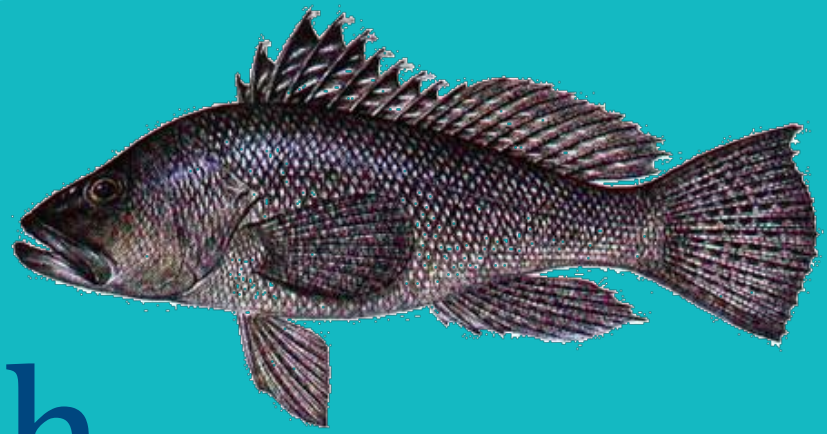
NOAA FISHERIES



SEDAR 76 South Atlantic Black Sea Bass

SSC Review

April 2023

Atlantic Fisheries Branch Beaufort, NC

Outline

- Background
- Data
- Assessment Model
- Assessment Results
- Uncertainty
- Projections

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Background

- SEDAR 25 (2011)
  - Not overfished but not fully rebuilt
    - $SSB_{2020}/MSST=1.13$ but $SB_{2010}/SSB_{MSY}=0.7$
  - Overfishing occurring
    - $F_{2009\text{-}2010}/F_{MSY}=1.07$
- SEDAR 25 Update (2013)
  - Not overfished ($SSB_{2012}/MSST=1.66$)
  - Not overfishing ($F_{2011\text{-}2012}/F_{MSY}=0.66$)
- SEDAR 56 Standard assessment
  - Not overfished ($SSB_{2016}/MSST=1.15$)
  - Not overfishing ($F_{2014\text{-}2016}/F_{MSY}=0.64$)
- SEDAR 76 Operational Assessment
  - This assessment
  - SPOILER ALERT!!
  - Overfished and Overfishing

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SEDAR 76

- SEDAR 78 TORs and schedule approved June 2020 and March 2021
  - Extended terminal model year to 2021
- Data submissions completed August 2022
- 1 data scoping call Sept 2022
- 5 assessment webinars Sept 2022 – Feb 2023
- Panel input and approval of all decisions
- SSC review April 2023 (today)

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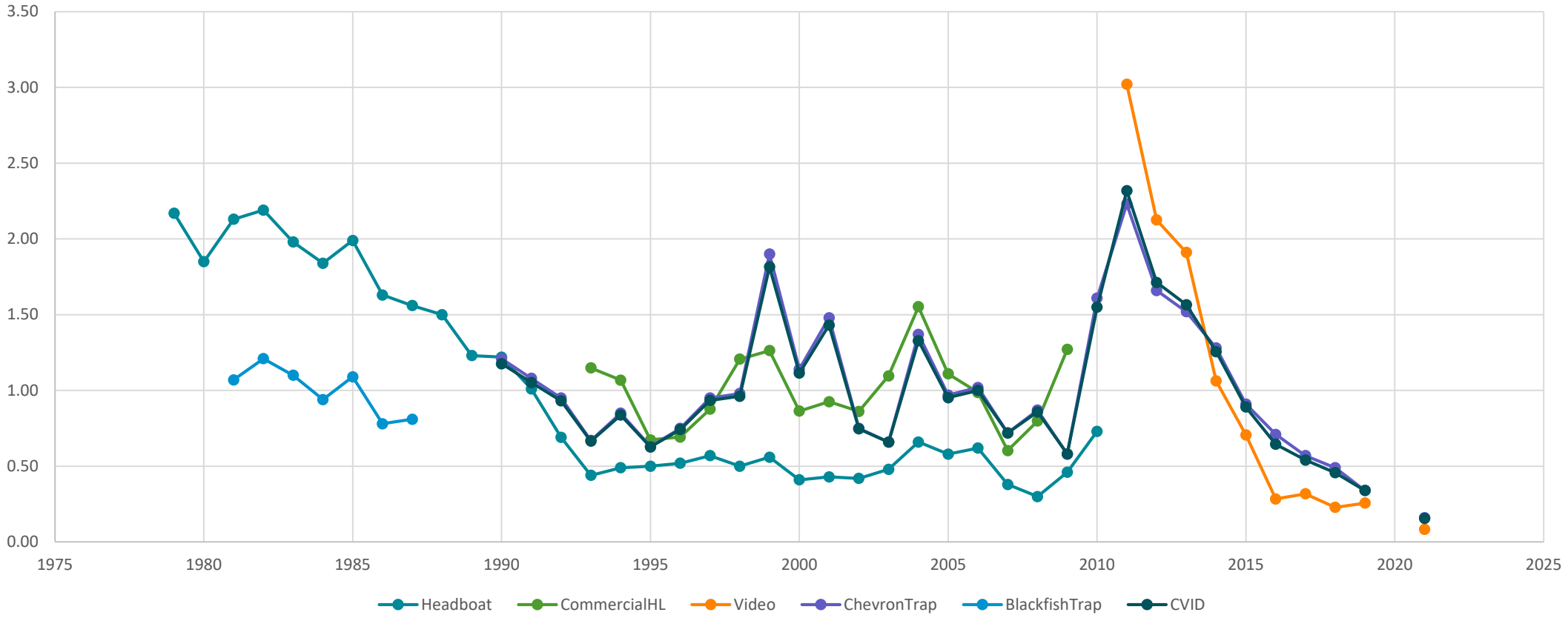
Indices of abundance

- Two fishery dependent indices of abundance
  - Commercial handline (1993 – 2009)
  - Headboat (1979 – 2010)
- Two fishery independent indices of abundance
  - MARMAP blackfish trap (1981 – 1987)
  - SERFS combined trap and video (1990 – 2021)
    - Tested sensitivities to combinations of index

Indices of abundance



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wineandspirits.com

Landings and Discards

- Eight removal time series
- Commercial
  - Trawl (1978 – 1990)
  - Handline landings (1978 – 2021)
  - Pots landings (1978 – 2021)
  - Discards (open and closed seasons) (1993 – 2021)
- Recreational
  - Headboat landings (1978 – 2021)
  - General recreational landings (1981 – 2021)
  - Headboat discards (1986 – 2021)
  - General recreational discards (1981 – 2021)

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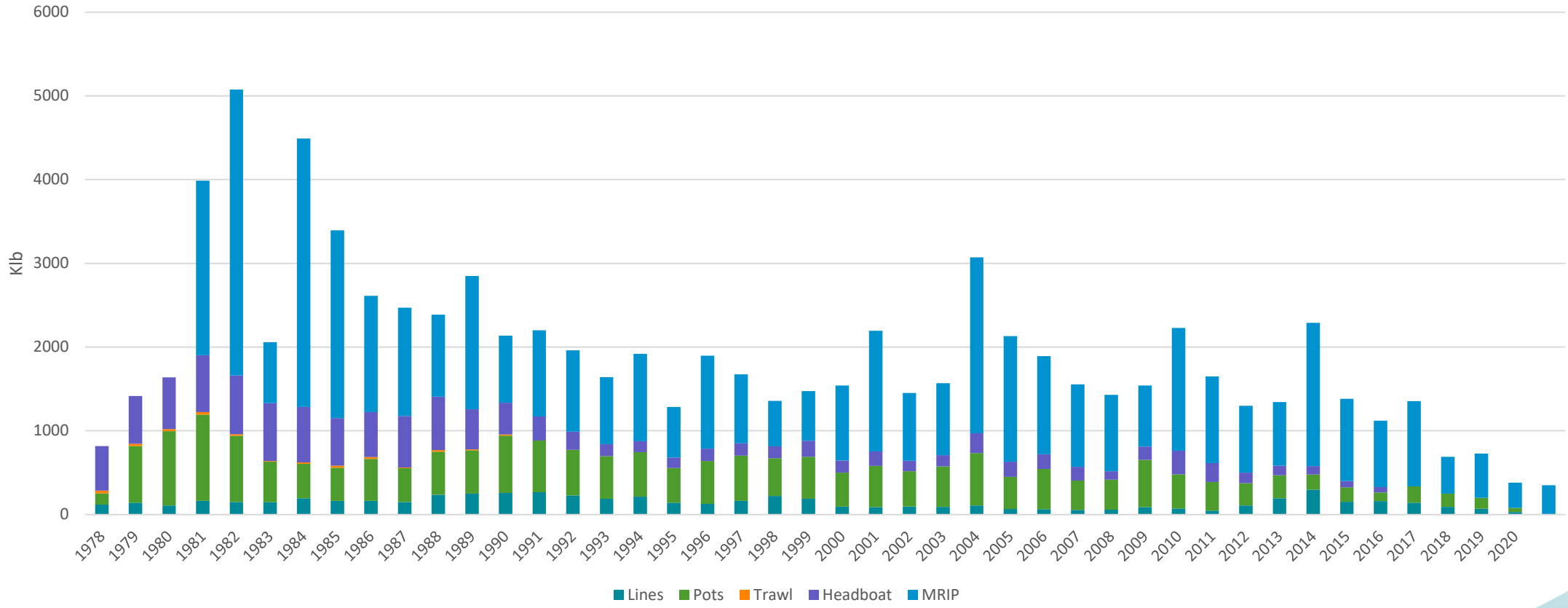
Landings



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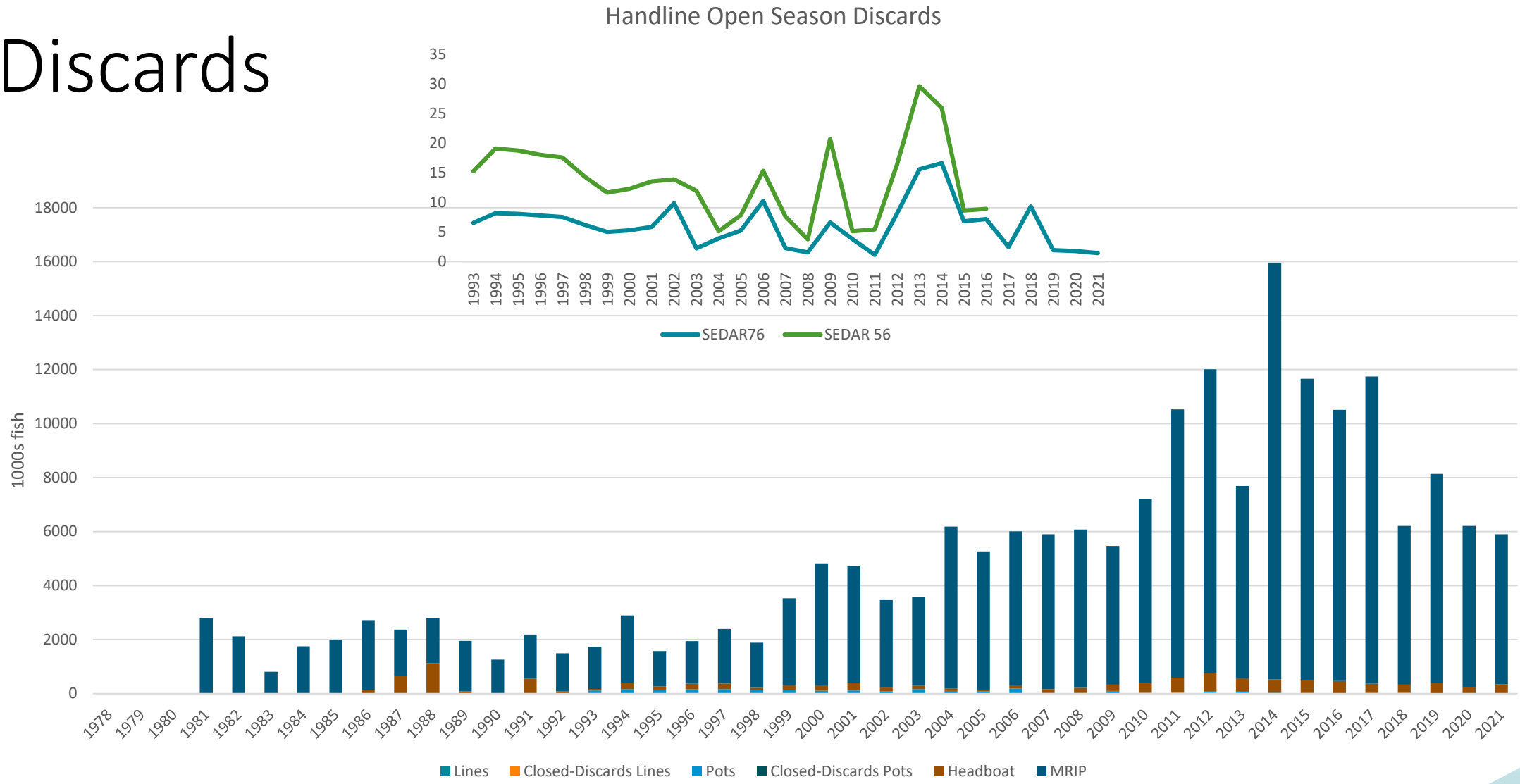
Discards



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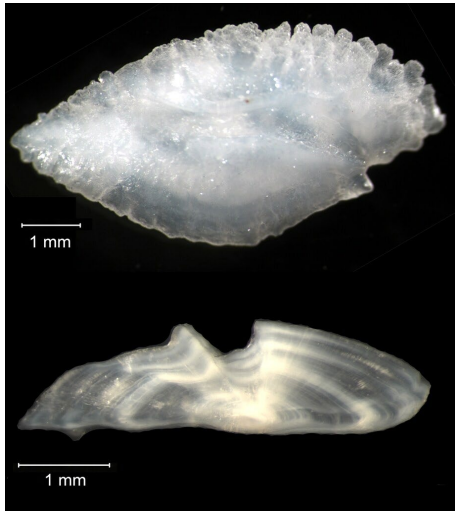
Composition Data



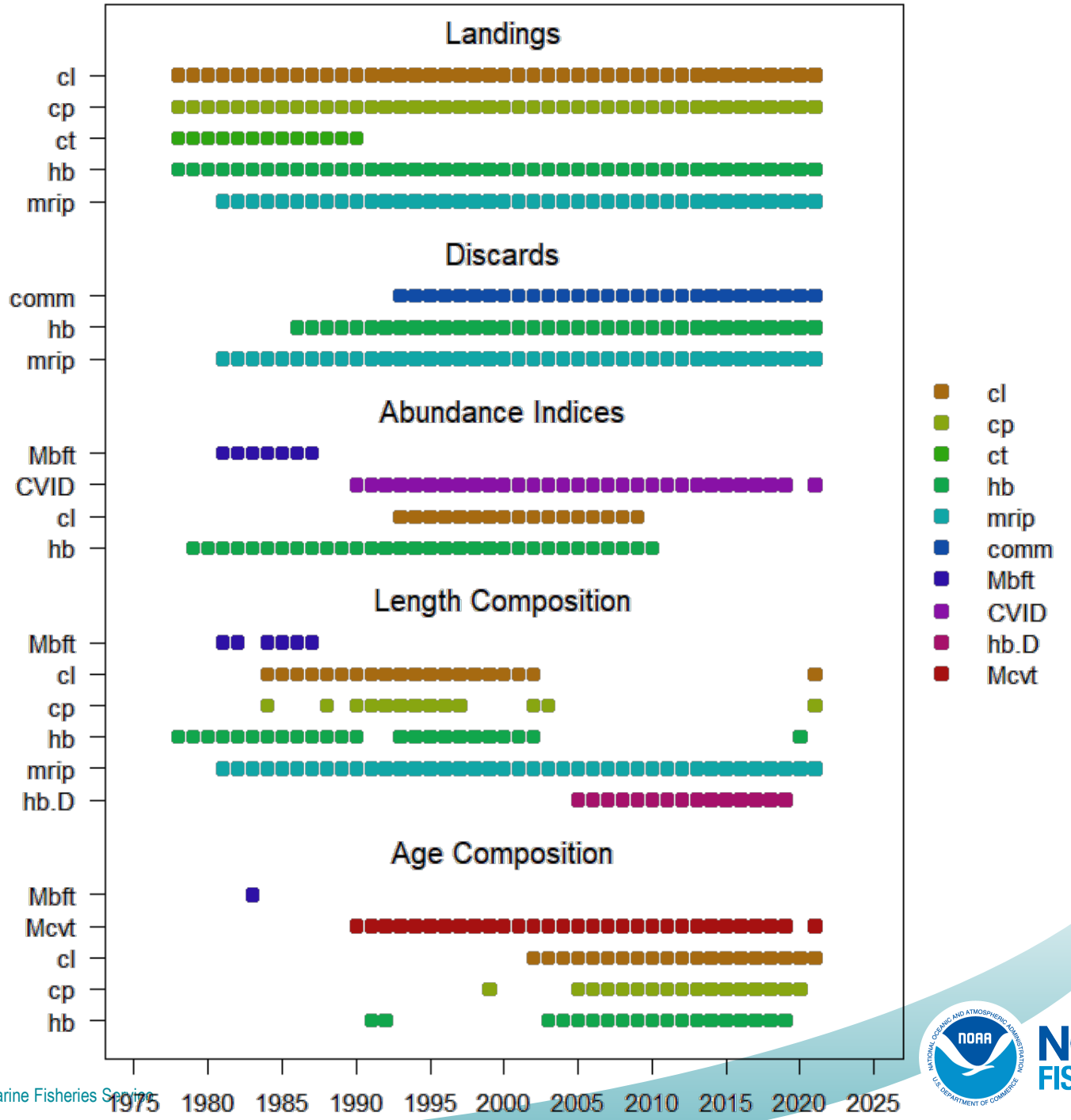
Fishery Dependent

- Handline
  - Age: 2002 - 2021
  - Length: 1984 – 2002
- Pots
  - Age: 1999, 2005 - 2020
  - Length: 1984 – 2003, 2021
- Headboat
  - Age: 1991, 1992, 2003 - 2019
  - Length: 1978 – 2002, 2020
- General Recreation
  - Length: 1981 – 2021
- Headboat discard
  - Length: 2005 – 2019

Fishery Independent

- MARMAP blackfish trap
  - Age: 1983
  - Length: 1981 – 1983 except 1983
- SERFS
  - Age: 1990-2021, except 2020

Data Availability



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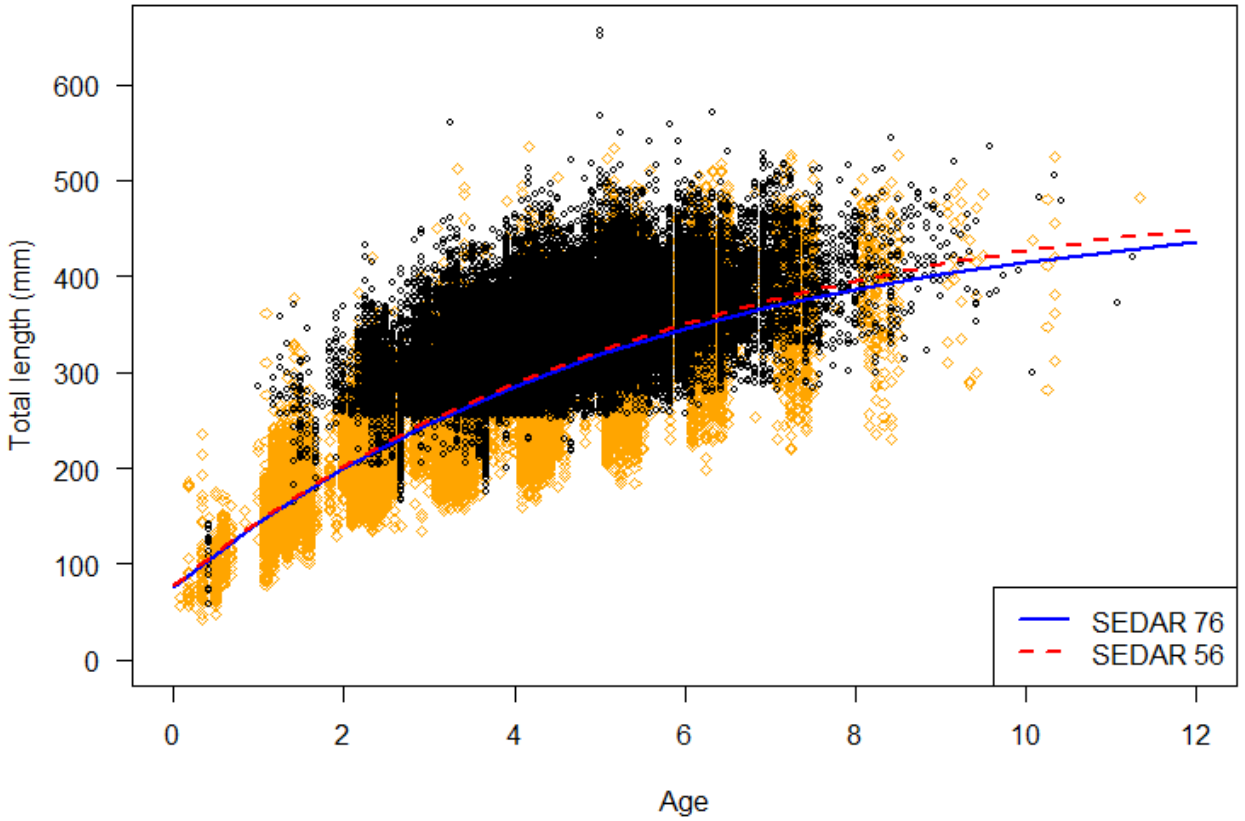
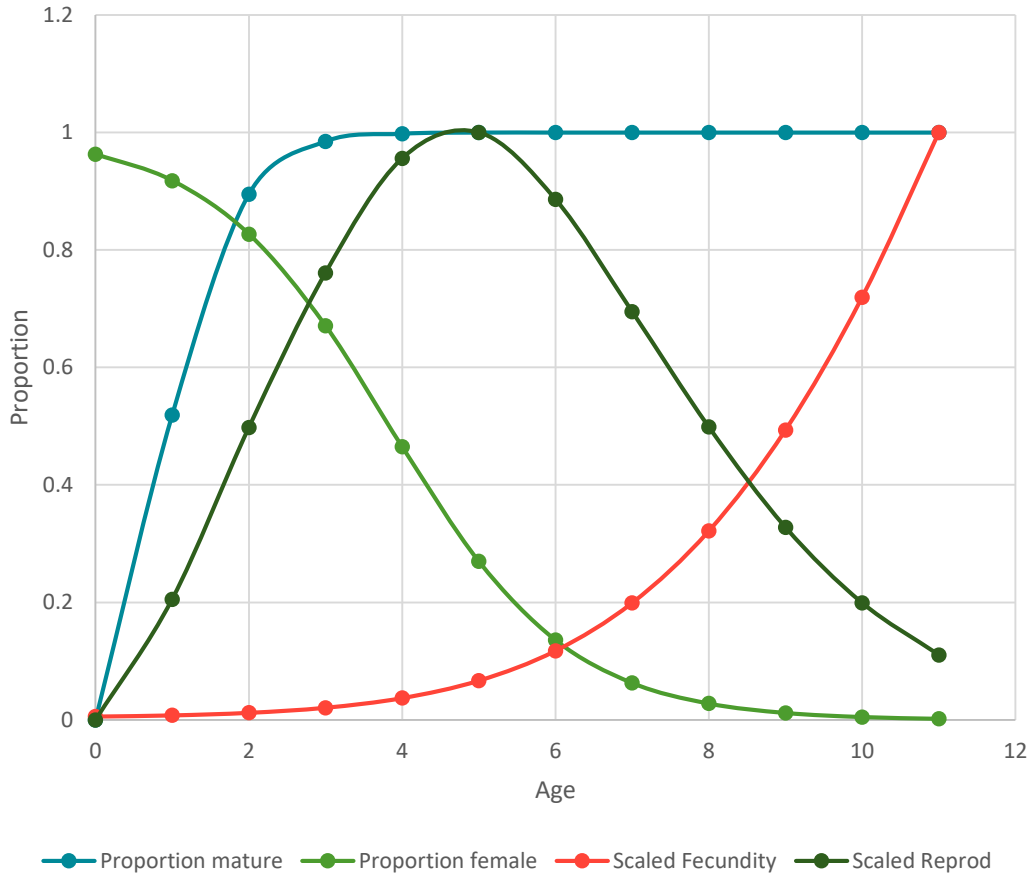
Life history - Growth

- Updated growth from additions to age/length composition data
- Used standard ADMB code with size limits and weighting by calendar age where ages 9+ were grouped as in SEDAR 25
- Minimal difference in growth curve



Life history – Fecundity, maturity, etc

- No new information available
- Used ogives from SEDAR 56
- Recruitment modeled with a mean recruitment model



Life history – Discard mortality

- SEDAR 56 Handline based on Rudershausen et al 2014 – 19%
  - Headboat (15.2) and general rec (13.7) reweighted by FL observer for hire discard and depth data
  - “release of gas from the abdominal cavity during tagging of black sea bass”
- Commercial pot discard based on Rudershausen et al 2008
  - 1.5” panel 14% and 2” panel 6.8%

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Life history – Discard mortality

- Rudershausen et al 2020 found that survival from venting and descender devices was 1.5 times the survival of the control
  - No difference in survival between the mitigation techniques
- New studies estimate higher discard mortality
  - Schweitzer et al (2020) commercial trap 1.5” with 2.68” vents 47.1%
    - MD & DE, 25-30 m, Cages 4-10d following sorting by commercial pots, sometimes > 10 minutes exposure before returned to water
  - Zemeckis et al (2020) Headboat vented 21.9% not vented 50.4%
    - NJ 45 – 67 m, Dec – March, Acoustic tagging 128 hr
- Suggests that discard mortality estimates may be underestimated

Life history – Discard mortality

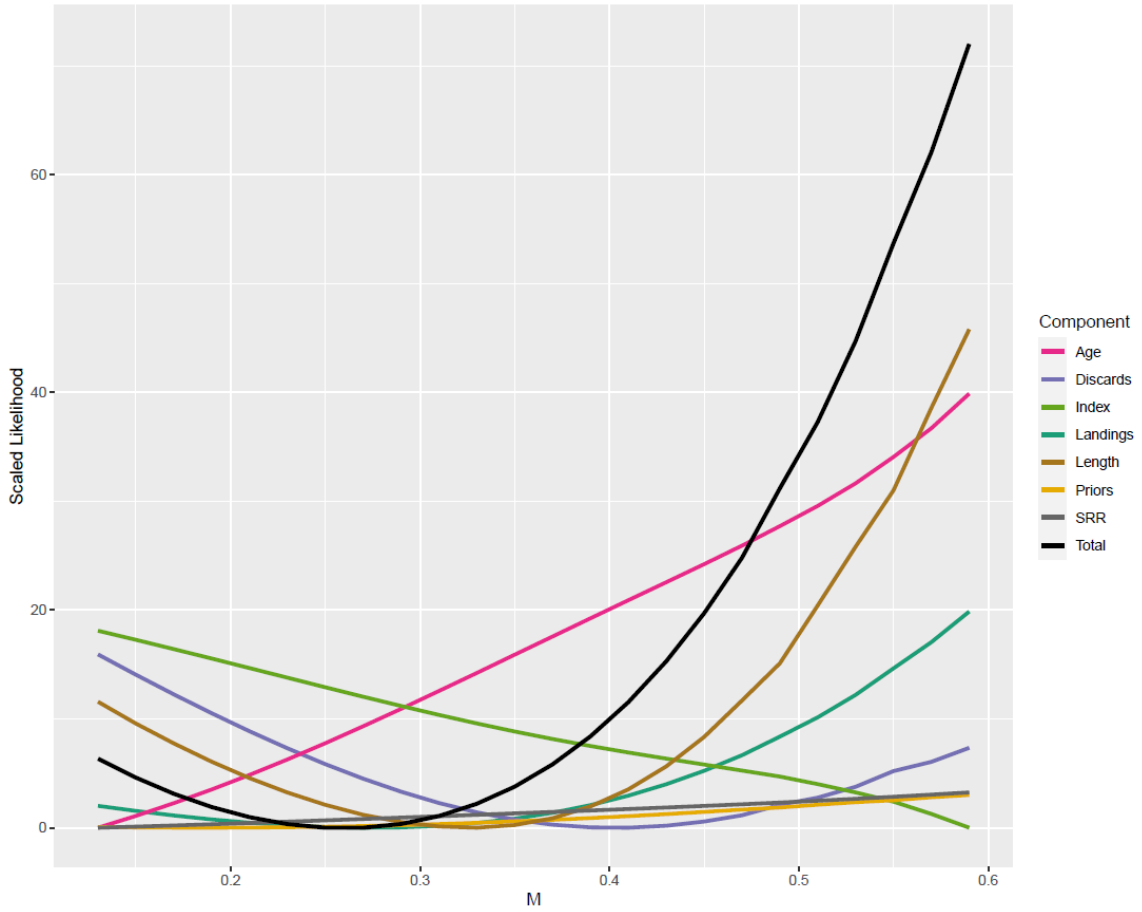
- Many panel members were hesitant to disregard the Rudershausen et al (2008) level of mortality
- Concerns that the Zemeckis et al (2020) study was in deeper waters than typical in SE
- Concerns that exposure time in Schweitzer et al (2020) was longer than experience in SE
- Retained base levels from SEDAR 56 but expanded uncertainty scenarios

Life history – Natural mortality

- SEDAR 56
  - Used on Hewitt and Hoenig (2005)
    $M = \frac{4.22}{A_{max}} = 0.38$
  - M at age from Lorenzen (1996)
    $M_a = 3.69 * W_a^{-0.305}$
- SEDAR 76
  - Hamel and Cope (2022)
    $M = \frac{5.4}{A_{max}} = 0.49$
  - Lorenzen (2022) and Lorenzen et al (2022) Generalized length inverse mortality model
  - $M_a = \beta(L_a)^{-1}$
  - β would be scaled to a mean M estimate

But Wait There's More!!!

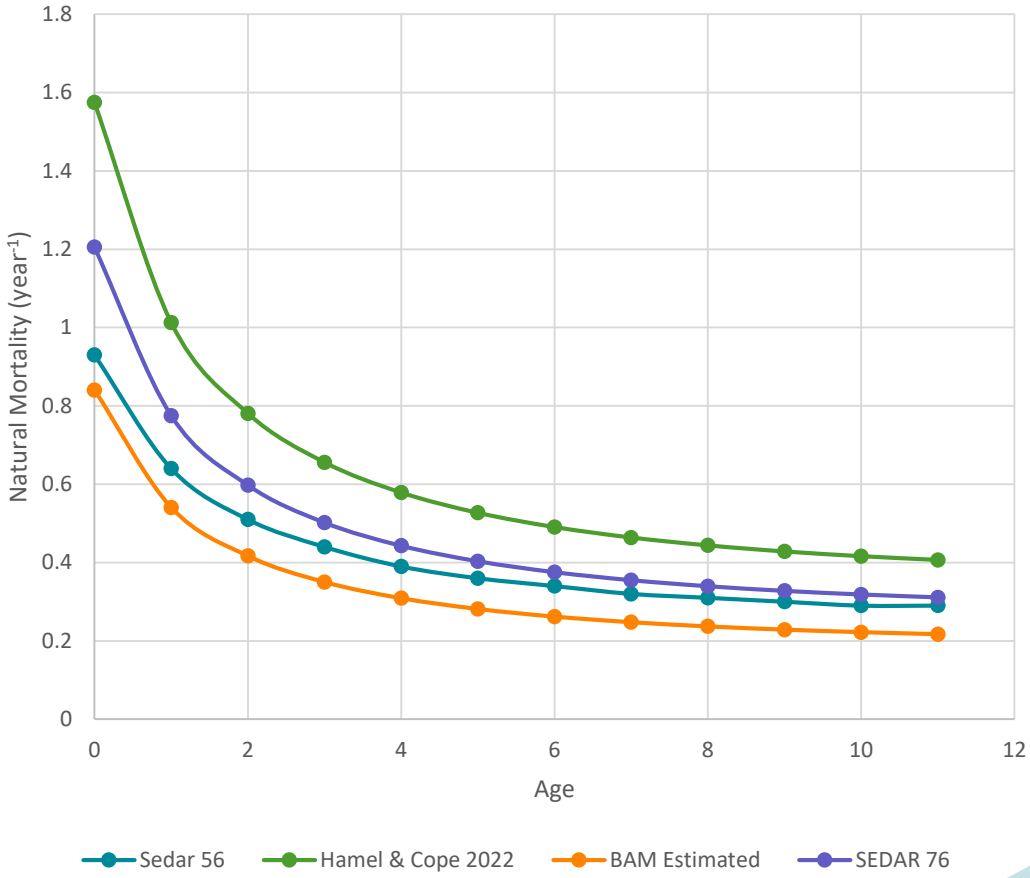
Life history – Natural mortality



- Estimated mean M as 0.26
- Conflict between age composition and index for SERFS survey
- Panel decided M estimation should be near minimum from the age composition
- Not enough evidence to use as base model

Life history – Natural mortality

- Most data sources from external M estimates are based on fully selected fish
- Determined age 3 as first fully selected age and scaled mortality to be same as 3+
- Used average of Hamel & Cope (2022) and Bam estimated value
  - M =0.375
  - Scaled by inverse length at age



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Modifications to BAM

- Added code to accommodate missing year in SERFS data
- Added effective sample size calculations for Dirichlet multinomial composition data
- Estimated all Dirichlet multinomial variance parameters
- Changed biomass calculations from metric tons to 1000 pounds
- Changed phasing of parameter estimates to converge more efficiently
- Changed commercial discard selectivity for 2009-2013 to include open season discard, but before and after this period it does not

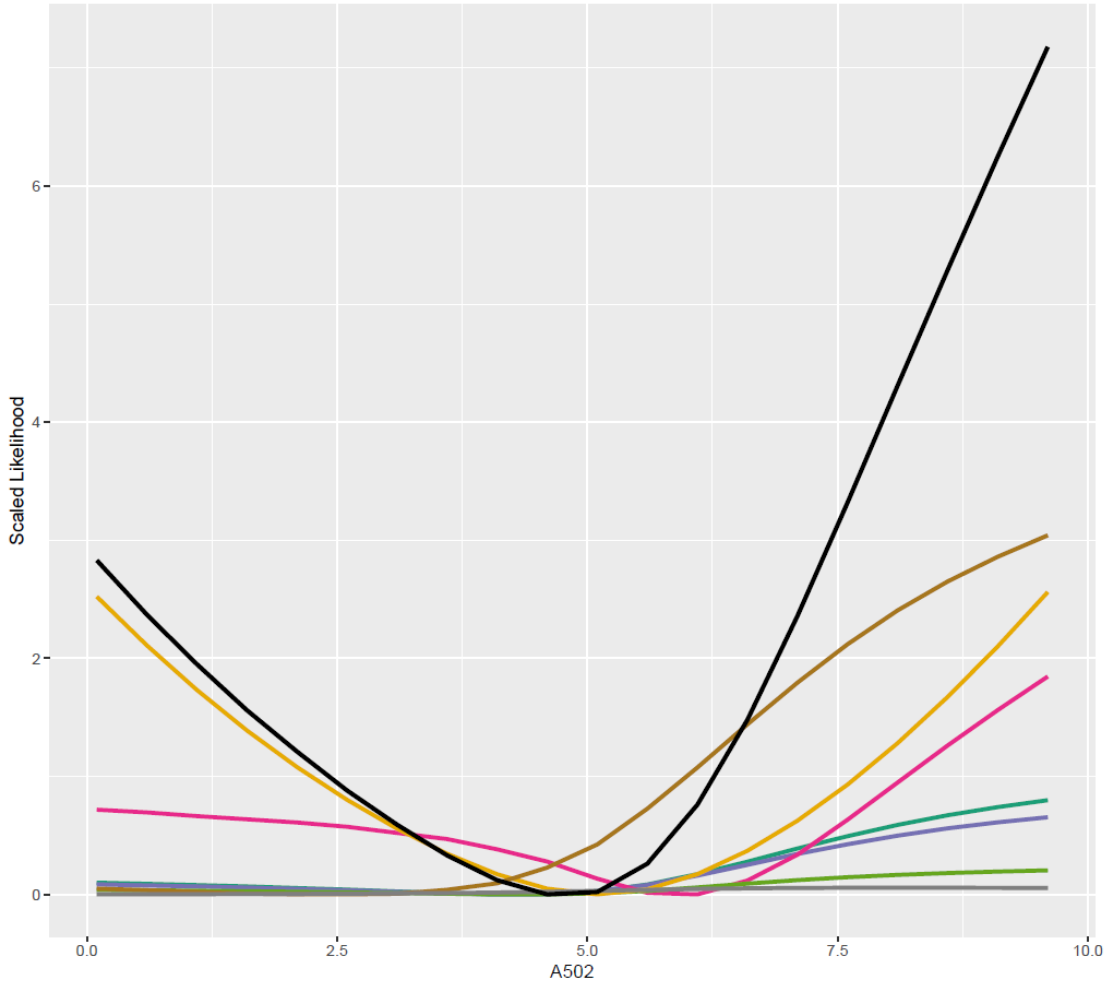
Modifications to BAM

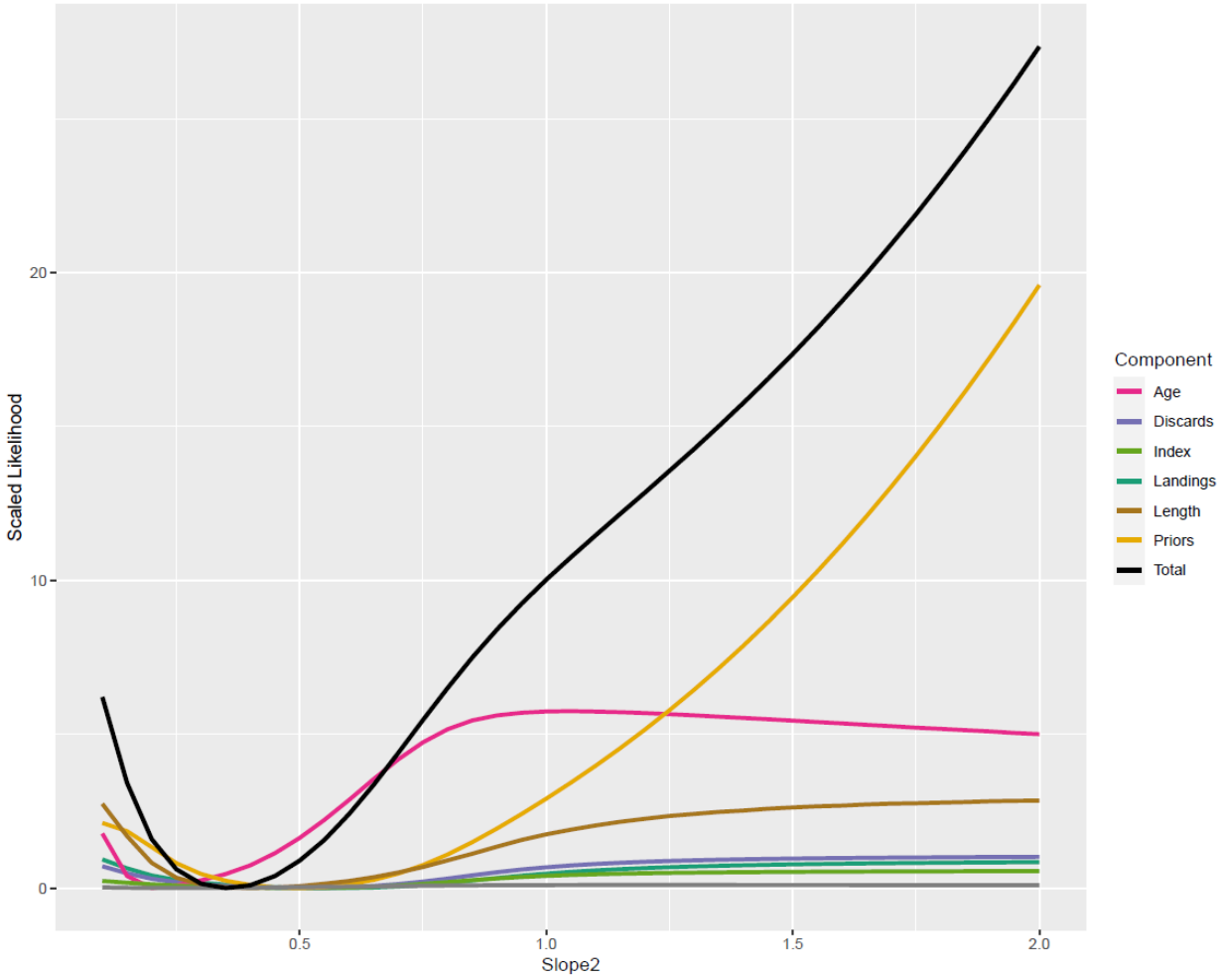
- Corrected start date for rec and comm selectivities recent time blocks
- Corrected general recreational and headboat discard mortality values
- Calculate M-at-age within BAM to allow estimation of M
- Estimate domed selectivity for SERFS survey
- Implemented a mean recruitment model
- Recruitment in last 2 years at recent mean from 2014
- Set F_{init} equal to 1 because estimated at lower bound

Domed SERFS Selectivity

- Investigated possibility of domed selectivity in all fleets and surveys
- Only the SERFS selectivity resulted in an improvement in the likelihood
- Conducted likelihood profiles to determine estimability of parameters

SERFS Selectivity Profiles





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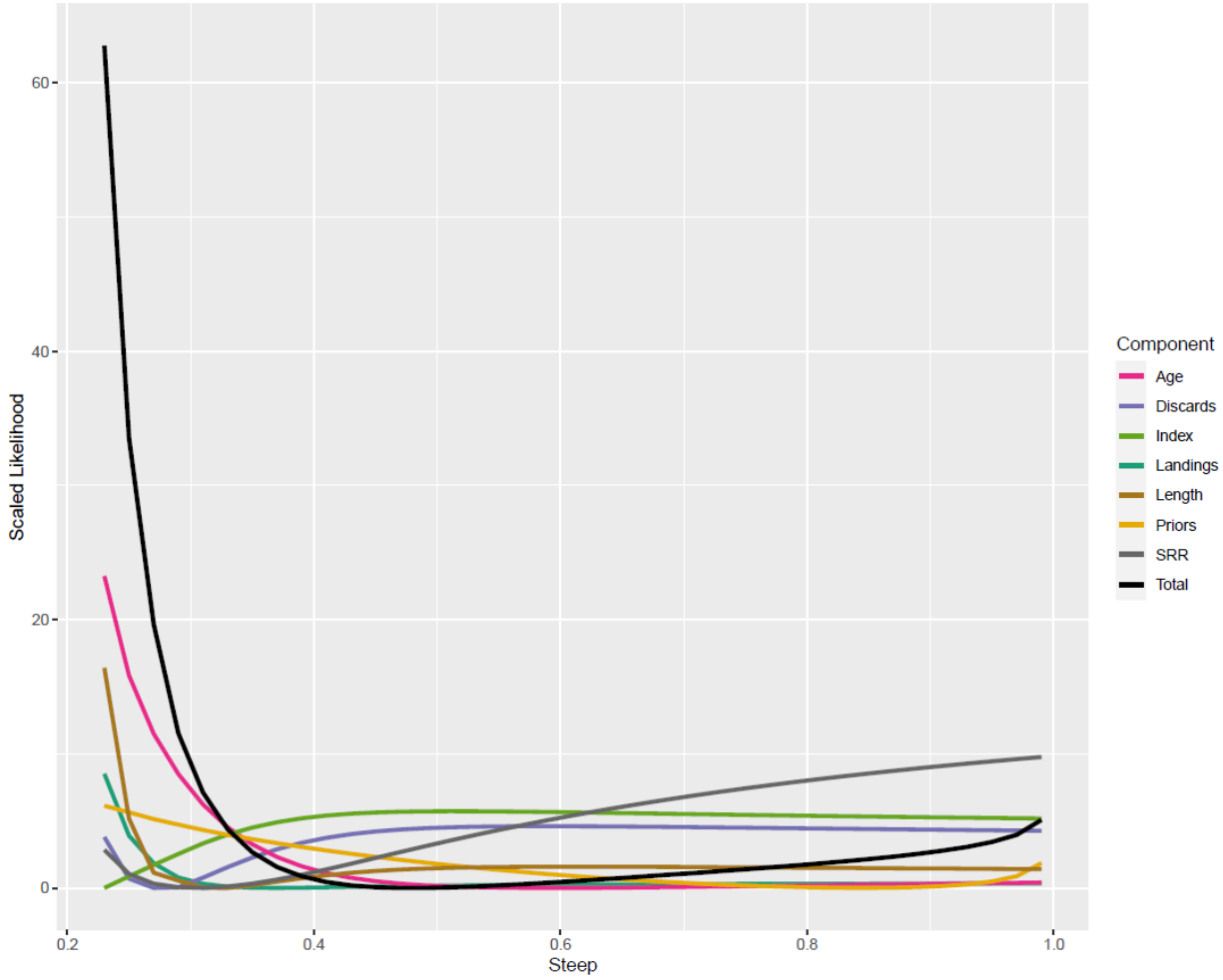
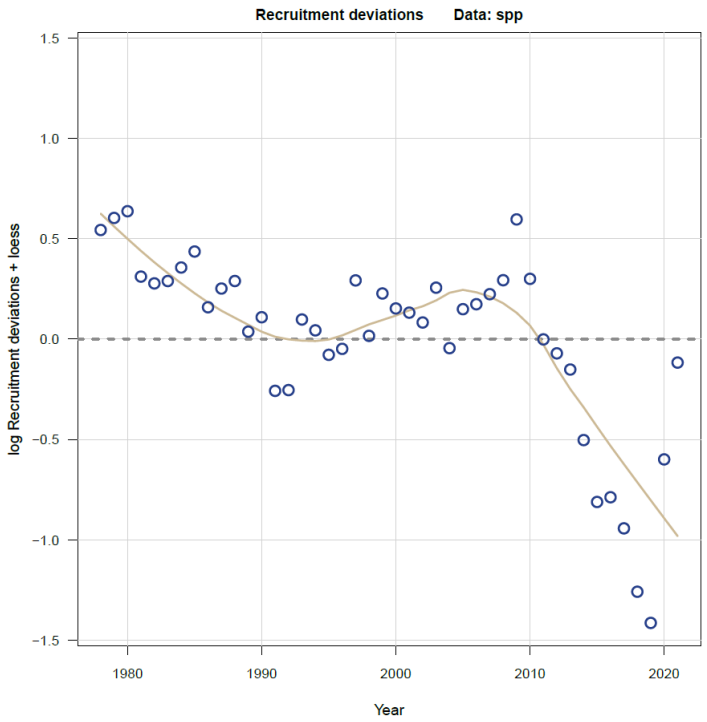
Spawner-Recruit Model

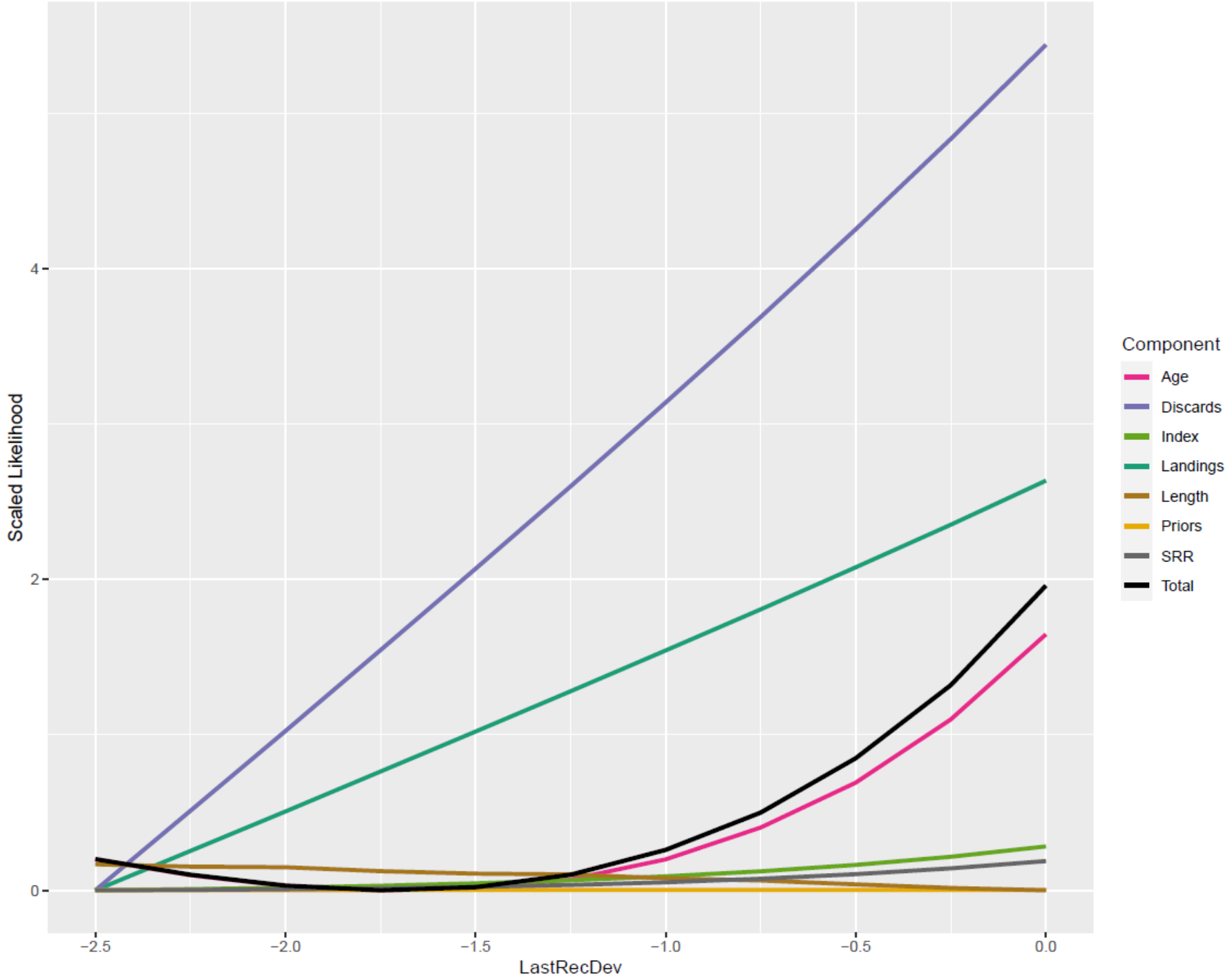
- Recruitment modeled with mean recruitment model, instead of Beverton-Holt
- Likelihood profile on steepness did not support estimability
  - Each data source preferring upper or lower bound
- No additional information on steepness



Terminal Recruitment Deviation

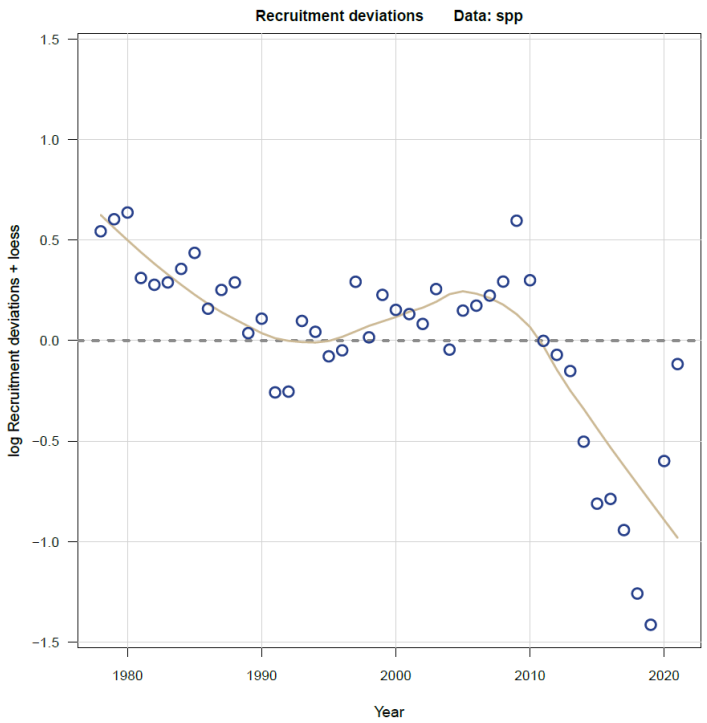
- 2021 is poorly estimated

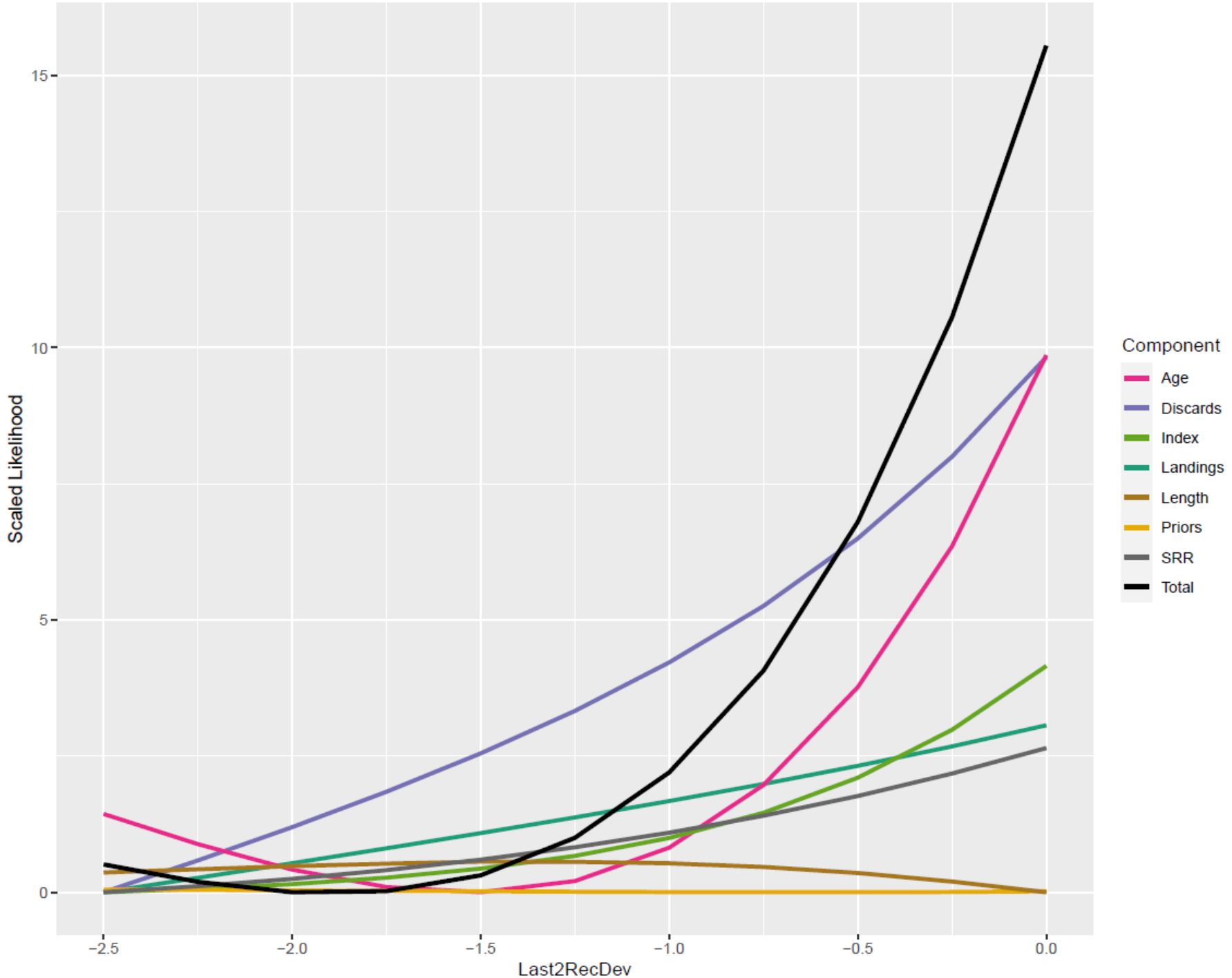




Terminal Recruitment Deviation

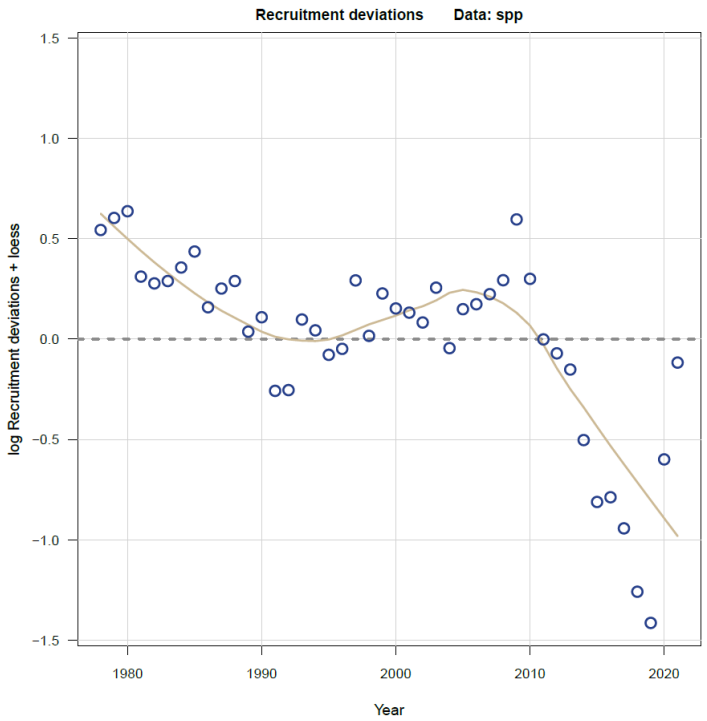
- 2020 is poorly estimated

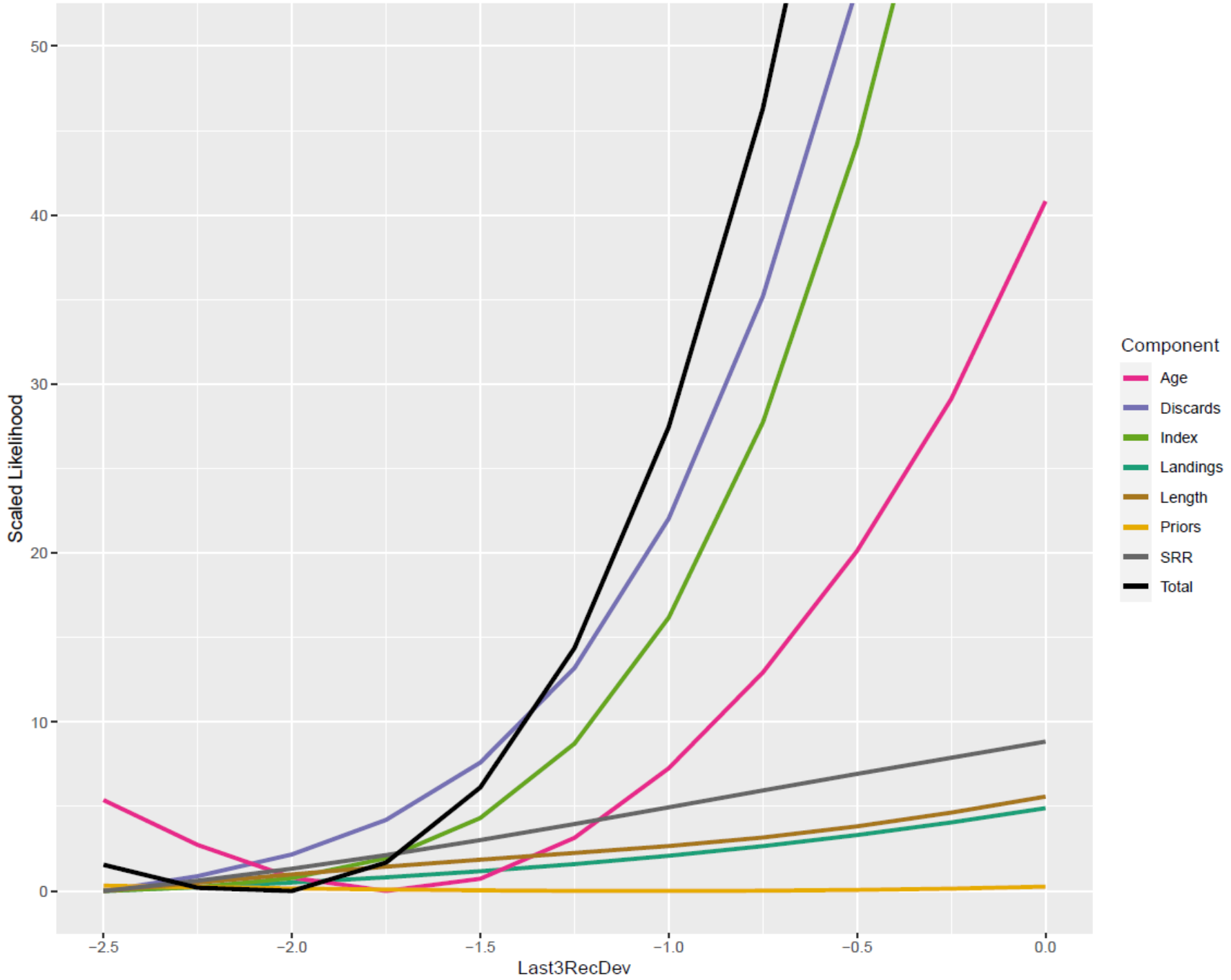




Terminal Recruitment Deviation

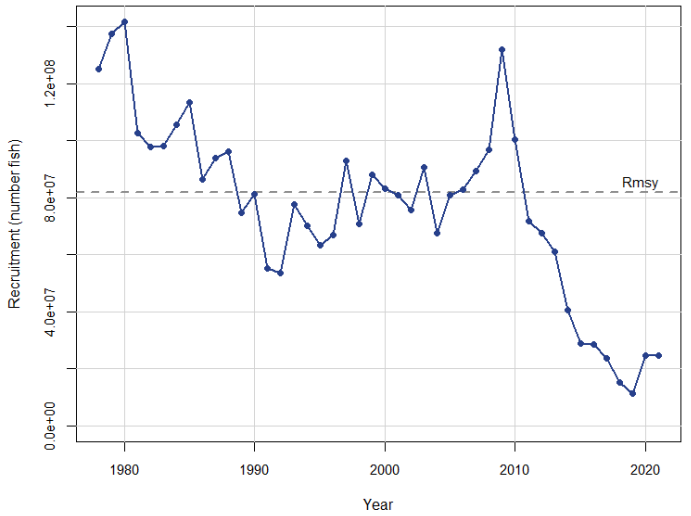
- 2019 is well estimated

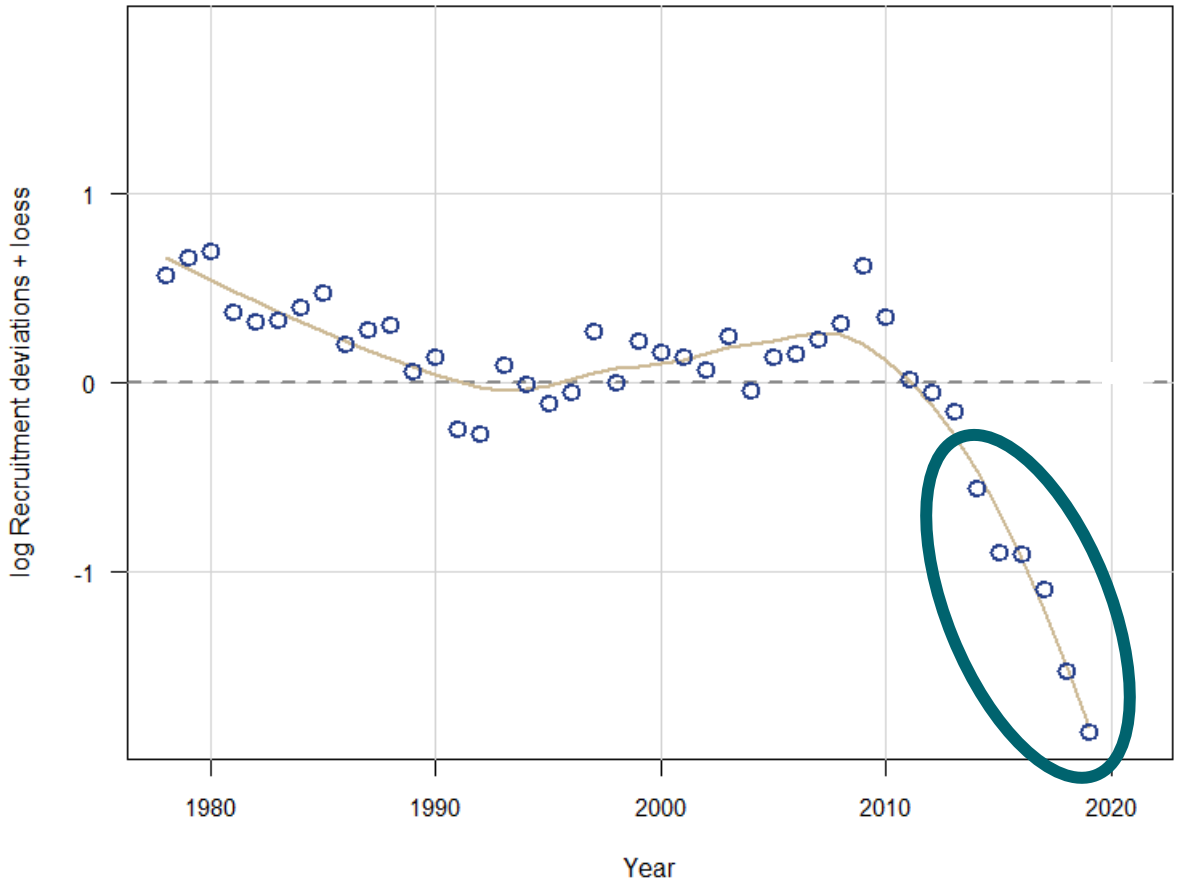




Terminal recruitment deviations

- Estimate rec devs through 2019
- Estimates in 2020 and 2021 are essentially forecasts fixed at recent average (2014 – 2019)
- Change point analysis determined 2014 as cutoff





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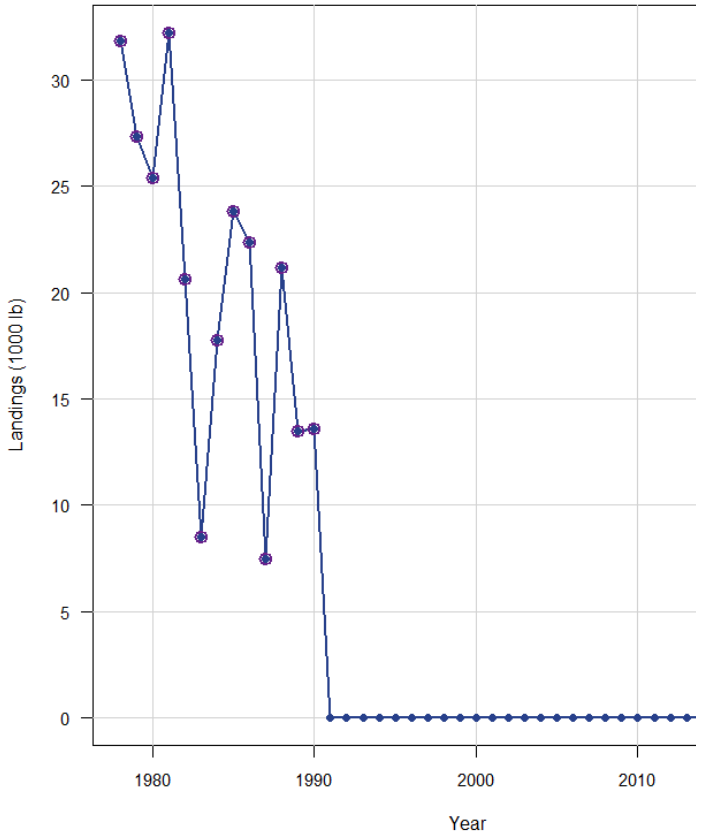
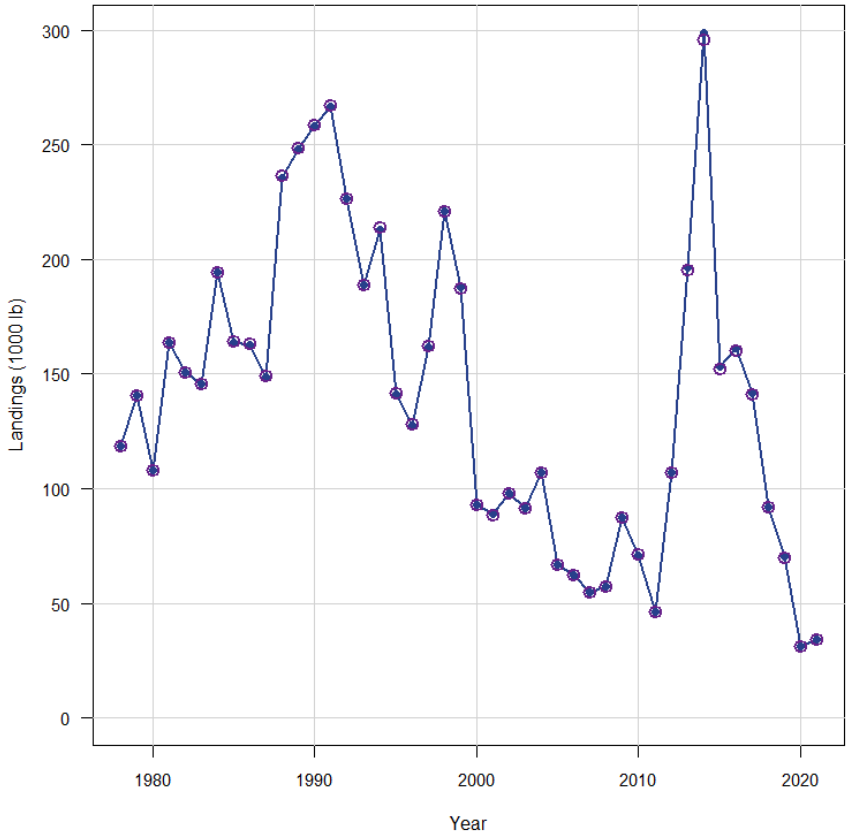
BAM base model – fits to comm landings

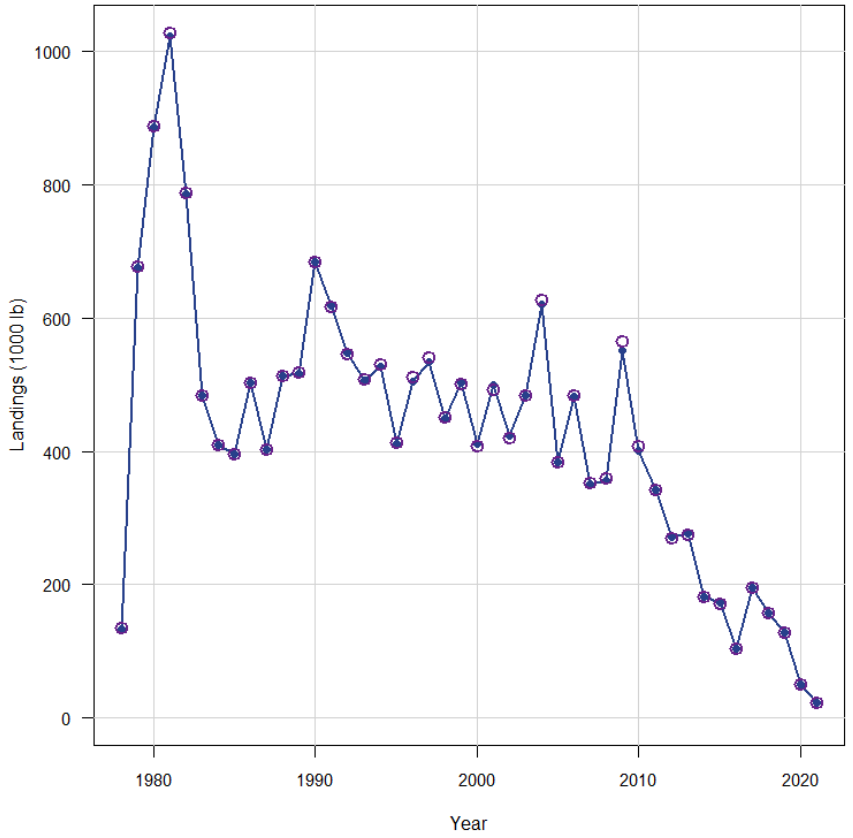
Commercial trawl



Commercial handline



Commercial pots



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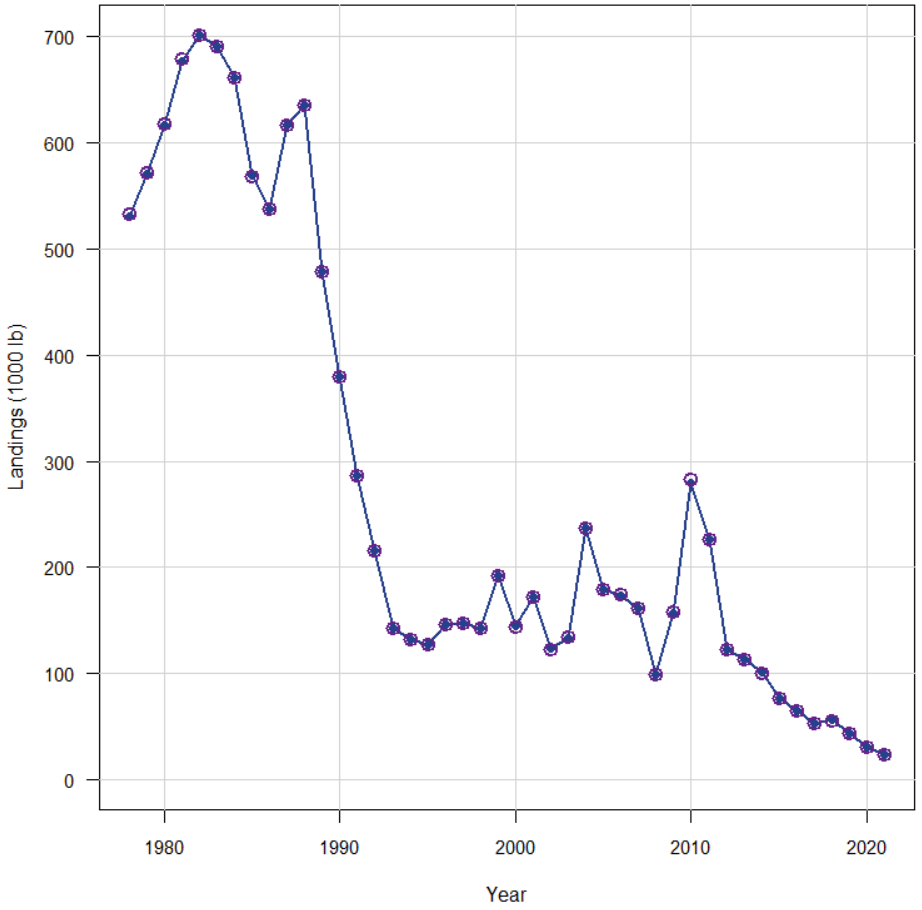
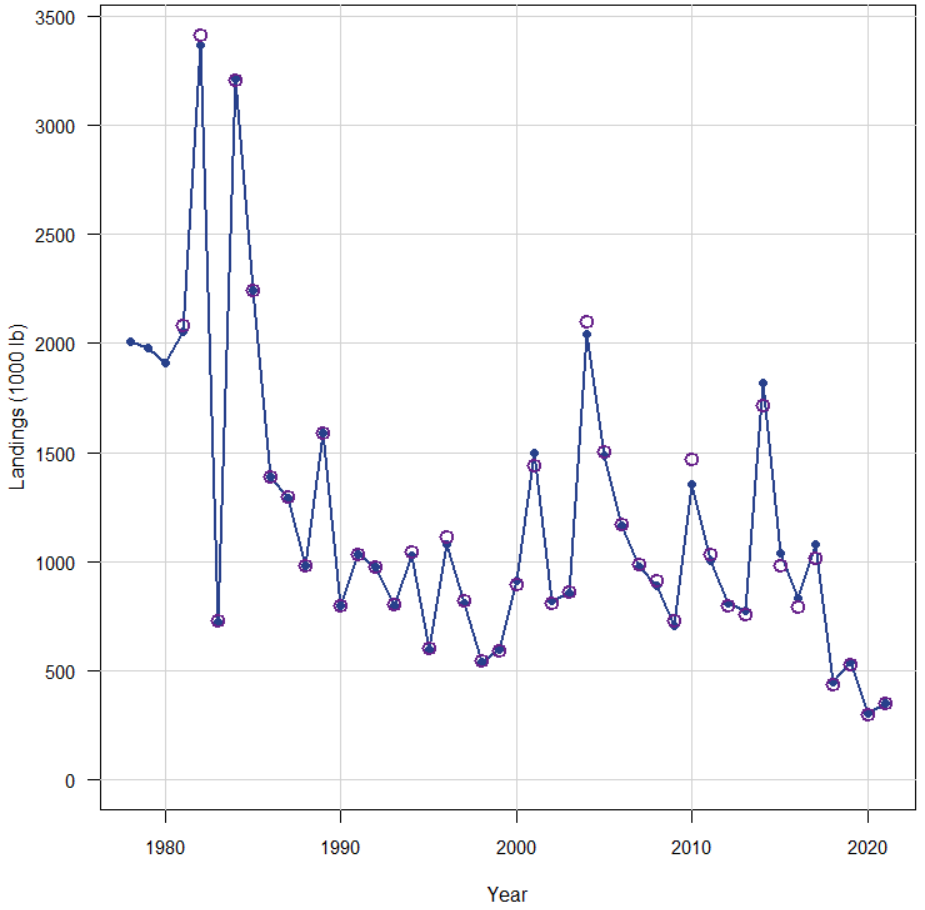
BAM base model – fits to rec landings

Headboat

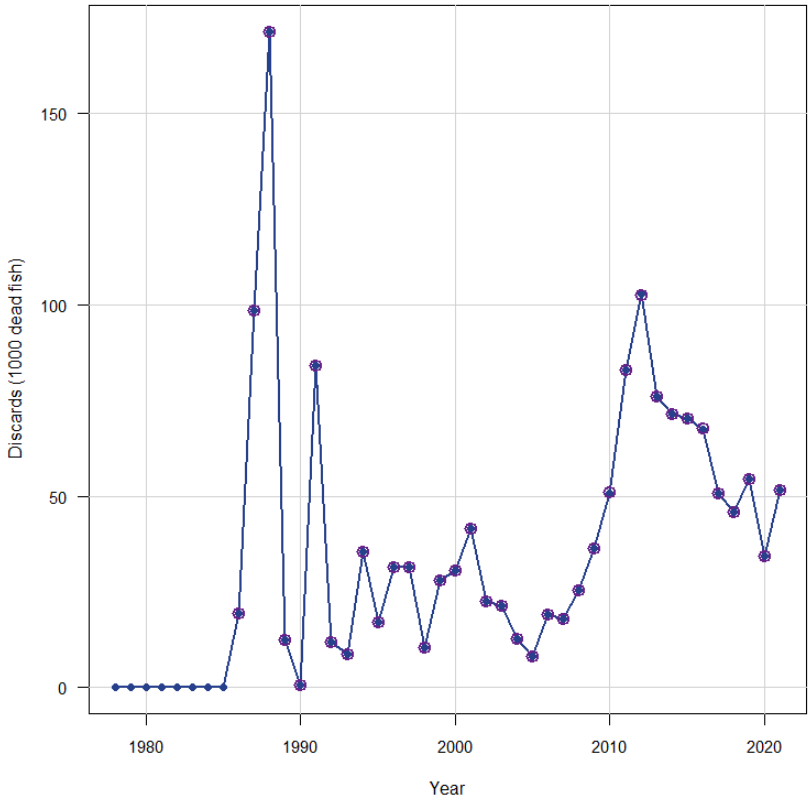


General recreational

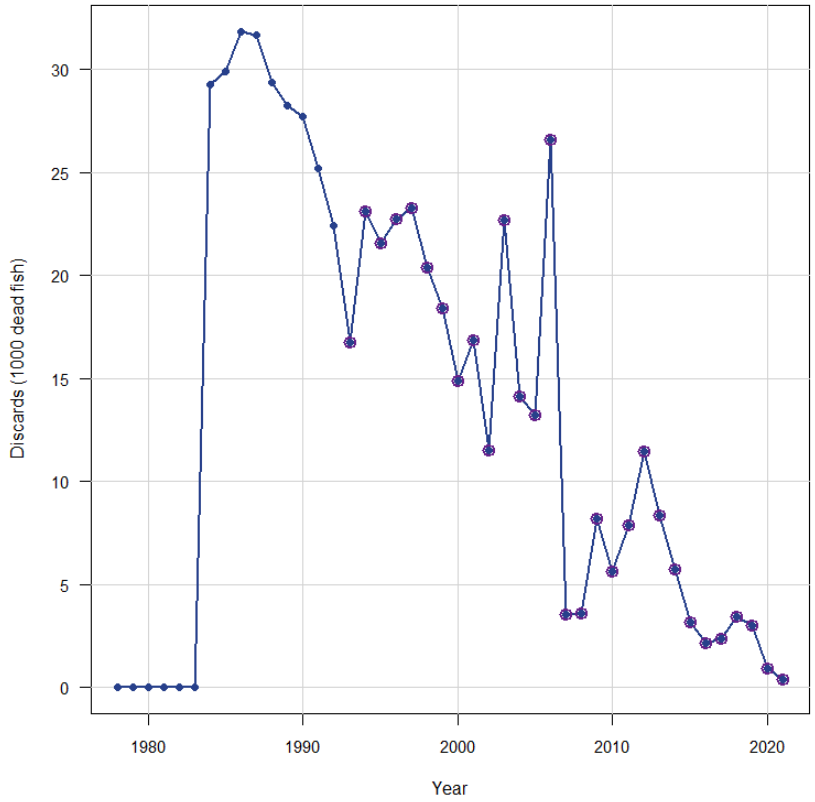


BAM base model – fits to discards

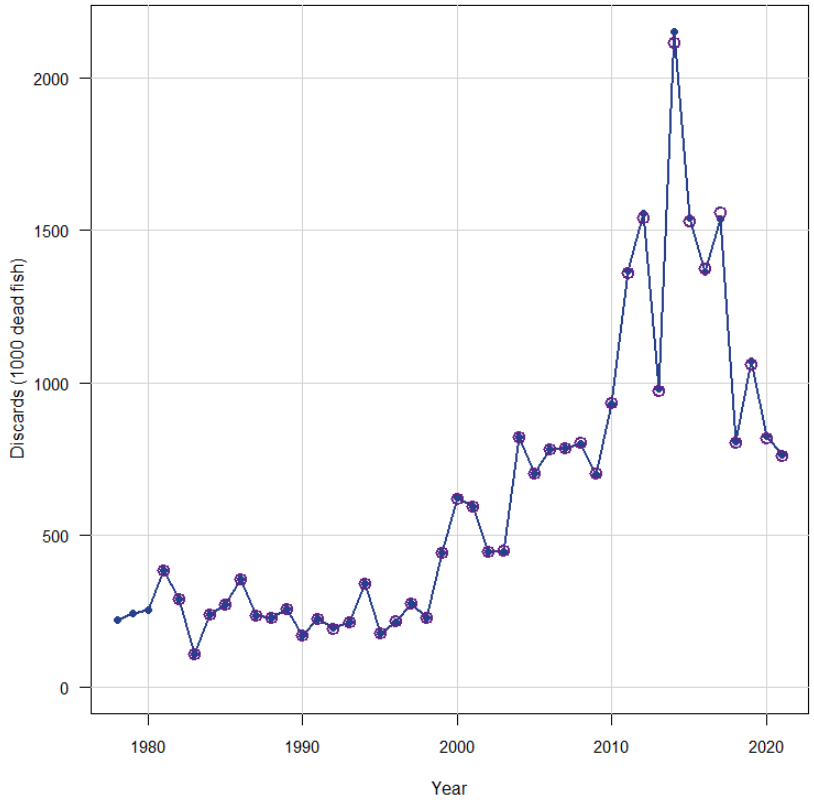
Headboat



Commercial



General recreational



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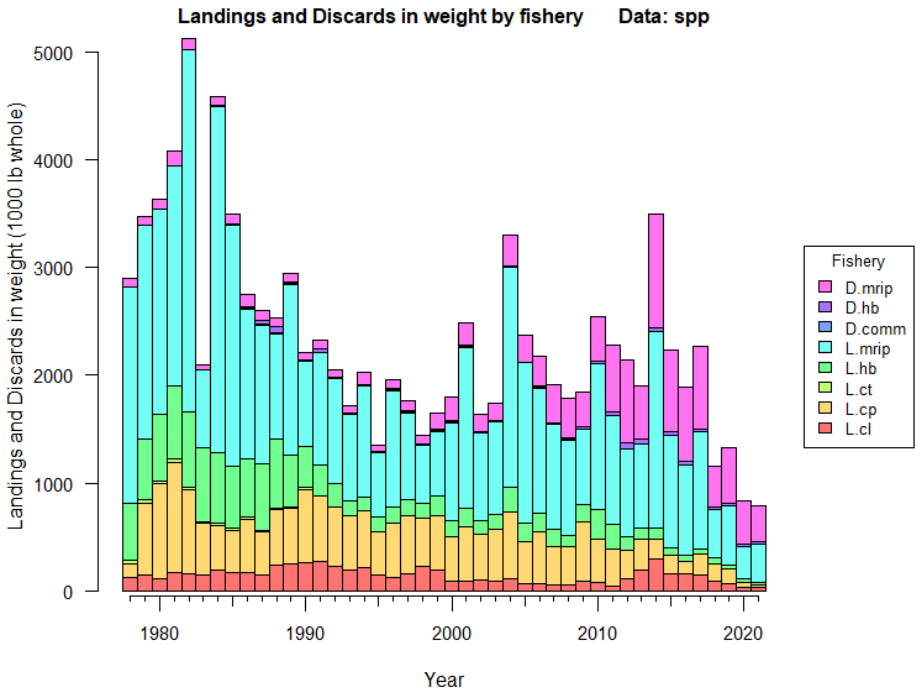
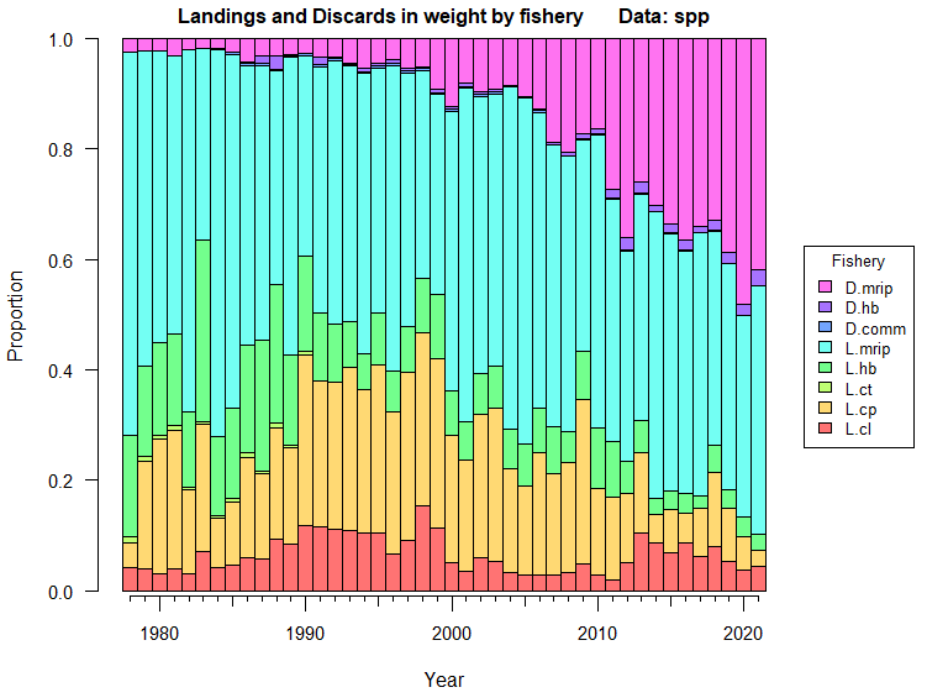
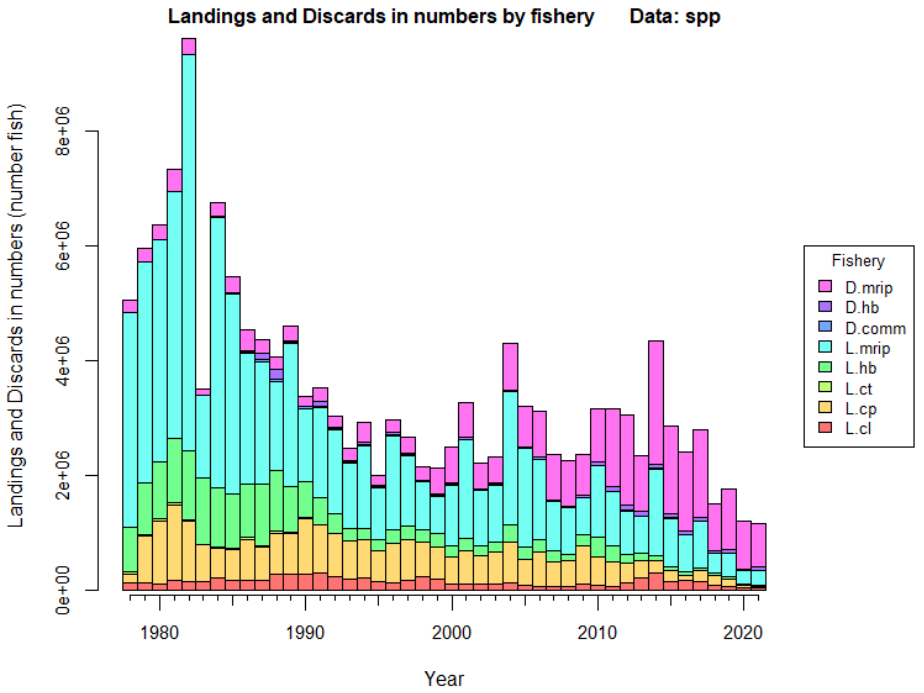
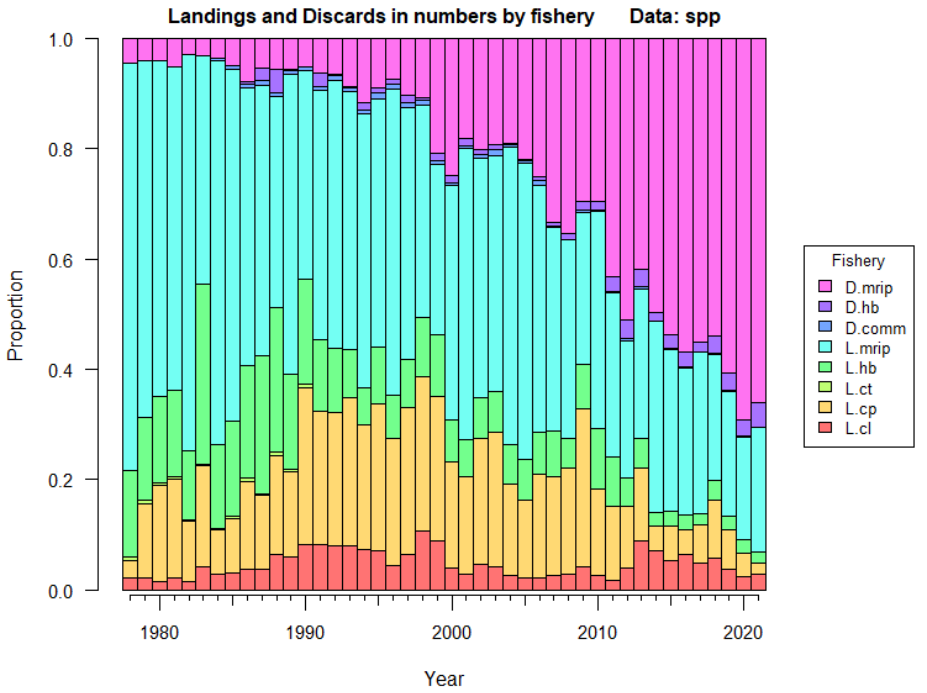
BAM base model – Estimated Landings and Discard



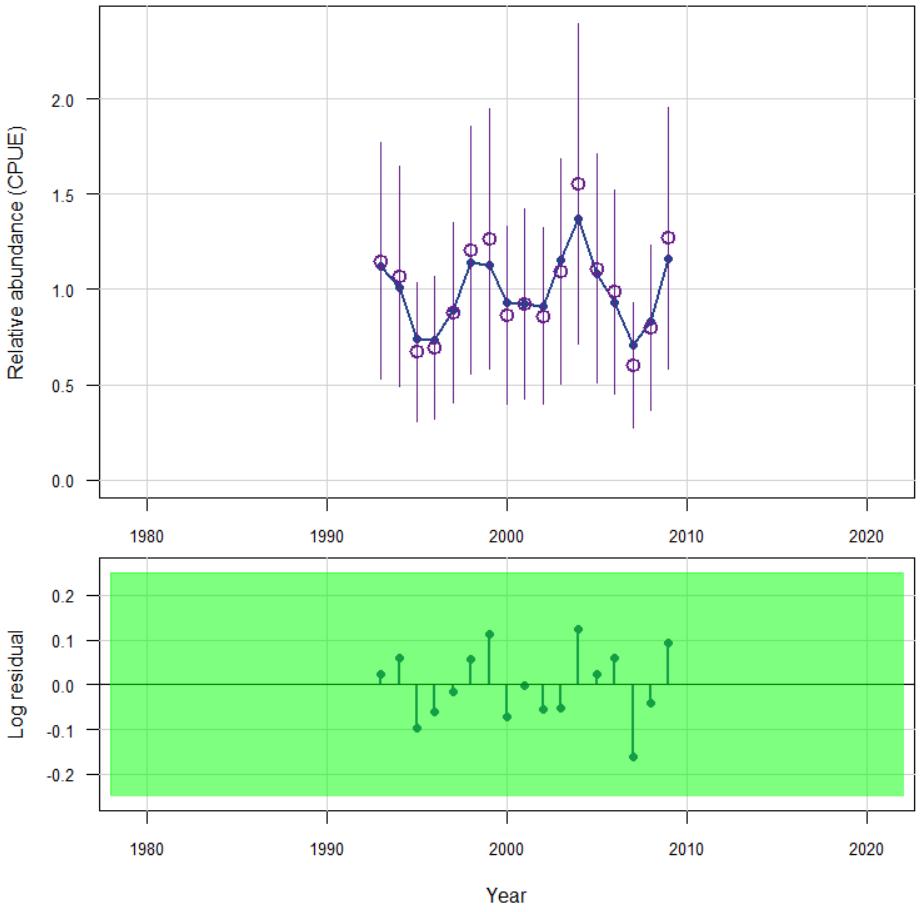




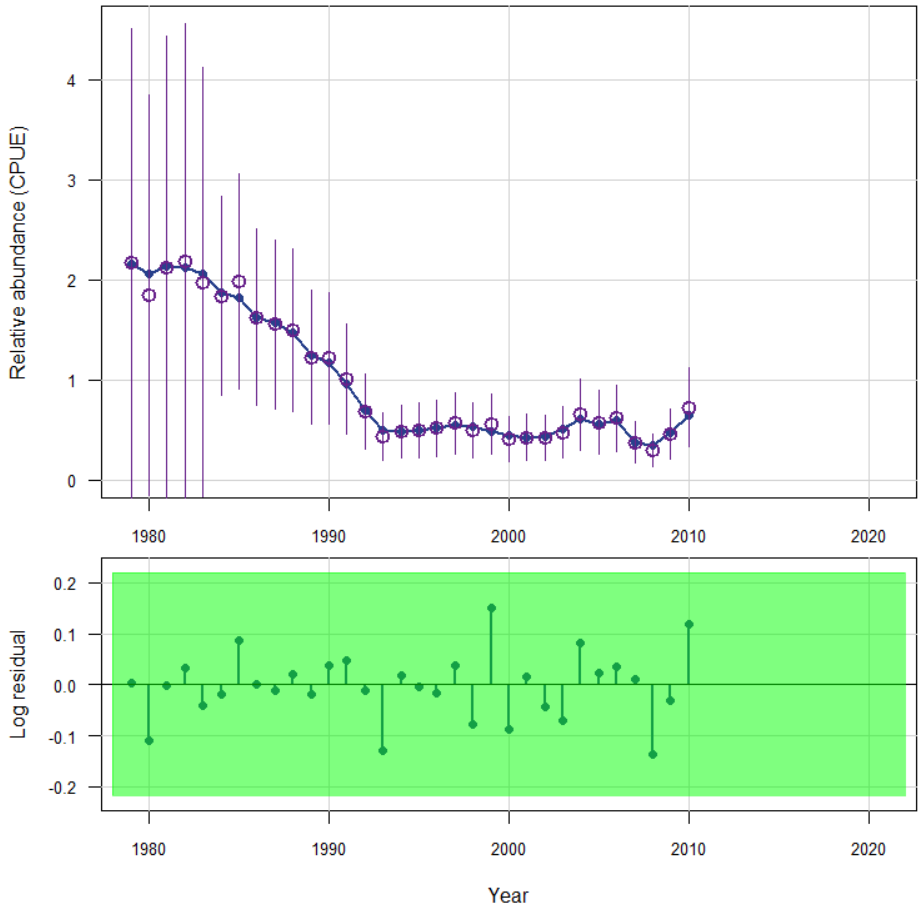


BAM base model – fits to fishery index

Commercial handline

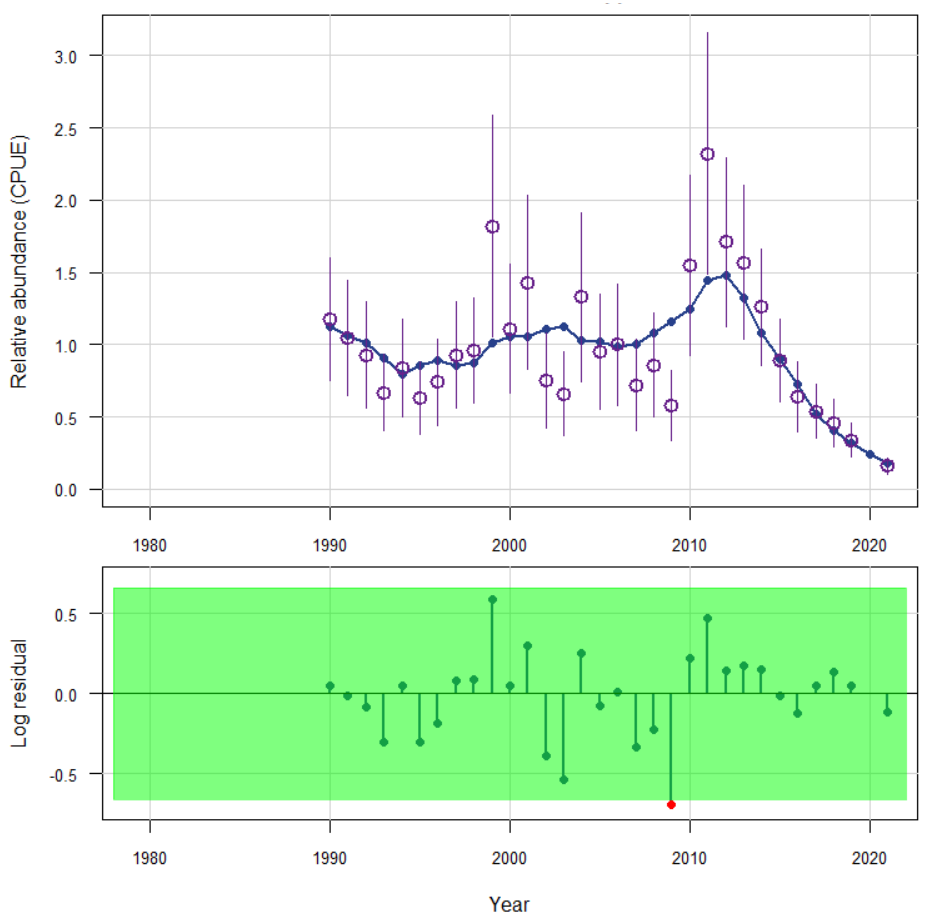


Headboat

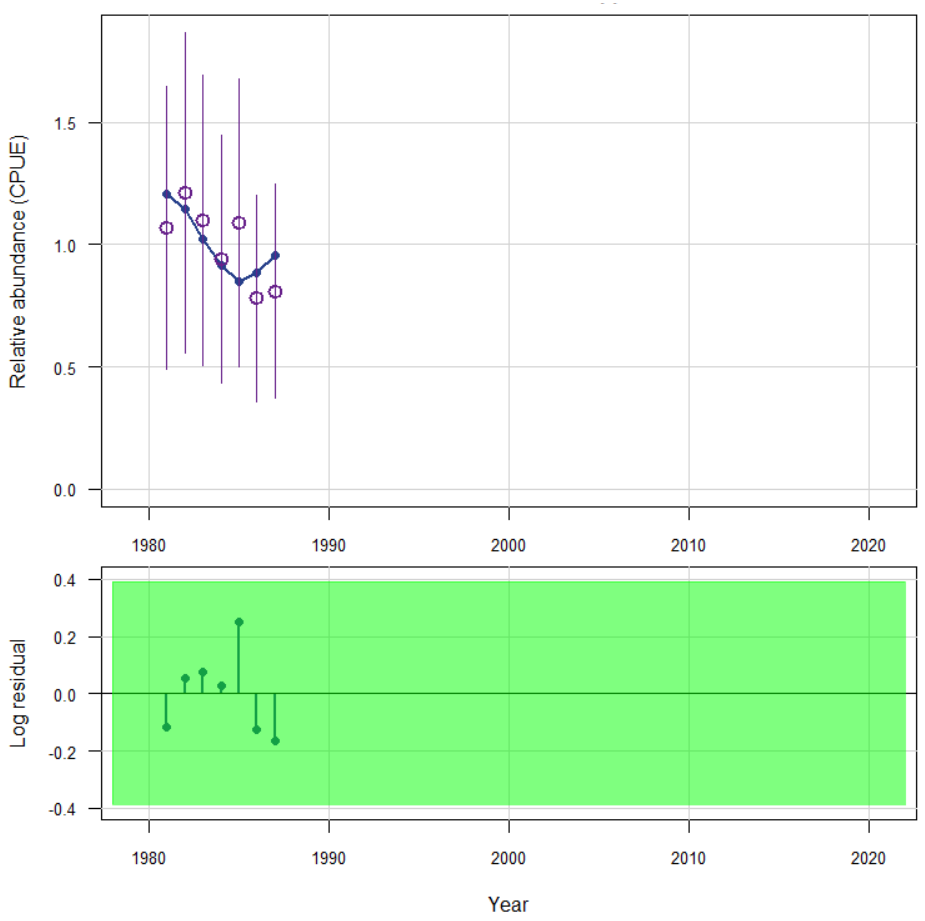


BAM base model – fits to survey index

SERFS



MARMAP blackfish



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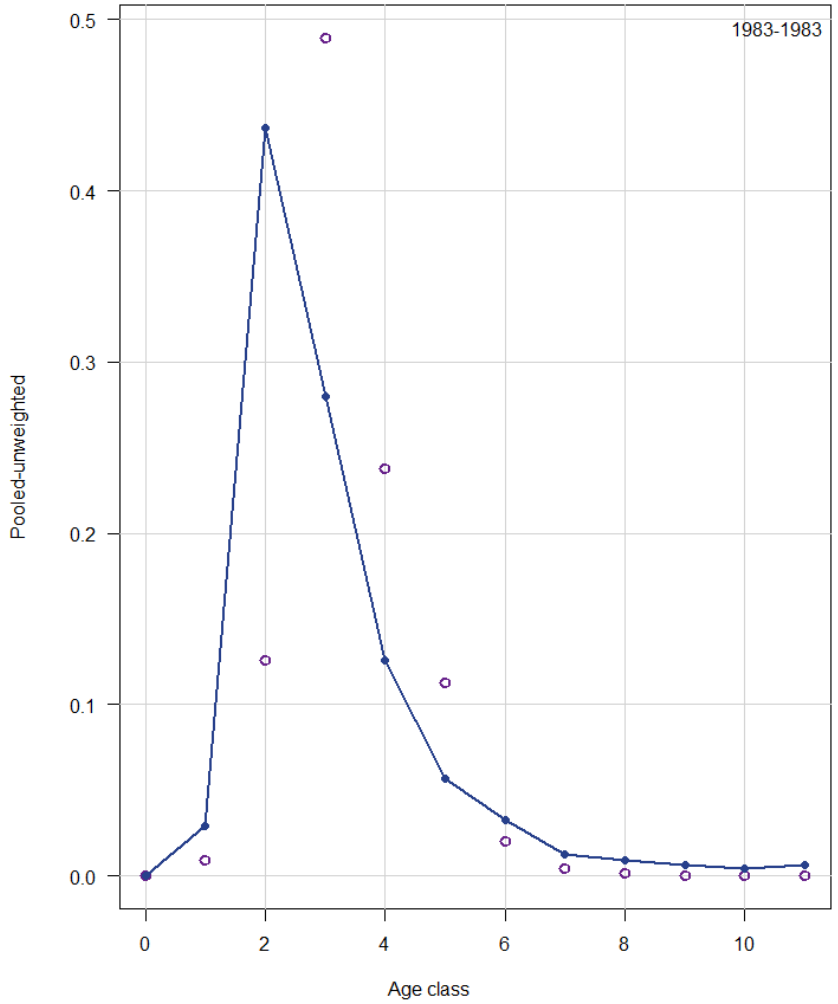
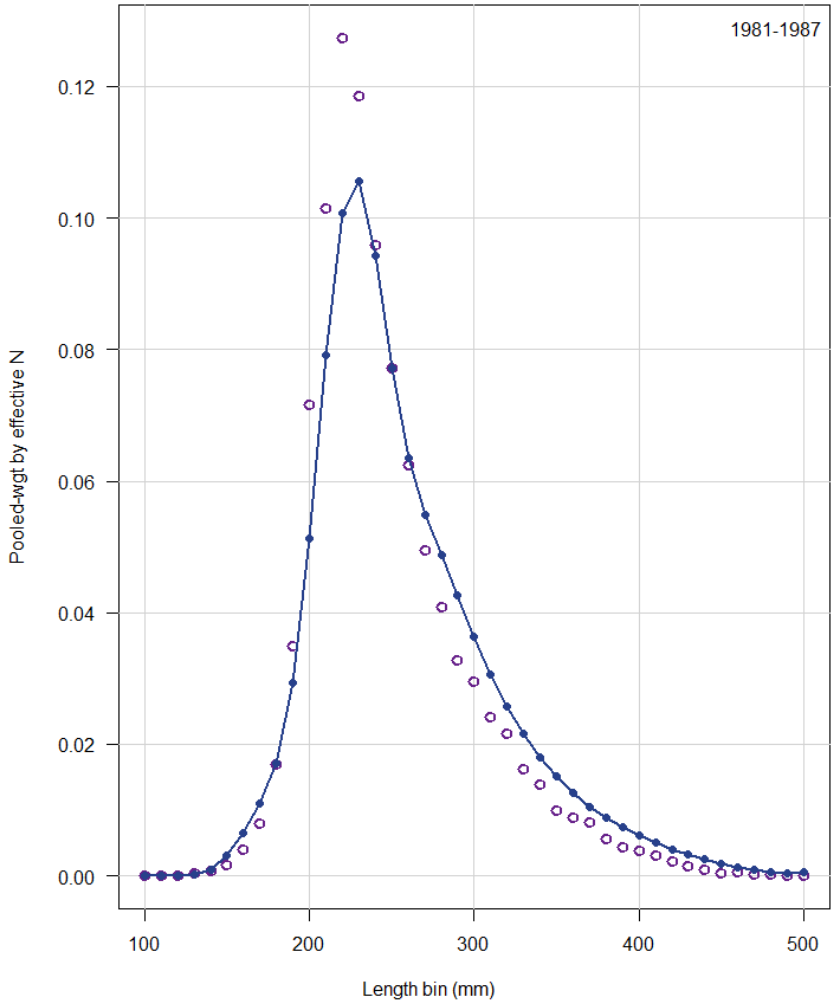
BAM base model – fits to MARMAP blackfish length and age composition

Age Comp MARMAP blackfish



Length Comp MARMAP blackfish



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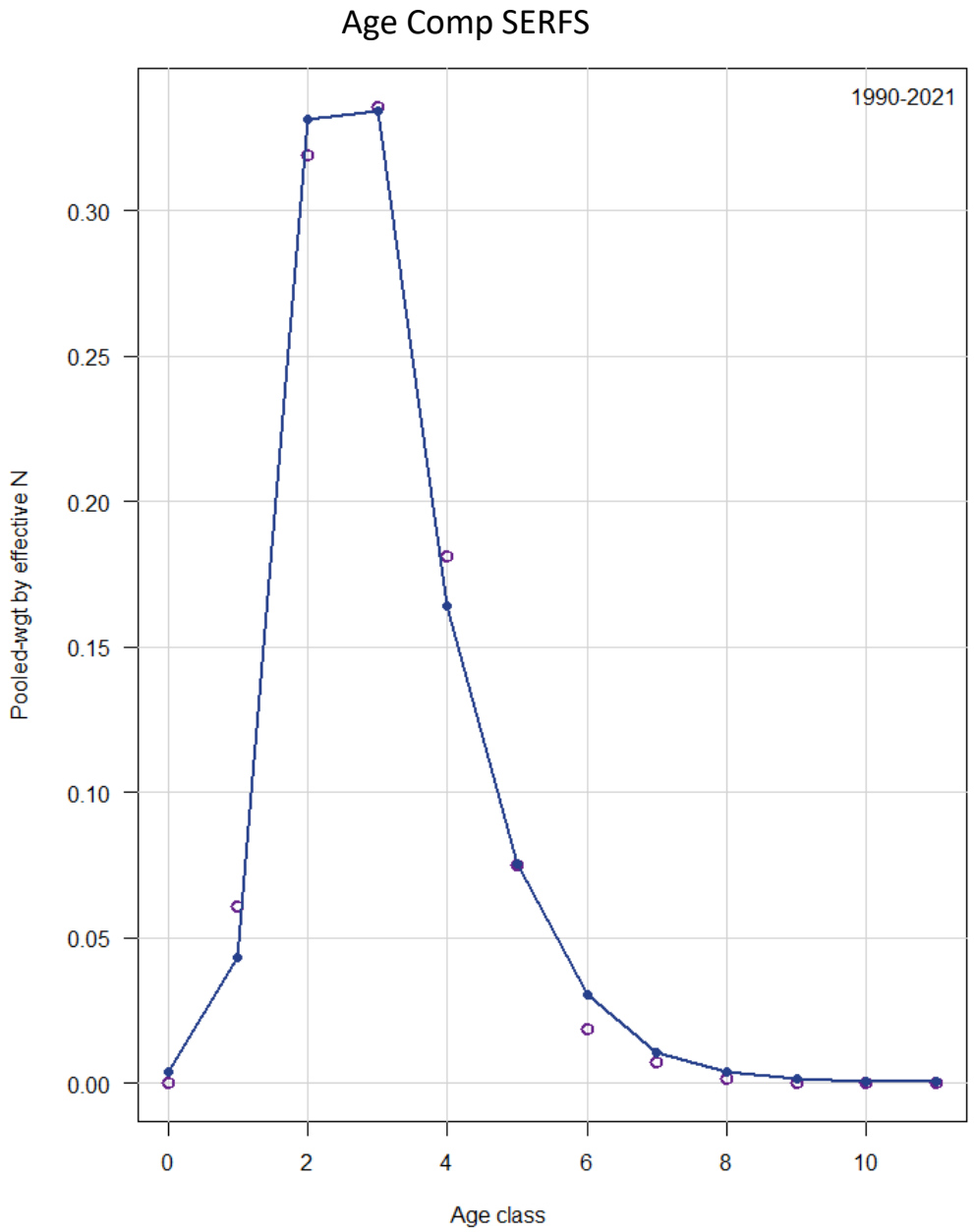
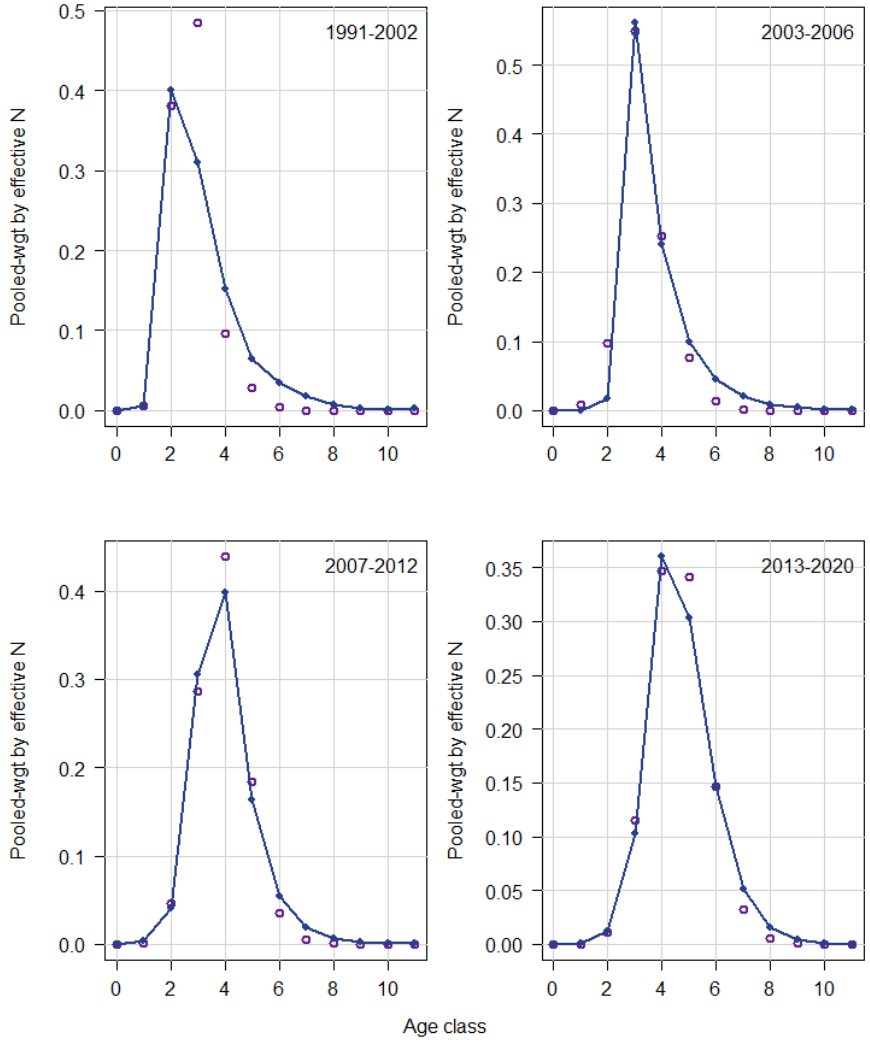
BAM base model – fits to SERFS age composition

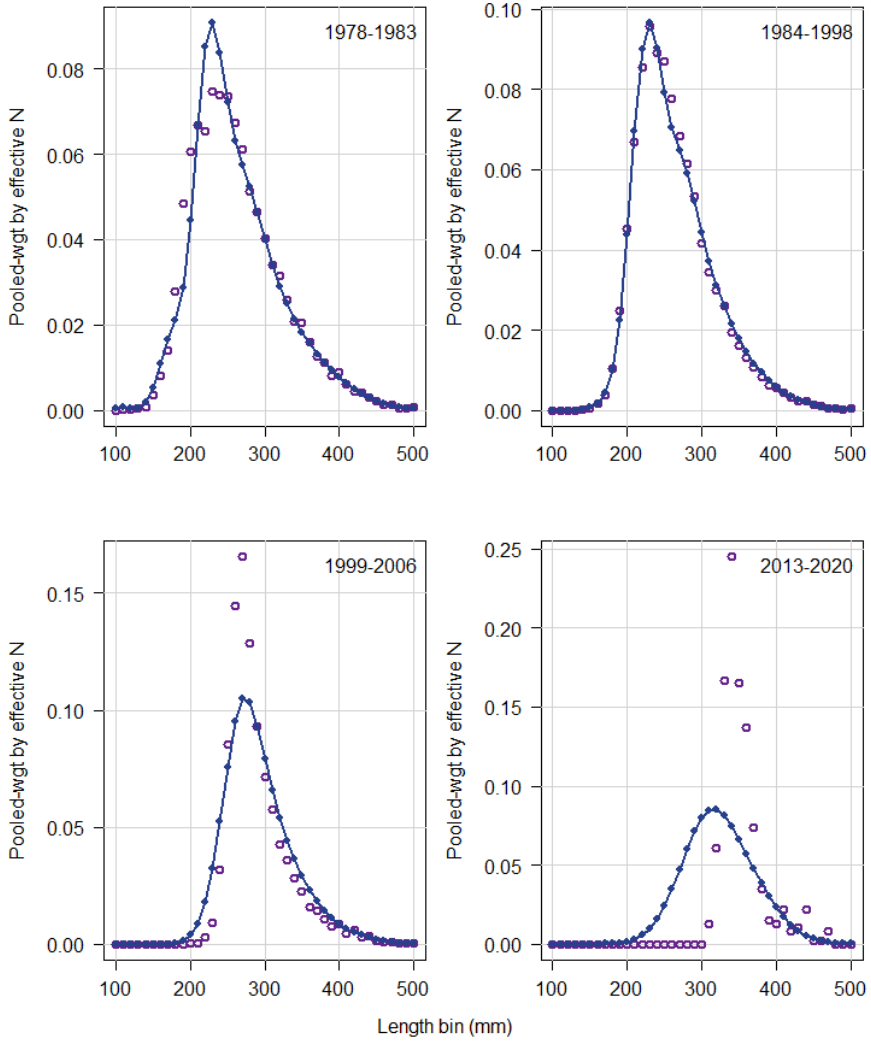


BAM base model – fits to Headboat length and age composition

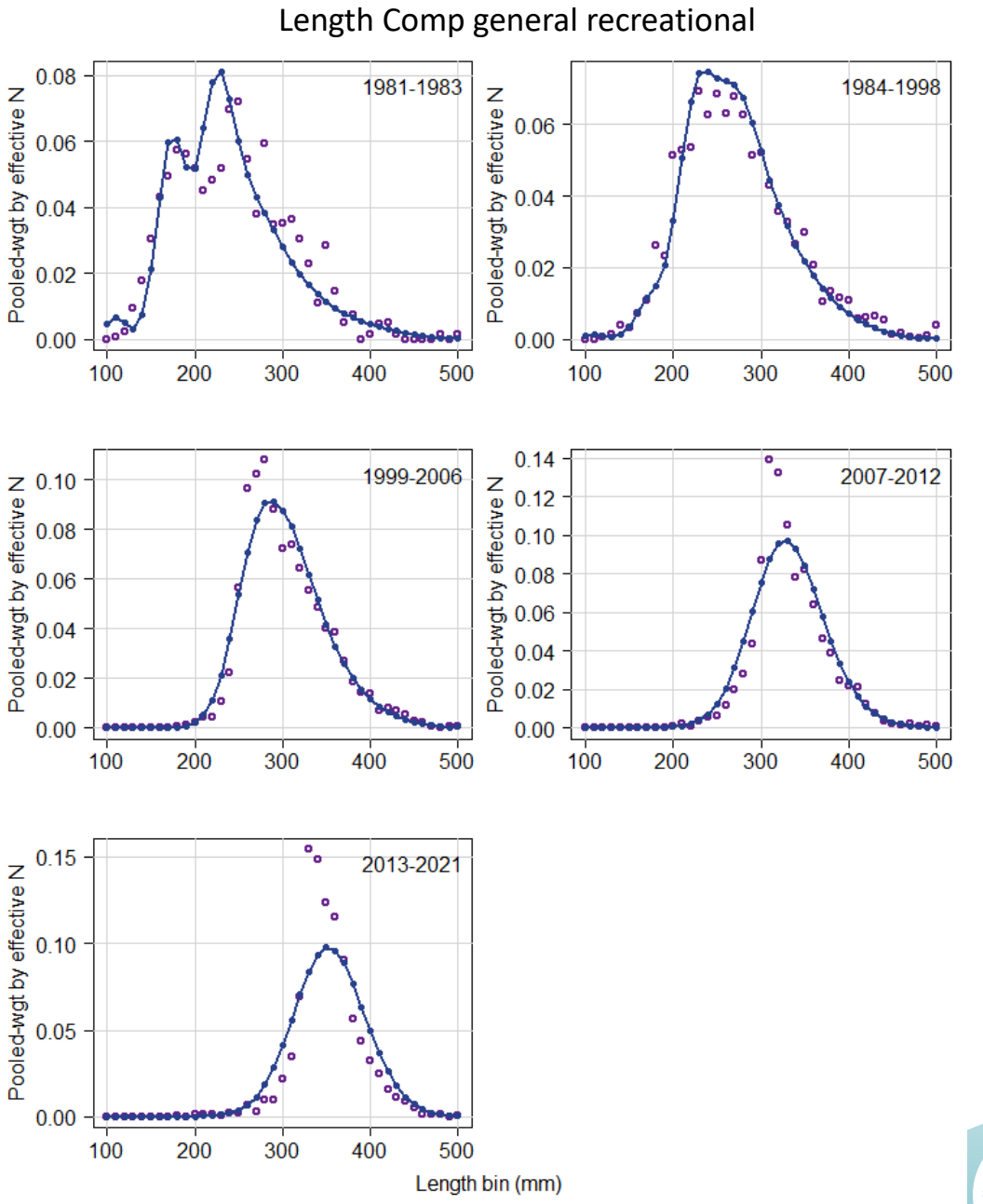
Age Comp headboat



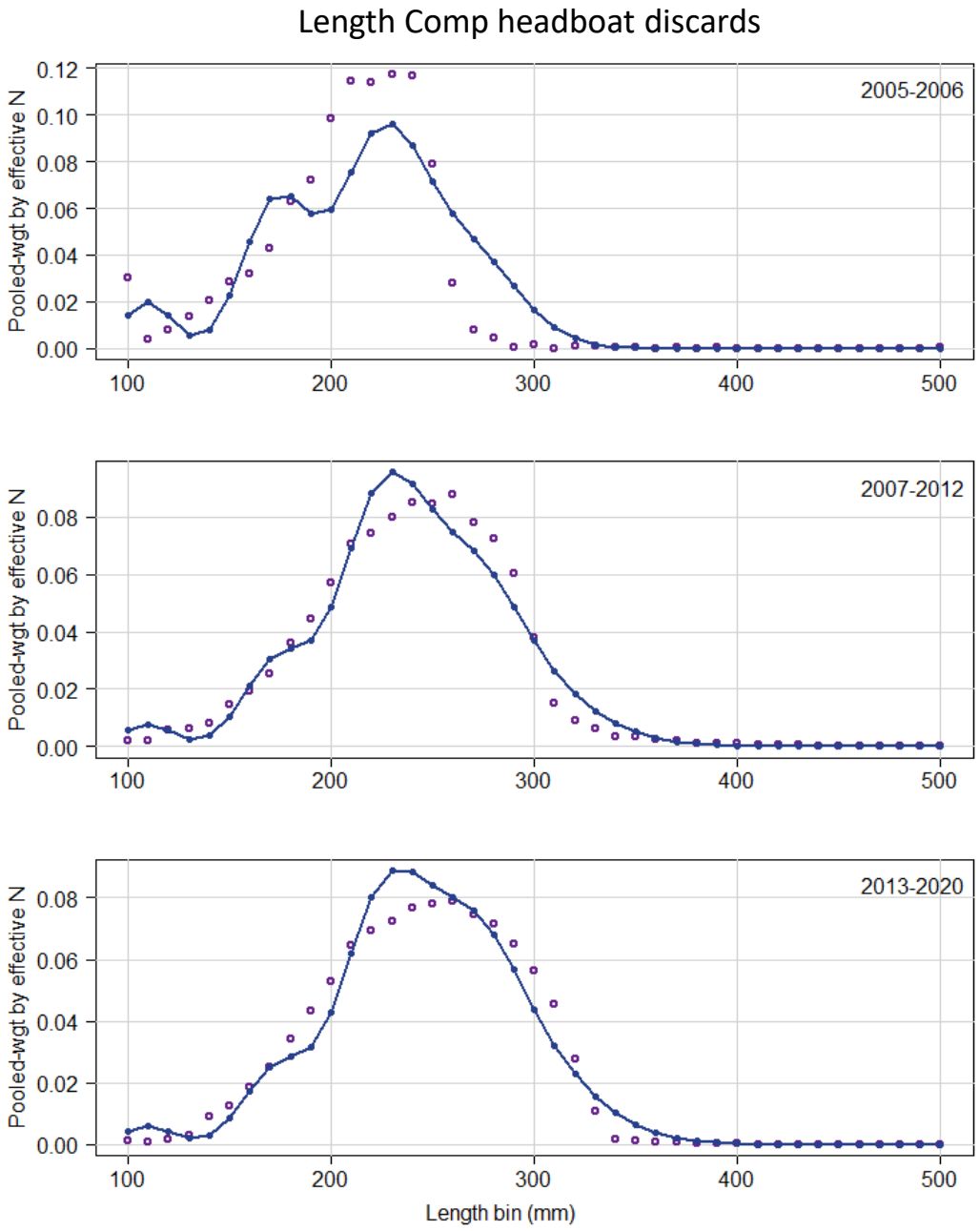
Length Comp headboat



BAM base model – fits to general recreational length composition



BAM base model – fits to Headboat discards length composition



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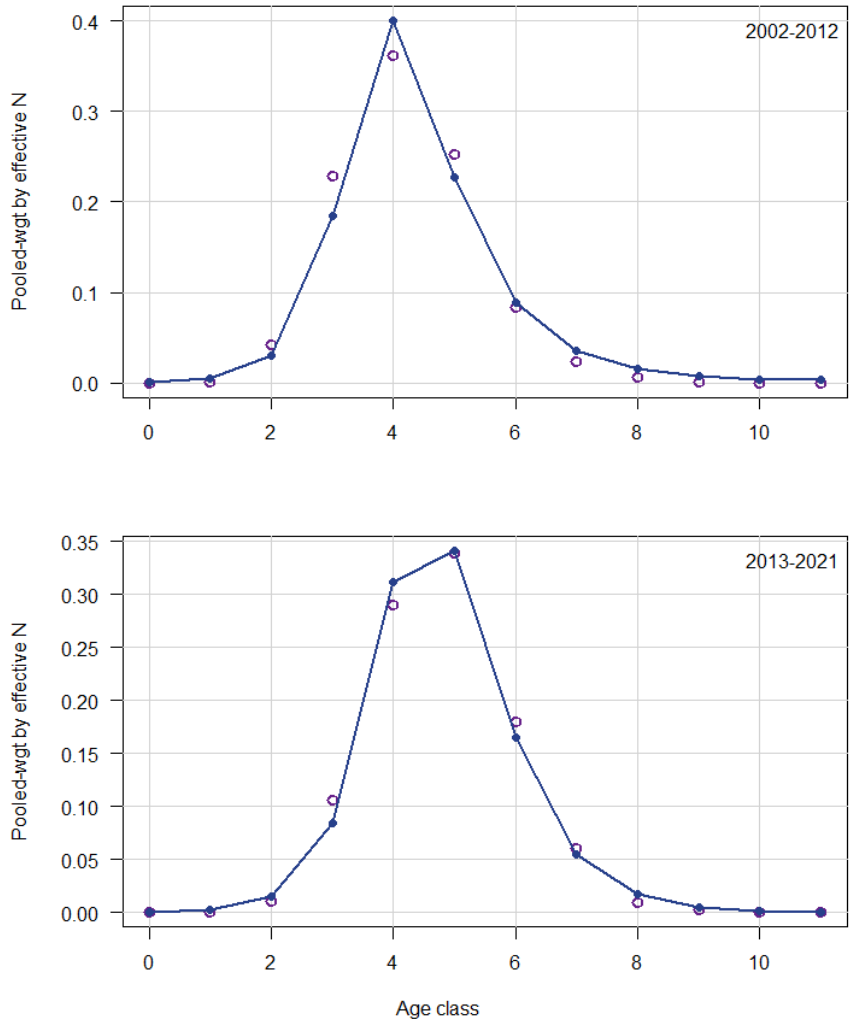
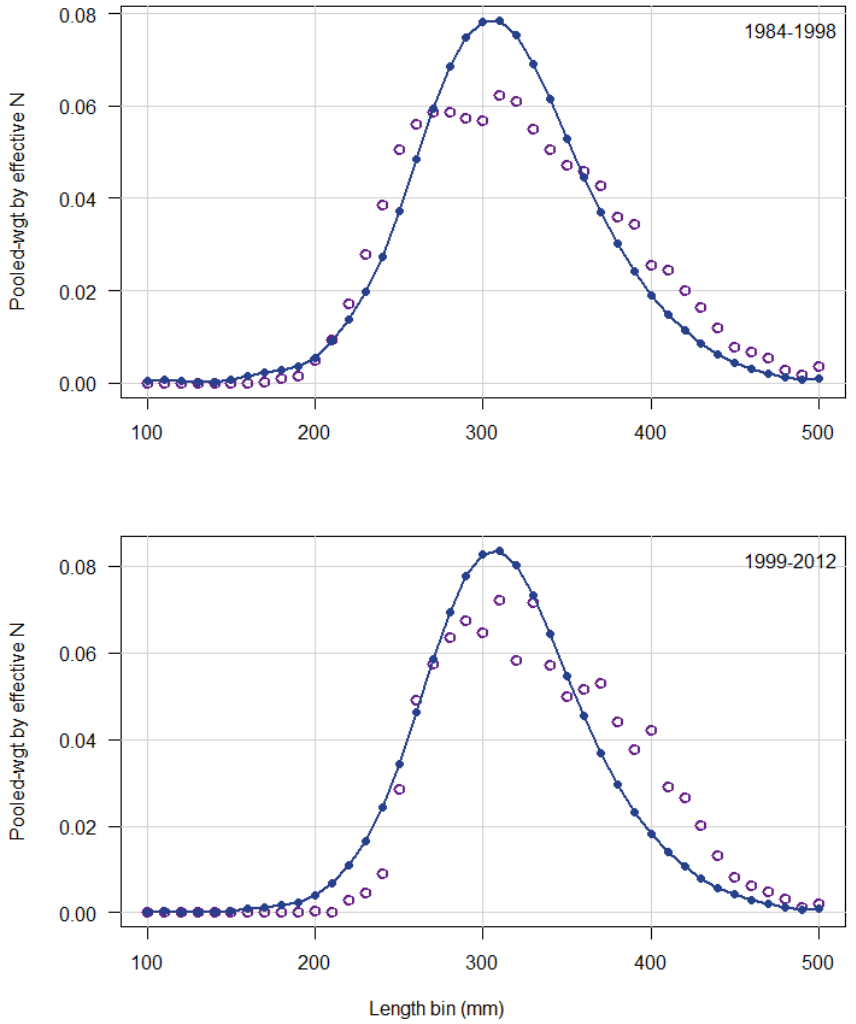
BAM base model – fits to commercial handline length and age composition

Age Comp commercial handline

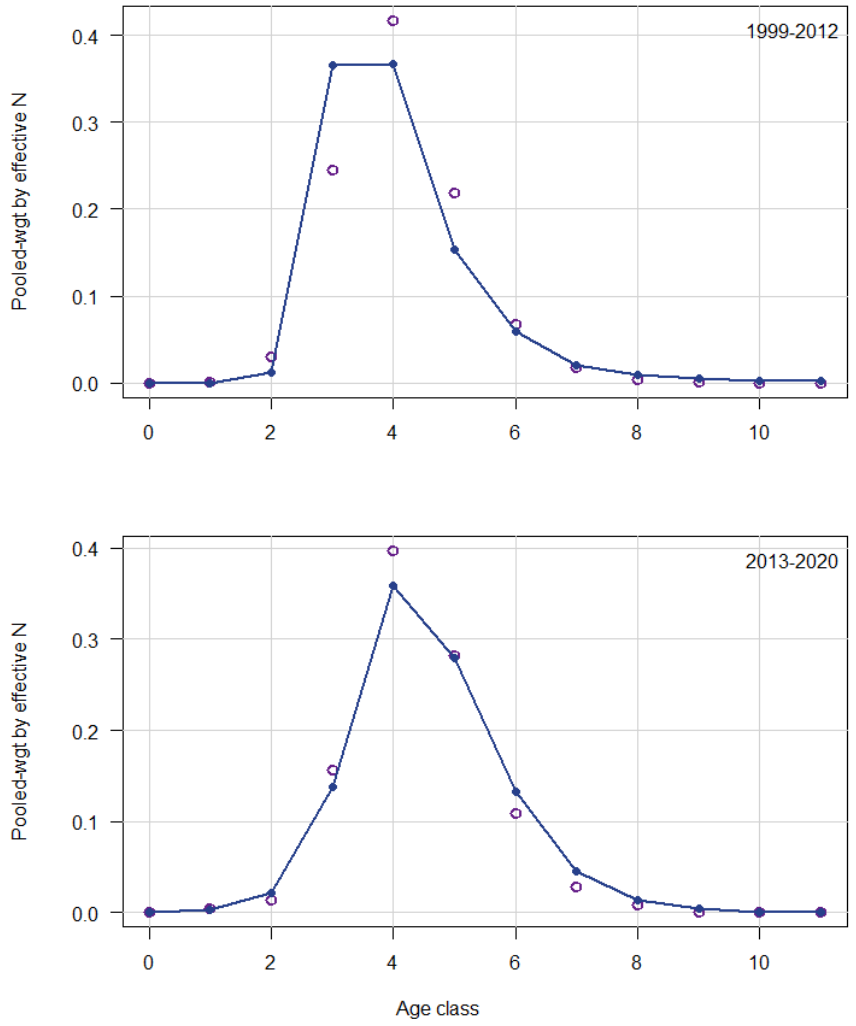


Length Comp commercial handline

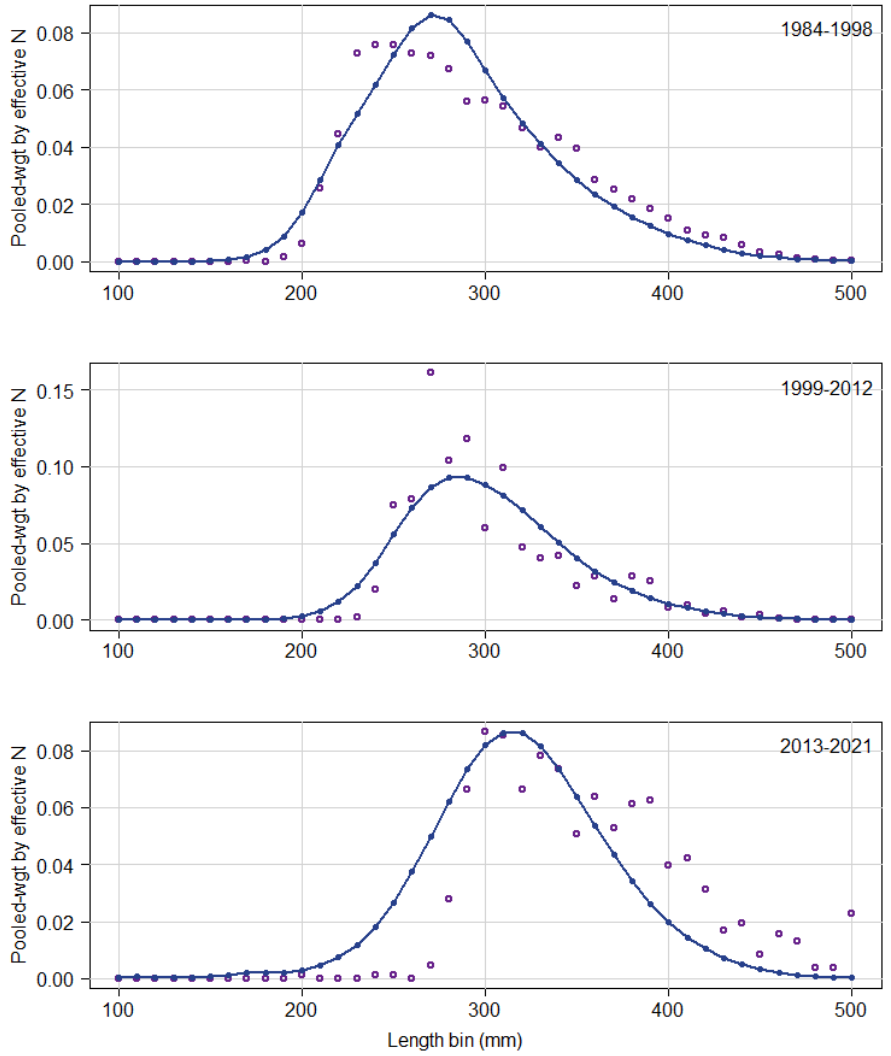


BAM base model – fits to commercial pots length and age composition

Age Comp commercial pots

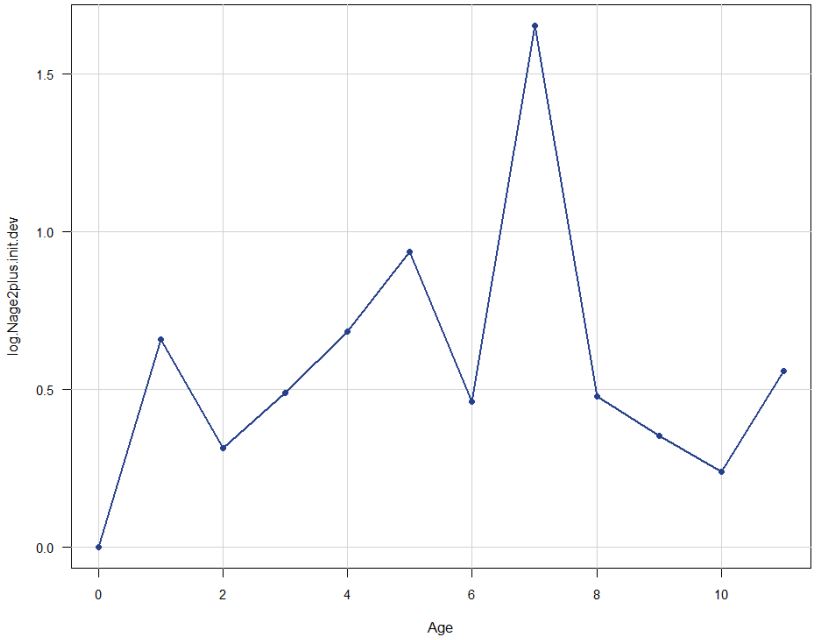


Length Comp commercial pots

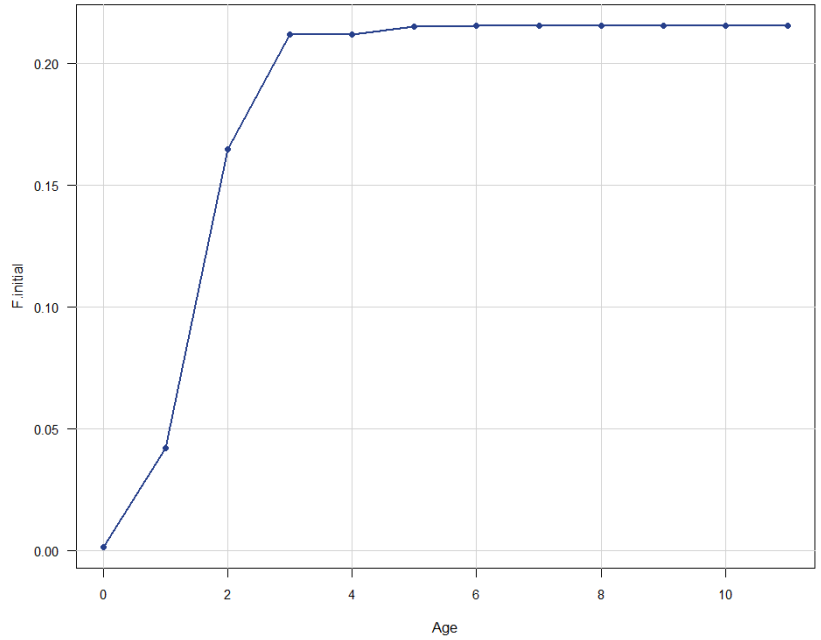


BAM base model – Initial conditions

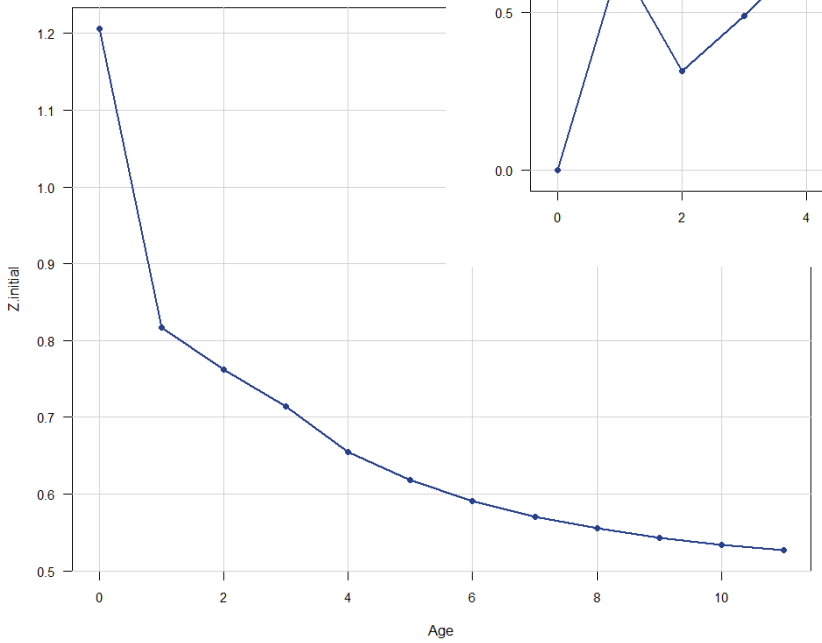
Initial N deviates



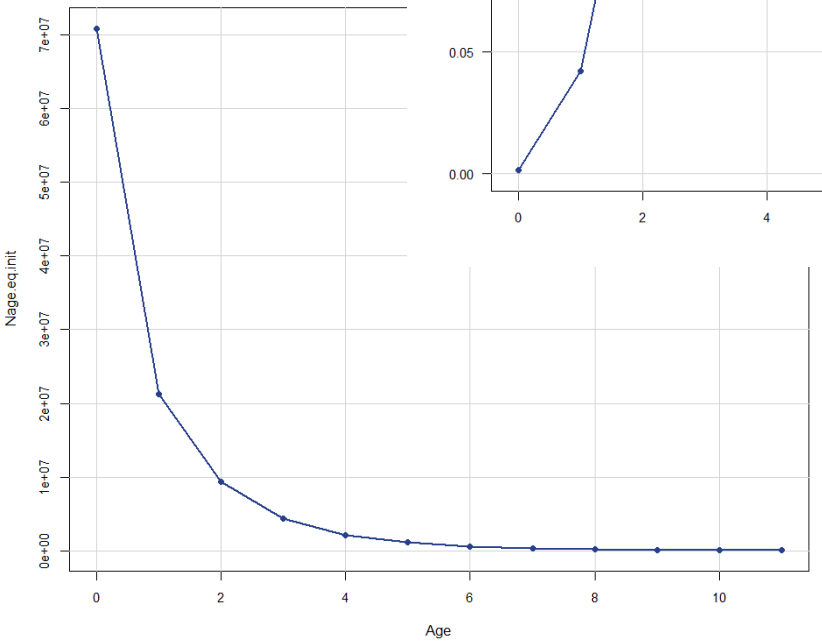
Initial F at age



Initial Z at age

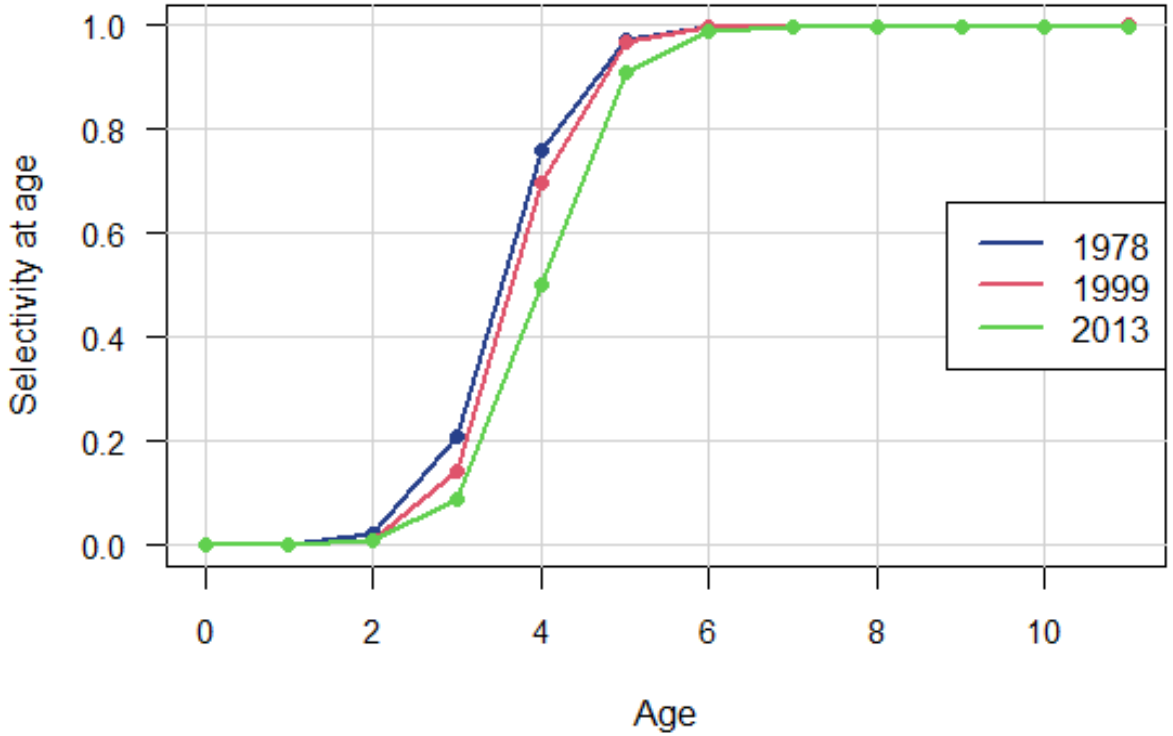


Initial N at age

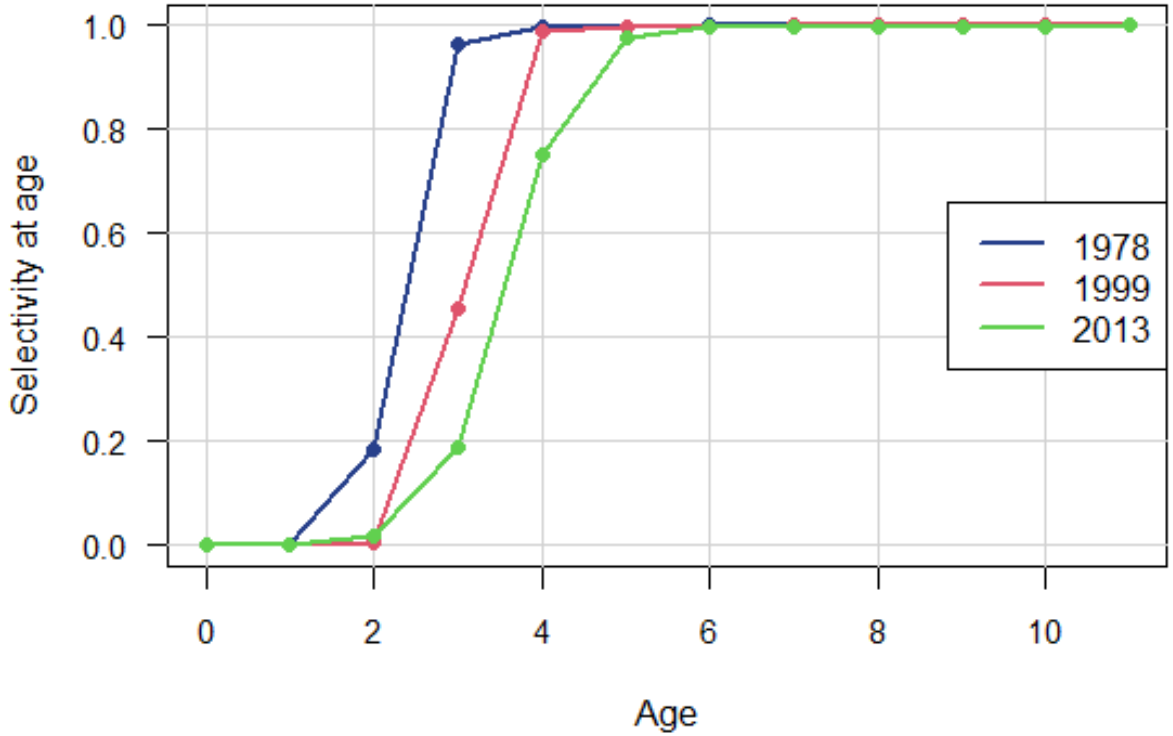


BAM base model – Commercial selectivity

Commercial Lines Selectivity

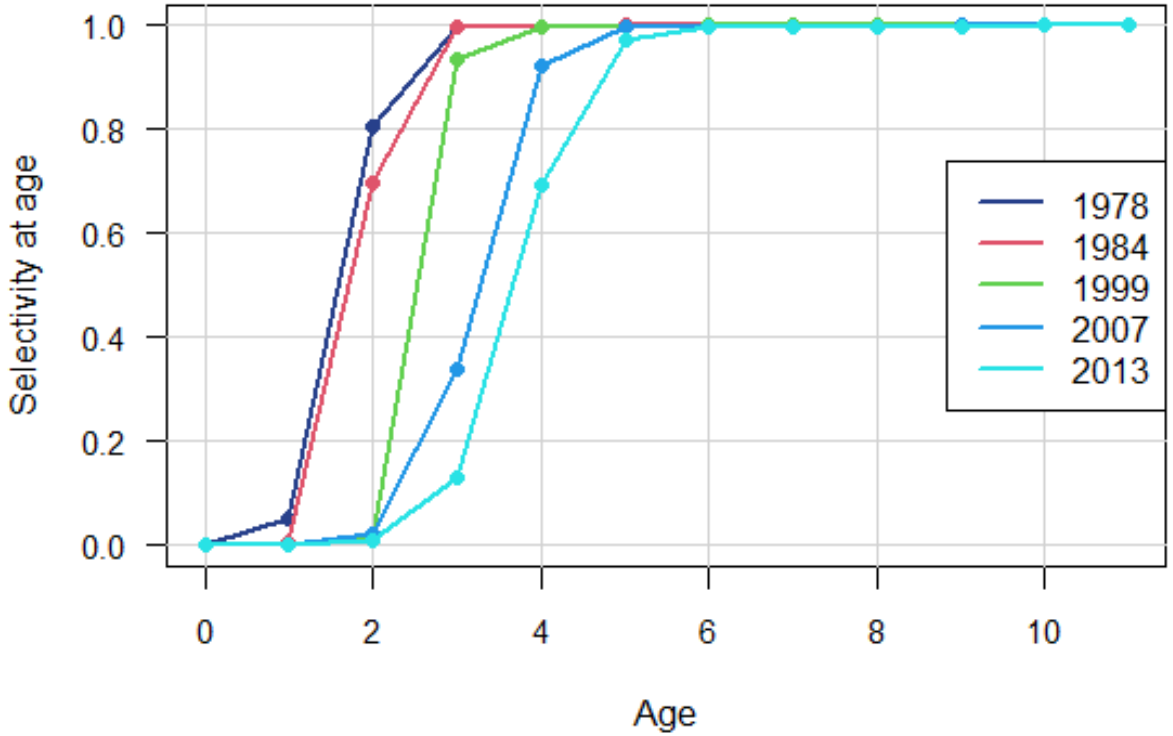


Commercial pots Selectivity

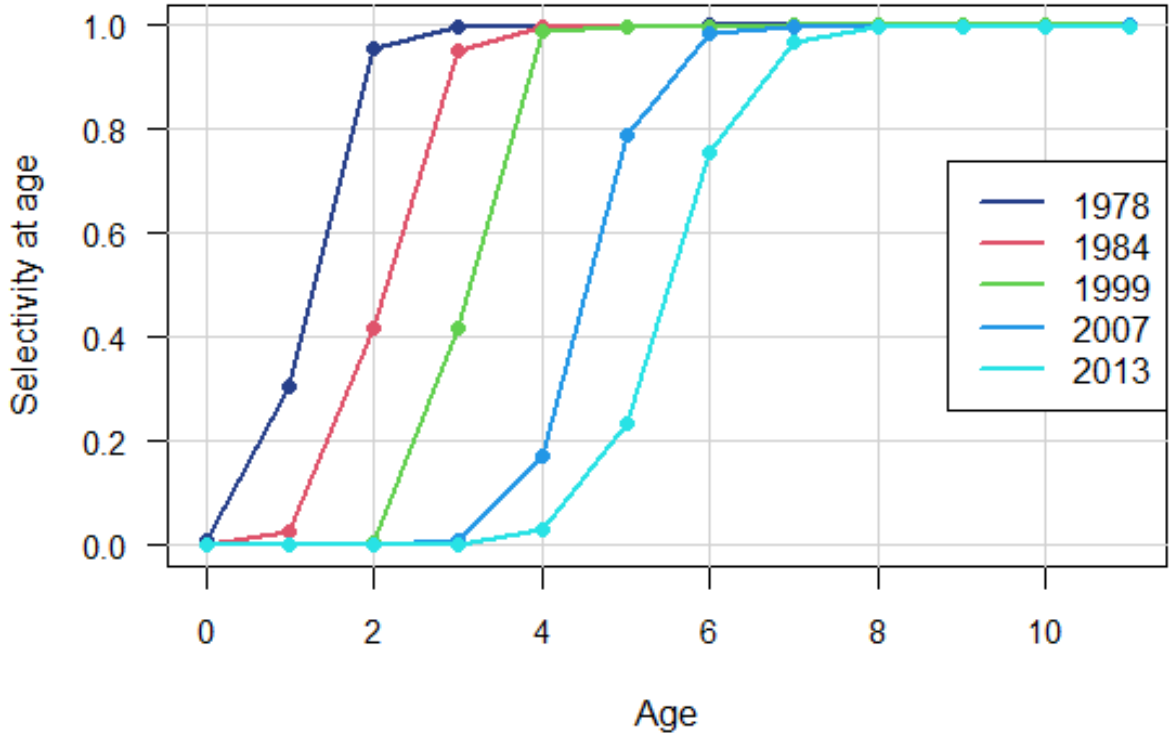


BAM base model – Recreational selectivity

Headboat Selectivity

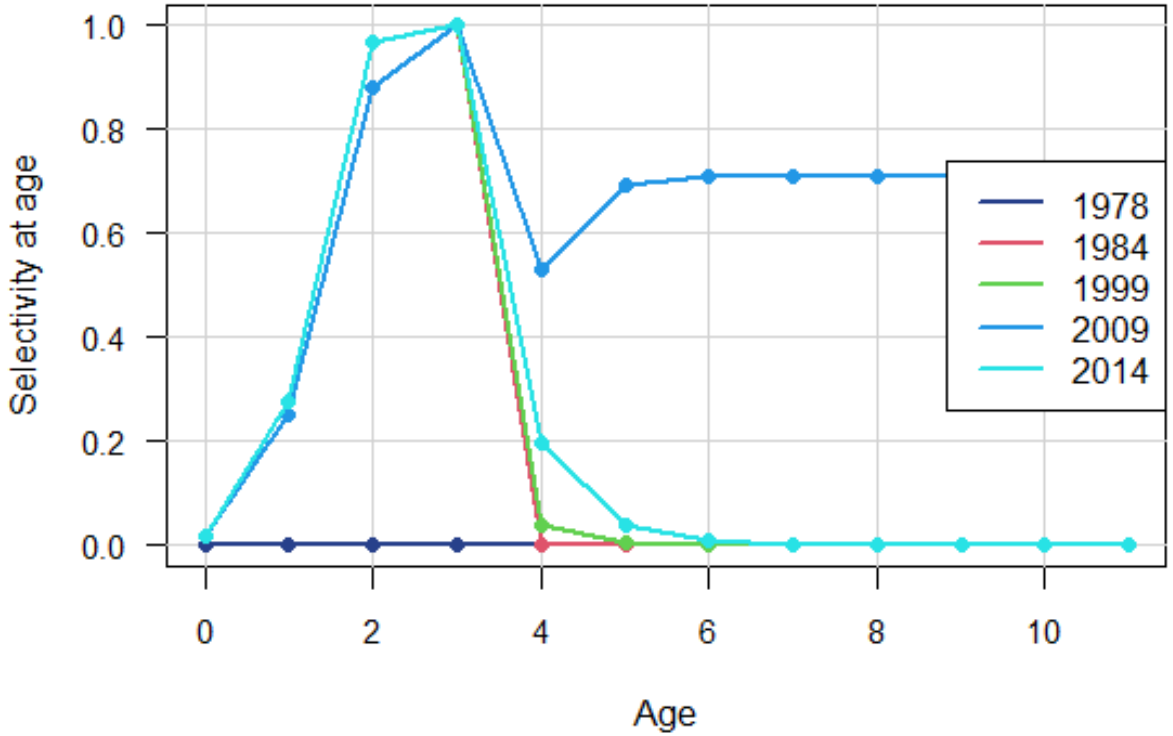


General Recreational Selectivity

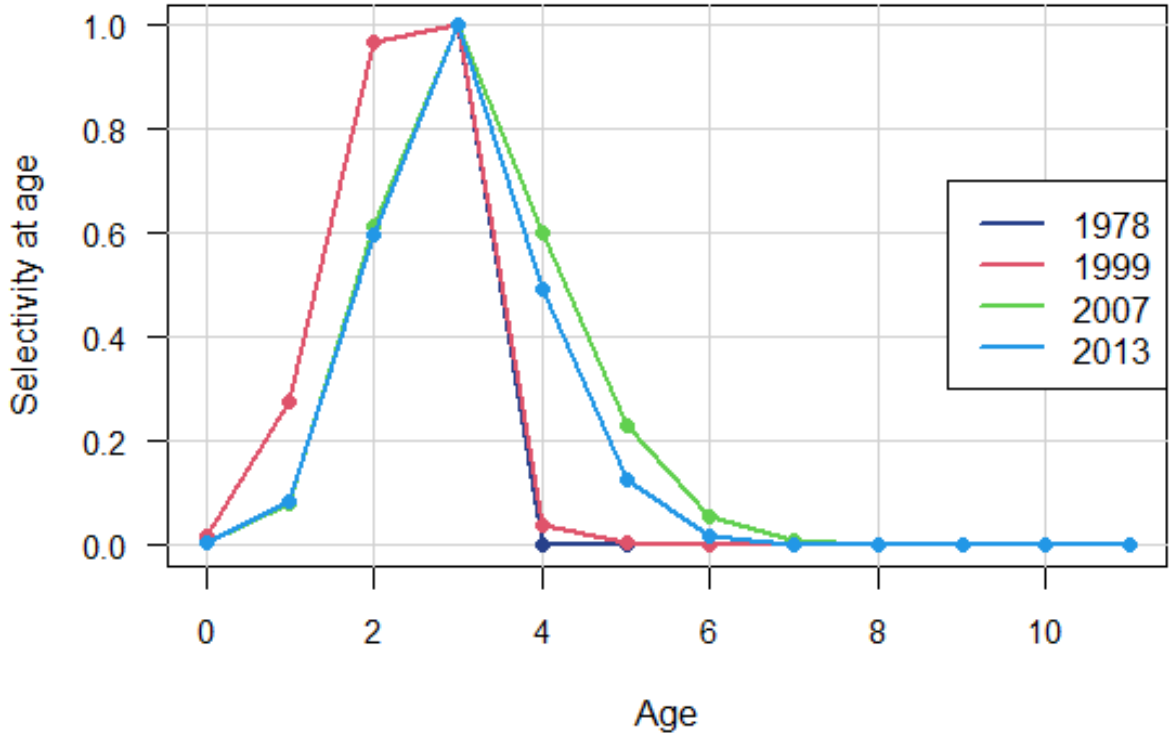


BAM base model – Discard selectivity

Commercial Discard Selectivity

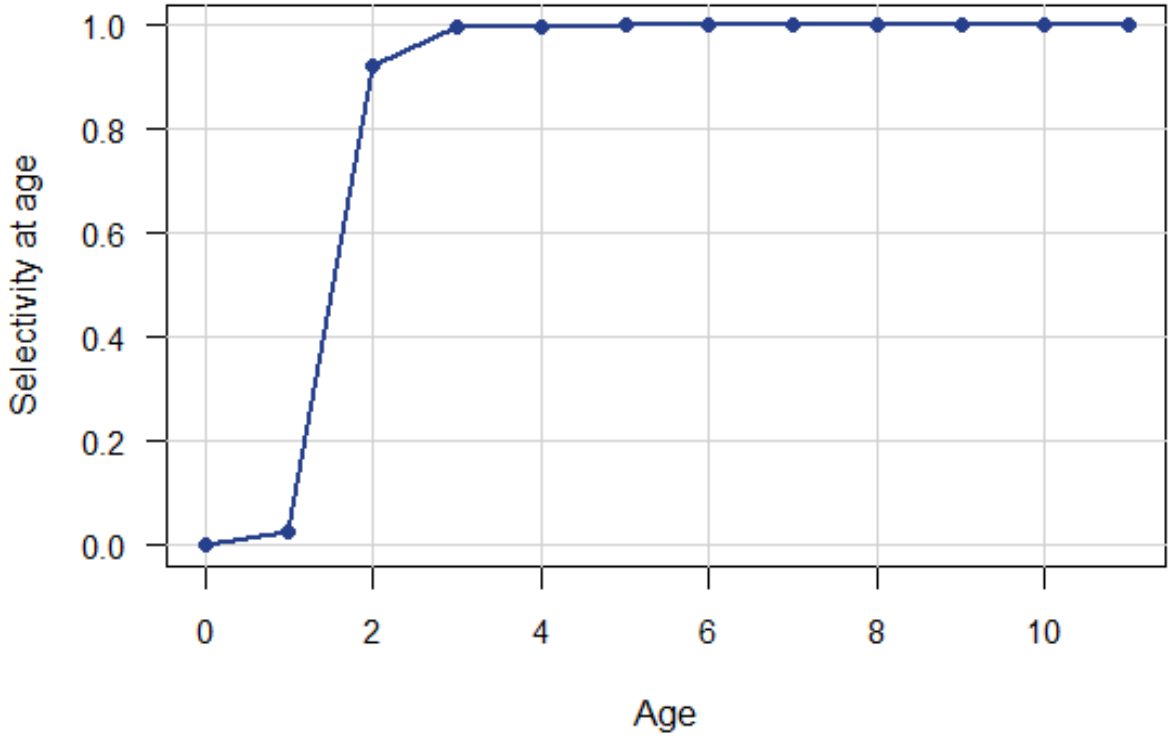


General Recreational and Headboat discard Selectivity

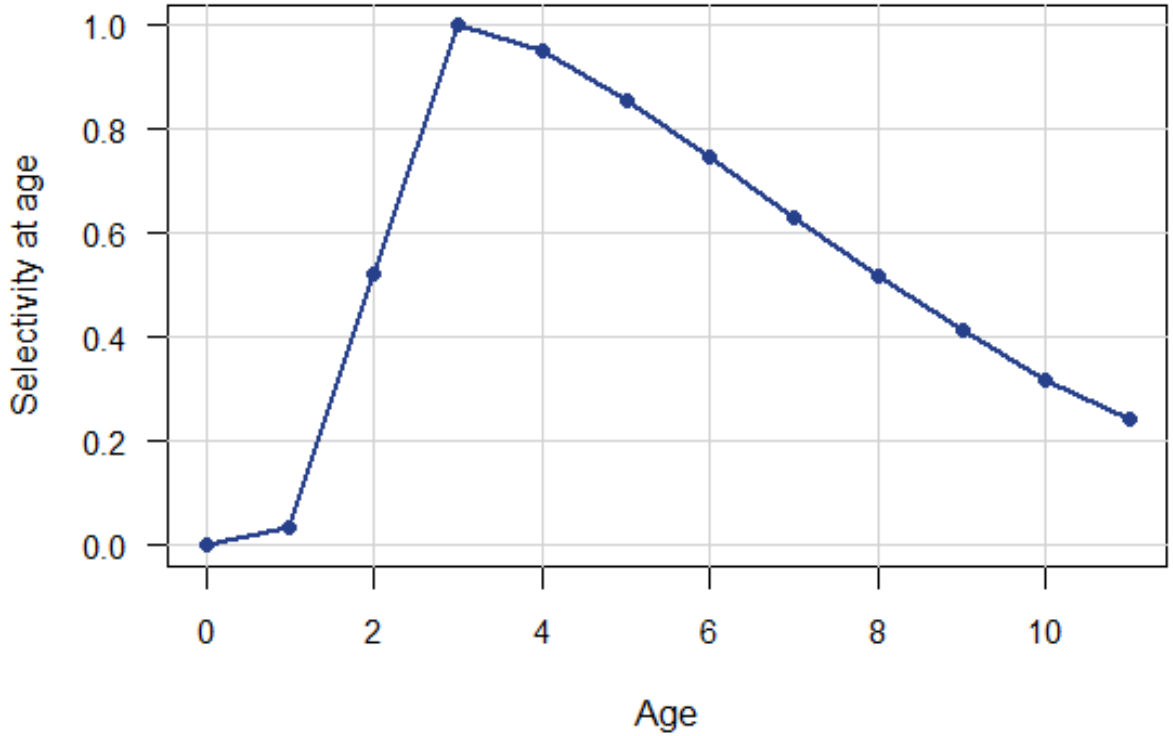


BAM base model – Survey selectivity

MARMAP Blackfish Survey Selectivity

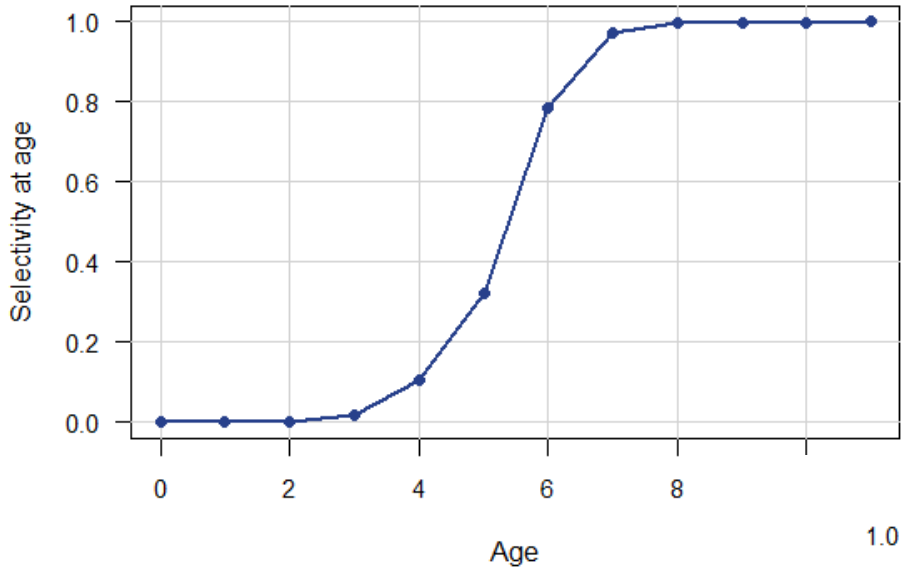


SERFS Survey Selectivity

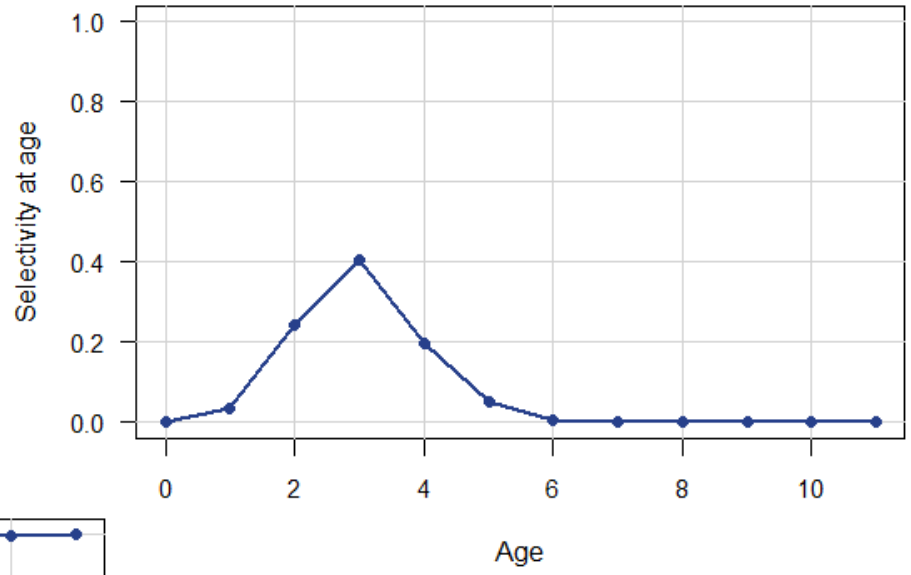


BAM base model – Weighted selectivity

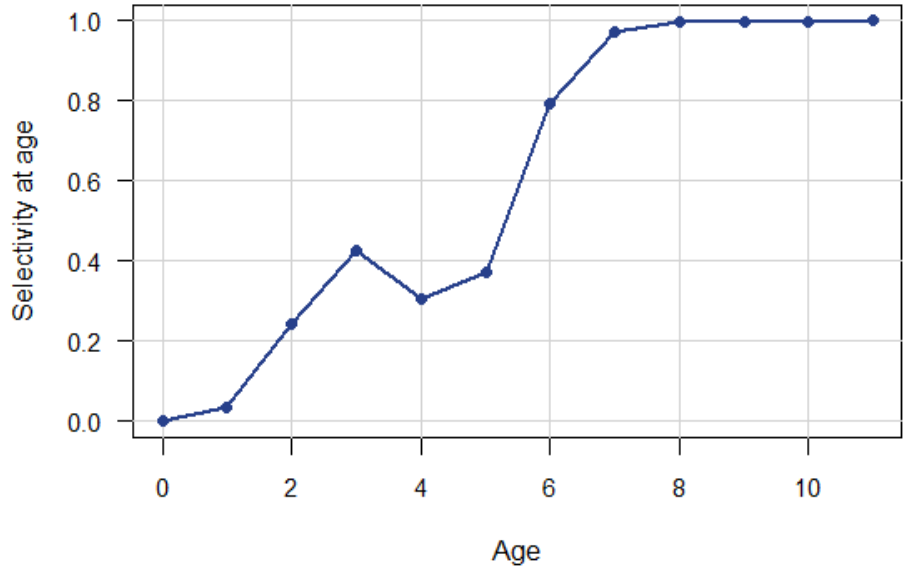
Landings weighted Selectivity



Discards weighted Selectivity



Total weighted Selectivity



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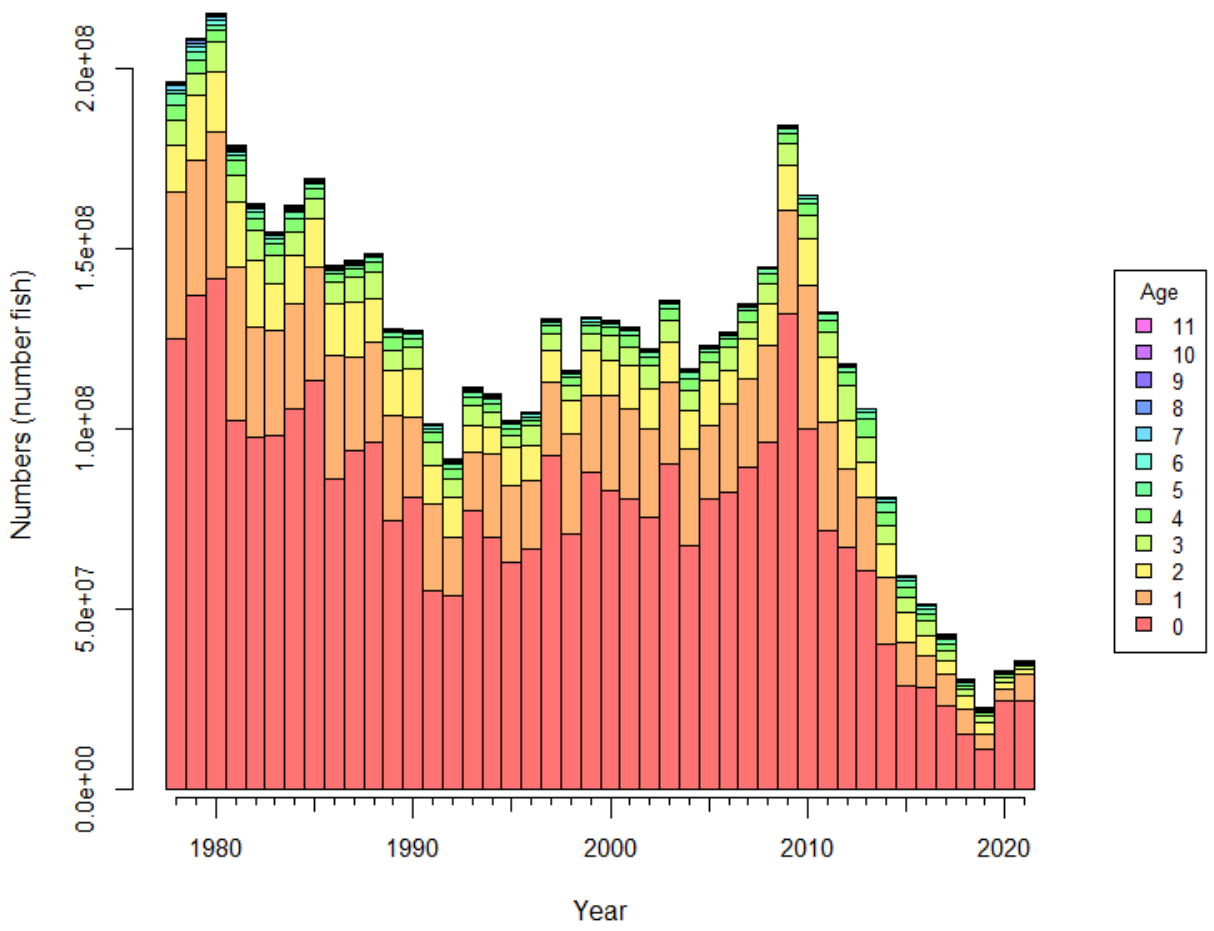
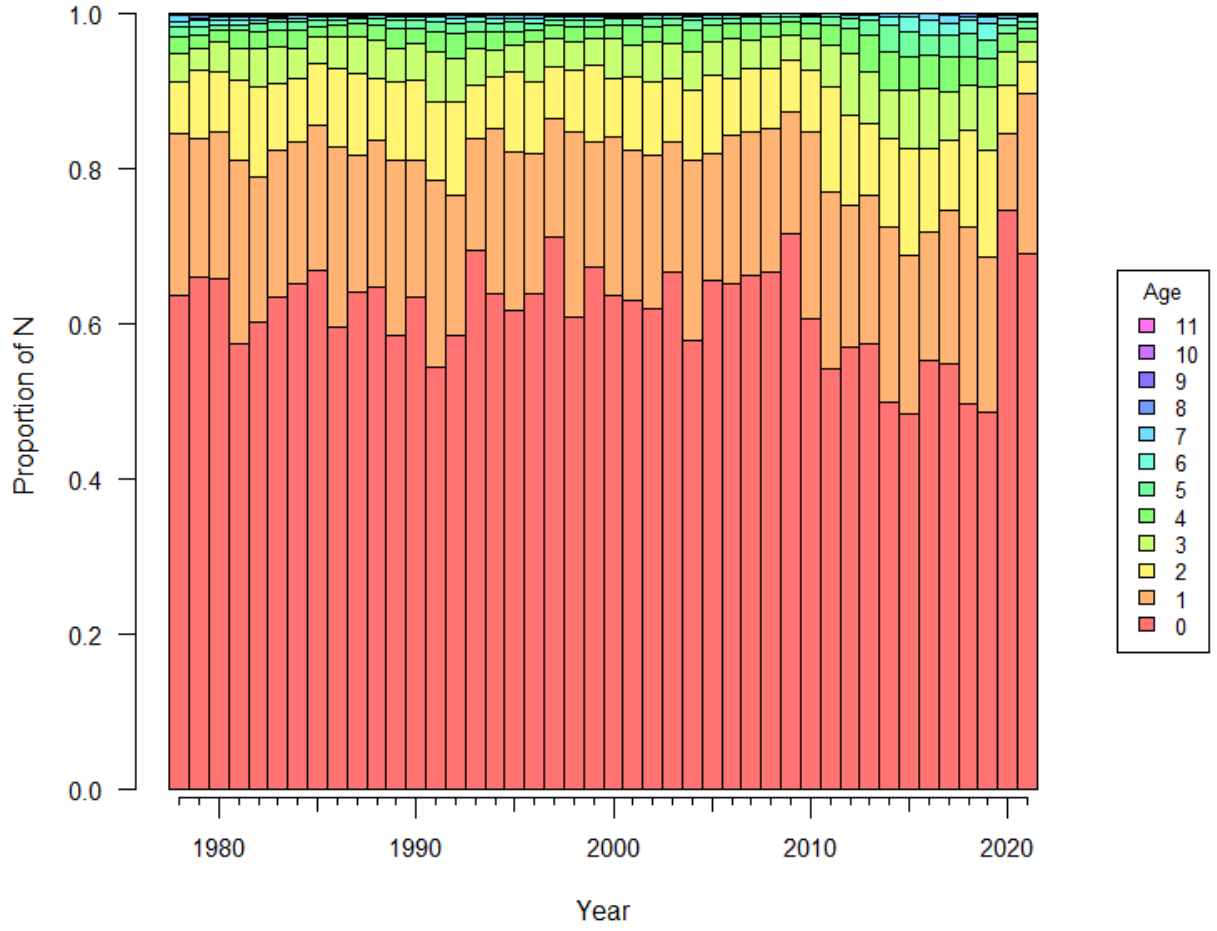
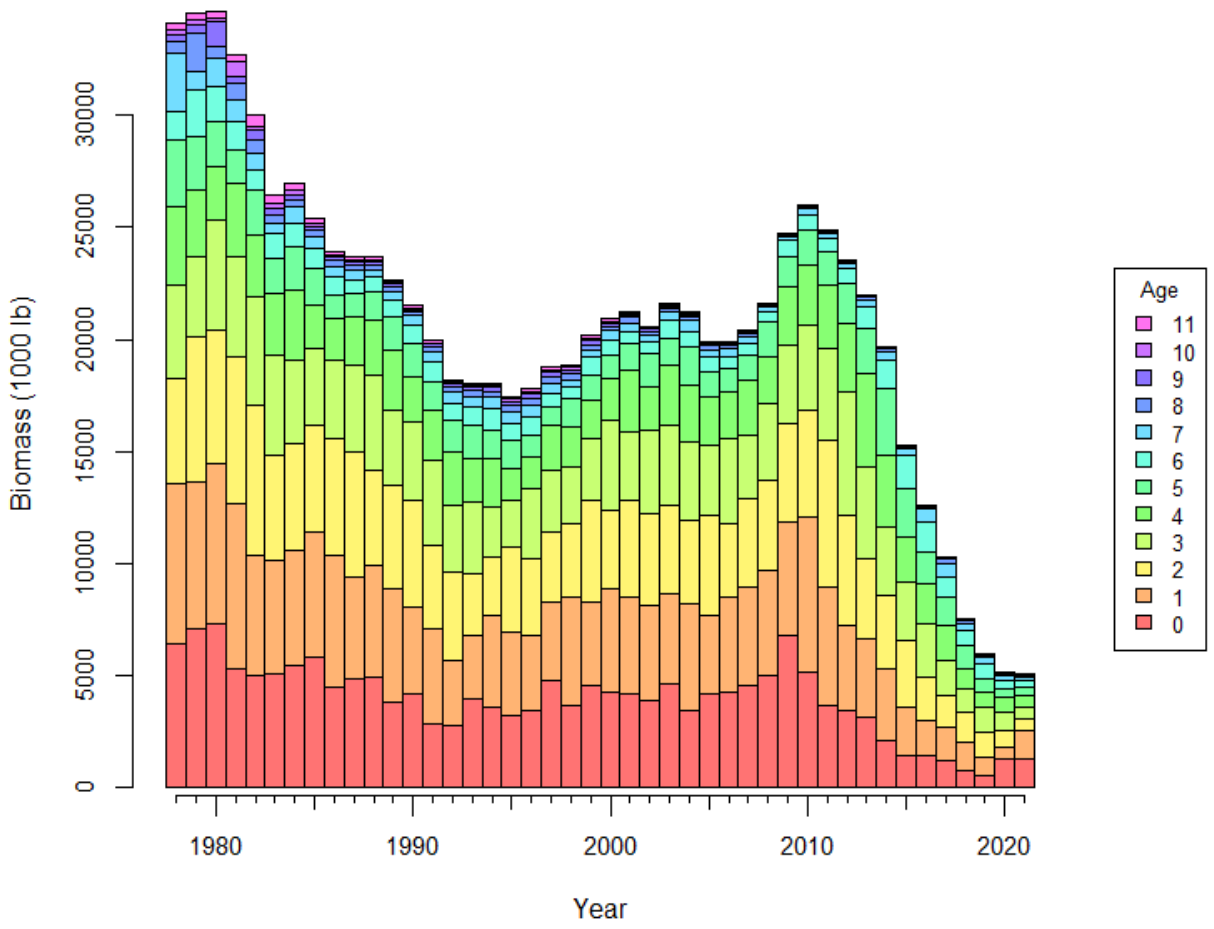
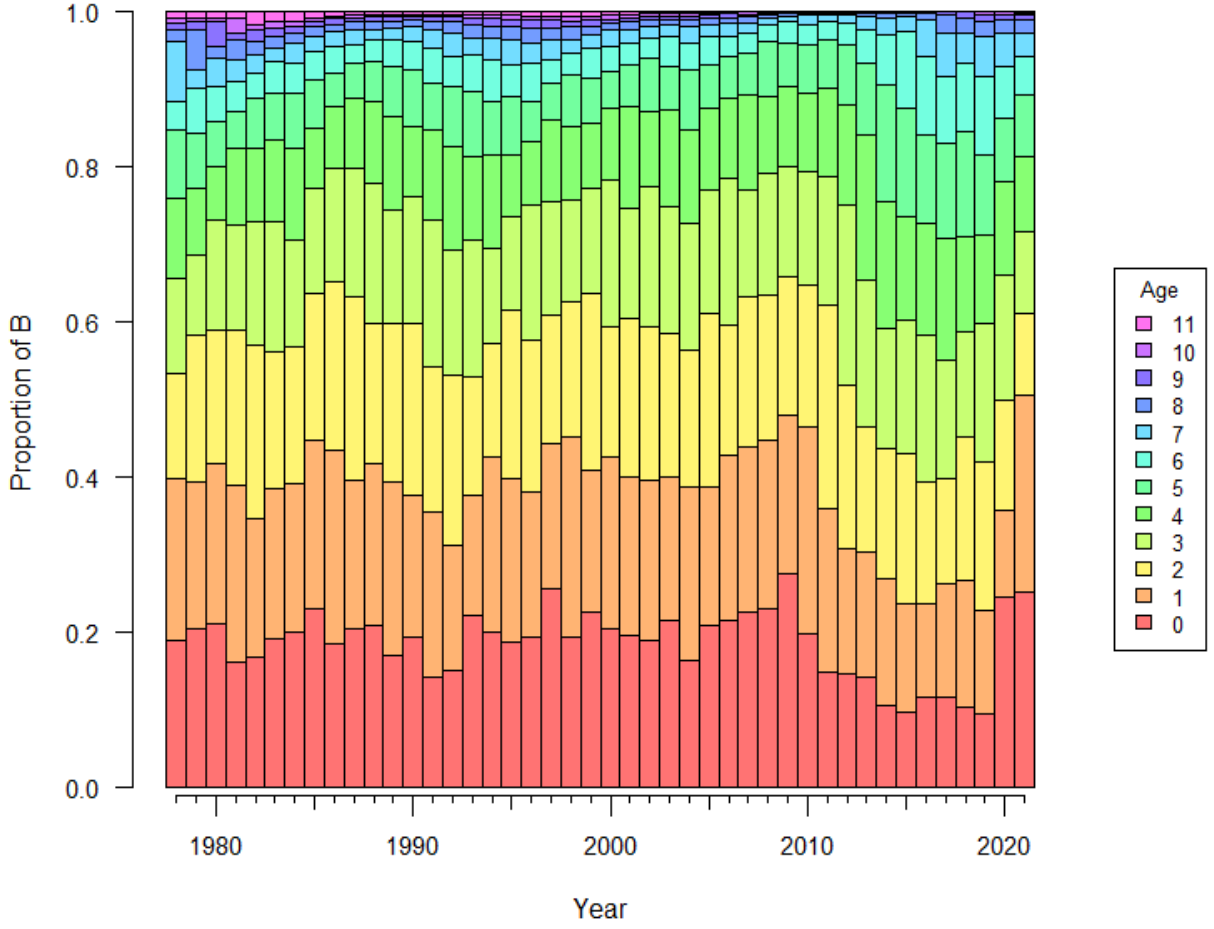
BAM base model – Abundance at age



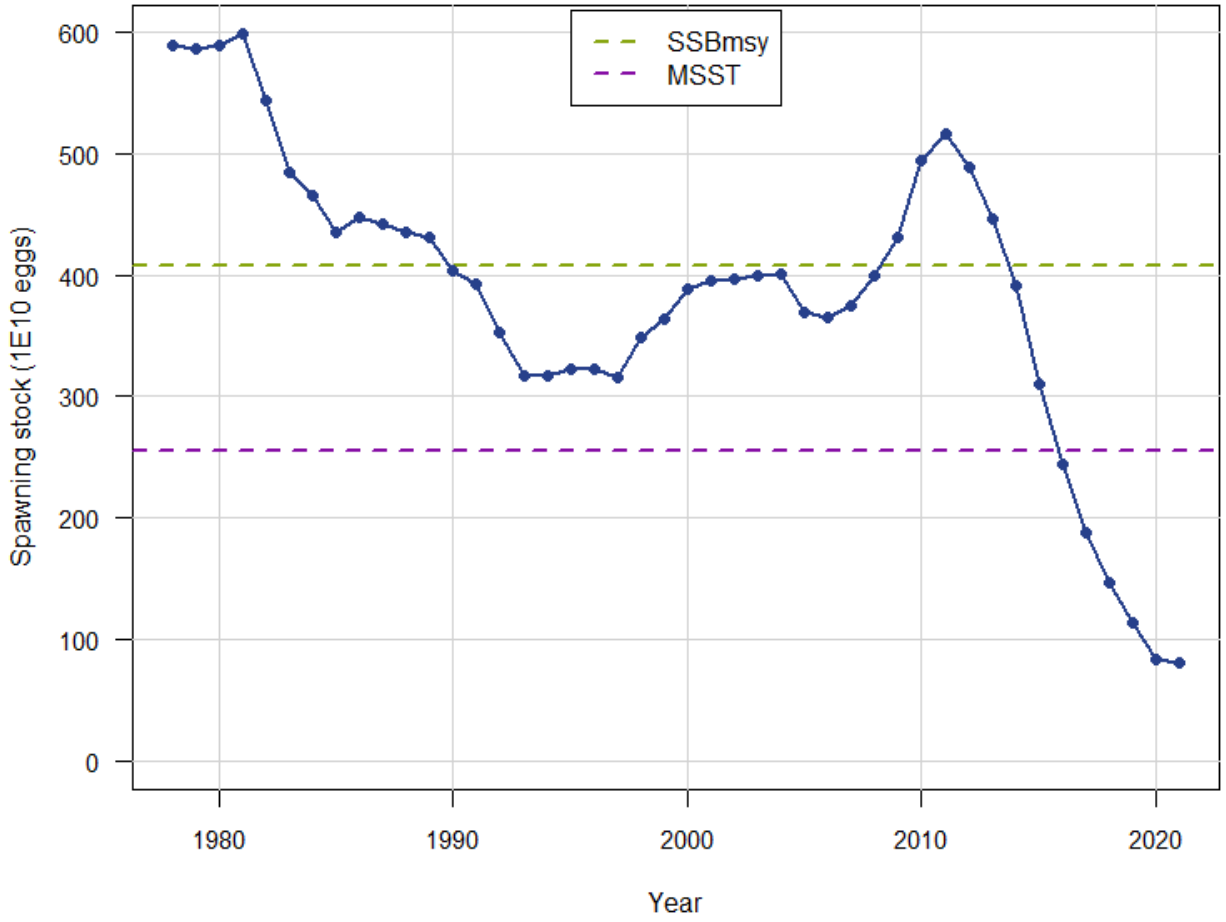


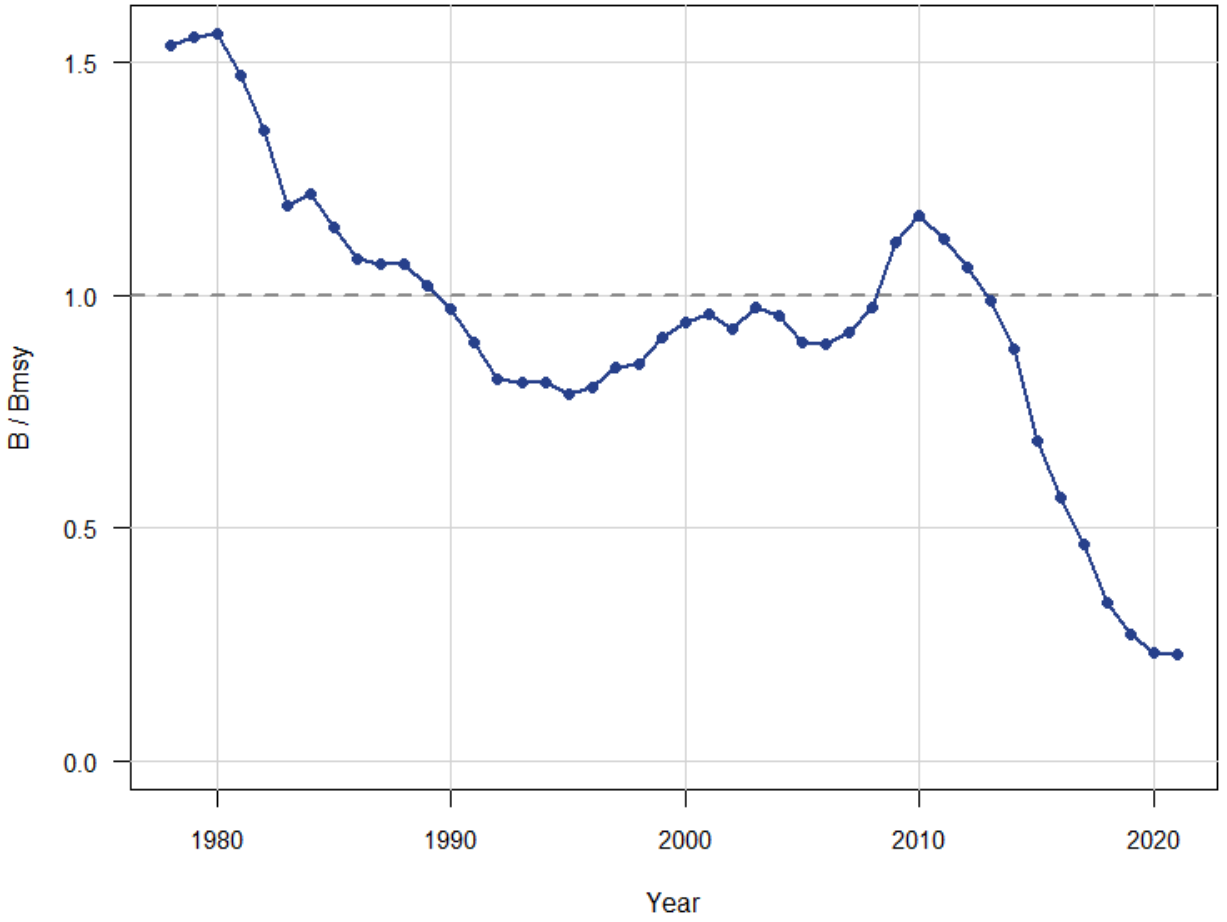
BAM base model – Biomass at age



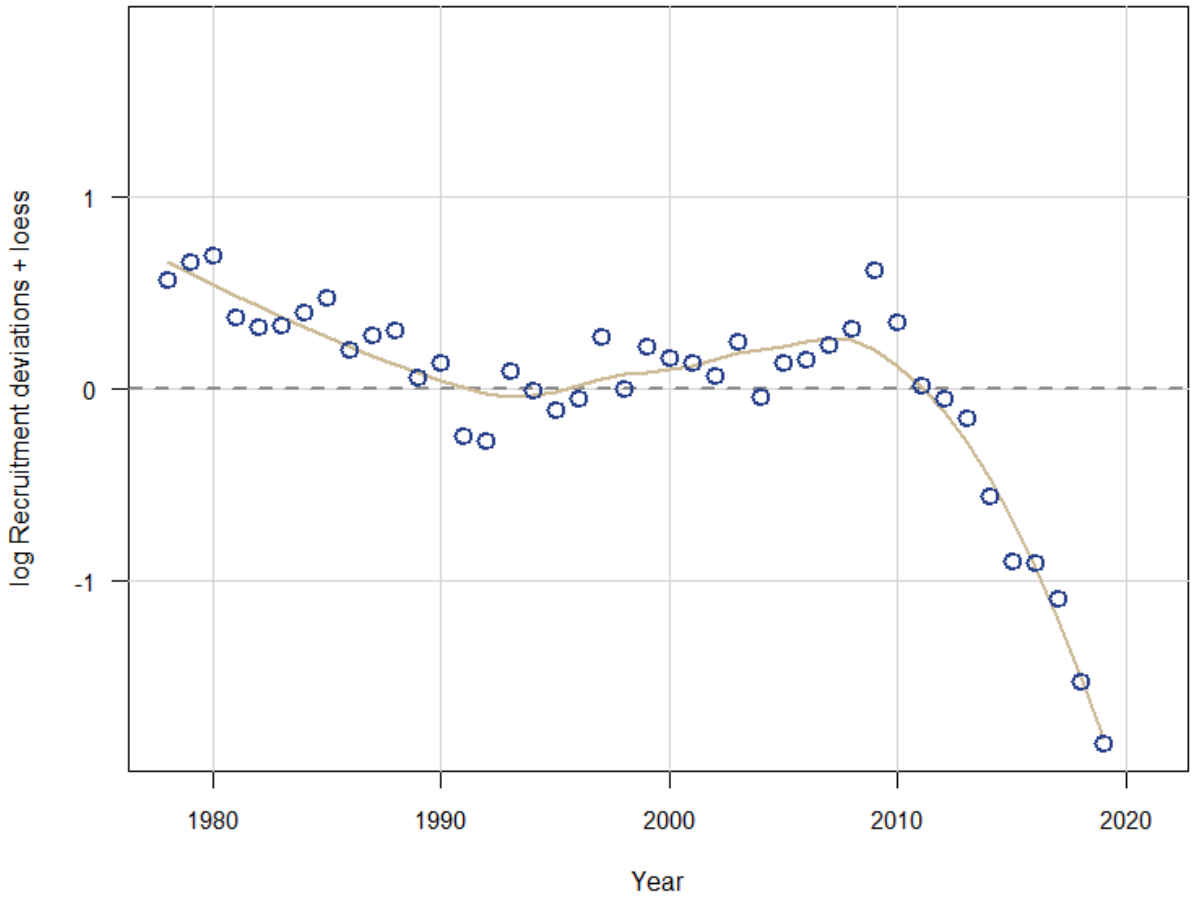


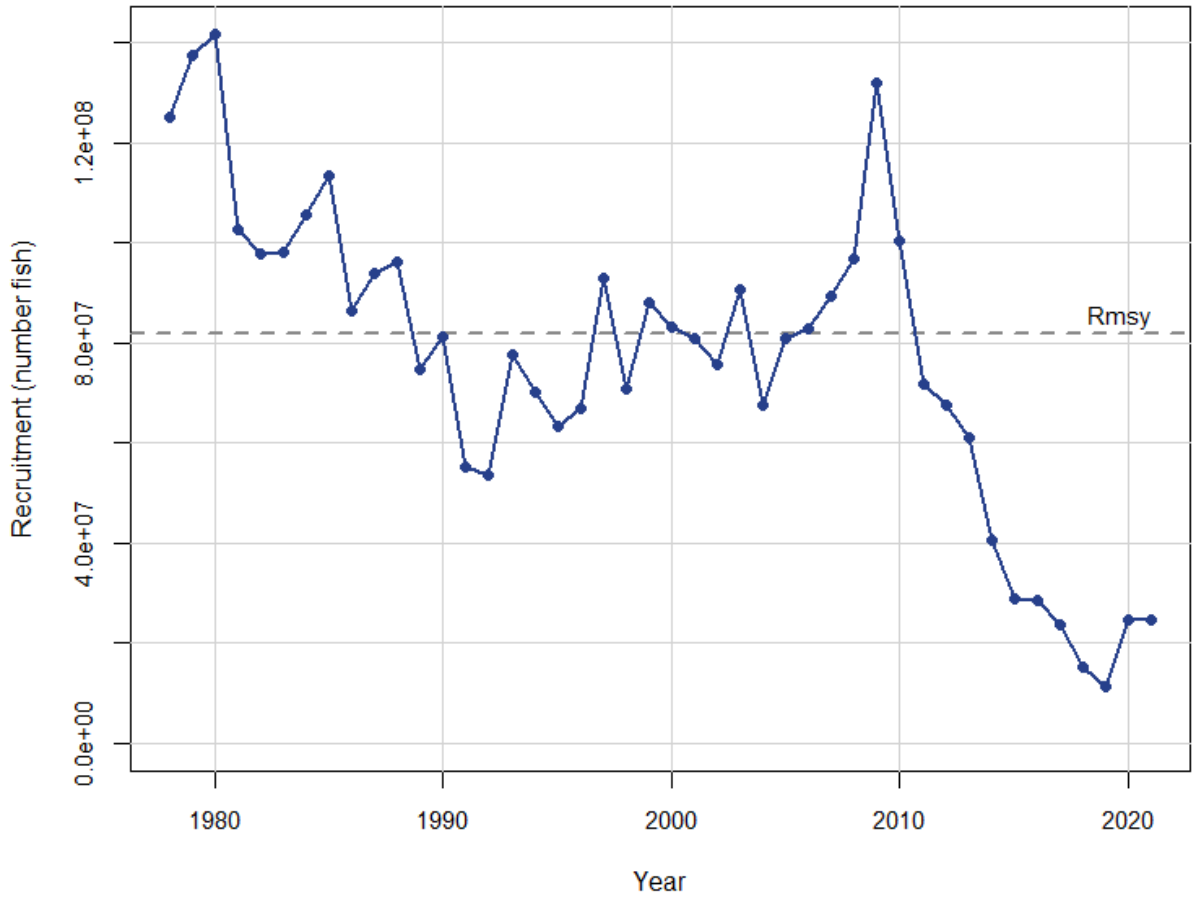
BAM base model – Spawning stock



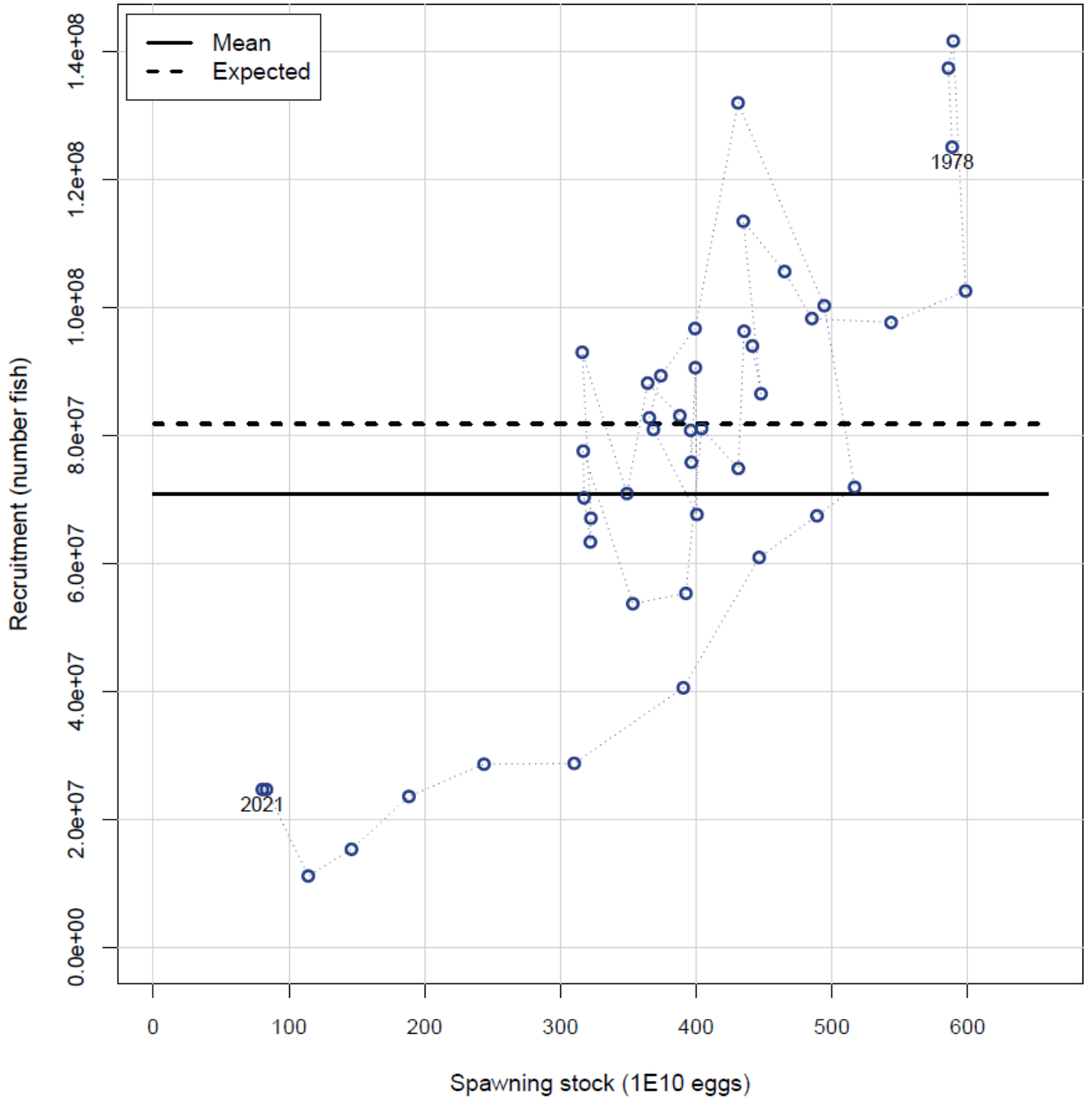


BAM base model – Recruitment

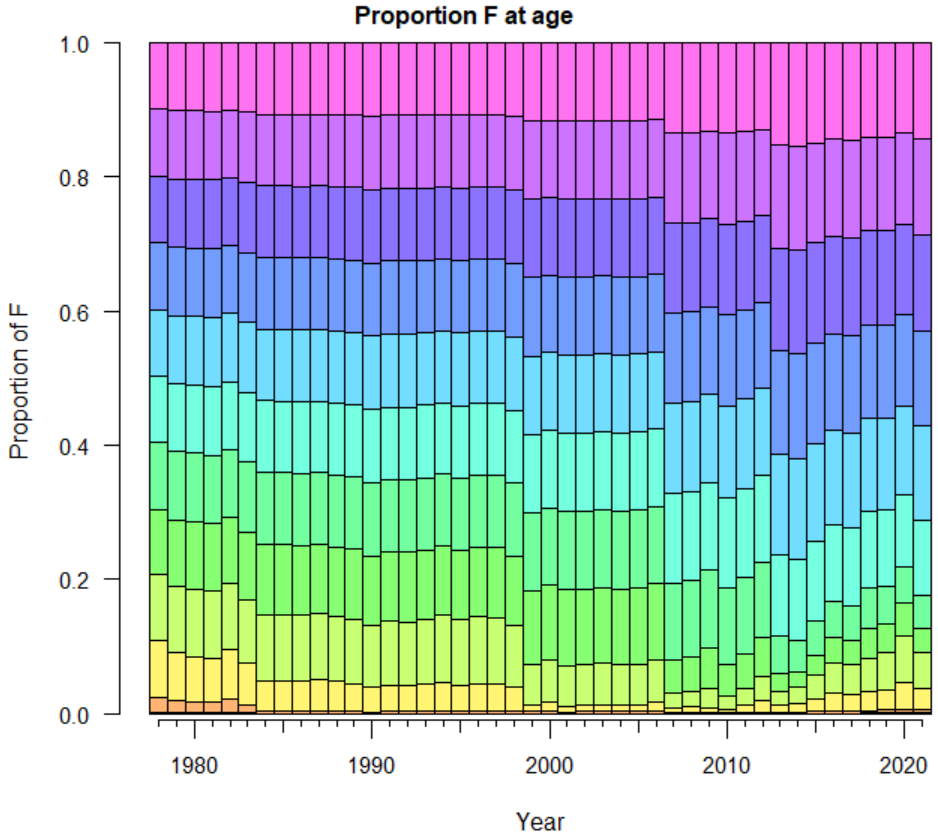


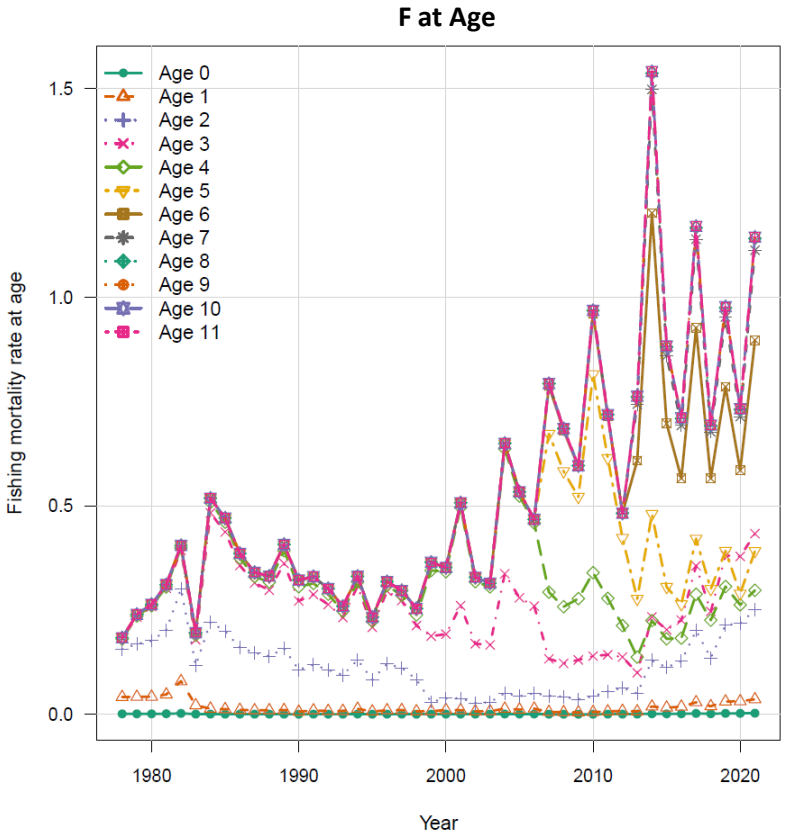


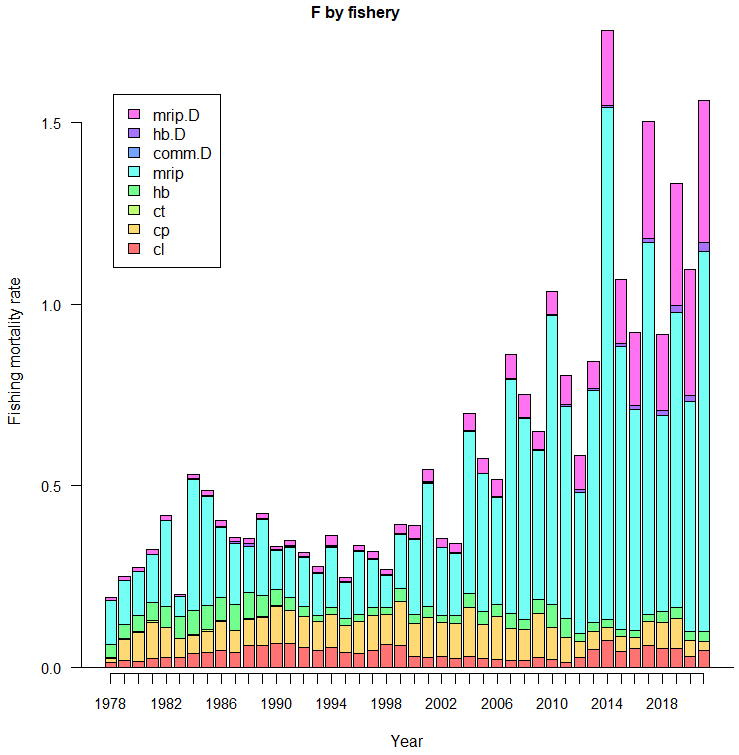
BAM base model – Spawners-recruits



BAM base model – Fishing mortality

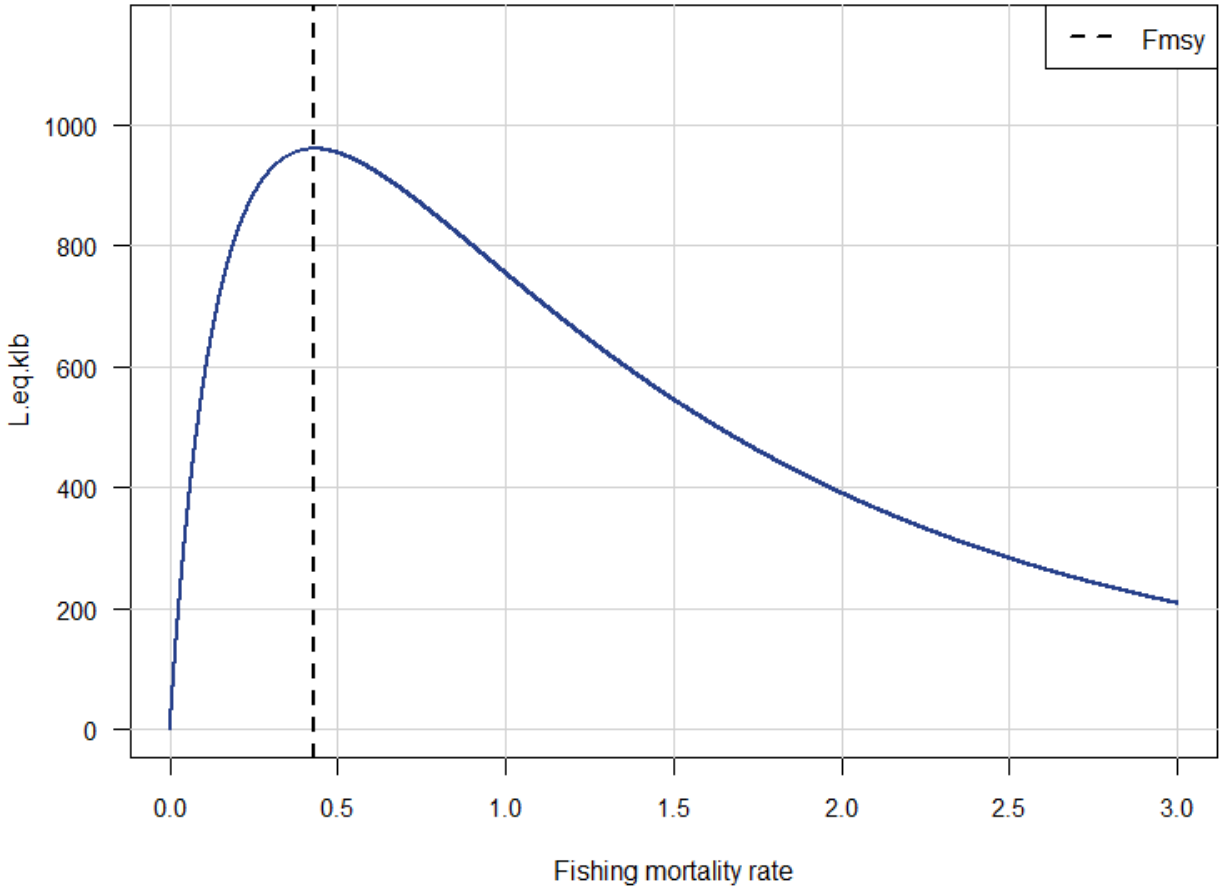




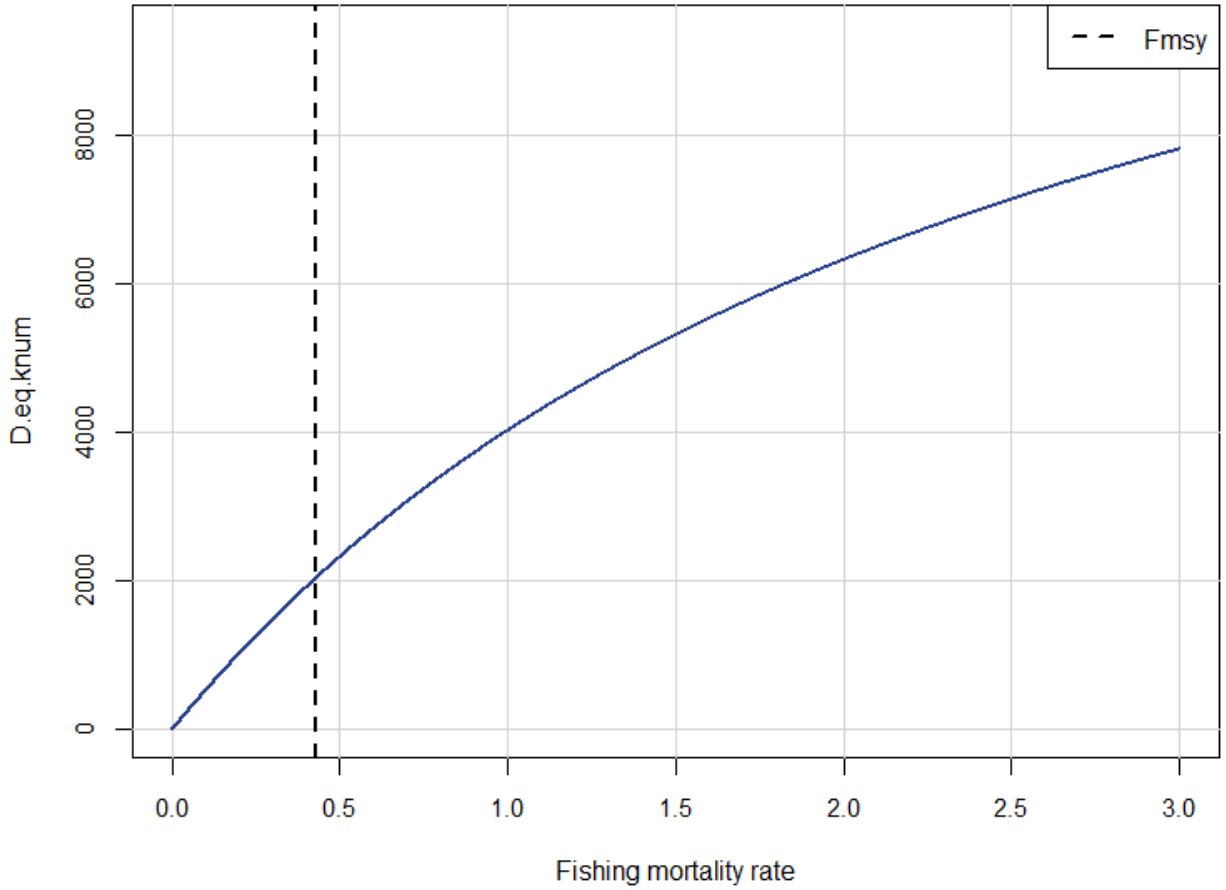


BAM base model – Equilibrium Landings and Discard

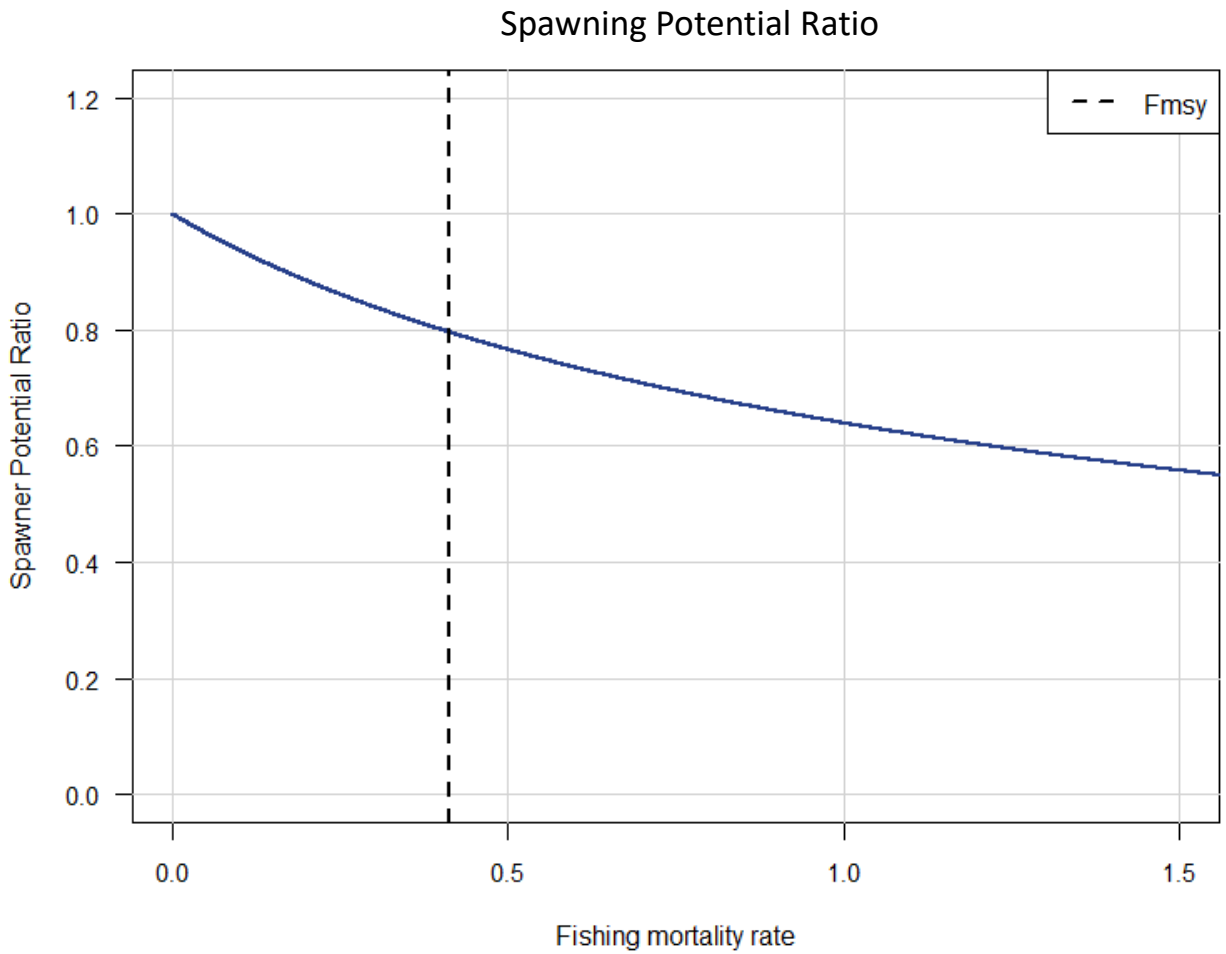
Equilibrium Landings

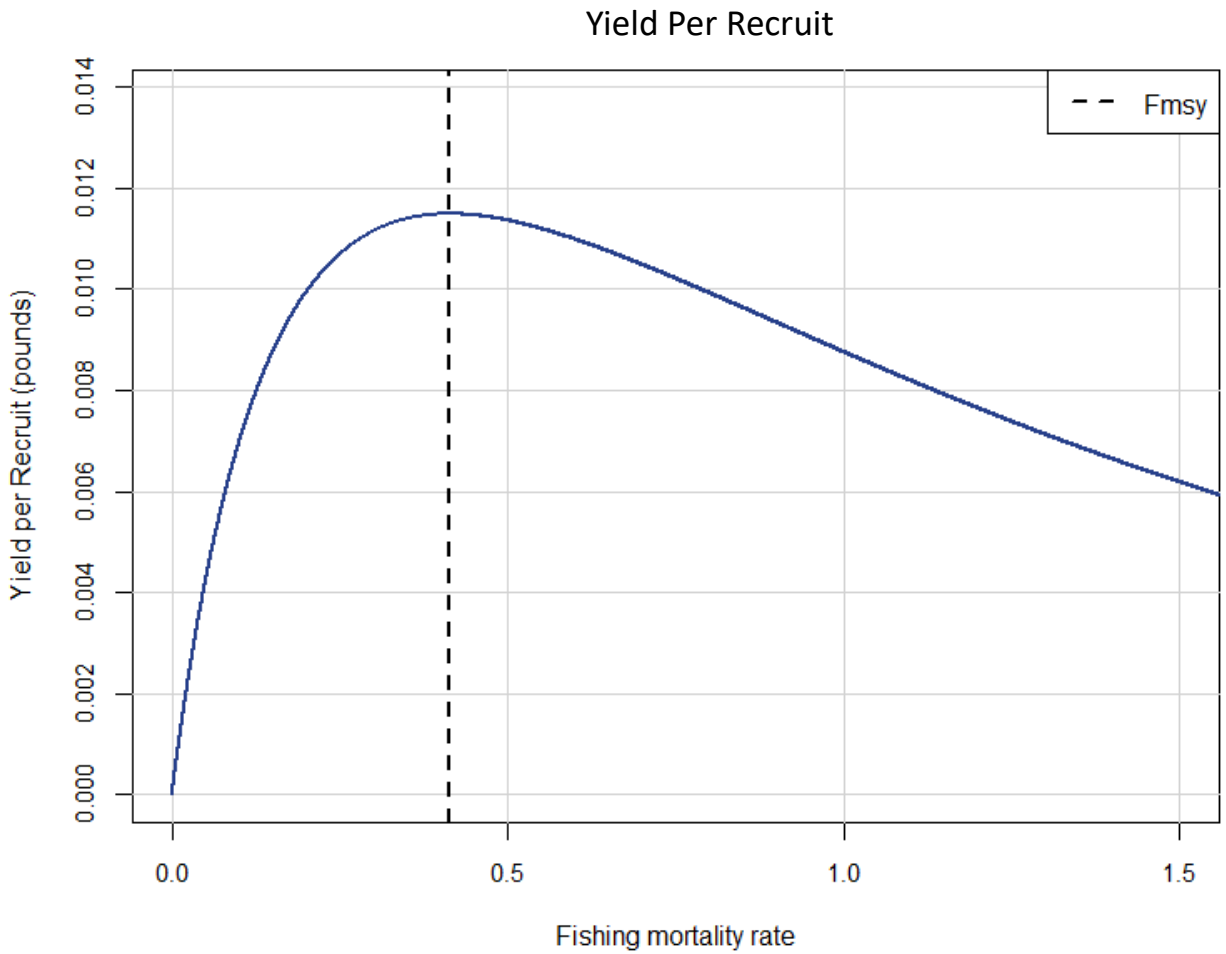


Equilibrium discards

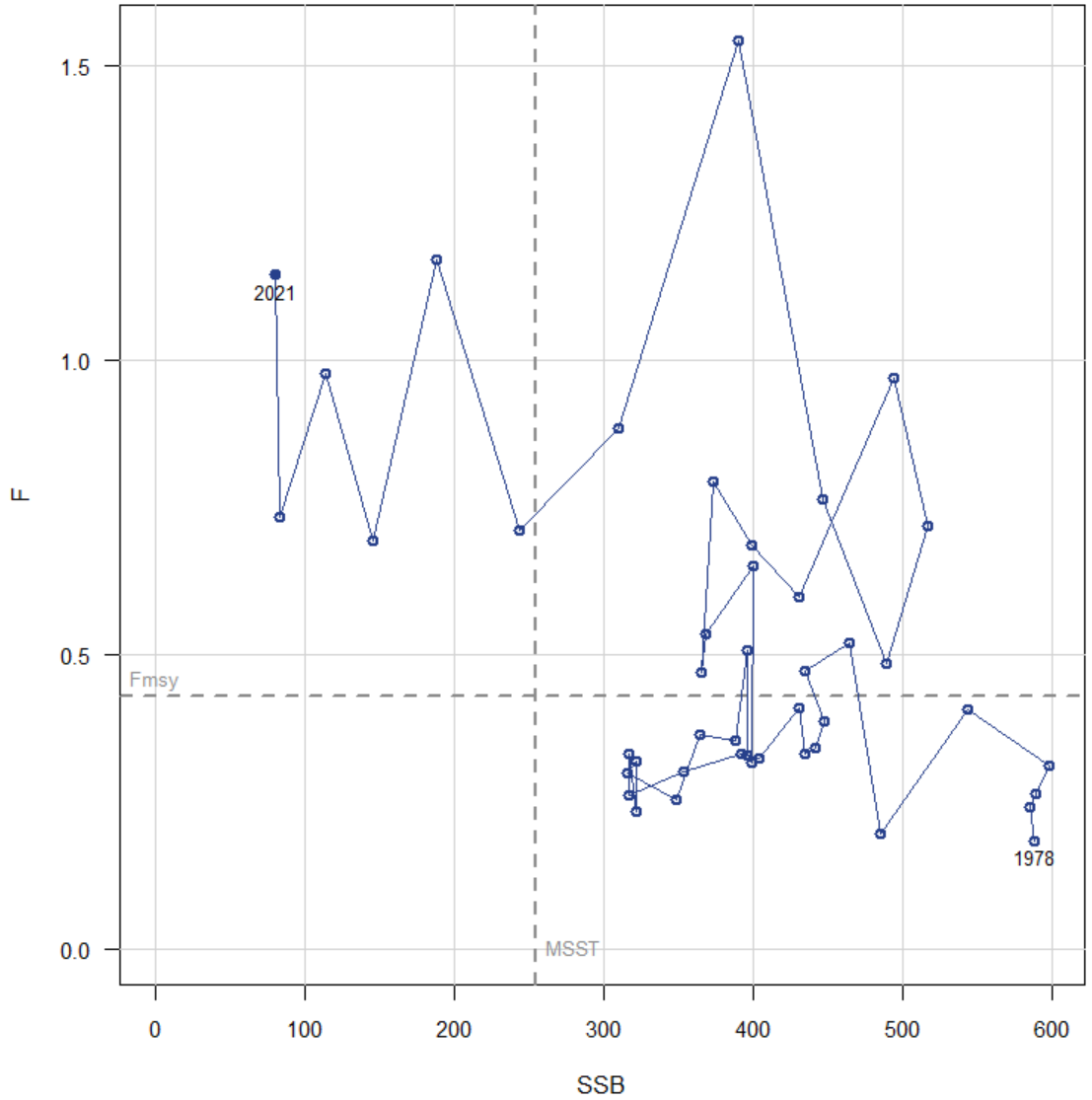


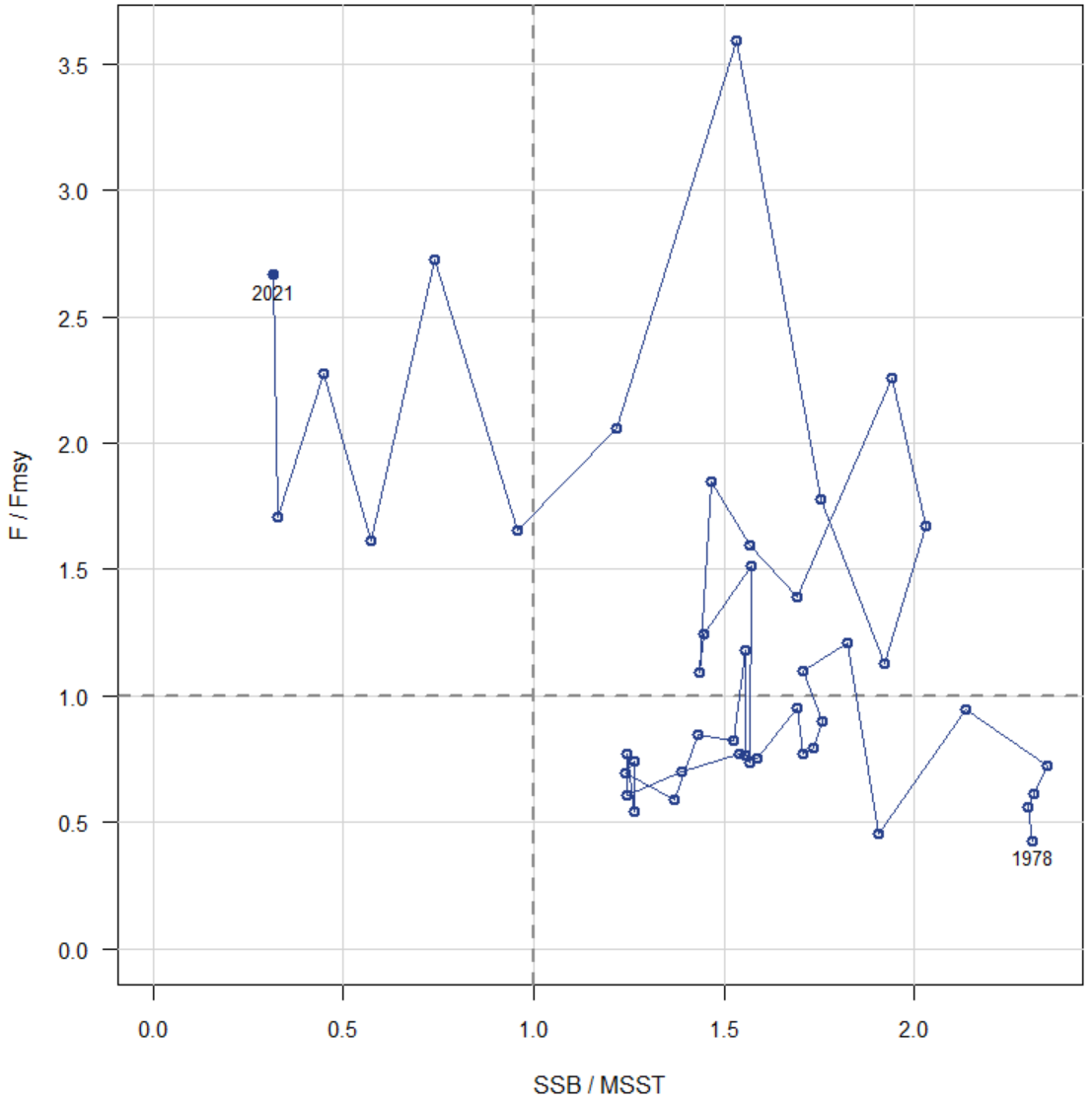
BAM base model – Per recruit



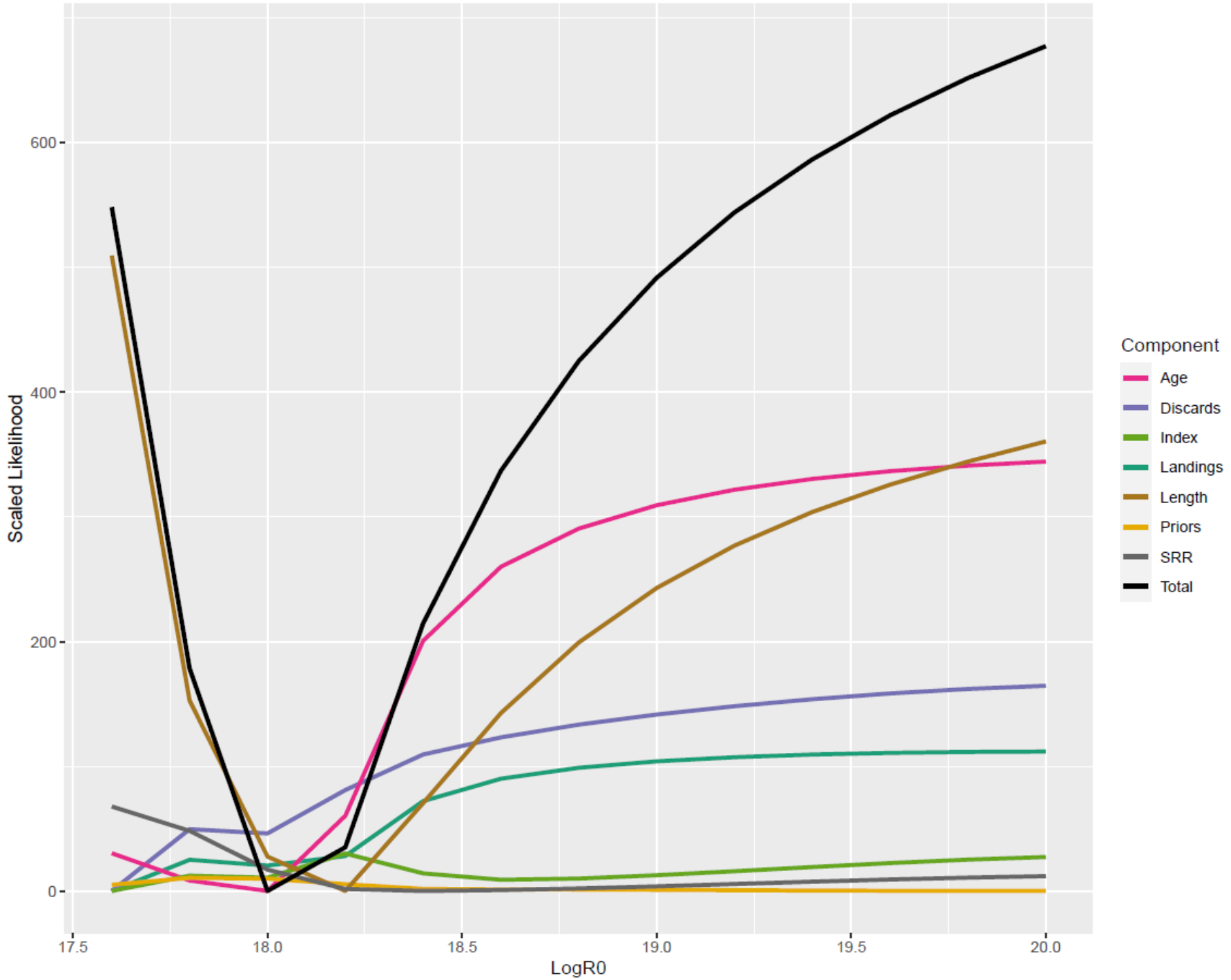


BAM base model – Phase plot

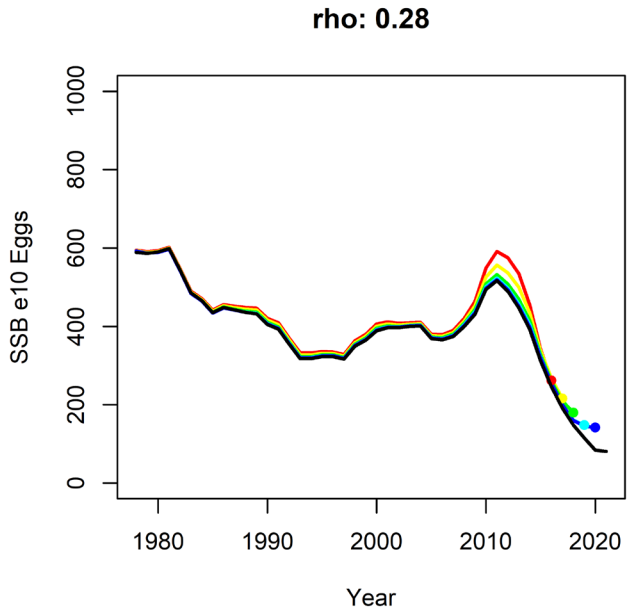


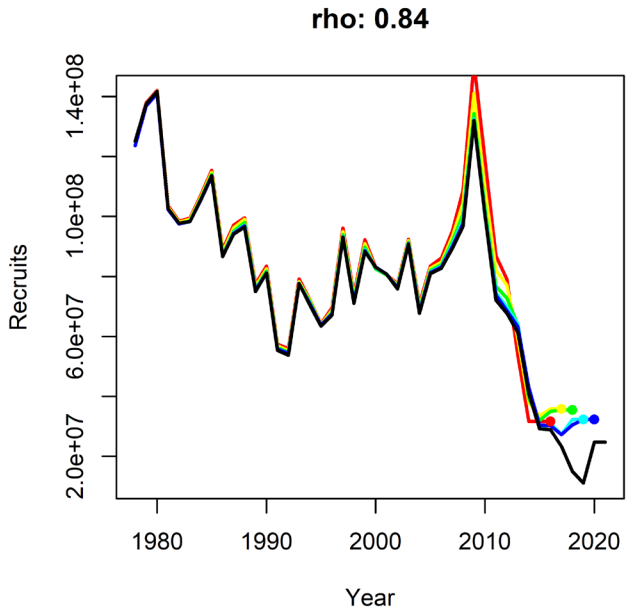


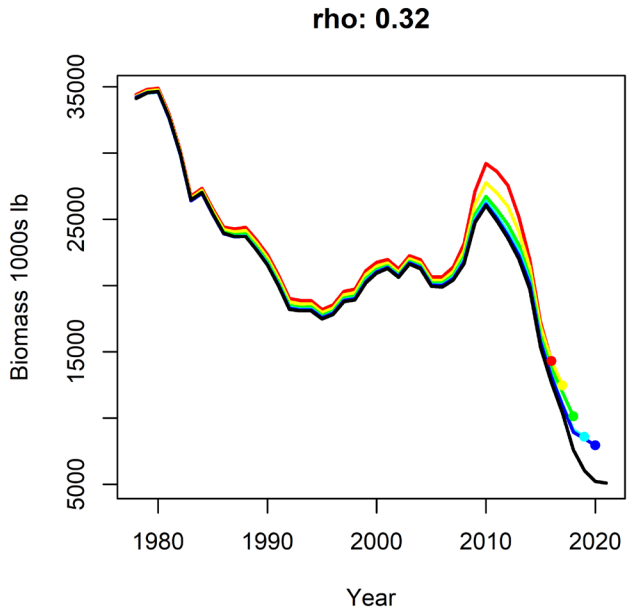
BAM base model – Log R0 Profile

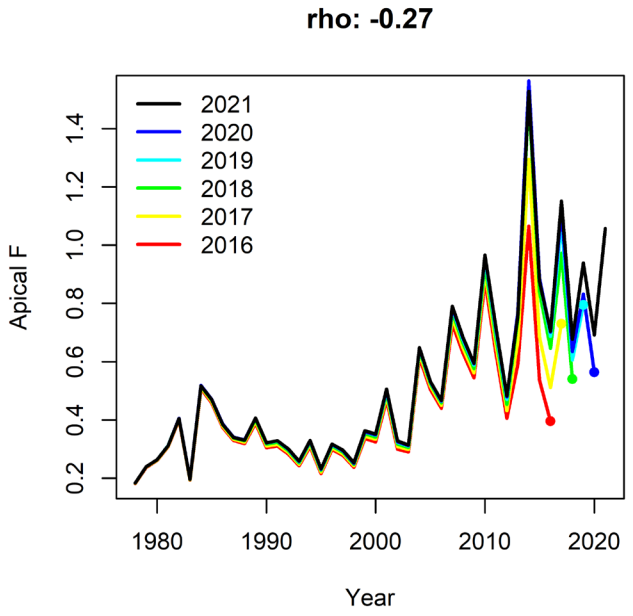


BAM base model – Retrospective analysis

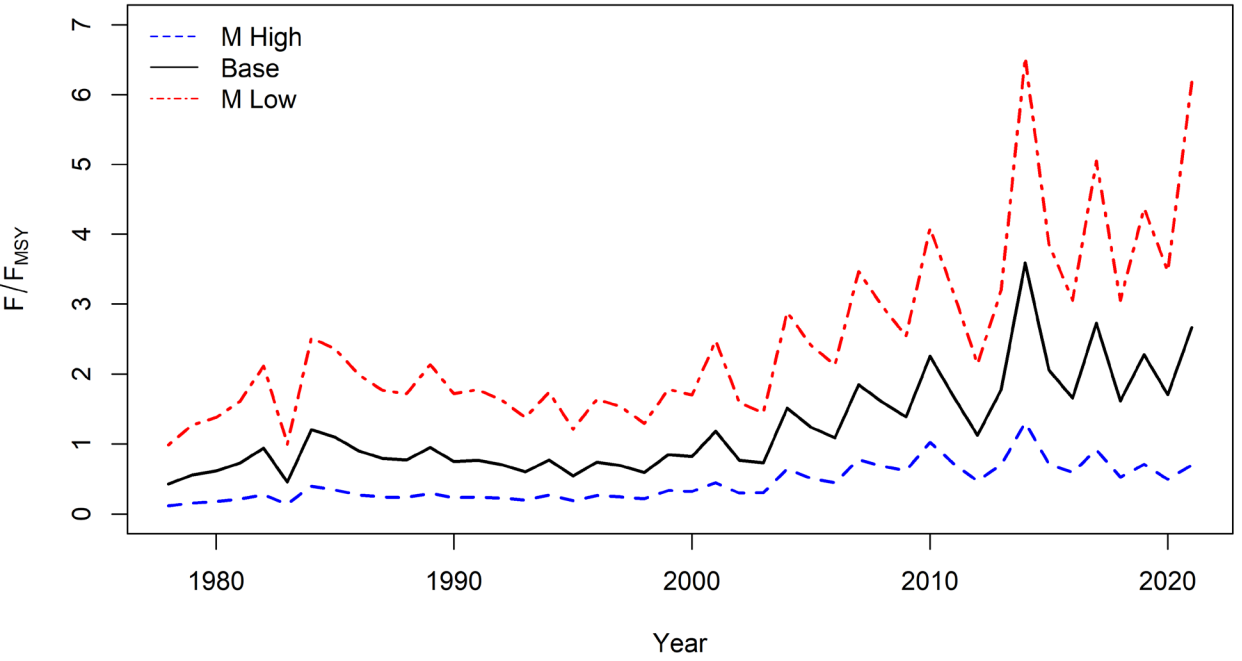


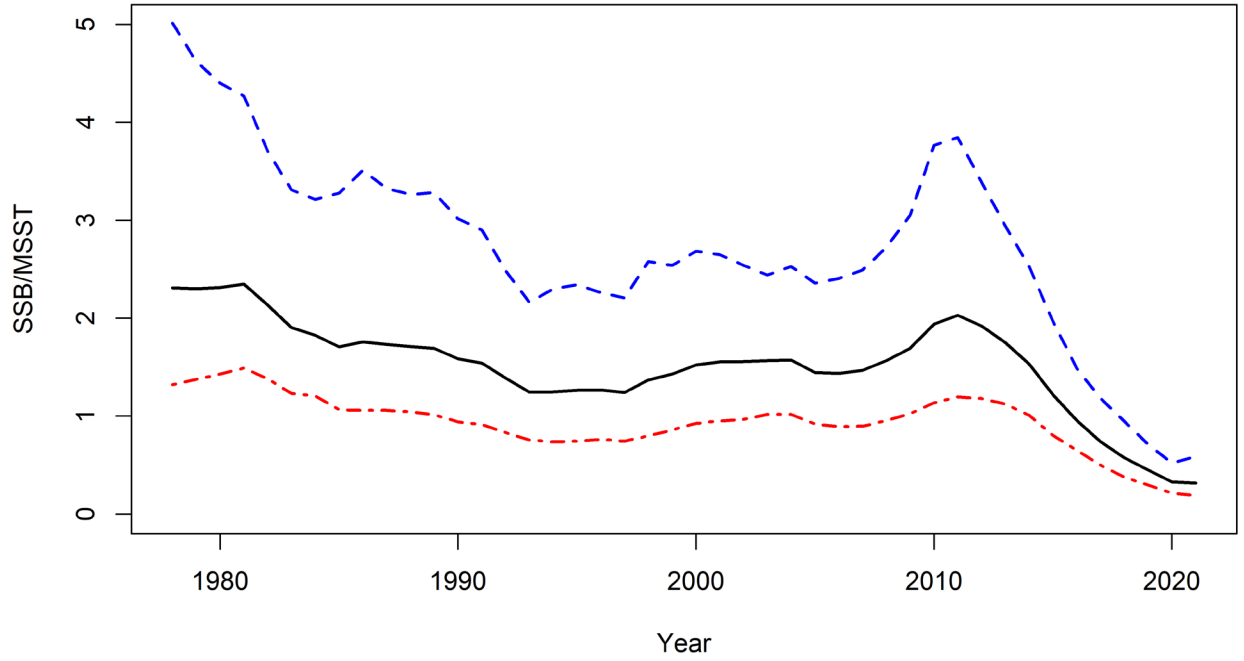




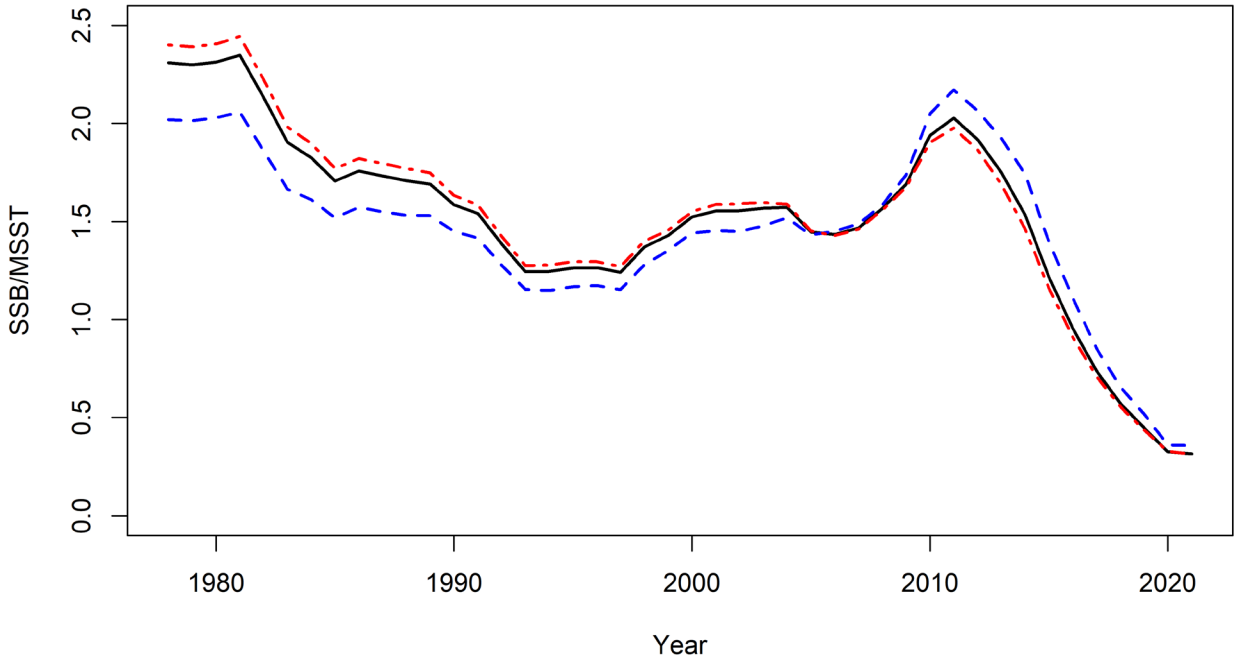


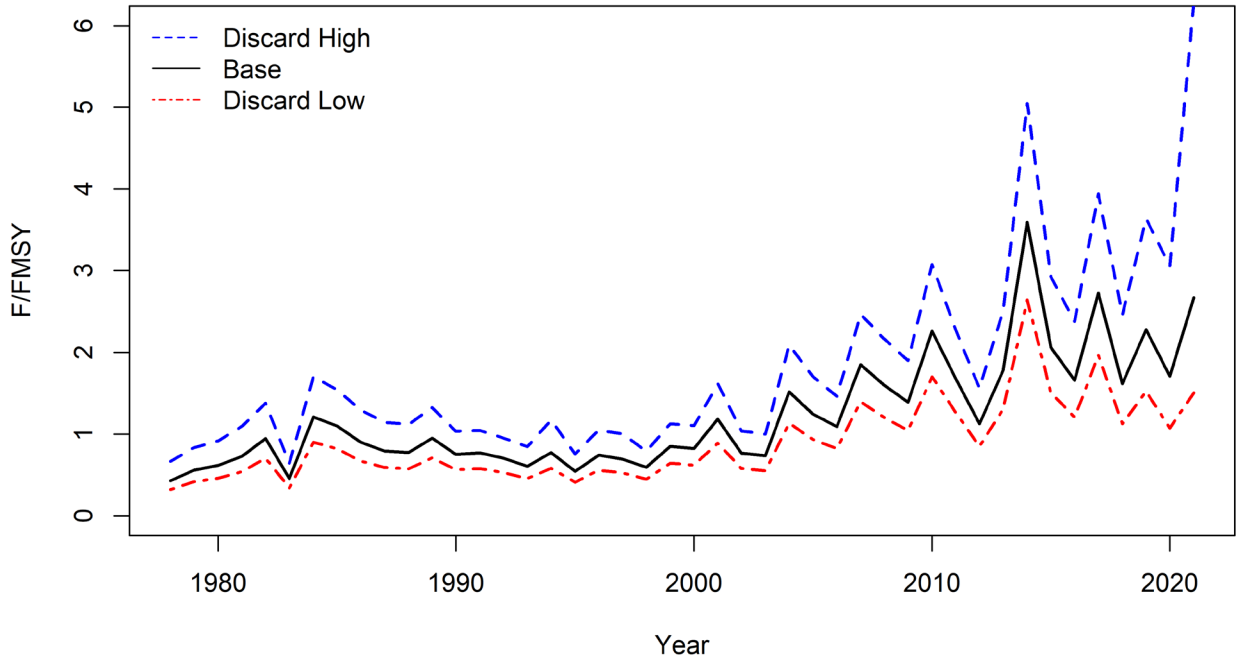
BAM base model – Natural mortality sensitivity



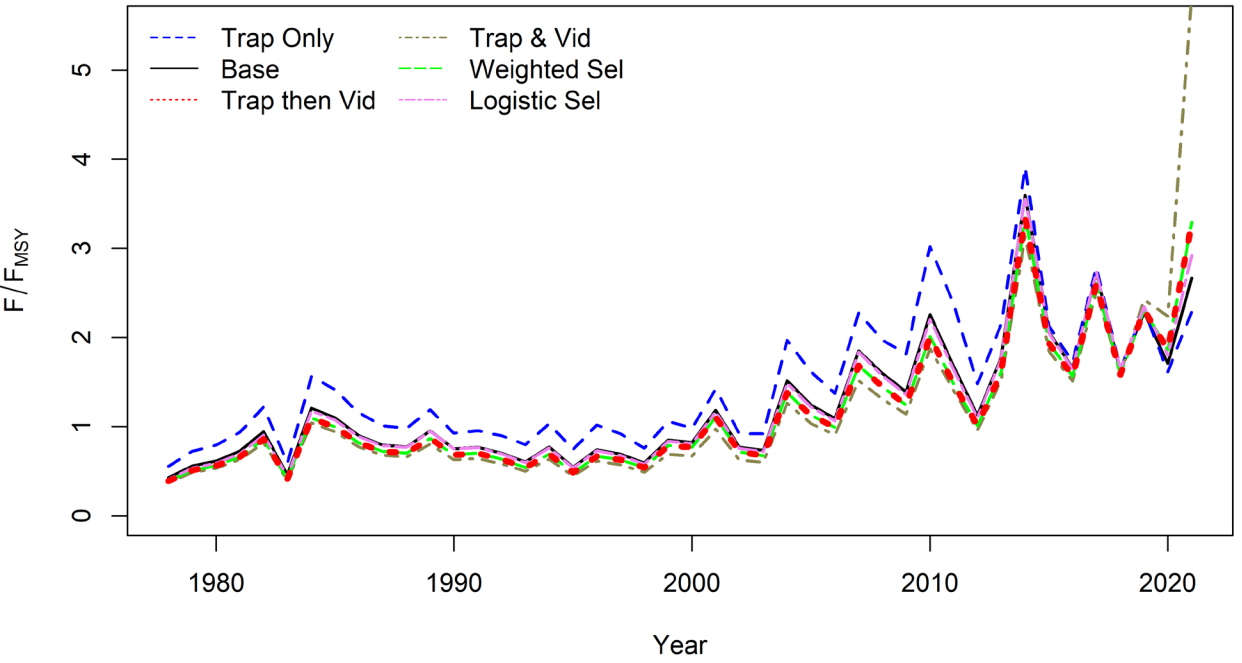


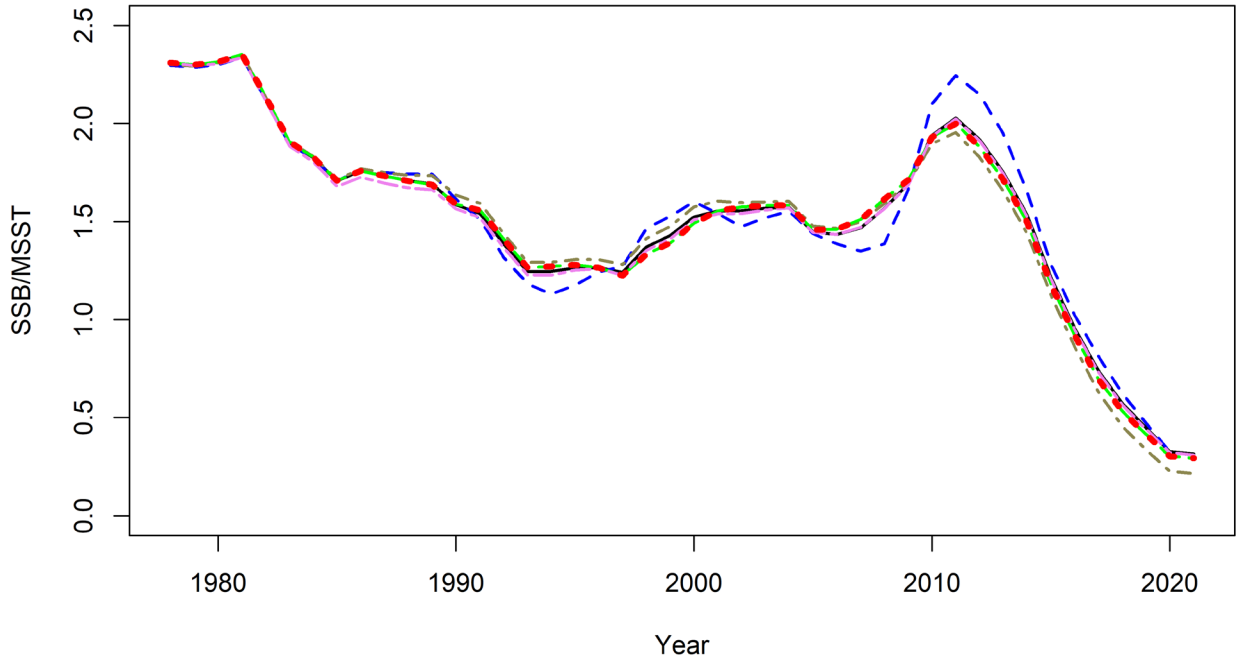
BAM base model – Discard mortality sensitivity



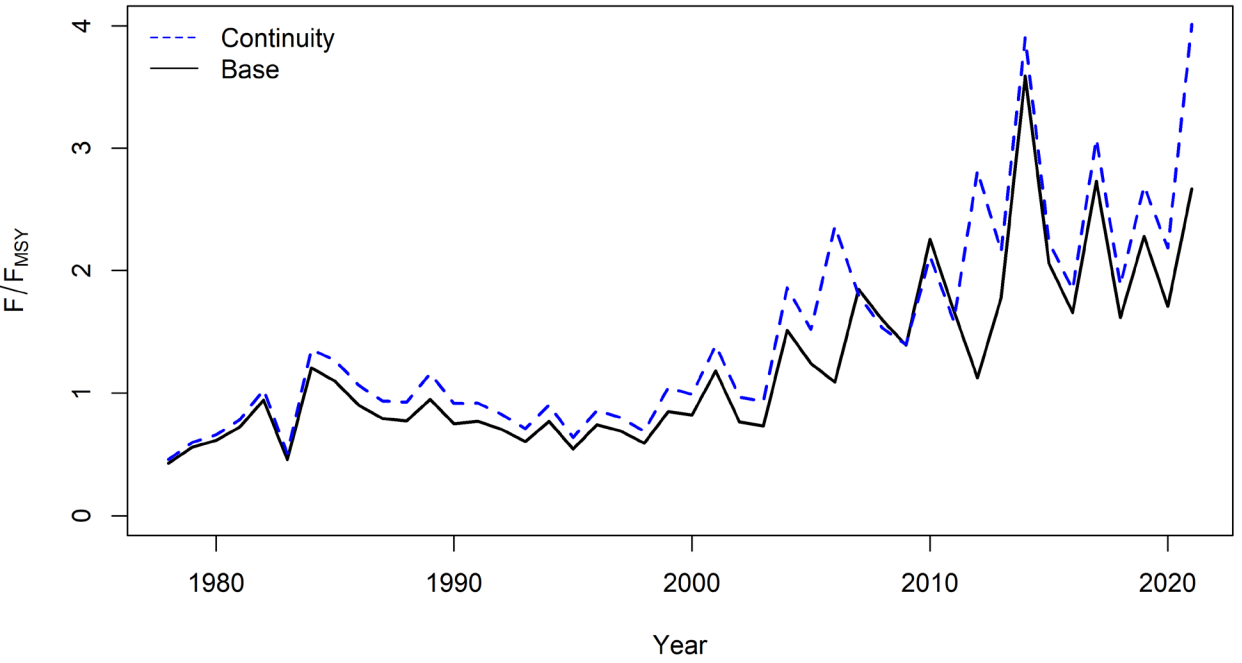


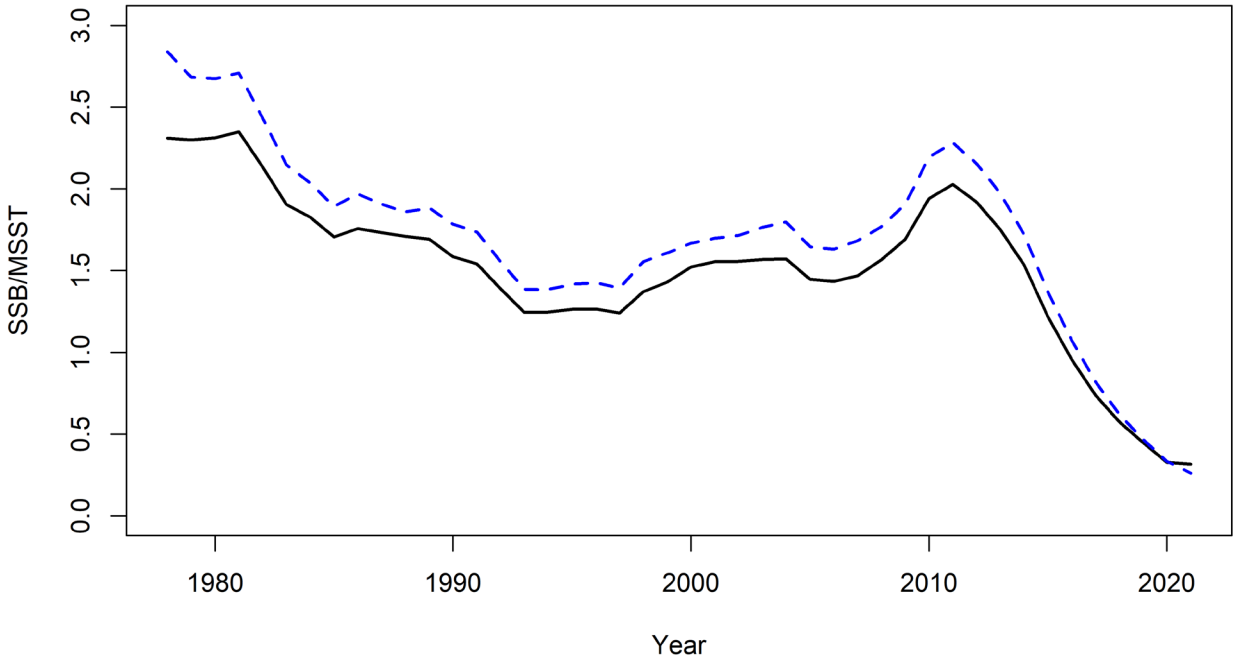
BAM base model – SERFS sensitivity



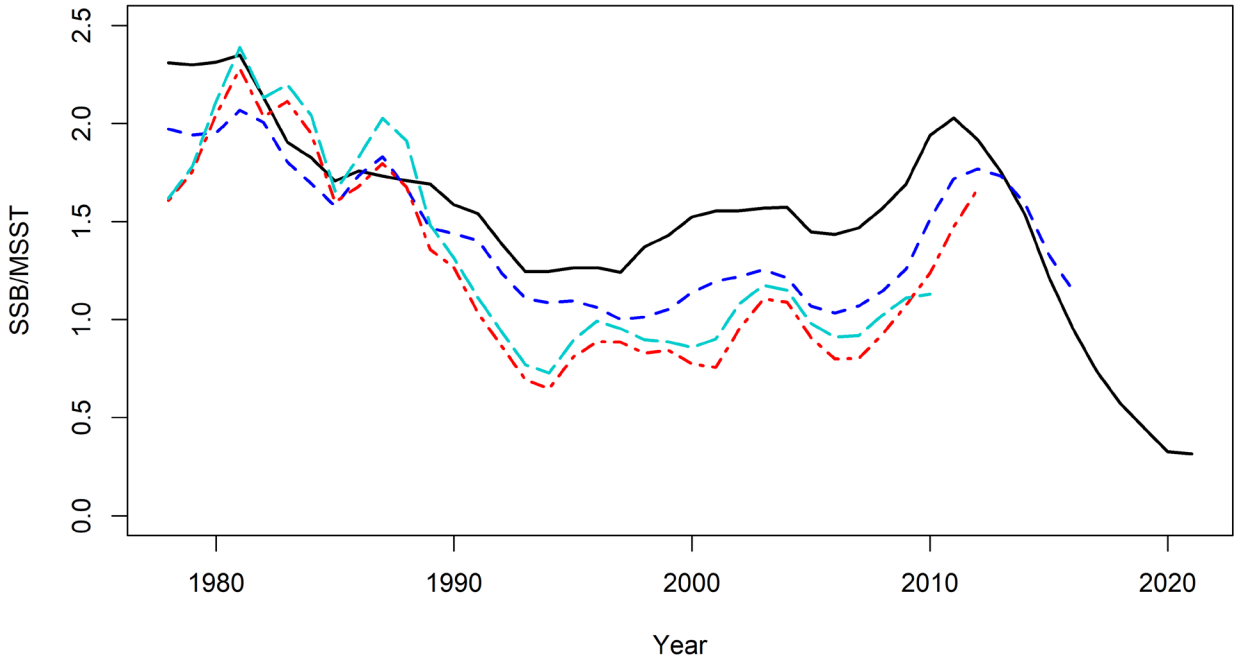


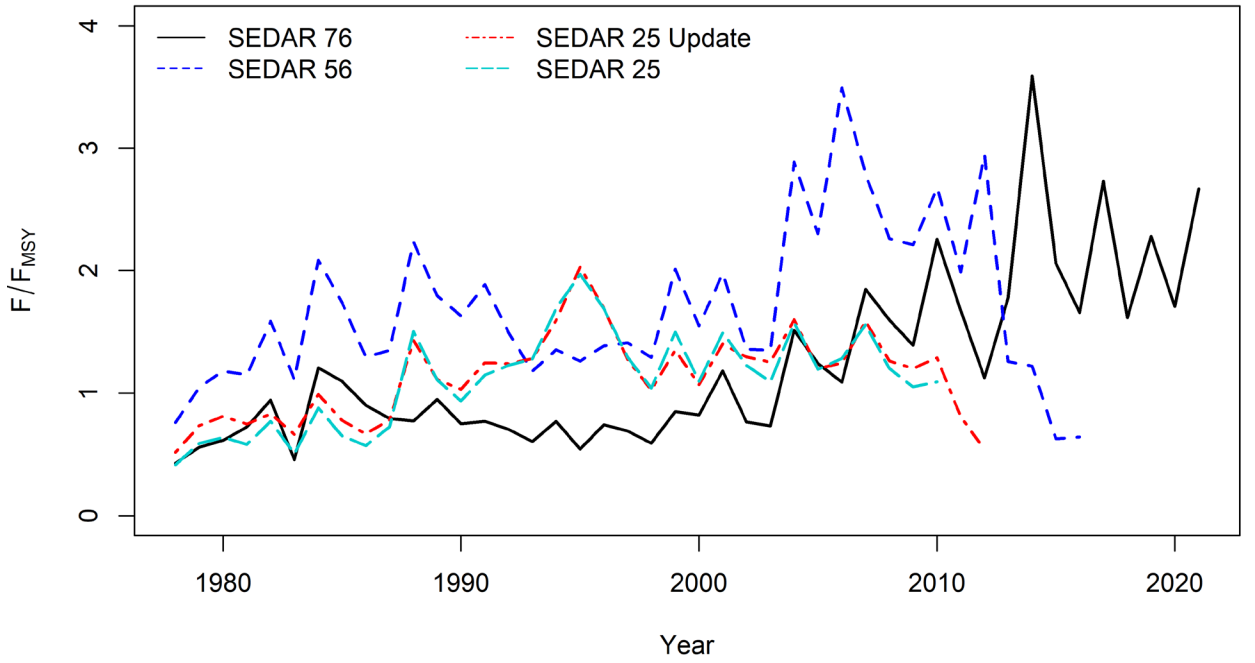
BAM base model – Continuity sensitivity





BAM base model – Previous assessments





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Outline

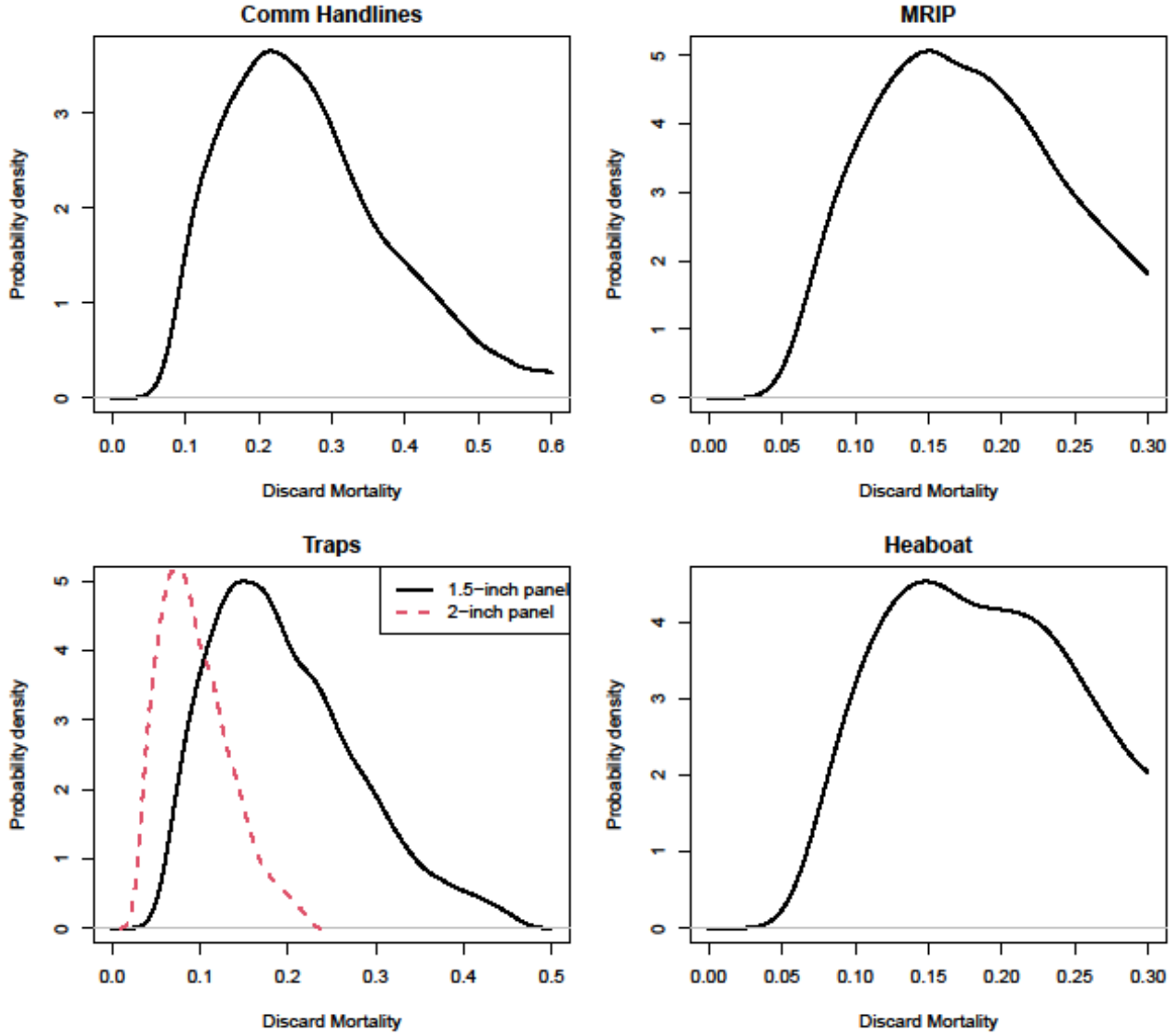
- Background
- Data
- Assessment Model
- Assessment Results
- **Uncertainty**
- Projections

Characterizing uncertainty: Monte Carlo/Bootstrap Ensemble (MCBE)

- Bootstrap the data
  - Multinomial resampling of age and length compositions
  - Multiplicative lognormal error on indices and removals
- Monte Carlo draws
  - Natural mortality: Drawn from U(0.22, 0.6)
  - Discard Mortality: Drawn from fleet specific truncated gamma distribution
  - Index weights : Drawn from U(1.875, 3.125) as in SEDAR 56
- 4000 model fits
  - 3929 (98%) trials converged with parameters away from bounds

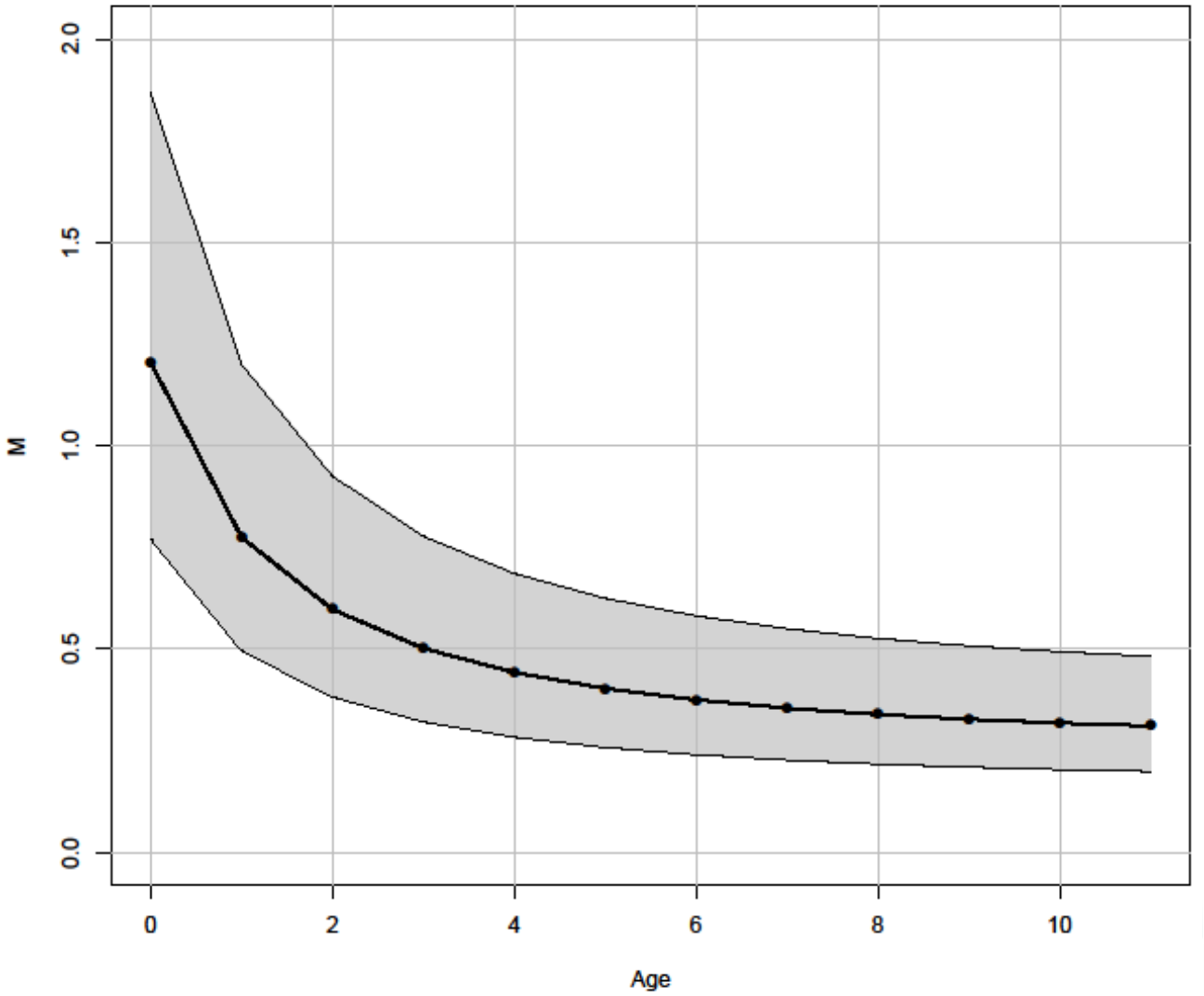
Uncertainty in Discard Mortality

- Assessment panel decided on a 95% CI of 0.5*value – 3*value for fleet specific discard mortality rates from SEDAR 56
- Fit a gamma distribution to the mode and 95% CI for each fleet to estimate the α and β parameters
- Truncated the distribution at 0.9*2.5% and 1.1*97.5%
- Drew value from truncated gamma distribution for each fishery except 2” pot was set to 0.483*1.5” pot value

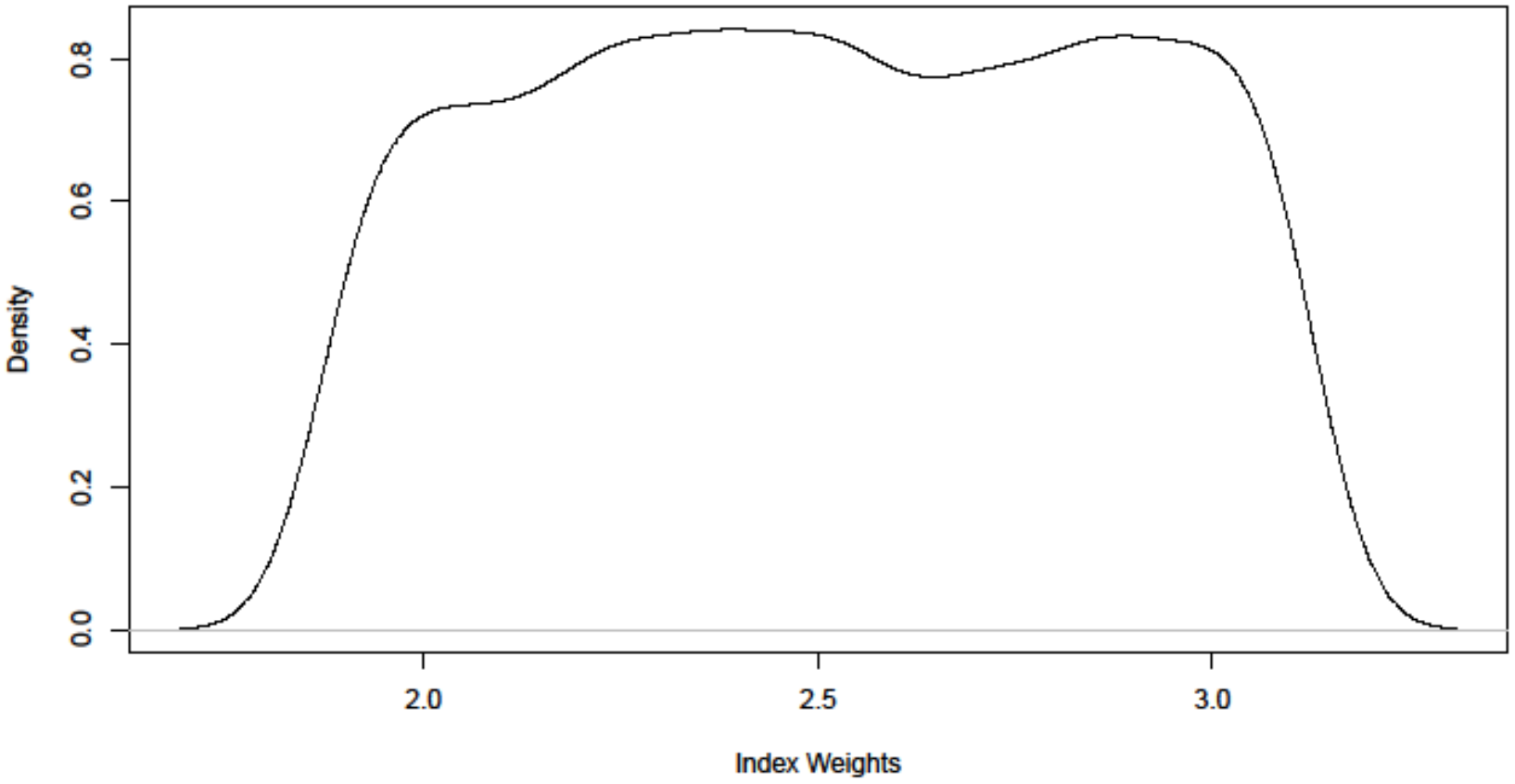


Uncertainty in M

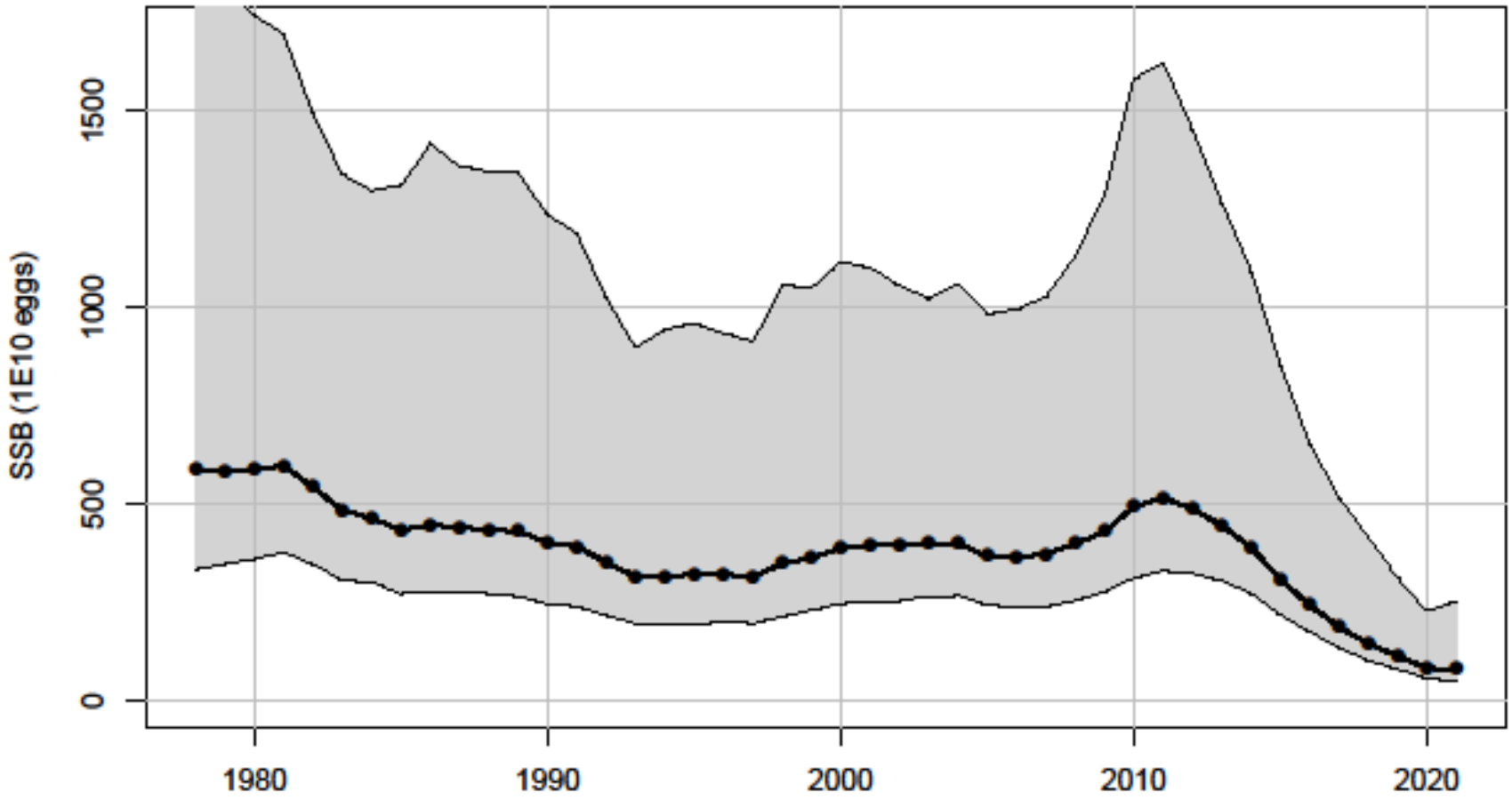
- Range of natural mortality came from 2 sources
- Upper bound (0.6)
  - Upper 97.5% from Hamel and Cope (2022) bootstrap of data with maximum age ~ N(11, 1)
- Lower bound (0.22)
  - Lower 2.5% from MCBE analysis that estimated M within BAM



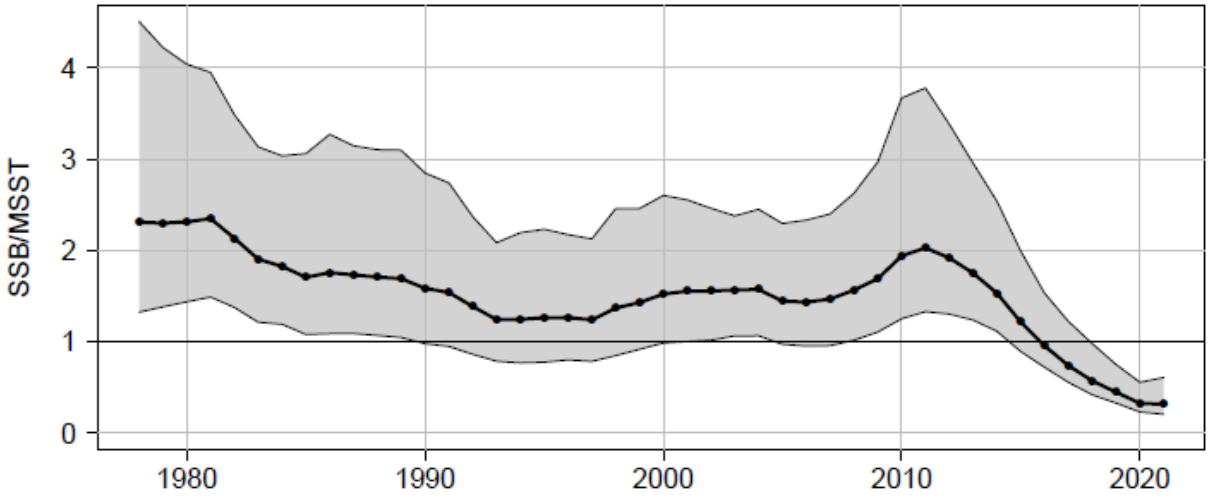
Uncertainty in weight on indices

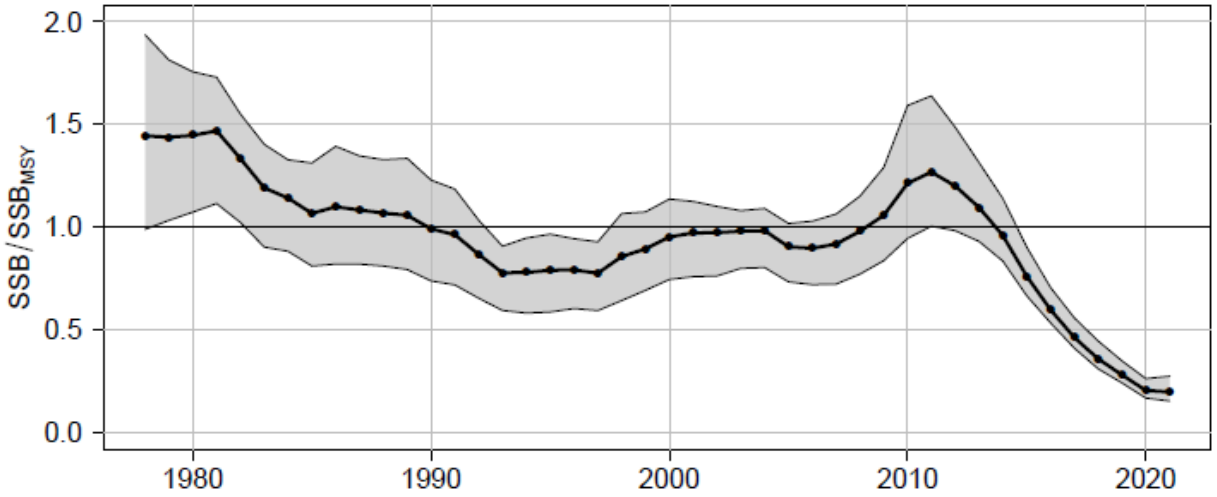


MCBE – SSB

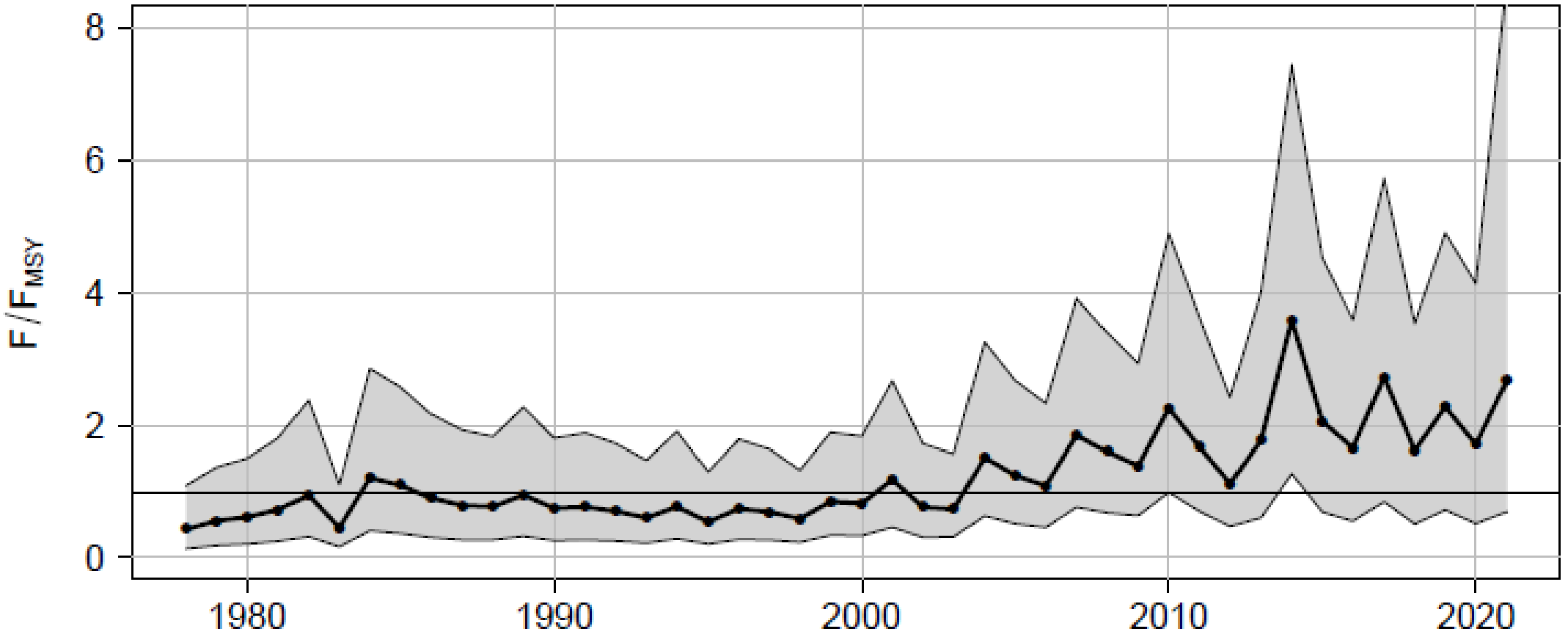


MCBE – Relative spawning stock

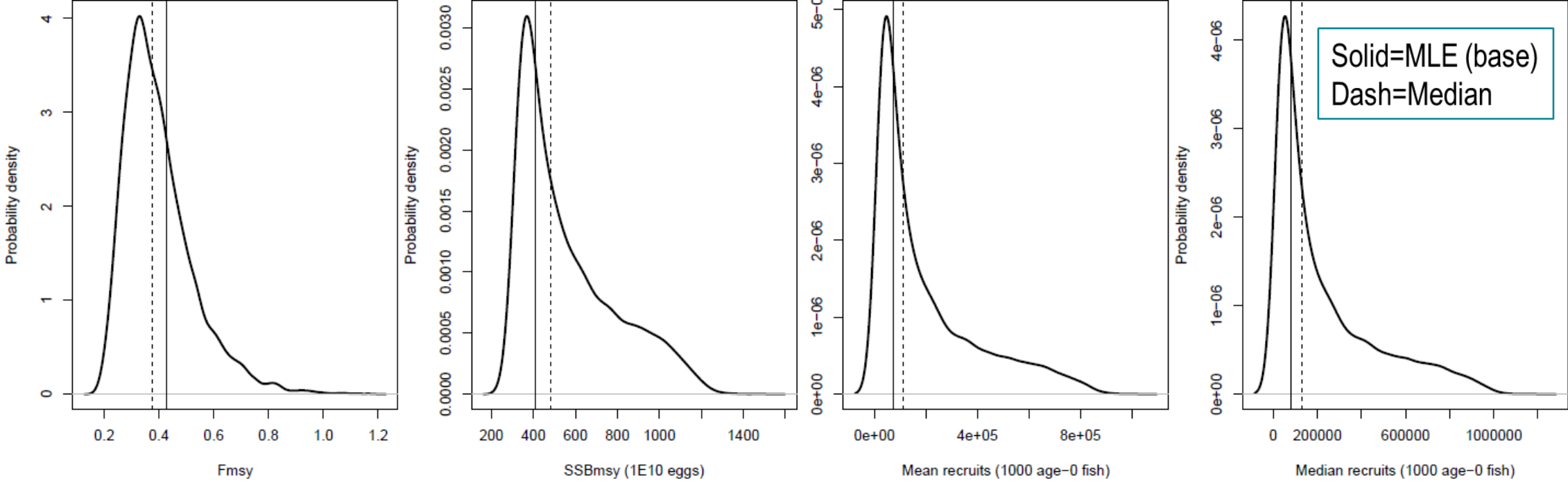


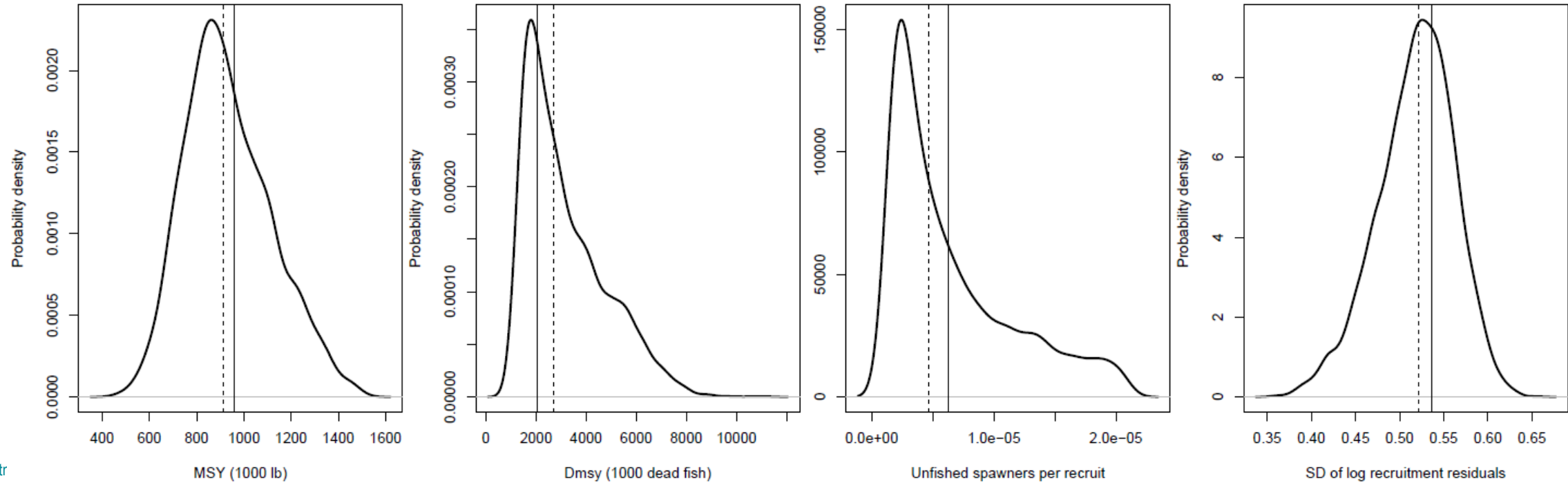


MCBE – Fishing mortality

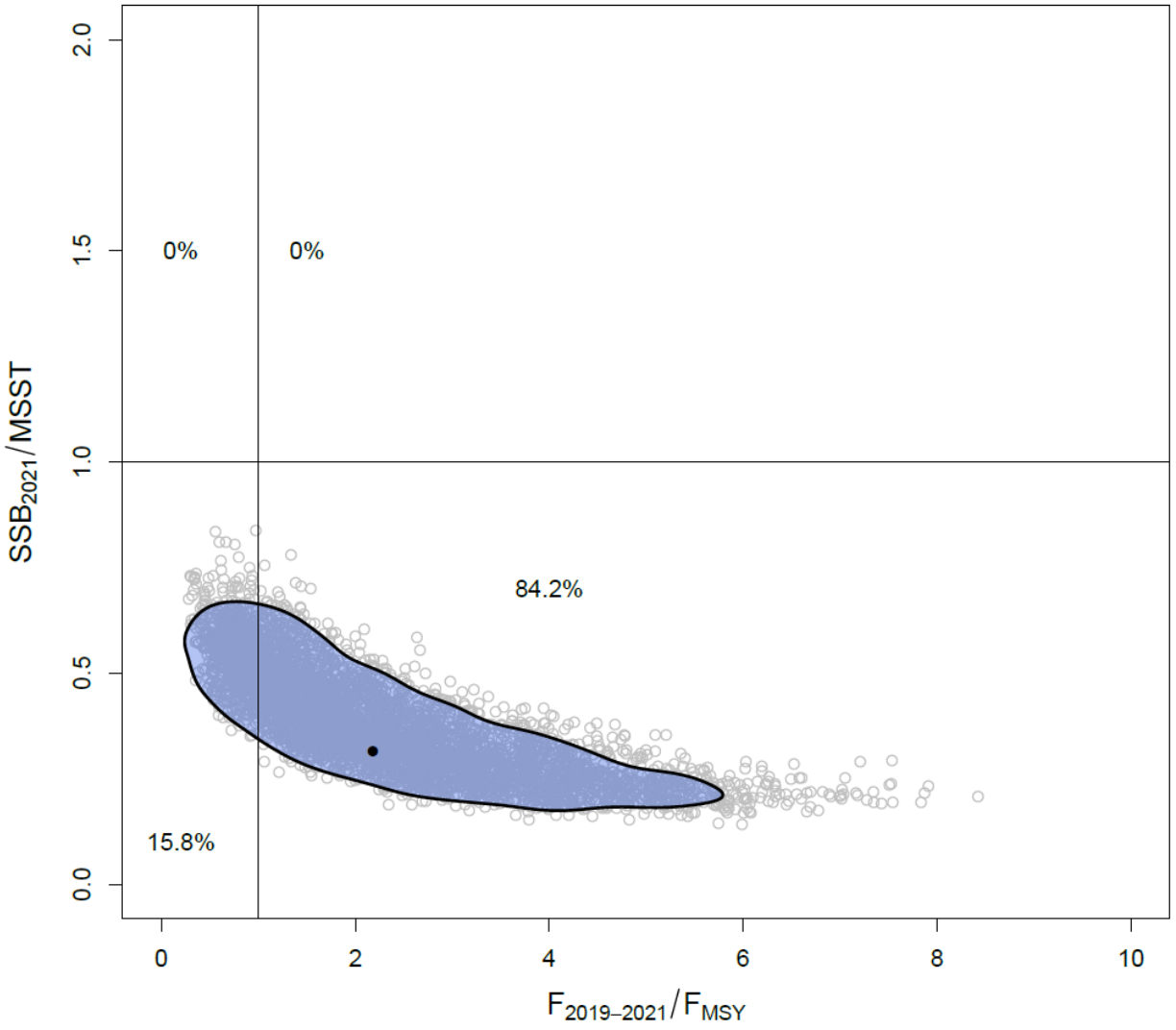


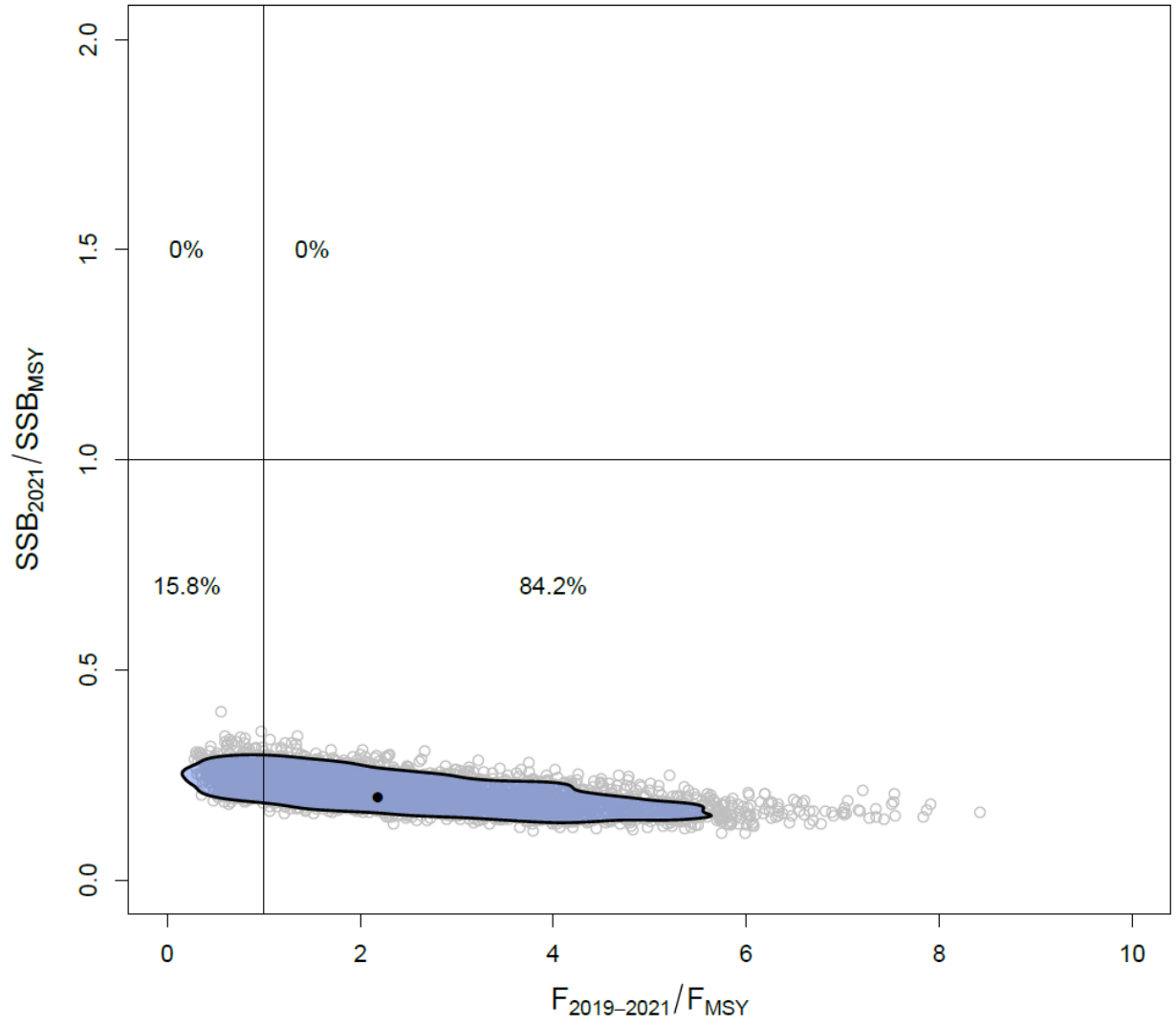
MCBE – Benchmarks





MCBE – Management quantities

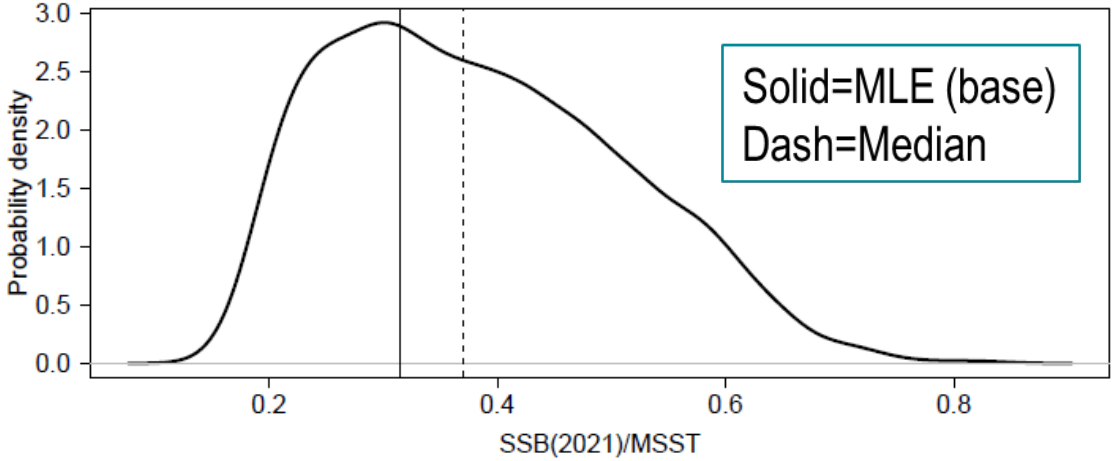


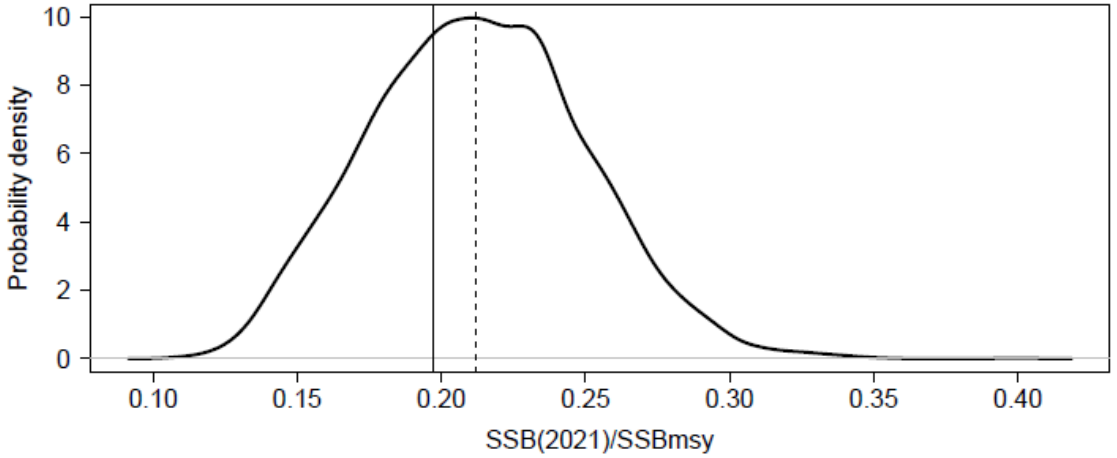


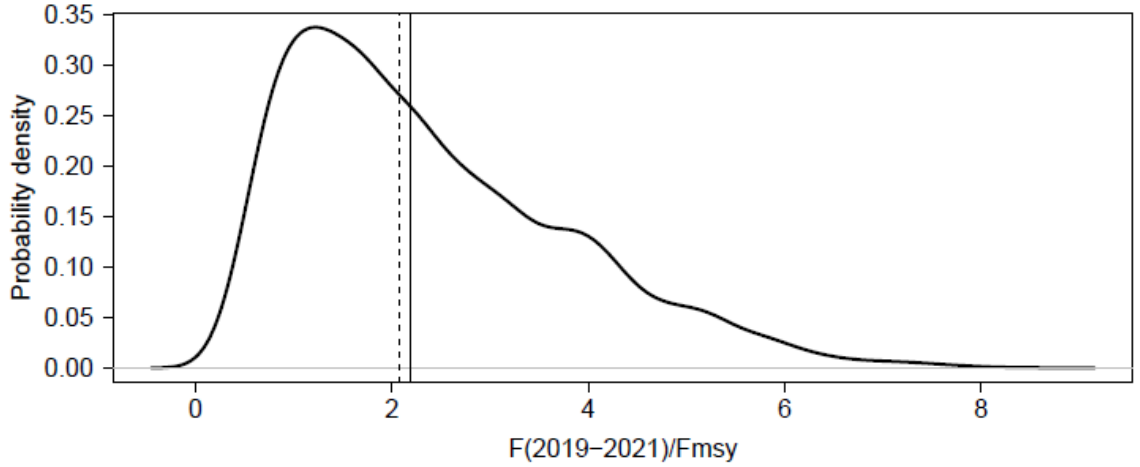
MCBE – Status indicators

100% of distribution below 1.0 (i.e., overfished)

~84.2% of distribution above 1.0 (i.e., overfishing)







MCBE – Status Indicators

Quantity	Units	Estimate	Median	SE
F_{MSY}	y^{-1}	0.48	0.37	0.13
$75\%F_{\text{MSY}}$	y^{-1}	0.36	0.28	0.10
B_{MSY}	1000 lb	53481.22	27725.96	22013.58
SSB_{MSY}	1E10 eggs	752.58	480.84	228.19
MSST	1E10 eggs	254.75	284.71	63.20
MSY	1000 lb	959.85	911.56	184.75
$L_{75\%\text{MSY}}$	1000 lb	937.39	888.39	181.78
L_{current}	1000 lb	544.23	536.40	65.80
D_{MSY}	1000 dead fish	931.45	2694.03	1600.53
$D_{75\%\text{MSY}}$	1000 dead fish	1586.27	2094.29	1251.13
D_{current}	1000 dead fish	437.42	1242.30	530.60
R_{MSY}	millions fish	390.60	127.32	232.69
$F_{2019-2021}/F_{\text{MSY}}$	—	2.18	2.07	1.42
$\text{SSB}_{2021}/\text{MSST}$	—	0.32	0.37	0.13
$\text{SSB}_{2021}/\text{SSB}_{\text{MSY}}$	—	0.20	0.21	0.04

Summary of assessment results

- SA black seabass is overfished/depleted (100%)
- Overfishing is occurring in terminal years (84% of MCBE runs)
- Natural mortality and discard mortality are important sources of uncertainty in this assessment
  - Though stock status is robust to range used in this assessment
- Pattern of low recruitment since 2014 raises the question of a regime shift

Klaer et al (2015) scoring rubric with score ≥7 supports acceptance of a regime shift

Table 1
Scoring guidelines.

Score	Observed change in a productivity indicator	Understanding of assessment model input data	Understanding of assessment model structural assumptions	Explanatory hypothesis
0	Short period less than one generation	Model input uncertainties are unknown	Key population parameters affected have not been identified	The mechanism is unknown
1	More than one generation	A number of model inputs are uncertain and the extent of uncertainty has not been characterised	Modeled changes in one or more key population parameters have fitted with observed biomass changes	A plausible mechanism for productivity shift has been developed from general knowledge of biophysical processes
2	Multiple generations and across several assessment/management cycles	Uncertain model inputs have been characterised and plausible ranges for those uncertainties have been investigated	Modeled changes in key production parameters have been somewhat validated by investigation of alternative model structures and/or improved model behaviour such as the removal of retrospective patterns	Output from a limited biophysical or multispecies model is consistent with observed patterns of change in productivity
3	Multiple generations and across many regular assessment/management cycles in the same timeframe	The character of model inputs is well understood and uncertainty has largely been eliminated or well estimated statistically	Validated modeled changes are consistent with output from a biophysical or multispecies model	Output from a comprehensive biophysical multispecies model is consistent with observed patterns of change in productivity
	1	2 or 3	0	0

- Current research
- Multi-spp evidence
- Nature of any mechanism would be critical

Outline

- Background
- Data
- Assessment Model
- Assessment Results
- **Projections**

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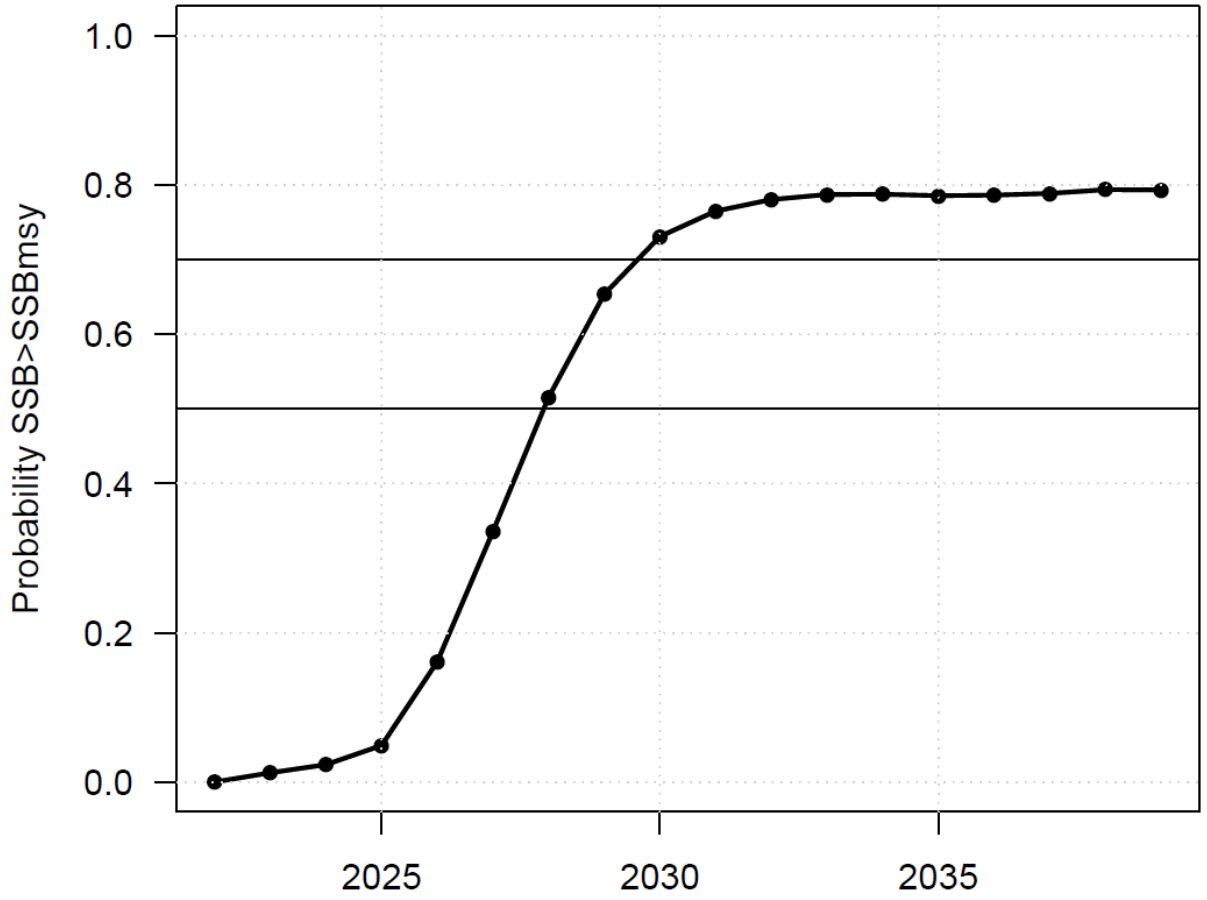
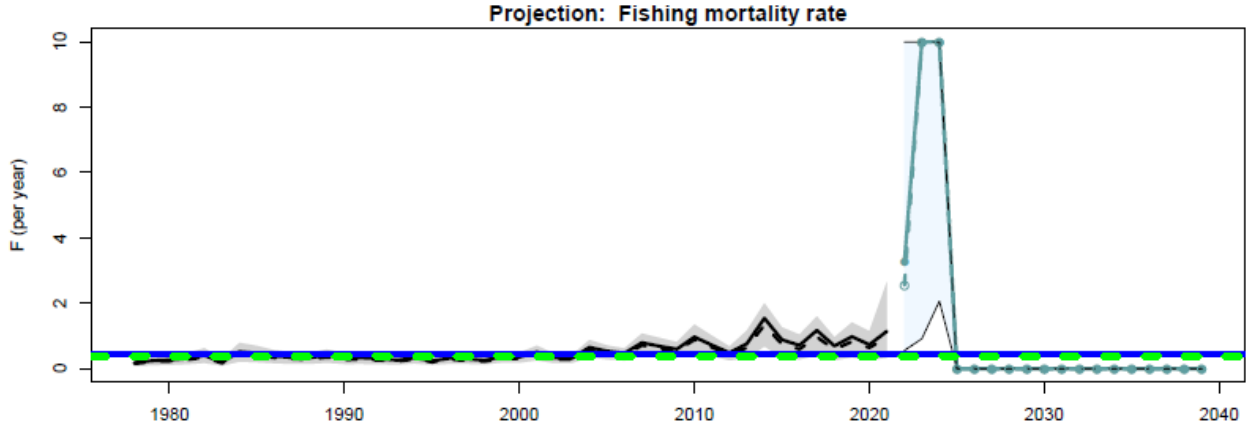
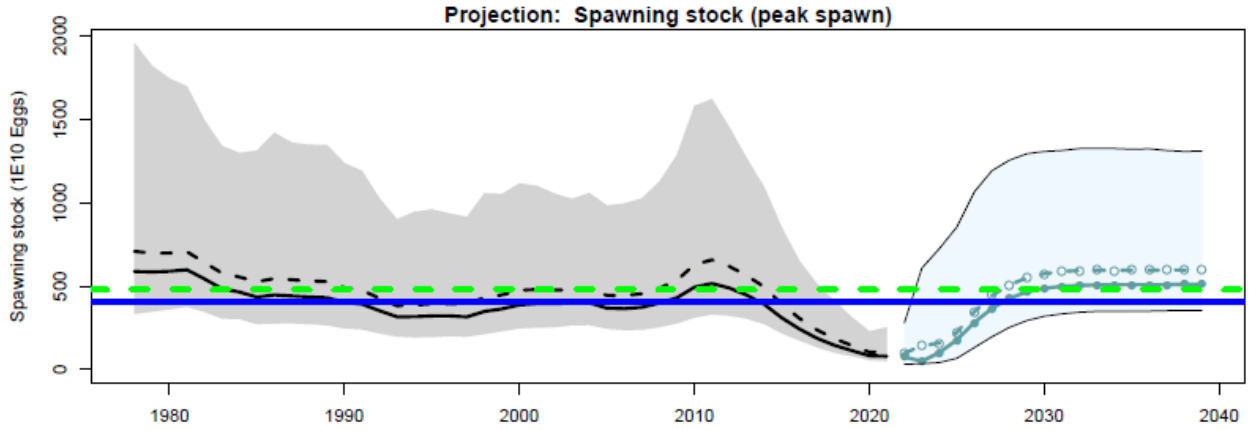
Projections

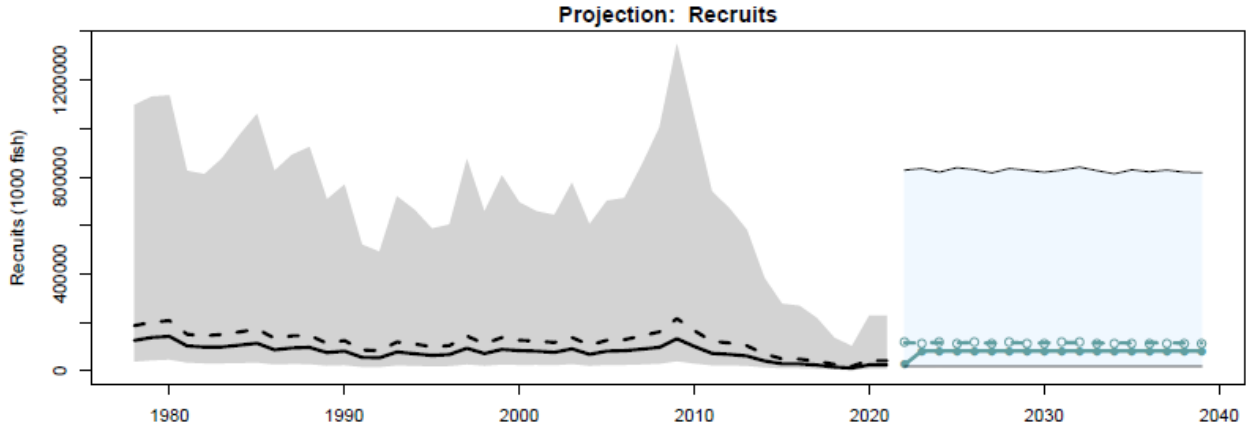
- 4 Scenarios
  - F=0 with long-term average recruitment
  - F=0 with recent average recruitment
  - $F_{current}$ with recent average recruitment
  - F_{MSY} with recent average recruitment
- New F starts in 2025
- Interim period (2022-2024) applies average removals from 2019-2021 with a maximum F =10
- For scenarios with long-term average recruitment starts in 2023

F=0 with long-term average recruitment

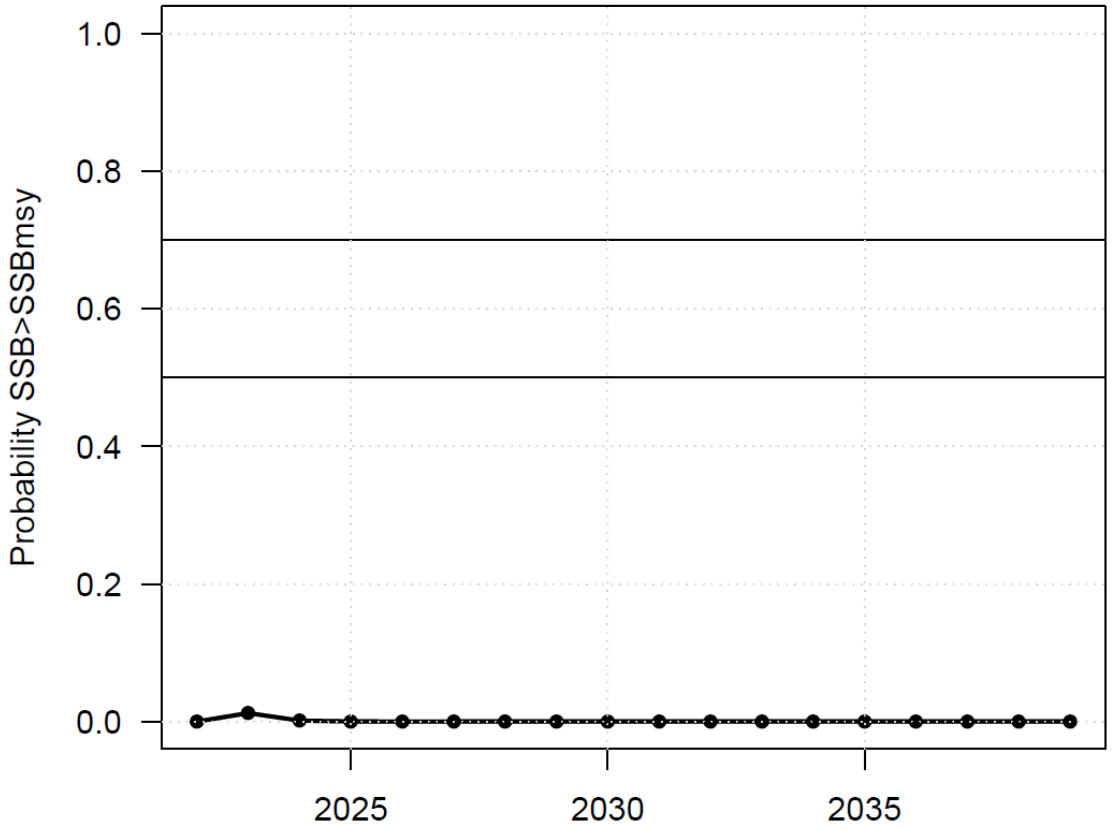


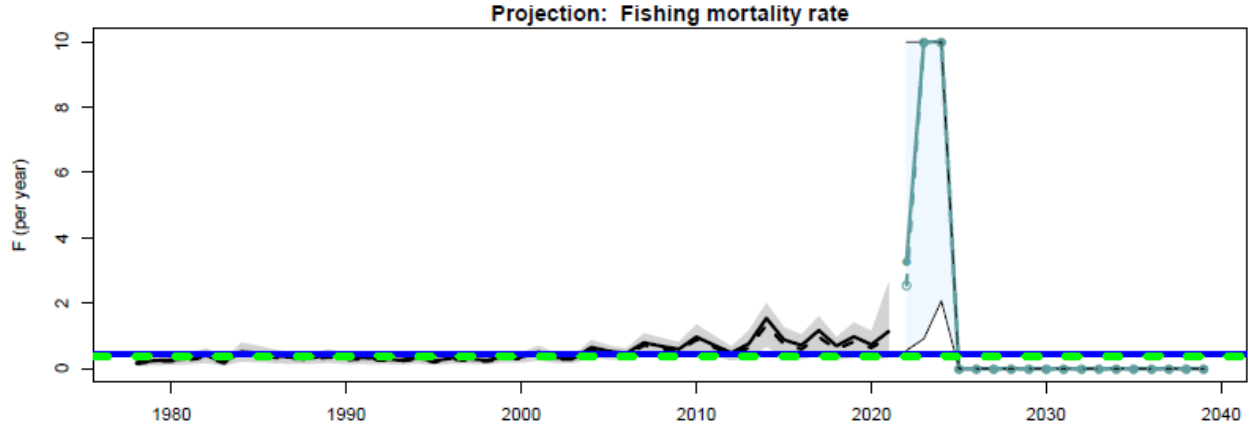


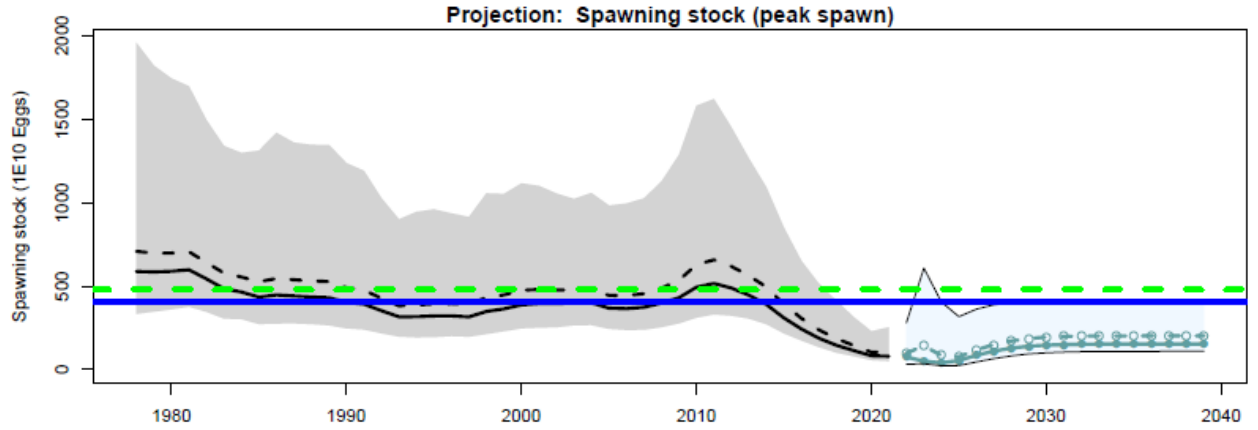


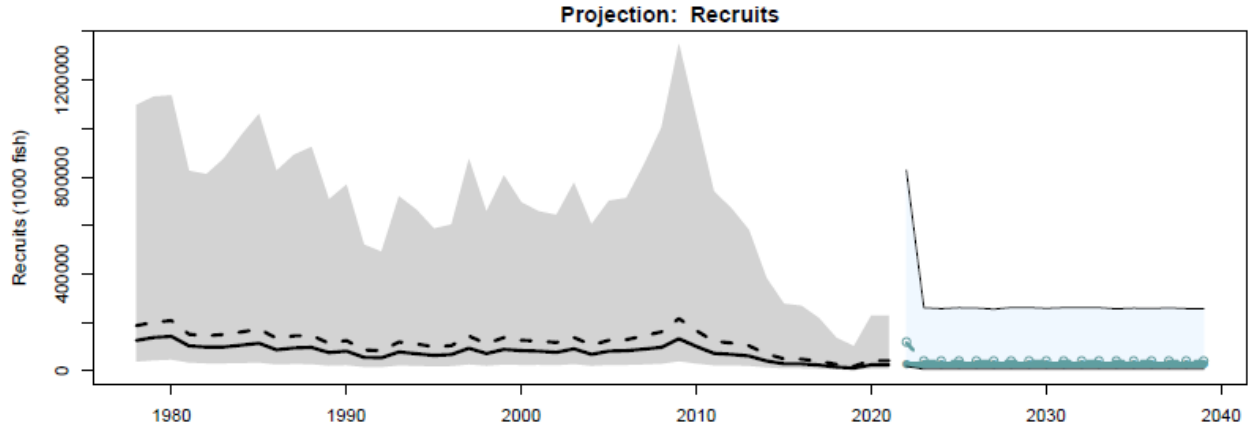


F=0 with recent average recruitment



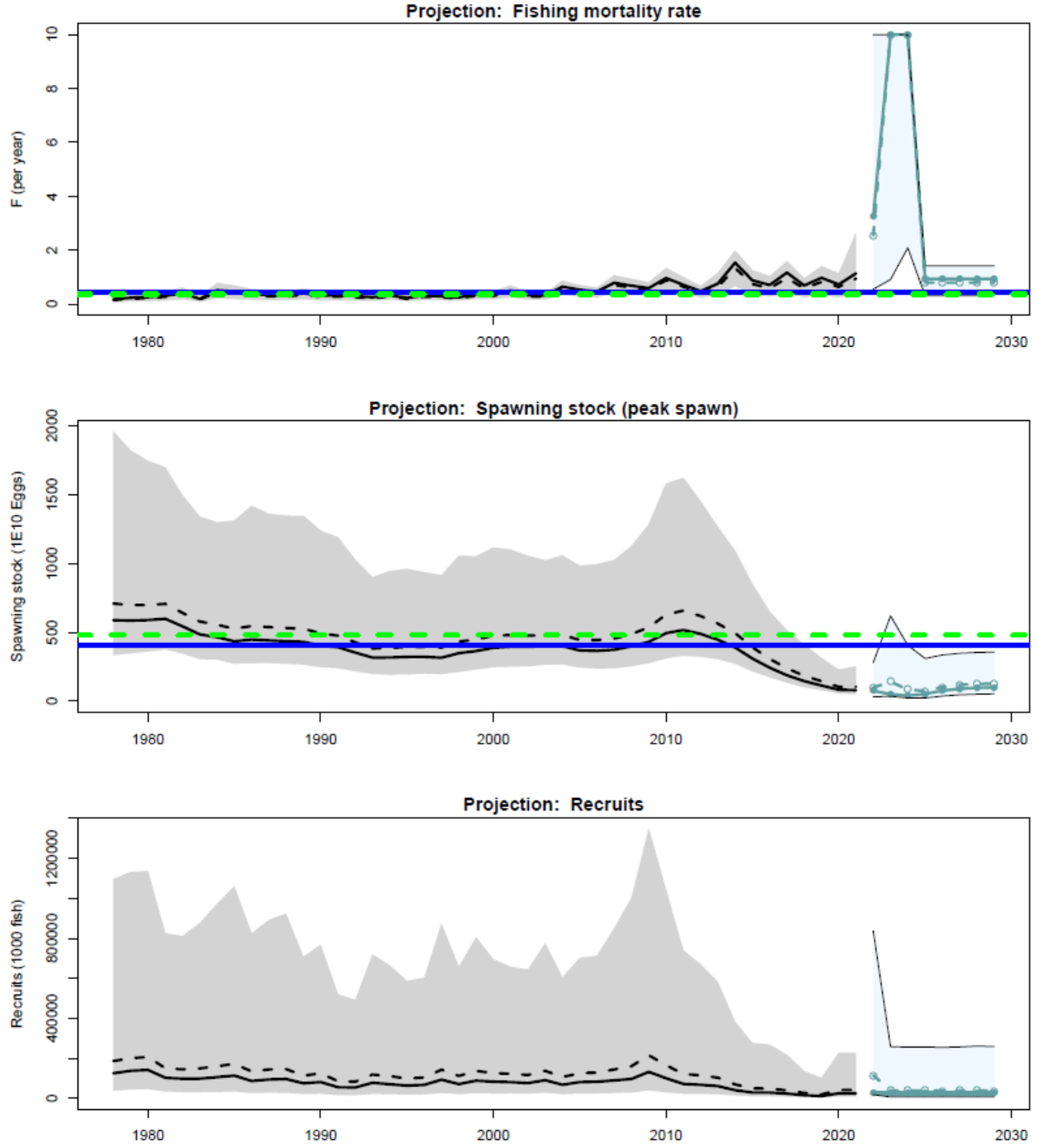




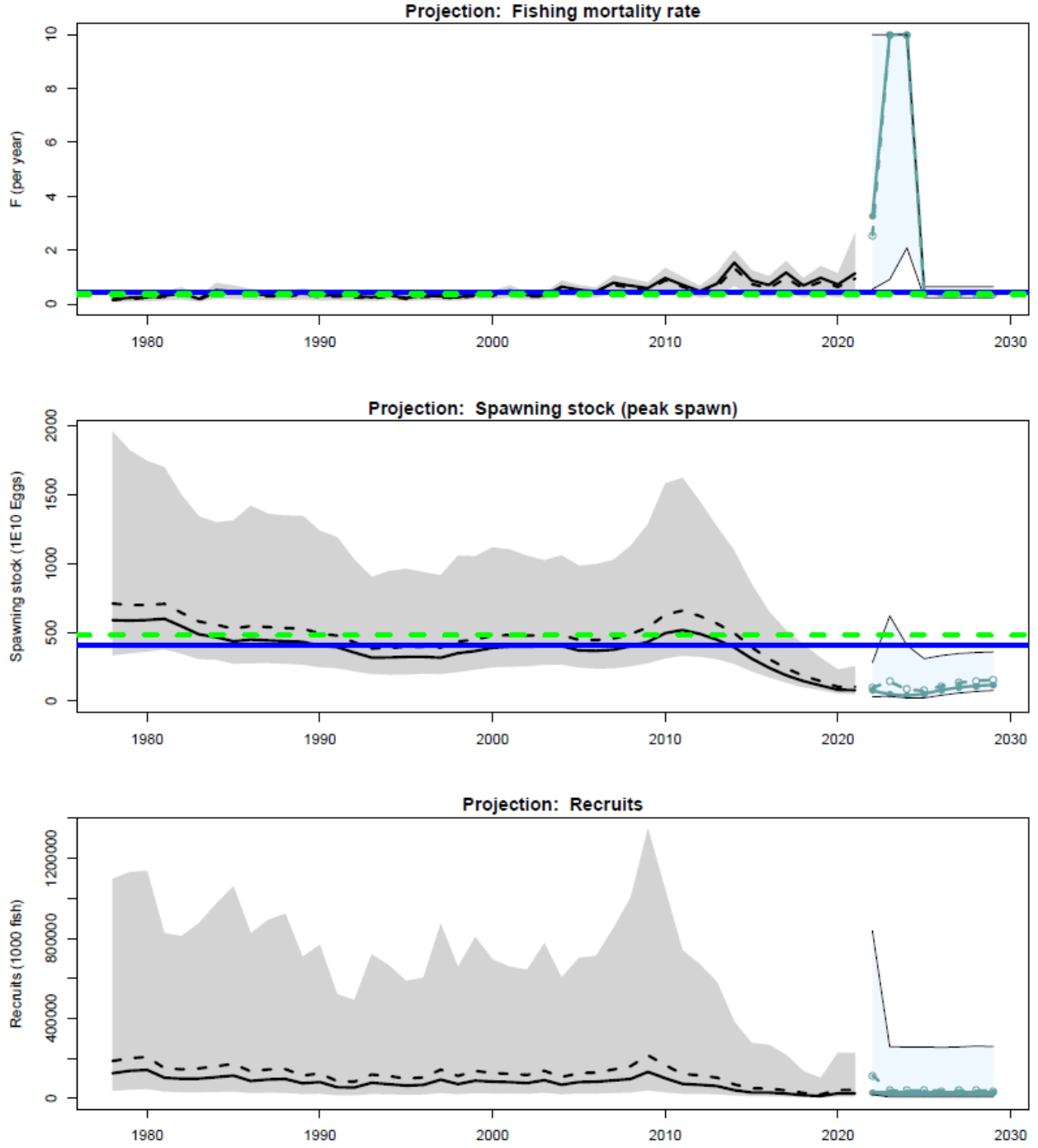


Service

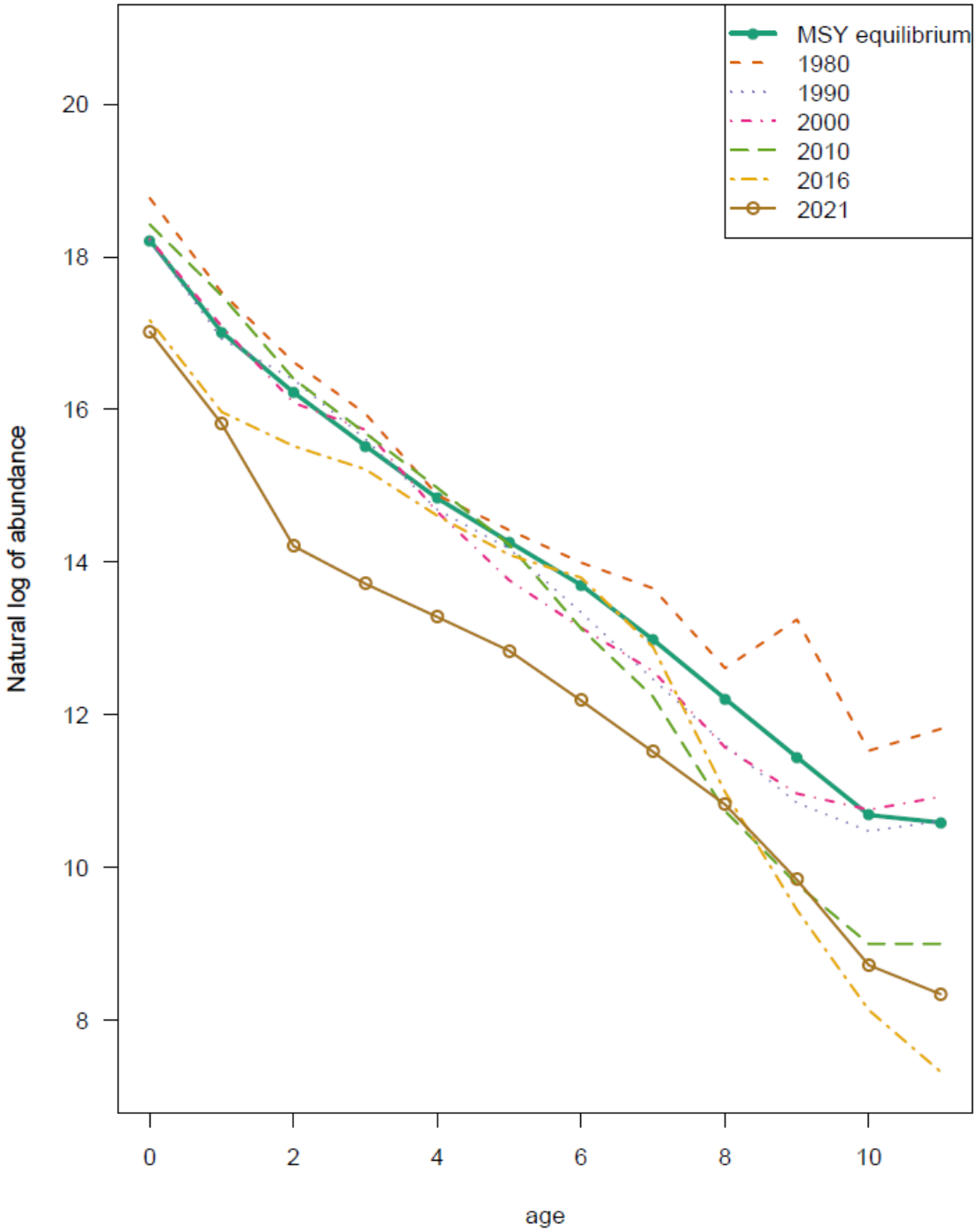
$F=F_{current}$ with recent average recruitment



$F=F_{MSY}$ with recent average recruitment



Extras



BAM base model – abundance age structure

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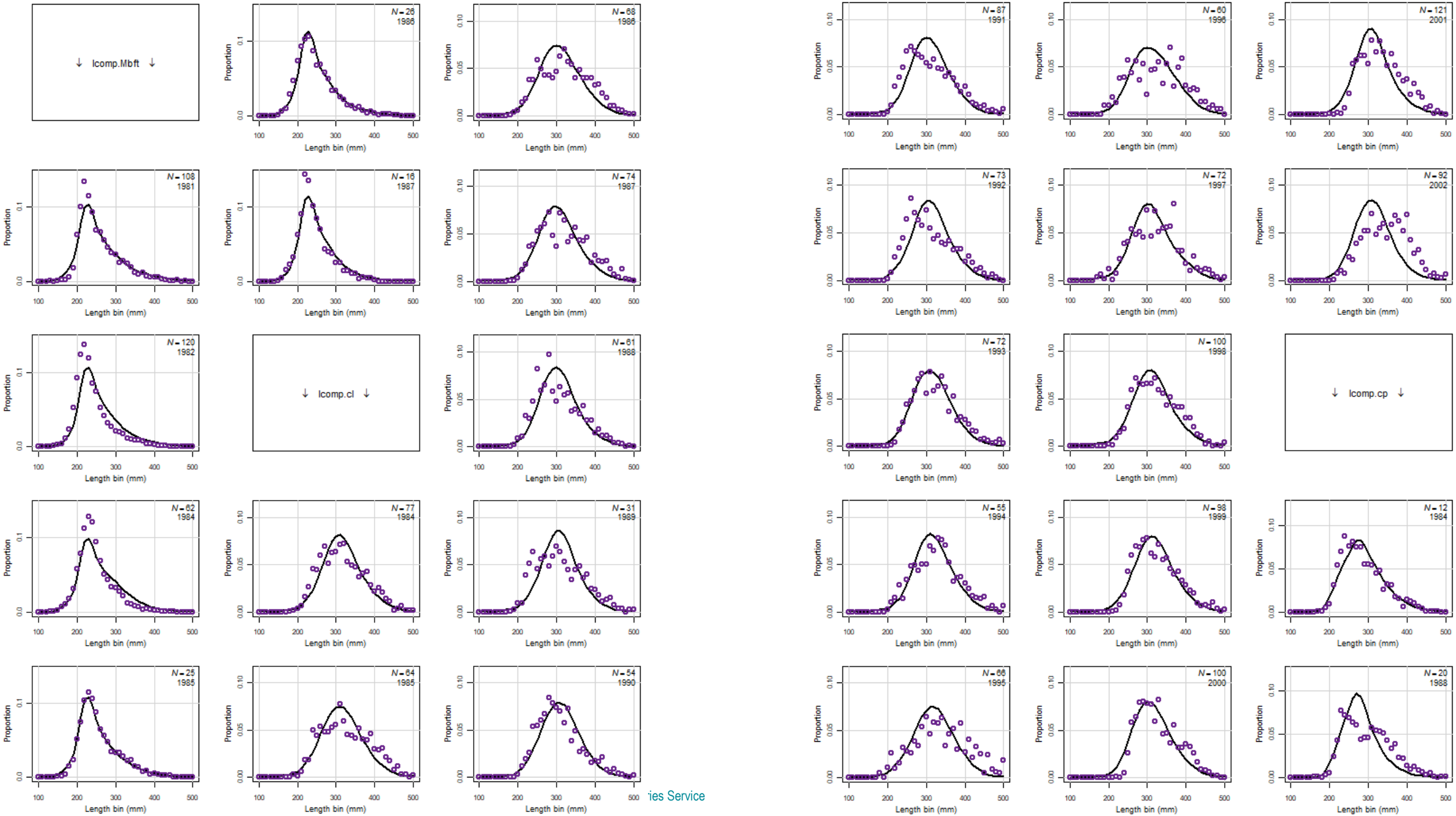
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N = 68
1986
N = 87
1991
N = 60
1996
N = 121
2001
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1981
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1987
N = 74
1987
N = 73
1992
N = 72
1997
N = 92
2002
N = 120
1982
↓ lcomp.cl ↓
N = 61
1988
N = 72
1993
N = 100
1998
↓ lcomp.cp ↓
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1984
N = 77
1984
N = 31
1989
N = 55
1994
N = 98
1999
N = 12
1984
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1985
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1990
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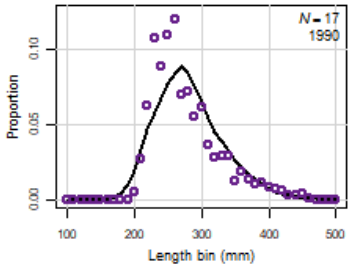
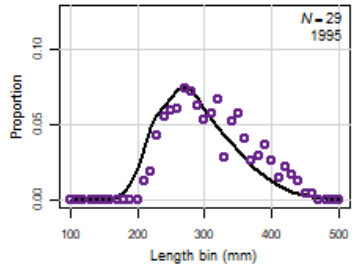
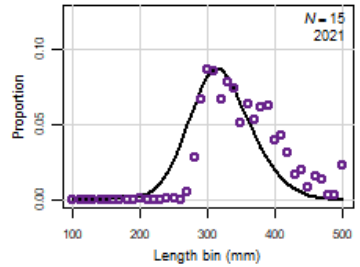
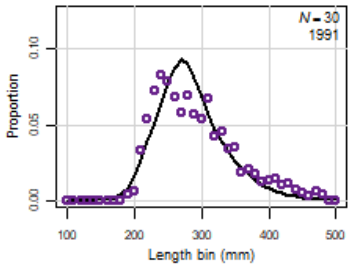
1995
N = 100
2000
N = 20
1988
Proportion
Length bin (mm)

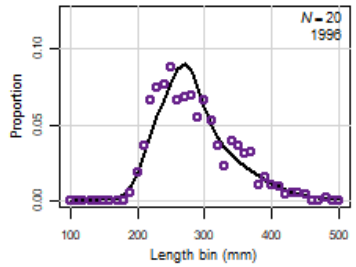
ies Service











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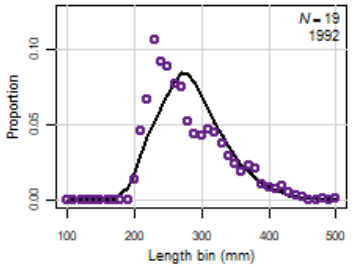
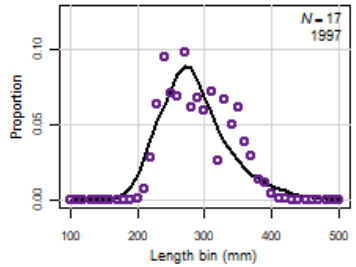
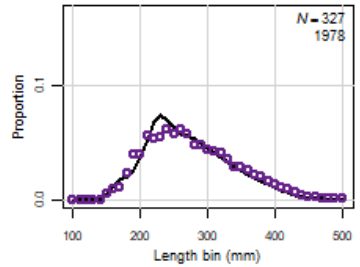
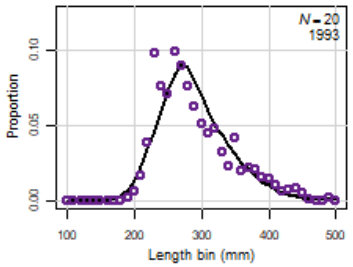
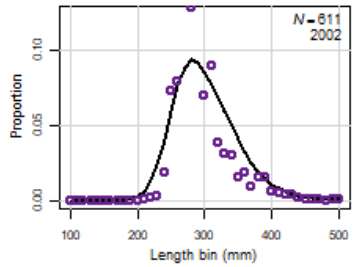
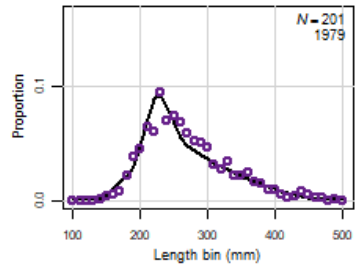


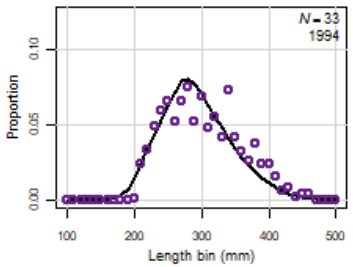


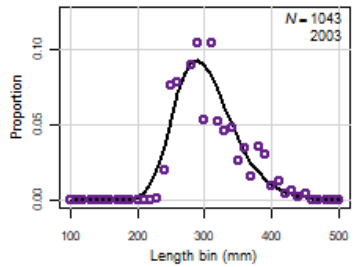


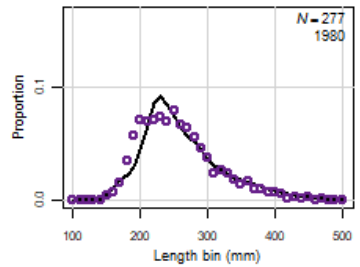




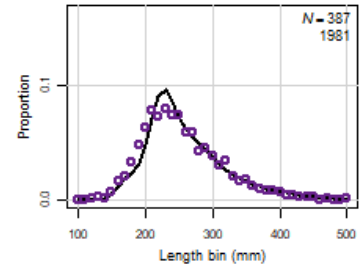


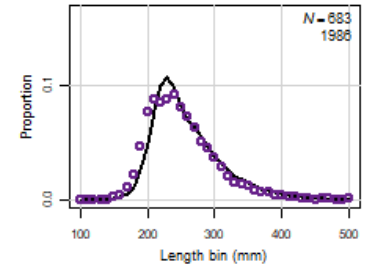


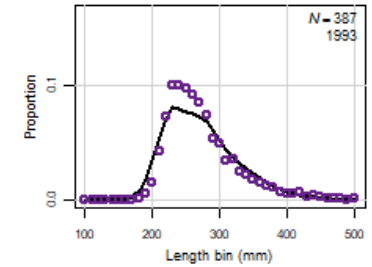


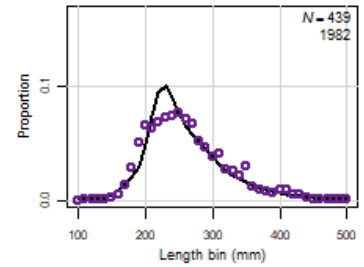


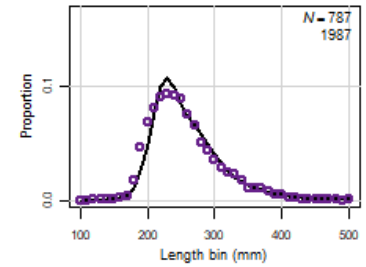
ies Service

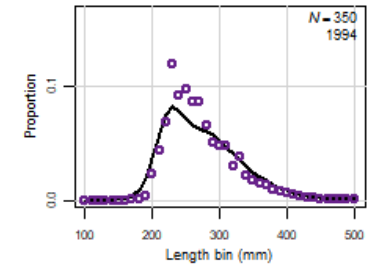


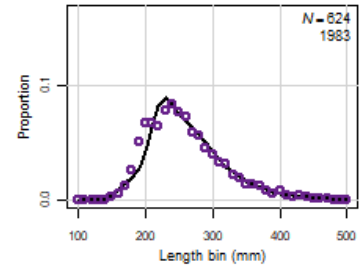


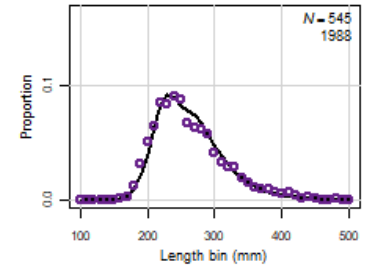


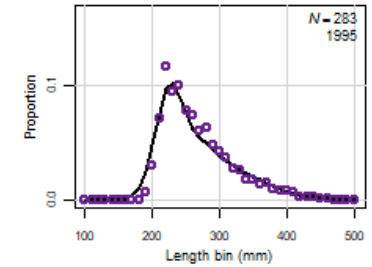


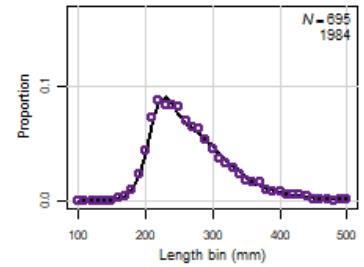


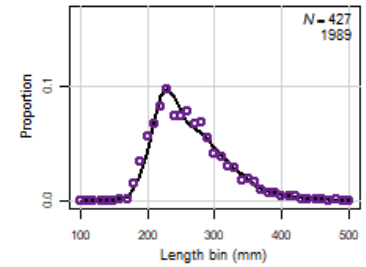


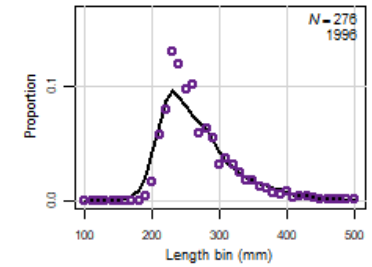


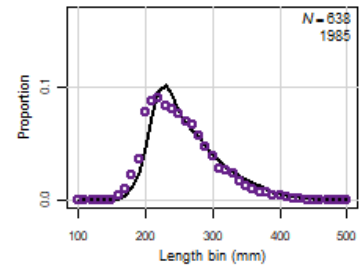


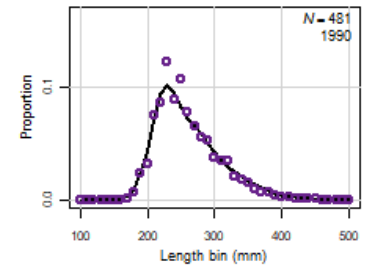


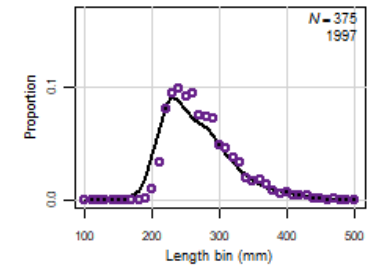


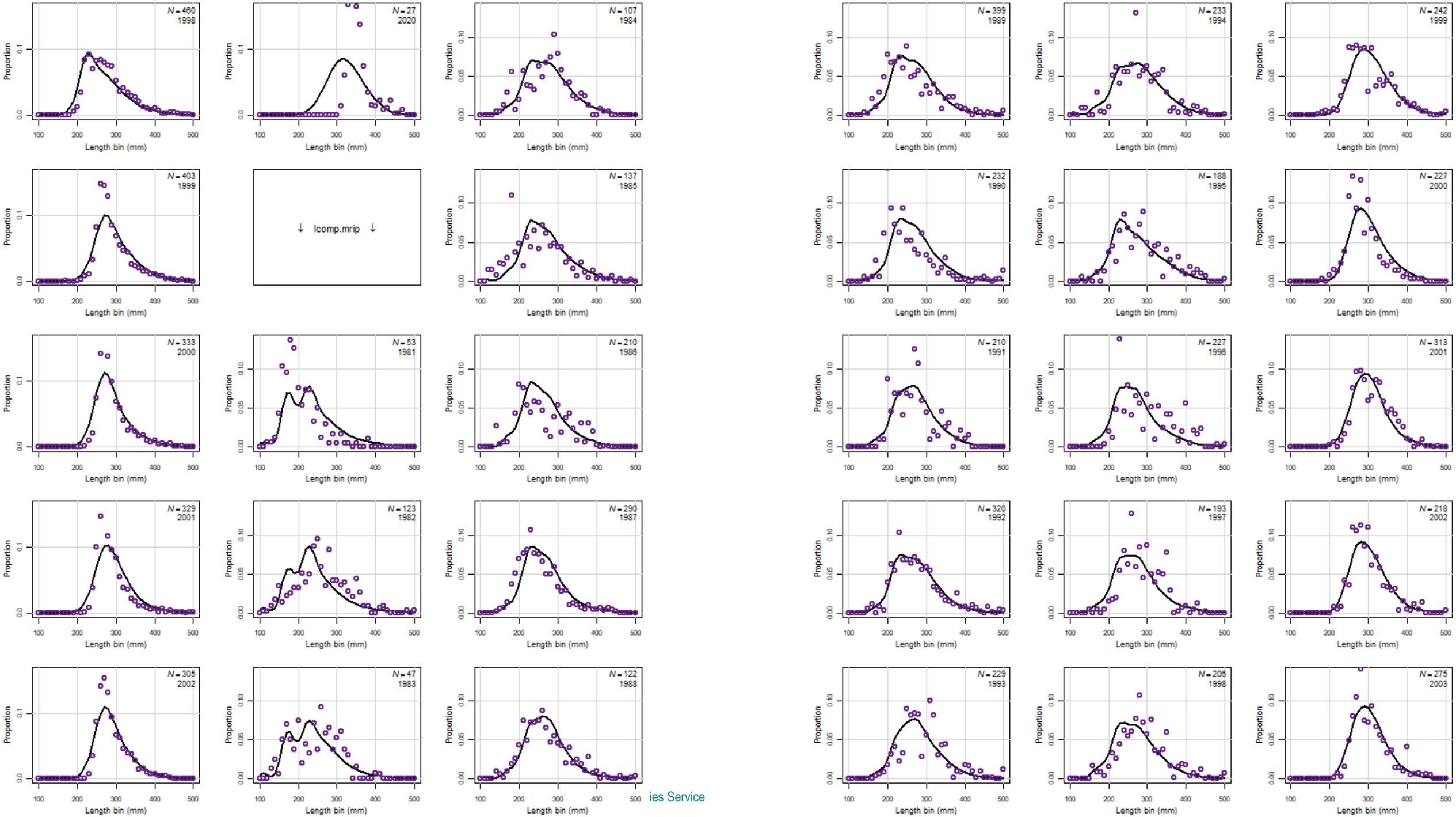




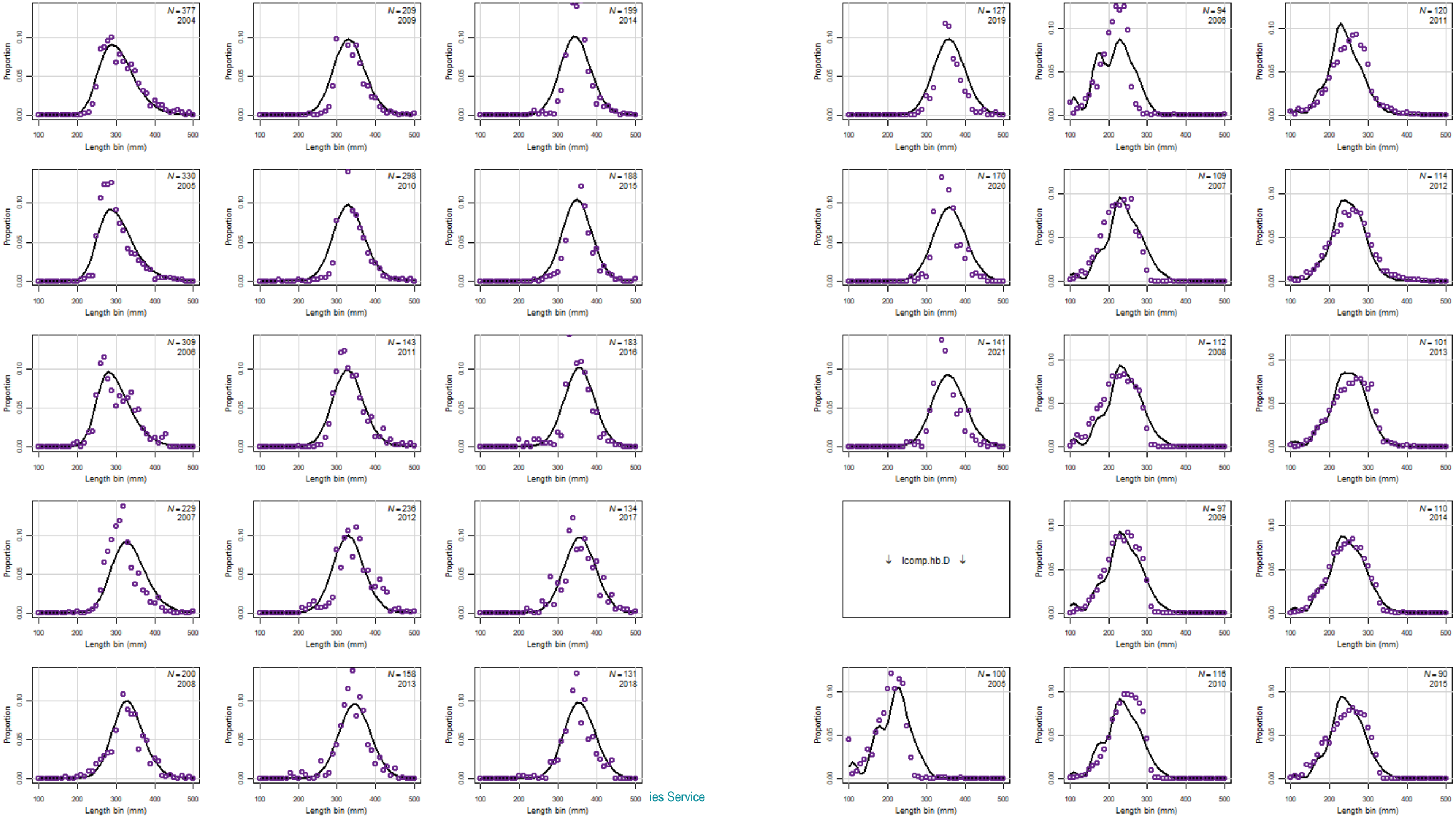




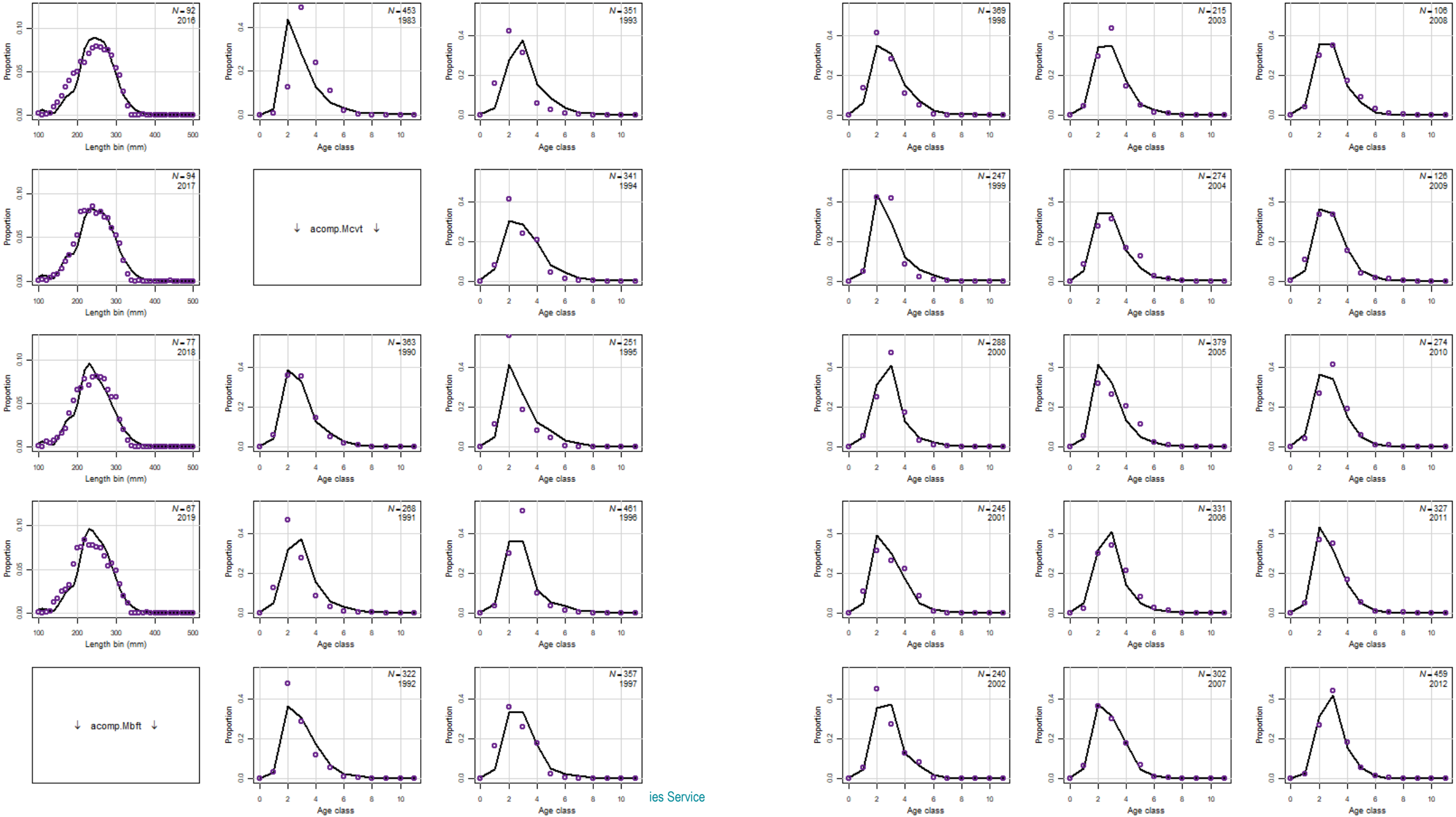


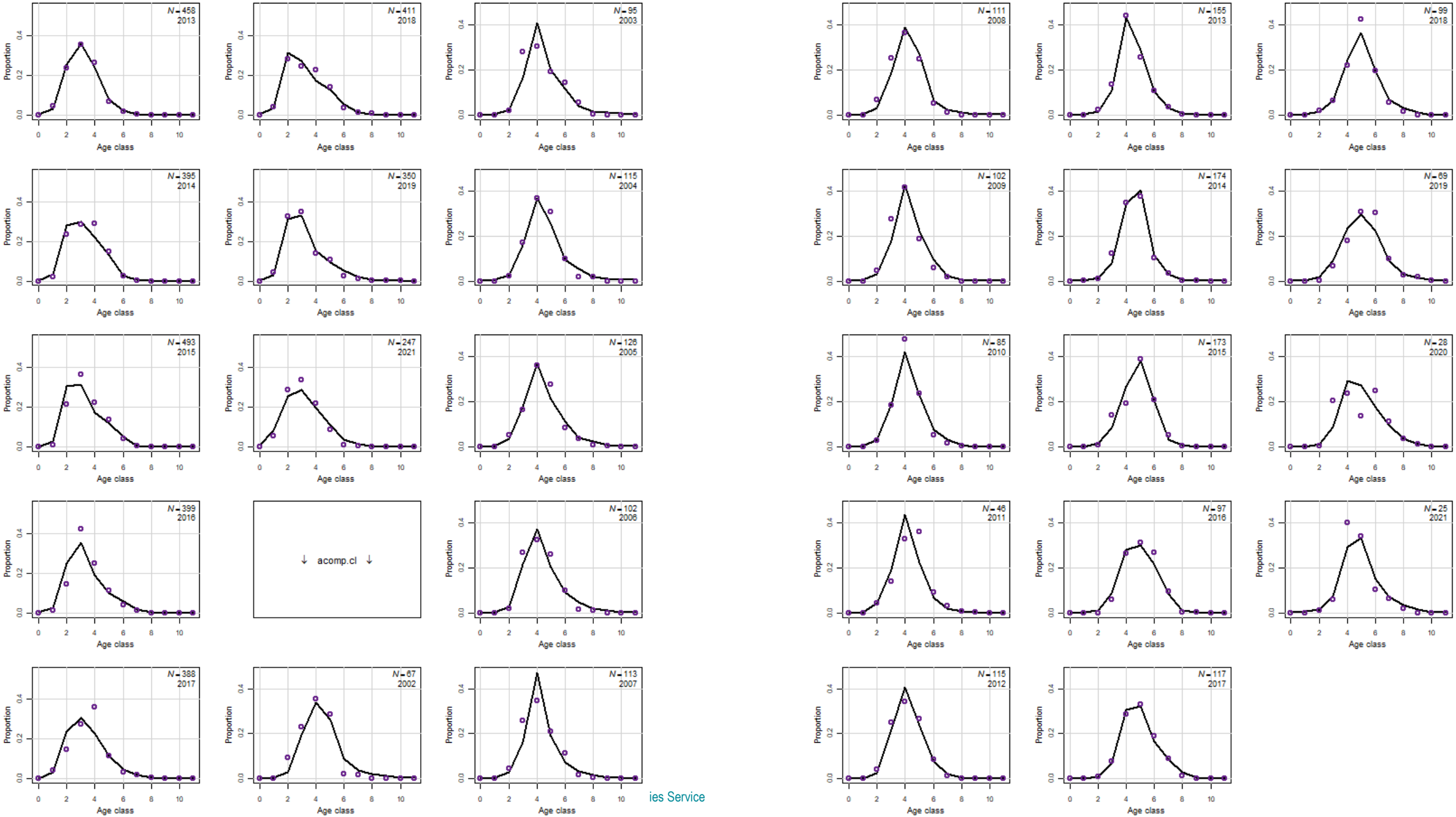

N = 460
1998
N = 27
2020
N = 107
1984
N = 399
1989
N = 233
1994
N = 242
1999
N = 403
1999
↓ lcomp.mrip ↓
N = 137
1985
N = 232
1990
N = 188
1995
N = 227
2000
N = 333
2000
N = 53
1981
N = 210
1986
N = 210
1991
N = 227
1996
N = 313
2001
N = 329
2001
N = 123
1982
N = 290
1987
N = 320
1992
N = 193
1997
N = 218
2002
N = 305
2002
N = 47
1983
N = 122
1988
N = 229
1993
N = 206
1998
N = 275
2003
Proportion
Length bin (mm)

ies Service

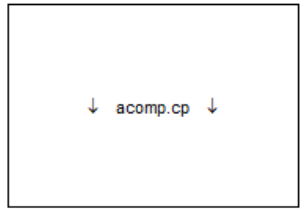

N = 377
2004
N = 209
2009
N = 199
2014
N = 127
2019
N = 94
2006
N = 120
2011
N = 330
2005
N = 298
2010
N = 188
2015
N = 170
2020
N = 109
2007
N = 114
2012
N = 309
2006
N = 143
2011
N = 183
2016
N = 141
2021
N = 112
2008
N = 101
2013
N = 229
2007
N = 236
2012
N = 134
2017
↓ lcomp.hb.D ↓
N = 97
2009
N = 110
2014
N = 200
2008
N = 158
2013
N = 131
2018
N = 100
2005
N = 116
2010
N = 90
2015
Proportion
Length bin (mm)

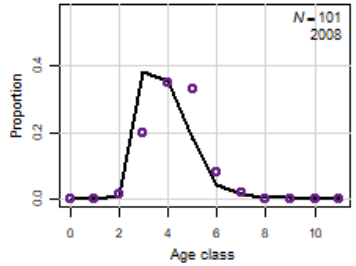
ies Service

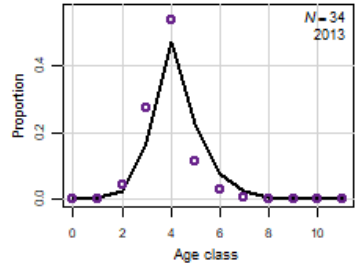

N = 92
2016
N = 453
1983
N = 351
1993
N = 369
1998
N = 215
2003
N = 106
2008
N = 94
2017
↓ acomp.Mcvt ↓
N = 341
1994
N = 247
1999
N = 274
2004
N = 126
2009
N = 77
2018
N = 363
1990
N = 251
1995
N = 288
2000
N = 379
2005
N = 274
2010
N = 67
2019
N = 268
1991
N = 461
1996
N = 245
2001
N = 331
2006
N = 327
2011
↓ acomp.Mbft ↓
N = 322
1992
N = 357
1997
N = 240
2002
N = 302
2007
N = 459
2012
Proportion
Length bin (mm)
Age class

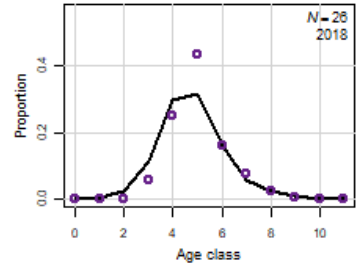

N = 458
2013
N = 411
2018
N = 95
2003
N = 111
2008
N = 155
2013
N = 99
2018
N = 395
2014
N = 350
2019
N = 115
2004
N = 102
2009
N = 174
2014
N = 69
2019
N = 493
2015
N = 247
2021
N = 126
2005
N = 85
2010
N = 173
2015
N = 28
2020
N = 399
2016
↓ acomp.cl ↓
N = 102
2006
N = 46
2011
N = 97
2016
N = 25
2021
N = 388
2017
N = 67
2002
N = 113
2007
N = 115
2012
N = 117
2017
Proportion
Age class

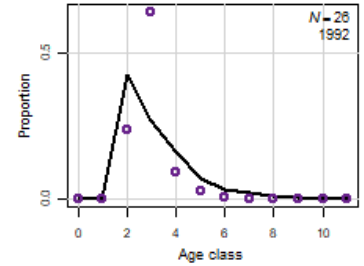
ies Service

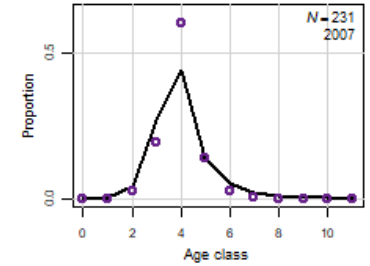

↓ acomp.cp ↓

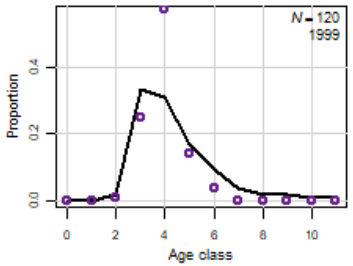

N = 101
2008
Proportion
Age class

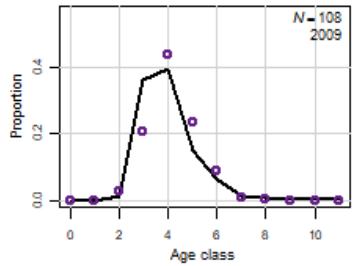

N = 34
2013
Proportion
Age class

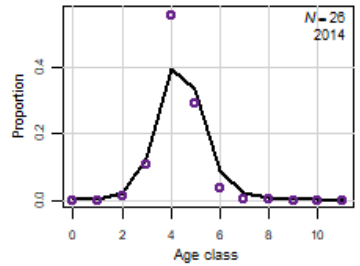

N = 26
2018
Proportion
Age class


N = 26
1992
Proportion
Age class

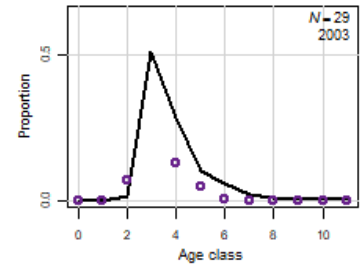

N = 231
2007
Proportion
Age class

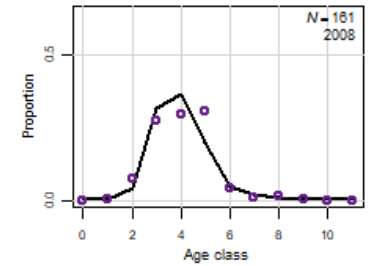

N = 120
1999
Proportion
Age class

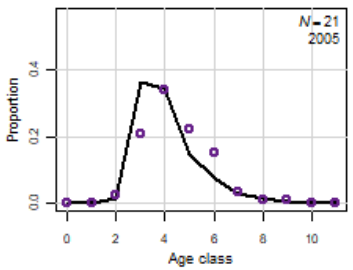

N = 108
2009
Proportion
Age class

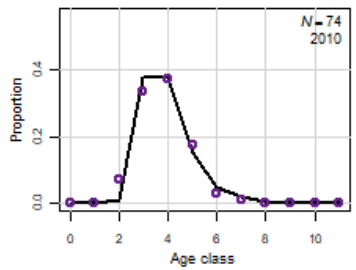

N = 26
2014
Proportion
Age class

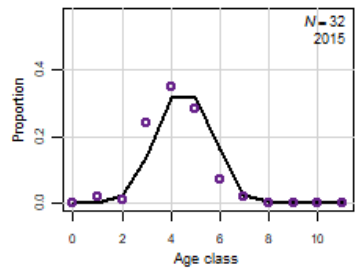

N = 17
2019
Proportion
Age class

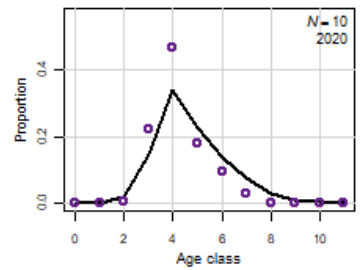

N = 29
2003
Proportion
Age class

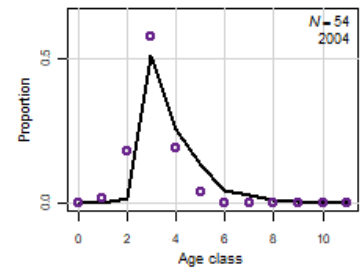

N = 161
2008
Proportion
Age class

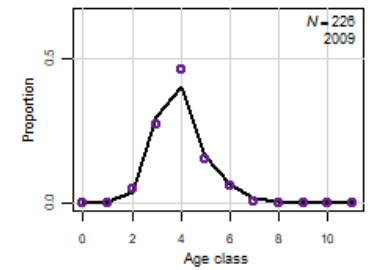

N = 21
2005
Proportion
Age class

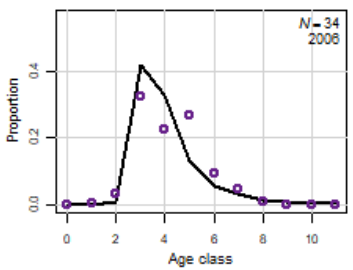

N = 74
2010
Proportion
Age class

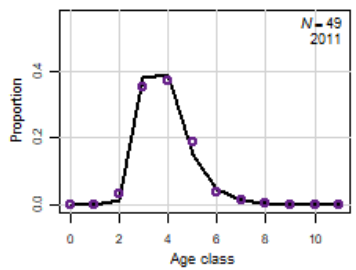

N = 32
2015
Proportion
Age class

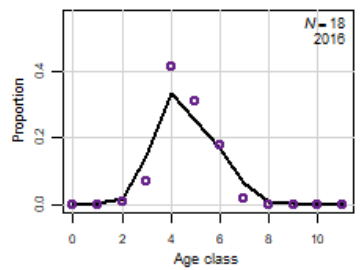

N = 10
2020
Proportion
Age class


N = 54
2004
Proportion
Age class

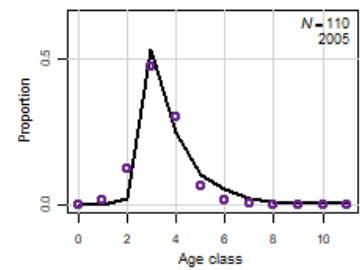

N = 226
2009
Proportion
Age class

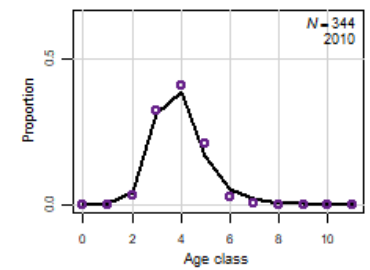

N = 34
2006
Proportion
Age class

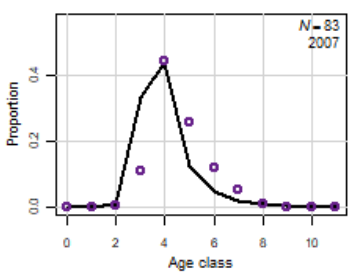

N = 49
2011
Proportion
Age class

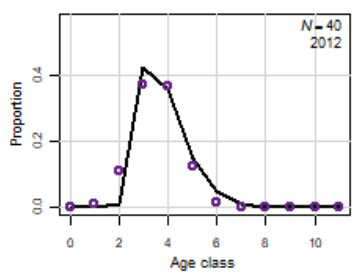

N = 18
2016
Proportion
Age class

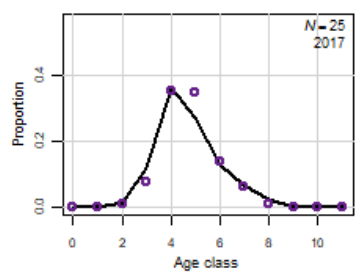

↓ acomp.hb ↓

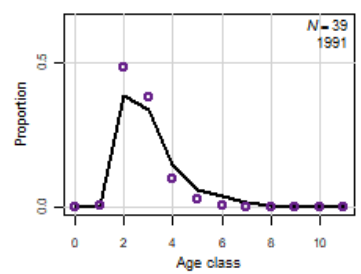

N = 110
2005
Proportion
Age class

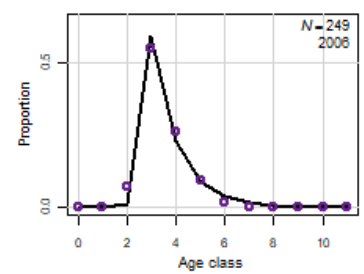

N = 344
2010
Proportion
Age class

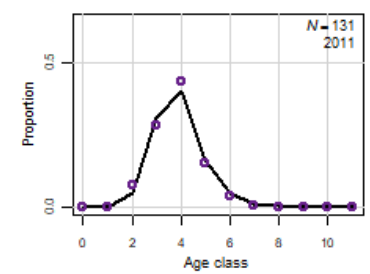

N = 83
2007
Proportion
Age class

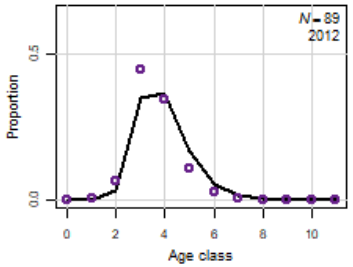

N = 40
2012
Proportion
Age class

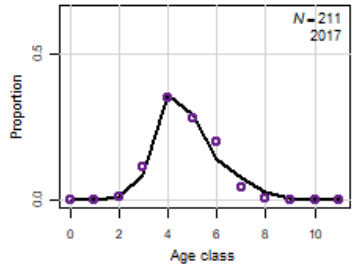

N = 25
2017
Proportion
Age class

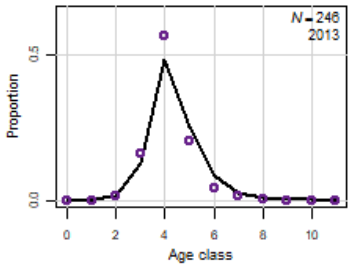

N = 39
1991
Proportion
Age class

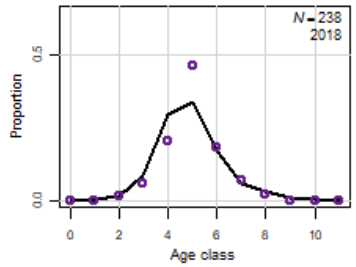

N = 249
2006
Proportion
Age class

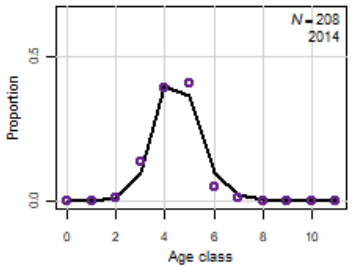

N = 131
2011
Proportion
Age class

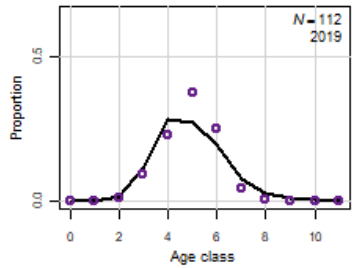


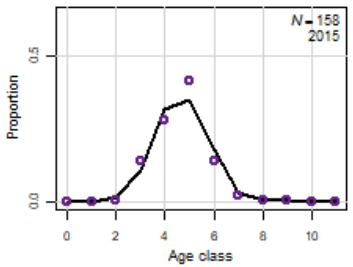


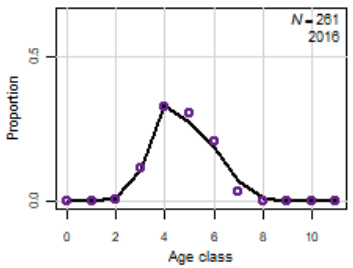












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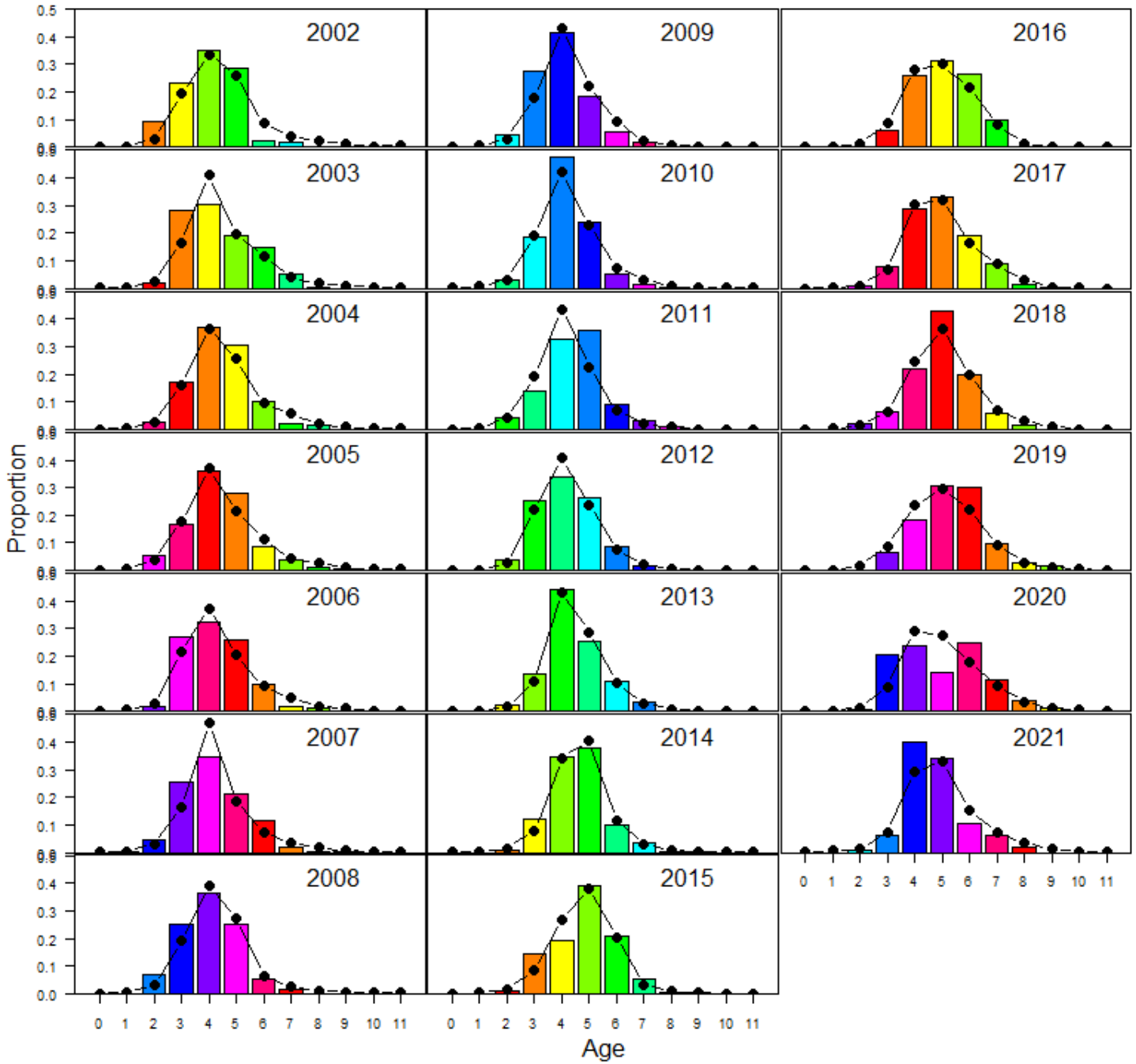
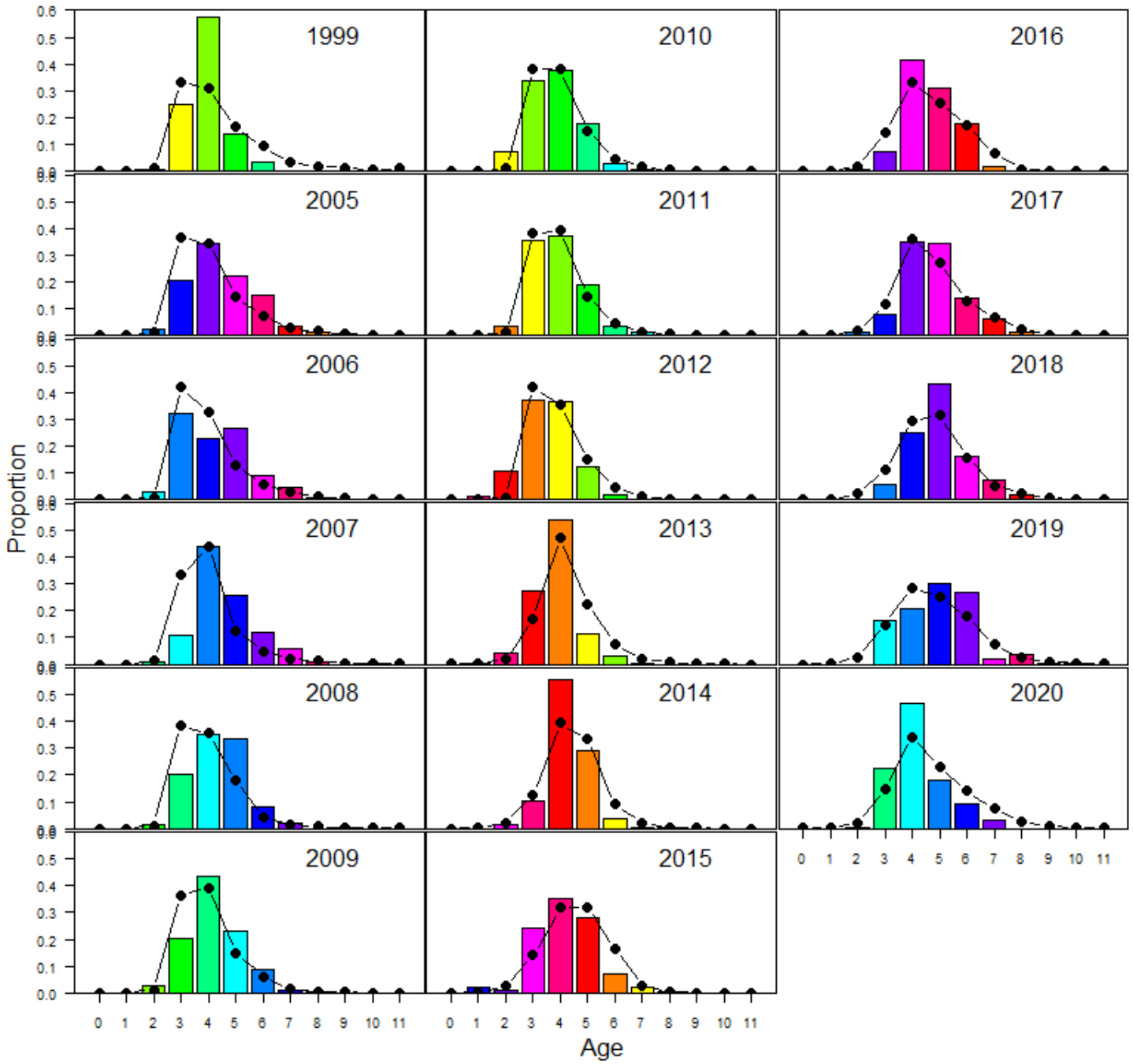
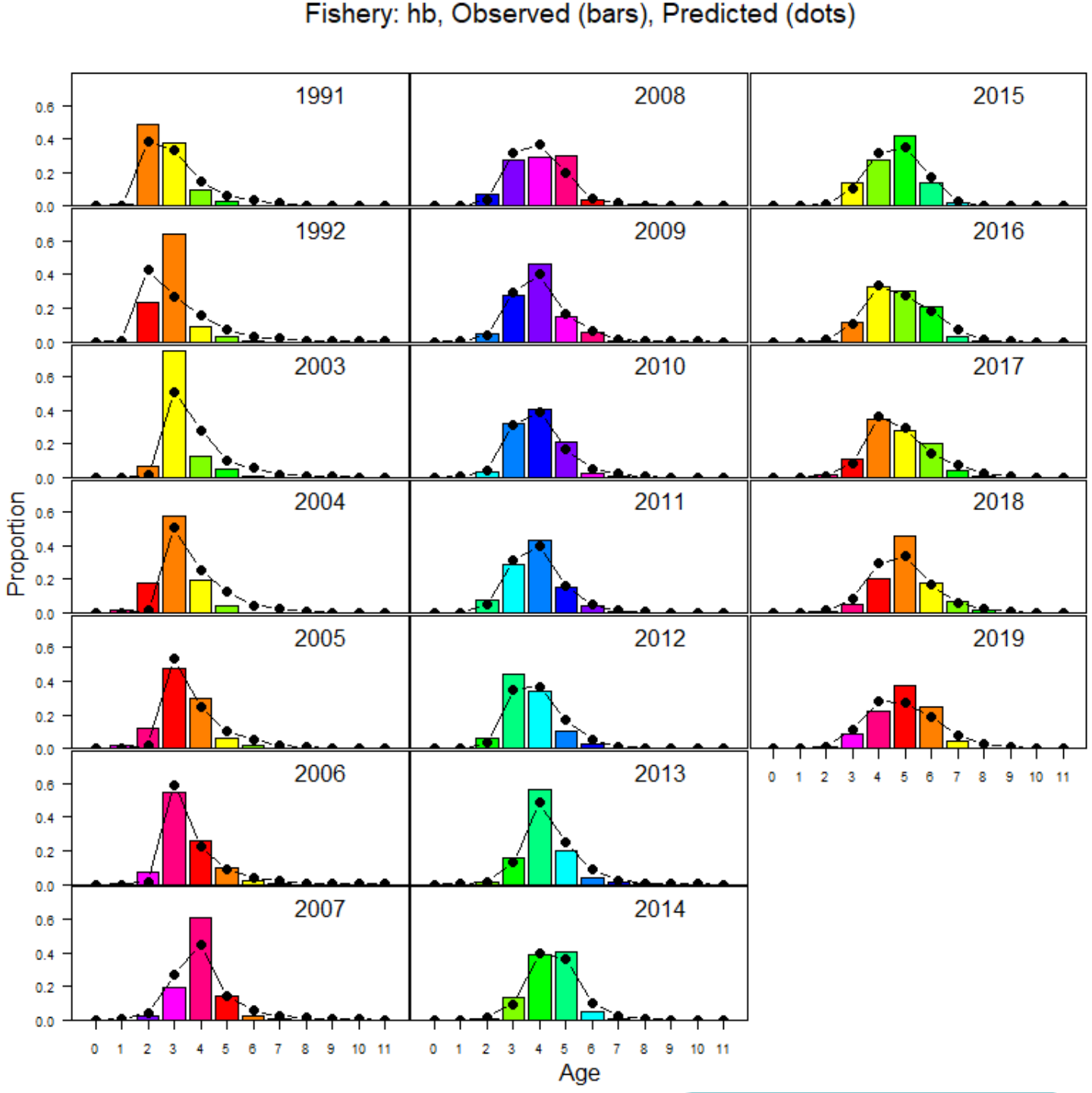
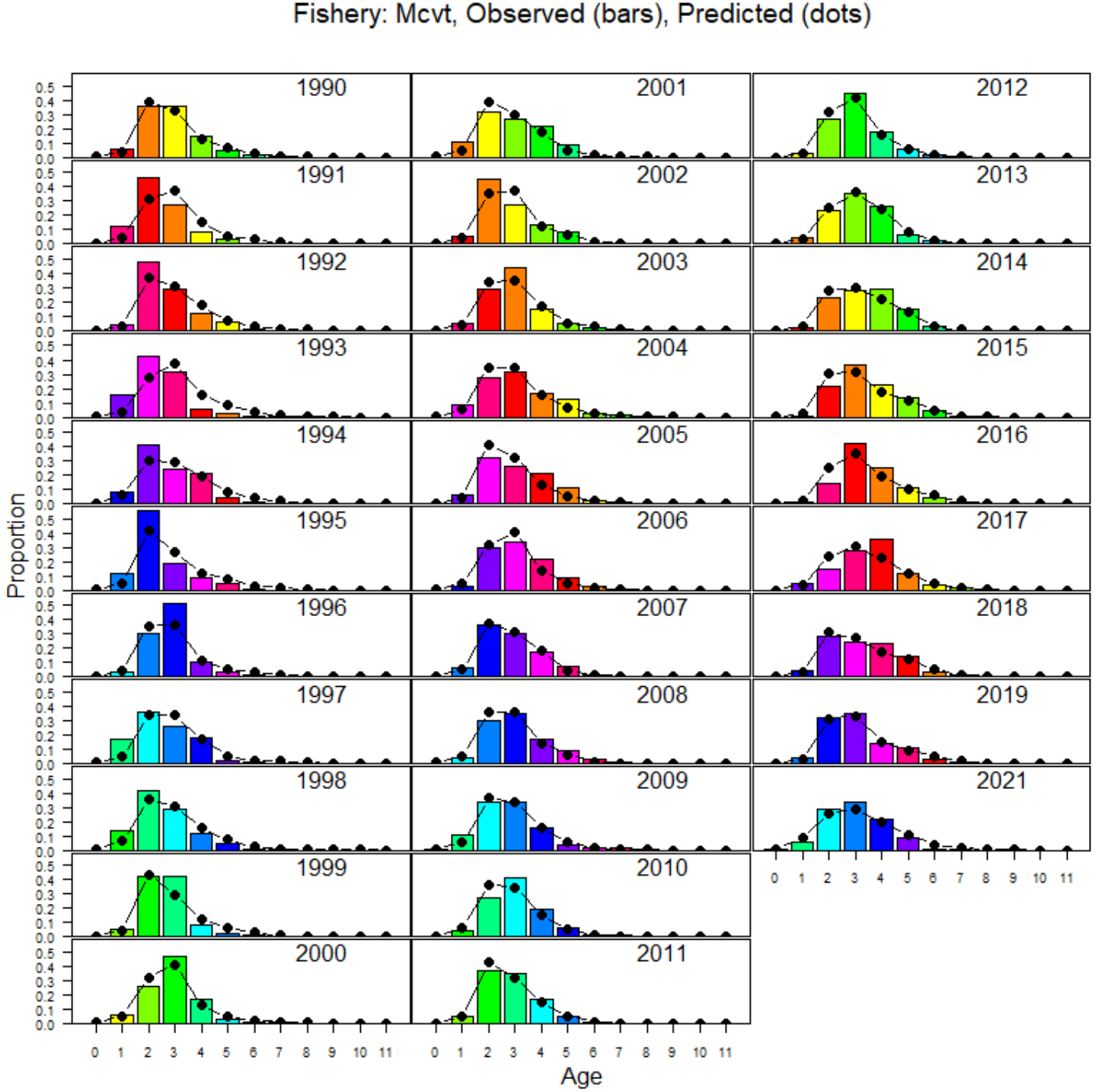
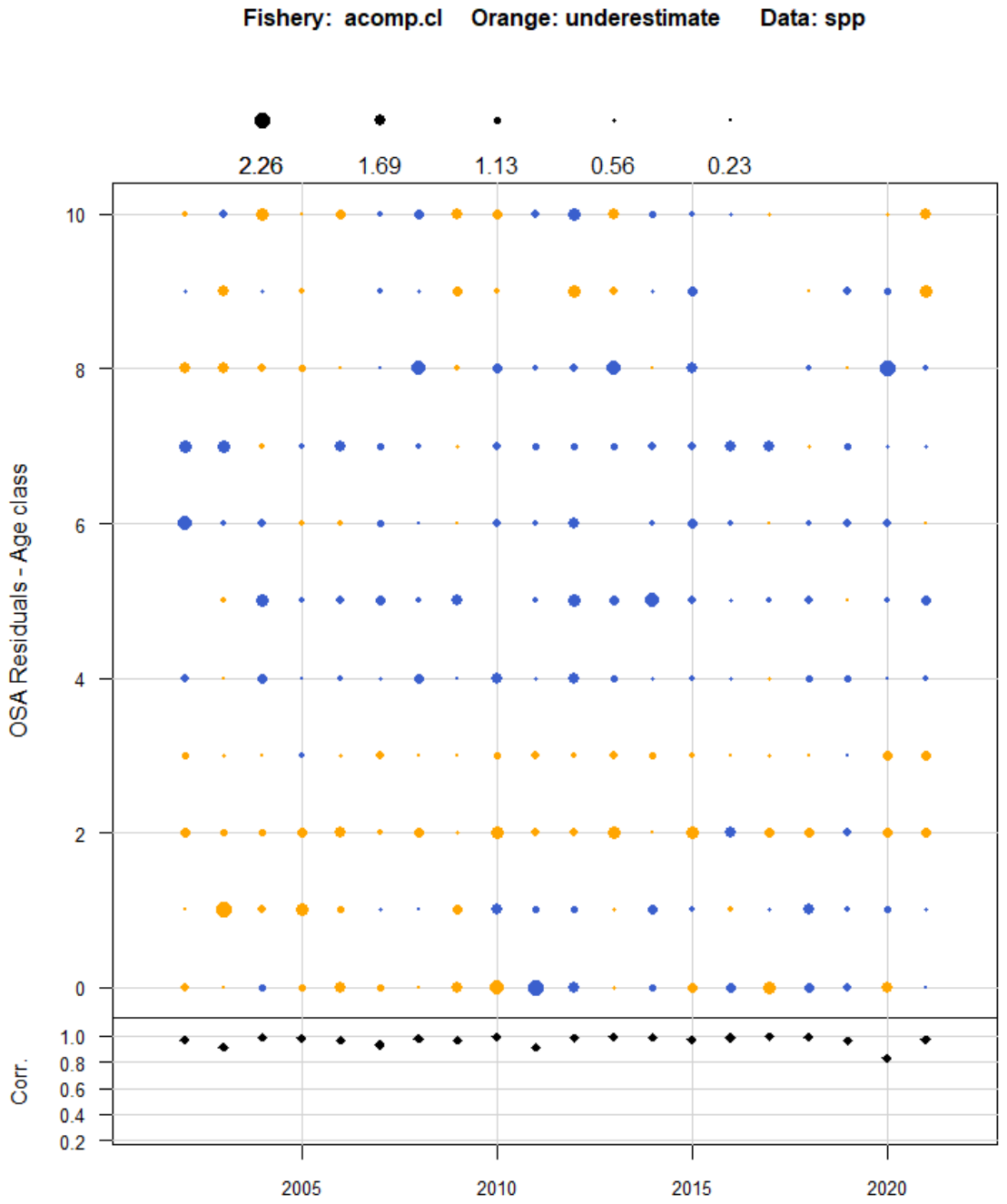

Fishery: cl, Observed (bars), Predicted (dots)
Proportion
Age
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021


Fishery: cp, Observed (bars), Predicted (dots)
1999
2010
2016
2005
2011
2017
2006
2012
2018
2007
2013
2019
2008
2014
2020
2009
2015
Proportion
Age

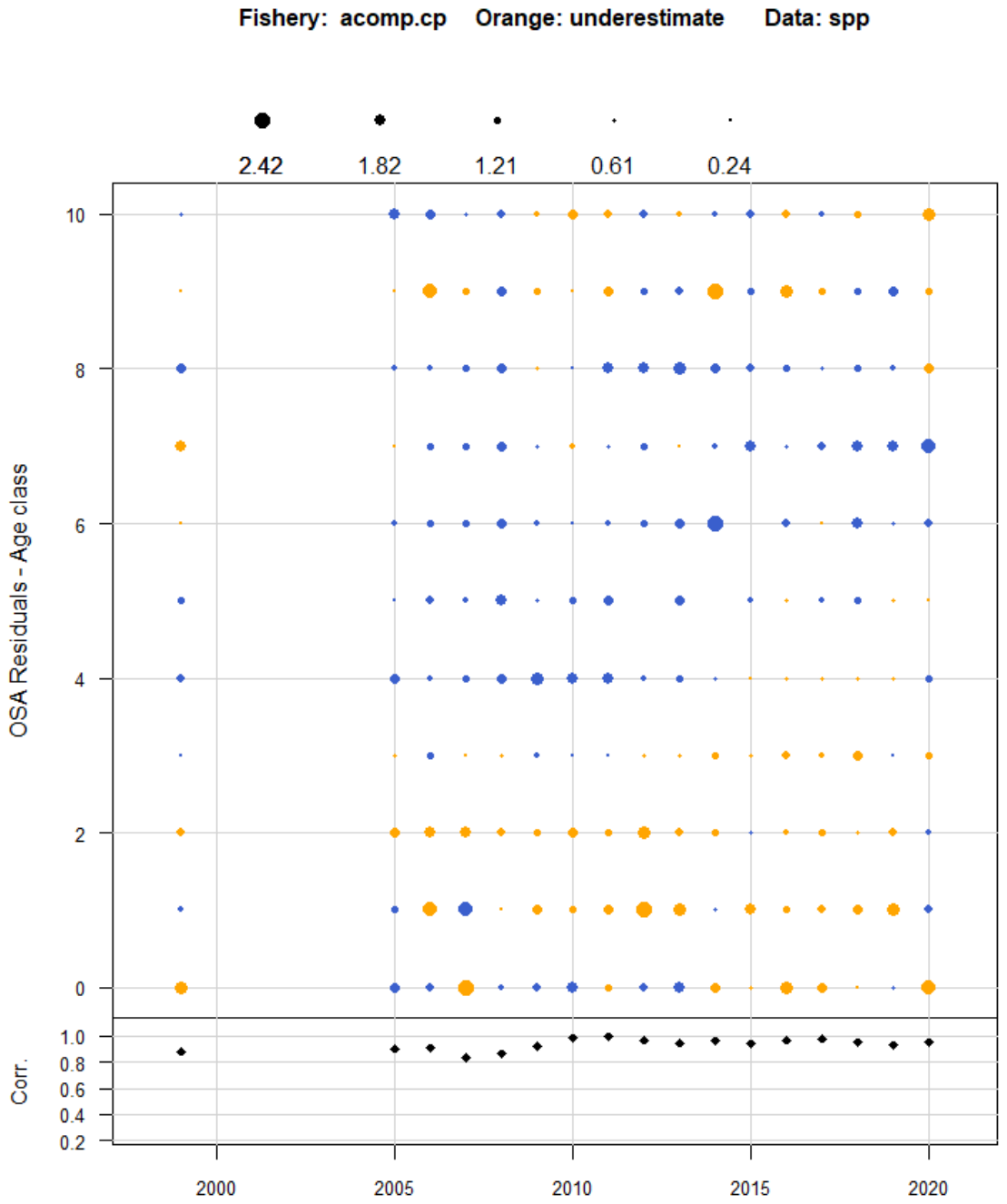

Fishery: hb, Observed (bars), Predicted (dots)
1991
2008
2015
1992
2009
2016
2003
2010
2017
2004
2011
2018
2005
2012
2019
2006
2013
2007
2014
Proportion
Age


Fishery: Mcvt, Observed (bars), Predicted (dots)
Proportion
Age
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2021

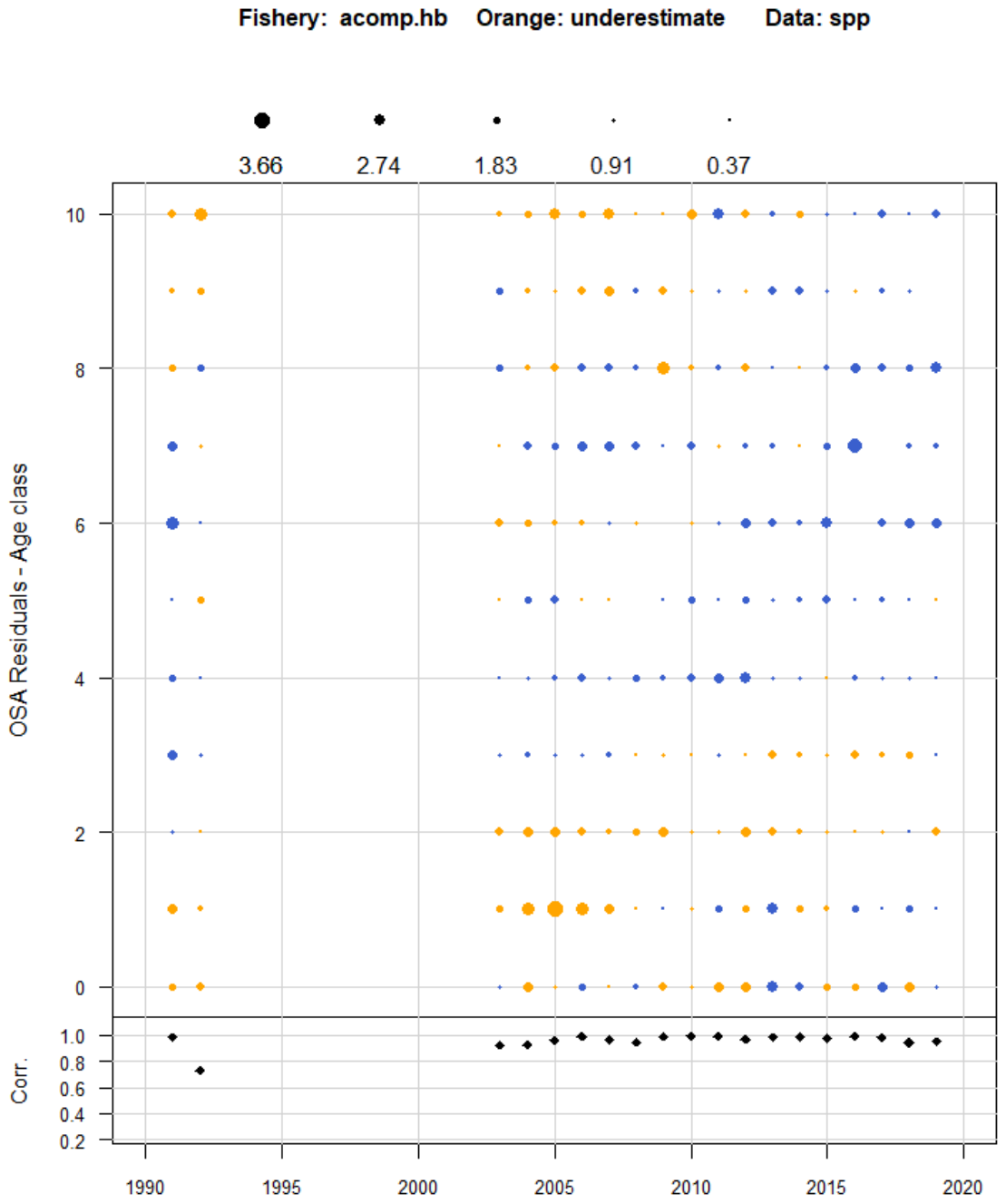
One Step Ahead Residuals Age composition commercial handline



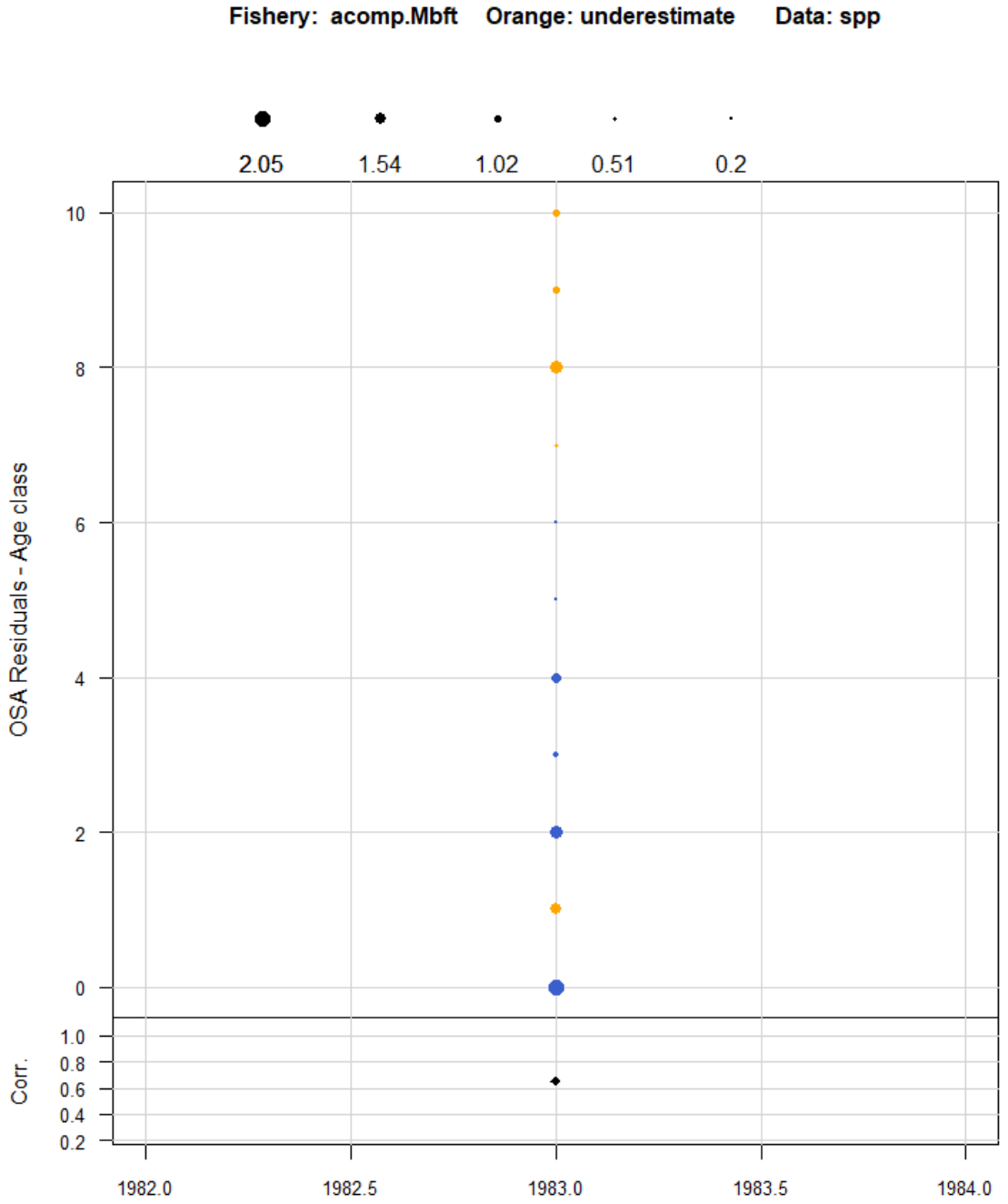
One Step Ahead Residuals Age composition commercial pots



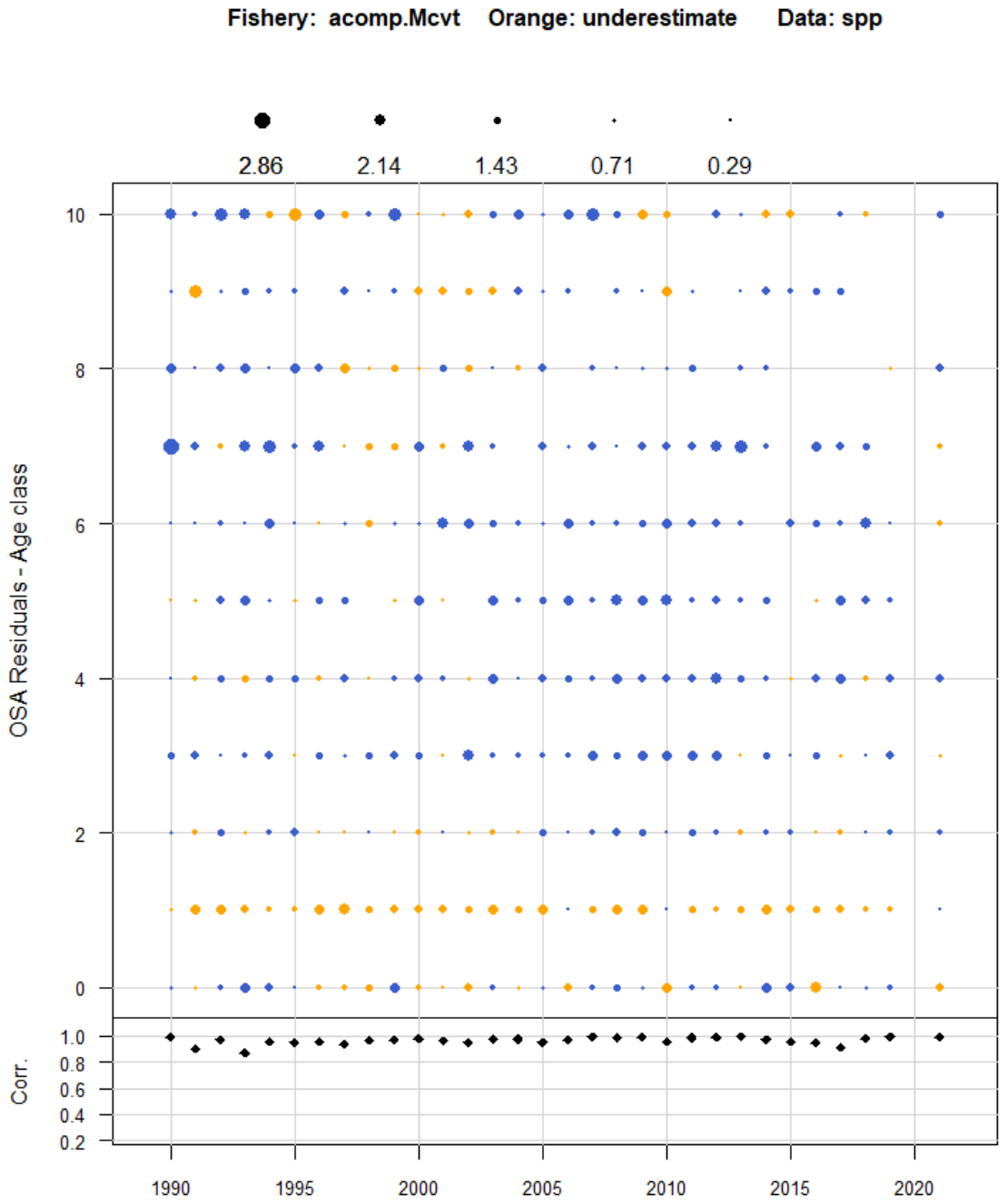
One Step Ahead Residuals Age composition headboat



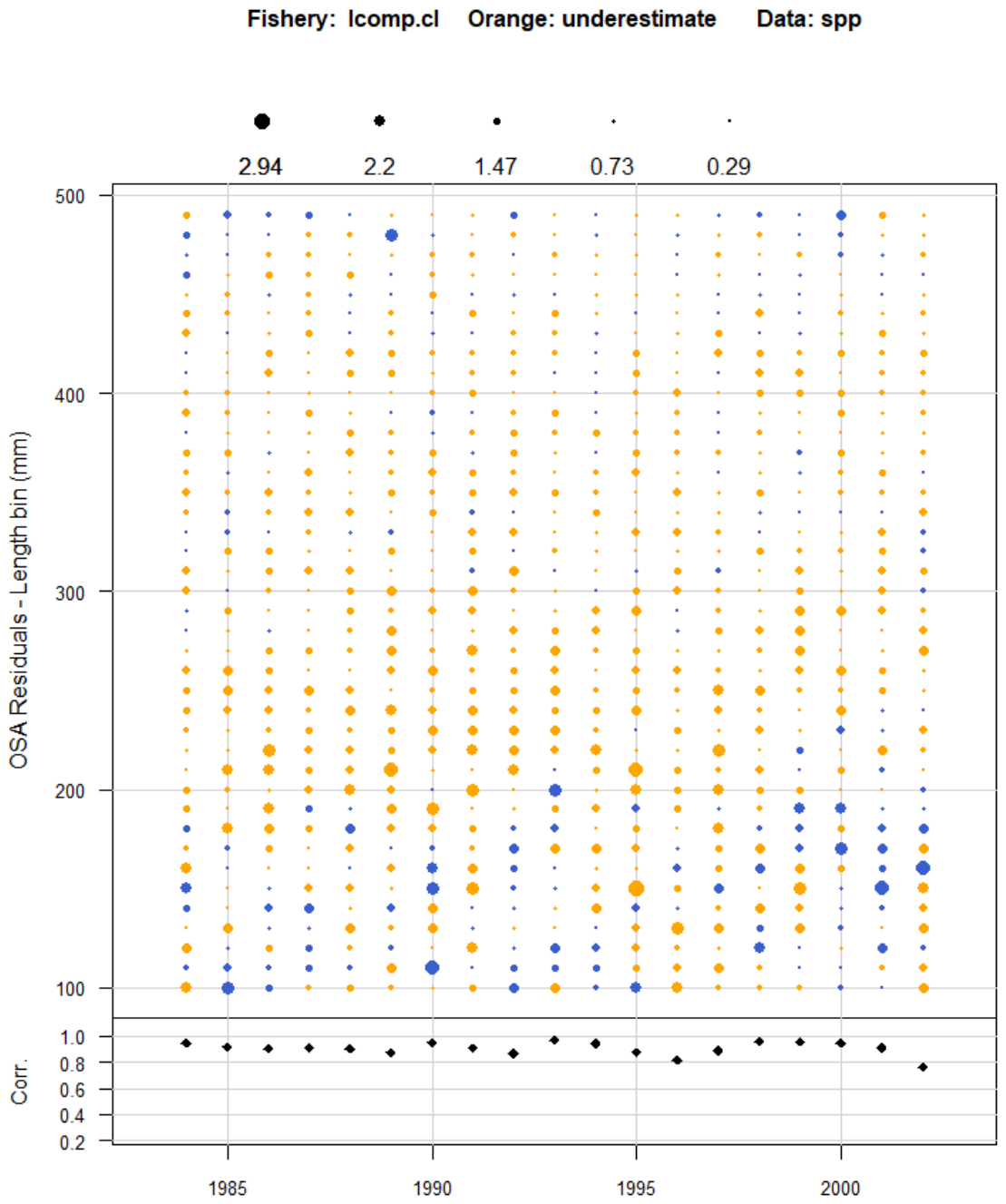
One Step Ahead Residuals Age composition MARAMAP blackfish survey



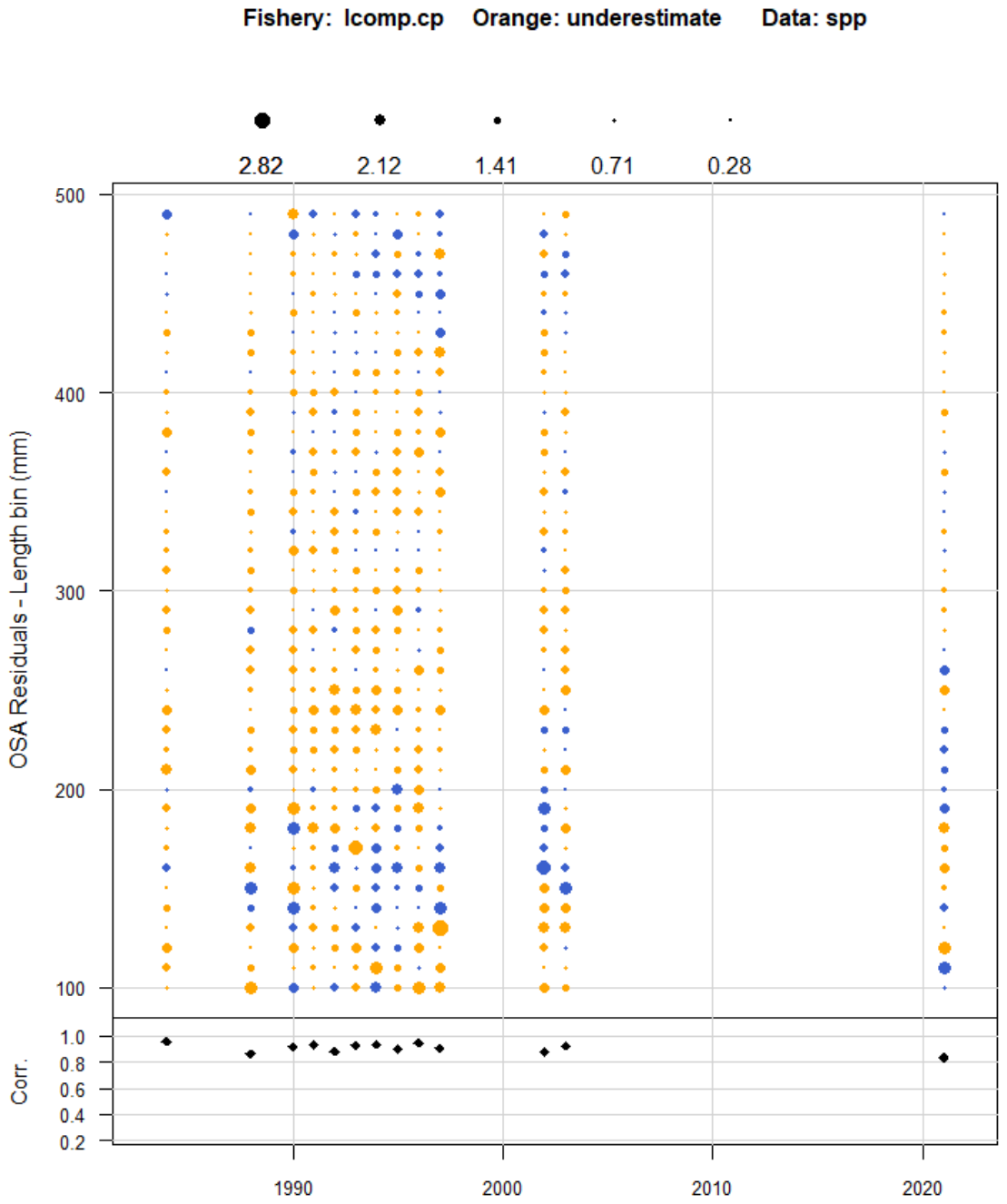
One Step Ahead Residuals Age composition SERFS



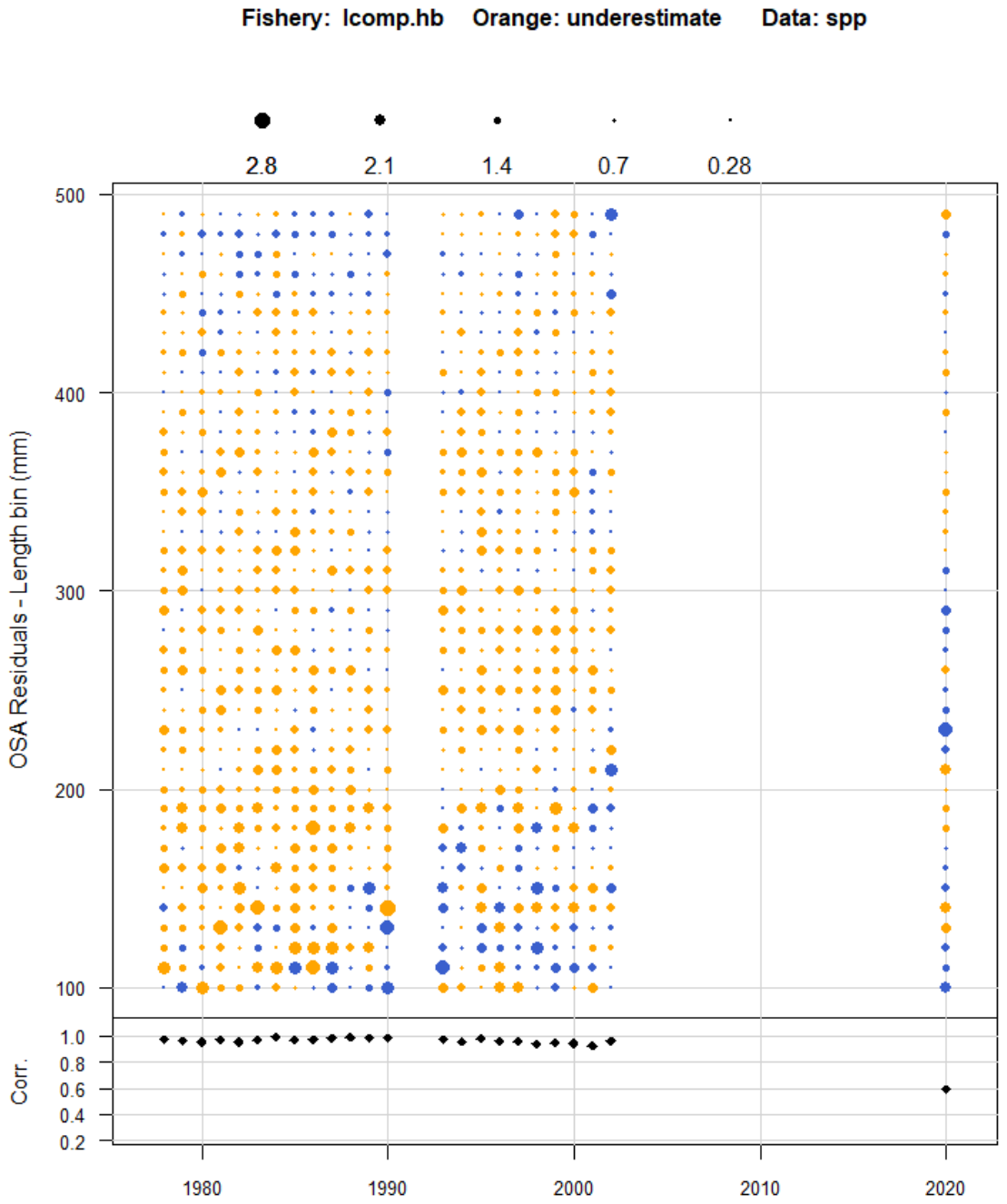
One Step Ahead Residuals Length composition commercial handline



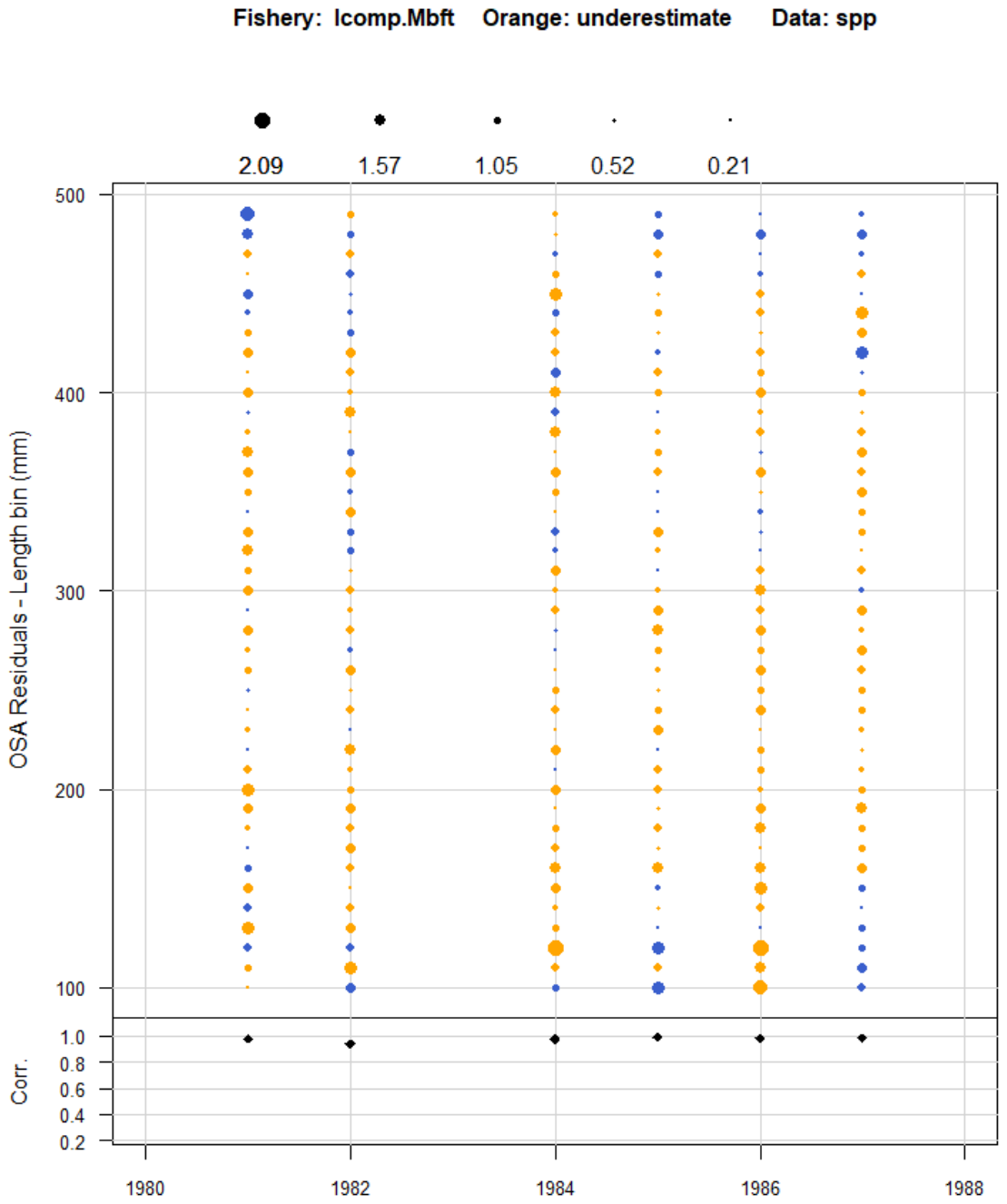
One Step Ahead Residuals Length composition commercial pots



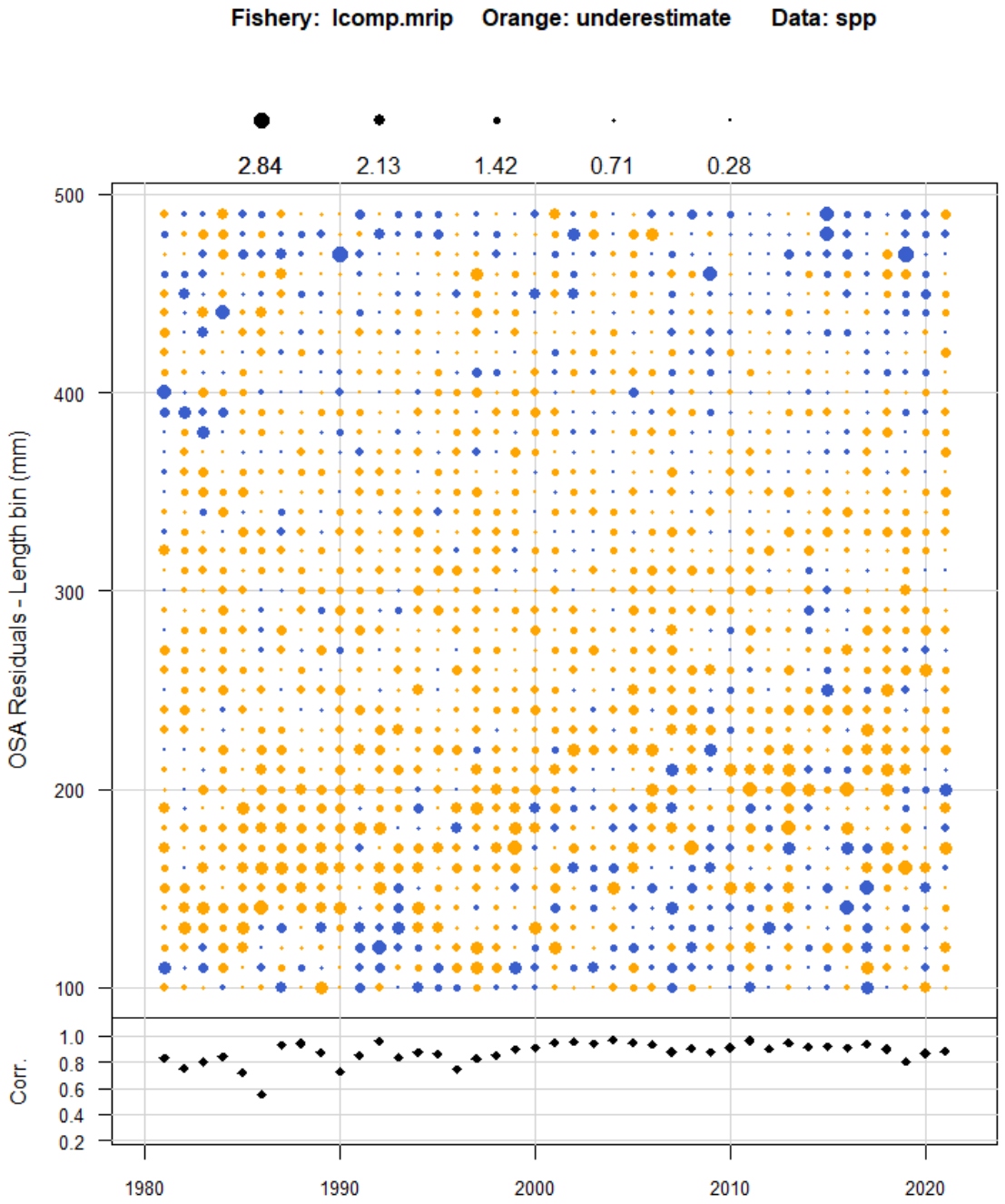
One Step Ahead Residuals Length composition headboat



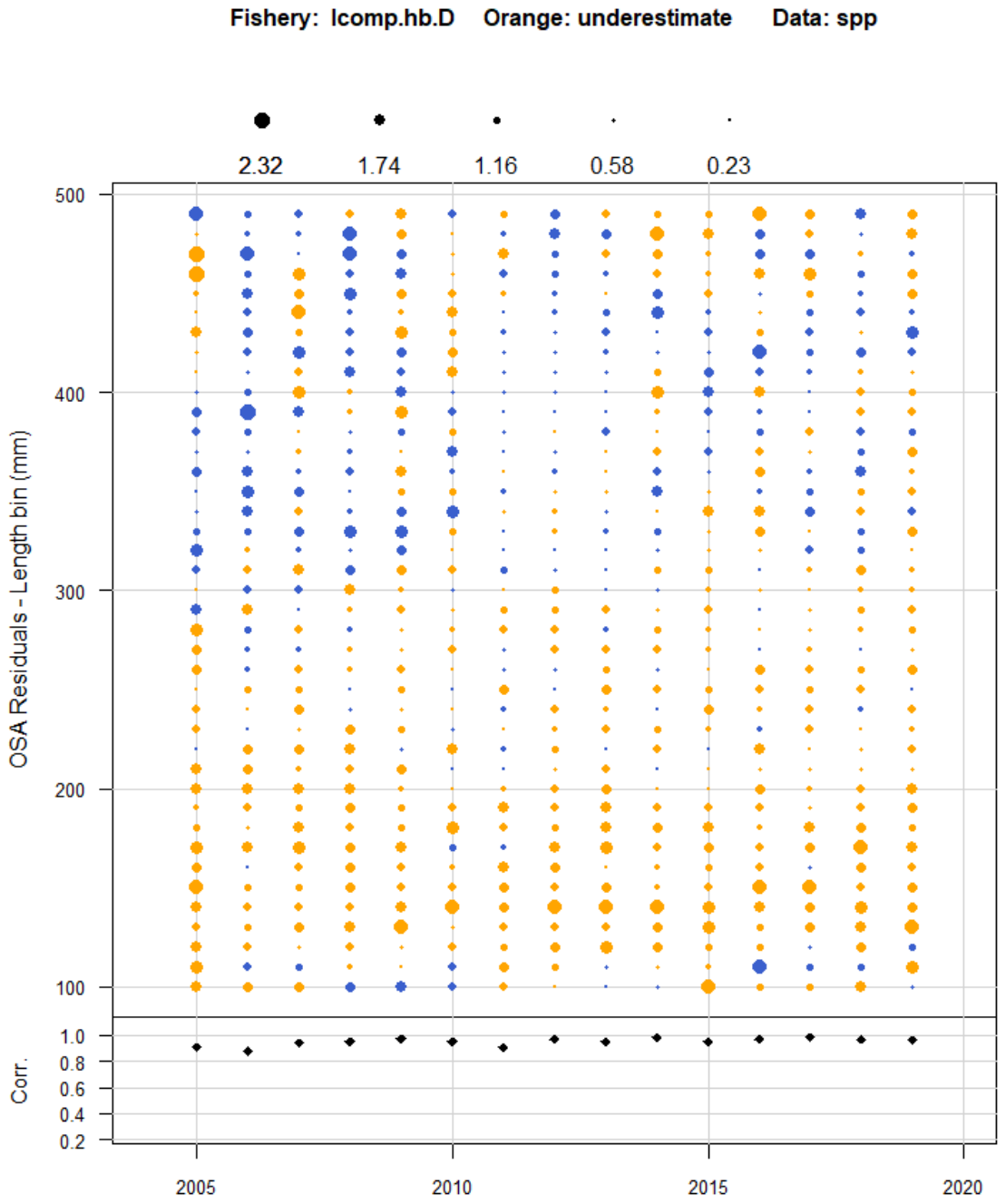
One Step Ahead Residuals Length composition MARAMAP blackfish survey



One Step Ahead Residuals Length composition general recreational



One Step Ahead Residuals Length composition headboat discards



Projection F=0, long-term mean recruitment

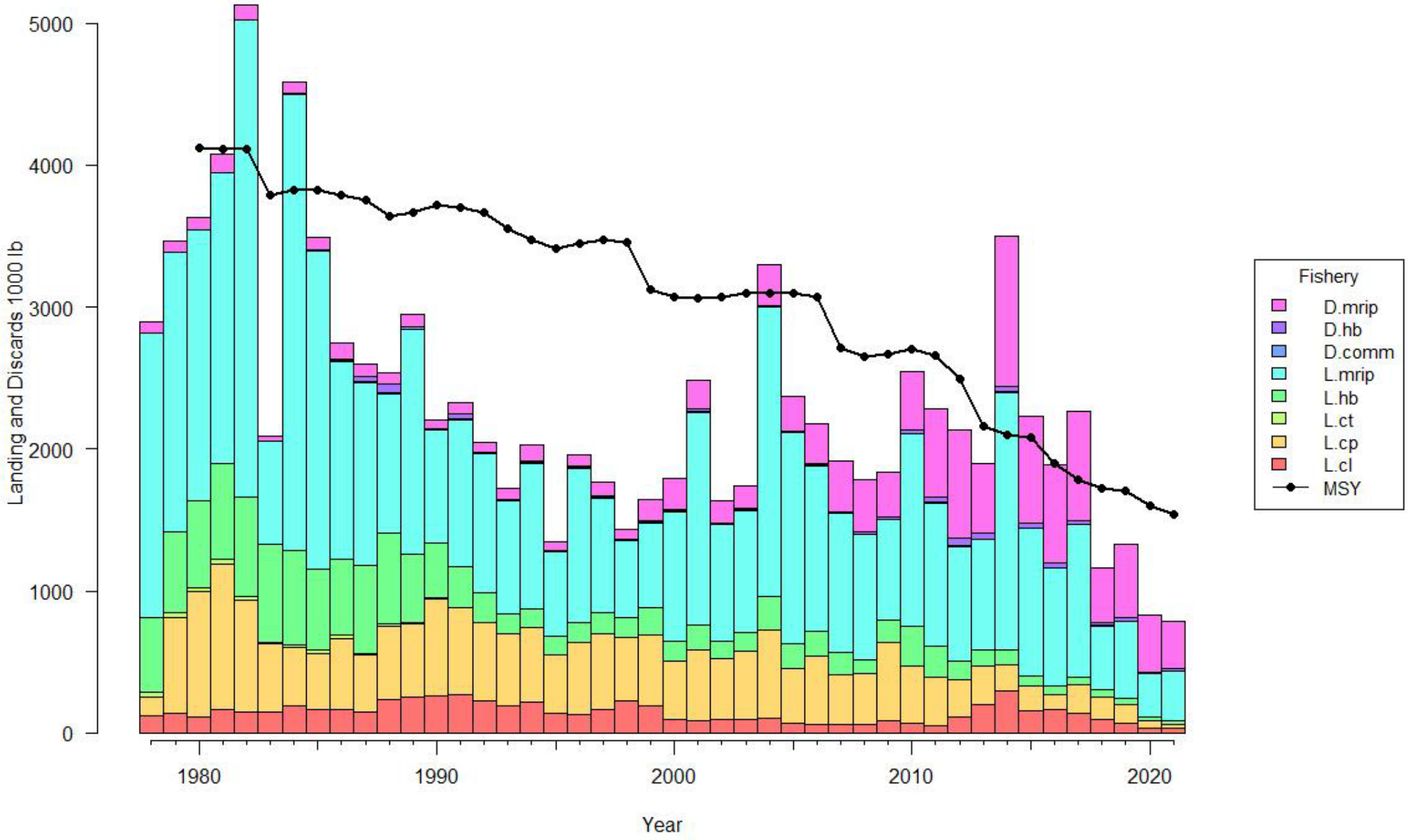
Table 22. Projection results with fishing mortality rate fixed at $F = 0$ starting in 2025 and long-term, average recruitment starting in 2023. R = number of age-0 recruits (in millions), F = fishing mortality rate (per year), S = spawning stock (1E10 eggs), L = landings and D = discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb), pr.reb = proportion of stochastic projection replicates with $\text{SSB} \geq \text{SSB}_{\text{MSY}}$. The extension b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b	S.med	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2022	25	116	3.255	2.558	76	99	465	419	544	508	2603	3791	953	1236	0.000
2023	82	115	10.000	10.000	50	143	219	281	205	261	5892	8975	1621	2167	0.012
2024	82	117	10.000	10.000	103	160	53	86	18	27	8244	14957	1668	3743	0.023
2025	82	115	0.000	0.000	178	223	0	0	0	0	0	0	0	0	0.049
2026	82	116	0.000	0.000	282	347	0	0	0	0	0	0	0	0	0.161
2027	82	114	0.000	0.000	367	444	0	0	0	0	0	0	0	0	0.336
2028	82	116	0.000	0.000	427	509	0	0	0	0	0	0	0	0	0.516
2029	82	115	0.000	0.000	466	549	0	0	0	0	0	0	0	0	0.654
2030	82	115	0.000	0.000	488	575	0	0	0	0	0	0	0	0	0.731
2031	82	116	0.000	0.000	499	588	0	0	0	0	0	0	0	0	0.765
2032	82	116	0.000	0.000	505	594	0	0	0	0	0	0	0	0	0.781
2033	82	114	0.000	0.000	507	595	0	0	0	0	0	0	0	0	0.787
2034	82	115	0.000	0.000	508	595	0	0	0	0	0	0	0	0	0.788
2035	82	114	0.000	0.000	509	595	0	0	0	0	0	0	0	0	0.786
2036	82	115	0.000	0.000	509	595	0	0	0	0	0	0	0	0	0.787
2037	82	115	0.000	0.000	510	596	0	0	0	0	0	0	0	0	0.789
2038	82	114	0.000	0.000	510	597	0	0	0	0	0	0	0	0	0.794
2039	82	115	0.000	0.000	510	597	0	0	0	0	0	0	0	0	0.794

Projection F=0, recent mean recruitment

Table 23. Projection results with fishing mortality rate fixed at $F = 0$ starting in 2025 and recent average recruitment starting in 2023. R = number of age-0 recruits (in millions), F = fishing mortality rate (per year), S = spawning stock (1E10 eggs), L = landings and D = discards expressed in numbers (n, in 1000s) or whole weight (w, in 1000 lb*), pr.reb = proportion of stochastic projection replicates with* $\text{SSB} \geq \text{SSB}_{\text{MSY}}$*. The extension* b *indicates expected values (deterministic) from the base run; the extension* med *indicates median values from the stochastic projections.*

Year	R.b	R.med	F.b	F.med	S.b	S.med	L.b(n)	L.med(n)	L.b(w)	L.med(w)	D.b(n)	D.med(n)	D.b(w)	D.med(w)	pr.reb
2022	25	116	3.255	2.558	76	99	465	419	544	508	2603	3791	953	1236	0.000
2023	25	38	10.000	10.000	50	143	215	275	205	261	4980	8117	1573	2126	0.012
2024	25	38	10.000	10.000	41	85	33	63	15	24	3829	9586	1007	2935	0.001
2025	25	38	0.000	0.000	55	78	0	0	0	0	0	0	0	0	0.000
2026	25	38	0.000	0.000	86	119	0	0	0	0	0	0	0	0	0.000
2027	25	38	0.000	0.000	111	150	0	0	0	0	0	0	0	0	0.000
2028	25	38	0.000	0.000	129	172	0	0	0	0	0	0	0	0	0.000
2029	25	38	0.000	0.000	141	187	0	0	0	0	0	0	0	0	0.000
2030	25	38	0.000	0.000	147	195	0	0	0	0	0	0	0	0	0.000
2031	25	38	0.000	0.000	150	199	0	0	0	0	0	0	0	0	0.000
2032	25	38	0.000	0.000	152	201	0	0	0	0	0	0	0	0	0.000
2033	25	37	0.000	0.000	153	202	0	0	0	0	0	0	0	0	0.000
2034	25	38	0.000	0.000	153	202	0	0	0	0	0	0	0	0	0.000
2035	25	38	0.000	0.000	153	202	0	0	0	0	0	0	0	0	0.000
2036	25	38	0.000	0.000	153	203	0	0	0	0	0	0	0	0	0.000
2037	25	38	0.000	0.000	154	203	0	0	0	0	0	0	0	0	0.000
2038	25	38	0.000	0.000	154	203	0	0	0	0	0	0	0	0	0.000
2039	25	38	0.000	0.000	154	203	0	0	0	0	0	0	0	0	0.000


Landing and Discards 1000 lb
5000
4000
3000
2000
1000
0
1980
1990
2000
2010
2020
Year
Fishery
D.mrip
D.hb
D.comm
L.mrip
L.hb
L.ct
L.cp
L.cl
MSY