Report of the First Intersessional Meeting of Panel 4 on
North Atlantic Swordfish Management Strategy Evaluation (MSE)
(Online, 6 March 2023)

1. Opening of the meeting and meeting arrangements

The meeting was opened by the Chair of Panel 4, Mr. Amar Ouchelli (Algeria).

2. Appointment of Rapporteur

Dr Lisa Crawford (United States) was appointed as rapporteur.

3. Adoption of Agenda

A representative of the Standing Committee on Research and Statistics (SCRS) suggested revisions to the Agenda to better align the discussion with the structure of the SCRS presentation. While appreciating the SCRS suggestion, the Panel chose to follow the Agenda as originally circulated and adopted it without changes (PA4_01/i2023). The Agenda was adopted (**Appendix 1**).

The Chair introduced the 13 Contracting Parties present at the meeting: Algeria, Canada, Côte d'Ivoire, Egypt, European Union, France (SPM), Gabon, Guinea Rep., Japan, Mexico, Morocco, United States and Venezuela.

The Chair also introduced the two ICCAT Cooperating Non-Contracting Parties, Entities or Fishing Entities present at the meeting, Chinese Taipei and Costa Rica. Finally, the Chair introduced three Non-Governmental Organisations attending as observers: EAC (Ecology Action Centre), SCIAENA (*Associaçao de Ciencias Marinhas e Cooperaçao*), and The Ocean Foundation.

The List of Participants is contained in **Appendix 2.**

4. Review of the N-SWO MSE framework

Dr Kyle Gillespie (SCRS Swordfish Species Group Coordinator and North Atlantic Swordfish (N-SWO) Rapporteur) presented the information contained in the documents 'North Atlantic Swordfish MSE – Background & Structure' (**Appendix 3**) and 'Northern Swordfish Management Strategy Evaluation (MSE) – Background, Structure, and Key Decision Points' (**Appendix 4**). The aim of the presentation was to update the Panel on the progress of N-SWO MSE work so far and to highlight key decision points that would require Panel input during the course of 2023. He provided general biological, behavioral, and fisheries information related to N-SWO as well as background on ICCAT's efforts to conserve and manage the stock, noting that N-SWO was considered rebuilt as of 2009. As of the 2022 ICCAT Atlantic Swordfish Stock Assessment, the stock was in the green zone of the Kobe plot (not overfished and overfishing not occurring). He noted that the current Total Allowable Catch (TAC) of 13,200 t has a 60% probability of the stock being in the green quadrant of the Kobe plot.

Dr Gillespie provided an overview of the primary components of MSE, including the operating models (OMs), the candidate management procedures (CMPs), and management objectives together with related performance metrics (PMs), the latter of which are used to assess the CMPs against management objectives to be agreed by Panel 4. Conceptual management objectives for the N-SWO MSE are described in *Resolution by ICCAT on development of initial management objectives for North Atlantic swordfish* (Res. 19-14) and include safety (probability of stock falling below B_{LIM}), stock status (the probability of the stock occurring in the green zone of the Kobe plot), stability (any increase or decrease in TAC between time periods), and yield (maximum overall catch levels). Mixing between the northern and southern stocks of swordfish or between the northern and Mediterranean stocks is not considered significant; thus, population dynamics models are simpler than for those species where stock mixing is an issue, such as bluefin tuna.

OM reference grid and robustness set

The nine OMs used in the MSE (reference grid) represent equally plausible scenarios of states of nature of N-SWO and are weighted equally. Various axes of uncertainty are incorporated into the OMs and thereby accounted for in the MSE simulation. The N-SWO OM reference grid was originally developed in 2018, and since then there have been two major revisions, which are explained in depth in (**Appendix 4**). The current grid of nine OMs captures the main sources of uncertainty. The primary axes of uncertainty for N-SWO are steepness and natural mortality as these parameters have the largest impact on stock dynamics; however, they are unpredictable and difficult to measure empirically. An additional set of 27 OMs are included as a robustness set and represent less likely scenarios than the OMs in the reference grid, but are still possible (similar to more extreme "sensitivity runs" in a stock assessment) and, therefore, merit review.

Robustness tests

Steepness is commonly defined as the fraction of recruitment from an unfished population obtained when the spawning stock biomass is 20% of its unfished level (Mangel *et al.,* 2010). The greater the steepness value, the higher the resilience of the stock to fishing. This value is biologically driven. There are limited data to support estimating this value. The SCRS recommended examining a higher value for steepness (h) in robustness tests and reporting back to Panel 4 to solicit feedback. The Panel supported this recommendation. According to the SCRS, recent studies of N-SWO life history estimate steepness over 0.9.

Minimum Size: A minimum size limit of 125 cm lower jaw fork length (LJFL) with a tolerance of 15% in landed catch was adopted in *Recommendation by ICCAT for the conservation of Atlantic swordfish stocks* [Rec. 90-02]. An alternative minimum size of 119 cm LJFL with no tolerance was adopted 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]. Discard reporting for these undersized fish is sparse and, prior to 2022, such data have not been included in stock assessments for most fisheries. Given the complexities associated with evaluating the effectiveness of minimum size limits as outlined in 'Northern Swordfish Management Strategy Evaluation (MSE) – Background, Structure, and Key Decision Points'. The SCRS recommended assessing size limits using robustness tests. Panel 4 agreed with this approach.

Illegal, unreported, and unregulated (IUU) fishing/underreporting: A CPC requested that the SCRS conduct a robustness test to assess the effect of IUU fishing and other under-reporting, including of dead discards, to determine if a CMP is robust to the underestimation of total fishing mortality. The SCRS noted that it has already modified the MSE modeling framework to account for underreporting of dead discards and agreed that IUU fishing could be explored by accounting for additional mortality in robustness tests.

Climate Change: CPCs strongly supported the SCRS suggestion that the impact of changing alternative environmental conditions on CMP performance be examined in additional robustness tests, noting the importance of the effects of climate change in that regard.

Selectivity: The Panel supported the SCRS suggestion to assess the effect of a 1% annual increase in catchability (q) in catch per unit effort (CPUEs) in the projection years.

Overall process

Throughout 2023 there will be three Intersessional Meetings of Panel 4 on North Atlantic Swordfish MSE, which will be held online, as well as the Panel 4 sessions at the ICCAT Annual meeting. In addition, three SCRS Species Group and MSE technical team meetings will be held during 2023 as well as three N-SWO MSE Ambassador meetings. Tentative meeting timing for the Ambassador meetings was provided in **Addendum 1 to Appendix 4.**

The Panel expressed concern about the limited time period between the Intersessional Meeting of the Swordfish Species Group (including MSE), which will be held from 22-26 May 2023 and the Second Intersessional Meeting of Panel 4 on North Atlantic Swordfish MSE, planned for 1 June 2023. The Panel noted that finalizing the necessary scientific materials to provide sufficient time for CPC preparations during such a compressed time period would be very difficult. In light of this, the Panel agreed to delay the next Intersessional Meeting Panel 4 until 30 June 2023. Further, there was agreement that an Ambassador meeting should be held before that meeting.

5. Discussion on operationalizing the conceptual management objectives (Res. 19-14) and guidance on performance metrics

To facilitate dialogue between managers and scientists, Dr Gillespie presented information on the key decisions requiring feedback from Panel 4. This information and relevant discussion is summarized below.

Key decision: Determine probability values for the conceptual management objectives found in Res. 19-14

Prior to discussing the conceptual management objectives outlined in Res. 19-14, Dr Gillespie explained the procedure for developing and testing CMPs. Throughout development, CMPs are tuned to common targets to make comparisons and allow for evaluation against minimum thresholds. These thresholds are set using the probability values that are agreed for the relevant management objectives. Therefore, in order for the SCRS to continue with CMP development, the SCRS needed Panel 4 to begin to develop operational management objectives taking into account the conceptual objectives included in Res. 19-14 by providing at least interim probability values.

Stock Status

Res. 19-14 provides the following text for the stock status conceptual management objective: "The stock should have a greater than [_]% probability of occurring in the green quadrant of the Kobe matrix." Prior to entering into discussions on the actual probability value, the United States provided a clarifying edit to start to bring this management objective into greater alignment with more recent work of the Commission and better reflect how the SCRS evaluates this management objective. The Panel agreed to the following revised phrasing: "The stock should have a [_]% or greater probability of occurring in the green quadrant of the Kobe matrix."

With respect to the probability value, CPCs offered diverging views, with some offering support for a 50% minimum probability value and others preferring 60% or greater for consistency with what was done for bluefin tuna and northern albacore. During discussions, it was noted that *Recommendation by ICCAT amending the Recommendation for the conservation of North Atlantic swordfish, Rec. 16-03* [Rec. 17-02] paragraph 1 establishes that the probability of N-SWO being in the green quadrant of the Kobe plot as *greater* than 50%. In light of the terms of Rec. 17-02, one CPC stated that, if a value below 60% was to be considered, it was not appropriate to set the minimum for testing below 51%. It was further noted that the current TAC has a 60% probability of the stock being in the green. Given the differing views expressed, it was noted that, as the SCRS was requesting input on a minimum threshold for initial testing, 51% would allow the SCRS to assess higher values, including 60%, while ensuring consistency with the terms of the current N-SWO management measure. The Panel agreed on this way forward, although some CPCs reiterated their preference for a much higher stock status probability value.

Safety

Res. 19-14 provides the following text for the safety conceptual management objective: "There should be a less than [_]% probability of the stock falling below B_{LIM}." Prior to entering into discussions on the actual probability value, the United States provided a clarifying edit to better align this management objective with more recent work of the Commission, and better reflect how the SCRS evaluates this management objective. The Panel agreed to the following revised phrasing: "There should be a [_]% or less probability of the stock falling below B_{LIM} at any point during the 30-year evaluation period."

With respect to the probability value, the SCRS noted that the safety probability for bluefin tuna is 15% and suggested this value as a potential starting point for N-SWO. One CPC suggested 15% was too high and the limit should be either 5% or 10%. Several CPCs stated that it seemed premature to exclude 15% and indicated a preference for the SCRS to test a range of values, namely 15%, 10%, and 5%. This approach would provide a range of results from the CMP testing for evaluation by the Panel with a view to making a final decision on the safety probability value later in 2023.

Stability

Regarding the stability statistic, the SCRS sought feedback from the Panel regarding possible limits on the change in TAC to be allowed between management cycles. Dr Gillespie informed the Panel that no constraints are required by the MSE. He noted that the MSE can be applied without stability constraints and that this would allow the SCRS to report back to the Panel with the results of testing so the Panel could consider at a future meeting if establishing limits on TAC changes between management periods was desirable. The SCRS Chair further noted that such limits can be built into the MSE or established later, as needed. In the first case, the limits become part of the rules governing CMP culling should it breach the established limits. In the latter case, the Panel can decide and implement stability values after it sees the results of testing and is considering tradeoffs among multiple CMPs. One CPC requested that 25% be established as a maximum cap on stability. Other CPCs advocated for testing to occur with no limits on TAC increases or decreases between management periods. A CPC highlighted that the approach to stability may differ depending on whether the management period that is eventually adopted is empirically based or model based. That CPC recalled the case of northern albacore, which specifies that the 25% limit on TAC increases and the 20% limit on TAC decreases only applies when $B_{current}$ is greater than or equal to $B_{threshold}$ (i.e., the stock is in the green), noting that it is appropriate not to limit the percent that a TAC can decrease between management periods if the stock falls out of the green. The Panel agreed that the SCRS should test CMPs using a 25% limit on TAC increases between management periods as well as with no limits on TAC changes.

Yield

As no probability values are associated with Yield, discussions related to the performance metrics were held under the next subsection.

Key decision: Determine key performance metrics for CMPs, their probability values, and over which years they are to be calculated

The Chair opened discussion on the proposed corresponding performance statistics for the management objectives discussed above. These performance statistics can be found in **Addendum 1 of Appendix 3**. As a general note, one CPC suggested that the listed time frames should be adjusted to the following: Short term: 1-10 years, mid-term: 11-20 years, and long-term: 20-30 years. The Panel agreed all the performance statistics for Status, Safety, and Yield should be evaluated along these timeframes. The SCRS noted that some CMPs need time to allow the stock to achieve the safety management objective as some OMs have the stock below B_{MSY} at the start of the evaluation period. Evaluating CMP performance with respect to safety in the early part of the evaluation period could lead to some CMPs being unnecessarily culled.

A CPC asked the SCRS if it intended to only present information on performance regarding the terminal year of the 30-year evaluation period, such as PGK, noting that this could inaccurately capture the CMP performance over the full course of the evaluation period. The SCRS stated that calculating a value for the terminal year alone may result in a large proportion of the time series not being examined for PGK or other performance metrics. For that reason, the Panel requested that the SCRS examine and provide information to the Panel on the performance statistics (e.g., probability of the stock to be in the green quadrant of the Kobe plot (PGK), limit reference point (LRP), and average catch (AvC)) on a time series so that CMP performance can be assessed over the course of the evaluation period as well as at the terminal year. Further, as with bluefin tuna, the SCRS should provide performance statistics for evaluating other aspects of stock status beyond PGK, such as overfishing (POF), with the understanding that these additional statistics could need some modification to work in the N-SWO MSE.

In terms of other performance statistics for yield, several CPCs asked the SCRS to also provide Catch in year 1 (C1) as an output of CMP testing to assess performance with respect to Yield. Given the preliminary nature of the MSE process, it was understood that the Panel may request additional performance statistics in the future to help assess CMP performance.

For the safety management objective, the SCRS set the interim LRP at 40% B_{MSY} as specified by the Commission in various N-SWO Recommendations, noting as well that this value is used for northern albacore and bluefin tuna. The SCRS suggested Panel 4 should consider 40% as acceptable unless and until other analyses indicate that another value is more appropriate. The Panel agreed with this recommendation.

Key decision: Identify any minimally acceptable levels for key performance metrics, which would eliminate a given CMP from further consideration if those criteria are not met

The Panel briefly discussed how CMPs might be evaluated to determine which should be retained for further consideration and which culled. It was noted that the approach used for bluefin tuna could be followed for N-SWO where the safety and status management objectives had to be satisfied through the MSE testing process before the Panel considered the tradeoffs between stability and yield. The Panel agreed to consider these questions further once outputs from CMP testing were available.

Key decision: Provide feedback to the SCRS on an interval schedule for applying the adopted management procedure (MP), reviewing MP performance, and conducting stock assessments

Management cycles/advice intervals

The proposed interval schedule for applying the adopted MP, evaluating exceptional circumstances, and conducting stock assessments (i.e., reviewing the MP) was presented by the SCRS. The Panel asked the SCRS to update the table to clarify that the term 'stock assessment' was intended to reflect the year that a review of the MP would be carried out. The SCRS noted that the table was assuming a three-year management period but that longer management periods, such as four or five years could be evaluated. In the table as presented, an MP adopted at the 2023 ICCAT Annual meeting would set the TAC starting in 2024 through 2026. Under the three-year management period scenario, the MP would need to be run again in 2026 to set the TAC for the next cycle (2027-2029). The SCRS advised conducting a stock assessment to review the MP after two management cycles (i.e., 2029), which would bring in new biological data and allow for an evaluation of how well the MP is functioning. The SCRS would check for exceptional circumstances every year and advise the Commission in line with an exceptional circumstances protocol which would be developed and agreed in 2024. One CPC offered their strong support for a three-year management cycle. Another CPC indicated that if a three-year management procedure were set, review of the MP by the SCRS may need to begin in years four or five to be completed by year six and that the review may include reconditioning of the MSE, particularly in the case of exceptional circumstances. The SCRS explained that the MSE model structures are robust to changing data and noted that reconditioning of the MSE may or may not be required when a review of the MSE (i.e., stock assessment) is done. The Panel agreed that a three-year management period should be the minimum, particularly in the case of empirical CMPs. The SCRS noted that if a longer period is of interest to the Panel, the timetable would need to be revised. For instance, the MP review would likely be needed in year eight if a four-year management period were adopted. The SCRS indicated its intention to update the proposed cycle in light of CPC comments and noted that longer or shorter management periods could be tested once the number of CMPs has been reduced.

6. Review of CMPs in development by the SCRS and their tuning

Key decision: Determine the types of CMPs to be developed (management actions; assessment model-based vs empirical procedures; etc.)

CMP specifications

Model-based CMPs use data inputs to generate model outputs like B/B_{MSY} to inform decision rules, while empirical CMPs set index targets, calculate the ratio of the current index relative to the target, and set the TAC using the ratio. The Panel agreed to the SCRS recommendation to allow for examination of both model-based and empirical CMPs, allow for various indices to be used in CMP development, and allow the CMPs to set the TAC for all of the North Atlantic region regardless of gear type.

Key decision: Approval of process for narrowing (culling) of CMPs to retain a reduced subset for further development

Panel 4 agreed that the CMP culling process should generally follow the process used for the bluefin tuna MSE, as presented by the SCRS. Given the preliminary nature of the operational management objective discussions; however, the Panel agreed that this issue would need further consideration at a later meeting. Specifically, only interim advice had been given by the Panel on the percentage values to be evaluated through MSE with respect to the status, safety, and stability management objectives. CMP testing based on these interim objectives should result in a range of outputs related to the performance of the CMPs for consideration by the Panel at its next meeting. This feedback will allow management objectives to be refined and inform future discussions and decisions on culling CMPs.

7. Feedback and guidance on trade-offs and additional changes to CMPs by Panel 4 to SCRS

Key decision: Feedback on trade-off preferences and how they may be presented graphically

The Panel did not discuss this decision point.

8. Other matters

8.1 Decide how to proceed regarding para 25 of Recommendation by ICCAT on the conservation of North Atlantic stock of shortfin mako caught in association with ICCAT fisheries (Rec. 21-09) *and Recommendation by ICCAT on the conservation of the South Atlantic stock of shortfin mako caught in association with ICCAT fisheries* (Rec. 22-11)

Regarding the provision in both the North and South shortfin mako Recommendations calling for ICCAT to hold a meeting of stakeholders in 2023 to share best practices on ways to reduce interactions with and mitigate mortality of these stocks, it was noted that the 2023 ICCAT meeting schedule was very full. It was also noted that it should be possible to hold the meeting in early 2024 and still ensure its objectives are met, including providing information to SCRS so it can provide a response to the Commission in 2024. An early 2024 meeting was the preference of the SCRS Shark Species Group. One CPC indicated its preference to hold the meeting in 2023 but noted it could go along with a meeting held in early 2024 under the circumstances.

9. Adoption of report and closure

The Chair thanked the ICCAT Secretariat, interpreters, and participants for their hard work and adjourned the meeting. The Panel agreed to adopt its report by correspondence.

References

Mangel, M., Brodziak, J., & DiNardo, G. 2010. Reproductive ecology and scientific inference of steepness: A fundamental metric of population dynamics and strategic fisheries management. Fish and Fisheries, 11(1), 89–104. https://doi.org/10.1111/j.1467-2979.2009.00345.x

Appendix 1

Agenda

1. Opening of the meeting and meeting arrangements

2. Appointment of Rapporteur

3. Adoption of Agenda

4. Review of the N-SWO MSE framework

5. Discussion on operationalizing the conceptual management objectives (Res. 19-14) and guidance on performance metrics

    - Key decision: Determine probability values for the conceptual management objectives found in Res. 19-14

    - Key decision: Determine key performance metrics for Candidate Management Procedures (CMPs), their probability values, and over which years they are to be calculated

    - Key decision: Identify any minimally acceptable levels for key performance metrics, which would eliminate a given CMP from further consideration if those criteria are not met

    - Key decision: Provide feedback to the SCRS on an interval schedule for applying the adopted management procedure (MP), reviewing MP performance, and conducting stock assessments

6. Review of Candidate Management Procedures (CMPs) in development by the SCRS and their tuning

    - Key decision: Determine the types of CMPs to be developed (management actions; assessment model-based vs empirical procedures; etc.)

    - Key decision: Approval of process for narrowing (culling) of CMPs to retain a reduced subset for further development

7. Feedback and guidance on trade-offs and additional changes to CMPs by PA4 to SCRS

    - Key decision: Feedback on trade-off preferences and how they may be presented graphically

8. Other matters

    8.1 Decide how to proceed regarding para 25 of Recs. 21-09 and 22-11 on shortfin mako shark

9. Adoption of Report and closure

Appendix 2

List of Participants[1]

CONTRACTING PARTIES

ALGERIA

Ouchelli, Amar *
Sous-directeur de la Grande Pêche et de la Pêche Spécialisée, Ministère de la pêche et des productions halieutiques, Route des quatre canons, 16000 Alger
Tel: +213 550 386 938, Fax: +213 234 95597, E-Mail: amarouchelli.dz@gmail.com; amar.ouchelli@mpeche.gov.dz

Mennad, Moussa
Ministère de la Pêches et des Ressources Halieutiques, CNRDPA, 11 Bd Colonel Amirouche, 42415 Tipaza
Tel: +213 560 285 239, Fax: +213 243 26410, E-Mail: mennad.moussa@gmail.com

Tamourt, Amira
Ministère de la Pêche & des Ressources Halieutiques, 4, Route des Quatre Canons, 16100 Alger
Tel: +213 664 367 720, E-Mail: miratamourt@gmail.com

CANADA

Waddell, Mark *
Director General, Fisheries and Oceans Canada, 200 Kent Street, Ottawa ON K1A0E6
Tel: +1 613 897 0162, E-Mail: mark.waddell@dfo-mpo.gc.ca

Atkinson, Troy
Nova Scotia Swordfisherman's Association, 155 Chain Lake Drive, Suite #9, Halifax, NS B3S 1B3
Tel: +1 902 499 7390, E-Mail: atkinsontroy215@gmail.com; hiliner@ns.sympatico.ca

Cossette, Frédéric
200 Kent St., Ottawa, Ontario K1A 0E6
Tel: +1 343 541 6921, E-Mail: frederic.cossette@dfo-mpo.gc.ca

Couture, John
Oceans North, 74 Bristol Drive, Sydney NS B1P 6P3
Tel: +1 902 578 0903, E-Mail: jcouture@oceansnorth.ca

Drake, Kenneth
Prince Edward Island Fishermen's Associations, Morell P.E.I. C0A1S0

Duprey, Nicholas
Senior Science Advisor, Fisheries and Oceans Canada, 200-401 Burrard Street, Vancouver, BC V6C 3R2
Tel: +1 604 499 0469, E-Mail: nicholas.duprey@dfo-mpo.gc.ca

Gillespie, Kyle
Aquatic Science Biologist, Fisheries and Oceans Canada, 125 Marine Science Drive, St. Andrews, NB, E5B 0E4
Tel: +1 506 529 5725, E-Mail: kyle.gillespie@dfo-mpo.gc.ca

MacDonald, Carl
Senior Advisor, Fisheries and Oceans Canada, 1 Challenger Drive, PO Box 1006, Bedford Institute of Oceanography, Dartmouth, NS B2Y 4A2
Tel: +1 902 293 8257, E-Mail: carl.macdonald@dfo-mpo.gc.ca

Marsden, Dale
Deputy Director, International Fisheries Policy, Fisheries and Oceans Canada, 200 Kent Street, Ottawa, ON K1A 0E6
Tel: +1 613 791 9473, E-Mail: Dale.Marsden@dfo-mpo.gc.ca

[1] Head Delegate.

CÔTE D'IVOIRE
Diaha, N'Guessan Constance
Chercheur Hydrobiologiste, Laboratoire de biologie des poissons du Département des Ressources Aquatiques Vivantes (DRAV) du Centre de Recherches Océanologiques (CRO), 29, Rue des Pêcheurs - B.P. V-18, Abidjan 01
Tel: +225 21 35 50 14; +225 21 35 58 80, E-Mail: diahaconstance@yahoo.fr; diahaconstance70@gmail.com; constance.diaha@cro-ci.org

EGYPT
Abdelaziz, Mai Atia Mostafa
Production Research Specialist, 210, area B - City, 5th District Road 90, 11311 New Cairo
Tel: +201 003 878 312, Fax: +202 281 117 007, E-Mail: janahesham08@gmail.com

Badr, Fatma Elzahraa
Fish Production Specialist, Agreements Administration, Lakes and Fish Resources Protection and Development Agency, 210, area B - City, 5th District Road 90, 11311 New Cairo
Tel: +201 092 348 338, Fax: +202 228 117 008, E-Mail: fatima.elzahraa.medo@gmail.com

Elsawy, Walid Mohamed
Associate Professor, National Institute of Oceanography and Fisheries, 210, area B - City, 5th District Road 90, 11311 New Cairo
Tel: +201 004 401 399, Fax: +202 281 117 007, E-Mail: walid.soton@gmail.com

Shawky, Doaa Hafez
International Agreements Specialist, Foreign Affairs Specialist, 210, area B - City, 5th District Road 90, 11311 New Cairo
Tel: +201 017 774 198, Fax: +202 281 117 007, E-Mail: doaahafezshawky@gmail.com; doaahafezshawky@yahoo.com; gafrd_eg@hotmail.com

EUROPEAN UNION
Molledo, Luis *
Head of Unit - European Commission, DG Mare B 2, Rue Joseph II, 99, B-1049 Brussels, Belgium
Tel: +32 2 299 24 57; +32 229 95026, E-Mail: luis.molledo@ec.europa.eu

Biagi, Franco
Senior Expert Marine & Fishery Sciences, Directorate General for Maritime Affairs and Fisheries (DG-Mare) - European Commission, Unit C3: Scientific Advice and data collection, Rue Joseph II, 99, 1049 Brussels, Belgium
Tel: +322 299 4104, E-Mail: franco.biagi@ec.europa.eu

Howard, Séamus
European Commission, DG MARE, Rue Joseph II 99, 1000 Brussels, Belgium
Tel: +32 229 50083; +32 488 258 038, E-Mail: Seamus.HOWARD@ec.europa.eu

Amoedo Lueiro, Xoan Inacio
Biólogo, FIP Blues Technical team, Pza. de Ponteareas, 11, 3ºD, 36800 Pontevedra, España
Tel: +34 678 235 736, E-Mail: tecnico@fipblues.com

Coelho, Rui
Researcher, Portuguese Institute for the Ocean and Atmosphere, I.P. (IPMA), Avenida 5 de Outubro, s/n, 8700-305 Olhão, Portugal
Tel: +351 289 700 508, E-Mail: rpcoelho@ipma.pt

Cortina Burgueño, Ángela
Puerto Pesquero, edificio "Ramiro Gordejuela", 36202 Vigo, Pontevedra, España
Tel: +34 986 433 844, Fax: +34 986 439 218, E-Mail: angela@arvi.org

Koutsis, Kostas
Ministry of Rural Development and Food, General Directorate of Fisheries, 150, Syggroy Avenue - GR17671 Athens, 17671, Greece
Tel: +302 109 287 117, E-Mail: kkoutsis@minagric.gr

Mathieu, Héloïse
Comité des Pêches Guadeloupe (CRPMEM-IG), 2 bis rue Schoelcher, 97110 Pointe-à-Pitre, Guadeloupe, France
Tel: +33 590 909 787, E-Mail: mathieu.crpmem971@orange.fr

Orozco, Lucie
Chargée de mission affaires thonières, Direction générale de affaires maritimes, de la pêche et de l'aquaculture (DGAMPA), Bureau des Affaires Européennes et Internationales (BAEI), 1 place Carpeaux, 92055 La Défense, Ile de France, France
Tel: +33 140 819 531; +33 660 298 721, E-Mail: lucie.orozco@mer.gouv.fr

Sarricolea Balufo, Lucía
Secretaría General de Pesca, Ministerio de Agricultura, Pesca y Alimentación, Calle Velázquez, número 144, 28006 Madrid, España
Tel: +34 913 476 170; +34 618 330 518, E-Mail: lsarricolea@mapa.es

Teixeira, Isabel
Chefe de Divisão de Recursos Externos da Direção-Geral de Recursos Naturais, Segurança e Serviços Marítimos, DGRM, Avenida Brasilia, 1449-030 Lisboa, Portugal
Tel: +351 919 499 229, E-Mail: iteixeira@dgrm.mm.gov.pt

Yagüe Sabido, Ismael
C/ Velázquez 144, 28006 Madrid, España
Tel: +34 913 476 178; +34 606 873 653, E-Mail: iyague@mapa.es

FRANCE (ST. PIERRE & MIQUELON)

Haziza, Juliette *
Chargée de mission des négociations thonières, Secrétariat d'Etat à la mer - Direction Générale des Affaires Maritimes, de la Pêche et de l'Aquaculture (DGAMPA), Tour Sequoia, 1 place Carpeaux, 92055 La Défense
Tel: +33 659 542 827, E-Mail: juliette.haziza@developpement-durable.gouv.fr; juliette.haziza@agriculture.gouv.fr

GABON

Angueko, Davy
Chargé d'Etudes du Directeur Général des Pêches, Direction Générale des Pêche et de l'Aquaculture, BP 9498, Libreville Estuaire
Tel: +241 6653 4886, E-Mail: davyangueko83@gmail.com; davyangueko@yahoo.fr

GUINEA REP.

Kolié, Lansana
Chef de Division Aménagement, Ministère de la Pêche et de l'Economie maritime, 234, Avenue KA 042 - Commune de Kaloum BP: 307, Conakry
Tel: +224 624 901 068, E-Mail: klansana74@gmail.com

JAPAN

Morita, Hiroyuki
Assistant Director, International Affairs Division, Fisheries Agency of Japan, 1-2-1 Kasumigaseki, Chiyoda-Ku, Tokyo 100-8907
Tel: +81 3 3502 8460, Fax: +81 3 3504 2649, E-Mail: hiroyuki_morita970@maff.go.jp

Daito, Jun
Manager, Japan Tuna Fisheries Co-operative Association, 31-1, Eitai 2-Chome, Koto-ku, Tokyo 135-0034
Tel: +81 356 462 382, Fax: +81 356 462 652, E-Mail: daito@japantuna.or.jp

Uozumi, Yuji
Advisor, Japan Tuna Fisheries Co-operation Association, Japan Fisheries Research and Education Agency, Tokyo Koutou ku Eitai 135-0034

MEXICO

Rivera Vizcarra, Karla Gabriela
Av. Camarón Sábalo #1210 Fracc. Sábalo Country Club, 82100 Mazatlán, Sinaloa
Tel: +52 669 915 6900, E-Mail: karla.rivera@conapesca.gob.mx

MOROCCO

Bensbai, Jilali
Chercheur, Institut National de Recherche Halieutique à Casablanca - INRH/Laboratoires Centraux, Ain Diab près du Club équestre OULAD JMEL, Rue Sidi Abderrhman / Ain Diab, 20100 Casablanca
Tel: +212 661 59 8386, Fax: +212 522 397 388, E-Mail: bensbaijilali@gmail.com

UNITED STATES

Kryc, Kelly *
U.S. Federal Government Commissioner to ICCAT and Deputy Assistant Secretary for International Fisheries, Office of the Under Secretary for Oceans and Atmosphere, National Oceanic and Atmospheric Administration (NOAA); Department of Commerce, 1401 Constitution Ave, Washington, DC 20230
Tel: +1 202 961 8932; +1 202 993 3494, E-Mail: kelly.kryc@noaa.gov

Banks, Kesley
Harte Research Institute for Gulf of Mexico Studies Texas A&M University-Corpus Christi, 6300 Ocean Drive, Unit 5869, Texas 78412
Tel: +1 361 825 3071, Fax: +1 361 825 2004, E-Mail: kesley.banks@tamucc.edu

Blankenbeker, Kimberly
Foreign Affairs Specialist, Office of International Affairs, Trade, and Commerce (F/IATC), NOAA, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring Maryland 20910
Tel: +1 301 427 8357, Fax: +1 301 713 1081, E-Mail: kimberly.blankenbeker@noaa.gov

Bogan, Raymond D.
Alternate U.S. Recreational Commissioner, Sinn, Fitzsimmons, Cantoli, Bogan, West and Steuerman, 501 Trenton Avenue, P.O. Box 1347, Point Pleasant Beach, Sea Girt New Jersey 08742
Tel: +1 732 892 1000; +1 732 233 6442, Fax: +1 732 892 1075, E-Mail: rbogan@lawyernjshore.com

Cass-Calay, Shannon
Director, Sustainable Fisheries Division, Southeast Fisheries Science Center, NOAA, National Marine Fisheries Service, 75 Virginia Beach Drive, Miami, Florida 33149
Tel: +1 305 361 4231, Fax: +1 305 361 4562, E-Mail: shannon.calay@noaa.gov

Crawford, Lisa
1315 East-West Highway, Silver Spring, Maryland 20910
Tel: +1 301 427 8525, E-Mail: lisa.crawford@noaa.gov

Delaney, Glenn Roger
Alternate U.S. Commercial Commissioner, 601 Pennsylvania Avenue NW Suite 900 South Building, Washington, D.C. 20004
Tel: +1 202 434 8220, Fax: +1 202 639 8817, E-Mail: grdelaney@aol.com

Grubbs, Dean
3618 Highway 98, St. Teresa, FL 32358
Tel: +1 850 445 0652, E-Mail: dgrubbs2@fsu.edu

Keller, Bryan
Foreign Affairs Specialist, Office of International Affairs, Trade and Commerce (F/IATC), NOAA, National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, Maryland 20910
Tel: +1 202 897 9208; +1 301 427 7725, E-Mail: bryan.keller@noaa.gov

McLaughlin, Sarah
Senior Policy Advisor, NOAA - National Marine Fisheries Service, Highly Migratory Species Management Division, 55 Great Republic Drive, Gloucester, Massachusetts 01930
Tel: +978 281 9260, Fax: +978 281 9340, E-Mail: sarah.mclaughlin@noaa.gov

Peterson, Cassidy
Fisheries Biologist, NOAA Fisheries, Southeast Fisheries Science Centre, 101 Pivers Island Rd, Miami, FL 28516
Tel: +1 910 708 2686, E-Mail: cassidy.peterson@noaa.gov

Schirripa, Michael
Research Fisheries Biologist, NOAA Fisheries, Southeast Fisheries Science Center, 75 Virginia Beach Drive, Miami, Florida 33149
Tel: +1 305 445 3130; +1 786 400 0649, Fax: +1 305 361 4562, E-Mail: michael.schirripa@noaa.gov

Sissenwine, Michael P.
Marine Policy Center, Woods Hole Oceanographic Institution, 39 Mill Pond Way, East Falmouth Massachusetts 02536
Tel: +1 508 566 3144, E-Mail: m.sissenwine@gmail.com

Soltanoff, Carrie
Fishery Management Specialist, Highly Migratory Species Management Division, NOAA National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, Maryland 20910
Tel: +1 301 427 8587, Fax: +1 301 713 1917, E-Mail: carrie.soltanoff@noaa.gov

Weber, Richard
South Jersey Marina, 1231 New Jersey 109, Cape May, New Jersey 08204
Tel: +1 609 884 2400; +1 609 780 7365, Fax: +1 609 884 0039, E-Mail: rweber@southjerseymarina.com

VENEZUELA

Evaristo, Eucaris del Carmen
Ministerio del Poder Popular de Pesca y Acuicultura, Corresponsal del Atlántico, Parque Central, Torre Este, piso 17, Caracas
Tel: +58 416 883 3781, E-Mail: eucarisevaristo@gmail.com

Galicia, Jeiris
Directora General de Pesca Industrial, Viceministerio de Producción primaria Pesquera y Acuícola
E-Mail: jgalicia.minpesca@gmail.com; dgpi.minpesca@gmail.com

OBSERVERS FROM COOPERATING NON-CONTRACTING PARTIES, ENTITIES, FISHING ENTITIES

CHINESE TAIPEI

Su, Nan-Jay
Associate Professor, Department of Environmental Biology and Fisheries Science, National Taiwan Ocean University, No. 2 Beining Rd., Zhongzheng Dist., 202301 Keelung City
Tel: +886 2 2462 2192 #5046, Fax: +886-2-24622192, E-Mail: nanjay@ntou.edu.tw

COSTA RICA

Álvarez Sánchez, Liliana
Funcionaria de la Oficina Regional del Caribe – Limón, Instituto Costarricense de Pesca y Acuicultura, 4444
Tel: +506 863 09387, Fax: +506 263 00600, E-Mail: lalvarez@incopesca.go.cr

OBSERVERS FROM NON-GOVERNMENTAL ORGANIZATIONS

ASSOCIAÇAO DE CIENCIAS MARINHAS E COOPERAÇAO - SCIAENA

Blanc, Nicolas
Incubadora de Empresas da Universidade do Algarve, Campus de Gambelas, Pavilhão B1, 8005-226 Faro, Portugal
Tel: +351 917 018 720, E-Mail: nblanc@sciaena.org

ECOLOGY ACTION CENTRE - EAC

Isnor, Holly
Ecology Action Centre - EAC, 2705 Fern Lane, Halifax Nova Scotia B3K 4L3, Canada
Tel: +1 902 580 0600, E-Mail: hollyisnor@ecologyaction.ca

THE OCEAN FOUNDATION

Miller, Shana
The Ocean Foundation, 1320 19th St., NW, 5th Floor, Washington, DC 20036, United States
Tel: +1 631 671 1530, E-Mail: smiller@oceanfdn.org

OTHER PARTICIPANTS

SCRS CHAIRMAN

Brown, Craig A.
SCRS Chairman, Sustainable Fisheries Division, Southeast Fisheries Science Center, NOAA, National Marine Fisheries Service, 75 Virginia Beach Drive, Miami, Florida 33149, United States
Tel: +1 305 586 6589, E-Mail: craig.brown@noaa.gov

*****

ICCAT Secretariat
C/ Corazón de María 8 – 6th floor, 28002 Madrid – Spain
Tel: +34 91 416 56 00; Fax: +34 91 415 26 12; E-mail: info@iccat.int

Manel, Camille Jean Pierre
Neves dos Santos, Miguel
Ortiz, Mauricio
Palma, Carlos
Kimoto, Ai
Taylor, Nathan
Mayor, Carlos
De Andrés, Marisa

ICCAT INTERPRETERS
Baena Jiménez, Eva J.
Calmels, Ellie
Hof, Michelle Renée
Liberas, Christine
Linaae, Cristina
Pinzon, Aurélie

Appendix 3

North Atlantic Swordfish MSE – Background & Structure

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.

Background

The SCRS's Swordfish Species Group has been developing a management strategy evaluation (MSE) framework for North Atlantic swordfish (NSWO) for a decade. In 2009, ICCAT called for development of a limit reference point for swordfish (*Supplemental recommendation by ICCAT to amend the rebuilding program for North Atlantic swordfish* [Rec. 09-02]), and the Commission adopted $0.4*B_{MSY}$[2] as the interim limit reference point in 2013 (*Recommendation by ICCAT for the conservation of North Atlantic swordfish* [Rec. 13-02]). Recommendation 13-02 also tasked the SCRS with development of a harvest control rule for NSWO. In 2015, the Commission called for adoption of a management procedure (MP) based on an MSE for 8 priority stocks, including NSWO (*Recommendation by ICCAT on the Development of Harvest Control Rules and of Management Strategy Evaluation* [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. The Commission adopted conceptual management objectives for NSWO in 2019 (*Resolution by ICCAT on development of initial management objectives for North Atlantic swordfish* [Res. 19-14]) to help guide MSE development. In 2022, the SCRS carried out a new stock assessment in which the base case model was modified to incorporate discard mortality of undersized fish, and the MSE was updated with this new model. The MSE work is on track for ICCAT to adopt an MP in 2023, in accordance with the Commission's MSE workplan.

MSE Overview

The NSWO MSE is built using an open-source MSE software package called openMSE. The package can input information from Stock Synthesis stock assessments (the 2022 ICCAT Atlantic Swordfish Stock Assessment Meeting, in this case) to efficiently create – and then customize – an MSE framework for testing candidate management procedures (CMPs), including the approximately 100 CMPs that come preloaded in openMSE.

Indices of Abundance

Data from six different longline indices and a harpoon index were used in the stock assessment and are used to condition the MSE. A combined index that incorporates data from seven CPCs is being used as the primary index for CMP development. The MSE's historical period is from 1950 through to 2020, and projections cover the subsequent 30 years.

Operating Models

Each operating model (OM) in the MSE represents a plausible scenario/a potential truth for the dynamics of the stock and fishery. The NSWO MSE includes 9 main operating models (i.e., the "reference set or grid of OMs") based on two major sources of uncertainty:

1. Stock productivity: steepness of the relationship between stock size and recruitment potential is one of the most important and uncertain inputs into stock assessments. Practically, this is often thought of as a measure of the stock's ability to rebuild biomass when depleted to a low level (3 options);
2. Natural mortality: the rate at which individuals die of natural causes (3 options).

[2] Spawning stock biomass (SSB; biomass of mature females), is used in this MSE.

The 9 OMs allow for all combinations of these options (3x3=9). All OMs are considered to be equally plausible, so they are weighted equally.

There are also three sets of "robustness" OMs to evaluate the performance of the CMPs under less likely but still possible scenarios, similar to more extreme "sensitivity runs" in a stock assessment. These 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.

An environmental variable related to the Atlantic Multidecadal Oscillation (AMO) is used to modulate catchability in some of the indices. In previous versions of the OM reference grid, the AMO was included as one of the uncertainties. Analyses revealed that use of the environmental covariate had no detectable influence on either the predicted stock size or CMP performance. Therefore, the AMO covariate was included in all models in the reference set. The impact of changing alternative environmental conditions on CMP performance may be examined in additional robustness tests, if desired.

The OMs were developed to match the existing size limit regulations as closely as possible, where fleets have the options of a minimum length of 119 cm lower jaw fork length (LJFL) for retained NSWO, or a 125 cm size limit with a 15% tolerance. As in the most recent NSWO stock assessment, the OMs assume a minimum size limit and associated discard mortality in the fishery. Should Panel 4 wish to test alternative minimum size formulations, the SCRS proposes to do so through the addition of robustness OMs.

Management Objectives

The NSWO MSE currently includes seven key performance statistics as an initial benchmark for evaluation of the Commission's selected management objectives (see **Addendum 1 to Appendix 3**). Panel 4 input is requested to a) operationalize the management objectives (by completing the probability blanks in Res. 19-14 and adding timeframes) and b) provide input on the proposed performance statistics. The former was discussed at the 2021 Intersessional meeting of PA4, but only one CPC provided feedback, so the proposed probabilities are not presented here, as more feedback is needed before these values can be used.

Candidate Management Procedures

The SCRS's Swordfish Species Group is working collaboratively to develop and test a number of CMPs. All CMPs currently assume a 3-year management cycle and calculate a single total allowable catch (TAC) for the North Atlantic. Existing CMPs are all model-based rather than empirical (empirical CMPs use indices of abundance to directly set the TAC rather than putting them through a model). The North Atlantic albacore MP (*Recommendation by ICCAT on conservation and management measures, including a management procedure and Exceptional Circumstances Protocol, for North Atlantic albacore* [Rec. 21-04]*)* is model-based, whereas the Atlantic bluefin tuna MP (*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]) is empirical. Panel 4 input is solicited with regard to CMP specifications, including limits on maximum and/or minimum TAC and maximum/minimum percent change in TAC from one management cycle to the next.

Next Steps

Three Panel 4 meetings are scheduled in 2023 for the exchange of information among the SCRS, Panel 4, and stakeholders in advance of the 2023 Commission meeting. The Swordfish Species Group has also appointed ambassadors to help improve understanding of the MSE and answer questions. The ambassador sessions will be run in English, French and Spanish.

Feedback is requested at the First Intersessional Meeting of Panel 4 in March from managers on the following decisions (described in more detail in NSWO MSE Extended Summary **Appendix 4**):

1. Operating model reference grid and robustness set

Beginning in 2018, the swordfish MSE technical team identified uncertainties and evaluated their relative importance in stock dynamics and under a variety of candidate management procedures. The SCRS has identified the most consequential uncertainties, which now form a core set of nine reference OMs which are being used in CMP testing and development. The SCRS welcomes comments and any additional uncertainties that Panel 4 may suggest, noting that these may be included as robustness tests.

2. Approach for incorporating evaluation of the minimum size limit

Minimum size limits were introduced in the first management measure for Atlantic swordfish (*Recommendation by ICCAT for the conservation of Atlantic swordfish stocks* [Rec. 90-02] and *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]). In subsequent years, it was noted that high levels of at-haulback mortality in undersized fish may be impacting the usefulness of this management measure. Resolution 19-14 requests that the SCRS evaluate this uncertainty within the MSE. The SCRS is seeking clarity from Panel 4 on how to proceed with this request. The issue is complex and requires additional analysis, so the SCRS considers that the best approach would be to evaluate the effect of minimum size limits on CMP performance through a robustness test.

3. Management objectives and performance metrics

The SCRS is requesting that Panel 4 provide threshold probability values and timeframes for the conceptual management objectives found in Res. 19-14. These threshold probabilities for status, safety, and stability will serve as guides for the SCRS in the development of CMPs. Once those probabilities are met, CMPs will be tuned to maximize yield. The SCRS has developed a set of candidate performance metrics to support generating these management objective probabilities, and further recommends that Panel 4 provide their preferences on which performance metrics are to be used. The SCRS is currently using the interim B_{LIM} established in the NSWO recommendations (*Recommendation by ICCAT for the Conservation of North Atlantic Swordfish* [Rec. 13-02]; $B_{LIM} = 0.4*B_{MSY}$) for the performance indicator of Safety.

4. CMP specifications

The SCRS recommends that Panel 4 endorses the development of both empirical and model based CMPs that use a three-year (or longer) management cycle. Additionally, the SCRS recommends that CMPs provide a constant annual Total Allowable Catch (TAC) for each management cycle and that the CMP developers be allowed to use either the longline combined index, or individual, CPC-provided indices. The SCRS requires input from Panel 4 on management cycle length, the minimum and maximum change in TAC between management cycles, and on their desire for potential inclusion of a minimum and/or maximum TAC.

5. Overall process

The SCRS recommends that Panel 4 approve the MSE development timelines and CMP tuning process defined by the SCRS (see detailed timelines in 'NSWO MSE Extended Summary' **Addendum 1 to Appendix 4**); a description of the two-step tuning process is contained in the same document). 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), the 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. 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 meetings 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 management procedure in November 2023, for implementation in 2024.

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)

Addendum 1 to Appendix 4

Management objectives (from Res. 19-14) and the proposed corresponding performance statistics

Management Objectives (Res. 19-14)	*Proposed Corresponding Performance Statistics*
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., $SSB \geq SSB_{MSY}$ and $F < F_{MSY}$) in year 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
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
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

Addendum 2 to Appendix 4

Key terminology used in this document

Limit reference point (LRP): A benchmark for an indicator that defines an undesirable biological state of the stock such as the B_{LIM} or the biomass limit which is undesirable to be below. To keep the stock safe, the probability of violating an LRP should be very low.

Management objectives: Formally adopted social, economic, biological, ecosystem, and political (or other) goals for a stock and fishery. They include high-level or conceptual objectives often expressed in legislation, conventions or similar documents. They must also include operational objectives that are specific and measurable, with associated timelines. When management objectives are referenced in the context of management procedures, the latter, more specific definition applies, but sometimes conceptual objectives are adopted first (e.g., Res. 19-14 for NSWO).

Management procedure (MP): Some combination of monitoring, assessment, harvest control rule and management action designed to meet the stated objectives of a fishery, and which has been simulation tested for performance and adequate robustness to uncertainties. Also known as a harvest strategy.

Management strategy evaluation (MSE): A simulation-based, analytical framework used to evaluate the performance of multiple management procedures relative to the pre-specified management objectives.

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 models will usually be considered to reflect the uncertainties about the dynamics of the resource and fishery, thereby testing the robustness of management procedures.

Performance statistic: A quantitative expression of a management objective used to evaluate how well an objective is being achieved by determining the proximity of the current value of the statistic to the objective. Also known as a performance metric or performance indicator.

Reference Grid: The operating models that represent the most important uncertainties in stock and fishing dynamics, which are used as the principal basis for evaluating CMP performance. The reference operating models are specified according to factors (e.g., natural mortality rate) that have multiple levels (possible scenarios for each factor, e.g., high / low natural mortality rate). Reference operating models are organized in a usually fully crossed orthogonal 'grid' of all factors and levels.

Robustness Set: Other potentially important uncertainties in stock and fishing dynamics may be included in a Robustness Set of operating models that provide additional tests of CMP performance robustness. They can be used to further discriminate between CMPs. Compared to the Reference Grid operating models, the Robustness Set models will be typically less plausible and/or influential on performance.

Appendix 4

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* ***Addendum 1 to Appendix 4****.*

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

Addendum 1 to Appendix 4

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
30 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

* Panel 4 agreed to hold the meeting on 30 June 2023 to allow for more time following the Swordfish Species Group meeting.