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New projections from the assessment of the Cod Stock in NAFO Division 3M

by

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Abstract

During the Annual meeting of NAFO In September 2011 the Fisheries Commission made the following request: "*With respect to 3M cod, provide short term projection (2012-2014) of spawning biomass, fishing mortality and yield for four alternative scenarios of total removals in 2012: 11 000 t, 12 000 t, 13 000 t and 14 000 t and with constant fishing mortality (F of 2012) afterwards. Provide also a risk analysis with associated probabilities of spawning biomass falling below B_{lim}, fishing mortality increasing above F_{max} (proxi of F_{lim}) and probability if reaching B_{msy} in 2012-2014"*. The aim of the present work in to answer this request. A Bayesian model has been used in the assessment of the 3M cod stock since 2008. With the data of the approved assessment in June of 2011 the projection under $F_{0.1}$ leads in a Yield for 2012 of 9 280 t. The proposed four alternative projections were made. The probability of being over F_{max} in the projection years (2012-2014) ranks from 0.15 for a Yield of 11 000 t and 0.4 for a Yield of 14 000 t. It is no possible to calculate the B_{msy} for this stock at this moment.

Introduction

The 3M cod stock had been on fishing moratorium since 1999 to 2009 following its collapse. The assessments performed since then confirmed the poor situation, with SSB at very low levels, well below B_{lim} (14 000 t) (Vázquez and Cerviño, 2005). Nevertheless, Spawning Stock Biomass (SSB) was estimated to increase a bit in 2004, 2005 and 2006 (Fernández, *et al.*, 2007) and above average recruitment levels were estimated for 2005 and 2006. Another large increase in SSB in 2007-2009, largely due to the recruitments in 2005-2006, has happened, reaching in 2009 the second highest values of the studied series (González-Troncoso and Vázquez, 2010).

In 2007 results from a Bayesian model were presented (Fernández *et al.*, 2007) and in 2008 this Bayesian model was further developed and approved by the NAFO SC (Fernández *et al.*, 2008), being used since then.

The results of the 2009 assessment led to a reopening of the fishery with 5 500 t of catch in 2010. The estimated catch for 2010 is 9 291 t, which almost double the TAC. In 2011 a TAC of 10 000 t was established.

The results of the assessment of 2011 were presented in the NAFO Scientific Council of NAFO of June 2011. Together with the results, some short-term projections were presented with different scenarios. The aim of this manuscript is to present alternative projections to this assessment.

Material and Methods

A stock assessment based in a Bayesian XSA model was presented for 2011 in the Scientific Council of NAFO (González-Troncoso and Vázquez, 2011). The results present an increase in Total Biomass (B), Spawning Stock Biomass (SSB), Recruitment (R) and Fishing Mortality (F).

During the Annual meeting of NAFO in September 2011, the following request was made: "*With respect to 3M cod, provide short term projection (2012-2014) of spawning biomass, fishing mortality and yield for four alternative scenarios of total removals in 2012: 11 000 y, 12 000t, 13 000 t and 14 000 t and with constant*

fishing mortality (F of 2012) afterwards. Provide also a risk analysis with associated probabilities of spawning biomass falling below B_{lim}, fishing mortality increasing above F_{max} (proxi of F_{lim}) and probability if reaching B_{msy} in 2012-2014". The aim of the present work in to answer this request.

With the data of the approved assessment in June there were made some projections for years 2012-2014 calculating the BRPs in 2011, leading projections of B, SSB and Yield for $F_{0.1}$ (0.13), F_{max} (0.21) and F_{2010} (0.28). The results can be seen in González-Troncoso and Vázquez, 2011. The Yield for 2012 that leads from the value of $F_{0.1}$, which is the BRP commonly used to establish the TAC, is 9 280 t.

Alternative projections for years 2012-2014 with a Yield for 2012 of 11 000, 12 000, 13 000 and 14 000 t were made, calculating the F_{bar} for 2012 associated to theses values. These F_{bar} were used to calculate the Yield of the following years of the projection (2103 and 2014).

Results

The results for the projections for years 2012-2014 for a given Yield for 2012 are presented in Table 1 for the four different scenarios, that is, for Yield_2012=11 000 t, Yield_2012=12 000 t, Yield_2012=13 000 t and Yield_2012=14 000 t. In this table we can see the projected B, SSB and Yield for all the Scenarios.

In Table 2 the probability of F_{bar} being over F_{max} of 2011 (F_{max}=0.21) and the probability of SSB being under B_{lim} (B_{lim}=14 000 t) are presented. The SSB has a very high probability of being always, with all the Scenarios, over B_{lim}. The probability of F_{bar} over F_{max} is the same for 2012-2014 as we are assuming a constant F_{bar} for those years equal to the F_{bar} in 2012 with the given Yield. The probability of being over F_{max} in the projection years (2012-2014) is 0.15 for a Yield of 11 000 t, 0.22 for a Yield of 12 000 t, 0.31 for a Yield of 13 000 t and 0.4 for a Yield of 14 000 t.

At this moment it is no possible to calculate the B_{msy} for this stock, so the last part of the request can not be answered.

References

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Table 1.- Results of the projection with a constant Yield for 2012 of 11 000, 12 000, 13 000 and 14 000 t, respectively.

	Yield 2012 = 11 000 t											
	Total Biomass			**SSB**			**F_{bar}**			**Yield**		
	5%	**50%**	**95%**	**5%**	**50%**	**95%**	**5%**	**50%**	**95%**	**5%**	**50%**	**95%**
2011	54477	75818	106165	35258	50474	71150	0.1215	0.2146	0.3928		10000	
2012	77726	112364	164404	46625	65071	90808	0.0820	0.1467	0.2587		11000	
2013	114682	175321	272127	68185	99626	153879	0.0820	0.1467	0.2587	11591	19260	34026
2014	167564	265179	433481	103976	166193	273178	0.0820	0.1467	0.2587	17004	29380	52568
	Yield 2012 = 12 000 t											
	Total Biomass			**SSB**			**F_{bar}**			**Yield**		
	5%	**50%**	**95%**	**5%**	**50%**	**95%**	**5%**	**50%**	**95%**	**5%**	**50%**	**95%**
2011	54327	75969	105888	35086	50531	71514	0.1215	0.2146	0.3928		10000	
2012	77391	112636	167273	46678	65163	91471	0.0900	0.1608	0.2788		12000	
2013	112943	173994	274448	66952	98434	153519	0.0900	0.1608	0.2788	12452	20735	36230
2014	161477	262211	426406	102108	163703	268570	0.0900	0.1608	0.2788	18438	31872	57770
	Yield 2012 = 13 000 t											
	Total Biomass			**SSB**			**F_{bar}**			**Yield**		
	5%	**50%**	**95%**	**5%**	**50%**	**95%**	**5%**	**50%**	**95%**	**5%**	**50%**	**95%**
2011	54537	76191	105828	35518	50555	71453	0.1215	0.2146	0.3928		10000	
2012	77162	112277	166261	46595	65221	90325	0.0981	0.1764	0.3071		13000	
2013	110448	171901	268751	65936	97101	150526	0.0981	0.1764	0.3071	13113	22318	38827
2014	158013	257662	420873	99075	158797	262922	0.0981	0.1764	0.3071	19202	33415	59748
	Yield 2012 = 14 000 t											
	Total Biomass			**SSB**			**F_{bar}**			**Yield**		
	5%	**50%**	**95%**	**5%**	**50%**	**95%**	**5%**	**50%**	**95%**	**5%**	**50%**	**95%**
2011	54586	75972	106126	35331	50617	72006	0.1215	0.2146	0.3928		10000	
2012	77221	111678	168116	46435	65190	90937	0.1077	0.1918	0.3391		14000	
2013	111621	169739	268689	65423	95471	147022	0.1077	0.1918	0.3391	14127	23638	41417
2014	157165	249990	418048	95478	154360	256762	0.1077	0.1918	0.3391	20441	35742	64049

Table 2.- Probabilities of being F_{bar} over F_{max} in 2011 (0.21) and SSB under B_{lim} (14 000 t)

	Yield 2012							
	11 000		**12 000**		**13 000**		**14 000**	
	$P(F_{bar}>F_{max})$	**P(SSB<Blim)**	**$P(F_{bar}>F_{max})$**	**P(SSB<Blim)**	**$P(F_{bar}>F_{max})$**	**P(SSB<Blim)**	**$P(F_{bar}>F_{max})$**	**P(SSB<Blim)**
2011	0.5258	0.0000	0.5258	0.0000	0.5258	0.0000	0.5258	0.0000
2012	0.1470	0.0000	0.2166	0.0000	0.3064	0.0000	0.3990	0.0000
2013	0.1470	0.0000	0.2166	0.0000	0.3064	0.0000	0.3990	0.0000
2014	0.1470	0.0000	0.2166	0.0000	0.3064	0.0000	0.3990	0.0000