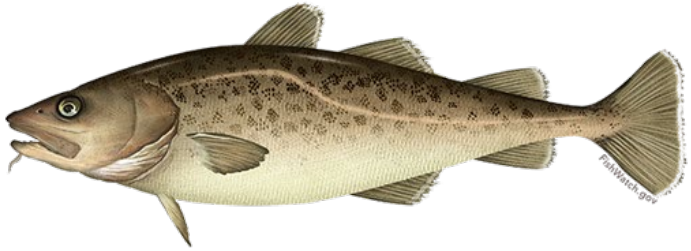


GOA PACIFIC COD

P. HULSON, S. BARBEAUX, B. FERRISS, K. ECHAVE, J. NIELSEN, S. MCDERMOTT, B. LAUREL, A. ABOOKIRE, INGRID SPIES, AND S. K. SHOTWELL

NOAA FISHERIES

November 2024, Presentation to the GOA Plan Team

ASSESSMENT OVERVIEW

- BLUF:
  - GOA Pacific cod: Tier 3b
  - 2024 projected spawning biomass to be at $B_{28.7\%}$
  - 2025 recommended ABC <1% different than 2024 ABC
- Outline:
  - SSC/Plan Team comments
  - Summary of changes from 2023 assessment
  - 2024 recommended model results

SSC/PLAN TEAM COMMENTS: GENERAL

- "*The SSC continues to support a three-category risk table with categories normal, increased, and extreme, and requests that the category descriptions be revised to cover the range covered by the original table.*"
- "*The SSC reiterates that only fishery performance indicators that provide some inference regarding biological status of the stock should be used.*"
- "*The SSC recommends that the risk tables consider potential future risks when these can be anticipated.*"
- "*When risk scores are reported, the SSC requests that a brief justification for each score be provided, even when that score indicates no elevated risk.*" (SSC, Dec 2023)

SSC/PLAN TEAM COMMENTS: GENERAL

- *"The SSC requests that when Bayesian model output is reported, basic convergence diagnostics are also presented."* (SSC, Dec 2023)
- "*The Team recommended as a best practice that appendices be linked in the front of the document (as with the sablefish assessment) to allow for an easier review of the appendices.*" (Plan Team, November 2023)

SSC/PLAN TEAM COMMENTS: SPECIFIC

- *"The SSC appreciates the preliminary evaluation of conditional age-at-length patterns and recommends further evaluation of growth-related issues, including updating the length-weight relationship with more recent data, evaluating if there have been significant growth changes, and examining empirical weight at age. The SSC encourages consistency with EBS and AI cod assessments in approaches to these and other issues, where possible."* (SSC, Dec 2022)
- *"The Team recommended that the data for length-weight relationships be reevaluated and examined for sensitivity to the trends over time and areas."* (Plan Team, Nov 2022)
- *"The Team recommended the authors look at the model-predicted mean weight-at-age (by gear type), and compare to the observed weight-at-age data to see if there are discernible spatial or temporal patterns that the model is missing."* (Plan Team, Nov 2022)
- *"The Team recommended that an evaluation comparing how growth changes may affect the residuals be pursued. The Team also recommended the author investigate whether size-based selectivity affects the patterns observed."* (Plan Team, Nov 2022)

Krista Oke

- *"Based on recent tagging and genetic studies, the SSC encourages further exploration of fish movement as a potential major cause of population changes. Movement should be considered in concert with high natural mortality events for future models, and specifically consideration should be given to an Alaska-wide stock or GOA/EBS model."* (SSC, Dec 2022)

?

SSC/PLAN TEAM COMMENTS: SPECIFIC

- *"The SSC reiterates its encouragement for the authors to consider whether information from the IPHC setline survey and NMFS longline survey, alongside the NMFS bottom trawl survey, may provide a superior basis for apportionment recommendations, perhaps through the use of an integrated spatiotemporal model or a multi-survey random effects model."* (SSC, Dec 2023)
- *"The SSC requests the authors evaluate the utility of the 14 forecast recruitment deviations. It is not clear where they are used in the document and whether they affect the estimation of other parameters."* (SSC, Dec 2023)
- *"The Team recommended the author only bring forward their preferred model as "2024" in November, in addition to the base model used in the previous assessment."* (Plan Team, Sept 2024)

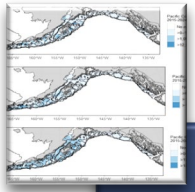
SSC/PLAN TEAM COMMENTS: SPECIFIC

- *"The Team recommended using Akaike Information Criterion (AIC) to inform selection of the aging error model."* (Plan Team, Sept 2024)
- *"The Team also noted that weight-at-age is produced as a standard output of this model (as it is needed to fit the catch biomass), and recommended comparing the model-estimated weight-at-age to empirical data on weight-at-age."* (Plan Team, Sept 2024)
- *"The SSC requests a thorough revaluation of the current modeling approach for survey selectivity and catchability, including alternatives to the current selectivity blocks in the trawl survey, and alternatives to a strongly dome-shaped selectivity in the longline survey, and whether selectivity rather than catchability is more appropriately modeled with a time-varying temperature covariate."* (SSC, Dec 2023)

SSC/PLAN TEAM COMMENTS: SPECIFIC

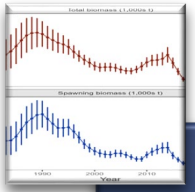
- *"The Team recommended that sufficient samples be processed and analyzed so that the resulting data can be used in the assessment."* (Plan Team, Nov 2023)
- *"The SSC supports the GOA GPT recommendation to work up the backlog of maturity data, and further to evaluate trends in maturity, as well as relationships between growth and maturity."* (SSC, Dec 2023)

ASSESSMENT EVALUATION OUTLINE



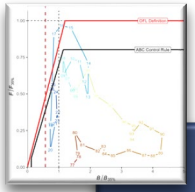
Data

- Fishery
- Surveys
- Other



Results

- Alt model eval
- Diags
- Fits
- Derived quantities

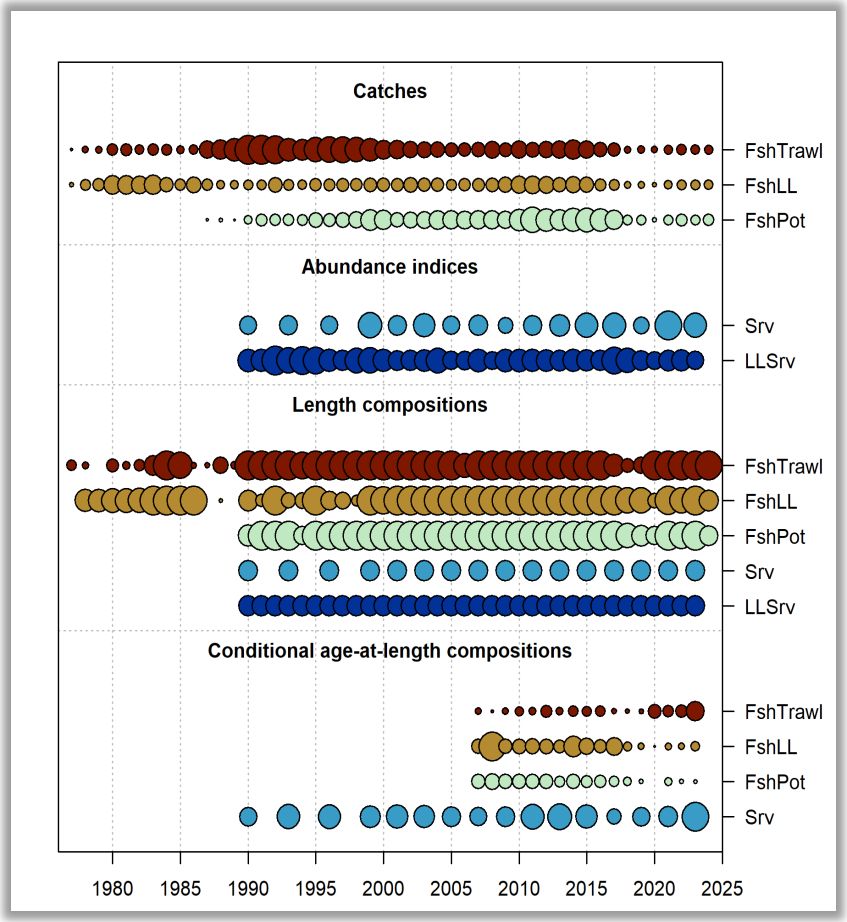


Recommendations

- Risk table
- ABC/OFL

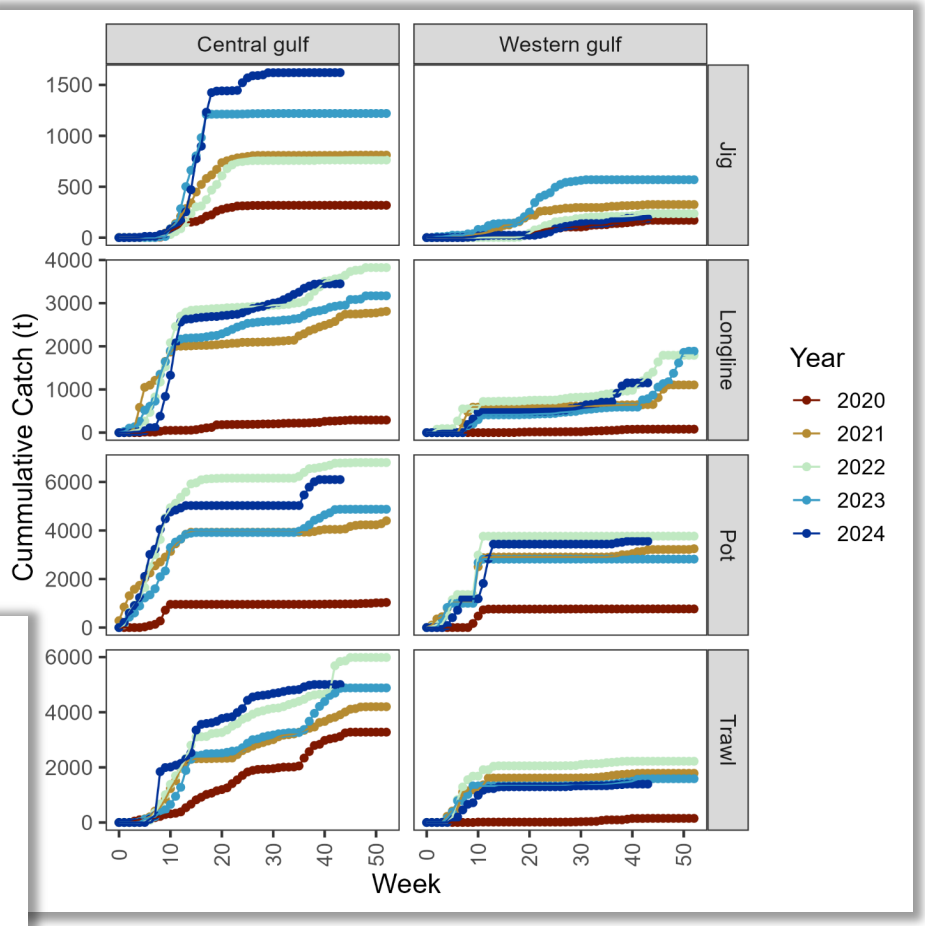
DATA OVERVIEW

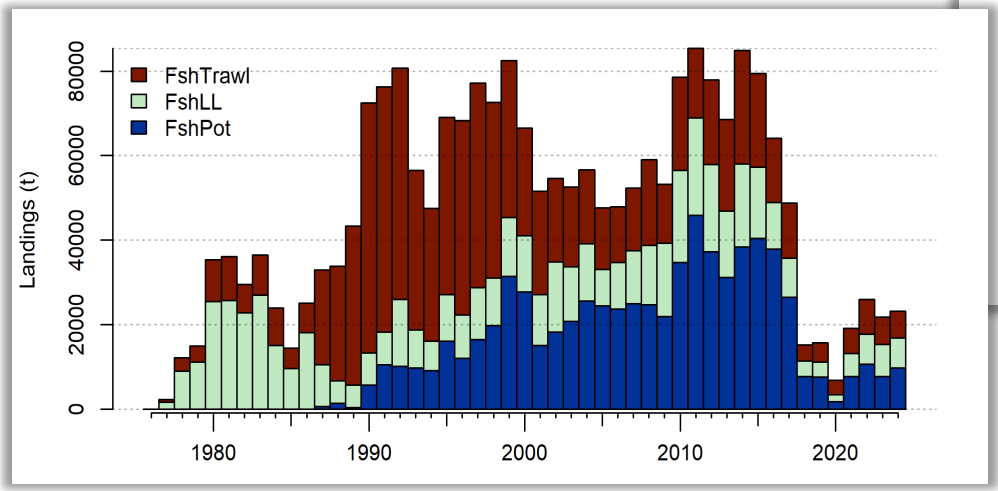
New Data	Years
Federal and state fishery catch, by gear type	2023, 2024
Federal and state fishery length composition, by gear type	2023, 2024
Federal fishery conditional age-at-length	2023
GOA AFSC bottom trawl survey conditional age-at-length	2023



DATA - CATCH

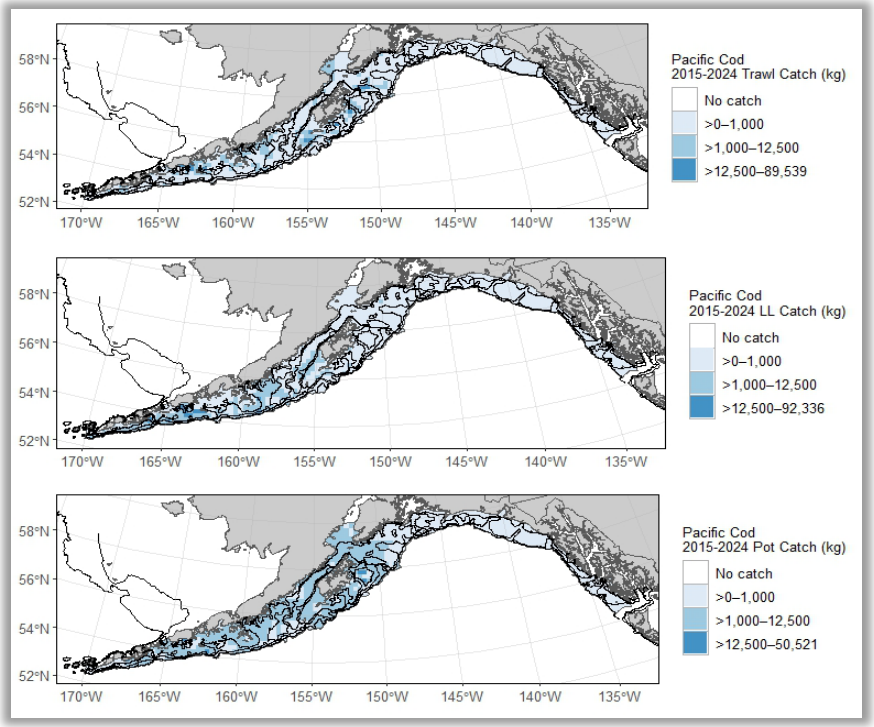
- Increased since 2023
- Pot majority > LL > Trawl
- Large jig increase in CGOA and decrease in WGOA
- Others similar to what was seen in 2022

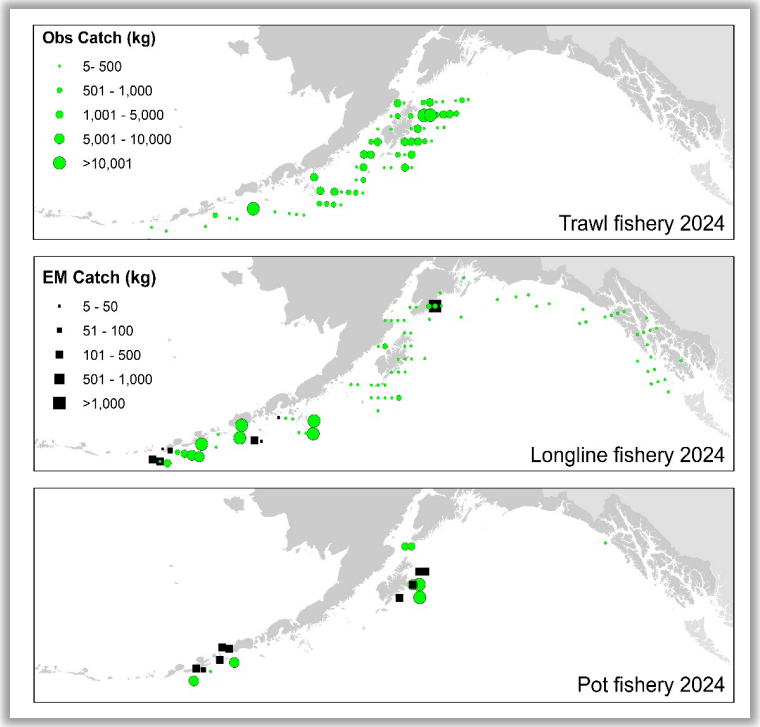




DATA – CATCH DISTRIBUTION

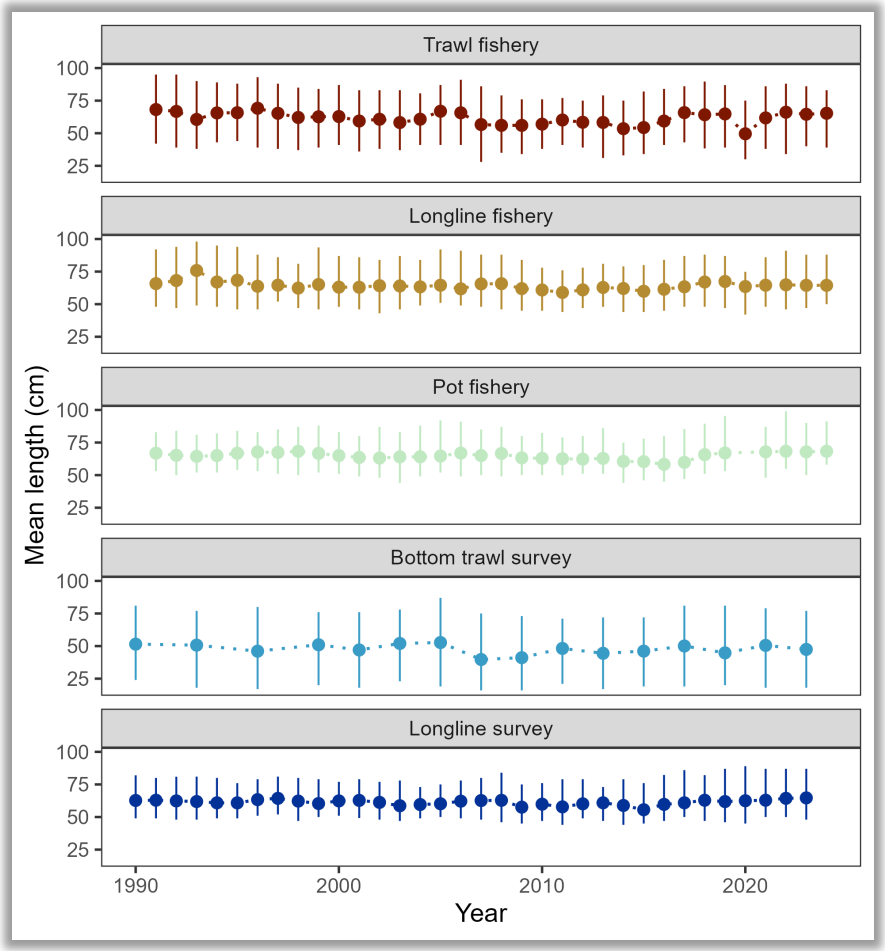
- 2024 distribution similar to catch distribution since 2015
- For how much relative catch is taken by pot, small # observed hauls



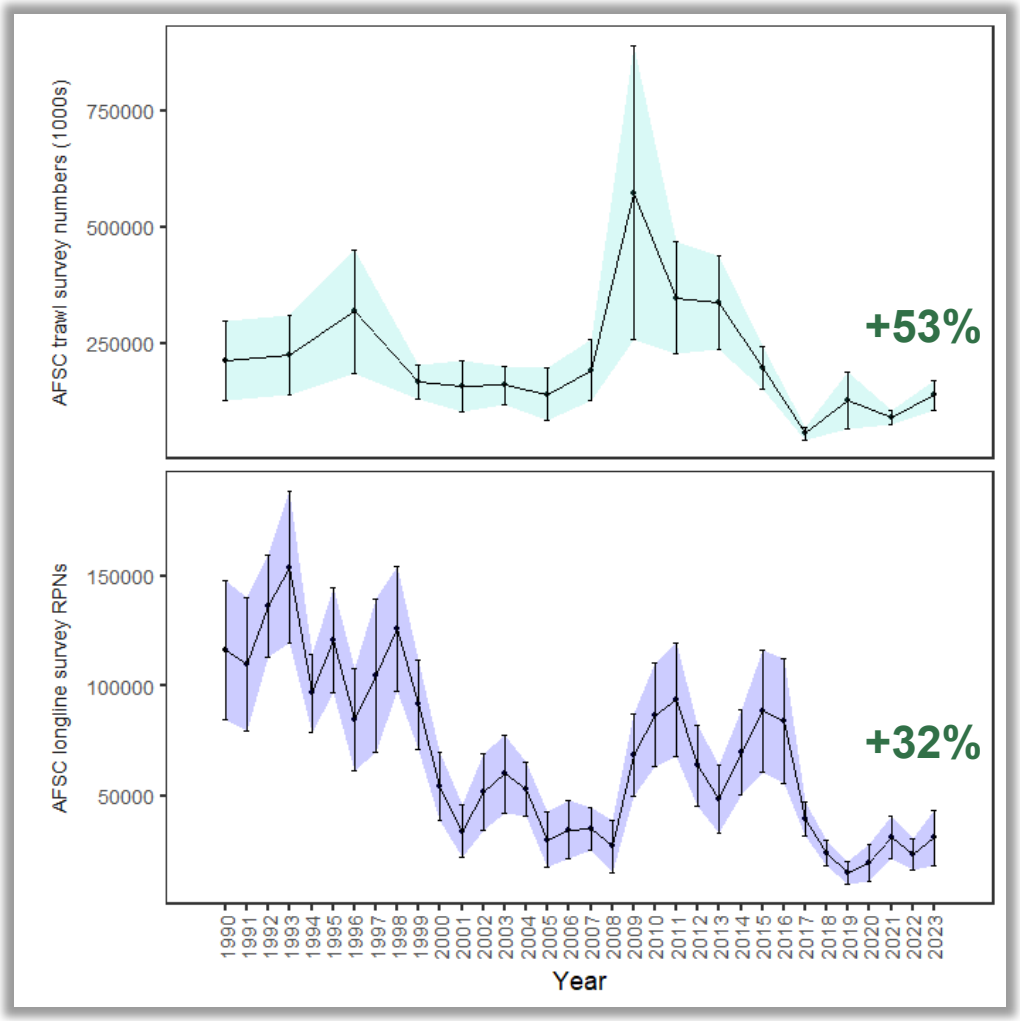


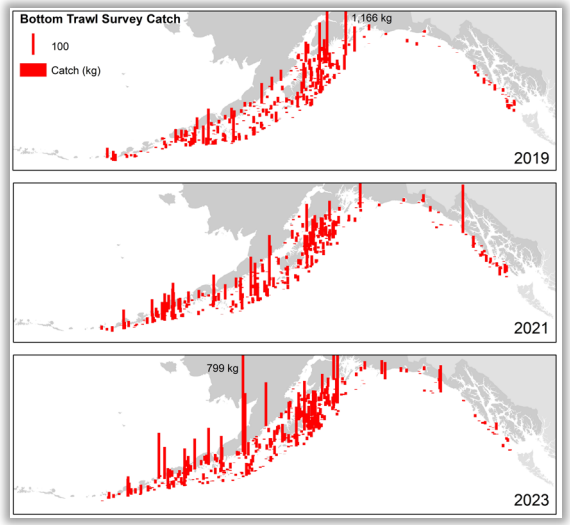
DATA – LENGTH COMPS

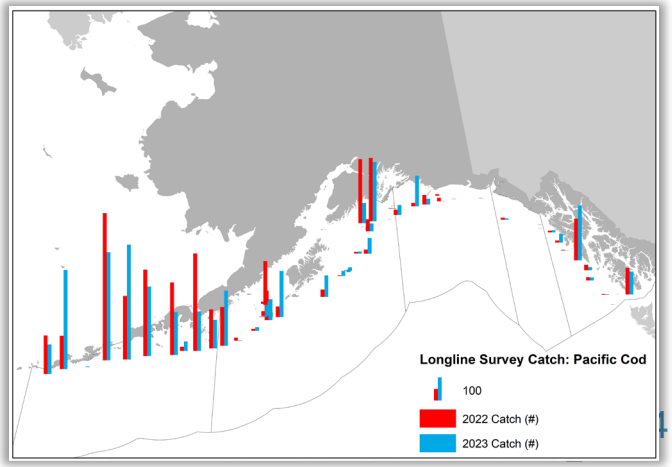
- In general, mean length in 2024 similar to that in previous 4 or so years



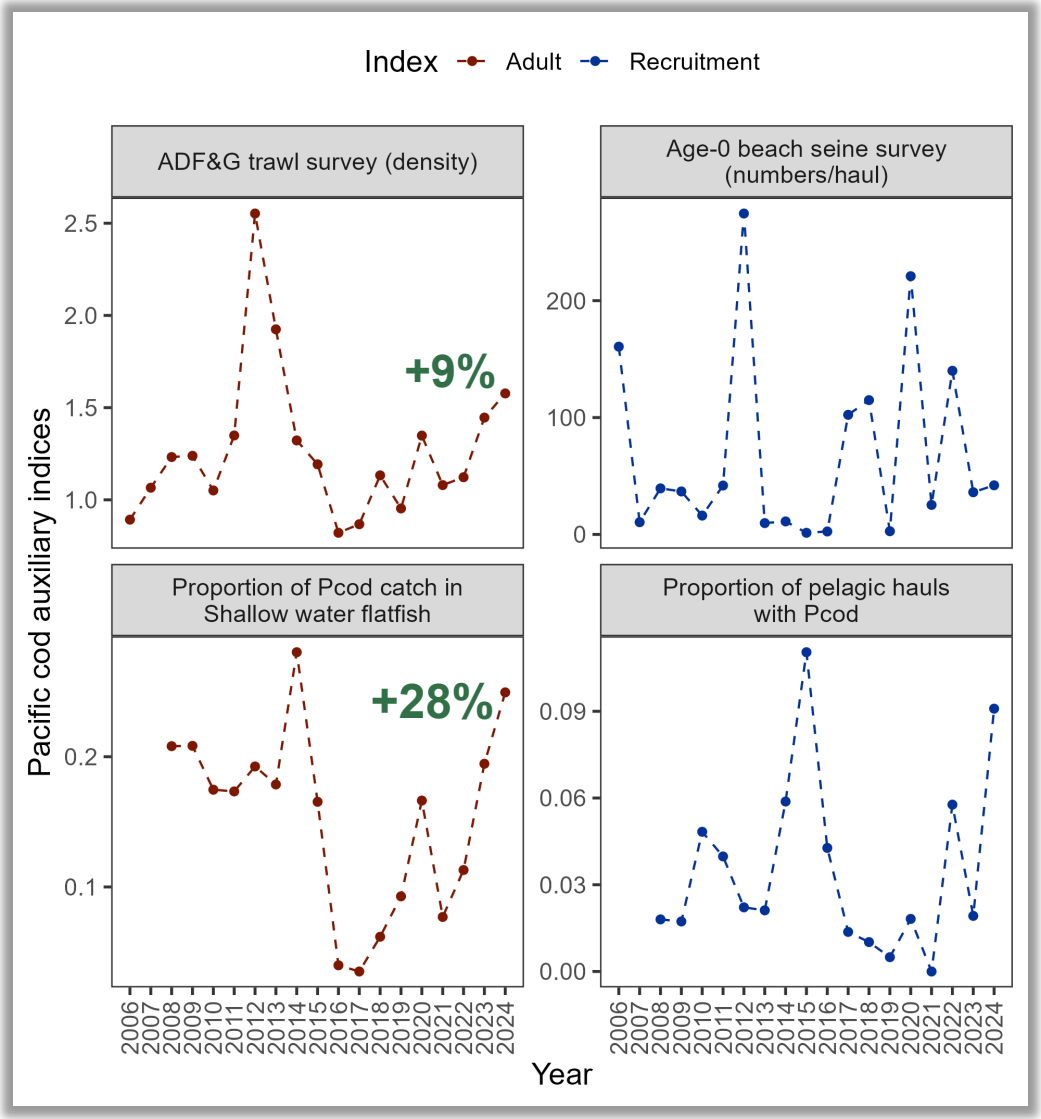
SURVEYS – FITTED (FROM 2023)





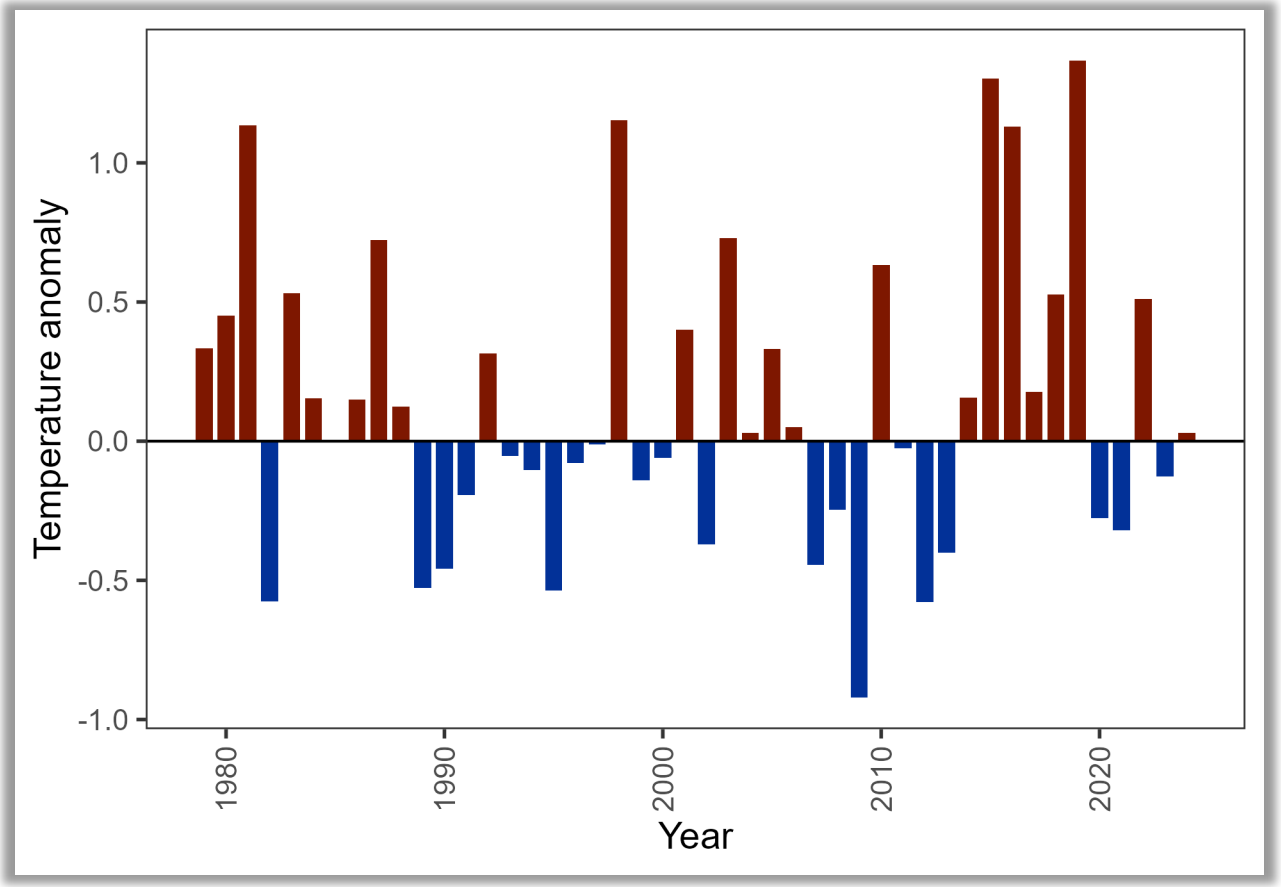


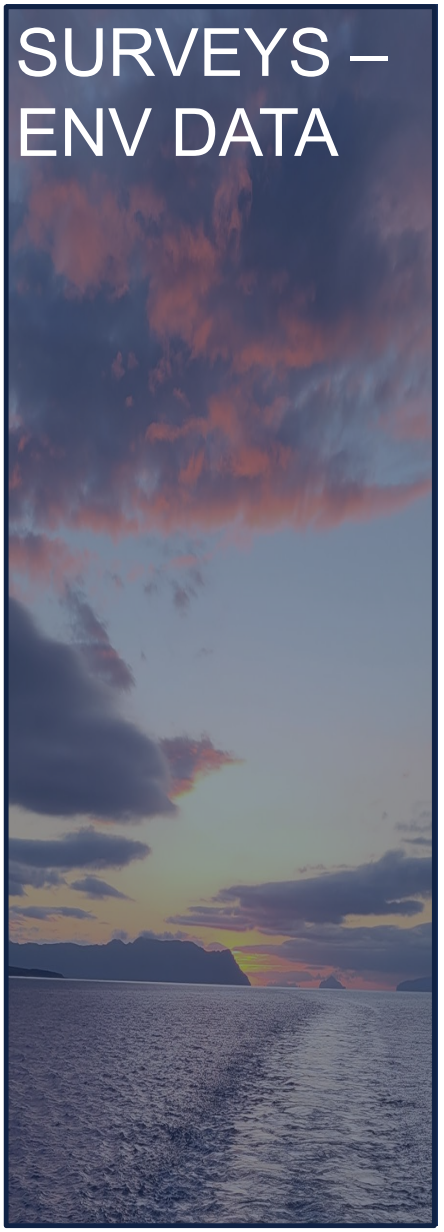
DATA – AUXILIARY INFORMATION



SURVEYS – ENV DATA

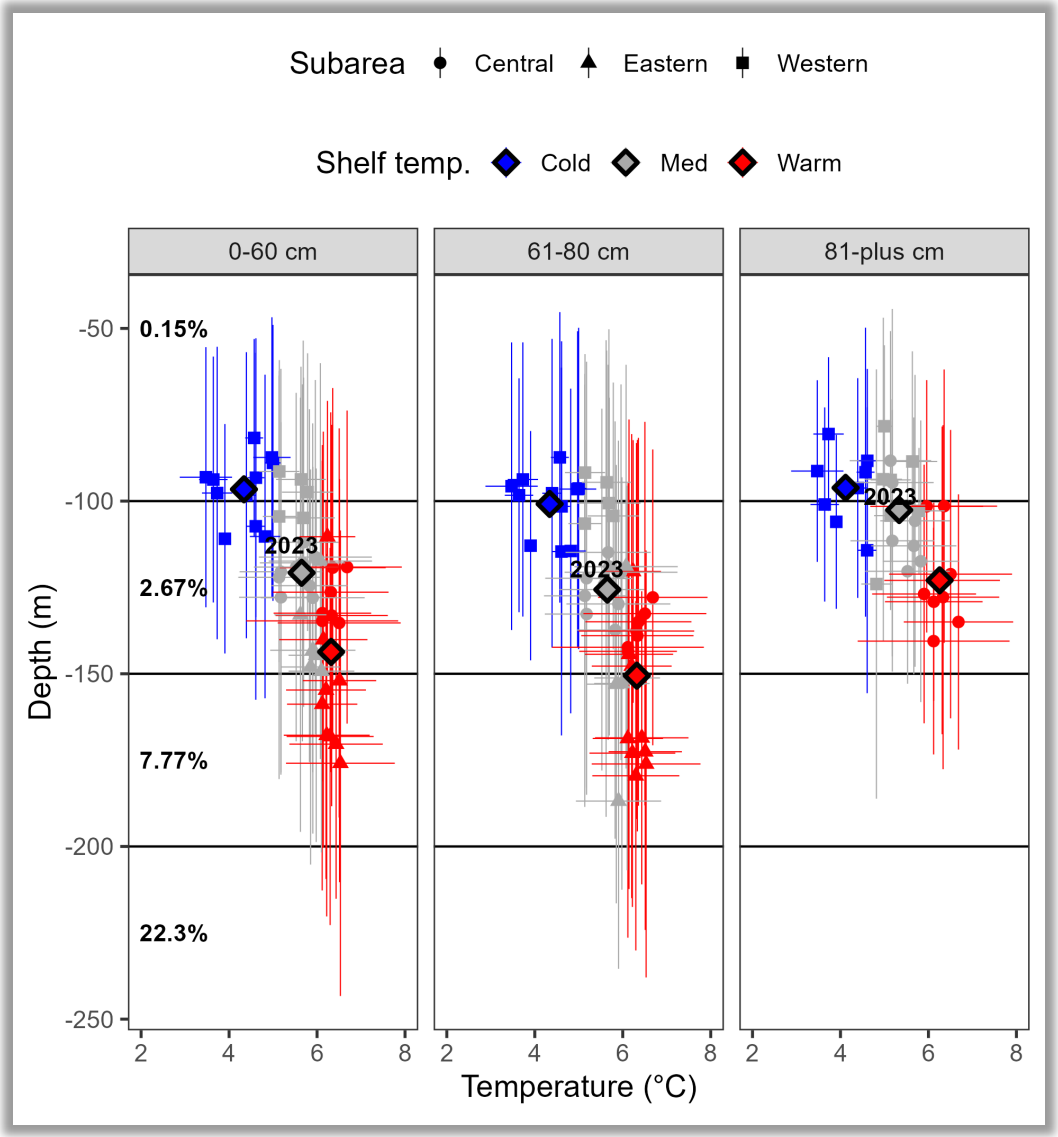
- CFSR bottom temperature below mean in 2023, slightly above in 2024

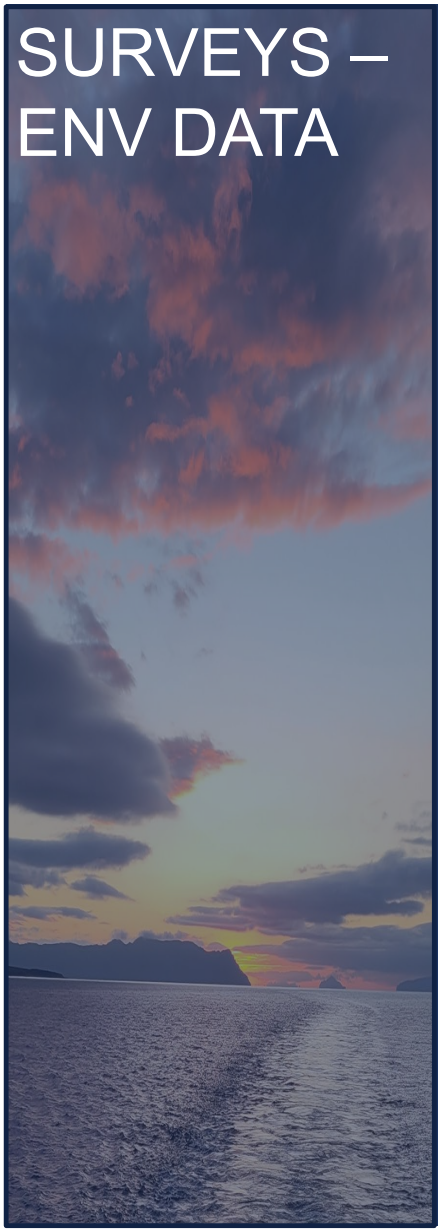




SURVEYS – ENV DATA

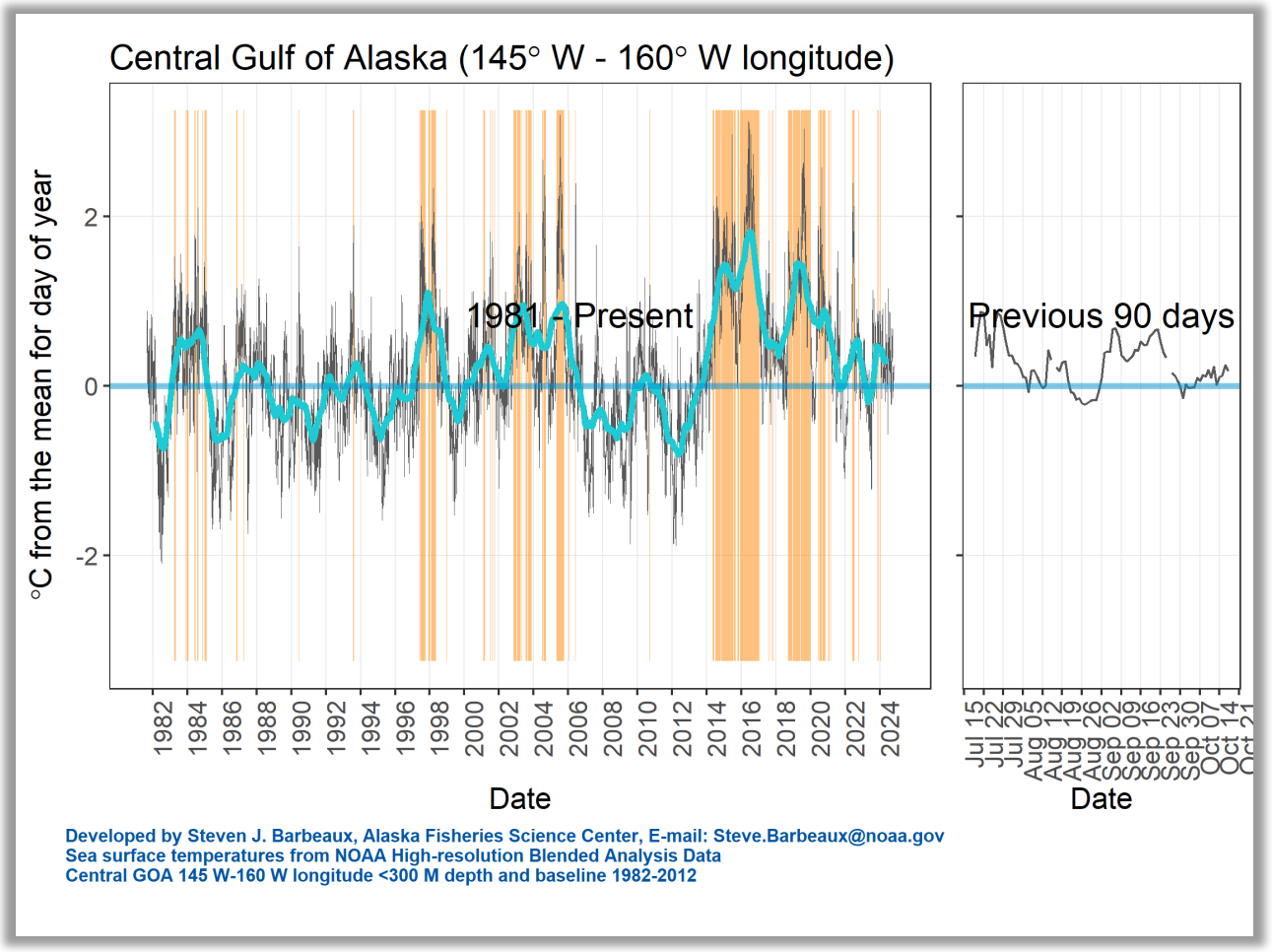
- Cod depth distribution related to temperature, variable overlap with AFSC longline survey distribution

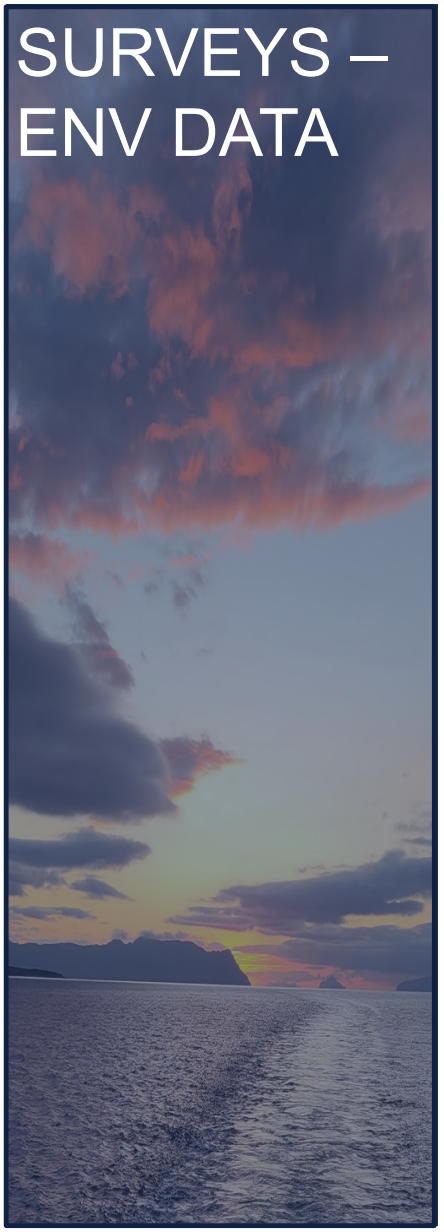




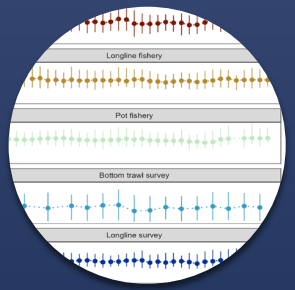
SURVEYS – ENV DATA

- Above avg sea surface temperature, but not like seen before



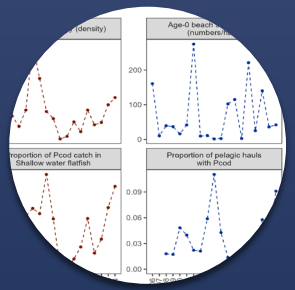


DATA – SUMMARY



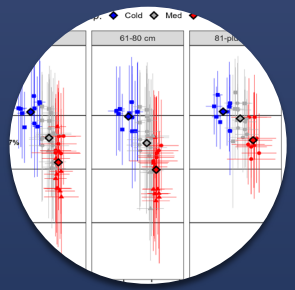
Length comp trends:

- No red flags, recent lengths consistent



Index trends:

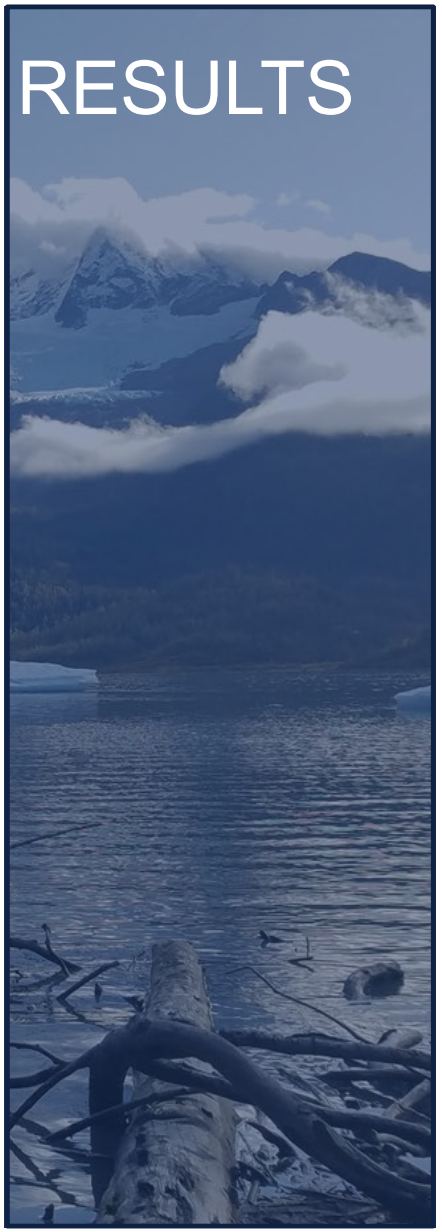
- Available auxiliary sources increased in 2024



Environmental trends:

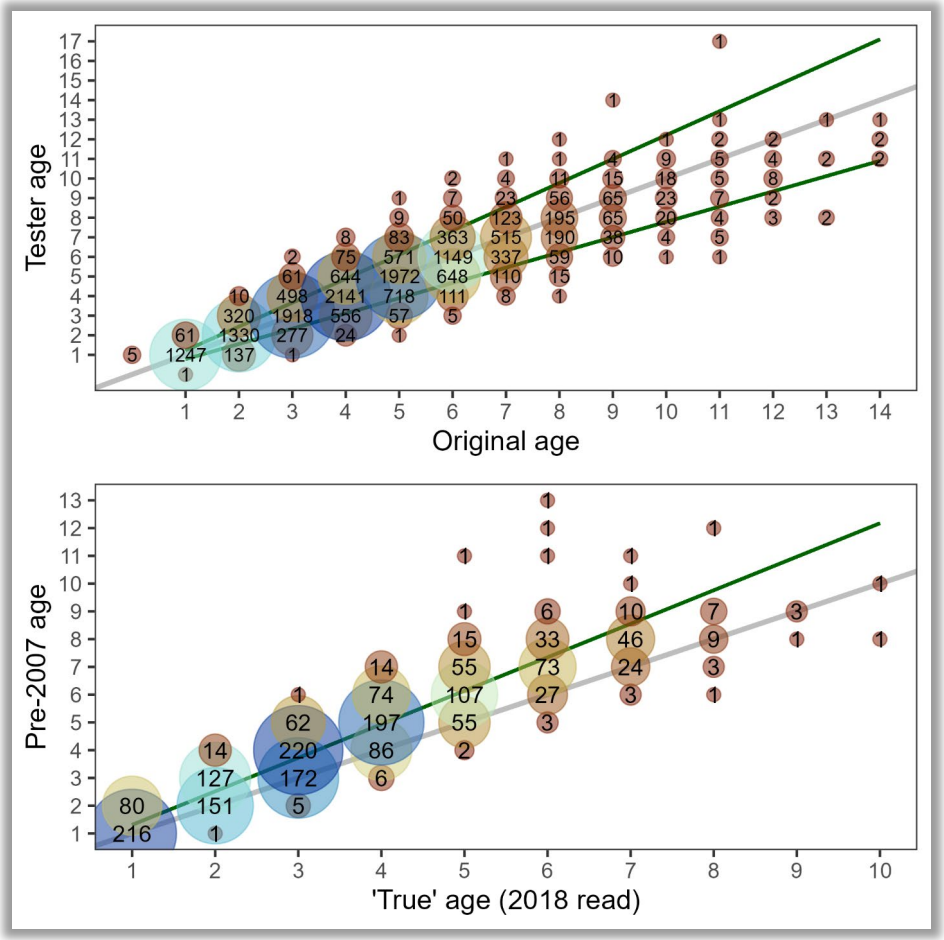
- 2024 average year, no red flags

RESULTS



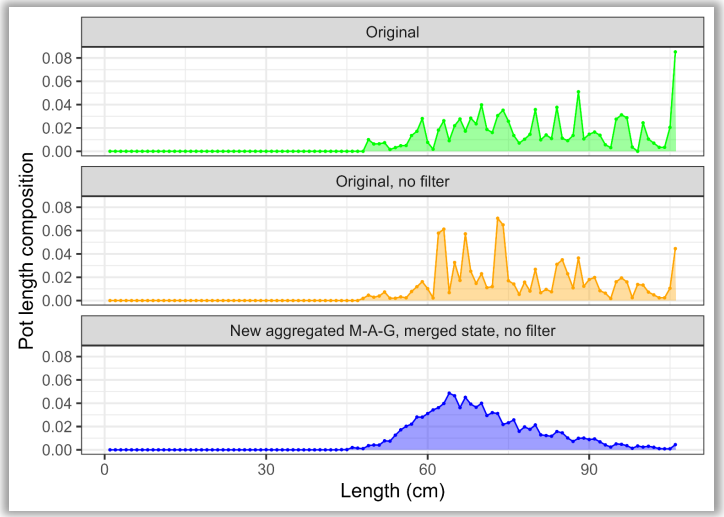
- Alternative model comparison
- Data fits
- Model diagnostics
- Parameter/Time series results
- Recommendations

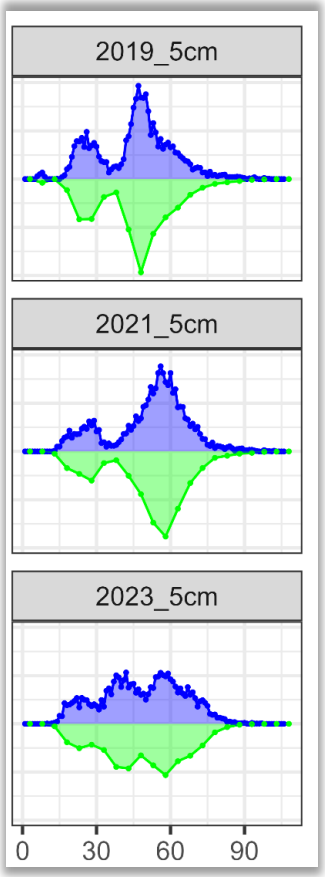
- 19.1c: input file corrections (Appendix 2.2)
- 19.1d: update ageing error & bias (AgeingError)
  - Combined EBS & GOA
  - Linear (AIC pref): start at age-1
  - Bias fixed rather than estimated



RESULTS: ALT. MODELS

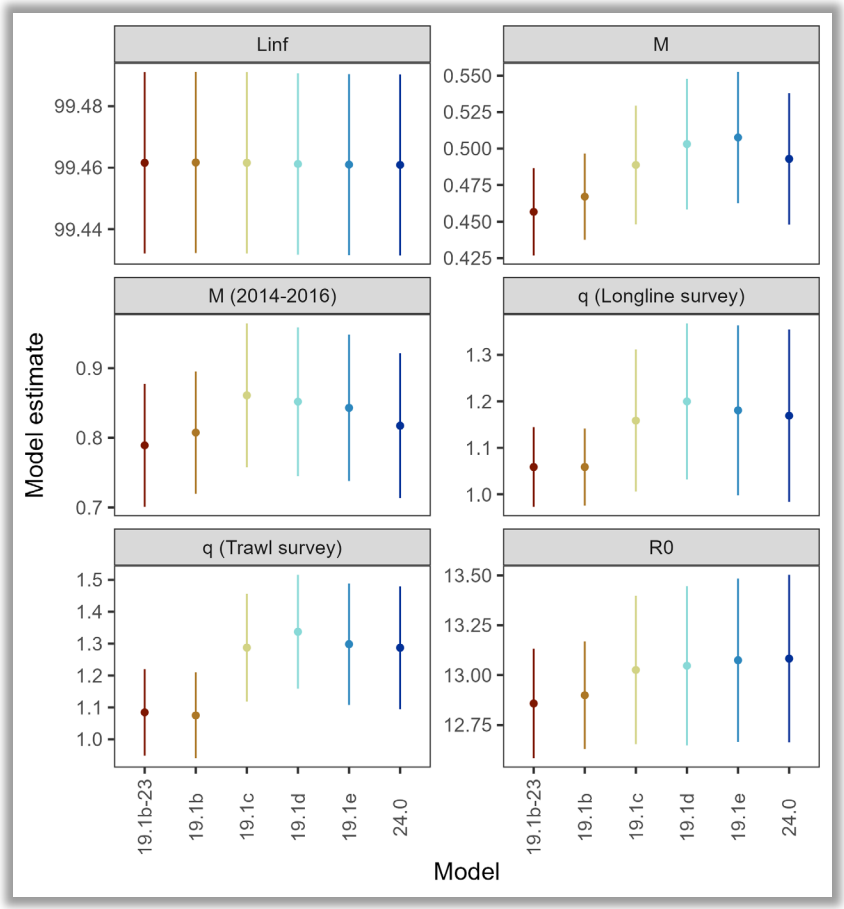
- 19.1d: new method to compute fishery length comps:
  - Weekly → Monthly
  - Use all ADF&G data
  - Remove filters
- 24.0: 1 → 5 cm bins





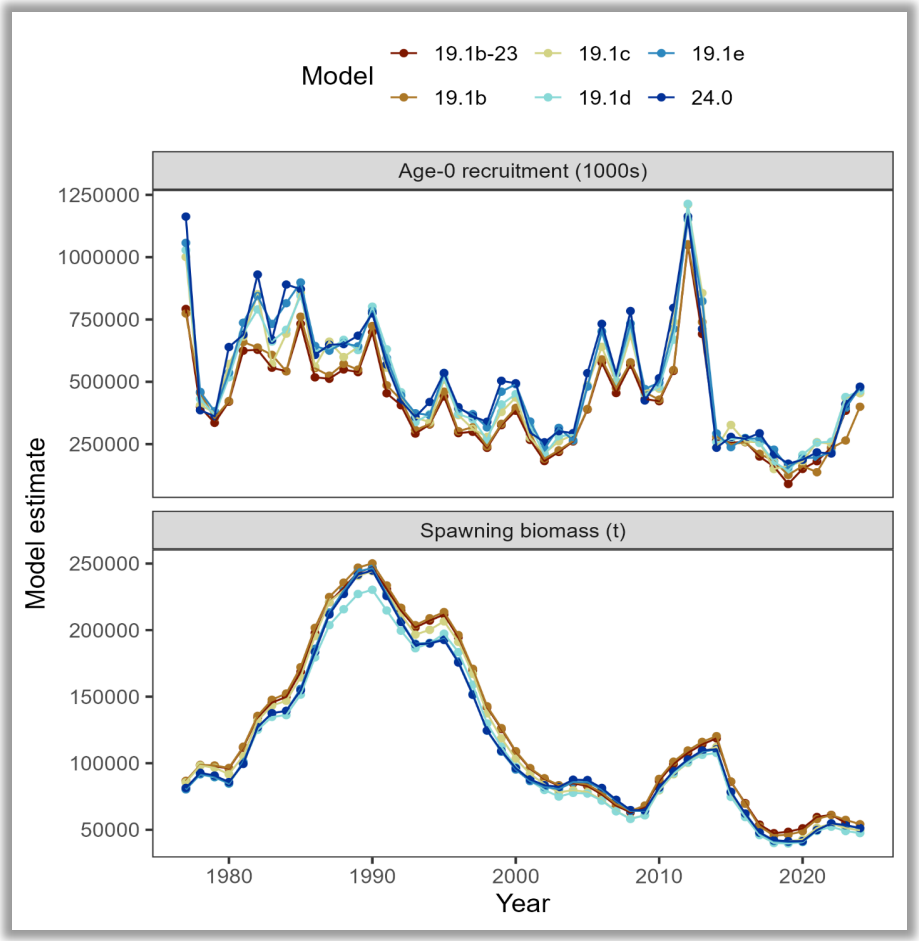
RESULTS: ALT. MODELS

- Largest shift in parameter estimates occurred in the 19.1c transition



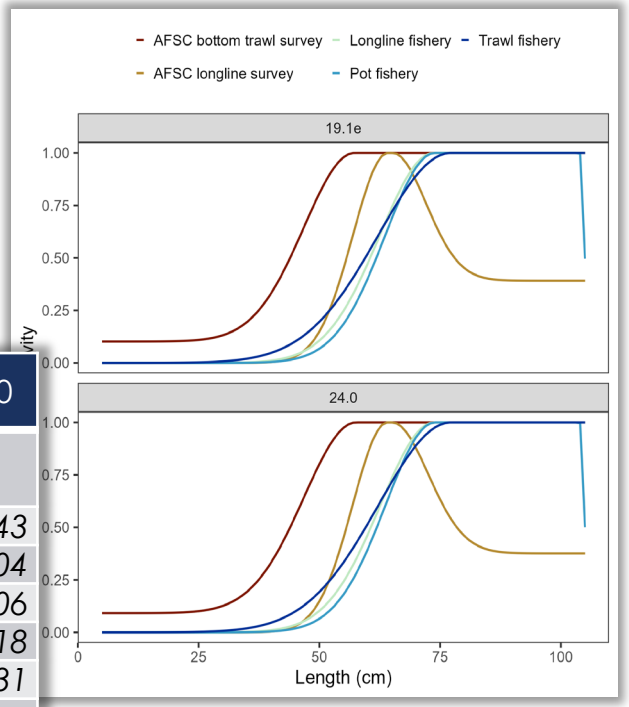
RESULTS: ALT. MODELS

- In general, consistent estimates of recruitment & spawning biomass



RESULTS: ALT. MODELS

- No discernable difference in, for example, selectivity when shifting from 1 → 5 cm bins
- But, improvement in ISS/ESS

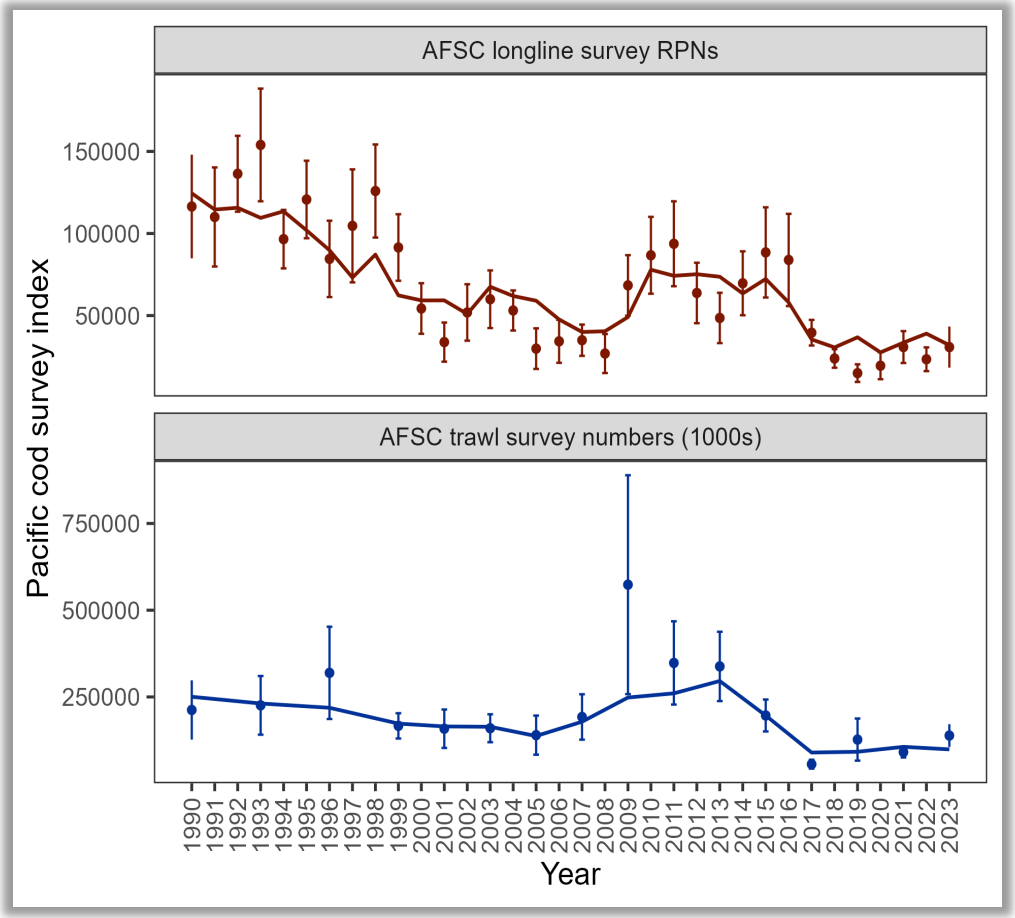


Component	19.1b -23	19.1b	19.1c	19.1d	19.1e	24.0
Length composition mean ISS/ESS	**0.35**	**0.35**	**0.33**	**0.33**	**0.33**	**1.41**
Trawl fishery	*0.35*	*0.37*	*0.33*	*0.33*	*0.33*	*1.43*
Longline fishery	*0.26*	*0.26*	*0.25*	*0.25*	*0.26*	*1.04*
Pot fishery	*0.5*	*0.48*	*0.46*	*0.47*	*0.45*	*2.06*
Bottom trawl survey	*0.32*	*0.31*	*0.31*	*0.3*	*0.31*	*1.18*
Longline survey	*0.35*	*0.35*	*0.32*	*0.32*	*0.33*	*1.31*
Conditional age-at-length mean ISS/ESS	**0.35**	**0.37**	**0.29**	**0.32**	**0.32**	**0.83**
Trawl fishery	*0.42*	*0.42*	*0.28*	*0.29*	*0.27*	*0.6*
Longline fishery	*0.4*	*0.41*	*0.27*	*0.27*	*0.28*	*0.66*
Pot fishery	*0.3*	*0.32*	*0.23*	*0.23*	*0.24*	*0.48*
Bottom trawl survey	*0.32*	*0.34*	*0.33*	*0.4*	*0.4*	*1.28*

RESULTS: ALT. MODELS

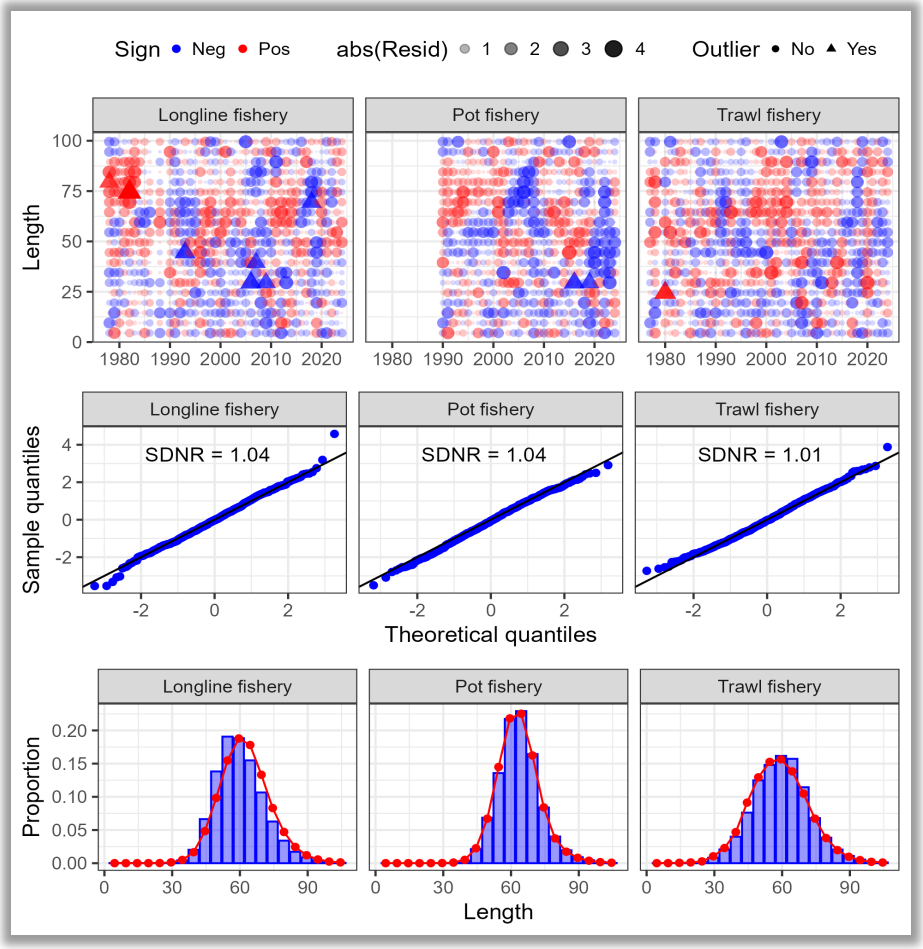
- 19.1c & 19.1d data/model updates
- 19.1e:
  - Provides simpler and more efficient method,
  - serves to smooth variability across lengths,
  - leverages previously under-used source of information (that is included in total catch).
- 24.0:
  - Doesn’t mask any signal in data.
  - seems to improve statistical attributes of model,
  - improves model efficiency (reduces run time >50%)

- Pattern of expecting larger RPN from longline survey in 5 of last 6 years, but, model hits 2023
- Trawl survey fit between lows in 2017 & 2021 and larger in 2019 & 2023 – model expects less abundance than observed in 2023
- Consistent with 2023 assessment



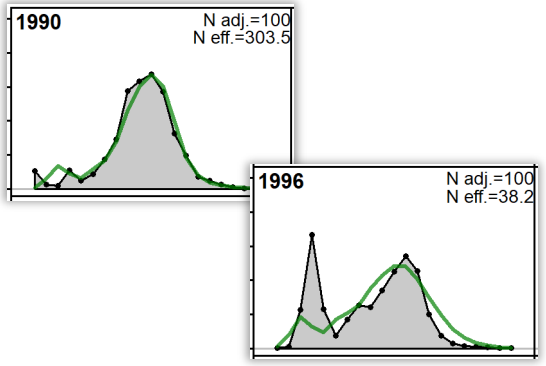
RESULTS: DATA FITS

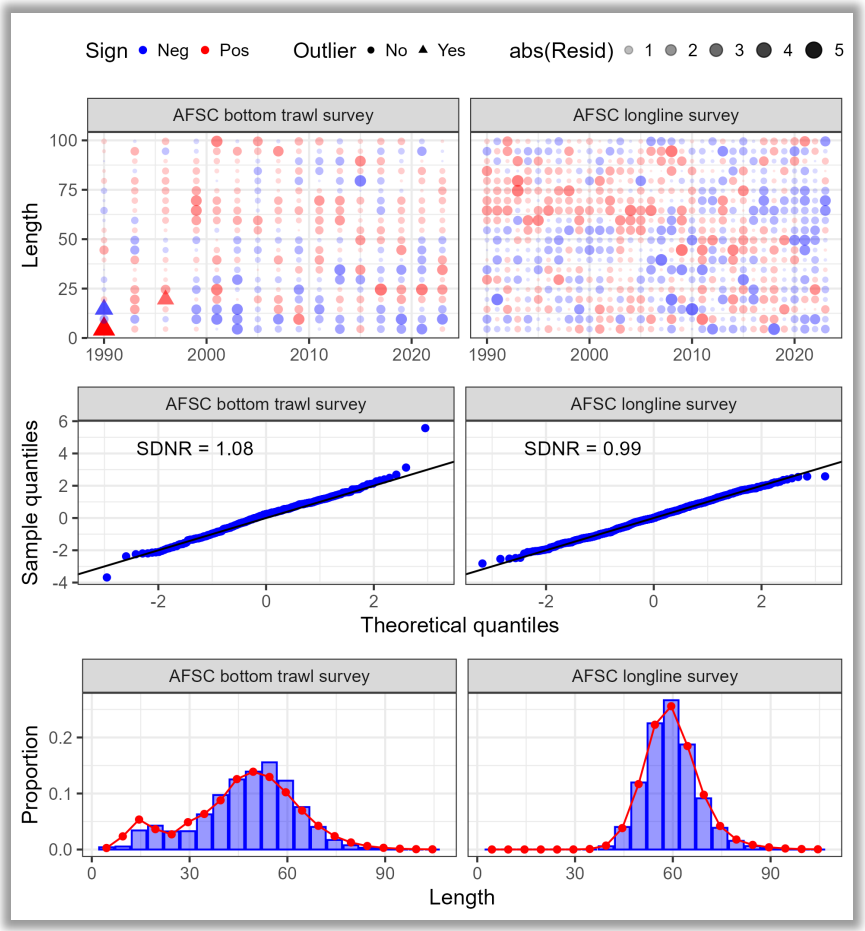
- No glaring sign of model misspecification in fit to fishery length composition



RESULTS: DATA FITS

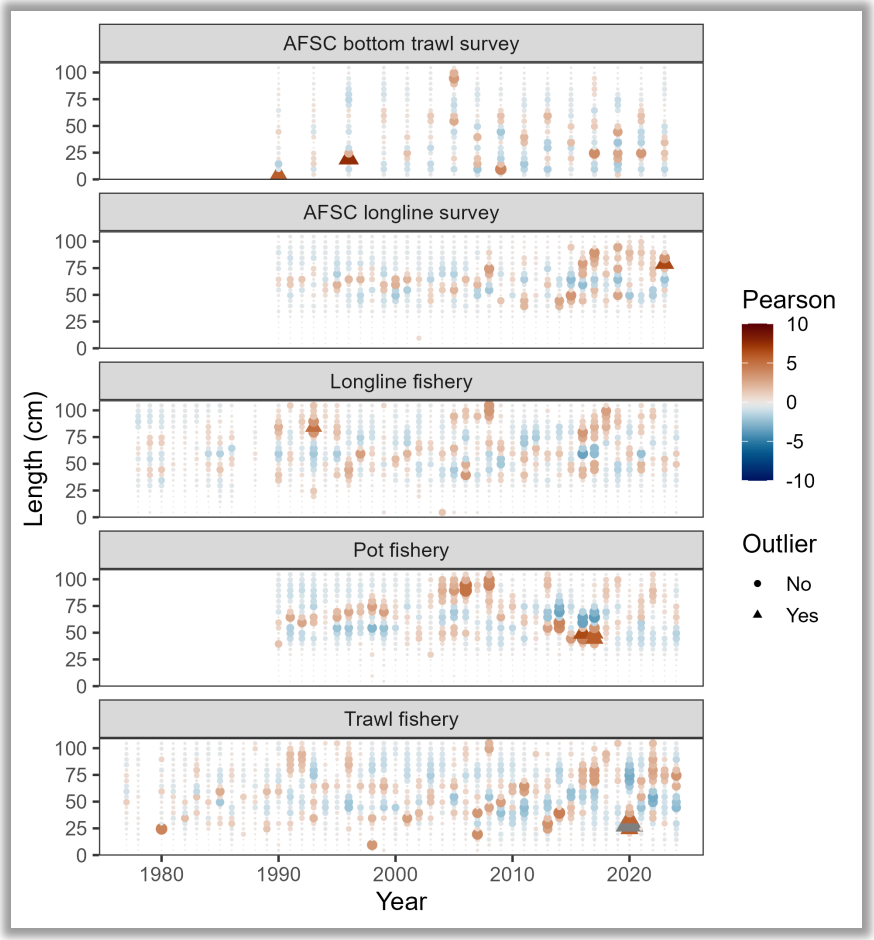
- No glaring sign of model misspecification in fit to survey length composition
- But, some large residuals at smaller lengths in early trawl survey years and later longline survey years





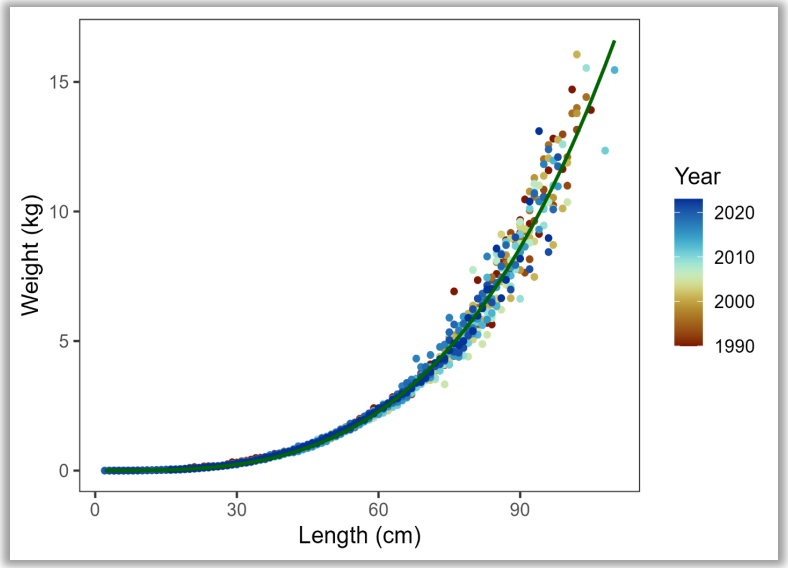
RESULTS: DATA FITS

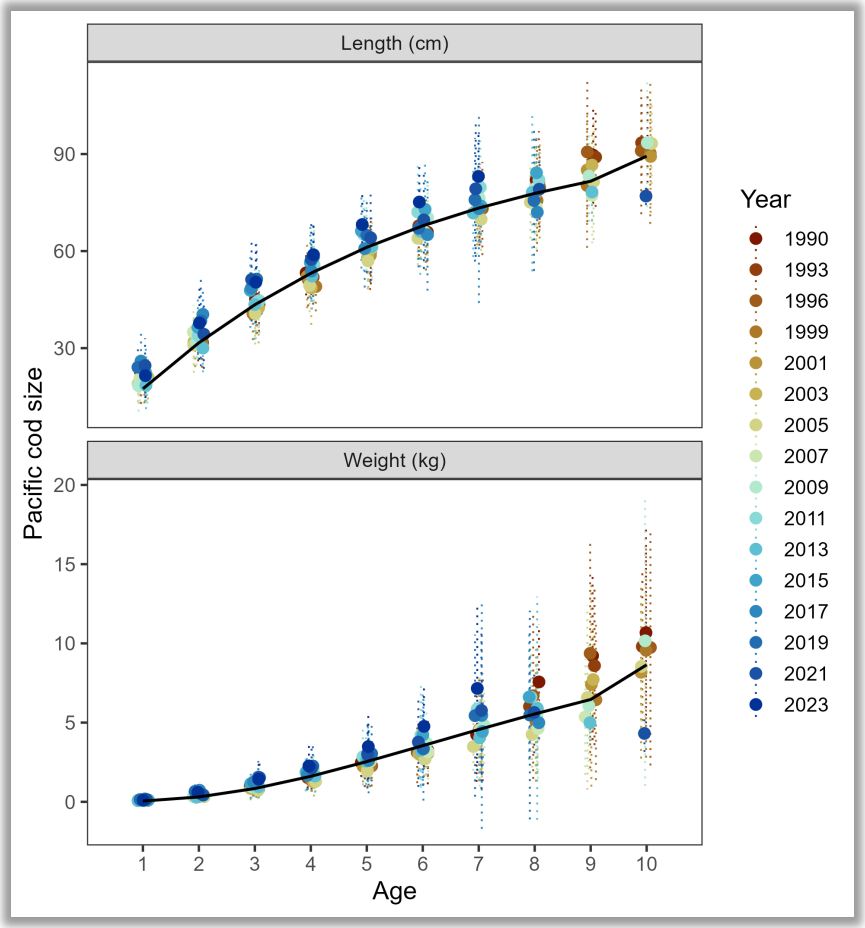
- Some large Pearson residuals reflected in OSA, some not



RESULTS: DATA FITS

- Model estimates growth reasonably well, but…
- Use beach seine length-weight data this year

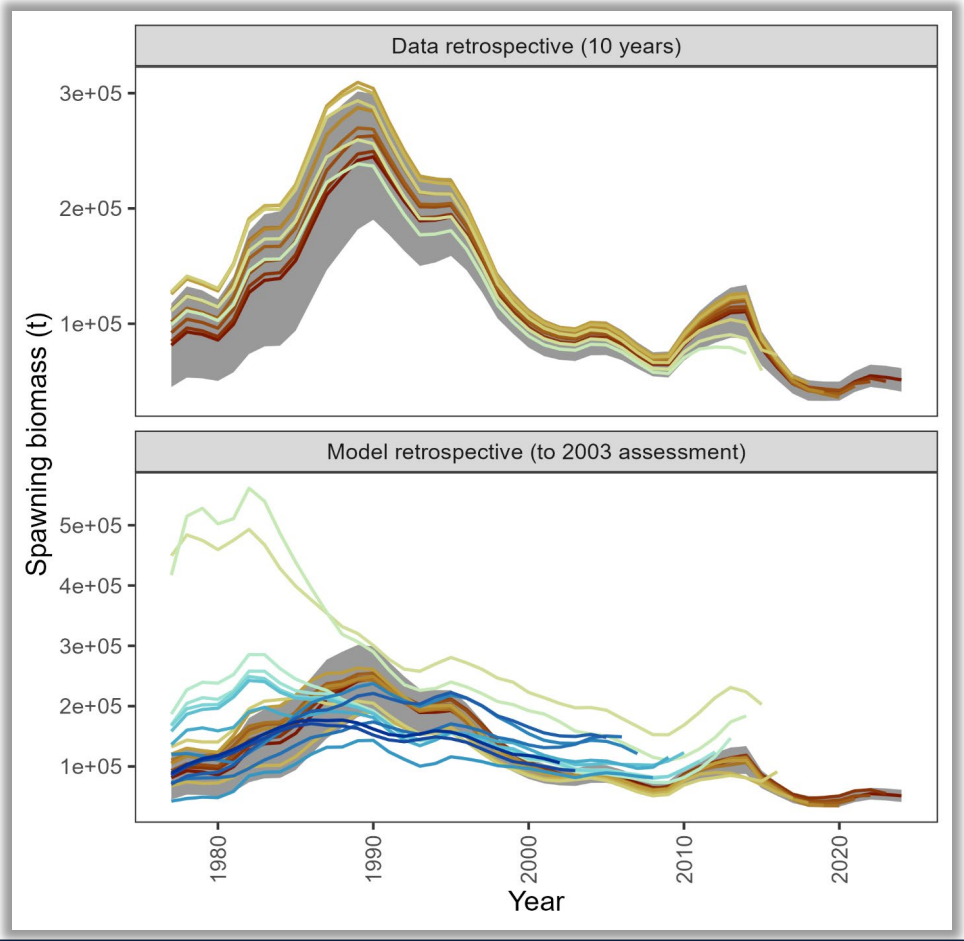




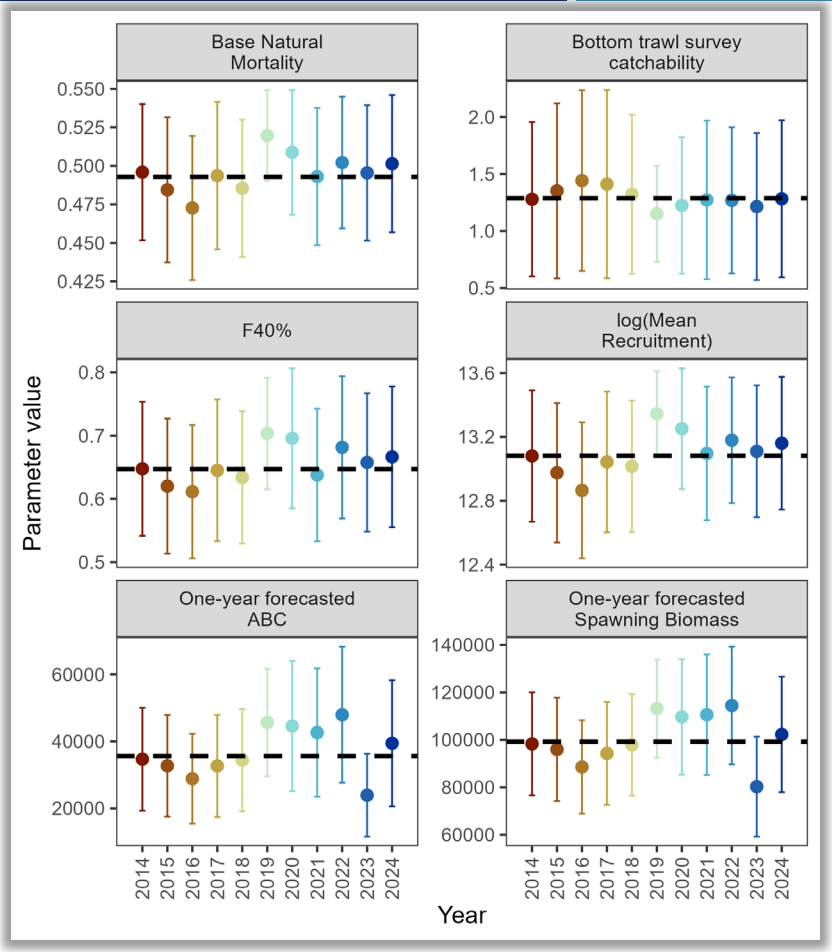
RESULTS: DATA FITS

- Presented model diagnostics:
  - Retrospective: data and model
  - Leave-one-out: leave a year of data out
  - Add-one-in: add one new source of data at a time
  - Profile for key parameters
- Other diagnostics:
  - Model convergence: final gradient was $6.57e^{-6}$, -no_hess ran with message "The fact this was successful gives strong evidence of convergence to a mode with quadratic log-likelihood surface."
  - Jitter analysis: 50 at 5% CV, 44 converged, 78% to MLE
- See in document:
  - MCMC: key parameter histograms, mixing, correlation
  - AFSC longline survey catchability sensitivity

- Data retrospective small & negative
- Recent model retrospective consistent, but large retrospective pattern across models prior to 2015 assessment



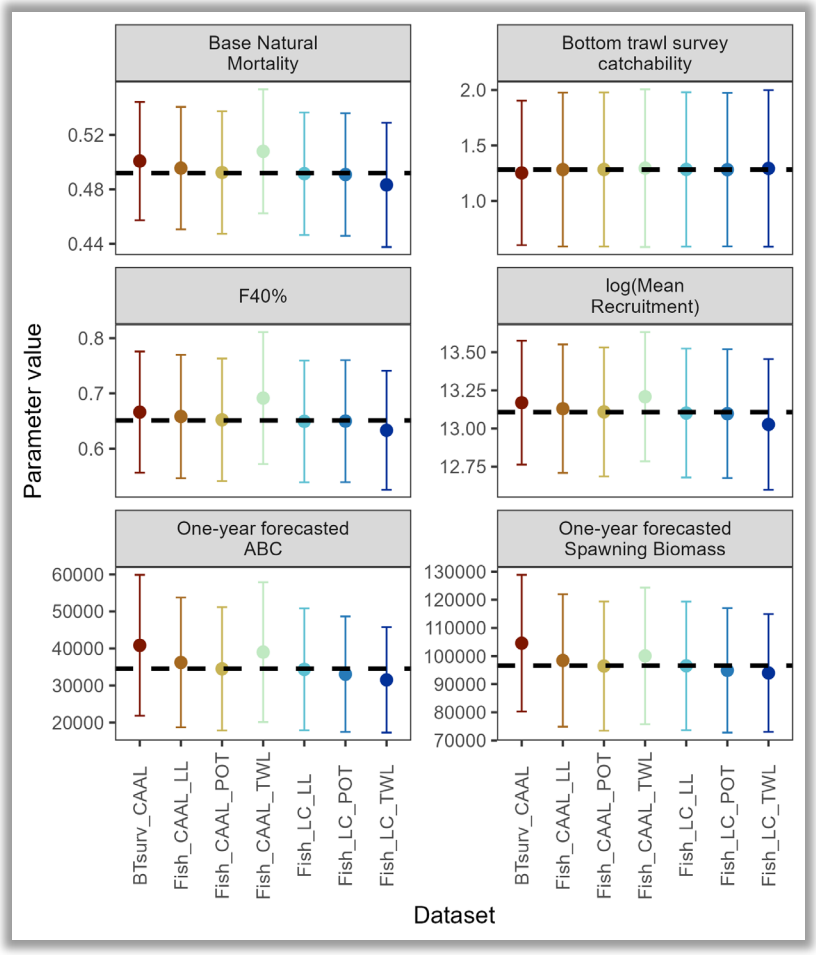
RESULTS: DIAGNOSTICS



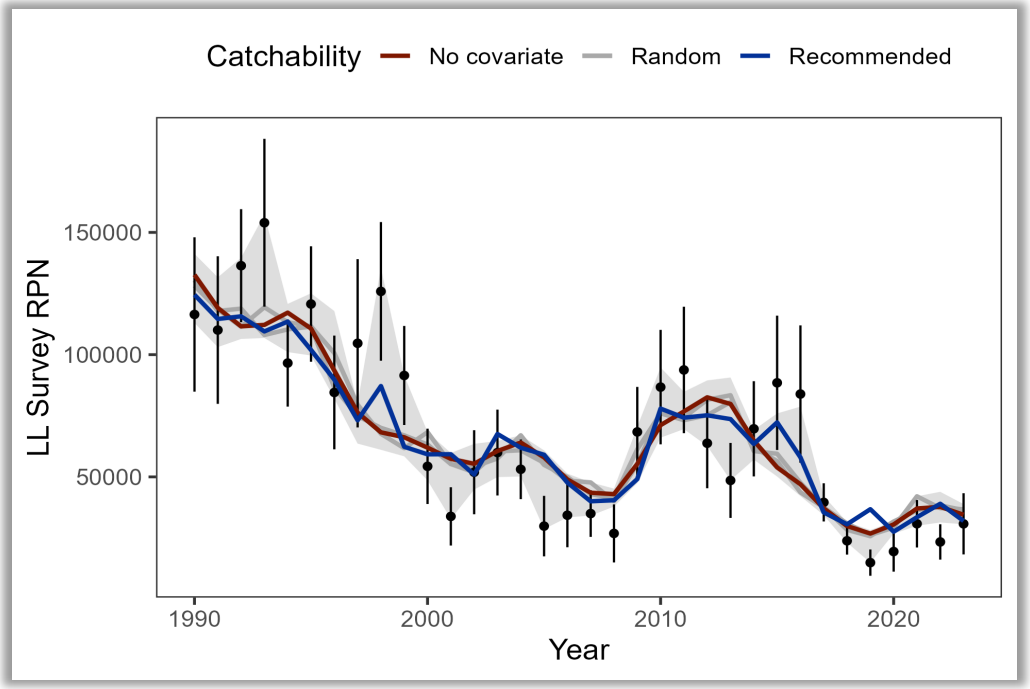
- Leave-one-out: 2023 remains an influential year

RESULTS: DIAGNOSTICS

- Add-one-in: 2023 AFSC bottom trawl survey and trawl fishery CAAL data influential on ABC, 2024 trawl fishery length comp to some extent

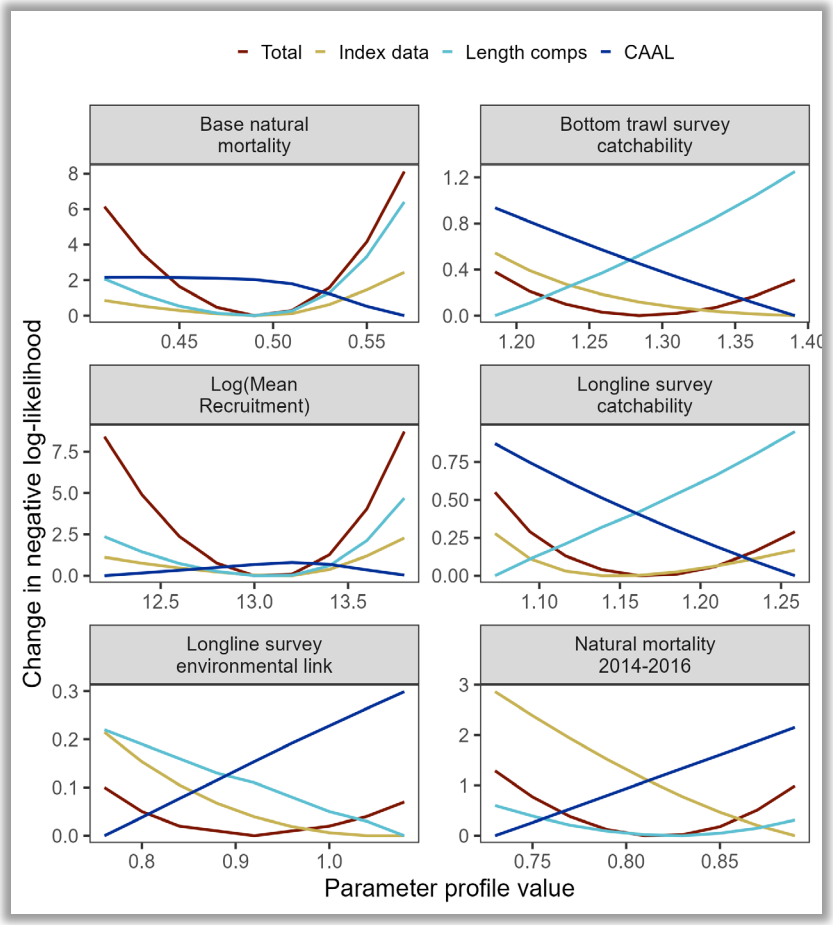


RESULTS: DIAGNOSTICS



- AFSC longline survey catchability sensitivity: Environmental link with CFSR remains preferred

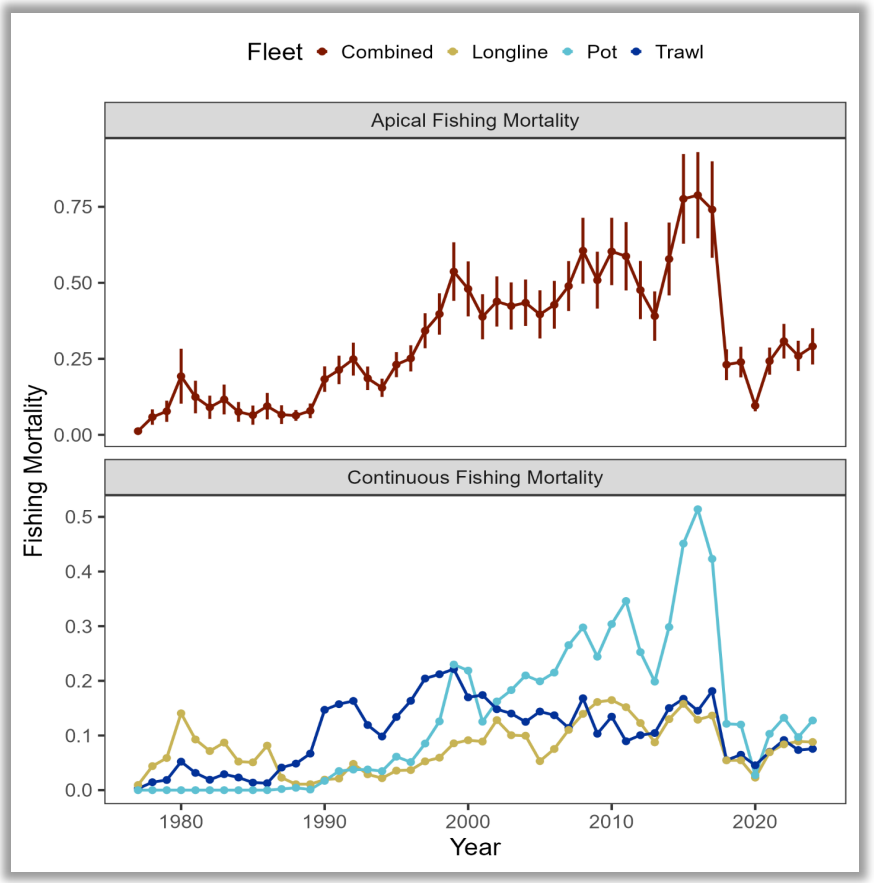
RESULTS: DIAGNOSTICS



- Parameter profiles:
- Catchability: conflict between length comps and CAAL
- Base M & $\ln R_0$: minima confirmed by both length comps and index data

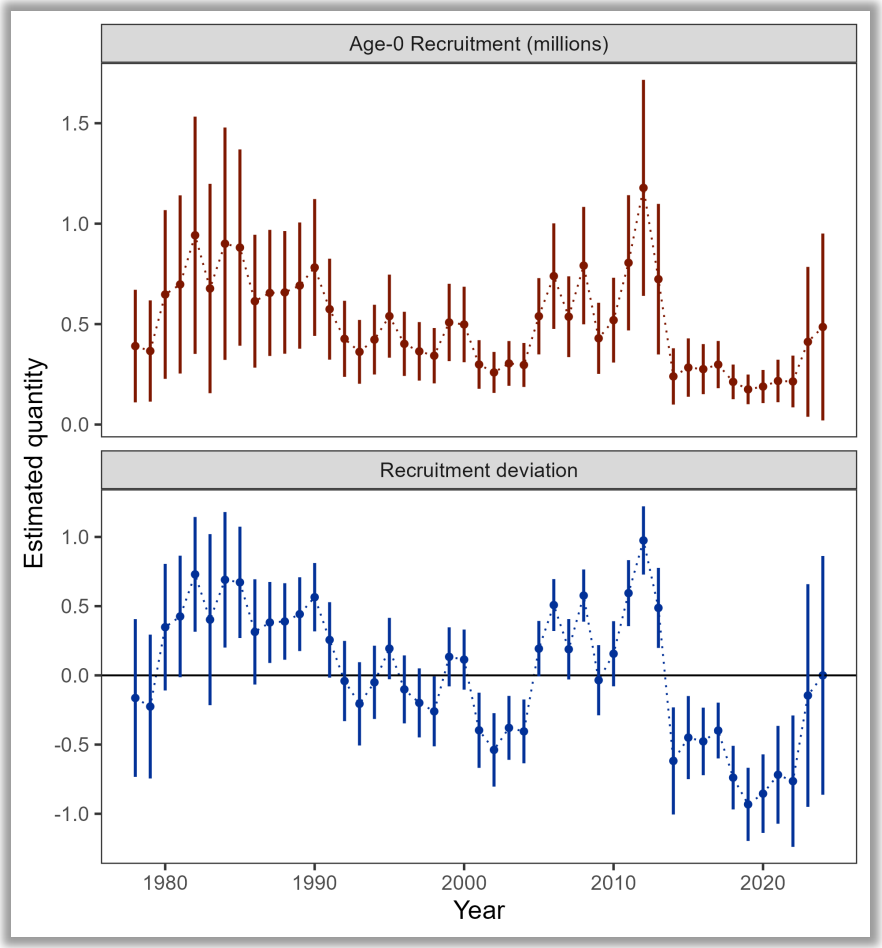
RESULTS: DIAGNOSTICS

- F staying consistent across last 4 years



RESULTS: PARAMETER ESTIMATES

- Below average recruitment since 2014 (following a stanza of above avg recruitment)

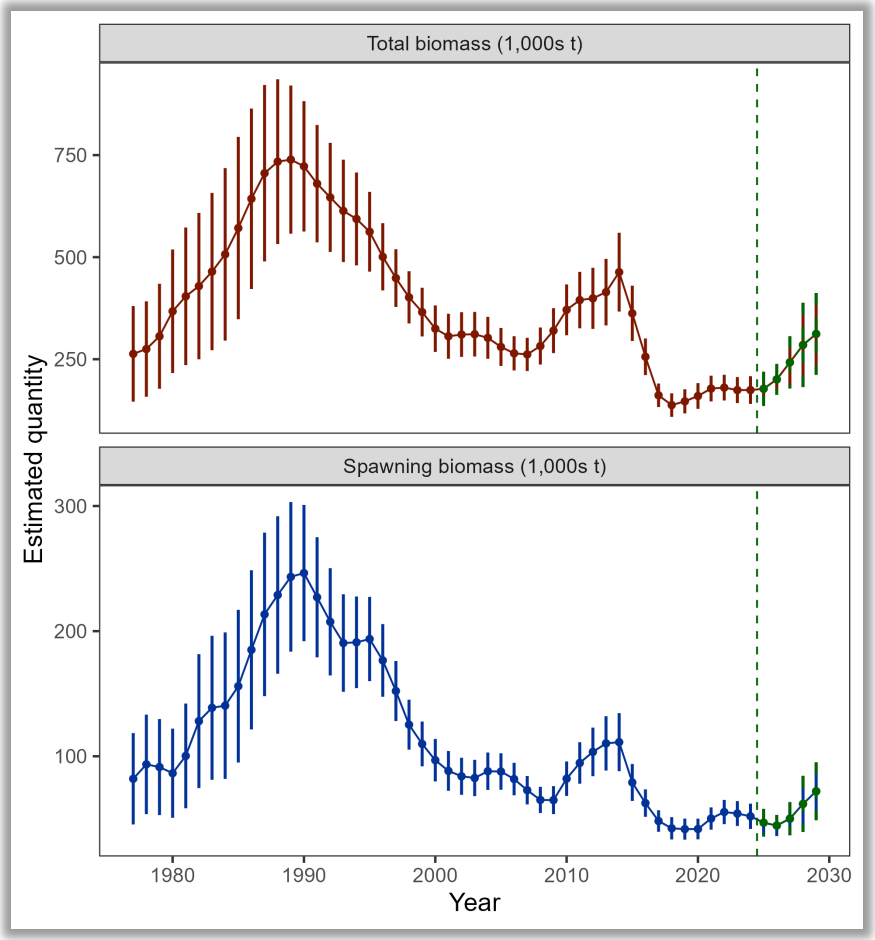


RESULTS: PARAMETER ESTIMATES

Name	Value	SD
Biology	--	--
Beginning of year length at age-1 (cm)	17.43	0.314
Beginning of year length at age-10 (cm)	99.46	0.015
Growth rate	0.19	0.002
SD in length-at-age for age-1	4.01	0.187
SD in length-at-age for age-10	8.99	0.345
Natural mortality (2014-2016)	0.82	0.053
Natural mortality (all years)	0.49	0.023
Recruitment/Abundance	--	--
log(mean recruitment)	13.09	0.213
1976 Regime adjustment	-0.68	0.19
Survey catchability	--	--
Bottom trawl survey	1.28	0.125
Longline survey	1.16	0.108
Longline survey environmental coefficient	0.94	0.411

RESULTS: PARAMETER ESTIMATES

- Biomass projected to increase, but, based on realization of average recruitment

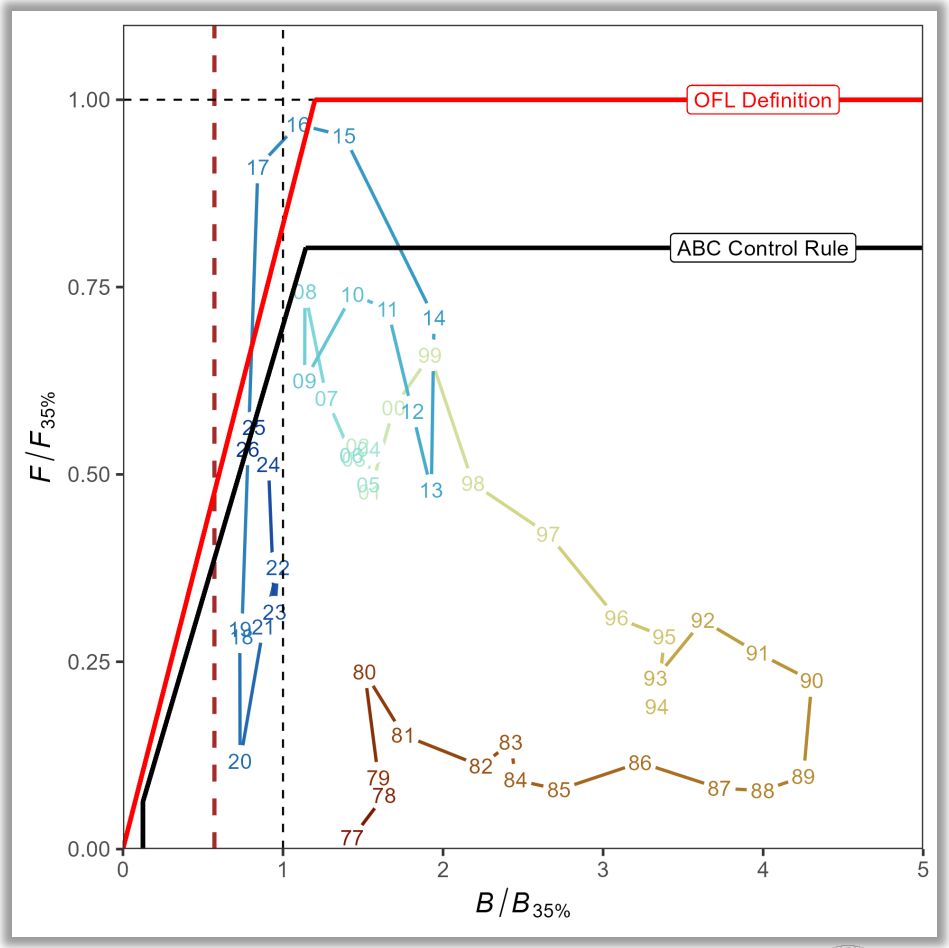


RESULTS: TIME SERIES

- Stock status
- Risk table
- ABC/OFL recommendations
- Apportionment

STOCK STATUS

- Tier 3b: on the ramp
- Estimated to be above $B_{20\%}$ (dashed red line), 2025 = $B_{28.7\%}$



RISK TABLE

- **Assessment considerations:** Level 1
- **Pop dy considerations:** Level 2 – will remain while population at low levels with added uncertainty as to how processes will respond to future environmental conditions (i.e., recruitment)
- **Environmental/ecosystem considerations:** Level 1
- **Fishery performance:** Level 1

ABC/OFL RECOMMENDATIONS

- Recommend Model 24.0: <1% different than 2024 ABC

Quantity	As estimated or *specified last* year for: 2024	2025	As estimated or *specified this* year for: 2025	2026
M (natural mortality rate)	0.46*	0.46*	0.49*	0.49*
Tier	3b	3b	3b	3b
Projected total (age 0+) biomass (t)	184,242	202,618	177,497	200,521
Female spawning biomass (t)				
Projected	51,959	47,698	46,920	44,674
$B_{100\%}$	175,187	175,187	163,585	163,585
$B_{40\%}$	70,075	70,075	65,434	65,434
$B_{35\%}$	61,315	61,315	57,255	57,255
F_{OFL}	0.52	0.48	0.57	0.51
$maxF_{ABC}$	0.42	0.38	0.46	0.43
F_{ABC}	0.42	0.38	0.46	0.43
OFL (t)	38,712	33,970	**38,688**	33,099
maxABC (t)	32,272	28,184	32,141	30,193
ABC (t)	32,272	28,184	**32,141**	30,193
Status	As determined *last* year for: 2022	2023	As determined *this* year for: 2023	2024
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

**Base natural mortality M varies between 0.49 and 0.82*
*** Assumed 2024 catch to be the 2024 ABC. For 2026 projections the 2025 catch was assumed to be at the projected ABC.*

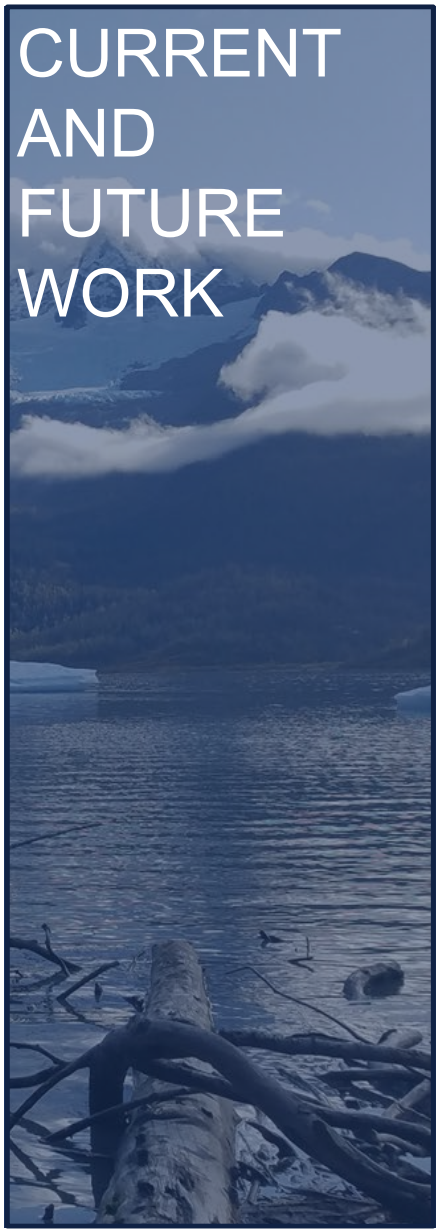
APPORTIONMENT

	Western	Central	Eastern	Total
Random effects area apportionment	27.1%	63.8%	9.1%	100%
2024 ABC	8,745	20,590	2,937	32,272
2025 ABC	7,638	17,981	2,565	28,184

- Same as 2023, but with updated ABC

	Western	Central	Eastern	Total
Area apportionment	27.10%	63.80%	9.10%	100%
2025 ABC	8,710	20,506	2,925	32,141
2026 ABC	8,182	19,263	2,748	30,193

CURRENT AND FUTURE WORK



- Assessment to do:
  1. Input sample size for comp data
     - Fishery & longline survey
  2. Processes needing investigation
     - Selex & growth
     - What comp/other data & structure used?
  3. Develop REMA with environmental link to scaling coefficient
  4. Start looking at R-TMB
  5. Port SAFE into RMD
- Important consideration:
  - Maturity information update

QUESTIONS?