Updated 2013 rock lobster assessments for Inaccessible and Gough islands

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Summary

This paper provides updated assessments of the rock lobster resources at Inaccessible and Gough islands. These assessments include updated data from the commercial fishery, and are also extended to fit to data from Leg1 of the annual biomass surveys. Projections at the current TAC values (70 MT for Inaccessible and 95 MT for Gough) do not indicate any concern with respect to future spawning biomass or catch rate trends.

Introduction

The age-structured population model used for these assessments is described fully in Johnston and Butterworth (2013). Note that stock-recruitment residuals are now estimated for the period 1992-2010[1]). The 2013 assessment models are fit to the following data:

1) Standardised longline CPUE data for 1997-2011. [Note these assessments will be updated later in the year to include the 2012 CPUE – the raw data were available at the time of these assessments (see Figure 1), but due to time constraints, updated GLM analyses have not yet been applied including these data.]
2) Biomass survey Leg1 CPUE data (2006-2012, with 2008 data absent).
3) Catch-at-length data from the onboard observers (males and females separate) (1997-2011).
4) Catch-at-length data from the Leg1 biomass survey (males and females separate) (2006-2012, with 2008 data absent).
5) Discard % (1997-2011).

Note that the 2012 assessment models did not include the biomass survey CPUE or CAL data in the likelihood used to fit the model.

These models also take into account a number of minor errors identified by MRAG during 2013 whilst reviewing the 2013 Tristan updated assessment and OMP (Edwards and Rademeyer, 2013).

The models assume that selectivity varies over years. The time-variation is effected by estimating three or four different μ values (males and females separately) for the selectivity function for each of different time periods.

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

The generic selectivity function formulation used is as follows:

$$S_{y,l}^{m,comm} = \frac{e^{-\mu_y^m l}}{1+e^{-\delta^m (l-l_*^m)}} \tag{1}$$

$$S_{y,l}^{f,comm} = P\frac{e^{-\mu_y^f l}}{1+e^{-\delta^f (l-l_*^f)}} \tag{2}$$

where the estimable parameters are thus:

- $l_*^{m/f}$,
- $\delta^{m/f}$,
- $\mu^{m/f}$ [with different values for each of the selectivity periods shown in table below]
- *P* (the female scaling parameter)

The selectivity functions for males are scaled so that the maximum selectivity value is 1.0, and the female selectivity function is scaled by the multiplicative parameter *P* so that the maximum selectivity value for females is equal to *P*. It was further found that the model consistently overestimated the number of male lobsters in the larger size classes. For this reason two further adjustments were made to improve the model fit:

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

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

Inaccessible	**Gough**
1990-2000	1990-2001
2001-2003	2002-2006
2004-2005	2007+
2006+	

For Gough, two alternate somatic growth models are used – the Pollock growth model and the James Glass growth model (see Johnston and Butterworth 2011, 2013 for further details).

Gough: model changes to selectivity function to improve fit to catch-at-length at small sizes

Original fits to catch-at-length data for both the Pollock and James Glass growth models for Gough showed poor fits to the CAL data at small sizes. The logistic selectivity function was clearly unable to provide sufficient flexibility to fit to these data. Modifications to the selectivity function at smaller length classes (below 70mm CL) were thus explored. Initially fitting additional selectivity parameters for these small lengths was attempted, but this was unsuccessful. What was successful however, was to fix additional selectivity parameters at the smaller length classes for both the male and female commercial selectivity functions, and for the survey selectivity function for the female biomass. The original male biomass selectivity function provided a satisfactory fit to all the length classes, so no further modification to that was required. The modifications to the selectivity functions are described in the Appendix.

Impact of the OLIVA on Inaccessible

The impact that the OLIVA had on the resource at Inaccessible is modelled by assuming a 35% once off mortality of lobsters aged 1, 2 and 3 years during the 2011 season, as considered the most reasonable assumption[2].

Projections

In MARAM/TRISTAN/2013/JUN/10 MARAM the following recommendations regarding the 2013/14 TAC at Inaccessible and Gough were made:

> Inaccessible
> A provisional 70 MT is advised. This is based on the nomimal CPUE trend – see Figure 1. The nominal CPUE value for the most recent 2012/13 season shows an increase compared to the previous year's CPUE – two years of increased CPUE at Inaccessible island have now been observed. The TAC amount will be revised in September when the updated assessment for Inaccessible will be completed.
>
> Gough
> A provisional 95 MT is advised. This is based on the nomimal CPUE trend – see Figure 1. The 2012/13 nominal CPUE value is down from the 2011/12 season's value – but only slightly lower than the 2010/11 value. This follows a period of sustained increase in the CPUE. The CPUE trend does not however show cause for concern for the immediate future. The provisional TAC will be revised in September when the updated assessment for Gough will be completed.

Here, the updated 2013 assessment models for Inaccessible and Gough are projected forwards to 2031 under the assumption that the future (2013+) TACs for each island remain at these values, i.e:

- Inaccessible – 70 MT
- Gough – 95 MT

For projections, one hundred simulations are run with a lognormal random error of CV= 0.4 added to the future recruitment for each resource.

Results

Updated Inaccessible assessment

Table 1 reports the Inaccessible 2013 updated assessment results, and provides the 2012 assessment results for comparison. Note that the total –lnL values are not comparable as the 2013 assessment uses

[2] Cape Town Workshop held 16-18 November 2011.

additional data. It is evident that the 2013 model fits the CPUE data better than the 2012 model, but the fit to the catch-at-length data deteriorates. Estimates of the spawning biomass (Bsp) relative to 1990 (0.49) are higher than those estimated in 2012 (0.20), and the current Bsp/K is estimated to be at a healthy 0.81K. The difference in the estimate of Bsp(1990)/K between the 2012 and 2013 assessments is due to a combination of factors which include updated commercial CPUE data (which incorporate corrections to earlier data) plus further data included in the likelihood. Figure 2a shows that this updating of the CPUE data over the past year has led to considerable differences.

Figures 3a and b provide various plots of the updated Inaccessible assessment. The model fits well to both commercial and survey CPUE trends, but underestimates the discard proportion. Improvements to the model to fit these data better through changing the selectivity function shape will be investigated when these results are updated to incorporate further GLM-standardised CPUE data. Nevertheless this current underestimation is not seen as an immediate major concern because the manner in which these data are collected – fairly rough onboard estimates of amounts discarded – means that they are probably not that accurate. The fits to both the longline and biomass survey catch-at-length data are good in terms of aggregates over years (Figures 3c and d), but residual patterns do remain at the annual level (Figures 3e and f). The recent exploitable biomass trend is increasing whilst the spawning biomass is estimated to be fairly steady (Figure 2a). Note, however, that the OLVIA effect of an assumed 35% mortality of the age 1-3 year olds in 2011 does not yet impact the assessment results, and that this possible effect will be evident only around 2016 (see projections in Figure 5).

Updated Gough Assessment

Table 2 reports the Gough 2013 updated assessment results, and provides the 2012 assessment results for comparison. Note that results are produced for both somatic growth models – the James Glass and the Pollock growth model. What is interesting is that the two growth models now produce very similar results. The 2012 assessment results showed greater differences between the model fits for the two growth models. This is likely to be a result of the additional data to which the models are now fitted, which has helped resolve these differences. Note that Figure 2b shows that the updating of the CPUE data over the past year has led to relatively small differences.

Both models estimate current Bsp/K to be healthy (~0.88K), although this trend is decreasing. This can be seen more clearly in the plots of Figure 4a. The fits to discard proportion data are poor, as for the Inaccessible assessment.

Projection results

Figure 5 reports the median projections for the Inaccessible resource under a continued 70 MT future catch. This figure shows that there would be no immediate concern to the resource under this annual catch tonnage. Note that the effect of the OLIVA can be seen in the predicted Bsp trajectory around 2017, but that the spawning biomass continues its increasing trend thereafter.

Similarly, Figure 6 reports the median projections of the Gough resource (for both growth models) under a continued 95 MT annual catch in future. In both cases, the spawning biomass does decline, but then flattens at an acceptable level (similar to that estimated for around 2005) which still remains healthy as it is well above the biomass that would yield MSY. An obvious management question is what the future target catch rate for this resource should be.

Future work

- The CPUE data from the 2012 season will be included in an update of the CPUE GLM analyses for Inaccessible and Gough.
- The stock assessments will be updated taking into account the 2012 standardised CPUE values.
- OMPs will be developed for both islands, along the lines pursued for Tristan.
- Consultation will be required in order to determine the management objective for each island. For Tristan the management objective was to maintain current catch rates. This consultation would probably be best initiated when some initial OMP results first become available, so that the trade-offs (between catches and catch rates) associated with different target catch rate levels become evident.

References

Edwards, C.E. and Rademeyer, R. A. 2013. Fisheries advice to the Tristan da Cunha Administration. Phase ii: Development of a new management plan for rock lobster fisheries in the Tristan da Cunha archipelago. MRAG Ltd London, 23 pp.

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

Johnston, S.J. and Butterworth, D.S. 2013. The age structured population modeling approach for the assessment of the rock lobster resources at the Tristan da Cunha group of islands. MARAM/Tristan/2013/Mar/07. 15pp.

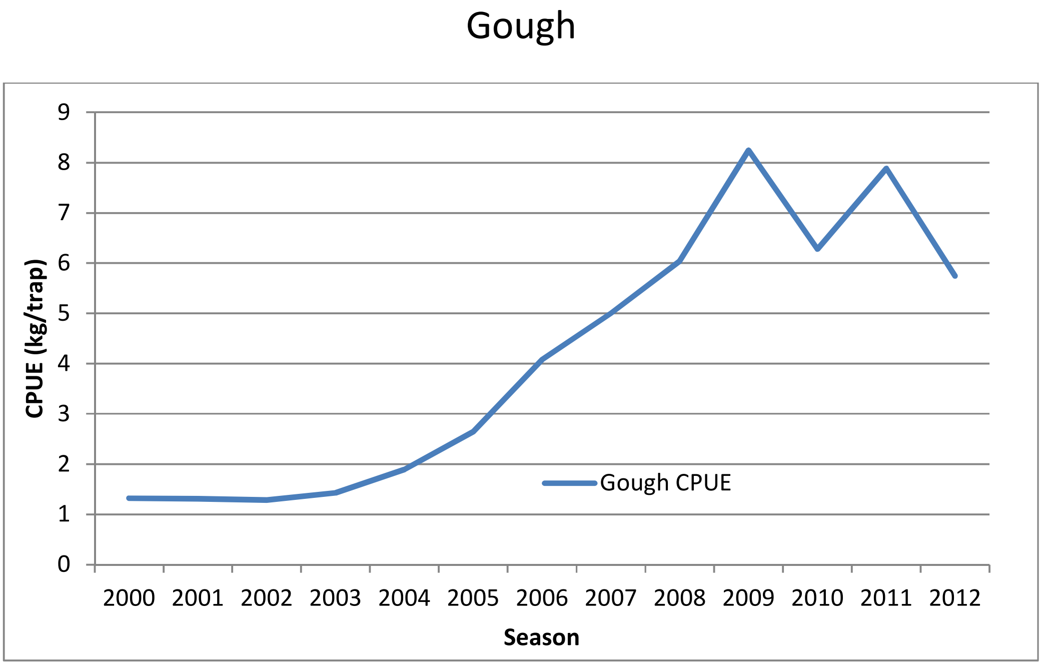
Table 1: Inaccessible 2013 assessment results. The 2012 assessment results are reported to allow comparison. The shaded values are fixed on input.

	2012 assessment	**2013 assessment Fit to all data**
	F_{2009}=0.3	**F_{2009}=0.3**
K	1480	1284
h	0.95	0.91
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	0.010	0.023
Male selectivity μ 01-03	0.022	0.013
Male selectivity μ 04-05	0.007	0.001
Male selectivity μ 06+	0.055	0.032
Female selectivity μ 90-00	0.141	0.149
Female selectivity μ 01-03	0.179	0.179
Female selectivity μ 04+	0.205	0.198
θ	0.221	0.522
L_∞^m	125	125
L_∞^f	90	90
-lnL total	-18.09	-21.83
-lnL CPUE T	-14.63	-28.83
-lnL CPUE longline	-14.63	-22.97
-lnL CPUE Survey Leg1	-	-5.86
-lnL CAL	-52.78	-10.97
-lnL CAL onboard observer	-52.78	12.28
-lnL CAL Survey Leg 1	-	-23.15
SR1 pen	0.78	5.02
-lnL discard	1.77	3.75
Bsp(1990)/Ksp	0.20	0.49
Bsp(2011)/Ksp	0.85	0.82
Bsp(2012)/Ksp	0.89	0.82
Bsp(2013)/Ksp	-	0.81
Bsp(2011)/Bsp(1990)	4.34	1.70
Bsp(2012)/Bsp(1990)	4.49	1.68
Bsp(2013)/Bsp(1990)	-	1.69
Bexp(2012)/Bexp(1990)	1.68	1.52
Program	(2012) Yinac.tpl, I3.rep	Test4.*

Table 2: Gough updated assessment results for both the "Pollock" and "James Glass" growth models. The 2012 assessment results are reported to allow comparison. The shaded values are fixed on input.

Somatic growth rate option	**"Pollock"**		**"James Glass"**	
	2012	**2013**	**2012**	**2013**
	F_{2009}=0.3	**F_{2009}=0.3**	**F_{2009}=0.3**	**F_{2009}=0.3**
K	988	258	429	340
h	0.95	0.98	0.96	0.98
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	0.004	0.001	0.000	0.022
Male selectivity µ 02-06	0.000	0.0002	0.000	0.017
Male selectivity µ 07+	0.015	0.011	0.009	0.024
Female selectivity µ 90-01	0.085	0.491	0.065	0.037
Female selectivity µ 02-06	0.100	0.458	0.066	0.0002
Female selectivity µ 07+	0.062	0.482	0.050	0.027
θ	0.684	0.916	0.675	0.935
L_{∞}^{m}	150	150	147	147
L_{∞}^{f}	90	90	99	99
-lnL total	-0.19	-6.08	-2.18	-8.13
-lnL CPUE T	-11.63	-23.50	-12.65	-23.34
-lnL CPUE longline	-11.63	-20.19	-12.65	-20.01
-lnL CPUE Survey Leg1		-3.31		-3.32
-lnL CAL T	86.79	32.42	66.73	34.67
-lnL CAL onboard observer	86.79	93.55	66.73	95.89
-lnL CAL Survey Leg 1		-61.13		-61.23
SR1 pen	0.59	3.36	1.28	4.78
-lnL discard	2.80	11.09	3.03	3.50
Bsp(1990)/Ksp	0.60	0.86	0.60	0.87
Bsp(2011)/Ksp	0.88	0.98	0.83	0.98
Bsp(2012)/Ksp	0.88	0.92	0.82	0.92
Bsp(2013)/Ksp	-	0.88	-	0.87
Bsp(2011)/Bsp(1990)	1.46	1.15	1.37	1.13
Bsp(2012)/Bsp(1990)	1.45	1.08	1.36	1.06
Bsp(2013)/Bsp(1990)	-	1.02	-	1.00
Bexp(2012)/Bexp(1990)	0.76	1.12	0.56	1.14
Programs	G2.rep	Ptry.tpl; ptry.rep (M=0.2)	G1.rep	JGtry.tpl, Jgtry.rep (M=0.2)

Figure 1: Gough and Inaccessible nominal CPUE trends including 2012/13 season. [Taken from MARAM/TRISTAN/2013/JUN/10]



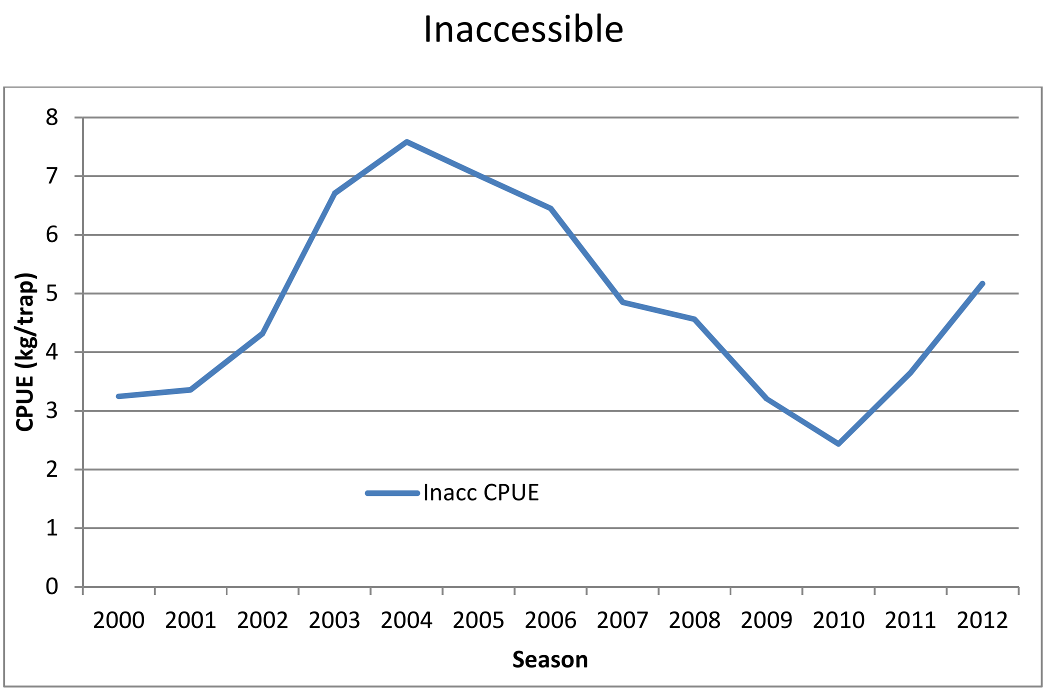


Figure 2a: Comparison between the standardized CPUE trend for Inaccessible calculated and used in the 2012 assessment, and the updated trend used in the 2013 assessment.

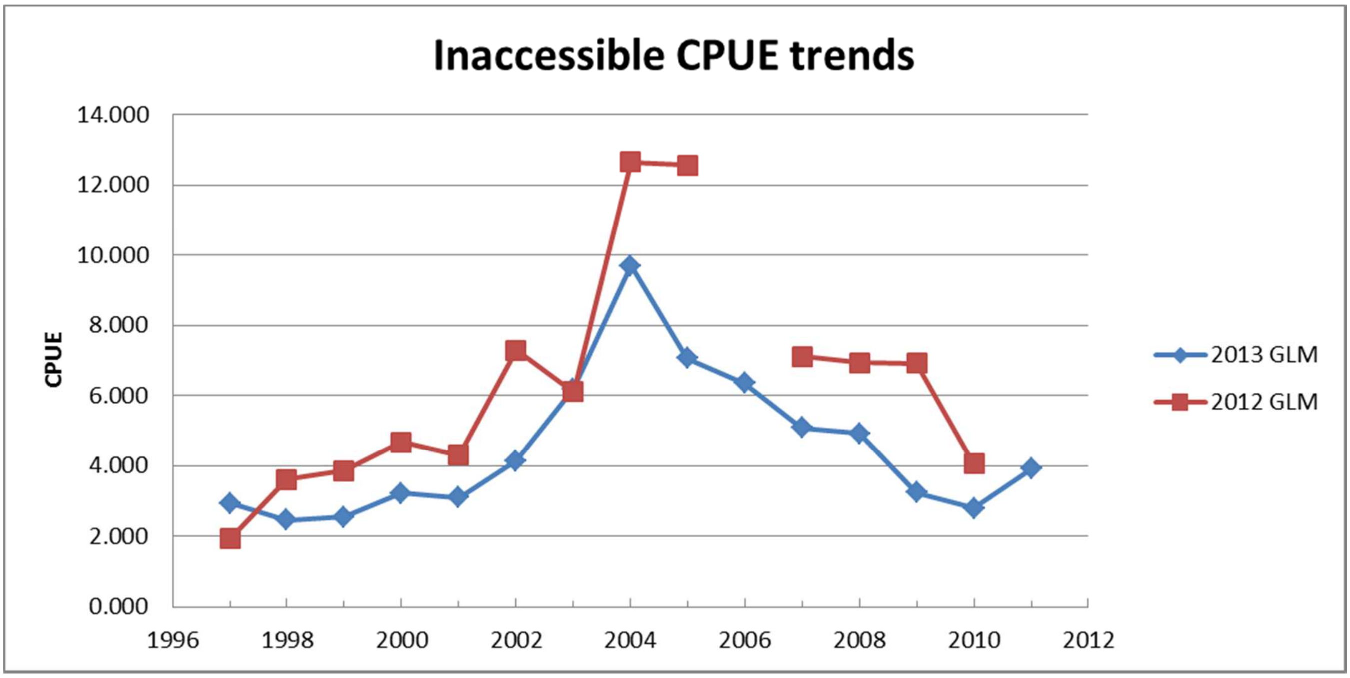


Figure 2b: Comparison between the standardized CPUE trend for Gough calculated and used in the 2012 assessment, and the updated trend used in the 2013 assessment.

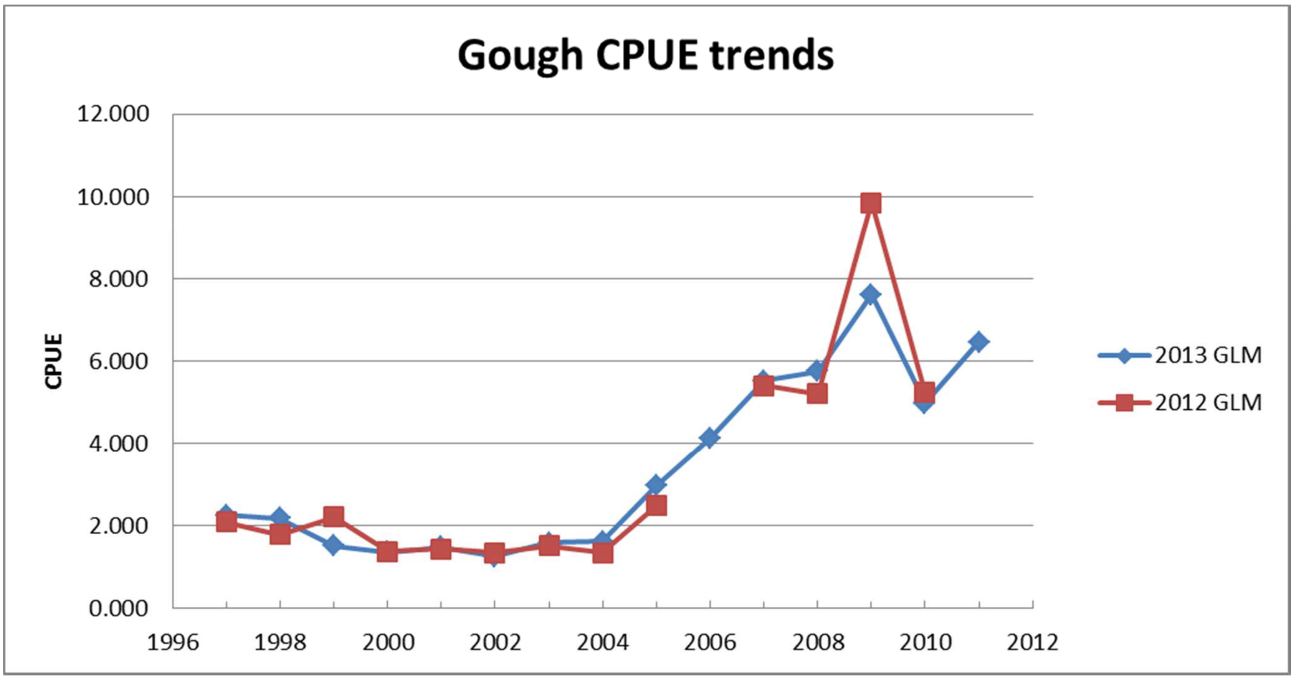


Figure 3a: Inaccessible 2013 assessment results.

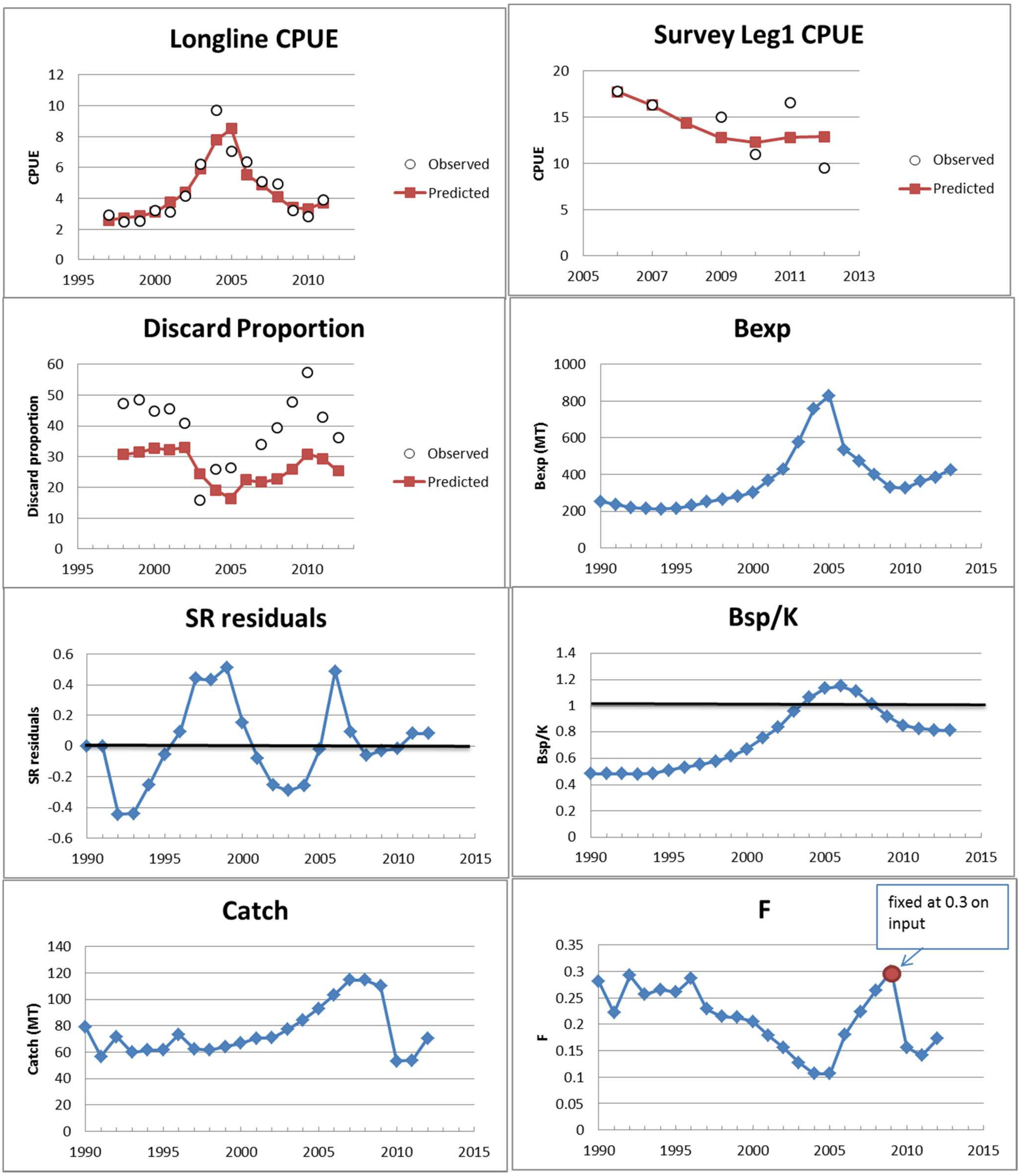


Figure 3b: Inaccessible selectivity functions (see text re change allowed for CL>110mm).

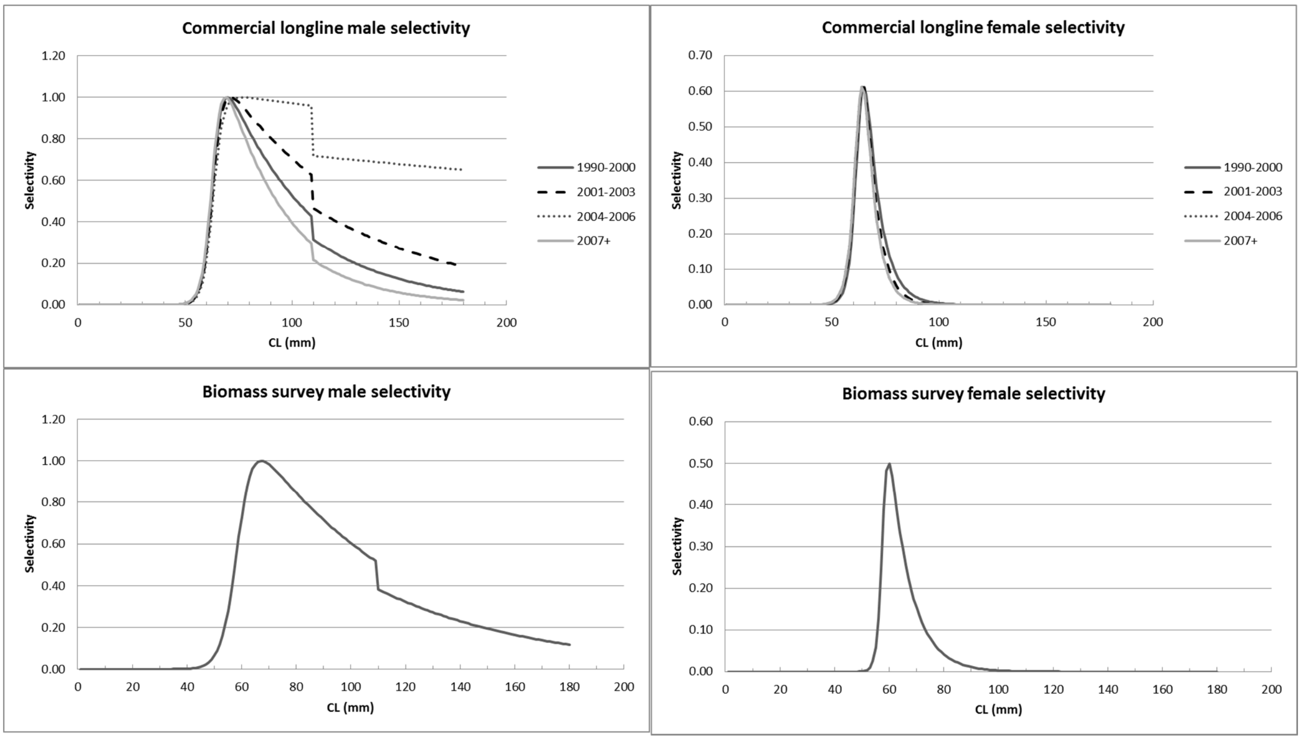


Figure 3c: Inaccessible commercial longline CAL fits averaged over years.

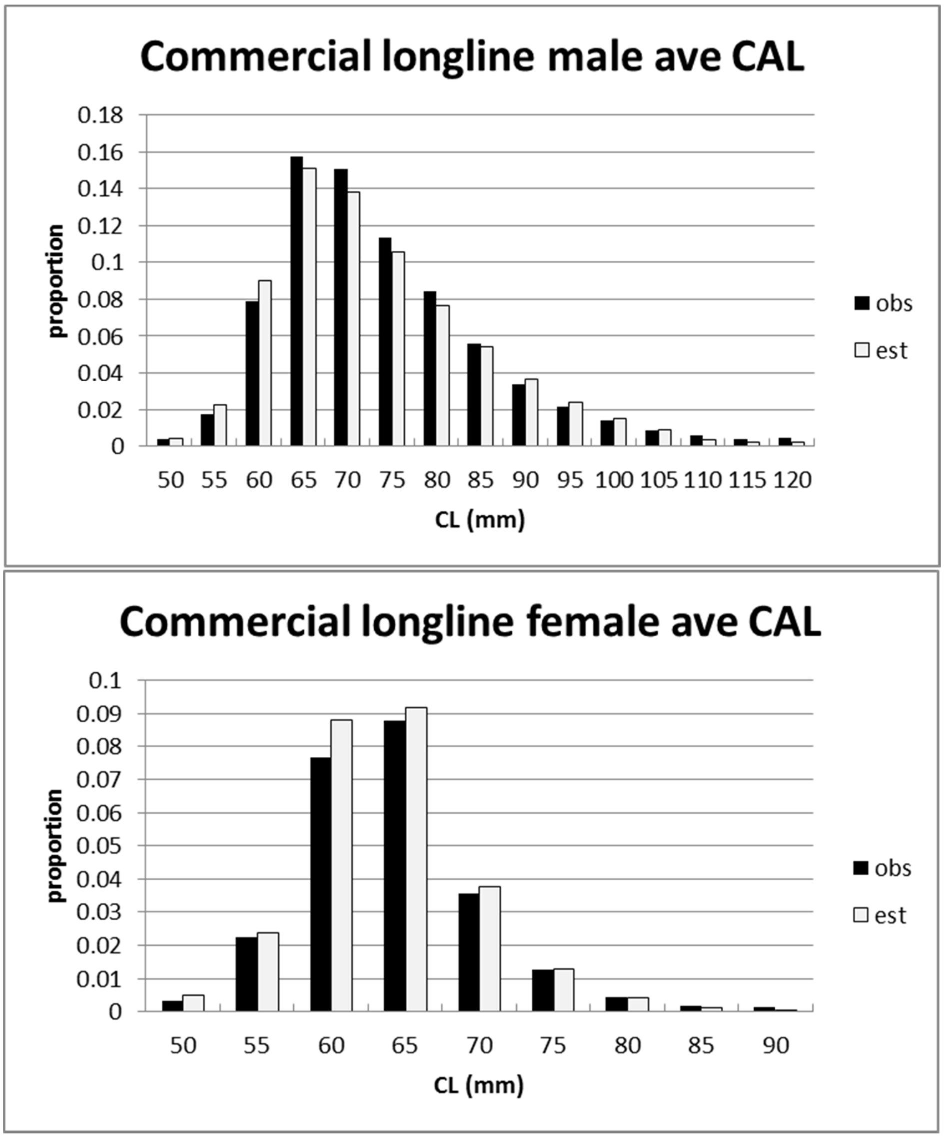
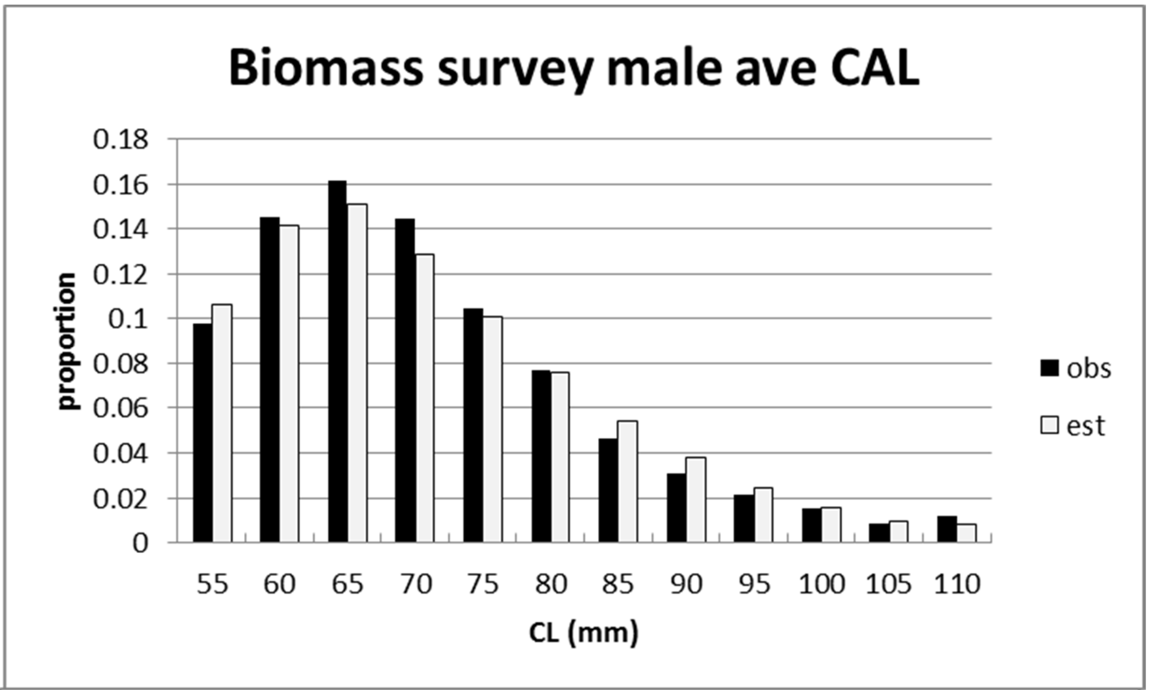


Figure 3d: Inaccessible biomass survey Leg1 CAL fits averaged over years.



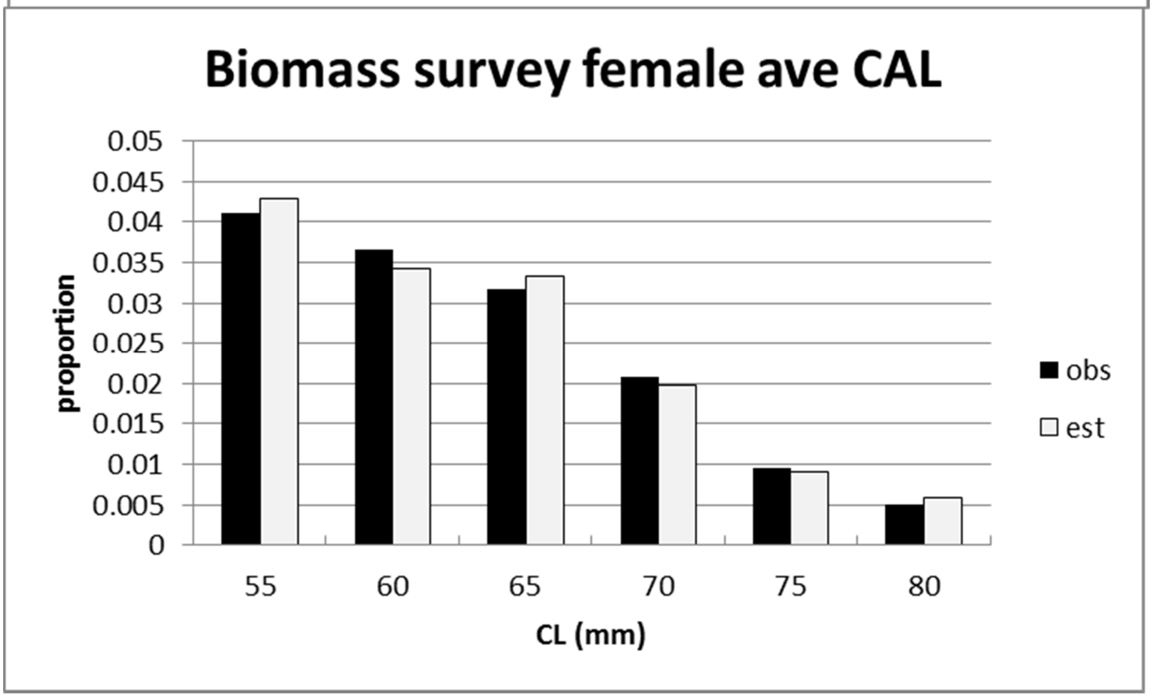
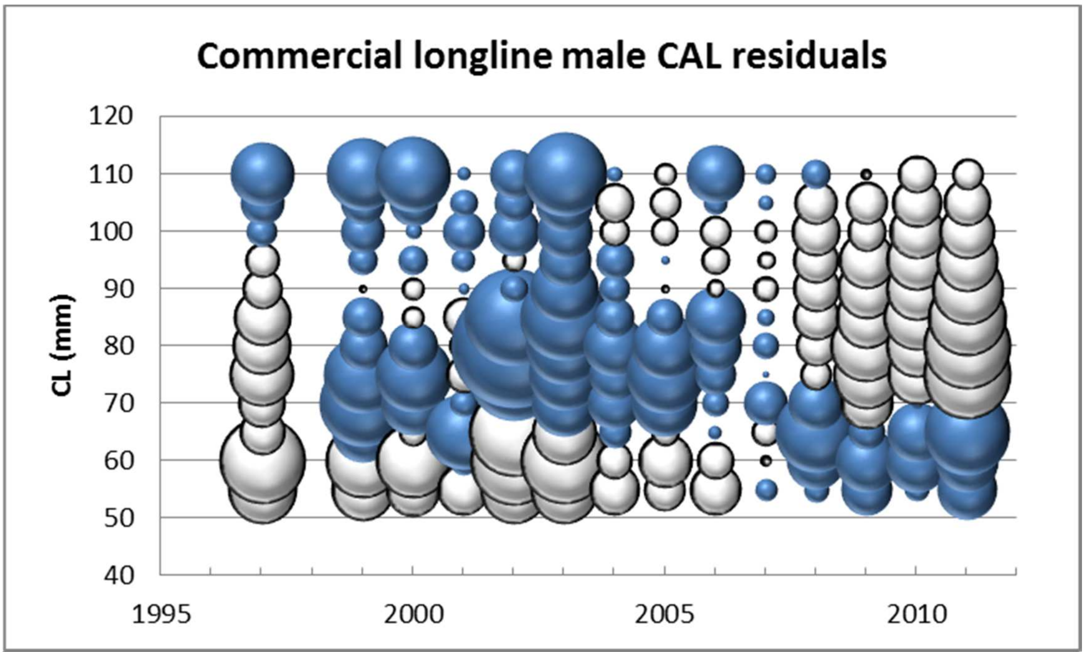


Figure 3e: Inaccessible standardised commercial longline CAL residuals. The dark bubbles reflect positive and the light bubbles negative residuals, with the bubble radii proportional to the magnitudes of the residuals.



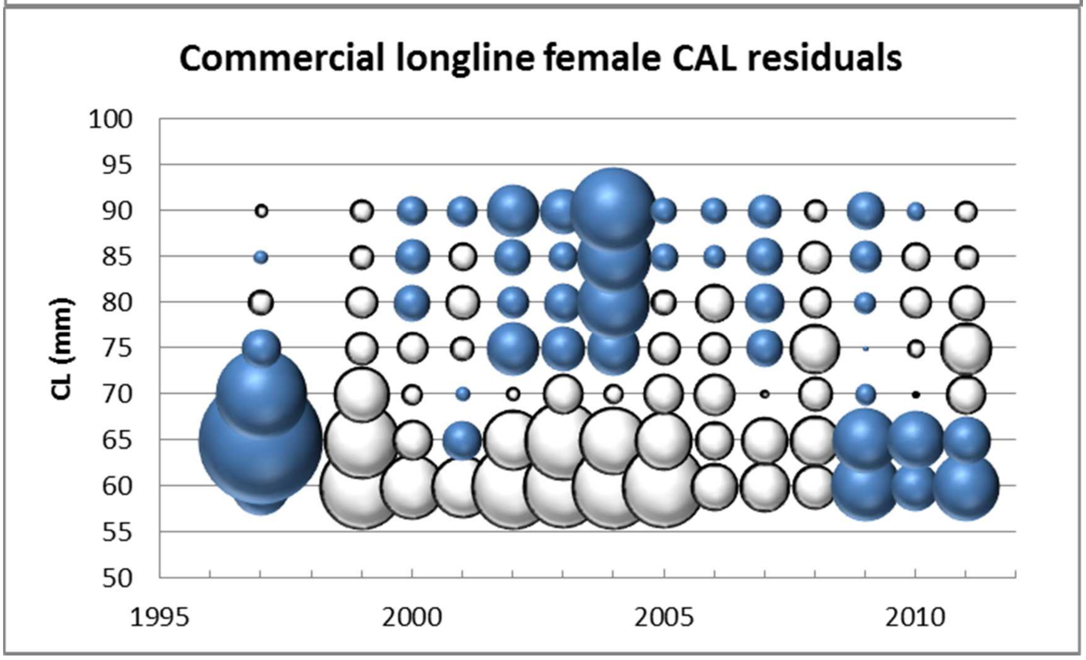


Figure 3f: Inaccessible standardised biomass survey Leg1 CAL residuals. The dark bubbles reflect positive and the light bubbles negative residuals, with the bubble radii proportional to the magnitudes of the residuals.

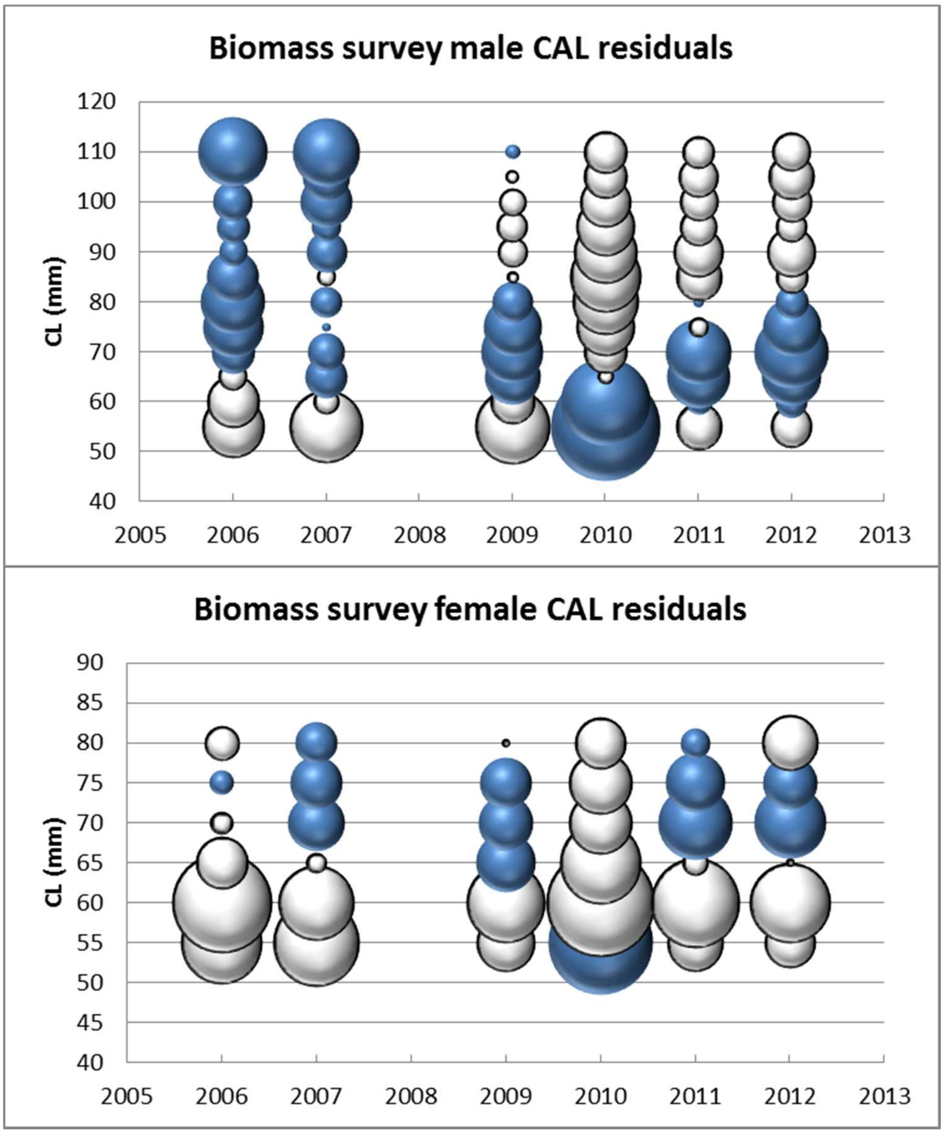


Figure 4a: Gough 2013 assessment results for both the James Glass and Pollock growth models.

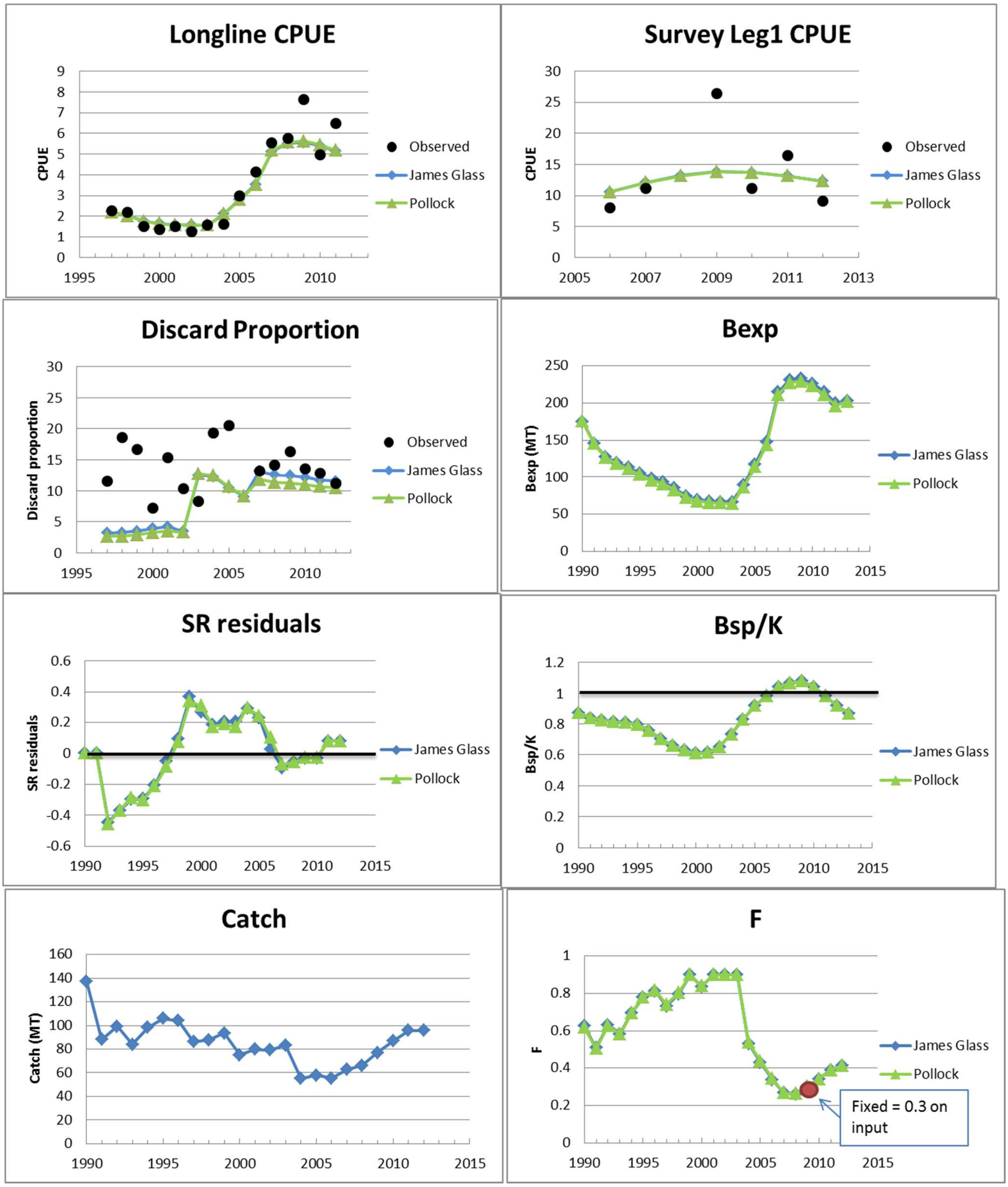


Figure 4b: Gough selectivity functions – James Glass growth (see text re change allowed for CL>110 mm)

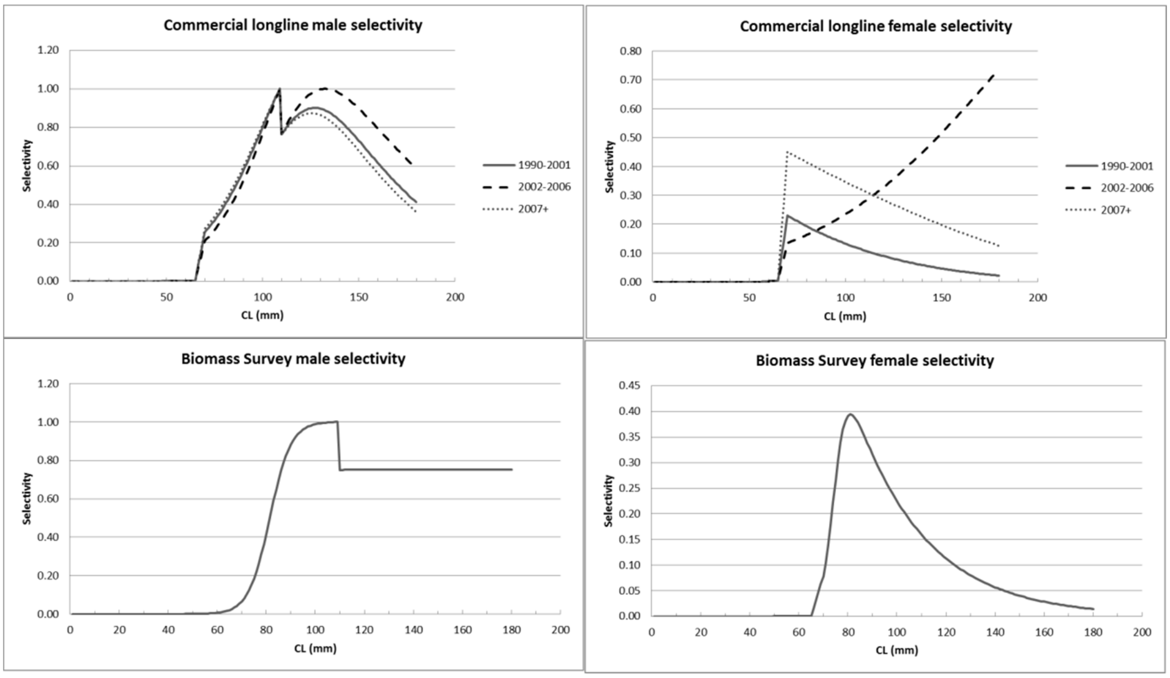


Figure 4c: Gough selectivity functions – Pollock growth.

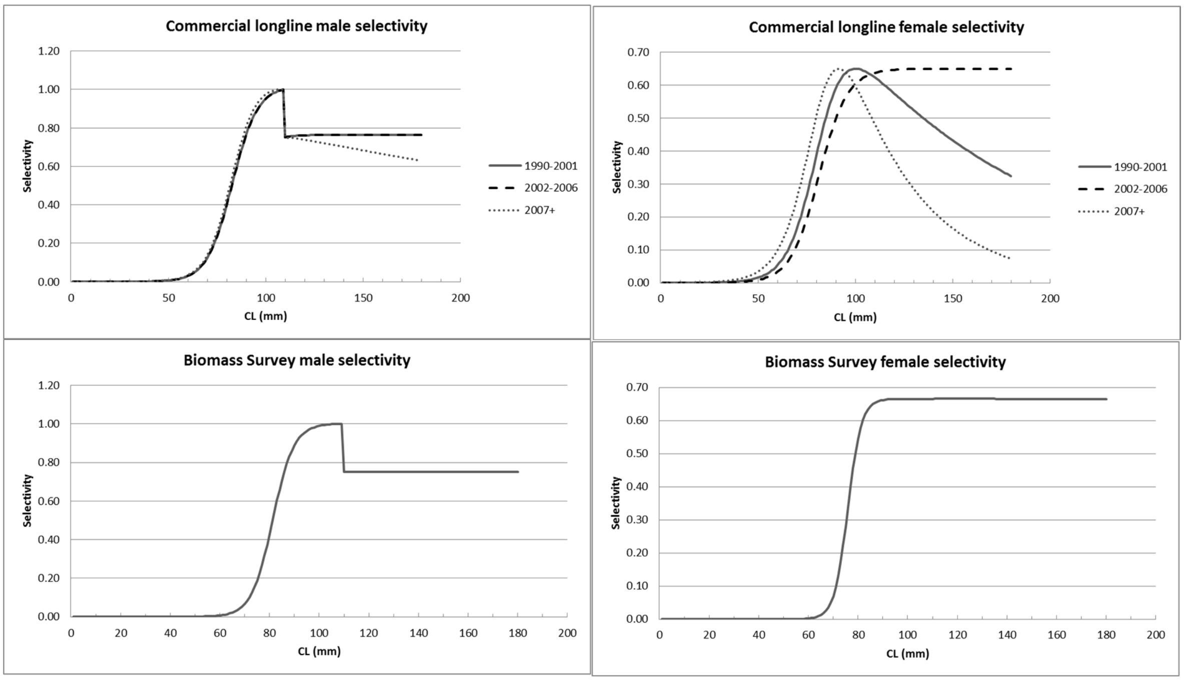
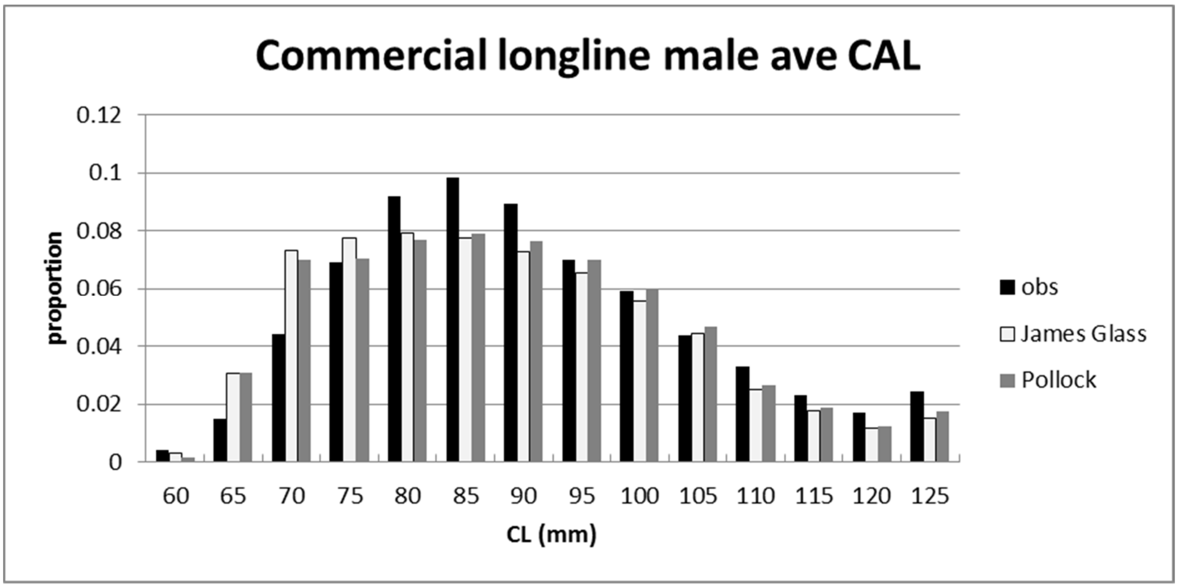


Figure 4d: Gough commercial longline CAL fits averaged over years for both growth equations.



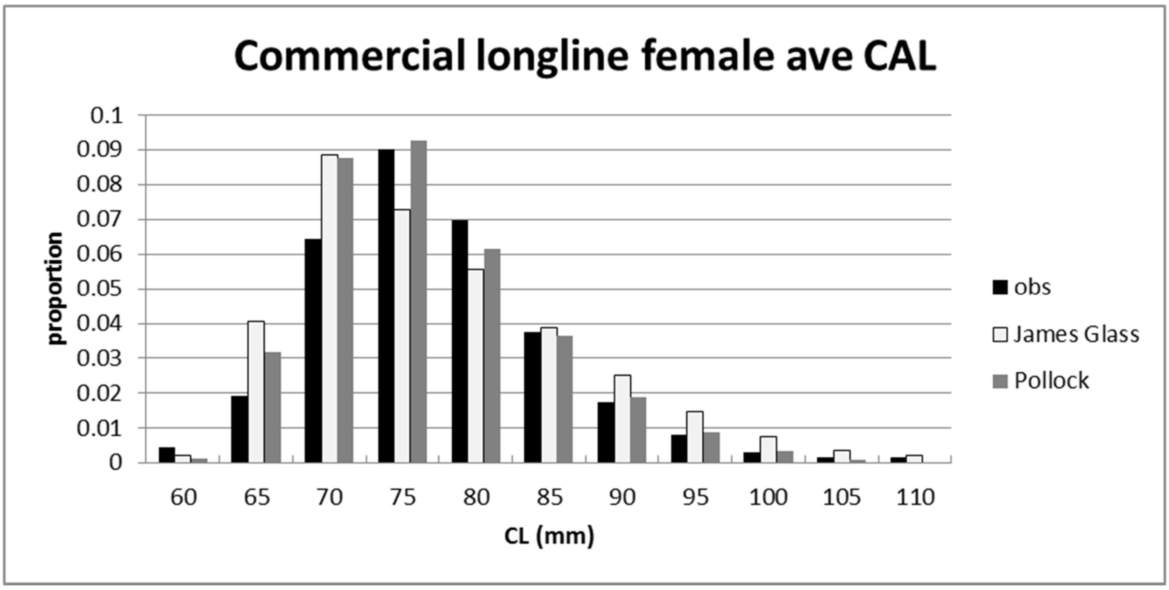
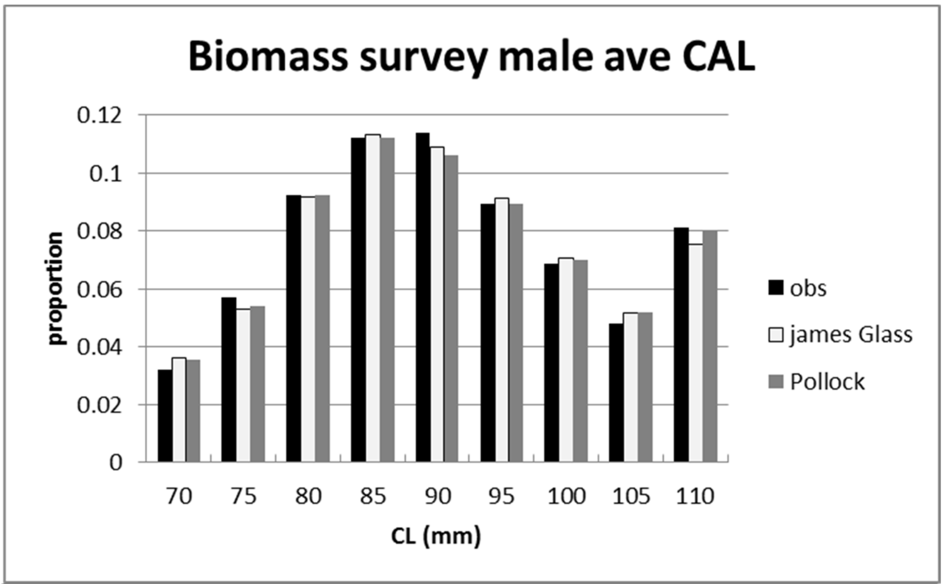


Figure 4e: Gough biomass survey Leg1 CAL fits averaged over years for both growth equations.



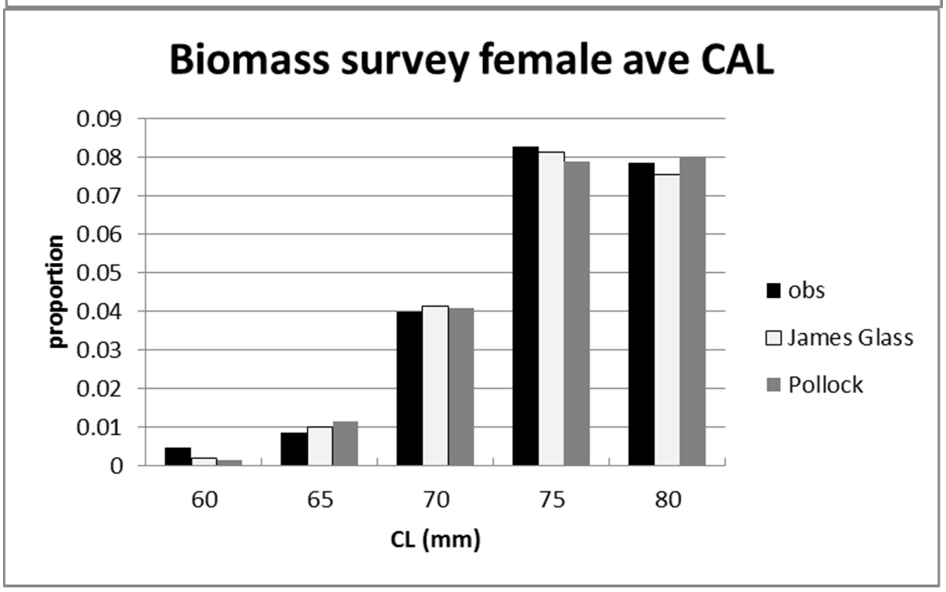


Figure 4f: Gough (James Glass growth) standardised commercial longline CAL residuals. The dark bubbles reflect positive and the light bubbles negative residuals, with the bubble radii proportional to the magnitudes of the residuals.

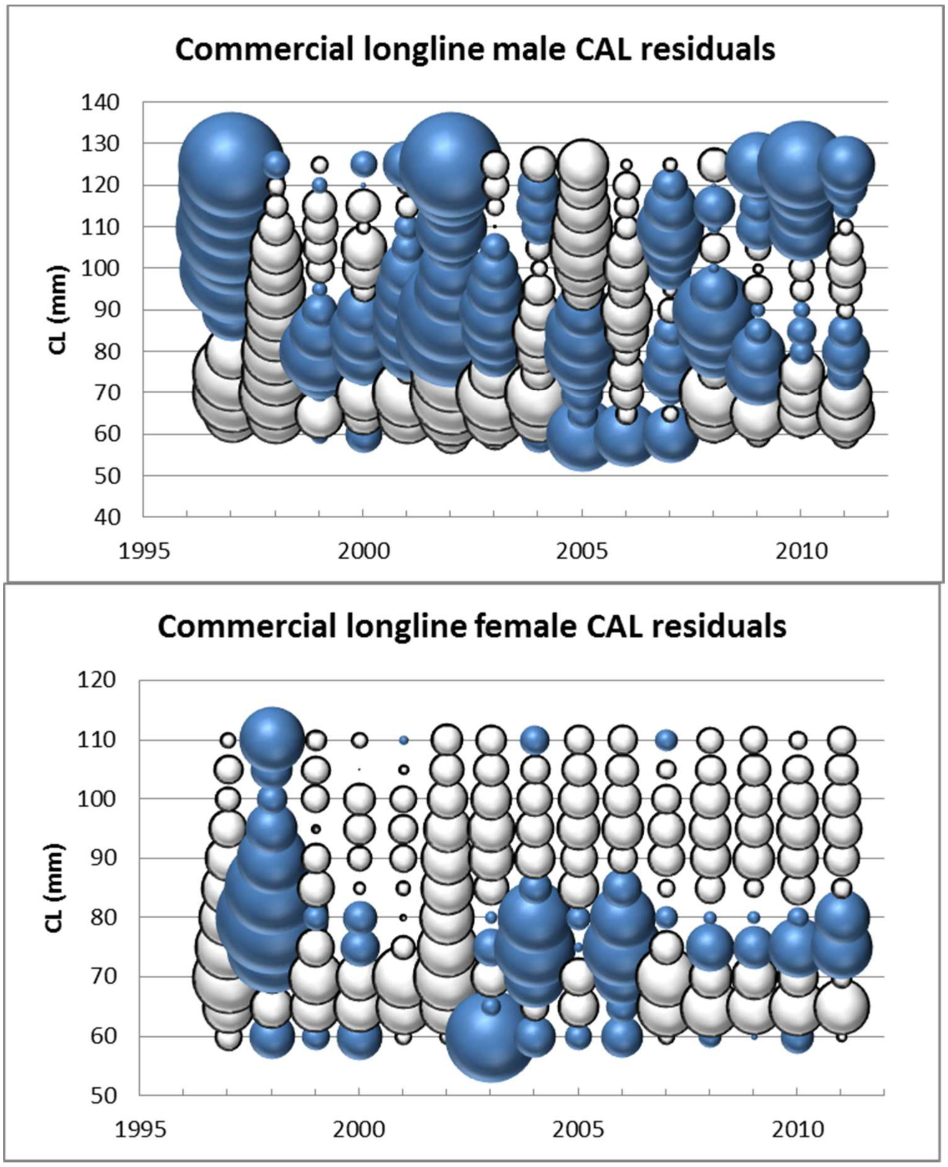
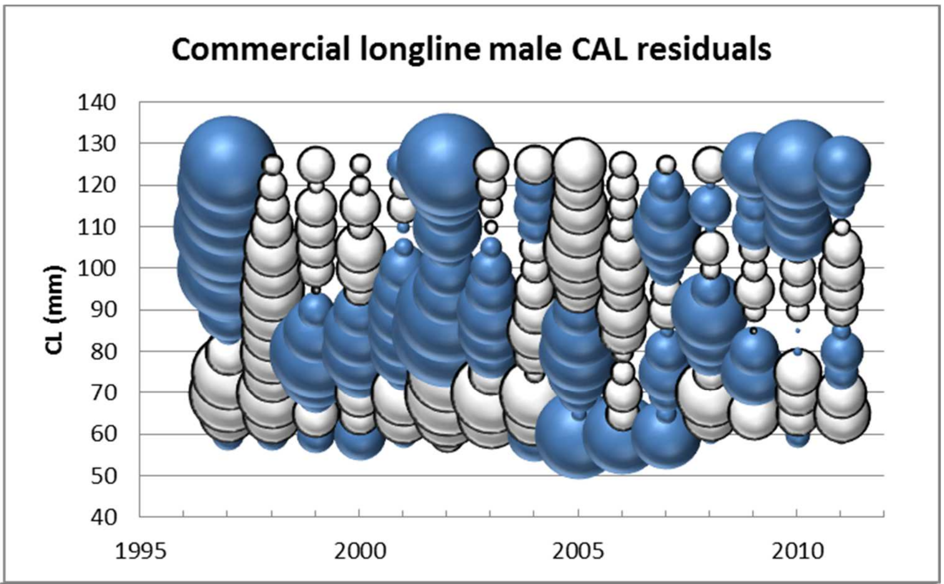


Figure 4g: Gough (Pollock growth) standardised commercial longline CAL residuals. The dark bubbles reflect positive and the light bubbles negative residuals, with the bubble radii proportional to the magnitudes of the residuals.



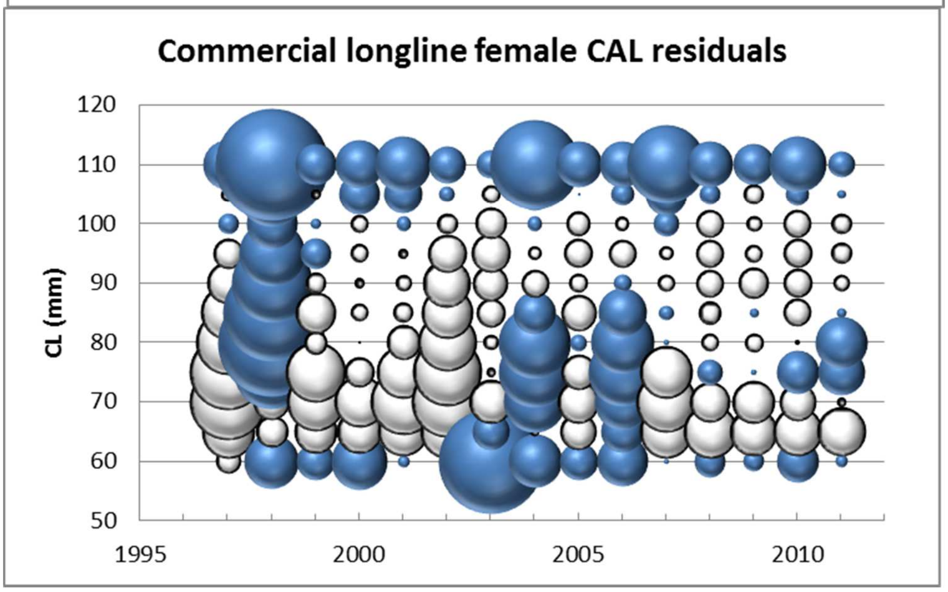
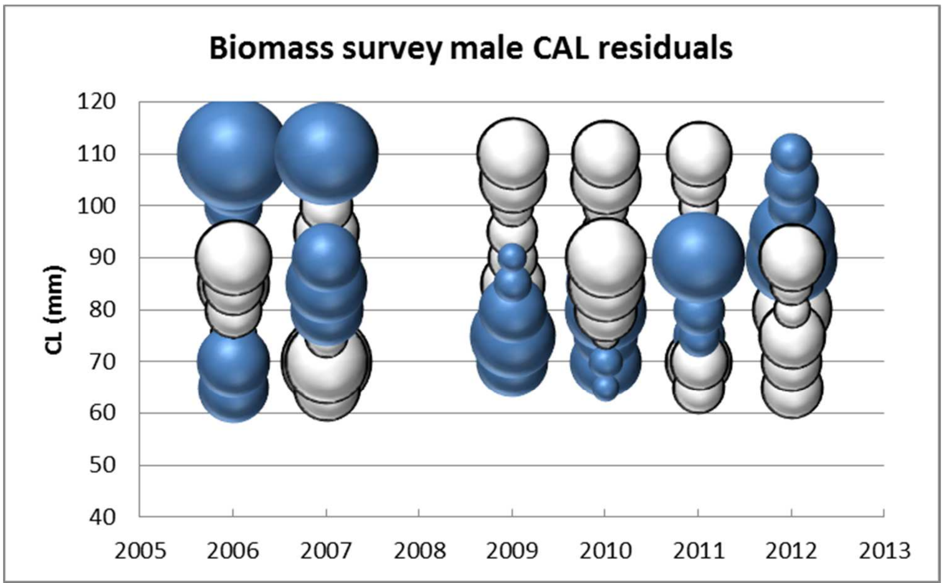


Figure 4h: Gough (James Glass growth) standardised biomass survey Leg1 CAL residuals. The dark bubbles reflect positive and the light bubbles negative residuals, with the bubble radii proportional to the magnitudes of the residuals.



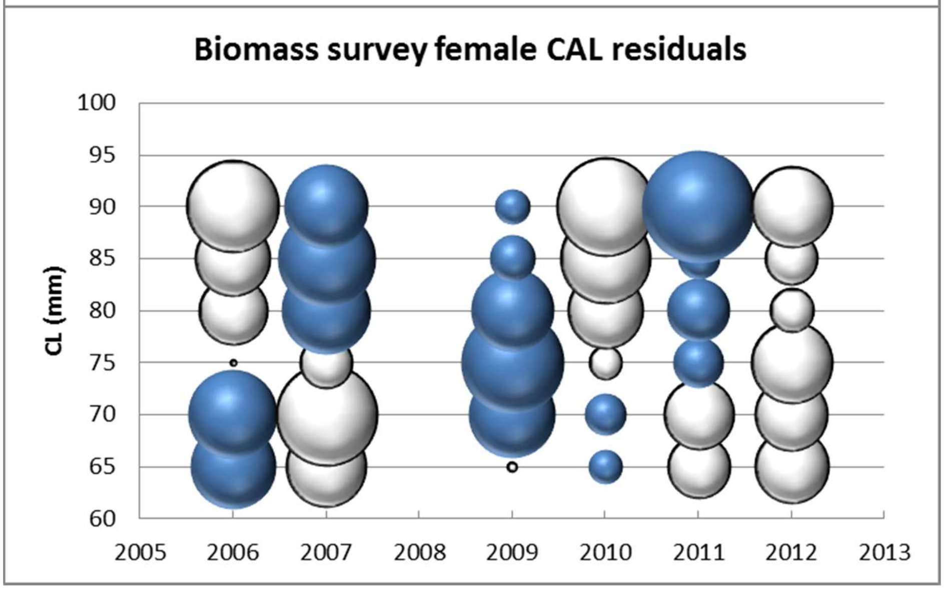


Figure 4i: Gough (Pollock growth) standardised biomass survey Leg1 CAL residuals. The dark bubbles reflect positive and the light bubbles negative residuals, with the bubble radii proportional to the magnitudes of the residuals.

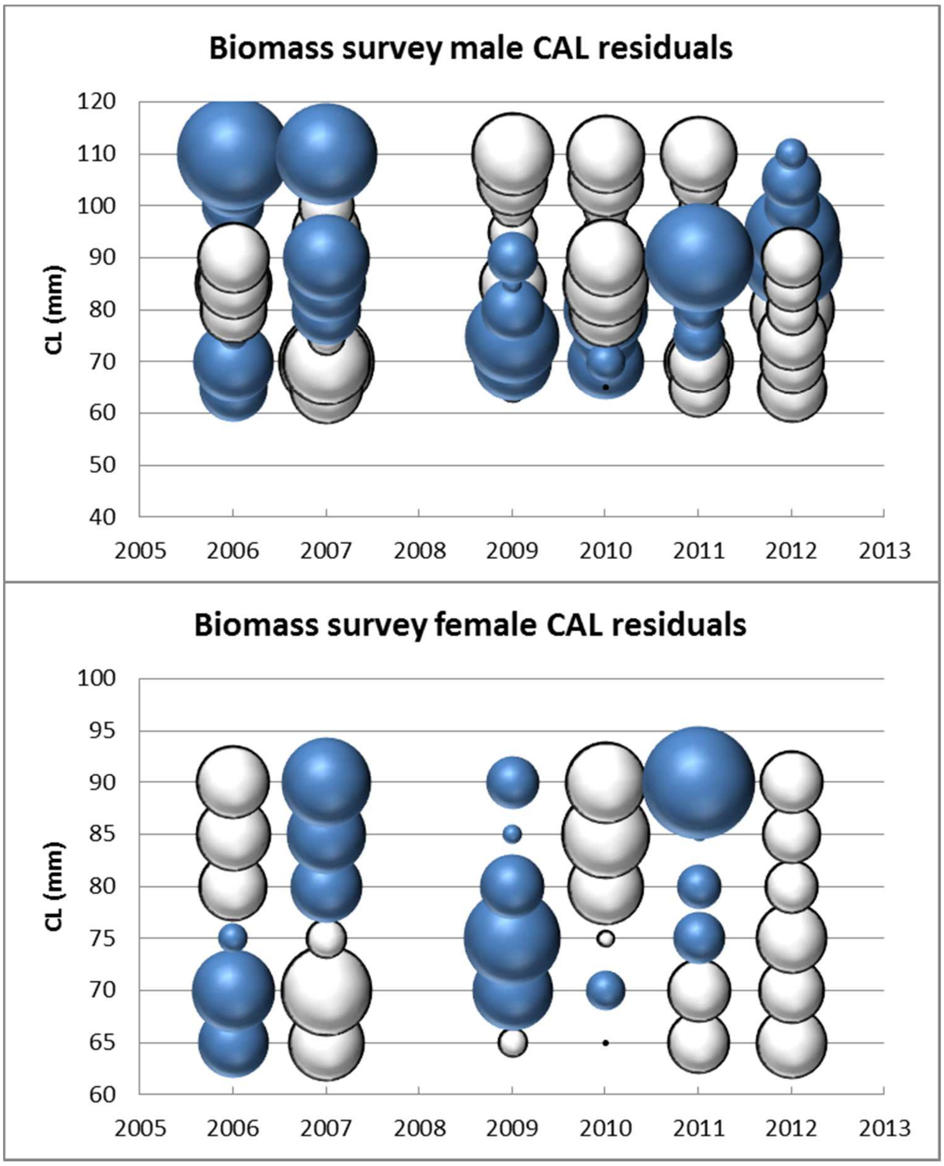
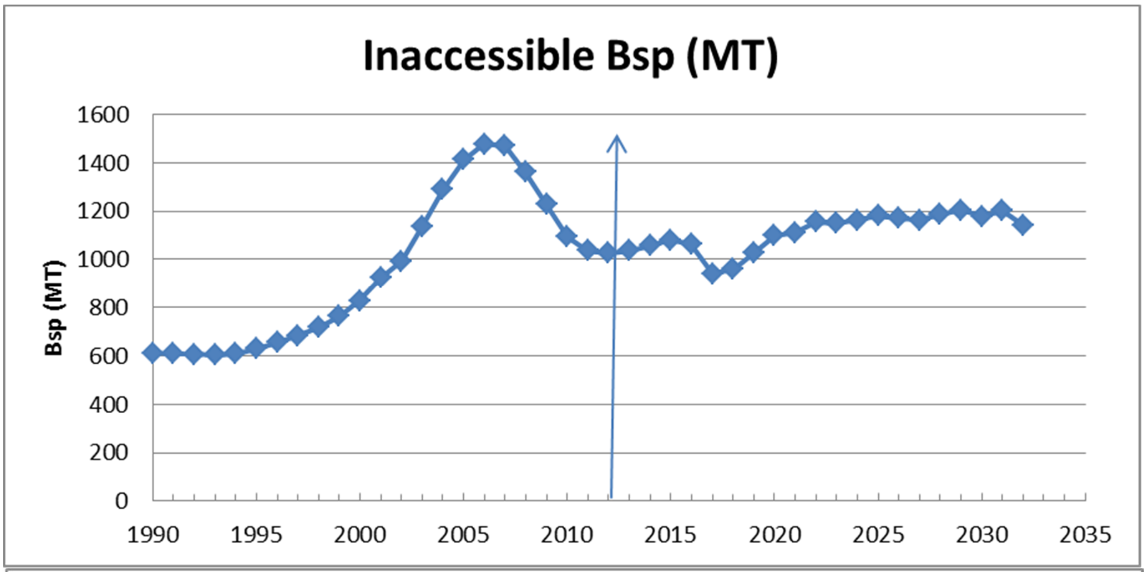


Figure 5: Inaccessible projections of median spawning biomass (Bsp) and catch rate (CR) under a future TAC = 70 MT. The dip in Bsp in 2017 is a reflection of an assumed impact of the oil spill from the OLIVA on recruitment success.



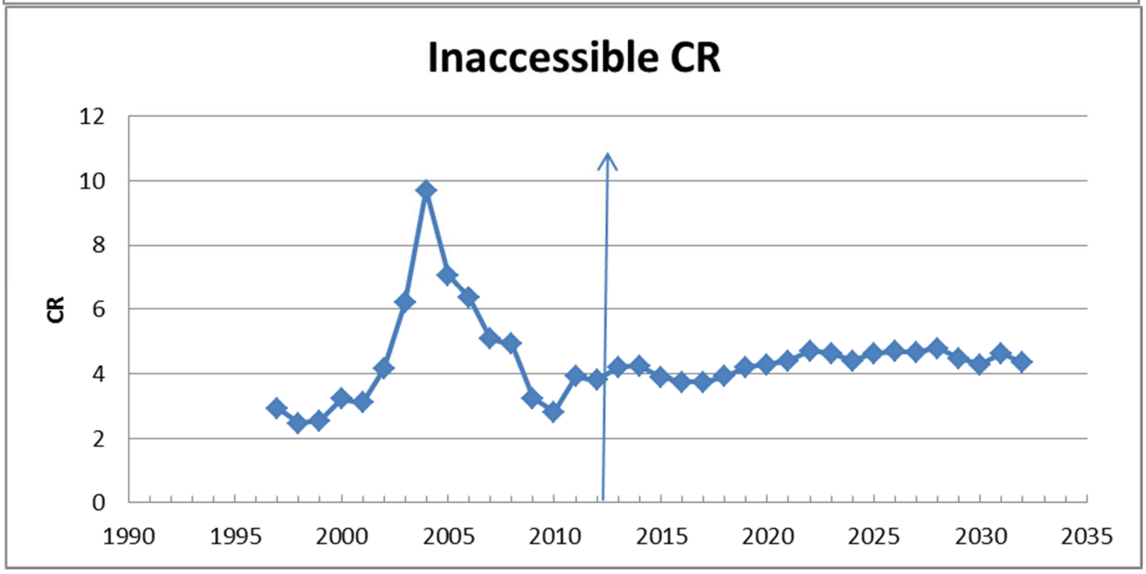
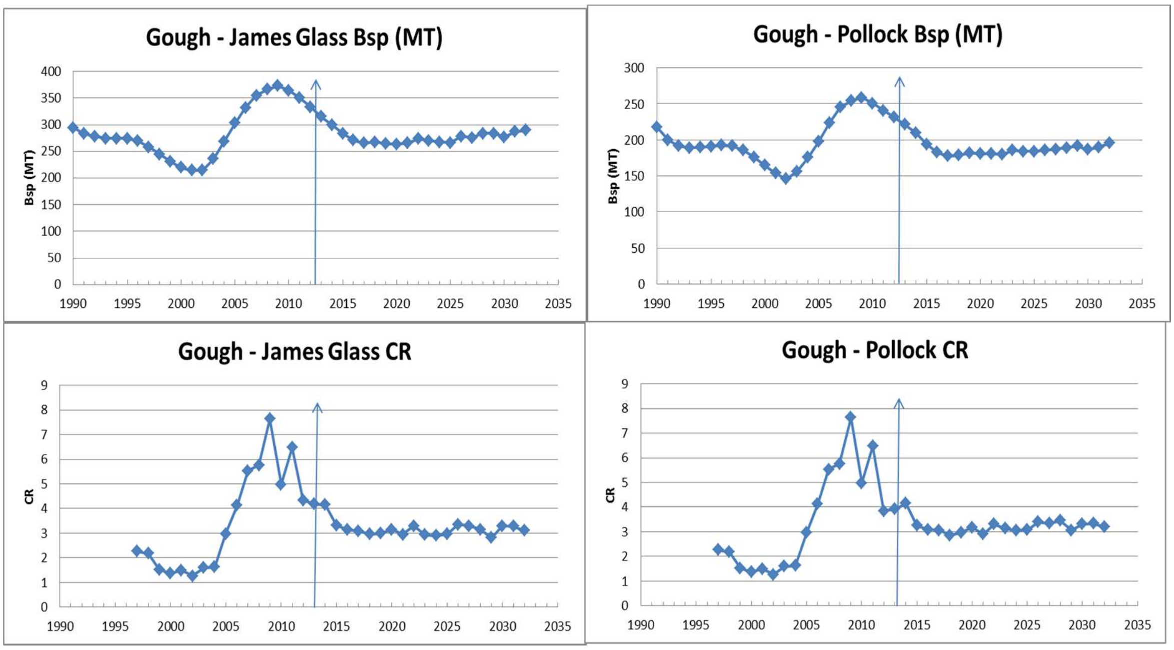


Figure 6: Gough projections of median spawning biomass (Bsp) and catch rate (CR) under a future TAC = 95 MT. Results shown for both the James Glass and the Pollock growth models.



Appendix: Modification of the Gough selectivity functions

James Glass somatic growth model

Commercial Males:

$S_l^{m,comm} = 0$ $\quad l \leq 40$mm CL

$S_l^{m,comm}$ linear increase from 0 at 40mm CL to P1 at 65mm CL

i.e. $S_l^{m,comm} = \frac{P1}{25} l - 40\frac{P1}{25}$ $\quad 40mm \text{ CL } \leq l \leq 65mm \text{ CL}$

$S_l^{m,comm}$ linear increase from P1 at 65mm CL to $S_{70}^{m,comm}$ at 70mm CL

i.e. $S_l^{m,comm} = \left(\frac{S_{70}^{m,comm} - P1}{25}\right) l + P1 - 65\left(\frac{S_{70}^{m,comm} - P1}{5}\right)$ $\quad 65mm \text{ CL } \leq l \leq 70mm \text{ CL}$

Commercial Females:

$S_l^{f,comm} = 0$ $\quad l \leq 55$mm CL

$S_l^{f,comm}$ linear increase from 0 at 55mm CL to P2 at 65mm CL

i.e. $S_l^{f,comm} = \frac{P2}{10} l - 55\frac{P2}{10}$ $\quad 55mm \text{ CL } \leq l \leq 65mm \text{ CL}$

$S_l^{f,comm}$ linear increase from P2 at 65mm CL to $S_{70}^{f,comm}$ at 70mm CL

i.e. $S_l^{f,comm} = \left(\frac{S_{70}^{f,comm} - P2}{5}\right) l + P2 - 65\left(\frac{S_{70}^{f,comm} - P2}{5}\right)$ $\quad 65mm \text{ CL } \leq l \leq 70mm \text{ CL}$

Survey Females:

$S_l^{f,SURV} = 0$ $\quad l \leq 40$mm CL

$S_l^{f,SURV}$ linear increase from 0 at 40mm CL to P3 at 65mm CL

$S_l^{f,SURV}$ linear increase from P3 at 65mm CL to $S_{70}^{f,SURV}$ at 70mm CL

i.e. $S_l^{f,SURV} = \left(\frac{S_{70}^{f,SURV} - P3}{5}\right) l + P3 - 65\left(\frac{S_{70}^{f,SURV} - P3}{5}\right)$ $\quad 65mm \text{ CL } \leq l \leq 70mm \text{ CL}$

with P1, P2 and P3 fixed at: P1 = 0.003, P2 = 0.005, and P3 = 0.0003.

Pollock somatic growth model

Commercial Males: $S_l^{m,comm} = 0$ $\quad l \leq 40$mm CL

$S_l^{m,comm}$ linear increase from 0 at 40mm CL to P1a at 50mm CL

i.e. $S_l^{m,comm} = \frac{P1a}{10} l - 40\frac{P1a}{10}$ $\quad 40mm\text{ CL } \leq l \leq 50mm\text{ CL}$

$S_l^{m,comm}$ linear increase from P1a at 50mm CL to P1b at 55mm CL

i.e. $S_l^{m,comm} = \left(\frac{P1b-P1a}{5}\right) l + P1a - 50(\frac{P1b-P1a}{5})$ $\quad 50mm\text{ CL } \leq l \leq 55mm\text{ CL}$

$S_l^{m,comm}$ linear increase from P1b at 55mm CL to P1c at 60mm CL

i.e. $S_l^{m,comm} = \left(\frac{P1c-P1b}{5}\right) l + P1b - 55(\frac{P1c-P1b}{5})$ $\quad 55mm\text{ CL } \leq l \leq 60mm\text{ CL}$

$S_l^{m,comm}$ linear increase from P1c at 60mm CL to P1d at 65mm CL

i.e. $S_l^{m,comm} = \left(\frac{P1d-P1c}{5}\right) l + P1c - 60(\frac{P1d-P1c}{5})$ $\quad 60mm\text{ CL } \leq l \leq 65mm\text{ CL}$

$S_l^{m,comm}$ linear increase from P1d at 65mm CL to P1e at 70mm CL

i.e. $S_l^{m,comm} = \left(\frac{P1e-P1d}{5}\right) l + P1d - 65(\frac{P1e-P1d}{5})$ $\quad 65mm\text{ CL } \leq l \leq 70mm\text{ CL}$

$S_l^{m,comm}$ linear increase from P1e at 70mm CL to $S_{75}^{m,comm}$ at 75mm CL

i.e. $S_l^{m,comm} = \left(\frac{S_{75}^{m,comm}-P1e}{5}\right) l + P1e - 70(\frac{S_{75}^{m,comm}-P1e}{5})$ $\quad 70mm\text{ CL } \leq l \leq 75mm\text{ CL}$

Commercial Females and *Survey Females* modified as for Gough, with P1a-d, P2 and P3 fixed at:

P1a = 0.001

P1b = 0.001

P1c = 0.0012

P1d = 0.0015

P1e = 0.25

P2 = 0.003

P3 = 0.0003