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Orange roughy east (*Hoplostethus atlanticus*) cross-catch risk assessment based upon the 2017 stock assessment

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Executive summary

This paper presents a cross-catch risk assessment for eastern orange roughy based upon the model structure of Haddon (2017). Two models are considered that differ only by the assumed value of natural mortality, M. The base-case model has M=0.04 and an alternative has M=0.032. The alternative value for natural mortality was chosen to define a low productivity model, and used the value with highest likelihood from the likelihood profile of Haddon (2017).

The catches input to the two model structures were the predicted projected catches from each model, and a fixed 3-year catch series proposed by industry; thus three projected catch scenarios associated with each natural mortality used. The purpose of the risk assessment was to identify if any of the catch series led to biomass trajectories that may be perceived as a risk to the long-term sustainability of the stock. The consequent six scenarios (2 models × 3 catch series) were projected 55 years into the future.

Results showed that, as expected, the model with lower productivity (the M=0.032 model) and with the highest catches (from the M=0.04 model) had the lowest long-term biomass series (in terms of annual tonnage of female spawning biomass). This series stabilised at approximately 30% of virgin biomass. All other scenarios had biomass levels that were considerably greater than this. As far as short-term catches and depletion were concerned, the differences between biomass trajectories across catch series were minimal within a model structure (i.e. for a particular value of M). For example, by 2025, the depletion ranged between 0.40 and 0.42 for the M=0.04 models, whereas the depletion ranged between 0.31 and 0.34 for the M=0.032 model.

1 Introduction and Methods

This paper presents a cross-catch risk assessment for eastern orange roughy based upon the underlying stock assessment of Haddon (2017). The 2017 stock assessment provided a base-case assessment (M=0.04, h = 0.75) and an alternative based upon a likelihood profile that suggested the stock may be less productive (M=0.036, h = 0.60). A cross-catch risk assessment was conducted on these models, whereby the projected catch predicted by the usual HCR from one model structure was used as an input for deterministic projections in the other model (Haddon, 2017).

At the August 2018 SESSFRAG meeting (AFMA, 2018a) an alternative series of catches from industry was proposed. SERAG has now been asked to consider the industry catches in a cross-catch risk assessment using the base-case (M=0.04, h=0.75) and an alternative low productivity model (M=0.032, h=0.75). The choice of parameters for the alternative model was based upon a natural mortality value of M=0.032, being the most likely value from the likelihood profile analysis conducted by Haddon (2017). As steepness would only become important for catches in the future, only M is varied in the scenarios considered in the cross-catch risk assessment, with steepness fixed at the base-case value of h=0.75. The model with M=0.032 has been tuned using the same method as the base-case M=0.04 model of Haddon (2017). Note that aspects of the model tuning process and platform have changed since this assessment was conducted, however it was not within the remit of this work to reassess the stock. As such the same model structure, platform and tuning methods were applied as those conducted on the base-case in 2017. Catches from 2017 were recalculated based on landings from the eastern roughy zone and logbook catches from Pedra Branca. Haddon (2017) used the TAC to estimate catches in 2017 for projections.

There are 6 scenarios to consider: 2 model structures × 3 catch series (AFMA, 2018b). The scenario definitions are in Table 1 and the catch series for each scenario from 2017 to 2025 is given in Table 2. Note that the projected catches from the base-case model (M=0.04) are greater than 1.5 times the current TAC. As such, annual catches were set equal to 1.5 times the previous year's catch until projected catches were no longer greater than 1.5 times the previous year (invoking the 50% change rule). This only affected models 04w04 and 032w04 (shaded cells of Table 2).

Table 1. The definitions of each of the 6 scenarios where the name of the scenario is given by "Model" with "Catch", eg "04w032" refers to the M=0.04 model structure and with catch from the model having M=0.032.

Scenarios		Model	
		Base-case (M=0.04)	Low productivity (M=0.032)
Catch	Base-case HCR	04w04	032w04
	Low productivity HCR	04w032	032w032
	Industry proposal	04wInd	032wInd

Table 2. The catches from years 2017 to 2025. Note the model was projected to 2071, but only catches to 2025 are shown here for brevity. The shaded cells were fixed in the projection model due to (i) known catches from 2017, (ii) as fixed input catches from one model into the alternative (04w032, 032w04), (iii) due to the influence of the 50% catch limit meta-rule (04w04, 032w04), (iv) due to fixed 3-year industry proposed catches (04wInd, 032wInd). The unshaded catch values come directly from the SESSF Tier 1 20:35:48 HCR.

	Scenario					
	04w04	04w032	04wInd	032w032	032w04	032wInd
2017	346	346	346	346	346	346
2018	698	537	709	537	698	709
2019	1046	615	900	615	1046	900
2020	1398	686	900	686	1398	900
2021	1423	750	1437	750	1423	722
2022	1443	806	1457	806	1443	779
2023	1459	855	1473	855	1459	828
2024	1472	896	1485	896	1472	871
2025	1481	931	1494	931	1481	907

2 Results

The trajectory of female spawning biomass and relative female spawning biomass are shown in Figure 1-3, with relative values for years 2017 to 2025 in Table 3. As expected, the higher productivity model (M=0.04) with the lower catches (from the M=0.032 model) shows the largest biomass over time (04w032; blue). The higher productivity model with catches from this model (04w04) and with the industry proposed catches (04wInd) show little difference over time (both long and short term; Table 3). Likewise, the lower productivity model (M=0.032) with the higher catches (from the model with M=0.04) shows the lowest biomass trajectory (032w04; yellow). The lower productivity model with catches from this model (032w032) and with the industry proposed catches (032wInd) show little difference over time (both long and short term; Table 3). This is because the industry proposed catches are only applied for 3 years before returning to the standard Tier 1 HCR of the particular model.

In terms of risk, the lowest biomass occurs with the low productivity model with the high productivity model catches (032w04). In this case the biomass stabilises at approximately 0.30Bo. All other scenarios stabilise at a relative biomass level well above this. Note that these are deterministic projections and the uncertainty surrounding these trajectories has not been estimated using methods such as MCMC (further work). However the asymptotic confidence intervals are all above the limit reference point from approximately 2017 onwards (Figure 3). The greatest difference in realised biomass between these models is, not surprisingly, in the utilisation of one or other of the models with differing natural mortality.

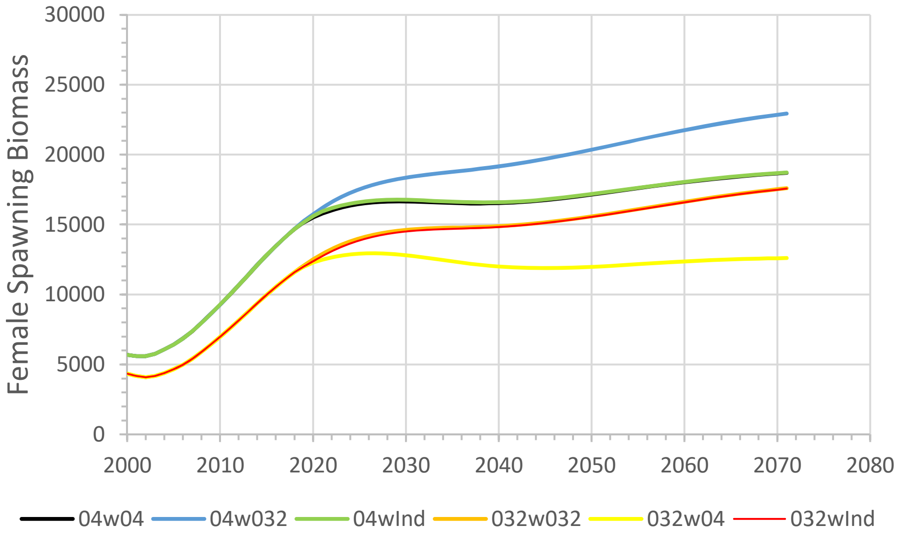

Figure 1. The female spawning biomass (t) for eastern orange roughy under each of the six scenarios described in Table 1.

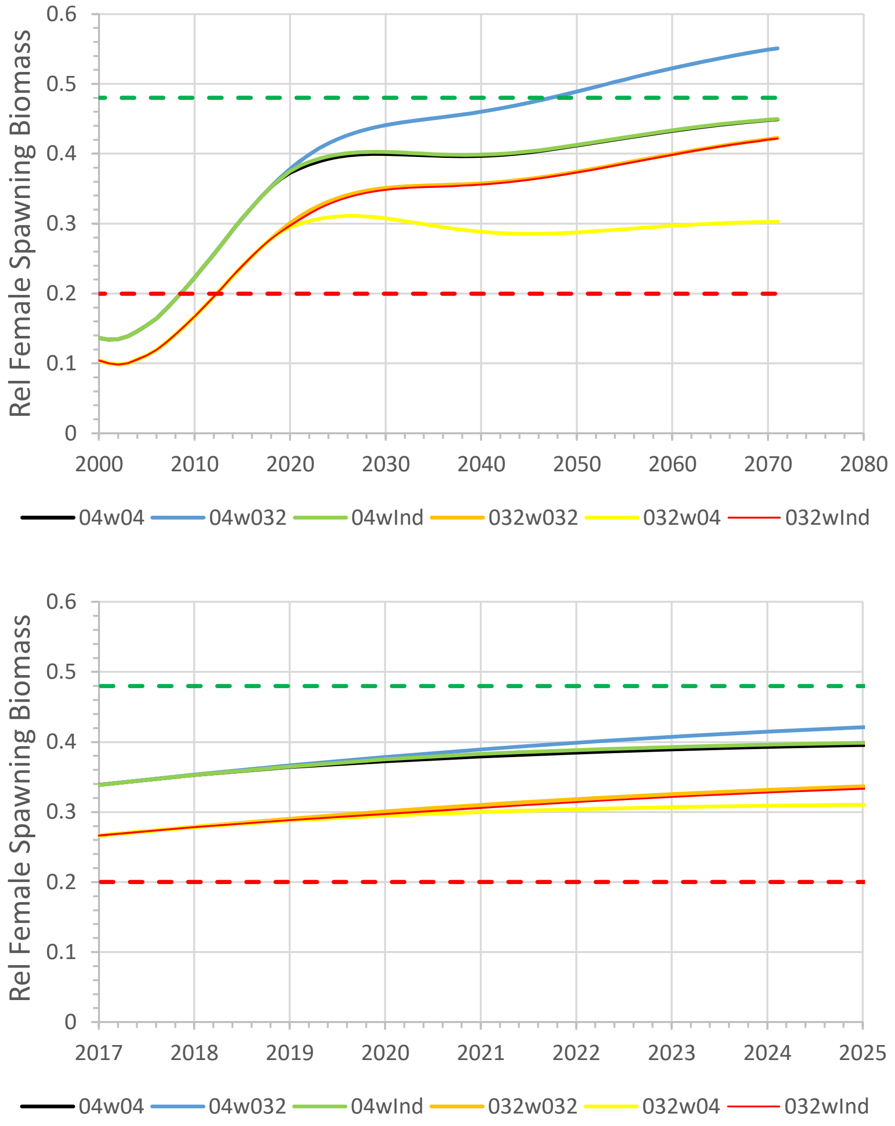

Figure 2. The relative female spawning biomass for eastern orange roughy under each of the six scenarios described in Table 1 (top) and with restricted years to better show detail of the trajectories (bottom).

Table 3. The relative female spawning biomass from 2017 to 2025 for each of the six scenarios of Table 1.

	Scenario					
	04w04	04w032	04wInd	032w032	032w04	032wInd
2017	0.34	0.34	0.34	0.27	0.27	0.27
2018	0.35	0.35	0.35	0.28	0.28	0.28
2019	0.36	0.37	0.36	0.29	0.29	0.29
2020	0.37	0.38	0.37	0.30	0.29	0.30
2021	0.38	0.39	0.38	0.31	0.30	0.31
2022	0.38	0.40	0.39	0.32	0.30	0.31
2023	0.39	0.41	0.39	0.33	0.31	0.32
2024	0.39	0.41	0.40	0.33	0.31	0.33
2025	0.40	0.42	0.40	0.34	0.31	0.33

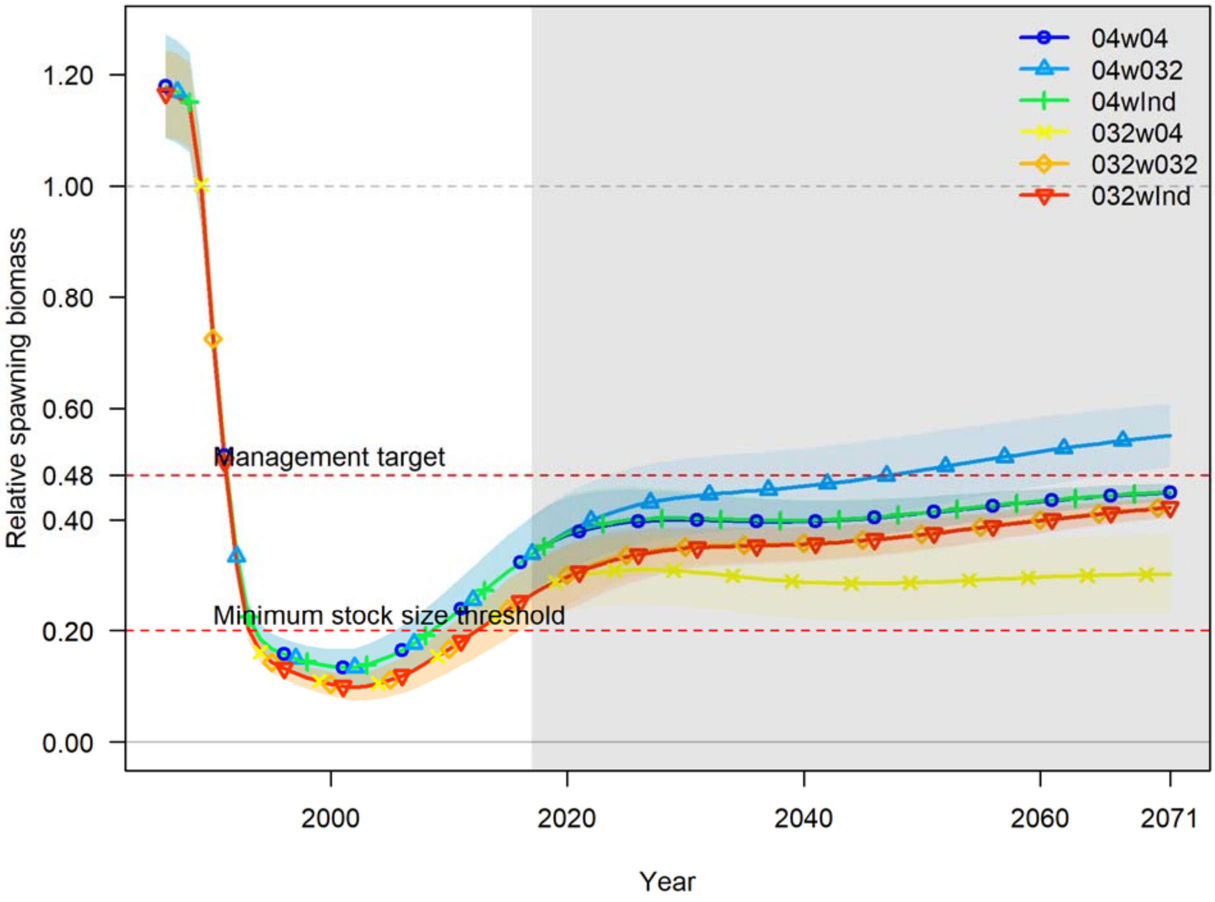

Figure 3. The relative female spawning biomass for eastern orange roughy under each of the six scenarios described in Table 1 with asymptotic 95% confidence intervals.

Discussion

This paper presents a cross-catch risk assessment for eastern orange roughy based upon the model structure of Haddon (2017). Two models are considered that differ only by the assumed value of natural mortality, M. The base-case model has M=0.04 and an alternative has M=0.032. The alternative value for natural mortality was chosen to define a low productivity model that then bounds a greater degree of uncertainty across parameterisations than the cross-catch risk assessment of Haddon (2017) that used M=0.036. The value of M=0.032 also was the most likely value of M for the given model structure and data inputs identified in the likelihood profile of Haddon (2017).

The catches input to the two model structures were the respective catches from each model, and a 3-year catch series proposed by industry. The purpose of the risk assessment was to identify if any of the catch series led to biomass trajectories that may be perceived as a risk to the long-term sustainability of the stock. The consequent six scenarios (2 models × 3 catch series) were projected 55 years into the future.

Results showed that the model with lower productivity and with the highest catches (Model 032w04) had the lowest long-term biomass series (in terms of annual tonnage of female spawning biomass). This series stabilised at approximately 30% of virgin biomass. All other scenarios had biomass levels that were considerably greater than this although only in model 04w04 did the depletion level rise above $0.48B_0$ after 55 years. As far as short term (out t o 2025) catches and depletion are concerned, the differences between biomass trajectories across catch series were minimal within a model structure (i.e. for a particular chosen value of M). For example, by 2025, the depletion ranged between 0.40 and 0.42 for the M=0.04 models, whereas the depletion ranged between 0.31 and 0.34 for the M=0.032 models. These small differences are unlikely to be distinguishable within the natural stochastic variability of the stock and the uncertainty in the model. The greater uncertainty is with regard to the value of M used in the model. This is not unusual for stock assessment models, as M is known to be influential, but unfortunately in many cases difficult to determine. This uncertainty in natural mortality should be explored further and AFMA (2018b) proposes analyses to do this.

References

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