

Status Report: Gmacs BBRKC

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January 2017

Gmacs SMBKC

The image shows two GitHub repository pages side-by-side. The left page is for the repository `seacode/gmacs`, which contains a generic size-structured stock assessment model. The right page is for the repository `Gmacs`, which is described as a generalized size-structured stock assessment modelling framework.

Left Page: seacode/gmacs

- This repository has 1,322 commits, 3 branches, 4 releases, and 6 contributors.
- A recent commit by `quantifish` deleted the `twosex` directory.
- The latest commit was 3e4bcb7, made 19 minutes ago.
- Recent commits include changes to `docs`, `examples`, `gmr`, `src`, `.gitignore`, `.travis.yml`, `CHANGELOG.md`, `Makefile`, and `README.md`.

Right Page: Gmacs

- This repository has 40 issues, 0 pull requests, 0 projects, 0 wiki, and 0 pulse.
- The `Issues` tab is selected.
- A **Pre-release** tag is present, identified as `smbkc_2016` (commit `4c5e63e`).
- The tag is associated with the **SMBKC 2016** stock assessment.
- The tag note states: "quantifish released this on 28 Sep 2016 - 47 commits to develop since this release. This tag identifies the code that was used for the 2016 SMBKC stock assessment. This is the assessment after it was presented to the CPT and some edits were made to the document, but before the assessment was presented to the SSC."
- The **Downloads** section offers source code in zip and tar.gz formats.

Gmacs Description

A generalized size-structured stock assessment modelling framework. Gmacs includes:

- The [Gmacs](#) model
- A simulation model
- An R [package](#) for working with Gmacs output files
- A [Wiki](#)

Gmacs BBRKC Progress

- Sex-specific recruitment - uses a proportion m/f parameter that is logit transformed with normal prior (rather than 50/50 split)
- Sex-specific time-varying natural mortality
- Sex-specific custom growth matrices
- Sex-specific natural mortality rates by year (can be fixed-custom)
- Better numbers at length plots, selectivity plots, molt probability plots, etc
- Updated BBRKC model input data
- BBRKC model progress
- BBRKC document with comparisons in progress

Bristol Bay Red King Crab Stock Assessment 2017

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Executive Summary

1. **Stock:** Red king crab (RKC), *Paralithodes camtschaticus*, in Bristol Bay, Alaska.
2. **Catches:** Peak historical harvest was 4288 tonnes (9.454 million pounds) in 1983/84¹. The fishery was closed for 10 years after the stock was declared overfished in 1999. Fishing resumed in 2009/10 with a fishery-reported retained catch of 209 tonnes (0.461 million pounds), less than half the 529.3 tonne (1.167 million pound) TAC. Following three more years of modest harvests supported by a fishery catch per unit effort (CPUE) of around 10 crab per pot lift, the fishery was again closed in 2013/14

Problems Encountered

Gmacs

- Gmacs is slow (~15 minutes per BBRKC model run) - model flexibility adds excess baggage, be careful what you wish for
- Positive definite Hessian issues

2016 Model

- The 2016 model is initialised with no oldshell male crab in 1975. In 1976 they appear!
- The code is very difficult to follow. Figures in document can be misleading.

Gmacs BBRKC

- Had to fix initial numbers at those estimated in 2016 model for now as I cannot match this initialisation - this likely causes other problems
- Had to fix growth matrix to 2016 model matrix for now as I could not match - 2016 model derived differently
- Poor fit to NMFS survey - particularly the bulge in biomass around 1990
- Not fitting to BSFRF survey if $q = 1$

Model Dimensions & Why Gmacs is Slow

Size-classes	20	65-165
Sexes	2	Male, Female
Shell conditions	2	Oldshell, Newshell
Seasons	4	1-4
Years	42	1975-2016

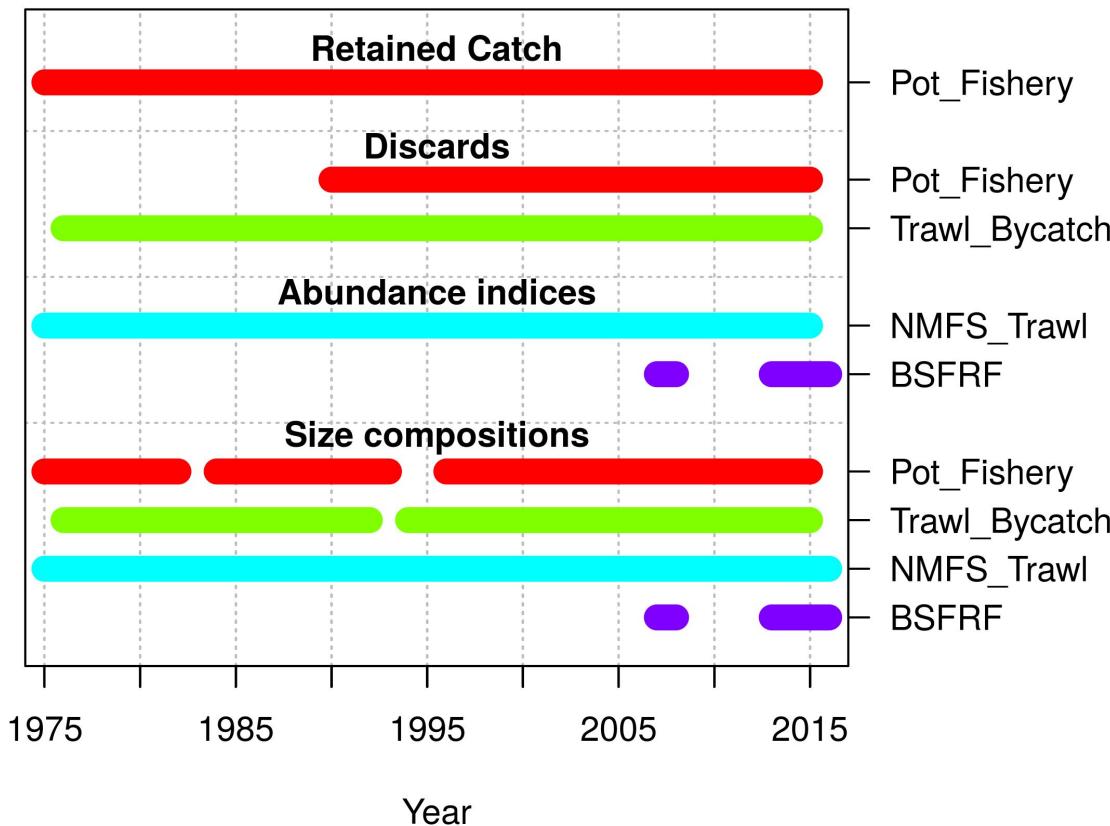
$$20 \times 2 \times 2 \times 4 \times 42 = 13440 \text{ dimensions}$$

c.f. a BBRKC-specific model

$$20 \times 3 \times 1 \times 42 = 2520 \text{ dimensions}$$

Data

1. Catch
 - a. Pot fishery retained males
 - b. Pot fishery discarded males
 - c. Pot fishery discarded females
 - d. Trawl bycatch males+females
2. Survey
 - a. NMFS survey males
 - b. NMFS survey females
 - c. BSFRF survey males+females
3. Length-frequency
 - a. Pot fishery retained males
 - b. Pot fishery discarded males
 - c. Pot fishery discarded females
 - d. Trawl bycatch males
 - e. Trawl bycatch females
 - f. NMFS survey males
 - g. NMFS survey females
 - h. BSFRF survey males
 - i. BSFRF survey females



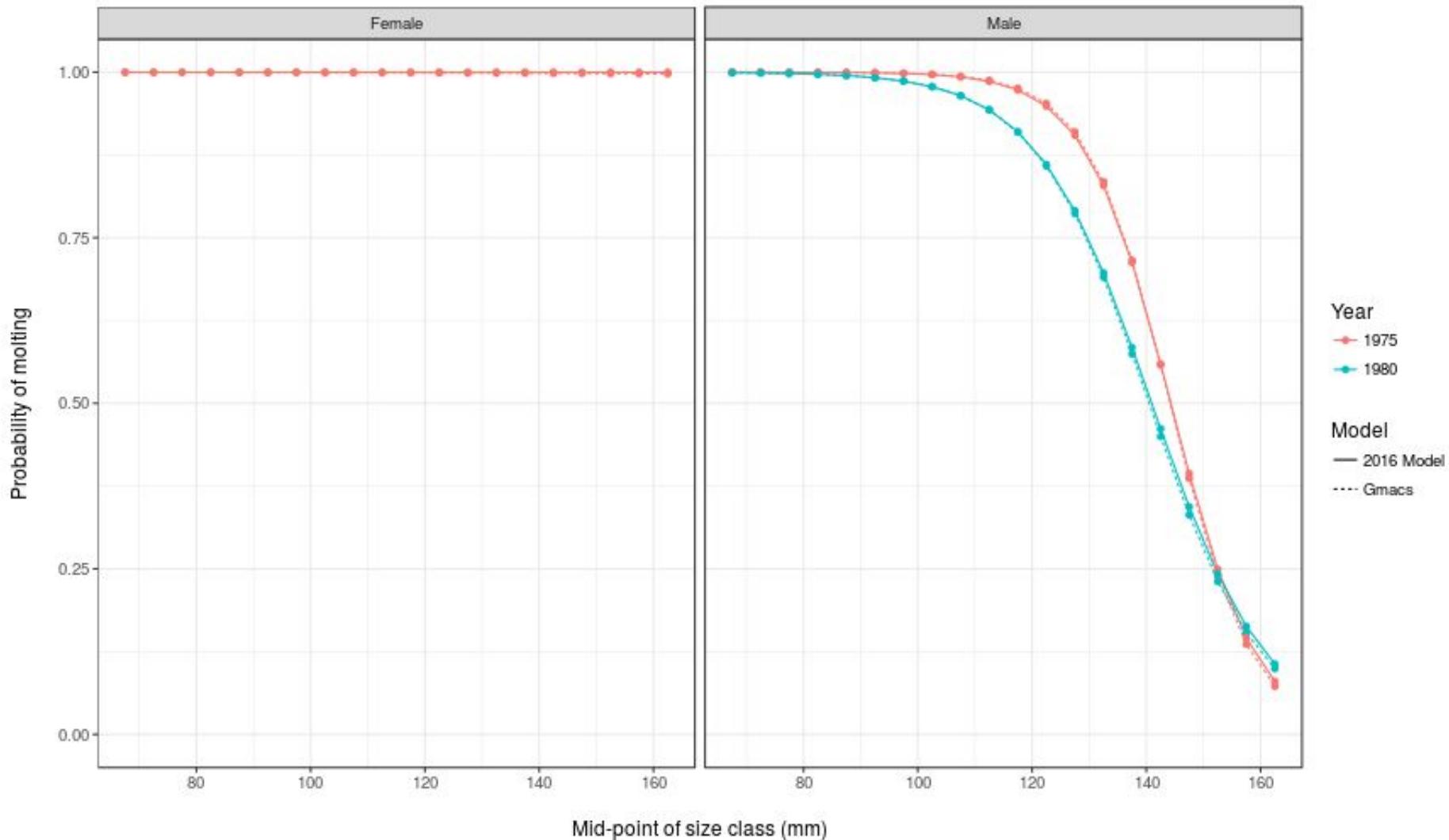
Timing

Four seasons defined to try to best match 2016 model dynamics

Season	What happens
1	Recruitment
2	Trawl bycatch fishery
3	Natural mortality, molting & growth, directed pot fishery, surveys (NMFS and BSFRF)
4	Calculate MMB

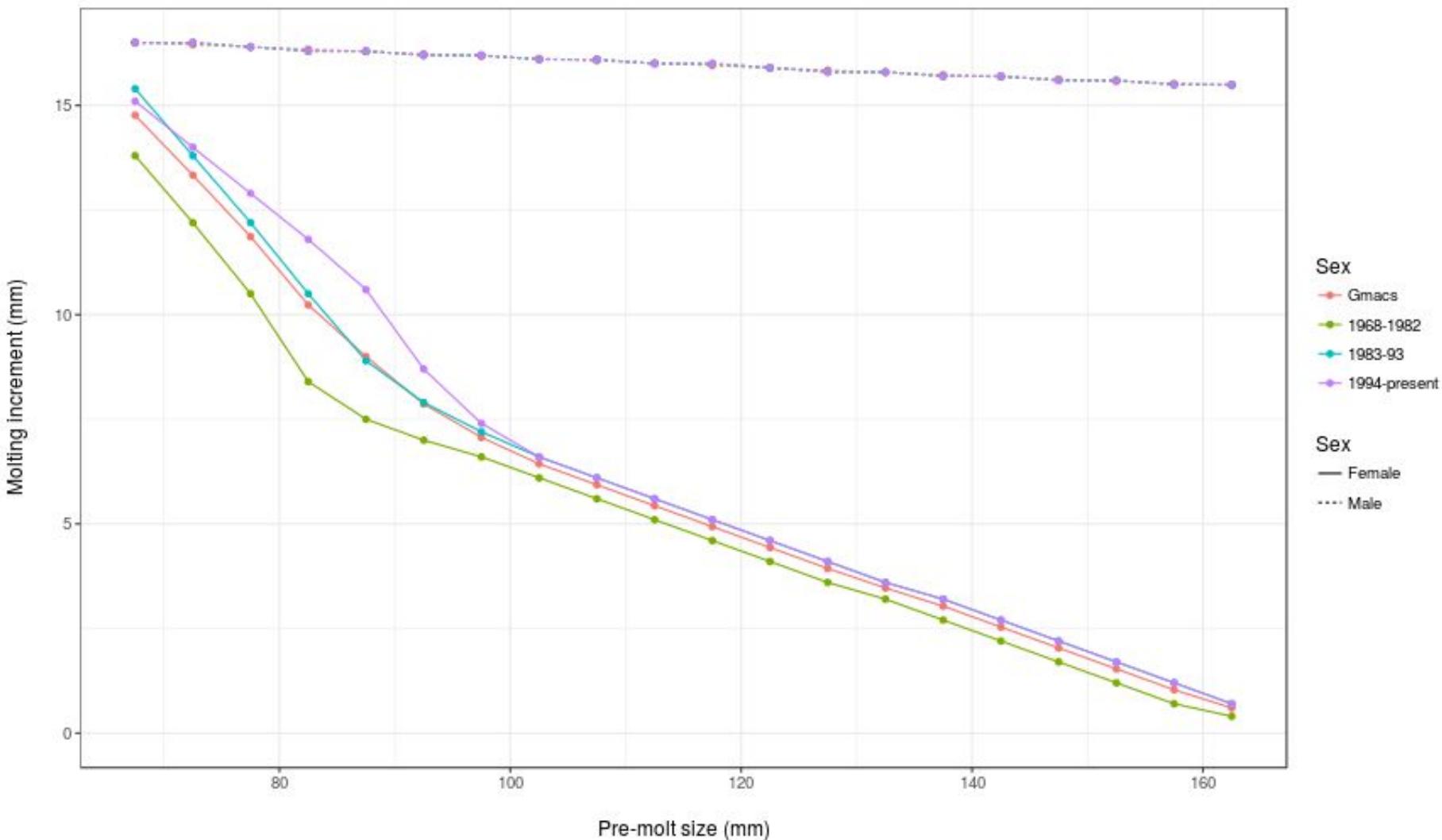
Molt Probability

- Females molt every year
- Gmacs is using time-varying molt probability - these match up well with 2016 model



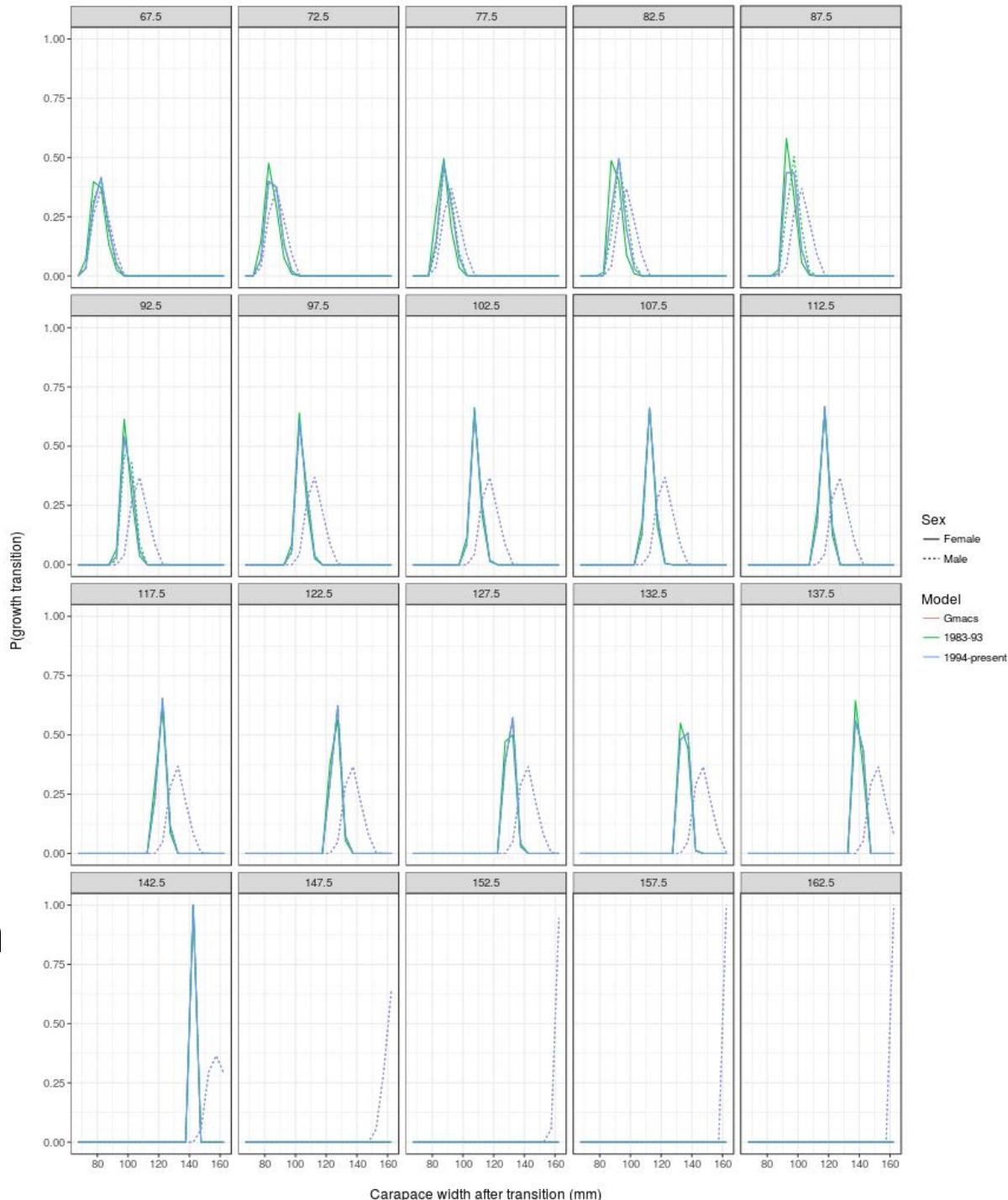
Growth Increment Each Molt

- Gmacs not using time-varying growth (for females), as there is little evidence to support doing so

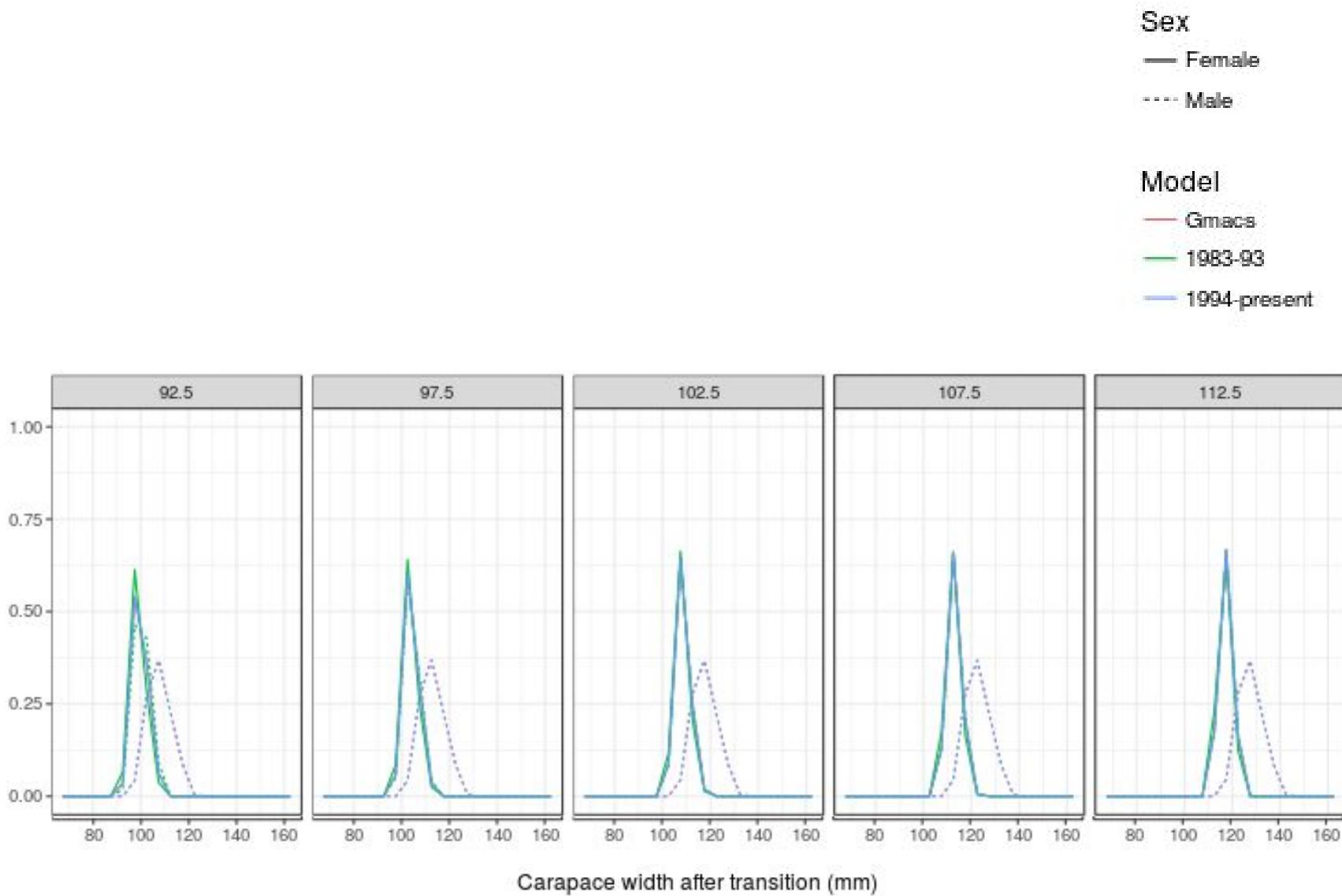


Growth Matrix

- Gmacs not using time-varying growth (for females), as there is little evidence to support doing so
- Gmacs has fixed the growth matrix to the 2016 model as a similar matrix could not be derived (given the growth increments on the previous slide)

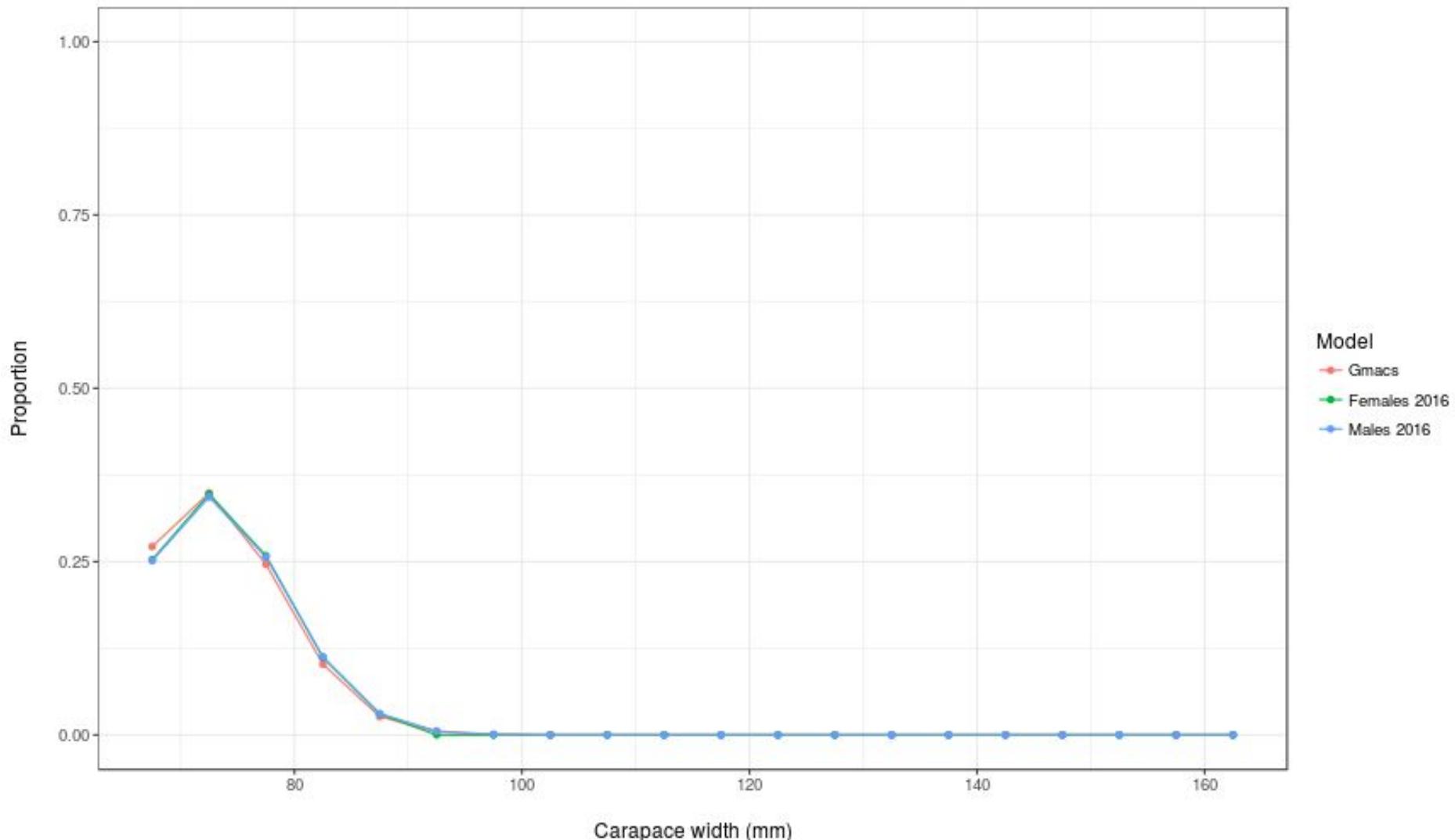


Growth Matrix



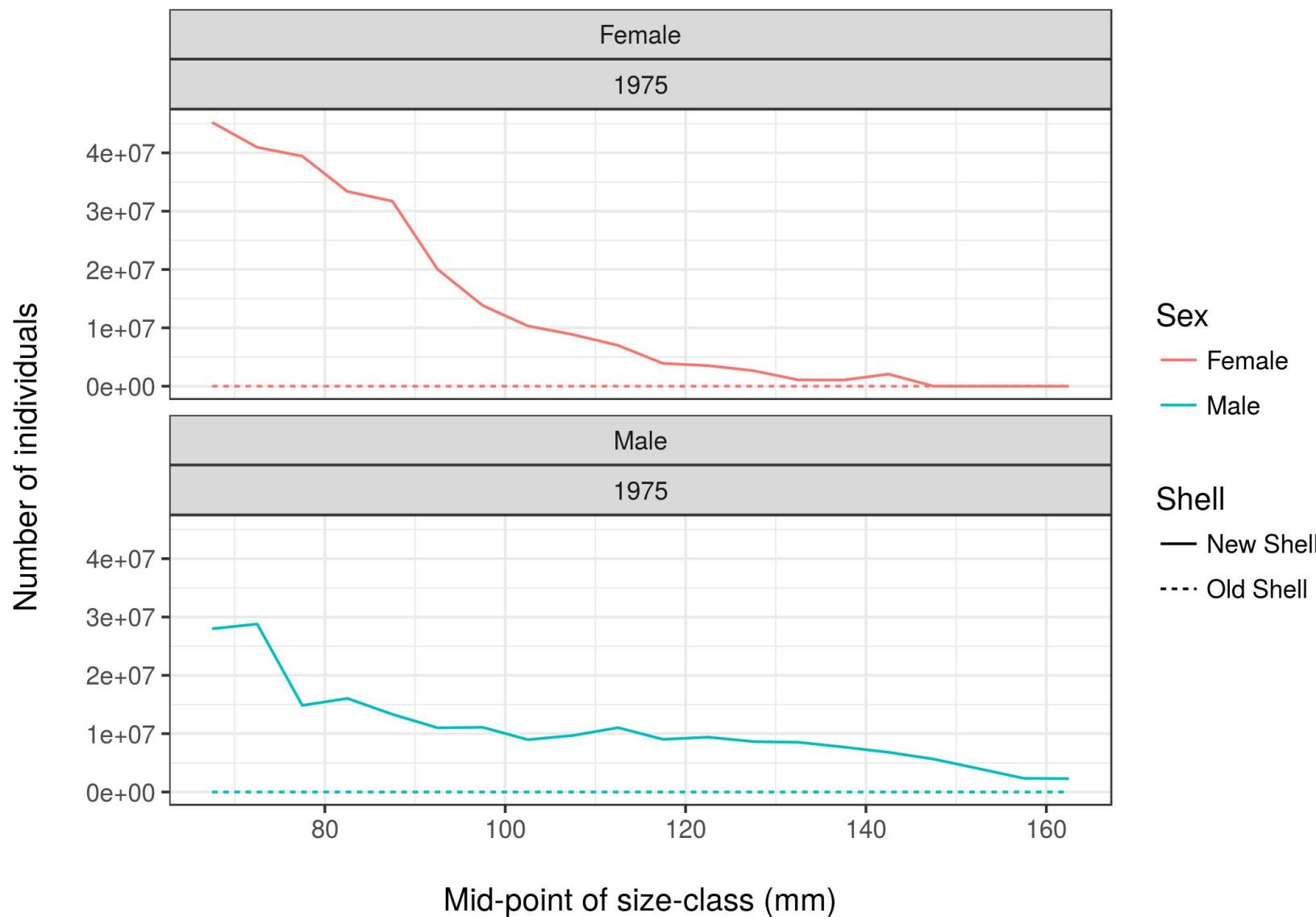
Recruitment Size

Gmacs not using sex-specific recruitment size--seems unnecessary



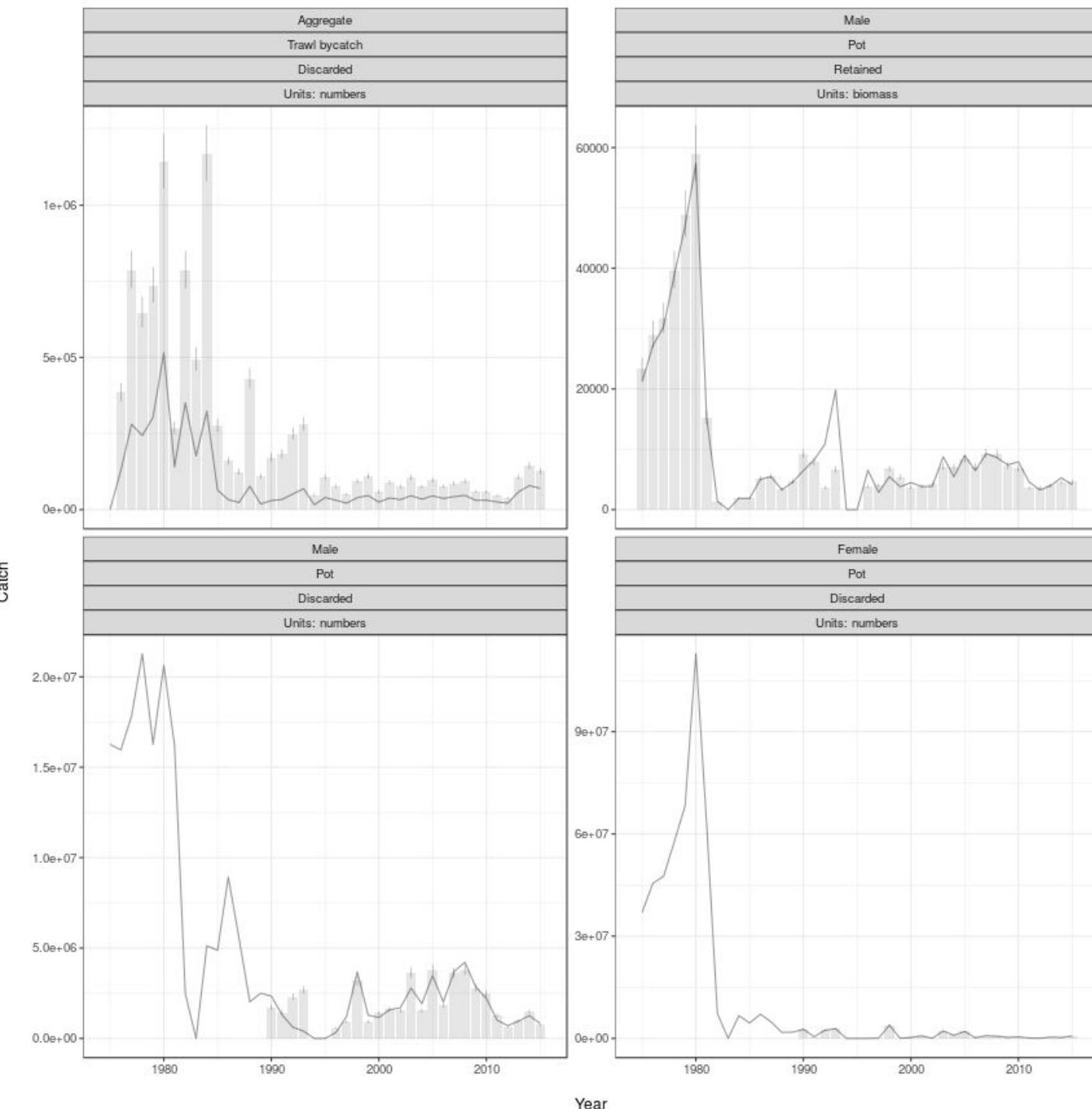
Initial Numbers (season 1)

Gmacs initial numbers fixed at those used in 2016 model - could not replicate this initialisation - but this seems to be causing problems



Catch

- Why is current model not using full catch time-series?

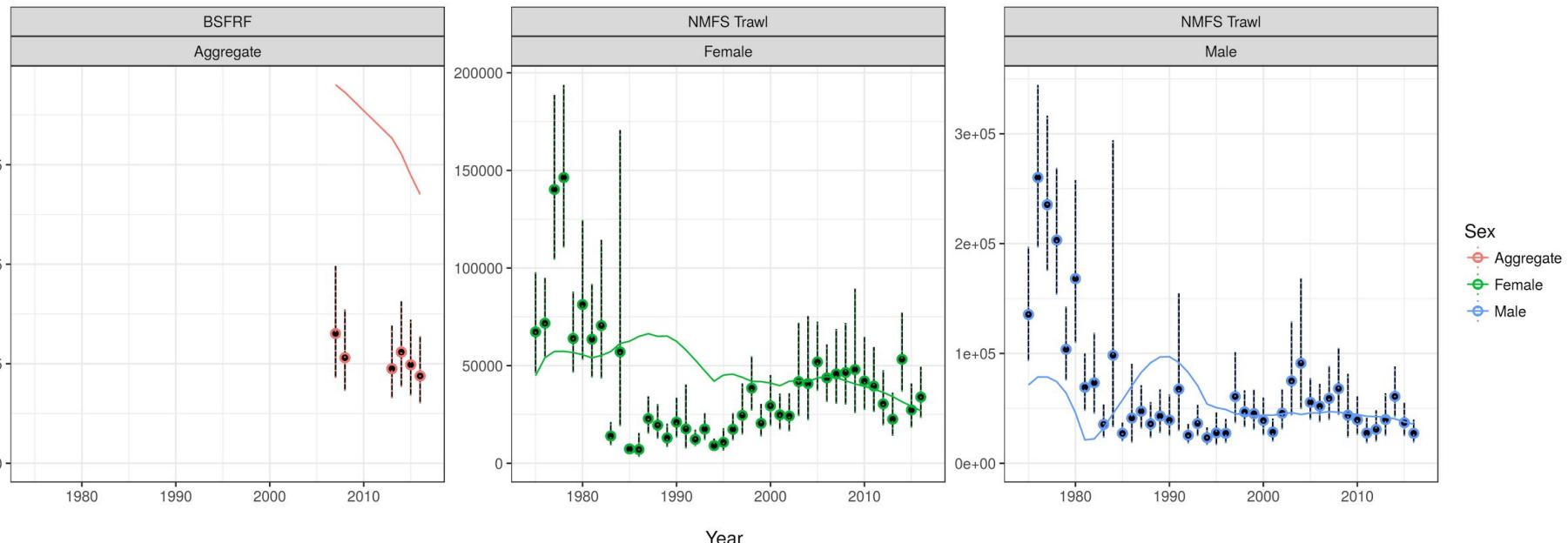
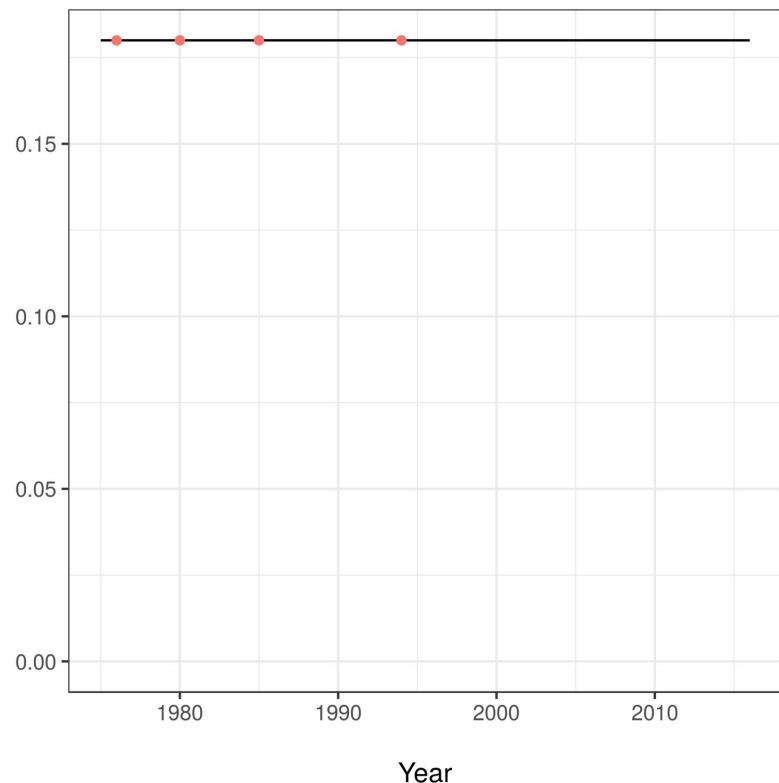
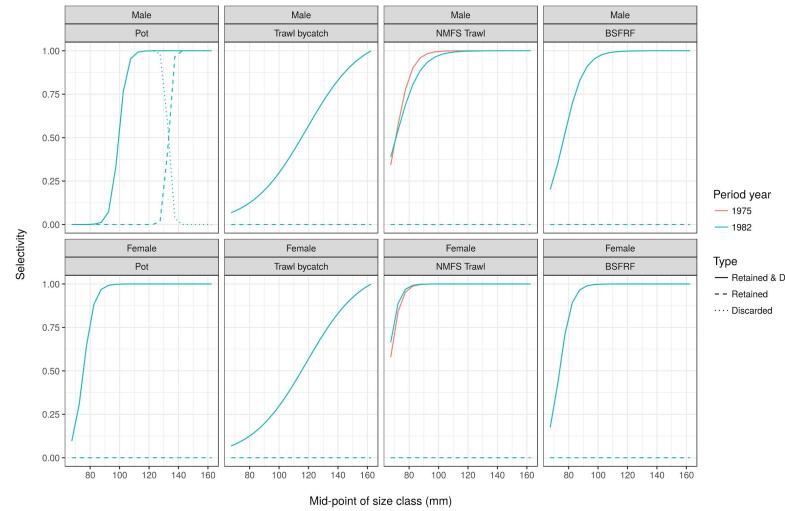


Gmacs BBRKC: Different Model Structures

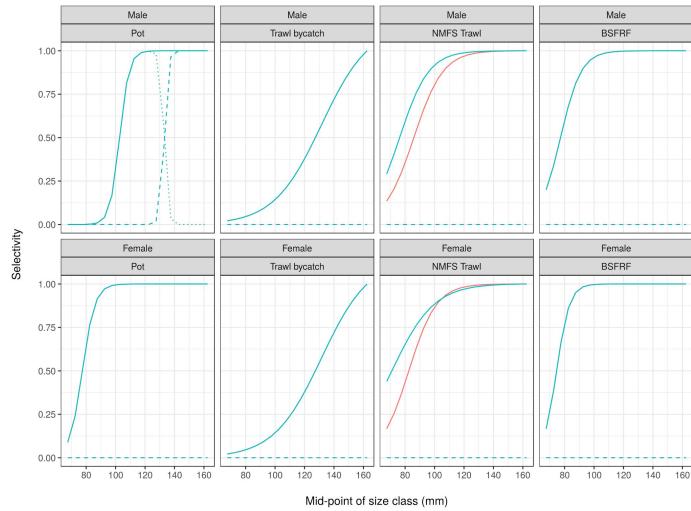
Different model structures

Model name	M	BSFRF q	NMFS Lambda
Constant M	Constant	Fixed at 1	1.0
Random Walk M	Random walk	Fixed at 1	1.0
Model M	At 2016 values	Fixed at 1	1.0
Estimate BSFRF q	At 2016 values	Estimated	1.0
NMFS Lambda=4	At 2016 values	Fixed at 1	4.0

1. Constant M

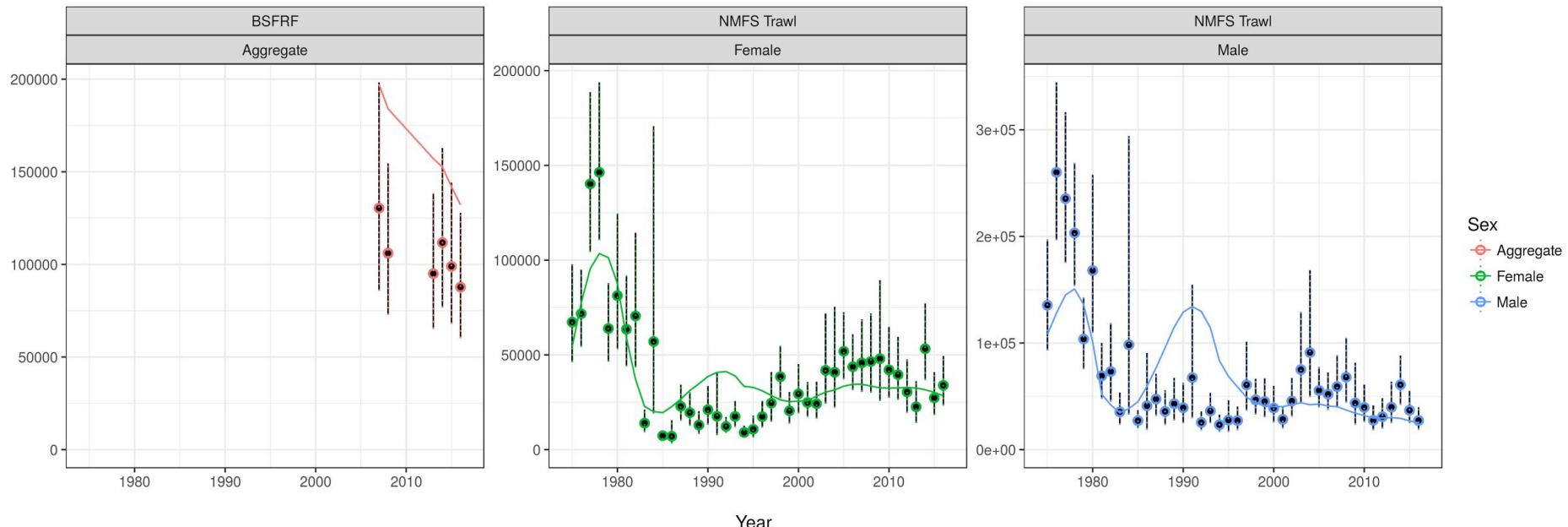
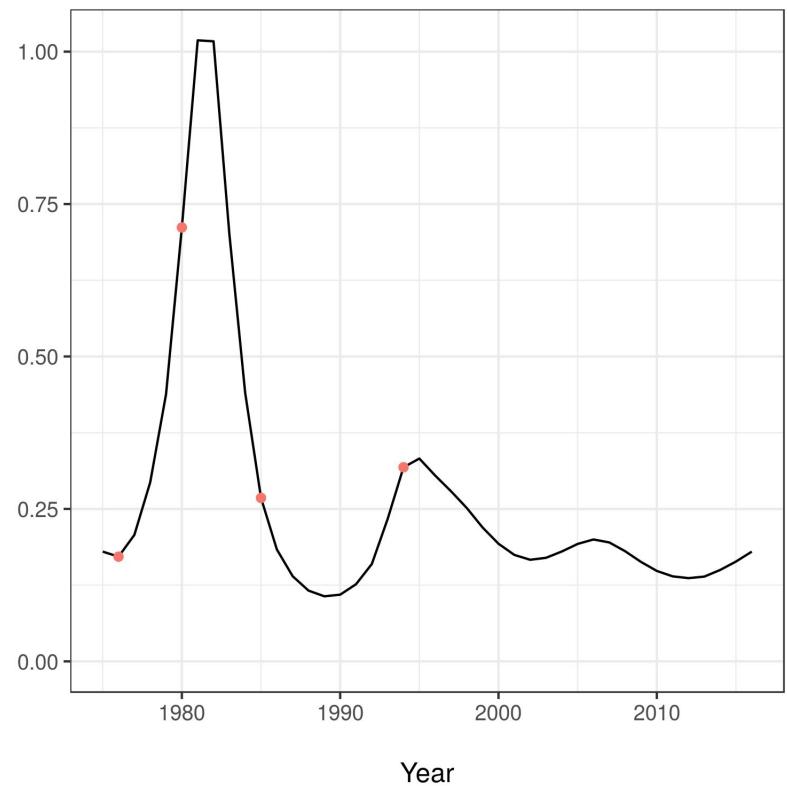


2. Random Walk M

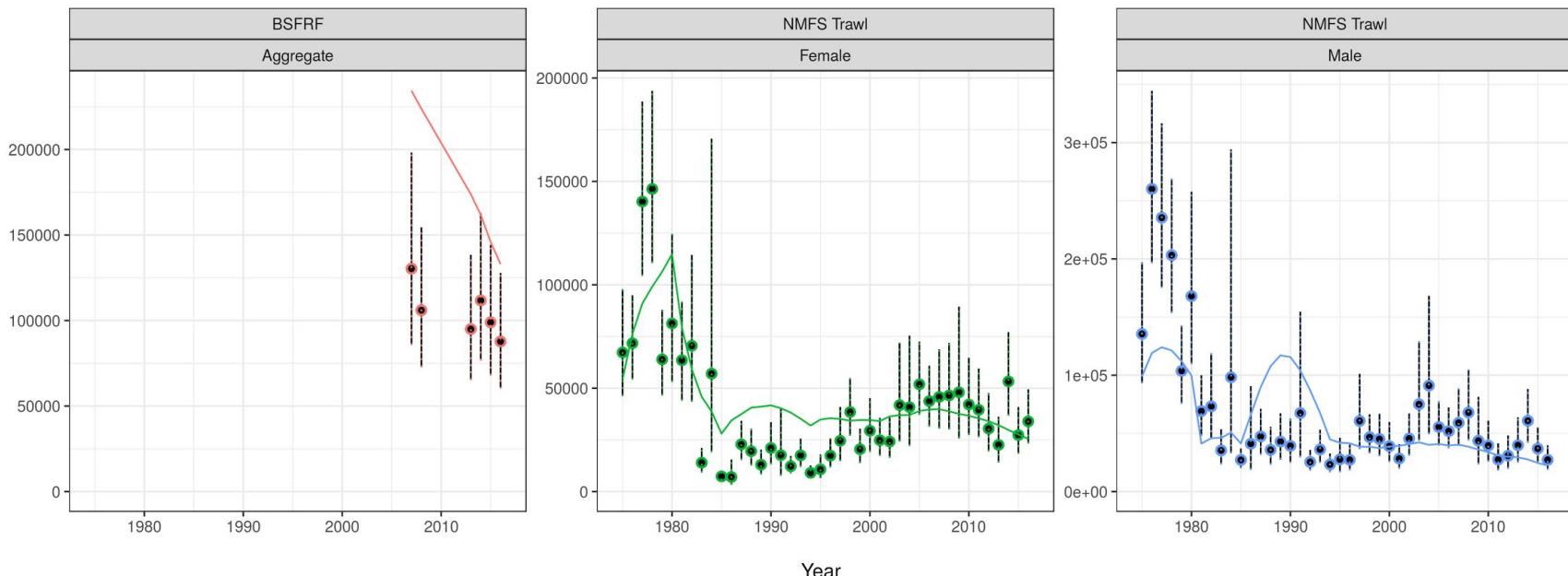
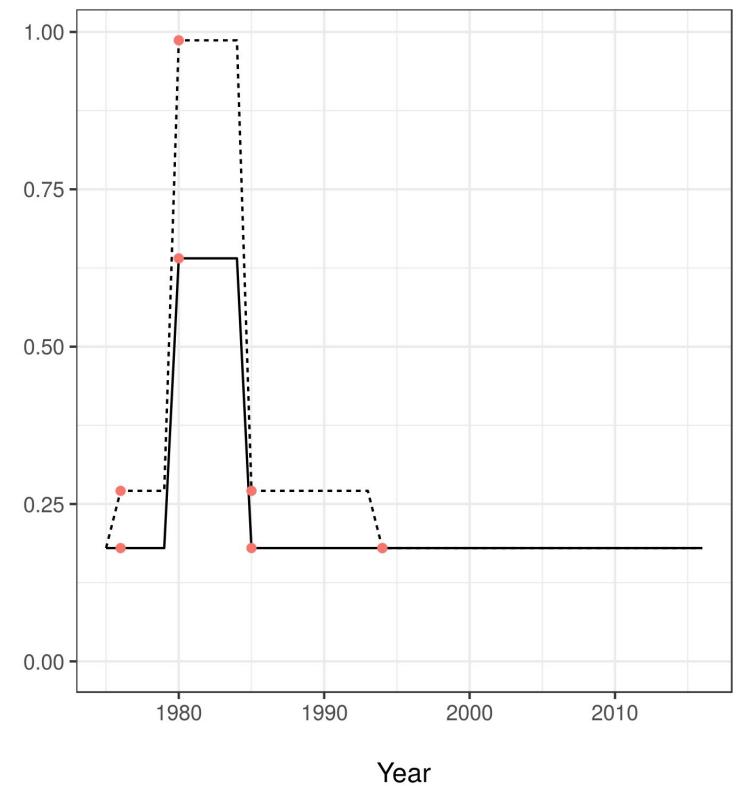
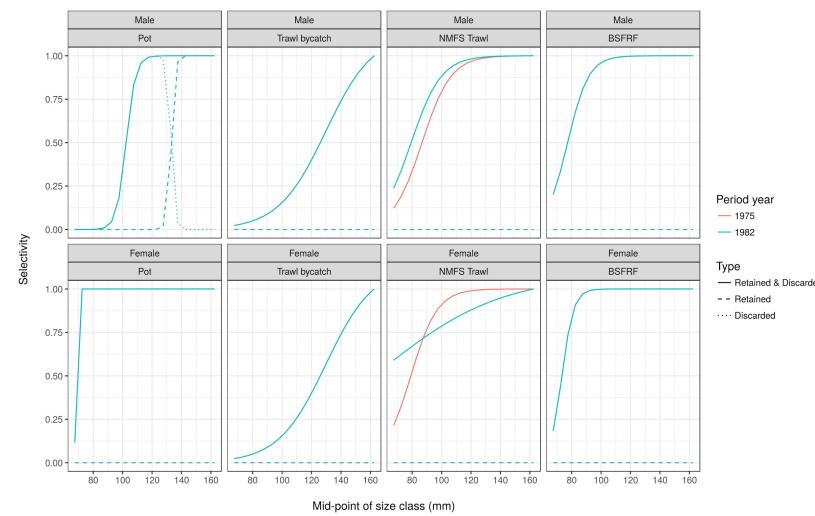


Period year
— 1975
— 1982

Type
— Retained & Discarded
- - Retained
... Discarded



3. 2016 Model M



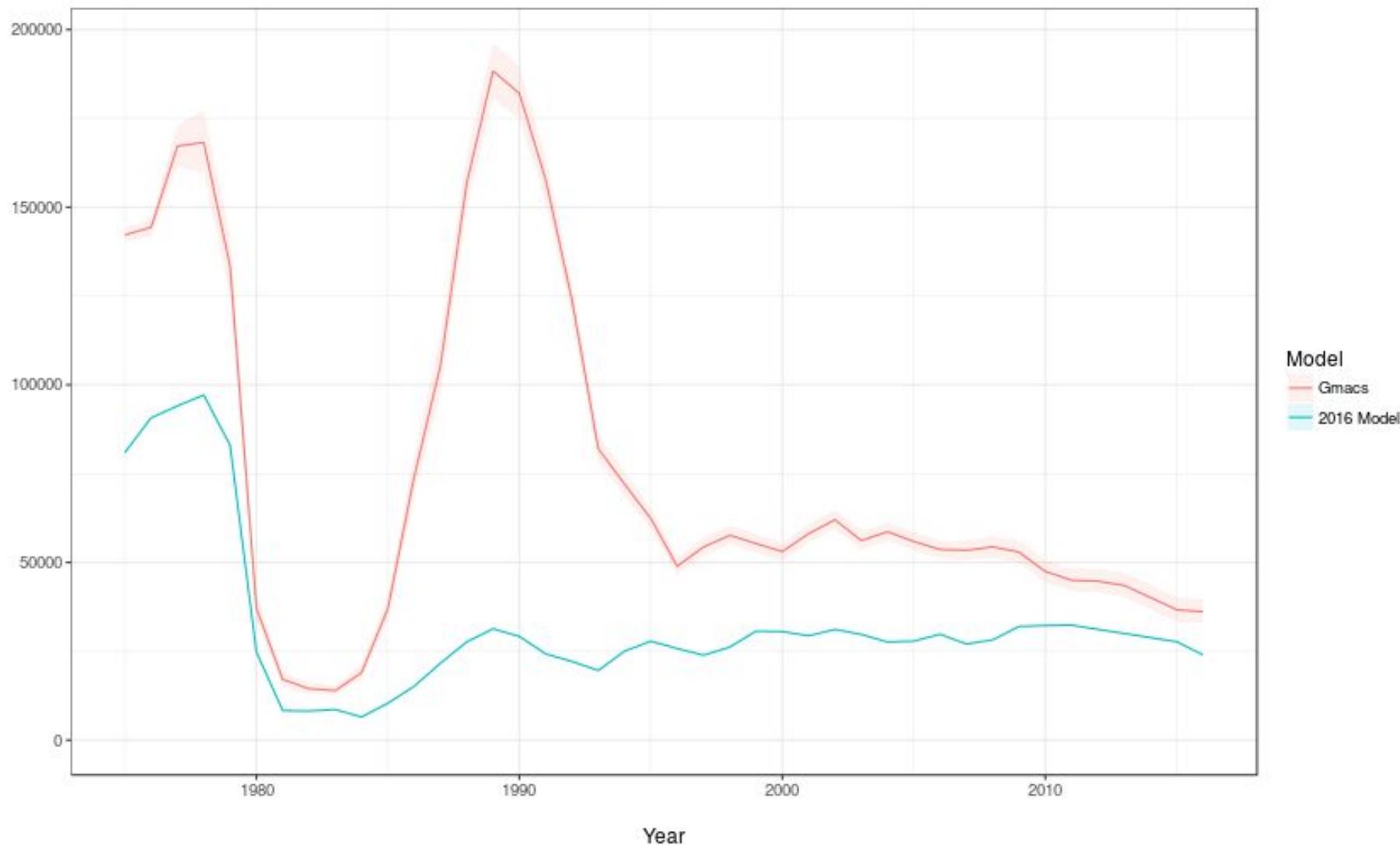
Sex
 — Female
 - - - Male

Knot

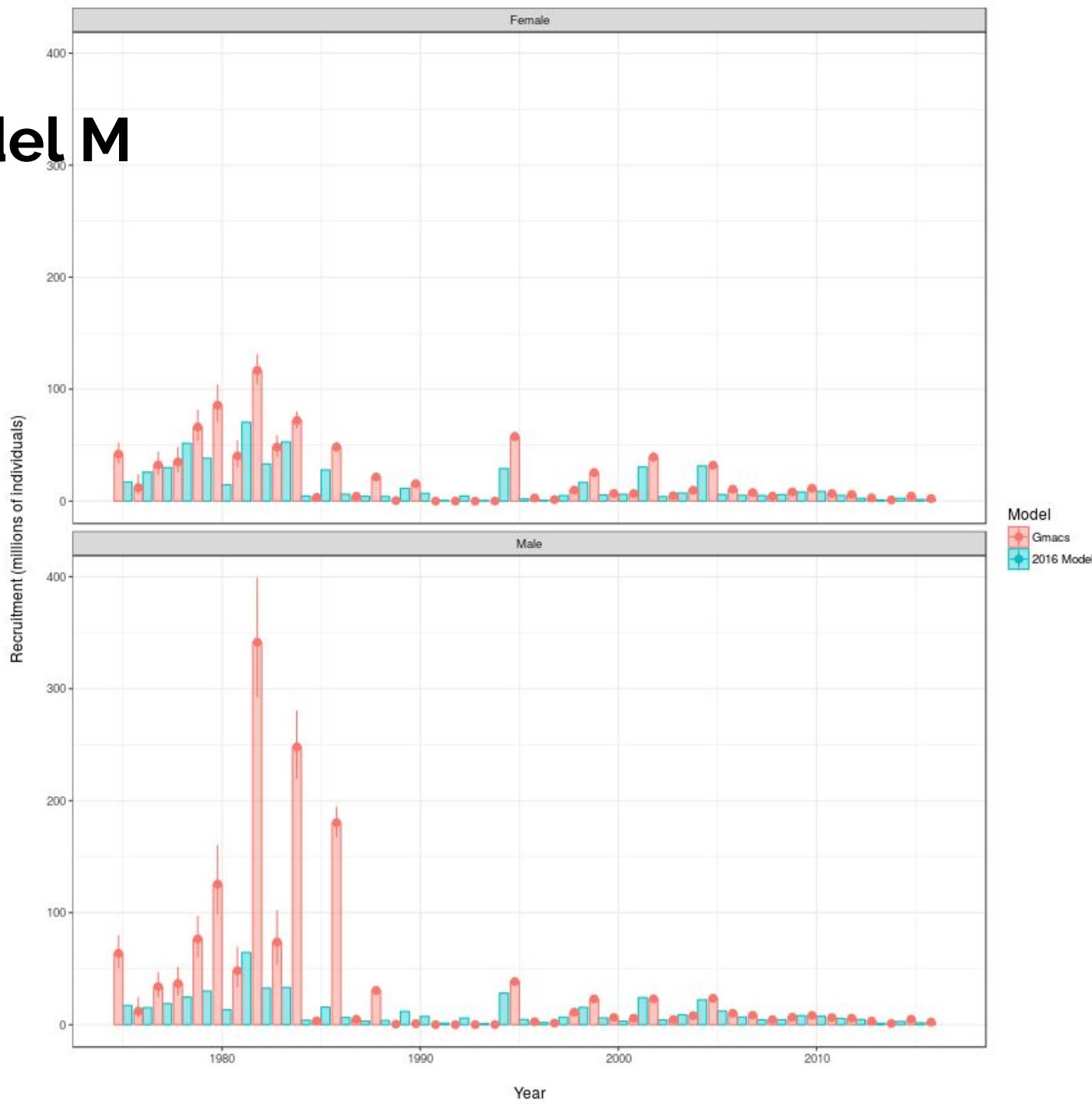
Sex
 ● Aggregate
 ● Female
 ● Male

3. 2016 Model M

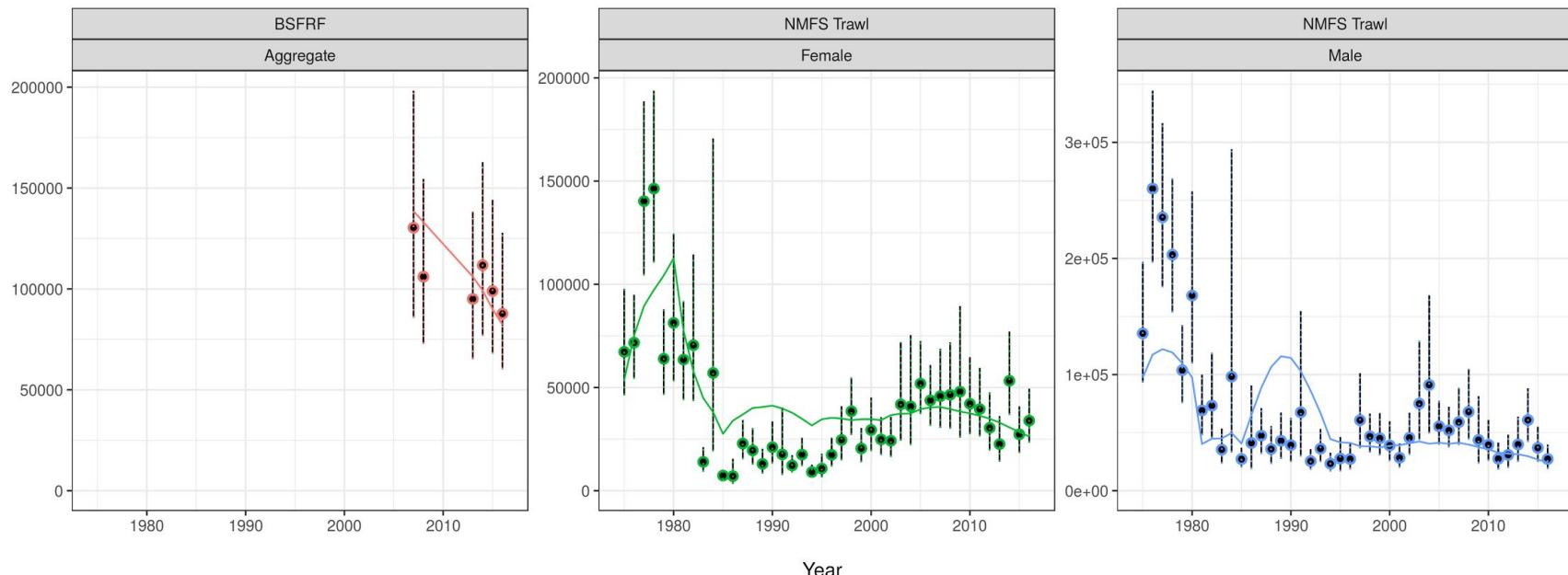
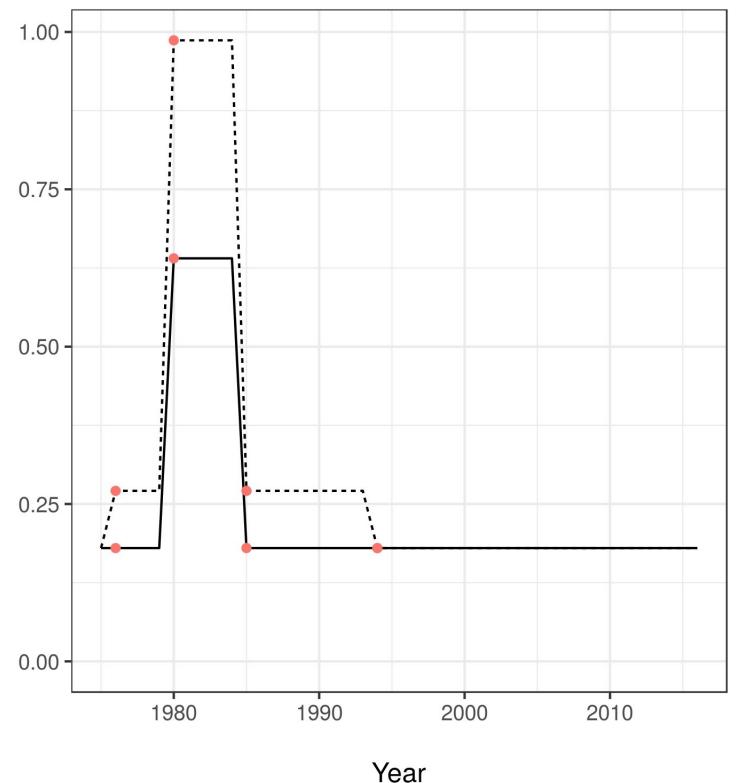
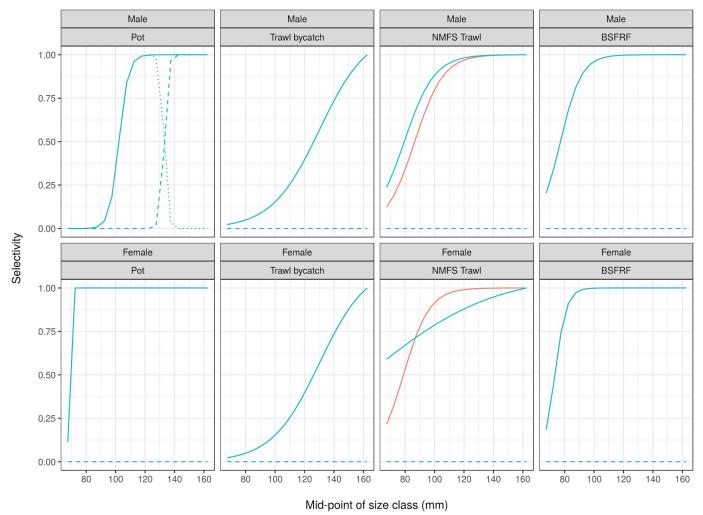
Mature male biomass (tonnes) on 15 February



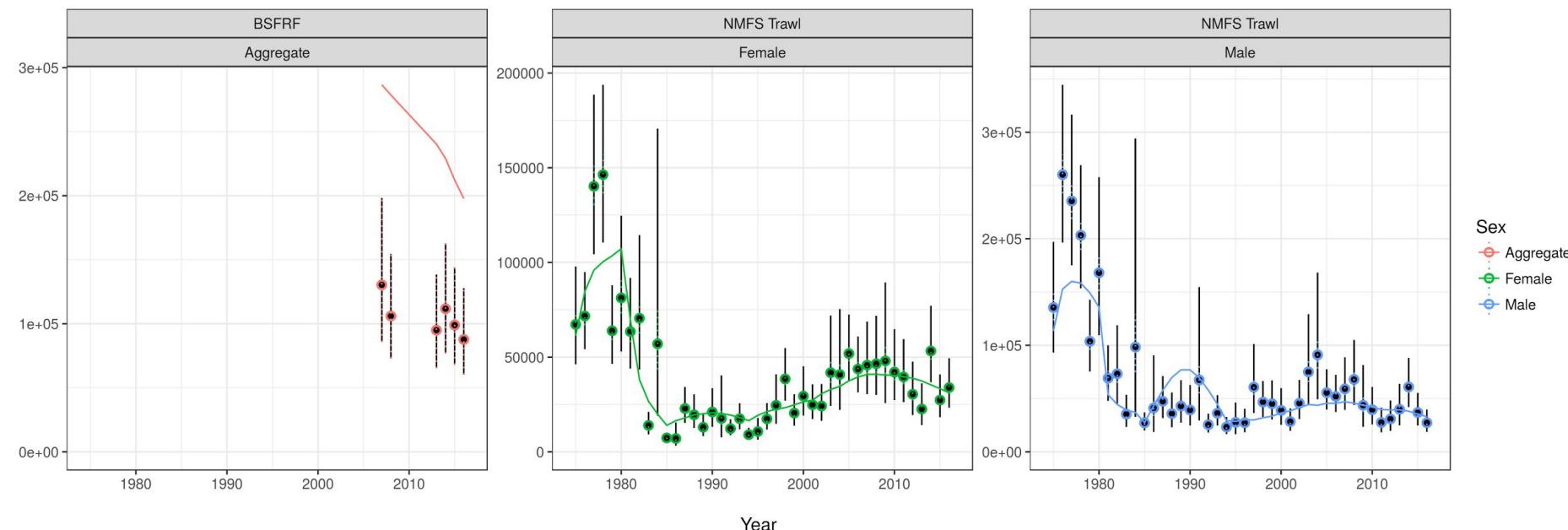
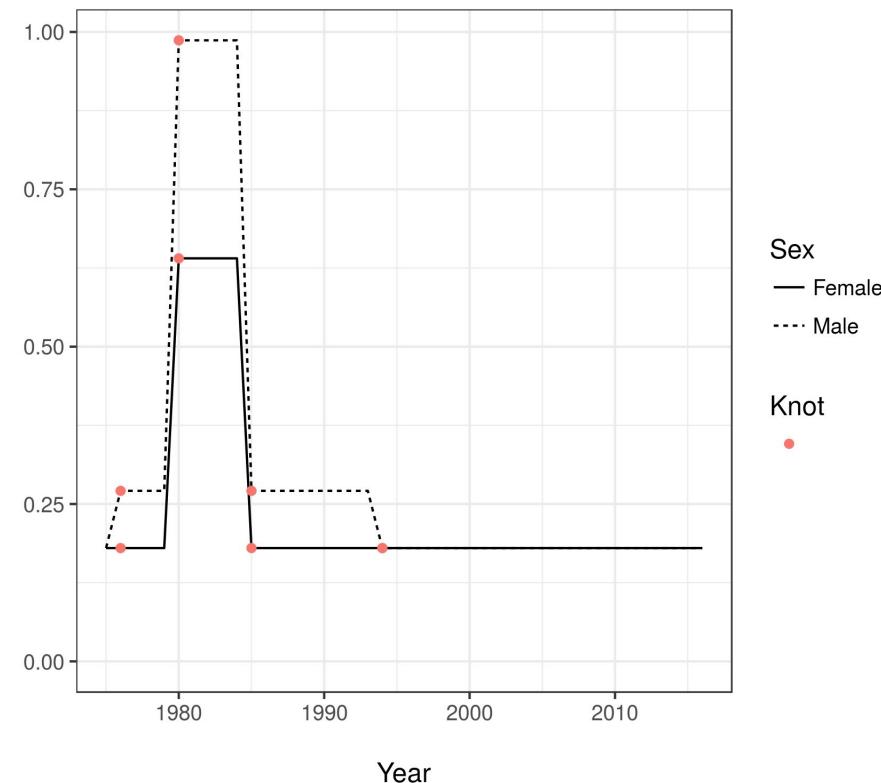
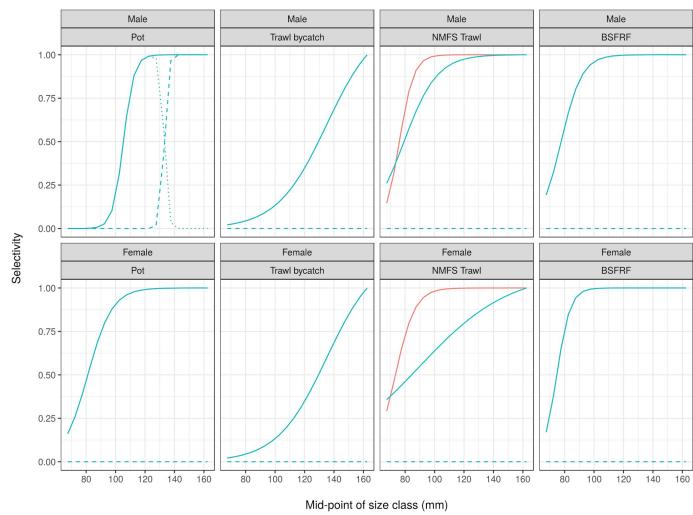
3. 2016 Model M



4. Estimate BSFRF q

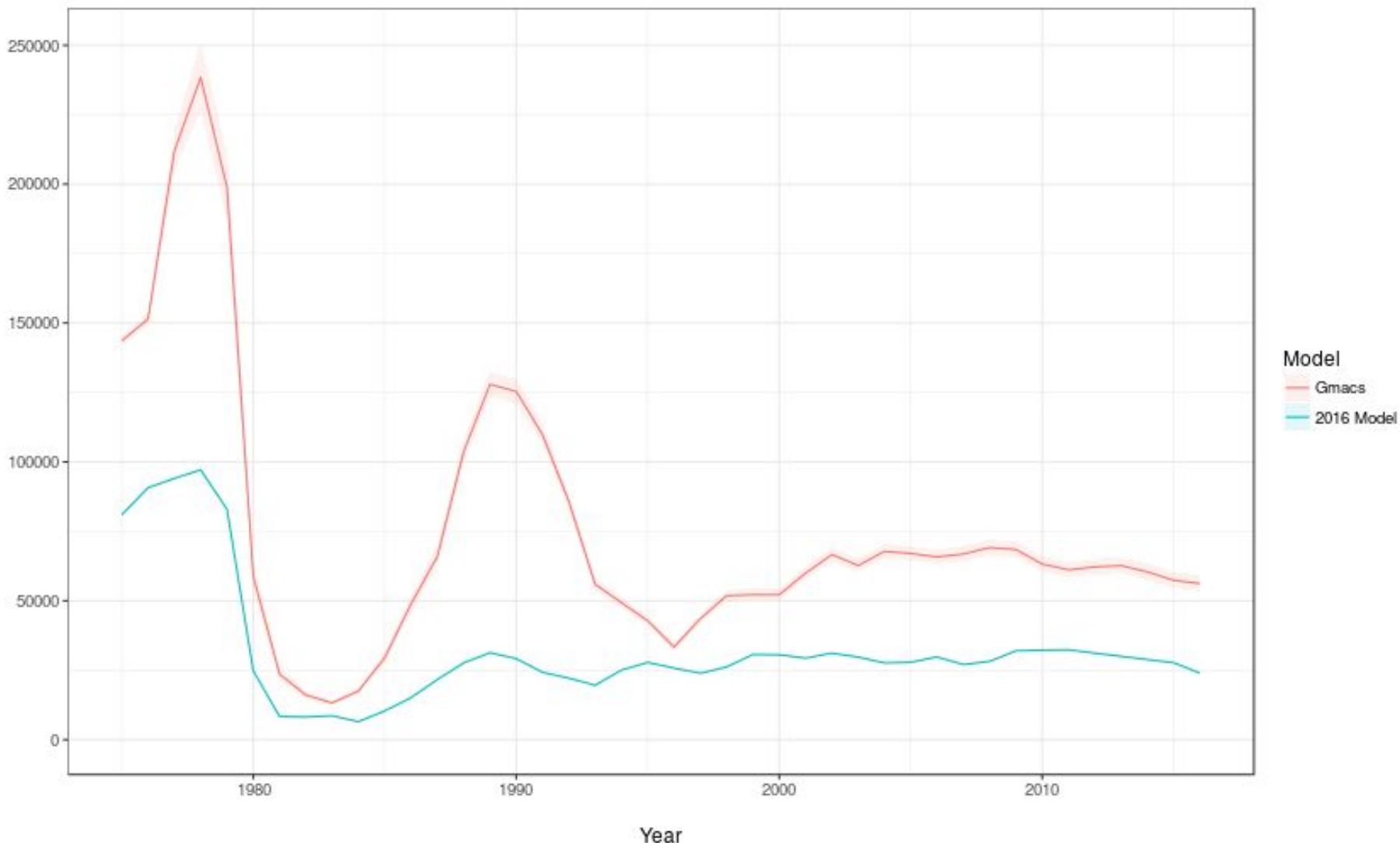


5. NMFS lambda = 4

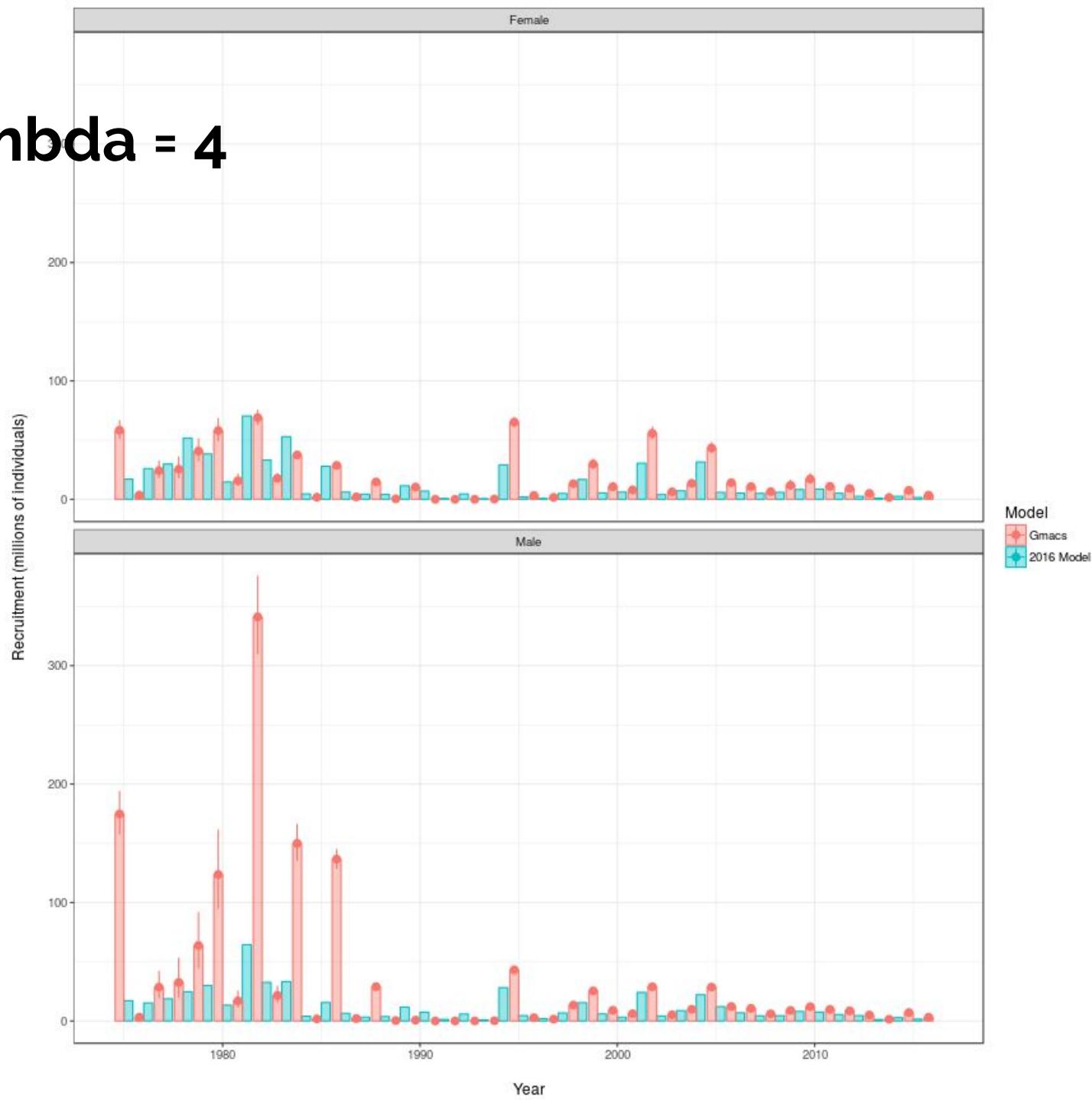


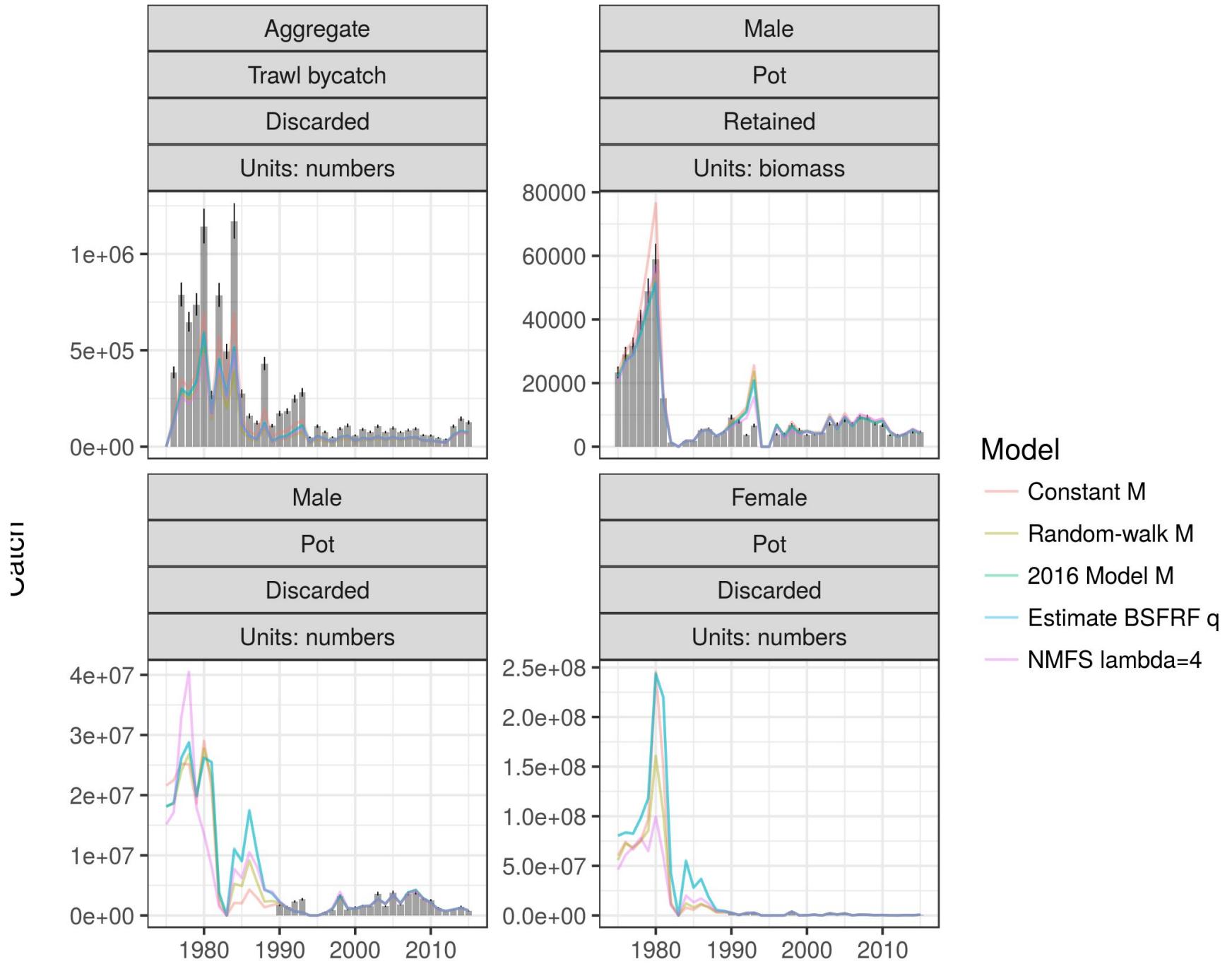
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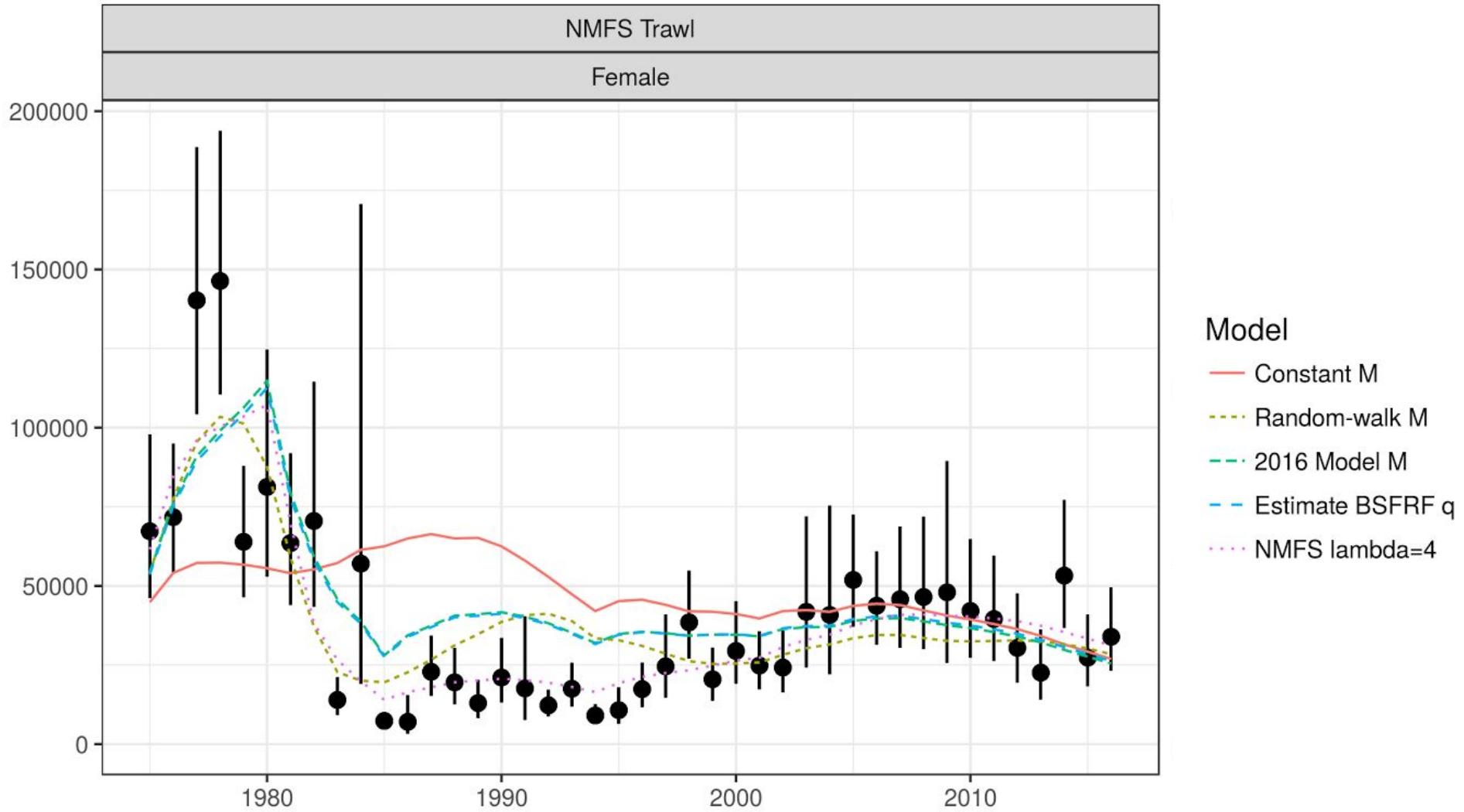


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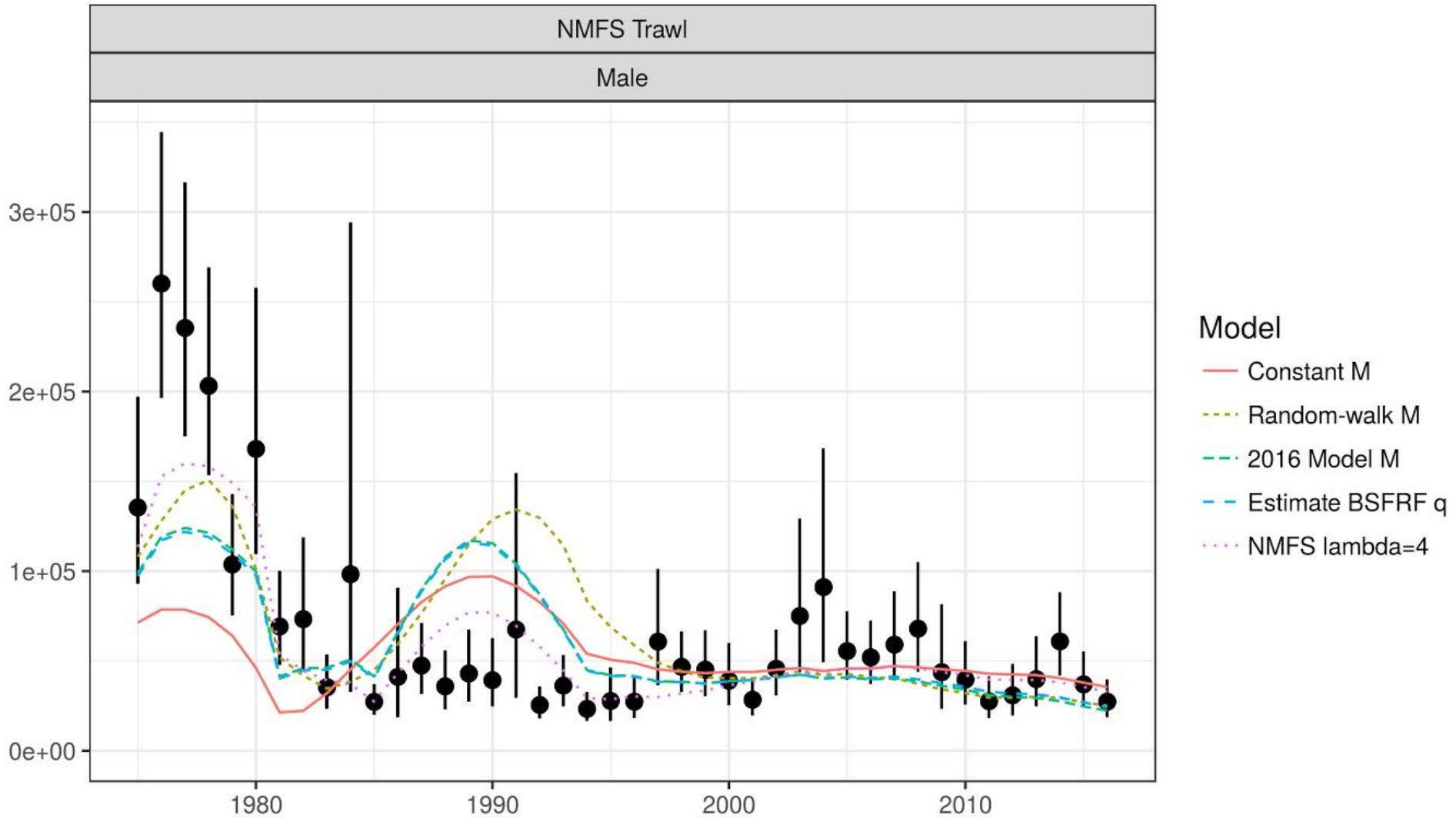


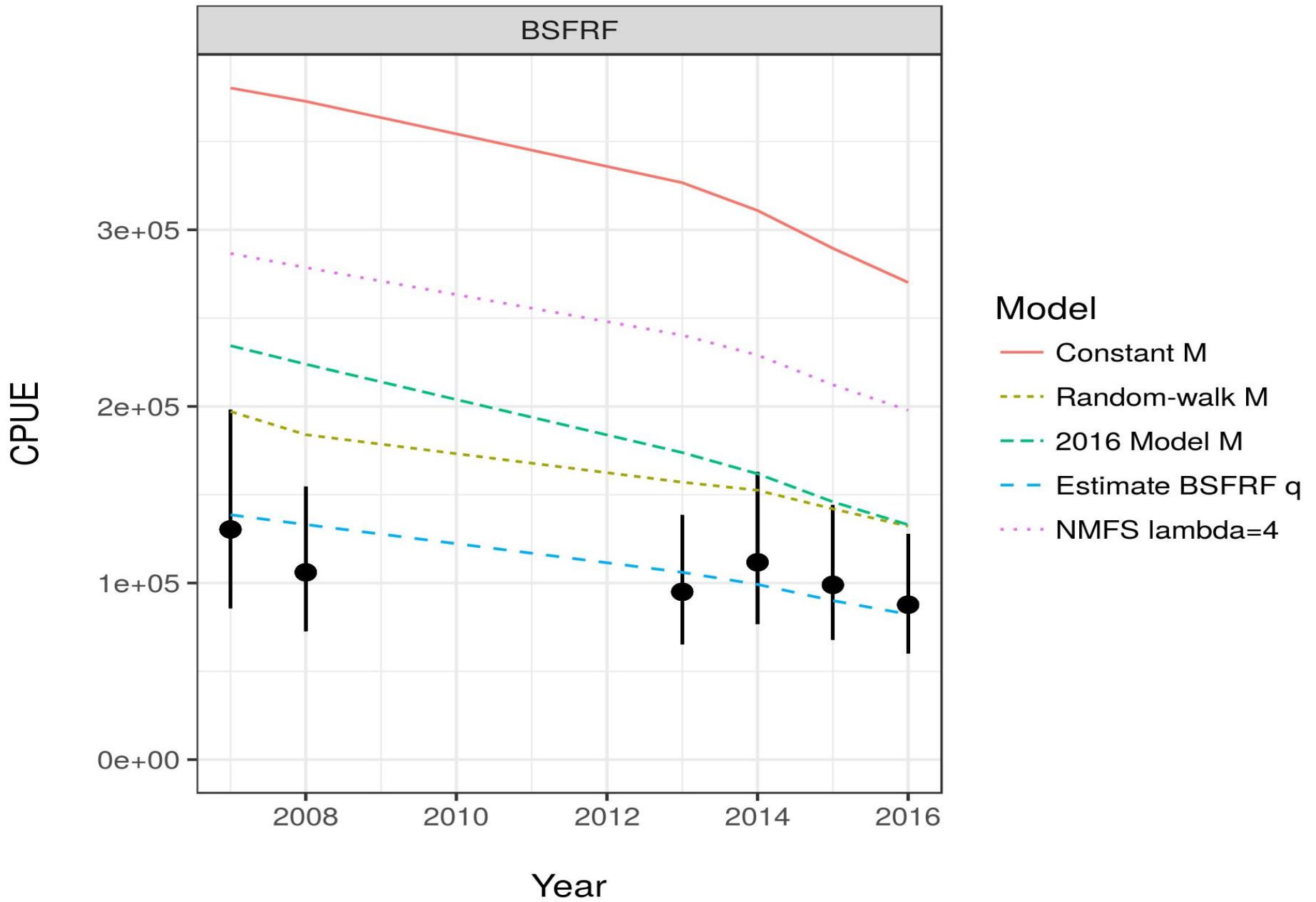


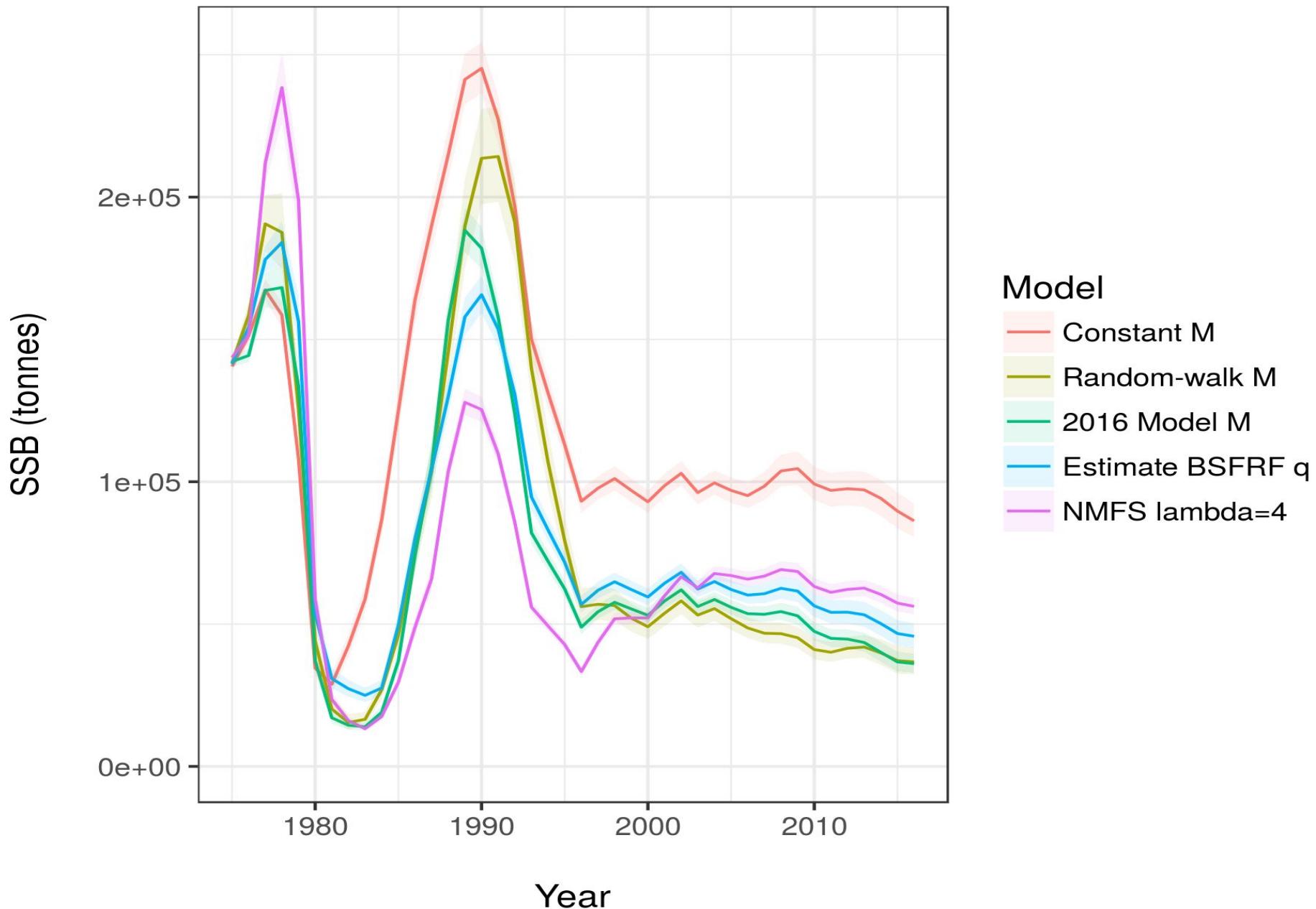
Model fits (Female)



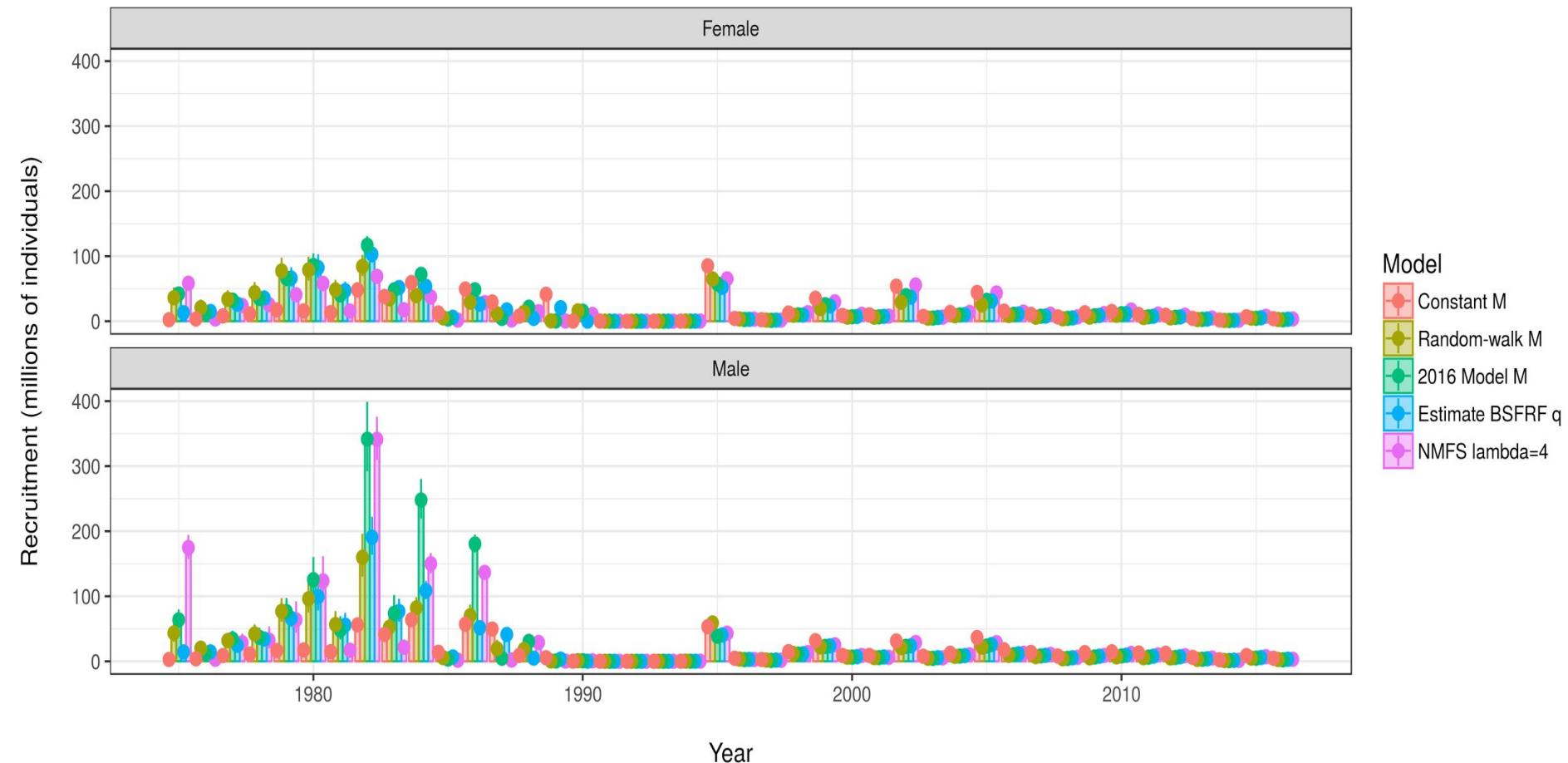
Model fits (male)





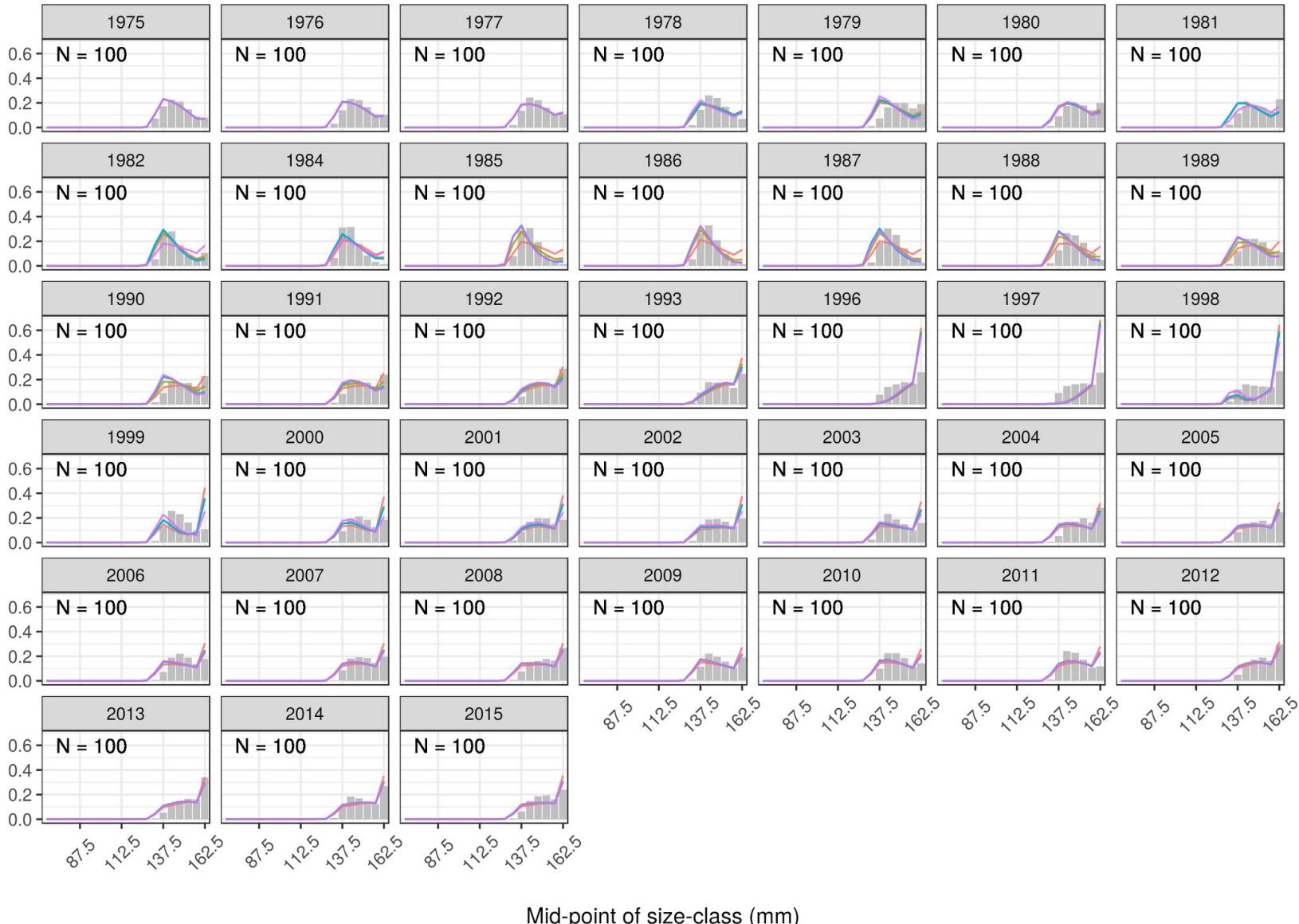


Recruitment



Retained Males

Gear = Pot , Sex = Male , Season = 3

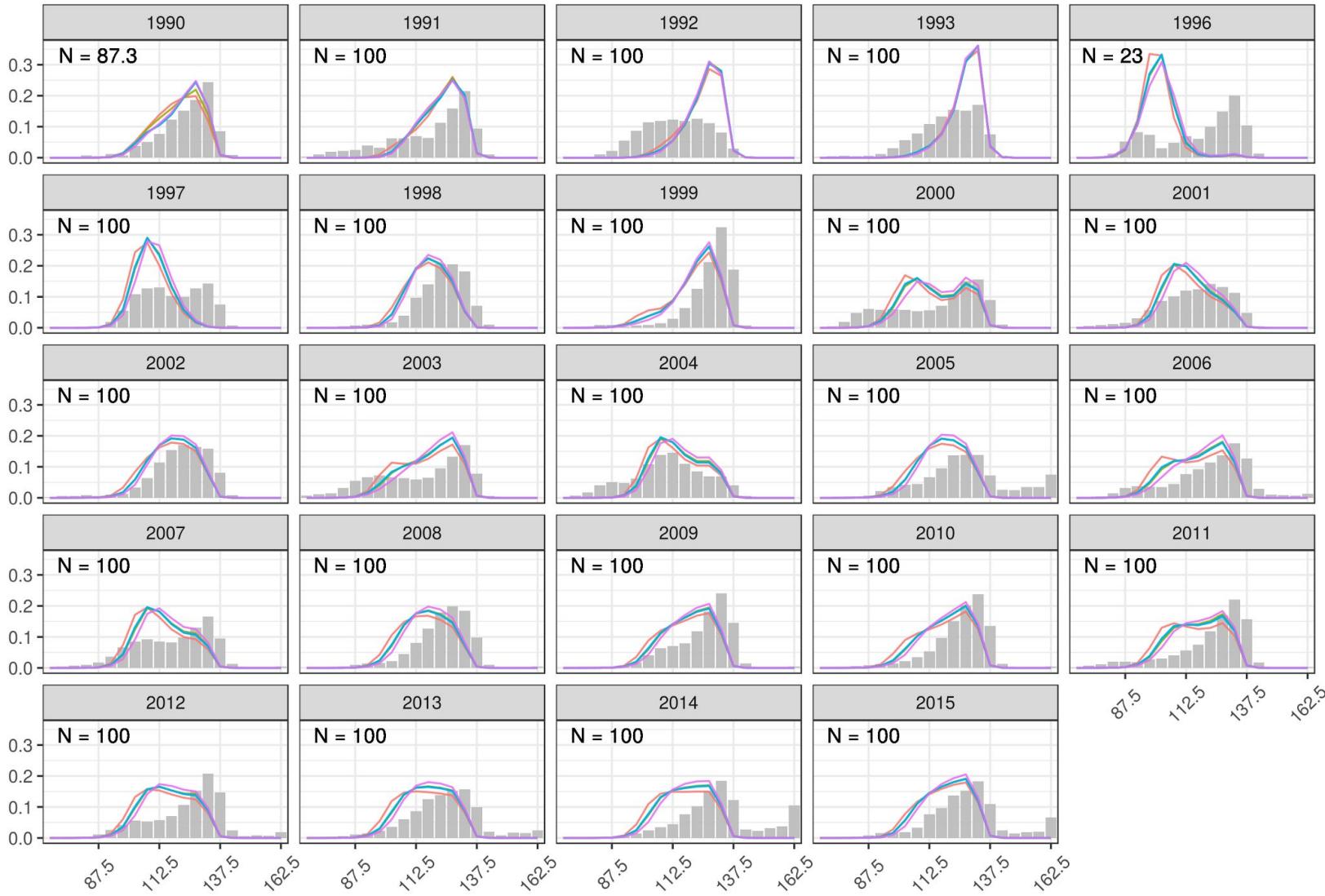


- Model
- Constant M
- Random-walk M
- 2016 Model M
- Estimate BSFRF q
- NMFS lambda=4

Mid-point of size-class (mm)

Discarded Males

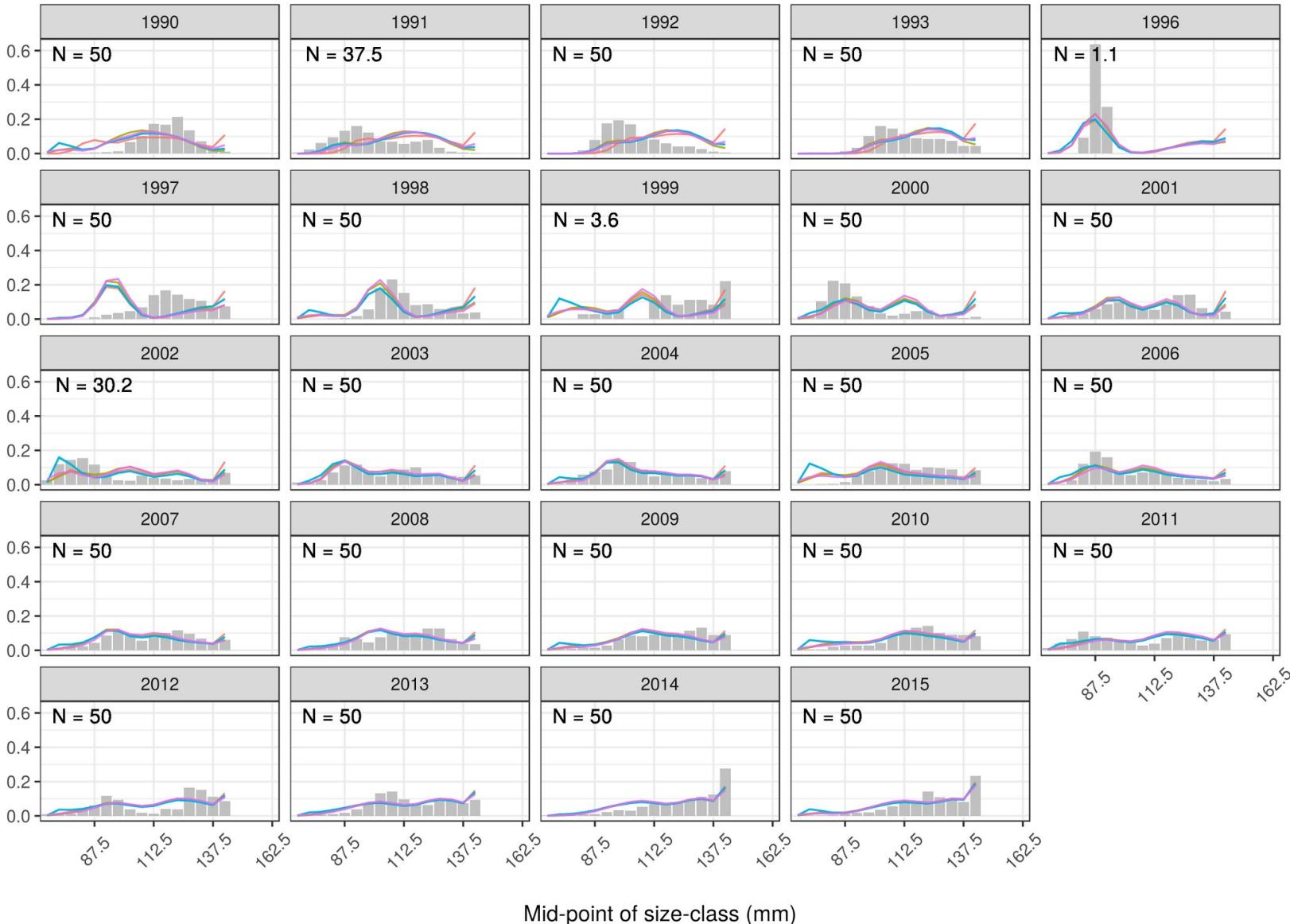
Gear = Pot , Sex = Male , Season = 3



- Model**
- Constant M
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Discarded Females

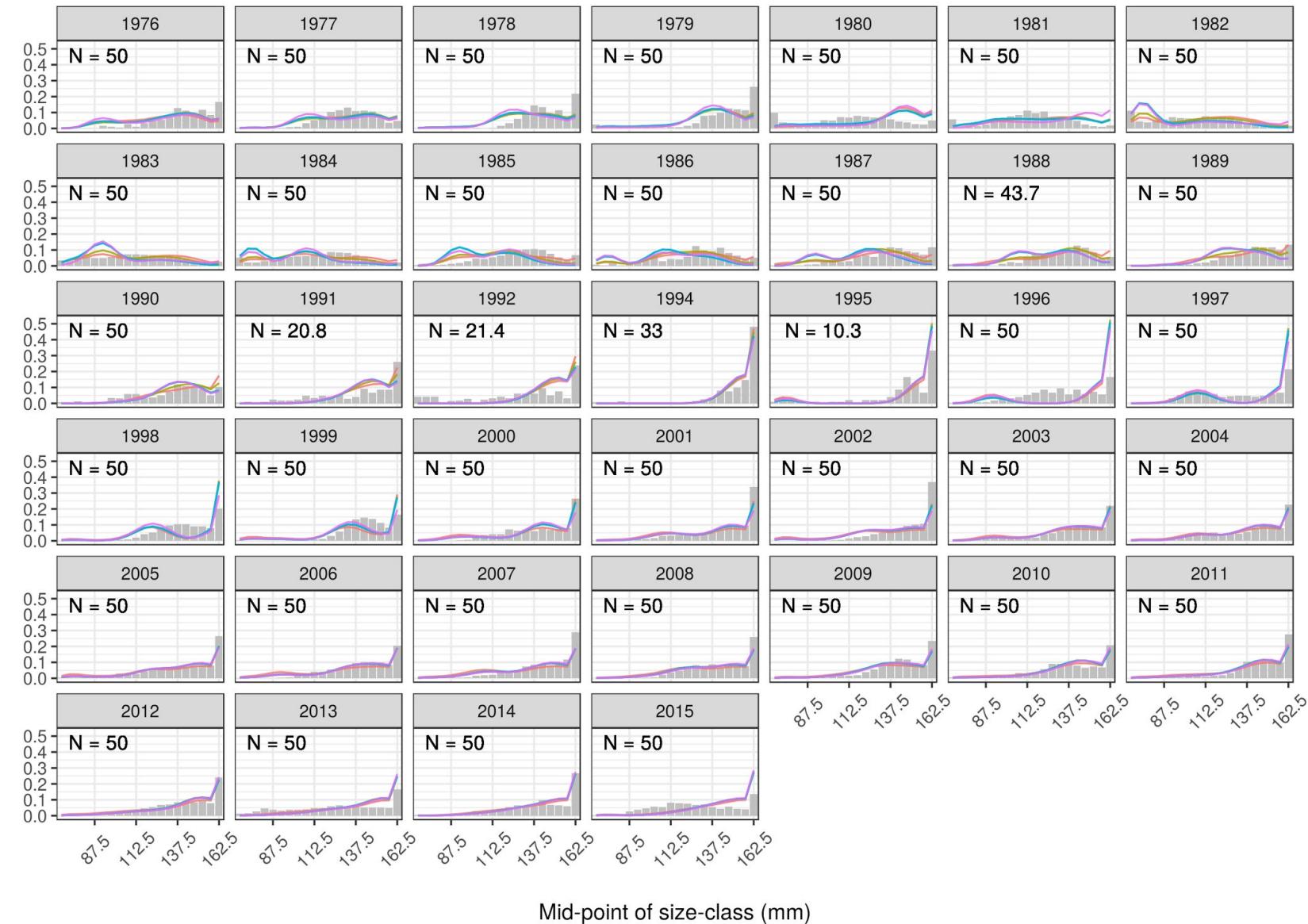
Gear = Pot , Sex = Female , Season = 3



- Model
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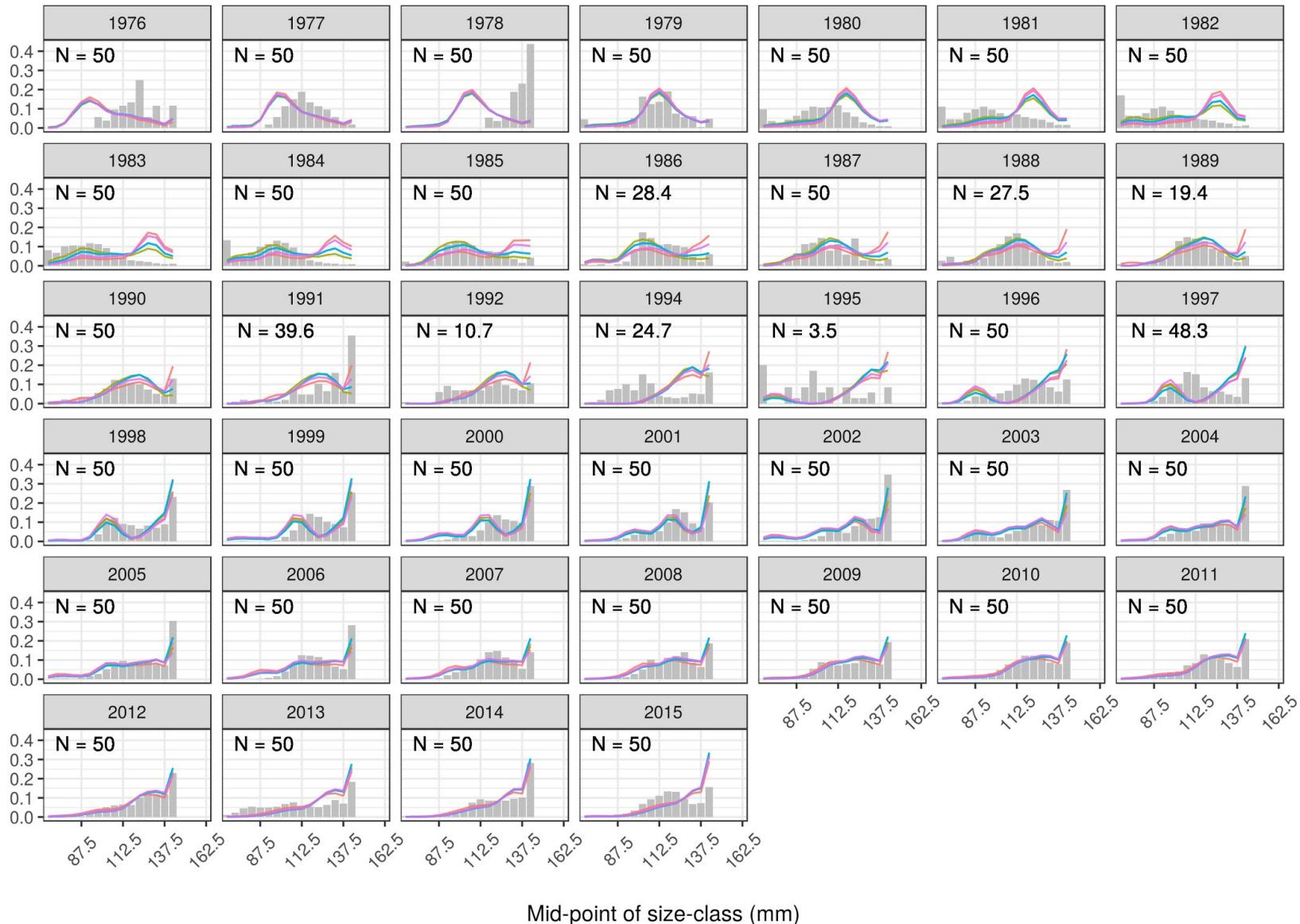
Trawl Bycatch Males

Gear = Trawl bycatch , Sex = Male , Season = 2



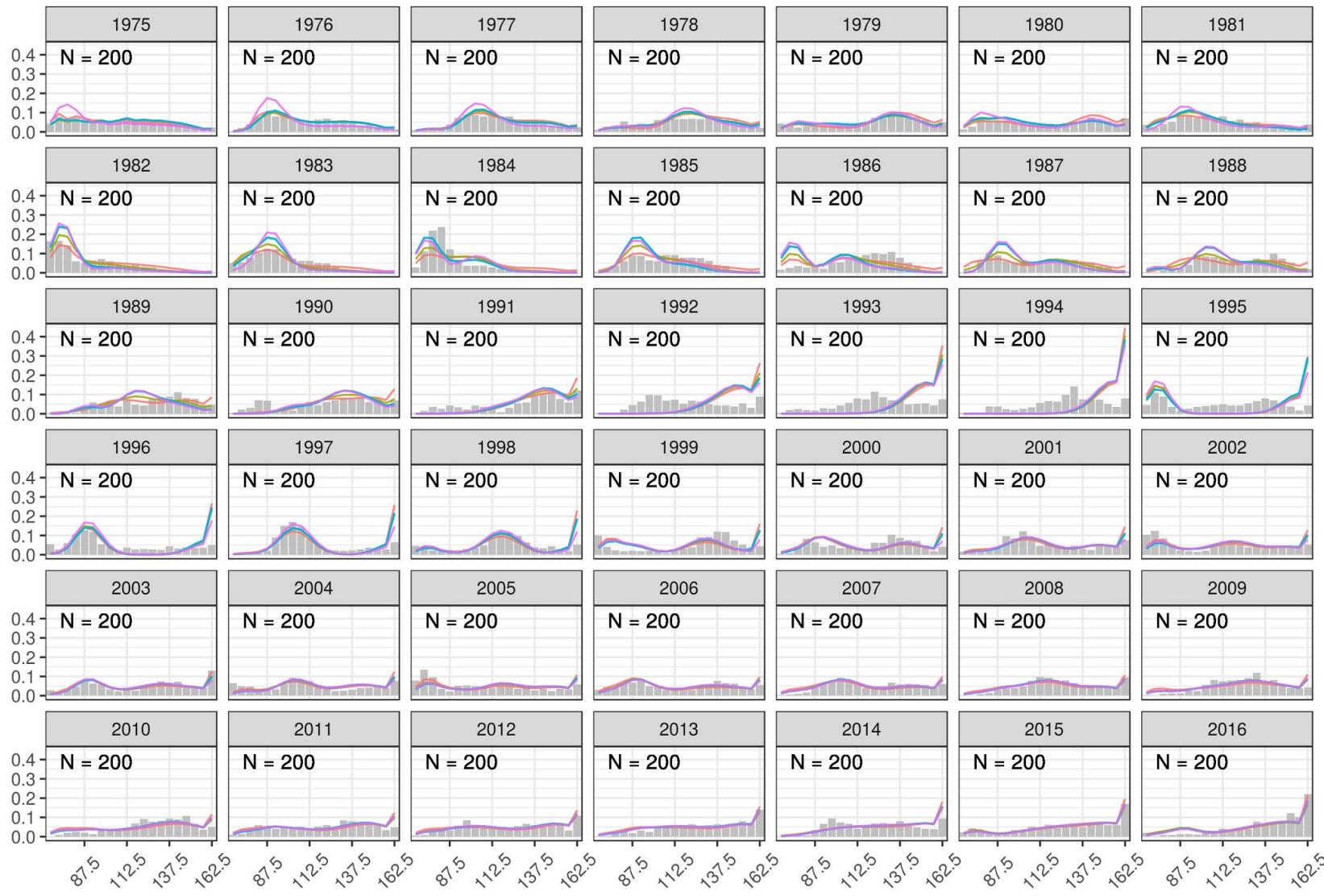
Trawl Bycatch Females

Gear = Trawl bycatch , Sex = Female , Season = 2



NMFS Trawl Males

Gear = NMFS Trawl , Sex = Male , Season = 3

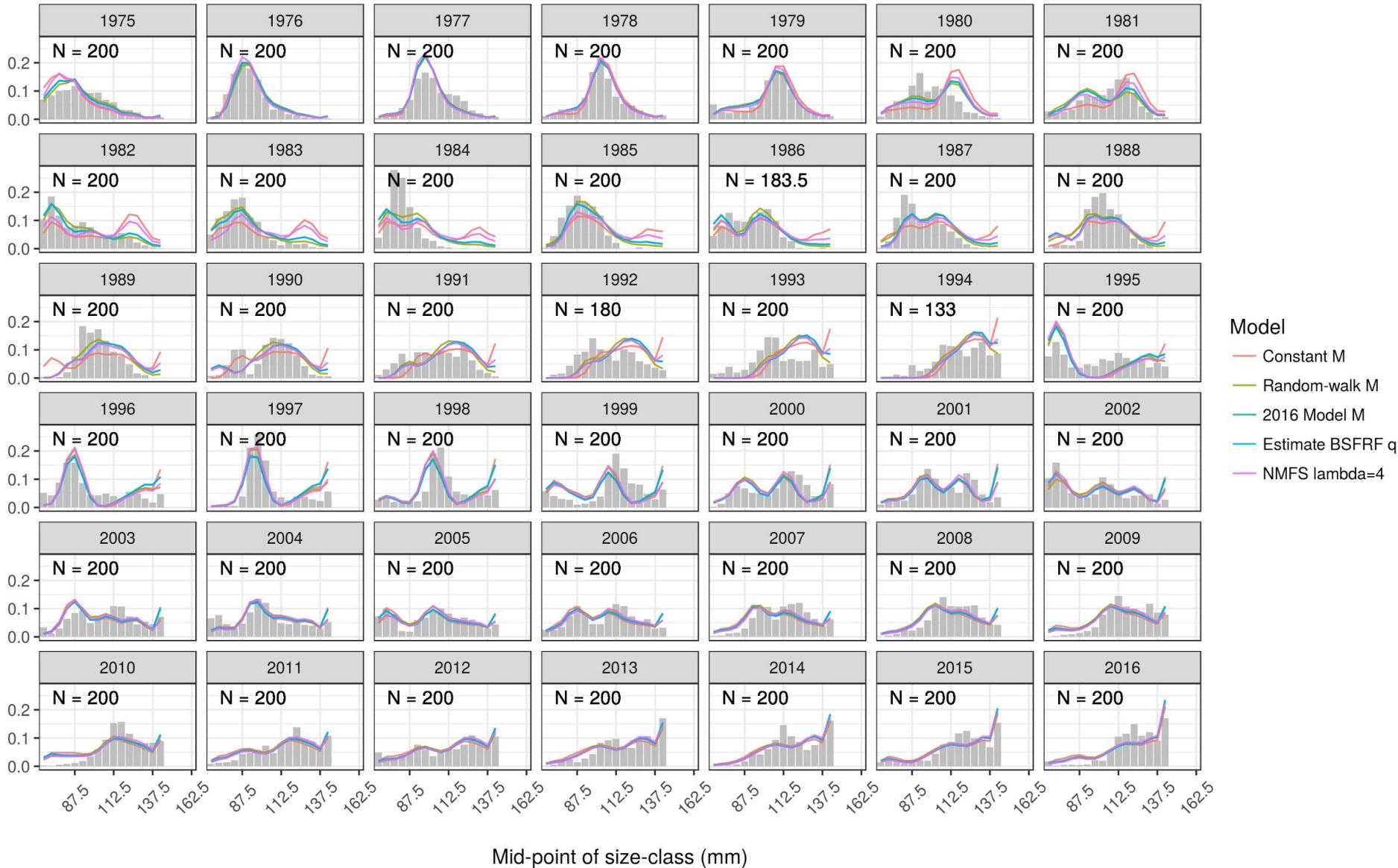


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 - Estimate BSFRF q
 - NMFS lambda=4

Mid-point of size-class (mm)

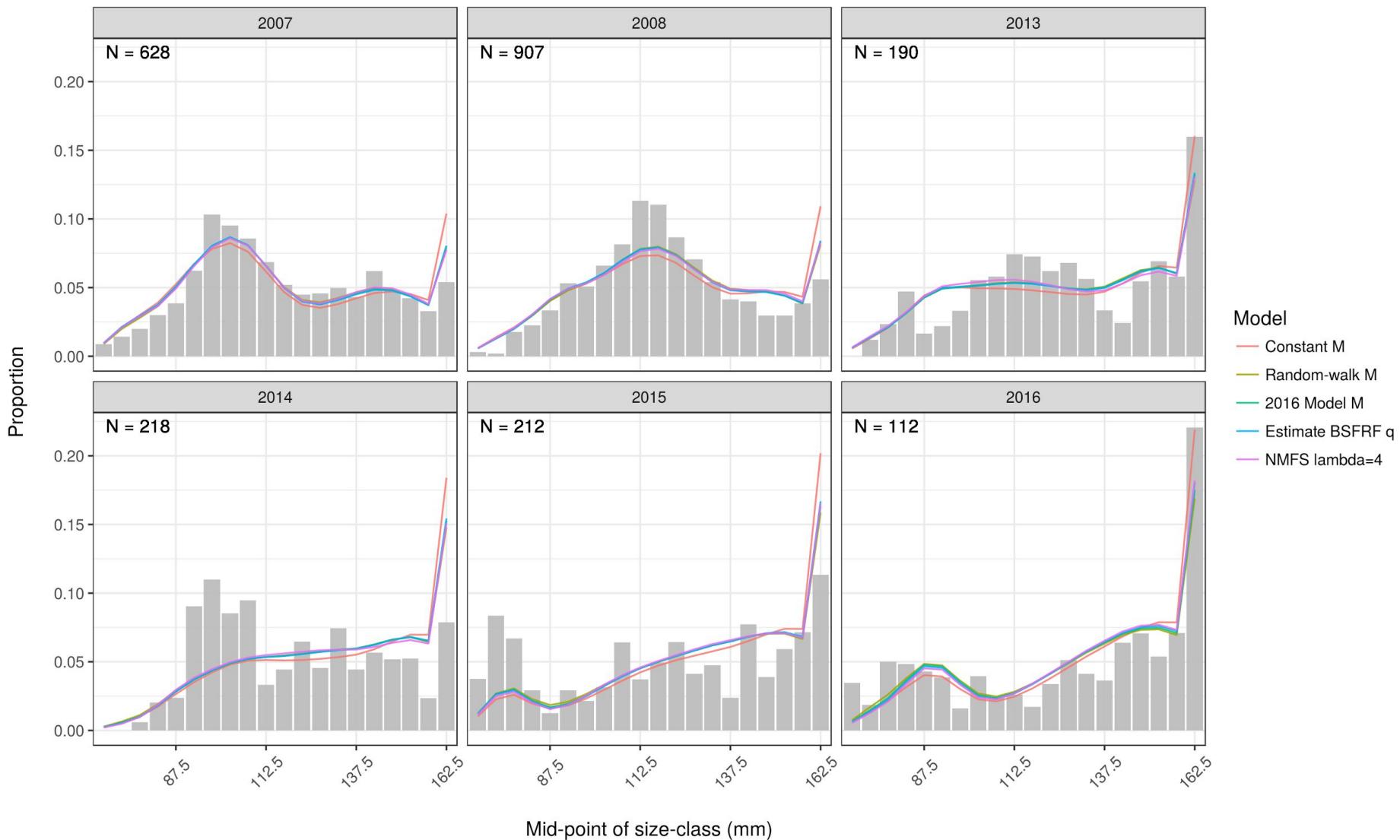
NMFS Trawl Females

Gear = NMFS Trawl , Sex = Female , Season = 3



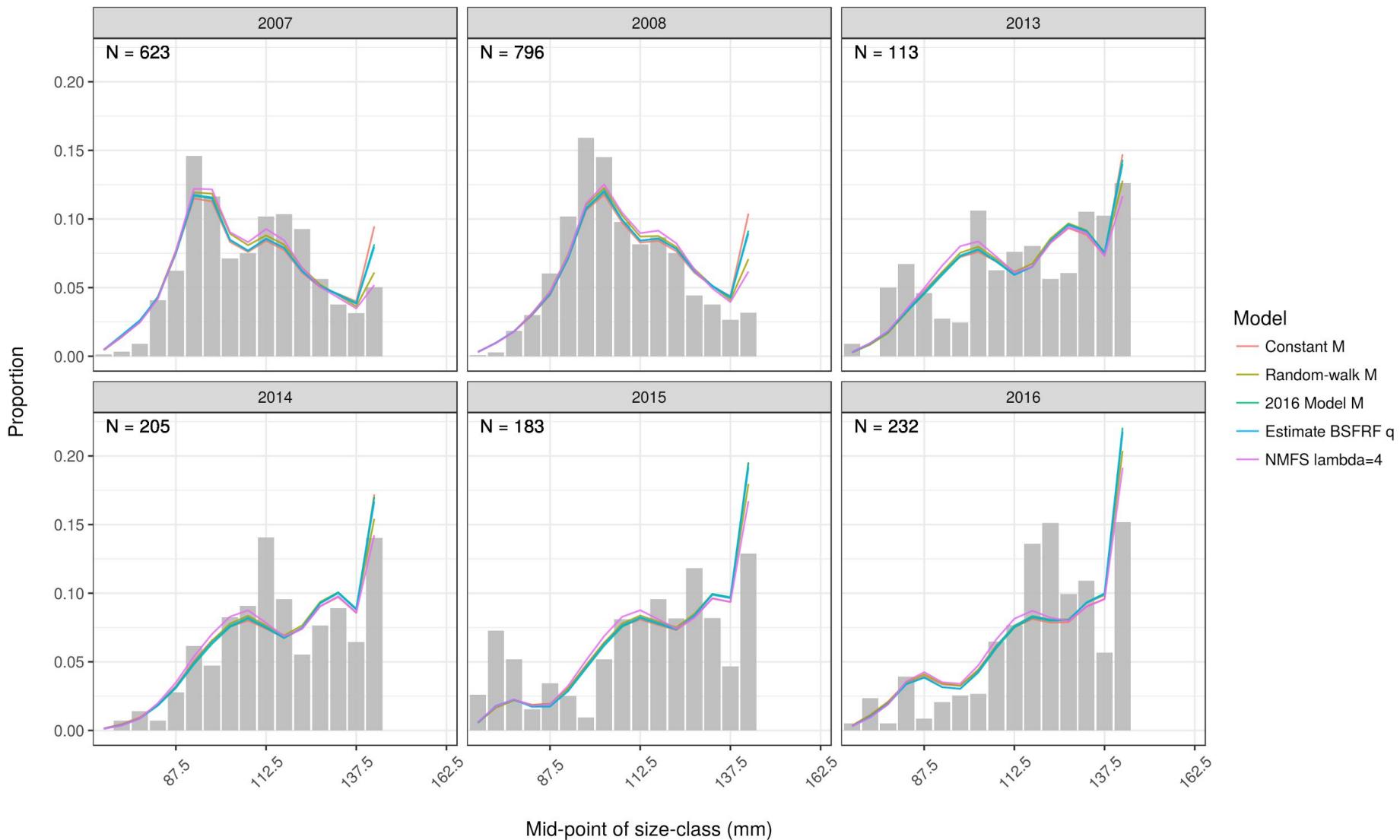
BSFRF Males

Gear = BSFRF , Sex = Male , Season = 3



BSFRF Females

Gear = BSFRF , Sex = Female , Season = 3



To do

1. Need to figure out what is going on with BBRKC initialisation - all of these issues likely stem from this
2. Same goes for growth matrix

This will hopefully result in better survey fits, then:

3. Write-up document

Bristol Bay Red King Crab Stock Assessment 2017

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