# South Coast Rock Lobster Operating models – further results

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## Introduction

Here we report results for further OM variants for Model 3 (areas A1E, A1W and A2+3). Sensitivity to both time-varying selectivity and the value of growth rate in sub-area 1E, Δg1E, is explored.

### Time varying selectivity

$$S_{y,l}^{m/f,A} = \frac{1}{1+e^{-\ln 19(l-(l_{50}^{m/f,A}+\delta_y^{m/f,A})/\Delta^{m/f,A}}} \tag{1}$$

$$-\ln L \rightarrow -\ln L + \sum_{m/f}\sum_{A}\sum_{y=1995}^{y=2010}\left(\frac{\delta_y^{m/f,A}}{\sigma_{sel}}\right)^2$$

SEN4: No time-varying selectivity

SEN5: $\sigma_{sel}$ = 1.0 (RC=7.5)

SEN6: $\sigma_{sel}$ = 15.0

### Somatic growth Δg1E values

OLRAC (2012) estimated Δg1E to be low at -2.840. Initial model fits using this value produced very poor fits to the data (pushed *K* very high). In order to move forward with OM development the Δg1E value was fixed at the same value estimated for Δg1W (-0.796). OM results presented in Johnston and Butterworth (2012) all assumed that Δg1E = -0.796. Here the OM outputs are explored for alternate Δg1E values. It was foiund that the original fits yielding high K with a lesser Δg1E value reflected a local minimum, and that more realistic fits could be found for the following scenarios:

SEN7: Fix Δg1E = -2.840 (the OLRAC estimated value)

SEN8: Estimate all five growth parameters within the fitting procedure using the method described in MARAM IWS/NOV12/SCRL/P2 section 2.7.

## Results

### Time varying selectivity

Table 1 compares results of SEN5, SEN5 and SEN6 with the RC. Figure 1a compares the RC, SEN4 and SEN6 fits to CPUE. Figure 2a compares SEN4 (no time varying selectivity), the RC ($\sigma_{sel}$ = 7.5) and SEN5 ($\sigma_{sel}$ = 15.0) CAL residuals, with Figure 3 comparing individual year fits for Area 2+3 males for both SEN4 and the RC.

### Somatic growth

Table 2 compares results of SEN7 and SEN8 with those of the RC, Figure 2b compares the RC and SEN8 fits to CPUE data (SEN7 not shown as it is intermediate of RC and SEN8 results). Figure 2b shows the SEN8 fits to CAL data.

## Discussion

Changing the extent which selectivity can vary interannually through the parameter $\delta$ makes little difference to the current depletion estimates for the resource (Table 1). For larger values of $\sigma_{sel}$ the CAL data are certainly better fitted, but at the expense of some of the fits to CPUE data. Strangely though, there seems little improvement in the CAL residual patterns (Figure 2a) as more variability in selectivity ifs allowed. A closer inspection of these fits to the example CAL data from males in area 2+3 in Figure 3 suggests that the largest improvement to the –lnL comes from better fits to the proportion in the smaller length group when selectivity is allowed to vary in terms of Equation (1). However, this form of variation does not seem to capture sufficient of the changes in selectivity from year to year.

Alternative Δg1E inputs, or estimation of these parameter in the model fitting procedure resulted in slightly lower estimates of overall resource depletion. Internal estimation to refine values for the somatic growth parameters results in little change from the original OLRAC estimates.

### References

Johnston, S.J. and Butterworth, D.S. 2012. 2012 South Coast rock lobster operating models – some initial results. MARAM IWS/NOV12/SCRL/P2.

Table 1: Model 3 (areas A1E, A1W and A2+3) estimated parameter and –*ln*L values for the RC and three further sensitivity analyses related to the time-varying selectivity assumptions. Values italicised indicate the changes made for sensitivities. Note that these changes render the total and some components of the negative log likelihood non comparable.

| | SEN4 | SEN5 | RC | SEN6 |
|---|---|---|---|---|
| | V1dnosel | V1h | V1d | V1i |
| $w_{len}$ | 1.0 | 1.0 | 1.0 | 1.0 |
| $\sigma_{sel}$ | *No time varying selectivity* | *1.0* | 7.5 | *15.0* |
| $\sigma_R$ | 0.8 | 0.8 | 0.8 | 0.8 |
| $\sigma_\lambda$ | 1.0 | 1.0 | 1.0 | 1.0 |
| -lnL Total | **-252.64** | **-271.33** | **-420.53** | **-442.04** |
| -lnl CPUE | **-125.85** | **-125.43** | **-108.48** | **-106.33** |
| -lnl CPUE A1E | -20.38 | -20.03 | -16.08 | -16.32 |
| -lnl CPUE A1W | -49.49 | -49.98 | -40.41 | -38.33 |
| -lnl CPUE A2+3 | -55.98 | -55.43 | -51.98 | -51.69 |
| -ln SCI CAL | **-148.72** | **-185.69** | **-356.55** | **-364.94** |
| -ln SCI CAL A1E | 29.64 | 24.37 | -13.73 | -15.52 |
| -ln SCI CAL A1W | -93.29 | -103.82 | -165.99 | -170.64 |
| -ln SCI CAL A2+3 | -85.08 | -106.24 | -176.83 | -179.05 |
| CPUE A1E σ | 0.333 | 0.337 | 0.378 | 0.375 |
| CPUE A1W σ | 0.141 | 0.139 | 0.185 | 0.196 |
| CPUE A2+3 σ | 0.117 | 0.119 | 0.131 | 0.133 |
| SCI CAL A1E σ | 0.170 | 0.165 | 0.131 | 0.131 |
| SCI CAL A1W σ | 0.092 | 0.088 | 0.069 | 0.068 |
| SCI CAL A2+3 σ | 0.093 | 0.087 | 0.069 | 0.069 |
| $K$ | 2498 | 2470 | 2546 | 2560 |
| $\lambda^{A1E}$ | 0.108 | 0.110 | 0.102 | 0.098 |
| $\lambda^{A1W}$ | 0.353 | 0.343 | 0.341 | 0.342 |
| $\lambda^{A2+3}$ | 0.538 | 0.546 | 0.557 | 0.559 |
| g75 | 3.280 fixed | 3.280 fixed | 3.280 fixed | 3.280 fixed |
| kappa | 0.099 fixed | 0.099 fixed | 0.099 fixed | 0.099 fixed |
| Δgm | 0.996 fixed | 0.996 fixed | 0.996 fixed | 0.996 fixed |
| Δg1E | -0.796 changed | -0.796 changed | -0.796 changed | -0.796 changed |
| Δg1W | -0.796 fixed | -0.796 fixed | -0.796 fixed | -0.796 fixed |
| $B_{sp}(2011)$ ($B_{sp}(2011)/K_{sp}$) | 683 (0.273) | 666 (0.270) | 713 (0.280) | 711 (0.278) |
| $B_{exp}(2011)$ ($B_{exp}(2011)/K_{exp}$) A1E | 110 (0.287) | 106 (0.276) | 85 (0.205) | 79 (0.191) |
| $B_{exp}(2011)$ ($B_{exp}(2011)/K_{exp}$) A1W | 806 (0.450) | 769 (0.437) | 791 (0.438) | 810 (0.456) |
| $B_{exp}(2011)$ ($B_{exp}(2011)/K_{exp}$) A2+3 | 1632 (0.311) | 1632 (0.313) | 1553 (0.304) | 1532 (0.304) |

Table 2: Model 3 estimated parameter and –*ln*L values for the RC and two further sensitivity analyses related to somatic growth estimation. Values italicised indicate the changes made for sensitivities. Note that these changes render the total and some components of the negative log likelihood non comparable.

| | RC | SEN7 | SEN8 |
|---|---|---|---|
| | V1d | V1da | Xv1d |
| $w_{len}$ | 1.0 | 1.0 | 1.0 |
| $\sigma_{sel}$ | 7.5 | 7.5 | 7.5 |
| $\sigma_R$ | 0.8 | 0.8 | 0.8 |
| $\sigma_\lambda$ | 1.0 | 1.0 | 1.0 |
| -lnL Total | **-420.53** | **-421.94** | **-442.42** |
| -lnl CPUE | **-108.48** | **-115.31** | **-117.66** |
| -lnl CPUE A1E | -16.08 | -15.95 | -16.83 |
| -lnl CPUE A1W | -40.41 | -42.38 | -45.07 |
| -lnl CPUE A2+3 | -51.98 | -56.99 | -55.76 |
| -ln SCI CAL | **-356.55** | **-351.70** | **-356.66** |
| -ln SCI CAL A1E | -13.73 | -9.80 | -7.97 |
| -ln SCI CAL A1W | -165.99 | -171.86 | -173.56 |
| -ln SCI CAL A2+3 | -176.83 | -170.04 | -175.13 |
| CPUE A1E σ | 0.378 | 0.379 | 0.370 |
| CPUE A1W σ | 0.185 | 0.174 | 0.161 |
| CPUE A2+3 σ | 0.131 | 0.113 | 0.118 |
| SCI CAL A1E σ | 0.131 | 0.135 | 0.136 |
| SCI CAL A1W σ | 0.069 | 0.068 | 0.067 |
| SCI CAL A2+3 σ | 0.069 | 0.071 | 0.070 |
| *K* | 2546 | 2257 | 2305 |
| $\lambda^{A1E}$ | 0.102 | 0.214 | 0.201 |
| $\lambda^{A1W}$ | 0.341 | 0.295 | 0.281 |
| $\lambda^{A2+3}$ | 0.557 | 0.491 | 0.518 |
| g75 | 3.280 fixed | 3.280 fixed | 3.351 |
| kappa | 0.099 fixed | 0.099 fixed | 0.108 |
| Δgm | 0.996 fixed | 0.996 fixed | 0.931 |
| Δg1E | -0.796 changed | -2.640 fixed | -2.788 |
| Δg1W | -0.796 fixed | -0.796 fixed | -0.462 |
| $B_{sp}(2011)$ ($B_{sp}(2011)/K_{sp}$) | 713 (0.280) | 564 (0.250) | 556 (0.241) |
| $B_{exp}(2011)$ ($B_{exp}(2011)/K_{exp}$) A1E | 85 (0.205) | 144 (0.300) | 129 (0.272) |
| $B_{exp}(2011)$ ($B_{exp}(2011)/K_{exp}$) A1W | 791 (0.438) | 478 (0.331) | 504 (0.349) |
| $B_{exp}(2011)$ ($B_{exp}(2011)/K_{exp}$) A2+3 | 1553 (0.304) | 1307 (0.289) | 1438 (0.303) |

Figure 1a: CPUE fits for the RC SEN4 (no time-varying selectivity) and SEN6 ( ) sensitivities.

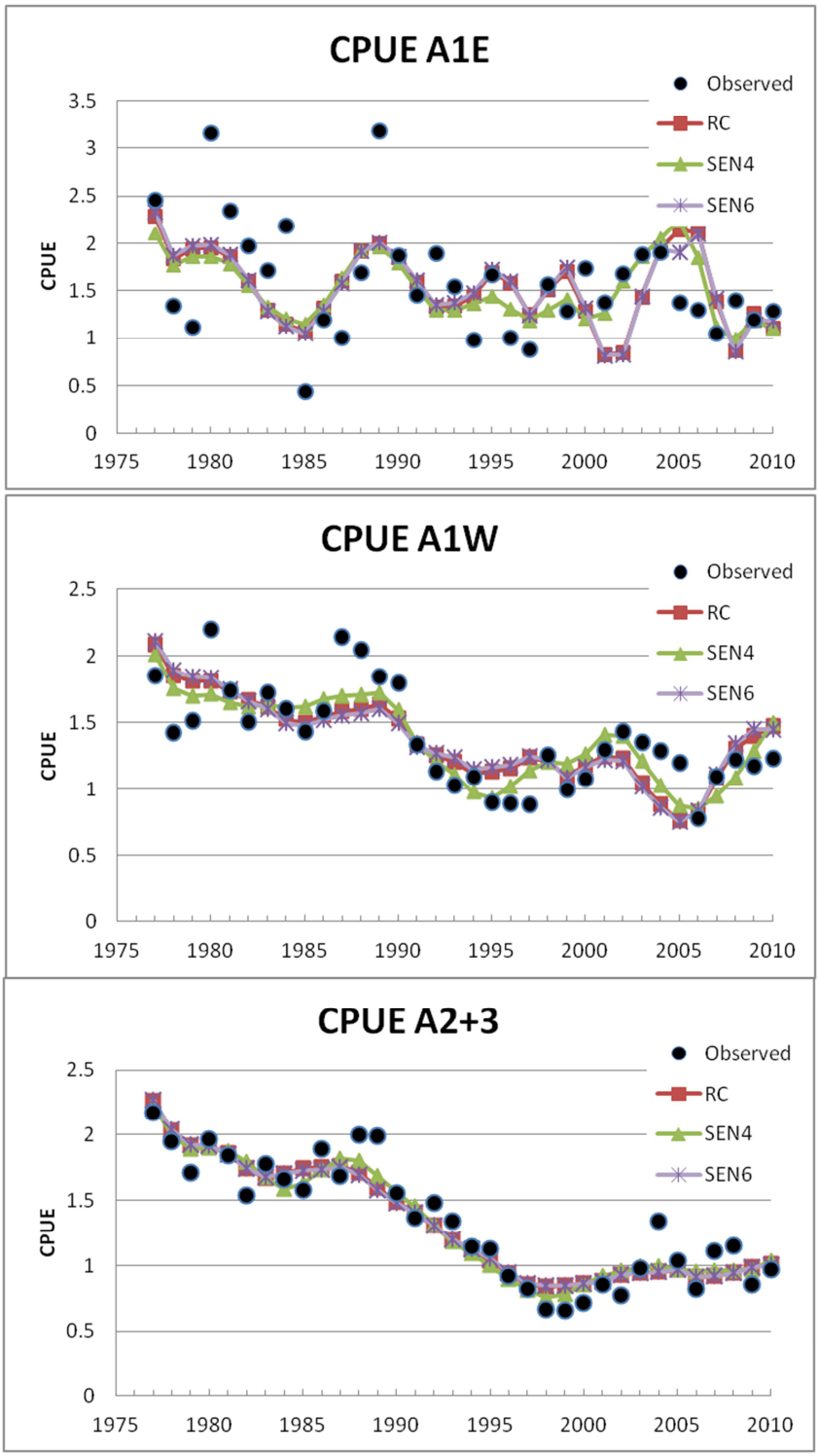

Figure 1b: CPUE fits comparing the RC (somatic growth fixed) with SEN8 (somatic growth estimated).

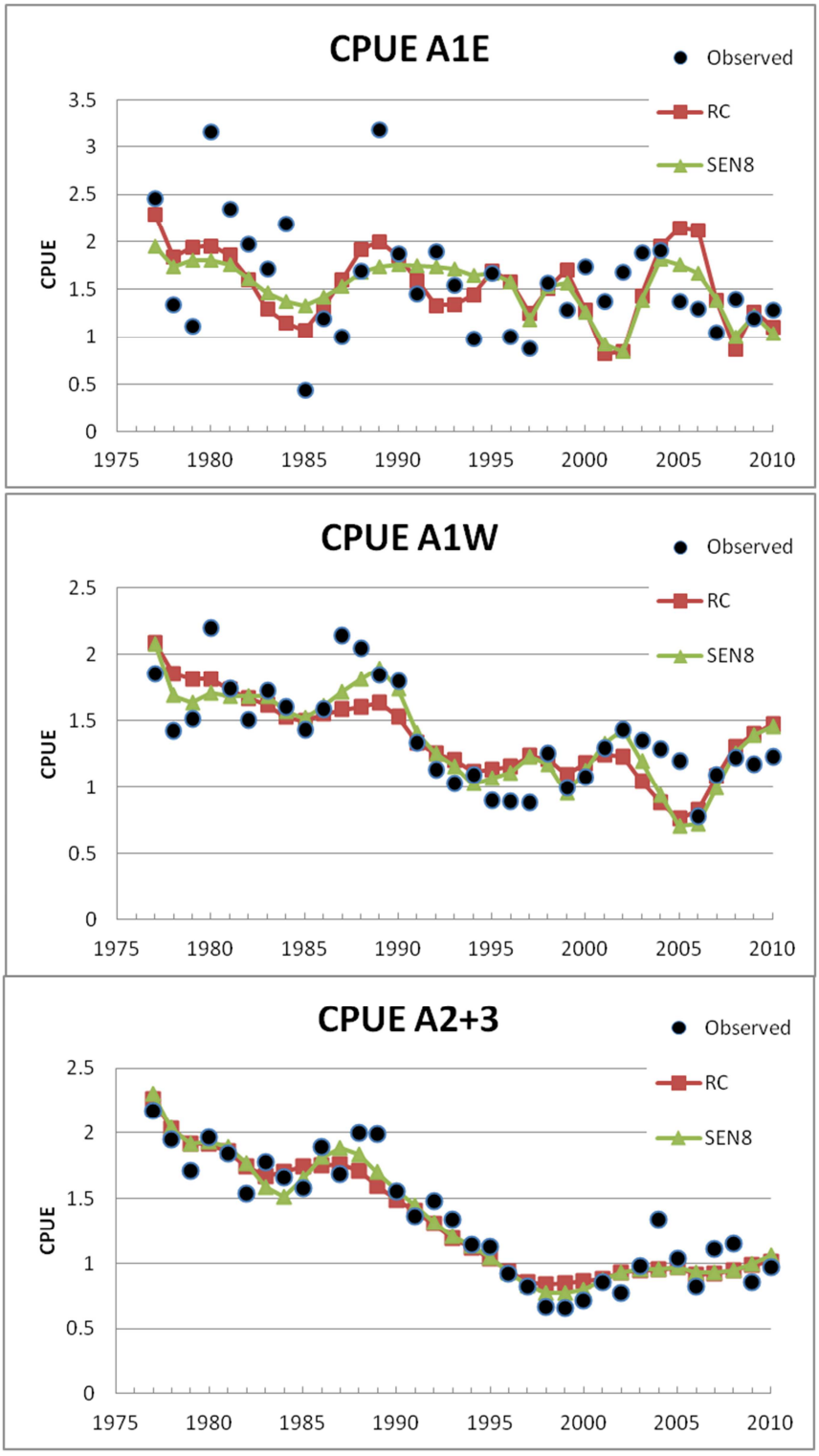

Figure 2a: Comparison between SEN4 (no time-varying selectivity), RC ( = 7.5) and SEN6 ( = 15) CAL standardised residuals.

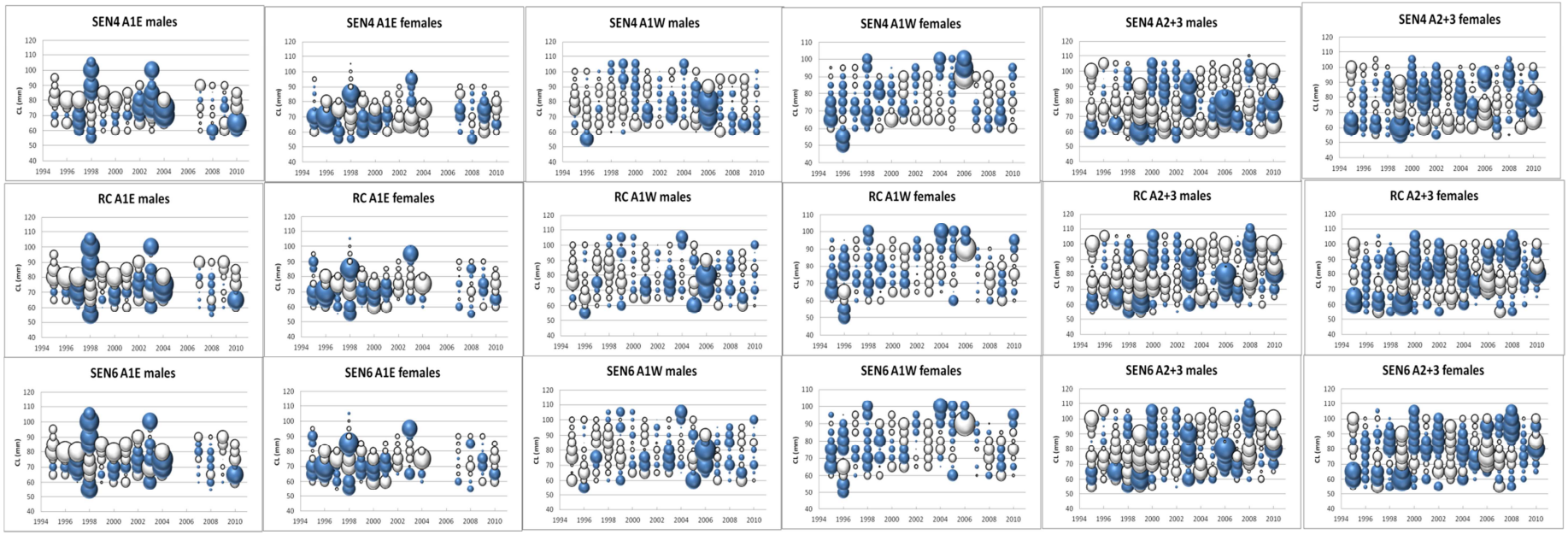

Figure 2b: RC (somatic growth fixed – with Δg1E fixed at -0.796) with SEN8 (somatic growth estimated) CAL standardised residuals.

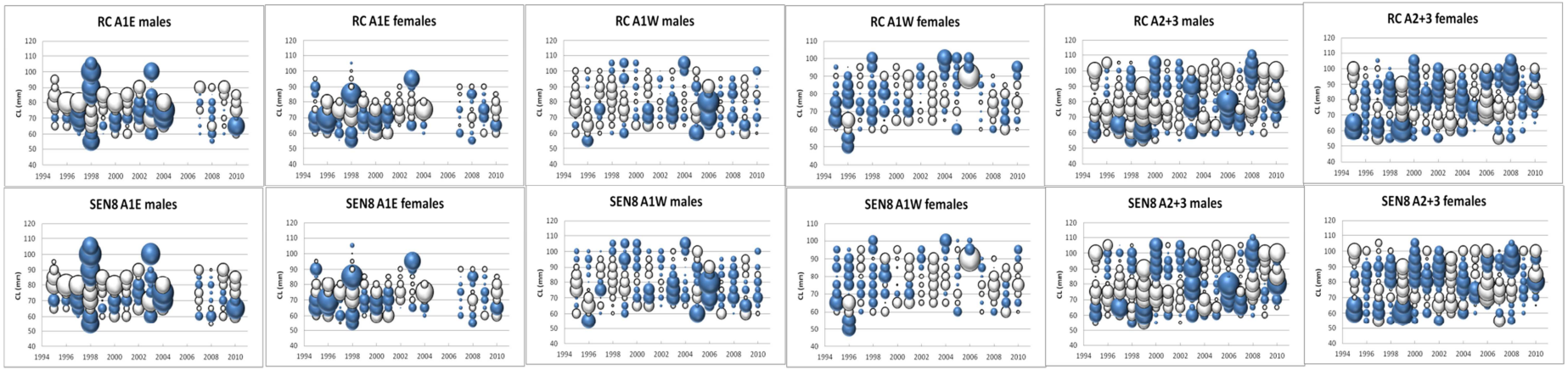

Figure 3: Observed versus model predicted CAL proportions for Area 2+3 males comparing the RC (with time varying selectivity) to SEN4 (no time varying selectivity).

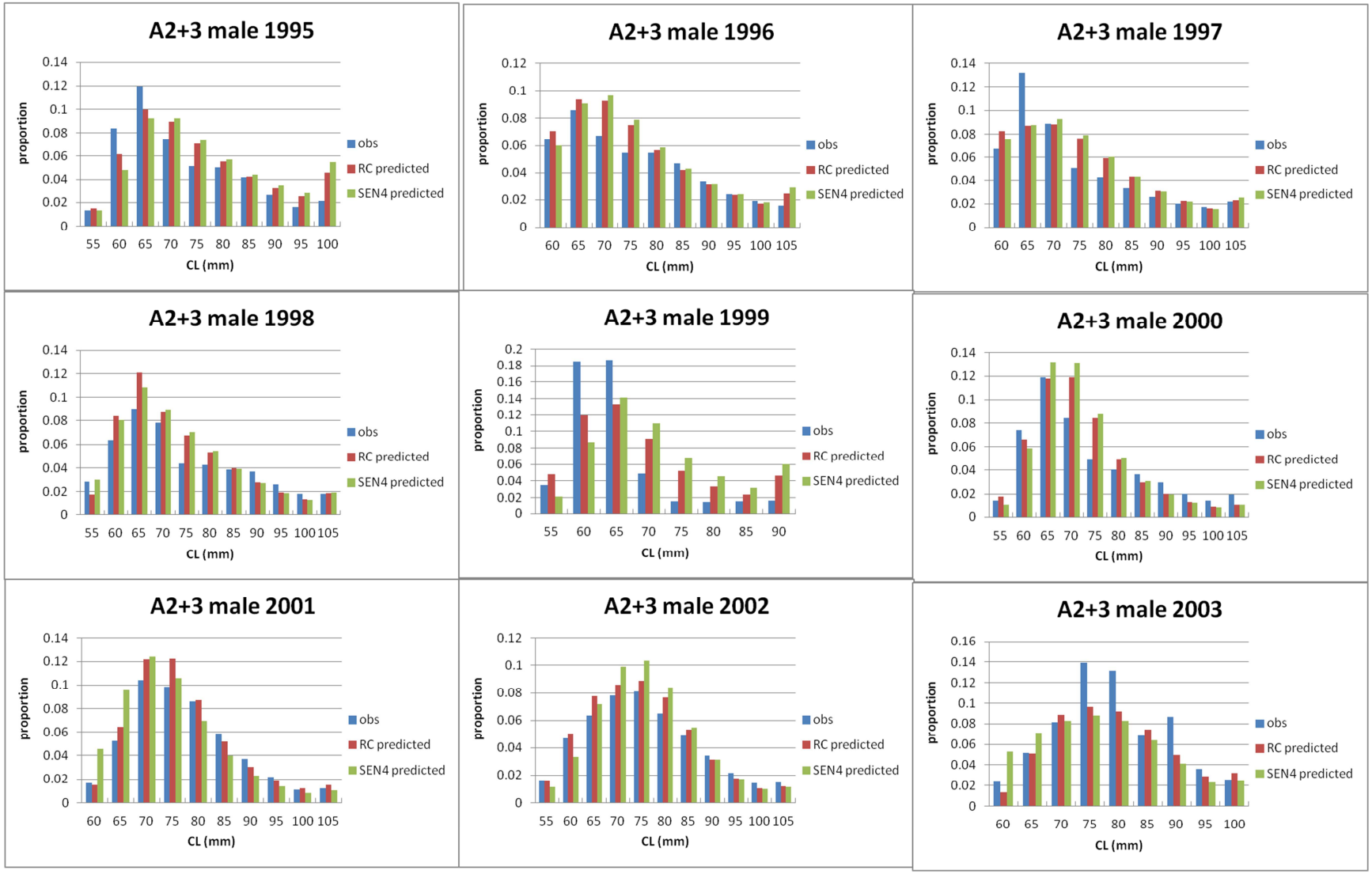

Figure 3 cont.

Figure 4: The values estimated for Area 2+3 males for the RC.

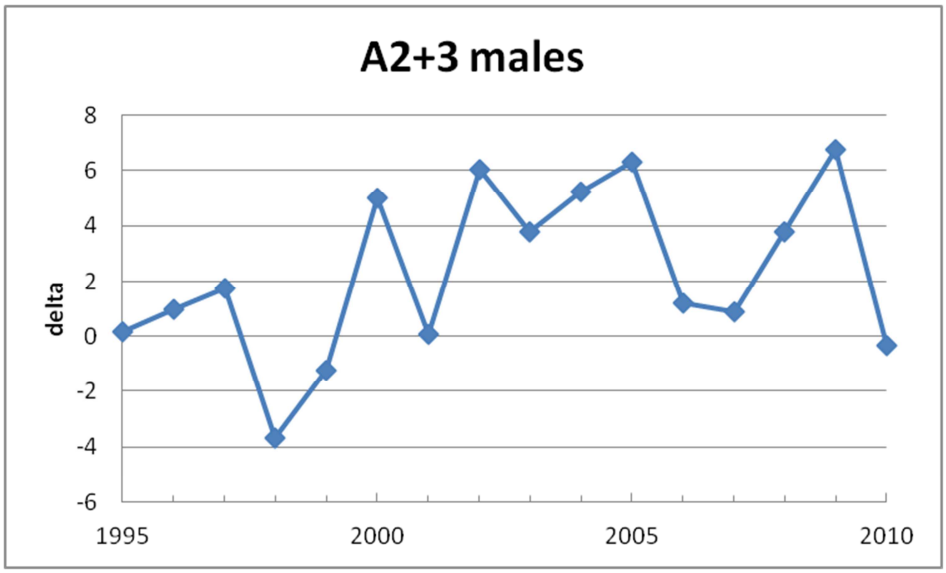

Table 3: The improvement in –lnL going from SEN4 (no time varying selectivity) to the RC for the plots shown in Figure 3.

| Season | -lnL change (RC-SEN4) |
|---|---|
| 1995 | -3.18 |
| 1996 | -2.49 |
| 1997 | -1.06 |
| 1998 | -1.15 |
| 1999 | -2.85 |
| 2000 | -2.03 |
| 2001 | -5.55 |
| 2002 | -3.89 |
| 2003 | -2.52 |
| 2004 | -1.08 |
| 2005 | -3.86 |
| 2006 | -6.16 |
| 2007 | -3.71 |
| 2008 | 1.38 |
| 2009 | -3.31 |
| 2010 | -4.00 |
| Total | -45.48 |