

2018 updated west coast rock lobster assessments

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Summary

A new set of 2018 assessments for all five super-areas for the west coast rock lobster resource has recently been completed. These provide the bases for projecting the resource forwards (in each super-area) under alternative future catches to in turn provide a basis for management advice, as is reported in MARAM/IWS/2018/WCRL/P4. Limitations of the analysis are also discussed.

Background and Assumptions made

This document provides results of recently updated assessments for west coast rock lobster for each of the five super-areas. Results focus on the base case poaching scenario, but also include results for two sensitivities to this (see MARAM/IWS/2018/WCRL/P1).

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 most recent (2017¹) season.

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).

Results

Assessment results were evaluated for the three poaching scenarios (MARAM/IWS/2018/WCRL/P1). Focus is however on the Base Case (BC) poaching scenario. There are also some comparative results from the previous 2016 assessments.

The results are reported for each of the five super-areas (Section A for A1+2, Section B for A3+4, Section C for A5+6, Section D for A7 and Section E for A8+). Finally, some results for the resource as a whole are presented (Section F).

As an example, for A8+ the following set of figures is produced in Section E.

- Figure E1: Comparison of estimated B75m (MT) trends for four of the assessments for A8+.

¹ Conventionally, given a split-year season, e.g. 2017/18, this is referenced by the first of the two years concerned, i.e. here 2017.

- Figure E2: Estimated recruitment for A8+ for both the 2016 and 2018 assessments (assuming the 2016 BC poaching scenario).
- Figure E3: Estimated (input) somatic growth.
- Figure E4: Updated 2018 fits to GLM standardised CPUE data for the BC poaching scenario.
- Figure E5: 2018 model fits for percent females in the catch for the BC poaching scenario.
- Figure E6a: A8+ BC TRAP male averaged CAL fits.
- Figure E6b: A8+ BC TRAP female averaged CAL fits.
- Figure E7a: A8+ BC Hoop male averaged CAL fits.
- Figure E7b: A8+ BC Hoop female averaged CAL fits.
- Figure E8a: A8+ BC FIMS male averaged CAL fits.
- Figure E8b: A8+ BC FIMS females averaged CAL fits.

For some super-areas there is either no trap fishing or no hoop fishing, and thus no results for these are presented.

For Section F where comparative results of biomass and egg production are reported for each super-area and the total resource, the following Tables and Figures are reported.

- Table F1: B75m (MT) values for 1910 (effectively K), 2018 and the ratio of 2018/1910.
- Table F2: Egg production values for 1910 (effectively K), 2018 and the ratio of 2018/1910.
- Figure F1: Catches taken for each super-area and the resource as a whole.
- Figure F2: B75m (MT) estimated trajectories from the 2018 assessments assuming BC poaching.
- Figure F3: B75m (MT) and B75m/K estimated trajectories for the total resource from the updated 2018 assessments assuming BC poaching.
- Figure F4: Egg production estimated trajectories from the 2018 assessments assuming BC poaching. The bottom plot shows values for 1975+ only.
- Figure F5: Egg production and egg production/K estimated trajectories for the total resource from the updated 2018 assessments assuming BC poaching. The bottom plot shows values for 1975+ only.

In Section G male selectivity functions are shown for each super-area (note these are time-invariant), in each for whichever of trap, hoop and FIMS operations occur.

Abundances are primarily reported as B75m, the biomass of males above 75mm carapace length, which has been the minimum legal size for capture since 1993. This is the measure most pertinent to the fishery, as relatively few females reach this size. Section F also includes some results for female abundances reported as “egg production” (where the egg production is calculated for females 65mm CL and larger and takes into account the number produced by each size when calculating the total egg production).

Discussion

The following points merit noting.

1. The resource at present is very depleted; overall at around 2% of initial (1910) abundance for B75m (see Table F1 and Figure F3).
2. Most of the depletion was caused by heavy exploitation over the 1930s, 1940s and 1950s (see Figure F1).

3. Females egg production is also depleted (to around 9% of the 1910 level) – this extent of depletion is not as large as for males but still substantial (see Table F2 and Figure F5).
4. Recruitment levels throughout are now much less than in 1910 (see Figures A2, B2, C2, D2 and E2).
5. Since 1990, the fishery has relied primarily on the much larger B75m in A8+, but this has been declining (see Figure F2).
6. A particular recent concern has been the relatively large drop (about 50%) in B75m for A8+ since 2012 – this is mainly the result of poor recruitment, though increased poaching has played some role (see Figures E2 and F2).
7. There is a very recent upturn in A8+, which is interpreted to be a consequence of recent enhanced recruitment (see Figure F2).
8. Somatic growth rates show no sign of an increase towards the higher values observed prior to around 1989 (see Figures A3, B3, C3, D3 and E3).

Fits to data:

The models generally fit the various data well. There are some problem areas such as:

- There are many cases of systematic lack of fit to the catch-at-length data, e.g. for both male and female data in A1+2.
- Generally large observation errors for the FIMS indices, so that these have proportionately less influence on results.
- F% model estimates are often too low in earlier years.

It is worth noting that unfortunately no new catch-at-length data have been collected from this fishery since 2008.

Assessment shortfalls

These fall under two headings.

Data limitations

1. The abundance indices available are entirely based on captures by hoops and traps; it is unclear how closely such data reflect linear proportionality to true abundance.
2. FIMS is designed to provide bias-free indices that are comparable over time, but has poor precision and consequently relatively little influence on assessment results.
3. Commercial CPUE is GLM standardised, but the area strata in the standardisation are large, with the data as recorded possibly at too large a scale to adjust such indices adequately for changes in fishing patterns at a smaller scale.
4. Data on female somatic growth rates are very sparse.
5. Data on poaching are limited, with an especially important gap being the absence of information on the extent and trend of illegal sales on the local market.

Analysis limitations

1. Convergence is difficult to achieve for model fits, which are carried out in FORTRAN using downhill Simplex AMOEBA routine (attempts to convert to ADMB have proved problematic). This limits the possibilities for estimation of precision (AMOEBA does not provide Hessians). Sometimes this has been achieved for key parameters by conducting a likelihood profile “by hand”.
2. While the assessments are spatially disaggregated alongshore, they assume homogeneity with depth. Data are inadequate to further stratify the assessments on an inshore/offshore basis, with this being a concern as some fishery sectors operate entirely “inshore” with hoops, while others work offshore with traps. Such (weak) indications as are available suggest that inshore-offshore mixing is slow (i.e. on a scale of years rather than months). Estimation of the proportion of abundance inshore vs offshore from FIMS is confounded by this survey not covering the very close inshore areas.
3. Additional variance (annual catchability variation) for abundance indices is large. If this could be reduced by use of environmental correlates (e.g. in GLM standardisations), these indices would carry more information and have a greater impact on assessment results.
4. Recruitment projections currently ignore any possible stock-recruitment effect.

Section A: Details of A1+2 2018 assessments

Figure A1: Estimated A1+2 B75m (MT) trends for the 2018 updated assessment. Poaching is not appreciable in this super-area, so has been set at zero. The lower plot is shows values for 1975+ only.

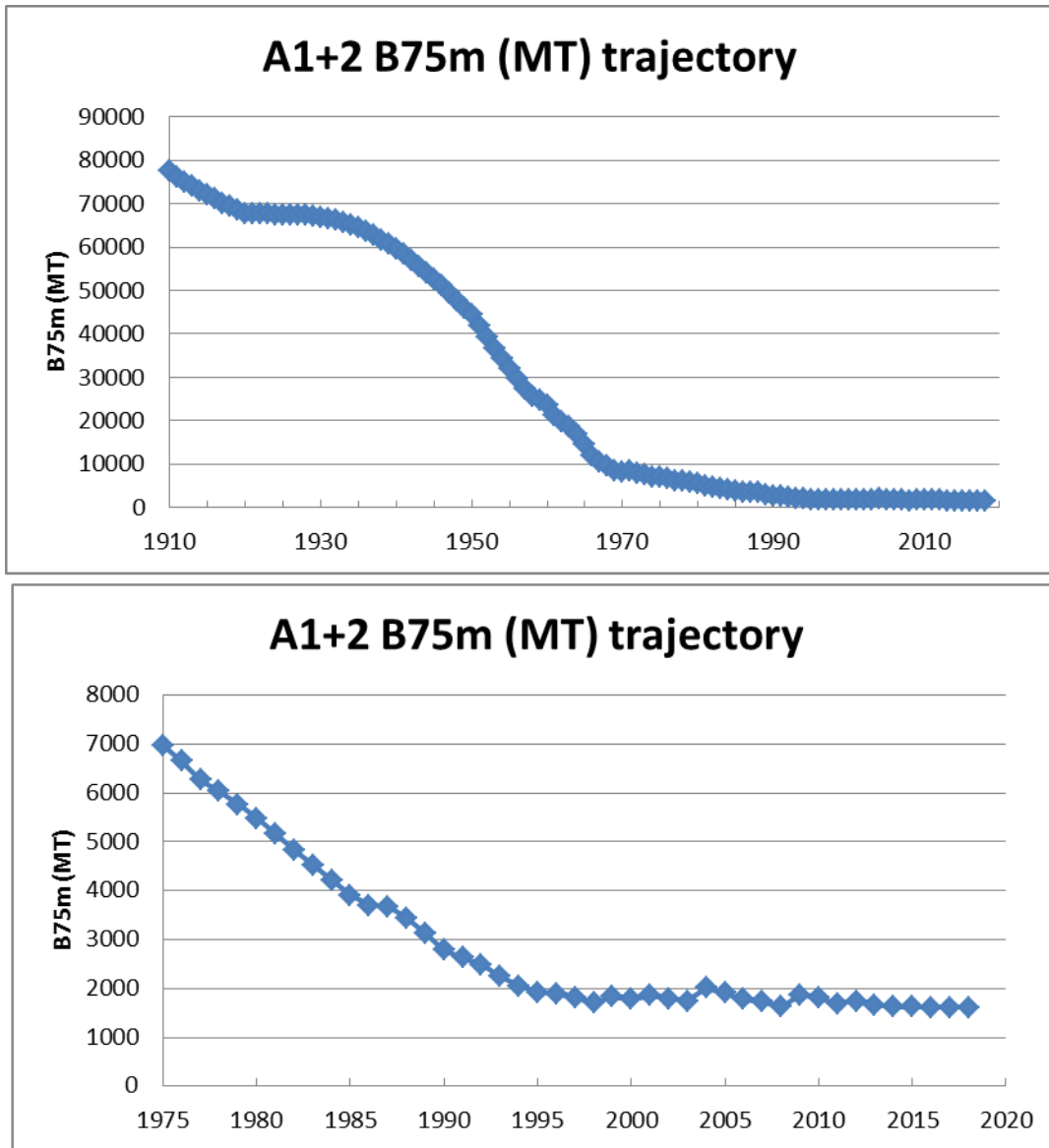


Figure A2: Estimated recruitment for A1+2 for the 2018 assessments. The symbols indicate the years for which parameters are actually estimated for (linear interpolation estimates are assumed to apply between these). The vertical arrows in the lower plot indicate the start of the recruitment projection period.

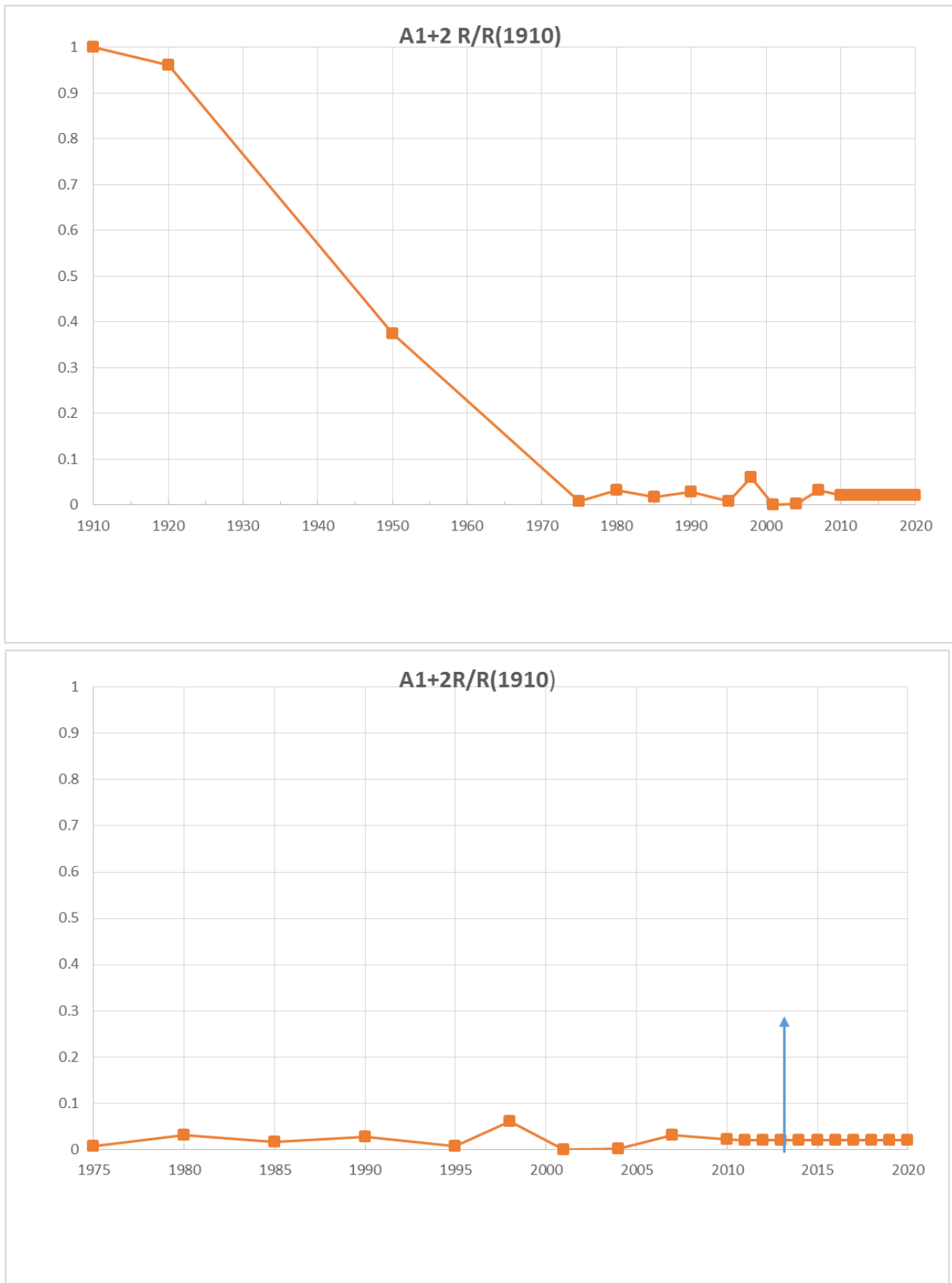


Figure A3: Estimated somatic growth for A1+2 as input to the 2018 updated assessment. Vertical arrows indicate start of projection periods.

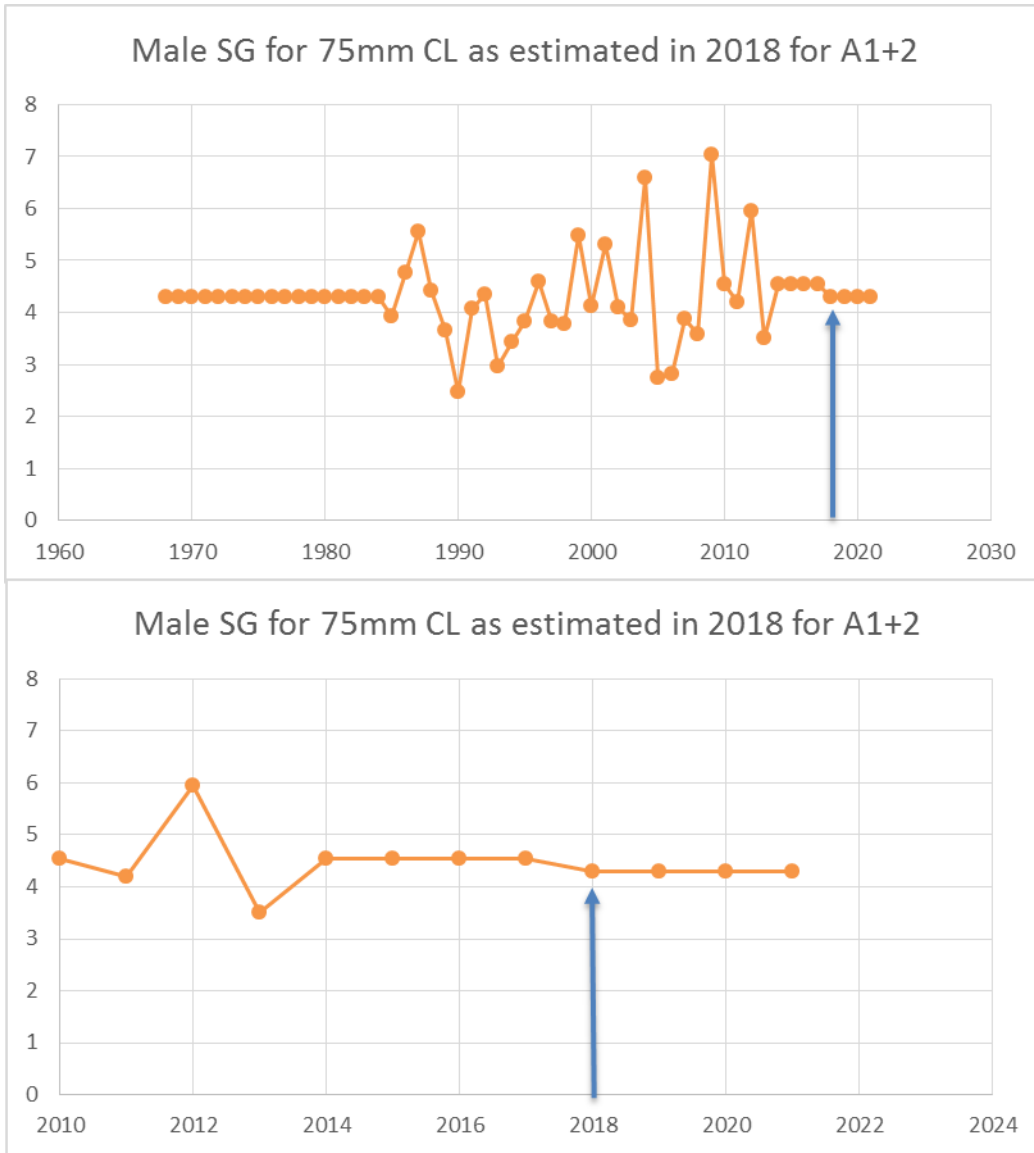


Figure A4: Updated 2018 fits for A1+2 to GLM standardised Hoop CPUE – this is a hoop only sector and FIMS is not collected from this area either.

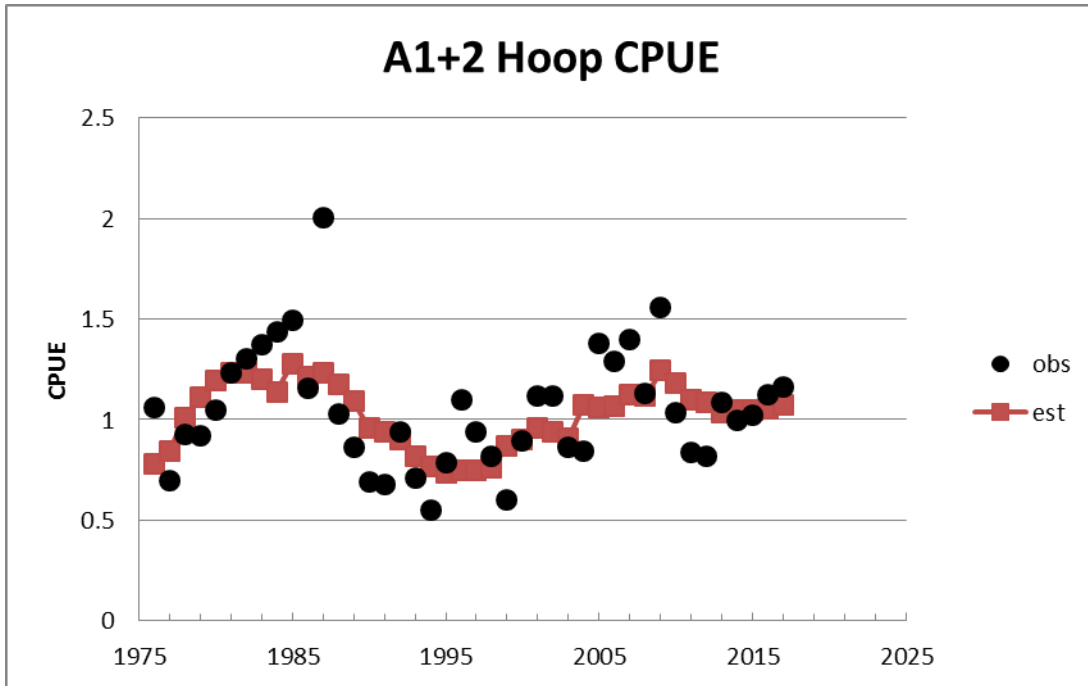


Figure A5: 2018 model fits for A1+2 percent females in the hoop catch.

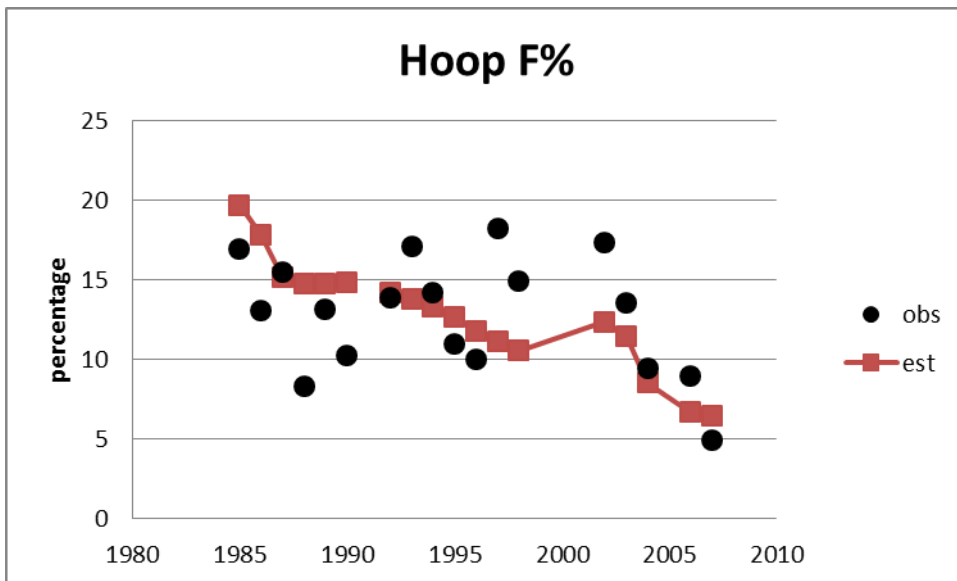


Figure A7a: A1+2 HOOP male CAL fits.

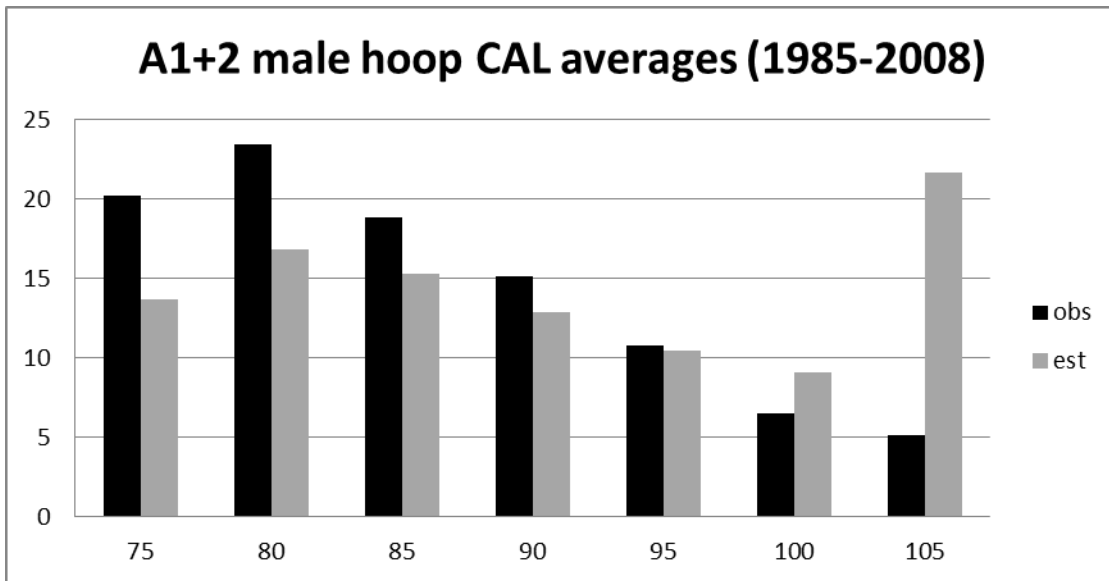
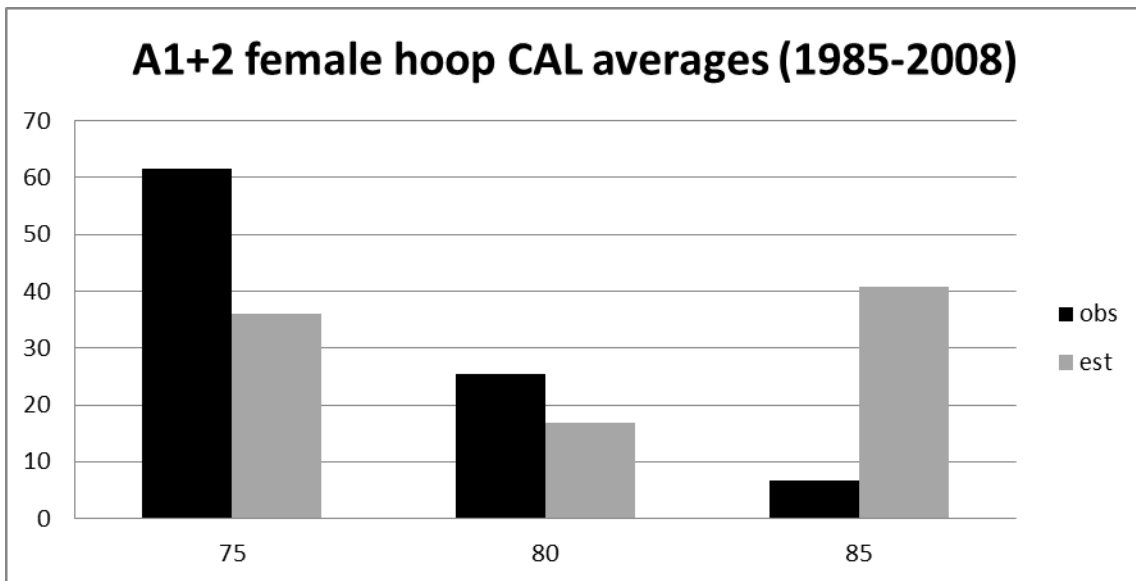


Figure A7b: A1+2 Hoop females CAL.



Section B: Details of A3+4 2018 assessments

Figure B1: Comparison of estimated A3+4 B75m (MT) trends for three poaching scenarios. The lower plot shows values for 1975+ only.

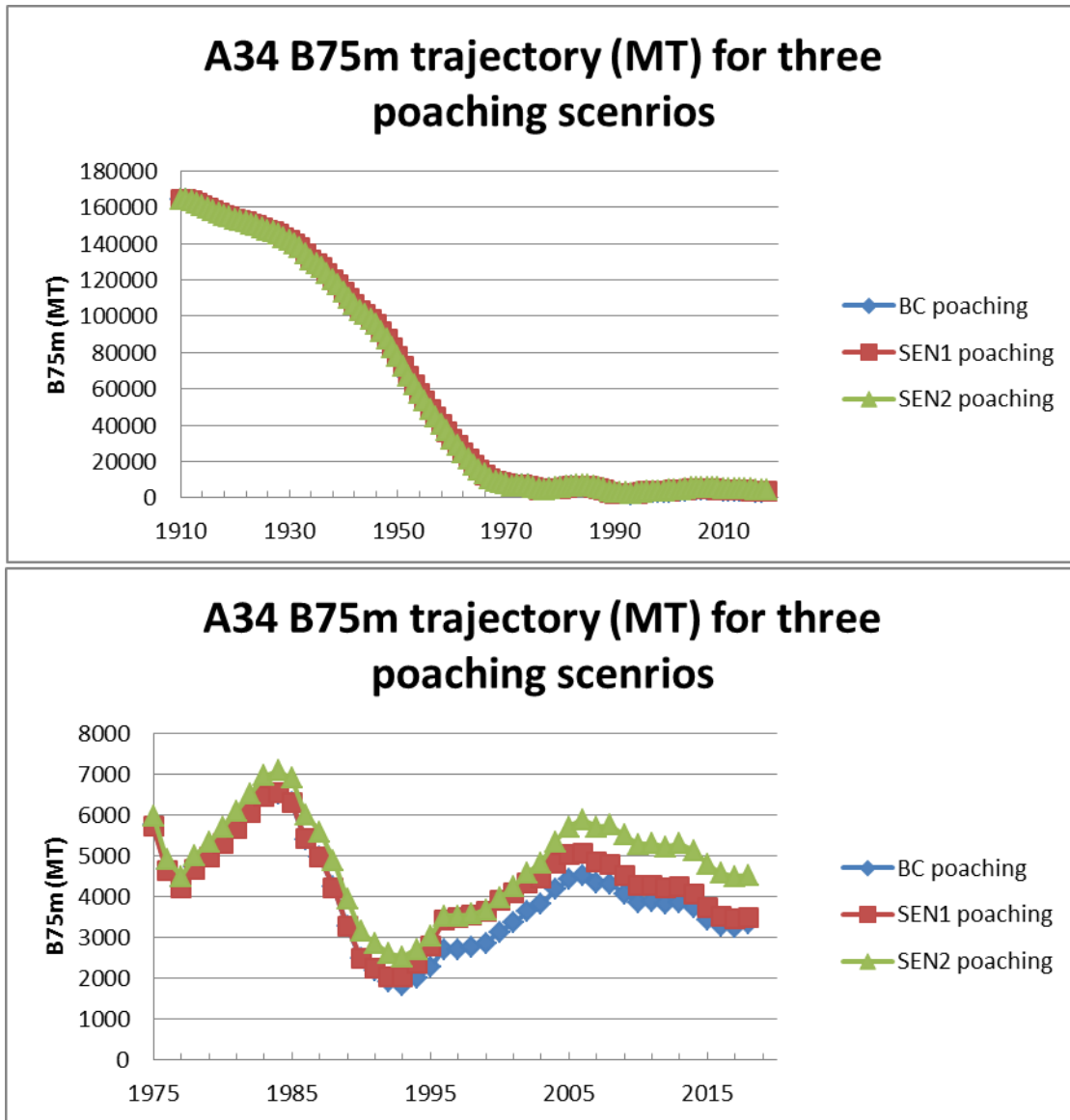


Figure B2: Estimated recruitment for A3+4 for the 2018 assessments (assuming the BC poaching scenario). The symbols indicate the years for which parameters are actually estimated for (linear interpolation is assumed between). The vertical arrow in the lower plot indicates the starts of the recruitment projection period.

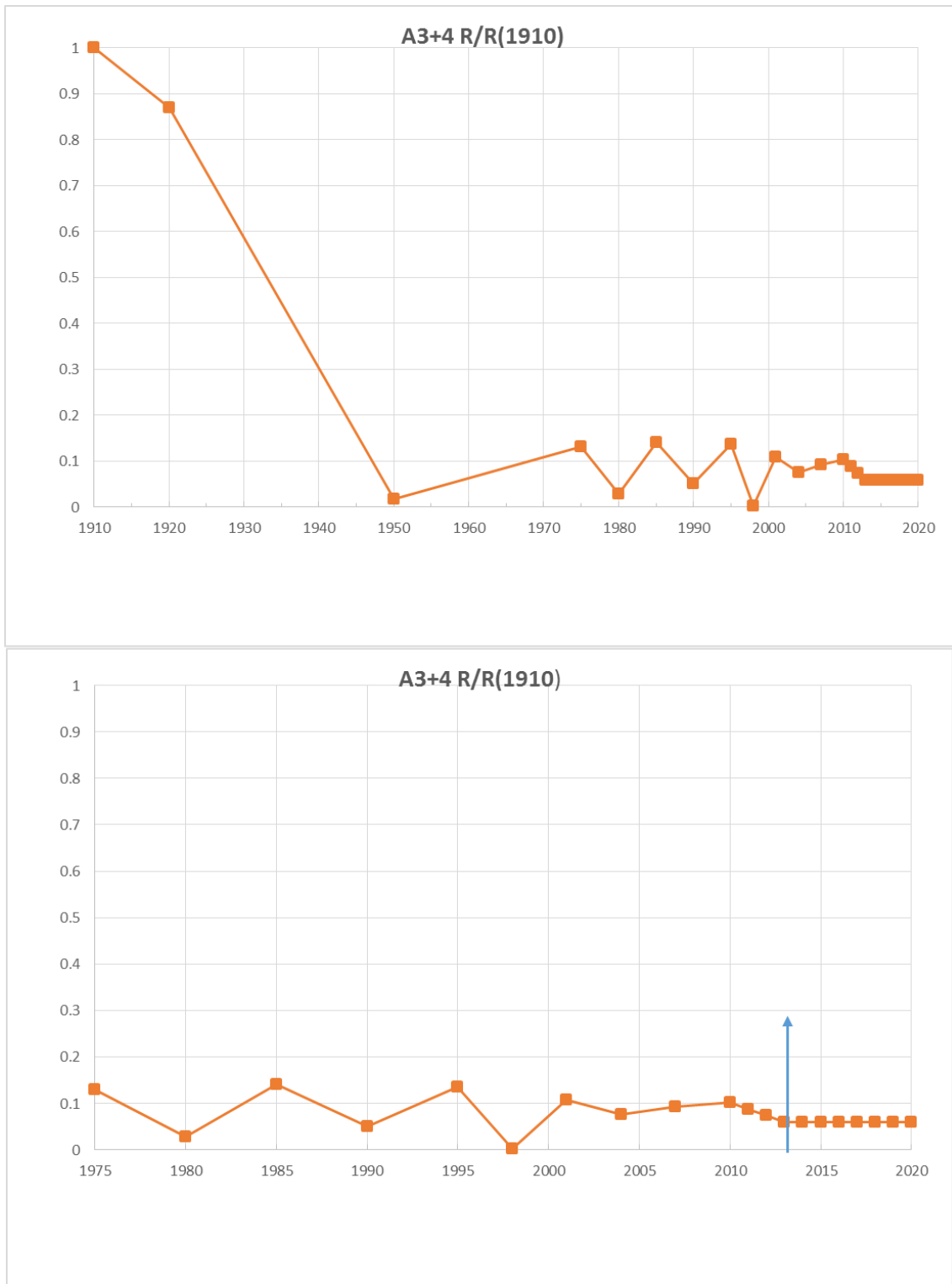


Figure B3: Estimated 2018 (input) somatic growth for A5+6. Vertical arrows indicate start of projection period.

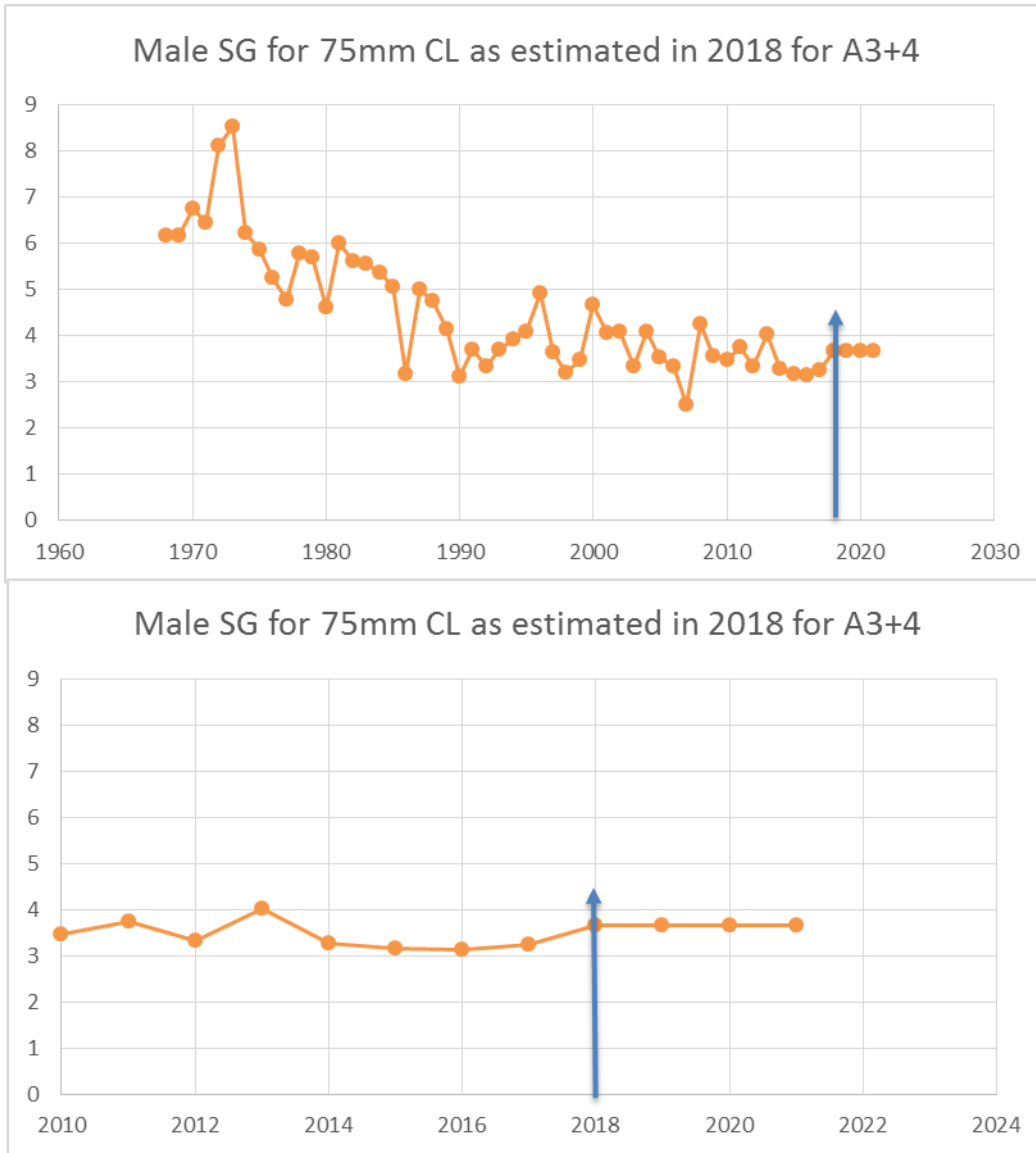


Figure B4: Updated 2018 fits for A3+4 to GLM standardised CPUE data for BC poaching scenario.

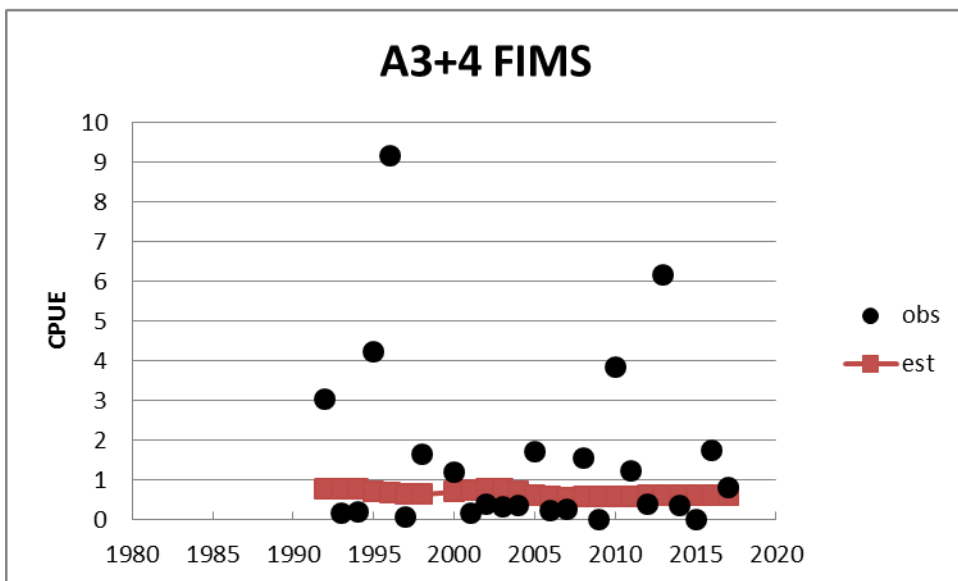
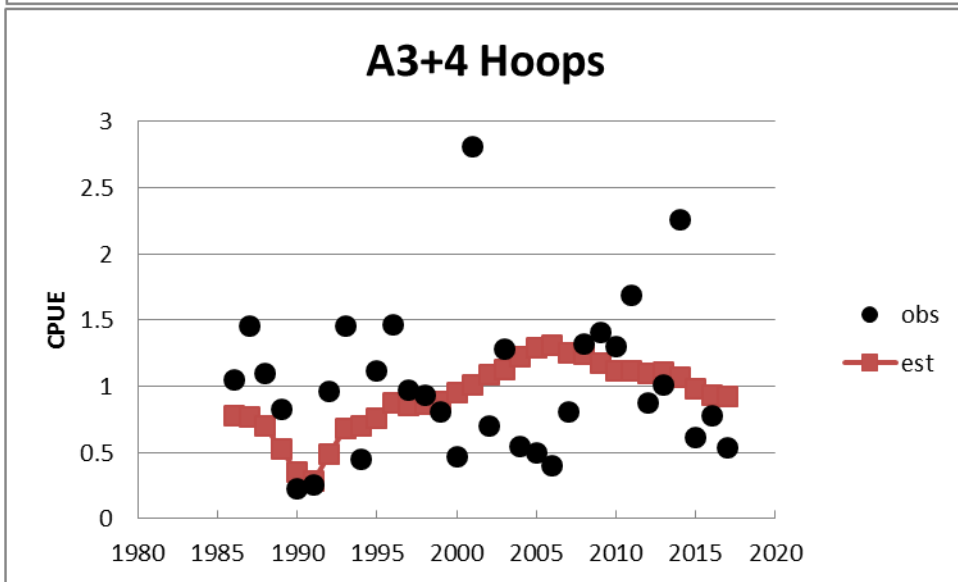
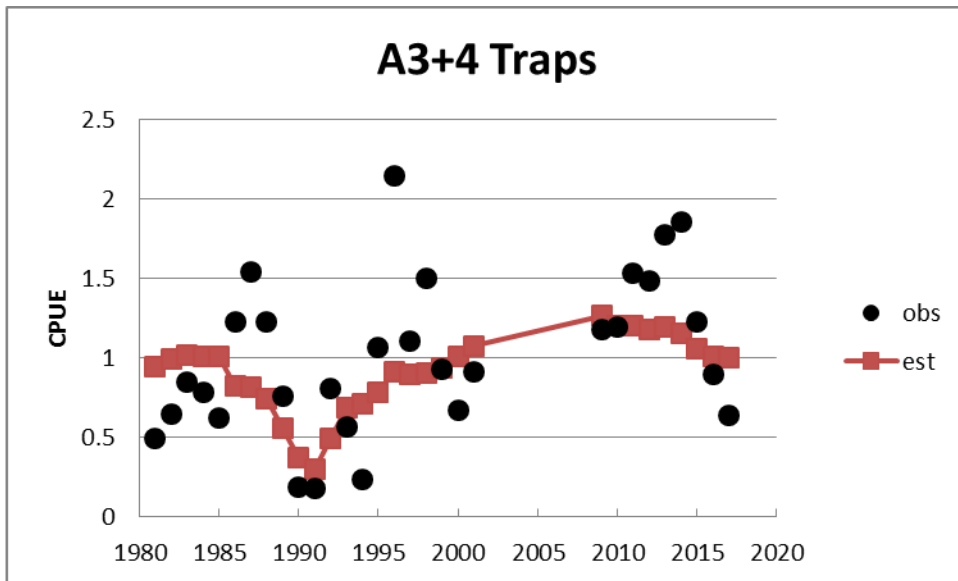


Figure B5: 2018 model fits for A3+4 percent females in the catch. BC poaching scenario.

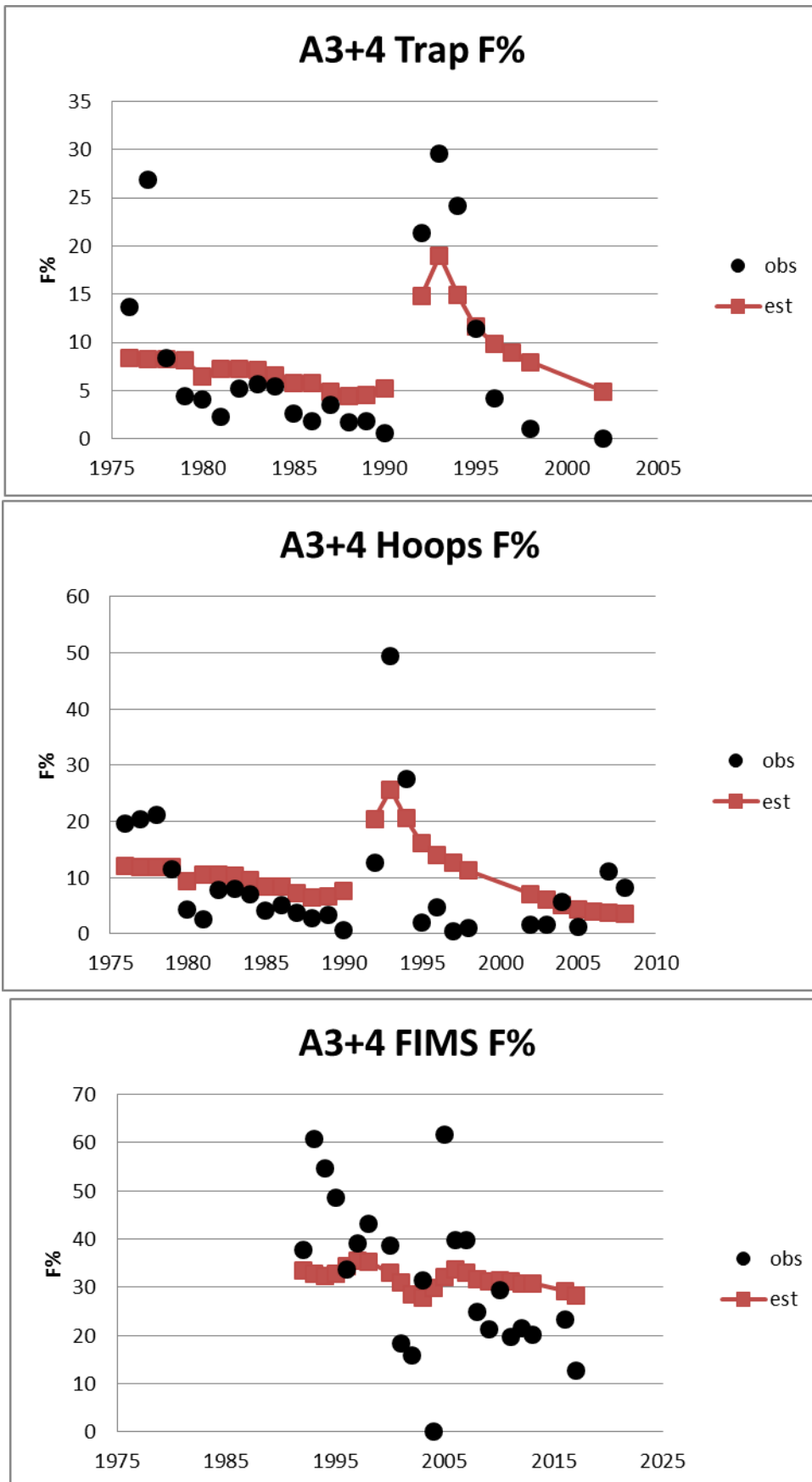


Figure B6a: A3+4 BC Trap male CAL fits.

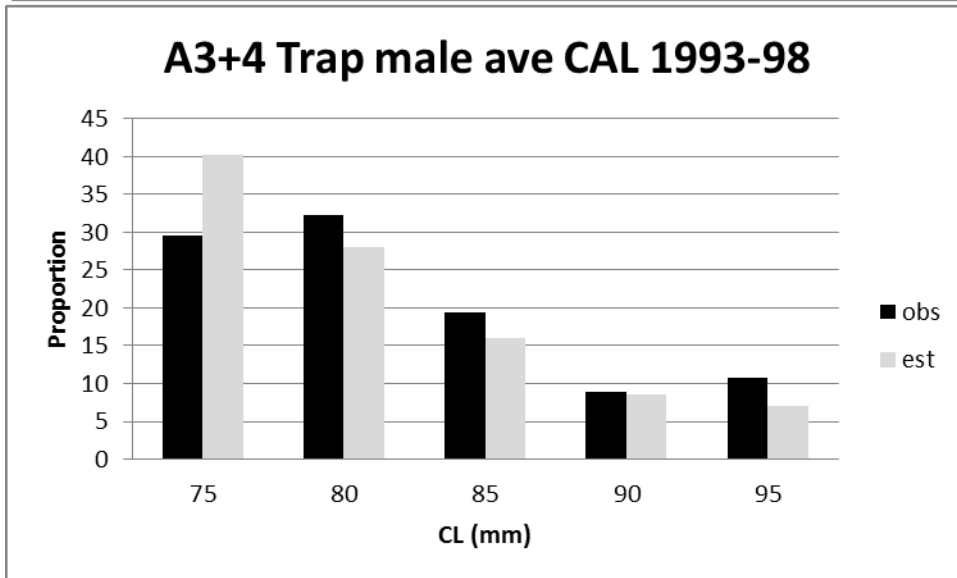
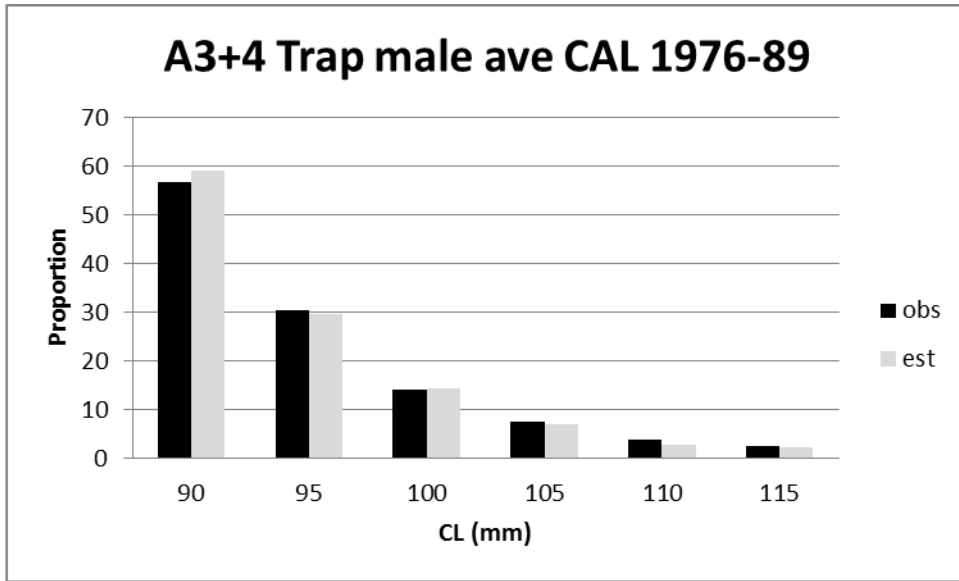


Figure B6b: A3+4 BC Trap female CAL fits.

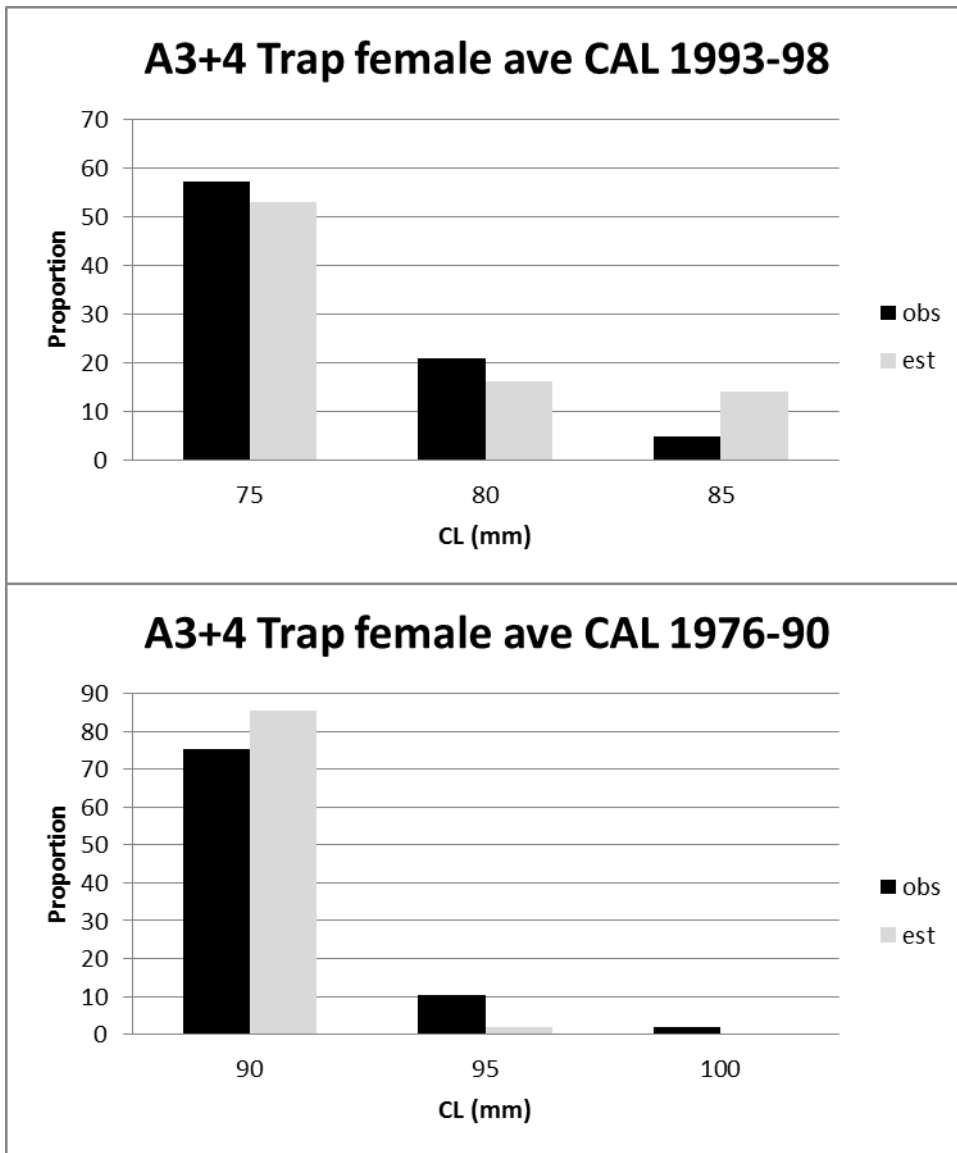


Figure B7a: A3+4 BC HOOP male CAL fits.

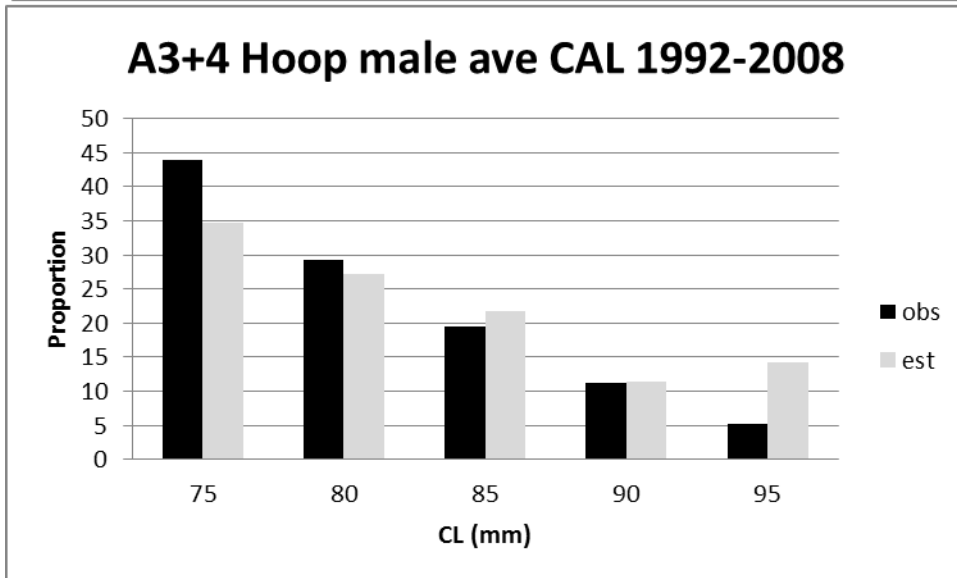
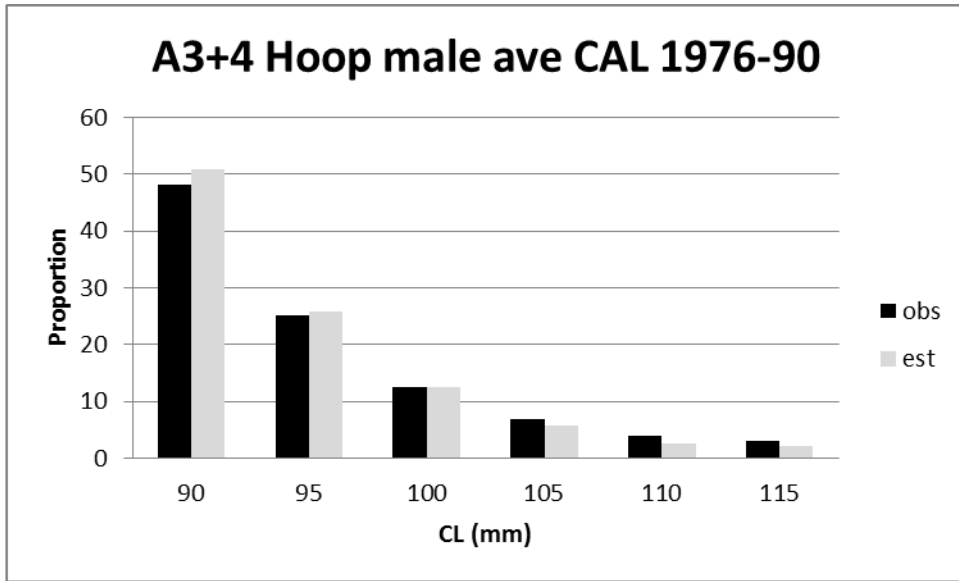


Figure B7b: A3+4 BC Hoop females CAL.

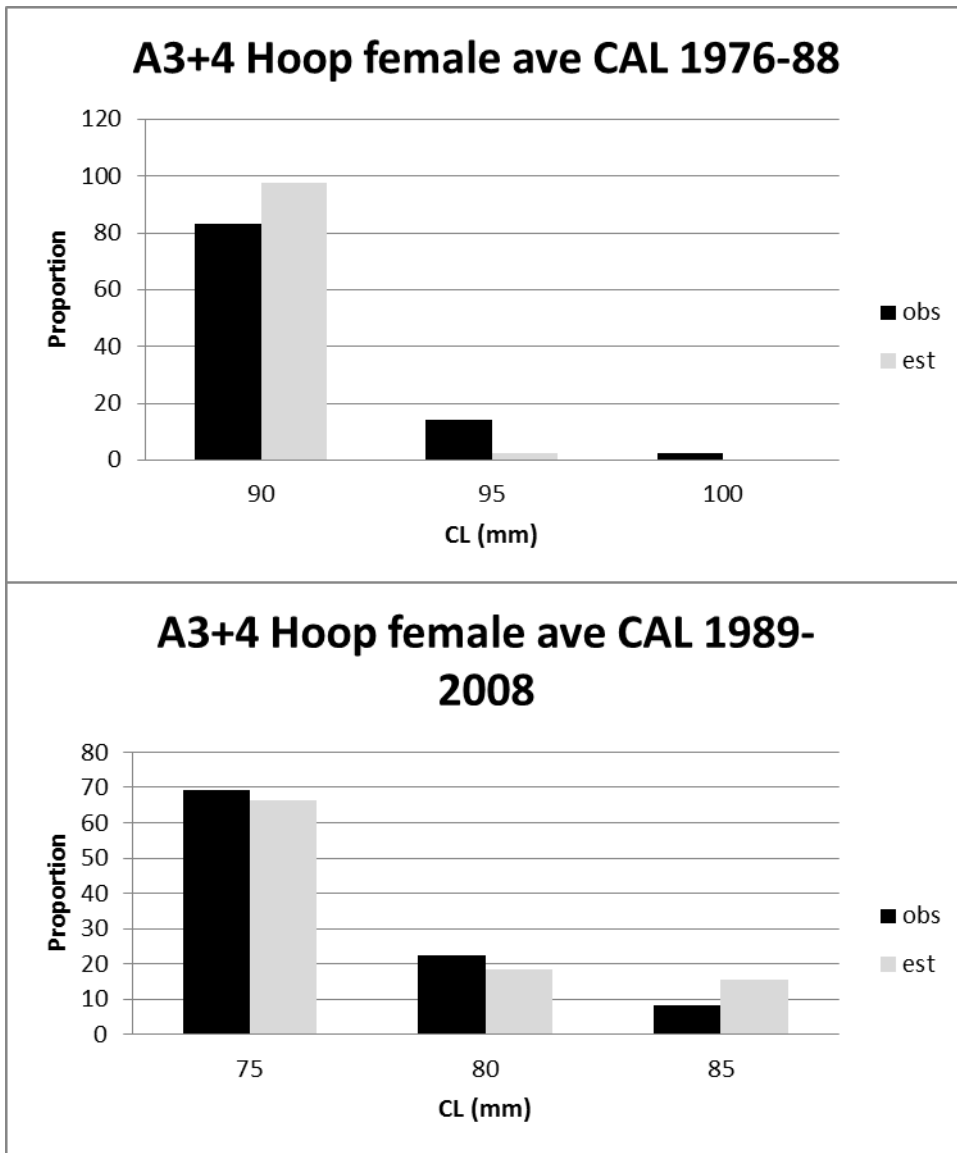


Figure B8a: A3+4 BC FIMS male CAL fits.

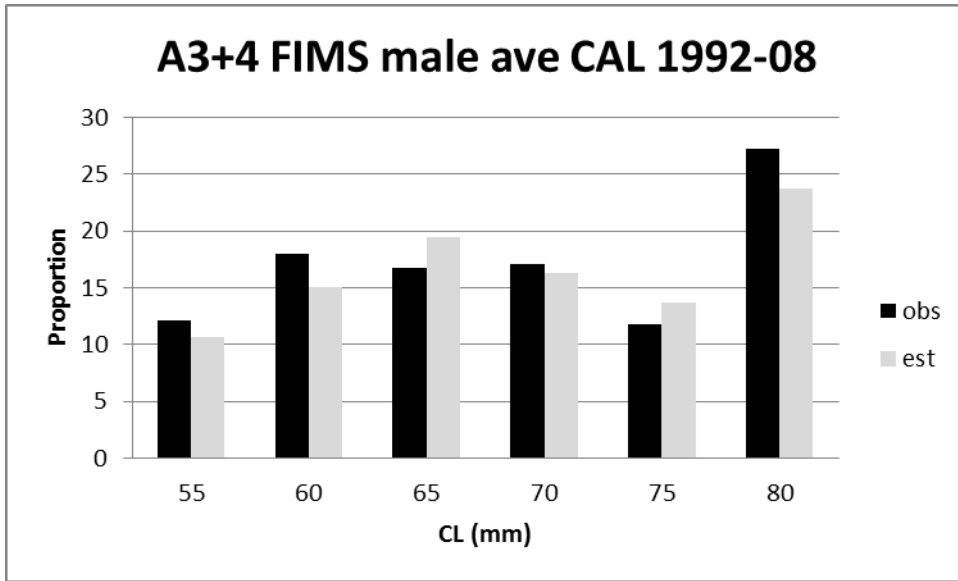
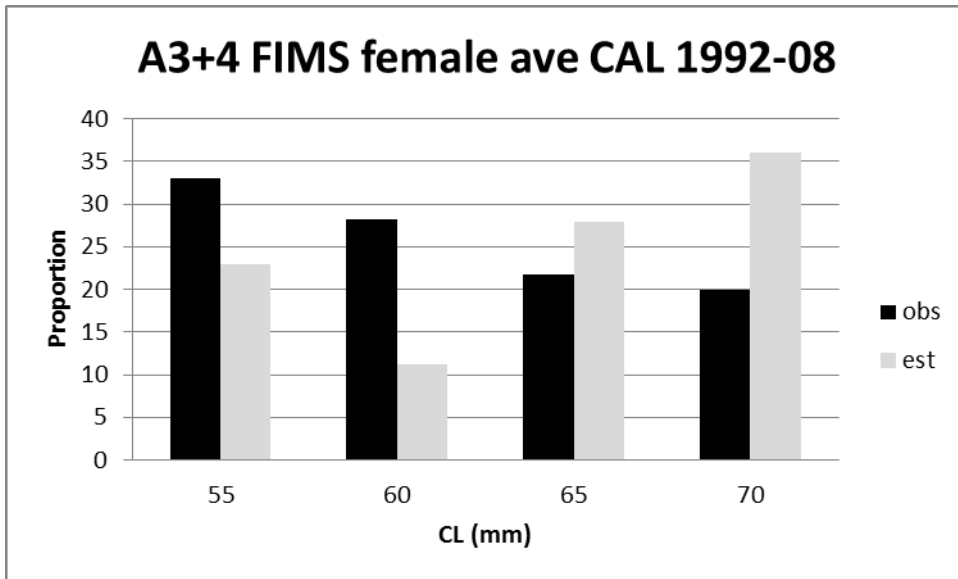


Figure B8b: A3+4 BC FIMS females CAL.



Section C: Details of A5+6 2018 assessments

Figure C1: Comparison of estimated A5+6 B75m (MT) trends for three poaching scenarios. The lower plot shows values for 1975+ only.

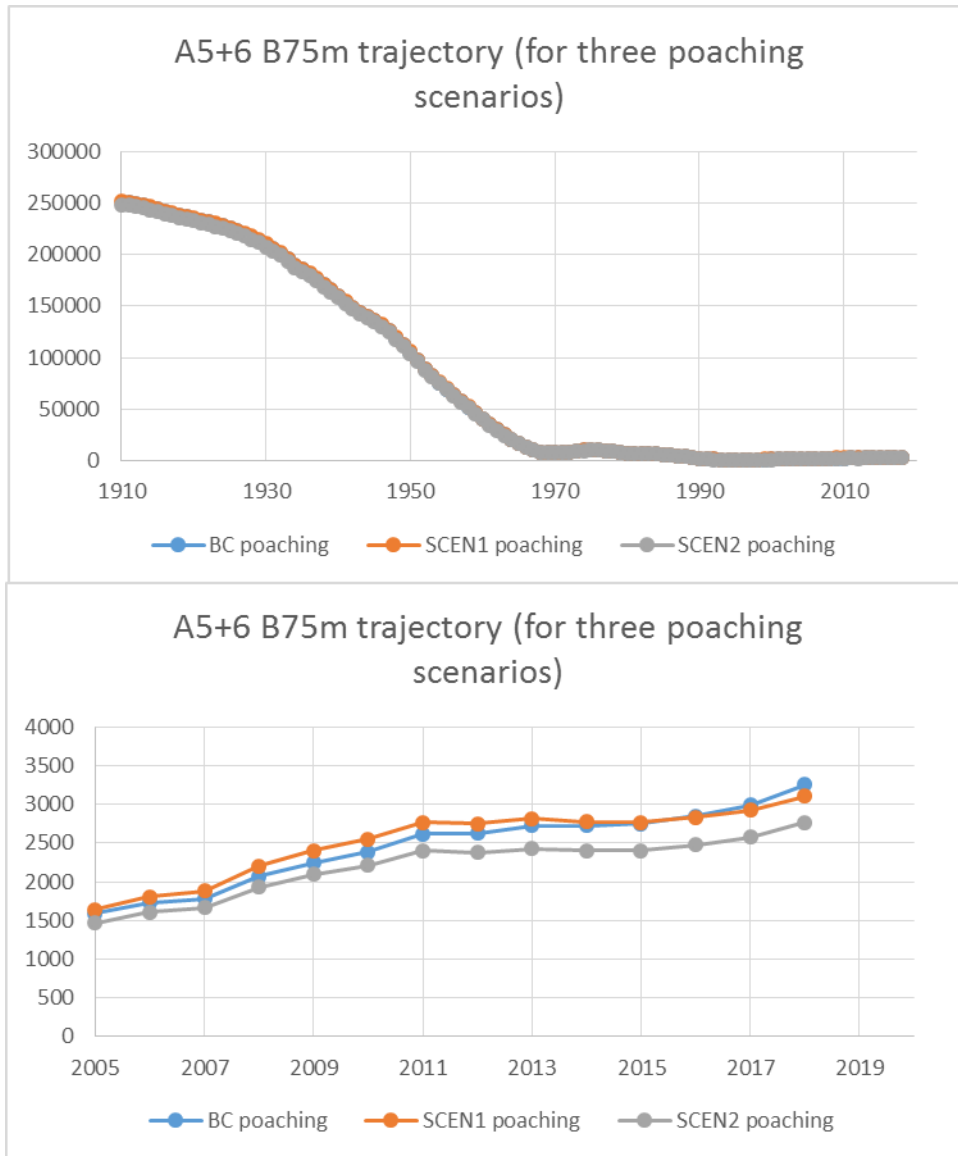


Figure C2: Estimated recruitment for A5+6 for the 2018 assessments (assuming the BC poaching scenario). The symbols indicate the years for which parameters are actually estimated for (linear interpolation is assumed between). The vertical arrow in the lower plot indicate the start of the recruitment projection period.

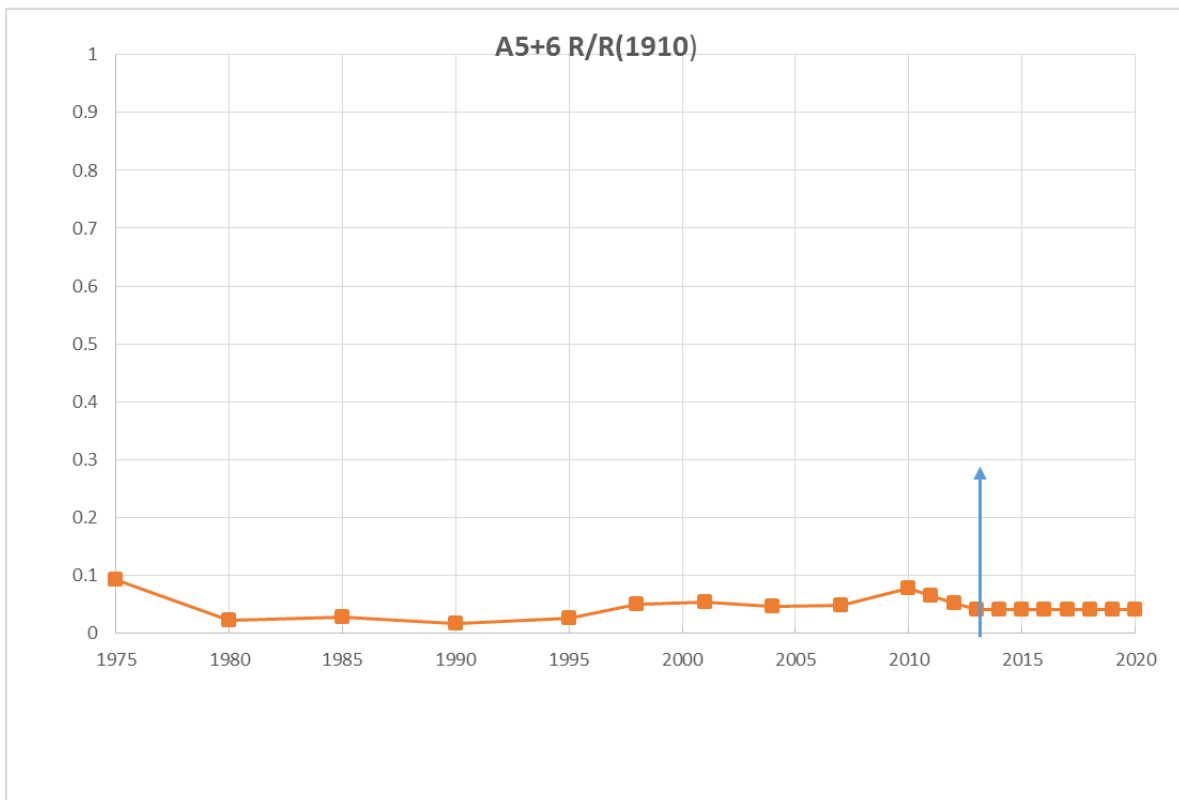
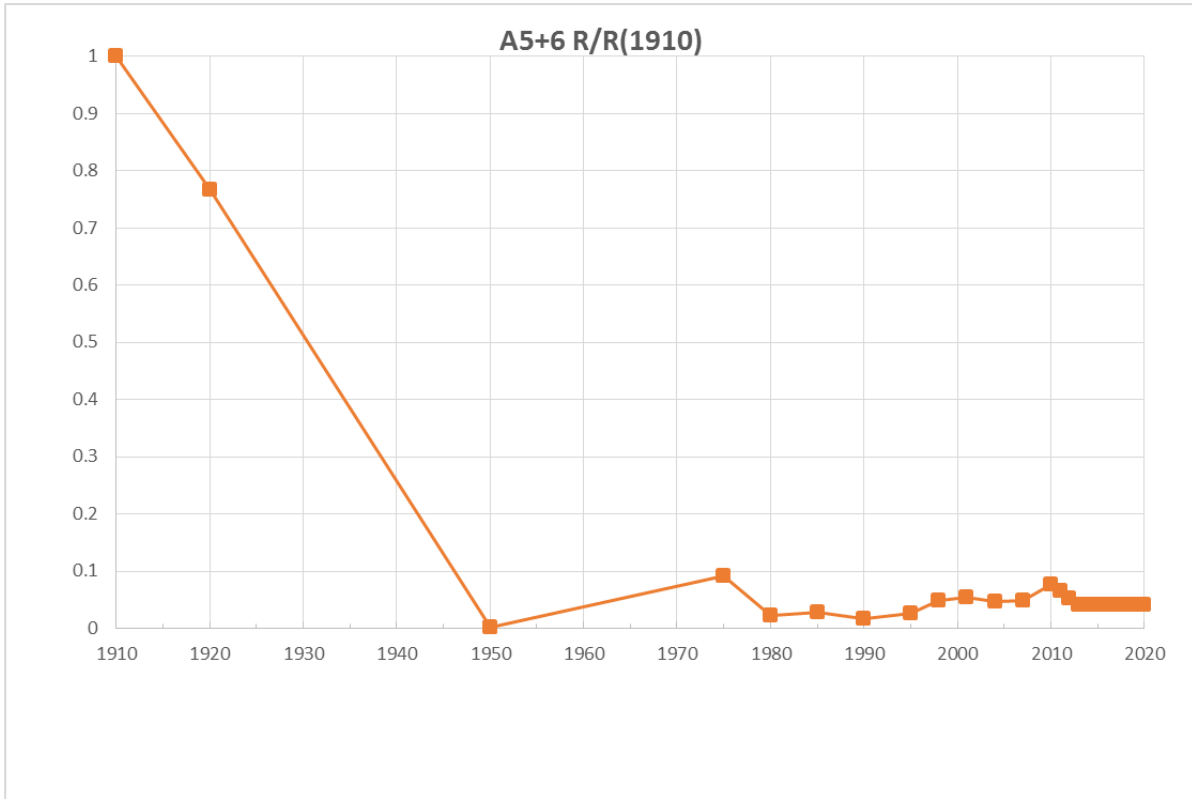


Figure C3: Estimated 2018 (input) somatic growth for A5+6. Vertical arrows indicate start of projection period.

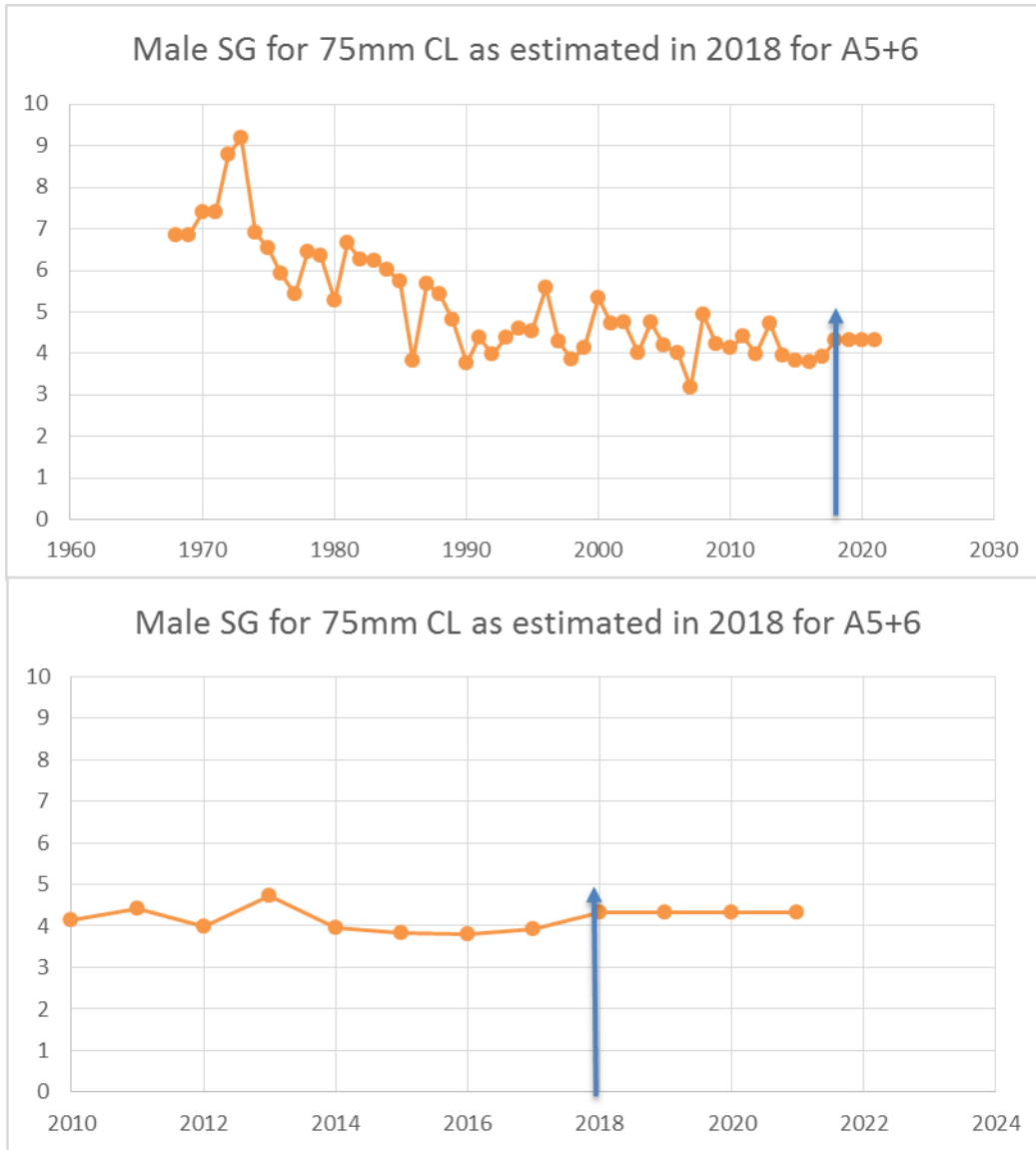


Figure C4: Updated 2018 fits for A5+6 to GLM standardised CPUE data for BC poaching scenario. Note this fishery is a hoop fishery only (no traps).

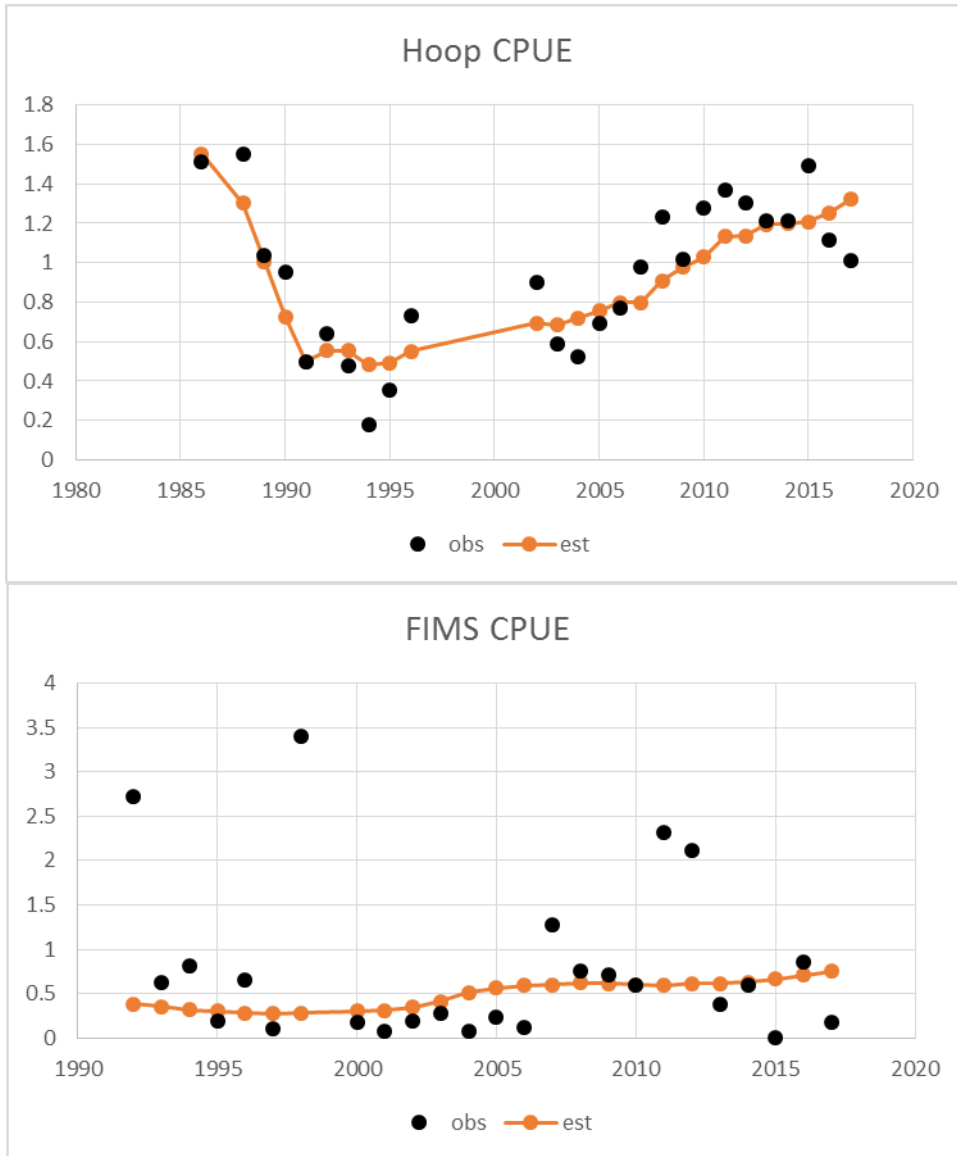


Figure C5: 2018 model fits for A5+6 percent females in the catch. BC poaching scenario. Note this fishery is a hoop fishery only (no traps).

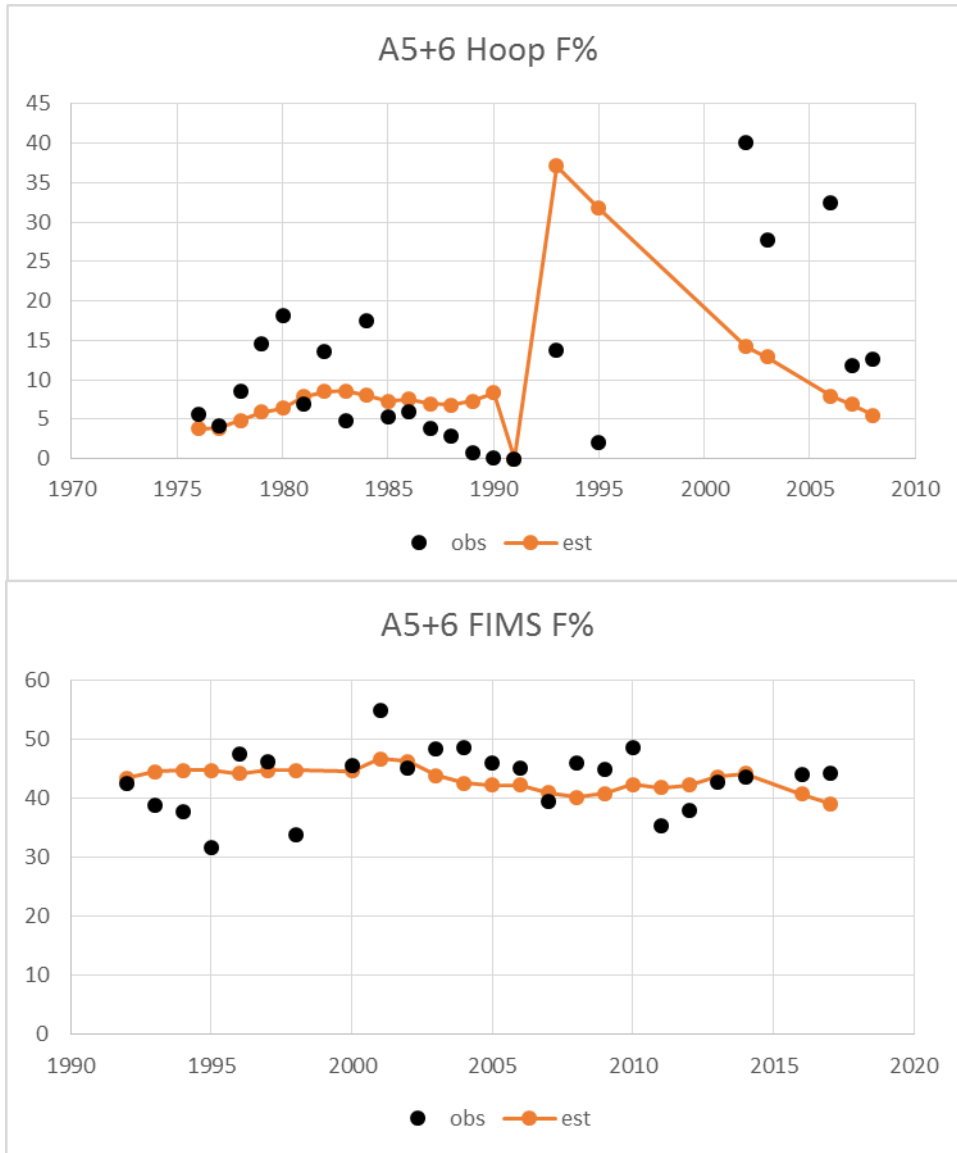


Figure C7a: A5+6 BC Hoop male CAL fits.

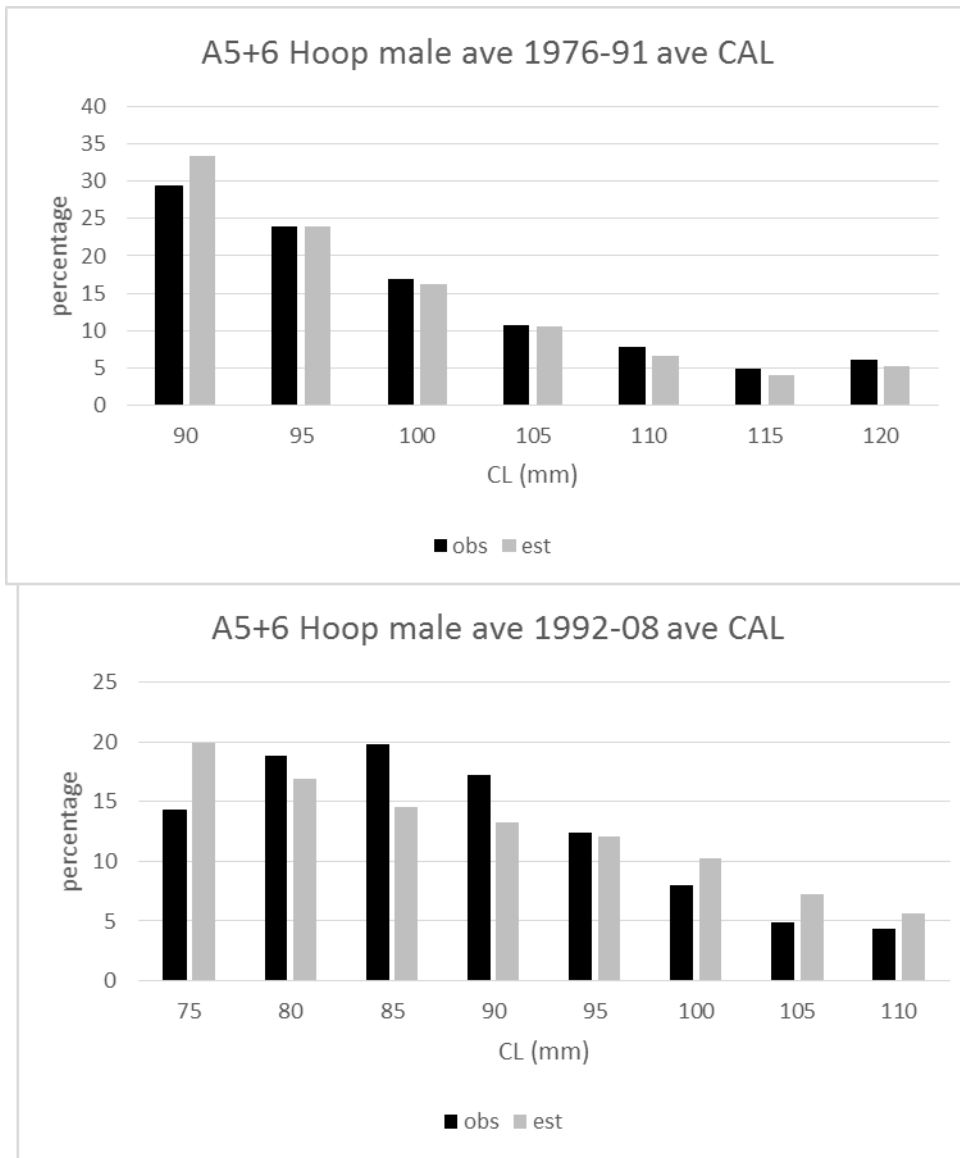


Figure C7b: A5+6 BC Hoop female CAL fits.

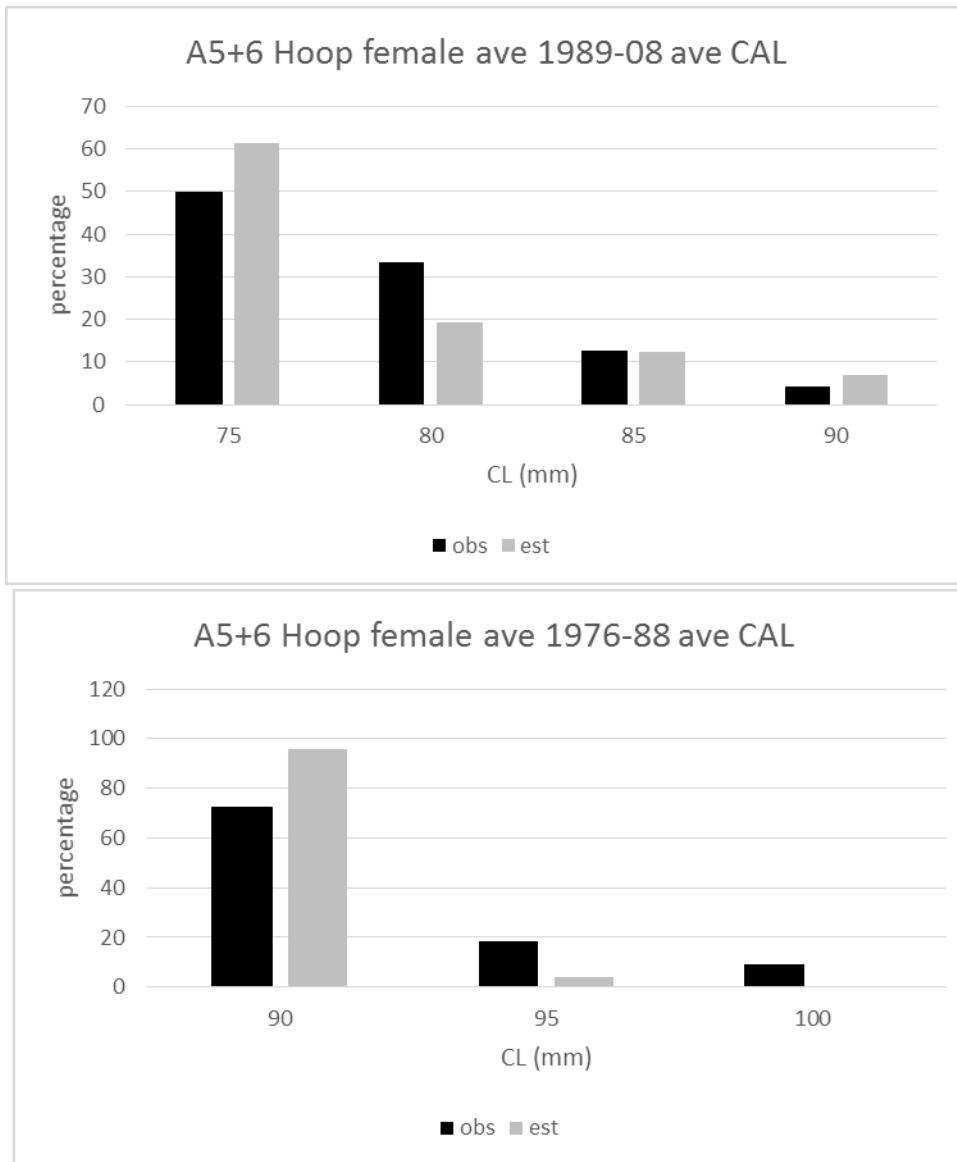


Figure C8a: A5+6 BC FIMS male CAL fits.

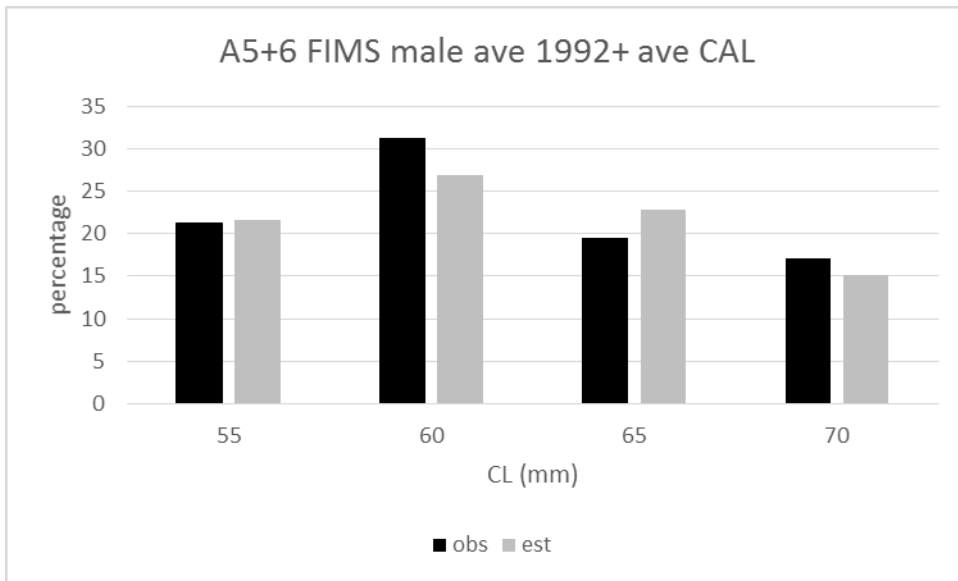
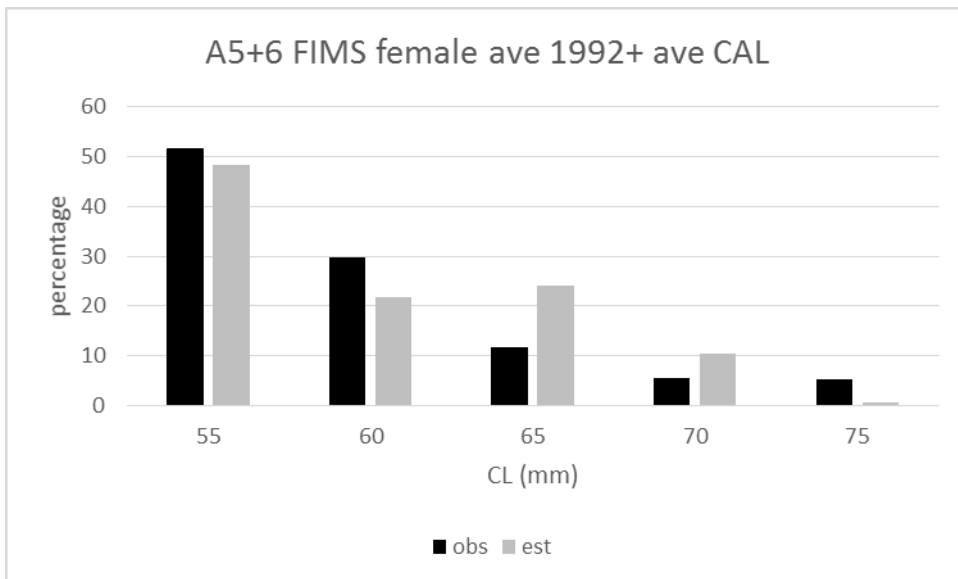


Figure C8b: A5+6 BC FIMS females CAL.



Section D: Details of A7 2018 assessments

Figure D1: Comparison of estimated A7 B75m (MT) trends for three poaching scenarios. The lower plot shows values for 1975+ only.

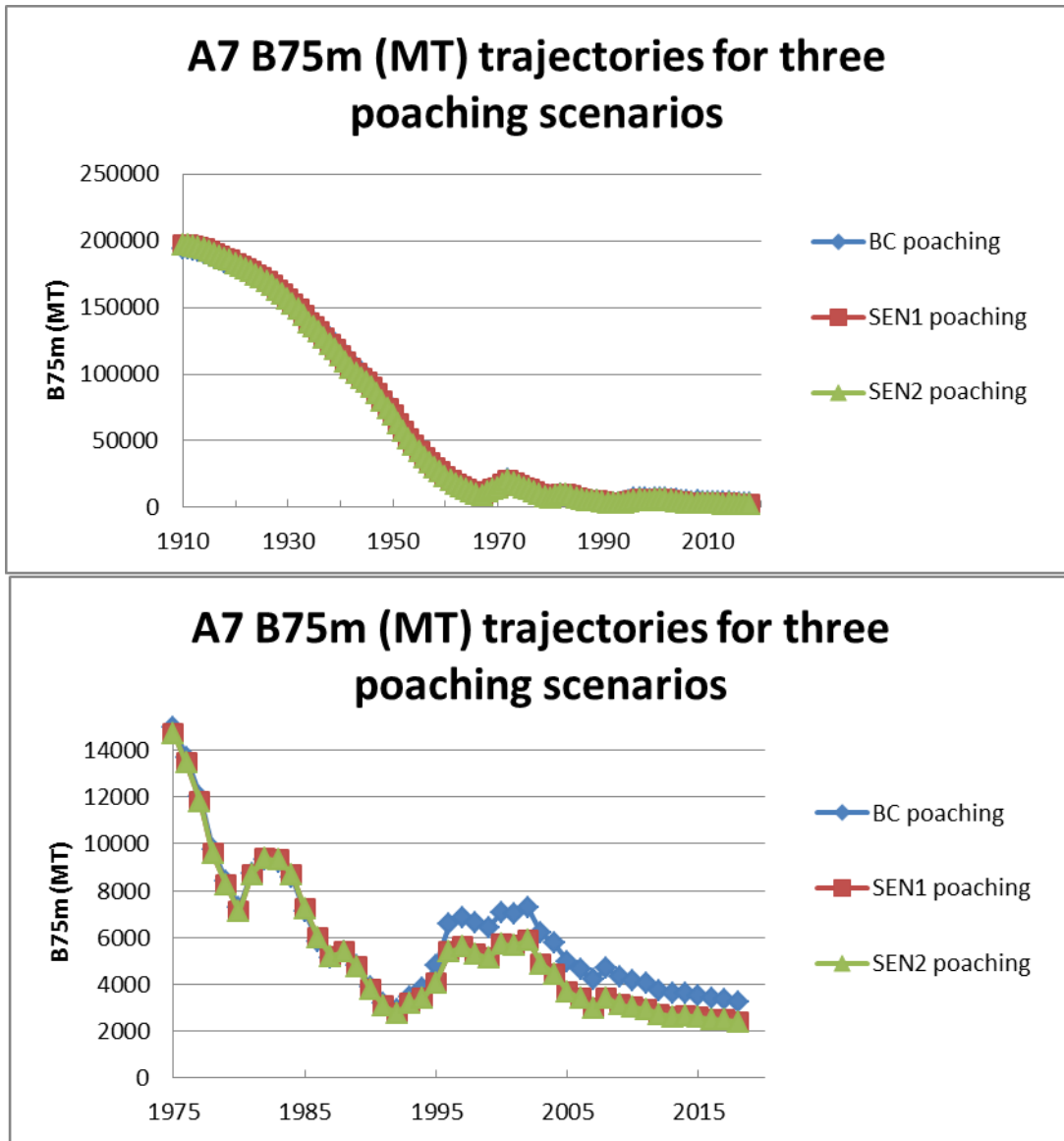


Figure D2: Estimated recruitment for A7 for the 2018 assessments (assuming the BC poaching scenario). The symbols indicate the years for which parameters are actually estimated for (linear interpolation is assumed between). The vertical arrow in the lower plot indicate the start of the recruitment projection period.

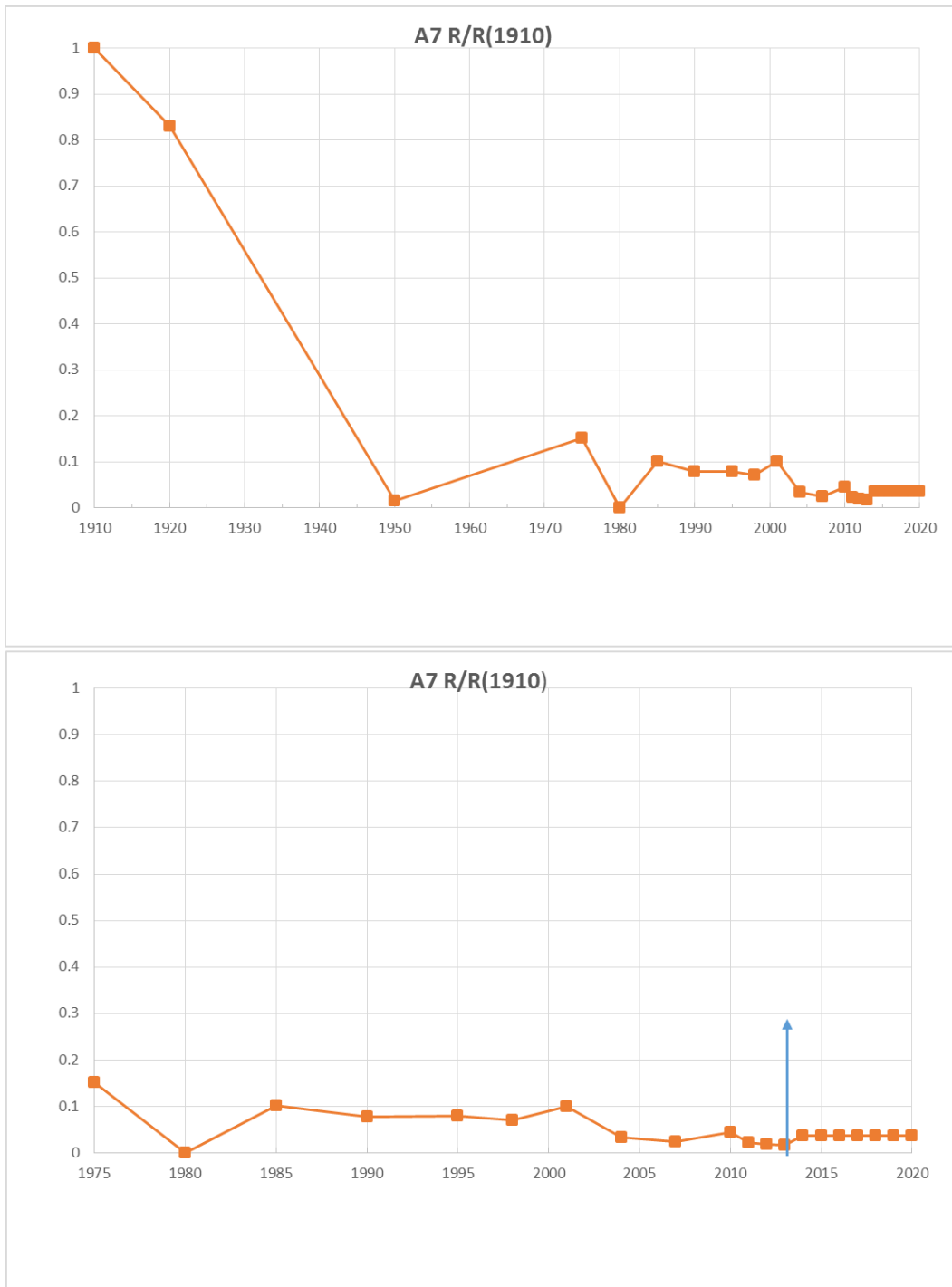


Figure D3: Estimated 2018 (input) somatic growth for A7. Vertical arrows indicate start of projection period.

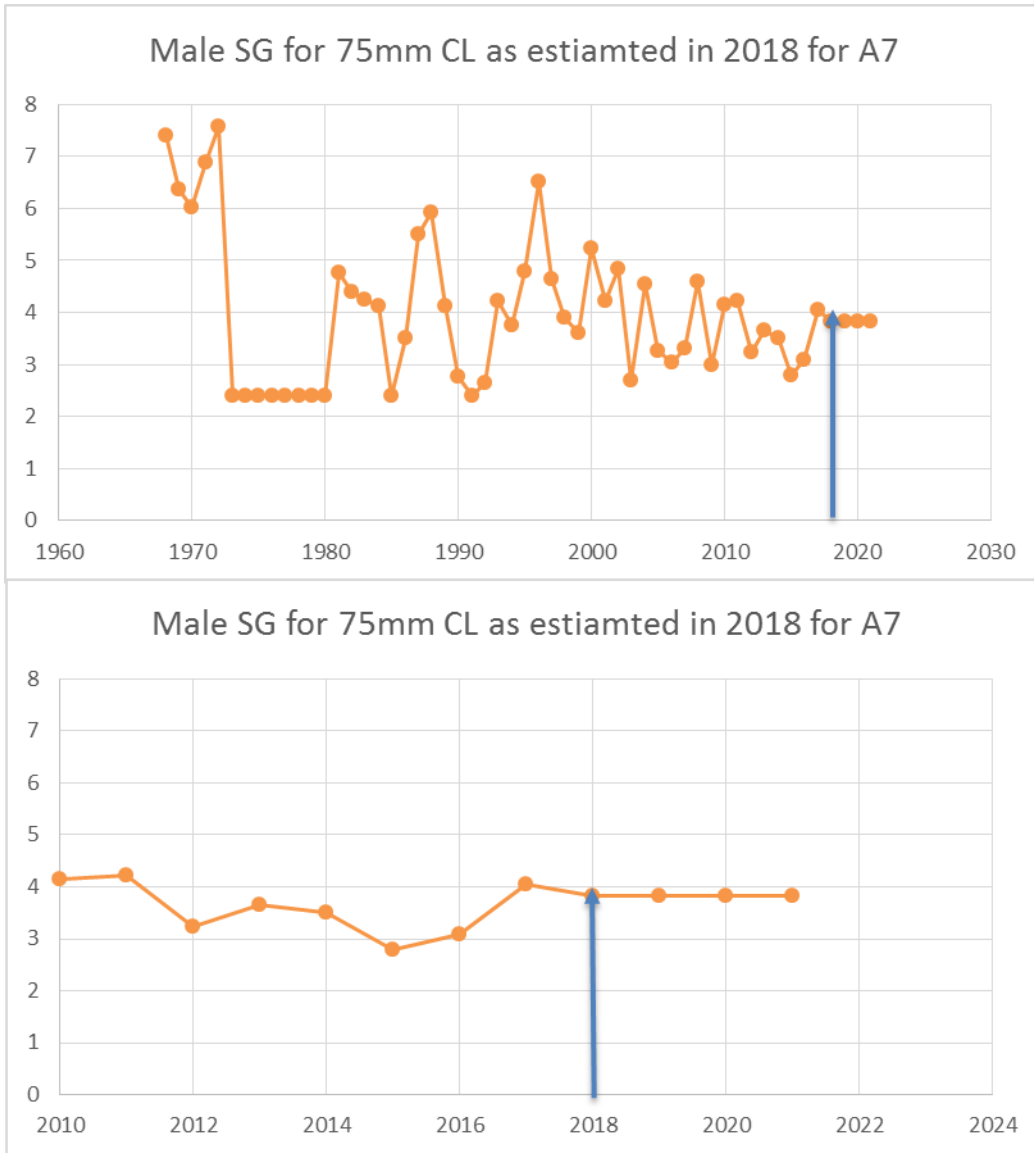


Figure D4: Updated 2018 fits for A7 to GLM standardised CPUE data for BC poaching scenario. Note this fishery is a trap only fishery.

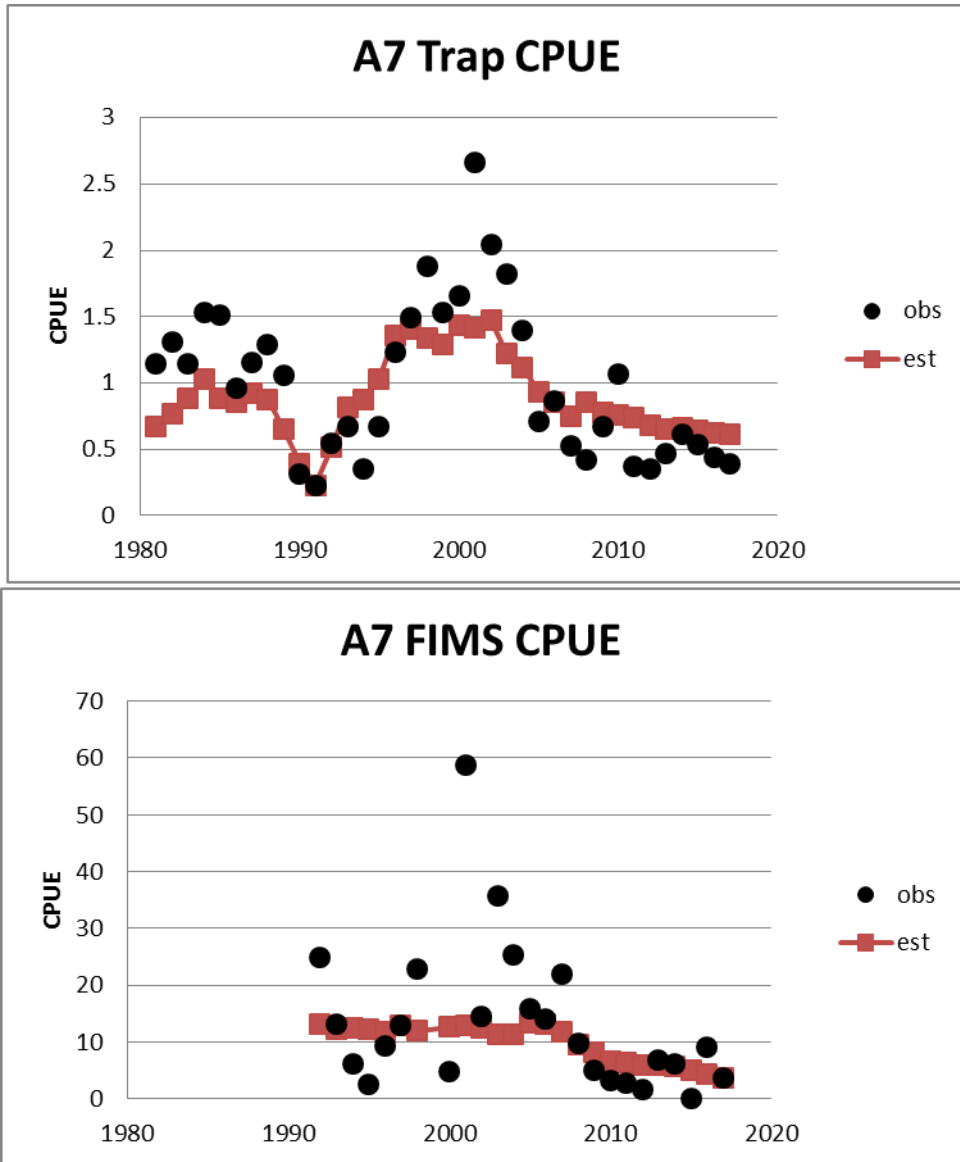


Figure D5: 2018 model fits for A7 percent females in the catch. BC poaching scenario. Note this fishery is a trap fishery only.

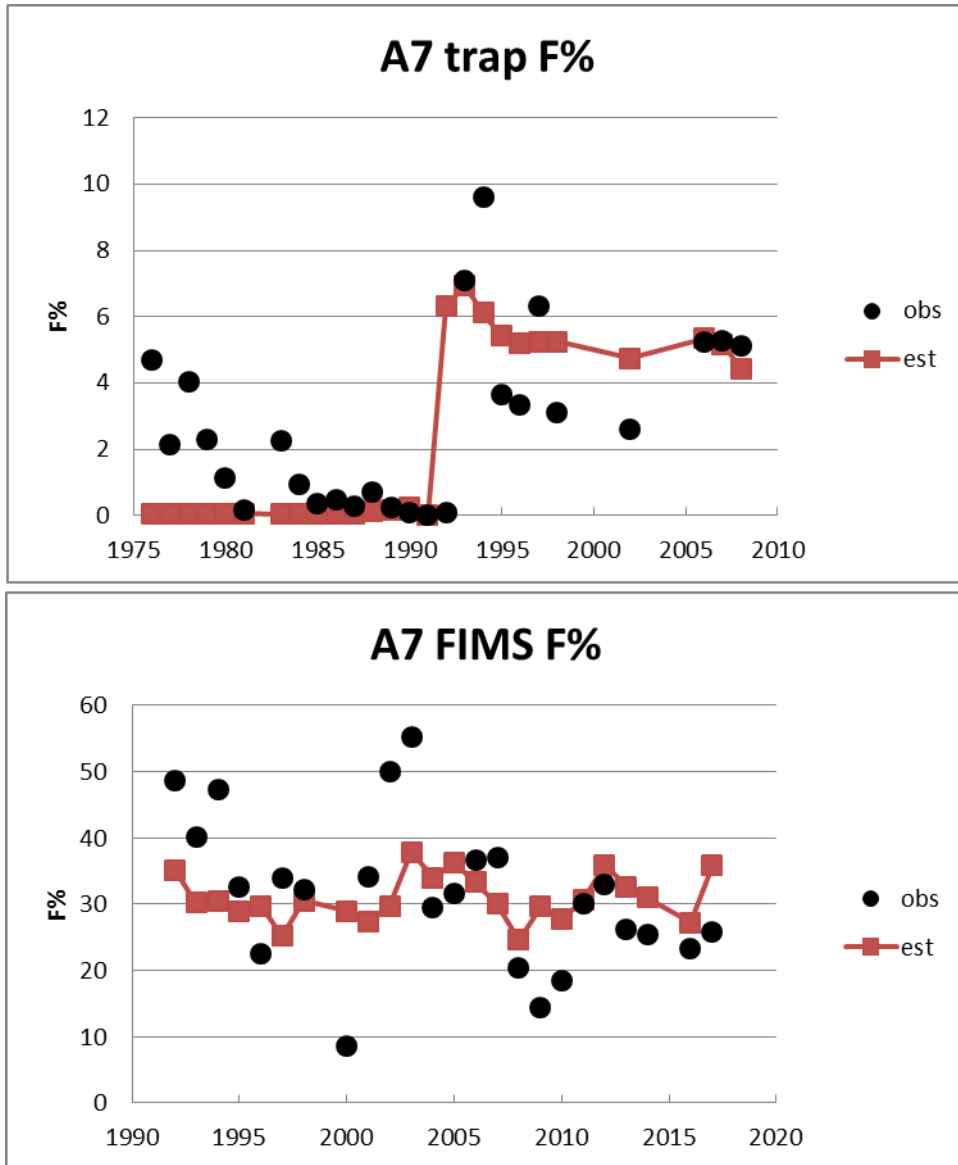


Figure D7a: A7 BC Trap male CAL fits.

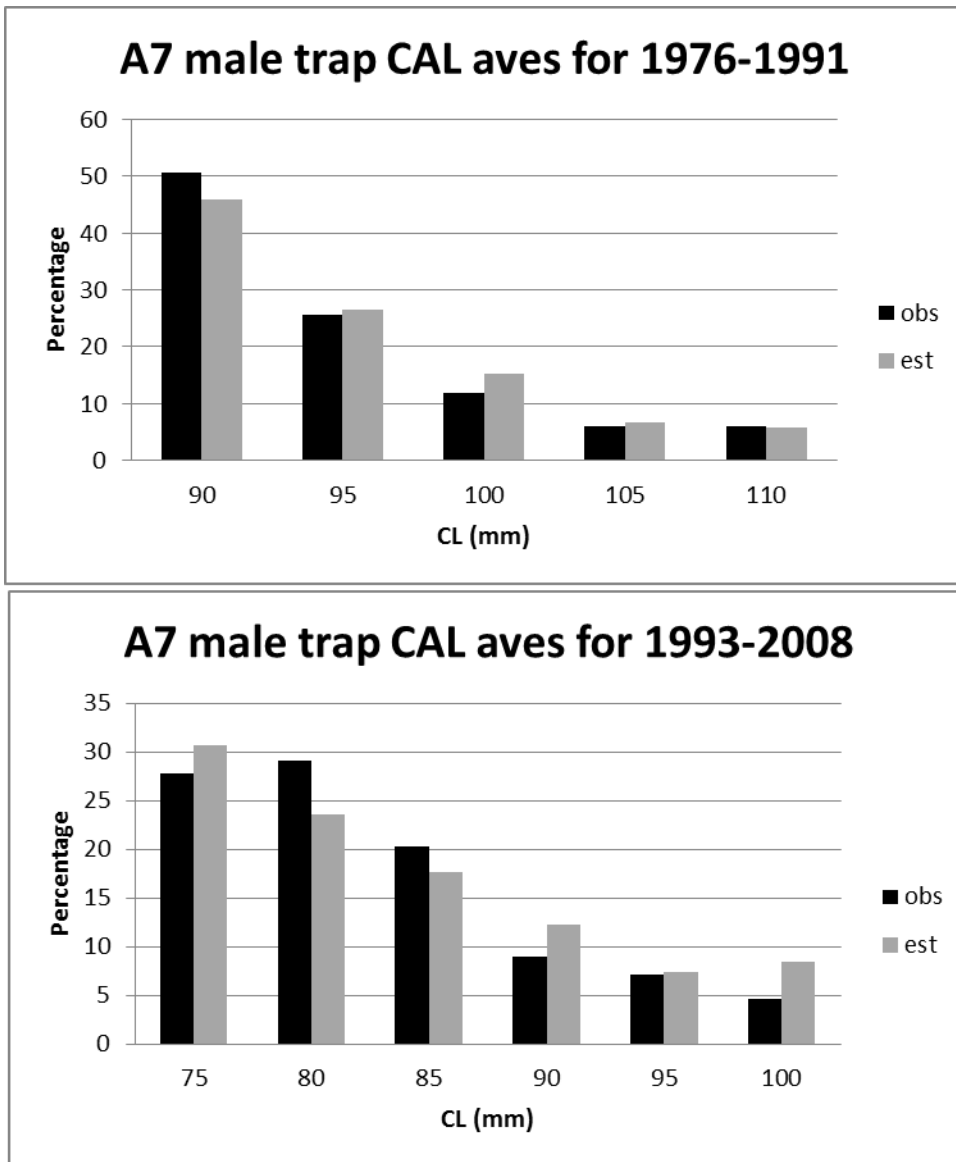


Figure D7b: A7 BC Trap female CAL fits.

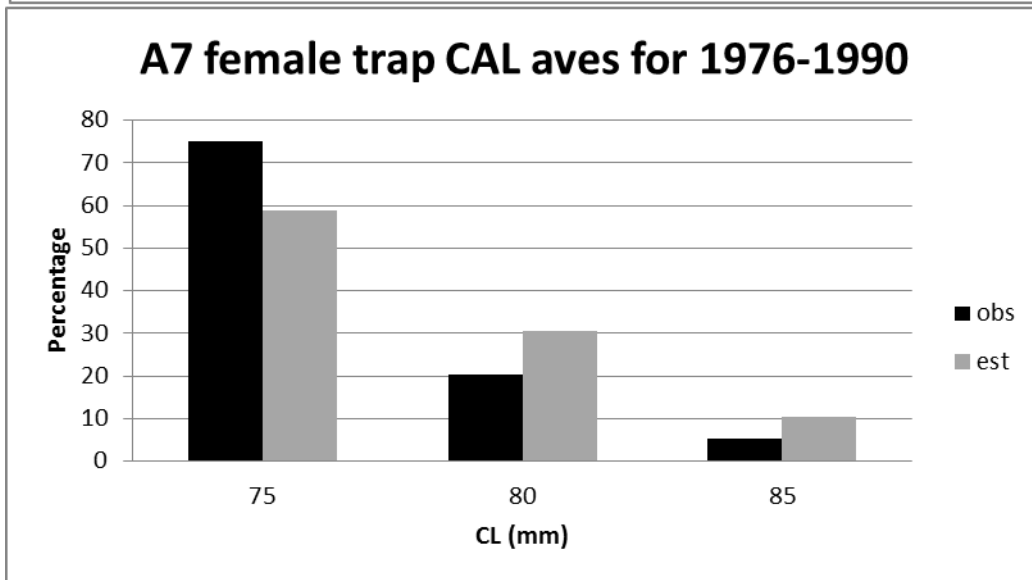
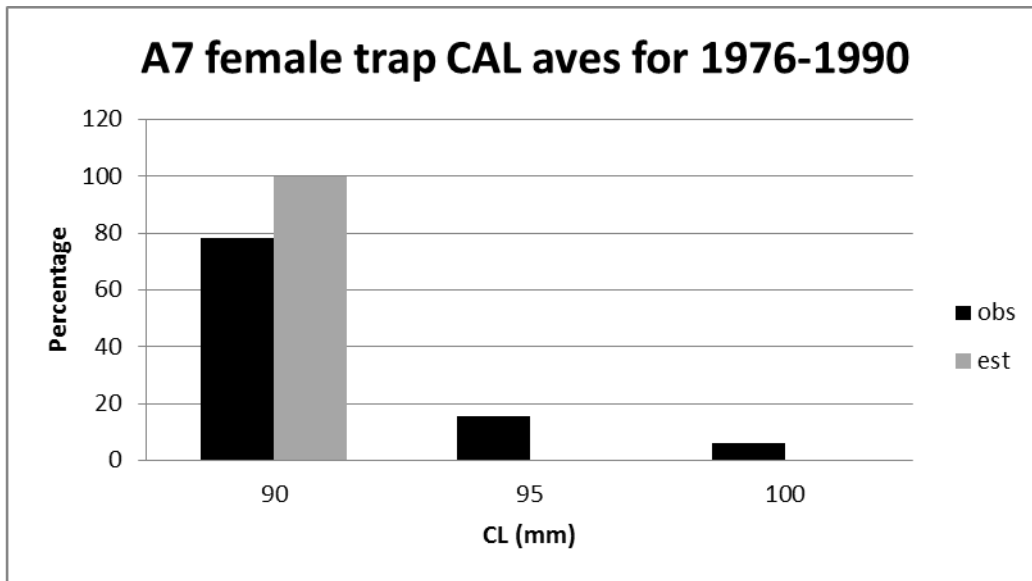


Figure D8a: A7 BC FIMS male CAL fits.

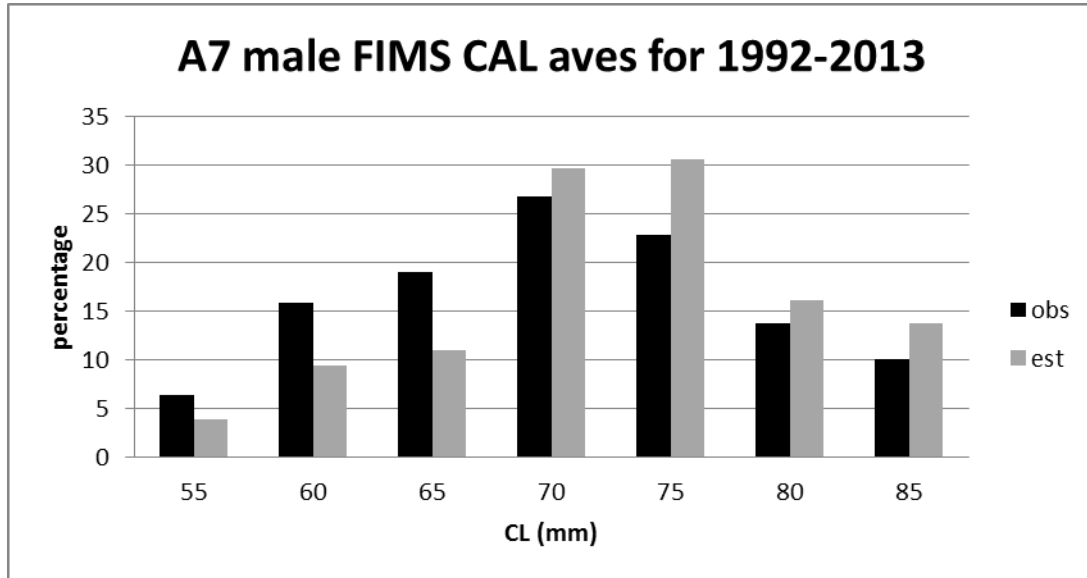
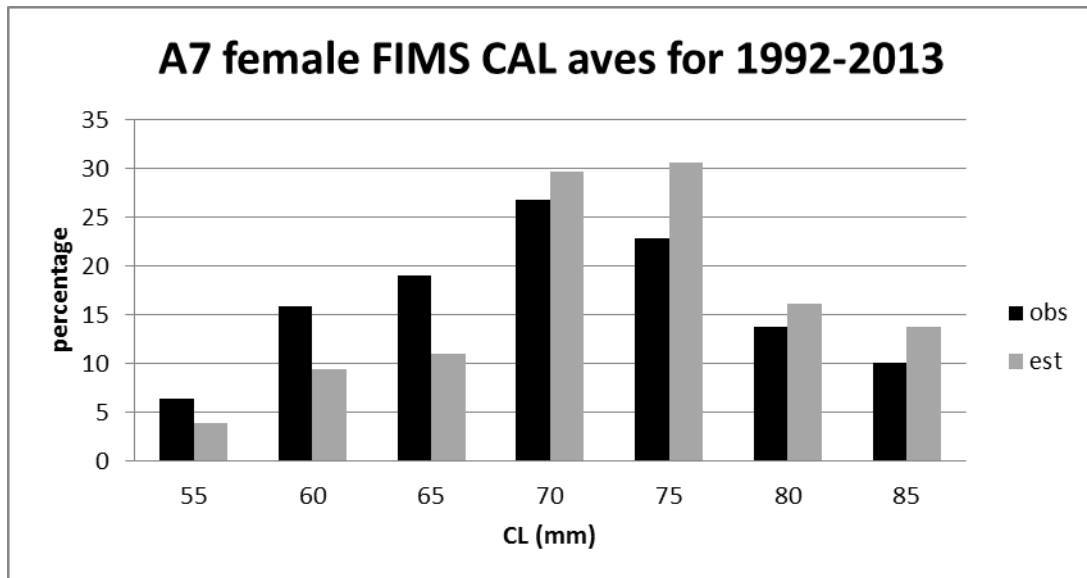


Figure D8b: A7 BC FIMS females CAL.



Section E: Details of A8+ 2018 assessments for 2018 with some comparisons to 2016

Figure E1: Comparison of estimated A8+ B75m (MT) trends for four of the assessments. Note that “Scenario 5” refers to the 2016 BC poaching scenario, and “OLD” refers to 2016.

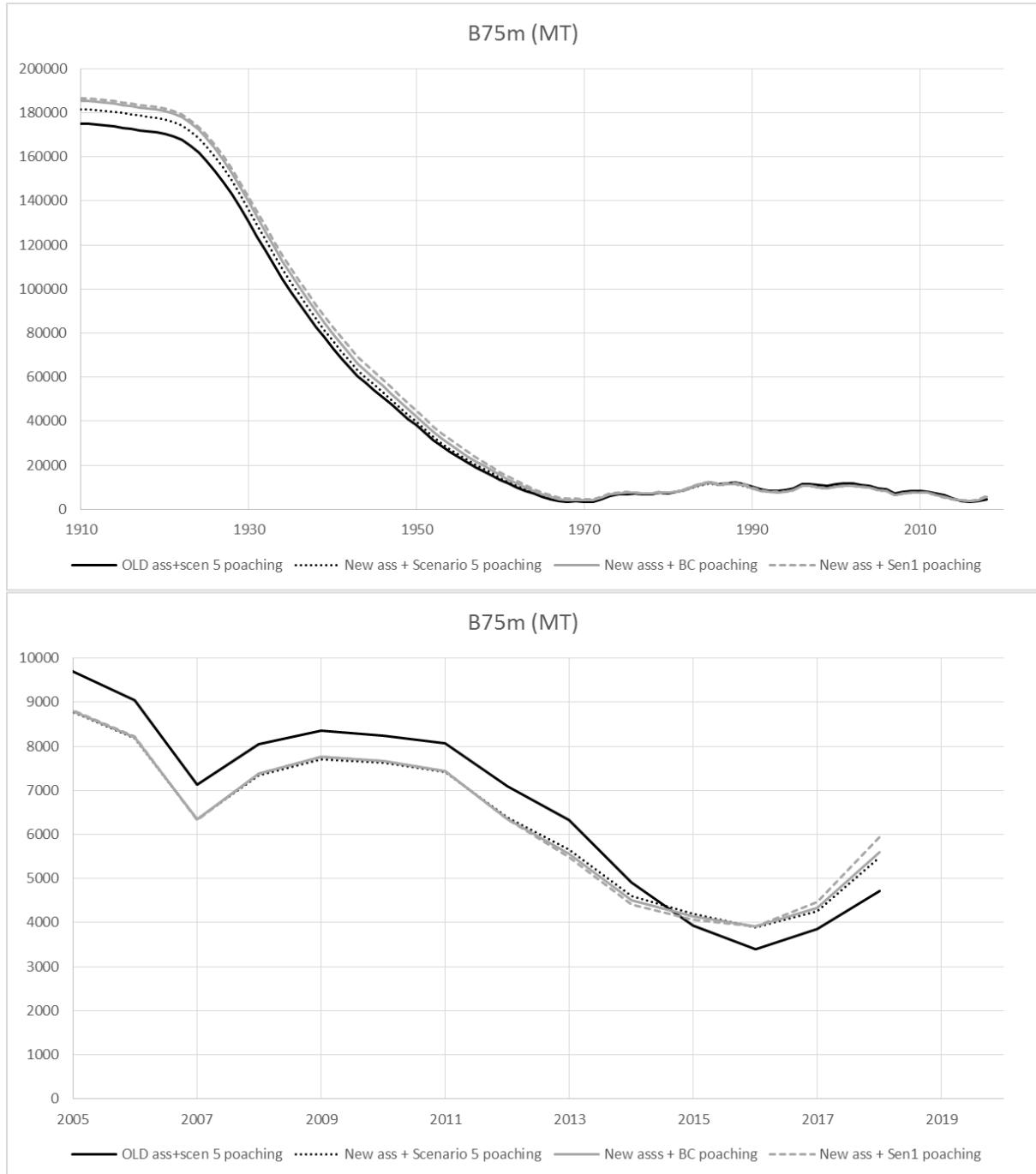


Figure E2: Estimated recruitment for A8+ for both the 2016 and 2018 assessments (assuming the 2016 BC poaching scenario in both cases). The symbols indicate the years for which parameters are actually estimated for (linear interpolation is assumed between). The vertical arrows in the lower plot indicate the starts of the 2016 and 2018 recruitment projection periods.

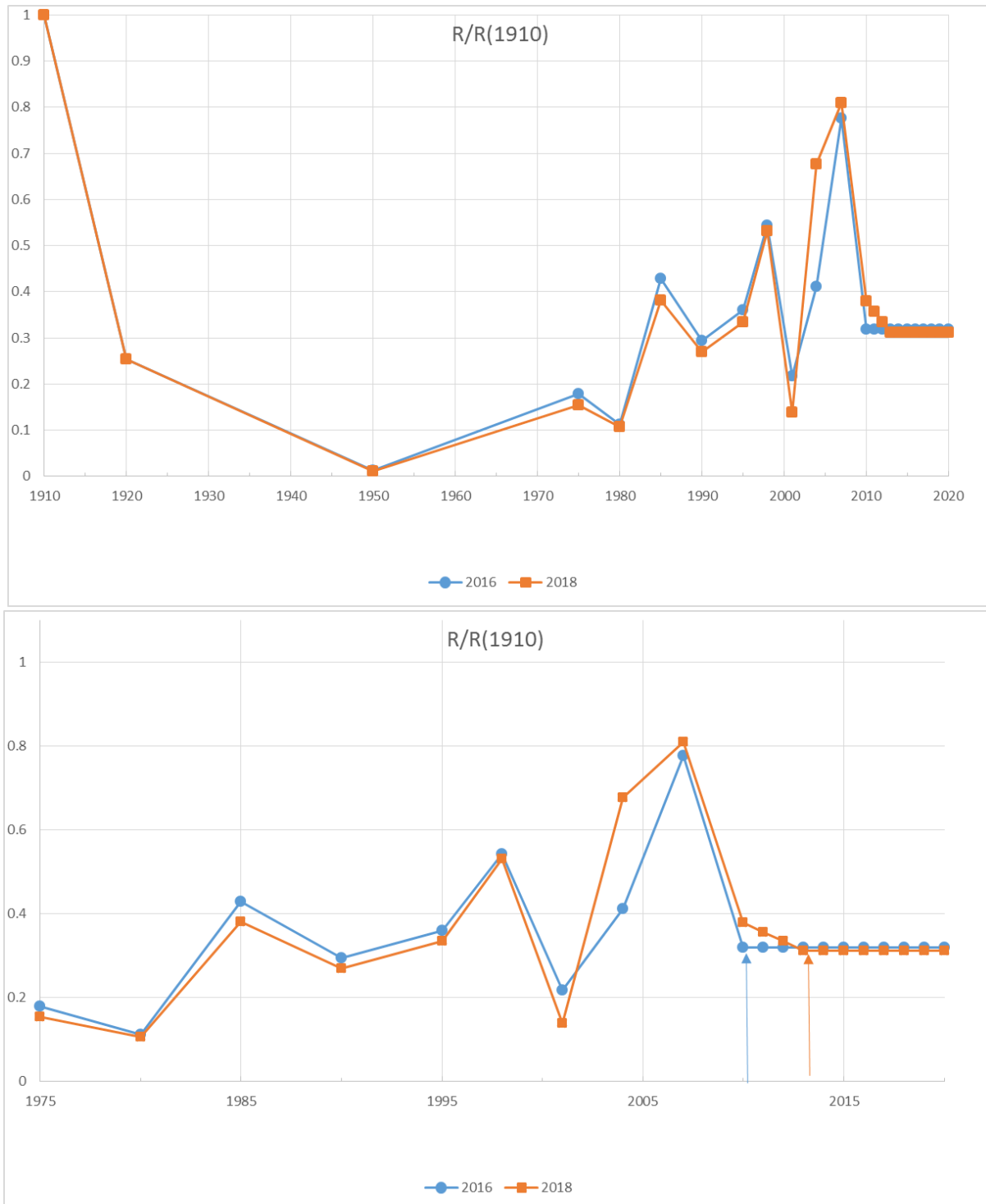


Figure E3: Estimated (input) somatic growth. Vertical arrows indicate start of projection periods.

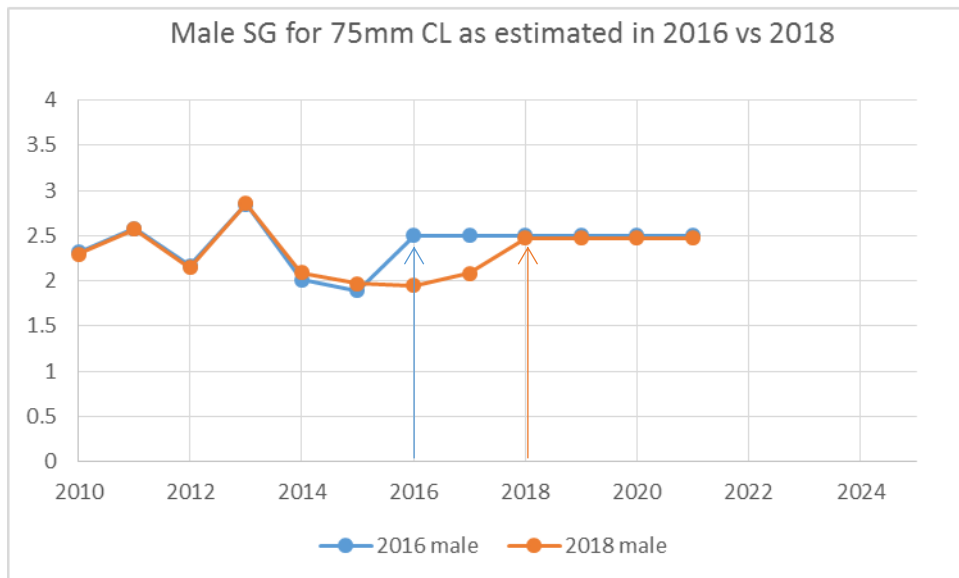
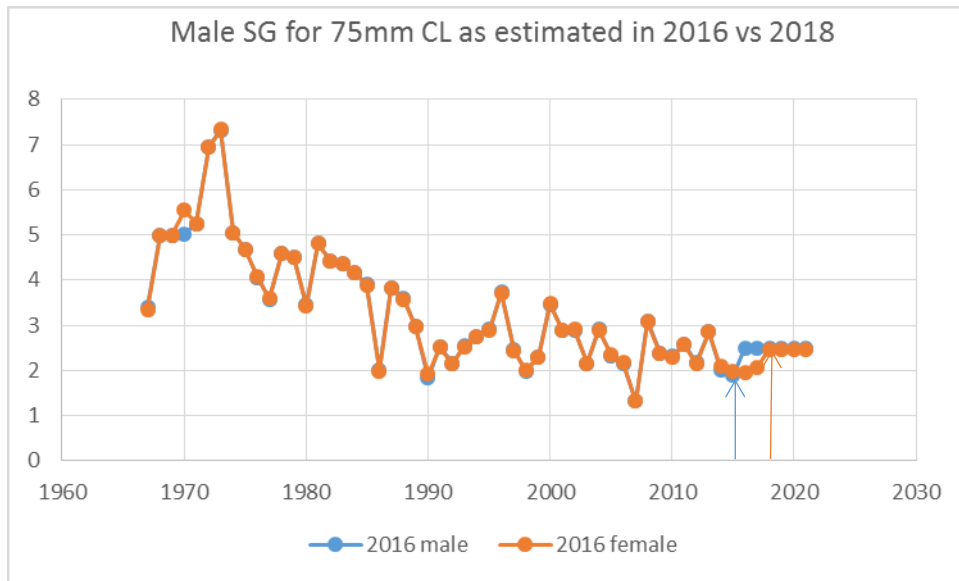


Figure E4: Updated 2018 fits to GLM standardised CPUE data for BC poaching scenario.

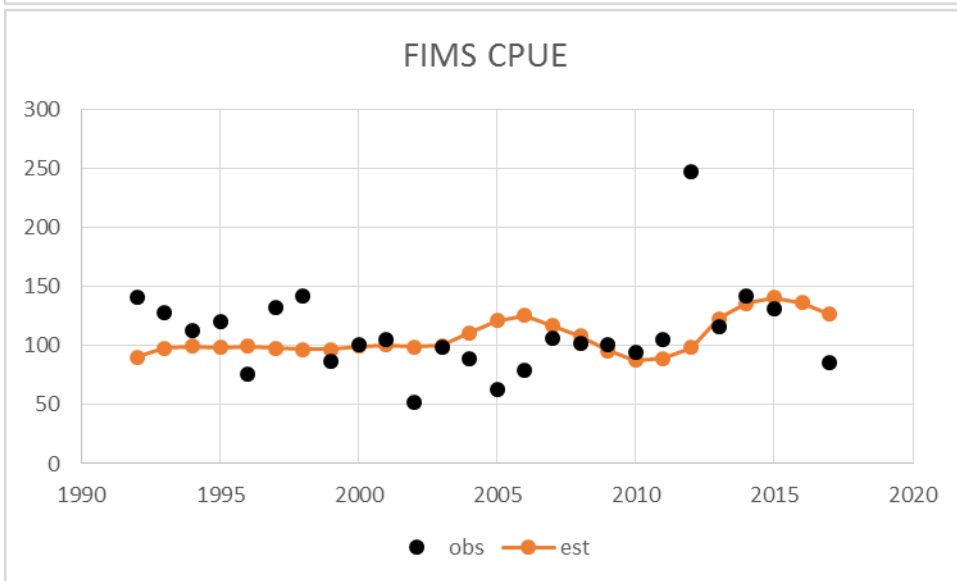
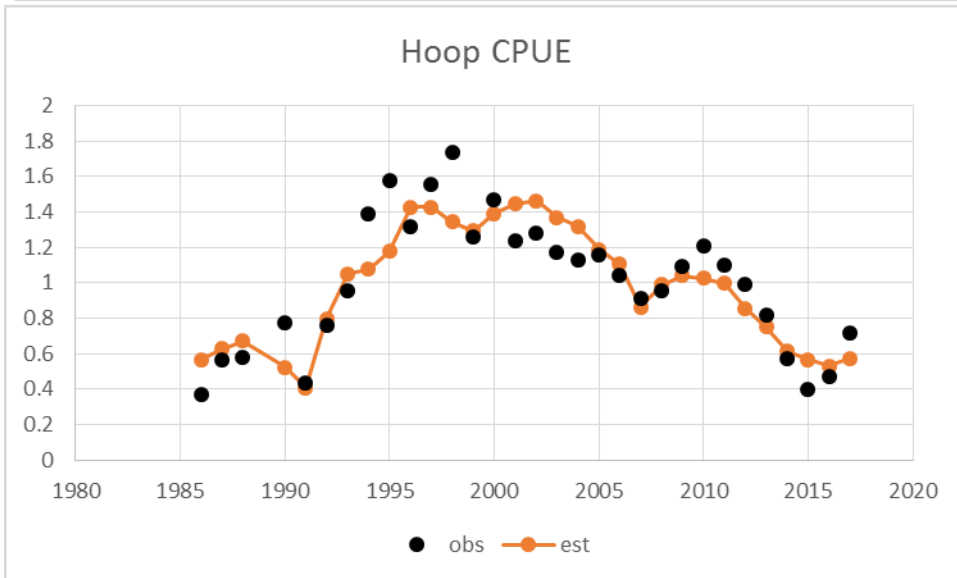
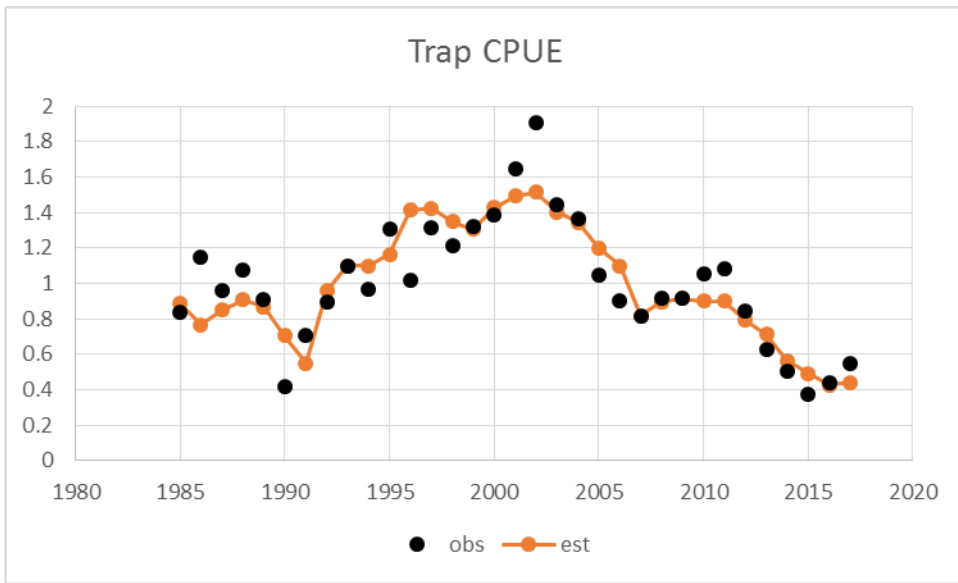


Figure E5: 2018 model fits for percent females in the catch. BC poaching scenario.

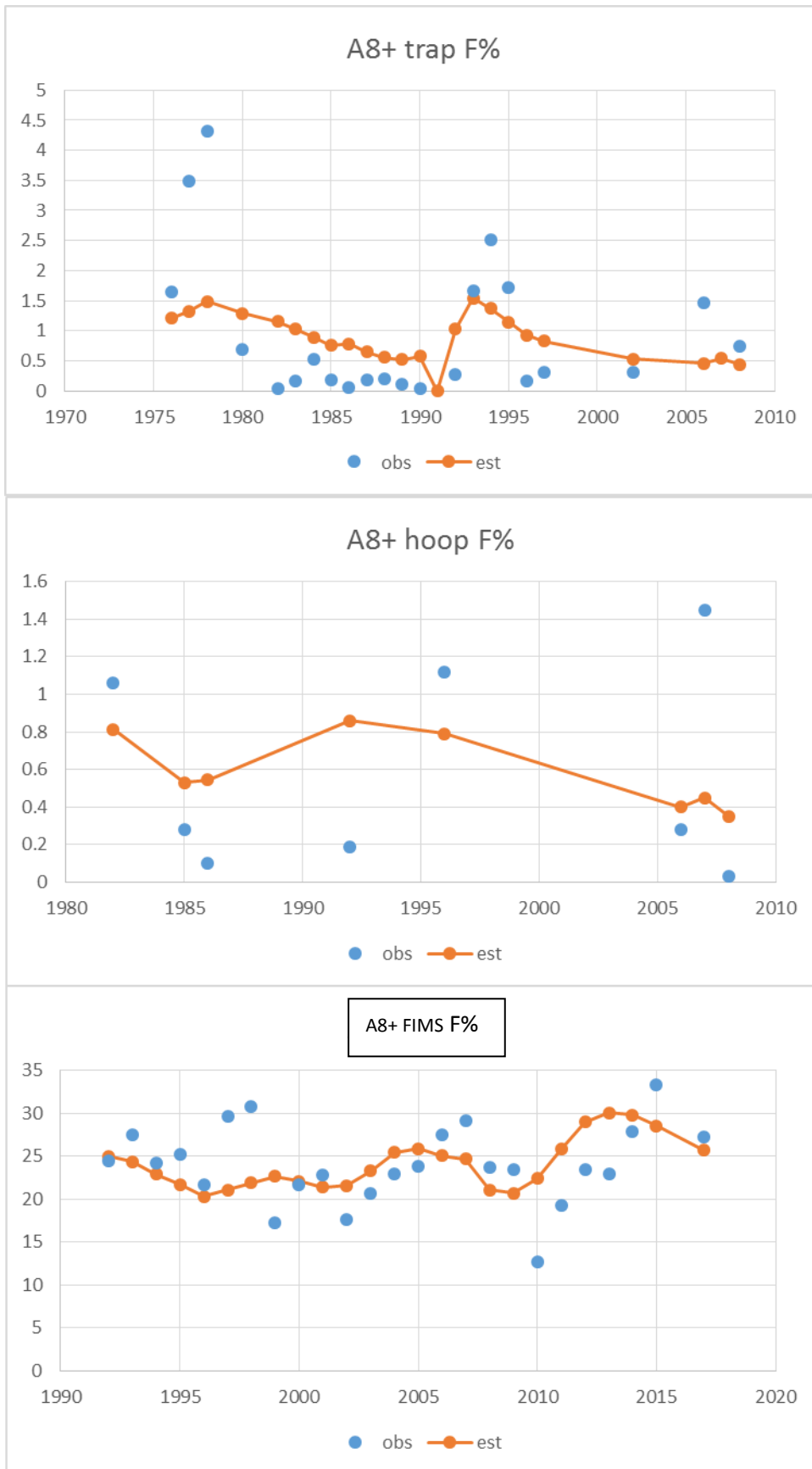


Figure E6a: A8+ BC TRAP male CAL fits.

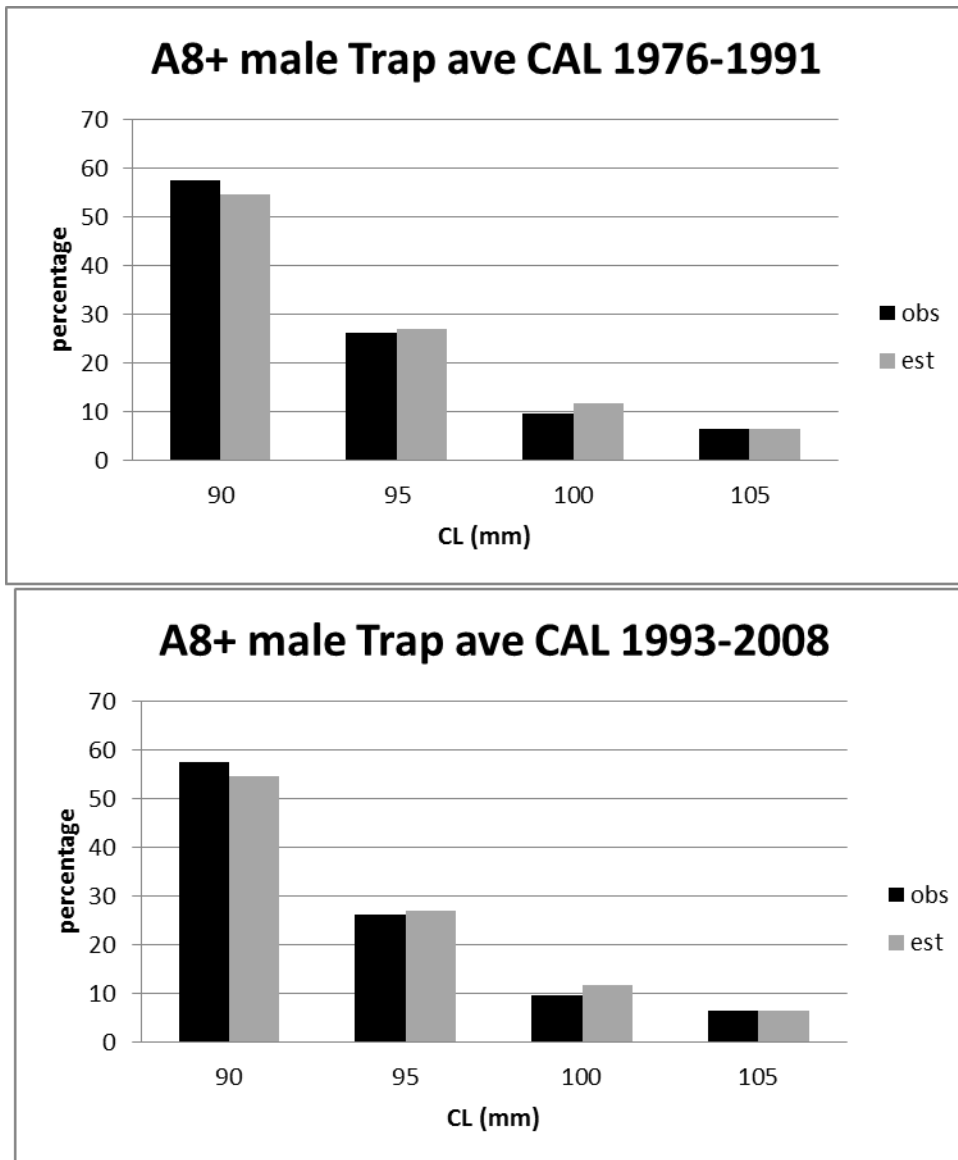


Figure E6b: A8+ BC TRAP female CAL fits.

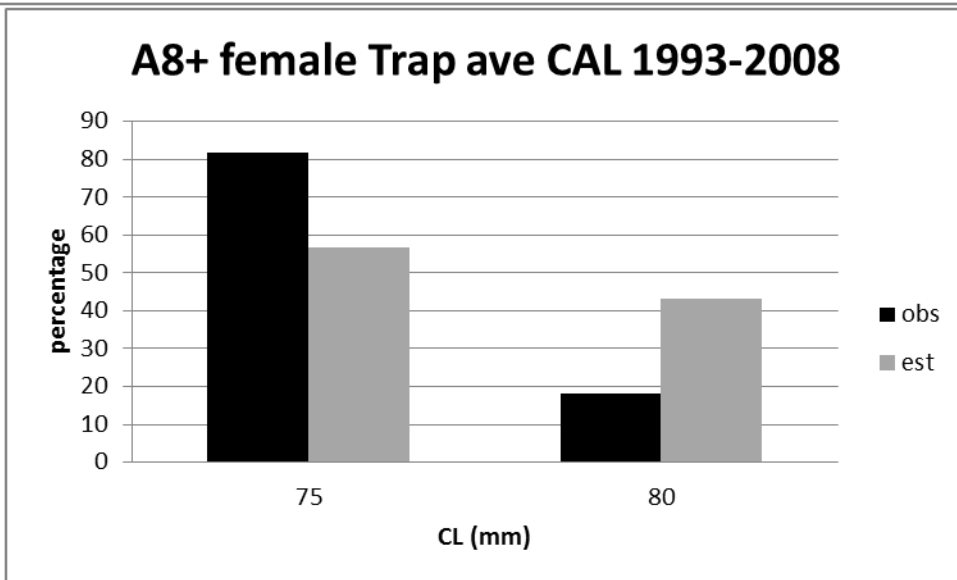
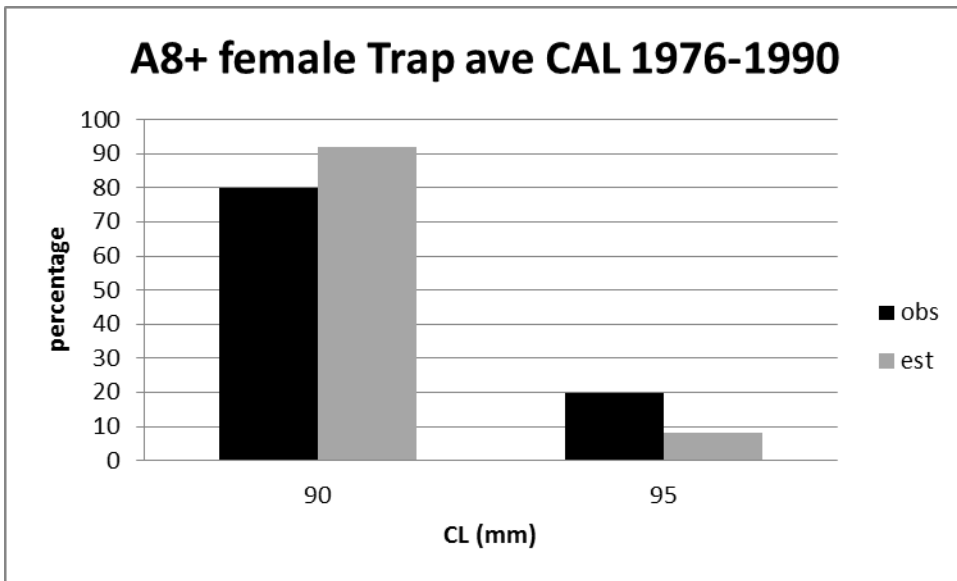


Figure E7a: A8+ BC Hoop male CAL fits.

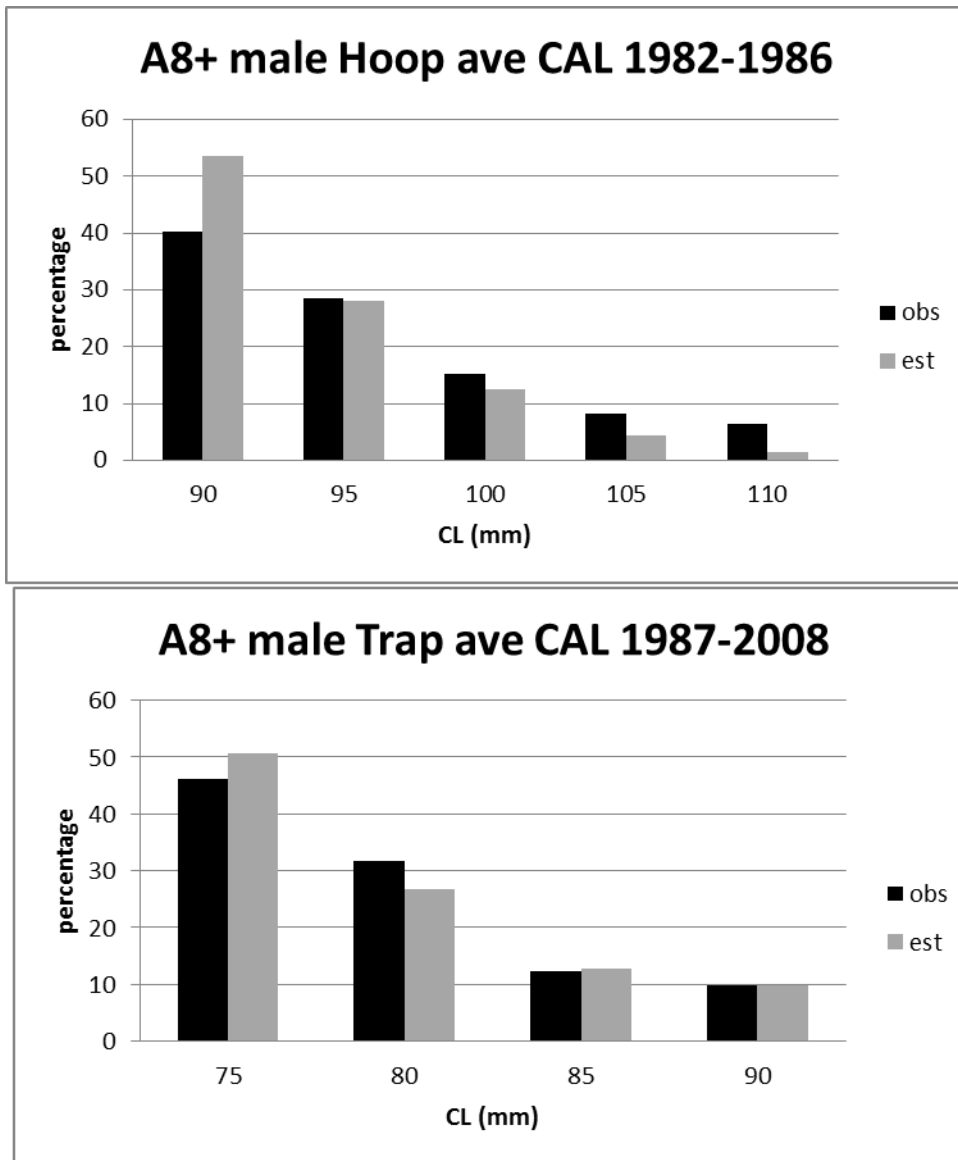


Figure E7b: A8+ BC Hoop female CAL fits.

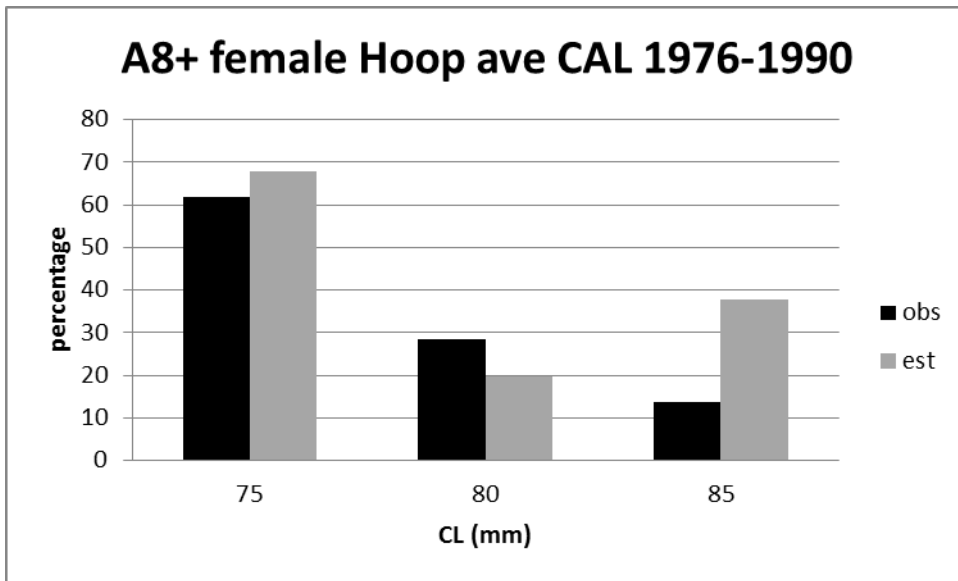


Figure E8a: A8+ BC FIMS male CAL fits.

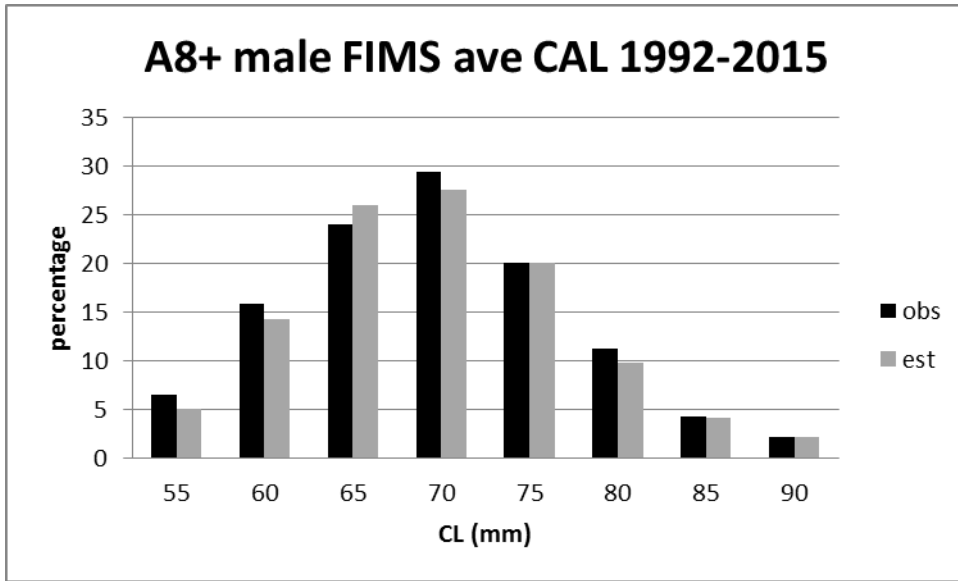
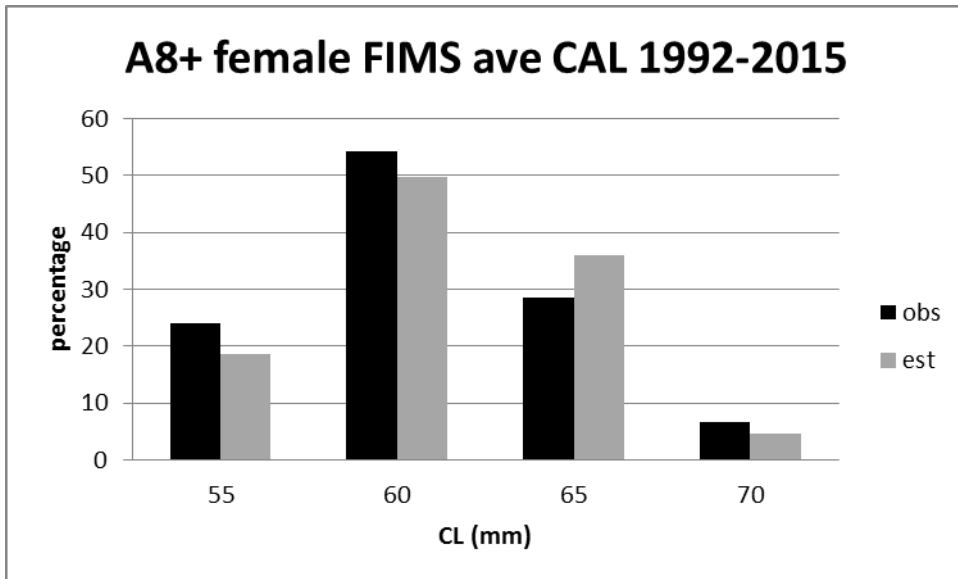


Figure E8b: A8+ BC FIMS females CAL.



Section F: Comparative catch, biomass and egg production plots for the five super-areas and the resource as a whole

Table F1: B75m (MT) values for 1910 (effectively K), 2018 and the ratio of 2018/1910.

	A1+2	A3+4	A5+6	A7	A8+	Total
1910	77 427	164 433	251 044	196 962	185 362	875 229
2018	1618	3346	3262	1674	5589	15 489
2018/1910	0.021	0.020	0.013	0.009	0.030	0.018

Table F2: Egg production values for 1910 (effectively K), 2018 and the ratio of 2018/1910.

	A1+2	A3+4	A5+6	A7	A8+	Total
1910	1.52×10^{13}	3.73×10^{13}	4.94×10^{13}	4.84×10^{13}	5.07×10^{13}	2.01×10^{14}
2018	4.80×10^{11}	1.71×10^{12}	1.45×10^{12}	1.88×10^{12}	1.18×10^{13}	1.74×10^{13}
2018/1910	0.031	0.045	0.029	0.041	0.232	0.086

Figure F1: Annual catches taken for each super-area and the resource as a whole.

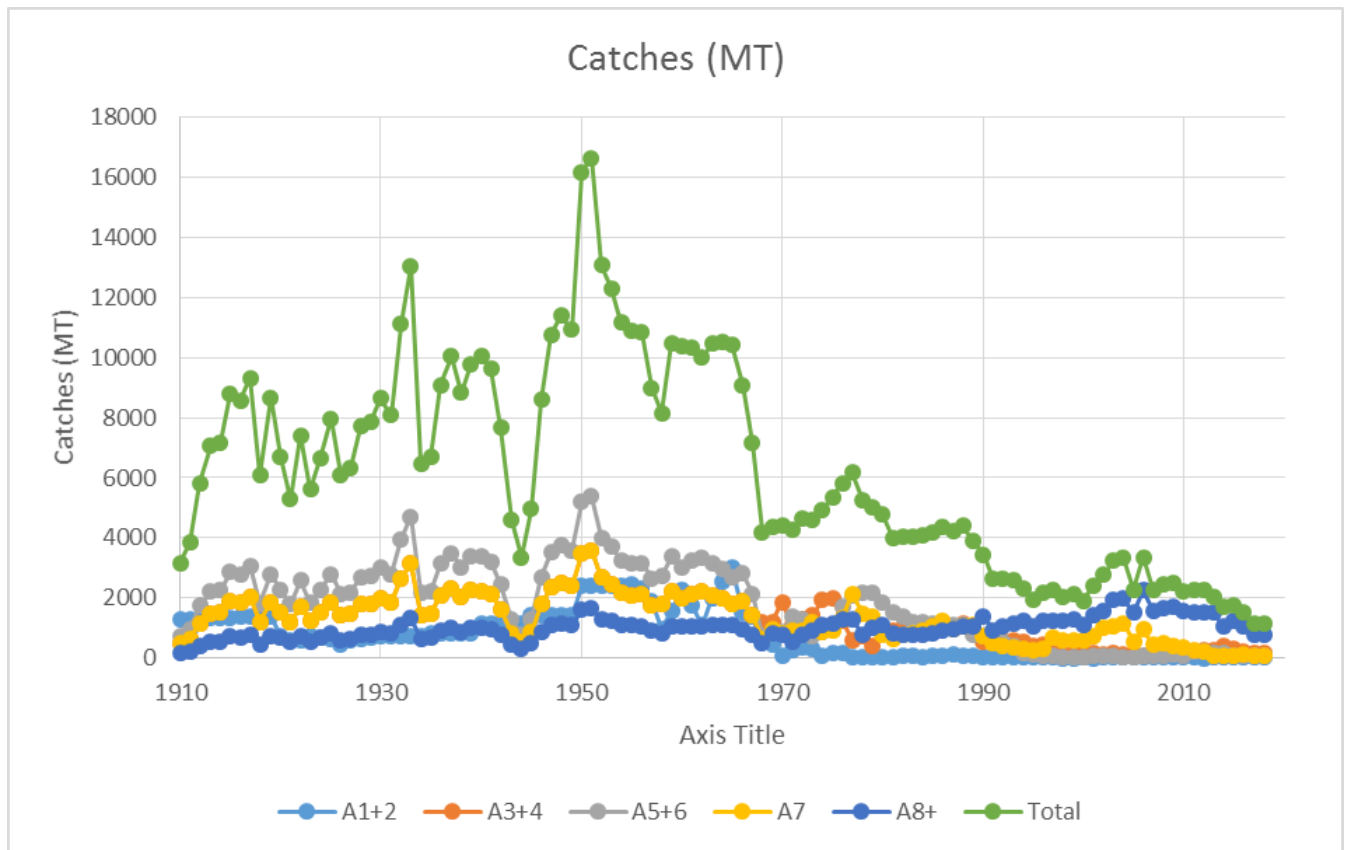


Figure F2: B75m (MT) estimated trajectories from the 2018 assessments which assume BC poaching.

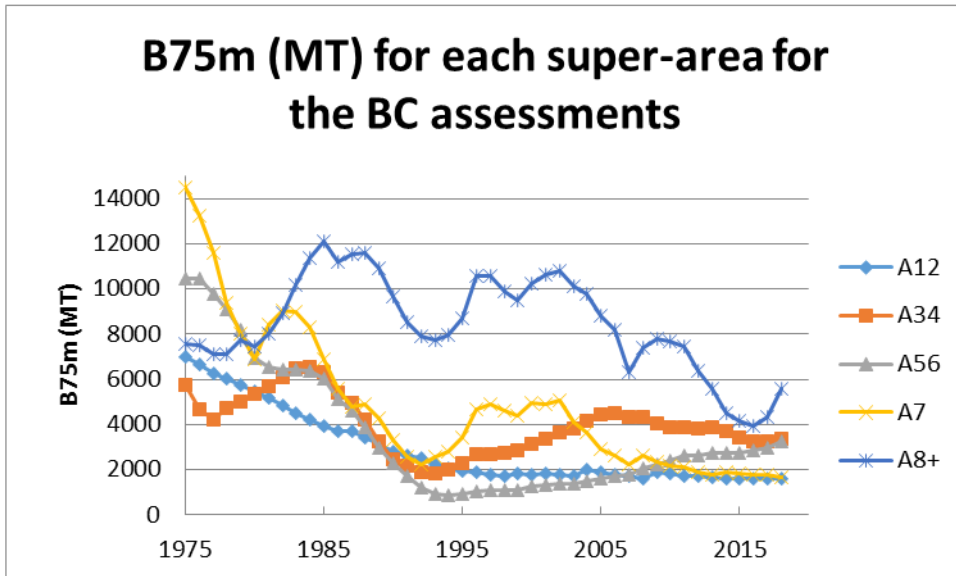
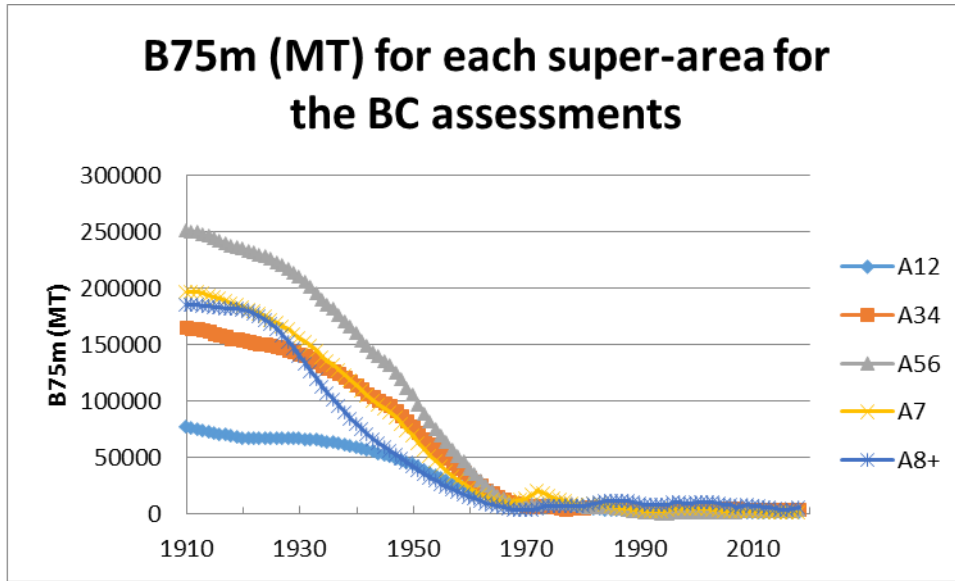


Figure F3: B75m (MT) and B75m/K estimated trajectories for the total resource from the updated 2018 assessments which assume BC poaching.

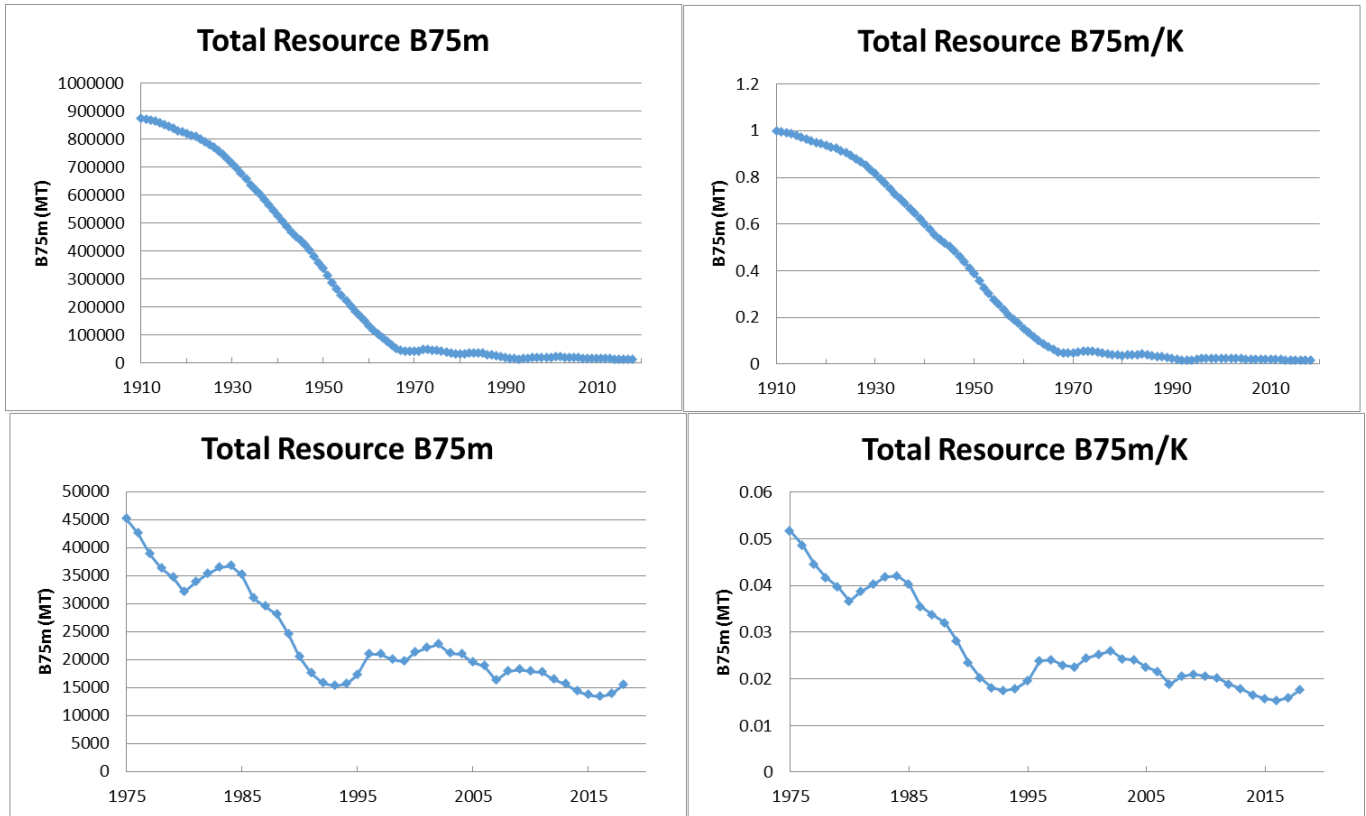


Figure F4: Egg production estimated trajectories from the 2018 assessments which assume BC poaching. The bottom plot shows values for 1975+ only.

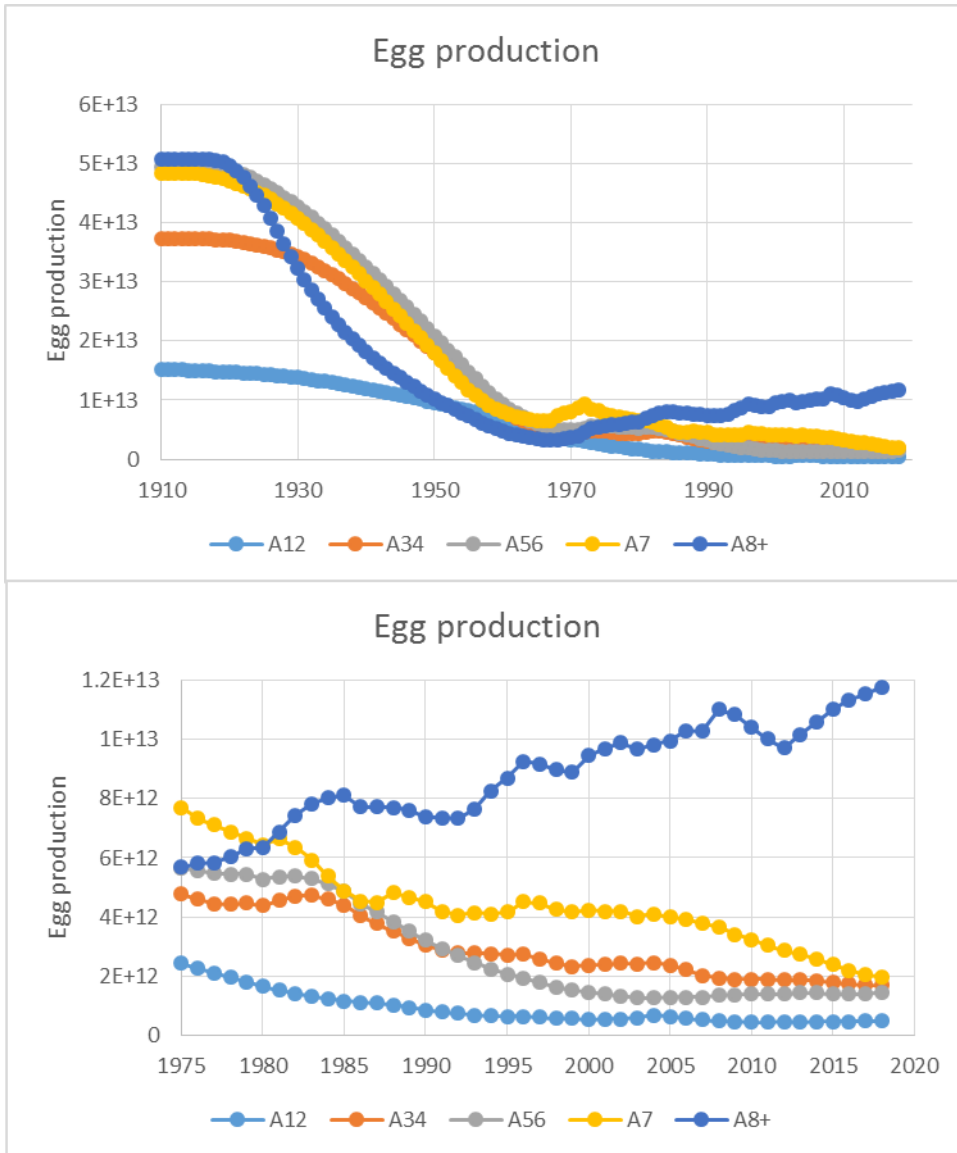
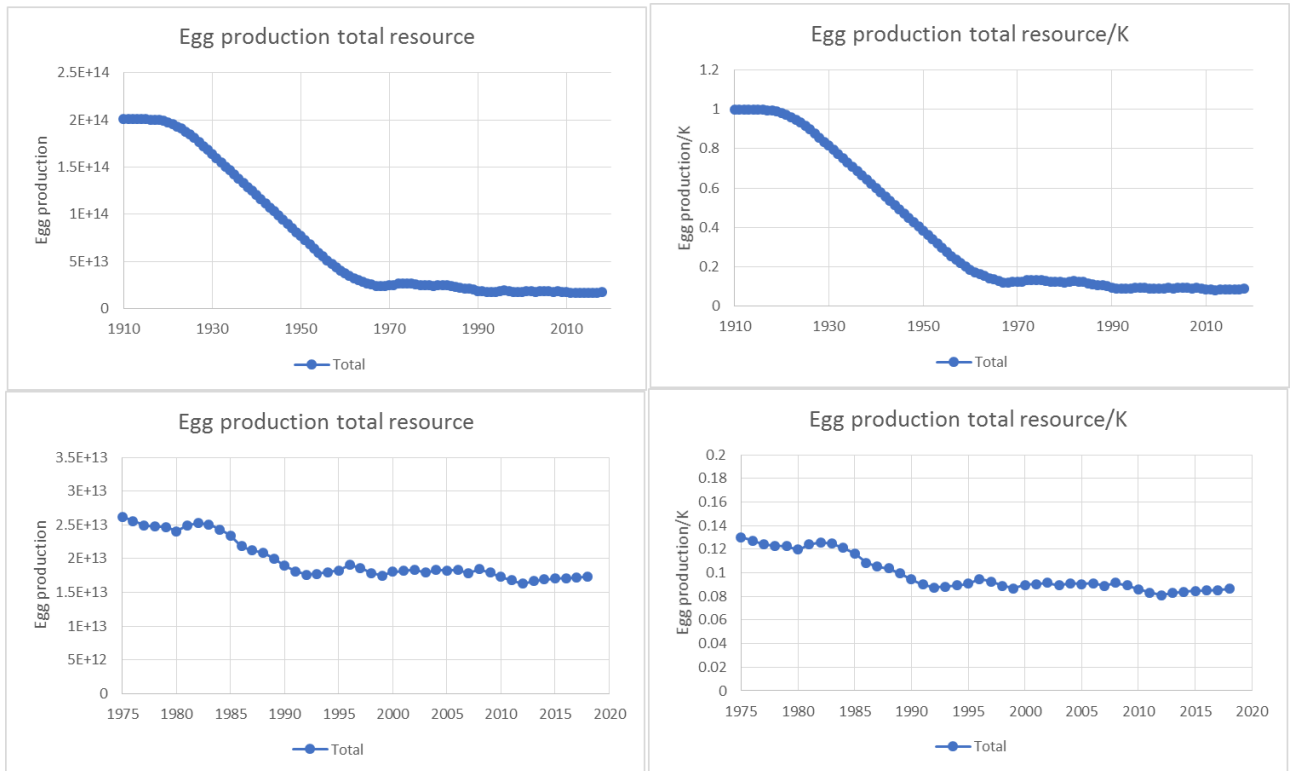
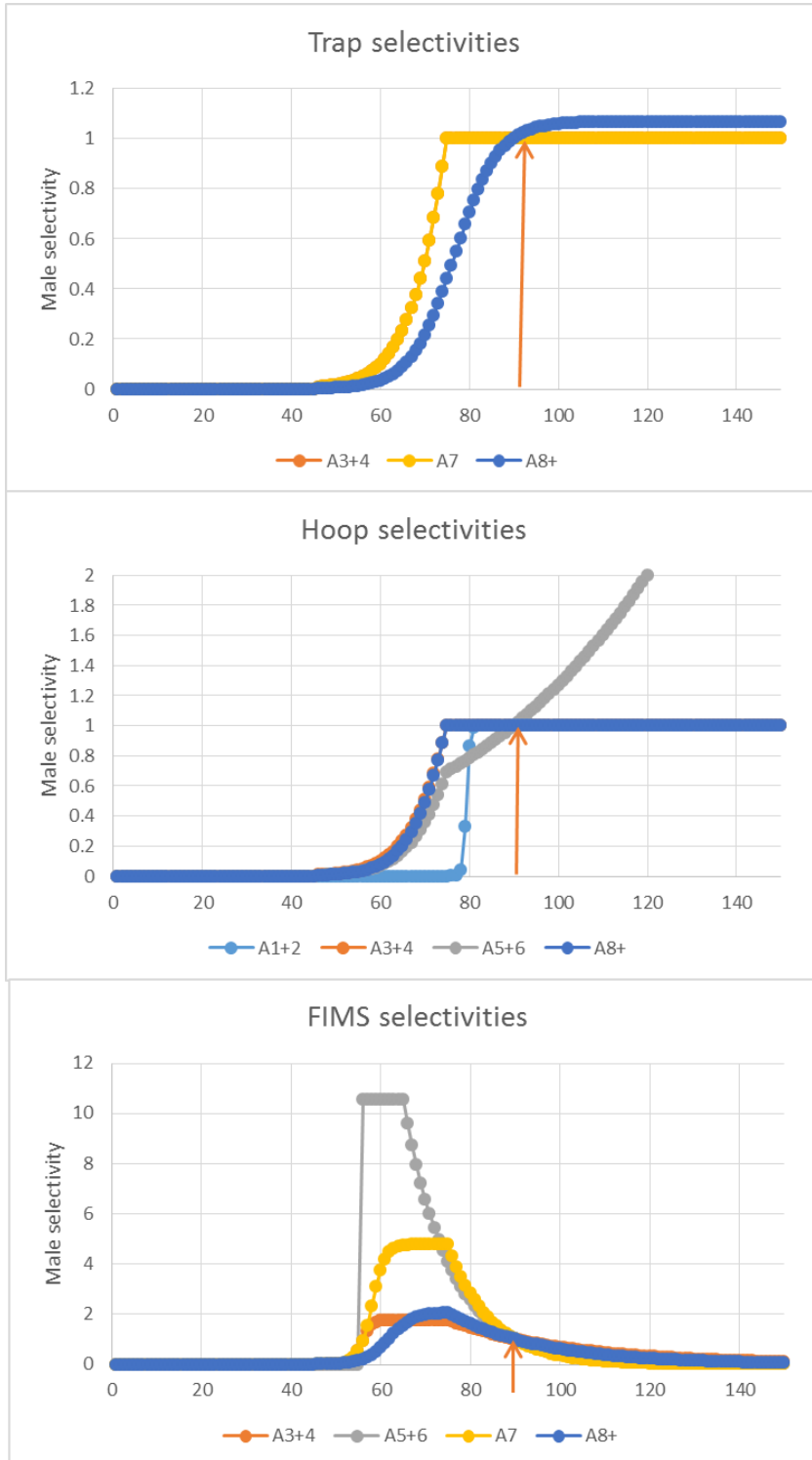


Figure F5: Egg production and egg production/K estimated trajectories for the total resource from the updated 2018 assessments which assume BC poaching. The bottom plot shows values for 1975+ only.



Section G: Male selectivity functions for traps, hoops and FIMS

Figure G1: Note that results are shown only for cases where that fishing method was used of FIMS conducted in the super-area in question. The vertical arrows indicate where the functions are scaled to 1.0 at 90mm CL. The trap and hoop selectivities are logistic in form, whereas the FIMS selectivity allow for a domed shape selectivity.



Appendix A

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 values are estimated for the years indicated in the notation following:

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 $-lnL$ based on the geometric mean as follows:

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

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

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

- 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.

Poaching Scenarios used in the assessments

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, where it is denoted “2016 BC”.

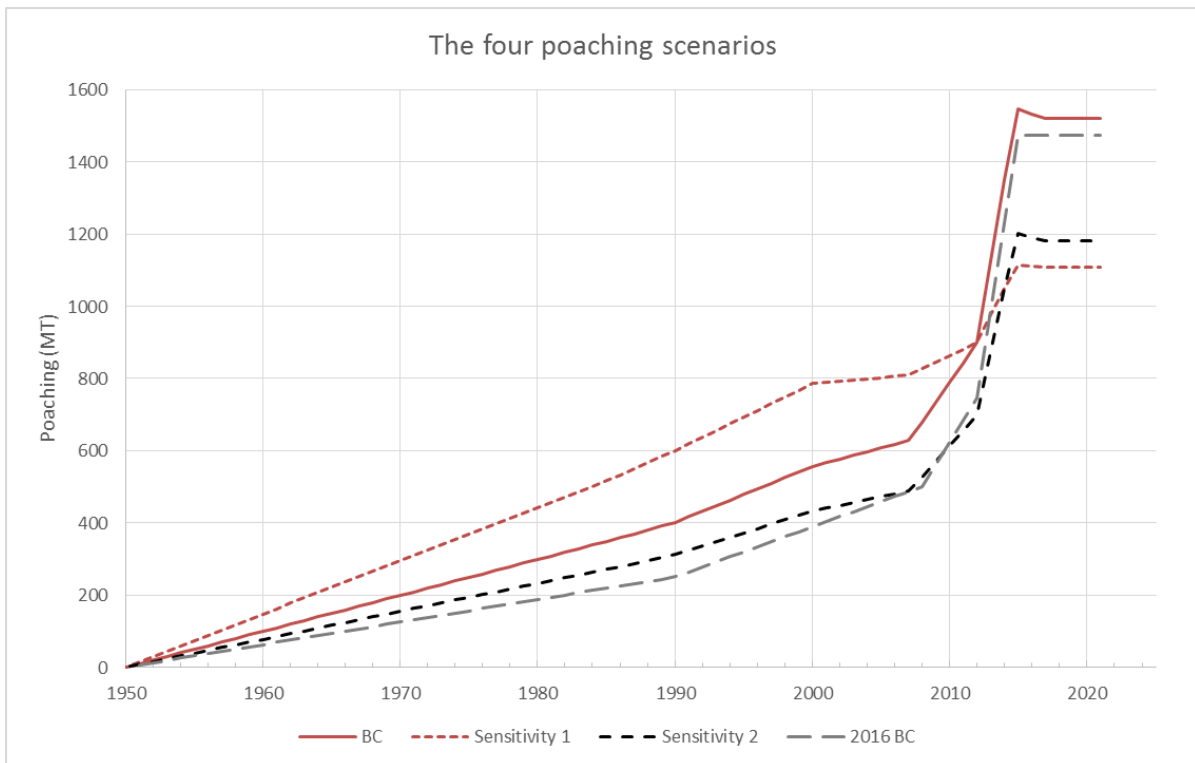
In 2018, a WCRL Task Team examined all the current information regarding poaching – both absolute (from TRAFFIC sources) and trend information from compliance and TRAFFIC sources of data.

MARAM/IWS/2018/WCRL/P1 provides 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 as well as the 2016 BC poaching scenario.

Table A1: Poaching amounts for the Total resource for the Base Case and two sensitivity proposals, as well as the 2016 BC poaching scenario. The bold values are the absolute values used to scale the trend information.

	Base Case	Sensitivity 1	Sensitivity 2	2016 BC
1950	0	0	0	0
1985	348	516	271	219
1990	402	601	312	420
2000	556	785	432	550
2008	678	826	527	578
2012	900	900	700	745
2014	1350	1050	1050	1232
2015	1546	1115	1202	1475
2017	1521	1107	1183	1475
+				

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



Appendix B**Final catches for the 2017 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

