose CMP
2. Tune CMP to PGK_short: 51, 60, 70%
3. Filter for Safety: LRP ≤ 15%



1. Propose CMP
2. Tune CMP to PGK_short: 51, 60, 70%
3. Filter for Safety: LRP ≤ 15%
4. Trade-Offs: Filter Dominated CMPs
5. Present Trade-offs and Other Plots

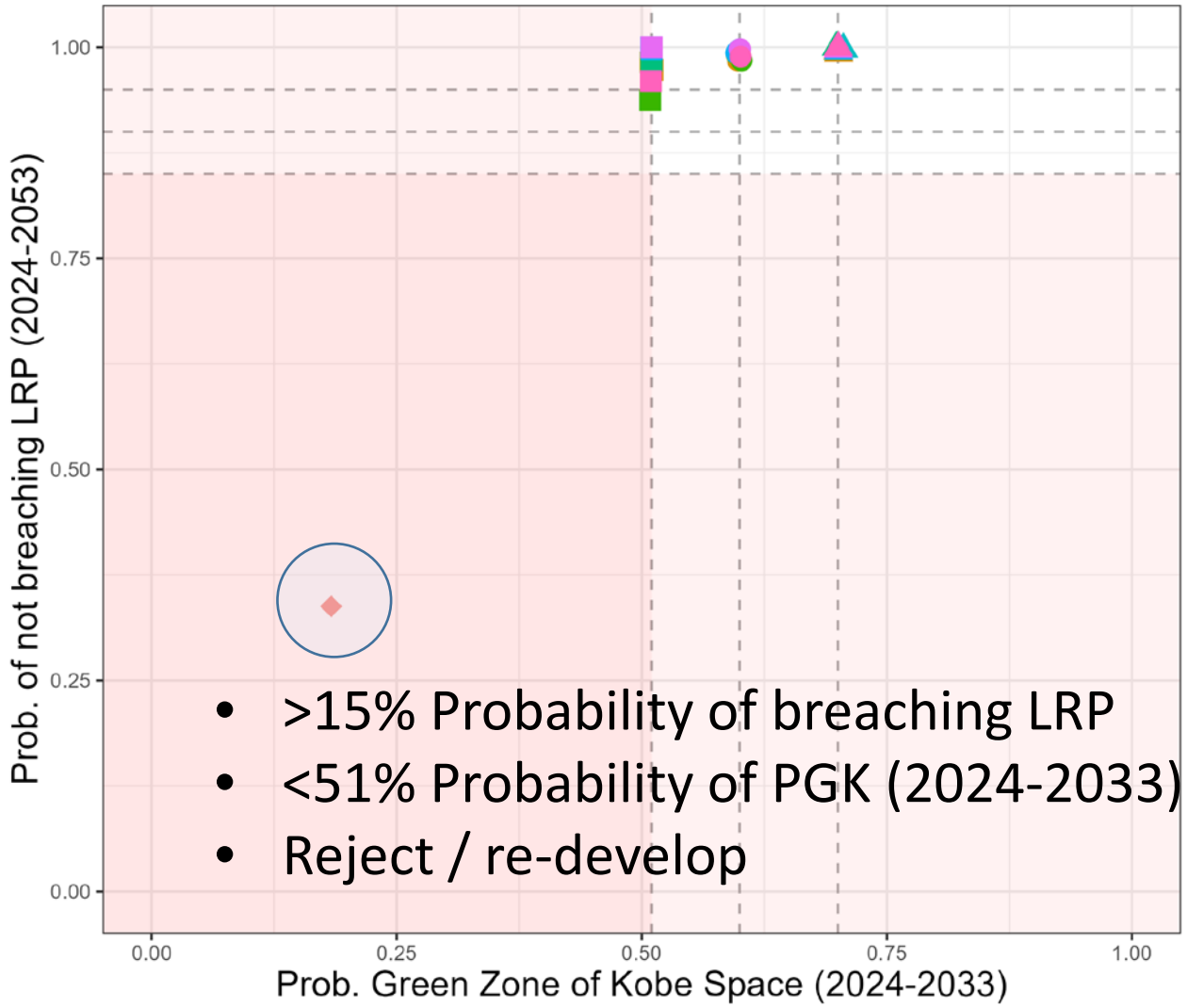
2. Tune CMP to PGK_short: 51, 60, 70%

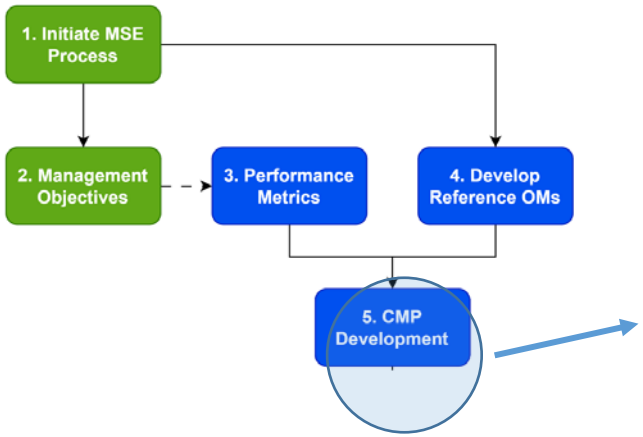


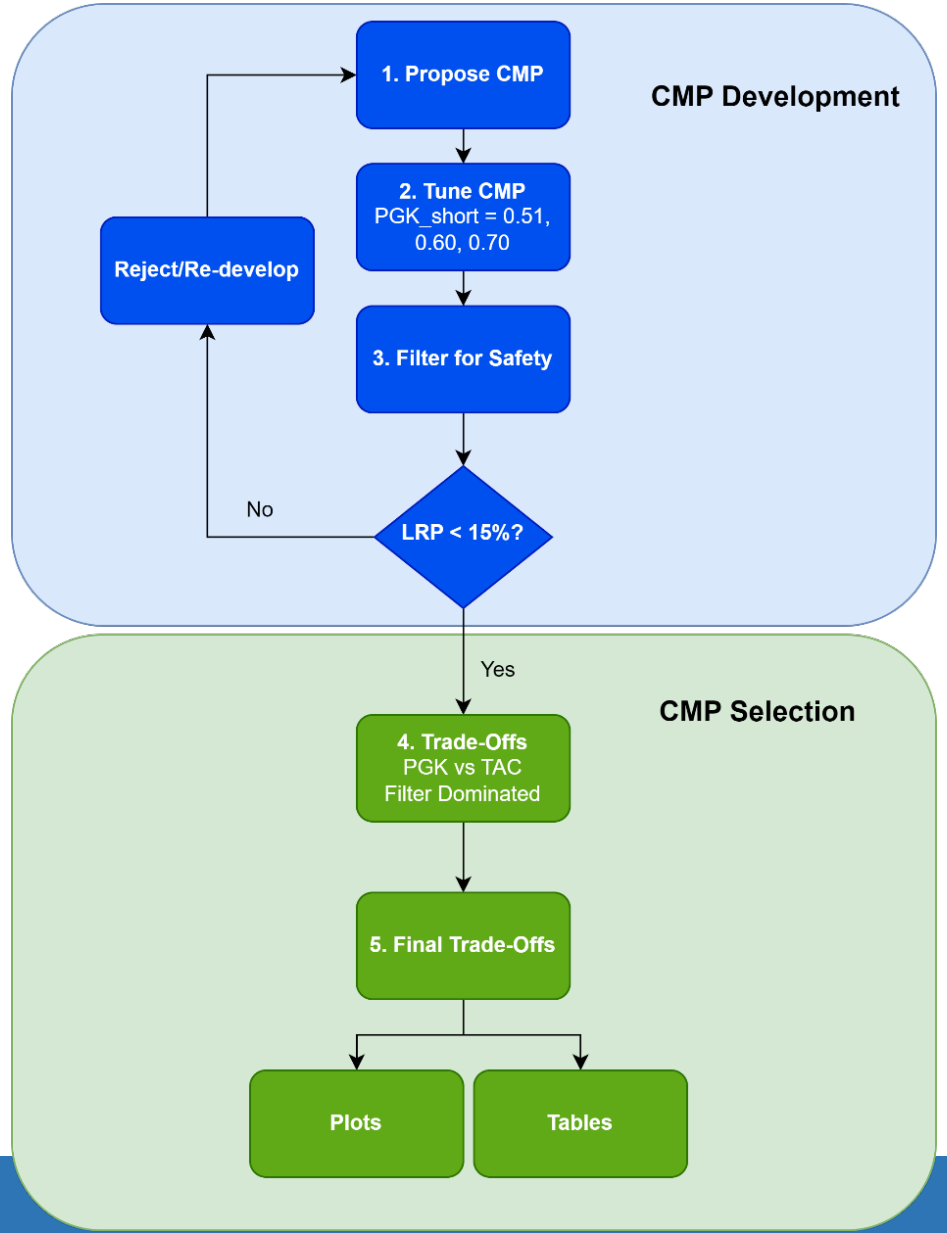


Filter for Safety: LRP ≤ 15%

Proposed CMPs that cannot achieve the tuning targets, or have >15% probability of breaching LRP are rejected/re-developed



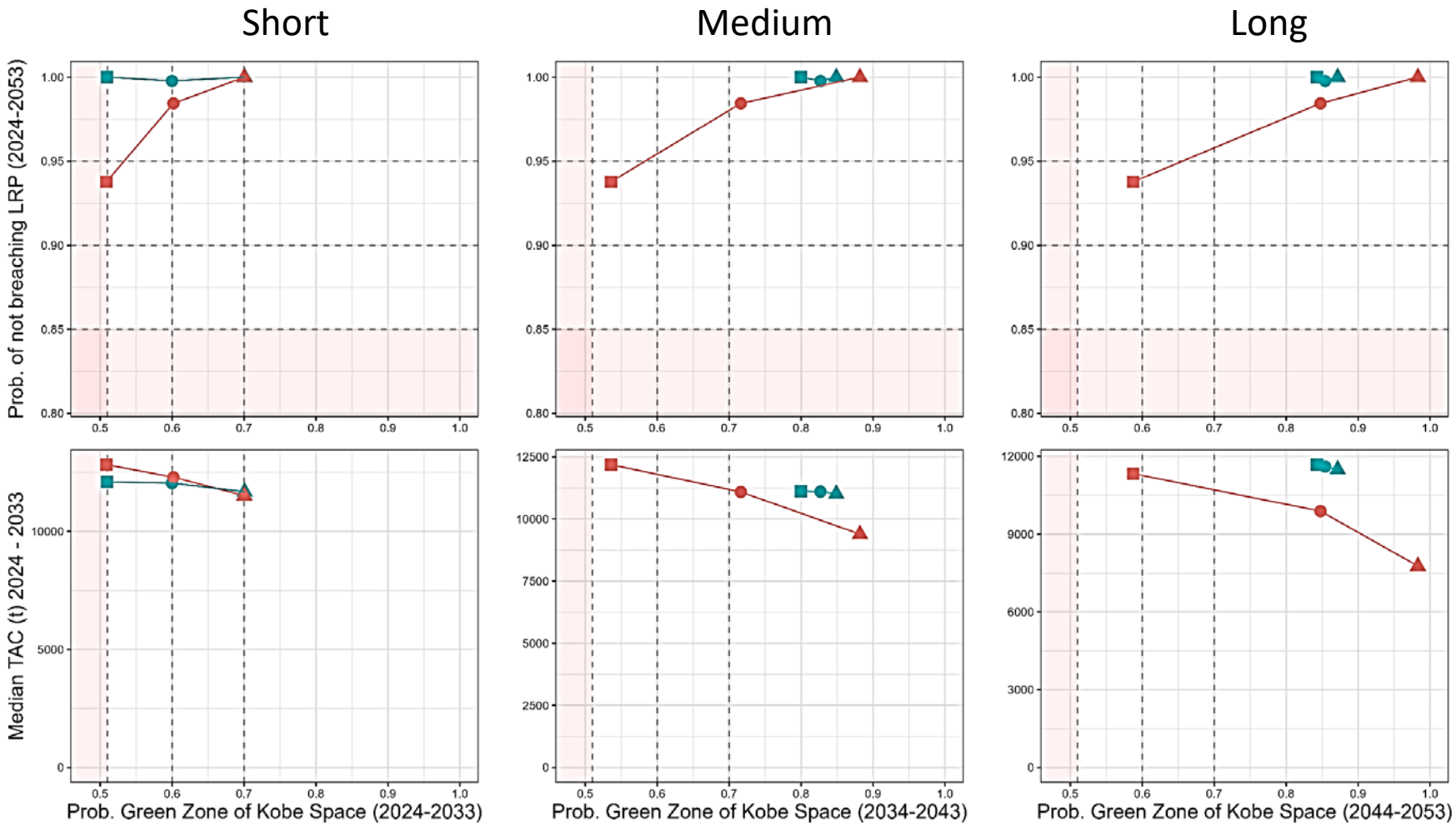




1. Propose CMP
2. Tune CMP to PGK_short: 51, 60, 70%
3. Filter for Safety: LRP ≤ 15%
4. Trade-Offs: Filter Dominated CMPs
5. Present Trade-offs and Other Plots

2. Tune CMP to PGK_short: 51, 60, 70%

Tuning to PGK_short 51, 60 & 70% allows us to quantify the trade-off space across the region of 'Pretty Good Yield' (2 example CMPs)



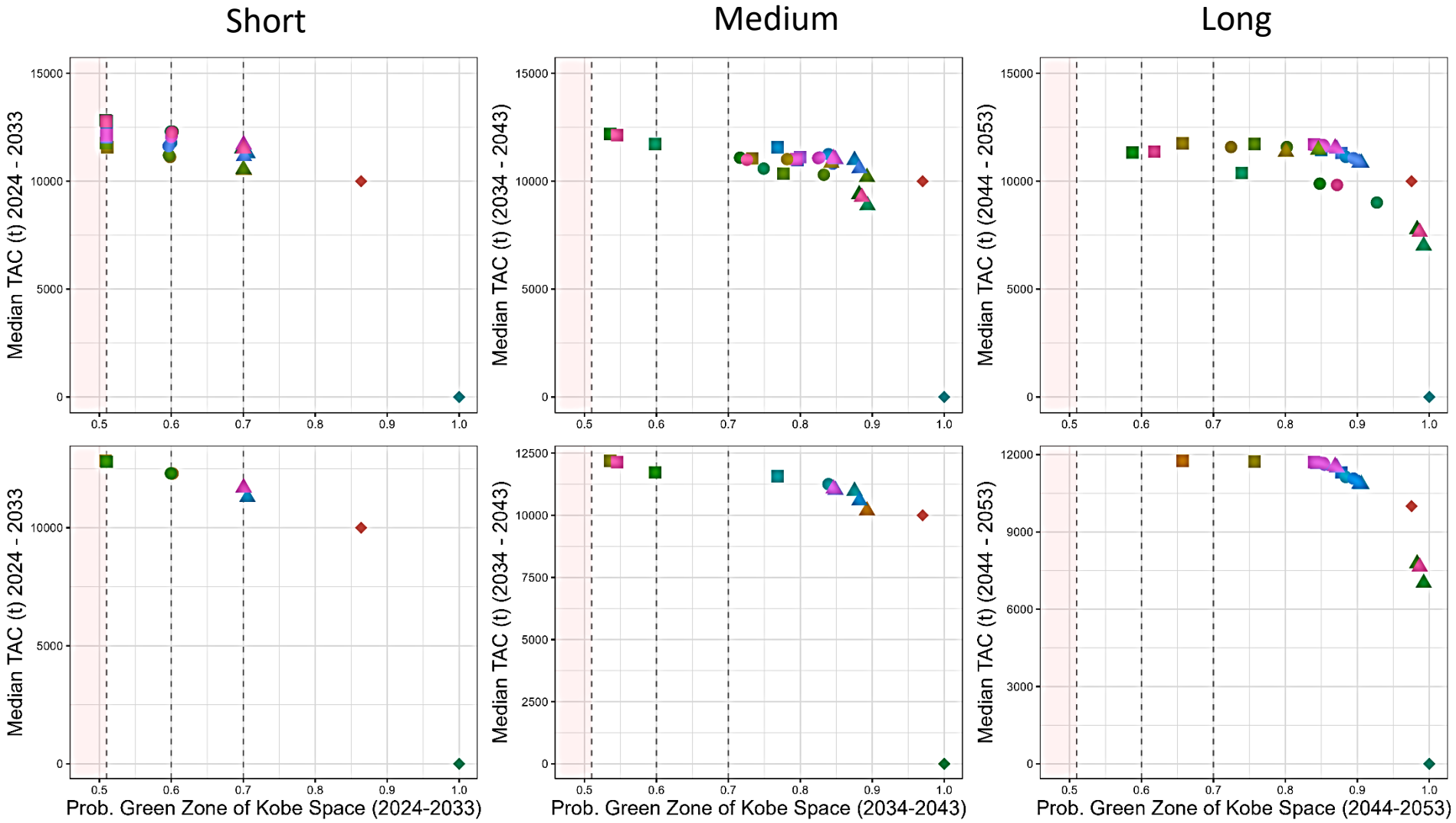
4. Trade-Offs: Filter Dominated CMPs

Approach:

1. Trade-offs between PGK and median TAC over Short, Medium and Long time-frames
2. Trade-offs between TAC and variability in TAC

4. Trade-Offs: Filter Dominated CMPs

Dominated CMPs: worse performance with respect to both metrics

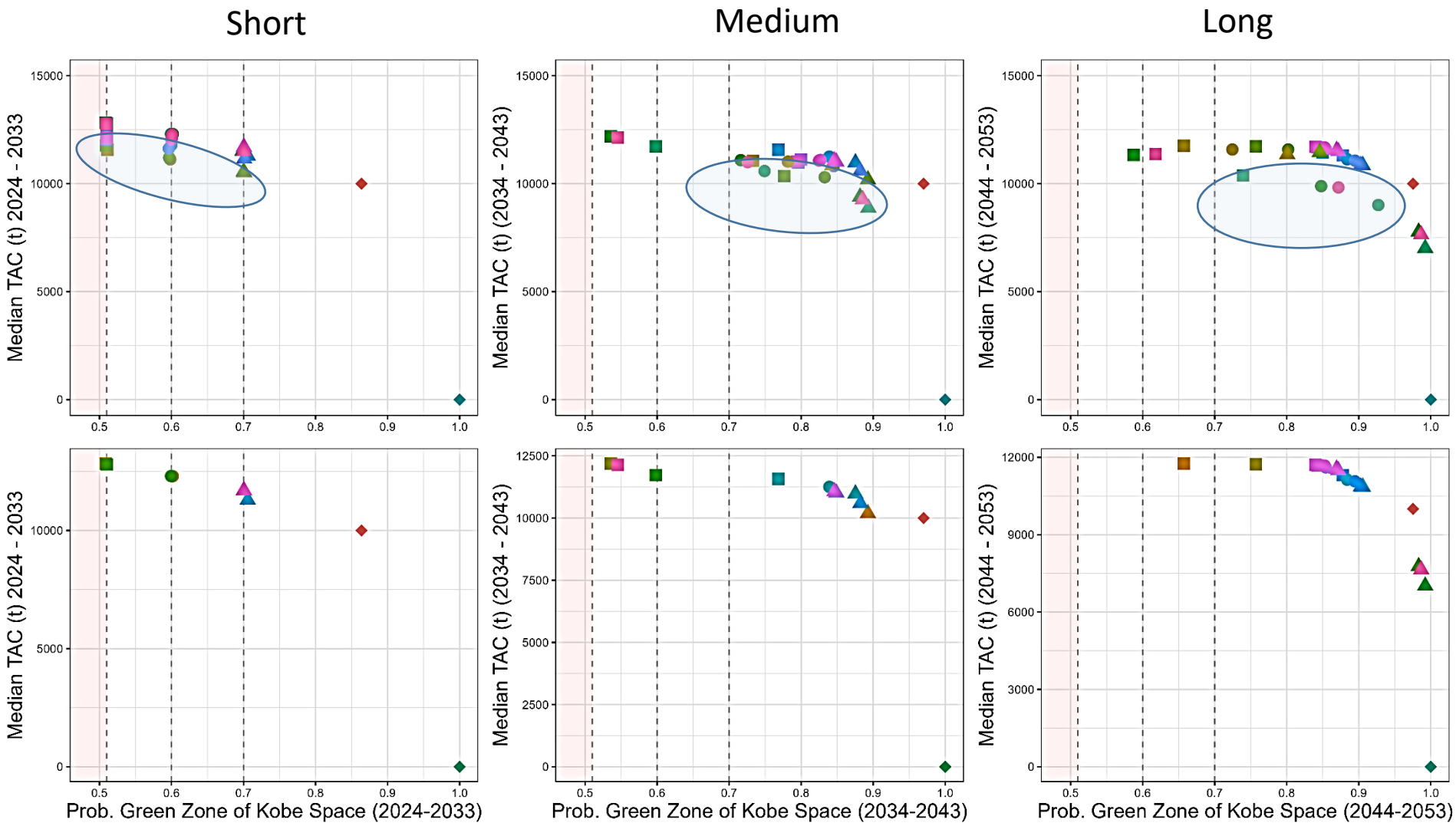


All CMPs

Non-Dominated CMPs

4. Trade-Offs: Filter Dominated CMPs

Dominated CMPs: worse performance with respect to both metrics

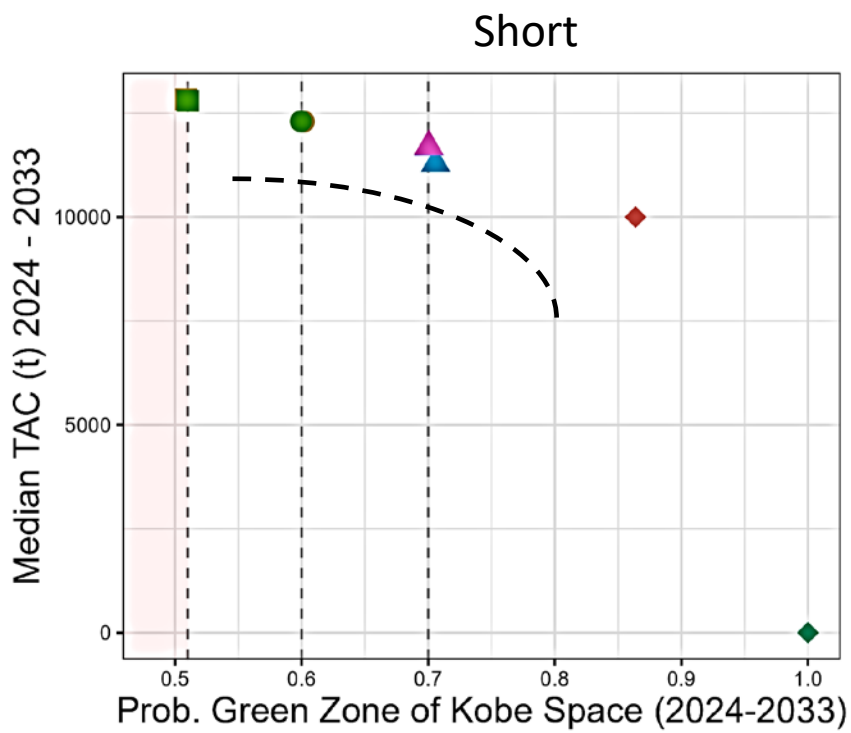


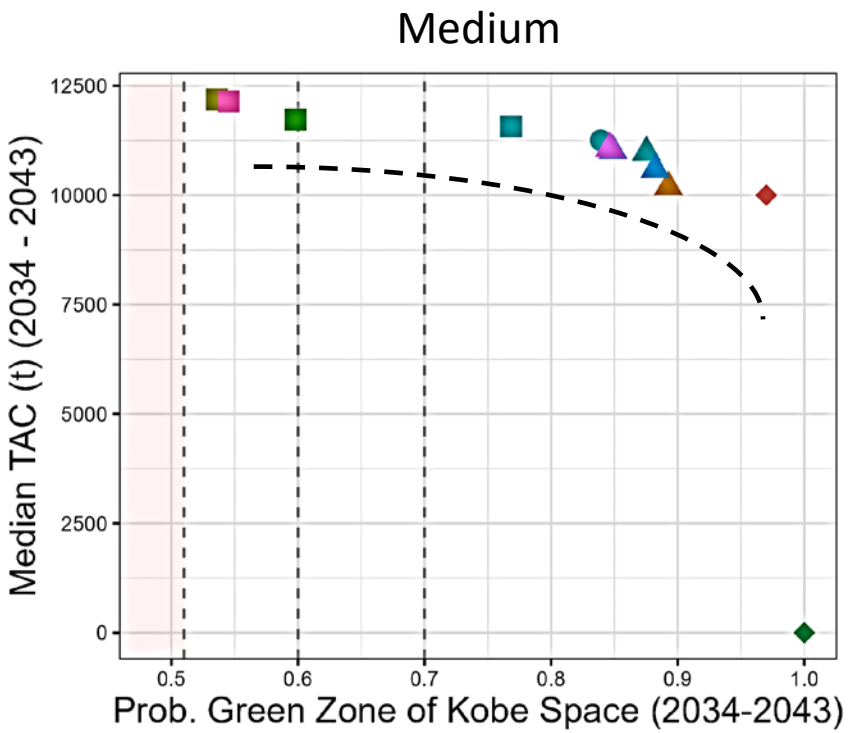
All CMPs

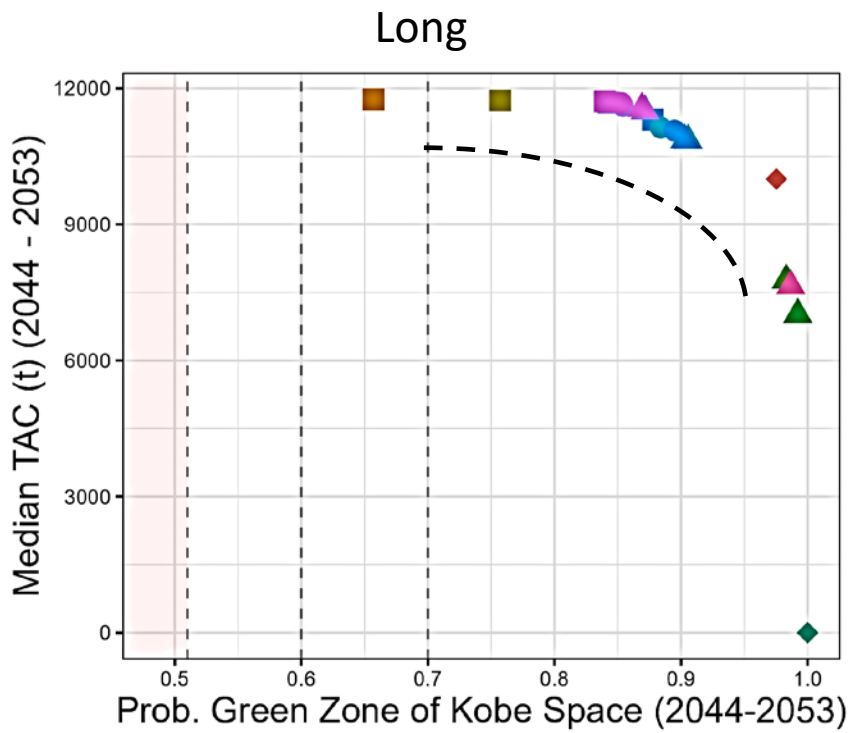
Non-Dominated CMPs

4. Trade-Offs: Filter Dominated CMPs

Efficient Frontier: trade-off space between PGK and TAC







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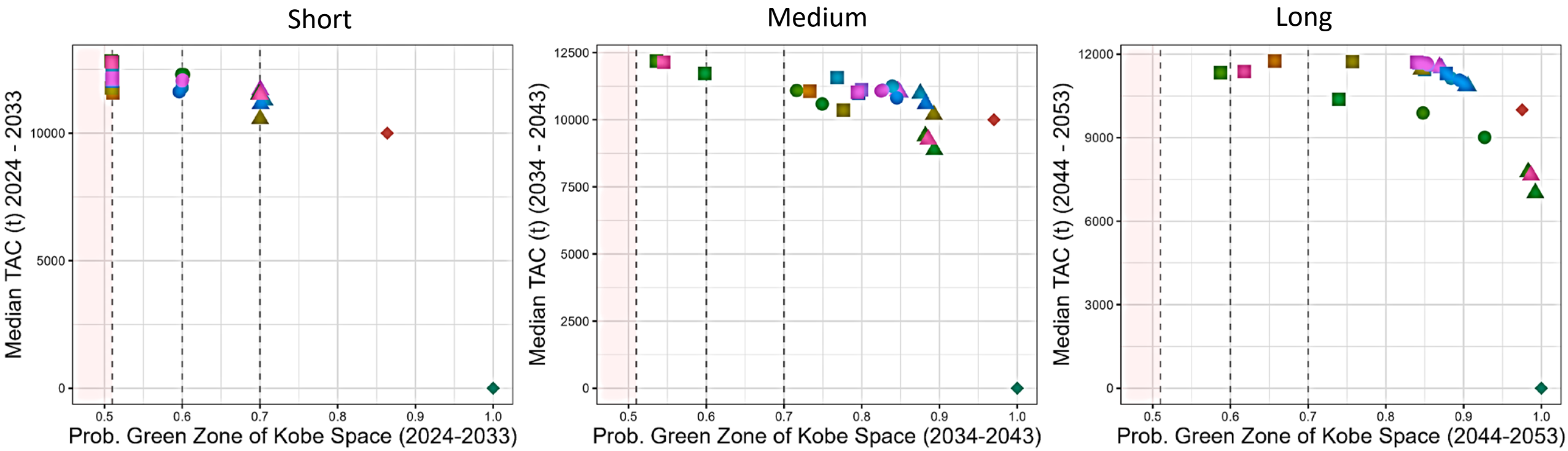
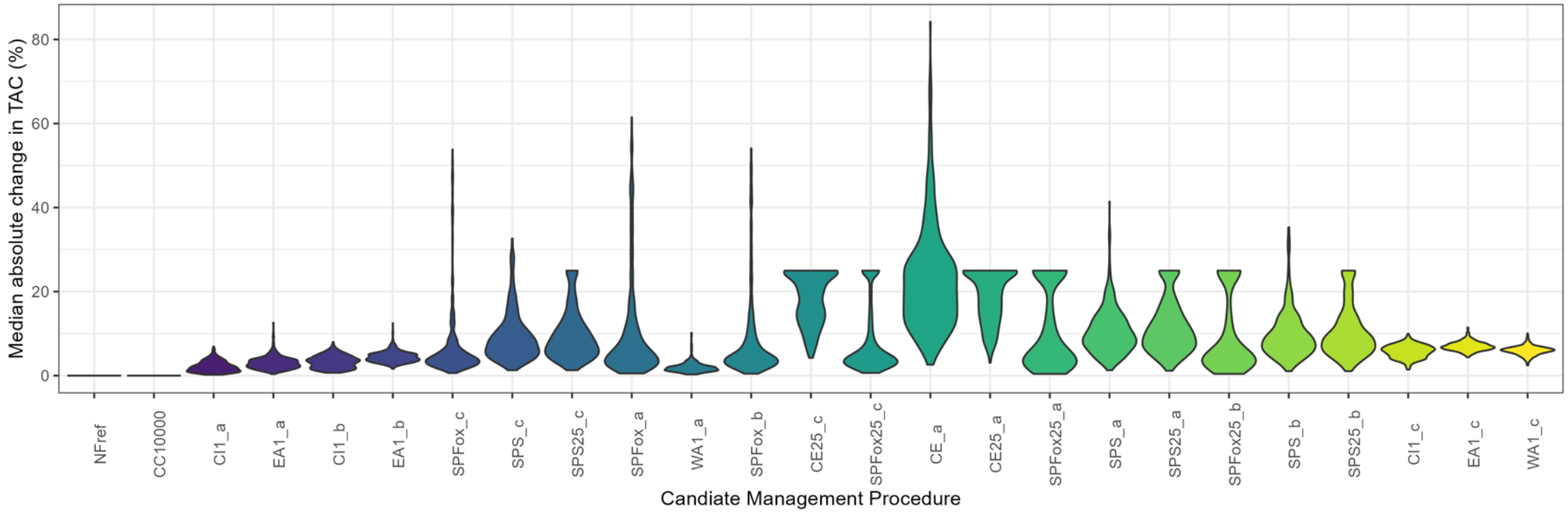
Efficient Frontier: trade-off space between PGK and TAC



Only remove CMPs that are dominated in **all** three trade-off plots

25 CMPs remain

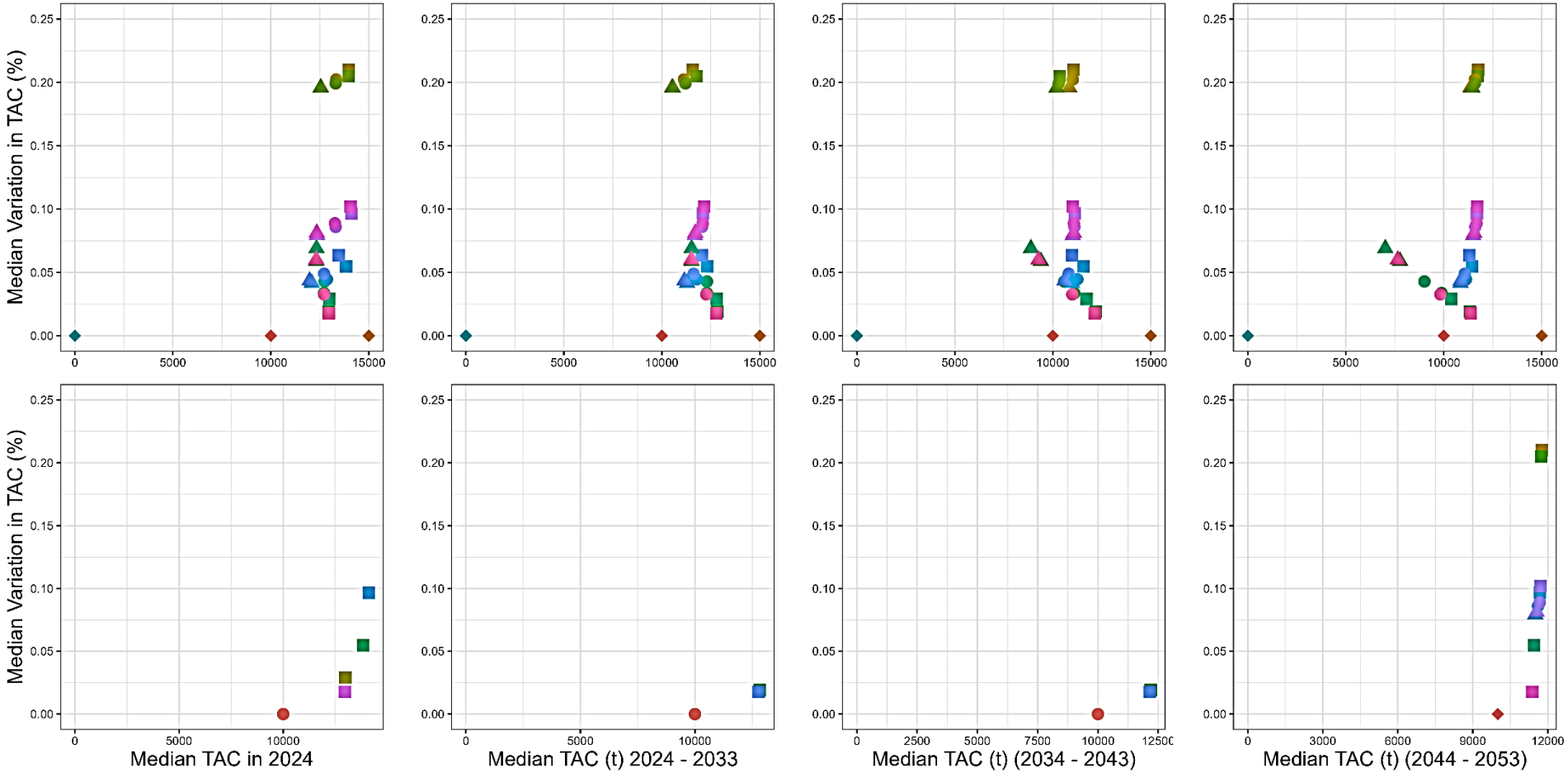
Variability in TAC



Large difference in variability in TAC across CMPs

4. Trade-Offs: Filter Dominated CMPs

Trade-off between TAC and variability in TAC

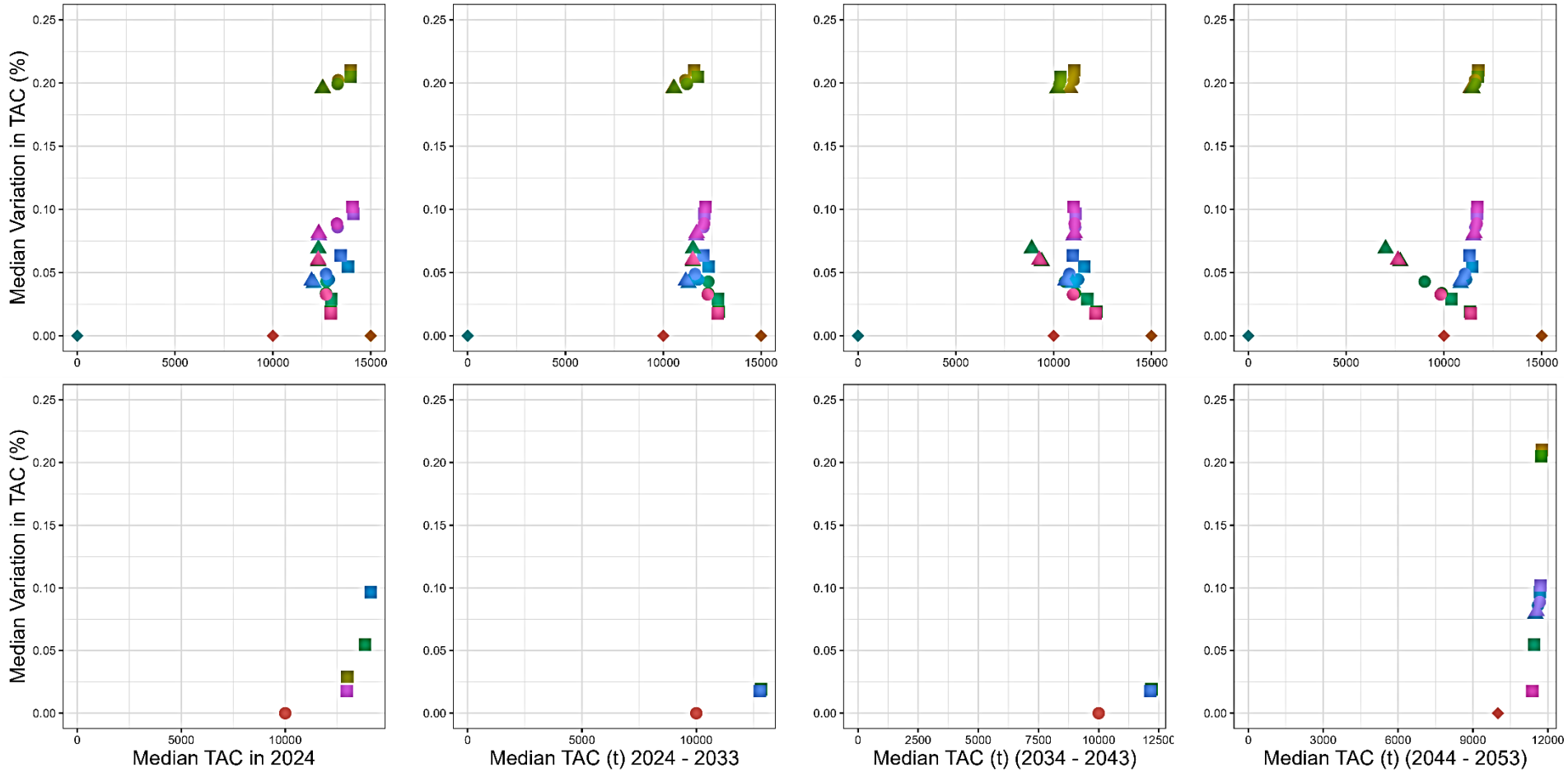


All CMPs

Non-Dominated CMPs

4. Trade-Offs: Filter Dominated CMPs

Trade-off between TAC and variability in TAC



All CMPs

Non-Dominated CMPs

Only remove CMPs that are dominated in **all** four trade-off plots (more variability and less yield in all time-frames)

13 CMPs remain

Table of CMPs

MP	Type	PGK tuning target	Indices	Description
CC10000	Empirical	-	-	Constant TAC at 10,000 t
CE_a	Empirical	51%	Combined	Constant Exploitation Rate
CE25_a	Empirical	51%	Combined	Constant Exploitation Rate with a maximum absolute change in TAC of 25%
CI1_a	Empirical	51%	Combined	Index ratio method using the Combined Index, smoothed and scaled by the inverse variance before averaging
EA1_a	Empirical	51%	SP, MO, PO	Index ratio method using the SP, MO, and PO indices, smoothed and scaled by the inverse variance before averaging
WA1_a	Empirical	51%	CA, US, CT, JP	Index ratio method using the CA, US, CT, and JP indices, smoothed and scaled by the inverse variance before averaging
SPFox_a	Model	51%	Combined	Fox Surplus Production with an HCR.
SPS_a	Model	51%	Combined	Schaefer Surplus Production with an HCR
SPS_b	Model	60%	Combined	Schaefer Surplus Production with an HCR
SPS_c	Model	70%	Combined	Schaefer Surplus Production with an HCR
SPS25_a	Model	51%	Combined	Schaefer Surplus Production with an HCR with a maximum absolute change in TAC of 25%
SPS25_b	Model	60%	Combined	Schaefer Surplus Production with an HCR with a maximum absolute change in TAC of 25%
SPS25_c	Model	70%	Combined	Schaefer Surplus Production with an HCR with a maximum absolute change in TAC of 25%

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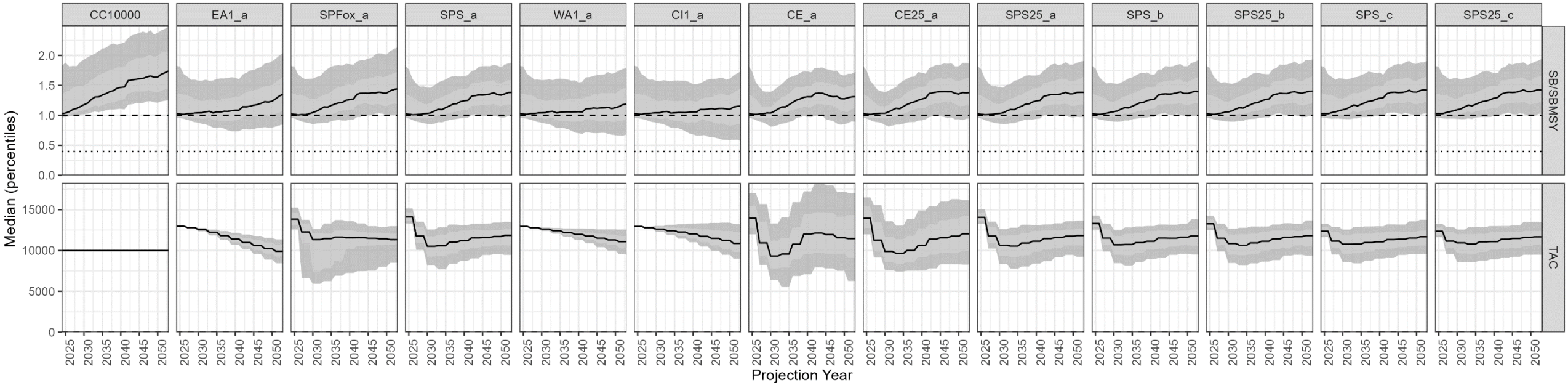
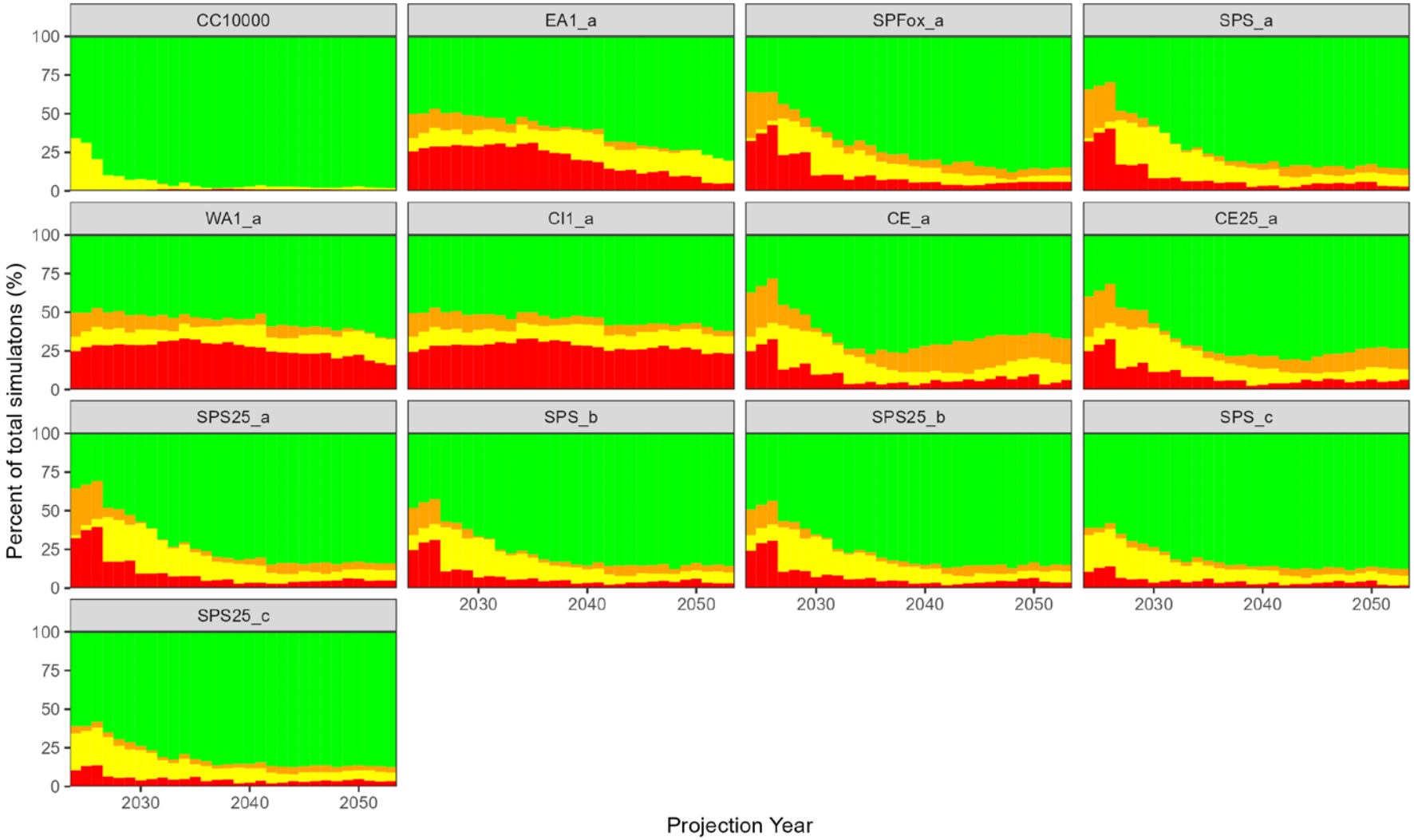
5. Other plots of Final CMPs

Time-series plot of SB/SBMSY and TAC



Kobe Time Plot



5. Other plots of Final CMPs

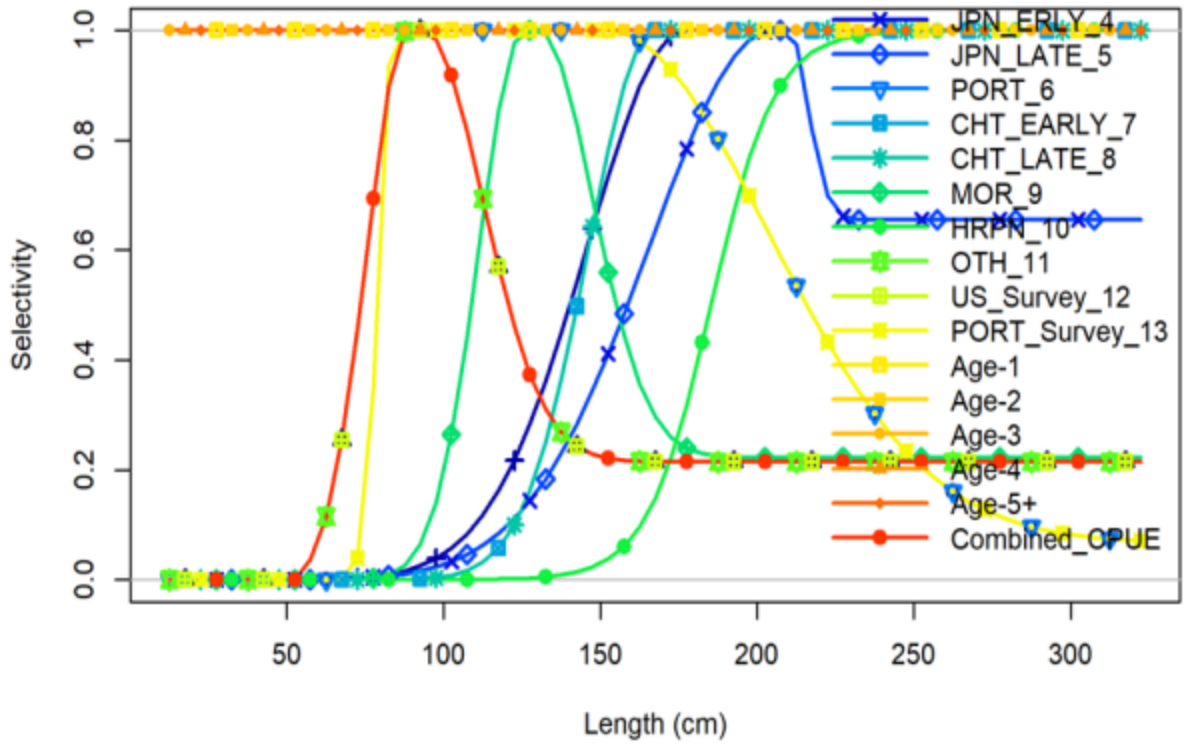
Quilt plot

What MPs to show?

	MP	AvTAC_long	AvTAC_med	AvTAC_short	PGK	TAC1	VarC
1	CC10000	10000	10000	10000	0.94	10000	0
2	CE_a	11757.96	11059.54	11578.28	0.63	13976.51	0.21
3	CE25_a	11731.07	10352.71	11769.12	0.68	13968.84	0.21
4	CI1_a	11333.93	12190.62	12833.28	0.54	12954.11	0.02
5	EA1_a	10381.35	11725.91	12796.53	0.62	12987.7	0.03
6	SPFox_a	11450.04	11572.7	12320.15	0.71	13840.43	0.05
7	SPS_a	11684.32	11118.73	12101.24	0.72	14111.09	0.1
8	SPS25_a	11710.05	11023.8	12156.43	0.71	14062.34	0.1
9	WA1_a	11375.06	12139.14	12780.95	0.56	12960.43	0.02
10	SPS_b	11607.55	11103.1	12046.95	0.76	13304.77	0.09
11	SPS25_b	11678.4	11072.09	12088.38	0.76	13269.93	0.09
12	SPS_c	11499.81	11015.97	11685.01	0.81	12353.87	0.08
13	SPS25_c	11553.02	11071.46	11706.32	0.81	12343.41	0.08

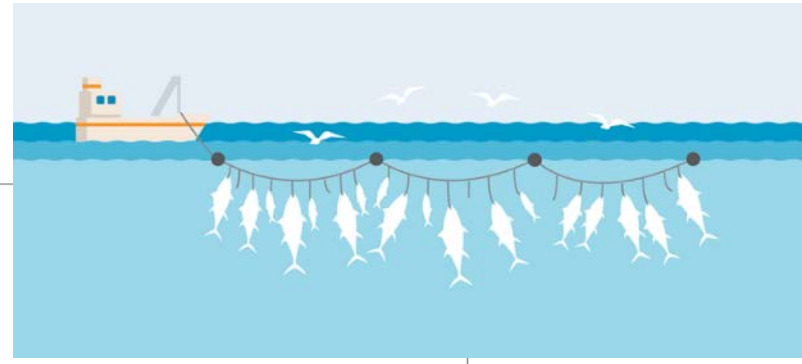
CMP assumptions

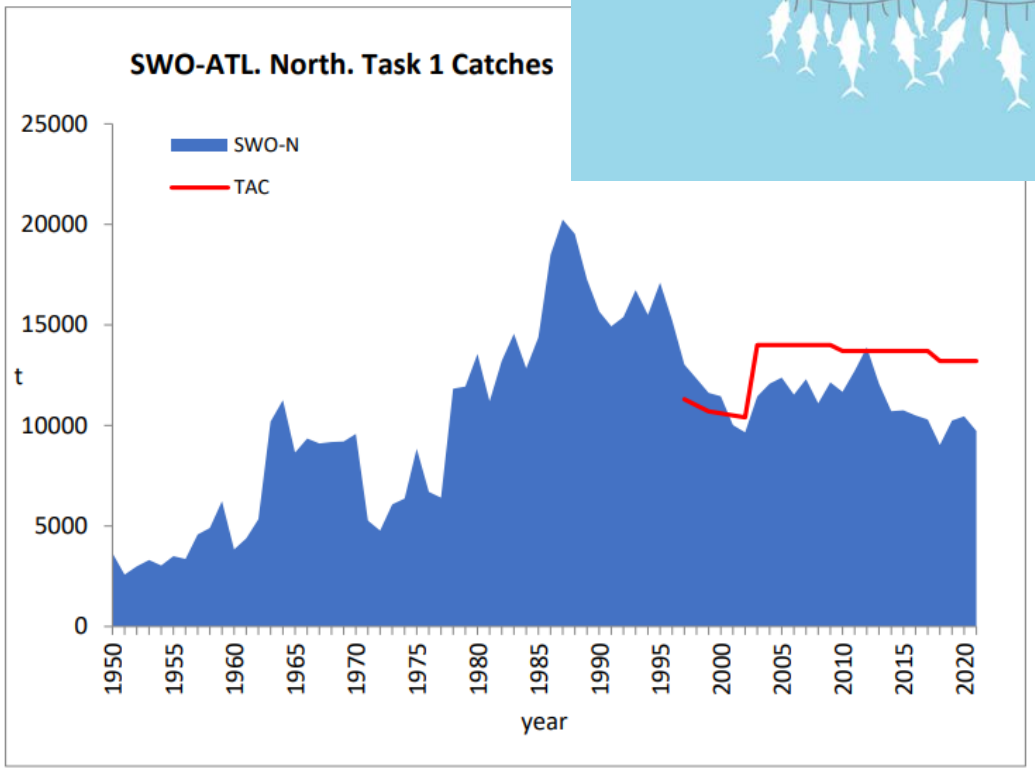
- Simulation assumes:
  - TAC = catch
  - Selectivity patters remain constant
    - Selectivity patterns may change if allocations among fleets change



History of the fishery

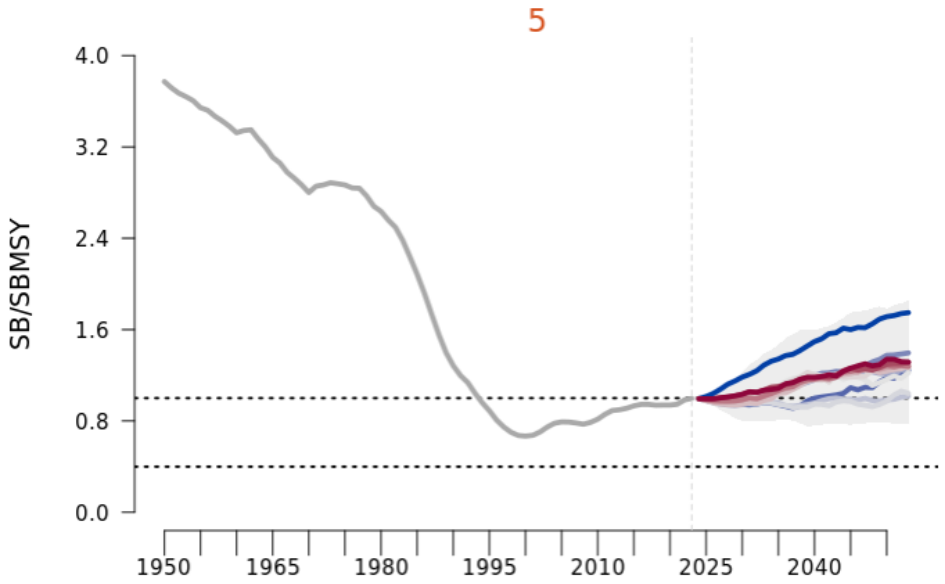
- Current: Surface longline directed and bycatch
  - From 1960s to present
  - Limited harpoon fishery
  - Limited gillnet fishery
- Historical: Harpoon directed
  - In the Atlantic, 1950s – present
  - Less common 1960 onward
- Catch peaked in 1987
  - 20,238 t





Results resources

- SWO MSE website
- Slick tool



North Atlantic Swordfish MSE

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26 June, 2023

Introduction

Welcome to the North Atlantic Swordfish MSE homepage.

This site contains links to documents, reports, and presentations related to the management strategy evaluation (MSE) process for the North Atlantic Swordfish.

The MSE is being conducted with the open-source openMSE framework. The code for the swordfish MSE is available in the `SWOMSE` R package available in the ICCAT GitHub repository.

MSE Process Documentation

1. Trial Specifications Doc (HTML) (PDF)
2. CMP Development Guide (HTML)
3. SWOMSE User Manual (HTML)

Agenda

4. Review of Panel 4 feedback and requests in March 2023
5. Summary of work done since the March 2023 meeting of the Panel
6. Modifications to the OM grid
7. Management objectives and key performance metrics
8. Initial CMPs and their results
9. MSE development timeline for 2023
10. Key decisions to be taken by PA4

Technical team next steps

- Develop additional CMPs (input welcomed)
- Generate trade-off plots requested by PA4
- Regularly update the Slick tool with new results
- Diagnostics for CMPs

MSE development timeline beyond 2023

		Activity					Data inputs			
Year	Management cycle	MP run	MP advice implemented	Stock assessment	MSE Review	Exceptional circumstances evaluated	Combined index	Other CPUEs	Catch data	Exceptional circumstance indicators
2023		x					x	x	x	x
2024	1		x			x				x
2025	1					x				x
2026	1	x				x	x		x	x
2027	2		x			x				x
2028	2			x (alternative)		x				x
2029	2	x		x		x	x	x	x	x
2030	3		x	x (alternative)		x				x
2031	3					x				x
2032	3	x			x	x	x		x	x

Agenda

10. Key decisions to be taken by PA4
    a. Choice of a key performance metrics, timeframes, and minimum/maximum acceptable thresholds (if applicable) for each of the Status, Safety, Stability, and Yield objectives
    b. Choice of tuning objective, including time frame
    c. Definition of minimum threshold for TAC change between management cycles, if desired
    d. Prioritization of robustness and sensitivity tests

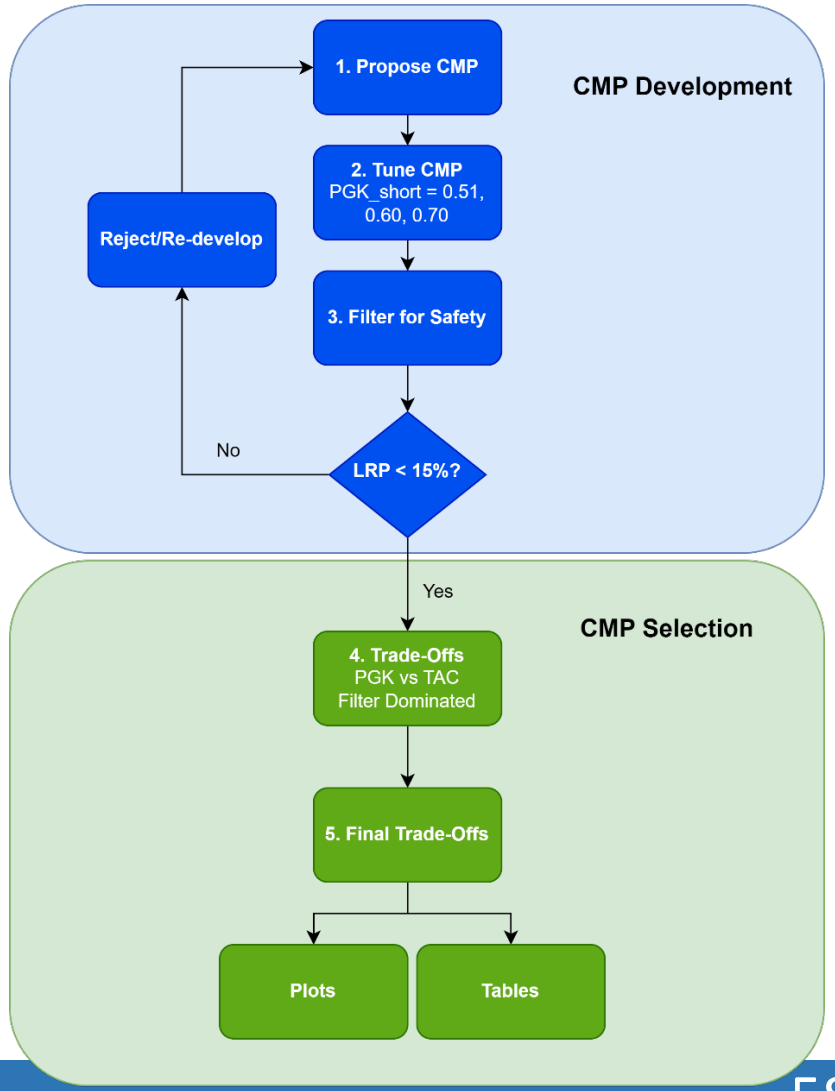
10. a) Choice of a key performance metrics

- Factors to consider
  - Time period: Status of the stock at the start of the projection period
  - Key tradeoffs among the 4 categories
  - Volume of information for PA4 to consider

Family	Name	Description	Minimum Acceptable Values
Status	PGK_short	Probability of being in Green Zone of Kobe Space (SB>SBMSY & F<FMSY) in years 1-10 (2024-2033)	51, 60, 70
	PGK_med	Probability of being in Green Zone of Kobe Space (SB>SBMSY & F<FMSY) in years 11-20 (2034-2043)	51, 60, 70
	PGK_long	Probability of being in Green Zone of Kobe Space (SB>SBMSY & F<FMSY) in years 21-30 (2044-2053)	51, 60, 70
	PGK	Probability of being in Green Zone of Kobe Space (SB>SBMSY & F<FMSY) over all years (2024-2053)	51, 60, 70
	PGK_30	Probability of being in Green Zone of Kobe Space (SB>SBMSY & F<FMSY) in year 30 (2053)	51, 60, 70
	POF	Probability of Overfishing (F>FMSY) over all years (2024-2053)	
	PNOF	Probability of Not Overfishing (F<FMSY) over all years (2024-2053)	
Safety	LRP_short	Probability of breaching the limit reference point (SB<0.4SBMSY) in any of the first 10 years (2024-2033)	5, 10, 15
	LRP_med	Probability of breaching the limit reference point (SB<0.4SBMSY) in any of years 11-20 (2034-2043)	5, 10, 15
	LRP_long	Probability of breaching the limit reference point (SB<0.4SBMSY) in any of years 21-30 (2044-2053)	5, 10, 15
	LRP	Probability of breaching the limit reference point (SB<0.4SBMSY) in any year (2024-2053)	5, 10, 15
Yield	TAC1	TAC (t) in the first implementation year (2024)	
	AvTAC_short	Median TAC (t) over years 1-10 (2024-2033)	
	AvTAC_med	Median TAC (t) over years 11-20 (2034-2043)	
	AvTAC_long	Median TAC (t) over years 21-30 (2044-2053)	
Stability	VarC	Median variation in TAC (%) between management cycles over all years	
	MaxVarC	Maximum variation in TAC (%) between management cycles over all years	No minimum value and 25

10. b) Choice of tuning objective, including time frame

- PGK_short: 0.51, 0.6, 0.7
- Factors to consider:
  - Stock status at start of projections
  - Are all probability levels needed?



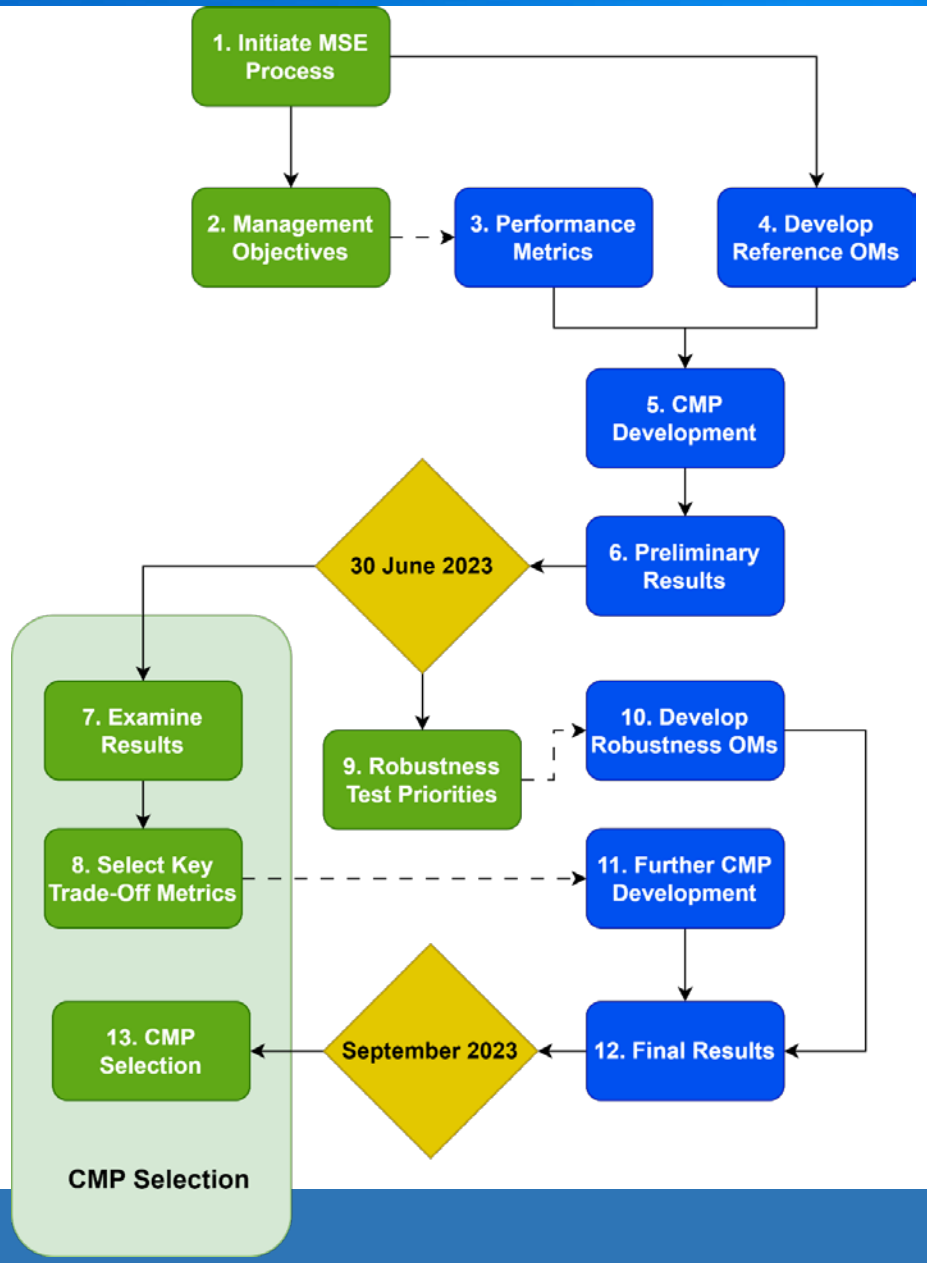
10. c) Definition of minimum threshold for TAC change between management cycles, if desired

- E.g.
  - Management cycle 1: TAC 13,000 t
  - Management cycle 2: 13,200 t

- Factors to consider
  - Would PA4 like to have a minimum threshold?
  - If so, is the threshold a set tonnage? A percentage of the TAC?
  - Is it symmetrical? Asymmetrical? I.e. a different threshold for decreases in TAC vs increases in TAC

10. d) Prioritization of robustness and sensitivity tests

	Test	Purpose	Uncertainty type	Analysis requirements
	1. Lower steepness	Evaluate sensitivity to stock with low resilience	Conditioning	Low
	2. Higher recruitment variability	Evaluate sensitivity to higher variability in recruitment process error	Conditioning	Low
	3. Exclude length composition data	Evaluate impact of only using indices of abundance in OM conditioning (i.e. do not include catch at length data in the model fitting)	Conditioning	Low
★	4/5. Catchability in historical and projection periods	Evaluate impact of an increase in catchability that was not accounted for in the standardization of the indices of abundance	Conditioning/projection	Low
★	6. a) Climate change recruitment	Evaluate impact of systematic pattern in recruitment deviations in projection periods; a proxy for impact of climate change on productivity	Projection	Medium
	6. b) Climate change alternative scenarios	Investigate impacts of climate change on stock biology, distribution; fishing fleets	Projection/management	High
	7. Implementation error	Evaluate impact of illegal, unreported, or unregulated catches	Management	Medium
★	8. Size limit	Evaluate impact of different size limits, including removing all size regulations	Management	Medium
	9. Alternative management cycles	Evaluate the impact of a longer management cycle	Management	Low



1. MSE Process initiated
2. Management Objectives stated
3. Develop Performance Metrics
4. Develop Reference OMs
5. Develop Candidate Management Procedures
6. Generate Preliminary Results
7. Examine Results
8. Select Key Trade-Off Metrics
9. Prioritize Robustness Tests
10. Develop Robustness OMs
11. Further CMP Development
12. Final Results (including Robustness OMs)
13. Final CMP Selection (figures, tables, and process agreed on at June 30 meeting)

Summary

- Modifications made to OM grid
- CMPs in development – suggestions for additional CMPs welcomed
- Key tradeoffs among MPs need to be identified
- Communications tools developed

Acknowledgements

This work is funded by the ICCAT Science Envelope and by special contributions from ICCAT CPCs

The SWO Species Group Coordinator would like to acknowledge the work of the SWO MSE technical team. This dedicated group of CPC scientists has worked exceptionally hard to achieve these results and the content in this presentation

Questions?

Performance Metrics - BFT

Name	Description
AAVC	**Average annual variation in catches among CMP update times t (note that except where the resource is heavily depleted so that catches become limited by maximum allowed fishing mortalities, catches will be identical to TACs) defined by:** $$AAVC = \frac{1}{nt}\sum_{t=1}^{nt} \lvert C_t - C_{t-1}\rvert / C_{t-1}$$
AvC10	**Mean catches over first 10 projected years. Required to provide short-term vs long-term (AvC30) yield trade-offs.**
AvC30	**Mean catches over first 30 projected years**
AvgBr	**Average Br (spawning biomass relative to dynamic SSB_{MSY}) over projection years 11-30**
Br30	**Depletion (spawning biomass relative to dynamic SSB_{MSY}) after projection year 30**
PGT	**'Probability Good Trend', 1 minus probability of negative trend (Br31 – Br35) and Br30 is less than 1. Probability of 1 is biologically better. In cases where all simulations are above Br30, PGT = 1 regardless of trend. This allows further discrimination between CMPs that have comparable fraction of simulations below Br30.**
C10	Mean catches over the first 10 projected years
C20	Mean catches over projected years 11-20
C30	Mean catches over projected years 21-30
D10	Depletion (spawning biomass relative to dynamic SSB0) after the first 10 projected years
D20	Depletion (spawning biomass relative to dynamic SSB0) after projection year 20
D30	Depletion (spawning biomass relative to dynamic SSB0) after projection year 30
DNC	D30 using the MP relative to D30 had no catches been taken over the 30 projected years
LD	Lowest depletion (spawning biomass relative to dynamic SSB0) over the 30 years for which the CMP is applied.
LDNC	LD using the MP relative to LD had no catches been taken over the 30 projected years.
POS	Probability of Over-Fished status (spawning biomass < SSB_{MSY}) after 30 projected years.

Key statistics