An alternative two mixing stock hypothesis for South African sardine

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Background

The results of the two mixing stock hypothesis for South African sardine presented in de Moor and Butterworth (2016) assumed recruitment to each coastal management unit was dependent only on the spawner biomass (SSB) of that coastal management unit. In this document some contribution from the south coast SSB to the effective west coast SSB is considered as an alternative two mixing stock hypothesis.

Methods

The "effective spawner biomass" for the west/south coast management unit was previously assumed to consist of the spawner biomass from the west/south coast management unit only (equations A12 of de Moor and Butterworth (2016), with $\chi_w = \chi_s = 0$). One could assume a time-invariant proportion ($0 < \chi_s \leq 1$) of the south coast SSB to contribute to the effective SSB of the west coast management unit, upon which west coast recruitment is based. However, Coetzee (2016) estimated the annual proportion of successfully transported eggs from the south coast to the west coast nursery area. Here we assume these proportions are indicative of the contribution of south coast SSB to the effective SSB of the west coast management unit. The annual values, $\chi_{s,y}$, are repeated in Table 1 for ease of reference.

Results

Table 2 compares the model fit to the data showing the fit for this hypothesis is not as good as that of de Moor and Butterworth (2016) at the joint posterior mode. The largest improvement is obtained from the model fit to the November 2011 survey estimates of abundance (Figure 1) and the largest "loss" in terms of model fit to data is from fitting to the November survey length frequencies (Figure 2). There is little difference in the estimated stock recruitment curves (Figures 3 and 4).

Summary

Note that the comparative objective function values at the joint posterior mode cannot be used to give definitive weighting to one hypothesis over another. However, these results show that this alternative hypothesis is consistent

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with the data and it is currently planned to use both these two mixing stock hypotheses as Operating Models during OMP-017 development.

References

Coetzee, J.C. 2016. Estimation of the effective proportion of sardine biomass contributing to putative western stock recruitment by including the proportion of eggs transported to the West Coast nursery area from South Coast spawning areas. DAFF: Branch Fisheries Document FISHERIES/2016/AUG/SWG-PEL/37.

de Moor, C.L., and Butterworth, D.S. 2016. Assessment of the South African sardine resource using data from 1984-2015: Results at the joint posterior mode for the two mixing-stock hypothesis. DAFF: Branch Fisheries Document FISHERIES/2016/JUL/SWG-PEL/22REV2.

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Table 1. The annual proportion of south coast SSB assumed to contribute to the effective SSB of the west coast management unit.

Year	$\chi_{s,y}$	Year	$\chi_{s,y}$
1984	0.147	2000	0.038
1985	0.137	2001	0.097
1986	0.029	2002	0.070
1987	0.097	2003	0.064
1988	0.131	2004	0.049
1989	0.066	2005	0.104
1990	0.128	2006	0.074
1991	0.148	2007	0.040
1992	0.039	2008	0.045
1993	0.116	2009	0.145
1994	0.031	2010	0.062
1995	0.039	2011	0.073
1996	0.047	2012	0.079
1997	0.147	2013	0.098
1998	0.070	2014	0.112
1999	0.077	2015	0.049

Table 2. The individual contributions to the posterior distribution at the joint posterior mode for this model, compared to the results presented by de Moor and Butterworth (2016).

Contribution to Posterior	South coast SSB contribution to effective west coast SSB		Difference
	None (dM and B, 2016)	Variable (This document)	
-lnposterior	689.22	696.77	7.6
$-\ln L^{Nov}$	60.51	58.10	-2.4
$-\ln L^{rec}$	64.52	64.27	-0.2
$-\ln L^{compropl}$	-387.32	-385.17	2.1
$-\ln L^{surpropl}$	-356.39	-360.29	5.1
$-\ln L^{prev}$	1280.64	1283.43	2.8
$-\ln prior(k_{ac})$	-1.42	-1.44	0.0
-lnprior(recres)	25.51	25.63	0.1
-lnprior(movres)	-27.69	-27.72	0.0
-lnprior(t0res)	40.64	40.76	0.1
-lnprior(b/K)	-0.84	-0.84	0.0

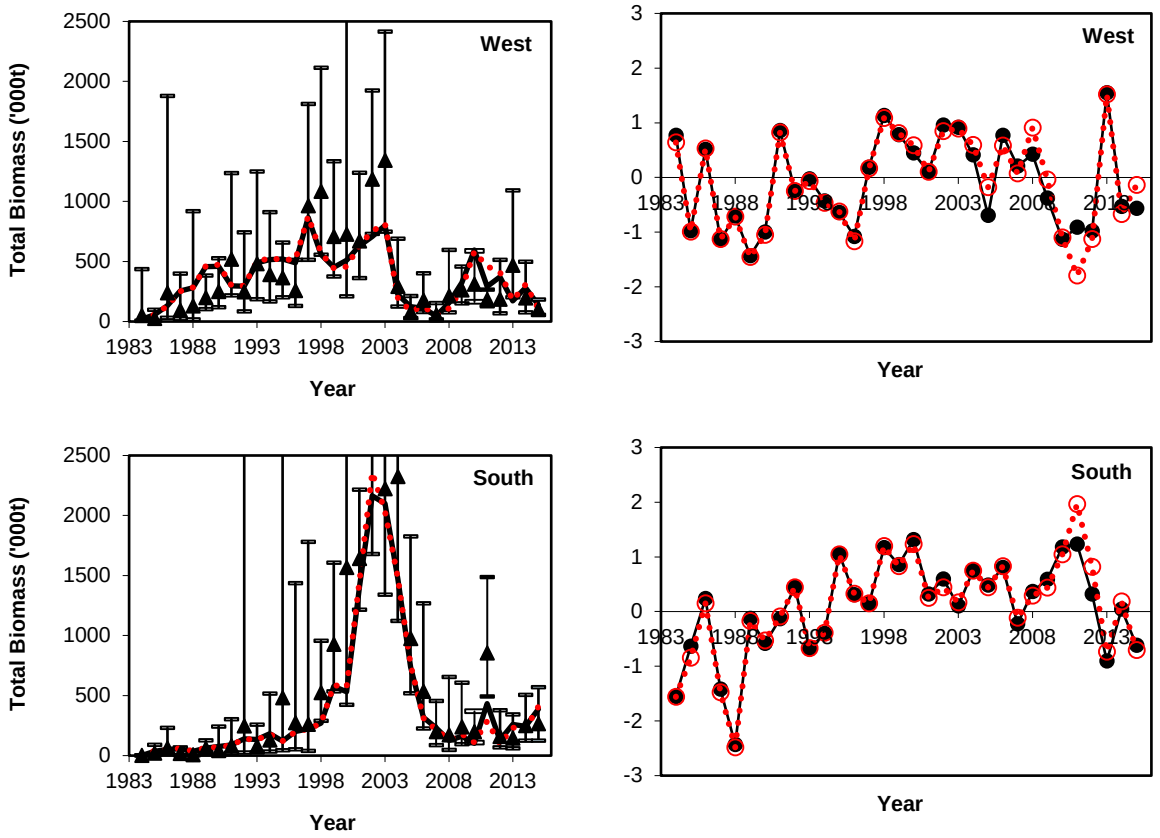

Figure 1. Acoustic survey estimated and model predicted November sardine 1+ biomass from 1984 to 2015 for the two mixing stock hypothesis with no south coast contribution to west coast effective spawning (red dotted lines) and with variable south coast contribution to west coast effective spawning (black solid lines). The observed indices are shown with 95% confidence intervals. The standardised residuals (i.e. the residual divided by the corresponding standard deviation, including additional variance where appropriate) from the fits are given in the right hand plots.

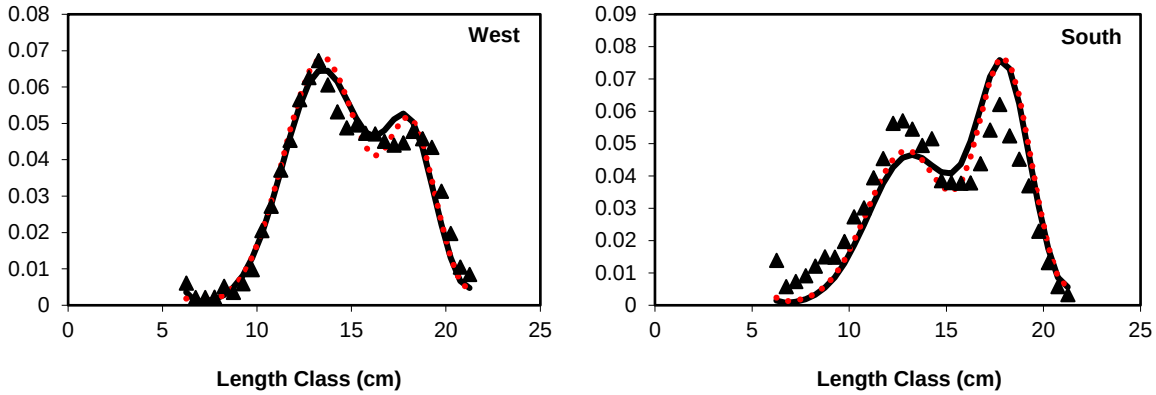

Figure 2. Average (over all years) model predicted and observed proportion-at-length in the November survey for the two mixing stock hypothesis with no south coast contribution to west coast effective SSB (red dotted lines) and with variable south coast contribution to west coast effective SSB (black solid lines).

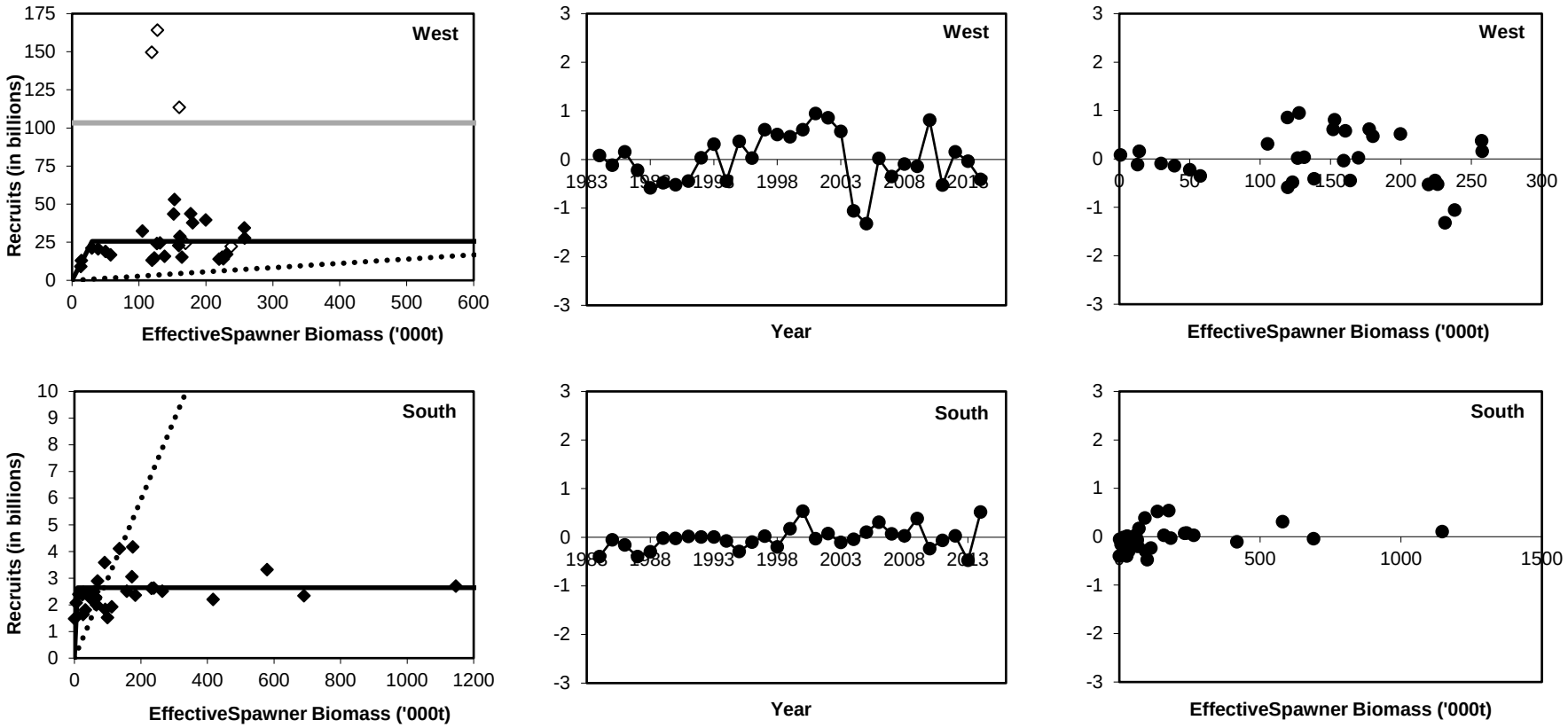

Figure 3. Model predicted sardine recruitment (in November) plotted against spawner biomass from November 1984 to November 2014 with the estimated Hockey stick stock recruitment relationships shown in the left side plots. The faded line shows the median 2000-2004 west coast recruitment and the open diamonds correspond to these same 'peak' years. The dotted line indicates the replacement line. The standardised residuals for the fits are given in the centre and right side plots, against year and against spawner biomass respectively.

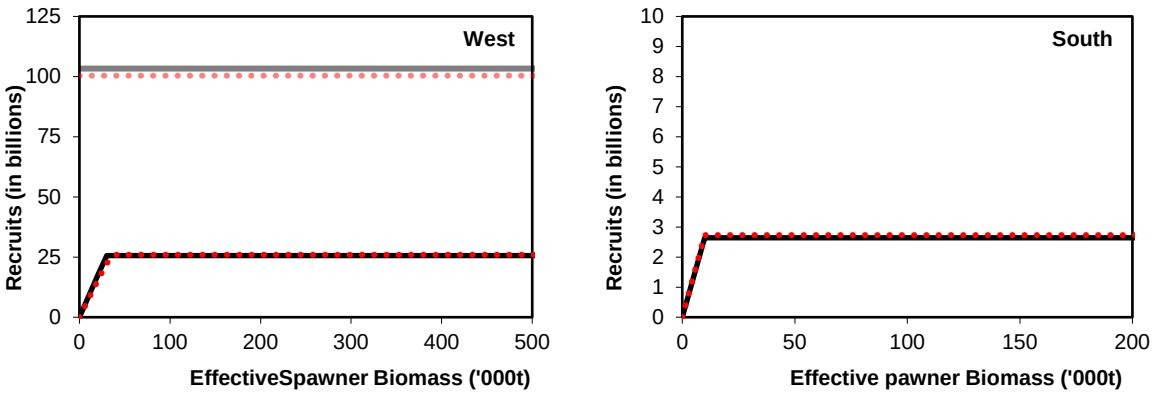

Figure 4. Model estimated Hockey stick stock recruitment relationships for the two mixing stock hypothesis with no south coast contribution to west coast effective SSB (red dotted lines) and with variable south coast contribution to west coast effective SSB (black solid lines).