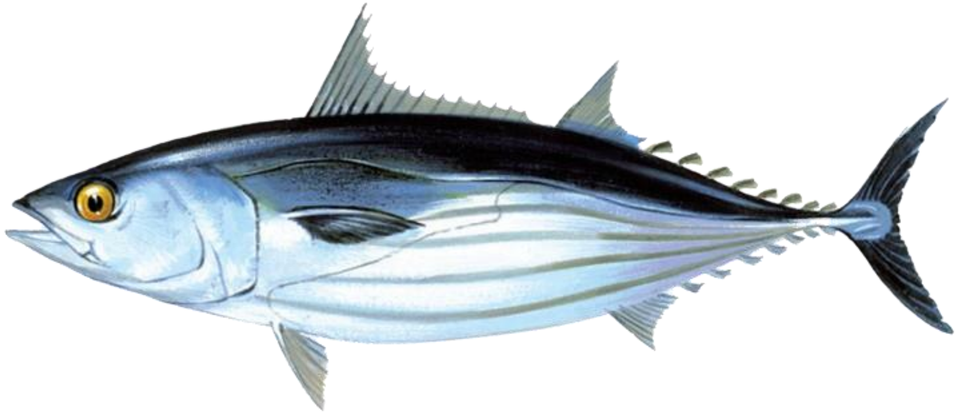


Western Skipjack
Management Strategy Evaluation

1st Intersessional Meeting of Panel 1 on Western Skipjack MSE

Meeting Objectives

- Inform to the ICCAT Commission on progress in the development of SKJ-W MSE;
- Update the ICCAT Commission about the proposed workplan for the continuation of the SKJ-W MSE planned to be carried out during 2024;
- Request the ICCAT Commission engagement regarding the demands for updating data necessary for the continuity of the SKJ-W MSE;
- Provide information to support ICCAT Commission decision making on possible MP selection and MP specifications;
- Receive feedback from the ICCAT Commission on the progress of the SKJ-W MSE with a view to adopting an MP later this year.

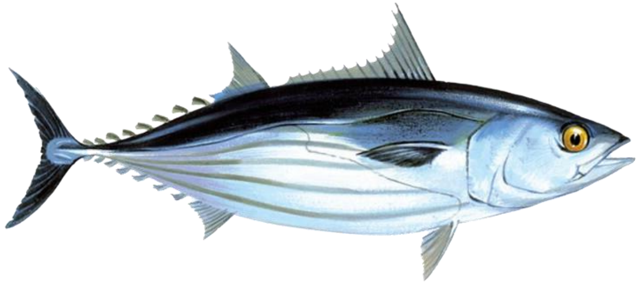
Presentation Outline

1. Review of the progress of the SKJ-W MSE;
   - Timeline of the process;
   - Stock Assessment, OMs and Robustness tests;
   - Candidate Management Objectives and Performance Metrics;
   - Preliminary results;
   - Slick interactive communication tool;

2. Workplan for SKJ-W MSE in 2024;
   - Overview of the work plan for 2024;
   - Climate change scenarios for Robustness tests;

3. Overview of the data needs and process to generate TAC;
   - Required update of SKJ-W abundance indices;

4. Discussions and feedback



1. Review of the progress of the SKJ-W MSE

Timeline of the process

2020

* A Demonstration MSE framework for Western Skipjack tuna (SCRS/2020/140);

2021

* Building Capacity on MSE Methods: from concepts to practice (JCAP-2/ICCAT Project);

2022

* Western Atlantic skipjack tuna MSE: RCM (SCRS/2022/097);

* Western Atlantic skipjack tuna Stock Assessment (SCRS/2022/098);

* Operating model conditioning based on the Stock Synthesis model (SCRS/2022/180);

* COMM adopted conceptual Management Objectives (Res. 22-02);

2023

* SCRS discussion and testing CMPs based on Management Objectives;

* COMM intersessional meeting – update progress;

* SCRS incorporation of COMM feedbacks;

* SCRS CMPs.

Key Concepts: Identifying Uncertainties

- **Operating model (OM):** A model representing a plausible scenario for stock and fishery dynamics that is used to simulation test the management performance of CMPs.

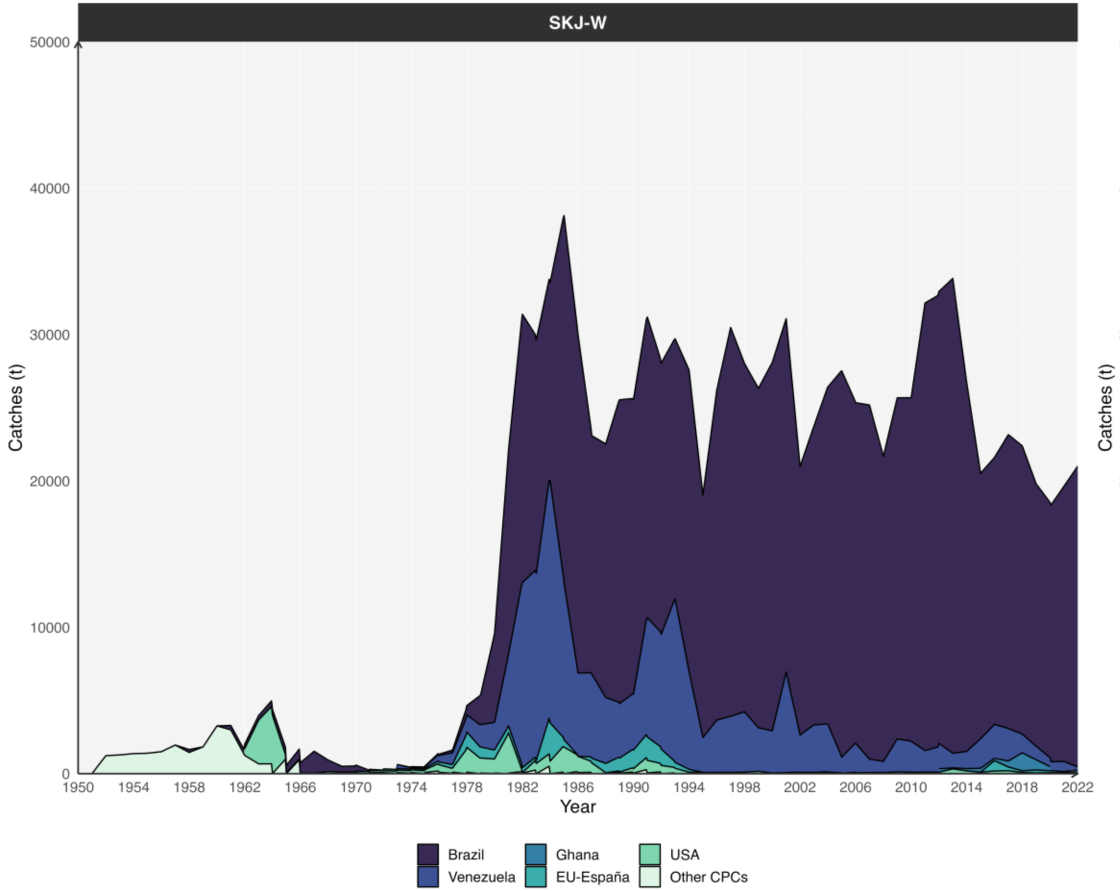
    - Multiple OMs will almost always be considered to reflect the uncertainties about the dynamics of the resource and fishery, thereby testing the robustness of management procedures to these uncertainties.

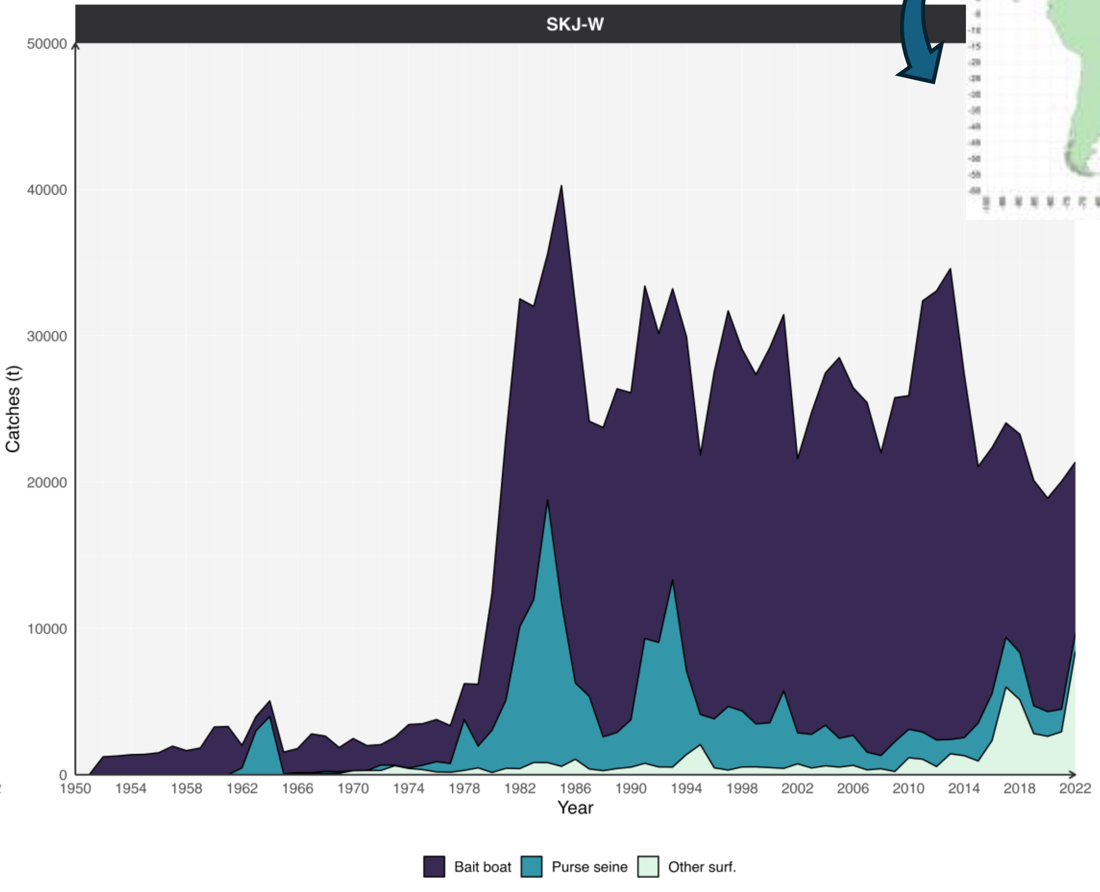
Key Concepts: Identifying Uncertainties

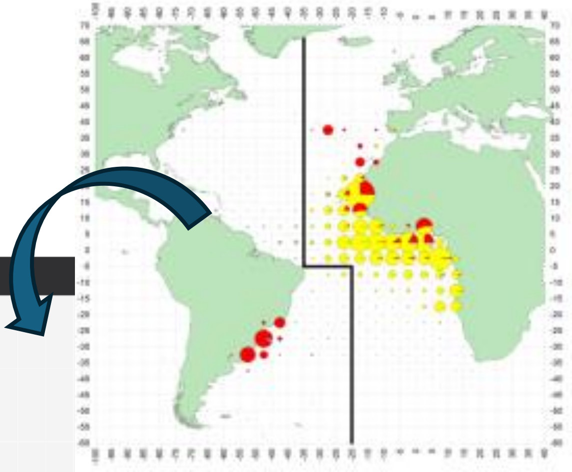
Reference set: most plausible scenarios or hypotheses with greatest impact on outcomes, can be equally or differentially weighted

Robustness set: unlikely but still possible scenarios or hypotheses. What-if and worst-case scenarios.

Stock Structure and Assessment







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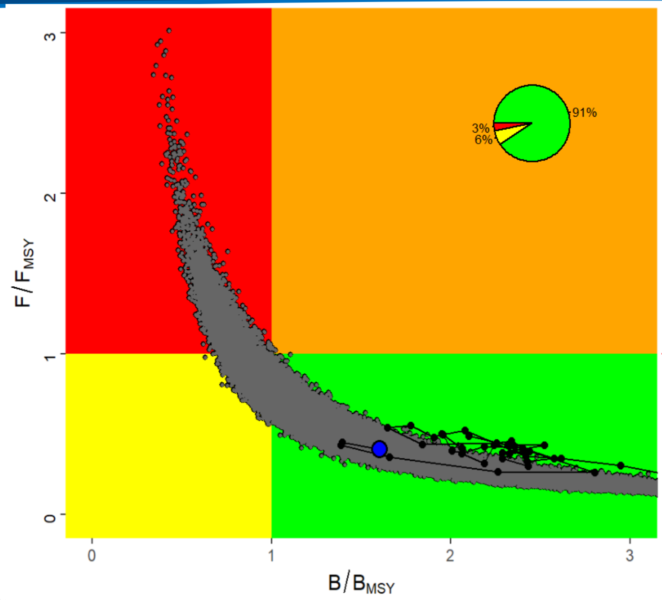
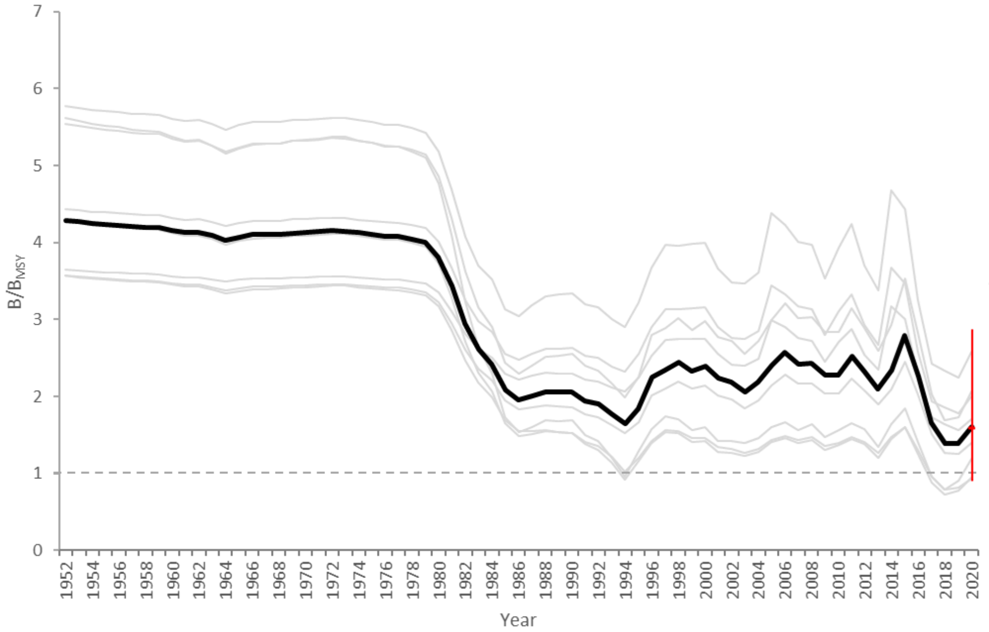
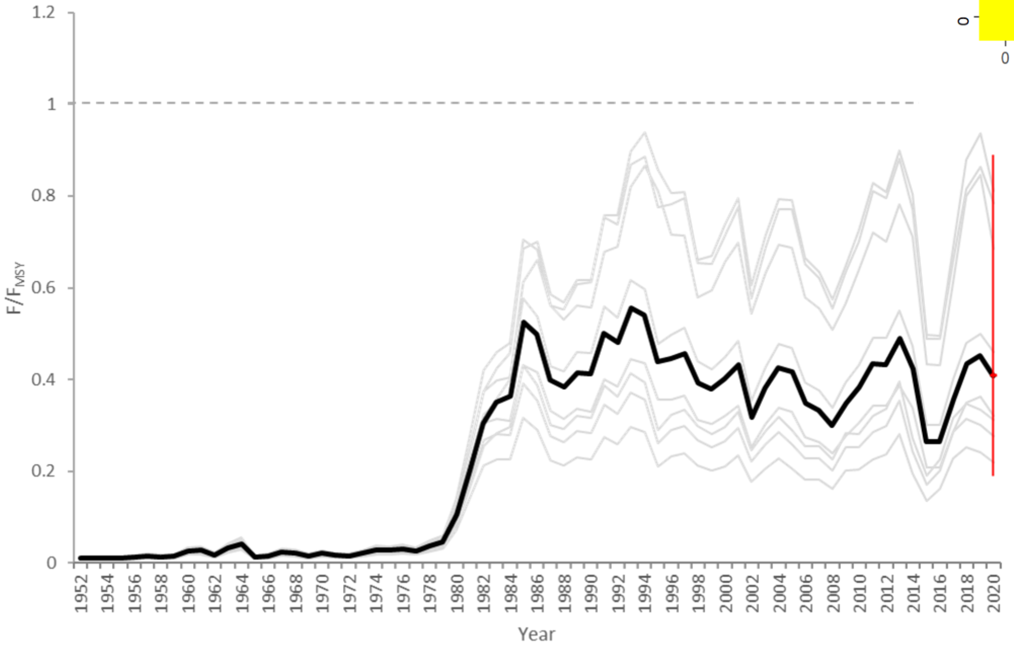
Stock Structure and Assessment

Stock Assessment Uncertainty Grid	Key uncertainty	Option 1	Option 2	Option 3
	Recruitment (steepness, h)	0.6	0.7	0.8
	Growth vector	25	50	75







Operating Models Structure

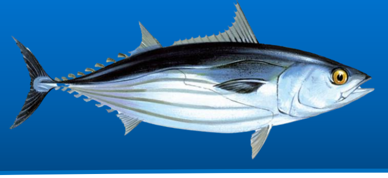
Stock Assessment Uncertainty Grid	Key uncertainty	Op. 1	Op. 2	Op. 3
	Recruitment (steepness, h)	0.6	0.7	0.8
	Growth vector	25	50	75

	Operating model	Growth vector	Steepness	SigmaR	Scenario
Reference	OM 1	25th	0.6	0.4	Perfect TAC implementation
	OM 2	50th			
	OM 3	75th			
	OM 4	25th	0.7		
	OM 5	50th			
	OM 6	75th			
	OM 7	25th	0.8		
	OM 8	50th			
	OM 9	75th			

Operating Models Structure

Stock Assessment Uncertainty Grid + Robustness Tests	Key uncertainty	Op. 1	Op. 2	Op. 3
	Recruitment (steepness, h)	0.6	0.7	0.8
	Growth vector	25	50	75
	TAC Implementation Error	**0%**	**10%**	**20%**

	Operating model	Growth vector	Steepness	SigmaR	Scenario
	OM 1	25th			
	OM 2	50th	0.6		
	OM 3	75th			
	OM 4	25th			
Reference	OM 5	50th	0.7		Perfect TAC implementation
	OM 6	75th			
	OM 7	25th			
	OM 8	50th	0.8		
	OM 9	75th			
	OM 10	25th			
	OM 11	50th	0.6		
	OM 12	75th			
	OM 13	25th			
Robustness 01	OM 14	50th	0.7	0.4	10% overage TAC error implementation
	OM 15	75th			
	OM 16	25th			
	OM 17	50th	0.8		
	OM 18	75th			
	OM 19	25th			
	OM 20	50th	0.6		
	OM 21	75th			
	OM 22	25th			
Robustness 02	OM 23	50th	0.7		20% overage TAC error implementation
	OM 24	75th			
	OM 25	25th			
	OM 26	50th	0.8		
	OM 27	75th			



Management Objectives and Performance Metrics

Second Intersessional meeting of Panel 1 on Western Skipjack MSE
(Online, 5 May 2023)

Management Objectives (Res. 22-02)	*Proposed Corresponding Performance Metric Statistics*
Status The stock should have a 70% or greater probability of occurring in the green quadrant of the Kobe matrix using a 30-year projection period as determined by the SCRS.	**PGK_{short}**: Probability of being in the Kobe green quadrant (i.e., $SSB \geq SSB_{MSY}$ and $F<F_{MSY}$) in year 1-3 **PGK_{medium}**: Probability of being in the Kobe green quadrant (i.e., $SSB \geq SSB_{MSY}$ and $F<F_{MSY}$) in year 4-10 **PGK_{long}**: Probability of being in the Kobe green quadrant (i.e., $SSB \geq SSB_{MSY}$ and $F<F_{MSY}$) over years 11-30 **PGK**: Probability of being in the Kobe green quadrant (i.e., $SSB \geq SSB_{MSY}$ and $F<F_{MSY}$) over years 1-30 **POF**: Probability of $F>F_{MSY}$ over years 1-30 **PNOF**: Probability of $F<F_{MSY}$ over years 1-30
Safety There should be no greater than 10% probability of the stock falling below B_{LIM} ($0.4*B_{MSY}$) at any point during the 30-year projection period.	**LRP_{short}**: Probability of breaching the limit reference point (i.e., $SSB<0.4*SSB_{MSY}$) over years 1-3 **LRP_{medium}**: Probability of breaching the limit reference point (i.e., $SSB<0.4*SSB_{MSY}$) over years 4-10 **LRP_{long}**: Probability of breaching the limit reference point (i.e., $SSB<0.4*SSB_{MSY}$) over years 11-30 **LRP**: Probability of breaching the limit reference point (i.e., $SSB<0.4*SSB_{MSY}$) over years 1-30 **$nLRP_{short}$**: Probability of not breaching the limit reference point (i.e., $SSB<0.4*SSB_{MSY}$) over years 1-3 **$nLRP_{medium}$**: Probability of not breaching the limit reference point (i.e., $SSB<0.4*SSB_{MSY}$) over years 4-10 **$nLRP_{long}$**: Probability of not breaching the limit reference point (i.e., $SSB<0.4*SSB_{MSY}$) over years 11-30 **nLRP**: Probability of not breaching the limit reference point (i.e., $SSB<0.4*SSB_{MSY}$) over years 1-30
Yield Maximize overall catch levels in the short (1-3 years), medium (4-10 years) and long (11-30 years) terms.	**AvC_{short}** – Median catches (t) over years 1-3 **AvC_{medium}** – Median catches (t) over years 4-10 **AvC_{long}** – Median catches (t) over years 11-30
Stability Any changes in TAC between management periods should be 20% or less.	**$VarC_{medium}$** – Variation in TAC (%) between management cycles over years 4-10 **$VarC_{long}$** – Variation in TAC (%) between management cycles over years 11-30 **Var_{all}** – Variation in TAC (%) between management cycles over years 1-30

Decision Point 01:

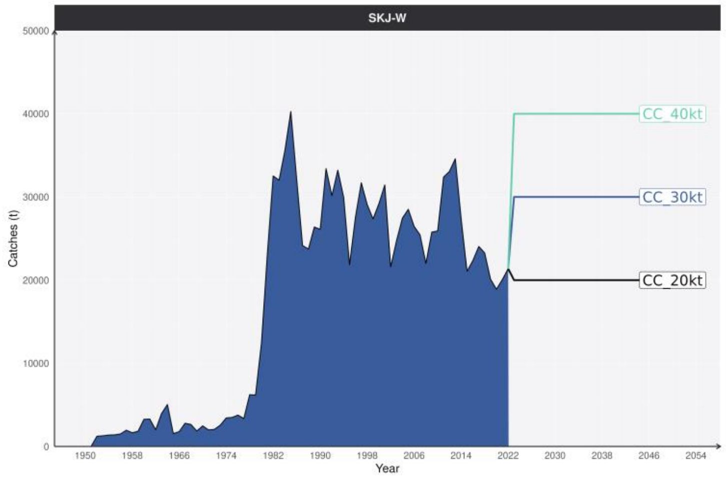
Safety – Consider a reduction to 5%?

Stability – Test the CMPs with and without a 20% restriction on TAC changes. Also evaluate the implementation of asymmetric TAC restrictions where there would be no limit on TAC decreases if $B_{curr} < B_{MSY}$

Candidate Management Procedures

Constant catch MP:

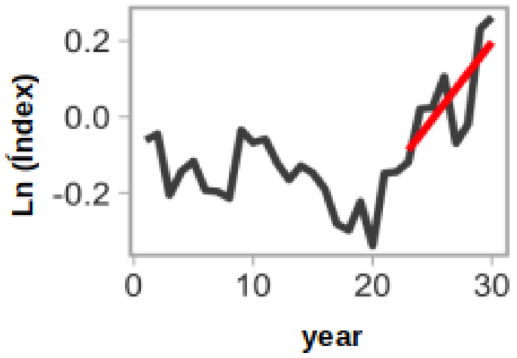
- *CC_30kt*
- *CC_40kt*



Empirical index-based MP:

- *Islope1*
- *Iratio*
- *GB_slope*

If *CPUE* increases, *TAC* also increases;
If *CPUE* reduces, *TAC* also reduces;
If *CPUE* is stable, *TAC* is also stable.



Decision Point 02:

(a) to develop, implement, and evaluate new CMPs, or;

(b) to reduce the current list of CMPs.

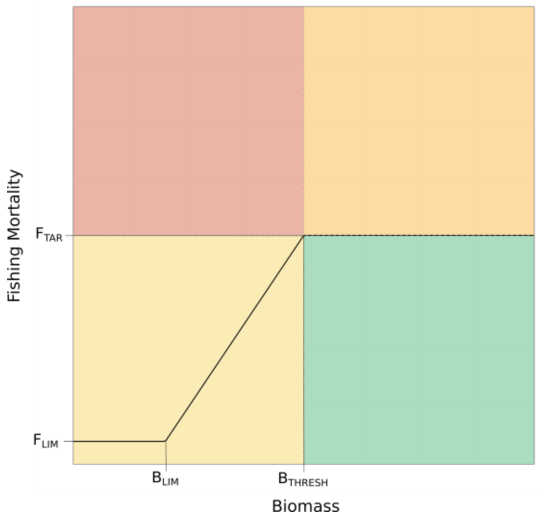
In both cases, the idea is to continue further developing the presented CMPs to try to improve each respective yield performance.

Candidate Management Procedures

Model-based MP:

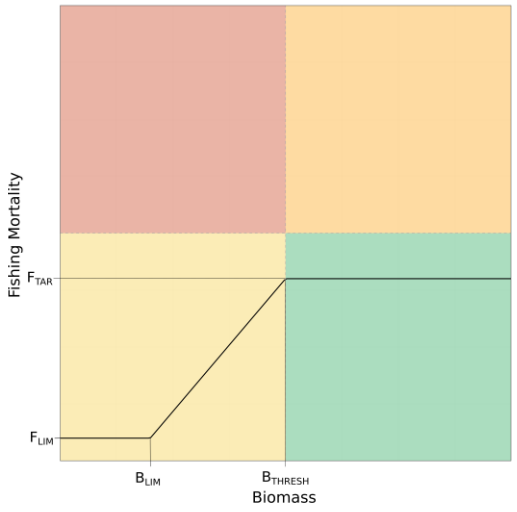
FMSY, if ≥ BMSY :

- Statistical catch-at-age *(SCA01)*
- Surplus production model *(SP01)*
- State-space surplus production model *(SPSS01)*



80% FMSY, if ≥ BMSY :

- Surplus production model *(SP02)*
- State-space surplus production model *(SPSS02)*



Decision Point 02:

(a) to develop, implement, and evaluate new CMPs, or;

(b) to reduce the current list of CMPs.

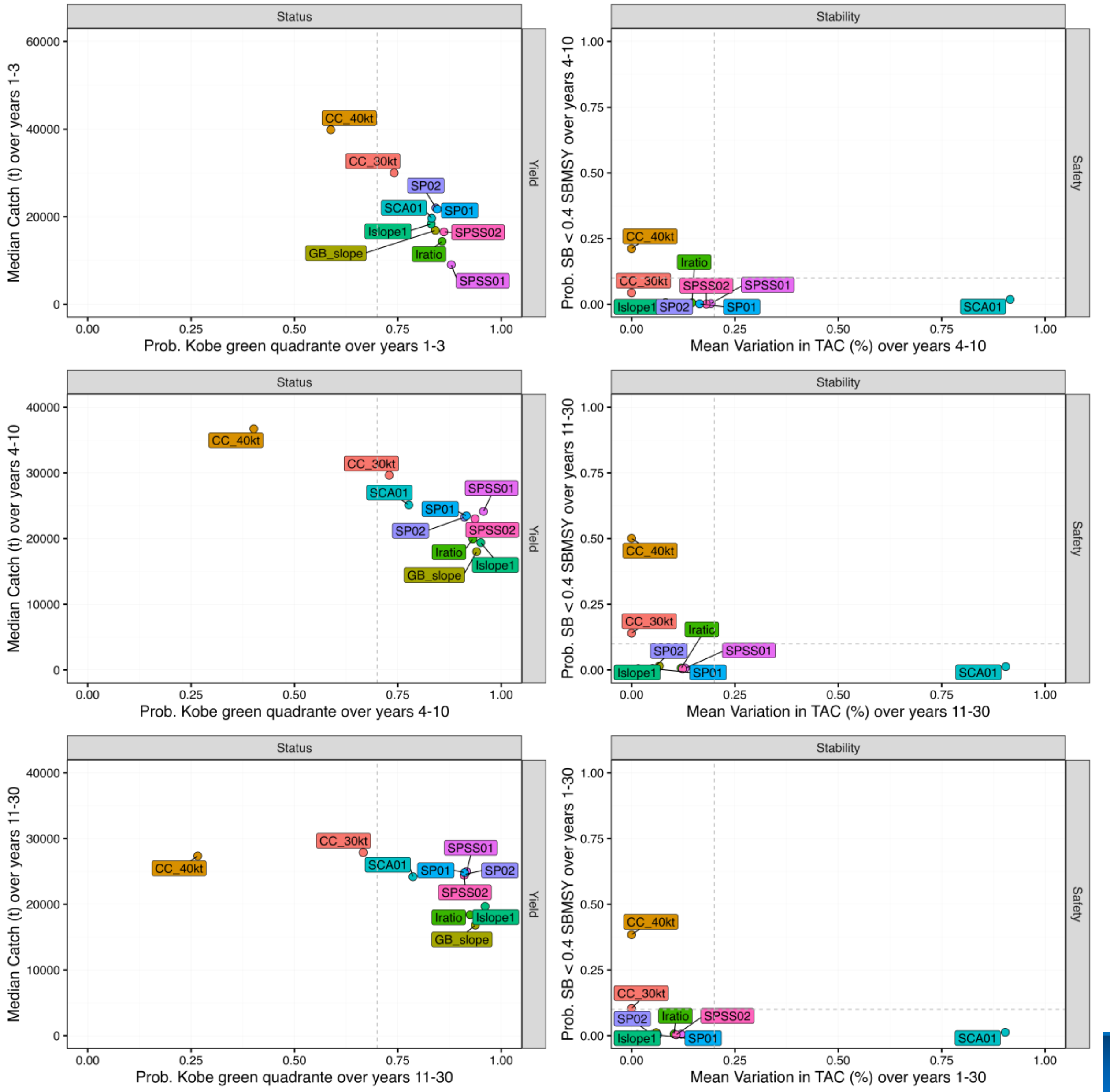
In both cases, the idea is to continue further developing the presented CMPs to try to improve each respective yield performance.

Preliminary Results

CMP Performance:

Reference Case [OMs 1-9]

(Tradeoff plots – *Status, Stability, Safety and Yield*)

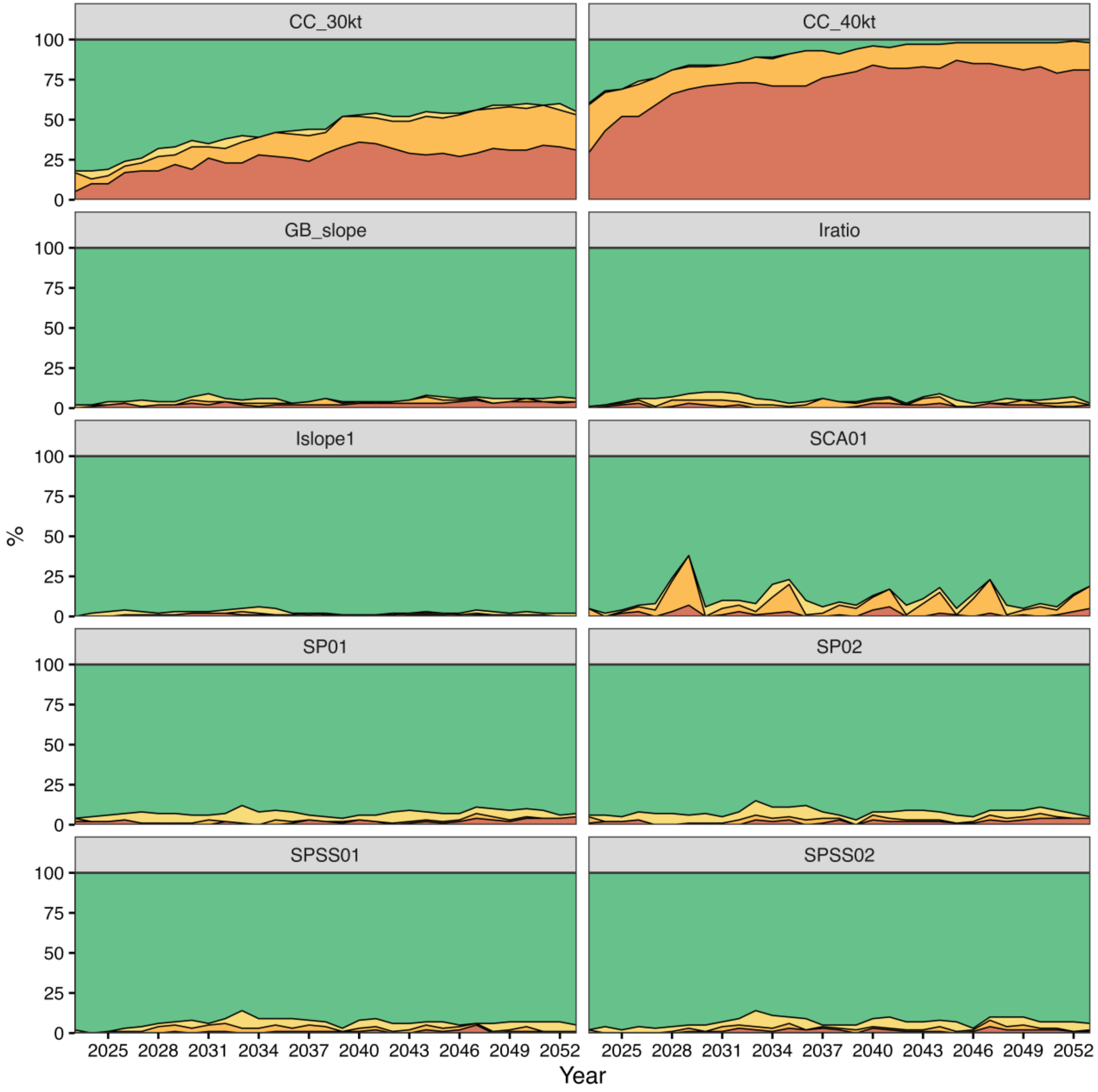


Preliminary Results

CMP Performance:

Reference Case [OMs 1-9]

(Time series Kobe plot – Kobe plot probabilities)

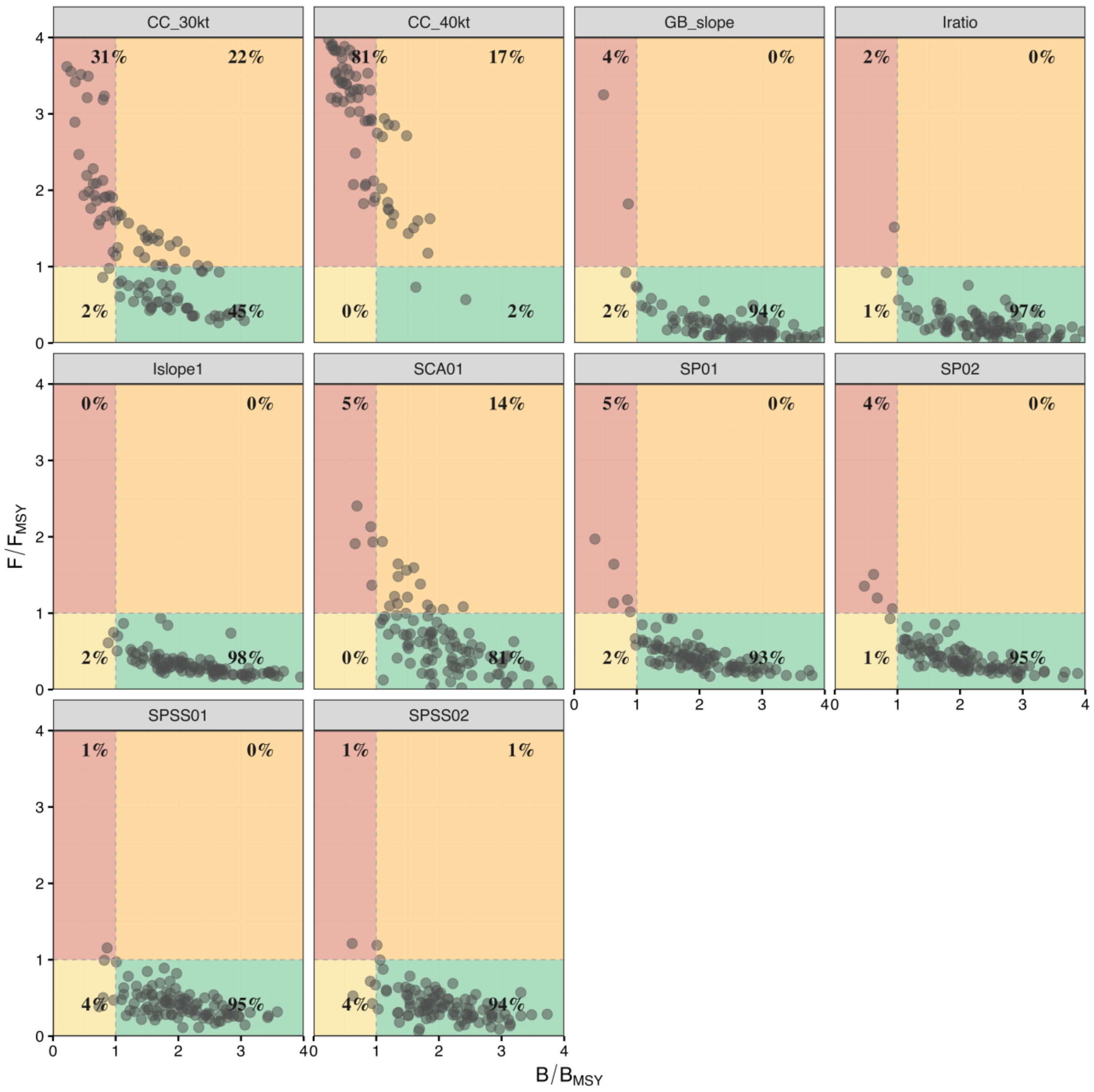


Preliminary Results

CMP Performance:

Reference Case [OMs 1-9]

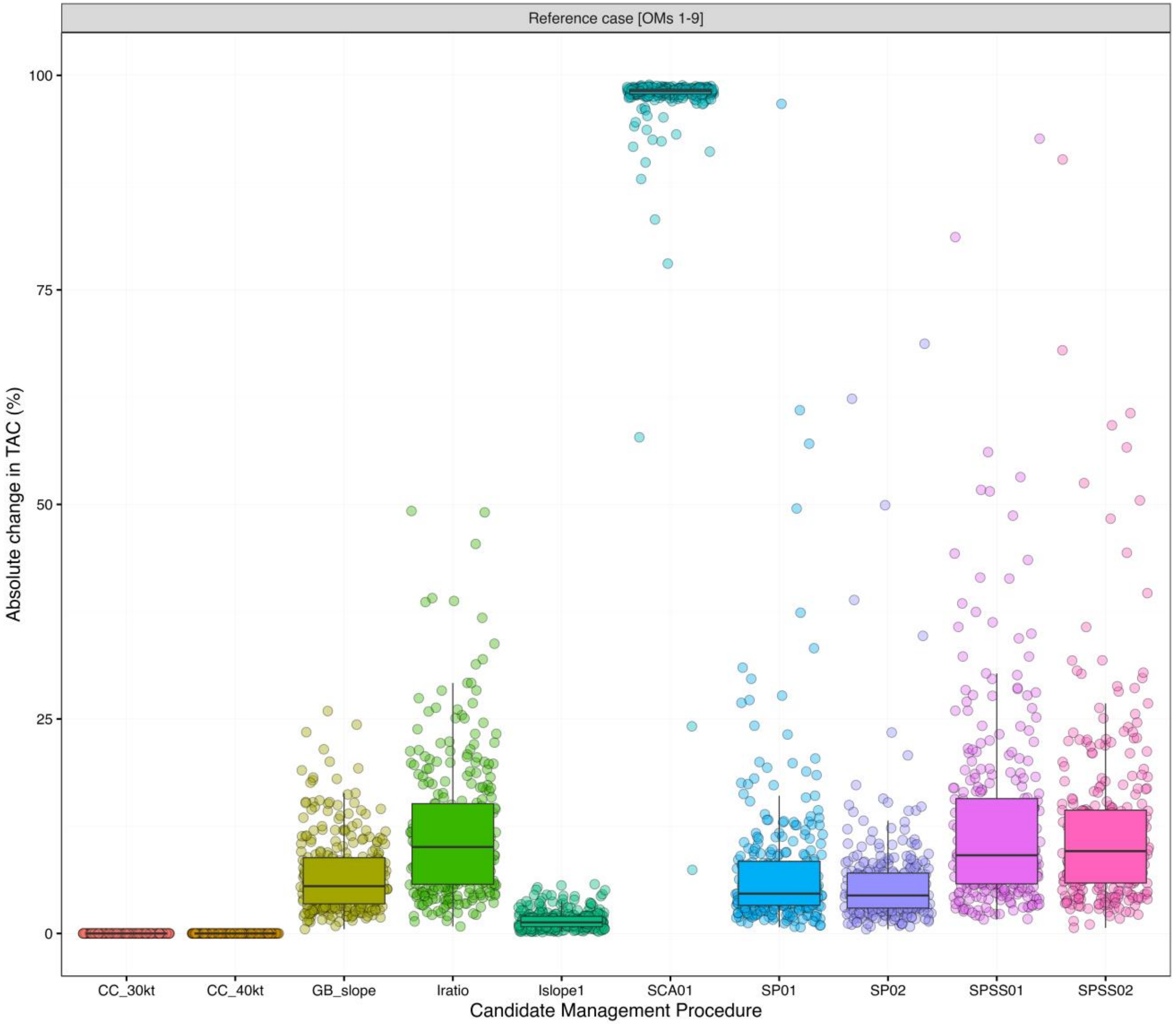
(Kobe plot of the last projected year)



Preliminary Results

CMP Performance:

Reference Case [OMs 1-9]
(Stability performance boxplot)



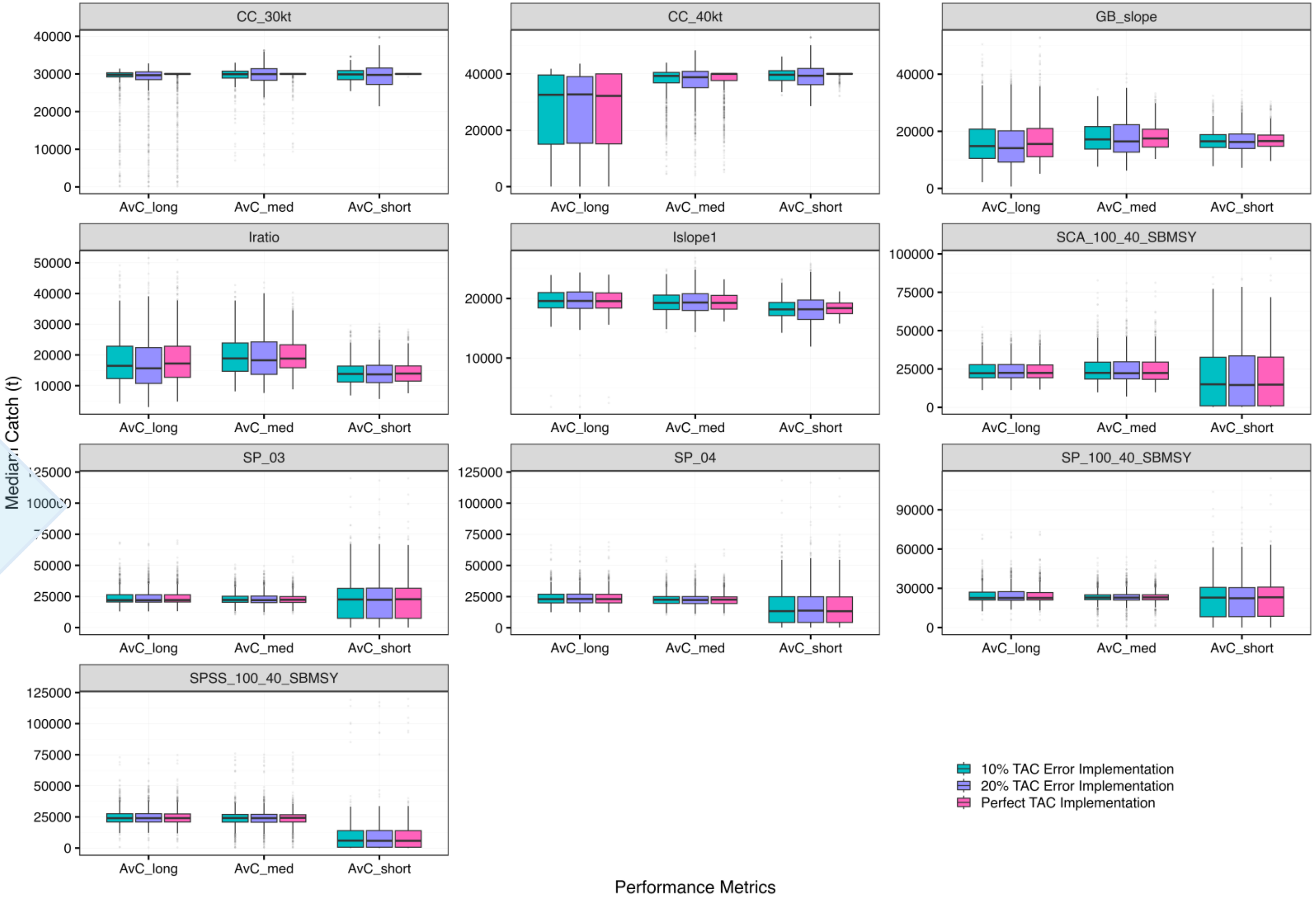
Preliminary Results

CMP Performance:

Robustness tests comparisons

(Median Catches (t) over years - *AvC*)

Yield



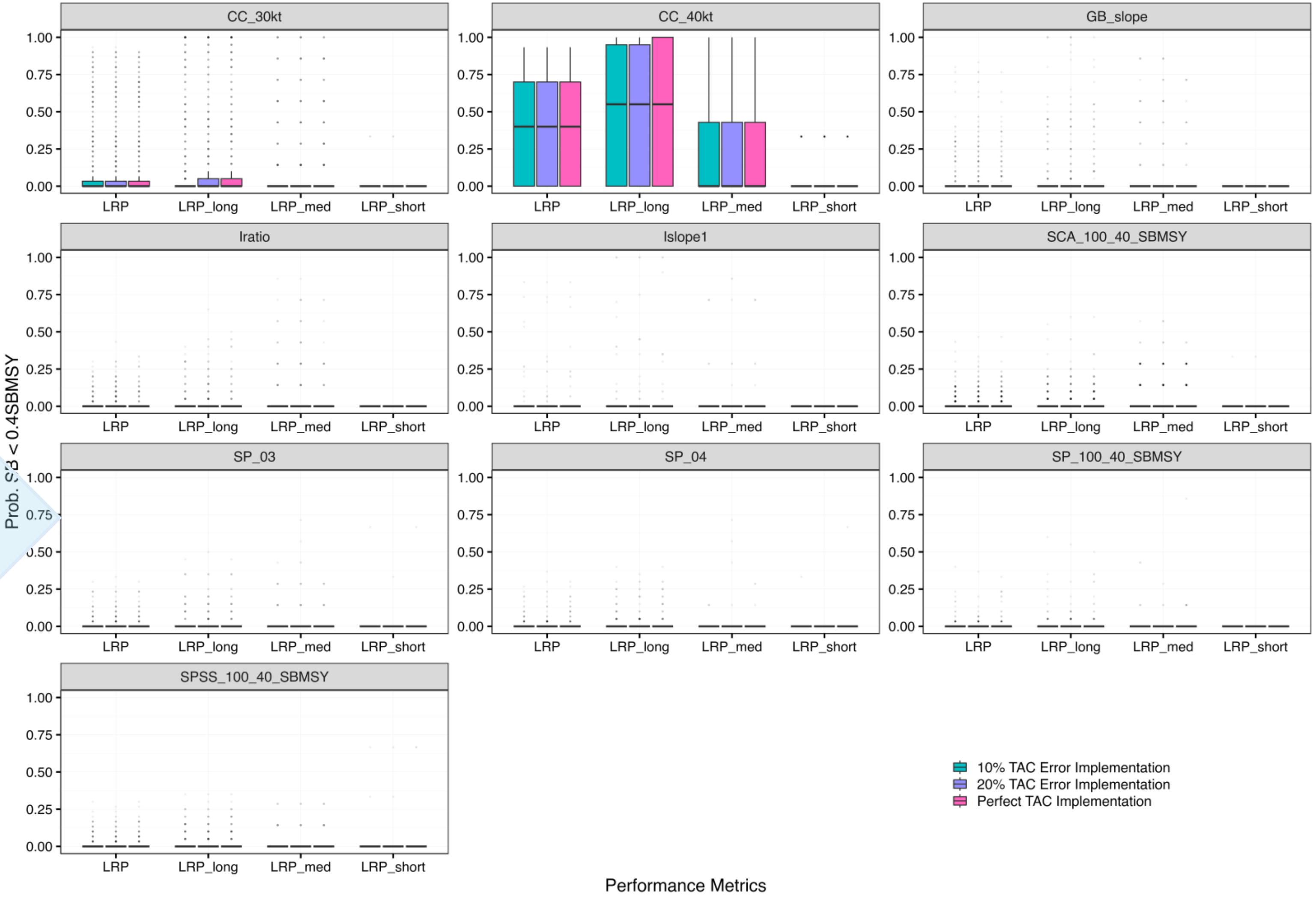
Preliminary Results

CMP Performance:

Robustness tests comparisons

(Prob. of breaching the limit reference point - *LRP*)

Safety



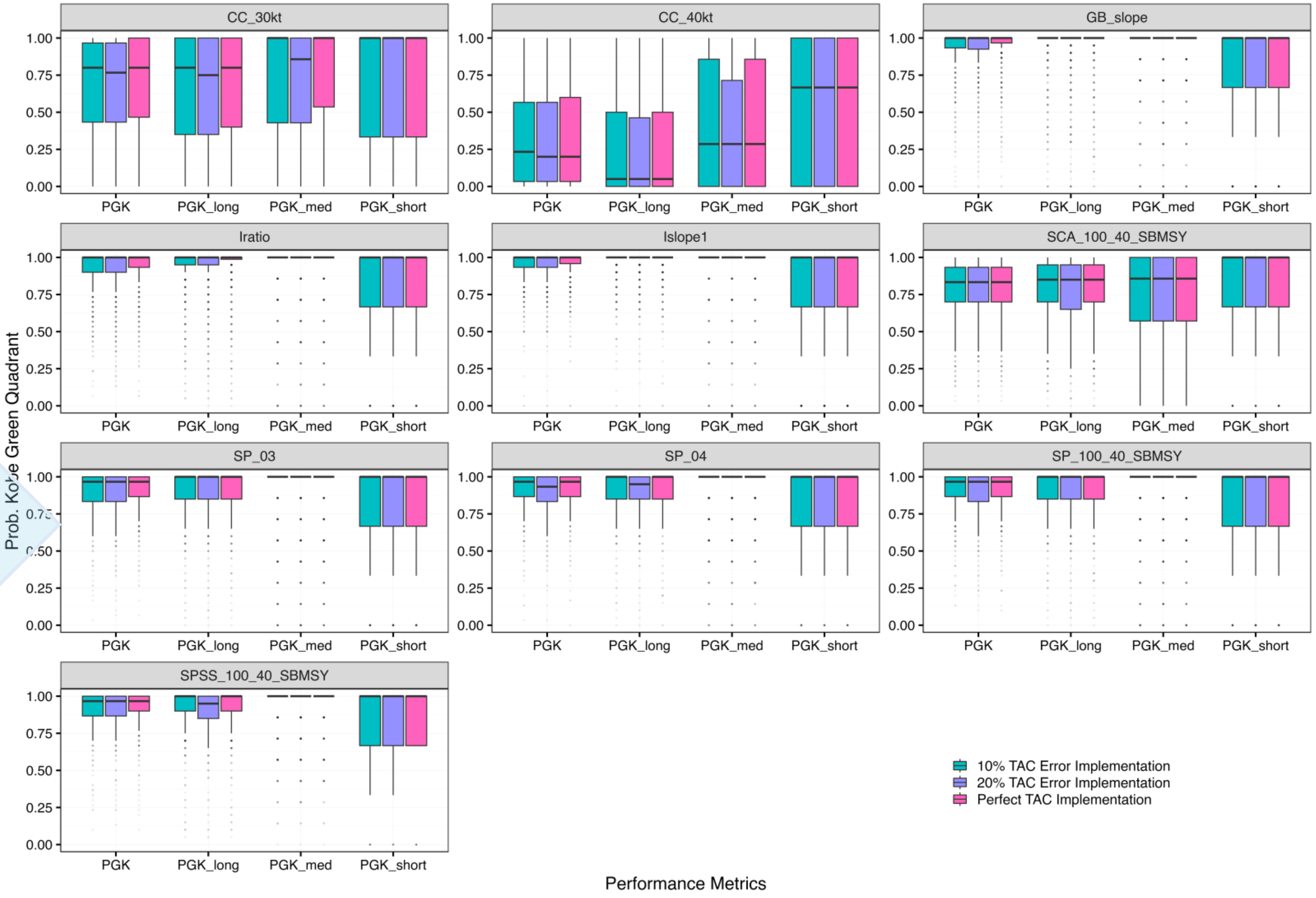
Preliminary Results

CMP Performance:

Robustness tests comparisons

(Prob. of breaching the limit reference point - *PGK*)

Status



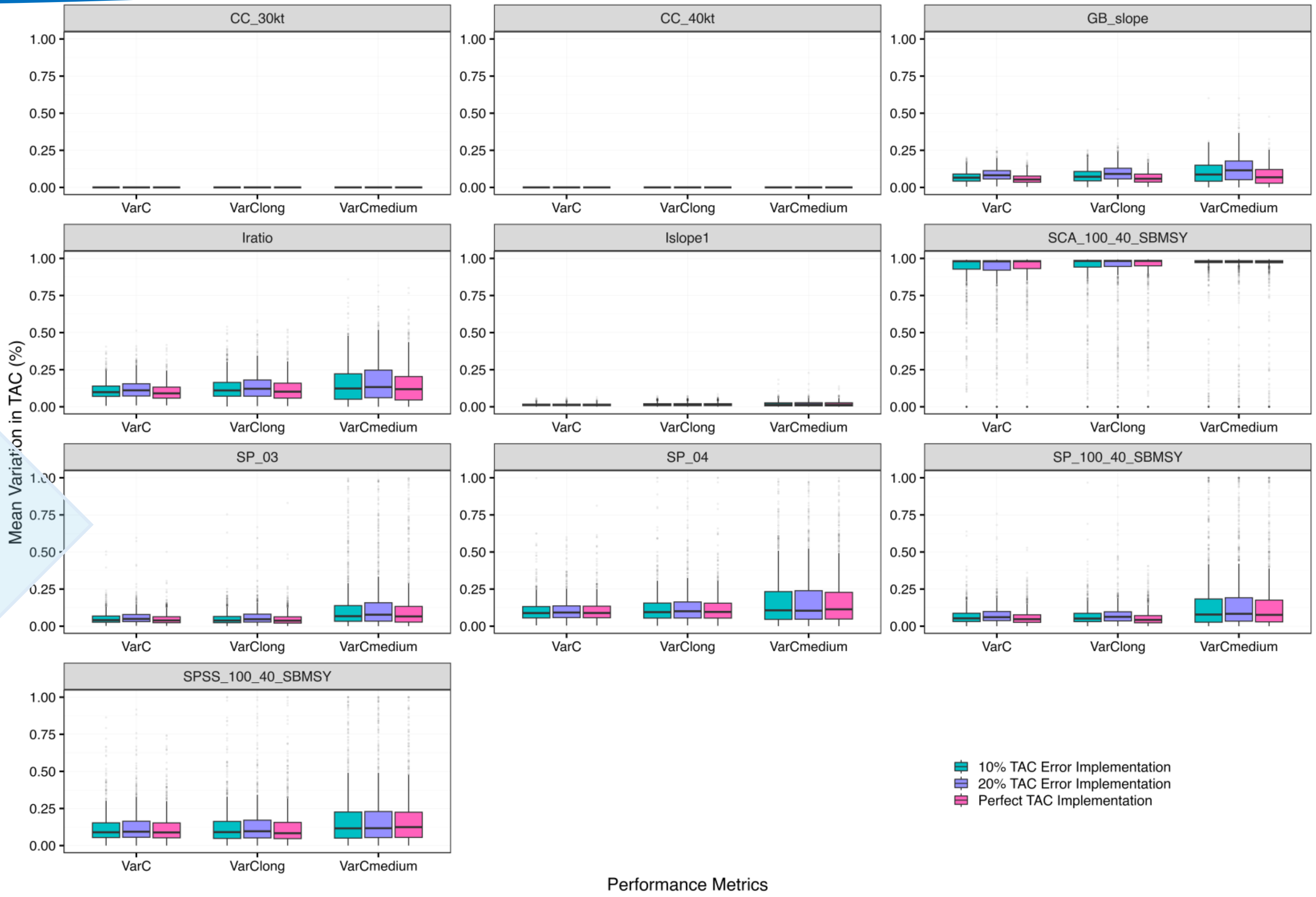
Preliminary Results

CMP Performance:

Robustness tests comparisons

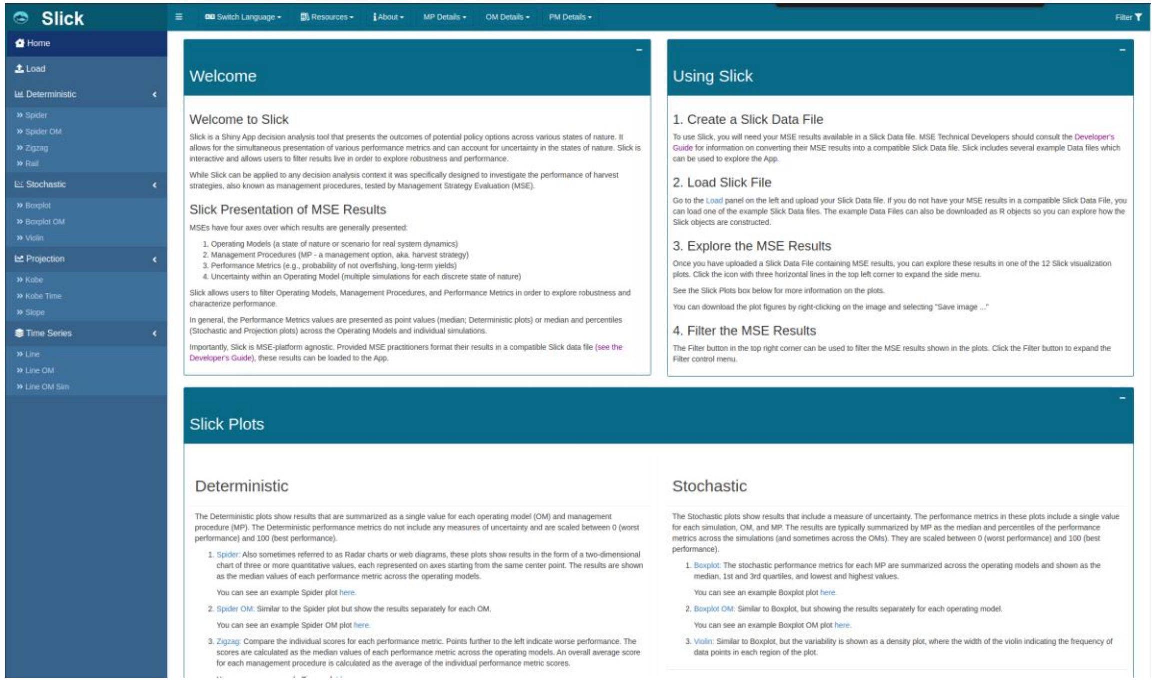
(Var. in TAC (%) between management cycles - *VarC*)

Stability



Preliminary Results

https://shiny.bluematterscience.com/app/slick



CMP Performance:

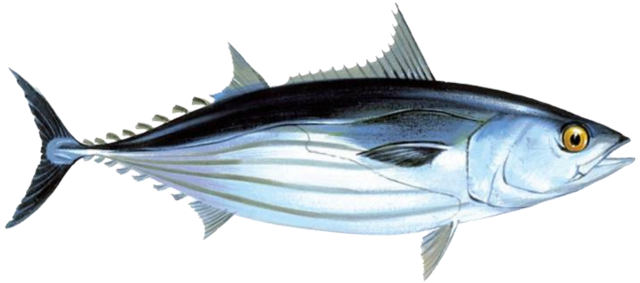
Slick interactive communication tool

(Link to access the Slick tool)

About Slick tool:

Slick was developed by Blue Matter Science and designed and commissioned by The Ocean Foundation's International Fisheries Conservation Project and www.harveststrategies.org, with support from The Pew Charitable Trusts, and the Common Oceans Tuna Fisheries Project, which is funded by GEF and implemented by the FAO.

Slick is undergoing further development. All feedback is welcome. Please contact Shana Miller with any comments or suggestions for further development.



2. Workplan for SKJ-W MSE in 2024

Overview of the work plan for 2024

February	March	April	July	August
- Present and receive Commission feedback on the current SKJ-W MSE;	- Initiate a series of online meetings, as needed, of the TT Technical Sub-group on MSE; - Present and discuss the receive feedback from Commission;	- Share Panel 1's recommendations with SCRS during YFT DP Meeting; - Present the action plan and method proposal to SCRS for addresing the feedback;	- Update the SKJ-W MSE following the action plan and method defined; - Present the SKJ-W MSE evolution to the SCRS during the YFT SA Meeting;	- Implement new robustness OMs to incorporate possible effects of Climate Change;

Consider continuous time in the processes presented above.

Overview of the work plan for 2024

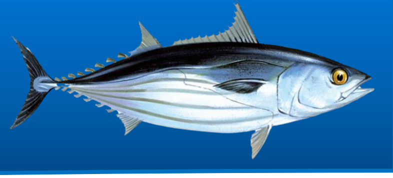
September

- Update performance projections of the CMPs using the abundance indices updated through 2022;
- Present the draft of the final SKJ-W MSE results to the SCRS group during SCRS TT Species Group meeting;
- Present the same results for SCRS at SCRS Plenary for adoption;

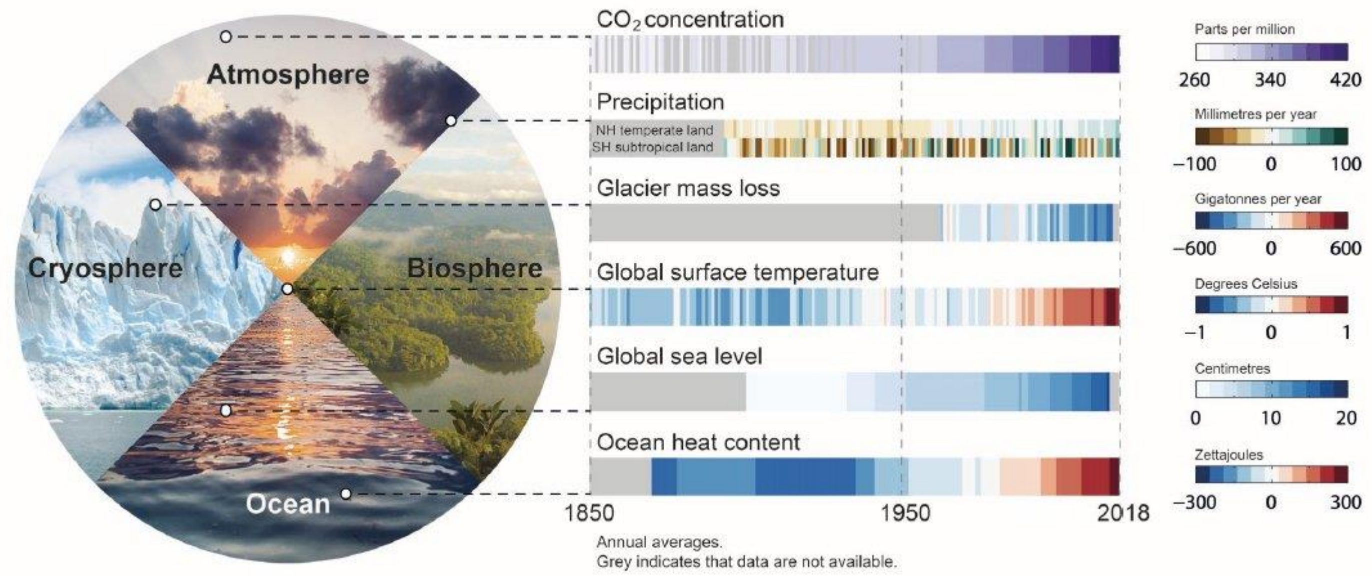
November

- Update SKJ-W MSE results for including the feedback from SCRS;
- Prepare communication materials to be used at the 24th Special Meeting of the ICCAT Commission;
- Present the SKJ-W MSE final results to the ICCAT Commission, Panel 1, for consideration for MP adoption, during the 24th Special Meeting of the ICCAT Commission.

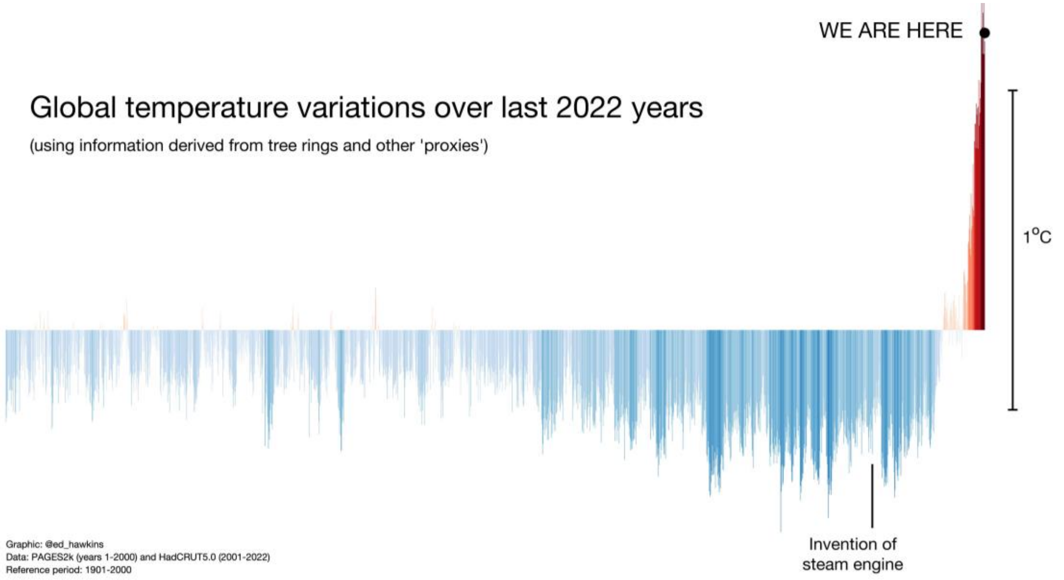
Consider continuous time in the processes presented above.

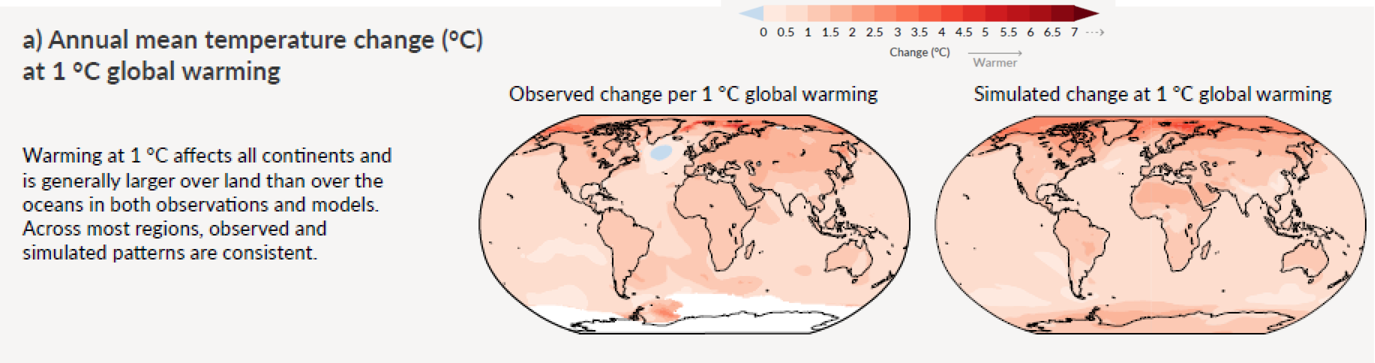


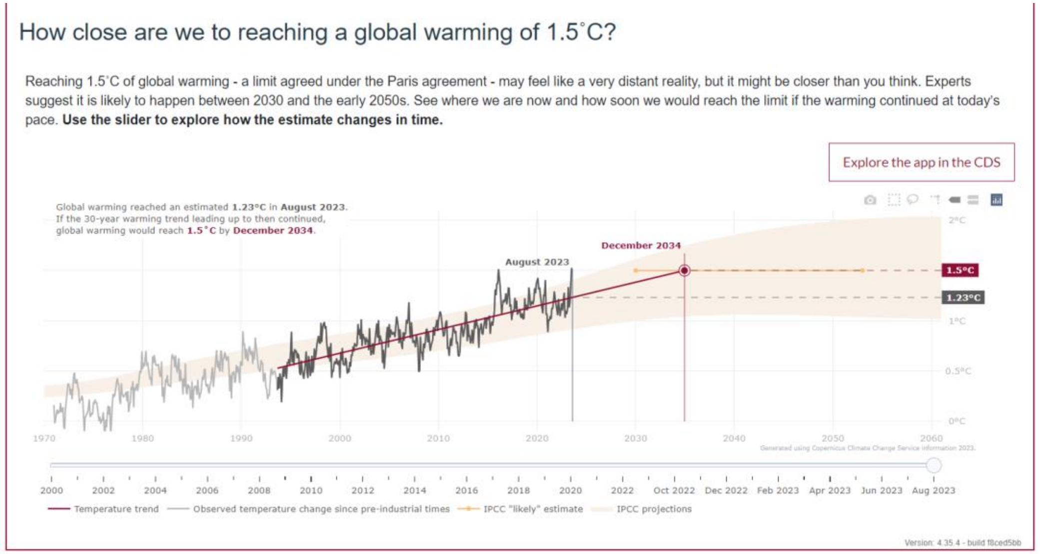
Climate Change scenarios for Robustness tests



Source: IPCC AR6, August 2021.



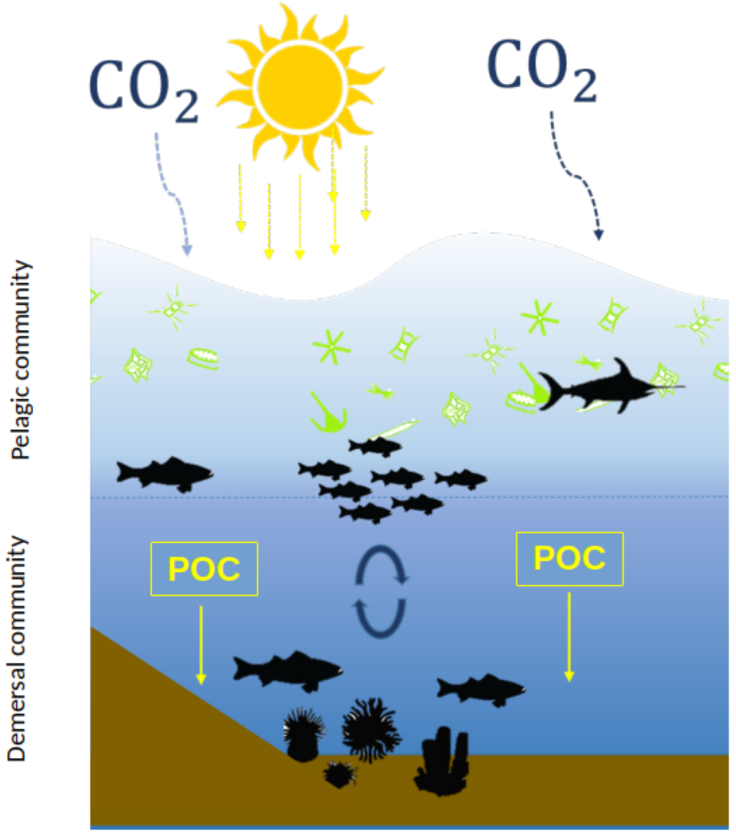




Climate Change scenarios for Robustness tests

But what are the possible effects of Climate Change on fishing activity?

GHG Emissions



Changes in Planetary Climate	• ↑ atmospheric temperature • Increase in catastrophic weather events
Physical and biogeochemical changes in the ocean	• ↑ surface temperature • ↑ sea level • ↑ stratification of the water column • Decrease in primary productivity • Changes in ocean circulation • Acidification and deoxygenation
Changes in the structure and functioning of marine ecosystems	• Species vital functions • Species spatial and temporal distribution • Species growth and reproduction • Community structure – diversity • Food webs – ecosystem energy flow
Changes in the provision of ecosystem services	• Fishing Productivity • Composition of catches

Climate Change scenarios for Robustness tests

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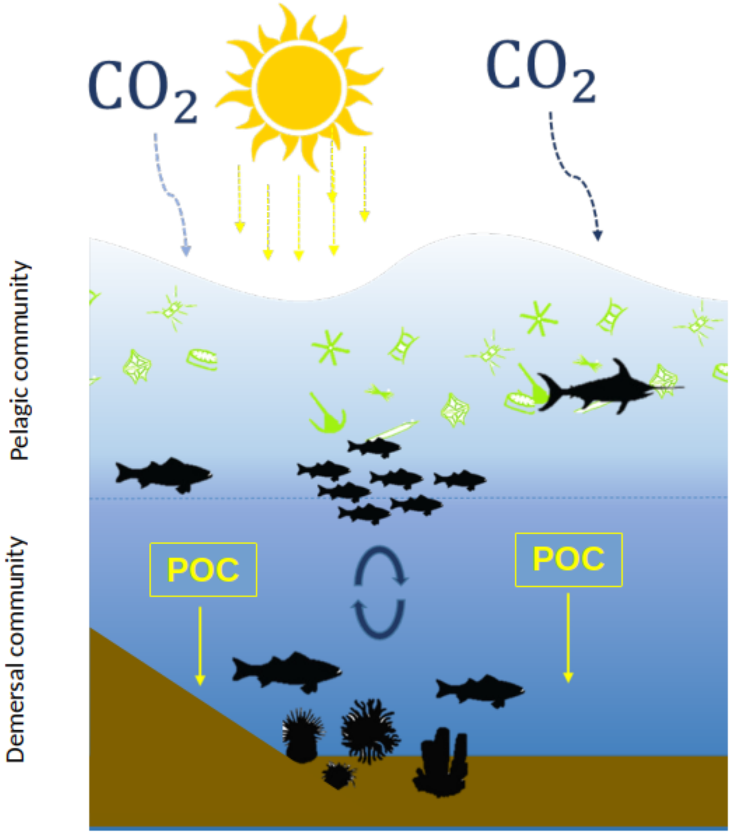

Changes in Planetary Climate	• ↑ atmospheric temperature • Increase in catastrophic weather events
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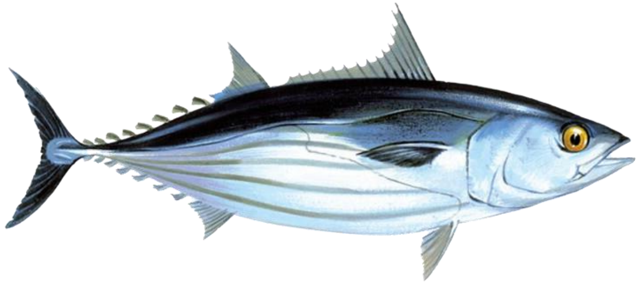
Changes in the provision of ecosystem services	• Fishing Productivity • Composition of catches

SKJ-W MSE Robustness test:

- ***[First step]*** Include scenarios that could represent effects on produtivity of the stock (changes in recruitment);
- Explore possibilities of include scenarios of changes in the stock distribution that could affect, for example, the fishing catchability;
- Evaluate other possibilities to be explored in the near future.

The methodological plan will be presented to the SCRS for adoption as presented in workplan.



3. Overview of the data needs and process to generate TAC

Required update of SKJ-W abundance indices

Considering that all CMPs will use a 2-year data lag, e.g. in 2024, the TAC for 2025 will be set with data available up to 2022.

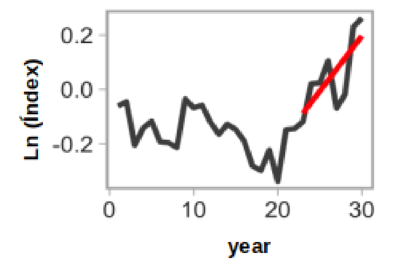
Therefore, it is important that all indices are updated by 2022 and are presented during the Yellowfin tuna Stock Assessment meeting that will take place in July 2024.

Index	Fleet	CPC	Period	Update to
PS_West	Purse seine	Venezuela	1987-2020	2022
BB_West	Bait boat	Brazil	2000-2021	2022
LL_USA	Longline	United States of America	1993-2020	2022
HL_BRA	Hand line	Brazil	2010-2016	2022

Preliminary proposal of process to generate TAC

1. Empirical index-based CMP, example:

GB_slope or Islope1

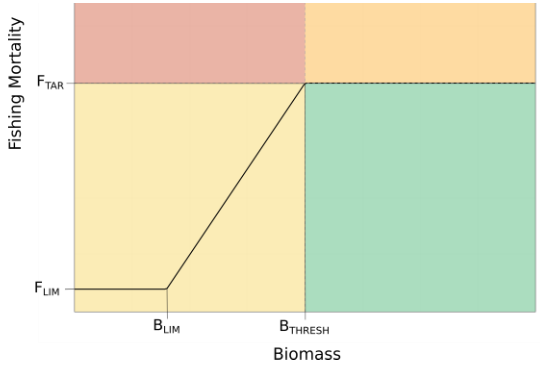


$$TAC_{y+1} = (1 + \theta\lambda)C_{y-2}$$

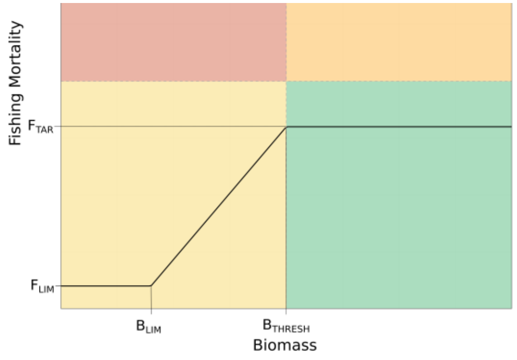
where, θ is the slope of log(abundance index) in the most recent 3 years of the time-series; λ is a tuning parameter (λ= 0.2 for Islope1, and λ= 1 for GB_slope); C is also the observed catch, and y is the indexed year. Additionally, GB_slope includes a constraint rule where TAC cannot exceed the limits of 80-120% of the most recent catch, which tests the 20% stability objective

2. Model-based CMP with "hockey-stick" HCR, example:

$$F_{mort} = \begin{cases} F_{tar}, if\ B_{y-2} \geq B_{thresh} \\ F_{tar}\left(-0.5 + 1.5\frac{B_{y-2}}{B_{thresh}}\right), if\ B_{thresh} > B_{y-2} > B_{lim} \\ F_{min}, otherwise \end{cases}$$



$$F_{mort} = \begin{cases} F_{tar}, if\ B_{y-2} \geq B_{thresh} \\ F_{tar}\left(-0.367 + 1.167\frac{B_{y-2}}{B_{thresh}}\right), if\ B_{thresh} > B_{y-2} > B_{lim} \\ F_{min}, otherwise \end{cases}$$



$$TAC_{y+1} = F_{mort} * B_{y-2}$$

In this way, the TAC for the first year (2025) of the first management cycle (2025-2027) will be estimated based on the biomass estimated from the application of the CMP to data updated until 2022.

Acknowledgments

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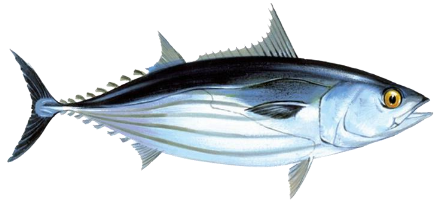

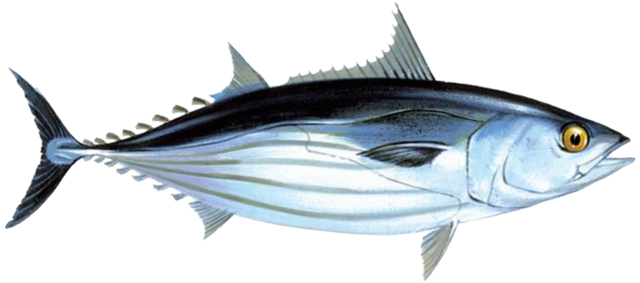

4. Discussions and feedback