Northern Swordfish Management Strategy Evaluation (MSE)

N-SWO MSE Ambassador Session

June 12, 2023

Reference: Swordfish MSE website

ICCAT CICTA CICAA

Objectives

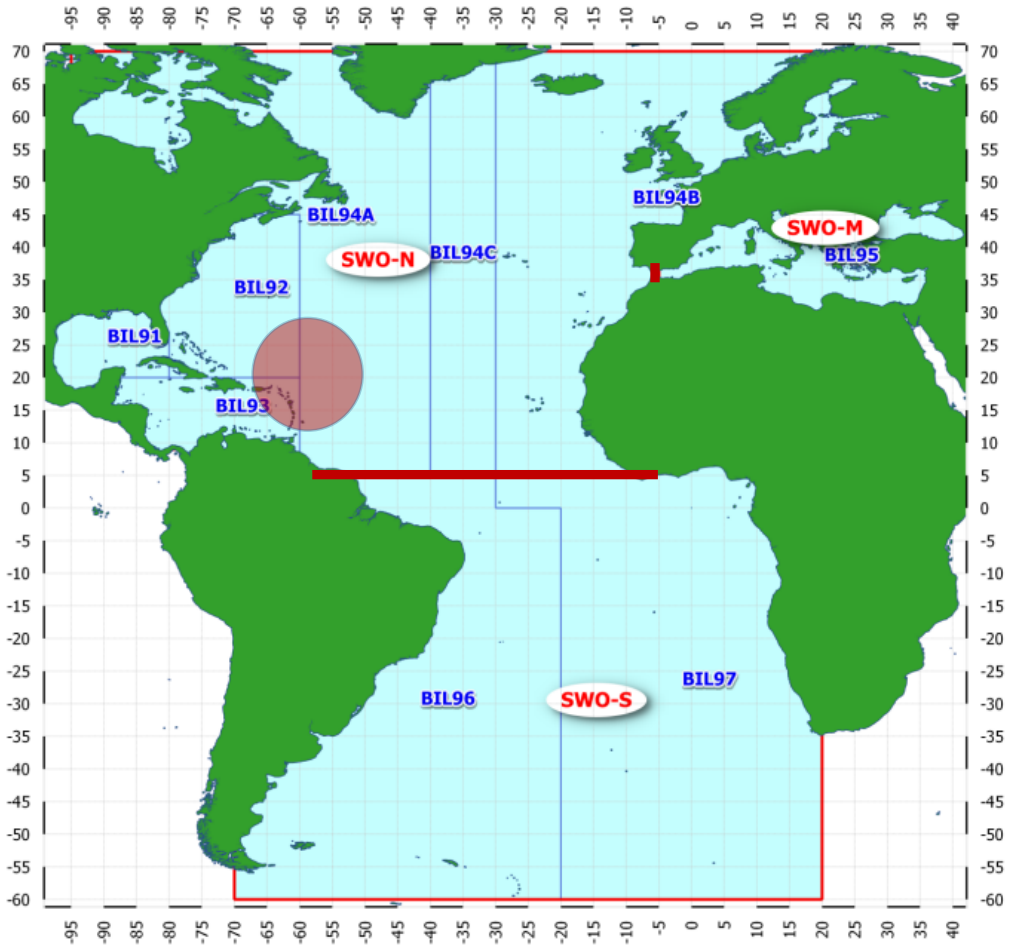
- Provide sufficient knowledge to facilitate discussion among scientists, fishery managers and other stakeholders on the development of N-SWO MSE; and,

- Articulate upcoming key discussion items

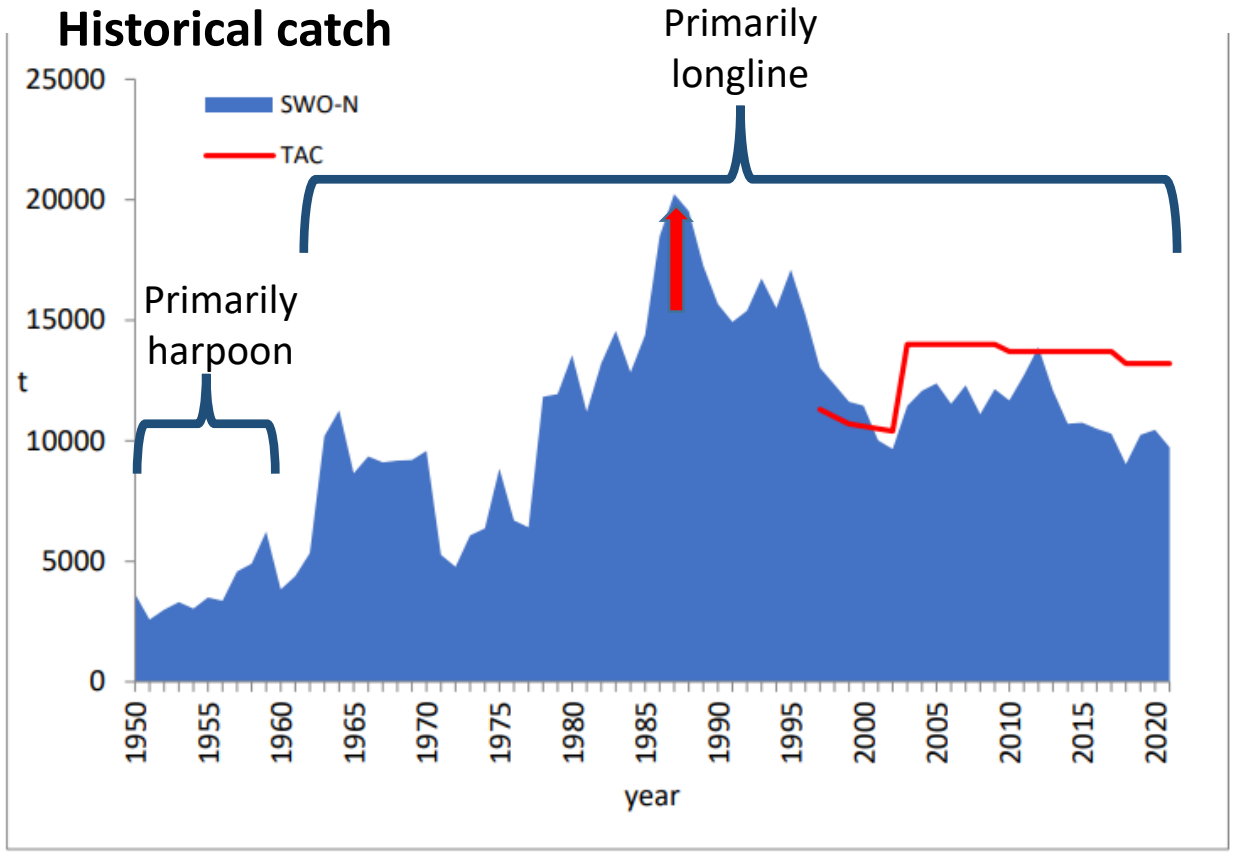
Agenda

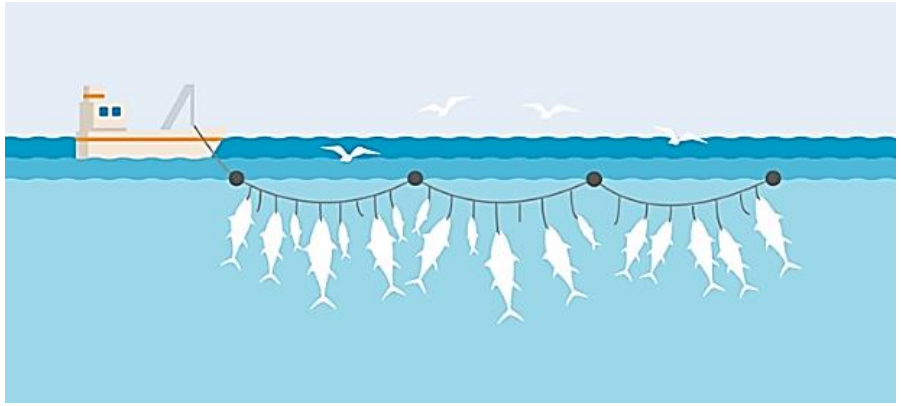
1. The North Atlantic swordfish fishery
2. Management strategy evaluation
3. Northern Atlantic swordfish stock status & development of the N-SWO MSE
4. Work completed since March Panel 4 meeting
5. Upcoming decision items for the Commission

North Atlantic swordfish stock features



History of the fishery





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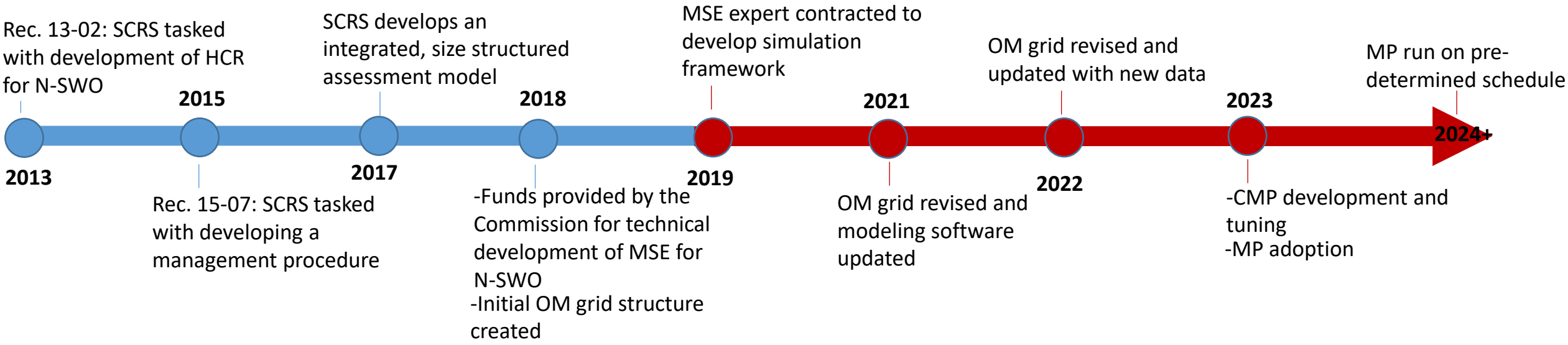
N-SWO MSE development



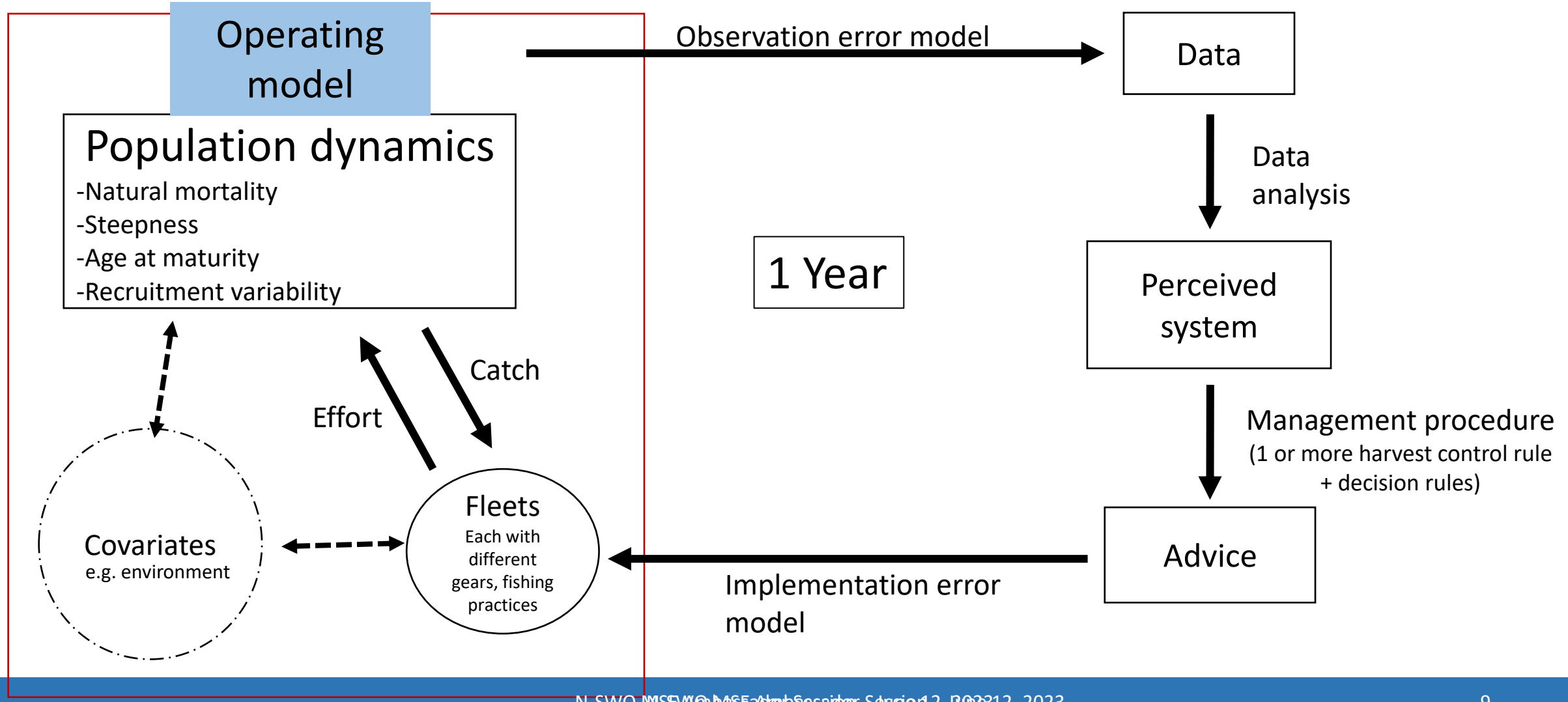
Primary components of MSE

- **Operating models (OMs):**
  - a collection of mathematical/statistical models that describe alternative hypotheses of the historical stock dynamics and specifications for simulating the collection of data and implementation of management measures in the future;

- **Candidate management procedures (CMPs):**
  - a set of proposed algorithms that generate TAC from fishery data, and will be evaluated in the MSE;

- **Performance metrics (PMs):**
  - statistics used to quantitatively evaluate the CMPs against specified management objectives.

MSE simulation framework



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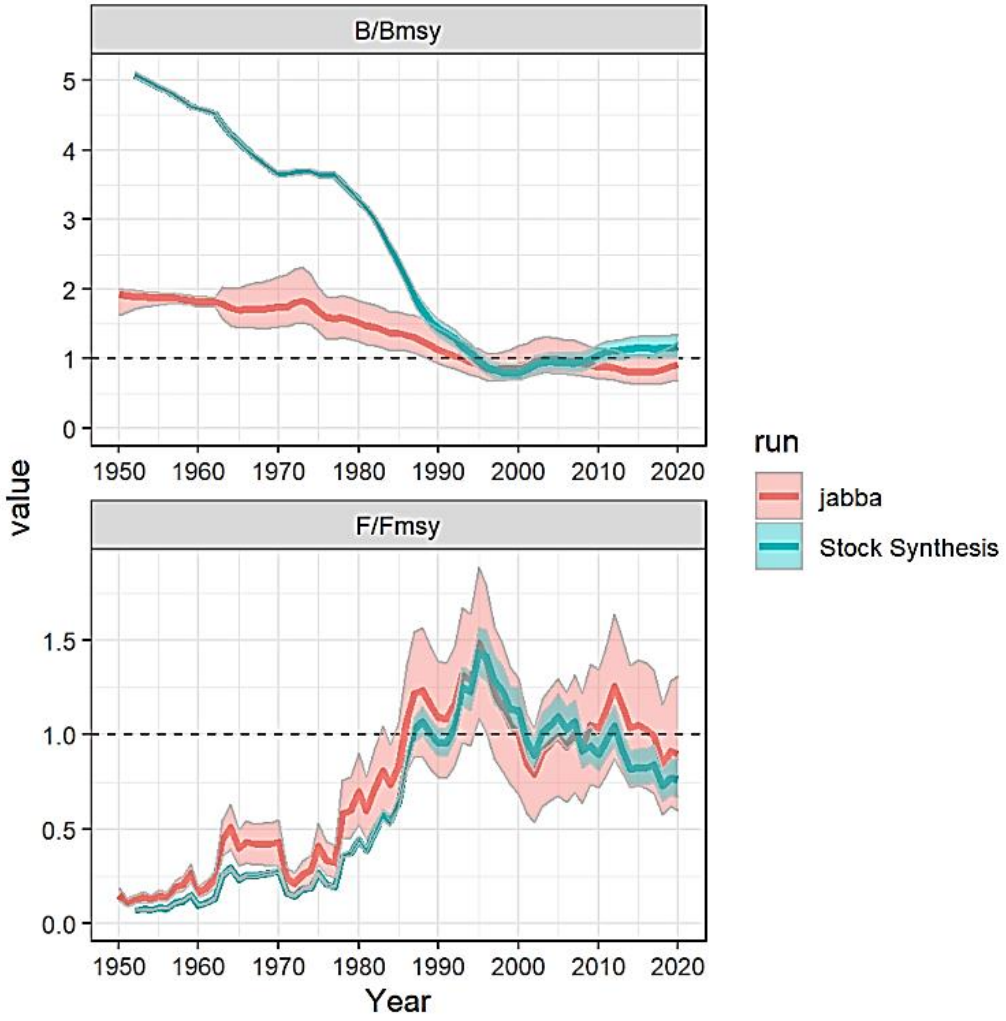
2022 N-SWO stock assessment

- Fully integrated stock assessment model for North Atlantic swordfish first developed for 2017 N-SWO assessment

- Data inputs
  - Data to 2020
  - Landings (8 fleets)
  - CPUE (6 indices)
  - Age specific CPUE (5 indices)
  - Length composition (7 fleets)



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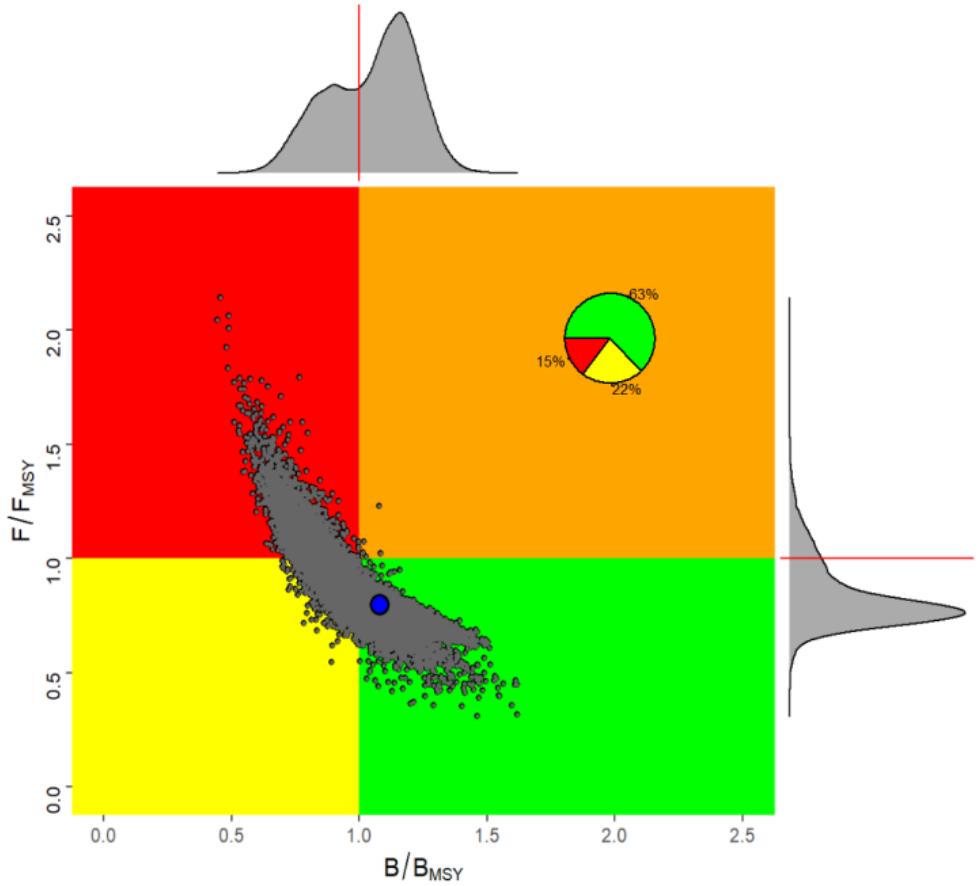


Operating model grid

- 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

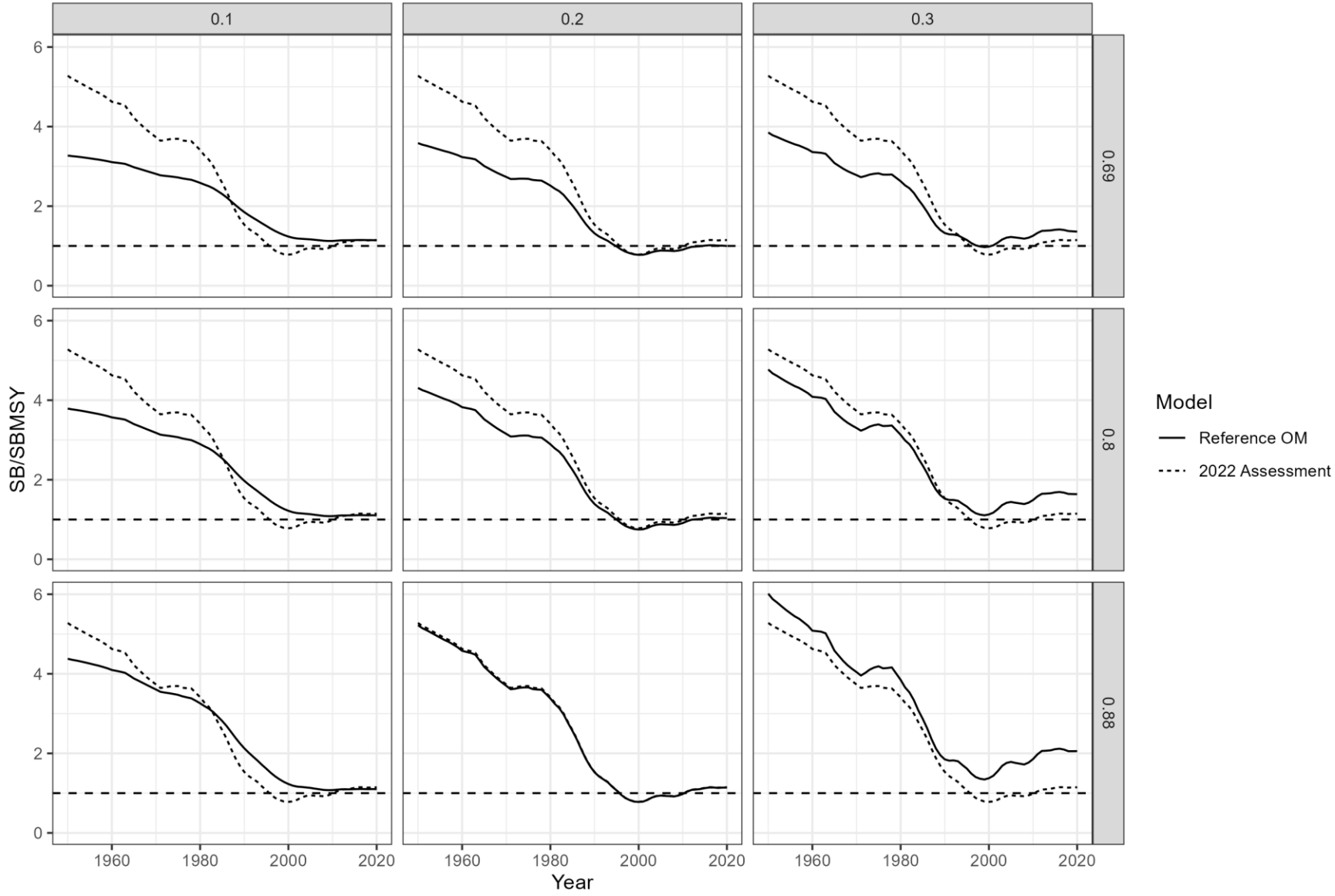
Grid as presented to PA4 in March 2023

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

Stock biomass in the historical period (1950 – 2020) under different assumptions



Candidate Management procedures

- A set of “if-then” rules
  - E.g. If CPUE increases __%, then TAC increases by __% in each of the next two years
  - E.g. If a Limit Reference Point is breached, the catch is reduced by __%

- A CMP can include one or more indicators/analyses *and* one or more harvest control rules (e.g. TAC, gear types, effort controls, etc.) that lead to management actions

- CMPs are tested in the MSE simulation

How do we choose a management procedure?

Set priorities (management objectives)

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Evaluate the strengths and weaknesses of the management procedures using computer simulation

How do we choose a management procedure?

Set priorities (management objectives)

Generate management procedures that attempt to meet those priorities

Evaluate the strengths and weaknesses of the management procedures using computer simulation

Choose a management procedure

Conceptual management objectives

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 less than [___]% probability of the stock falling below B_{LIM}
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

Performance metrics – example

- More specific than management objectives
- Include probabilities and time spans
- Can be multiple performance metrics for each objective

Objective	**Possible performance metrics**
Status The stock should have a [51%, 60%, 70%] or greater probability of occurring in the green quadrant of the Kobe matrix	**PGK_short:** probability of being in Green Zone of Kobe Space ($SB>SB_{MSY}$ & $F<F_{MSY}$) in years 1-10 (2024-2033) **PGK_med:** Probability of being in Green Zone of Kobe Space ($SB>SB_{MSY}$ & $F<F_{MSY}$) in years 11-20 (2034-2043) **PGK_30:** Probability of being in Green Zone of Kobe Space ($SB>SB_{MSY}$ & $F<F_{MSY}$) in year 30 (2053) **PGK:** Probability of being in Green Zone of Kobe Space ($SB>SB_{MSY}$ & $F<F_{MSY}$) over all years (2024-2053)

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Recap of 1st 2023 PA4 Meeting

- 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

Grid as presented to PA4 in March 2023

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- 9 reference OMs
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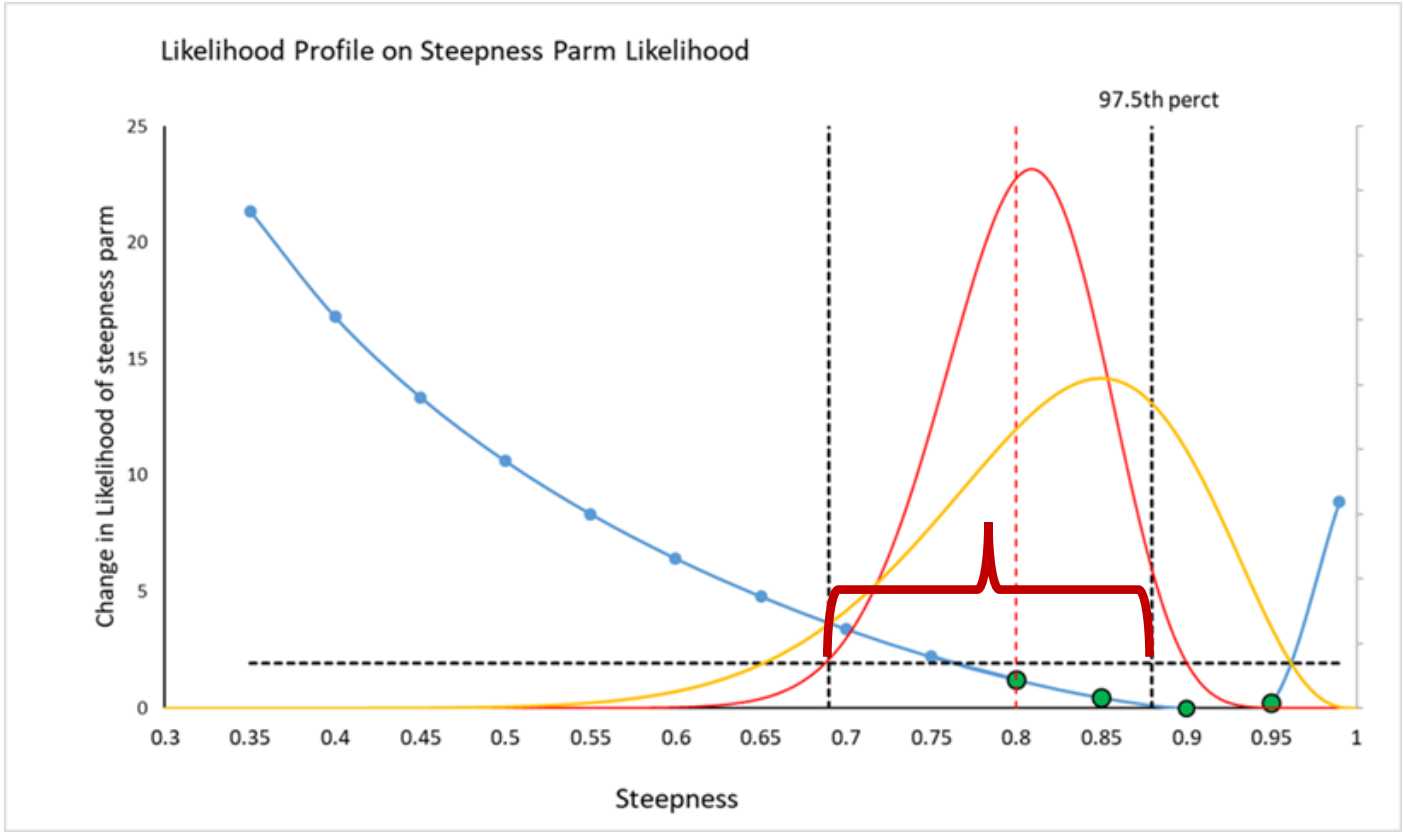
1. Updates to the OM grid - steepness

- 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	

Initial Robustness OMs

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

1. Updates to the OM grid – robustness OMs

Test	Purpose
Lower steepness	Evaluate sensitivity to stock with low resilience
Higher recruitment variability	Evaluate sensitivity to higher variability in recruitment process error
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)
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
Implementation error	Evaluate impact of illegal, unreported, or unregulated catches
Climate change recruitment	Evaluate impact of systematic pattern in recruitment deviations in projection periods; a proxy for impact of climate change on productivity
Size limit	Evaluate impact of different size limits, including removing all size regulations
Alternative management cycles	Evaluate the impact of a longer management cycle

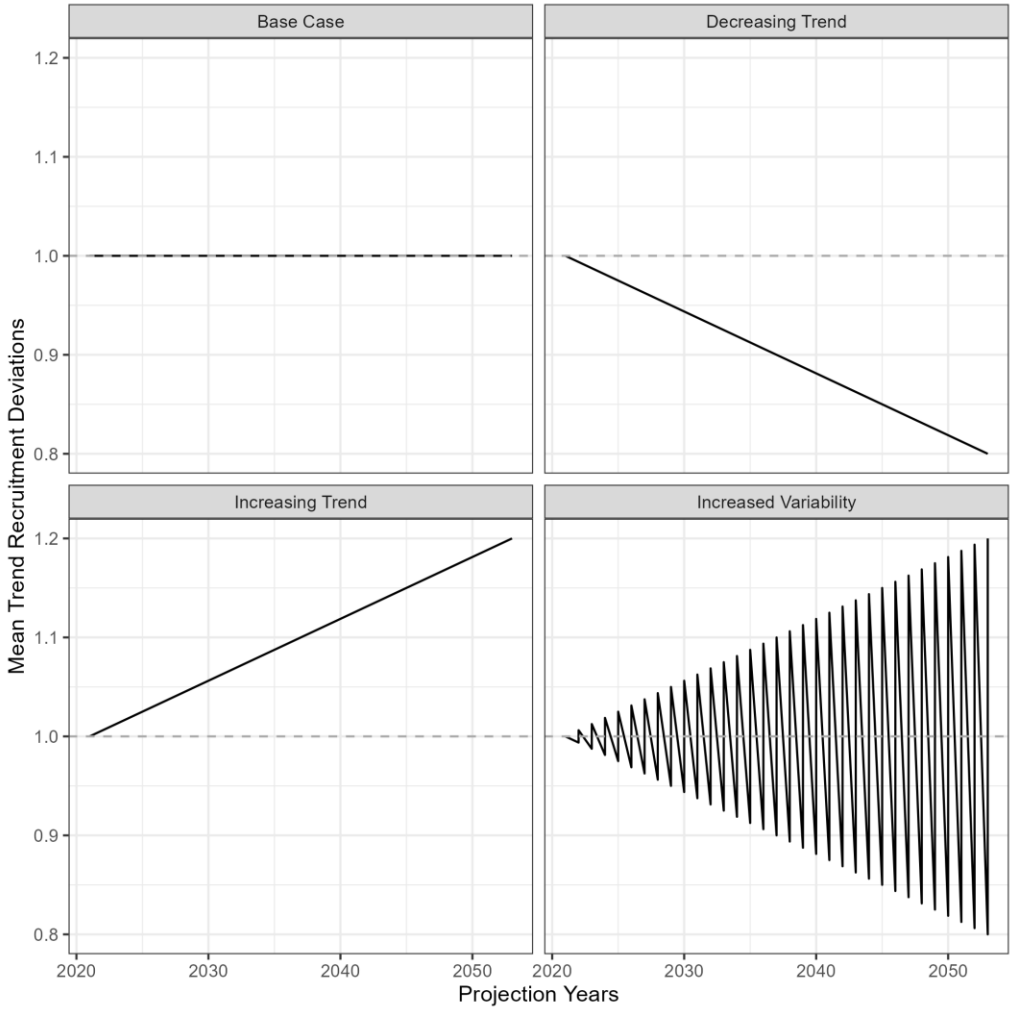
Robustness OMs: Climate change

- Climate change may have varying effects on different features of the stock
  - 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



2. Approach to the 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

3. 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

4. CMP specifications

- Two types of CMP
  - Model based
    - Data inputs (indices, catch, etc.) are used in a stock assessment model
    - Model outputs (vulnerable biomass, B/B_{MSY}, F/F_{MSY}) used to inform the decision rule
  - Empirical
    - Set an index target (e.g. mean index 2010 to 2020)
    - Calculate ratio of current index value relative to the target, sets TAC using the ratio

- CMP to set TAC for whole North Atlantic

5. Overall process – short term

- Meetings in 2023
  - Commission level
    - Intersessional Panel 4: 3 meetings (online)
    - Annual meeting: 1 meeting (hybrid)
  - SCRS meetings
    - SWO MSE technical team: 2 meetings (online)
    - SWO Species Group intersessional: 1 meeting (hybrid)
    - SWO Species Group annual: 1 meeting (hybrid)
    - SCRS annual: 1 meeting (hybrid)
  - Communications meetings
    - Ambassador sessions: 2 (online)

- Communications materials
  - PA4 summary documents
  - Slide presentations
  - Interactive website

5. Overall process – longer term

		Activity					Data inputs			
Year	Management cycle year	MP run	MP advice implemented	Stock assessment	MSE Review	Exceptional circumstances evaluated	Combined index	Other CPUEs	Catch data	Exceptional circumstance indicators
2023	0	x				x	x	x	x	x
2024	1		x			x				x
2025	2					x				x
2026	3	x				x	x		x	x
2027	4		x			x				x
2028	5			x (alternative)		x				x
2029	6	x		x		x	x	x	x	x
2030	7		x	x (alternative)		x				x
2031	8					x				x
2032	9	x			x	x	x		x	x

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Guidance needed from PA4 on June 30

1. Operationalize management objectives and refine key performance metrics
    a. Choice of a key performance metric for each of the Status, Safety, and Yield objectives.
    b. Choice of tuning objective, including timeframe.
    c. Status: Choice of the minimum acceptable probability of the stock being in the quadrant of the Kobe matrix
    d. Safety: Choice of the maximum acceptable probability of the stock breaching the limit reference point
    e. Stability: Choice of the maximum acceptable change in TAC between management cycles (if desired)
2. Minimum TAC change between management cycles
3. Prioritize robustness OMs for analysis in 2023

1. a) Choice of a key performance metric for each of the Status, Safety, and Yield objectives.

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_6_10	Probability of being in Green Zone of Kobe Space (SB>SBMSY & F<FMSY) in years 6-10 (2029-2033)	51, 60, 70
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	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
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Yield	TAC1	TAC (t) in the first implementation year (2024)	
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	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. b) Choice of tuning objective, including timeframe.

- A common metric that will allow comparison among the CMPs
- Current target: PGK_6-10 at 60% probability
- Would PA4 like a different target?

1. c) Status: Choice of the minimum acceptable probability of the stock being in the green quadrant of the Kobe matrix

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Stability	VarC	Median variation in TAC (%) between management cycles over all years	
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1. d) Safety: Choice of the maximum acceptable probability of the stock breaching the limit reference point

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Stability	VarC	Median variation in TAC (%) between management cycles over all years	
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1. e) Stability: Choice of the maximum acceptable change in TAC between management cycles (if desired)

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2. Minimum TAC change between management cycles

- At each application of the MP, it may be desirable to set a minimum bound for TAC change for administrative purposes.

- Would Panel 4 like to set a minimum level in tonnage for TAC change for all CMPs?

- Current TAC: 13,200 t

3. Prioritize robustness OMs for analysis in 2023

- CMPs are not tuned to robustness tests
- Currently there is a large list of robustness OMs
- The SCRS is unable to provide analysis on all robustness OMs in 2023 and would like to know which are a priority for analysis this year

Summary

- MSE simulation uses the existing assessment model as the base case
- OM grid reconditioned and CMP tuning is in progress
- SCRS requires additional feedback from Panel 4 on probability thresholds, key performance metrics, and priority robustness tests
- SCRS plans for N-SWO MSE meetings and communication sessions throughout 2023
- MP adoption is scheduled for 2023 with implementation in 2024

Acknowledgements

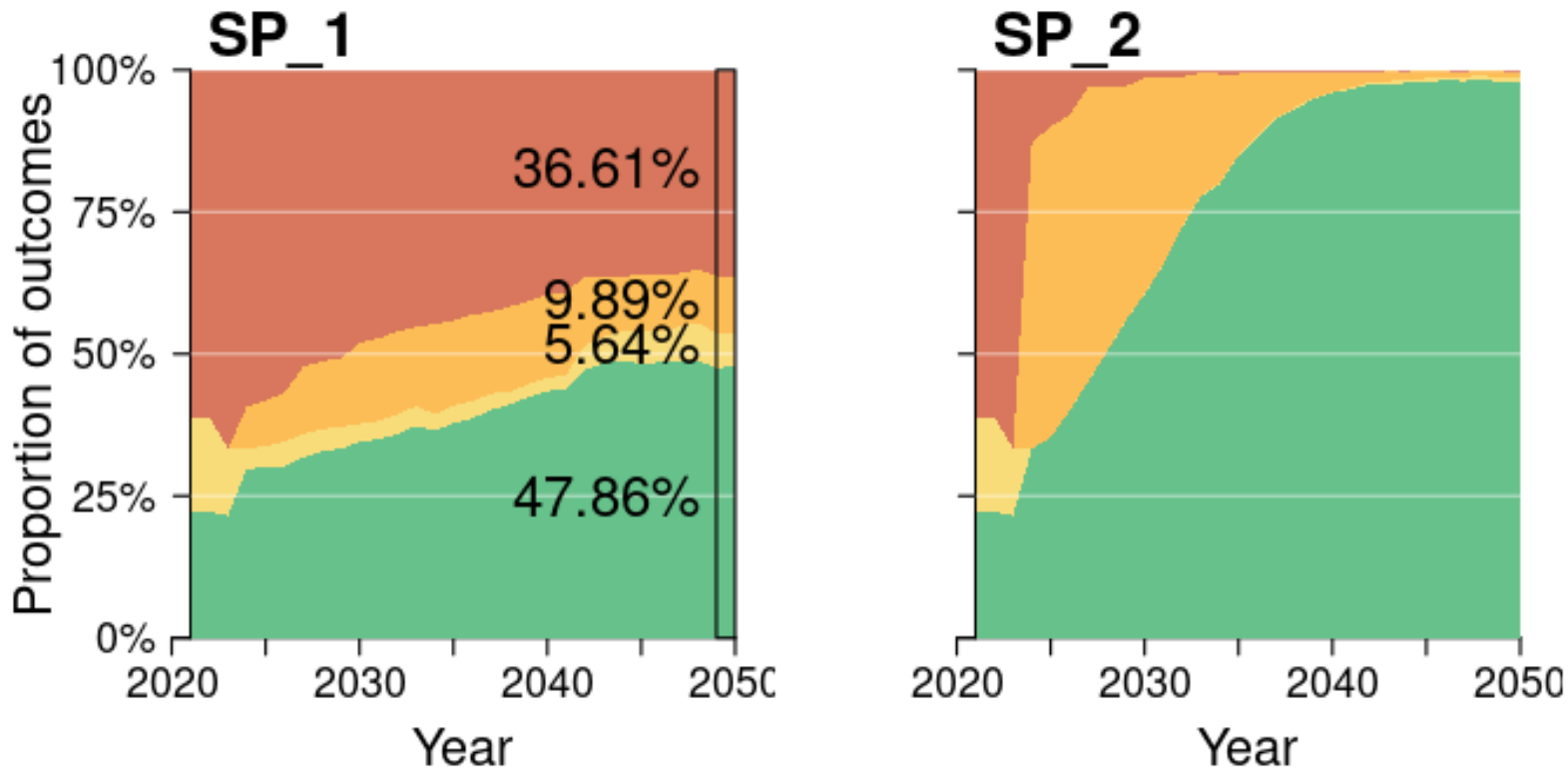
This work is funded by the ICCAT Science Envelope and by special contributions from ICCAT CPCs

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

SLICK tool – CMP results and trade-offs

Tool for evaluating:

- CMP results and,
- the tradeoffs between CMPs



Questions?