OMP-18 development: selecting an interim Harvest Control Rule for directed sardine

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Introduction

A new joint Operational Management Procedure (OMP) is under development for South African sardine and anchovy. An interim-OMP is to be agreed shortly, before the final TACs and TABs for 2018 are recommended. This interim-OMP is to mimic the final OMP-18 as closely as possible, although some changes from the interim-OMP may be required following further analyses during the latter half of 2018.

The Harvest Control Rule for setting the directed sardine TACs under OMP-18 involves a TAC being set at the beginning of each year, with no mid-year adjustment. It is empirical and depends on the survey estimated total sardine biomass (Figure 1). Recent analyses have narrowed the Candidate Management Procedure (CMP) alternatives (de Moor 2018a,b), but two key choices are yet to be finalised: the values for the Critical Biomass threshold and the stable TAC. This document focuses on results under alternative values for the Critical Biomass threshold and stable TAC in order to inform such decisions.

Method

The Reference Case CMP is as follows (Figure 1), with the bold points already agreed by the OMP Task Team to form part of the directed sardine HCR for interim OMP-18:

- A stable directed sardine TAC of 65 000t.
- **A minimum directed sardine TAC of 10 000t.**
- **A maximum directed sardine TAC of 200 000t.**
- Critical Biomass threshold of 350 000t on total survey estimated sardine biomass.
- **Above the Critical Biomass threshold, the maximum proportion by which the directed sardine TAC can be decreased from one year to the next (in the absence of the Critical Biomass metarule and linear smoothing) is 0.2.**
- Below the Critical Biomass threshold, the maximum proportion by which the directed sardine TAC can be increased[1] or decreased from the previous year's TAC (in the absence of linear smoothing) is 0.5.
- **Linear smoothing of the HCR applying for 100 000t above the Critical Biomass threshold, i.e. from 350 000t to 450 000t[2].**
- **Linear smoothing of the metarule applying for 50 000t below the Critical Biomass threshold, i.e. from 300 000t to 350 000t[3].**

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[1] The maximum of 10 000t or $1.5TAC_{y-1}^{S}$ is used as the constraint.

[2] This is to avoid any discontinuities in the rule at the Critical Biomass threshold when the metarule below 350 000t does not allow for the same % constraint in the decrease in directed sardine TAC from one year to the next.

[3] This is to avoid any discontinuities in the rule at the Critical Biomass threshold given the metarule has a constraint on the increase in directed sardine TAC from one year to the next, which does not apply above 350 000t.

The β control parameter of the Reference Case CMP was tuned such that the 20%ile of the total biomass depletion in the final projection year matched that considered appropriate for former OMPs (de Moor 2018c). This resulted in $\beta = 0.137$, with corresponding sardine risk of 0.20. The sardine risk is the probability of the effective west component spawner biomass falling below the lowest historical level during the projection period of 20 years (de Moor 2018c).

The alternatives considered in this document include:

- A stable directed sardine TAC of 50 000t.
- Critical Biomass threshold of 300 000t on total survey estimated sardine biomass.
- Below the Critical Biomass threshold, the maximum proportion by which the directed sardine TAC can be increased[4] or decreased from the previous year's TAC (in the absence of linear smoothing) is 0.4.

As the SWG-PEL has not yet signed off on the maximum proportion by which the directed sardine TAC can be decreased for one year to the next in the absence of the Critical Biomass metarule and linear smoothing, some results are also presented assuming the proportion is 0.5, instead of the Reference Case value of 0.2.

Simulations were run assuming the baseline OM for anchovy and the baseline sardine OM with MoveR and p=0.08.

Results and discussion

All the alternative HCRs are compared at equivalent risk, i.e. all HCRs are tuned such that sardine risk <0.20 (Table 1).

If the Critical Biomass threshold were decreased from the Reference Case 350 000t to 300 000t, the median annual variation in total directed sardine catch decreases, but with the cost of a decrease in the total directed sardine catch (Table 1, Figures 2-5).

If the stable directed sardine TAC were decreased from the Reference Case 65 000t to 50 000t, the total directed sardine catch would increase, with a cost of an increase in median annual variation in total directed sardine catch (Table 1, Figures 2-5). However, the differences are small.

If the maximum proportion by which the directed sardine TAC can be increased or decreased from the previous year's TAC when the survey estimate of biomass is below the Critical Biomass threshold is decreased from the Reference Case 0.5 to 0.4, the median annual variation in total directed sardine catch decreases, but with the cost of a small decrease in the total directed sardine catch (Table 1, Figures 2-5).

Some adjustments to the HCRs for Interim OMP-18 may result prior to the finalisation of OMP-18, following additional analyses. In particular, planned analyses include accounting for a Reference Set of Operating Models for sardine, the implications of alternative spatial management of sardine, the use of a the two-tier threshold for sardine and anchovy (including potential future pulses in sardine recruitment) and alternative HCRs for setting the <14cm sardine TAB with anchovy.

[4] The maximum of 10 000t or $1.4TAC_{y-1}^{S}$ is used as the constraint.

References

de Moor CL. 2018a. OMP-18 development: constraints on inter-annual decreases in sardine TACs. DAFF: Branch Fisheries Document FISHERIES/2018/JUL/SWG-PEL/15.

de Moor CL. 2018b. OMP-18 development: linear smoothing for the sardine HCR. DAFF: Branch Fisheries Document FISHERIES/2018/JUL/SWG-PEL/16.

de Moor CL. 2018c. Multiple sardine Operating Models and associated risk. DAFF: Branch Fisheries Document FISHERIES/2018/JUL/SWG-PEL/19.

Table 1. Sardine performance statistics for the alternative sardine Harvest Control Rules. The reference case HCR is shown with $\beta = 0.137$, while all other cases are shown tuned to a risk of <0.20. Where appropriate, medians [90% probability intervals] are provided, and for some statistics the means are additionally provided in **bold**. All biomasses are given in thousands of tons.

Performance Statistic	No Catch		0.2 constraint when $B_{y-1}^{obs,S} > B_{crit}^{S}$					0.5 constraint when $B_{y-1}^{obs,S} > B_{crit}^{S}$			
		Ref Case	$c_{stbl}^{S} = 65$			$c_{stbl}^{S} = 50$		$c_{stbl}^{S} = 65$		$c_{stbl}^{S} = 50$	
			$B_{crit}^{S} = 350$	$B_{crit}^{S} = 350$	$B_{crit}^{S} = 300$	$B_{crit}^{S} = 350$	$B_{crit}^{S} = 300$	$B_{crit}^{S} = 350$	$B_{crit}^{S} = 300$	$B_{crit}^{S} = 350$	$B_{crit}^{S} = 300$
Constraint when $B_{y-1}^{obs,S} < B_{crit}^{S}$		0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
β	-	0.137	0.130	0.147	0.132	0.155	0.144	0.162	0.152	0.167	0.161
$Risk^{S}$	0.08	0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
p(TAC^{S}<20)	-	0.07	0.05	0.07	0.05	0.08	0.06	0.07	0.05	0.08	0.06
$B_{tot,2036}^{S}$	**379**	**253**	**252**	**250**	**251**	**248**	**249**	**249**	**251**	**249**	**250**
	320 [141,807]	206 [59,599]	205 [55,605]	204 [56,595]	205 [57,600]	203 [55,595]	204 [55,593]	205 [57,590]	205 [57,589]	204 [56,590]	205 [56,589]
$B_{west,2036}^{S}$	**183**	**126**	**125**	**125**	**125**	**124**	**125**	**125**	**125**	**125**	**125**
	138 [29,506]	87 [12,376]	86 [11,378]	86 [11,375]	86 [11,376]	86 [12,369]	86 [11,371]	86 [12,371]	85 [12,374]	86 [12,369]	86 [12,371]
$B_{south,2036}^{S}$	**195**	**127**	**126**	**125**	**126**	**124**	**125**	**125**	**126**	**124**	**125**
	165 [69,426]	104 [30,310]	103 [27,312]	101 [28,308]	103 [28,311]	101 [27,308]	102 [28,306]	101 [27,308]	103 [28,307]	101 [26,308]	102 [27,307]
$\frac{B_{tot,2036}^{S}}{B_{tot,2015}^{S}}$	4.2 [1.3,21.3]	2.6 [0.6,15.0]	2.6 [0.6,15.0]	2.6 [0.6,14.8]	2.6 [0.6,15.1]	2.6 [0.6,14.7]	2.6 [0.6,14.9]	2.6 [0.6,14.2]	2.6 [0.6,14.4]	2.6 [0.6,14.3]	2.6 [0.6,14.3]
$\frac{B_{west,2036}^{S}}{B_{west,2015}^{S}}$	3.0 [0.6,19.3]	1.9 [0.2,13.6]	1.9 [0.2,13.5]	1.9 [0.2,13.1]	1.9 [0.2,13.6]	1.9 [0.2,13.0]	1.9 [0.2,13.5]	1.9 [0.2,12.9]	1.9 [0.2,13.0]	1.9 [0.2,12.9]	1.9 [0.2,13.0]
$\frac{B_{south,2036}^{S}}{B_{south,2015}^{S}}$	0.9 [0.4,2.4]	0.6 [0.2,1.7]	0.6 [0.2,1.7]	0.6 [0.2,1.7]	0.6 [0.2,1.7]	0.6 [0.2,1.7]	0.6 [0.2,1.7]	0.6 [0.2,1.7]	0.6 [0.2,1.7]	0.6 [0.2,1.7]	0.6 [0.2,1.7]
$B_{tot,min}^{S}$	157 [92,233]	90 [34,164]	89 [30,163]	89 [33,161]	89 [29,163]	87 [32,158]	88 [31,160]	88 [32,163]	88 [30,164]	87 [31,162]	88 [32,164]
$B_{west,min}^{S}$	31 [8,71]	18 [3,51]	18 [3,51]	18 [3,51]	18 [3,51]	18 [3,51]	18 [3,51]	18 [3,50]	18 [3,51]	18 [3,51]	18 [3,51]
$B_{south,min}^{S}$	78 [37,134]	39 [10,86]	38 [8,86]	38 [9,84]	39 [9,86]	37 [8,83]	38 [9,84]	37 [8,84]	38 [8,86]	37 [8,84]	37 [9,84]

Table 1. (continued)

Performance Statistic	No Catch	Ref Case	0.2 constraint when $B_{y-1}^{obs,S} > B_{crit}^S$					0.5 constraint when $B_{y-1}^{obs,S} > B_{crit}^S$			
			$c_{stbl}^S = 65$			$c_{stbl}^S = 50$		$c_{stbl}^S = 65$		$c_{stbl}^S = 50$	
			$B_{crit}^S = 350$	$B_{crit}^S = 350$	$B_{crit}^S = 300$	$B_{crit}^S = 350$	$B_{crit}^S = 300$	$B_{crit}^S = 350$	$B_{crit}^S = 300$	$B_{crit}^S = 350$	$B_{crit}^S = 300$
Constraint when $B_{y-1}^{obs,S} < B_{crit}^S$		0.5	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
C_{tot}^S	**1** 0 [0,28]	**87** 74 [17,200]	**87** 73 [23,200]	**90** 78 [17,200]	**88** 73 [21,200]	**92** 80 [16,200]	**90** 79 [19,200]	**91** 79 [18,200]	**89** 74 [21,200]	**92** 82 [16,200]	**90** 79 [20,200]
Med C_{tot}^S [5]	0 [0,0]	75 [44,130]	75 [46,126]	79 [44,137]	75 [56,128]	82 [41,142]	80 [48,136]	80 [45,123]	76 [54,116]	83 [41,127]	80 [48,123]
C_{west}^S	**1** 0 [0,24]	**62** 54 [13,146]	**62** 54 [15,143]	**63** 54 [13,149]	**62** 55 [15,144]	**63** 54 [12,150]	**63** 54 [14,148]	**63** 55 [13,151]	**62** 55 [15,148]	**63** 54 [12,152]	**63** 54 [14,151]
C_{south}^S	**0** 0 [0,4]	**26** 17 [1,83]	**25** 17 [1,80]	**27** 18 [1,87]	**26** 18 [1,81]	**28** 18 [1,91]	**27** 18 [1,87]	**28** 18 [1,88]	**26** 18 [1,84]	**28** 18 [1,91]	**27** 18 [1,88]
$\frac{C_{west}^S}{C_{tot}^S}$	0 [0,0.87]	0.77 [0.35,0.98]	0.77 [0.34,0.98]	0.77 [0.34,0.98]	0.77 [0.34,0.98]	0.76 [0.33,0.98]	0.77 [0.34,0.98]	0.77 [0.33,0.98]	0.77 [0.34,0.98]	0.76 [0.33,0.98]	0.77 [0.34,0.98]
ByC_{tot}^S	**0.3** 0 [0,5.2]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.9** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.9** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]
ByC_{west}^S	**0.3** 0 [0,5.2]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]	**17.8** 10.6 [1.4,57.9]
ByC_{south}^S	**0.0** 0 [0,0]	**0.0** 0.0 [0.0,0.1]	**0.0** 0.0 [0.0,0.0]	**0.0** 0.0 [0.0,0.1]	**0.0** 0.0 [0.0,0.0]	**0.0** 0.0 [0.0,0.1]	**0.0** 0.0 [0.0,0.1]	**0.0** 0.0 [0.0,0.1]	**0.0** 0.0 [0.0,0.1]	**0.0** 0.0 [0.0,0.1]	**0.0** 0.0 [0.0,0.1]
MAV_{tot}^S [6]	-	0.46 [0.20,0.50]	0.40 [0.20,0.40]	0.48 [0.20,0.50]	0.34 [0.20,0.50]	0.50 [0.20,0.50]	0.42 [0.20,0.50]	0.50 [0.31,0.50]	0.50 [0.27,0.50]	0.50 [0.32,0.50]	0.50 [0.31,0.50]
MAV_{west}^S	-	0.38 [0.23,0.52]	0.34 [0.22,0.49]	0.39 [0.23,0.53]	0.36 [0.21,0.52]	0.40 [0.24,0.53]	0.38 [0.22,0.53]	0.41 [0.26,0.53]	0.40 [0.25,0.53]	0.42 [0.26,0.54]	0.41 [0.26,0.54]
MAV_{south}^S	-	0.77 [0.51,1.00]	0.72 [0.46,1.00]	0.76 [0.51,1.00]	0.74 [0.49,1.00]	0.77 [0.52,1.00]	0.75 [0.50,1.00]	0.79 [0.55,1.00]	0.79 [0.53,1.00]	0.80 [0.56,1.00]	0.79 [0.54,1.00]
$p(B_y^{Sobs} < B_{crit}^S, B_y < B_{crit}^S/k_N^S)$	-	0.24	0.24	0.24	0.16	0.24	0.16	0.24	0.16	0.24	0.16
$p(B_y^{Sobs} < B_{crit}^S, B_y \geq B_{crit}^S/k_N^S)$	-	0.14	0.14	0.14	0.16	0.14	0.16	0.14	0.16	0.14	0.16
$p(B_y^{Sobs} \geq B_{crit}^S, B_y < B_{crit}^S/k_N^S)$	-	0.12	0.12	0.12	0.08	0.12	0.09	0.12	0.09	0.12	0.09
$p(B_y^{Sobs} \geq B_{crit}^S, B_y \geq B_{crit}^S/k_N^S)$	-	0.50	0.50	0.50	0.60	0.50	0.60	0.50	0.60	0.50	0.59

[5] This gives the median and 90%ile of the 1000 median catches.

[6] Median and 90%ile of $AAV_y^b = \left(C_{tot,y}^{S,b} - C_{tot,y-1}^{S,b}\right)/C_{tot,y-1}^{S,b}$

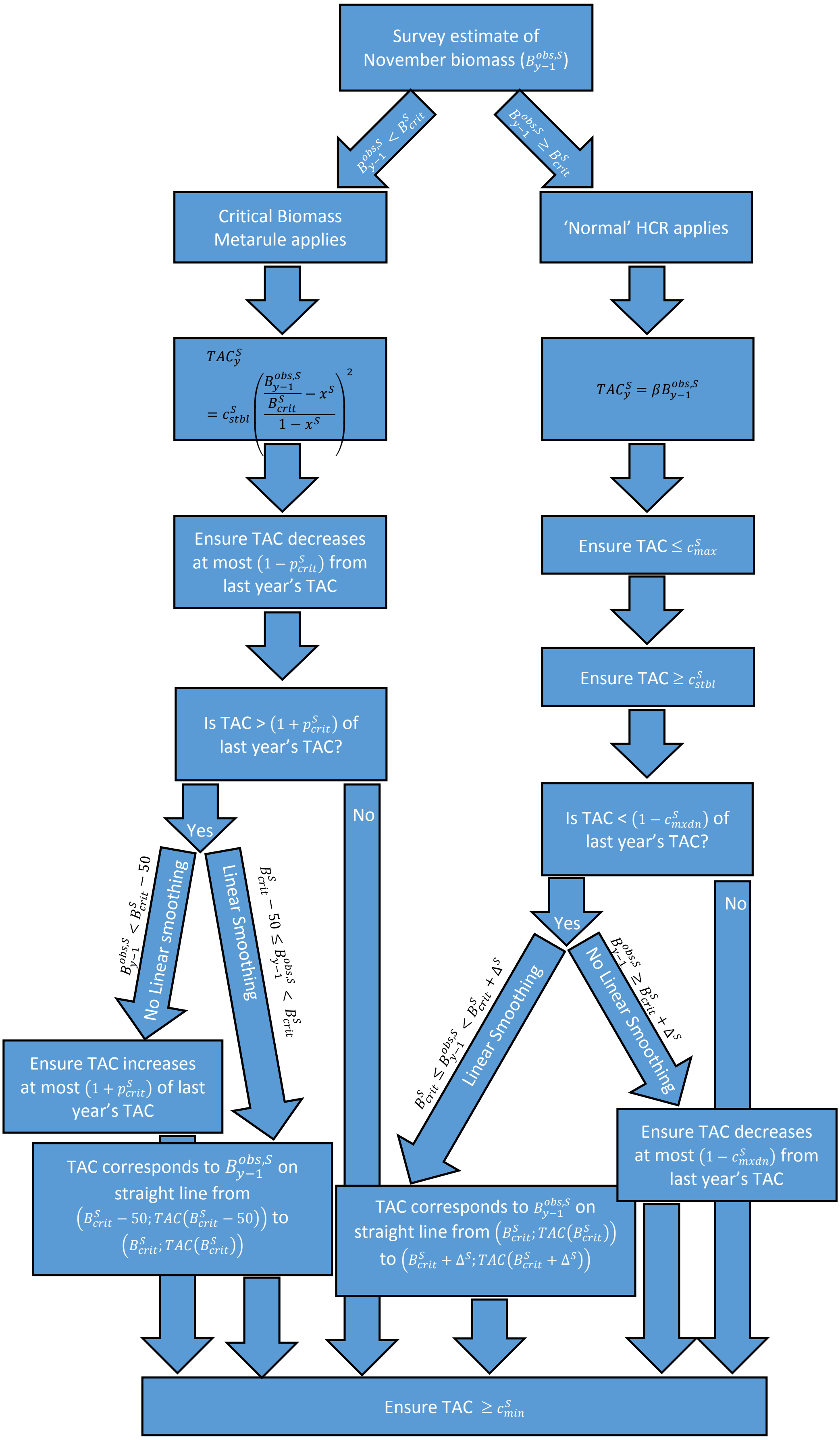


Figure 1. A flow chart depicting the Reference Case Harvest Control Rule, with $B_{crit}^S = 350$, $\Delta^S = 100$, $c_{max}^S = 200$, $c_{stbl}^S = 65$, and $c_{mxdn}^S = 0.2$, and has $c_{stbl}^S > \beta B_{y-1}^{obs,S}$.

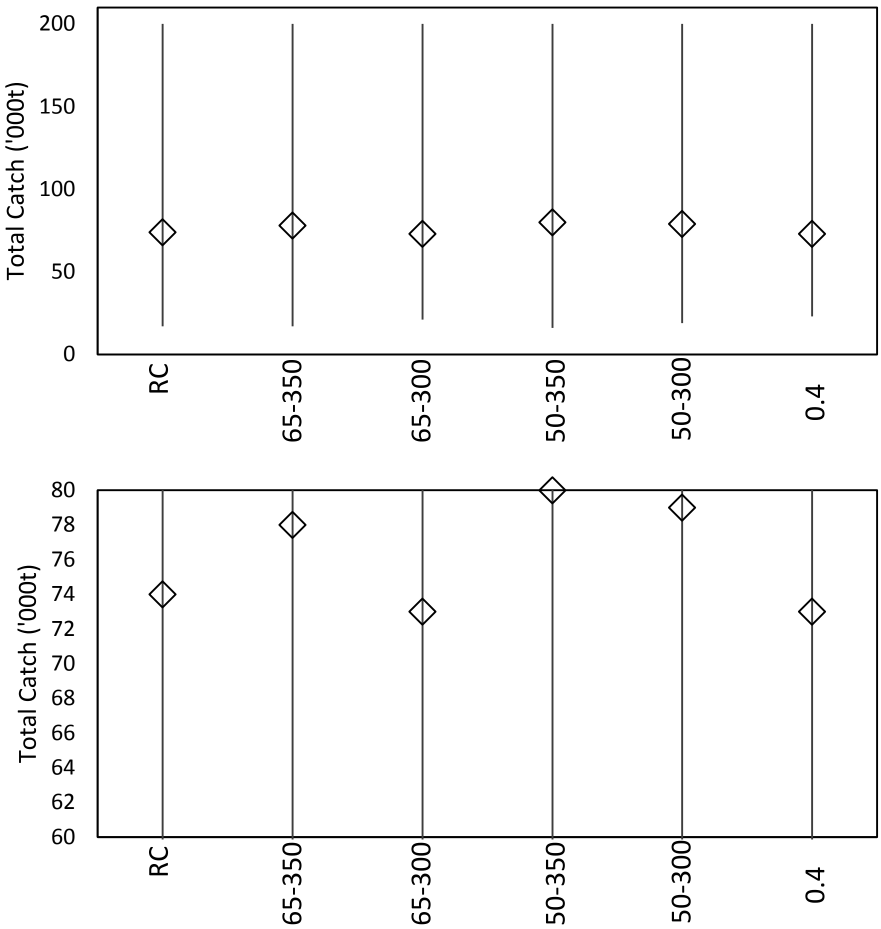


Figure 2. The median and 90% probability intervals for total directed sardine catch, tuned to risk of <0.20 for the HCRs tested in this document with a 0.2 proportional constraint on inter-annual decreases in TACs when $B_{y-1}^{obs,S} > B_{crit}^{S}$. The HCR labels denote either the reference case ("RC"), the four alternative combinations for the stable directed sardine TAC and the Critical Biomass threshold (c_{stbl}^{S}-B_{crit}^{S}), and the alternative proportional constraint on inter-annual increases or decreases in TACs when $B_{y-1}^{obs,S} < B_{crit}^{S}$ ("0.4"). The lower panel compares has a smaller vertical axis range.

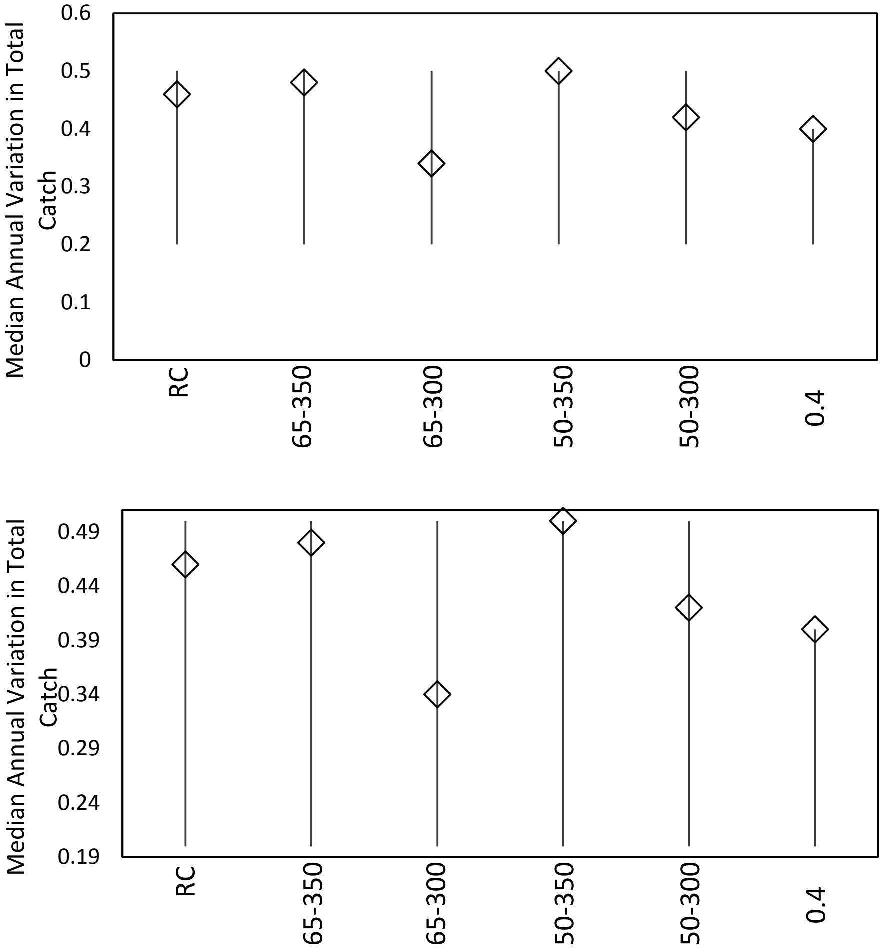


Figure 3. The median and 90% probability intervals for median annual variation in total directed sardine catch, tuned to risk of <0.20 for the HCRs tested in this document with a 0.2 proportional constraint on inter-annual decreases in TACs when $B_{y-1}^{obs,S} > B_{crit}^{S}$. The HCR labels denote either the reference case ("RC"), the four alternative combinations for the stable directed sardine TAC and the Critical Biomass threshold (c_{stbl}^{S}-B_{crit}^{S}), and the alternative proportional constraint on inter-annual increases or decreases in TACs when $B_{y-1}^{obs,S} < B_{crit}^{S}$ ("0.4"). The lower panel compares has a smaller vertical axis range.

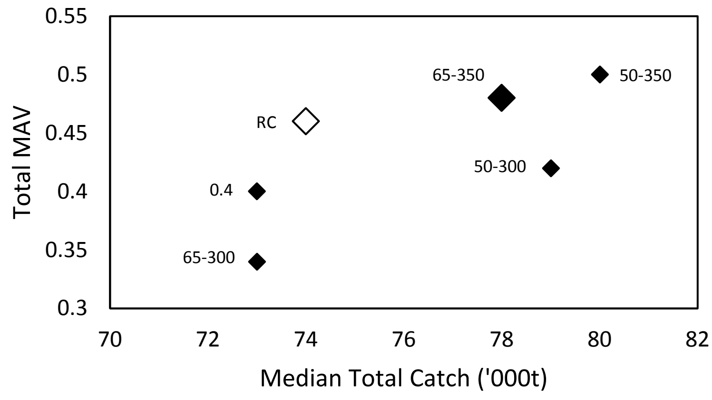
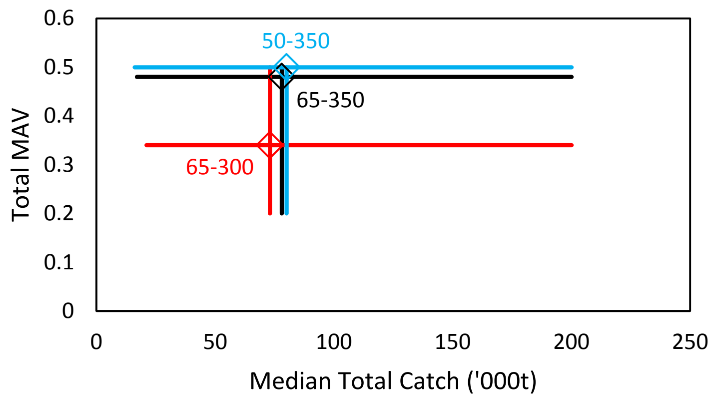


Figure 4. The MAV in the total directed sardine catch plotted against median total directed sardine catch, tuned to risk of <0.20 for all HCRs tested in this document with a 0.2 proportional constraint on inter-annual decreases in TACs when $B_{y-1}^{obs,S} > B_{crit}^{S}$. The data labels correspond with those given on pages 1-2. The data labels denote either the reference case ("RC"), the four alternative combinations for the stable directed sardine TAC and the Critical Biomass threshold (c_{stbl}^{S}-B_{crit}^{S}), and the alternative proportional constraint on inter-annual increases or decreases in TACs when $B_{y-1}^{obs,S} < B_{crit}^{S}$ ("0.4").



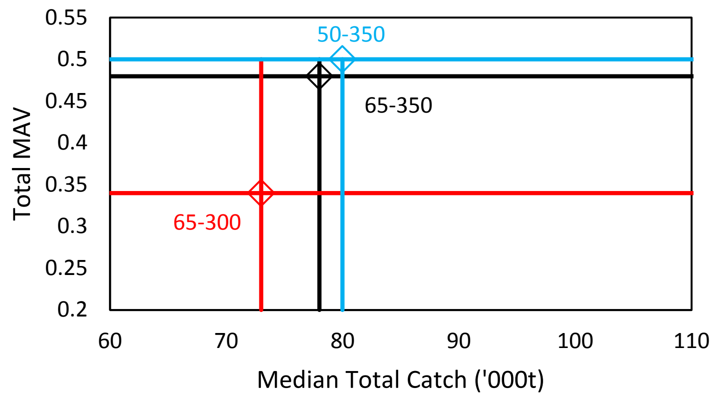


Figure 5. The median and 90% probability intervals of MAV in the total directed sardine catch and median total directed sardine catch, tuned to risk of <0.20. Results are shown for three alternative combinations of the stable directed sardine TAC and the Critical Biomass threshold (c_{stbl}^{S}-B_{crit}^{S}), The data labels correspond with those given on pages 1-2.