Preliminary 2013 South Coast rock lobster assessment updates.

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Following recommendations made during the NOV 2012 International Workshop held at UCT (see Appendix for Workshop Panel recommendations for South Coast rock lobster taken from MARAM IWS/NOV12/REP/1) the following apply to the PRELIMINARY SCRL assessment base case (BC) model presented here.

BC model:

1) Model splits fishing areas into A1E, A1W and A2+3.
2) CAL data and CPUE data received equal weighting in –lnL.
3) Estimate all five growth parameters within the fitting procedure using the method described in MARAM IWS/NOV12/SCRL/P2 section 2.7. Time varying selectivity (TVS) for all three sub-areas for 1995-2010 period.
4) Fits only to CAL data that either have a total annual sample size of >200, and two of the four quarters have been sampled. If either of these two constraints are not achieved, then the CAL data for that sub-area is NOT included in the likelihood. The NEW CAL data are discussed and listed in Glazer and Butterworth (2013).
5) Fits TVS for A2+3 only – only for the years for which CAL data are included in the –lnL. The δ values for other years (years for which CAL data are not available/utilised) are set equal to zero.
6) Re-parameterise the way in which the average recruitment proportions to areas and the year-specific recruitment proportions to areas are modelled (see equation A.29 in MAMARM IWS/NOV12/SCRL/P2) as suggested in A.7 and A.8 (see Appendix).
7) Specify the proportion mature in terms of length, and compute maturity-at-age taking the distribution of length-at-age into account (A.10).
8) Similarly, formulate quantities which depend on weight in terms of weight-at-length and account for the probability distribution for length-at-age (A.10).
   [A full model description with all formulae and assumptions is in preparation.]

Three variants on the above BC are explored here:

VAR1: No TVS at all (A.3)

VAR2: The TVS for females are modelled as constant proportions of those for males (A.3)

VAr3: Weight assigned to the CAL data is explored – try w_{len}=10 and w_{len}=0.1.

Following recommendation A.3: “The selection of a base-case formulation for time-varying selectivity should be decided considering the ability to fit the data, and the sensitivity of model results to the weight assigned to the size-composition data (w_{len}).”

The SWG will thus need to consider the results presented here and select an appropriate BC (or “reference case”) assessment model, as well as a number of variants to be carried forward into the OMP development stage.

Results

Table 1 reports the estimated model parameters and –*ln*L values for the BC and four variants.

Figure 1a compares the CPUE fits between the BC (TVS for A2+3), VAR1 (no TVS) and VAR2 (TVS A2+3 female = constant proportion of male TVS).

Figure 1b compares the BC (CAL WT=1.0) with VAR3b (CAL WT=0.1).

Figures 2a-f show the BC catch-at-length (CAL) model fits to data for each area and sex.

Figure 3 compares the CAL residuals between the BC and VAR1 (no TVS).

Figure 4 plots the BC A2+3 selectivity “deltas”.

Figure 5 plots the BC stock-recruit residuals.

Figure 6 plots the BC recruitment proportion splits between the three areas.

Figure 7 plots the BC selectivity functions.

Further model development

Following the workshop recommendations (see A.5), it was recommended that the final set of sensitivity tests should include:

1. Model the parameter δ, which determines time-varying-selectivity, as an AR-1 processes in time.
2. Weight the size-frequencies for each year as a function of sample size (perhaps with the weight increasing linearly from 0 at zero sample size to 1 at some intermediate sample size).

3. Examine different assumptions regarding spatial structure (models 2 and 3 of MARAM IWS/NOV12/SCRL/P2).
4. Change the value of the parameter (w_{len}) which weights the length-frequency data.
5. Change the value assumed for natural mortality, M (e.g. to 0.08 and 0.15yr^{-1}).
6. Estimate separate residual variance parameters for the trawl CPUE series for the years before and after 1990 in area 1E (given the apparent reduction in inter-annual variation in CPUE after 1990; Figure 1a of MARAM IWS/NOV12/SCRL/P2).
7. Set steepness to 0.8
8. Consider alternative models for time-varying selectivity (e.g. no time-varying selectivity at all; no time-varying selectivity for areas 1E and 1W; perfect correlation between δ for males and females);
9. Change the values for σ_λ, σ_{sel}, σ_R and ρ
10. Consider alternative scenarios for the historical catches. Show results for cases in which catchability for the commercial fishery is changing over time. These latter sensitivity tests would not be used to select an OMP, but would rather be used to understand the behaviour of the OMP, given a factor which should substantially impact performance.
11. Consider a model in which fishery selectivity is governed by a double logistic (or double-normal) function, and where several of the parameters of this function are time-varying (A.11).

Reference

Glazer and Butterwoth (2013). Investigation of the South Coast Rock Lobster size data for assessment purposes. FISHERIES/2012/FEB/SWG-SCRL/01.

Table 1: Estimated model parameters and –*ln*L values for the BC and four variants.

	BC	VAR1 No TVS	VAR2 Female TVS = constant proportion of male	VAR3a* CAL data WT=10	VAR3b CAL data WT=0.1
	Newbc.tpl	Var1.tpl	Var2.tpl	Var3a.tpl	Var3b.tpl
# parameters	149	117	134	149	149
AIC	-492.6	-415.8	-507.1	-	-
w_{len}	1.0	1.0	1.0	**10**	**0.1**
σ_{sel}	7.5	7.5	7.5	7.5	7.5
σ_R	0.8	0.8	0.8	0.8	0.8
σ_λ	1.0	1.0	1.0	1.0	1.0
-lnL Total	**-395.31**	**-324.91**	**-387.53**	**-3277.62**	**-163.38**
-lnl CPUE	**-116.93**	**-116.71**	**-116.83**	**-82.32**	**-140.35**
-lnl CPUE A1E	-17.26	-17.30	-17.29	0.659	-17.53
-lnl CPUE A1W	-48.45	-48.73	-48.49	-41.73	-58.47
-lnl CPUE A2+3	-51.21	-50.68	-51.04	-42.23	-64.35
-ln SCI CAL	**-295.79**	**-218.45**	**-287.16**	**-327.65**	**-140.56**
-ln SCI CAL A1E	-11.10	-11.63	-11.26	-26.34	28.87
-ln SCI CAL A1W	-96.09	-94.94	-96.20	-101.46	-58.95
-ln SCI CAL A2+3	-188.61	-111.88	-179.70	-199.83	-110.49
CPUE A1E σ	0.365	0.364	0.365	0.618	0.362
CPUE A1W σ	0.146	0.145	0.146	0.178	0.109
CPUE A2+3 σ	0.135	0.137	0.135	0.180	0.091
SCI CAL A1E σ	0.129	0.129	0.138	0.123	0.190
SCI CAL A1W σ	0.091	0.092	0.091	0.089	0.105
SCI CAL A2+3 σ	0.066	0.085	0.068	0.064	0.085
K	2589	2676	2593	2815	3478
λ^{A1E}	0.176	0.181	0.174	0.129	0.635
λ^{A1W}	0.300	0.310	0.295	0.267	0.126
λ^{A2+3}	0.525	0.509	0.531	0.603	0.239
g75	3.401	3.428	3.404	3.335	3.298
kappa	0.111	0.114	0.112	0.102	0.101
Δgm	0.884	0.857	0.880	0.623	0.984
Δg1E	-2.800	-2.792	-2.800	-2.377	-2.844
Δg1W	-0.503	-0.491	-0.491	0.381	-0.711
$B_{sp}(2011)$ ($B_{sp}(2011)/K_{sp}$)	906 (0.35)	985 (0.37)	890 (0.34)	1066 (0.38)	1794 (0.52)
$B_{exp}(2011)$ ($B_{exp}(2011)/K_{exp}$) A1E	55 (0.16)	58 (0.17)	56 (0.16)	26 (0.10)	3630 (0.77)
$B_{exp}(2011)$ ($B_{exp}(2011)/K_{exp}$) A1W	692 (0.42)	704 (0.43)	692 (0.42)	697 (0.45)	403 (0.25)
$B_{exp}(2011)$ ($B_{exp}(2011)/K_{exp}$) A2+3	1806 (0.33)	1859 (0.34)	1666 (0.32)	2138 (0.39)	1371 (0.31)

*model did not converge

Figure 1a: CPUE for each area for the BC (TVS for A2+3), VAR1 (no TVS) and VAR2 (female TVS constant proportion of male).

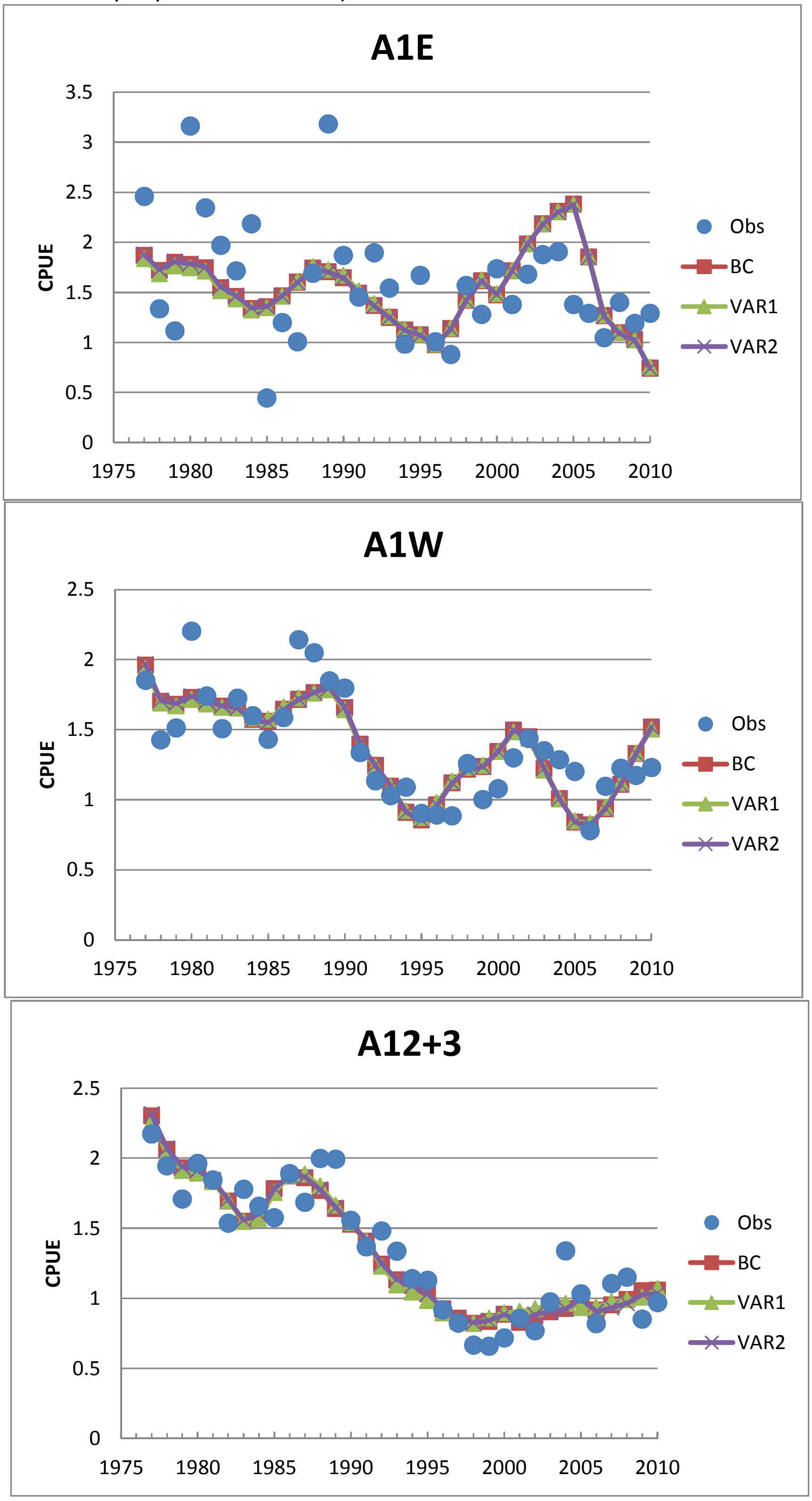
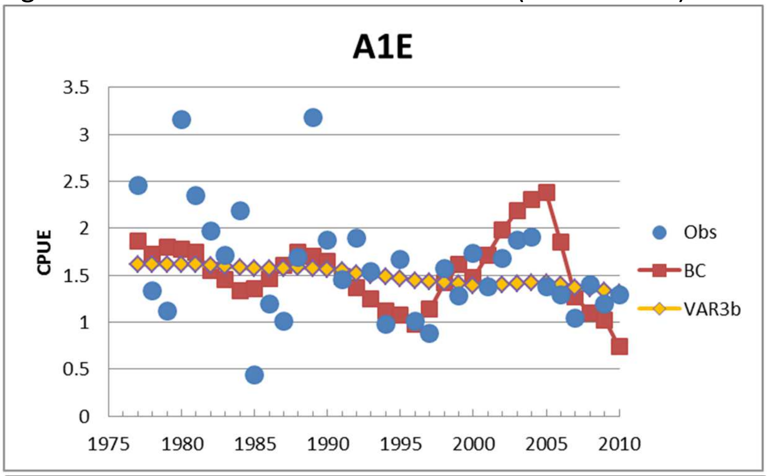
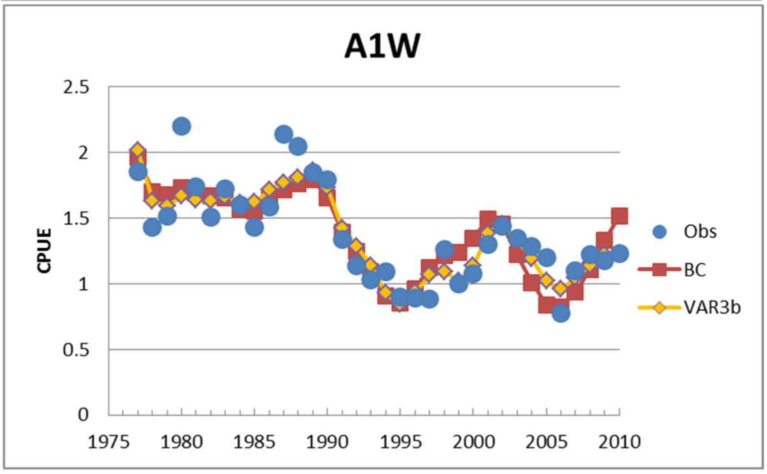


Figure 1b: CPUE for each area for the BC (CAL WT=1.0) and VAR3b (CAL WT=0.1).





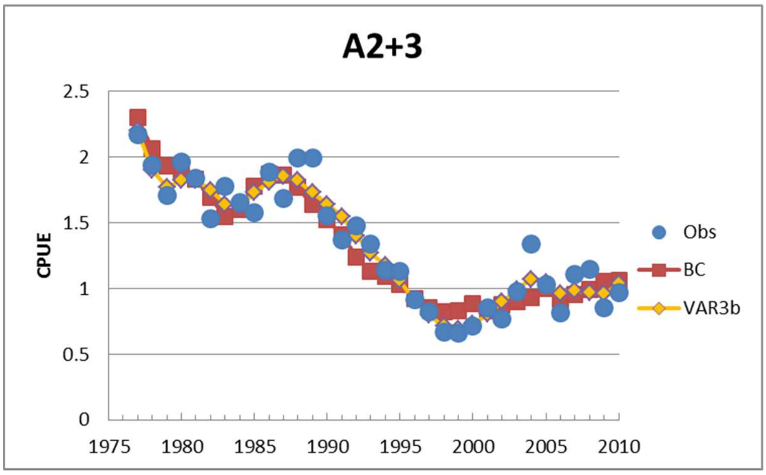


Figure 2a: BC A1E male CAL fits.

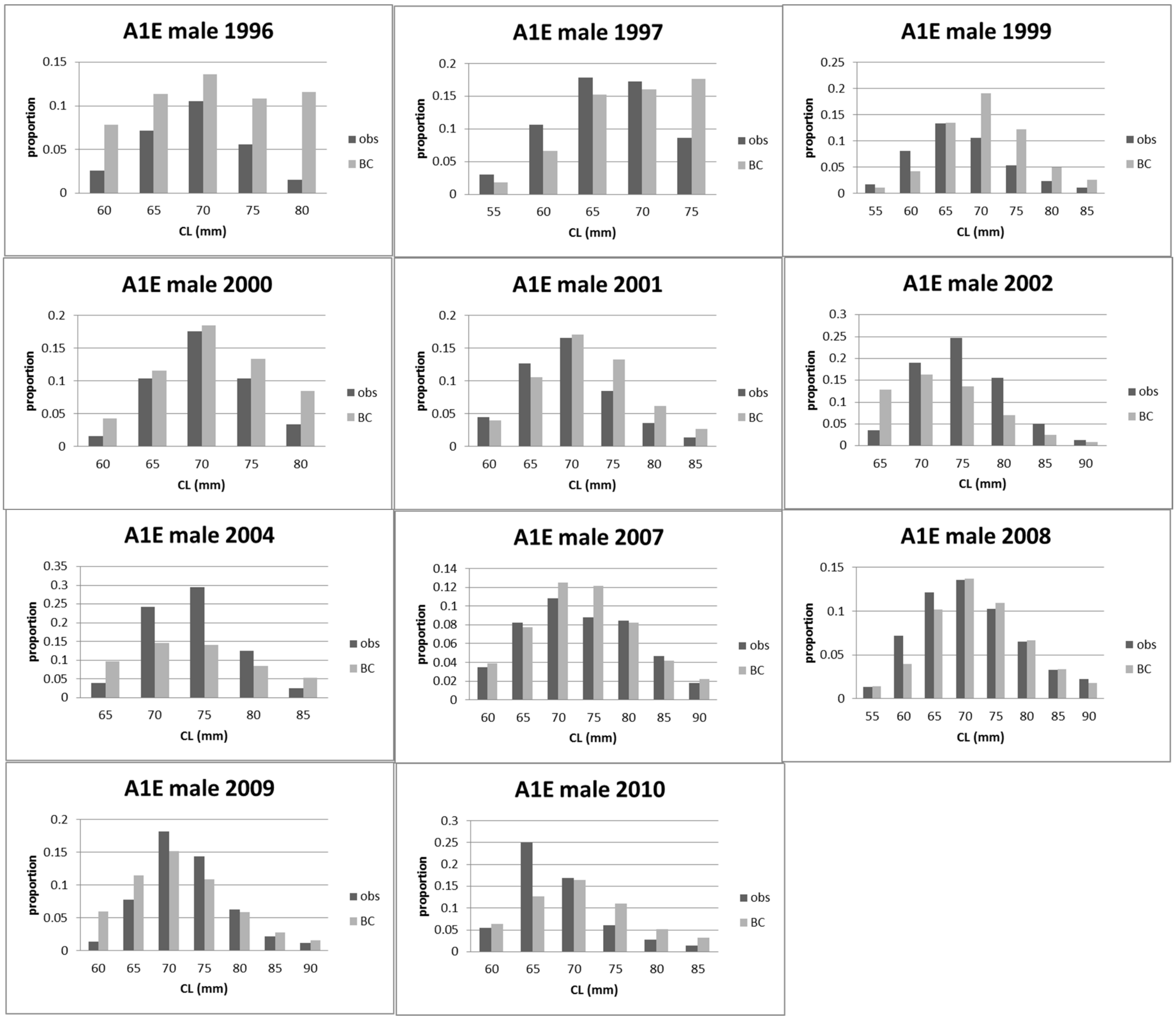


Figure 2b: BC A1E female CAL fits.

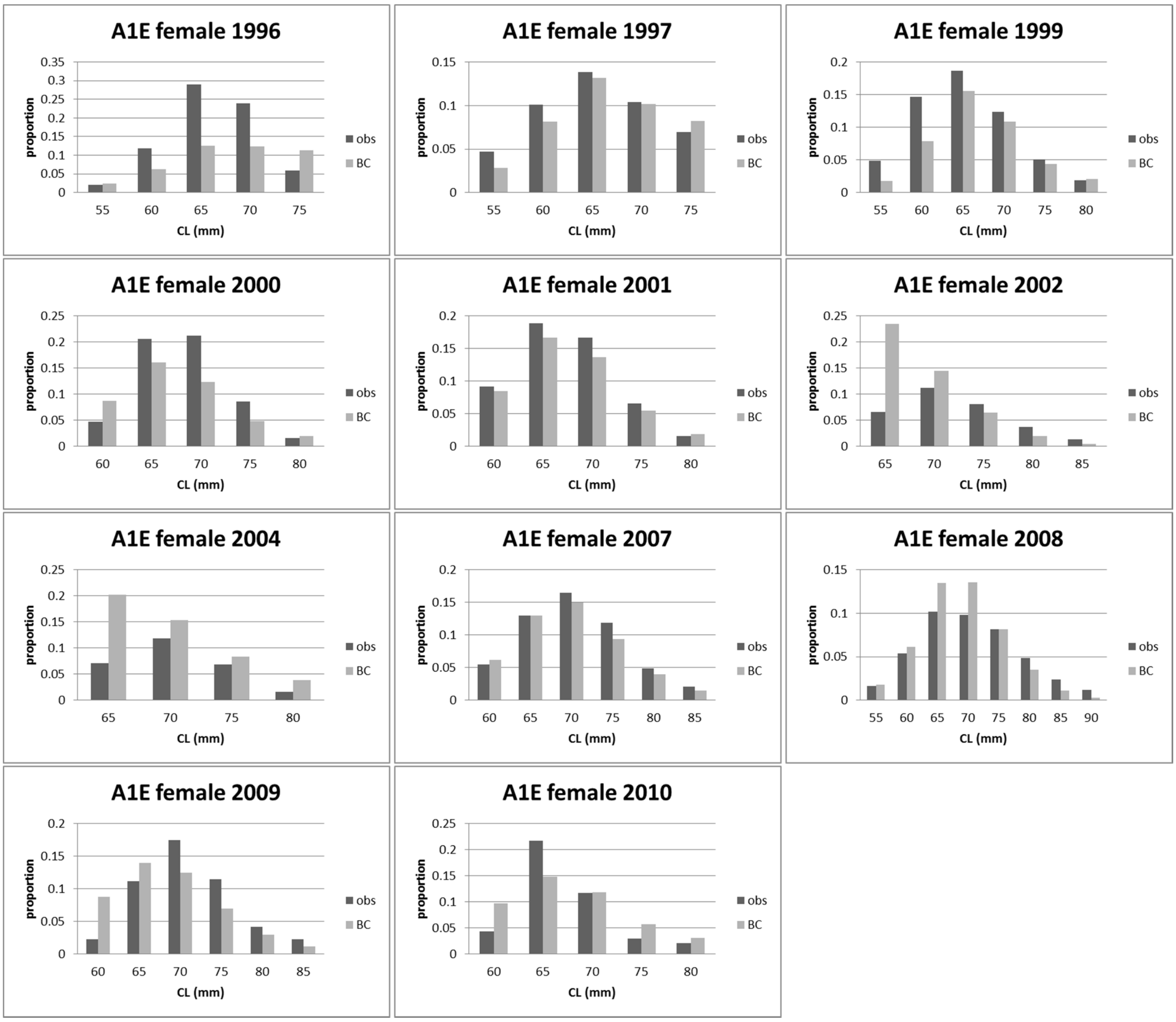


Figure 2c: BC A1W male CAL fits.

Figure 2d: BC A1W female CAL fits.

Figure 2e: BC and VAR1 (no TVS) A2+3 male CAL fits.

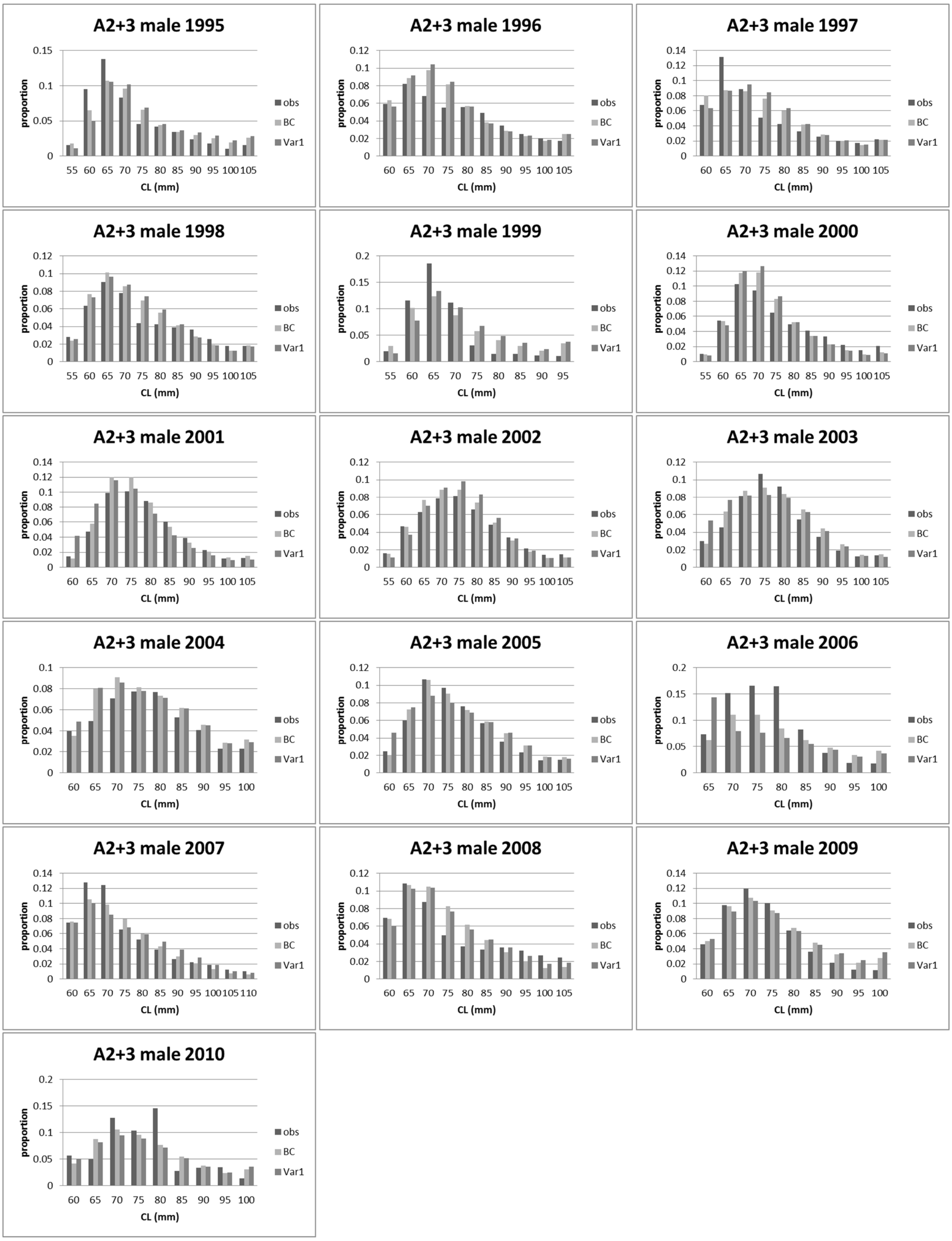


Figure 2f: BC and VAR1 (no TVS) A2+3 female CAL fits.

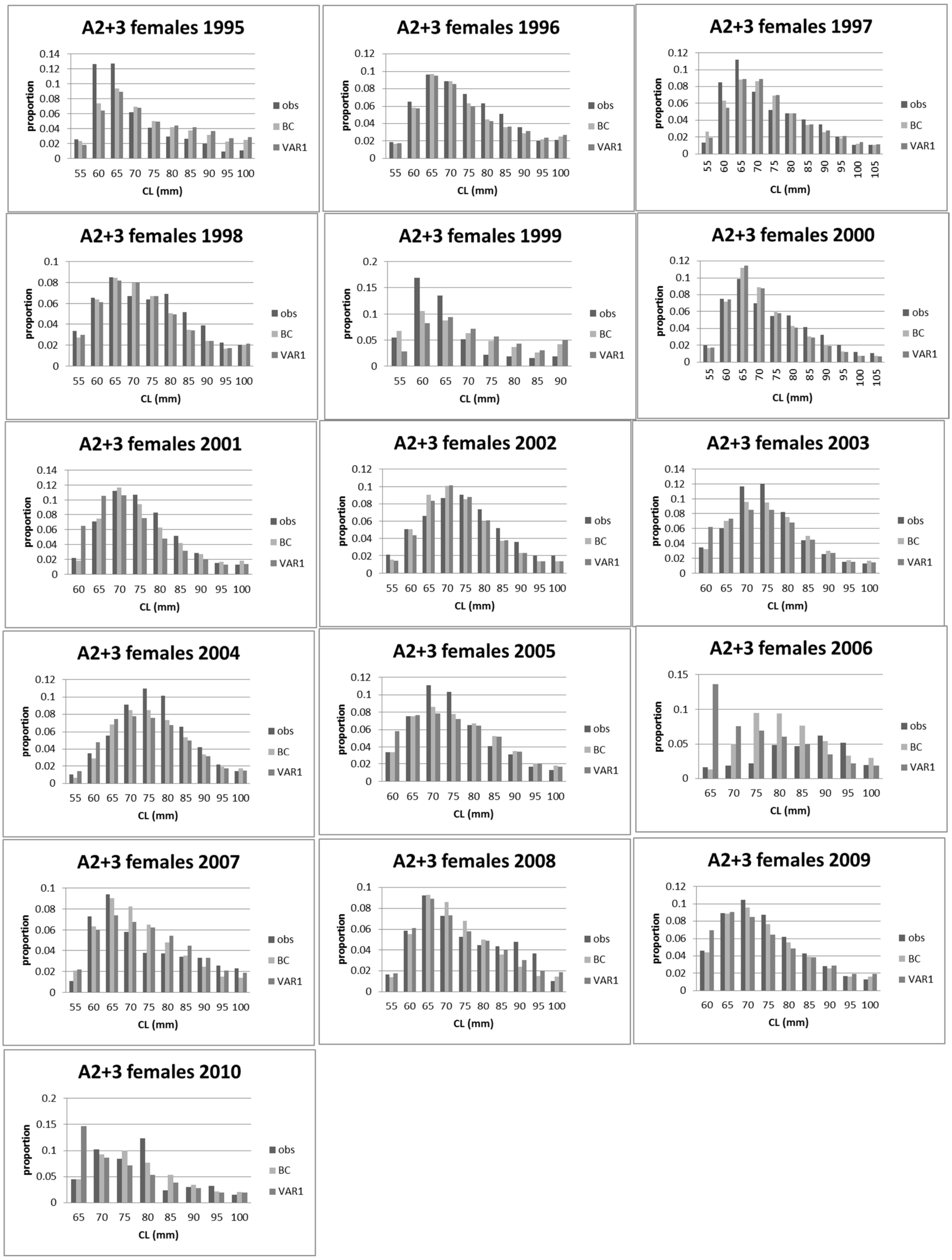


Figure 3: BC and VAR1 CAL residuals.

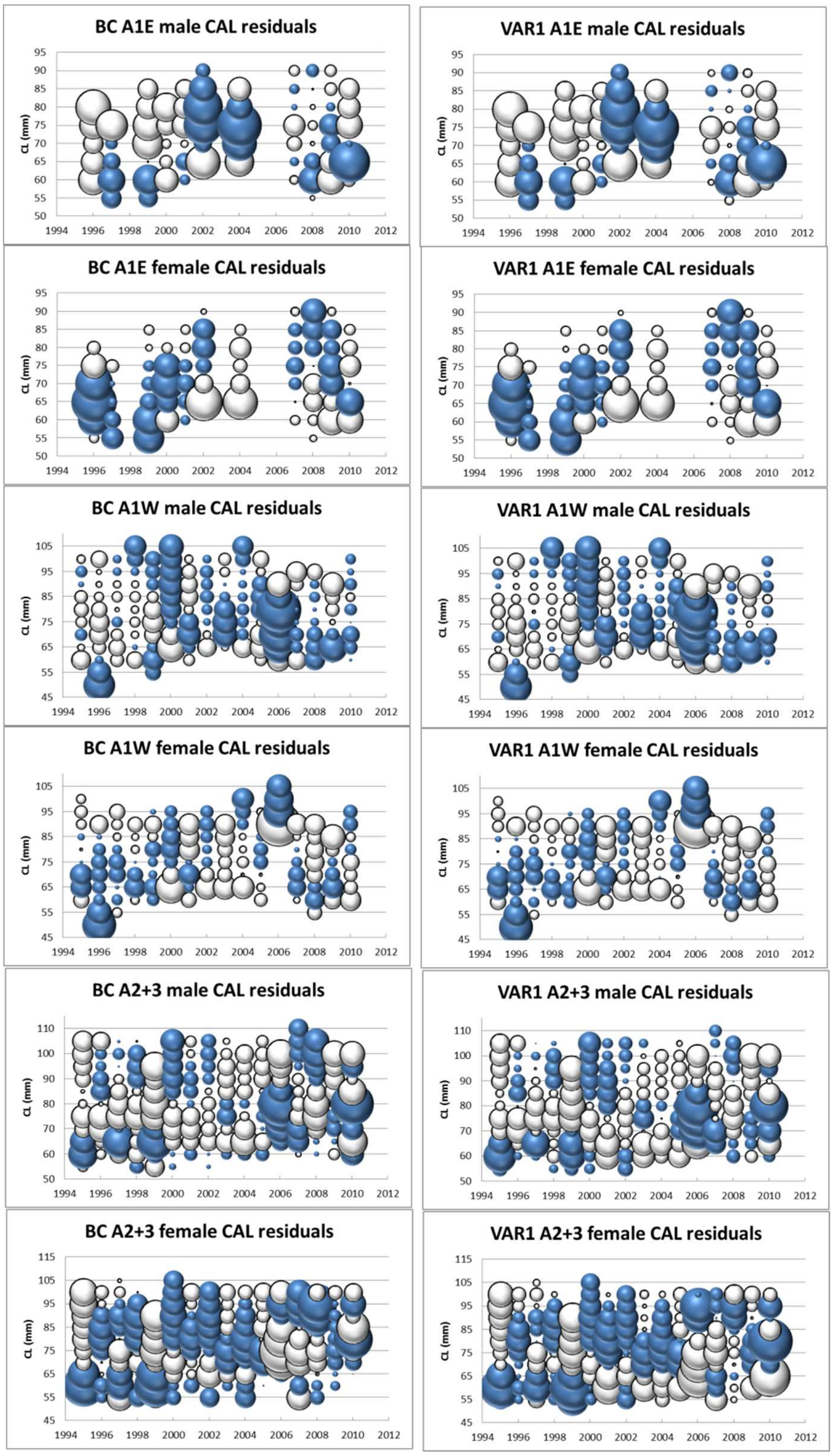


Figure 4: BC A2+3 selectivity “deltas”.

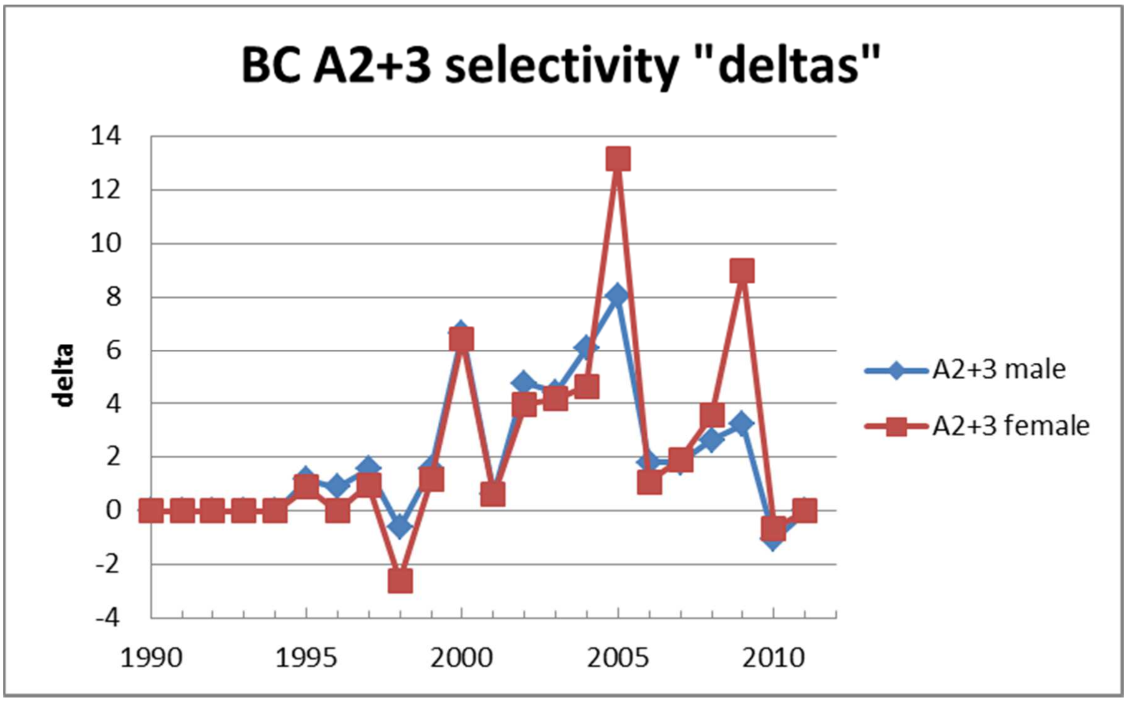


Figure 5: BC stock-recruit residuals.

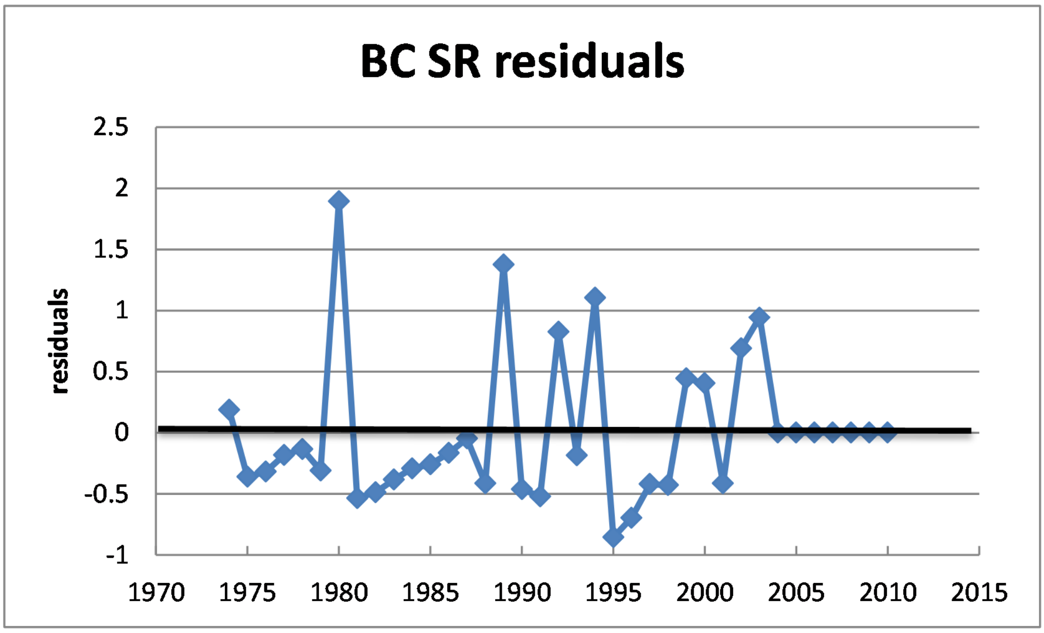
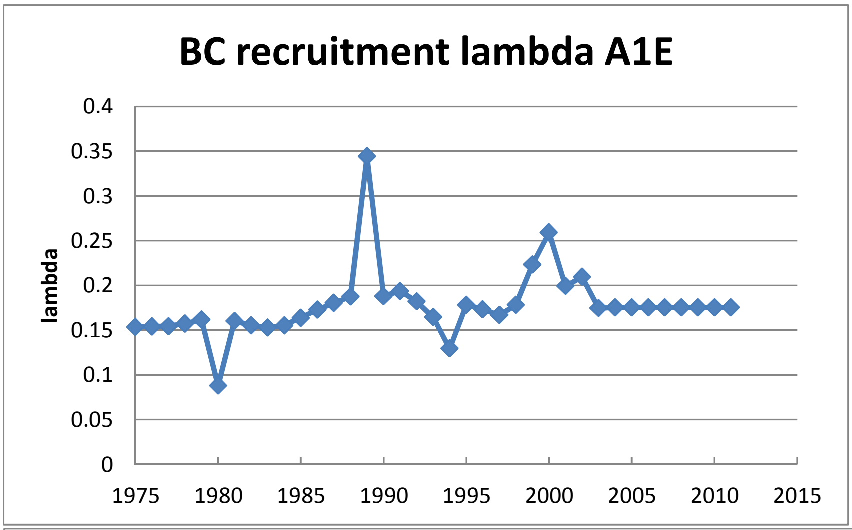
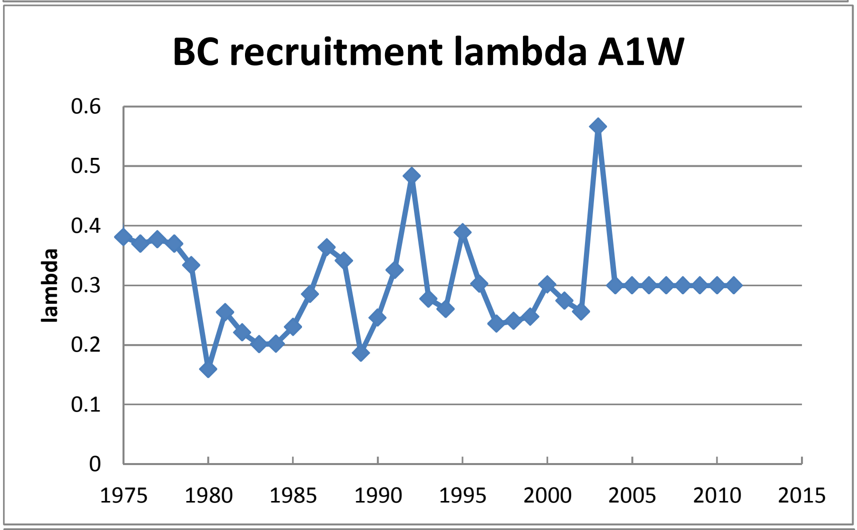


Figure 6: BC areal recruitment splits.





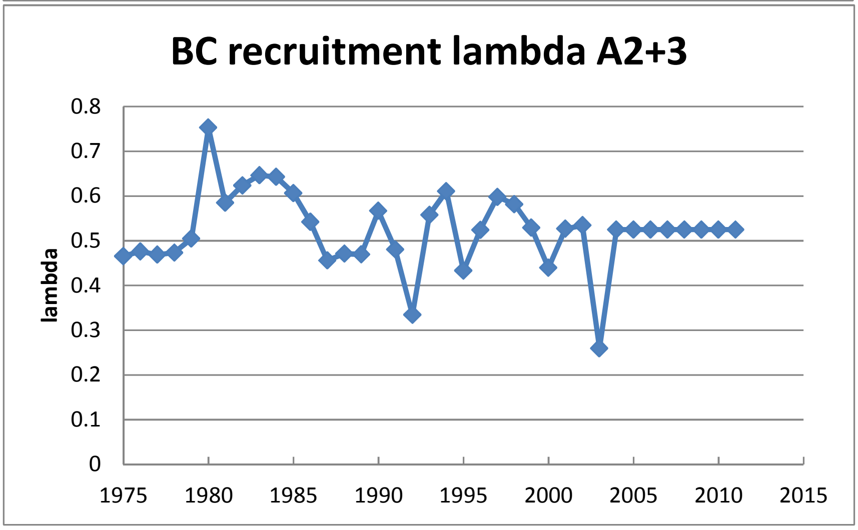
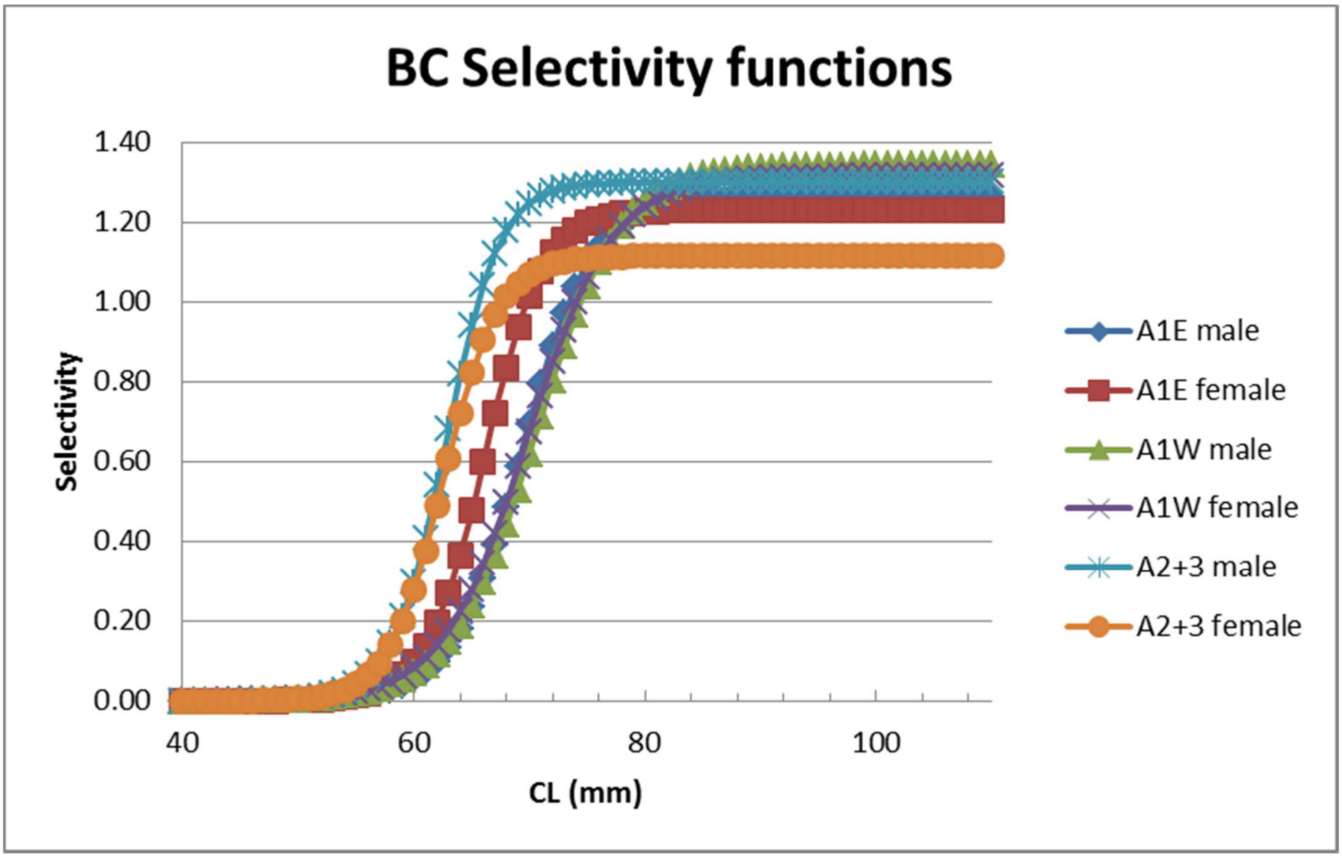


Figure 7: BC selectivity functions (assume a zero delta for A2+3).



Appendix: Workshop Panel recommendations for South Coast rock lobster (taken from MARAM IWS/NOV12/REP/1)

A. South Coast rock lobster

A.1 (H) Review how the catch size-composition data are constructed for each area/quarter. Impose a minimum on the number of animals which are measured during each sampling event (~50) and on the number of samples which are needed for inclusion in the assessment. [*Review assessment; Is there a need for time-varying selectivity; how best is this modelled?; See A.6 below for how this information could be used to inform the design of the observer program.*]

A.2 (H) Examine whether the size-frequencies differ among quarters, for example by applying a GLM to the mean catch lengths and to their standard deviations, including quarter as a factor. If there are consistent differences among quarters, this may impact how catch length-frequencies need to be constructed. [*Review assessment; Is there a need for time-varying selectivity; how best is this modelled? See A.6 below for how this information could be used to inform the design of the observer program.*]

A.3 (H) Further investigate the way time-varying selectivity is modelled. Variant 2, developed during the workshop, which allows for time-varying selectivity only for areas 2 and 3 led to a fit to the data which was not significantly worse than a model which allows for time-varying selectivity in all areas. Models with no time-varying selectivity, and models in which the values for δ for females are constant proportions of those for males, should be explored. The selection of a base-case formulation for time-varying selectivity should be decided considering the ability to fit the data, and the sensitivity of model results to the weight assigned to the size-composition data (w_{len}). [*Review assessment; Is there a need for time-varying selectivity; how best is this modelled?*]

A.4 (H) Some analyses of the tagging data suggest that total mortality may differ between areas 2 and 3. Consequently, the sensitivity tests should include operating models that distinguish these two areas (model 2 in MARAM IWS/NOV12/SCRL/P2). [*Review assessment.*]

A.5 (H) When evaluating candidate OMPs, construct sensitivity tests based on the following specifications: (a) model the parameter δ, which determines time-varying-selectivity, as an AR-1 processes in time; (b) weight the size-frequencies for each year as a function of sample size (perhaps with the weight increasing linearly from 0 at zero sample size to 1 at some intermediate sample size); (c) examine different assumptions regarding spatial structure (models 2 and 3 of MARAM IWS/NOV12/SCRL/P2); (d) change the value of the parameter (w_{len}) which weights the length-frequency data; (e) change the value assumed for natural mortality, M (e.g. to 0.08 and 0.15yr^{-1}); (f) estimate separate residual variance parameters for the trawl CPUE series for the years before and after 1990 in area 1E (given the apparent reduction in inter-annual variation in CPUE after 1990; Figure 1a of MARAM IWS/NOV12/SCRL/P2); (g) set steepness to 0.8; (h) consider alternative models for time-varying selectivity (e.g. no time-varying selectivity at all; no time-varying selectivity for areas 1E and 1W; perfect correlation between δ for males and females); (i) change the values for σ_{λ}, σ_{sel}, σ_R and ρ; and (j) consider alternative scenarios for the historical catches. Show results for cases in which catchability for the commercial fishery is changing over time. These latter sensitivity tests would not be used to select an OMP, but would rather be used to understand the behaviour of the OMP, given a factor which should substantially impact performance. [*Provide advice on range of operating models for OMP testing.*]

A.6 (M) The outcomes of recommendations A1 and A2 should be used to refine the design of the observer program. Therefore, the results of the analyses which explore the ideal number of samples per quarter, number of animals per sample, and the distribution of samples among quarters and areas should be provided to the group considering modifications to observer program. Consider how the size of the catch (e.g., over the most-recent five years) impacts the amount of size-composition data needed.

A.7 (M) Reparameterize the way in which the year-specific recruitment proportions by areas ($\varepsilon_{A,y}$ in equation A.29 in MAMARM IWS/NOV12/SCRL/P2) are modelled, so that one of the areas acts as a reference and the estimated parameters define deviations for the other areas with respect to the reference. [*Review assessment.*]

A.8 (M) Reparameterize the way in which the average recruitment proportions to areas (λ^A, in equation A.29 in MAMARM IWS/NOV12/SCRL/P2) are modelled to avoid calculating the proportion for area 3 by subtracting those for areas 1 and 2 from unity. This can be achieved by setting λ for area 1E to 1, estimating λ for areas 1W and 2+3, and renormalizing by dividing by the sum of the 3 λ's. [*Review assessment.*]

A.9 (M) Compare the estimates of total mortality from the assessment with the corresponding estimates based on the tagging data (MARAM IWS/NOV12/SCRL/BG5) to confirm earlier results that the tagging data and the model outputs are comparable. [*Review assessment.*]

A.10 (M) In the assessment model, specify the proportion mature in terms of length, and compute maturity-at-age taking the distribution of length-at-age into account. Similarly, formulate quantities which depend on weight in terms of weight-at-length and account for the probability distribution for length-at-age. [*Review assessment.*]

A.11 (M) Consider a model in which fishery selectivity is governed by a double logistic (or double-normal) function, and where several of the parameters of this function are time-varying. [*Review assessment; Is there a need for time-varying selectivity; how best is this modelled?*]

A.12 (L) Evaluate the implied distributions of length-at-age given the growth curves which are fitted using the tagging data (e.g. MARAM IWS/NOV17/SCRL/BG7), and compare these distributions to the distributions of length-at-age estimated in the assessment (which assume a constant CV of length-at-age). This will involve making assumptions regarding the distributions of birth dates and of the length-at-age at birth. [*Review assessment.*]