# Updated 2018 west coast rock lobster assessment results and associated biomass projections under a range of constant future legal catch levels

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**Summary**

A new set of 2018 assessments for all five super-areas for the west coast rock lobster resource has been completed. These are now used as bases for projecting the resource (in each super-area) forwards under a number of constant future legal catch (CC) scenarios, as well as for different past and future poaching scenarios, which also have different impacts on the assessments. Results are reported mainly in relation to the resource as a whole, but an Appendix provides more detailed results for super-area A8+, in which the bulk of the resource is to be found at present.

## Background and Assumptions made

This document provides results of recently updated assessments, followed by projections under different levels of constant future legal catch under various poaching scenarios – first the central one assumed for similar analyses in 2016, and then the base case and two sensitivity variants as agreed at the previous meeting of the WCRL SWG. First the most important assumptions made are set out in the main text below, followed by the results reported both in Tables and Figures. These relate mainly to the resource as a whole. They are followed by three Appendices:

Appendix A lists further assumptions made for the assessments, together with details of the various poaching scenarios considered;

Appendix B lists catches taken by super-area for the current (2017/18) season; these have been taken into account in the projections; and

Appendix C provides more detailed assessment and projections results for super-area A8+, since this super-area contains the bulk of the current WCRL population.

The assessments are essentially identical to those conducted in 2016, except that given further data now available a further recruitment parameter to be estimated, R(2010), has been added. Both the R(2007) and R(2010) recruitment parameters are constrained by a penalty function related to previous recruitments (see Appendix A for details).

The catch split per super-area is virtually as was assumed for the 2016 projections (see Table 1 below).

Table 1: Set of CC values for each super-area. The totals over all five super-areas are given in the first column. The super-area specific values are as used for the projections reported.

| | **A12** | **A34** | **A56** | **A7** | **A8** |
|---|---|---|---|---|---|
| 2016 CC projection values | 30 | 150 | 100 | 150 | 840 |
| 2016 proportional split of CC | 0.024 | 0.118 | 0.079 | 0.118 | 0.661 |
| Total CC= 2000 MT | 47.24 | 236.22 | 157.48 | 236.22 | 1322.83 |
| Total CC= 1500 MT | 35.43 | 177.17 | 118.11 | 177.17 | 992.13 |
| Total CC=1000 MT | 23.62 | 118.11 | 78.74 | 118.11 | 661.42 |
| Total CC=500 MT | 11.81 | 59.06 | 39.37 | 59.06 | 330.71 |
| Total CC=0 MT | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Projections are extended to 2030 rather than to 2021 only as in the past (so as to show the effect of transients resulting from recent recruitment variations, because 2021 is now so close), with catches (legal and poaching), recruitment and somatic growth all assumed to remain unchanged from 2018 onwards.

## Results

CC results are presented for the five assessment/poaching scenarios listed below (the intent is to also provide a comparison with results based on previous assessments and poaching assumptions).

A) OLD (2016) assessment with the 2016 Scenario 5 poaching applying.
B) NEW (2018) updated assessment with the 2016 Scenario 5 poaching applying
C) NEW (2018) updated assessment with the Base Case (BC) poaching scenario applying
D) NEW (2018) updated assessment with the SEN1 poaching scenario applying.
E) NEW (2018) updated assessment with the SEN2 poaching scenario applying.

The BC, SEN1 and SEN2 poaching scenarios are as agreed at the previous WCRL SWG meeting (see Appendix A).

Note that CC always refers to the legal catch only (offshore, inshore, IR and recreational). Results for A8+ are presented for all these scenarios and included in Table 2 below (with some related Figures in Appendix C), whereas results for the resource as a whole are presented in Table 3 and the Figure 1 below, but only for scenario A – the NEW assessment with the BC poaching scenario. Figure 2 shows these last results disaggregated by super-area.

## Discussion

In developing TAC recommendations, the most important Figure upon which to focus is Figure 1a, which shows projections under different future constant legal catches for the BC poaching scenario. The immediate mini-peak in abundance, followed by a decline for most CC levels shown, is primarily a consequence of some above average recruitment to A8+ in the middle years of the first decade of this century, followed by relatively weaker subsequent recruitment (see Figure 6c). Note that the flattening of the projections for the higher CC levels in the late 2020's reflects over-optimistic results,

as these computations have yet to take into account that recruitment will fall (on average) as the biomass is reduced to lower levels in these cases, resulting in future abundances less than shown.

Figures 1b and 1c show results for the poaching sensitivity scenarios, while Figure 1d shows these results compared across the BC and two sensitivities.

Figures 2a-2e show these results disaggregated by super-area. These show that the downward trends in the projections arise primarily from the situation in super-area 8+, where the sustainable legal catch is virtually zero given current extent of poaching. This suggests that a redistribution of the TAC away from the proportions shown in Table 1, likely through some A8+ allocation moved to A34, could be desirable.

Table 2: Projection results for A8+ for five assessments and 5 different future A8+ legal CC values. (These CC values correspond to 2000, 1500, 1000, 500 and 0 for the whole resource.)

| | Assessment | **B75m(2021/2006)** | **B75m(2030/2006)** | **B75m(2021/2018)** | **B75m(2030/2018)** |
|---|---|---|---|---|---|
| **CC=1322** | OLD+Scen 5 | 0.325 | - | 0.724 | - |
| | NEW+Scen 5 | 0.733 | 0.180 | 1.097 | 0.269 |
| | NEW+BC | 0.749 | 0.030 | 1.100 | 0.043 |
| | NEW+SEN1 | 0.949 | 0.196 | 1.313 | 0.272 |
| | NEW+SEN2 | 0.866 | 0.101 | 1.243 | 1.145 |
| | | | | | |
| **CC=992** | OLD+Scen 5 | 0.463 | - | 0.952 | - |
| | NEW+Scen 5 | 0.811 | 0.583 | 1.213 | 0.087 |
| | NEW+BC | 0.827 | 0.066 | 1.214 | 0.098 |
| | NEW+SEN1 | 1.027 | 0.548 | 1.421 | 0.758 |
| | NEW+SEN2 | 0.522 | 0.157 | 1.116 | 0.337 |
| | | | | | |
| **CC=661** | OLD+Scen 5 | 0.600 | - | 1.151 | - |
| | NEW+Scen 5 | 0.891 | 0.221 | 1.330 | 0.330 |
| | NEW+BC | 0.965 | 0.254 | 1.329 | 0.376 |
| | NEW+SEN1 | 1.105 | 0.887 | 1.529 | 1.228 |
| | NEW+SEN2 | 0.604 | 0.533 | 1.291 | 1.139 |
| | | | | | |
| **CC=331** | OLD+Scen 5 | 0.738 | - | 1.321 | - |
| | NEW+Scen 5 | 0.968 | 0.545 | 1.447 | 0.814 |
| | NEW+BC | 0.983 | 0.579 | 1.443 | 0.849 |
| | NEW+SEN1 | 1.183 | 1.218 | 1.637 | 1.686 |
| | NEW+SEN2 | 0.685 | 0.891 | 1.465 | 1.906 |
| | | | | | |
| **CC=0** | OLD+Scen 5 | 0.875 | - | 1.469 | - |
| | NEW+Scen 5 | 1.047 | 0.872 | 1.564 | 1.302 |
| | NEW+BC | 1.061 | 0.905 | 1.558 | 1.328 |
| | NEW+SEN1 | 1.261 | 1.547 | 1.745 | 2.141 |
| | NEW+SEN2 | 0.767 | 1.244 | 1.639 | 2.659 |

Table 3: Projection results for all five super-areas for five different future legal **total** CC values. Results are reported for the NEW assessment + BC poaching scenario.

| | CC | B75m(2021/2006) | B75m(2030/2006) | B75m(2021/2018) | B75m(2030/2018) |
|---|---|---|---|---|---|
| A1+2 | 47 | 0.947 | 0.789 | 0.968 | 0.809 |
| A3+4 | 236 | 0.777 | 0.599 | 1.049 | 0.809 |
| A5+6 | 157 | 2.259 | 2.234 | 1.197 | 1.184 |
| A7 | 236 | 0.683 | 0.910 | 0.975 | 1.300 |
| A8+ | 1322 | 0.749 | 0.030 | 1.100 | 0.043 |
| **Total** | **2000** | **0.875** | **0.591** | **1.070** | **0.722** |
| | | | | | |
| A1+2 | 35 | 0.979 | 0.882 | 1.000 | 0.900 |
| A3+4 | 177 | 0.801 | 0.707 | 1.082 | 0.955 |
| A5+6 | 118 | 2.302 | 2.424 | 1.220 | 1.282 |
| A7 | 177 | 0.707 | 0.959 | 1.010 | 1.369 |
| A8+ | 992 | 0.827 | 0.066 | 1.214 | 0.098 |
| **Total** | **1500** | **0.922** | **0.660** | **1.127** | **0.807** |
| | | | | | |
| A1+2 | 24 | 1.008 | 0.967 | 1.030 | 0.987 |
| A3+4 | 118 | 0.826 | 0.815 | 1.116 | 1.100 |
| A5+6 | 79 | 2.345 | 2.613 | 1.244 | 1.384 |
| A7 | 118 | 0.731 | 1.007 | 1.043 | 1.438 |
| A8+ | 661 | 0.965 | 0.254 | 1.325 | 0.376 |
| **Total** | **1000** | **0.968** | **0.788** | **1.184** | **0.964** |
| | | | | | |
| A1+2 | 12 | 1.040 | 1.060 | 1.062 | 1.083 |
| A3+4 | 59 | 0.851 | 0.921 | 1.149 | 1.244 |
| A5+6 | 39 | 2.390 | 2.806 | 1.266 | 1.487 |
| A7 | 59 | 0.754 | 1.055 | 1.077 | 1.506 |
| A8+ | 331 | 0.983 | 0.579 | 1.443 | 0.849 |
| **Total** | **500** | **1.015** | **0.970** | **1.241** | **1.186** |
| | | | | | |
| A1+2 | 0 | 1.072 | 1.154 | 1.095 | 1.179 |
| A3+4 | 0 | 0.877 | 1.029 | 1.183 | 1.382 |
| A5+6 | 0 | 2.433 | 2.993 | 1.289 | 1.586 |
| A7 | 0 | 0.779 | 1.103 | 1.116 | 1.574 |
| A8+ | 0 | 1.061 | 0.905 | 1.558 | 1.328 |
| **Total** | **0** | **1.061** | **1.152** | **1.298** | **1.409** |

Figure 1a: Comparison of resource total B75m projections for the NEW assessment and the BC poaching scenario under five different future total CC values. The green horizontal line indicated the 2006 biomass level.

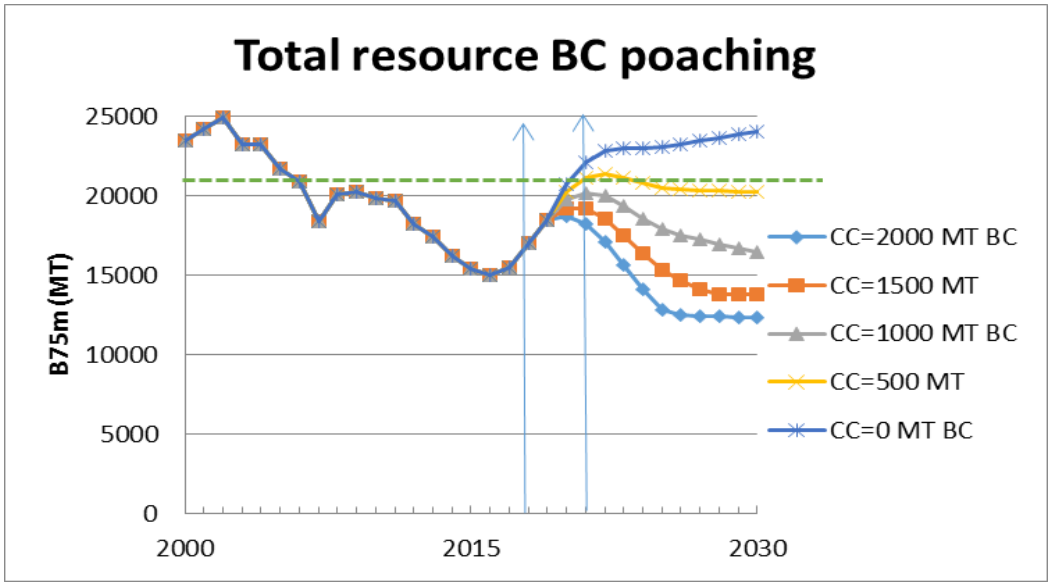



Figure 1b: Comparison of resource total B75m projections for the NEW assessment and the SEN1 poaching scenario under five different future total CC values. The green horizontal line indicated the 2006 biomass level.

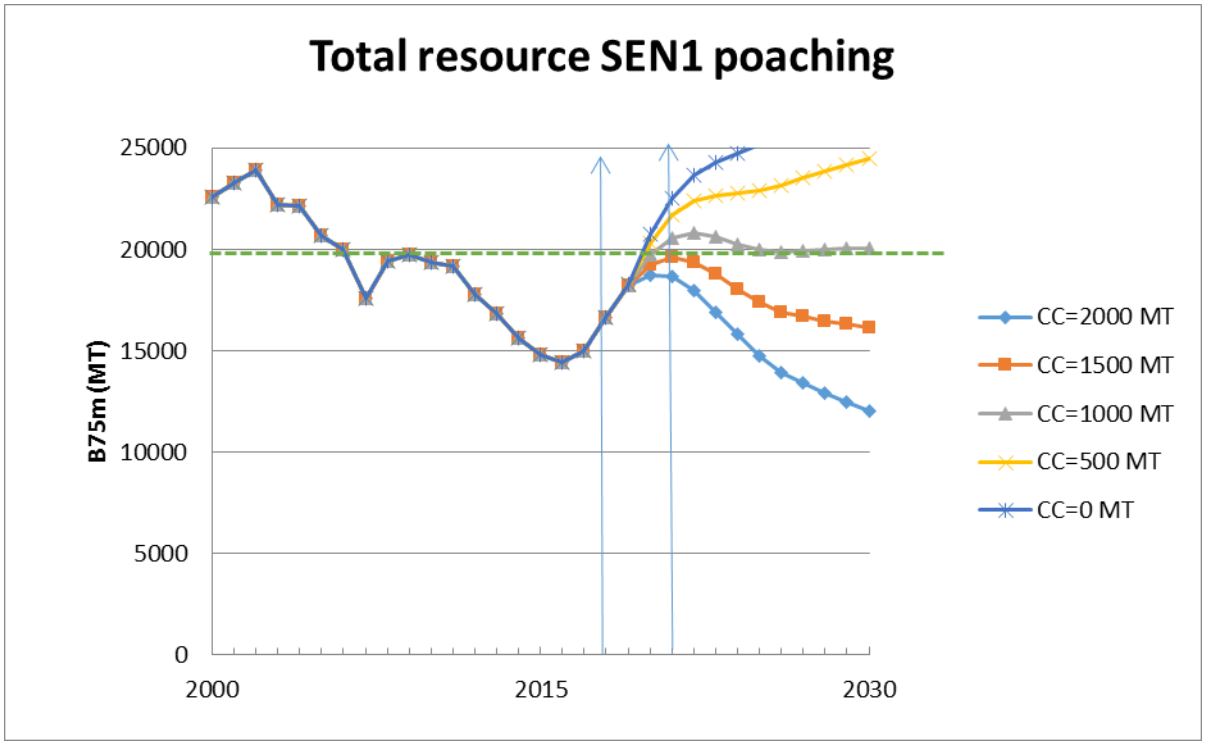


Figure 1c: Comparison of resource total B75m projections for the NEW assessment and the SEN2 poaching scenario under five different future total CC values. The green horizontal line indicated the 2006 biomass level.

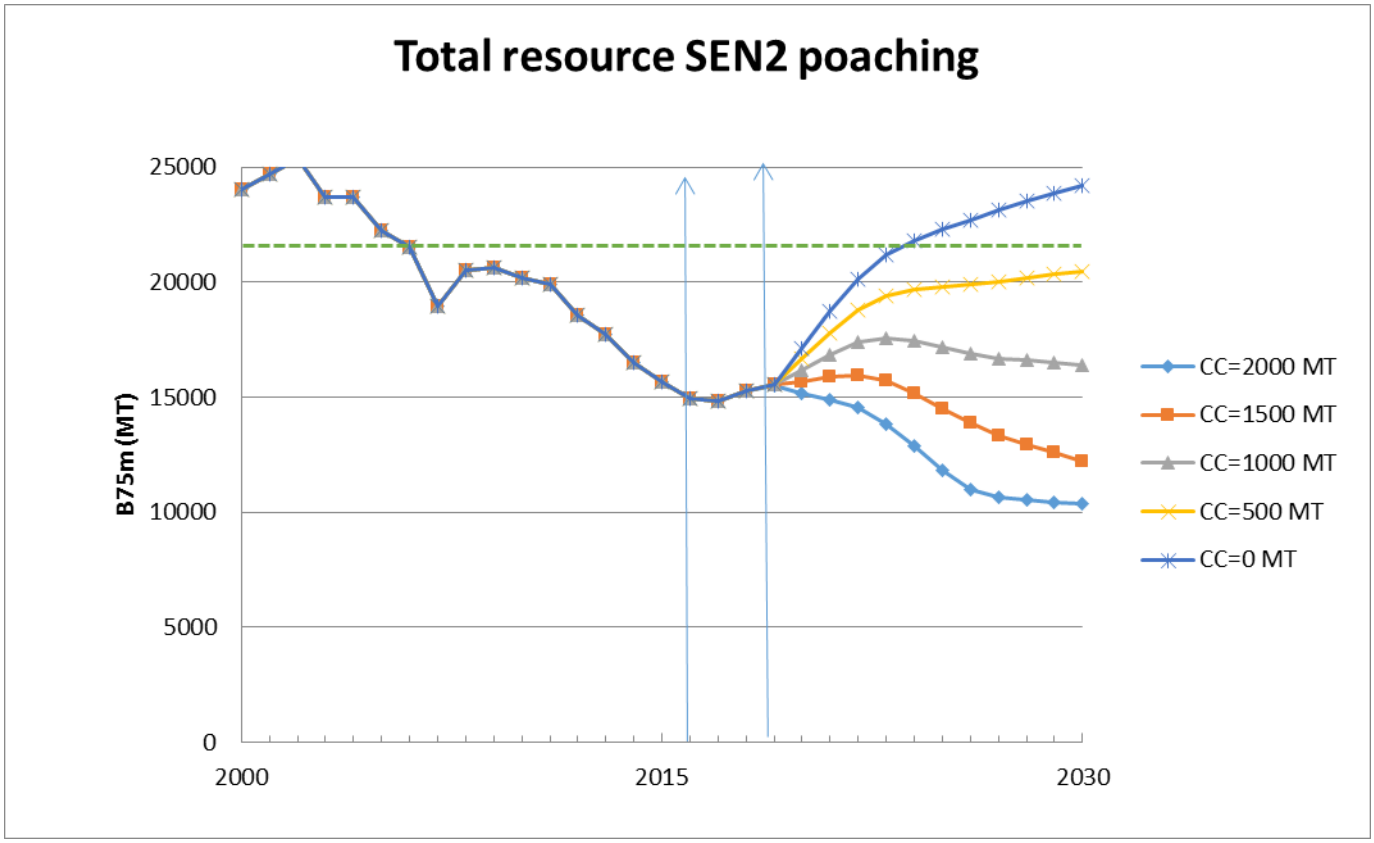


Figure 1d: Comparison of resource total B75m projections for the NEW assessment and the BC and SEN1 poaching scenarios under three different future total legal CC values (2000 MT, 1000 MT and 0 MT).

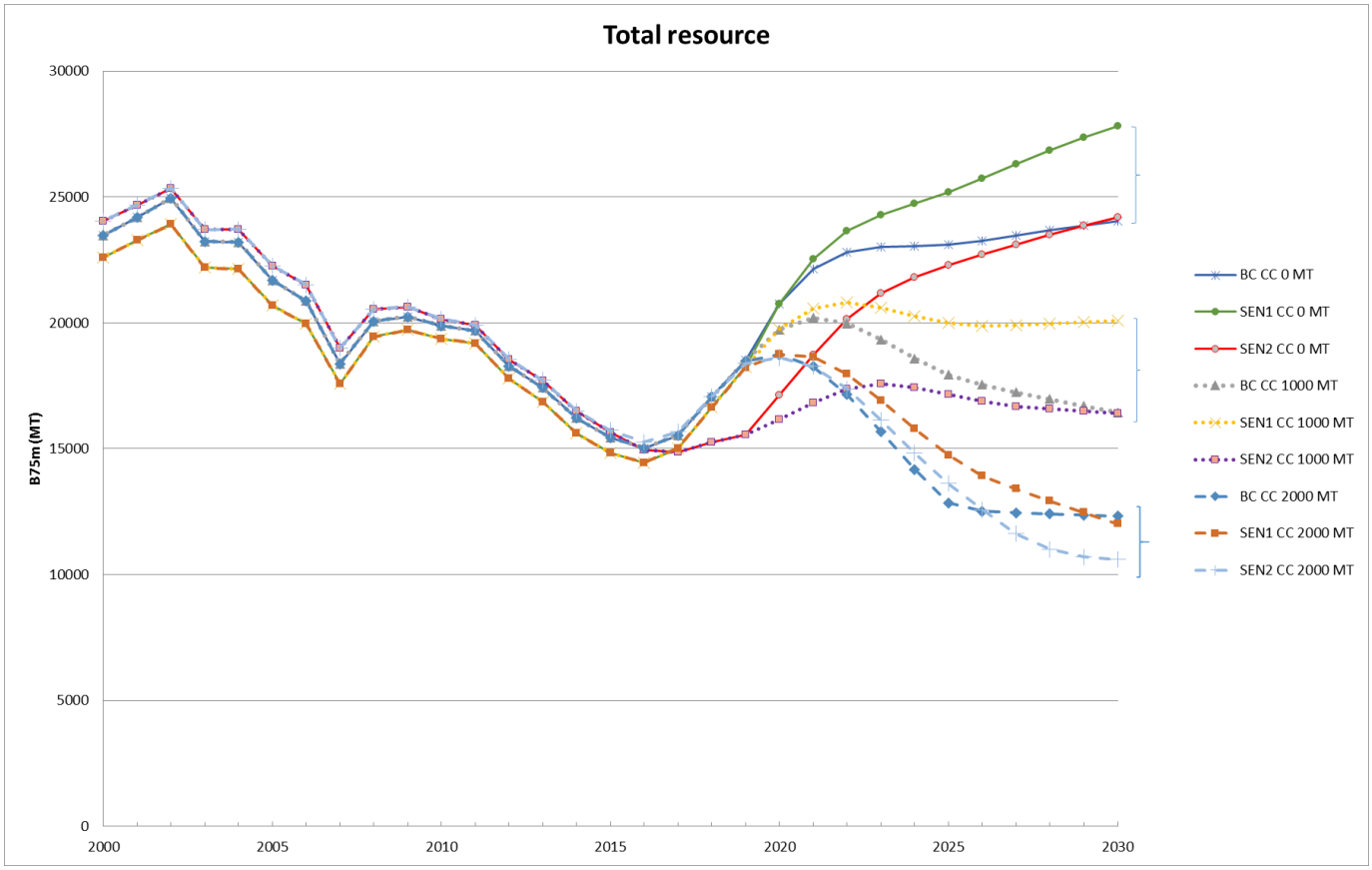
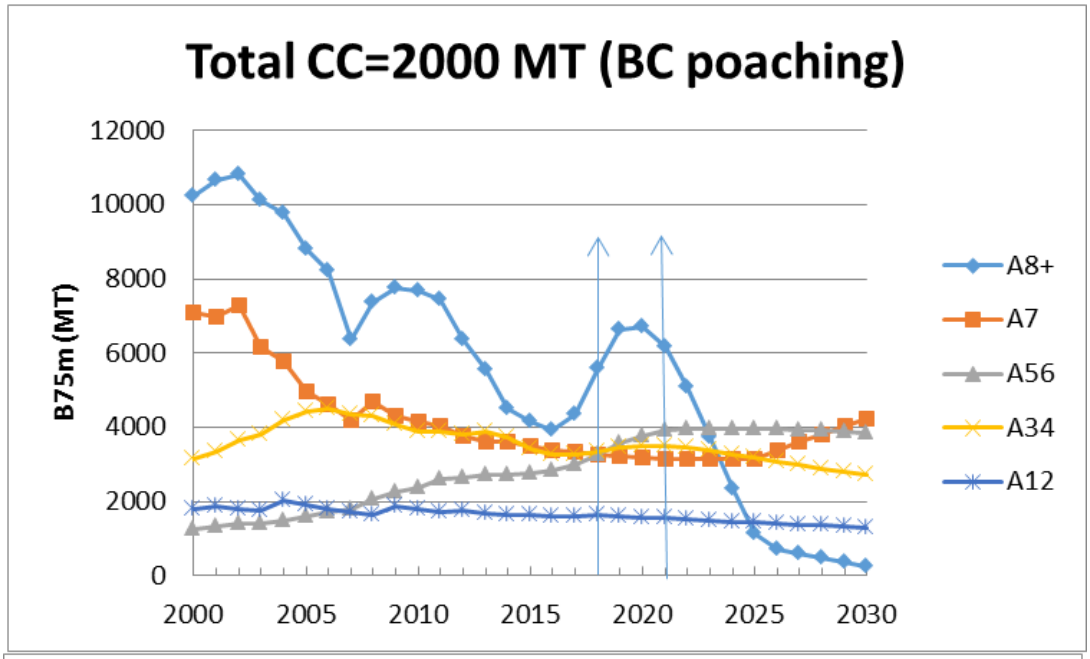


Figure 2a: B75m projections for all five super-areas assuming the NEW assessment and the BC poaching scenario applies: results are presented for a resource total legal CC of **2000 MT**.



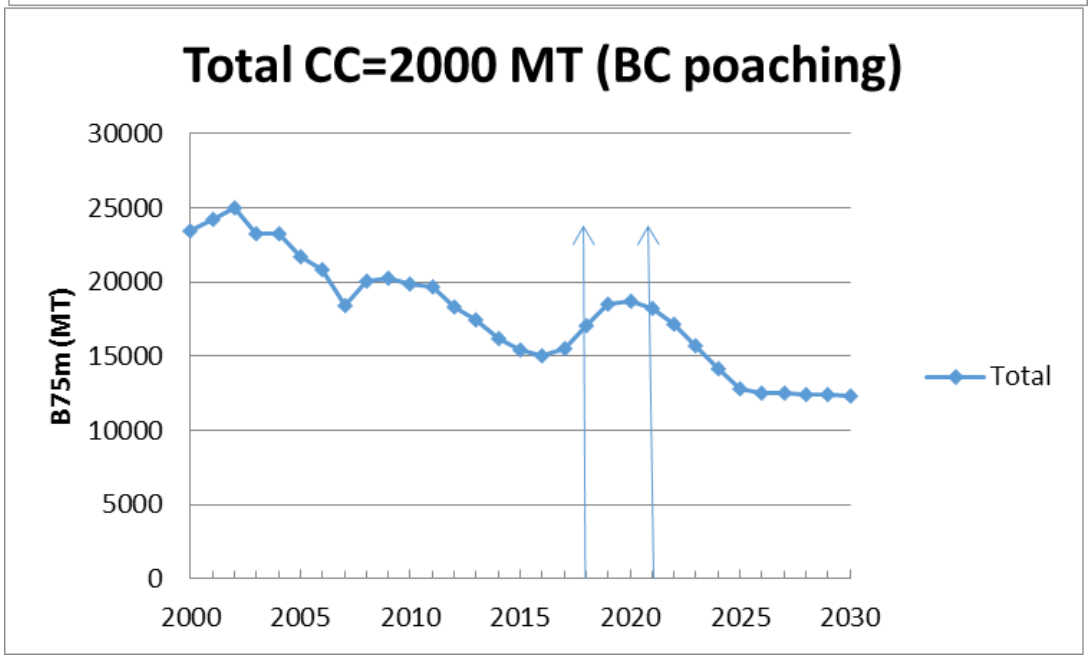
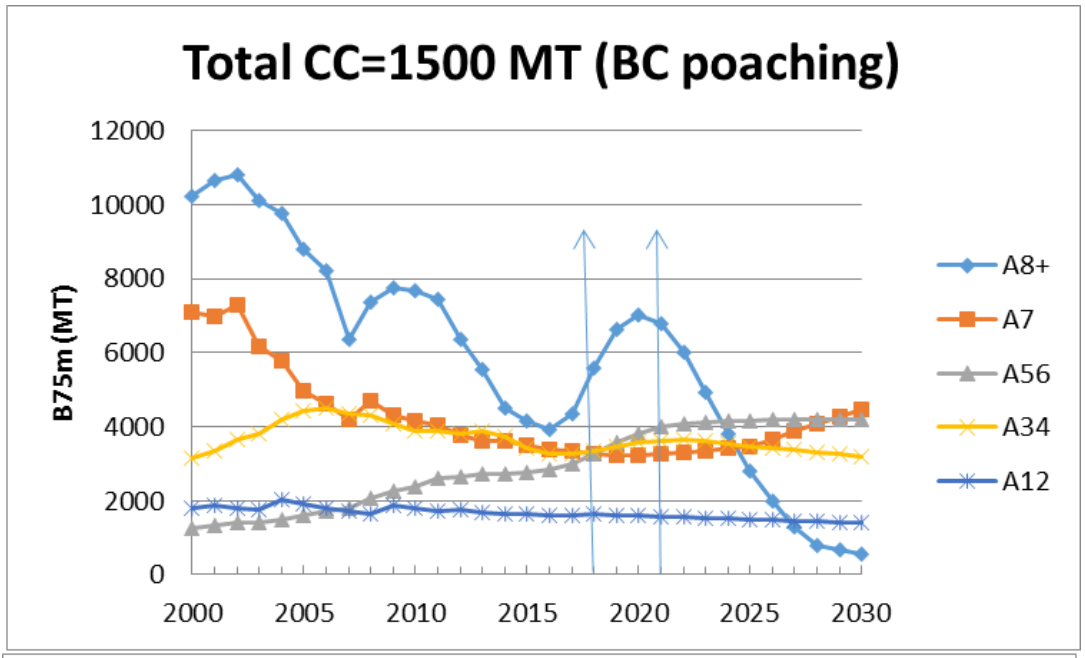



Figure 2b: B75m projections for all five super-areas assuming the NEW assessment and the BC poaching scenario applies: results are presented for a resource total of legal CC of **1500 MT**.



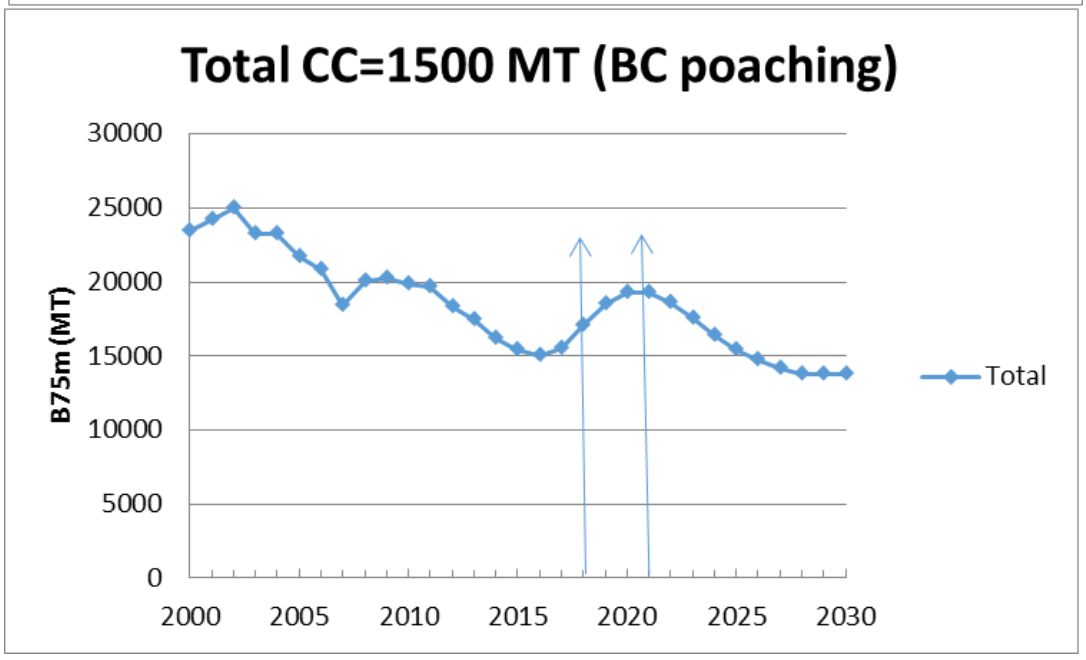
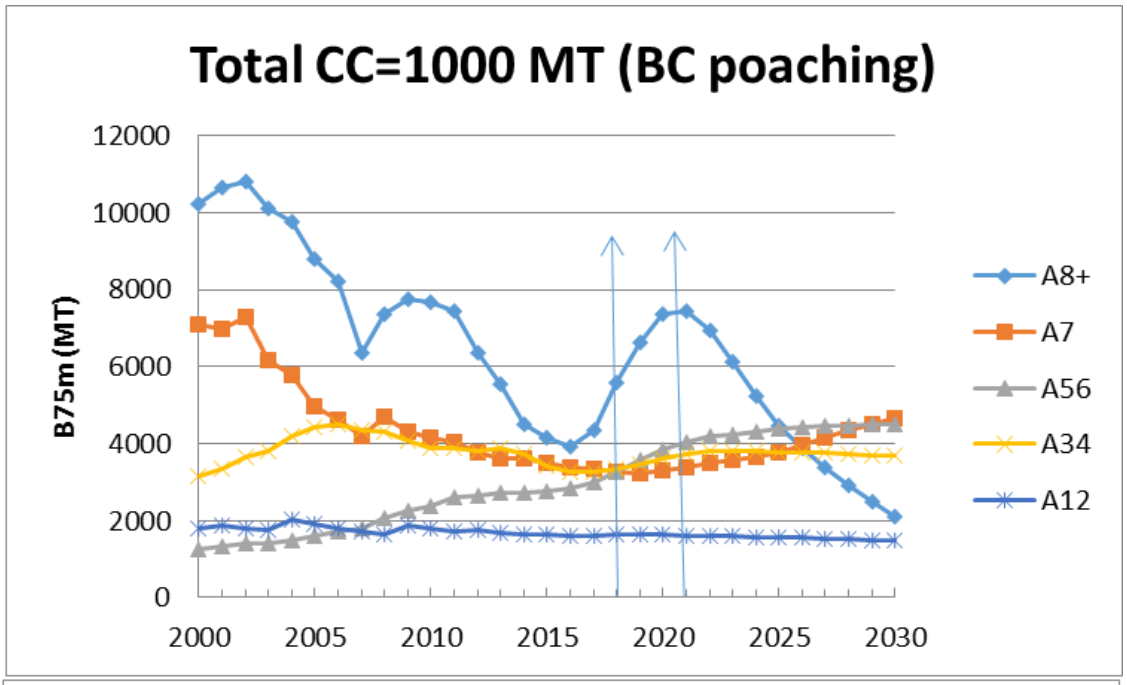



Figure 2c: B75m projections for all five super-areas assuming the NEW assessment and the BC poaching scenario applies: results are presented for a resource total legal CC of **1000 MT**.



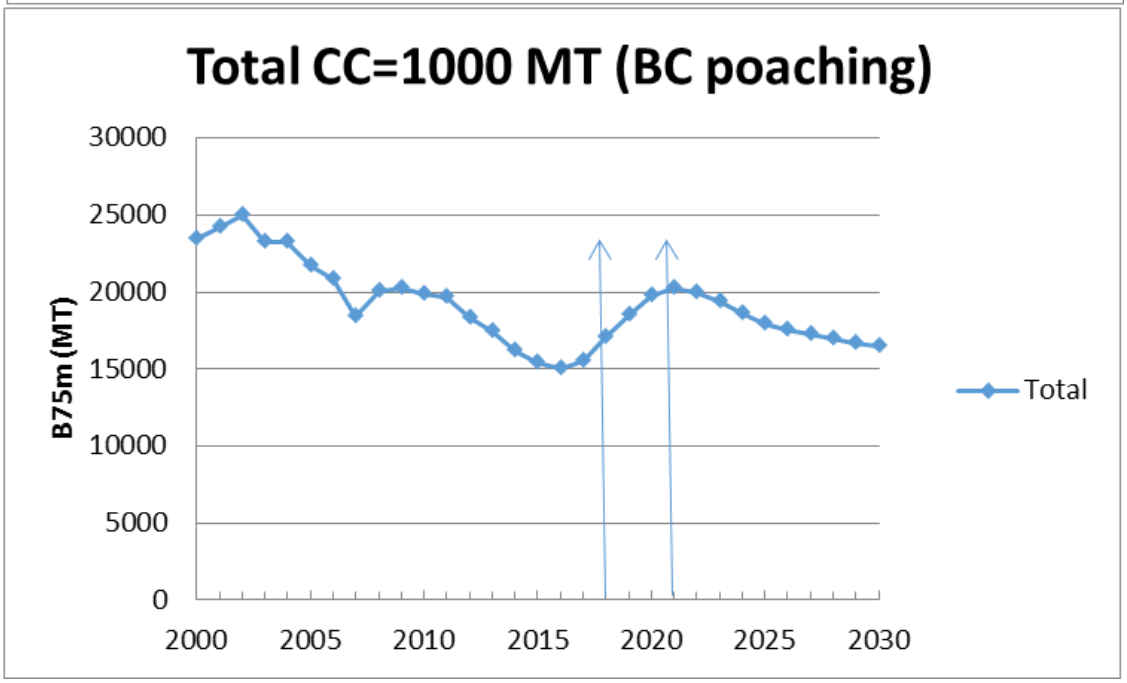
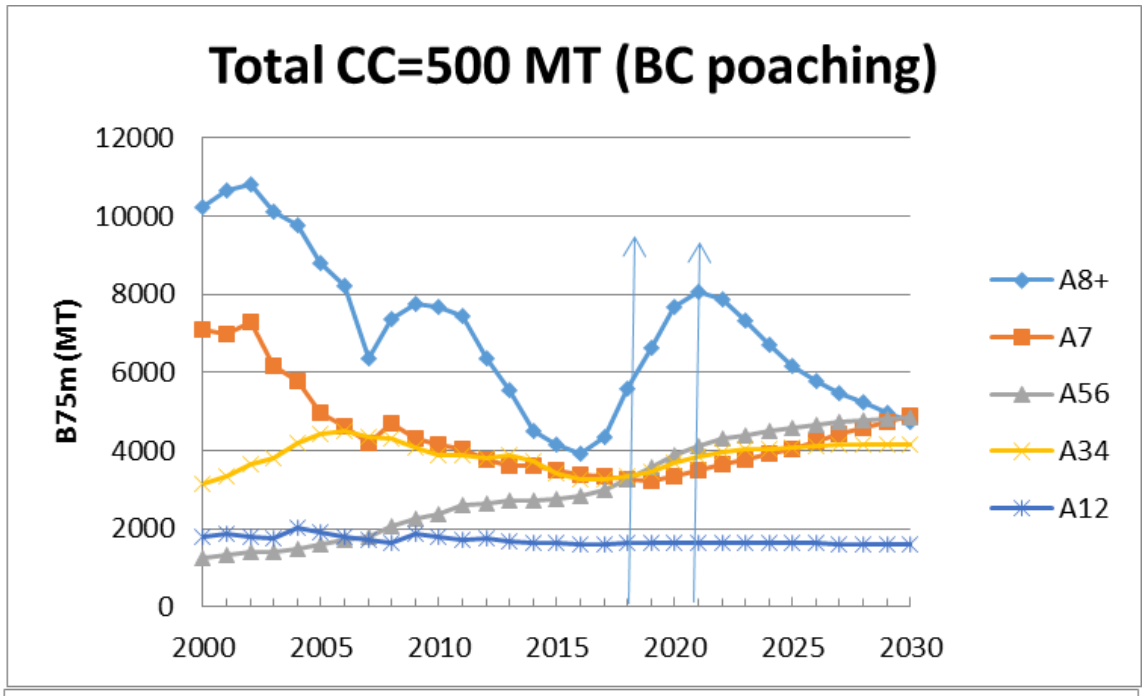



Figure 2d: B75m projections for all five super-areas assuming the NEW assessment and the BC poaching scenario applies: results are presented for a resource total legal CC of **500 MT**.



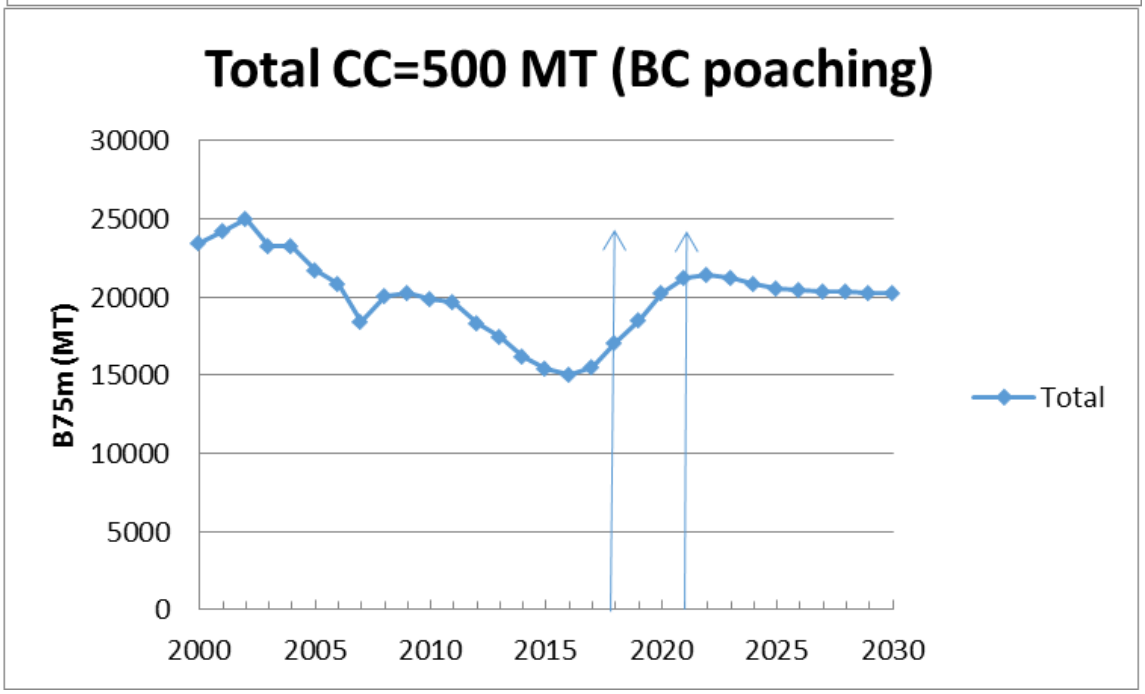
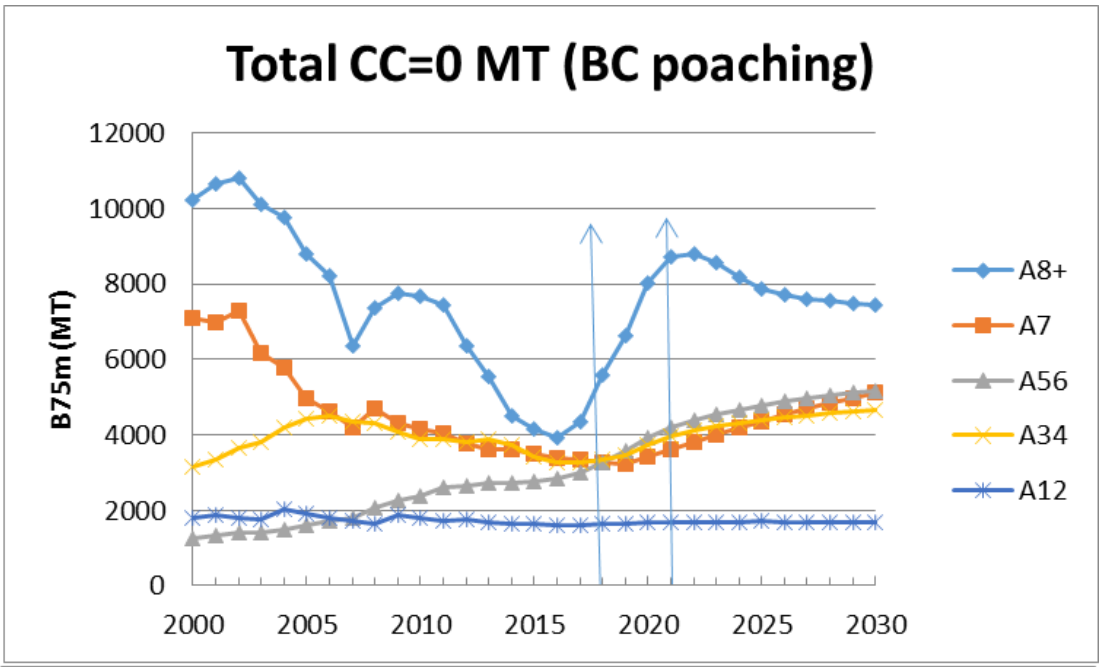
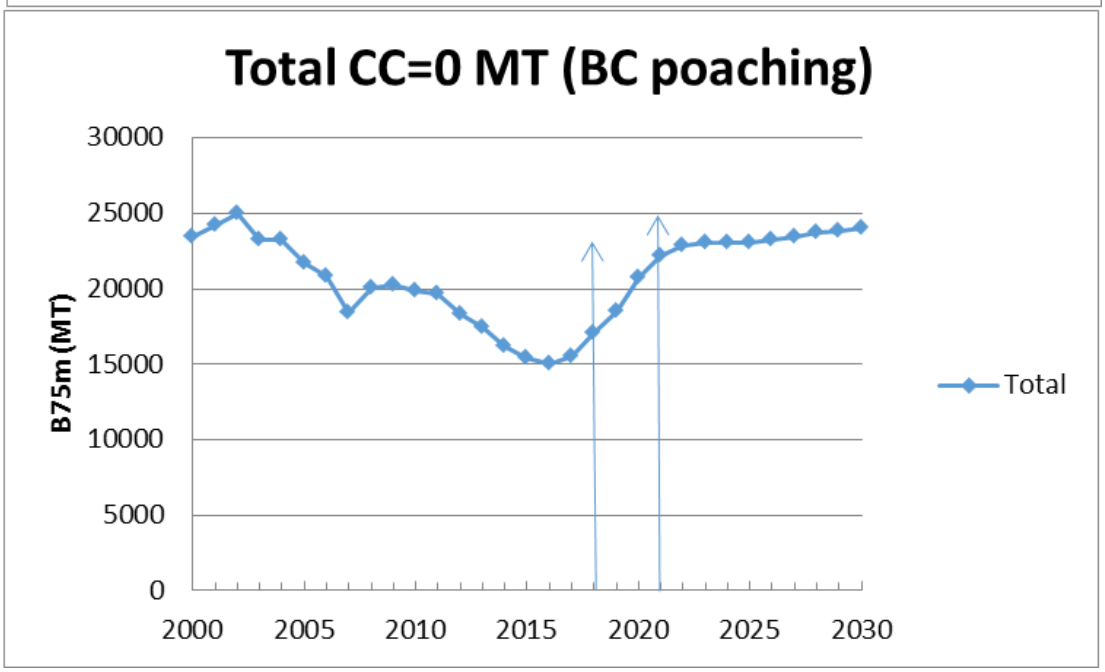



Figure 2e: B75m projections for all five super-areas assuming the NEW assessment and the BC poaching scenario applies: results are presented for a resource total CC of **0 MT**.



# Appendix A: Details of projections and poaching scenarios

**Estimation and projection of recruitment**

The recruitment trend is modelled as for the 2013-2015 assessments: recruitment is assumed to change linearly between a set of estimated recruitment values over time. Recruitment is estimated for the following years:

R1910, R1920, R1950, R1970, R1975, R1980, R1985, R1990, R1995, R1998, R2001, R2004, R2007 and R2010. The R2010 is a new additional recruitment parameter estimated in the model fit given the further years of data now available.

- R2013+ is set equal to the geometric mean ($\bar{R}$) of the R1975, R1980, R1985, R1990, R1995, R1998, R2001, R2004, R2007 and 2010 estimated values.
- The R2007 and 2010 values are constrained by a penalty added to the –*ln*L based on the geometric mean as follows:

$$pen1 = \frac{1}{2}\frac{(lnR_{2007} - ln\bar{R})^2}{\sigma_R^2} \quad \text{and}$$

$$pen2 = \frac{1}{2}\frac{(lnR_{2010} - ln\bar{R})^2}{\sigma_R^2} \quad \text{where}$$

$$\sigma_R^2 = \frac{\sum_{y=1975}^{y=2010}(lnR_y - ln\bar{R})^2}{9}$$

- All recruitments are constrained to be less than R1910.

Note that values assumed for recruitment after 2010 do not affect the assessment results shown, but do impact future projections.

- Future somatic growth (2018+) is set at the average value of the 1989-2017 values.

## Poaching Scenarios used in these projections

In 2016 the baseline poaching scenario used for projections when deliberating the TAC for the 2016/17 season was called “Scenario 5” and is shown in Figure A1 below.

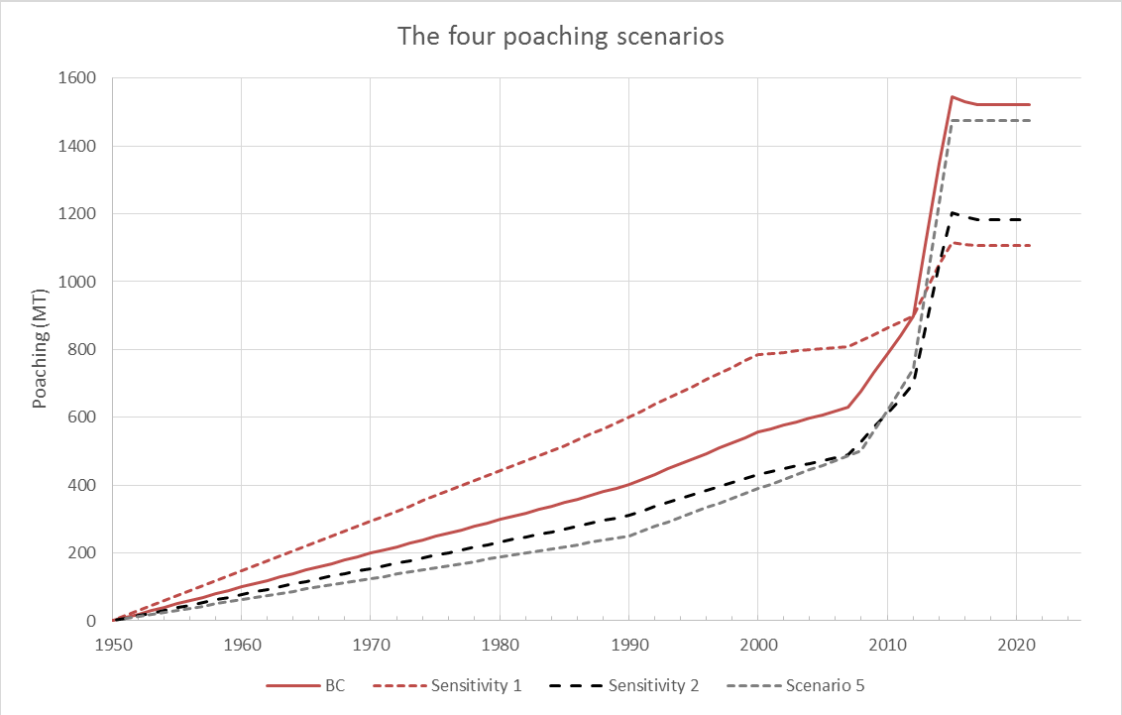
In 2018, a WCRL TT examined all the current information regarding poaching – both absolute (from TRAFFIC sources) and trend information from compliance and TRAFFIC sources of data.

FISHERIES/2018/AUG/SWG/WCRL22 provide details of the TT recommendations. Table A1 below sets out the values associated with the three 2018 poaching scenarios recently agreed by the WCRL SWG.

Table A1: Poaching amounts for the Total resource for the Base Case and two sensitivity proposals.

| | **Base Case** | **Sensitivity 1** | **Sensitivity 2** |
|---|---|---|---|
| 1950 | 0 | 0 | 0 |
| 1985 | 348 | 516 | 271 |
| 1990 | 402 | 601 | 312 |
| 2000 | 556 | 785 | 432 |
| 2008 | 678 | 826 | 527 |
| 2012 | **900** | **900** | **700** |
| 2014 | 1350 | 1050 | 1050 |
| 2015 | 1546 | 1115 | 1202 |
| 2017 + | 1521 | 1107 | 1183 |

Figure A1: The four poaching scenarios considered in this document.



## Appendix B: Final catches for the 2017/18 season

Table B1: Values in tons taken from FISHERIES/2018/APR/SWG/WCRL03.

| | |
|---|---|
| A1+2 | |
| Catch | 5.1 |
| | |
| A3+4 | |
| Catch | 175 |
| | |
| A5+6 | |
| Catch | 26 |
| | |
| A7 | |
| Catch | 99 |
| | |
| A8+ | |
| Catch | 984 |
| | |

# Appendix C: Details of A8+ assessments and projections for 2018 with some comparisons to 2016

Figure C1: Comparison of estimated A8+ B75m (MT) trends for four of the assessments.

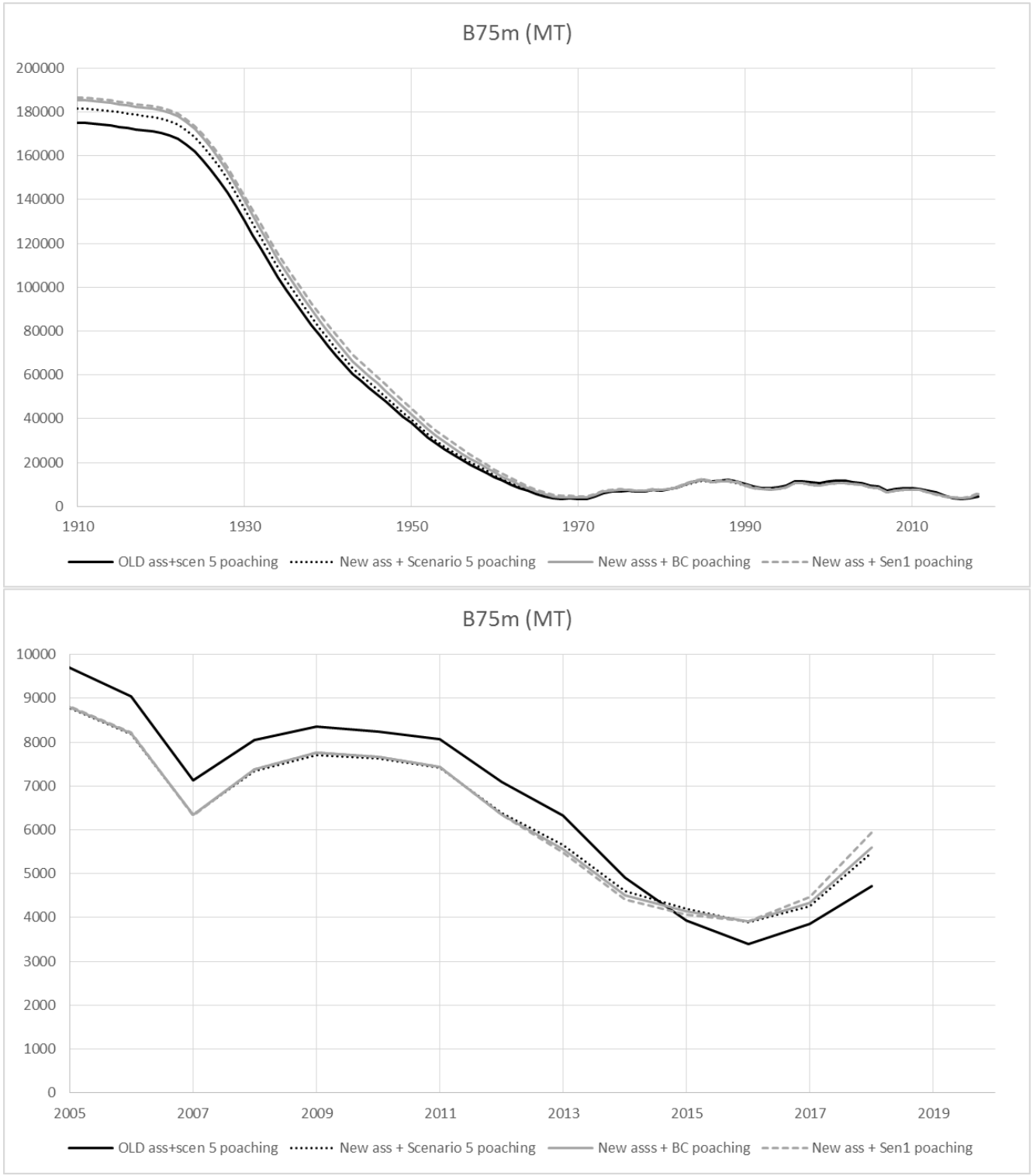


Figure C2: Comparisons of A8+ projected B75m biomass trends for each of the four assessments assuming a future legal CC=661 MT (corresponding to a legal CC for the whole resource of 1000 MT).

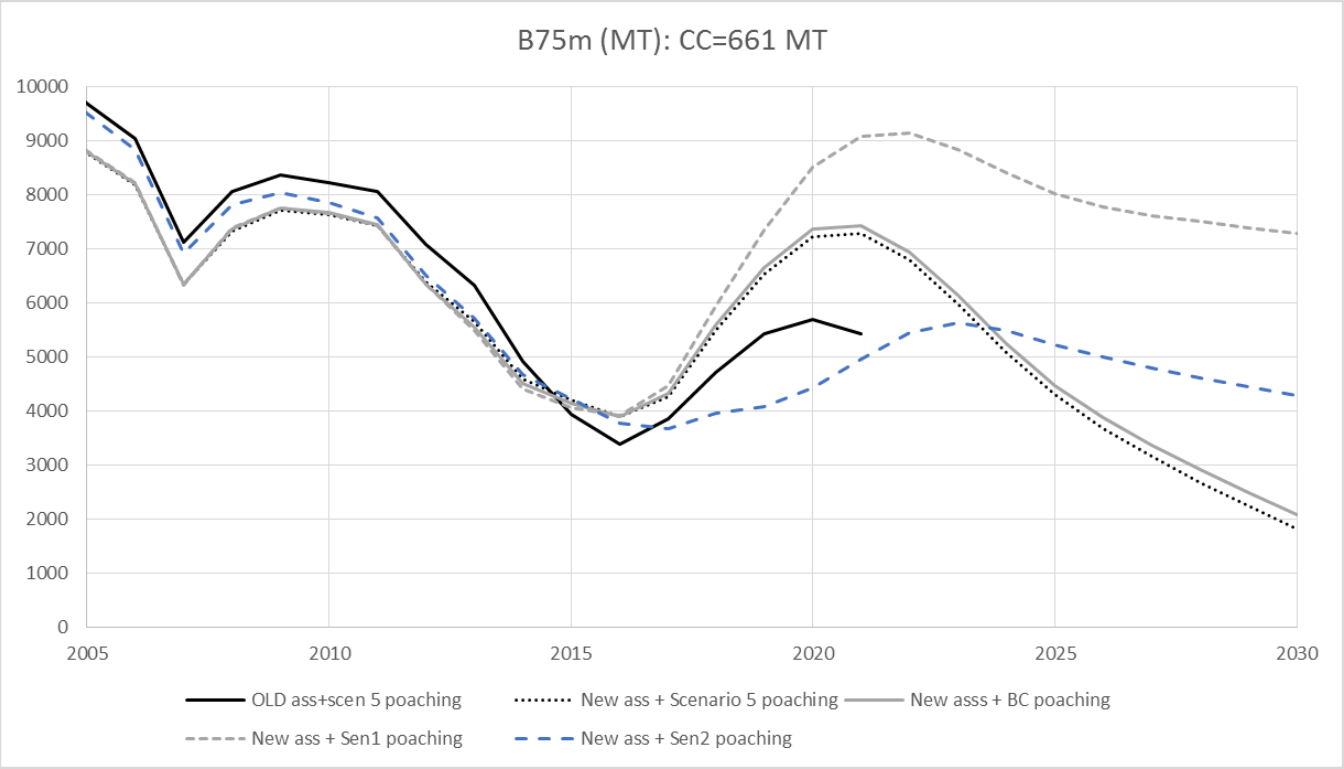


Figure C3 Comparisons of A8+ projected B75m biomass trends for the NEW assessment + BC poaching scenario, for five different future A8+ legal CC levels.

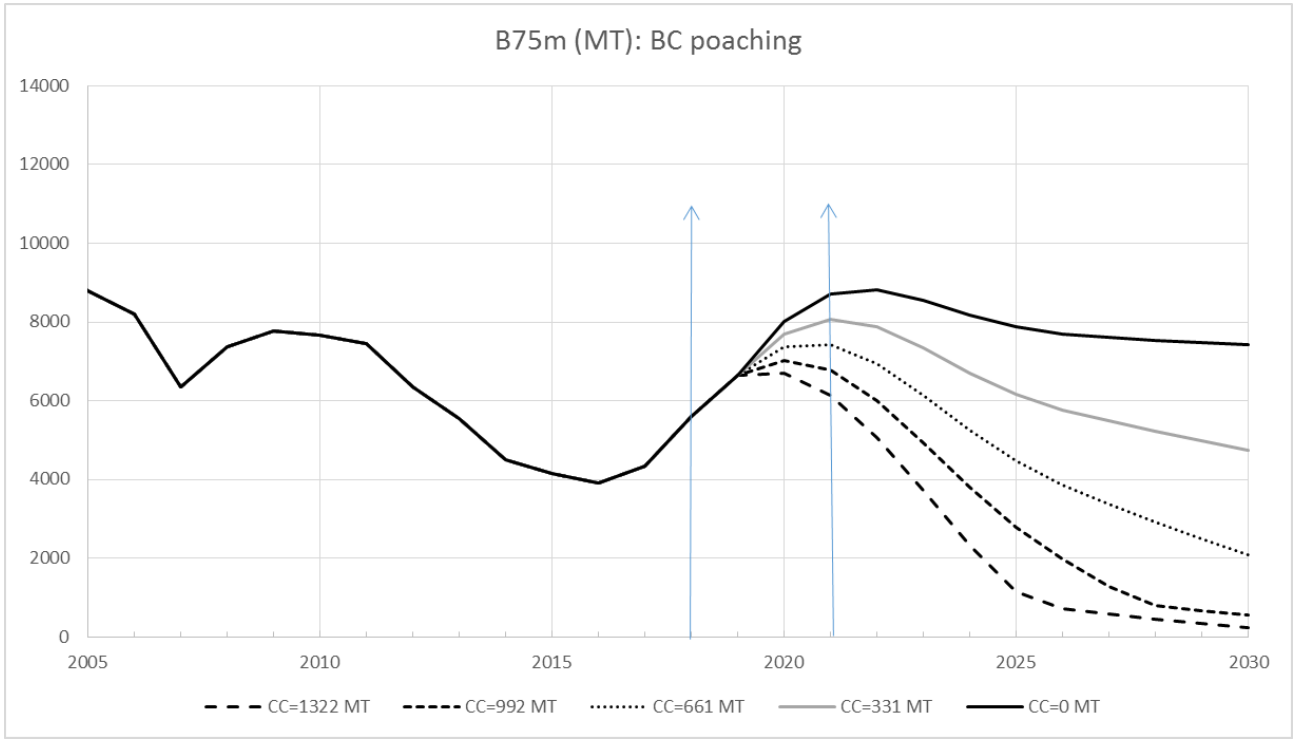



Figure C4: Comparisons of A8+ projected B75m biomass trends for the NEW assessment + SEN1 poaching scenario, for five different future A8+ legal CC levels.

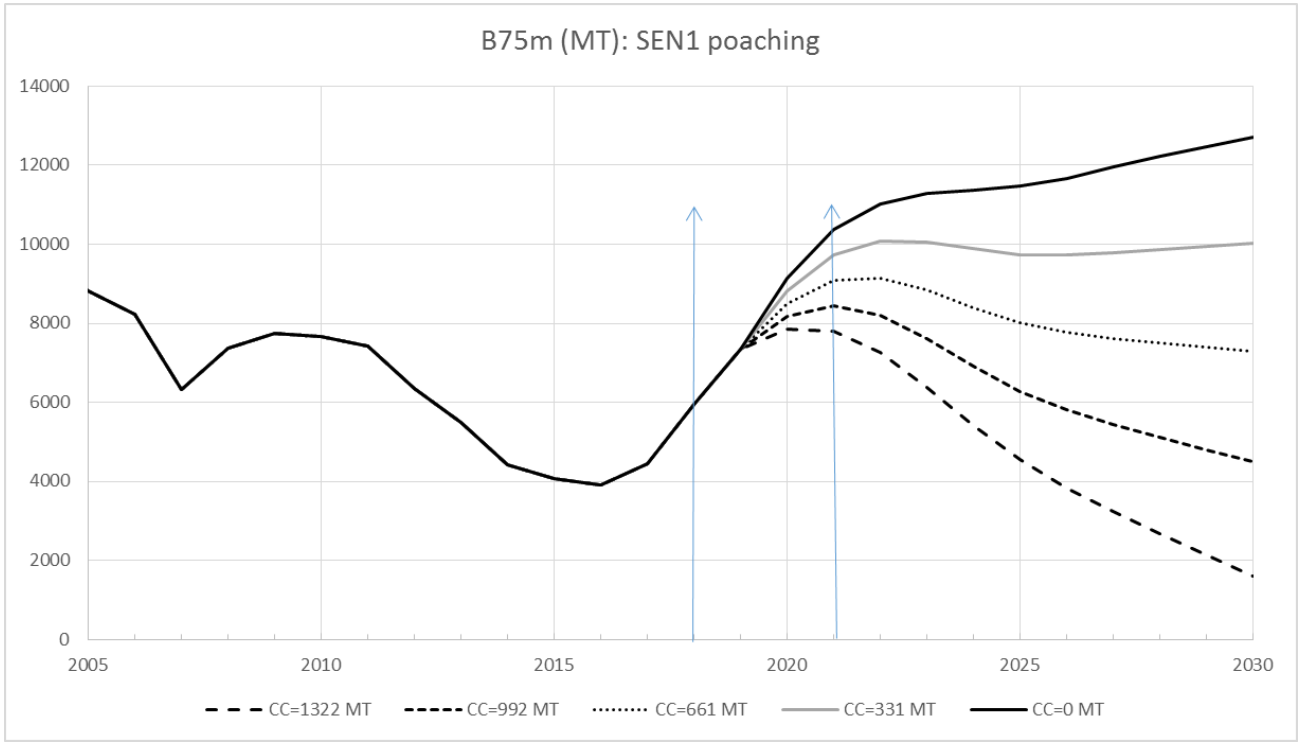


Figure C5: Comparisons of A8+ projected B75m biomass trends for the NEW assessment + SEN2 poaching scenario, for five different future A8+ legal CC levels.

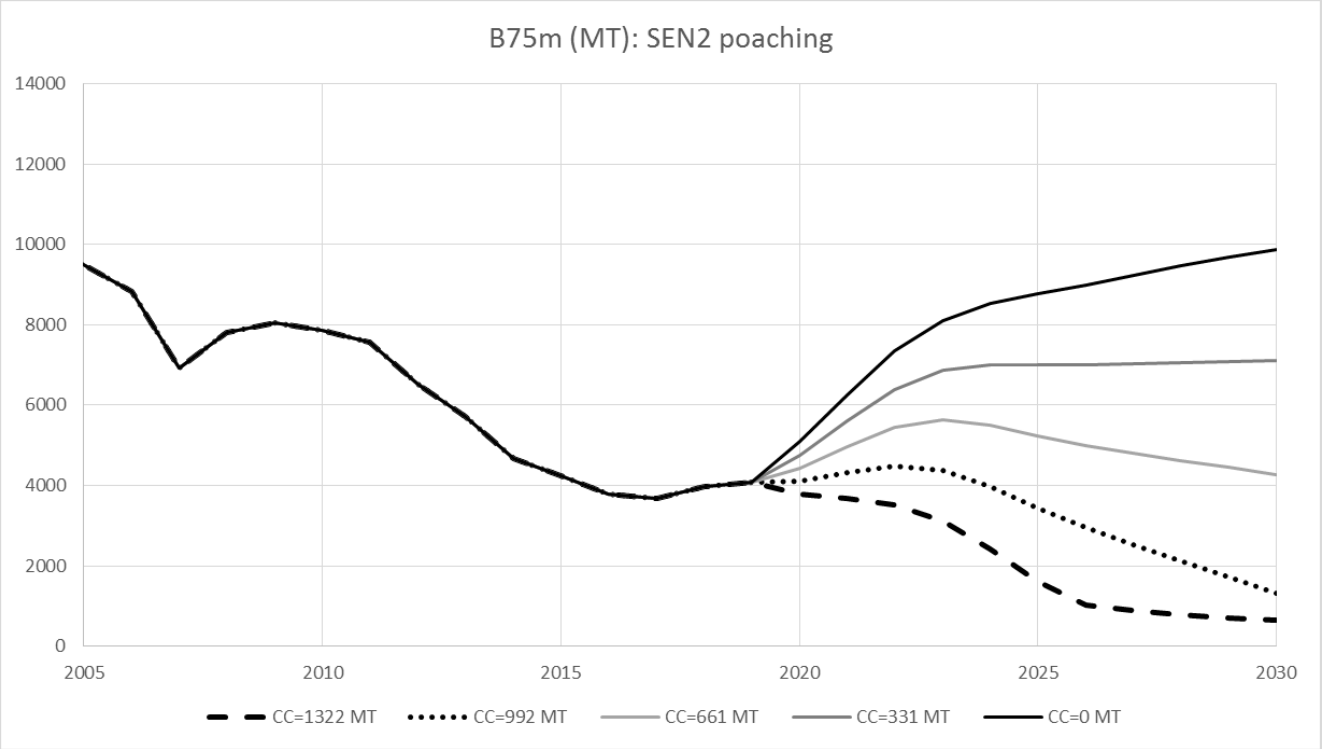
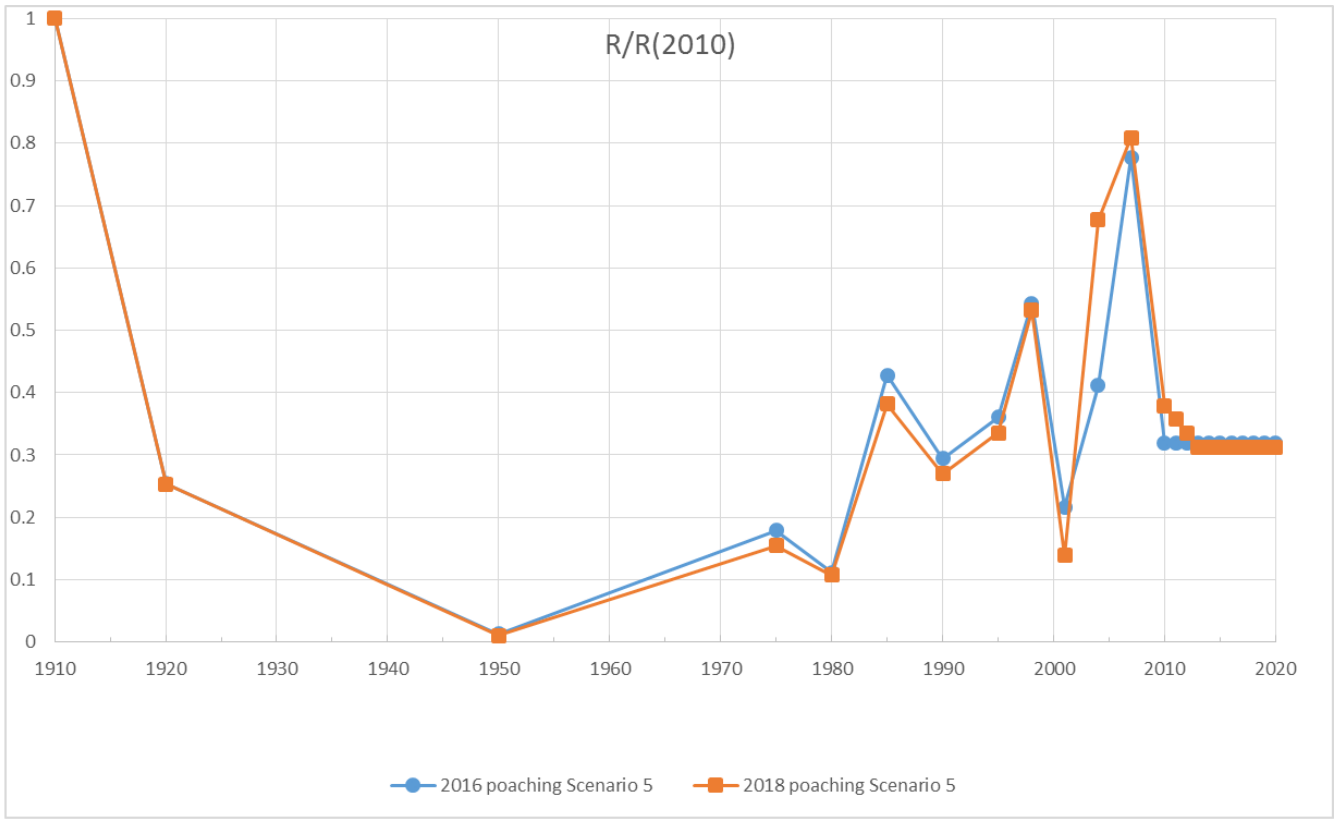


Figure C6: Estimated recruitment for A8+ for both the 2016 and 2018 assessments (assuming the scenario 5 poaching scenario). The symbols indicate the years for which parameters are actually estimated for (linear interpolation is assumed between). The horizontal arrows indicate the start of the recruitment projection periods.



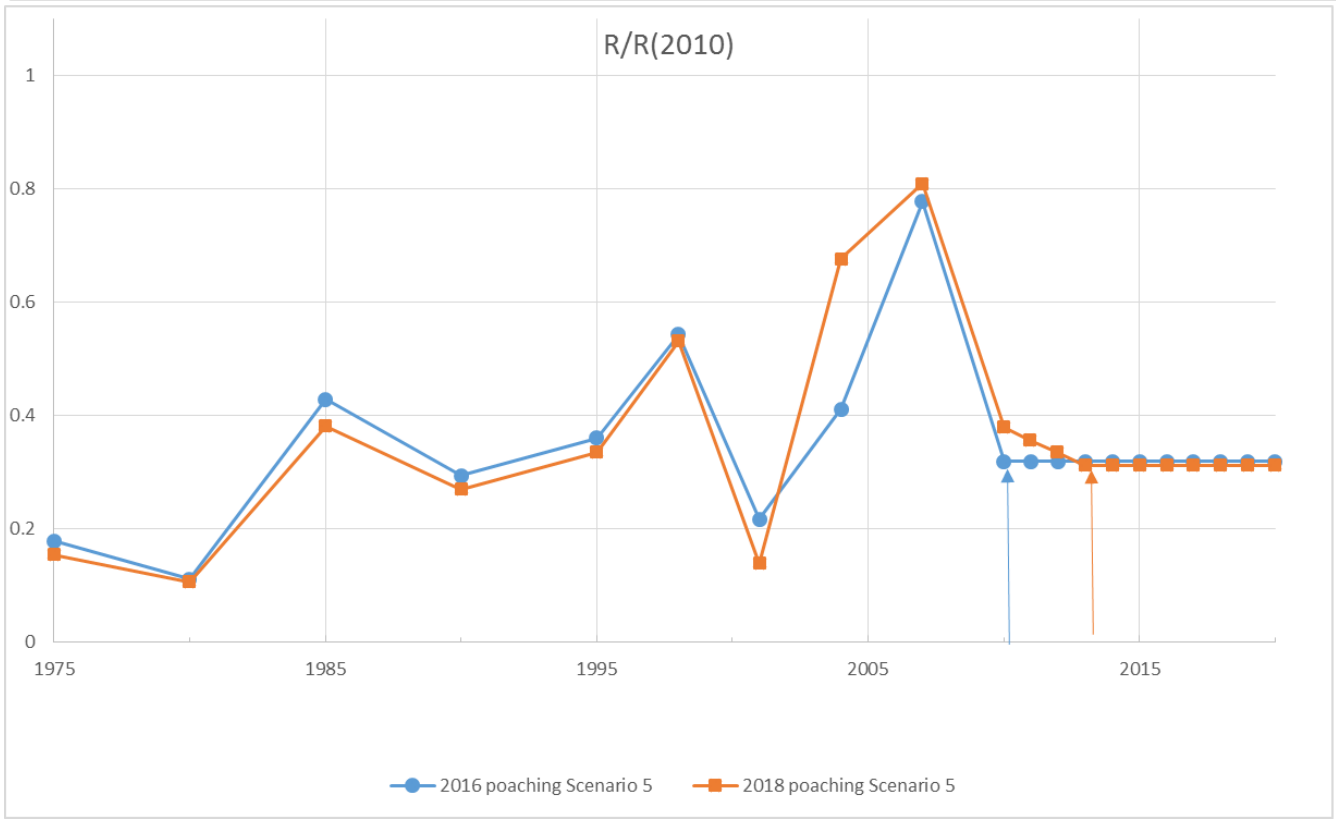
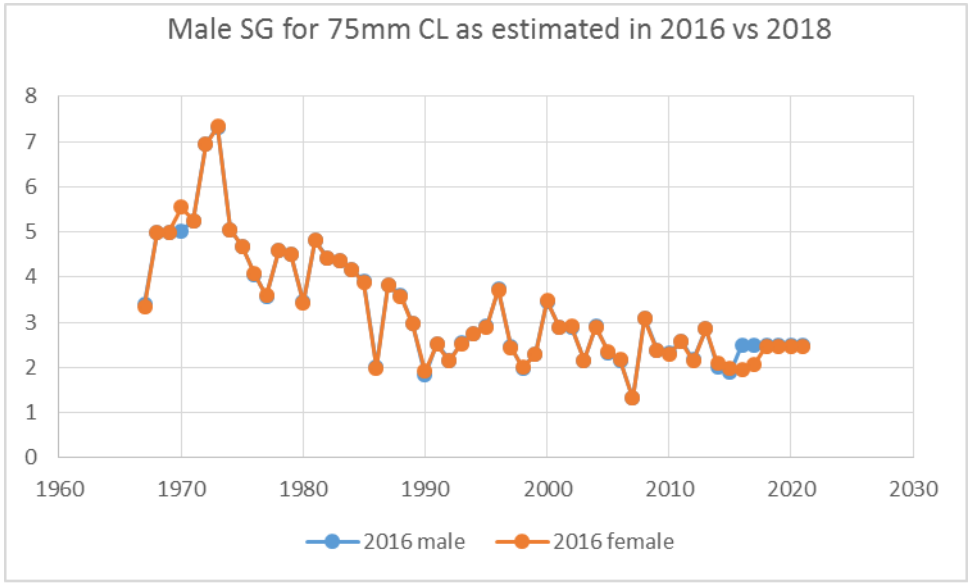



Figure C7: Estimated (input) somatic growth



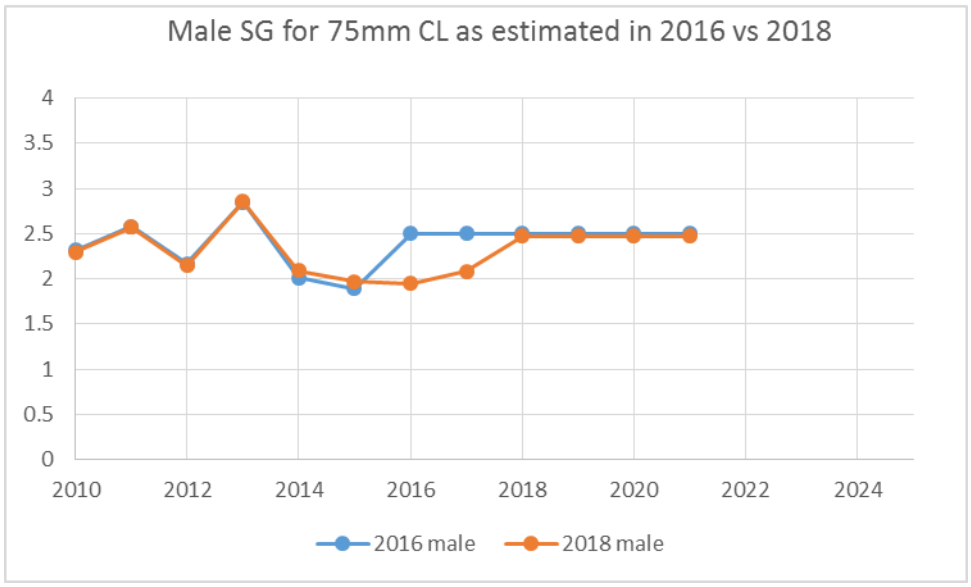
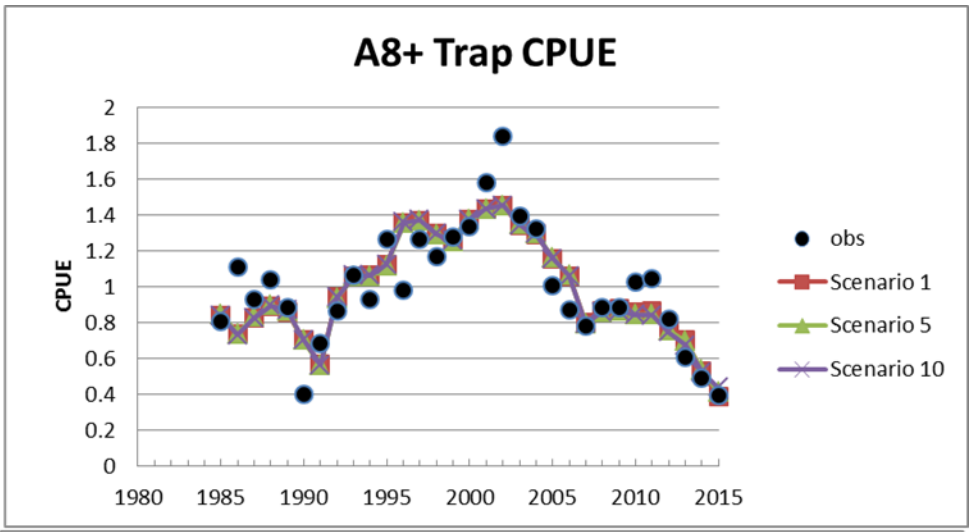
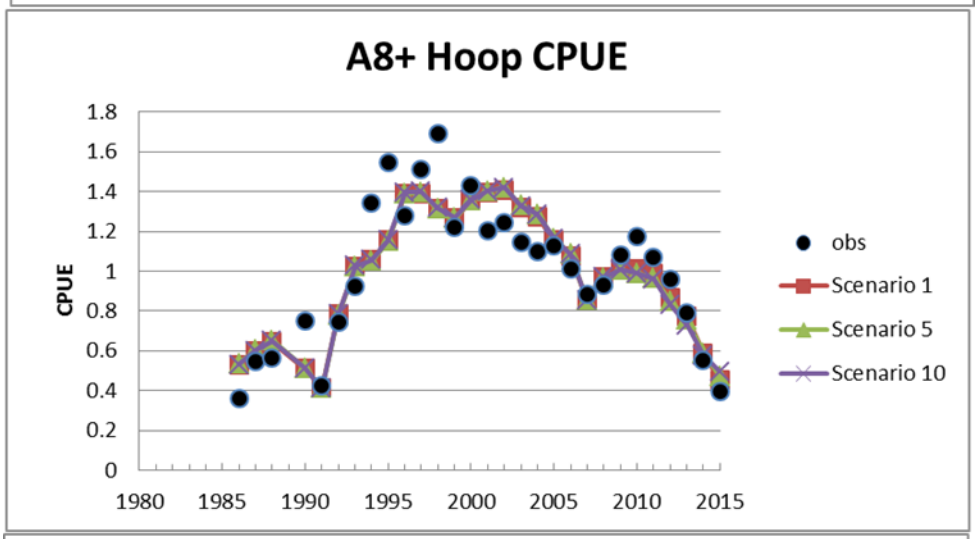



Figure C8a: Fits to data: 2016 fits for three poaching scenarios.



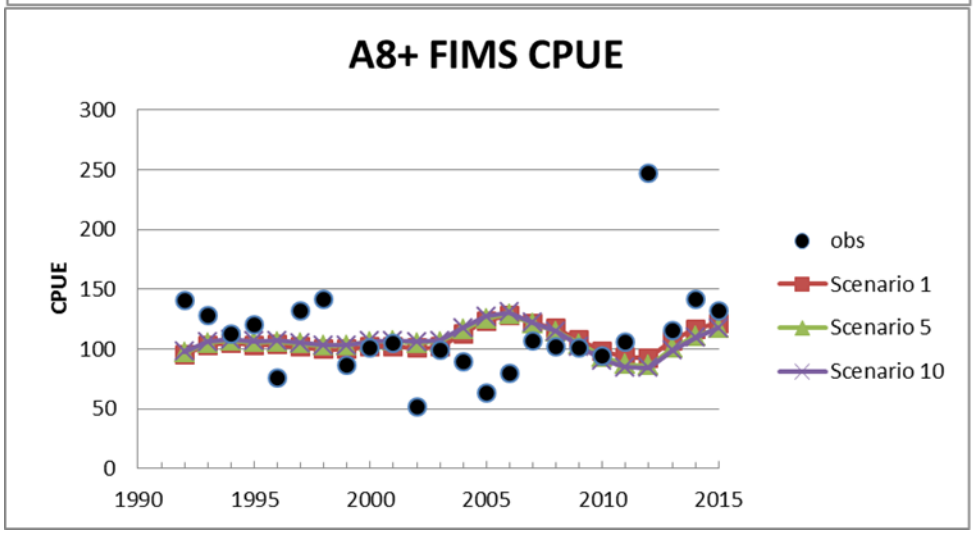
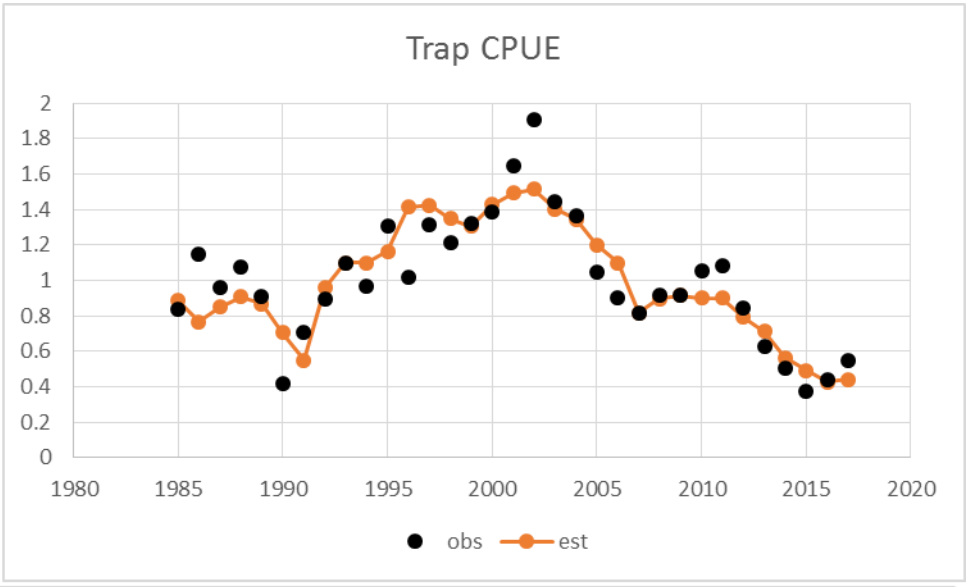
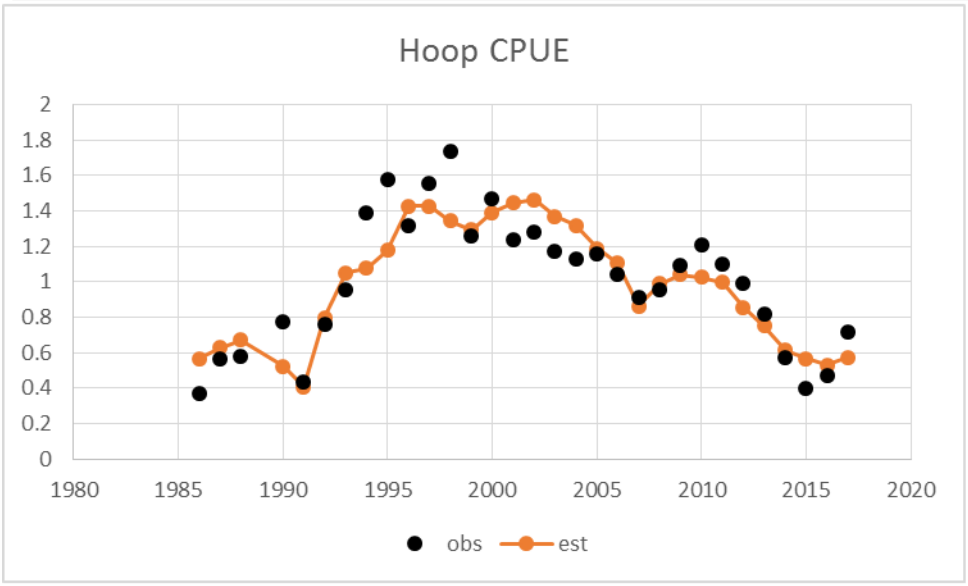



Figure C8b: Fits to data: 2018 fits for poaching scenario 5.



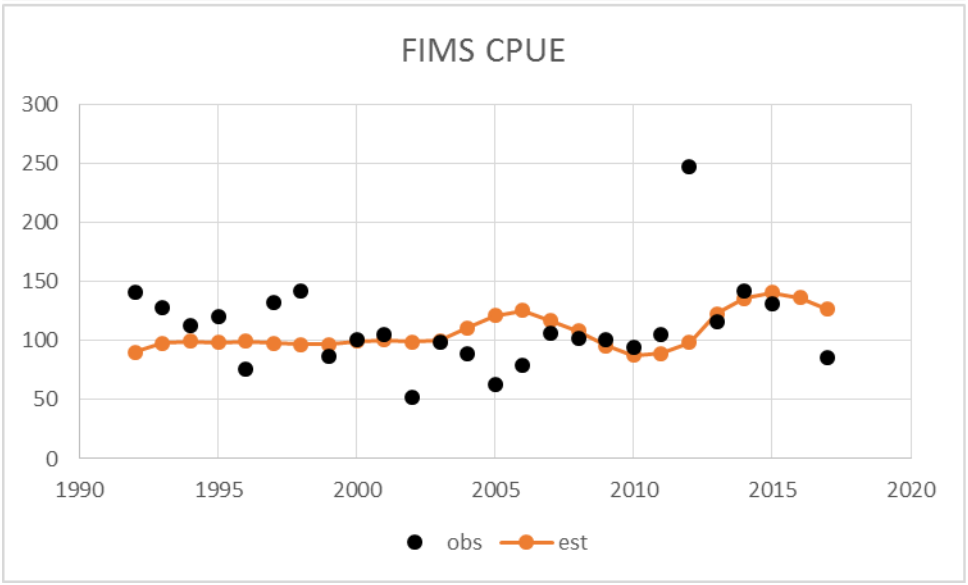



Figure C8c: Projections are both at 840 MT (and Scenario 5 poaching). Projections are to the right if the vertical arrows.

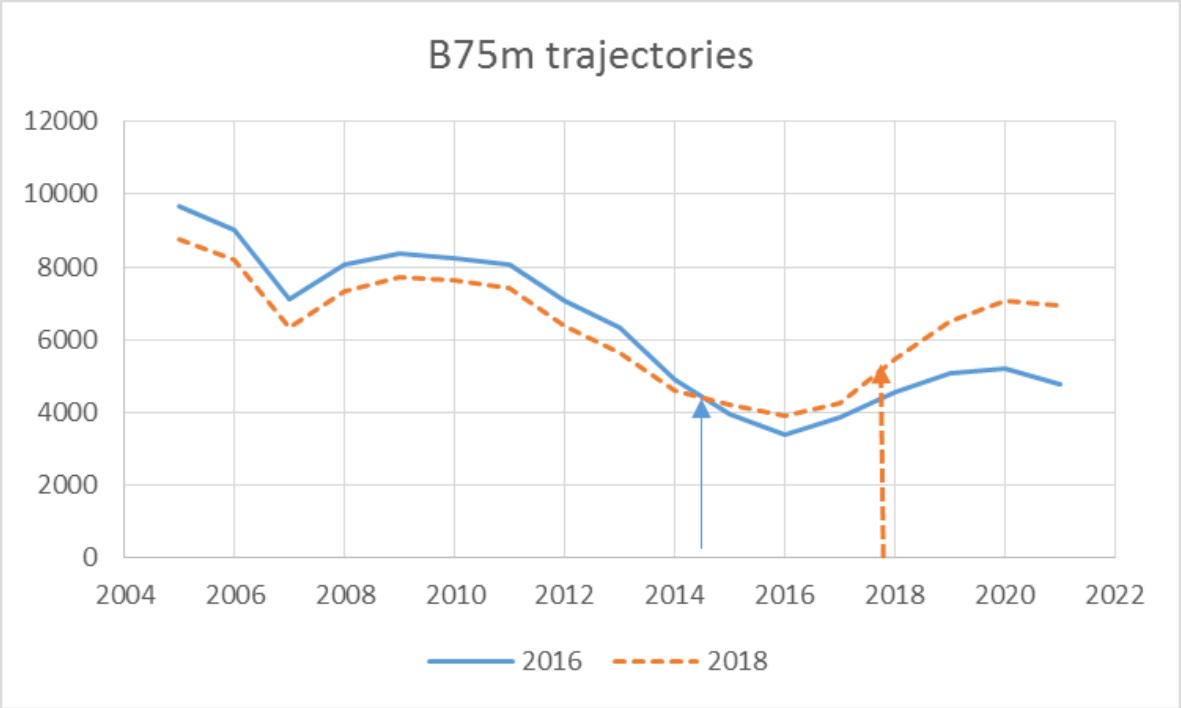



Table C1:

| | B75(2021/2015) | B75m(2021/2018) | B75m(2021/2006) |
|---|---|---|---|
| 2016 assessment | 1.213 | 1.049 | 0.523 |
| 2018 assessment | 1.654 | 1.267 | 0.848 |

Figure C9: 2018 model fits for percent females in the catch. BC future poaching scenario.

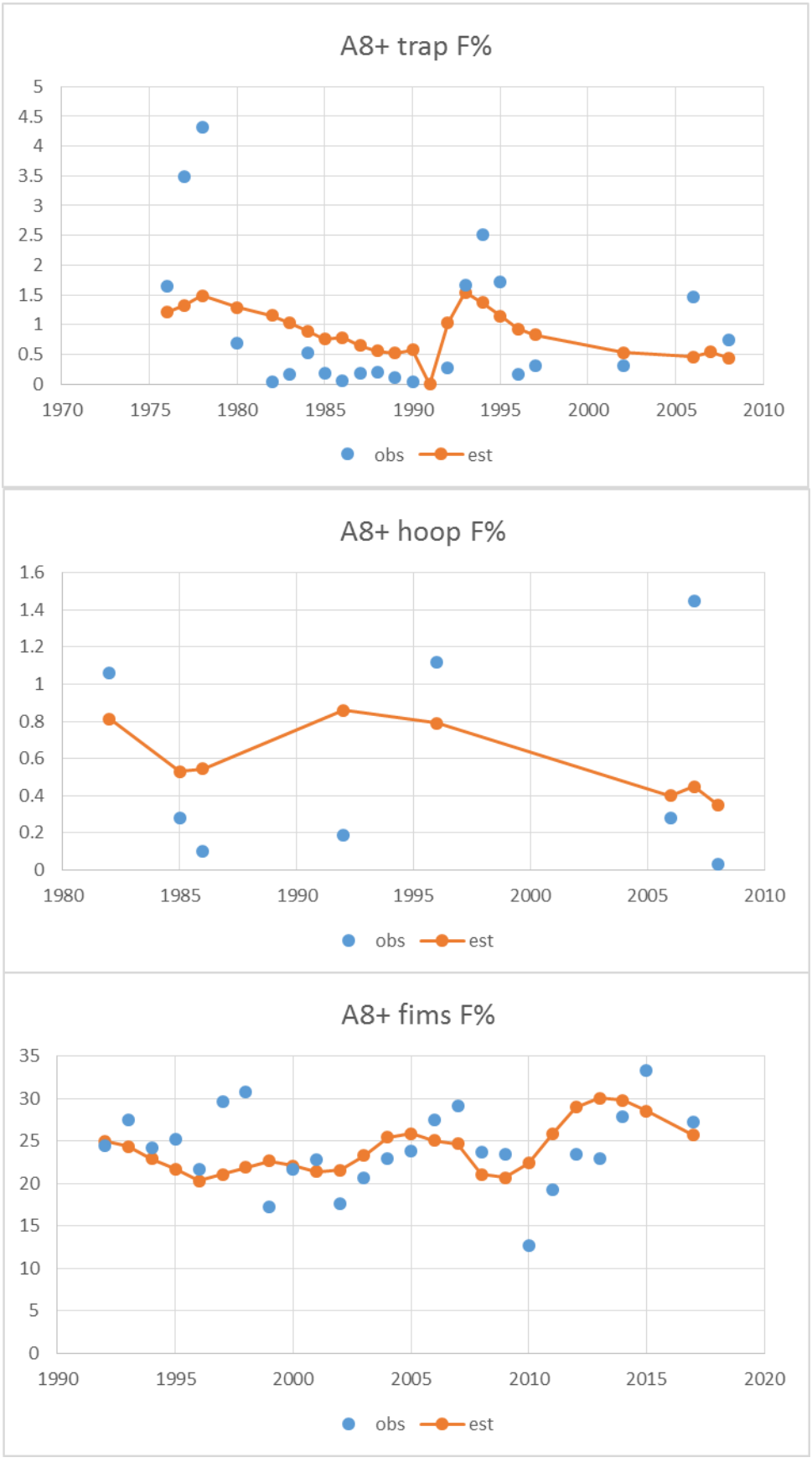


Figure C10: Comparison between the 2016 old assessment (and old Scenario 5 poaching assumptions) and the updated 2018 assessment with the BC poaching assumption: projections of CC-661 are from 2017 for the old assessment and 2018 for the new assessment.

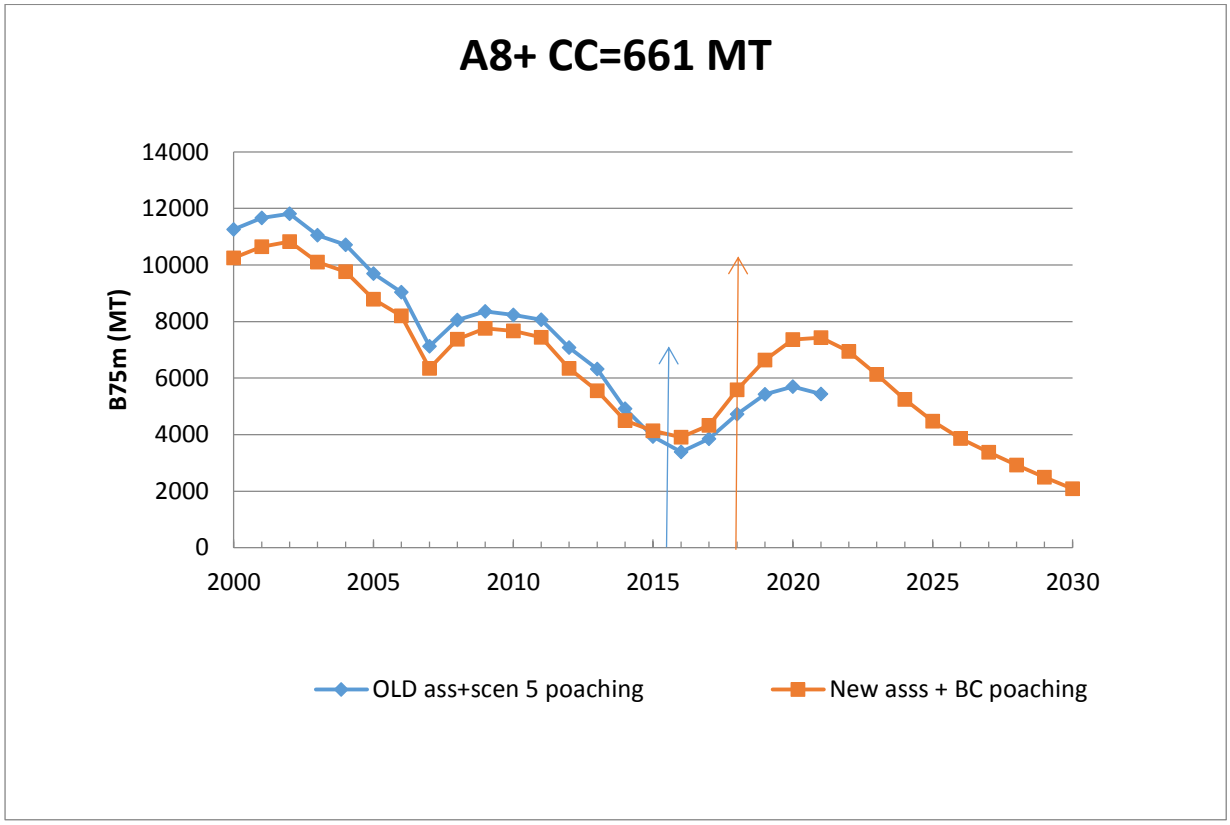



Figure C11: Comparison of the estimated A8+ recruitment and the FIMS CPUE.

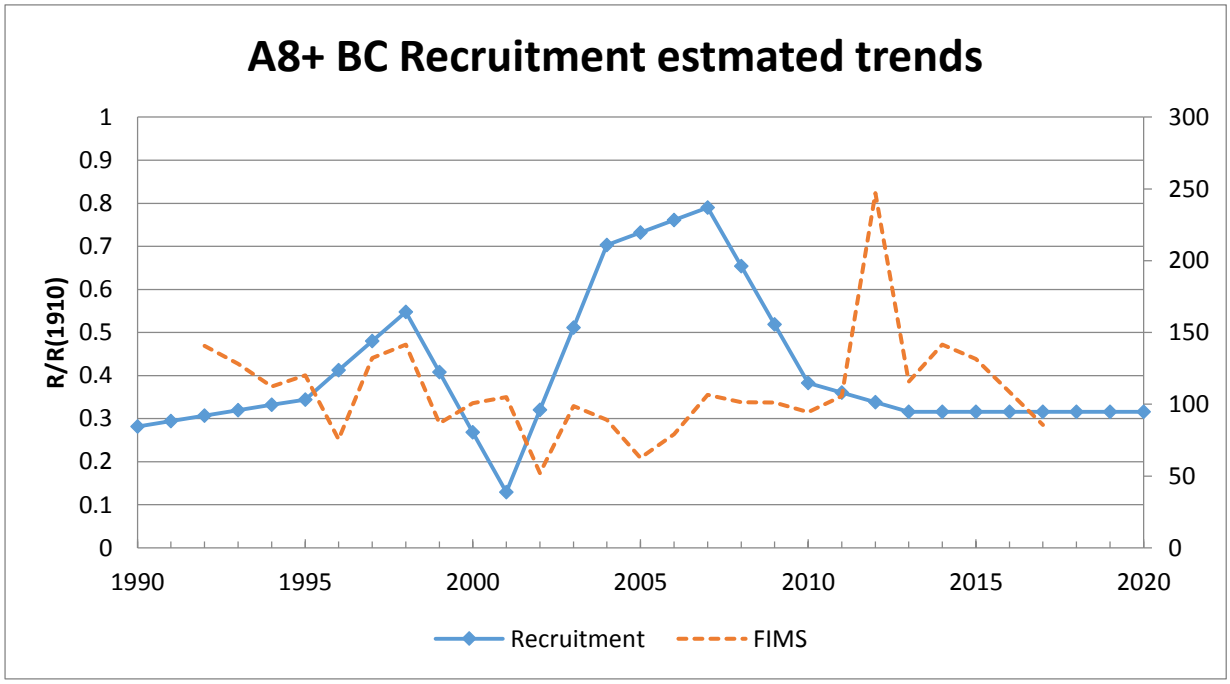


Figure C12: A8+ BC FIMS male CAL fits.

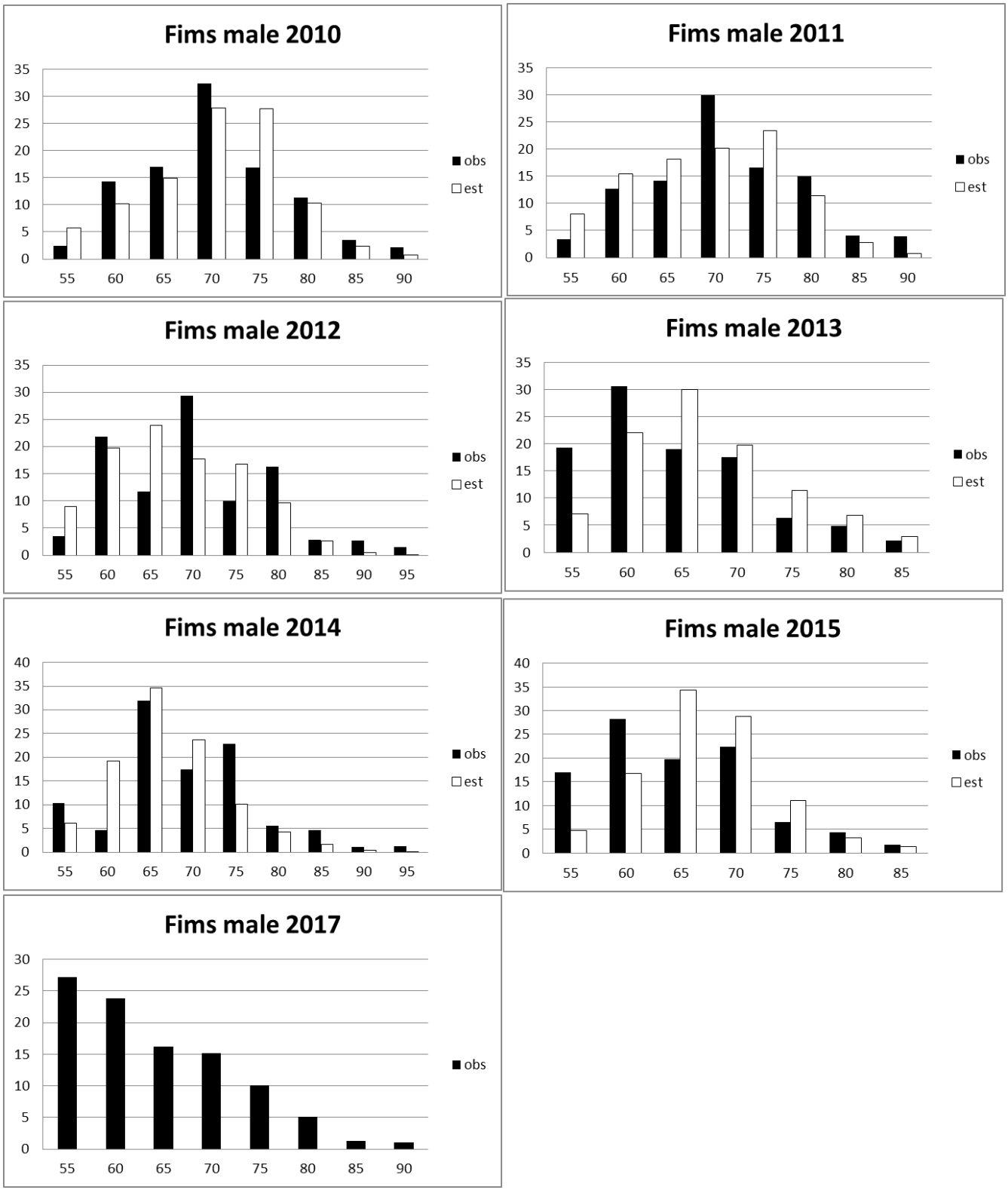


Figure C13: A8+ BC FIMS females CAL.