Gulf of Alaska walleye pollock 2024 CIE review materials

This document contains a brief overview of some of the proposals for updates to the data and model that will be presented for review. The goal is for reviewers to get a better sense of the scope of the review before arriving. A brief description and preliminary results are given, and further details will be presented at the review.

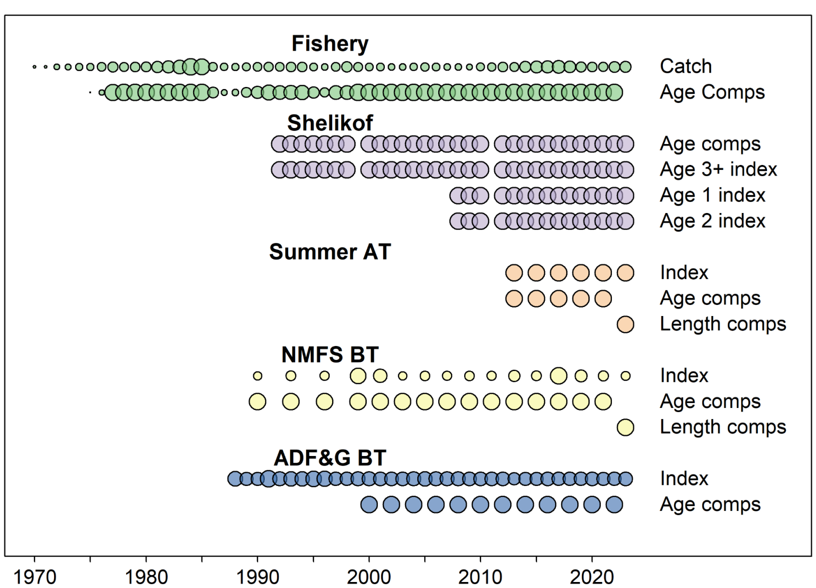
Supporting papers:

- Estimation of catch-at-age: Kimura (1989) [link]
- One-step-ahead (OSA) residuals: Thygessen et al. (2017) [link] and Trijoulet et al. (2023) [link]

Proposed data updates

The following figure shows an overview of the data sources used in the assessment model (as of 2023). Following is a table describing the assumptions made in the baseline model, and proposed alternatives. The size of the circles shows the relative weight (bigger = more information) of a data set within a row.

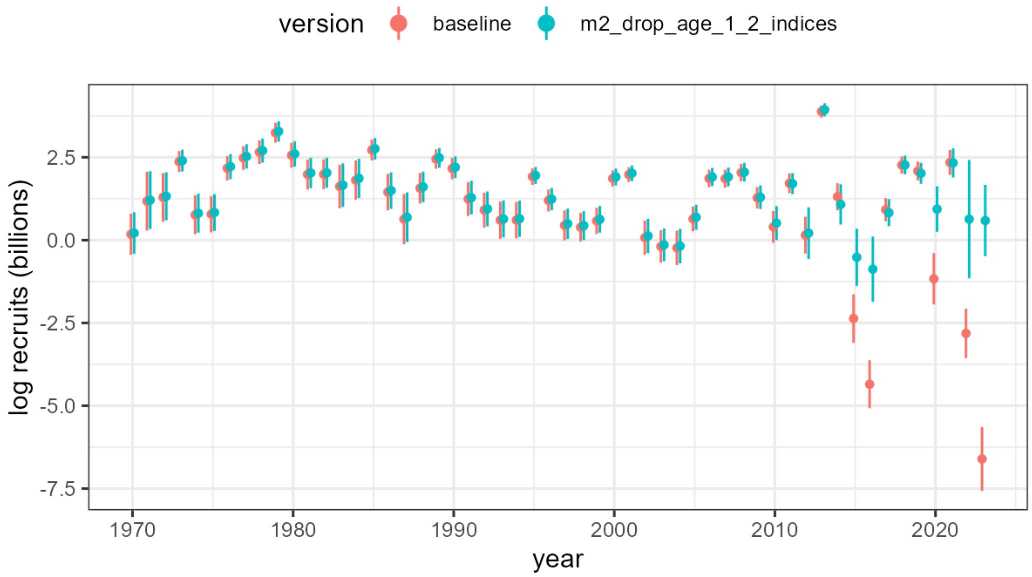
All indices of abundance are assumed to be lognormal with input CVs, and age composition data are assumed multinomial. For age compositions the iterative Francis approach is used to tune the input sample size (ISS) to get effective sample sizes (ESS) for multinomial data.



Data source	Range of values	Current method	Proposed method
Fishery ages	N=0.37-73.7	Min (200, number of trips). Francis tuned	Bootstrap approach coupled with Kimura et al. (1989) method to get estimates of ISS which are then Francis tuned
Shelikof Strait Age 1 index	CV=0.45 in all years	Tuned by hand many years previously	Drop survey, or use Urmy's total uncertainty approach
Shelikof Strait Age 2 index	CV=0.55 in all years	Tuned by hand many years previously	Drop survey, or use Urmy's total uncertainty approach
Shelikof Strait Age 3+ index	CV=0.2 for all years	Assumed	Urmy's total uncertainty approach in the future. For now, using annual CV estimates and rescale so that the mean is 0.2.
Shelikof Age 3+ age comps	N=5.7 for all years	Assumed, Francis tuned	Use # biological hauls and Franics tuning
NMFS bottom trawl index	CV=0.12-0.43	Design based estimator	No change
NMFS bottom trawl ages	N=8.2 for all years	Assumed, Francis tuned	Bootstrap approach (Hulson et al. 2024)
ADF&G bottom trawl index	CV=0.19-0.34	Bayesian GLMM rescaled to average CV=0.2	No change proposed
Summer acoustic index	CV=0.25 for all years	Assumed	Urmy's total uncertainty approach in the future. For now, using annual CV estimates and rescale that the mean is 0.2.
Summer acoustic age comps	N=37.2 for all years	Assumed, Francis tuned	Use # biological hauls and Franics tuning

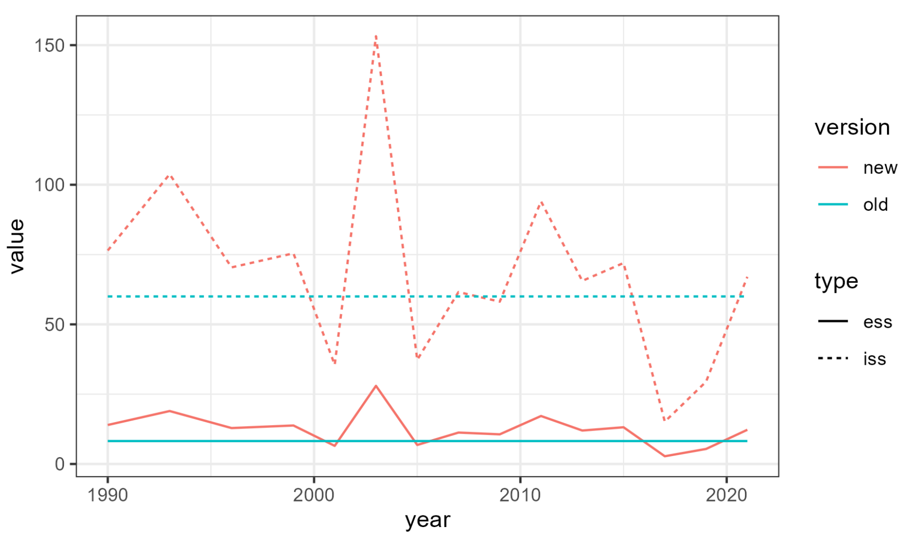
Drop age 1 and 2 Shelikof indices

The winter acoustic survey in the Shelikof Strait splits the index of abundance into age 1, age 2, and age 3+. The age 1 and 2 are modeled as numbers, while the age 3+ as biomass. I will propose to remove the age 1 and 2 indices from the model because (1) they are influential on the model estimates of recruitment, in particular some extremely low values of recent cohorts, and (2) the survey is a pre-spawning survey and those ages do not spawn and thus are not always expected to be available spatially to the survey.

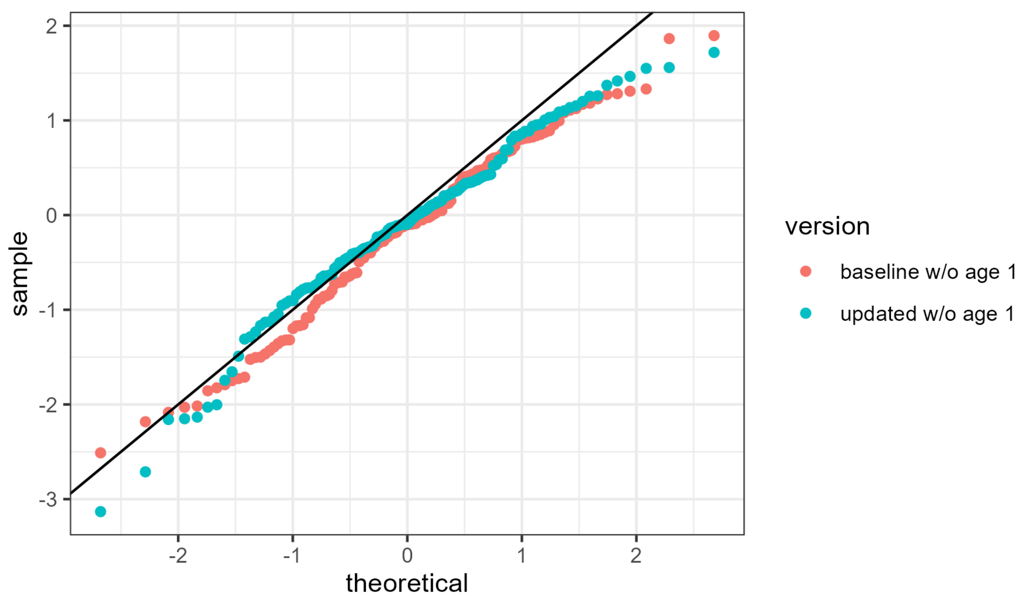


Update input sample size for the GAP trawl survey

I will propose the approach by Hulson and Williams (2024) [https://doi.org/10.1016/j.fishres.2023.106894] to use bootstrapping to get improved ISS values.



The following shows OSA residuals bubble plots and QQ plots. For a correctly specified model the residuals should be close to iid N(0,1) and have no patterns by age and year. Similar plots are used throughout to gauge model fit to the composition data.

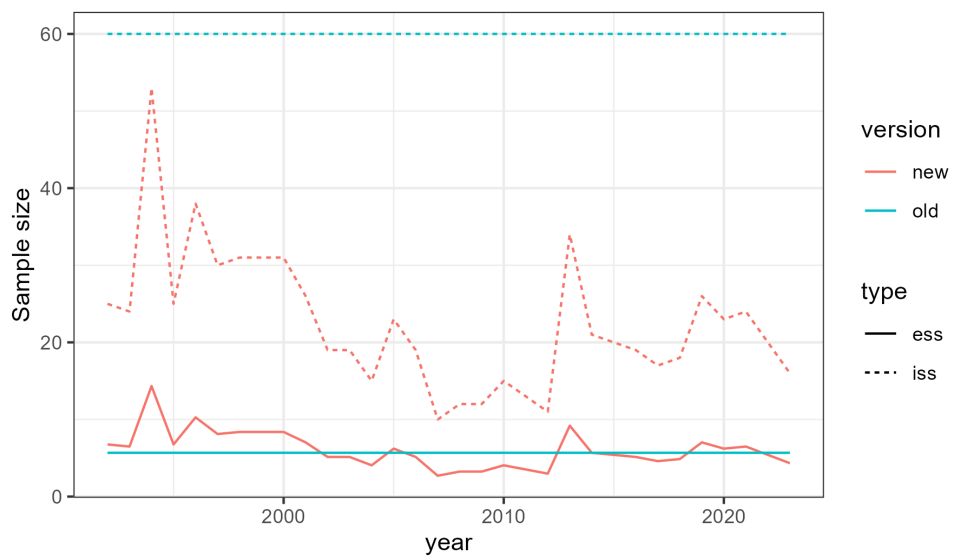


Update input sample sizes for winter and summer acoustic surveys

Currently both surveys assume the same arbitrary ISS for all years, and then are tuned via the Francis approach to get effective sample sizes.

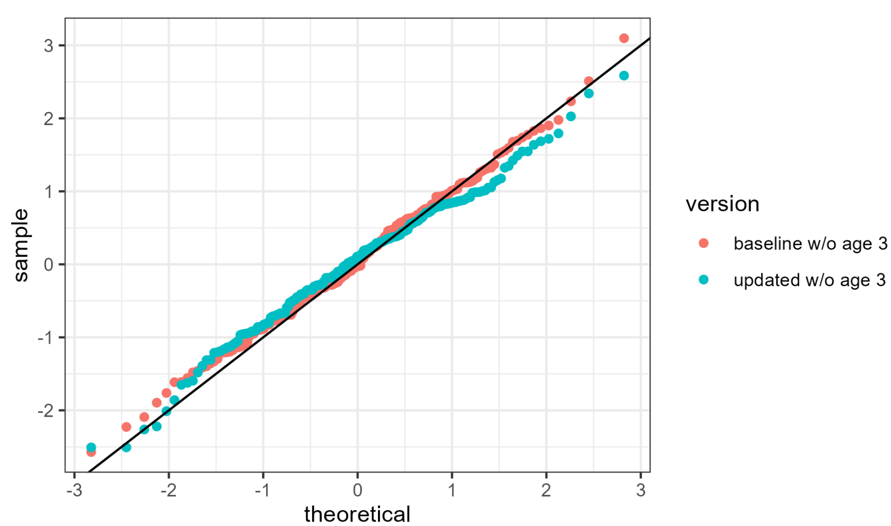
Winter survey ESS

I will propose to use the number of biological hauls as a proxy for ISS in place for the winter survey.



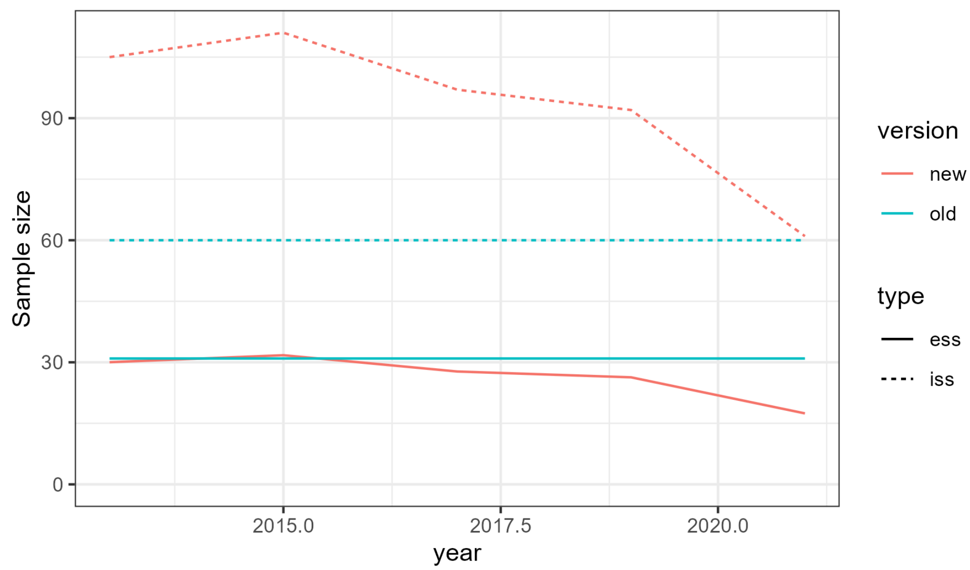
Sample size
year
version
new
old
type
ess
iss

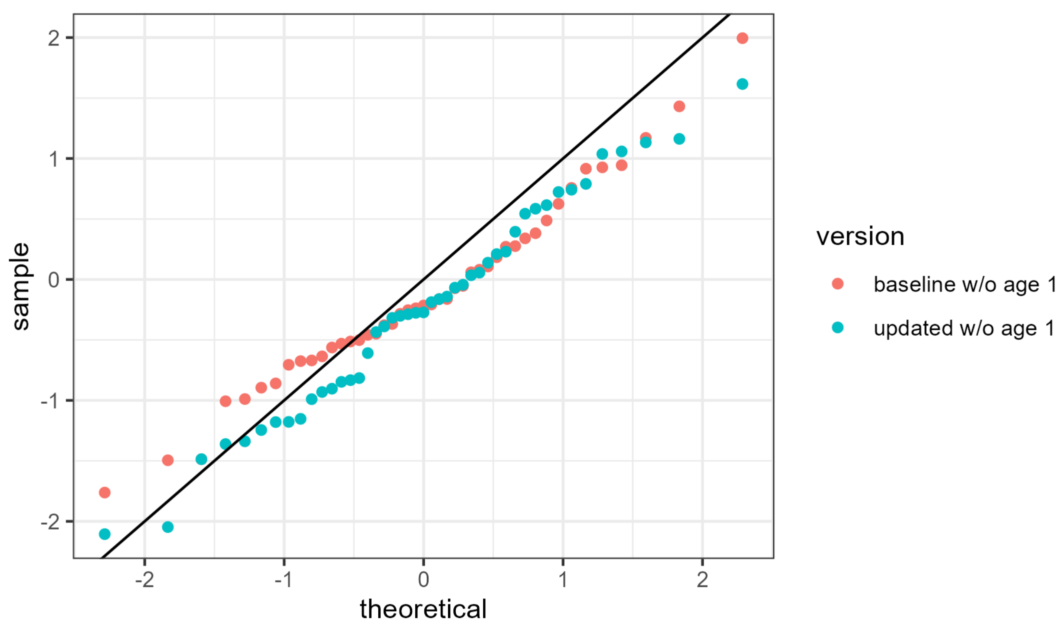
baseline w/o age 3
updated w/o age 3
Age
abs(resid)
resid > 0
FALSE
TRUE



sample
theoretical
version
baseline w/o age 3
updated w/o age 3

Summer survey ESS



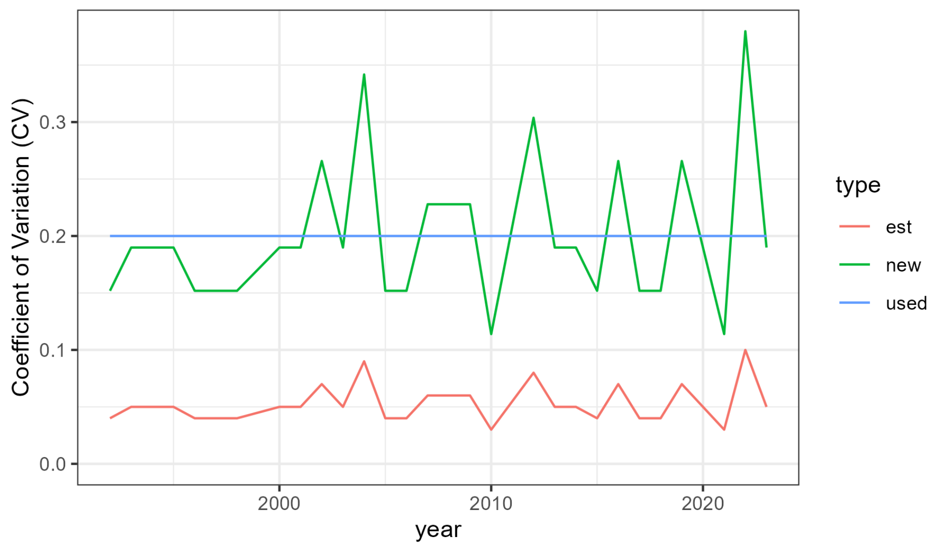


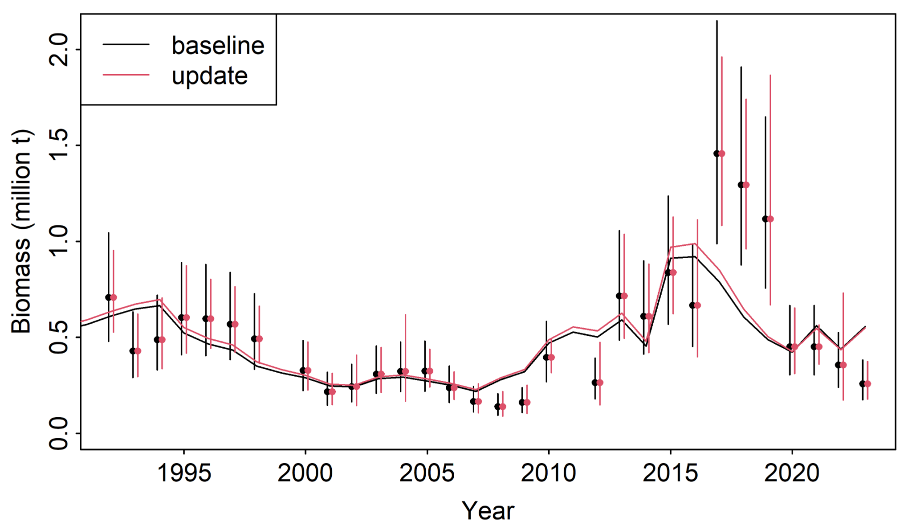
Update CV for winter and summer indices

Currently the CVs estimated by the acoustic survey team using a 1-D geostatistical approach are not used because they are deemed much too small (e.g., Walline 2007; link). Instead, a value of 0.2 is used for all years. The in-progress work by Urmy et al. is intended to provide more realistic estimates of uncertainty to use for the CV. However, this work is not ready for evaluation in the stock assessment. Instead, we will discuss the potential merits of the approach to be implemented later.

An alternative is to take the estimated CV time series, and scale it so that the mean is 0.2, but the relative CVs among years remains. This should reflect interannual variation in uncertainty but provide a more realistic weight to this data set.

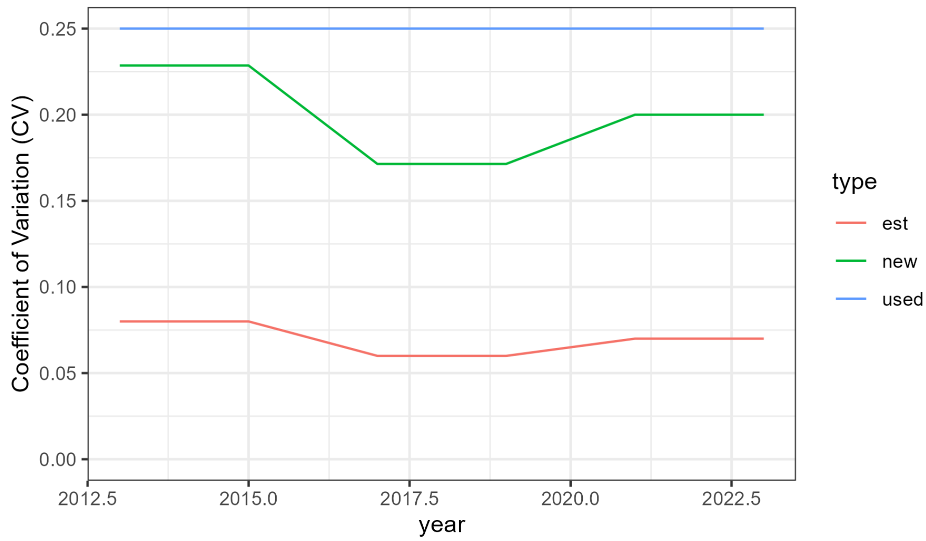
Winter survey biomass CV

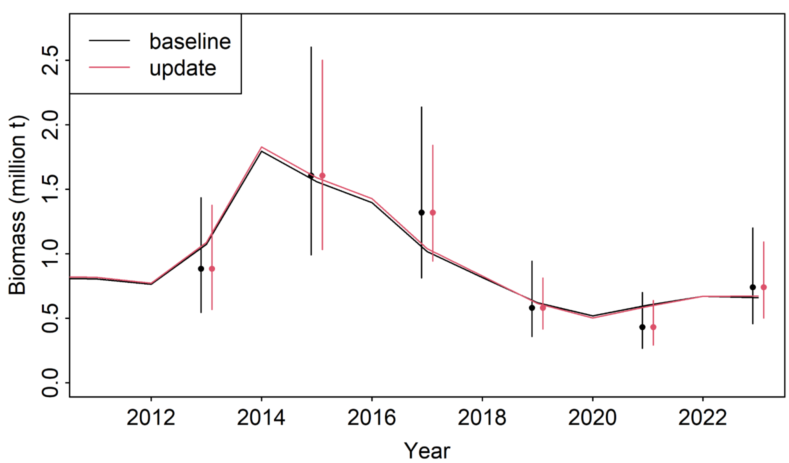




Summer survey biomass CV

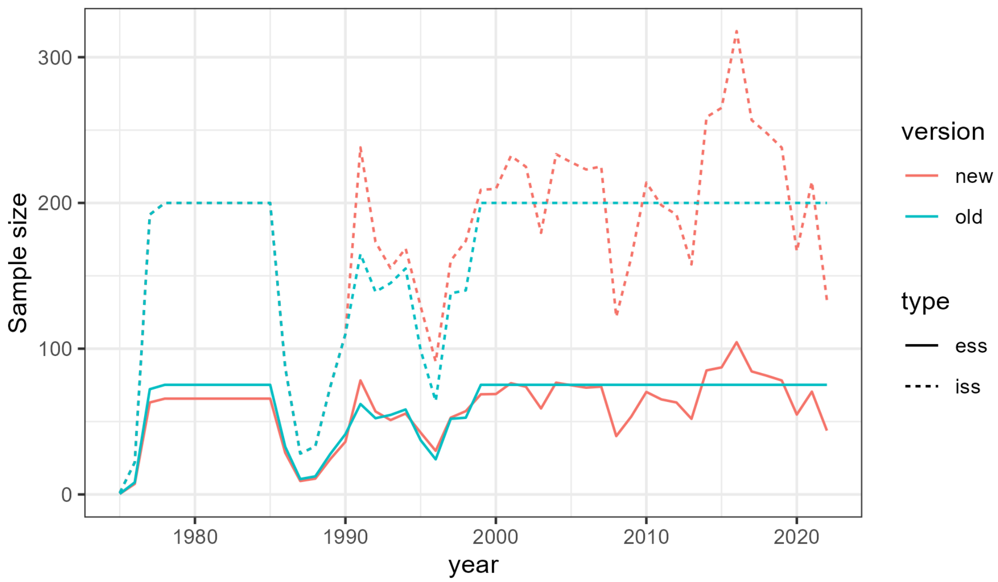
A similar approach as the previous section is used below.

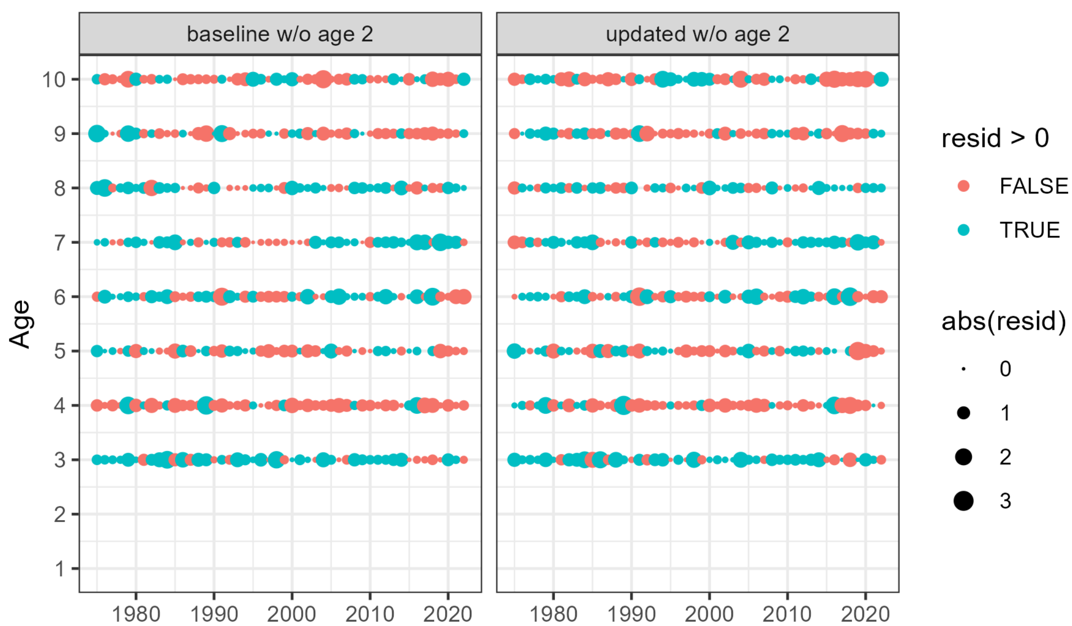


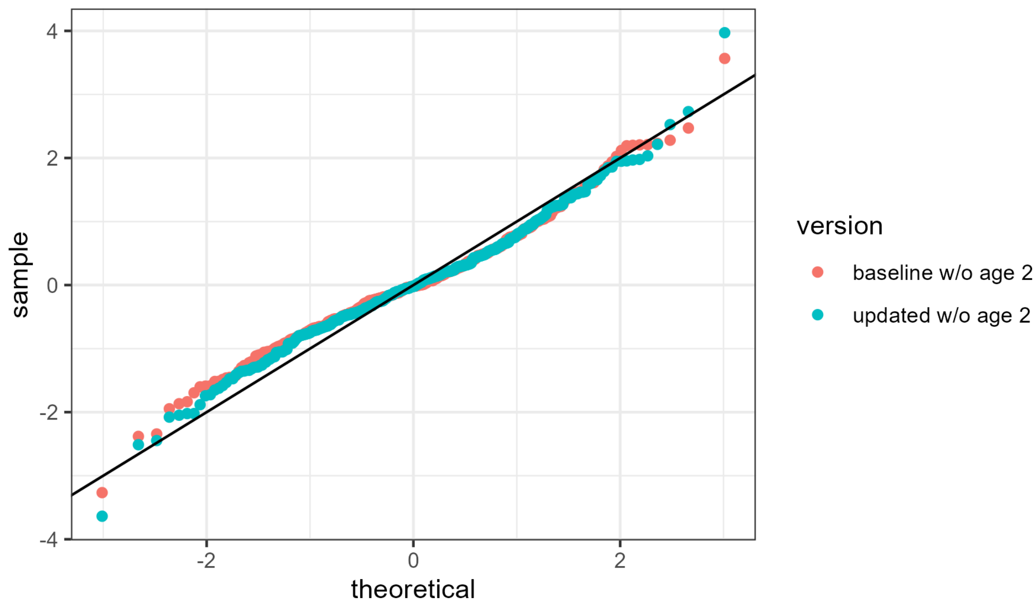


Update fishery input sample sizes and age composition

The current approach to get ISS is to use the minimum of 200 or the number of tows/deliveries taken. This led to a constant ISS for more than 20 years. Instead I will propose to use a bootstrapping approach to calculate ISS which varies among years, based on Kimura (1989) but with a bootstrapping component based on pre-defined strata. In the original model the data are stratified by area and season. Preliminary results suggest an unstratified approach may work better and is shown below. This approach is feasible for data after 1991, and the earlier time period will not be modified. Instead, the input ISS after 1990 is normalized to have a mean of 200 and then the entire ISS series is adjusted using the Francis approach to get ESS.


Sample size
year
version
new
old
type
ess
iss
0
100
200
300
1980
1990
2000
2010
2020


baseline w/o age 2
updated w/o age 2
Age
resid > 0
FALSE
TRUE
abs(resid)
0
1
2
3
1980
1990
2000
2010
2020



4
2
0
-2
-4
sample
-2
0
2
theoretical
version
baseline w/o age 2
updated w/o age 2

Proposed model changes

The assessment model is in TMB now and so application of random effects to different components is feasible. Below I discuss two specific random effect implementations for review, but I would like to have a general discussion about how and when to include such complexity in other model components.

Adding a timing covariate to catchability for the winter acoustic survey

Based on Rogers et al. (2024) [link]. Covariates related to survey timing were shown to have explanatory power for catchability. In particular, the proportion of fish mature as a proxy for survey timing relative to spawn timing is convenient because the covariate data are available each time there is a survey. The question is whether the added complexity of this formulation is worthwhile from a management perspective.

Non-parametric fisheries selectivity forms

In 2023 a 2D and 3D AR(1) fisheries selectivity form were tested [link] but not proposed for use in the operational assessment. We found evidence for improved fits to the fishery age compositions, but at a cost of much greater run time. Are these approaches an improvement?

Alternative biological components for discussion

This stock exhibits large annual variation in both growth (weight at age) and maturity. There are likely cohort effects in both as well. Statistical analyses of these processes could be incorporated into the assessment, rather than being done externally and assumed known without error. However, this would add quite a lot of complexity to the model and it is unclear how to justify or validate that.