PA4_03/i2023
02/03/2023 11:16

Original: English

Northern Swordfish Management Strategy Evaluation (MSE) – Background, Structure, and Key Decision Points

Executive Summary

This document describes core concepts of the North Atlantic swordfish management strategy evaluation (MSE). The intention is to provide sufficient knowledge to facilitate discussion among scientists, fishery managers and other stakeholders, commencing with the First Intersessional Meeting of Panel 4 on North Atlantic Swordfish MSE on 6 March 2023 and continuing in the lead up to scheduled adoption of a management procedure (MP) in November 2023. This document summarizes the MSE structure and process.

Introduction

Science underpins the management decisions made by ICCAT - its Standing Committee on Research and Statistics (SCRS) leading this provisioning of science-based advice. An important task of the SCRS is to carry out population assessments and advise the Commission on conservation and management measures. The 2015-2020 Science Strategic Plan for the functioning and orientation of the SCRS (adopted at the 19th Special Meeting of the Commission, Genova, November 2014) identified the need for a robust advice framework consistent with the Precautionary Approach. In response, SCRS has been developing a Management Strategy Evaluation (MSE) framework to take into account sources of uncertainty. This simulation framework allows current and alternative assessment and advice frameworks to be evaluated with respect to their ability to meet multiple management objectives with acceptable levels of risk. *Recommendation by ICCAT on the Development of Harvest Control Rules and of Management Strategy Evaluation* [Rec. 15-07] articulated the Commission's decision for the development of MSE processes and harvest control rules (HCRs) for priority stocks, including bluefin tuna, albacore tuna, tropical tunas, and North Atlantic swordfish (NSWO).

MSE is intended to be a collaborative process between scientists and decision-makers that involves using computer simulation to assess the relative ability of harvest strategies to achieve a set of management objectives. There are three main elements important for this process:

- Operating models (OMs): a collection of mathematical/statistical models that describe alternative hypotheses of the historical fishery 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 management recommendations from fishery data, and will be evaluated in the MSE;
- Performance metrics (PMs): statistics used to quantitatively evaluate the CMPs against specified management objectives.

The SCRS is charged with completing the technical elements of this process: identifying biological uncertainties; generating the simulation framework; coding the OMs and CMPs; and providing evaluations of tradeoffs among CMPs. The Commission's role is to define the management objectives against which CMPs will be evaluated; define the types of CMPs that are acceptable for development; set the timeframes for management intervals; evaluate the trade-offs among the CMPs; and select a final management procedure (MP) which sets the HCR. The Commission is scheduled to select a MP for NSWO in November 2023 with the MP to be implemented in 2024.

Development of the Northern Swordfish MSE began in 2013. *Recommendation by ICCAT for the conservation of North Atlantic swordfish* [Rec. 13-02] tasked the SCRS with development of a HCR for NSWO. In 2015, the Commission called for adoption of a MP based on an MSE for 8 priority stocks, including NSWO (Rec. 15-07). In 2017, the SCRS developed an integrated, sized-structured stock assessment model for NSWO on which a future MSE would be based. Funds were provided by the Commission in 2018 to develop the simulation framework, and following initial work by the SCRS, an MSE expert was contracted in 2019 to develop the NSWO MSE. MSE development by the SCRS then began in earnest. Continued work led to development and running of computer code that informed the hypotheses to be considered in an OM grid. CMP development is now ongoing and there is a need to refine these CMPs and develop associated

performance metric reports and visualizations that will help evaluate tradeoffs among the CMPs. This important step requires broad consultation and dialogue with the Commission and relevant stakeholders.

The objectives of this document are to:

1. Provide sufficient knowledge to facilitate discussion among scientists, fishery managers and other stakeholders on the development of NSWO MSE; and,
2. Articulate the key decisions needed from the *First Intersessional Meeting of Panel 4 on North Atlantic Swordfish MSE* on 6 March 2023 meeting, along with relevant background information to support Panel 4 in this decisions making.

Items requiring guidance from Panel 4

With many of the technical elements of the simulation framework now complete, the SCRS is seeking guidance and feedback from Panel 4 on five key items.

1. Operating model reference grid and robustness set

Operating models (OM) in the MSE each represents a plausible scenario/a potential truth for the dynamics of the stock and fishery. When there is uncertainty in biological parameters, MSE simulation allows for that uncertainty to be identified and then taken into account in the setting of harvest control rules. For example, natural mortality (M) is the rate at which individuals in the stock die of natural causes. This is also one of the most difficult parameters to estimate in fisheries science and is often highly uncertain. Historical NSWO assessments have often set M at 0.2, but the SWO Species Group judged that this value is equally likely to be 0.1 or 0.3. In this case, we can create three OMs, all identical except for this one parameter which varies among the models—each OM representing a plausible state of nature. When we include multiple uncertainties, we create even more unique combinations of variables. A MSE with two uncertainties (e.g., natural mortality and recruitment variability) each with three possible values, produces nine unique combinations (3 levels of natural mortality, multiplied by 3 levels of recruitment variability), each one of the nine being a unique OM. This differs from typical stock assessment models which often assume a single value for each biological parameter. Harvest control rules are challenged to be robust within this wide range of states of nature in the MSE simulation while still meeting pre-determined management objectives.

In 2017, a NSWO integrated assessment model was developed to provide management advice to the Commission. The Stock Synthesis (SS3) model incorporated CPUE indices from six CPCs/non-contracting parties, an age specific CPUE, catch, and inputs for growth, reproduction, size structure, and fleet selectivity. The initial OM grid was constructed and conditioned using this assessment model as the base case (i.e. each OM developed was a variation of that "base" model). The SS3 model was updated in 2022 with new data and for the first time, incorporated estimates of discard mortality that were previously not considered (for full details of the SS3 model, see the Report of the 2022 ICCAT Atlantic Swordfish Stock Assessment Meeting and Schirripa 2022). This assessment model served as the new base-case model for the OM grid adopted by the SCRS in 2022.

The size and complexity in the NSWO OM grid has varied considerably since it was initially formulated. In the early stages, seven main uncertainties were identified (**Table 1**), with each uncertainty consisting of two to three possible values. This produced an OM grid of 288 unique OMs. Since 2018, the NSWO MSE technical team has been working to evaluate which of these uncertainties are materially important in influencing the stock dynamics and this resulted in two major revisions to the grid. In 2021, the NSWO MSE technical team identified a redundancy in two of the uncertainties and the OM grid was revised by combining two of the data weighting uncertainty parameters into a single parameter, reducing the grid to 216 OMs (**Table 2**). In 2022, the OM grid was reduced again, from 216 OMs to nine OMs (**Table 3**). The reduction in uncertainty parameters was the result of analysis that evaluated the relative importance of each source of uncertainty in stock dynamics and under a variety of CMPs (Hordyk *et al.,* 2022). This new grid captures the most consequential uncertainties and was adopted as the OM reference grid by the SCRS in September, 2022. An additional set of 27 OMs (the robustness set), are considered less likely but still possible scenarios, similar to more extreme "sensitivity runs" in a stock assessment (**Table 3**).

The full OM set (reference and robustness sets) consists of 36 OMs. In the reference set, natural mortality and steepness are the two major sources of uncertainty (**Table 3**). All OMs are considered to be equally plausible in this set, so they are weighted equally. In the robustness set, additional uncertainties include 1) increased natural variability in recruitment, 2) removal of catch-at-length data from the fitting process, and 3) an assumed 1% annual increase in catchability for the indices used to condition the OMs. This OM structure is described in detail in the NSWO MSE Trial Specifications Document.

The SCRS welcomes comments and any additional uncertainties that Panel 4 may suggest, noting that these may be included as robustness tests.

2. Approach to the minimum size limit

In 1990, amid concern with regard to the status of the stock, *Recommendation by ICCAT for the conservation of Atlantic swordfish stocks* [Rec. 90-02] introduced a 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). The size limit was supplemented in *Recommendation by ICCAT regarding the implementation of an alternative option for the conservation of undersized Atlantic swordfish and the reduction of fishing mortality* [Rec. 95-10] with an alternative minimum size limit of 119 cm LJFL with no tolerance in the landed catch. The purpose of these recommendations was to reduce mortality in fish that had not yet reached maturity. Subsequent analyses suggest that these size limits may not be achieving their intended purpose. Data from observed fishing sets suggests that mortality in undersized swordfish is high at haulback, with an average mortality rate of 78%. Furthermore, discards reporting of these undersized fish are often sparse in the ICCAT database. The result is a source of mortality in small fish that, prior to 2022, has not been considered in the stock assessment.

Resolution by ICCAT on development of initial management objectives for North Atlantic swordfish [Res. 19-14] (para. 3) requests that the SCRS consider of effects of the minimum size limit in this MSE process:

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

Anticipating the need to address this request from the Commission, in the 2022 ICCAT Atlantic Swordfish Stock Assessment Meeting, the Species Group developed a method to account for this previously unaccounted for mortality. The assessment assumed a minimum legal length for all fleets from 1993 - 2020, and estimated the selectivity and retention curves from the available data. Mortality in the estimated discards was either estimated from the observer data (USA and Canada) or fixed at values taken from the literature (Schirripa, 2022). As this 2022 assessment became the base case for the OM grid, it is incorporated into the current OMs. This method represents an improvement from previous assessments, but the SCRS cautions that this issue is complex. The minimum size may alter fisher behavior (e.g., to successfully avoid/reduce catch of small swordfish) to provide some conservation benefit. Unfortunately, sufficient data to fully evaluate these changes is lacking. An appropriate analysis of the efficacy of minimum size limits would require size composition data from before and after minimum size was put in place and data on spatial-temporal interactions between undersize fish and the fishing fleets. Given these concerns, the SCRS considers that the best approach to evaluating the minimum size limits would be to evaluate the effect on CMP performance through a robustness test, noting that this will require several assumptions. Robustness tests could include scenarios in the projection period where a minimum size limit is eliminated or set at alternative sizes and provide an estimate of dead discarded biomass under varying size limit scenarios.

Noting that this issue is complex and requires additional analysis, the SCRS is seeking advice from Panel 4 on whether to include alternative size limit scenarios (e.g., no minimum size limit; status quo) as robustness tests within this MSE. Should this request be made, the SCRS reminds Panel 4 that CMPs would still be in the form of Total Allowable Catch (TAC) advice with accompanying analysis on the impacts of the minimum size limit.

3. Management objectives and performance metrics

A key feature of the MSE process is that performance of proposed HCRs is measured against pre-determined reference points and management objectives. This process explicitly identifies target biomass and fishing mortality levels and evaluates the probability of achieving those objectives while also specifying pre-agreed management actions when thresholds and targets are breached.

For the NSWO stock, ICCAT called for development of a limit reference point for swordfish (Rec. 09-02), and the Commission adopted $0.4*B_{MSY}$ as the interim limit reference point in 2013 (Rec. 13-02). Noting that additional reference points are useful for constructing harvest strategies, the Commission proposed a set of conceptual management objectives (Res. 19-14) for stock status, safety, yield, and stability for NSWO. The SCRS received preliminary feedback from Panel 4 on the minimum probabilities of achieving these conceptual management objectives and are described in the 2021 Report of the Intersessional meeting of Panel 4 (Anon., 2021), and as follows:

Status: the probability of being in the Green Zone of the Kobe matrix should be 50-60% (the SCRS interprets as this applying to female spawning biomass);
Safety: the probability that the stock is below B_{LIM} is 5-10% (in terms of female spawning biomass);
Stability: 15-25% maximum change in TAC between management cycles.

The SCRS considers **Table 4** as a summary of metrics based on the feedback of Panel 4 in 2021. The SCRS considers these to be preliminary values as feedback was received from only one CPC and is seeking confirmation from Panel 4 that these (or alternative) probability values be used as minimum standards that CMPs must achieve in the multi-step tuning process described in decision item 4. Panel 4 may also consider indicating a hierarchy of importance in the conceptual management objectives. Having such a hierarchy assists greatly in MP selection. This is because it defines the sequence with which a broad set of MPs can be eliminated from consideration.

Panel 4 should note that the current B_{LIM} ($0.4*B_{MSY}$) for NSWO is considered to be an "interim limit reference point" and this has been the case since it was first proposed in 2013, pending additional analysis. The ICCAT working groups have completed some work on B_{LIM} for NSWO (e.g. Sharma and Arocha 2017) but the SCRS requires further analysis before making recommendations on this reference point. The ICCAT Working Group on Stock Assessment Methods is exploring reference points for ICCAT stocks, but that work is outside of the scope of the NSWO MSE and will not be completed this year. The Group also noted that ICCAT uses $40\%SSB_{MSY}$ as the LRP for northern albacore and Atlantic bluefin as well. Additionally, IOTC uses $40\%SSB_{MSY}$ as the LRP for swordfish, yellowfin and albacore. The SWO MSE technical team suggests that Panel 4 may wish to consider the B_{LIM} ($0.4*B_{MSY}$) LRP as acceptable for this MSE until such a time where other analyses might suggest an alternative value is more appropriate.

Where conceptual management objectives set general standards for evaluating the CMPs, performance metrics (PMs) set out more detailed criteria for evaluating CMPs in that they specify both probability values, and the years over which those values are calculated. With the aim to ensure that the performance statistics being considered for NSWO are consistent with the recent deliberations that occurred at ICCAT for adopting the bluefin tuna (BFT) management procedure (MP), the SCRS has developed a set of PMs (**Table 4**) that are consistent with other ICCAT efforts and are relevant to the biology of the stock (for instance, the projection time periods over which specific performance metric should be calculated may be different for NSWO compared to BFT, along with differences such as initial starting status, biological differences in growth by sex, and reproductive patterns). While the most important reference point feedback needed from Panel 4 at this March 6 meeting is on the probability values for the conceptual management objectives, the SCRS is providing this list so that the Panel may start considering additions, removals, or modifications to these PMs over the coming months.

Additional performance statistics such as those considered for BFT (*Recommendation by ICCAT establishing a management procedure for Atlantic bluefin tuna to be used for both the western Atlantic and eastern Atlantic and Mediterranean management areas* [Rec. 22-09]) and/or ALB (*Recommendation by ICCAT on conservation and management measures, including a management procedure and Exceptional Circumstances Protocol, for North Atlantic albacore* [Rec. 21-04]) could be calculated in addition to the set presented in **Table 4**.

The SCRS requests that Panel 4 operationalize the conceptual management objectives by defining probability values for status, safety and stability. The SCRS also requests that Panel 4 begin considering the suggested PMs and identify modifications to this list as it sees fit.

4. CMP specifications

The SCRS is seeking guidance from Panel 4 on items related to CMP development, their format, and over how many years they provide management advice.

CMP outputs

Management procedures (MPs) are pre-agreed decision rules that dictate a particular harvest strategy based on management objectives and stock status. A set of CMPS are tuned to maximize yield while still satisfying standards for status, safety, and stability at agreed probabilities. For example, from one management cycle to the next, if indicators suggest an improvement in a stock indicator, the decision rule in the MP may increasing the TAC to a level that still satisfies the management objectives. NSWO is currently managed through setting a TAC after each assessment. The SCRS is seeking guidance from Panel 4 on the type of harvest control rule that is to be generated by the CMPs. The SCRS recommends that CMPs be formulated to provide a TAC for the entire Atlantic for the subsequent management cycle, while using robustness tests to report on the impacts of the minimum size limits.

CMP types

CMPs generally fall into two categories: empirical CMPs and model based CMPs. These differ in how they process data inputs. An empirical CMP use indices of abundance to directly set the TAC. In a simple empirical CMP, an increase in an indicator(s) may result in an increase in TAC, should other management objectives still be satisfied. A model-based CMP, on the other hand, feeds available data into an assessment model and uses model outputs related to stock status to inform the decision rule (while also still satisfying the management objectives). There are trade-offs between these two approaches that depend on model assumptions, stock biology, and quality of data inputs. There is precedent for both approaches at ICCAT: northern albacore (ALB) MSE uses a model-based approach, whereas BFT MSE uses an empirical approach. In NSWO MSE, initial development has focused on model-based approaches that use an aggregated data input that indexes all major fleets in the North Atlantic. As development continues, the SCRS would also like to examine the performance of empirical MPs, and with a variety of CPC indices and then evaluate the tradeoffs in performance of the approaches. The SCRS is seeking Panel 4's endorsement of this path forward.

Process for tuning and eliminating CMPs

NSWO CMP development is limited to a single team consisting of ICCAT CPC scientists who work collaboratively to produce and evaluate CMPs. This team requires guidance from Panel 4 on CMP minimum/maximum standards that CMPs must meet, and on a process for eliminating CMPs and tuning those that remain. The SCRS is proposing a multi-step process for culling and tuning CMPs. In the first step of this process, CMPs are tuned to a common target and compared to the PMs. Through an iterative process, CMPs would be redeveloped to improve performance and then evaluated against a set of minimum performance standards. For example, should Panel 4 suggest that a minimum standard for CMPs be that they result in a less than 10% probability of the stock falling below B_{LIM}, any CMPs that fail to achieve this benchmark would be eliminated from consideration. In subsequent rounds of tuning, the development group would eliminate any CMPs that were dominated by others (i.e., those for which other CMPs performed better across all criteria). Finally, a small subset of the best performing CMPs would then be presented to Panel 4, which would make a final decision on the CMP to be selected for providing management advice.

Management Cycles

The management cycle refers to how frequently the MP is updated with new data to produce management advice (**Table 5**). It also outlines how often a new base-case assessment model is used to check MSE stock status assumptions. Lastly, the management cycle defines the frequency at which the MSE is evaluated for exceptional circumstances.

The SCRS has typically conducted a NSWO stock assessment every 3 to 5 years. This 3 to 5 year gap allows adequate time to conduct data collection and progress model development for subsequent assessments. This cycle length also allows the SCRS time to address other requests from the Commission. The SCRS is requesting guidance from Panel 4 on whether it should continue assuming a default minimum cycle length of 3 years, with additional testing of 4 and 5 year management cycles. **Table 5** shows a possible management cycle schedule, assuming 3 year CMP implementation cycle. A stock assessment would be run every two to three management cycles as an additional check on the status of the stock but would not be used to set TAC. A protocol for evaluating exceptional circumstances will be developed in 2024 and will include a description of the frequency at which exceptional circumstance analysis would be conducted relative to other events in the management cycle. The SCRS is requesting feedback from Panel 4 on the planned testing of management cycles proposed here, as well as the management cycle proposal in **Table 5**. Once preliminary CMP results are available, the SCRS will be requesting guidance from Panel 4 on minimum and maximum levels of change in TAC between management cycles should this decision not be made during the First Intersessional Meeting of Panel 4 on 6 March 2023.

5. Overall process

NSWO MSE has been in development for several years and key advances and decisions are required in 2023. *The SCRS is seeking approval from Panel 4 for the overall process outlined in the above decision items as well as the schedule for MSE development in 2023, outlined below and in* ***Appendix A****.*

There are several meetings scheduled in 2023 for review of NSWO MSE progress and results: three Panel 4 meetings (March, June/July, and October), each coinciding with a NSWO MSE ambassador meeting. The SCRS is scheduled to address NSWO MSE at two technical team meetings (January and September), Intersessional meeting of the Swordfish Species Group (including MSE) (May), a regular Swordfish Species Group meeting (September), and a full meeting of the SCRS (September). The objectives of the First Intersessional Meeting of Panel 4 on North Atlantic Swordfish MSE (March) are to review the MSE structure and to discuss decision points listed here. The two subsequent Panel 4 meetings will address other key decision points and review results from the CMP development process. NSWO MSE ambassador sessions will be open to a broader group as accredited by their respective CPCs. The objective of these ambassador sessions is to present results and key decision points to stakeholders. In addition to these meetings, the technical team will be meeting regularly to advance development of CMPs and communications materials. Should Panel 4 and the SCRS be satisfied with the MSE structure and CMPs, the Commission is scheduled to adopt a MP in November 2023, for implementation in 2024.

The SCRS will be communicating results and key topics through a variety of means: for each Panel 4 meeting, a summary document, a more detailed results document, and a slide presentation. Results will also be made available on an interactive website (North Atlantic Swordfish MSE interactive Shiny App) available for the Commission and stakeholders to access at any time. The three ambassador sessions will have their own dedicated slideshow presentations, designed to be accessible to a broad audience.

Other Resources

North Atlantic Swordfish MSE splash page

North Atlantic Swordfish MSE interactive Shiny App (includes preliminary results)

Harveststrategies.org MSE outreach materials (multiple languages)

Table 1. Initial operating model uncertainties (2018).

Variable	***Stock assessment base case model***	***Operating model grid***		
Steepness	0.88 (estimated)	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	
CPUE CV	Fleet specific	0.3	0.6	
Effective sample size of the length comps	Fleet specific	2	20	
Catchability increase	0%	0%	1%/year	
Environmental effects	AMO effect in some fisheries	AMO effect in some fisheries	No environmental effects	

Table 2. Revised operating model uncertainties (early 2022).

Variable	***Stock assessment base case model***	***Operating model grid***		
Steepness	0.88 (estimated)	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	
CPUE Lambda	NA	0.05	1	20
Catchability increase	0%	0%	1%/year	
Environmental effects	AMO effect in some fisheries	AMO effect in some fisheries	No environmental effects	

Table 3. Current operating model uncertainties (2022 - present). The rows shaded yellow represent the uncertainties and their levels included in the reference set of OMs. The rows shaded blue are the uncertainties that are included in the robustness set. The shaded blue factor levels are the values held constant in the reference set.

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	

Table 4. Summary of proposed performance metrics, including years and minimum performance probabilities. For illustrative purposes the equivalent bluefin tuna (BFT) performance statistics are included. Probabilities are calculated across all simulations in a given time block specified by the Year column.

Management Objectives (Res. 19-14)	**Proposed Corresponding Performance Statistics**	**Probability (as per Panel 4 2021)**
Status The stock should have a greater than [__]% probability of occurring in the green quadrant of the Kobe matrix	**PGK_{short}**: Probability of being in the Kobe green quadrant (i.e., SSB≥SSB_{MSY} and F<F_{MSY}) in year 10 **PGK_{long}**: Probability of being in the Kobe green quadrant (i.e., SSB≥SSB_{MSY} and F<F_{MSY}) over years 11-30	50-60%
Safety There should be a less than [__]% probability of the stock falling below B_{LIM} (0.4*B_{MSY} as interim)	**LRP_{short}**: Probability of breaching the limit reference point (i.e., SSB<0.4*SSB_{MSY}) over years 1-10 **LRP_{long}**: Probability of breaching the limit reference point (i.e., SSB<0.4*SSB_{MSY}) over years 11-30	5-10%
Yield Maximize overall catch levels	**AvC10:** Median catches (t) over years 1-10 **AvC30:** Median catches (t) over years 11-30	
Stability Any increase or decrease in TAC between management periods should be less than [__]%	**VarC:** Variation in TAC (%) between management cycles	Maximum of 15 - 25%

Table 5. Proposed schedule for data provision, updating MPs and stock assessments.

Activity					***Data inputs***			
Year	Stock assessment	MP run	MP advice implemented	Exceptional circumstances evaluated	Combined index	Other CPUEs	Catch data	Exceptional circumstance indicators
0		x		x	x	x	x	x
1			x	x				x
2				x				x
3		x		x	x		x	x
4			x	x				x
5	x (alternative)			x				x
6	x	x		x	x	x	x	x
7	x (alternative)		x	x				x

Appendix A

NSWO MSE meeting timing and descriptions for 2023. Note the core modeling, CMP, and communications teams will be meeting intersessionally, outside of this schedule

Timing	***Event***	***Description/objectives***	***Responsibility***
November 2022 [Online]	SWO CMP development workshop 1	*Informal* 3–4-hour CMP development session. Guide participants through CMP creation and tuning process	SWO MSE TT / National scientists
25-26 January 2023 [Online]	SWO MSE TT meeting	Review progress on SWO MSE; develop proposals for PA4 to consider	SWO MSE TT / National scientists
February/March 2023 [Online]	SWO CMP development workshop 2 (if needed)	*Informal* 3–4-hour CMP development session. Review CMPs developed by CPC scientists and review tuning procedures	SWO MSE TT / National scientists
6 March 2023 [Online/In-person]	Panel 4 meeting	PA4 to consider MSE overview and proposals from SWO SG and provide feedback on performance metrics, advice intervals, CMPs	PA4 / SWO MSE TT
March/April 2023 [Online]	SWO MSE ambassador session	A communications session open to managers and stakeholders on SWO MSE progress.	SWO MSE communications and MSE TTs
22-26 May 2023 [In-person]	Intersessional SWO SG and MSE TT	Full species group to review MSE progress, particularly regarding CMP development.	SWO Species Group / MSE TT
1 June 2023*	Panel 4 meeting	PA4 to review progress on CMP development and consider trade-offs among CMPs	PA4 / SWO MSE TT
May/June 2023 [Online]	SWO MSE ambassador session	A communications session open to managers and stakeholders on SWO MSE progress.	SWO MSE communications and MSE TTs
4-5 September 2023 [Online]	SWO MSE TT meeting	Two-day meeting to review progress on SWO MSE and narrow down list of CMPs	SWO MSE TT / National scientists
September 2023 [In-person]	SG and SCRS Plenary	Full species group to consider smaller set of CMPs and review tuning and performance	SWO MSE TT, SWO SG
October 2023 [Online]	SWO MSE ambassador session	A communications session open to managers and stakeholders on SWO MSE progress.	SWO MSE communications and MSE TTs
10-11 October 2023 [Online]	Panel 4 meeting	Two days. PA4 to provide feedback on small set of CMPs and tunings	PA4 / SWO MSE TT
November 2023 [In-person]	Commission meeting	COMM to adopt a CMP for implementation in 2024	COMM
2024	Develop exceptional circumstances protocol		SWO MSE TT / PA4

*Assuming that this meeting occurs on 1 June 2023.