Updates to the 2011 Tristan da Cunha group of islands assessment models and final assessment results

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New data

Johnston and Butterworth (2011a and b) provided input data and stock assessment details for the Tristan da Cunha group of islands. Recently, three further year's catch-at-length data have become available and are listed here (Tables 1a-d).

The authors have also used the longline catch-and-effort database from the three outer islands to calculate a "discard percentage" for each season 1997-2008. These data are listed in this document (Table 2).

Alternate somatic growth rate data for Gough and Nightingale Islands

Johnston and Butterworth (2011c) summarise growth rate data and analyses available for the Tristan da Cunha group of islands. A task group met to discuss these and recommended that for Gough and Nightingale males, both the existing "Pollock" as well as the "James Glass" growth data should be explored in the assessments.

Model updates

Time-varying-selectivity

Model 1 variants have no time varying selectivity. Model assessment models were modified so that selectivity function can change over time. For each model, three period of selectivity are 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** (m and f separately) of the selectivity function for each of the different time period, although for Tristan this is effected by estimating different relative female scaling factors for each of the three period. [See Johnston and Butterworth (2011b) equations 21 and 32]. The time periods assumed for these selectivity periods in these assessments are:

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

These periods were selected based on examination of residual plots of the catch-at-length data.

Discard Proportion

From the catch and effort data base upon which the CPUE GLM was based, we have data on the estimated weight of discards for each pull. What I have thus done is calculate a discard percentage, *D*, where:

D=(weight lobsters discarded)/(weight of lobsters discarded + retained) *100.

$\widehat{D}$ is calculated in the model for each year, and this information is added to the likelihood as follows:

$$-lnL = -lnL + \sum_y \frac{(lnD_y^{obs} - ln\widehat{D}_y)^2}{2CV^2} \text{ where CV=0.8.}$$

[Note *d* – the discard mortality rate, which relates to mortality rate of discarded lobsters, is set equal to 0.1 in the model.]

Stock-recruit function residuals

Due to the availability of three further years' of catch-at-length data, the number of stock-recruit residuals that can be estimated in the model fit can be increased. Residuals for the 1992-2005 period are now estimated (see Johnston and Butterworth (2011b) equation 39). Future recruitment residuals (2006+) are set equal to 0.08 (the expected recruitment level), although these residuals will only come into play in the projections of the resource due to the time delay between recruitment and legal sized lobsters.

Weighting of CPUE and catch-at-length data in the likelihood

The catch-at-length data are down-weighted by a factor of 0.1 in the likelihood function

Assessment results

Results presented here compare assessments for which selectivity it assumed time invariant, with those for which selectivity is allow to vary over time. Note that in all model the 2009 catch-at-length data was EXCLUDED from the likelihood owing to the fact that these data appear anomalous with prior catch-at-length data. Model estimated values for 2009 catch-at-length are however provided for comparative purposes. Results were initially examined for a range of F_{2009} (0.2, 0.3, and 0.4) and CV for D (0.8, 0.6, 0.5). Here results for F_{2009}=0.3 and *D* CV=0.8 only are presented. It was found that F_{2009} value larger than 0.3 would result in F values for earlier years that would hit the upper boundary of 0.90 set for *F*, and lower values of F2009 produced deteriorating fits to data. Lower values than 0.8 of the *D* CV value were also associated with a deterioration to the data (particularly catch-at-length data).

Inaccessible

Table 3 reports the assessment results for both the time invariant (Model 1) and time-varying selectivity (Model 2). Model 2 clearly provides a better fit to all the data and hence is selected as the baseline model to be used for management purposes. Figures 1a-b report the both model fits to the data and estimated quantities.

Nightingale

Table 4 reports the assessment results for both the time invariant (Model 1) and time-varying selectivity (Model 2) for the "Pollock" growth rate, and for Model 2 for the "James Glass" growth rate. Figures 2a-b report the Model 2 fits to the data and estimated quantities for both growth rates. In Figure 2a it is evident that the "James Glass" model provides a better fit to the recent CPUE trend.

Gough

Table 5 reports the assessment results for both the time invariant (Model 1) and time-varying selectivity (Model 2) for the "Pollock" growth rate, and for Model 2 for the "James Glass" growth rate. Figures 3a-b report the Model 2 fits to the data and estimated quantities for both growth rates. The "James Glass" Model 2 provide the best fit to the data (see Table 5) and the –lnL values are improved for all data sources. In Figure 3a it is evident that the "James Glass" model provides a slightly fit to the recent CPUE trend.

Tristan

Table 6 reports the assessment results for both the time invariant (Model 1) and time-varying selectivity (Model 2). Figures 4a-b report the Model 1 and Model 2 fits to the data and estimated quantities.

References

Johnston, S.J. and D.S. Butterworth. 2011a. Data available for input to an age-structured production model of the Tristan fishery. MARAM document, MARAM/TRISTAN/2011/Feb/01. 14pp.

Johnston, S.J. and D.S. Butterworth. 2011b. The age-structured production modelling approach for assessment of the rock lobster resources at the Tristan da Cunha group of islands. MARAM document, MARAM/TRISTAN/2011/Feb/02. 9pp.

Johnston, S.J. and D.S. Butterworth. 2011c. Summary of growth rate data and analyses available for the Tristan da Cunha group of islands. MARAM document, MARAM/TRISTAN/2011/Jun/09. 8pp.

Table 1a: New 2007-2009 catch-at-length data for Inaccessible Island.

	MALES	MALES	MALES	FEMALES	FEMALES	FEMALES
	2007	2008	2009	2007	2008	2009
55	0.179	0.240	0.063	3.416	2.225	5.227
60	1.157	2.661	2.167	1.675	2.240	3.292
65	3.330	6.701	7.606	9.432	6.321	7.814
70	6.281	8.662	11.857	13.559	8.322	9.606
75	8.415	8.002	10.898	10.409	7.261	8.773
80	9.392	7.361	8.981	3.848	3.961	5.230
85	8.295	5.501	5.835	0.897	1.960	2.125
90	6.461	6.281	4.438	0.105	0.022	0.110
95	6.122	5.281	3.501			
100	4.506	5.381	2.667			
105	2.672	4.261	1.563			
110	1.695	3.361	0.813			
115	0.778	2.340	0.563			
120	0.319	1.200	0.208			
125	0.227	0.222	0.110			

Table 1b: New 2007-2009 catch-at-length data for Nightingale Island.

	MALES	MALES	MALES	FEMALES	FEMALES	FEMALES
	2007	2008	2009	2007	2008	2009
55	0.240	0.063	0.587	0.340	0.396	0.604
60	2.661	2.167	3.502	2.240	3.292	3.751
65	6.701	7.606	8.996	6.321	7.814	9.316
70	8.662	11.857	13.333	8.322	9.606	8.071
75	8.002	10.898	11.787	7.261	8.773	6.080
80	7.361	8.981	8.782	3.961	5.230	3.431
85	5.501	5.835	5.778	1.960	2.125	1.778
90	6.281	4.438	3.911	1.500	1.438	1.102
95	5.281	3.501	2.898			
100	5.381	2.667	1.938			
105	4.261	1.563	1.547			
110	3.361	0.813	1.280			
115	2.340	0.563	0.924			
120	1.200	0.208	0.320			
125	0.860	0.167	0.284			

Table 1c: New 2007-2009 catch-at-length data for Gough Island.

	MALES	MALES	MALES	FEMALES	FEMALES	FEMALES
	2007	2008	2009	2007	2008	2009
60	0.640	0.143	0.090	0.096	0.204	0.135
65	2.241	0.653	0.790	1.649	1.572	2.009
70	6.323	1.919	5.416	6.195	8.532	8.147
75	8.724	5.348	9.659	7.892	11.880	11.081
80	8.532	8.634	8.802	7.524	7.001	6.906
85	7.444	10.941	7.154	4.514	3.858	4.288
90	5.891	11.798	6.567	2.049	1.755	1.647
95	5.699	7.695	5.304	0.944	0.714	0.880
100	6.339	5.368	5.213	0.512	0.204	0.316
105	6.099	3.776	3.995	0.288	0.143	0.045
110	4.594	2.674	3.611	0.304	0.082	0.068
115	2.769	2.592	2.437			
120	1.457	1.266	1.738			
125	1.281	1.245	3.701			

Table 1d: New 2007-2009 catch-at-length data for Tristan Island.

	MALES	MALEs	MALES	FEMALES	FEMALES	FEMALES
	2007	2008	2009	2007	2008	2009
55	0.050	0.080	0.230			
60	0.050	0.581	1.889	0.397	0.481	1.820
65	0.843	3.084	5.991	0.744	1.802	3.157
70	2.133	7.669	8.894	0.992	3.604	5.069
75	4.762	11.794	9.770	0.546	3.885	4.700
80	7.192	14.077	9.493	0.198	2.002	3.134
85	10.218	13.036	8.848	0.099	0.781	1.313
90	12.599	13.116	9.055	0.050	0.260	0.806
95	14.335	10.533	8.641			
100	14.931	7.589	8.018			
105	14.534	3.624	5.876			
110	5.754	2.002	3.295			

Table 2: Discard percentages for Inaccessible, Nightingale and Gough islands.

	Inaccessible	Nightingale	Gough
1997	-	11.44	11.56
1998	47.18	25.79	18.62
1999	48.61	30.93	16.68
2000	44.74	24.00	7.19
2001	45.48	30.12	15.31
2002	40.97	30.09	10.29
2003	15.78	18.14	8.23
2004	26.01	20.92	19.31
2005	26.31	10.77	20.53
2006	-	-	-
2007	34.1	17.83	13.26
2008	39.49	18.26	14.12

Table 3: Inaccessible assessment results.

	Model 1 Time invariant selectivity	**Model 2 Time varying selectivity**
	F_{2009}=0.3	**F_{2009}=0.3**
K	1174	1327
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 90-00	0.027	0.020
Male selectivity μ 01-03	0.027	0.011
Male selectivity μ 04+	0.027	0.042
Female selectivity μ 90-00	0.183	0.151
Female selectivity μ 01-03	0.183	0.154
Female selectivity μ 04+	0.183	0.215
θ	0.305	0.250
L_∞^m	125	125
L_∞^f	90	90
-lnL total	-11.95	-21.31
-lnL CPUE	-11.53	-14.25
-lnL CAL	-45.67	-84.61
SR1 pen	1.72	1.63
-lnL discard	3.08	0.43
Bsp(1990)/Ksp	0.27	0.22
Bsp(2010)/Ksp	0.85	0.87
Bsp(2011)/Ksp	0.87	0.89
Bsp(2010)/Bsp(1990)	3.11	3.91
Bsp(2011)/Bsp(1990)	3.19	3.98
Bexp(2010)/Bexp(1990)	0.90	2.11
Program (snewi.tpl)	Snewix.rep	Sn2.rep

Table 4: Nightingale assessment results.

Somatic growth rate option	**"Pollock"**	**"Pollock"**	**"James Glass"**
	Model 1 Time invariant selectivity	**Model 2 Time varying selectivity**	**Model 2 Time varying selectivity**
	F_{2009}=0.3	**F_{2009}=0.3**	**F_{2009}=0.3**
K	732	781	456
h	0.961	0.920	0.948
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 1990-99	0.0	0.025	0.018
Male selectivity μ 2000-06	0.0	0.000	0.018
Male selectivity μ 2007+	0.0	0.019	0.049
Female selectivity μ 1990-99	0.121	0.104	0.089
Female selectivity μ 2000-06	0.121	0.110	0.108
Female selectivity μ 2007+	0.121	0.113	0.093
θ	0.442	0.430	0.275
L_∞^m	150	150	147
L_∞^f	90	90	99
-lnL total	-13.26	-14.26	-17.51
-lnL CPUE	-10.93	-11.51	-15.59
-lnL CAL	-25.30	-30.05	-23.45
SR1 pen	0.78	0.55	0.68
-lnL discard	0.12	0.38	0.42
Bsp(1990)/Ksp	0.39	0.38	0.25
Bsp(2010)/Ksp	0.72	0.72	0.68
Bsp(2011)/Ksp	0.74	0.74	0.70
Bsp(2010)/Bsp(1990)	1.86	1.90	2.80
Bsp(2011)/Bsp(1990)	1.90	1.94	2.83
Bexp(2010)/Bexp(1990)	0.90	1.20	1.55
Program (snewnb.tpl)	gb1.rep	Gb4.rep	Nnew5.rep

Table 5: Gough assessment results.

Somatic growth rate option	**"Pollock"**	**"Pollock"**	**"James Glass"**
	Model 1 Time invariant selectivity	**Model 2 Time varying selectivity**	**Model 2 Time varying selectivity**
	F_{2009}=0.3	**F_{2009}=0.3**	**F_{2009}=0.3**
K	1002	886	452
H	0.954	0.948	0.960
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 90-01	0.000	0.000	0
Male selectivity μ 02-06	0.000	0.000	0
Male selectivity μ 07+	0.000	0.025	0.018
Female selectivity μ 90-01	0.092	0.082	0.056
Female selectivity μ 02-06	0.092	0.095	0.067
Female selectivity μ 07+	0.092	0.042	0.048
θ	0.685	0.781	0.663
L_{∞}^{m}	150	150	147
L_{∞}^{f}	90	90	99
-lnL total	-3.09	-5.40	-7.27
-lnL CPUE	-11.80	-13.20	-15.49
-lnL CAL	53.31	65.90	52.08
SR1 pen	2.97	0.86	2.50
-lnL discard	1.10	0.94	1.13
Bsp(1990)/Ksp	0.60	0.69	0.59
Bsp(2010)/Ksp	0.93	0.88	0.88
Bsp(2011)/Ksp	0.93	0.87	0.88
Bsp(2010)/Bsp(1990)	1.54	1.27	1.49
Bsp(2011)/Bsp(1990)	1.54	1.27	1.48
Poisitive Hessian matrix	YES	**NO**	**Yes**
Bexp(2010)/Bexp(1990)	0.72	0.71	0.67
Programs (gnew.tpl; xgnew.tpl)	Xv1.rep	Pm1.rep	Gg1.rep

Table 6: Tristan assessment results.

	Model 1 Time invariant selectivity	**Model 2 Time varying selectivity**
	F_{2009}=0.3	**F_{2009}=0.3**
K	1790	1838
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	0.038	0.023
Female selectivity μ	0.155	0.146
Female scalar 1990-00	0.333	0.483
Female scalar 2001-05	0.333	0.287
Female scalar 2006+	0.333	0.151
θ	0.330	0.289
L_∞^m	125	125
L_∞^f	90	90
-lnL total	-15.44	-17.55
-lnL CPUE	-22.37	-23.38
-lnL CAL	61.91	50.27
SR1 pen	1.39	1.46
Bsp(1990)/Ksp	0.29	0.26
Bsp(2010)/Ksp	0.80	0.85
Bsp(2011)/Ksp	0.82	0.86
Bsp(2010)/Bsp(1990)	2.73	3.29
Bsp(2011)/Bsp(1990)	2.78	3.35
Bexp(2010)/Bexp(1990)	1.72	1.04
Program (tnew.tpl)	tn1.rep	tn3.rep

Figure 1a: Inaccessible model fits.

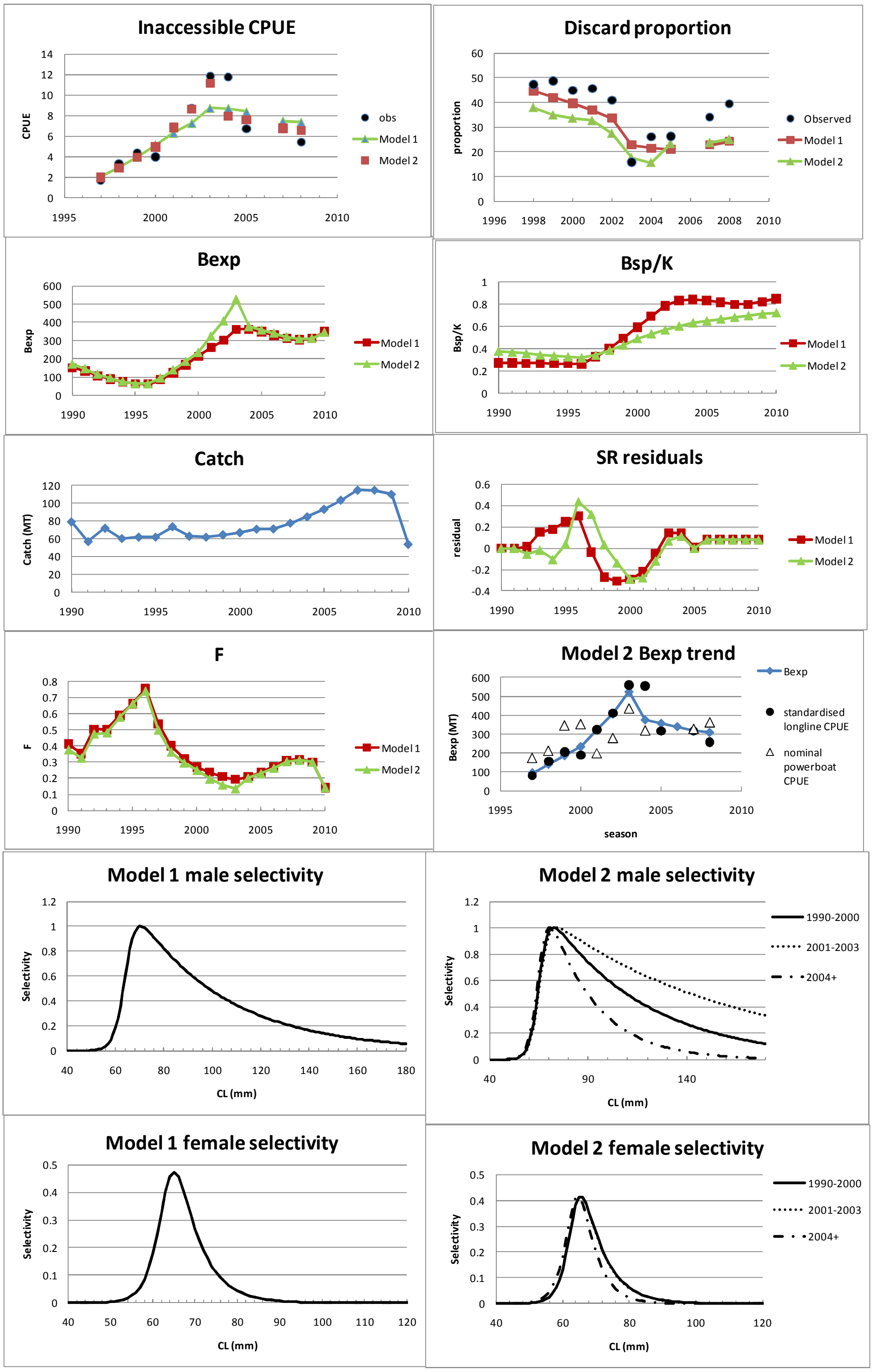

Figure 1b: Inaccessible catch-at-length fits for Model 1 and 2.

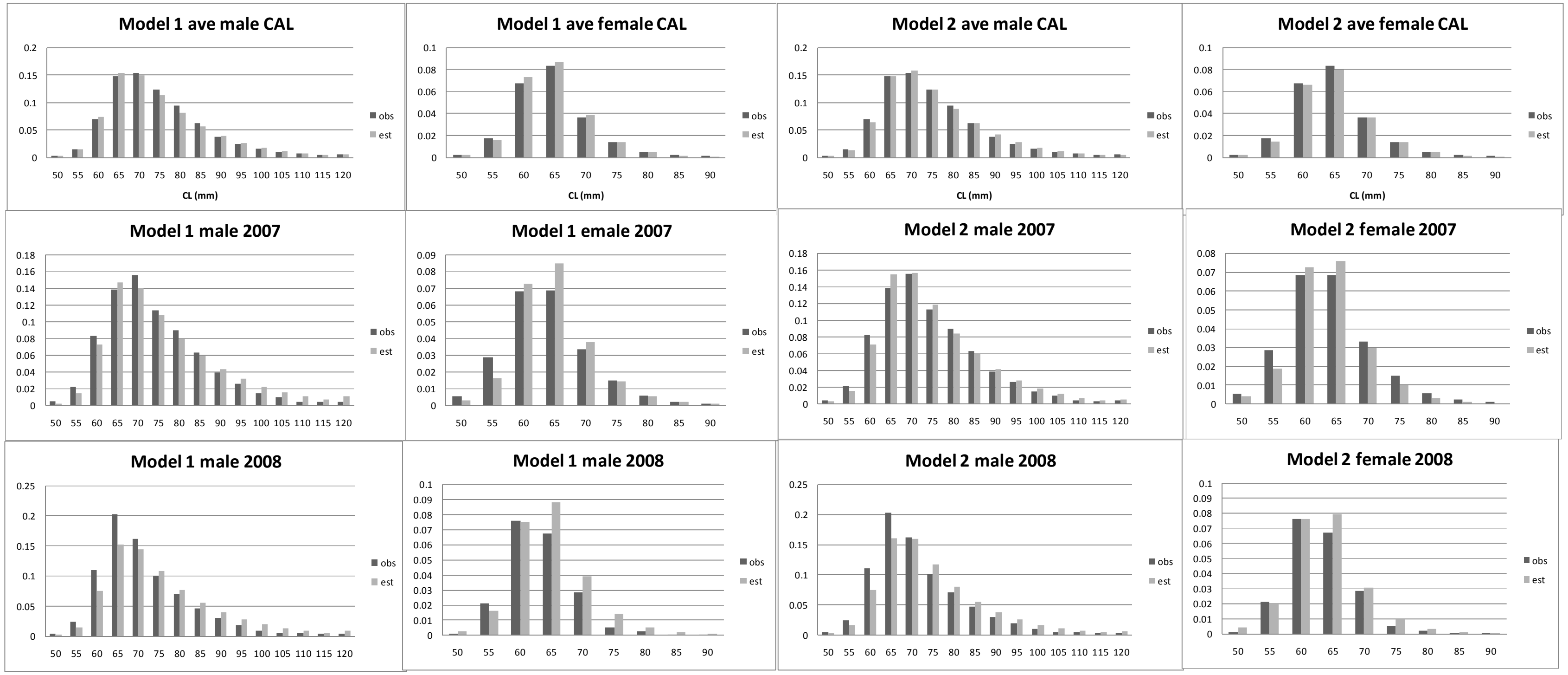

Figure 2a: Nightingale model fits for Model 2 comparing the “Pollock” and “James Glass” growth rate.

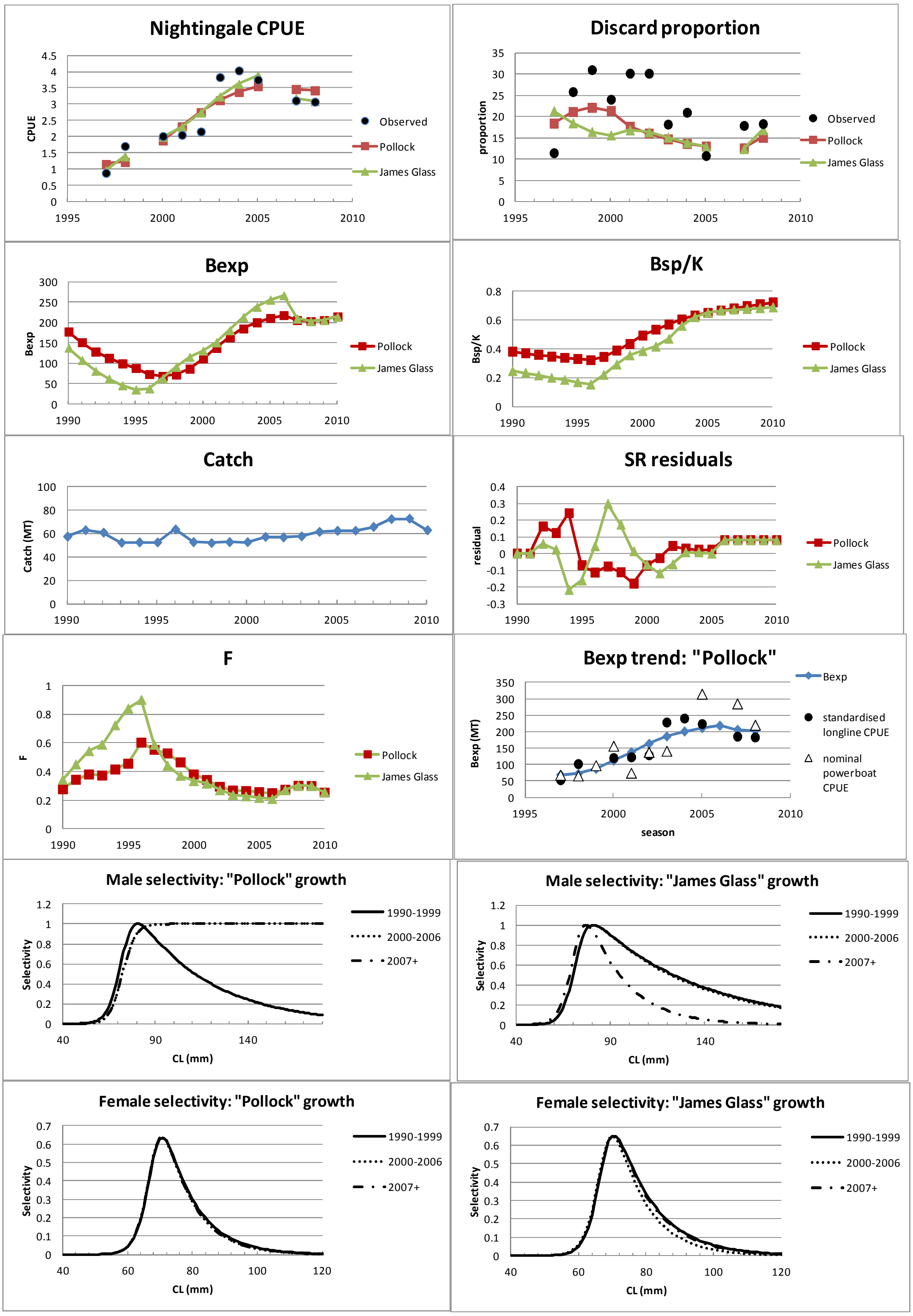

Figure 2b: Nightingale catch-at-length fits for Model 2 comparing the “Pollock” and “James Glass” growth rate.

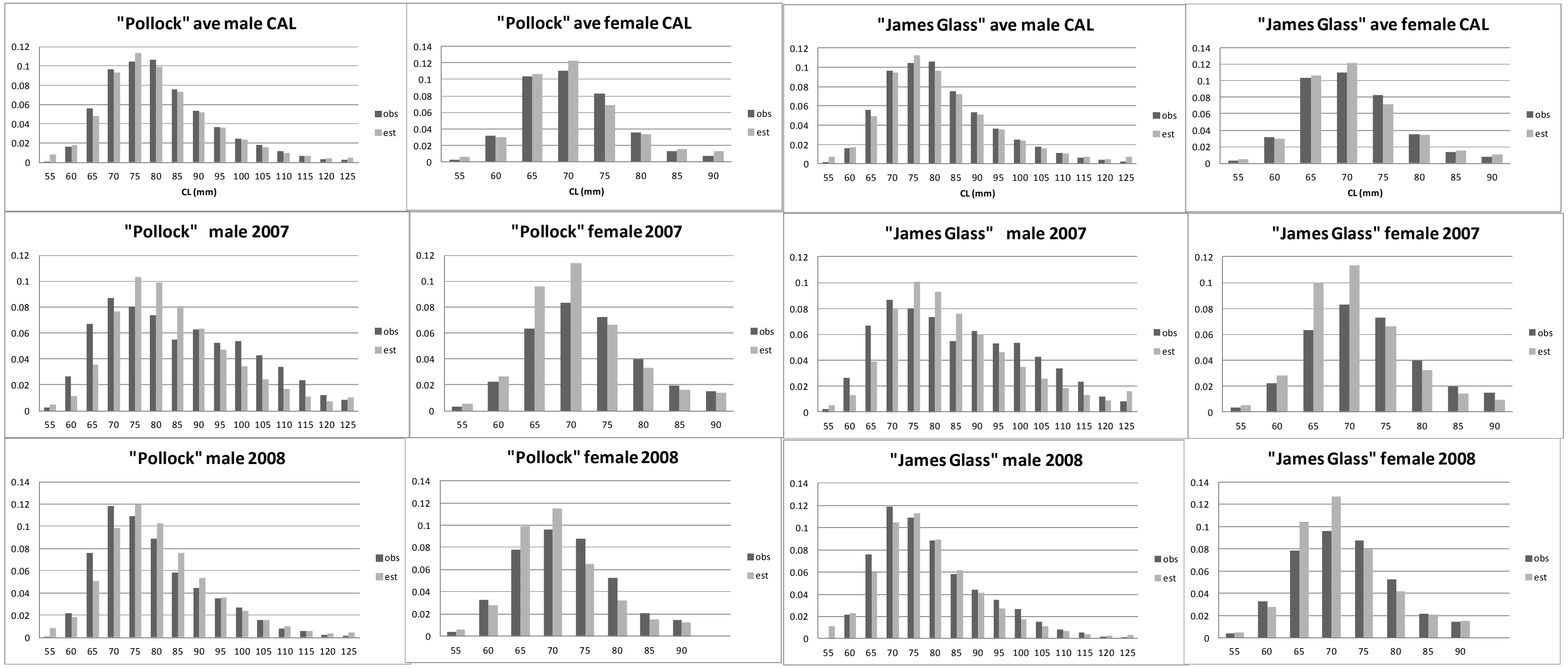

Figure 3a: Gough model fits for Model 2 comparing the “Pollock” and “James Glass” growth rate.

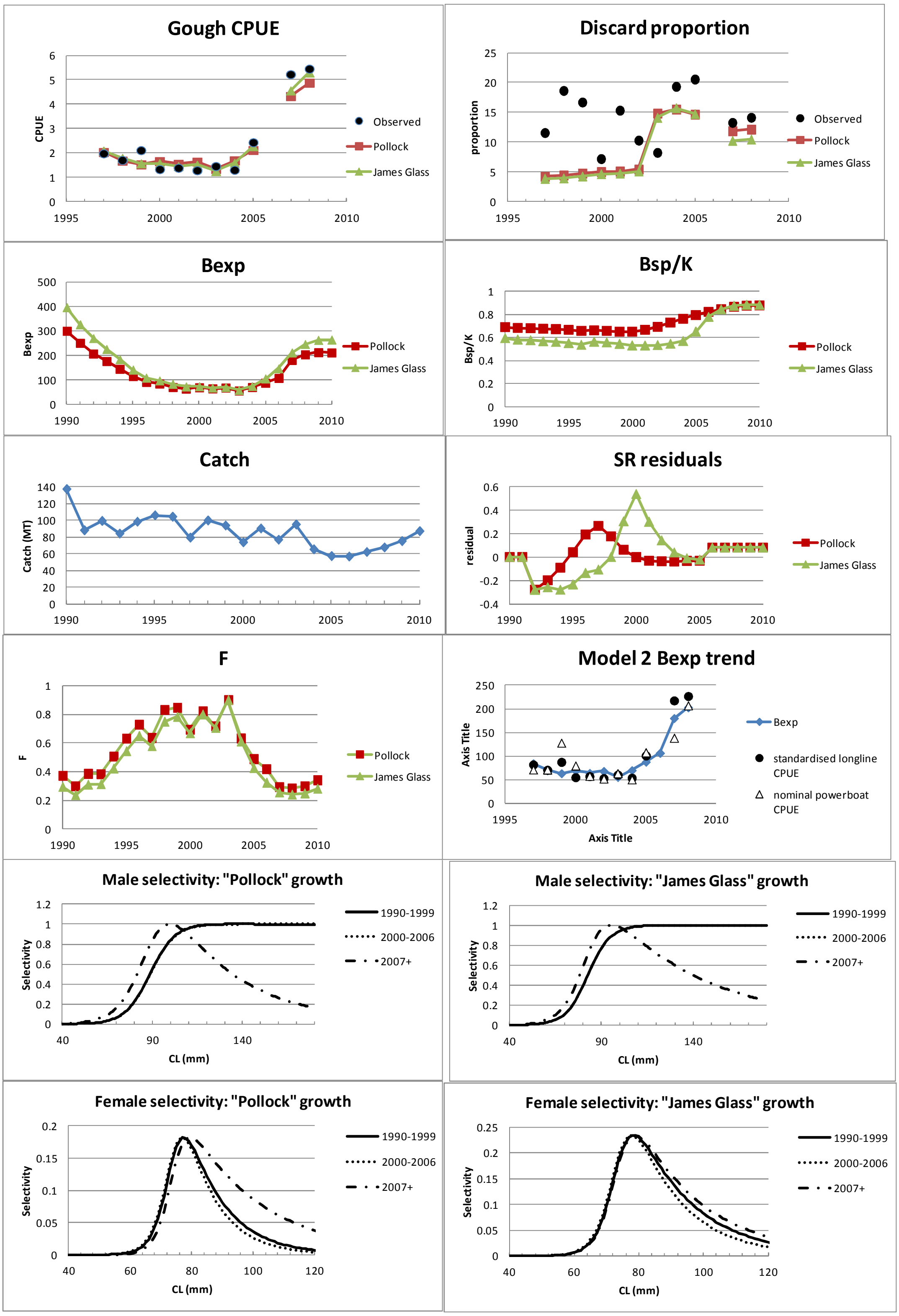

Figure 3b: Gough catch-at-length for Model 2 for both the “Pollock” and “James Glass” growth rate.

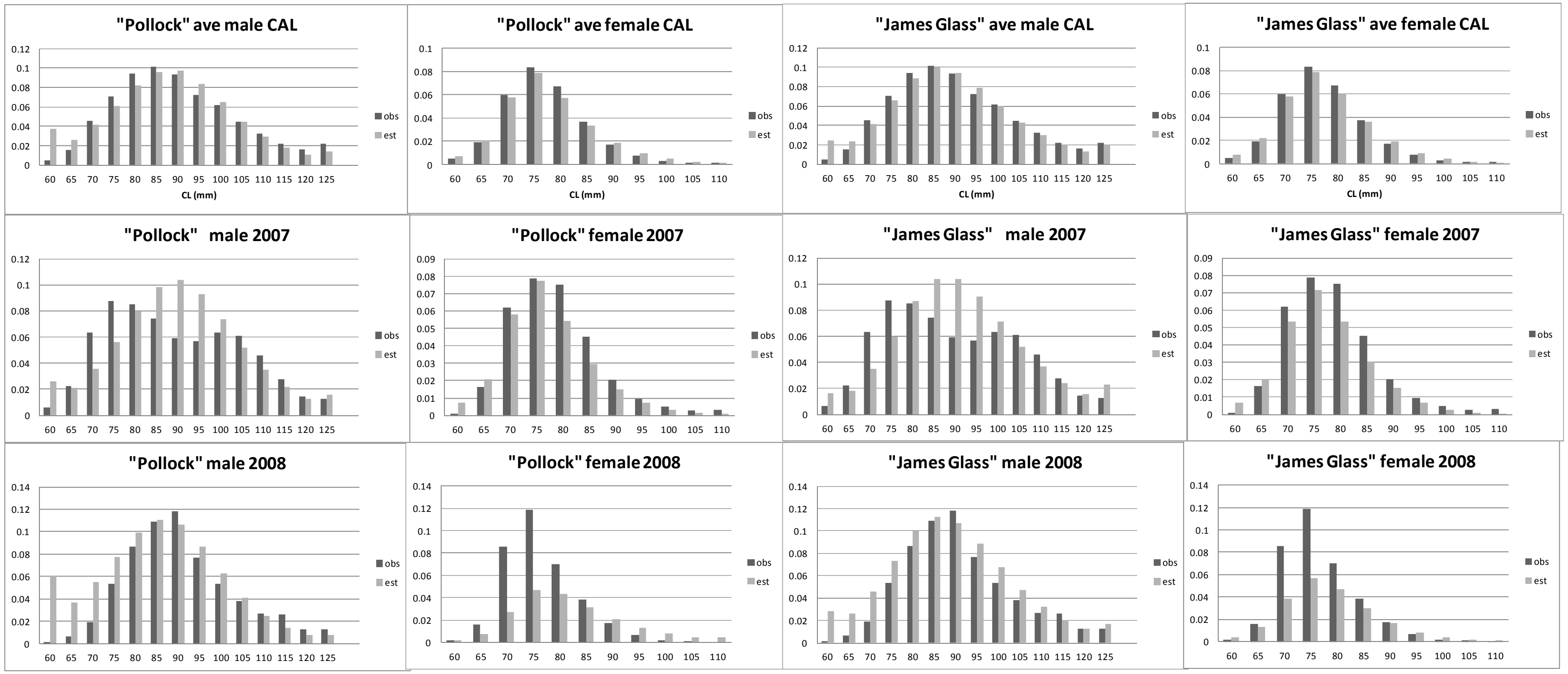

Figure 4a: Tristan model fits.

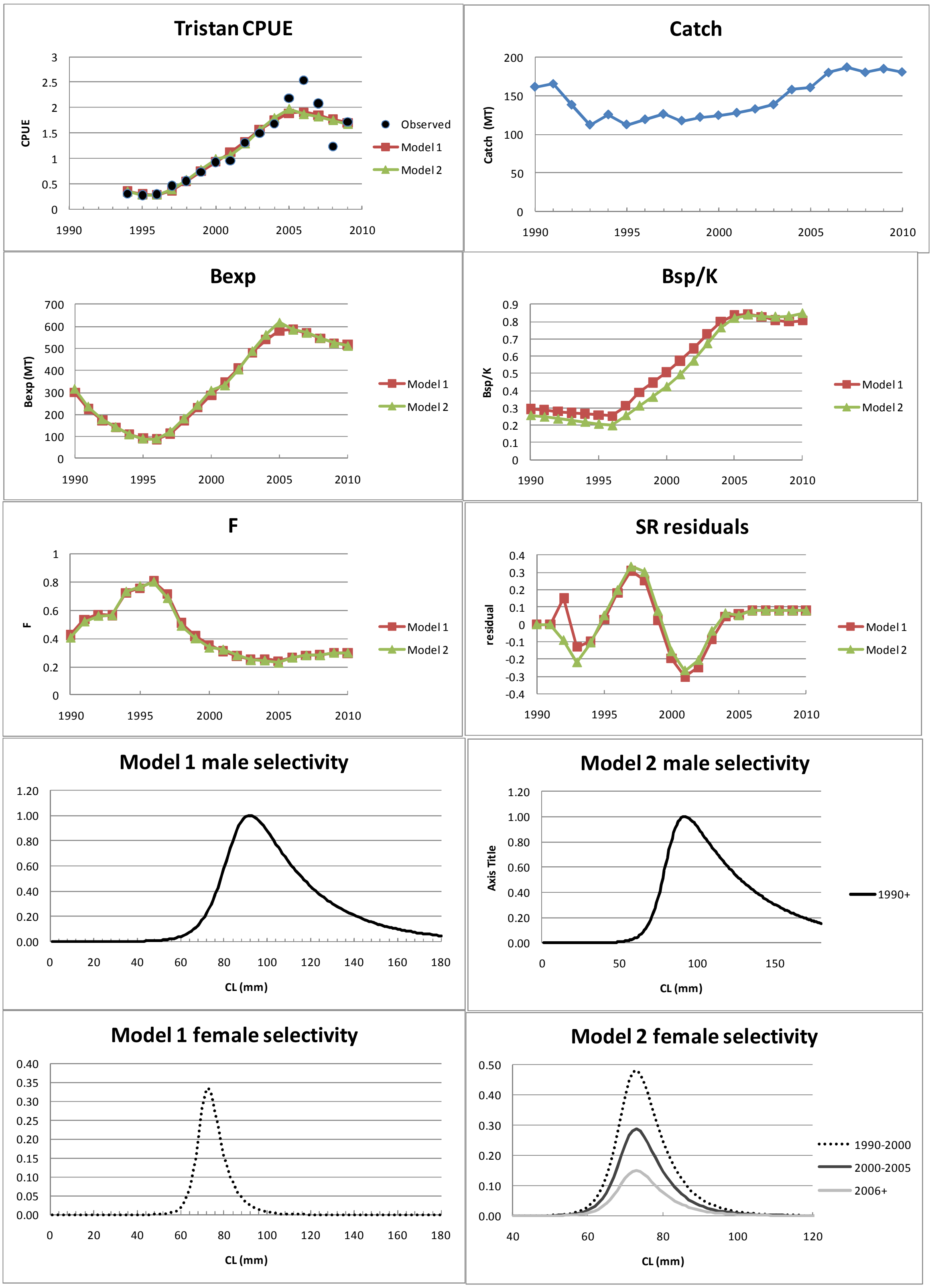

Figure 4b: Tristan catch-at-length fits.