

2018 updated South Coast Rock Lobster assessment results

S.J. Johnston and D.S. Butterworth

Summary

The 2017 assessment of the resource is updated given two further years of catch-at-length data now available. Recruitment is estimated to have increased over the last two seasons compared to the previous three seasons when recruitment was estimated to be poor. The spawning biomass trajectory decreases slightly over recent years. Current spawning biomass is estimated to be 27% of K . The RC MSY estimate is 259 MT at a B_{sp}/K of 0.27. F_{msy} is estimated to be 0.112. The RC model thus estimates that the resource is currently slightly above B_{msy} .

Introduction

The most recent South Coast rock lobster assessment that has been reported was that in 2017 (Johnston and Butterworth 2017). This document reports an update to this assessment, where this 2018 update includes fitting to the following data.

1. GLM standardised CPUE data for each area (A1E, A1W, and A2+3): 1977-2015. [Thus no new data].
2. Catch-at-length (CAL) data (males and females separately) for each area: 1995-2015 (the 2017 assessment included data to 2013 only).
3. Catch data for each area (1973-2016).

Stock recruit residuals are estimated for the 1974-2008 period.

Note that for the RC model, the CPUE and CAL data receive **equal** weighting and the 1999 and 2006 CAL data are removed from the likelihood because of very small sample sizes. Three sensitivity models are run (as for the 2017 assessment).

- Sen1: CAL data down-weighted by a factor of 0.5.
- Sen2: CAL data down-weighted by a factor of 0.1.
- Sen3: The stock-recruit log-residual standard deviation σ_R is reduced from the RC value of 0.8 to a value of 0.4.

Note that at the November 2017 International Stock Assessment Workshop held at UCT, the international Panel recommended that the CAL data should receive equal weight to the CPUE data, and that time-varying selectivity apply only for area A2+3.

Calculation of MSY and Bmsy

Future MSY and Bmsy values are now reported. These have been calculated making certain assumptions regarding the future.

Future recruitment:

$$R_y = \frac{\alpha B_y^{sp}}{\beta + (B_y^{sp})^\gamma} e^{\zeta_y} \quad (1)$$

where e^{ζ_y} is set to $e^{0.8^2/2}$ to give the average value for recruitment given the Reference Case assumption that $\sigma_R=0.8$.

Future proportional splits of recruitment between the three areas: (λ^A)

The baseline λ^A values are set at their point estimates:

$$\lambda^{A1E} = 0.15$$

$$\lambda^{A1W} = 0.26$$

$$\lambda^{A2+3} = 0.59$$

Future catch split by area:

Use the ratios of the average F (fishing proportion) over the 2012-2016 period for each area.

Future selectivity:

For A1E and A1W where selectivity is not time varying, these selectivities are assumed to apply into the future. For A2+3 where time variance is allowed in the fitting process for years where data are available, the baseline selectivity function is used.

The MSY, F_{msy} and B_{msy} values are estimated by projecting the population forwards 150 years under a range of fixed F values (ranging from 0 to 1.0). For each F value, the annual catch is calculated as follows:

$$C_{y+1} = F B_y^{exp} \quad (2)$$

Results of updated assessments

The assessment is essentially identical to that used in 2017, except for the addition of new catch-at-length data.

Table 1 reports the results of the 2018 updated RC assessment (with the comparable 2017 RC assessment results provided in the first column for comparative purposes). Table 1 also reports results of the three sensitivity tests where the catch-at-length data are down-weighted in the fitting procedure, and where the stock-recruitment log-residual standard deviation σ_R is reduced.

Figure 1a compares the 2017 and 2018 RC model fits to CPUE. Figure 1b compares the 2018 RC, Sen1 and Sen2 assessments, which show how down-weighting the CAL data affects the fit to CPUE.

Figure 1c compares the 2017 and 2018 estimated spawning biomass relative to pristine, whilst Figure 1d compares the 2018 RC, Sen1 and Sen2 Bsp/K trajectories. Figure 1e compares the estimated series of stock-recruit residuals between the 2017 and 2018 assessments. Figure 1f shows the 2018 RC estimated proportional splits of recruitment to each area.

Figure 2a shows plots of the exploitable biomass relative to K for the 2018 assessment, whilst Figure 2b compares the 2018 RC, Sen1 and Sen2 Bsp/K trajectories. Figure 3 shows model estimates of F (the harvest proportion).

Figure 4a shows the 2018 RC estimated selectivity functions for each area. Note that the A2+3 selectivity functions vary over time for the period 1995-2015 and these are shown in Figure 4b.

Figure 4c compares the stock recruit residuals between the RC ($\sigma_R=0.8$) with Sen3 ($\sigma_R=4$).

Figure 5 shows the catch at length residuals for the 2018 RC.

Figure 6 shows the sustainable yield (SY) curve estimated for the RC, as well the SY versus F curve, whilst Table 2 provides a summary of the MSY estimates for the different models.

Discussion

Comparison between the 2017 and 2018 assessment

The updated RC assessment produces slightly more pessimistic results than those from the 2017 assessment. In 2017 the spawning biomass in 2016 relative to pristine was estimated to be 0.32, whereas the 2018 updated assessment estimates this to be somewhat lower at 0.29, with current (2017) spawning biomass relative to K at 0.27 (see Table 1). The spawning biomass relative to K is reasonably stable over recent years, though decreasing slightly for this updated 2018 assessment (Figure 1c). Note also that the stock recruit residuals for the 2004-2006 period (Figure 1e) are much lower for the 2018 assessment

compared to the 2017 assessment, but increase back up to the higher levels for 2007 and 2008 as seen in the 2017 assessment.

The 2018 estimated exploitable biomass values (relative to pristine) for the three areas are slightly lower than those of the 2017 assessment (Table 1).

Sensitivity to down-weighting the CAL data

Previous assessments have shown that down-weighting the CAL data produces different results from the RC (which gives equal weight to both the CPUE and CAL data). This feature remains evident in the updated 2018 assessments. Down-weighting the CAL data produces more optimistic results. As the catch-at-length (CAL) data are down-weighted, as might be expected the fits to the CPUE are improved (see the $-\ln L$ CPUE values in Table 1 and Figure 2a) and the fits to the CAL data deteriorate (see $-\ln L$ SCI CAL values in Table 1). Figure 1b also compares the RC and Sen3 model fits to the A2+3 CPUE data for the 2005+ period, in order to show more clearly the improvement in CPUE fit to A2+3 CPUE when the CAL data are down-weighted. Figure 1d compares the exploitable biomass trends in each area for the RC and two CAL down-weighted sensitivities.

To summarise: the CAL data push the assessments towards a more negative appraisal of the resource, and when these data are down-weighted in the model fit, the appraisal of the status of the resource improves.

Changing the σ_R value from 0.8 to 0.4

The RC model assumes a stock recruitment log-residual standard deviation (σ_R) value of 0.80. This is quite a high value, but past analyses have consistently shown much better fits to the data with this value of σ_R . The sensitivity (Sen 3) using a lower σ_R value 0.4 produces inferior fits to both the CPUE and CAL data (see Table 1).

MSY estimates

The MSY, B_{msy}^{sp} and F_{msy} values have been estimated for the RC and sensitivity models (see Table 1). Table 2 provides a summary of the MSY, B_{msy} , F_{msy} and current $B_{sp}(2017)$ estimates for the RC and three sensitivity tests Figure 6 shows graphical plots for the RC of SY versus B_{msy} (top) indicating MSY, B_{msy} and the current biomass. The lower plot shows the RC estimated F versus B_{msy} . The RC model estimates the current population to be slightly higher than the B_{msy} value. The current TAC (2017) was set at 388 MT – a value larger than the estimated MSY value of 259 MT. With down-weighting the CAL data, the MSY values increase, and the ratio of the current $B(2017)$ above the estimated B_{msy} value increases.

All the models examined here (RC, Sen1-3) estimate current spawning biomass to be slightly to well above the B_{msy} estimates.

Reference

Johnston, S.J. and Butterworth, D.S. 2017. 2017 updated south coast rock lobster assessment results. FISHERIES/2017/AUG/SWG-SCRL/06.

Table 1: Estimated model parameters and $-\ln L$ values for the updated 2018 RC and three sensitivity models. The comparable 2017 RC results are reported in the first column for comparison. Values in parenthesis are σ values.

	2017 RC CAL data received equal weight to CPUE	2018 RC CAL data received equal weight to CPUE	2018 Sen1 CAL data down- weighted by factor of 0.5	2018 Sen2 CAL data down- weighted by factor of 0.1	2018 Sen3 $\sigma_R=0.4$
	Scl17.tpl/rep	Om18.tpl	Om18s1.tpl	Om18s2.tpl	Om18s3.tpl
# parameters	250	262	262	262	262
$-\ln L$ Total	-487.17	-450.63	-265.13	-180.40	-427.22
$-\ln L$ CPUE	-120.23	-122.84	-139.55	-185.45	-113.78
$-\ln L$ CPUE A1E	-24.21 (0.33)	-24.09 (0.33)	-24.20 (0.33)	-24.56 (0.32)	-22.55 (0.33)
$-\ln L$ CPUE A1W	-54.92 (0.15)	-49.44 (0.17)	-56.78 (0.14)	-65.36 (0.11)	-49.46 (0.17)
$-\ln L$ CPUE A2+3	-41.09 (0.21)	-49.30 (0.17)	-58.58 (0.30)	-95.53 (0.05)	-40.72 (0.21)
$-\ln$ SCI CAL	-421.95	-408.40	-318.71	-84.79	-406.28
$-\ln$ SCI CAL A1E	-14.61 (0.14)	12.39 (0.15)	16.34 (0.15)	20.55 (0.16)	14.90 (0.15)
$-\ln$ SCI CAL A1W	-156.93 (0.08)	-143.21 (0.08)	-125.23 (0.09)	-68.19 (0.10)	-137.16 (0.80)
$-\ln$ SCI CAL A2+3	-250.41 (0.06)	-277.58 (0.06)	-209.82 (0.07)	-37.15 (0.10)	-282.02 (0.05)
K	4353	3450	3689	4672	4449
λ^{A1E}	0.15	0.15	0.15	0.15	0.15
λ^{A1W}	0.26	0.26	0.26	0.26	0.26
λ^{A2+3}	0.59	0.59	0.59	0.59	0.59
$B_{sp}(2014) (B_{sp}(2014)/K_{sp})$	1384 (0.32)	1071 (0.31)	1213 (0.33)	1737 (0.37)	1415 (0.32)
$B_{sp}(2015) (B_{sp}(2015)/K_{sp})$	1386 (0.32)	1022 (0.30)	1172 (0.33)	1740 (0.37)	1401 (0.31)
$B_{sp}(2016) (B_{sp}(2016)/K_{sp})$	1404 (0.32)	979 (0.29)	1150 (0.31)	1775 (0.38)	1401 (0.31)
$B_{sp}(2017) (B_{sp}(2017)/K_{sp})$	-	944 (0.27)	1132 (0.31)	1802 (0.39)	1442 (0.32)
$B_{exp}(2015) (B_{exp}(2015)/K_{exp})$ A1E	131 (0.49)	101 (0.46)	103 (0.47)	110 (0.50)	96 (0.40)
$B_{exp}(2015) (B_{exp}(2015)/K_{exp})$ A1W	281 (0.36)	222 (0.30)	216 (0.29)	206 (0.31)	241 (0.32)
$B_{exp}(2015) (B_{exp}(2015)/K_{exp})$ A2+3	851 (0.32)	689 (0.29)	840 (0.33)	1139 (0.40)	963 (0.32)
$B_{exp}(2016) (B_{exp}(2016)/K_{exp})$ A1E	-	104 (0.47)	106 (0.49)	118 (0.53)	101 (0.77)
$B_{exp}(2016) (B_{exp}(2016)/K_{exp})$ A1W	-	176 (0.24)	179 (0.24)	200 (0.30)	200 (0.26)
$B_{exp}(2016) (B_{exp}(2016)/K_{exp})$ A2+3	-	633 (0.27)	783 (0.31)	1139 (0.40)	968 (0.33)
MSY	-	259	342	584	424
B_{msy}^{sp}	-	866 = 0.27K	706 = 0.21 K	649 = 0.15K	1480 = 0.27K
F_{msy}	-	0.112	0.167	-=0.280	0.112

Table 2: MSY, Bmsy, Fmsy and current Bsp(2017) estimates for the RC and three sensitivity tests (units are MT where applicable).

	RC	Sen1 CAL data down- weighted by factor of 0.5	Sen2 CAL data down- weighted by factor of 0.1	Sen3 $\sigma_R=0.4$
MSY	259	342	584	424
Bmsy	866	706	649	1480
Bmsy/K	0.27	0.21	0.15	0.27
Bsp(2017)	944	1132	1802	1442
Bsp(2017)/K	0.27	0.31	0.32	0.32
Fmsy	0.112	0.167	0.280	0.112

Figure 1a: Comparison of 2018 RC fits to CPUE data for each area, together with fits obtained from the 2017 RC assessment.

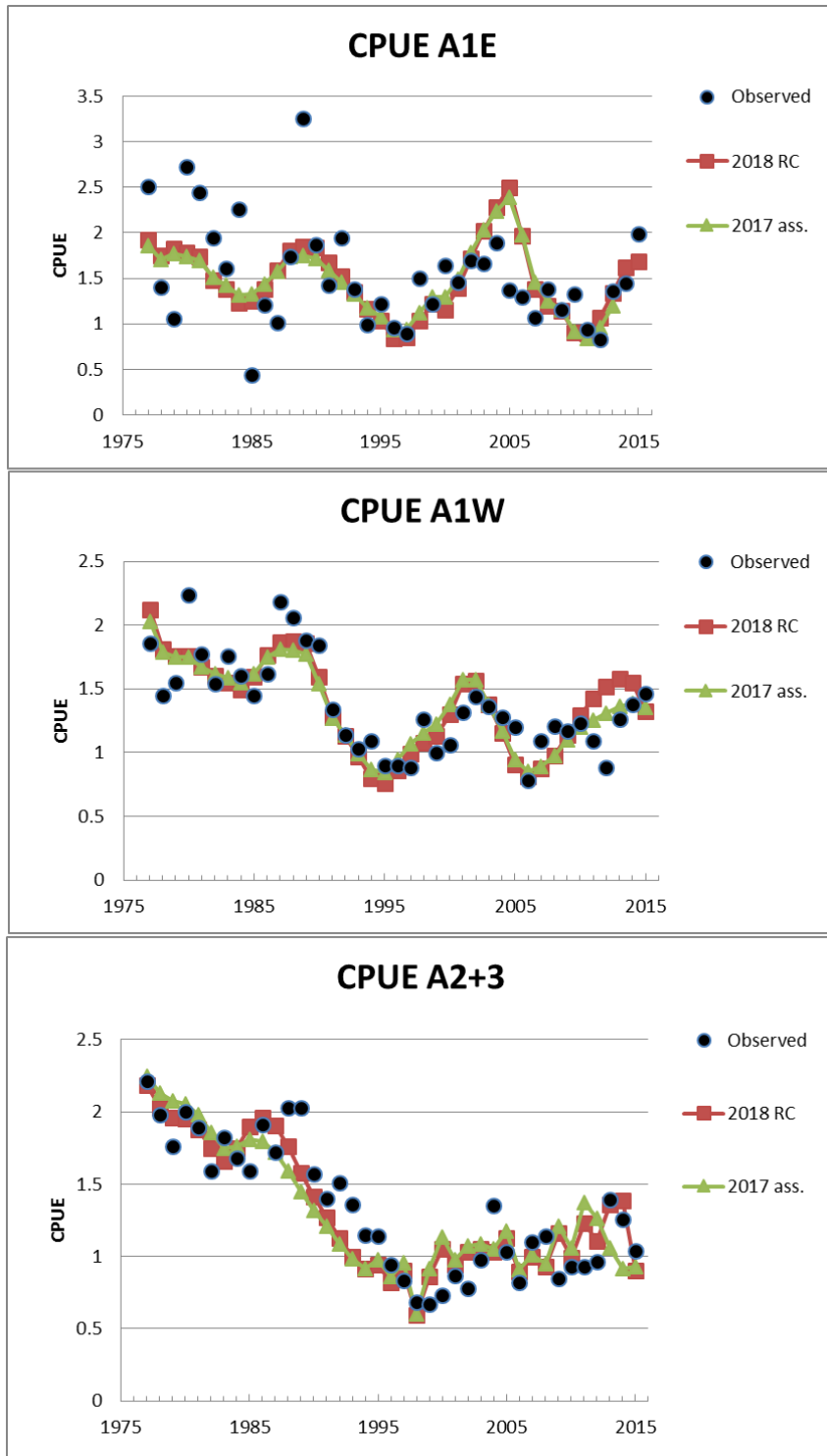


Figure 1b: Comparison of 2018 fits to CPUE data for each area, for the RC (CAL data equal weight), Sen1 (CAL data down-weighted by a factor of 0.5) and Sen2 (CAL data down-weighted by a factor of 0.1).

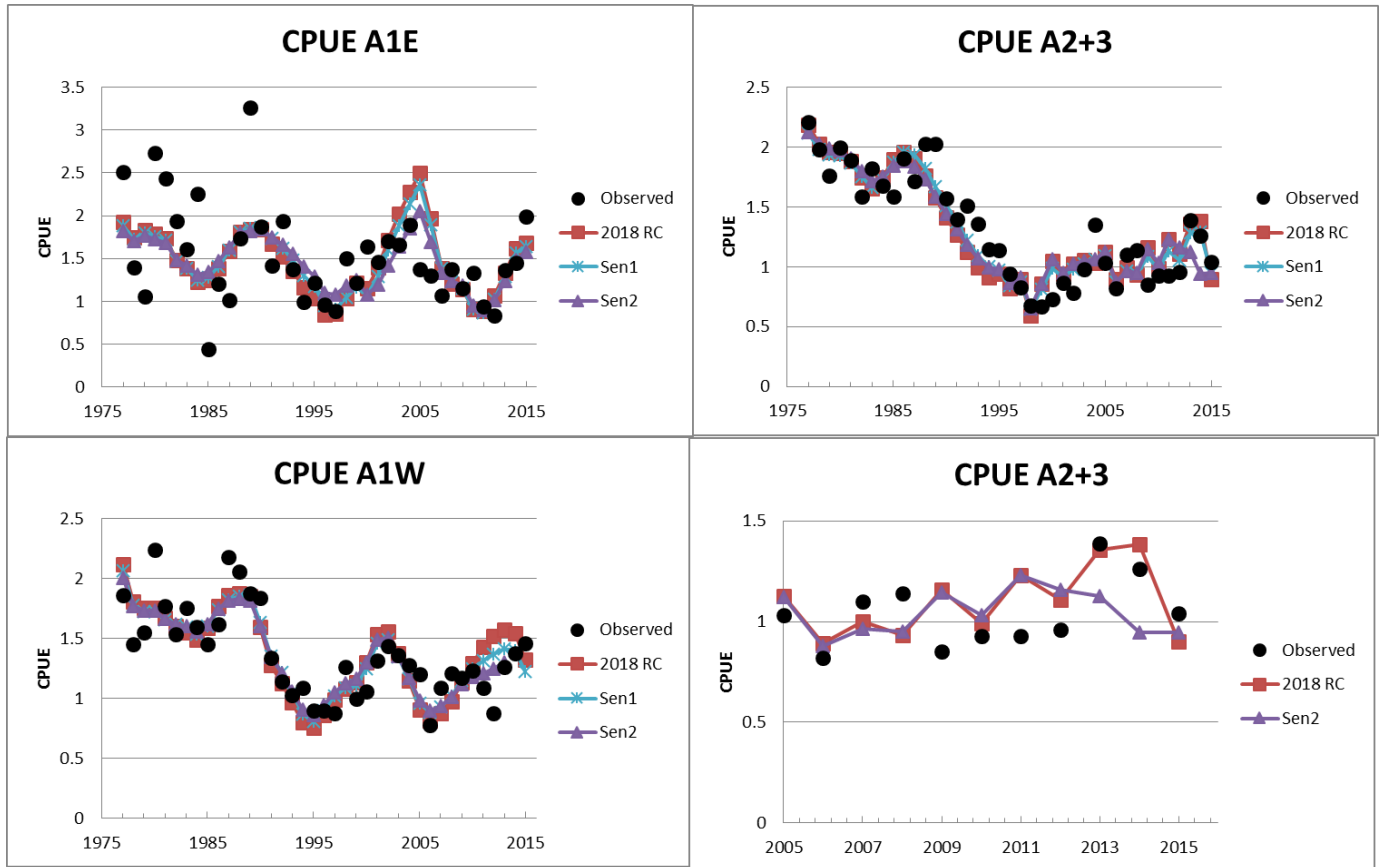


Figure 1c: Comparison of 2018 RC estimated Bsp/K, with the trend obtained from the 2017 RC assessment.

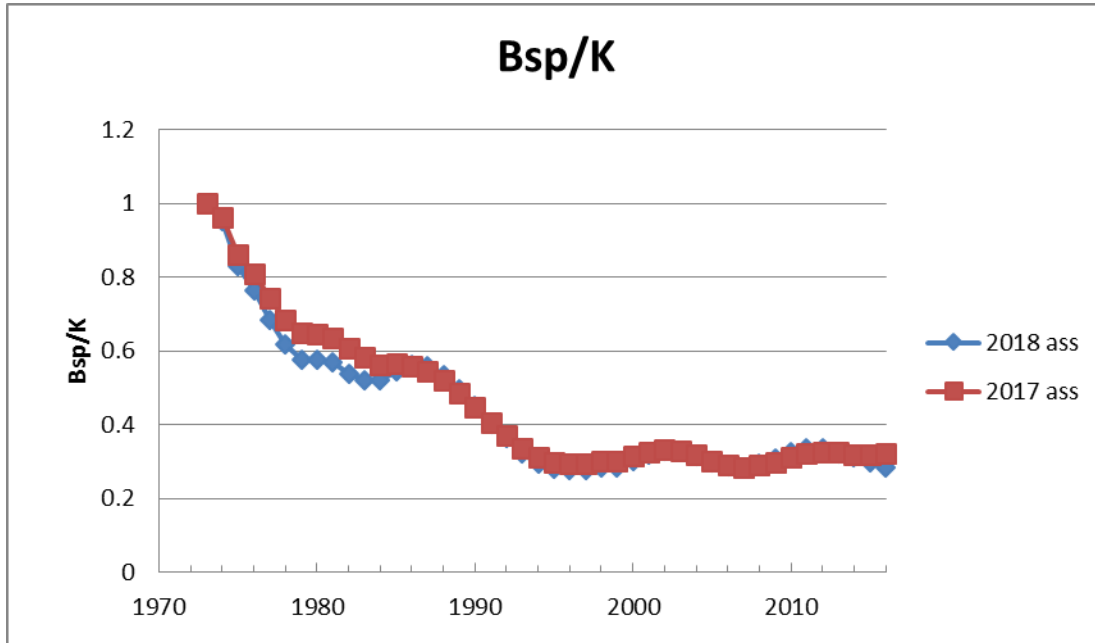


Figure 1d: Comparison of 2018 estimated Bsp/K for the RC (CAL data equal weight), Sen1 (CAL data down-weighted by a factor of 0.5) and Sen2 (CAL data down-weighted by a factor of 0.1).

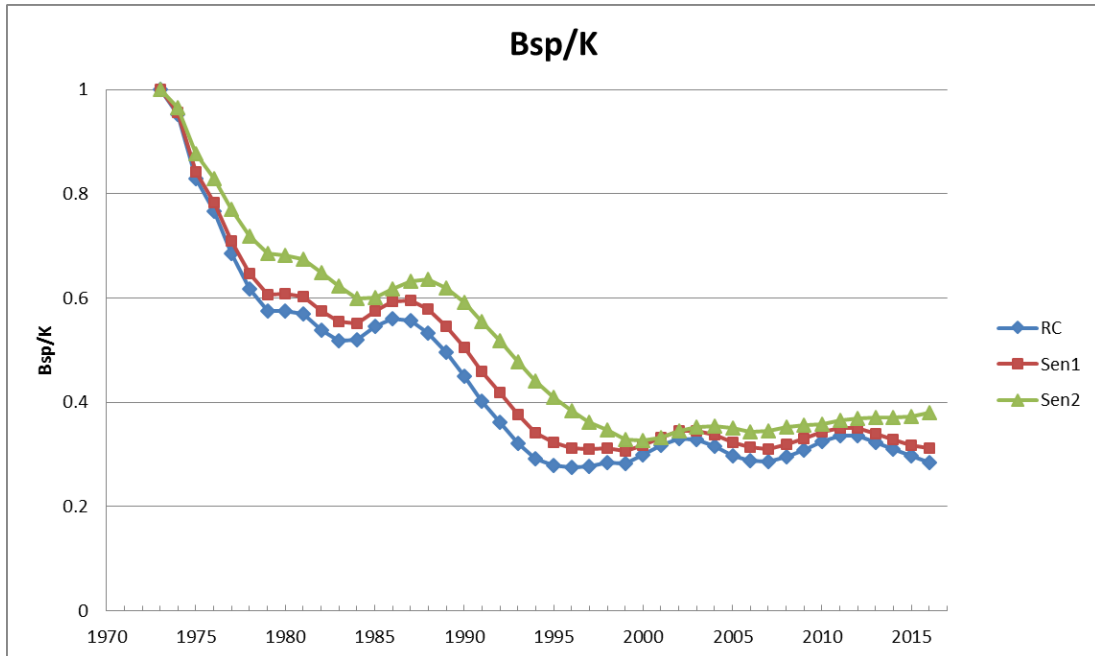


Figure 1e: Comparison of 2018 RC stock-recruitment residuals, with those obtained from the 2017 RC assessment.

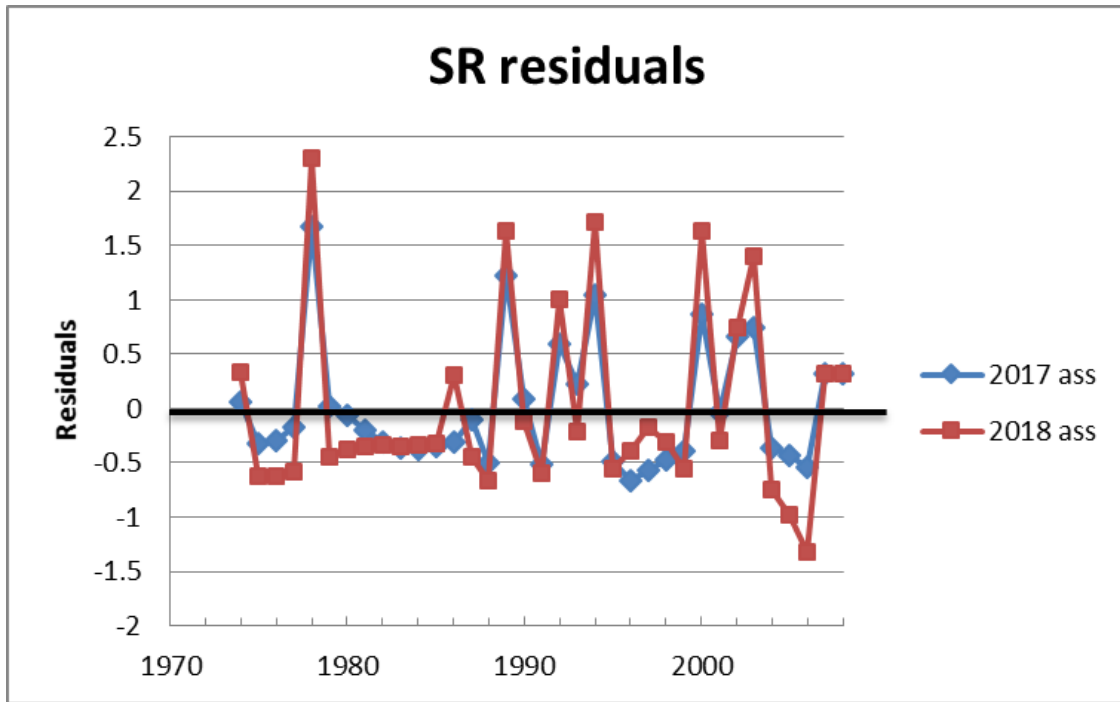


Figure 1f: RC proportional splits of recruitment to each area.

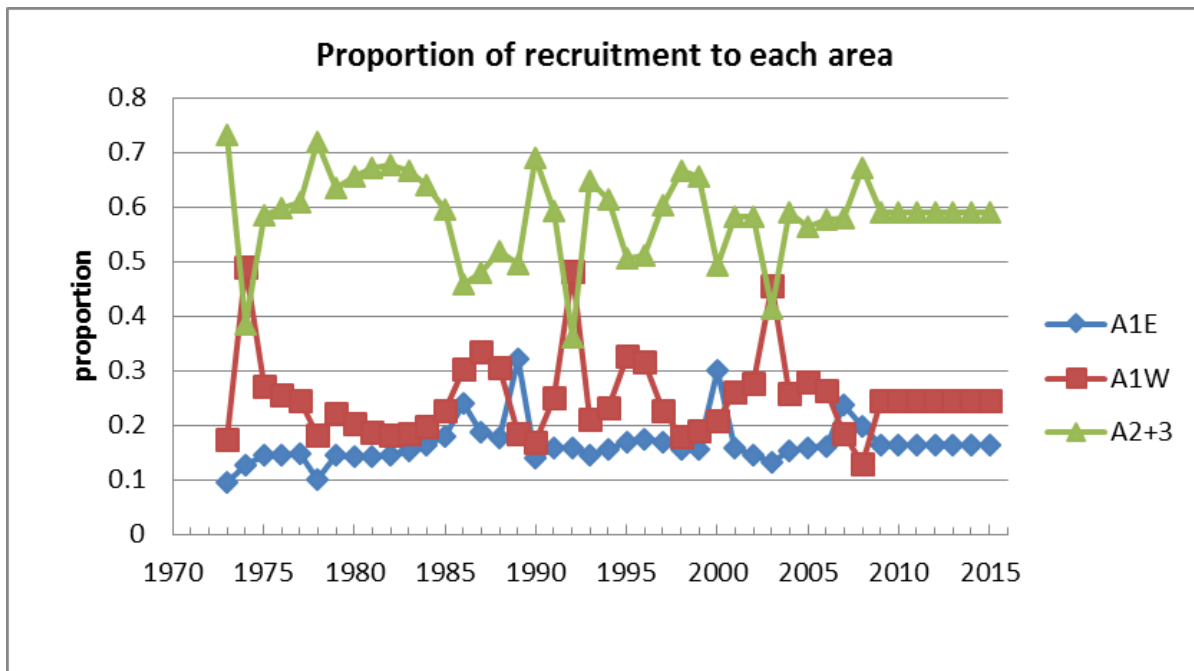


Figure 2a: Model estimates of **exploitable biomass relative to K** for the 2018 RC assessment.

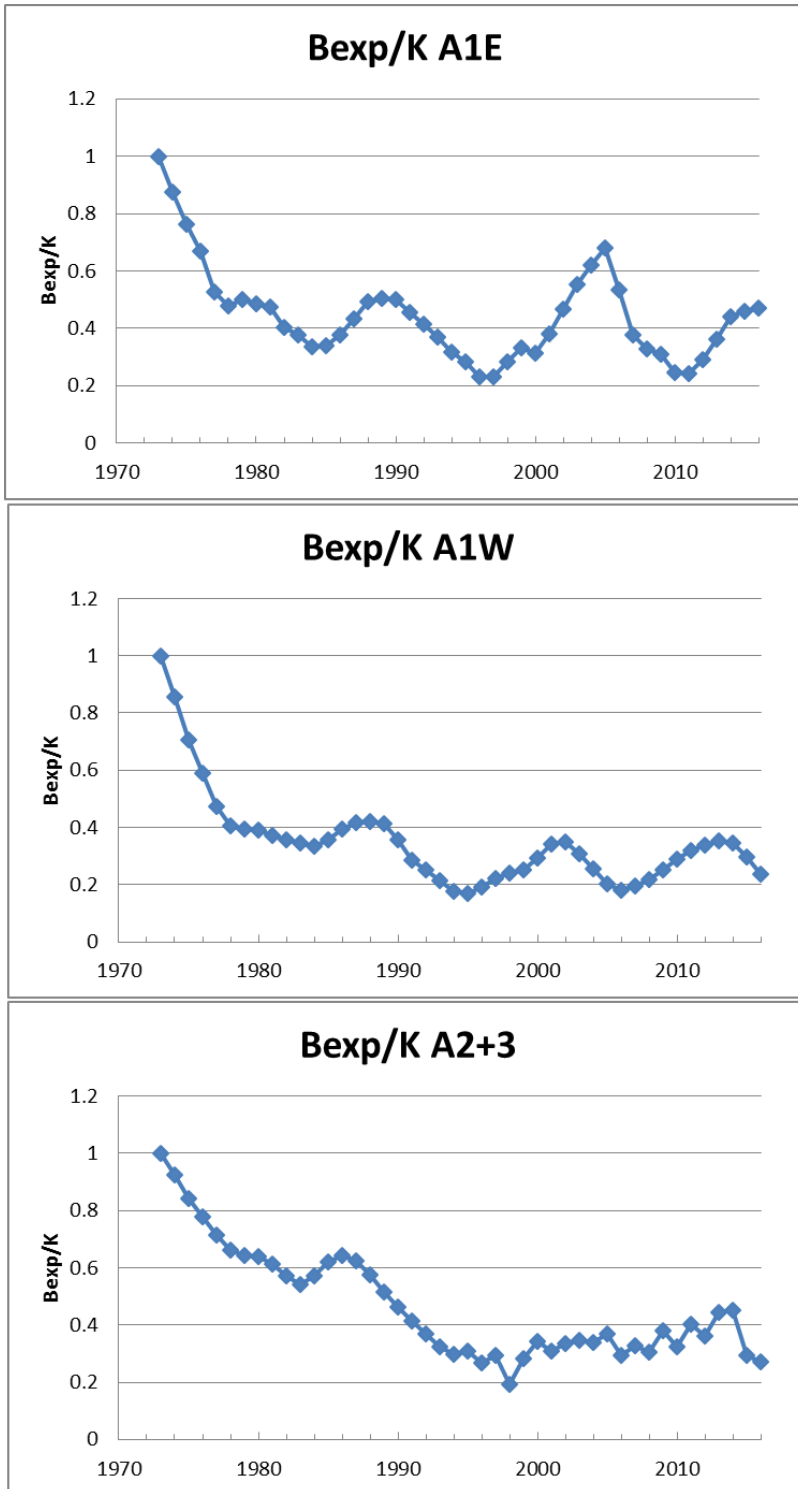


Figure 2b: Model estimates of **spawning biomass relative to K** for the RC, Sen1 (RC but down-weights CAL data by 0.5) and Sen2 (RC but down-weights CAL data by 0.10).

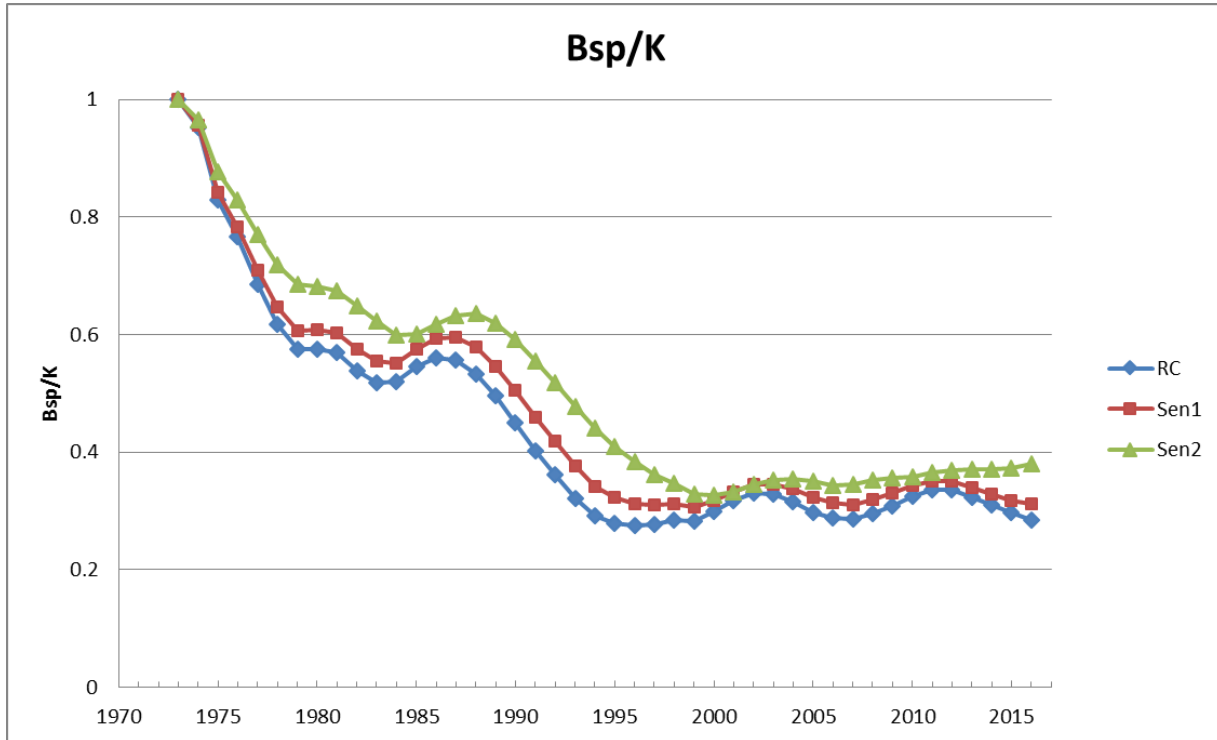


Figure 3: Model estimates of F (the harvest proportion) for the 2018 RC assessment.

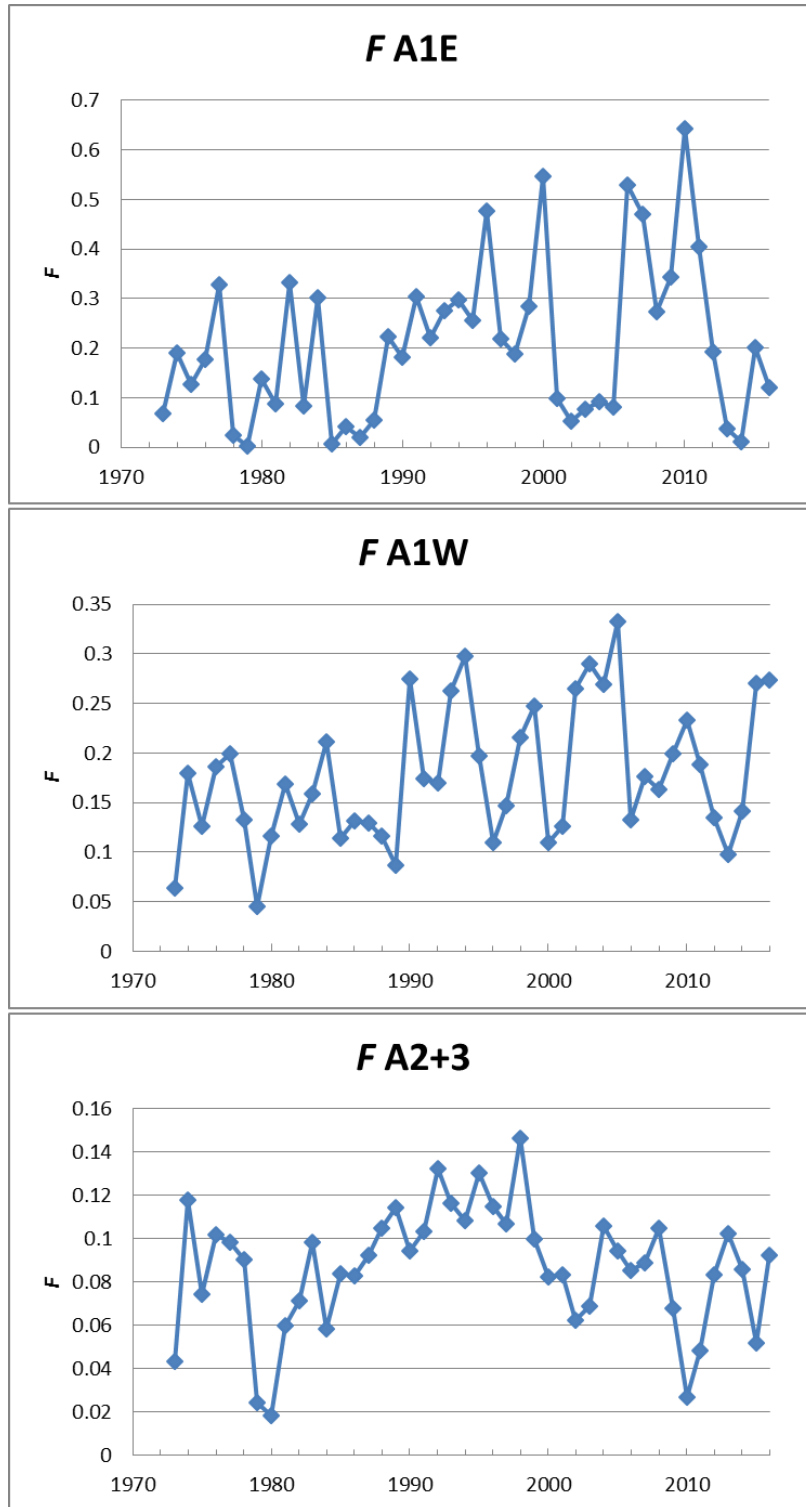


Figure 4a: RC estimated selectivity functions for A1E, A1W and A2+3 (for the 1973-1994 period). Note that the A2+3 selectivity functions vary over time for the period 1995-2015 and these are shown in Figure 4b.

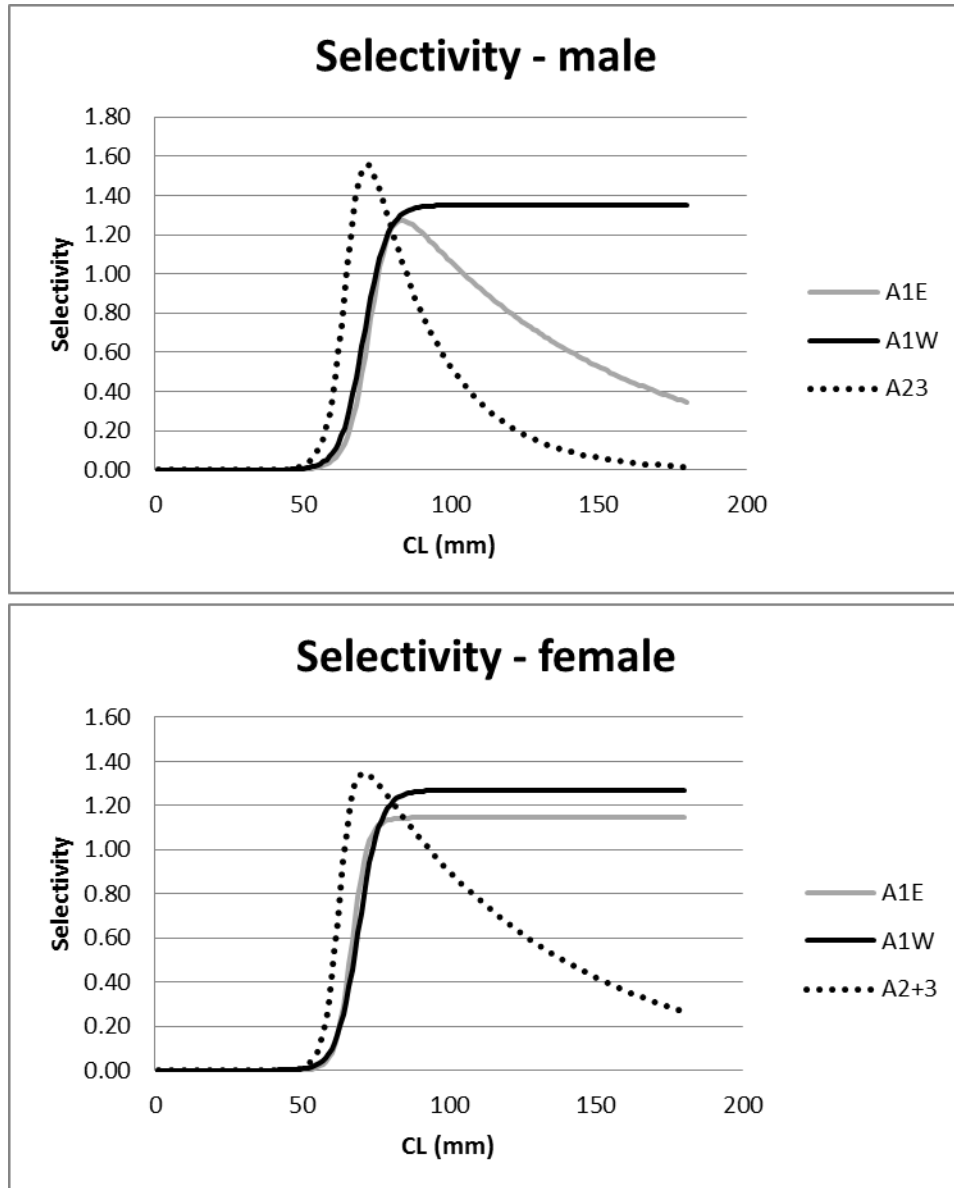


Figure 4b: RC estimated selectivity functions for A2+3 for 1995-2015.

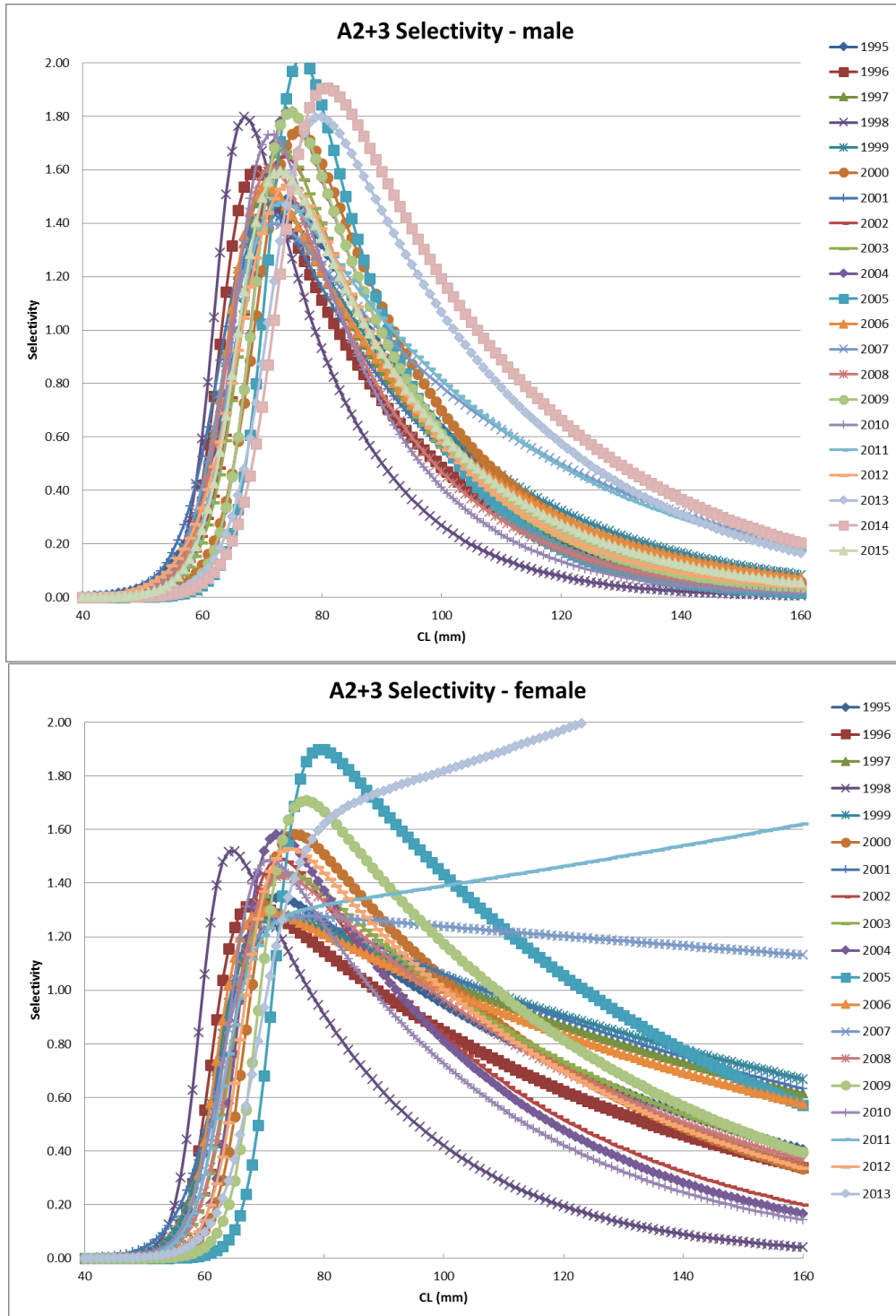


Figure 4c: Comparison of the stock-recruit residuals estimated for the RC ($\sigma_R=0.8$) and Sen3 ($\sigma_R=0.4$).

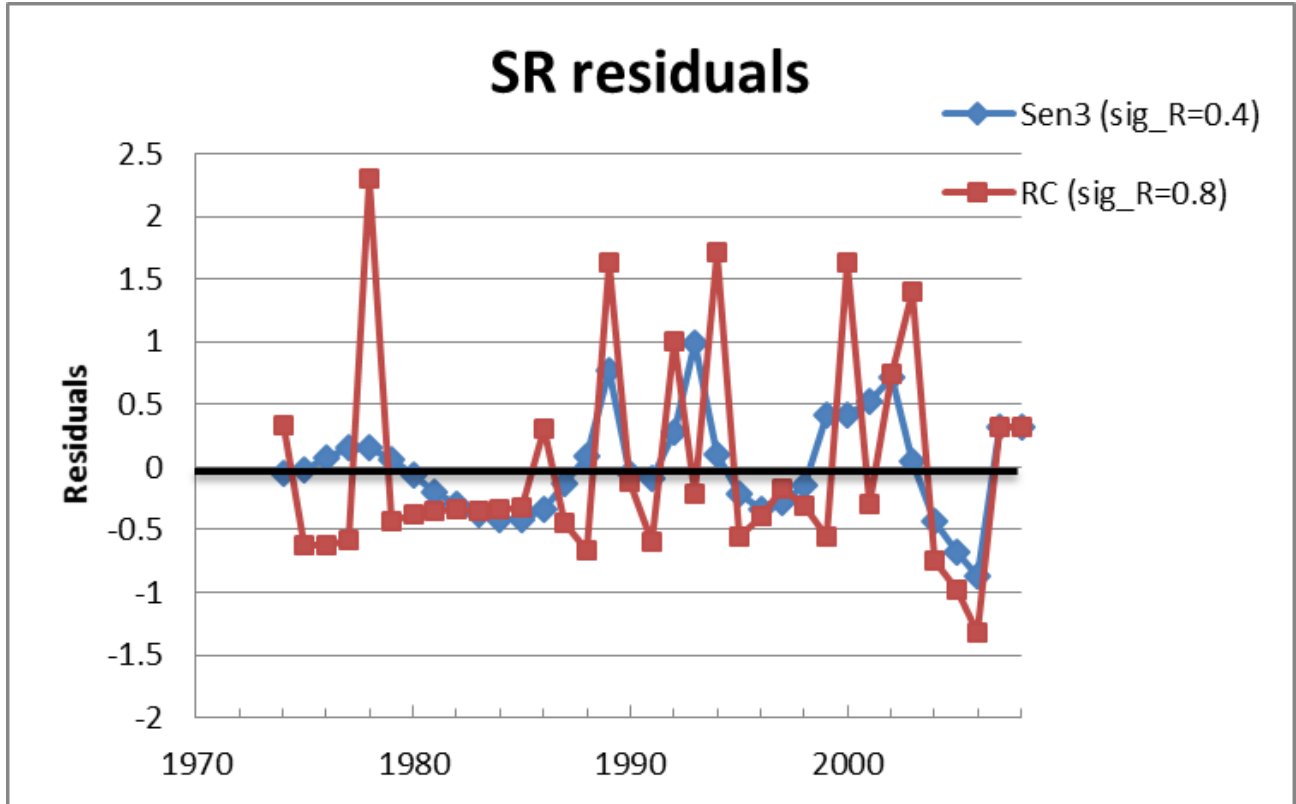


Figure 5: RC catch-at-length residuals. The dark bubbles reflect positive and the light bubbles reflect negative residuals, with the bubble radii proportional to the magnitudes of the residuals.

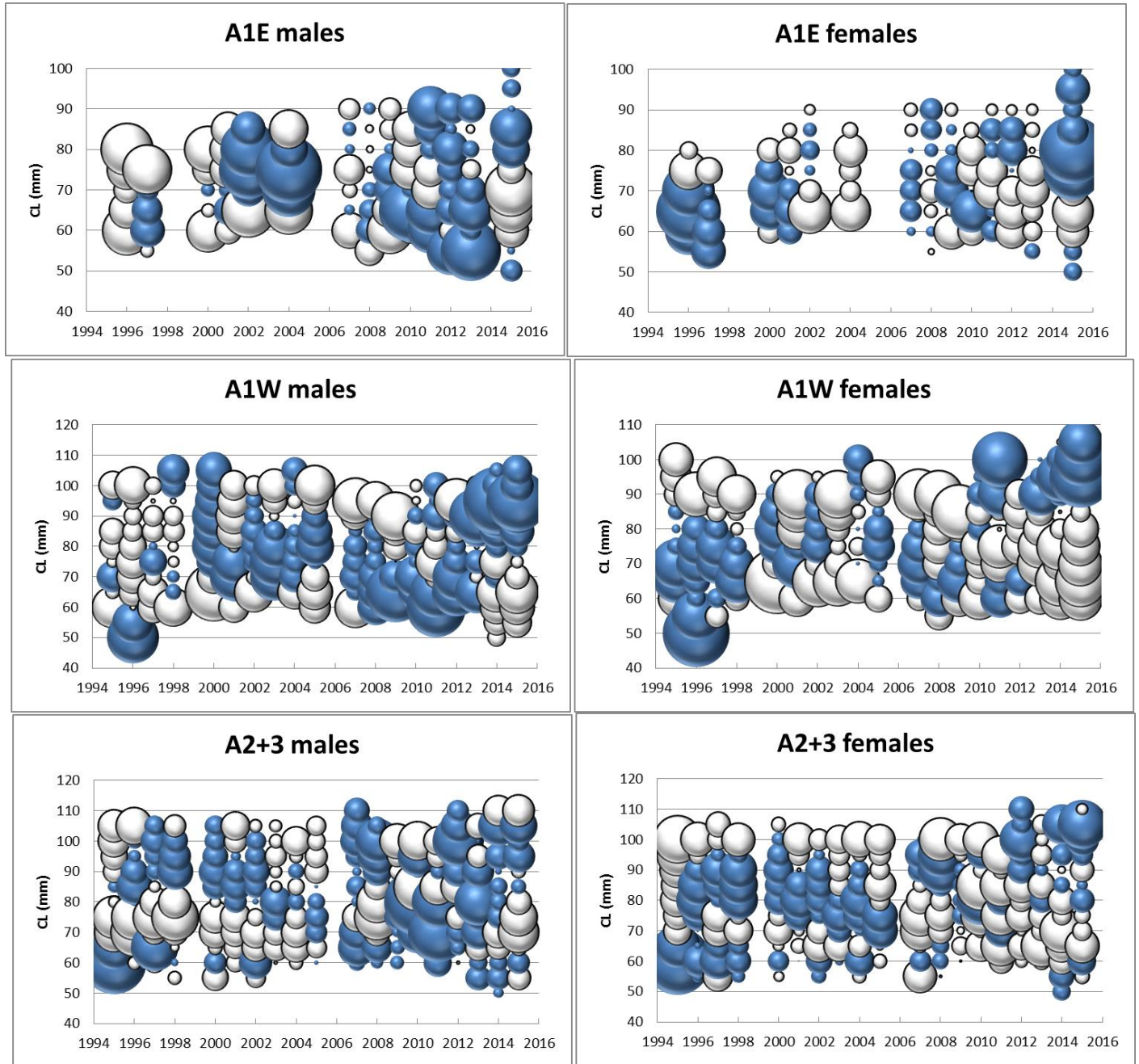


Figure 6: The sustainable yield (SY) versus spawning biomass (Bsp) curve (top) and SY versus F estimated for the 2018 RC assessment model. The current (2017) Bsp value is also indicated on the top plot.

