WESTERN ATLANTIC BLUEFIN TUNA STOCK ASSESSMENT 1950-2018 USING STOCK SYNTHESIS: PART III PROJECTION AND FISHERY STATUS

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SUMMARY

This document describes a stock assessment model using Stock Synthesis (version 3.30) for the Western Atlantic population of Bluefin tuna. This document describes projection results and stock status based on F based reference point, F0.1, which is estimated from YPR curve in assessment result. Current F during 2016-2018 was below the F0.1, hence the stock was not subject to be overfishing. On the other hand, projection results indicate that F will probably overshoot the reference point in the near future under current total allowable catch (TAC) scenario. It is also showed that the probability which is the F under several constant catch scenario is below the F0.1. This paper represents the third in a series of three papers that will describe the update assessment process.

RÉSUMÉ

Ce document décrit un modèle d'évaluation des stocks utilisant Stock Synthesis (version 3.30) pour la population de thon rouge de l'Atlantique Ouest. Ce document décrit les résultats de la projection et l'état des stocks sur la base du point de référence basé sur F, F0,1, qui est estimé à partir de la courbe YPR dans le résultat de l'évaluation. Le F actuel pour la période 2016-2018 était inférieur au F0,1, le stock n'était donc pas sujet à la surpêche. D'autre part, les résultats des projections indiquent que F dépassera probablement le point de référence dans un avenir proche dans le cadre du scénario actuel de total des prises admissibles (TAC). Il est également montré que la probabilité que le F en vertu de plusieurs scénarios de captures constantes est inférieur à F0,1. Ce document est le troisième d'une série de trois documents qui décriront le processus d'actualisation de l'évaluation.

RESUMEN

Este documento describe un modelo de evaluación de stock que utiliza Stock Synthesis (versión 3.30) para la población de atún rojo del Atlántico occidental. Este documento describe los resultados de la proyección y el estado del stock basándose en un punto de referencia basado en F, $F_{0,1}$, que se estima a partir de la curva YPR en el resultado de la evaluación. La F actual durante 2016-2018 era inferior a $F_{0,1}$, por lo tanto, el stock no estaba sufriendo sobrepesca. Por otra parte, los resultados de la proyección indican que F probablemente superara el punto de referencia en un futuro cercano en el marco del actual escenario de total admisible de captura (TAC). Se demuestra también la probabilidad de que F, bajo varios escenarios de captura constante, esté por debajo de $F_{0,1}$. Este documento representa el tercero de una serie de tres documentos que describirán el proceso de actualización de la evaluación.

KEYWORDS

Stock assessment, bluefin tuna, Stock Synthesis

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Introduction

According to the terms of reference outlined in the 2019 SCRS report (Anon 2020, Appendix 5) the stock assessment in 2020 represents as strict of an update of the 2017 stock assessment as possible. The 2017 assessment terminal year of data was 2015 and for this assessment we update with data up until 2018. Input data and model settings agreed in SCRS ABTWG in May 2020 were used (SCRS/2020/072). There were two models by maturity schedules; model 1 was assumed to be a late maturity schedule (100% maturity at age 13) and model 2 was assumed to be earlier maturity schedule (100% maturity at age 5). This paper describes the uncertainty in the future projection estimated by multi-variable lognormal, projection results and stock status base on the F (fishing mortality) based reference point, F0.1.

Projection Settings and uncertainty quantification

The biological and fisheries parameters for projection, e.g. growth curve and selectivities, are derived from deterministic run of final base case agreed at the May meeting (SCRS/2020/121) (**Table 1**). F based reference point, F0.1 is calculated using the Yield per Recruitment (YPR) curve. Future recruitment is set to the average of recent six years (2010-2015). The catch in 2019, 2020 is assumed to be current TAC (2,350 t) and those after 2021 is assumed to be constant values by catch scenario with 250 t intervals from 1,000 t to 3,500 t. The future catch by fleet assumed that the recent fisheries would continue, and the allocation was calculated based on the allocation table in Rec. 17-06 by CPC (without considering the transfers) and the average catch (Task1) ratios in 2016-2018 by CPC and by gear (**Table 2**). In the projection, every fleet will exhaust their quota every year. A projection which has no catch limit and set future F to F0.1 is also conducted to evaluate the yield at F based reference point. The uncertainty in parameter estimation is taken into account by the multivariate lognormal approximation (MVLN).

For the previous assessment in 2017, the uncertainty of parameter estimation in the assessment was quantified with bootstrap replicates. Bootstrap method is commonly used for evaluation of uncertainty for stock synthesis, while it usually takes much time because every replicate requires parameter estimation by dataset with perturbed data. On the other hand, uncertainty quantification by MVLN was applied to some assessment in ICCAT recently (Walter 2020, Winker 2019). It is expected to have equivalent performance to bootstrap, reducing a lot of calculation time. In the case of this assessment, F distributions with 250 times either bootstrap or MVLN replicates by models are almost overlapped and Those replicates have similar peak values and shapes of distribution (**Figure 1**). This approach has been applied to the other ICCAT species, e.g. bigeye and yellowfin, for their scientific advices (Anon 2019, Anon 2018). Therefore, MVLN approximation can be alternative way and used for this projection to evaluate uncertainty.

Projection Results

The geometric mean of F for last three years (2016-2018), was less than F0.1, and hence current fishery status could be regarded as not overfishing. On the other hand, future trajectory of SSB showed declining trend not only under the assumption of the current TAC scenario but also under the assumption of all catch scenarios for both model (**Figures 2** and **3**). The probability table for F < F0.1 under the assumption of each TAC scenario implies that F will be with high probability of overshooting the F based reference point when the catch scenario is assumed to be more than 2,000 t (**Table 3**). This more pessimistic result than previous assessment might be because of the lower level of biomass in this assessment than that in previous assessment and very low level of the recruitment in recent years since 2010 which is similar to previous assessment (SCRS/2020/121). Note that the final matrix for the advice will be integrated result from VPA and 2 models by stock synthesis and the Group will complete that task during the July 18-28, 2020 online meeting, after review and adoption of the projection models.

Acknowledgements

We are grateful for the contributions of the Secretariat, the combined efforts of a vast number of colleagues who, through GBYP, have resurrected age-length information, catches and other historical data that facilitate creating an integrated model that uses as much data as possible for WBFT.

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Table 1. The parameters and settings for projection and current fishery status based on fishing mortality.

	Model 1	Model 2
F_current (2016-18)	0.076	0.076
F_0.1 based on YPR curve	0.089	0.090
F_current/F_0.1	0.84	0.84
Fishery Status	not overfishing	not overfishing
Future Recruitment (1,000 fish) Average during 2010 -2015	89.5	89.7
Selectivity Mirrored specified duration	2016-2018	2016-2018
Projected_Yield_F0.1_2021	1905 t	1900 t
Projected_Yield_F0.1_2022	1762 t	1756 t
Projected_Yield_F0.1_2023	1669 t	1664 t

Table 2. The allocation of future catch by catch scenario.

Catch (t)	JAPAN_LL	USA_CAN_PSFS	USA_CAN_PSFB	USA_TRAP	USA_CAN_HARPOON	USA_RRFB	USA_RRFS	OTHER_ATL_LL	CAN_HOOKLINE	GOM_LL_US_MEX	JLL_GOM	CAN_TRAP	CAN_GSL1
1000	169	0	0	0	41	369	68	124	163	61	0	4	0
1250	213	0	0	0	52	465	86	147	206	76	0	5	0
1500	258	0	0	0	62	561	104	170	248	91	0	6	0
1750	302	0	0	0	73	657	122	192	290	107	0	7	0
2000	346	0	0	0	84	753	140	215	333	122	0	8	0
2250	390	0	0	0	95	850	158	237	375	137	0	9	0
2350	407	0	0	0	99	888	165	246	392	143	0	9	0
2500	473	0	0	0	103	927	172	256	410	149	0	9	0
2750	670	0	0	0	105	946	175	260	417	166	0	10	0
3000	732	0	0	0	115	1033	192	280	456	181	0	10	0
3250	794	0	0	0	125	1121	208	301	494	196	0	11	0
3500	856	0	0	0	134	1208	224	321	533	211	0	12	0

Table 3. Probability of not overfishing (F < F0.1) under the several catch scenarios for Bluefin tuna in the West Atlantic by multivariate lognormal approximation in this projection.

Model 1 (Late maturity schedule)

Catch (t)	2021	2022	2023	2024	2025
1000	100%	100%	100%	100%	100%
1250	100%	100%	100%	100%	99%
1500	99%	94%	88%	82%	82%
1750	63%	24%	14%	15%	13%
2000	3%	0%	0%	1%	0%
2250	0%	0%	0%	0%	0%
2350	0%	0%	0%	0%	0%
2500	0%	0%	0%	0%	0%
2750	0%	0%	0%	0%	0%
3000	0%	0%	0%	0%	0%
3250	0%	0%	0%	0%	0%
3500	0%	0%	0%	0%	0%

Model 2 (Early maturity schedule)

Catch (t)	2021	2022	2023	2024	2025
1000	100%	100%	100%	100%	100%
1250	100%	100%	100%	100%	99%
1500	99%	96%	88%	82%	72%
1750	63%	27%	17%	13%	16%
2000	4%	1%	0%	0%	1%
2250	0%	0%	0%	0%	0%
2350	0%	0%	0%	0%	0%
2500	0%	0%	0%	0%	0%
2750	0%	0%	0%	0%	0%
3000	0%	0%	0%	0%	0%
3250	0%	0%	0%	0%	0%
3500	0%	0%	0%	0%	0%

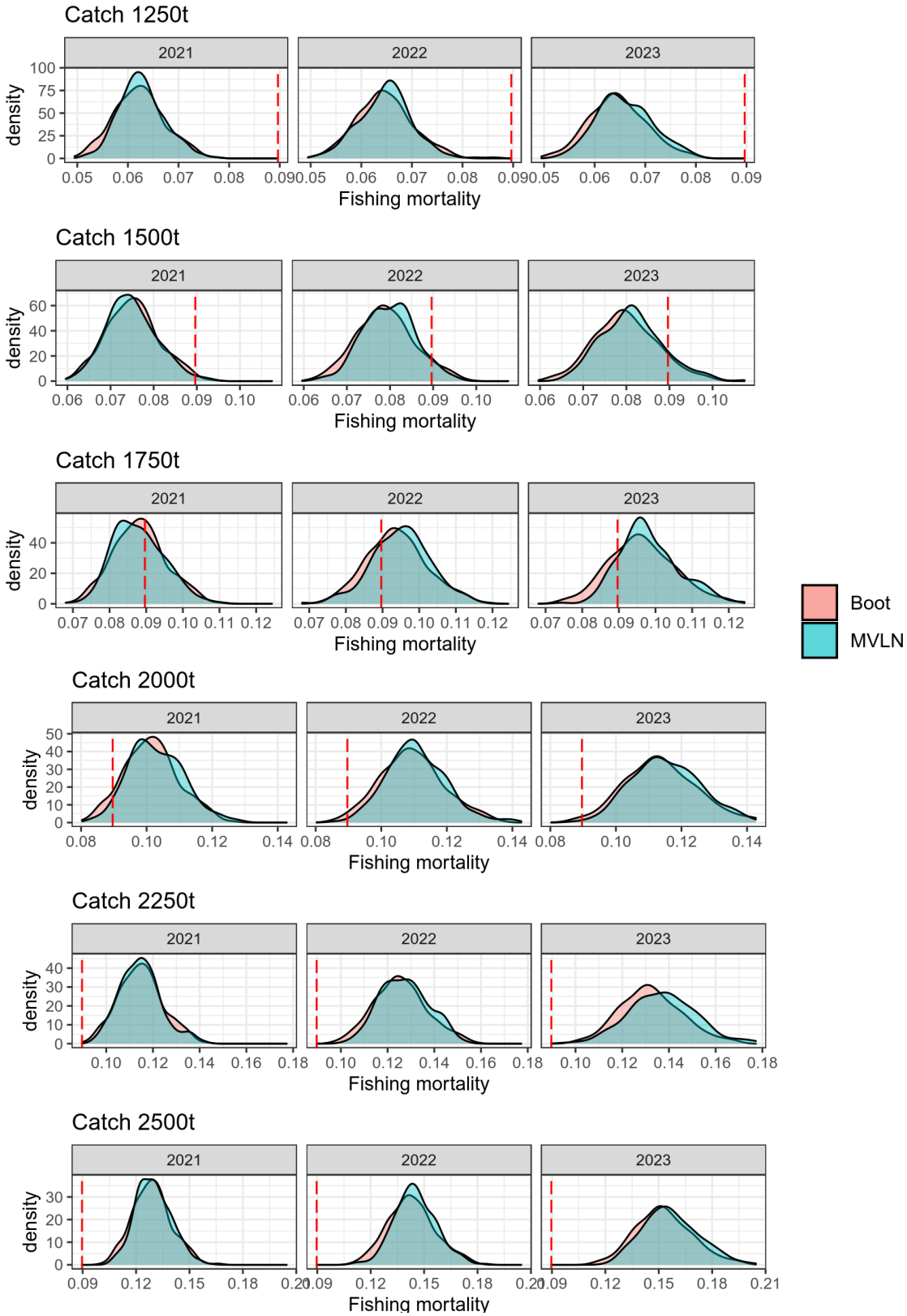

Figure 1. Density distribution of F in 2021, 2022 and 2023 derived from 250 replicates by bootstrap and multivariate lognormal approximation (MVLN) for model 1. Red dashed line shows F0.1.

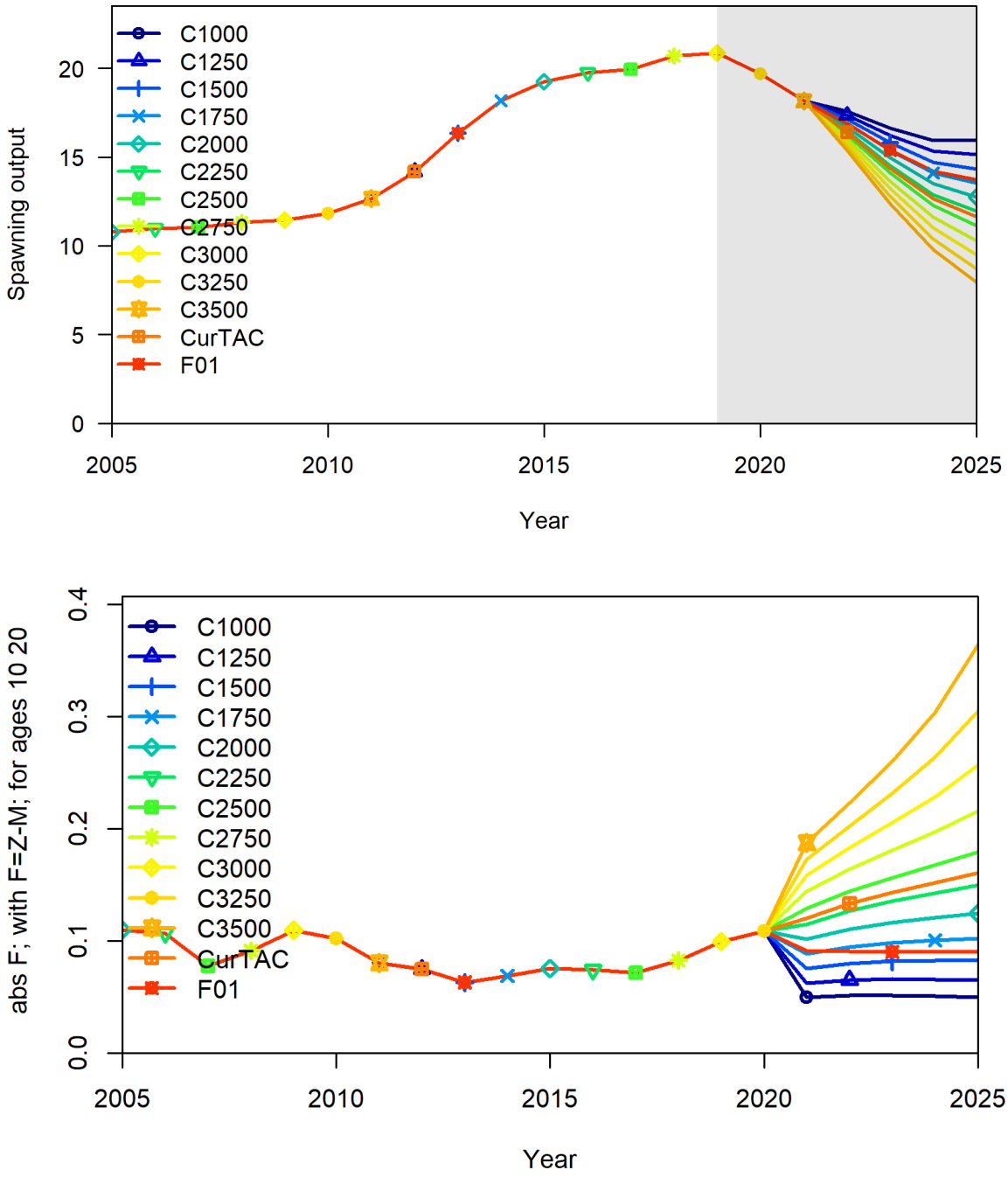

Figure 2. Future trajectory under each catch scenario for model 1 (Upper: SSB, Lower: Fishing mortality).

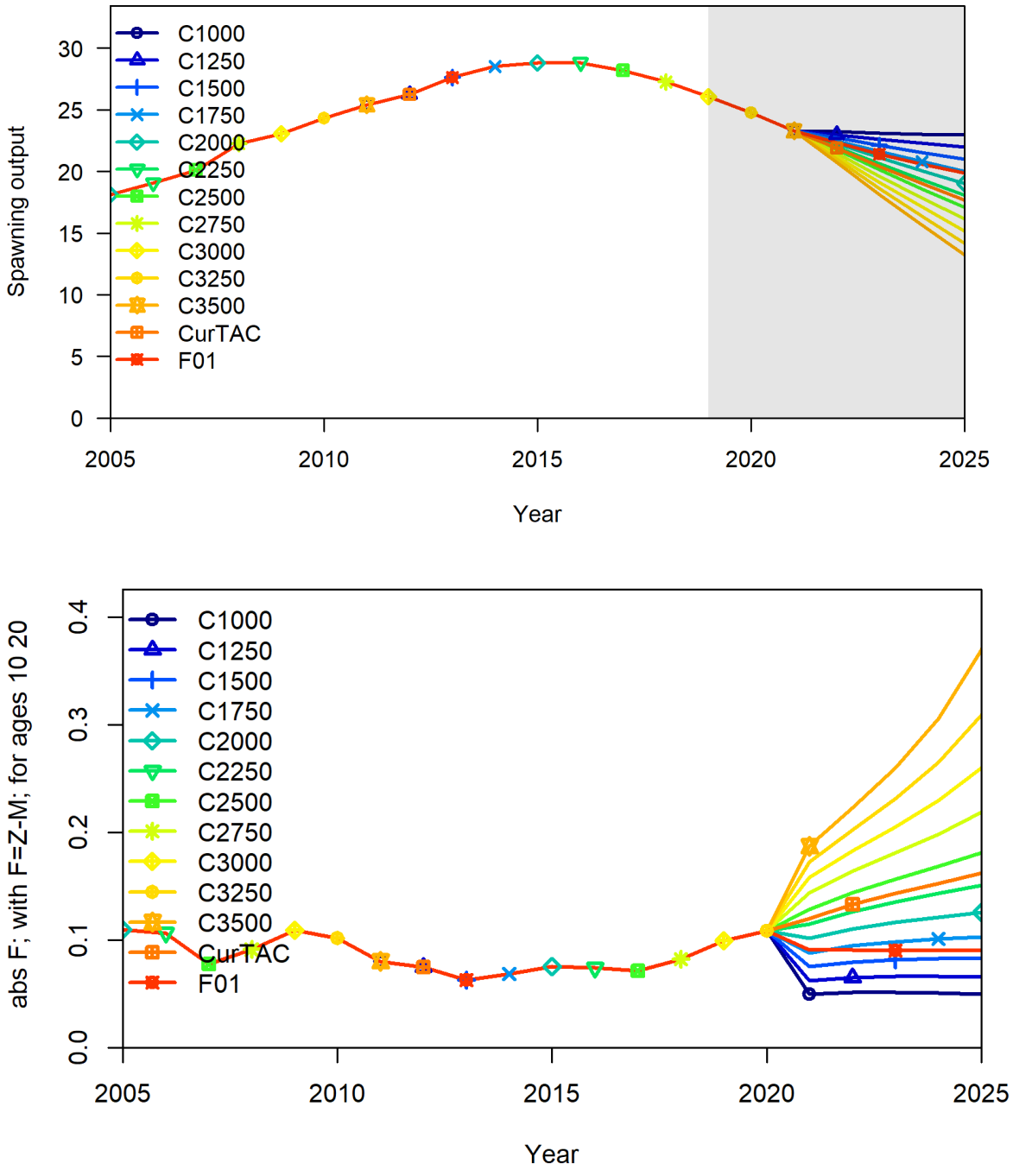

Figure 3. Future trajectory under each catch scenario for model 2 (Upper: SSB, Lower: Fishing mortality).