Incorporation of EBS slope survey data in Tier 3 BSAI rockfish models, and further evaluation of data weighting

Paul Spencer
Alaska Fisheries Science Center

Background

- Recent comments from the BSAI Plan Team has encouraged evaluation of including EBS slope survey data into Tier 3 BSAI rockfish models
- For the BSAI blackspotted/rougheye rockfish model, this would require expanding the area of the model from AI to the BSAI

General approach for survey catchability

- In the current AI-only model for blackspotted/rougheye rockfish, the area of the AI survey matches the area of the modeled stock
- With a BSAI model, some portion of the modeled stock would not be "available" to the AI survey
- The "availability" of the stock was modeled from the relative proportions of smoothed estimates of survey biomass

Modification to survey catchability

Old approach

$$S_{a,t} = qB_{a,t}$$

New approach

$$S_{a,t} = p_{AI,t}qB_{a,t}$$

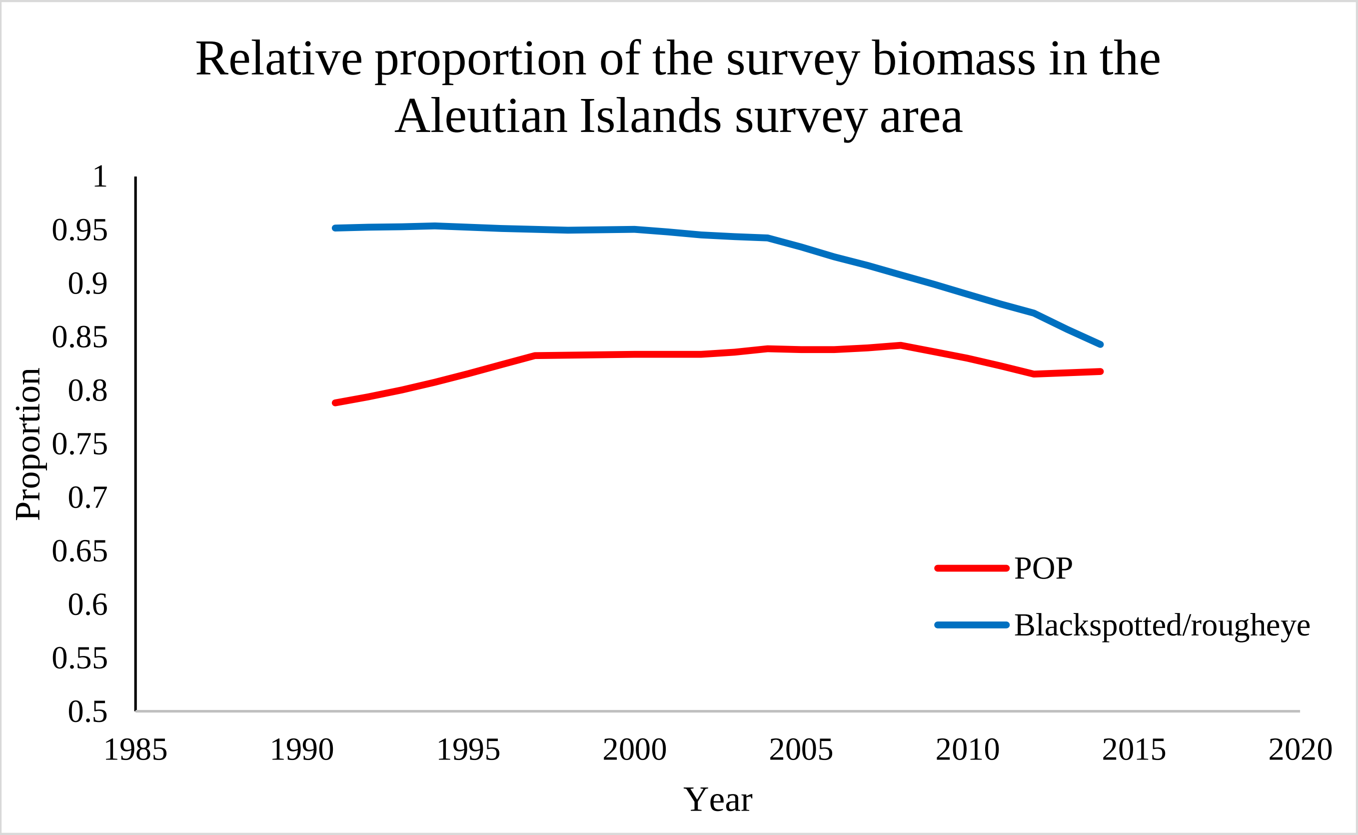
$B_{a,t}$ = modeled biomass at age *a* in year *t* (after adjusting for survey selectivity).

$S_{a,t}$ = Predicted AI survey biomass at age *a* and year *t*.

q = survey catchability

p_{AI} = proportion of stock in the AI area

Time series of relative proportions



Methods for re-weighting composition data (from Francis 2011)

General approach is that the “second stage” sample sizes ($N_{j,y}$) are the product of a “first stage” sample sizes ($\tilde{N}_{j,y}$) and a weight

$$N_{j,y} = w_j \tilde{N}_{j,y}$$

A single weight for each data type (*j*)

The weights are updated with each model run, and iterated until they converge

Methods of data weighting

Inverse of residual variance (method TA1.2 in Francis 2011)

Weight by the inverse of the variance of the standardized residuals

McAllister-Ianelli (method TA1.1 in Francis 2011)

Weight by the average ratio of effective sample size to the stage 1 sample size

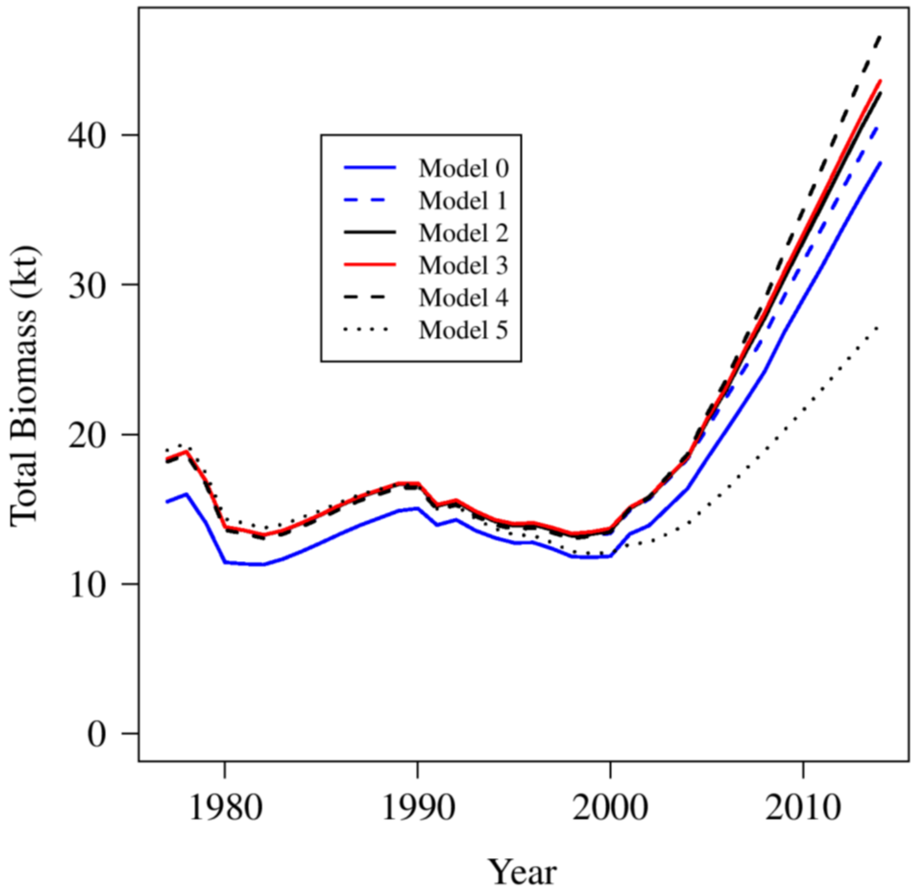
"The Francis method" (method TA1.8 in Francis 2011)

Weight by the inverse of the variance of standardized residual between the means of observed and predicted ages (or lengths). One data point per year.

Description of model runs

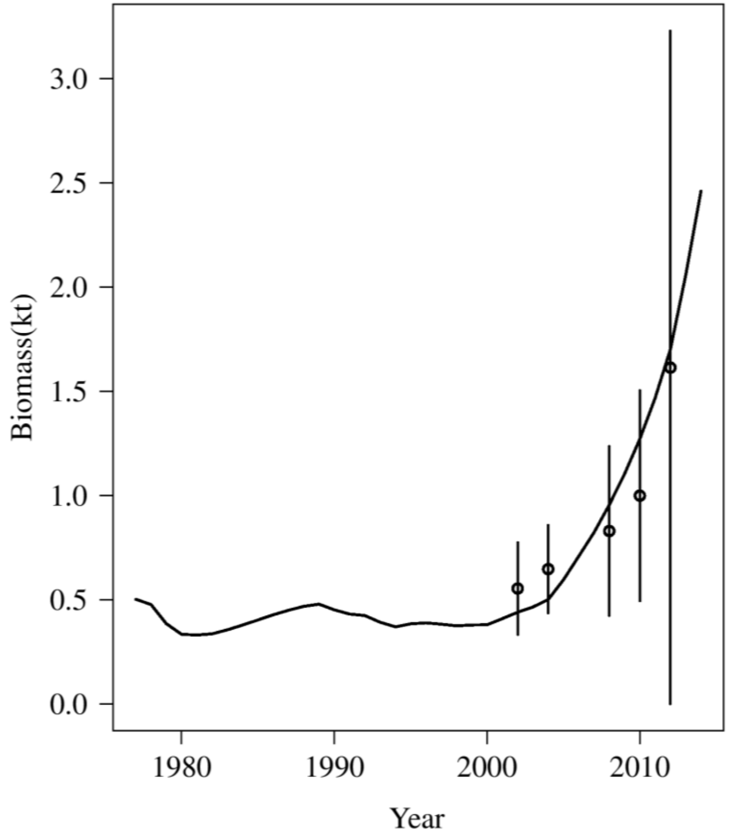
Model number	Description	Blackspotted/Rougheye rockfish	Pacific ocean perch	Northern rockfish
Model 0	2014 Model	✓	✓	✓
Model 1	Use BSAI catch and age composition data (w/o EBS survey)	✓	✗	✗
Model 2	BSAI model with EBS slope survey	✓	✓	✗
Model 3	Inverse variance weights	✓	✓	✗
Model 4	McAllister-Iannelli weights (TA1.1)	✓	✓	✓
Model 5	Francis weight (TA1.8)	✓	✓	✓

Results – blackspotted/rougheye rockfish
Total biomass across the models



Rougheye/blackspotted model 1

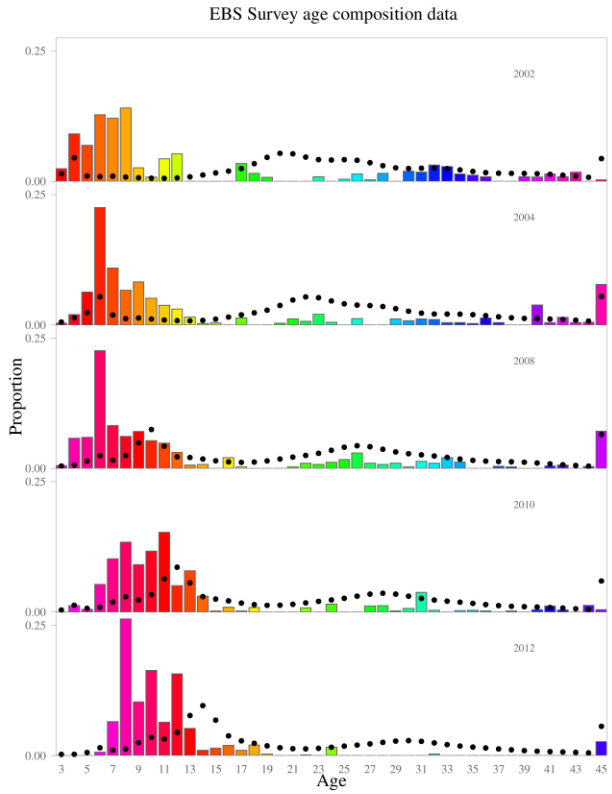
EBS slope survey data – not being fit, but the model predictions are consistent with to the data



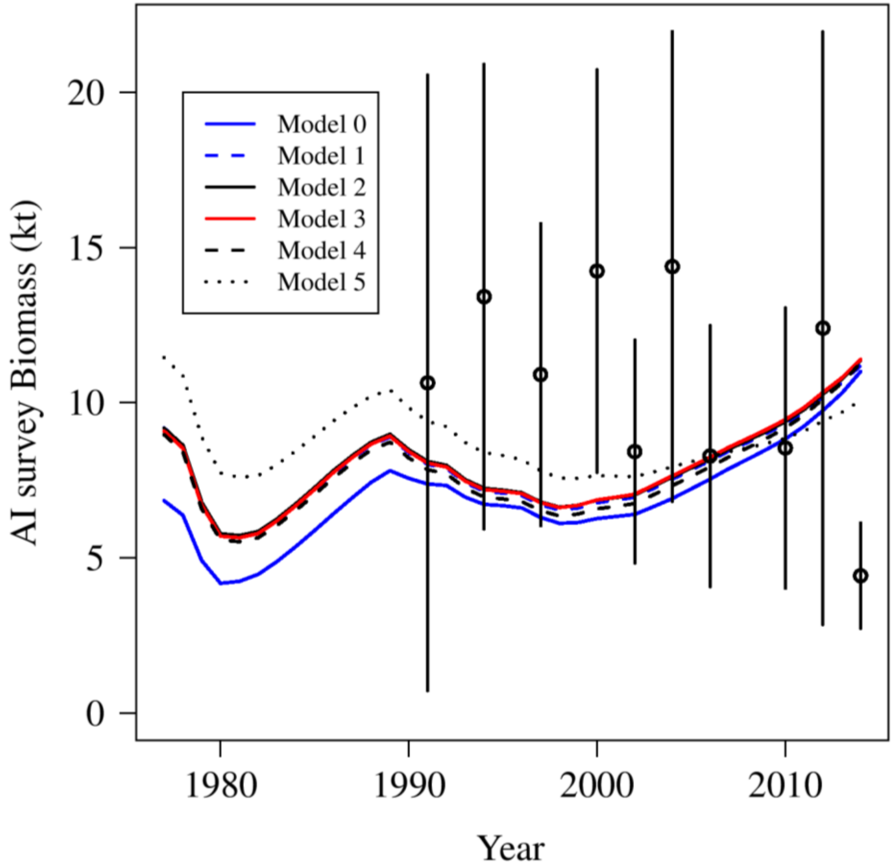
Suggests consistency between EBS and AI Slope surveys

Rougheye/blackspotted model 1

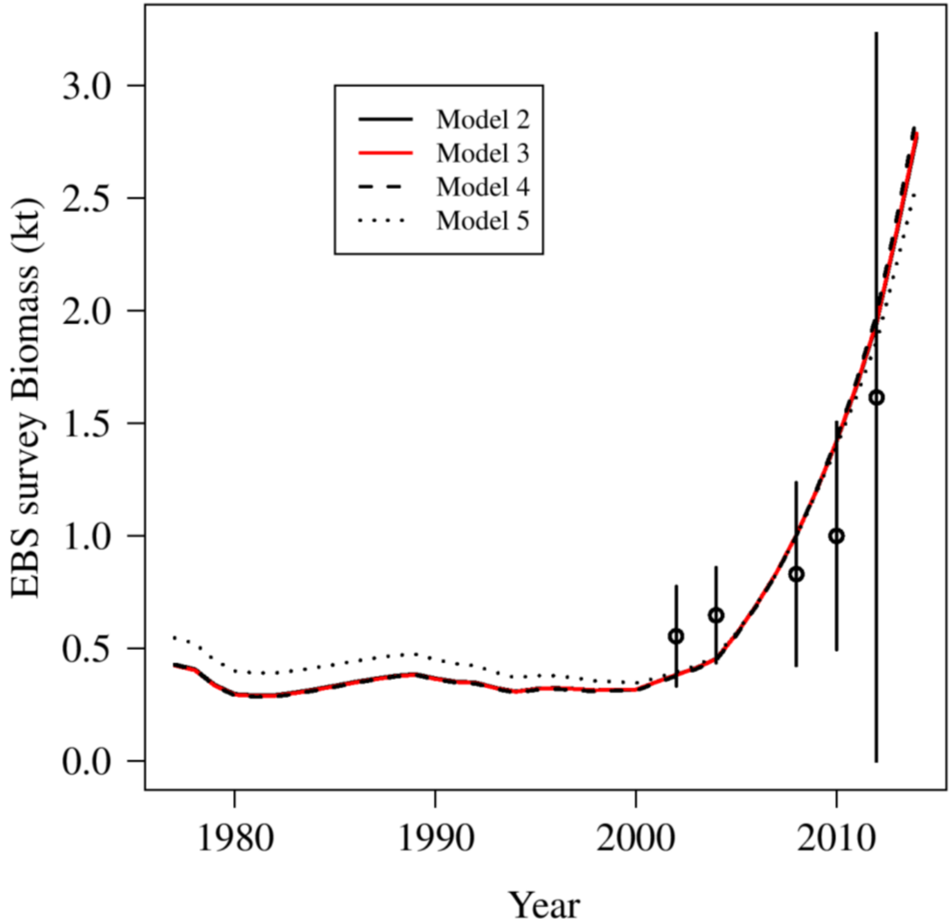
EBS survey age comps – some inconsistencies with other age and length composition data



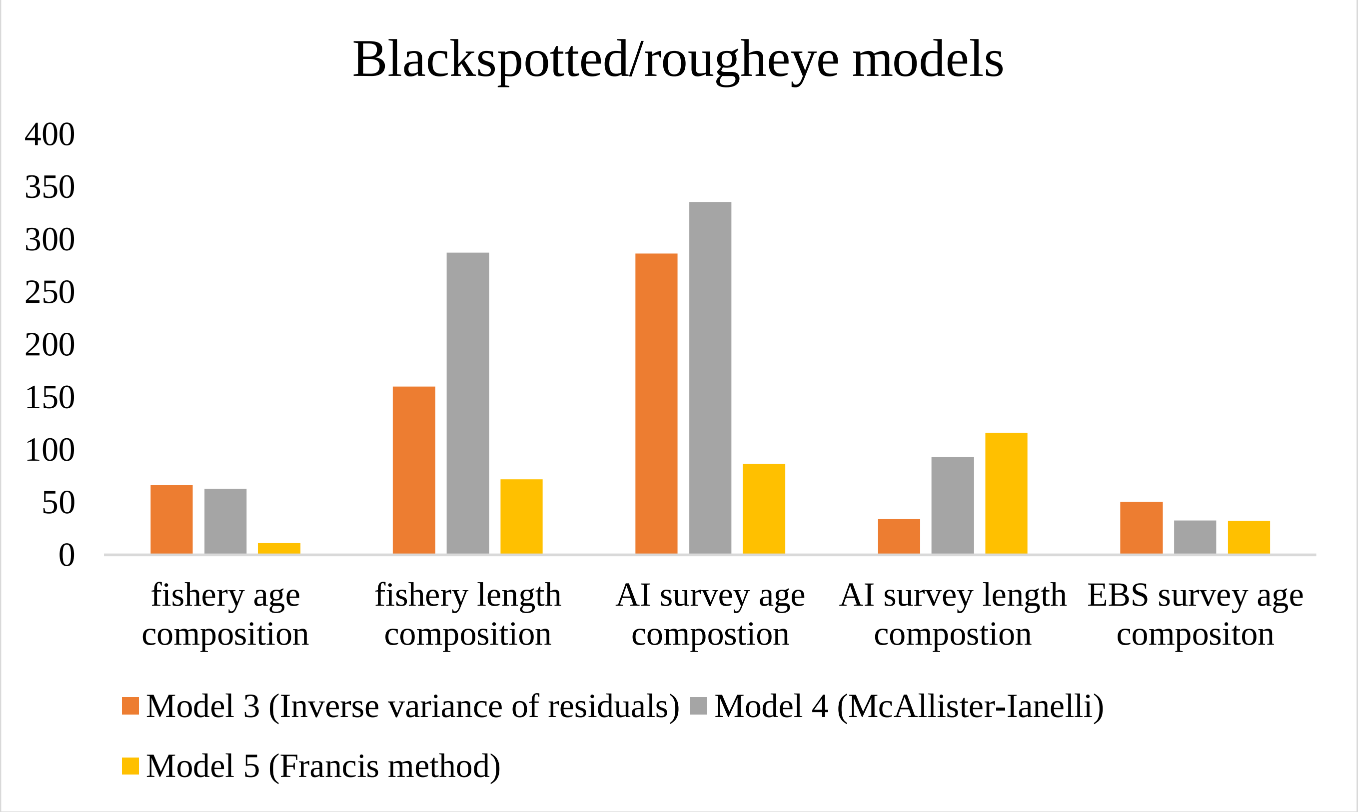
Blackspotted/rougheye rockfish
Fits to the AI survey biomass



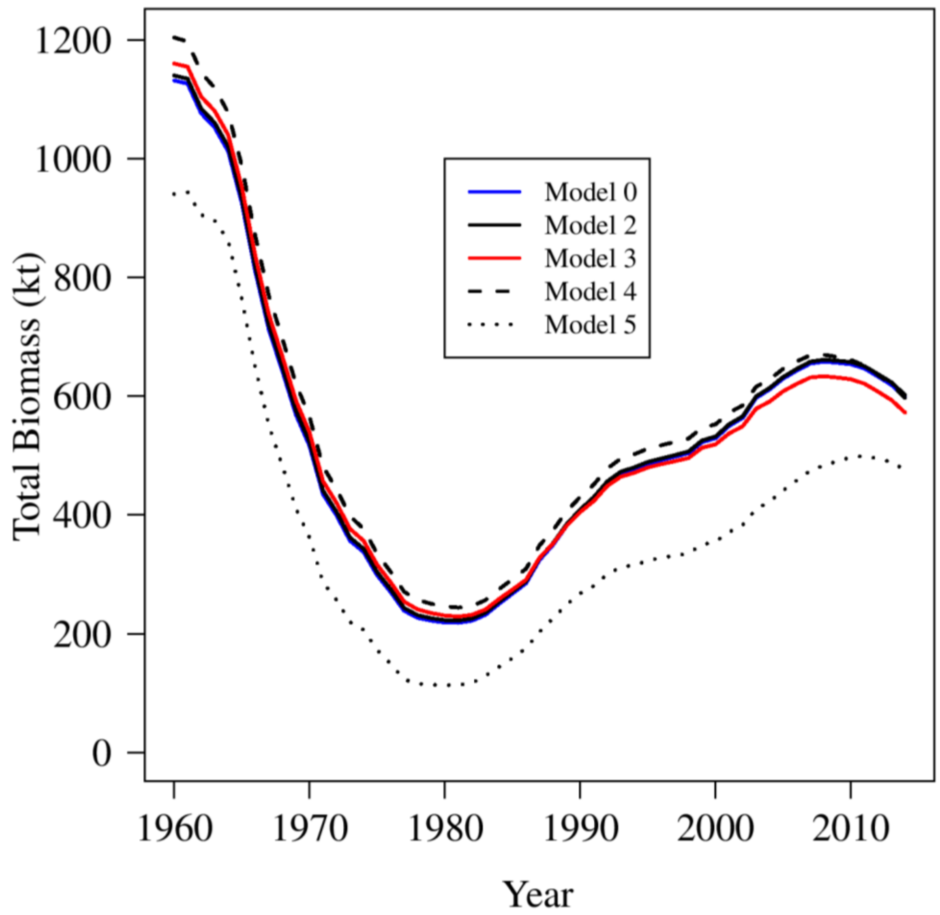
Blackspotted/rougheye rockfish
Fits to the EBS survey biomass



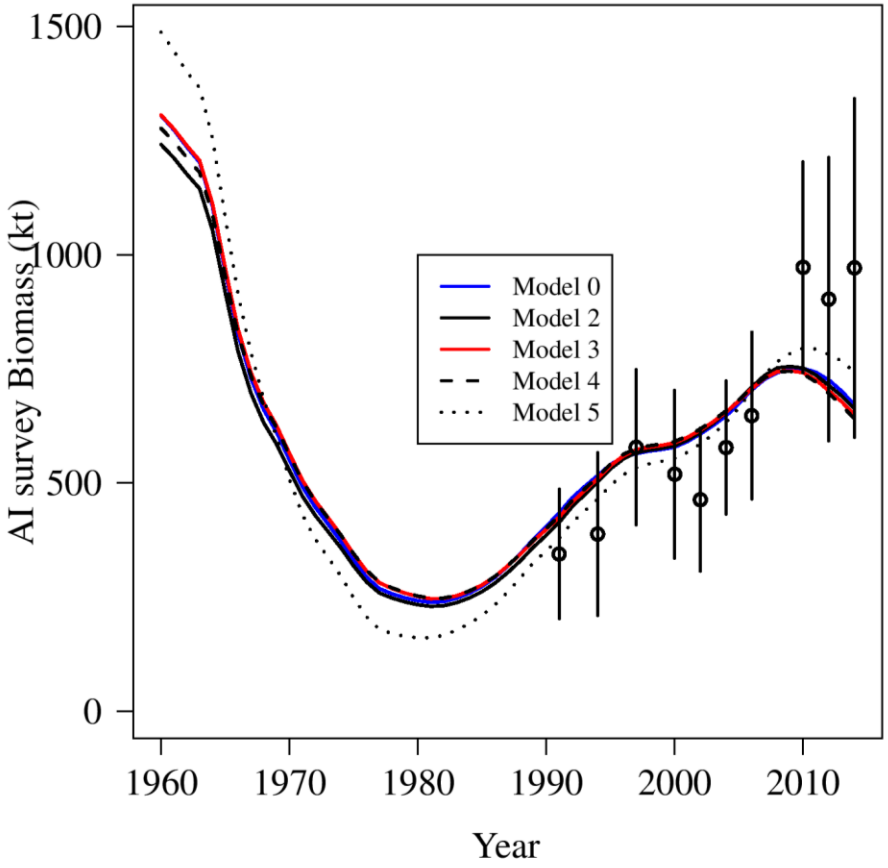
Blackspotted/rougheye rockfish
Sample sizes



Pacific ocean perch
Total biomass across models

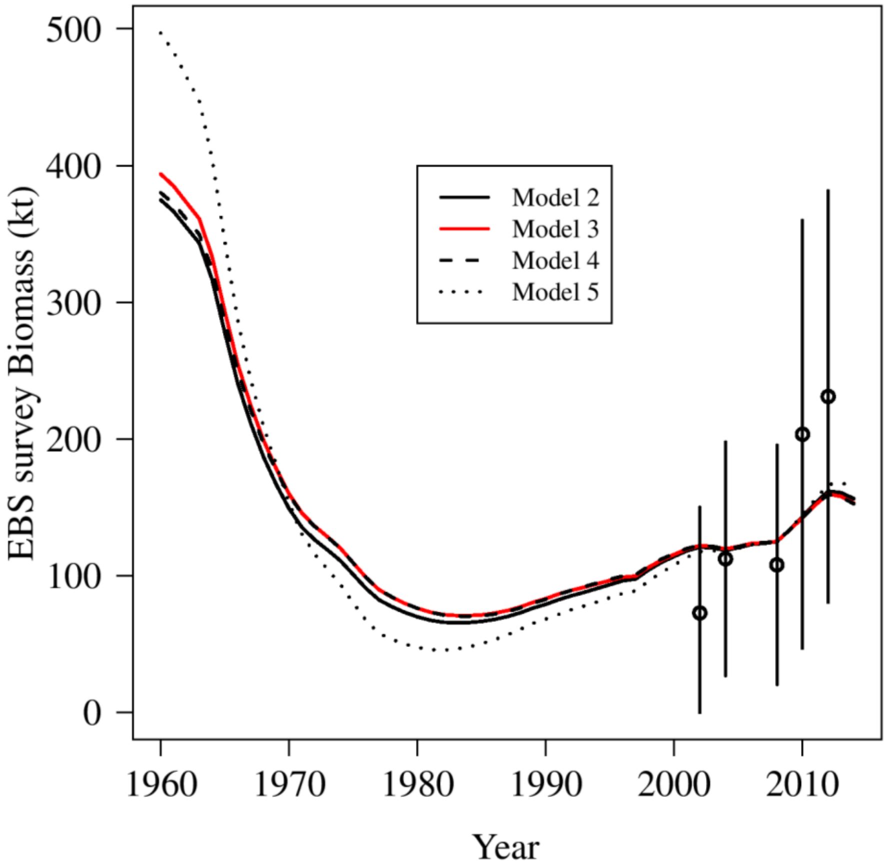


Pacific ocean perch
Fits to the AI survey biomass

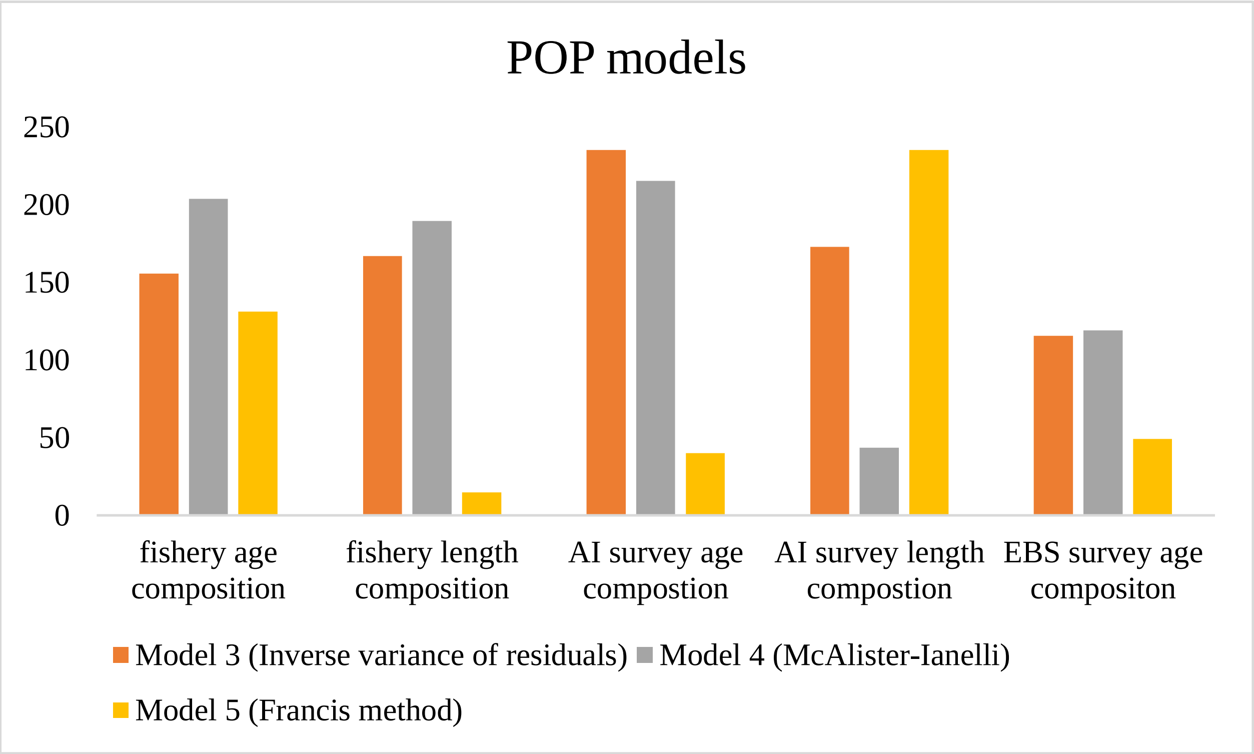


Pacific ocean perch

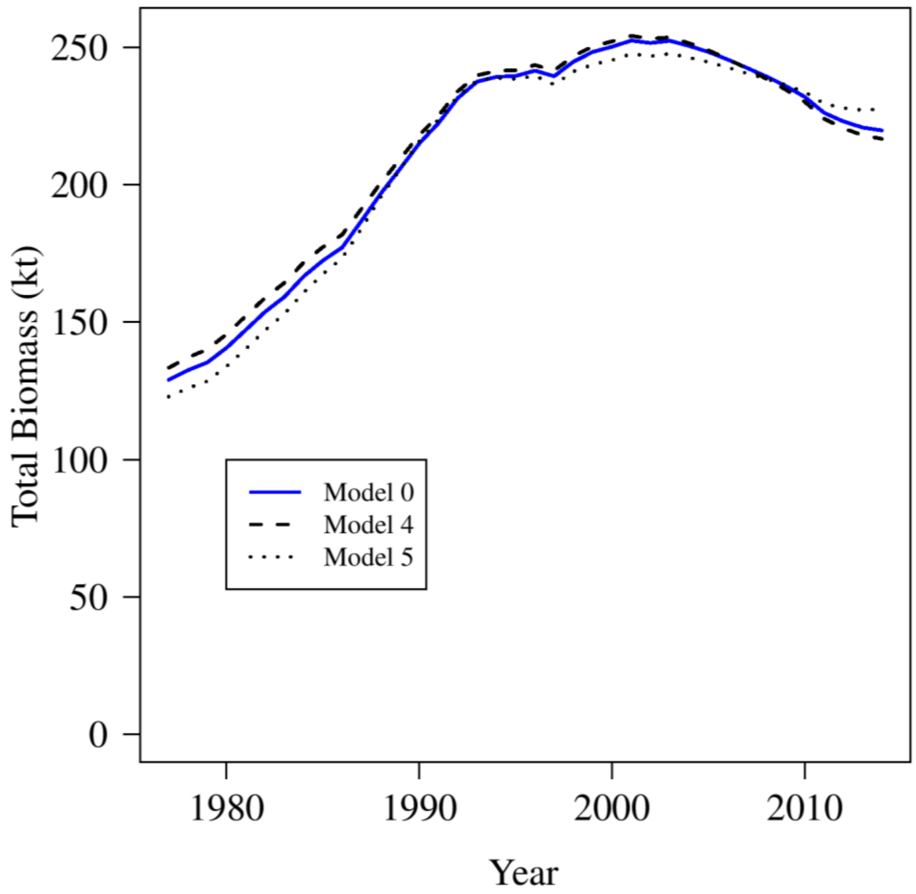
Fits to the EBS survey biomass



Pacific ocean perch sample sizes

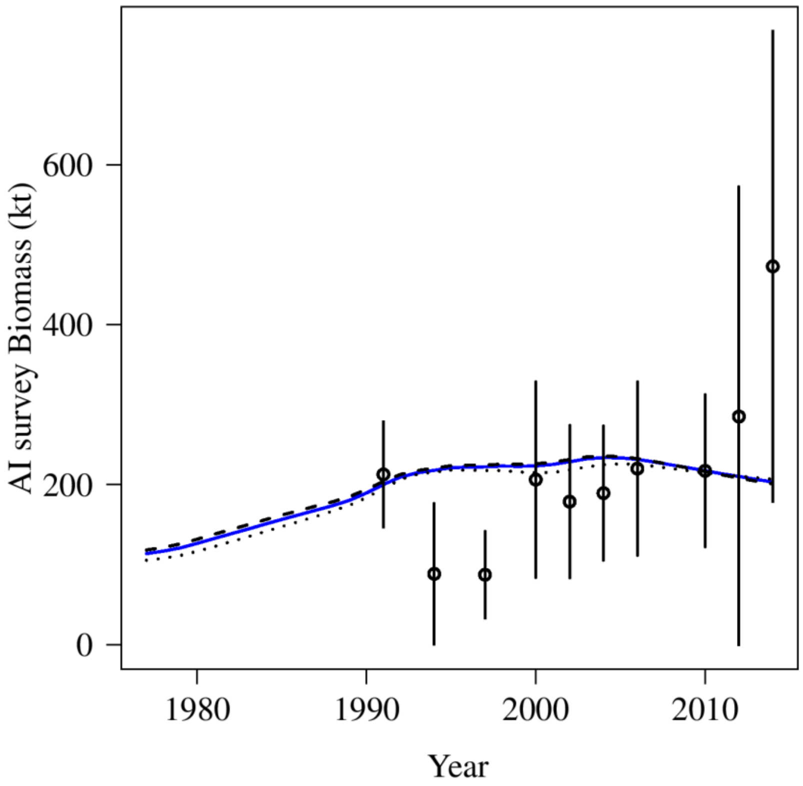


Northern rockfish
Total biomass across models

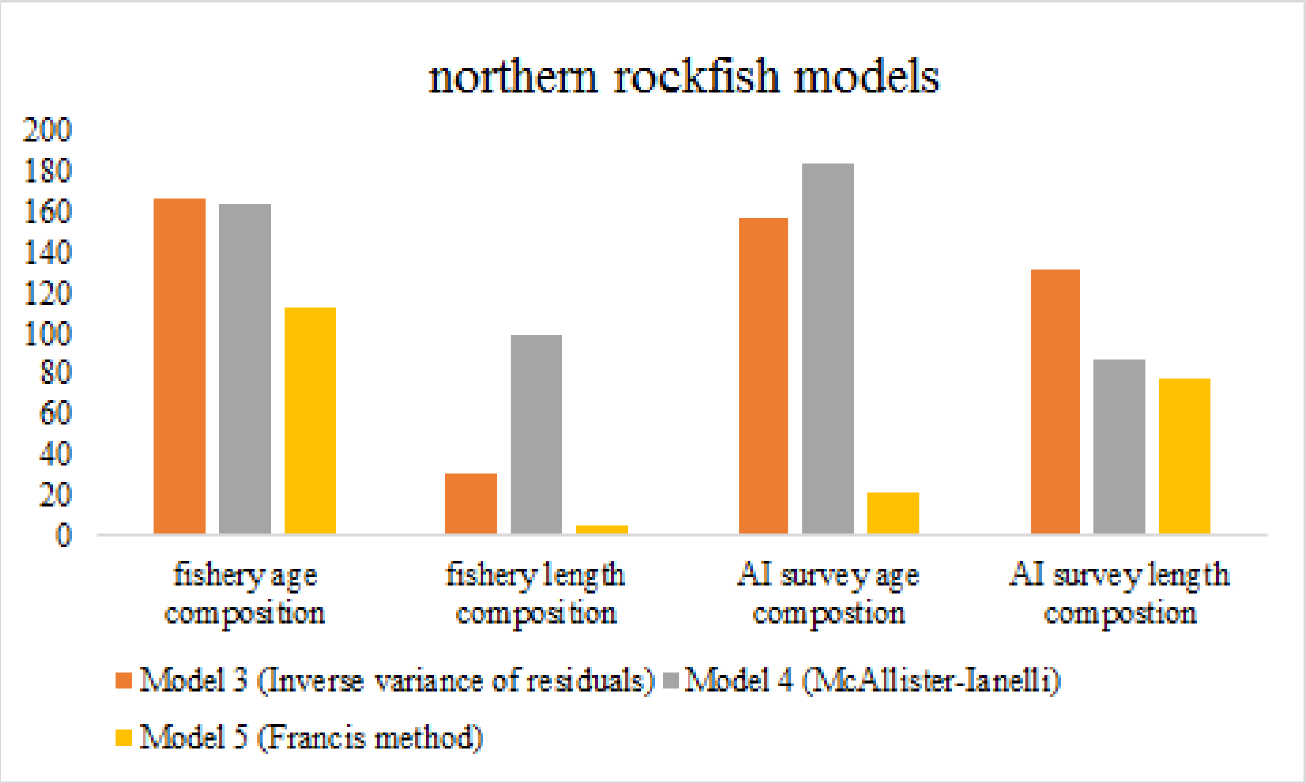


Northern rockfish

Fits to the AI survey biomass



Northern rockfish sample sizes



Some thoughts about the Francis method

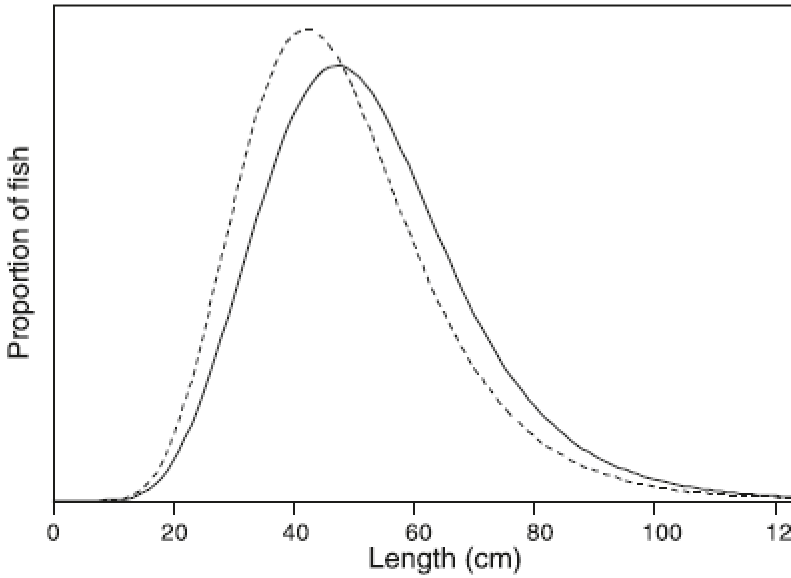
1) Accounts for correlation in residuals between age or length bins, and proposed as a way to improve the fits to survey biomass estimates.

2) Does so in a way that reduces the information for each year to a single data point (in the weighting procedure).

3) Data types with a small number of years may have unreliable estimates of their sample variance (i.e. blackspotted/rougheye rockfish do not have more than 9 years for any of the compositional data, with 3 data types <= 6 years).

4) Francis recommends pairing of data types with small number of years with other data types, but it is unclear how this pairing affects model results

5) For these stocks, the Francis method did not result in substantial changes in the fits to the survey biomass time series



From Francis (2011)

Conclusions

1) Given current management, it is reasonable to convert the AI model to blackspotted/rougheye to a BSAI model.
2) For blackspotted/rougheye rockfish and POP, the EBS slope survey biomass estimates are consistent with the AI survey biomass.
3) Iterative weighting of the composition data by the inverse of the variance of standardized residuals appear reasonable.
4) The Francis method resulted in one or both of the fishery composition data sets being nearly removed from the model. Additionally, the fits to the survey biomass estimates did not appear to be substantially affected.
5) The Francis method may warrant more study on its application when one or more compositional data types have a relatively small number of years.