Model evaluation for Plan Team consideration for the Yellowfin Sole Stock in the Bering Sea and Aleutian Islands

Ingrid Spies and James Ianelli

September 9, 2020

Why are we presenting this model?

SSC and Plan Team Comments:

In their December 2019 minutes the SSC concurred with the Plan Team's recommendation to use Model 18.1a for management in 2020, as Model 18.2 had not received thorough review.

In response we have prepared this update.


Ingrid Spies

Two models will be presented for consideration.

- Model 18.1a: Same model as in the 2018 assessment, updated with 2019 data. Model 18.1a used the same natural mortality for males and females, M=0.12.

- Model 18.2: Uses a fixed value for female natural mortality (M=0.12) and allowed male natural mortality to be estimated within the model. Model 18.2 is the preferred model.

The SSC requested the authors clarify and justify why natural mortality *M* is estimated in the model for males, rather than for females or both sexes, and whether the value previously used for both sexes combined (*M*=0.12) is appropriate for a single sex.

- First step towards examining sex-specific *M* for Yellowfin sole.
- Skewed sex ratio in Yellowfin Sole, other flatfish -> evidence for higher male *M*.
- Sex-specific *M* -> common feature for flatfish (e.g. Arrowtooth Flounder).
- High proportion of females -> better understanding of female *M*.
- Female *M*: 0.10 to 0.33, Male *M*: 0.16 to 0.51 (Wilderbuer and
- Turnock 2009).
- Assumptions in Model 18.2 based on best available information.


Ingrid Spies

Data included in the models:

Data source	Year
Fishery catch	1954 - 2019
Fishery age composition	1964 - 2018
Fishery weight-at-age	1964 - 2018
Survey biomass and standard error	1982 - 2019
Bottom temperature	1982 - 2019
Survey age composition	1979 - 2018
Annual length, weight-at-age surveys	1979 - 2018
Age at maturity	Combined 1992 and 2012 samples

Likelihood table for Model 18.1a and Model 18.2

Likelihood component	Model 18.1*a*	Model 18.2
Survey age	589.18	560.25
Fishery age	651.62	609.64
Selectivity	63.4	62.81
Survey biomass	91.98	95.08
Recruitment	26.9	28.25
Catchability	0.0083	0.0069
Total	1423.09	1356.03

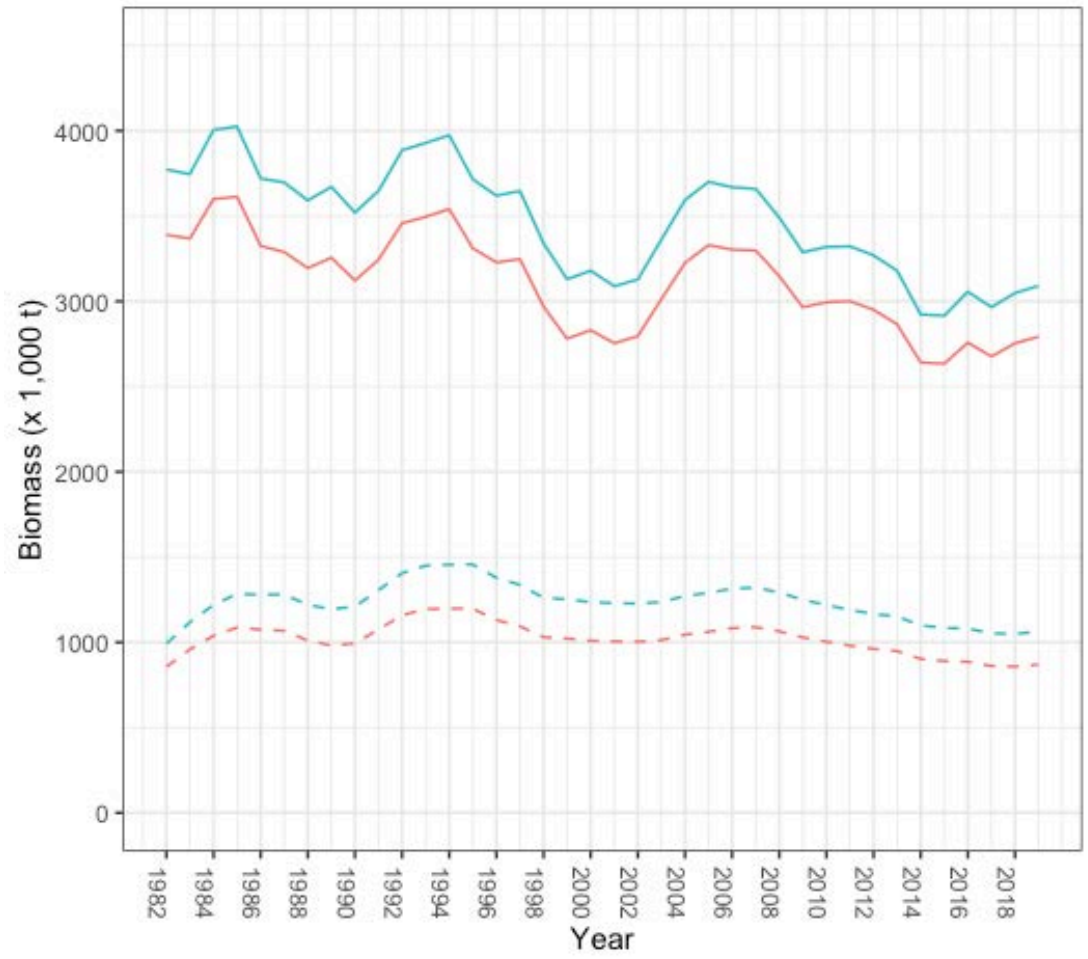

Ingrid Spies

Comparison of results for Model 18.1a and Model 18.2

Quantity	Model 18.2 2020	Model 18.2 2021	Model 18.1a 2020	Model 18.1a 2021
M (natural mortality rate)	0.12, 0.135	0.12, 0.135	0.12	0.12
Tier	1a	1a	1a	1a
Projected total (age 6+) biomass (t)	2,726,370	2,733,120	2,466,130	2,472,760
Projected female spawning biomass (t)	1,051,050	1,005,310	859,256	820,588
$B_{100\%}$	1,501,510	1,501,510	1,275,940	1,275,940
$B_{MSY\%}$	542,791	542,791	467,194 t	467,194 t
F_{OFL}	0.118	0.118	0.117	0.117
$maxF_{ABC}$	0.109	0.109	0.106	0.106
F_{ABC}	0.109	0.109	0.106	0.106
OFL	321,794	322,591	289,512	290,290
$maxABC$	296,060	296,793	262,632	263,337
ABC	296,060	296,793	262,632	263,337
Status	2018	2019	2018	2019

Projections for Model 18.1a and 18.2 were based on estimated catches of 118,642 t in 2019 and 137,230 used in place of maximum ABC for 2020.

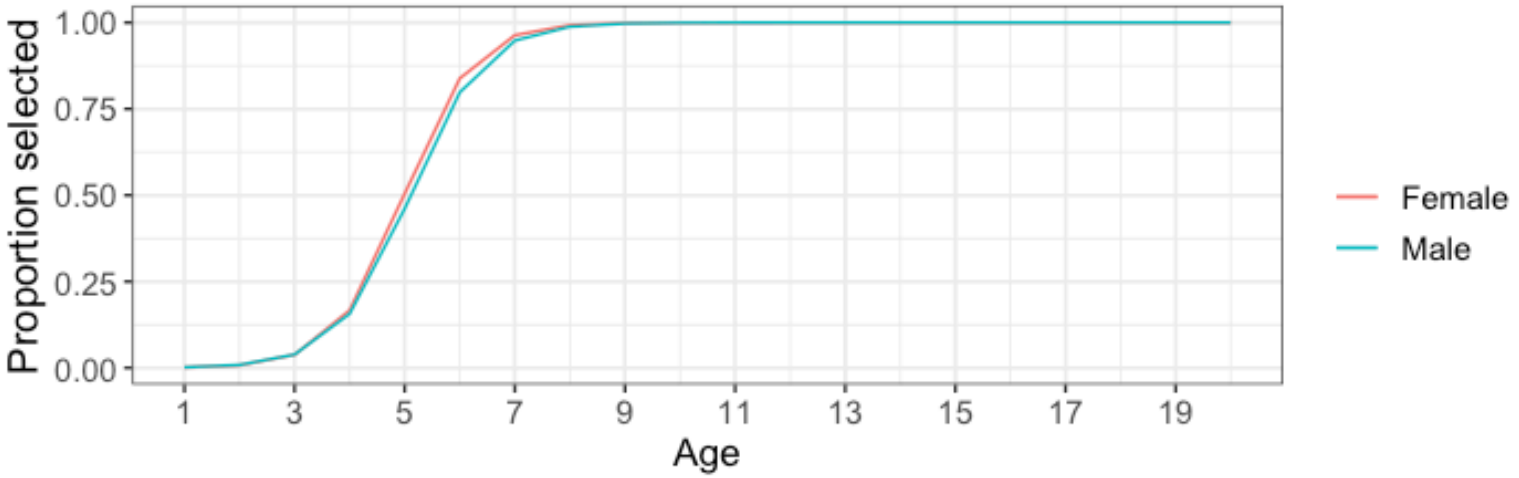
Estimates of total (solid line) and spawning (dotted line) biomass, Model 18.2a and Model 18.2, 1982-2019



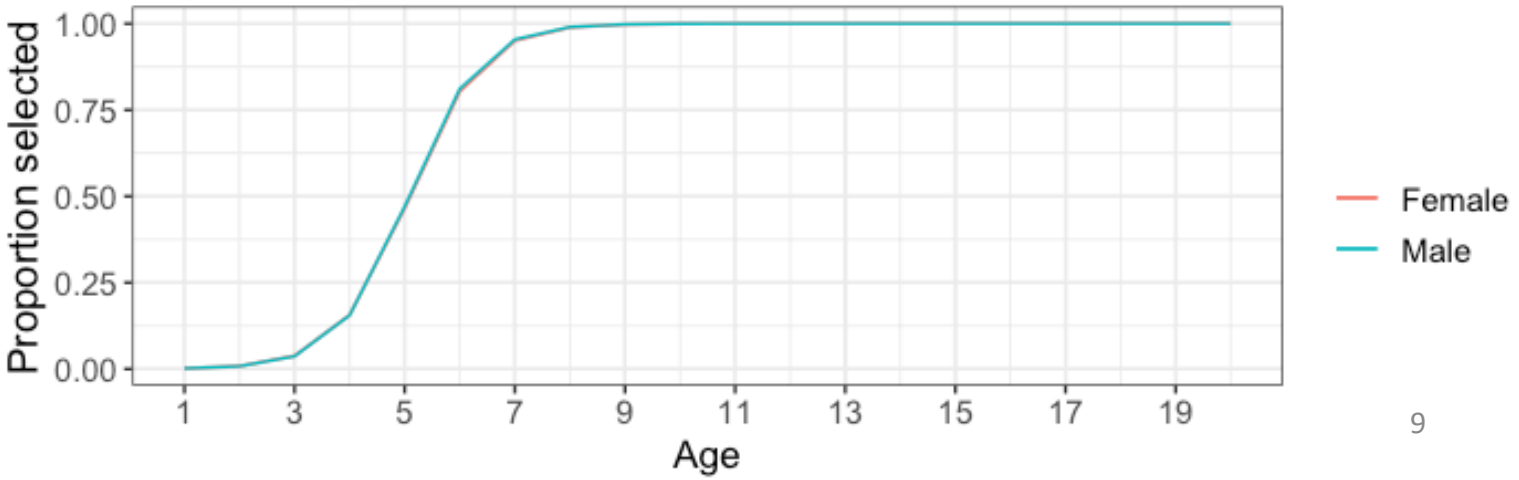
Model 18.1a
Model 18.2

Similar survey selectivity for males and females, Models 18.1a and 18.2

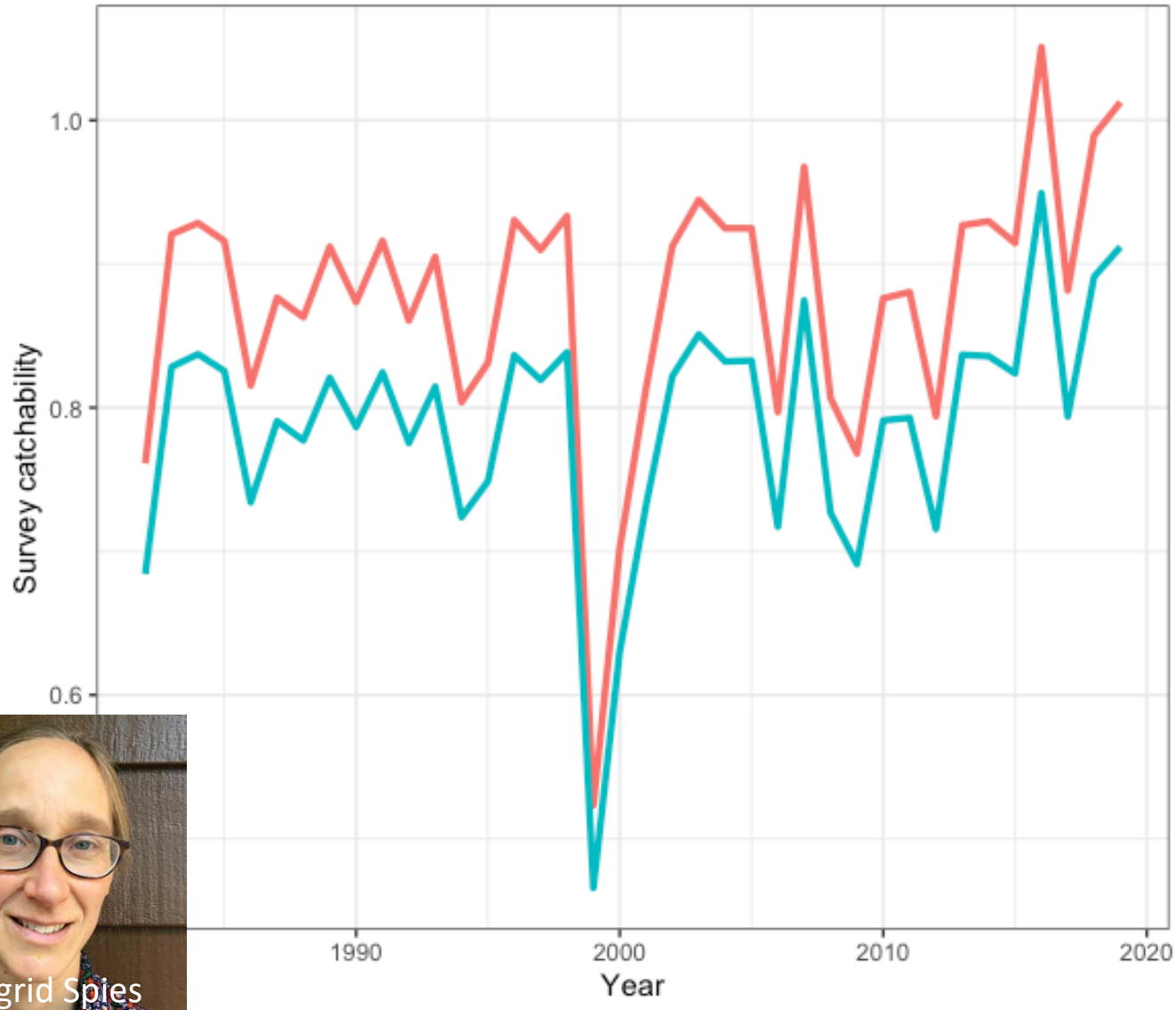
Model 18.1a



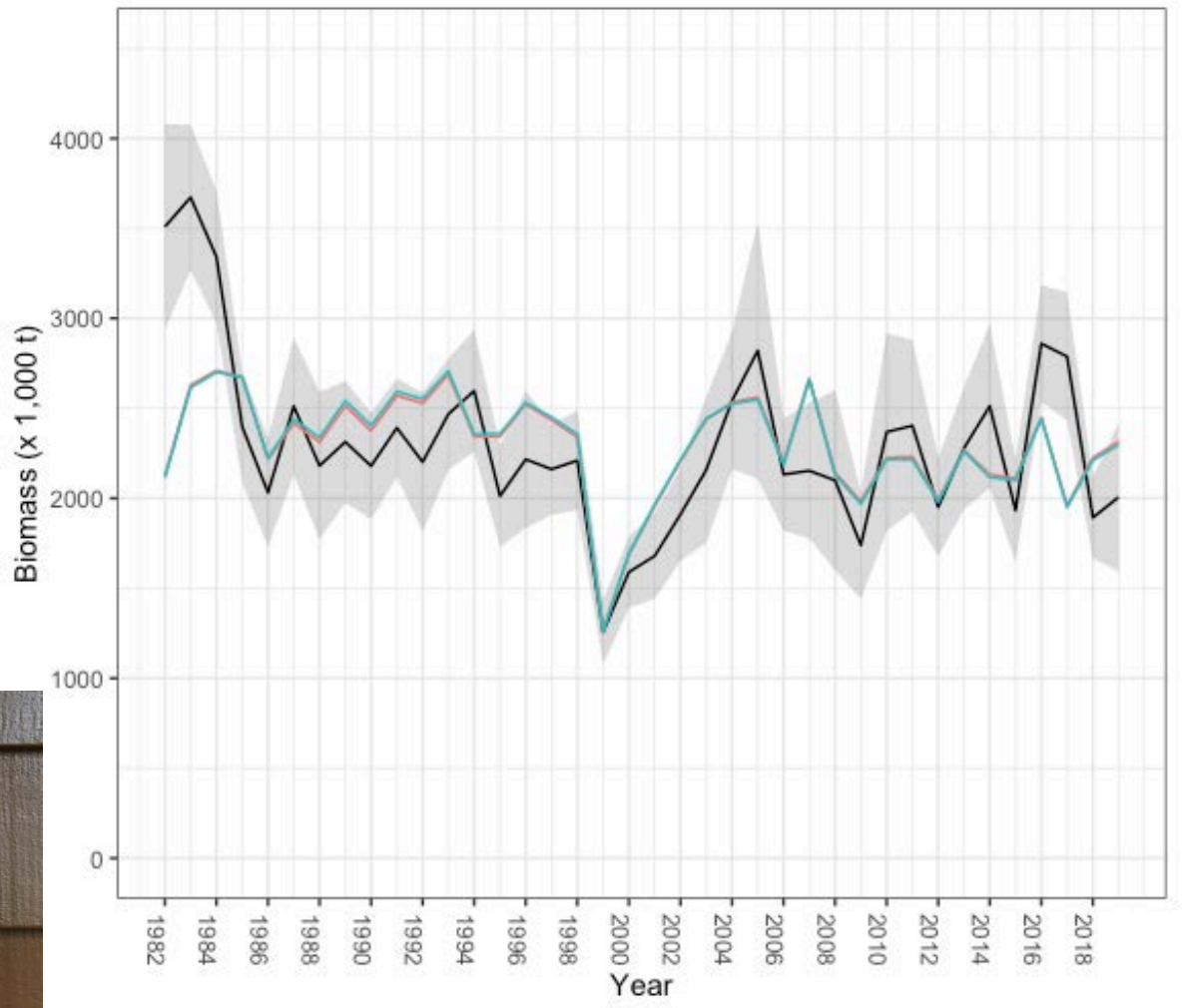
Model 18.2



Survey catchability for Model 18.1a and 18.2, 1982-2019.

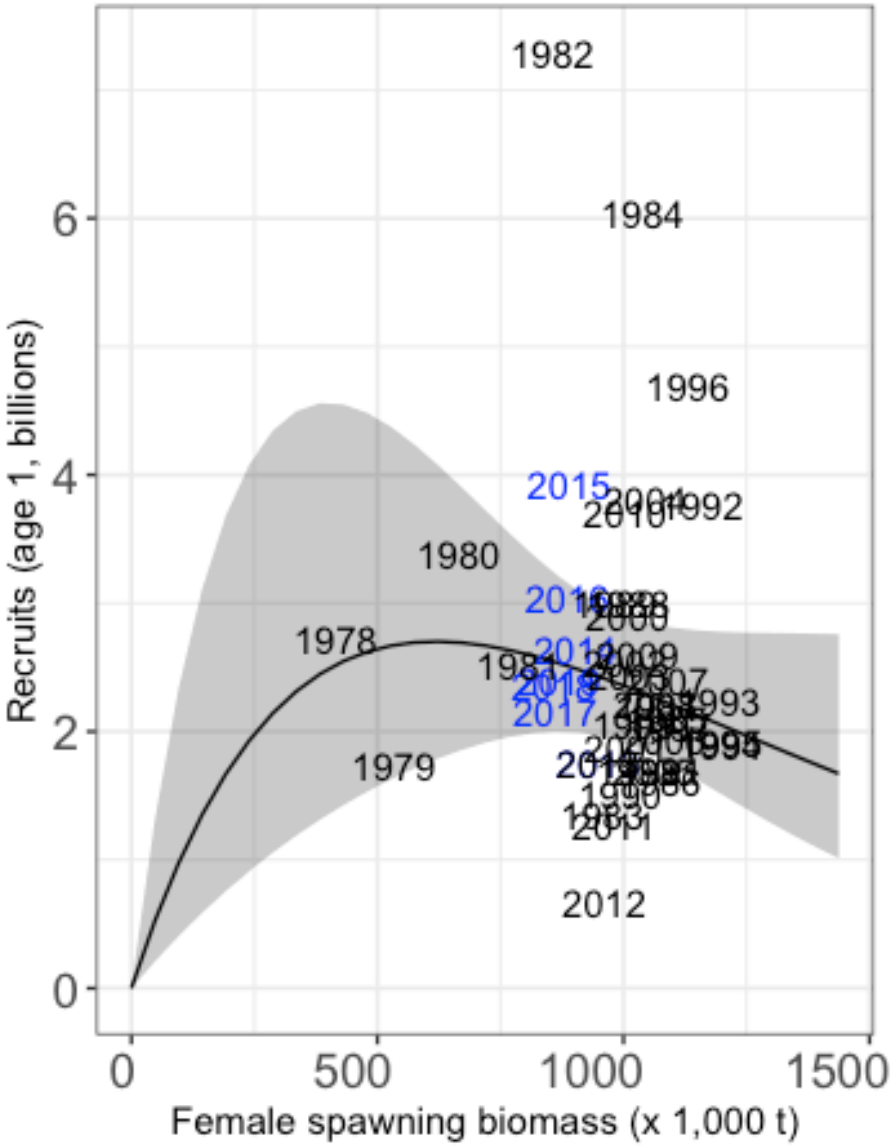


NMFS EBS survey biomass estimates, Model 18.1a and 18.2 fit to survey biomass estimates, 1982-2019.

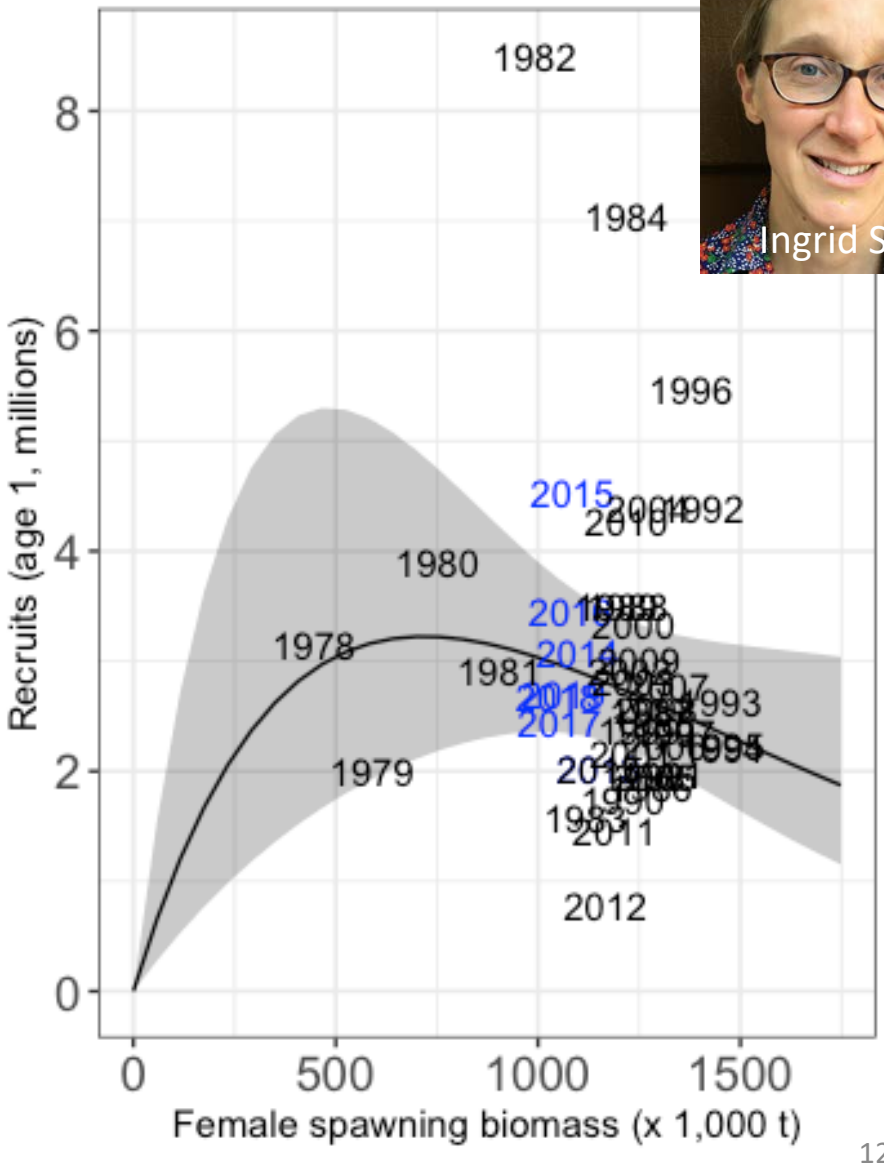



Ingrid Spies

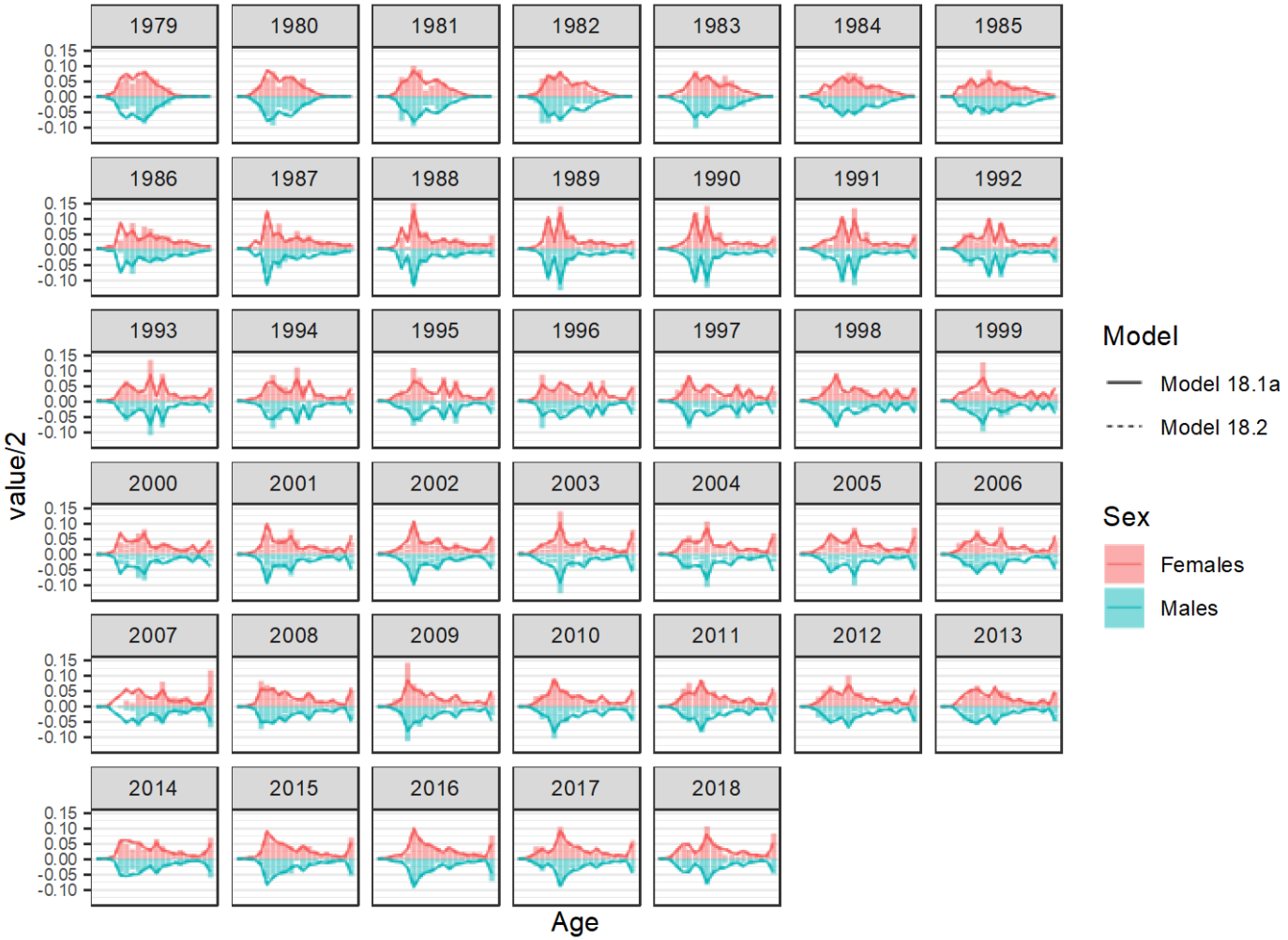
Model 18.1a

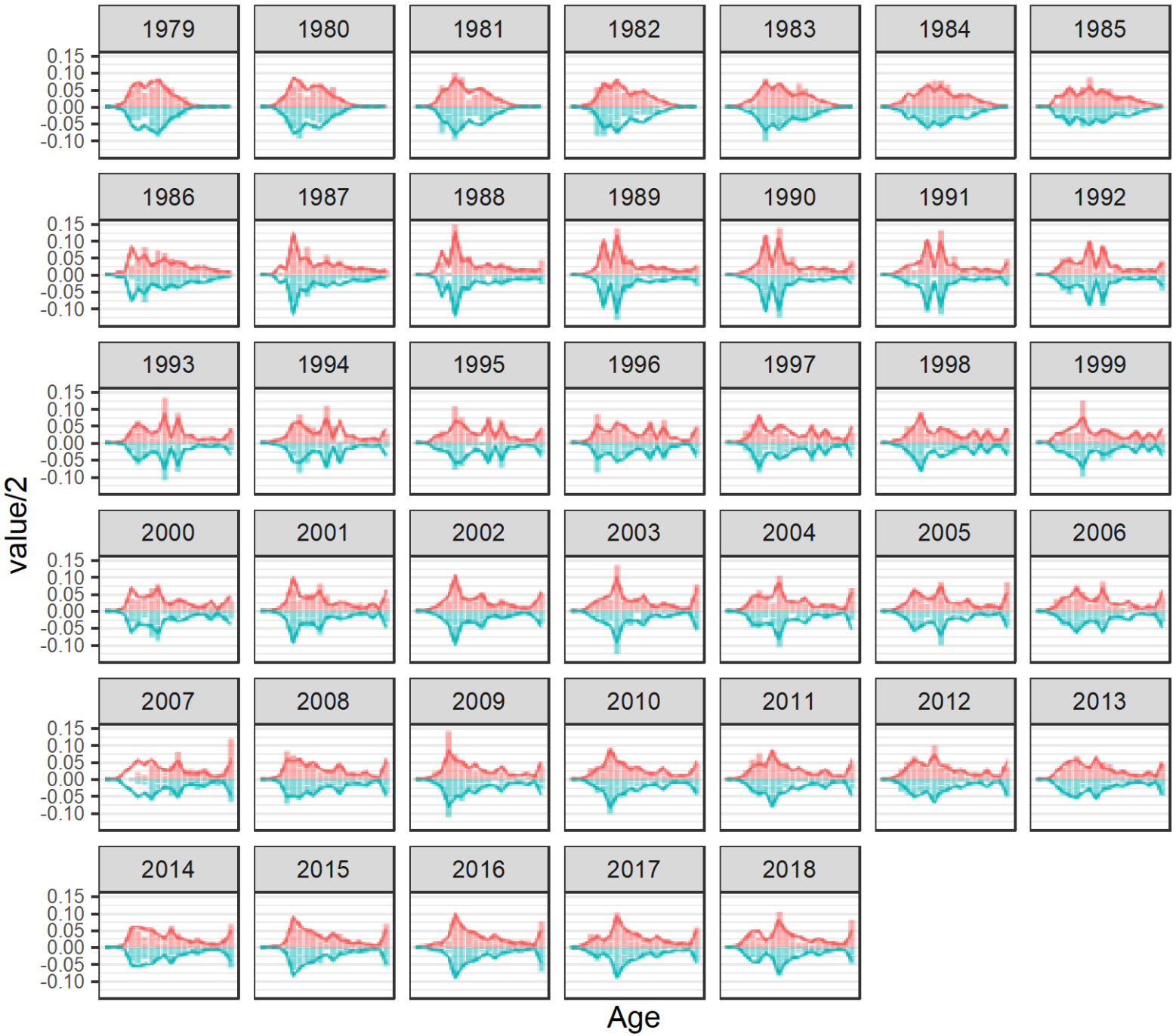


Model 18.2



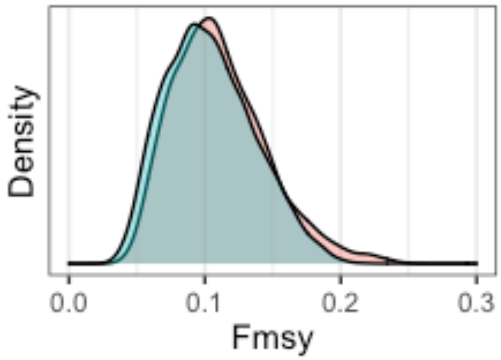
Fit to the time-series of survey age composition, by sex, 1979-2018, Models 18.2 and 18.1a.

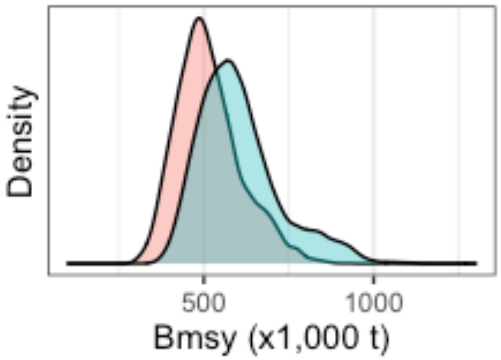


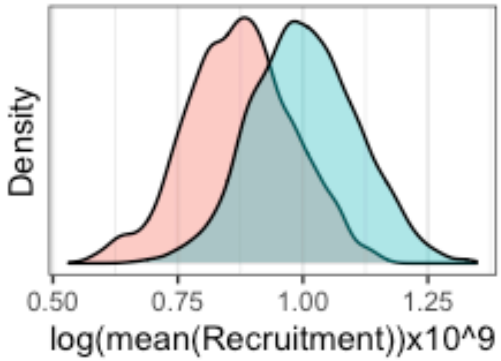

1979
1980
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
0.15
0.10
0.05
0.00
-0.05
-0.10
value/2
Age
Model
Model 18.1a
Model 18.2
Sex
Females
Males

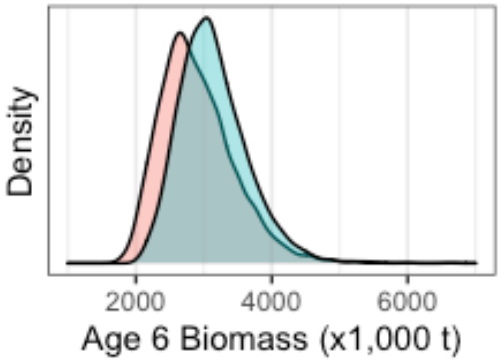

Ingrid Spies

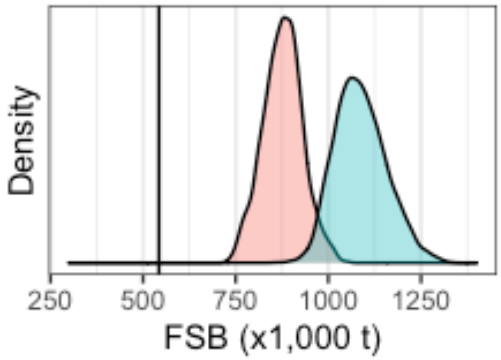
MCMC posterior distributions for Models 18.1a and 18.2.

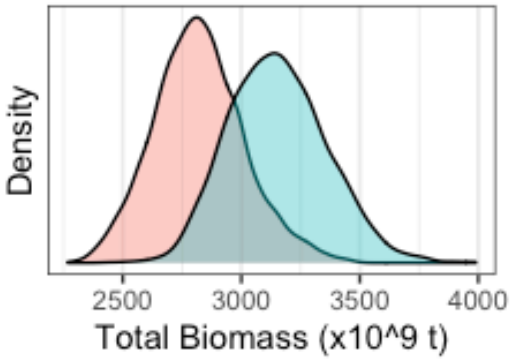






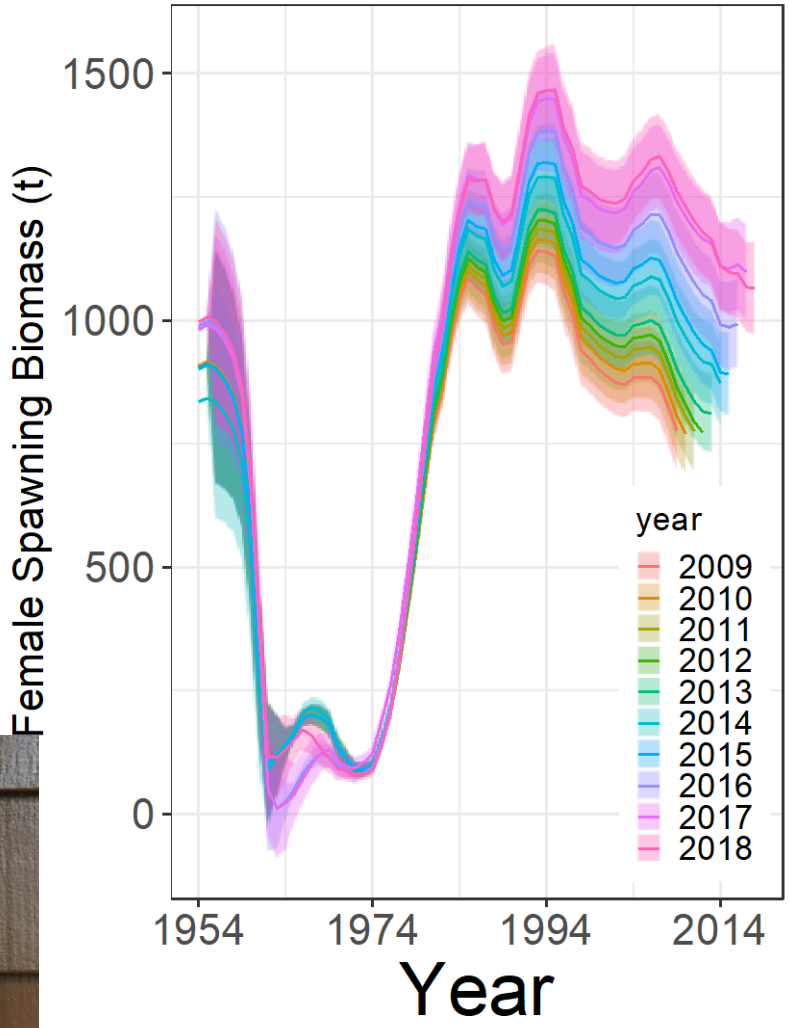




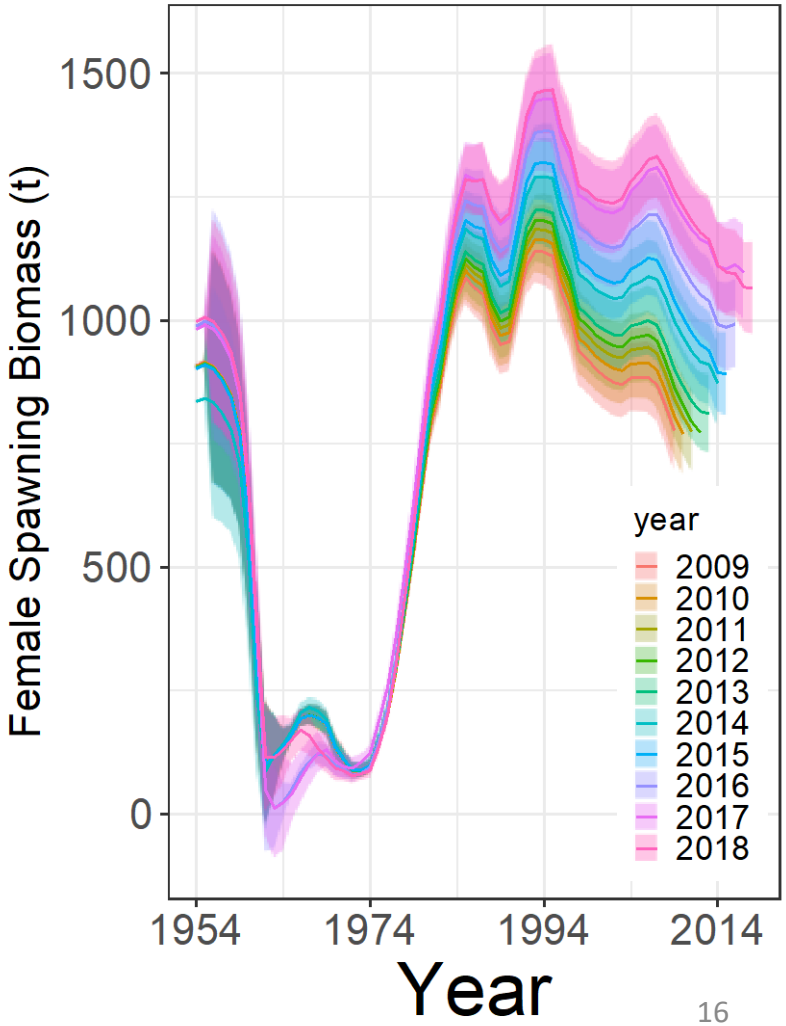


Retrospective plots of female spawning biomass

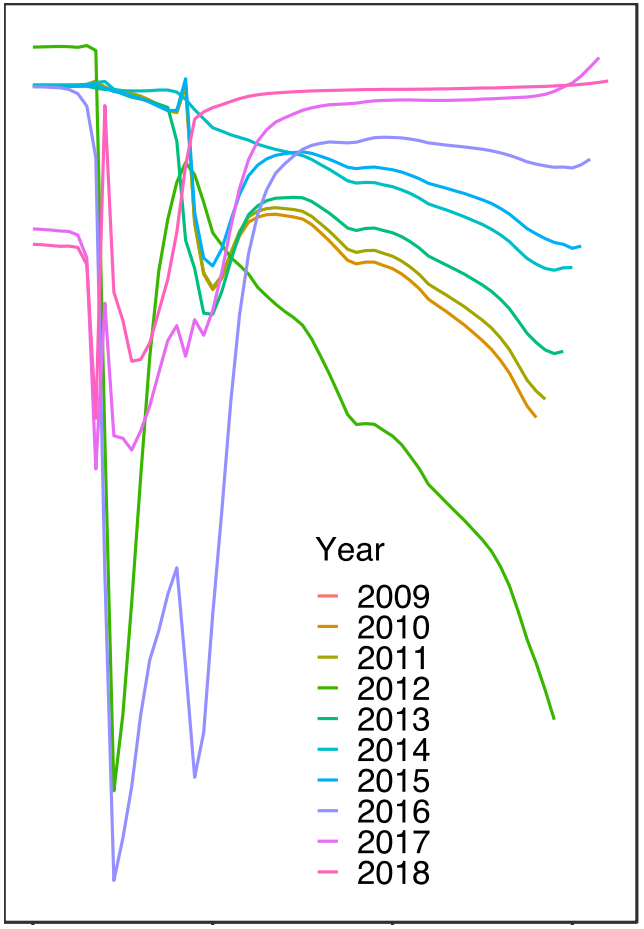
Model 18.1a



Model 18.2



Relative difference in FSB between recent model and retrospective runs



Retrospective results

- Mohn's rho was -0.219 using Model 18.2 and -0.254 under Model 18.1a.

- Retrospective differences were almost always negative under Model 18.1a but more balanced under 18.2.


Ingrid Spies

Conclusions

- Model 18.2 has several characteristics that indicate it is a better model than 18.1a.
- Higher male natural mortality is accepted for the population dynamics of other flatfish species.
- Model 18.2 has higher total likelihood.
- Model 18.2 has an improved difference in female spawning biomass retrospective patterns and less negative Mohn's rho.


Ingrid Spies

Questions?