OMP-18 development: constraints on inter-annual decreases in sardine TACs

C.L. de Moor*

Correspondance email: *carryn.demoor@uct.ac.za*

Introduction

Recent sardine Harvest Control Rules (HCRs) that have been tested as part of the development of a new joint Operational Management Procedure (OMP) for South African sardine and anchovy have included constraints on the maximum proportion by which the TACs can be increased and decreased when the survey estimate of biomass is below the Critical Biomass threshold (de Moor 2018a). Two alternatives to how this constraint on decreasing TACs is applied have been tested. The difference between these alternatives occurs in years for which the survey estimate of biomass drops below the Critical Biomass threshold, such that the metarule is applied, but the TAC in the previous year was high. In the one case, termed “Option (i)” (de Moor 2018b), the TAC in the year for which the biomass falls below the Critical Biomass threshold is always restricted by the maximum metarule proportional decrease from the previous year’s TAC. This is 50% in the Reference Case sardine HCR, but 40% is also considered herein (see below). In the other case, termed “Option (ii)” (de Moor 2018b), the TAC in the year for which the biomass falls below the Critical Biomass threshold is set to a maximum of the stable TAC, which is 65 000t in the Reference Case HCR.

Method

The Candidate Management Procedures with the following constraints were used for these analyses:

- 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 0.4 or 0.5.
- Linear smoothing of the HCR applying for 350 000t above the Critical Biomass threshold, i.e. from 350 000t to 700 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].

* MARAM (Marine Resource Assessment and Management Group), Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch, 7701, South Africa.

[1] The maximum of 10 000t or $1.4TAC_{y-1}^{S}$ (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.

Given the SWG-PEL is yet to recommend a preferred maximum percentage change in inter-annual TACs, results are shown for two values, 0.4 and 0.5. The β control parameter of the two CMPs were 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,e). This resulted in $\beta = 0.129$ for a constraint of 0.4, with corresponding sardine risk of 0.20, and $\beta = 0.146$ for a constraint of 0.5, 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 above CMP corresponds to "Option (i)". "Option (ii)" differs from the above CMP changing the 6th bullet point as follows so that in any year where the survey estimate of biomass is below the Critical Biomass threshold, the directed sardine TAC is at most the stable TAC of 65 000t:

- Below the Critical Biomass threshold, the maximum proportion by which the directed sardine TAC can be increased[4] or decreased is 0.4 or 0.5 from the previous year's TAC (in the absence of linear smoothing), **but the decrease applies to the minimum of TAC^S_{y-1} or 108 333t[5] or 130 000t[6]**.

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

Results and discussion

The same β control parameter was used for both Option (i) and Option (ii) for a given constraint below the Critical Biomass threshold. Results are therefore not risk equivalent, but rather show the difference for the HCR that is the same in all aspects except when the survey estimated biomass drops sharply to a level below the Critical Biomass threshold, after a relatively high survey estimate in the previous year.

Option (ii) results in TACs of 65 000t in years where a large inter-annual decrease in survey estimated biomass is observed, whereas Option (i) has TACs constrained to a maximum percentage decrease from the previous year's TAC (Figure 1). In the 4% of cases where Options (i) and (ii) would result in different TACs being set, the average TAC is 18 000t higher for Option (i) when the constraint on inter-annual changes in TACs for $B^{obs,S}_{y-1} < B^S_{crit}$ is 0.5 (Figure 1, Table 1). When the constraint is, instead, 0.4, the average TAC is 23 000t higher for Option (i). This is an average 20-25% difference in TACs (Table 1).

The more conservative Option (ii) results in higher total biomass and west component spawner biomass (Table 2). While the difference in total biomass can be substantial as a direct result of lower catches from Option (ii), the difference in the west component spawner biomass is on average 2.5 to 3.5 thousand tons. This is a difference of 3-5% in west component spawner biomass, compared to the 20-25% difference in TACs. It is possible that the lower catch under Option (ii) may result in a spawner biomass value that results in a higher recruitment. However, the hinge point for this OM has a 90%ile

[4] The maximum of 10 000t or $1.4TAC^S_{y-1}$ (or $1.5TAC^S_{y-1}$) is used as the constraint.
[5] $65000t/(1-0.4)$, when the restriction is 0.4, which results in $TAC^S_y = 65$.
[6] $65000t/(1-0.5)$ when the restriction is 0.5, which results in $TAC^S_y = 65$.

of [3, 68] thousand tons, with a median of 16 thousand tons (de Moor 2018d, with further updates). It is therefore expected that any resultant difference in recruitment would be small.

Recommendation

The OMP Task Team therefore recommends that Option (i) be used in favour of Option (ii). However, should the constraints for the proposed interim OMP-18 differ substantially from those tested here, this recommendation may require re-checking.

Acknowledgements

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References

de Moor CL. 2018a. OMP-18 development: alternative constraints on the sardine Harvest Control Rule. DAFF: Branch Fisheries Document FISHERIES/2018/MAY/SWG-PEL/07rev.

de Moor CL. 2018b. OMP-18 development: alternative constraints relating to the sardine Critical Biomass metarule. DAFF: Branch Fisheries Document FISHERIES/2018/MAY/SWG-PEL/12rev.

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de Moor CL. 2018e. Some comparisons against a reference sardine harvest control rule for OMP-18. DAFF: Branch Fisheries Document FISHERIES/2018/MAR/SWG-PEL/03.

Table 1. Average, median and 90%iles (rounded to nearest 100t) of the differences in directed sardine Total Allowable Catch between Options (i) and (ii). Biomasses are given in thousand t. The differences are considered in the 4% of years for which the TACs differ between the two options.

Constraint for $B_{y-1}^{obs,S} < B_{crit}^{S}$	Difference : Option (i) – Option(ii)	4% of cases	
		Average	Median & 90%ile
0.4	TAC	23 000t	21 000t [2 000t, 55 000t]
0.5	TAC	18 000t	15 000t [2 000t,35 000t]

Constraint for $B_{y-1}^{obs,S} < B_{crit}^{S}$	% Difference : [Option (i) – Option(ii)] / Option(i)	4% of cases	
		Average	Median & 90%ile
0.4	TAC	0.25	0.24 [0.04,0.46]
0.5	TAC	0.20	0.19 [0.02,0.35]

Table 2. Average, median and 90%iles (rounded to nearest 100t) of the differences in total biomass and west component spawner biomass between Options (i) and (ii). Biomasses are given in thousand t. The differences are considered in the 4% of years for which the TACs differ between the two options and in the final year of all simulations for which Option (i) applies for at least one year.

Constraint for $B_{y-1}^{obs,S} < B_{crit}^{S}$	Difference : Option (ii) – Option(i)	4% of cases		Final year	
		Average	Median & 90%ile	Average	Median & 90%ile
0.4	Total Biomass	19.2	16.4 [1.9, 42.8]	6.9	1.3 [0.0, 32.7]
	West Component Spawner Biomass	3.5	2.1 [0.0, 12.2]	1.3	0.1 [-0.1, 6.9]
0.5	Total Biomass	12.7	10.1 [1.4, 28.1]	4.1	0.4 [0.0, 20.4]
	West Component Spawner Biomass	2.5	1.5 [0.0, 8.5]	0.8	0.0 [-0.1, 4.4]

Constraint for $B_{y-1}^{obs,S} < B_{crit}^{S}$	Difference : Option (ii) – Option(i)	4% of cases		Final year	
		Average	Median & 90%ile	Average	Median & 90%ile
0.4	Total Biomass	0.04	0.03 [0.00,0.12]	0.02	0.00 [0.00,0.07]
	West Component Spawner Biomass	0.05	0.04 [0.00,0.14]	0.05	0.00 [0.00,0.08]
0.5	Total Biomass	0.03	0.02 [0.00,0.07]	0.01	0.00 [0.00,0.04]
	West Component Spawner Biomass	0.03	0.00 [0.00,0.04]	0.01	0.00 [0.00,0.06]

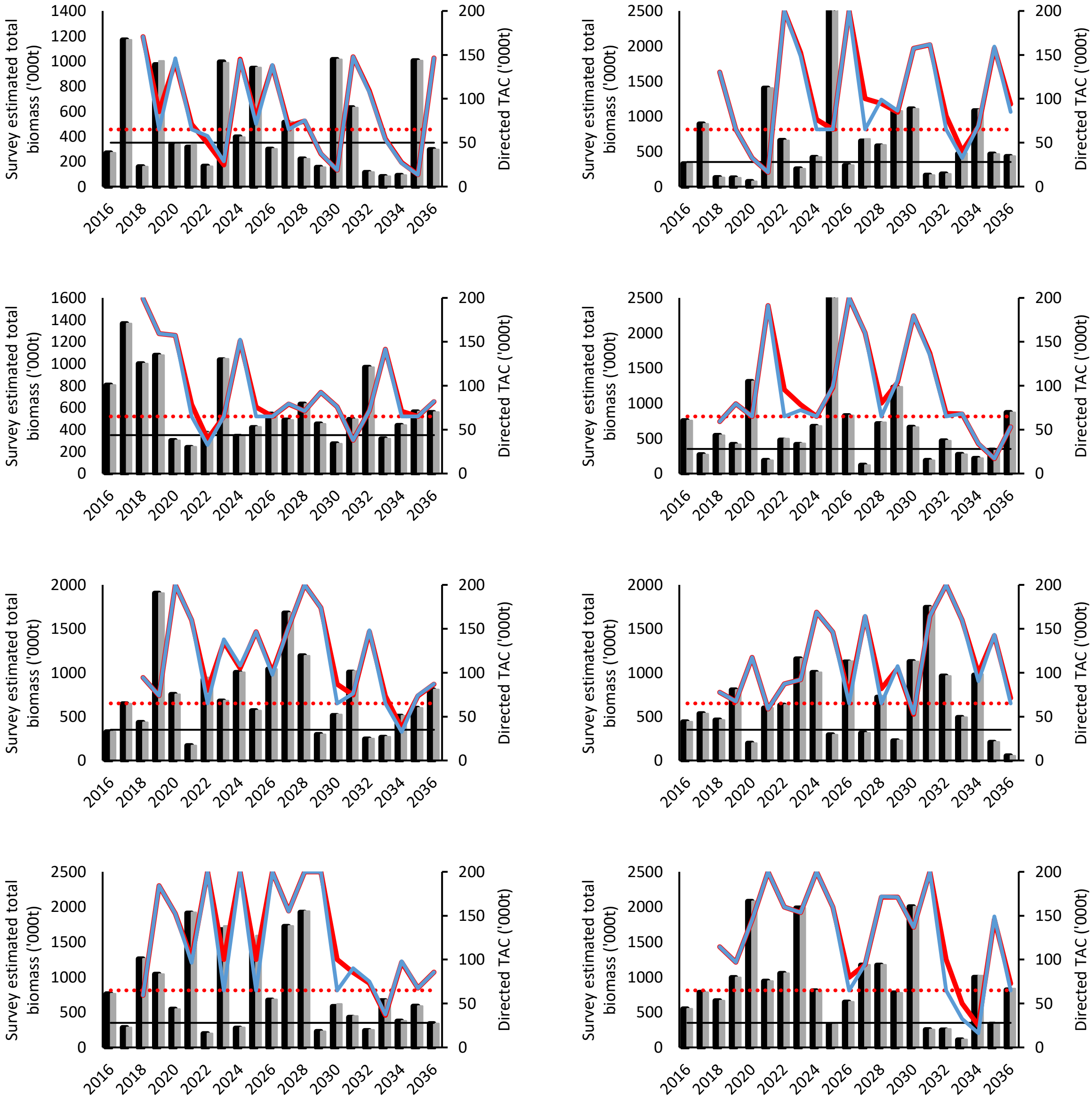

Figure 1. The November survey estimated total sardine biomass, and resultant directed sardine TAC in the following year from the Harvest Control Rules with Option (i) (black bars, red lines) and Option (ii) (grey bars, blue lines), for the 16 out of 1000 cases that display a difference more than 2 times in a simulation. In some years, survey estimates of biomass > 2.5 million tons are simulated, but the vertical axis is scaled to a maximum of 2.5 million tons such that the lower values can be distinguished. The black solid line indicates a survey estimate of 350 000t; years for which the survey estimate drops below this level while the previous year's TAC was relatively high will result in different TACs in the following year for Options (i) and (ii). The red dashed line indicates a directed sardine TAC of 65 000t, which is the level TACs are decreased to in Option (ii) for years when the survey estimate of biomass in less than 350 000t and the previous year's TAC was relatively high.

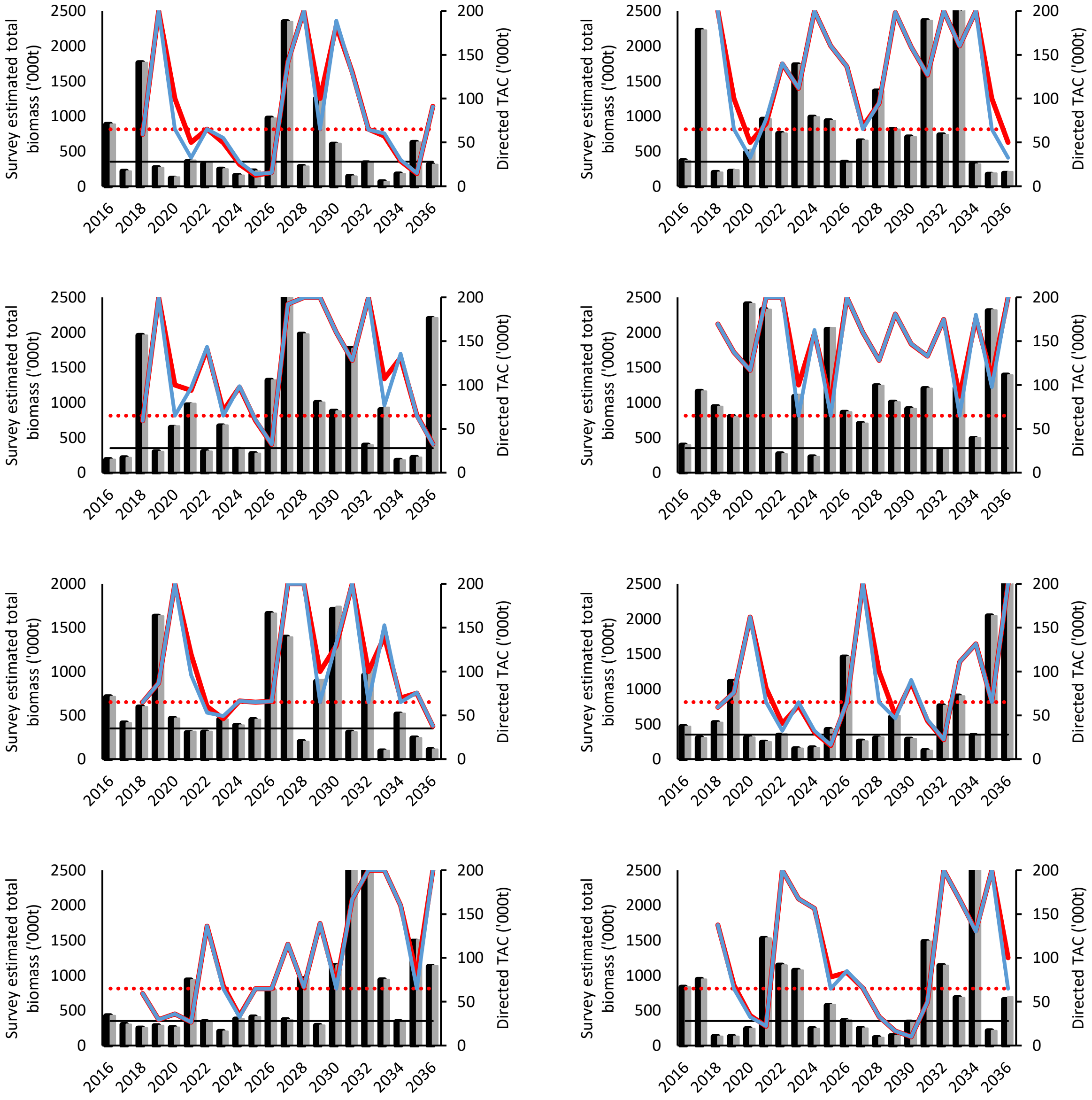

Figure 1 (continued).