

Updates to West Coast Rock Lobster assessments and projections made in 2019 taking account of recommendations made by IWS 2018 panel

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Summary

This document provides the most recent updates of all five super-area assessments for west coast rock lobster, as well as projections taking into account recommendations made at the December 2018 International Workshop.

RESPONSES TO KEY IWS 2018 RECOMMENDATIONS

Following recommendations from the IWS in December 2018, some new methods for estimating historical west coast rock lobster recruitments, and from those the recruitments for projections based on the stock assessments have been implemented. This includes the suggestion that these be done:

“preferably by re-parameterizing the 1975-2017 recruitment parameters via an estimated mean level \bar{R} multiplied by annual recruitment deviates. This last parameterization would enable projections via randomly selecting recruitment values from their estimated distribution.”

To recap:

The 2018 assessment method:

Estimation and projection of recruitment

Recruitment was modelled as for previous assessments and projections. Historically recruitment was assumed to have changed linearly between a set of estimated recruitment values over time. Thus, past recruitments were estimated for each super-area for the years indicated by the following list of parameters:

- R1910, R1920, R1950, R1970, R1975, R1980, R1985, R1990, R1995, R1998, R2001, R2004, R2007 and R2010, where furthermore
- the R2007 and 2010¹ values were constrained by a penalty added to the $-lnL$ based on the geometric mean as follows:

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

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

$$\sigma_R^2 = \frac{\sum_{y=1975}^{y=2010} (\ln R_y - \ln \bar{R})^2}{9} \quad (3)$$

and finally

- all recruitments were constrained to be less than R1910.

Then for the (deterministic) projections (as reported in 2018):

¹ Note that recruitment corresponds to age zero. More recent recruitments cannot be estimated as lobsters take about seven years to reach a size where they are sampled in research surveys and the commercial catch.

- R2013+ values were set equal to the **geometric mean (\bar{R})** of the R1975, R1980, R1985, R1990, R1995, R1998, R2001, R2004, R2007 and R2010 estimated values for the super-area in question.

This projection approach had a number of problems (some of which were identified by the IWS).

- Being deterministic, rather than based on stochastic sampling from past recruitments as in earlier analyses for OMPs, the approach should have used the mean rather than the median of these past recruitments to better reflect average past resource productivity when projecting into the future.
- The R2007 and R2010 values were not dealt with appropriately in the estimation.
- In estimating a median (or average), ideally account needed to be taken of the lesser precision of the more recent estimates of recruitment.

The new 2019 assessment method (following IWS recommendation):

The 2018 method estimates:

$R_{1910}, x_{1920}, x_{1950}, x_{1970}, x_{1975}, x_{1980}, x_{1985}, x_{1990}, x_{1995}, x_{1998}, x_{2001}, x_{2004}, x_{2007}$ and x_{2010} ,

where $x_y = \frac{R_y}{R_{1910}}$. [14 estimable parameters]

NOW for the new 2019 method

Estimate $R_{1910}, x_{1920}, x_{1950}$ [3 estimable parameters]

Estimate $\bar{x} = \sum_{y=1970}^{y=2010} (x_y) / 11$ [1 estimable parameter]

Estimate for $y=1970\dots 2010$: $x_y = \bar{x} e^{\varepsilon_y - \sigma_R^2/2}$ [11 estimable ε_y parameters]

Add to the $-\ln L$ a penalty which is

$$\frac{1}{2\sigma_R^2} \sum_{y=1970}^{y=2010} \varepsilon_y^2 \quad (4)$$

Note that estimating \bar{x} directly in this way takes some account of the different precisions with which the individual recruitment values are estimated.

For each assessment a value for $\sigma_R = 1.0$ is assumed. Estimates of σ_R from the assessment outputs for each super-area differ widely and at times (e.g. for A8+) lead to serious misfits to recent abundance indices. This is not surprising given the limited data available for each super-area. Hence the more robust approach of using a common value for all super-areas was preferred. The value selected was 1.0, which was intermediate amongst the estimated value for each super-area² and did not overly constrain recruitment estimates such as to result in a mis-fit to abundance indices, while still providing some estimation stabilisation for the more recent recruitment estimates.

[Note that for A7 the initial model fits to the Trap CPUE data were very poor. As in previous assessments for A7, this issue was addressed by increasing the weight of the 2009-2018 Trap CPUE

² A12 $\sigma_R=2.55$; A34 $\sigma_R=1.32$; A56 $\sigma_R=0.55$; A7 $\sigma_R=1.97$; A8+ $\sigma_R=0.24$.

data in the likelihood by a factor of 10, which in particular provided a much improved reflection of the recent downward trend in trap CPUE for that super-area.]

Updated assessment results for each super-area, using the new 2019 assessment methodology, are reported for the two different poaching scenarios. The scenario which implies an estimate of illegal local sales of 400 MT in 2018 is termed here “**LS 400**” while the scenario which implies one of illegal local sales of 700 MT that year is termed “**LS 700**”. (The 2018 poaching trend along with the LS 400 and LS 700 trends is shown in Figure 1.) Note that final resource projections were based on the “LS 700” poaching scenario.

Figures 2a-e report the recruitment estimates (relative to those in 1910) for each of the five super-areas for the two different poaching scenarios. The recruitment estimates for the old 2018 estimation methodology are also indicated.

Fits of the new 2019 assessments to the different CPUE data are reported in Figures 3a-e for each super-area. Comparisons to the 2018 fits are also provided.

Figures 4a-e compare B75m (the exploitable male biomass) trajectories for the different assessments for each super-area.

Figure 5 compares the total estimated resource biomass in absolute terms (top plot) and relative to 2006 (bottom plot) for the 2018 assessment and the two 2019 assessments.

Projections

Initially two possible variants with respect to future recruitments were explored:

Variante 1: Future recruitment values (i.e. R2015, R2020, R2025 and R2030) are drawn at random with replacement from the estimated R1970...R2007 parameter estimates (i.e. excluding R2010), where these values were estimated using the “2019 new assessment method”.

Variante 2: 25% of the simulations are as described above. For 75% of the simulations, future recruitment values (i.e. R2015, R2025 and R2030) are drawn at random with replacement from the estimated R1970...R2001 parameters estimates (i.e. the R2004, R2007 and R2010 estimates are excluded). The motivation is that these last three estimates are less precisely determined in the model fitting. (The Assessment software that is currently implemented precluded accurate assessment of these precisions.)

The “Variante 1” method above was the selected method to be used in final projections, i.e. the most recent recruitment values were not down-weighted in the projections. The “LS 700” poaching scenario was also selected for final projections.

Projections are reported for constant future annual legal catches (CC)³ by all sectors of either:

- 1) Future (2019+) CC = as per the current 2-step recommendation (i.e. a total future annual TAC of 244 MT)
- 2) Future (2019+) CC = zero, which gives the maximum recovery possible under current poaching levels.

³ Future illegal catches are kept equal to their estimates for 2018.

- 3) Future (2019+) CC such that the median $B75m(2025)/B75m(2006)=1.00$ (corresponds to a CC of 1280 MT), i.e. no recovery by 2025 above the benchmark 2006 abundance.
- 4) Future (2019+) CC such that the $B75m(2025)/B75m(2006)$ recovery is halfway between that for 2) and 3) above.
- 5) Future (2019+) CC is unchanged for the 2018 season TAC of 1084 MT.

Table 1 reports biomass recovery statistics ($B75m(2025)/B75m(2006)$) for the resource as a whole. Figure 6 compares median biomass recovery trajectories for a number of future CC, whilst Figure 7a shows the medians, 50% and 90% probability envelopes for a future CC of 640 MT, and Figure 7b shows the these same plots for a future CC of 1084 MT. Figure 8 shows the median and lower 5th %ile biomass recovery statistics as a function of a future constant TAC.

Table 1: Total resource biomass projections estimates. For example, the 1.071 value for the 2018 2-step scenario reflects a 7.1% increase of biomass by the 2025 target year above the benchmark 2006 level ($B75m(2025)/B75m(2006)=1.071$). Results assume future local poaching sales of 700 MT.

2018	B75m(2025/2006)
Deterministic B75m(2025)/B75m(2006) CC=2-step	1.071
Deterministic B75m(2025)/B75m(2006) CC=0	1.132
2019	
	Median B75m(2025/2006)
Median B75m(2025)/B75m(2006) CC=0 MT	1.303
Median B75m(2025)/B75m(2006) CC=244 MT	1.251
Median B75m(2025)/B75m(2006) CC=640 MT	1.150
Median B75m(2025)/B75m(2006) CC=1084 MT	1.040
Median B75m(2025)/B75m(2006) CC=1280 MT	1.000

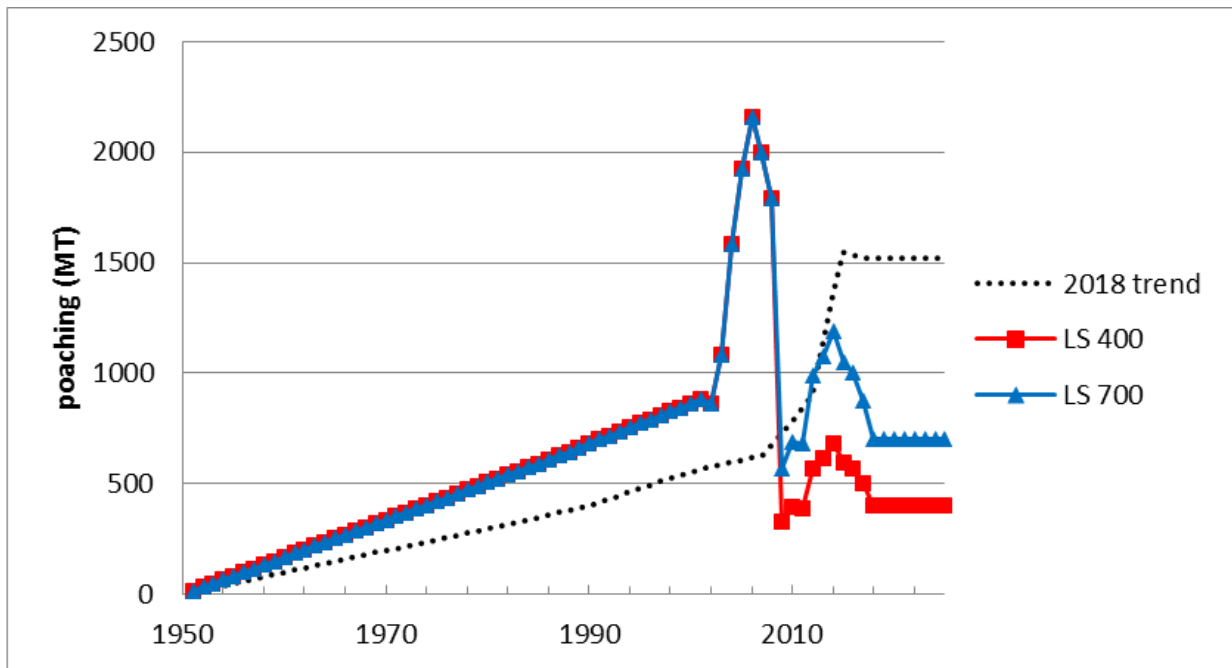


Figure 1: Poaching trends assumed for the 2018 assessments and for the two new 2019 scenarios (LS 400 and LS 700). The LS 700 trend was assumed for final projections and scientific recommendations. (LS=local poaching sales).

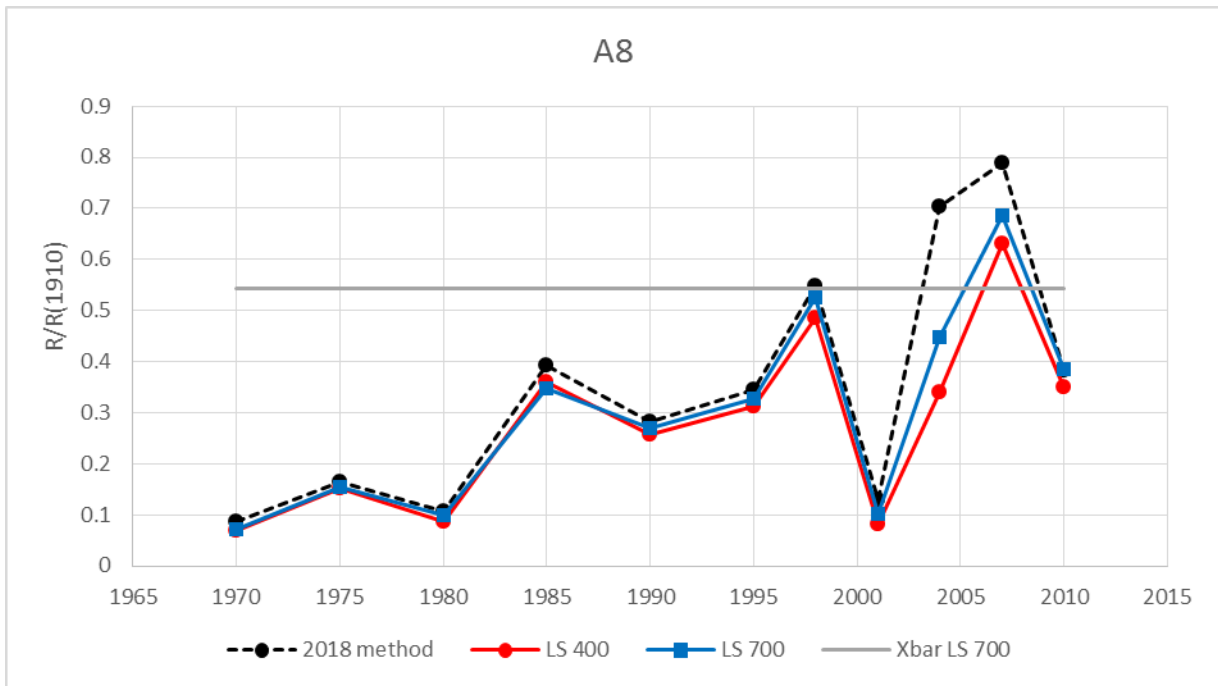


Figure 2a: R estimates (relative to that in 1910) for A8+ for two different poaching scenarios.

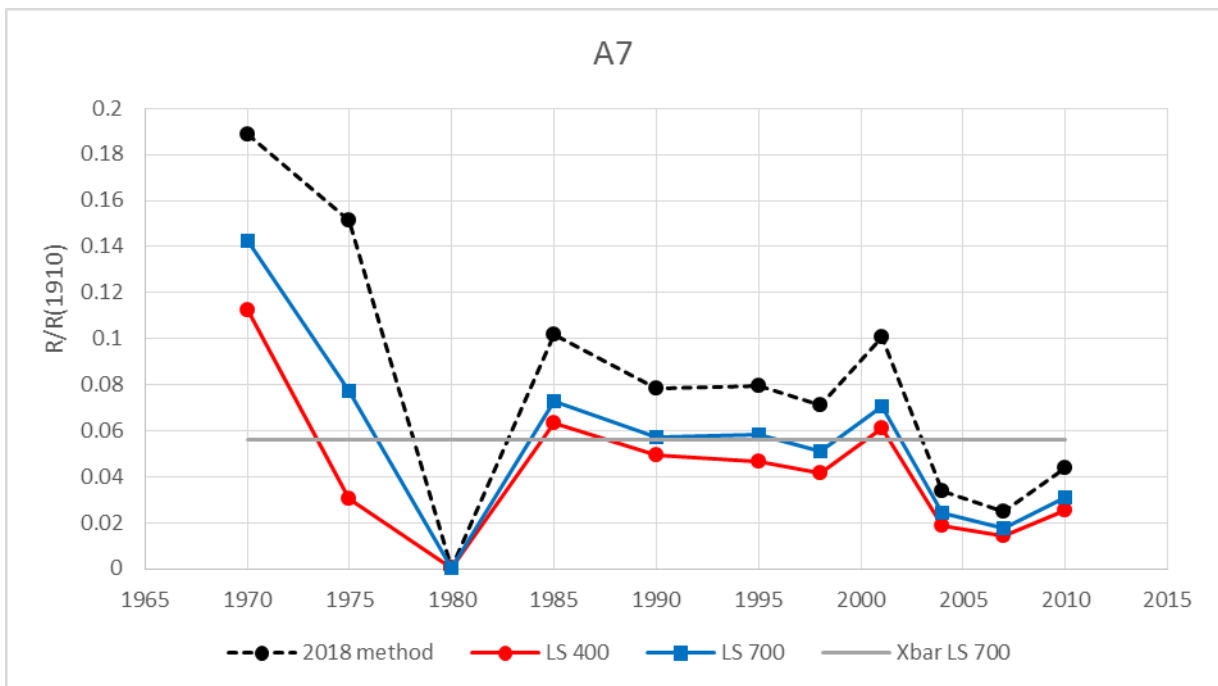


Figure 2b: R estimates (relative to that in 1910) for A7 for two different poaching scenarios.

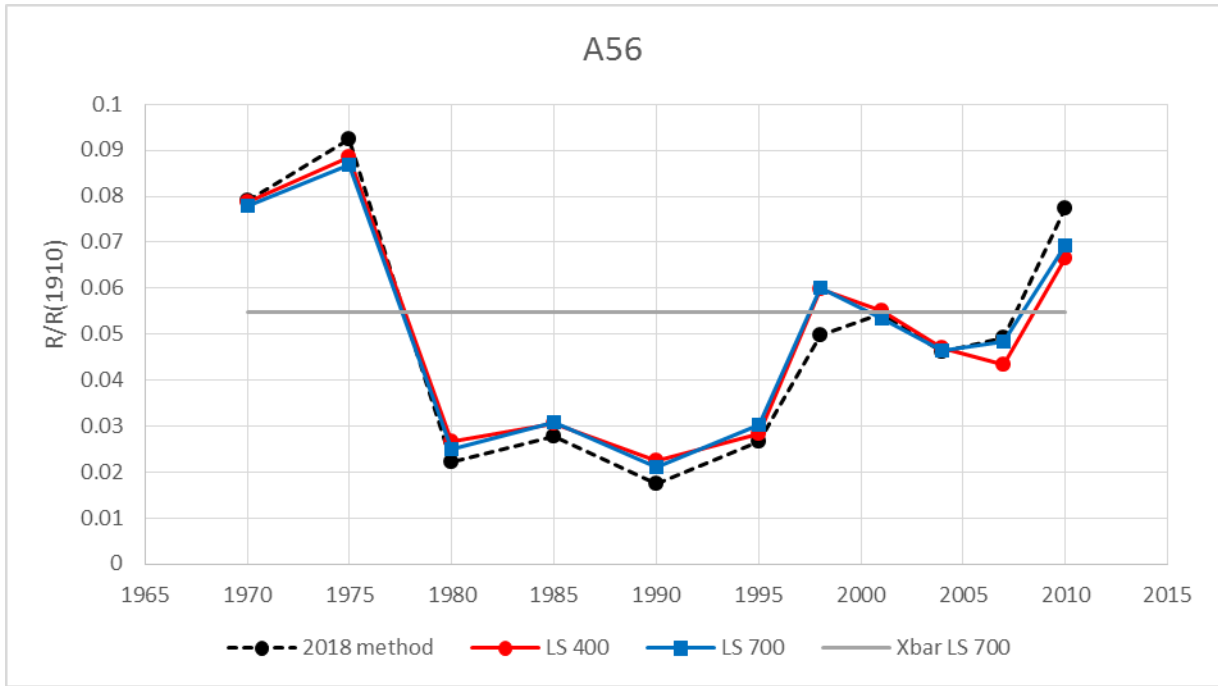


Figure 2c: R estimates (relative to that in 1910) for A56 for two different poaching scenarios.

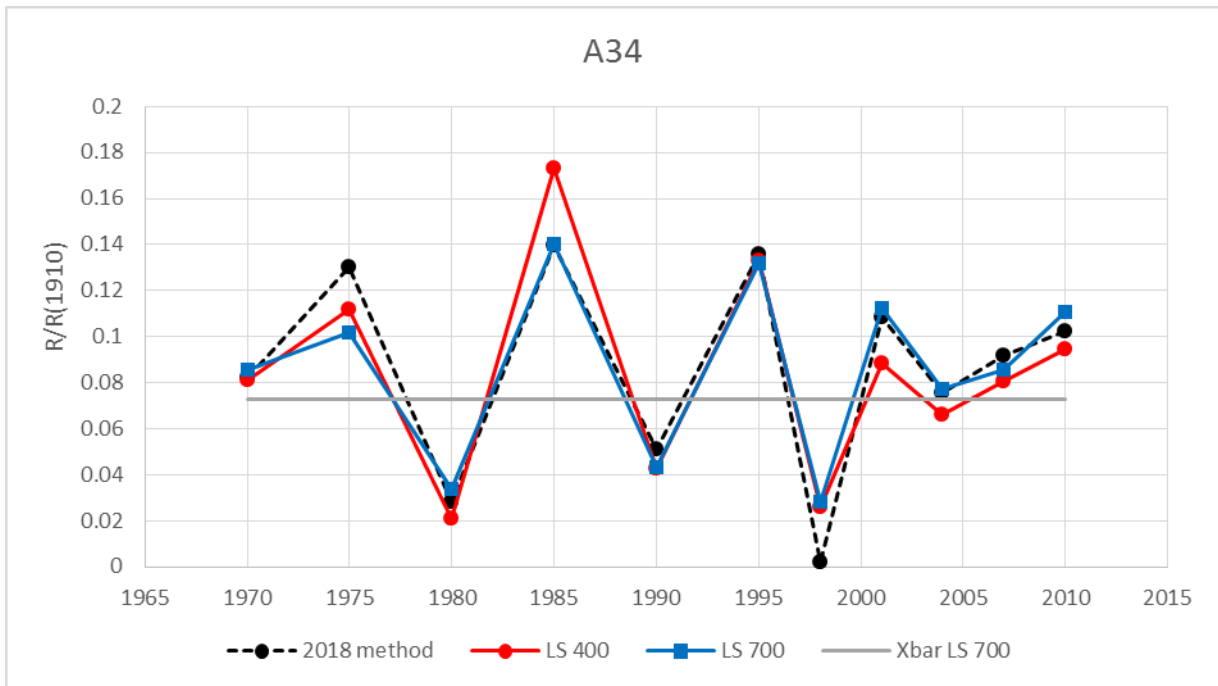


Figure 2d: R estimates (relative to that in 1910) for A34 for two different poaching scenarios.

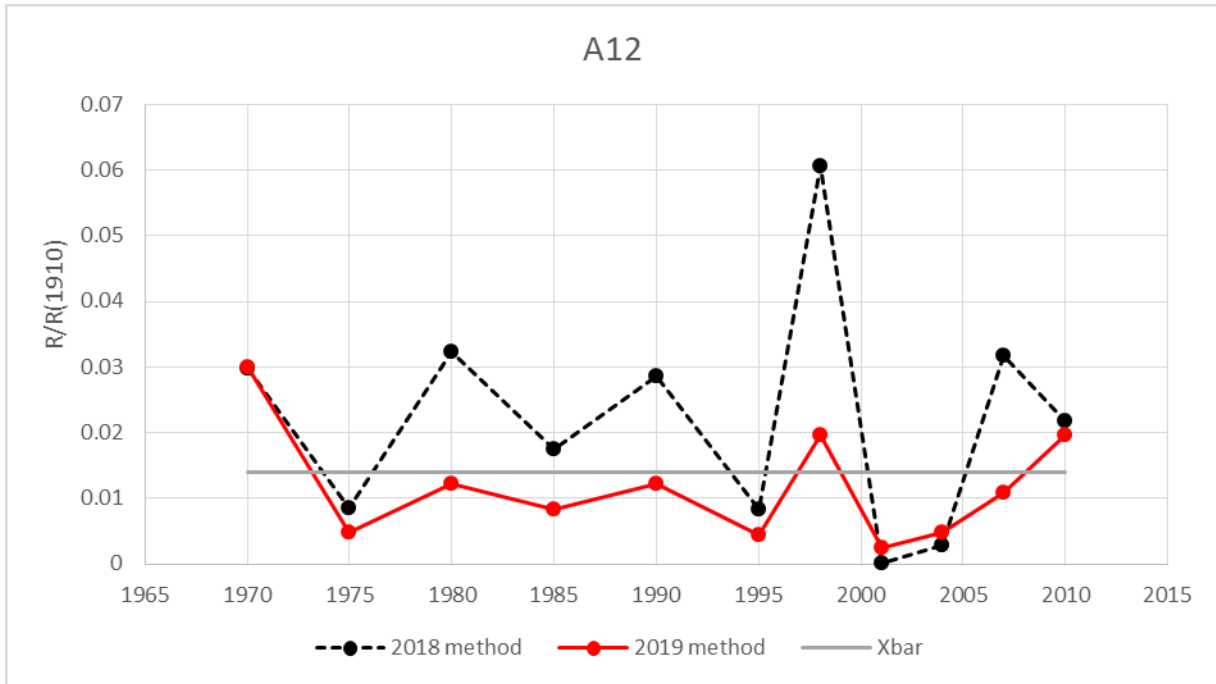


Figure 2e: R estimates (relative to that in 1910) for A12. Note it is assumed poaching in A12 is zero hence the LS 400 and LS 700 scenarios are identical.

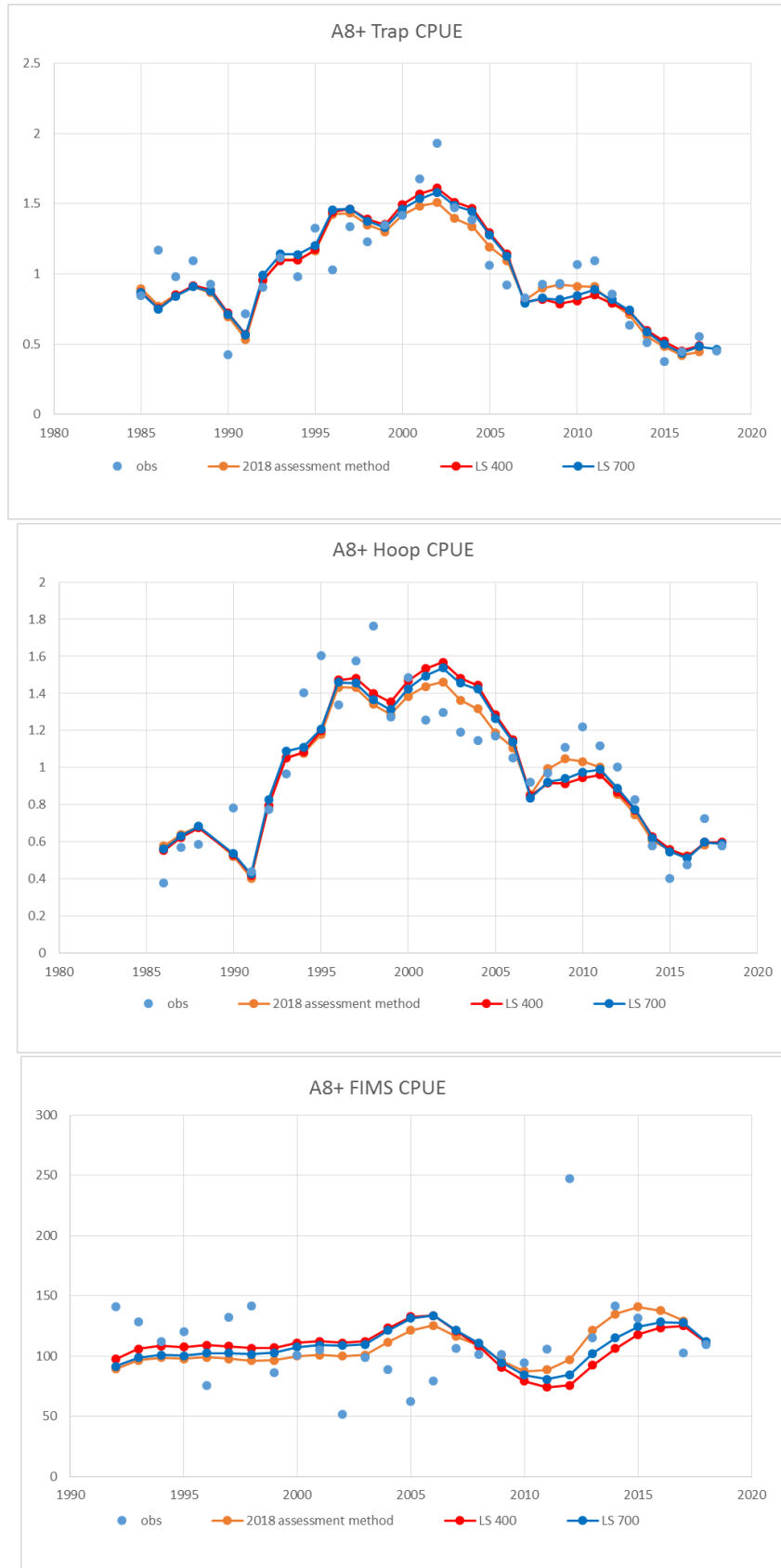


Figure 3a: Comparison of fits to A8+ CPUE for the different assessments.

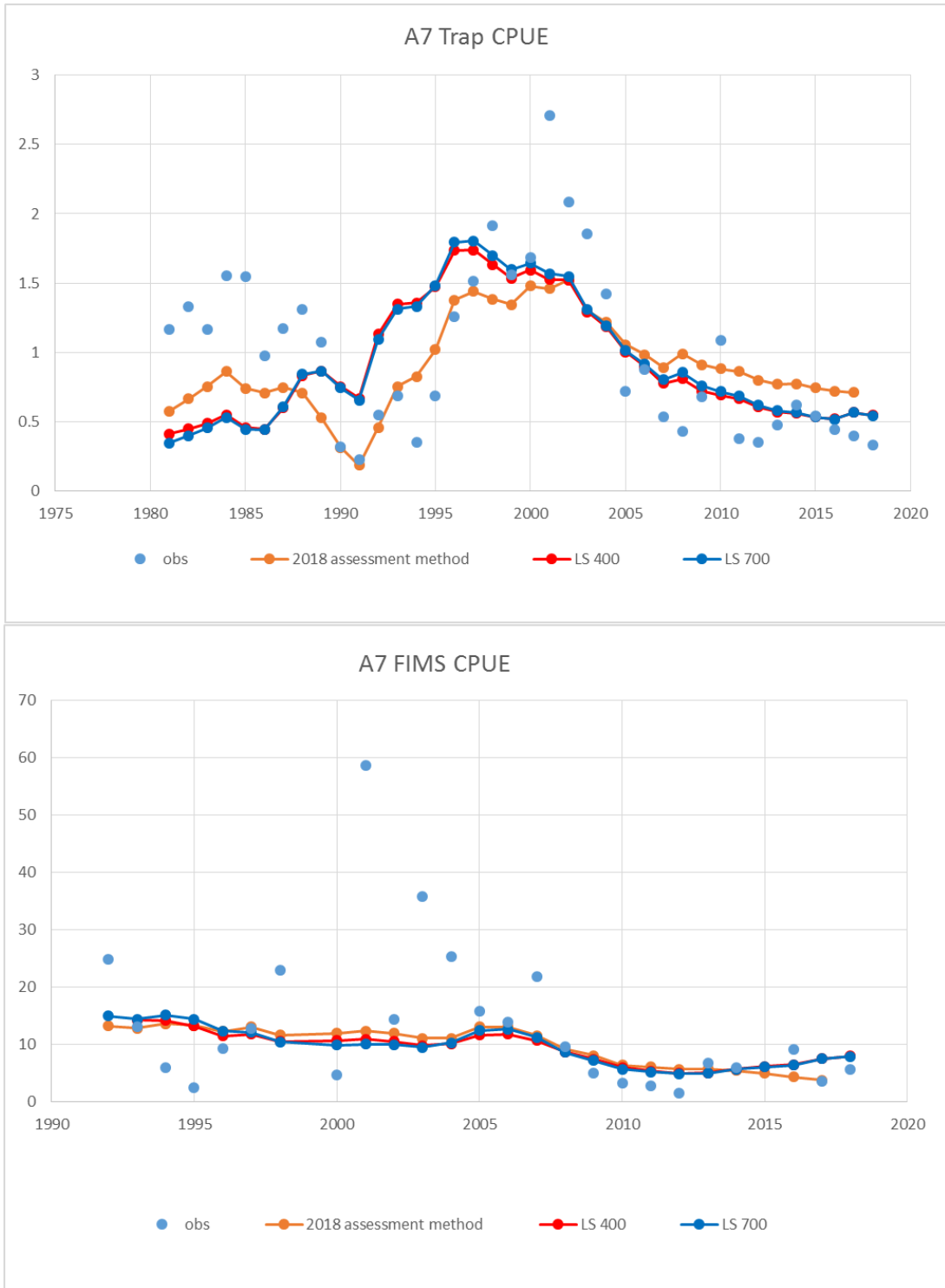


Figure 3b: Comparison of fits to A7 CPUE for the different assessments

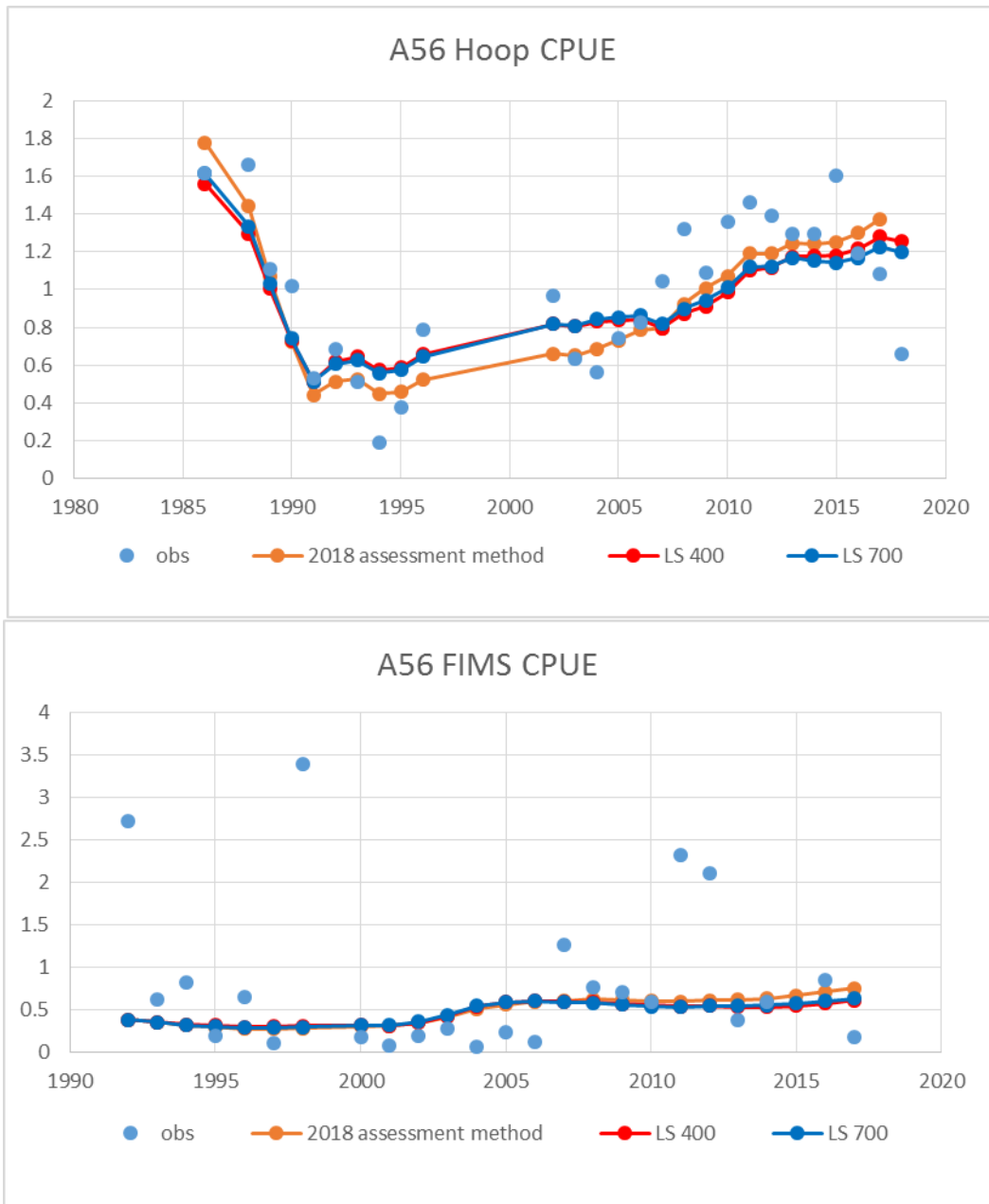


Figure 3c: Comparison of fits to A56 CPUE for the different assessments.

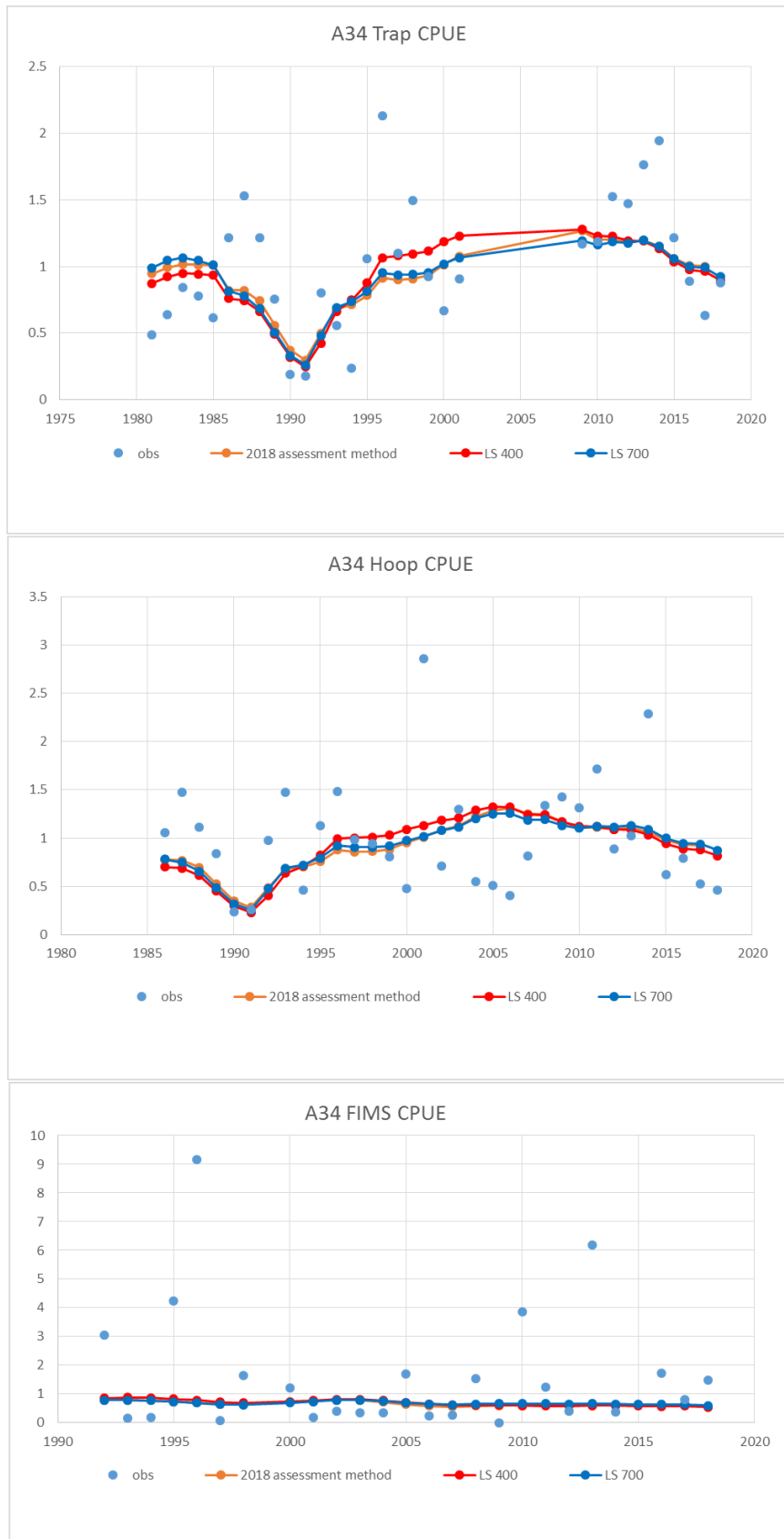


Figure 3d: Comparison of fits to A34 CPUE for the different assessments.

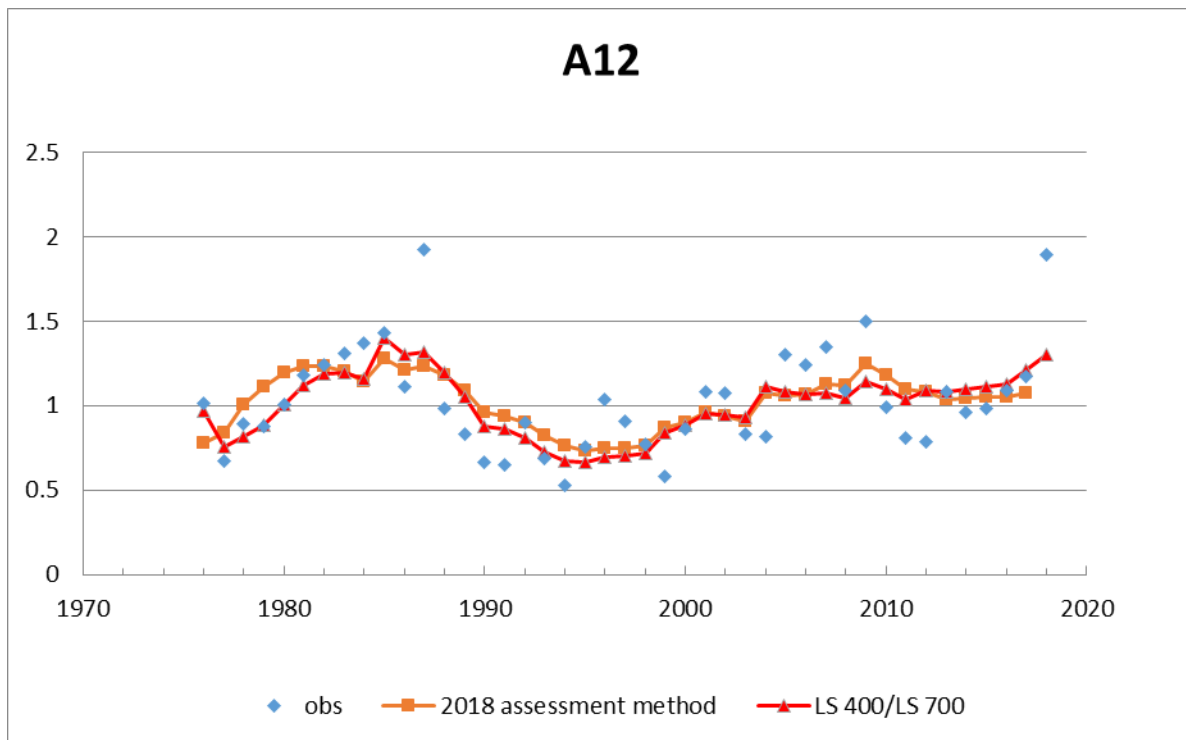


Figure 3e: Comparison of fits to A12 CPUE for the different assessments.

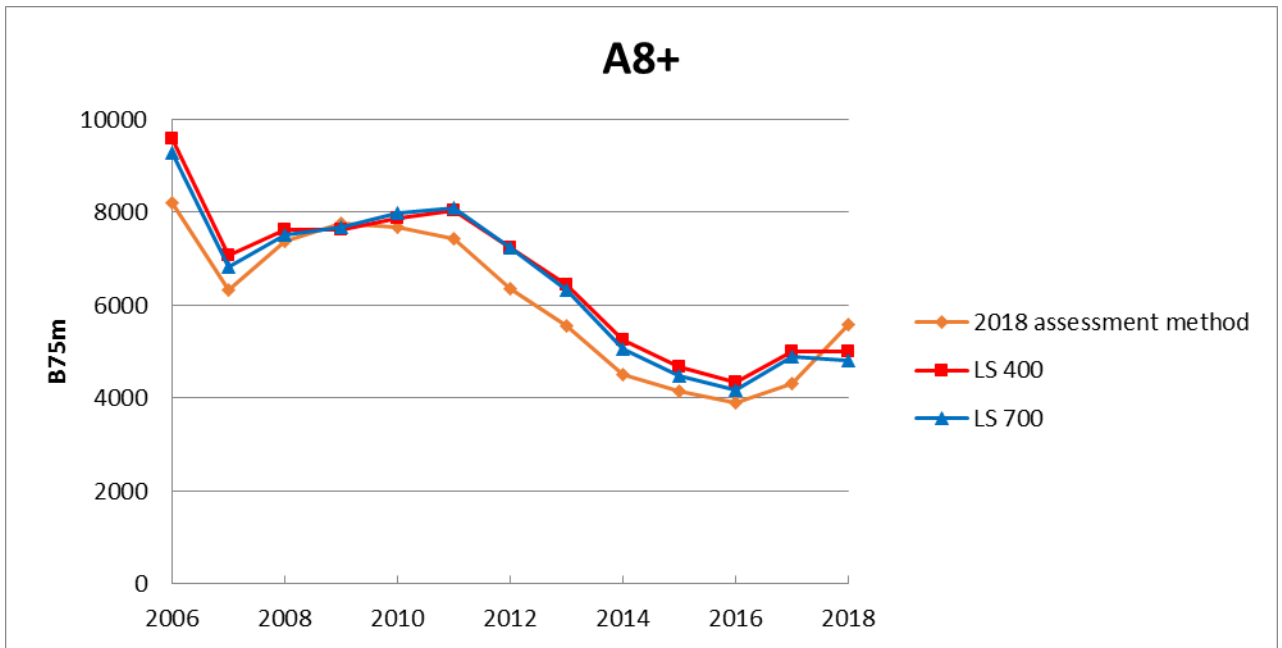


Figure 4a: Comparison between the A8+ B75m trajectories (for 2006-2018) for the different assessments.

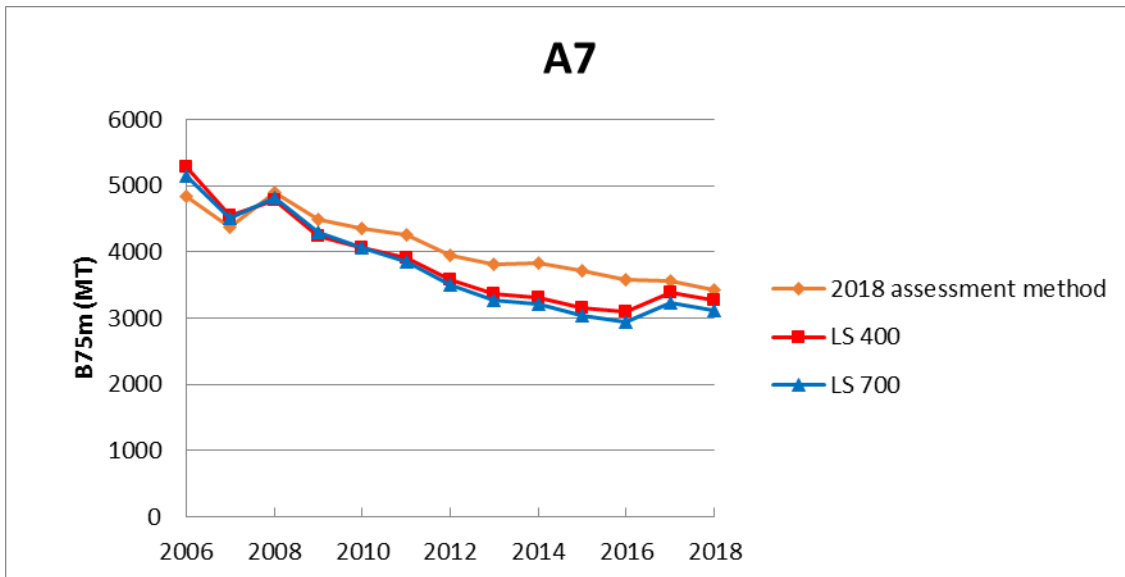


Figure 4b: Comparison between the A7 B75m trajectories (for 2006-2030) for the different assessments and projections.

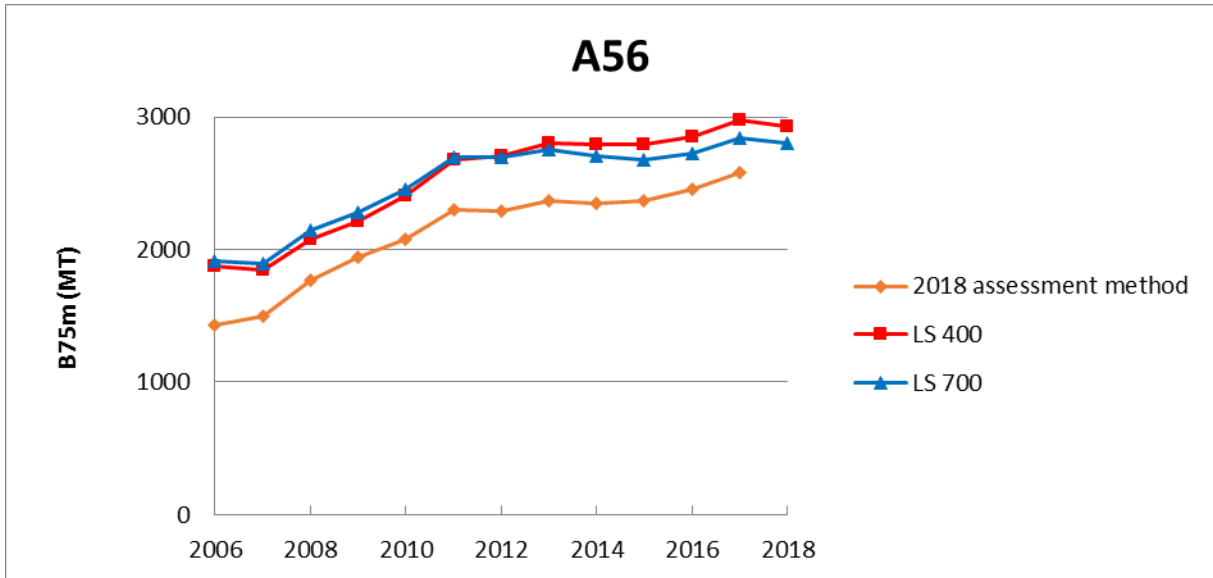


Figure 4c: Comparison between the A56 B75m trajectories (for 2006-2030) for the different assessments and projections.

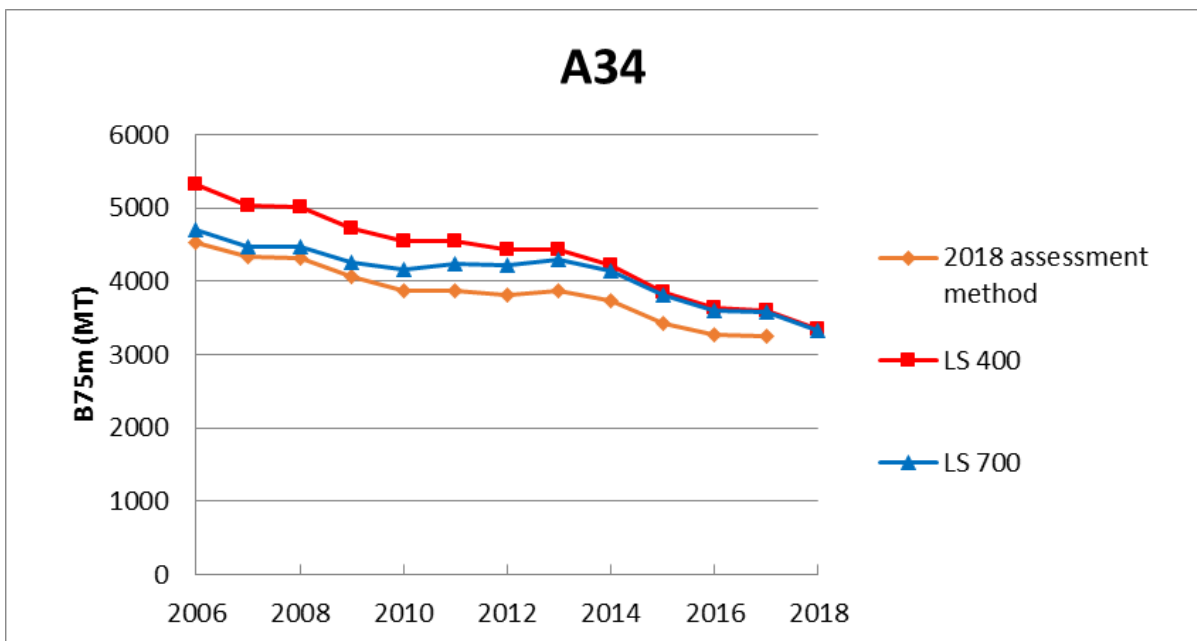


Figure 4d: Comparison between the A34 B75m trajectories (for 2006-2030) for the different assessments and projections.

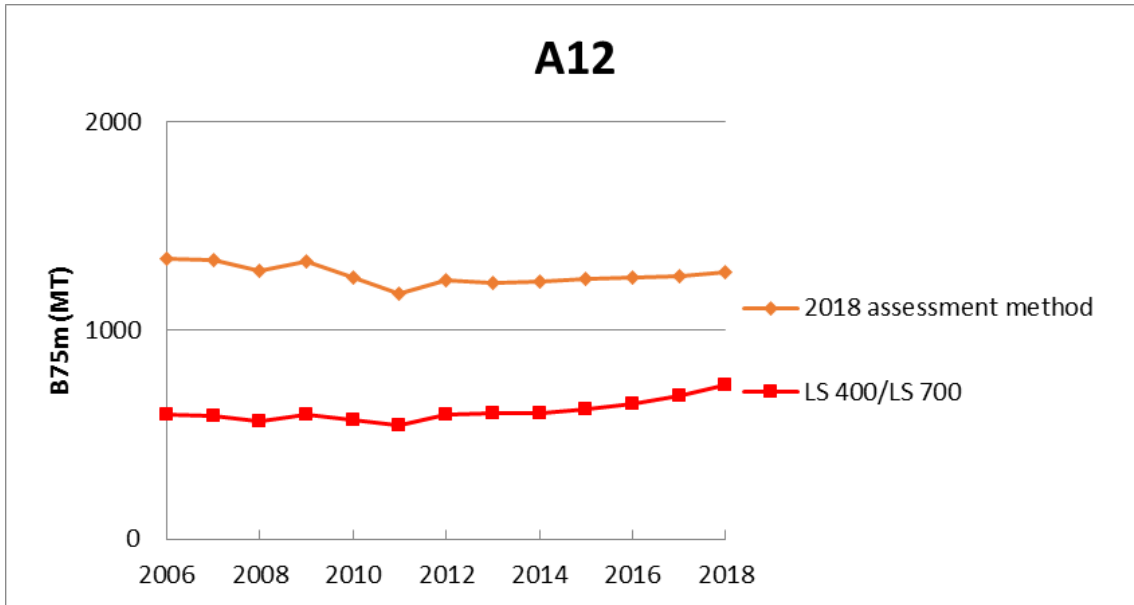


Figure 4e: Comparison between the A12 B75m trajectories (for 2006-2030) for the different assessments and projections. The LS 400 and LS 700 estimates are identical because it is assumed no poaching occurs in A12.

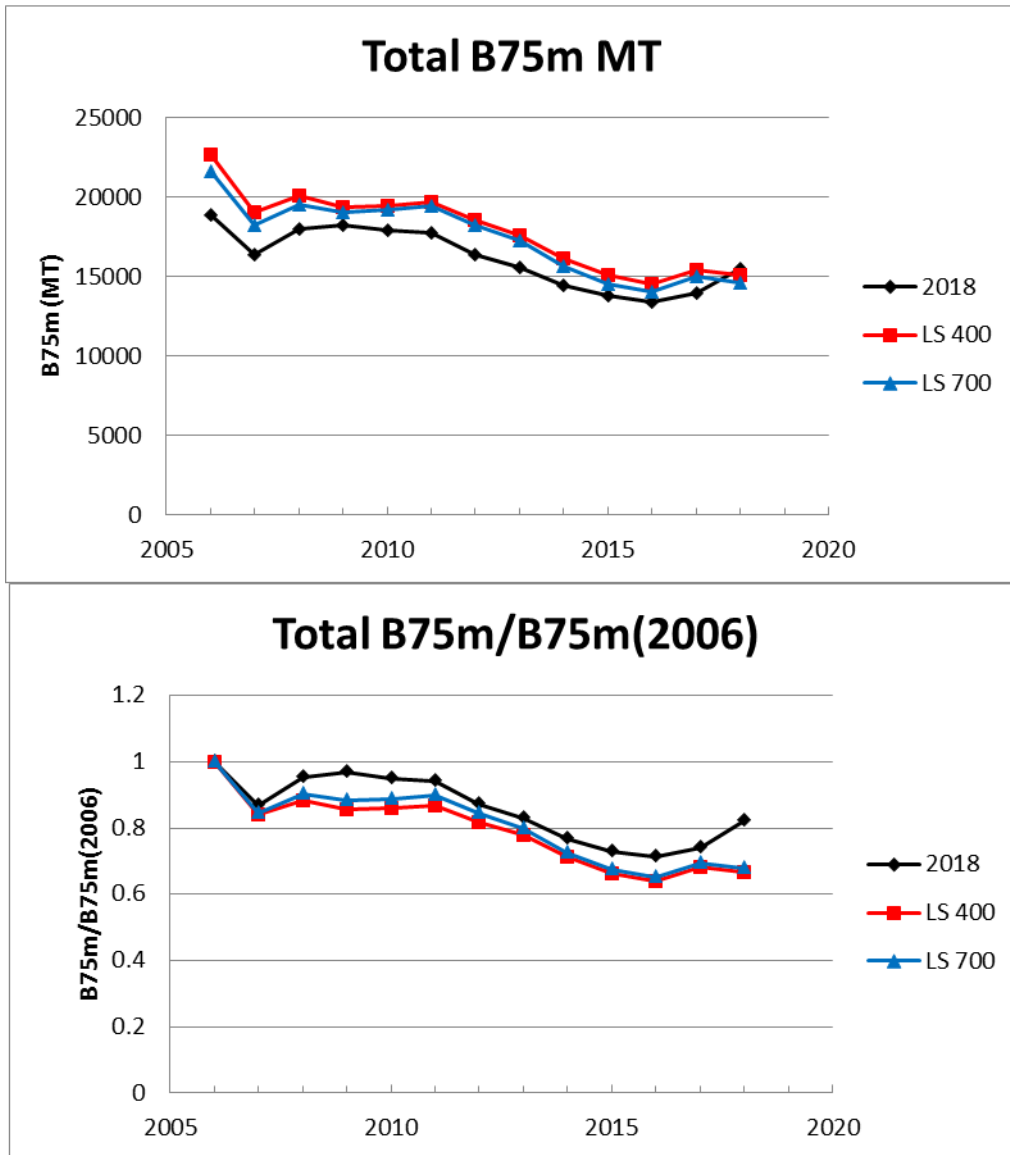


Figure 5: Comparison of the total estimated resource biomass in absolute terms (top plot) and relative to 2006 (bottom plot) for the 2018 assessment and the two 2019 assessments.

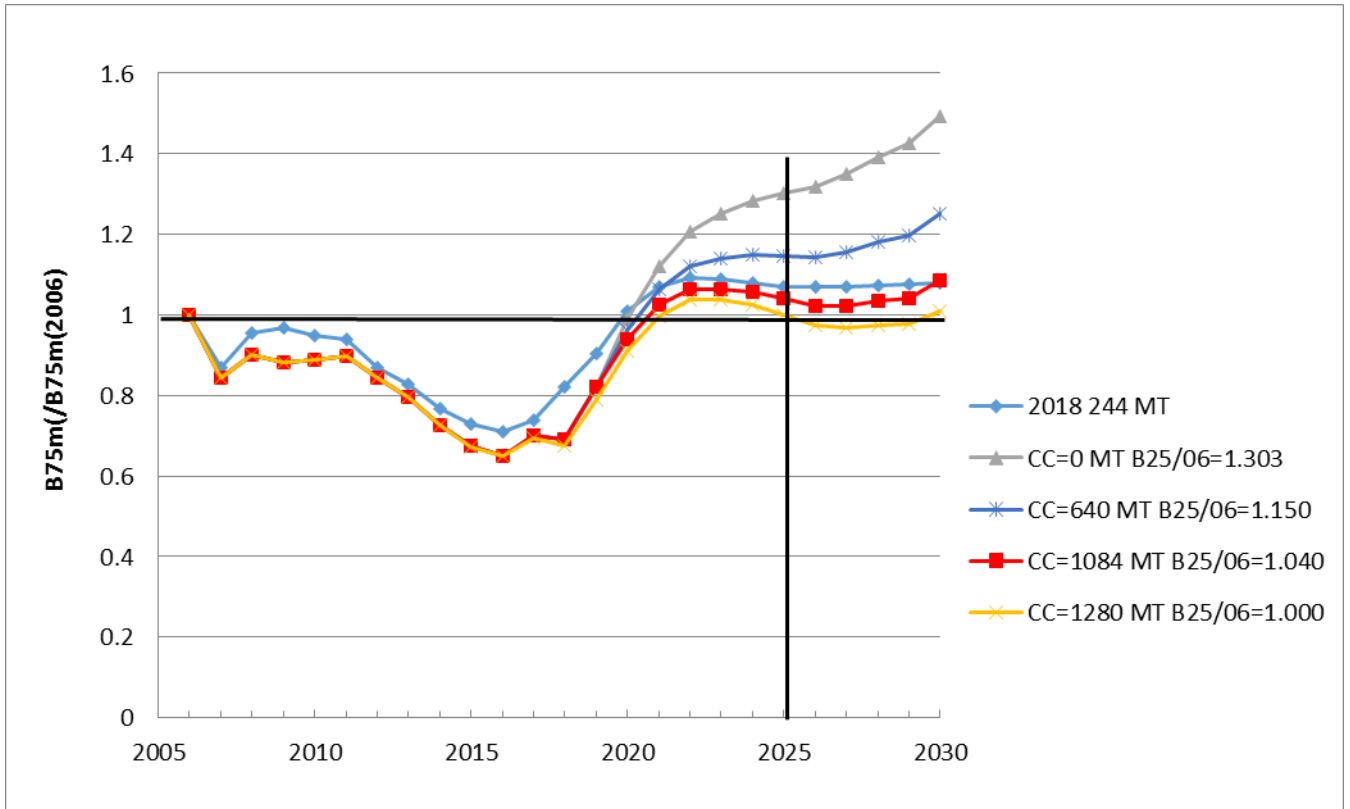


Figure 6: Total median biomass (B75m) trajectories for B75m/B75m(2006) for a range of future constant annual legal catch (CC) values for analyses conducted in 2019. The corresponding trajectory for 2018 (a deterministic result rather than a median) is also shown. These are based on the LS 700 poaching scenario.

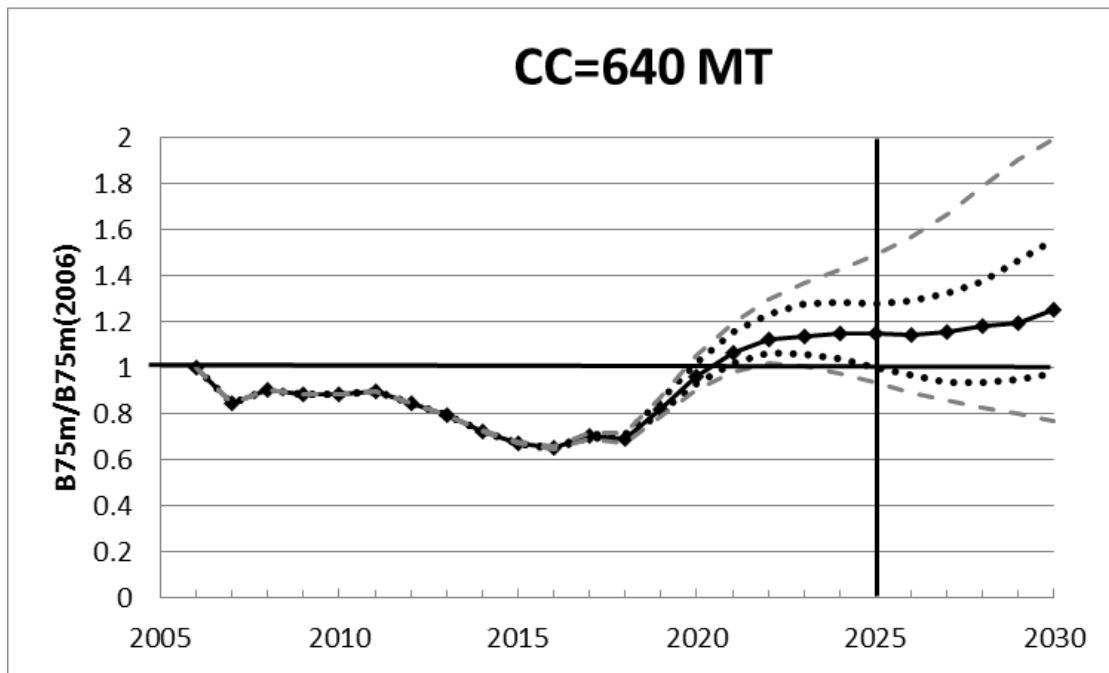


Figure 7a: Median (solid curve), 50% (black dots) and 90% (grey dashed) probability envelopes for biomass ($B_{75m}/B_{75m(2006)}$) for a future CC of 640 MT under the LS 700 poaching scenario.

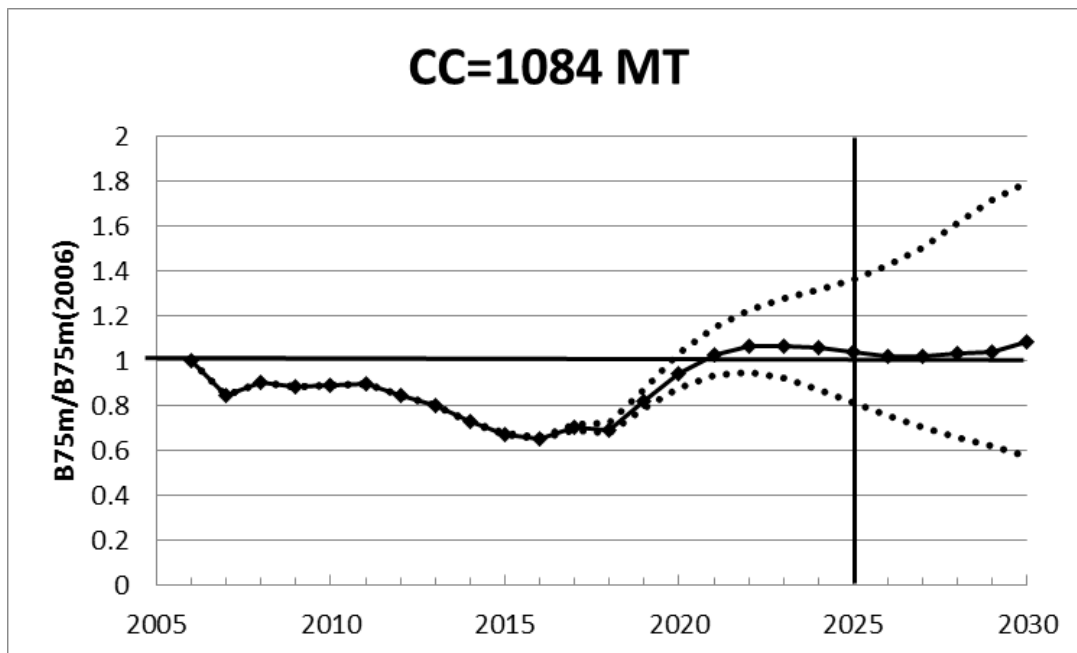


Figure 7b: Median (solid curve) and 90% (black dots) probability envelopes for biomass ($B_{75m}/B_{75m(2006)}$) for a future CC of 1084 MT under the LS 700 poaching scenario.

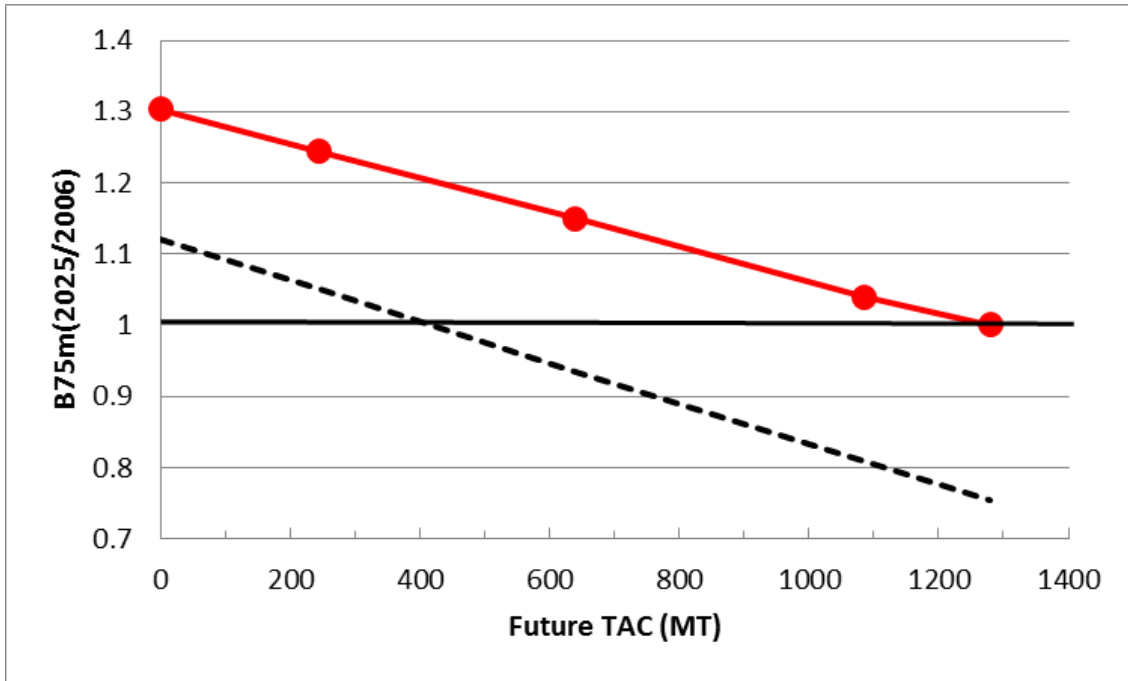


Figure 8: The median extent of resource recovery ($B75m/B75m(2006)$) expected to occur by 2025 for different levels of constant future TAC (shown as by the solid red curve). The lower 5% probability for the extent of recovery is shown by the black dotted line. Thus, for example, a future TAC of 400 MT would be equally likely to be higher or lower than a biomass which is about 20% greater than the 2006 abundance in 2025, but there would be a 5% chance of biomass being below that 2006 level in 2025.