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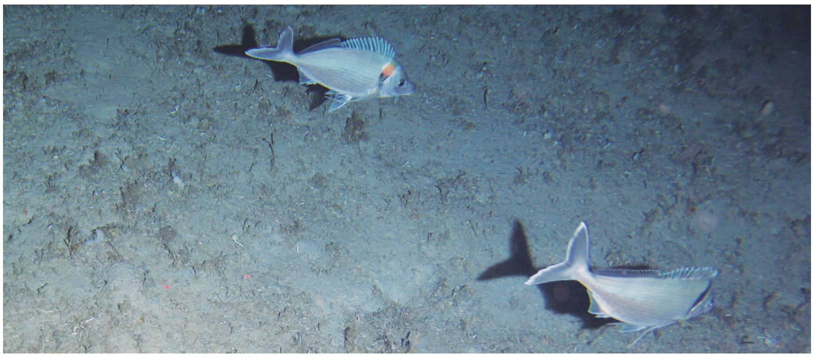
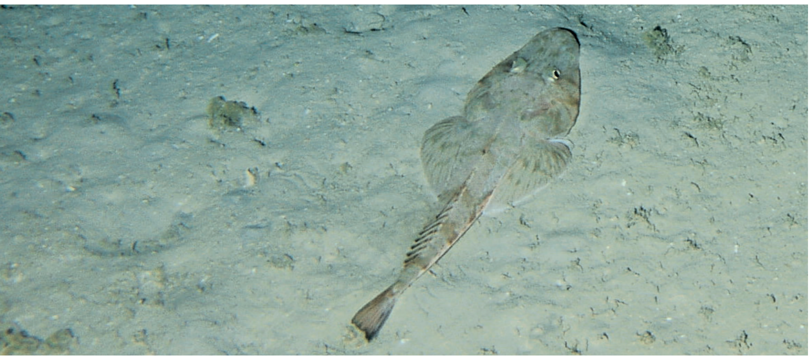
2015/0817 June 2018

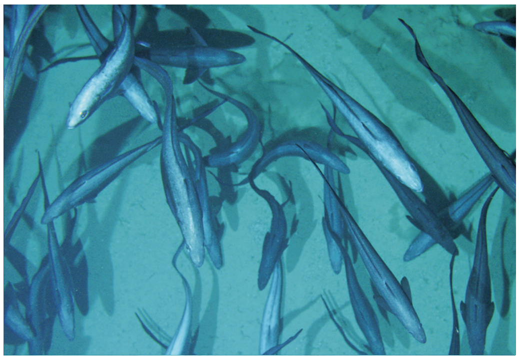
Stock Assessment for the Southern and Eastern Scalefish and Shark Fishery: 2016 and 2017

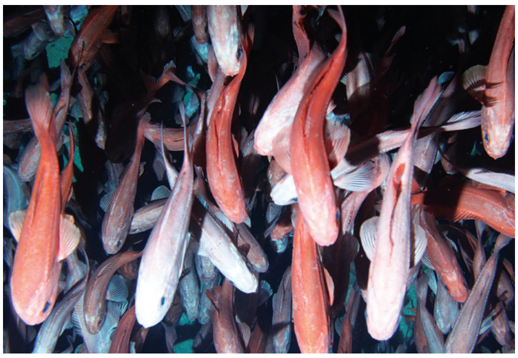
PART 2

2017









Principal investigator **G.N. Tuck**

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Cover photographs

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

Report structure

Parts 1 and 2 of this report describe the assessments of 2016 and 2017 respectively

Stock Assessment for the Southern and Eastern Scalefish and Shark Fishery 2016 and 2017

Part 2: 2017

G.N. Tuck
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Australian Fisheries Management Authority

Stock Assessment for the Southern and Eastern Scalefish and Shark Fishery: 2017

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16. Redfish (*Centroberyx affinis*) stock assessment based on data up to 2016 – development of a preliminary base case

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16.1 Executive Summary

This document presents a suggested base case for an updated quantitative Tier 1 eastern redfish (*Centroberyx affinis*) assessment for presentation at the first SERAG meeting in 2017. The last full assessment was presented in 2014 (Tuck and Day, 2014; Tuck, 2014). The preliminary base case has been updated by the inclusion of data up to the end of 2016, which entails an additional 3 years of catch, discard, CPUE, length and age data and ageing error updates since the 2014 assessment. This document describes the process used to develop a preliminary base case for redfish through the sequential updating of recent data to the stock assessment, using the stock assessment package Stock Synthesis (SS-V3.30).

The base case specifications agreed by the ShelfRAG in 2014 were maintained into the preliminary base case presented here. The main differences however are: separating length frequencies into onboard and port collected components, weighting length frequencies by shots (onboard) and trips (port) rather than fish measured; and using the latest tuning methods.

Results show reasonably good fits to the catch rate data, length data and conditional age-at-length data. Issues to note include that there is considerable difference between the port and onboard retained length frequencies, with the mode of port lengths generally larger than onboard lengths. The magnitude of the estimated recruitment in 2011 in the 2104 assessment has been greatly reduced in the 2017 preliminary assessment (although estimates of recent recruitment are improved over the poor period during 2002-2010). The 2017 preliminary assessment estimates that the projected 2018 spawning stock biomass will be 8% of virgin stock biomass (projected assuming 2017 catches in 2018), compared to 11% at the start of 2015 from the last assessment (Tuck, 2014).

Further development should include an exploration of the observed differences between port and onboard lengths, differences in length compositions between adjacent years, and refining the model structure (eg years of recruitment estimation, selectivity and retention blocking).

16.2 Introduction

16.2.1 *Bridging from 2014 to 2017 assessments*

The previous full quantitative assessment for redfish was performed in 2014 (Tuck and Day, 2014; Tuck, 2014) using Stock Synthesis (version SS-V3.24f, Methot, August 2012). The 2017 assessment uses the current version of Stock Synthesis (version SS-V3.30.06.02, Methot, 2017).

As a first step in the process of bridging to a new model, the data used in the 2014 assessment was used in the new software (SS-V3.30). This was followed by the inclusion in the model of updated data and new data from 2014-2016. This additional data included new catch, discard, CPUE, length frequency and age-at-length data. The last year of recruitment estimation was extended to 2015 (2012 in the 2014 assessment). The usual process of bridging to a new model by adding new data piecewise and analysing which components of the data could be attributed to changes in the assessment outcome was conducted. Details of this process are provided below.

16.2.2 *Update to Stock Synthesis SSV-3.30*

The 2014 redfish assessment was converted to the most recent version of the software, Stock Synthesis version SS-V3.30. There were negligible changes to the spawning biomass and recruitment time series following conversion (trajectories are overlapping in Figure 16.1 and Figure 16.2).

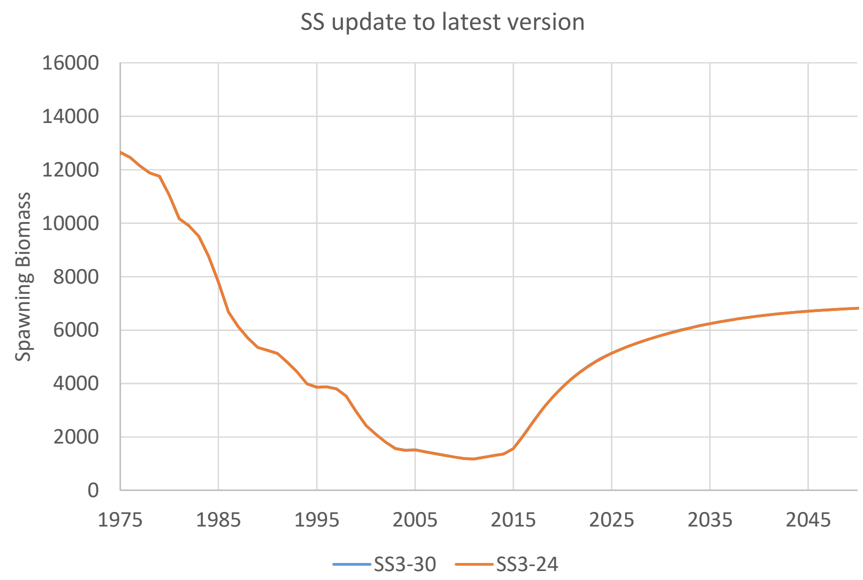

Figure 16.1. Comparison of the spawning biomass time series for the 2014 assessment (SS3-24) and a model converted to SS-V3.30 (SS3-30).

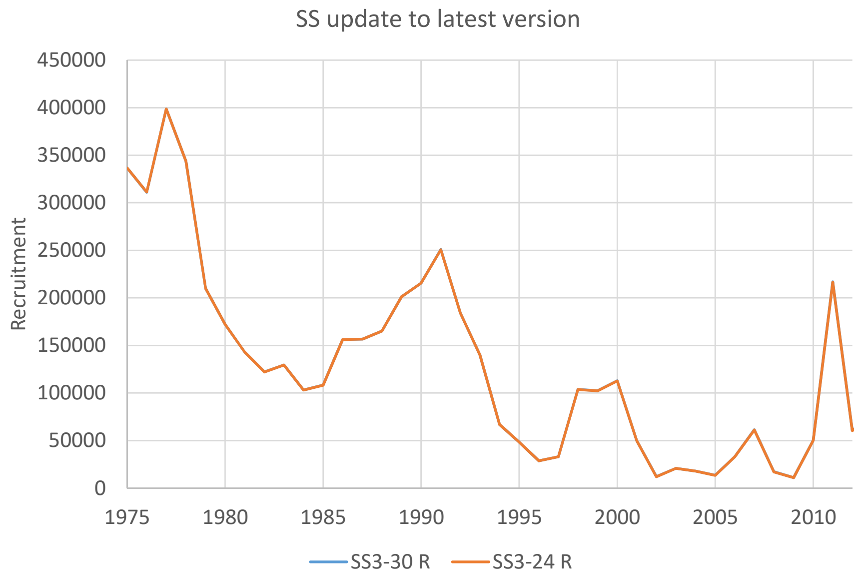

Figure 16.2. Comparison of the recruitment time series for the 2014 assessment (SS3-24 R) and a model converted to SS-V3.30 (SS3-30 R).

16.2.3 *Inclusion of new data*

The data inputs to the assessment come from multiple sources: length and age-at-length data from the trawl fishery, updated standardized CPUE series (Sporcic and Haddon, 2017), the annual total mass landed and discard rates, and age-reading error. Data were formulated by calendar year (i.e. 1 Jan to 31 Dec) and were aggregated across all eastern zones (Zones 10, 20 and 30).

Starting from the converted 2014 base case model, additional and updated data to 2016 were added sequentially to develop a preliminary base case for the 2017 assessment:

1. Change final assessment year to 2016, add catch to 2016 (NewC).
2. Add CPUE to 2016 (from Sporcic and Haddon (2017)) (NewC_CPUE).
3. Add updated discard fraction estimates to 2016 (NewC_CPUE_D).
4. Update length frequency data, including both port and onboard length frequencies (NewC_CPUE_D_POL).
5. Add updated age error matrix and age-at-length data to 2016 (NewC_CPUE_D_POL_A).
6. Change the final year for which recruitments are estimated from 2012 to 2015 (NewC_CPUE_D_POL_A_R).
7. Retune using latest tuning protocols (Tuned17).

16.2.3.1 Catch data

Total annual catches (t) for redfish have been estimated based on a combination of sources, including Sydney Fish Market (SFM) data (to 1986), NSW and Victorian landings and the SEF logbook data (Table 28 of Rowling (1994); Appendix 1 of Rowling (1999); Table 1 of Thomson (2002); Table 1 of Klaer (2005)). The estimated annual tonnages of landings, discard rates and CPUE are provided in Table 16.1. Where available, previously agreed catch tonnages from RAGs were used (Rowling, 1999;

Klaer, 2005). CDR records and NSW state catch data are used from 2005 for the base-case model (referred to as BC4 in Tuck (2014)). Figure 16.3 shows a comparison of the agreed total catch (Commonwealth and NSW combined) from the 2014 assessment and the updated catch estimates for the 2017 assessment. Table 16.1 shows the annual catch values used in the assessment.

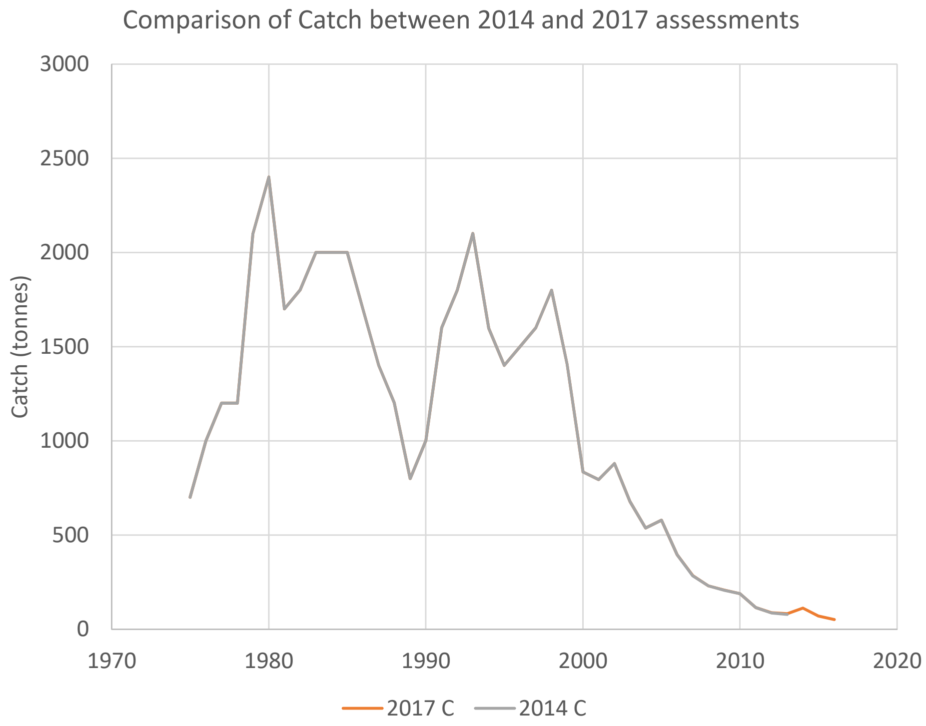

Figure 16.3. A comparison of total annual catches from the 2014 base case assessment (2014 C) and the updated catch used in the 2017 assessment (2017 C).

Table 16.1. Estimated landings (t), discard rates and standardized CPUE (Sporcic and Haddon, 2017) for redfish by calendar year. Total catch (Commonwealth and state) for years 1975 to 2004 were taken from previously agreed catch estimates from redfish assessment group meetings (Rowling, 1999, Appendix 1; Klaer, 2005) and from CDR records for 2005 onwards. Also shown are the NSW state catches from 2005 onwards. State catches exist prior to 2005 but are included in the redfish assessment group agreed catches (Landings column) until 2004.

Year	Landings (t)	NSW	Total Landings (t)	Discard Rates	CPUE
1975	700		700	0.40	
1976	1000		1000	0.40	
1977	1200		1200	0.40	
1978	1200		1200	0.40	
1979	2100		2100	0.40	
1980	2400		2400	0.30	
1981	1700		1700	0.20	
1982	1800		1800	0.20	
1983	2000		2000	0.20	
1984	2000		2000	0.20	
1985	2000		2000	0.20	
1986	1700		1700	0.20	1.81
1987	1400		1400	0.15	1.55
1988	1200		1200	0.15	1.74
1989	800		800	0.15	1.28
1990	1000		1000	0.10	1.62
1991	1600		1600	0.10	1.79
1992	1800		1800	0.25	2.25
1993	2100		2100	0.588	2.70
1994	1600		1600	0.569	1.99
1995	1400		1400	0.767	1.29
1996	1500		1500	0.265	1.16
1997	1600		1600	0.067	1.22
1998	1800		1800	0.213	1.43
1999	1406		1406	0.046	1.20
2000	835		835	0.131	0.80
2001	794		794	0.375	0.76
2002	880		880	0.580	0.71
2003	677		677	0.327	0.61
2004	538		538	0.398	0.54
2005	532	47	579	0.231	0.60
2006	321	76	397	0.038	0.56
2007	230	54	284	0.124	0.55
2008	201	29	231	0.018	0.49
2009	182	26	208	0.357	0.42
2010	166	23	188	0.120	0.41
2011	99	17	115	0.143	0.30
2012	72	16	88	0.021	0.21
2013	66	17	83	0.261	0.27
2014	96	16	112	0.333	0.36
2015	59	11	70	0.429	0.22
2016	43	9	52	0.404	0.17

16.2.3.2 Discard rates

Discard rates prior to 1992 are those estimated by the redfish RAG (Rowling, 1999; Thomson, 2002). Discard rates after 1992 were estimated from on-board data which gives the weight of the retained and discarded component of those shots that were monitored (Thomson and Klaer, 2011). Rowling (1999) provides considerable detail on how the historical discard rates were estimated and the factors that influenced discard practices. Redfish discarding was discussed at a redfish workshop held in Cronulla in April 1997 and at various open redfish assessment group meetings during late 1997 and early 1998. The resulting discard rates are documented in Rowling (1999) and also listed in the last redfish assessment group (Thomson, 2002) and Shelf RAG (Klaer, 2005) assessments of redfish. Here we update the discard estimates by the addition of on-board estimates through to 2016 (Table 16.1).

The assessment model allows an estimation of the probably of retention (which is 1 – P(discard)) as a function of length in order to estimate the annual discard rate and any information on discard length composition. It is apparent that the redfish fishery has undergone numerous changes that may have influenced the behaviour of discarding; these changes are documented in Rowling (1999; Appendix 2). In consultation with K. Rowling (pers. comm.), the following discarding periods have been identified:

1975 – 1985. Market driven discarding

1975 – 1985. Discards largely across all size ranges, but with more small fish discarded

1986 – 2000. Surimi markets period

1986 – 1992. Surimi market. Discarding rates lower, mainly small fish.

1993 – 1995. Quantity of fish sent to surimi market declined, Geelong surimi market closes; consequent increase in discarding.

1996 – 2000. Discarding declined ‘as redfish became less available’. Close of Hacker surimi processor in 2000.

2001 – 2013. Size based discarding period

2001 – 2013. Assume mostly small fish discarded

These changes in discarding behaviour have influenced the large variations in discard rates observed (Table 16.1), as well as the catches, catch rates and discard length composition. The RAG agreed (2014) base case model allows the retention function to vary according to the identified discard period from 1975 to 1985 (market driven), and from 1986 to 2016 (size driven).

16.2.3.3 Catch rates

Sporcic and Haddon (2017) provides the updated catch rate series for redfish (Table 16.1; Figure 16.4). After substantial increases in catch rate in the early and late 1990s, the catch rate has continued to decline since then, and is now less than 10% of levels in 1986. A small increase in catch rate occurred in 2013-14 but has since declined.

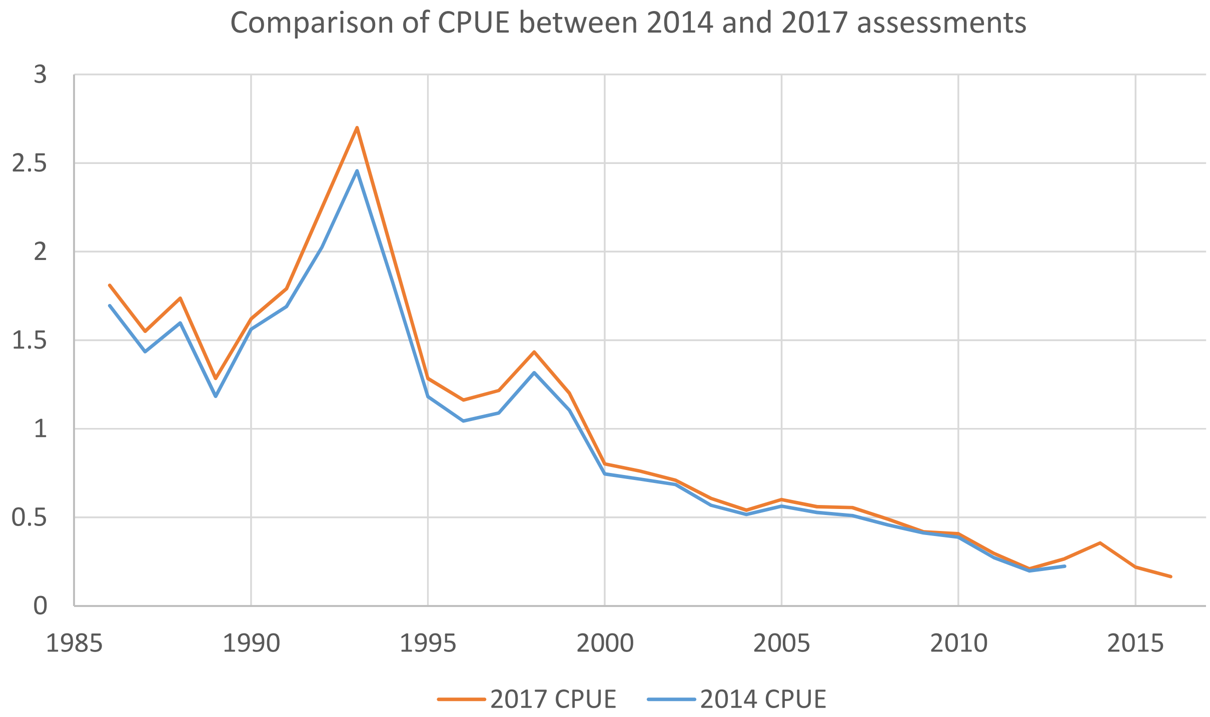

Figure 16.4. A comparison of the annual catch rates series for redfish between 2014 (2014 CPUE) and 2017 (2017 CPUE).

16.2.3.4 Length frequencies and age data

Length and age data have been included in the model as length frequency data and conditional age-at-length data by year and sex (when available). Age composition data is included in diagnostic plots but is not used directly within the fitting procedure. Catch length frequency data were obtained from NSW records of fish measured at the Sydney Fish Markets to 1991. After 1991 length frequencies were obtained from ISMP on-board and port measurements. The observed length and age data are shown in later figures with the corresponding model predicted values. The Kapala length frequencies and Fishery Independent Survey (FIS) abundance indices are not included in the RAG agreed base-case model (Tuck and Day, 2014).

16.2.3.5 Biological parameters and stock structure assumptions

The assessment assumes that length at 50% maturity is 19cm for females (Thomson, 2002). Natural mortality is assumed to be $0.10y^{-1}$. Redfish natural mortality is generally assumed to be in the 0.05 and 0.15 y^{-1} range (SEFAG, 2000). Morison and Rowling (2001) calculated natural mortality values between 0.07 and 0.11 y^{-1}. Steepness is assumed to be 0.75. Parameters for the length weight relationship were taken from Klaer (2005; also used by Thomson, 2002). Growth parameters, including the von Bertalanffy growth parameter k, are estimated (Thomson, 2002). Data were formulated by calendar year (i.e. 1 Jan to 31 Dec) and were aggregated across all eastern zones (Zones 10, 20 and 30), as sufficiently strong evidence to suggest a north-south split did not exist (Shelf RAG agreement, September 2014; Haddon, 2014). The 2017 base case model structure follows the RAG agreed base case from 2014 (Tuck and Day, 2014; Tuck, 2014) except that length data are now separated into port and onboard, and updated tuning methods are applied.

16.2.3.6 Age-reading error

Standard deviations for aging error by reader have been estimated, producing the age-reading error matrix of Table 16.2 (A.E. Punt, pers. comm.).

16.2.3.7 Analytic approach

The 2017 preliminary base case assessment of eastern redfish uses an age- and size-structured model implemented in the generalized stock assessment software package, Stock Synthesis (SS) (Version 3.30.06.02, NOAA 2011). The methods utilised in SS are based on the integrated analysis paradigm. SS can allow for multiple seasons, areas and fleets, but most applications are based on a single season and area. Recruitment is governed by a stochastic Beverton-Holt stock-recruitment relationship, parameterized in terms of the steepness of the stock-recruitment function (h), the expected average recruitment in an unfished population (R_0), and the degree of variability about the stock-recruitment relationship (σ_r). SS allows the user to choose among a large number of age- and length-specific selectivity patterns. The values for the parameters of SS are estimated by fitting to data on catches, catch-rates, discard rates, discard and retained catch length-frequencies, and conditional age-at-length data. The population dynamics model and the statistical approach used in fitting the model to the various data types are given in the SS technical documentation (Methot, 2005).

Table 16.2. The standard deviation of age reading error.

Age	St Dev	Age	St Dev
0	0.214	20	0.922
1	0.214	21	0.946
2	0.267	22	0.969
3	0.317	23	0.992
4	0.365	24	1.013
5	0.412	25	1.034
6	0.456	26	1.053
7	0.499	27	1.072
8	0.540	28	1.090
9	0.579	29	1.108
10	0.617	30	1.125
11	0.654	31	1.141
12	0.688	32	1.156
13	0.722	33	1.171
14	0.754	34	1.185
15	0.785	35	1.199
16	0.815	36	1.212
17	0.843	37	1.225
18	0.870	38	1.237
19	0.897	39	1.249
		40	1.260

The base–case model includes the following key features:

a) A single region, single stock model is considered, aggregated across zones 10, 20 and 30 (RAG agreed base-case, 2014).

b) The selectivity pattern for the trawl fleet was assumed to be length-specific and logistic. The parameters of the selectivity function for each fleet were estimated within the assessment. A selectivity pattern is estimated for each of port and onboard lengths due to large differences in length compositions.

c) The model accounts for males and females separately.

d) The initial and final years are 1975 and 2016. Previous models (Thomson, 2002; Klaer, 2005) used 1975 as the initial year due to the generally perceived poorer quality of data prior to this year. An initial fishing mortality is estimated to account for catches prior to the starting year.

e) The CVs of the CPUE indices were initially set at a value equal to the standard error from a loess fit (0.247; Sporcic and Haddon, 2017), before being re-tuned to the model-estimated standard errors within SS.

f) Discard tonnage was estimated through the assignment of a retention function. This was defined as a logistic function of length, and the inflection and slope of this function were estimated where discard information was available. A retention function was estimated for each 'block' period: namely 1975 – 1985 and 1986 – 2013.

g) Over the period 1975-1985 include a logistic retention function with a cap less than 1.0 (i.e. larger fish do not reach full retention and can be discarded; fixed at 0.8; Tuck and Day, 2014).

h) The rate of natural mortality, M, is assumed to be constant with age, and also time-invariant. The value for M is 0.1 y^{-1}.

i) Recruitment to the stock is assumed to follow a Beverton-Holt type stock-recruitment relationship, parameterised by the average recruitment at unexploited spawning biomass, R_0, and the steepness parameter, h. Steepness for the base-case analysis is set to 0.75.

j) The initial value of the parameter determining the magnitude of the process error in annual recruitment, σ_r, is set to 0.6.

k) The population plus-group is modelled at age 40 years, as is the maximum age for observations.

l) Growth is assumed to follow a von Bertalanffy type length-at-age relationship, with the parameters of the growth function being estimated separately for females and males inside the assessment model.

m) Retained and discard onboard length sample sizes were capped at 200 and required to have a minimum of 100 fish sampled to be included. For Sydney Fish Market samples (1975 to 1991) numbers of fish were divided by 10 and capped at 200. For port samples, numbers of trips were used as the sampling unit, with a cap of 100 (which was not reached). The sample size is reduced because the appropriate sample size for length frequency data is probably more closely related to the number of shots (onboard) or trips (port) sampled, rather than the number of fish measured.

The values assumed for some of the (non-estimated) parameters of the base case models are shown in Table 16.3.

Table 16.3. Parameter values assumed for some of the non-estimated parameters of the base-case model.

Parameter	Description	Value
M	Natural mortality	0.1
h	"steepness" of the Beverton-Holt stock-recruit curve	0.75
x	age observation plus group	40 years
a	allometric length-weight equations	0.0577 g^{-1}.cm
b	allometric length-weight equations	2.77
l_m	Female length at 50% maturity	19cm

16.2.3.8 Tuning method

Iterative rescaling (reweighting) of input and output CVs or input and effective sample sizes is a repeatable method for ensuring that the expected variation of the different data streams is comparable to what is input. Most of the indices (CPUE, surveys, composition data) used in fisheries underestimate their true variance by only reporting measurement or estimation error and not including process error.

In iterative reweighting, the effective annual sample sizes are tuned/adjusted so that the input sample size was equal to the effective sample size calculated by the model. In SS3.3 there is an automatic adjustment made to survey CVs (CPUE).

1. set the standard error for the relative abundance indices (CPUE, acoustic abundance survey, or FIS) to their estimated standard errors for each survey or for CPUE (and FIS values) to the standard deviation of a loess curve fitted to the original data (which will provide a more realistic estimate to that obtained from the original statistical analysis. SS3.3 then re-balances the relative abundance variances appropriately.

An automated tuning procedure was used for the remaining adjustments. For the recruitment bias adjustment ramps:

2. adjust the recruitment variance (σ_R) by replacing it with the RMSE or a defined set minimum and iterate to convergence (keep altering the recruitment bias adjustment ramps as predicted by SS3.3 at the same time).

Finally for the age and length composition data:

3. multiply the initial sample sizes by the sample size multipliers for the age composition data using Francis weights (Francis, 2011).
4. similarly multiply the initial samples sizes by the sample size multipliers for the length composition data
5. repeat steps 2 to 4, until all are converged and stable (proposed changes are < 1 – 2%).

This procedure may change in the future after further investigations but constitutes current best practice.

16.3 Results

16.3.1 *Transition to the latest version of SS and updated data*

Inclusion of the new data resulted in minimal changes to the estimates of recruitment and the relative spawning biomass time series until length data were included. Including the new length data resulted in a reduced 2011 recruitment estimate and consequent reduced spawning biomass (Figure 16.5 and Figure 16.6). The final tuned preliminary base case model produced spawning biomass that is less in recent years compared to the 2014 assessment, largely due to changes in the length data.

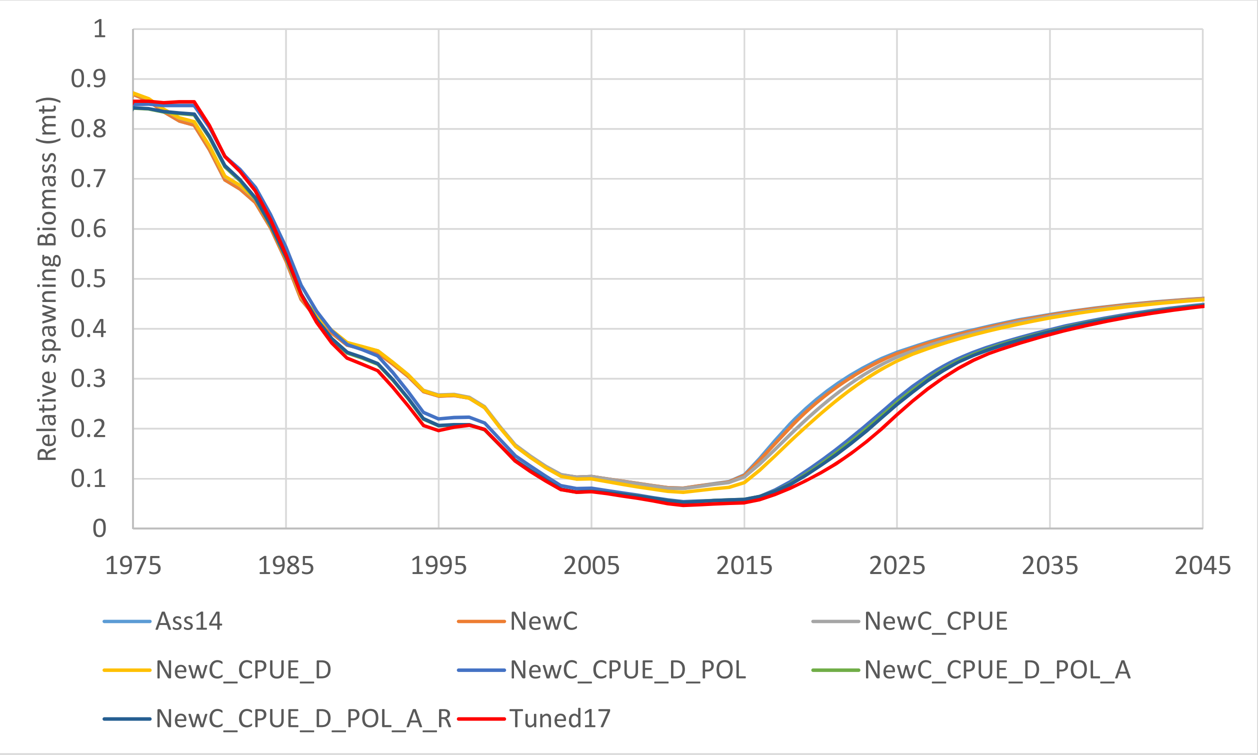

Figure 16.5. A comparison of relative spawning biomass according to the step-wise addition of updated data starting from the 2014 assessment (Ass14) through to the tuned preliminary 2017 assessment (Tuned17). C = Catch, CPUE = catch rates, D = discard, POL = port and onboard lengths, A = age data, R = additional years of recruitment estimation to 2015.

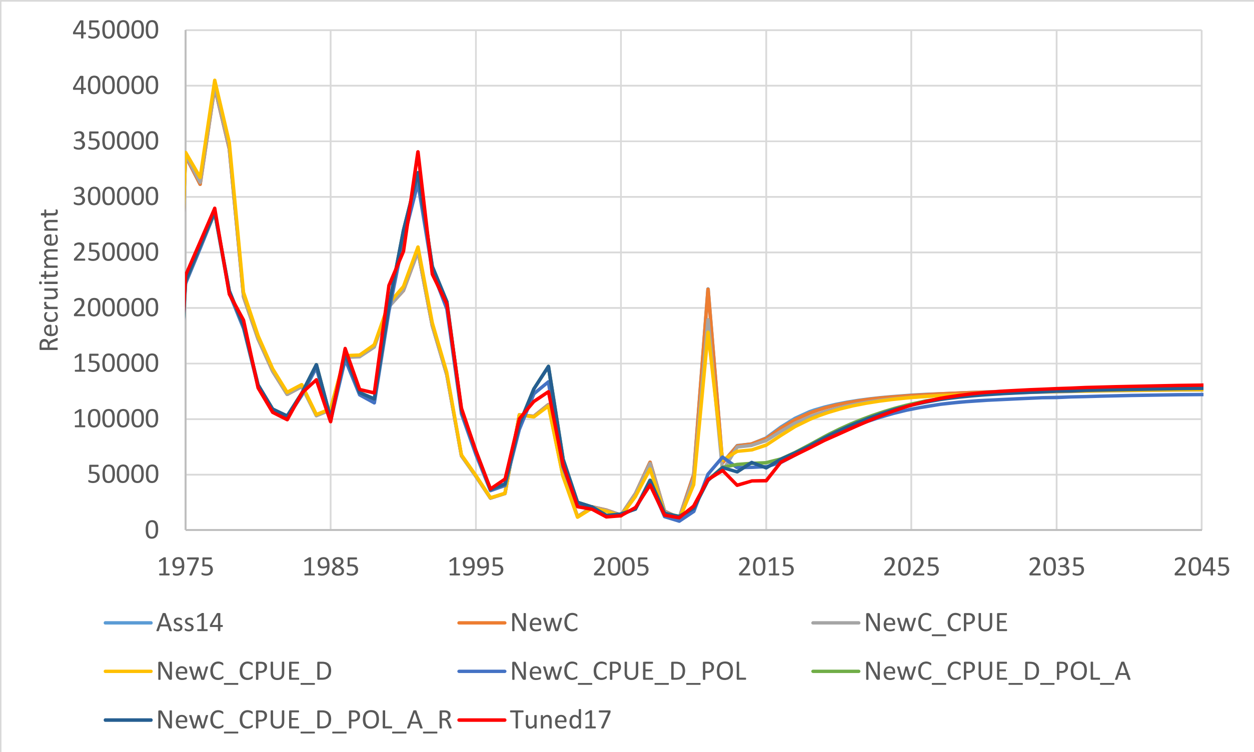

Figure 16.6. A comparison of the estimated annual recruitment according to the step-wise addition of updated data starting from the 2014 assessment (Ass14) through to the tuned preliminary 2017 assessment (Tuned17). C = Catch, CPUE = catch rates, D = discard, POL = port and onboard lengths, A = age data, R = additional years of recruitment estimation to 2015.

16.3.2 *The 2017 preliminary base case*

The base case specifications agreed by the ShelfRAG in 2014 were maintained into the 2017 preliminary base case presented here. The main differences however are: separating length frequencies into onboard and port collected components, weighting length frequencies by shots (onboard) and trips (port) rather than fish measured; and using the latest new tuning methods.

Results show reasonably good fits to the catch rate data, length data and conditional age-at-length data (Appendix). Issues to note include that there is considerable difference between the port and onboard retained length frequencies, with the mode of port lengths generally larger than onboard lengths (Figure A.5). The magnitude of the estimated recruitment in 2011 in the 2014 assessment has been greatly reduced in the 2017 preliminary assessment (although estimates of recent recruitment are improved over the poor period during 2002-2010; Figure 16.6). The 2017 preliminary assessment estimates that the projected 2018 spawning stock biomass will be 8% of virgin stock biomass (projected assuming 2017 catches in 2018; Figure 16.7), compared to 11% at the start of 2015 from the last assessment (Tuck, 2014).

Further development should include an exploration of the observed differences between port and onboard lengths, differences in length compositions between adjacent years, and refining the model structure (eg years of recruitment estimation, selectivity and retention blocking).

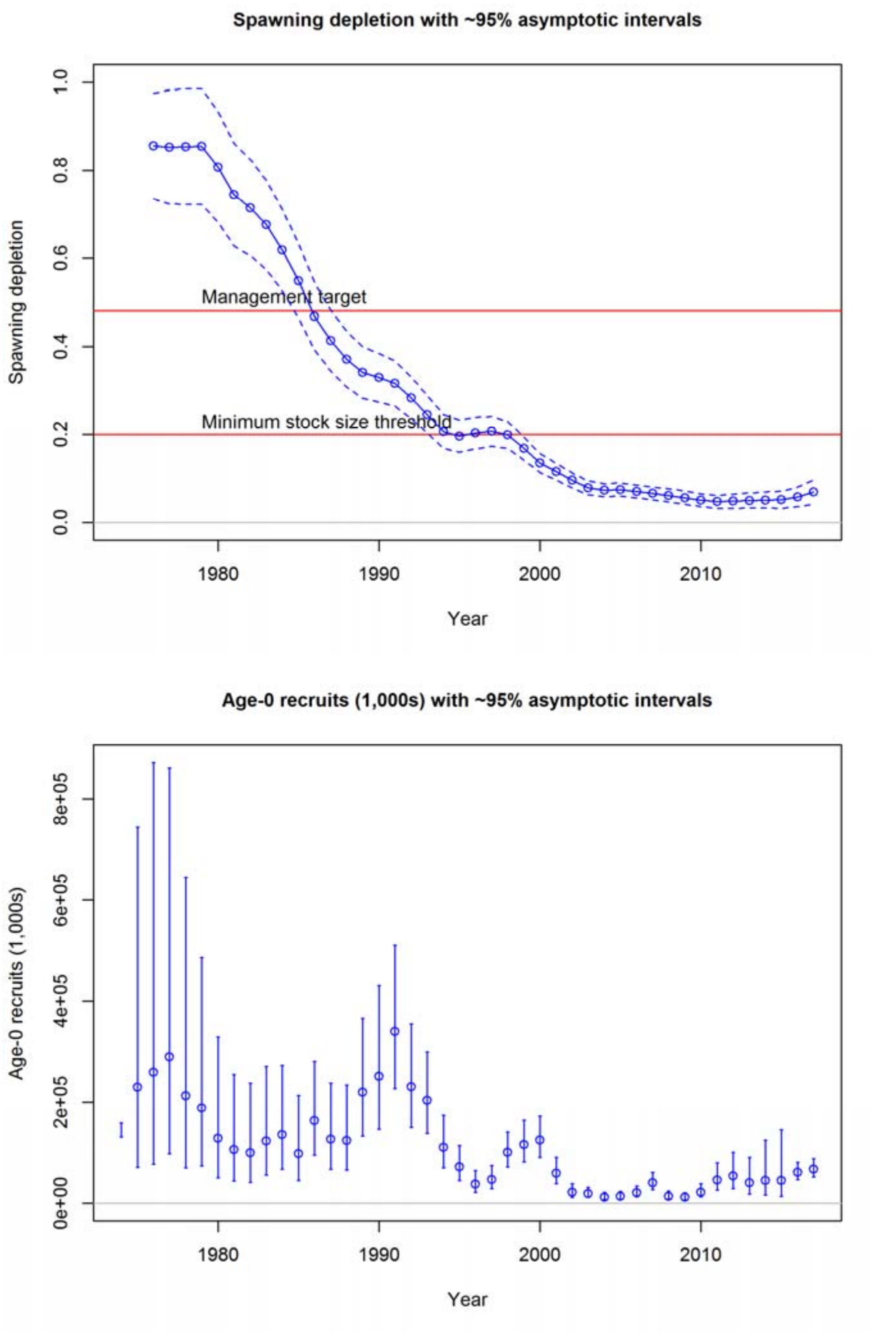

Figure 16.7. The estimated time-series of relative spawning biomass and annual recruitment for the 2017 preliminary base case assessment for redfish.

16.4 Acknowledgements

Age data was provided by Kyne Krusic-Golub (Fish Ageing Services), ISMP and AFMA logbook and CDR data were provided by John Garvey (AFMA). Mike Fuller, Roy Deng and Franzis Althaus (CSIRO) pre-processed the data. Jemery Day, Malcolm Haddon, Andre Punt, Robin Thomson, Rich Little, Miriana Sporcic and Claudio Castillo-Jordan are thanked for helpful discussions on this work.

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16.6 Appendix A

16.6.1 Preliminary base case diagnostics

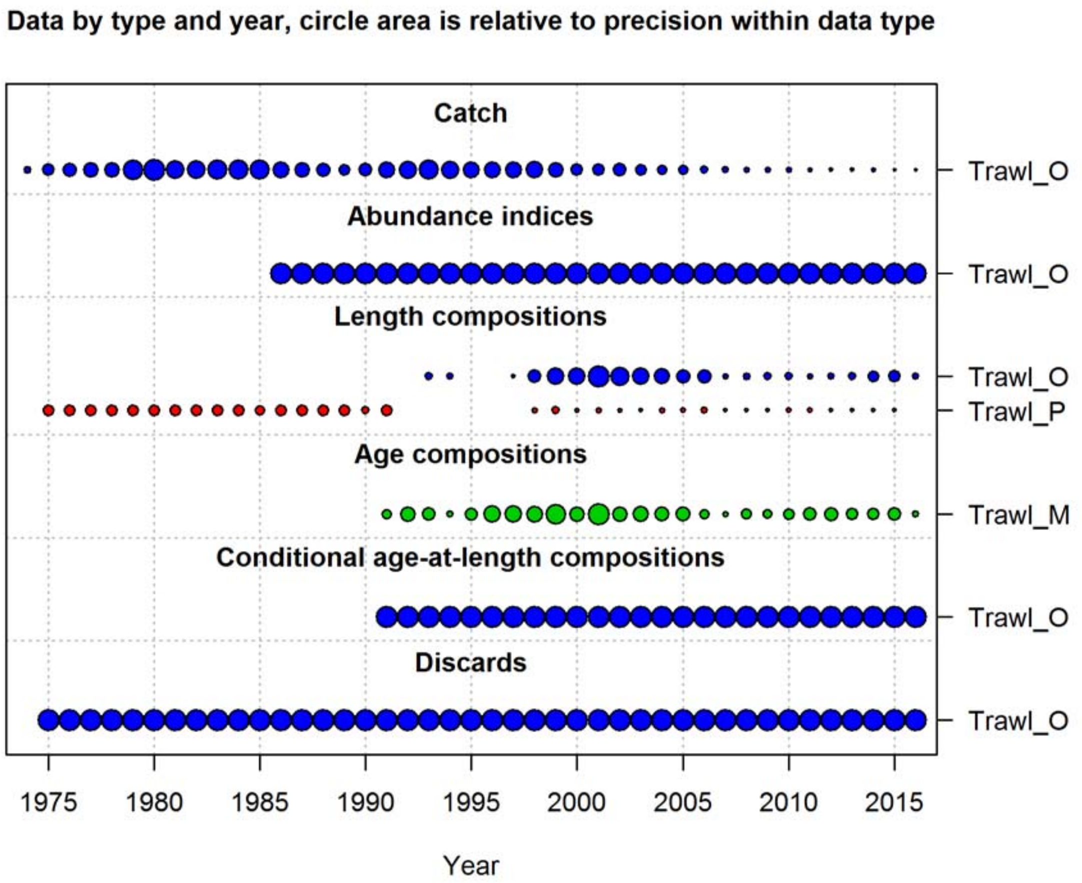
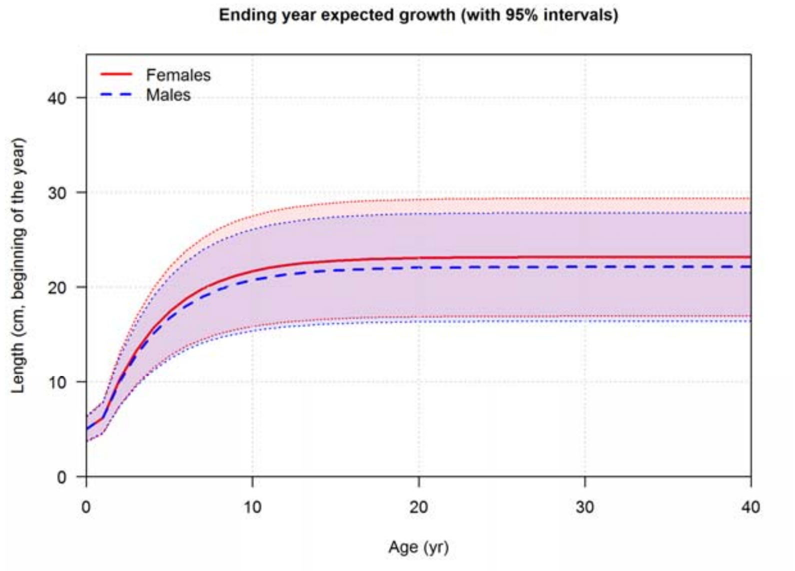


Figure A 16.1. Summary of data sources for the preliminary base case assessment. O = on board, P = port, M = mirrored (used to observe age composition fits).



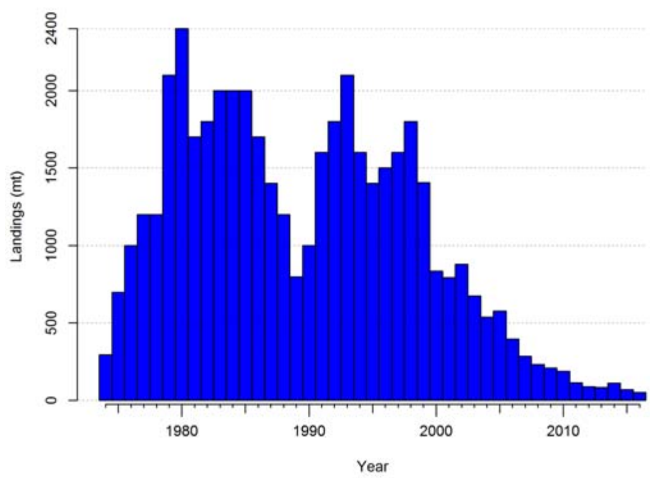


Figure A 16.2. Growth and landings for redfish.

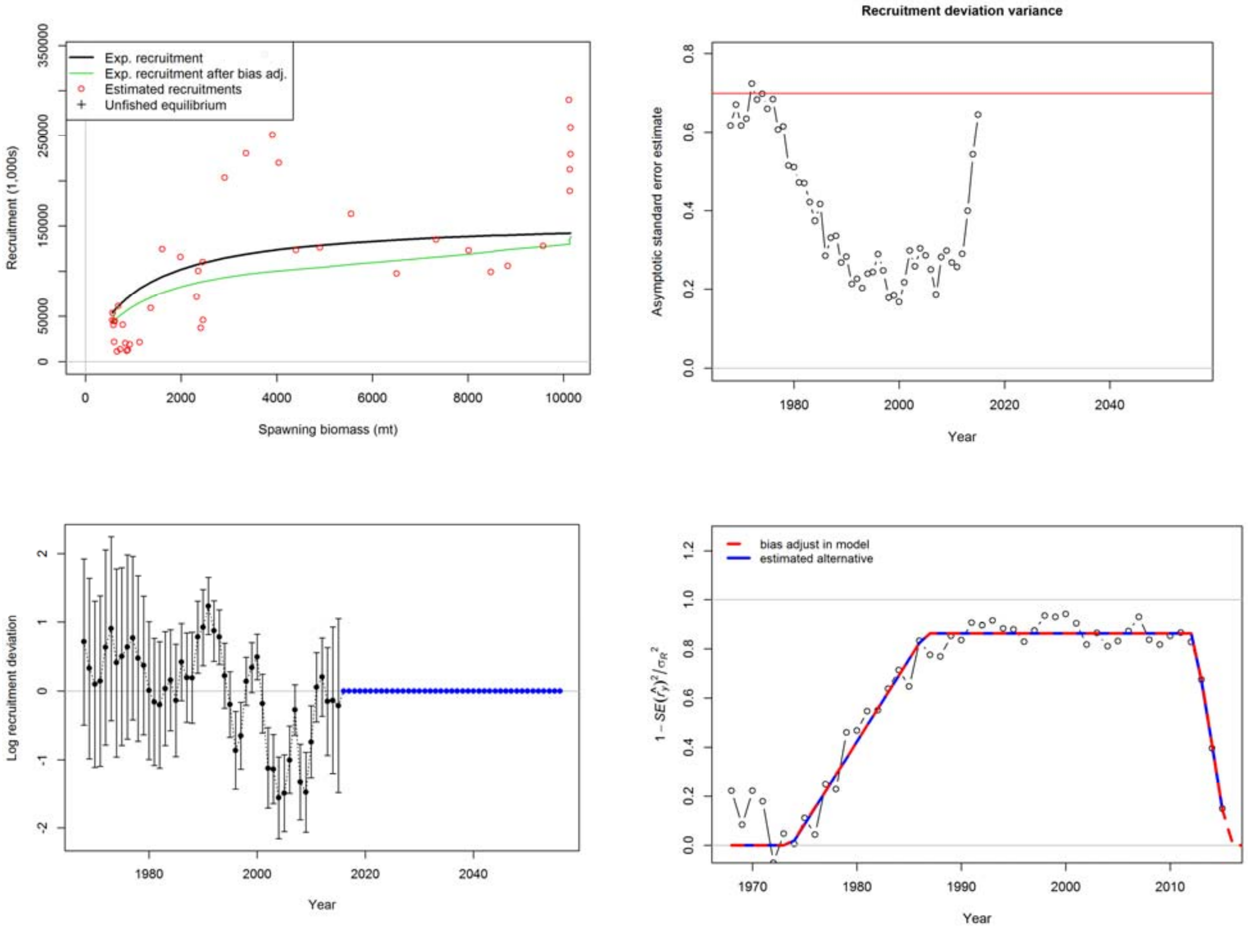


Figure A 16.3. Time series showing the stock recruitment curve, recruitment deviations and recruitment deviation variance check for redfish.

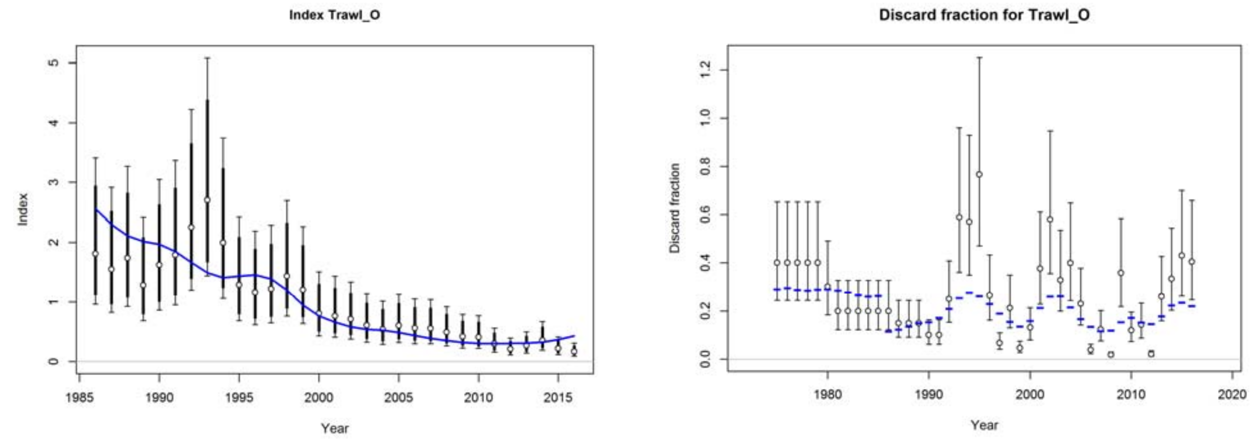


Figure A 16.4. Fits to trawl CPUE and discards for redfish.

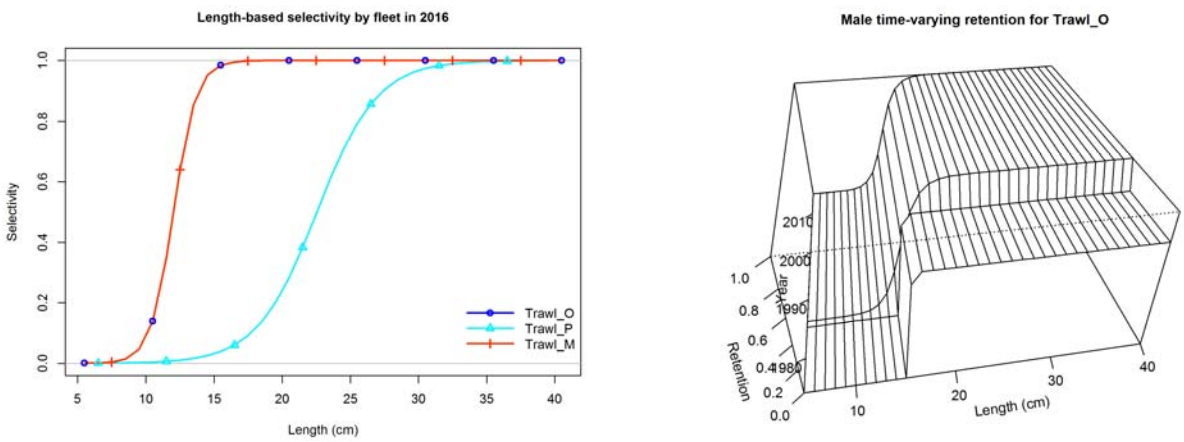


Figure A 16.5. Estimated trawl selectivity for port (P) and onboard (O) and the retention function for redfish.

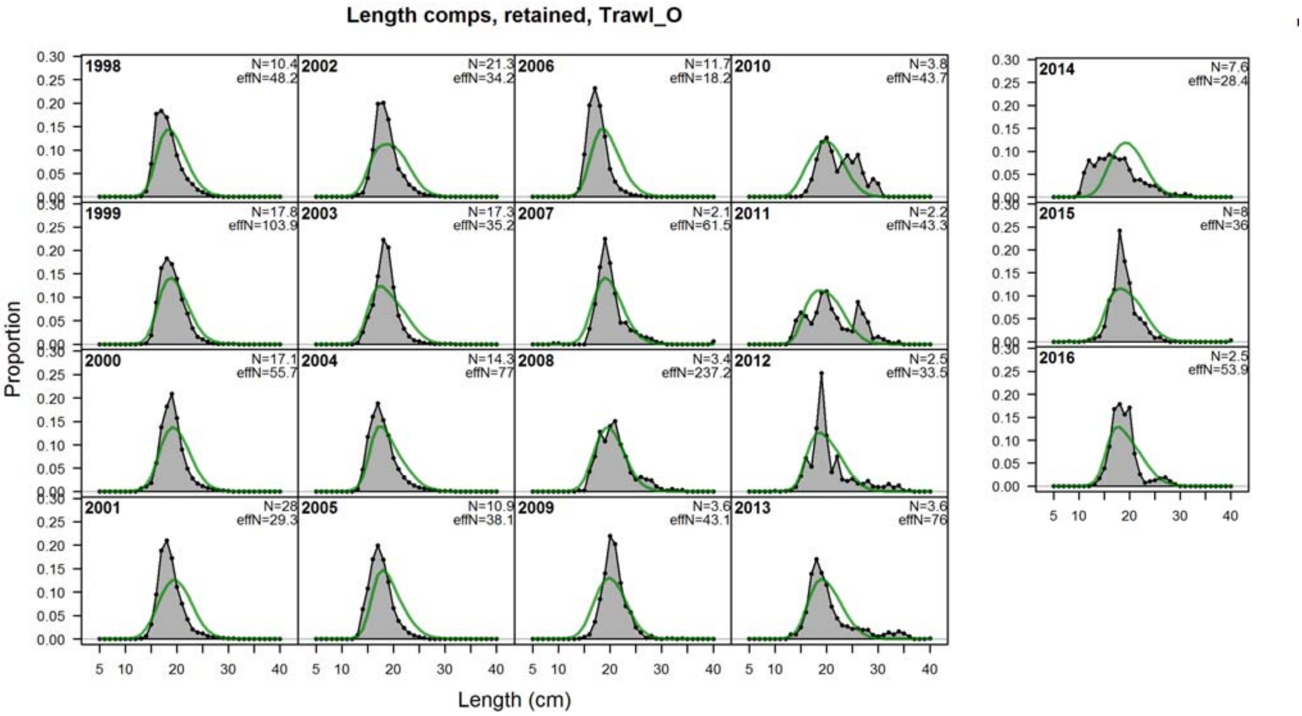


Figure A 16.6. Redfish length composition fits: onboard trawl retained.

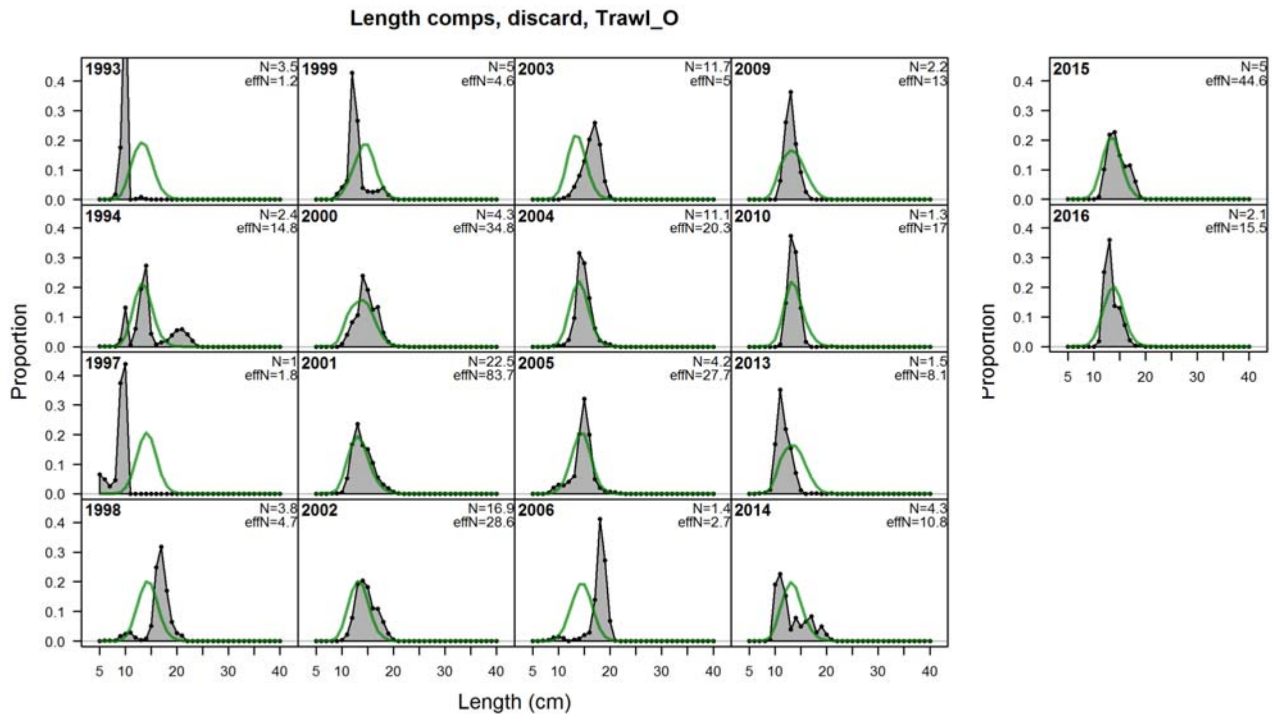


Figure A 16.7. Redfish length composition fits: onboard trawl discard.

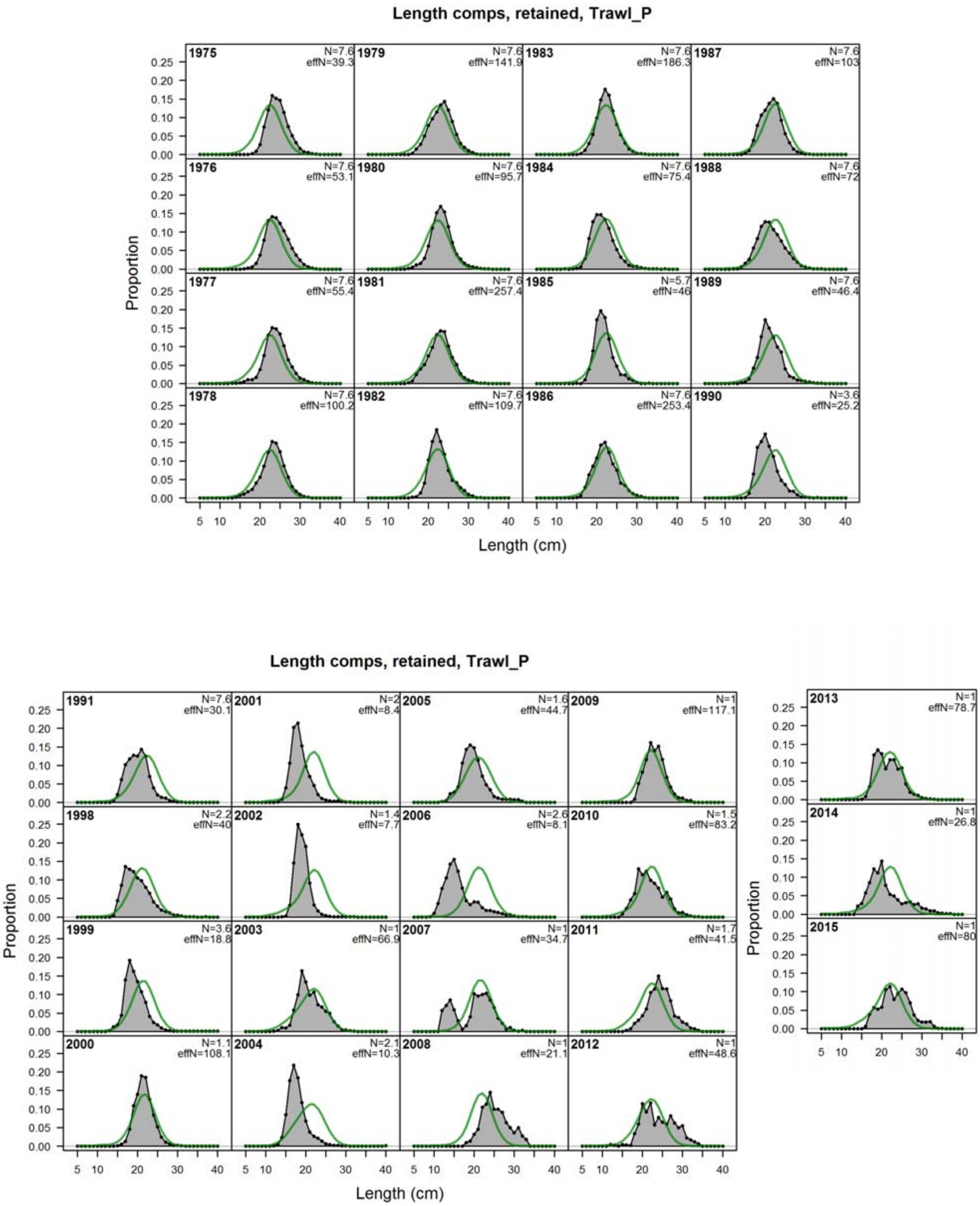


Figure A 16.8. Redfish length composition fits: Port trawl.

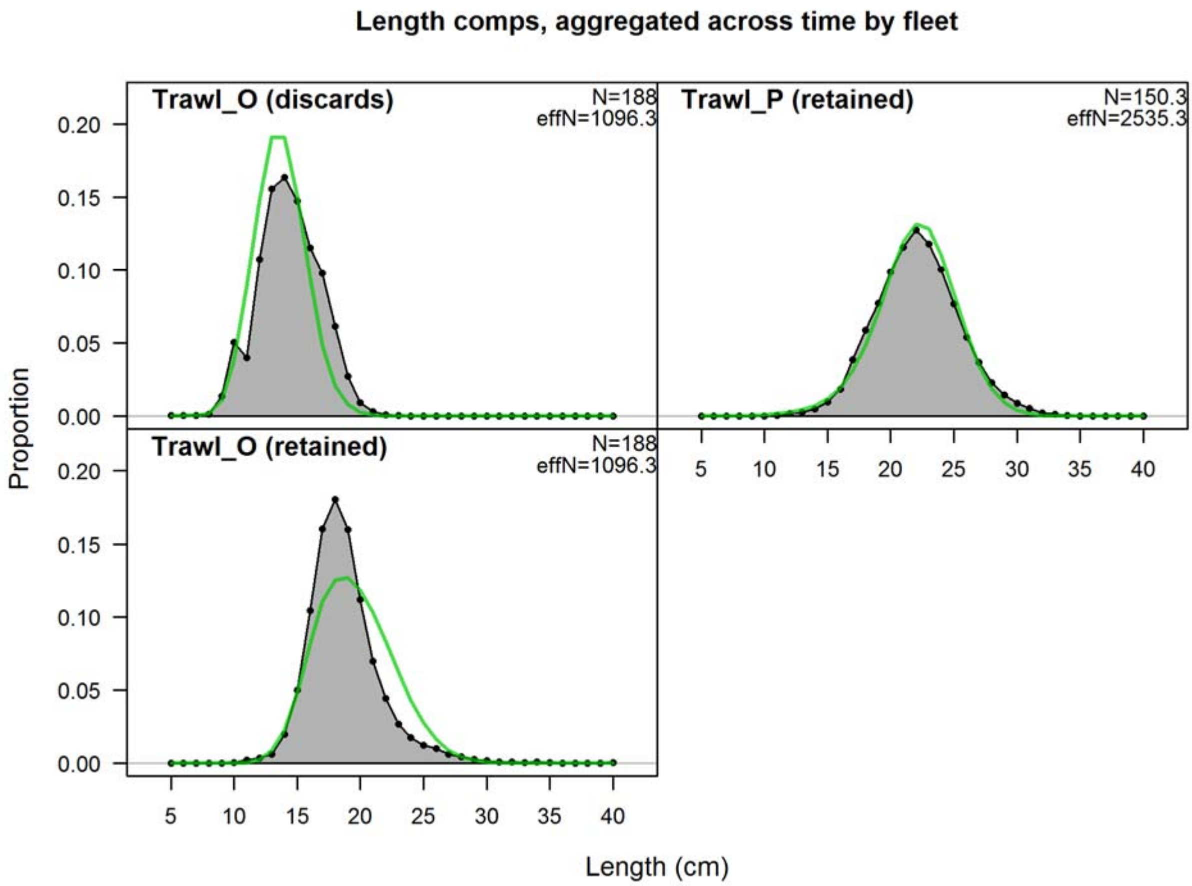


Figure A 16.9. Redfish length composition fits aggregated across years.

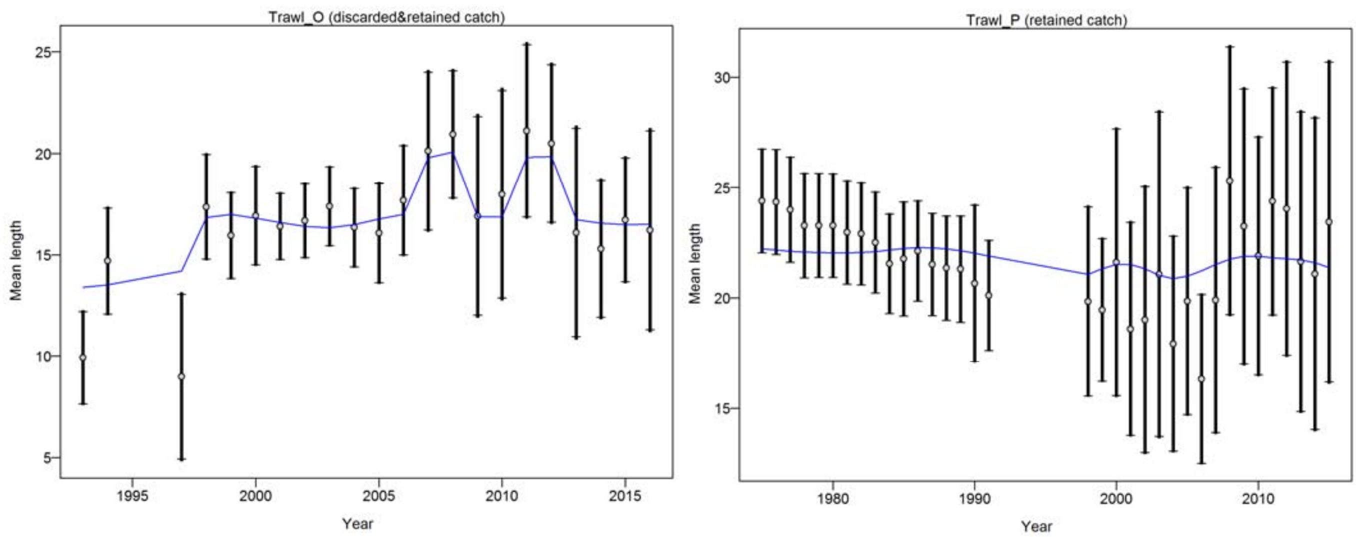
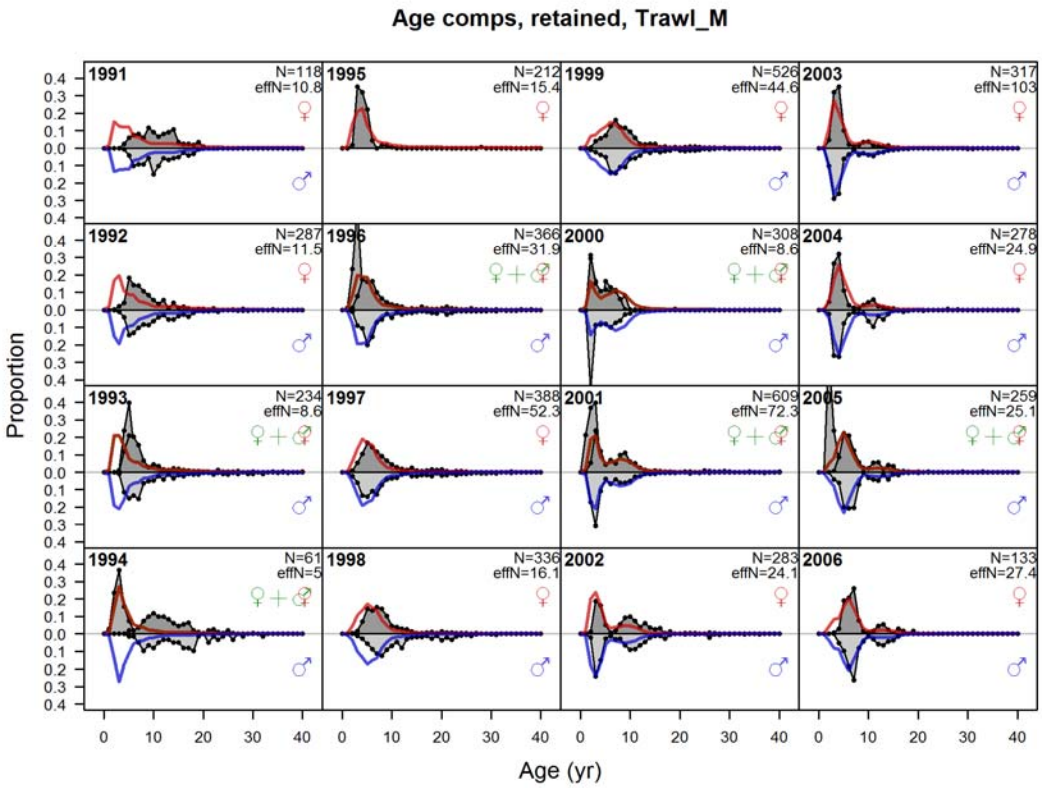


Figure A 16.10. Redfish length composition fit diagnostics from tuning. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for length data.



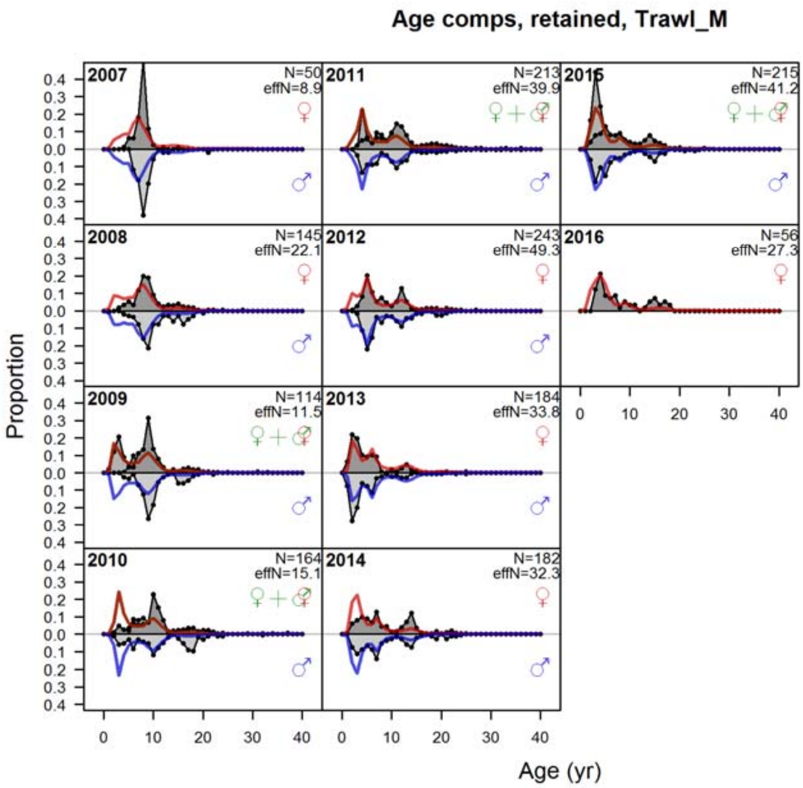


Figure A 16.11. Redfish age composition fits.

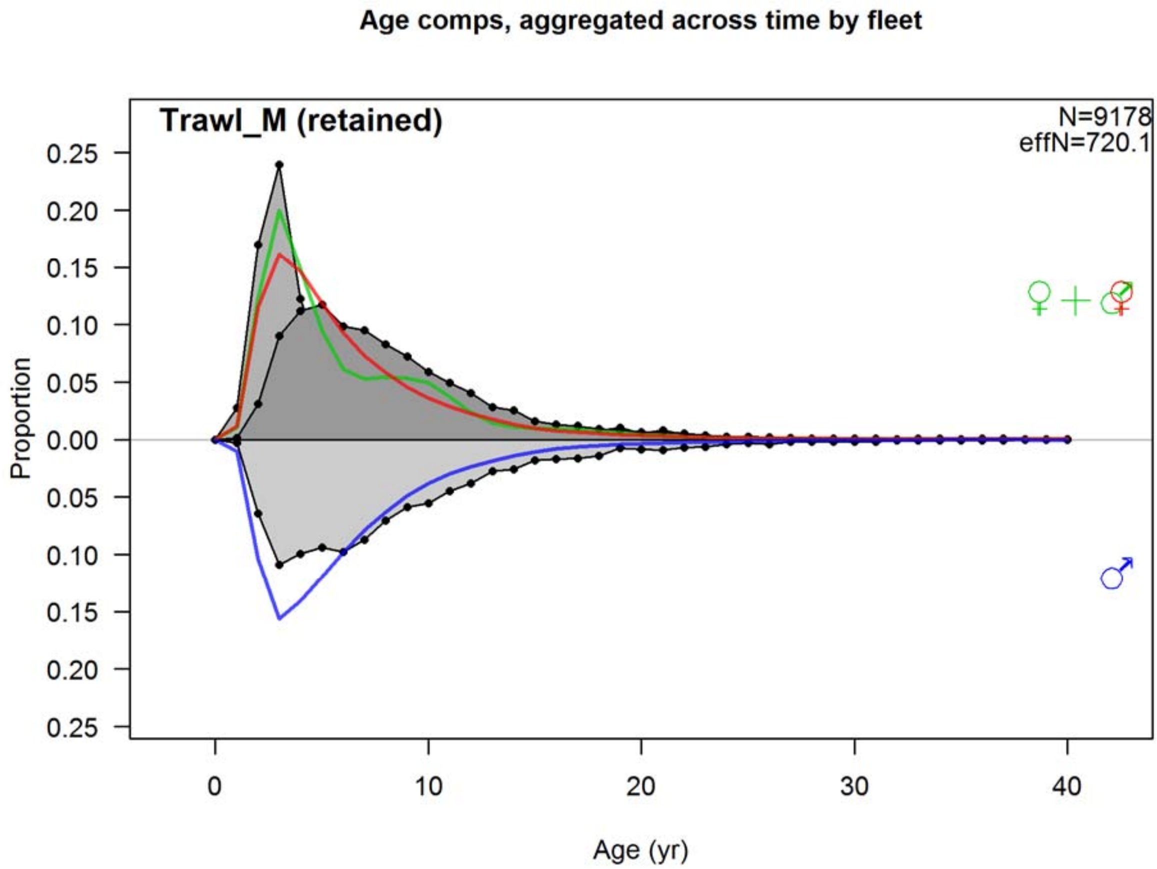


Figure A 16.12. Redfish age composition fit aggregated across years.

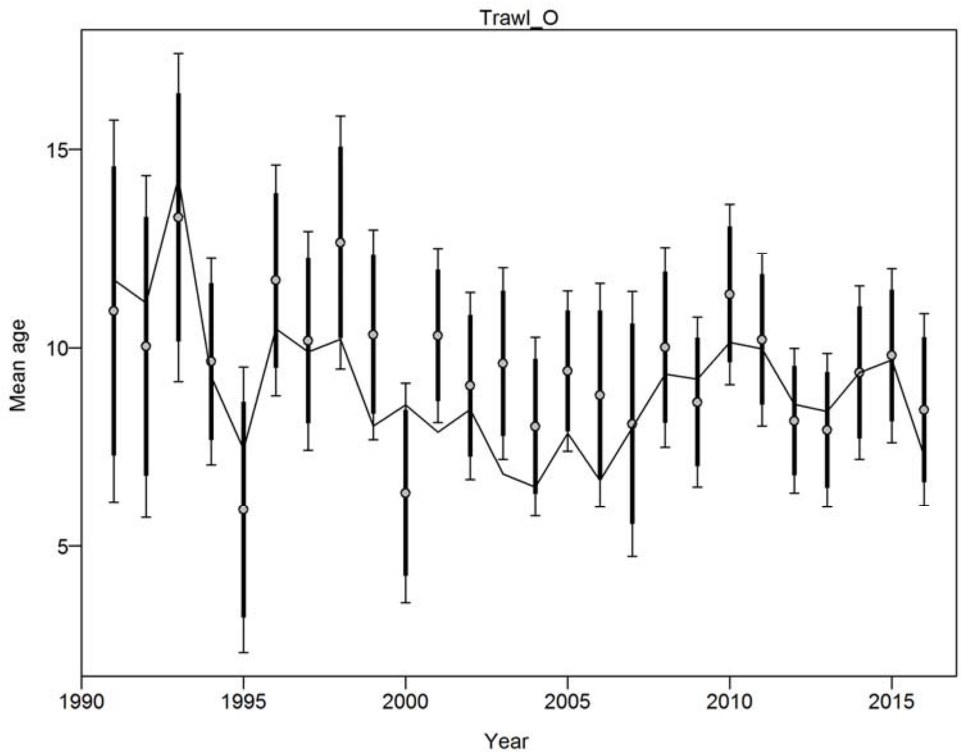
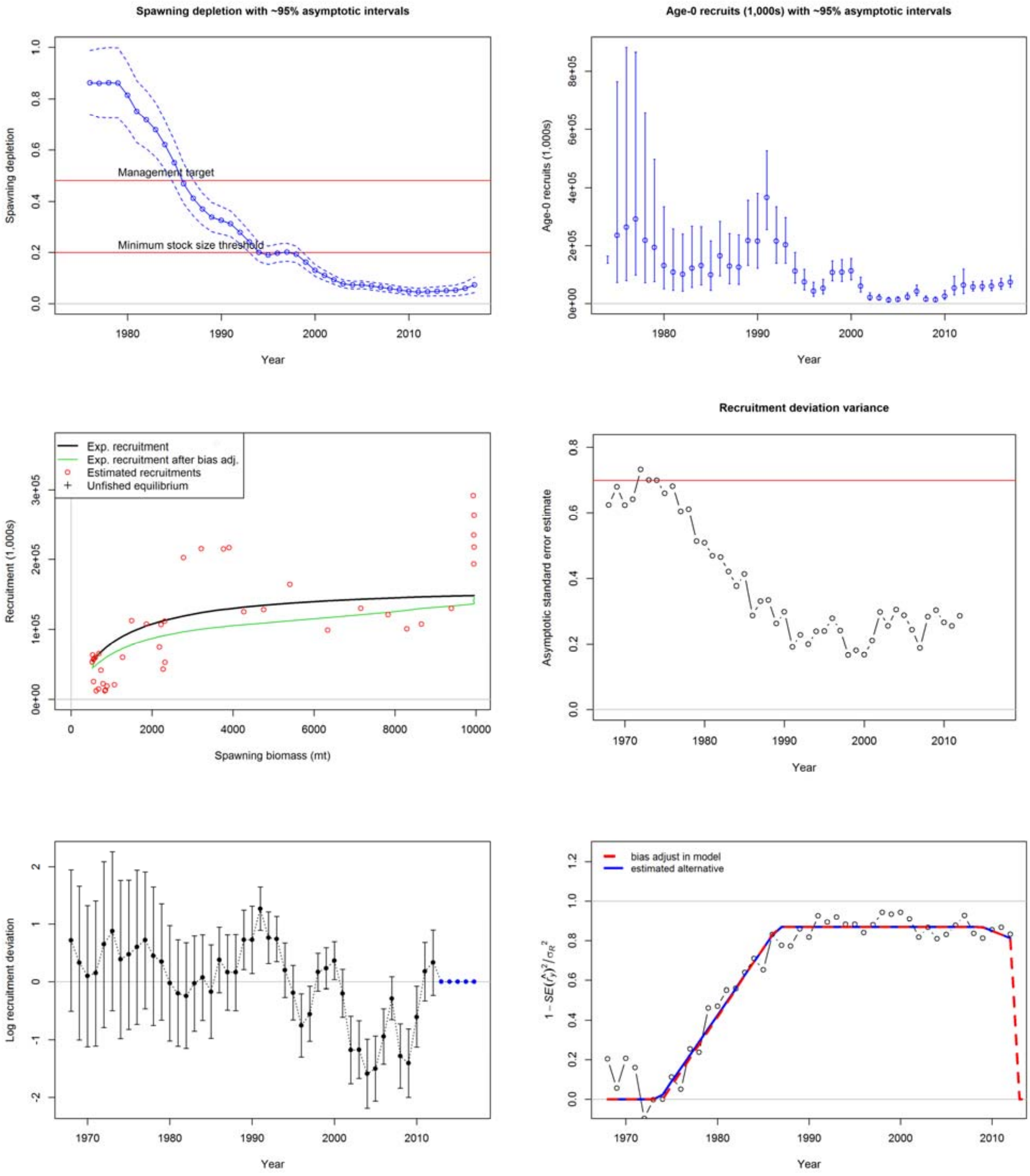


Figure A 16.13. Redfish conditional age at length fit diagnostics from tuning. Francis data weighting method TA1.8: thinner intervals (with capped ends) show result of further adjusting sample sizes based on suggested multiplier (with 95% interval) for conditional age-at-length data.

16.6.2 *Additional diagnostics*

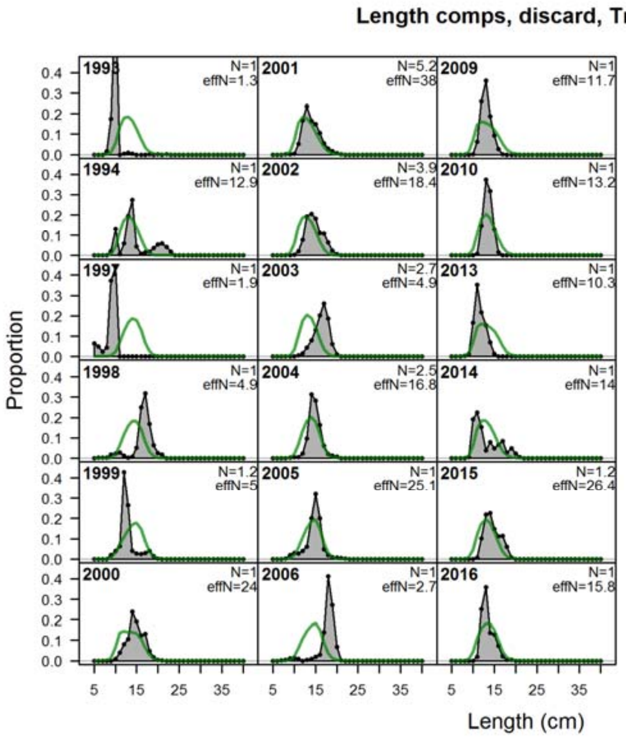
16.6.2.1 Last year of recruitment estimation is 2012

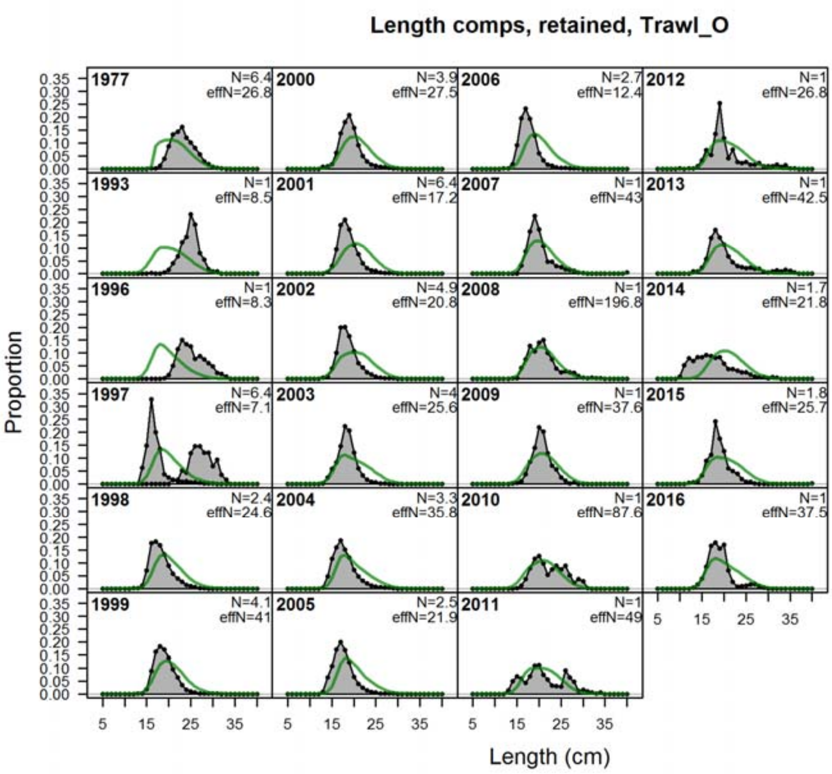
In this sensitivity, the last year of estimated recruitments is 2012 instead of 2015. The stock status in 2018 is 9%.

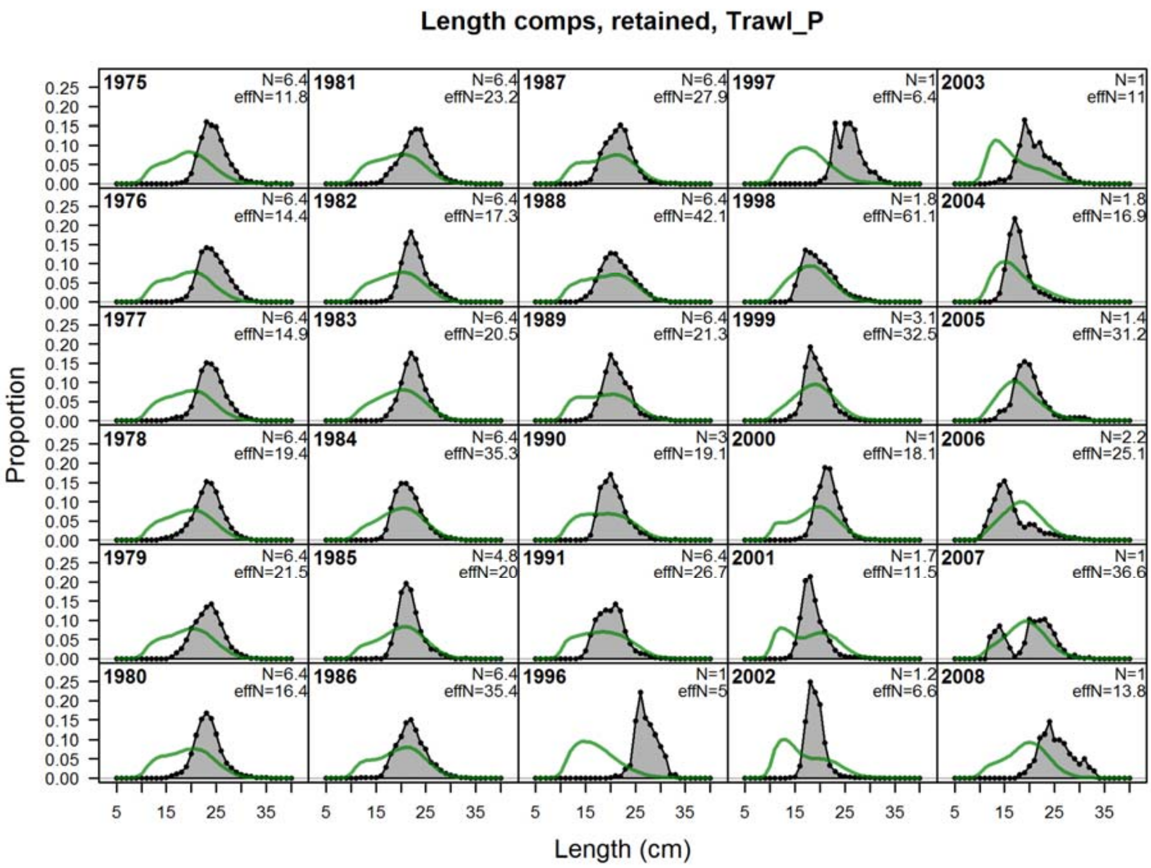


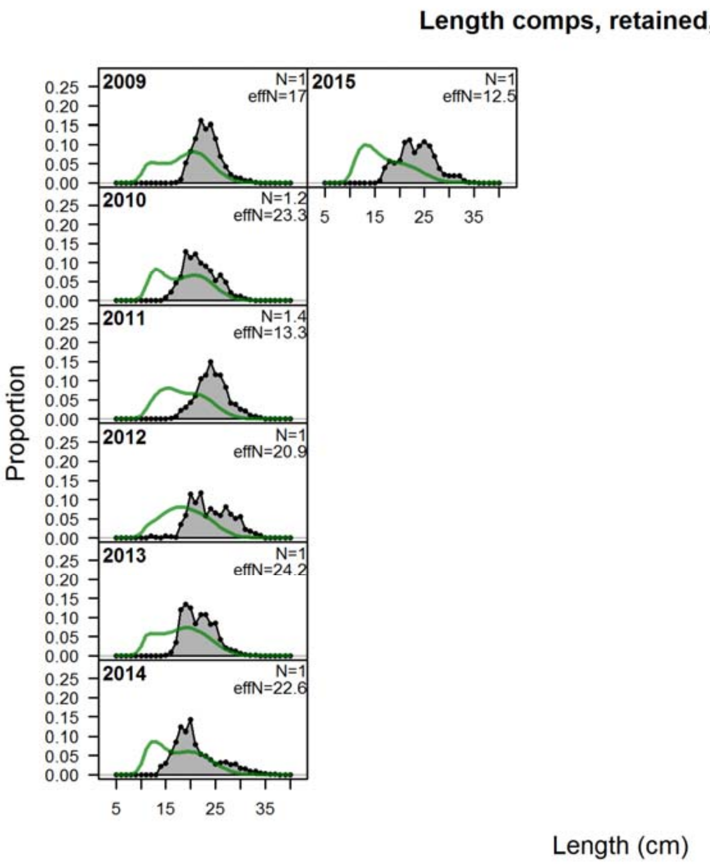
16.6.2.2 Single selectivity for port and onboard lengths

In this sensitivity, only a single selectivity is fit to port and onboard lengths.






Length comps, retained, Trawl_P
Proportion
Length (cm)
1975 N=6.4 effN=11.8
1976 N=6.4 effN=14.4
1977 N=6.4 effN=14.9
1978 N=6.4 effN=19.4
1979 N=6.4 effN=21.5
1980 N=6.4 effN=16.4
1981 N=6.4 effN=23.2
1982 N=6.4 effN=17.3
1983 N=6.4 effN=20.5
1984 N=6.4 effN=35.3
1985 N=4.8 effN=20
1986 N=6.4 effN=35.4
1987 N=6.4 effN=27.9
1988 N=6.4 effN=42.1
1989 N=6.4 effN=21.3
1990 N=3 effN=19.1
1991 N=6.4 effN=26.7
1996 N=1 effN=5
1997 N=1 effN=6.4
1998 N=1.8 effN=61.1
1999 N=3.1 effN=32.5
2000 N=1 effN=18.1
2001 N=1.7 effN=11.5
2002 N=1.2 effN=6.6
2003 N=1 effN=11
2004 N=1.8 effN=16.9
2005 N=1.4 effN=31.2
2006 N=2.2 effN=25.1
2007 N=1 effN=36.6
2008 N=1 effN=13.8


Length comps, retained, Trawl_P
Proportion
Length (cm)
2009 N=1 effN=17
2010 N=1.2 effN=23.3
2011 N=1.4 effN=13.3
2012 N=1 effN=20.9
2013 N=1 effN=24.2
2014 N=1 effN=22.6
2015 N=1 effN=12.5