Update on BSAI POP Assessment

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Objectives

- Discuss initial responses to Plan Team and SSC comments, and exploratory model runs
- Recommendations of potential modeling options to consider for the final 2024 assessment

Plan Team/SSC comments

- (BSAI Plan Team, September 2020) *Of these CIE recommendations, the author recommended the following changes to be brought forward in November 1) fitting the model to survey abundance instead of biomass, 2) exploring stochastic initial age compositions, and 3) for equilibrium initial age composition, explore mortality rates other than that currently used in the model.*

- Item #1 was explored in 2022. Items #2 and #3 are explored now

Plan Team/SSC comments

- (BSAI Plan Team, November 2022) *The Team discussed investigating the mortality rates by age particularly for the plus group as there were poor fits to this group in the eastern Bering Sea (EBS) slope survey. The Team noted that time blocks could be explored for the plus group or consider time-varying selectivity as there were younger fish in the AI BTS than the EBS slope survey.*

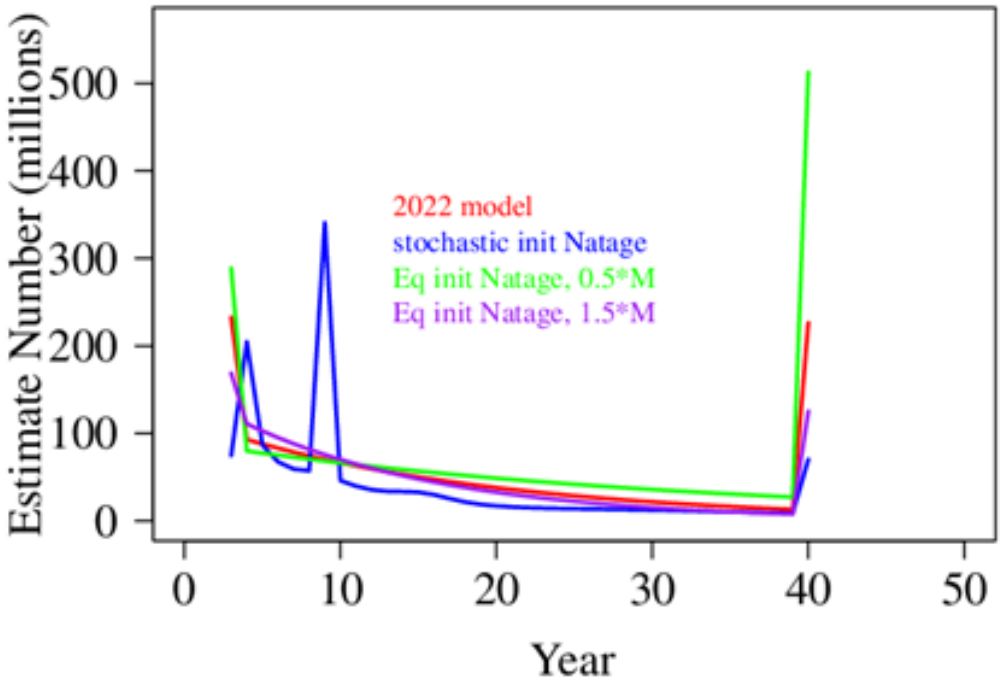
- (SSC, December 2022) *The SSC concurs with the BSAI GPT suggestion to pursue time-varying survey selectivity for the AI bottom trawl survey and supports the BSAI GPT's other suggestions for model improvements*

Models with time-varying survey selectivity were explored

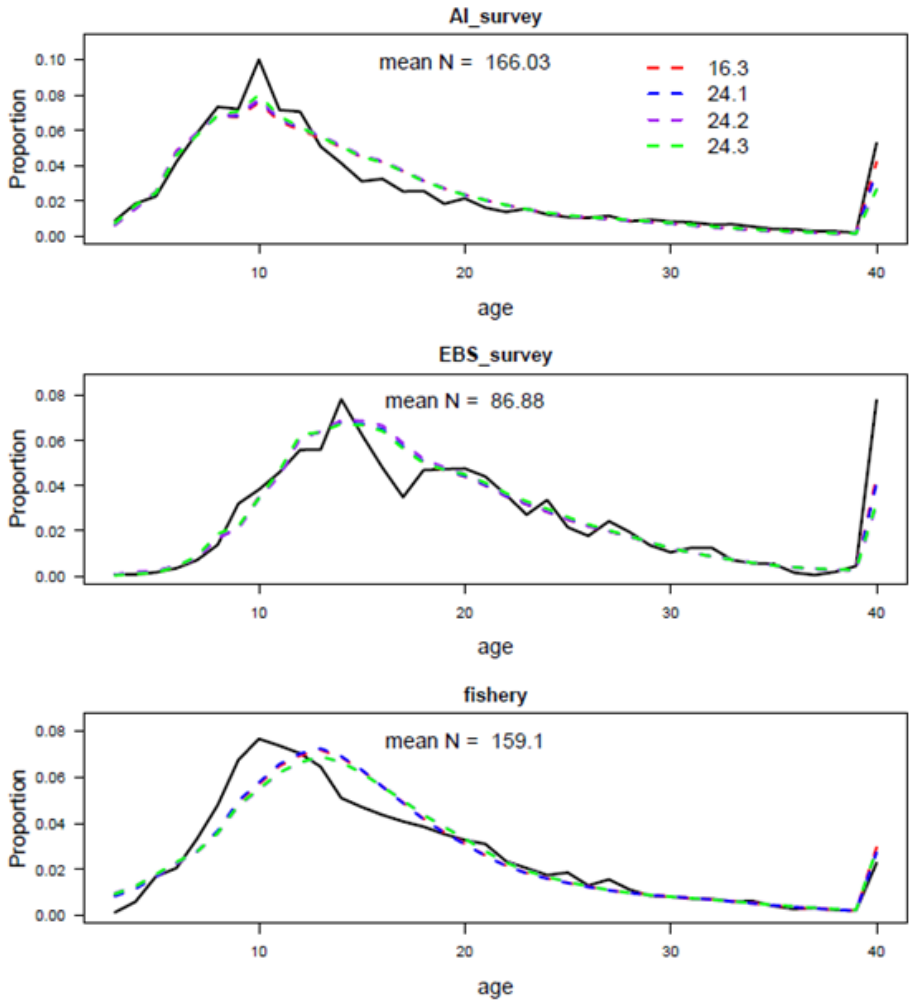
Models considered in this report

Model	Description
Model 16.3	Accepted model from the 2022 assessment, which freely estimates the AI and EBS survey catchability coefficients without prior distributions
Model 24.1	Model 16.3, but with estimation of the recruitment for the initial numbers at age as stochastic variables
Model 24.2	Model 16.3, but with the penalty for the dome-shapedness in the bicubic spline used for fishery selectivity increased from 10 to 30, and a lognormal prior on the AI survey catchability (mean=1, CV=0.15)
Model 24.3	Model 24.2 but with selectivity for the AI and EBS trawl survey modeled with time-varying double normal curves

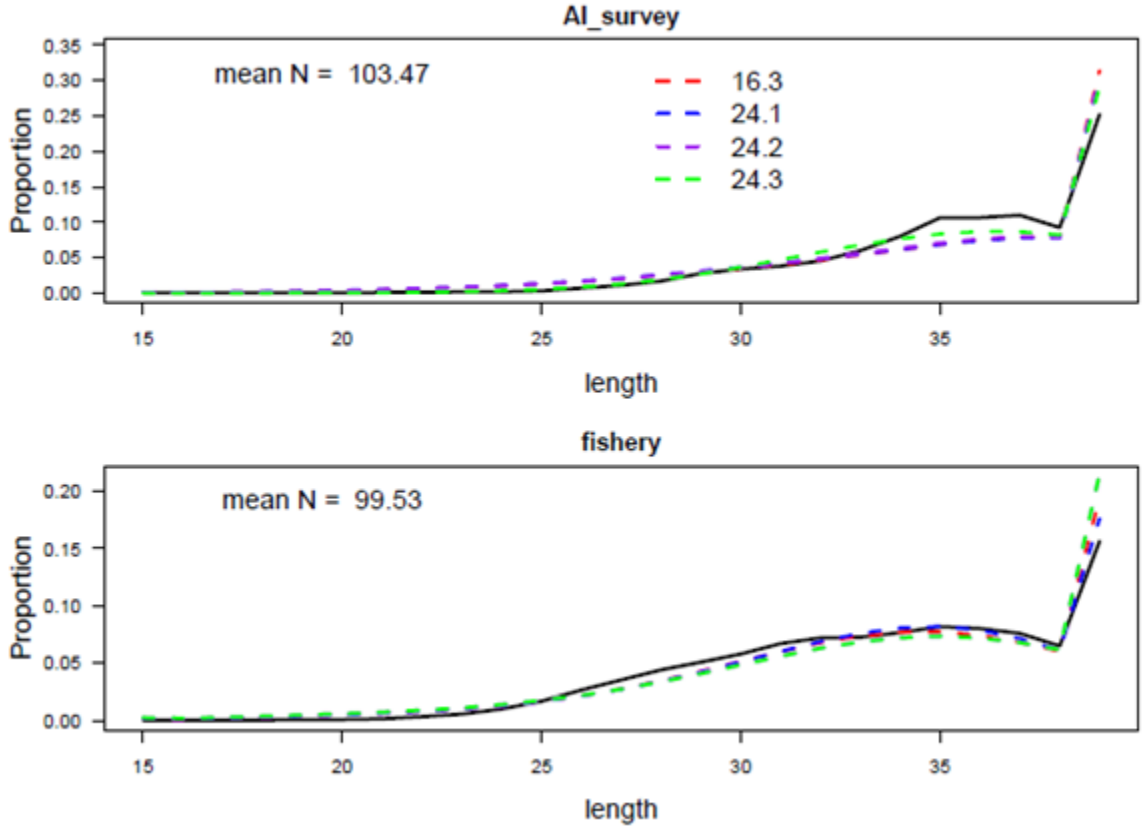
Estimation of initial numbers at age



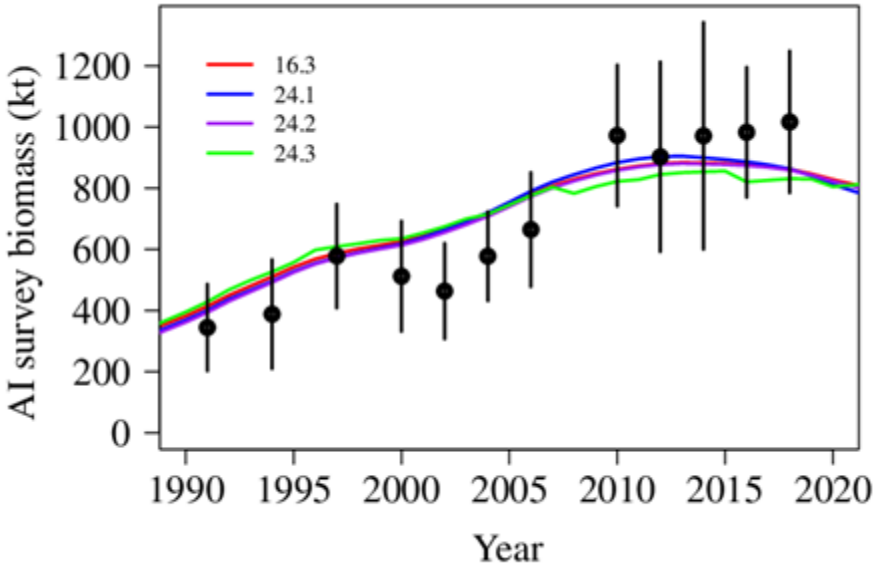
Aggregate age comps



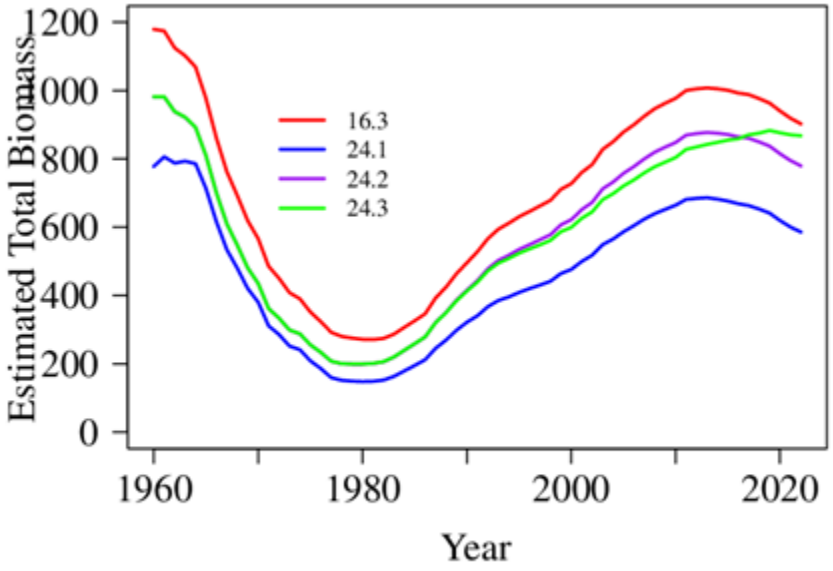
Aggregate length comps



Fit to the AI survey biomass index



Estimated total biomass



Estimated mortality and survey catchabilities

Parameter	Model 16.3	Model 24.1
Natural morality (M)	0.056	0.044
AI survey catchability	1.00	1.51
EBS survey catchability	0.25	0.37

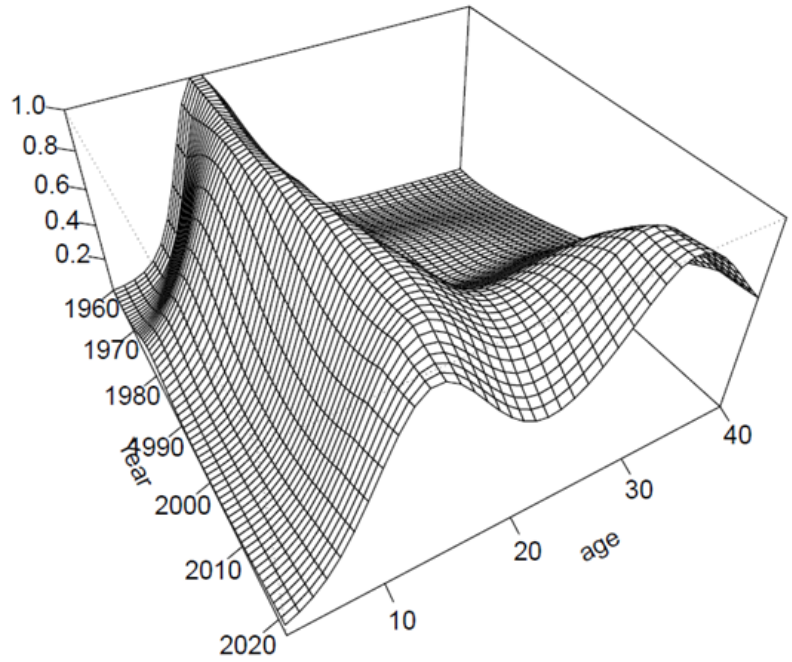
Evaluation of estimation of initial numbers at age

- Estimation of stochastic initial numbers at age had little effect in fitting the fishery length comps and the AI survey biomass index
- This may be because of the relatively long period between the model start year (1960) and the first year of age composition data (1981 for the fishery). (Although we do have fishery length compositions in the mid-1960s)

What might AI survey selectivity be for POP?

- Reminder – q > 1 means the survey is overestimating the biomass
- Jones et al (2021) – field work in Gulf of Alaska, measured densities in trawlable and untrawlable grounds. Estimated at 1.15
- However, the proportion of the stock in the EBS is unavailable to the AI survey, which would reduce *q*
- In 2020 and prior assessments, AI survey q had a prior with a mean of 1 and CV of 0.45.

Estimation of fishery selectivity in current model



- Selectivity in recent years shows a multimodal pattern that is hard to explain
- The rate of selectivity decrease with age in a dome-shaped pattern is controlled by a penalty applied the first difference (set to 10 in the current model).

Model 24.2

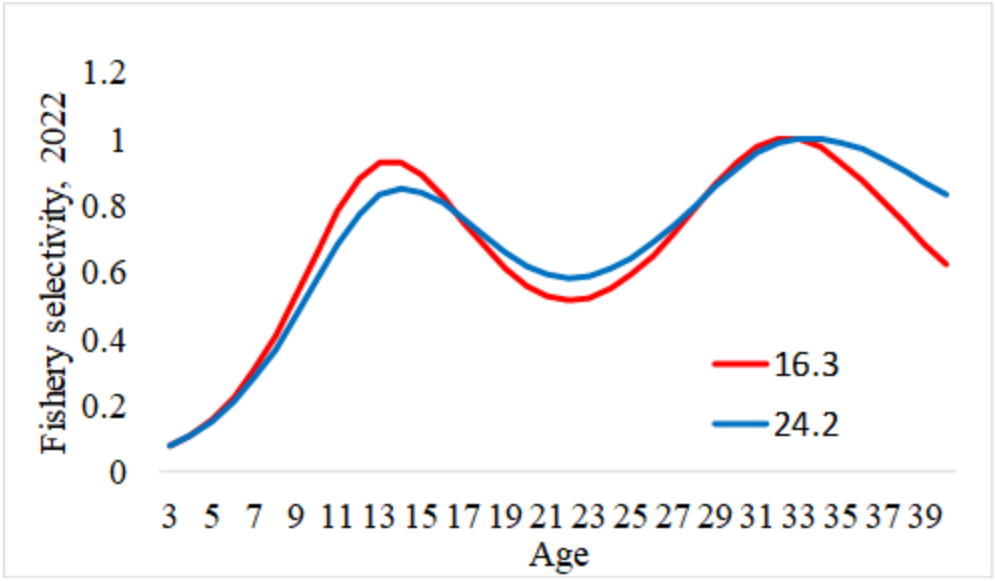
- 1) Restore prior distribution on AI survey q, with mean at 1 and CV of 0.15
  - Consistent with the field work of Jones at al. (2021)
  - Generally consistent with past assessments

- 2) Increase penalty on dome-shapedness for bicubic fishery selectivity from 10 to 30 to produce more stability across ages

Estimated mortality and survey catchabilities

Parameter	Model 16.3	Model 24.1	Model 24.2
Natural morality (M)	0.056	0.044	0.054
AI survey catchability	1.00	1.51	1.16
EBS survey catchability	0.25	0.37	0.30

Estimation of terminal year (2022) selectivity)



Model 24.3

- Motivated by PT/SSC comments on the poor fits to the plus group in the survey data
- Current model consistently underestimates the plus group in the AI and EBS survey age compositions, and overestimated the fishery age composition plus group
- Model 24.3 – has the features of Model 24.2, but with AI and EBS trawl survey selectivity modeled with a double normal curve in time blocks
  - AI blocks – 1960,1996,2000,2004,2008,2012,2014,2024
  - EBS blocks – 1960, 2004,2008,2012

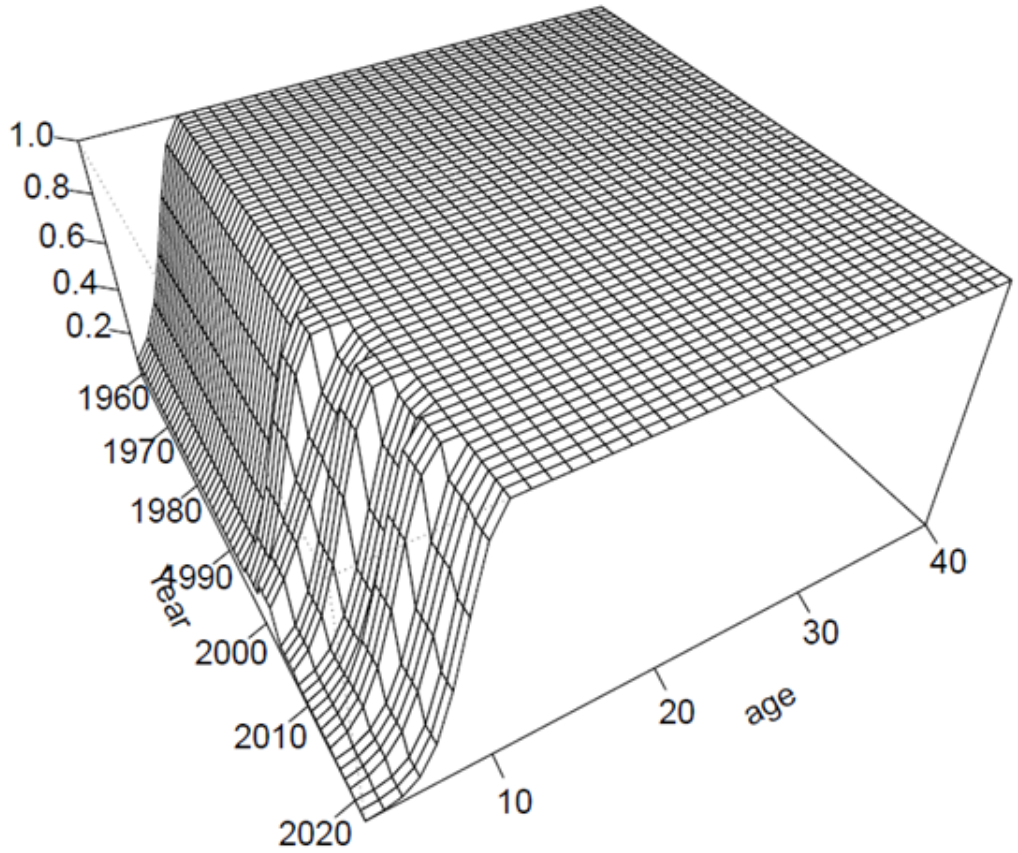
Double normal curve

- Joins two normal curves

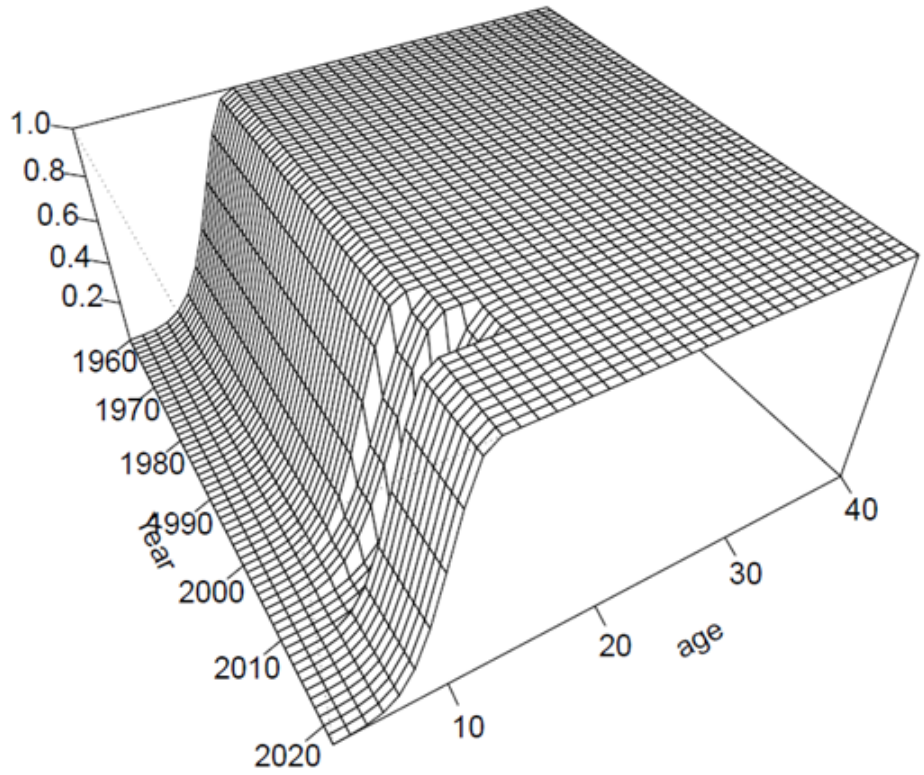
$$s_a = \begin{cases} e^{\frac{-(a-\mu)^2}{2\sigma_1^2}} & for\ a < \mu \\ 1 & for\ \mu < a < \mu + d \\ e^{\frac{-(a-(\mu+d))^2}{2\sigma_2^2}} & for\ a > \mu + d \end{cases}$$

- The means of the two normal distributions are μ and μ+d.
- Slopes of the ascending and descending portions are controlled by σ1 and σ2, respectively
- All 4 parameters can vary between blocks (with penalty on deviations)
- Can take on a variety of dome-shaped and sigmoidal patterns.

Model 24.3, AI survey selectivity



Model 24.3, EBS survey selectivity

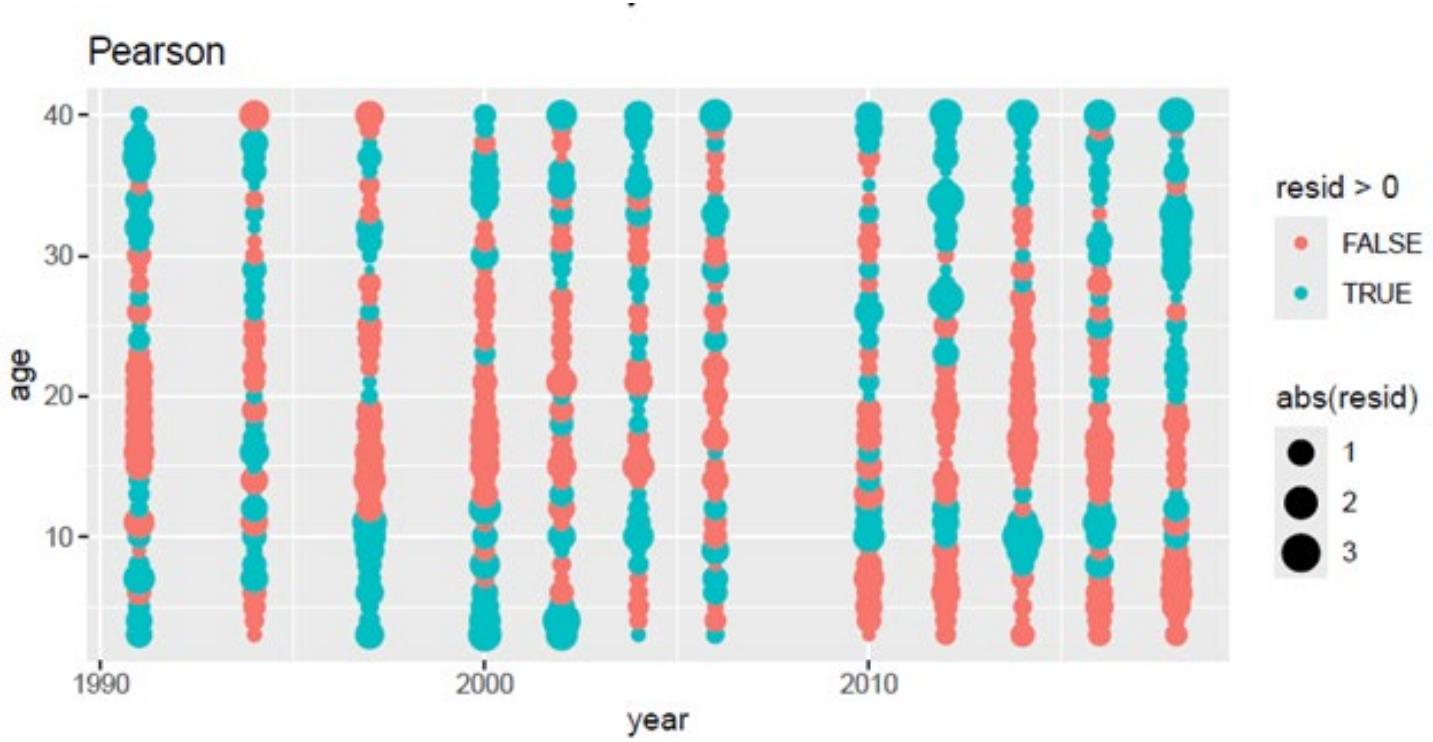


- For either the AI or EBS survey selectivities, there were slight variations between blocks in the ascending portion of the curve.
- Dome-shaped patterns were not estimated

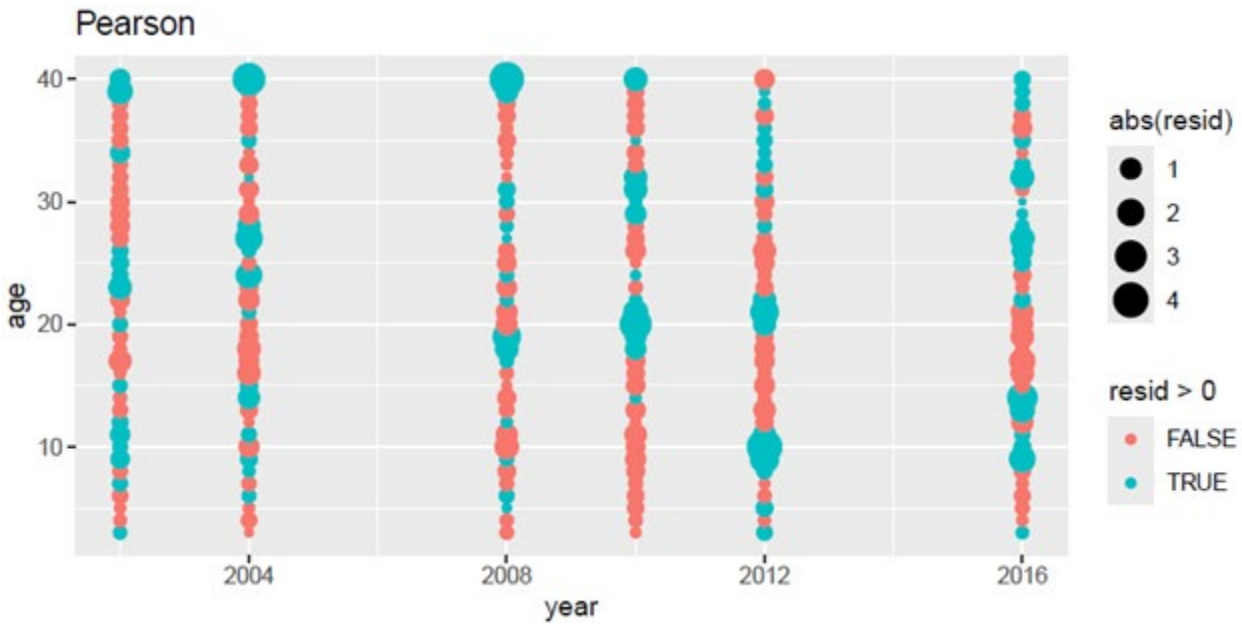
Estimated mortality and survey catchabilities

Parameter	Model 16.3	Model 24.1	Model 24.2	Model 24.3
Natural morality (M)	0.056	0.044	0.054	0.054
AI survey catchability	1.00	1.51	1.16	1.21
EBS survey catchability	0.25	0.37	0.30	0.31

Pearson residuals, model 16.3, AI survey ages

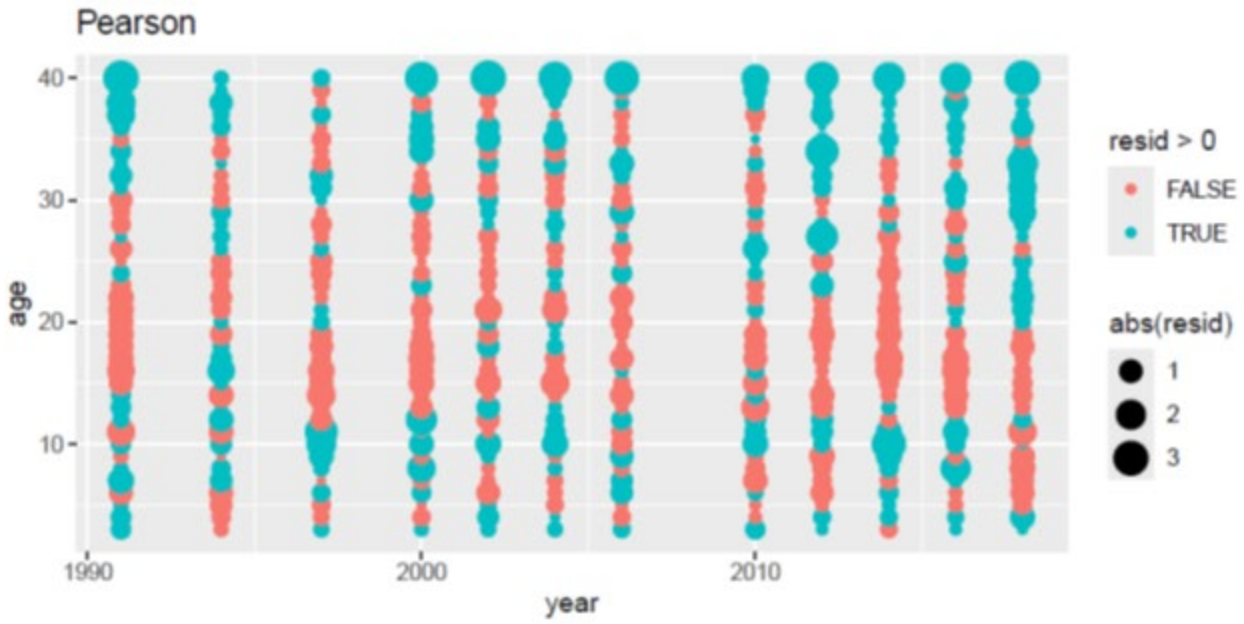


Pearson residuals, model 16.3, EBS survey ages

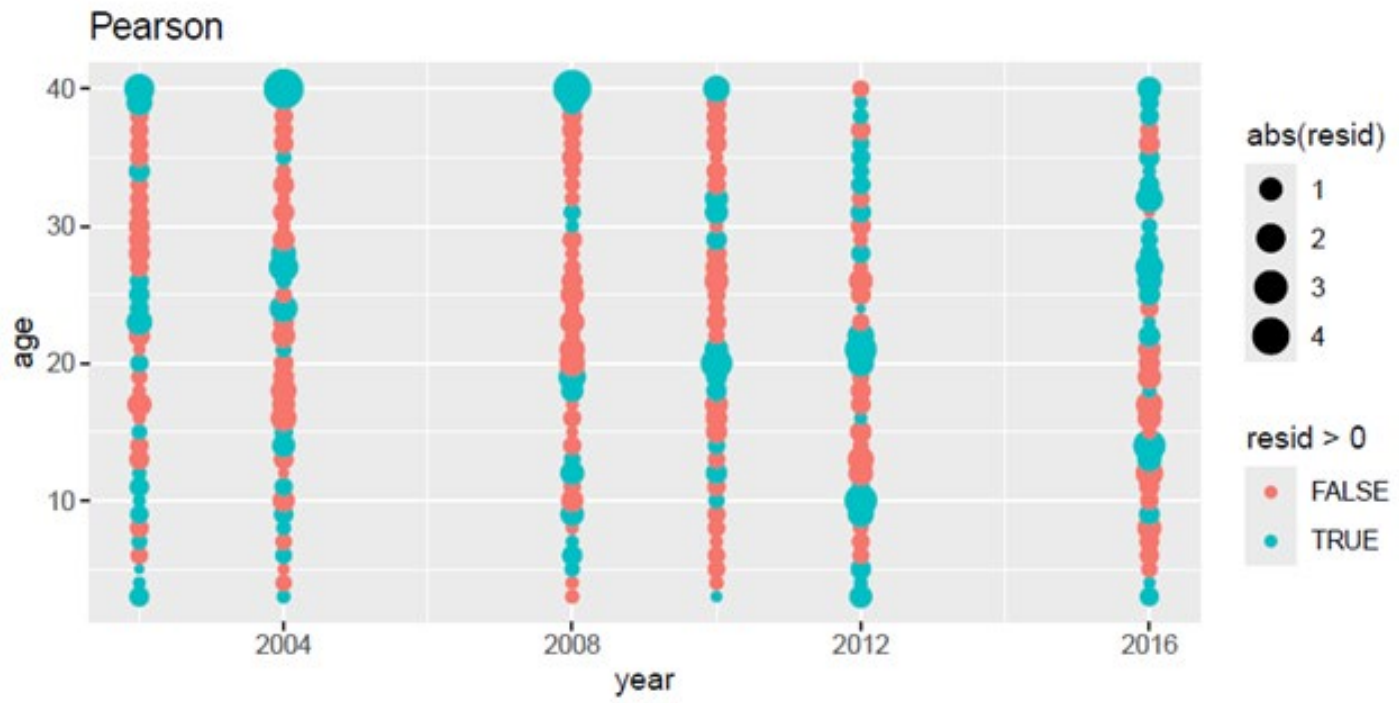


Pearson residuals, model 16.3, Fishery ages

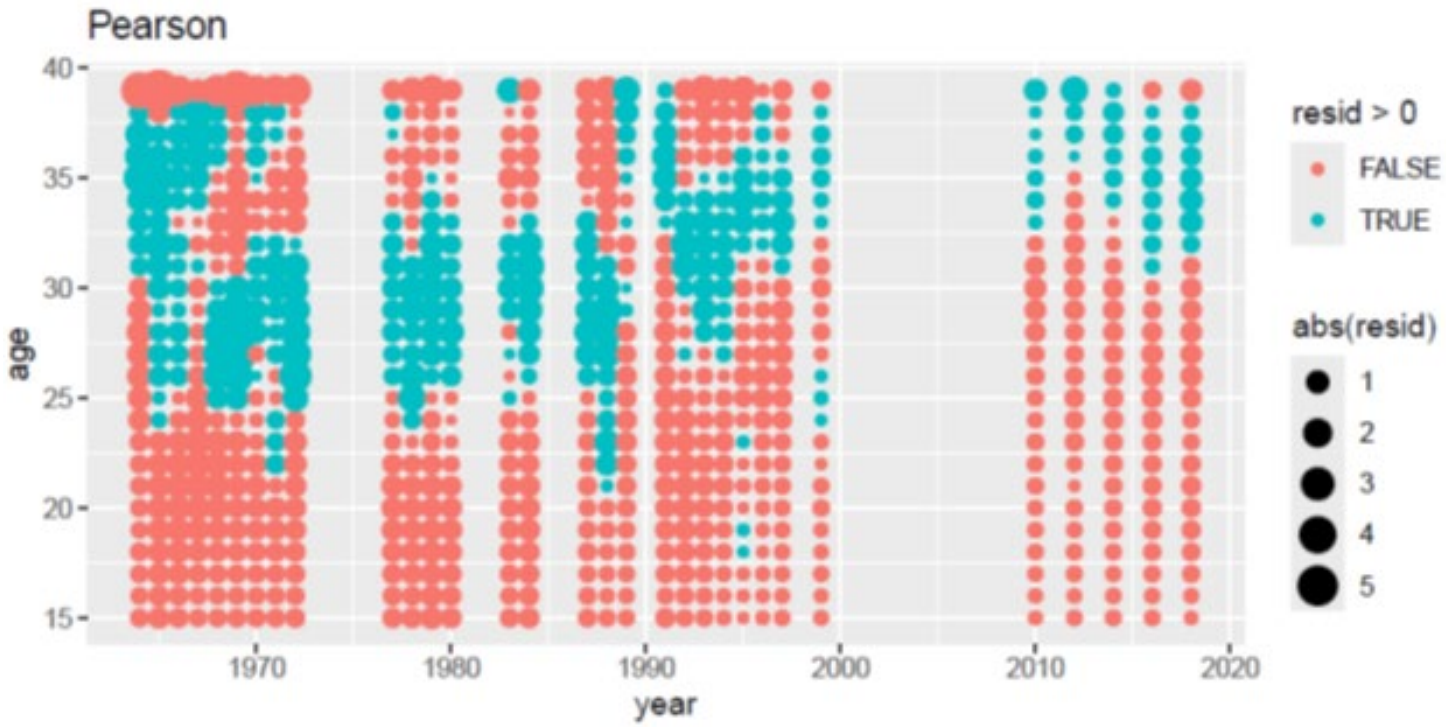
Pearson residuals, model 24.3, AI survey ages



Pearson residuals, model 24.3, EBS survey ages



Pearson residuals, model 24.3, Fishery ages



Recommendations for fall assessment

- Models that evaluated options for estimating the initial numbers at age, and time-varying survey selectivity, did not resolve the fits to the age and length composition data, and the AI survey index.
- We recommend model 24.2 be considered
  - Restores a prior distribution on AI survey catchability, which was a feature of past assessments and consistent with the field study of Jones et al. (2021)
  - The increased penalty on fishery selectivity dome-shapedness across ages adds stability