

An age-structured assessment model for yelloweye rockfish (*Sebastes ruberrimus*) in Southeast Alaska Outside Waters

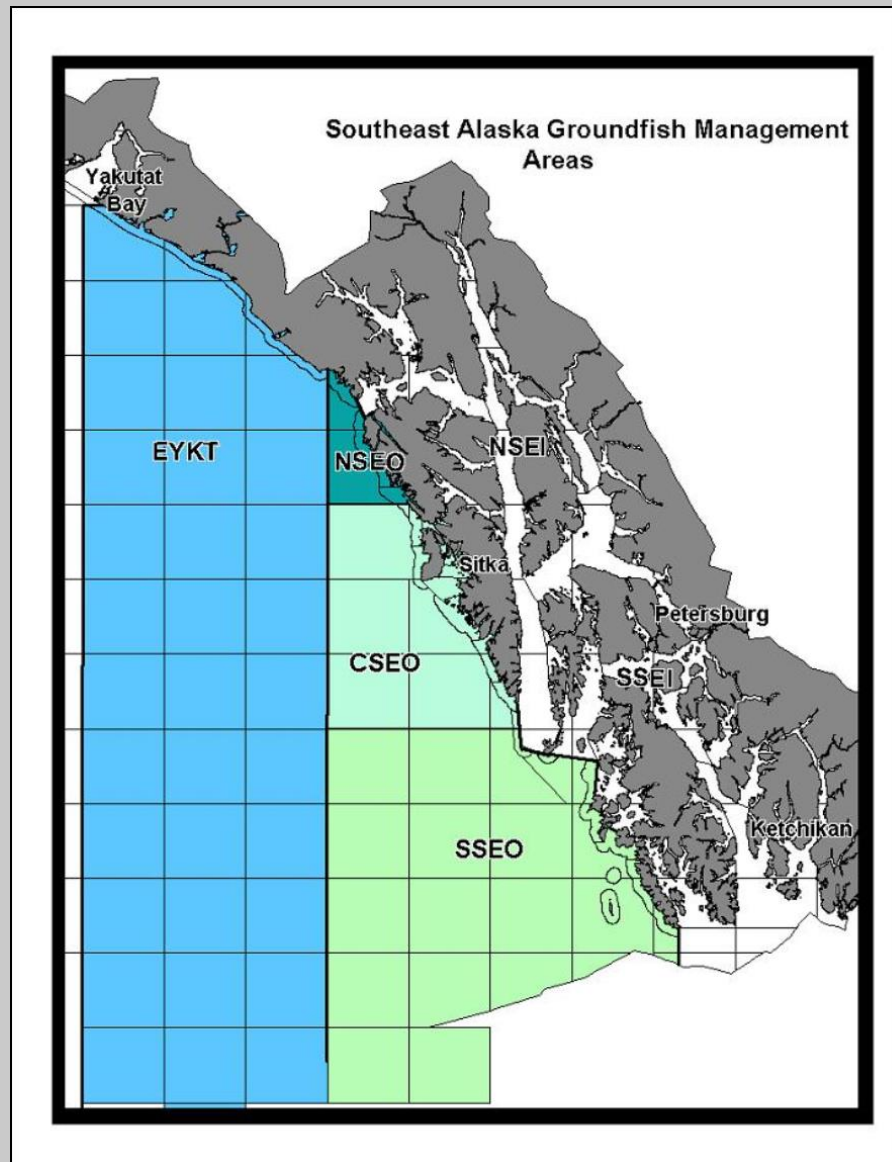


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Southeast Alaska Outside Waters





Changes to model data & structure



Data updated through 2015

1. Total annual catch:
Commercial fishery, sport fishery, halibut fishery bycatch
2. Age composition:
Commercial fishery, halibut fishery bycatch
3. Density:
ROV survey

Structural changes

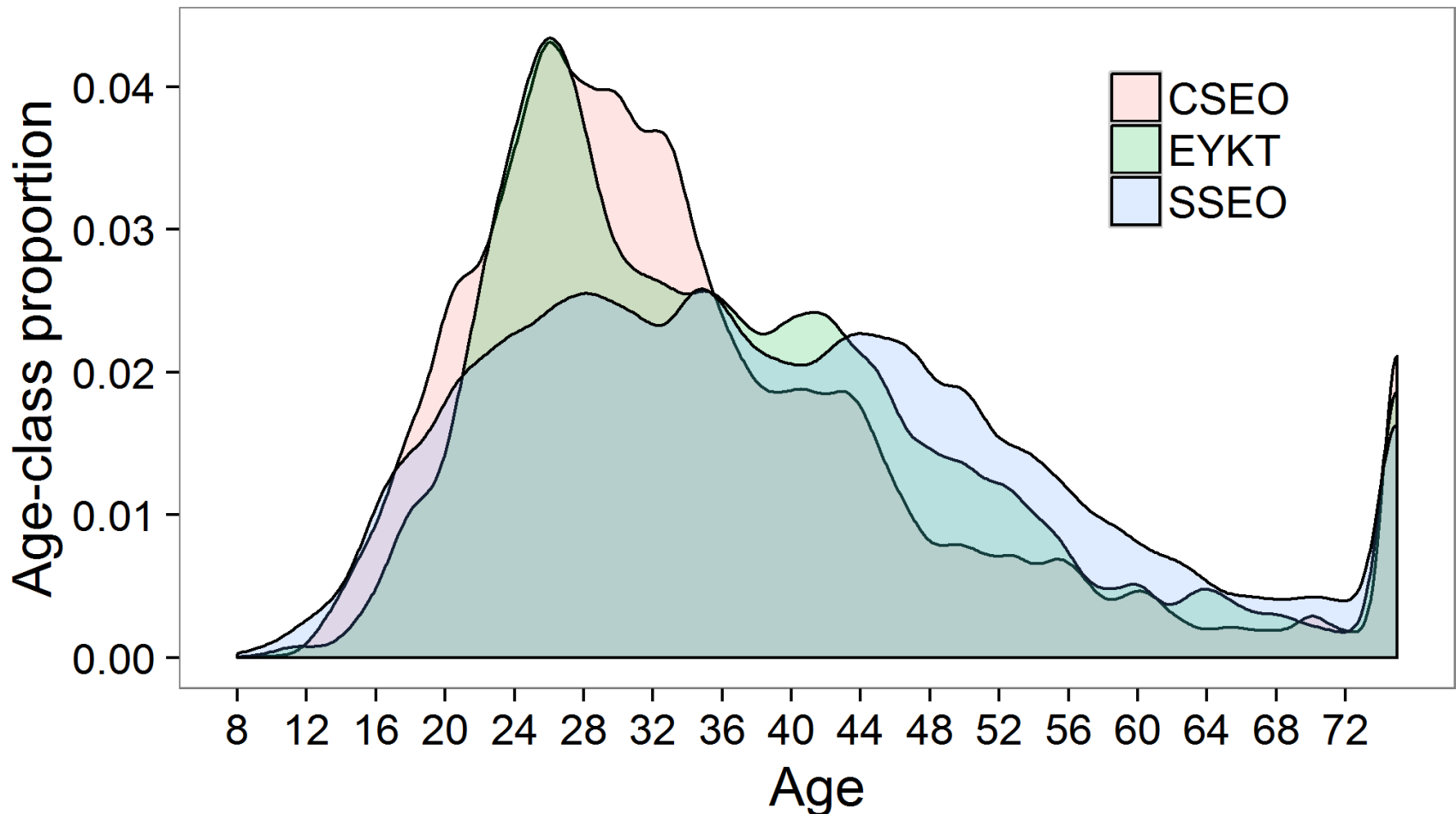
1. Terminal plus-class changed from 97+ to 75+
2. Natural mortality is estimated
3. CPUE scaled
4. Lower 90% CI for model-estimated biomass, F_{xx} ,
and ABC used when evaluating potential harvest levels
5. Additional sigma parameter for density from last year's
assessment removed due to confounding with estimating
natural mortality



Changes to model structure



- Plus-class changed from 97+ to 75+
- number of age classes was reduced
- proportion of individuals in the plus-class did not exceed any sub-plus-class age proportion





Four model structures



Model 1:

1. Regionally-distinct data and likelihood;
2. Asymptotic fishery selectivity-at-age

Model 2:

1. Regionally-distinct data and likelihood;
2. Common parameters:
 - a. natural mortality
 - b. commercial fisheries catchability
 - c. IPHC survey catchability
3. Asymptotic fishery selectivity-at-age

Model 3:

1. Regionally-distinct data and likelihood;
2. Common parameters:
 - a. natural mortality
 - b. commercial fisheries catchability
 - c. IPHC survey catchability
3. Dome-shaped fishery selectivity-at-age option

Model 4: (global)

1. Data and likelihood merged over regions;
2. Common parameters:
 - a. natural mortality
 - b. commercial fisheries catchability
 - c. IPHC survey catchability
 - d. mean age-8 recruitment
 - e. mean year-1 abundance
 - f. sigma for year-1 abundance deviation vector
 - g. mean full-recruitment fishing mortality
 - h. selectivity curve parameters
 - i. annual deviation vectors for recruitment, abundance, and fishing mortality
3. Asymptotic fishery selectivity-at-age



Four model structures



Alternative structures

Multivariate logistic likelihood for age composition

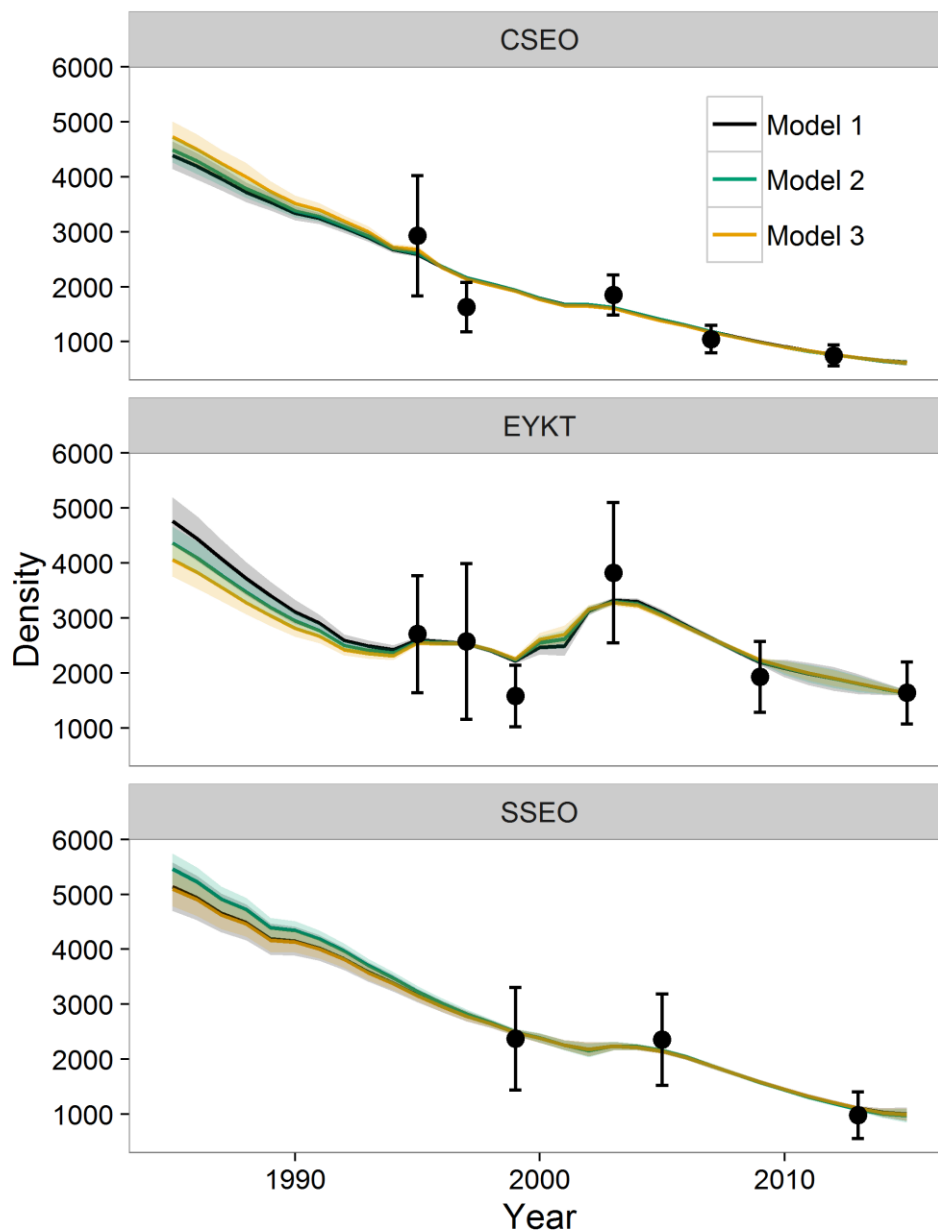
Partitioning global dataset to fit regional likelihoods

Spawner-recruit curves

Global recruitment partitioned into region-specific recruitment

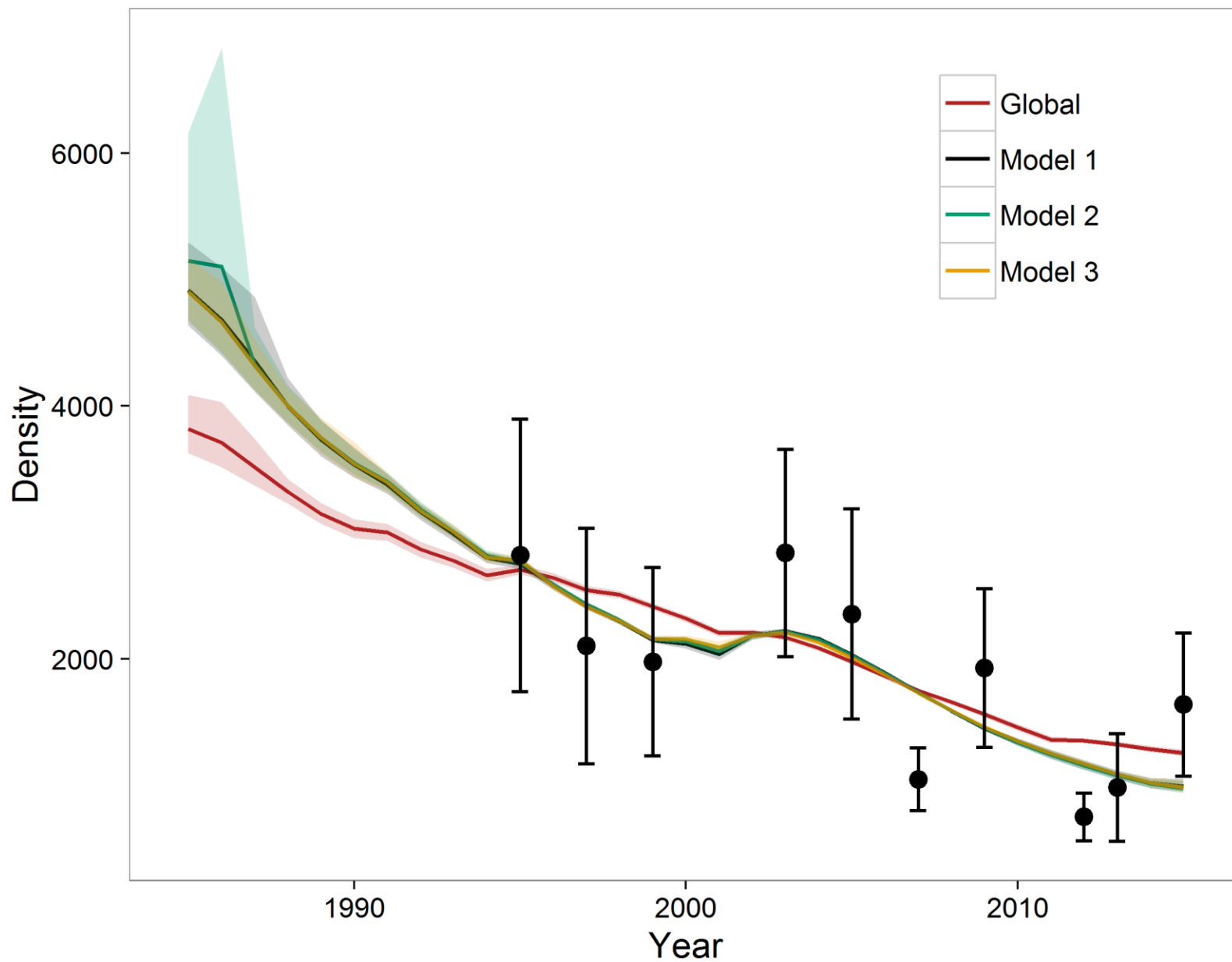


Results: Regional density



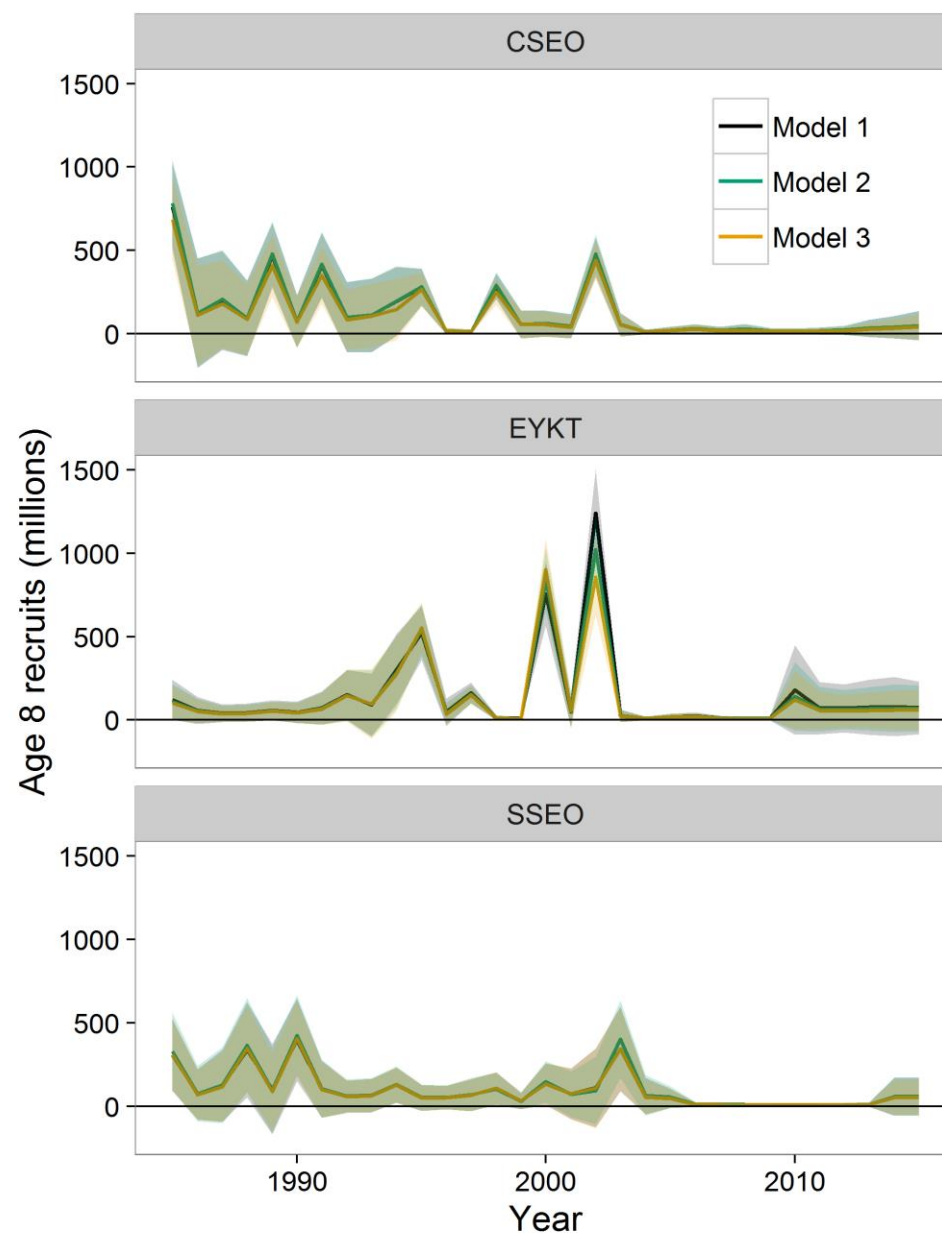


Results: Total density



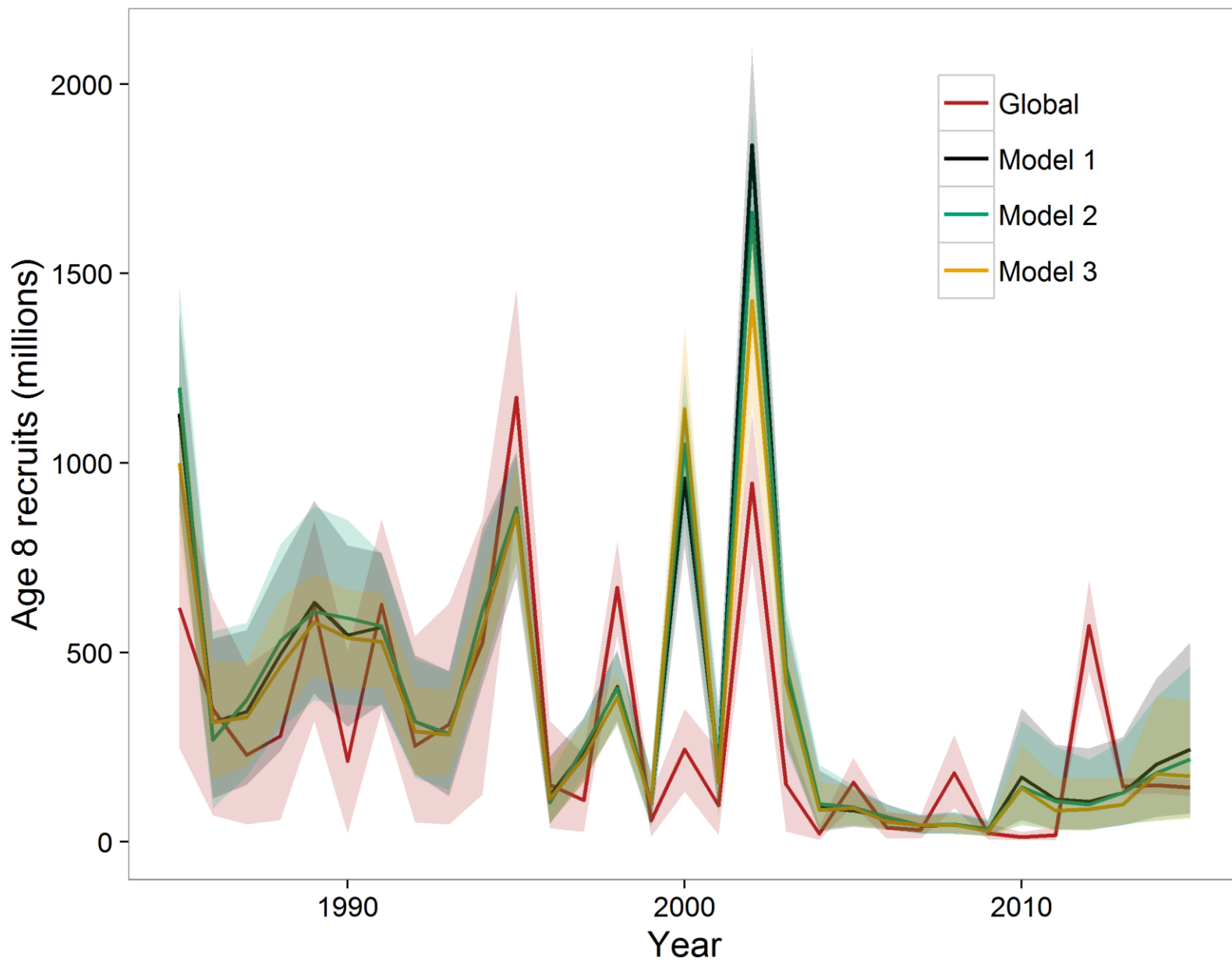


Results: Regional recruitment



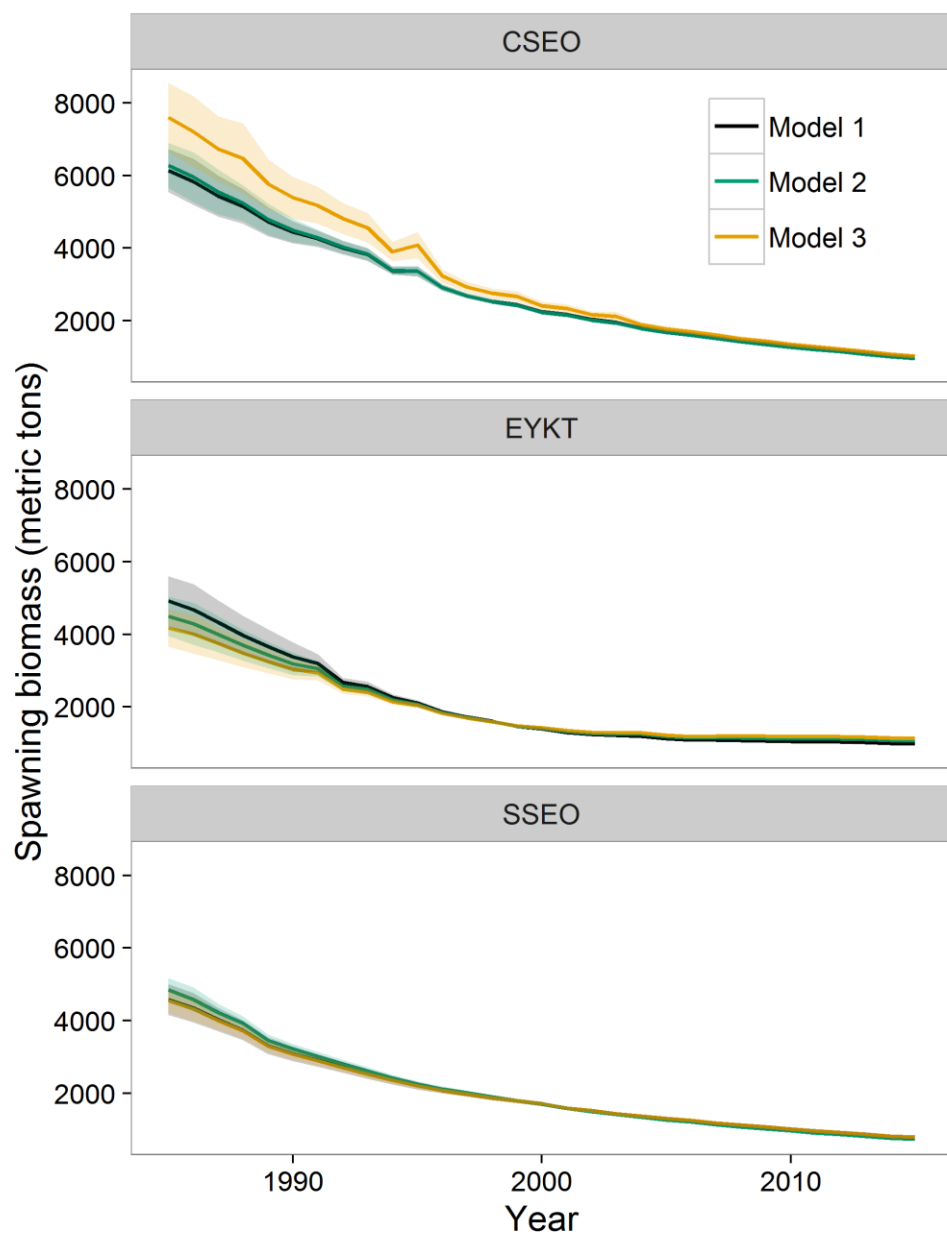


Total recruitment



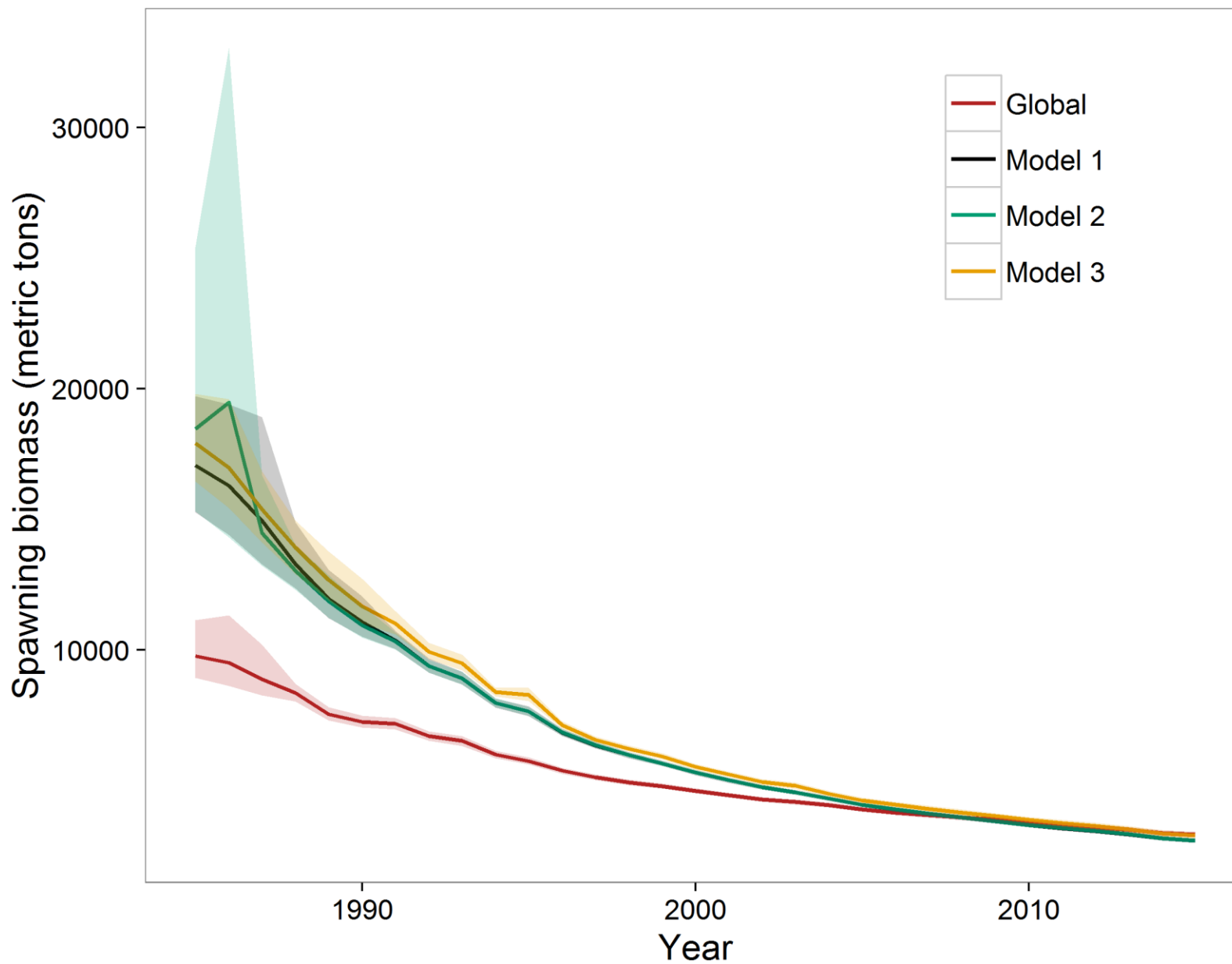


Results: Regional spawning biomass



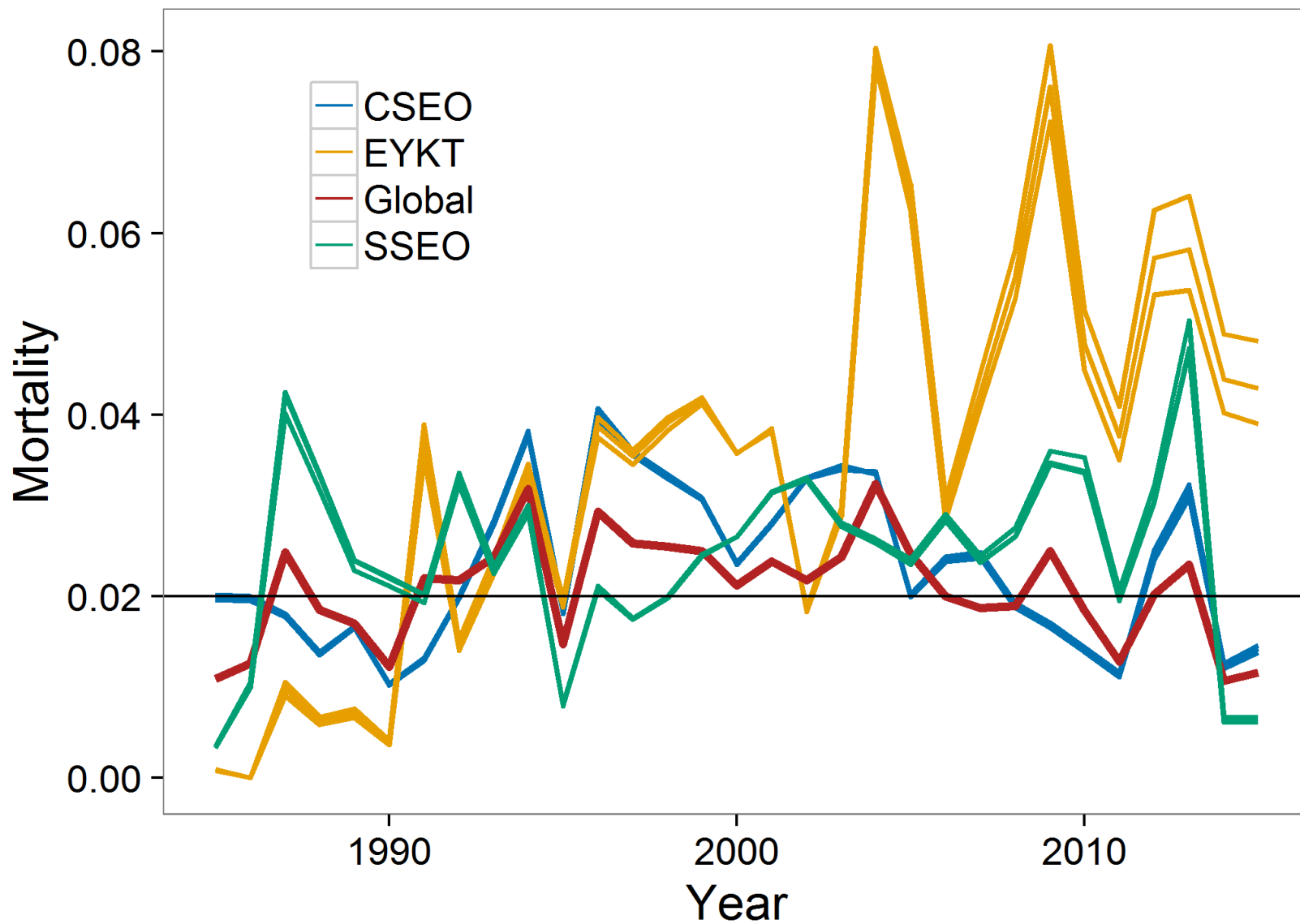


Result: Total spanning biomass



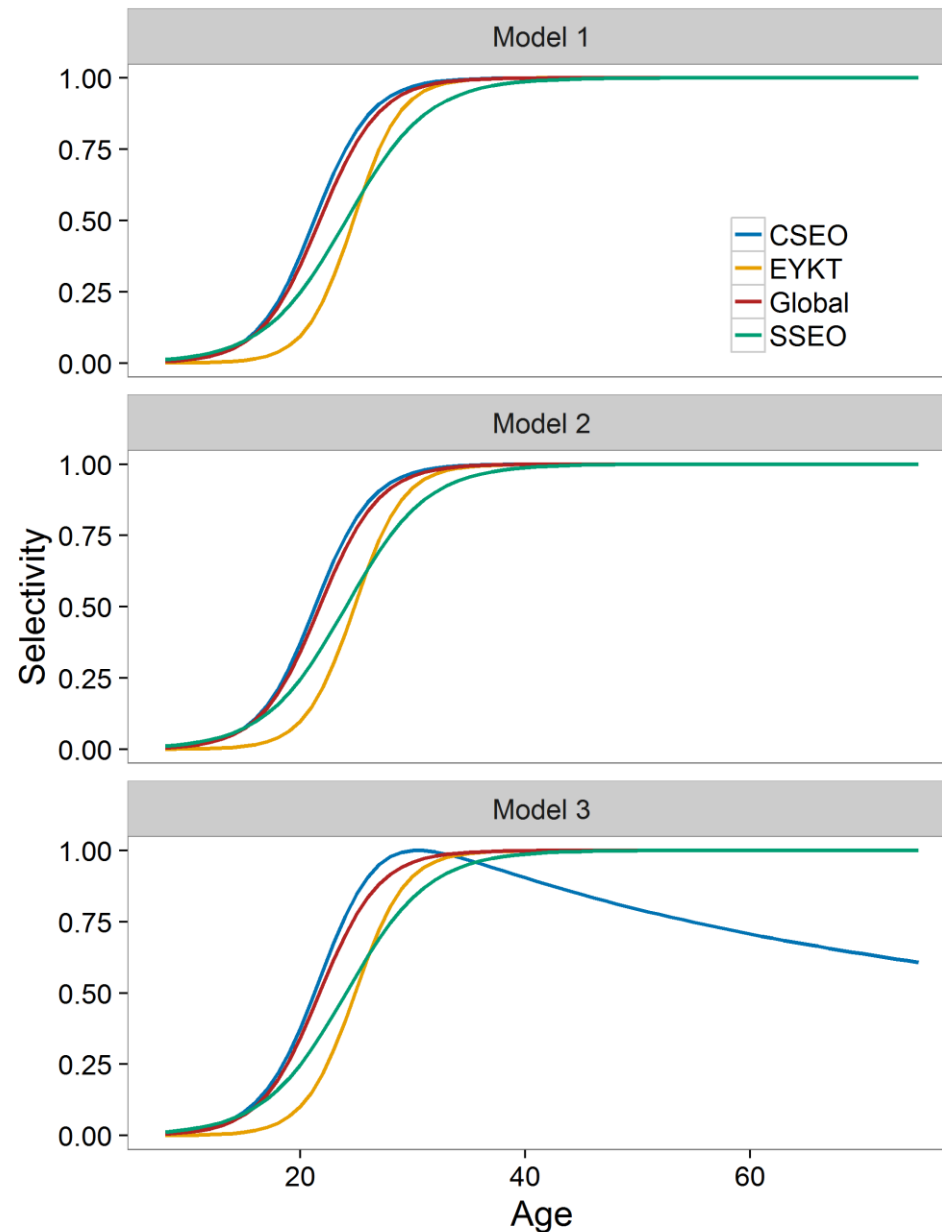


Results: Full-recruitment fishing mortality



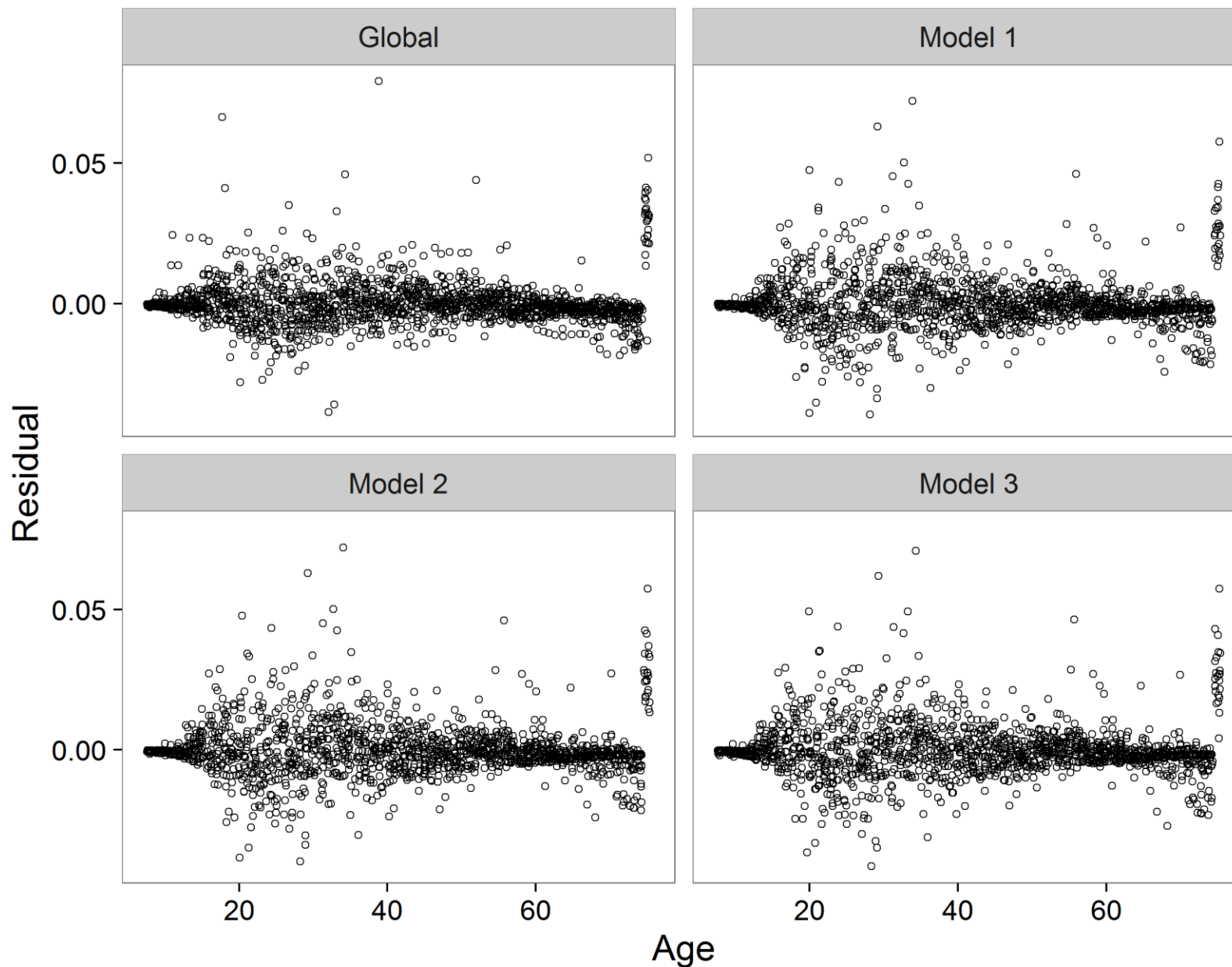


Results: Fishery selectivity



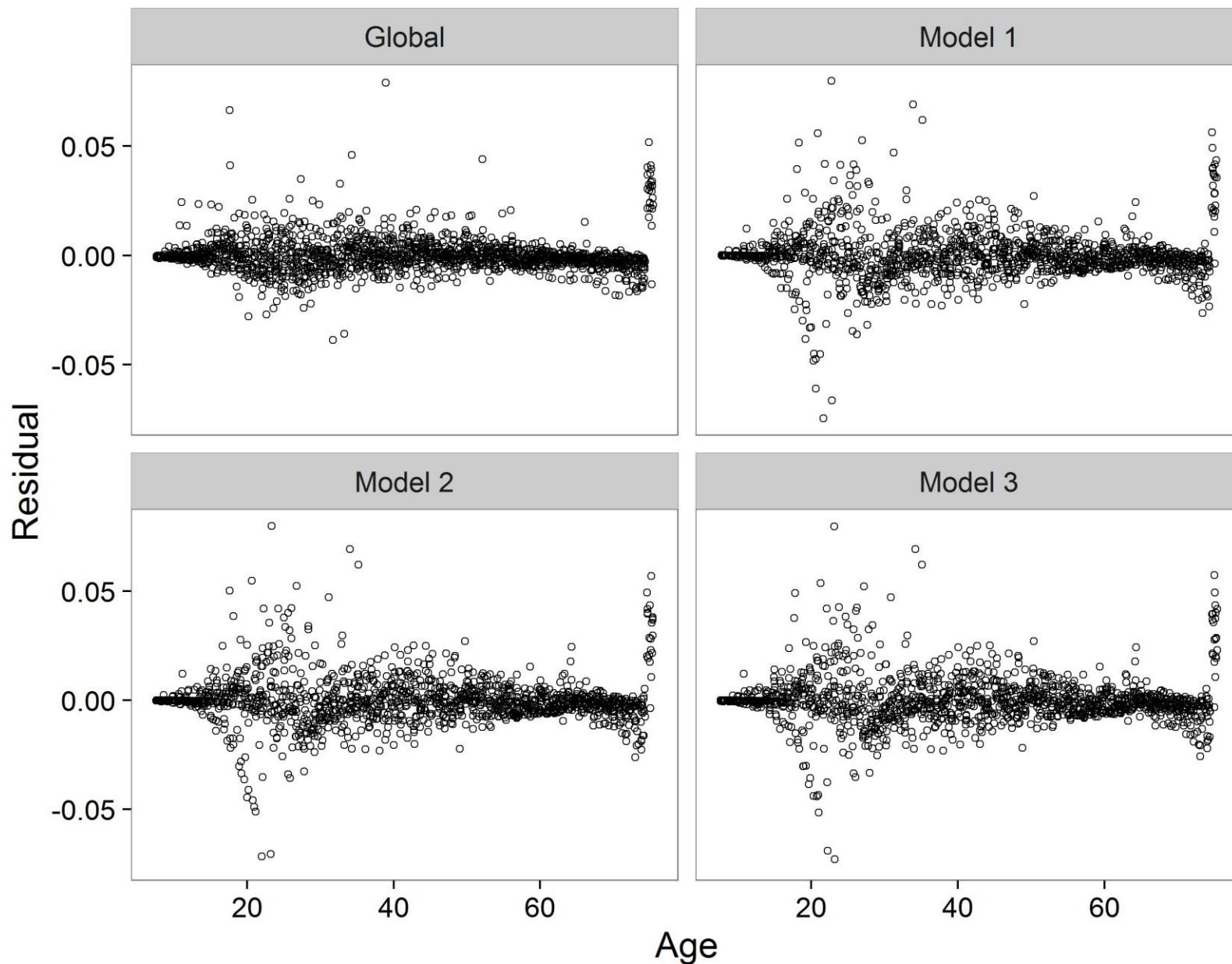


Results: Catch-age residuals - CSEO



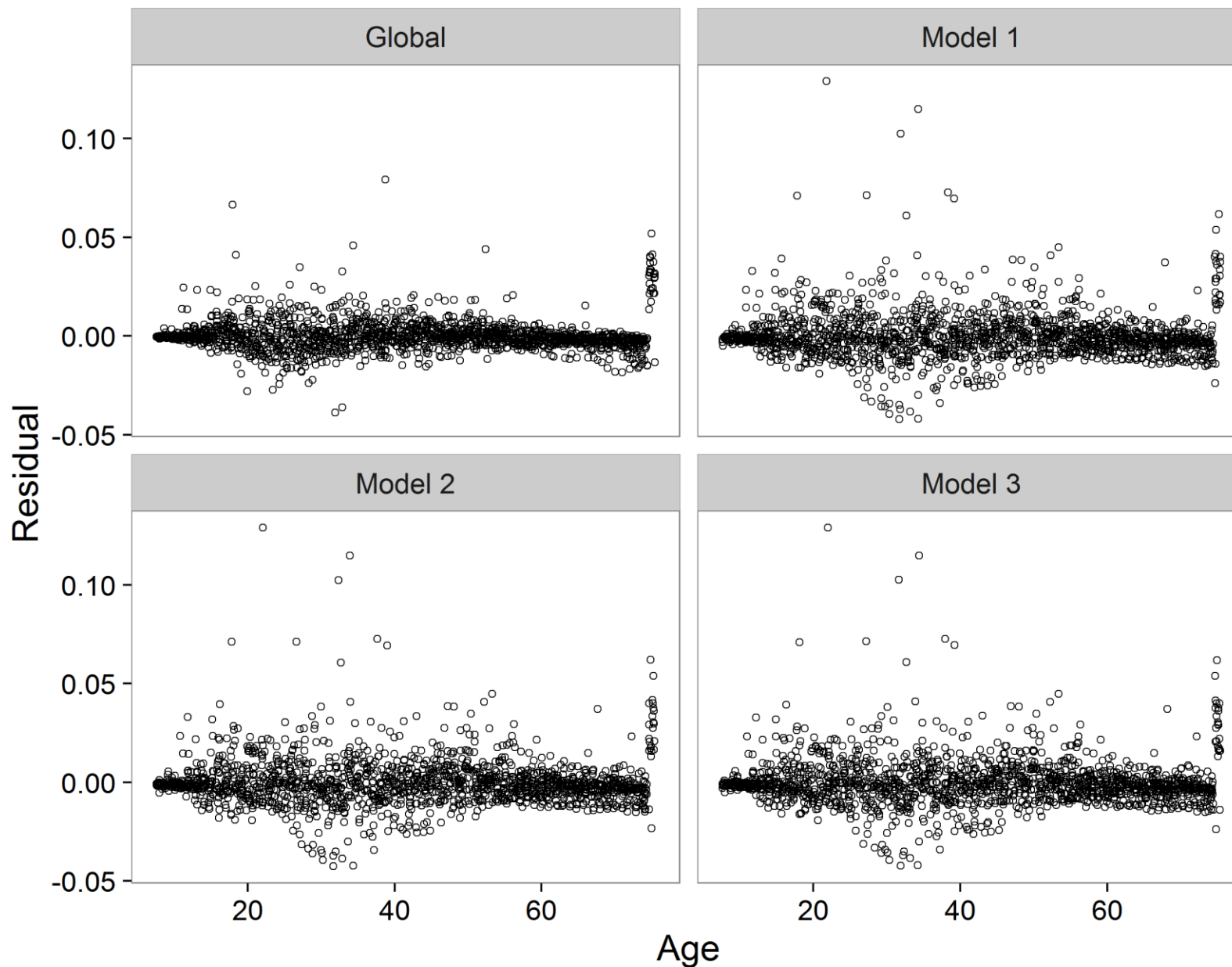


Results: Catch-age residuals - SSEO



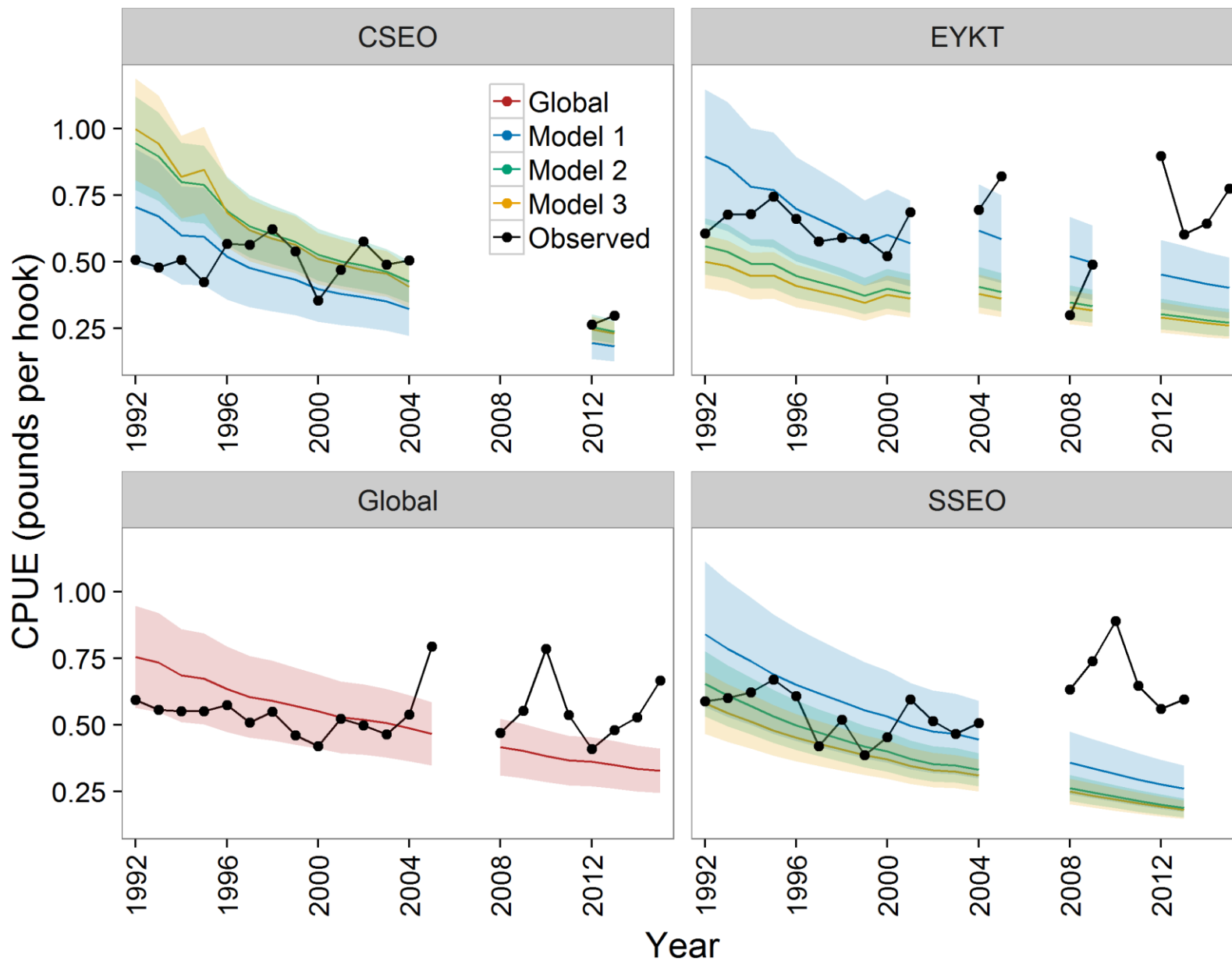


Results: Catch-age residuals - EYKT



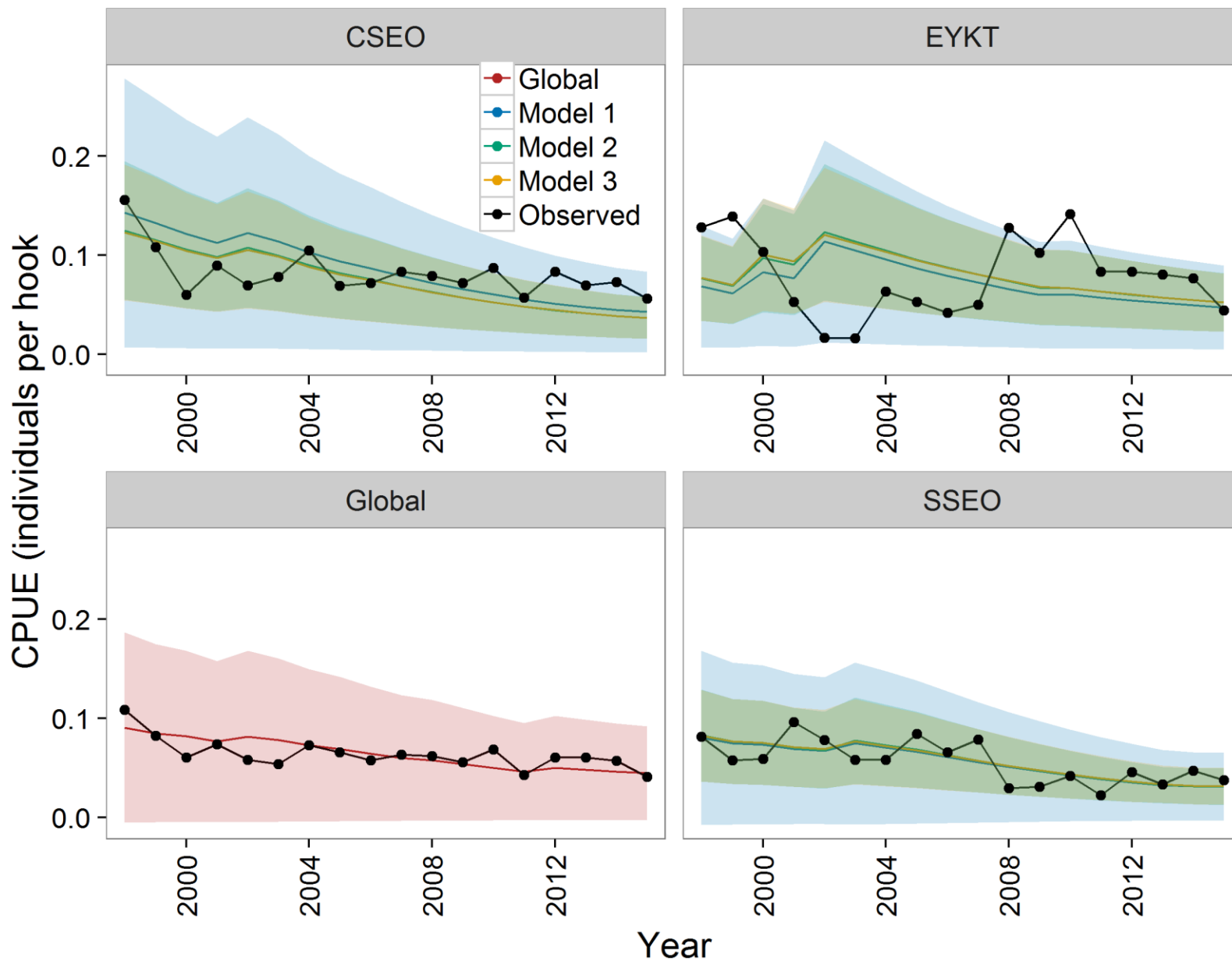


Results: Commercial fisheries CPUE





Results: IPHC survey CPUE





Model Results: Shared parameters



Natural mortality M

Model 1	Model 2	Model 3	Model 4
CSEO – 0.0831			
SSEO – 0.0804	0.0850	0.0798	0.0791
EYKT – 0.0915			

Commercial fishery CPUE catchability

Model 1	Model 2	Model 3	Model 4
CSEO – 0.0697			
SSEO – 0.1233	0.0927	0.0858	0.0341
EYKT – 0.1431			

Full-recruitment F_{45}

Model 1	Model 2	Model 3	Model 4
CSEO – 0.1203	0.1263	0.111	
SSEO – 0.1562	0.1736	0.154	0.1331
EYKT – 0.3271	0.2636	0.2225	

IPHC survey CPUE catchability

Model 1	Model 2	Model 3	Model 4
CSEO – 0.0464			
SSEO – 0.0396	0.0405	0.0406	0.0117
EYKT – 0.0363			



Model Results: Comparisons



Deviance Information Criterion

DIC values for all models from 2,000,000 MCMC iterations, saving every 100th

MODEL ONE

Expectation of log-likelihood	11797
Expectation of theta	13421
Number of estimated parameters	439
Effective number of parameters	-1624
DIC	10173.5

MODEL TWO

Expectation of log-likelihood	11814
Expectation of theta	13482
Number of estimated parameters	433
Effective number of parameters	-1667
DIC	10147

MODEL THREE

Expectation of log-likelihood	11724
Expectation of theta	11787
Number of estimated parameters	441
Effective number of parameters	-63
DIC	11661

MODEL FOUR (Global)

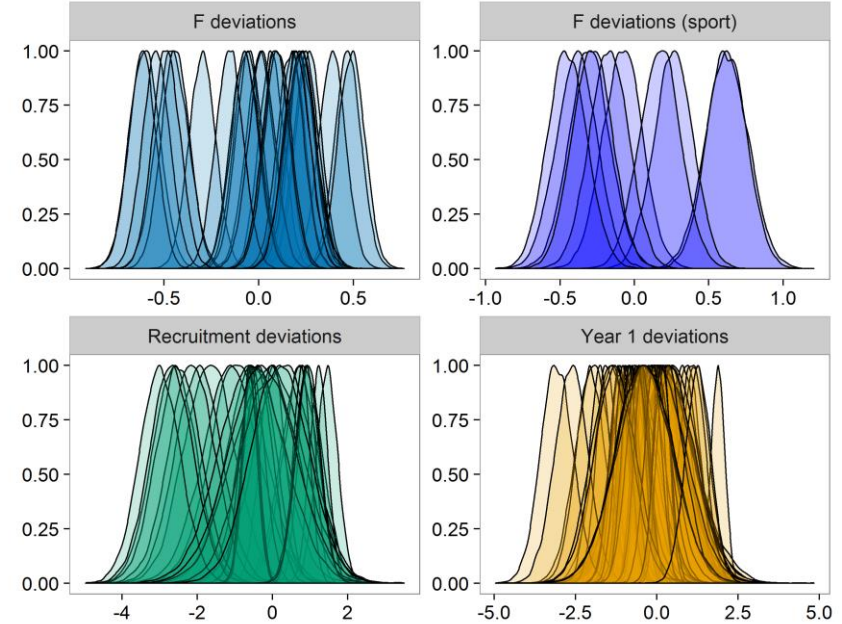
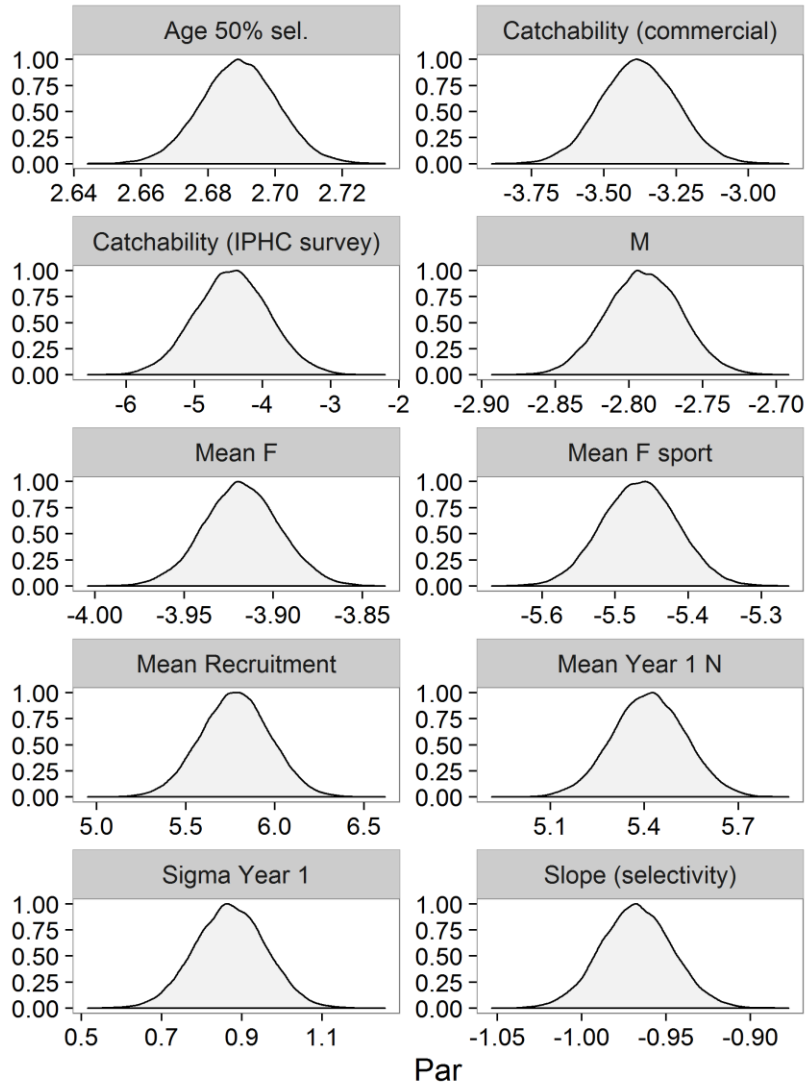
Expectation of log-likelihood	9743
Expectation of theta	10374
Number of estimated parameters	149
Effective number of parameters	-632
DIC	9111



Global model evaluation



20,000 parametric bootstrap draws:
Full parameter space explored; no bound constraints

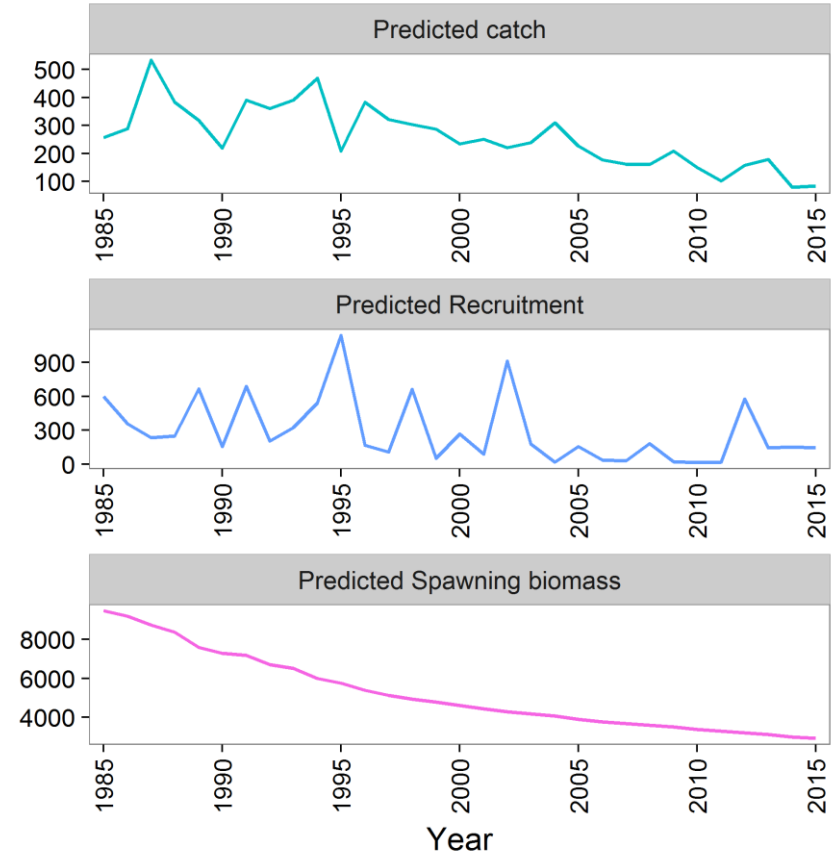
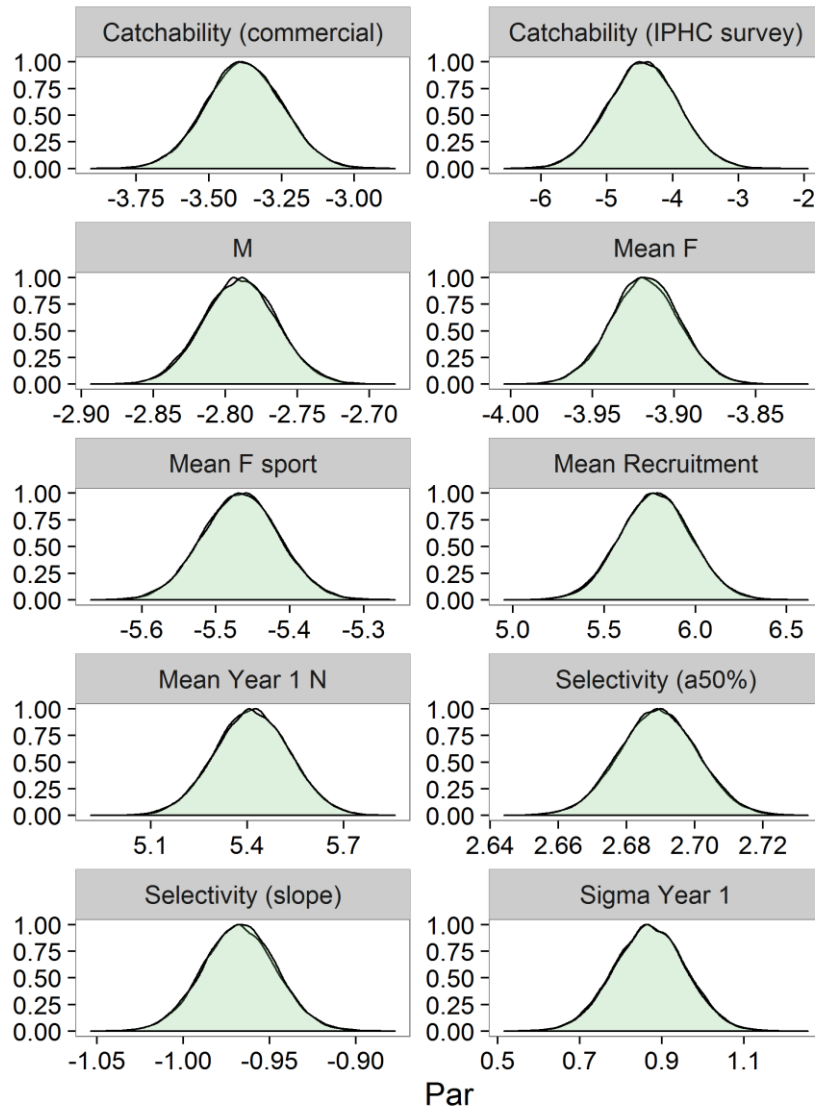




Global model evaluation



Self-test

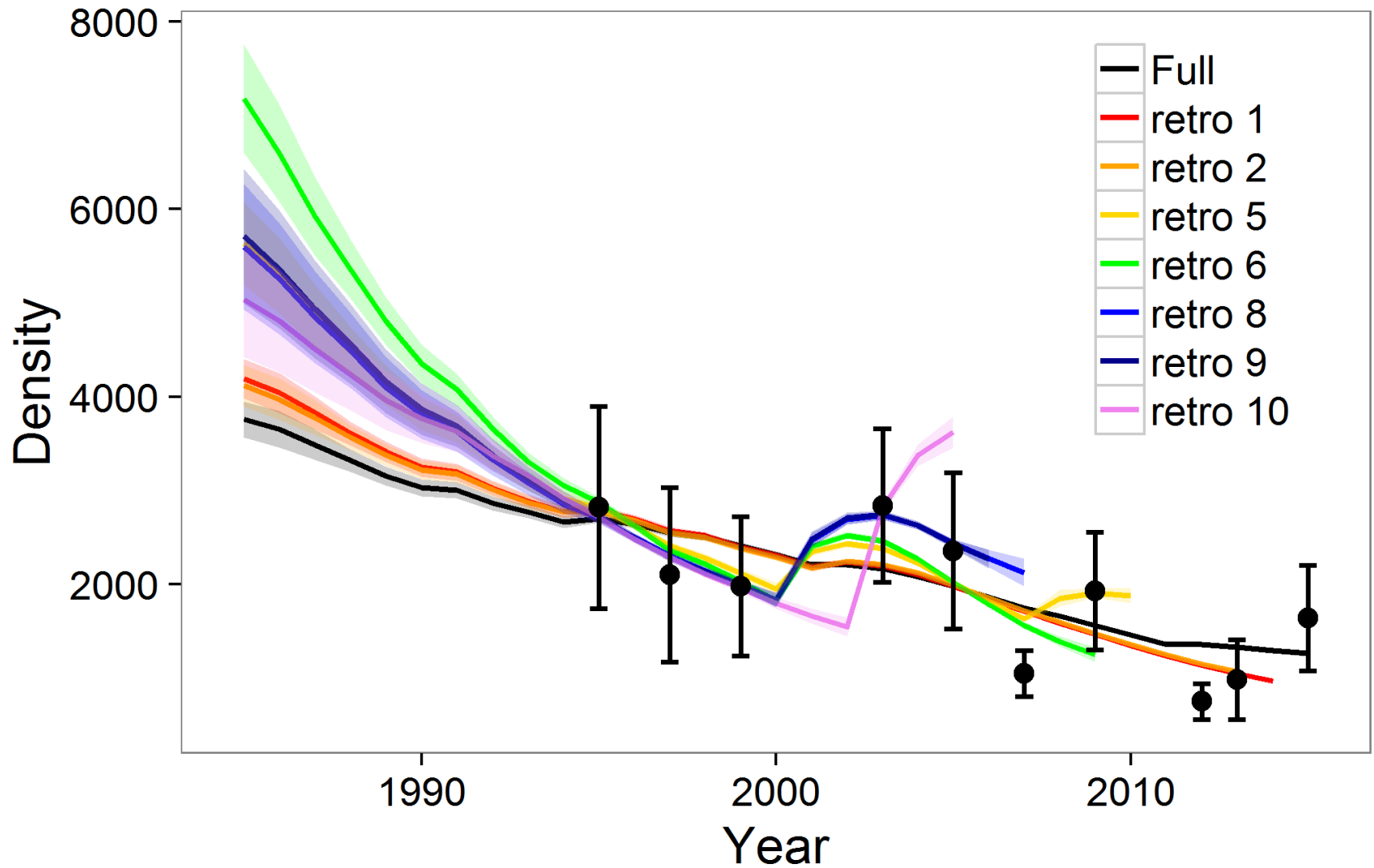




Global model evaluation

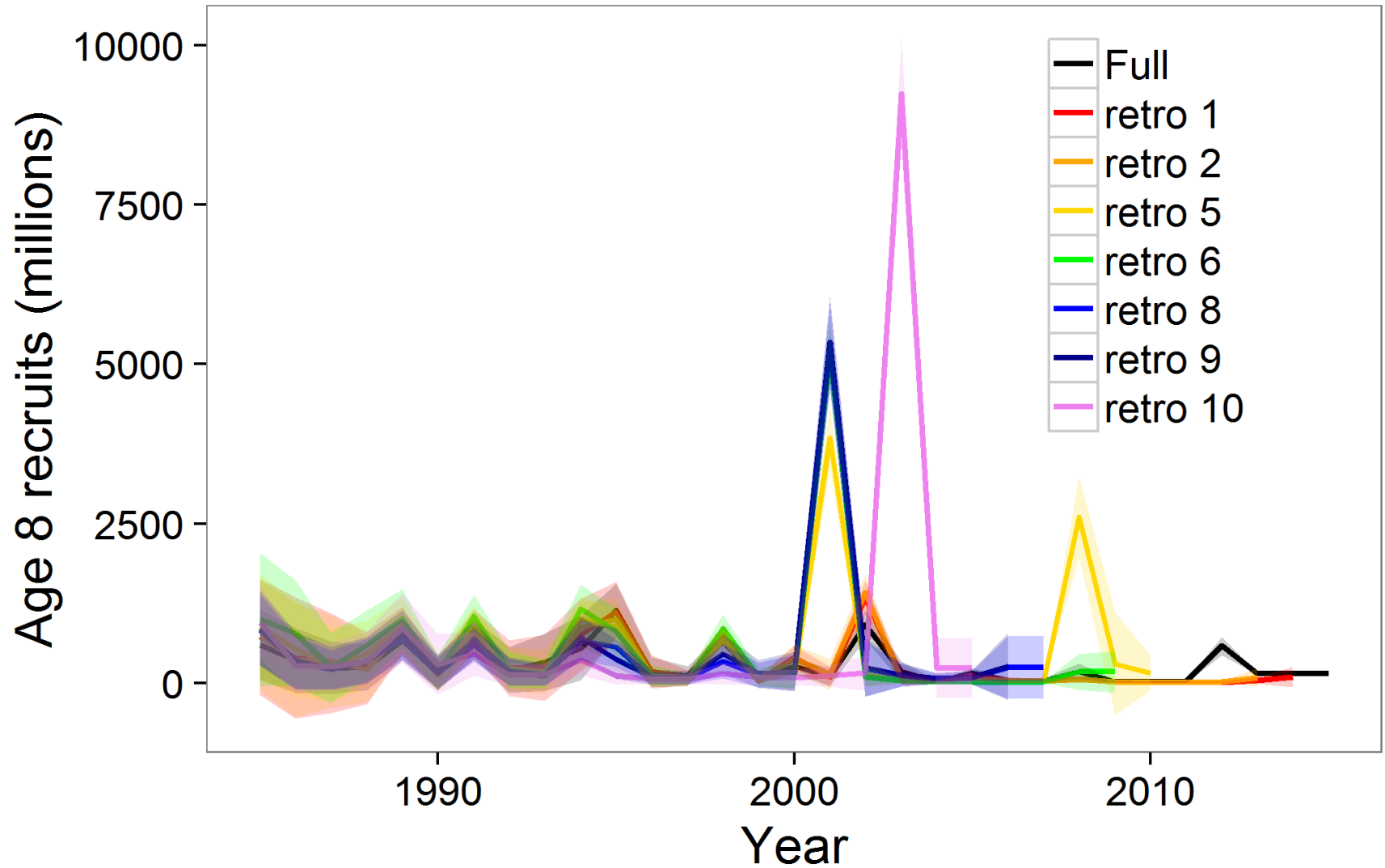


Retrospective analysis: density





Retrospective analysis: age 8 recruitment

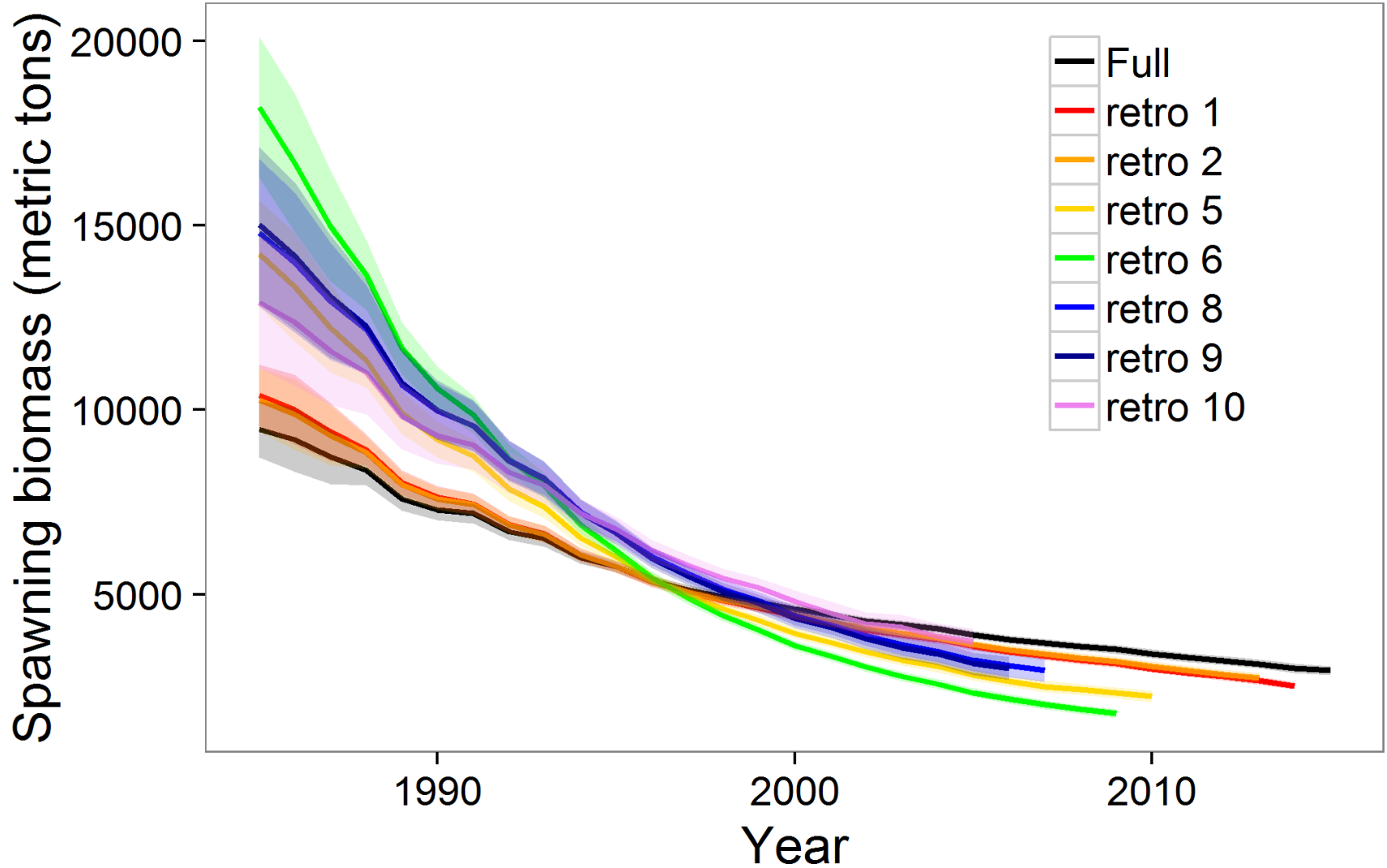




Global model evaluation



Retrospective analysis: spawning biomass





Global model evaluation



Estimating natural mortality

Confounded with extra variance term

M goes to zero

$$L = 0.5\ln(2\pi) + \ln(\sigma_{dens} + \sigma_+) + 0.5 \frac{(\ln(obs_den) - \ln(pred_den))^2}{2(\sigma_{dens}^2 + \sigma_+^2)}$$

$$\sigma_{dens}^2 = \log(1 + \sigma_{distance} / obs_den^2) \quad (\text{Burnham } et al. 1987)$$

1. Evaluated root mean-squared error (RMSE) for density surveys inside model structure with no extra variance term;
2. Used the fixed RMSE as additional variance term

$$\sigma_{dens}^2 = \log(1 + (\sigma_{distance} + rmse) / obs_den^2)$$

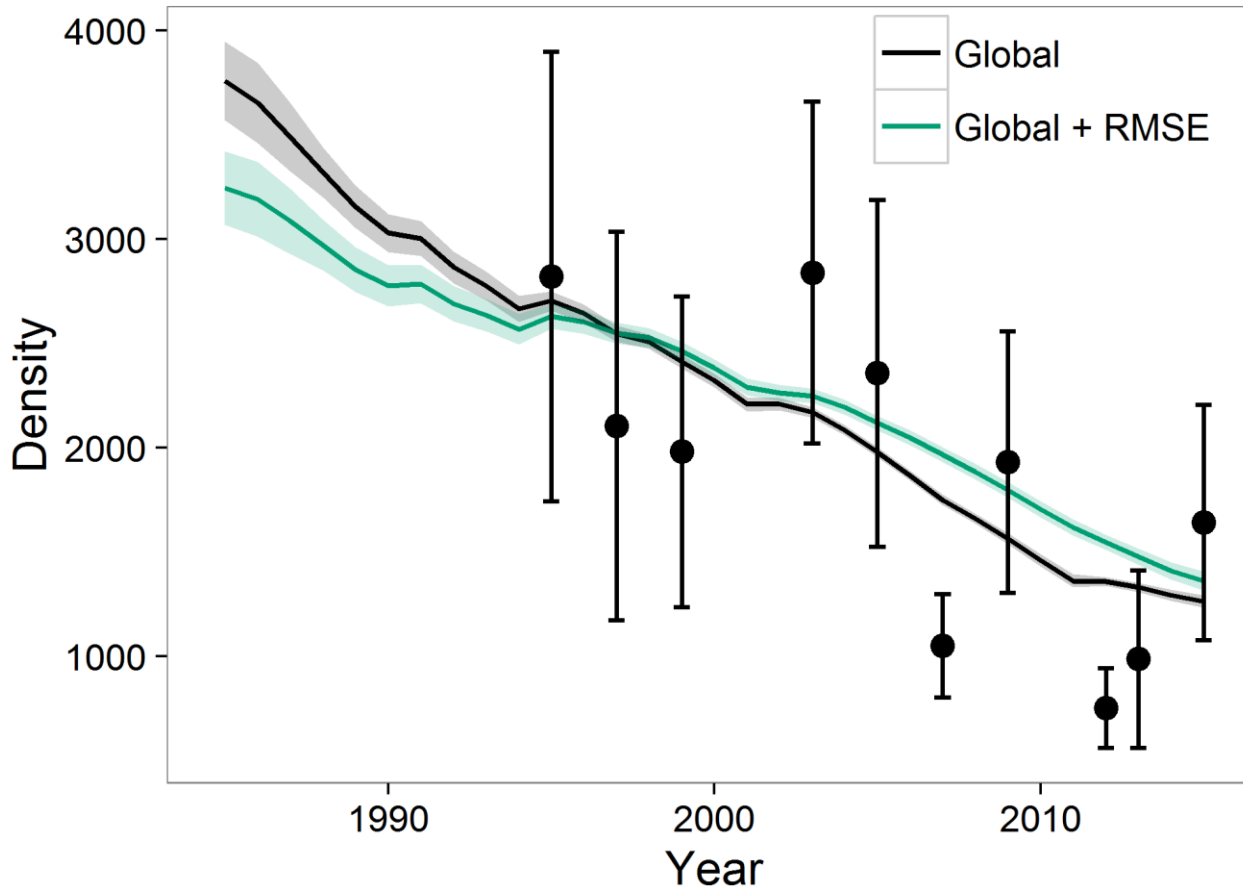


Global model evaluation



DIC values for all models from 2,000,000 MCMC iterations, saving every 100th

RMSE Global model		Global model	
Expectation of log-likelihood	6644	Expectation of log-likelihood	9743
Expectation of theta	6928	Expectation of theta	10374
Number of estimated parameters	149	Number of estimated parameters	149
Effective number of parameters	-283	Effective number of parameters	-632
DIC	6361	DIC	9111



Natural mortality

Global: 0.791

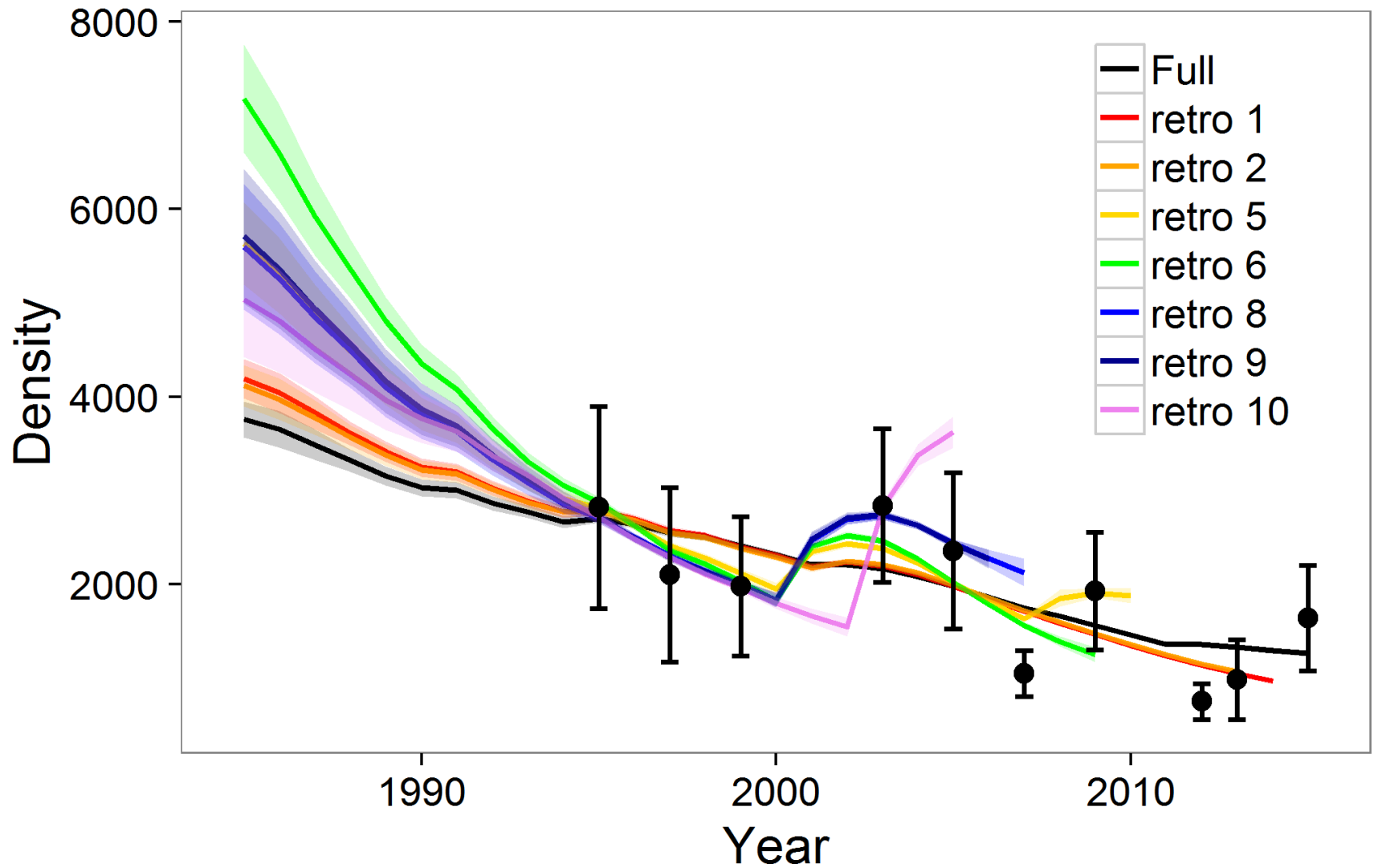
RMSE: 0.467



Model Results: Comparisons



Global model: density retrospective

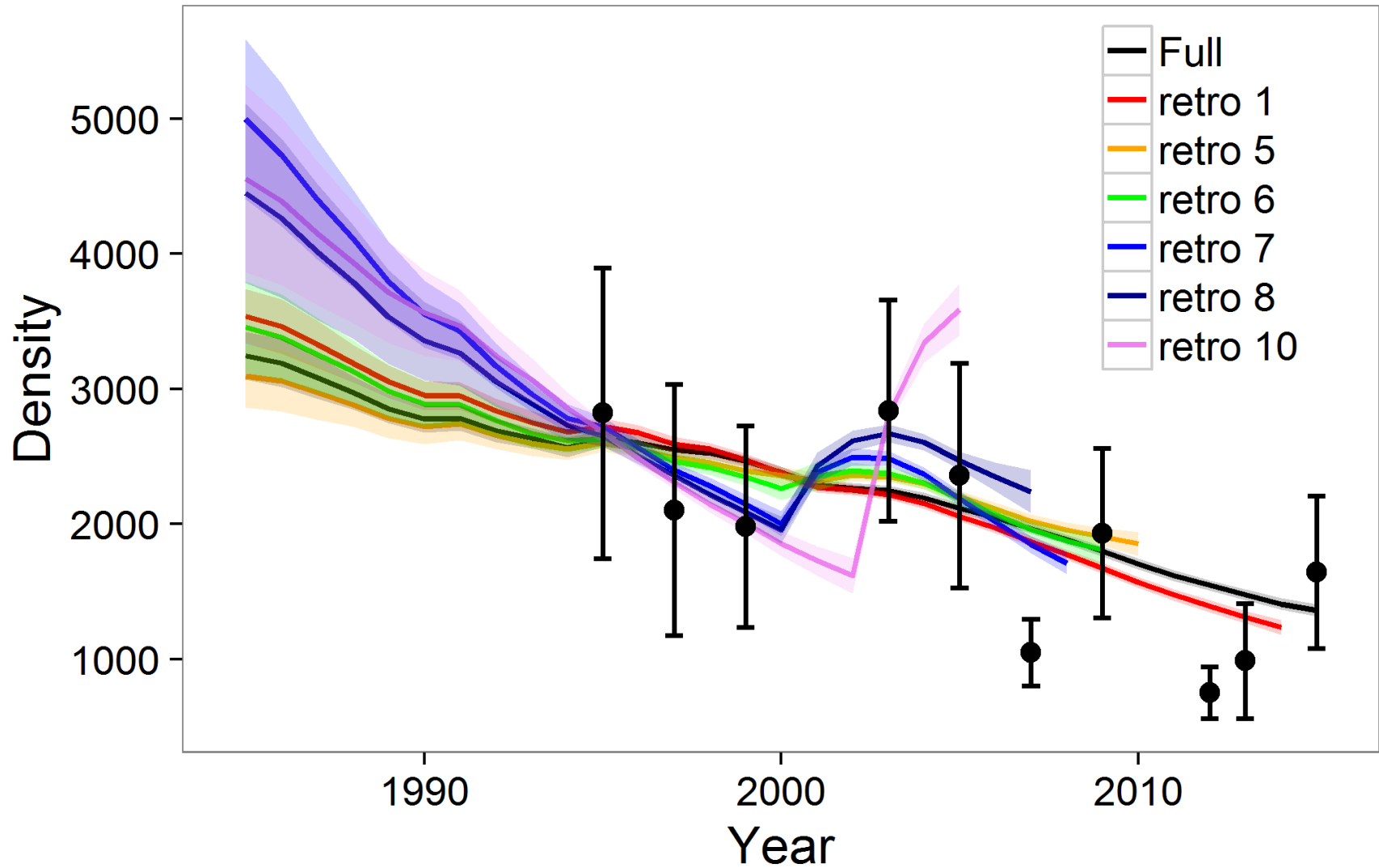




Model Results: Comparisons

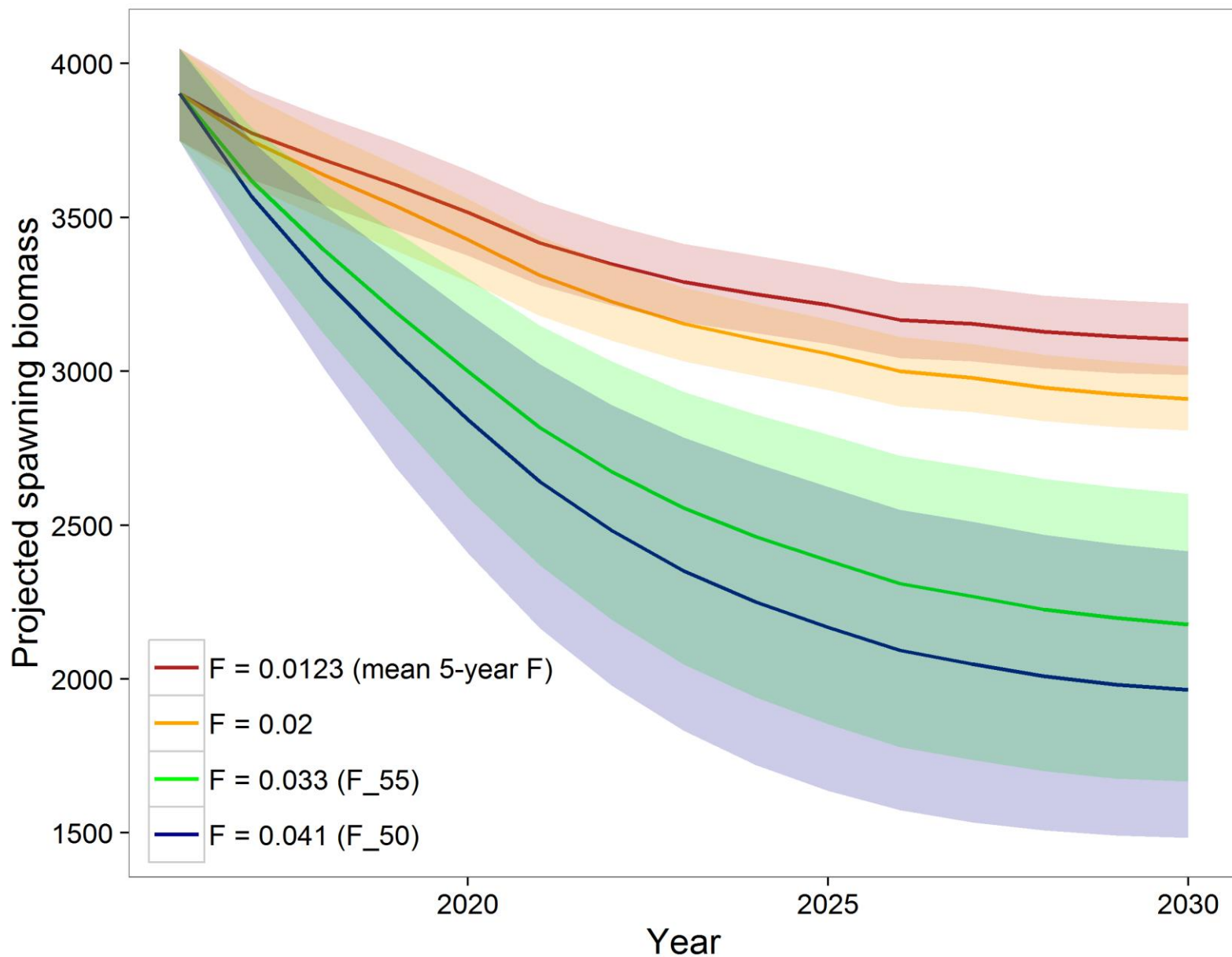


RMSE global model retrospective: density





Spawning biomass projections





Model Recommendation



F level	Biomass (metric tons)	ABC	ABC (metric tons)
F_{45} (0.060)	L 90% CI (11,317)	Point-estimate	554
F_{50} (0.049)	L 90% CI (11,317)	Point-estimate	454
F_{55} (0.041)	L 90% CI (11,317)	Point-estimate	382
L 90% CI of F_{45} (0.032)	L 90% CI (11,317)	Point-estimate	309
L 90% CI of F_{50} (0.027)	L 90% CI (11,317)	Point-estimate	253
L 90% CI of F_{55} (0.022)	L 90% CI (11,317)	Point-estimate	207
F_{45} (0.060)	Point-estimate (11,697)	L 90% CI	314
F_{50} (0.049)	Point-estimate (11,697)	L 90% CI	263
F_{55} (0.041)	Point-estimate (11,697)	L 90% CI	216
CURRENT ABC ($F = 0.02$, assumes no selectivity)			218

If the RMSE-modified global model is accepted for purposes of management advice, the author recommends reducing harvest levels to F_{55} and using the lower 90% confidence interval of the model-estimated ABC to set catch levels, which produces an ABC level for 2016 of **216** metric tons, which is essentially equivalent to the ABC of **218** metric tons under current management methods.



Priorities



1. Determine best approach for incorporating density uncertainty;
2. Re-analyze ADF&G survey data for global model;
3. Explore alternative methods for ROV survey – adaptive-cluster sampling for relative density zones across habitat

