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. 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

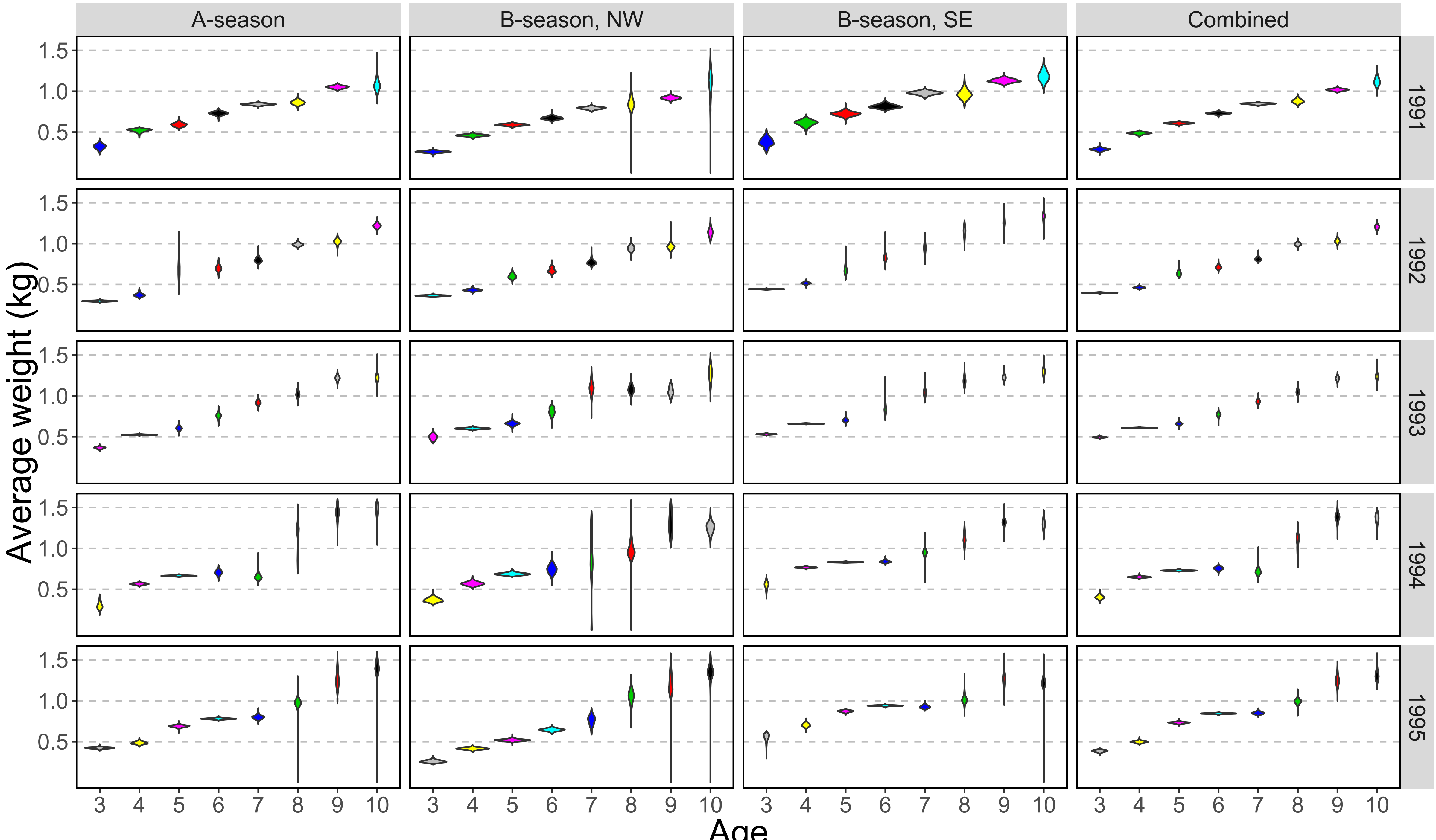
Data recompilation

- 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

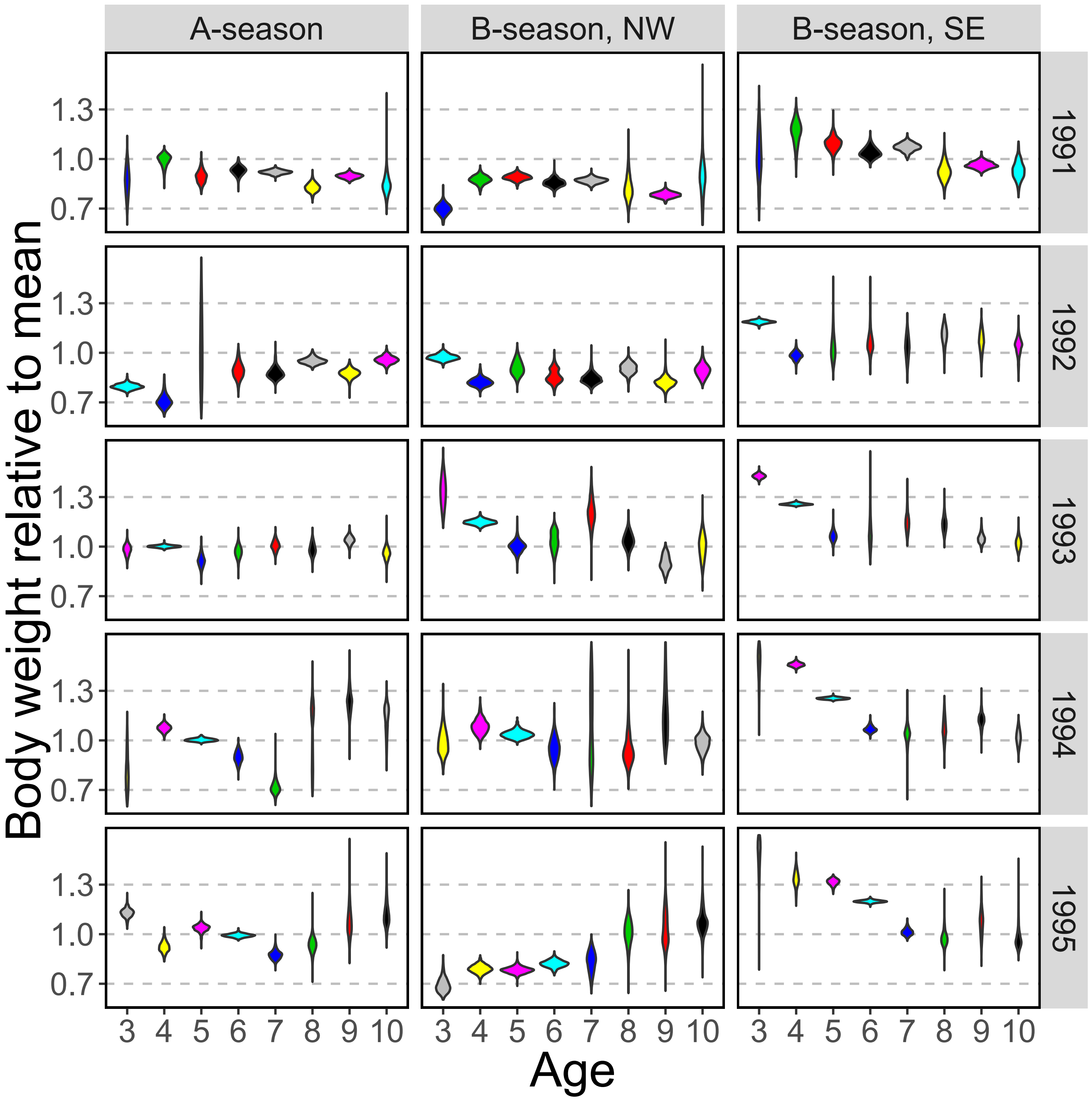
Appendix 1

- Example weights-at-age output


A-season
B-season, NW
B-season, SE
Combined
1991
1992
1993
1994
1995
Average weight (kg)
0.5
1.0
1.5
3
4
5
6
7
8
9
10
Age

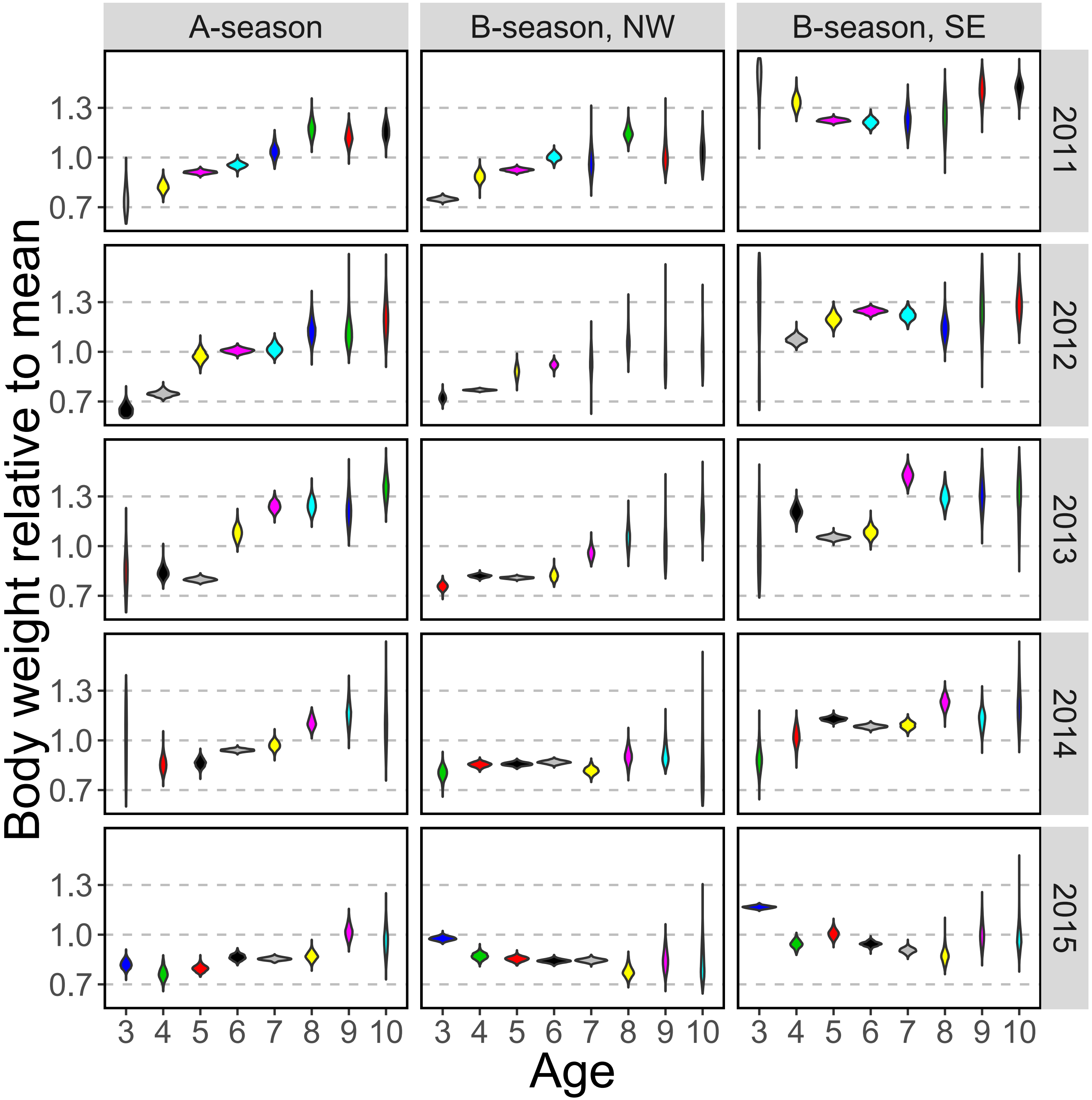
Normalized

- By strata



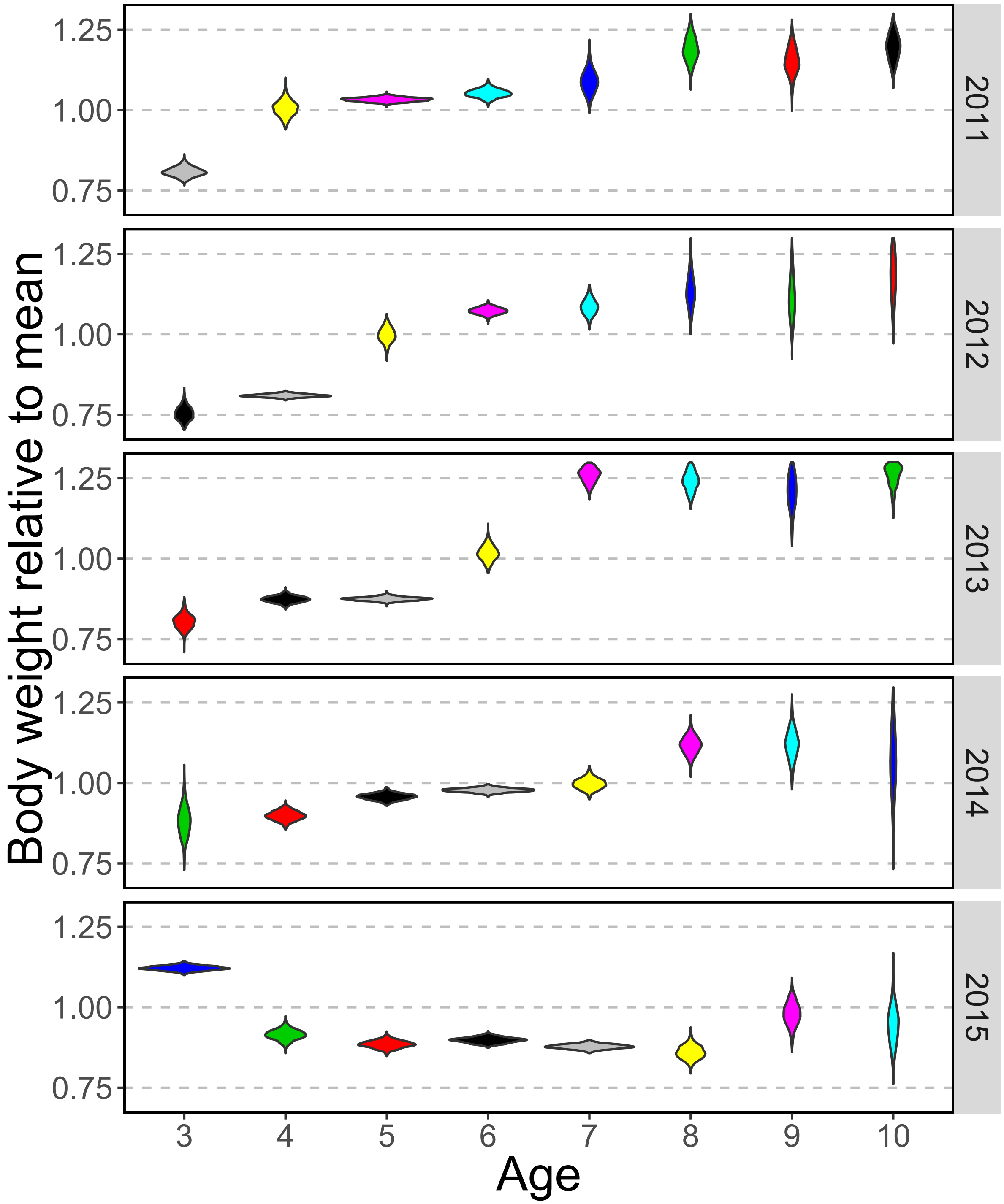
Normalized

- 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	[illegible]	
2008	[illegible]	[illegible]	

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

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

Growth:
predicting mean fishery body weight-at-age

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

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

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

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

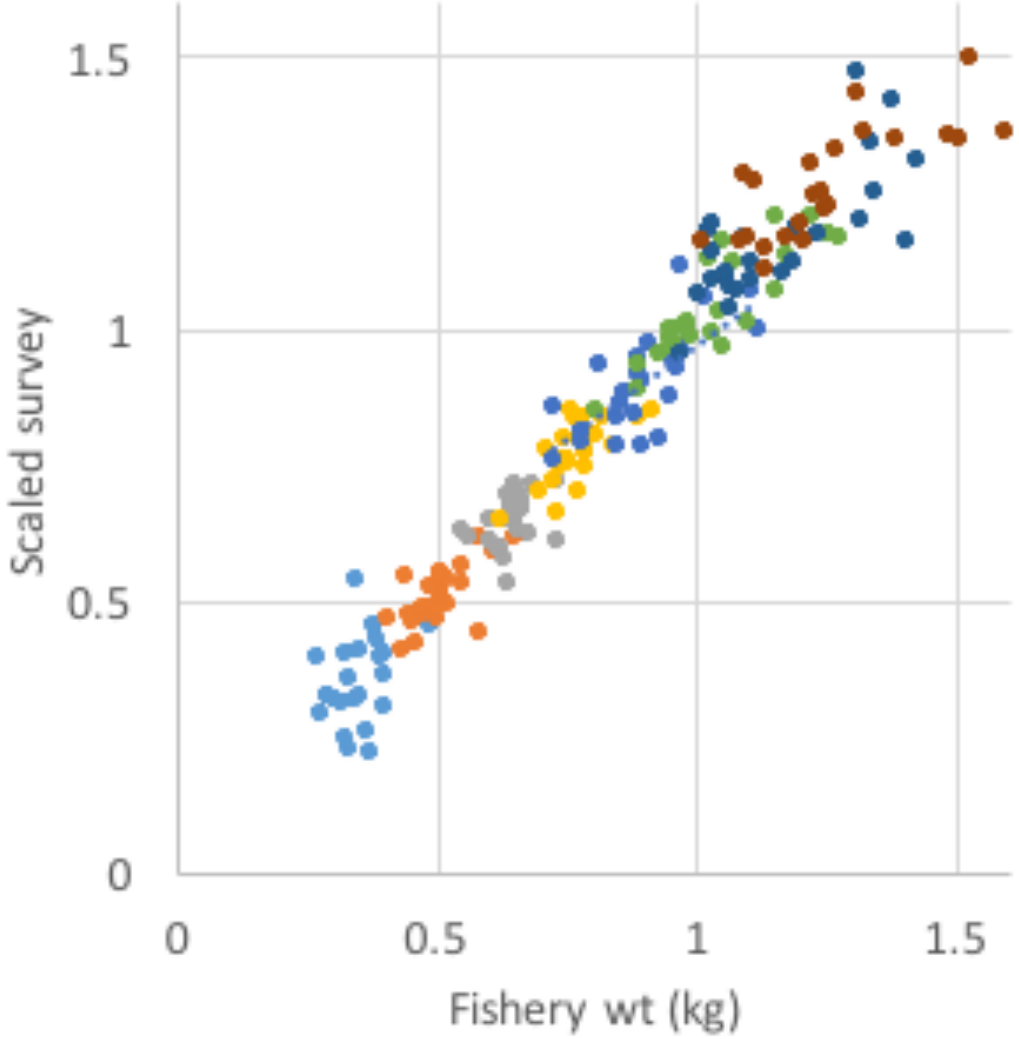
Method	Description
Means	Mean fishery weights-at-age of most recent *n* years of data (*n* =1, 3, 5, and 10)
Year and Cohort	Year and cohort effect model
Year and Cohort with scaled survey data	Include scaled survey weights-at-age ($\hat{w}_{i,j}^{k=2} = \lambda_j w_{i,j}^{survey}$)
Year effect only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

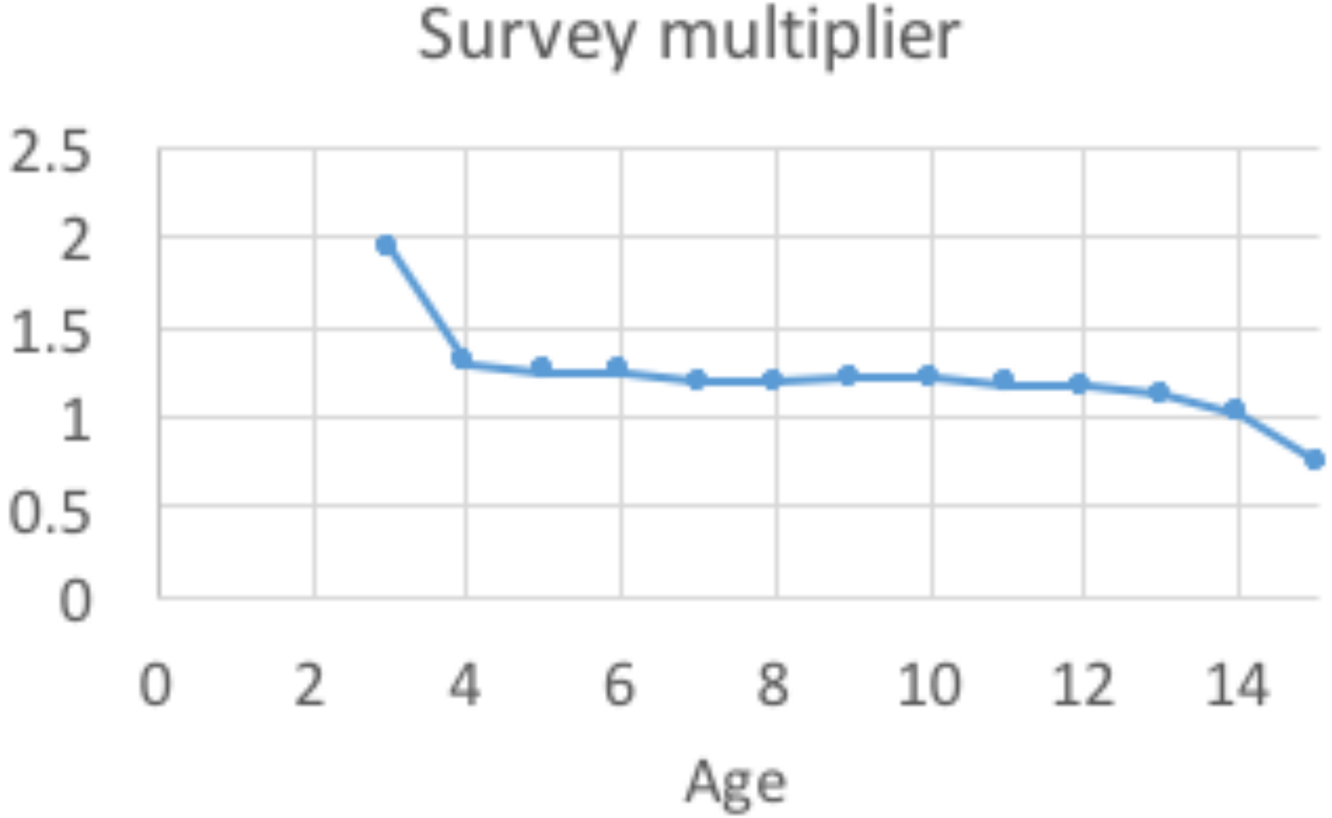
Adding current year survey data to predictions

Including survey data

- To help w/ predictions

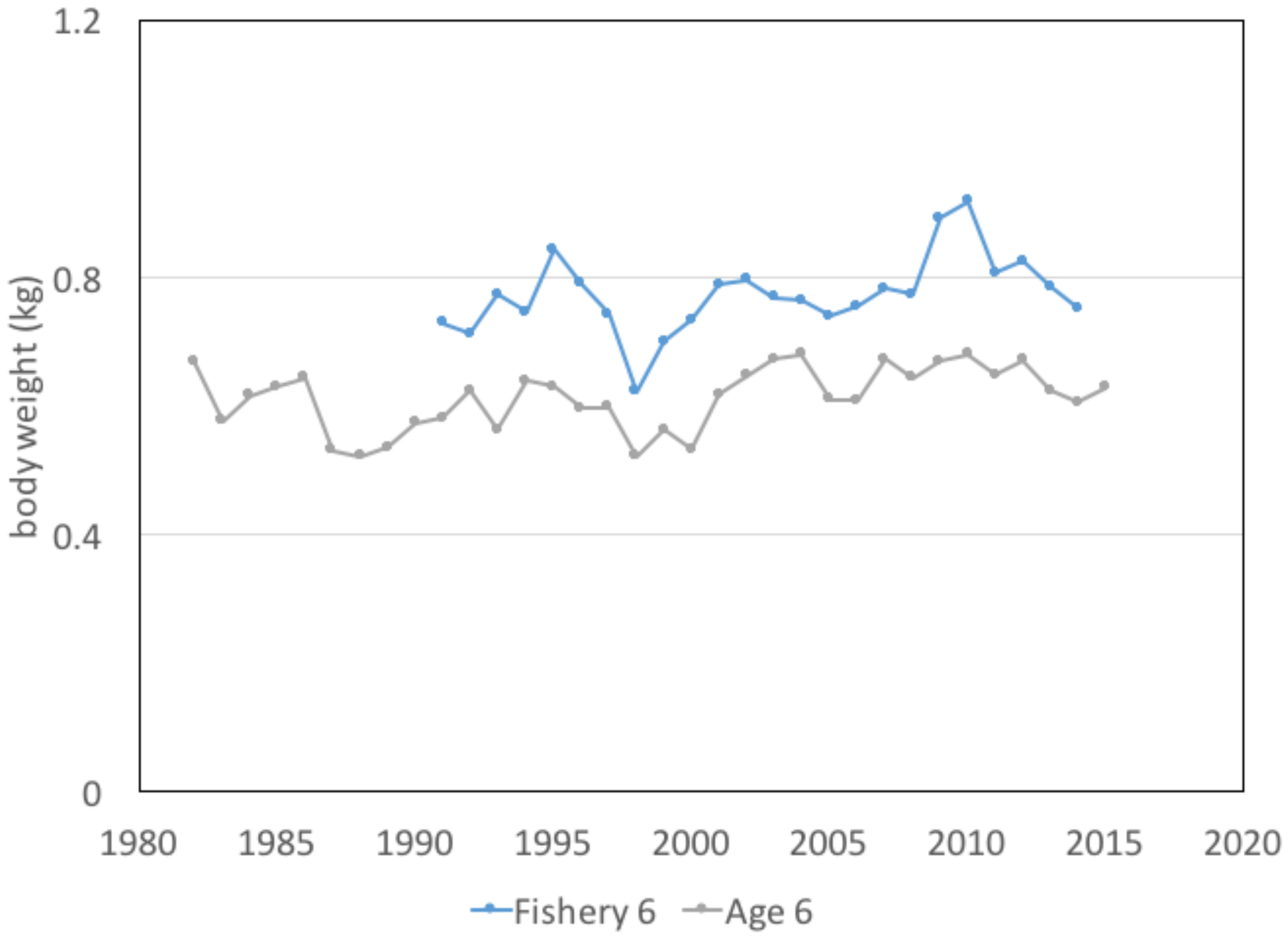
$$\hat{w}_{i,j}^{k=2} = \lambda_j w_{i,j}^{survey}$$





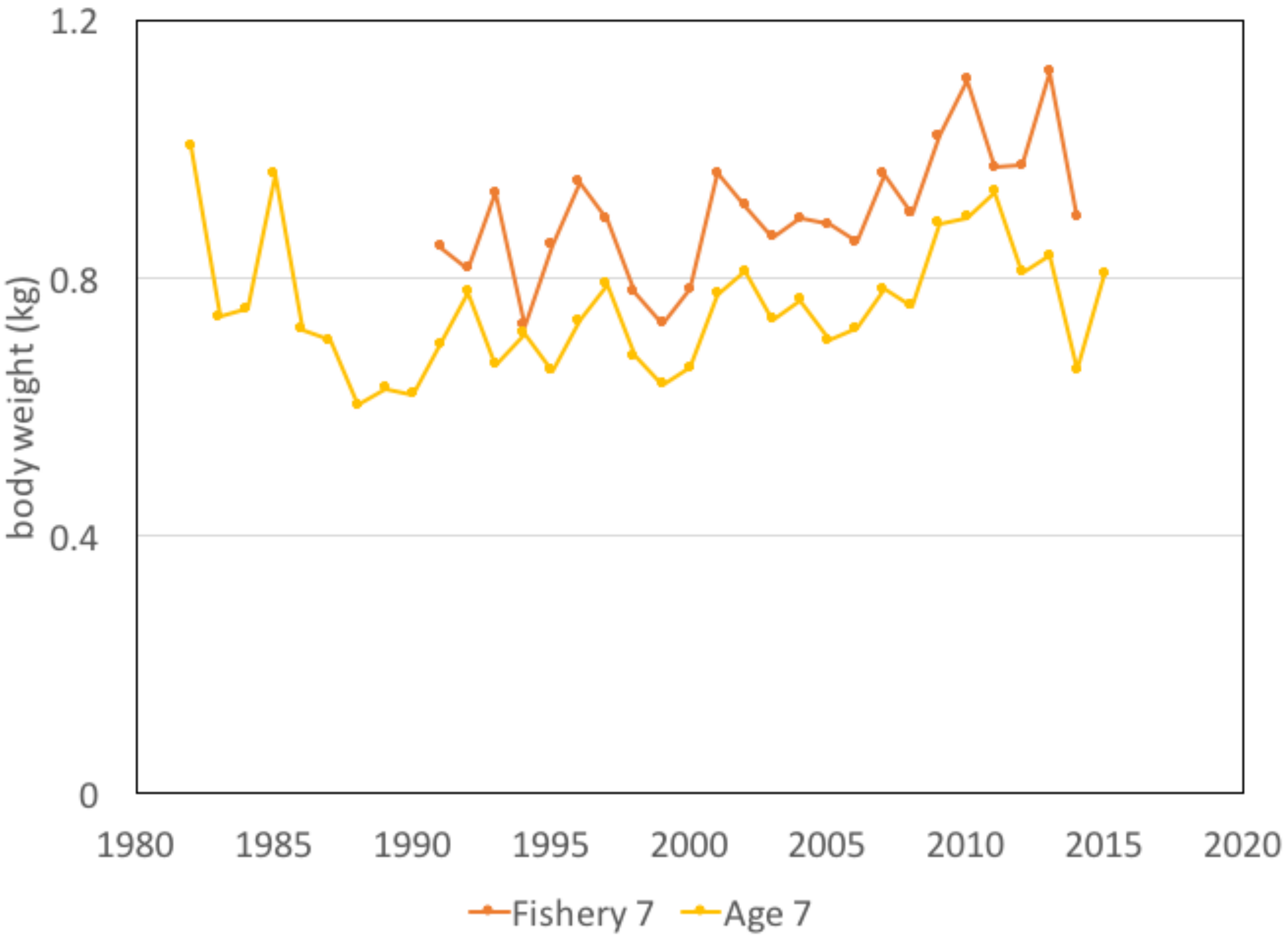
Age 6

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

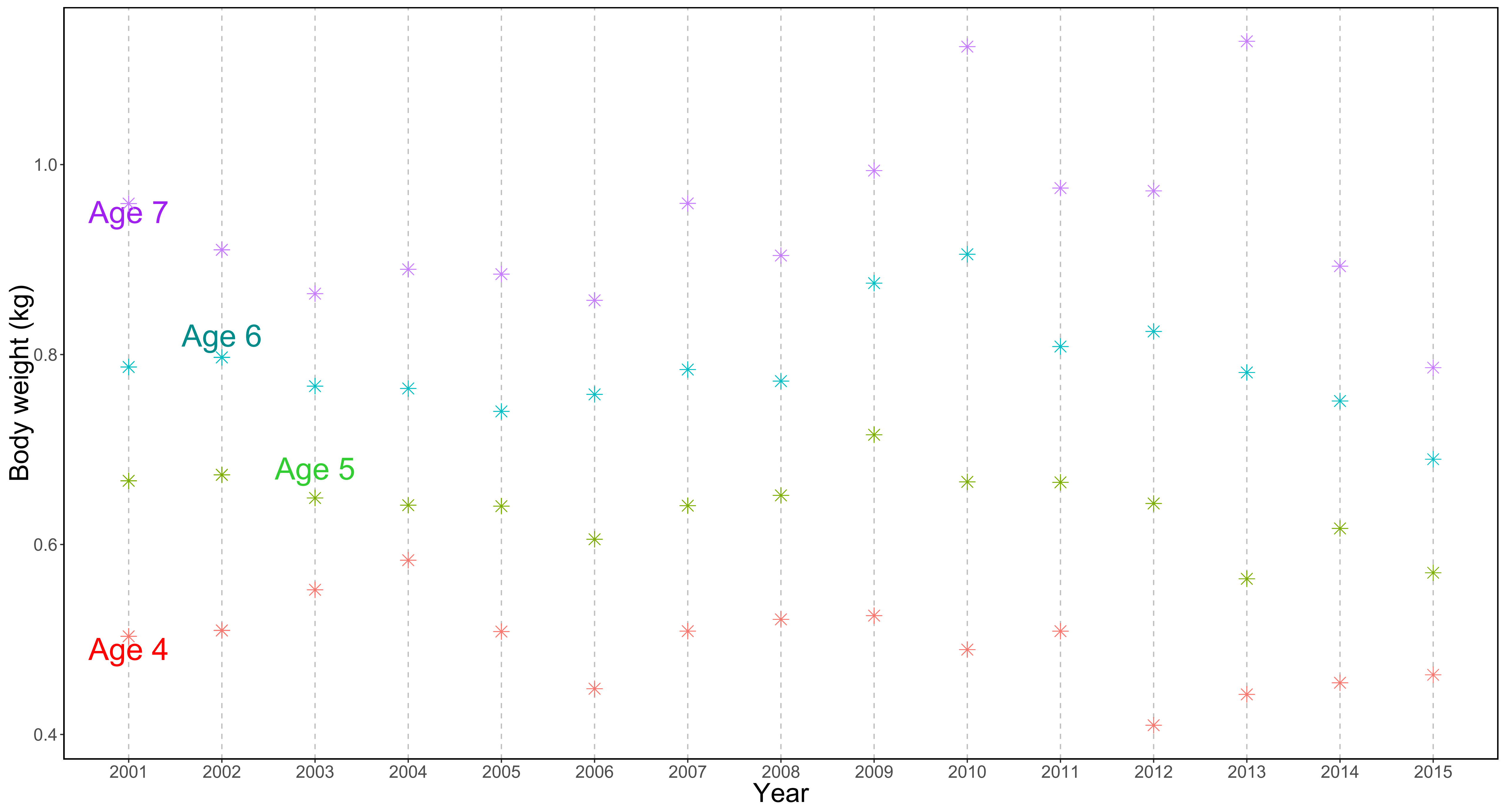
  Tested method for predicting year 2000 and 2001 mean body weight-at-ages:

  Projection year 0 and projection year 1
- Calculated scores
  - Weighted by importance:

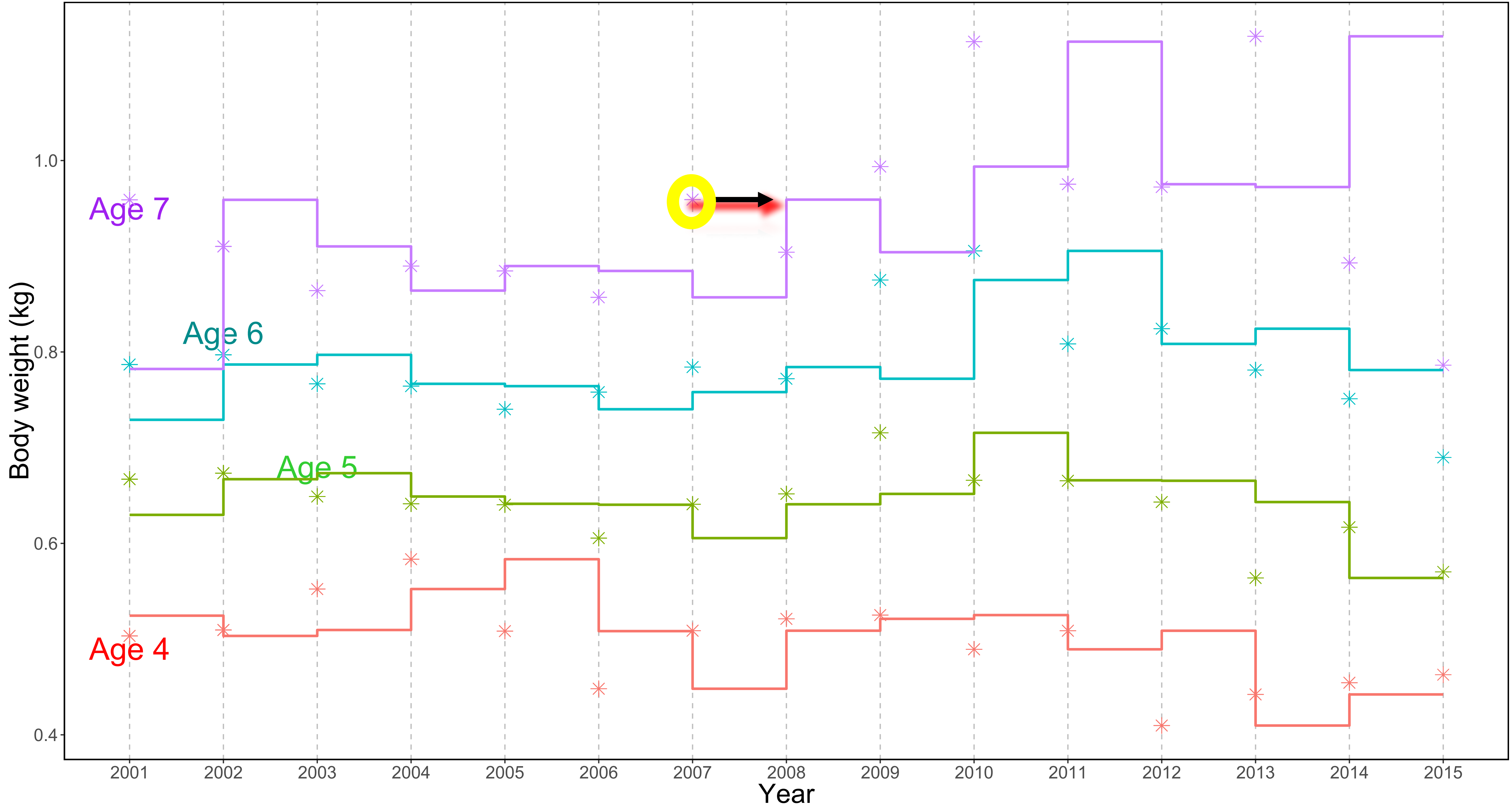
$$\gamma_a = \frac{\bar{N}_a s_a \bar{w}_a}{\sum \bar{N}_a s_a \bar{w}_a}$$

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

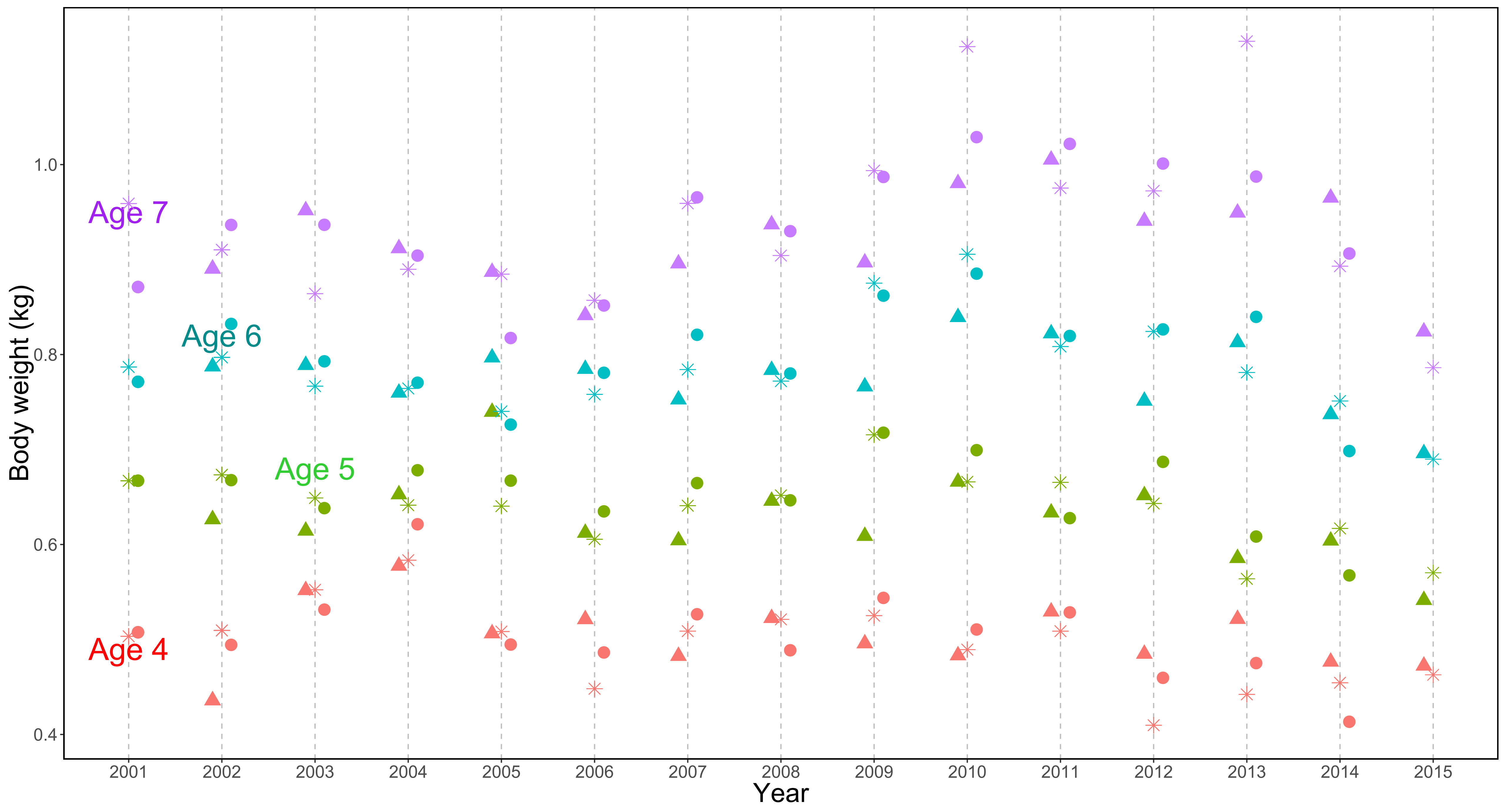
Results…

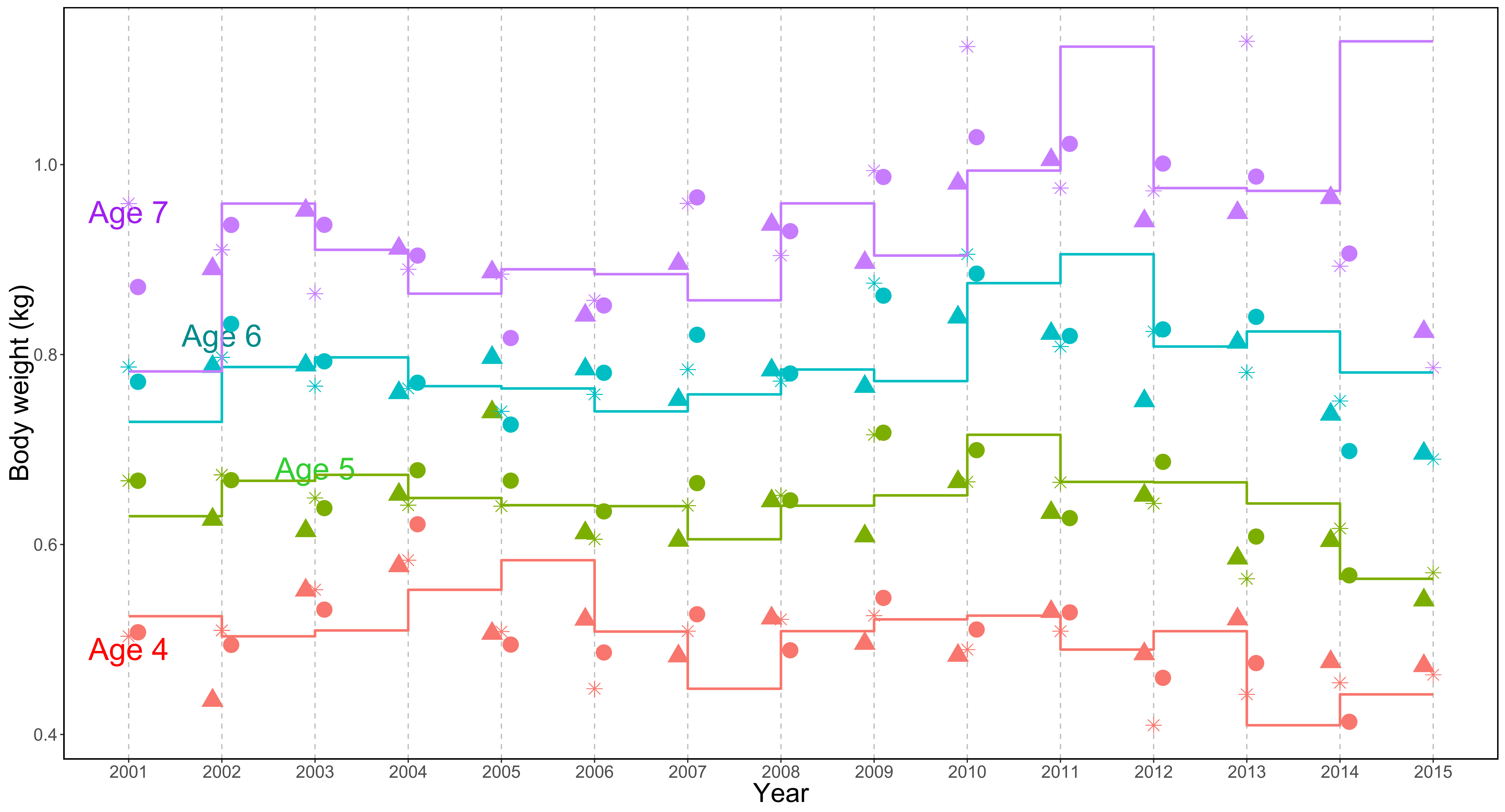


Age 7
Age 6
Age 5
Age 4
Body weight (kg)
1.0
0.8
0.6
0.4
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Year



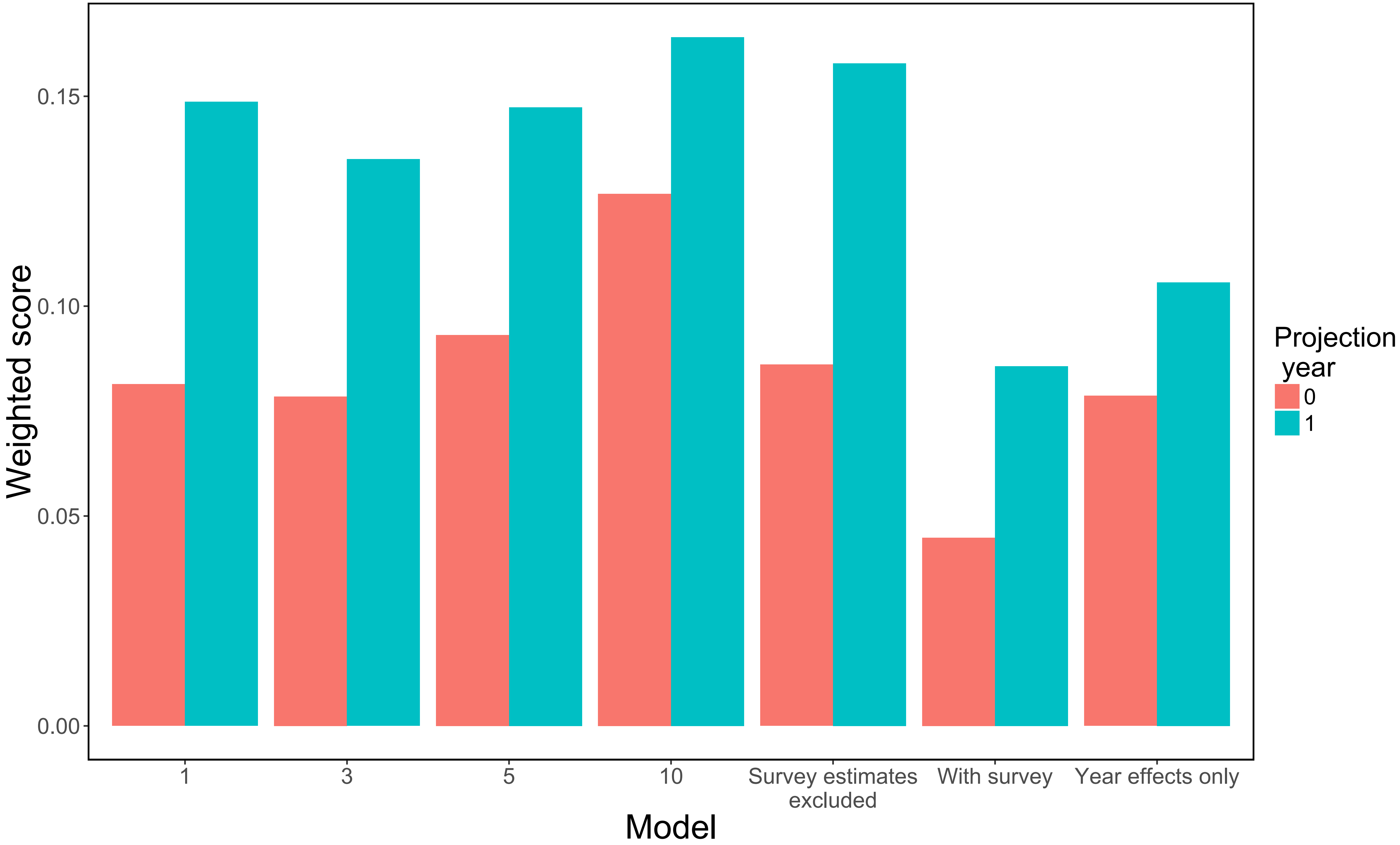
Age 7
Age 6
Age 5
Age 4
Body weight (kg)
1.0
0.8
0.6
0.4
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Year


Age 7
Age 6
Age 5
Age 4
Body weight (kg)
1.0
0.8
0.6
0.4
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Year



Age 7
Age 6
Age 5
Age 4
1.0
0.8
0.6
0.4
Body weight (kg)
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
Year

Scores by method



Weighted score
0.00
0.05
0.10
0.15
1
3
5
10
Survey estimates excluded
With survey
Year effects only
Model
Projection year
0
1

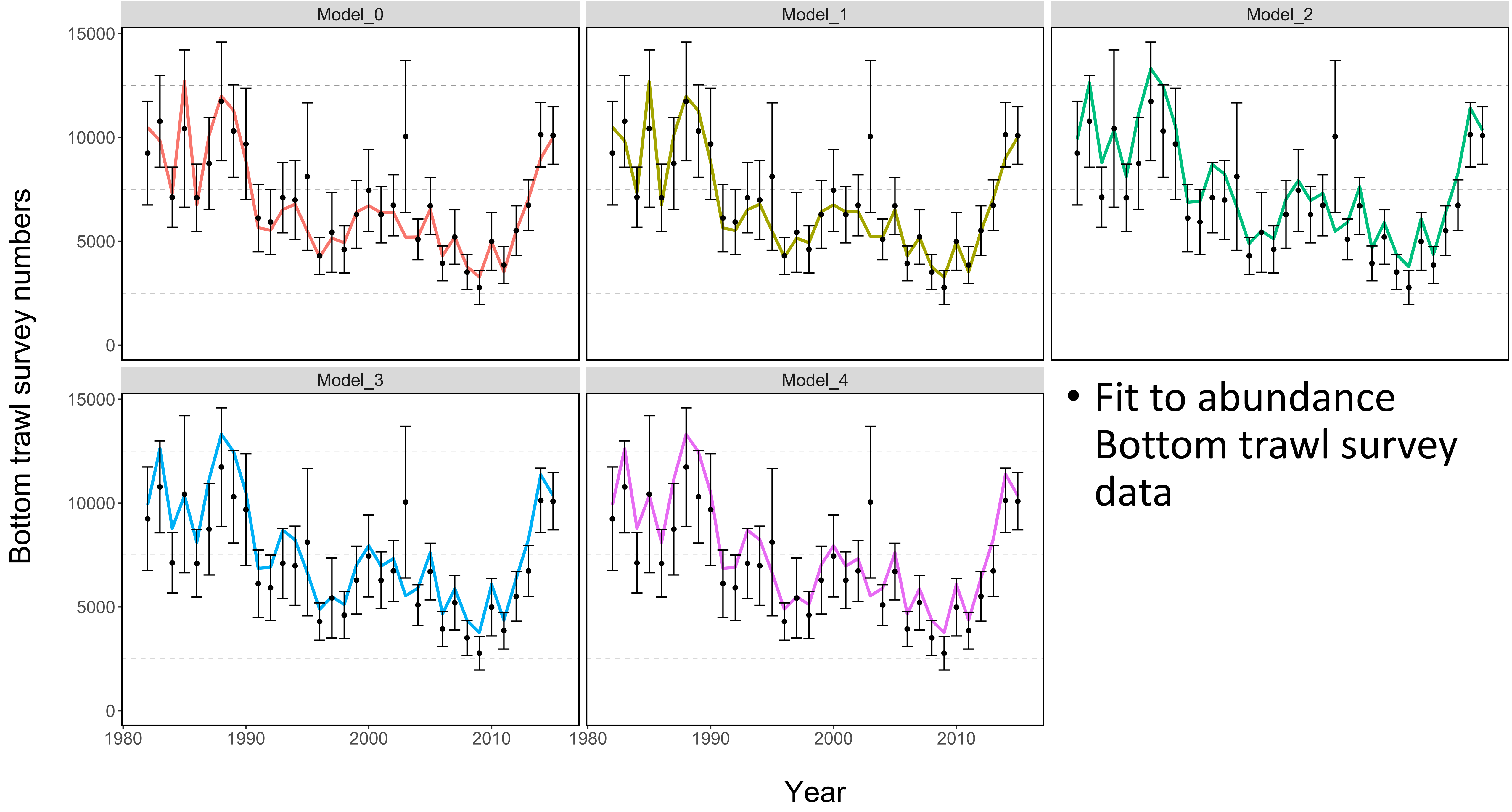
Alternative indices

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

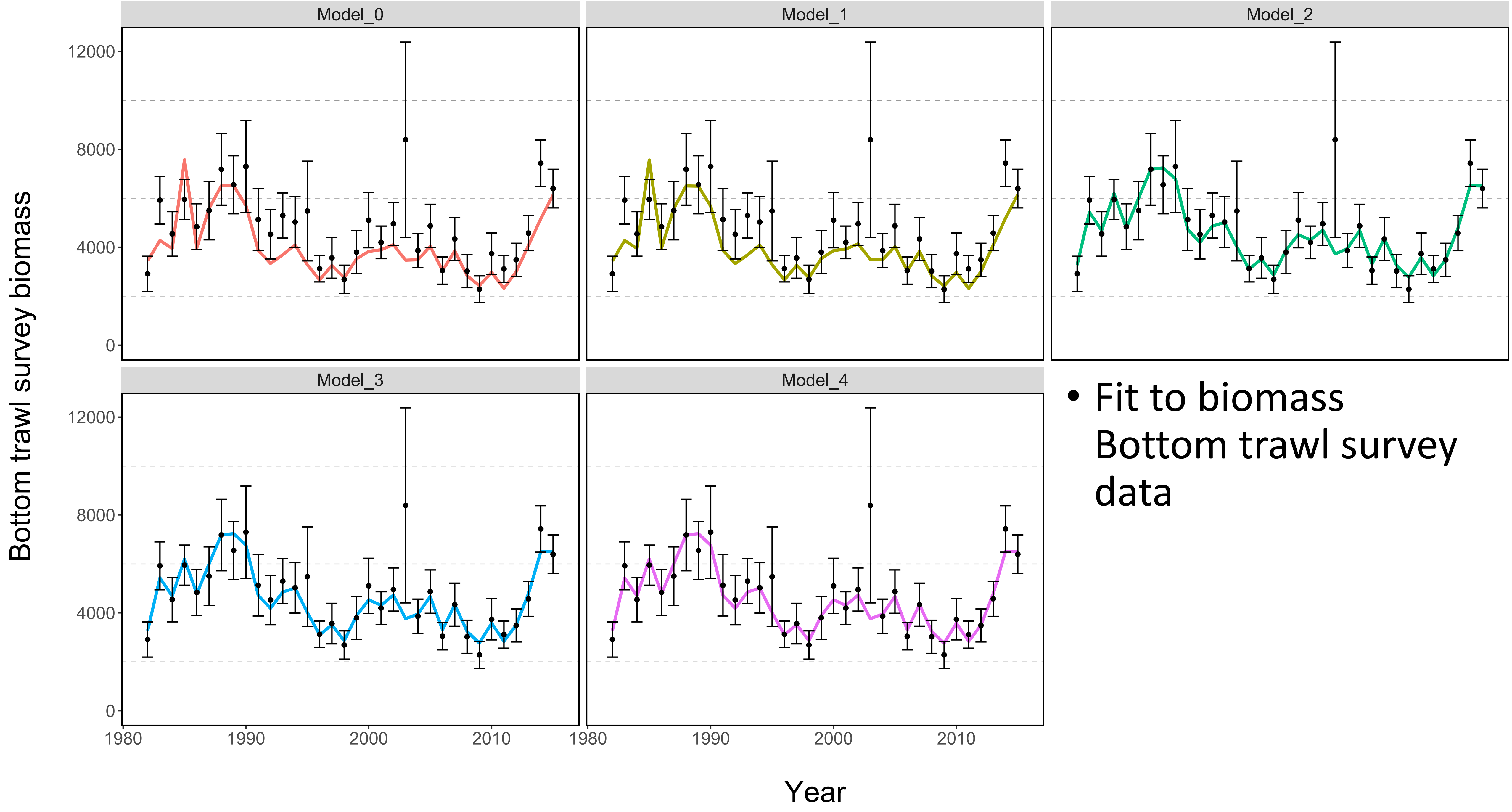
Model	Description
Model 0.0	The 2015 model used for management advice
Model 0	As Model 0.0 but using the design-based trawl survey estimates (and likelihoods) instead of the Kotwicki index
Model 1	As Model 0 but tuned to acoustic survey biomass instead of AT numbers
Model 2	As Model 0 but tuned to bottom 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…

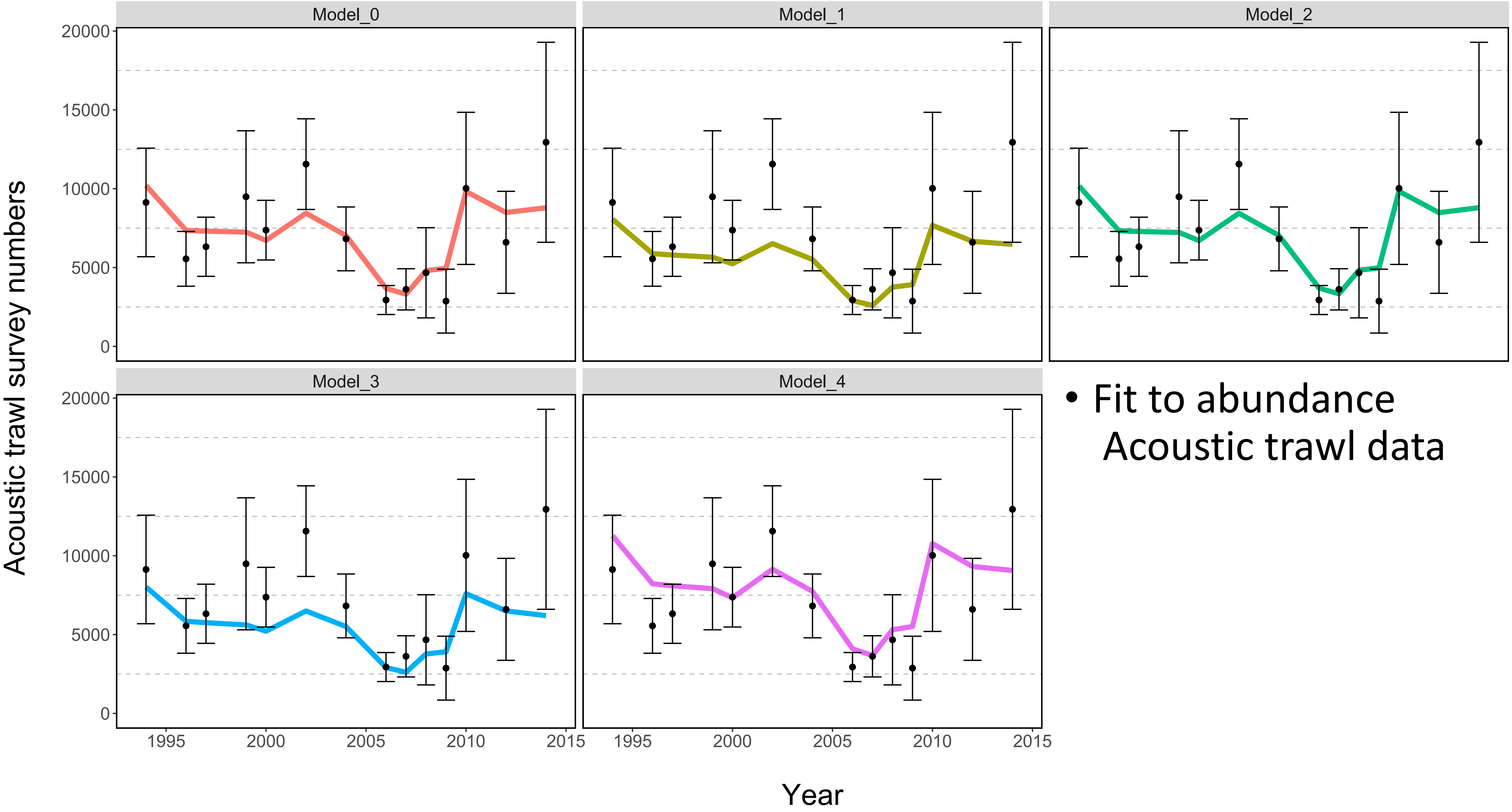
- Whether that form of index is included or not…



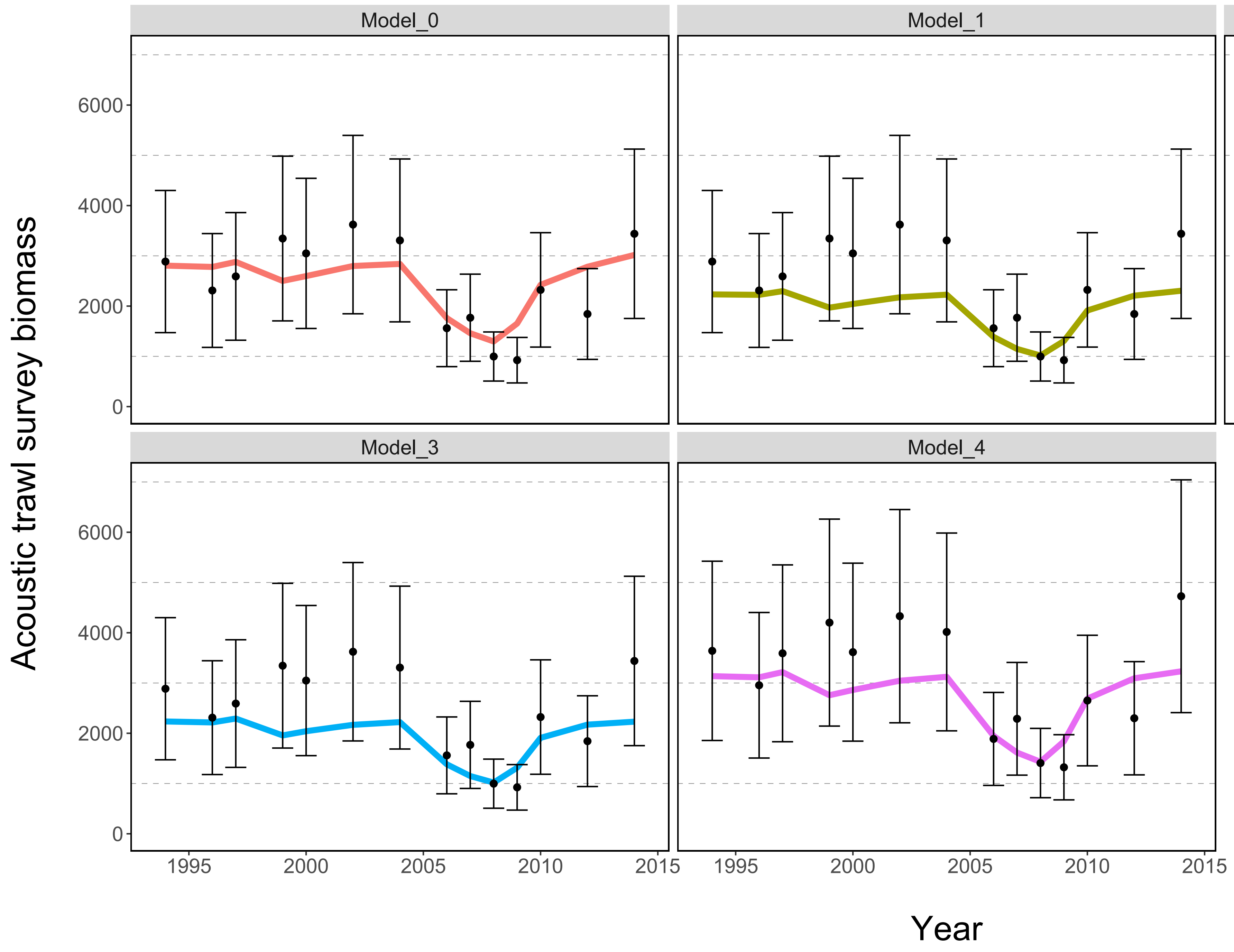
- Fit to abundance Bottom trawl survey data



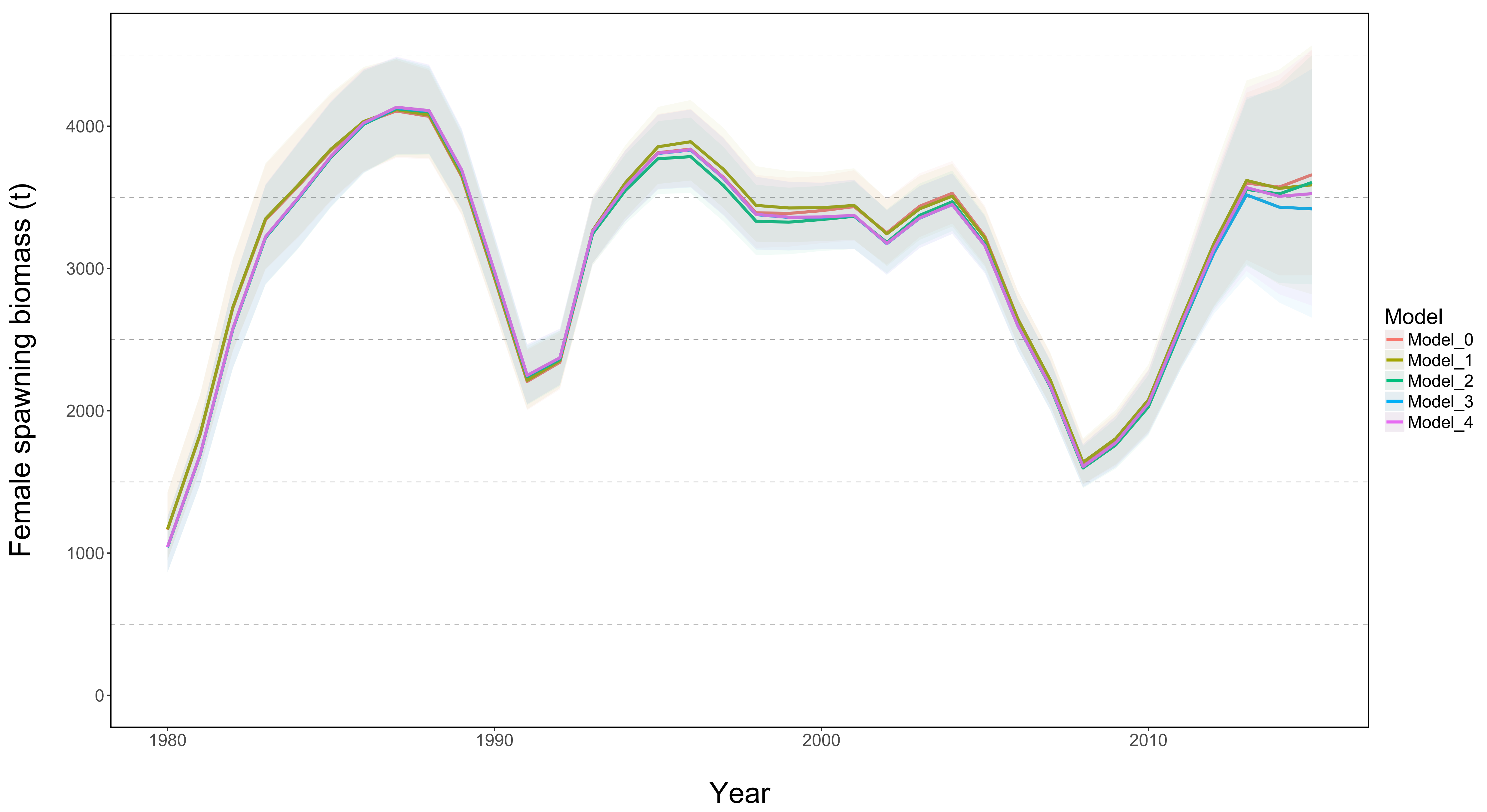
- Fit to biomass Bottom trawl survey data



- Fit to abundance Acoustic trawl data



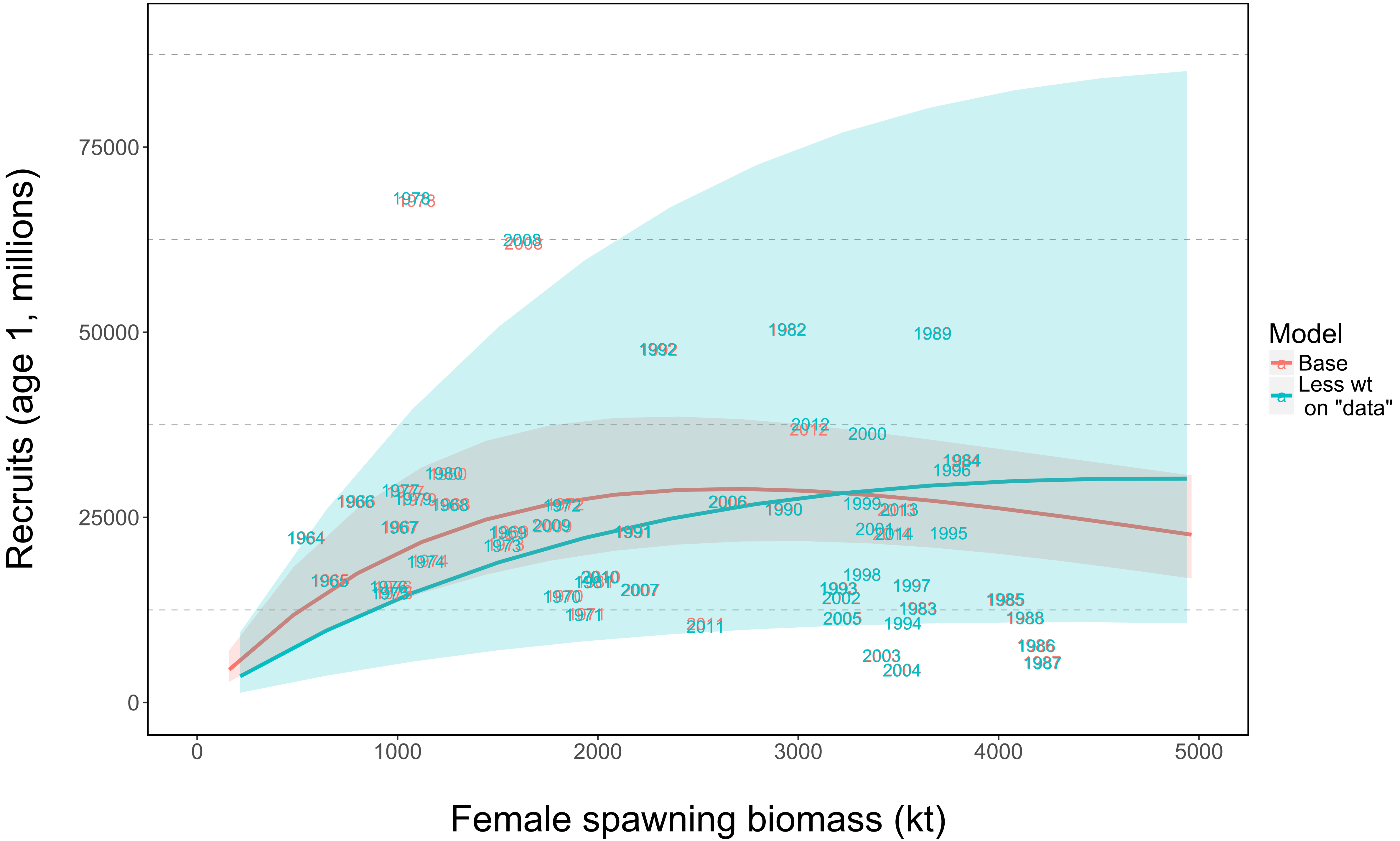
- Fit to biomass Acoustic trawl data



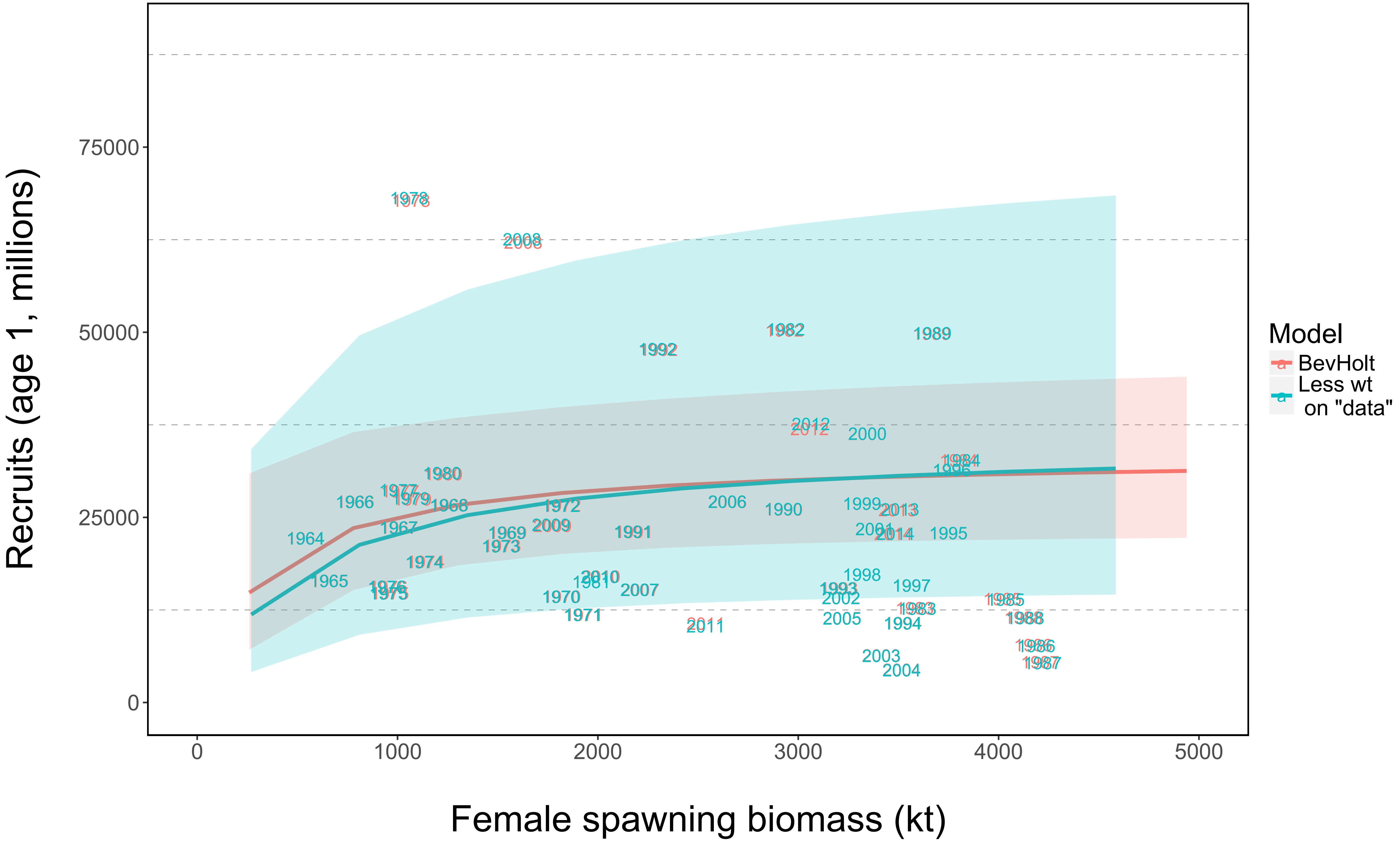
Female spawning biomass (t)
0
1000
2000
3000
4000
1980
1990
2000
2010
Year
Model
Model_0
Model_1
Model_2
Model_3
Model_4

Components of variability in PDF of F_{msy}

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



Recruits (age 1, millions)
Female spawning biomass (kt)
0
25000
50000
75000
0
1000
2000
3000
4000
5000
Model
Base
Less wt
on "data"


Recruits (age 1, millions)
75000
50000
25000
0
0
1000
2000
3000
4000
5000
Female spawning biomass (kt)
Model
BevHolt
Less wt on "data"
1978
2008
1992
1982
1989
2012
2000
1984
1980
1977
1979
1966
1968
1972
2006
1990
1999
2013
1964
1967
1969
2009
1991
2001
2014
1995
1973
1974
1998
1965
1976
1975
2010
1981
2007
1993
1997
1970
2002
1985
1983
1971
2005
1988
2011
1994
1986
2003
1987
2004

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