

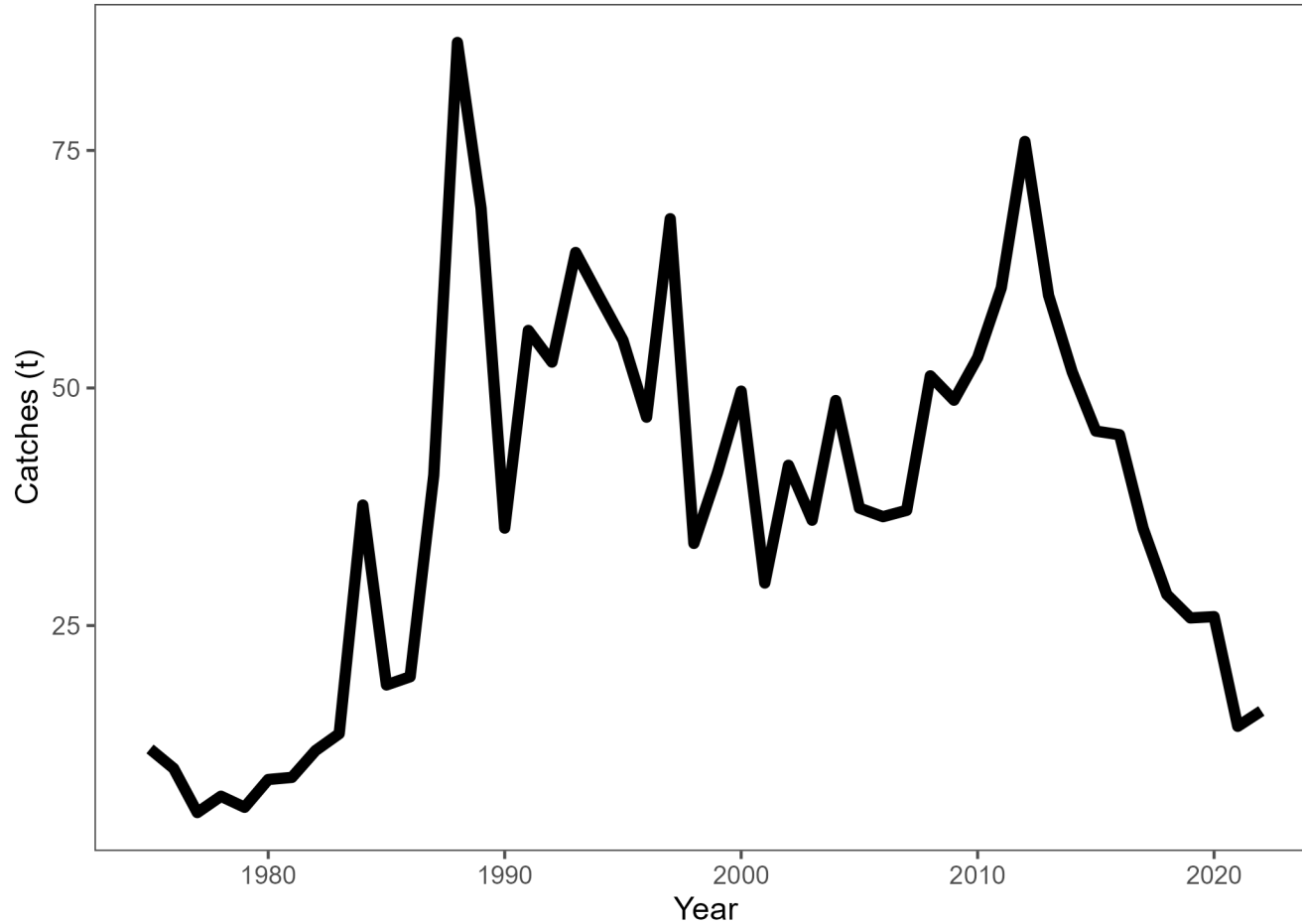
# BSAI Northern Rock Sole

Carey R. McGilliard, Jim Ianelli, and Elizabeth Siddon  
November 2024



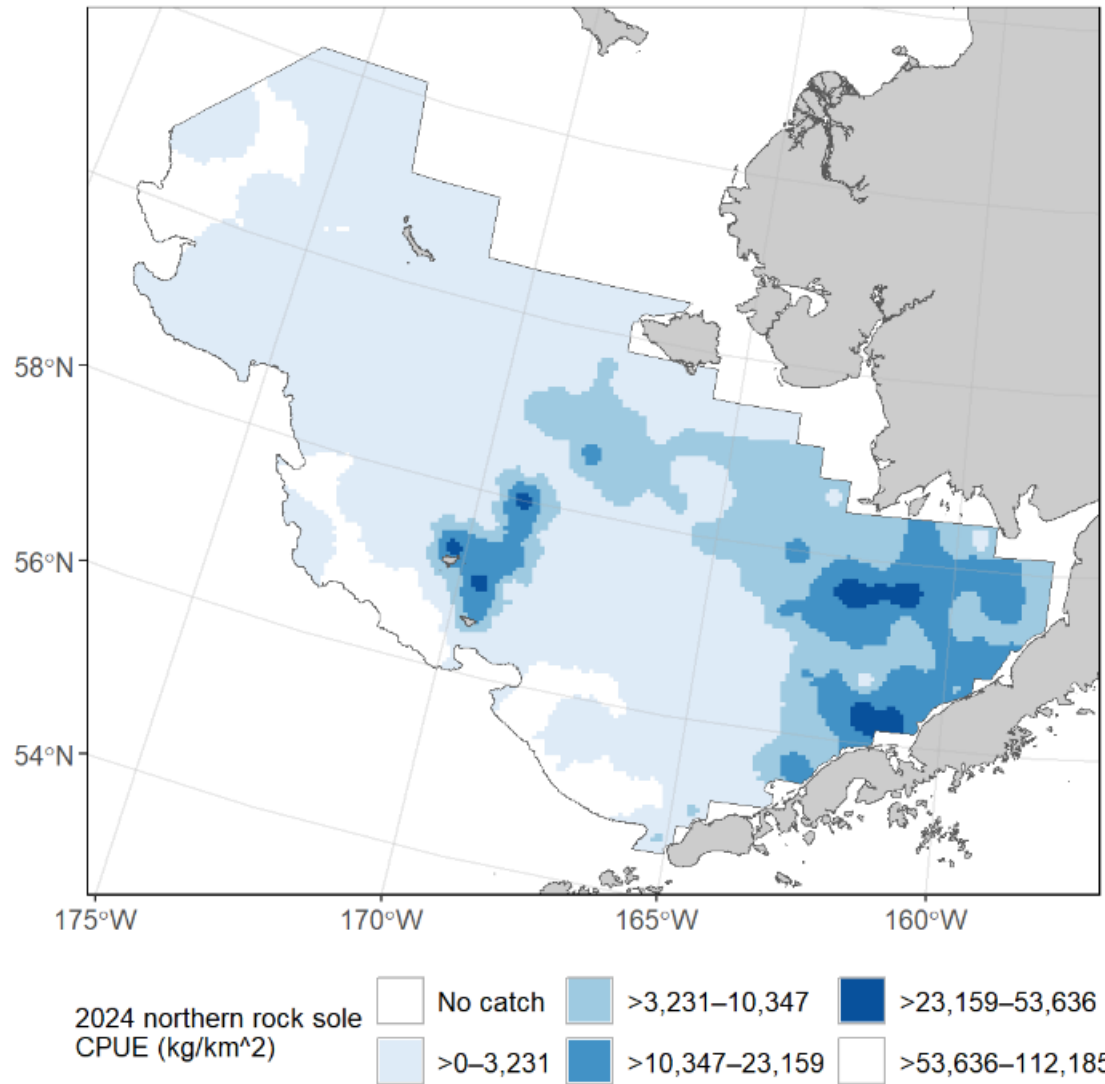
**NOAA**  
FISHERIES

# Catch Time series



2024

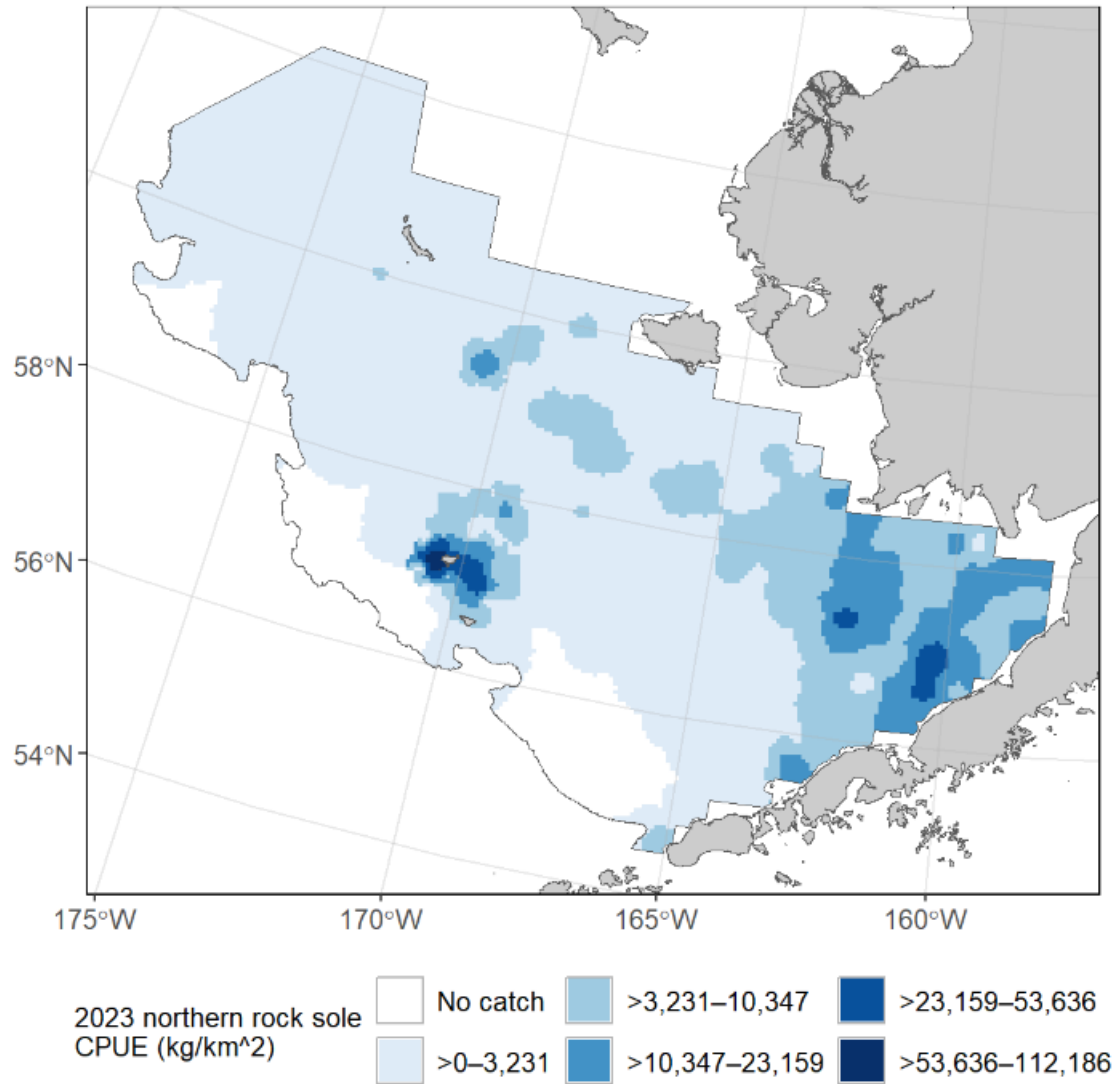
# Survey CPUE (previous years)



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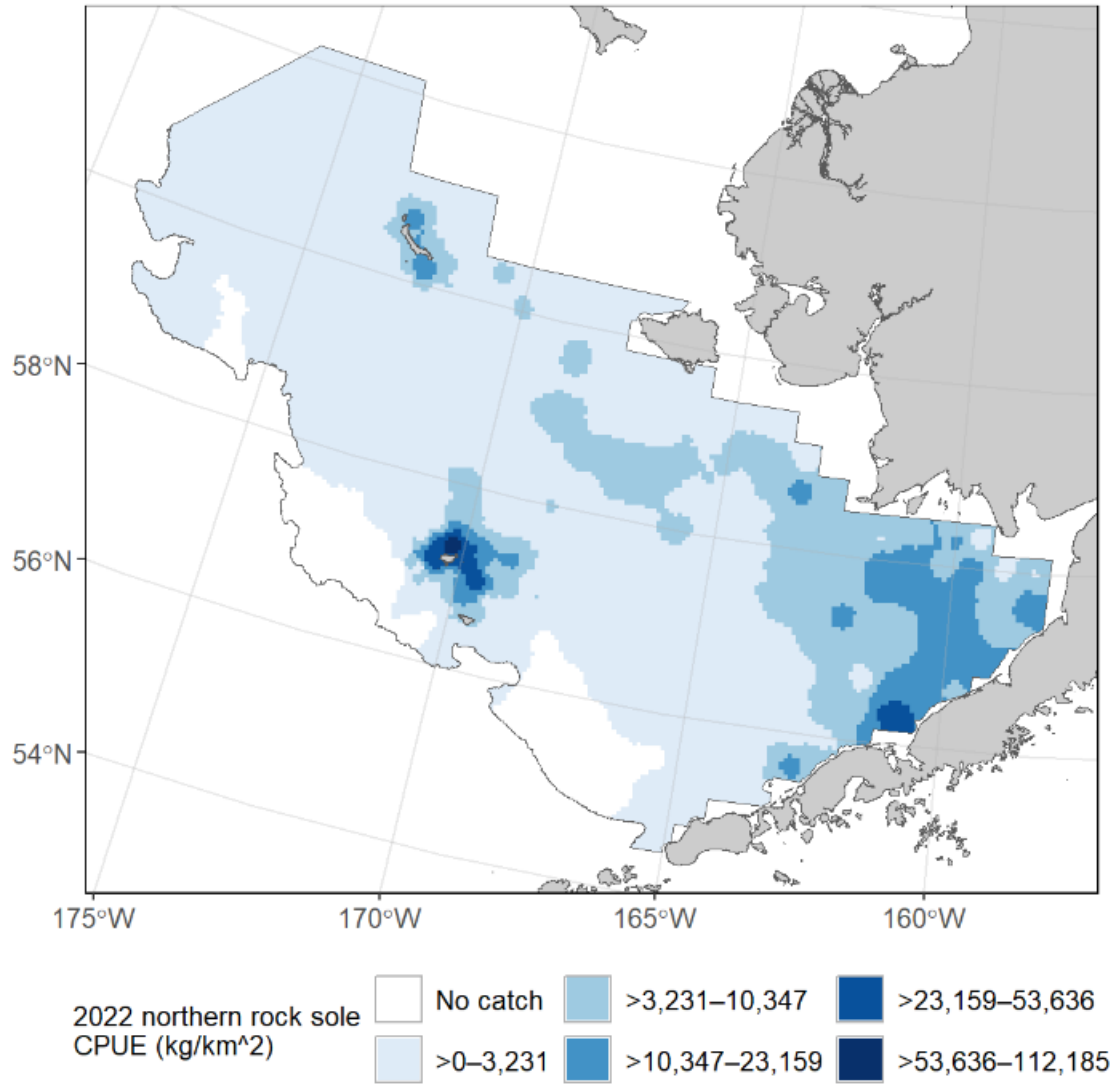
# Survey CPUE (previous years)

2023

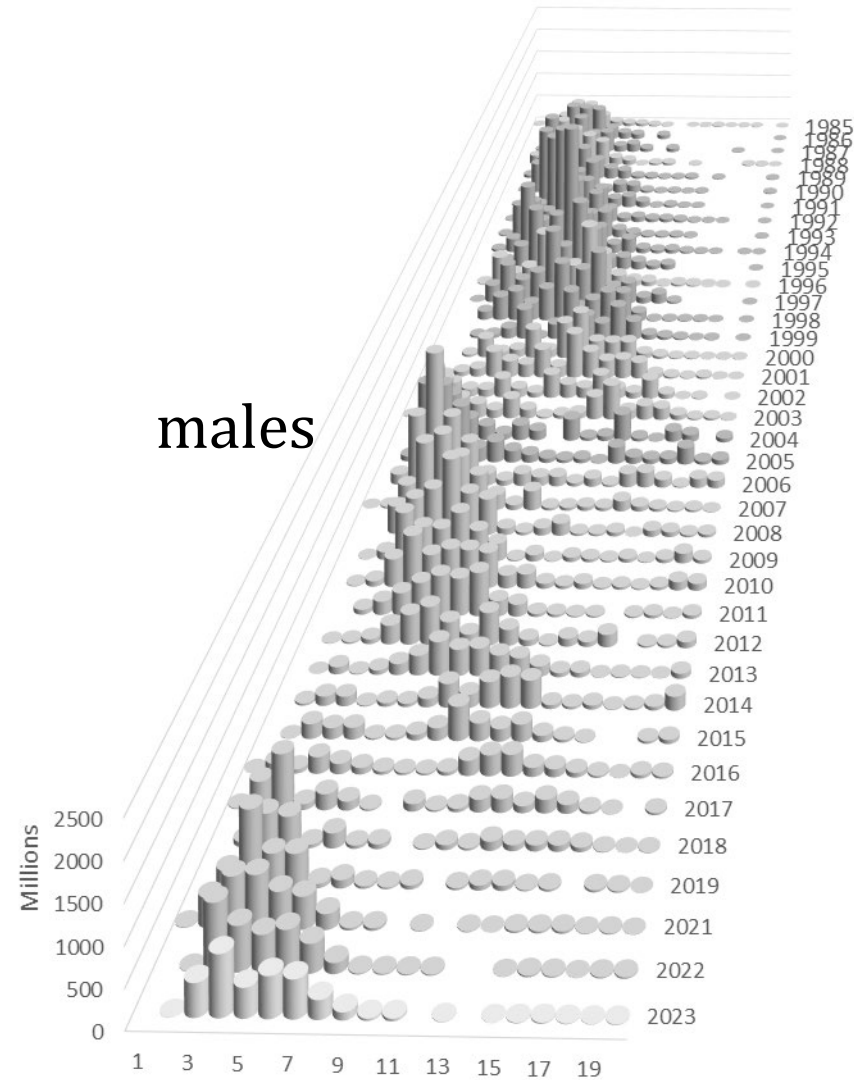
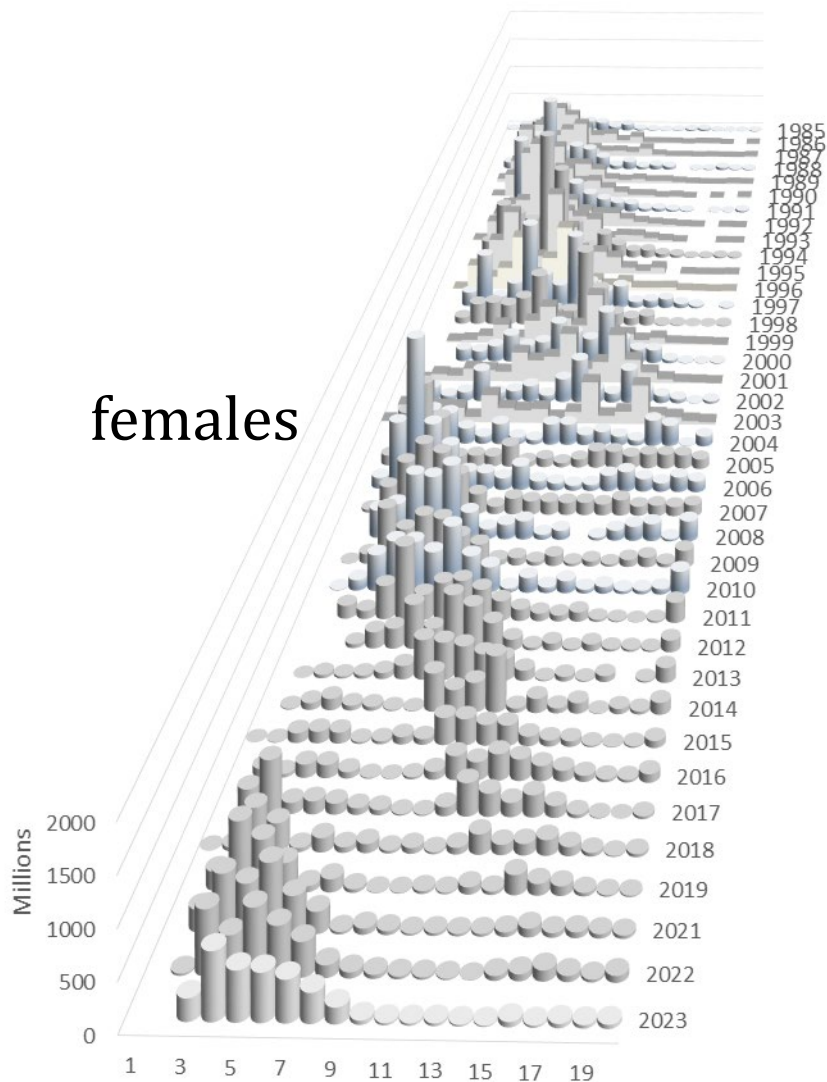


2022

# Survey CPUE (previous years)



# Survey age composition



# Data inputs

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

# 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
  - $\sigma_R = 0.6$
  - Female natural mortality = 0.15 (Model 18.3, Model 18.3\_new)
  - Maturity-at-age



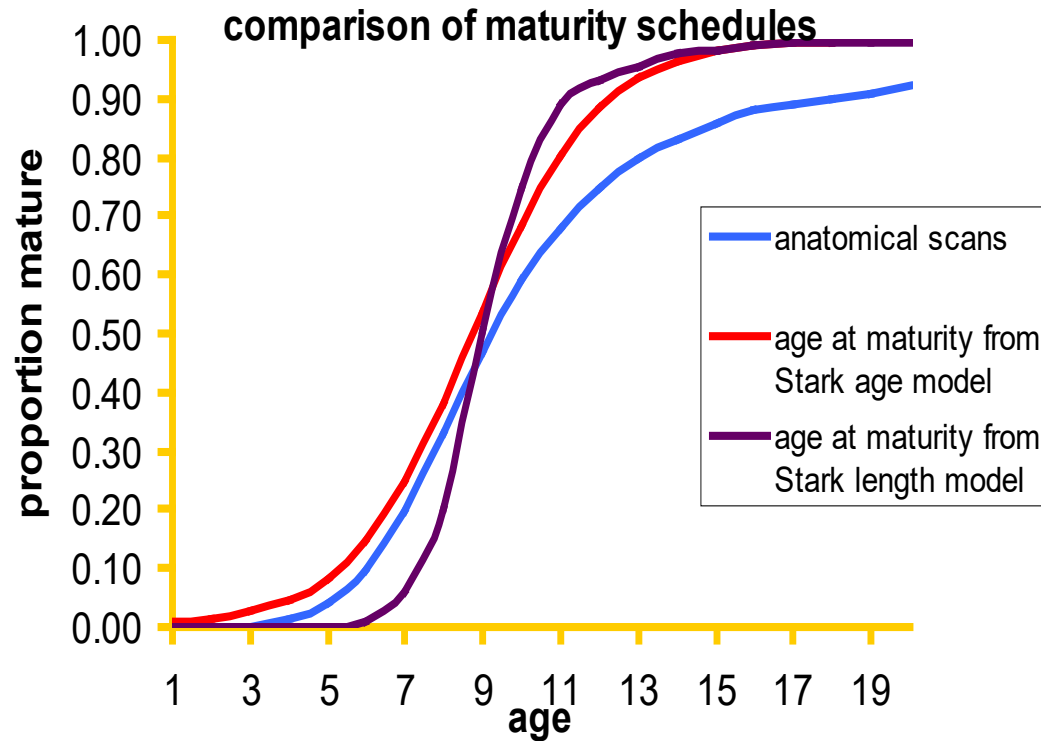


# Life history

- 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



# Maturity ogive from a 2012 paper



# 2022-2023 Models and ABC

- Model 18.3: The 2022 accepted model, substantial retrospective pattern – recent recruitment estimates consistently revised to be smaller with new years of data
- Model 22.1: As for 18.3, adds Francis data weighting
- Model 22.2: As for 22.1, but estimates female M (as well as male M, which was already estimated)
  
- Reduced ABC = OFL from Model 22.1 in 2022-2023
  - Addresses probability that true, but unknown OFL is smaller than the ABC



# SSC and PT Comments

*From the December 2022 SSC minutes: The SSC thanks the authors for being responsive to the SSC comments <from Dec 2020>. In particular, the alternative model provided reasonable estimates of natural mortality and shows promise for estimating catchability closer to empirical results. The SSC looks forward to future analyses on weighting to address model fits to survey and age composition data as well as development of the climate-enhanced projection model.*

We are bringing forward a model with estimation of M and Francis data-weighting

We hope to present on the climate-enhanced projection model in 2026



**NOAA**  
**FISHERIES**

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*From the November 2022 Plan Team minutes: The Team recommended the authors put Models 22.1 and 22.2 forward - with likelihood profiles and an evaluation of performance - as alternative models to the base model in the 2024 assessment cycle, to be presented in September 2024.*

We are bringing forward a model with estimation of  $M$  and Francis data-weighting. We include joint posterior distributions for  $M$  and  $q$  estimates

We hope to present on the climate-enhanced projection model in 2026



# SSC and PT Comments

*From the October 2024 SSC minutes: The BSAI GPT recommended bringing forward Model 18.3 (base) and Model 24.2 for December. The BSAI GPT also recommended future research on fixed selectivity for earlier years, examination of why One Step Ahead residuals are not standard normal, exploration of input sample sizes using the ISS bootstrap approach, updates of maturity which has not been examined in 20 years, and exploration of other potential issues including aging error. The SSC supports bringing models 18.3 and 24.2 forward for comparison in December and supports the BSAI GPT recommendations for future explorations.*

We are bringing forward Model 18.3 and 24.2 in this presentation.

We look forward to further tweaking the model to improve MCMC convergence and to incorporating currently ongoing research on fishery input sample sizes, as well as exploring maturity and ageing error in 2026.



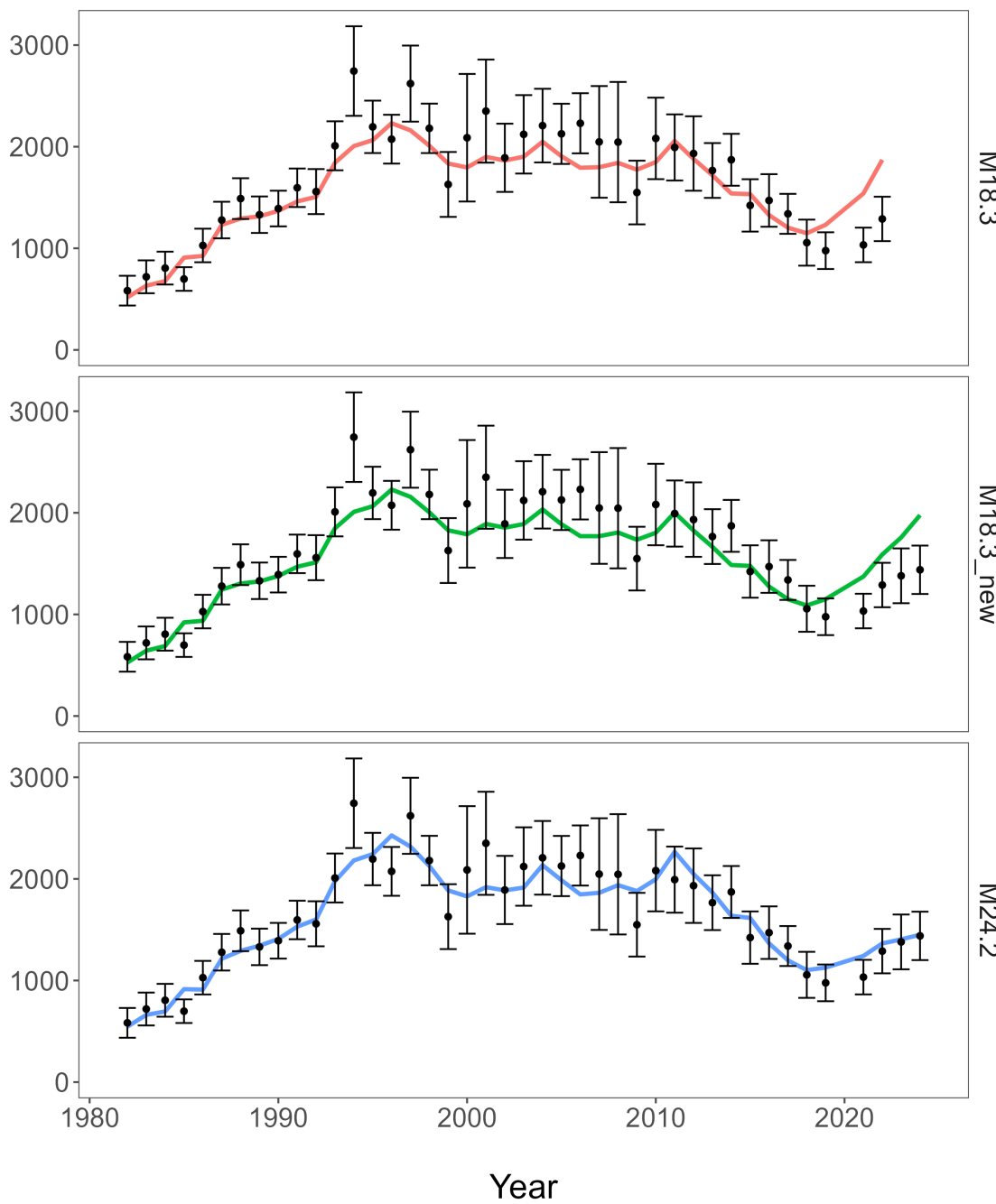
# Models presented

- Model 18.3: The 2022 accepted model
- Model 18.3\_new: the 2022 accepted model with available new data
- Model 24.2: estimates female natural mortality with lognormal prior, Francis data-weighting, Hulson et al. 2023/Stewart and Hamel 2014 input sample size approach
  - (male M already estimated in all models)



# Fits to survey biomass

Bottom trawl survey biomass index



M18.3

M18.3\_new

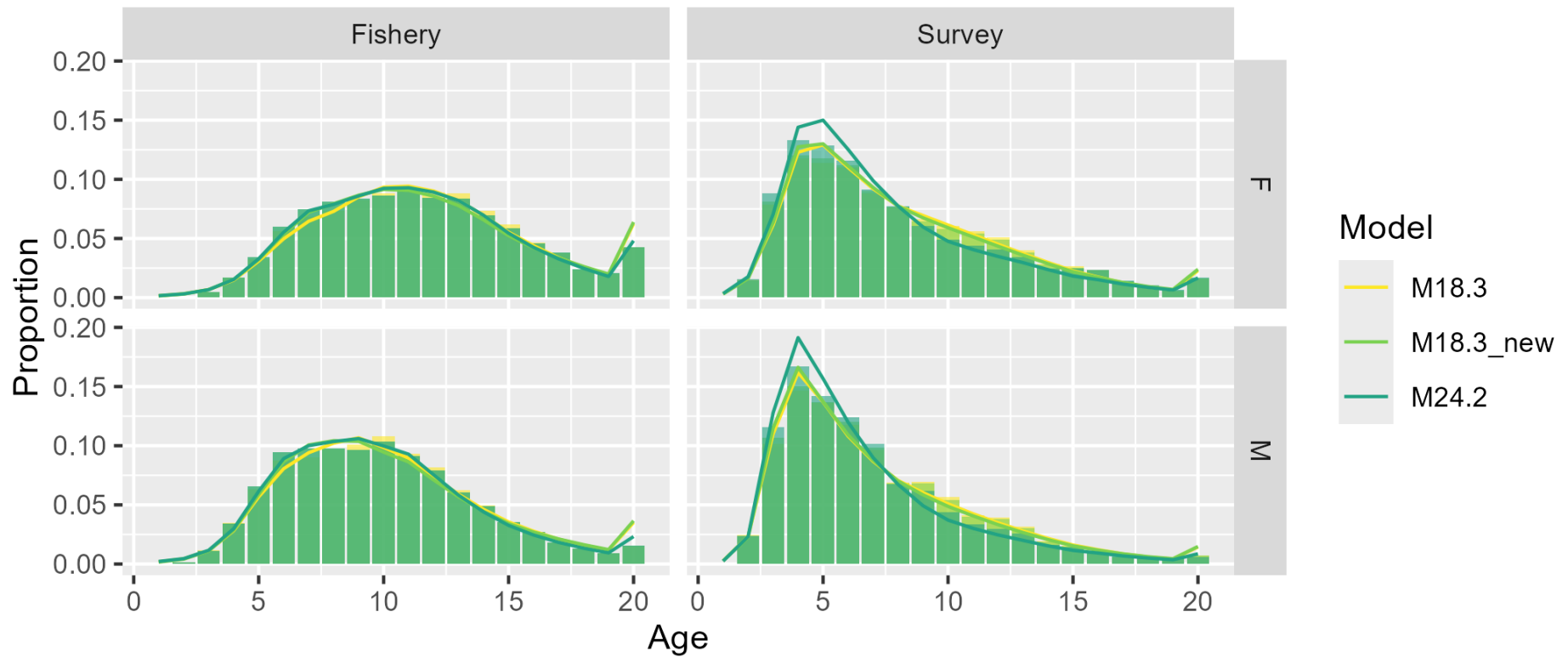
M24.2



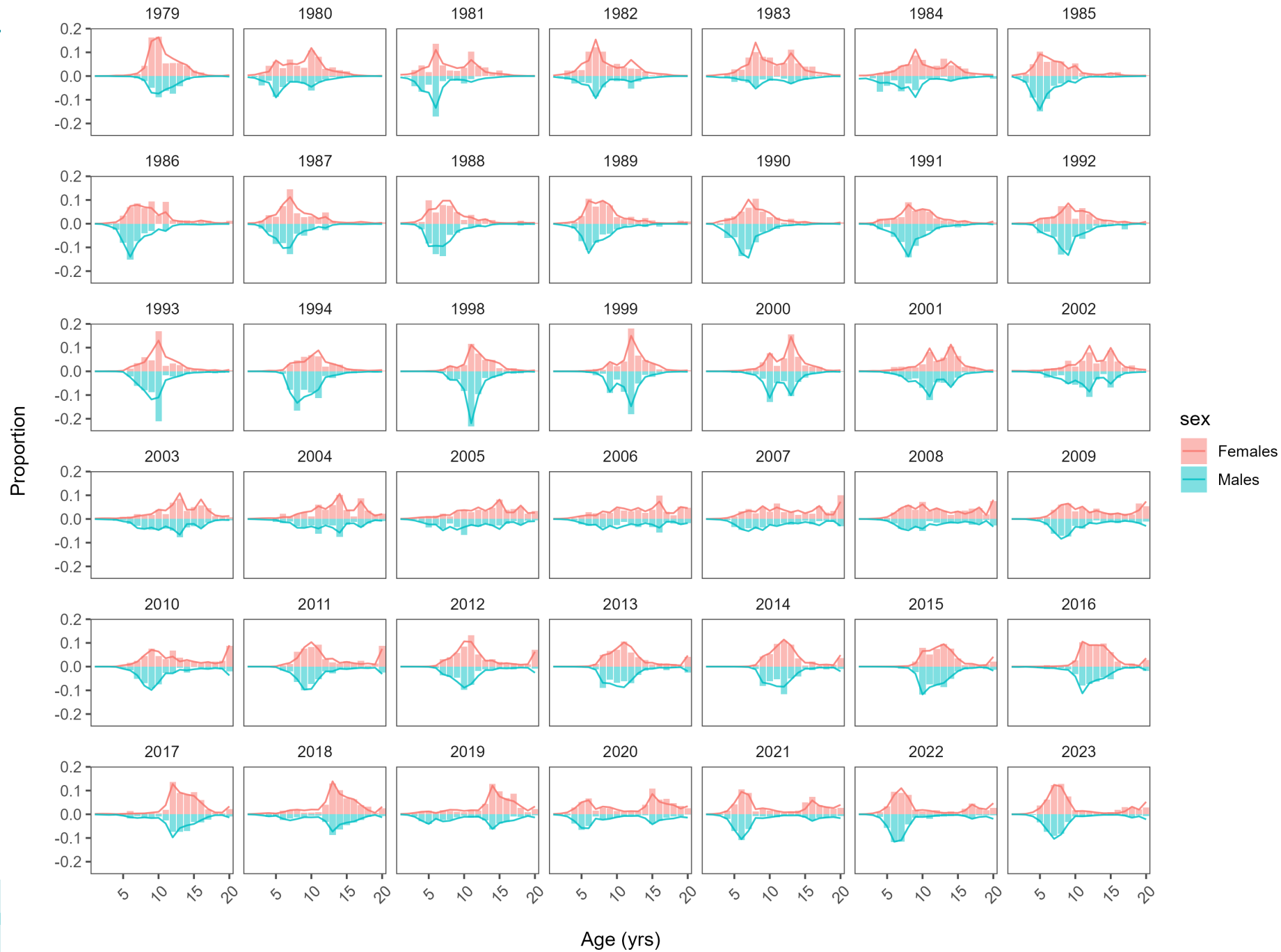
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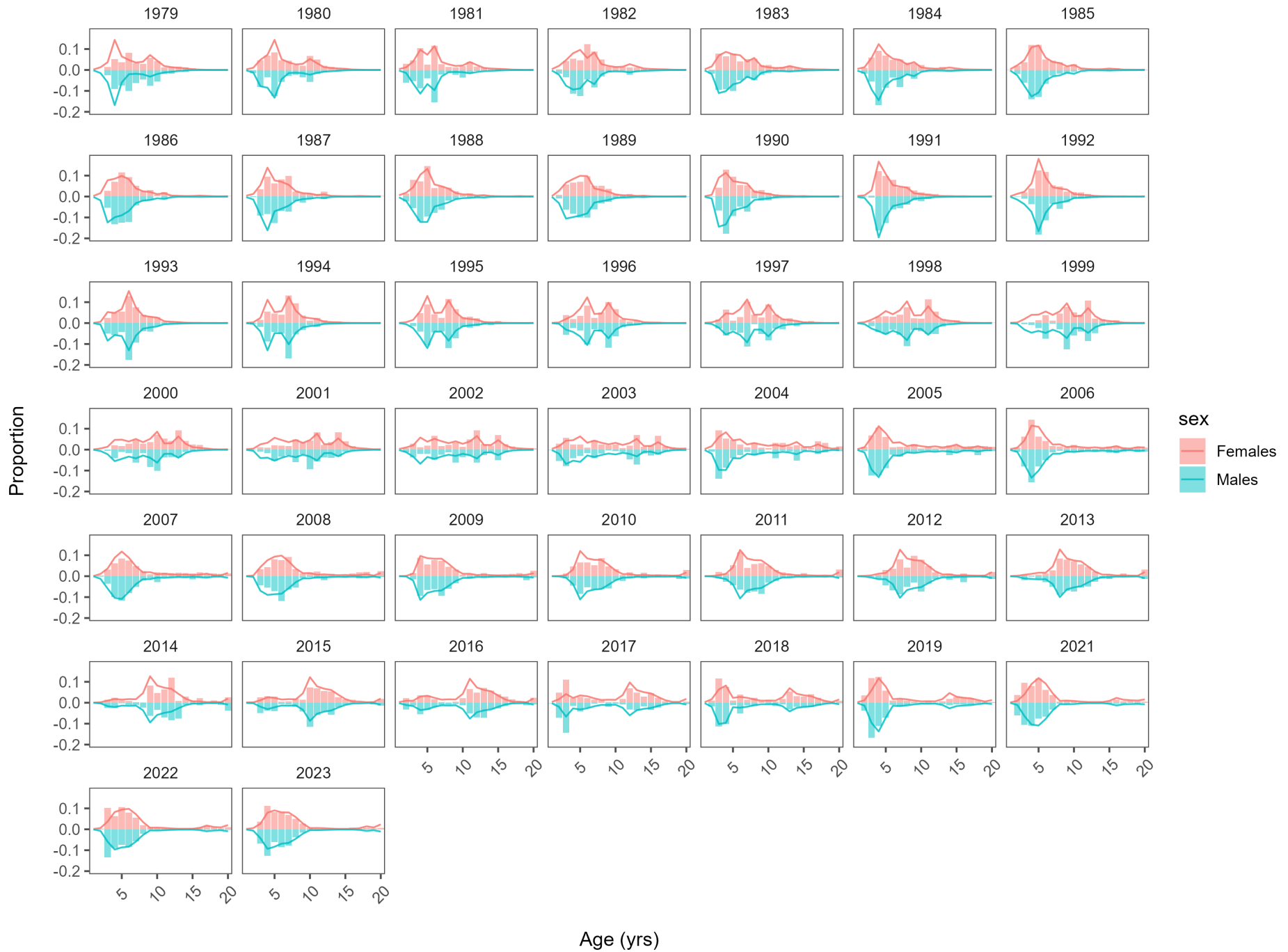
# Fits to age composition data



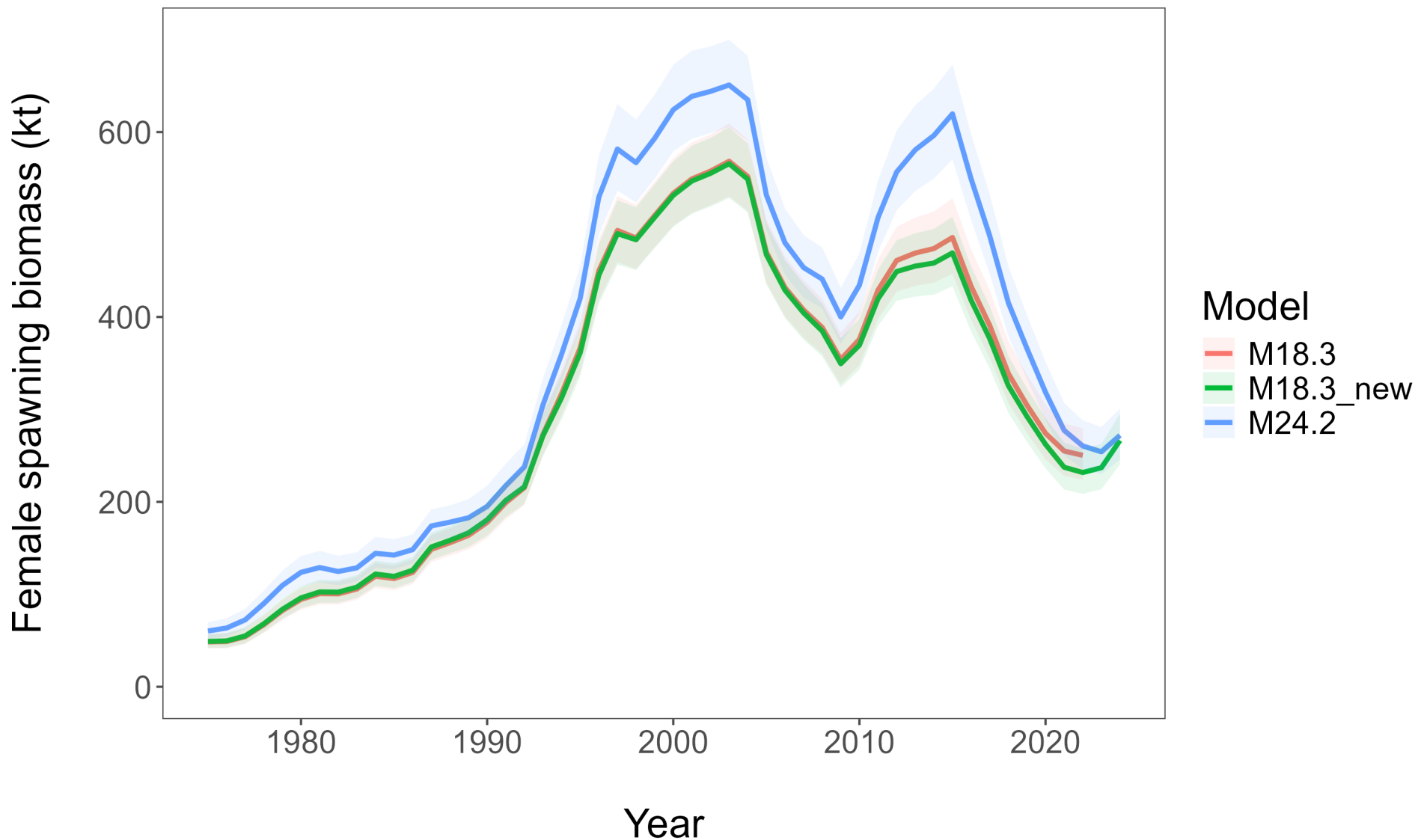
# Fishery age compositions



# Survey age compositions



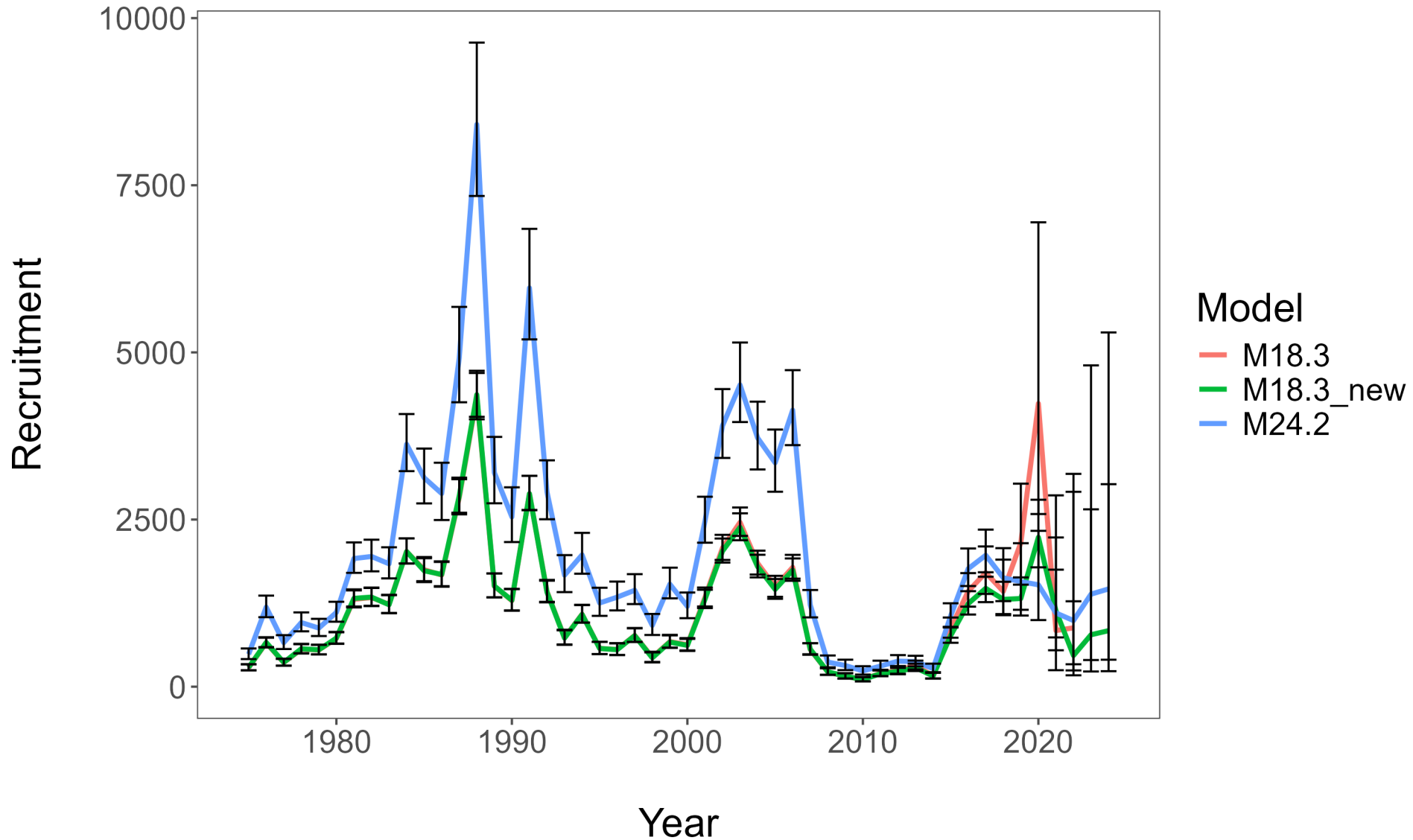
# Spawning biomass



Model

- M18.3
- M18.3\_new
- M24.2

# Recruitment estimates

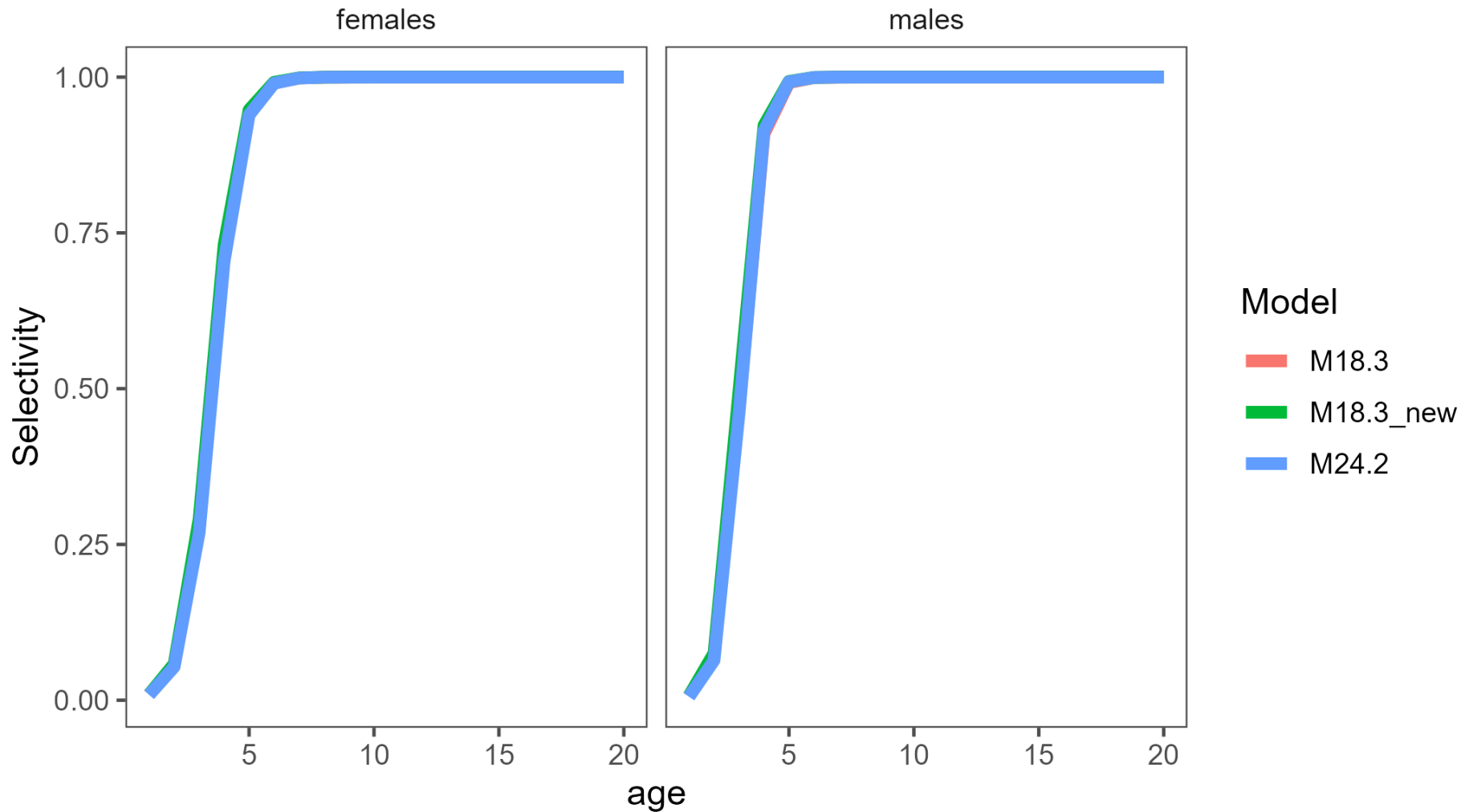


Model

- M18.3
- M18.3\_new
- M24.2



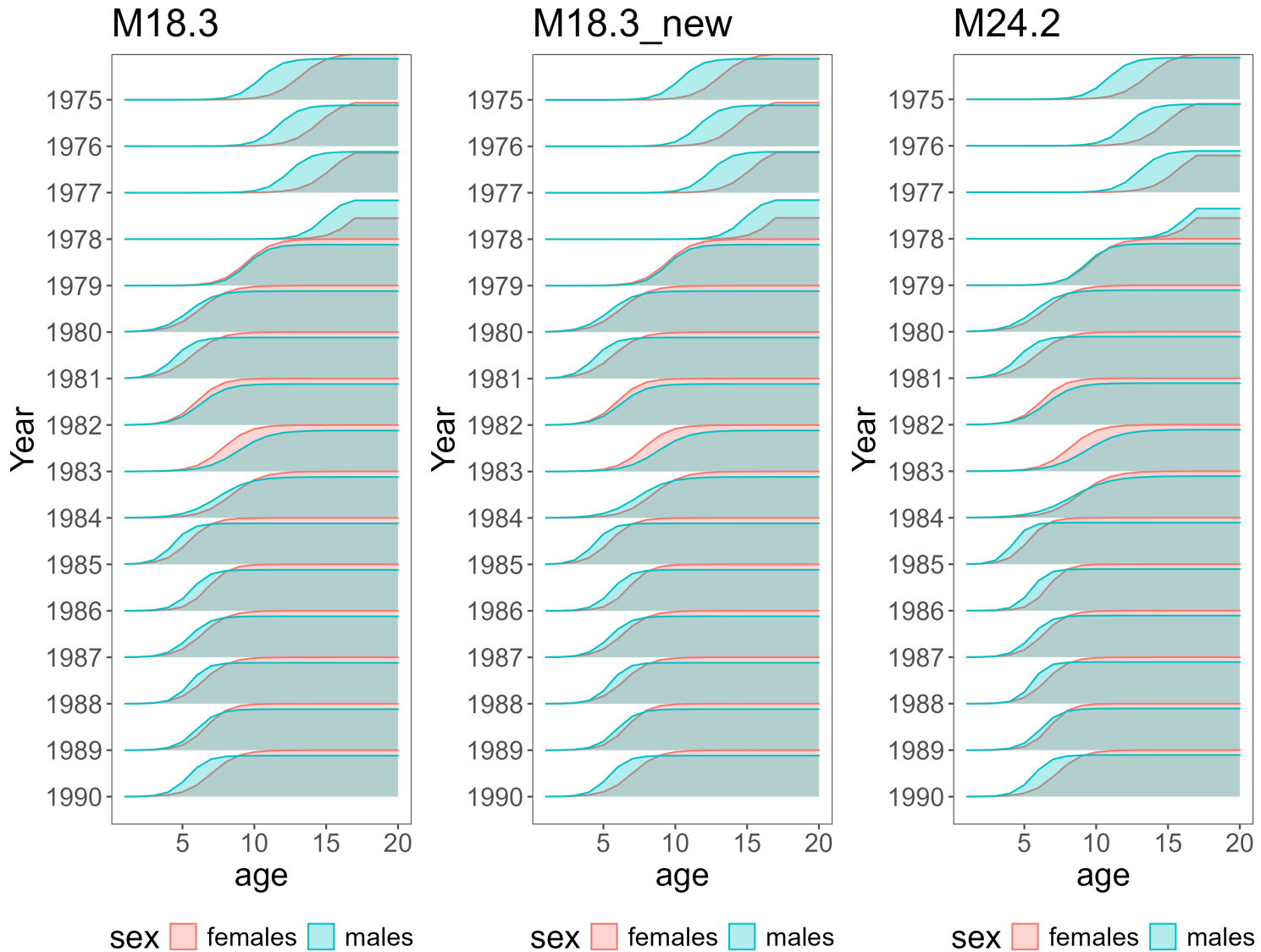
# Survey selectivity



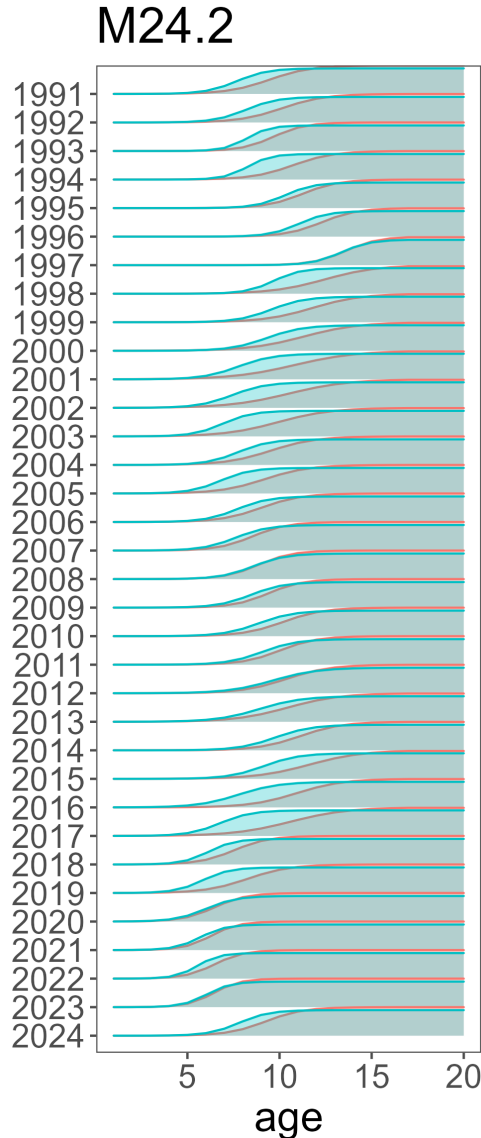
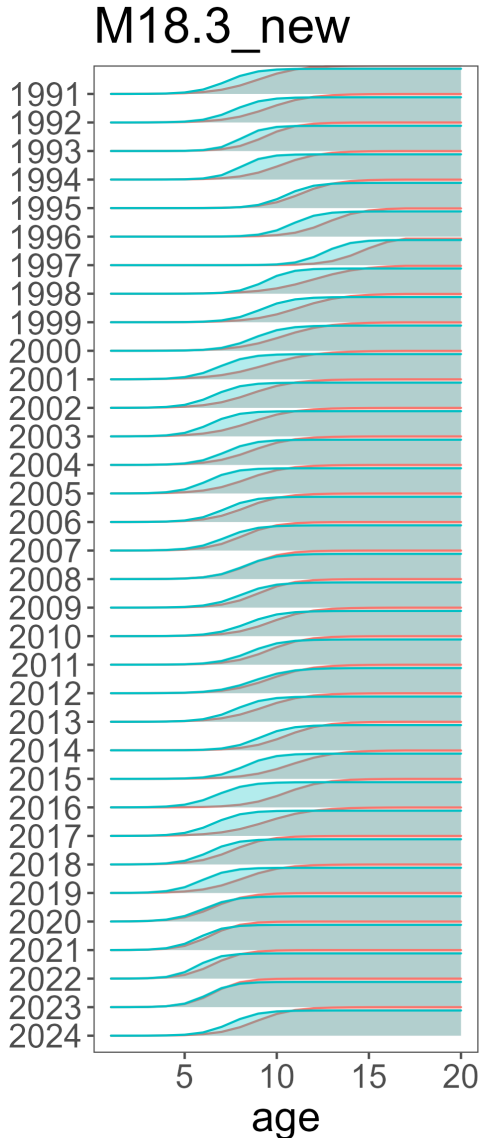
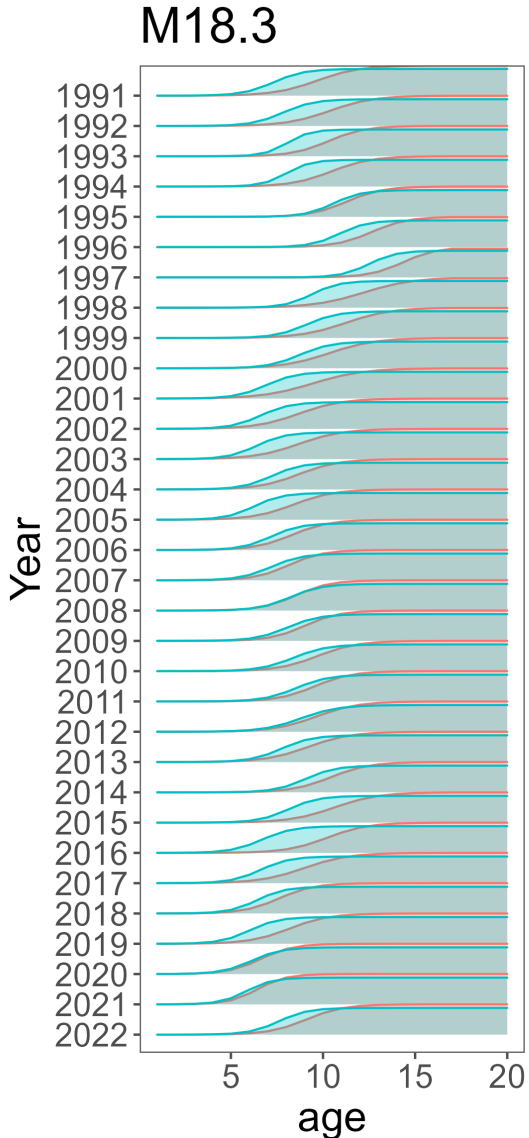
- Model
- M18.3
  - M18.3\_new
  - M24.2



# Early fishery selectivity



# Later fishery selectivity



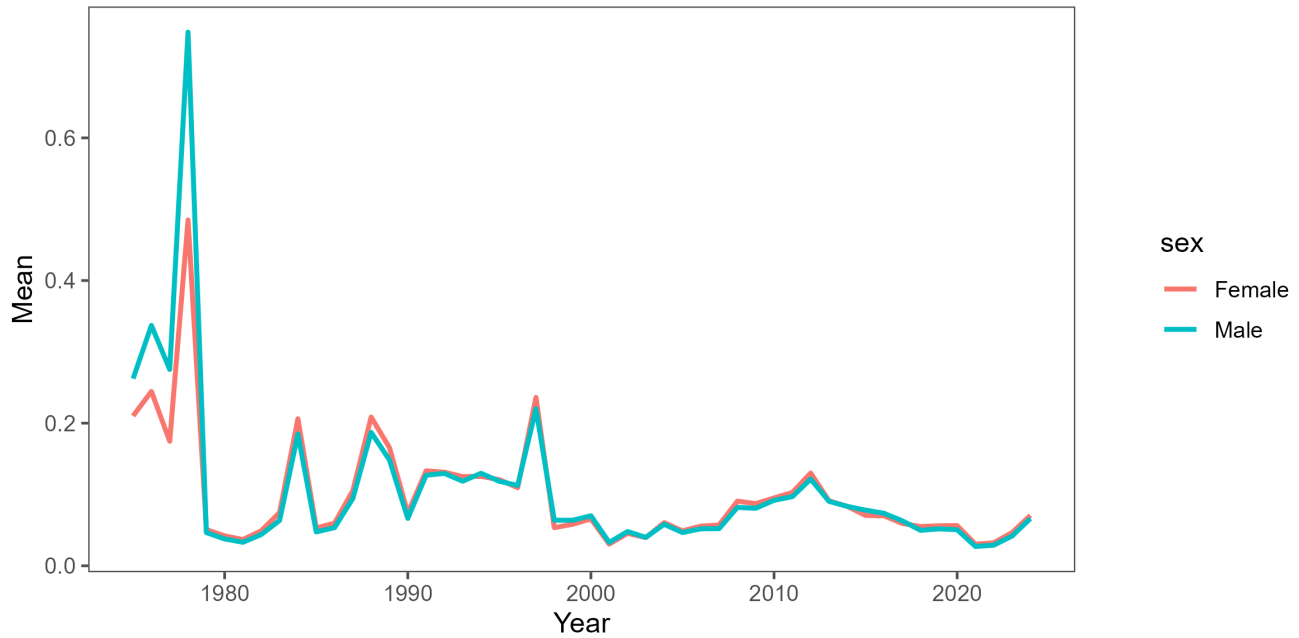
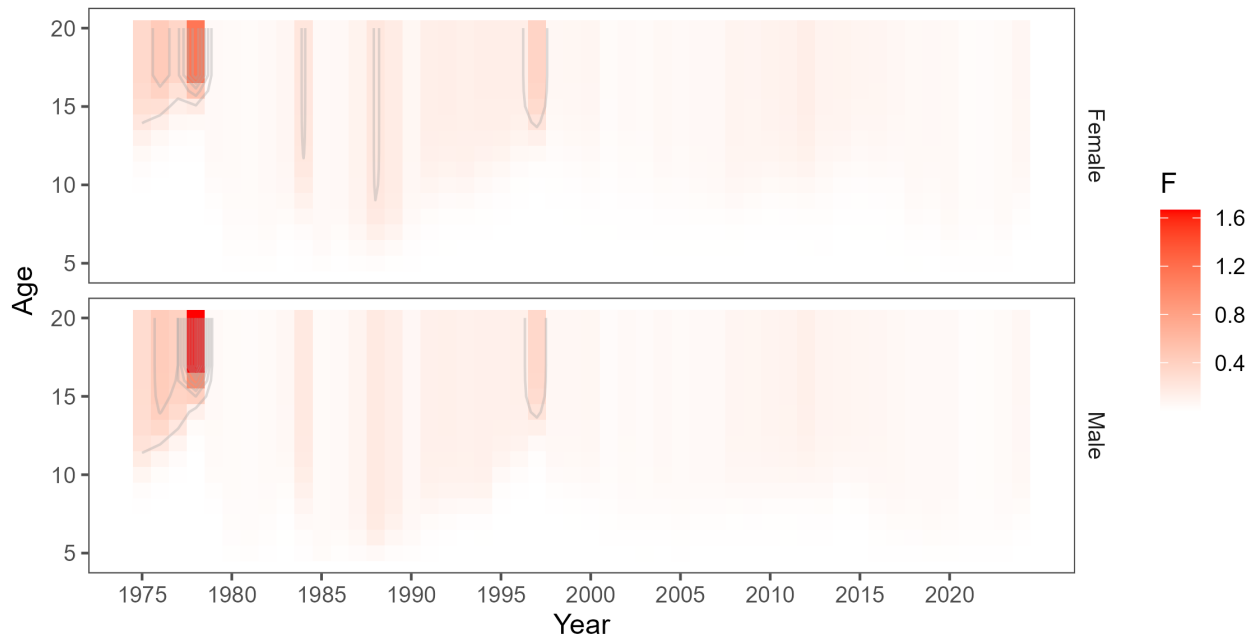
sex females males

sex females males

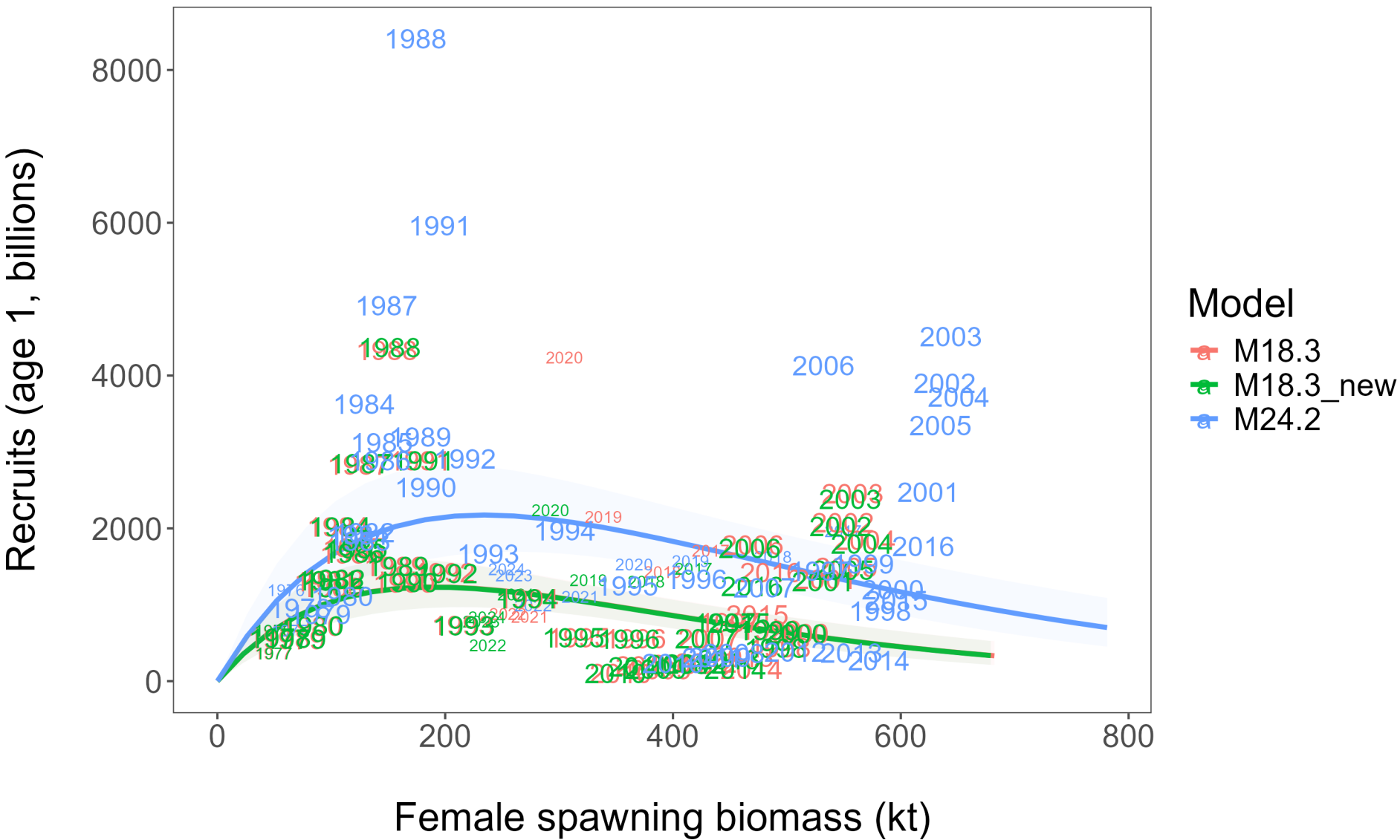
sex females males



# Fishing mortality



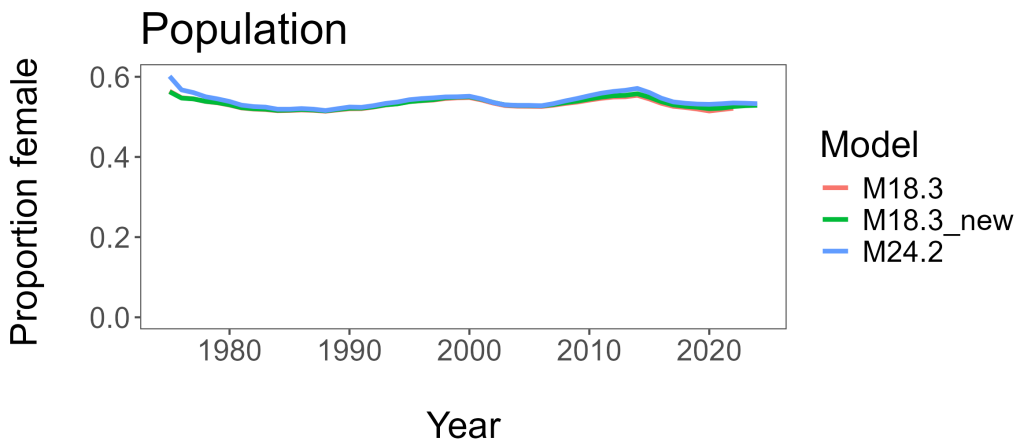
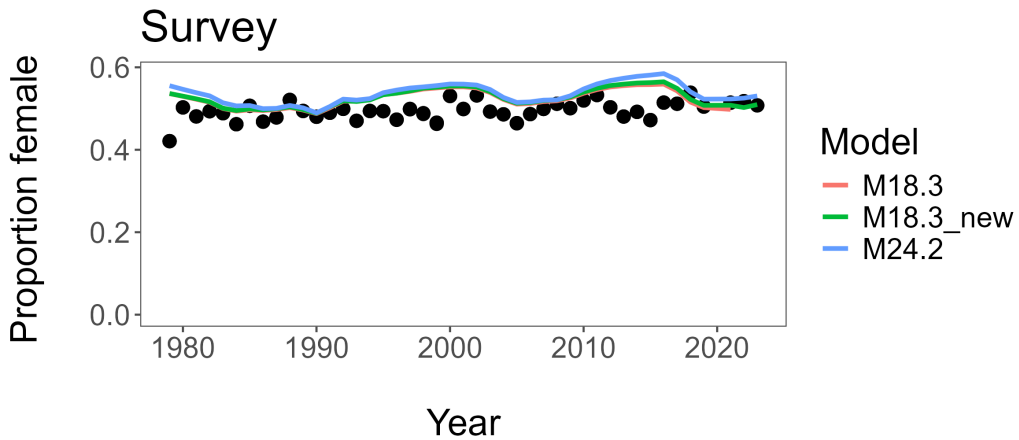
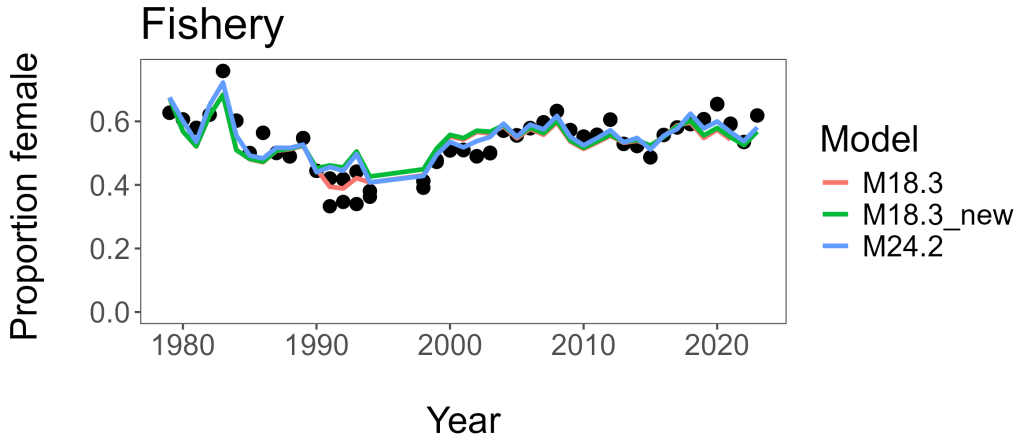
# Stock-recruit curves



- Model**
- M18.3
  - M18.3\_new
  - M24.2



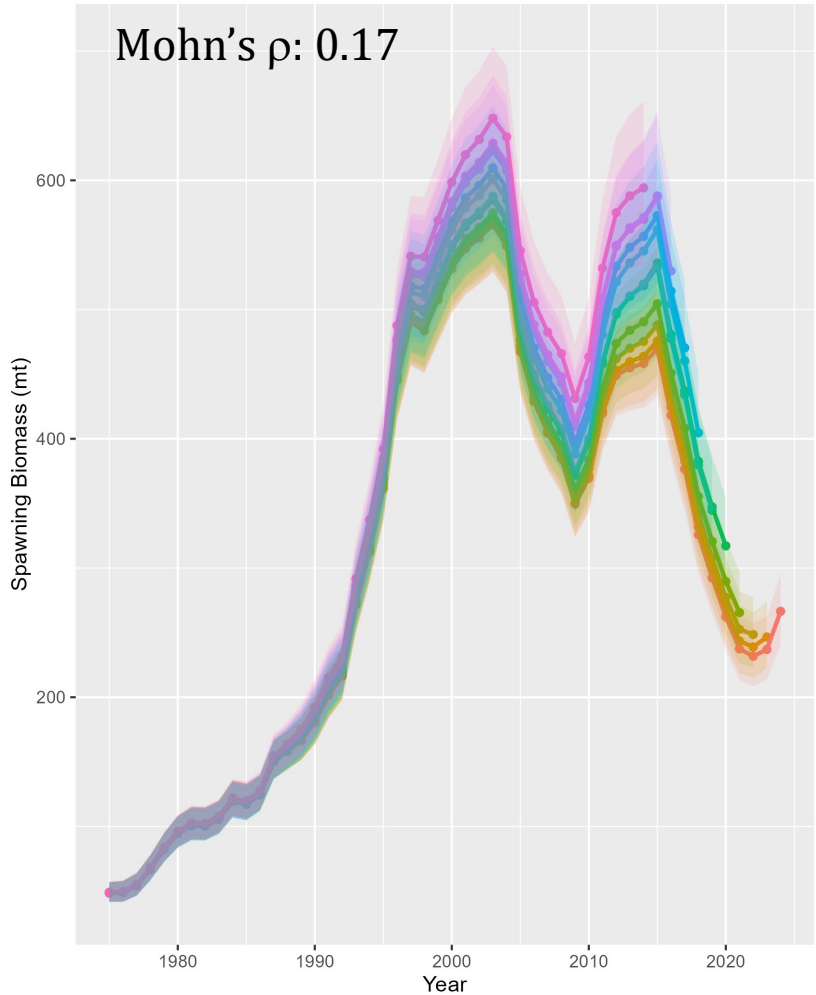
# Sex Ratios



# Retrospective analysis

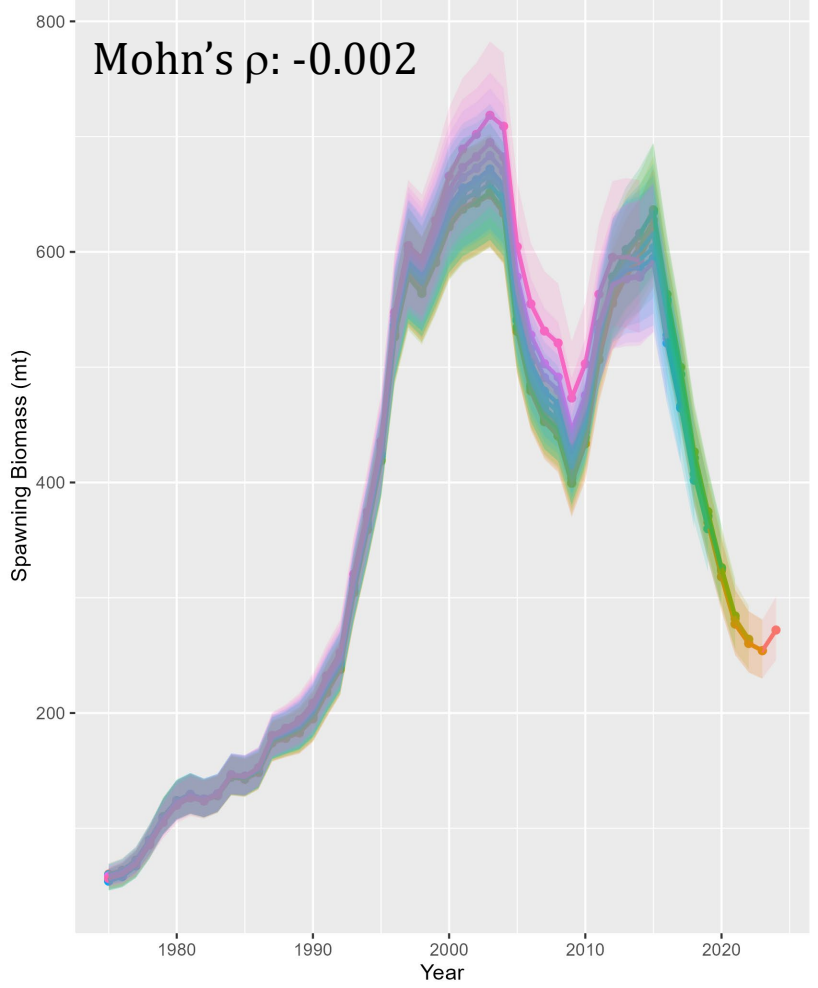
## Model 18.3\_new

Mohn's  $\rho$ : 0.17



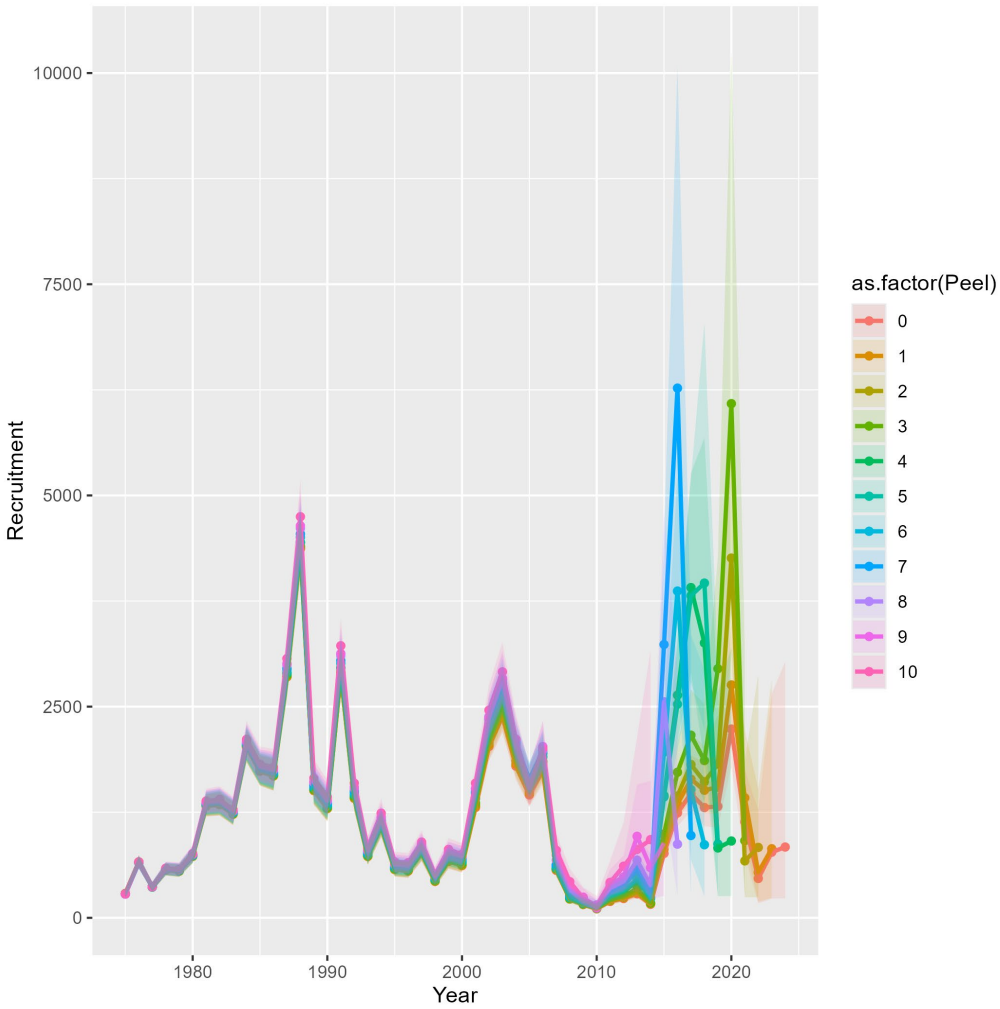
## Model 24.2

Mohn's  $\rho$ : -0.002

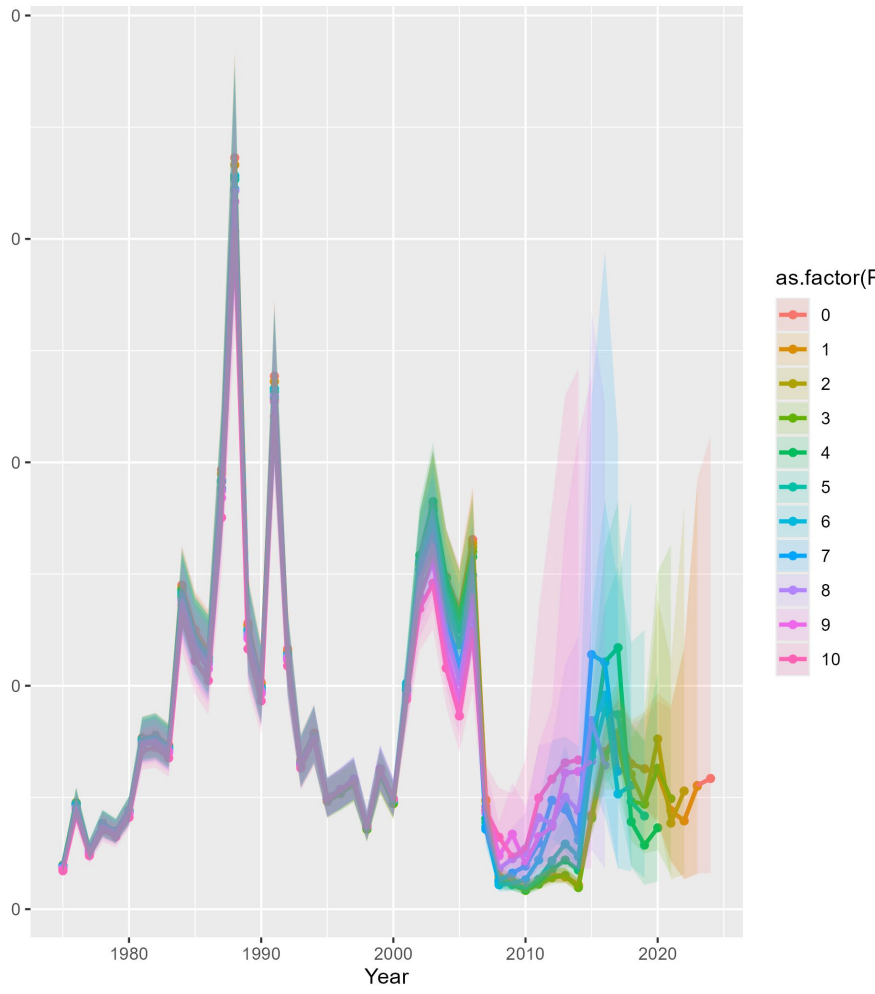


# Retrospective analysis: Recruitment

## Model 18.3\_new



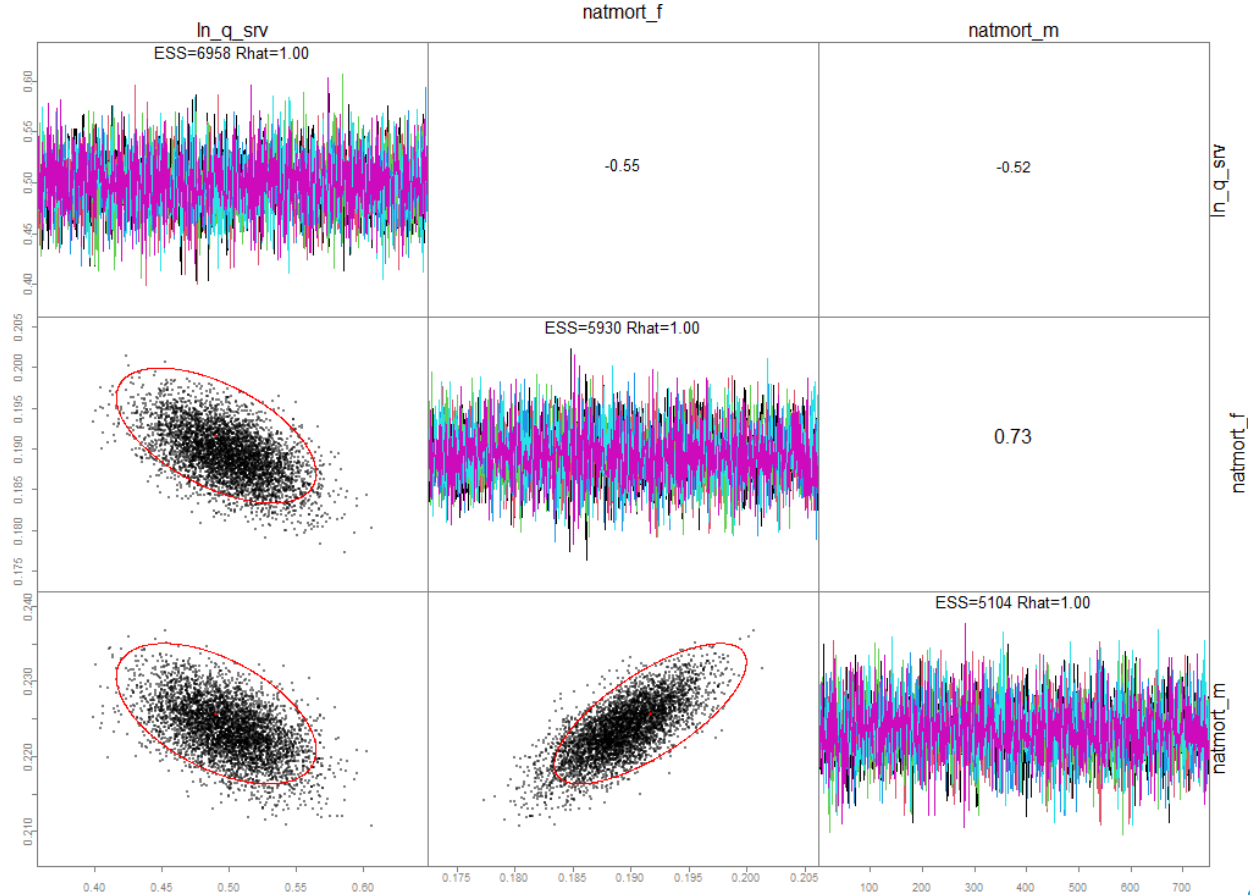
## Model 24.2



# Bayesian analysis: M24.2 M and q

## MLE estimates

- Female M 0.192 (sd 0.003)
- Male M 0.226 (sd 0.004)
- q 1.633 (sd 0.05)



# Executive Summary Table (M24.2)

- Estimated catch for 2024 calculated using average proportion of Oct-Dec catches
- Estimated catch for 2025-2026 is recent 10-year average
- Stock recruit curve based on 1978-2018
- No substantial risk table concerns (Level 1 in all categories)

Quantity	As estimated or <i>specified last year for:</i>		As estimated or <i>recommended this year for:</i>	
	2024	2025	2025	2026
<i>M</i> (natural mortality rate)	0.15 (f), 0.17 (m)	0.15 (f), 0.17 (m)	0.19(f), 0.23(m)	0.19(f), 0.23(m)
Tier	1a	1a	1a	1a
Projected total (age 6+) biomass (t)	1,121,670	1,501,330	881,154	885,284
Projected Female spawning biomass (t)	296,808	347,811	301,051	330,774
<i>B<sub>0</sub></i>	447,795	447,795	516,007	516,007
<i>B<sub>MSY</sub></i>	155,293	155,293	183,756	183,756
<i>F<sub>OFL</sub></i>	0.176	0.176	0.188	0.188
<i>maxF<sub>ABC</sub></i>	0.169	0.169	0.179	0.179
<i>F<sub>ABC</sub></i>	0.129	0.108	0.179	0.179
OFL (t)	197,828	264,789	165,444	166,220
maxABC (t)	189,360	253,455	157,487	158,225
ABC (t)	122,091	122,535	157,487	158,225
Status	As determined <i>last year</i> for:		As determined <i>this year</i> for:	
	2022	2023	2023	2024
Overfishing	no	n/a	no	n/a
Overfished	n/a	no	n/a	no
Approaching overfished	n/a	no	n/a	no



# 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)

