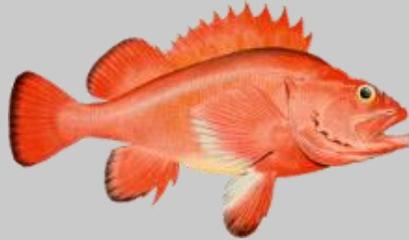


# An age-structured assessment for yelloweye rockfish (*Sebastes ruberrimus*) in Southeast Alaska Outside Waters

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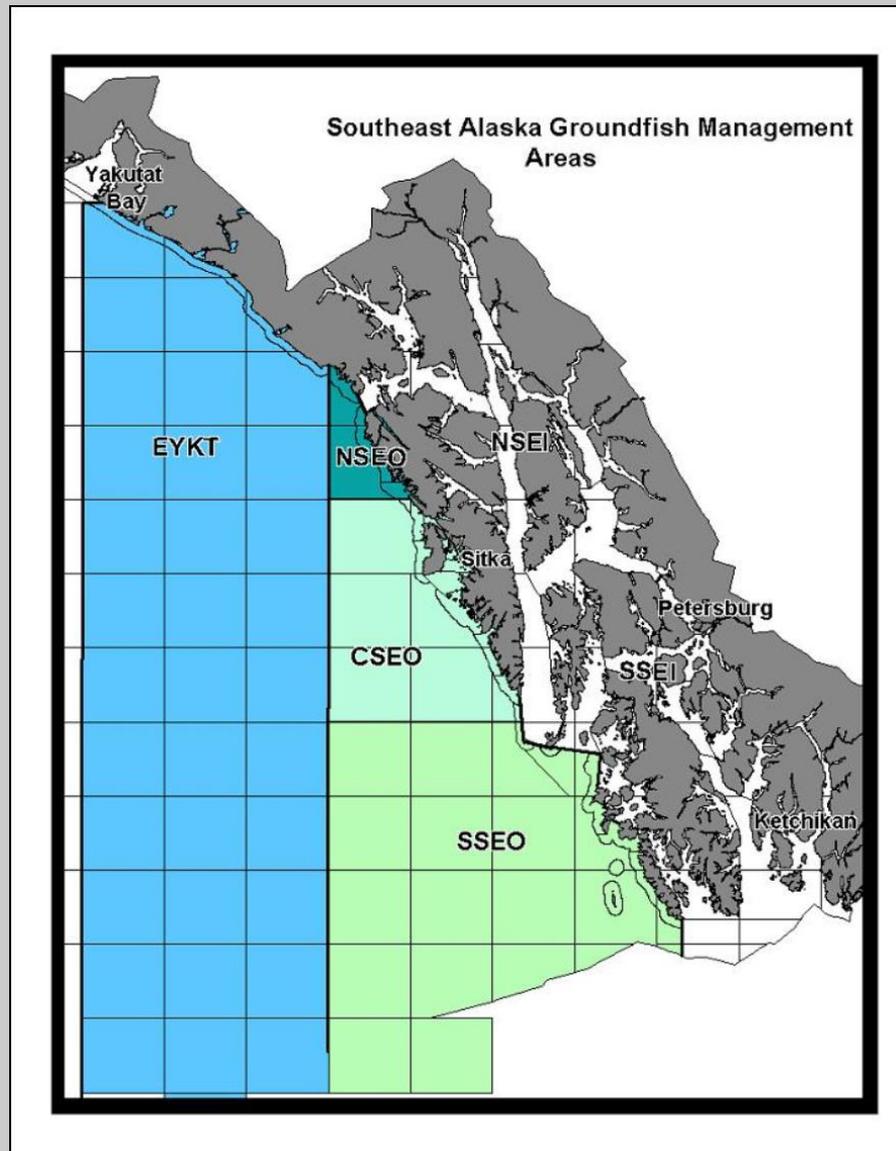


Kray Van Kirk  
Alaska Dept. of Fish and Game

Andrew Olson  
Ben Williams  
Jennifer Stahl  
Kamala Carroll



# Southeast Alaska Outside Waters





# Changes to model data & structure



## Data updated through 2015

No changes from September

## Model issues

1. Overfits to survey density data
2. Overestimates  $M$
3. Underestimates uncertainty
4. Requires additional constraints in penalties and mechanisms in density likelihood

## Suggested mechanisms

1. Fix  $M$
2. Iterative reweighting of survey density data (SDNR)
3. RMSE addition to density likelihood
4. Addition of extra variance term in density likelihood



# Changes to model data & structure



## Structural changes

1. Error in density likelihood corrected
  - a) Resolves model over-fitting to density survey data
  - b) Resolves underestimation of model uncertainty
  - c) Resolves model estimate of  $M$  (previously too high)
  - d) Eliminates need for RMSE or other mechanisms in density likelihood

$$\text{var}(\log(\hat{D})) = \log\left(1 + \frac{\text{var}(\hat{D})}{\hat{D}^2}\right)$$

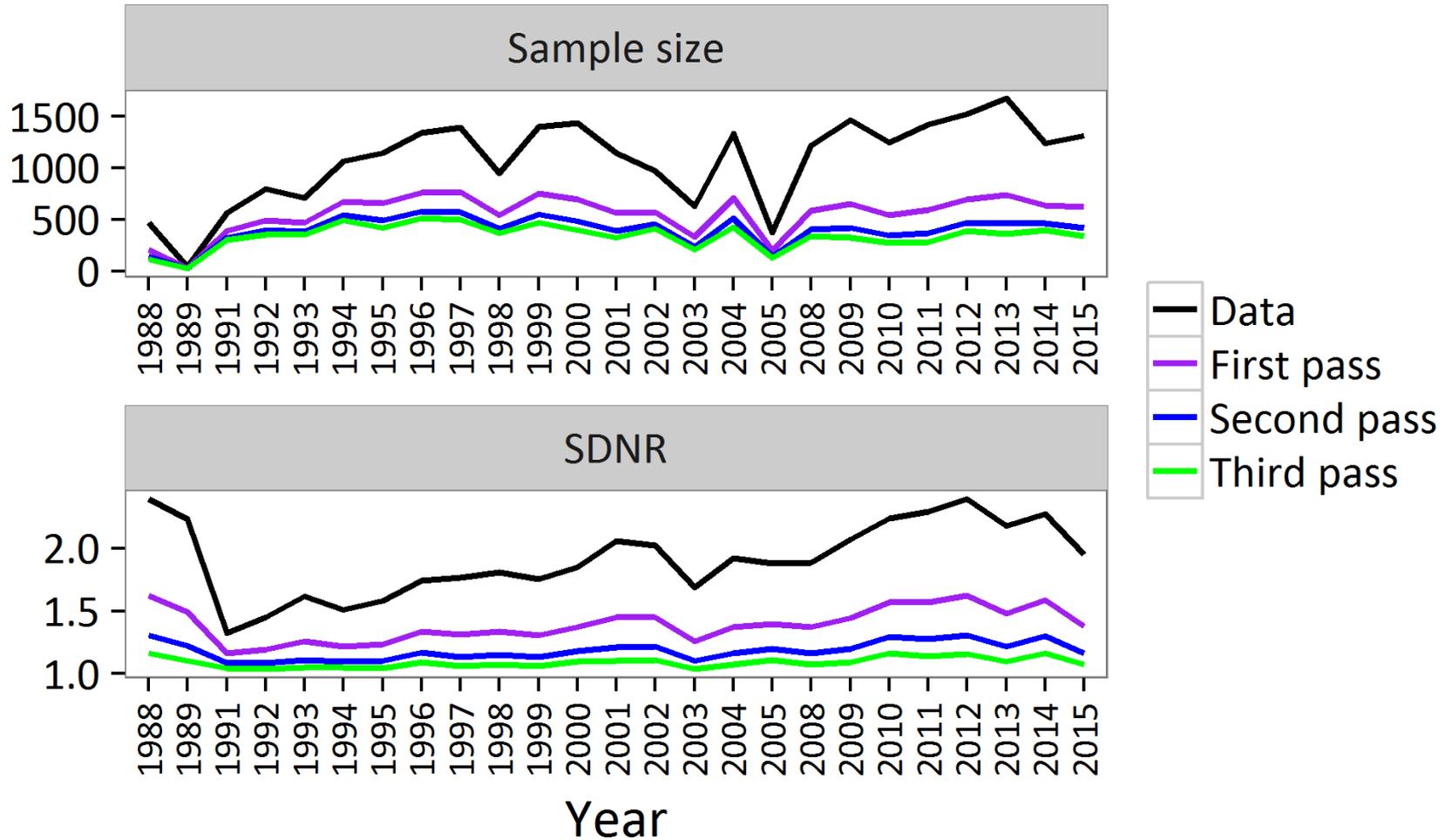
~~$$\text{var}(\log(\hat{D})) = \log\left(1 + \frac{sd(\hat{D})}{\hat{D}^2}\right)$$~~



# Standard deviation of normalized residuals



$$\max(sdnr) < [\chi_{0.95}^2 / (m - 1)]^{0.5} = 1.231 \text{ (Francis 2011)}$$





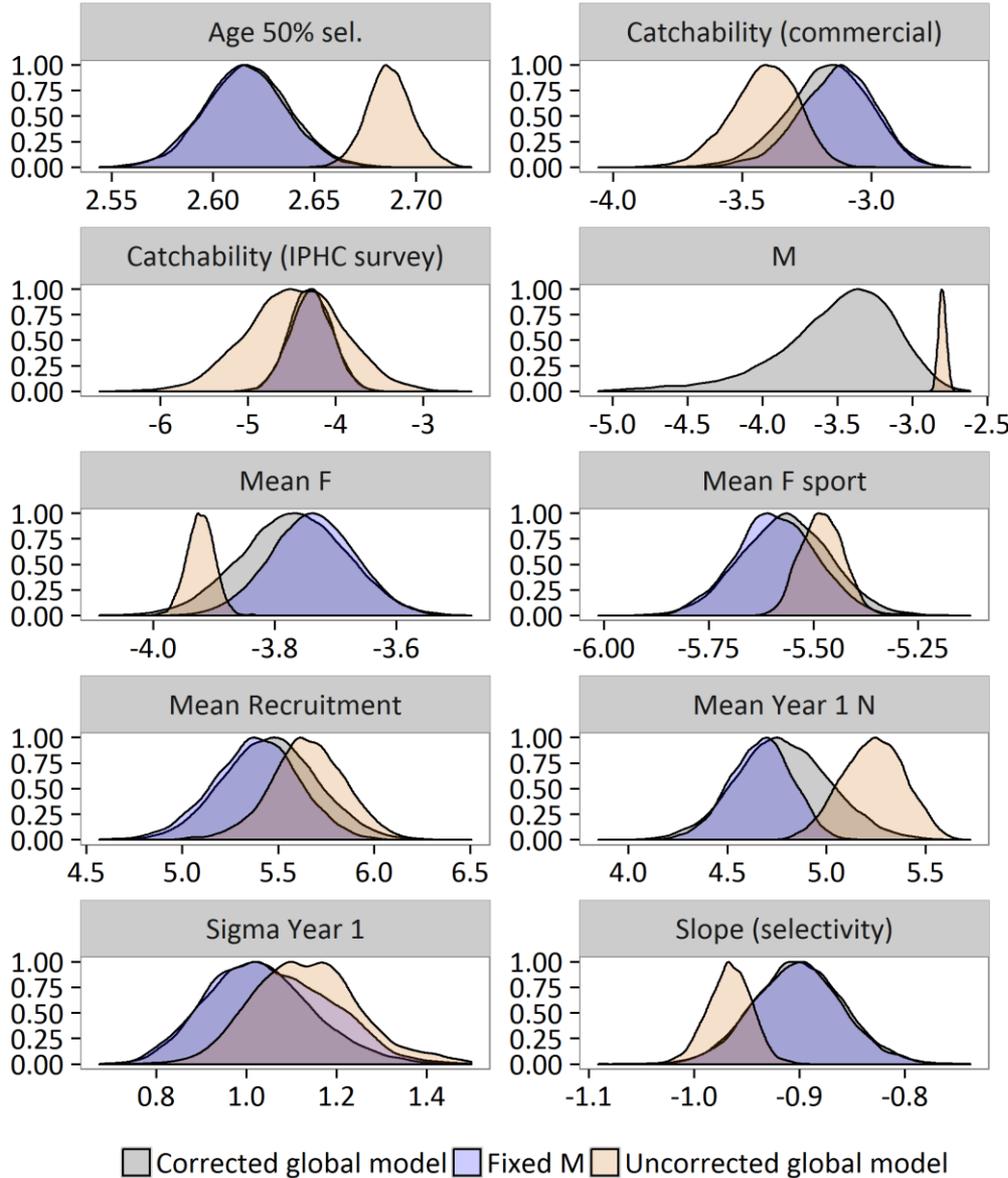
# Models presented



1. Uncorrected Global model
2. Corrected Global model
3. Fixed M



# Primary parameters



Corrected and Fixed M:  
 10,000,000 MCMC draws  
 Every 500<sup>th</sup> retained  
 25% burn-in

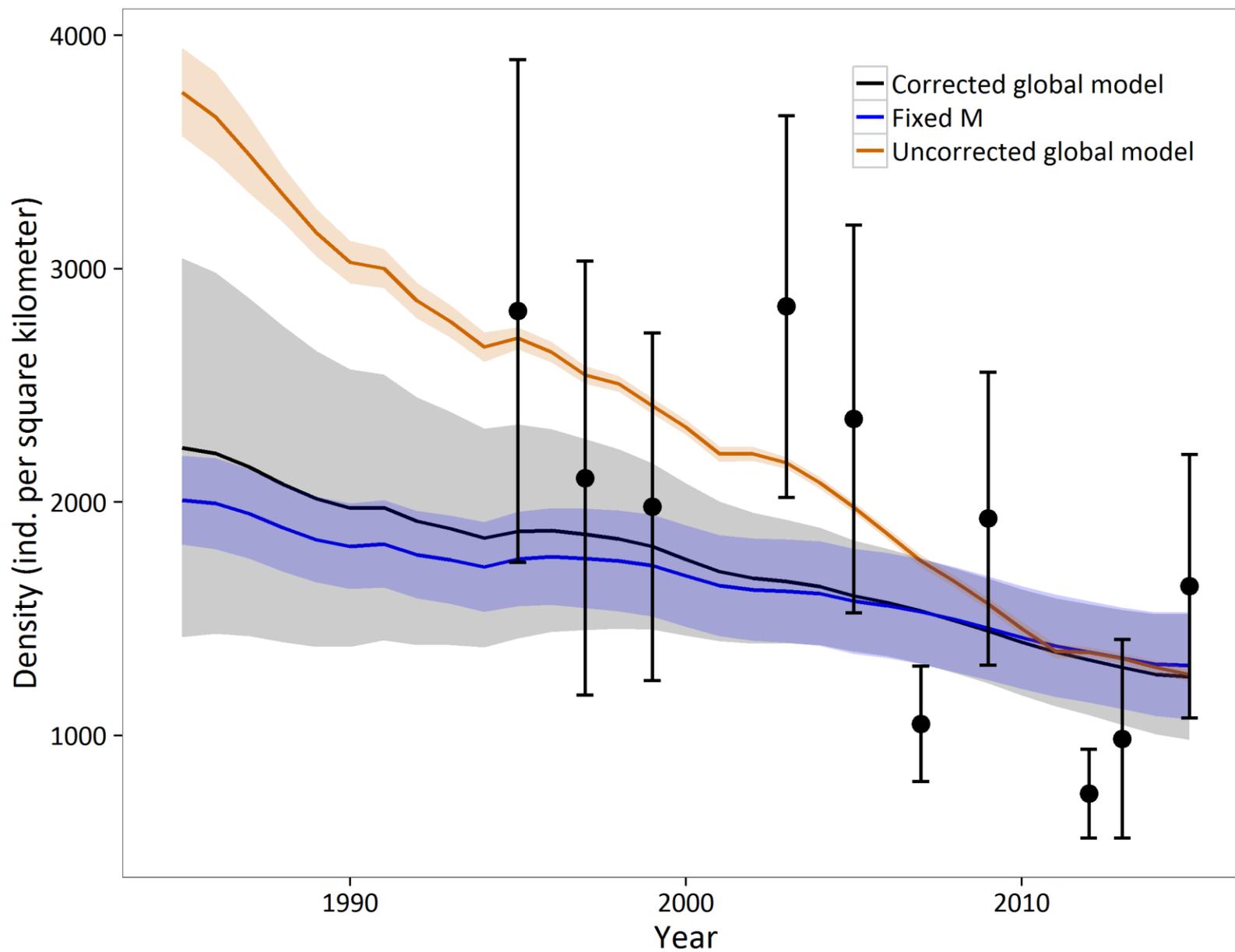
Uncorrected:  
 2,500,000 MCMC draws  
 Every 100<sup>th</sup> retained  
 25% burn-in

$$M = 0.032$$

$$Tier\ 4 = 0.026$$

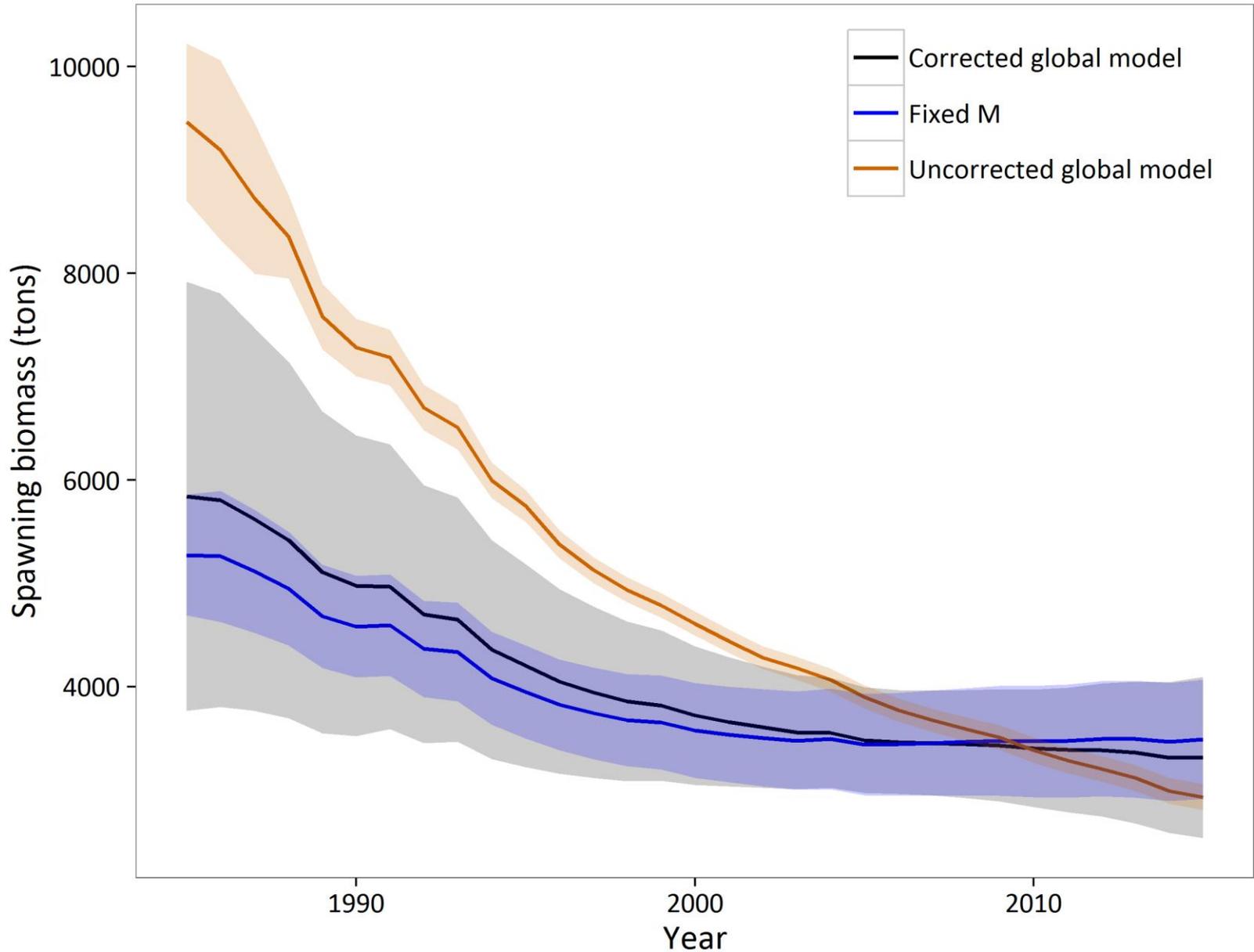


# Results: Density



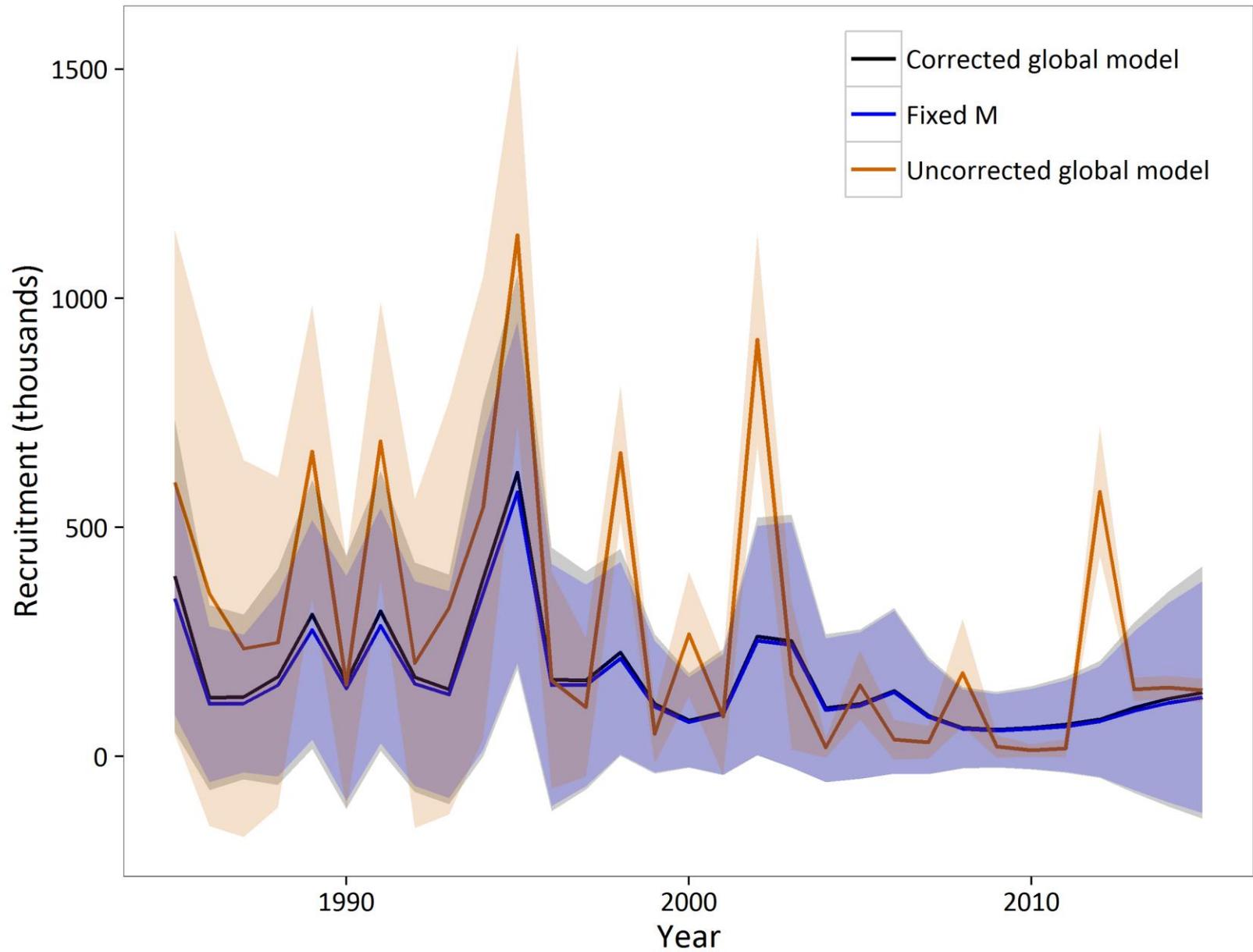


# Result: Total spawning biomass





# Total recruitment

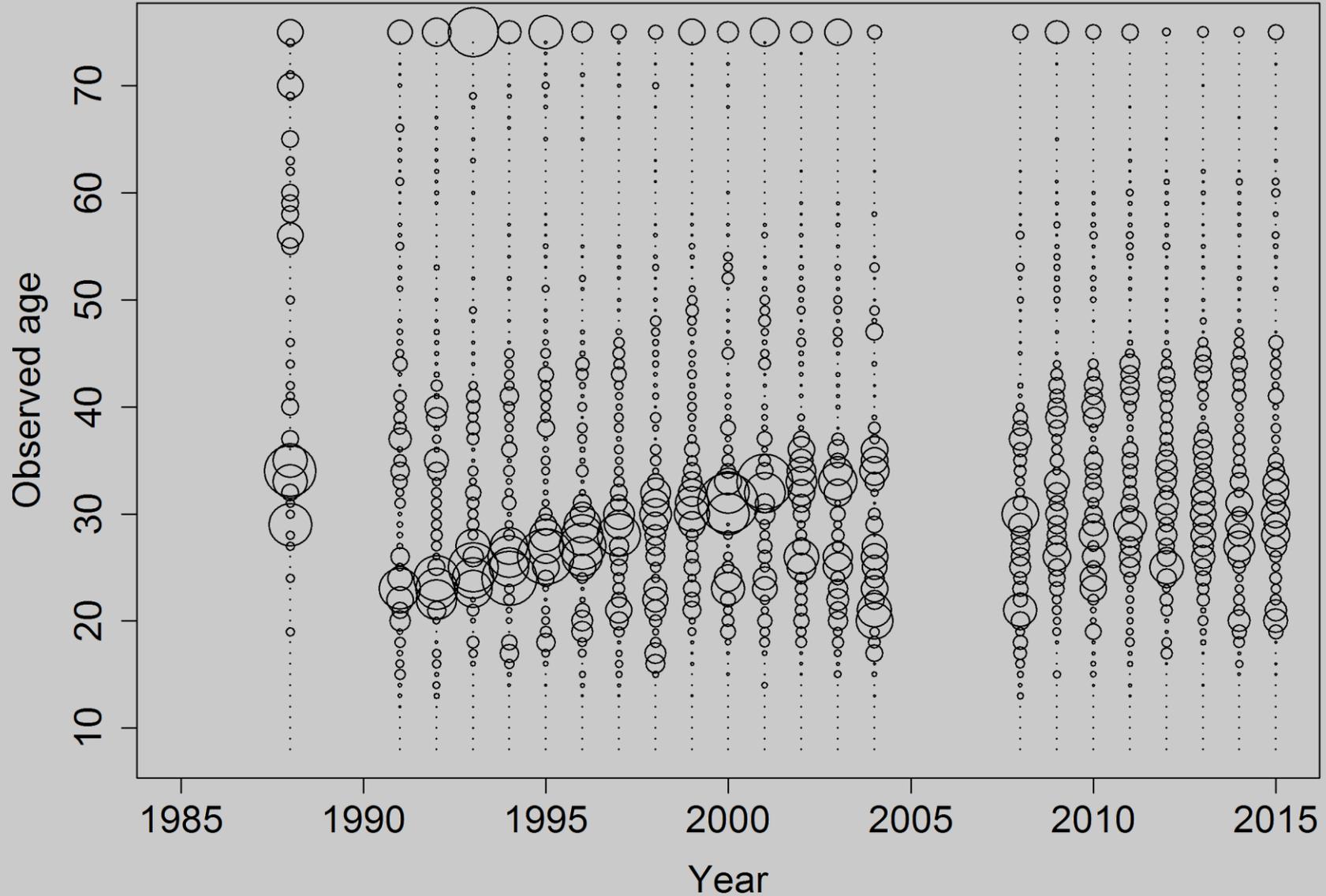




# Results: recruitment indications



Observed catch composition CSEO

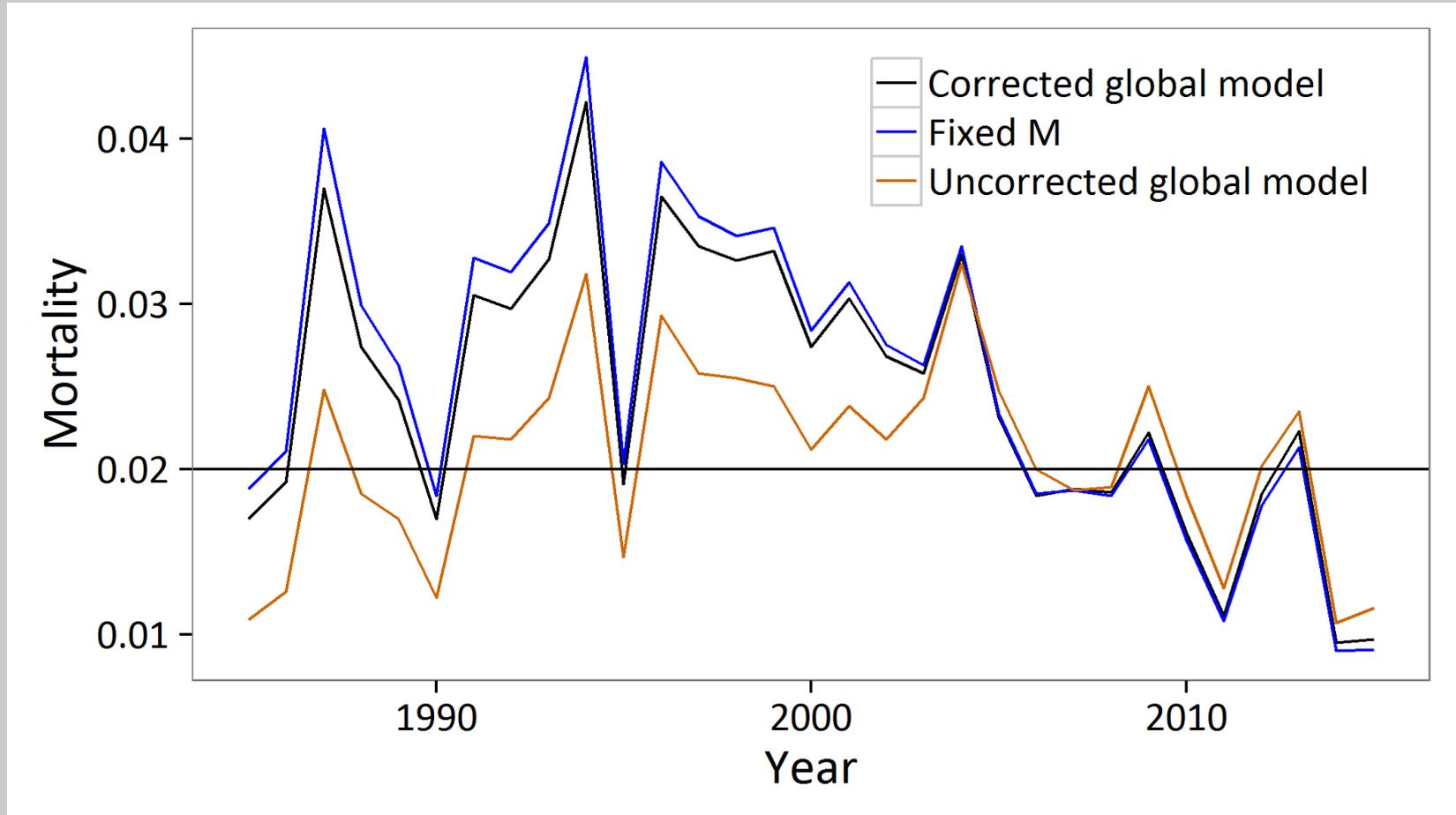






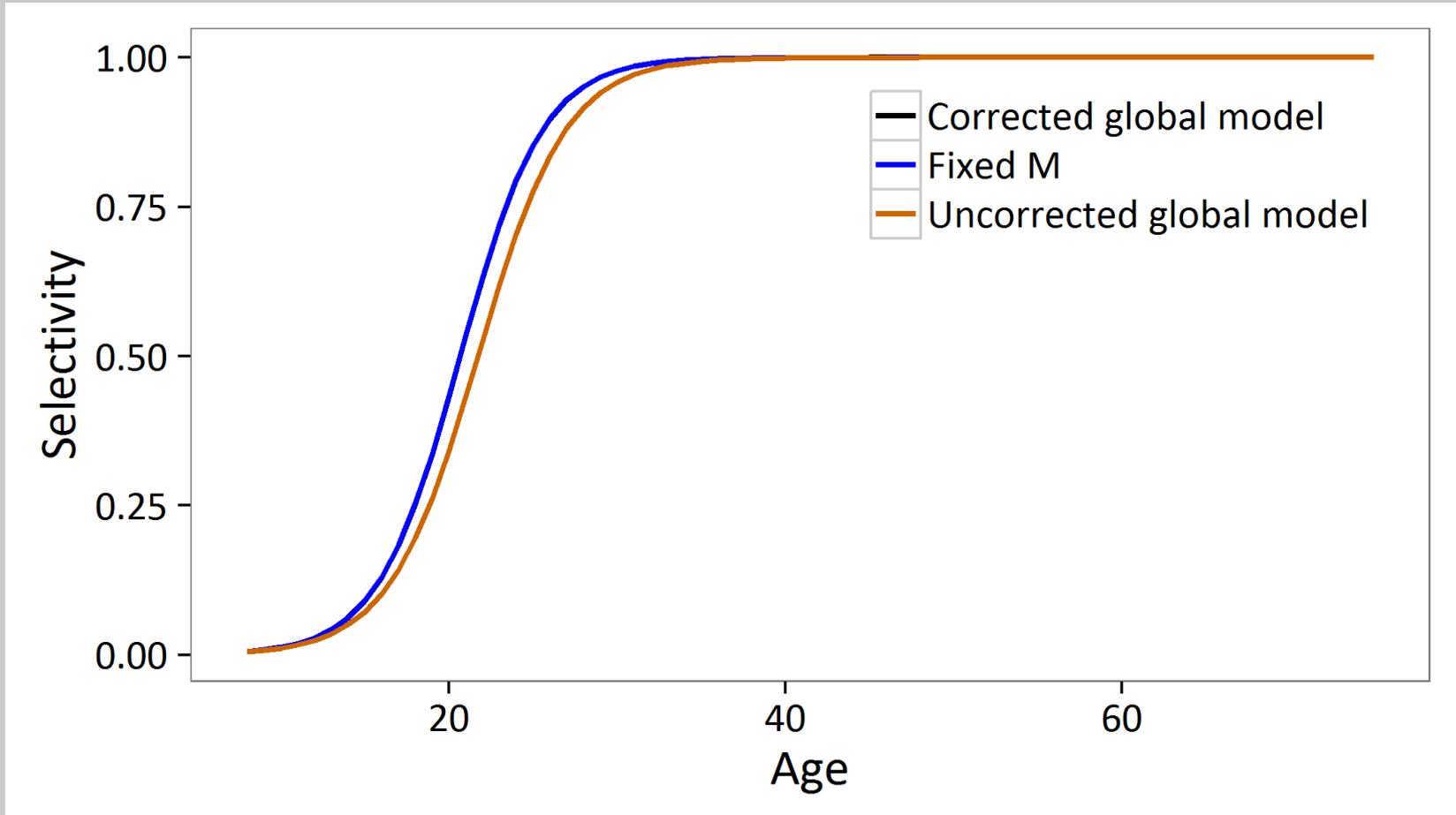


# Results: Full-recruitment fishing mortality



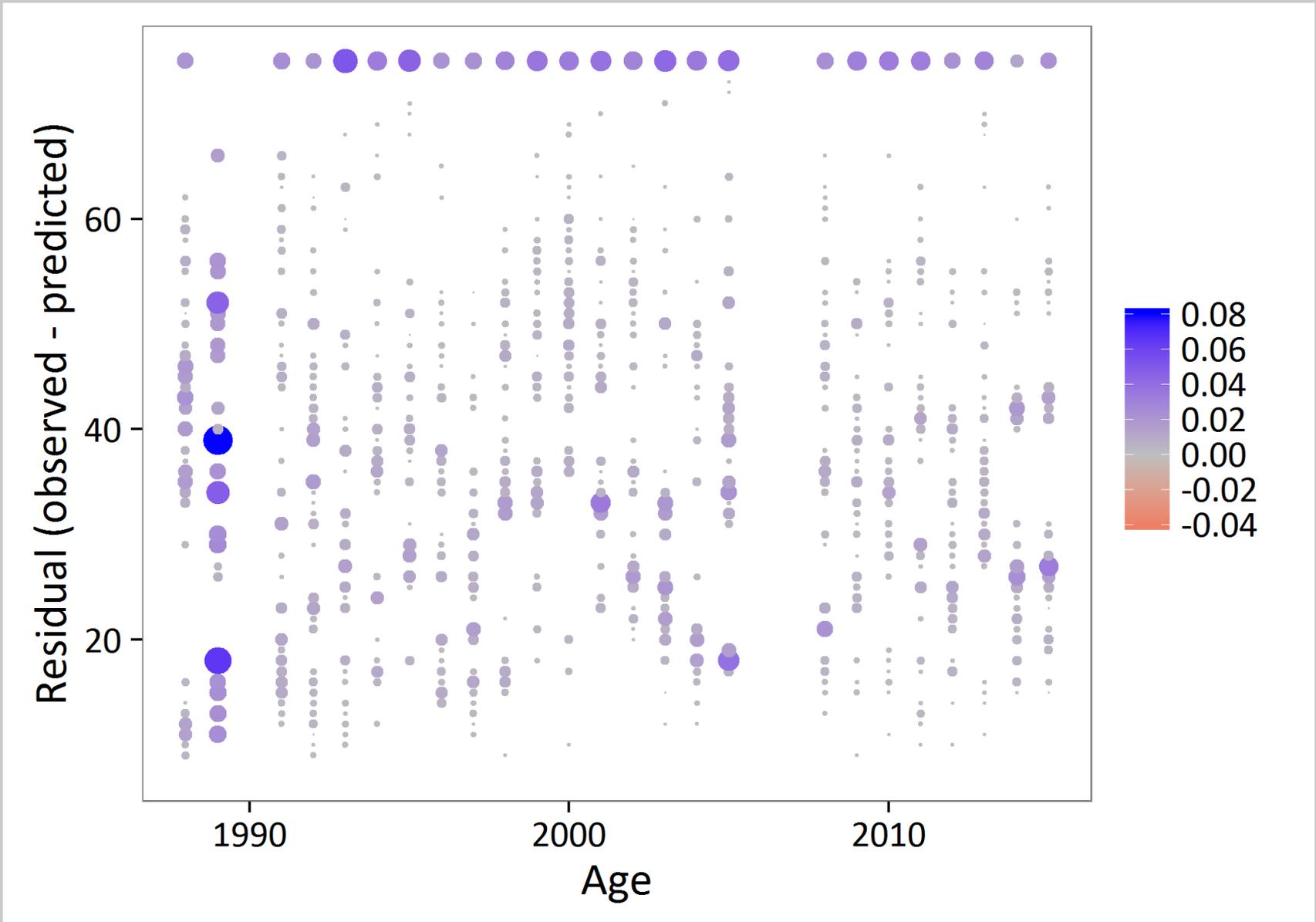


# Results: Fishery selectivity



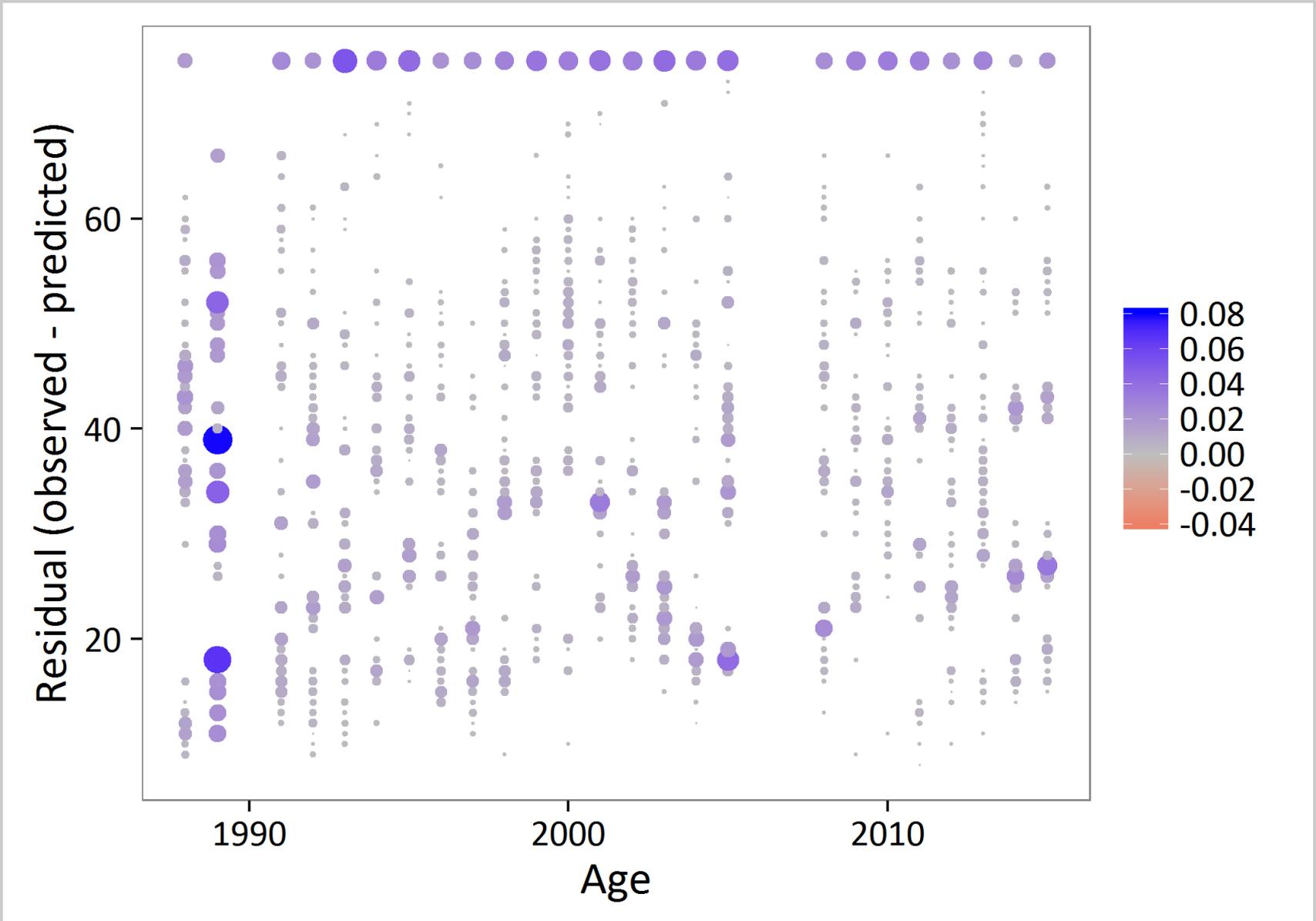


# Results: Catch age residuals - corrected



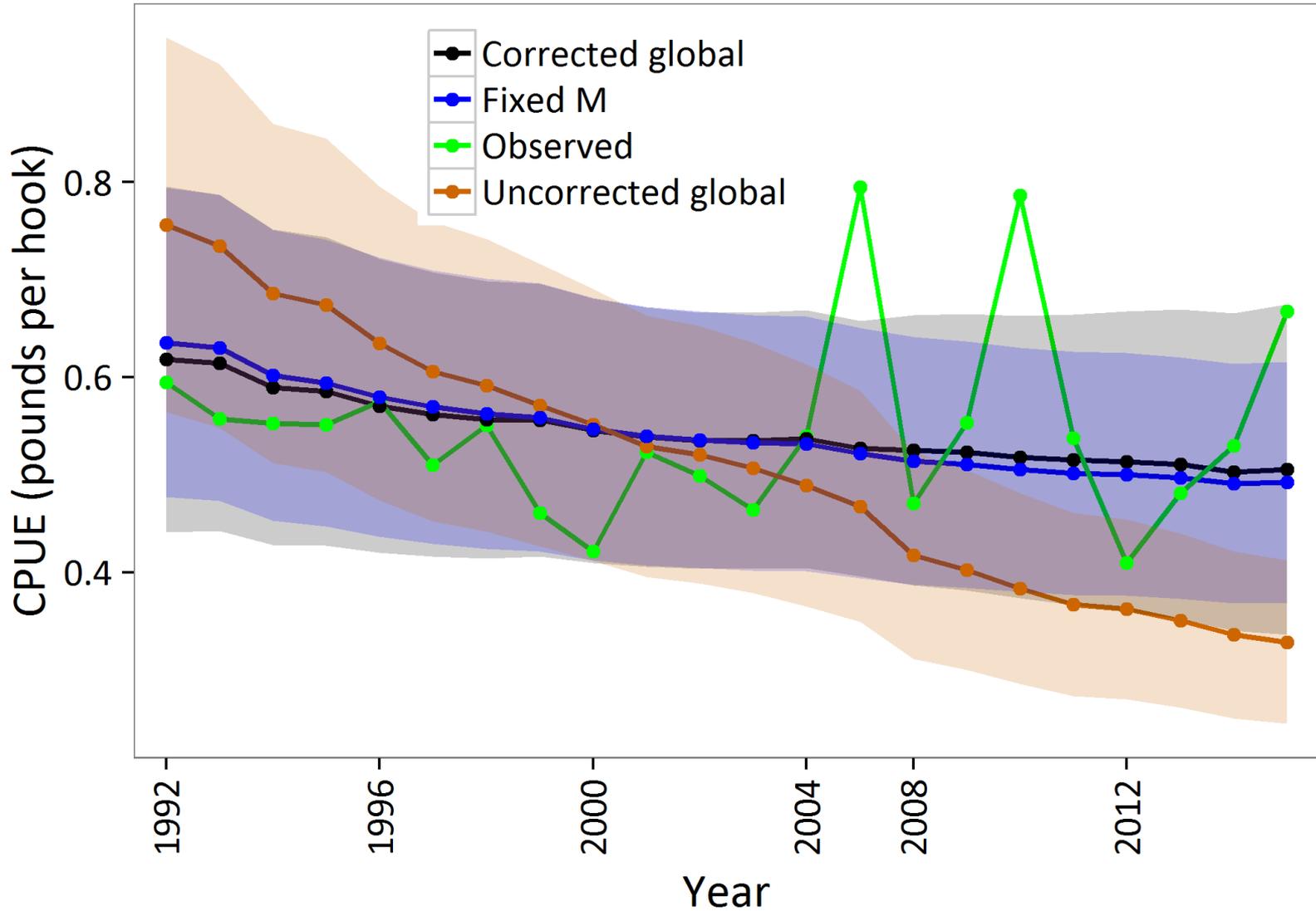


# Results: Catch age residuals - uncorrected



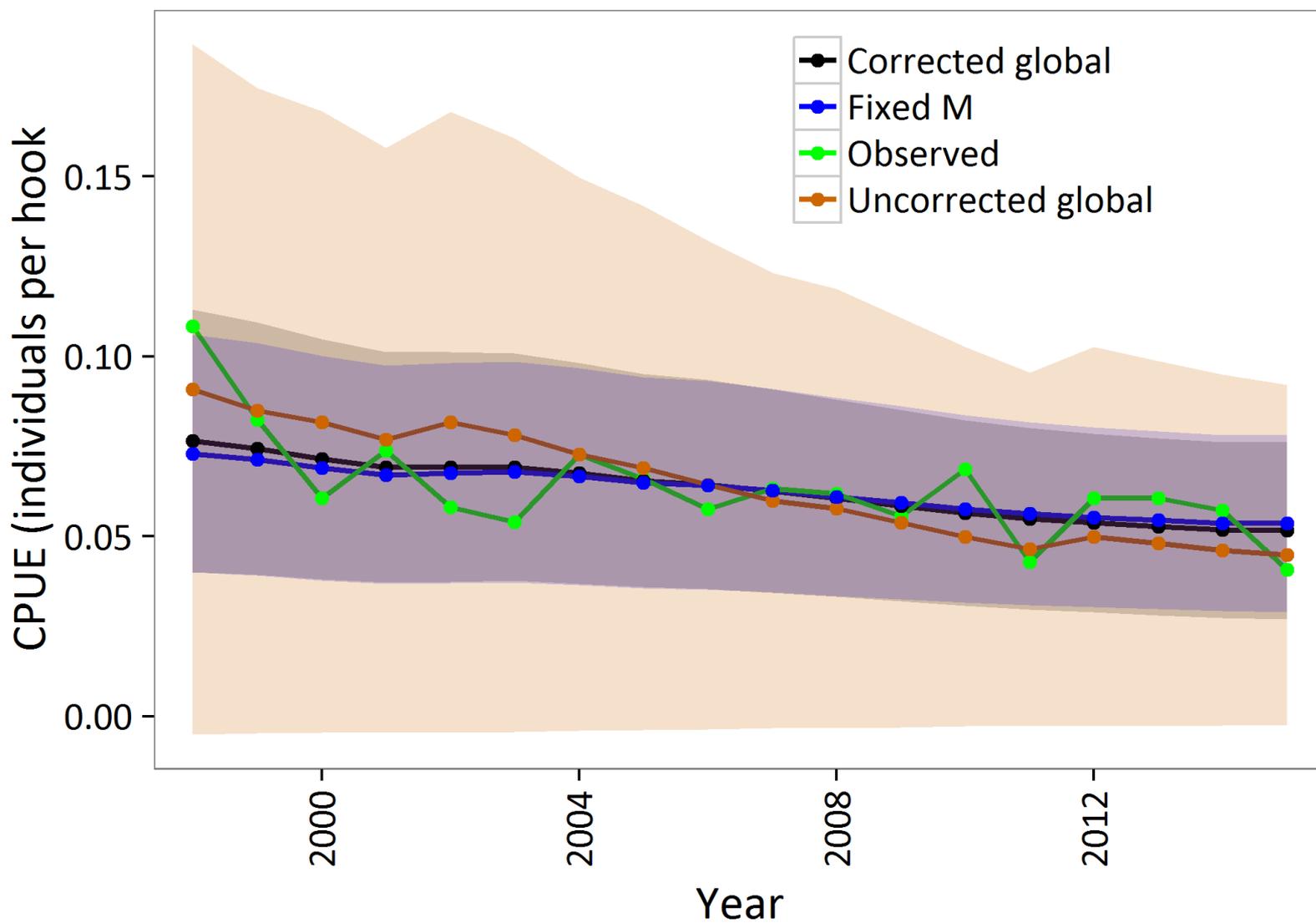


# Results: Commercial fisheries CPUE





# Results: IPHC survey CPUE





# Model Results: Likelihoods



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Likelihood	Corrected model	Fixed M	Uncorrected model
Commercial catch	-2.06	-2.06	7.26
Sport catch	-1.38	-1.38	-0.48
Age composition	835.77	835.94	2660.93
Survey density	6.40	7.66	2072.84
CPUE	-43.70	-43.97	-42.07
IPHC CPUE	10.51	10.53	25.29



# Model Results: Comparisons

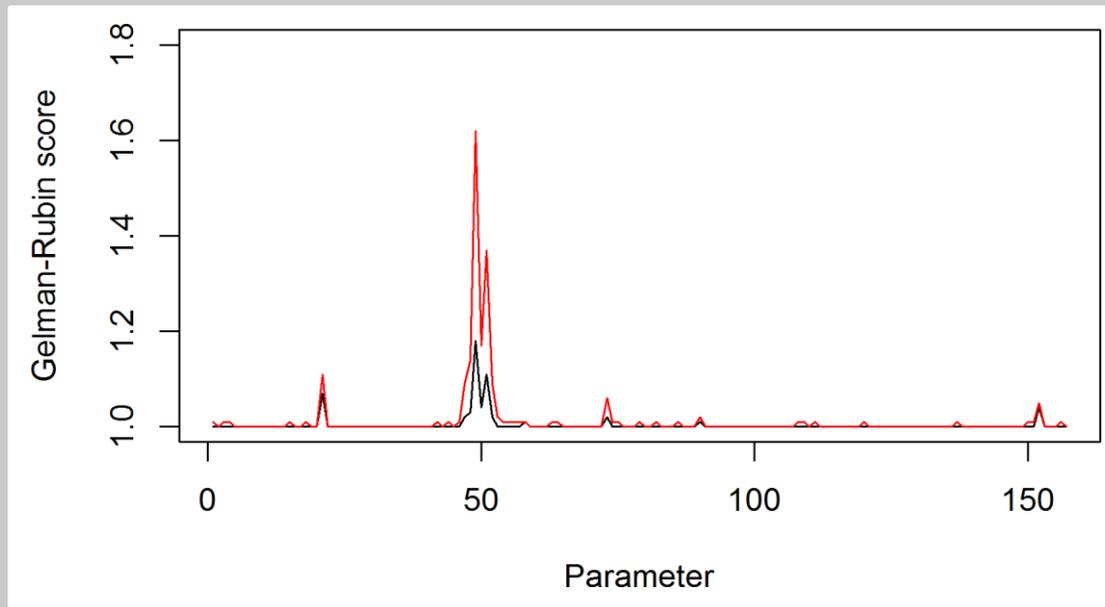


## Deviance Information Criterion

DIC values for models from 10,000,000 MCMC iterations, saving every 500<sup>th</sup>

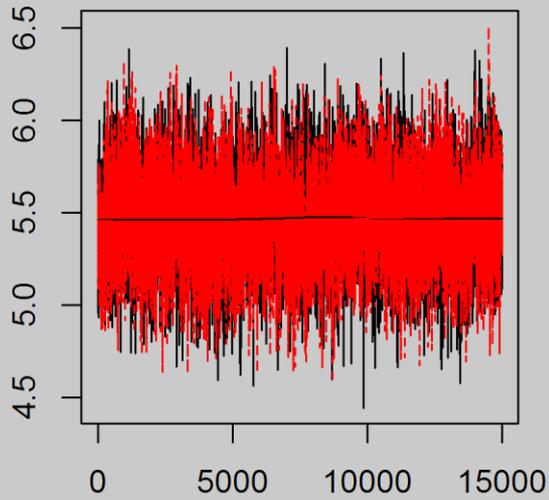
	Corrected – Chain 1	Corrected – Chain 2	Uncorrected*
Expectation of log-likelihood	1825	1824	9743
Expectation of theta	1832	1927	10274
Effective number of parameters	-7	-103	-632
DIC	1818	1722	9111

\*The Uncorrected model was from the previous MCMC run, using 2,000,000 iterations and preserving every 100<sup>th</sup>

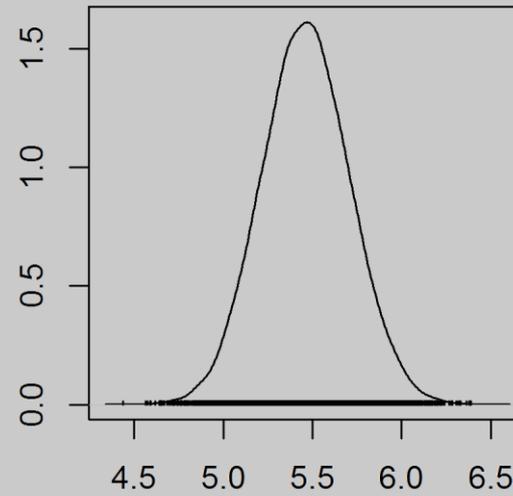




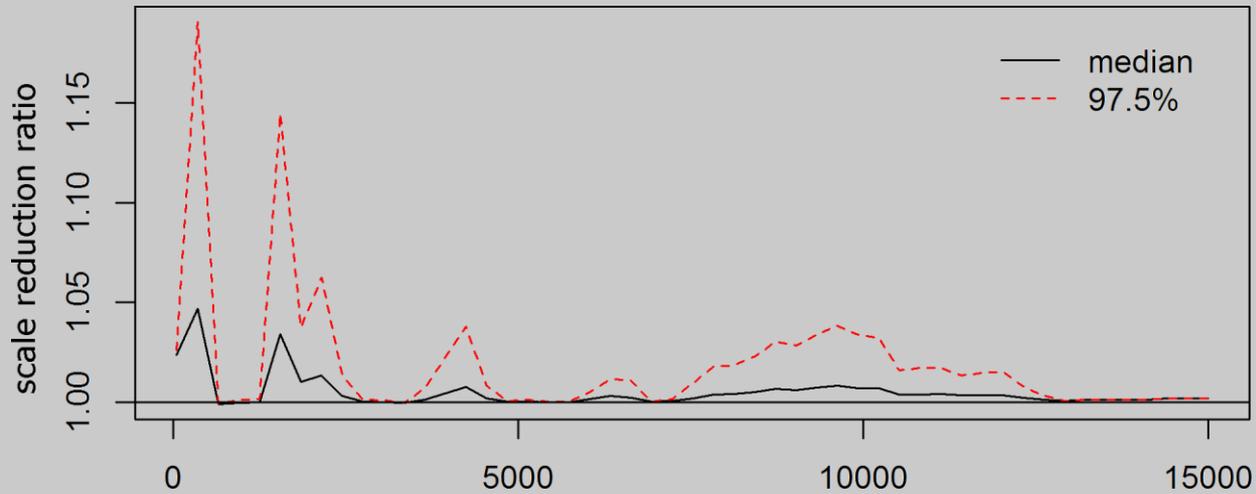
# Model Results: Mean recruitment



Iterations



Distribution of parameter draws

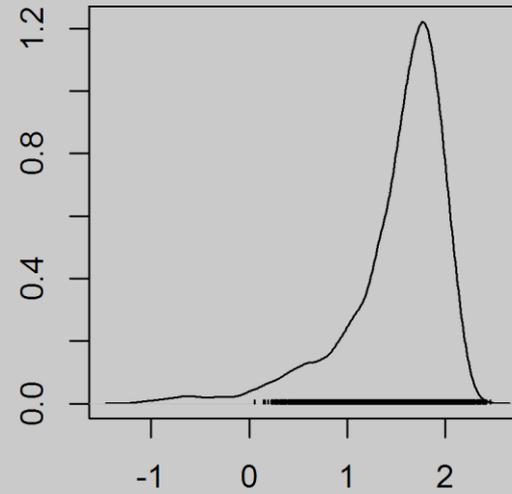
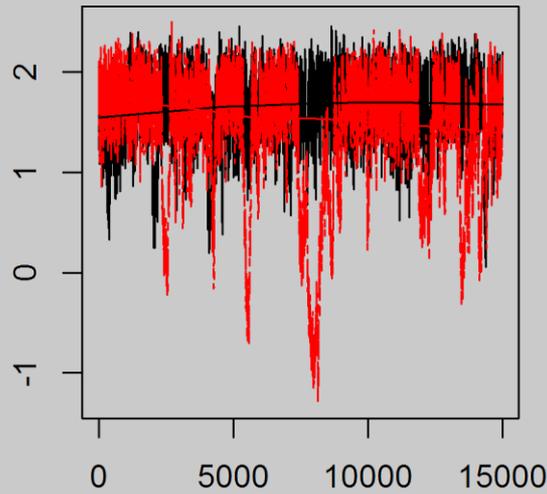


last iteration in chain

Gelman diagnostic

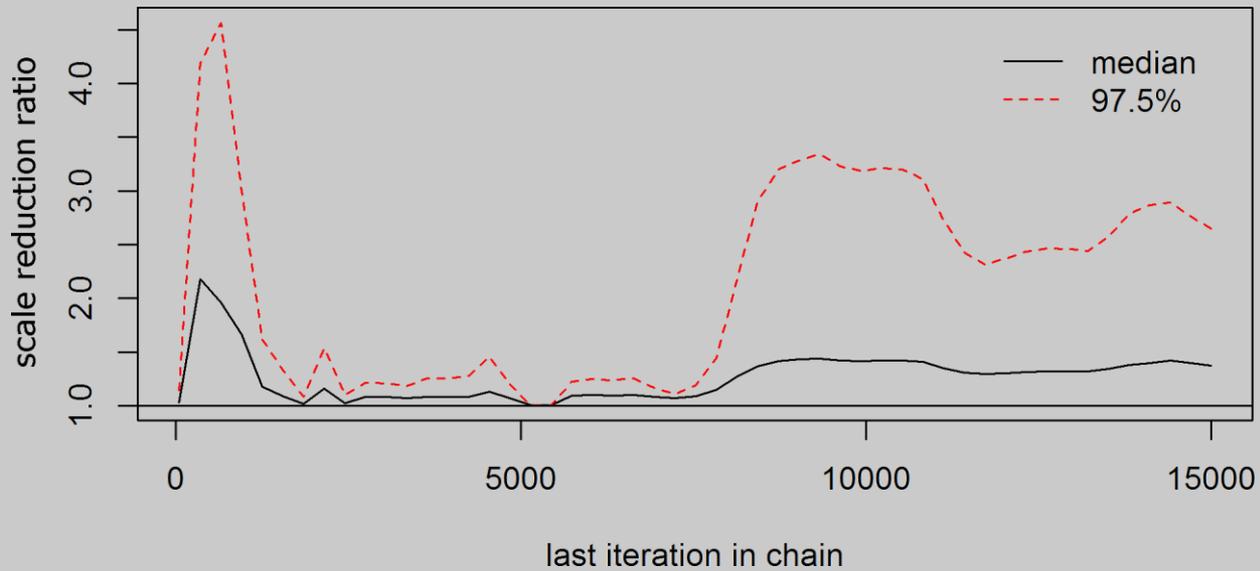


# Model Results: Year 1 age 16 abundance



Iterations

Distribution of parameter draws



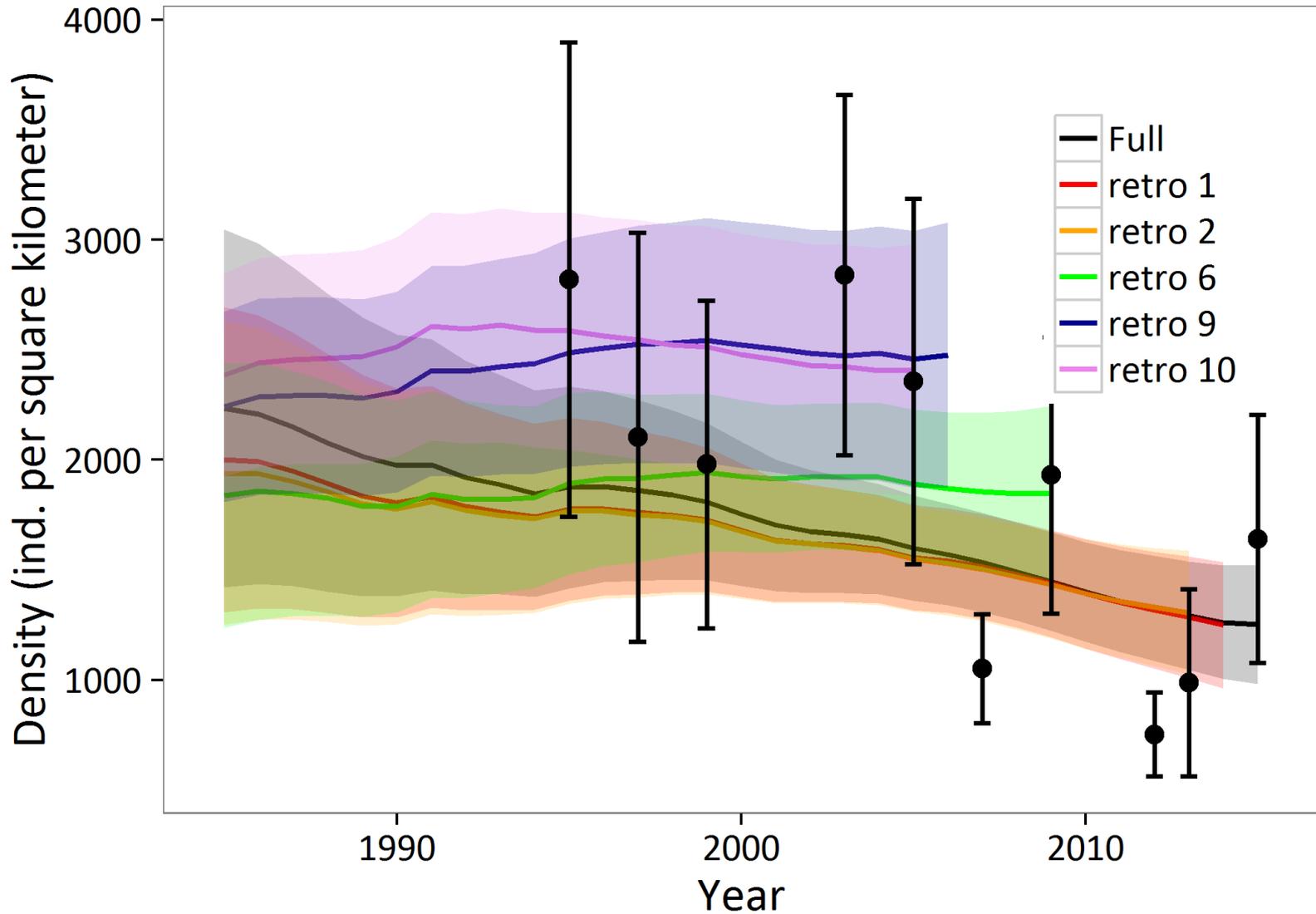
Gelman diagnostic



# Global model evaluation



## Retrospective analysis: density

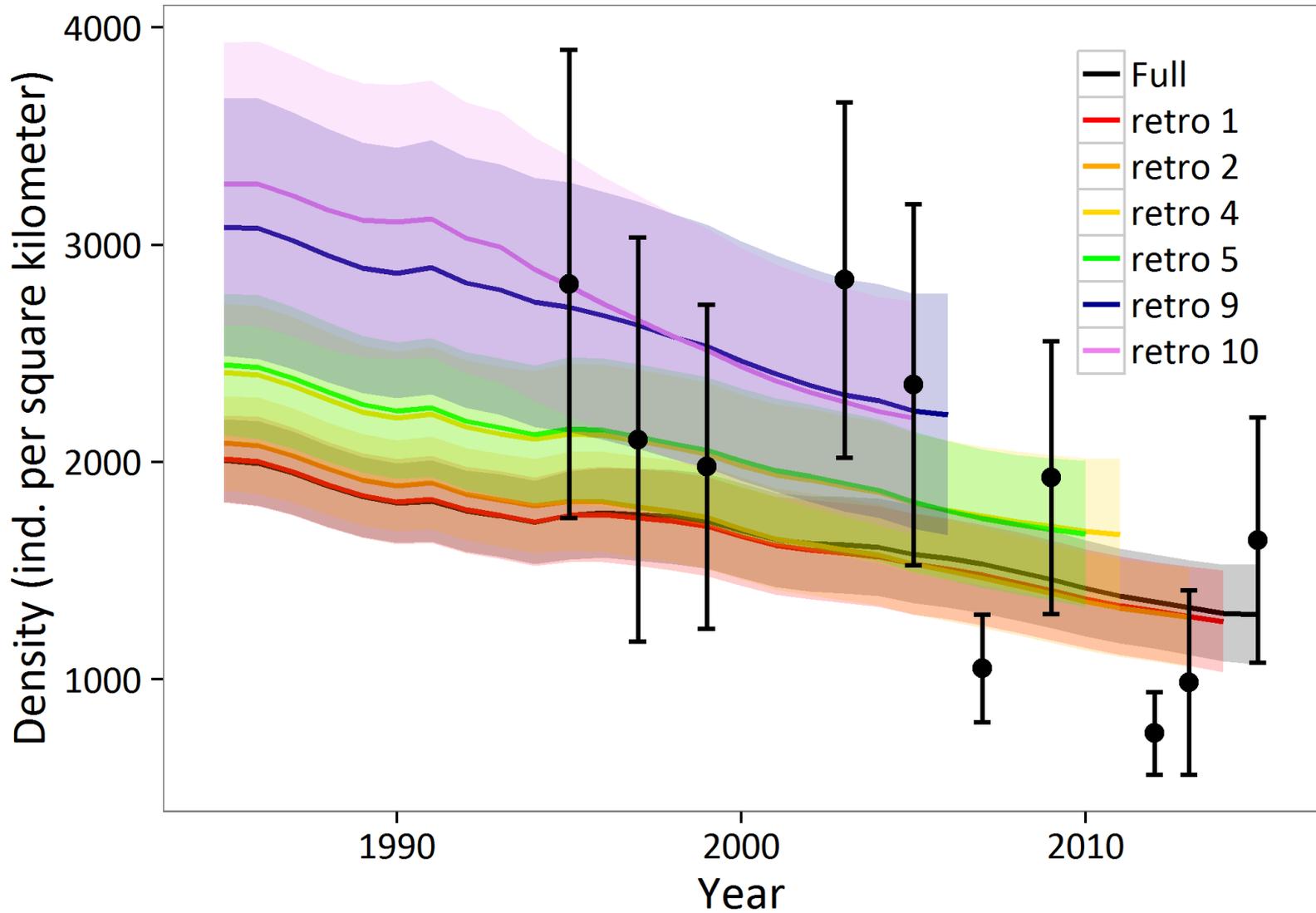




# Fixed M model evaluation



## Retrospective analysis: density

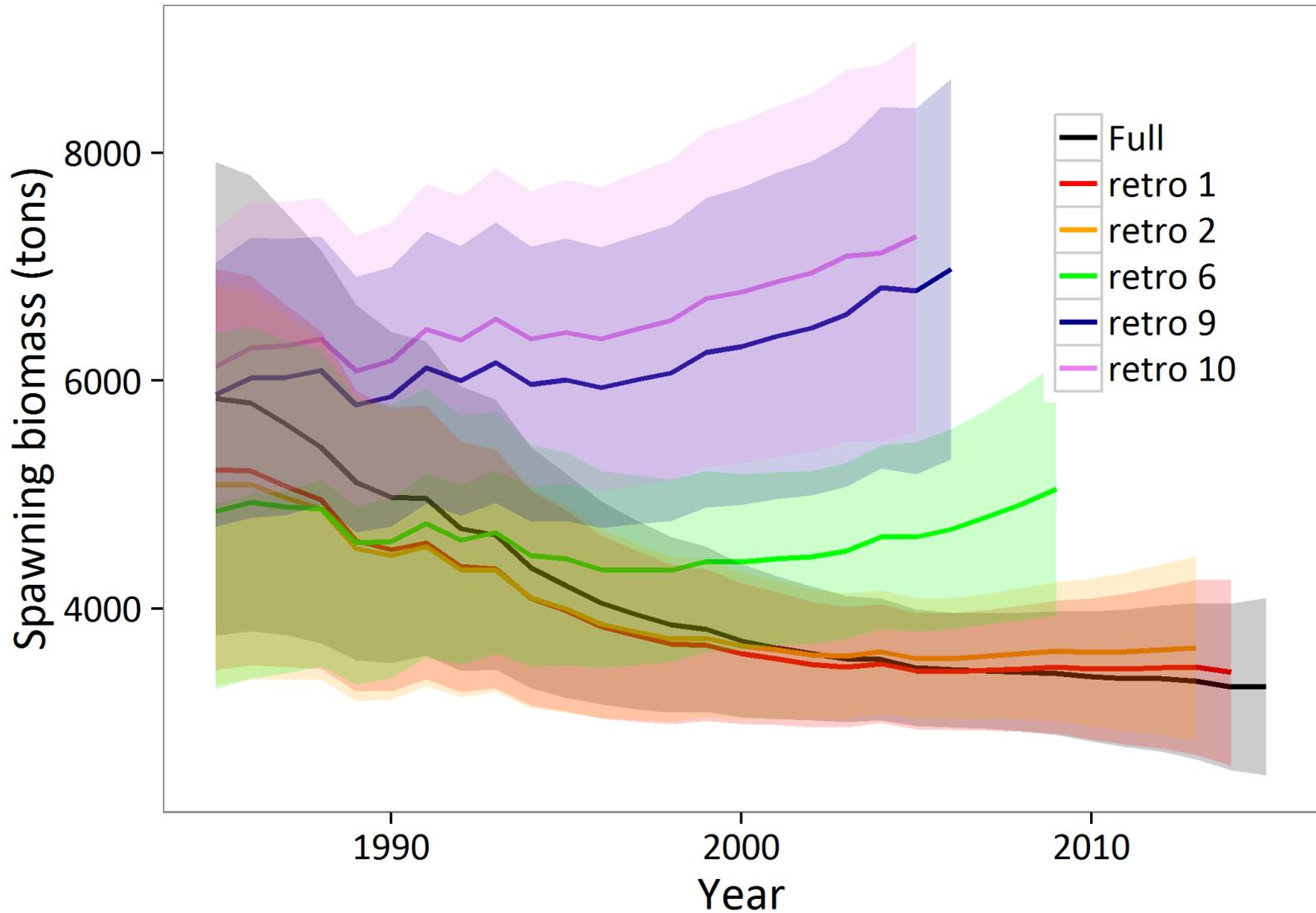




# Global model evaluation



## Retrospective analysis: spawning biomass

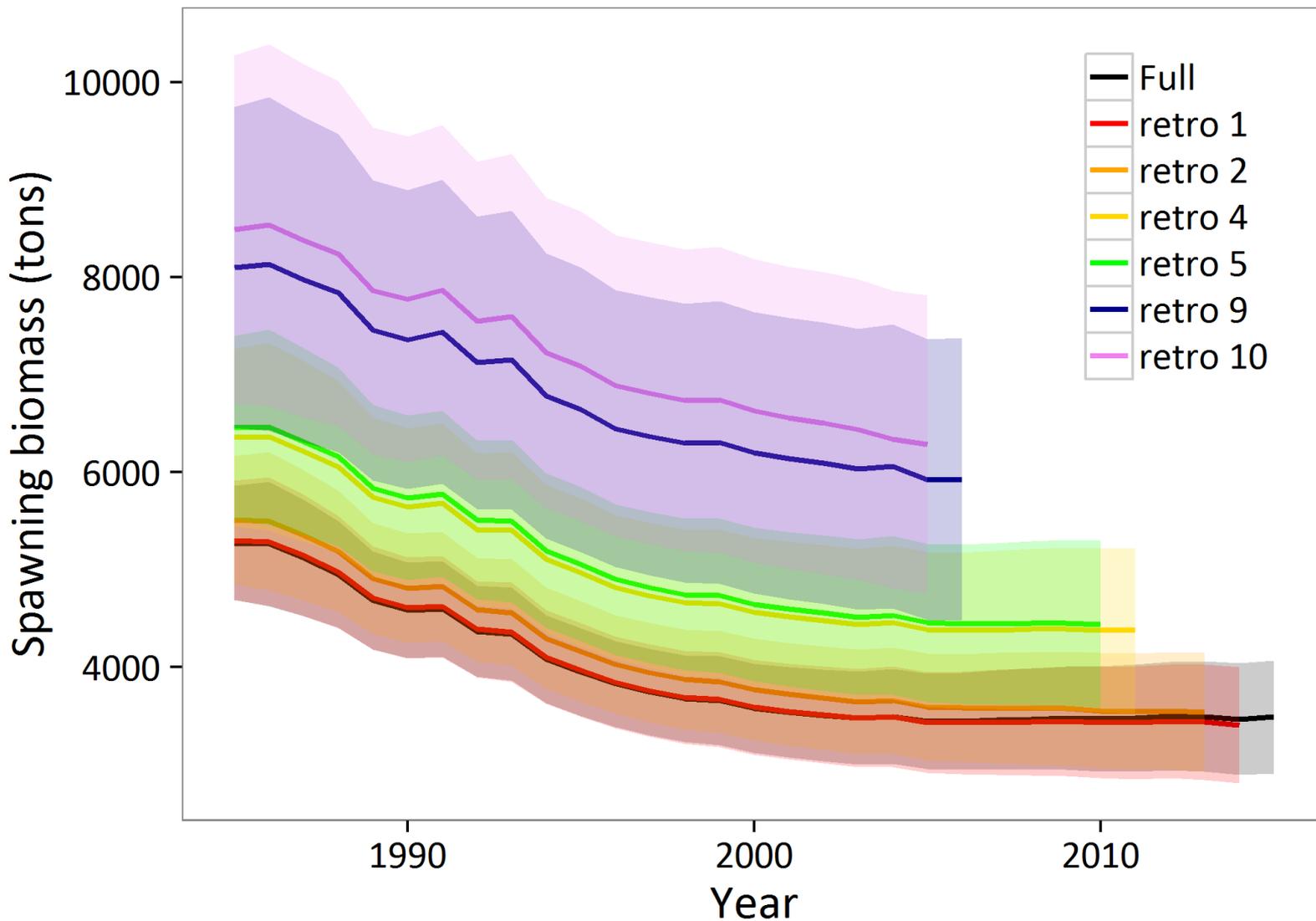




# Fixed M model evaluation



Retrospective analysis: spawning biomass

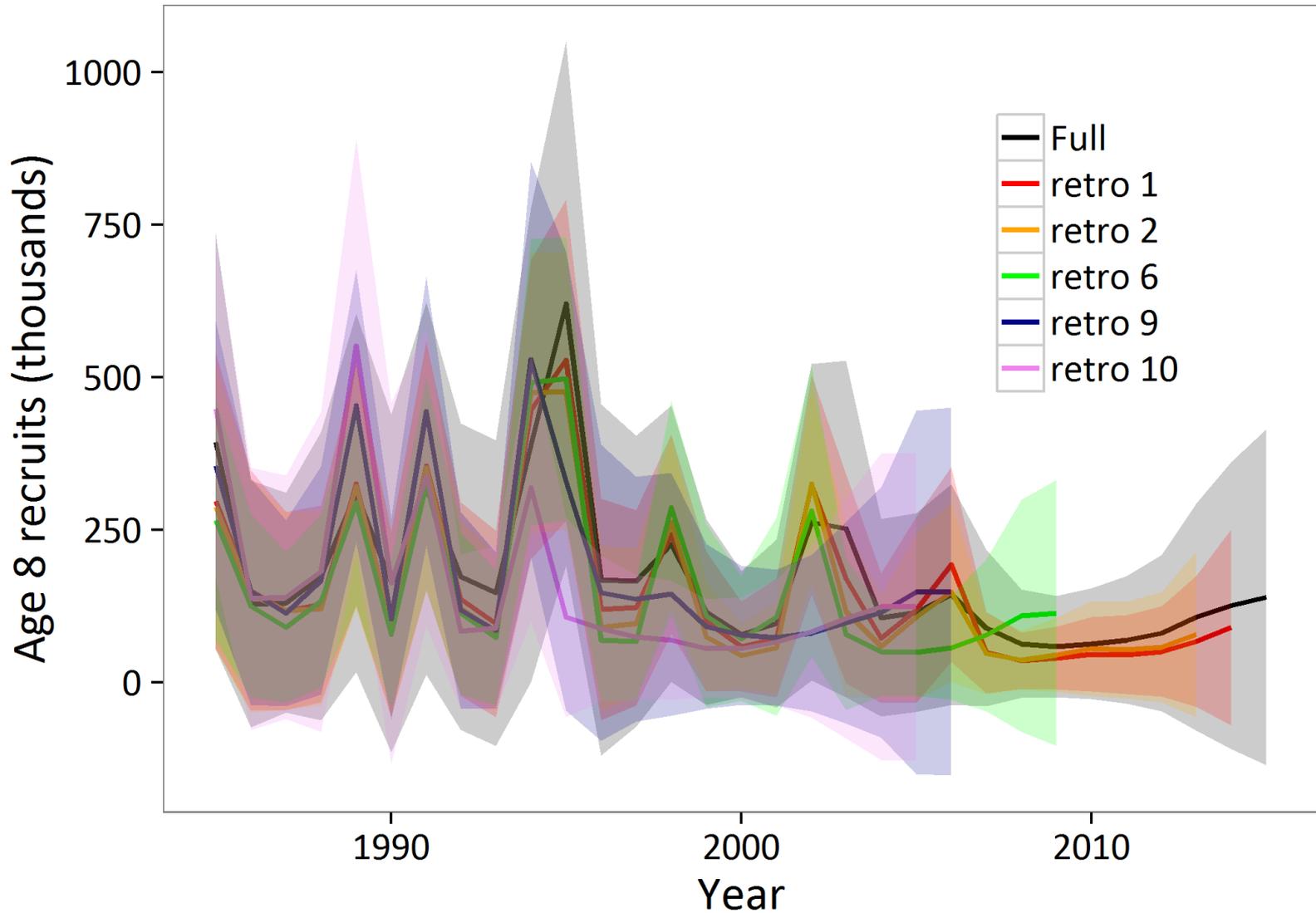




# Global model evaluation



## Retrospective analysis: age 8 recruitment

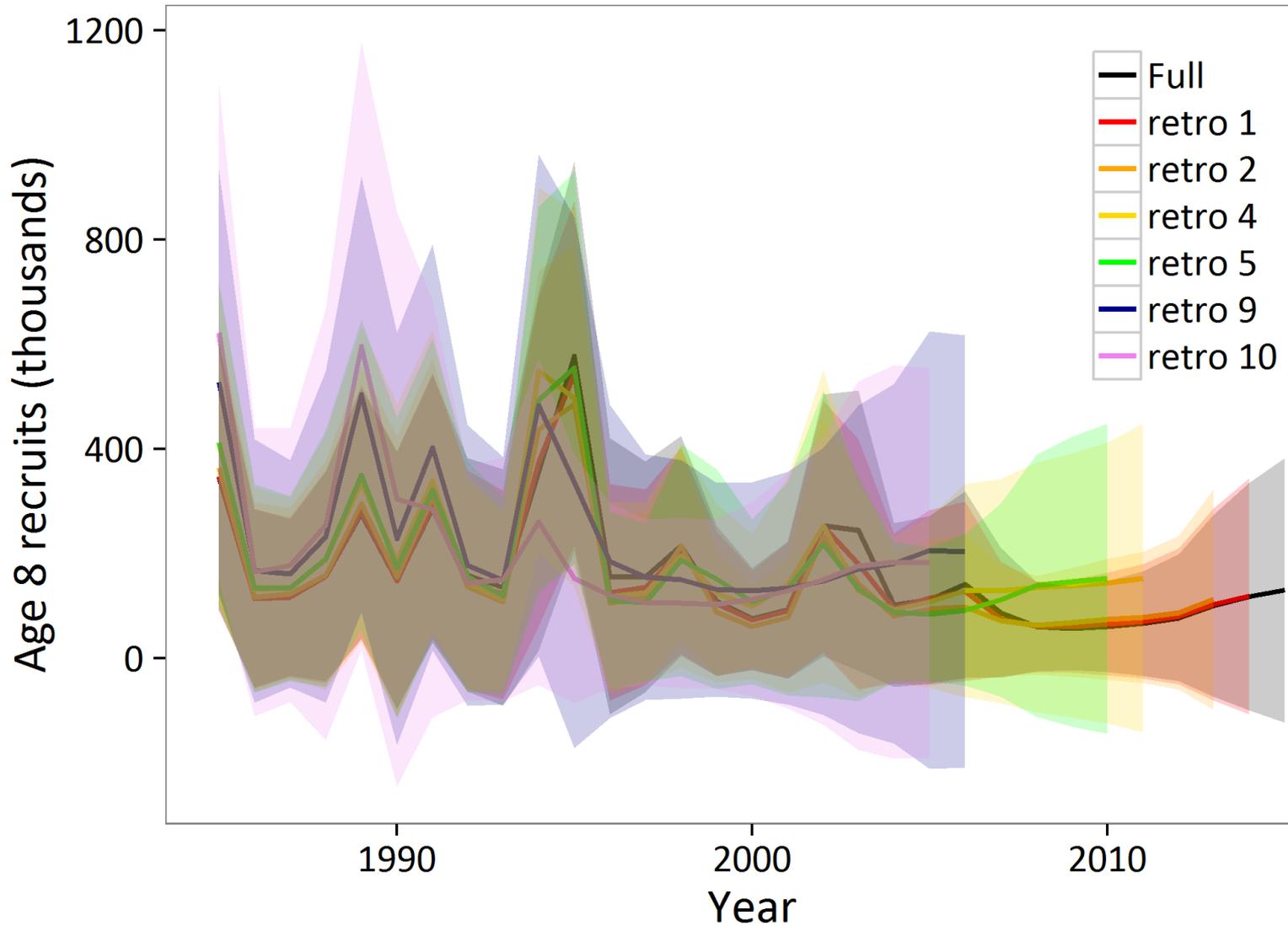




# Fixed M model evaluation

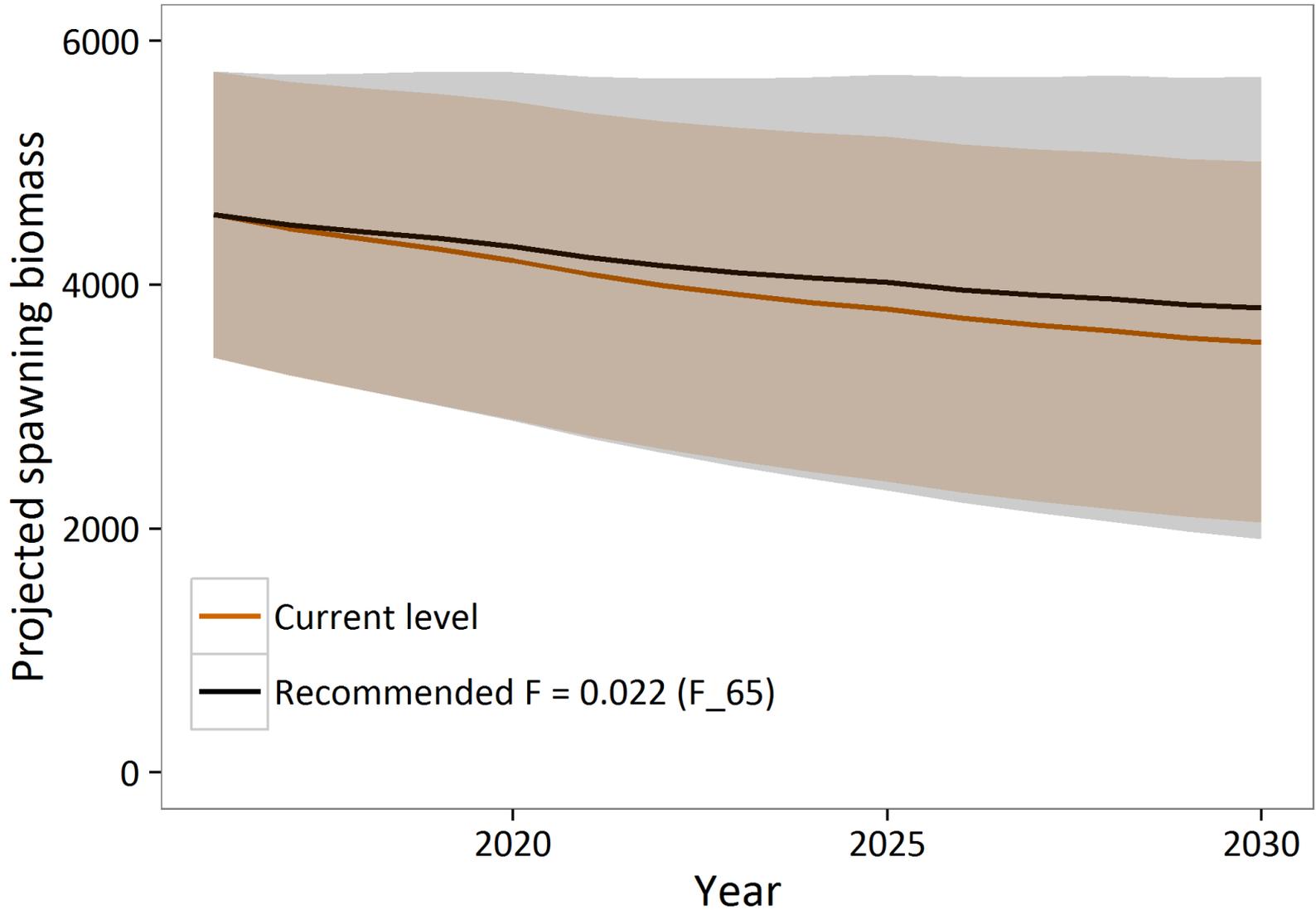


Retrospective analysis: age 8 recruitment





# Spawning biomass projections





# Model Recommendation



<b>F level</b>	<b>Biomass</b> (metric tons)	<b>ABC</b> (metric tons)
$F_{65}$ (0.022)	L 90% CI (8392)	150
$F_{60}$ (0.026)	L 90% CI (8392)	181
$F_{55}$ (0.031)	L 90% CI (8392)	217
<b>CURRENT ABC</b> ( $F = 0.02$ , assumes no selectivity)		<b>211</b>

Current ABC (211 tons) under global model =  $F = 0.0305$

2015 OFL (361 tons) under global model =  $F = 0.0419$

If the corrected global model were accepted for purposes of management advice, the author recommends setting harvest levels to  $F_{65}$  and using the lower 90% confidence interval of the model-estimated biomass to set catch levels, which produces an ABC level for 2016 of **150** metric tons and is directed towards recovery from observed declining abundance.



# Priorities



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

