Updated 2012 rock lobster assessments of the Tristan da Cunha group of islands

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Summary

This paper provides updated assessments of the rock lobster resources at the four islands of the Tristan da Cunha group, now incorporating two further years of data. Abundances at all four islands are estimated to be high (B_{sp}/K estimates in the range 0.75 to 0.89 for 2012), though these results assume no impact from the Oliva incident.

Introduction

The age-structured population model used for these assessments is described fully in Johnston and Butterworth (2011). Note that stock-residuals are now for a further two years (for the period 1992-2007[1]). These models are fit to the following data:

1) Standardised longline CPUE data (1997-2010 for the 3 outer islands) and standardised powerboat CPUE for Tristan (1994-2010).
2) Catch-at-length data (males and females separate) (1997-2010)
3) Discard % (1997-2010) for the three outer islands.

These data are reported in Johnston and Butterworth (2012).

For each island, two models are explored:

Model 1: Time invariant fishing selectivity

Model 2: Time-varying fishing selectivity

For Model 2, three periods of selectivity were initially modelled – these vary slightly between islands and were selected after studying the residual trends from the model fits to the catch-at-length data. The time-varying is effected by estimated **three different μ values** (males and females separately) of the selectivity function for each of the different time periods, although for Tristan this is effected by estimating different relative female scaling factors for each of the three periods.

[1] Note that 2007 refers to the split season 2007/08 for example

For Inaccessible, a further model (Model 3) was explored. After examining the CAL residuals from Model 2 it was clear that there was a misfit for males for the most recent few years, so Model 2 was extended to allow for an extra male "mu" for the 2006+ period to form "Model 3".

[Note that the results presented all assume NO impact on the resource from the Oliva incident.]

The time periods assumed for these selectivity periods in these assessments are:

Inaccessible		**Nightingale**	**Gough**	**Tristan**
Model 2	*Model 3*	*Model 2*	*Model 2*	*Model 2*
1990-2000	1990-2000	1990-1999	1990-2001	1990-2000
2001-2003	2001-2003	2000-2006	2002-2006	2001-2005
2004+	2004-2005	2007+	2007+	2006+
	2006+			

For both Gough and Nightingale, two alternate growth models are used – the Pollock growth model and the James Glass growth model (see Johnston and Butterworth 2011a for further details).

Results

Inaccessible

Table 1 reports the Inaccessible assessment results. It is clear that Model 2 is not AIC preferred, but rather Model 3. The CAL residuals for Model 3 are particularly much improved and reasonably fitted. Model 3 is thus selected as the Reference Case model. Note though that the recent high discard levels are not reproduced by the model (Figure 1a). Time varying selectivity is required in order to be able to reflect the high observed CPUE values for 2004 and 2005. Poor recruitment is estimated to have occurred around the turn of the century. Nevertheless, B_{sp}/K is high at 0.89. Recent declines in both longline and powerboat CPUE are evident.

Nightingale

Table 2 reports the Nightingale assessment results. For the Pollock growth model, Model 2 is AIC preferred (to time invariant Model 1) and is thus an obvious choice for the Reference Case model. For the James Glass growth model, Model 2 is not AIC preferred, but it is suggested nonetheless to choose that for the Reference Case (consistency and improves CPUE fit).

There are good model fits to longline CPUE (Figure 2a), and the powerboat CPUE is compatible with model estimates. The CAL data are reasonably fit, though the model consistently overpredicts the number of males in the smallest size class. There is an indication of discards being higher than predictions for the last two years. The status of the resource is good (B_{sp}/K is high at 0.75-0.77). Results are very similar for the two different growth models, except that poor recruitment comes later under the James Glass growth model.

Gough

Table 3 reports the Gough assessment results. For both growth models, neither time varying selectivity models (Model 2) are AIC preferred although there really is not much difference between the results for Models 1 and 2. Hence Model 2 is selected for the Reference Case (to be consistent with other islands).

There is a good fit to longline CPUE (except that the model does not reflect the 2009 "peak"), and the powerboat CPUE is compatible with model estimates. The CAL data are reasonably fit, although the model consistently overpredicts the number of males in the smallest size class. The model fails to reflect the high discard level over the 1990s. The status of the resource is good (B_{sp}/K is high at 0.82-0.88). Results are very similar for the two different growth models, except that good recruitment comes later under the James Glass growth model.

Tristan

Table 4 reports the Tristan assessment results. Model 2 is AIC preferred (remember the time varying selectivity here applies to the female scalar). Model 2 is selected as the Reference Case. There is a good fit to longline CPUE, though data indicates a faster decline over the last five years compared to the model. The CAL data are reasonably fit, though the model consistently overpredicts the number of males in the smallest and largest size classes. The status of the resource is good (B_{sp}/K is high at 0.85), despite the period of poor recruitment in the early 2000s.

References

Johnston, S.J. and D.S. Butterworth. 2011. The Age-structured Production Modelling approach for assessment of the Rock Lobster Resources at the Tristan da Cunha group of islands, MARAM/Tristan/2011/Dec/19.

Johnston, S.J. and D.S. Butterworth. 2012. Data used in the 2012 assessments of the Rock Lobster Resources at the Tristan da Cunha group of islands, MARAM/Tristan/2012/JUL/11.

Table 1: Inaccessible assessment results.

	Model 1 Time invariant selectivity	**Model 2 Time varying selectivity (3 male mu's)**	**Model 3 Time varying selectivity (4 male mu's)**
	F_{2009}=0.3	**F_{2009}=0.3**	**F_{2009}=0.3**
K	1211	1311	1480
h	0.99	1.00	0.95
M	0.2	0.2	0.2
d (discard mortality rate)	0.1	0.1	0.1
σ_{length}	0.2	0.2	0.2
F_{2009} fixed at	0.3	0.3	0.3
Male selectivity μ 90-00	0.029	0.008	0.010
Male selectivity μ 01-03	0.029	0.021	0.022
Male selectivity μ 04-05	0.029	0.038	0.007
Male selectivity μ 06+	0.029	0.038	0.055
Female selectivity μ 90-00	0.180	0.142	0.141
Female selectivity μ 01-03	0.180	0.179	0.179
Female selectivity μ 04+	0.180	0.207	0.205
θ	0.348	0.245	0.221
L_{∞}^{m}	125	125	125
L_{∞}^{f}	90	90	90
-lnL total	-8.72	-11.15	-18.09
-lnL CPUE	-9.99	-9.03	-14.63
-lnL CAL	-12.07	-47.57	-52.78
SR1 pen	1.00	1.39	0.78
-lnL discard	2.14	1.92	1.77
Bsp(1990)/Ksp	0.31	0.22	0.20
Bsp(2010)/Ksp	0.81	0.82	0.84
Bsp(2011)/Ksp	0.85	0.86	0.85
Bsp(2012)/Ksp	0.89	0.90	0.89
Bsp(2010)/Bsp(1990)	2.61	3.75	4.24
Bsp(2011)/Bsp(1990)	2.74	3.95	4.34
Bsp(2012)/Bsp(1990)	2.88	4.14	4.49
AIC	34.56	37.70	25.82
Bexp(2011)/Bexp(1990)	2.16	1.72	1.68
Program (inac.tpl; xinac.tpl)	12.rep	I1.rep	I3.rep

Table 2: Nightingale assessment results.

Somatic growth rate option	**"Pollock"**		**"James Glass"**	
	Model 1 Time invariant selectivity*	**Model 2 Time varying selectivity**	**Model 1 Time invariant selectivity**	**Model 2 Time varying selectivity**
	F_{2009}=0.3	**F_{2009}=0.3**	**F_{2009}=0.3**	**F_{2009}=0.3**
K	761	762	415	435
h	0.98	0.98	1.00	1.00
M	0.2	0.2	0.2	0.2
d (discard mortality rate)	0.1	0.1	0.1	0.1
σ_{length}	0.2	0.2	0.2	0.2
F_{2009} fixed at	0.3	0.3	0.3	0.3
Male selectivity μ 1990-99	0.025	0.024	0.030	0.013
Male selectivity μ 2000-06	0.025	0.000	0.030	0.017
Male selectivity μ 2007+	0.025	0.025	0.030	0.038
Female selectivity μ 1990-99	0.119	0.097	0.102	0.072
Female selectivity μ 2000-06	0.119	0.112	0.102	0.101
Female selectivity μ 2007+	0.119	0.119	0.102	0.100
θ	0.455	0.455	0.346	0.285
L_{∞}^{m}	150	150	147	147
L_{∞}^{f}	90	90	99	99
-lnL total	-8.41	-15.73	-16.33	-18.87
-lnL CPUE	-14.44	-15.69	-17.92	-20.14
-lnL CAL	7.88	-28.02	-25.17	-19.82
SR1 pen	1.43	1.41	1.82	1.28
-lnL discard	1.98	2.00	2.95	2.64
Bsp(1990)/Ksp	0.40	0.40	0.31	0.25
Bsp(2010)/Ksp	0.71	0.72	0.66	0.68
Bsp(2011)/Ksp	0.73	0.74	0.69	0.70
Bsp(2012)/Ksp	0.77	0.77	0.75	0.75
Bsp(2010)/Bsp(1990)	1.78	1.80	2.15	2.68
Bsp(2011)/Bsp(1990)	1.81	1.83	2.23	2.75
Bsp(2012)/Bsp(1990)	1.91	1.93	2.42	2.95
AIC	35.18	28.54	19.34	22.26
Bexp(2011)/Bexp(1990)	1.36	1.28	1.96	1.60
Program (nightjg.tpl, nightp.tpl Xnightjg.tpl, xnighp.tpl)	N4.rep	N2.rep	N3.rep	N1.rep

*Not fully converged

Table 3: Gough assessment results.

Somatic growth rate option	**"Pollock"**		**"James Glass"**	
	Model 1 Time invariant selectivity	**Model 2 Time varying selectivity**	**Model 1 Time invariant selectivity***	**Model 2 Time varying selectivity**
	F_{2009}=0.3	**F_{2009}=0.3**	**F_{2009}=0.3**	**F_{2009}=0.3**
K	1058	988	440	429
h	0.95	0.95	0.96	0.96
M	0.2	0.2	0.2	0.2
d (discard mortality rate)	0.1	0.1	0.1	0.1
σ_{length}	0.2	0.2	0.2	0.2
F_{2009} fixed at	0.3	0.3	0.3	0.3
Male selectivity µ 90-01	0.000	0.004	0.000	0.000
Male selectivity µ 02-06	0.000	0.000	0.000	0.000
Male selectivity µ 07+	0.000	0.015	0.000	0.009
Female selectivity µ 90-01	0.096	0.085	0.066	0.065
Female selectivity µ 02-06	0.096	0.100	0.066	0.066
Female selectivity µ 07+	0.096	0.062	0.066	0.050
θ	0.633	0.684	0.654	0.675
L_∞^m	150	150	147	147
L_∞^f	90	90	99	99
-lnL total	1.09	-0.19	-1.68	-2.18
-lnL CPUE	-10.60	-11.63	-12.31	-12.65
-lnL CAL	69.60	86.79	63.84	66.73
SR1 pen	2.45	0.59	1.69	1.28
-lnL discard	2.97	2.80	3.13	3.03
Bsp(1990)/Ksp	0.56	0.60	0.58	0.60
Bsp(2010)/Ksp	0.92	0.87	0.85	0.83
Bsp(2011)/Ksp	0.93	0.88	0.85	0.83
Bsp(2012)/Ksp	0.92	0.88	0.84	0.82
Bsp(2010)/Bsp(1990)	1.66	1.45	1.45	1.37
Bsp(2011)/Bsp(1990)	1.66	1.46	1.45	1.37
Bsp(2012)/Bsp(1990)	1.65	1.45	1.44	1.36
AIC	54.18	59.62	48.64	55.64
Bexp(2011)/Bexp(1990)	0.81	0.76	0.58	0.56
Programs (goughjg.tpl, goughp,tpl,xgoughjg,tpl, xgoughp.tpl)	G4.rep	G2.rep	G3.rep	G1.rep

*Not fully converged

Table 4: Tristan assessment results.

	Model 1 Time invariant selectivity	**Model 2 Time varying selectivity (with female scalar)**
	F_{2009}=0.3	**F_{2009}=0.3**
K	1711	1685
h	1.00	1.00
M	0.2	0.2
d (discard mortality rate)	0.1	0.1
σ_{length}	0.2	0.2
F_{2009} fixed at	0.3	0.3
Male selectivity μ	0.026	0.008
Female selectivity μ	0.154	0.145
Female scalar 1990-00	0.356	0.679
Female scalar 2001-05	0.356	0.330
Female scalar 2006+	0.356	0.185
θ	0.340	0.287
L_∞^m	125	125
L_∞^f	90	90
-lnL total	-15.53	-19.18
-lnL CPUE	-23.77	-25.38
-lnL CAL	68.02	46.71
SR1 pen	2.09	2.19
Bsp(1990)/Ksp	0.30	0.26
Bsp(2010)/Ksp	0.78	0.82
Bsp(2011)/Ksp	0.78	0.83
Bsp(2012)/Ksp	0.80	0.85
Bsp(2010)/Bsp(1990)	2.57	3.19
Bsp(2011)/Bsp(1990)	2.59	3.24
Bsp(2012)/Bsp(1990)	2.63	3.30
AIC	20.94	17.64
Bexp(2011)/Bexp(1990)	1.52	1.52
Program (Tristan.tpl)	T1.rep	T3.rep

Figure 1a: Inaccessible model fits comparing Model 1 (time invariant selectivity) with Model 2 (time-varying selectivity).

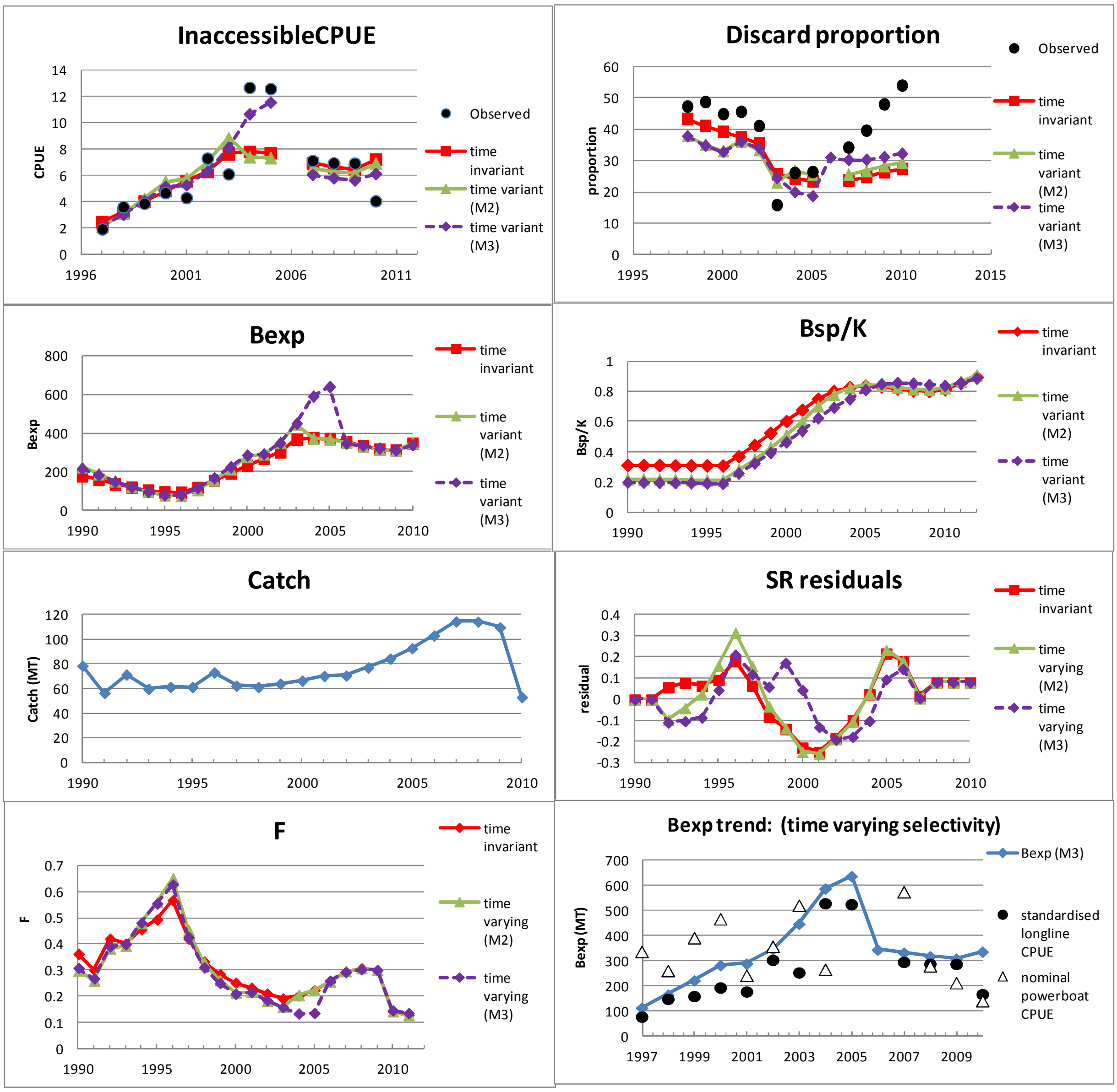


Figure 1b: Inaccessible selectivity functions for all three models (time invariant, time variant M2 and time variant M3).

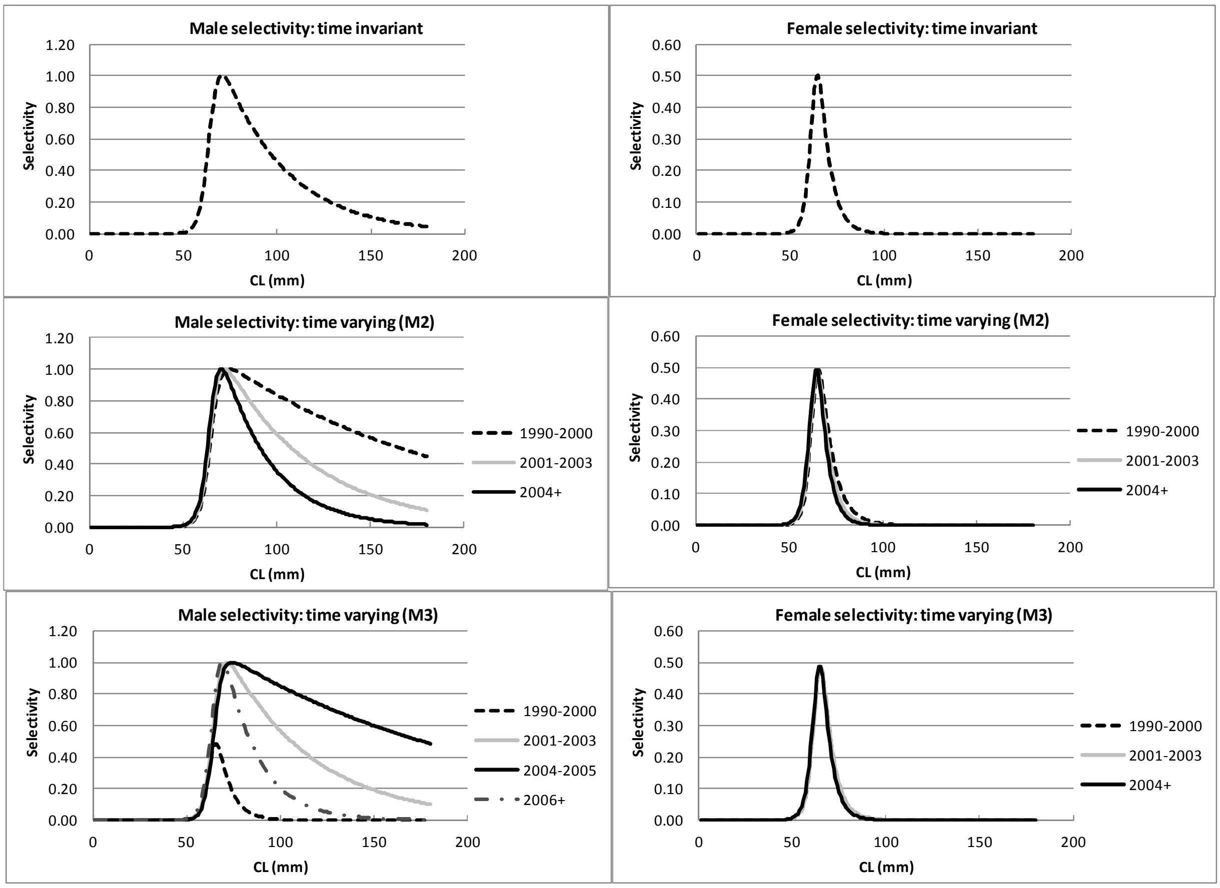
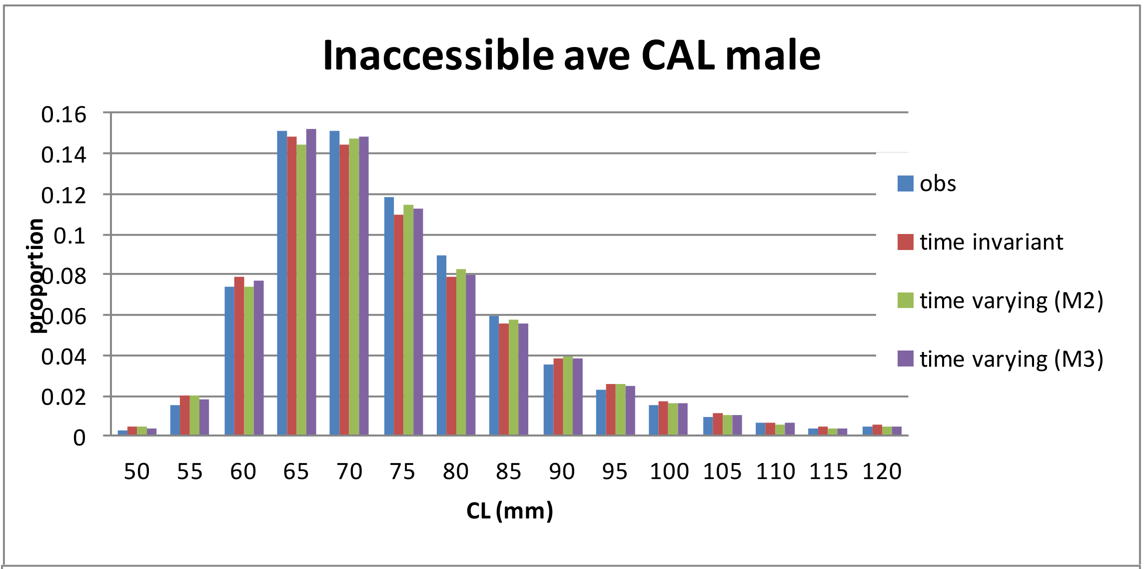


Figure 1c: Inaccessible average CAL fits for comparing Model 1 (time invariant), Model 2 and 3 fits.



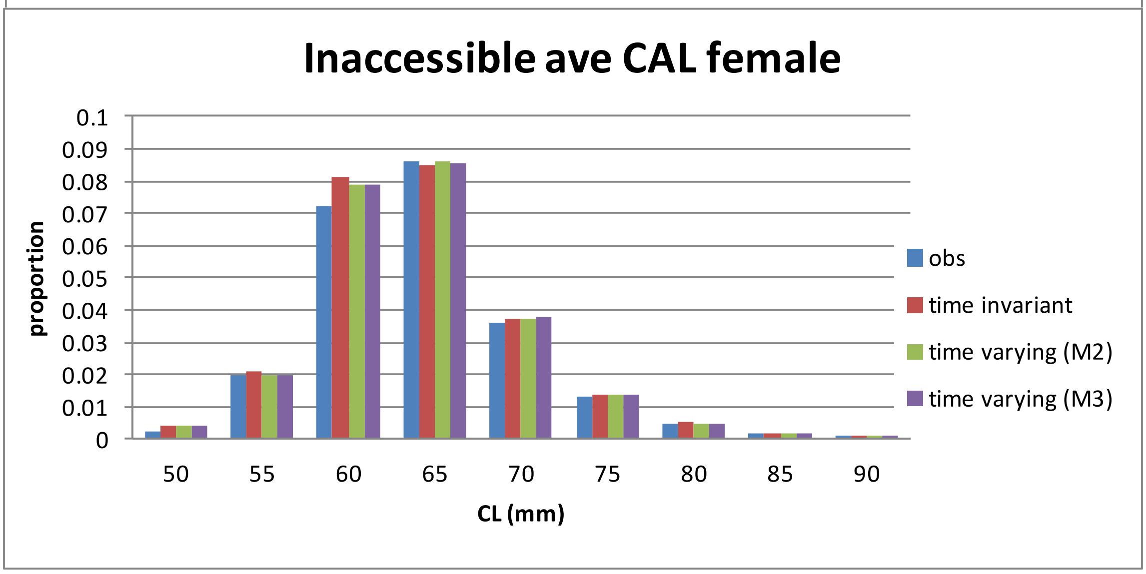


Figure 1d: Inaccessible standardised CAL residuals comparing Model 1, Model 2 and Model 3. The dark bubbles reflect positive and the light bubbles negative residuals, with the bubble radii proportional to the magnitudes of the residuals.

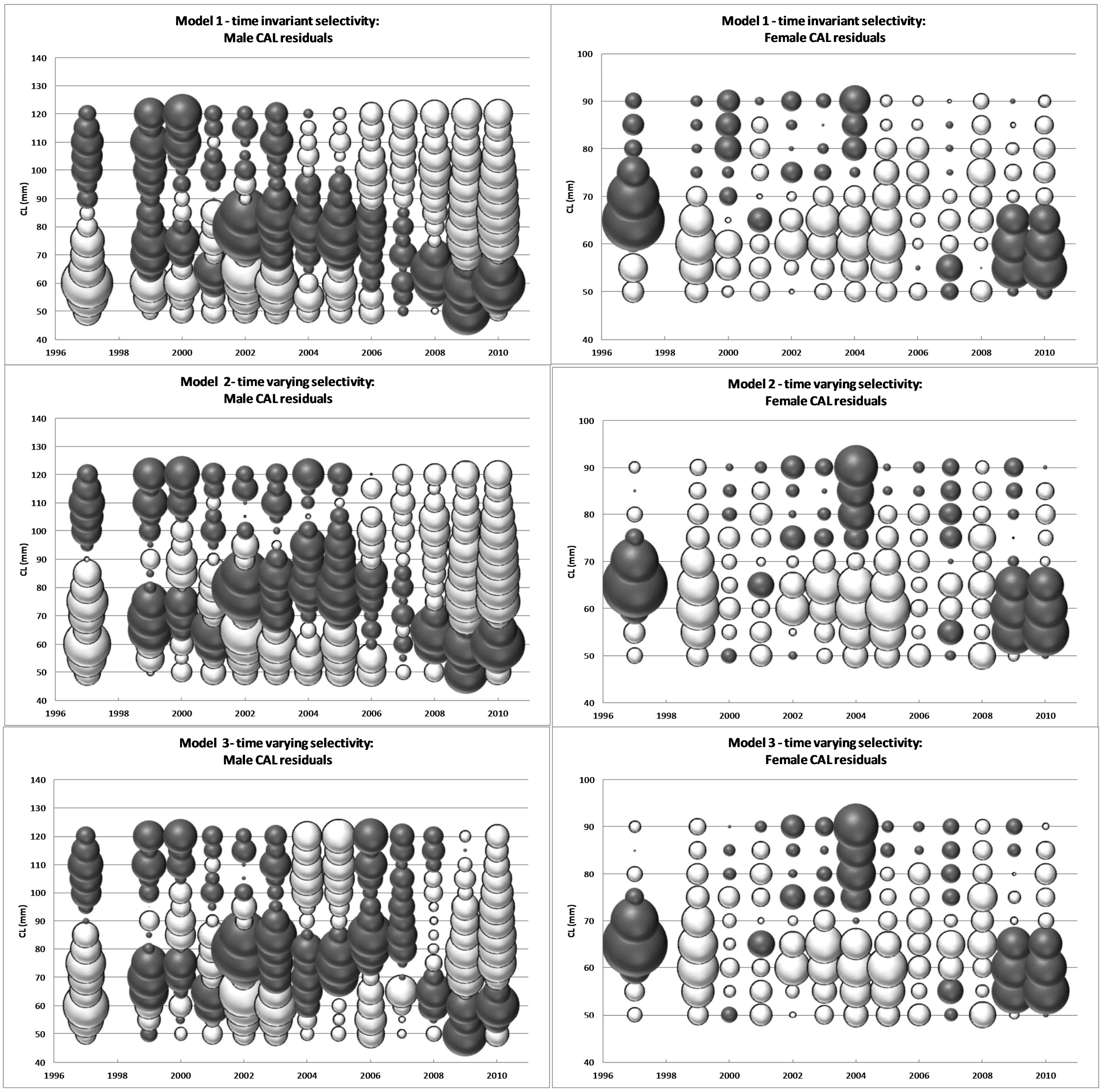


Figure 2a: Nightingale model fits for Model 2 time-varying selectivity comparing the “Pollock” and “James Glass” growth models.

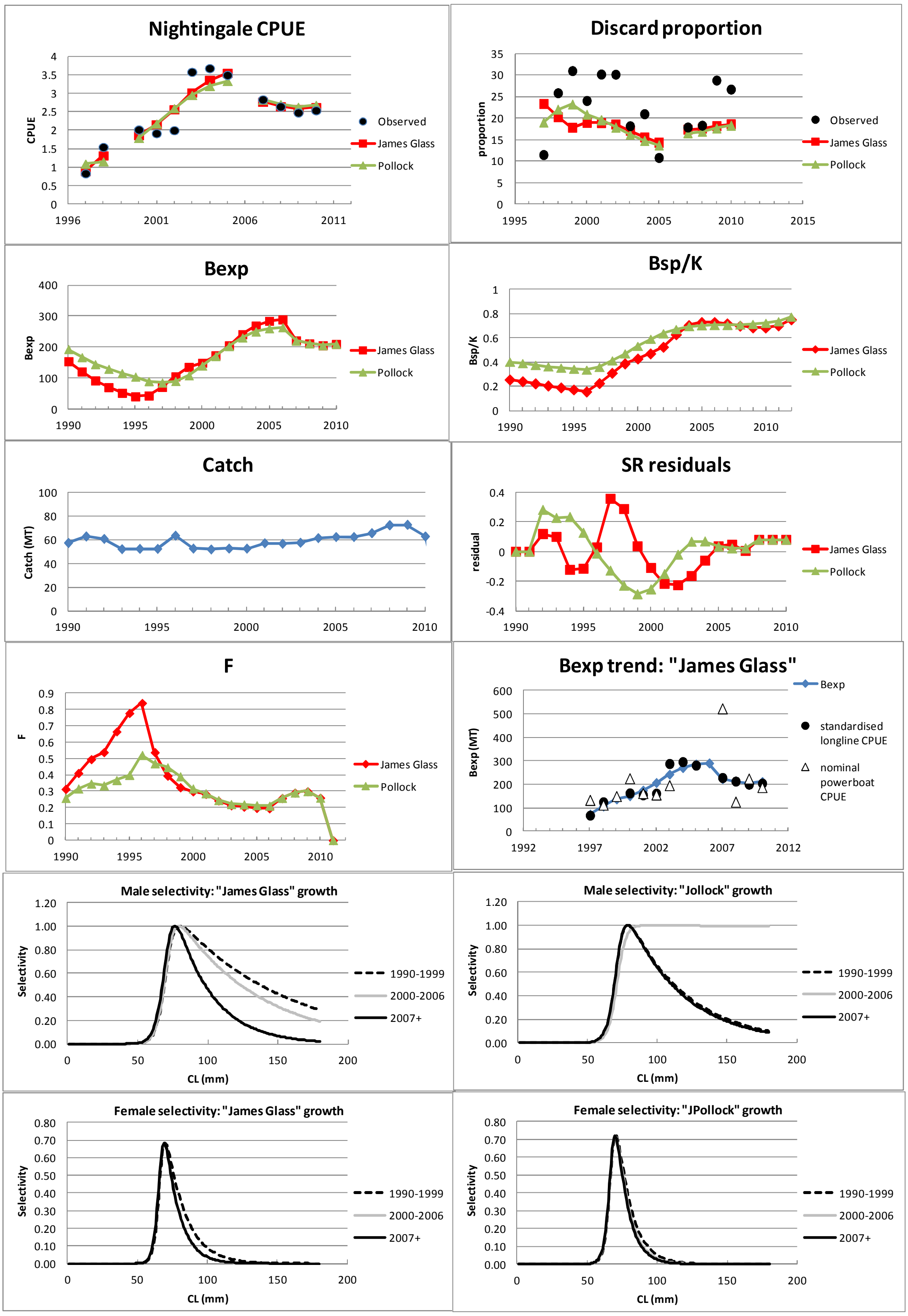
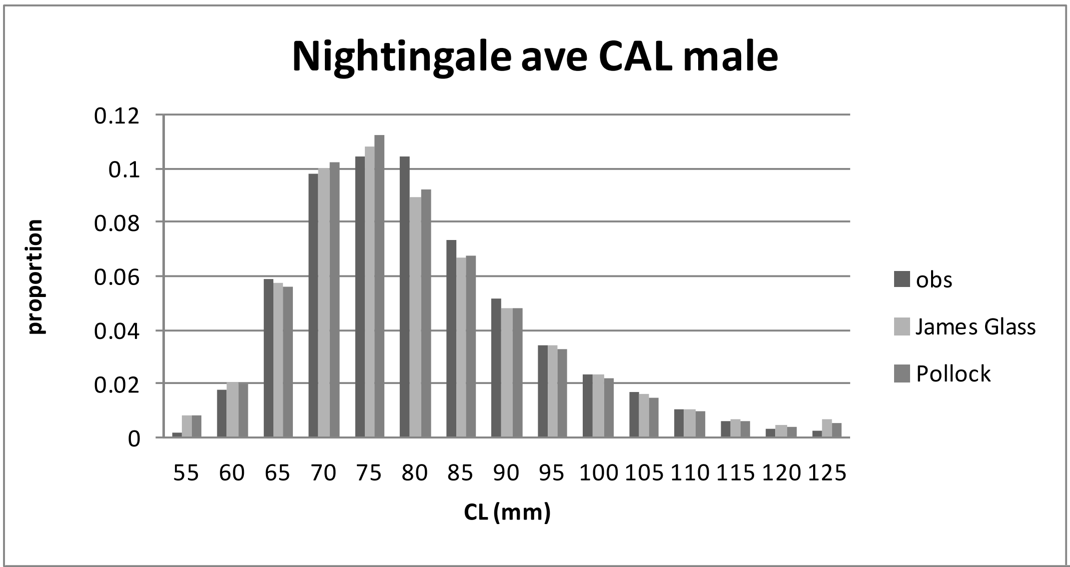


Figure 2b: Nightingale average CAL fits for Model 2 time-varying selectivity comparing the “Pollock” and “James Glass” growth models.



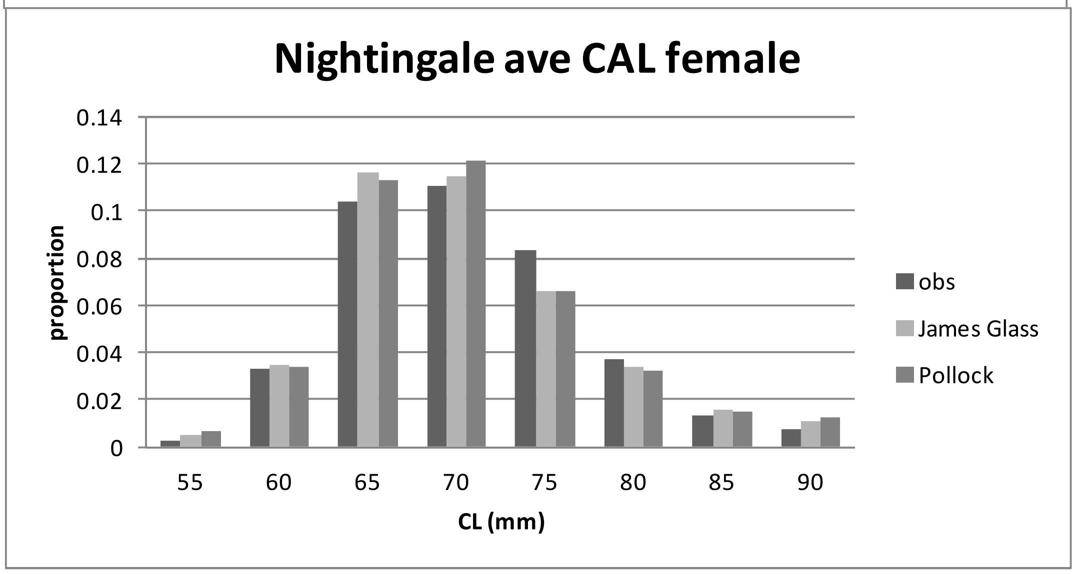


Figure 2b: Nightingale standardized CAL residuals for Model 2 (time-varying selectivity) for both the "Pollock" and "James Glass" growth models. The dark bubbles reflect positive and the light bubbles negative residuals, with the bubble radii proportional to the magnitudes of the residuals.

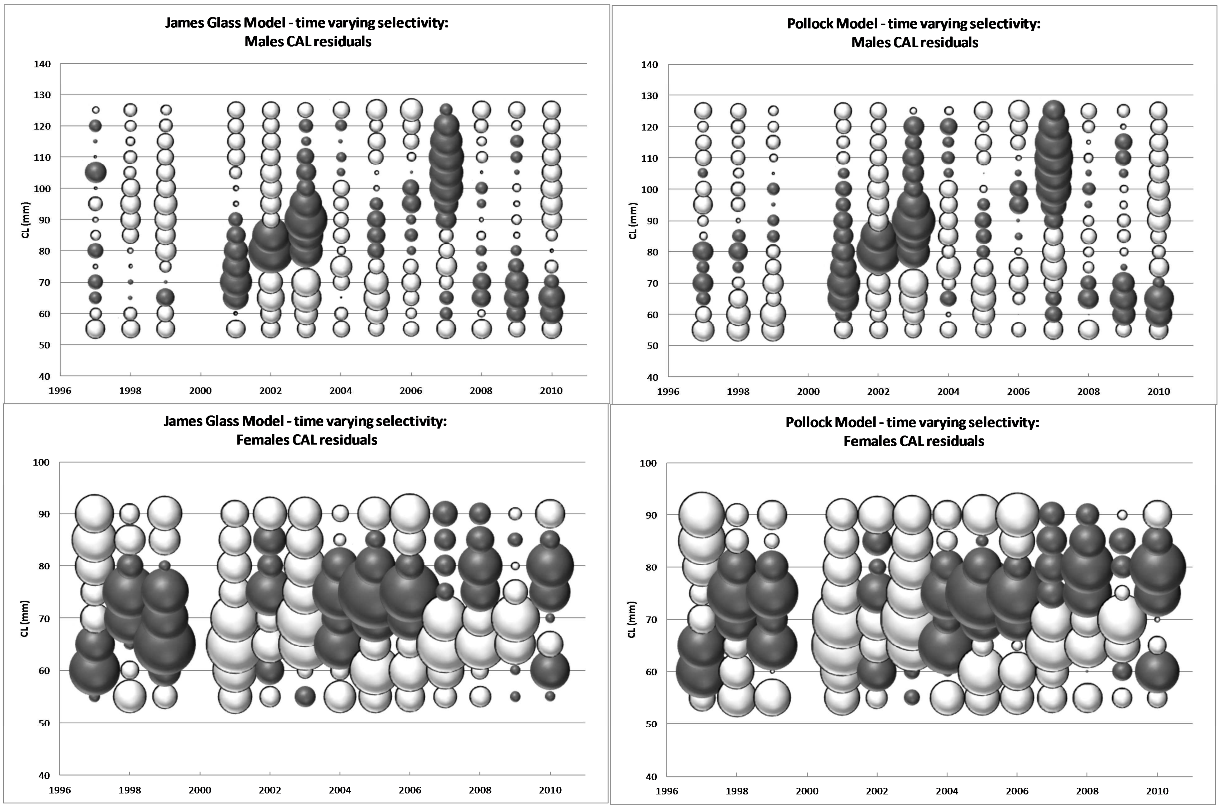


Figure 3: Gough Model 2 (time varying selectivity) results for both Pollock and James Glass models.

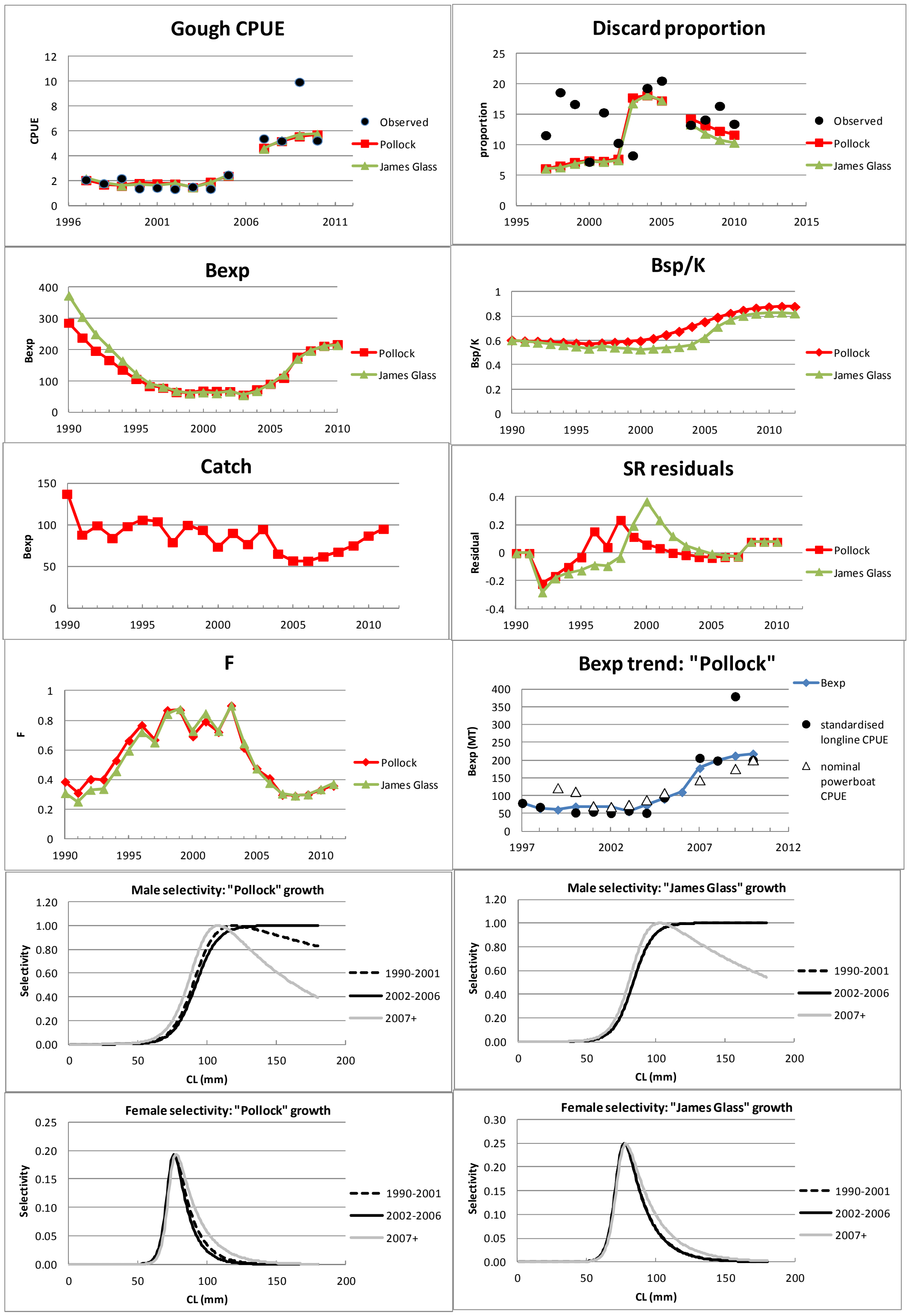
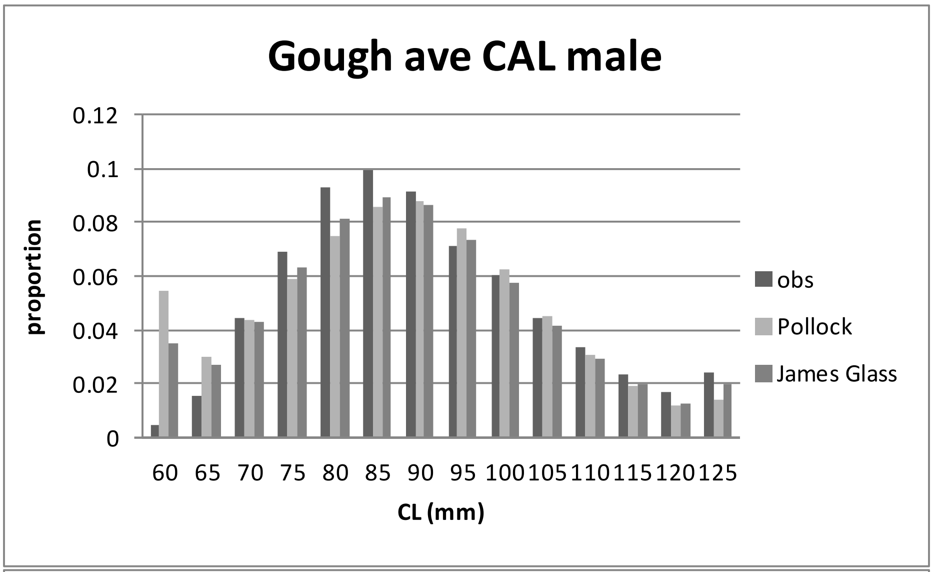


Figure 3b: Gough average CAL fits for Model 2.



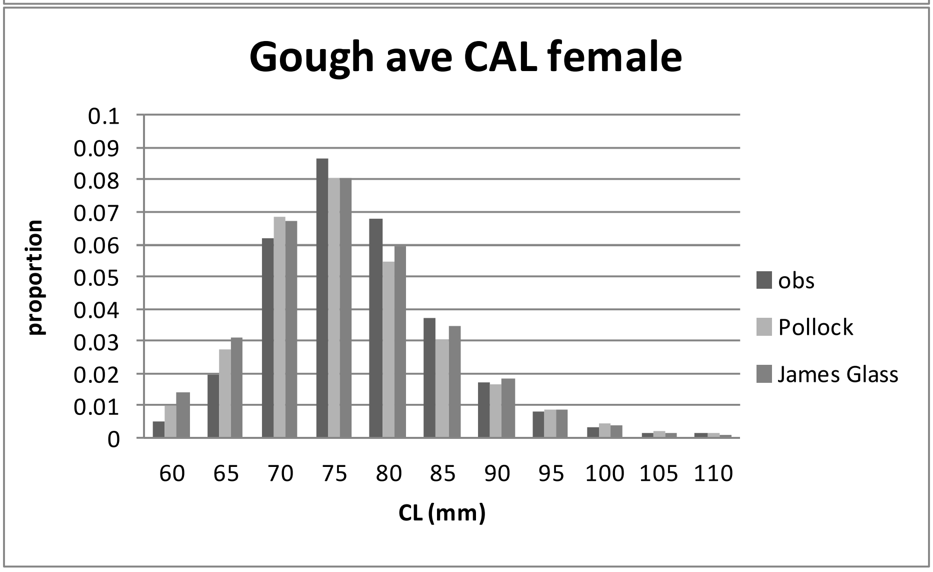


Figure 3c: Gough standardized CAL residuals for Model 2. The dark bubbles reflect positive and the light bubbles negative residuals, with the bubble radii proportional to the magnitudes of the residuals.

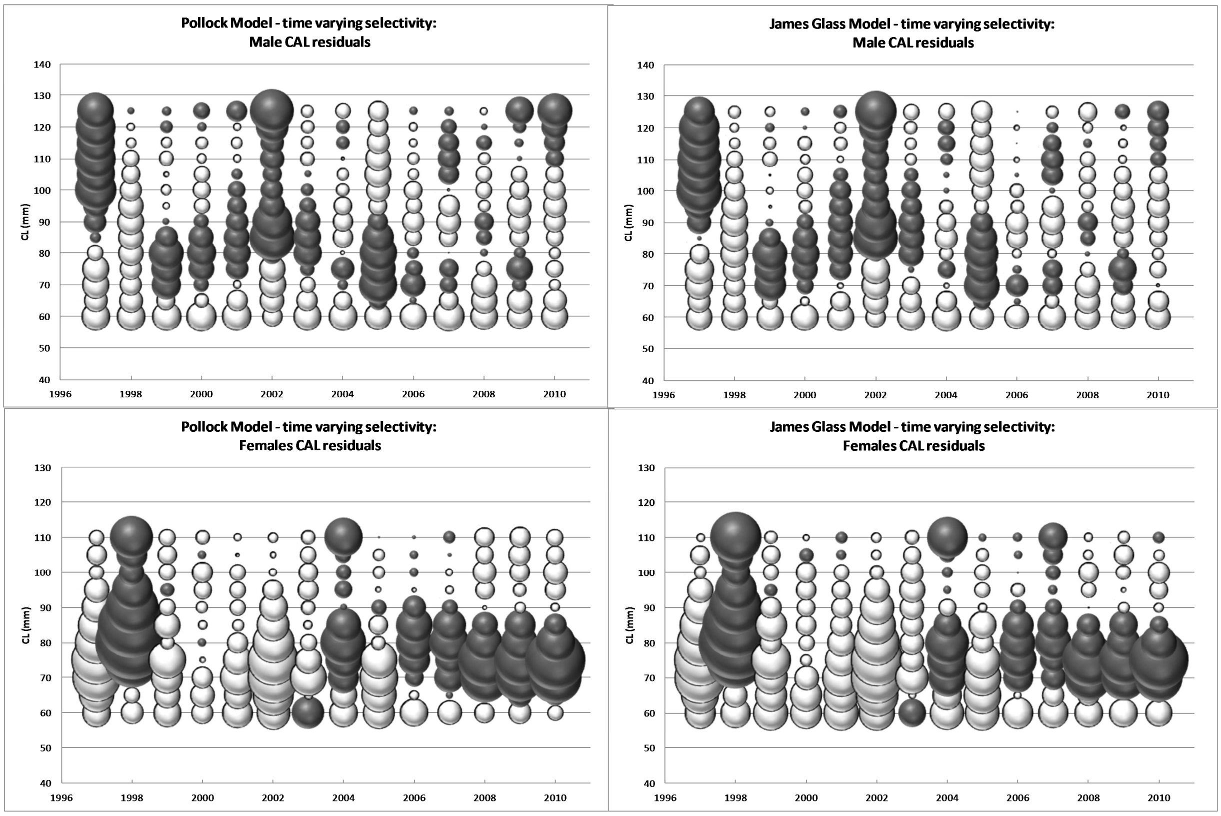


Figure 4a: Tristan model results.

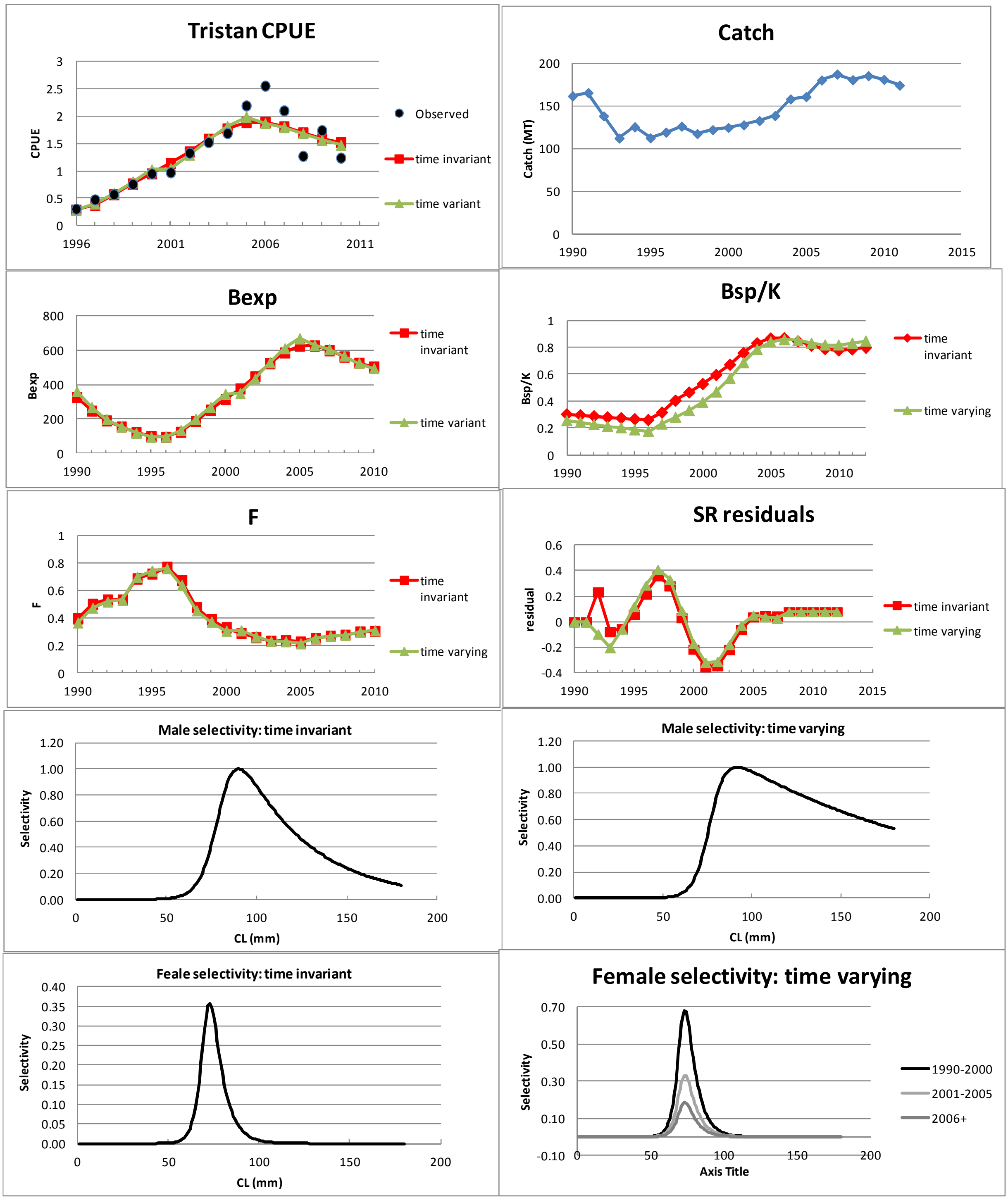
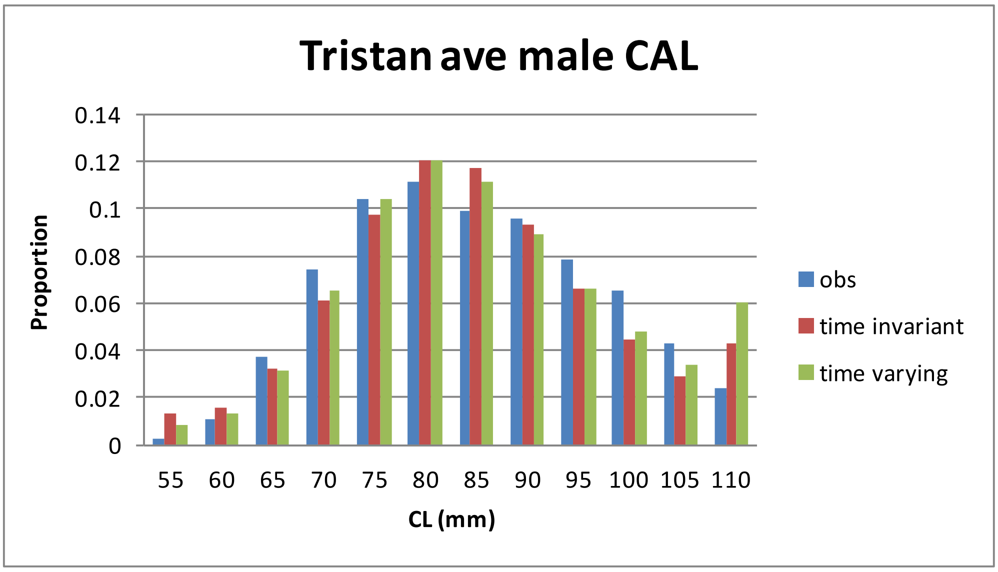


Figure 4b: Tristan average CAL results.



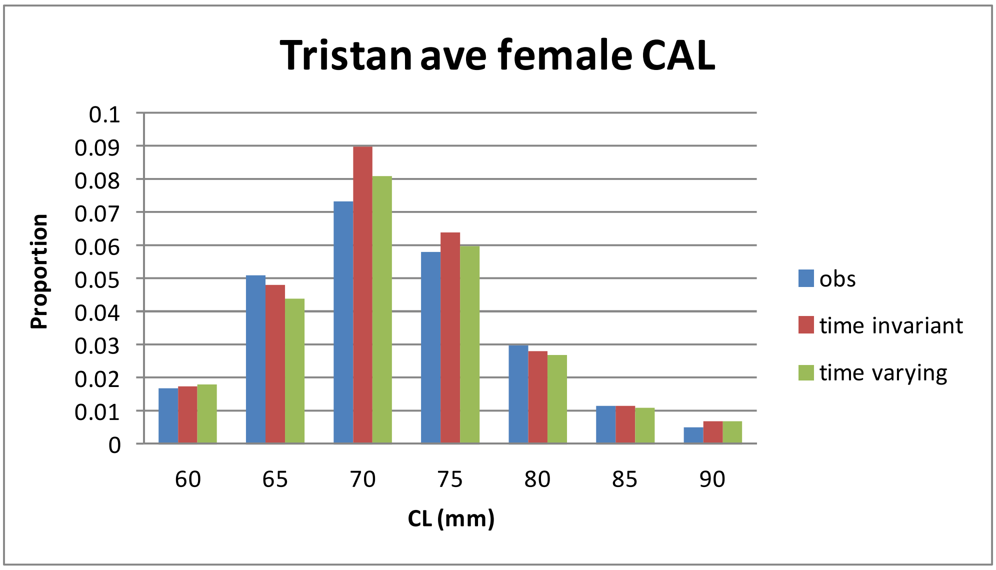


Figure 4b: Tristan standardized CAL residuals. The dark bubbles reflect positive and the light bubbles negative residuals, with the bubble radii proportional to the magnitudes of the residuals.