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## Considerations for the Management Strategy Evaluation Program of Work for 2023-2025

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### PURPOSE

To provide the MSAB with potential management procedures to simulate, how exceptional circumstances are part of the MSE process, a discuss of objectives and performance metrics, and future planning of MSE work.

### INTRODUCTION

The MSE Program of Work for 2021-2023 was completed and delivered at the 99<sup>th</sup> Session of the IPHC Annual Meeting (AM099; see [IPHC-2023-AM099-13](#)). The MSE framework was improved and results investigating size limits and multi-year assessments were presented. Pertinent to size limits and multi-year assessments, the Commission agreed to the following.

[IPHC-2023-AM099-R](#), para. 84: The Commission **AGREED** sufficient analysis has been completed and **RECOMMENDED** not to change the current 32 inch size limit. 85.

[IPHC-2023-AM099-R](#), para. 85: The Commission **AGREED** that there is utility in continuing to explore multi-year stock assessment management procedures, in a manner consistent with the advice from SRB and MSAB.

The Commission also requested some investigation of exceptional circumstances, especially with respect to multi-year assessments.

[IPHC-2023-AM099-R](#), para. 88: **NOTING** paragraph 60 from the 21st Session of the SRB (SRB021), the Commission **REQUESTED** the Secretariat develop a description of options to responding to exceptional circumstances that would trigger a stock assessment in non-assessment years and additional MSE analyses.

[IPHC-2022-SRB021-R](#), para 60: *The SRB RECOMMENDED that Exceptional Circumstances be defined to determine whether monitoring information has potentially departed from their expected distributions generated by the MSE. Declaration of Exceptional Circumstances may warrant re-opening and revising the operating models and testing procedures used to justify a particular management procedure*

As noted by the SRB above, an exceptional circumstance is a defined event that would result in re-examination of the MSE process to determine if an update to the evaluation of management procedures is necessary. An exceptional circumstance, in an MSE context, is not usually defined to trigger an action within the management procedure, but a trigger can be defined such that action does take place. An example is the 30:20 control rule which defines a reduction in the

fishing intensity when stock status is less than 30%. A similar trigger could be defined that indicates an assessment should be done in a year when one was normally not scheduled.

Without an agreed upon distribution procedure, the recent MSE simulations integrated over five potential distribution procedures (see IPHC-2023-MSAB018-06). The Commission acknowledged that a distribution procedure has not been agreed upon at this time and provided the following.

[IPHC-2023-AM099-R](#), para. 87: The Commission **AGREED** that following agreement about a distribution procedure, the IPHC Secretariat and MSAB should reassess multi-year stock assessment management procedures, as well as coastwide elements of a management procedure such as the SPR value.

The advice from the 2022 full stock assessment ([IPHC-2023-SA-01](#)) using the current interim management procedure with an SPR of 43% was a TCEY of 52.0 Mlbs. This TCEY was higher than expected from previous assessments largely because natural mortality (*M*) was estimated higher than a previously fixed value in one of four models in the ensemble, thus increasing the perceived productivity of the stock. In contrast to this optimistic advice, the coastwide FISS index of O32 WPUE was at its lowest value observed in the time-series, declining by 8% from the previous year, and a TCEY of 52.0 Mlbs in 2023 would have a 75% chance of a lower spawning biomass in 2024. The Commission departed from the current interim management procedure and chose a TCEY of 36.97 Mlbs, noting

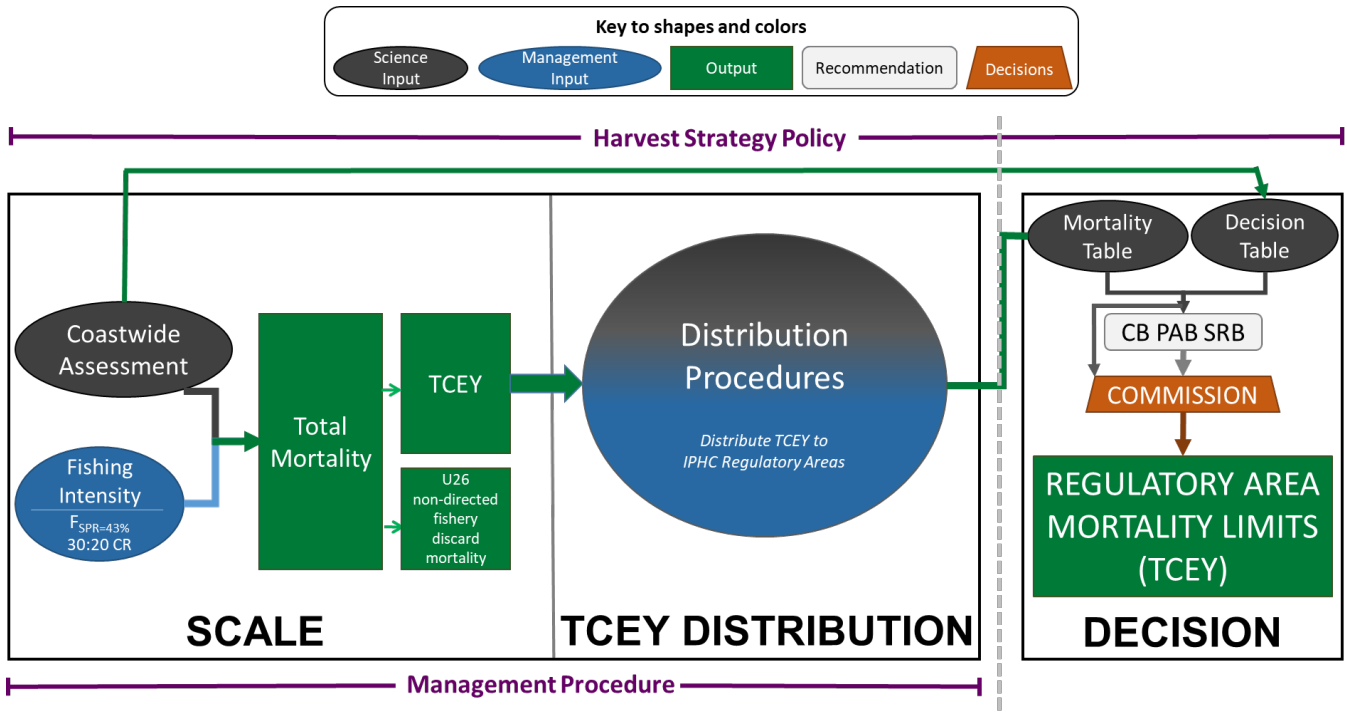
[IPHC-2023-AM099-R](#), para. 94. The Commission **NOTED** that the adopted mortality limits for 2023 correspond to a 38% probability of stock decline through 2024, and a 36% probability of stock decline through 2026.

Although the status of the stock was above the target spawning biomass of 36% and had a small chance (25%) of falling below 30% at any TCEY up to 60 Mlbs, the Commission decided to reduce the TCEY from the TCEY determined using the reference harvest level.

This document considers the responses from the Commission during AM099 that are related to the MSE. Potential management procedures are discussed that incorporate multi-year assessments, a trigger to conduct an assessment in a non-assessment year, and control rules that may lead to a management procedure mimicking the TCEY decision made at AM099. Potential objectives related to the TCEY decision made at AM099 are also discussed. Exceptional circumstances are defined and then additional considerations for the MSE program of work are presented.

## MANAGEMENT PROCEDURES

The current interim management procedure consists of a scale component to determine the coastwide TCEY which is then passed through a distribution procedure to distribute the TCEY to each IPHC Regulatory Area ([Figure 1](#)). Many elements make up each of these components. A decision process occurs at the end of the harvest strategy policy where the final TCEYs for each IPHC Regulatory Area may deviate from those determined by the management procedure, as seen at AM099.



**Figure 1.** Illustration of the Commission interim IPHC harvest strategy policy (reflecting paragraph ID002 in [IPHC-2020-CR-007](#)) showing the coastwide scale and TCEY distribution components that comprise the management procedure. The distribution procedure is currently undefined. The decision component is the Commission decision-making process, which considers inputs from many sources.

The coastwide Total Mortality (TM) is determined from an SPR-based fishing intensity, which is reduced when stock status is less than 30% and effectively set to zero when stock status is less than 20% (called the 30:20 control rule). The coastwide TCEY is determined by subtracting the U26 non-directed fishery discard mortality. Additional elements can easily be added to the MP to evaluate using the MSE framework.

Multi-year MPs use a simple procedure in years without an assessment to determine the TCEY. This simple procedure can be based on the FISS WPUE and adjust the TCEY up or down in proportion to the change in the FISS WPUE, thus reflecting the trend in abundance. If there is an additional concern of being at low catch-rates or below a specific FISS WPUE, a trigger could be added to reduce the TCEY even further or to trigger an assessment in a year when one normally would not occur. There would be little time to conduct an assessment after the survey results came in, however.

In paragraph 88 of the Report from AM099 ([IPHC-2023-AM099-R](#); see above), “exceptional circumstances that would trigger a stock assessment in non-assessment years” was mentioned. It may be preferable to define this trigger as part of the management procedure because an exceptional circumstance, in the classic MSE sense, is when an observation is made outside of what was simulated in the closed-loop simulations of the MSE, requiring the MSE simulations to

be reconsidered. Putting a trigger to conduct an assessment in the management procedure allows it to be evaluated as part of the MSE process.

At AM099, the Commission decided to depart from the reference SPR and choose a lower TCEY. Paragraph 94 of [IPHC-2023-AM099-R](#) (see above) suggests that the Commission was not willing to accept a high chance of further declines in the spawning biomass. If that was the case, the 30:20 control could be revised to avoid going to low levels, although the decision was probably a combination of many factors which may include low catch rates, continually declining indices, a recent series of poor recruitment, mostly relying on one year class, and low weight-at-age.

An element can be added to the management procedure that would account for any of these factors. If low catch-rates and declining indices was an important factor in the decision to reduce the TCEY, the management procedure may incorporate an additional control rule based on the FISS O32 WPUE. For example, the fishing intensity (or TCEY) could be linearly reduced when the FISS O32 WPUE is below some value. Various values could be tested to produce the desired performance. However, that performance may depend on a new objective related to catch-rates or FISS WPUE (see the Objectives section below).

In summary, potential elements of MPs to evaluate with the MSE include

- Multi-year assessment with the TCEY in non-assessment years determined from the change in FISS WPUE and an assessment is triggered when the FISS WPUE is below some value, the FISS WPUE or NPUE changes by a considerable amount, or some other trigger.
- Additional reduction in the TCEY if the FISS WPUE is below some value to mimic decisions made at AM099. The probability of further decline in spawning biomass could be also included.
- Various SPR values and control rules to re-evaluate those elements with a newly updated OM.

## **OBJECTIVES AND PERFORMANCE METRICS**

Document IPHC-2023-MSAB018-06 for this meeting presented the four Commission-recommended priority objectives and associated performance metrics. The MSAB has previously defined a set of primary objectives, and associated performance metrics, which includes some area-specific objectives as well ([Appendix A](#)). These primary objectives have been used in past evaluations. Furthermore, the MSE Explorer has options to select many performance metrics beyond those defined by the primary objectives. These have been called statistics of interest in the past, meaning they are performance metrics without a specific objective defined by a measure, time-frame, and tolerance.

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The primary objectives are a subset of two defined goals

1. Biological Sustainability (also referred to as conservation goal)
  - 1.1. Keep female spawning biomass above a limit to avoid critical stock sizes and conserve spatial population structure.
2. Optimise directed fishing opportunities (also referred to as fishery goal)
  - 2.1. Maintain spawning biomass at or above a level that optimises fishing activities
  - 2.2. Provide directed fishing yield
  - 2.3. Limit variability in mortality limits

Details of the primary goals and objectives defined by the Commission, along with performance metrics, are shown in Appendix A, renumbered to reflect the priority order as recommended by the Commission in paragraph 76 of [IPHC-2023-AM099-R](#) (see document IPHC-2023-MSAB018-06).

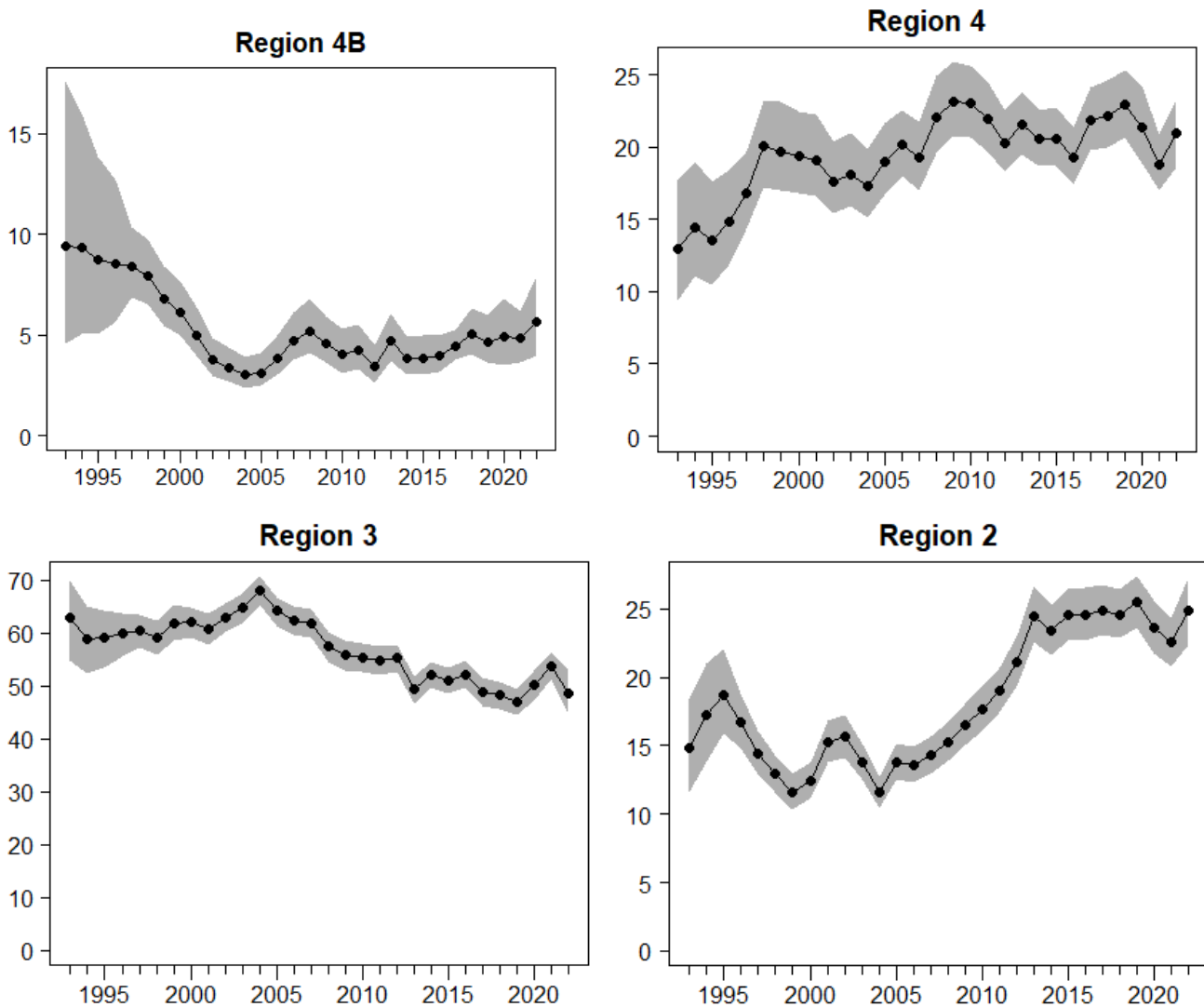
One measurable objective that can use refinement is the Biological Region-specific objective “maintain a defined minimum proportion of female spawning biomass in each Biological Region.” The purpose of this objective is to conserve population structure because it is not known how each Biological Region contributes to the sustainability of the stock in each IPHC Regulatory Area or Biological Region. Allowing the spawning biomass to get too low in one Biological Region may result in unintended consequences. Proportions were defined *ad hoc* for each Biological Region based on historical estimates of distribution ([Figure 2](#)), but recent MSE results were never able to meet the objective for Biological Region 4B due to a large amount of variability (e.g. the “Both” for the “Fished” run in [Figure 3](#)). Further investigation of the percentage of spawning biomass in Biological Region 4B under scenarios of persistent low PDO and persistent high PDO ([Figure 3](#)) show that the percentage of spawning biomass in Biological Region 4B is much more variable when fished than when not fished, and the “high” PDO results in lower percentages of spawning biomass in that region, sometimes less than 1%.

There are many solutions to alleviate this issue and find MPs that meet the objective of maintaining coastwide spawning biomass in Biological Region 4B.

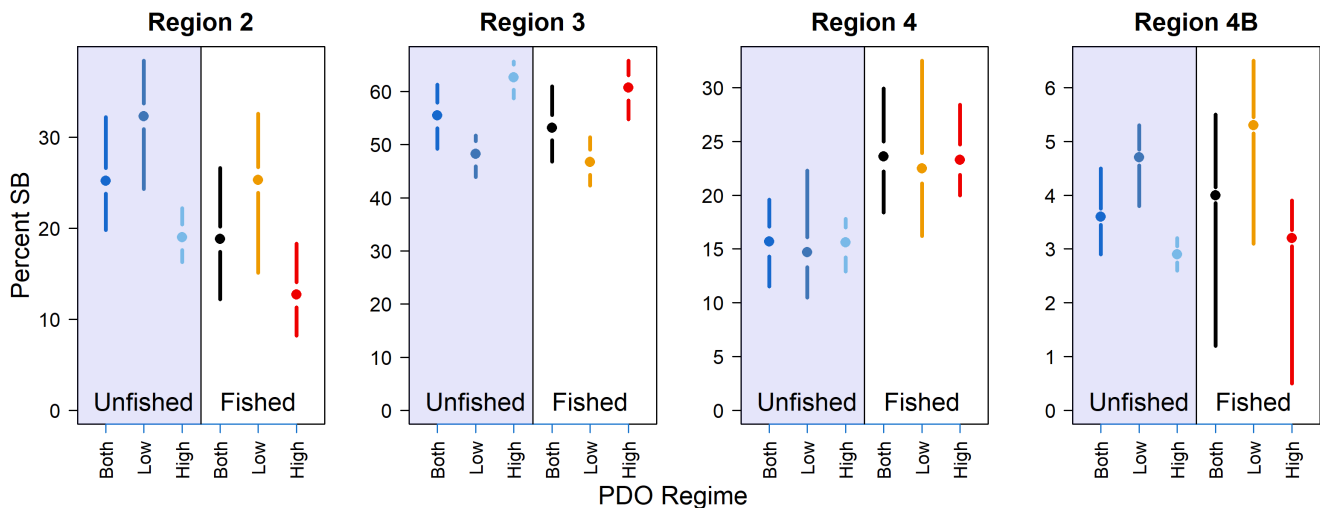
- a) Determine a new value for the minimum percentage in Biological Region 4B (currently 2%).
- b) Adjust the tolerance to a value great than 5%.
- c) Find a management procedure that will meet the current objective. This would likely be achieved by lowering the relative harvest rate in IPHC Regulatory Area 4B.

As noted above, the Commission decision at AM099 to depart from the reference SPR and choose a lower TCEY (paragraph 94 of [IPHC-2023-AM099-R](#)) suggests that the Commission was not willing to accept a high chance of further declines in the spawning biomass. This indicates that there is potentially an undefined objective. This may be related to catch-rates or the FISS WPUE, or indicate that the Commission would be willing to operate at a lower fishing intensity (i.e. higher SPR). It may be useful to the MSAB to identify potential objectives or performance metrics that may assist in evaluating management procedures to identify ones that would satisfy this concern of declining spawning biomass. Some examples are

- a) The FISS O32 (or all sizes) WPUE does not fall below a specified value with a defined tolerance. This could be a proxy for fishery catch-rates.
- b) If the FISS O32 (or all sizes) WPUE falls below a specified value, the spawning biomass recovers at a certain rate with a defined tolerance, recovers to a value within a certain time-frame with a defined tolerance, or has a specified chance of increasing.
- c) When stock status is below a threshold, the spawning biomass recovers at a certain rate with a defined tolerance, recovers to a value within a certain time-frame with a defined tolerance, or has a specified chance of increasing.



**Figure 2.** Estimated percent stock biomass in each Biological Region, with 95% credible intervals, from the space-time model using FISS data.



**Figure 3.** Percentage of spawning biomass in each Biological Region when fished with an SPR of 43% and when not fished. The PDO is modelled with low and high periods in “Both”, is persistently low in “Low”, and is persistently high in “High”.

There are two other goals, with undefined objectives, that were defined by the MSAB early in the process.

3. Minimize discard mortality in directed fisheries.
4. Minimize discards and discard mortality in non-directed fisheries (bycatch).

These goals, related to discard mortality in directed fisheries and non-directed fisheries, have not yet been specifically considered in the MSE but are identified by the MSAB as important to consider in the future. The current MSE framework can provide meaningful performance metrics related to discard mortality in the directed fisheries, but non-directed discard mortality is modelled as a random factor that represents potential non-directed discard mortality, but is not a meaningful performance metric because its link to management choices is very weak.

Many performance metrics are provided in the [MSE explorer](#) under additional metrics (and most defined on the help page). There may be additional performance metrics of interest to the MSAB, or some performance metrics could be removed to simplify the choices.

### EXCEPTIONAL CIRCUMSTANCES

An exceptional circumstance is defined as a process for deviating from an adopted MP (de Moor et al. 2022). The IPHC interim harvest strategy policy has a decision-making step after the MP ([Figure 1](#)), thus the Commission may deviate from an adopted MP. The SRB originally used this definition of exceptional circumstances, but provided clarity at SRB021 to fit within the IPHC process.



[IPHC-2020-SRB017-R](#), para. 27. The SRB **AGREED** with conclusions of the independent peer reviewer that:

- d) the IPHC Secretariat establish a formal process for determining whether Exceptional Circumstances exist in a given year that would justify deviating from the harvest control rule.

[IPHC-2022-SRB021-R](#), para 60: The SRB **RECOMMENDED** that Exceptional Circumstances be defined to determine whether monitoring information has potentially departed from their expected distributions generated by the MSE. Declaration of Exceptional Circumstances may warrant re-opening and revising the operating models and testing procedures used to justify a particular management procedure

These two statements indicate that exceptional circumstances should be defined using observations rather than model outputs and should be compared to the distribution generated by the MSE simulations. If the observation(s) are outside of that range, revising the MSE framework and conducting additional simulations should be considered. It is important to have clear definitions for when the agreed upon MP should be re-evaluated.

The Commission may have interpreted the continued decline in abundance indices and projected spawning biomass seen at AM099 as an exceptional circumstance, but this is within the distribution of simulations from the MSE. Figure 4 shows that in the near-term, the spawning biomass has a chance of continuing to decline (the 5<sup>th</sup> percentile shows a decline before subsequently increasing). However, after a few years of projections, the spawning biomass is very likely to increase. In the long-term, it is not unlikely that the spawning biomass would be at levels seen recently, according to these simulations with an SPR of 43%.

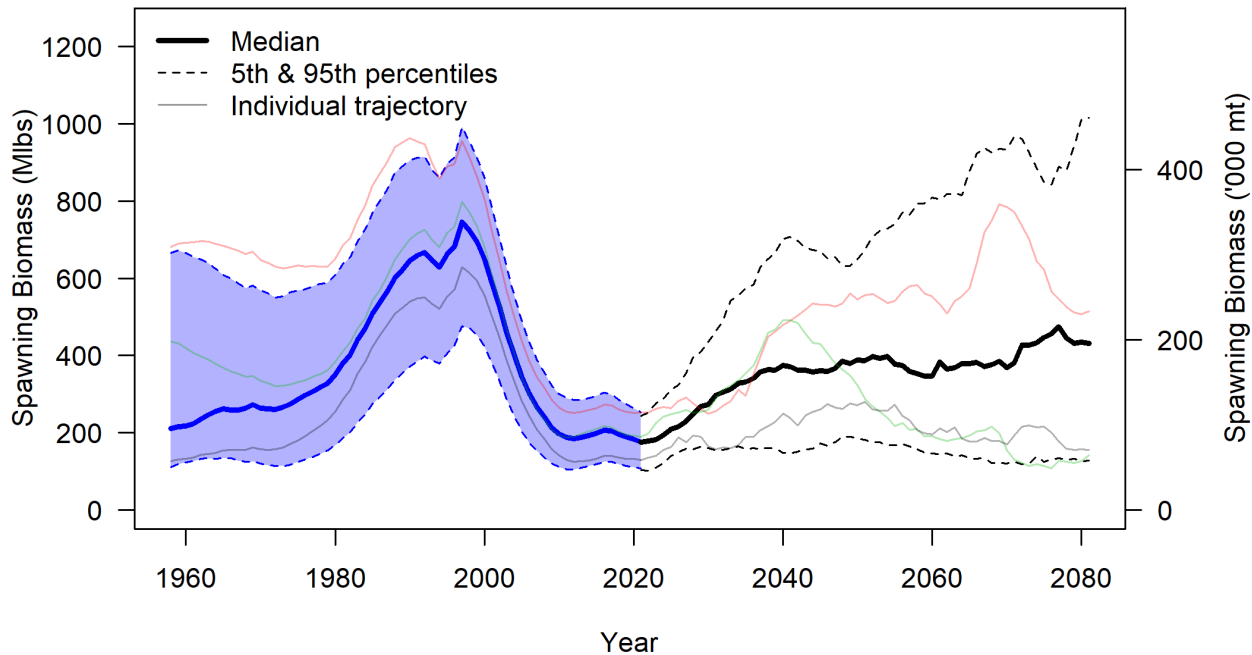
Given the SRB statements, potential exceptional circumstances could be as follows.

- a) The coastwide all-sizes FISS WPUE or NPUE falls above the 97.5<sup>th</sup> percentile or 2.5<sup>th</sup> percentile of the simulated FISS index.
- b) The observed percentage of FISS all-sizes WPUE is above the 97.5<sup>th</sup> percentile or 2.5<sup>th</sup> percentile of the simulated FISS index for each Biological Region. These data were used to condition the OM, so may be a reasonable choice.
- c) The proportions-at-age in the coastwide or region-specific FISS observations are above the 97.5<sup>th</sup> percentile or 2.5<sup>th</sup> percentile of the simulated FISS proportions-at-age. Exactly how to make this comparison over all ages would have to be determined.

The all-sizes index would be a better option because to calculate O32, the OM needs to make an assumption how to split the observations into U32 and O32.

If a multi-year MP was implemented and an exceptional circumstance occurred in a year without a stock assessment, it may be useful to specify that a stock assessment would be completed as soon as possible along with the re-examination of the MSE.





**Figure 4.** Median, 5<sup>th</sup> percentile, and 95<sup>th</sup> percentile of projected spawning biomass when using an SPR of 43%. Three individual trajectories (chosen ad hoc) are shown as thin lines to provide an idea of the variability in one trajectory over the entire period.

#### **ADDITIONAL CONSIDERATIONS FOR FUTURE MSE WORK**

There may be other considerations for future MSE work to discuss at MSAB018. One task that will be done is to update the OM, as specified in document IPHC-2023-MSAB018-06, and then re-evaluate SPR values and the 30:20 control rule. In fact, before any evaluations of MPs, the OM should be updated based on the most recent stock assessment.

#### **TWO-YEAR PROCESS FOR THE MSE**

An MSE process may take one to 4 years, but because the MSE process at IPHC has matured and an MSE framework is in place, the timeframe for presenting results to the Commission on these topics is likely to take two years. How advisory bodies may engage in the MSE process over the next two years, and what that may entail is described next.

#### **Scientific Review Board**

The SRB reviews the technical aspects of the MSE, trusting that the MSE developers are correctly implementing those details. The SRB also plays an important role in reviewing objectives and making sure that performance metrics are appropriate and correct. The Secretariat also works with the SRB to determine effective and succinct ways to present results to the Commission.

Two SRB meetings each year works well with the MSE process. SRB engagement in 2023 and 2024 may occur as follows.

***Spring 2023 SRB meeting:***

- Review outcomes of the Spring MSAB meeting.
- Review any technical aspects of the MSE framework that have not been reviewed before.
- Review the set of primary objectives and performance metrics to be used for evaluation.
- Review proposed MPs for evaluation and identify if the set should be narrowed or expanded.

***Fall 2023 SRB meeting:***

- Review preliminary simulation results including those related to questions of scientific interest and of interest to decision-makers.
- Assist in narrowing down the MPs to a succinct set to present to the Commission.
- Provide guidance on communicating progress.

***Spring 2024 SRB meeting:***

- Review outcomes of the Spring MSAB meeting.
- Review any technical aspects of the MSE framework that have not been reviewed before.
- Review the set of primary objectives and performance metrics to be used for evaluation.
- Review proposed MPs for evaluation and identify if the set should be narrowed or expanded.
- Provide guidance on methods for communicating results.

***Fall 2024 SRB meeting:***

- Review the simulation results including those related to questions of scientific interest and of interest to decision-makers.
- Assist in narrowing down the MPs to a succinct set to present to the Commission.
- Provide further guidance on communicating results.

## **Management Strategy Advisory Board**

The MSAB may best serve the Commission by considering methods and inputs for the MSE process. One meeting per year would be sufficient, although adding in an information session when appropriate may be useful to keep MSAB members informed as they prepare for the Interim and Annual Meetings. Engagement with the MSAB in 2023 and 2024 may be as follows.

***Spring 2023 MSAB meeting:***

- Discuss a broad set of objectives for use in the MSE process.
- Using guidance from the Commission, identify specific management procedures for simulation and evaluation that may be presented to the Commission.
- Define performance metrics to be used to evaluate the current MPs.
- Articulate interests and concerns of constituents related to the MPs being considered.
- Identify methods to disseminate current MSE information to constituents.
- Provide suggestions of fishery-related scenarios that may be used in the simulations to represent uncertainty about aspects of the fisheries that cannot be or are not managed.

**Spring 2024 MSAB meeting:**

- Further discussion of a broad set of objectives for use in the MSE process.
- Using guidance from the Commission and preliminary results from 2023, identify specific management procedures for simulation and evaluation that may be presented to the Commission at AM101. Possibly prioritize the MPs to help identify a smaller set to be considered by the Commission.
- Define performance metrics to be used to evaluate the current MPs.
- Articulate interests and concerns of constituents related to the MPs being considered.
- Identify methods to disseminate current MSE information to constituents.
- Provide suggestions of fishery-related scenarios that may be used in the simulations to represent uncertainty about aspects of the fisheries that cannot be or are not managed.
- Provide guidance on potential elements and trade-offs to consider when evaluating results.

**Fall 2024 MSAB Informational Session (optional):**

- Receive an educational presentation on a specific part of the MSE process.
- Receive a summary of the primary objectives and MPs currently being considered.
- Receive a presentation of results and evaluation.

**REFERENCES**

de Moor CL, Butterworth DS, Johnston S. 2022. Learning from three decades of Management Strategy Evaluation in South Africa. ICES Journal of Marine Science. 79. 1843-1852.

**RECOMMENDATION/S**

- 1) The MSAB **NOTE** paper IPHC-2023-MSAB018-07 presenting potential management procedures to evaluate, objectives and performance metrics, a discussion of exceptional circumstances, and additional considerations for future MSE work.

**APPENDICES**

[Appendix A](#): Primary objectives defined by the Commission for the MSE

[Appendix B](#): Supplementary material

## APPENDIX A

### PRIMARY OBJECTIVES DEFINED BY THE COMMISSION FOR THE MSE

**Table I.1.** Primary objectives, evaluated over a simulated ten-year period, accepted by the Commission at the 7<sup>th</sup> Special Session of the Commission (SS07). Objective 1.1 is a biological sustainability (conservation) objective and objectives 2.1, 2.2, and 2.3 are fishery objectives. Priority objectives are shown in green text.

GENERAL OBJECTIVE	MEASURABLE OBJECTIVE	MEASURABLE OUTCOME	TIME-FRAME	TOLERANCE	PERFORMANCE METRIC
1.1. KEEP FEMALE SPAWNING BIOMASS ABOVE A LIMIT TO AVOID CRITICAL STOCK SIZES AND CONSERVE SPATIAL POPULATION STRUCTURE	Maintain the long-term coastwide female spawning stock biomass above a biomass limit reference point at least 95% of the time	$B < \text{Spawning Biomass Limit } (B_{Lim})$  $B_{Lim} = 20\%$ unfished spawning biomass	Long-term	0.05	$P(SB < SB_{Lim})$
	Maintain a defined minimum proportion of female spawning biomass in each Biological Region	$p_{SB,2} > 5\%$ $p_{SB,3} > 33\%$ $p_{SB,4} > 10\%$ $p_{SB,4B} > 2\%$	Long-term	0.05	$P(p_{SB,R} < p_{SB,R,min})$
2.1 MAINTAIN SPAWNING BIOMASS AT OR ABOVE A LEVEL THAT OPTIMIZES FISHING ACTIVITIES	Maintain the long-term coastwide female spawning stock biomass at or above a biomass reference point ( $B_{36\%}$ ) 50% or more of the time	$B < \text{Spawning Biomass Target } (B_{Targ})$  $B_{Targ} = B_{36\%}$ unfished spawning biomass	Long-term	0.50	$P(SB < SB_{Targ})$
2.2. PROVIDE DIRECTED FISHING YIELD	Optimize average coastwide TCEY	Median coastwide TCEY	Short-term		Median $\overline{TCEY}$
	Optimize TCEY among Regulatory Areas	Median $TCEY_A$	Short-term		Median $\overline{TCEY_A}$
	Optimize the percentage of the coastwide TCEY among Regulatory Areas	Median $\%TCEY_A$	Short-term		Median $\left(\frac{\overline{TCEY_A}}{\overline{TCEY}}\right)$
	Maintain a minimum TCEY for each Regulatory Area	Minimum $TCEY_A$	Short-term		Median $Min(TCEY)$
	Maintain a percentage of the coastwide TCEY for each Regulatory Area	Minimum $\%TCEY_A$	Short-term		Median $Min(\%TCEY)$
2.3. LIMIT VARIABILITY IN MORTALITY LIMITS	Limit annual changes in the coastwide TCEY	Annual Change (AC) > 15% in any 3 years	Short-term		$P(AC_3 > 15\%)$
		Median coastwide Average Annual Variability (AAV)	Short-term		Median AAV
	Limit annual changes in the Regulatory Area TCEY	Annual Change (AC) > 15% in any 3 years	Short-term		$P(AC_3 > 15\%)$
		Average AAV by Regulatory Area ( $AAV_A$ )	Short-term		Median $AAV_A$

**APPENDIX B**  
**SUPPLEMENTARY MATERIAL**

The MSE technical document (IPHC-2022-MSE-01) and is available on the IPHC MSE page (<https://www.iphc.int/management/science-and-research/management-strategy-evaluation>).

The MSE Explorer will also be updated with additional results.

(<http://shiny.westus.cloudapp.azure.com/shiny/sample-apps/MSE-Explorer/>).