

**Stock assessment for eastern Bering Sea Walleye Pollock:  
some preliminary alternative evaluations  
based on external review**

September 15, 2016

AFSC Seattle, WA

Three independent experts reviewed the stock assessment for eastern Bering Sea Walleye Pollock in May 2016. The terms of reference and presentations and their subsequent reports can be found at: [www.tinyurl.com/pollockCIE2016](http://www.tinyurl.com/pollockCIE2016). Several improvements to the assessment were recommended and those seen as highest priority that could be reasonably addressed this year include:

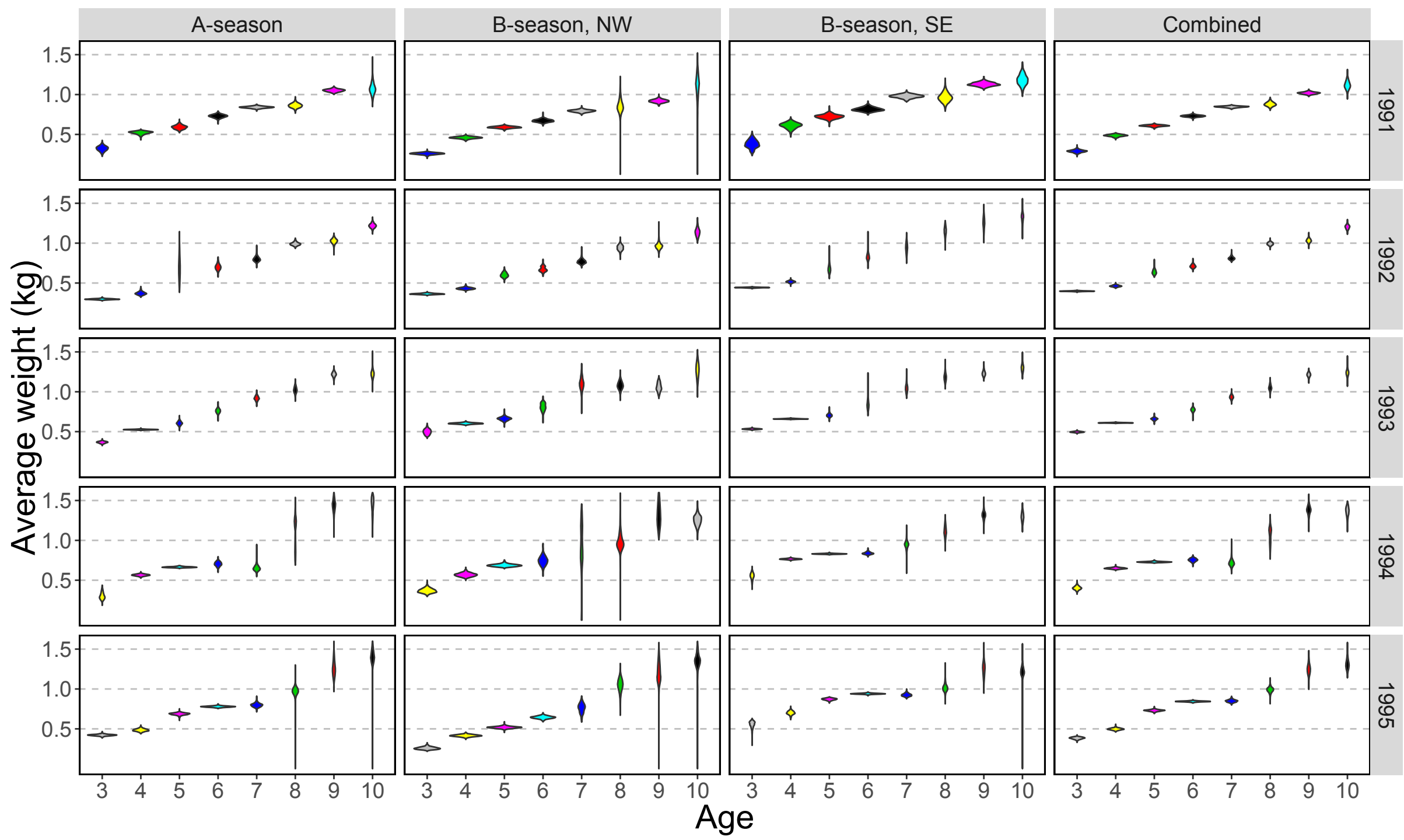
1. Modify the **body weight-at-age estimation** method to be based on increment rather than expected values
2. Fit the model to **biomass indices** rather than total population numbers
3. For the acoustic trawl data, use the time series that covers the water column **down to a half meter** from bottom rather than down to 3 meters
4. Evaluate data weightings from first principles for input sample sizes
5. Evaluate whether weightings are appropriate given model fit
6. Consider **components of variability of the  $F_{msy}$**  estimation and the effect of the prior

# Data recompilation

- Two-stage bootstrap sampling of observer data:
  1. Draw hauls from all sampled hauls (with replacement)
  2. From those, draw samples (lengths for Lfreq or ages for ALK; with replacement)
- Weighted by catch within strata

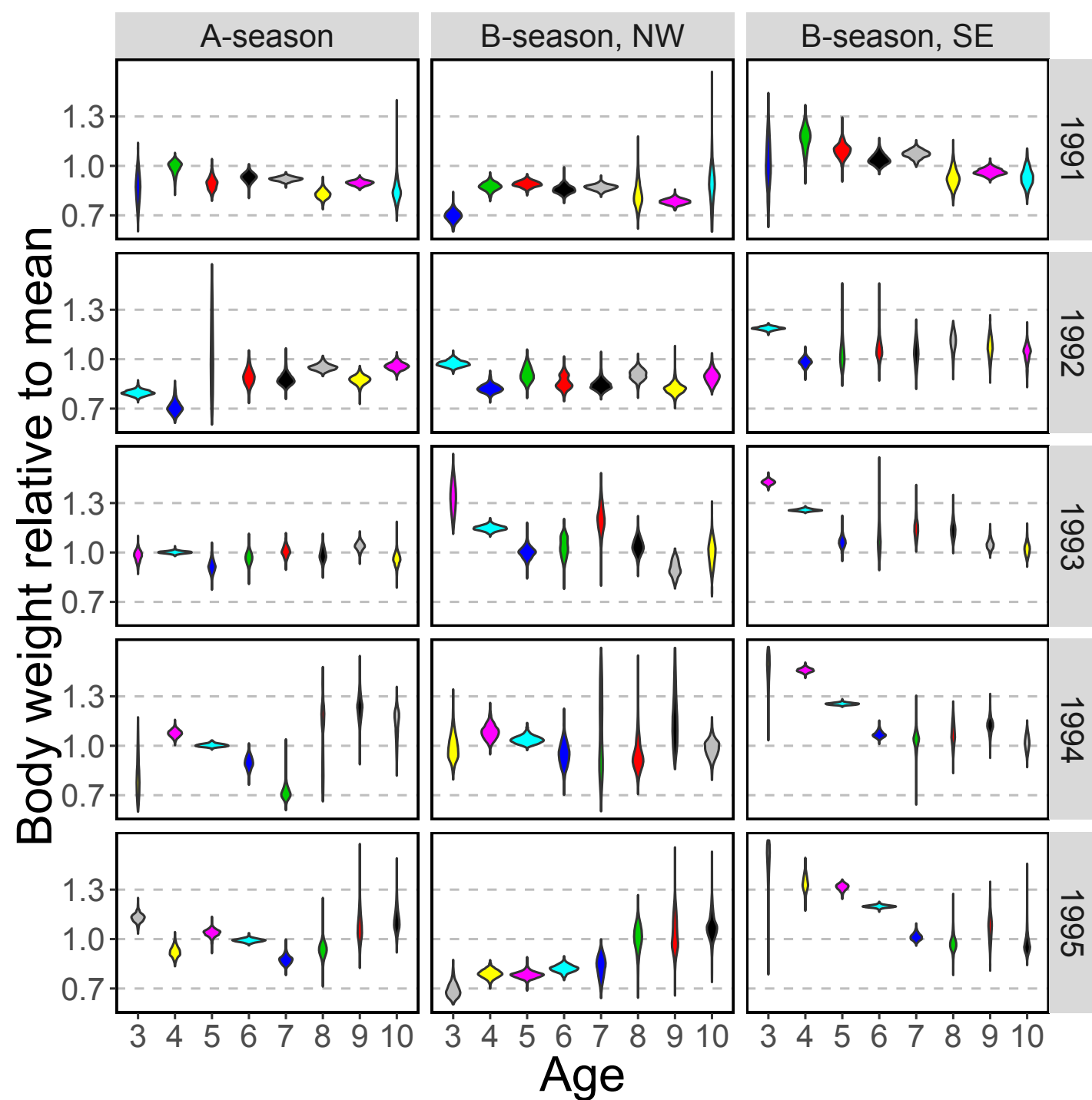
# Appendix 1

- Example weights-at-age output



# Normalized

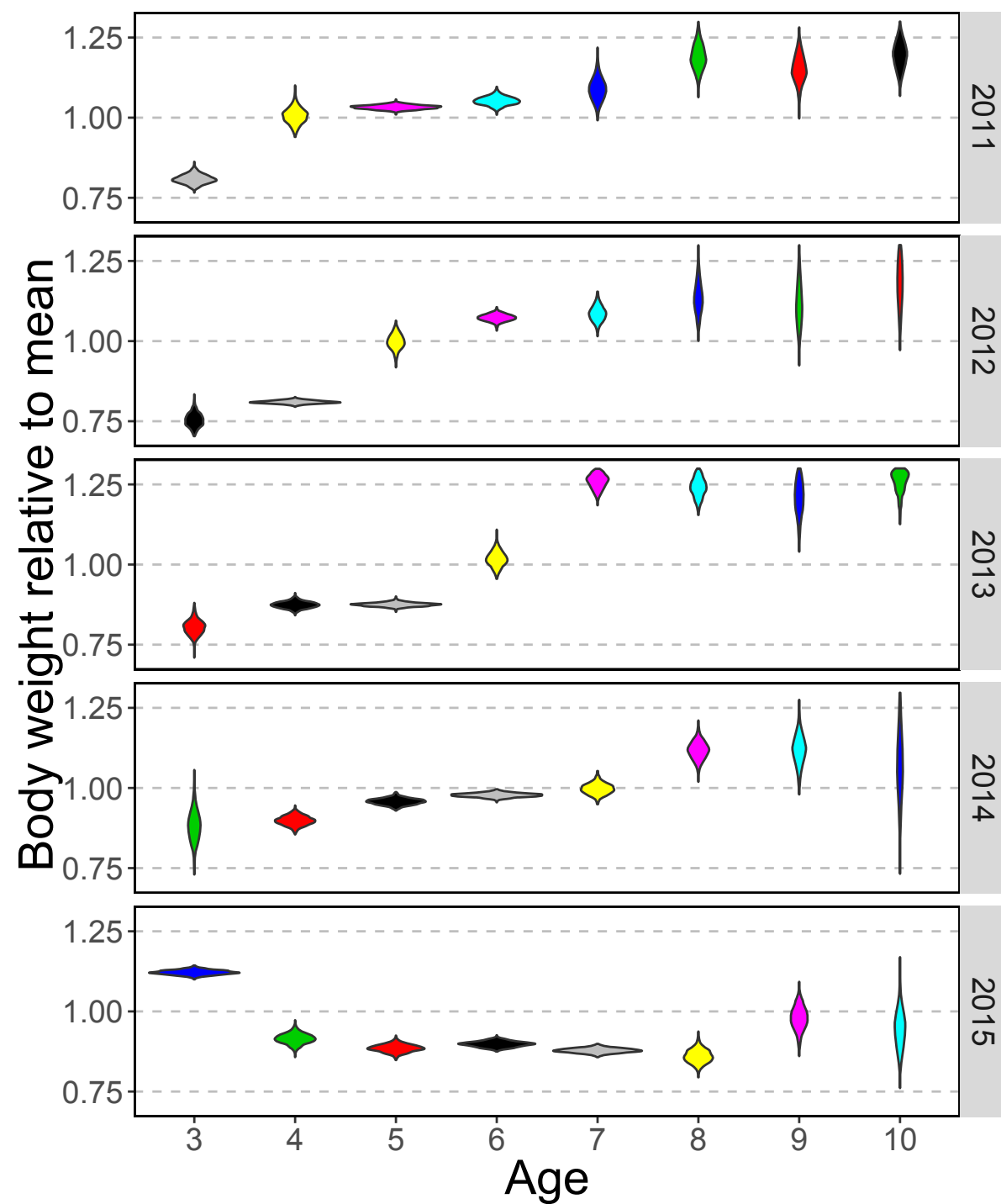
- By strata





# Normalized

- Annual





Sample size estimates derived from bootstrap variability and

Year	Mean age	CV Mean age	Eff
1991	7.56	0.78%	
1992	6.07	0.73%	
1993	4.86	0.42%	
1994	5.13	0.62%	
1995	5.74	0.50%	
1996	6.48	0.58%	
1997	5.98	0.47%	
1998	6.19	0.48%	
1999	5.74	0.49%	
2000	5.95	0.46%	
2001	6.23	0.55%	
2002	6.12	0.57%	
2003	5.55	0.55%	
2004	5.41	0.61%	
2005	5.52	0.43%	
2006	5.80	0.50%	
2007	6.14		
2008			

$$N_y = v_y / V_j(\bar{A}_{jy})$$

$$v_y = \sum_a a^2 p_{ay} - \left( \sum_a a p_{ay} \right)^2$$

# Growth:

predicting mean fishery body weight-at-age

$$\hat{w}_{ij} = \mu_j e^{\delta_i} \quad j = 1, \quad i \geq 1$$

$$\hat{w}_{ij} = \hat{w}_{i-1,j-1} + \Delta_j e^{\zeta_i} \quad j > 1, \quad i > 1$$

$$\Delta_j = \mu_{j+1} - \mu_j \quad j < J$$

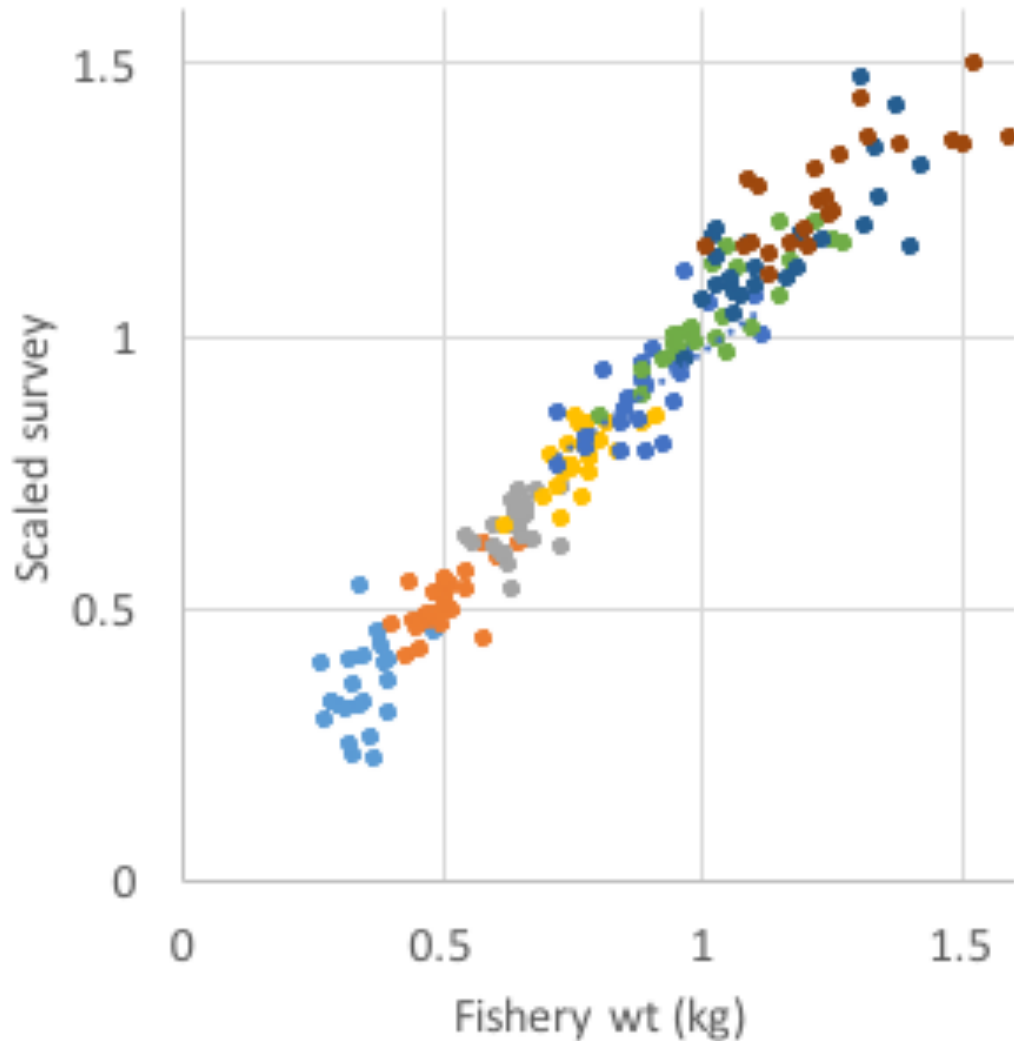
$$\mu_j = \alpha \left[ L_1 + (L_2 - L_1) \left( \frac{1 - K^{j-1}}{1 - K^{J-1}} \right) \right]^3$$

Method	Description
Means	Mean fishery weights-at-age of most recent $n$ years of data ( $n = 1, 3, 5,$ and $10$ )
Year and Cohort	Year and cohort effect model
Year and Cohort with scaled survey data	Include scaled survey weights-at-age ( $\hat{w}_{i,j}^{k=2} = \lambda_j w_{i,j}^{survey}$ )
Year effect only (with scaled survey data)	Year effect model (a random effect parameter for each annual growth increment)

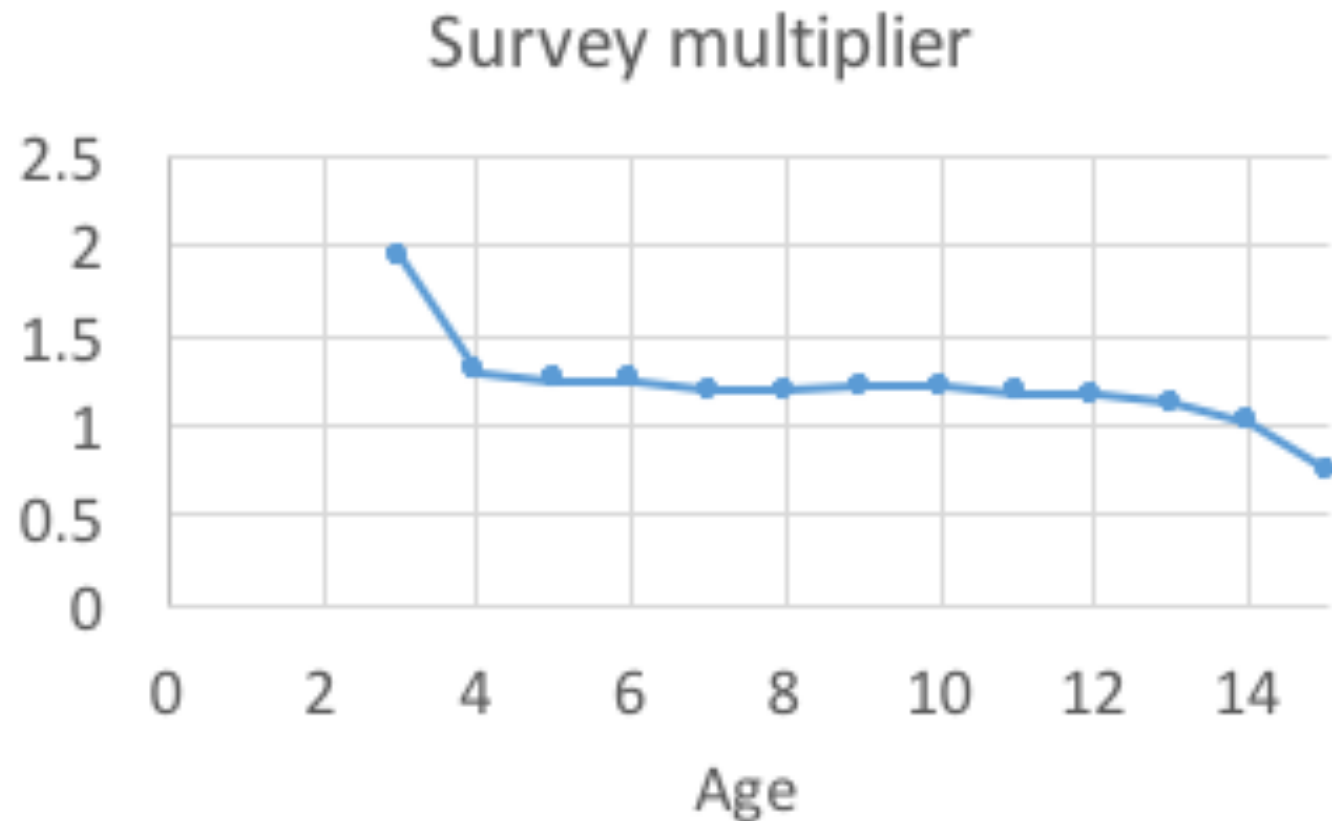
Adding current year survey data to predictions

# Including survey data

- To help w/ predictions

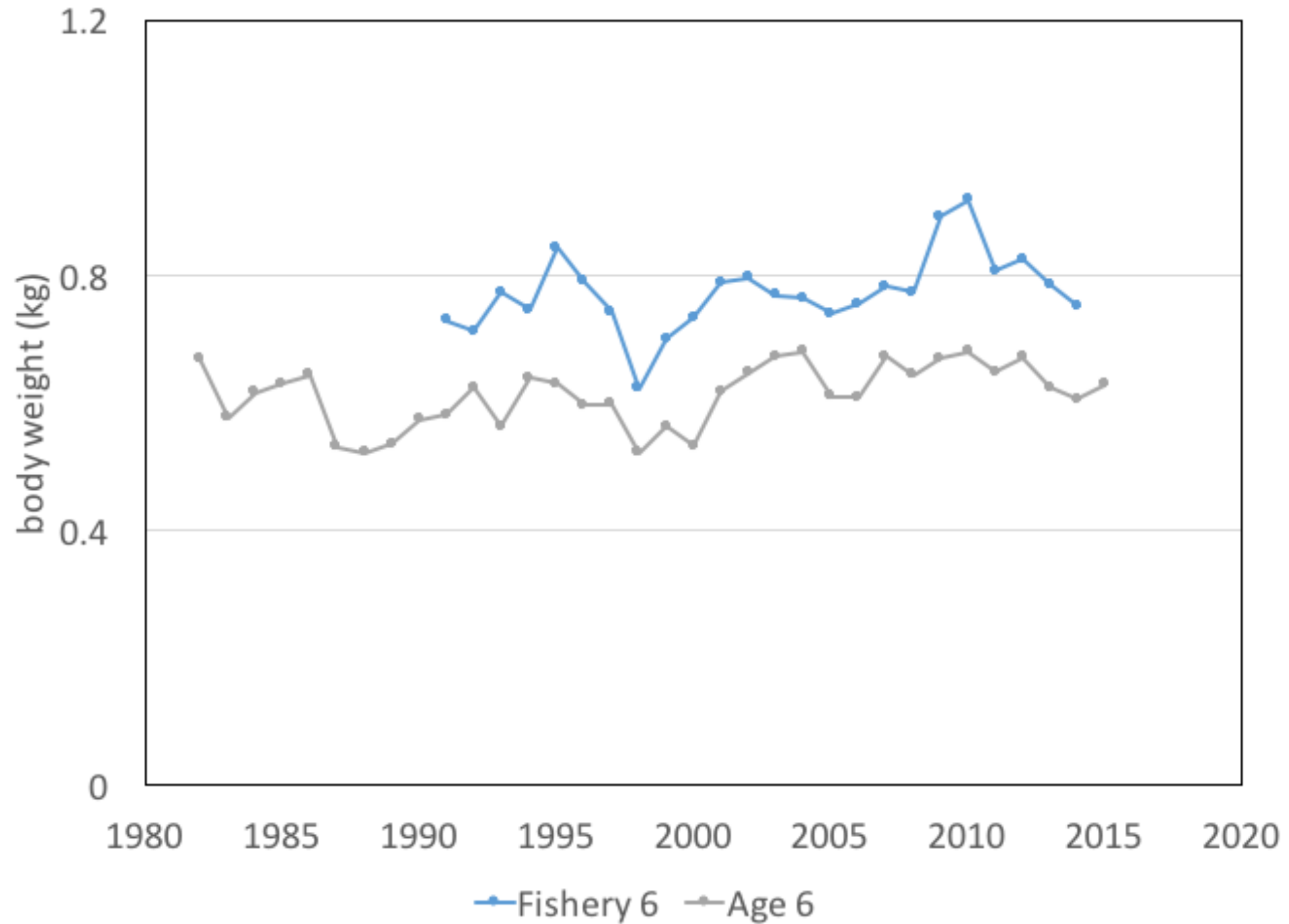


$$\hat{w}_{i,j}^{k=2} = \lambda_j w_{i,j}^{survey}$$



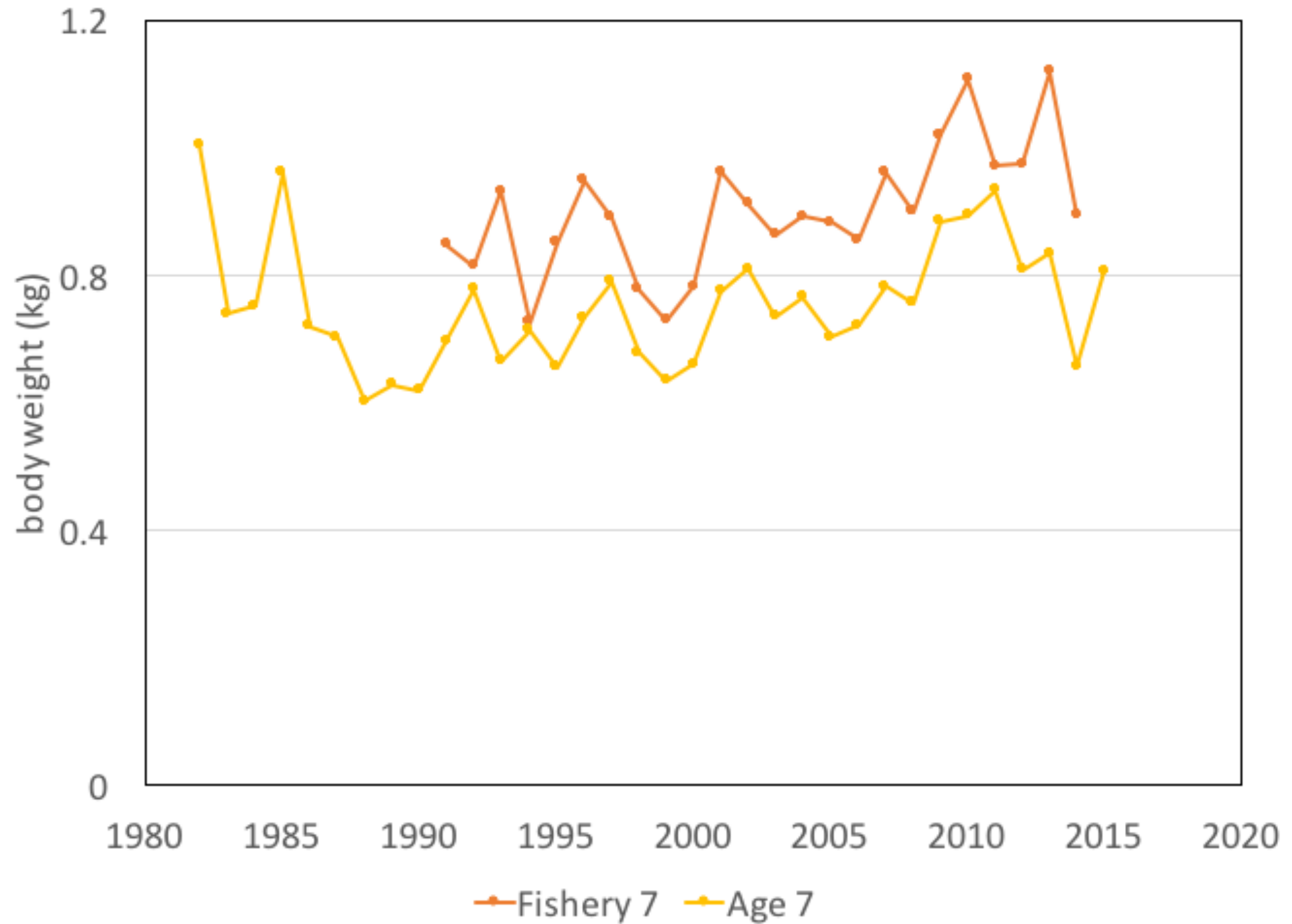
Age  
6

Fishery  
and survey  
mean wt-at-age



Age  
7

Fishery  
and survey  
mean wt-at-age



# Scoring out-of sample prediction

- Went back to 2000

Tested method for predicting year 2000 and 2001 mean body weight-at-ages:  
Projection year 0 and projection year 1

- Calculated scores

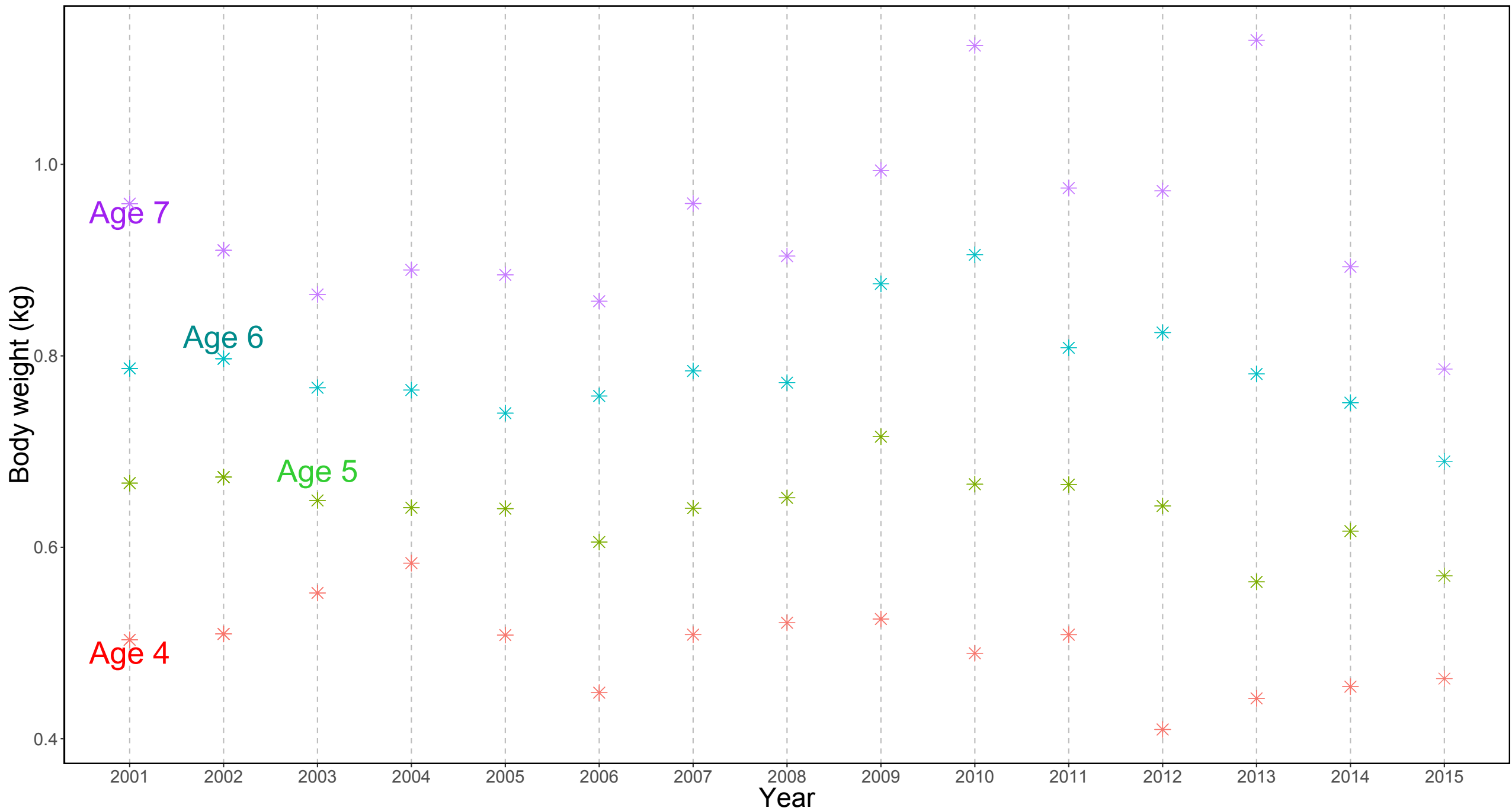
- Weighted by importance:

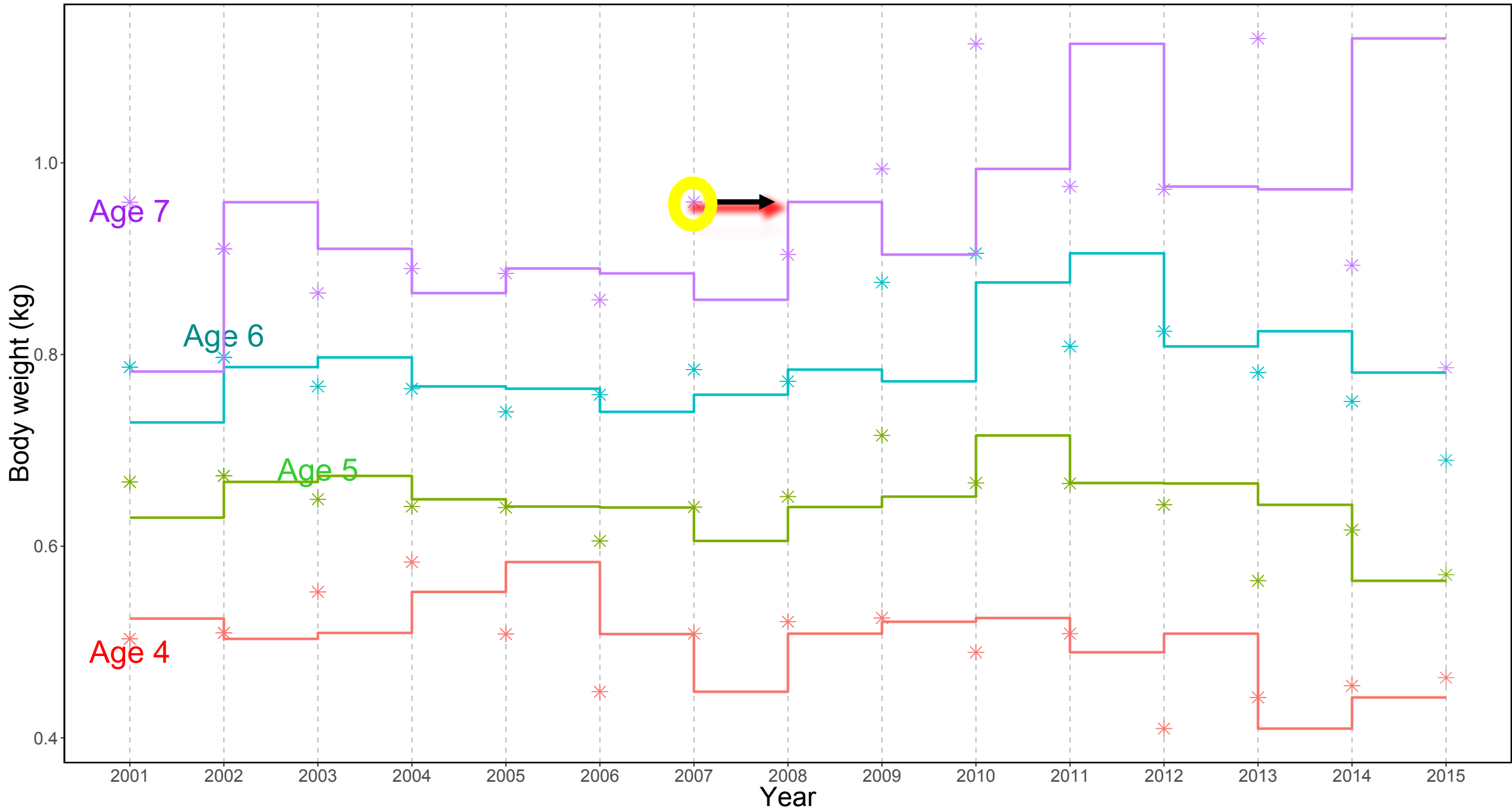
$$\gamma_a = \frac{\bar{N}_a s_a \bar{w}_a}{\sum \bar{N}_a s_a \bar{w}_a}$$

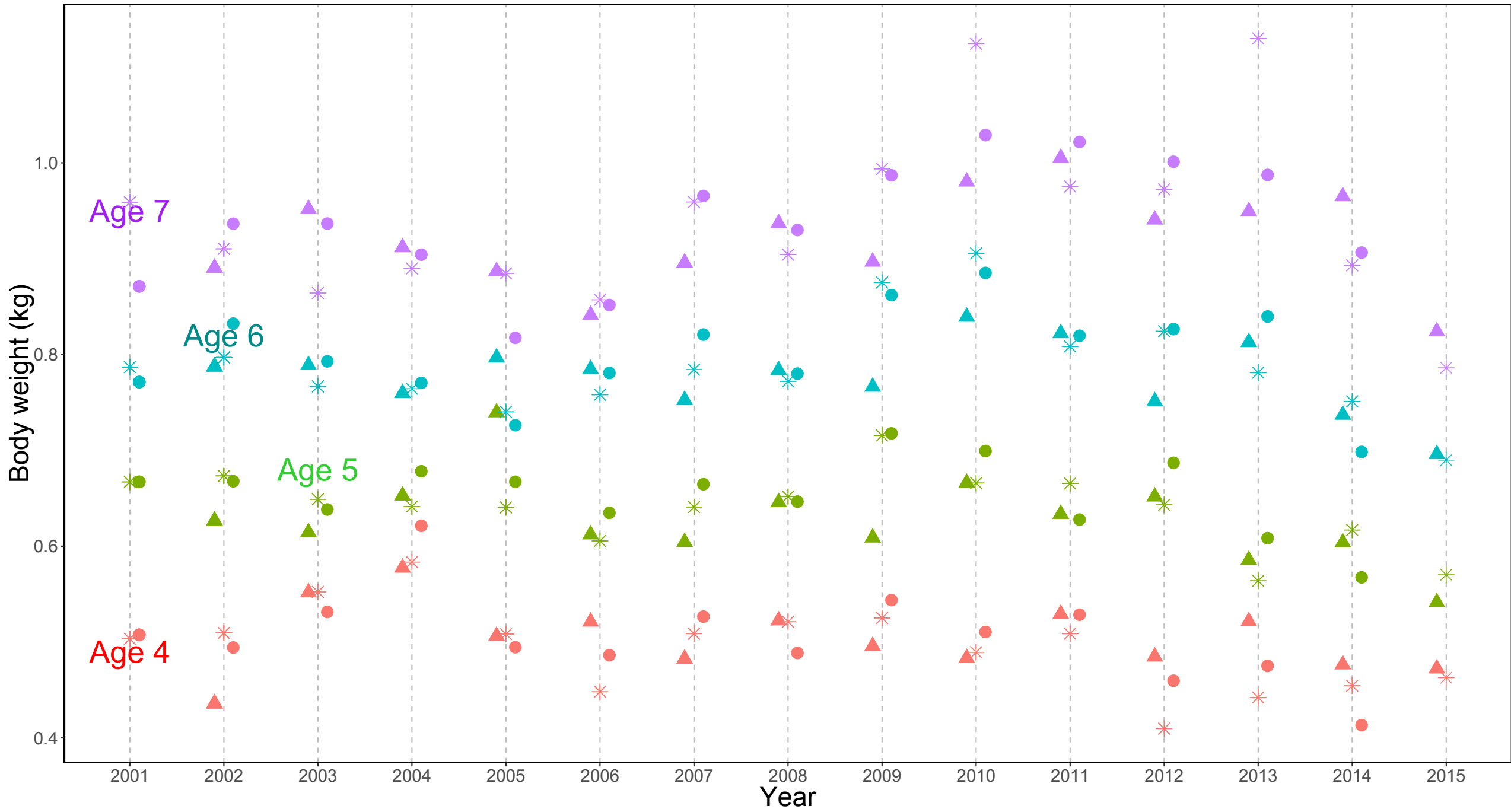
$$\sum_{y=2001}^{2014} \sum_{t=y}^{y+1} \sum_{a=3}^{10} \gamma_a \left( w'_{t,a} - \hat{w}_{t,a}^k \right)^2$$

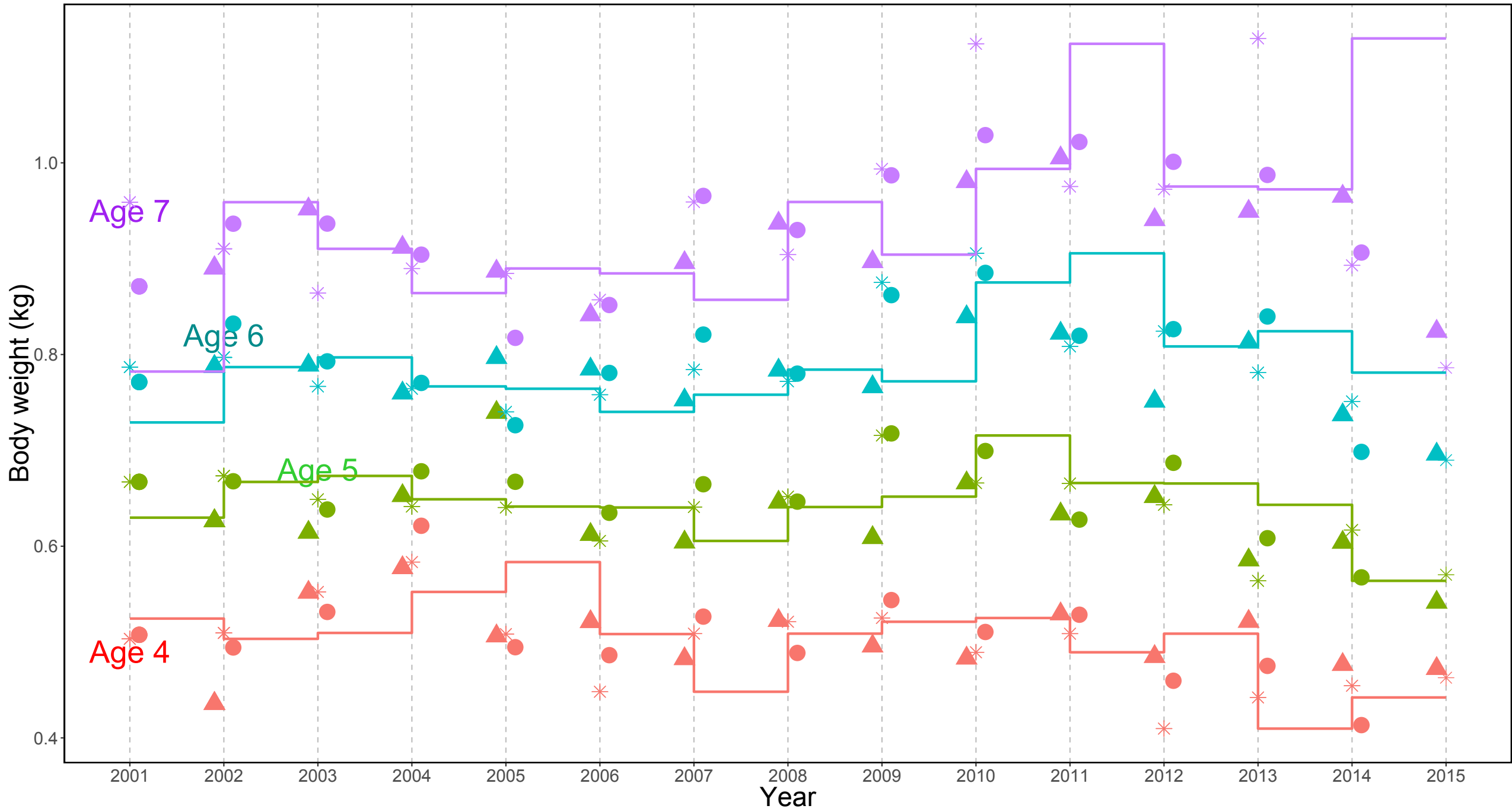


Results...

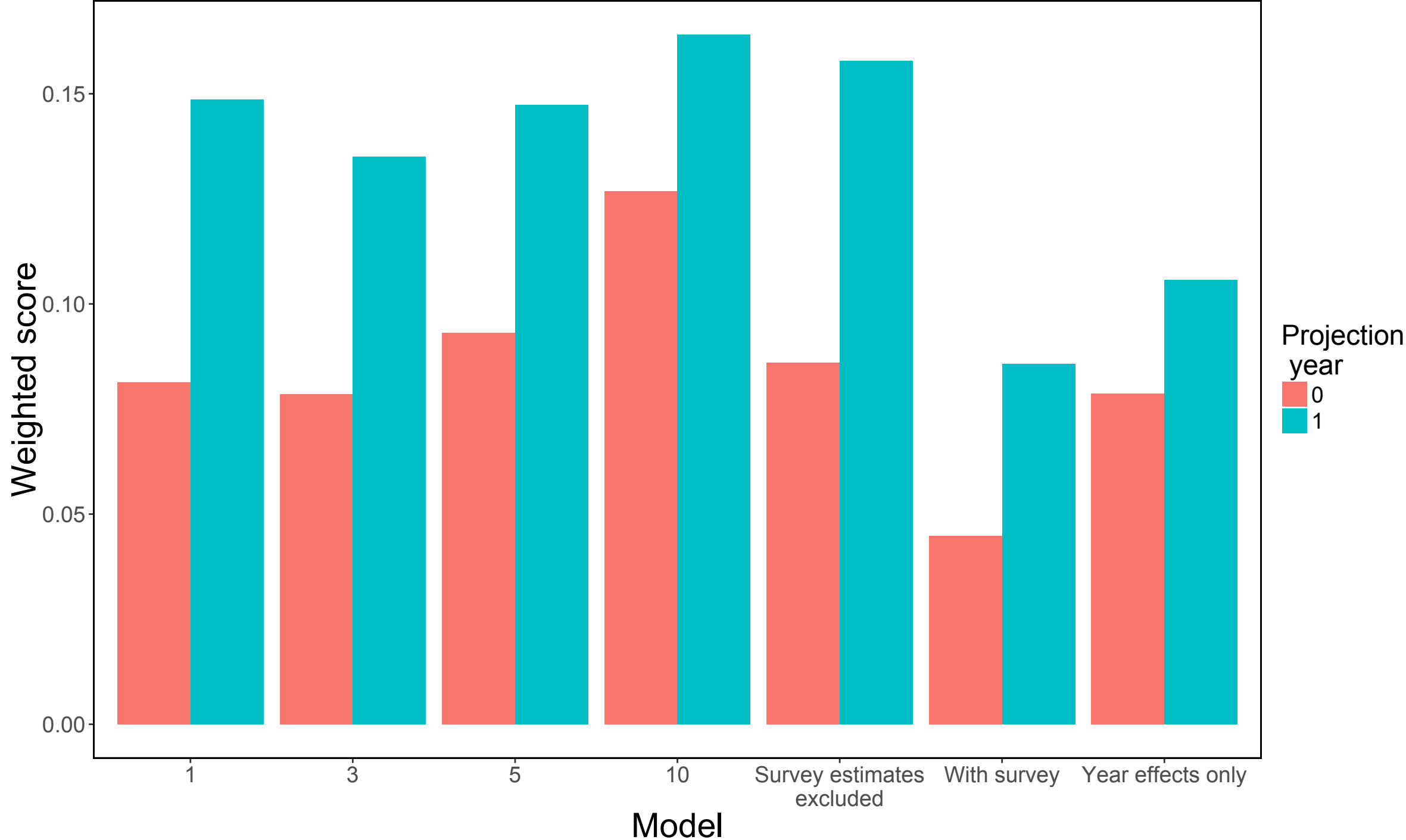








# Scores by method



# Alternative indices

- Biomass instead of numbers
- Acoustic trawl to 0.5 m instead of 3.0

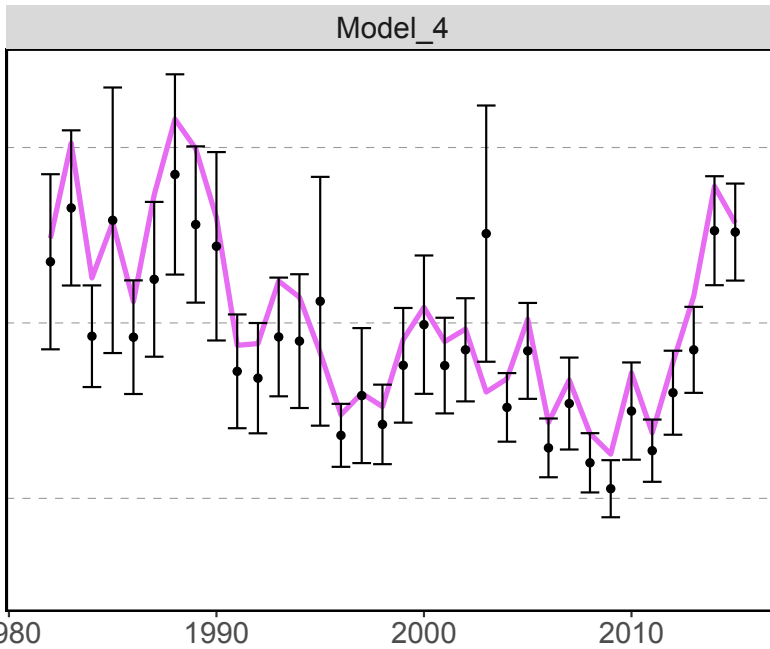
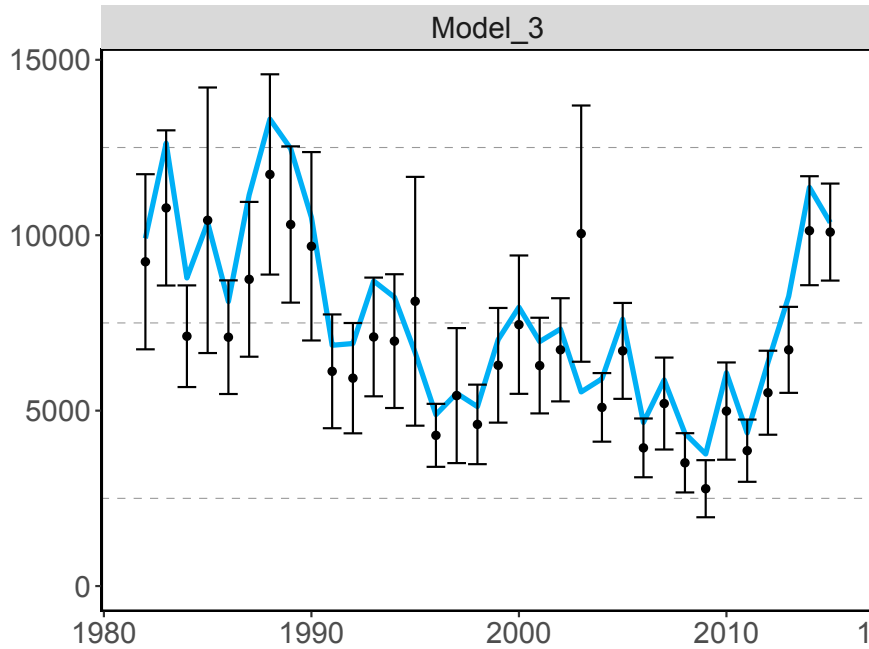
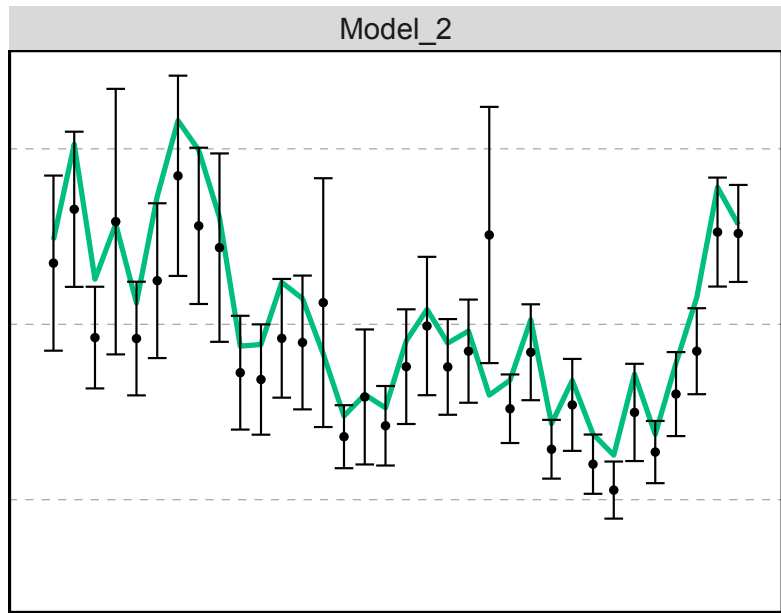
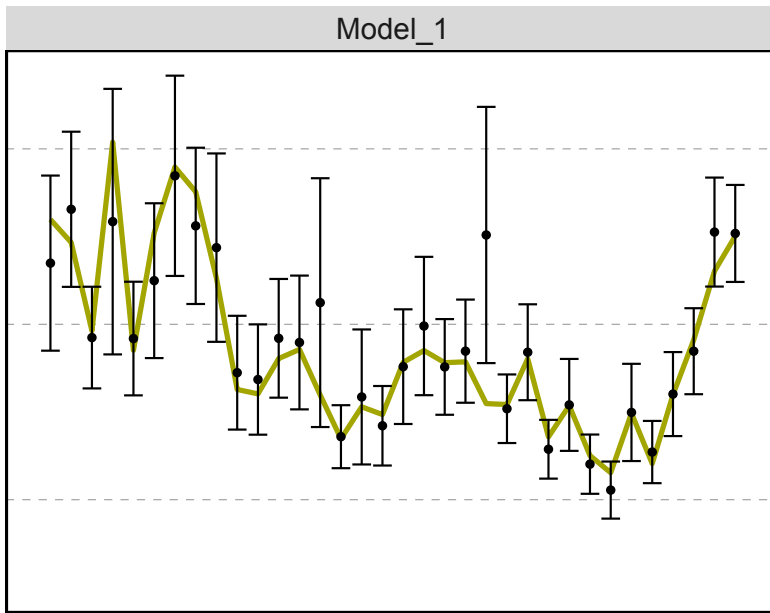
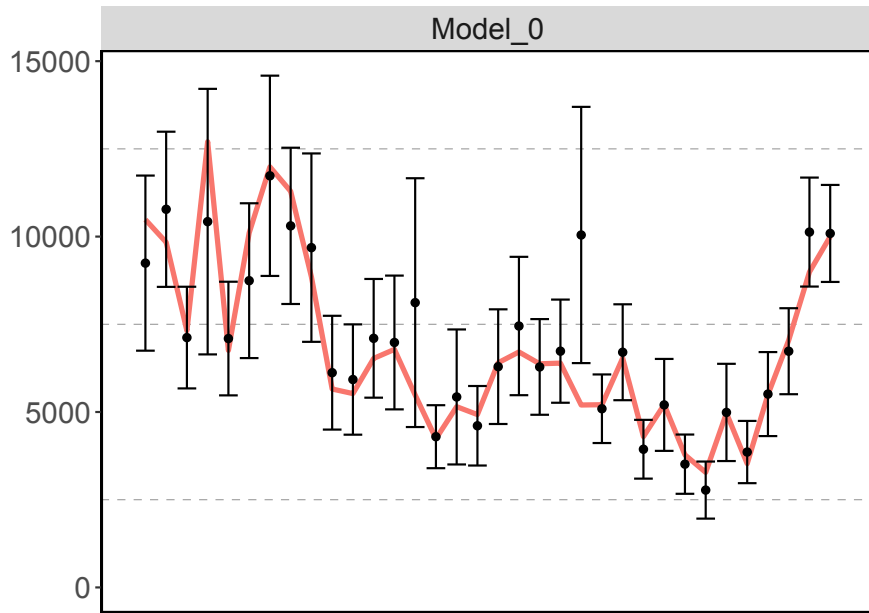


Model	Description
Model 0.0	The 2015 model used for management advice
Model 0	As Model 0.0 but using the design-based trawl survey estimates (and likelihoods) instead of the Kotwicky index
Model 1	As Model 0 but tuned to acoustic survey biomass instead of AT numbers
Model 2	As Model 0 but tuned to bottom trawl survey biomass instead of bottom trawl survey numbers
Model 3	As Model 0 but tuned to both acoustic and bottom trawl survey biomass estimates instead of numbers
Model 4	As Model 3 but using the acoustic trawl survey data covering the water column extended to 0.5 m from bottom instead of the traditional 3 m.

# Following figures show fits...

- Whether that form of index is included or not...

Bottom trawl survey numbers



- Fit to abundance Bottom trawl survey data

1980

1990

2000

2010

1980

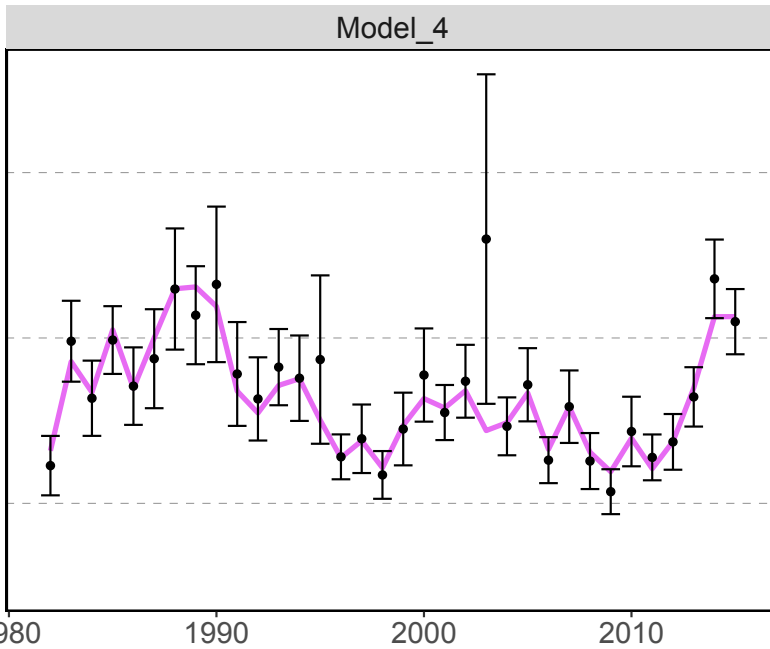
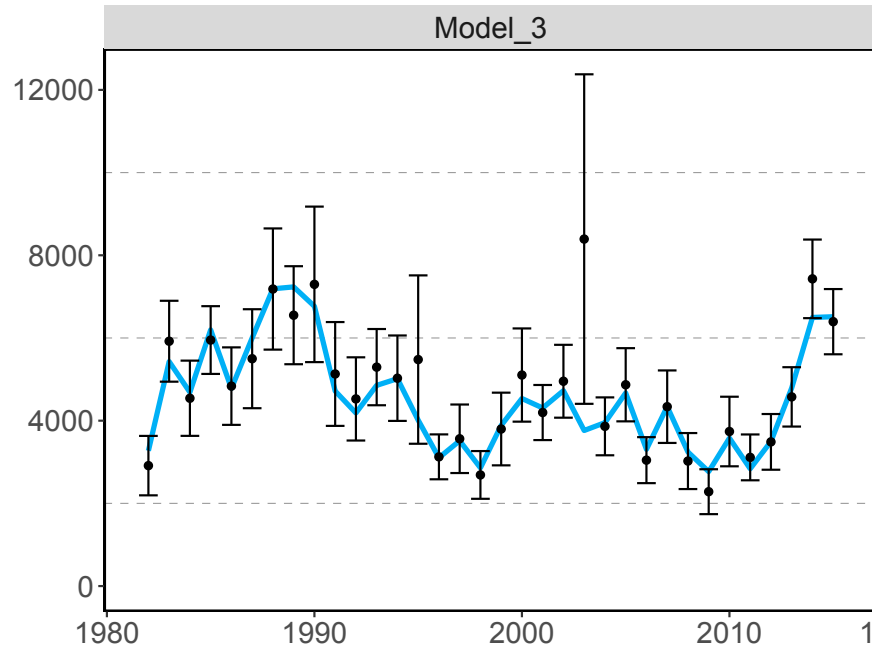
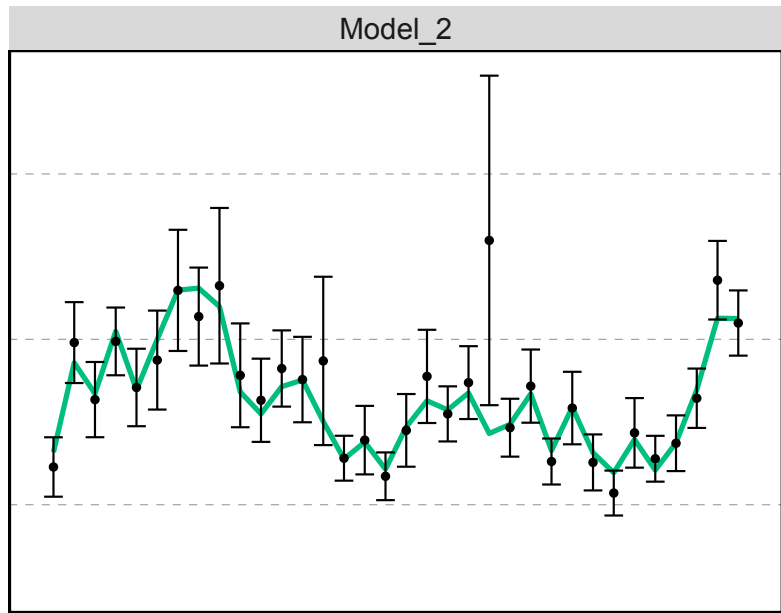
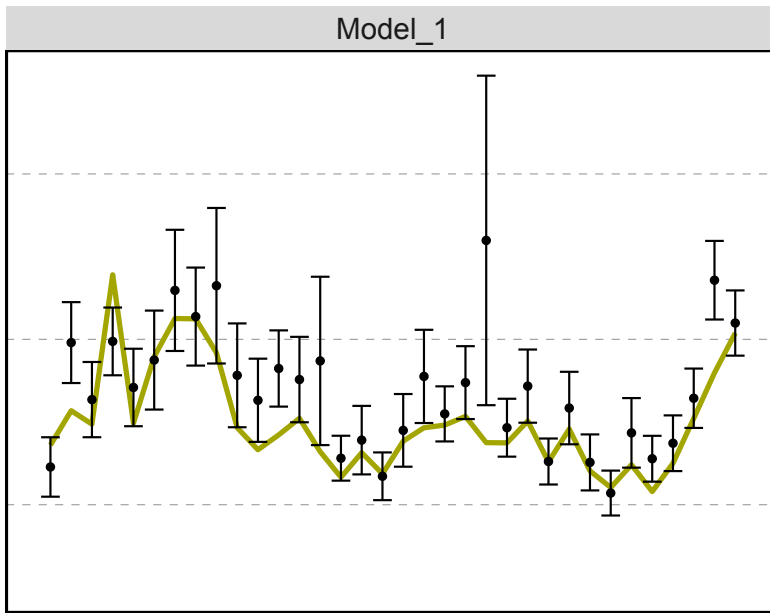
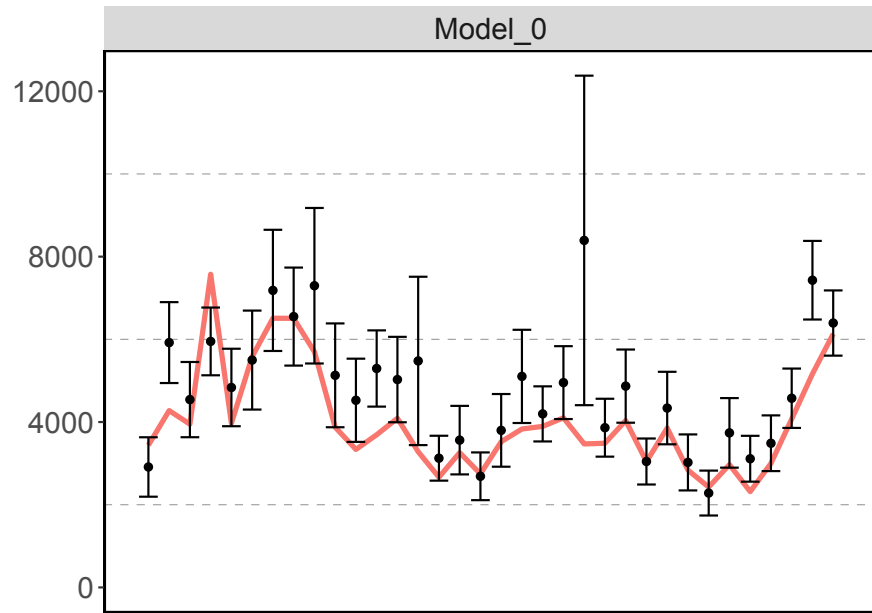
1990

2000

2010

Year

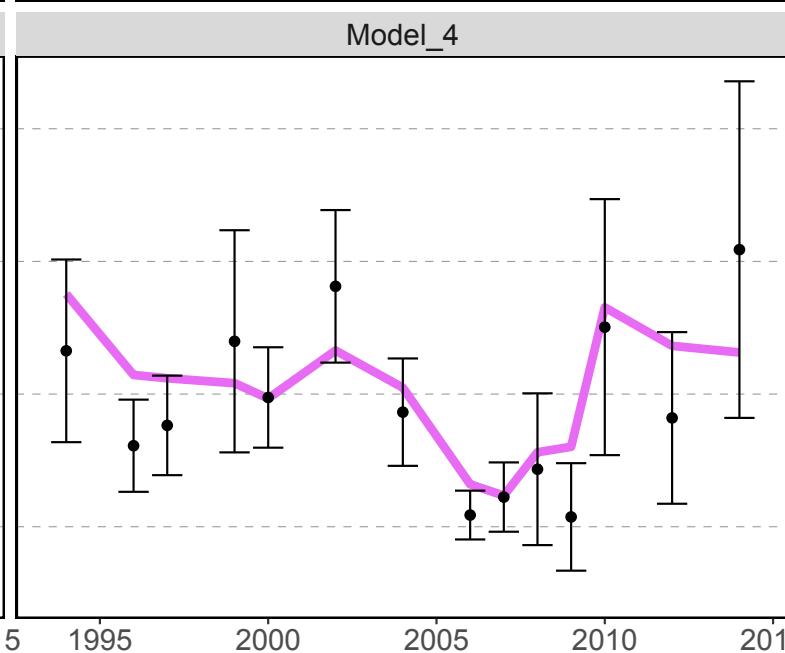
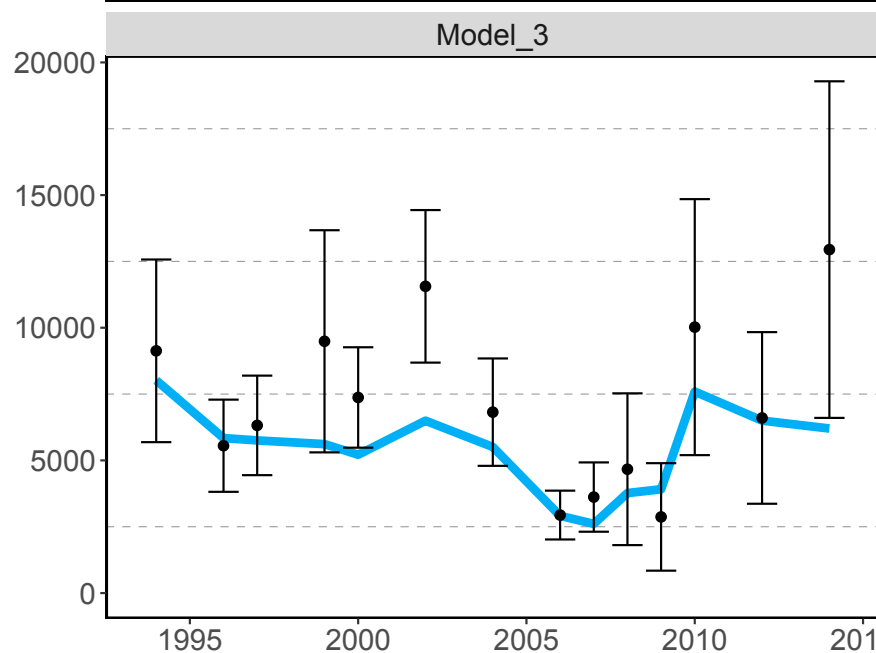
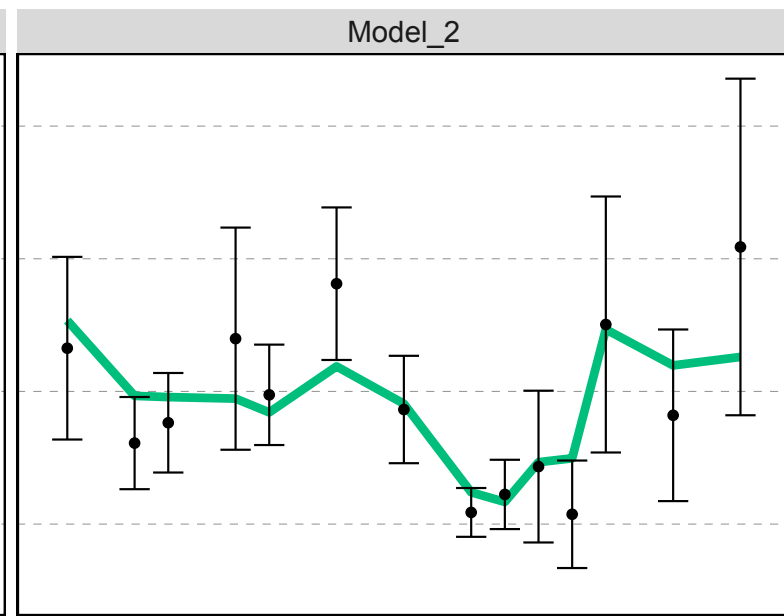
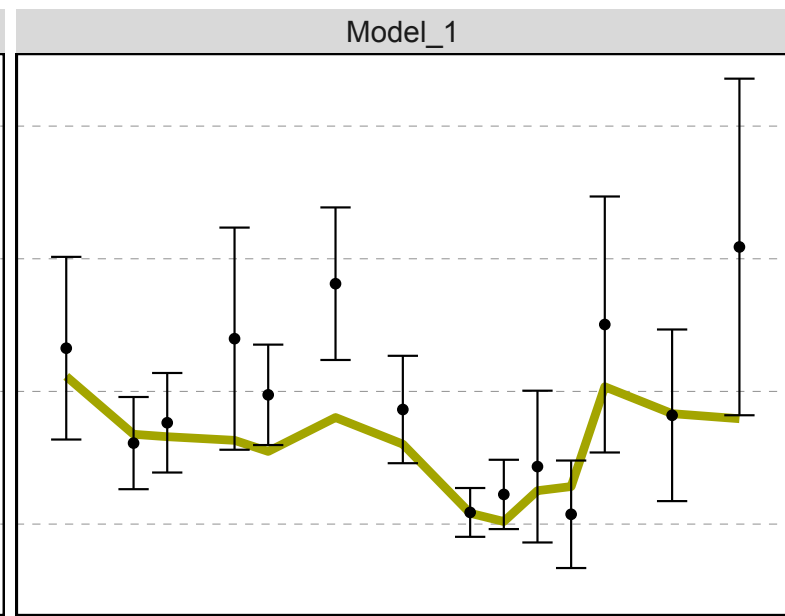
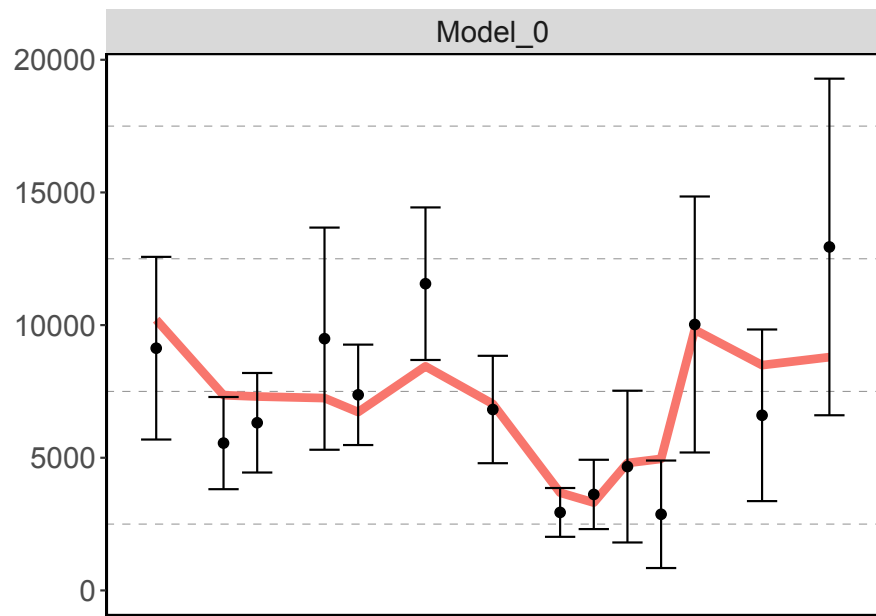
Bottom trawl survey biomass



- Fit to biomass
- Bottom trawl survey data

Year

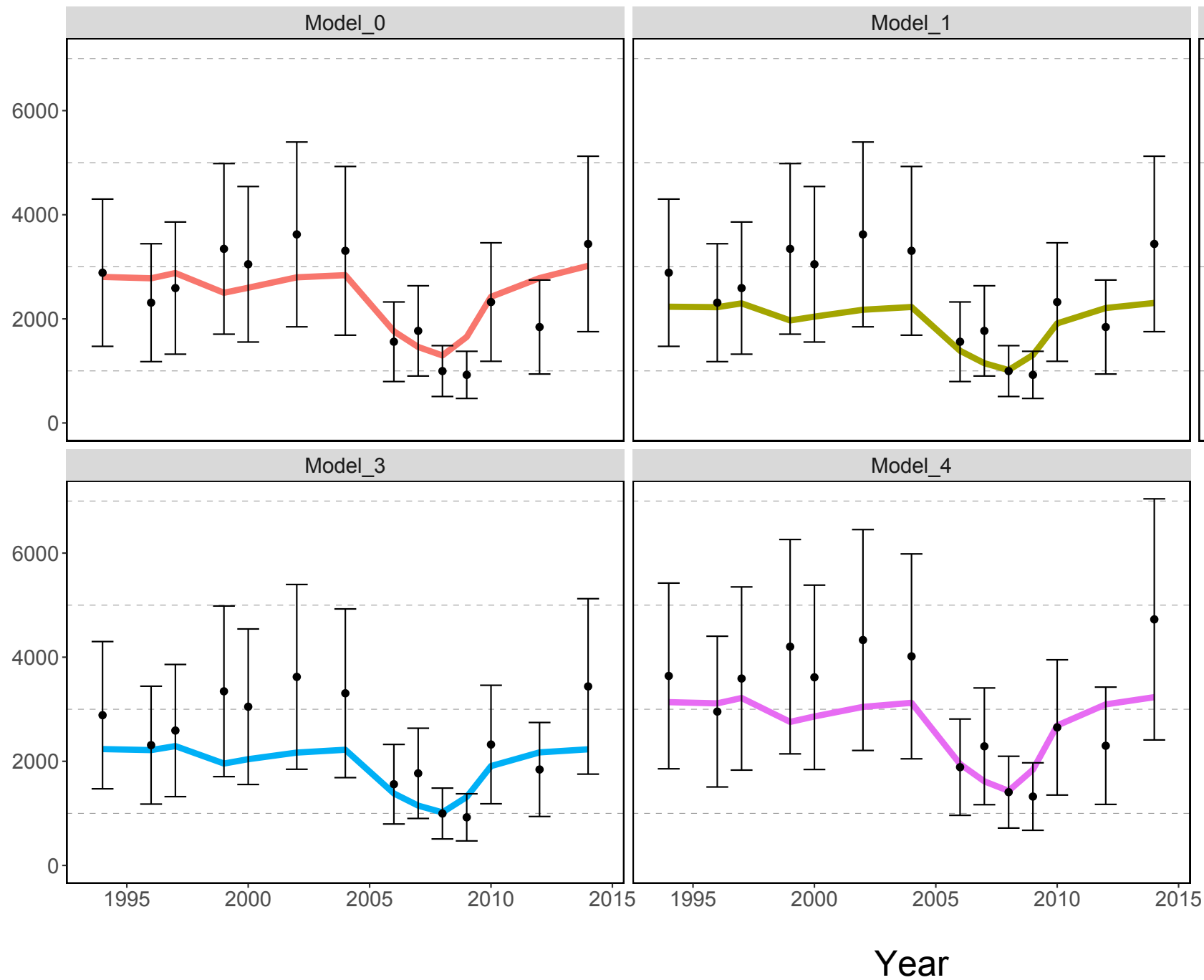
Acoustic trawl survey numbers



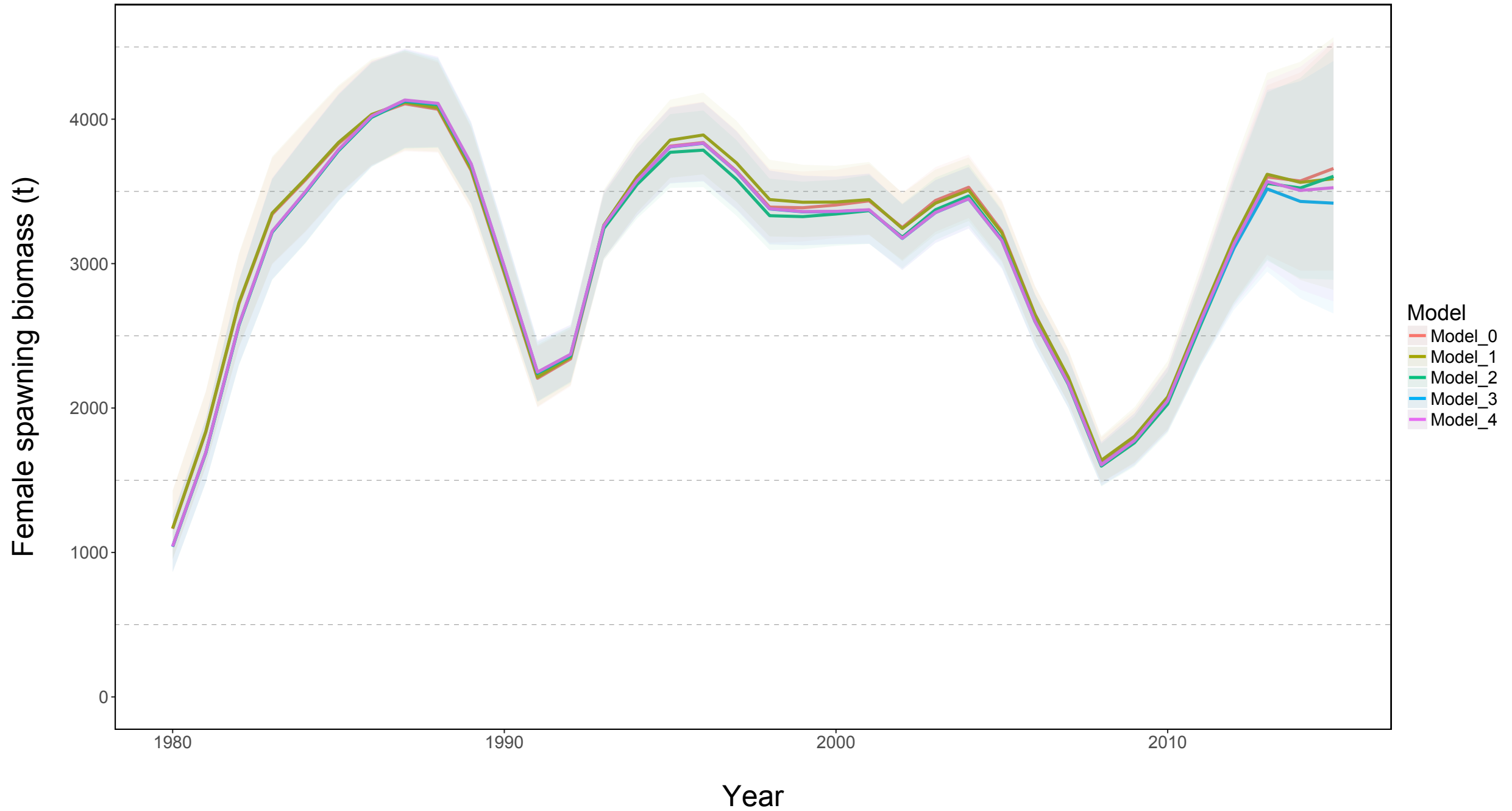
- Fit to abundance
- Acoustic trawl data

Year

Acoustic trawl survey biomass



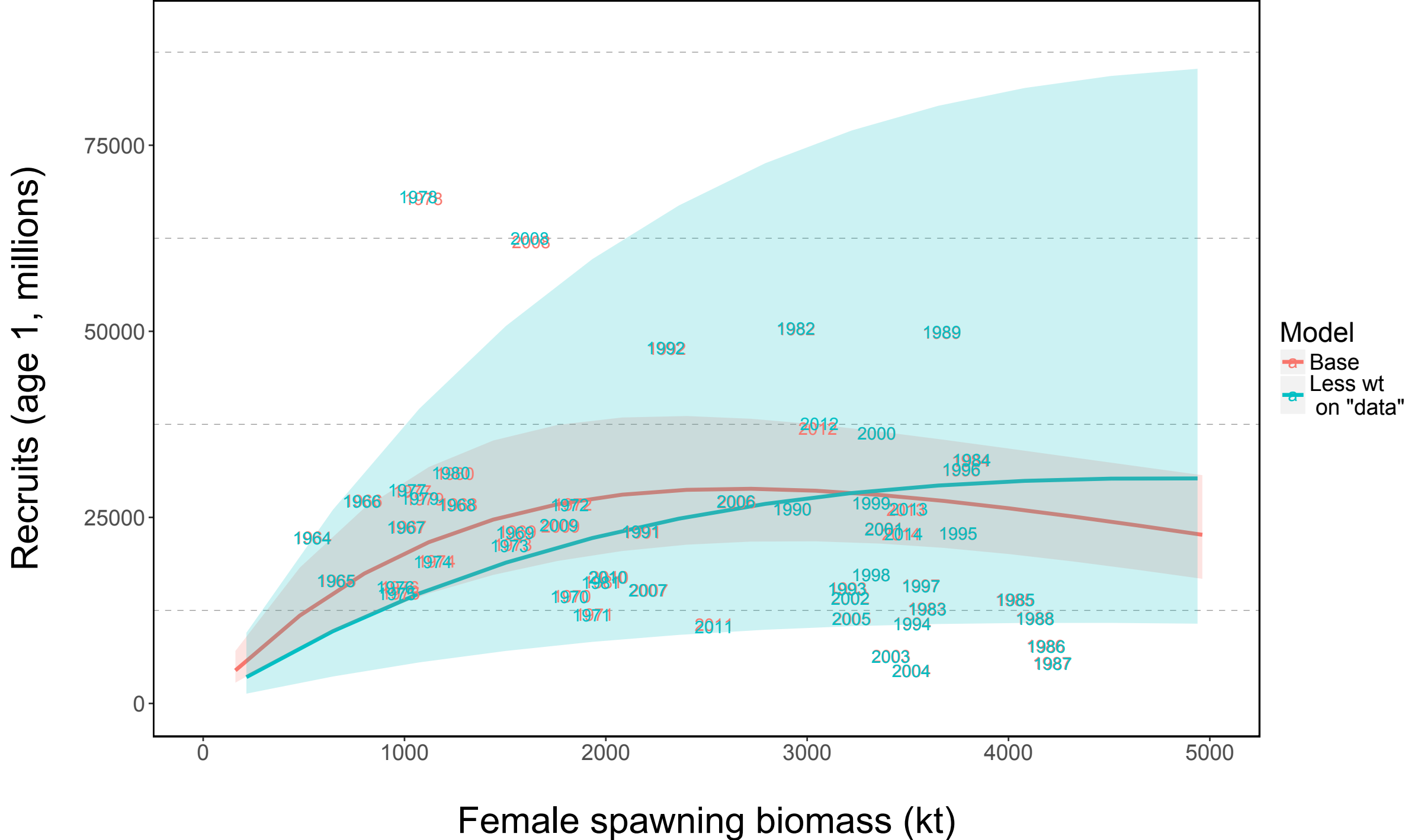
• Fit to biomass  
Acoustic trawl data



# Components of variability in PDF of $F_{msy}$

- Set up models for fixed mean weights and selectivity
- Alternatives for SRR





Recruits (age 1, millions)

75000  
50000  
25000  
0

0

1000

2000

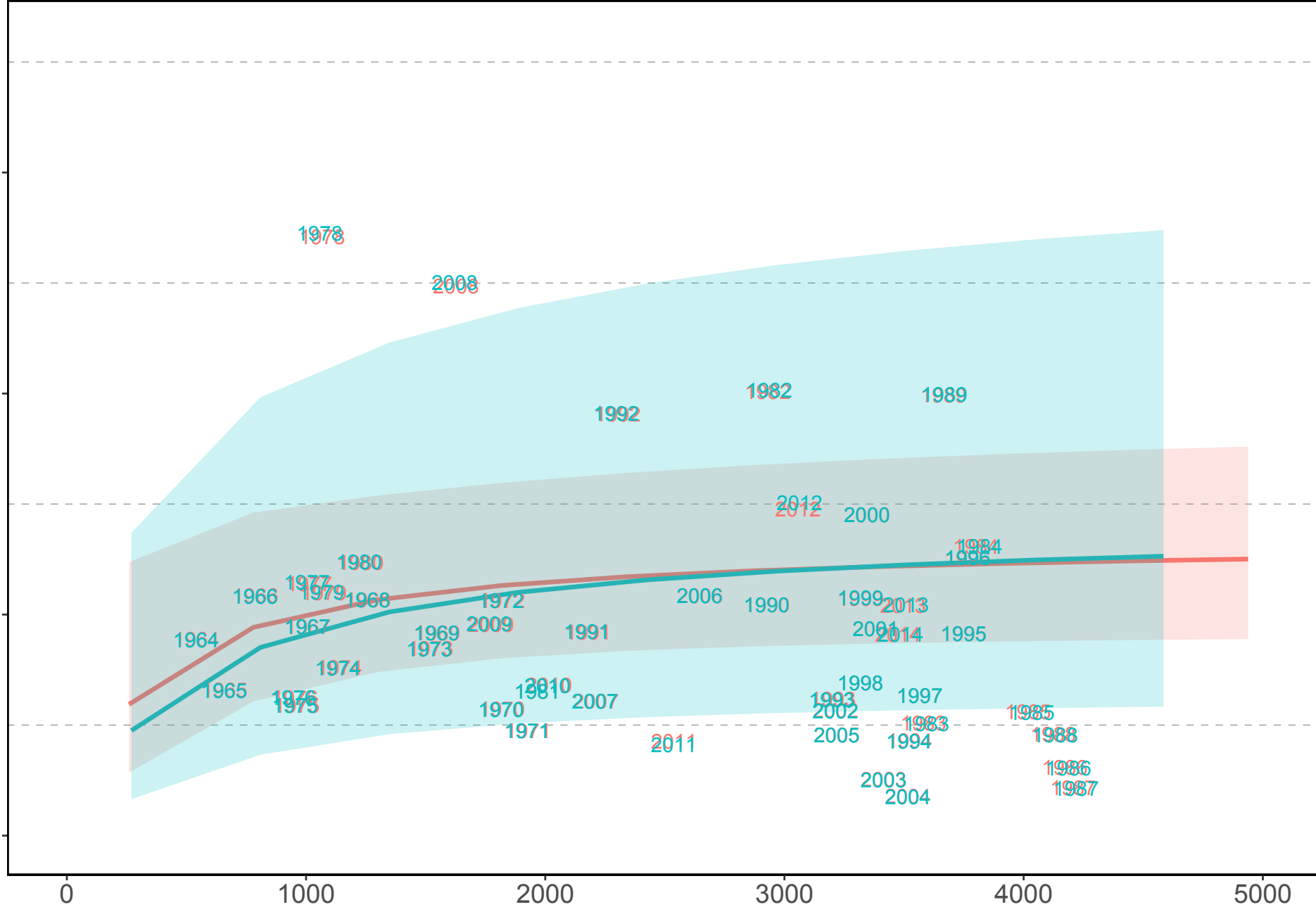
3000

4000

5000

Female spawning biomass (kt)

Model  
BevHolt  
Less wt  
on "data"





Exploratory profiles of  
impacts of wt-age and  
selectivity-age

