



**NOAA
FISHERIES**



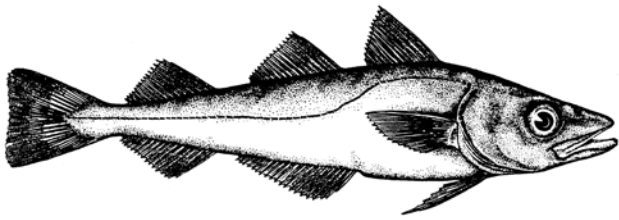
GOA Pollock

Cole Monnahan
November 2022 GOA Plan Team



Outline for today

- Overview of key results and current model
- New data updates for 2022
- Updated biology
- Model fits and diagnostics
- Results and risk table concerns
- Reference point calculations & Apportionment
- Plan and priorities for 2023



Gulf of Alaska pollock

Overview of results

Changes to the assessment model

- Estimate summer acoustic selex & $\sigma_R=1.3$ for all devs (model 19.1a)

Author's 2023 ABC 148,937 t

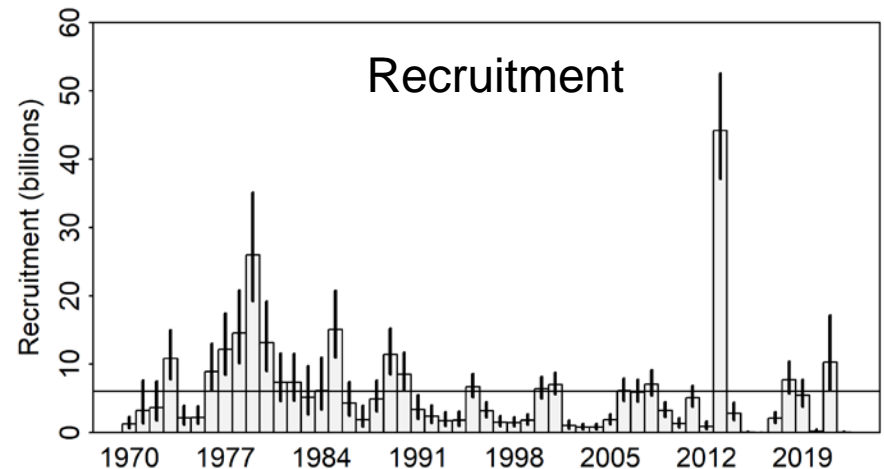
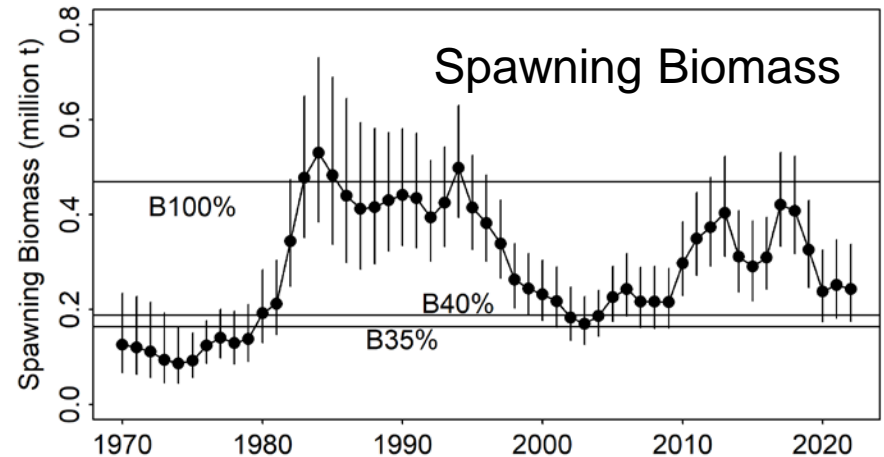
- Increase of 12% from 2022
- 2024 ABC decreases to 161,080 t
- No reduction from max ABC

Concerns:

- Continuing scale sensitivity

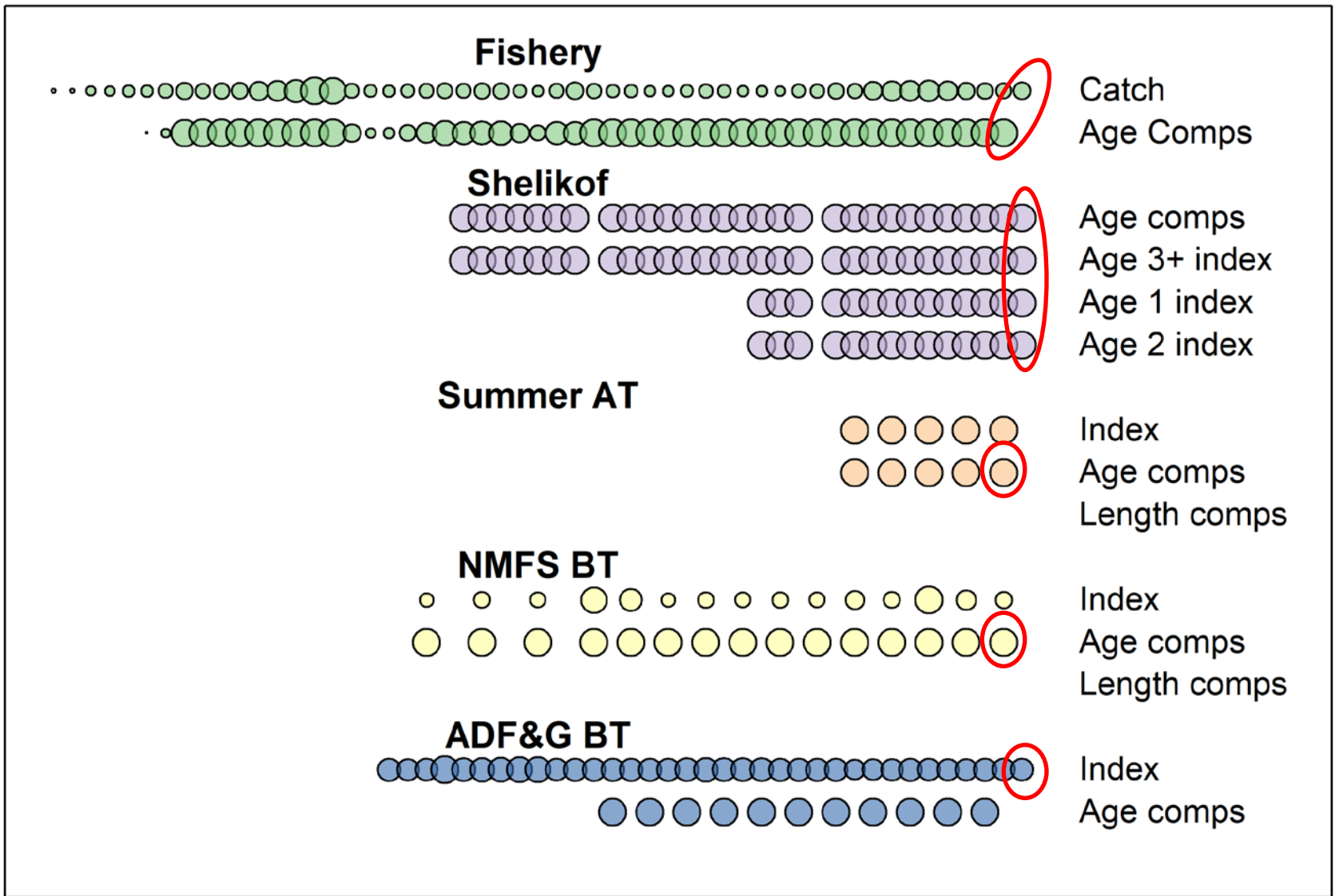
Positives:

- Return to normal age diversity w/ decline in 2012 cohort
- Large 2017, 2018, 2020 cohorts



Model overview

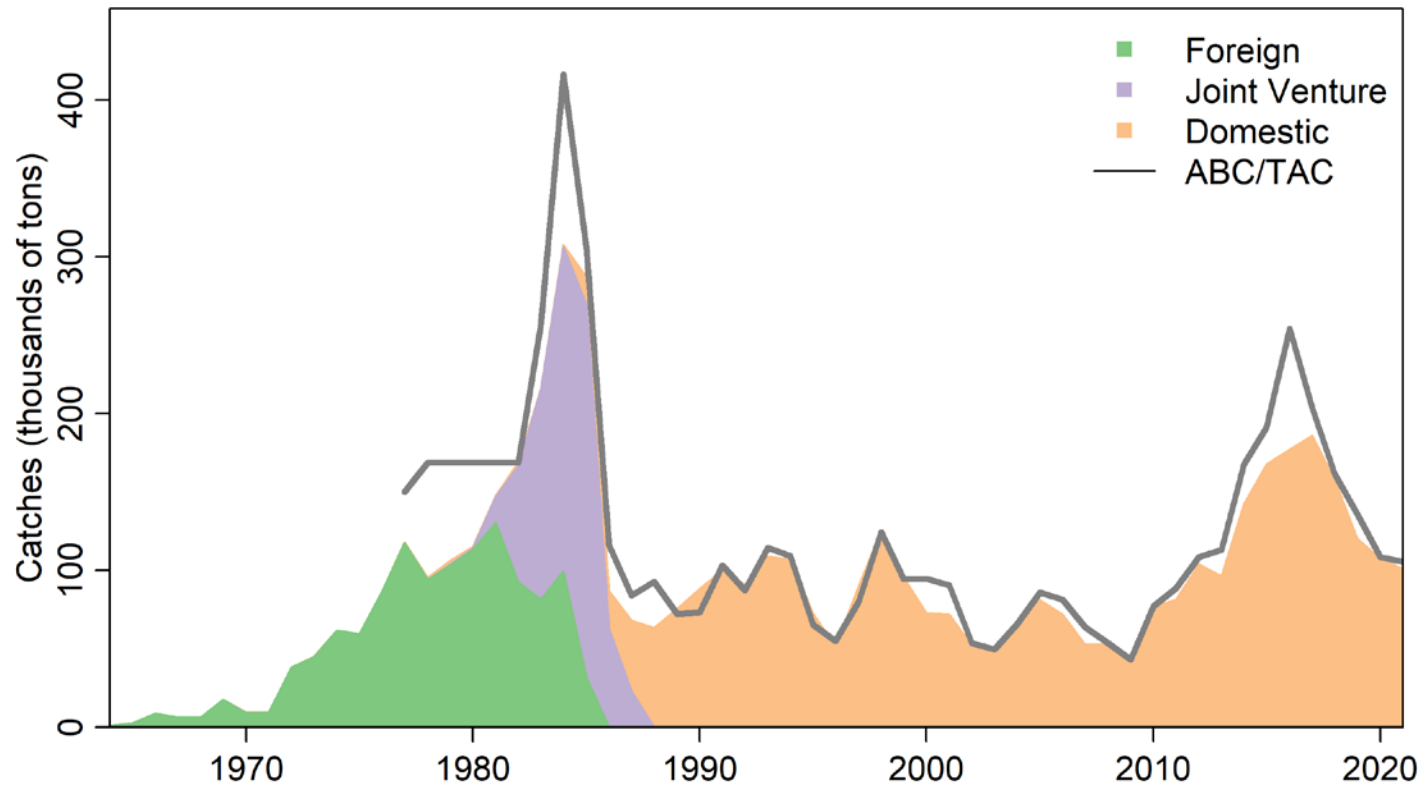
- Single-sex, single-fleet, ages 1-10+
- Empirical weight at age
 - No internal length dynamics, all processes age-based
 - Length compositions converted via specified matrices
- Fishery selectivity time-varying double-logistic
- Fitted to 4 surveys
 - NMFS winter (Shelikof) + summer (coast wide) acoustic
 - NMFS & ADF&G summer bottom trawl
- Time-varying catchability for Shelikof and ADF&G
- Recruits freely estimated, except initial and last two years ($\sigma_R=1$)
- Francis tuning used for compositional data



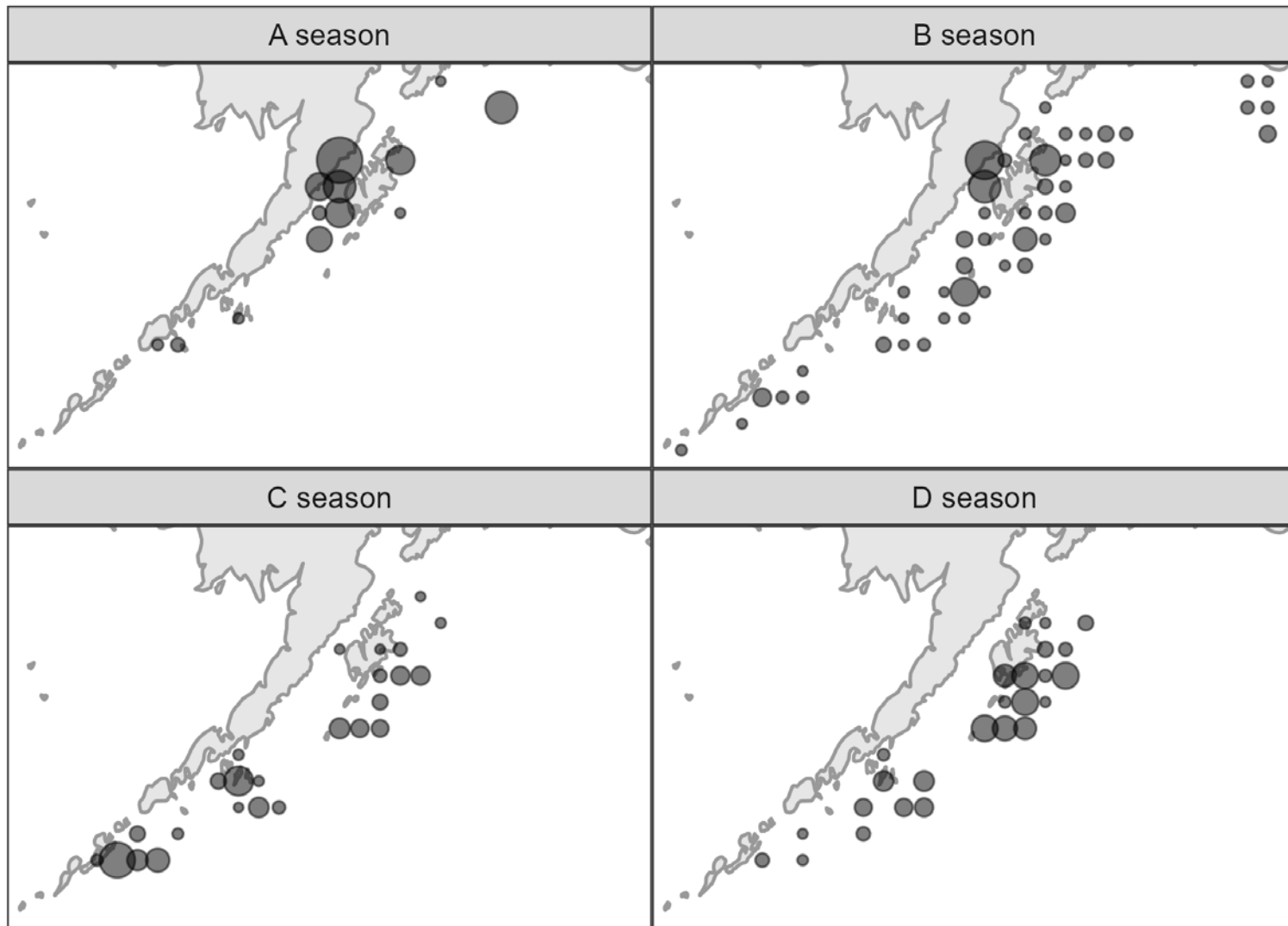
1970 1980 1990 2000 2010 2020

Catch history

- 2021 projected catch = 92,342 t
- 2021 realized catch = 101,160 t
- 2022 projected catch = 129,754 t (TAC)



2021 fishery catch distribution



Survey overview

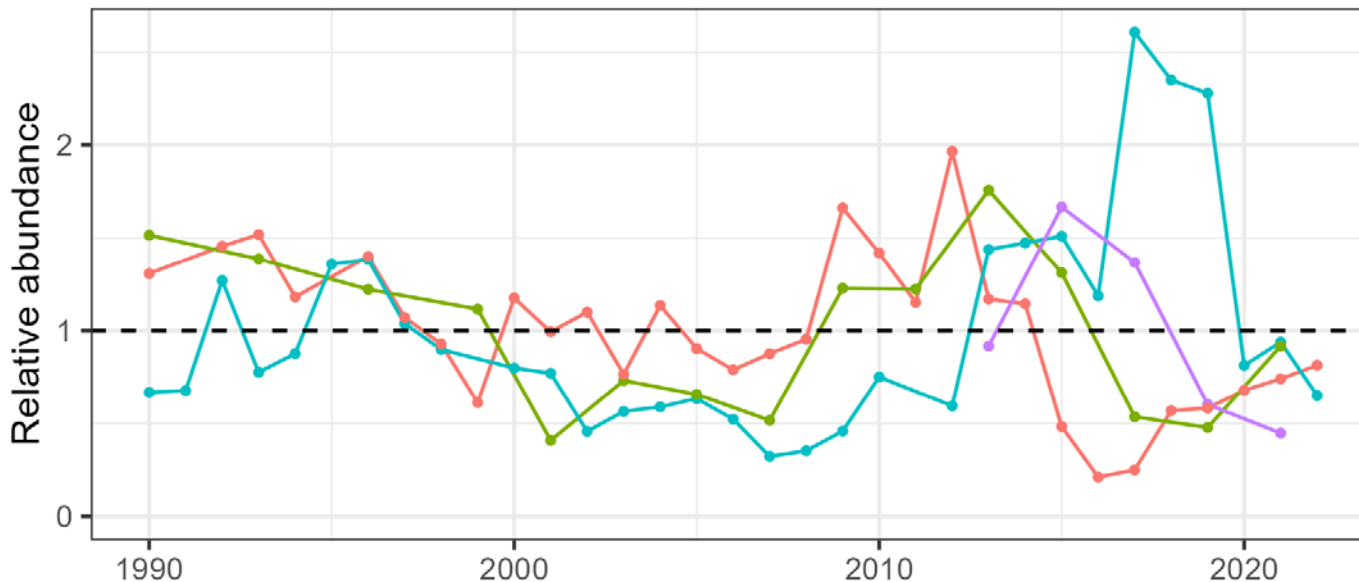
2022 is “off” year for surveys in the GOA.

2022 biomass estimates:

Shelikof acoustic: 365 kt, **31% decrease** from 2021.

ADF&G bottom trawl: 71 kt, **9% increase** from 2021

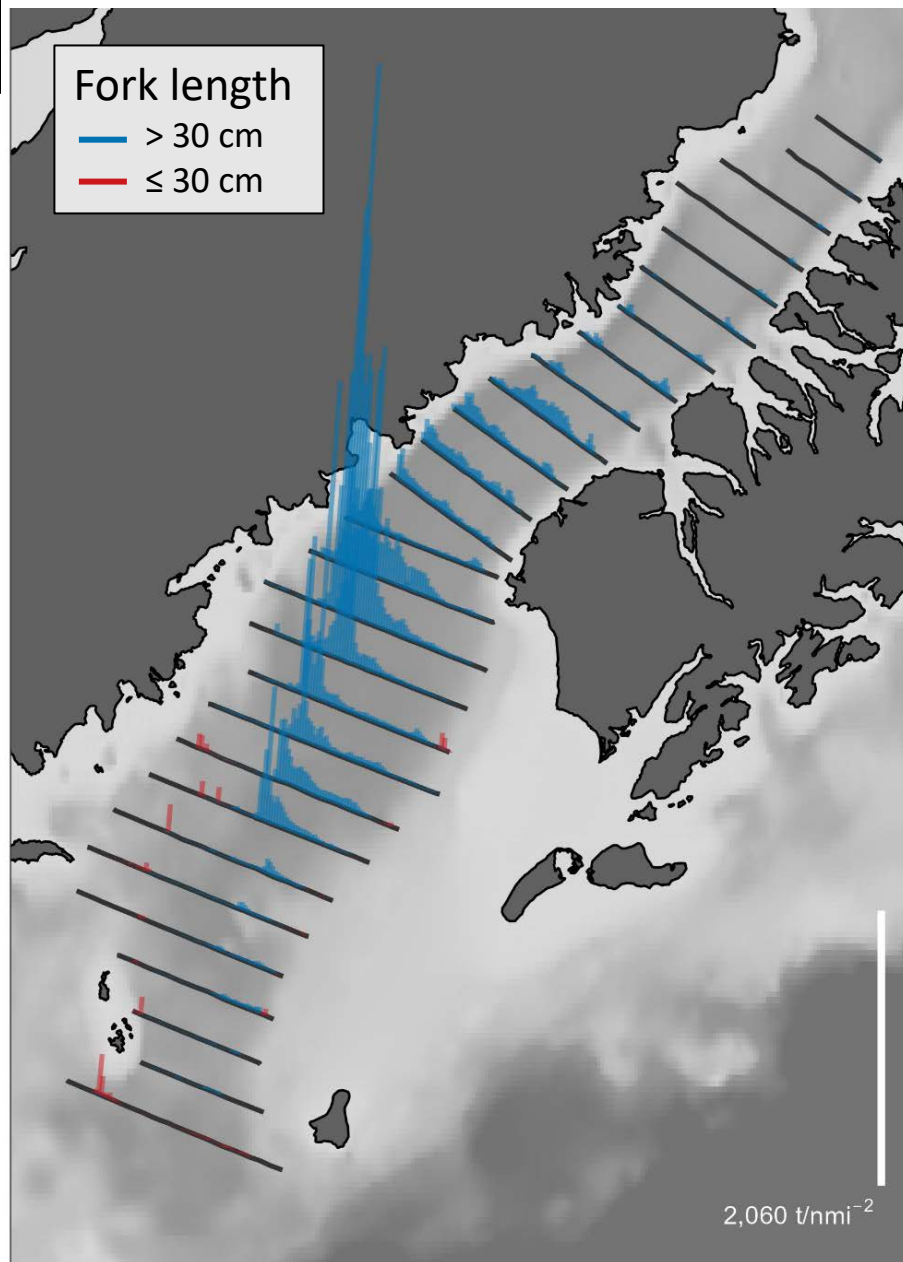
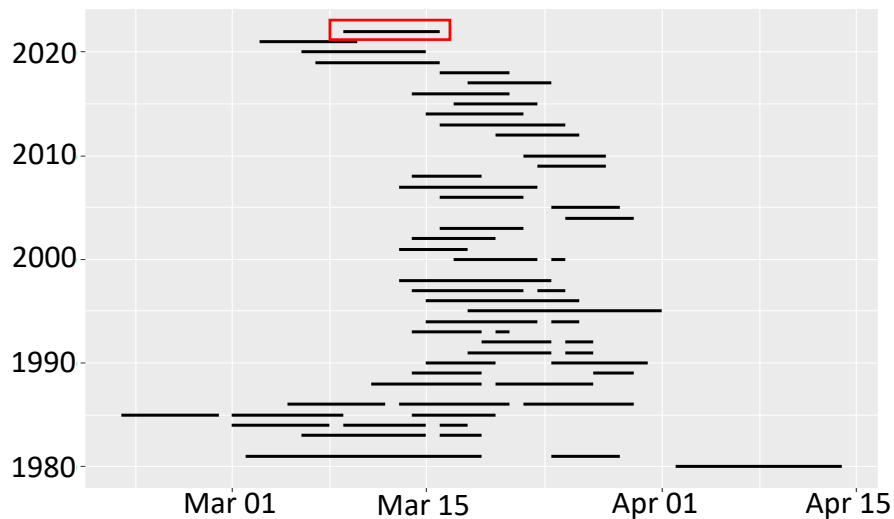
- ADFG crab/groundfish survey
- Shelikof Strait acoustic survey
- NMFS bottom trawl west of 140W
- Summer gulfwide acoustic survey



Survey Timing

Survey started 1-week later than planned, but closer to historical survey period

80% females (> 40 cm) pre-spawning, indicates survey timing was appropriate

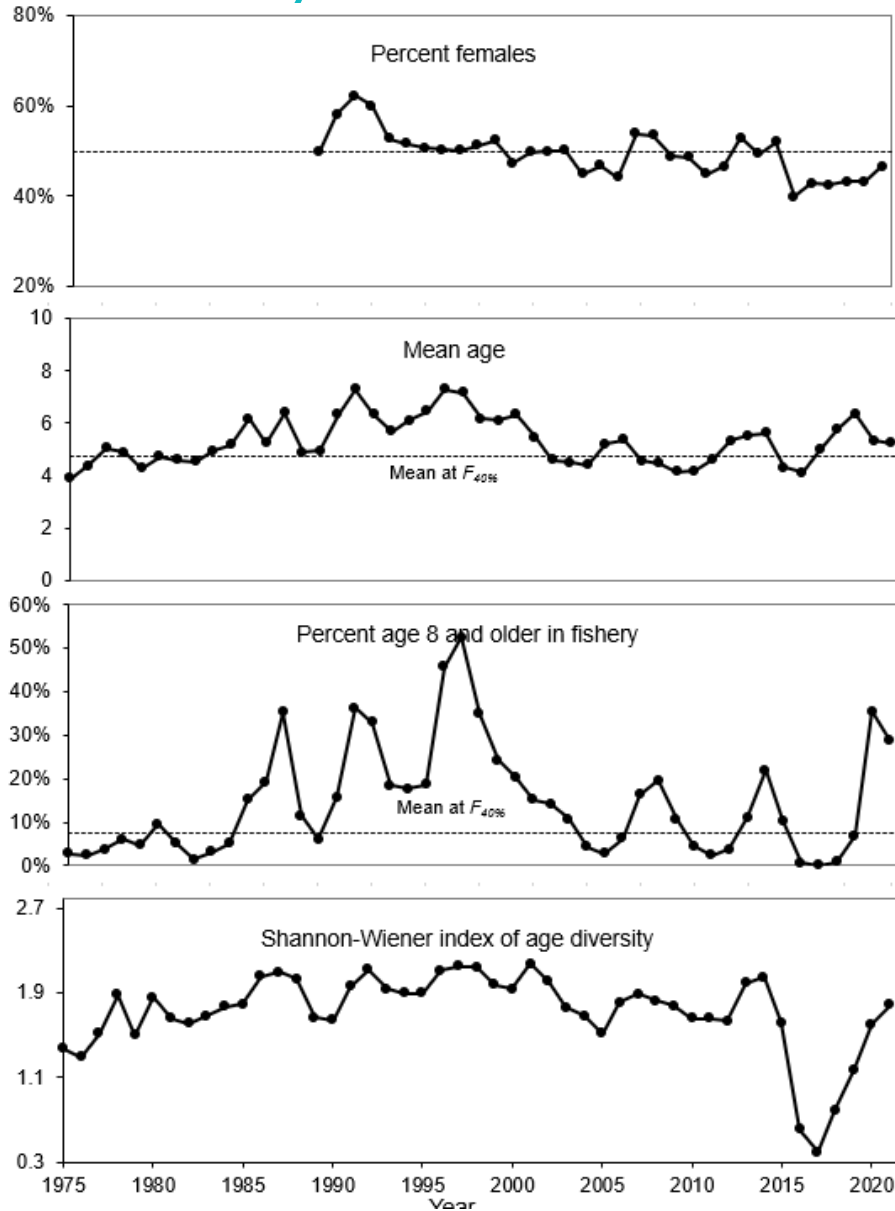


Percent

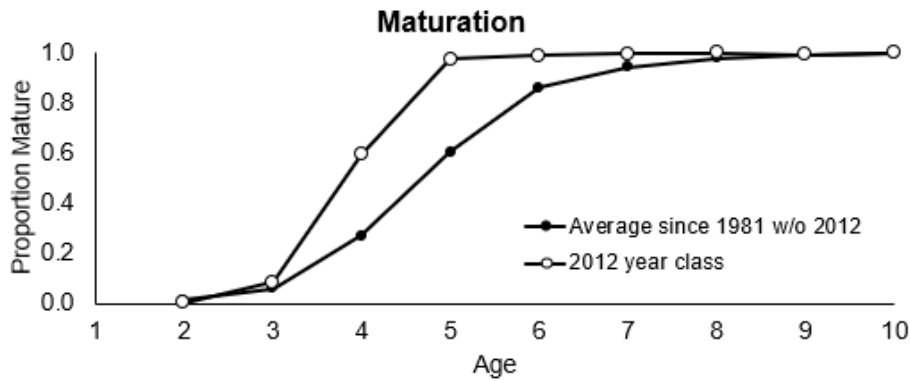
Immature Developing Prespawning Spawning Spent

Maturity stage

Fishery catch indicators



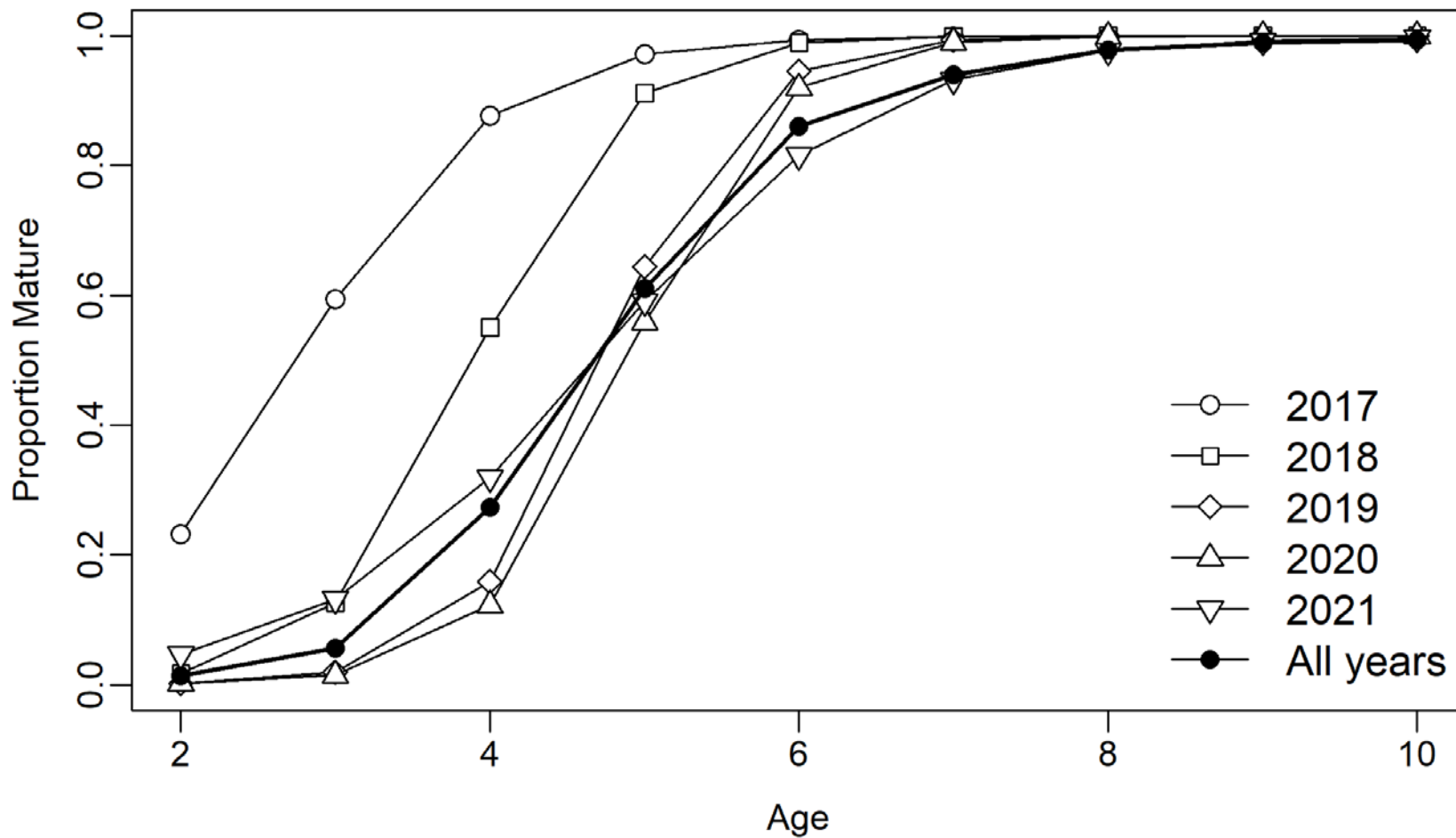
Unusual life history of the 2012 cohort



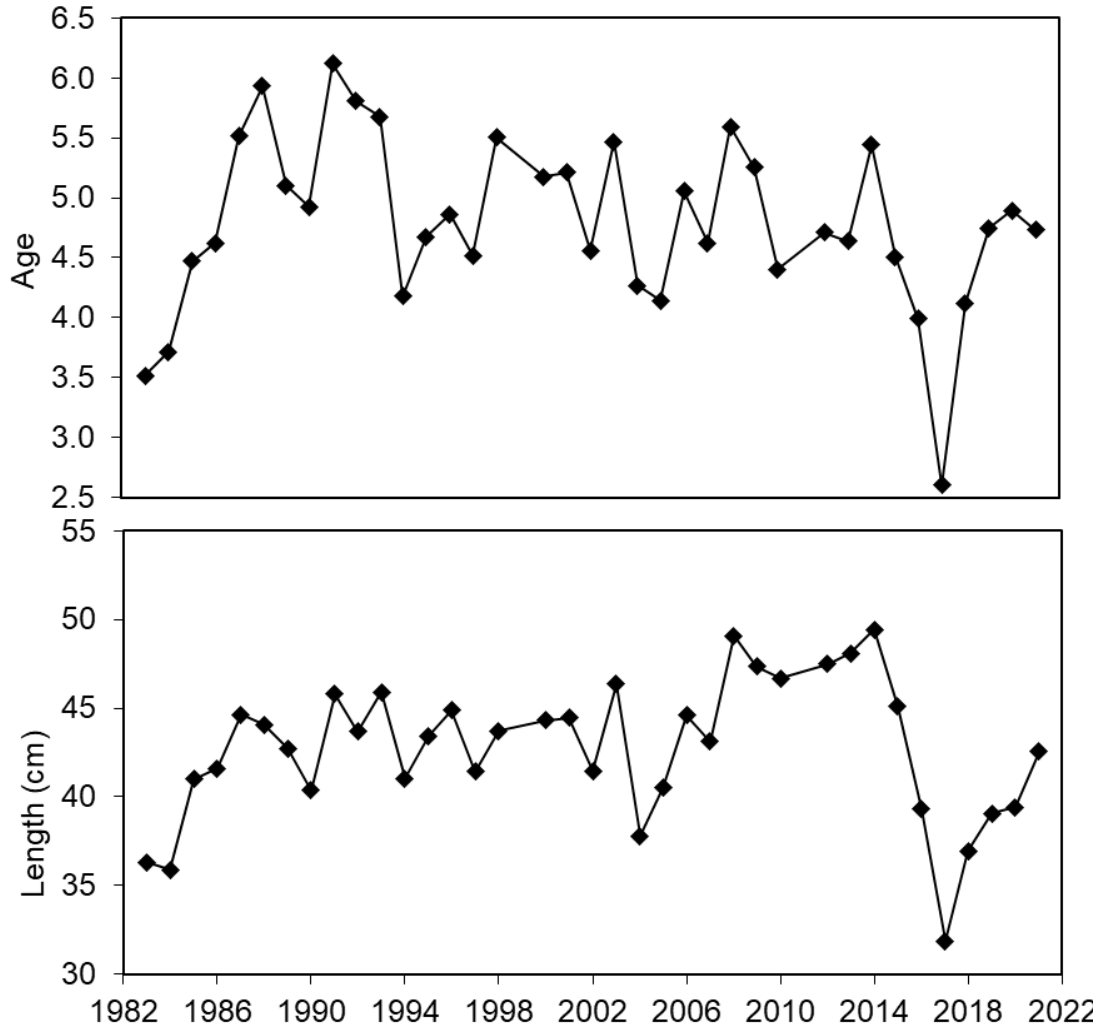
Parameters estimated externally

- Natural mortality: age-specific pattern
- Fishery weight at age
 - Data used through 2021
 - A RE model used for 2022
 - 5-year average used for projections
- Spawning weight at age
 - Annual data exclusively from Shelikof Strait
 - 5-year average for projections
- Population weight at age
 - Projections use average of last 3 NMFS BT surveys
- Proportion mature at age
 - Long-term (1983-present) average used throughout

Maturity



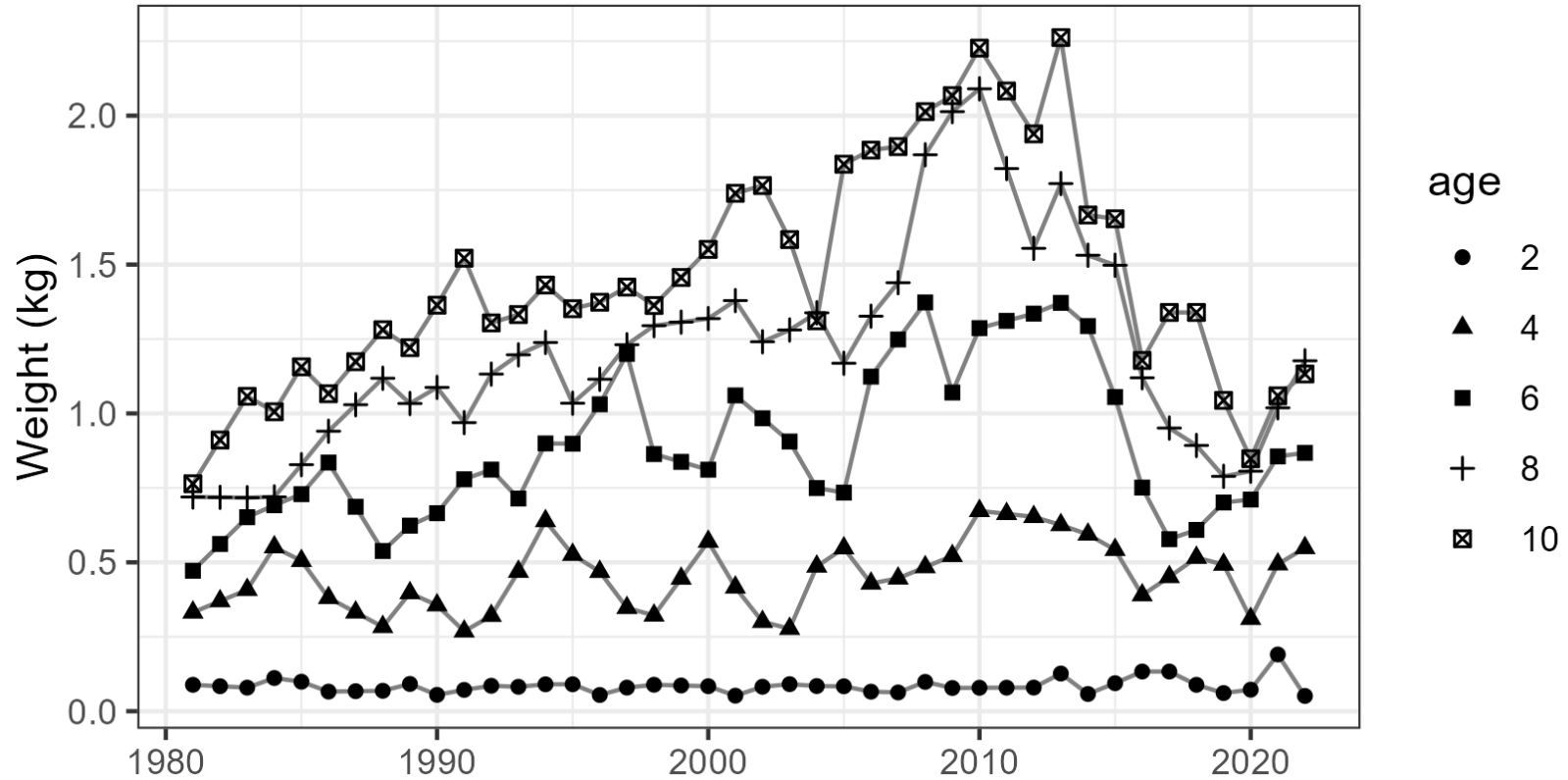
Changes in maturity



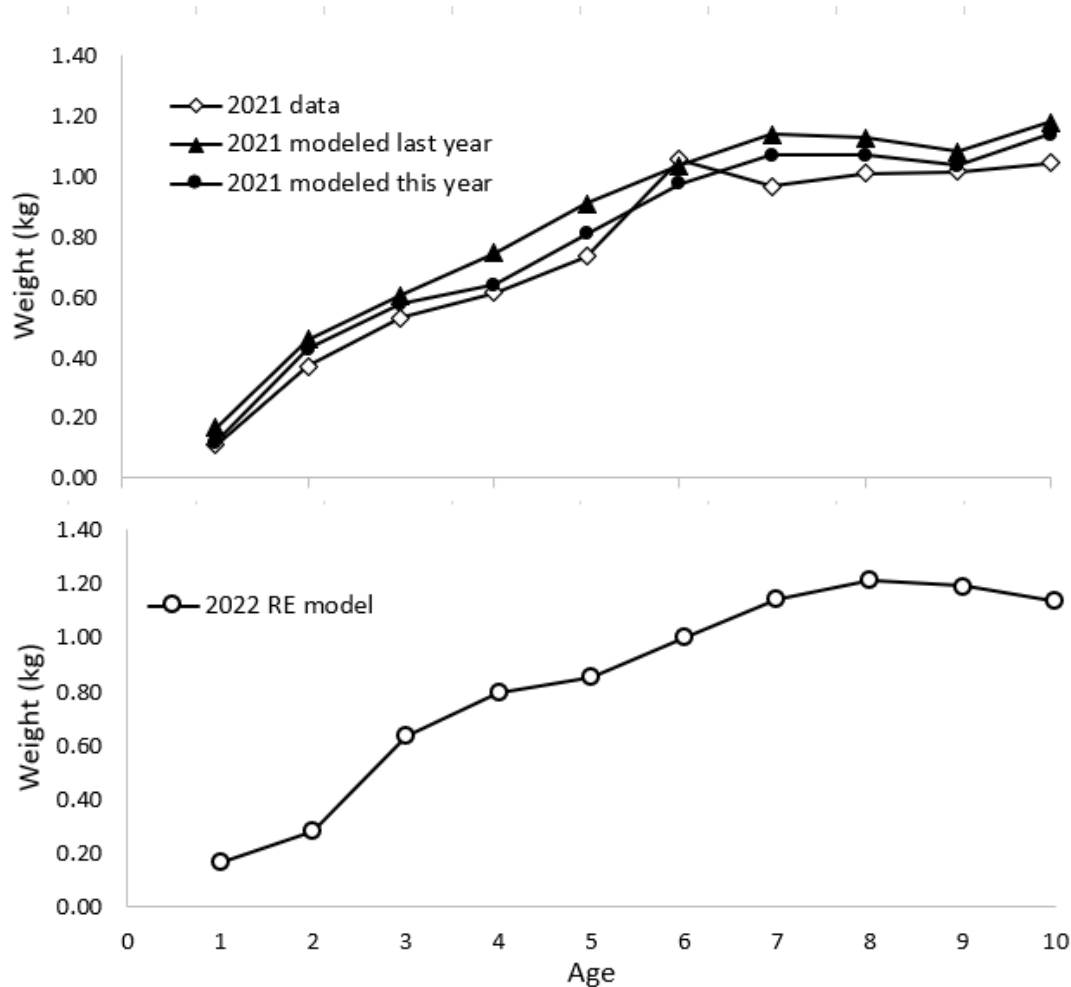
Annual GLM estimates of age and length at 50% mature

Data after 2003 use local abundance weighting

Shelikof weight at age



Fishery weight at age



Did the RE model accurately predict the 2021 fishery WAA last year?

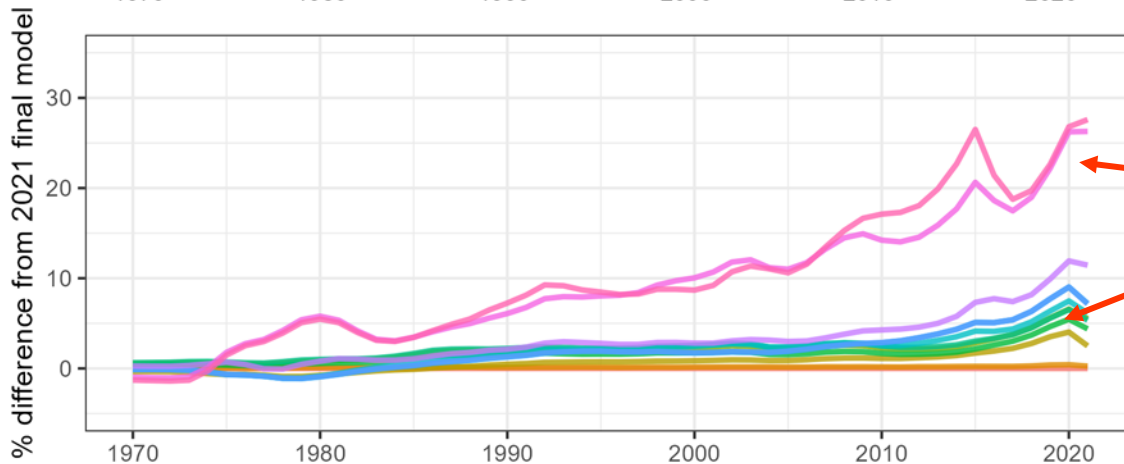
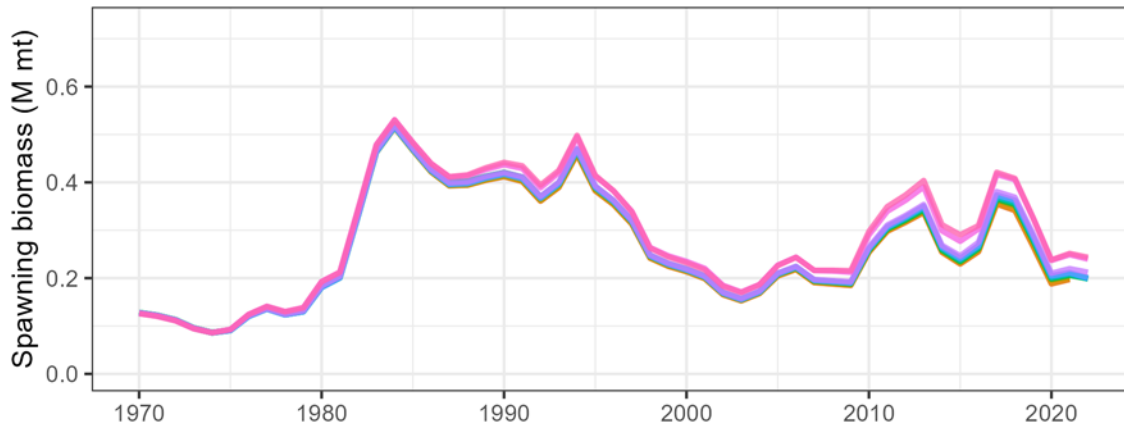
..... no

Parameters estimated

Population process modeled	Number of parameters	Estimation details
Recruitment	Years 1970-2022 = 53	Estimated as log deviances from the log mean; recruitment in 1970-77, and 2018 and 2019 constrained by random deviation process error.
Natural mortality	Age-specific= 10	Not estimated in the model
Fishing mortality	Years 1970-2022 = 53	Estimated as log deviances from the log mean
Mean fishery selectivity	4	Slope parameters estimated on a log scale, intercept parameters on an arithmetic scale
Annual changes in fishery selectivity	2 * (No. years-1) = 104	Estimated as deviations from mean selectivity and constrained by random walk process error
Mean survey catchability	No. of surveys = 6	Catchabilities estimated on a log scale. Separate catchabilities were also estimated for age-1 and age-2 winter acoustic indices.
Annual changes in survey catchability	2 * (No. years-1) = 104	Annual catchability for winter acoustic surveys and ADF&G surveys estimated as deviations from mean catchability and constrained by random walk process error
Survey selectivity	6 (Shelikof acoustic survey: 2, BT survey: 2, ADF&G survey: 2)	Slope parameters estimated on a log scale.
Total	120 estimated parameters + 208 process error parameters + 10 fixed parameters = 338	

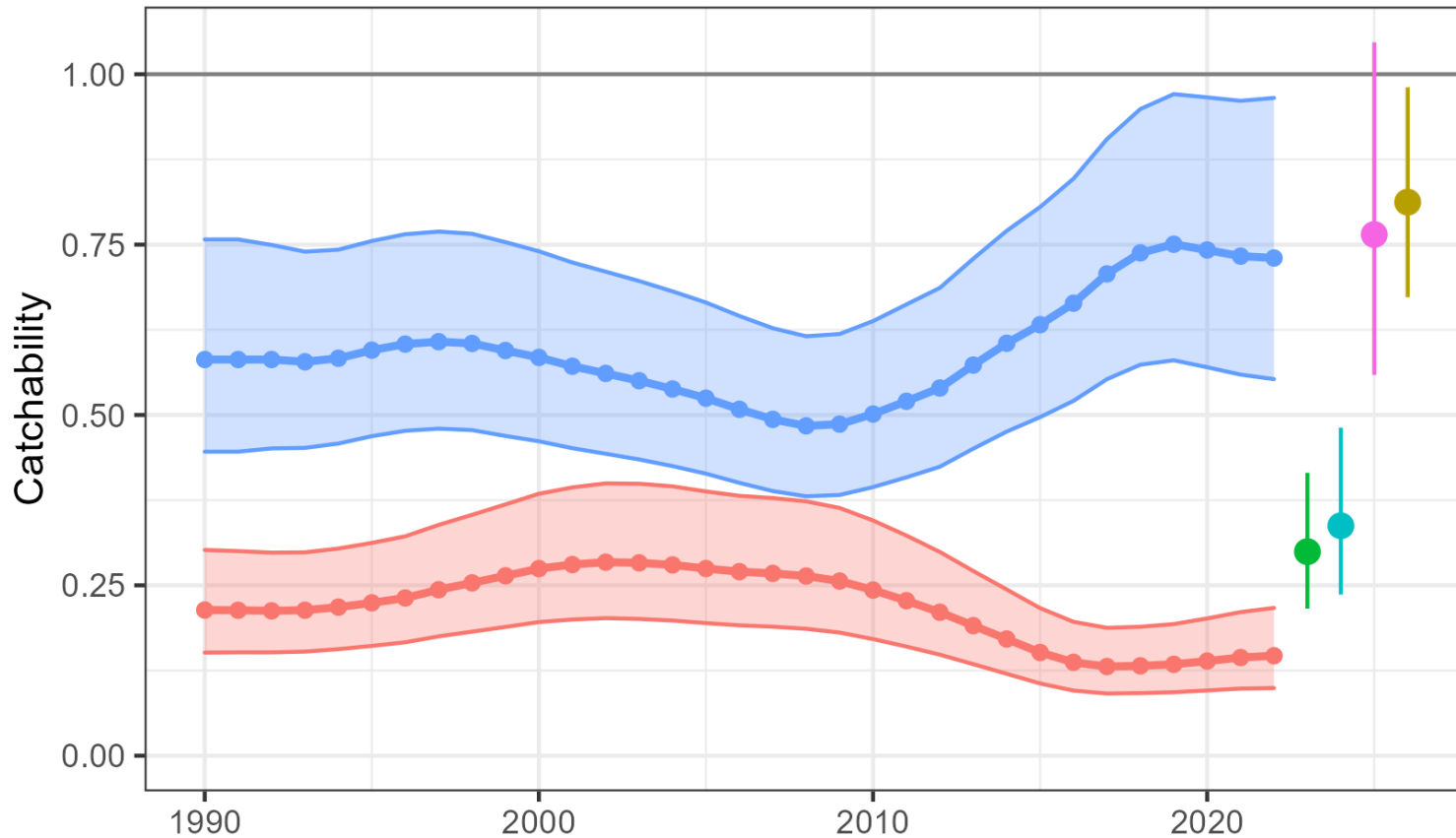
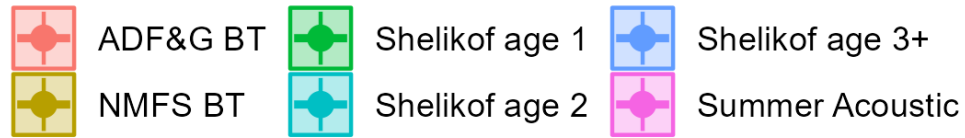
Sequential addition of data

- 2021 final
- + 2021 Summer AT ages
- + 2022 Shelikof WAA
- + updated 2021 catch
- + 2021 NMFS BT ages
- + updated WAA & maturity
- + 2021 fish ages
- + 2022 Shelikof index
- + 19.1a
- + 2022 ADF&G index
- + 2022 Shelikof ages
- + Francis weights



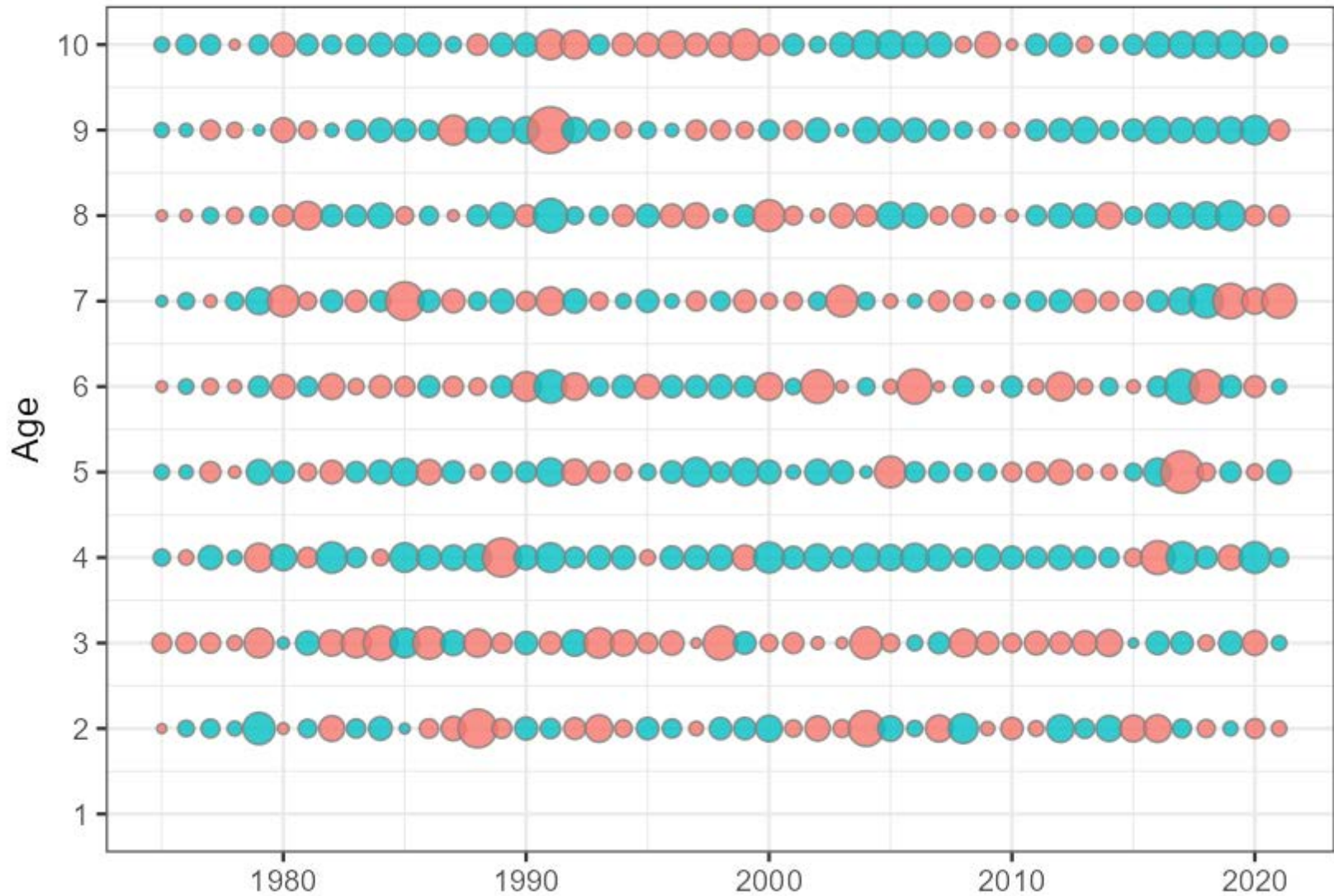
Both new data and model updates increased scale of SSB

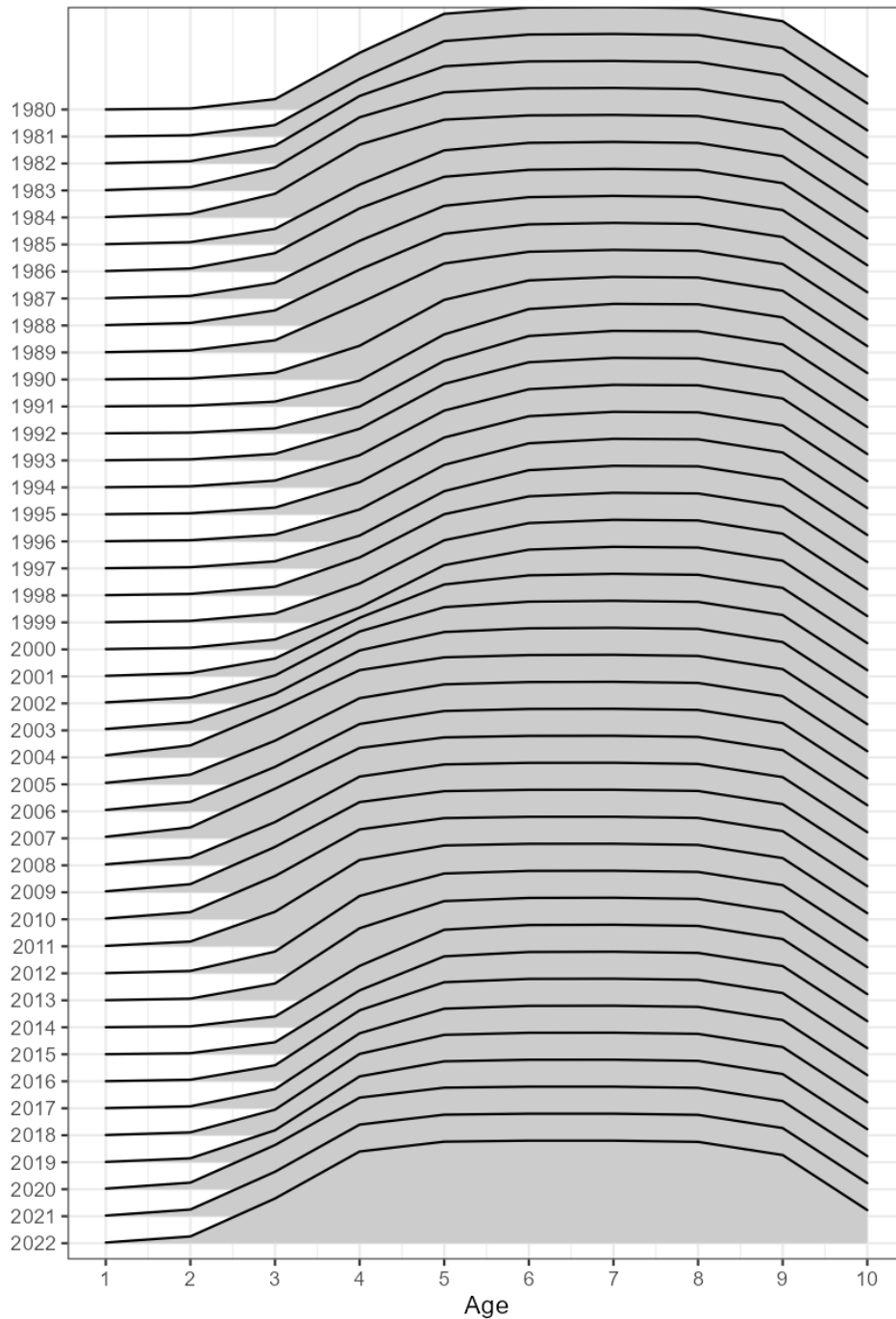
Time-varying catchabilities



Fishery age residuals

Pearson residual range: -2.2 to 4.7



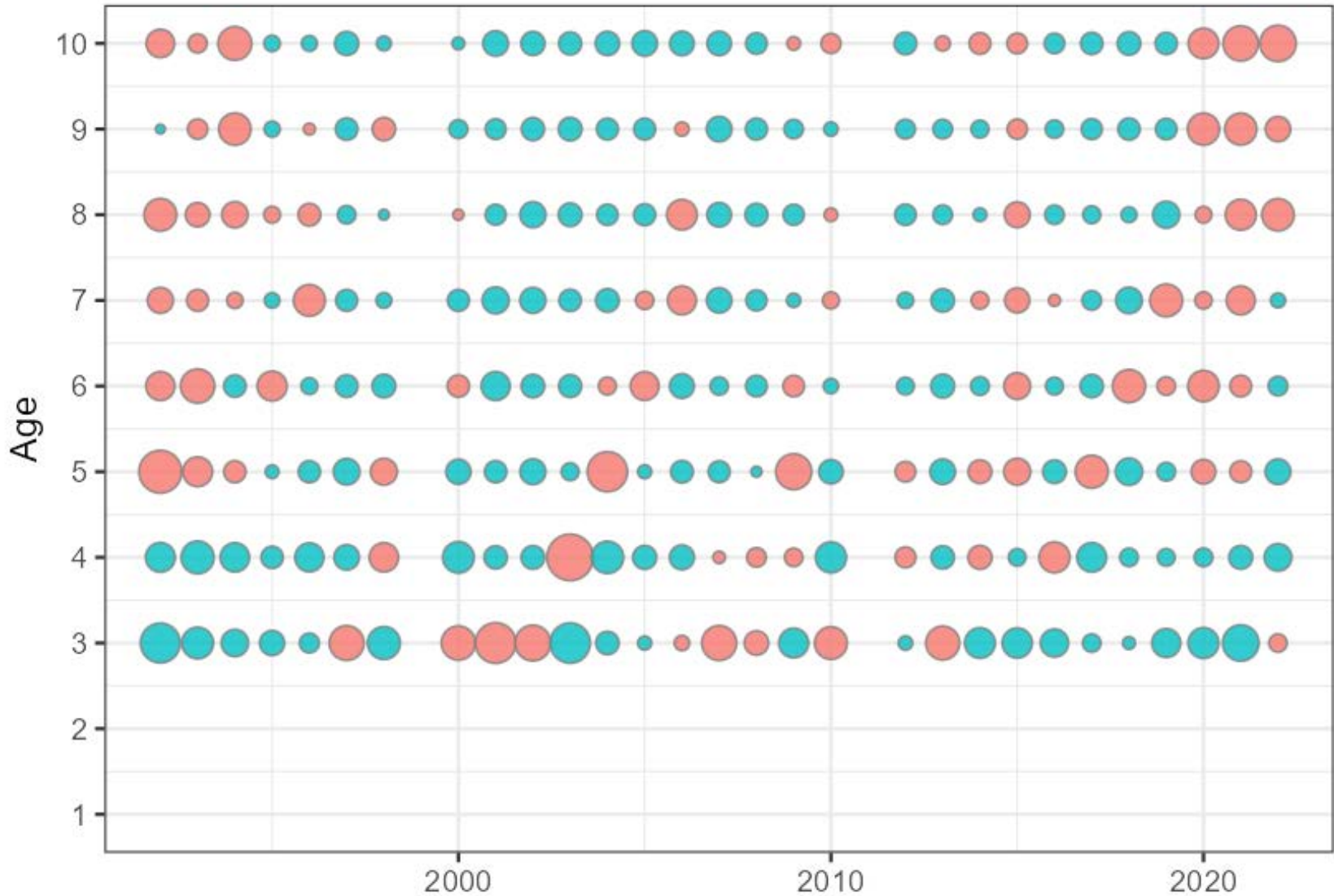


Fishery selectivity

Double-logistic with
time varying
ascending slope and
inflection

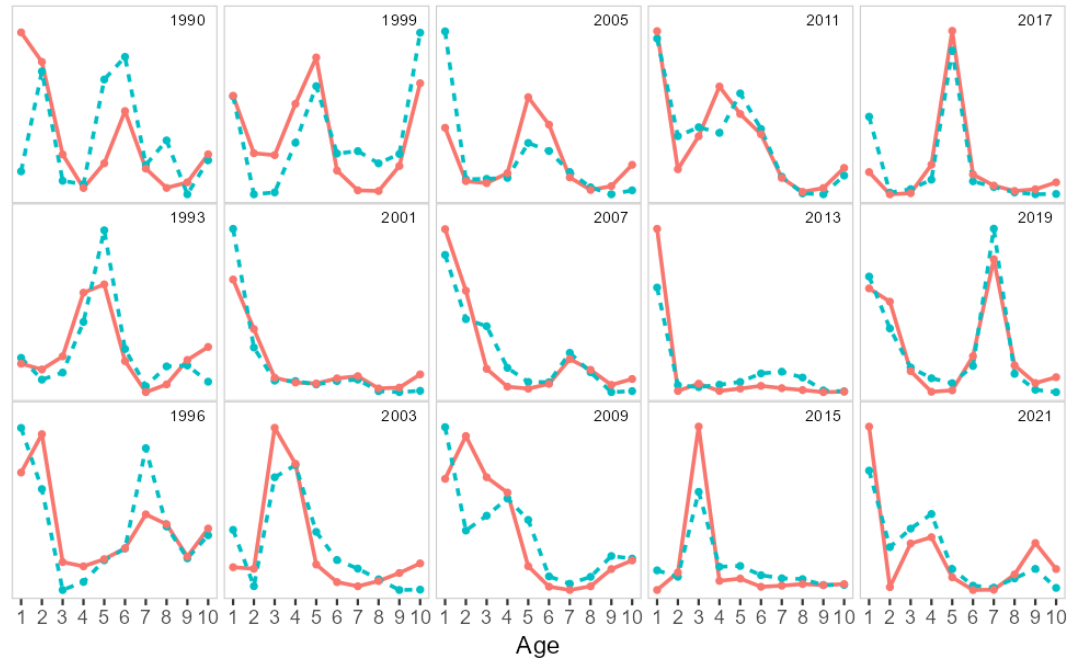
Shelikof age residuals

Pearson residual range: -2 to 2.8

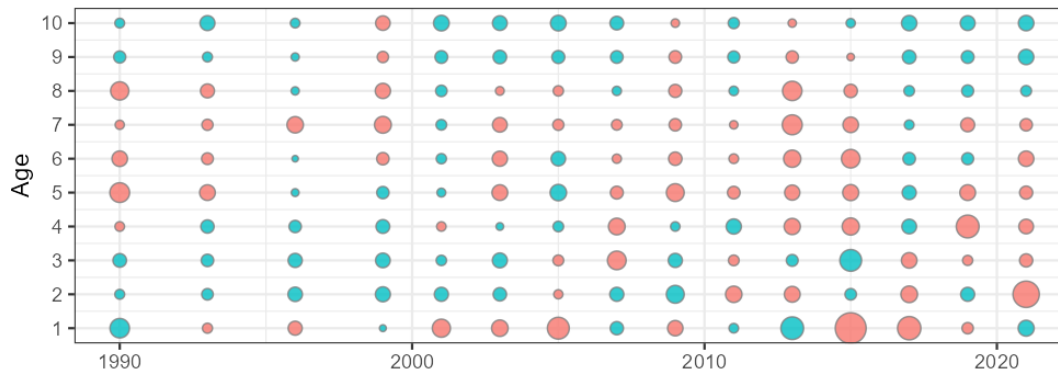


NMFS BT age residuals

NMFS bottom trawl

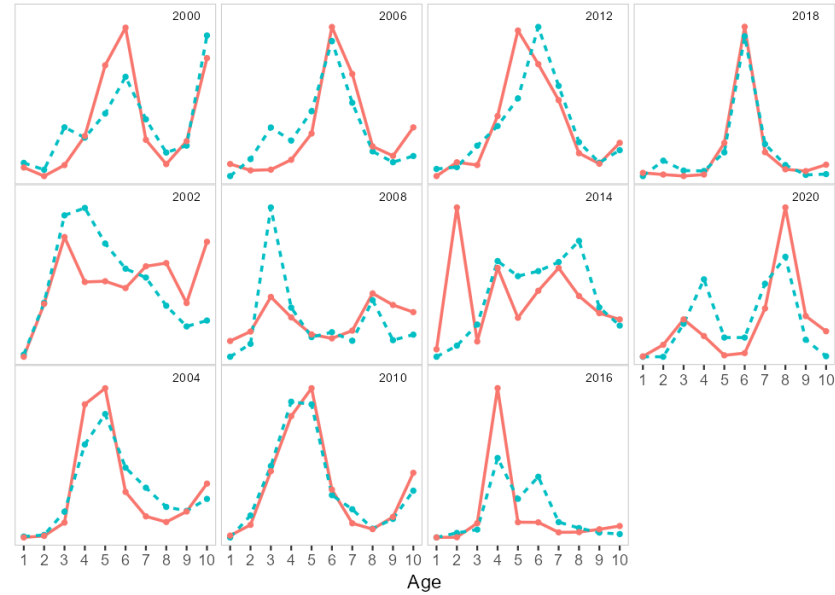


Pearson residual range: -2 to 4.5

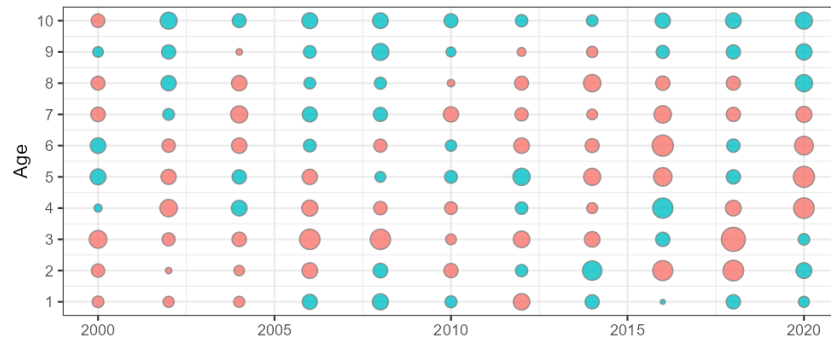


ADF&G BT age residuals

ADF&G bottom trawl



Pearson residual range: -3.2 to 7.2

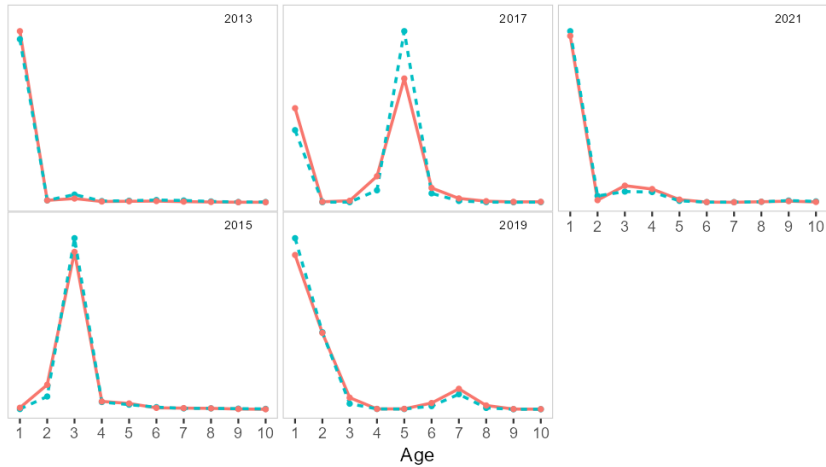


Summer acoustic age residuals

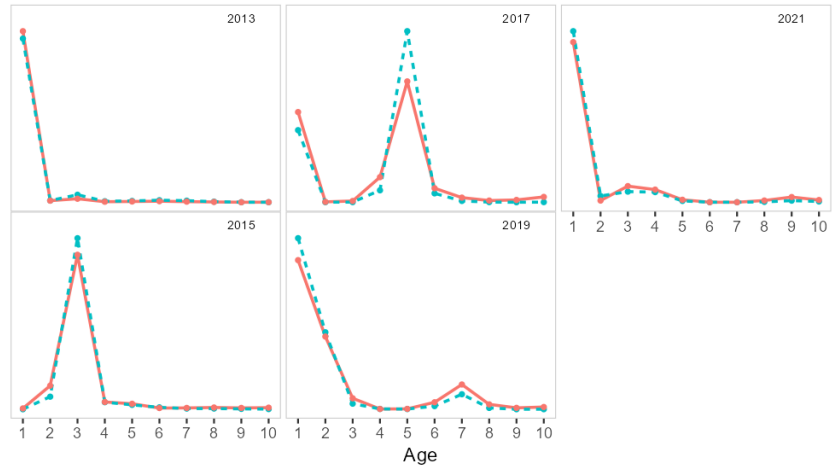
Selectivity estimated

Selectivity fixed at 1

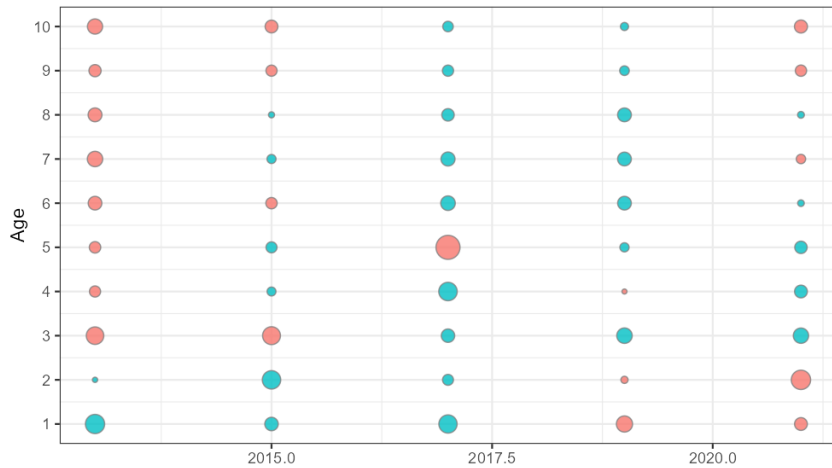
Summer Acoustic



Summer Acoustic



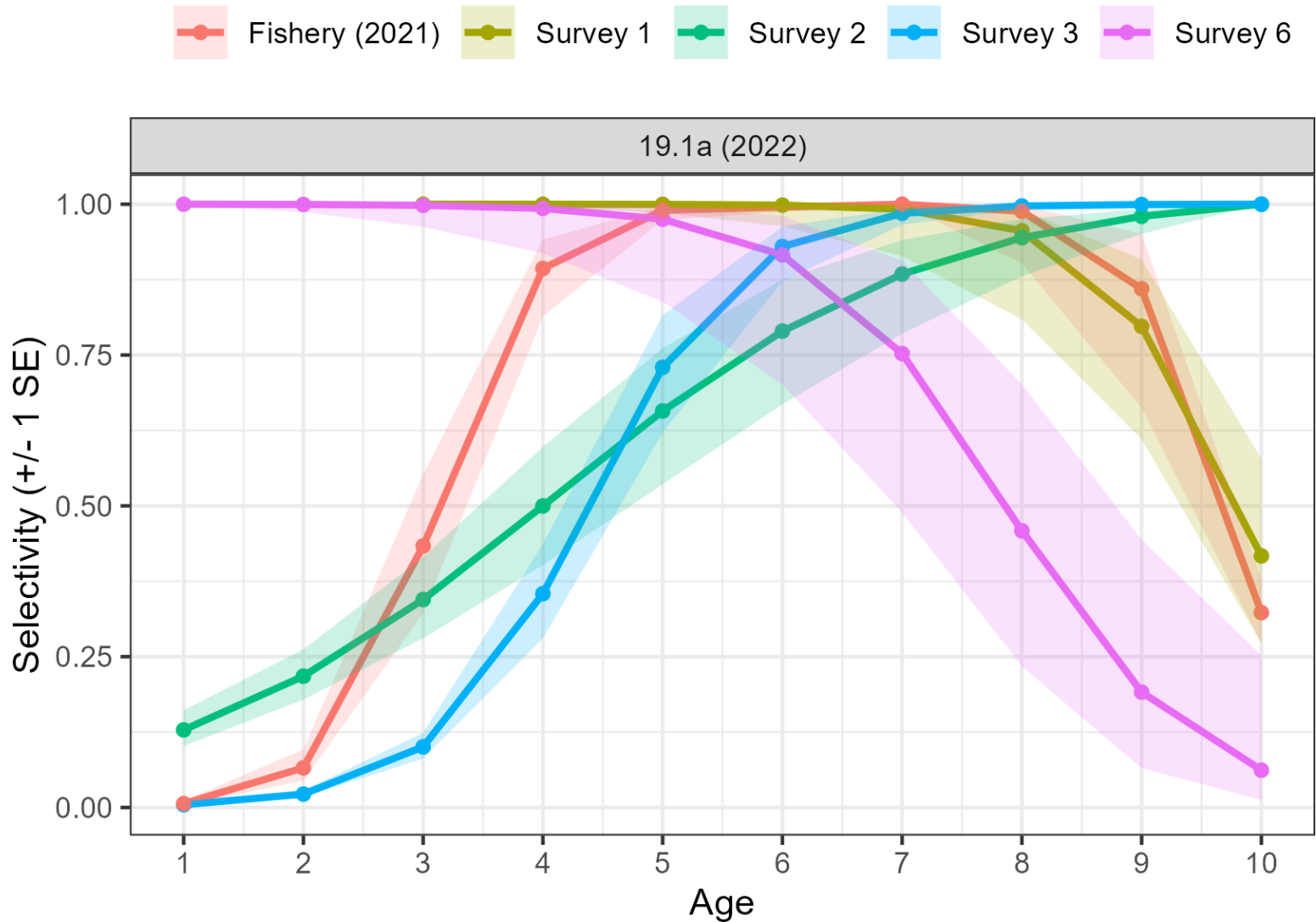
Pearson residual range: -1.3 to 2.3



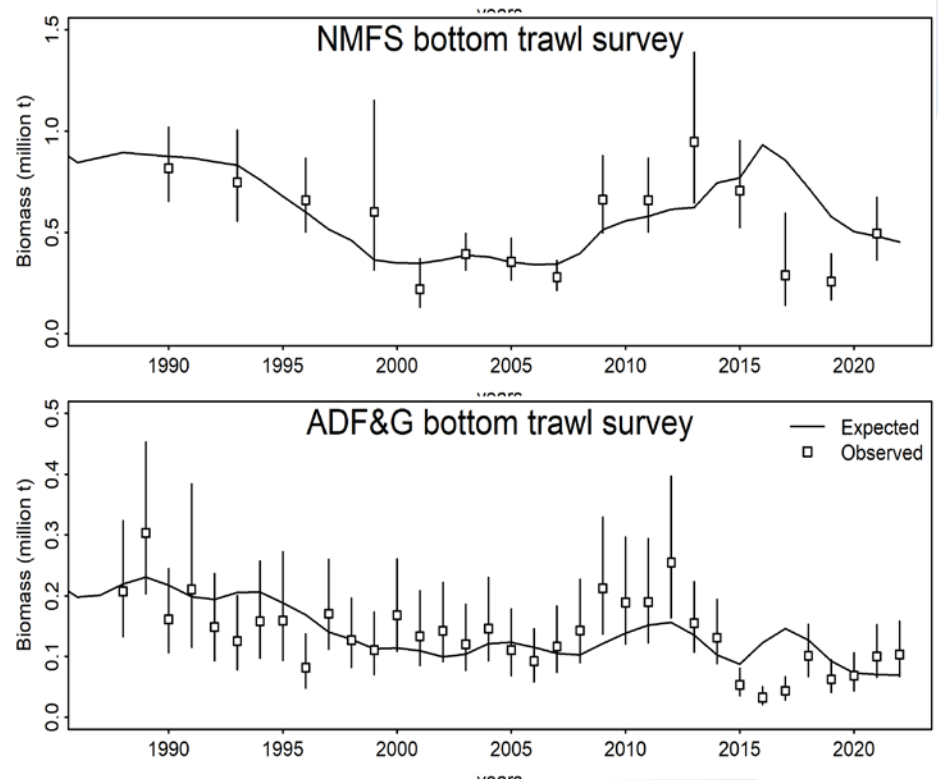
Pearson residual range: -1.1 to 2.4



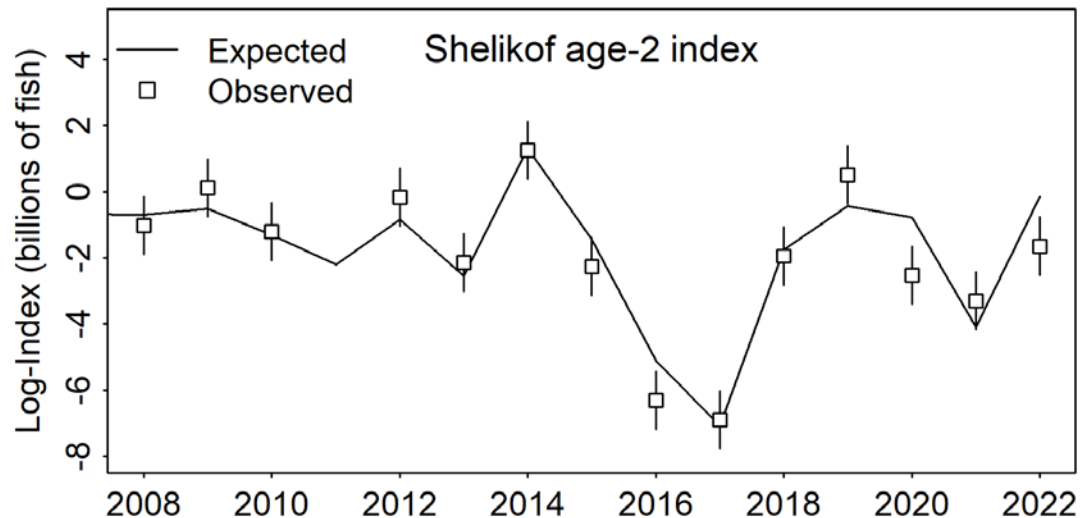
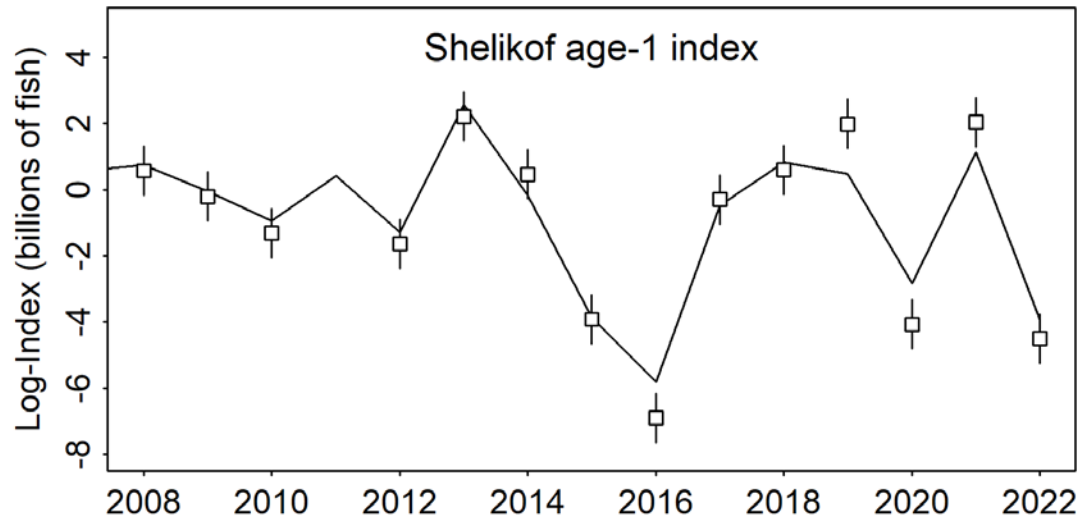
Estimated survey selectivities



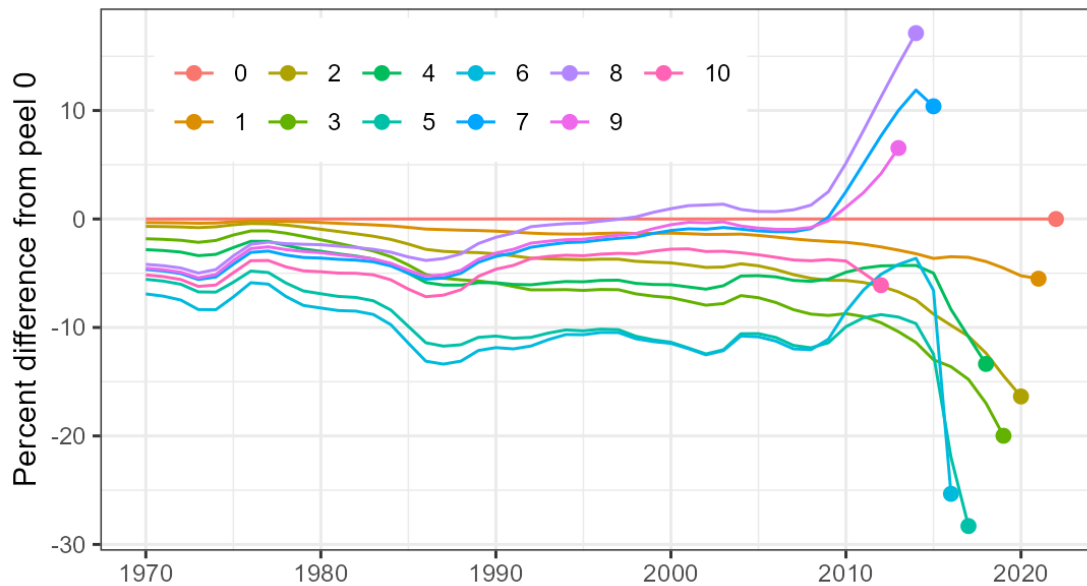
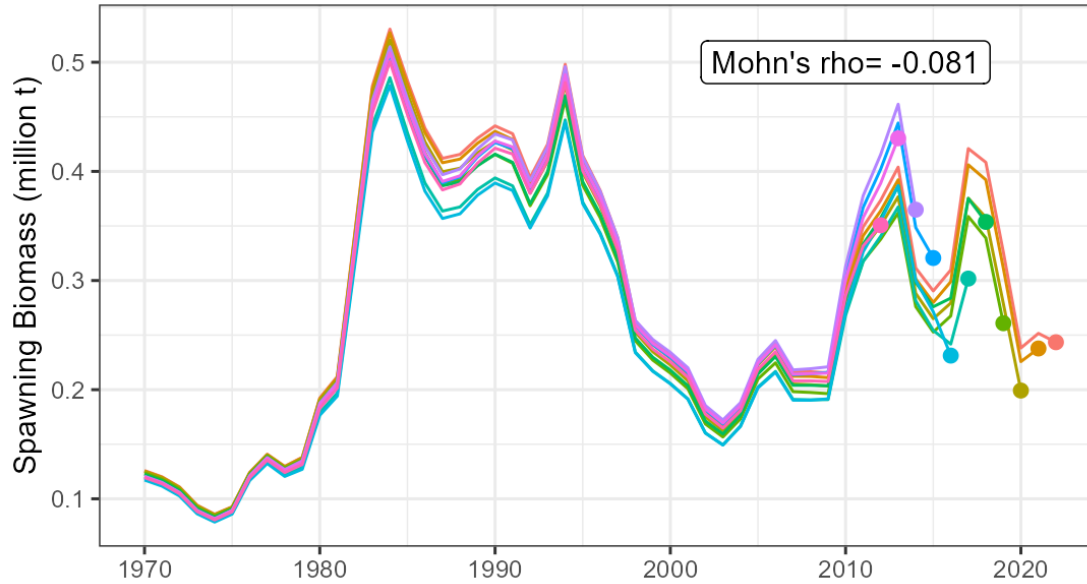
Fits to indices



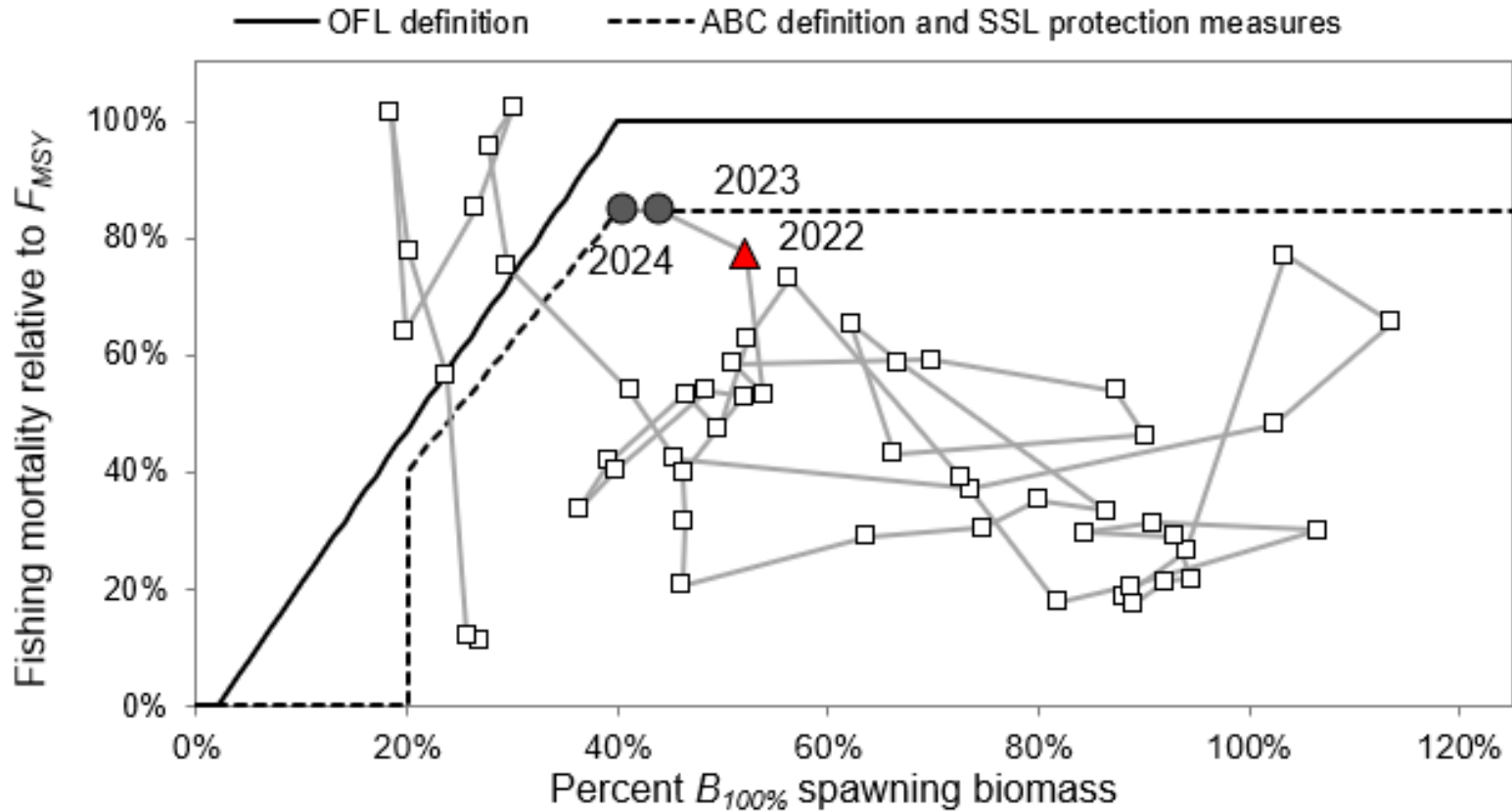
Fits to indices



Retrospective analysis

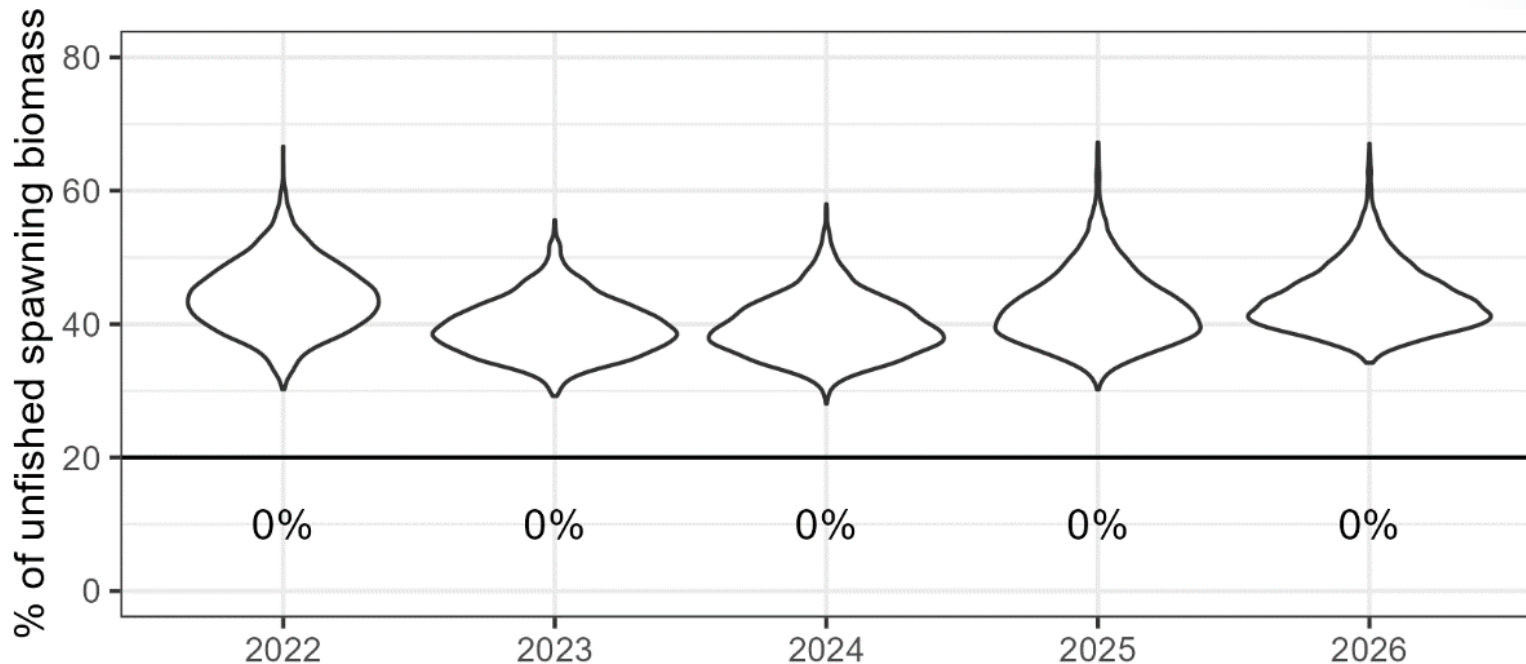


SSB vs fishing mortality

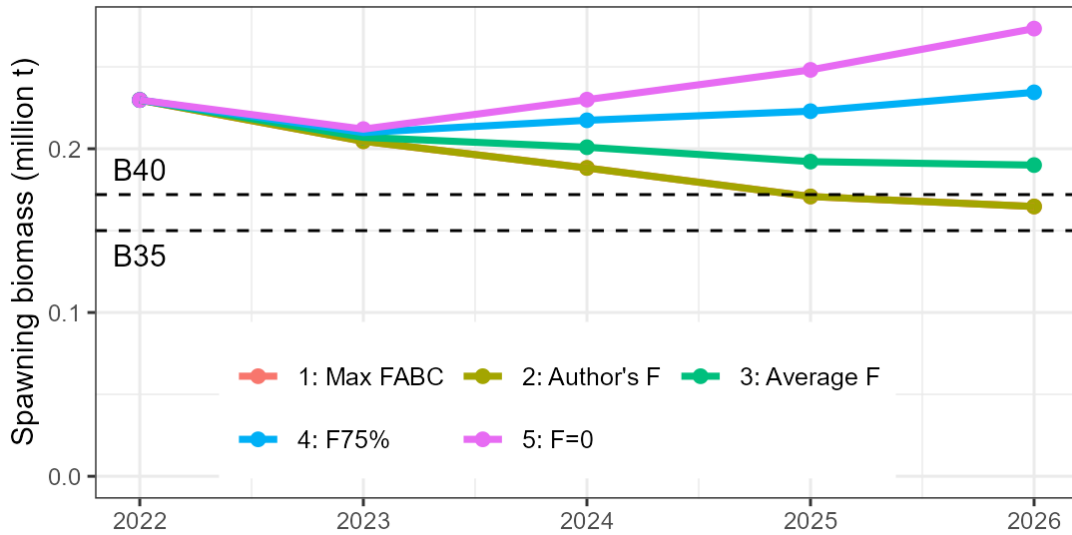


Probability of falling below B20%

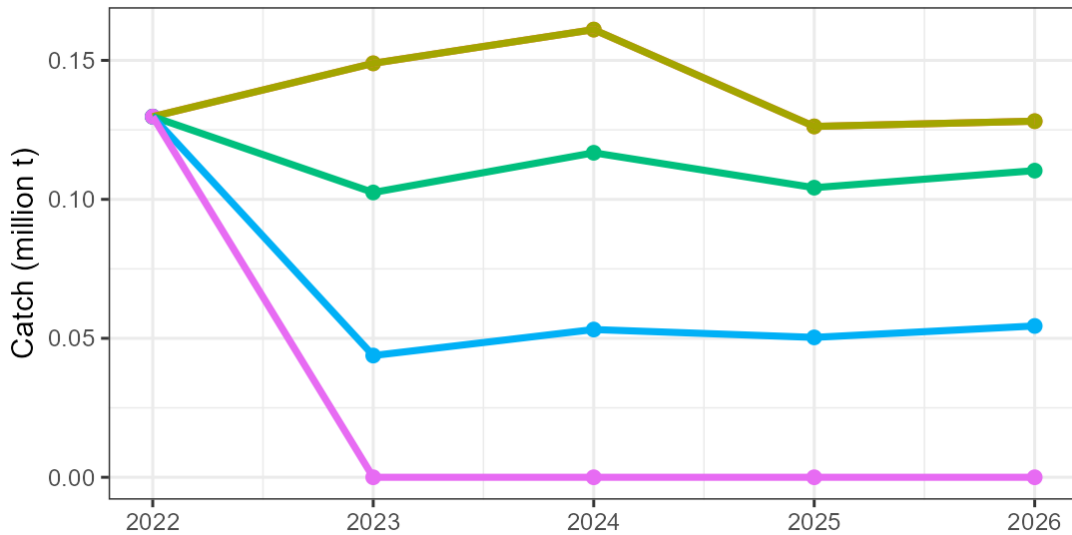
Run MCMC samples through an internal projection module to calculate $\Pr(\text{SSB} < \text{B20}\%)$ for SSL measures



5-year
projections



Mean spawning
biomass



Mean yield

Risk table

- Assessment considerations
 - 2018 cohort size still in conflict, but stable and no affecting model
 - Overall scale remains an ongoing issue
- Population dynamics considerations
 - Fishery characteristics returning to normal from unusual 2012 cohort
- Environmental/ecosystem considerations
 - Ecosystem conditions in 2022 were 'average' for pollock, with the exception that the adult condition was below average.
- Fishery performance
 - No issues with fishery CPUE
- No increased concerns in any category, so **no reduction from max ABC is recommended.**

2022 model concerns

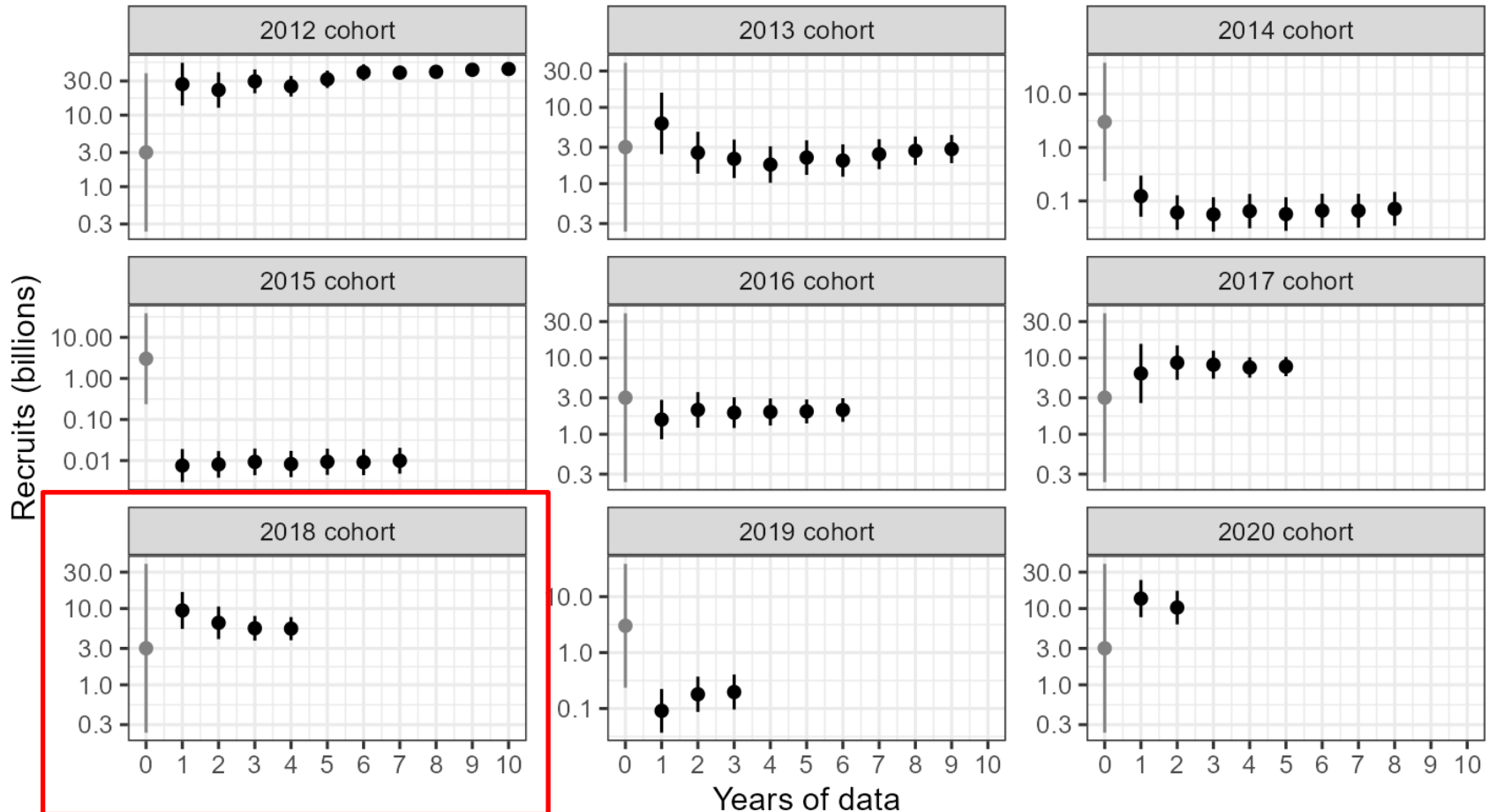
- Scale of population still sensitive, shows up in:
 - Data additions, model changes, prior effects
 - E.g., reference points (% change from previous year)

	2021	2022
SPR (F=0)	0.3%	0.4%
Mean Recruits	-3.5%	8.6%
B40	-3.2%	9.0%
SSB (2016)	-2.0%	21.4%
Projected maxABC	25.9%	11.9%

This is an ongoing issue that will continue to be investigated

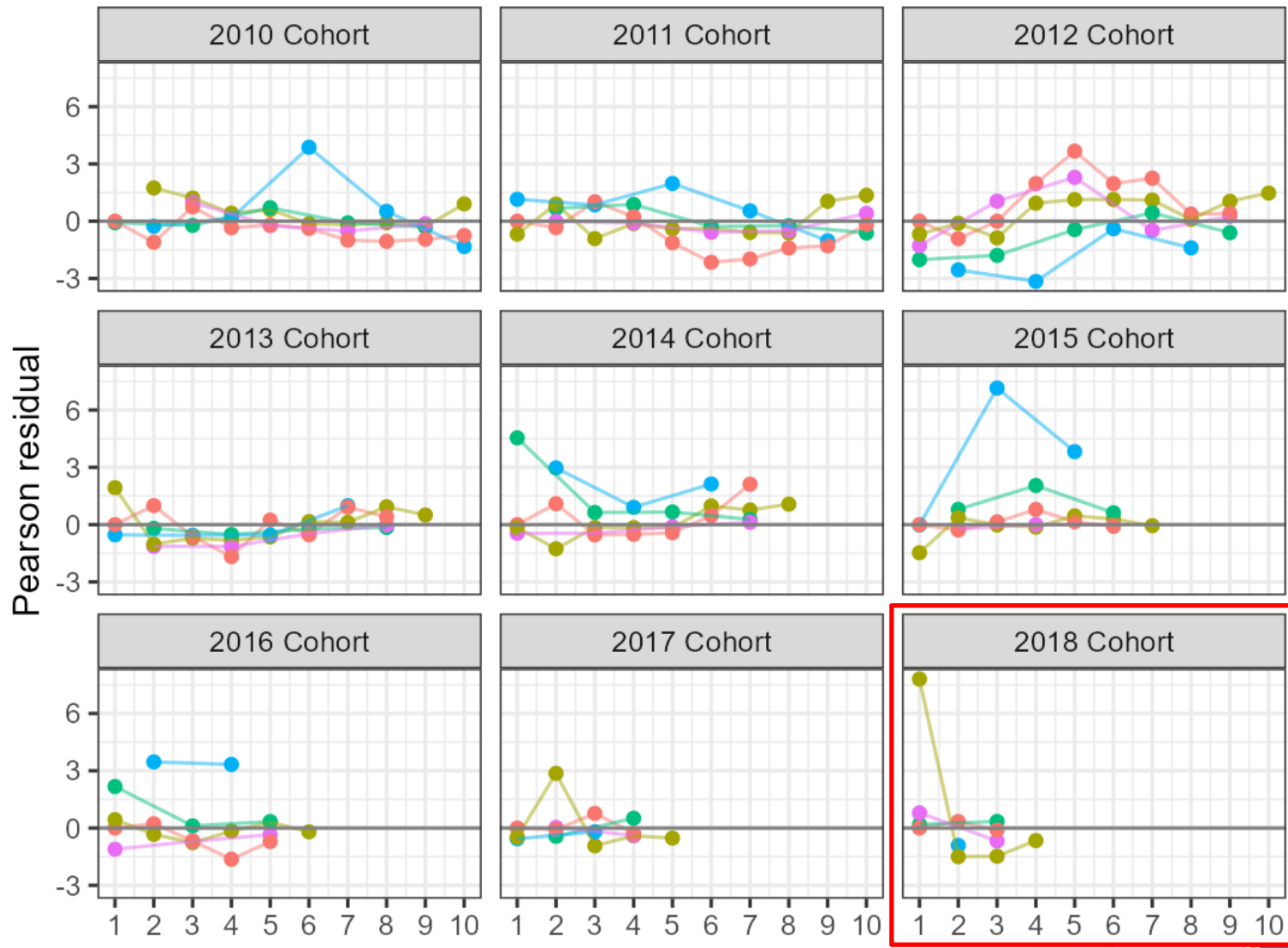
Size of the 2018 cohort

- Not an abnormal change in estimated size as more data are added



Residuals by cohort

—●— Fishery —●— Shelikof —●— NMFS BT —●— ADF&G BT —●— Summer AT



Size of the 2018 cohort

- Overall there remains conflict in the size of the cohort from the different data sources
- Residuals are high for Shelikof age 1, low for all others.
- ADF&G (2021) is slightly low but also does not target young fish
- Fishery, summer acoustic and NMFS bottom trawl survey age compositions are all relatively in line (5.3 billion)
- It seems clear that the **cohort abundance is unlikely to change in future years (is stable) and that there was not a mass mortality event.**

Size of the 2018 cohort

Two hypotheses seem plausible at this point:

1. *Unusual mortality and availability.* The 2018 cohort was originally huge but had a large mortality event between ages 1-1.5. Then, availability to the Shelikof survey was unusually low for ages 3 & 4.
 2. *Statistical noise + underestimated CVs by age.* The CV on age-1 estimate could be much too small (assumed 0.45) and we implicitly placed too much weight on this data point. Subsequent estimates are within the norm for Pearson residuals. *We're only focusing on this cohort b/c of the age-1 estimate which may not be reliable.*
- Bottom line: This does not appear to be an assessment issue, and I expect estimates to be stable over time.

PT/SSC proposed updates

- Investigate trends in weight at age
 - Ongoing research lead by G. Correa using WHAM (Appendix F)
- Shelikof survey timing effects on catchability, maturity, selectivity
 - Promising collaboration with L. Rogers et al. using WHAM
- General investigation of scale
 - Important, but unclear how to proceed.
- Data weighting and input CVs
 - Part of broader AFSC push to overhaul
- Combining BT and AT to estimate vertical availability (long-term)
- New selectivity forms
 - Try non-parametric forms for fishery

Status Summary for Gulf of Alaska Pollock in W/C/WYK Areas

Quantity/Status	As estimated or <i>specified last</i> year for:		As estimated or <i>recommended this</i> year for:	
	2022	2023	2023*	2024*
M (natural mortality)	0.300	0.300	0.300	0.300
Tier	3a	3a	3a	3a
Projected total (age 3+) biomass (t)	848,878	1,205,850	1,281,980	889,889
Projected female spawning biomass (t)	186,481	167,840	204,554	188,277
B _{100%}	430,000	430,000	469,000	469,000
B _{40%}	172,000	172,000	188,000	188,000
B _{35%}	150,000	150,000	164,000	164,000
F _{OFL}	0.311	0.301	0.304	0.302
maxF _{ABC}	0.263	0.256	0.257	0.257
F _{ABC}	0.263	0.256	0.257	0.257
OFL (t)	154,983	153,097	173,470	186,101
maxABC (t)	133,081	131,912	148,937	161,080
ABC (t)	133,081	131,912	148,937	161,080
Status	As determined <i>last</i> year for:		As determined <i>this</i> year for:	
	2021	2022	2022	2023
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

*Projections are based on an estimated catch of 129,754 t for 2022 and maximum permissible ABC for 2023 and 2024.

Final 2023 apportionment if TAC=148,937 t

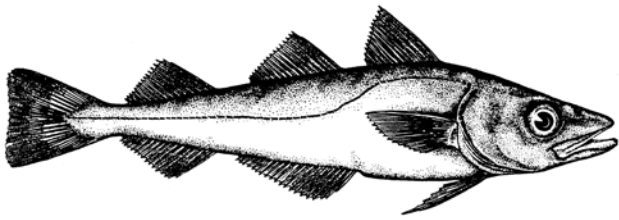
Area	TAC (t)		Percent	
	Season A	Season B	Season A	Season B
610	1,685	25,272	1.2%	17.4%
620	58,039	18,965	40.0%	13.1%
630	9,121	24,608	6.3%	16.9%
640	7,523		5.2%	

Final 2024 apportionment if TAC=161,080 t

Area	TAC (t)		Percent	
	Season A	Season B	Season A	Season B
610	1,823	27,333	1.2%	17.4%
620	62,771	20,511	40.0%	13.1%
630	9,864	26,614	6.3%	16.9%
640	8,136		5.2%	

Questions/comments?

- **Thanks!**
- **Coauthors:**
Martin W. Dorn, Giancarlo M. Correa, Alison L. Deary, Bridget E. Ferriss, Mike Levine, David W. McGowan, Lauren Rogers, S. Kalei Shotwell, Abigail Tyrell and Stephani Zador
- **Thanks to Kally Springer and Duane Stevenson for providing data**



Gulf of Alaska pollock

Overview of results

Changes to the assessment model

- Estimate summer acoustic selex & $\sigma_R=1.3$ for all devs (model 19.1a)

Author's 2023 ABC 148,937 t

- Increase of 12% from 2022
- 2024 ABC decreases to 161,080 t
- No reduction from max ABC

Concerns:

- Continuing scale sensitivity

Positives:

- Return to normal age diversity w/ decline in 2012 cohort
- Large 2017, 2018, 2020 cohorts

