Proposals to Split Sardine Catch West and East of Cape Agulhas

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Candidate Management Procedures (MPs) to be developed for use in managing the South African sardine and anchovy resources from 2014 are to be simulation tested against two key alternative sardine hypotheses: one assuming a single sardine stock (de Moor and Butterworth 2012a) and one assuming two mixing-stocks, with the split between "west" and "south" stocks assumed to occur at Cape Agulhas (de Moor and Butterworth 2013a). Alternative candidate MPs have been and will be proposed, with two key groups being those which recommend a single sardine TAC (regardless of the number of sardine stocks) and those which recommend a separate sardine TAC west and east of Cape Agulhas (again, regardless of the number of sardine stocks) (Figure 1).

This document considers the case when the underlying operating models upon which candidate MPs are being tested assumes two mixing-stocks of sardine, but the candidate MPs recommend only a single sardine TAC. In the implementation model (see de Moor and Butterworth 2012b), this single TAC needs to be split into an amount to be caught west and east of Cape Agulhas, which will be assumed to be caught from the "west" and "south" stocks, respectively. Three proposals are given for methods to split this catch in future simulations.

Historic split of catches

The catch data considered in this document are the directed sardine catches and sardine bycatch with round herring only. During future simulations, these catches are assumed to be all 1+ sardine, while the sardine bycatch with anchovy (assumed to be age 0 in future), is only assumed to consist of "west" stock sardine.

The catch east of Cape Agulhas has increased from zero in the early part of the time series to a max of 155 000t, or 64% of the total sardine catch, in 2005 (Figure 2). The average proportion of sardine catch taken east of Cape Agulhas has been 38% (CV of 50%) over the past 10 years (Table 1).

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Proposal 1:

The first option for future simulated implementation of a single TAC, given two sardine stocks, would be to randomly draw proportions from the last 10 years of catch taken west/east of Cape Agulhas (i.e. from the highlighted cells in Table 1).

This proposal does not take explicit account of any future shifts in the distribution of sardine biomass west and east of Cape Agulhas. Naturally the impact of taking an average of 38% of the catch to the east of Cape Agulhas on the "south" stock, and 62% to the west of Cape Agulhas on the "west" stock would be dependent on the biomass of each of these stocks (Figure 3).

Taking Stock Biomass into Consideration

Figure 4 shows the historic time series of November survey estimates of 1+ biomass west and east of Cape Agulhas and the proportions of these biomasses. The survey observations are considered here, as these would be available on an annual basis for input into a candidate MP's Harvest Control Rule.

The proportion of directed sardine catch and sardine bycatch with round herring taken west and east of Cape Agulhas in each year is plotted against the previous November's survey estimated 1+ biomass west and east of Cape Agulhas, and the proportions of these survey estimates west and east of Cape Agulhas (Figure 5a-d). When considering the data from 1999-2011[1], there is a decrease in the proportion of the catch west of Cape Agulhas as the absolute survey biomass west of Cape Agulhas decreases (Figure 6a). This is a stronger relationship than that with the proportion of survey biomass west of Cape Agulhas (Figure 6b). This could be because industry vessels originating from the west coast, where most of the processing capacity is located, will only fish east of Cape Agulhas once the sardine biomass west of Cape Agulhas falls below a threshold biomass, rather than a proportion of the total biomass. The relationships with the absolute survey biomass and proportion of survey biomass east of Cape Agulhas are not as clear, suggesting that even when the survey 1+ biomass east of Cape Agulhas is high, industry vessels originating from the west coast will not necessarily move east unless fishing west of Cape Agulhas is no longer viable (Figure 5b).

Proposal 2:

The second option for future simulated implementation of a single TAC, given two sardine stocks, would be to assume the relationship

$$p_w^{catch}(y) = 0.96 \times B_w(y-1) / (124.7 + B_w(y-1)),$$

where $B_w(y)$ is the survey estimated 1+ biomass west of Cape Agulhas in thousands of tons. This relationship implies that as the survey estimated 1+ biomass west of Cape Agulhas decreases below about

[1] The most recent years of the time series are used as these are assumed to be more indicative of future catches.

500 000t, the proportion of the directed sardine catch and sardine bycatch with round herring taken east of Cape Agulhas would increase.

Taking Sardine TAC into Consideration

A further consideration which may influence the proportion of catch west and east of Cape Agulhas is how large the directed sardine TAC is relative to the survey estimated 1+ biomass west of Cape Agulhas. Figures 5e and 6c show that the proportion of the directed sardine catch and sardine bycatch with round herring taken west of Cape Agulhas decreases as the directed sardine TAC increases relative to the survey 1+ biomass west of Cape Agulhas.

Proposal 3:

The third option for future simulated implementation of a single TAC, given two sardine stocks, would be to assume the relationship

$p_w^{catch}(y) = 1.0 - 0.89 \times \{TAC(y) / B_w(y-1)\} / (0.89 + \{TAC(y) / B_w(y-1)\})$,

where $TAC(y)$ is the directed >14cm sardine TAC in year y and the units of $TAC(y)$ and $B_w(y)$ are thousands of tons. This relationship implies that as the ratio of sardine TAC to survey biomass west of Cape Agulhas tends to zero, all the directed sardine catch and sardine bycatch with round herring would be taken from west of Cape Agulhas, whereas the proportion of catch west of Cape Agulhas approaches 0.4 as the TAC increases above that of the survey estimated 1+ biomass west of Cape Agulhas.

References

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de Moor, C.L., and Butterworth, D.S. 2012b. The simulation testing framework used during the development of OMP-13. DAFF: Branch Fisheries Document FISHERIES/2012/NOV/SWG-PEL/58. 24pp.

de Moor, C.L., and Butterworth, D.S. 2013a. Assessment of the South African sardine resource using data from 1984-2011: results for a two stock hypothesis at the posterior mode. DAFF: Branch Fisheries Document FISHERIES/2013/AUG/SWG-PEL/20. 46pp.

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Table 1. This historic directed sardine catch and sardine bycatch with round herring taken west and east of Cape Agulhas, and the November survey estimates of 1+ biomass west and east of Cape Agulhas, which area assumed in the two mixing-stock operating model to represent sardine from the "west" and "south" stocks, respectively. The highlighted cells correspond to Proposal 1.

	Catch ('000t)		Proportion of Catch		Model predicted 1+ biomass		Proportion of 1+ Biomass	
	West of Cape Agulhas	East of Cape Agulhas	West of Cape Agulhas	East of Cape Agulhas	West of Cape Agulhas	East of Cape Agulhas	West of Cape Agulhas	East of Cape Agulhas
1984	27.154	0.000	1.00	0.00	48.009	0.369	0.99	0.01
1985	30.712	0.000	1.00	0.00	25.457	19.556	0.57	0.43
1986	30.639	0.000	1.00	0.00	238.230	61.566	0.79	0.21
1987	26.703	0.000	1.00	0.00	94.165	17.120	0.85	0.15
1988	29.907	0.000	1.00	0.00	128.043	6.319	0.95	0.05
1989	24.516	0.218	0.99	0.01	198.328	58.327	0.77	0.23
1990	49.357	0.480	0.99	0.01	248.855	41.020	0.86	0.14
1991	44.521	1.379	0.97	0.03	517.180	80.678	0.87	0.13
1992	39.470	2.467	0.94	0.06	247.756	246.401	0.50	0.50
1993	42.167	2.300	0.95	0.05	480.822	79.198	0.86	0.14
1994	75.274	4.366	0.95	0.05	389.730	128.624	0.75	0.25
1995	94.021	4.942	0.95	0.05	363.542	480.402	0.43	0.57
1996	92.233	7.543	0.92	0.08	257.763	271.693	0.49	0.51
1997	108.212	4.264	0.96	0.04	964.835	259.797	0.79	0.21
1998	115.818	4.195	0.97	0.03	1082.547	524.781	0.67	0.33
1999	117.293	7.090	0.94	0.06	708.029	927.381	0.43	0.57
2000	121.931	6.045	0.95	0.05	726.230	1566.150	0.32	0.68
2001	166.318	11.280	0.94	0.06	669.617	1639.983	0.29	0.71
2002	221.121	27.250	0.89	0.11	1184.713	3021.538	0.28	0.72
2003	218.418	61.000	0.78	0.22	1343.118	2221.053	0.38	0.62
2004	290.128	77.454	0.79	0.21	292.522	2323.193	0.11	0.89
2005	85.936	154.970	0.36	0.64	75.604	973.386	0.07	0.93
2006	82.977	125.177	0.40	0.60	177.889	534.667	0.25	0.75
2007	54.380	81.184	0.40	0.60	53.139	199.061	0.21	0.79
2008	42.702	44.016	0.49	0.51	211.871	172.209	0.55	0.45
2009	57.379	34.141	0.63	0.37	262.175	239.400	0.52	0.48
2010	68.337	26.094	0.72	0.28	309.465	198.927	0.61	0.39
2011	69.399	29.842	0.70	0.30	182.825	854.235	0.18	0.82

		The type of sardine TAC arising from the candidate MP	
		Single Area TAC	Two Area TAC
The underlying sardine stock hypothesis	Single Sardine Stock	(eg de Moor and Butterworth 2013b)	Still to be developed
	Two Mixing Sardine Stocks		Still to be developed

Figure 1. A table showing the alternative combinations of candidate MPs and underlying sardine operating models to be tested. The proposals sought from the comparisons made in the document will apply to the highlighted cell.

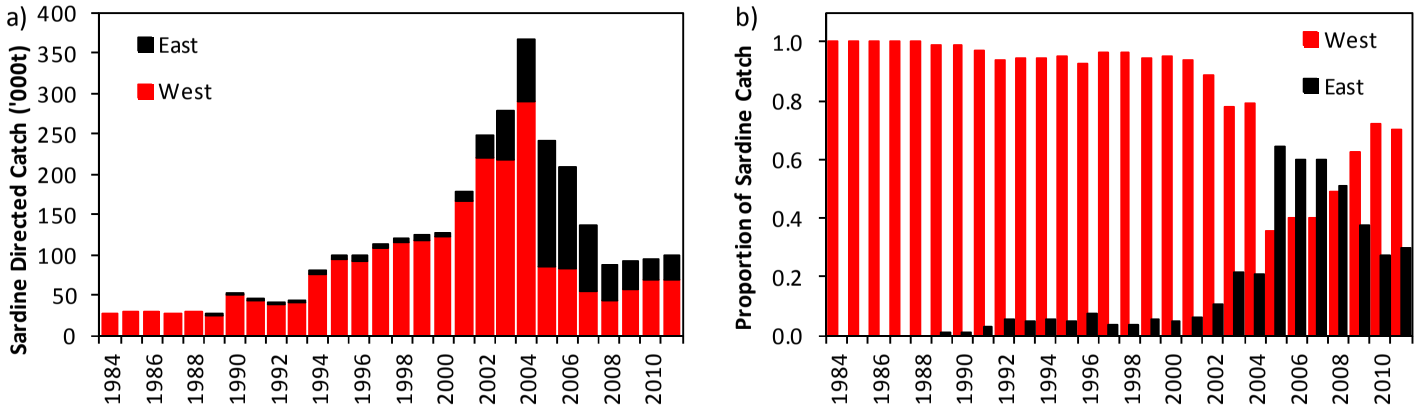

Figure 2. The a) directed sardine catch and sardine bycatch with round herring caught west and east of Cape Agulhas and b) the proportions of these catches west and east of Cape Agulhas.

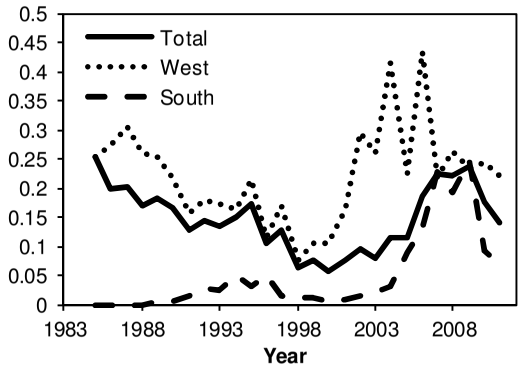

Figure 3. The harvest rate (Catch : model estimated 1+ November biomass) of the "west" and "south" sardine stocks (de Moor and Butterworth 2013a).

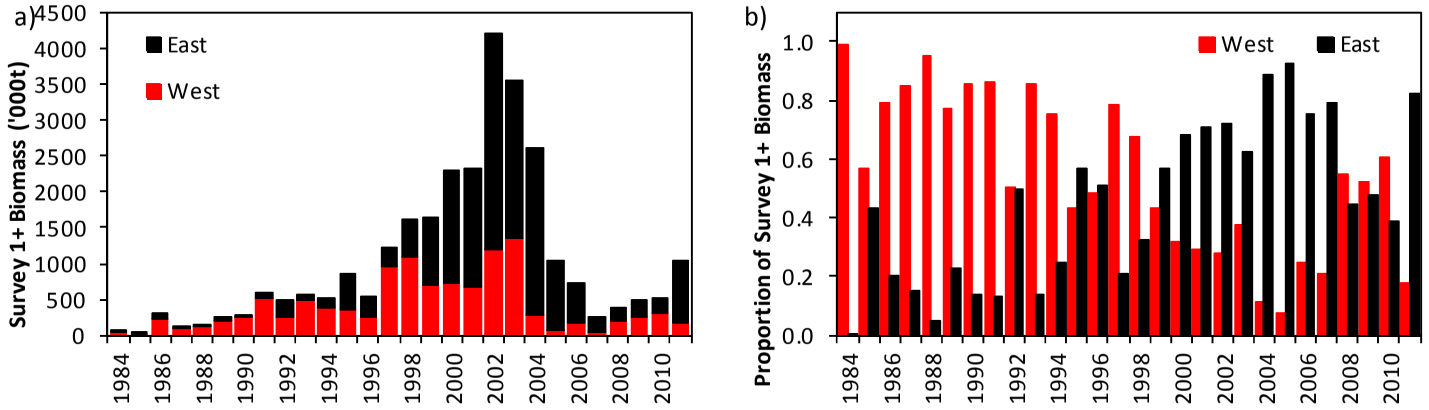

Figure 4. The a) November survey estimated 1+ biomass of sardine west and east of Cape Agulhas and b) the proportions of this biomass west and east of Cape Agulhas.

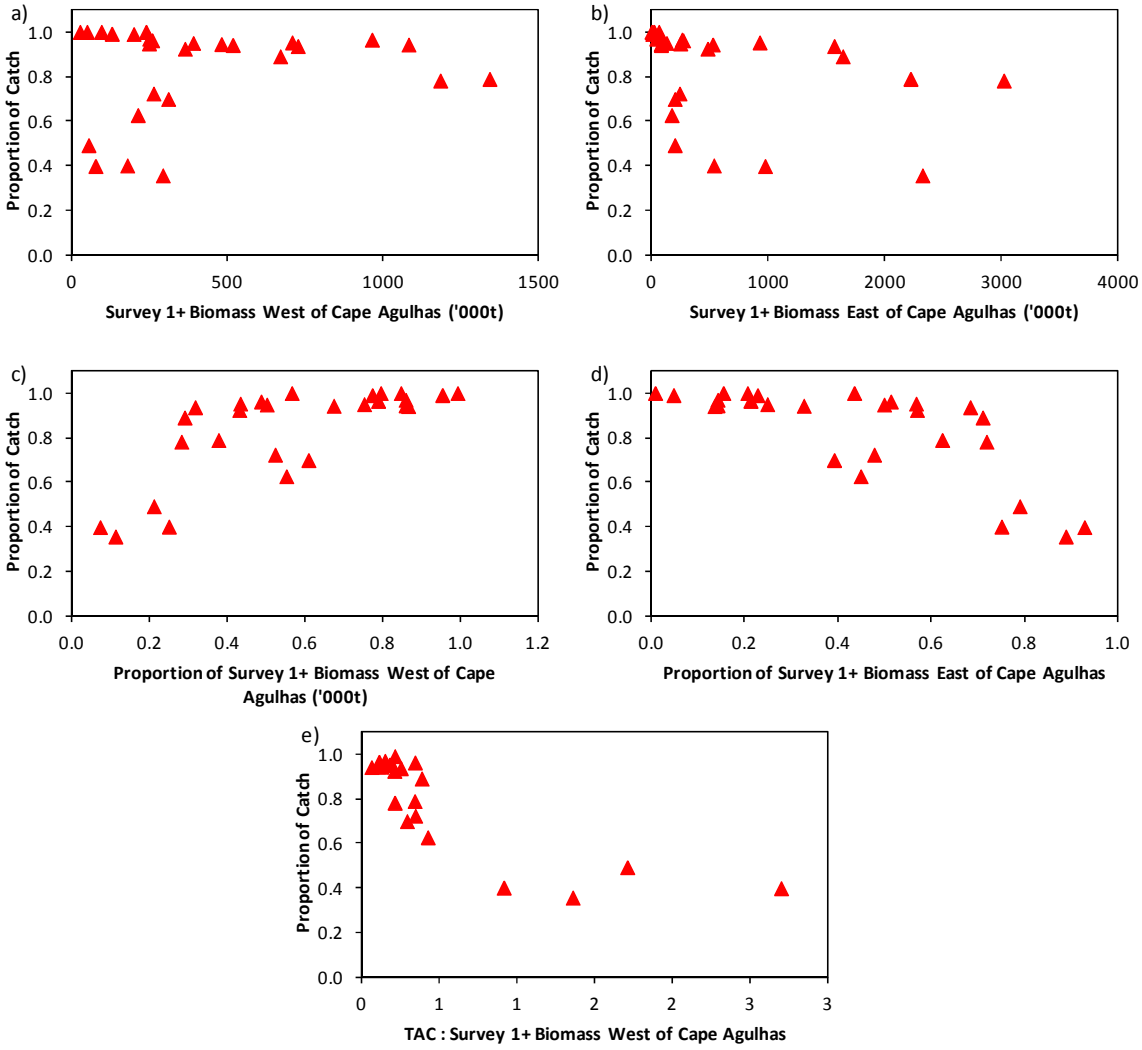

Figure 5. The proportion of directed sardine catch and sardine bycatch with round herring caught west of Cape Agulhas in year *y* plotted against a) the survey estimated 1+ biomass west of Cape Agulhas in November *y-1*, b) the survey estimated 1+ biomass east of Cape Agulhas in November *y-1*, c) the proportion of survey estimated 1+ biomass west of Cape Agulhas in November *y-1*, d) the proportion of survey estimated 1+ biomass east of Cape Agulhas in November *y-1*, and e) the ratio of the directed sardine TAC in year *y* to the survey estimated 1+ biomass west of Cape Agulhas in November *y-1*.

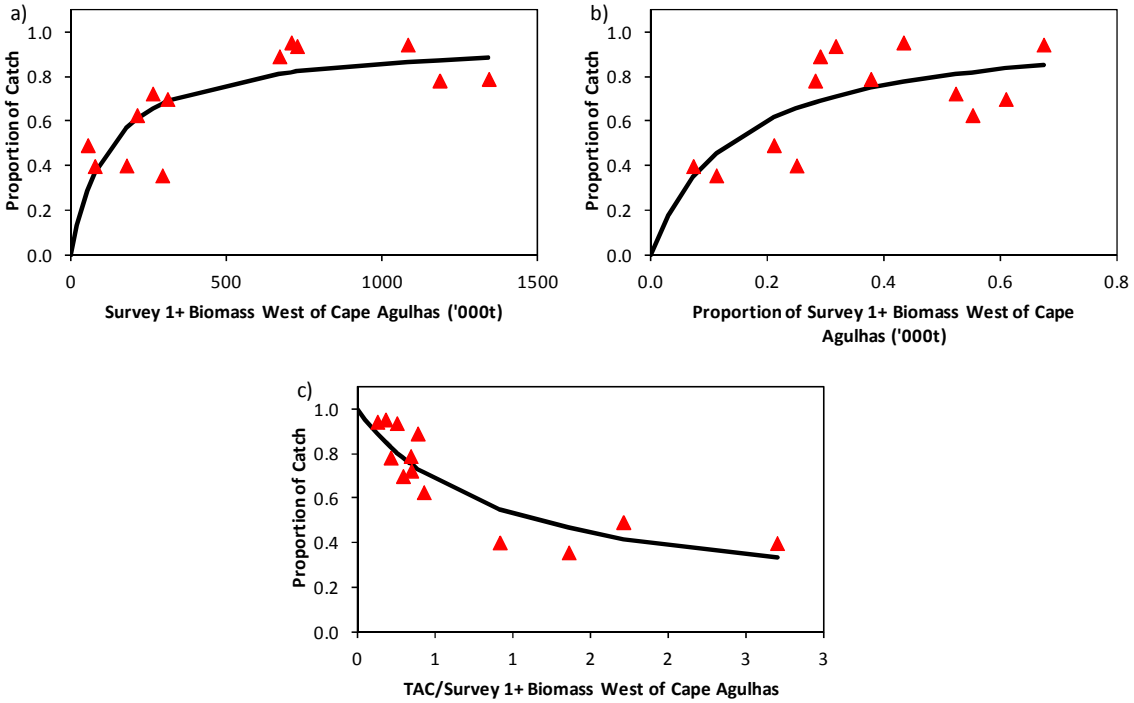

Figure 6. The proportion of directed sardine catch and sardine bycatch with round herring caught west of Cape Agulhas over the most recent assessment years (1999-2011) plotted against a) the survey estimated 1+ biomass west of Cape Agulhas in November of the previous year, b) the proportion of survey estimated 1+ biomass west of Cape Agulhas in November of the previous year, and c) the ratio of the directed sardine TAC in the same year to the survey estimated 1+ biomass west of Cape Agulhas in November of the previous year. The fitted relationships $p_w^{catch}(y) = 0.96 \times B(y)/(125 + B(y))$, $p_w^{catch}(y) = 1.03 \times p_w^{biomass}(y)/(0.14 + p_w^{biomass}(y))$ and $p_w^{catch}(y) = 1 + 0.89 \times \{TAC(y)/B(y)\}/(0.89 + \{TAC(y)/B(y)\})$ are also plotted.