Updated 2016 Reference Case Tristan da Cunha rock lobster assessment

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Summary

This paper provides details of an updated ("MAR 2016") assessment of the rock lobster resource at the island of Tristan da Cunha, which takes account of the most recent data available. This assessment is a refinement of previous assessments in that it takes explicit account of the separate data available from the powerboats, the Edinburgh and the annual biomass survey. Results are similar to previous assessments but do estimate that the decline in abundance over recent years has come to an end with a slight increase in exploitable biomass expected for the 2016 season. 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 and the biomass survey are now modelled independently. The previous assessment of this resource was conducted in September 2015 (Johnston and Butterworth 2015a). 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 Pieterse 2016a).
2) Standardised and rescaled powerboat CPUE (1994-2014) (Johnston and Butterworth, 2016b).
3) Nominal Edinburgh CPUE (2007-2014) (Johnston and Pieterse 2016c).
4) Biomass survey index data for Leg1 (2006-2015) (Johnston, 2015).
5) Powerboat catch-at-length data (males and females separate) (1997-2014, excluding 1999, 2002, 2011-2013) (Johnston 2016).
6) Edinburgh catch-at-length data (males and females separate) (2011-2014) (Johnston 2016).
7) Biomass survey catch-at-length data for Leg1 (2006-2014) (Johnston, 2015).

This updated assessment also assumes that the TAC of 120 MT set for the 2015 season will be caught, divided as follows: 50 MT powerboats and 70 MT Edinburgh.

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[1] Note that 2010 refers to the split season 2010/11 for example.

Selectivity functions are estimated for males and females separately for powerboats, Edinburgh 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 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 σ_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 2013b):

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

As previously, the RC model fits to Biomass survey data from Leg1 only. Leg1 is the survey conducted at the start of the season and is considered to be more reliable that the Leg2 survey which takes place at or near the end of the season.

Robustness tests

A Robustness test (**R1**) to a re-scaled powerboat GLM series, where fishermen efficiency is taken into account, is also run (see Johnston and Butterworth 2016b for details of CPUE rescaling).

Further Robustness tests are:

R2a: Fishing proportion in 2009 is 0.2 (RC F_{2009} = 0.3).

R2b: Fishing proportion in 2009 is 0.4.

Results and Discussion

Table 1a reports the updated March 2016 Tristan RC assessment results. Results from the 2013 and September 2015 assessment are also reported where comparable values are available. Table 1b reports the robustness test results. Figure 1a reports the updated March 2016 RC model estimated trends for biomass and related variables. Figure 1b reports the various estimated male and female selectivity functions whilst 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 March 2016 model). The fits to the data remain reasonable for the abundance indices (Figure 2a), and the CAL data (Figure 2b and c). Figure 2a shows that there is reasonable consistency between the downward trends in abundance since 2006 which are indicated by the CPUE and survey data, though the latter is less marked over recent years. Although the model does not fit to the percentage females in each catch series independently (this is covered indirectly 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 2015 spawning biomass at 0.64 K, though this is marginally lower than estimated in the previous assessment; this status is lower at 0.39 K when expressed in terms of the exploitable component of the biomass (see Table 1a). Note a slight estimated increase in the size of this component from 2015 to 2016. The population is estimated to have increased in size over the 1990-2006 period following the good recruitments in the late 1990's. The spawning biomass is estimated to have declined by about one third since 2006 as a result of poor recruitments during the early 2000's (see Figure 1a).

Fitting the model using the rescaled powerboat CPUE (R1) results in slightly less pessimistic biomass estimates for the more recent period (see Table 1b and Figure 3b). The overall model fit is however marginally worse that the RC (compare the –lnL total values in Table 1b).

Robustness tests to the value of fishing mortality assumed for 2009 (RC F_{2009}=0.3) similarly show marginally worse overall model fits to the data than the RC (see Table 1b and Figure 3c). Very similar biomass trends are however estimated for both R2a (F_{2009} = 0.2) and R2b (F_{2009} = 0.4) (see Figure 3d).

References

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Johnston, S.J. and D.S. Butterworth. 2016b. Rescaled Tristan GLM-standardised lobster CPUE to take account of fishing efficiency changes. MARAM/Tristan/2016/MAR/05.

Johnston, S.J. and Pieterse, R. 2016bc. Nominal Edinburgh CPUE for catches landed at Tristan da Cunha island. MARAM/Tristan/2016/FEB/04.

Table 1a: Updated Tristan RC assessment results. Results are also reported for the 2013 RC assessment estimates and the SEP 2015 assessment. Shaded values are fixed on input, and values in parentheses are σ values (the standard deviations of the residual series concerned).

	2013 RC	SEP 2015 RC	MAR 2016 RC
# parameters estimated	41	43	**50**
K (MT)[2]	1449	1297	**1231**
h[3]	0.96	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[4]	0.373	0.391	**0.412**
-lnL total	-42.81	-45.57	**-52.15**
-lnL powerboat CPUE (σ)	-35.28 (0.09)	-37.14 (0.10)	**-36.33 (0.11)**
-lnL Edinburgh CPUE (σ)			**-10.14 (0.17)**
-lnL Bio Sur Index Leg1 (σ)	-8.69 (0.15)	-12.54 (0.13)	**-12.43 (0.14)**
-lnL Powerboat CAL (σ)	6.23 (0.11)	20.97 (0.11)	**63.09 (0.10)**
-lnL Edinburgh CAL (σ)			**-14.02 (0.08)**
-lnL Bio Surv Leg 1 CAL (σ)	-30.21 (0.08)	-31.16 (0.08)	**-31.48 (0.08)**
SR pen	4.25	5.79	**5.60**
Bsp(2014) (MT)	-	863	**804**
Bsp(2015) (MT)	-	842	**789**
Bsp(2016) (MT)			**821**
Bsp(1990)/Ksp	0.35	0.34	**0.38**
Bsp(2014)/Ksp	-	0.67	**0.65**
Bsp(2015)/Ksp	-	0.65	**0.64**
Bsp(2016)/Ksp			**0.67**
Bexp(2012) (MT)	424	382	**351**
Bexp(2013) (MT)	-	333	**298**
Bexp(2014) (MT)	-	302	**284**
Bexp(2015) (MT)			**297**
Bexp(2014)/Kexp	-	0.39	**0.39**
Bexp(2015)/Kexp			**0.41**
Program	**Tnewup.tpl; tup.rep**	**T15up.tpl, r15up.rep**	**T16up.tpl**

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[2] K 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 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).

	RC $F_{2009} = 0.3$	R1 Rescaled GLM to allow for fishing efficiency changes	R2a $F_{2009} = 0.2$	R2b $F_{2009}=0.4$
# parameters estimated	**50**	50	50	50
K (MT)	**1231**	1251	1629	1075
h	**0.99**	0.99	0.99	0.99
M	0.1	0.1	0.1	0.1
d (discard mortality rate)	0.1	0.1	0.1	0.1
σ_R	0.4	0.4	0.4	0.4
F_{2009} fixed at	0.3	0.3	0.3	0.3
θ	**0.412**	0.403	0.353	0.456
-lnL total	**-52.15**	-51.67	-50.54	-49.70
-lnL powerboat CPUE (σ)	**-36.33 (0.11)**	-36.93 (0.10)	-36.15 (0.11)	-35.33 (0.11)
-lnL Edinburgh CPUE (σ)	**-10.14 (0.17)**	-8.66 (0.21)	-10.02 (0.17)	-9.84 (0.18)
-lnL Bio Sur Index Leg1 (σ)	**-12.43 (0.14)**	-12.68 (0.12)	-12.46 (0.14)	-12.37 (0.14)
-lnL Powerboat CAL (σ)	**63.09 (0.10)**	64.62 (0.11)	63.35 (0.10)	67.23 (0.11)
-lnL Edinburgh CAL (σ)	**-14.02 (0.08)**	-14.76 (0.08)	-13.24 (0.08)	-6.81 (0.09)
-lnL Bio Surv Leg 1 CAL (σ)	**-31.48 (0.08)**	-29.77 (0.08)	-29.18 (0.08)	-34.67 (0.08)
SR pen	**5.60**	5.14	6.66	5.16
Bsp(2014) (MT)	**804**	858	1070	702
Bsp(2015) (MT)	**789**	831	1059	683
Bsp(2016) (MT)	**821**	854	1110	706
Bsp(1990)/Ksp	**0.38**	0.37	0.33	0.42
Bsp(2014)/Ksp	**0.65**	0.69	0.66	0.65
Bsp(2015)/Ksp	**0.64**	0.66	0.65	0.64
Bsp(2016)/Ksp	**0.67**	0.68	0.68	0.66
Bexp(2012) (MT)	**351**	392	533	298
Bexp(2013) (MT)	**298**	340	461	252
Bexp(2014) (MT)	**284**	321	438	239
Bexp(2015) (MT)	**297**	330	458	250
Bexp(2014)/Kexp	**0.39**	0.43	0.46	0.36
Bexp(2015)/Kexp	**0.41**	0.44	0.48	0.37
Program	**T16up.tpl**	T16r1.tpl	T16ra.tpl	T16rb.tpl

Figure 1a: Tristan RC updated March 2016 model results. The stock-recruitment residuals are estimated to 2012 with the 2013+ values indicating the level that is assumed for future projections.
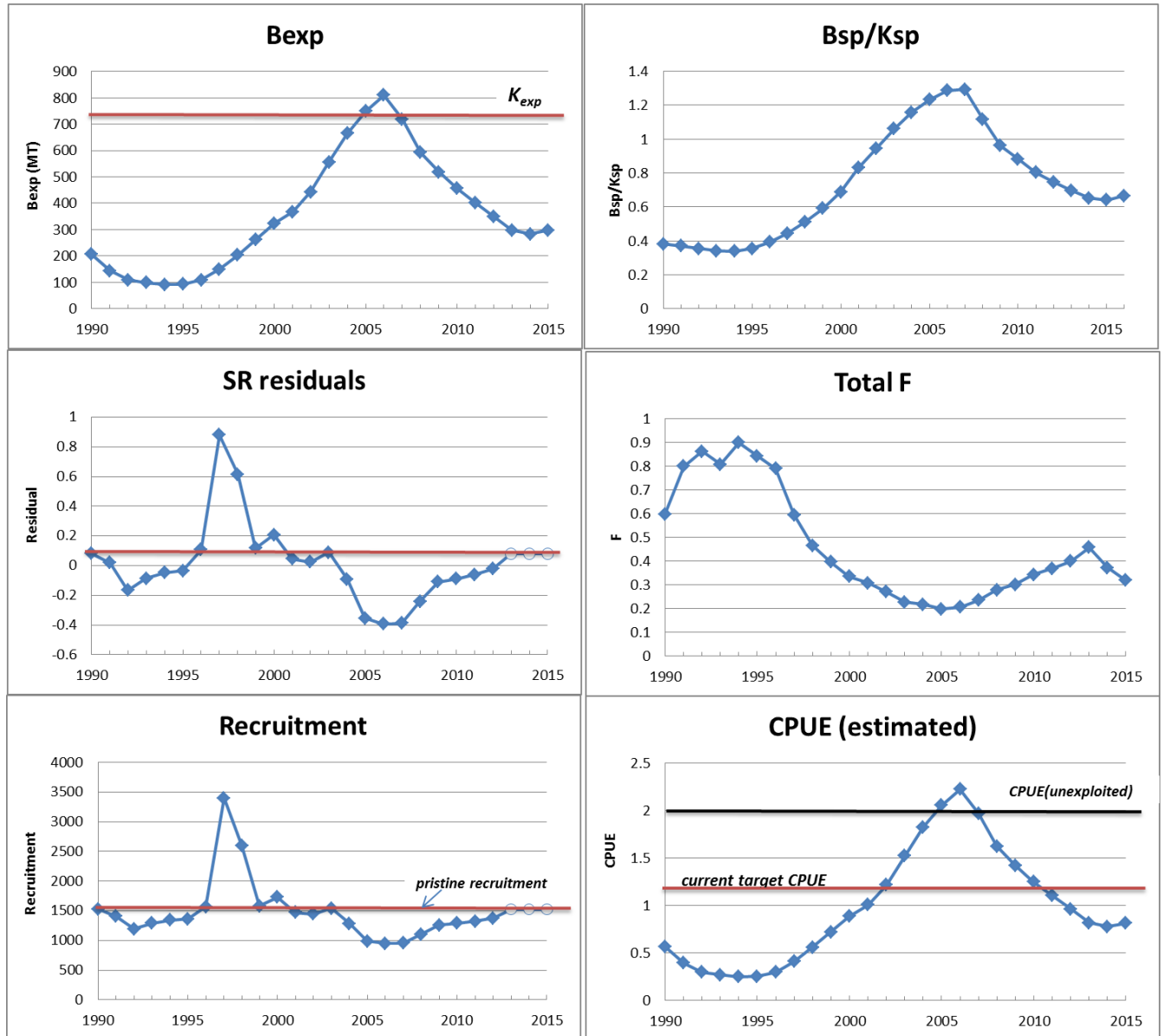
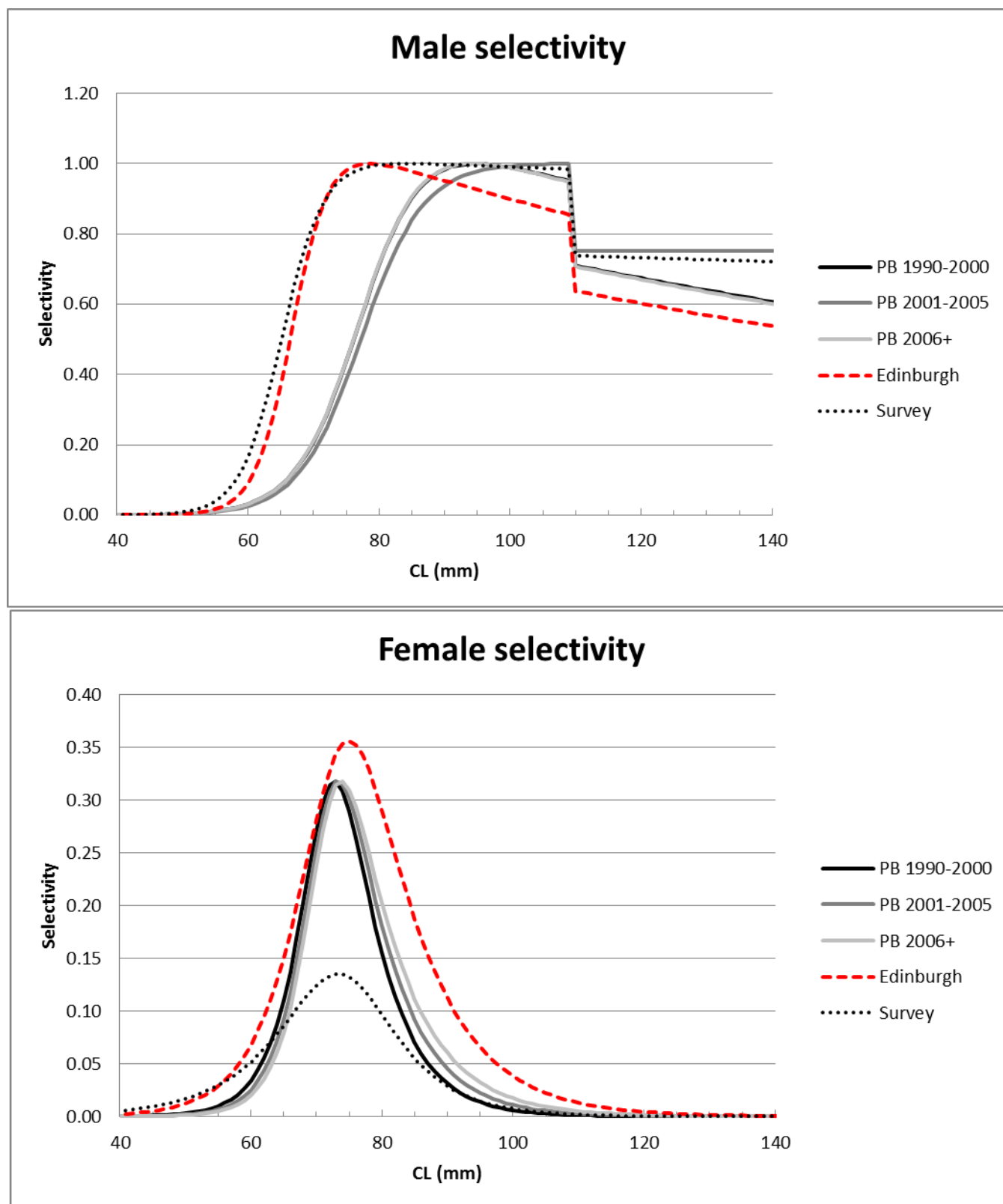Figure 1b: Tristan March 2016 RC selectivity functions.

Figure 2a: Tristan March 2016 RC model fits to PB and Edinburgh CPUE and Biomass survey index data.
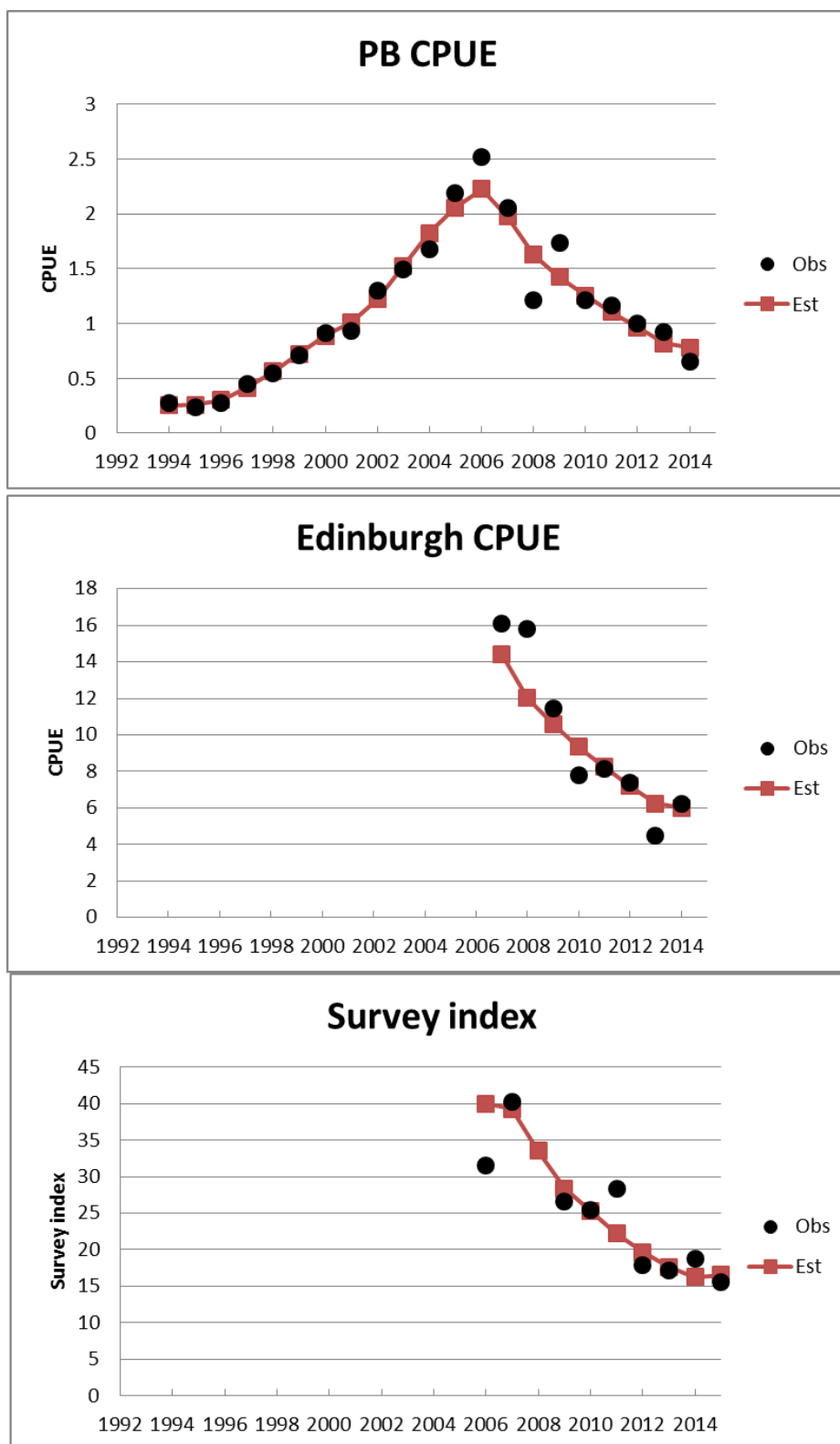
Figure 2b: Tristan March 2016 RC CAL results averaged over years for which data are available. Note that, e.g. 55 refers to the length range 55-59 and 110 to sizes 110 mm and above.

Figure 2c: Tristan March 2016 RC comparative 2014 observed and estimated CAL data for the PB, Edinburgh and Survey data.

Figure 2d: March 2016 RC CAL residual plots for all powerboats, Edinburgh and Survey catch data.

Figure 2e: Tristan March 2016 RC F% (percentage females) in catch (shown for comparative purposes – not independent data in likelihood).

Figure 3a: Comparative Tristan assessment model fits to CPUE and abundance data for the March 2016 RC (left) and the R1 (right) (rescaled CPUE series) robustness test.
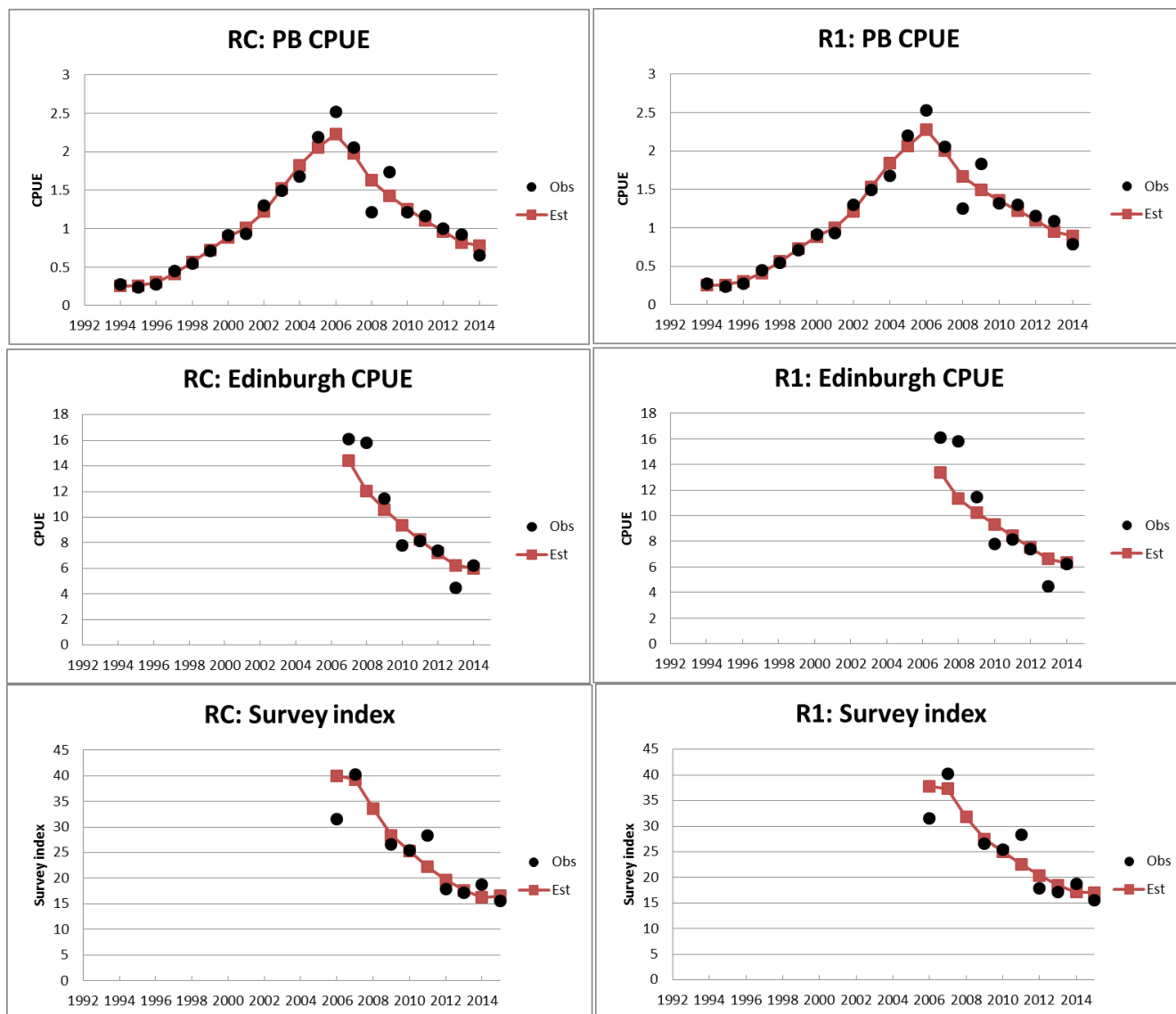
Figure 3b: Comparative Tristan model estimates of Bsp/K and powerboat CPUE for the March 2016 RC and the R1 (rescaled CPUE series) robustness test.
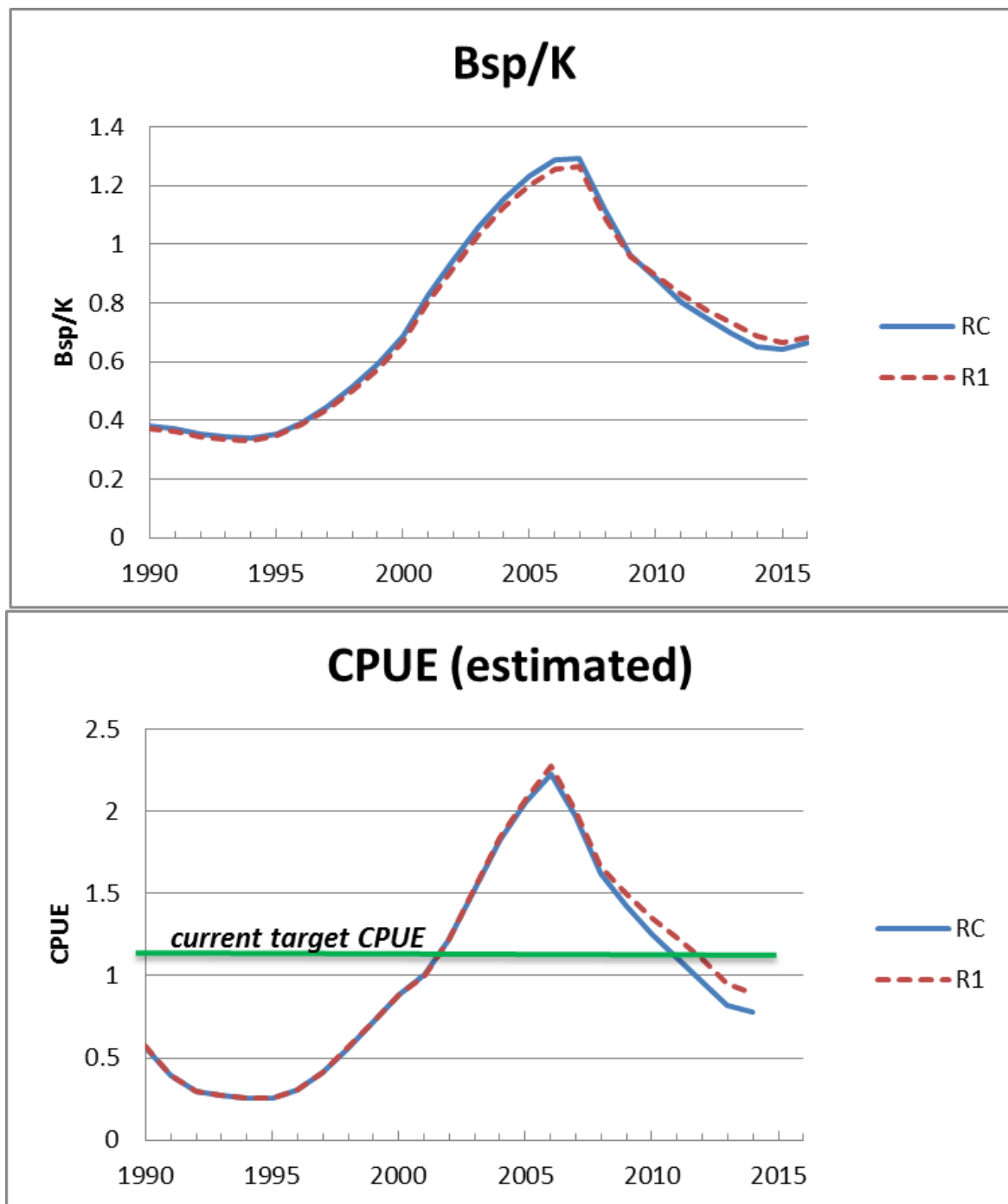
Figure 3c: Comparative Tristan assessment model fits to CPUE and abundance data for the R2a (left – F_{2009}=0.2) and R2b (right – F_{2009} = 0.4) robustness tests.
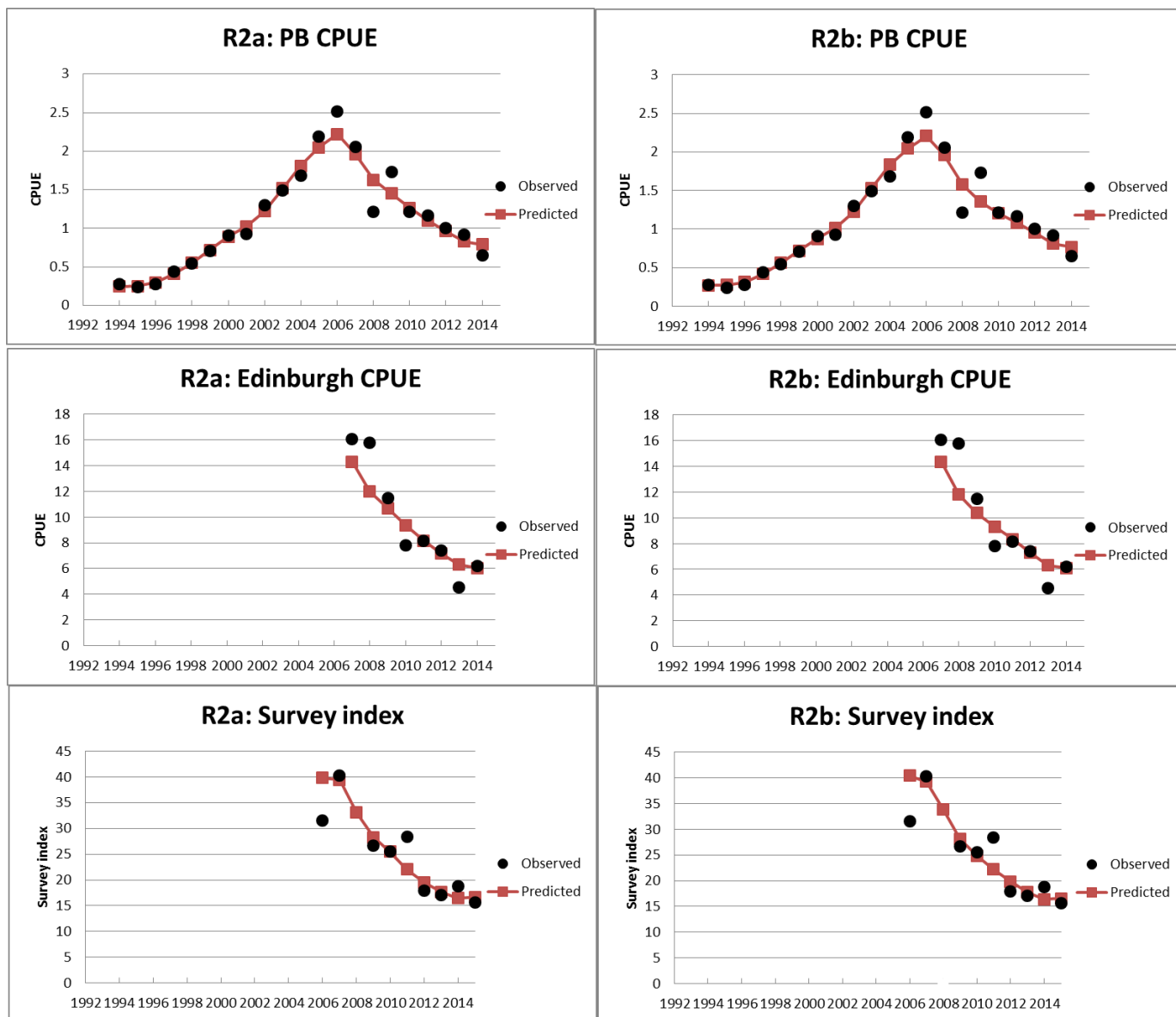
Figure 3d: Comparative Tristan model estimates of Bsp/K and powerboat CPUE for the March 2016 RC and for the R2a (F_{2009}=0.2) and R2b (F_{2009} = 0.4) robustness tests.