Further projections for the toothfish (*Dissostichus eleginoides*) resource in the Prince Edward Islands vicinity

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ABSTRACT

For stochastic future recruitment and for annual catch levels of both 575 tons (the present TAC) and 700 tons, the median of the spawning biomass estimates drops initially, but returns to its current level within a decade, while the exploitable biomass increases from 2016 Omitting the single tag-recapture datum currently available for 2016 from the assessment makes a negligible difference to the results.

INTRODUCTION

This paper reports on further projections for the Prince Edward Islands (PEI) toothfish resource to those carried out by Brandão and Butterworth (2016). In this paper, projections take into account stochasticity in future recruitment under future annual constant catches of 575 t and 700t as requested by the DWG.

The Base case model of Brandão and Butterworth (2016) is also rerun with the recapture of a single tag in 2016 is omitted from the input data, because full recapture results for this year are not yet available.

RESULTS AND DISCUSSION

Table 1 shows the results for the Base case in which the recapture data for 2016 is omitted from the assessment. For comparison, the results reported for the Base case model (that includes this datum) in Brandão and Butterworth (2016) are repeated here. The effect of omitting this datum is negligible.

Figure 1 shows the median spawning biomass depletion together with twenty year projections assuming future stochastic recruitment under constant future annual catches of 575 t and 700 t for the Base case model (with tagging data) and for three sensitivity tests. Projections assume that in future all catches are from the trotline fishery, as has been the case since 2014, and that there are no illegal removals. As the pot fishery has not been operational since 2005, the projections assume no pot fishery. Figure 2 shows the above projections together with their 95% probability envelopes. Median, 5th and 95th percentiles for spawning biomass depletion for the **Base case** model under future annual catches of 575 and 700 tonnes for the current year (2016) and every 5th year thereafter are given in Table 2.

Figures 3 and 4 provide similar results to Figure 1, but the projections are for the longline (Figure 3) and the trotline (Figure 4) exploitable components of the biomass.

CONCLUSIONS

For all scenarios under both future catch levels considered the median of the spawning biomass estimates drops initially, but returns to its current level inside a decade, while the exploitable biomass increases from the current time. After the first few years the 700 ton projections yield spawning biomasses about 4% less than if the annual TAC is maintained at 575 tons.

REFERENCE

Brandão, A. and Butterworth, D.S. 2016. Updated assessment of the toothfish (*Dissostichus eleginoides*) resource in the Prince Edward Islands vicinity to include data from 1997 to 2016. DAFF Branch Fisheries document: FISHERIES/2016/OCT/SWG-DEM/69-amended 13 Oct.

Table 1. Estimates for a **Base case** model with three fleets (longline, trotline and pot) that assumes different commercial selectivities for the three gears, and also a change in selectivity for the longliners between 2002 and 2003, when fitted to the CPUE and catch-at-length data for toothfish from the Prince Edward Islands EEZ. Results for a **sensitivity** to omitting the 2016 tagging datum are also shown. The estimates shown are for the pre-exploitation toothfish spawning biomass (K_{sp}), the current spawning stock depletion (B_{sp}^{2017}) in terms of both K_{sp} and $MSYL_{sp}$, and the (longline) exploitable biomass ($B_{\exp}^{2017}$) at the beginning of the year 2017 (assuming the same selectivity as for 2016). Estimates of parameters pertinent to fitting the catch-at-length information are also shown, together with contributions to the (negative of the) log-likelihood. Numbers in brackets represent CVs. The details of the various model variants reported are given in the text.

Parameter estimates		**Model**	
		Base case	**Base case (no 2016 tagging datum)**
K_{sp} (tonnes)		35 815 (0.118)	36 057 (0.118)
$MSYL_{sp}$ (Longline)/K_{sp}		0.244	0.244
B_{sp}^{2016}/K_{sp}		0.494 (0.093)	0.496 (0.093)
B_{sp}^{2017}/K_{sp}		0.512 (0.094)	0.515 (0.094)
B_{sp}^{1997}/K_{sp}		1.257 (0.095)	1.254 (0.095)
$B_{sp}^{2017}/MSYL_{sp}$(Longline)		2.102	2.112
$B_{\exp}^{2017}$ (tonnes)	Longline	14 246 (0.144)	14 448 (0.143)
	Pot	22 497 (0.128)	22 763 (0.129)
	Trotline	17 257 (0.132)	17 521 (0.133)
σ_{CPUE}	Longline	0.416	0.418
	Trotline	0.203	0.203
σ_R		0.500††	0.500††
a_{50}^{97-02} (yr)		6.499	6.499
δ^{97-02} (yr^{-1})		0.020	0.020
ω^{97-02} (yr^{-1})		0.058	0.058
a_{50}^{03-16} (yr)	Longline	6.447	6.448
	Pot	8.696	8.703
	Trotline	7.347	7.349
δ^{03-16} (yr^{-1})	Longline	0.128	0.128
	Pot	0.885	0.886
	Trotline	0.292	0.294
ω^{03-16} (yr^{-1})	Longline	0.070	0.069
	Pot	0.000	0.000
	Trotline	0.033	0.033
β		0.118 (0.018)	0.118 (0.018)
σ_{len}	Longline	0.042	0.042
	Pot	0.035	0.035
	Trotline	0.039	0.039

†† Input value.

* The results shown for the "current" biomass-related values for the previous Base case are for 2016, and not for 2017 as for the results for present Base case model except for B_{sp}/K_{sp} .

Table 1 cont. Estimates for a **Base case** model with three fleets (longline, trotline and pot) that assumes different commercial selectivities for the three gears, and also a change in selectivity for the longliners between 2002 and 2003, when fitted to the CPUE and catch-at-length data for toothfish from the Prince Edward Islands EEZ. Results for a **sensitivity** to omitting the 2016 tagging datum are also shown. The estimates shown are for the pre-exploitation toothfish spawning biomass (K_{sp}), the current spawning stock depletion (B_{sp}^{2017}) in terms of both K_{sp} and $MSYL_{sp}$, and the (longline) exploitable biomass ($B_{\exp}^{2017}$) at the beginning of the year 2017 (assuming the same selectivity as for 2016). Estimates of parameters pertinent to fitting the catch-at-length information are also shown, together with contributions to the (negative of the) log-likelihood. Numbers in brackets represent CVs. The details of the various model variants reported are given in the text.

Parameter estimates		Model: Base case	Model: Base case (no 2016 tagging datum)
-ln L: Length		-826.2	-825.9
-ln L: CPUE		-15.167	-15.09
-ln L: Recruitment		0.163	-0.147
-ln L: Tagging		184.1	184.5
-ln L: Total		-657.1	-656.7
MSY (tonnes)	Longline	1 438†	1 448†
	Pot	1 590	1 601
	Trotline	1 516	1 527

† Based upon the average of the two selectivity functions estimated.

Table 2. Median, 5th and 95th percentiles for spawning biomass depletion for the **Base case** model assuming stochastic future recruitment and under future annual catches of 575 and 700 tonnes for the current year (2016) and every 5th year thereafter.

	Future catch of 575 t			Future catch of 700 t		
	5th percentile	**Median**	**95th percentile**	**5th percentile**	**Median**	**95th percentile**
Current (2016)		0.494			0.494	
2021	0.436	0.444	0.446	0.427	0.432	0.438
2026	0.412	0.555	0.983	0.393	0.533	0.959
2031	0.461	0.866	2.096	0.433	0.835	2.060
2036	0.626	1.207	3.486	0.591	1.167	3.440

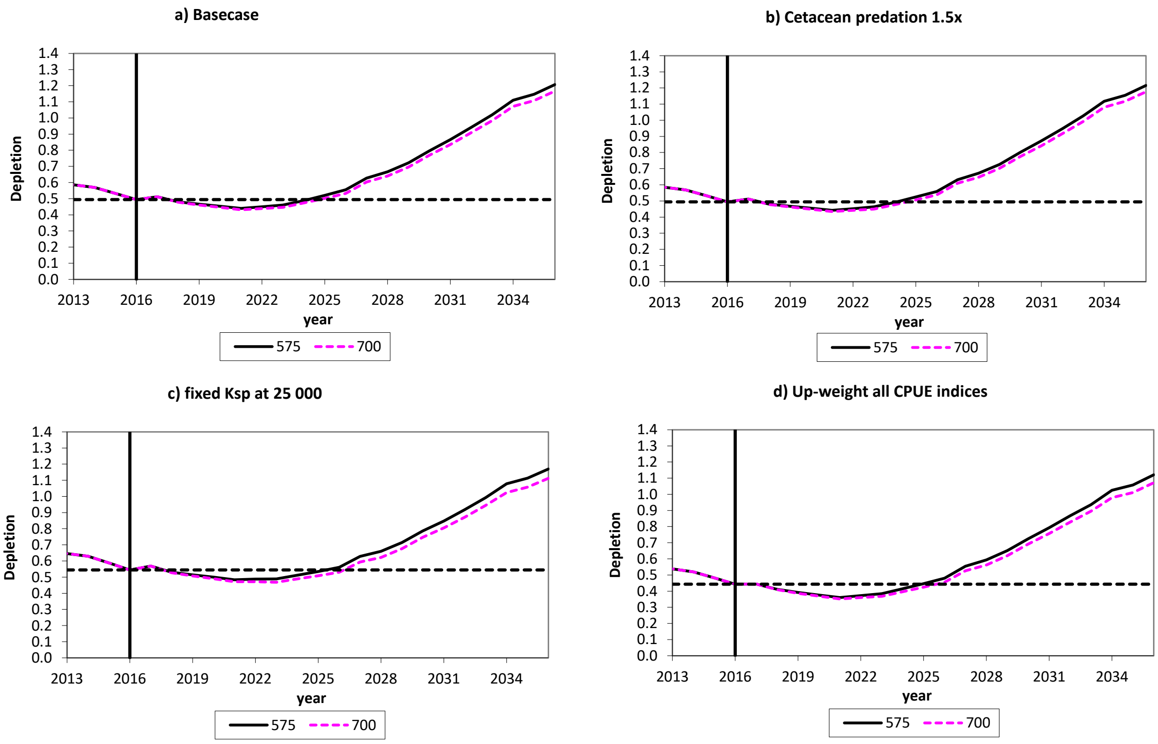
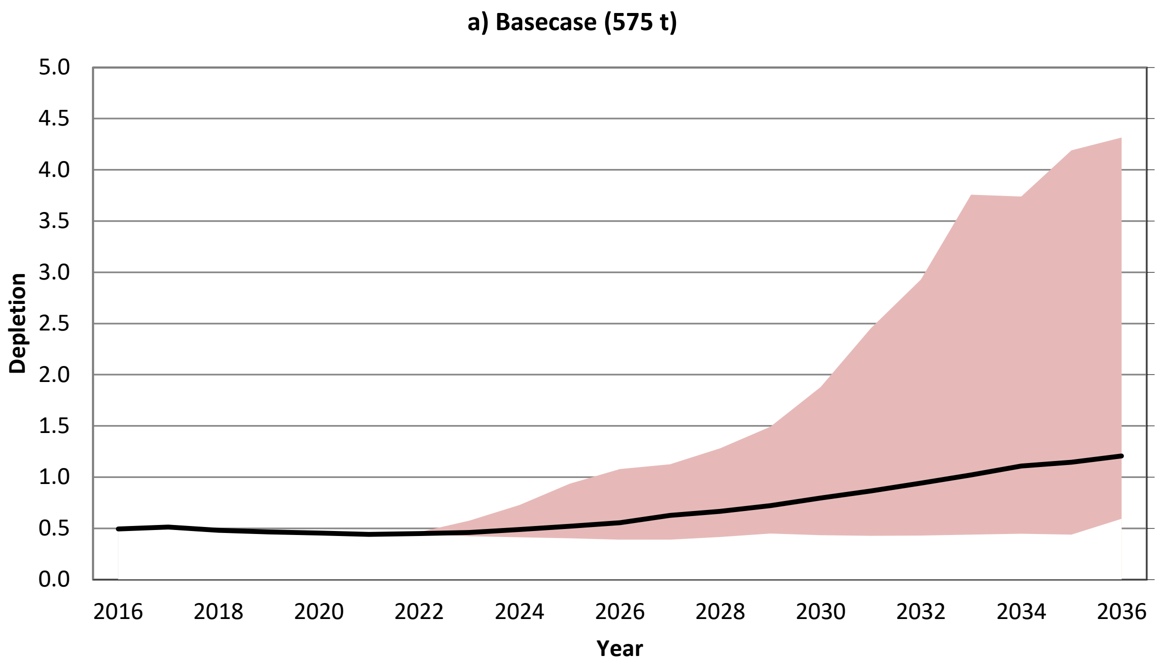


Figure 1. Median spawning biomass depletion projections (shown after the vertical line) assuming stochastic future recruitment and under future annual catches of 575 and 700 (assumed to be all from trotlines as is the case for catches taken since 2014) for the **Base case** (a) and three **sensitivity tests** ((b) assumes cetacean predation of 1.5, (c) fixes K_{sp} at 25 000, and (d) up-weights all CPUE indices). The dashed horizontal line shows the current (2016) depletion value.



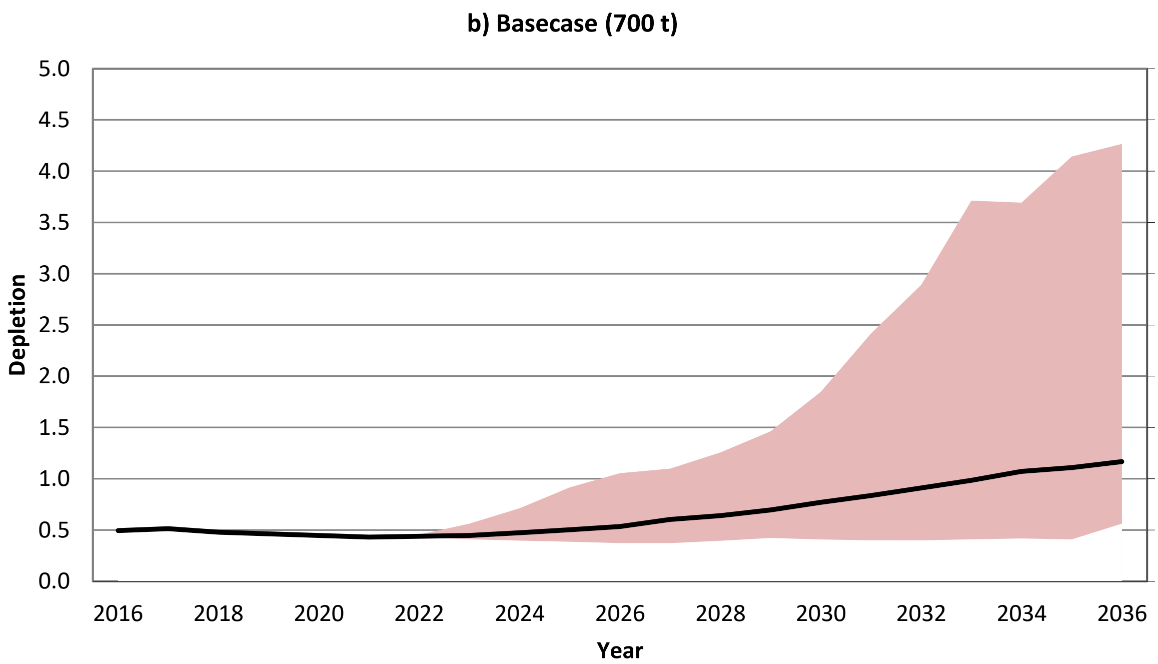


Figure 2. Median spawning biomass depletion projections assuming stochastic future recruitment and under future annual catches of 575 (a) and 700 (b) (assumed to be all from trotlines as is the case for catches taken since 2014) for the **Base case** model together with their 95% envelopes.

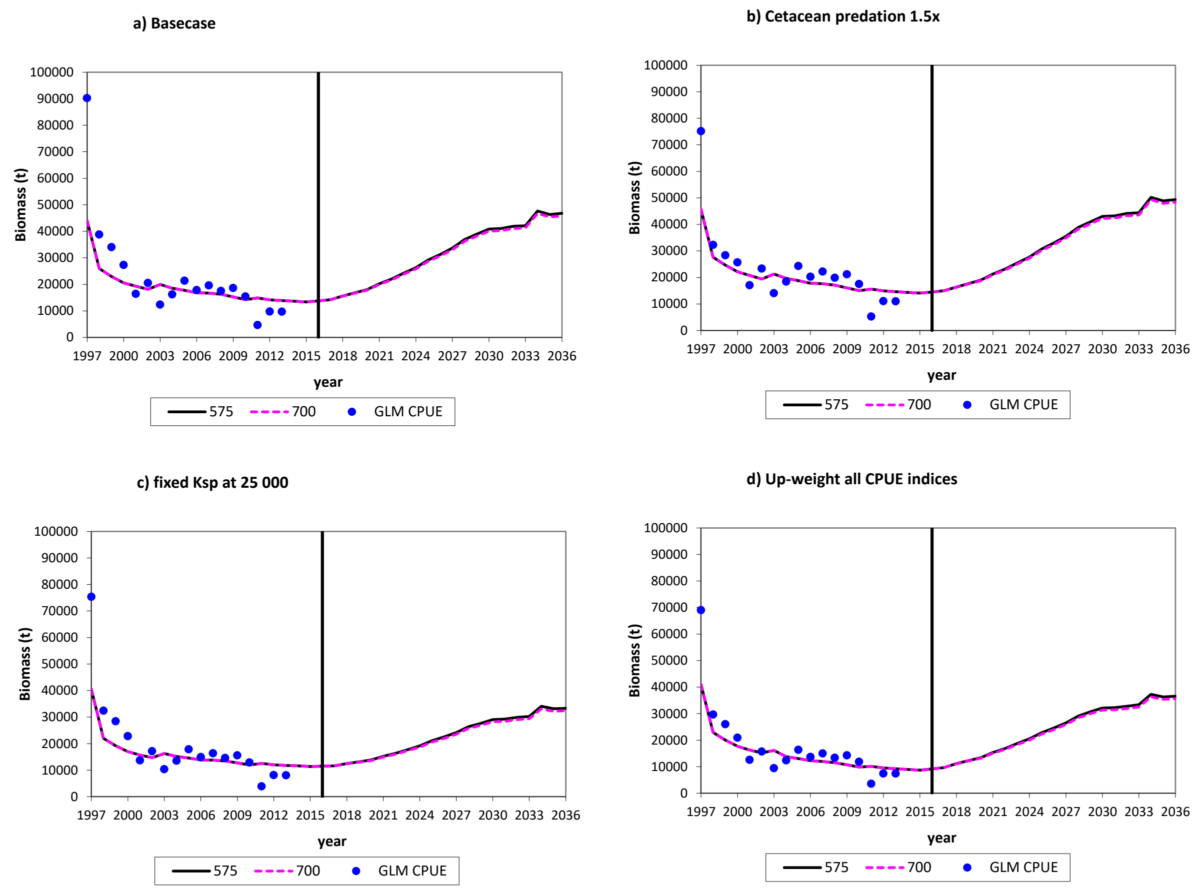


Figure 3. Exploitable biomass for the **longline** fishery and the GLM-standardised CPUE indices to which the model is fit (divided by the estimated catchability *q* to express them in biomass units), together with projections (shown after the vertical line) for future catches for the **Base case** and three **sensitivities** as in Figure 1.

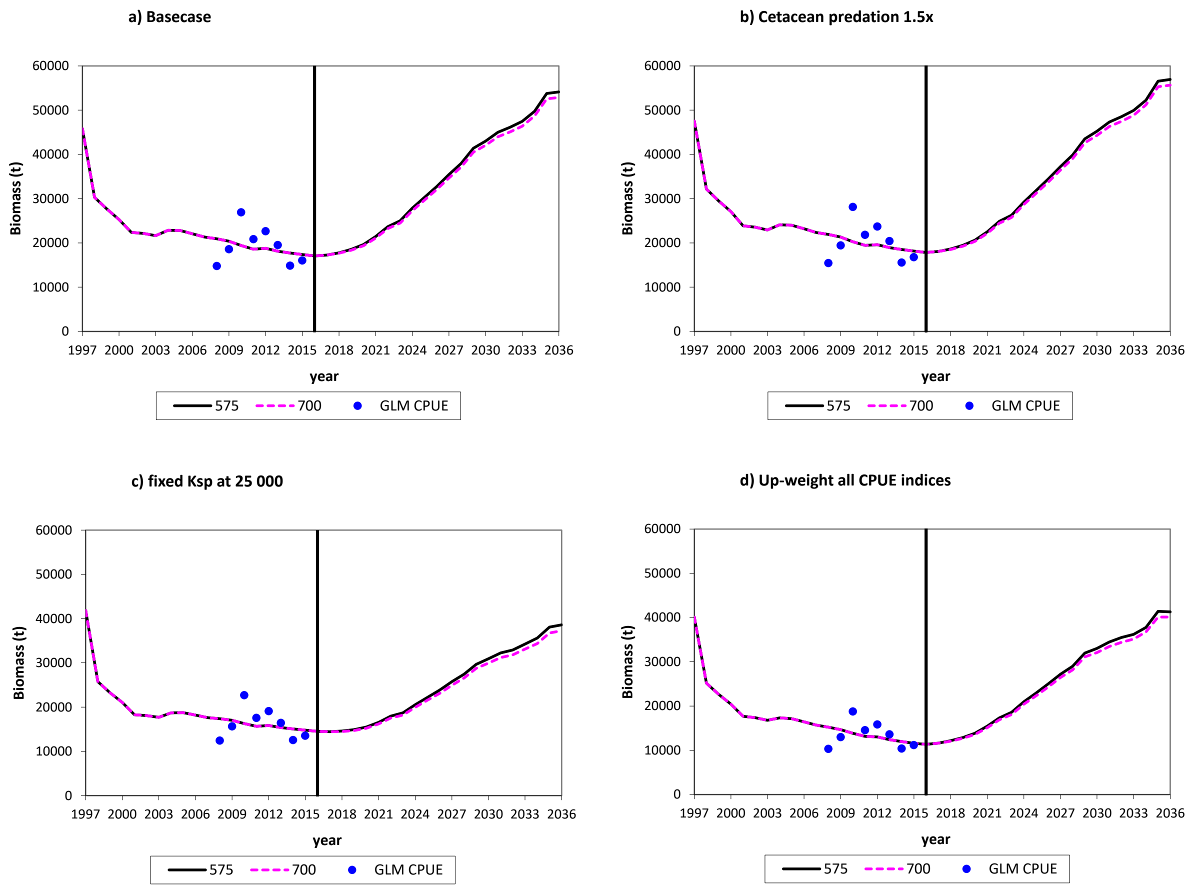


Figure 4. Exploitable biomass projections (shown after the vertical line) as shown in Figure 2, except here for the **trotline** rather than the longline fishery.