Work progress on the
Multi-stock Tropical Tuna Management Strategy Evaluation (MSE)

Gorka Merino[1], Agurtzane Urtizberea[1], Ane Laborda[1]

SUMMARY

As part of the science and strategic plan for orientation and guidance adopted by the SCRS, the multi-stock tropical tuna MSE aims to help develop a robust advice framework consistent with the Precautionary Approach for Atlantic bigeye, yellowfin and Eastern skipjack. Under this framework, we aim to evaluate the capacity of a range of management procedures to meet management objectives with acceptable levels of risks. In this document, we provide an update on the simulation framework being developed to assist the Commission adopt multi-stock management measures for these stocks. The multi-stock tropical tuna MSE started in 2018 but the Commission lowered its priority. Since 2021, new developments have been made on this MSE including the exploration of the main sources of uncertainty of tropical tuna dynamics, preliminary conditioning of the Operating Models of the three stocks and a draft proposal for multi-stock management objectives. In this document we also discuss the next steps to complete the multi-stock MSE for tropical tunas.

KEYWORDS

Tropical tunas, Bigeye, Yellowfin,
Eastern skipjack, Management Strategy Evaluation (MSE)

1.   Introduction

The International Commission for the Conservation of Atlantic Tunas (ICCAT) has committed to a path of adopting Management Procedures (MP) to achieve its management objectives of high long-term yields whilst maintaining stocks within sustainable limits with high probability, consistent with the Precautionary Approach (PA). The PA requires fisheries management bodies to determine the status of fish stocks relative to target reference points (TRP) and limit reference points (LRP), to predict outcomes of management alternatives for reaching the targets while avoiding the limits, and to characterize the uncertainty in both cases. The current management framework of ICCAT's tropical tuna stocks is based on *Recommendation By ICCAT on the Principles of Decision Making for ICCAT Conservation and Management Measures* [Rec. 11-13] which has been updated through *Recommendation by ICCAT on the development of harvest control rules and of management strategy evaluation* [Rec. 15-07]. This Recommendation establishes management actions for the different states of exploitation of the stocks, expressed in biomass (B) and harvest rates (F) relative to their corresponding Maximum Sustainable Yield RPs. The implicit target of this recommendation is to maintain the stocks in the green area (B>B_{MSY} and F<F_{MSY}) with high probability, which adds to the traditional objective of achieving the maximum sustainable catch (MSY). However, this recommendation relies on the interpretation of what is considered '*high probability*' and '*as short a period as possible*'. The SCRS after *Recommendation by ICCAT on a Multi-Annual Conservation and Management Programme for Tropical Tunas* [Rec. 15-01] is committed to evaluate specific probabilities and timeframes of alternative management strategies or MPs. In this context, the main objective of the tropical tuna multi-stock MSE is to support the development of a robust advice consistent with the PA for Atlantic bigeye, yellowfin and East-Atlantic skipjack by evaluating Candidate Management Procedures (CMP) based on their probabilities of achieving management objectives and avoiding risk.

The main difference of this MSE in relation to the other frameworks developed in ICCAT (bluefin, north-Atlantic albacore, swordfish) is that it will account for the multispecific nature of tropical tuna fisheries. For example, the fleets using purse seine, baitboat, longline and other artisanal gears often catch bigeye, yellowfin, and skipjack simultaneously. This interaction between species and gears needs to be accounted for when designing a management system for these stocks. In other words, achieving the MSY (or other RP) for one stock may impose constraints on the management of others and ways to reconcile the management objectives for the three stocks need to be developed. For this, the tropical tuna MSE will include the population and fishery dynamics of tropical tunas in the same simulation framework, as well as MPs that respond to the trends of the three stocks.

The multi-stock MSE for the Atlantic tropical tuna stocks started in 2018 with an initial phase that included the design of the simulation framework including the development of Operating Models (OMs), multi-stock MPs and other components of the MSE. The second phase, which was planned for 2019, was not carried out, following the indication from the Commission at the end of 2018 to revise the schedules for the different MSE processes, lowering the priority for tropical tunas'. During the 2019 and 2020 meetings of the Tropical Tuna Species Group, discussions on MSE reiterated the need to continue the development of the MSE, albeit at a slower pace than initially scheduled. In 2021, a Tropical Tuna MSE technical group meeting was convened where the main sources of uncertainty on tropical tuna stock assessments and the MSE roadmap were discussed. In 2022, the technical development of the MSE framework advanced with the preliminary conditioning of the OMs of bigeye and yellowfin and the development of a Stock Synthesis model for Eastern skipjack. In 2023, the current state of development of the MSE was discussed in the intersessional meeting of the Tropical Tuna Species Group including a range of options for multi-stock management objectives. In this document we provide details of the MSE development and discuss the plans for its completion and the communication of results.

2.   Progress and development of multi-stock Management Strategy Evaluation

The multi-stock MSE for tropical tunas started in 2018 with the design of the simulation framework. The MSE is built using the software FLBEIA (García et al., 2010), a bio-economic impact assessment model based on R and FLR libraries. FLBEIA is a modelling toolbox that allows the evaluation of biological and economic variables in mixed fisheries. It has been demonstrated that this model can be used to evaluate multi-stock harvest control rules for multi-specific fisheries mostly in the International Council for the Exploration of the Sea (ICES) framework. In this first phase, four SCRS papers and two presentations to the tropical tuna

Species Group were presented including a design document that detailed the object oriented design of the MSE model (SCRS/2018/112), a plan for development for Eastern Atlantic skipjack Stock Synthesis model (SCRS/P/2018/052), a plan for conditioning OMs from the stock assessments available at that time (SCRS/2018/146), a document describing options for multispecies Management Procedures based on demersal and pelagic fisheries in ICES (SCRS/2018/147), a proposal for a Shinny demonstrator to facilitate communication with stakeholders (SCRS/P/2018/053), and a summary report of this initial phase (SCRS/2019/033).

In 2018, the Commission reviewed the schedules for the different MSEs and lowered the priority for this. In 2019 and 2020, the tropical tuna Species Group discussed the state of development of this MSE and requested the continuation of its development.

The MSE development in 2021 consisted on a description and discussion of the major axes of uncertainty of tropical tuna stock assessments (SCRS/2021/016). These uncertainties were discussed in the Tropical Tuna MSE Technical Group Meeting (online, 29-31 March 2021), and agreed to explore options for biological parameters (steepness, sigmaR, natural mortality, growth, maximum age and maturity). The Group also discussed how another important component of the MSE framework, the Observation Error Model (OEM) should be developed. Following these discussions, the OEM is being developed including autocorrelated and random errors for the generation of simulated indices of abundance.

In 2022, the OMs for bigeye and yellowfin were completed, both based on the Stock Synthesis stock assessments of 2019 (yellowfin) and 2021 (bigeye). Also in 2022, the first Stock Synthesis model was developed for Eastern skipjack as the main model for its assessment. Its output was used to condition the OM for this stock. In 2023, the multi-stock OM is being developed and, for this, the fleet structure of the three stock assessments needs to be harmonized. This way, the management measures applied to limit the catch or fishing mortality of one stock will limit the activity of the fleets and this will also have an impact on the other stocks too. These developments were discussed in the Intersessional Meeting of Tropical Tunas MSE Technical Sub-group (online, 19-20 May 2022).

In the 2023 Intersessional meeting of the Tropical Tuna Species Group (including MSE) (hybrid/Madrid, Spain 27 February - 3 March 2023), the state of development of the MSE was presented (SCRS/2023/P/07). In this presentation, the utility of multi-stock MSE frameworks was presented using a preliminary version of the OMs to illustrate how measures applied to limit the catch of one stock can produce impacts on the other stocks and their fisheries. In addition, another document (SCRS/2023/020) provided a list of possible operational multi-stock management objectives could be used to develop this management framework. These alternative multispecies management objectives were based on options developed for mixed fisheries in the ICES, with a focus on procedures that consider interactions between gears and the three tropical tuna species. This document aimed to foster discussions within the Tropical Tuna Species Group and with Panel 1.

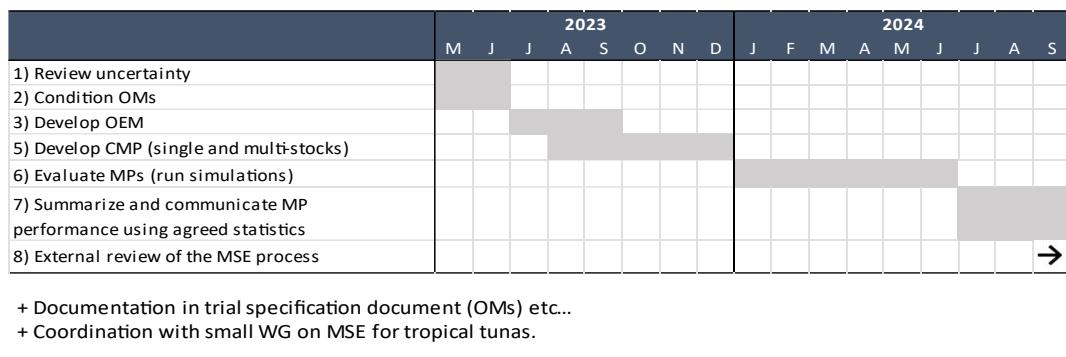The remaining steps will be to (see estimated schedule in **Figure 1**):

- Continue the review and exploration of uncertainties to finalize the conditioning of OMs.
- To further develop the OEM using the fits of the OMs to the available indices of abundance.
- To develop single and multi-stock CMPs.
- To evaluate CMPs using simulations with the MSE framework.
- To summarize and communicate CMP performance using agreed statistics.
- To develop a trial specification document that documents the entire development of the MSE, including detailed analyses of the OMs using diagnostic tools.
- To externally review the MSE process.

All these steps will be done in coordination with the recently created small working group on MSE for tropical tunas, the Tropical Tuna Species Group, the Working Group on Stock Assessment Methods (WGSAM) and the Standing Committee on Research and Statistics (SCRS) in general.

Acknowledgements

	2023								2024								
	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
1) Review uncertainty	░	░															
2) Condition OMs	░	░															
3) Develop OEM			░	░	░												
5) Develop CMP (single and multi-stocks)				░	░	░	░	░									
6) Evaluate MPs (run simulations)									░	░	░	░	░	░			
7) Summarize and communicate MP performance using agreed statistics															░	░	░
8) External review of the MSE process																	→

+ Documentation in trial specification document (OMs) etc...
+ Coordination with small WG on MSE for tropical tunas.

Figure 1. Estimated schedule for the different components of the MSE development.

List of relevant SCRS documents and presentations of the tropical tuna multi-stock MSE:

– SCRS/2018/112. A simple operating model for a basis of a discussion about the development of a management strategy evaluation for tropical tuna fisheries. *Urtizberea et al (2018).* Withdrawn.

– SCRS/2018/146. Steps to consider for the conditioning of the Operating Models of a multispecific model of tropical tuna fisheries in a MSE framework. *Urtizberea et al (2018).* Withdrawn.

– SCRS/2018/147. Management Procedure options for a MSE in tropical tuna fisheries. *Urtizberea et al (2018).* Withdrawn.

– SCRS/P/2018/052. Initial development of a stock synthesis model for Eastern skipjack tuna to support tropical tuna management strategy evaluation. *Harford et al (2018).*

– SCRS/P/2018/053. The initial steps of a shiny web application developed to facilitate communication and share the results of the management strategy evaluation model for tropical tuna fisheries. *Urtizberea et al (2018).*

– SCRS/2019/033. Final report of the ICCAT short-term contract: Modelling approaches to support the ICCAT tropical tuna MSE process. *Merino et al (2019).*

– SCRS/2021/016. Characterization of structural uncertainty in tropical tuna stocks' dynamics*. Merino et al (2021).*

– SCRS/2021/055. Progress on characterization of structural uncertainty in tropical tuna stocks' dynamics with summary of discussions held during the tropical tuna MSE meeting (29-31st March 2021). *Merino et al (2021).*

– SCRS/2023/020. Options for multispecies management objectives for tropical tunas. Merino et al (2023).