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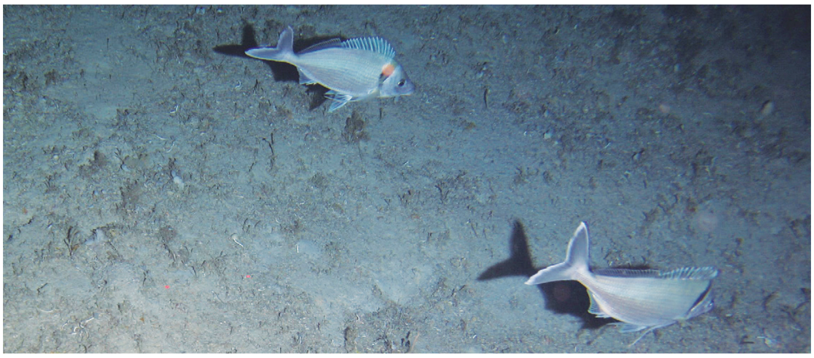
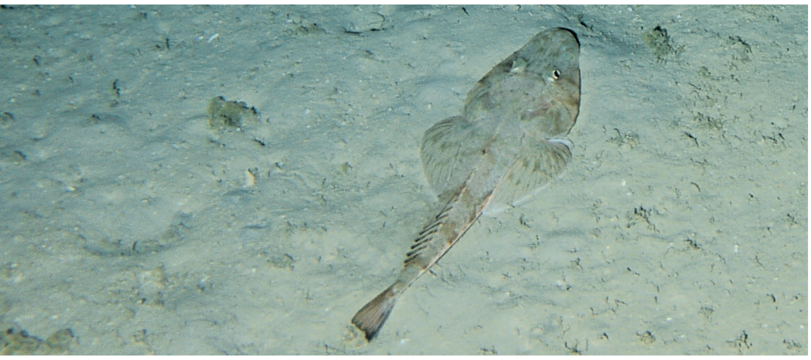
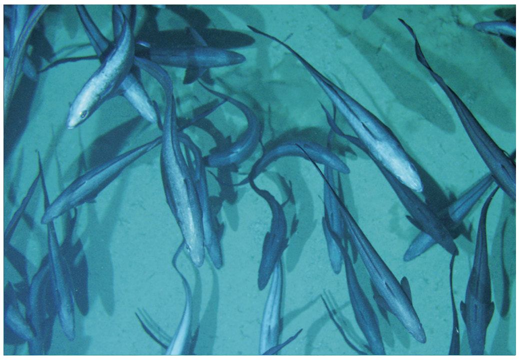
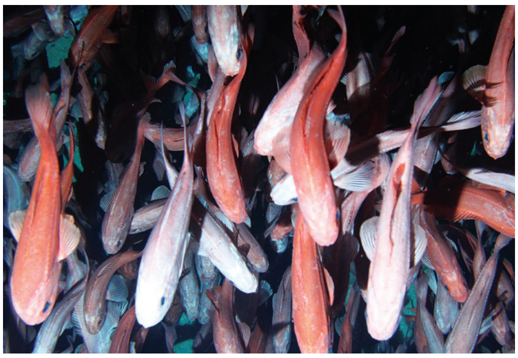
Stock Assessment for the Southern and Eastern Scalefish and Shark Fishery: 2015



PART 1







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Cover photographs

Front cover, jackass morwong, orange roughy, blue grenadier, and flathead.

Report structure

Part 1 of this report describes the Tier 1 assessments of 2015. Part 2 describes the Tier 3 and Tier 4 assessments, catch rate standardisations and other work contributing to the assessment and management of SESSF stocks in 2015.

Stock Assessment for the Southern and Eastern Scalefish and Shark Fishery: 2015

Part 1: Tier 1 assessments

G.N. Tuck
June 2016
Report 2014/0818

Australian Fisheries Management Authority

Stock Assessment for the Southern and Eastern Scalefish and Shark Fishery: 2015
Part 1

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11. Assessment of the western stock of Jackass Morwong (*Nemadactylus macropterus*) based on data up to 2014

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11.1 Summary

This chapter presents the data and results from the 2015 assessment of the western stock of jackass morwong *Nemadactylus macropterus* in the Southern and Eastern Scalefish and Shark Fishery (SESSF). The assessment uses an age- and size-structured model implemented using the generalized stock assessment software package, Stock Synthesis (SS). The assessment includes data up to the end of the 2014 calendar year. Data include annual landings, catch rates, and length/age compositions.

The 2015 base case assessment of the western stock of jackass morwong estimates the 2016 spawning biomass to be 69% of unexploited biomass. In comparison, the last full assessment in 2011 estimated the 2012 spawning biomass to be 67% of unexploited biomass. The female equilibrium spawning biomass in 1986 is estimated to be 1,349 t and in 2016 the female spawning biomass is estimated to be 936 t. The RBC for the base case assessment for the western stock of jackass morwong under the 20:35:48 harvest control rule is 249 t. The long-term RBC is 159 t.

It should be noted that the assessment for the western stock is increasingly uncertain, as (i) there are only sporadic age data available, (ii) length compositions are based on low numbers of sampled fish and (iii) the catch in the western region is now very low. There is also strong conflict between the length data and the catch rate data. As such, the robustness of model results should be questioned. Models where greater emphasis is given to the trend evident in the abundance index should be considered, including Tier 4 for this stock.

11.2 Introduction

An integrated analysis model, implemented using the generalized stock assessment software package, Stock Synthesis (SS) (Methot, 2011; Methot and Wetzel, 2013. V3.24U), was applied to the western stock of jackass morwong of the SESSF, with data from the 1986 to the 2014 calendar year (length and age data; age-error, catch rate series; Fishery Independent Survey (FIS), and landings). The model fits directly to length frequencies and conditional age-at-length data.

The population dynamics model, and the statistical approach used in the fitting of the model to the various types of data, is outlined fully in the SS user manual (Methot, 2005; 2011) and is not reproduced here.

11.3 Data

The assessment data for the western (Zones 40/50) stock of jackass morwong assumes a single trawl fleet. Data series have been updated to the end of 2014. Length data have been separated into samples collected in port and onboard commercial trawl vessels, with a single trawl selectivity function estimated. Other data series include age-at-length data, catch rate series (Sporcic and Haddon, 2015), the FIS (Knuckey et al, 2015), the annual total mass landed, and age-reading error.

11.3.1 *Catch and catch rates*

Landed catch data for the western stock of jackass morwong since 2011 were updated by scaling up logbook data using the ratio of total landed morwong catch to total logbook morwong catch. The catches for the years prior to 2012 were the same as those on which the 2011 assessment was based. After peaking in the early 2000s, catch has since declined substantially, to be less than 50 t per year since 2012 (Table 11.1; Figure 11.1).

Table 11.1. Landed morwong catches (mt) and catch rates for the western stock of jackass morwong.

	Catch (mt)	CPUE
1986	153	1.97
1987	60	1.54
1988	67	2.30
1989	85	1.67
1990	83	1.68
1991	47	1.15
1992	72	0.93
1993	27	0.90
1994	27	0.87
1995	91	0.92
1996	44	1.01
1997	62	0.80
1998	65	0.84
1999	89	0.77
2000	134	1.11
2001	316	1.20
2002	289	1.20
2003	199	1.01
2004	216	1.07
2005	230	1.15
2006	217	0.92
2007	140	0.75
2008	124	0.76
2009	77	0.61
2010	47	0.44
2011	99	0.47
2012	41	0.35
2013	42	0.34
2014	13	0.26

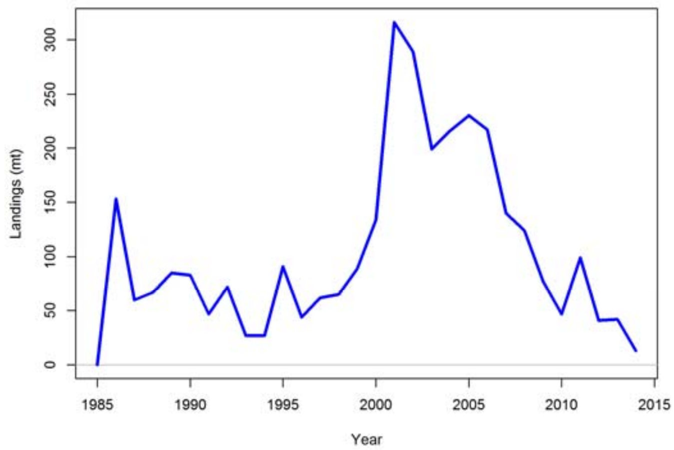


Figure 11.1. Landed morwong catches (mt) for the western stock of jackass morwong

Sporcic and Haddon (2015) provide the updated standardized catch rate series for the western stock of jackass morwong (Figure 11.2). After a substantial decline in catch rate from the mid-1980s to early 1990s, the catch rate levelled before showing a further decline from the mid-2000s. The catch rate series from the updated analysis is similar to that used in the last assessment in 2011 (Wayte, 2011).

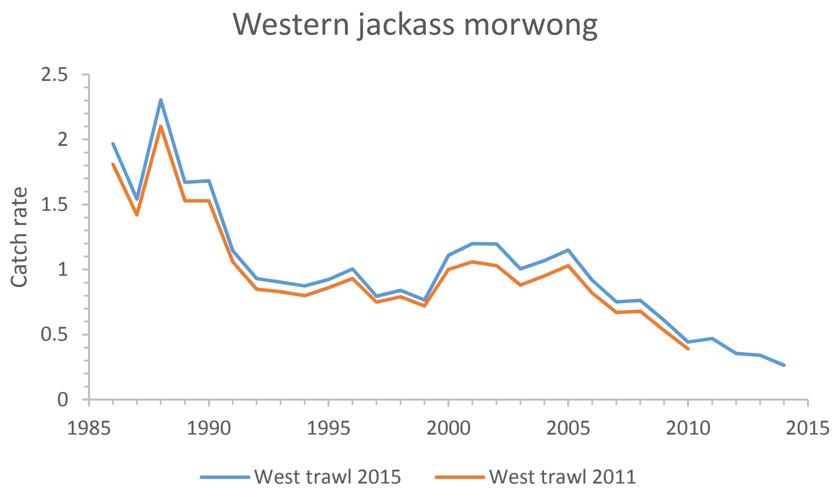


Figure 11.2. The western stock of jackass morwong standardised CPUE for the trawl fleets (Sporcic and Haddon, 2015). This figure shows a comparison between the series used in the 2011 assessment and that used in the current assessment (2015).

11.3.2 *Length frequencies and age data*

Length data have been separated into records collected in port and onboard commercial vessels. Age data have been included in the model as conditional age-at-length data. Age composition data is included in diagnostic plots, but is not used directly within the fitting procedure. Figures of the observed length and age data are shown in later figures (Figure 11.8 to Figure 11.11), with the corresponding model predicted values. Table 11.2 shows (by year) the number of fish lengths sampled onboard and in port with corresponding counts of shots or trips.

Table 11.2. The number of fish sampled, shots and trips for onboard and port length measurements. Grey cells indicate either length records that were excluded due to small sample sizes (fish sampled <100) or age samples less than 50.

	Ages	Onboard Lengths		Port Lengths	
Year	Samples	Number fish	Number shots	Number fish	Number trips
1996		-	-	364	3
1997		245	2	505	4
1998		373	4	2	1
1999		412	4	341	3
2000		124	1	572	5
2001		1434	11	2232	18
2002		859	4	1918	12
2003	83	124	1	1680	10
2004	474	397	3	873	10
2005	282	2116	15	1426	14
2006	156	820	6	690	7
2007	51	-	-	-	-
2008	24	47	2	109	1
2009	49	140	4		
2010		72	2		
2011	41	208	9		
2012	87	318	17		
2013	118	723	25	53	1
2014	37	241	6	61	1

11.3.3 *Age-reading error*

The ages are assumed to be unbiased but subject to random age-reading errors. Standard deviations for aging error by reader have been estimated, producing the age-reading error matrix of Table 11.3 (A.E. Punt, pers. comm.).

Table 11.3. The standard deviation (StDev) of age reading error.

Age	St Dev	Age	St Dev
0	0.216	16	0.699
1	0.216	17	0.732
2	0.247	18	0.765
3	0.279	19	0.798
4	0.311	20	0.831
5	0.343	21	0.864
6	0.375	22	0.897
7	0.407	23	0.931
8	0.439	24	0.964
9	0.471	25	0.997
10	0.504	26	1.031
11	0.536	27	1.065
12	0.568	28	1.098
13	0.601	29	1.132
14	0.634	30	1.166
15	0.666		

11.3.4 *Fishery independent survey (FIS) estimates*

Abundance indices for jackass morwong for the surveys conducted in 2008, 2010, 2012 and 2014 are provided in Knuckey et al. (2015). Indices from the FIS were re-estimated for the western stock of jackass morwong (Zones 40/50) (Table 11.4). The length composition data from the FIS have not been included in this assessment and the FIS is assumed to have the same selectivity as the trawl fleet.

Table 11.4. FIS derived abundance indices for the western stock of jackass morwong with corresponding coefficient of variation (cv).

	2008	2010	2012	2014
West Index	51.56	25.52	39.26	7.27
c.v.	0.25	0.26	0.25	0.27

11.3.5 *Biological parameters*

A single-sex single-stock assessment for the western stock of jackass morwong was conducted using the software package Stock Synthesis (SS, version 3.24U). Selectivity of the trawl fleet was modelled as being time-invariant and a logistic function of length. The two parameters of the selectivity function for each fleet were estimated within the assessment.

The rate of natural mortality rate, M, was assumed to be constant with age, and also time-invariant. The rate of natural mortality for the base-case analysis was set to 0.15 yr^{-1} in accordance with previous assessments (Table 11.3).

Recruitment was assumed to follow a Beverton-Holt type stock-recruitment relationship, parameterized by the average recruitment at unexploited spawning biomass, R_0, and the steepness parameter, *h*. Steepness for the base-case analysis was set to 0.7, in accordance with previous assessments (Wayte, 2011). Deviations from the average recruitment at a given spawning biomass (recruitment deviations) were estimated for 1989-2011. Recruitment deviations are estimated to 2011, as the recruitment signal from young fish must have appeared in the catch and length frequency data in sufficient numbers to allow its estimation. The value of the parameter determining the magnitude of the process error in annual recruitment, σ_R, was set equal to 0.46 (Wayte, 2011). Tuning to σ_R suggested lower values, but these were unrealistic and so the value was set at that used in Wayte (2011).

A plus-group was modelled at age 25. Growth of morwong was assumed to be time-invariant, that is, there has been no change over time in the mean size-at-age, with the distribution of size-at-age being determined from the fitting of the growth curve within the assessment using the age-at-length data. No differences in growth by gender are modelled, as the stock was modelled as a single-sex. The parameters of the length-weight relationship are the same as those used in previous assessments (a=1.7×10^{-5}, b=3.031). These values are taken from Smith and Robertson (1995).

Port and onboard length frequency data based on fewer than 100 fish were not included in the model fitting procedure as they were deemed to be insufficient samples. As the effective sample size for length frequency data is probably more related to the number of shots sampled for onboard data and trips for port data, those values are used as the initial effective sample sizes. The length frequency data would be given too much weight relative to other data sources if the number of fish measured were used. The sample sizes (with port and onboard lengths fit separately) were also individually tuned according to the method TA1.8 outlined in Francis (2011).

The values assumed for some of the (non-estimated) parameters of the base case models are shown in Table 11.5.

Table 11.5. Parameter values assumed for some of the non-estimated parameters of the base-case model.

Parameter	Description	Value
M	Natural mortality	0.15
σ_r	Initial c.v. for the recruitment residuals	0.4
h	"steepness" of the Beverton-Holt stock-recruit curve	0.7
x	age observation plus group	25 years
a	allometric length-weight equations	1.7×10^{-5}
b	allometric length-weight equations	3.031
l_m	Female length at 50% maturity	24.5cm

11.4 The tuning procedure

The tuning procedure used (Andre Punt pers comm.; from Thomson *et al.* 2015) was to:

1. Set the CV for the commercial CPUE value 0.1 for all years (set those for the FIS to the estimated CVs) (this relatively low value is used to encourage a good fit to the abundance data);
2. Simultaneously tune the sample size multipliers for the length frequencies and ages using Francis weights for the LFs and Francis B (the larger of the Francis A and B factors, Francis 2011). Iterate to convergence;

3. Adjust the recruitment variance (σ_r) by replacing it with the RMSE and iterating to convergence (keep altering the recruitment bias adjustment ramps at the same time);
4. Weight the commercial CPUE and FIS abundance indices by replacing these with the relevant variance adjustment factors. Iterate to convergence;
5. Reweight the age data using the Francis A adjustment factor, just once (no iterating);
6. Repeat steps 3 and 4. Finish.

11.5 Results and Discussion

11.5.1 *The base case stock assessment*

Comparisons between the 2011 assessment results (Wayte, 2011) and updates with data to 2014 and updated assessment software (SS3.24Y) were conducted in the previous report (Tuck et al., 2015b) and not repeated here. These comparisons indicated consistency between data and assessment platforms.

Following recommendations from the September Shelf RAG originating from concerns regarding poor fits to catch rate data and length/age data largely driven by inconsistent year to year observed length and age compositions (which may in turn be related to small sample sizes) the assessment here (referred to as the base case assessment) removes all annual age records where samples are less than 50 (see Table 11.2) and uses the growth parameters from the eastern jackass morwong assessment base cade model (Tuck et al., 2015a). These growth parameters are *Lmin*=22.0 cm (length at age 3), *Lmax*=35.2cm (length at age 20), *K*=0.217, cv of growth = 0.104. The assessment model presented at the September RAG had growth parameters *Lmin*=24.5 cm (length at age 3), *Lmax*=38 cm (length at age 20), *K*=0.095, cv of growth = 0.1. Figure 11.3 shows that little difference exists between the relative biomass trajectories of the new base-case model and the model presented at the September Shelf RAG.

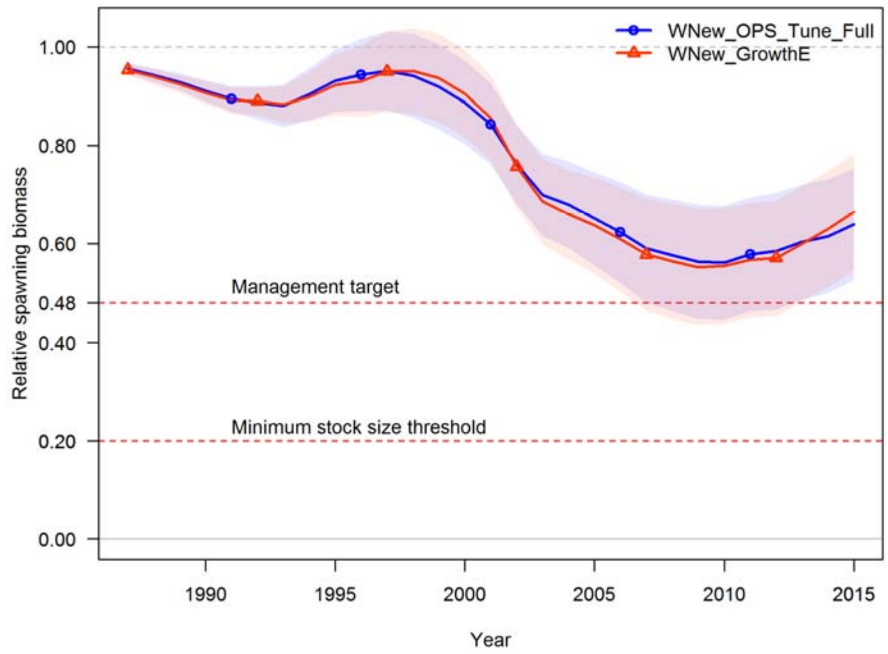


Figure 11.3. The relative spawning biomass trajectories for the western stock of jackass morwong. WNew_OPS_Tune_Full (blue) is the assessment presented at the September Shelf RAG, and WNew_GrowthE (red) is the new base case where growth parameters are taken from the eastern morwong assessment.

11.5.1.1 Base case parameter estimates and model fits

A listing of the data for the fully tuned base case model is shown in Figure 11.4, and the growth, length-weight, and selectivity functions for the various fleets are shown in Figure 11.5 and Figure 11.6. Fits to the data are shown in Figure 11.7 to Figure 11.11 (and the Appendix), and the estimated spawning biomass trajectory for the base-case model is illustrated in Figure 11.3 and Figure 11.13.

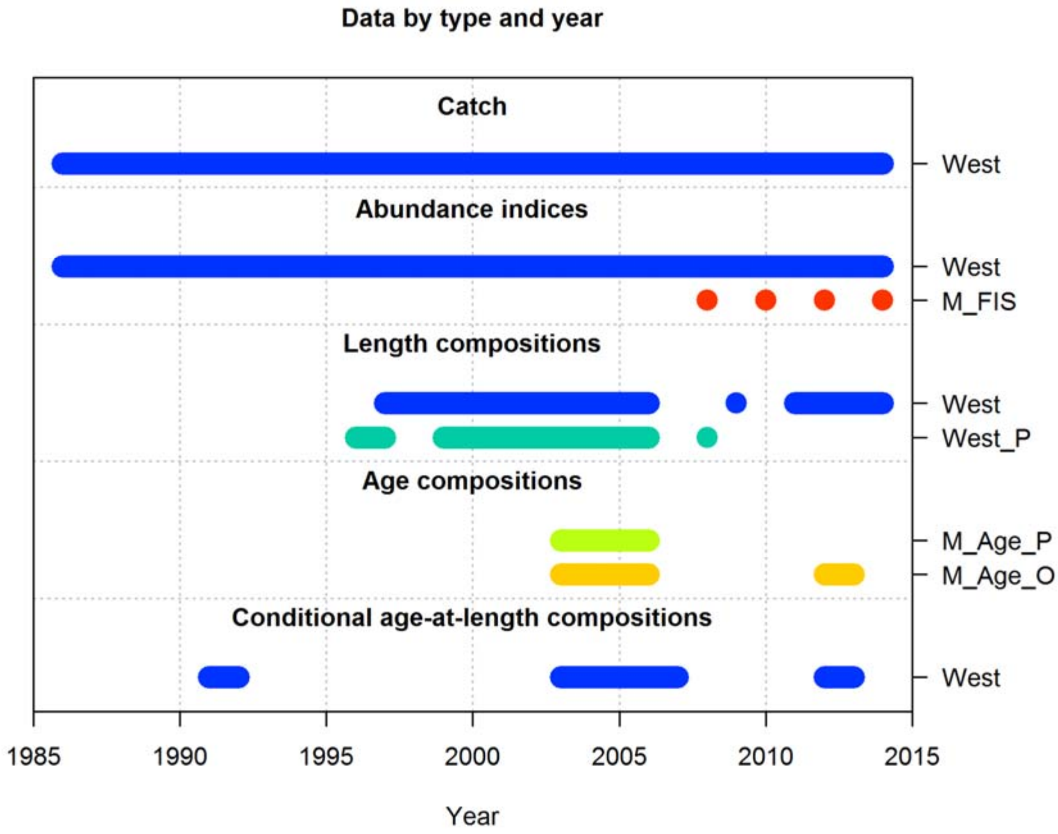


Figure 11.4. The various data types by fleet for the western stock of jackass morwong.

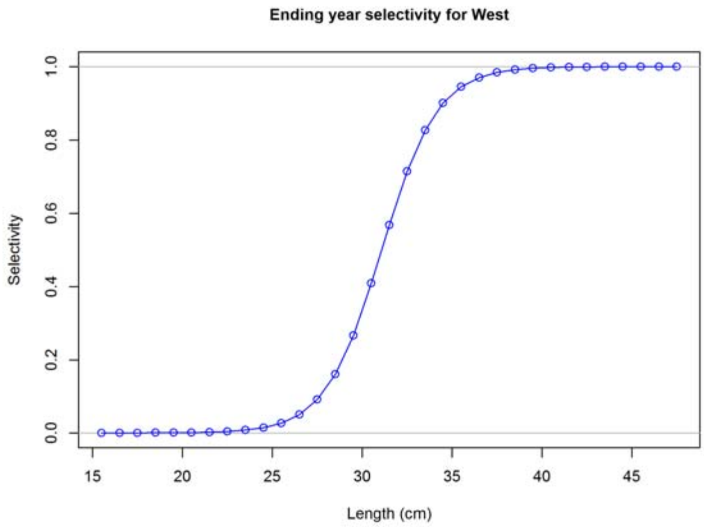


Figure 11.5. Selectivity for the western stock of jackass morwong

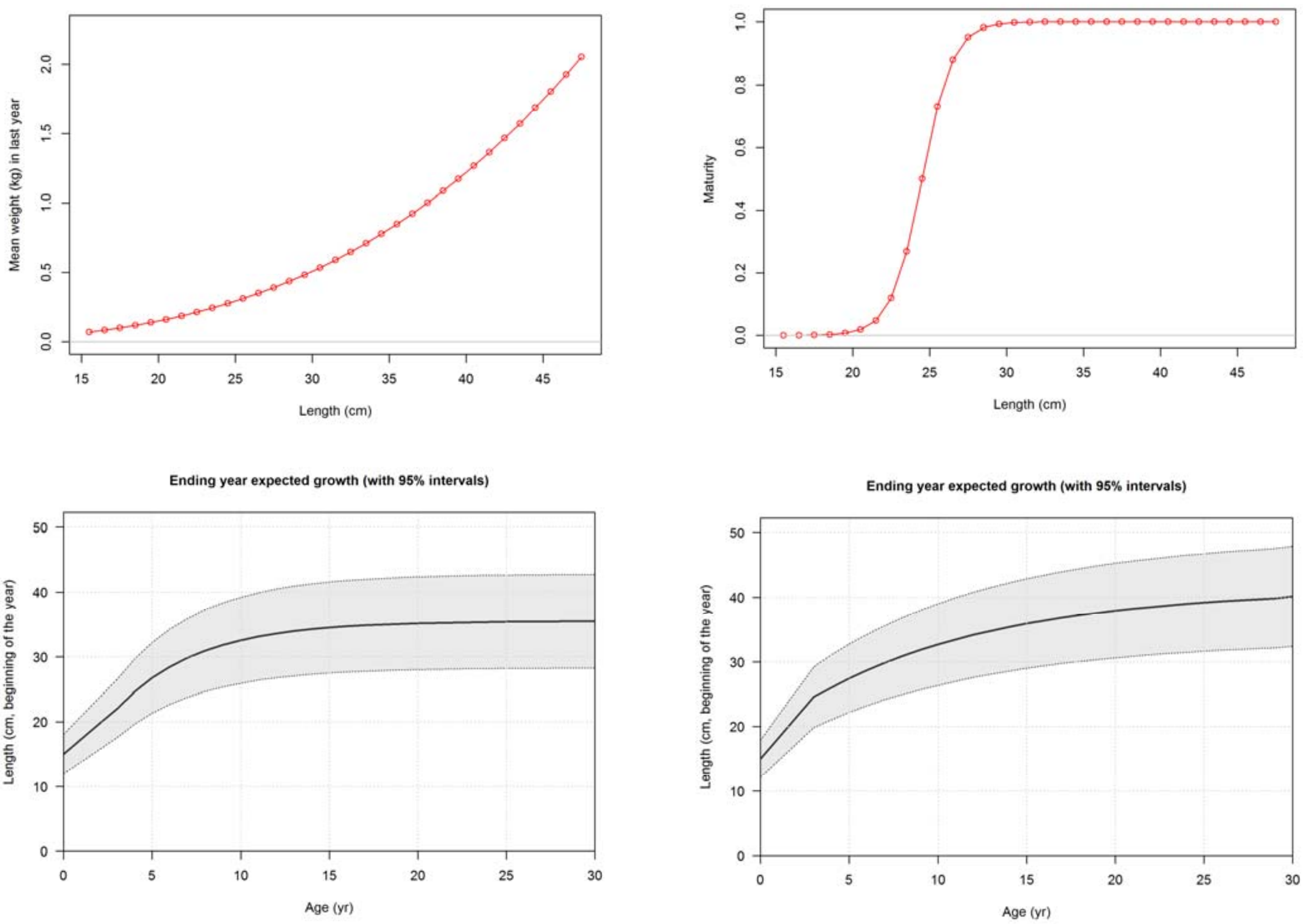


Figure 11.6. The length-weight (top left), maturity ogive (top right) and length-age relationships (bottom left) for the western stock of jackass morwong base case assessment. The length-age relationship from the assessment presented at the September 2015 RAG is shown for comparison (bottom right).

11.5.1.2 Fits to the data

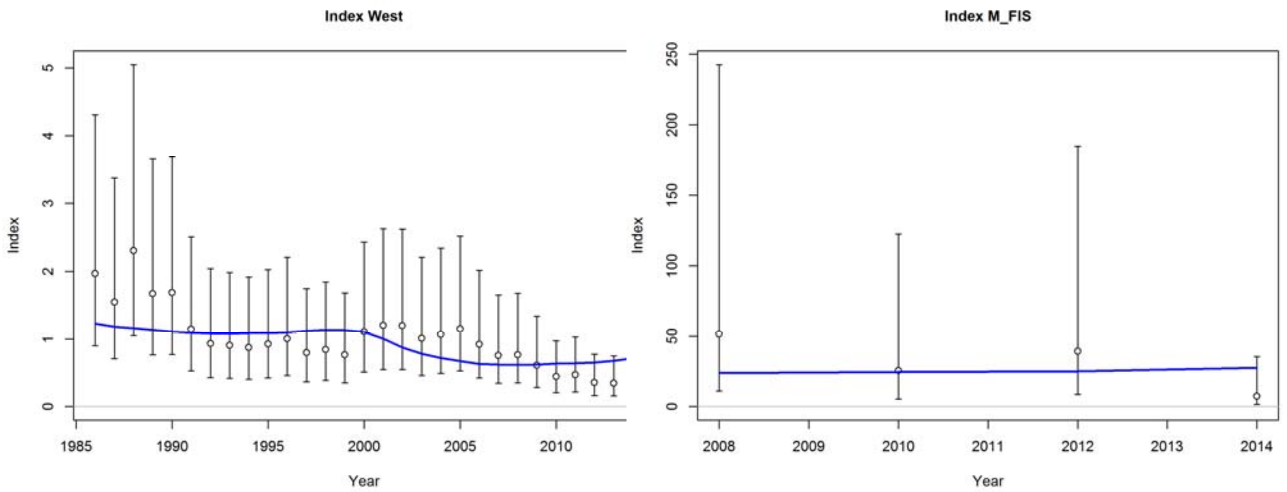


Figure 11.7. Fits to the standardized trawl CPUE (left) and the FIS indices (right) for the western trawl fishery for jackass morwong.

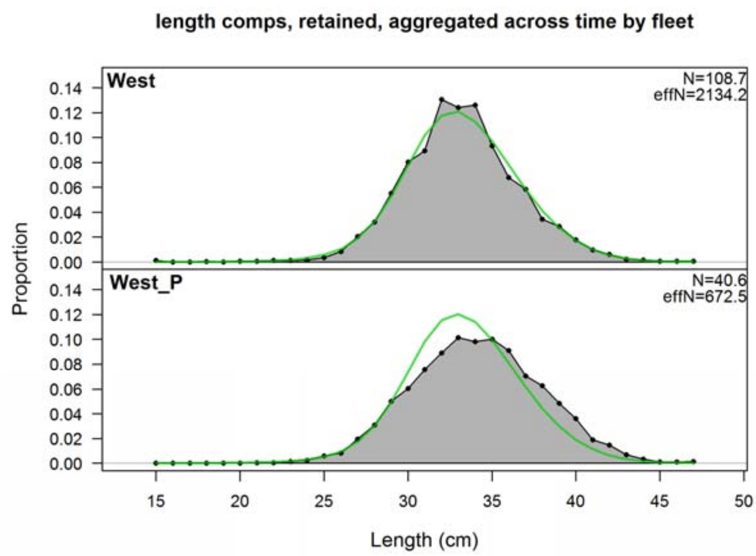
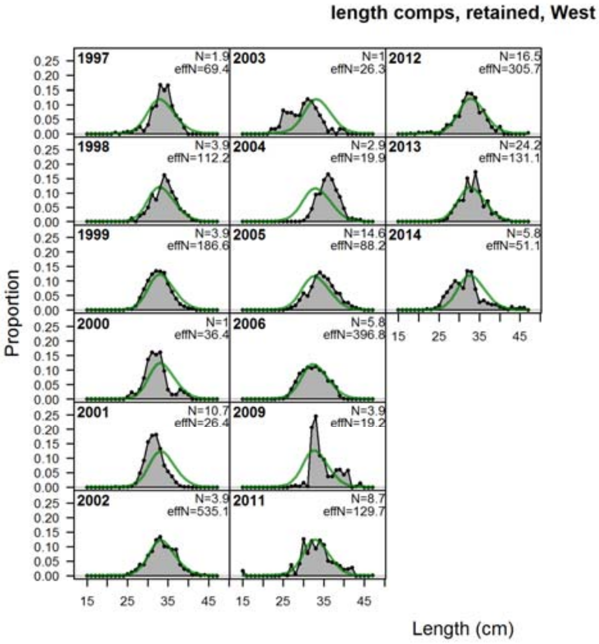


Figure 11.8. Fits to the retained length by fleet (West_P = Port, West = onboard).



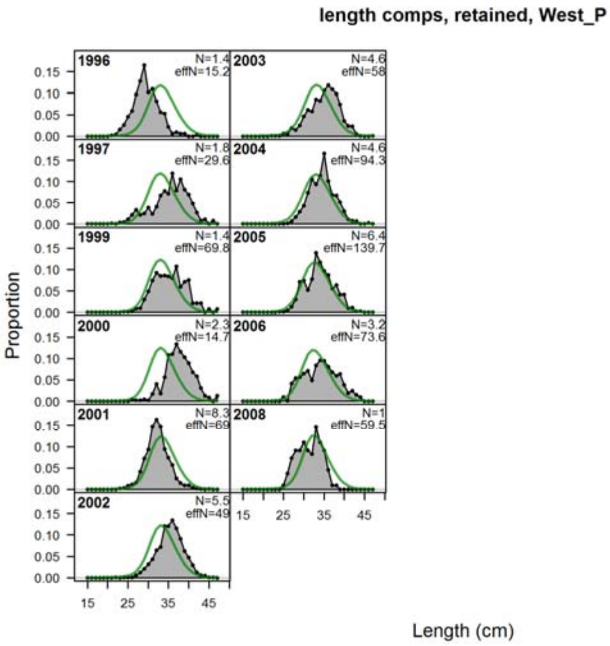


Figure 11.9. Fits to the retained length by year and fleet (West_P = Port, West = onboard).

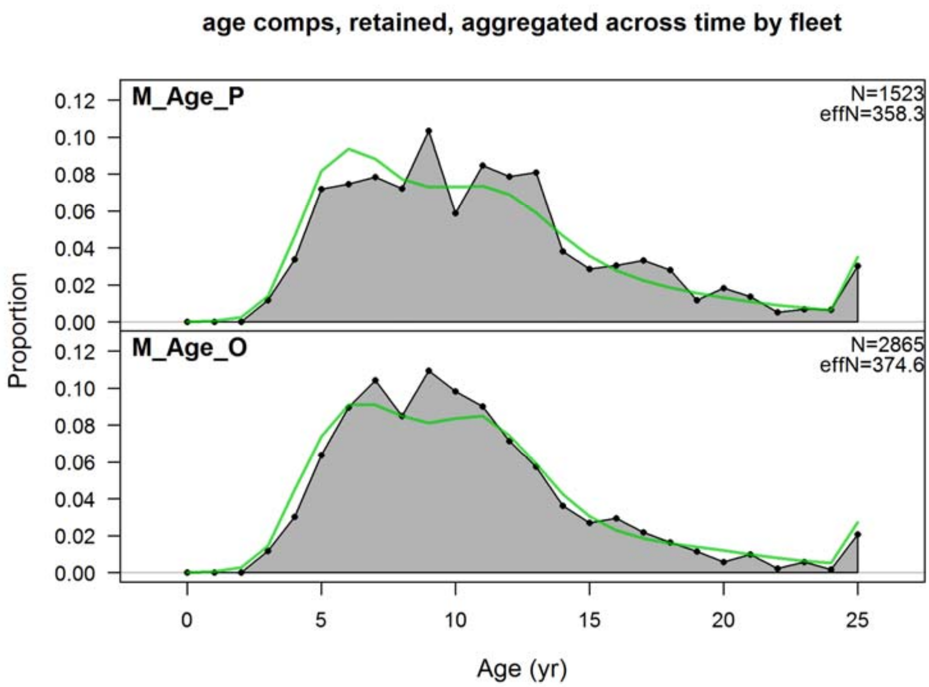


Figure 11.10. The implied fits to port (top) and onboard (bottom) age composition data for the western stock of jackass morwong.

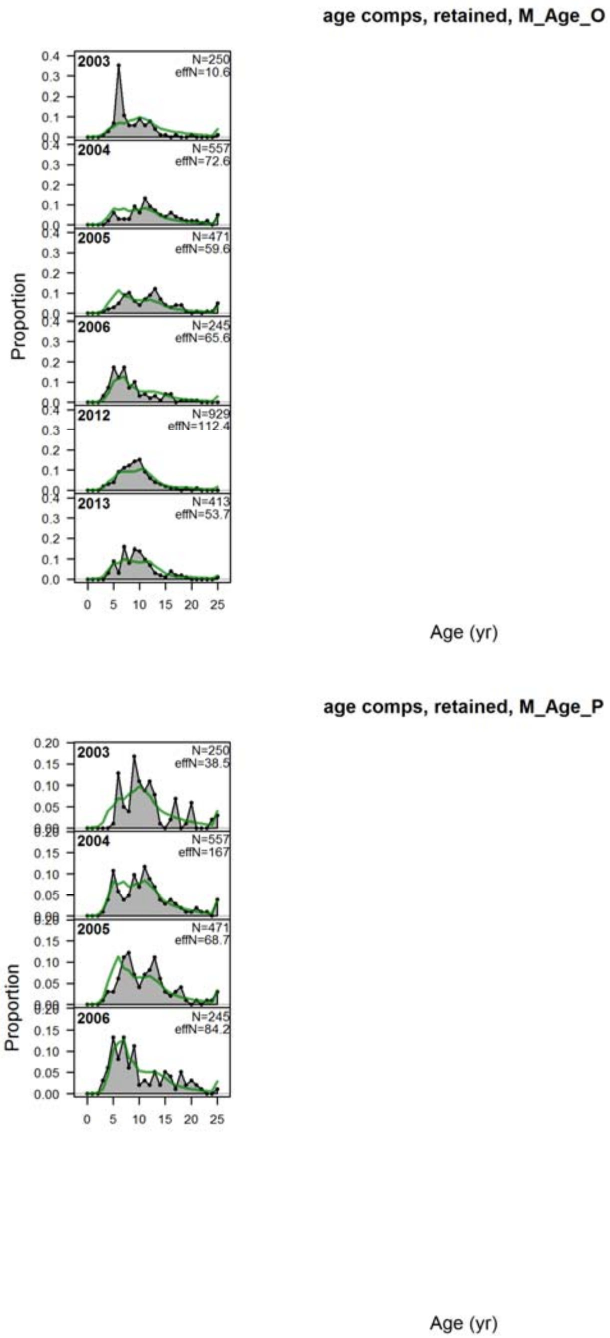


Figure 11.11. The implied fits to onboard (top) and port (bottom) age composition data by year for the western stock of jackass morwong.

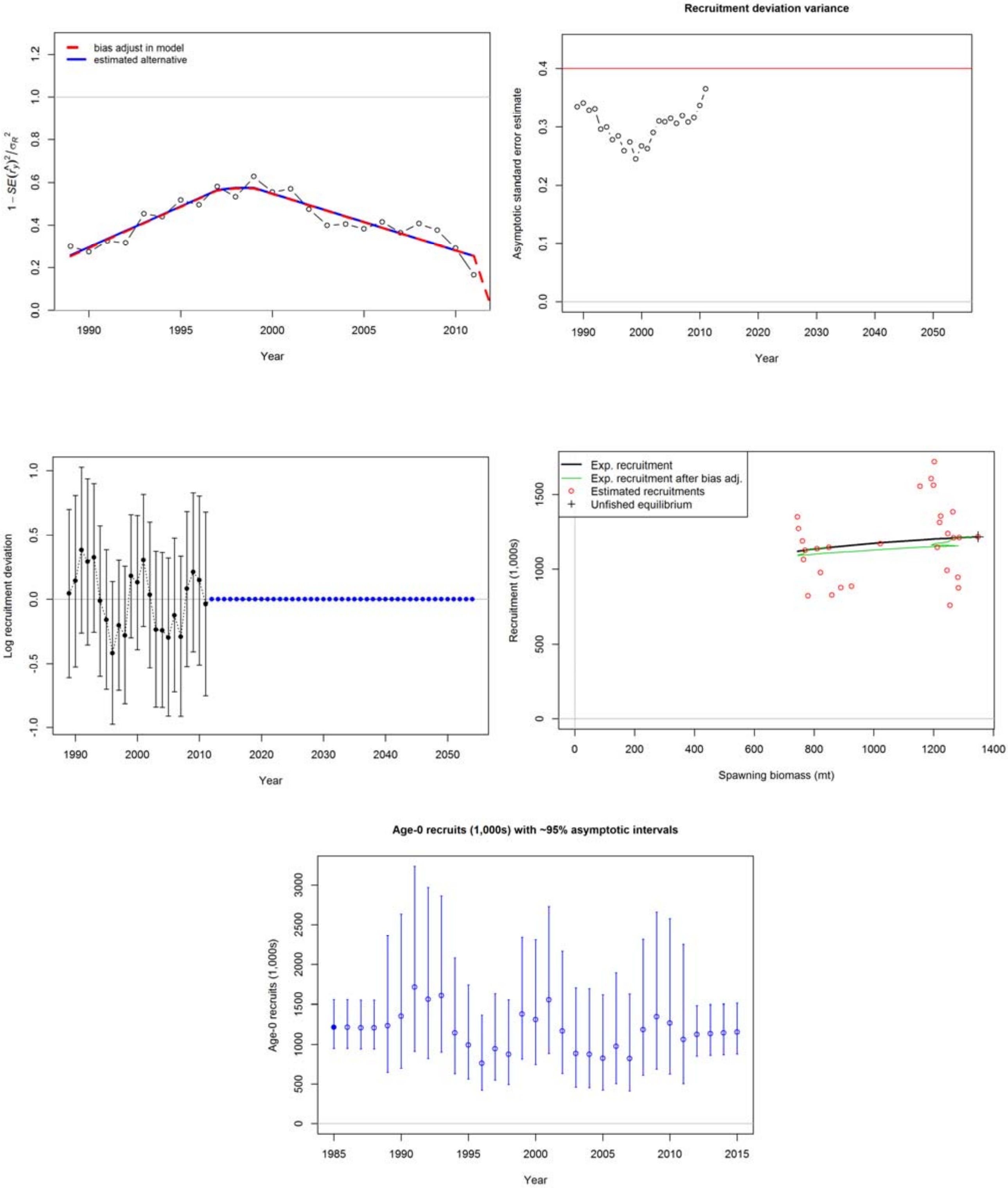


Figure 11.12. Diagnostics for recruitment, the stock–recruitment relationship and annual estimates of recruitment numbers with confidence intervals.

11.5.1.3 Assessment outcomes

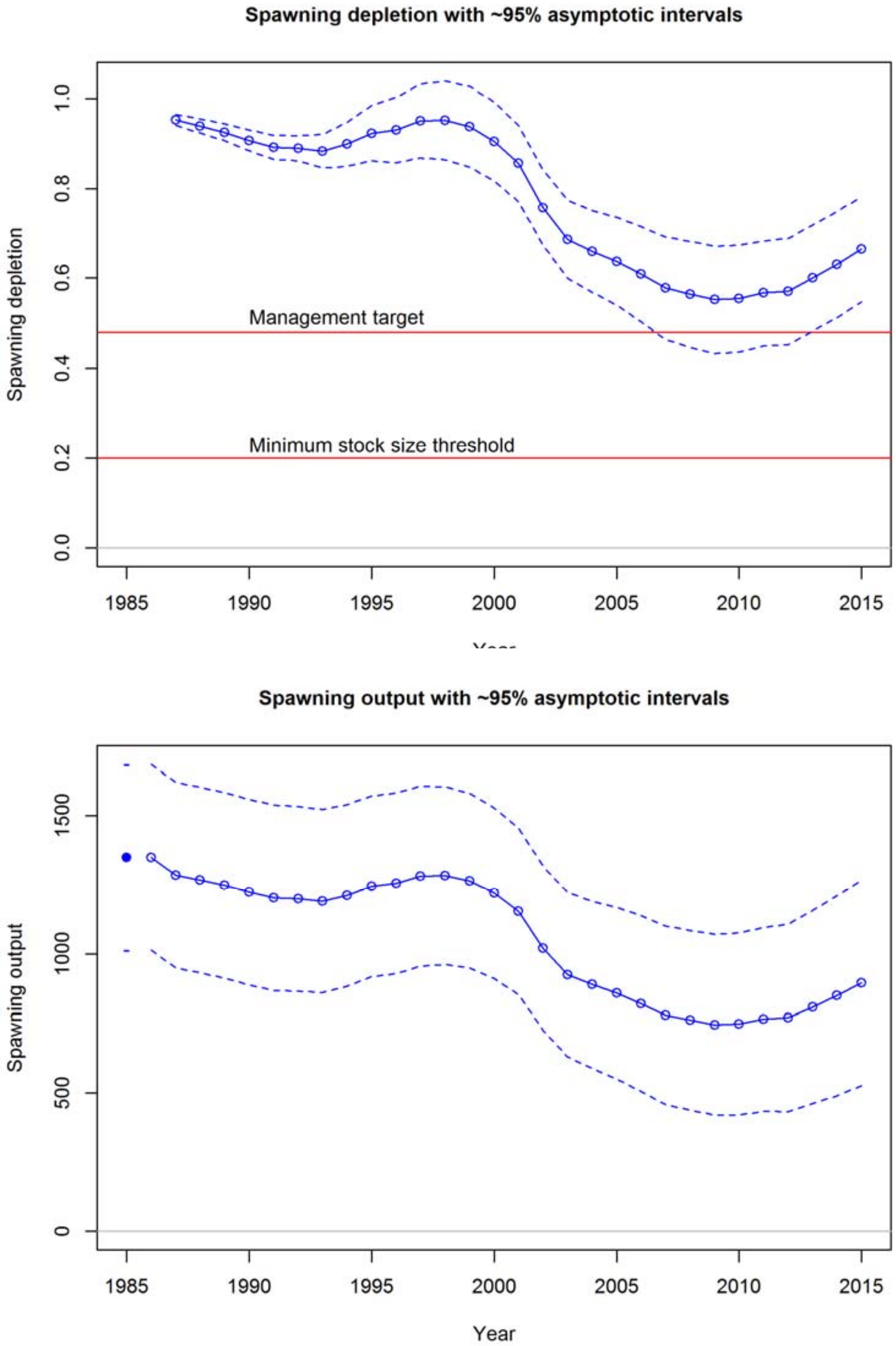


Figure 11.13. Time trajectories of spawning biomass depletion (top) with 95% confidence intervals and magnitude of spawning biomass (bottom) for the base case assessment of the western stock of jackass morwong.

11.5.2 *Discussion*

The 2015 base case assessment of the western stock of jackass morwong estimates the 2016 spawning biomass to be 69% of unexploited biomass (projected assuming 2014 catches in 2015). The female equilibrium spawning biomass in 1986 is estimated to be 1,349 t and in 2016 the female spawning biomass is estimated to be 936 t. The RBC for the base case assessment for the western stock of jackass morwong under the 20:35:48 harvest control rule is 249 t (Table 9.17). The long-term RBC is 159 t. In comparison, the last full assessment in 2011 (Wayte, 2011) estimated the 2012 spawning biomass to be 67% of unexploited biomass (Figure 11.14), with an RBC for 2012 of 282 t.

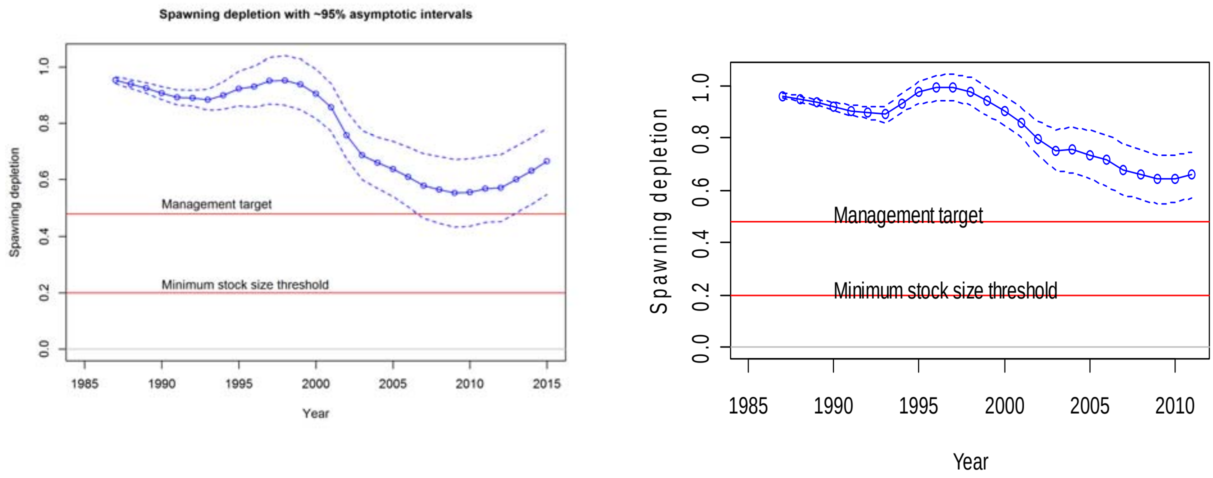


Figure 11.14. A comparison between the 2015 (left) and 2011 (right) assessments of the western stock of jackass morwong.

It should be noted that the assessment for the western stock is increasingly uncertain, as (i) there are only sporadic age data available, (ii) length compositions are based on very low numbers of sampled fish and (iii) the catch in the western region is now very low (Table 11.1 and Table 11.2).

As discussed in the assessment presented at the September Shelf RAG meeting (Tuck et al., 2015), the base case model fit to the index of abundance (Figure 11.7, and Figure 11.15 below) is poor, with an overall declining trend of the point estimates not well reflected in the estimated available biomass trend. A principle espoused by Francis (2011) in his paper on tuning in stock assessments is that modelled estimates of biomass should reflect observations (eg from cpue or surveys). This does not occur for the base case model. Recommendations from the Shelf RAG to use the growth parameters from the eastern jackass morwong assessment and to remove age records where samples were inadequate has not resolved this issue.

The poor fit to the index data (cpue) occurs on tuning the cpue index as part of the adopted tuning method. If the age and length data are tuned (the first steps of the tuning process) and the cpue is not tuned (cvs fixed at 0.1) then the model fit to cpue shows the declining trend of the observations (Figure 11.15). The spawning biomass trend in comparison to the base case (fully tuned) model is shown in Figure 11.16.

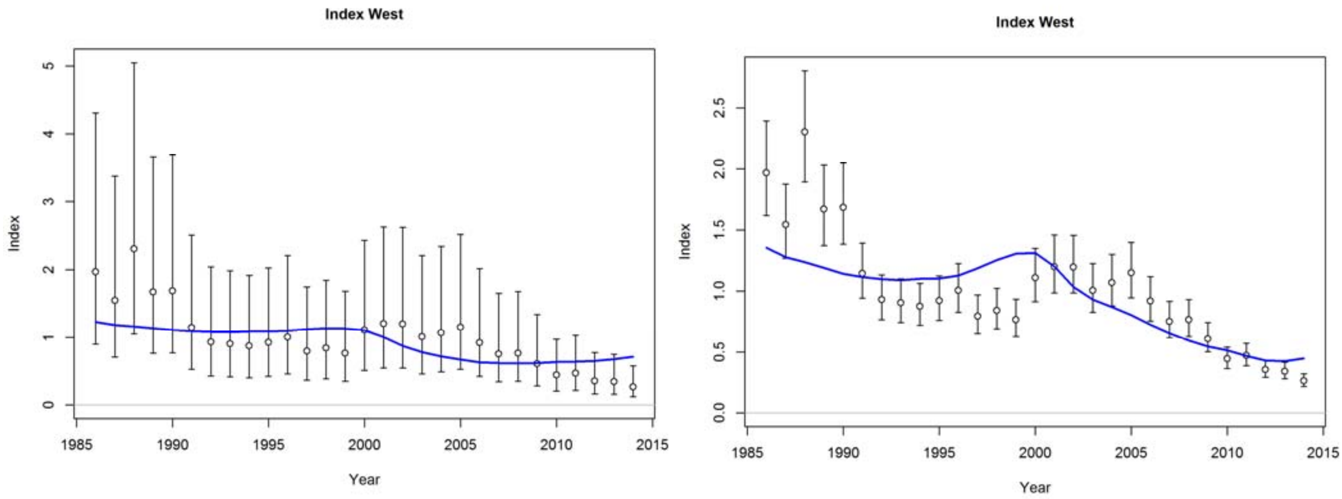


Figure 11.15. Time trajectories of the fit to the standardized catch rate data for the western stock of jackass morwong. Base case (left) and a model where only length and age data are tuned (right) and the catch rate cvs remain at the fixed values of 0.1.

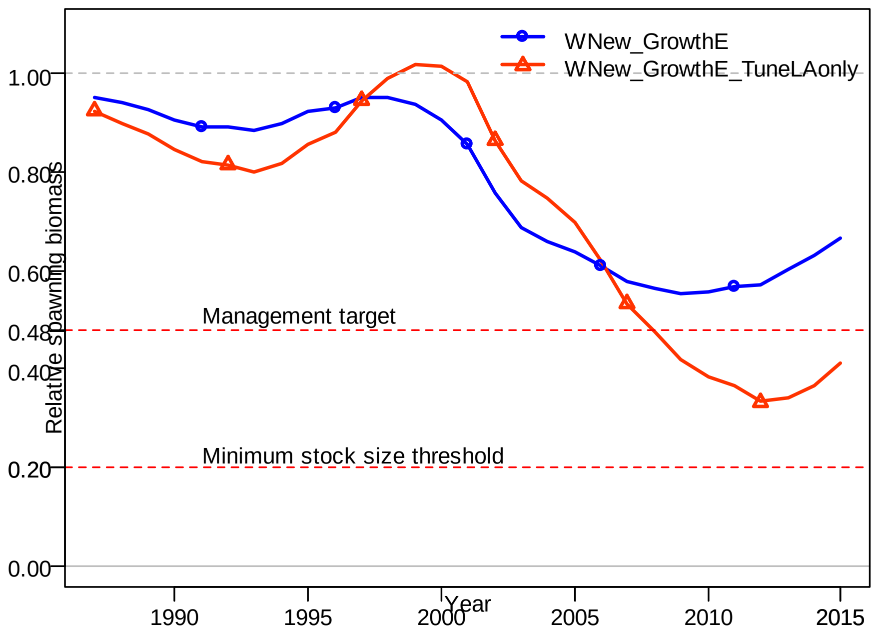


Figure 11.16. Trajectories of relative spawning biomass for the base case model (WNew_GrowthE; blue) and a model where only length and age data are tuned (WNew_GrowthE_TuneLAonly; red).

However, while fits to the catch rate series may appear better, the estimated trend in available biomass does not consistently cross the 95% confidence intervals of the observations, and this model has a considerably poorer fit to the length data (Figure 11.17). This suggests that a strong conflict exists between the input catch rate data and the length data.

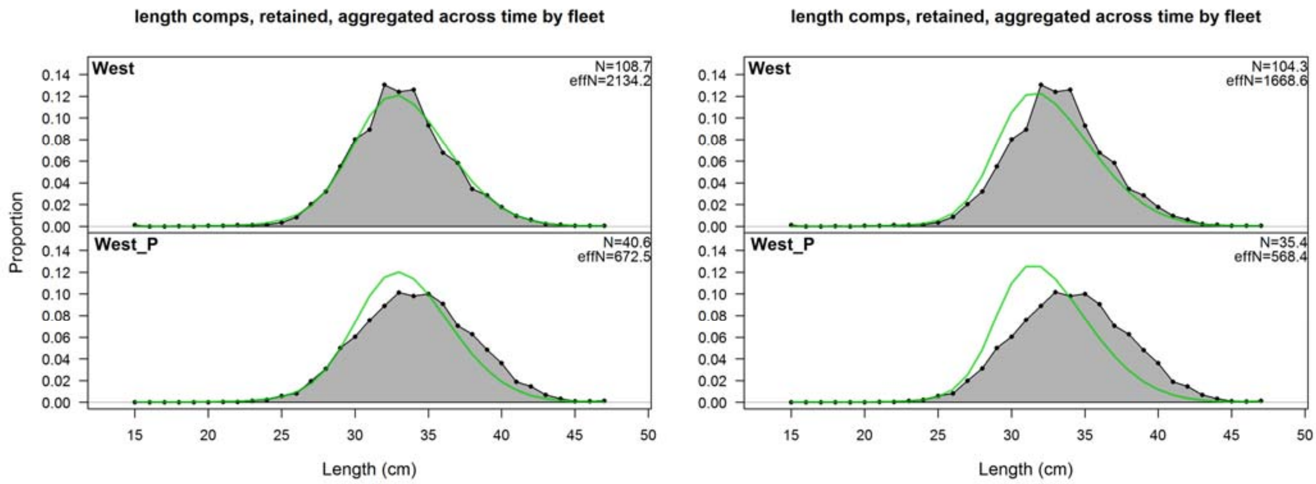


Figure 11.17. The fit to port (West_P) and onboard (West) length data for the western stock of jackass morwong. Base case (left) and a fit where only length and age data are tuned (right).

11.5.3 *Sensitivities*

Results of the sensitivity tests are shown in Table 9.18. This table indicates that biomass depletion is not overly sensitive to changes in parameters or weightings, except for natural mortality. Models with only Zone 50 data led to some changes in biomass trajectory, but did not resolve the issue of the poor fit to the catch rate data (Figure 11.18).

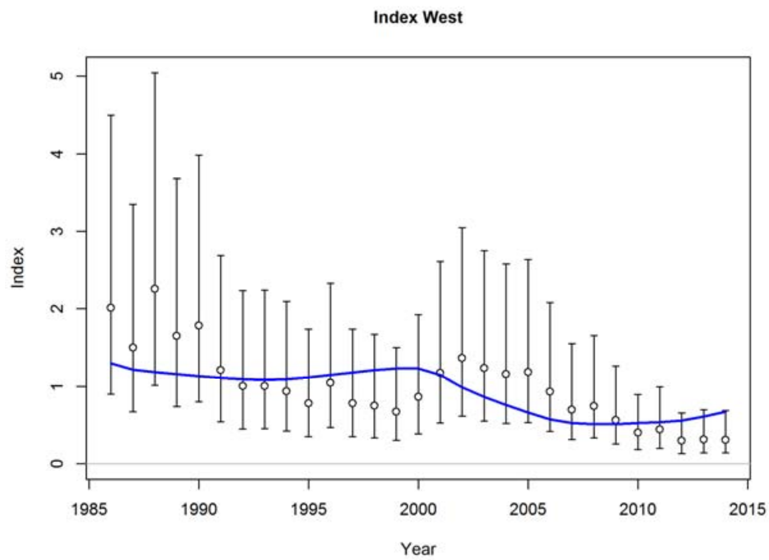


Figure 11.18. The catch rate fit for the assessment model where only Zone 50 data are used.

Table 11.6. The 10-year projected RBC and depletion from the base case model of the eastern (see Tuck et al., 2015b) and western stock of jackass morwong. The jackass morwong TAC (across east and west) for season 2015/16 is currently 598 t.

Year	RBC - east	Depletion	RBC - west	Depletion
2016	314	0.36	249	0.69
2017	320	0.37	231	0.65
2018	327	0.38	216	0.61
2019	336	0.39	204	0.59
2020	344	0.40	195	0.57
2021	352	0.41	188	0.55
2022	359	0.42	182	0.54
2023	365	0.43	178	0.53
2024	371	0.43	175	0.52
2025	375	0.44	172	0.51

11.6 Acknowledgements

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Table 11.7 Summary of results for the base-case and sensitivity tests. Lower log-likelihood values indicate a better fit to the data. Log-likelihood (-ln L) values in italics are not comparable with the base-case. Likelihood values for sensitivities are shown as differences from the base-case.

West	female SB_0	female SB_{2016}	SB_{2016}/ SB_0	2016 RBC 20:35:48	Likelihood total diff	CPUE	Length	Age	Recruit
Base-case (*M*=0.15, *h*=0.7, 50% mat=24.5)	1349	936	69%	249	275.96	-11.43	22.13	269.71	-5.09
Base from Sept 2015	1501	996	66%	239	*145.54*	*-0.39*	*-1.12*	*146.69*	*-0.51*
Tune Len & Age only	840	384	46%	89	*267.23*	*71.18*	*4.29*	*176.95*	*15.06*
Zone 50 only	725	469	65%	120	*91.70*	*1.35*	*-3.93*	*91.71*	*1.16*
$M = 0.1$ yr^{-1}	1071	454.5	42%		6.89	-2.64	0.03	8.14	1.50
$M = 0.2$ yr^{-1}	2600	2363	91%		4.68	4.27	-0.13	0.01	-0.17
$h = 0.6$	1346	898	67%		-0.30	-0.37	0.03	0.02	-0.04
$h = 0.8$	1352	965	71%		0.32	0.28	-0.03	-0.02	0.03
50% maturity at 22 cm	1445	1030	71%		4.95	0.04	-0.01	0.03	0.01
Double weight on CPUE	1231	795	65%		*0.79*	*-1.71*	*-0.05*	*1.60*	*1.01*
Halve weight on CPUE	1433	1040	73%		*0.31*	*1.19*	*0.08*	*-0.76*	*-0.24*
Double weight on LF data	1375	965	70%		*0.12*	*-0.13*	*-0.28*	*0.50*	*0.01*
Halve weight on LF data	1324	907	69%		*0.13*	*0.02*	*0.42*	*-0.33*	*0.04*
Double weight on age data	1384	1013	73%		*1.30*	*1.27*	*0.48*	*-3.08*	*2.60*
Halve weight on age data	1311	876	67%		*1.05*	*-0.91*	*-0.28*	*3.72*	*-1.44*

11.7 References

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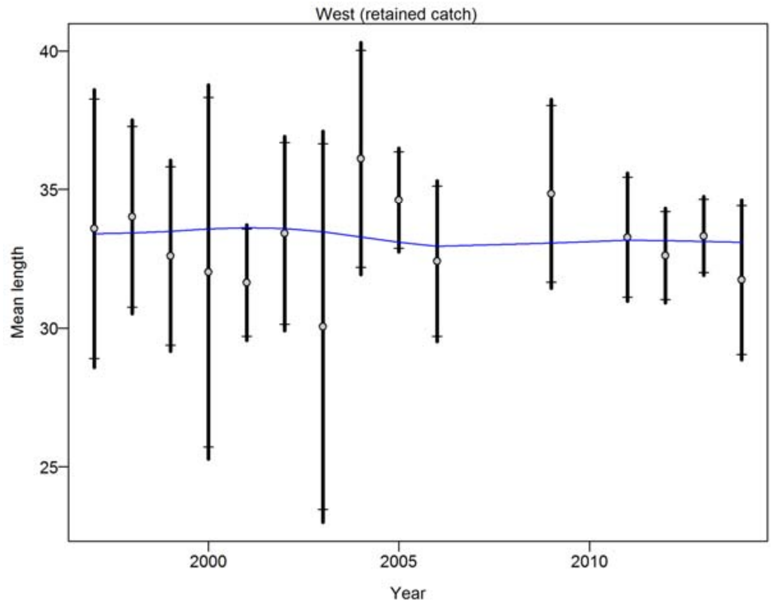
11.8 Appendix: The base case model length fit diagnostics



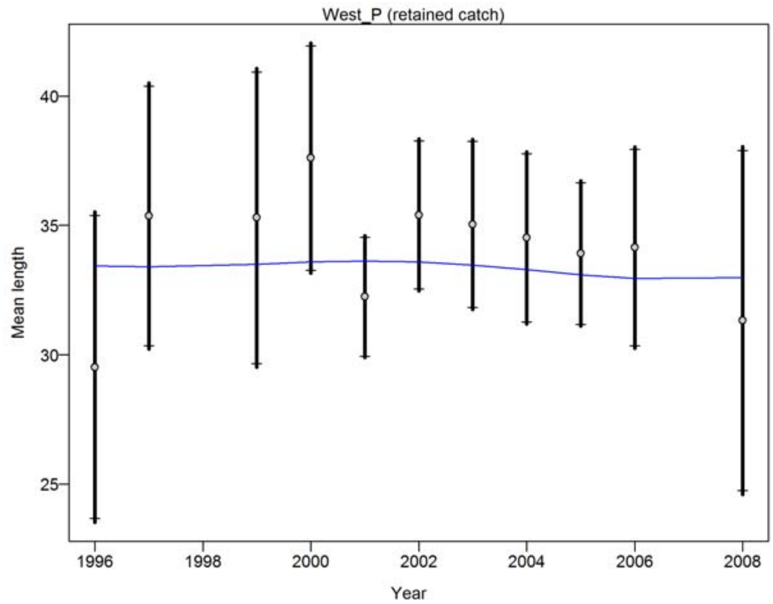


Figure A1. Francis data weighting diagnostic plot for mean lengths of the western stock of jackass morwong onboard (top) and port (bottom) length data