CHANGES MADE TO THE NORTH ATLANTIC SWORDFISH MANAGEMENT STRATEGY EVALUATION CODE AND ALGORITHMS IN RESPONSE TO THE RECOMMENDATIONS FROM THE PEER REVIEW

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SUMMARY

The Standing Committee on Research and Statistics (SCRS) requested a peer review of the code and algorithms that are being used to conduct the management strategy evaluation for the North Atlantic swordfish fishery. The reviewer made 3 recommendations for improvement to the documentation of the MSE process, and 10 recommendations (7 major and 3 minor) related to the code used to simulate the swordfish fishery and conduct the closed-loop evaluation of the candidate management procedures. This paper documents the changes that have been made to the documentation and code in response to the reviewer's recommendations. All 13 recommendations have been addressed, and the reviewer's diagnostic tests have been run to confirm that the changes to the code have rectified the issues identified by the reviewer.

RÉSUMÉ

Le Comité permanent pour la recherche et les statistiques (SCRS) a demandé un examen par les pairs du code et des algorithmes utilisés pour réaliser l'évaluation de la stratégie de gestion de la pêcherie d'espadon de l'Atlantique Nord. L'examinateur a formulé 3 recommandations visant à améliorer la documentation du processus de MSE et 10 recommandations (7 majeures et 3 mineures) relatives au code utilisé pour simuler la pêche à l'espadon et réaliser l'évaluation en boucle fermée des procédures de gestion potentielles. Ce document étaie les changements qui ont été apportés à la documentation et au code en réponse aux recommandations de l'examinateur. Les 13 recommandations ont été traitées et les tests de diagnostic de l'examinateur ont été exécutés pour confirmer que les changements apportés au code ont corrigé les problèmes identifiés par l'examinateur.

RESUMEN

El Comité Permanente de Investigación y Estadísticas (SCRS) solicitó una revisión por pares del código y los algoritmos que se están utilizando para llevar a cabo la evaluación de estrategias de ordenación para la pesquería de pez espada del Atlántico norte. El revisor formuló 3 recomendaciones para mejorar la documentación del proceso de la MSE, y 10 recomendaciones (7 importantes, 3 menores) relacionadas con el código utilizado para simular la pesquería de pez espada y realizar la evaluación de circuito cerrado de los procedimientos de ordenación candidatos. Este documento describe los cambios que se han realizado a la documentación y al código en respuesta a las recomendaciones formuladas por el revisor. Las 13 recomendaciones se han abordado y las pruebas de diagnóstico del revisor se han ejecutado para confirmar que los cambios realizados al código han rectificado los problemas identificados por el revisor.

KEYWORDS

Mathematical models, Management Strategy Evaluation, Simulation, Code Review

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1 Introduction

The Standing Committee on Research and Statistics (SCRS) requested a peer review of the code and algorithms that are being used to conduct the management strategy evaluation (MSE) for the North Atlantic swordfish (hereafter swordfish).

The code for the swordfish MSE is stored in an open-access R package called SWOMSE, available in an ICCAT GitHub repository (Hordyk, 2021). The SCRS contracted a reviewer who conducted an in-depth code review of SWOMSE, and its dependencies the openMSE R packages (Hordyk *et al*., 2021), and submitted their findings to the SCRS in June 2021 (Anon., 2021).

While the reviewer concluded that the SWOMSE and related packages are good examples of applied scientific computing software and are well suited for testing management procedures for the swordfish fishery, they made a series of recommendations for improvements to the documentation and the code. This paper reports the changes that have been made to the SWOMSE package and its dependencies in response to the code review.

Following the review in SCRS/2021/097 (Anon., 2021), this paper is divided into three sections: 1) Documentation Recommendations, 2) Major Code Recommendations, and 3) Minor Code Recommendations.

2 Documentation Recommendations

2.1 Include description of method used to generate MSEtool OM from SS3 output

The reviewer requested a "*precise mathematical description of the method used to translate the sex-structured, multi-fleet SS3 model outputs to the combined-sex, single-fleet MSEtool operating model*".

The openMSE help documentation has been updated to include a detailed explanation of the method used to convert the sex-structured, multi-fleet SS3 models into the combined-sex, single-fleet operating model (see https://openmse.com/features-importing-ss3/ for details).

The updated help documentation includes examples for comparing the dynamics of the combined-sex, single-fleet operating model with those predicted by the sex-structured, multi-fleet Stock Synthesis 3 (SS3) model. As noted by the reviewer, the dynamics of the combined-sex, aggregated fleet model closely follow those from the sex-structured, multi-fleet SS3 model, although averaging the sex-specific differences such as dimorphic growth can lead to some mismatch in the absolute magnitude of some variables such as the spawning stock biomass or absolute catch levels.

Additionally, the MSEtool package has been updated so that the sex-structured, multi-fleet SS3 model can be imported directly into the MSE framework, which reproduces the exact dynamics predicted by the SS3 model in a multi-sex, multi-fleet openMSE operating model. While the multi-sex, multi-fleet operating model (OM) does reproduce the SS3 dynamics exactly, it is more computationally intensive and takes a longer time to run the simulations. Further research will be conducted to determine if the multi-sex, multi-fleet operating model leads to an improvement in the evaluation of the performance of the candidate management procedures.

2.2 Revise Trial Specifications Document and OM reports

As recommend by the reviewer, the Trial Specifications Document (TSD; https://iccat.github.io/nswo-mse/TS/Trial_Specs.html) has been revised to remove the misleading impression that the SWOMSE OMs were more different to the SS3 output than is actually the case.
The reviewer also noted that some the OM reports and comparison plots available on the Swordfish MSE homepage (https://iccat.github.io/nswo-mse/) were mislabeled or appeared to refer to the incorrect operating models. The OM diagnostic and comparison reports on the Swordfish MSE homepage have been updated to match the current operating models in the SWOMSE package.

3 Major Code Recommendations

3.1 Correct the plus-group calculations in the computation of the population dynamics

The reviewer noted that the equation used to calculate the numbers-at-age in the plus-group were incorrect in the code used to compute the population dynamics. The code for calculating the numbers-at-age in the plus-group has been corrected as recommended by the reviewer. The code in the MSEtool package now uses the correct equation provided by the reviewer (https://github.com/Blue-Matter/MSEtool/blob/ff25a632d03232e1e503b32f92df091199cf7a15/src/popddynCPP.cpp#L35).

3.2 Analyse sensitivity of the method used to calculate aggregate fleet selectivity from the fleet-specific selectivity patterns

The reviewer recommended a sensitivity analysis of the weightings used to calculate the overall selectivity pattern from the fleet-specific selectivity patterns estimated by the SS3 model. As described in Section 2.1, the method to calculate the overall fleet selectivity from the fleet-specific selectivity patterns has been updated and simplified in the recent update to the MSEtool package. The aggregate selectivity pattern is now calculated directly from the F-at-age predicted by the Stock Synthesis 3 model, and weighting by fleet-specific exploitation rate or catches is no longer relevant.

3.3 Improve convergence criteria for Newton-Raphson function for calculating fishing mortality

As recommended by the reviewer, the calcF function in the MSEtool package has been modified to use relative rather than absolute error in the convergence criteria (https://github.com/Blue-Matter/MSEtool/blob/ff25a632d03232e1e503b32f92df091199cf7a15/R/popdyn.R#L889).

3.4 Consider adding alternative projection scenarios testing for robustness to future selectivity patterns.

The reviewer noted that the operating models assume the selectivity pattern in the projection years is fixed at the pattern from the last historical year. As there is some evidence of time-varying selectivity in the OM conditioning, the reviewer suggested that alternative selectivity patterns be considered in the projection years.

This current assumption of a fixed selectivity pattern in the projection years is documented in the Trial Specifications document, and the reviewer's recommendation has also been noted there. The Swordfish Species Working Group will discuss this issue and decide if they wish to include alternative assumptions for the fishery selectivity pattern in the projection years.

3.5 Remove commented out code and deprecated functions

As recommended by the reviewer, deprecated functions and commented out code have been removed from the latest release of the MSEtool and SWOMSE R packages.

3.6 Compare simulated length-composition data from the aggregated fleet to the true data

The reviewer requested plots of the catch-at-length distributions generated by the operating model and the observed catch-at-length data (CAL; aggregated over the fishing fleets). Plots of the simulated catch-at-length data from the first operating model (OM_1) and the observed CAL data are shown in **Figure 1** for the nine most recent years that have CAL observations.

This plots reveal that the overall simulated catch-at-length compositions (including discards) are a reasonable approximation of the observed catch-at-length data in each year. It should be noted, however, that the CAL data is provided directly to the operating model, so that the actual historical CAL data (and catch data and indices) are used by the candidate management procedures. In other words, for all simulations, the CAL data for the historical period will exactly match the aggregated CAL data that was used in the operating model conditioning.

3.7 Explain the mismatch between the TAC and the simulated catch for fixed catch CMPs

The reviewer tested a series of fixed catch candidate management procedures (CMPs) and noted that the simulated catch did not always match the TAC exactly (between 7% and 15% error). The reviewer noted that this is a potential issue with the code, and ask for an explanation of this behaviour.
There were two reasons for this. Firstly, as the reviewer noted elsewhere, the routine for calculating fishing mortality from the total allowable catch limit (TAC; the calcF function) was unstable in some cases, particularly when TACs and the corresponding fishing mortality were very low. This issue has been fixed with the changes made in response to the reviewer's recommendations (see sections 3.3 and 4.3).

Second, as the reviewer suggested, previously the code assumed that the TAC included both retained and discarded catch. This can lead to a discrepancy between the specified TAC and the simulated retain catch due to removals being included in the TAC. The default behaviour of the updated model is that the TAC is applied to the retained catch, with an option for users to specify if they wish the TAC to include discards.

The reviewer's diagnostic tests have been run on the updated model to confirm that the simulated catches now correspond exactly to the TAC in the fixed-catch CMPs (see code in Review directory in the ICCAT GitHub repository).

4 Minor Code Recommendations

4.1 Remove deprecated fleet aggregation code from SWO_SS2OM function

As recommended by the reviewer, the updated version of the SWOMSE package has removed deprecated code functions (e.g., SWO_SS2OM function).

4.2 Simplify the equilibrium survival calculations for the plus-group

The reviewer noted that the equilibrium survival calculations could be simplified for a marginal decrease in computational requirements. This recommendation has been implemented in the most recent version of the MSEtool package (https://github.com/Blue-Matter/MSEtool/blob/ff25a632d03232e1e503b32f92df091199cf7a15/R/runMSE.R#L149).

4.3 Scale step-sizes in calcF function by half

As recommended by the reviewer, the step sizes in the calcF function has been scaled by half to improve convergence performance (https://github.com/Blue-Matter/MSEtool/blob/4f87fba78e37319f74adec1cb66f1c5da0fd5b26/R/popdyn.R#L913).

5 Conclusion

The reviewer made 3 recommendations related to the documentation of the North Atlantic swordfish MSE process, and 10 recommendations (7 major and 3 minor) related to the code in the SWOMSE R package and its dependency the MSEtool package. All recommendations made by the reviewer have been addressed, with the necessary changes made to the code and documentation.

The updated version of the SWOMSE R package (v0.5.0) is now available on the ICCAT Github repository (https://github.com/ICCAT/nswo-mse). A new version of the MSEtool package (v3.2.0), incorporating the corrections and recommendations made by the reviewer, has now been released to CRAN (https://cran.r-project.org/package=MSEtool).

6 Acknowledgements

We are grateful to the reviewer for their helpful recommendations for the documentation and code of the SWOMSE package and its dependencies. This work was carried out under the provision of the ICCAT Science Envelope and the ICCAT – EU Grant Agreement – Strengthening the scientific basis for decision-making in ICCAT. The contents of this paper do not necessarily reflect the point of view of ICCAT or other funders and in no ways anticipate ICCAT future policy in this area.

References

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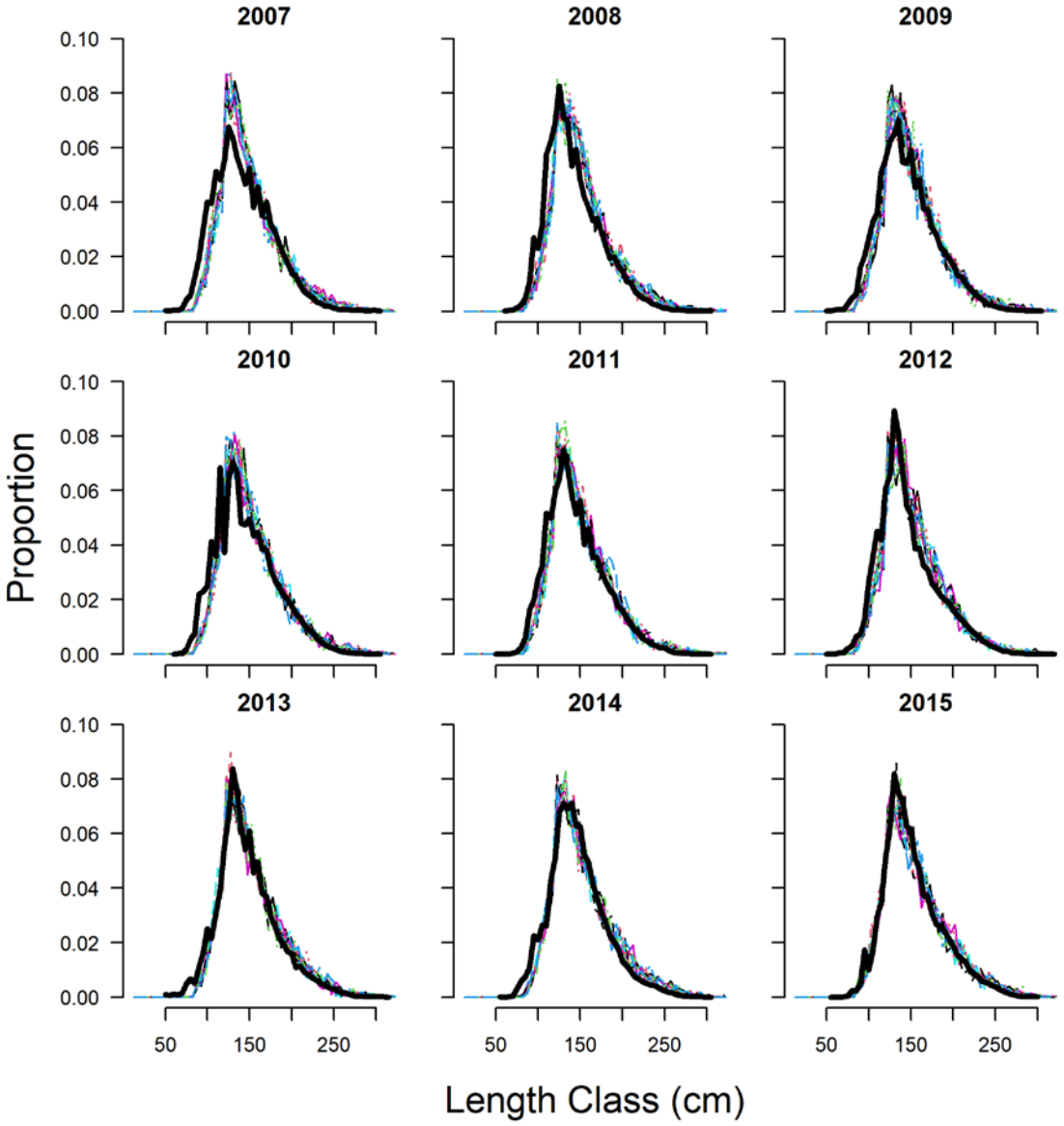

Figure 1. The simulated catch-at-length (CAL) compositions in OM 1 for the 9 most recent years with CAL data (coloured lines) and the corresponding observed CAL data (solid black line).