Alternative Models for BSAI Northern Rock Sole

Carey R. McGilliard and Jim Ianelli
September 2024

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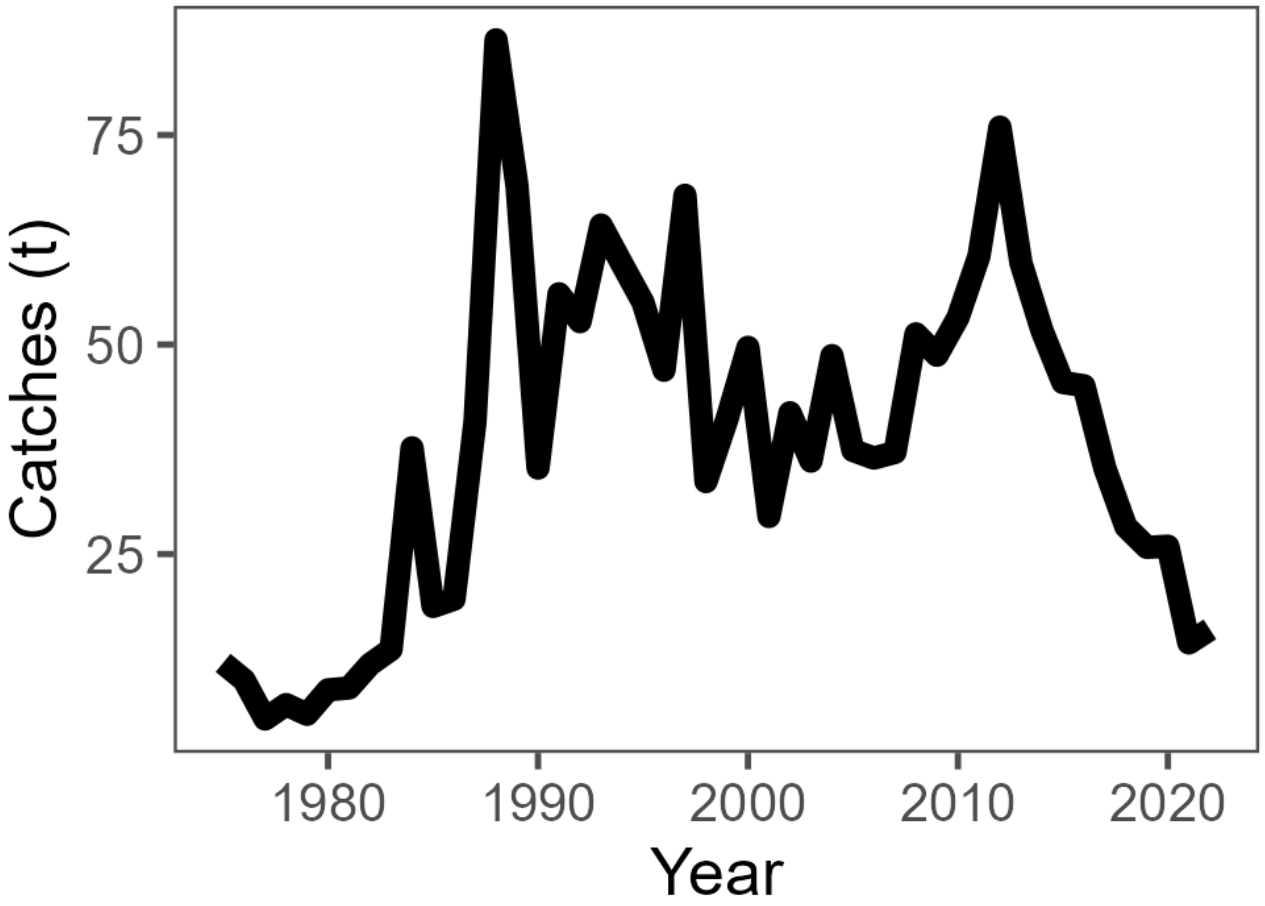
Catch Time series



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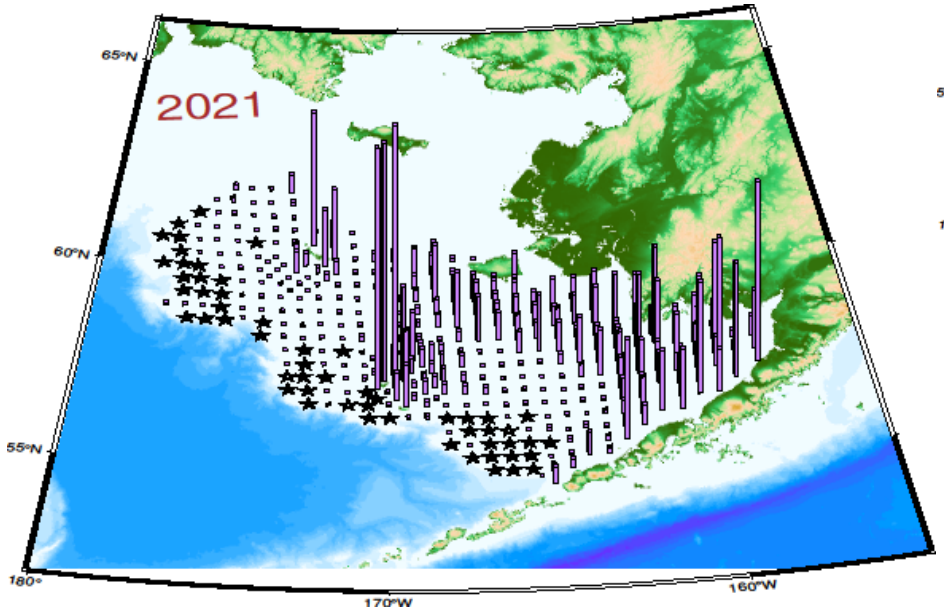
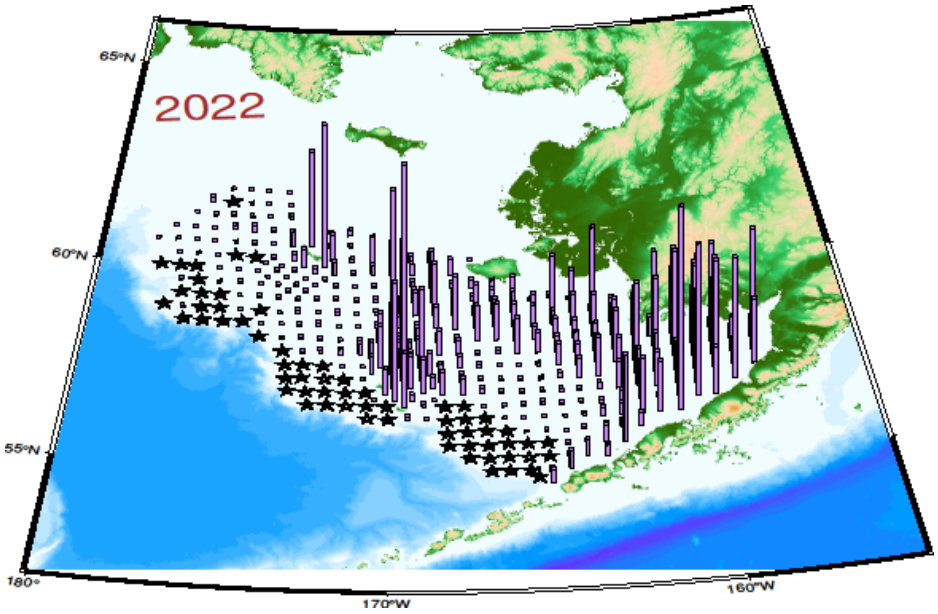
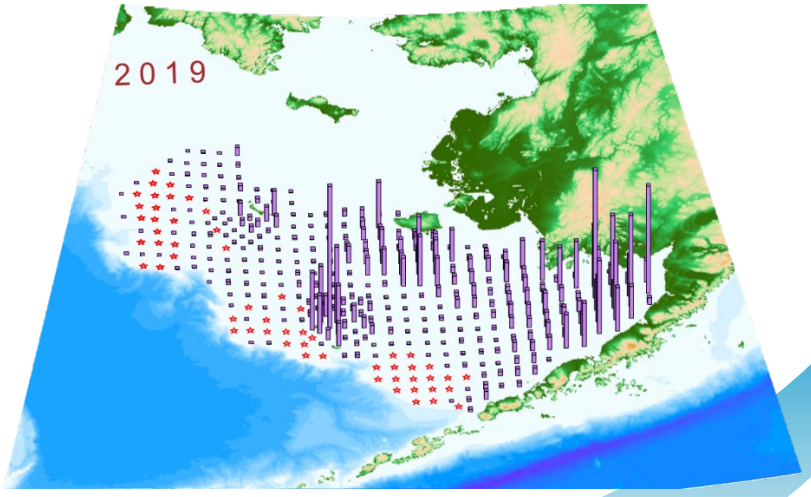
Survey CPUE (previous years)







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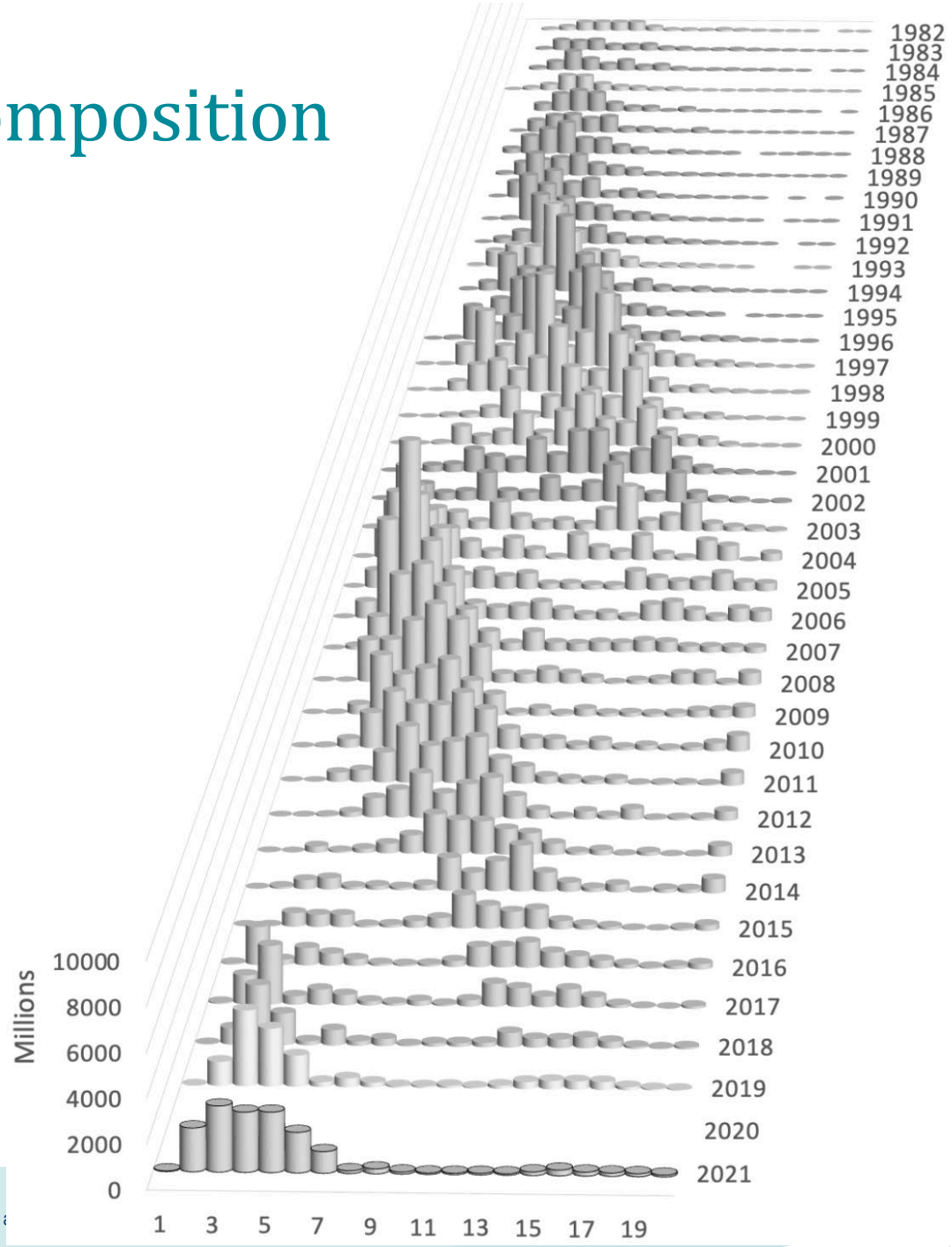
Survey age composition



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Data inputs

- Yearly empirical mean weight-at-age estimates
- Fishery age composition
- EBS shelf bottom trawl survey index
- EBS shelf bottom trawl survey ages

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General model setup

- Parameters estimated within the model:
  - Yearly time-varying fishery selectivity (sex-specific)
  - Male fishery selectivity offset (time-invariant)
  - Time-invariant logistic survey selectivity (sex-specific)
  - Survey catchability (with prior), time-invariant
  - Male natural mortality (with prior)
  - Female natural mortality (with prior; Model 24.2)
  - Mean recruitment, mean fishing mortality, recruitment and fishing mortality deviations
  - Initial age comps
  - Bmsy, Fmsy
- Parameters estimated outside of the model
  - sigmaR = 0.6
  - Female natural mortality = 0.15 (Model 18.3_new, Model, 22.1, Model 24.1)
  - Maturity-at-age

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Life history

- Plus group at age 20 (age 37 has been observed in the data)
- Spawn December – March
- Separate winter spawning and summer feeding grounds
- Northern spawning area near the Pribilof Islands appears very successful in warm years (Cooper et al. 2020)
- Time-varying, sex-specific growth

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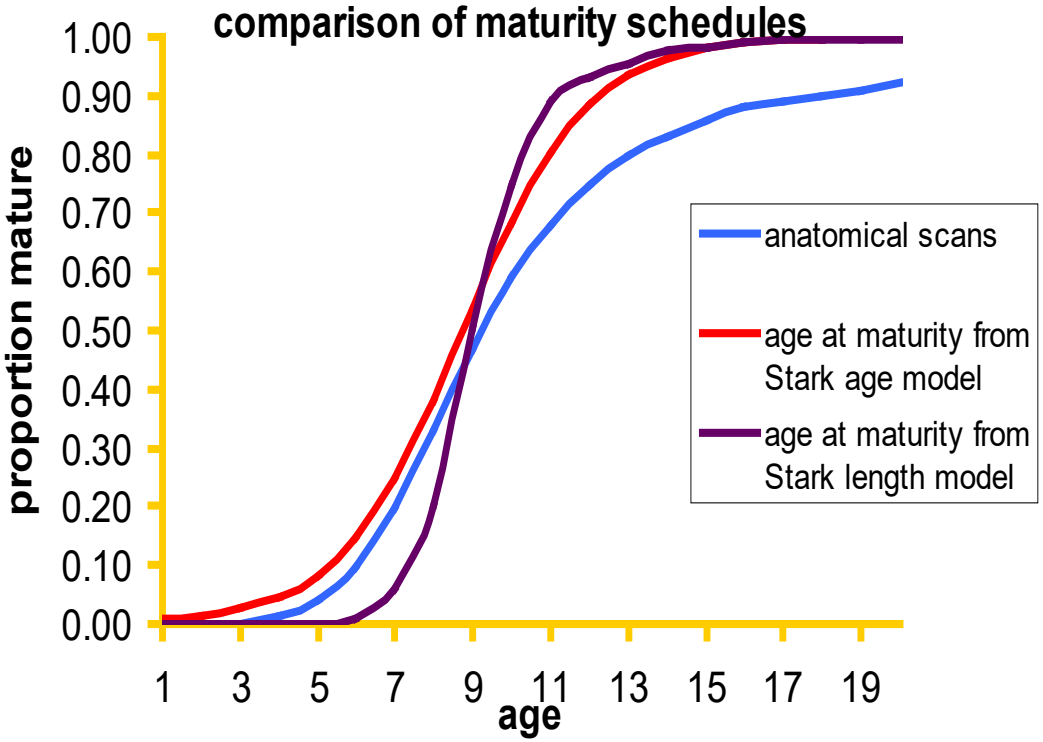
Maturity ogive from a 2012 paper



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Models presented and used in bridging

- Model 18.3: The 2022 accepted model
- Model 18.3_new: the 2022 accepted model with available new data
- Model 22.1: As for 18.3_new, but with Francis data weighting
  - Current ABC is the OFL from the 2022 version of this model.
- Model 24.1: As for Model 22.1, but with Hulson et al. 2023/Stewart and Hamel 2014 input sample size approach
  - Uses afscISS package for input sample sizes and calculating survey age comp data
- Model 24.2: As for Model 24.1, but estimates female natural mortality with lognormal prior
  - (male M already estimated in all models)

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Candidate models in bold

- Model 18.3: The 2022 accepted model
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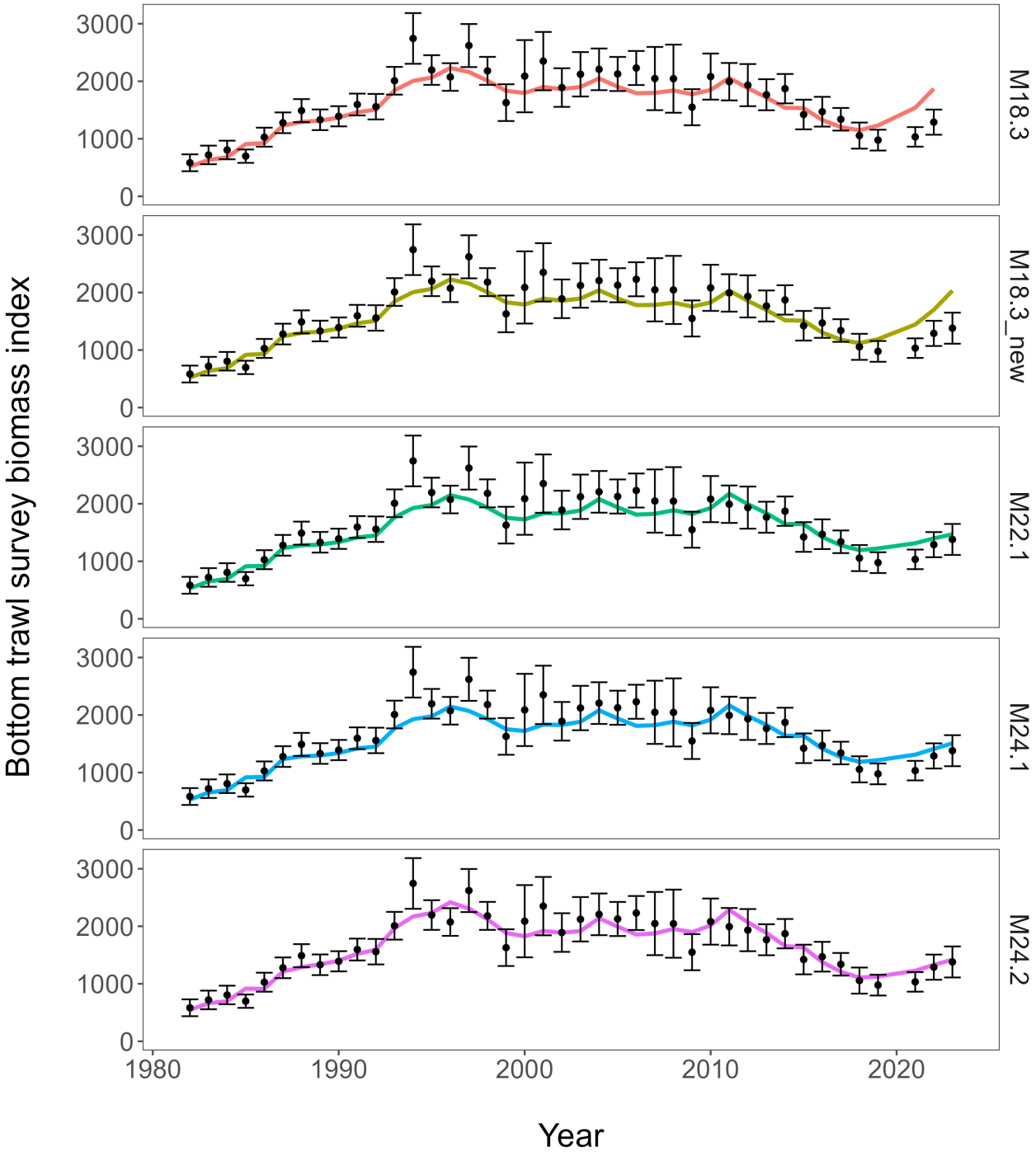
Bridging: Fits to survey biomass



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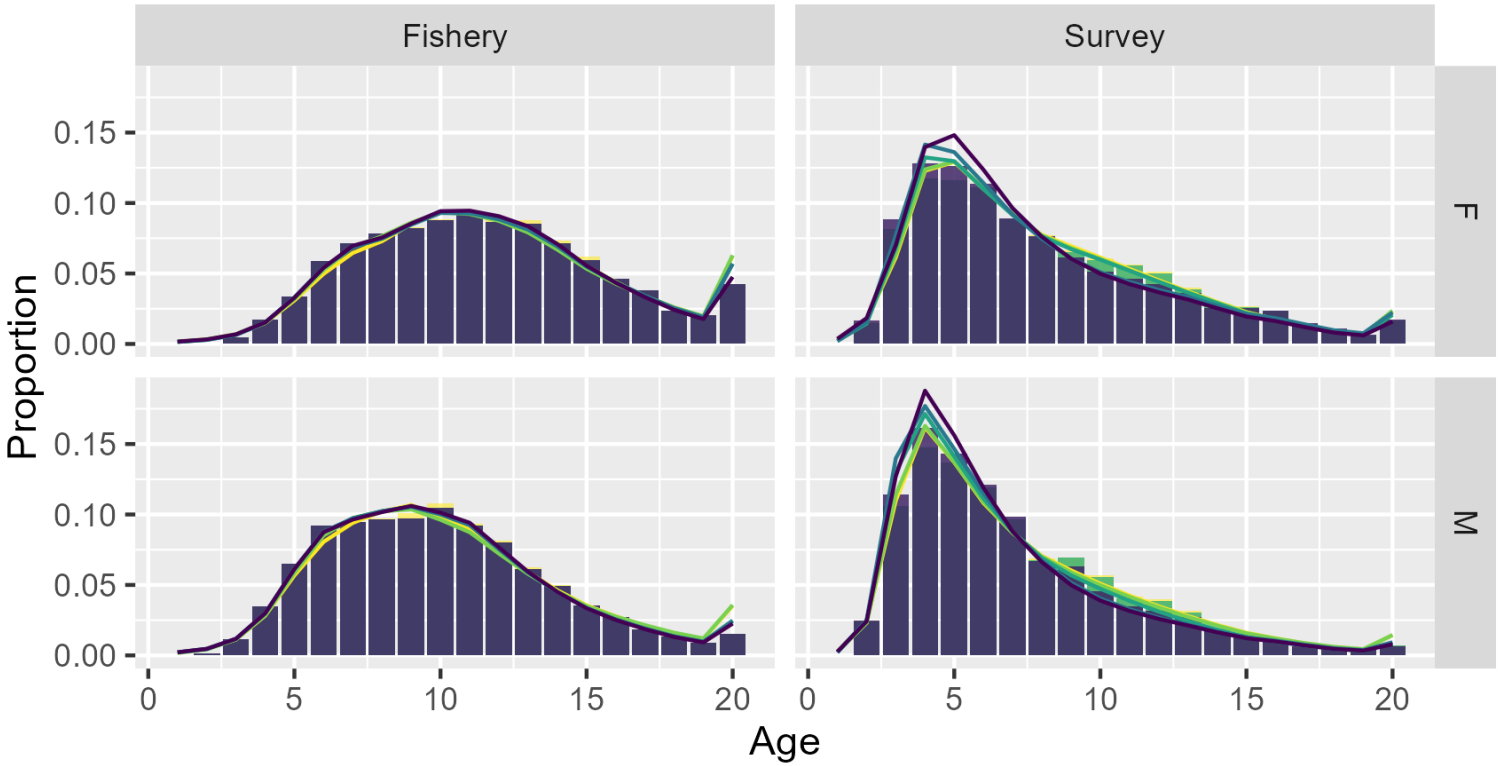
Bridging: Fits to age composition data



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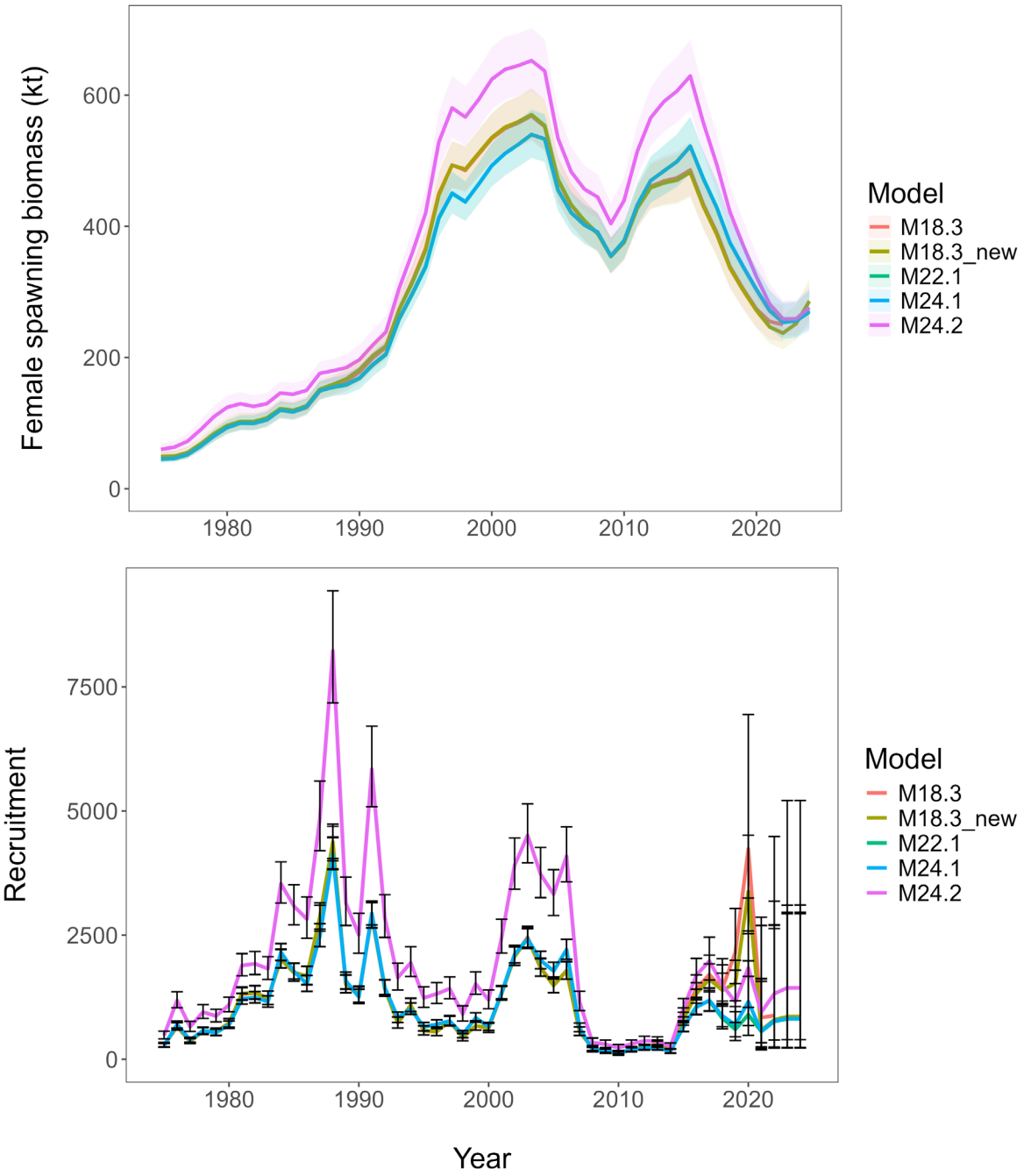
Bridging: Spawning biomass and recruitment estimates



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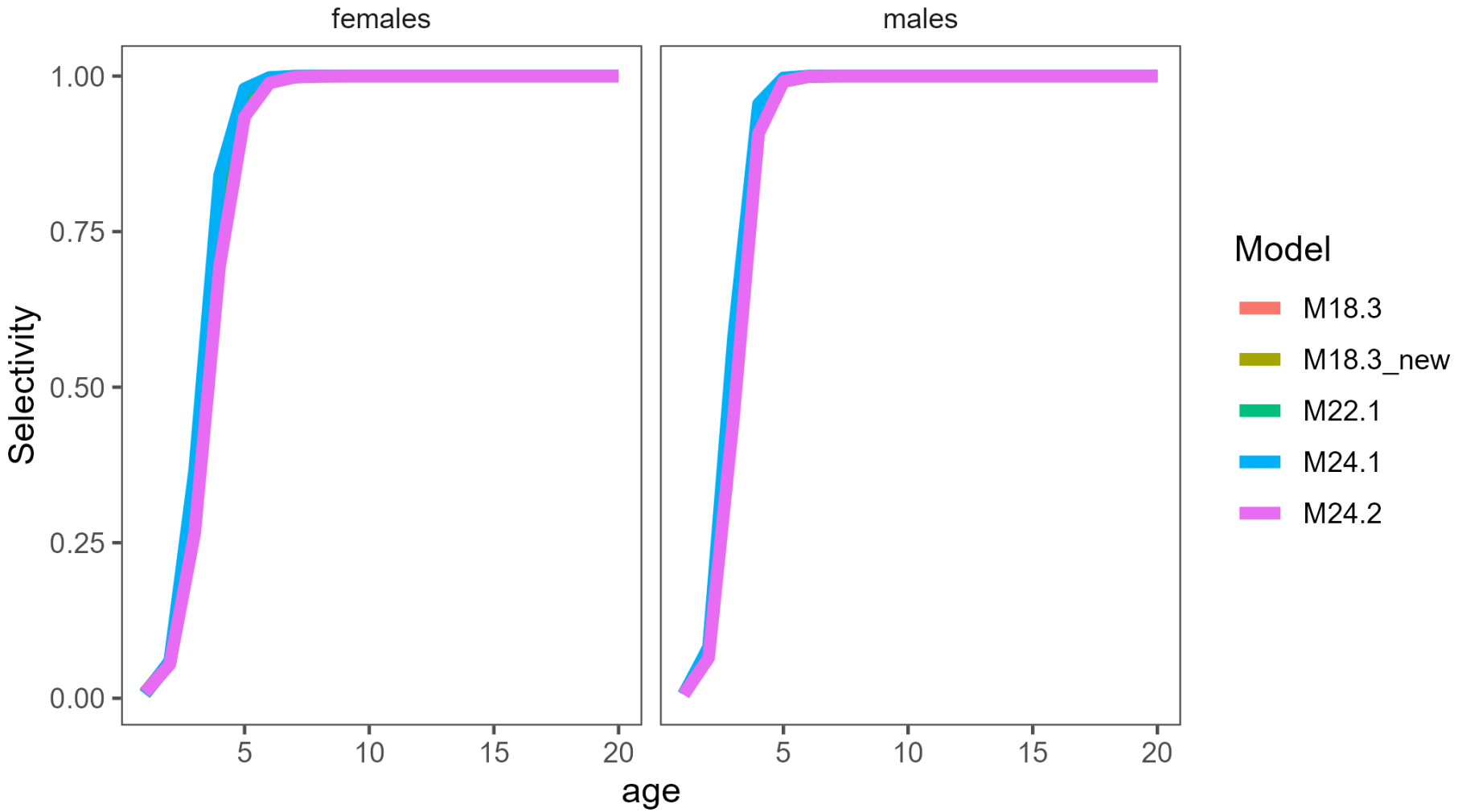
Bridging: Survey selectivity



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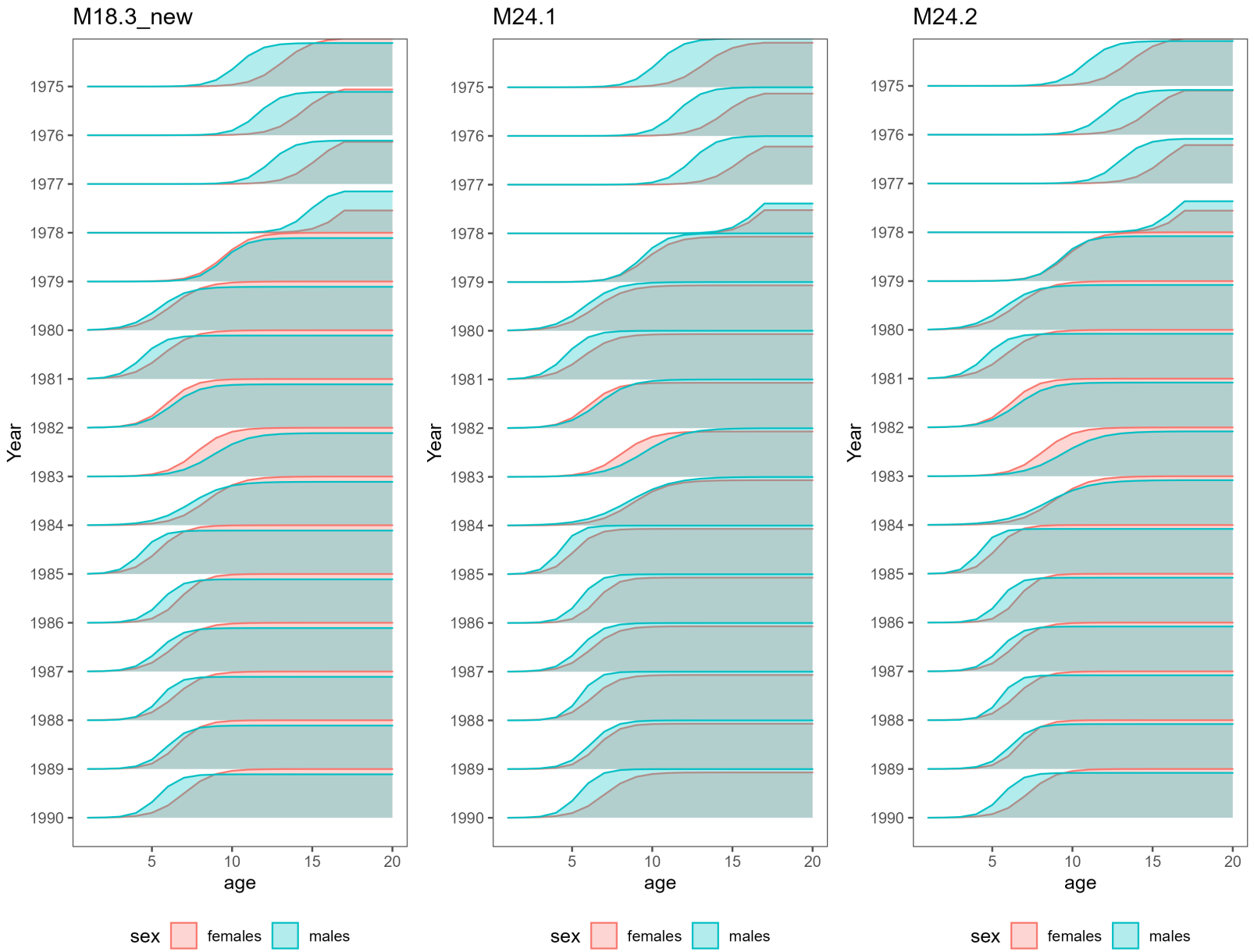
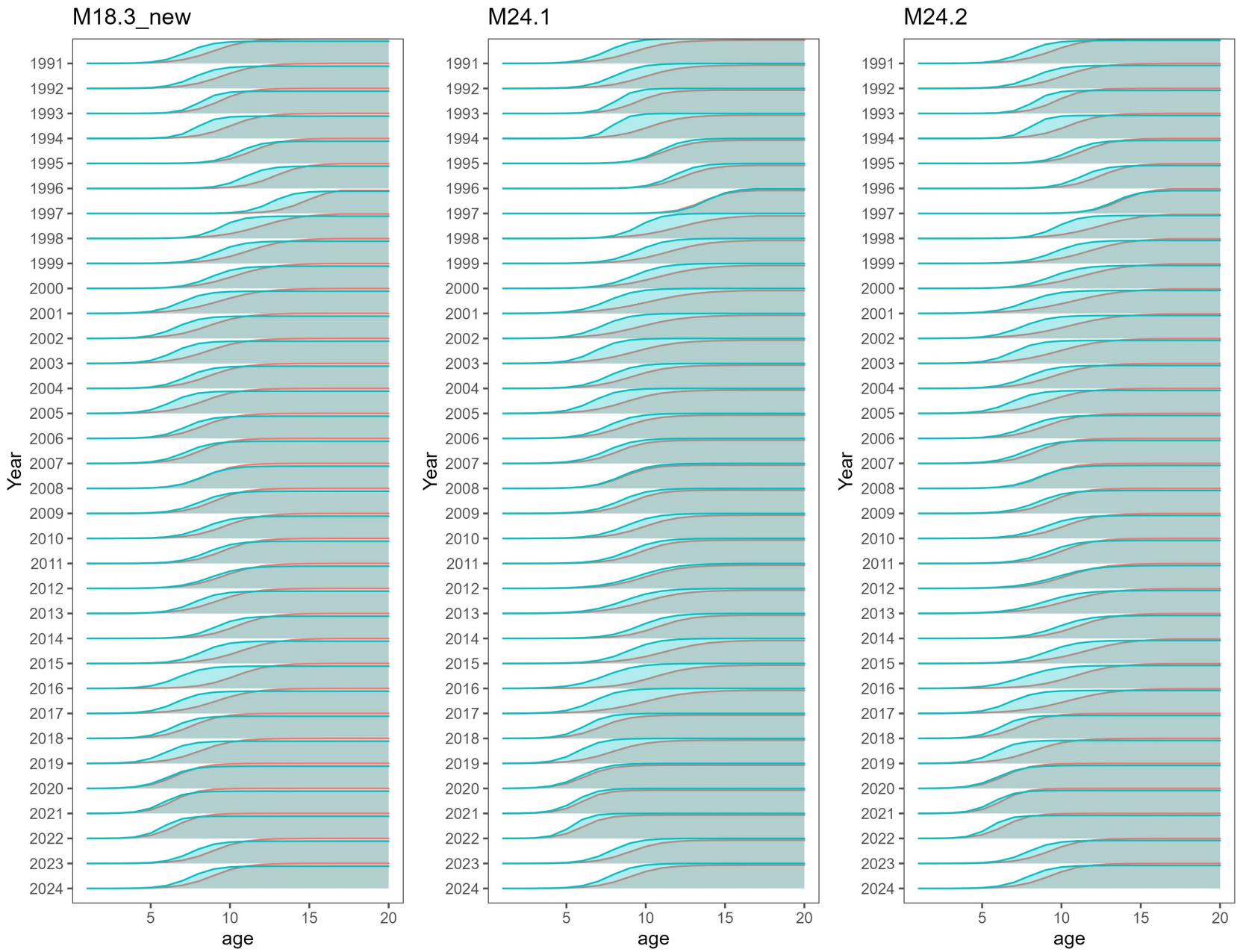
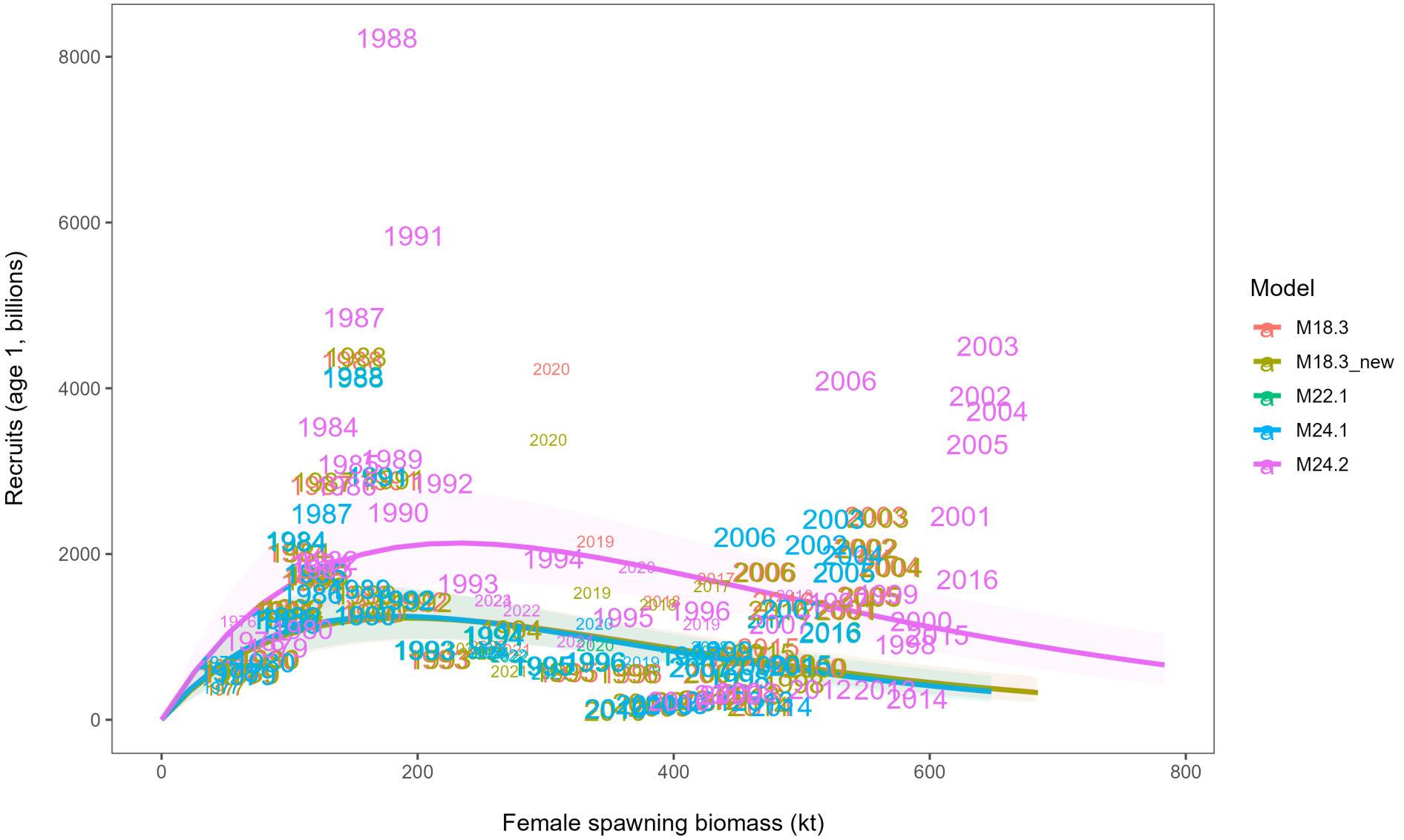
Candidate models: early fishery selectivity



Candidate models: later fishery selectivity



Stock-recruit curves



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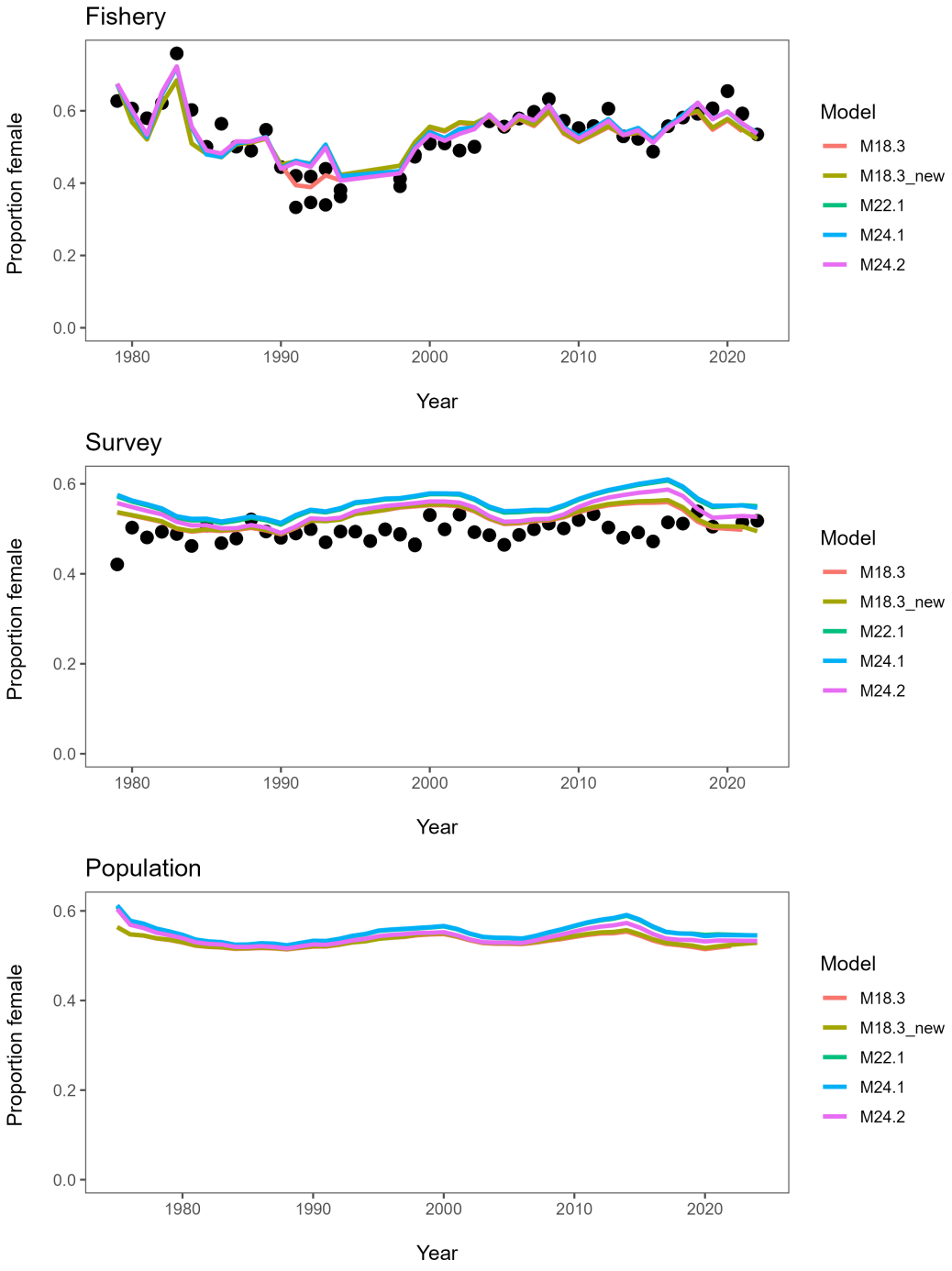
Sex Ratios



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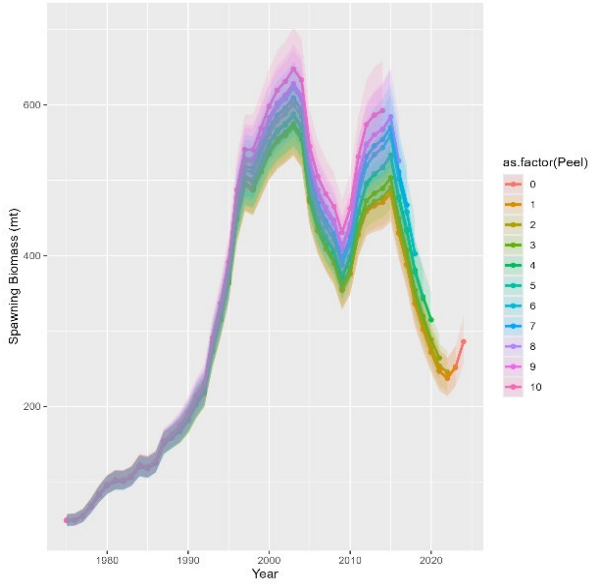
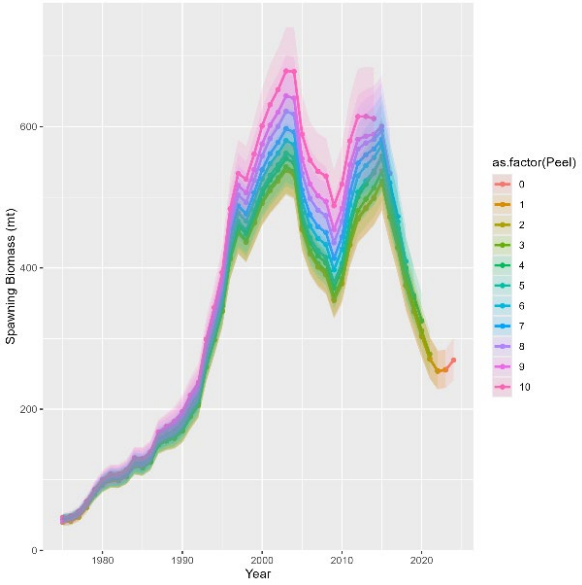
Retrospective analysis: Spawning biomass

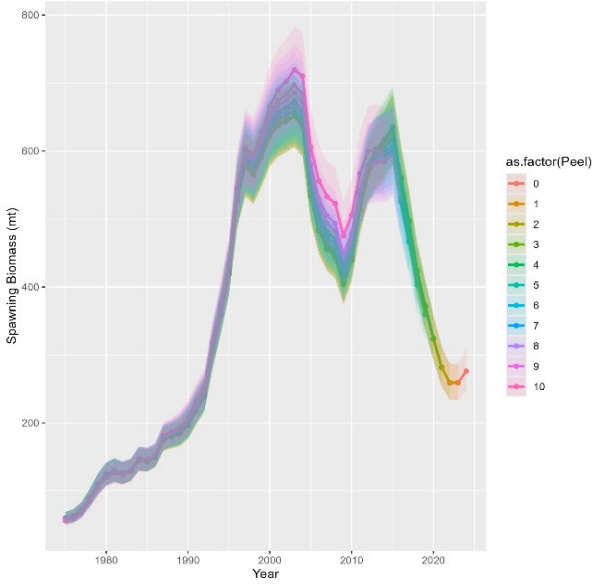
Model 18.3_new



Model 24.1



Model 24.2



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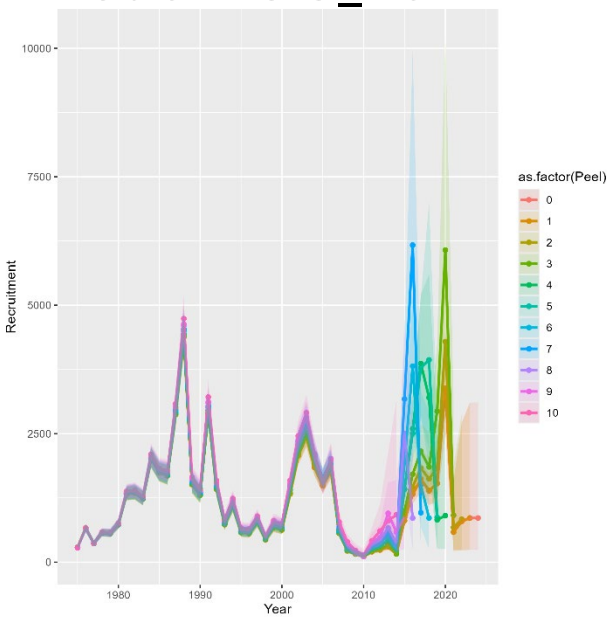
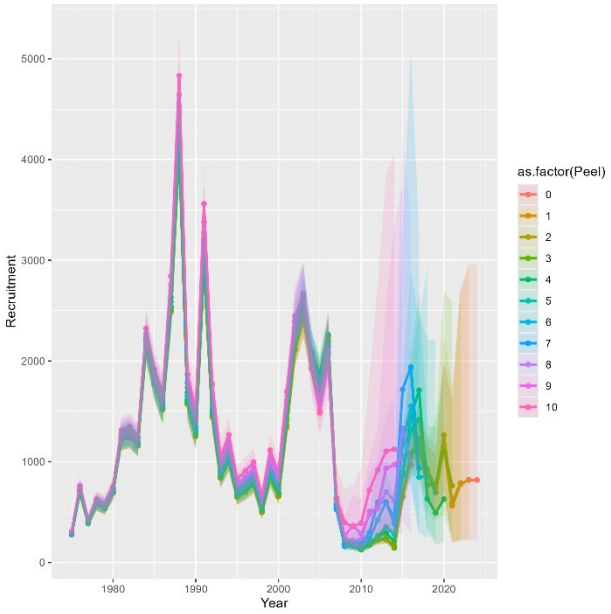
Retrospective analysis

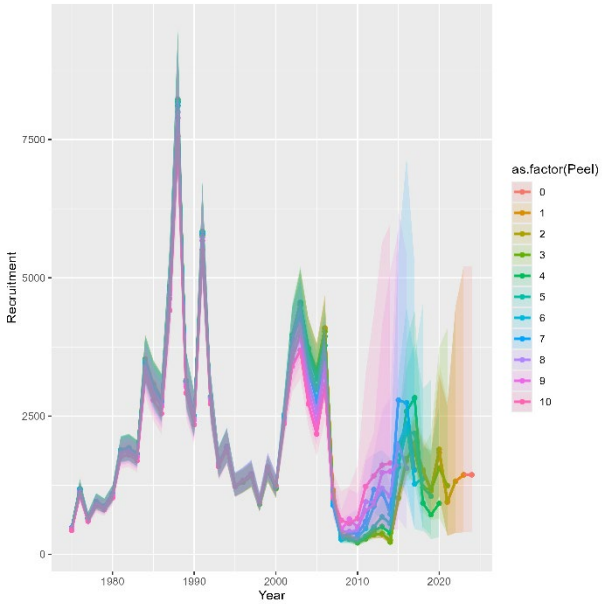
Model 18.3_new



Model 24.1



Model 24.2



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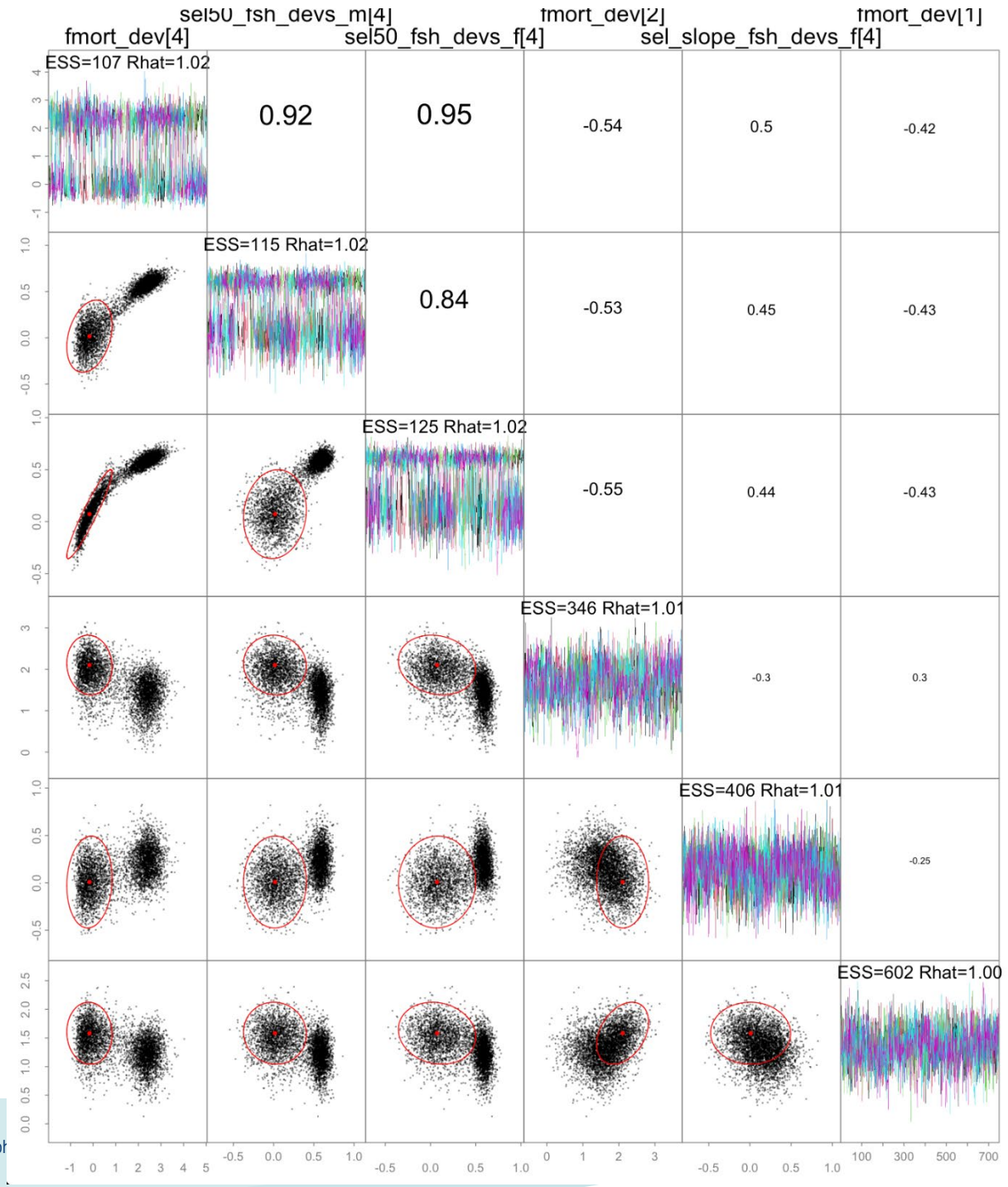
Bayesian analysis: M24.2

Slowest-mixing parameters

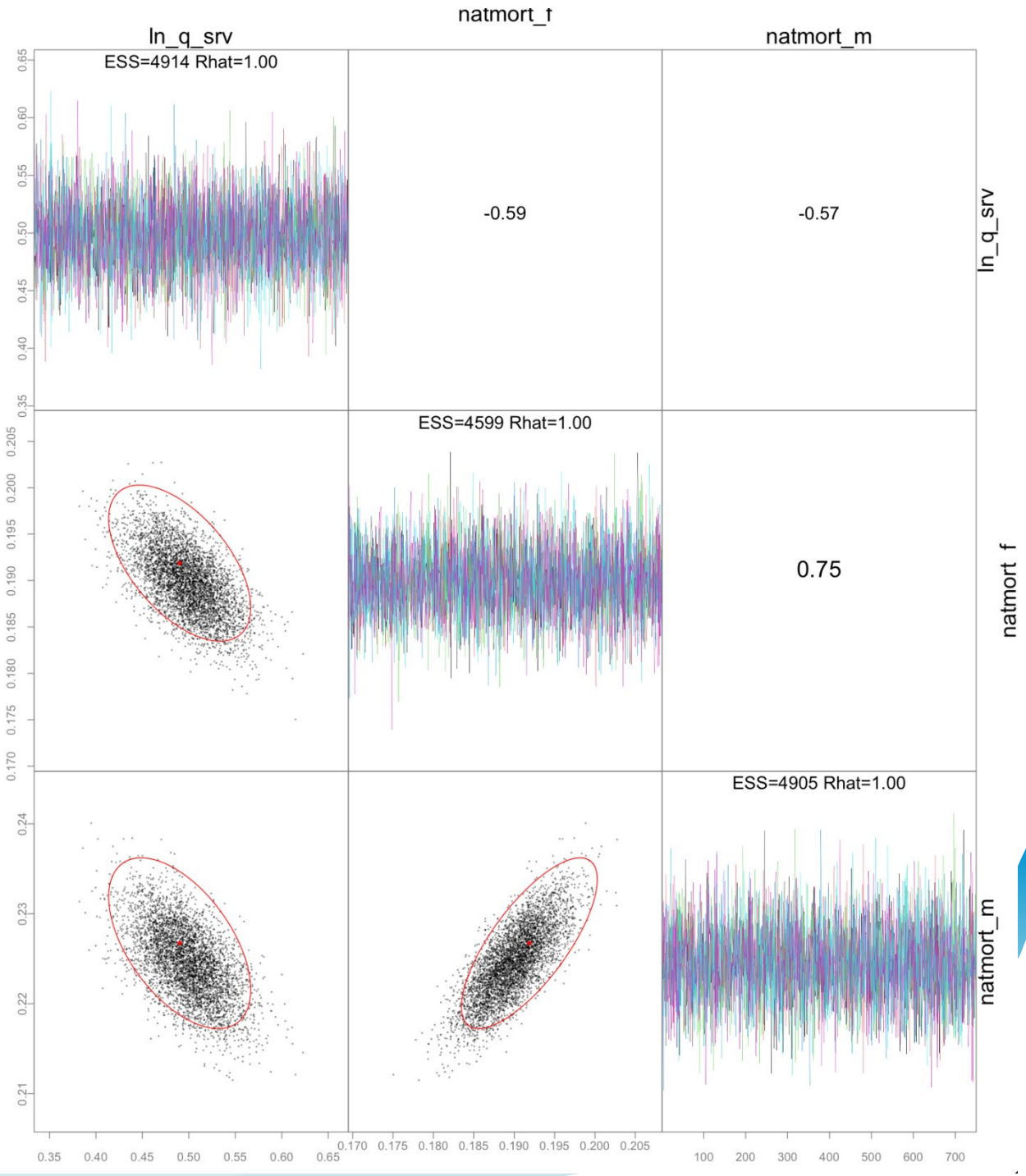


Bayesian analysis: M24.2

Natural mortality and catchability

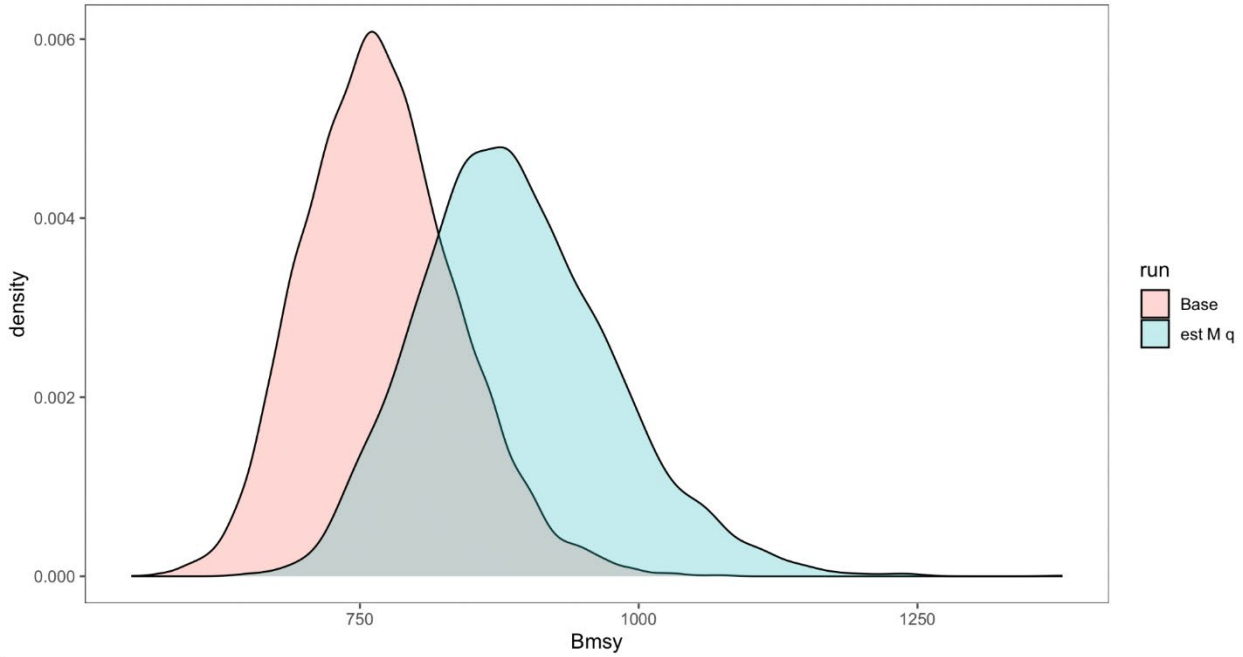
MLE estimates

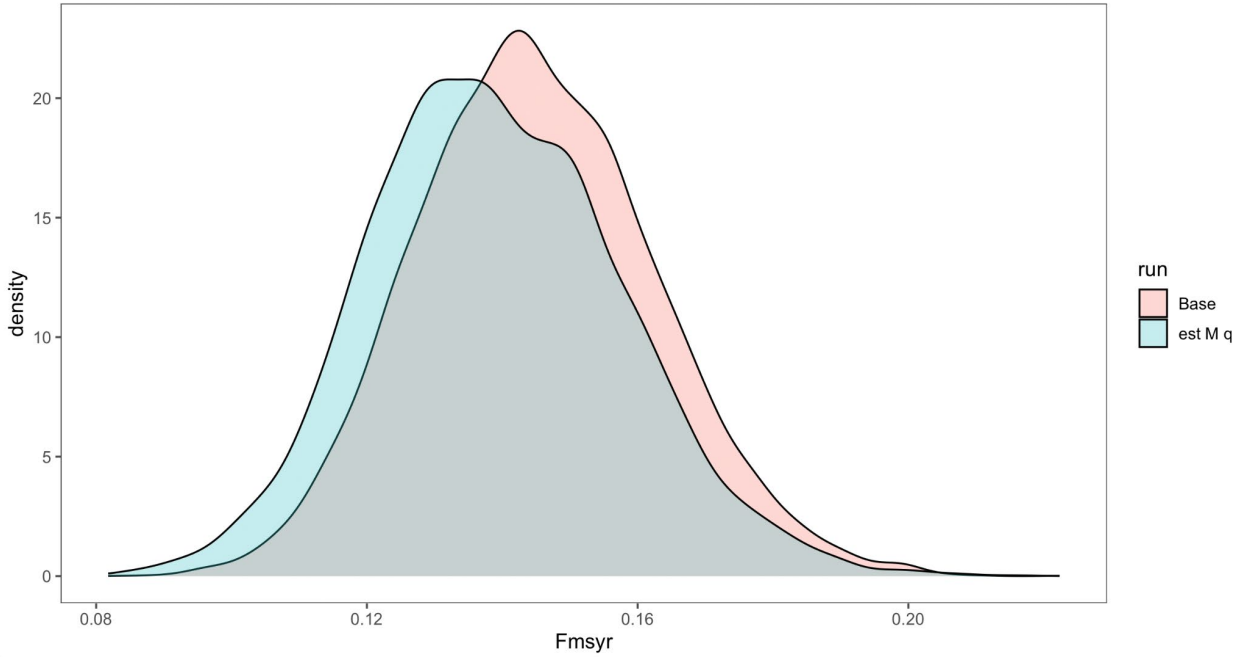
- Female M 0.19 (sd 0.003)
- Male M 0.225 (sd 0.004)
- q 1.638 (sd 0.05)



Bayesian analysis: M24.2

Marginal posteriors for derived parameters





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Potential future research

- Explore data conflict between survey biomass and survey age data: is age-specific availability to the survey time-varying and why?
- Account for uncertainty in maturity
- Re-parameterize/simplify fishery selectivity for years without fishery age data
- Incorporate ageing-error matrix
- Further exploration of linkages between population dynamics and environmental conditions and accounting for uncertainty in future environmental conditions in estimating future ABCs and OFLs
- Refine fishery input sample sizes based on ongoing research (Hulson, Barbeaux, and others)

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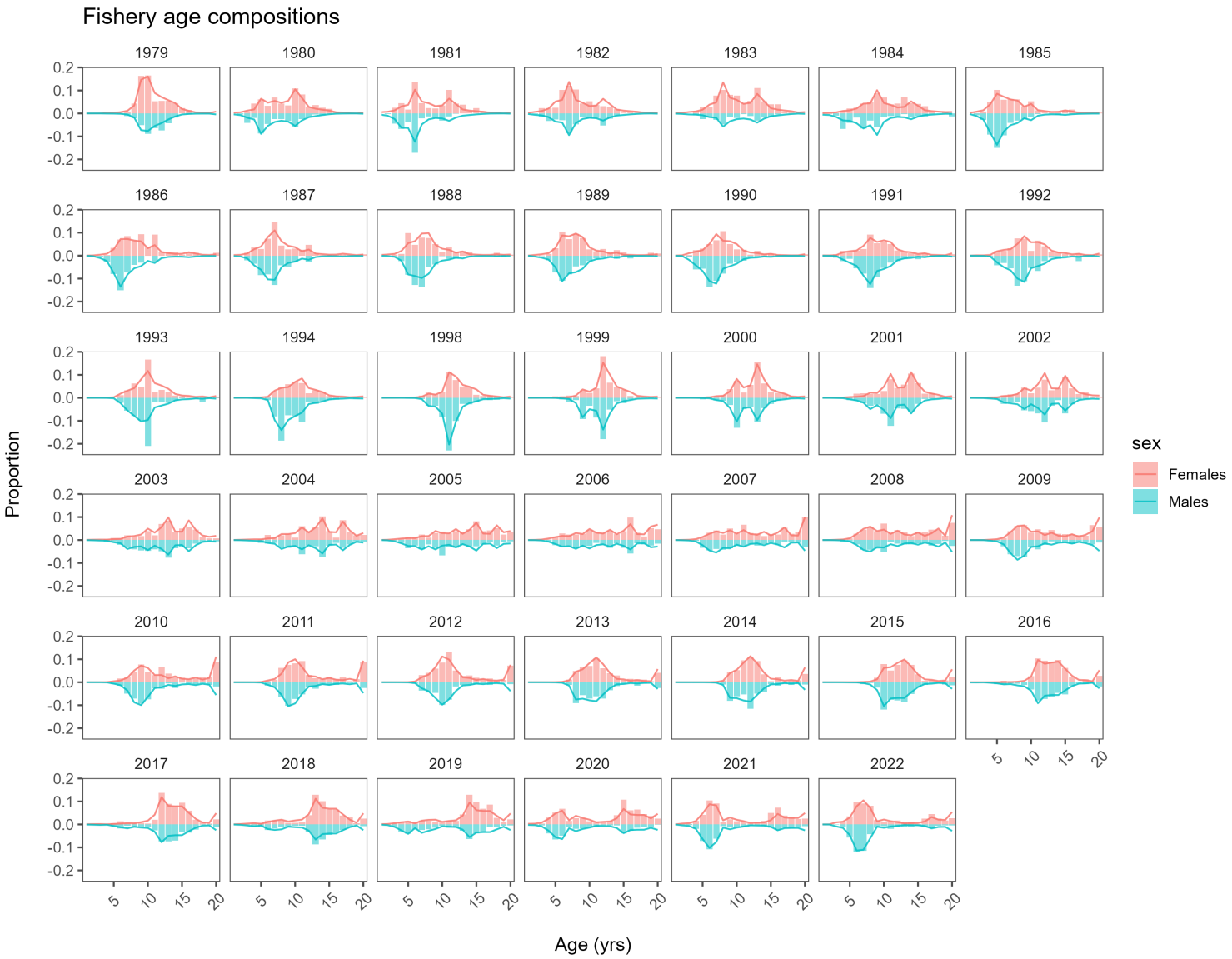
Model 18.3_new



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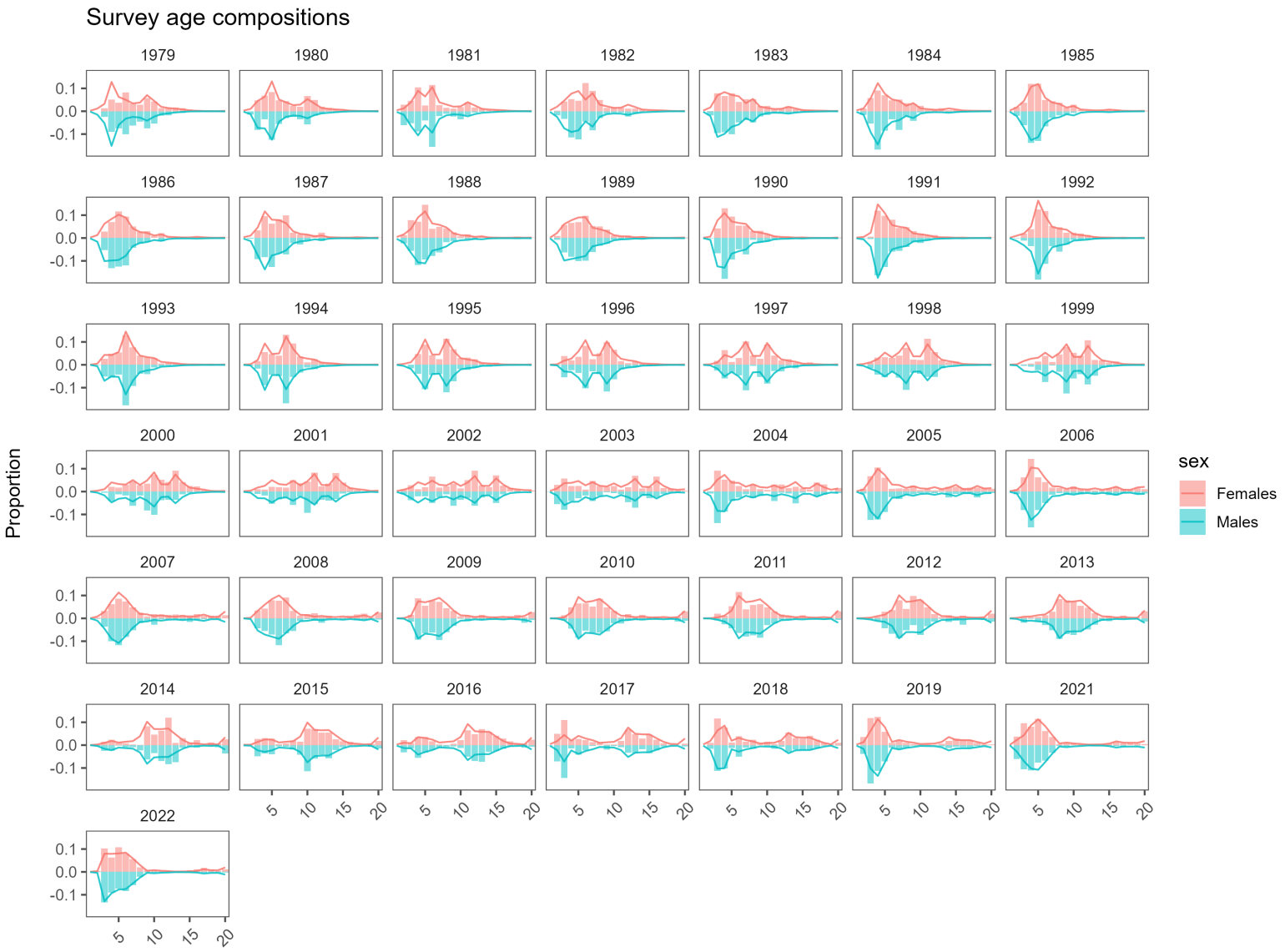
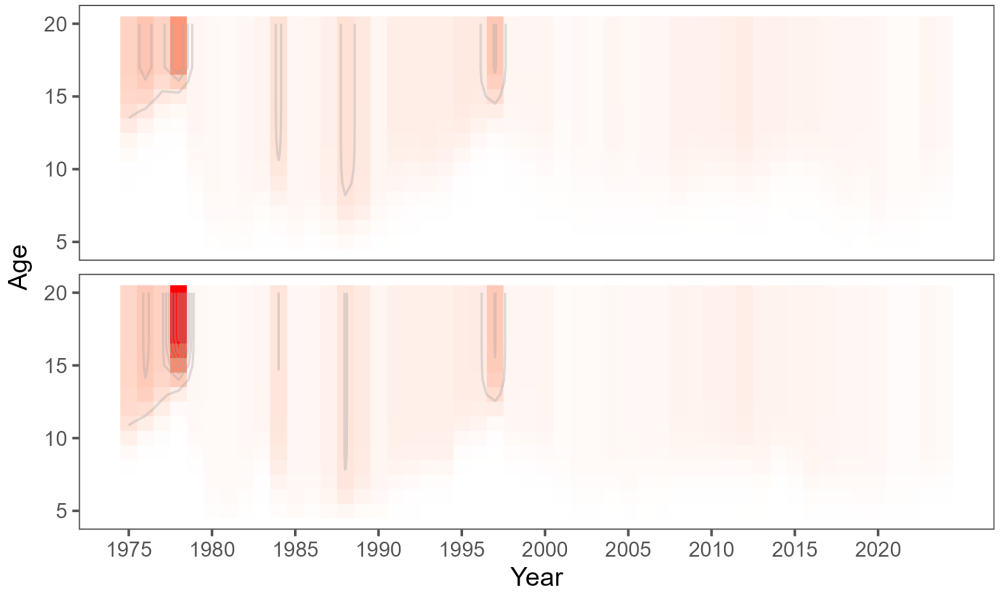
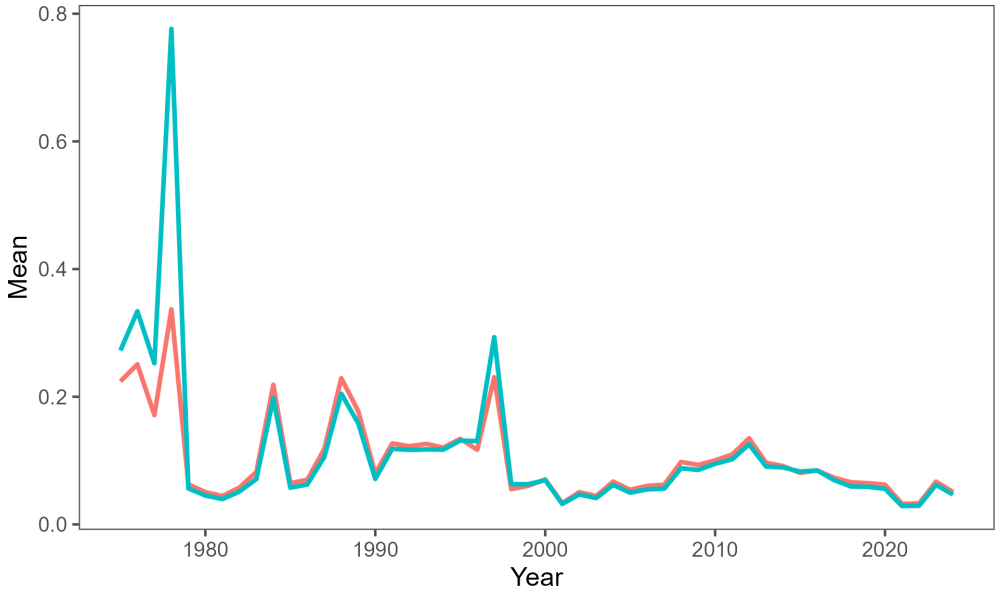


Model 18.3_new





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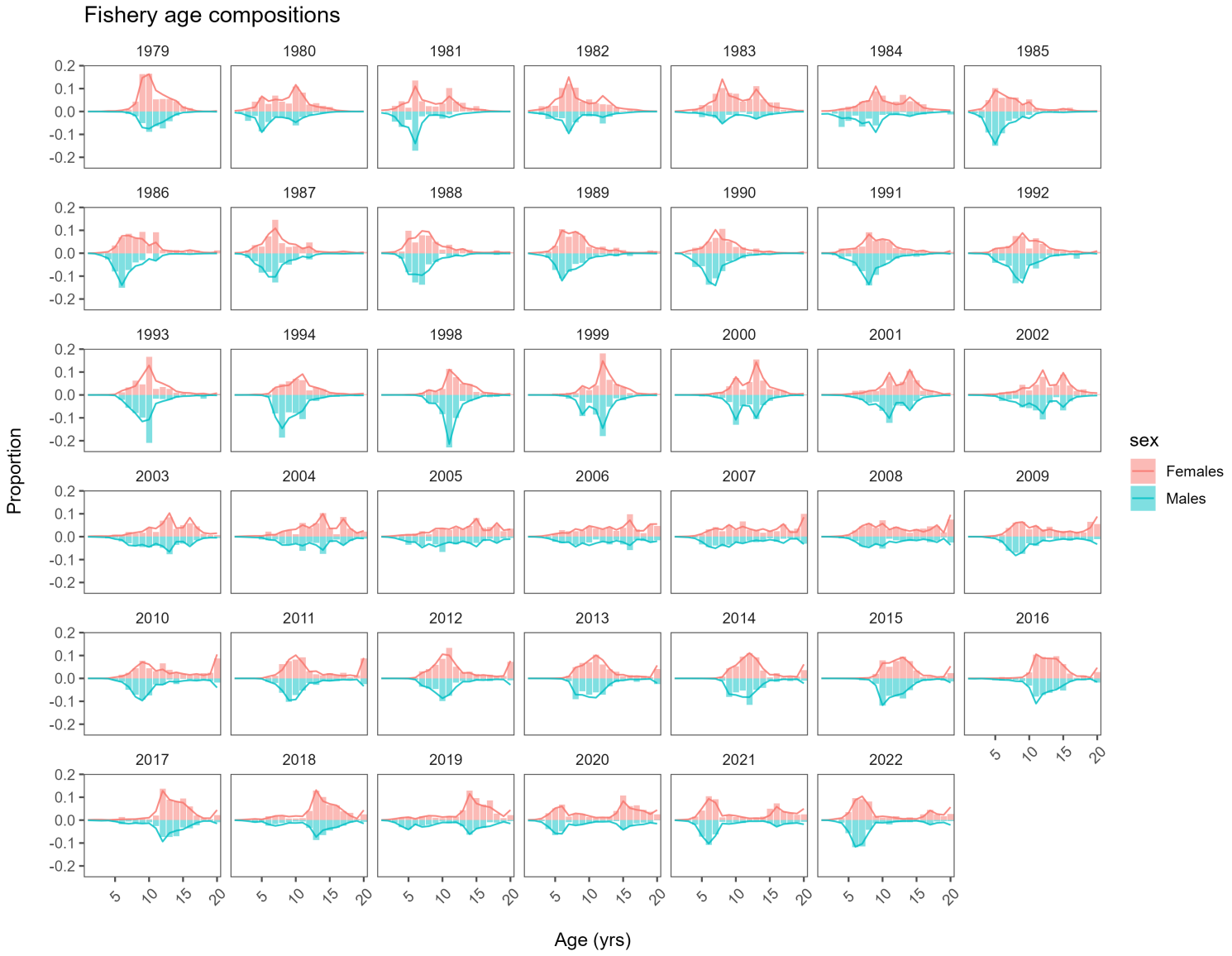
Model 24.1



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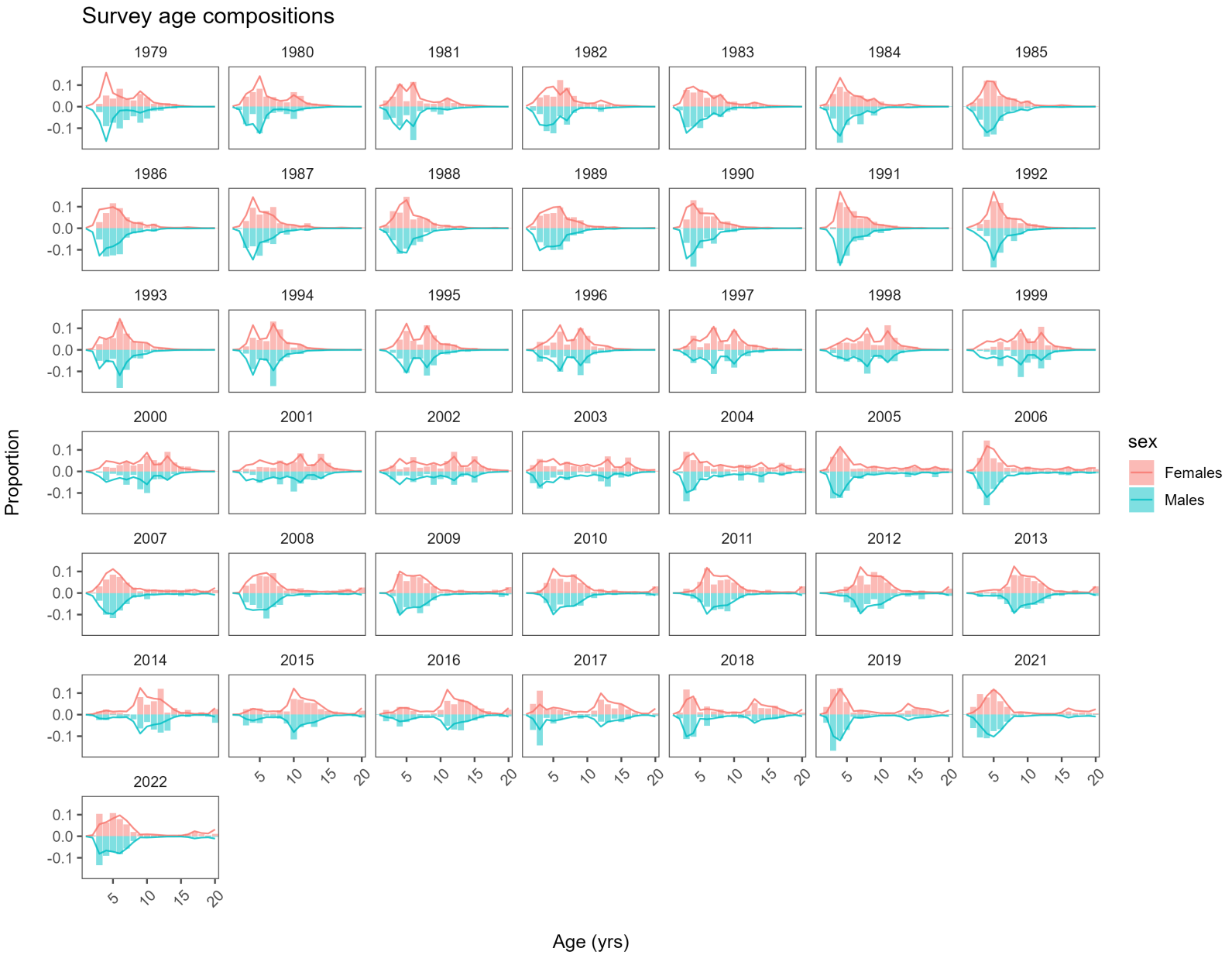
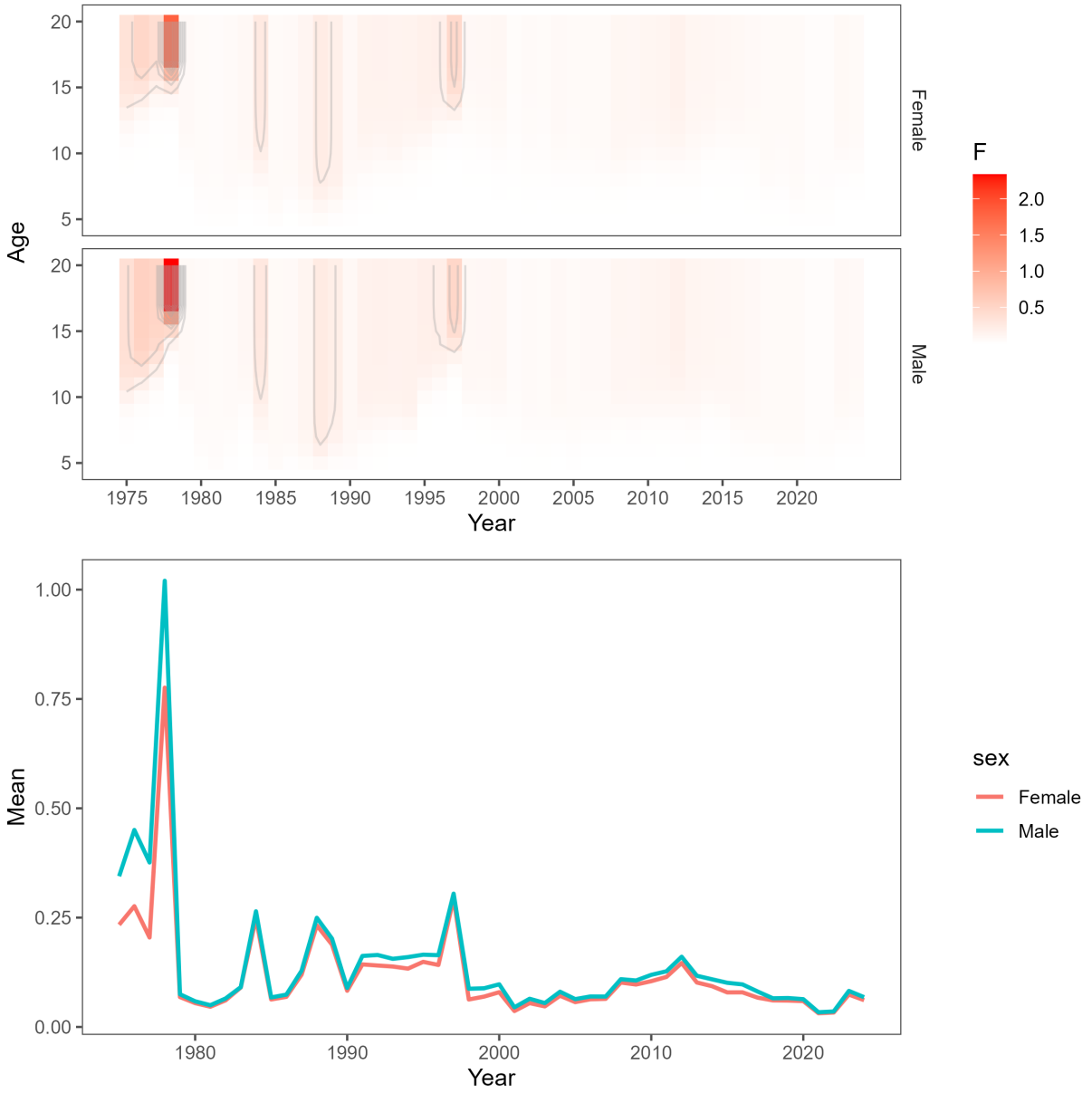

Survey age compositions
1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2021
2022
0.1
0.0
-0.1
5
10
15
20
Proportion
Age (yrs)
sex
Females
Males

Model 24.1



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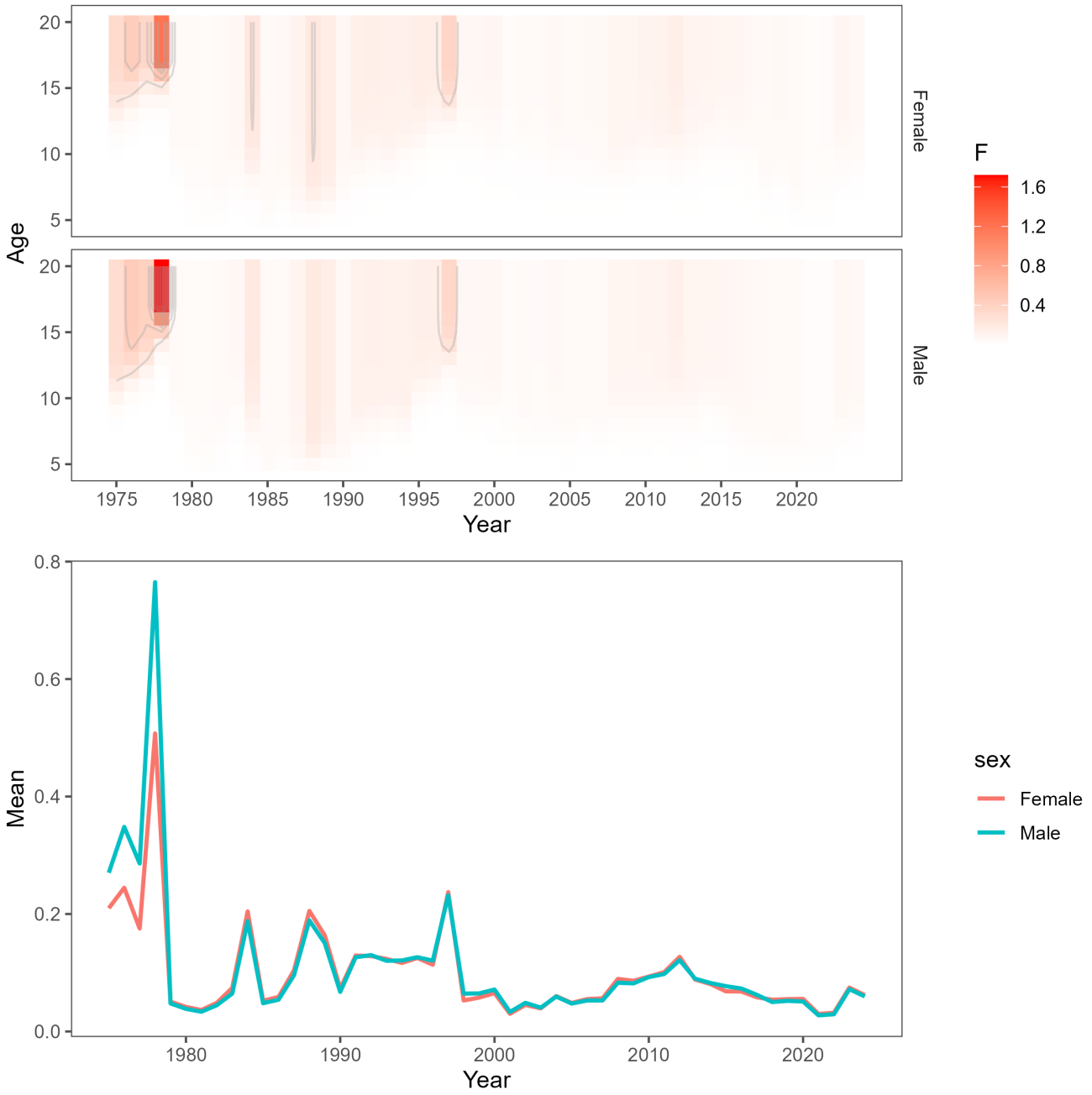
Model 24.2

NOAA FISHERIES

Model 24.2


Age
20
15
10
5
Female
Male
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Year
F
1.6
1.2
0.8
0.4
Mean
0.8
0.6
0.4
0.2
0.0
1980
1990
2000
2010
2020
Year
sex
Female
Male

Additional slides (if needed)

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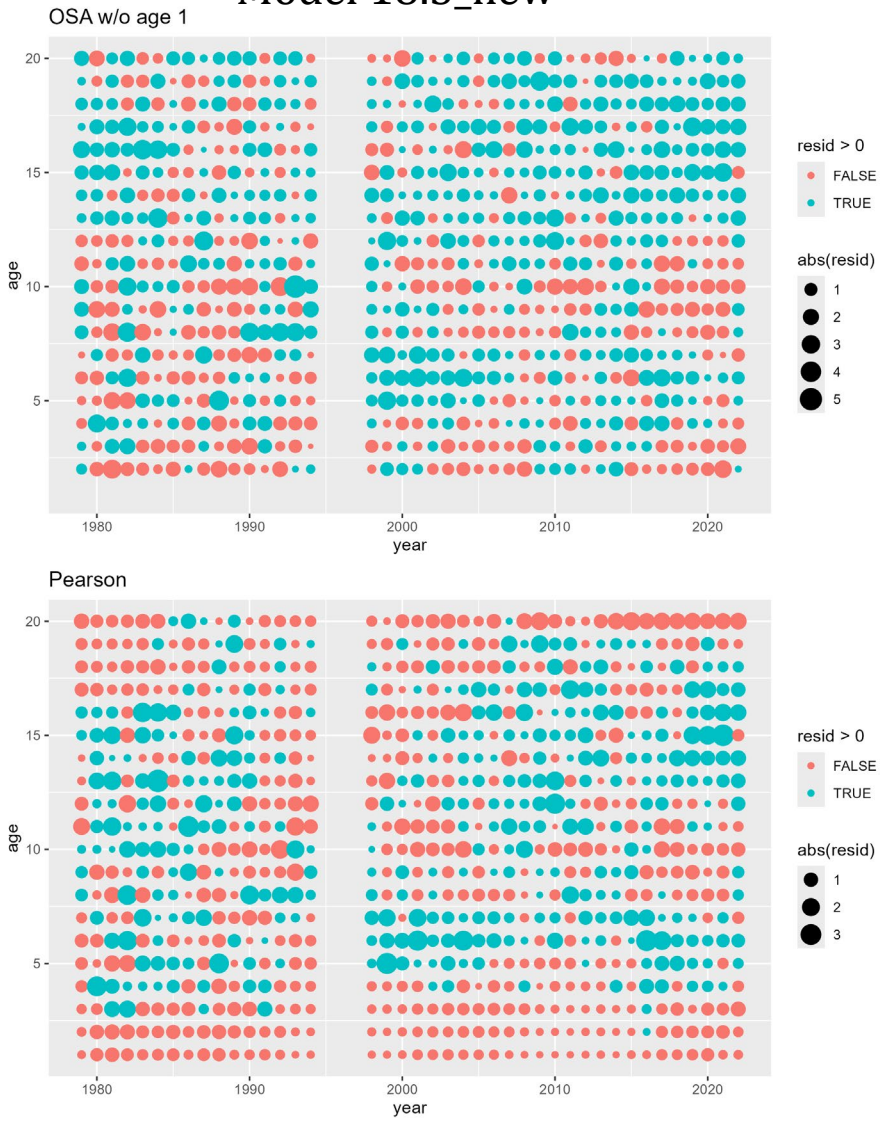
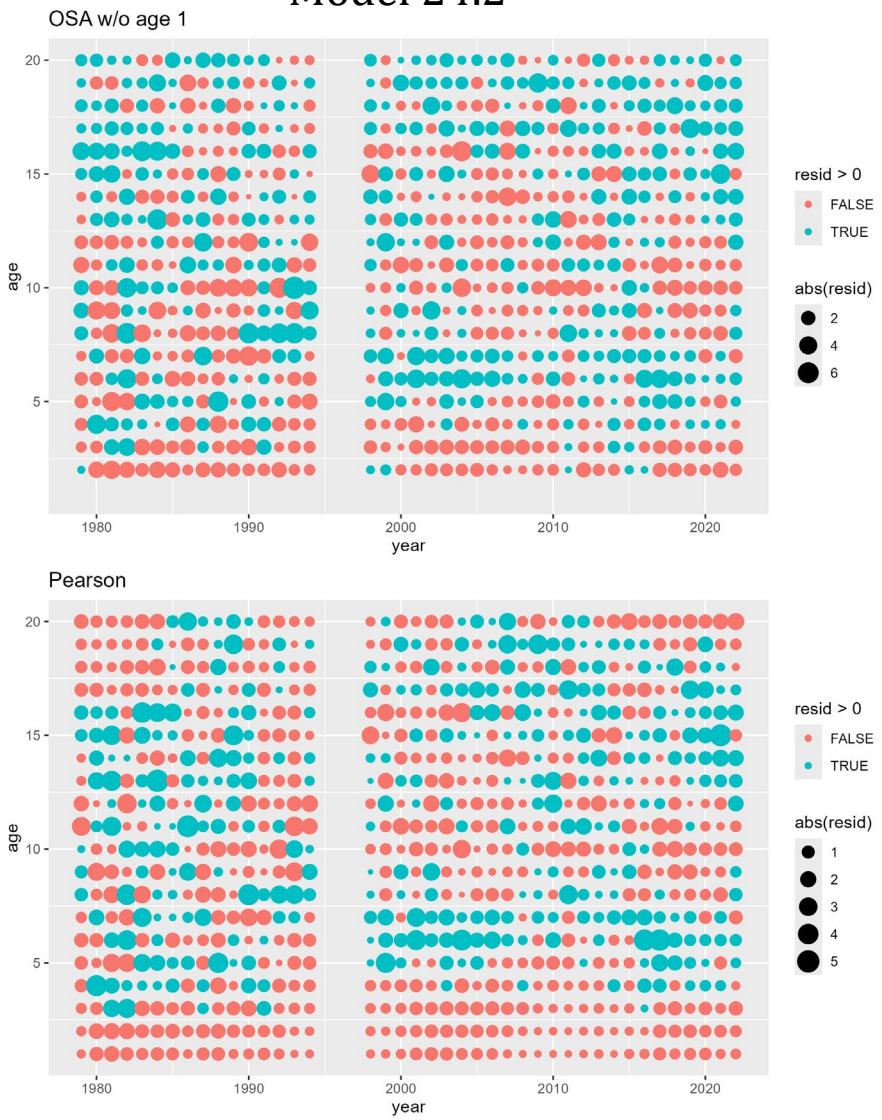
OSA residuals for fishery ages (females)

Model 18.3_new



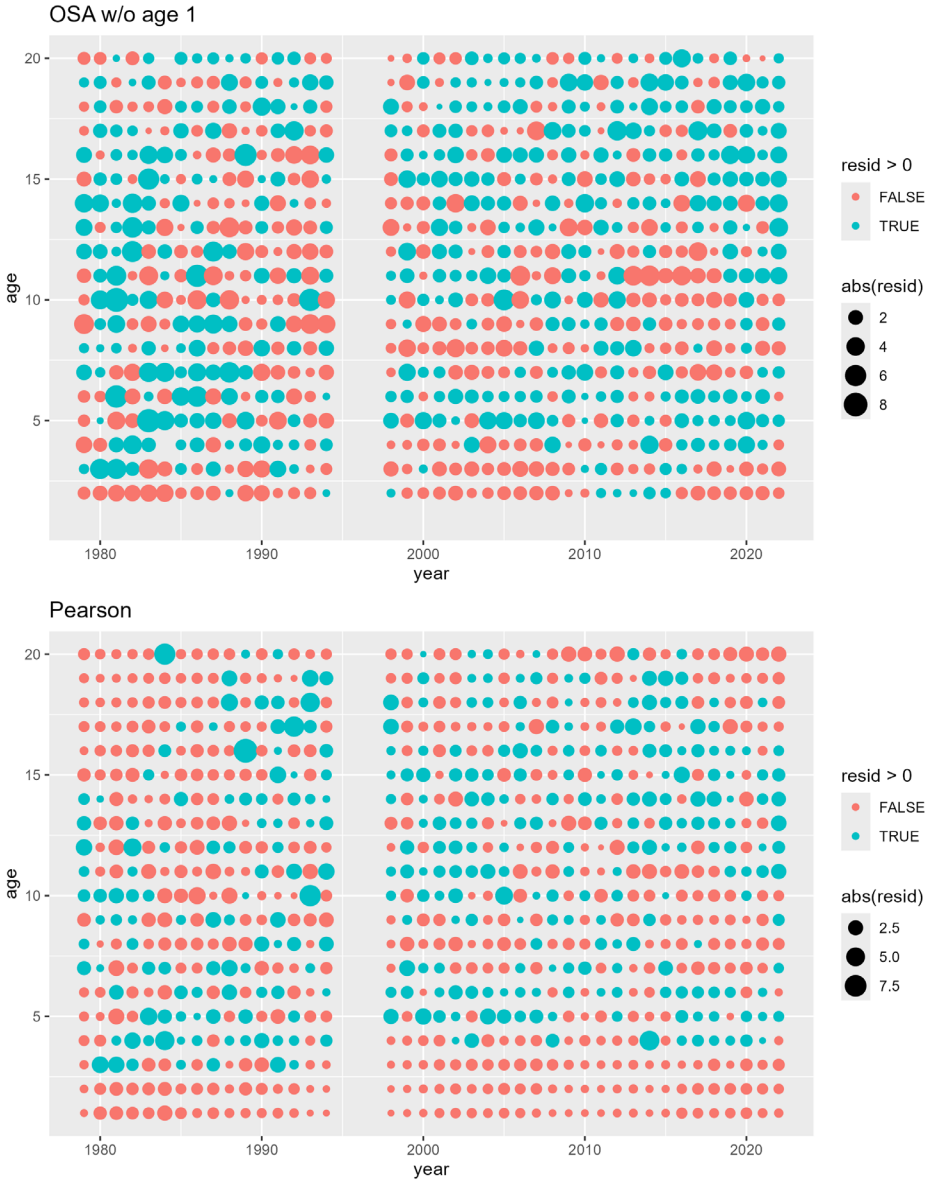
Model 24.2



OSA residuals for fishery ages (males)

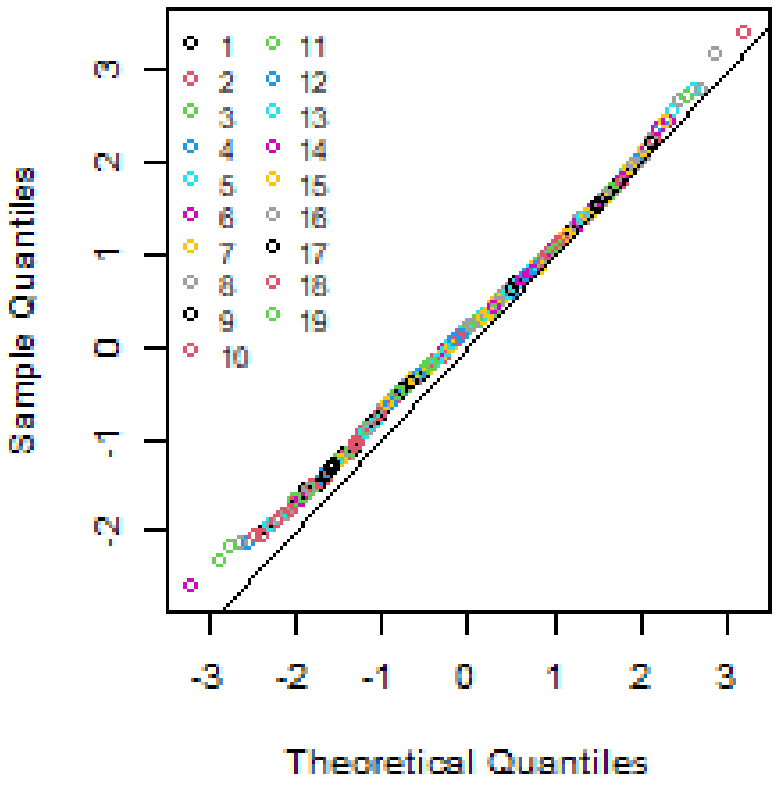
Model 18.3_new

Model 24.2

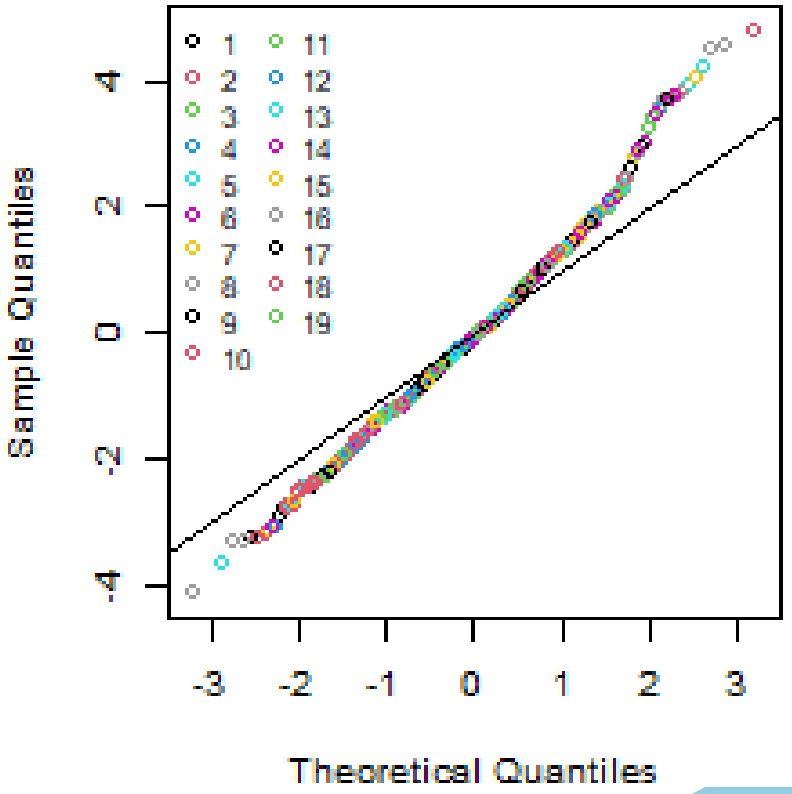


Are the OSA residuals for fishery ages normally distributed?

Model 18.3_new (females)



Model 24.2 (females)



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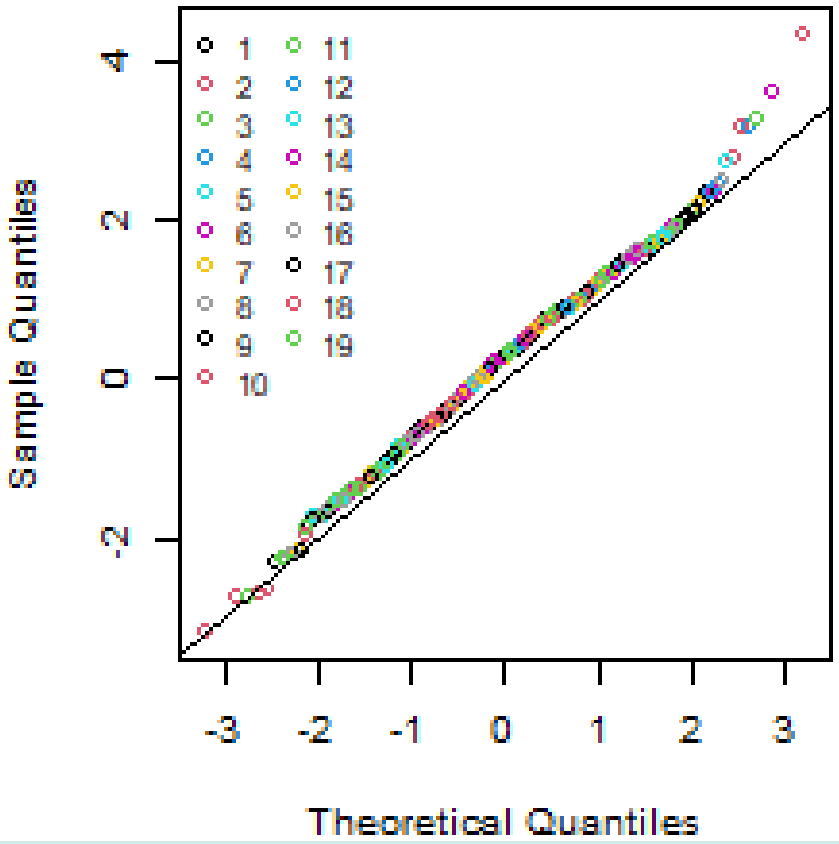
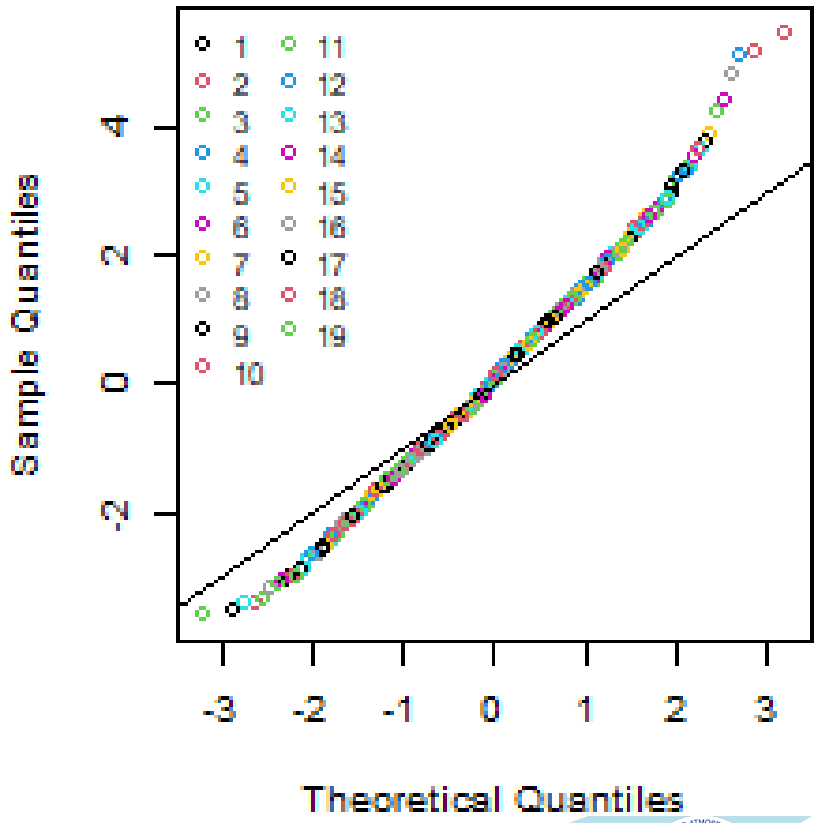
Are the OSA residuals for fishery ages normally distributed?

Model 18.3_new (males)



Model 24.2 (males)



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A few sensitivity runs

- Include previously used 1995-1997 fishery ages (unknown origin; not in observer database)
- Initiate the model with a high initial F deviation for 1978
- Leave out fishery age compositions from the model

- Note: further lowering survey age comp sample sizes after Francis data weighting led to non-convergence

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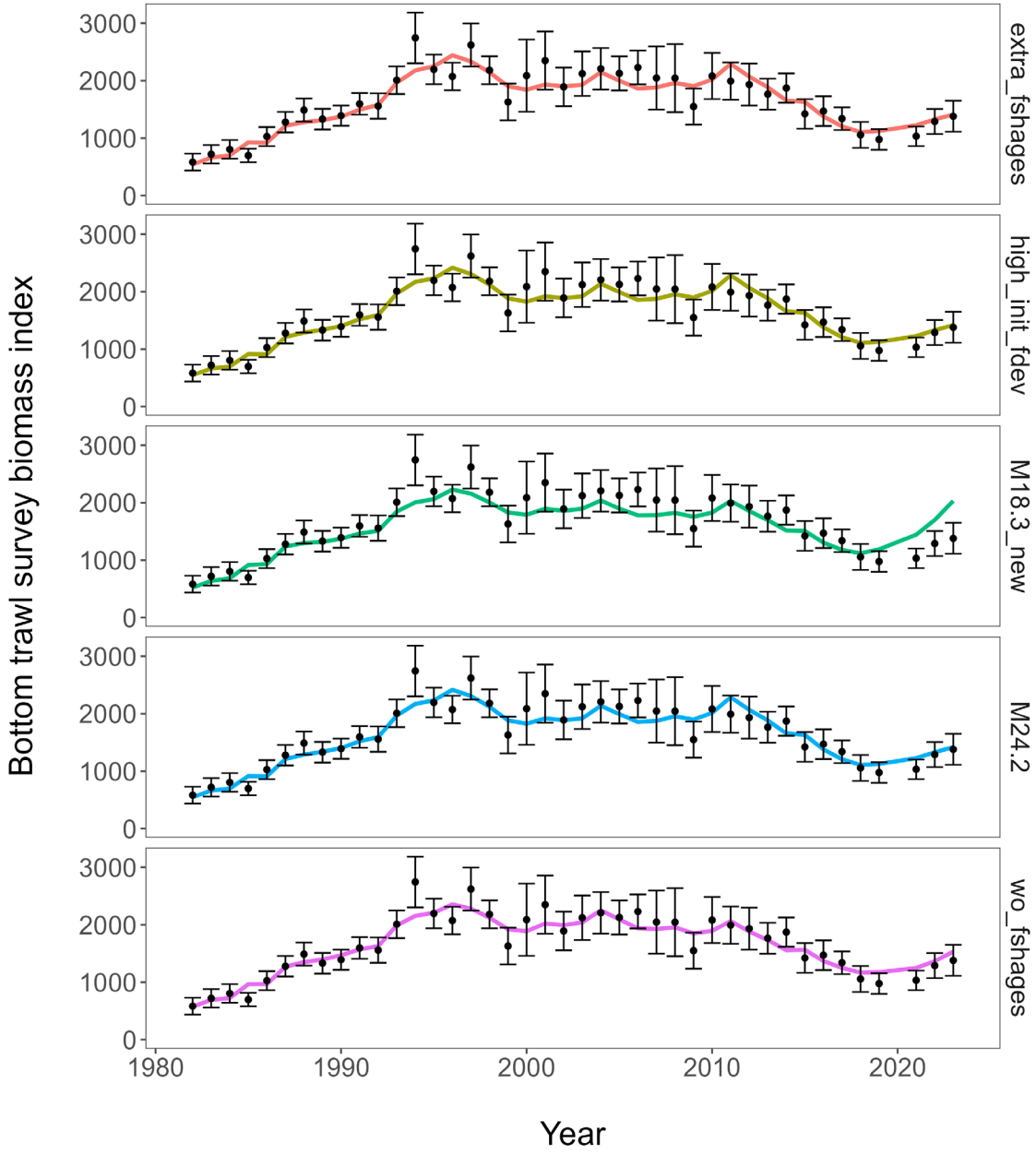
A few sensitivity runs



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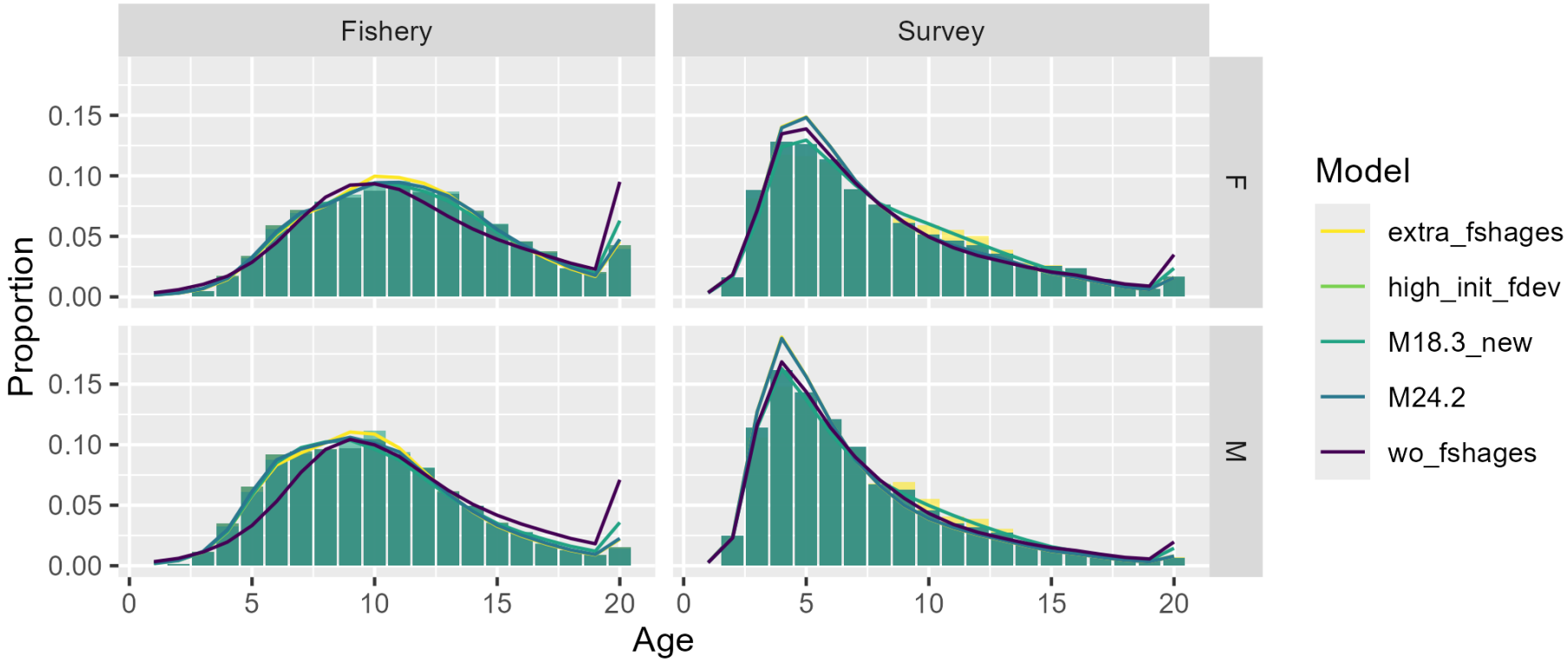

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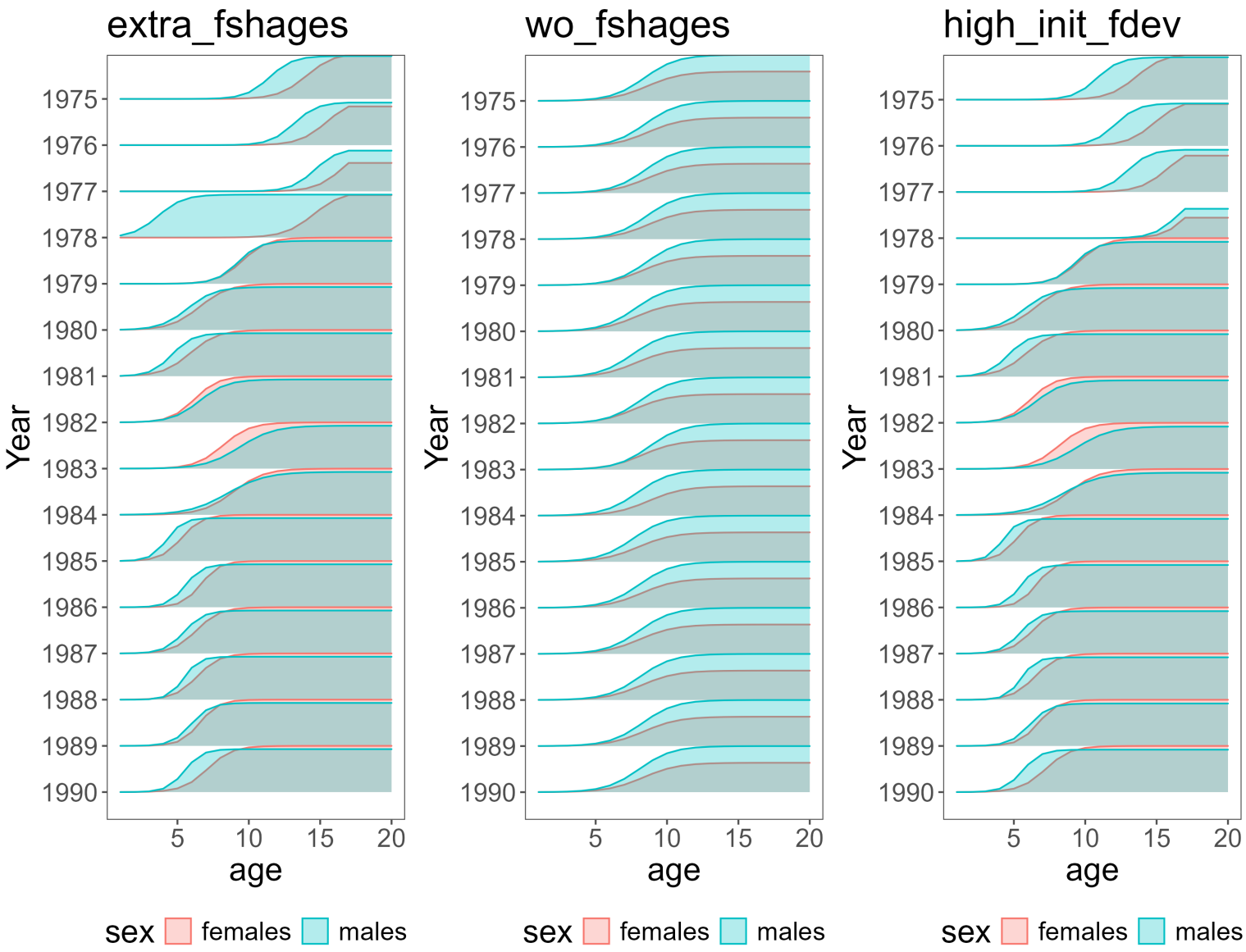

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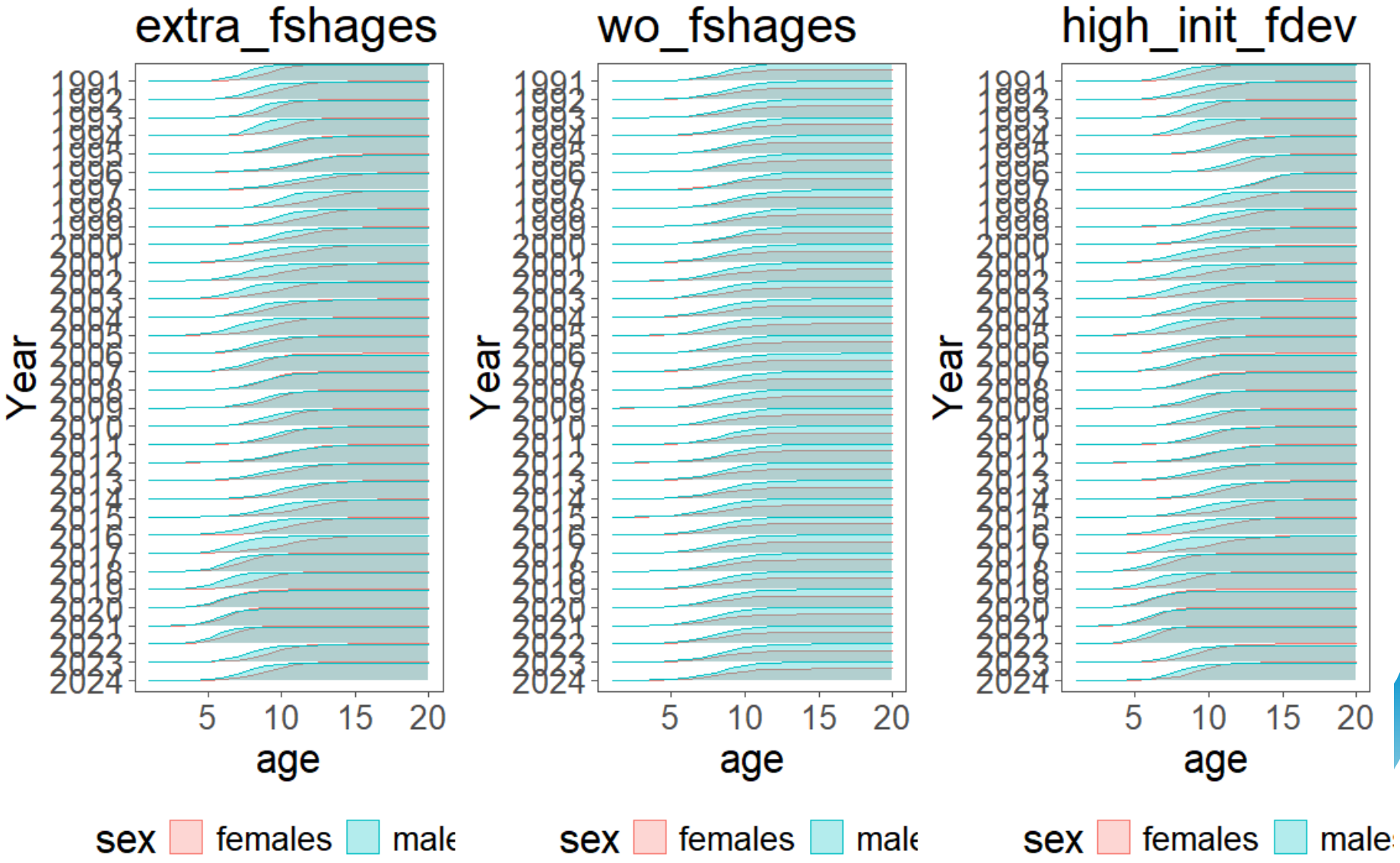

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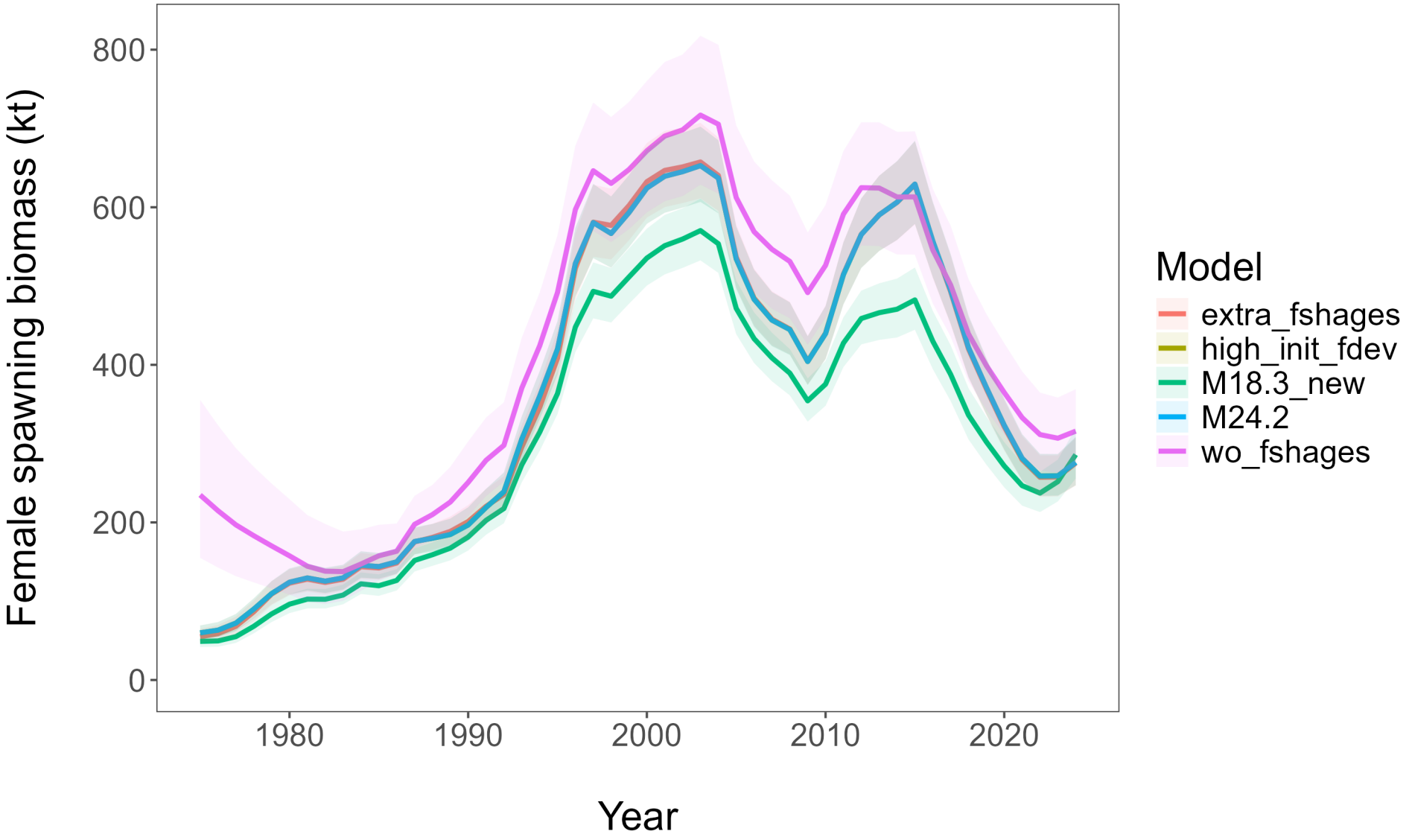
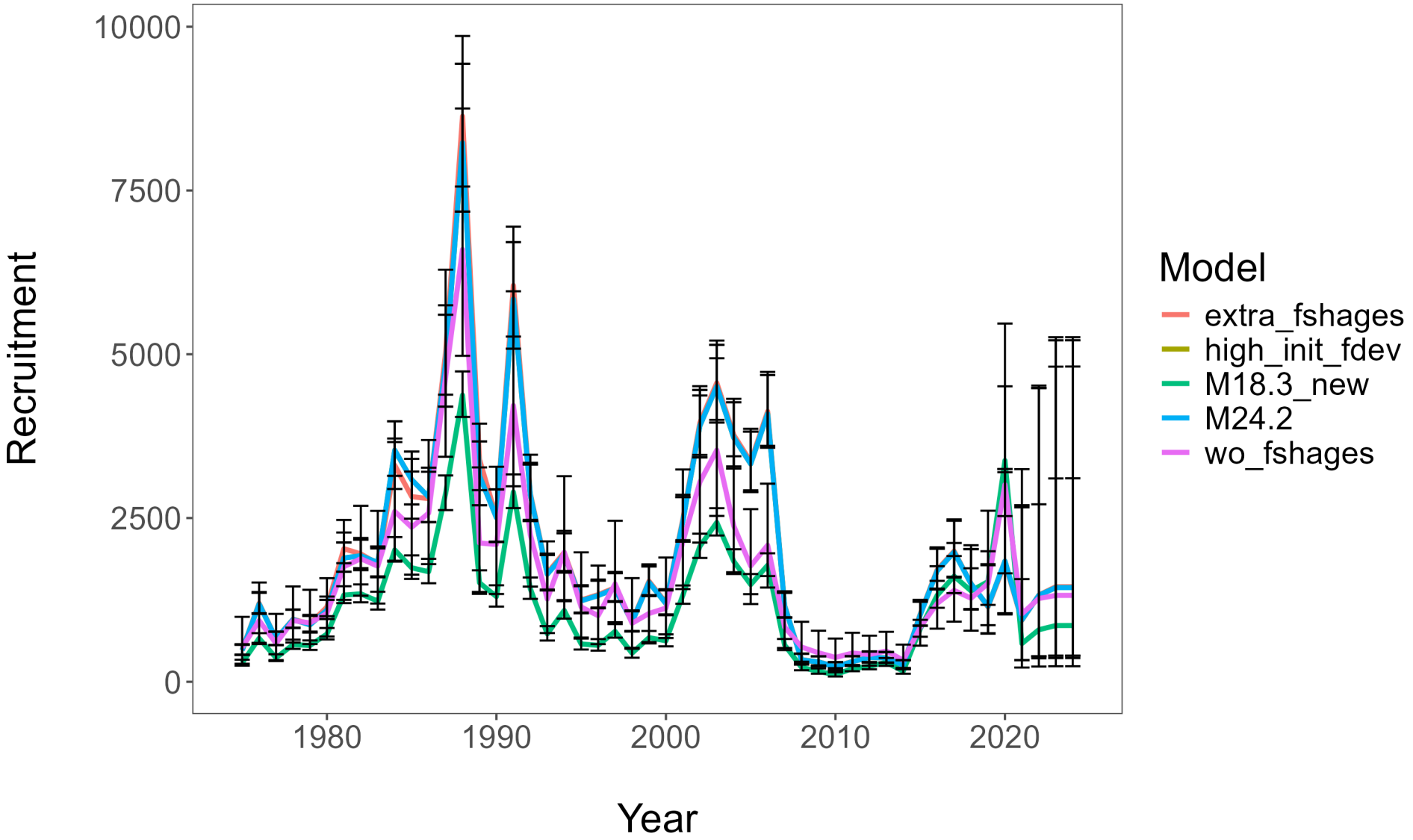


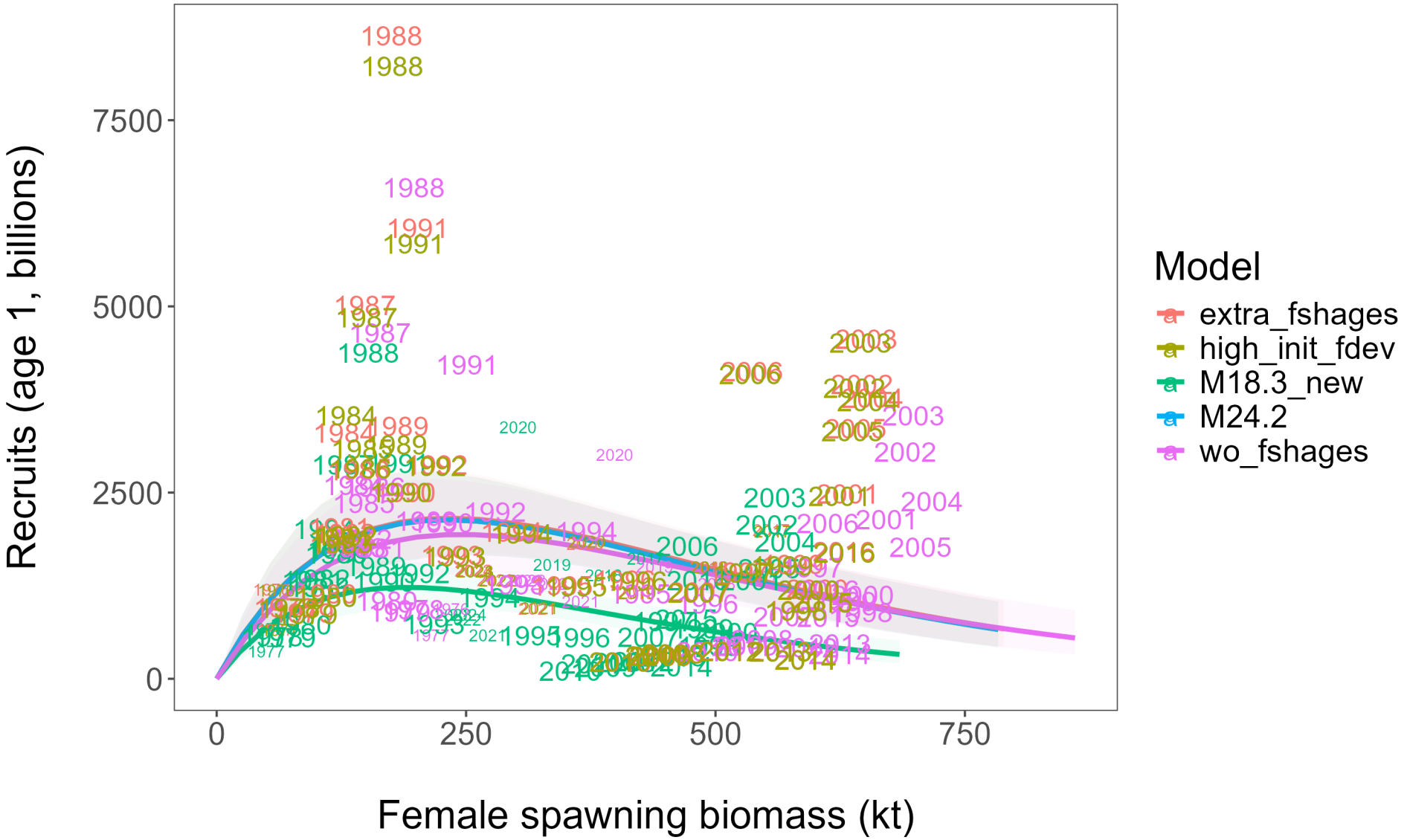
NOAA FISHERIES

A few sensitivity runs



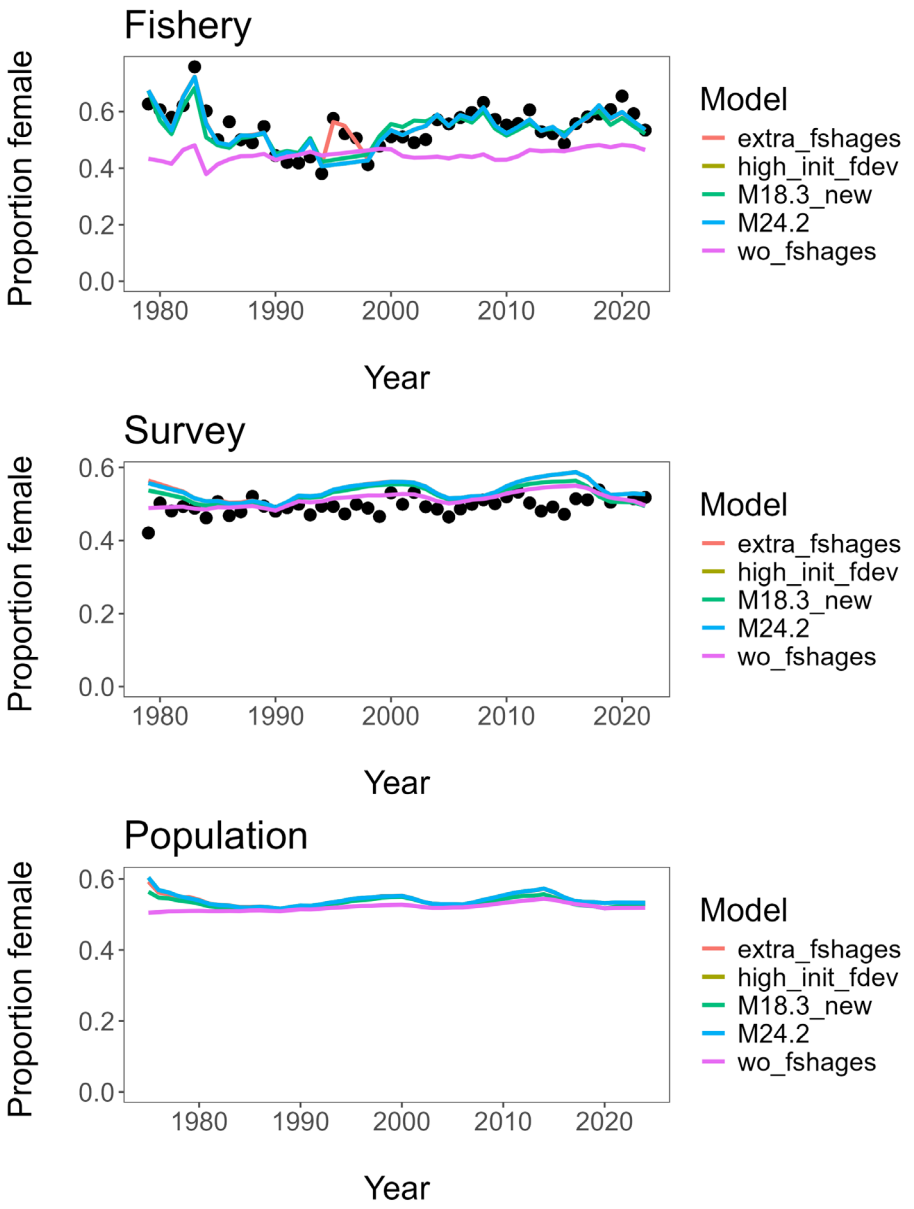
NOAA FISHERIES

A few sensitivity runs



NOAA FISHERIES

A few sensitivity runs



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