BSAI Blackspotted/rougheye modeling options

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Objectives

- Review SSC comment, and issues with 2016 BSAI assessment model, pertaining to integrating the EBS and AI areas in a single model.
- Conduct some exploratory sensitivity analyses to address SSC comment
- Consider modeling alternatives
- Note: Potential alternatives pertain to the spatial aggregation of data, not the modeling methodology.

SSC comments, Dec 2016

"Although the use of a single model for the whole area (AI and BS) was recommended this year by the SSC, it may not represent the best approach. The SSC recommends that this choice be reevaluated, with particular investigation into which aspects of adding the EBS data, and how treatment of these data in a combined analysis, are most influencing the model results."

Models presented in 2016 (AI models in blue, BSAI models in red)

- ***Model 14*** The 2014 model with AI data updated through 2016
- ***Model 16.1*** BSAI model, with EBS slope survey data, age/length data weights set to 2014 values
- ***Models 16.2, 16.3, and 16.4***

  Model 14, but different types of iterative reweighting of the age/length composition data
- ***Models 16.5*, 16.6, and 16.7***

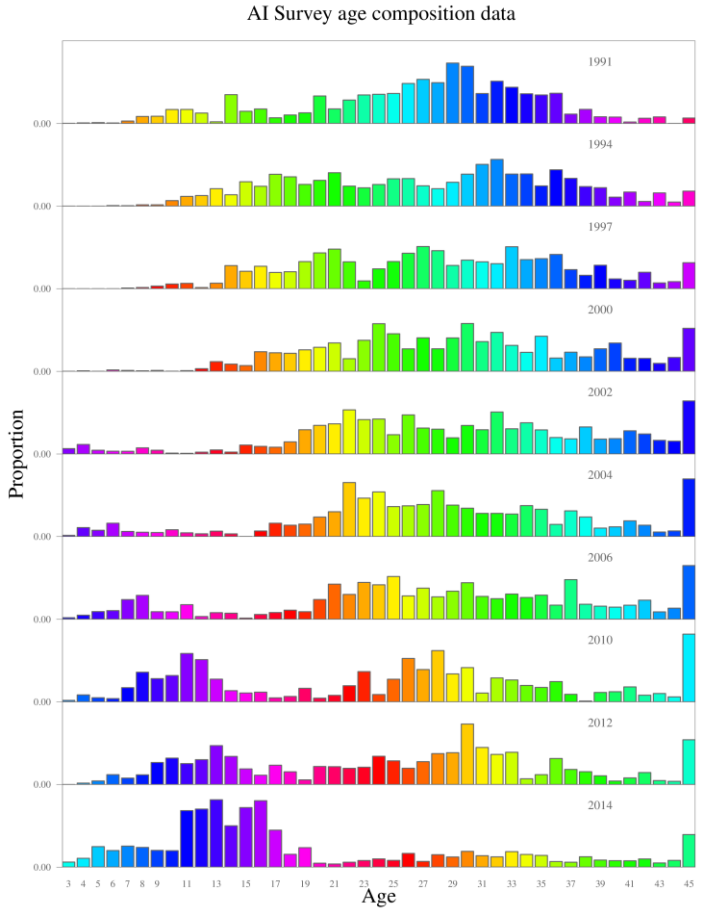
  Model 16.1, but different types of iterative reweighting of the age/length composition data

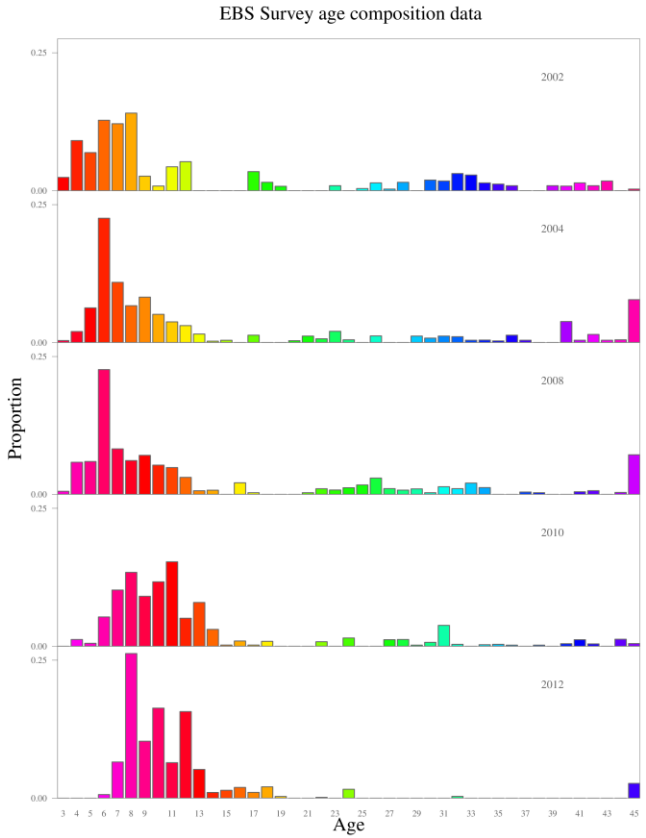
  *(final model – uses McAllister-Ianelli weighting)

Issues with the 2016 model

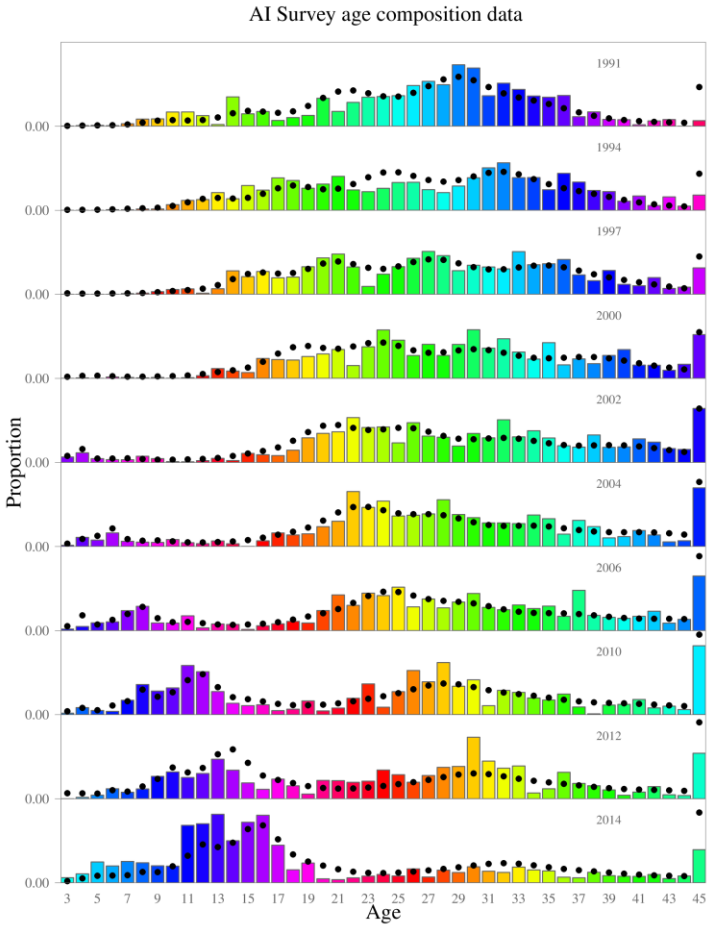
- Inconsistencies between EBS slope and AI trawl survey age compositions
- Uncertainty regarding the availability of the BSAI population to each survey
- More generally, age and length composition data are not consistent with time series of survey biomass estimates (affects both AI and BSAI models)
- Projected population trends based in relatively uncertain recent year class (affects both AI and BSAI models)

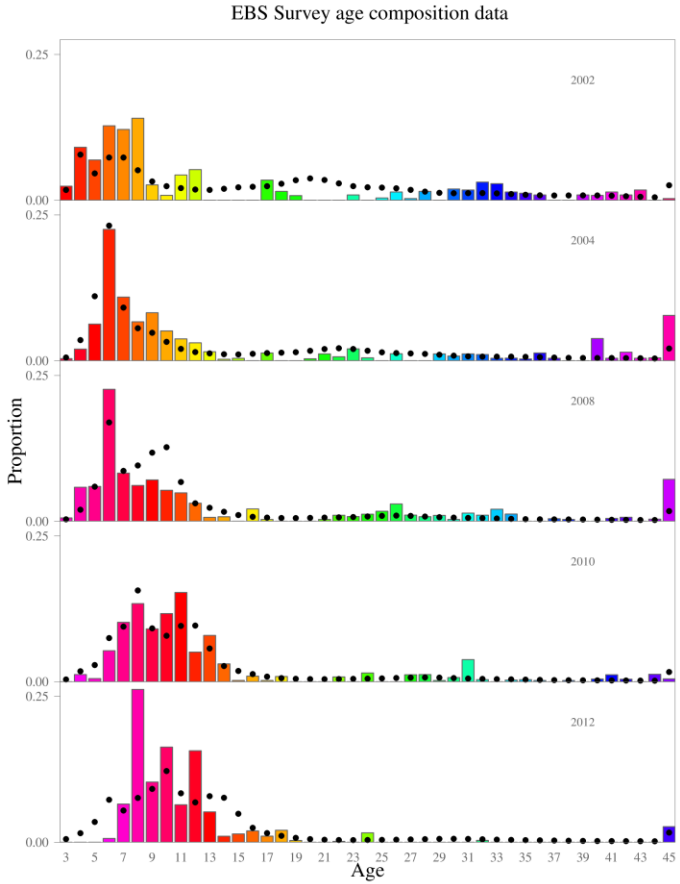
Survey age compositions



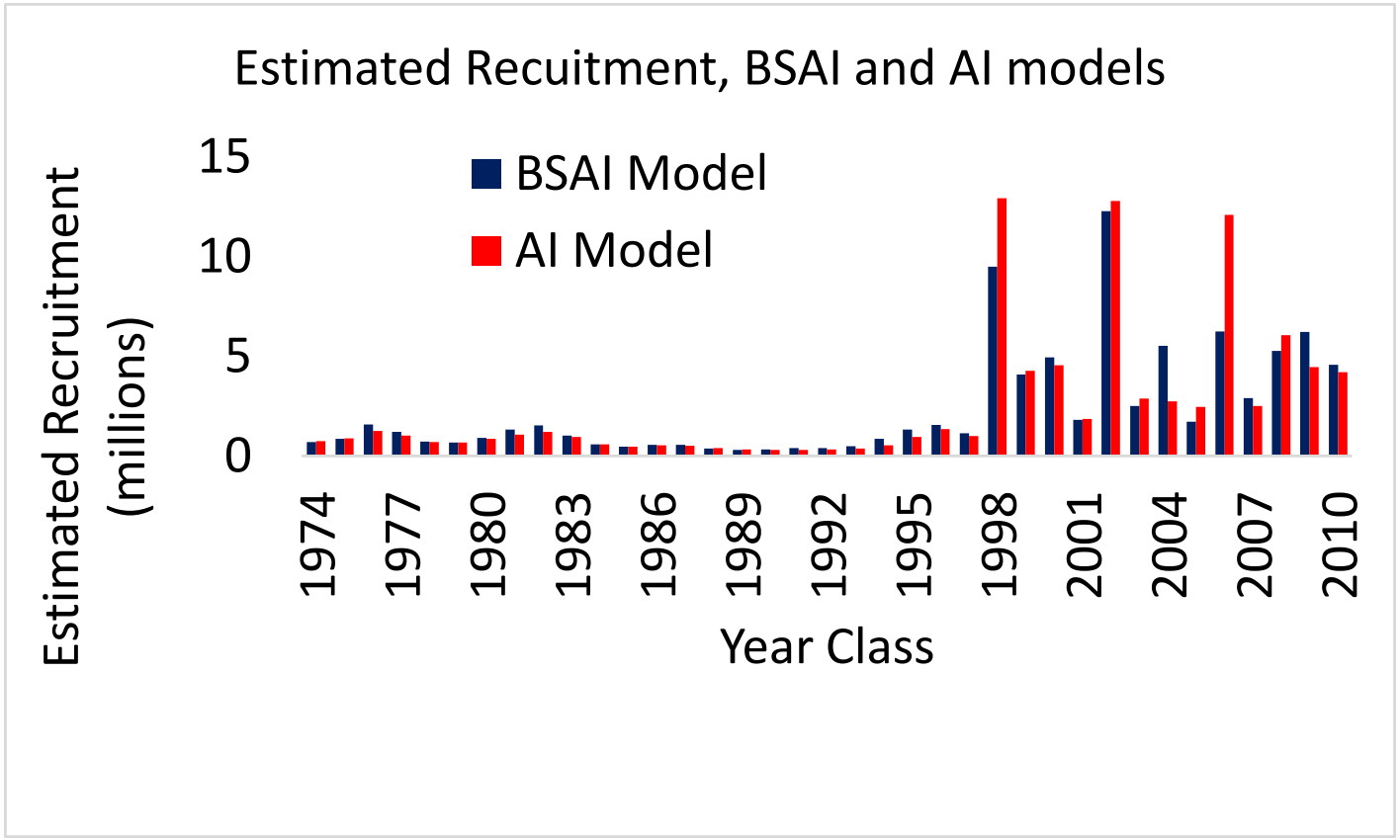


Fit to survey age compositions

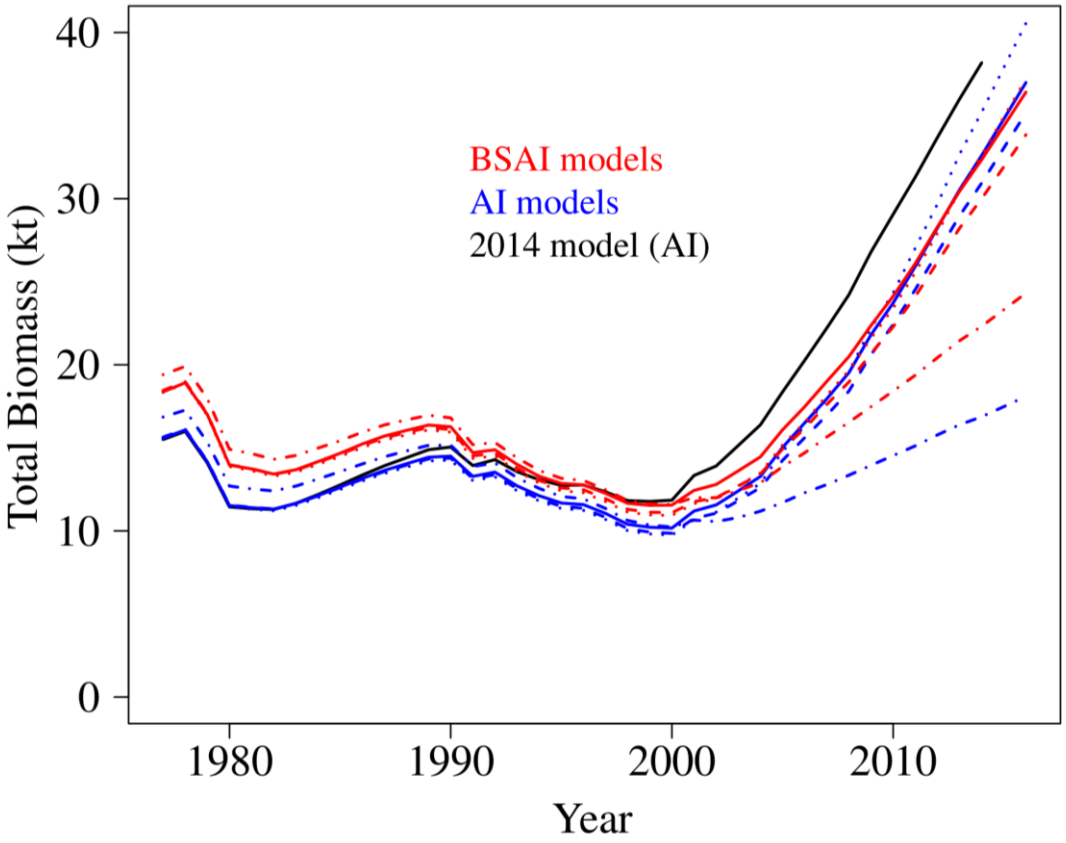




Plot of recruitment strengths from the BSAI model and AI models



Total biomass from BSAI and AI models estimated in 2016



The biomass estimates from the BSAI and AI models are similar in scale, and both have declined from the 2014 biomass estimates (due to additional age/length composition data introduced in 2016)

Issues with the 2016 model

- What do we assume about catchability when we have two surveys, neither of which cover the entire area of the stock?

Modification to survey catchability

$$S_{a,t} = p_{AI,t} q B_{a,t}$$

$B_{a,t}$ = 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

Estimates of the proportions of the stock in the AI and EBS areas are obtained from the survey biomass estimates.

This method implies that availability is a function of the survey biomass estimates; in practice, the survey biomass estimates are a function of the availability.

This would not be an issue if catchability for each survey could be reliably estimated.

What happens when we freely estimate survey q's?

Results from 2016 model, with priors on survey q's removed:

AI trawl survey: q = 5.68

EBS slope survey: q = 3.27

Current model has prior on AI trawl survey q (mean = 1, CV = 0.05), and freely estimates q for EBS slope survey

How have others handled this issue?

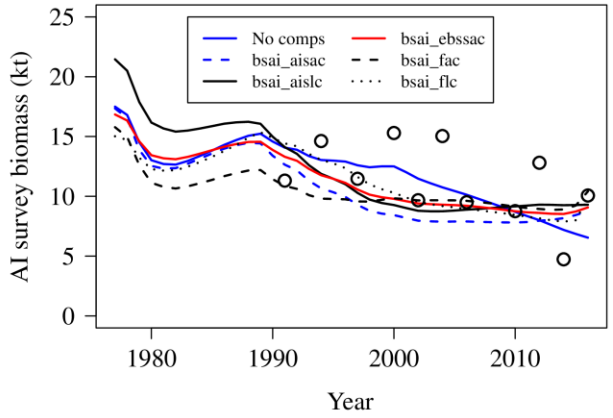
- **Greenland turbot** – prior distributions for slope survey *q* with mean of 0.75 (this value had been fixed in previous assessments), and 0.5 for the shelf survey
- **Arrowtooth flounder** – Survey *q* is fixed, and biomass is partitioned between 3 non-overlapping survey areas (Aleutian Islands, EBS slope, and EBS shelf) from smoothed estimates applied to the nominal survey biomass estimates.
- **Kamchatka flounder** – Initial model runs in 2016 assessment fixed survey *q* according to survey biomass estimates; final model runs fixed EBS slope survey *q* and freely estimated *q* for the Aleutian Islands and EBS shelf survey.

Sensitivity model runs to evaluate the influence of age and length composition data

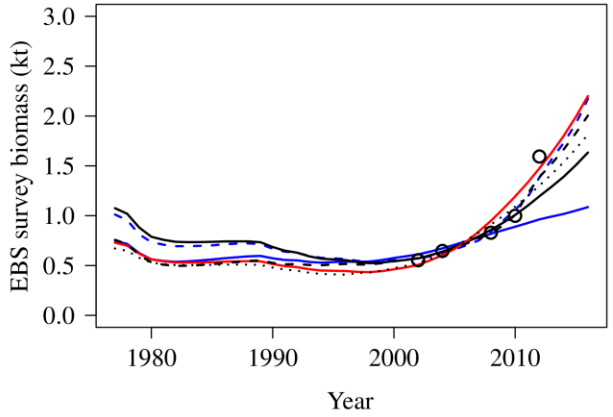
1) Remove all age and length composition data, examine fit to the survey biomass estimates
2) Evaluate how including each composition data (by itself) type affects the fit to the survey biomass estimates.
3) Sequentially add in each composition type, based on the largest effect on the fit to the survey biomass.

BSAI model – relative influence of each type of composition data

aisac – Aleutian Islands survey age composition
aislc – Aleutian Islands survey length composition
ebssac – eastern Bering Sea survey age composition
fac – fishery age composition
flc - fishery length composition

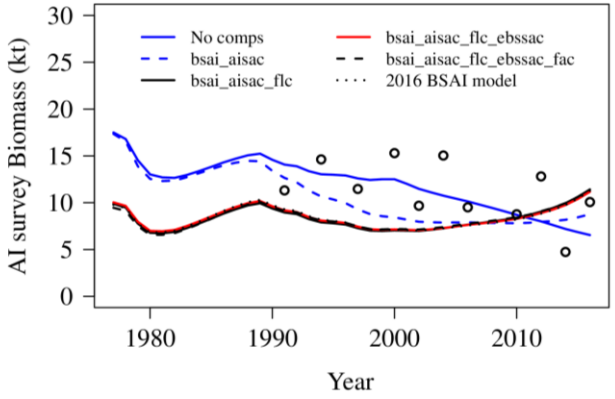


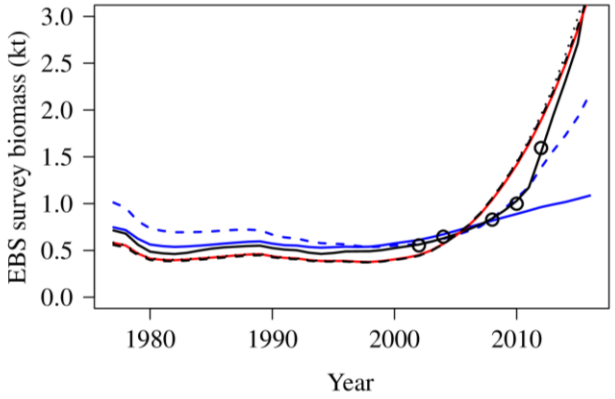
Adding any composition data degrades the fit to the Aleutian Islands survey biomass time series.



Adding any composition data improves the fit to the eastern Bering Sea survey biomass time series.

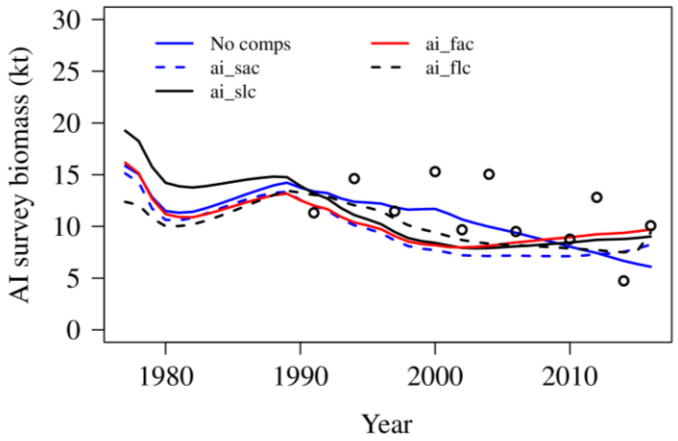
BSAI model – cumulative influence of adding composition data





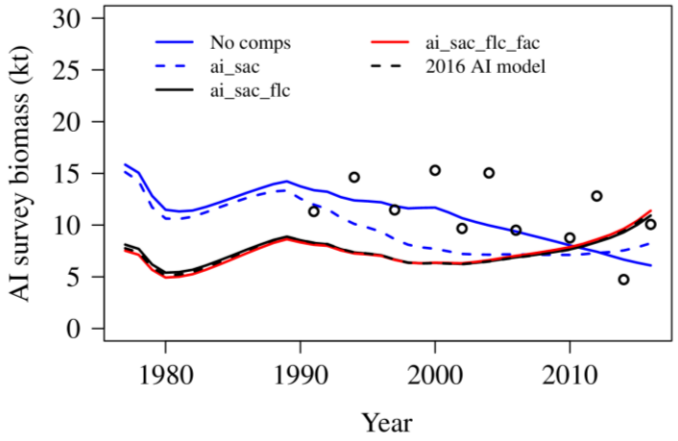
After the Aleutian Islands survey age composition and fishery length composition are included, the effect of including the remaining composition data types is minor.

AI model –influence of adding composition data

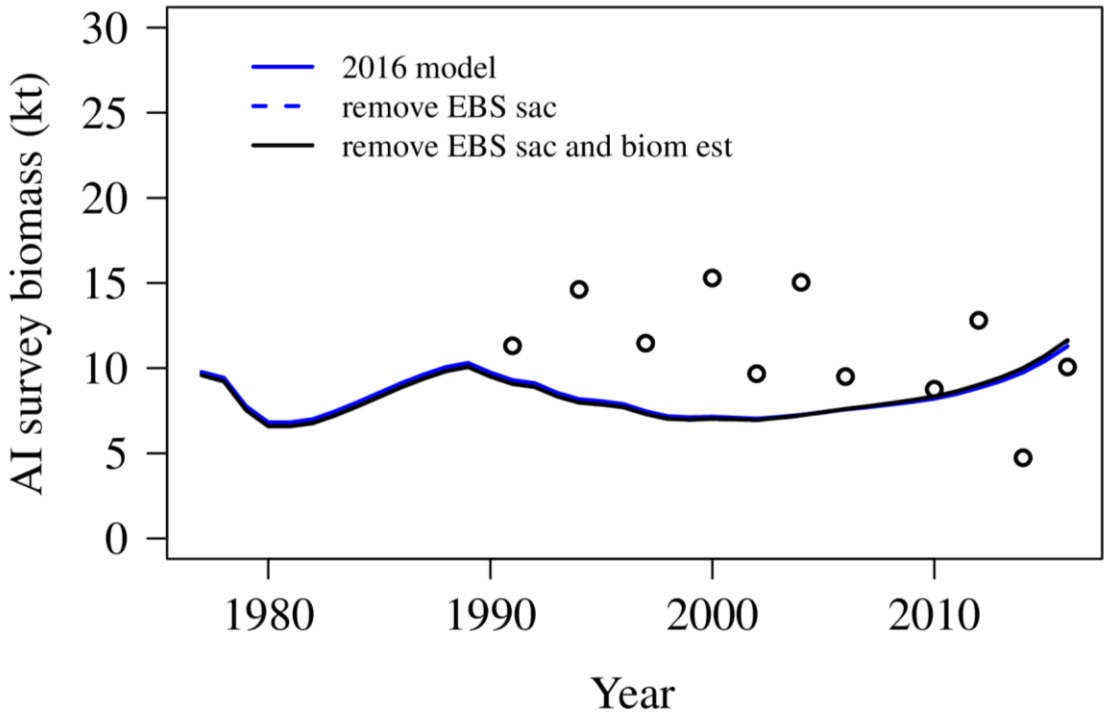


Ai_sac – Aleutian Islands survey age composition
Ai_slc – Aleutian Islands survey length composition
Ai_fac – Aleutian Islands fishery age composition
Ai_flc - Aleutian Islands fishery length composition

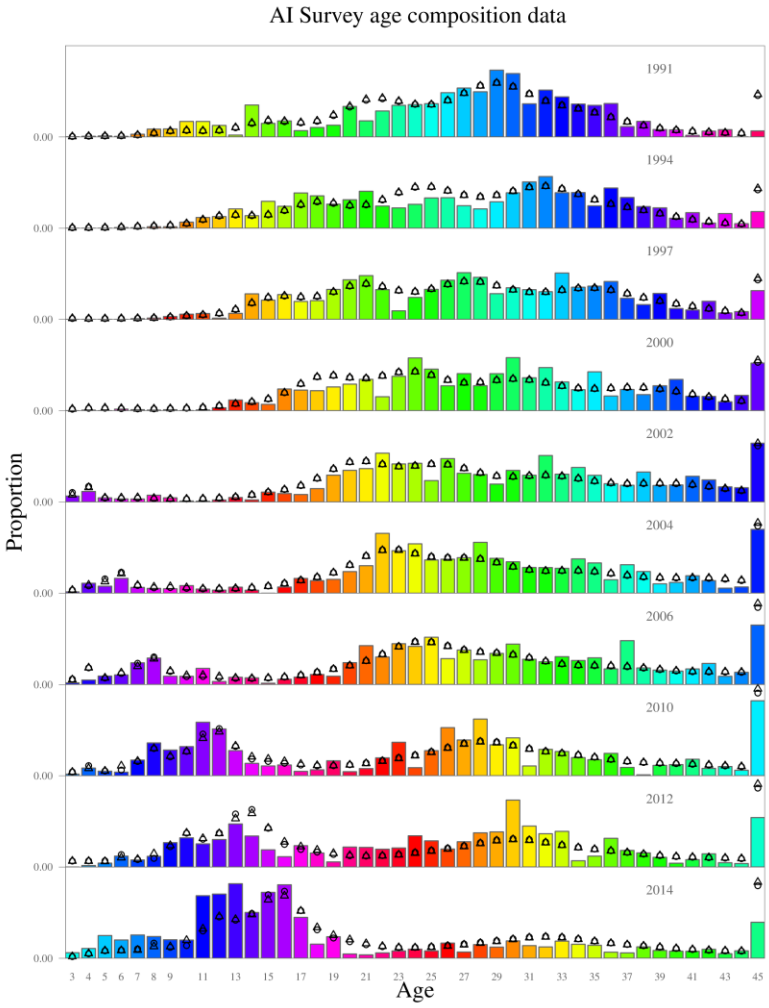
Same pattern is observed with an AI model.



What is the effect of removing EBS data from the 2016 BSAI model?



Improved fit the AI survey age comps?



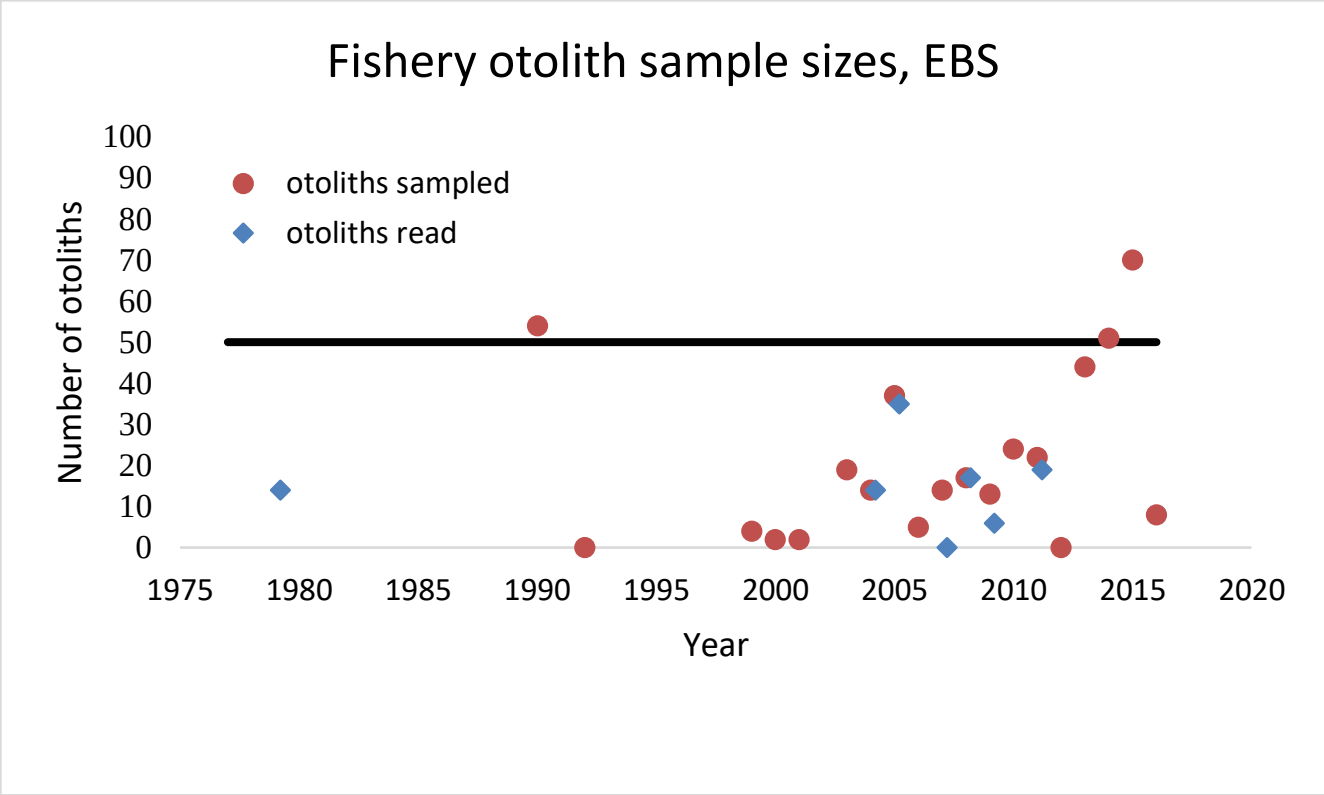
Δ – BSAI model, including EBS slope survey and age compositions

O – BSAI model, excluding EBS slope survey and age compositions

Can we develop an age structured model for the EBS?

Same issues with the previous models (inconsistencies between survey biomass estimates and composition data), but now with smaller sample sizes for the composition data

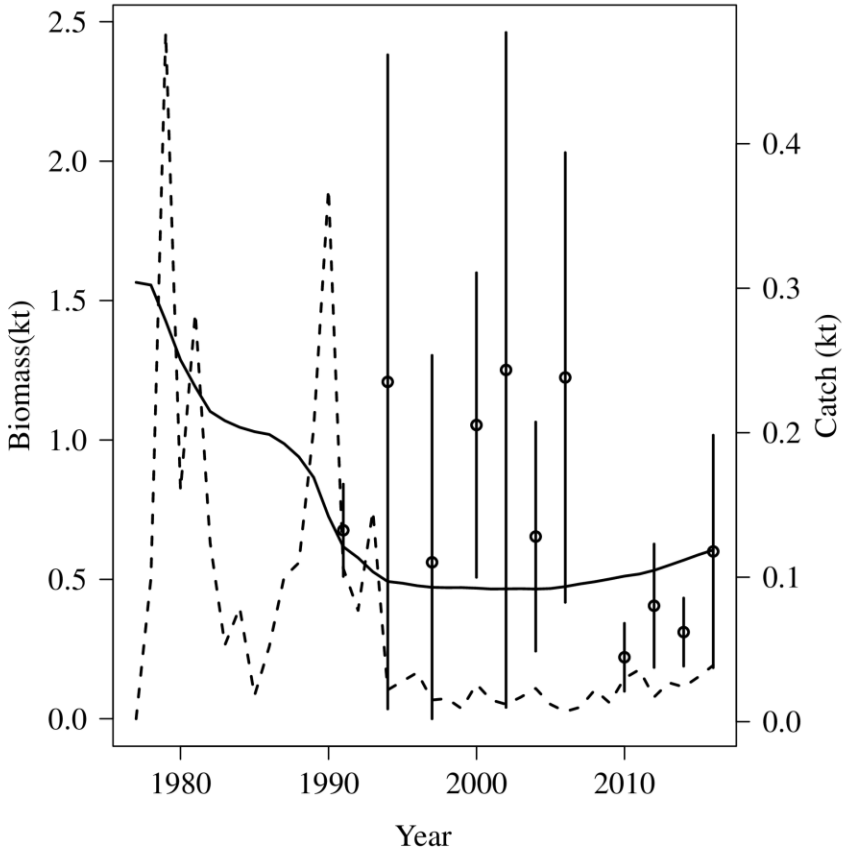
Sample sizes for survey age composition



Sample sizes for survey age composition

	Aleutian Islands survey, SBS			Eastern Bering Sea slope		
Year	Sampled	Read	Hauls	Sampled	Read	Hauls
1991	79	79	6			
1994	194	130	13			
1997	76	52	9			
2000	116	115	16			
2002	114	114	15	104	104	27
2004	103	102	14	217	216	48
2006	120	120	19			
2008				206	206	40
2010	27	26	10	262	130	36
2012	92	77	13	162	161	36
2014	57					
2016				150		

EBS age-structured model, fit to survey biomass in the Southern Bering Sea area



Not a great fit to the biomass estimates in the Southern Bering Sea area

Conclusions

- For either a BSAI or AI model, the most relevant issue is that the AI survey biomass and the age/length composition data are strongly inconsistent with each other.
- Additionally, the increases in biomass attributed to the composition data are based on relatively recent cohorts, and led to variability between assessment results between 2014 and 2016.

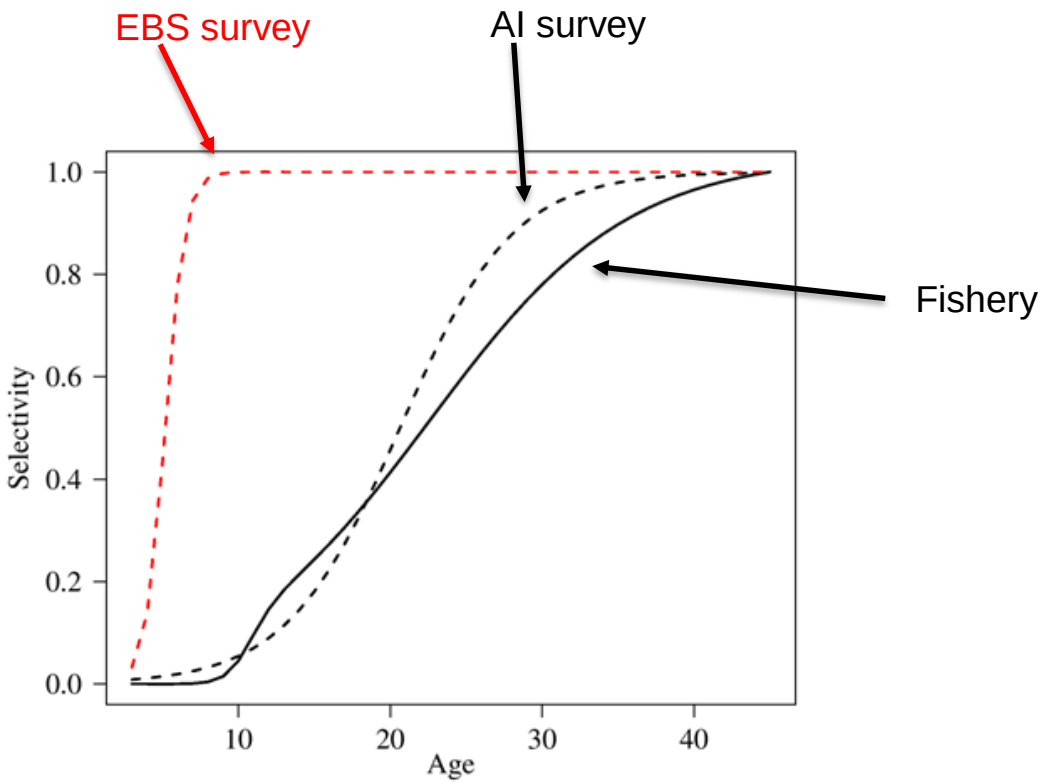
Issues with current BSAI model

- EBS and AI survey biomass estimates trending in opposite directions
- Some inconsistencies in year class strength between the AI and EBS composition data
- EBS slope and AI are separate ecosystems
- Species composition of the blackspotted/rougheye complex – in the Aleutian Islands there is mostly blackspotted, whereas in the eastern Bering Sea and Gulf of Alaska there is a more even mix of rougheye and blackspotted.

Modeling options for November

- Current BSAI model (used since 2016)
- Age-structured model for AI, Tier 5 for EBS (used from 2008 – 2015)
- If the inconsistency between the survey biomass estimates and the composition data are an immediate concern, we could consider Tier 5 for each area (used prior to 2008)
  - A fairly drastic step, as we usually do not move down in Tiers

Fishery and survey selectivity curves



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

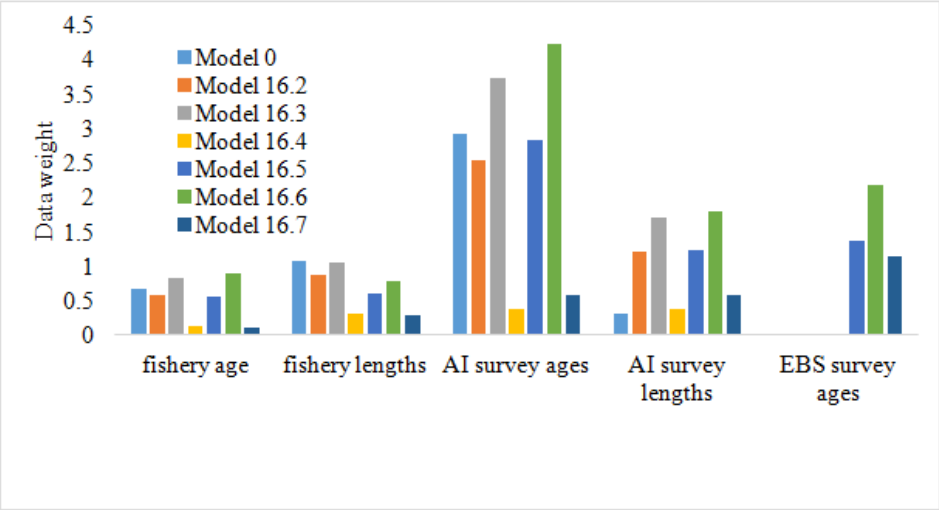
General approach is that the "second stage" sample sizes ($N_{j,y}$) are the product of a "first stage" sample sizes ($\tilde{N}_{j,y}$) and a weight

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

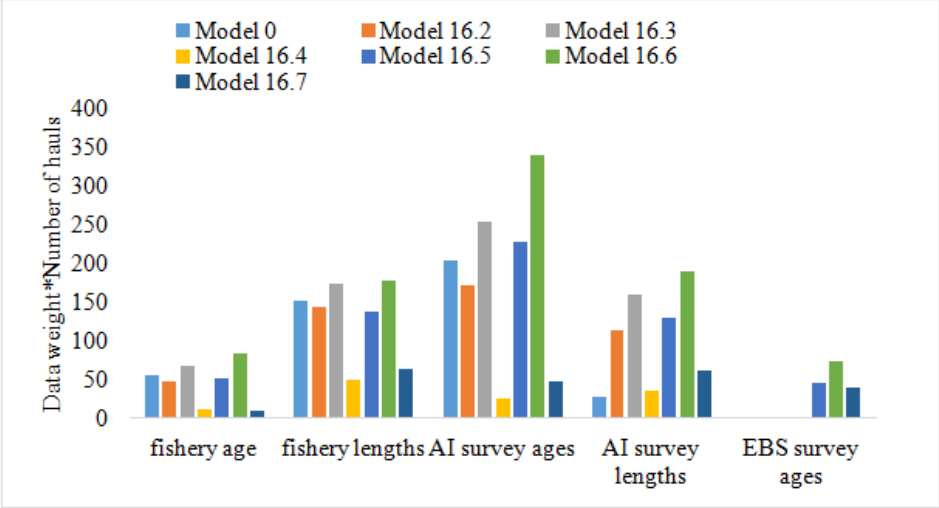
A single weight for each data type (*j*)

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

Age/length comp weights



Data weights



Data weights * mean # of hauls