Spatial Management of Sardine: Initial Suggestions for TAC split rules

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Two types of candidate MPs will need to be tested: one which gives a single directed sardine TAC, and one which gives two directed sardine TACs, with one to apply west and the other to apply east of Cape Agulhas. Both types of candidate MPs will need to be tested under the assumptions of a sardine single stock OM and of a sardine two-stock OM.

At basis, the directed sardine TAC in the current OMP is set in terms of a constant fishing mortality applied to the November survey abundance estimate. However this TAC is subject to maximum and minimum constraints as well as constraints on the maximum inter-annual decrease. This maximum inter-annual decrease is lower when the previous year's TAC was below a 'two-tier' threshold. However, if the previous year's TAC was above a 'two-tier' threshold, then the decrease can be larger. The 'two-tier' threshold was introduced to enable the industry to take advantage of "boom" periods without increasing the risk to the resource (de Moor *et al*. 2011). The equations detailing this harvest control rule are given in the appendix.

We propose that when two TACs are awarded, that equation (1) be modified to allocate a TAC to the west of Cape Agulhas using the observed November 1+ biomass west of Cape Agulhas, and to allocate a TAC to the east of Cape Agulhas using the observed November 1+ biomass east of Cape Agulhas.

- Will we need minimum and maximum for each of these TACs?
- Will we need separate Exceptional Circumstances thresholds for each TAC?
- Will we need separate 2-tier thresholds for each TAC?
- Will we need separate B^{S}_{smooth} parameters (see Appendix) for each TAC?

When simulation testing the candidate MP which allows two directed sardine TACs with an underlying OM which assumes two sardine stocks, the generation of observations of November 1+ biomass will be straightforward. However, when the underlying OM assumes a single sardine stock, how do we generate observations of November 1+ biomass west and east of Cape Agulhas, given a survey estimate generated for the full area? We propose the proportion of this observation to be assumed to be west/east of Cape Agulhas is drawn randomly from the historic observations over the last decade.

When simulation testing a candidate MP, the future projected TACs (in mass) are converted through the Implementation Model into catch numbers-at-age:

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i) The method is already developed for how to simulate the conversion of the TAC into catches-at-age for the case where a single directed sardine TAC is awarded and the underlying OM assumes a single sardine stock.

ii) The extension of that method to convert the TACs into catches-at-age for the case of two directed sardine TACs (west and east of Cape Agulhas), and the underlying OM assumes two sardine stocks, is straightforward.

iii) In the case where a single sardine TAC is awarded and the underlying OM assumes two sardine stocks, we propose that the proportions of the catch taken east and west of Cape Agulhas are drawn at random from pairs of fishing proportions in each area from 2001 to 2010 multiplied by the biomass in each area, and then renormalized to the total catch awarded.

iv) In the case where two sardine TACs are awarded and the underlying OM assumes a single sardine stock, the two TACs will simply be added together and then the simulation method used in i) above will be applied.

References

de Moor, C.L., Butterworth, D.S., and De Oliveira, J.A.A. 2011. Is the management procedure approach equipped to handle short-lived pelagic species with their boom and bust dynamics? The case of the South African fishery for sardine and anchovy. ICES Journal of Marine Science. 68(10):2075-2085.

Appendix: Directed Sardine Harvest Control Rule in OMP-08

The harvest control rule to calculate the directed sardine TAC in OMP-08 is as follows. The directed sardine TAC is set at a proportion of the previous year's November spawner biomass index of abundance, i,e.

$$TAC_y^S = \beta\, B_{y-1,Nov}^{obs,S} \tag{1}$$

However, this TAC is subject to the constraints of a minimum and a maximum value as well as the constraint of a maximum interannual percentage decrease. This maximum interannual percentage decrease only applies when the previous year's TAC was below the 'two-tier' threshold. If the previous year's TAC is above the 'two-tier' threshold, any reduction in the TAC is limited only by a lower bound of the corresponding threshold less the maximum percentage drop, i.e.

if $TAC_{y-1}^S > c_{tier}^S$: $\quad (1 - c_{mxdn}^S) c_{tier}^S \;\le\; TAC_y^S \;\le\; c_{mxtac}^S$

If the previous year's TAC is below the 'two-tier' threshold, then the TAC is calculated as follows:

if $TAC_{y-1}^S \le c_{tier}^S$:

$$\max\left\{(1 - c_{mxdn}^S)TAC_{y-1}^S \times \frac{B_{y-1,N}^{obs,S} - B_{ec}^S}{B_{smooth}^S - B_{ec}^S} + TAC_y^{S*}\frac{B_{smooth}^S - B_{y-1,N}^{obs,S}}{B_{smooth}^S - B_{ec}^S} ; c_{mntac}^S\right\} \le TAC_y^S \le c_{mxtac}^S \quad \text{if } B_{y-1,N}^{obs,S} \le B_{smooth}^S$$

$$\max\left\{(1 - c_{mxdn}^S)TAC_{y-1}^S ; c_{mntac}^S\right\} \le TAC_y^S \le c_{mxtac}^S \quad \text{if } B_{y-1,N}^{obs,S} > B_{smooth}^S$$

where $TAC_y^{S*} = \max\left\{\beta\, B_{y-1,N}^{obs,S} ; c_{mntac}^S\right\}$

In the equations above the symbols used are (biomasses are given in thousands of tons):

TAC_y^S	- the directed sardine TAC in year y.
$\beta = 0.097$	- a control parameter reflecting the proportion of the previous year's November spawner biomass index of abundance that is used to set the directed sardine TAC.
$B_{y,N}^{obs,S}$	- the observed estimate of sardine abundance from the hydroacoustic spawner biomass survey in November of year y.
$c_{tier}^S = 255$	- the two-tier threshold for directed sardine TAC.
$c_{mxdn}^S = 0.20$	- the maximum proportional amount by which the directed sardine TAC can be reduced from one year to the next.
$c_{mxtac}^S = 500$	- the maximum directed TAC to be set for sardine.
$c_{mntac}^S = 90$	- the minimum directed TAC to be set for sardine, in the absence of Exceptional Circumstances.
$B_{smooth}^S = 800$	- the threshold below which the directed sardine TAC is decreased linearly until the Exceptional Circumstances threshold, B_{ec}^S, is reached (i.e. overriding $c_{mxdn}^S = 0.20$)
$B_{ec}^S = 300$	- the biomass threshold below which Exceptional Circumstances apply for sardine.