Some initial results using the revised two mixing-stock hypothesis for South African sardine

C.L. de Moor* and D.S. Butterworth

Correspondence email: *carryn.demoor@uct.ac.za*

Introduction

The operating model of the South African sardine resource is being updated from the last assessment (de Moor and Butterworth 2015a) to take account of data collected between 2012 and 2014. New data on the differences in infection of sardine on the west and south coasts by a digenean 'tetracotyle-type' metacercarian endoparasite are to be included in the model with the aim of obtaining improved estimates of sardine movement in the two stock hypothesis. In addition, refinements to the previous two mixing stock hypothesis are being considered.

This document presents some initial results from the revised two mixing stock hypothesis.

Available Data

de Moor et al. (2015) detail all the data used in this assessment. Key changes from the data used by de Moor and Butterworth (2012), and how they are utilised in the model, include the following.

i) The incorporation of three more year's survey data from November 2012 to 2014.

ii) The incorporation of parasite prevalence-by-length from samples from November surveys from 2010 to 2014.

Population Dynamics Model

The operating model used for the South African sardine resource is detailed in de Moor and Butterworth (2015b).

Key changes in the population dynamics model from de Moor and Butterworth (2015a) include the following.

i) The assumption is made that the November survey estimate of biomass is an estimate of total (0+) biomass, i.e. all sardine of lengths ≥2.5cm, rather than only 1+ biomass.

ii) A logistic trawl survey selectivity-at-length is used, to reflect the lower selectivity on smaller sardine in the trawls used to capture survey length-frequency data. Given the survey design, uniform trawl selectivity is assumed for all lengths ≥7cm.

* MARAM (Marine Resource Assessment and Management Group), Department of Mathematics and Applied Mathematics, University of Cape Town, Rondebosch, 7701, South Africa.

iii) Instead of assuming all 2+ sardine are mature, spawner biomass is calculated from 1+ sardine after taking a maturity-at-length relationship into account. This relationship is allowed to vary over time (van der Lingen et al. 2006). Future work may also include differences in maturity by stock.

iv) Weight-at-length, rather than weight-at-age, is now used, being more appropriate for this model formulation.

During initial testing of this model the parasite prevalence data are not yet included in the likelihood, i.e. the model is not yet tuned to these data. However, plots are shown of model predicted prevalence-by-length compared to that sampled from the November surveys to inform on the choice of appropriate model assumptions. Four alternatives models are presented here:

Model a): Only age-1 sardine move and 20% of uninfected west stock sardine are infected with the endoparasite annually.

Model b): Only age-1 sardine move and 40% of uninfected west stock sardine are infected with the endoparasite annually

Model c): Age 1+ sardine move, with the proportion moving being the same for ages 2 to 5+ and a smaller proportion of that estimated for age-1, and 20% of uninfected west stock sardine are infected with the endoparasite annually.

Model d): Age 1+ sardine move, with the proportion moving being the same for ages 2 to 5+ and a smaller proportion of that estimated for age-1, and 40% of uninfected west stock sardine are infected with the endoparasite annually.

Results and Discussion

Initial results and model fits to the November survey biomass data, May survey recruitment data and proportion-at-length data in the commercial catches and November survey are shown in Figures 1 to 8 and 10. It is hoped some of these model fits can be further improved.

Considering the match in the model predicted parasite prevalence-at-length to the observed prevalence-at-length from the November surveys (Figure 9), the following points are worth discussing further within the Small Pelagic Scientific Working Group:

- The assumption of a constant annual infection rate, bearing in mind the limitation of having five years of data only.
- The treatment of the many zero observations. The model predicted prevalence increases monotonically with length and the differences from zero observations may substantially impact the minimisation of the likelihood (estimation of parameters).

References

de Moor CL and Butterworth DS. 2015a. Assessing the South African sardine resource: two stocks rather than one? African Journal of Marine Science 27:41-51.

de Moor CL and Butterworth DS. 2015b. The stock assessment model for South African sardine. MARAM International Fisheries Stock Assessment Workshop Report No MARAM IWS/DEC15/Sardine/P1.

de Moor CL, Coetzee J, Merkle D, van der Westhuizen JJ, can der Lingen C. 2015. A record of the generation of data used in the 2015 sardine and anchovy assessments. Department of Agriculture, Forestry and Fisheries Report No FISHERIES/2015/NOV/SWG-PEL/42. 25pp.

van der Lingen CD, Fréon P, Fairweather TP, van der Westhuizen JJ. 2006. Density-dependent changes in reproductive parameters and condition of southern Benguela sardine *Sardinops sagax*. African Journal of Marine Science 28:625-636.

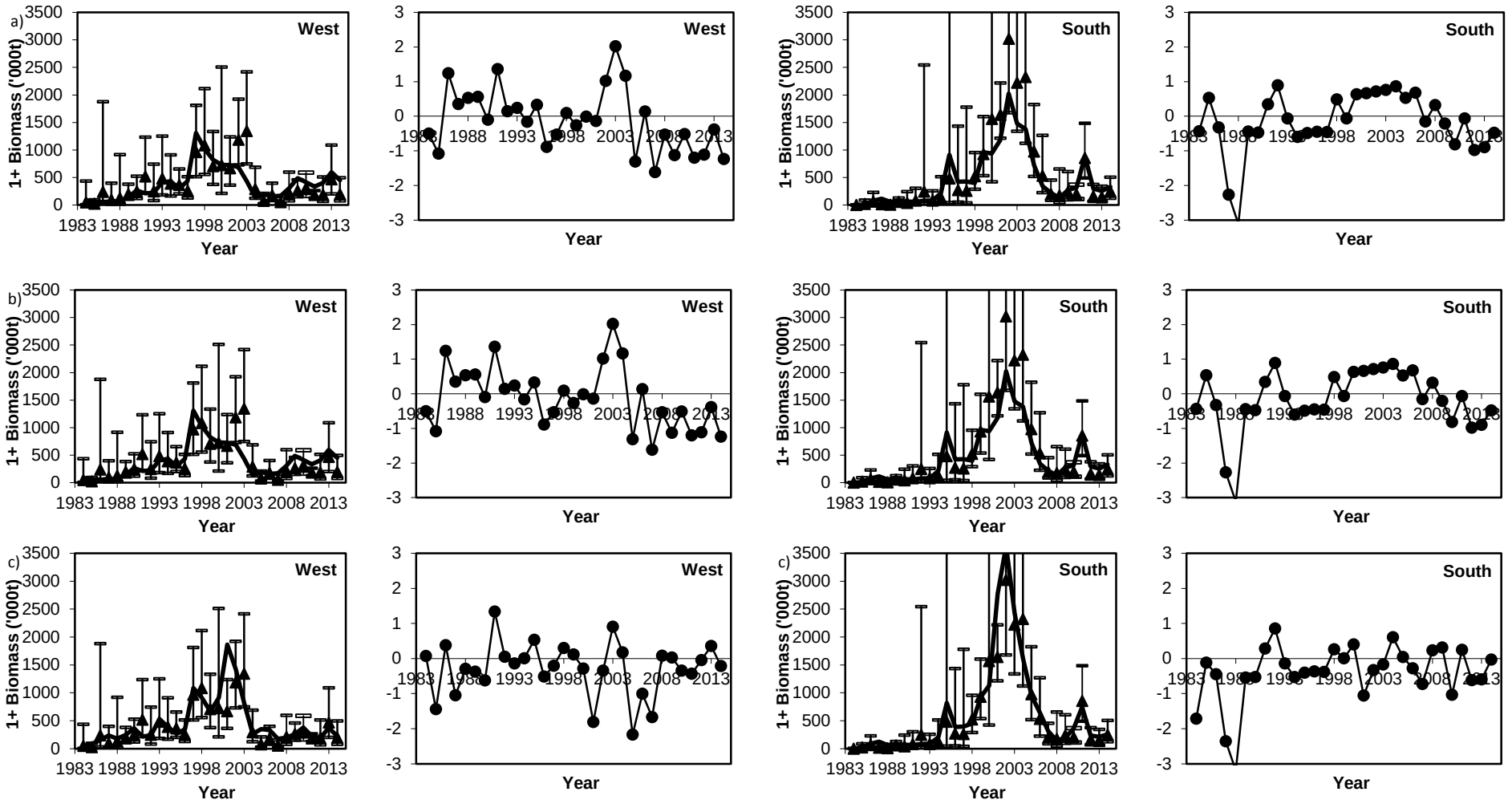


Figure 1. Acoustic survey results and model estimates for November sardine total biomass from 1984 to 2014, for west and south of Cape Agulhas, corresponding to the west and south stocks. The survey indices are shown with 95% confidence intervals reflecting survey inter-transect variance. The standardised residuals are given in the right hand plots. Results are shown assuming models a) – d).

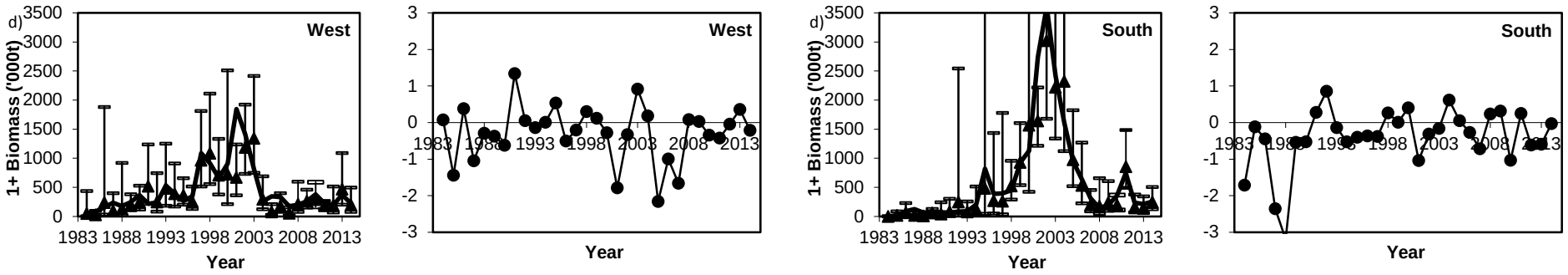


Figure 1 (cont).

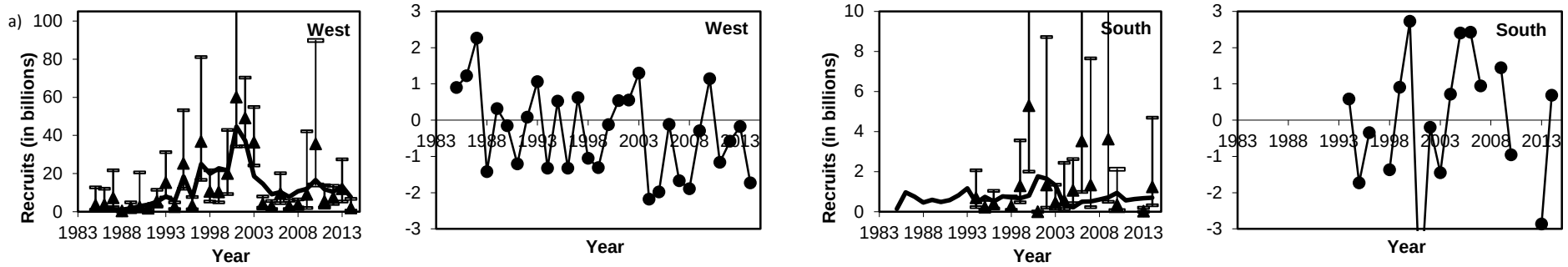
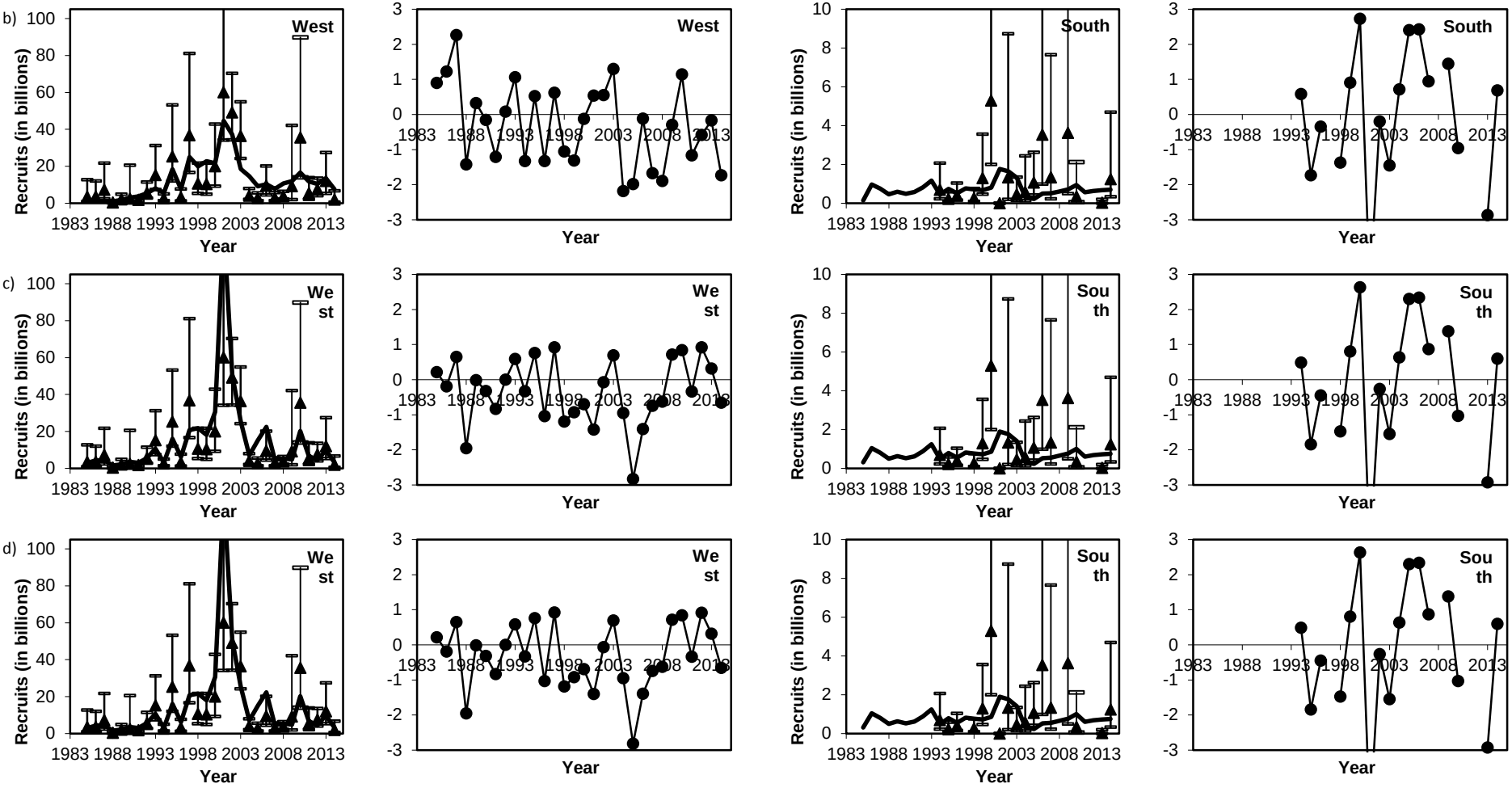


Figure 2. Acoustic survey results and model estimates for sardine recruitment numbers from May 1985 to May 2014, for west and south of Cape Infanta, corresponding to the west and south stocks. The survey indices are shown with 95% confidence intervals reflecting survey inter-transect and additional variance. The horizontal bars on these vertical lines reflect the 95% confidence intervals from the survey inter-transect variance only. The standardised residuals are given in the right hand plots. Results are shown assuming models a) – d).



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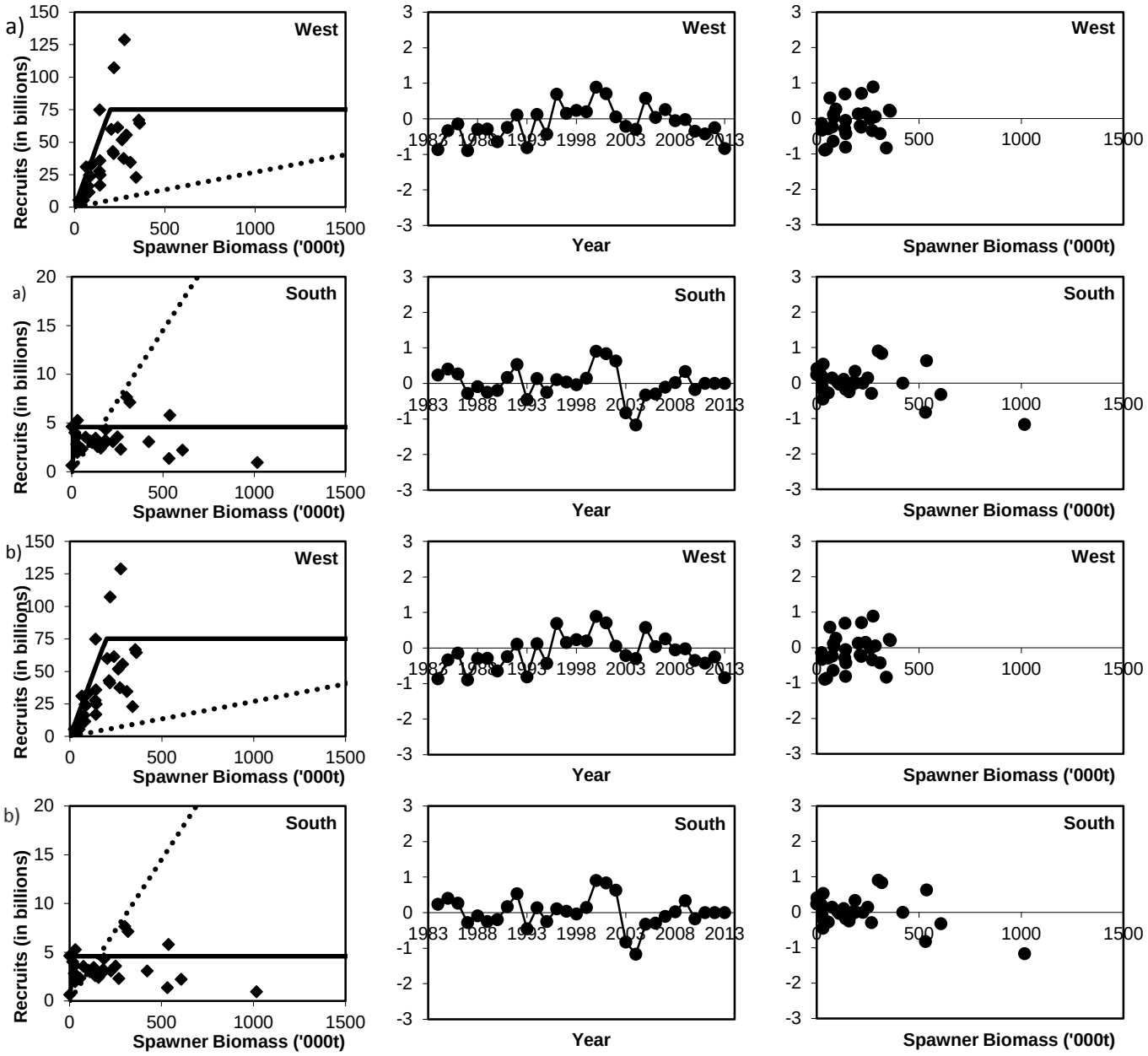
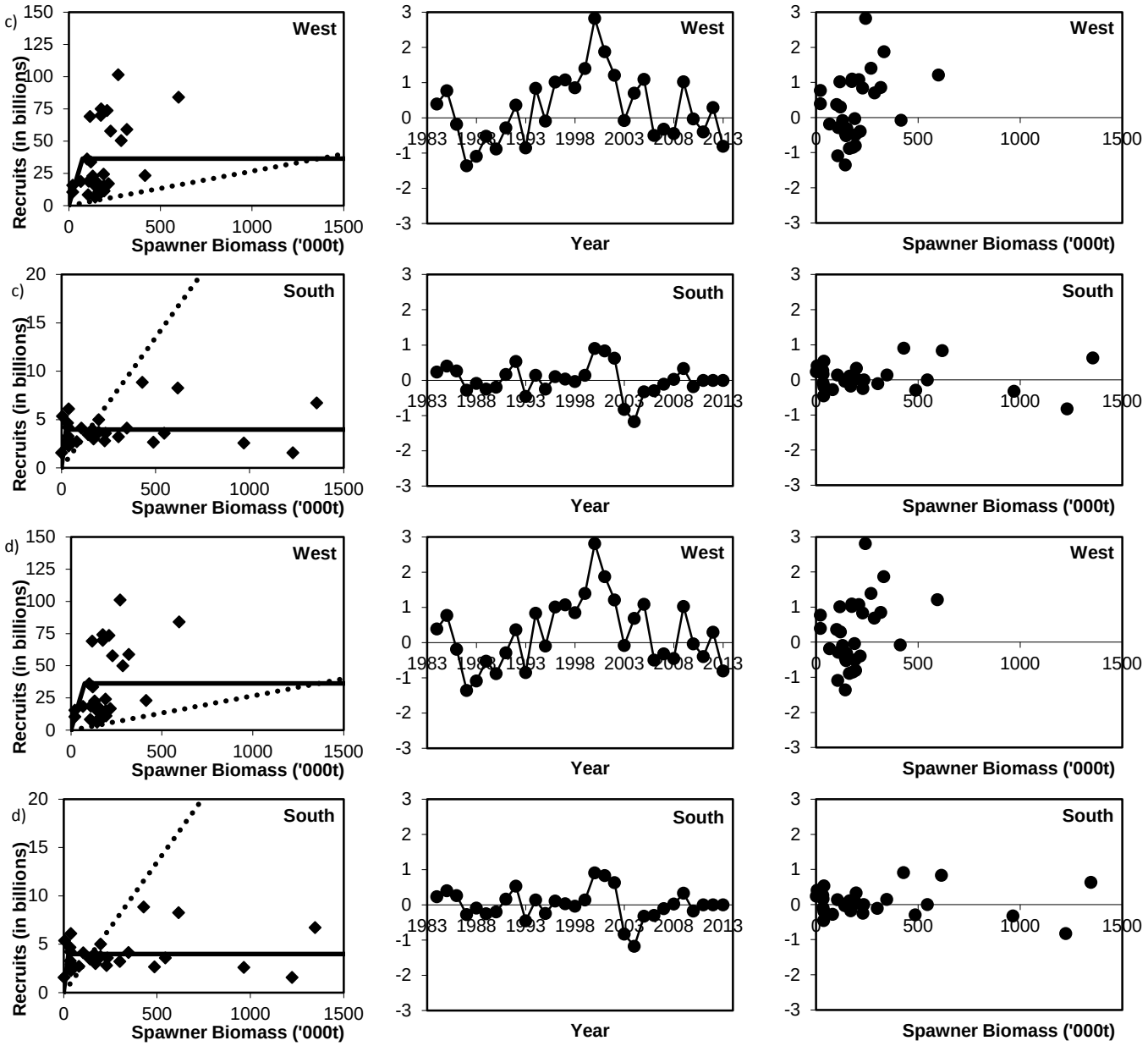


Figure 3. Model predicted sardine recruitment (in November) plotted against spawner biomass from November 1984 to November 2013 for the west and south stocks, with the Hockey Stick stock recruitment relationship. The dotted line indicates the replacement line. The standardised residuals from the fit are given in the right hand plots, against year and against spawner biomass. Results are shown assuming models a) – d).



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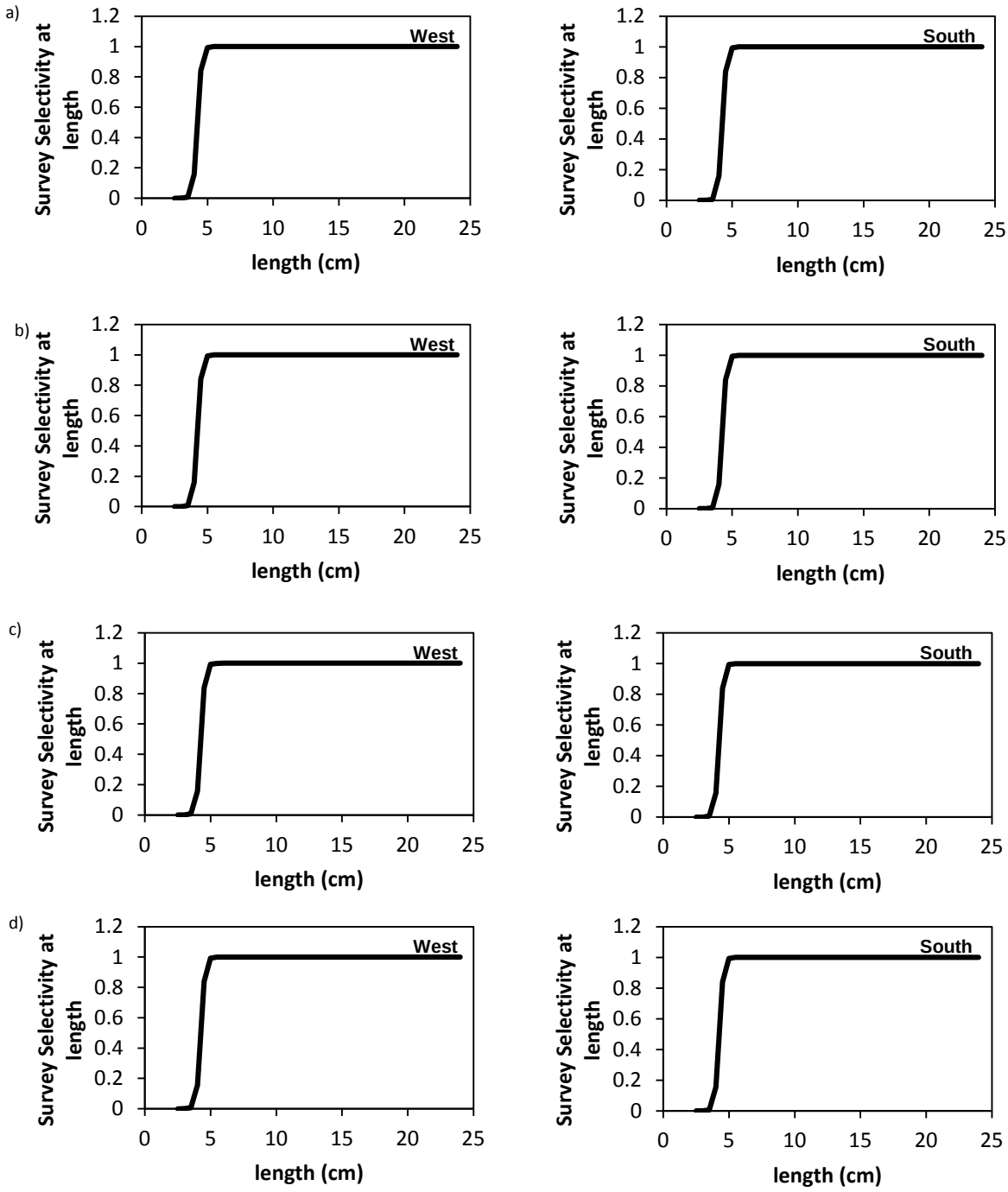


Figure 4. Model estimated trawl survey selectivity at length for west and south of Cape Agulhas, corresponding to the west and south stocks. Results are shown for models a) to d).

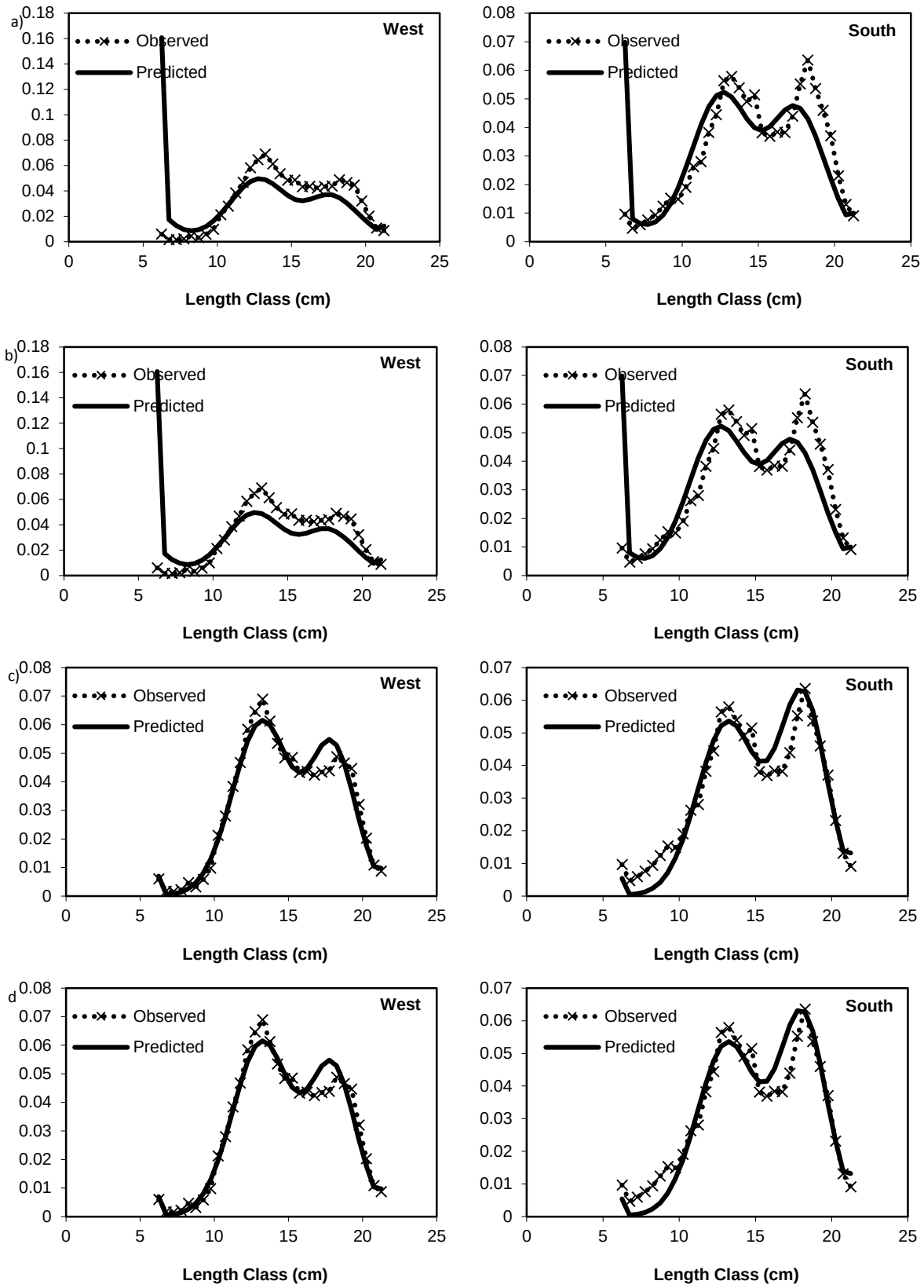


Figure 5. Average (over all years) model predicted and observed proportions-at-length in the November survey trawls for west and south of Cape Agulhas, corresponding to the west and south stocks. Results are shown for models a) to d).

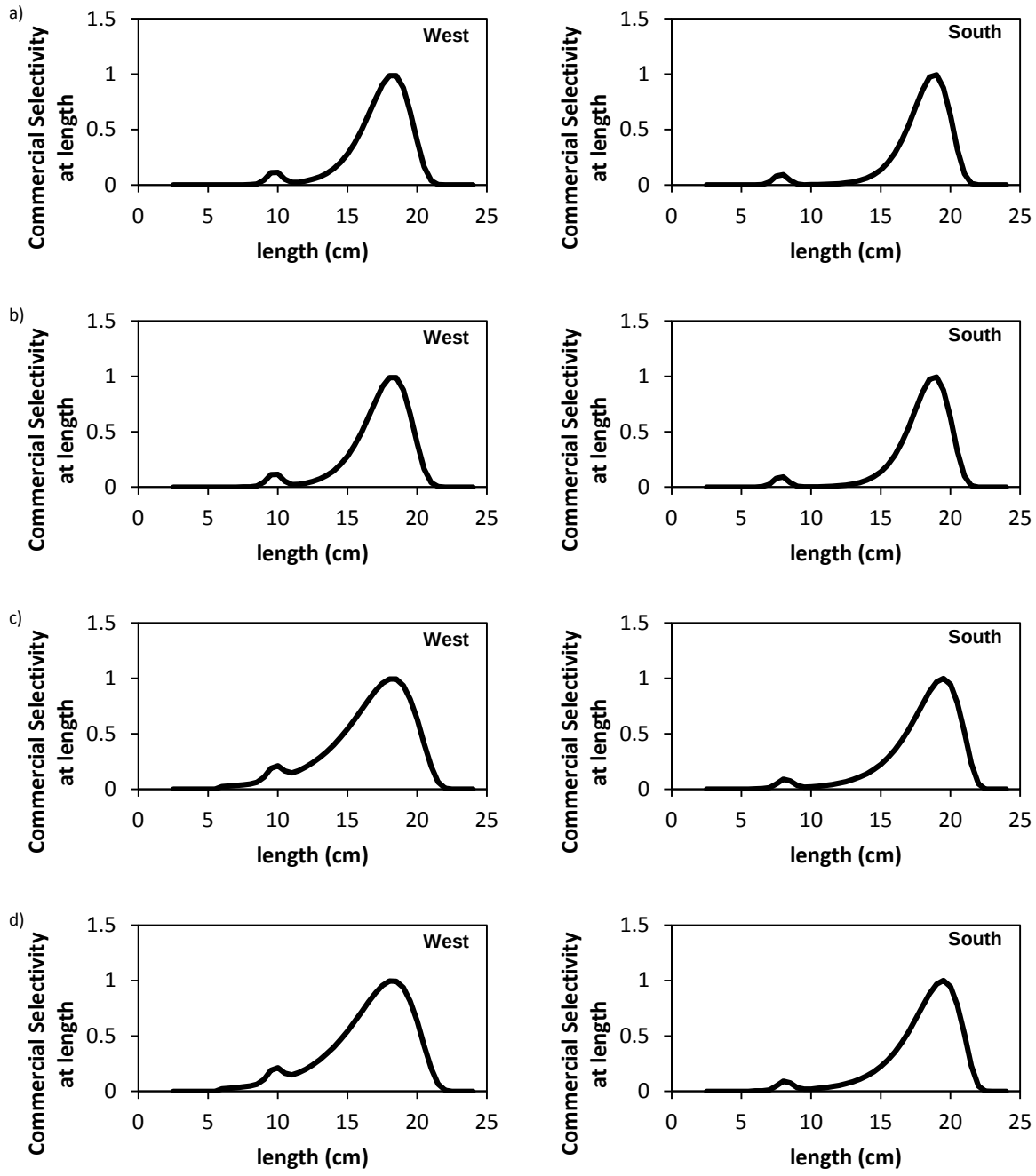


Figure 7. Model estimated quarterly commercial survey selectivity at length for the west and south stocks. Results are shown for models a) to d).

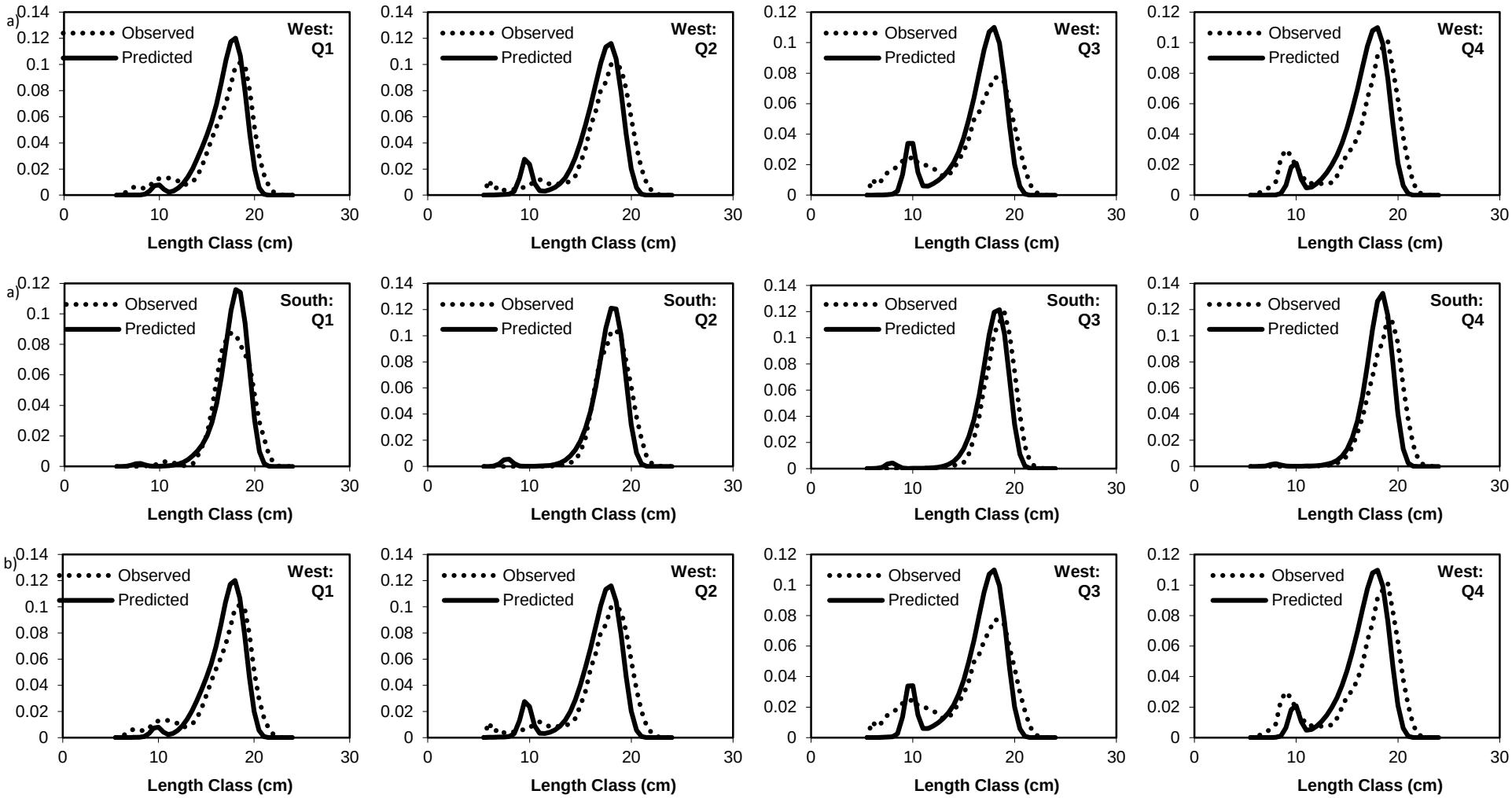
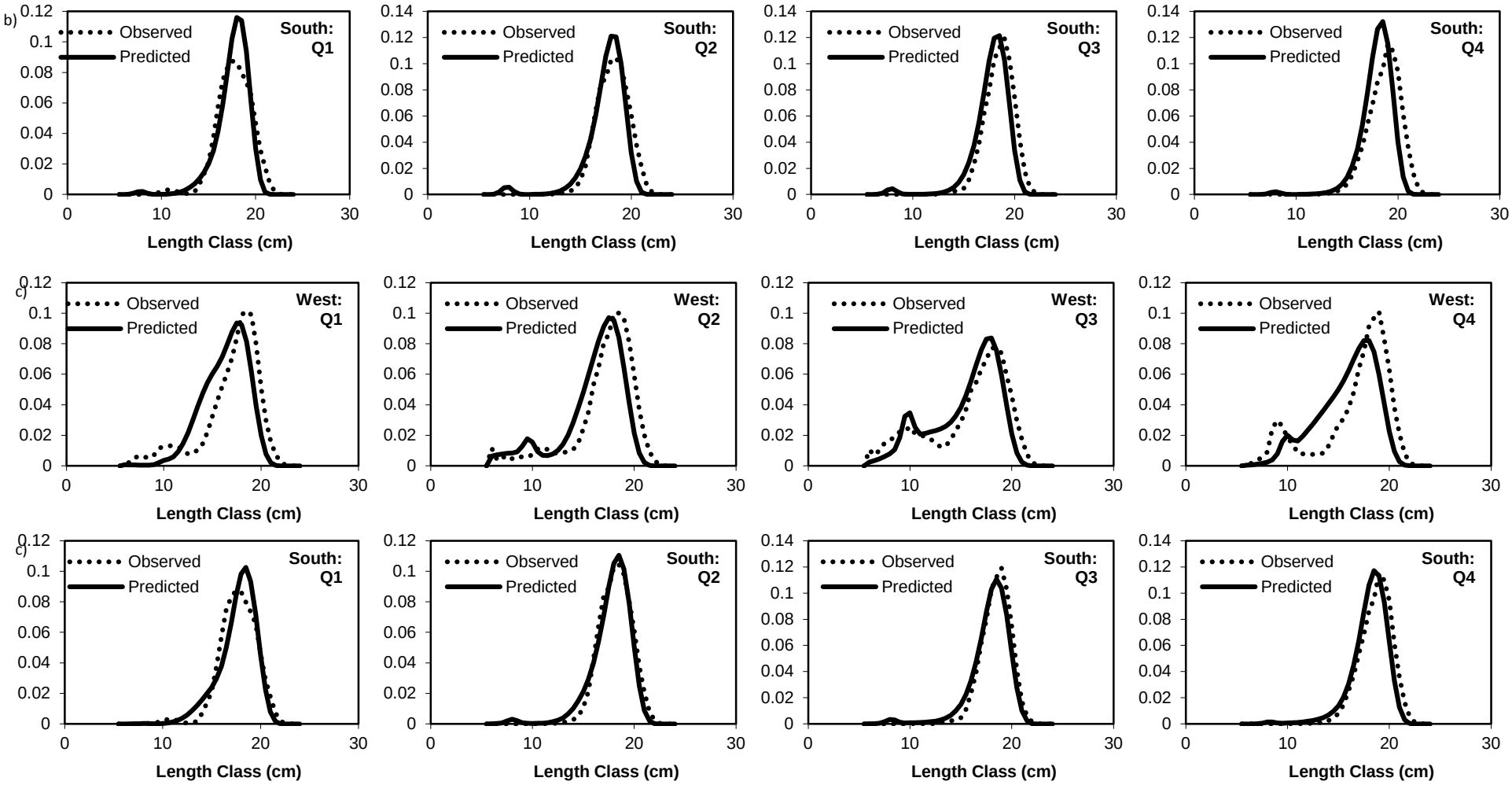


Figure 8. Average (over all years) model predicted and observed proportions-at-length in the quarterly commercial catch for the west and south stocks. Results are shown for models a) to d).



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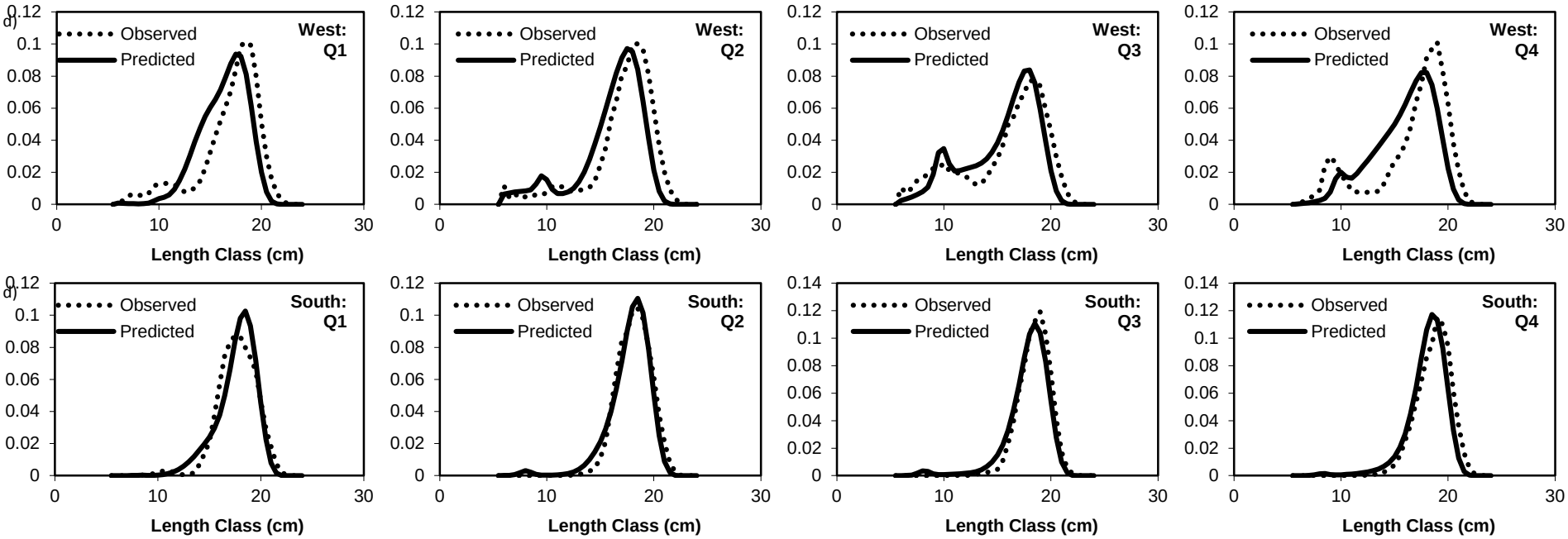

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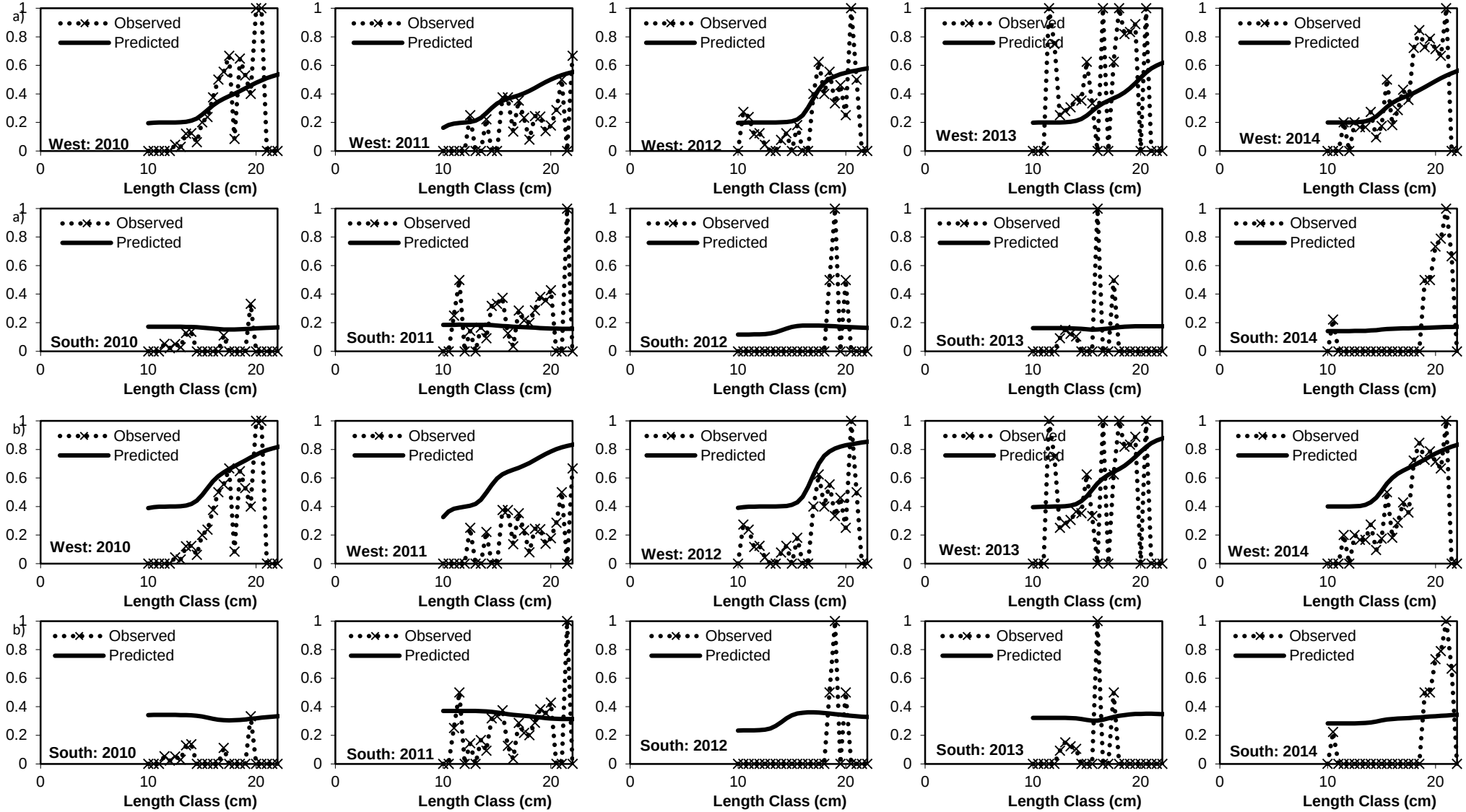
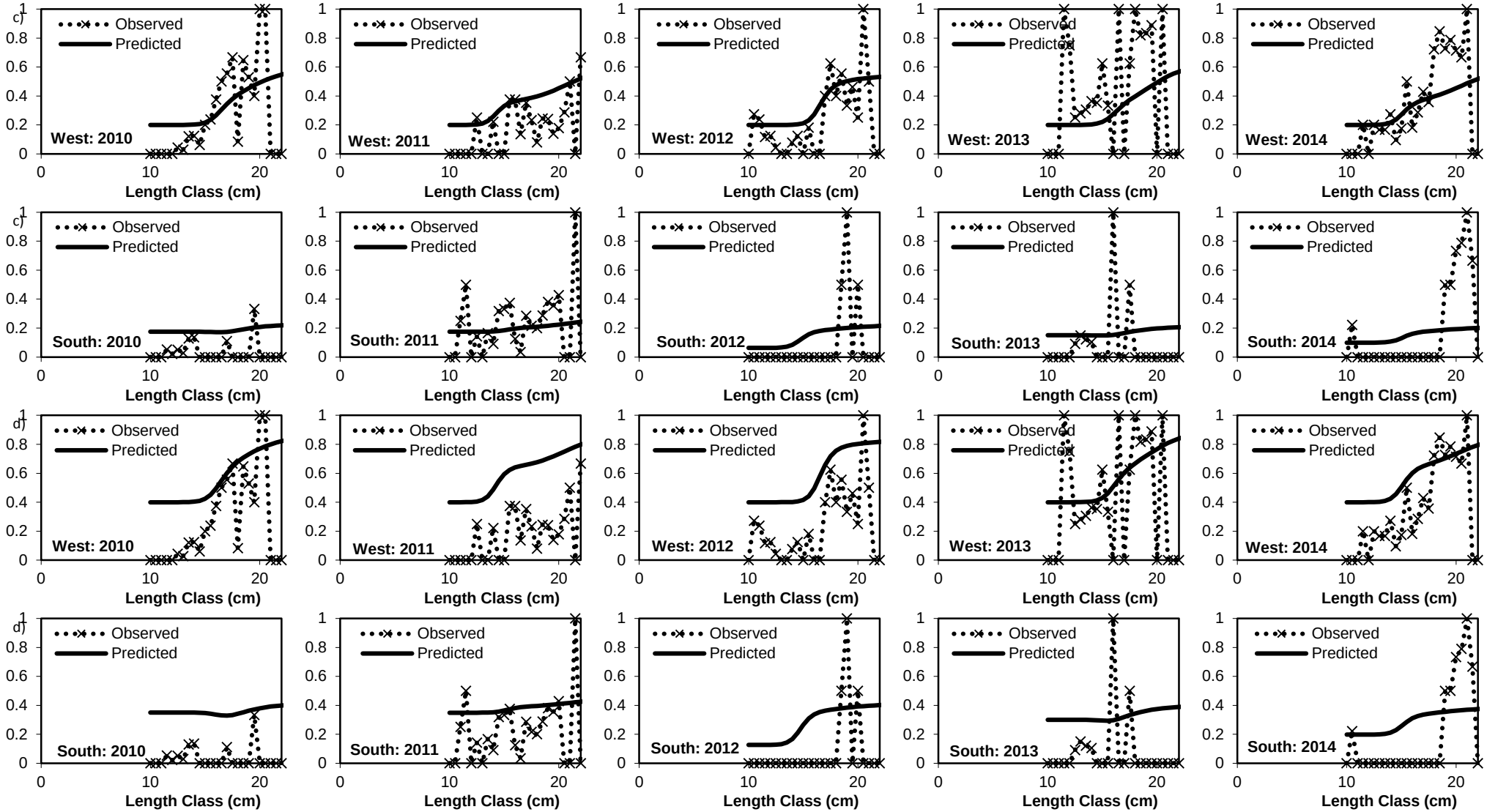


Figure 9. Model predicted and observed parasite prevalence-at-length in the November surveys for the west and south stocks. Results are shown for models a) to d). Note these data are not currently fit within the model.



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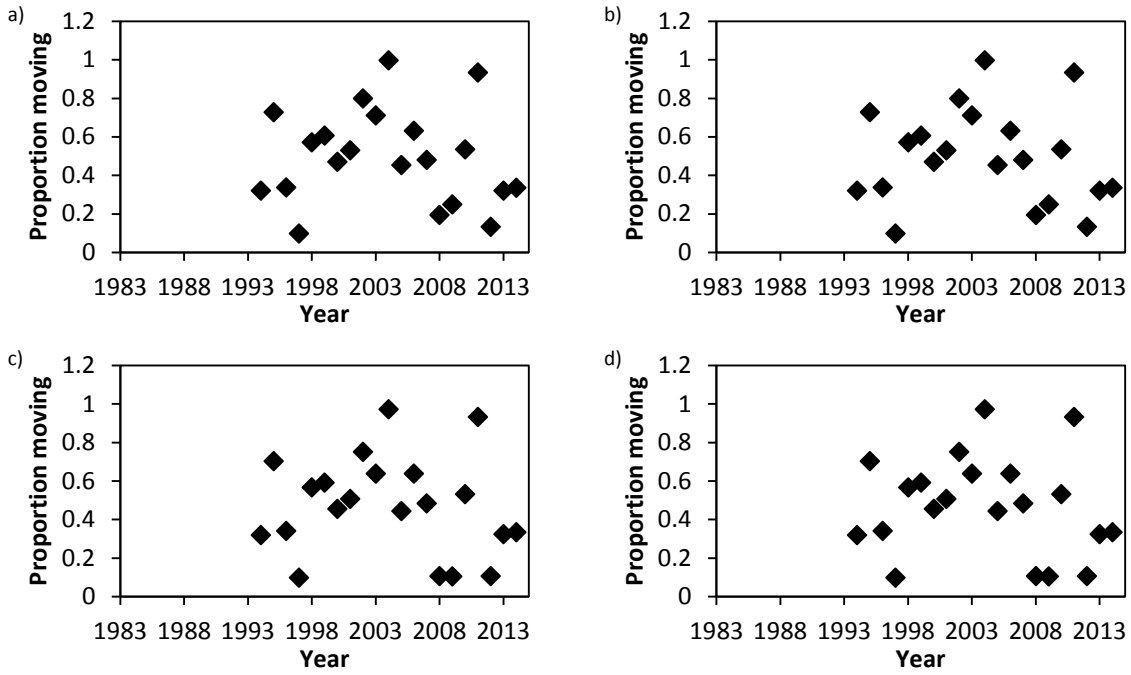

Figure 10. Model estimated proportion of age-1 sardine moving from the west to south stock annually. Results are shown for models a) and b), which assume no movement of age 2+ sardine, and for models c) and d) which assume the proportion of age 2+ sardine moving from the west to the south stock annually is X% of the proportion of 1 year olds.