OMP-13: Further Investigation of the Anchovy Control Rule

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Introduction

de Moor and Butterworth (2013) have shown that under equivalent leftward shifts of the OMP to no catch biomass distribution in the transition from operating models (whether HS0.9[1] or BH1.2[2]) based on data to 2006 to those based on data to 2011, the anchovy $risk^A$ statistic deteriorates, reflecting an appreciably greater probability that the adult anchovy biomass falls below 10% of its average value over the November 1984 to November 1999 period at least once during a 20-year projection period.

This document explores the effect of changes to the anchovy catch control rule, in particular to the threshold survey biomass level B_{ec}^A below which Exceptional Circumstances provisions are invoked.

Results

Table 1 summarises key results for alternative Candidate OMP-13s from de Moor and Butterworth (2013) as well as the Interim OMP-13 of de Moor and Butterworth (2012), assuming the BH1.2 operating model. The particular focus is on Candidate OMP-13 with c_{mxtac}^A=450, for which $risk^A = 0.347$, a risk statistic much greater than its corresponding value of 0.219 for OMP-08 for the corresponding BH1.2 operating model for data to 2006.

Table 2 considers various modifications to the anchovy control rule parameter values to attempt to reduce this value of 0.347 for $risk^A$.

1) The Exceptional Circumstances threshold biomass B_{ec}^A is increased from 400 to first 500 and then 600 thousand tons. The average anchovy TAC is little affected, and risk decreases, both in terms of $risk^A$ and of a lesser "leftward shift" of the projected no catch to catch biomass distribution. There is however a "cost" involved: the probability of a TAC less than $c_{mntac}^A = 120$ thousand tons increasing from 26 to 31% as B_{ec}^A is increased from 400 to 600 (Table 2). Figure 1 shows that the frequency of zero anchovy TAC is slightly decreased, while the frequency of an anchovy TAC below 50 000t is slightly increased.
2) Considering either a higher threshold (Δ^A) above B_{ec}^A at which linear smoothing is introduced before anchovy Exceptional Circumstances are declared, or a maximum proportion (100% rather than 25%) by

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[1] Hockey Stick stock recruitment relationship with a fixed inflection point of $b^A = 0.2K^A$ and $\overline{M}_j^A = \overline{M}_{ad}^A = 0.9$ year^{-1}

[2] Beverton Holt stock recruitment relationship with $\overline{M}_j^A = \overline{M}_{ad}^A = 1.2$ year^{-1}

which normal season anchovy TAC can be reduced annually (c^A_{mxdn}), the probability of a TAC less than $c^A_{mntac} = 120$ thousand tons reduces slightly and also, for the latter case, $risk^A$ decreases.

3) A rather extreme conservative rule in which the "protection level" (zero TAC) is the same as B^A_{ec} ($x^A = 1$) while there is no restriction on the proportion by which normal season anchovy TAC can be reduced annually ($c^A_{mxdn} = 1$), reduces $risk^A$ down to 11%. Note, however, that the proportion of times Exceptional Circumstances are declared (and anchovy TAC set to zero) remains high at an average of 1 in 4 years (Table 2, Figure 1).

4) Attempting to achieve the same leftward shift with $B^A_{ec} = 600$ as with $B^A_{ec} = 400$ by changing the α and β control parameter values, which leads to slightly higher anchovy TACs at the expense of lower sardine TACs.

The trade-off curves for some of these options are compared in Figure 2.

Tables 3 and 4 repeat the results of Tables 1 and 2 respectively for the same control parameter values, but for an HS0.9 operating model. In qualitative terms there are similarities in the BH1.2 and HS0.9 results in terms of relative patterns. The main difference is that a greater average anchovy TAC will eventuate if HS0.9 reflects reality better than BH1.2. Note also that when compared to the OMP-08 trade-off curve, potential anchovy TACs are not greatly reduced, though there is a larger decrease in the predicted average directed sardine catch (Figure 3).

Conclusions

The results of this paper indicate that the value of the $risk^A$ statistic can be reduced by changing the values of other control parameters without greatly changing the average predicted anchovy TAC, but the frequency of low anchovy TACs then increases.

References

de Moor, C.L. and Butterworth, D.S. 2012. Interim OMP-13. Department of Agriculture, Forestry and Fisheries Document FISHERIES/2012/DEC/SWG-PEL/64. 17pp.

de Moor, C.L. and Butterworth, D.S. 2013. Re-considering the appropriate risk level for anchovy in OMP-13 development. Department of Agriculture, Forestry and Fisheries Document FISHERIES/2013/APR/SWG-PEL/04. 18pp.

Table 1. The risk to the resources, the ratio of lower percentiles of the predicted distribution of anchovy 1+ biomass in the final projection year under the MP to that under a no catch scenario, and average projected annual directed catch (with average anchovy assumed caught during the additional season in parentheses), for OMP-08, a Candidate OMP-13 (with $c^A_{mxtac} = 600$ or $c^A_{mxtac} = 450$, and $B^A_{ec} = 400$) and Interim OMP-13. All results given assume a Beverton Holt stock recruitment relationship and $\overline{M}^A_j = \overline{M}^A_{ad} = 1.2\,\text{year}^{-1}$ for the underlying operating model (BH1.2), with the operating model used for OMP-08 based on data up to 2006 and that for Candidate and Interim OMP-13 based on data up to 2011. All biomasses are given in thousands of tons. The two different sets of control parameters for Candidate OMP-13 with $c^A_{mxtac} = 600$ correspond to using different operating models to match the "leftward shift" in predicted biomass distributions from a no catch to MP scenario (see de Moor and Butterworth 2013 for details).

	OMP-08	Candidate OMP-13			Interim OMP-13
c^A_{mxtac}	600	600	600	450	450
β	0.097	0.067	0.082	0.082	0.090
α	0.78	0.782	0.635	0.636	0.321
$risk^A$	0.219	0.436	0.347	0.347	0.197
$risk^S$	0.159	0.188	0.208	0.207	0.209
10%ile	0.11	0.10	0.11	0.11	0.22
20%ile	0.14	0.14	0.14	0.14	0.31
30%ile	0.18	0.17	0.17	0.17	0.37
40%ile	0.20	0.20	0.20	0.20	0.41
50%ile	0.22	0.24	0.24	0.24	0.43
$\overline{C}^A$	395	292 (67)	289 (69)	281 (69)	259 (70)
$\overline{C}^S$	193	129	145	145	154

Table 2. The risk to the resources, the ratio of lower percentiles of the predicted distribution of anchovy 1+ biomass in 2032 under the MP to that under a no catch scenario, and average annual directed catch (with average anchovy assumed caught during the additional season in parentheses), for a Candidate OMP-13 (with $c^A_{mxtac} = 450$) and Interim OMP-13. All results given assume a Beverton Holt stock recruitment relationship and $\overline{M}^A_j = \overline{M}^A_{ad} = 1.2$ year^{-1} in the underlying operating model (BH1.2). All biomasses are given in thousands of tons. Comparisons (shown in **bold**) are made among:

5) alternative thresholds, B^A_{ec}, below which Exceptional Circumstances for anchovy are invoked,
6) a higher threshold (Δ^A) above B^A_{ec} at which linear smoothing is introduced before anchovy Exceptional Circumstances are declared,
7) a maximum proportion by which normal season anchovy TAC can be reduced annually (c^A_{mxdn}),
8) a maximum proportion by which normal season anchovy TAC can be reduced annually with a higher proportion below B^A_{ec} at which anchovy TAC is zero, x^A, and
9) a final column which corresponds to a closer "leftward shift" to that of the first column.

	Candidate OMP-13 with $c^A_{mxtac} = 450$						
B^A_{ec}	**400**	**500**	600	600	600	600	600
Δ^A	100	100	100	**400**	100	100	100
c^A_{mxdn}	0.25	0.25	0.25	0.25	**1.00**	**1.00**	0.25
x^A	0.25	0.25	0.25	0.25	0.25	**1.00**	0.25
β	0.082	0.082	0.082	0.082	0.082	0.82	**0.071**
α	0.636	0.636	0.636	0.636	0.636	0.636	**1.214**
$risk^A$	0.347	0.258	0.186	0.183	0.165	0.106	0.298
$risk^S$	0.207	0.205	0.201	0.199	0.194	0.184	0.208
10%ile	0.11	0.15	0.19	0.19	0.20	0.25	0.14
20%ile	0.14	0.18	0.22	0.22	0.23	0.28	0.16
30%ile	0.17	0.20	0.24	0.24	0.24	0.28	0.17
40%ile	0.20	0.23	0.26	0.26	0.27	0.30	0.19
50%ile	0.24	0.26	0.29	0.29	0.30	0.32	0.21
$\overline{C}^A$	281 (69)	285 (70)	287 (71)	287 (70)	282 (75)	285 (77)	297 (50)
$\overline{C}^S$	145	145	146	146	146	147	131
$TAC^S_y < c^S_{mntac}$	0.05	0.05	0.05	0.05	0.05	0.05	0.05
$TAC^A_y < c^A_{mntac}$	0.26	0.28	0.31	0.30	0.29	0.25[3]	0.38
EC^S_{consec}	1.4yrs	1.3yrs	1.3yrs	1.3yrs	1.3yrs	1.3yrs	1.4yrs
EC^A_{consec}	3.3yrs	3.2yrs	3.1yrs	3.1yrs	3.0yrs	2.5yrs	3.4yrs

[3] Note that this is counted as the proportion of times Exceptional Circumstances are declared in December, thus following a good recruitment, the revised TAC may increase from zero (cf Figure 1).

Table 3. A repeat of Table 1 (i.e. no change to the control rules and parameters from Table 1), but where all results are given assuming a Hockey Stick stock recruitment relationship with $b^A = 0.2K^A$ and $\overline{M}_j^A = \overline{M}_{ad}^A = 0.9\,\text{year}^{-1}$ in the underlying operating model (HS0.9).

	OMP-08	Candidate OMP-13			Interim OMP-13
c_{mxtac}^A	600	600	600	450	450
β	0.097	0.067	0.082	0.082	0.090
α	0.78	0.782	0.635	0.636	0.321
$risk^A$	0.107	0.209	0.087	0.086	0.021
$risk^S$	0.183	0.118	0.221	0.222	0.212
10%ile	0.30	0.32	0.39	0.39	0.60
20%ile	0.36	0.36	0.42	0.42	0.61
30%ile	0.40	0.42	0.47	0.47	0.64
40%ile	0.43	0.46	0.51	0.51	0.66
50%ile	0.47	0.52	0.55	0.55	0.68
$\overline{C}^A$	380	385 (95)	362 (91)	356 (91)	287 (82)
$\overline{C}^S$	190	127	143	144	154

Table 4. A repeat of Table 2 (i.e. no change to the control rules and parameters from Table 2), but where all results are given assuming a Hockey Stick stock recruitment relationship with $b^A = 0.2K^A$ and $\overline{M}_j^A = \overline{M}_{ad}^A = 0.9\,\text{year}^{-1}$ in the underlying operating model (HS0.9).

	Candidate OMP-13 with $c_{mxtac}^A = 450$						
B_{ec}^A	**400**	**500**	600	600	600	600	600
Δ^A	100	100	100	**400**	100	100	100
c_{mxdn}^A	0.25	0.25	0.25	0.25	**1.00**	**1.00**	0.25
x^A	0.25	0.25	0.25	0.25	0.25	**1.00**	0.25
β	0.082	0.082	0.082	0.082	0.082	0.82	**0.071**
α	0.636	0.636	0.636	0.636	0.636	0.636	**1.214**
$risk^A$	0.086	0.040	0.028	0.023	0.022	0.010	0.053
$risk^S$	0.222	0.219	0.218	0.215	0.205	0.203	0.244
10%ile	0.39	0.42	0.45	0.45	0.46	0.49	0.36
20%ile	0.42	0.44	0.47	0.47	0.47	0.51	0.40
30%ile	0.47	0.50	0.51	0.51	0.51	0.53	0.45
40%ile	0.51	0.52	0.53	0.54	0.54	0.55	0.48
50%ile	0.55	0.56	0.57	0.58	0.58	0.59	0.52
$\overline{C}^A$	356 (91)	354 (91)	352 (90)	350 (88)	341 (94)	336 (94)	386 (67)
$\overline{C}^S$	144	144	144	144	145	146	129
$TAC_y^S < c_{mntac}^S$	0.05	0.05	0.05	0.05	0.05	0.05	0.06
$TAC_y^A < c_{mntac}^A$	0.08	0.11	0.13	0.13	0.13	0.11	0.17
EC_{consec}^S	1.4yrs	1.4yrs	1.3yrs	1.3yrs	1.3yrs	1.3yrs	1.4yrs
EC_{consec}^A	1.9yrs	1.9yrs	1.8yrs	1.8yrs	1.8yrs	1.5yrs	2.0yrs

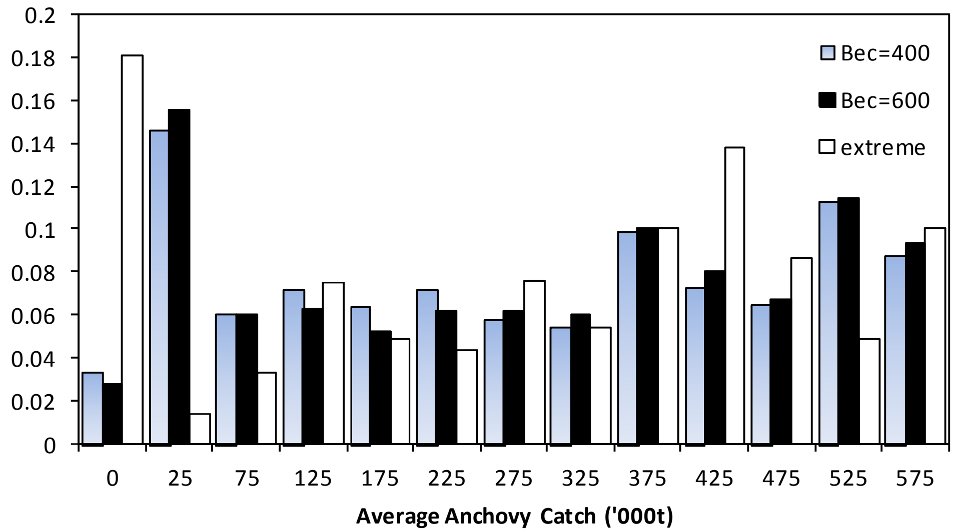

Figure 1. Histograms of total annual anchovy catch for Candidate OMP-13 with $c^{A}_{mxtac} = 450$ and a) $B^{A}_{ec} = 400$ or b) $B^{A}_{ec} = 600$, or c) a rather "extreme" conservative rule in which the anchovy TAC is set to zero as soon as survey estimated biomass falls below B^{A}_{ec} in addition to no restriction on the proportion by which normal season anchovy TAC can be reduced annually.

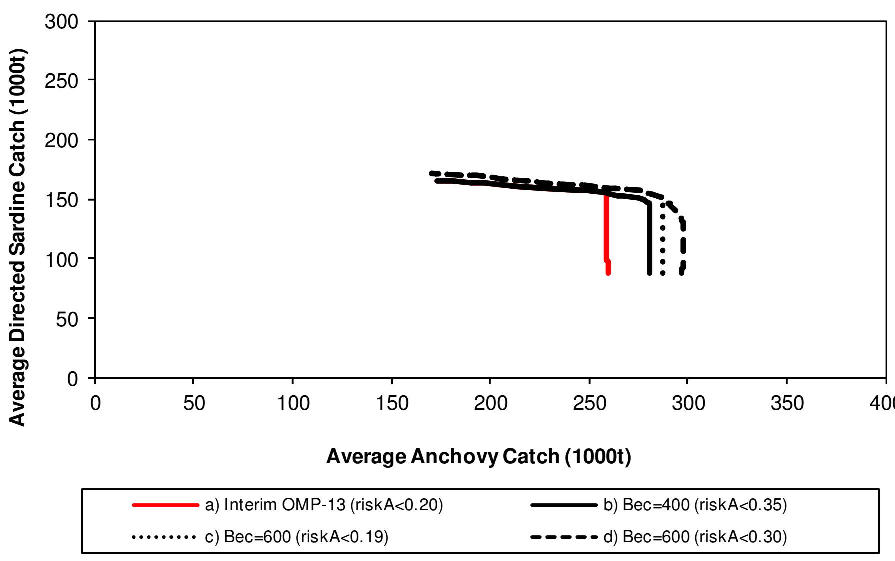

Figure 2. Trade-off curves for a) Interim OMP-13 ($B^{A}_{ec} = 400$) which was tuned to $risk^{A} < 0.20$, and Candidate OMP-13 with $c^{A}_{mxtac} = 450$, and b) $B^{A}_{ec} = 400$ with $risk^{A} < 0.35$, c) $B^{A}_{ec} = 600$ with $risk^{A} < 0.19$, and d) $B^{A}_{ec} = 600$ with $risk^{A} < 0.30$. All curves are tuned such that $risk^{S} < 0.21$ and based on an underlying operating model assuming a Beverton Holt stock recruitment relationship and $\overline{M}^{A}_{j} = \overline{M}^{A}_{ad} = 1.2$ year^{-1}.

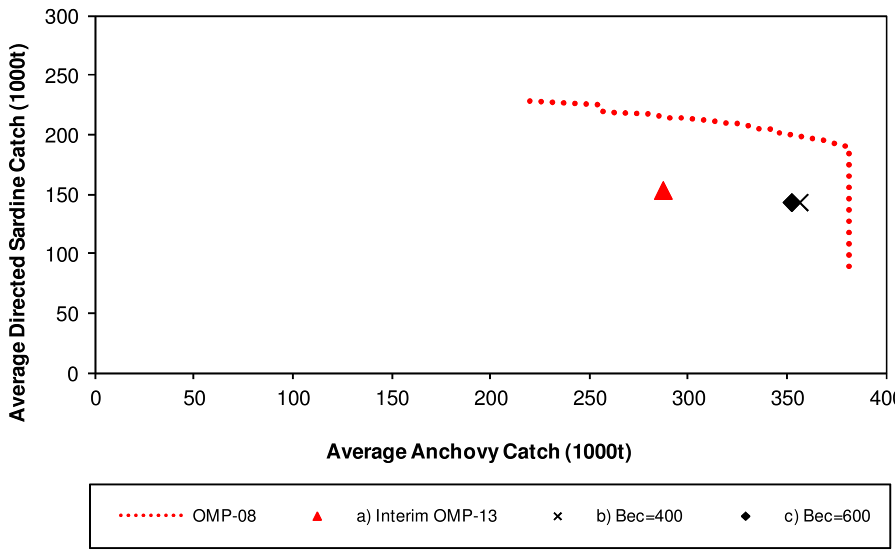

Figure 3. Trade-off curve for OMP-08 and corresponding corner trade-off points from Figure 2 a), b) and c), but based on an underlying operating model assuming a Hockey Stick stock recruitment relationship with $b^A = 0.2K^A$ and $\overline{M}_j^A = \overline{M}_{ad}^A = 0.9$ year^{-1}.