

Alternative hypotheses of west to south movement considered for South African sardine

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Background

A key consideration in the simulation projection framework to be used to test Candidate Management Procedures for OMP-17 are alternative hypotheses of the proportion of 1-year-old sardine that move from the west coast to the south coast each year. (The proportion of older sardine that move is linked to the proportion of 1-year-olds which move.) This document outlines the movement hypotheses considered thus far based on results at the joint posterior mode of de Moor and Butterworth (2016) and de Moor (2016).

MoveA: The proportion of 1 year olds which move is assumed to be autocorrelated (Appendix), using the autocorrelation coefficient¹ estimated during OM conditioning. However, the movement parameters are more precisely estimated for the latter years as a consequence of the availability of parasite prevalence by length data:

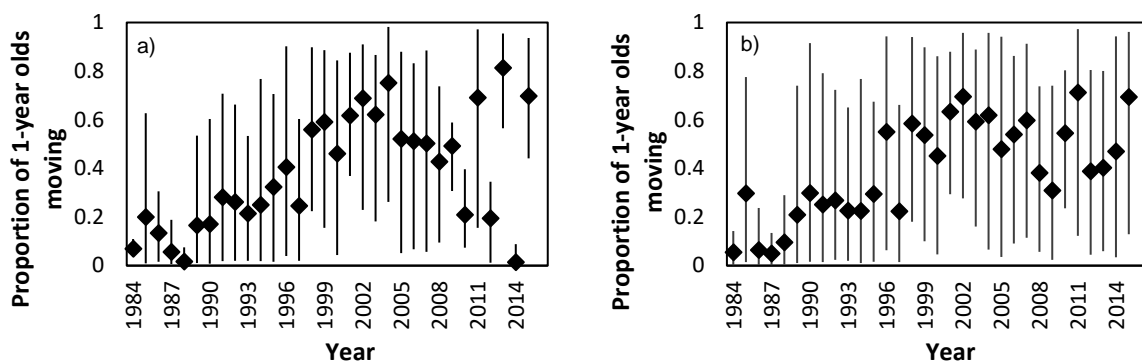


Figure 1 [Fig. S6 of de Moor et al. (In Review)]: The posterior median and 95% probability intervals of proportions of 1-year olds estimated to move from the west to the south stock each November, for a) S_{with} and b) $S_{without}$.

The (untransformed) autocorrelation coefficient at the joint posterior mode over 1984-2015, for example, is 0.71, but is 0.04 from 2008-2015 for the two sub-stock hypothesis with separate stock-recruitment relationships. The autocorrelation is 0.64 over 1984-2015, but is 0.06 from 2008-2015 for the two sub-stock hypothesis with south coast SSB contributing to west coast recruitment:

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¹ This coefficient differs for each sample from the posterior distribution

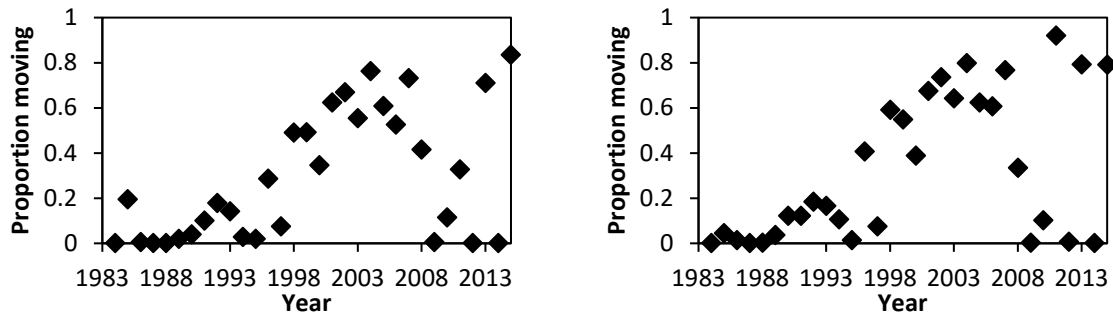


Figure 2: The proportion of age-1 sardine moving from the west to south coast sub-stock at the joint posterior mode for a) the two sub-stock hypothesis with separate stock-recruitment relationships (de Moor and Butterworth 2016) and b) the two sub-stock hypothesis with south coast SSB contributing to west coast recruitment (de Moor 2016).

Given the low autocorrelation in recent years, this MoveA hypothesis received a **low priority** from the SPSWG in earlier discussions.

MoveR: The proportion of 1-year-olds which move is drawn randomly from the proportions estimated by the model between 2006-2015. (For each of the 1000 simulations, the projected proportions will be drawn randomly from the estimated 2006-2015 proportions for that *same* simulation.) The SPSWG considered this hypothesis to receive a **high priority**.

MoveE: The proportion of 1 year olds which move is assumed to be linked to some environmental index. An application of the STARS method to an extended time series of upwelling for Cape Agulhas (an update of Blamey et al. 2012) shows no further “switch points” from those assumed by de Moor and Butterworth (2013b):

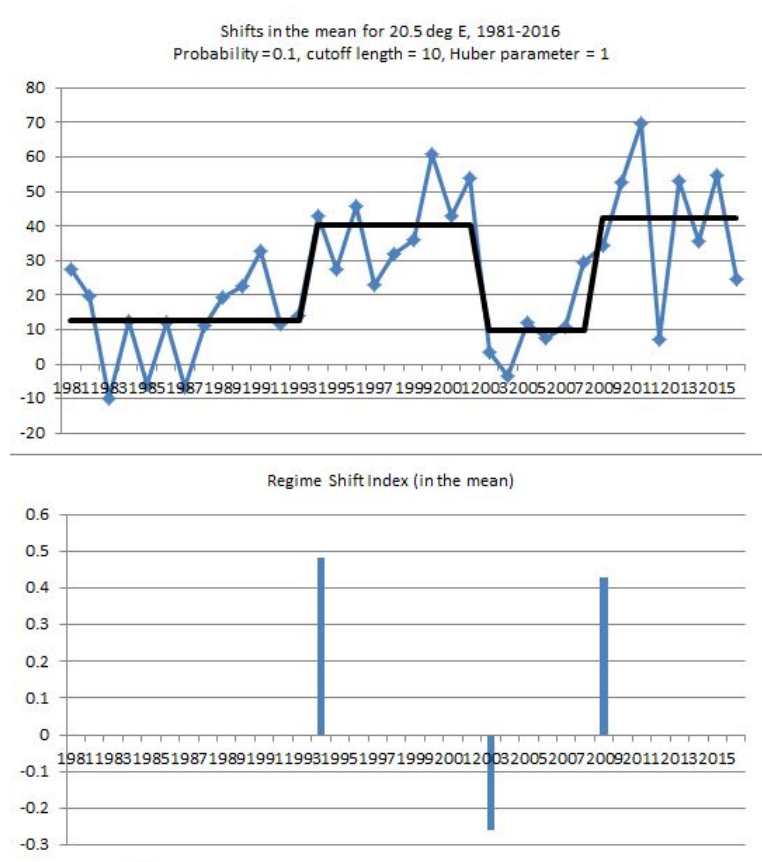


Figure 3 (Laura Blamey pers comm): The updated application of the STARS method to the time series of upwelling for Cape Agulhas, showing “switch points” of 1994, 2003 and 2009.

The concern with this movement hypothesis that arose during OMP-14 development was the frequency with which future switches from increasing to decreasing proportions moving would occur, and the lack of further switches in the update does not help solve this concern. In addition, following the 2009 “switch”, movement is now more precisely estimated and does not indicate a pattern of generally increasing or generally decreasing proportions moving (see Figure 1). The authors thus recommend this is given a **low priority**.

MoveD1: The proportion of 1 year olds which move in year y is assumed to be related to the west coast biomass in year $y-1$. This hypothesis is based on the idea that movement is density dependent, with more sardine moving from the west coast in years of high west coast biomass.

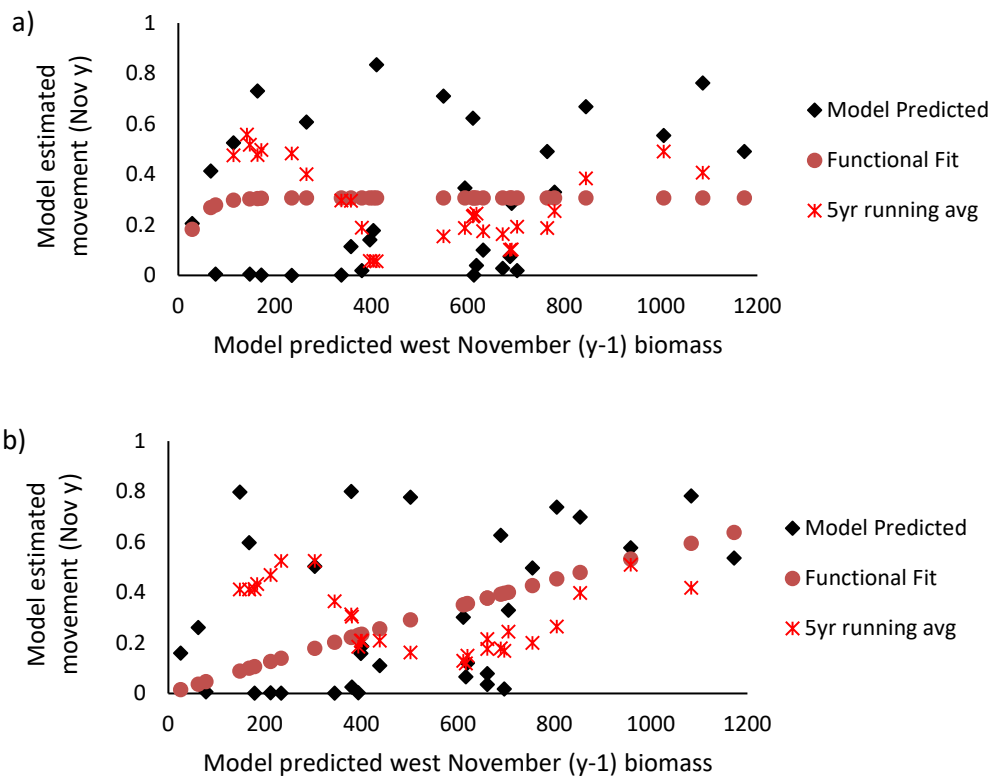


Figure 4: The model estimated movement in November of year y plotted against west coast biomass in November of year $y-1$ for a) the two sub-stock hypothesis with separate stock-recruitment relationships and b) the two sub-stock hypothesis with south coast SSB contributing to west coast recruitment.

A 5-year running average fitted functional form to these data does not show any clear pattern indicating this movement hypothesis should have a **low priority**.

MoveD2: The proportion of 1 year olds which move in year y is assumed to be related to the west coast biomass in year y immediately preceding movement. This hypothesis is also based on a density dependent mechanism, with more sardine moving from the west coast in years of high west coast biomass.

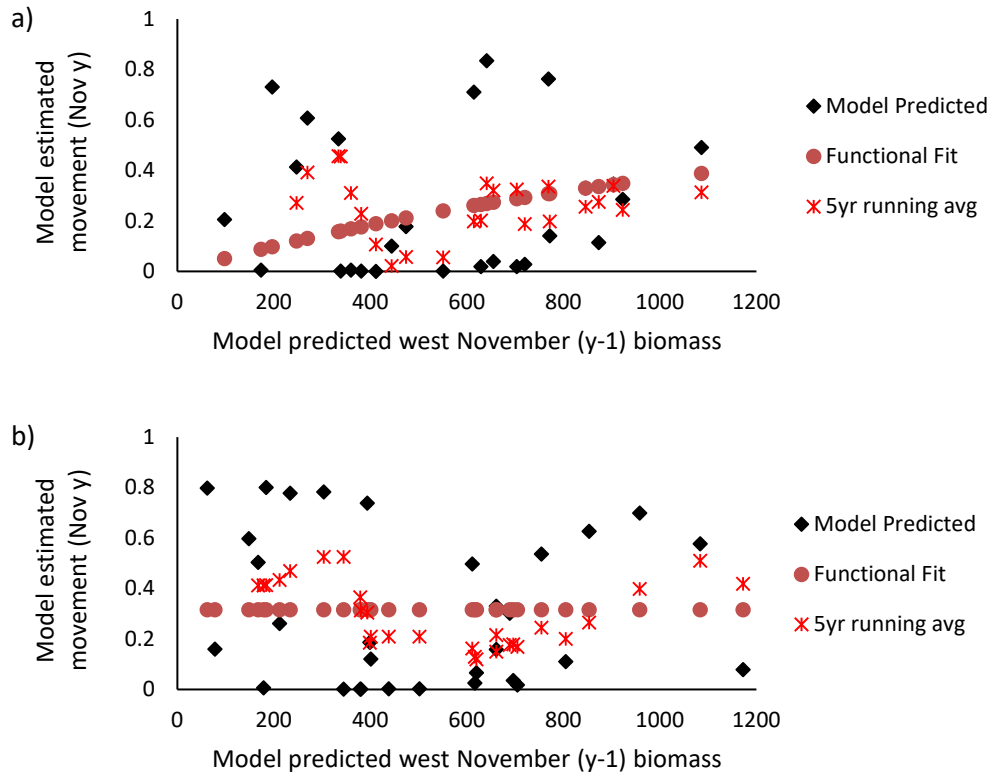


Figure 5: The model estimated movement in November of year y plotted against west coast biomass in November of year y immediately preceding movement for a) the two sub-stock hypothesis with separate stock-recruitment relationships and b) the two sub-stock hypothesis with south coast SSB contributing to west coast recruitment.

A 5-year running average fitted functional form to these data does not show any clear pattern indicating this movement hypothesis, while preferred over MoveD1, should have a **low priority**.

MoveB: The proportion of 1 year olds which move in November year y is assumed to be related to the ratio of south:west biomass in November year $y-1$. This hypothesis suggests that the proportion moving drops from a maximum as the south coast biomass relative to that of the west decreases below a threshold of about 1.7. This could be indicative of entrainment, in which a higher relative south coast biomass the previous year (which could be considered a surrogate to the 2+ biomass in the current year) could better facilitate the movement of more recruits in the current year. Another possibility is that a higher ratio of south to west coast November biomass may be a proxy to indicate improved environmental suitability for both juvenile and adult sardine east rather than west of Cape Agulhas.

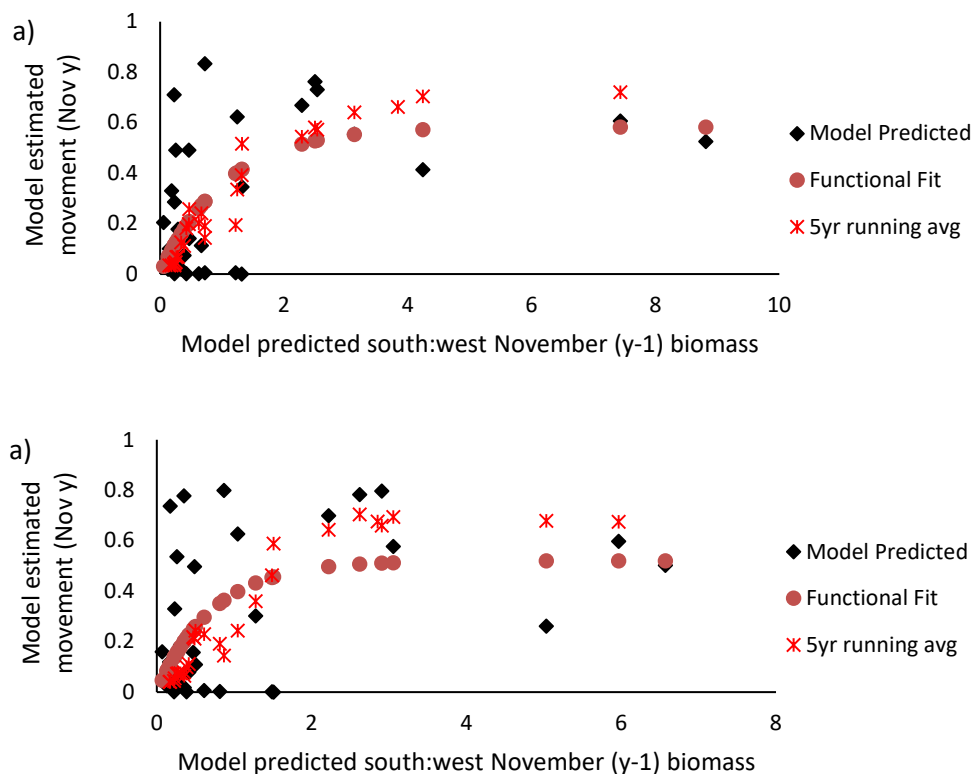


Figure 6: The model estimated movement in November of year y plotted against ratio of south:west coast biomass in November of year $y-1$ for a) the two sub-stock hypothesis with separate stock-recruitment relationships and b) the sub-stock hypothesis with south coast SSB contributing to west coast recruitment.

A 5-year running average and functional form fitted to the results at the joint posterior mode indicate this hypothesis should receive **high priority**.

Move N: The proportion of 1 year olds which move in November of year y is assumed to be related to the contribution to West Coast recruitment from South Coast spawning in year $y-1$, i.e., recruits from eggs spawned on the South Coast move back to the South Coast at the end of the year (natal homing). The contribution from South Coast spawning is based on annual (biomass-weighted) estimates of egg movement from the hydrodynamic model (Coetzee 2016), as used in de Moor (2016).



Figure 7: The model estimated movement in November of year y plotted against the proportion of south coast spawner biomass estimated to contribute to west coast recruitment in November of year $y-1$ for a) the two sub-stock hypothesis with separate stock-recruitment relationships and b) the two sub-stock hypothesis with south coast SSB contributing to west coast recruitment.

A 5-year running average fitted functional form to these data does not show any clear pattern indicating this MoveN movement hypothesis should have a **low priority**.

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