Autocorrelated sardine movement

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The sardine two-mixing stock hypothesis requires a model to inform on the future annual proportion of "west" stock recruits that move to the "south" stock. Previous projections have assumed three different models (de Moor and Butterworth 2013a):

NoMove - no future movement

MoveB - future movement is based on a relationship with the ratio of "south" to "west" stock 1+ biomass

MoveE - future movement "switches" between increasing or decreasing towards an equilibrium proportion, based on whether a favourable or unfavourable environment exists on the south coast.

NoMove was included purely as an extreme scenario, while it was recently agreed that *MoveB* would be removed from further simulations (Anon, 2013, SPSWG, 2014). A further model has been proposed, and is detailed in the Appendix:

MoveAutoC - future autocorrelated movement

Figure 1 shows the future simulated annual proportions of "west" stock recruits moving to the "south" stock. The proportions moving for *NoMove*, *MoveE* and *MoveAutoC* are all independent of the simulated biomass and are thus the same for both catch and no catch scenarios. One may *a priori* expect the median proportion moving to decrease slower than that plotted in Figure 1 under *MoveAutoC*. However, the rapid movement of the median towards around 0.5 is due to the low autocorrelation in logit space (Figure 2) – logit transformation of the proportion moving is necessary to maintain the 0 – 1 range.

Figures 3 and 4 show the future simulated 1+ biomass trajectories for *NoMove*, *MoveE* and *MoveAutoC*.

References

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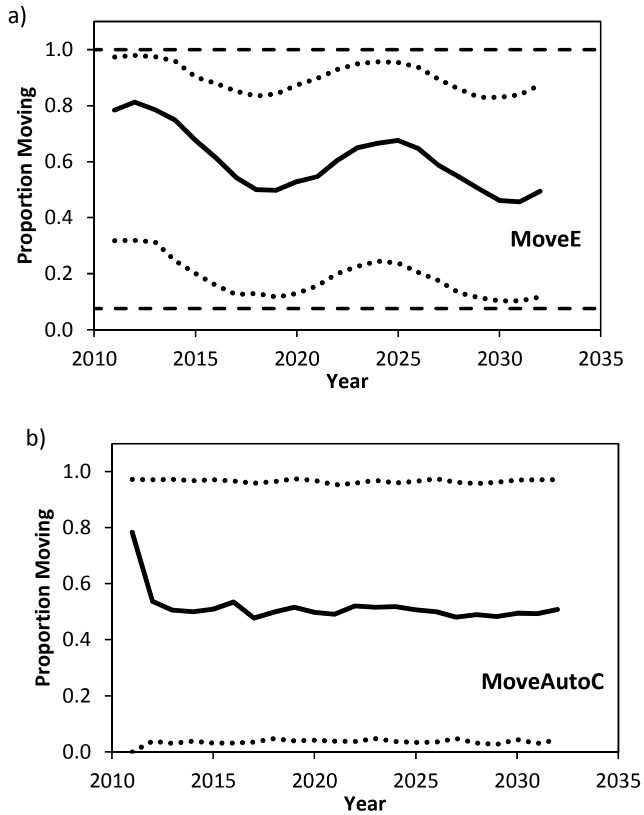

Figure 1. The median and 90% probability interval of future projected proportions of “west” stock recruits moving to the “south” stock, assuming different movement relationships: a) *MoveE* and b) *MoveAutoC*.

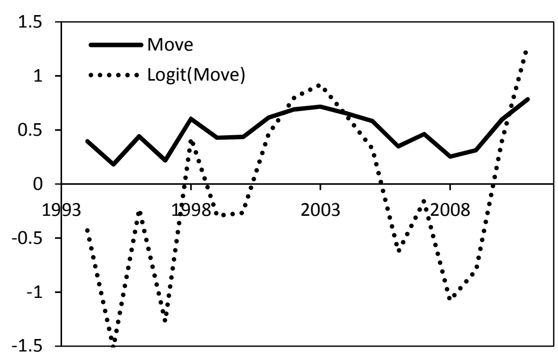

Figure 2. The median estimated annual proportions of “west” stock recruits that move to the “south” stock and the logit transformation of these proportions.

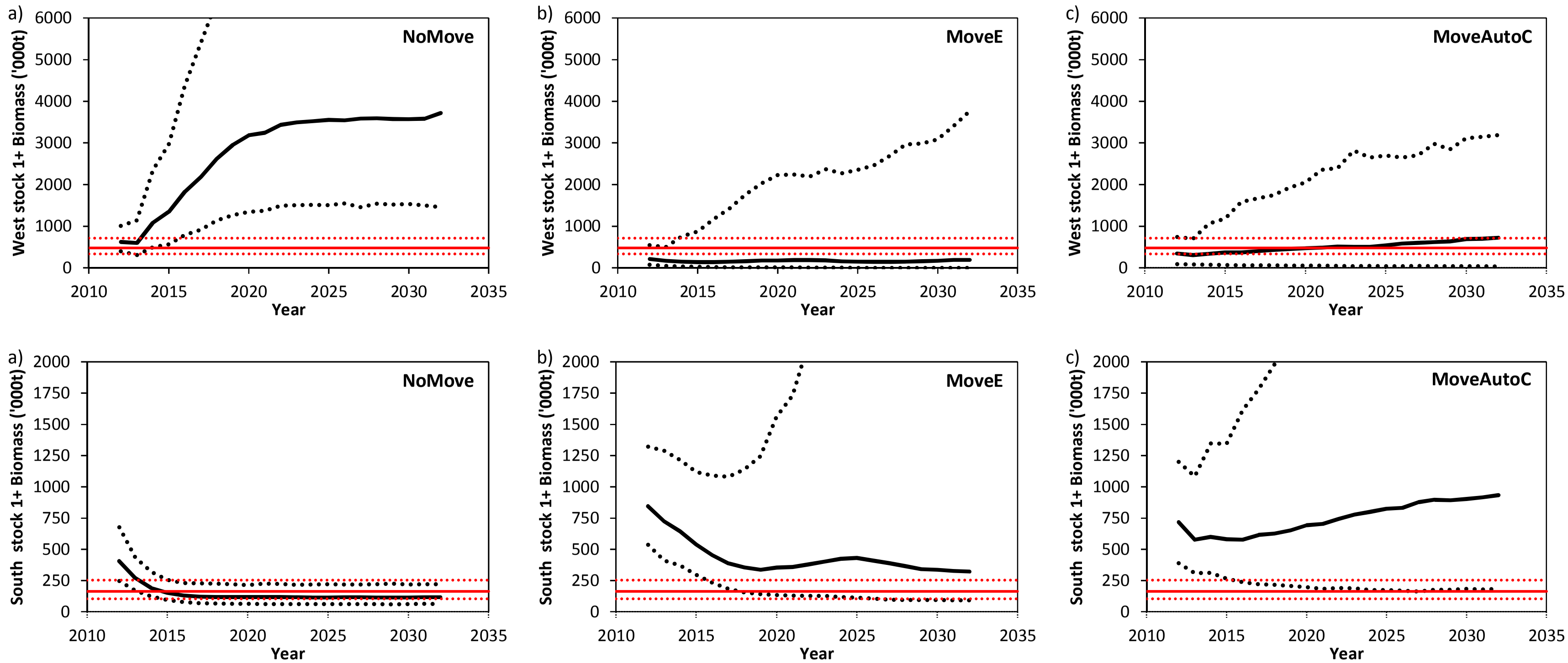

Figure 3. The median and 90% probability interval of future projected sardine 1+ biomass for the “west” stock (upper row) and “south” stock (lower row) under a no catch scenario and different movement relationships: a) *NoMove*, b) *MoveE* and c) *MoveAutoC*.

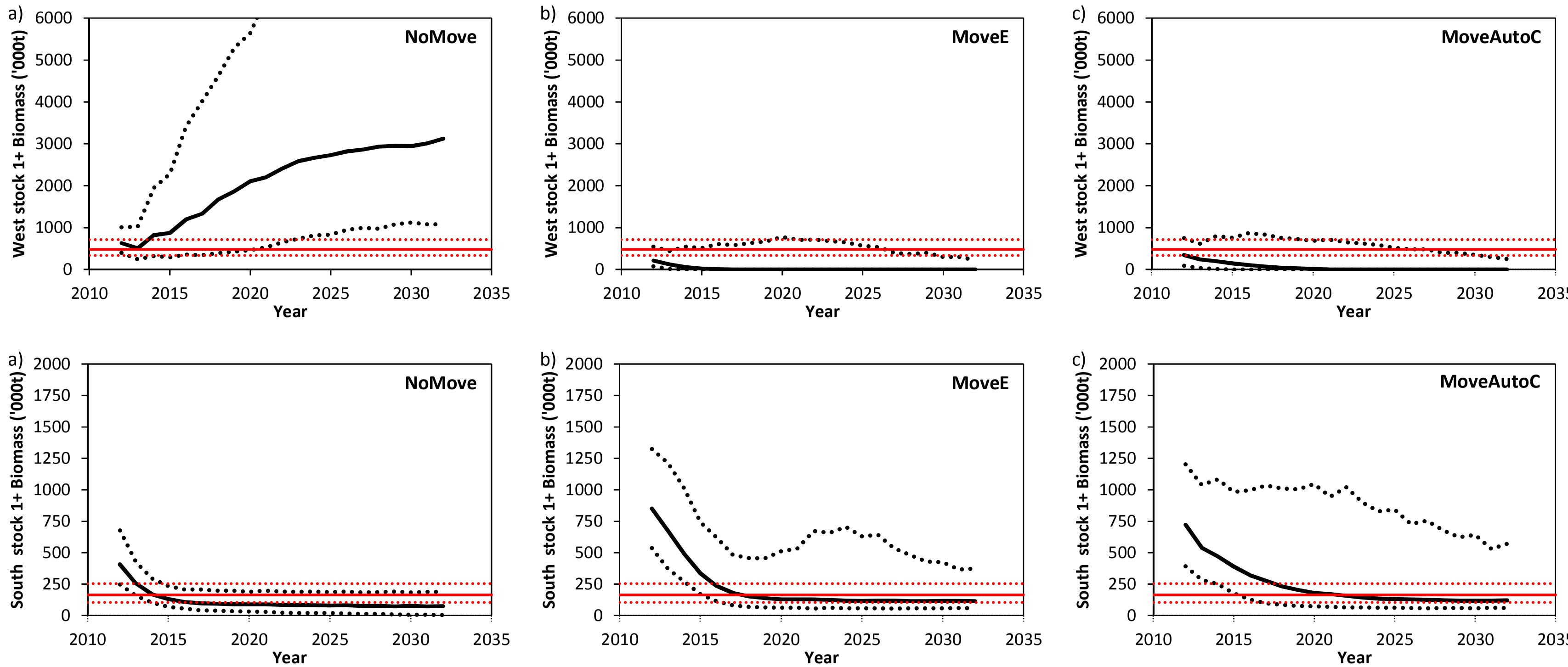

Figure 4. The median and 90% probability interval of future projected sardine 1+ biomass for the "west" stock (upper row) and "south" stock (lower row) under Interim OMP-13v2 (de Moor and Butterworth 2013b) and different movement relationships: a) *NoMove*, b) *MoveE* and c) *MoveAutoC*.

Appendix : Autocorrelated movement

In order to maintain $0 \le move_y \le 1$, the autocorrelated movement is calculated in logit-space. Thus setting

$$move_y^* = \ln\left(\frac{move_y}{1 - move_y}\right), \text{ for } 1994 \le y \le 2011$$

$$\rho_{move} = \frac{\sum_{y=1994}^{2010} move_y^* move_{y+1}^*}{\sum_{y=1994}^{2010} \left(move_y^*\right)^2}$$

$$\sigma_{move}^2 = \frac{\sum_{y=1994}^{2010} \left(move_{y+1}^* - \rho_{move} move_y^*\right)^2}{2010 - 1994 + 1}$$

Future proportions moving are thus calculated as follows:

$$move_y = \frac{\exp\left(move_y^*\right)}{1 + \exp\left(move_y^*\right)}, \text{ where}$$

$$move_y^* = \rho_{move} \times move_{y-1}^* + \sqrt{1 - \rho_{move}^2}\,\varepsilon_y, \text{ with } \varepsilon_y \sim N\left(0, \sigma_{move}^2\right)$$