Revised 2021 assessment of *Jasus tristani* rock lobster at Gough island

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Summary

This paper provides a revised updated assessment of the *Jasus tristani* rock lobster resource at Gough island. This revision constrains the sigma values of the commercial and biomass survey indices to be ≥0.15. It also now takes updated standardised CPUE and discard % data from the commercial fishery for the 2020 season as well as the final catch figure for 2020 into account. This assessment was last fully updated in 2018. This revised updated 2021 assessment has produced somewhat more optimistic results (compared with the 2018 assessment) with respect to current spawning biomass. Current resource abundance is estimated to be 86% of pristine – a very healthy state. This updated assessment model will function as the underlying baseline operating model in the development of a new 2021 OMP.

KEY WORDS: Gough island, *Jasus tristani*, stock assessment

Introduction

The age-structured population model used for this assessment is described fully in Johnston and Butterworth (2021a). The assessment was last updated in 2018 (Johnston and Butterworth 2018) and 2021 (Johnston and Butterworth 2021a). The revised updated 2021 assessment includes the following data (updates **bolded**):

1) Standardised longline CPUE data for 1997-**2020** (Johnston 2021b). Note this GLMM takes length of fishing trip information into account.
2) Biomass survey CPUE data (2006-**2019**, with data for 2008 absent because there was no survey that year).
3) Catch-at-length data from the onboard observers (males and females separate) (1997-**2019**).
4) Catch-at-length data from the biomass survey (males and females separate) (2006-**2019**, with 2008 data absent).
5) Discard % (2003-**2020;** earlier data are not included in the likelihood due to their unreliability).
6) Catch (1990-20**20**).

Whilst Johnston and Butterworth (2021b) reported updated 2021 assessment results for Gough, it was later realised that the overly good fit of the assessment model to commercial CPUE data, and hence a rather σ value, was inappropriate. The assessment consequently needed to be revised by constraining the σ values for both the commercial CPUE and the biomass survey indices not to be less than some plausible minimum, now taken here to be ≥0.15. This is an approach commonly used when the estimation flexibility introduced by allowing for recruitment variability allows overfitting of an abundance index series.

The modification to the earlier 2021 assessment to omit pre-2003 Discard % data (due to the fact that these data are now considered questionable as they show little difference from subsequent data despite a 5mm increase in minimum size at that time) has been retained.

Sensitivity models

Results are initially run for the same set of assumptions assumed in 2018. Table 1 reports these Reference case model assumptions. A series of sensitivity models are then run to explore the sensitivity of the assessment results to these assumptions. These are:

Sen1: fix h = 0.90

Sen2: fix h = 0.80

Sen3: fix h = 0.70

Sen3b: fox h=0.50

Sen4: M=0.2

Sen5: d = 0.2

Sen6: F_{2009}=0.3

Sen7: CPUE and survey index σ constraint increased to ≥ 0.20 (from 0.15)

Results

RC model fits

Table 3a reports the Gough 2021 updated RC assessment results, and provides the 2018 assessment results for comparison.

Figure 2 shows the estimated selectivity functions for both the commercial and biomass survey gears. Figures 3a and b show the time-varying selectivity values of the estimated parameters μ and P.

Figures 4a and b show the average fits to the catch-at-length data for males and females for both the commercial and biomass survey data.

Figures 5a and b show the standardised CAL residuals for the commercial and biomass survey data. The dark bubbles reflect positive and the light bubbles negative residuals, with the bubble radii proportional to the magnitudes of the residuals.

Results of sensitivity model fits

Table 3b reports results for the sensitivity models.

Discussion

The current Bsp/K is estimated to be healthy at 0.86. Compared to the 2018 assessment results, the updated assessment is more optimistic in terms of current spawning biomass. This is a result of a number of factors: fitting to further data; estimation of a new female selectivity parameter, removal of pre-2003 Discard % data from the likelihood, and finally changing the RC *M* assumption from 0.2 to 0.1 yr^{-1} and the F_{2009} assumption of 0.3 to 0.2 following initial model fits indicating that these changes were appropriate (as they resulted in better fits to the data). The new 2021 OMP development will explore robustness of performance to the various sensitivity tests.

Removing the 1997-2002 Discard % data from the likelihood has improved fits to the CPUE and CAL data. The model fit to the commercial CPUE data remains reasonably good (Figure 1). The model is unable to reproduce the high discard rate values reported in recent years. In order to improve the fit to these data, the selectivity of smaller sub-legal lobsters would need to be increased; however, the commercial catch-at-length data would not support that, as the model currently overestimates the sub-legal CAL frequencies (Figure 4a). The recent discard % data and the commercial CAL data are thus not entirely compatible.

References

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Johnston, S.J. 2021b. Updated 2021 GLMM -standardised lobster CPUE from Gough Island of the Tristan da Cunha outer group of islands. MARAM/Tristan/2021/MAY/06.

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.

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Table 1: Natural mortality estimates obtained from the RAM legacy database.

Lobster stock	***M yr*$^{-1}$**
American lobster Georges Bank	0.150
American lobster Gulf of Maine	0.150
American lobster Southern New England	0.150
Yellow squat lobster Central-Southern Chile	0.300
Yellow squat lobster Northern Chile	0.300
Red squat lobster Central-Southern Chile	0.350
Red squat lobster Northern Chile	0.350
West coast rock lobster South Africa Areas 1-2	0.110
West coast rock lobster South Africa Areas 3-4	0.110
West coast rock lobster South Africa Areas 5-6	0.110
West coast rock lobster South Africa Area 7	0.110
West coast rock lobster South Africa Area 8	0.110
Southern spiny lobster South Africa South coast	0.100
Red rock lobster New Zealand Area CRA1	0.125
Red rock lobster New Zealand Area CRA2	0.161
Red rock lobster New Zealand Area CRA3	0.251
Red rock lobster New Zealand Area CRA4	0.322
Red rock lobster New Zealand Area CRA5	0.132
Red rock lobster New Zealand Area CRA7	0.103
Red rock lobster New Zealand Area CRA8	0.095
Rock lobster South Australia Northern Zone	0.100
Rock lobster South Australia Southern Zone	0.100
Average	0.171

Table 2: Reference case model assumptions.

	2018 assessment	**2021 assessment**
M natural mortality	0.2	0.1
Mean of the prior on *h* (the SR steepness parameter)	0.95	0.95
d (discard mortality rate)	0.1	0.1
F(2009) (harvest proportion in 2009)	0.3	0.2

Table 3a: Gough updated 2021 assessment results for the Reference Case (RC) model. The 2018 assessment results are reported in the first column to allow comparison. The shaded values are fixed on input.

	2018 RC assessment	**2021 RC assessment**
# parameters	105	113
K	302	302
h	0.87	0.90
M	0.2	0.1
d (discard mortality rate)	0.1	0.1
σ_{length}	0.2	0.2
F_{2009} fixed at	0.3	0.2
θ	0.616	0.637
Bsp(1990)/Ksp	0.58	0.59
Bsp(2018)/Ksp	0.77	0.85
Bsp(2020)/Ksp	-	0.86
Bexp(2017) (Bexp(2017)/Bexp(1990))	134 (0.93)	138 (0.86)
Bexp (2019) (Bexp(2019)/Bexp(1990))	-	175 (1.09)
Programs	Gough18.tpl	qGough21y.tpl

Table 3b: Gough 2021 assessment sensitivity model results. Fixed parameter values are in shaded block. Values in red are those altered from the RC.

	RC	**Sen1** **Fix *h*=0.90**	**Sen2** **Fix *h*=0.80**	**Sen3** **Fix *h*=0.70**	**Sen3b** **Fix *h*=0.50**	**Sen4** ***M*=0.2**	**Sen5** ***d*=0.2**	**Sen6** **F_{2009}=0.3**	**Sen7** **CPUE and survey** **$\sigma \geq 0.20$**
K	**302**	289	282	296	353	315	276	260	278
h	**0.90**	**Fix=0.90**	**Fix=0.80**	**Fix=0.70**	**Fix=0.50**	0.88	0.91	0.92	0.91
M	**0.1**	0.1	0.1	0.1	0.1	**0.2**	0.1	0.1	0.1
h prior mean	**0.95**	-	-	-	-	0.95	0.95	0.95	0.95
d (discard mortality rate)	**0.1**	0.1	0.1	0.1	0.1	0.1	**0.2**	0.1	0.1
F_{2009} fixed at	**0.2**	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2
θ	**0.637**	0.660	0.606	0.609	0.518	0.690	0.685	0.717	0.703
-lnL total	**15.71**	15.35	19.83	20.19	21.64	20.58	19.70	19.51	16.22
-lnL CPUE T	**-15.34**	-15.23	-15.42	-15.45	-15.26	-15.46	-15.43	-15.05	-13.29
-lnL CPUE longline	**-5.57** **(0.15)**	-5.57 (0.15)	-5.79 (0.15)	-5.82 (0.15)	-5.72 (0.15)	-5.67 (0.15)	-5.82 (0.15)	-5.39 (0.15)	-3.64 (0.20)
-lnL CPUE Survey Leg1	**-9.76** **(0.275)**	-9.66 (0.275)	-9.63 (0.275)	-9.63 (0.275)	-9.54 (0.276)	-9.79 (0.272)	-9.61 (0.276)	-9.46 (0.279)	-9.65 (0.275)
-lnL CAL T	**293.79**	206.80	254.84	255.07	248.74	260.30	254.98	257.37	202.11
-lnL CAL onboard observer	**326** **(0.134)**	330.10 (0.136)	399.20 (0.148)	379.15 (0.148)	372.25 (0.146)	385.17 (0.150)	379.83 (0.148)	383.00 (0.149)	326.53 (0.134)
-lnL CAL Survey Leg 1	**-122.66** **(0.076)**	-123.70 (0.076)	-124.37 (0.075)	-124.07 (0.075)	-123.51 (0.076)	-124.87 (0.075)	-124.86 (0.076)	-125.64 (0.076)	-124.42 (0.075)
SR1 pen	**3.63**	3.42	2.98	2.85	2.78	3.54	3.10	2.77	3.10
-lnL discard	**3.72**	3.78	3.48	3.46	3.41	3.43	3.56	3.49	3.62
Bsp(1990)/Ksp	**0.59**	0.61	0.61	0.57	0.48	0.64	0.64	0.67	0.65
Bsp(2018)/Ksp	**0.85**	0.84	0.80	0.79	0.71	0.87	0.81	0.82	0.85
Bsp(2020)/Ksp	**0.86**	0.84	0.81	0.80	0.73	0.87	0.82	0.82	0.86
Bexp(2017) (Bexp(2017)/Bexp(1990))	**138** **(0.86)**	130 (0.82)	130 (0.78)	131 (0.82)	141 (0.87)	131 (0.84)	128 (0.75)	112 (0.68)	118 (0.74)
Bexp (2019) (Bexp(2019)/Bexp(1990))	**175** **(1.09)**	174 (1.10)	162 (0.97)	164 (1.02)	176 (1.08)	164 (1.05)	160 (0.94)	`40 (0.85)	147 (0.92)
Programs	qGough21y.tpl	qgS1.tpl	qgS2.tpl	qgS3.tpl	qgS3b.tpl	qgS4.tpl	qgS5.tpl	qgS6.tpl	qgS6.tpl

Figure 1: Gough 2021 revised RC assessment results. The green dashed lines indicate the 2018 assessment's estimated values.

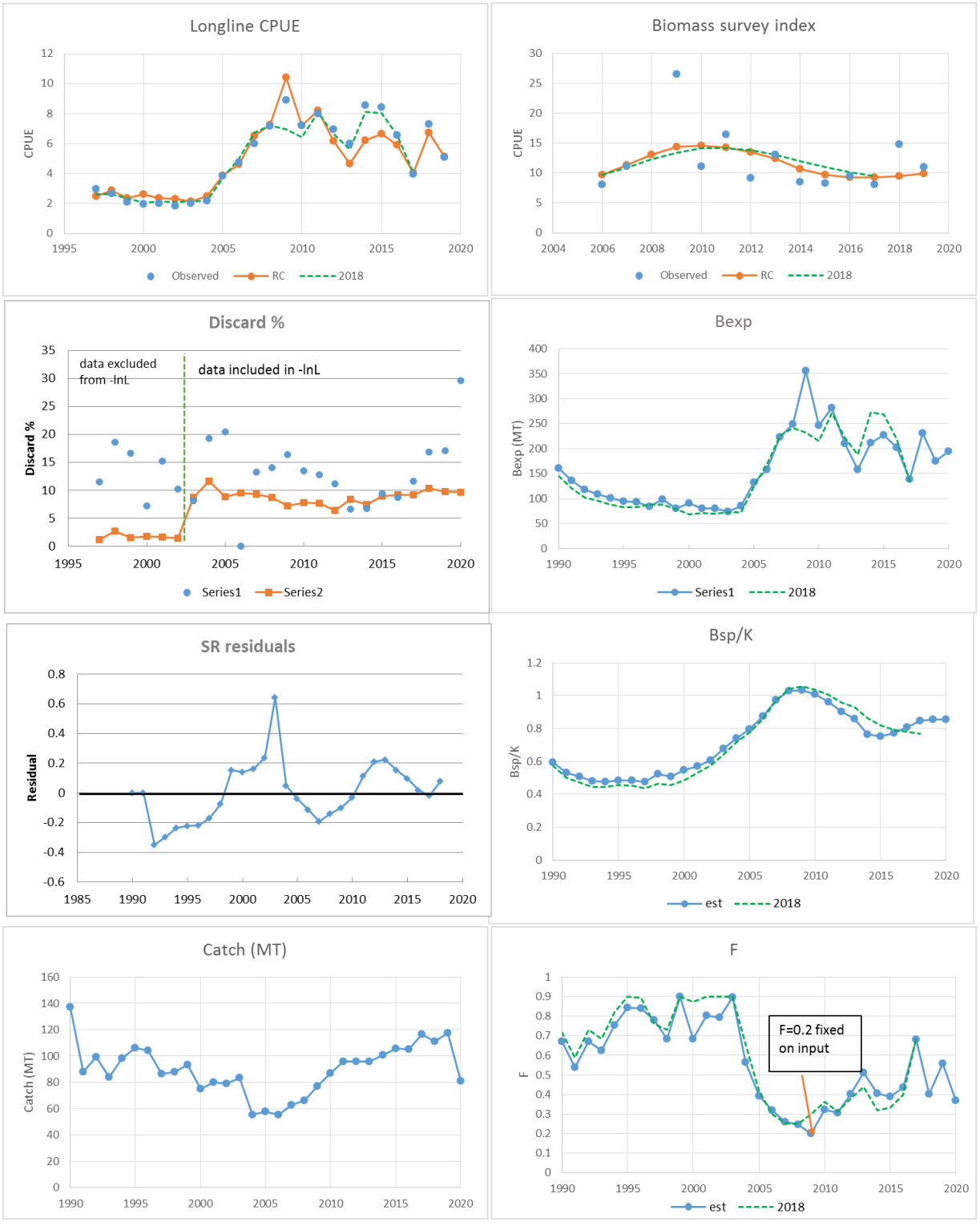
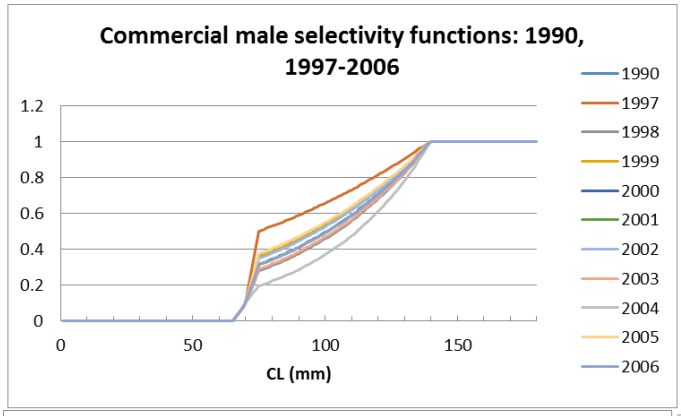
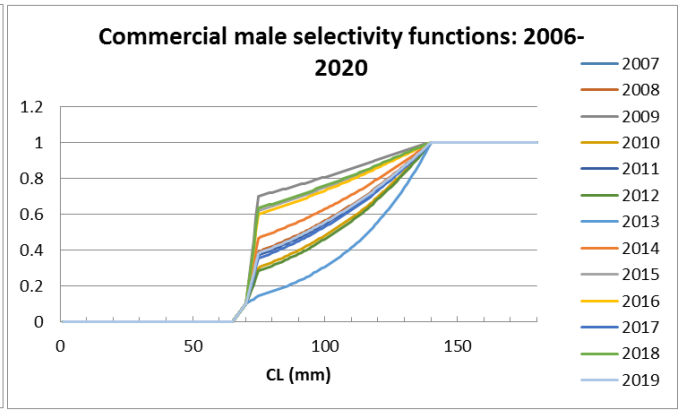
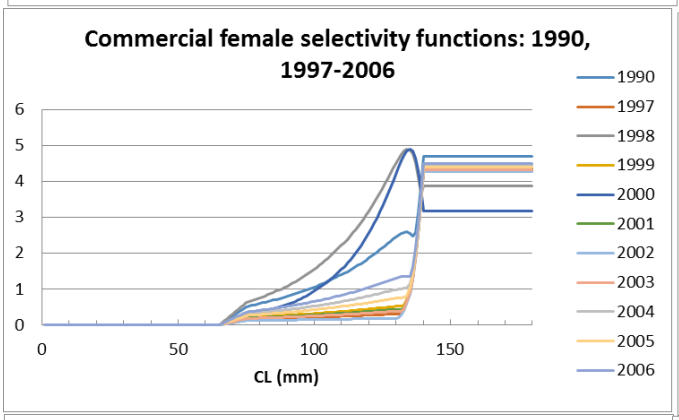
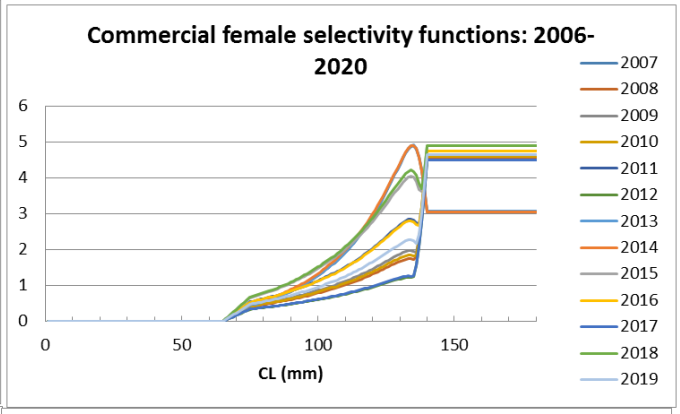


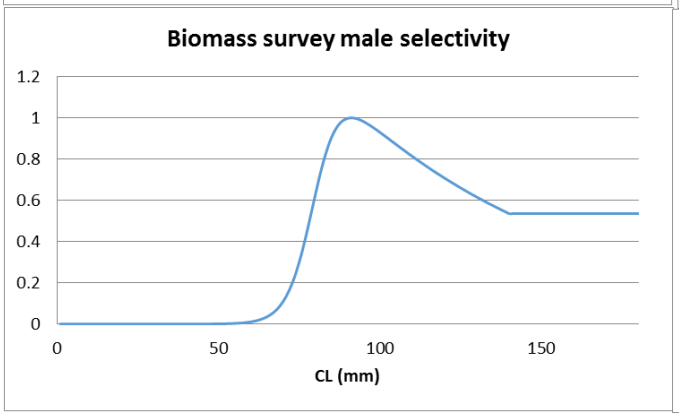
Figure 2: Gough revised RC assessment selectivity functions.











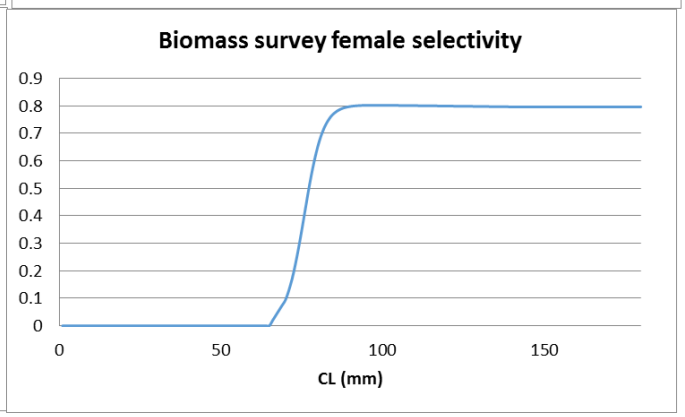


Figure 3a: Gough revised RC assessment estimated μ residuals (used for selectivity function variability).

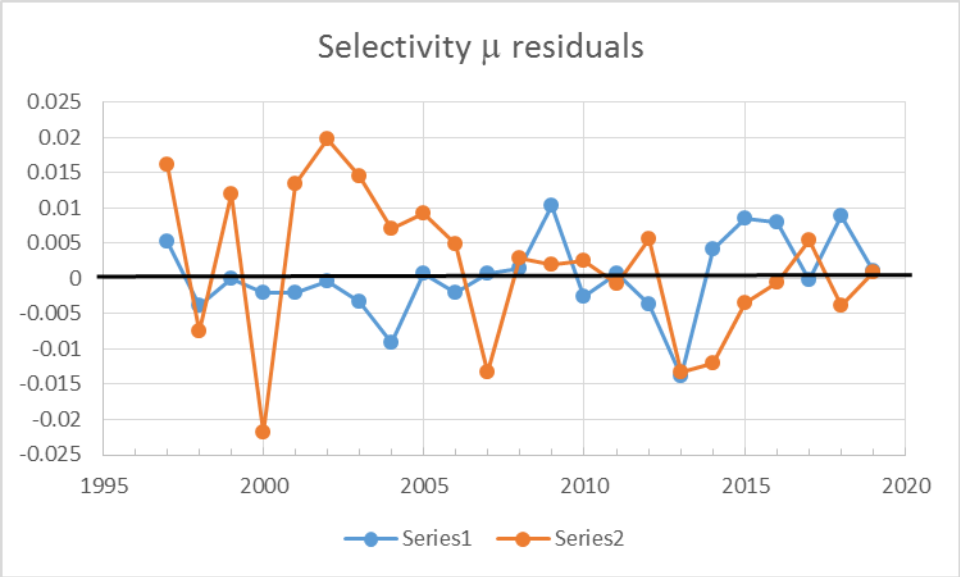


Figure 3b: Gough revised RC assessment estimated P residuals (used for female selectivity function variability).

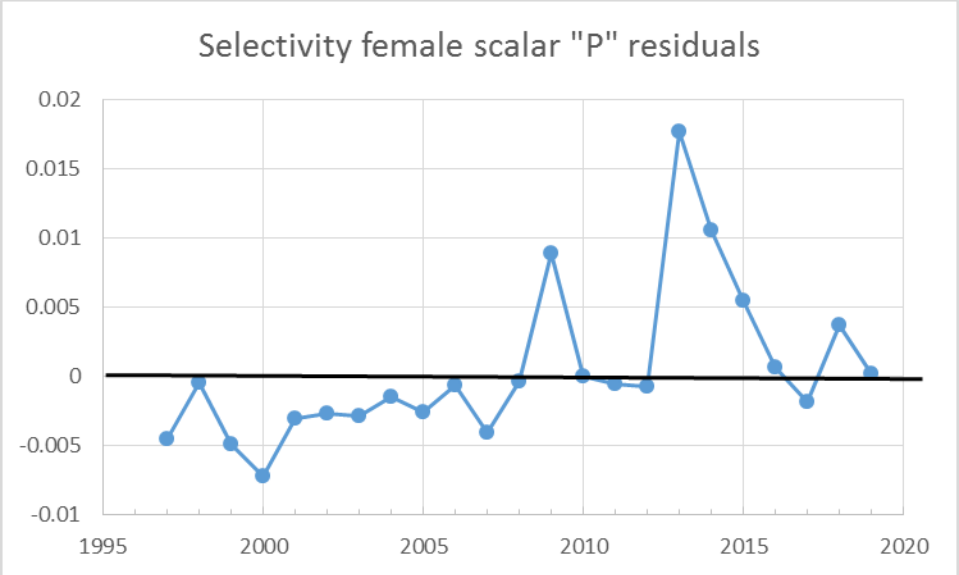
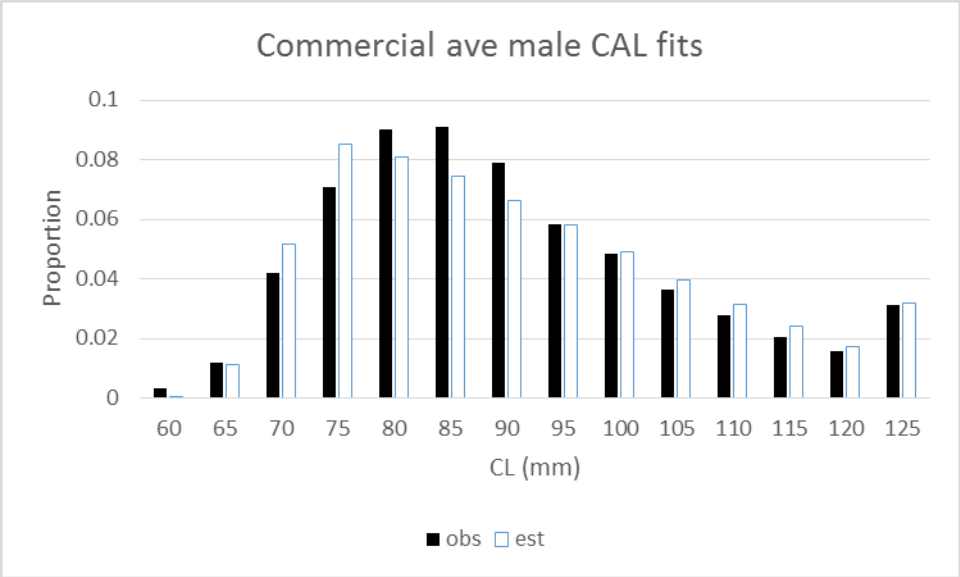


Figure 4a: Gough revised RC assessment commercial longline CAL fits averaged over years.



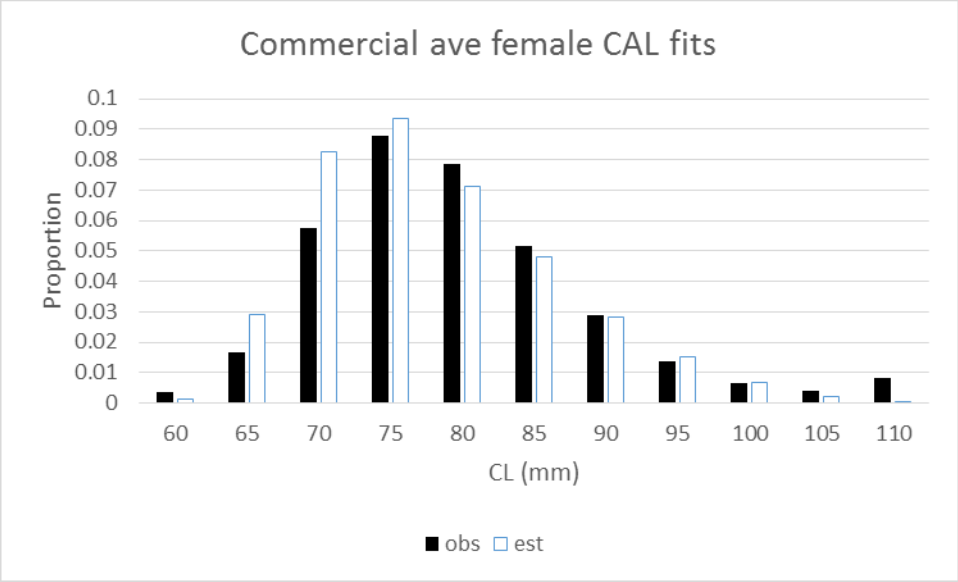
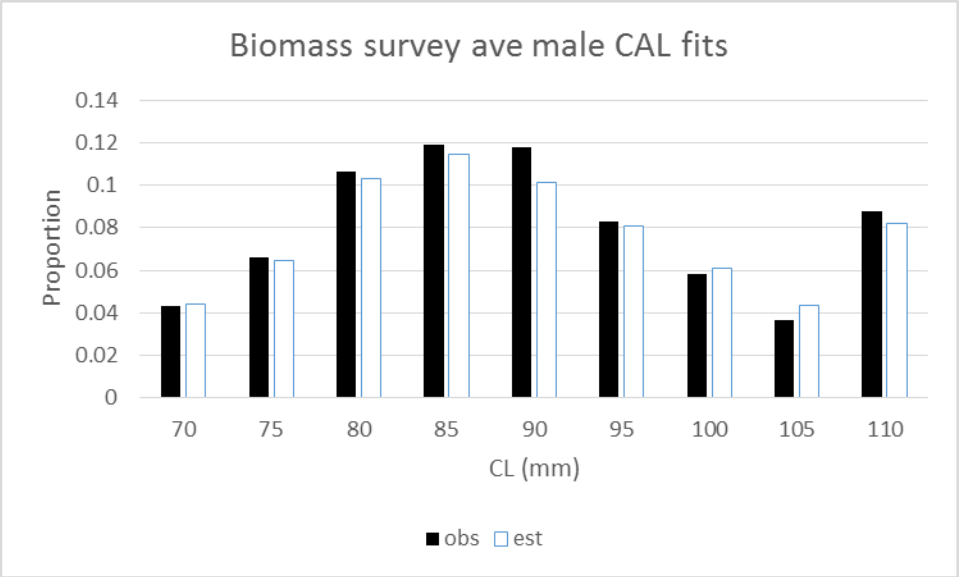


Figure 4b: Gough revised RC assessment biomass survey CAL fits averaged over years.



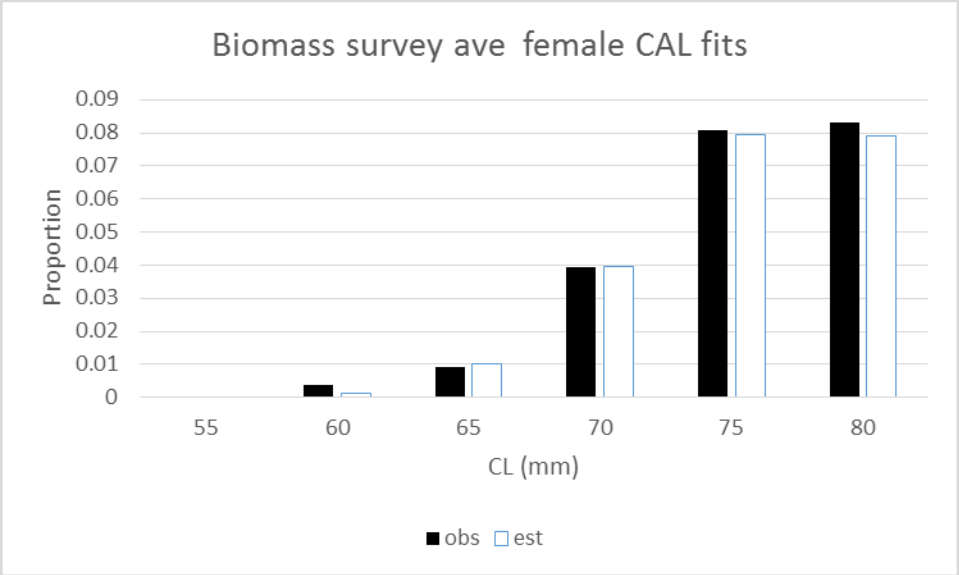
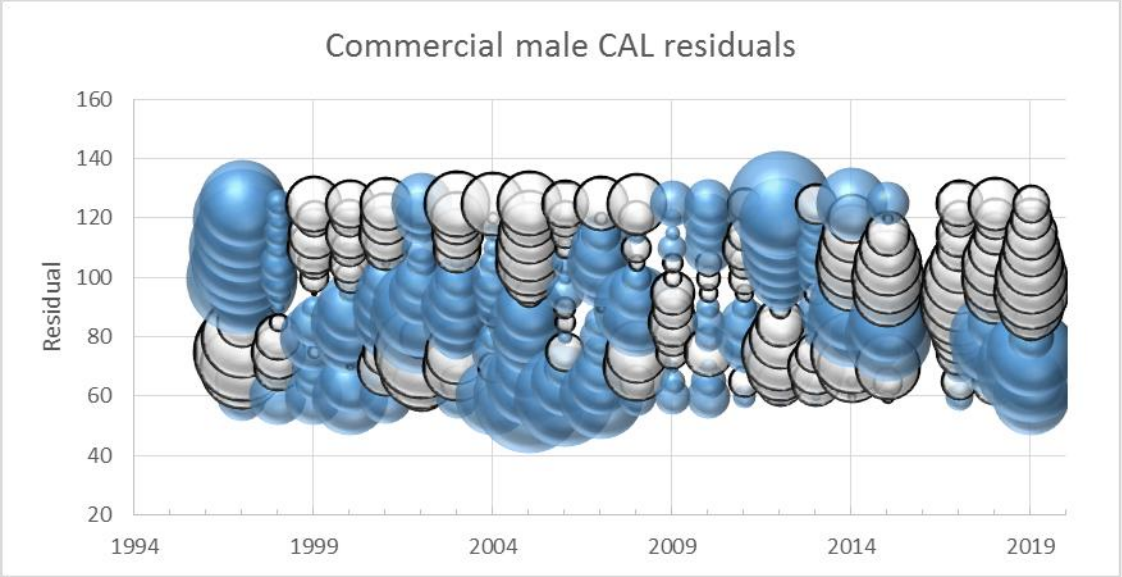


Figure 5a: Gough revised RC assessment standardised commercial longline CAL residuals. The dark bubbles reflect positive and the light bubbles negative residuals, with the bubble radii proportional to the magnitudes of the residuals.



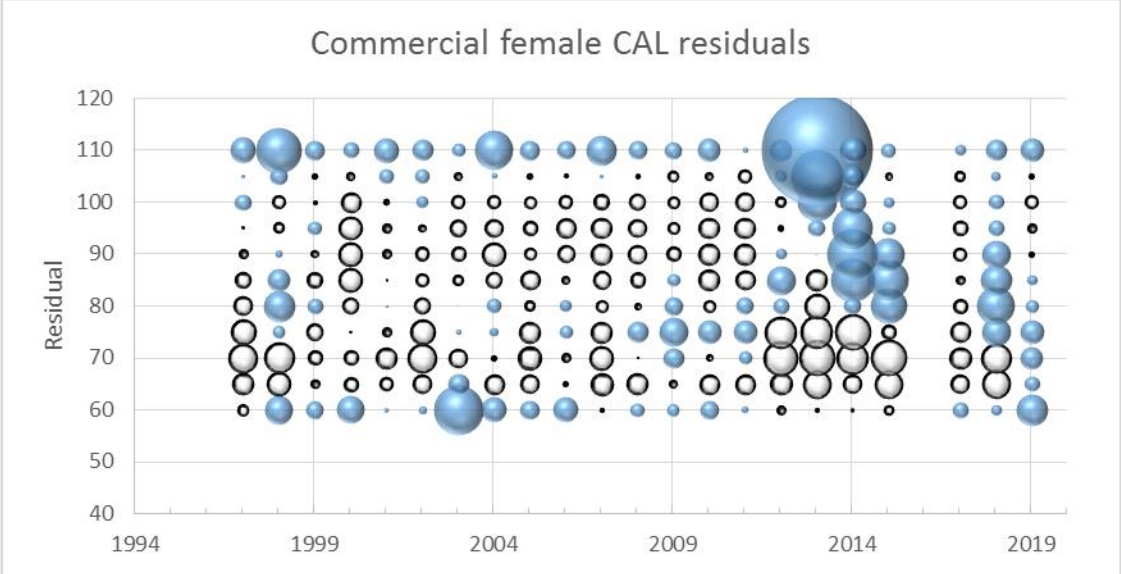


Figure 5b: Gough revised RC assessment standardised biomass survey Leg1 CAL residuals. The dark bubbles reflect positive and the light bubbles negative residuals, with the bubble radii proportional to the magnitudes of the residuals.