
# GOA Pollock Updates

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# Road map for today

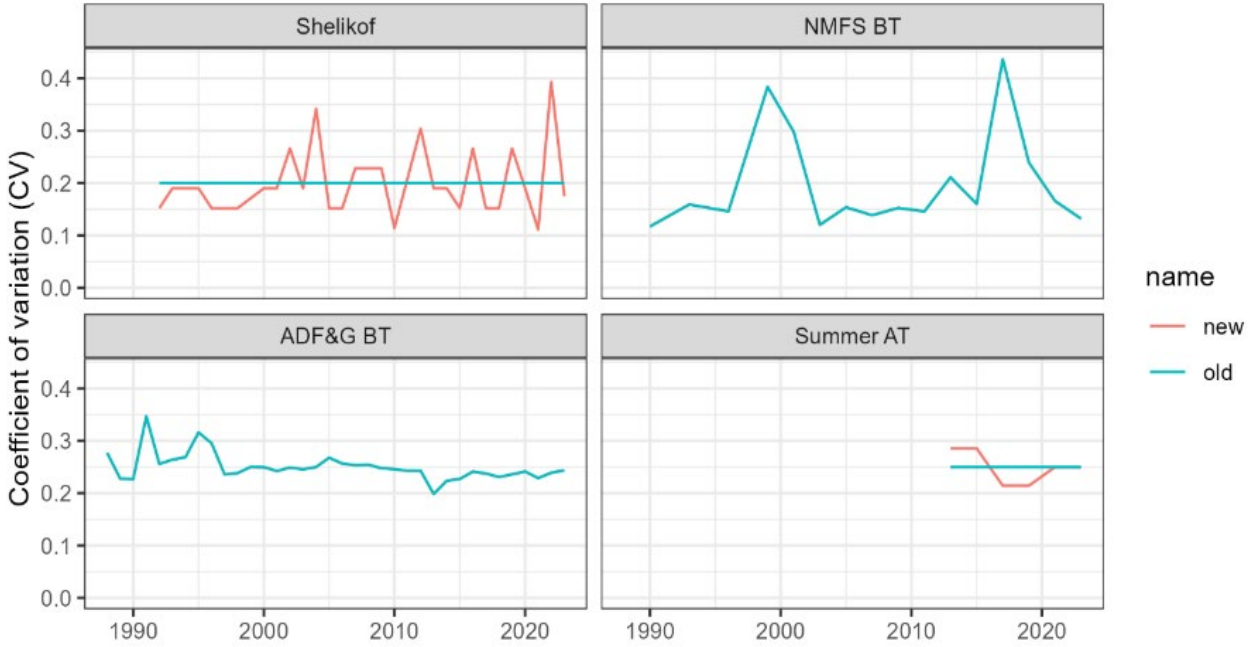
- CIE review overview
- Proposed changes:
  - 23a – Update input ISS and index CVs
  - 23b – Incorporate spawn timing covariate (Rogers et al. 2024)
  - 23c – Drop Shelikof age 1 and 2 indices
  - 23d – Switch to Dirichlet-multinomial
- New diagnostics: likelihood profiles (M, q2), OSA residuals, self-testing, MCMC, dropping surveys, jittering
- Issues: data conflict, ongoing scale uncertainty

# CIE review highlights

- May 2024, Seattle WA
- Drs. John Neilson, Yong Chen, Daniel Howel
- Generally positive that model is appropriate for management
- Had good suggestions for future research
  - Understand spatial distribution better
  - Expand plus group in light of large 2012 year class
  - Explore alternative weighting schemes and model frameworks

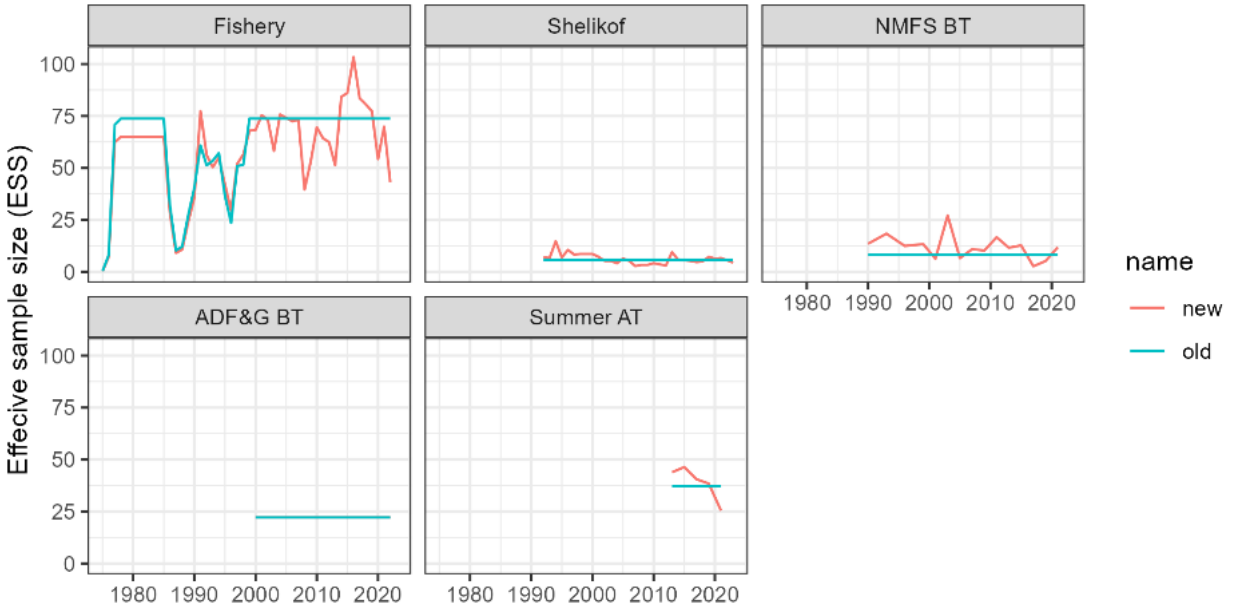
# Updating input CVs

- Historically acoustic CVs were constant (“old”)
- Instead use 1d geostatistical estimate and rescaled (“new”)
- Urmy et al. hopefully to improve on this next year



# Updating input sample size (ISS) for age comps

- Historically ISS were constant and Francis tuned (“old”)
- NMFS BT uses bootstrapping approach*
- Acoustic uses # hauls
- Fishery (>1991) uses bootstrapping and harmonic mean of RSS via ADMB “sampler” program
- ESS uses Francis tuning




*Hulson and Williams (2024) | https://afsc-assessments.github.io/afscISS/

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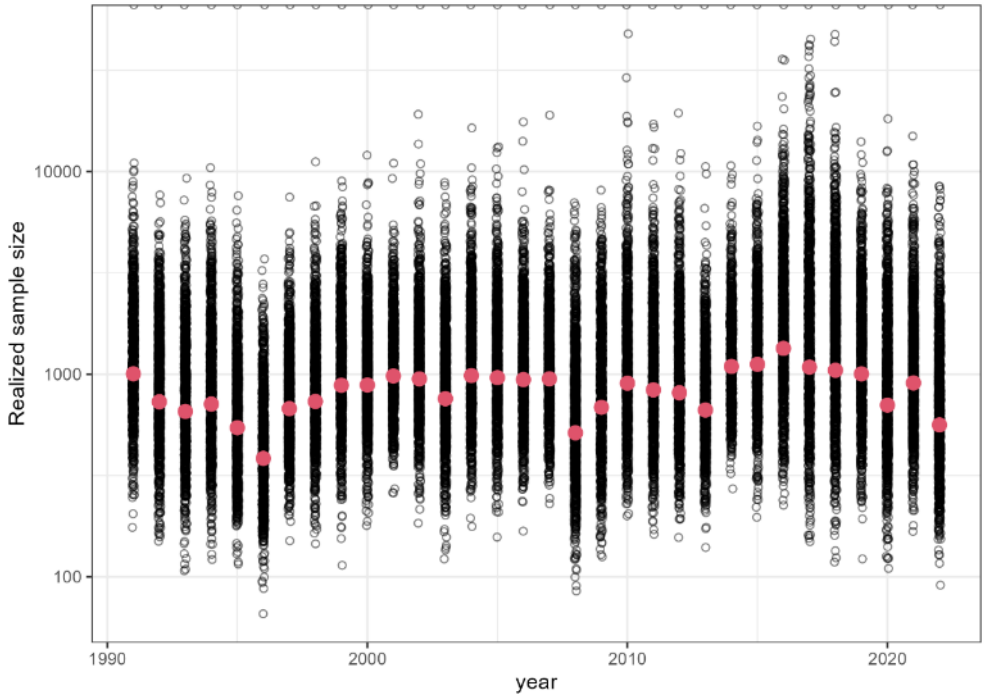


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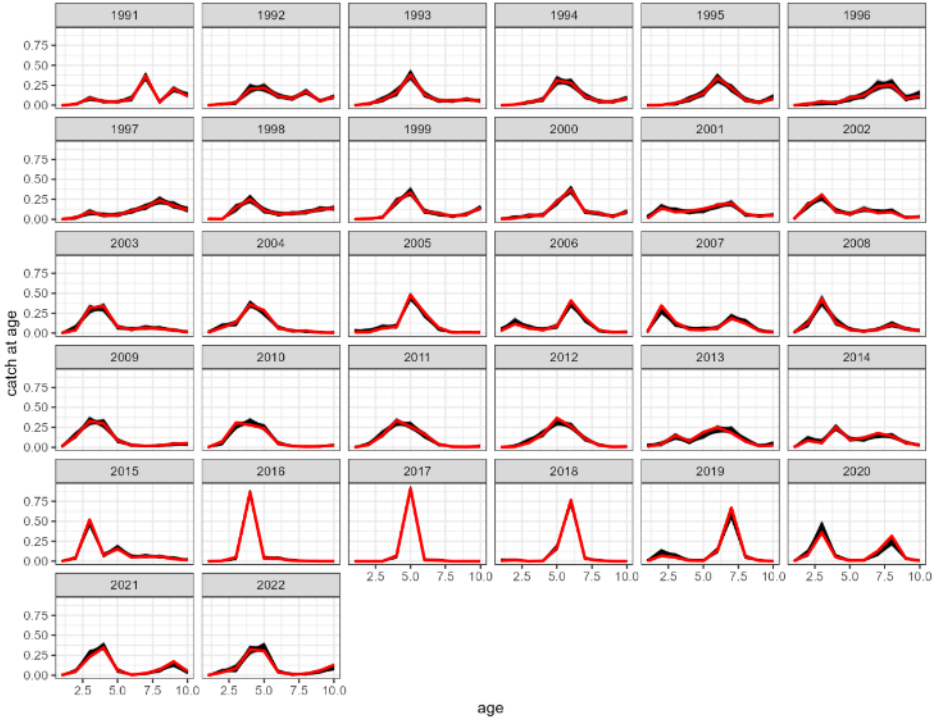


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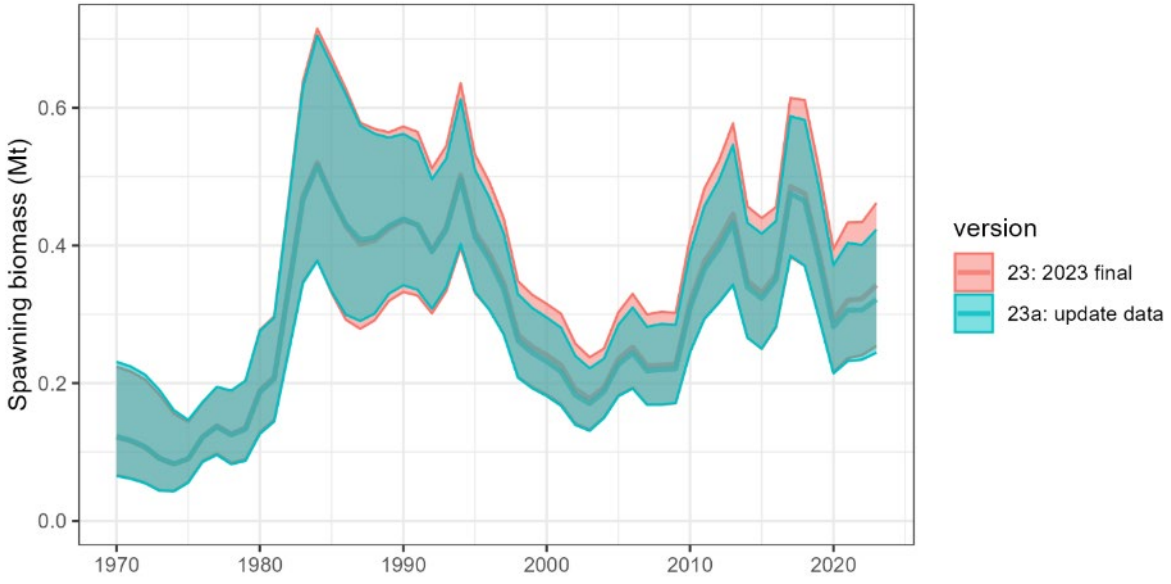
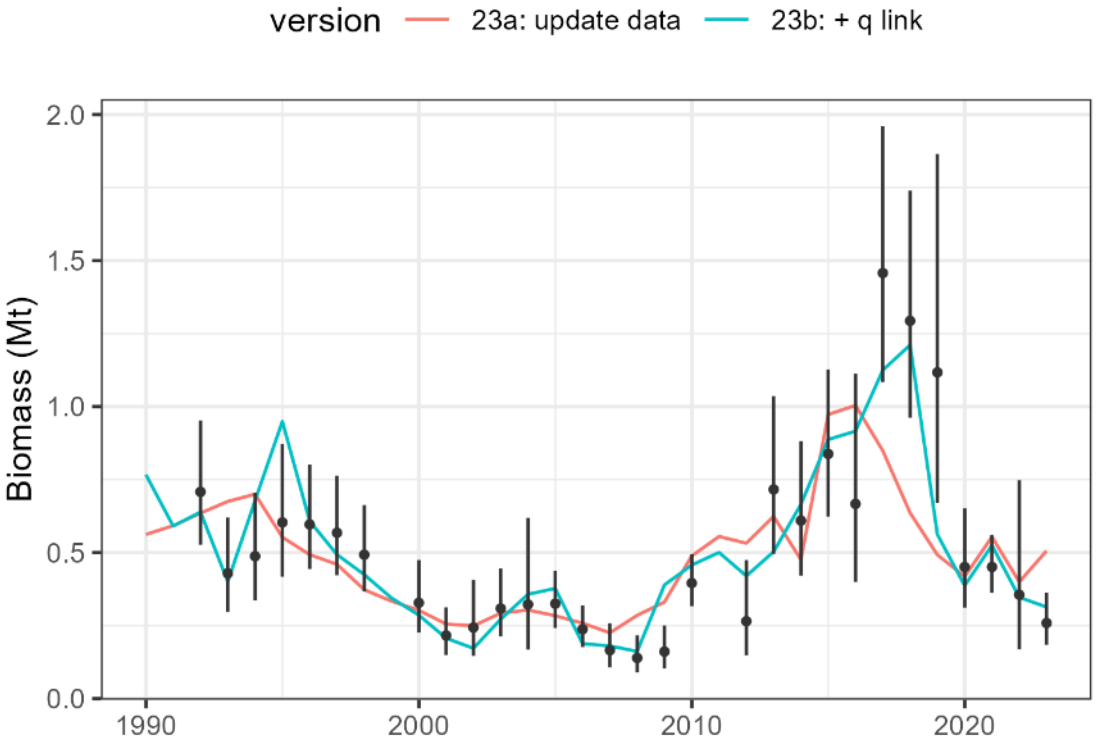
# Impacts of data input changes

- Relative minor changes to SSB from all data updates
- Diagnostics shown at end (no big changes)



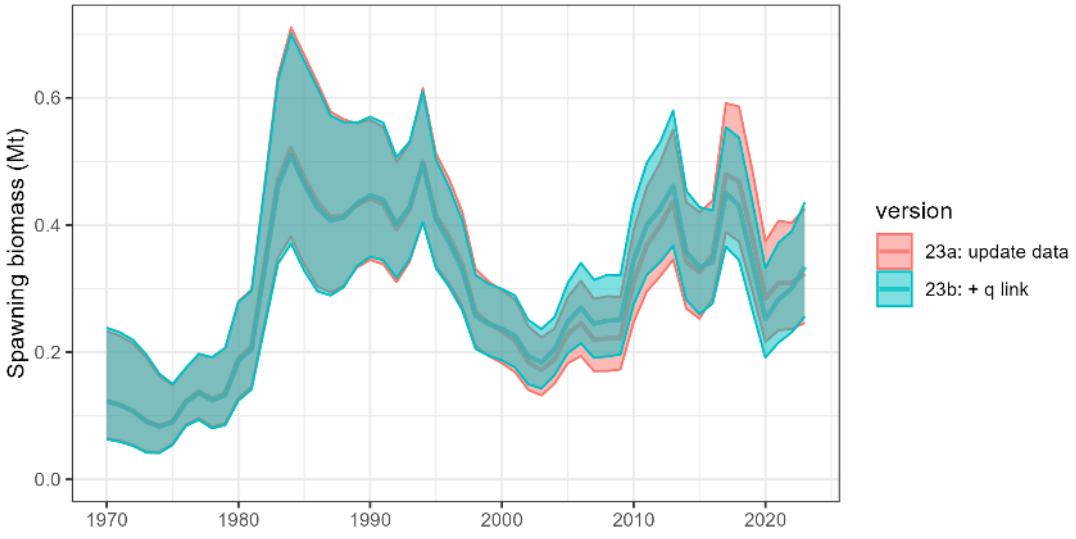

Kristensen et al. (2016), Monnahan and Kristensen (2018)

# 23b: Climate-driven changes in spawn timing




- Rogers et al. (2024) showed clear signal for Shelikof survey catchability varying by spawn timing
- Operationalized this year as model 23b (TMB).
- Uses logit of proportion mature
- Penalized RW still left on, but does little for now

# 23b: Climate-driven changes in spawn timing

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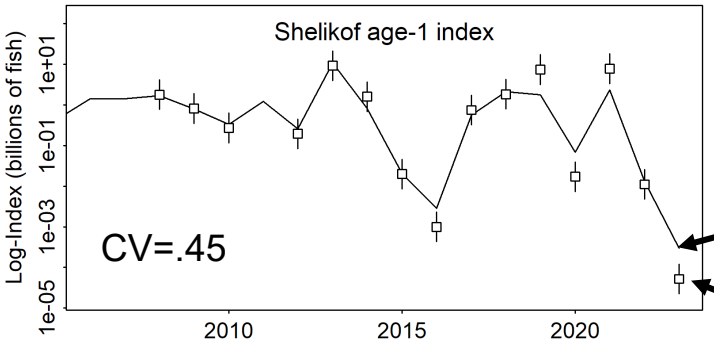
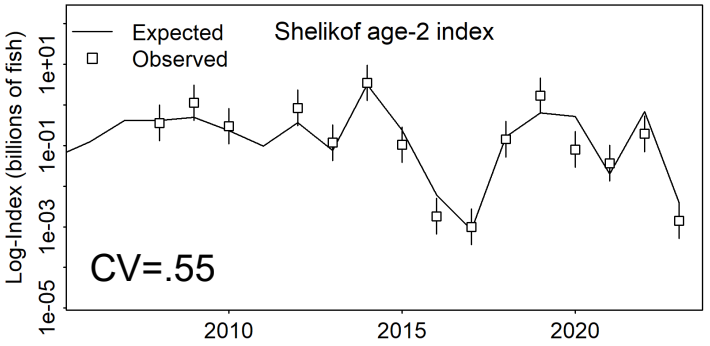
# 23c: Drop Shelikof age 1 and 2 indices

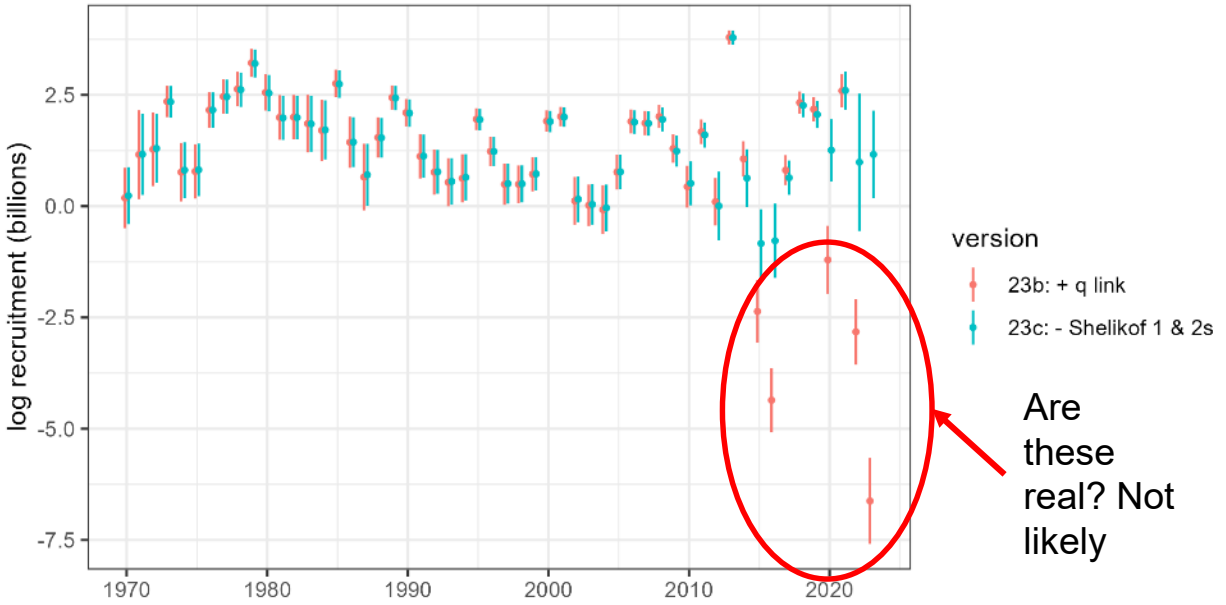
- Age 1 and 2 fish are modeled separately from age 3+ age comps and biomass
- Shelikof is a spawning survey and thus immature 1 & 2s do not necessarily go to spawning grounds
- Worked fine until recently with bad fits, and extreme cohort estimates



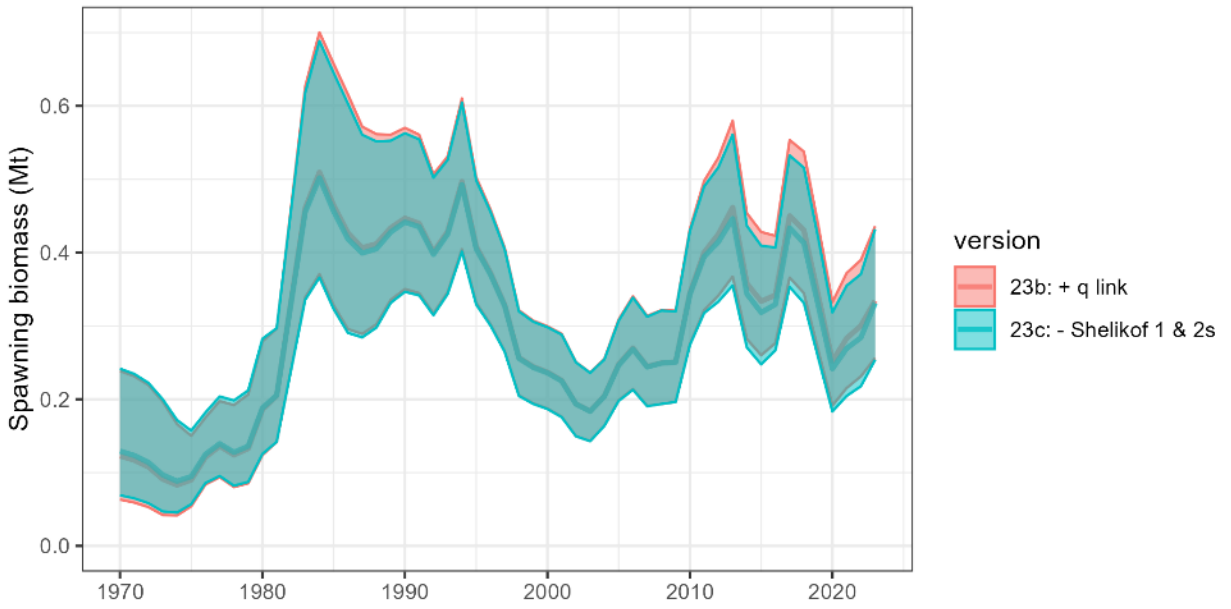
# 23c: Drop Shelikof age 1 and 2 indices

- Concern is that this unreliable data set drives alarming recruit estimates
- Also affects $\sigma_R$ estimates
- Future data cannot overcome these



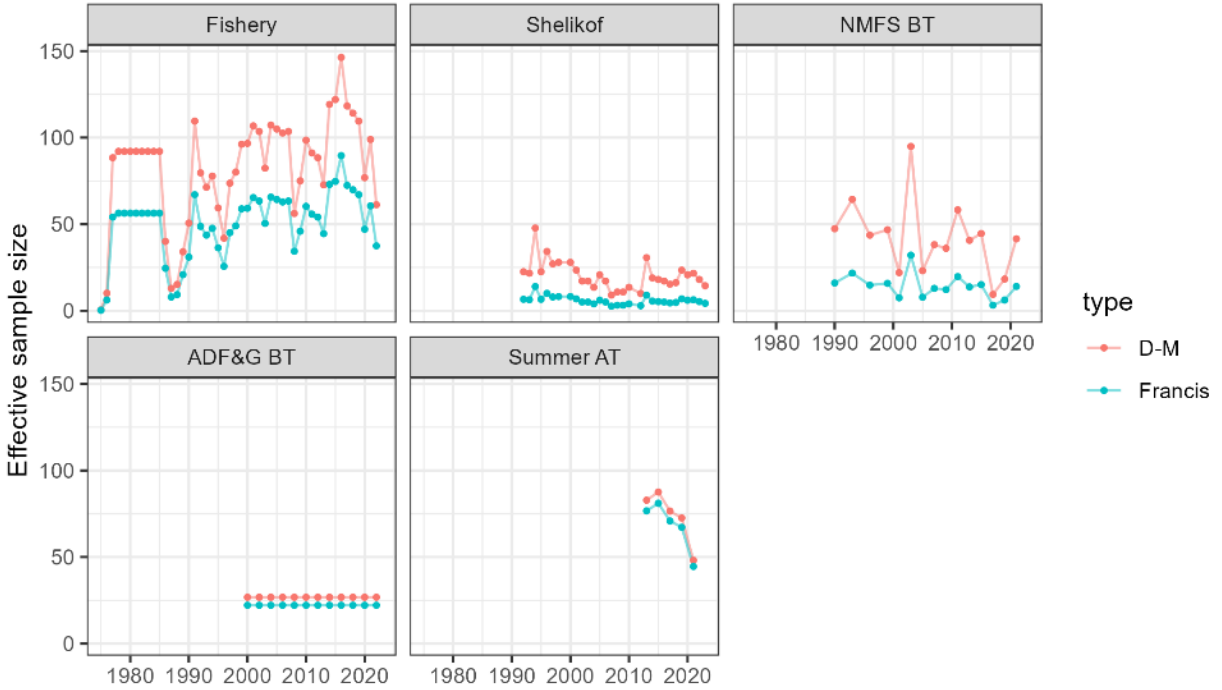
# 23c: Drop Shelikof age 1 and 2 indices

- Minor SSB impact
- A shame to lose this early signal of recruits
- Future work to appropriately model these and add back into the model



# 23d: Dirichlet-multinomial (DM) for age comps

- Francis tuning leads to very low ESS for age comps
- Unreliably so, and so information left on the table
- The DM was used and led to higher ESS



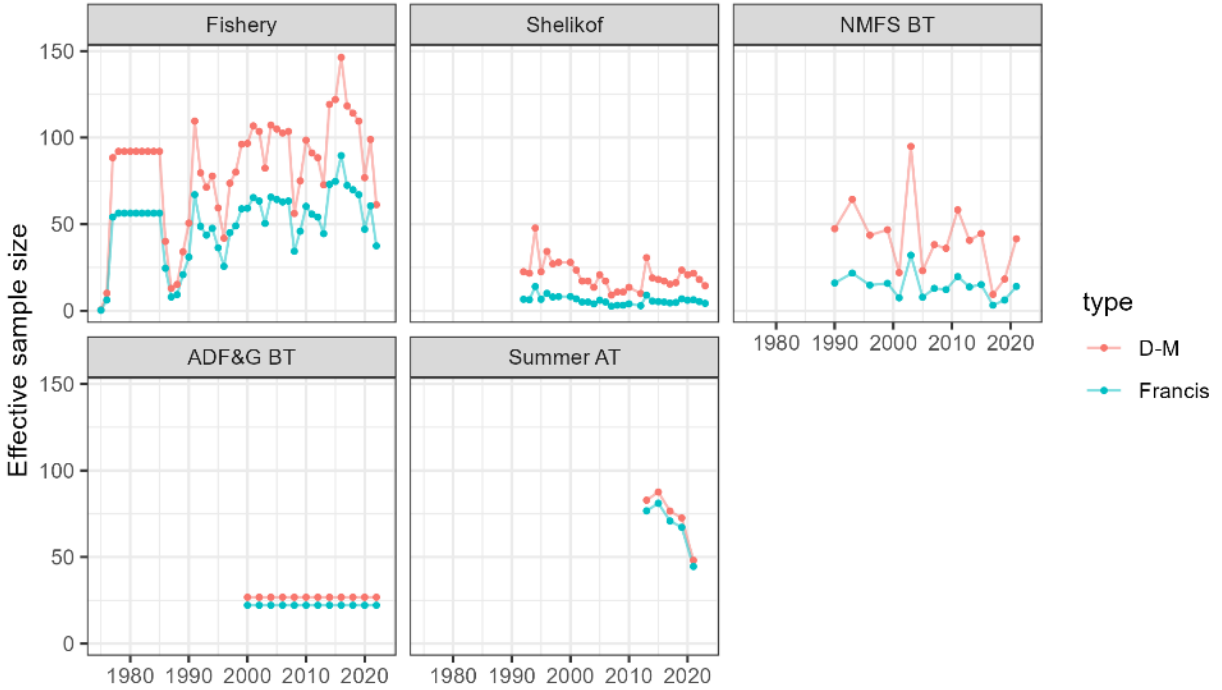
# 23d: Dirichlet-multinomial (DM) for age comps

**Pros**

- Self-tuning automated for all runs (retros, etc.)
- Higher and more realistic ESS

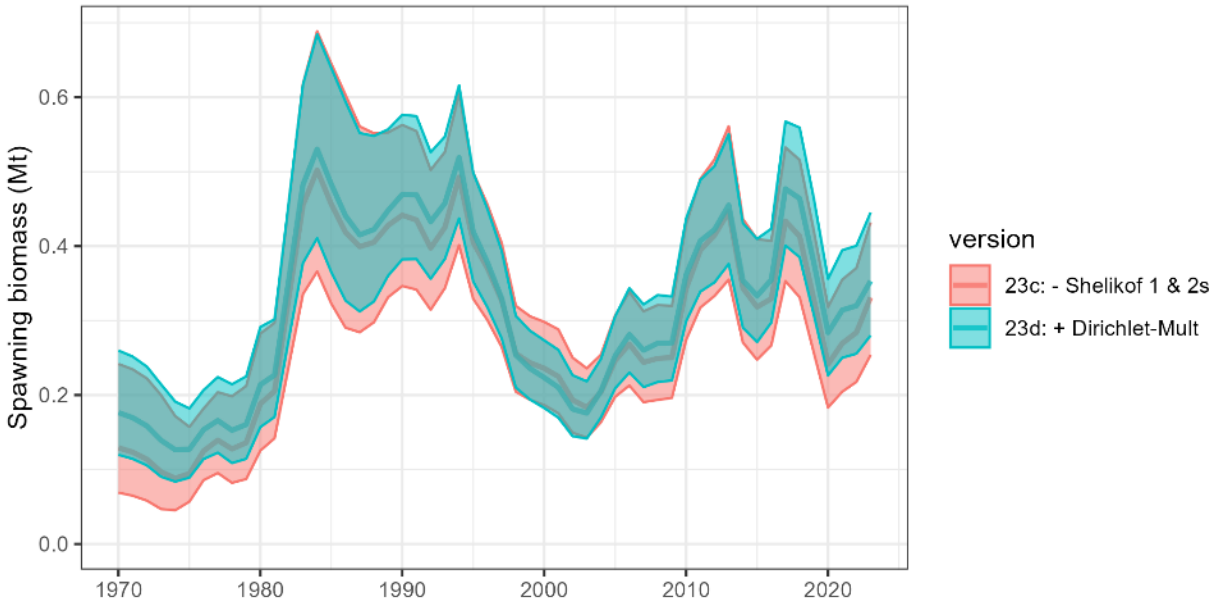
**Cons**

- One extra parameter per data set
- Must be careful with OSA and simulation



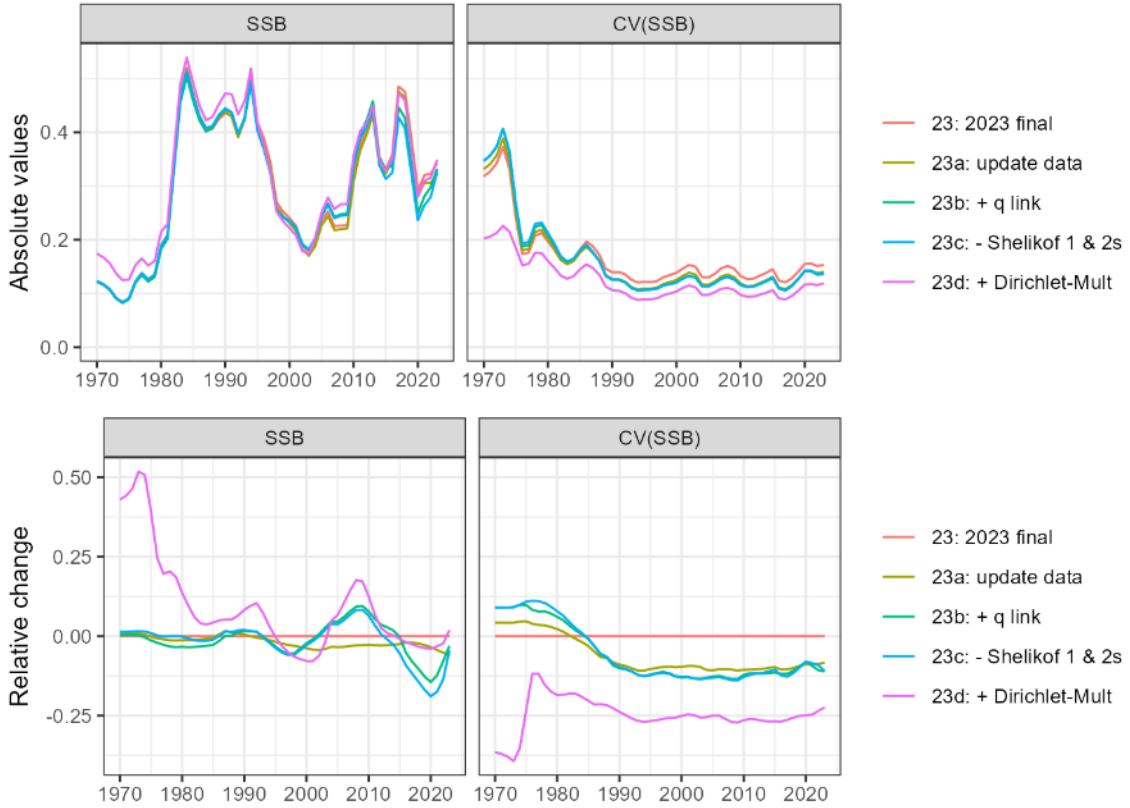
# 23d: Dirichlet-multinomial (DM) for age comps

- Have seen no estimation issues, appears very stable
- SSB estimated higher and with less uncertainty
- Particularly early in time series



# Model update summaries

- Changes are cumulative
- 23d is the biggest difference
- The CIE reviewers recommended 23d



# Model update summaries

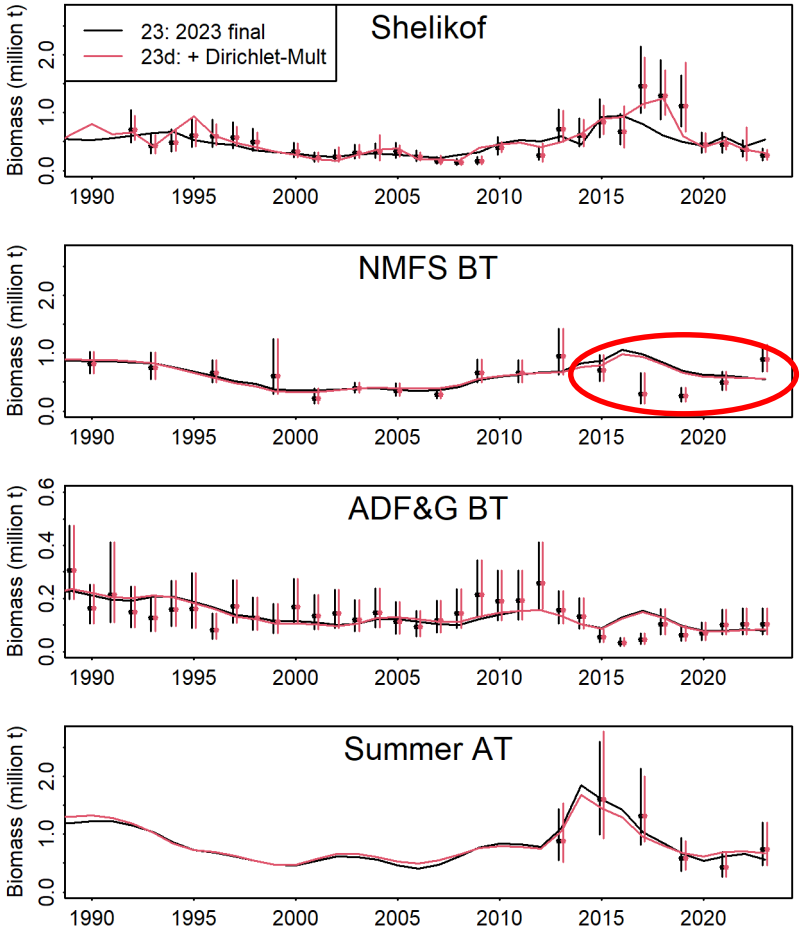
| Model | SSB (2023) | B0 | B40 | B35 | FOFL | FABC | OFL (2024) | ABC (2024) |
|---|---|---|---|---|---|---|---|---|
| **23**: 2023 final | 274,141 | 505,000 | 202,000 | 177,000 | 0.307 | 0.26 | 269,916 | 232,543 |
| **23c**: -Shelikof1&2s | 298,600 | 508,000 | 203,000 | 178,000 | 0.325 | 0.274 | 363,464 | 312,257 |
| **23d**: +Dirichlet-Mult | 292,172 | 517,000 | 207,000 | 181,000 | 0.316 | 0.267 | 307,749 | 264,903 |

# Model evaluation & new diagnostics

- Model 23 had minor issues with self-testing, jittering and MCMC
- Resolved with “regularizing” selex priors (Monnahan 2024)
  - Eliminate flat areas of likelihood space with negligible change to model fit.
- **Both 23c and 23d are stable, reliable and pass self-tests**

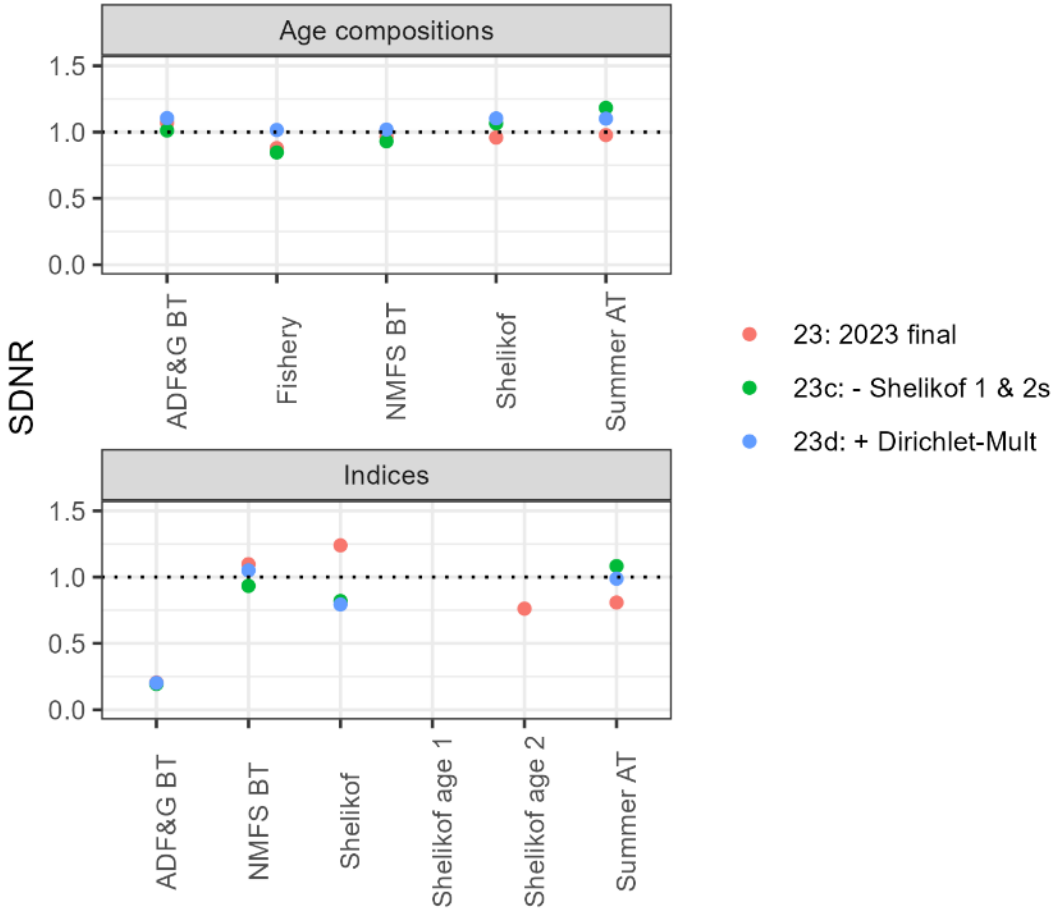
# Model validation

- Continued misfit to recent NMFS BT index
- Improved Shelikof fits due to *q*-link



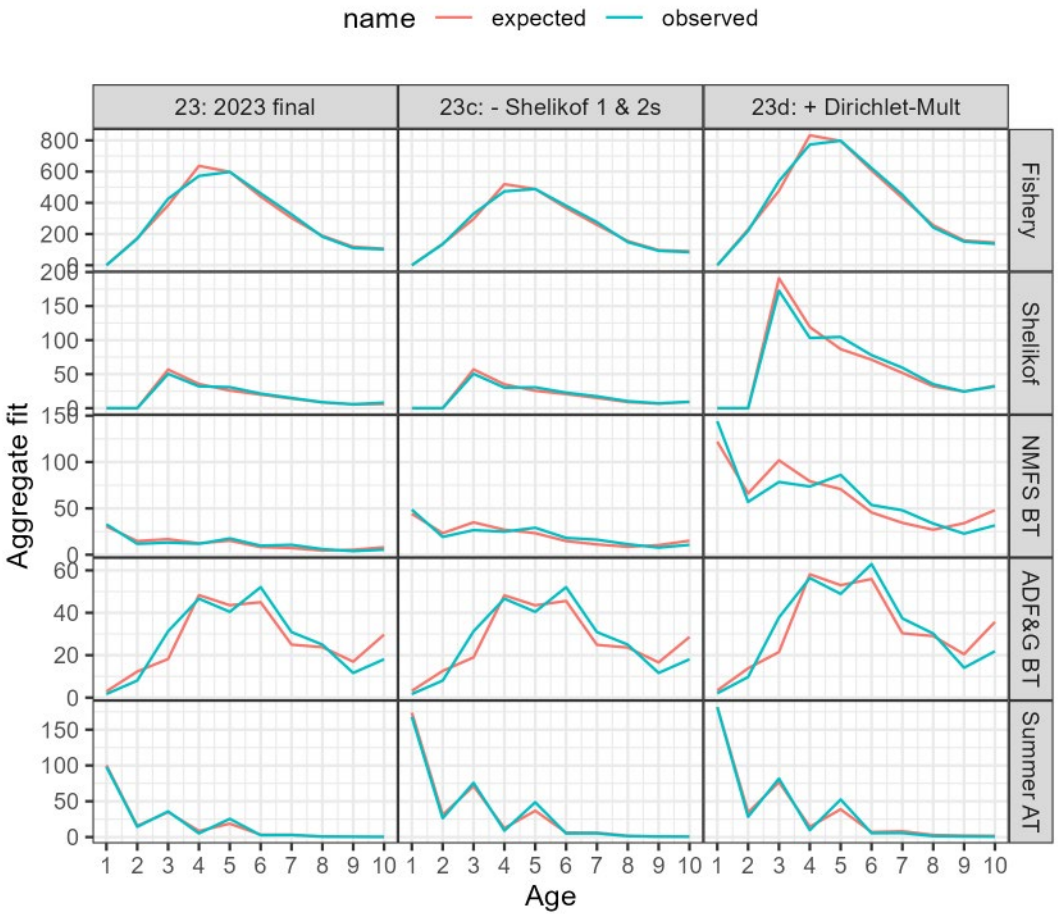
# Model validation

- Standard deviation of normalized residuals (SDNR) should be close to 1
- Assumes independence (so invalid for Pearson residuals)
- Overall improved
- (Model 23 Age 1 SDNR= 4.7; left off for clarity)



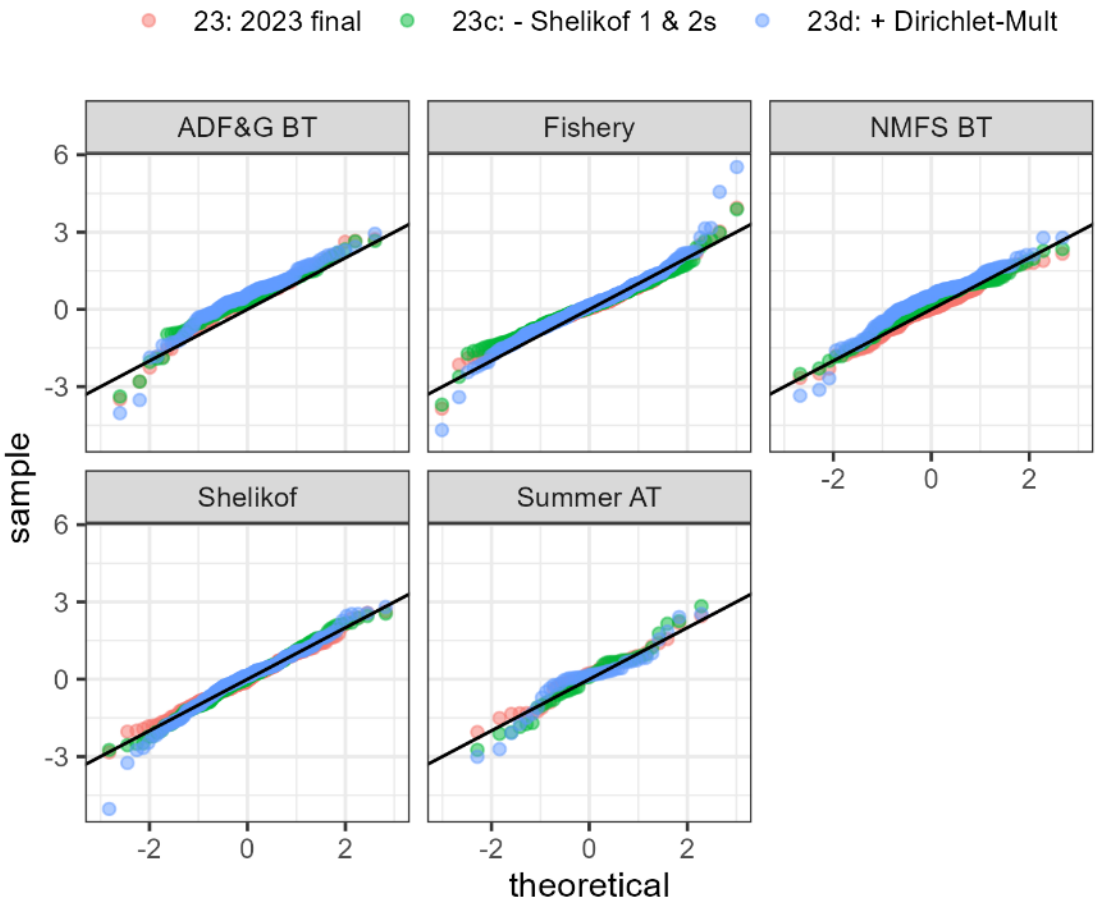
# Aggregate counts

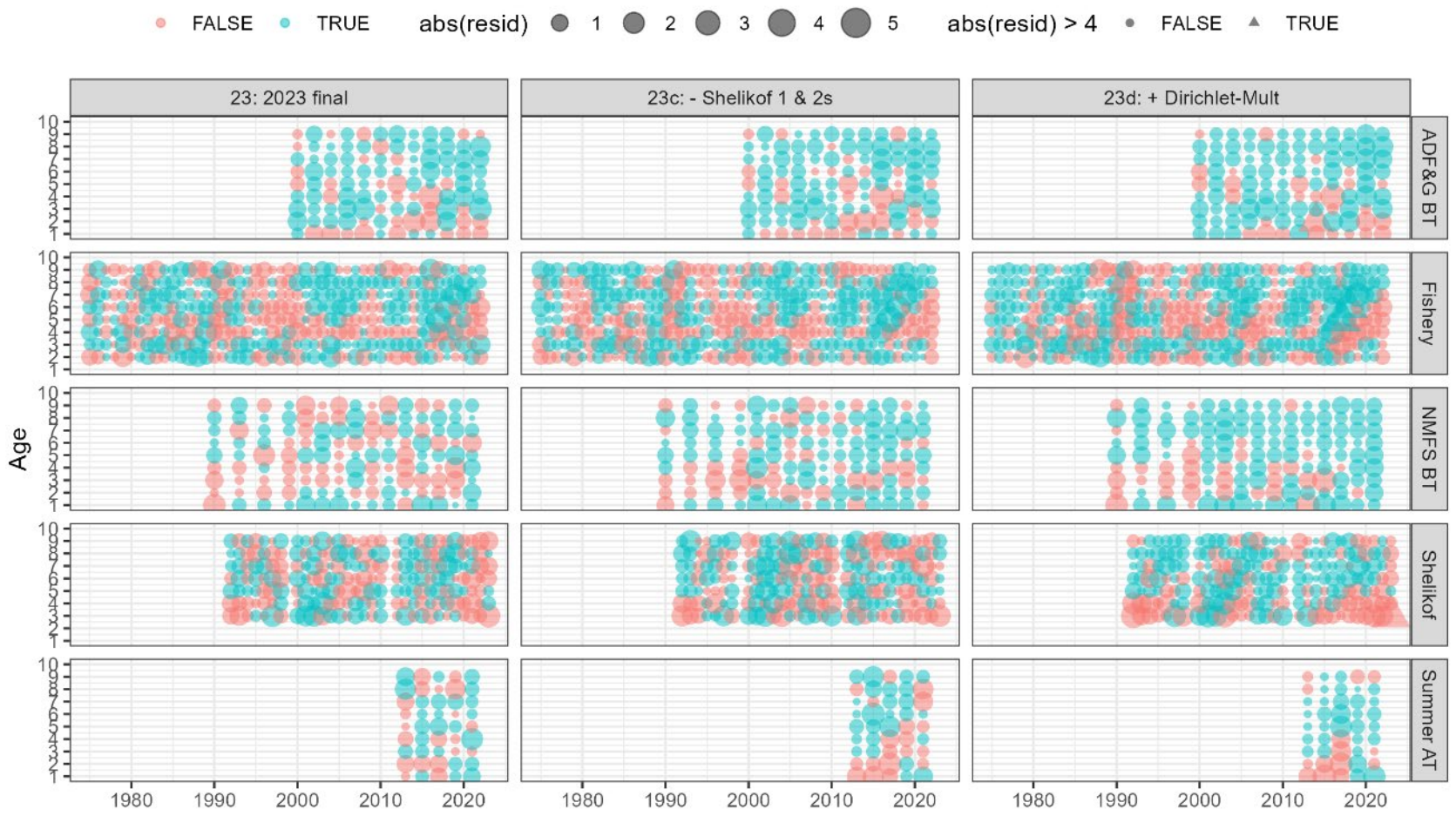
- Note difference in scale among rows
- Increased counts in model 23d due to the higher ESS from the DM
- Both BT surveys overestimate old fish
- Shelikof overestimates young fish (not spawning?)

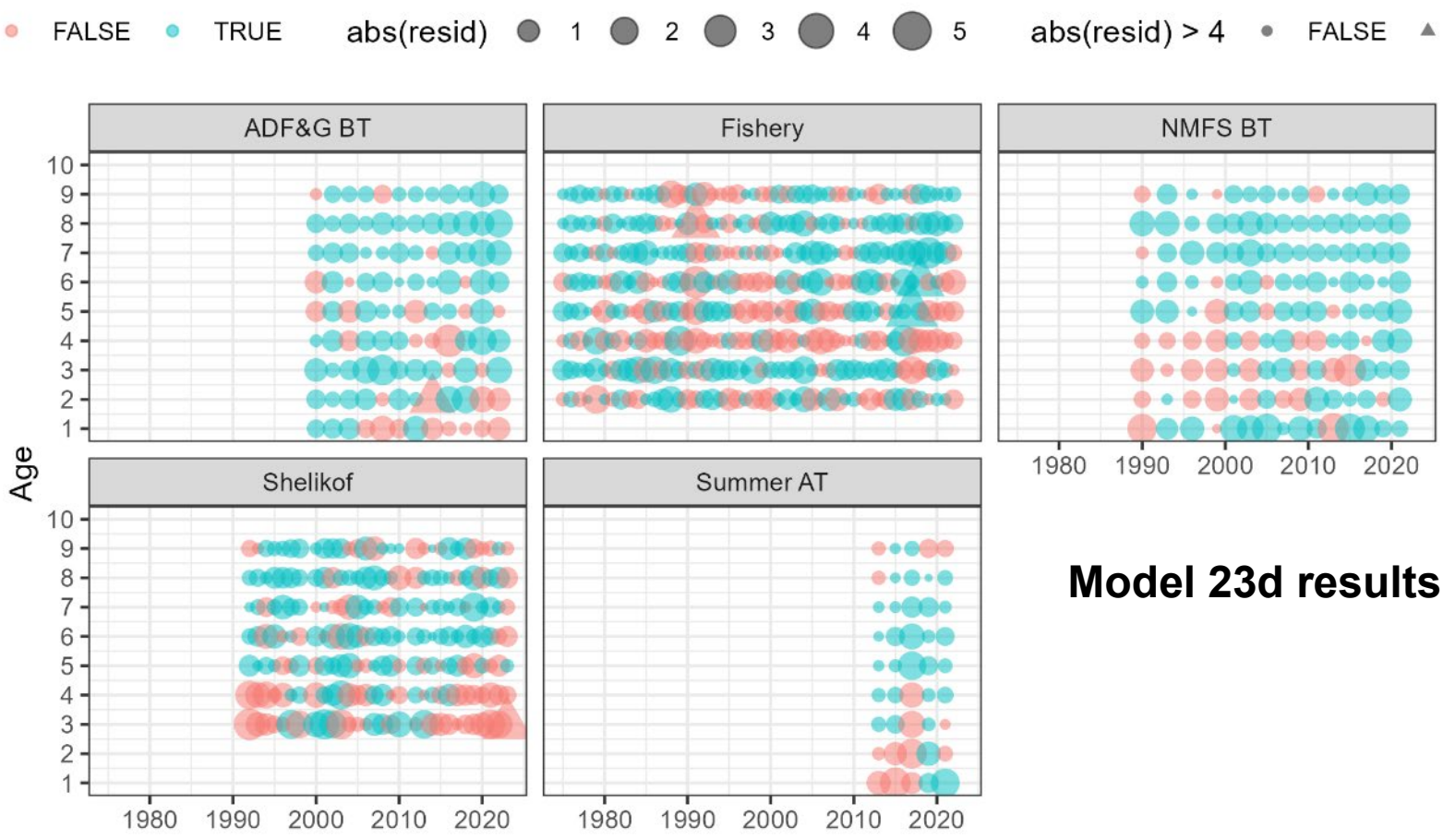


# OSA for age comps

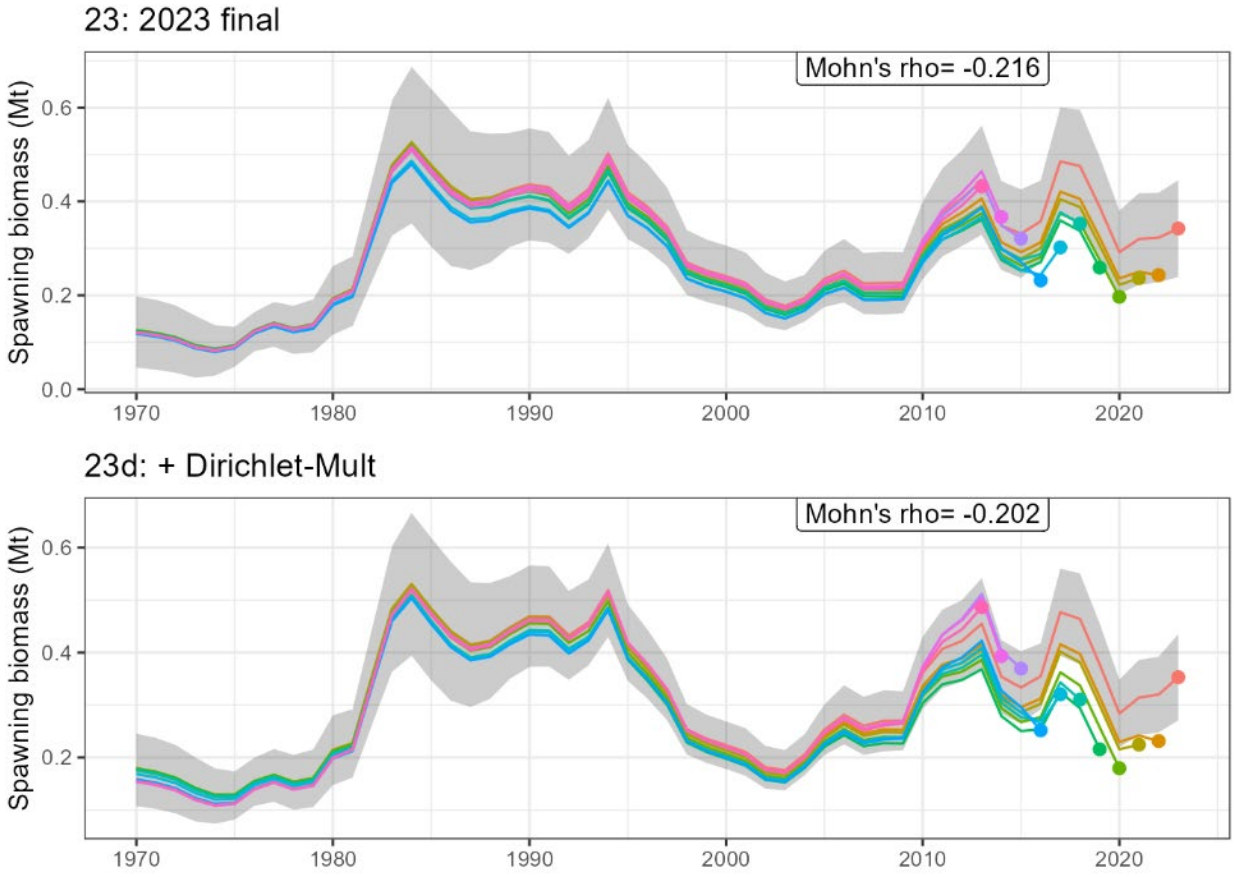
- One-step-ahead (OSA) used for composition data (Trijoulet et al. 2023)
- Calculated externally via the ‘compResidual’ package
- In future will be integrated into TMB assessment




FALSE
TRUE
abs(resid)
1
2
3
4
5
abs(resid) > 4
FALSE
TRUE
23: 2023 final
23c: - Shelikof 1 & 2s
23d: + Dirichlet-Mult
ADF&G BT
Fishery
NMFS BT
Shelikof
Summer AT
Age
1980
1990
2000
2010
2020




**Model 23d results**


23: 2023 final
Mohn's rho= -0.216
Spawning biomass (Mt)
0.0
0.2
0.4
0.6
1970
1980
1990
2000
2010
2020
23d: + Dirichlet-Mult
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0.2
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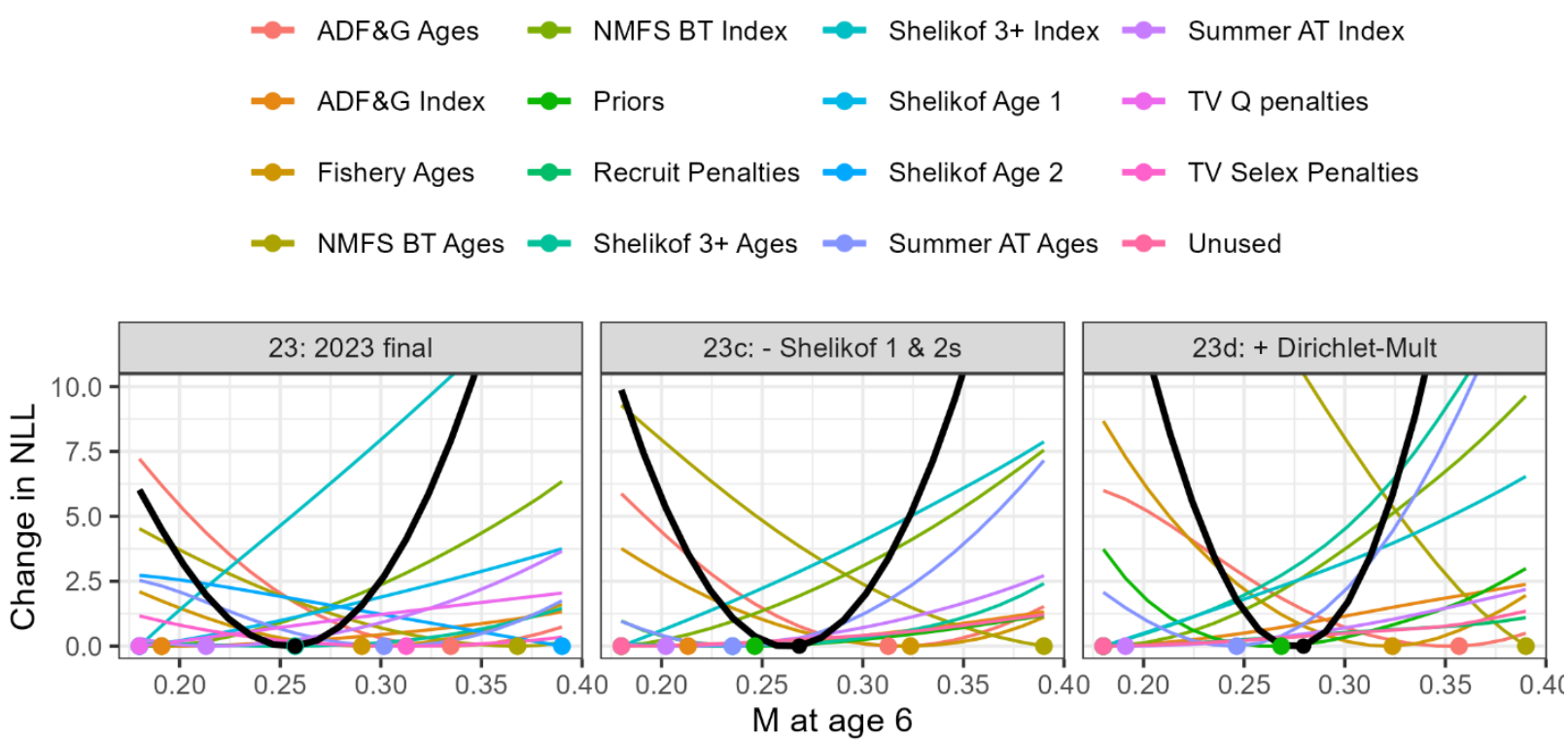
# Model validation: likelihood profile on M



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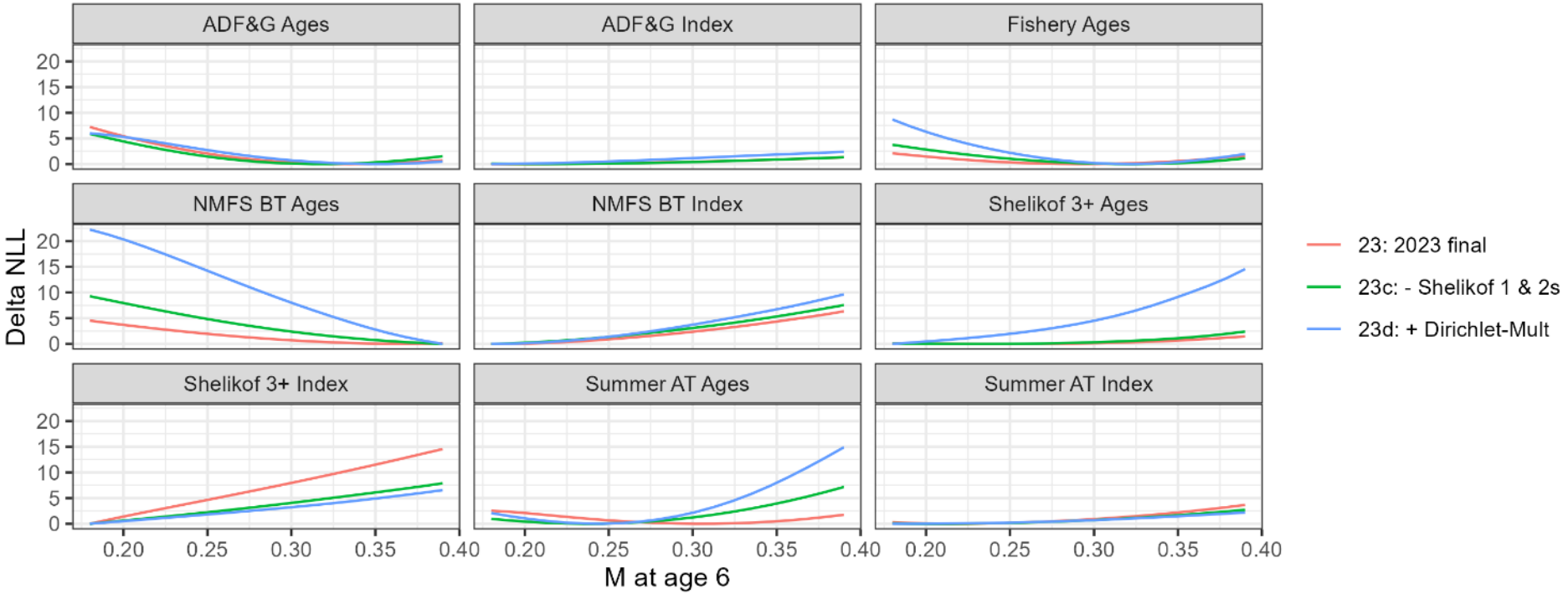
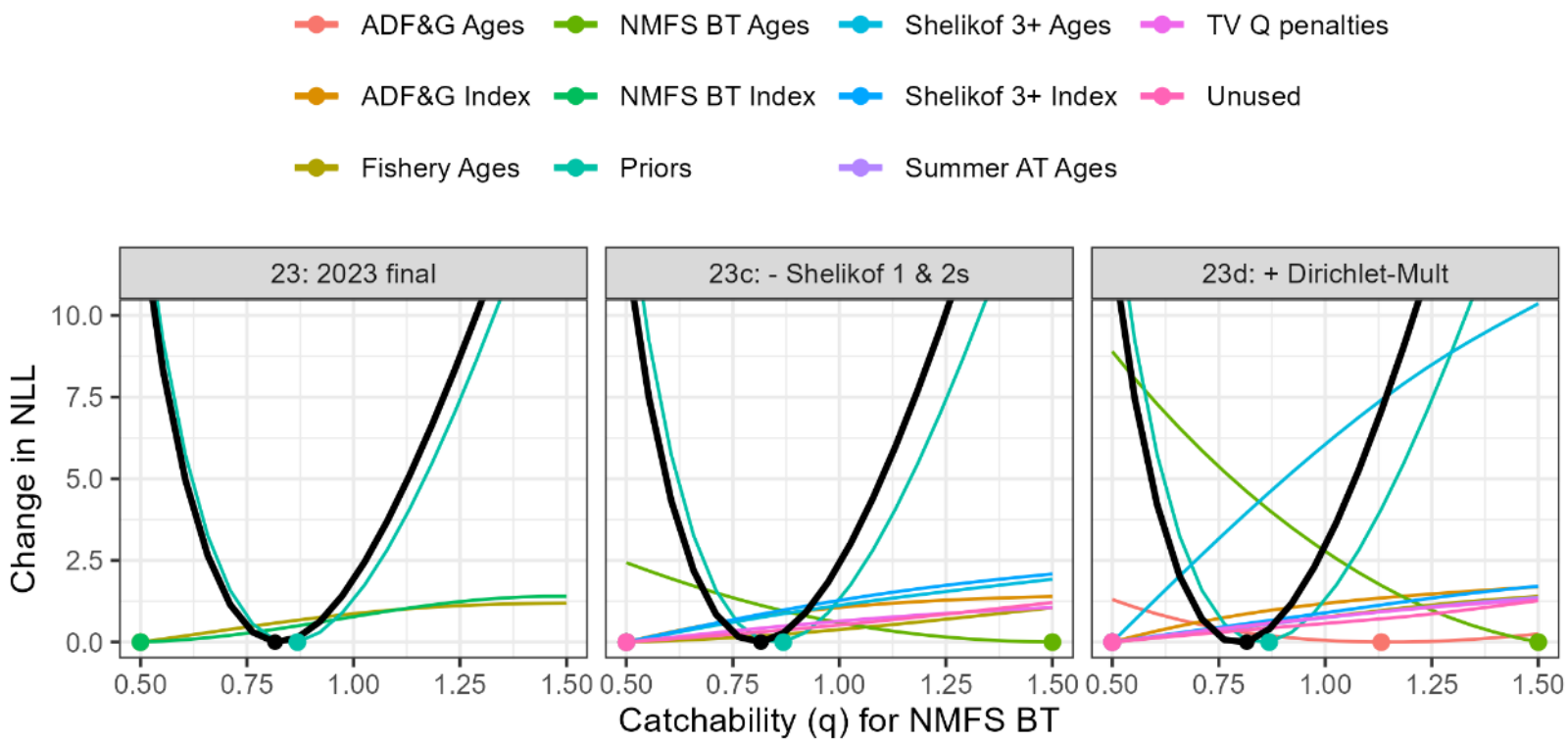
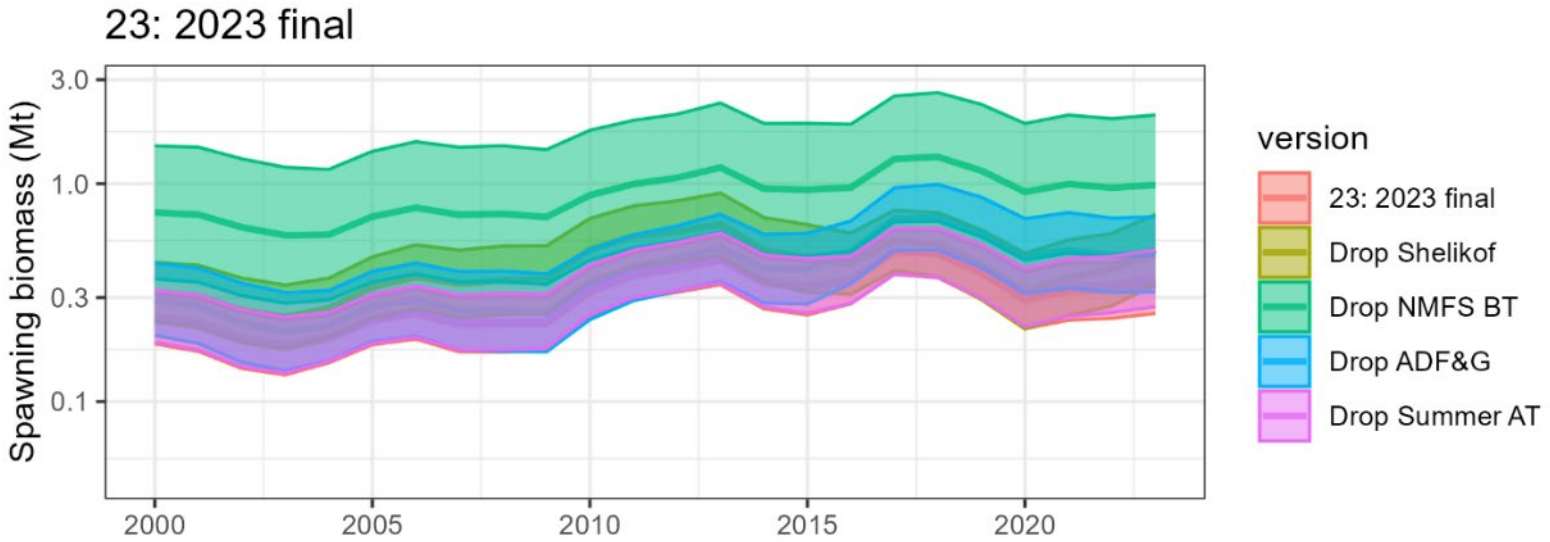


# Model validation: likelihood profile on NMFS BT q



# Model validation: effects of dropping surveys

- Big change in scale when dropping (heavily down-weighting) the NMFS BT survey

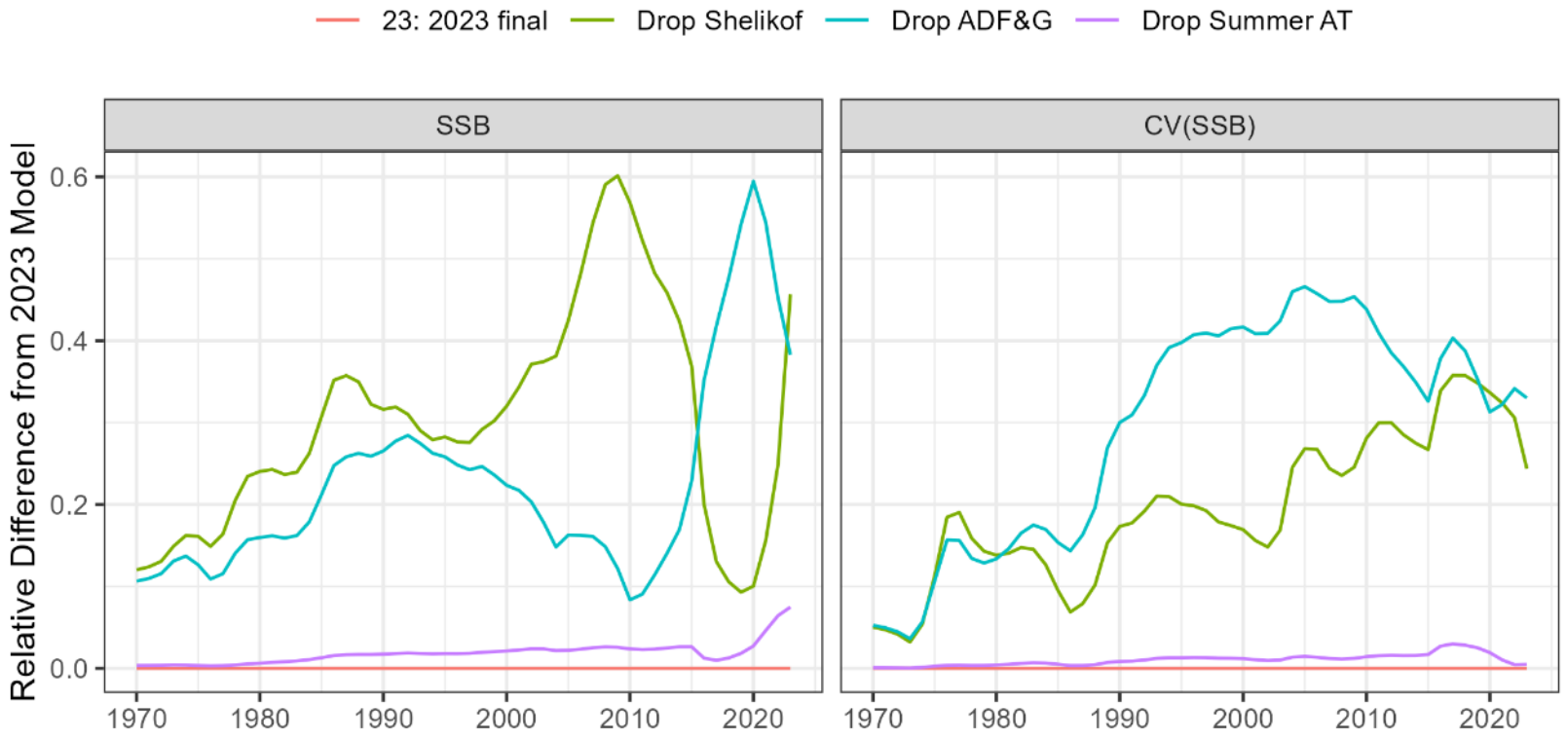


# Model validation: effects of dropping surveys

- Is this reasonable?
- Even worse if survey completely dropped
- Estimates of catchability make no sense.

| | NMFS BT q | Summer AT q |
|---|---|---|
| 23d: + Dirichlet-Mult | 0.782 | 0.614 |
| Drop BT prior | 0.404 | 0.409 |
| Drop BT survey | -- | 0.024 |

# Model validation: effects of dropping surveys



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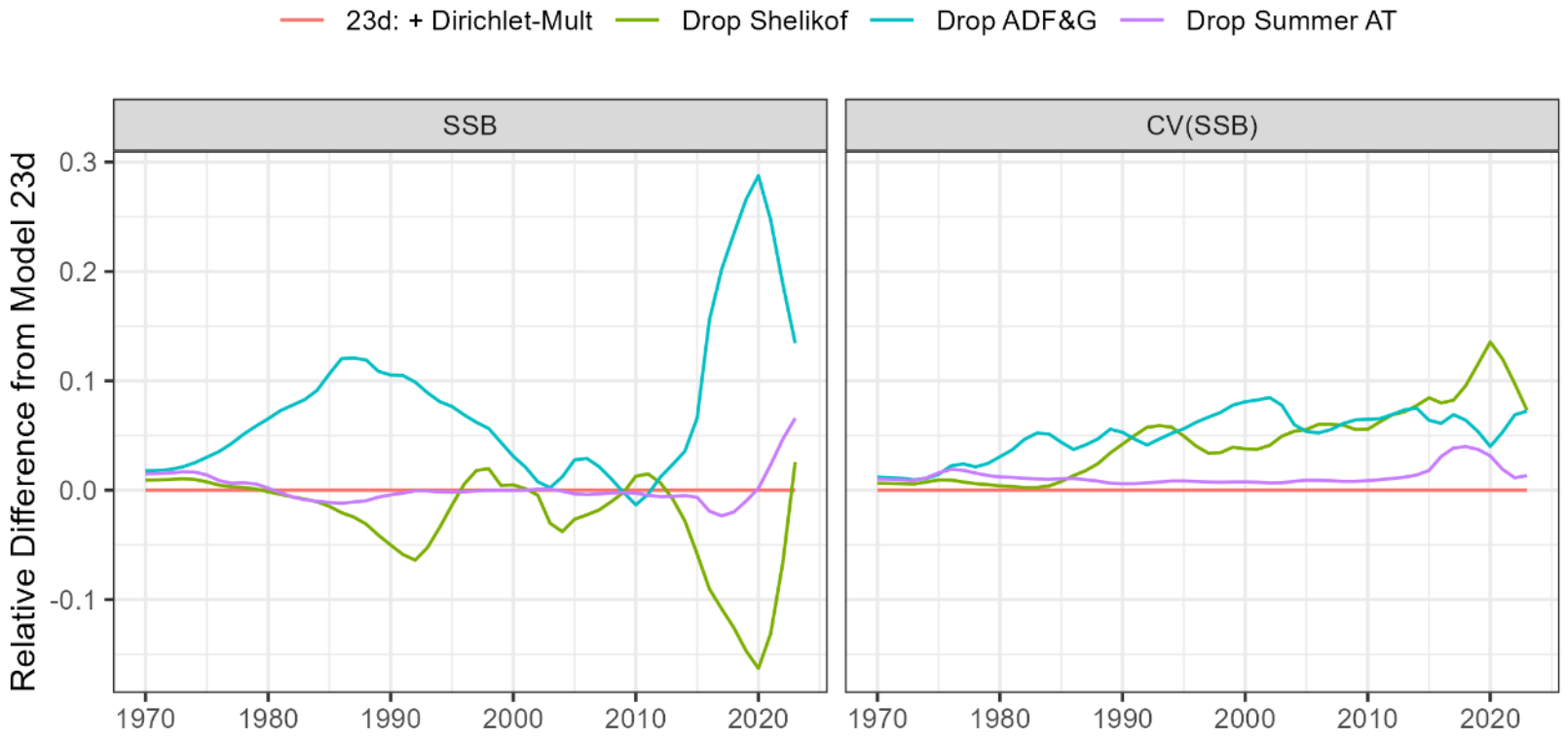

# Minor changes for November

- Working to overhaul how data are queried and processed
  - Transparent and reproducible
  - 2024 will update historical data as much as possible for NMFS BT, fishery,  (very minor differences found so far)
  - Major thanks to **Jane Sullivan** for helping me
- Will use terminal NAA in ‘spmR’ to avoid issues caused by large variation in growth.

# Causes of concern for discussion

- Continued issues with scale without the NMFS BT
- Continued misfit in recent indices, in particular NMFS BT
- Data conflict (profile likelihoods)
- Plus group could be too low – will present analysis next year on extending this
- Some clear temporal patterns in OSA bubble plots
- Need to be understand spatiotemporal availability to gear (e.g., Monnahan et al. 2021)

# 2024 recommendations

- I believe changes through model 23c are clear improvements to the data/model.
- 23c drops the age 1 and 2 indices
- 23d adds the Dirichlet-multinomial to 23c
- **I recommend 23d for use in 2024**
  - This was generally recommended by the CIE reviewers

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# References


Kristensen, K., A. Nielsen, C. W. Berg, H. Skaug, and B. M. Bell. 2016. TMB: Automatic differentiation and Laplace approximation. Journal of Statistical Software 70:21.

Hulson, P.-J. F., and B. C. Williams. 2024. Inclusion of ageing error and growth variability using a bootstrap estimation of age composition and conditional age-at-length input sample size for fisheries stock assessment models. Fisheries Research 270:106894.

Monnahan, C. C., and K. Kristensen. 2018. No-U-turn sampling for fast Bayesian inference in ADMB and TMB: Introducing the adnuts and tmbstan R packages. Plos One 13:e0197954.

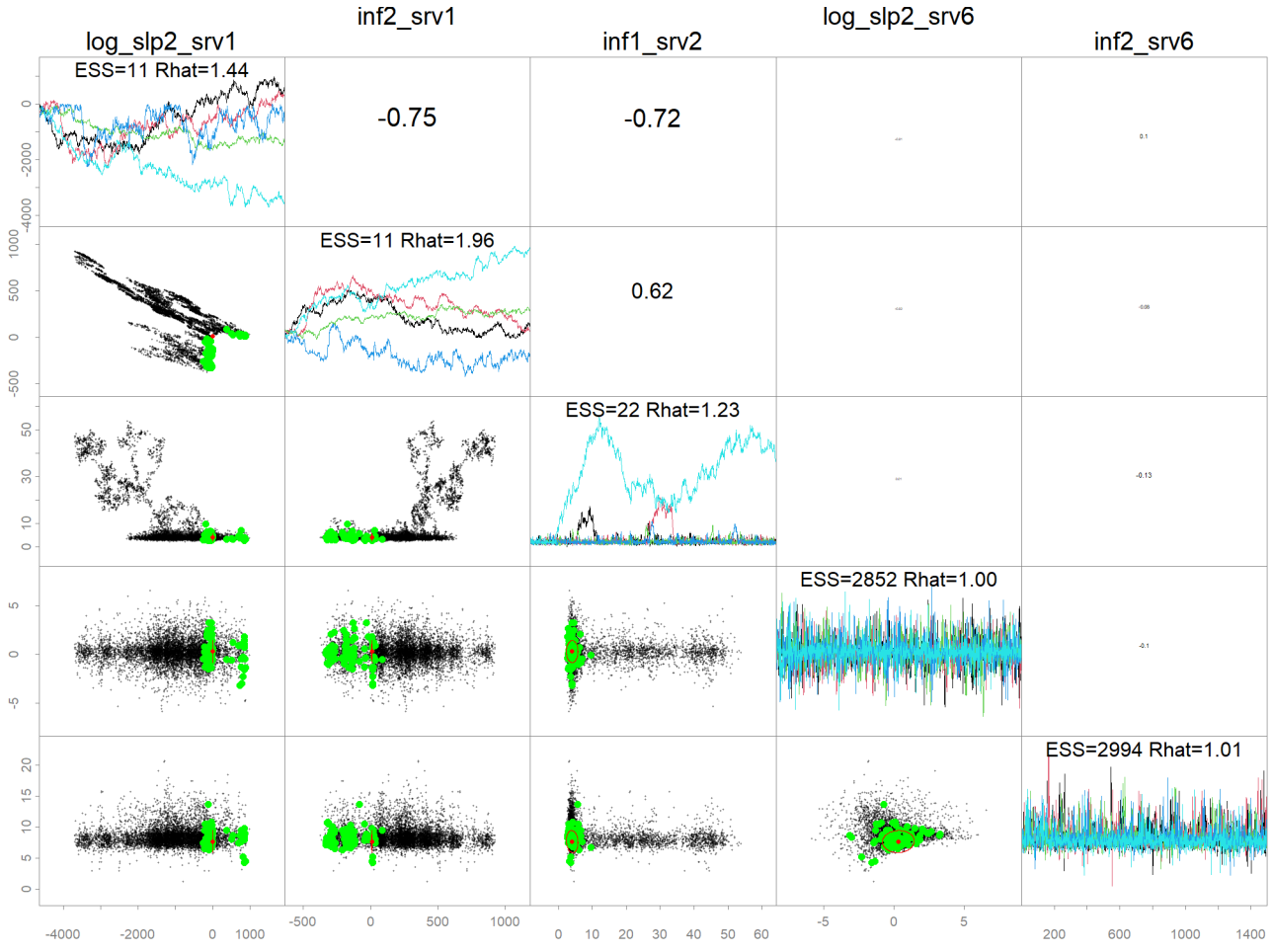
Monnahan, C. C. 2024. Toward good practices for Bayesian data-rich fisheries stock assessments using a modern statistical workflow. Fisheries Research 275:107024.

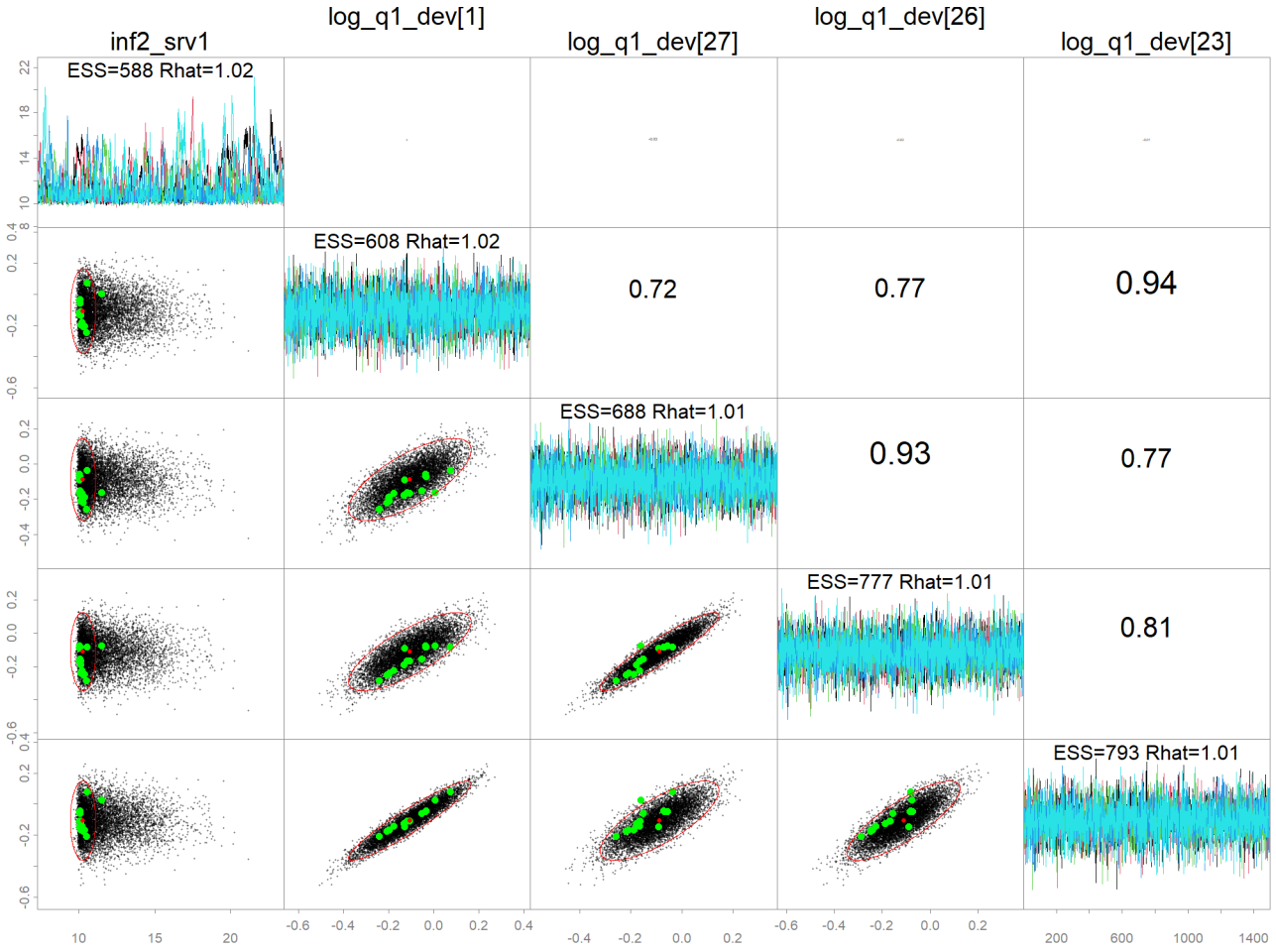
Monnahan, C. C., J. T. Thorson, S. Kotwicki, N. Lauffenburger, J. N. Ianelli, and A. E. Punt. 2021. Incorporating vertical distribution in index standardization accounts for spatiotemporal availability to acoustic and bottom trawl gear for semi-pelagic species. ICES Journal of Marine Science 78:1826-1839.

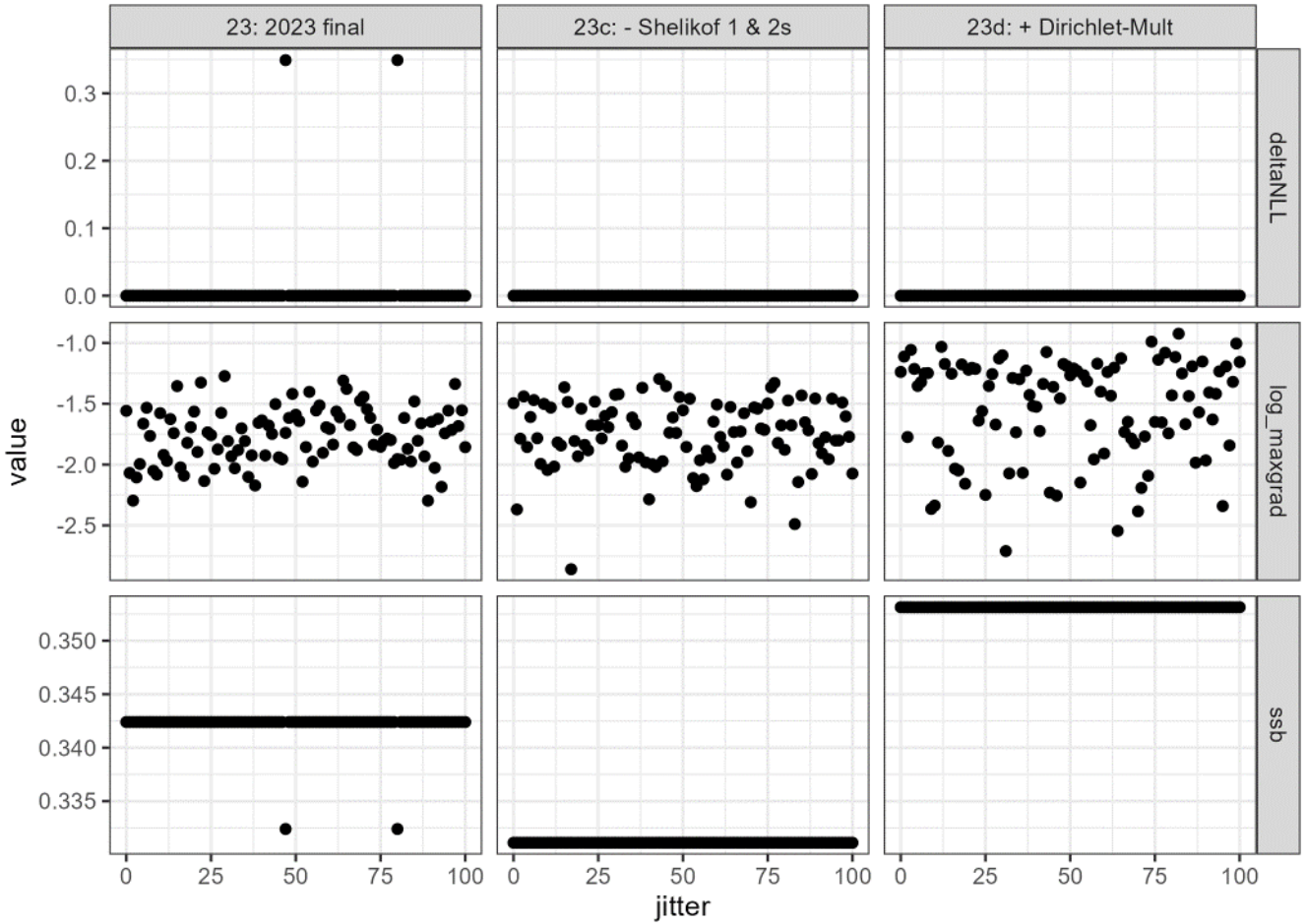
Rogers, L. A., C. C. Monnahan, K. Williams, D. T. Jones, and M. W. Dorn. 2024. Climate-driven changes in the timing of spawning and the availability of walleye pollock (Gadus chalcogrammus) to assessment surveys in the Gulf of Alaska. ICES Journal of Marine Science. 10.1093/icesjms/fsae005.

Trijoulet, V., C. M. Albertsen, K. Kristensen, C. M. Legault, T. J. Miller, and A. Nielsen. 2023. Model validation for compositional data in stock assessment models: Calculating residuals with correct properties. Fisheries Research 257:106487.

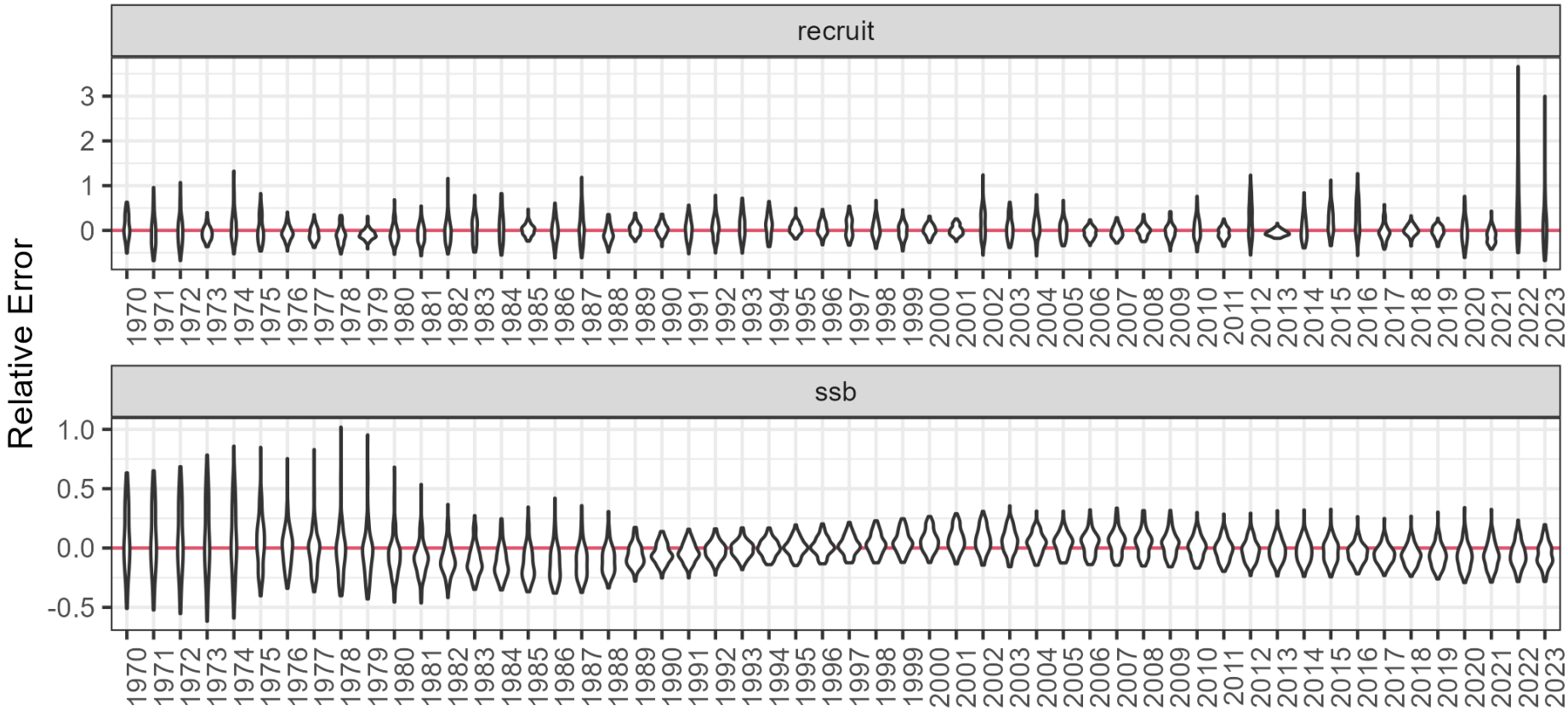
# Extra slides

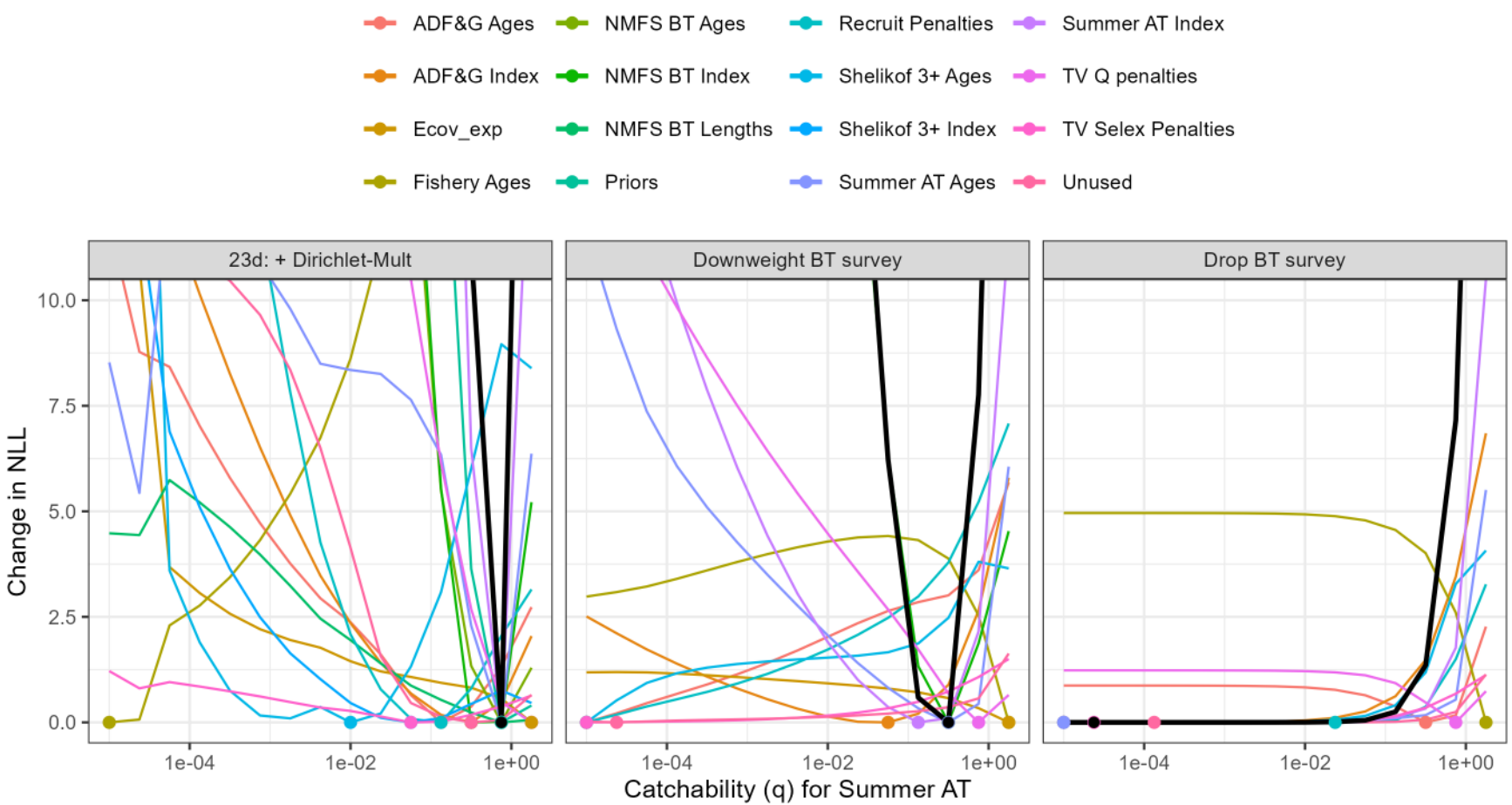

log_slp2_srv1
inf2_srv1
inf1_srv2
log_slp2_srv6
inf2_srv6
ESS=11 Rhat=1.44
-0.75
-0.72
ESS=11 Rhat=1.96
0.62
ESS=22 Rhat=1.23
ESS=2852 Rhat=1.00
ESS=2994 Rhat=1.01


inf2_srv1
log_q1_dev[1]
log_q1_dev[27]
log_q1_dev[26]
log_q1_dev[23]
ESS=588 Rhat=1.02
ESS=608 Rhat=1.02
0.72
0.77
0.94
ESS=688 Rhat=1.01
0.93
0.77
ESS=777 Rhat=1.01
0.81
ESS=793 Rhat=1.01


23: 2023 final
23c: - Shelikof 1 & 2s
23d: + Dirichlet-Mult
deltaNLL
log_maxgrad
ssb
value
jitter
0.3
0.2
0.1
0.0
-1.0
-1.5
-2.0
-2.5
0.350
0.345
0.340
0.335
0
25
50
75
100

# 23c: - Shelikof 1 & 2s




ADF&G Ages
ADF&G Index
Ecov_exp
Fishery Ages
NMFS BT Ages
NMFS BT Index
NMFS BT Lengths
Priors
Recruit Penalties
Shelikof 3+ Ages
Shelikof 3+ Index
Summer AT Ages
Summer AT Index
TV Q penalties
TV Selex Penalties
Unused
23d: + Dirichlet-Mult
Downweight BT survey
Drop BT survey
Change in NLL
10.0
7.5
5.0
2.5
0.0
1e-04
1e-02
1e+00
Catchability (q) for Summer AT