Excluding survey estimates of recruitment on the South Coast from the two mixing stock hypothesis for South African sardine

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Introduction

The international panel from the annual Stock Assessment Workshops have recommended that the sensitivity of the two mixing stock hypothesis to the inclusion of hydroacoustic survey estimates of recruitment on the South Coast be tested. This time series of data does not cover the full time period modelled, and these data have large CVs (Smith *et al*. 2013; Dunn *et al.* 2015). This document explores an alternative where these data are excluded from the two mixing stock model.

Methods

The assessment model of de Moor and Butterworth (2016) is used, except that the contribution of hydroacoustic estimates of recruitment between Cape Infanta and Cape St. Francis are excluded from the likelihood (equation A36 of de Moor and Butterworth (2016)).

Results

While the fit to the November hydroacoustic estimates of abundance is slightly improved under this sensitivity test (Table 1, Figure 1), the fits to the length frequency and parasite prevalence data are all slightly poorer (Table 1). The model estimated recruitment without the South Coast data is of the same scale to that estimated with the data (Figures 2 and 3), and, given the lack of recruit data, does not deviate much from the stock-recruitment relationship (Figure 5). The median maximum recruitment to the south stock is estimated to be a little higher under the sensitivity test (Figure 6), but recruitment is still an order of magnitude smaller than that of the west coast.

Of particular interest is the estimated proportions of sardine that move from the west to the south stocks (Figure 7). The estimated movement plays an important role in the ability of the hypothesis to fit historical data, and will likely have a similarly important role in projections of this resource. While full posterior distributions of the sensitivity test considered here have not been estimated, the Hessian-based 95% CIs are considered in Figure 7. The proportion of 1-year-olds moving in 2011 is higher and more precisely estimated under the sensitivity test. This higher proportion

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links directly to the greater November 2011 biomass predicted for the south stock under the sensitivity test (Figure 1). However, while the information of a low south stock recruitment in May 2010 is excluded under this sensitivity test, there were no survey observations of recruitment in May 2011 or May 2012. Thus this result is a little surprising.

While some key parameter estimates at the joint posterior mode are different under this sensitivity test, compared to the baseline assessment, full posterior distributions would need to be estimated to see if such differences are meaningful and/or whether they would be influential on future projections.

Summary

This document has explored the sensitivity of the two mixing stock hypothesis of de Moor and Butterworth (2016) to the exclusion of the time series of hydroacoustic survey estimates of recruitment between Cape Infanta and Cape St. Francis. The results indicate the key model results do not differ substantially if the survey estimates of South Coast recruitment are ignored. This is unsurprising given the relatively high CVs on these data.

References

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.

Dunn, A., Haddon, M., Parma, A.M., and Punt, A.E. 2015. International Review Panel Report for the 2015 International Fisheries Stock Assessment Workshop. 30 November – 4 December 2015, Cape Town, South Africa.

Smith, A.D.M., Cox, S., Parma, A.M., and Punt, A.E. 2013. International Review Panel Report for the 2013 International Fisheries Stock Assessment Workshop. 2 - 6 December 2013, Cape Town, South Africa.

Table 1. 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	Include South Coast data (dM and B, 2016)	Exclude South Coast data (This document)	Difference
-lnposterior	689.22	656.19	*
$-\ln L^{Nov}$	60.51	56.64	-3.9
$-\ln L^{rec}$	64.52	30.44	*
$-\ln L^{compropl}$	-387.32	-384.12	3.2
$-\ln L^{surpropl}$	-356.39	-361.83	3.6
$-\ln L^{prev}$	1280.64	1283.44	2.8
$-\ln prior(k_{ac})$	-1.42	-1.41	0.0
-lnprior(recres)	25.51	19.94	-5.6
-lnprior(movres)	-27.69	-27.88	0.2
-lnprior(t0res)	40.64	41.76	0.1
-lnprior(b/K)	-0.84	-0.85	0.0

* These are not directly comparable due to the exclusion of one time series of data in the results presented in this document.

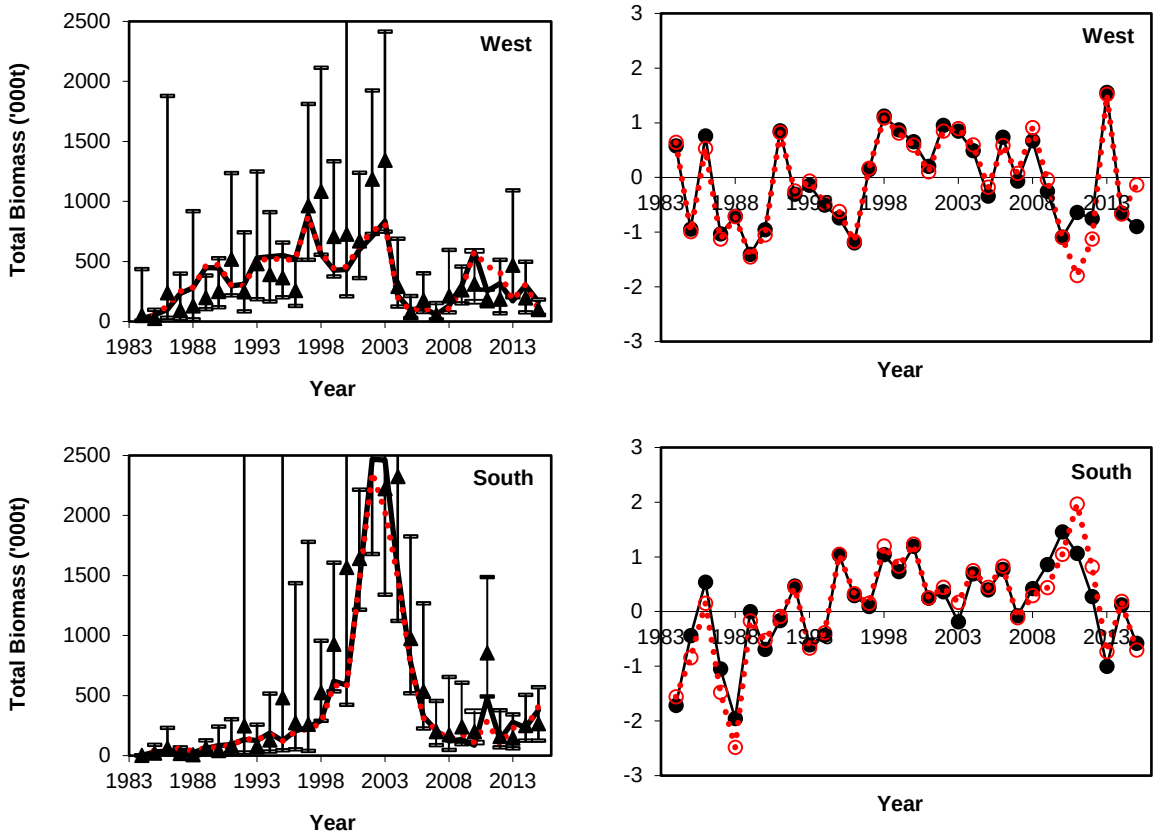

Figure 1. Acoustic survey estimated and model predicted November sardine 1+ biomass from 1984 to 2015 for the two mixing stock hypothesis fitted to hydroacoustic estimates of South Coast recruitment (red dotted lines) and excluding these data (black solid lines). The observed indices are shown with 95% 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.

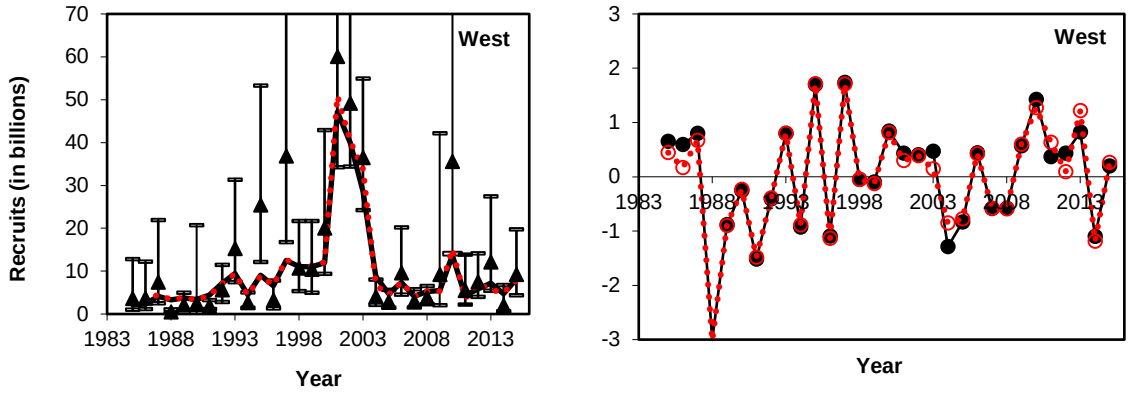

Figure 2. Acoustic survey estimated and model predicted West Coast sardine recruitment in May from 1985 to 2015 for the two mixing stock hypothesis fitted to hydroacoustic estimates of South Coast recruitment (red dotted lines) and excluding these data (black solid lines). The observed indices are shown with 95% confidence intervals. The standardised residuals from the fits are given in the right hand plots.

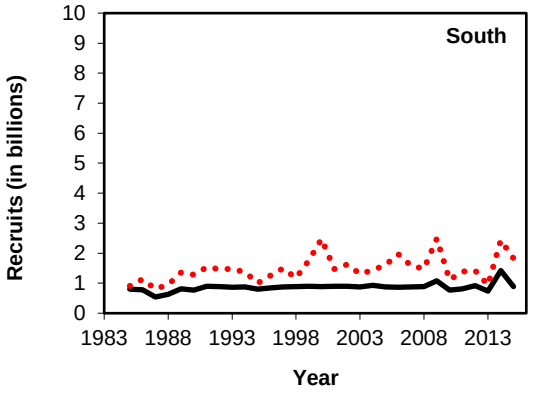

Figure 3. Model predicted (excluding survey bias) South Coast sardine recruitment in May from 1985 to 2015 for the two mixing stock hypothesis fitted to hydroacoustic estimates of South Coast recruitment (red dotted lines) and excluding these data (black solid lines).

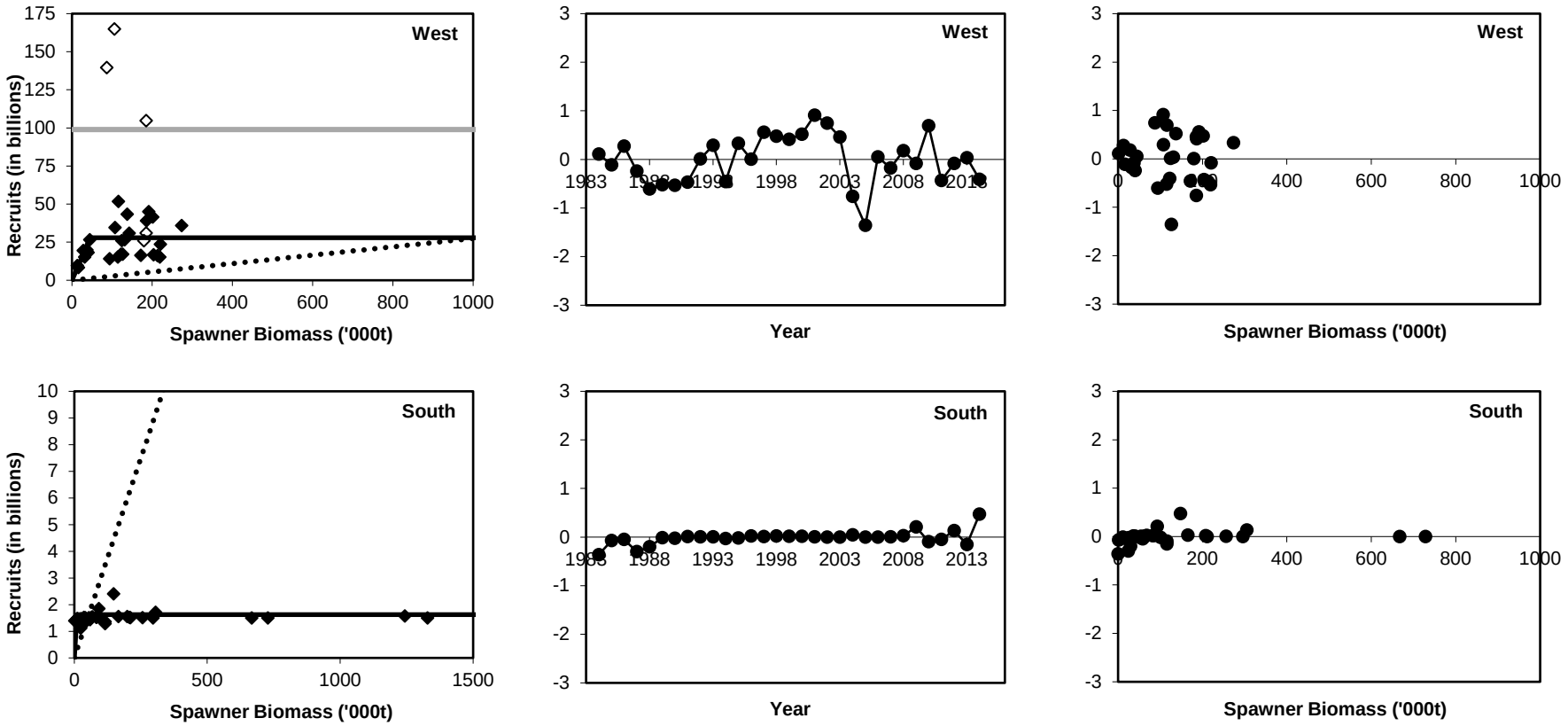

Figure 3. Model predicted sardine recruitment (in November) plotted against spawner biomass from November 1984 to November 2014 with the estimated Hockey stick stock recruitment relationships shown in the left side plots. The faded line shows the median 2000-2004 west coast recruitment and the open diamonds 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.

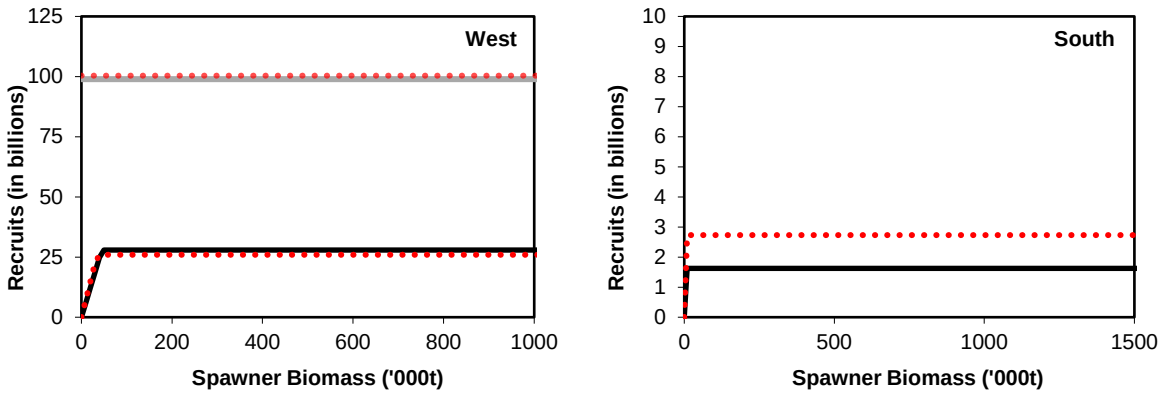

Figure 4. Model estimated Hockey stick stock recruitment relationships for the two mixing stock hypothesis that includes the hydroacoustic survey estimates of South Coast recruitment (red dotted lines) and excludes these same data (black solid lines).

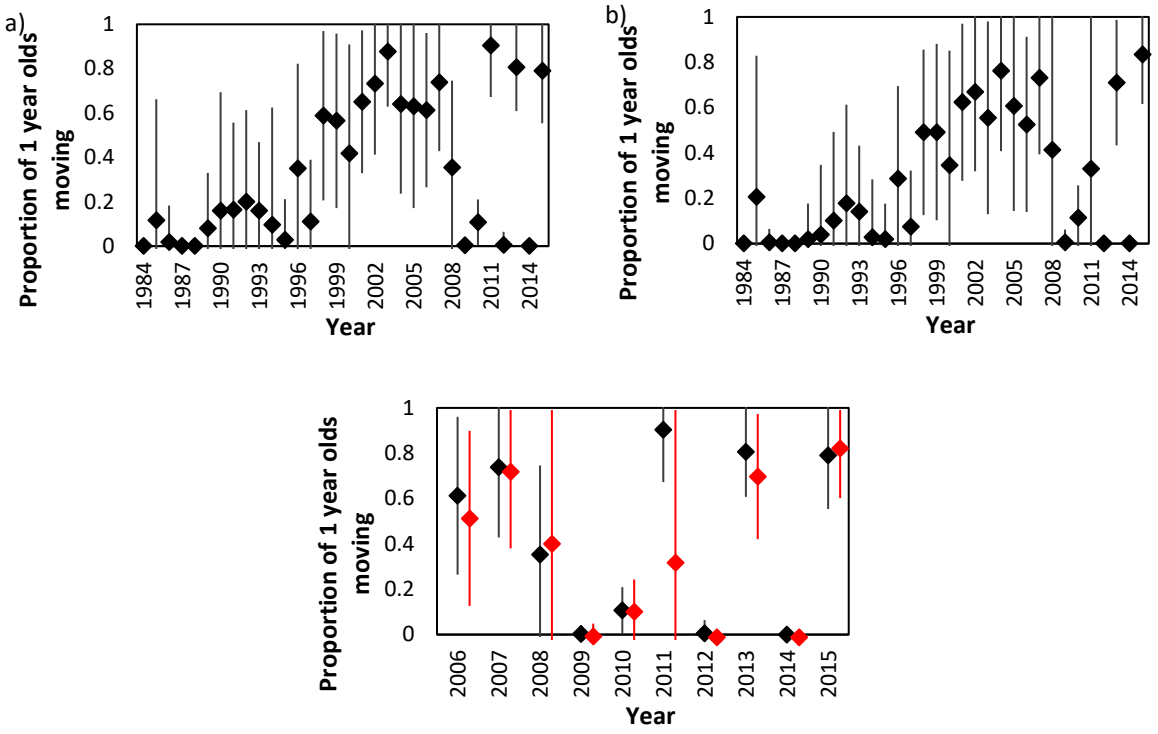

Figure 7. Model estimated annual proportions of 1-year-olds that move from the west to the south stocks, together with Hessian-based 95%CIs for a) this model that excludes the hydroacoustic estimates of South Coast recruitment and b) the model that includes the hydroacoustic estimates of South Coast recruitment. The lower plot overlays the two alternatives for the most recent years, with the red corresponding to the model that includes the time series of South Coast recruitment.