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Low recruitment 3M Cod Operating Model

by
Fernando González-Costas[1], Diana González-Troncoso[1], Carmen Fernández[2] and Agurtzane Urtizberea[3]

e-mail: fernando.gonzalez@ieo.es
[1] Instituto Español de Oceanografía, Vigo, Spain
[2] Instituto Español de Oceanografía, Gijón, Spain
[3] Azti-Tecnalia, Pasaia, Spain

ABSTRACT

This paper presents the results of F = 0 and the slope and target Harvest Control Rules (HCRs) for a selection of Operating Models (OMs) of 3M Cod with the Low Recruitment regime. The results of these scenarios show that if the current low level of recruitment continues for 2 or 3 more years, the risk of the SSB falling below B_{lim} in the short to medium term is greater than 50% in all scenarios, including those with F=0. Another conclusion that can be drawn from these results is that the current target HCR needs to be improved by investigating more deeply the values of the different parameters of this HCR.

INTRODUCTION

The SC at its meeting in January 2019 (NAFO SCS Doc. 19/04) agreed on the initial set of Operating Models (OMs) to test in the 3M cod MSE. From the set of agreed OMs, priority OMs were selected to be developed for the RBMS meeting in April 2019. The results of these OMs are displayed in the RBMS report (NAFO COM-SC Doc. 19-01) as Annexes 4 and 5.

The remaining OMs (Low Recruitment, Natural Mortality by steps, density-dependent biological parameters, etc.) have to be developed and presented at the RBMS meeting in September.

At the SC meeting in January 2019, three different options were agreed to estimate future recruitments: Bin Ricker, Hockey Stick and Low Recruitment regime. The first two options have already been implemented in different scenarios and their results were presented at the RBMS meeting in April 2019.

During the SC discussions on OMs for the recruitment, it was highlighted that the fits of these two options are quite poor and there is no clear signal that the observed recruitments depend on the existing SSBs. For this reason, the SC considered that it would be useful to develop an OM that simulates in the future the periods of low/high recruitment observed in the past (Figure 1). This document presents the option of a Low Recruitment regime.

LOW RECRUITMENT OM

Low recruitments were defined as those below the 2005-2006 levels, which allowed the recovery of the stock in the past. Taking into account this definition, Figure 1 shows that for the assessment approved in 2018 (Base Case), the longest period of low recruitment goes from 1993 to 2004 (i.e. 12 consecutive years). The three most recent recruitments (2015-2017) are also low.

The first idea was to simulate via bootstrap a period of low recruitment similar in length to that observed in the past. The aim is to bootstrap from the period 1993-2004, by OM and iteration, an annual recruitment for the first 8 or 9 years of the projections to simulate a period of 11-12 years of low recruitment in the future (taking into account that the three most recent recruitments observed are already low). After the low recruitment period, recruitments could be simulated until the end of the projection period (2037) using one of the options agreed by the SC (Bin Ricker or Hockey Stick). This option has the problem that after the period of low recruitment the SSB will fall to very low levels, and it would be very difficult for the stock to recover using any of the above options to simulate the recruitment in the period 2027-2037; this lack of stock recovery would be contrary to what has been observed in the past.

After some discussion and to avoid these problems, the technical team decided to apply the following modified approach. Bearing in mind that we have already observed 3 years of low recruitment (2015-2017), that we want to simulate a continuous period of low recruitment of about 10/11-year duration and that the projection period is from 2018 to 2037, it was decided that, for each OM and iteration, the annual recruitment values observed in the period 1998-2017 will be taken directed and applied to the projected period (2018-2037). This results in a continuous period of 10 years of low recruitment (2015-2024), followed by a period of medium and high recruitment to recover SSB as was observed in the past.

RESULTS

Figure 2 presents the median results for total biomass, SSB/B_{lim} ratio, recruitment at age 1, catches and F, of the low recruitment OMs under the scenarios of F=0. In all these scenarios there are some years in which the probability of the SSB being below B_{lim} is more than 50%. The period in which the SSB is below B_{lim} is longer in the OMs with MGadget (MG) than those with MVector (MV). This happens with the median, so the period with a risk greater than 10% of the SSB being below B_{lim} is much longer and practically starts for all the scenarios in the year 2023/2024 (Figure 3). This means that, regardless of the management measures adopted, in the short/medium term the fishery will likely be under moratorium if the recruitments are at the current low levels for a few more years.

The SSB increases from the late 2020s onwards are due to the beginning of the cycle of good recruitments (copied from those observed in the period 2005-2014). Within the OMs with the same M, the biomasses are higher when the simulation of the future biological parameters is done with the Random Walk method than with the 3-Year (2015-2017 average) method.

Figure 4 shows the median results (total biomass, SSB/B_{lim} ratio, recruitment at age 1, catches and F) of the low recruitment OMs under the slope HCR (MFS) and Figure 5 incorporates the 10 and 90 % percentiles (shaded areas). In these scenarios, we can again see that the period with more than 50% probability of the SSB being below B_{lim} is longer in the cases with the MGadget (MG) than with MVector (MV) setting, and within each of these, it is longer when the average of the last 3 years (3Y, i.e. 2015-2017 average) is used to simulate the biological parameters than when the Random Walk (RW) setting is used. The period in which the probability of SSB being below B_{lim} is more than 50% is longer and begins earlier (2022/2023) in scenarios where the MFS HCR is applied than in those with F=0.

As happened in the scenarios with F=0, in the MFS scenarios the SSB increases from the end of the decade of 2020s onwards are due to the beginning of the period of good recruitments (copied from those observed in 2005-2014), with the stock biomass reaching at the end of the projection period levels similar to the maximum observed in 2012-2013, except in the case of the MGadget with the 3Y setting for the biological parameters where the biomass increase is smaller. Note that when the MFS is applied, at the end of the projection period (where similar levels of biomass to those observed in 2012-2014 are reached), the median level of catches obtained by the MFS is quite similar to that observed in the period 2012-2014, although with a slightly lower F.

Figure 6 plots the median results (total biomass, SSB/B_{lim} ratio, recruitment at age 1, catches and F) of the low recruitment OMs under the target HCR (MFT) and Figure 7 incorporates the 10 and 90 % percentiles (shaded areas). The trends in biomass and SSB/B_{lim} are similar to those obtained with the MFS HCR. The period with more than 50% probability of the SSB being below B_{lim} is longer in the cases with MGadget than with MVector and, within each of these, it is longer when the 3Y setting is used to simulate the biological parameters than when the Random Walk is used. The SSB increases from the end of 2020s are due to the beginning of the period

of good recruitments (copied from those observed in 2005-2014), with the stock biomass reaching at the end of the projection period levels similar to the maximum observed in 2012-2013.

With the current MFT HCR, the median catches obtained in these scenarios are practically nil but with a high uncertainty since the beginning of the decade of 2020, even though the stock biomass values at the end of the projection period are similar to those observed in the period 2012-2014.

DISCUSSION

The results of these scenarios show that if the current low level of recruitment continues for 2 or 3 more years, the risk of the SSB falling below B_{lim} in the short to medium term is greater than 50% in all scenarios, including those with F=0. If these low recruitments continue for a couple of years, the fishery would likely be under moratorium in the short to medium term and the extent of the closure would depend on the length of the low recruitment period. If the duration of this period was similar to the one observed in the past (10/11 years), the fishery could likely not occur again until the beginning of the 2030s.

In the poor recruitment scenario, it may perhaps be more appropriate to perform annual assessments, instead of applying an HCR in "auto-pilot mode", so that specific management measures can be proposed in each year allowing for a quick reaction to these extreme situations. If the fishery closed in the short term, it would not be so urgent to have an HCR immediately in place for its management, and this would give more time and a more relaxed schedule to continue working on the MSE and to find an HCR that takes into account the extreme situations that can occur in this stock.

Another conclusion that can be drawn from these results is that the current target HCR needs to be improved by investigating more deeply the values of the different parameters of this HCR. Probably it may be that the current target value (average of survey biomass in 2008-2017) is not the most adequate, which means that resulting in minimal catches are minimal even at high levels of stock biomass.

REFERENCES

NAFO, 2019. Report of the NAFO Scientific Council Flemish Cap (NAFO Div. 3M) Cod Stock Management Strategy Evaluation (MSE). NAFO SCS Doc. 19/04. Serial No. N6911.

NAFO, 2019. Report of the RBMS meeting in April 2019. NAFO COM-SC Doc. 19-01. Serial No. N6958.

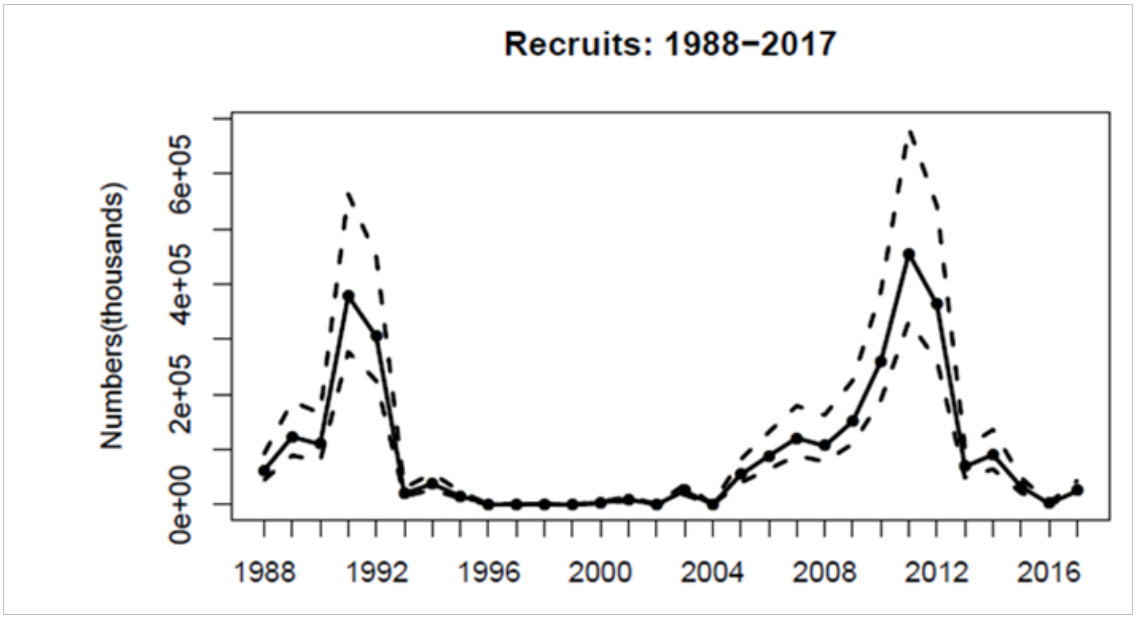

Figure 1. Results of the recruitment at age 1 in the 3M Cod assessment approved in 2018 (Base Case OM). The black line is the median and the dash lines are the 5 and 95 % percentiles.

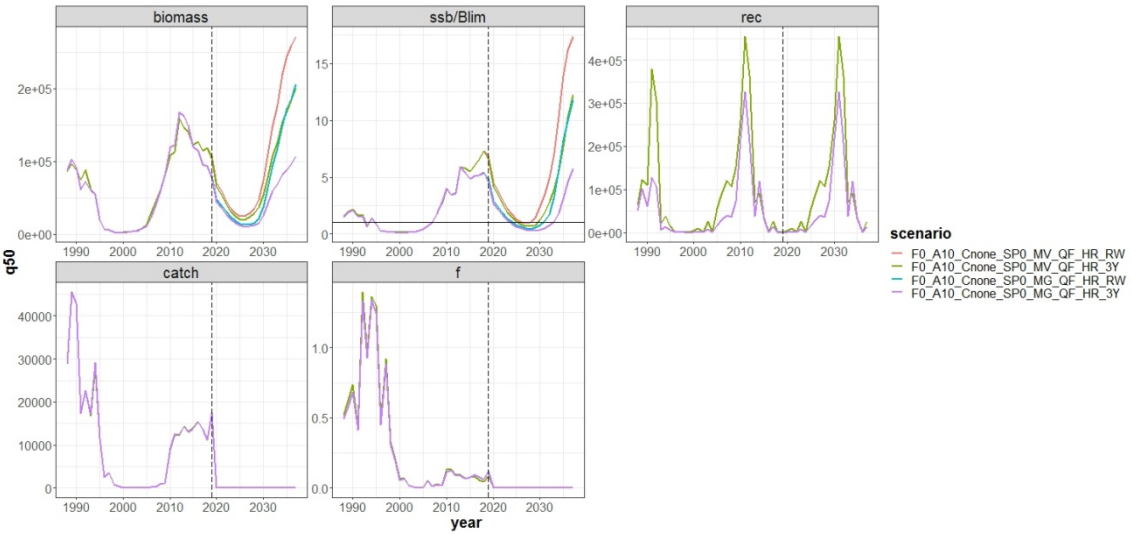

Figure 2. Median results (total biomass, SSB/B_{lim} ratio, recruitment at age 1, catches and F) of the low recruitment OMs under the scenarios with F=0. OM settings are: MVector (MV) or MGadget (MG) for M in historical years, and "Random Walk" (RW) or 3-Year average (3Y) for biological parameters in future years.

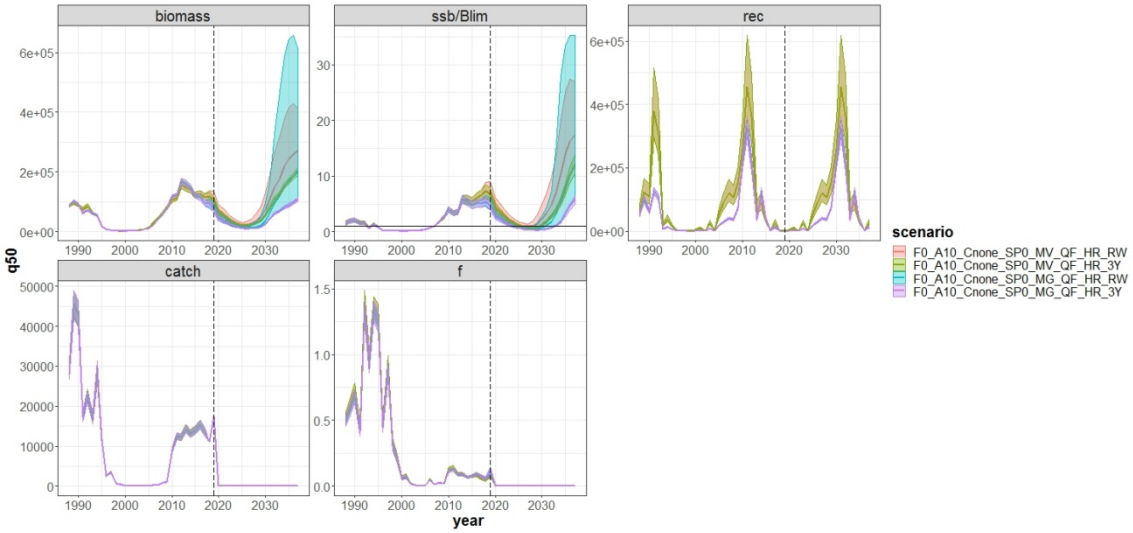

Figure 3. Percentiles 10th and 90th for total biomass, SSB/B_{lim} ratio, recruitment at age 1, catches and F (line) of the low recruitment OMs under the scenarios with F=0. OMs settings are: MVector (MV) or MGadget (MG) for M in historical years, and "Random Walk" (RW) or 3-Year average (3Y) for biological parameters in future years.

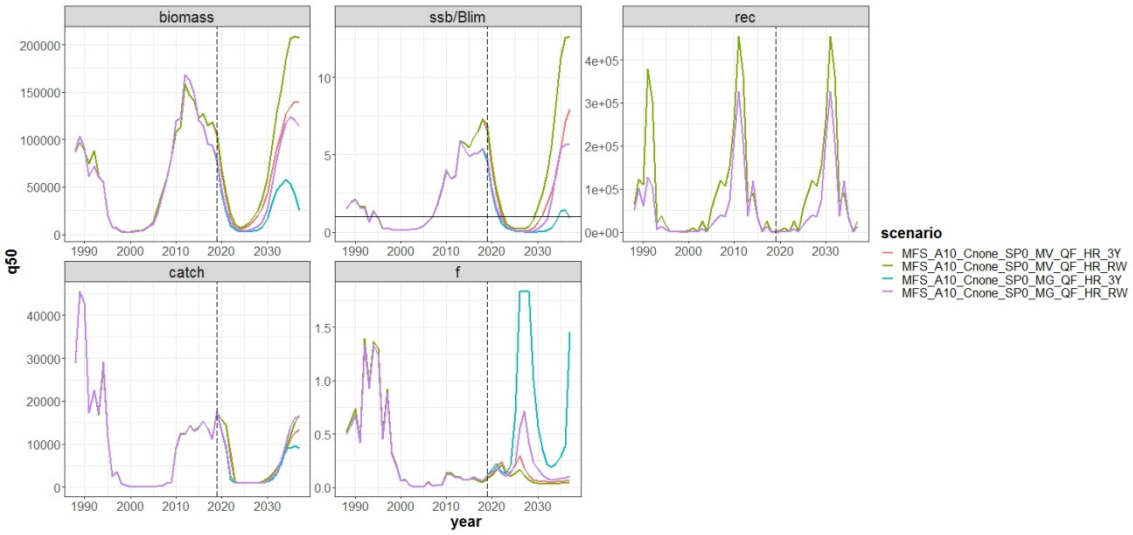

Figure 4. Median results (Total biomass, SSB/B_{lim} ratio, recruitment at age 1, catches and F) of the low recruitment OMs under the slope HCR (MFS). OM settings are: MVector (MV) or MGadget (MG) for M in historical years, and "Random Walk" (RW) or 3-Year average (3Y) for biological parameters in future years.

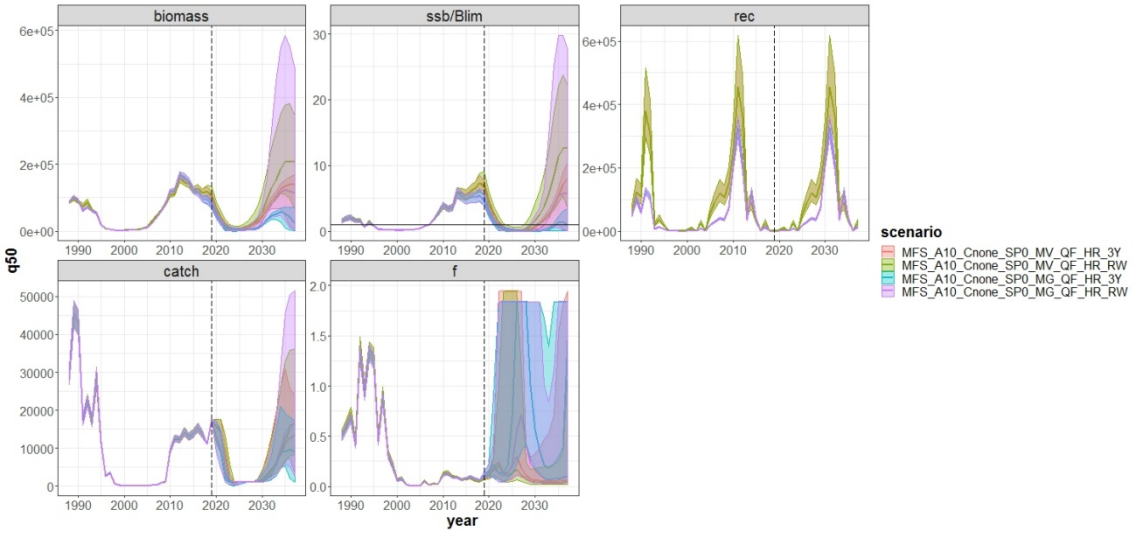

Figure 5. Percentiles 10th and 90th for total biomass, SSB/B_{lim} ratio, recruitment at age 1, catches and F (line) of the low recruitment OMs under the slope HCR (MFS). OMs settings are: MVector (MV) or MGadget (MG) for M in historical years, and "Random Walk" (RW) or 3-Year average (3Y) for biological parameters in future years.

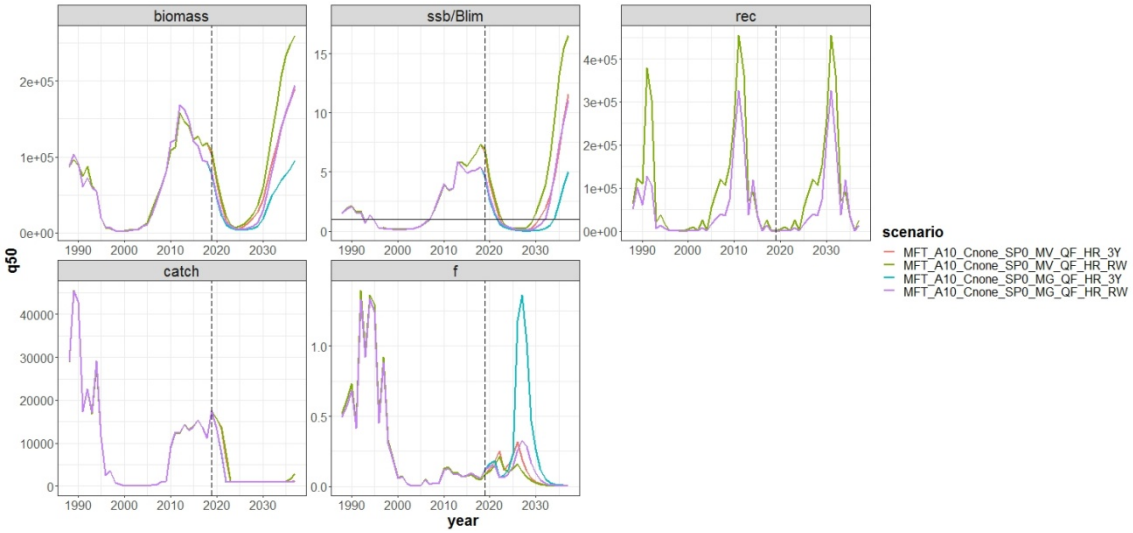

Figure 6. Median results (total biomass, SSB/B_{lim} ratio, recruitment at age 1, catches and F) of the low recruitment OMs under the target HCR (MFT). OM settings are: MVector (MV) or MGadget (MG) for M in historical years, and "Random Walk" (RW) or 3-Year average (3Y) for biological parameters in future years.

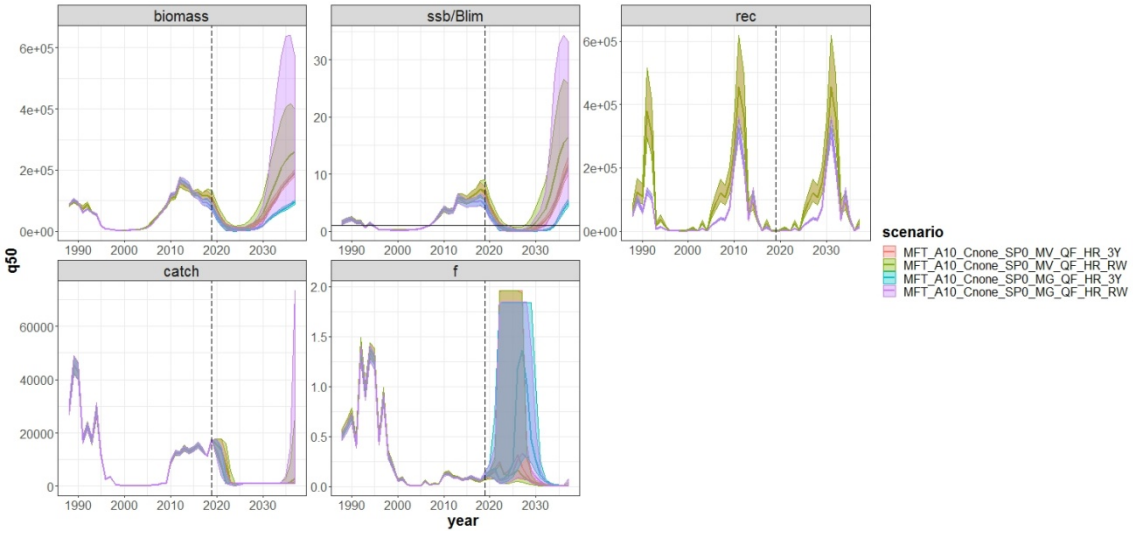

Figure 7. Percentiles 10th and 90th for the total biomass, SSB/B_{lim} ratio, recruitment at age 1, catches and F (line) and of the low recruitment OMs under the target HCR (MFT). The shadow corresponds to the 10 and 90 % percentiles. OMs settings are: MVector (MV) or MGadget (MG) for M in historical years, and "Random Walk" (RW) or 3-Year average (3Y) for biological parameters in future years.