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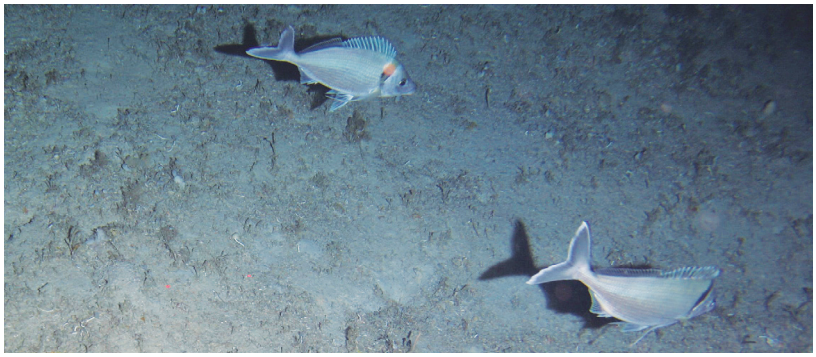
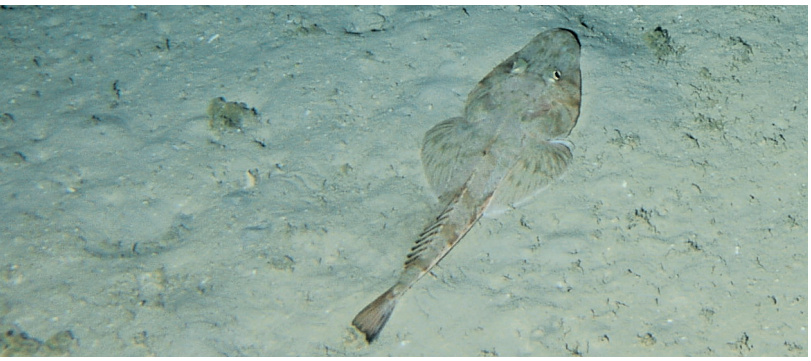
Australian Government
Australian Fisheries Management Authority

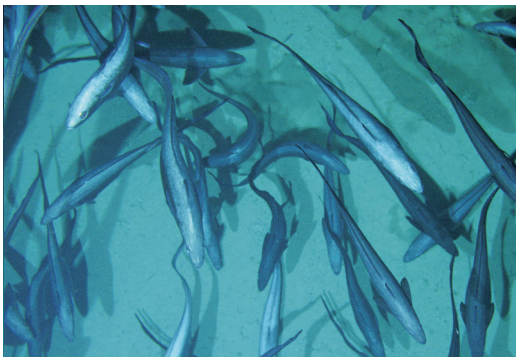
2014/0818 June 2016

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

PART 1







Principal investigator **G.N. Tuck**

CSIRO

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All authors wish to thank the science, management and industry members of the slope-deepwater, shelf, GAB and shark resource assessment groups for their contributions to the work presented in this report. Authors also acknowledge support from Fish Ageing Services (for fish ageing data) and AFMA (for the on-board and port length-frequencies, and in particular John Garvey, for the log book data). Toni Cracknell is greatly thanked for her assistance with the production of this report, and Tim Ryan and Bruce Barker are thanked for the cover photographs of SESSF fish.

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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8. Development of a base-case Tier 1 assessment of eastern Jackass Morwong (*Nemadactylus macropterus*) based on data up to 2014

G.N. Tuck, J. Day and S. Wayte

CSIRO Oceans and Atmosphere, Castray Esplanade, Hobart 7000, Australia

8.1 Summary

This chapter presents the data and results from a preliminary assessment developed to assist the establishment of a 2015 base-case assessment of eastern jackass morwong *Nemadactylus macropterus* in the Southern and Eastern Scalefish and Shark Fishery (SESSF). The assessment uses an age- and size-structured model implemented in 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, discard rates, and length/age compositions. The main purpose of this document is to initiate discussion regarding the data to be used and the assumptions to be included in the base-case model structure.

Results from the 2015 preliminary assessment conclude that the eastern jackass morwong spawning biomass in 2016 will be 32% of the 1988 equilibrium stock biomass. In comparison, the last full assessment in 2011 estimated the 2012 spawning biomass to be 35% of the 1988 equilibrium stock biomass.

8.2 Introduction

An integrated analysis model, implemented in the generalized stock assessment software package, Stock Synthesis (SS) (Methot, 2011; Methot and Wetzel, 2013. V3.24U), was applied to the eastern jackass morwong stock of the SESSF, with data from 1915 to the 2014 calendar year (length and age data; age-error, catch rate series; landings and discard rates). 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.

8.3 The Fishery

The assessment data for eastern jackass morwong have been separated into six ‘fleets’, which represent one or more gear, regional, or temporal differences in the fishery. Landings data from eastern Tasmania were separated from the catches from the other regions in the east, because the length compositions of catches from this area indicate that it lands larger fish (Wayte, 2011).

1. Eastern trawl (ET) – otter trawlers from NSW, eastern Victoria and Bass Strait (1986 – 2014).

2. Danish seine (DS) – Danish seine from NSW, eastern Victoria and Bass Strait (1986 – 2014).
3. Tasmanian trawl (TT) – otter trawlers from eastern Tasmania (1986 – 2014).
4. Steam trawl – steam trawlers (1915 – 1961).
5. Early Danish seine – Danish seine (1929 – 67). These landings may include a small amount of motor trawl catches.
6. Mixed – mixed Danish seine and diesel trawl catch (1968 – 85).

8.4 Data

The data inputs to the assessment come from multiple sources: length (port and onboard) and age-at-length data from the trawl and Danish Seine fisheries, updated cpue series (Sporcic and Haddon, 2015), the FIS, 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).

8.4.1 Catch and discard rates

Both the landed catch tonnage and predicted discard tonnage for eastern jackass morwong from the six fleets are shown in Figure 8.1. Landed catch data by fleet since 2011 was updated by scaling up logbook data using the ratio of total landed morwong catch to total logbook morwong catch.

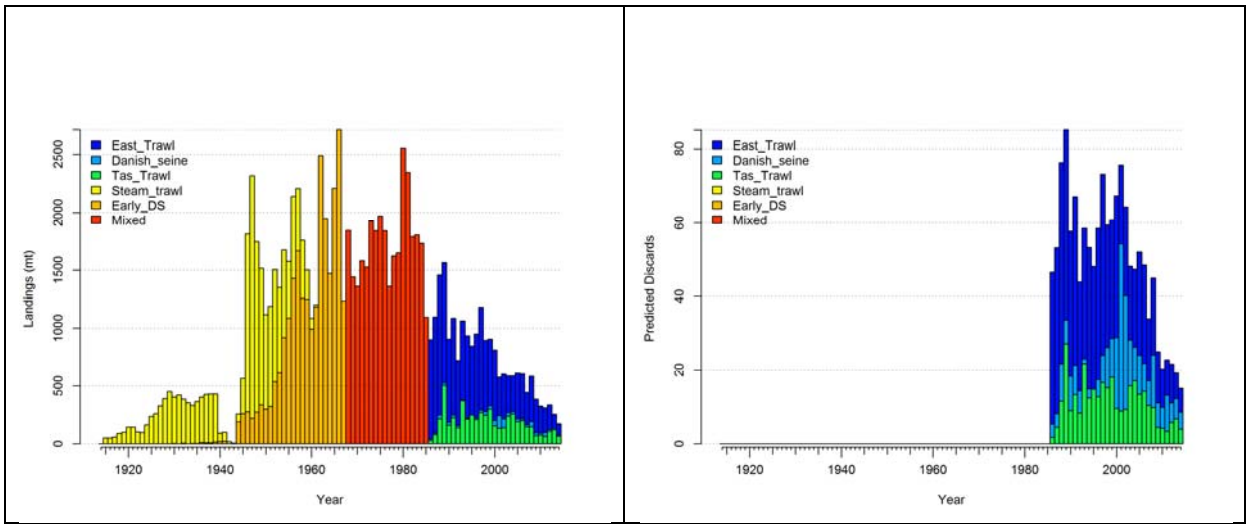

Figure 8.1. Landed morwong catches (mt) for all fleets by calendar year from 1915 and corresponding predicted discard mass (mt).

8.4.2 Catch rates

Sporcic and Haddon (2015) provides the updated standardized catch rate series for jackass morwong (Figure 8.2). After a substantial decline in catch rate from the mid-1980s to 2000, the catch rate for both Zones 10/20 and Zone 30 levelled before potentially showing a further decline in recent years. The catch rate from updated analyses compares well with that from the last assessment in 2011 (Wayte, 2011).

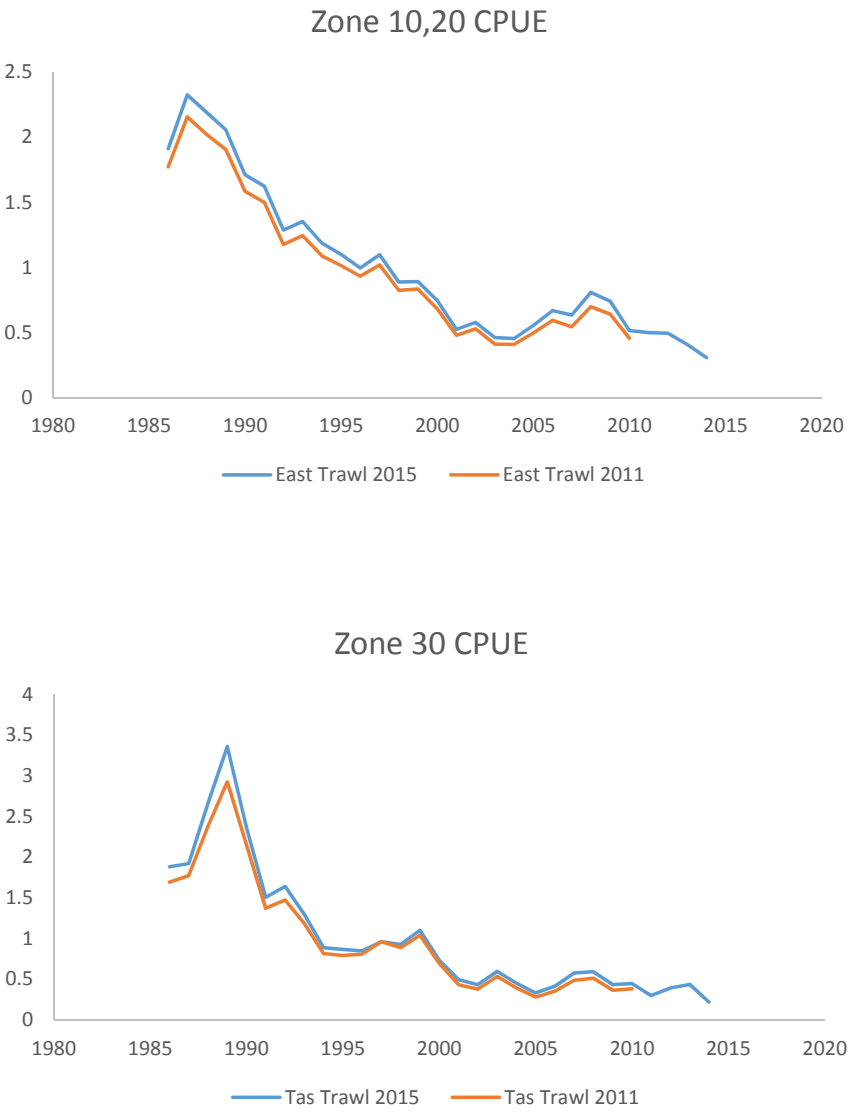

Figure 8.2. Eastern Jackass Morwong standardised CPUE for the NSW/Vic, and Tasmanian trawl fleets (Sporcic and Haddon, 2015). This figure shows a comparison between the series used in the 2011 assessment and the current assessment (2015).

8.4.3 *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 port and onboard. 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 8.9 and Figure 8.10, and the Appendix) with the corresponding model predicted values.

8.4.4 *Age-reading error*

Standard deviations for aging error by reader have been estimated, producing the age-reading error matrix of Table 8.1 (A.E. Punt, pers. comm.).

Table 8.1. 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		

8.4.5 *Fishery independent survey (FIS) estimates*

Abundance indices for eastern jackass morwong over surveys in 2008, 2010, 2012 and 2014 are provided in Knuckey et al. (2015). Indices from the FIS were re-estimated according to Zones 10/20 and Zone 30 (Table 8.2).

Table 8.2. FIS derived abundance indices of eastern jackass morwong with corresponding coefficient of variation (cv).

	2008	2010	2012	2014
Zone 10/20	6.92	6.52	3.55	1.24
c.v.	0.39	0.28	0.44	0.40
Zone 30	52.4	31.5	34.7	15.1
c.v.	0.30	0.32	0.31	0.36

8.4.6 *Biological parameters*

A single-sex stock assessment for jackass morwong was conducted using the software package Stock Synthesis (SS, version 3.22U). A single stock of jackass morwong was assumed for the eastern assessment, with an assumption of two recruitment regimes, or stock-recruitment relationships: the first from 1915 when the steam trawl fishery commenced, and the second, lower recruitment regime, from 1988 when recruitment became lower. Catches from western Tasmania and western Victoria were assumed to come from a separate stock and are therefore not considered in the eastern assessment.

The eastern assessment modelled the impact of six fishing fleets on the morwong population. Selectivity was assumed to vary among fleets, but the selectivity pattern for each fleet was modelled as being time-invariant and modelled as a function of length. Separate logistic functions were used for the selectivity ogives for each fleet. The two parameters of the selectivity function for each fleet were estimated within the assessment. Retention was also defined as a logistic function of length, and the inflection and slope of this function were estimated for those fleets where discard information was available (NSW/Vic trawl, Tasmanian trawl and Danish seine).

The rate of natural mortality rate, M, was assumed to be constant with age, and also time-invariant. The natural mortality for the base-case analysis was set to 0.15 yr^{-1} following previous assessments (Table 8.3).

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. For the eastern assessment the recruitment shift was modelled by estimating two R_0 values: one at the start of the fishery in 1915, and the other at the start of the lower recruitment regime in 1988. Steepness for the base-case analysis was set to 0.7 for both recruitment periods. Deviations from the average recruitment at a given spawning biomass (recruitment deviations) were estimated for 1945-2011 for the eastern assessment. Deviations were not estimated in the east prior to 1945, as there is not enough data prior to this date to estimate them (Wayte, 2011).

Recruitment deviations are estimated to 2011, as the recruitment signal from young fish must have appeared in the catch in sufficient numbers. The value of the parameter determining the magnitude of the process error in annual recruitment, σ_R, was set equal to 0.41 for the eastern assessment (to equal the amount of error estimated by the model).

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.

All sample sizes for port and onboard length frequency data less than 100 were not included in the model fitting procedure as they were deemed to be insufficient samples. As the appropriate sample size for length frequency data is probably more related to the number of shots sampled for onboard data and trips for port data, these values are used as the number of samples, with a cap of 200 and 100 respectively for onboard and port length data. The length frequency data would be given too much weight relative to other data sources if the number of fish measured were used. The historical length data (Sydney Fish Market, Blackburn), where only numbers of fish were available (not trips) were converted to a trip measure by dividing the number of fish sampled for the historical series by the average number of fish sampled per trip for the eastern trawl port lengths (123 fish per trip). The sample sizes for the six fleets (with port and onboard lengths separately fit for East Trawl, Danish Seine and Tas Trawl) were also individually tuned according to the method outlined in Francis (2011).

The CVs of the CPUE indices for the East and Tas Trawl fleets were initially set at a low value to encourage a fit to the abundance data, before being re-tuned to the model-estimated standard errors after tuning to length and age data.

The values assumed for some of the (non-estimated) parameters of the base case models are shown in Table 8.3.

Table 8.3. 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 (re-tuned)	0.6
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

8.5 Results and Discussion

8.5.1 *The base case stock assessment*

8.5.1.1 Comparison to the 2011 assessment

The base-case model largely uses the same assumptions and settings as the last full assessment in 2011. Recruitment deviations are estimated up until three years before the end of the data.

In 2010, the RAG decided to include both port and onboard retained length frequency data (for both historic and current years) in future assessments, whereas previously only port data have been used (Wayte, 2011). The 2015 assessment separates port and onboard length frequency data but estimates a single selectivity (for ET, DS and TT). Other changes include updates of data to the end of the 2014 calendar year as described earlier. FIS data for ET and TT are also included. Figure 3 shows the biomass and recruitment trajectories from the 2011 assessment, the un-tuned trajectory with updated data to 2014 (and previous weighting parameterization) and the new base case (with Francis weighting). This figure illustrates that there is little change in the historical trajectory between model configurations, and shows a substantial decline since pre-fishing years.

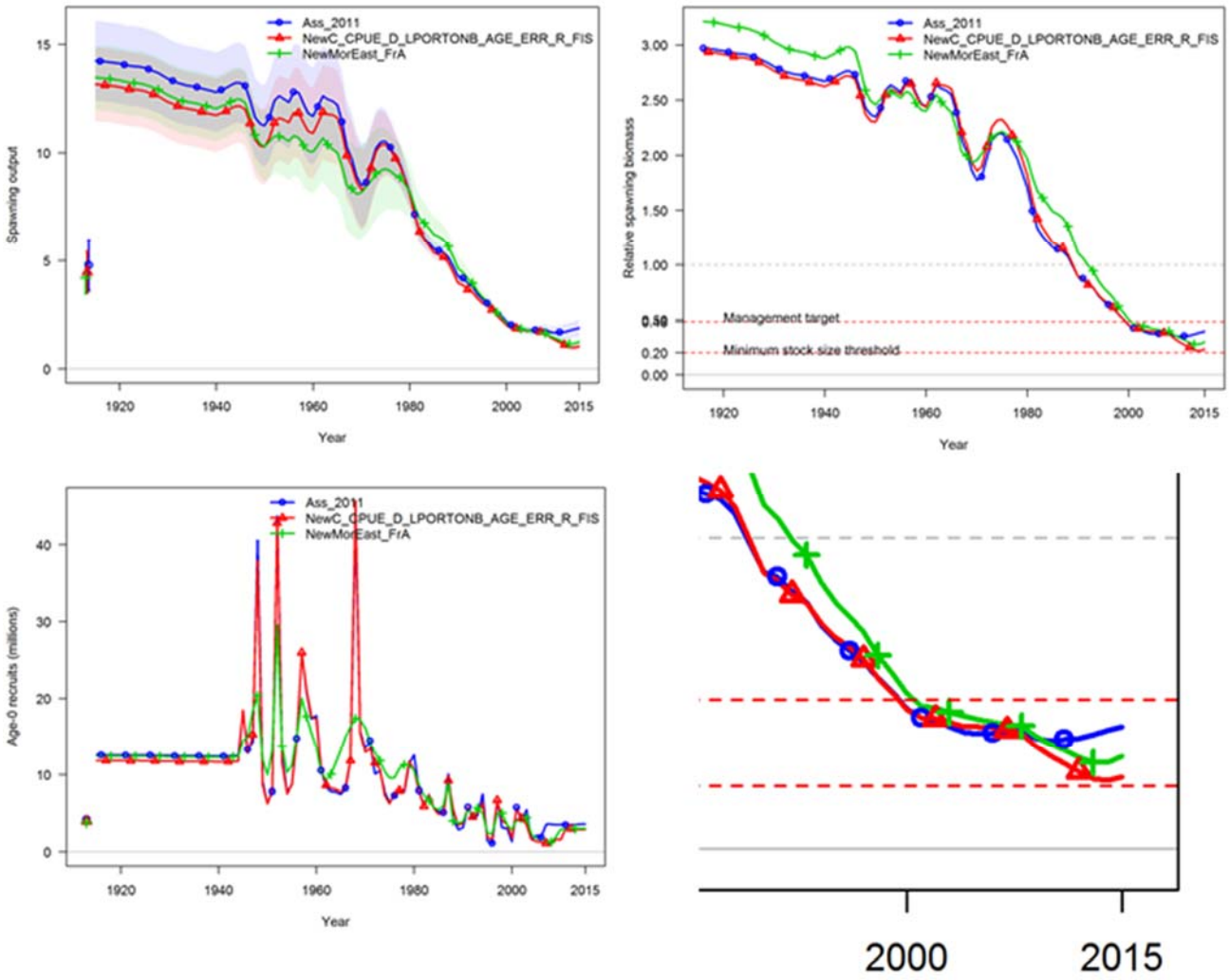

Figure 8.3. The spawning biomass and estimated recruitment trajectories for eastern jackass morwong. Ass_2011 is the assessment from 2011; NewC_CPUE_D_LPORTONB_AGE_ERR_R_FIS is a model with updated data to 2014, but with the same weighting parameterization as the 2011 assessment; NewMorEast_FrA is the new tuned base-case assessment. The recent relative spawning biomass trajectories from the top right hand figure are expanded in the bottom right hand figure.

8.5.1.2 Base case parameter estimates and model fits

A listing of the data is shown in Figure 8.4, and the growth, length-weight, and selectivity functions for the various fleets are shown in Figure 8.5 and Figure 8.6. Fits to the data are shown in Figure 8.7 to Figure 8.11 (and the Appendix), and the estimated spawning biomass trajectory for the base-case model is illustrated in Figure 8.12.

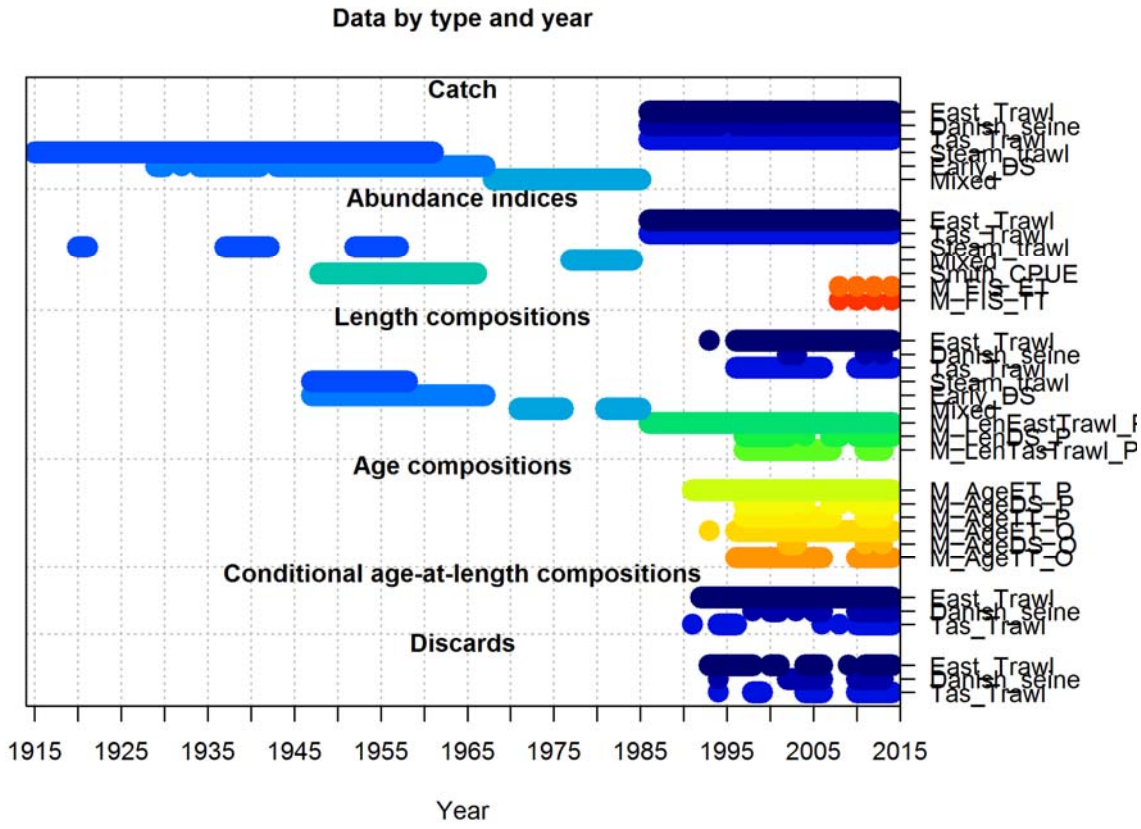

Figure 8.4. The various data types by fleet for eastern jackass morwong.

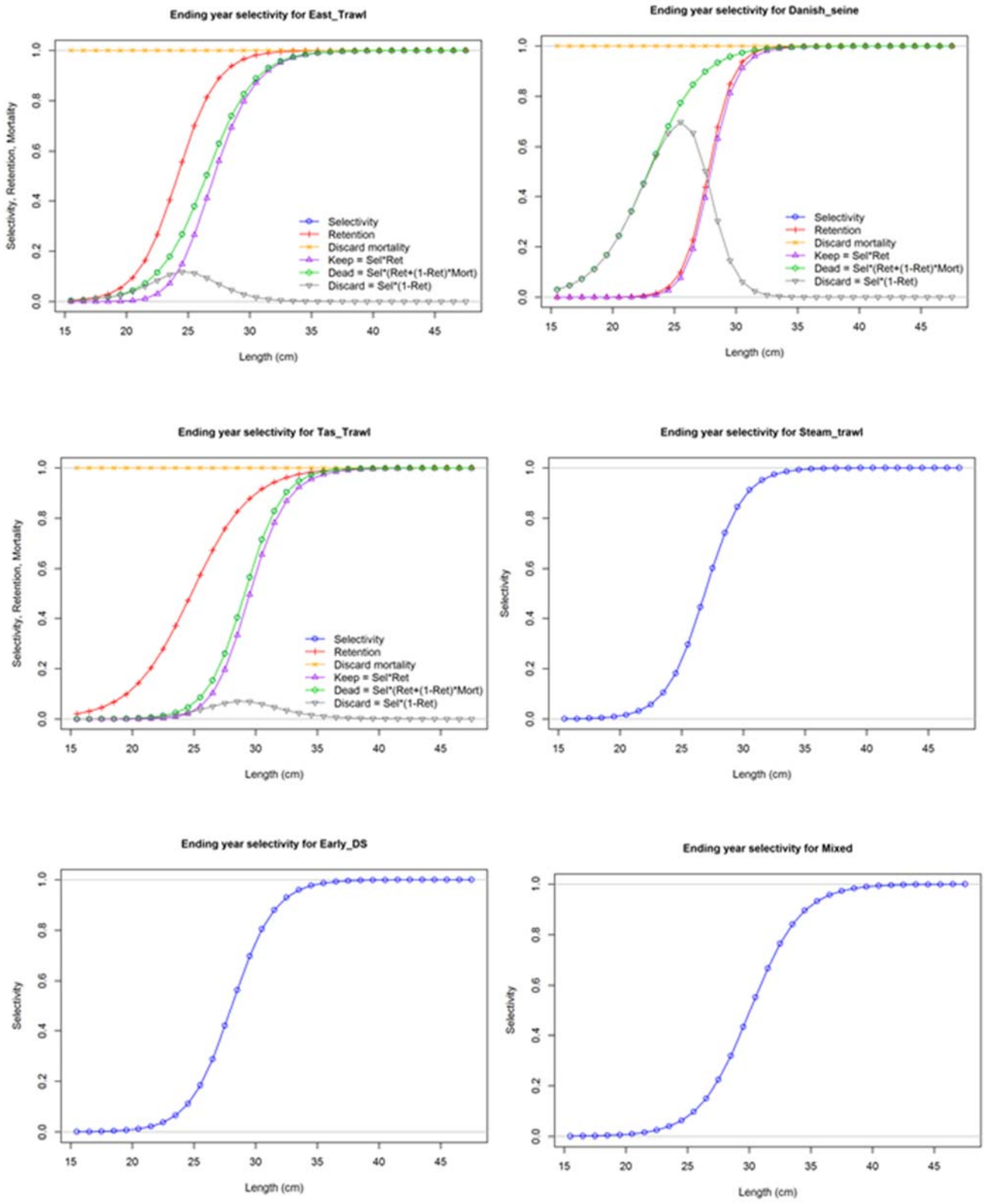

Figure 8.5. Selectivity (blue) and retention functions (red) for the six fleets.

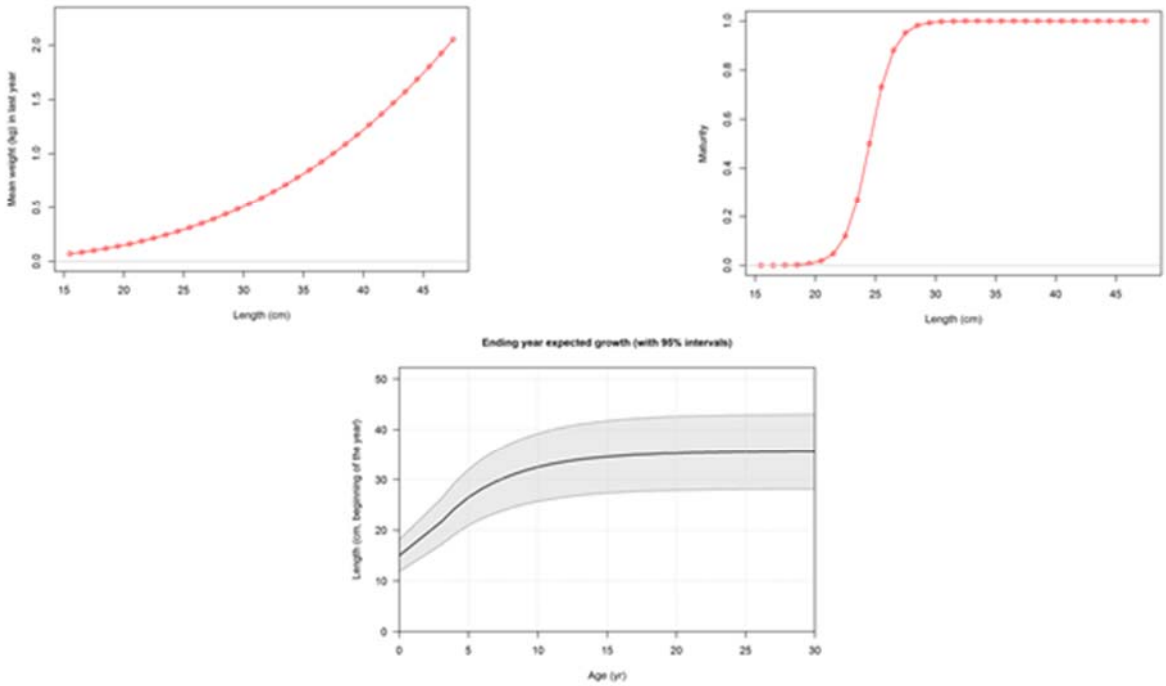

Figure 8.6. The length-weight (left), maturity ogive (right) and length-age relationships (bottom) for the eastern jackass morwong base case assessment.

8.5.1.3 Fits to the data

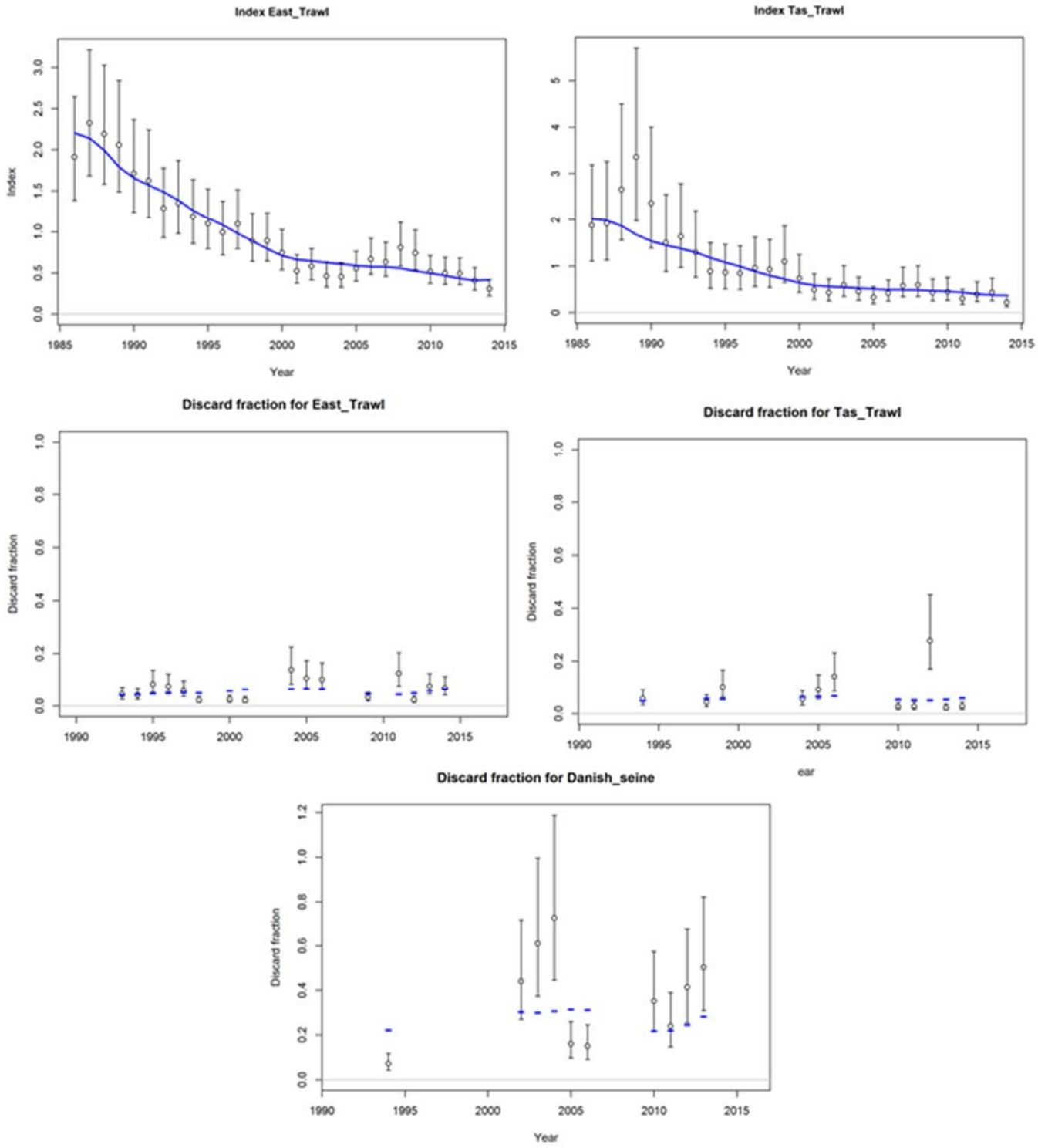

Figure 8.7. Fits to the standardized CPUE for the eastern and Tasmanian trawl fisheries, with the associated discard rates and fit. The fit to the Danish seine discard rates is also shown.

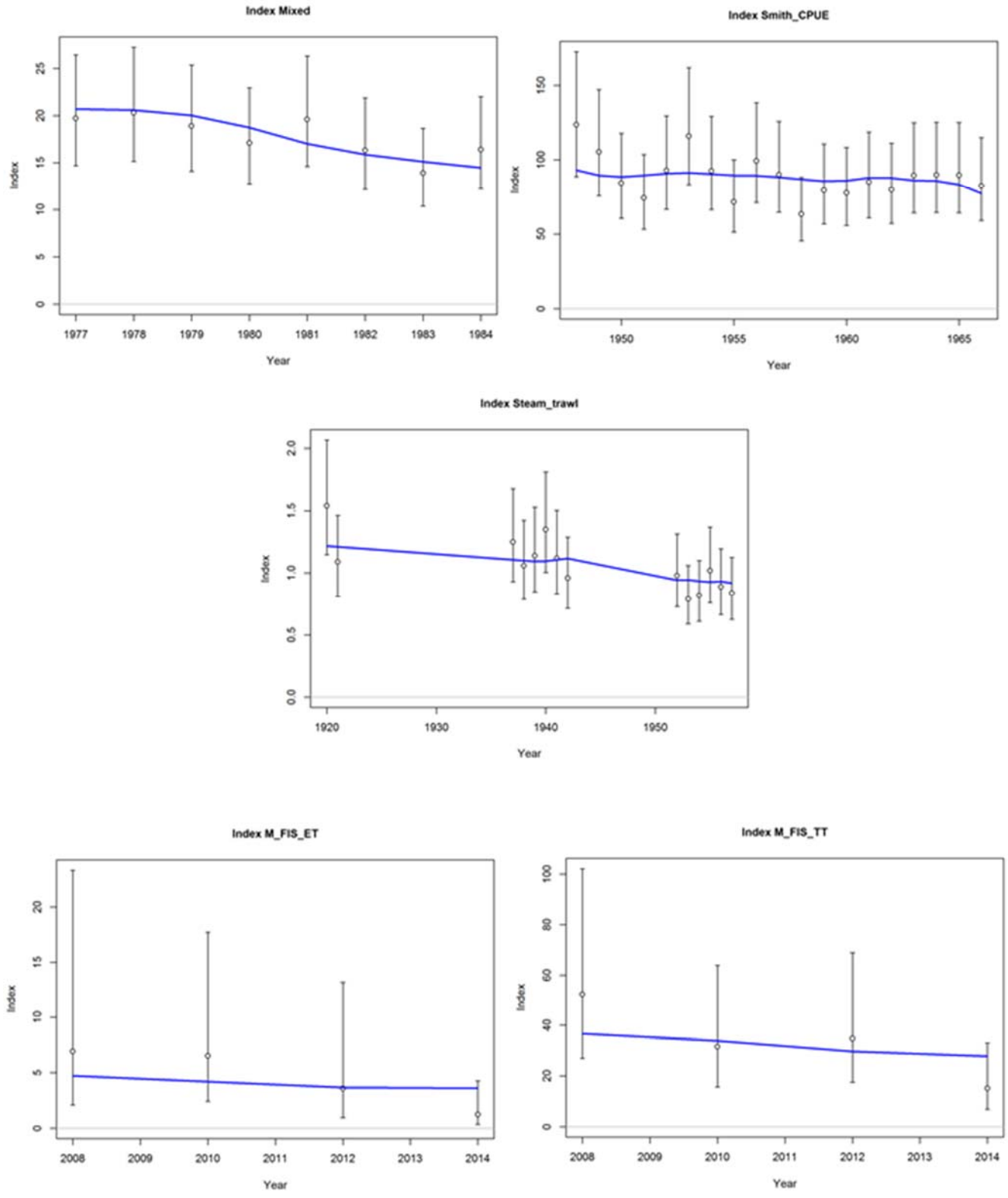

Figure 8.8. Fits to the index data for the mixed fleet, the steam trawl fleet, the Smith CPUE index and the FIS abundance indices from the east (Zones 10/20) and Tas (Zone 30).

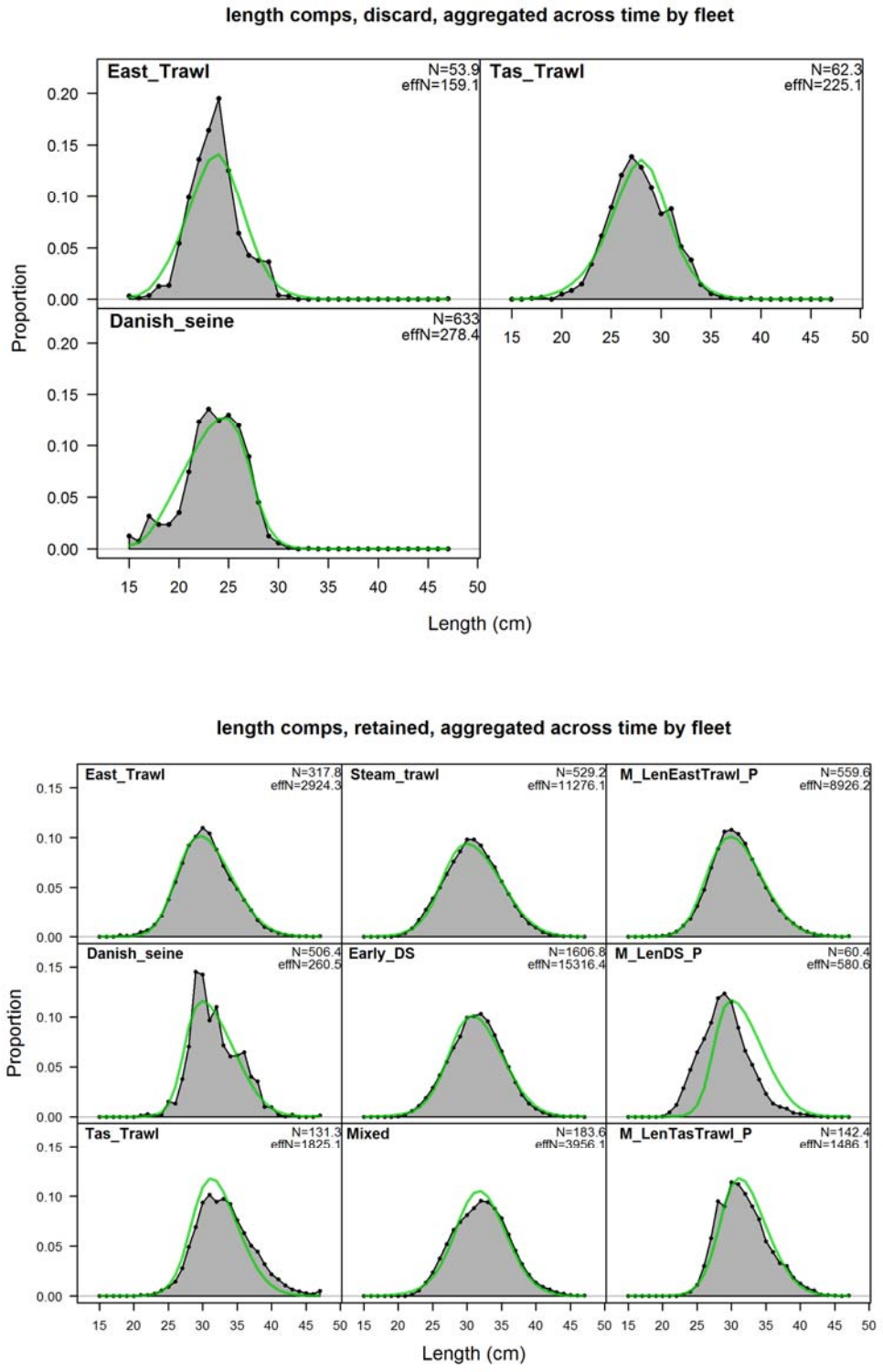

Figure 8.9. Fits to the discard and retained length by fleet (P = Port, otherwise onboard for ET, DS and TT).

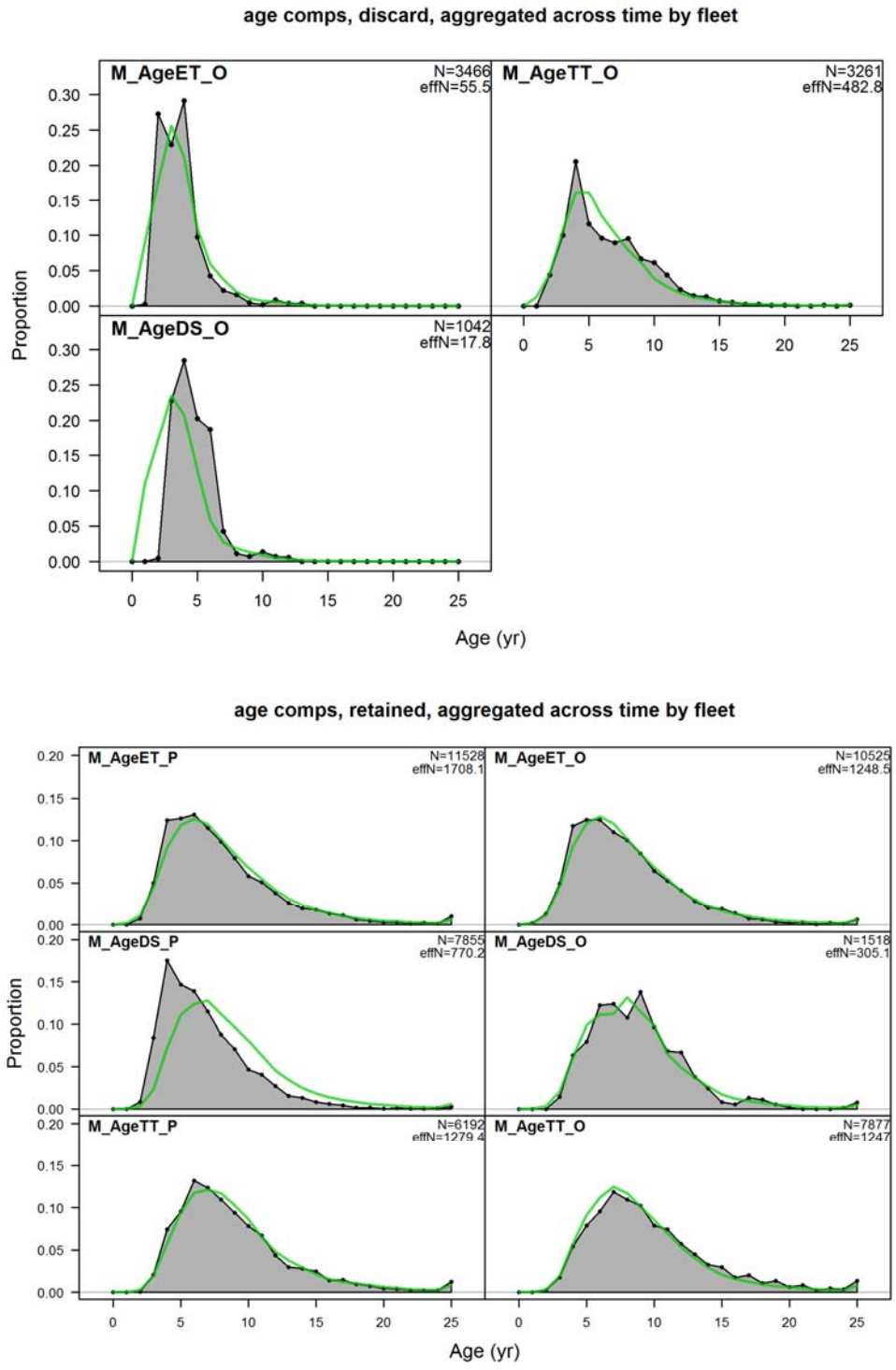

Figure 8.10. Fits to the implied age compositions for discard and retained (P = Port, O= onboard).

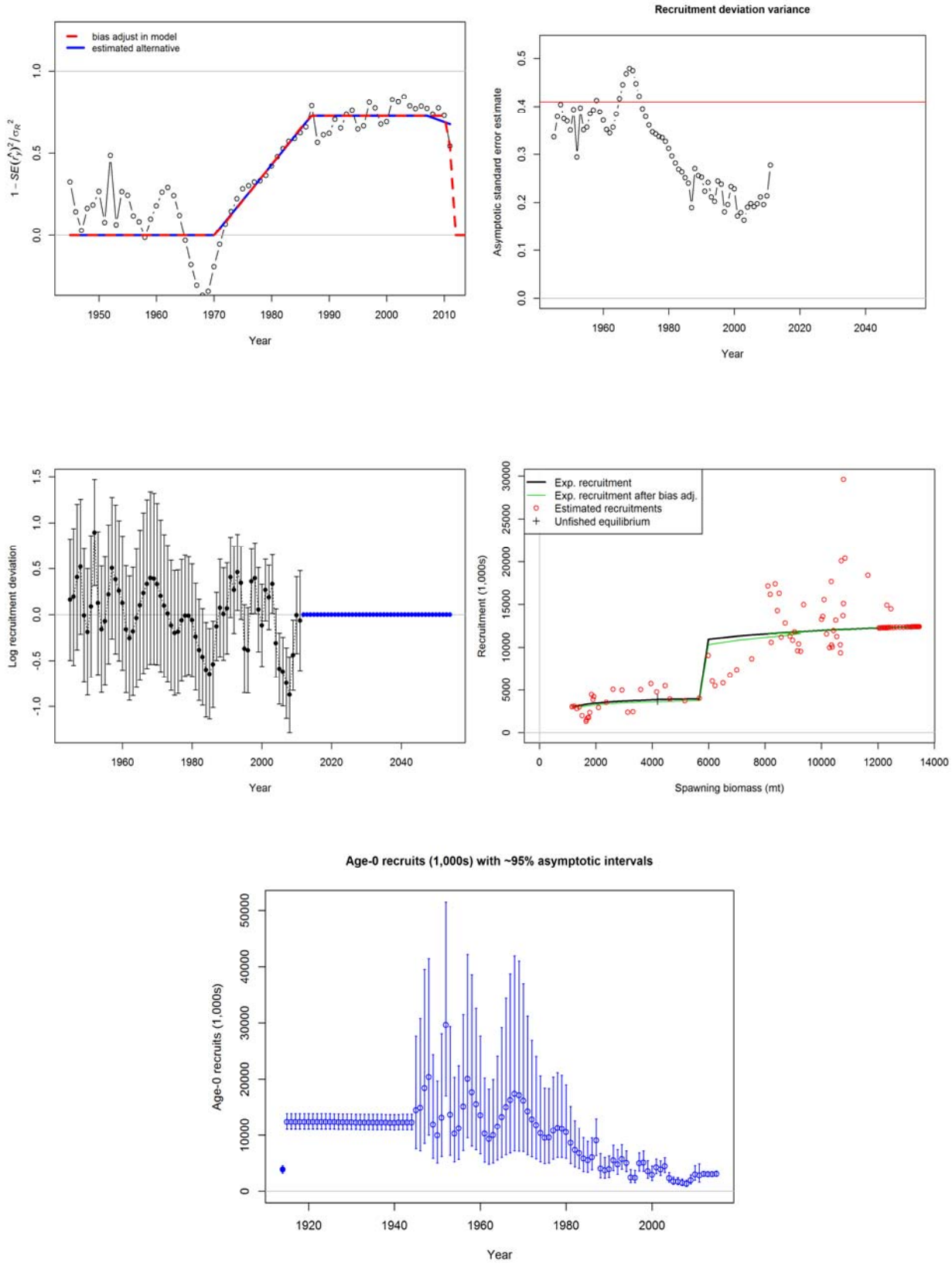

Figure 8.11. Diagnostics for recruitment, the stock–recruitment relationship and annual estimates of recruitment numbers with confidence intervals.

8.5.1.4 Assessment Outcomes

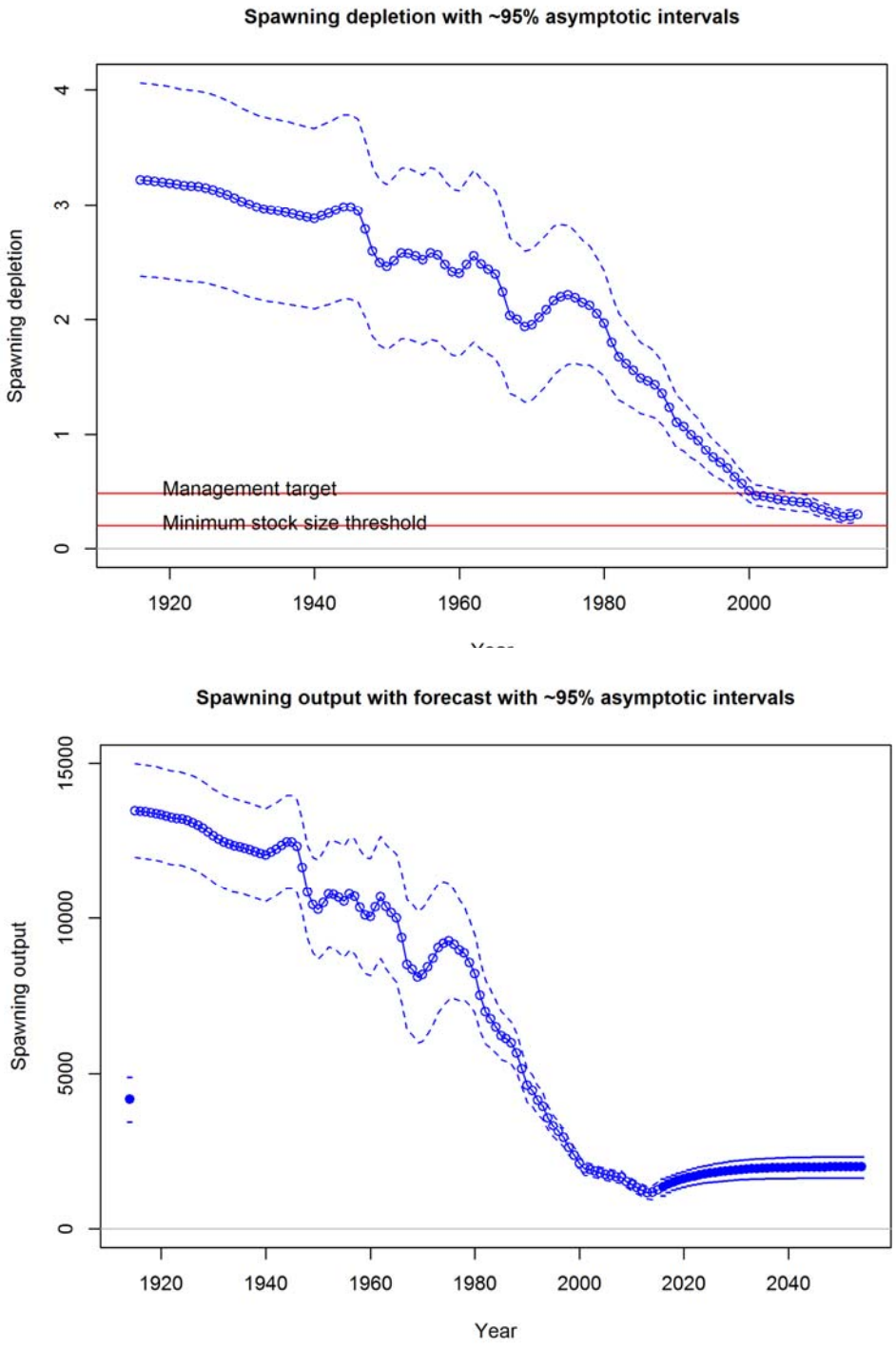

Figure 8.12. Time trajectories of spawning biomass depletion with 95% confidence intervals for the base case assessment of eastern jackass morwong.

8.5.2 *Discussion*

The 2015 assessment of eastern jackass morwong estimates the 2016 spawning biomass to be 32% of the 1988 equilibrium stock biomass. In comparison, the last full assessment in 2011 (Wayte, 2011) estimated the 2012 spawning biomass to be 35% of the 1988 equilibrium stock biomass. The female equilibrium spawning biomass in 1988 is estimated to be 4,184 t and in 2016 the female spawning biomass is estimated to be 1,340 t.

Further development of the model should consider:

- Refinement of fits to Danish Seine port length data (recognizing however this is now a small part of the fishery in terms of catch)
- Refinement of fits to Eastern Trawl discard length data
- Checking 2014 onboard length data for Eastern Trawl (unusual increase in small fish)
- Lack of small fish in 2012 Tas Trawl fleet length data (onboard and discard)
- Further refinements to the tuning methods (noting that this year the CAPAM workshop will focus on weighting methods, October 2015)

8.6 Acknowledgements

Many thanks are due to the CSIRO SESSF-WG: Robin Thomson, Judy Upston, Malcolm Haddon and André Punt for their assistance with model discussions and development. Miriana Sporcic is thanked for providing catch rate indices, Mike Fuller, Robin Thomson and Neil Klaer for their advice on data matters. Kyne Krusic-Golub (Fish Aging Services) and the AFMA observer section are thanked for providing the aging data and length frequency data respectively.

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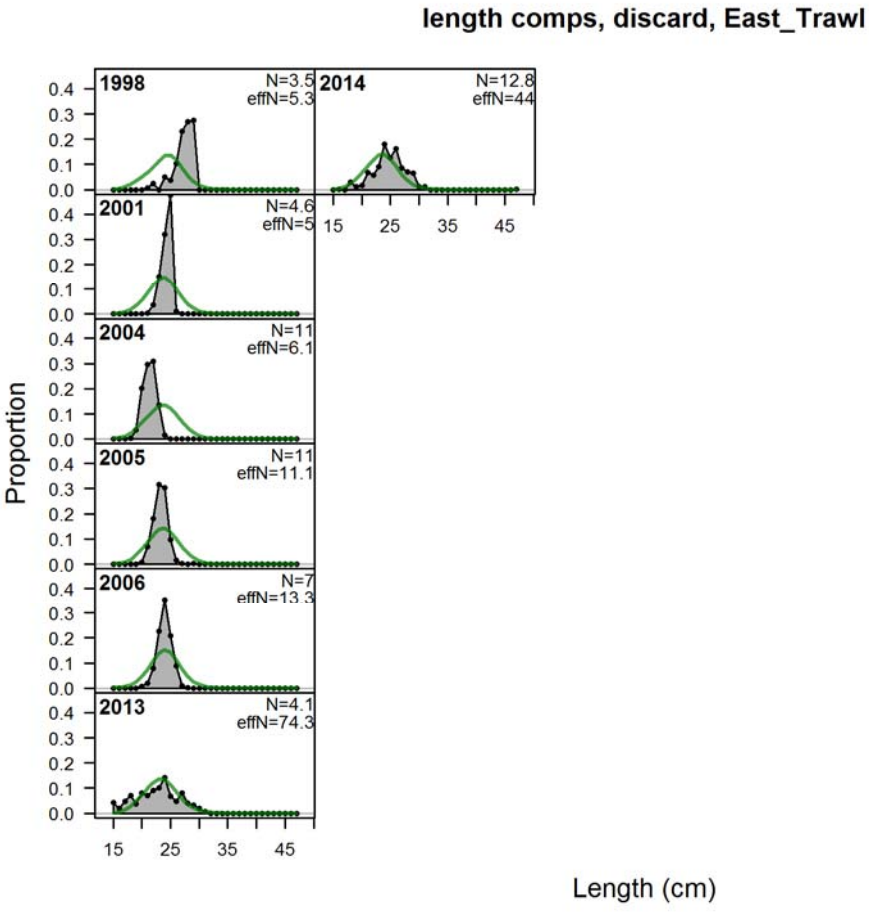
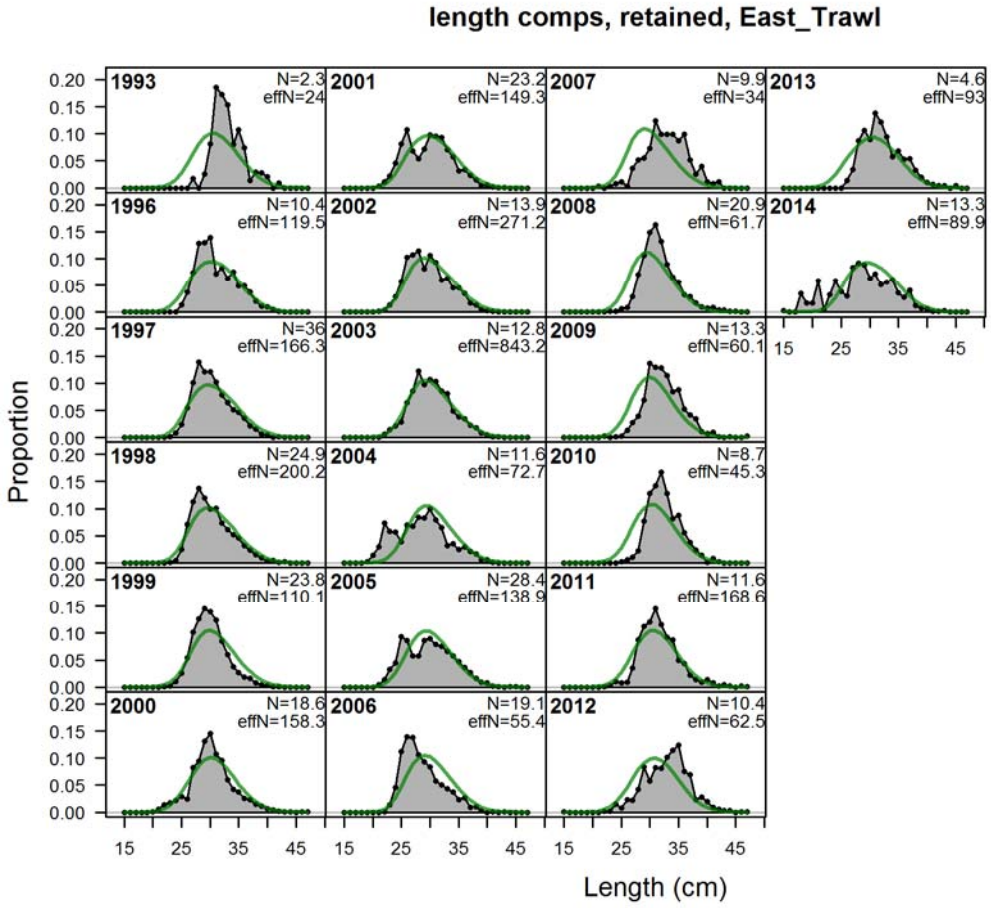
8.8 Appendix: Length fits

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1993 N=2.3 effN=24
2001 N=23.2 effN=149.3
2007 N=9.9 effN=34
2013 N=4.6 effN=93
1996 N=10.4 effN=119.5
2002 N=13.9 effN=271.2
2008 N=20.9 effN=61.7
2014 N=13.3 effN=89.9
1997 N=36 effN=166.3
2003 N=12.8 effN=843.2
2009 N=13.3 effN=60.1
1998 N=24.9 effN=200.2
2004 N=11.6 effN=72.7
2010 N=8.7 effN=45.3
1999 N=23.8 effN=110.1
2005 N=28.4 effN=138.9
2011 N=11.6 effN=168.6
2000 N=18.6 effN=158.3
2006 N=19.1 effN=55.4
2012 N=10.4 effN=62.5
Proportion
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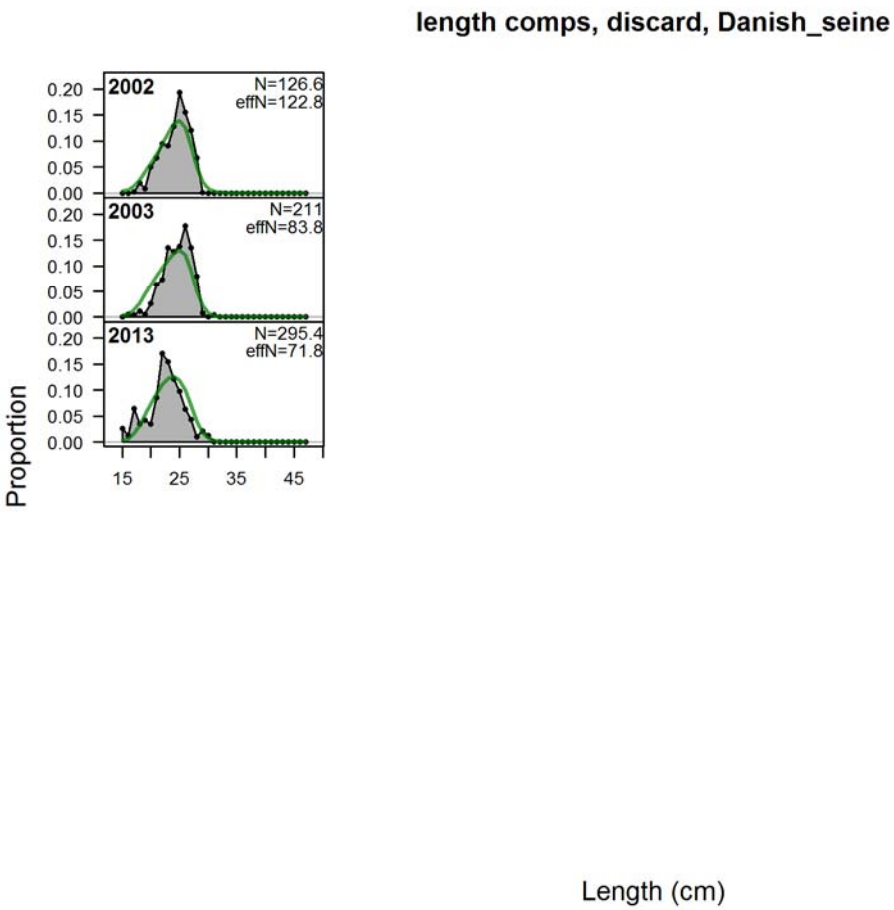
0.05
0.10
0.15
0.20
15
25
35
45
Length (cm)


length comps, discard, Danish_seine
2002
N=126.6
effN=122.8
2003
N=211
effN=83.8
2013
N=295.4
effN=71.8
Proportion
0.00
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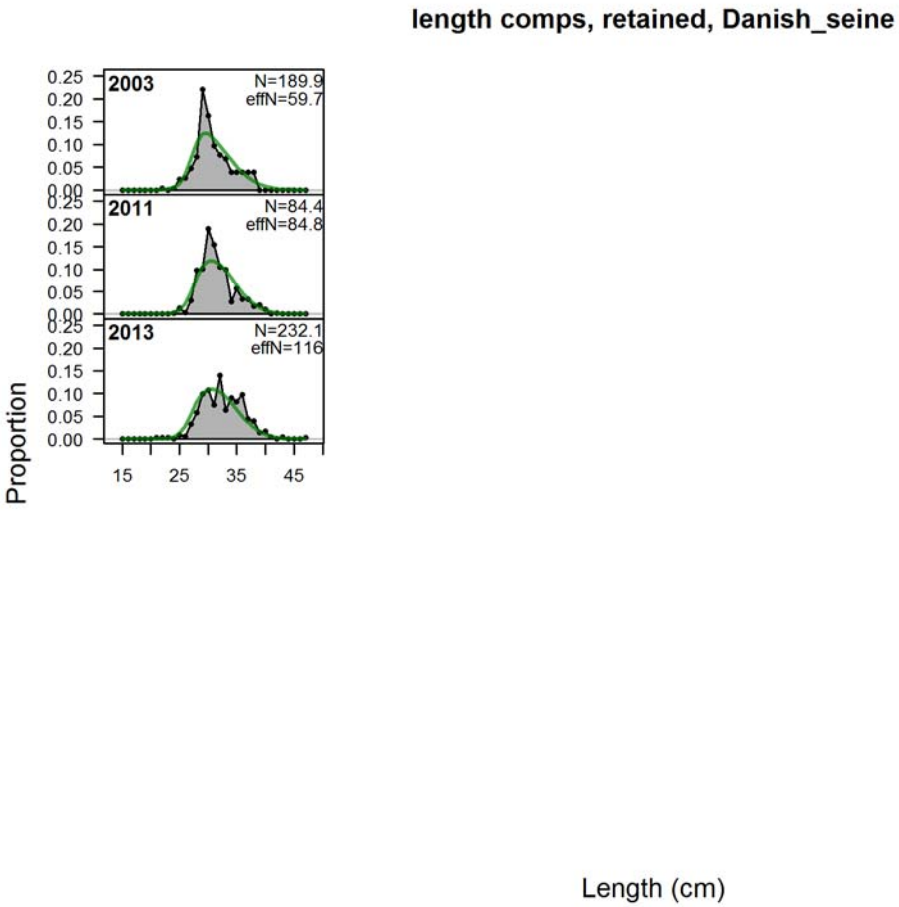
0.10
0.15
0.20
15
25
35
45
Length (cm)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effN=59.7
2011
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effN=84.8
2013
N=232.1
effN=116
Proportion
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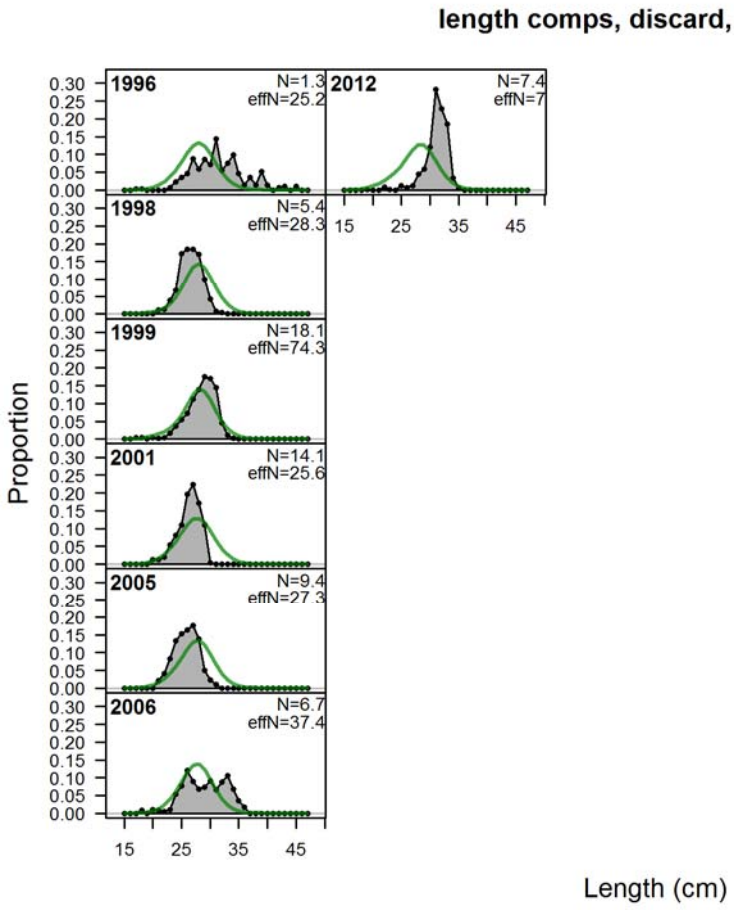
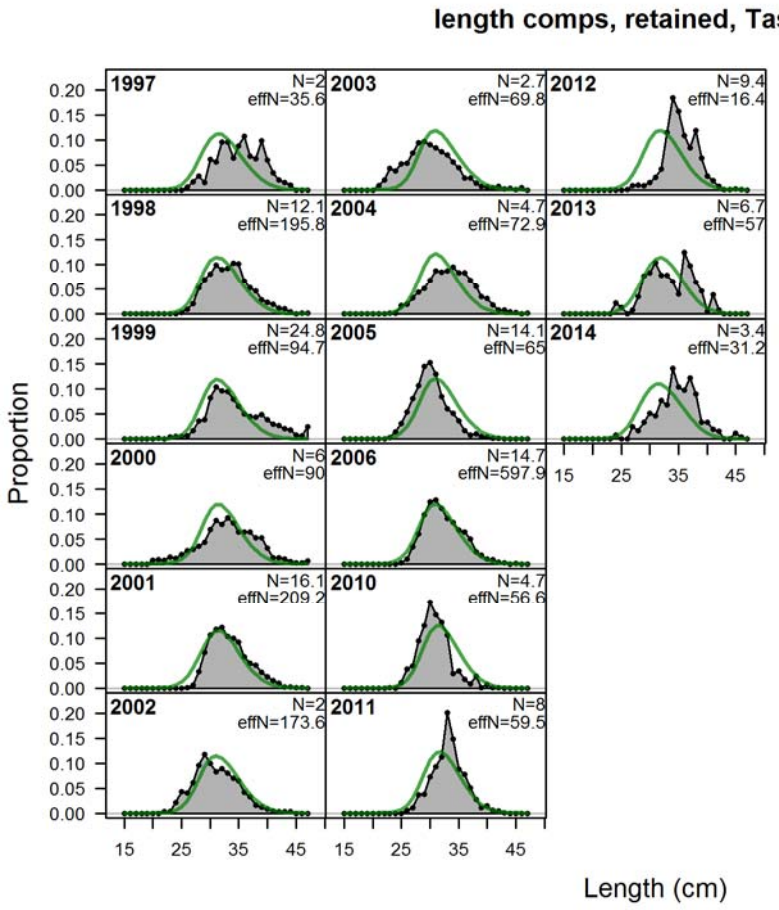
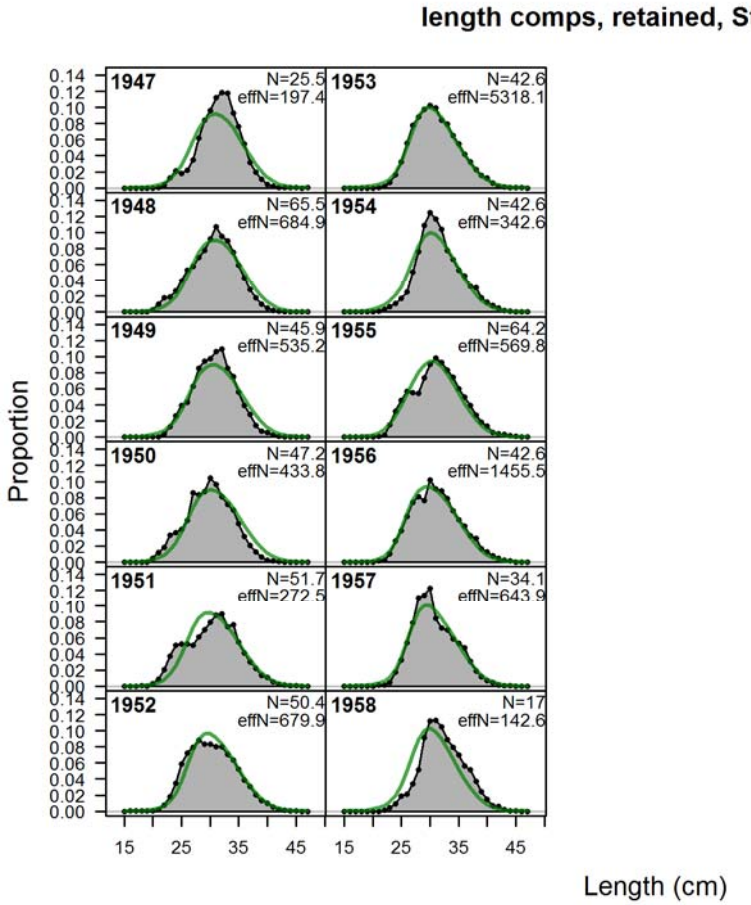
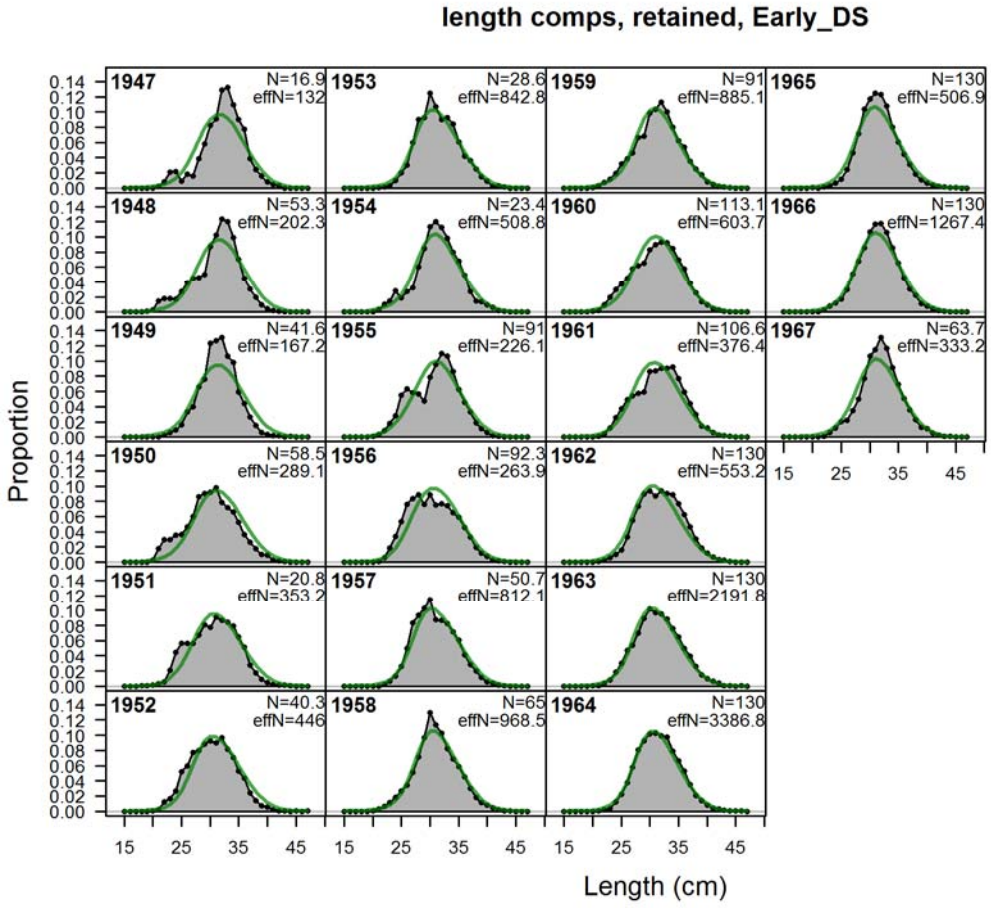
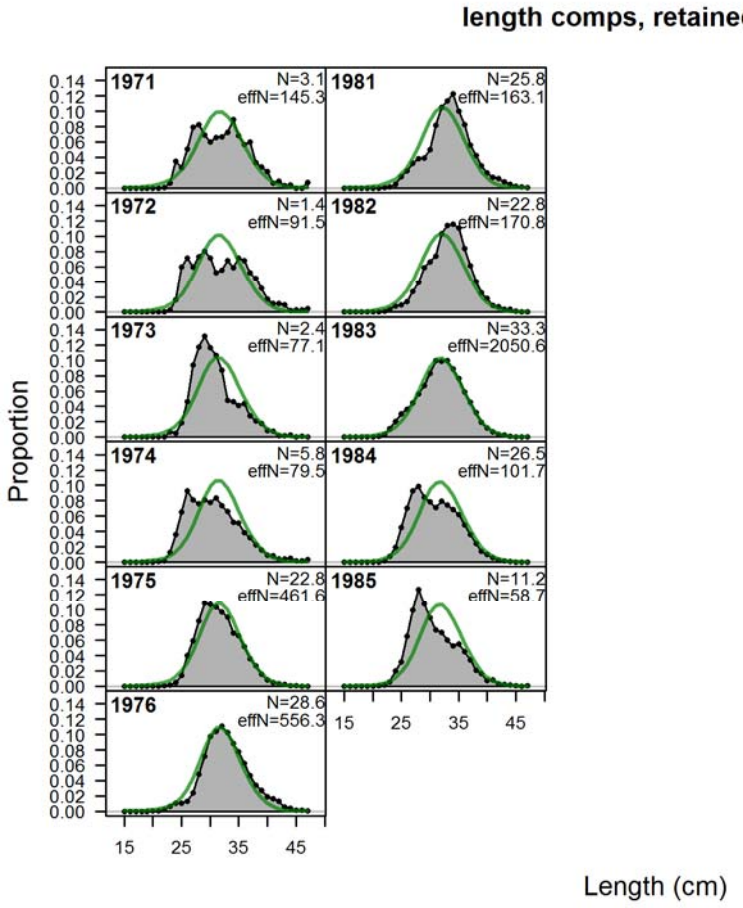
0.15
0.10
0.05
0.00
15
25
35
45
Length (cm)

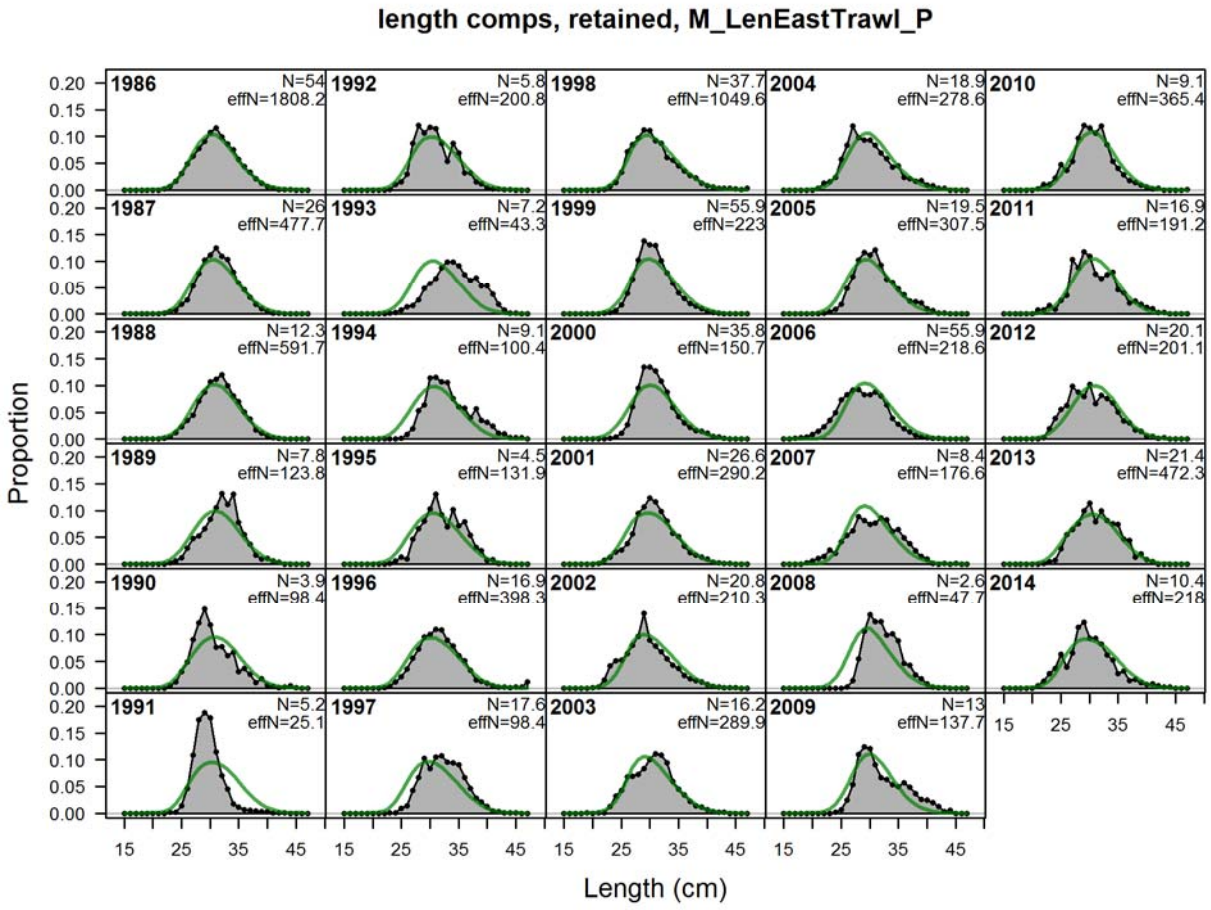

length comps, discard, Tas_Trawl
1996
N=1.3
effN=25.2
2012
N=7.4
effN=7
1998
N=5.4
effN=28.3
1999
N=18.1
effN=74.3
2001
N=14.1
effN=25.6
2005
N=9.4
effN=27.3
2006
N=6.7
effN=37.4
Proportion
0.00
0.05
0.10
0.15
0.20
0.25
0.30
15
25
35
45
Length (cm)

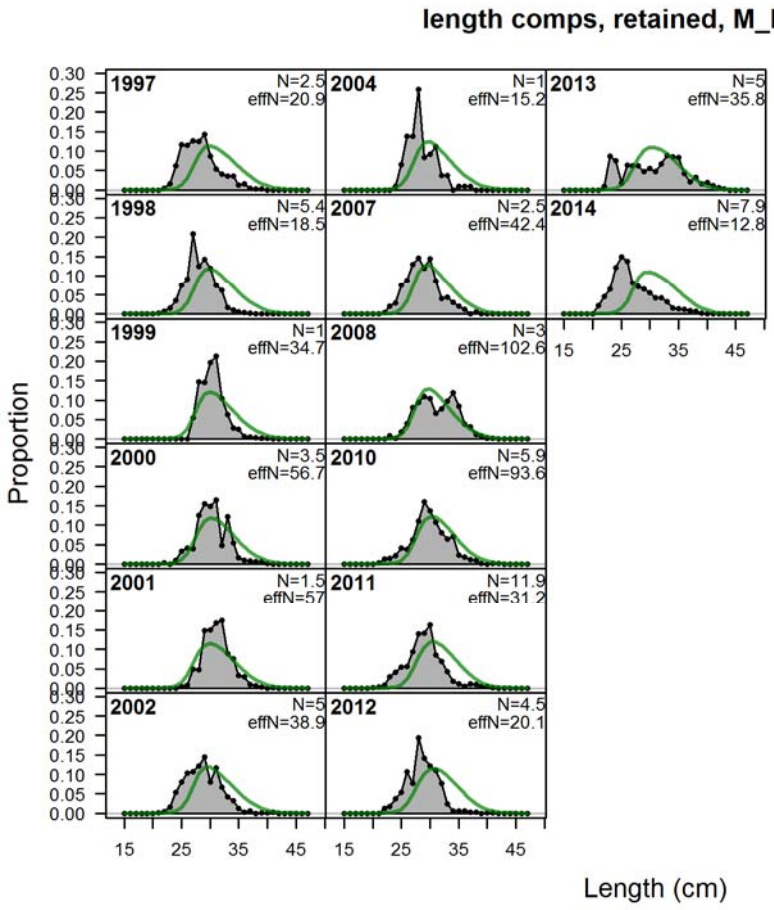

length comps, retained, Tas_Trawl
1997 N=2 effN=35.6
2003 N=2.7 effN=69.8
2012 N=9.4 effN=16.4
1998 N=12.1 effN=195.8
2004 N=4.7 effN=72.9
2013 N=6.7 effN=57
1999 N=24.8 effN=94.7
2005 N=14.1 effN=65
2014 N=3.4 effN=31.2
2000 N=6 effN=90
2006 N=14.7 effN=597.9
2001 N=16.1 effN=209.2
2010 N=4.7 effN=56.6
2002 N=2 effN=173.6
2011 N=8 effN=59.5
Proportion
0.00
0.05
0.10
0.15
0.20
15
25
35
45
Length (cm)

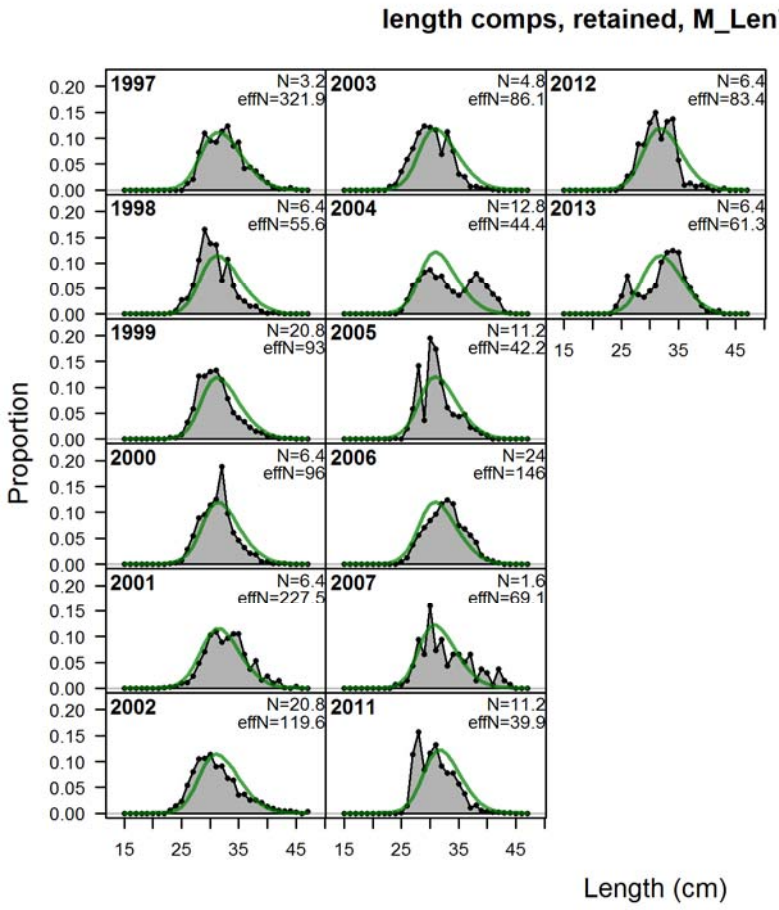

length comps, retained, Steam_trawl
1947 N=25.5 effN=197.4
1953 N=42.6 effN=5318.1
1948 N=65.5 effN=684.9
1954 N=42.6 effN=342.6
1949 N=45.9 effN=535.2
1955 N=64.2 effN=569.8
1950 N=47.2 effN=433.8
1956 N=42.6 effN=1455.5
1951 N=51.7 effN=272.5
1957 N=34.1 effN=643.9
1952 N=50.4 effN=679.9
1958 N=17 effN=142.6
Proportion
Length (cm)


length comps, retained, Early_DS
1947 N=16.9 effN=132
1953 N=28.6 effN=842.8
1959 N=91 effN=885.1
1965 N=130 effN=506.9
1948 N=53.3 effN=202.3
1954 N=23.4 effN=508.8
1960 N=113.1 effN=603.7
1966 N=130 effN=1267.4
1949 N=41.6 effN=167.2
1955 N=91 effN=226.1
1961 N=106.6 effN=376.4
1967 N=63.7 effN=333.2
1950 N=58.5 effN=289.1
1956 N=92.3 effN=263.9
1962 N=130 effN=553.2
1951 N=20.8 effN=353.2
1957 N=50.7 effN=812.1
1963 N=130 effN=2191.8
1952 N=40.3 effN=446
1958 N=65 effN=968.5
1964 N=130 effN=3386.8
Proportion
0.00 0.02 0.04 0.06 0.08 0.10 0.12 0.14
15 25 35 45
Length (cm)


length comps, retained, Mixed
1971 N=3.1 effN=145.3
1981 N=25.8 effN=163.1
1972 N=1.4 effN=91.5
1982 N=22.8 effN=170.8
1973 N=2.4 effN=77.1
1983 N=33.3 effN=2050.6
1974 N=5.8 effN=79.5
1984 N=26.5 effN=101.7
1975 N=22.8 effN=461.6
1985 N=11.2 effN=58.7
1976 N=28.6 effN=556.3
Proportion
Length (cm)


length comps, retained, M_LenEastTrawl_P
Proportion
Length (cm)
1986 N=54 effN=1808.2
1992 N=5.8 effN=200.8
1998 N=37.7 effN=1049.6
2004 N=18.9 effN=278.6
2010 N=9.1 effN=365.4
1987 N=26 effN=477.7
1993 N=7.2 effN=43.3
1999 N=55.9 effN=223
2005 N=19.5 effN=307.5
2011 N=16.9 effN=191.2
1988 N=12.3 effN=591.7
1994 N=9.1 effN=100.4
2000 N=35.8 effN=150.7
2006 N=55.9 effN=218.6
2012 N=20.1 effN=201.1
1989 N=7.8 effN=123.8
1995 N=4.5 effN=131.9
2001 N=26.6 effN=290.2
2007 N=8.4 effN=176.6
2013 N=21.4 effN=472.3
1990 N=3.9 effN=98.4
1996 N=16.9 effN=398.3
2002 N=20.8 effN=210.3
2008 N=2.6 effN=47.7
2014 N=10.4 effN=218
1991 N=5.2 effN=25.1
1997 N=17.6 effN=98.4
2003 N=16.2 effN=289.9
2009 N=13 effN=137.7
0.00 0.05 0.10 0.15 0.20
15 25 35 45


length comps, retained, M_LenDS_P
1997 N=2.5 effN=20.9
2004 N=1 effN=15.2
2013 N=5 effN=35.8
1998 N=5.4 effN=18.5
2007 N=2.5 effN=42.4
2014 N=7.9 effN=12.8
1999 N=1 effN=34.7
2008 N=3 effN=102.6
2000 N=3.5 effN=56.7
2010 N=5.9 effN=93.6
2001 N=1.5 effN=57
2011 N=11.9 effN=31.2
2002 N=5 effN=38.9
2012 N=4.5 effN=20.1
Proportion
Length (cm)


length comps, retained, M_LenTasTrawl_P
1997 N=3.2 effN=321.9
2003 N=4.8 effN=86.1
2012 N=6.4 effN=83.4
1998 N=6.4 effN=55.6
2004 N=12.8 effN=44.4
2013 N=6.4 effN=61.3
1999 N=20.8 effN=93
2005 N=11.2 effN=42.2
2000 N=6.4 effN=96
2006 N=24 effN=146
2001 N=6.4 effN=227.5
2007 N=1.6 effN=69.1
2002 N=20.8 effN=119.6
2011 N=11.2 effN=39.9
Proportion
0.00
0.05
0.10
0.15
0.20
15
25
35
45
Length (cm)