SCRS/2019/167 Collect. Vol. Sci. Pap. ICCAT, 76(8): 40-50 (2020)

ADDRESSING RECOMMENDATIONS OF THE PEER REVIEW AND AMMENDMENTS TO THE NORTH ATLANTIC ALBACORE MSE

G. Merino[1,*], J. Santiago[2], E. Andonegi[2], A. Urtizberea[1], H. Arrizabalaga[1]

SUMMARY

In 2017 ICCAT adopted a Harvest Control Rule (HCR) for North Atlantic albacore. This was used to set catch limits for the period 2018-2020. This and other HCRs were evaluated in a Management Strategy Evaluation (MSE) framework that was built in collaboration between scientists of the albacore working group, the ICCAT Secretariat and ICCAT's SCRS. In 2018, this MSE was reviewed by an independent expert (SCRS/2018/142) which considered that in general, the framework was high quality and robust to uncertainty. However, the independent review suggested improvements to increase transparency, further consideration of sources of uncertainty, better representation of results to illustrate variability of results across models, clarification of some parameters and additional checks to explain and understand the unexpected behaviour of some Operating Models. In this document we address the concerns and recommendations of the independent review. We do this by clarifying things as requested, exploring the variability of results, by presenting additional checks to ensure that the models are behaving as expected and by making small amendments to the MSE code as recommended by the reviewer.

RÉSUMÉ

L'ICCAT a adopté, en 2017, une règle de contrôle de l'exploitation (HCR) pour le germon de l'Atlantique Nord. Celle-ci a été utilisée pour établir les limites de capture de la période 2018-2020. Celle-ci et d'autres HCR ont été évaluées dans un cadre d'évaluation de la stratégie de gestion (MSE) qui a été construit en collaboration entre les scientifiques du Groupe d'espèces sur le germon, le Secrétariat de l'ICCAT et le SCRS. En 2018, cette MSE a été examinée par un expert indépendant (SCRS/2018/142) qui a estimé qu'en général, le cadre était de haute qualité et robuste à l'incertitude. Cependant, l'examen indépendant a suggéré des améliorations en vue d'accroître la transparence, un examen plus approfondi des sources d'incertitude, une meilleure représentation des résultats pour illustrer la variabilité des résultats entre les modèles, la clarification de certains paramètres et des vérifications supplémentaires pour expliquer et comprendre le comportement inattendu de certains modèles opérationnels. Dans ce document, nous répondons aux préoccupations et aux recommandations de l'examen indépendant. Nous le faisons en clarifiant les points requis, en explorant la variabilité des résultats, en présentant des vérifications supplémentaires pour nous assurer que les modèles se comportent comme prévu et en apportant de petites modifications au code MSE comme recommandé par le réviseur.

RESUMEN

En 2017, ICCAT adoptó una norma de control de la captura (HCR) para el atún blanco del Atlántico norte. Esta norma se utilizó para establecer límites de captura para el periodo 2018-2020. Esta y otras HCR fueron evaluadas en el marco de la evaluación de estrategias de ordenación (MSE) que se creó en colaboración entre científicos del Grupo de especies de atún blanco, la Secretaría de ICCAT y el SCRS de ICCAT. En 2018, esta MSE fue revisada por un experto independiente (SCRS/2018/142) que consideró que, en general, el marco era de elevada calidad y robusto ante la incertidumbre. Sin embargo, la revisión independiente sugirió algunas mejoras para aumentar la transparencia, la consideración adicional de fuentes de incertidumbre, una mejor representación de los resultados para ilustrar la variabilidad de los resultados entre los modelos, la aclaración de algunos parámetros y comprobaciones adicionales para explicar

[1] AZTI, Herrera Kaia Portualdea, 20110, Pasaia, Spain; E-mail: gmerino@azti.es
[2] AZTI, Txatxarramendi uhartea, 48395, Sukarrieta, Spain

y entender el inesperado comportamiento de algunos modelos operativos. En este documento abordamos las inquietudes y recomendaciones de la revisión independiente. Se pretende aclarar algunas cosas como se solicitó, explorando la variabilidad de los resultados, presentando comprobaciones adicionales para garantizar que los modelos se están comportando como estaba previsto y haciendo pequeñas modificaciones al código de la MSE como recomendó el revisor.

KEYWORDS

North Atlantic albacore, Management Strategy Evaluation,
Harvest Control Rules, Operating Models, Management Procedures, Independent review

1. Introduction

In 2017, ICCAT adopted Recommendation 17-04 which establishes interim reference points and a harvest control rule (HCR) to set 3-year constant annual total allowable catch (TAC) for the North Atlantic albacore stock. This recommendation was made after the advice from the SCRS, which was based upon the simulations conducted using a Management Strategy Evaluation (MSE) framework specifically developed for this stock (Merino et al., 2016; Merino et al., 2017a, 2017b; Merino et al., 2017c). In 2018, the code and algorithms used within the North Atlantic albacore MSE were reviewed to verify that the simulations were run as expected (Scully, 2018) and to evaluate the quality of the numerical framework. Overall, the MSE was found to be of high quality and robust to uncertainty. However, a series of recommendations to improve the MSE framework and the presentation of the results were provided (Scully, 2018).

In this document we address the recommendations made in the review, which include clarifications, checks and one small modification to the code of the MSE.

This document is one the agreed deliverables of the "*short-term contract for improvement of the North Atlantic albacore Management Strategy Evaluation (MSE) framework*" between ICCAT and AZTI.

2. Methodology & Results

We have addressed each of the recommendations in the peer review separately. Most of them required clarifications and checks and we respond to each of them. The explicit recommendations of the peer review are listed below with detailed responses and clarifications:

1) *"Some operating models do not appear to behave appropriately when F is set to* F_{MSY} *and projected to 2040. The authors should identify which models are causing the issue and consider if they can be fixed or should be discarded from the uncertainty grid.*"

We have run projections of the 132 OMs of the reference set at their F_{MSY} and results suggest that the model is running as expected. We have projected the OMs from 2015 to 2050 and all reach their B_{MSY} in the mid-long term (**Figure 1**). In order to increase transparency we show the script used for this in Annex I.

The projections and this figure were discussed with the author of the peer review (Scully, 2018) to clarify the trends shown in his document (see Figure 4 of Scully, 2018). The cause of the confusion is an error in the script provided for the review in 2018 ("*SCRS092_Script_R.3.3.1.R*"). This script was used by the reviewer to make the projections. The error consisted in the use of values of F_{MSY} estimated by the FLBRP library of FLR (L. T. Kell et al., 2007) into an object named *refp*, that re-estimates OMs' stock recruitment relationship. For the MSE, F_{MSY} and other reference points were estimated using the stock recruitment parameters from the outputs of the Multifan-CL model into an object named *eql*, which was the basis of the conditioning (Merino et al., 2017b). In the script made available for the review, the projection at *Fmsy* starts in line 775 by defining *Fmsy* from the object *eql*, but the projection object uses other reference points from the object *refp* (see script below). The estimated values of F_{MSY} from *repf* and *eql* are very similar but not equal, and particularly different from those OMs based upon the *Alt3* scenario (**Figure 2**). The use of reference points from the two different objects was the cause of the apparently wrong projections shown in the review. It has been checked and confirmed that in the MSE, the model uses the *eql* object.

```
Fmsy=FLQuant(c(FLBRP:::refpts(eql[[i]])['msy','harvest']),
           dimnames=list(year=iYr:fwdYr, iter=1))

  omp1[[i]]=fwdWindow(omp1[[i]], end=fwdYr, refp[[i]])
  omp1[[i]]=FLash:::fwd(omp1[[i]], f=Fmsy, sr=refp[[i]], sr.residuals=srDev[[i]])
```

2) *"Include a set of scenarios with a decrease in catchability as identified by the modelers. These plus the scenarios with an increase in catchability and the options for recruitment regimes could be presented separately as robustness cases to show the outcomes of the HCRs given less likely scenarios".*

We have done this by modifying the effort time series of the Multifan-CL models, before re-running and re-conditioning twelve OMs, in the same manner as it was done for the increasing catchability scenarios. Then, we have run the MSE with the HCR adopted in 2017 and the amended code. The full Robustness tests results will be included in a single consolidated report documenting all the MSE framework, that will be presented as an SCRS document during the Albacore Species Group meeting in late September 2019. However, **Figure 3** shows a summary of the performance of the HCR applied to the negative catchability scenarios.

3) *"Include an illustration of the range of TACs estimated for each HCR as the current figures are misleading by only indicating the mean. A violin plot would show the full distribution of the estimated TACs and the mean."*

This is a good idea. The performance metrics requested by the Commission were median and mean values and the robustness of the HCR can also be illustrated with the variability of the performance metrics. The reviewer suggested this for TAC and we show that in **Figure 4** with two alternatives for the HCR adopted in 2017. The carry over scenario is based on what was presented in 2018 at the request of the Commission in Resolution 17-04 (Merino, Arrizabalaga, & Santiago, 2018) updated with the recommendations of the review.

4) *"Run the MSE framework without error (CPUE index cv =0, recruitment deviations =0) and compare the recent biomass trends for the operating model and the biomass dynamics model. If biases exist, then additional investigation on where these biases arise from is necessary."*

This was already done in previous papers (see **Figure 9** in (2017(Merino et al., 2017c) and **Figure 6** in (Merino et al., 2016). The biomass dynamic model was also validated and cross tested with the data used to condition OMs in this framework (L. Kell, Arrizabalaga, Merino, & De Bruyn, 2016). However, this was not done with the updated MSE framework and this is shown in **Figure 5**. The OM conditioned from the Base Case model of the 2013 stock assessment is plotted against the estimator (MP). As shown in previous papers, this figure shows that the estimator estimates changes of biomass in the OM correctly but generally estimates smoother changes than those occurring in the OM. For example, the stock showed in this figure has recovered to levels above Bmsy by 2015 approximately but the MP estimates that this recovery has been slower. This updated figure will be used in the consolidated report documenting all the MSE framework.

5) *"There does not appear to be a mechanism in the management procedure to set TACs if a stock assessment fails to converge in a year of the MSE simulation. An improvement to the MSE framework would be to set a rule for how to set TACs given that the assessment fails to converge. This could be as simple as the new TAC is equal to the old TAC, or there is a slight reduction in the TAC from the previous three years as a precautionary measure. It is unrealistic to assume that an assessment model will never fail in the MSE framework."*

Agreed. This has been corrected in the amended version. Now, the R-code with the functions of the MSE contains a script to identify failed runs and instead of reducing TAC to a minimum, the simulation maintains previous years' TAC. This is the only change that has been done to the MSE R script in 2019. The new updated runs will be the basis of the single consolidated report documenting all the MSE framework. This document will contain the updated results after this modification.

6) *"Carefully examine the priors for the shape parameter in the biomass dynamics model and the steepness parameter in the age-structured population model and ensure that the shape parameter is estimated in a consistent manner to the demographic parameters in the age-structured model. Include details on how the shape parameter is estimated in the documentation."*

The priors for the shape parameter were set at the exact values used in the 2016 stock assessment. The priors were set in the meeting because a non-symmetrical production model (Pella and Tomlinson, Fox etc) better explains the dynamics of the North Atlantic albacore. In this case, the Fox model was used (B_{MSY} is at 0.36xB0). With regards to the different steepness parameters of the OMs, these were set to characterize the existing uncertainty on this parameter for tuna stocks. Initially, it would be inadequate to set different priors for the shape parameter for each OM, because that it would mean that the "true dynamics" of the stock are known. However, we compared the production functions of the estimated MPs for four OMs (Base Case (OM=201) plus three alternatives with the range of steepness (h=0.7, h=0.8 and h=0.9) (**Figure 6**).

7) *"Allow for the TAC to be exceeded or not be met in each year of the projection to better replicate the reality of fishing."*

This was considered in a suite of scenarios developed for the MSE in 2018. These were presented to the Species Working group in the document (Merino et al., 2018). However, these were run before the modification addressed in point 5 (see above). The updated results for this scenario will be included in the single consolidated report documenting all the MSE framework. However, in **Figure 7** we show the updated performance of the HCR adopted in 2017 with carry overs allowed. These results are very similar to the results produced in 2018.

8) *"Work with managers and stakeholders to identify minimums for a subset of the highest priority performance indicators and determine tiers of performance indicators. Then use these to reduce the number of HCRs presented and provide tradeoff plots of the lower priority performance indicators."*

At this stage this recommendation is out of the scope of the MSE modelling team. We agree that it is an appropriate recommendation for ICCAT's MSE process and that it would help reducing the number of potential HCR for adoption. At this moment, there is one single minimum standard from the management objectives of this stock, which is to maintain the stock in the green quadrant of the Kobe plot with a probability of at least 60%. This recommendation is also valid for other ICCAT stocks.

9) *"Use violin plots to present the tradeoffs of each HCR for performance indicators to better communicate the uncertainty associated with the point estimates from the simulations."*

The performance metrics requested by Panel 2 included only average and median values and this was the reason for showing only central tendency measures in the reports presented to the SCRS. However, we agree that it is important to show the uncertainty associated with the point estimates from the simulations when communicating results to stakeholders (**Figure 8**).

3. Discussion

In this document we address the recommendations made by the North Atlantic albacore peer review (Scully, 2018), which include clarifications, checks and one small modification to the MSE code. We have listed each recommendation and responded individually.

From the recommendations only one required modifying the code of the MSE. This is recommendation 5 from the list in the introduction and refers to the absence of a mechanism to set TAC if the estimator of the MP fails to converge. In the previous version of the MSE, when the estimator failed, the model would estimate that the biomass of the stock is at minimum levels and will reduce catch to a minimum (zero when TAC change was unconstrained and to the lowest limit when limits to the change of TAC were imposed). The MSE code has been modified so that, in the cases that the estimator of the MP fails to converge, TAC will be maintained at its previous level. This has an impact on the short term, because this is the period where the majority of MP failures occurred. In contrast, this doesn't seem to have an impact in the longer term for most of the performance indicators. However, this modification is now included in the North Atlantic albacore MSE.

Additionally, the recommendations for checks are individually described. Also, the recommendations for communication and results illustration will be used to improve the communication of MSE results in the future.

References

Kell, L., Arrizabalaga, H., Merino, G., & De Bruyn, P.-. (2016). Validation of the biomass dynamic stock assessment model for use in a Management Procedure. SCRS/2016/027.

Kell, L. T., Mosqueira, I., Grosjean, P., Fromentin, J., Garcia, D., Hillary, R., . . . Scott, R. D. (2007). FLR: an open-source framework for the evaluation and development of management strategies. *ICES Journal of Marine Science*, *64*(4), 640-646.

Merino, G., Arrizabalaga, H., Murua, H., Santiago, J., Ortiz de Urbina, J., Scott, G. P., & Kell, L. (2016). Evaluation of Harvest Control Rules for North Atlantic albacore through Management Strategy Evaluation. SCRS/2016/015.

Merino, G., Arrizabalaga, H., & Santiago, J. (2018). Evaluation of variants to the Harvest Control Rule adopted in 2017 for North Atlantic albacore. SCRS/2018/113.

Merino, G., Arrizabalaga, H., Santiago, J., Sharma, R., Ortiz de Zarate, V., De Bruyn, P., & Kell, L. (2017a). Options for an Observation Error Model for North Atlantic albacore MSE. SCRS/2017/091.

Merino, G., Arrizabalaga, H., Santiago, J., Sharma, R., Ortiz de Zarate, V., De Bruyn, P., & Kell, L. (2017b). Uncertainty grid for North Atlantic albacore Management Strategy Evaluation: Conditioning Operating Models. *ICCAT Collective Volumes of Scientific Papers, 74*, 432-456.

Merino, G., Arrizabalaga, H., Santiago, J., Sharma, R., Ortiz de Zarate, V., De Bruyn, P., & Kell, L. T. (2017c). Updated Evaluation of Harvest Control Rules for North Atlantic albacore through Management Strategy Evaluation. *ICCAT Collective Volumes of Scientific Papers*, *74*, 457-478.

Scully, M. L. (2018). Peer review of the code and algorithms used with the Management Strategy Evaluation framework for the North Atlantic albacore stock (SCRS/2018/142).

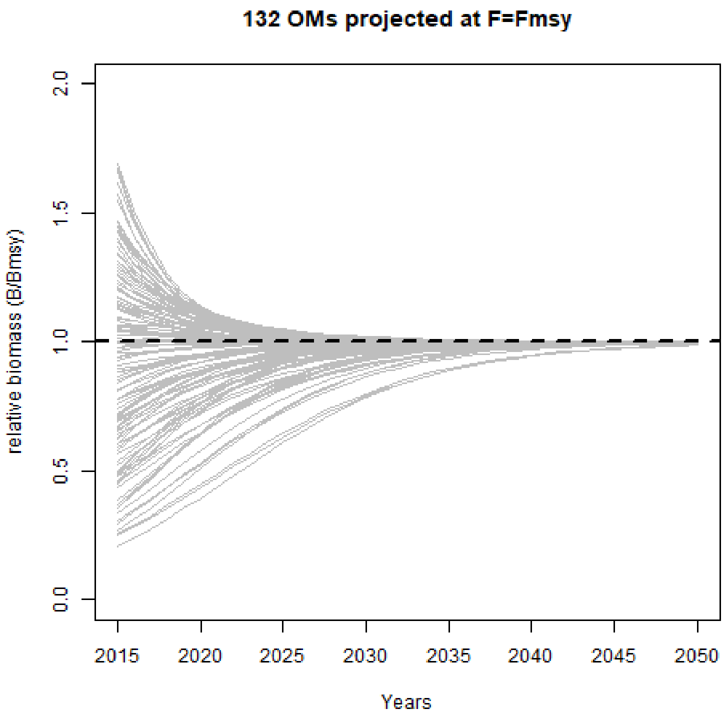

Figure 1. 132 OMs of the reference case projected at Fmsy.

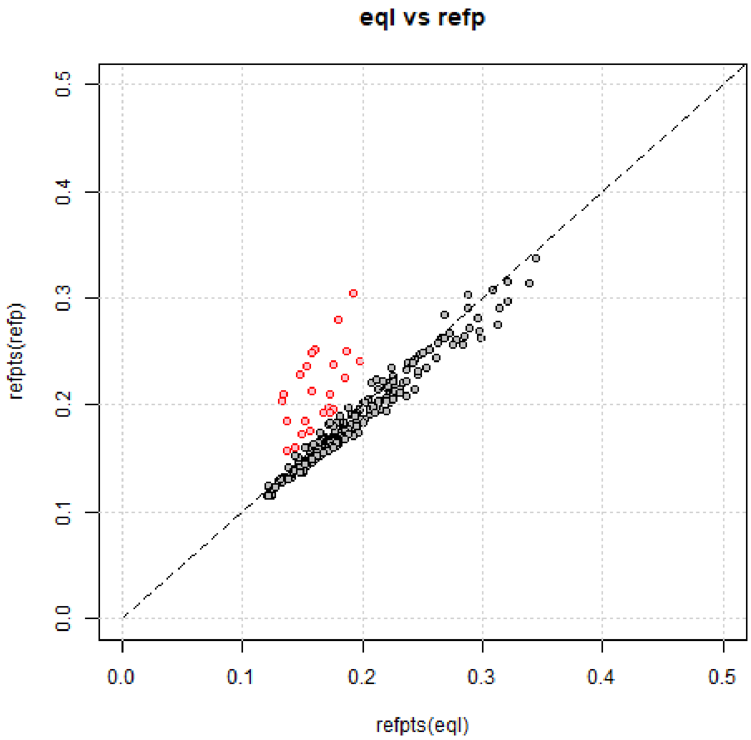

Figure 2. Comparison of the reference points estimated with two methods. In red, estimates for the *Alt 3* scenarios.

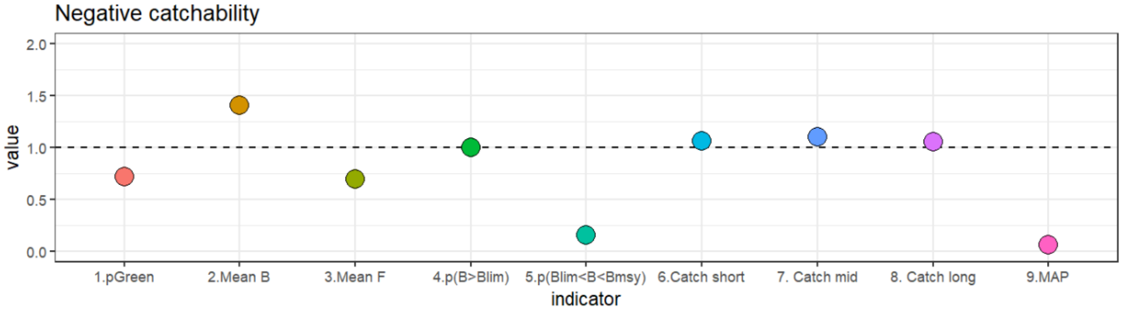

Figure 3. Performance indicators for the negative catchability OMs. Points are medians across the 12 negative q OMs. Catch values are relative to TAC in the period 2018-2020 (32,600 t).

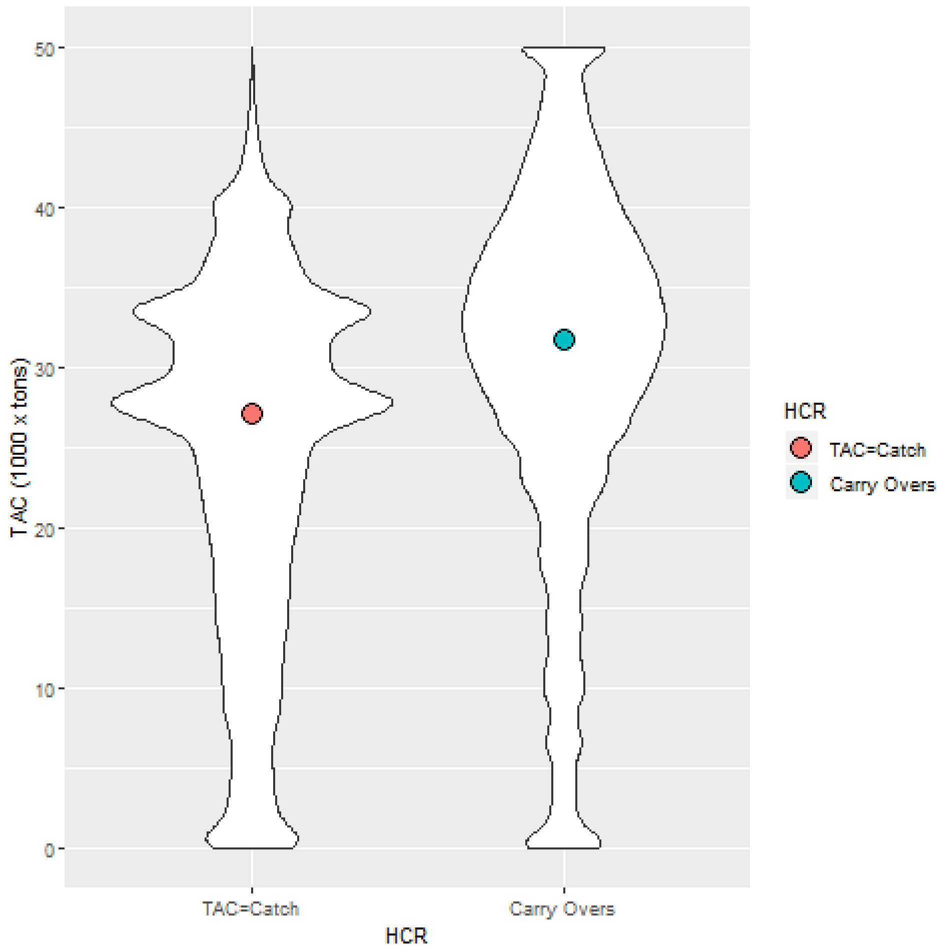

Figure 4. Violin plots of the TAC set for two alternatives of HCR. 1) Catches matching TAC and 2) with error on the implementation of the TAC. The later is based on the scenarios presented in 2018 (see Merino, Arrizabalaga and Santiago, 2018).

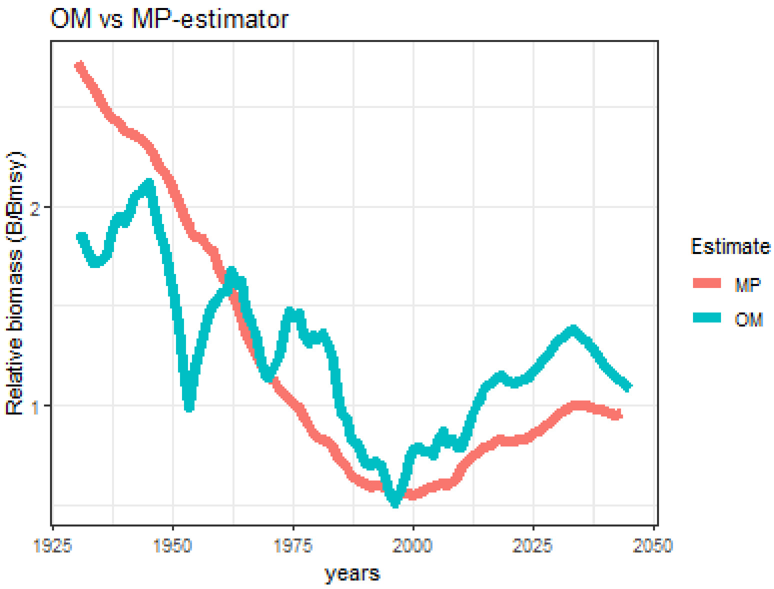

Figure 5. Trajectories of the Operating Model (blue) and its MP-estimator (blue).

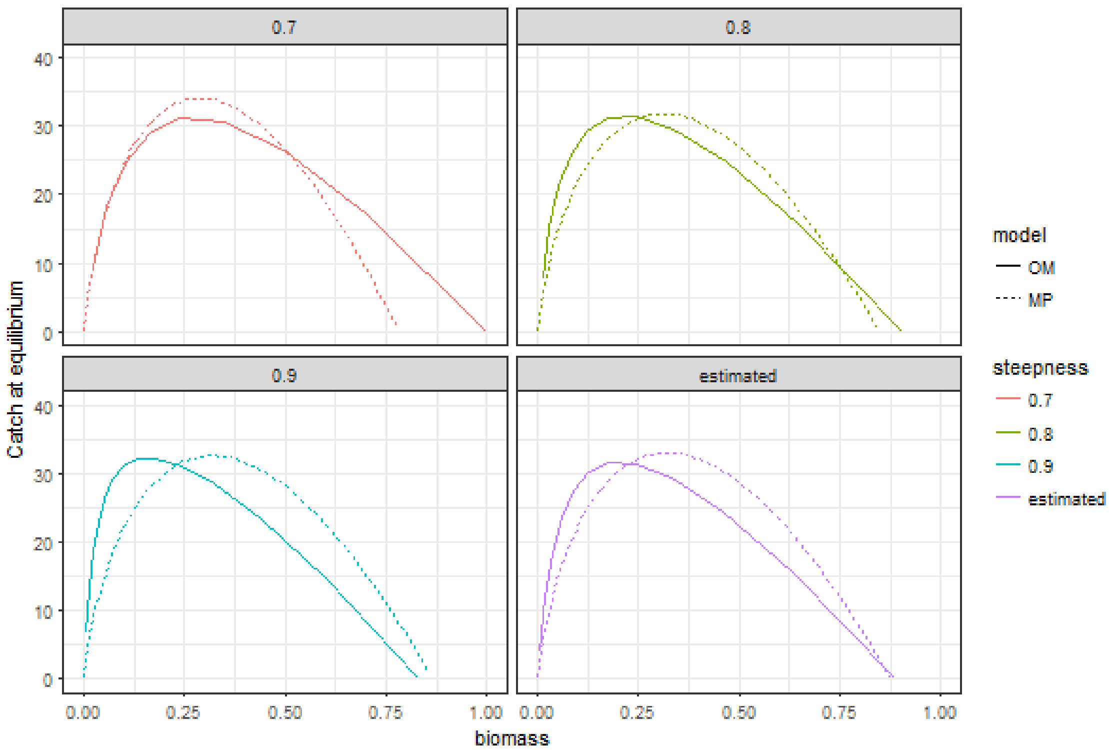

Figure 6. Production functions of four OMs based on the 2013 Base Case model with four alternatives for steepness (h=estimated, 0.7, 0.8 and 0.9).

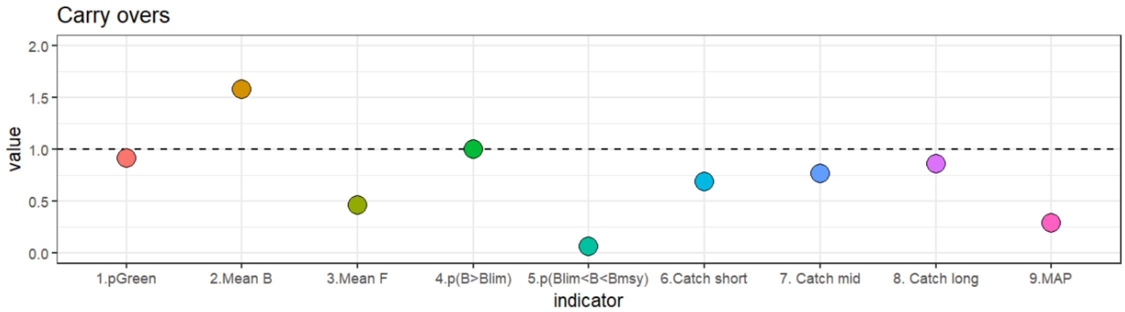

Figure 7. Performance of the adopted HCR with carry overs allowed. Catch values are relative to TAC in the period 2018-2020 (32,600 t).

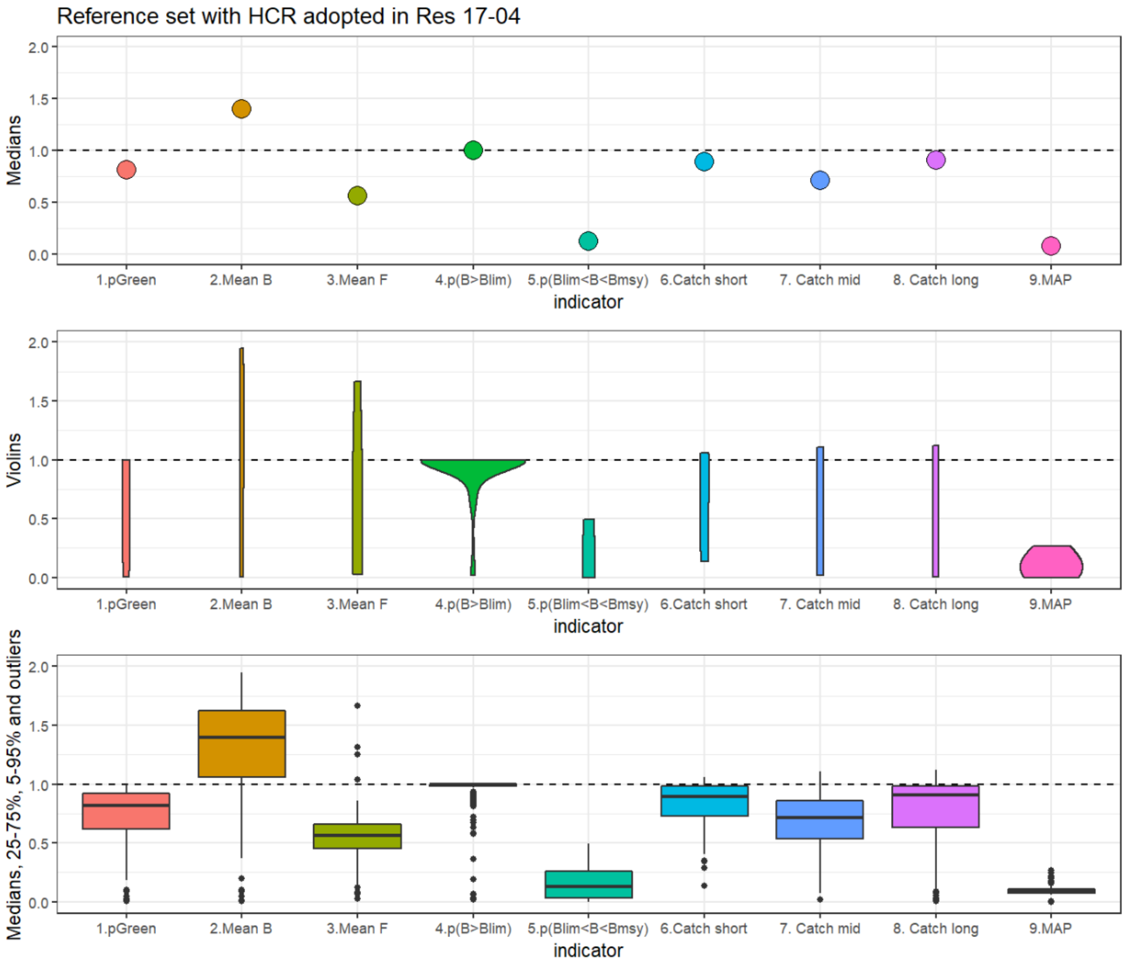

Figure 8. Performance indicators of the HCR adopted in Resolution 17-04 including uncertainty. Upper panel shows median values, middle panel shows uncertainty using violin plots and the lower panel shows boxplots with medians, 25-75% (box), 5-95% confidence intervals and outliers. Catch performance is relative to the TAC set for 2018-2020, which is 32,600 tons.

ANNEX I

```
# Script prepared by Gorka Merino (gmerino@azti.es) as part of the contract
# "SHORT.TERM CONTRACT FOR IMPROVEMENT OF THE NORTH ATLANTIC ALBACORE
MANAGEMENT STRATEGY EVALUATION (MSE) FRAMEWORK" BETWEEN ICCAT AND
AZTI (2019)
# ---------------------------------------------------------------------------
# This is script is generated to check that the OMs of the North Atlantic albacore are doing what is
expected. The independent review to the MSE code found unexpected behaviours in some OMs when
they are projected forward at Fmsy and this needed to be checked. This script suggests that OMs are
running OK.
# ----------------------------------------------------------------

# Run with R.3.6.1 in August 2019

# 1) Install libraries
install.packages("FLCore", repos="http://flr-project.org/R",dependencies=TRUE) ##
install.packages("FLasher", repos="http://flr-project.org/R") ##
install.packages("FLBRP", repos="http://flr-project.org/R") ##
install.packages("FLFishery", repos="http://flr-project.org/R")

# 2) Upload libraries
library(FLCore)
library(FLasher)
library(FLBRP)

# 3) Load the OMs as R Objects from directory (change as needed)
load('~/RObjects/om240.RData')

# 4) Select the OMs of the Reference Case (132 runs)
oms=seq(1,240,2)
x=seq(194, 216, 2)
oms=c(oms, x)

# 5) Deterministic catch projection to 2050
# Set projection parameters
iYr=2015
fwdYr=2050
nit=1
CVc=0

# function to assign recruitment deviates for projection = 0.
srDev2=function(runnames, iYr, fwdYr, CV){
  for (scen in 1:length(runnames)){
    srDev[[paste(runnames[scen])]]=exp(rnorm(1, FLQuant(0, dimnames=list(year=iYr:fwdYr)), CV))
  }
  res=srDev
}

srDev=FLQuants()
srDev=srDev2(names(om), iYr, fwdYr, 0.0) #This generates 1 iteration.#

options(digits=2)

# Projection object from om (omp)
omp=om

for (j in 1:132) {

  iYr=2015
```

```
  i=oms[j]
  omp[[i]] <- fwdWindow(omp[[i]], eql[[i]], end=fwdYr) # Iago's way plus rec dev my way
  omp[[i]]=fwd(omp[[i]], sr=as(eql[[i]], "FLSR"), control=fwdControl(year=2015:2050,    quant="f",
value=c(refpts(eql[[i]])['msy', 'harvest',])), deviances=srDev[[i]])
   print(as.numeric(stock(window(omp[[i]], start=2015))/refpts(eql[[i]])["msy", "biomass"]))

 }

## Do figure -------------------------------

plot(2015:2050, as.numeric(stock(window(omp[[1]], start=2015))/refpts(eql[[1]])["msy", "biomass"]),
main="132 OMs projected at F=Fmsy",ylim=c(0,2), type="l", col="gray", ylab="relative biomass
(B/Bmsy)", xlab="Years")
for (j in 1:length(oms)) {
  i=oms[j]
  lines(2015:2050, as.numeric(stock(window(omp[[i]], start=2015))/refpts(eql[[i]])["msy", "biomass"]),
col="gray")
}
abline(h=1, lty=2, lwd=2)

# End of script -----------------------------------------------------------------------------------------
```