Updated 2020 Tristan da Cunha rock lobster assessment

Susan Johnston and Doug Butterworth

MARAM

Department of Mathematics and Applied Mathematics

University of Cape Town

Rondebosch, 7701

Summary

This paper provides details of an updated 2020 assessment of the rock lobster resource at the island of Tristan da Cunha, which takes account of the most recent data available. This assessment takes explicit account of the separate data available from the powerboats, the Edinburgh/Geo Searcher and the annual biomass survey. Results are similar to previous assessments, but indicate that the decline in abundance since ~2006 has come to an end with increases in exploitable and spawning biomass over the 2015+ period, although the exploitable biomass is estimated to have declined slightly over the last two seasons. Current spawning biomass relative to pristine is estimated to be 75%. Results presented are for rescaled standardised CPUE which take recent fishing efficiency changes into account.

Introduction

The age-structured population model used for this assessment is based on that described in Johnston and Butterworth (2013), except that catch related data for the powerboats, the Edinburgh/Geo Searcher and the biomass survey are now modelled independently. The previous assessment of this resource was conducted in 2016 (Johnston and Butterworth 2016). Note that stock-recruitment residuals are now estimated for the period 1992-2012[1]). The model is fit to the following data, with their sources indicated:

1) Catches made by the powerboats, the Edinburgh and the biomass survey since 1994 (Johnston and Nelson 2020).
2) Standardised and rescaled powerboat CPUE (1994-2018) (Johnston and Butterworth, 2019a).
3) Nominal Edinburgh CPUE (2007-2014) (Johnston, 2019).
4) Biomass survey index data for Leg1 (2006-2019) (Johnston, 2020).
5) Powerboat catch-at-length data (males and females separate) (1997-2014, excluding 1999, 2002, 2011-2013) (Johnston 2016; James Glass pers. commn).
6) Edinburgh catch-at-length data (males and females separate) (2011-2014) (Johnston 2016; James Glass pers. commn).
7) Biomass survey catch-at-length data for Leg1 (2006-2019) (Johnston, 2020).

[1] Note that 2012 refers to the split season 2012/13 for example.

This updated assessment also assumes that the TAC of 128 MT set for the 2019 season will be caught.

Selectivity functions are estimated for males and females separately for powerboats, Edinburgh/Geo Searcher catches and biomass survey catches. These functions are assumed to change over time for the powerboats with three different functions estimated for the 1990-2000, 2001-2005 and 2006+ periods. Selectivity is assumed to be time-invariant for the Edinburgh and for the biomass surveys.

Reference case model

As for previous assessments, the Reference case (RC) model fixes the natural mortality *M*=0.1 and the fishing proportion in 2009 to be *F*(2009)=0.3. It also assumes the stock-recruitment residual variation parameter $\sigma_R$to be 0.4. The catch-at-length data are down-weighted by a multiplicative factor of 0.10 in the log-likelihood. As the model consistently overestimates the number of male lobsters in the larger size classes (as in previous assessments) two adjustments are made to improve the model fit (Johnston and Butterworth 2013):

i) Increase *M* to 1.5 for lobsters aged 10+.
ii) Decrease selectivity on male lobsters by 25% for lobsters of CL 110+mm.

Robustness tests

Robustness tests conducted here are:

R1: Fishing proportion in 2009 is 0.2 (RC F_{2009} = 0.3).

R2: Fishing proportion in 2009 is 0.4.

Results and Discussion

Table 1a reports the updated 2020 Tristan RC assessment results. Results from the 2016 assessment are also reported where comparable values are available. Table 1b reports the robustness test results. Figure 1a reports the updated 2020 RC model estimated trends for biomass and related variables. Figure 1b reports the various estimated male and female selectivity functions. Figure 2a reports the model fits to the CPUE and biomass survey index data, and Figure 2b the fits to the CAL data (for the updated 2020 model). The fits to the data remain reasonable for the abundance indices (Figure 2a), and the CAL data (Figure 2b and c). Although the model does not fit to the percentage females in each catch series directly (this is effected through the separate male and female CAL data), Figure 2e shows that there are some fairly large differences in the model estimates and the observed data values for F% values for all three data sources. For example, the model seems to underestimate the F% for the survey data fairly consistently.

The current status of the resource is estimated to be reasonably healthy with the 2020 spawning biomass at 0.75 *K.* The population is estimated to have increased in size over the 1990-2006 period following the good recruitments in the late 1990's. It subsequently declined since 2006 as a result of poor recruitments during the early 2000's (see Figure 1a), followed by slight increases since 2015.

Robustness tests to the value of fishing mortality assumed for 2009 (RC F_{2009}=0.3) show marginally worse overall model fits to the data than the RC (see Table 1b). Very similar biomass trends relative to pristine are however estimated for both R1 (F_{2009} = 0.2) and R2 (F_{2009} = 0.4) (see Figure 3). In absolute terms the R1 biomass estimates are higher and the R2 estimates are lower than those for the RC.

References

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Johnston, S.J. and D.S. Butterworth. 2019a. Updated (and rescaled) Tristan GLM-standardised lobster CPUE to take account of data for the 2018 season. MARAM/Tristan/2019/MAY/05.

Johnston, S.J., R. 2019. Nominal CPUE for the catches taken by the Edinburgh/Geo Searcher off Tristan da Cunha island. MARAM/Tristan/2019/JUN/08.

Johnston, S.J. 2020. Tristan Group Biomass survey Leg1 results including data from the 2019 season. MARAM/Tristan/2015/JAN/01.

Johnston, S.J. 2016. Powerboat and Edinburgh catch-at-length data currently available for the Tristan fishery. MARAM/Tristan/2016/FEB/02.

Table 1a: Updated Tristan RC assessment results. Results are also reported for the 2016 RC assessment. Shaded values are fixed on input, and values in parentheses are σ values (the standard deviations of the residual series concerned).

	2016 RC	**2020 RC**
# parameters estimated	50	**54**
K^{sp} (MT)[2]	1251	**1194**
h[3]	0.99	**0.99**
M	0.1	0.1
d (discard mortality rate)	0.1	0.1
σ_R	0.4	0.4
F_{2009} fixed at	0.3	0.3
θ[4]	0.403	**0.434**
-lnL total	-51.67	**-58.31**
-lnL powerboat CPUE (σ)	-36.93 (0.10)	**-47.57 (0.09)**
-lnL Edinburgh CPUE (σ)	-8.66 (0.21)	**-7.26 (0.32)**
-lnL Bio Sur Index Leg1 (σ)	-12.68 (0.12)	**-21.43 (0.11)**
-lnL Powerboat CAL (σ)	64.62 (0.11)	**171.04 (0.12)**
-lnL Edinburgh CAL (σ)	-14.76 (0.08)	**-13.78 (0.09)**
-lnL Bio Surv Leg 1 CAL (σ)	-29.77 (0.08)	**-36.79 (0.09)**
SR pen	5.14	**6.55**
Bsp(2016) (MT)	854	**860**
Bsp(2019) (MT)	-	**916**
Bsp(2020) (MT)	-	**900**
Bsp(1990)/K^{sp}	0.37	**0.40**
Bsp(2016)/K^{sp}	0.68	**0.72**
Bsp(2019)/K^{sp}	-	**0.77**
Bsp(2020)/K^{sp}	-	**0.75**
Bexp(2015) (MT)	330	**334**
Bexp(2020) (MT)	-	**372**
Bexp(2015)/K^{exp}	0.44	**0.63**
Bexp(2020)/K^{exp}	-	**0.70**
Program	T16r1.tpl	**T20up.tpl**

[2] K^{sp} is the carrying capacity of the resource (the unexploited spawning stock size).
[3] h is the steepness parameter of the stock-recruitment curve estimated for the resource.
[4] θ is the proportion of K^{sp} at which the stock is estimated to be in the first year for which catch data are available (1990).

Table 1b: Robustness tests results. Shaded values are fixed on input, and values in parentheses are σ values (the standard deviations of the residual series concerned).

	R1 F_{2009} **= 0.2**	**RC** F_{2009} **= 0.3**	**R2** F_{2009}**=0.4**
# parameters estimated	54	**54**	54
K (MT)	1598	**1194**	1000
h	0.99	**0.99**	0.99
M	0.1	0.1	0.1
d (discard mortality rate)	0.1	0.1	0.1
σ_R	0.4	0.4	0.4
F_{2009} fixed at	0.3	0.3	0.3
θ	0.379	**0.434**	0.483
-lnL total	-57.07	**-58.31**	-57.12
-lnL powerboat CPUE (σ)	-47.66 (0.09)	**-47.57 (0.09)**	-46.29 (0.10)
-lnL Edinburgh CPUE (σ)	-7.21 (0.31)	**-7.26 (0.32)**	-7.29 (0.31)
-lnL Bio Sur Index Leg1 (σ)	-21.47 (0.11)	**-21.43 (0.11)**	-21.31 (0.11)
-lnL Powerboat CAL (σ)	172.72 (0.12)	**171.04 (0.12)**	171.08 (0.12)
-lnL Edinburgh CAL (σ)	-13.10 (0.09)	**-13.78 (0.09)**	-13.53 (0.09)
-lnL Bio Surv Leg 1 CAL (σ)	-34.95 (0.09)	**-36.79 (0.09)**	-40.66 (0.08)
SR pen	7.47	**6.55**	5.97
Bsp(2016) (MT)	1182	**860**	703
Bsp(2019) (MT)	1271	**916**	741
Bsp(2020) (MT)	1248	**900**	728
Bsp(1990)/K^{sp}	0.35	**0.40**	0.45
Bsp(2016)/K^{sp}	0.74	**0.72**	0.70
Bsp(2019)/K^{sp}	0.80	**0.77**	0.74
Bsp(2020)/K^{sp}	0.78	**0.75**	0.73
Bexp(2015) (MT)	524	**334**	261
Bexp(2020) (MT)	587	**372**	288
Bexp(2015)/K^{exp}	0.69	**0.63**	0.59
Bexp(2020)/K^{exp}	0.78	**0.70**	0.65
Program	R1.tpl	**T20up.tpl**	R2.tpl

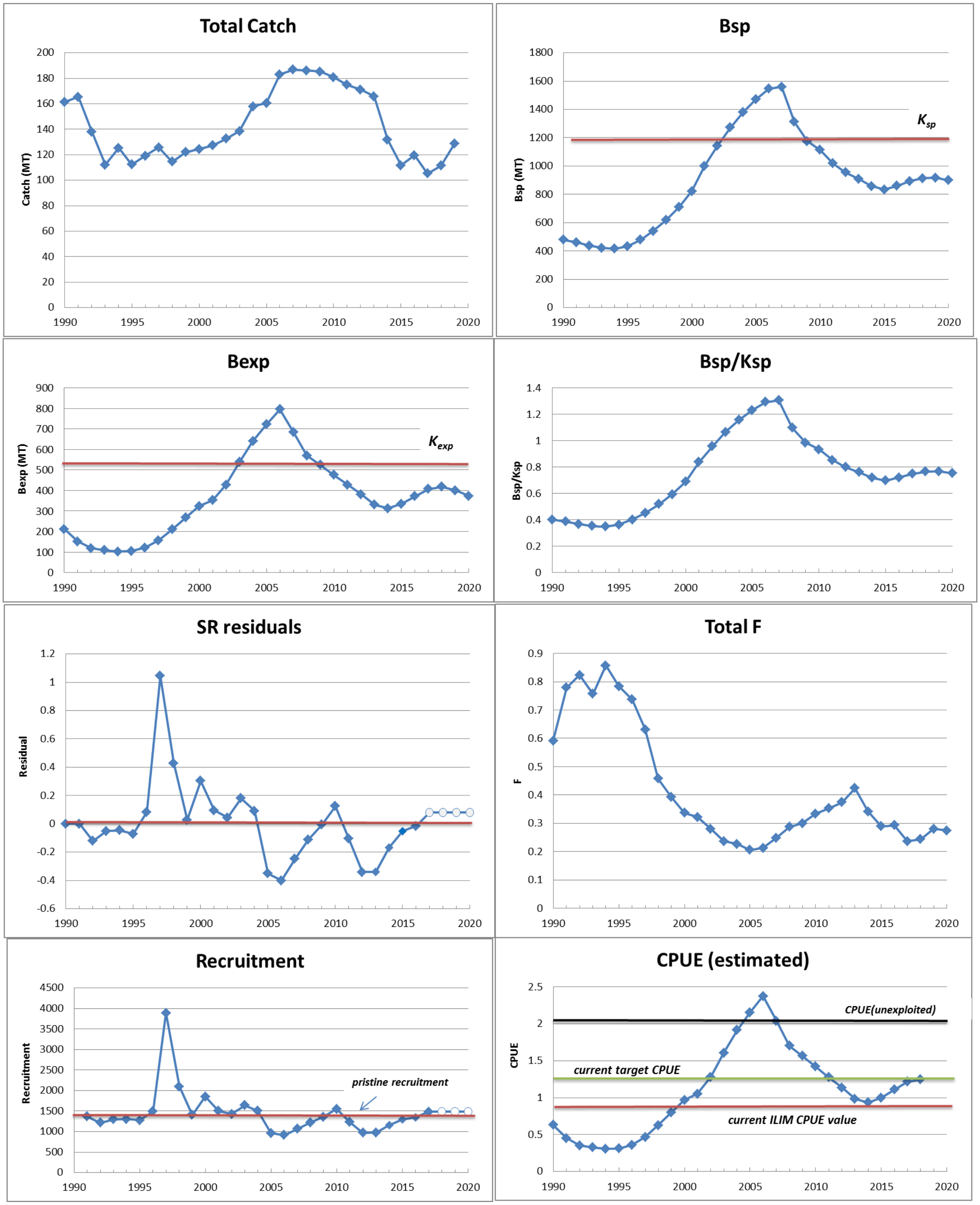

Figure 1a: Tristan RC updated 2020 model results. The stock-recruitment residuals are estimated to 2016, with the 2017+ values indicating the level that is assumed for future projections.

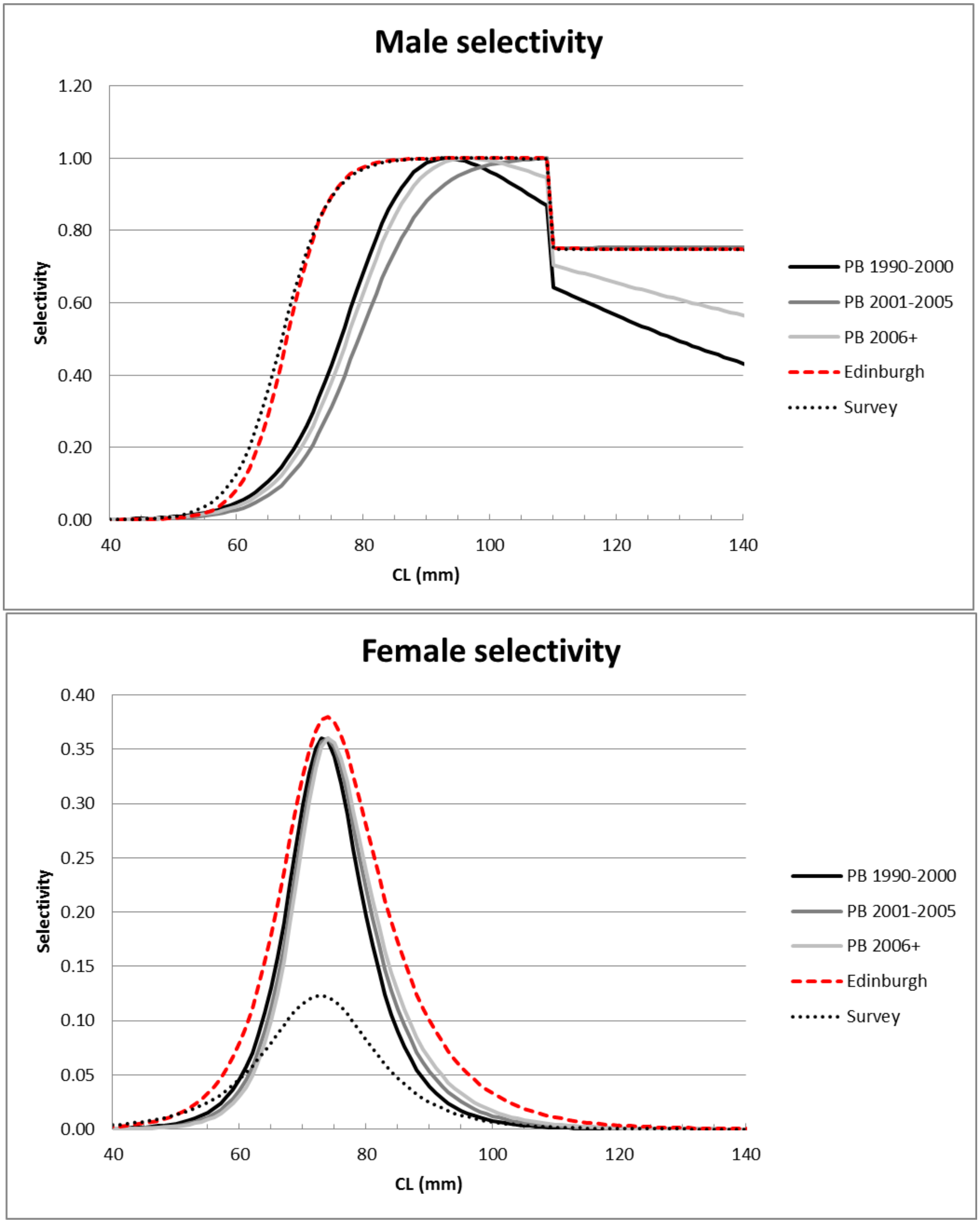

Figure 1b: Tristan 2020 RC selectivity functions.

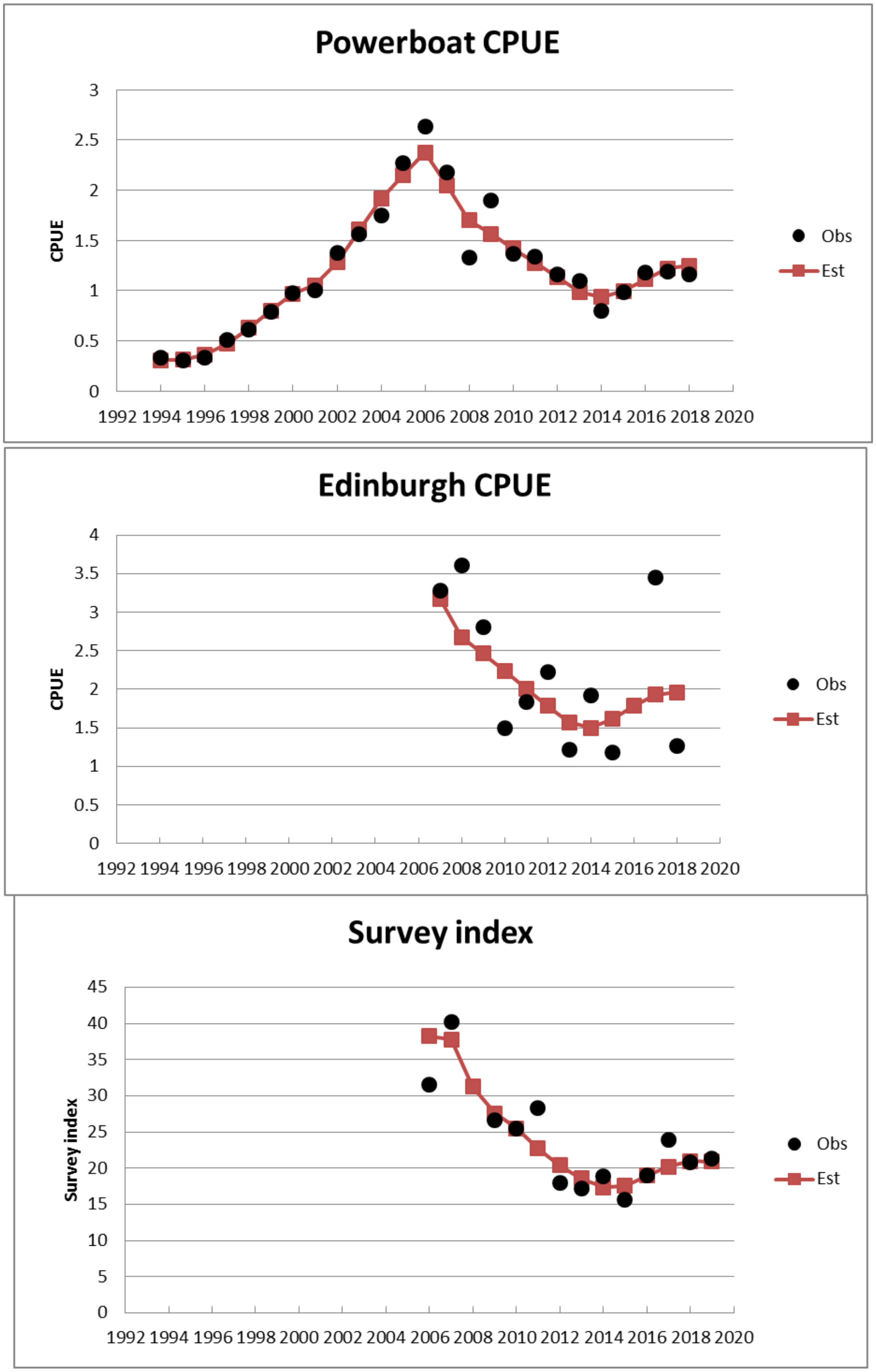

Figure 2a: Tristan 2020 RC model fits to powerboat and Edinburgh CPUE, and to Biomass survey index data.

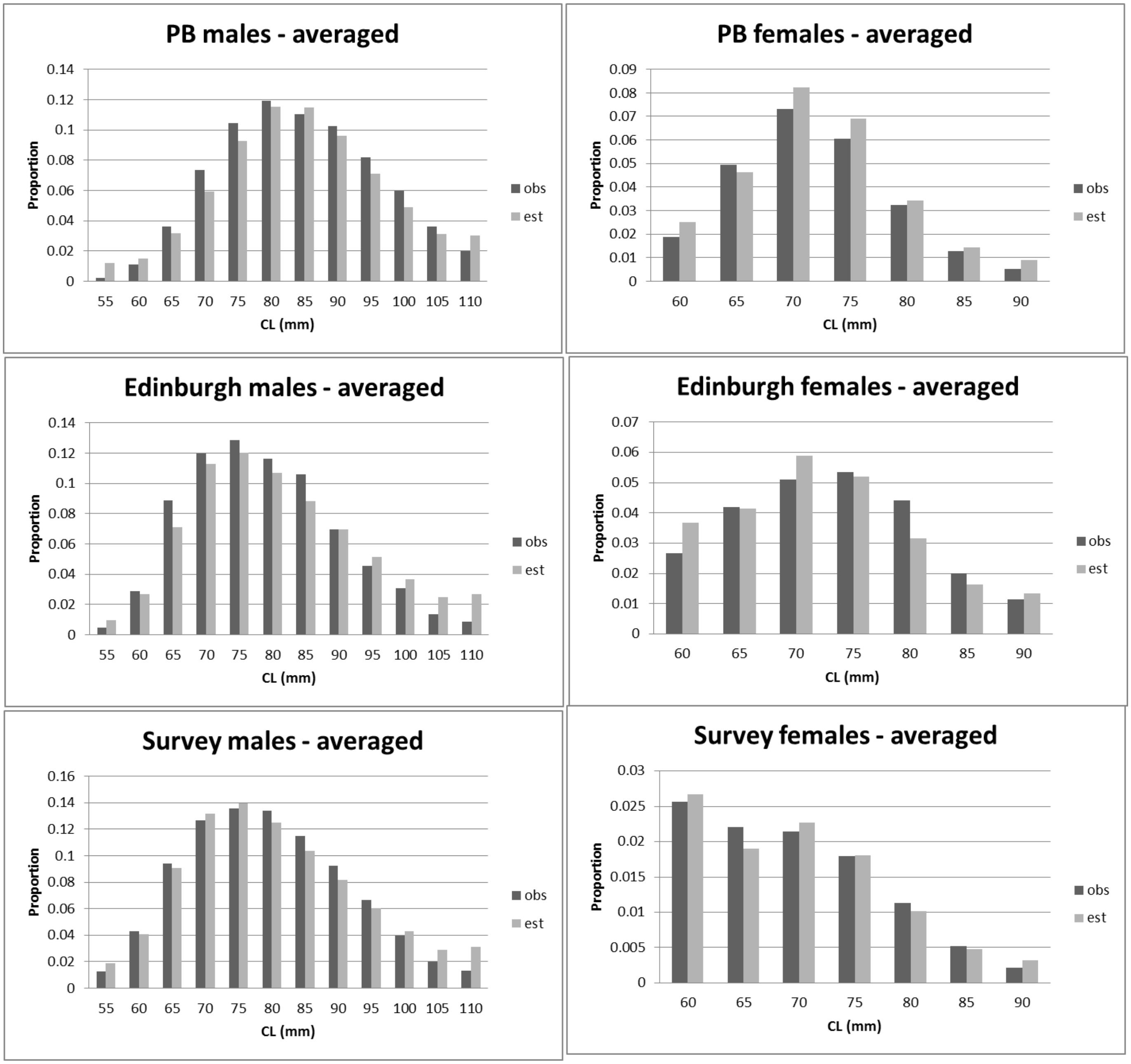

Figure 2b: Tristan 2020 CAL fit results averaged over years for which data are available. Note that, e.g. 55 refers to the length range 55-59 and 110 to sizes 110 mm and above.

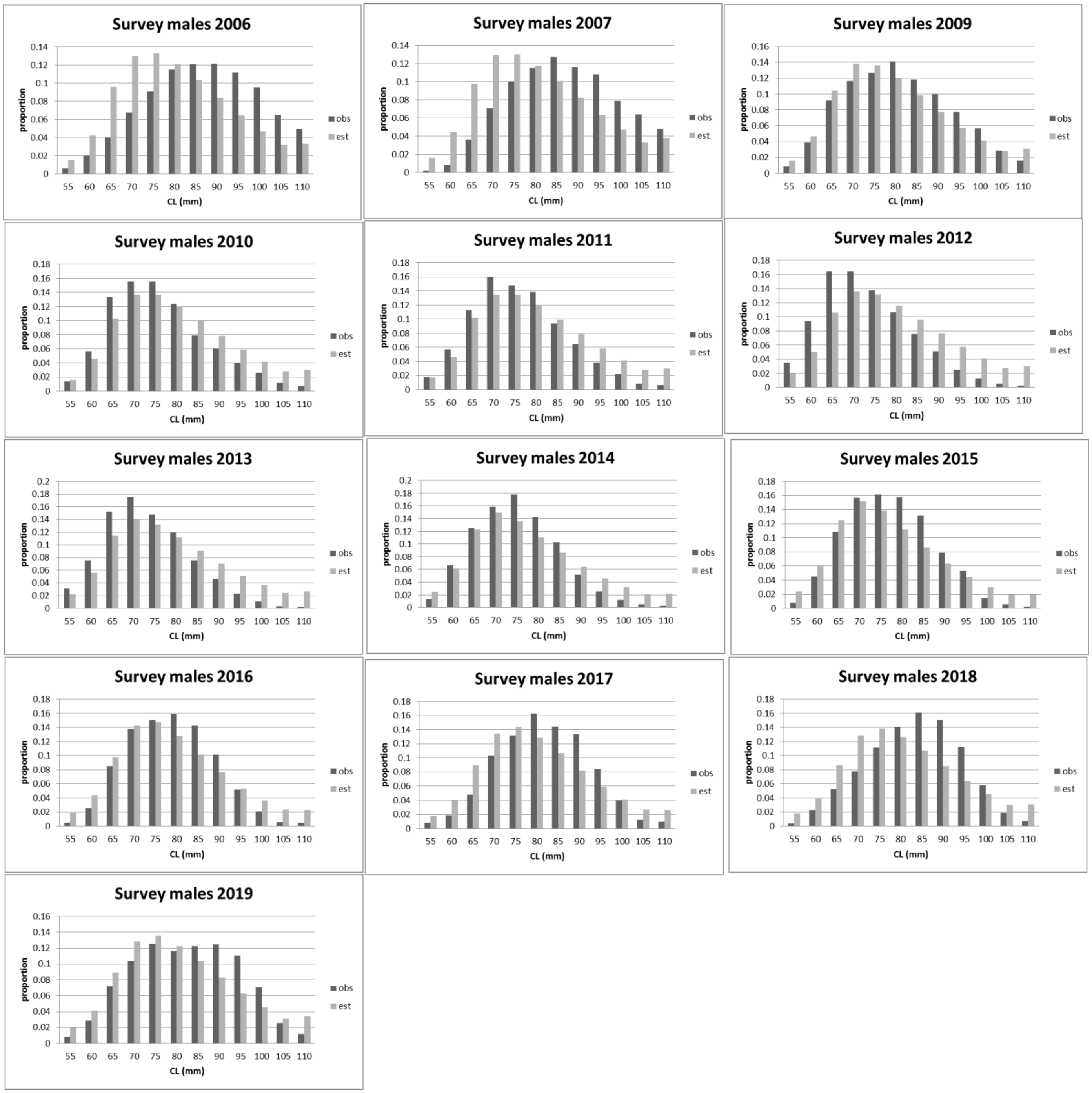

Figure 2c: Tristan March 2020 RC comparative observed and estimated CAL data for the surveys.

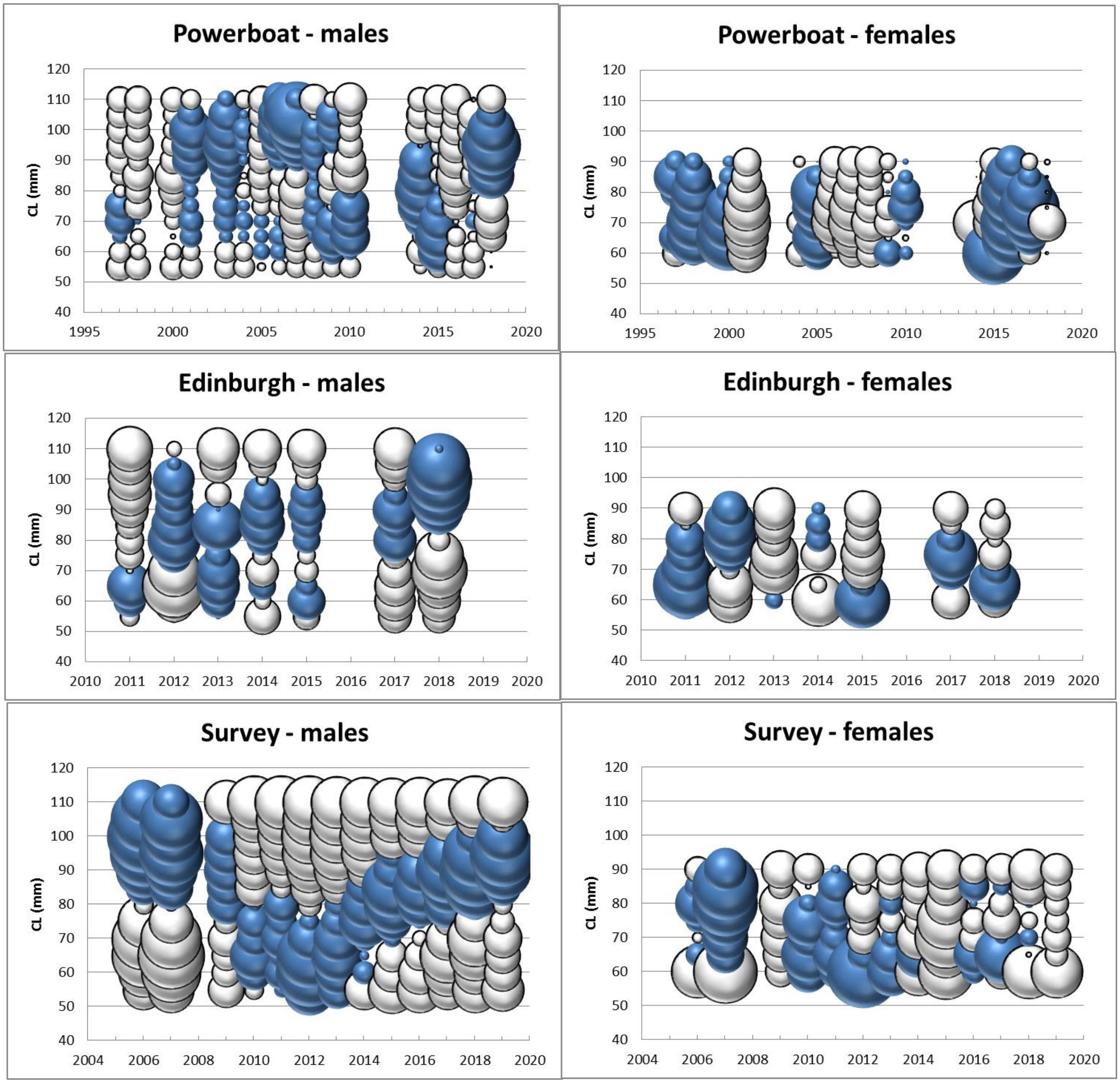

Figure 2d: March 2020 RC CAL residual plots for all powerboats, Edinburgh and Survey catch data.

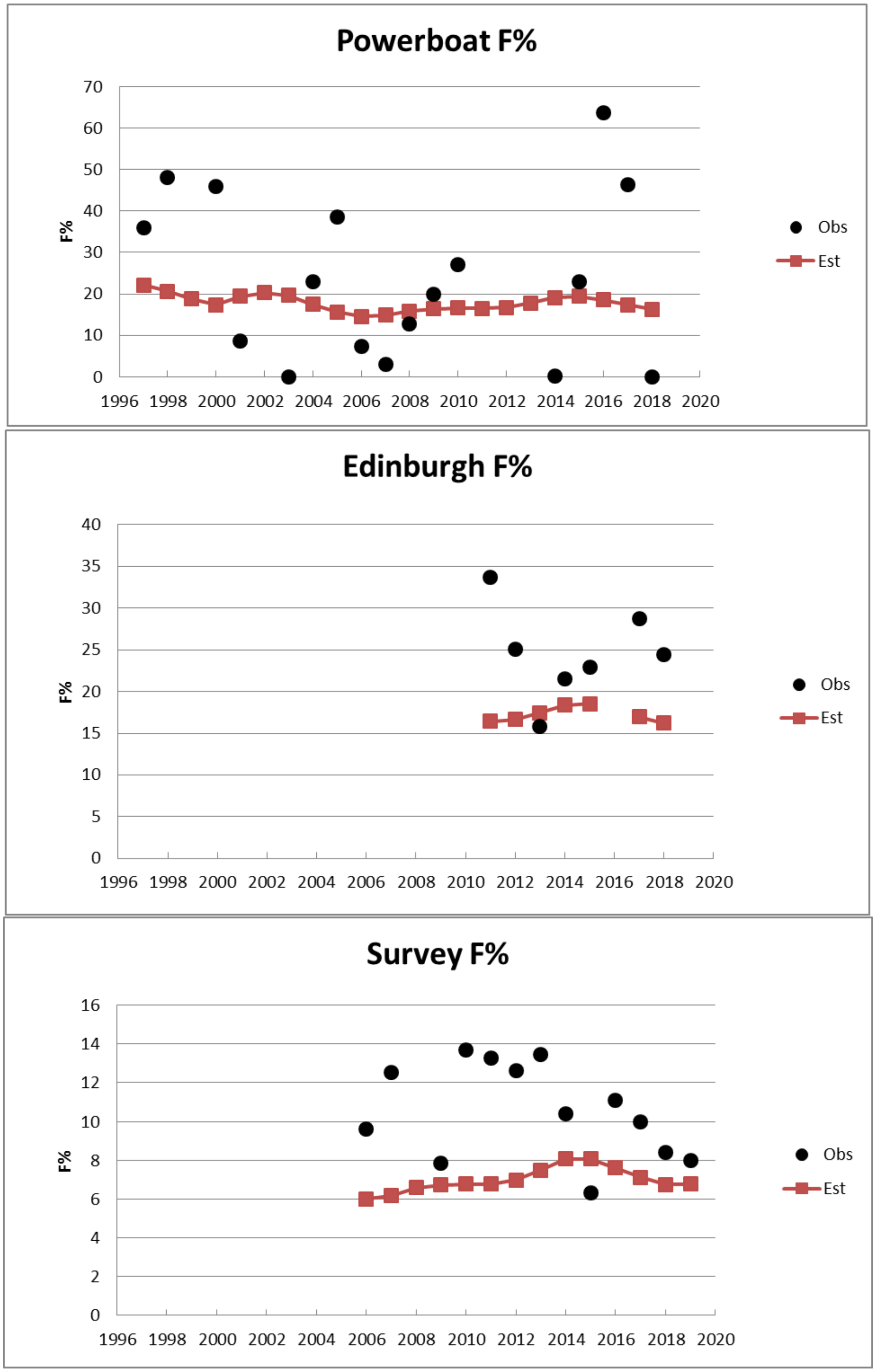

Figure 2e: Tristan 2020 RC F% (percentage females) in the catch (shown for comparative purposes – not independent data used in likelihood).

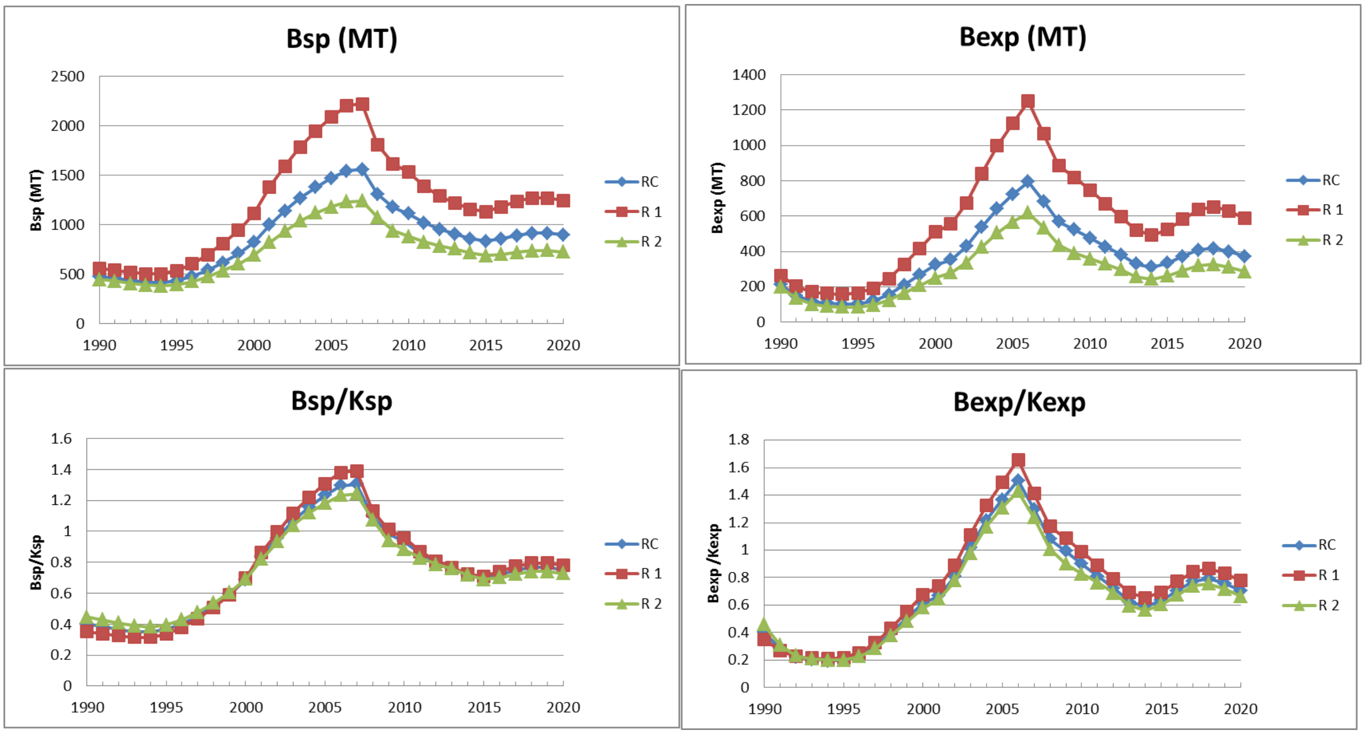

Figure 3: Comparative Tristan assessment model estimates of abundance data for the R1 (F_{2009}=0.2) and R2 (F_{2009} = 0.4) robustness tests.