Should OMP-14 be used to set South African sardine and anchovy catch limits for 2018?

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Background

OMP-14 (de Moor and Butterworth 2014) was tuned to satisfy the following risk criteria:

$risk_S$ <0.21, where $risk_S$ was defined as the probability that total sardine 1+ biomass falls below the average total sardine 1+ biomass over November 1991 and November 1994 at least once during the projection period of 20 years; and

$risk_A$ <0.25, where $risk_A$ was defined as the probability that anchovy 1+ biomass falls below 10% of the average anchovy 1+ biomass between November 1984 and November 1999 at least once during the projection period of 20 years.

While there was already strong evidence of spatial structure in the sardine population (de Moor and Butterworth 2013, 2015 and references therein), given uncertainties in the mixing between (sub-)stocks (components) of sardine at the time, OMP-14 was tuned assuming a baseline operating model (OM) of a single homogeneously distributed sardine stock (de Moor 2014, de Moor and Butterworth 2012, 2014). This was agreed on condition that some spatial management of directed sardine catches be developed and accepted as part of OMP-14 (e.g. DAFF 2014, de Moor 2014, de Moor and Butterworth 2014).

There has been a proposal that OMP-14 continue to be used to set the catch limits for sardine and anchovy in 2018, rather than using a new OMP that is currently under development. This document sets out some advantages and disadvantages of such a proposal.

Risk under a single stock hypothesis

Running OMP-14 under an updated single stock hypothesis for anchovy (de Moor 2016a) and sardine (de Moor and Butterworth 2016a) results in a higher risk to both anchovy and sardine resources, with $risk_A$ increasing from 0.234 (de Moor and Butterworth 2014 over the projection period 2013 to 2032) to 0.40 and $risk_S$ increasing from 0.209 (de Moor and Butterworth 2014) to 0.88, where the updated projections are over 2017 to 2036. de Moor and Butterworth (2016a) already showed that the sardine resource, as estimated at the joint posterior mode, had dropped below and then hovered above the threshold of average 1991-1994 biomass

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during recent years. The probability of being below the threshold during the projection period increases from 0.066 (de Moor and Butterworth 2014) to 0.53 given the updated OM.

Keeping the same anchovy control parameter of $\alpha = 0.889$, even if the sardine control parameter, β, was set to 0 (i.e. a directed sardine F=0 scenario), $risk_S$ is 0.78[1], which is much higher than deemed acceptable during OMP-14 development.

Risk under a two component hypothesis

Running OMP-14 with single area management modelled according to historical patterns (de Moor 2017), under an updated two component hypothesis for sardine with 20% of south coast spawner biomass contributing to west coast effective spawner biomass (de Moor 2016b, 2017) results in a higher risk to both anchovy and sardine resources, with $risk_A$ increasing from 0.234 (de Moor and Butterworth 2014) to 0.39 and $risk_S$ increasing from 0.209 (de Moor and Butterworth 2014) to 1, i.e. it is predicted that the risk threshold will be breeched at least once during the 2017 to 2036 projection period. Note here that risk is calculated in terms of total (west+south) biomass. de Moor and Butterworth (2016b) already showed that the total resource has dropped below the threshold of total average 1991-1994 biomass from 2012 onwards, while de Moor (2016b) showed that the total resource dropped below the threshold in 2013. The probability of being below the threshold during the projection period increases from 0.066 (de Moor and Butterworth 2014) to 0.81 given the updated OM.

If OMP-14 was instead simulated with two area management where the proportion of the TAC allocated west of Cape Agulhas in any year is equal to the proportion of the biomass surveyed west of Cape Agulhas in the preceding November (de Moor 2017), $risk_S$ remains at 1, while the probability of being below the threshold during the projection period decreases to 0.79.

Keeping the same anchovy control parameter of $\alpha = 0.889$, even if the sardine control parameter, β, was set to 0 (i.e. a directed sardine F=0 scenario), $risk_S$ is 0.98.

If the underlying reality proved more optimistic than assumed under the baseline hypothesis, and more sardine were retained on the west coast (i.e. west to south movement is modelled at half the proportions of MoveR), then $risk_S$ is 0.98 under OMP-14 with the probability of being below the threshold during the projection period being 0.71 (single area management) or 0.69 (two area management). Keeping the same anchovy control parameter of $\alpha = 0.889$, even if the sardine control parameter, β, was set to 0 (i.e. a directed sardine F=0 scenario), $risk_S$ is 0.96.

[1] 0.75 if there is no pelagic fishing at all.

Discussion

The primary advantage of delaying the adoption of a new OMP before December 2017 is that it allows for additional time to further explore and engage on alternative management options, particularly with regards to single versus two area management of the sardine resource.

The primary disadvantage of continuing to use OMP-14 for 2018 is the high risk to the sardine resource (Table 1), with consequential knock-on risks to both industry and dependent predators (Figure 1). The sardine resource in recent years has already dropped below the average 1991-1994 biomass, despite OMP-14 being tuned to avoid this with a relatively high probability. One reason for this could be that if the resource is not a single homogeneously distributed stock, OMP-14 with the realised spatial split of catches over the past few years was indeed too risky for a spatially structured population. The higher risk predicted over 2017 to 2036 probably results from i) the low current status of the population and ii) the lower productivity estimated for sardine under the new OM with updated data compared to that used during OMP-14 development, even for a single stock hypothesis (Figures 2 and 3).

These results show that continuing with OMP-14 would result in a higher risk to the anchovy resource over the 20 year projection period. However, given the proposal of continuing with OMP-14 is for a single year only (or part thereof) and the anchovy resource has been consistently high – much higher than the risk threshold - over the past number of years, one might argue the higher risk isn't too concerning for a single year extension of the existing OMP (Figure 4).

Since neither the use of OMP-14 nor a finalised version of OMP-18 seems best for recommending small pelagic quotas in December 2017, an interim OMP-18 may prove to be the best way forward. Results in this document indicate that a simple downward scaling of the sardine control parameter in OMP-14 may not suffice.

References

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Table 1. Summary of sardine risk statistics referred to in this document.

		Previous OM	Updated OM	Previous OM	Updated OM
		Probability of being below risk threshold at least once during the projection period		Probability of being below risk threshold during the projection period	
Single Stock	Sardine F=0		0.78		
	OMP-14	**<0.21**	0.88	0.07	0.53
Two Components with 20% south ->west and MoveR	Sardine F=0		0.98		
	OMP-14 one area		1.00		0.81
	OMP-14 two area		1.00		0.79
Two Components with 20% south ->west and 0.5MoveR	Sardine F=0		0.96		
	OMP-14 one area		0.98		0.71
	OMP-14 two area		0.98		0.69

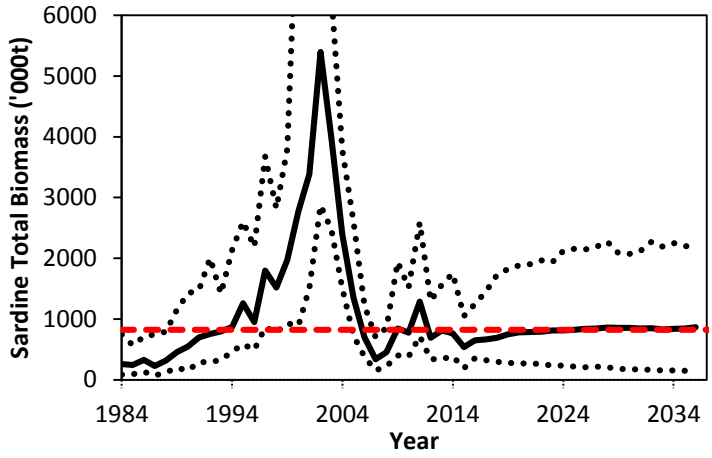

Figure 1. Median and 95% probability interval of sardine under a single stock hypothesis, projected forward under OMP-14 (with baseline anchovy OM).

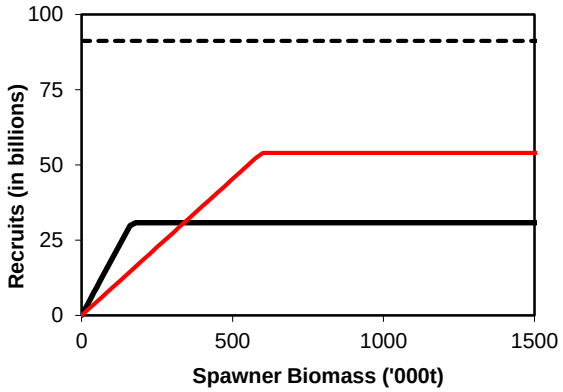

Figure 2. The single stock hockey stick stock recruitment curve estimated at the joint posterior mode using data up to 2011 (de Moor and Butterworth 2012, red line) and up to 2015 (de Moor and Butterworth 2016a, black lines).

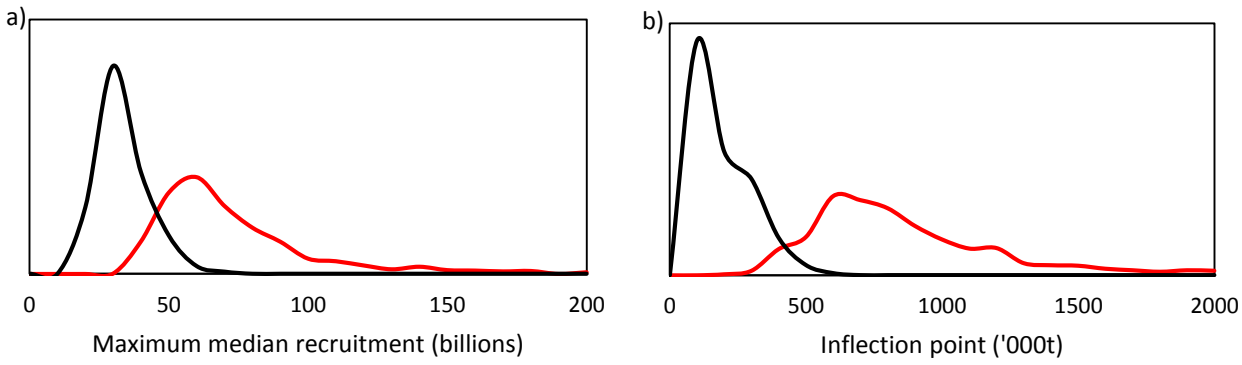

Figure 3. The posterior distributions of a) the median single stock maximum recruitment in non-peak years and b) the single stock inflection point using data up to 2011 (de Moor and Butterworth 2012, red line) and up to 2015 (de Moor and Butterworth 2016a, black lines).

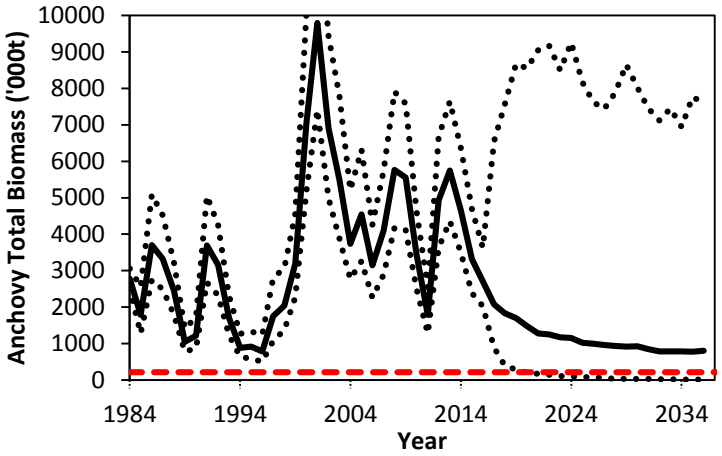

Figure 4. Median and 95% probability interval of anchovy projected forward under OMP-14 (assuming a single sardine stock OM).