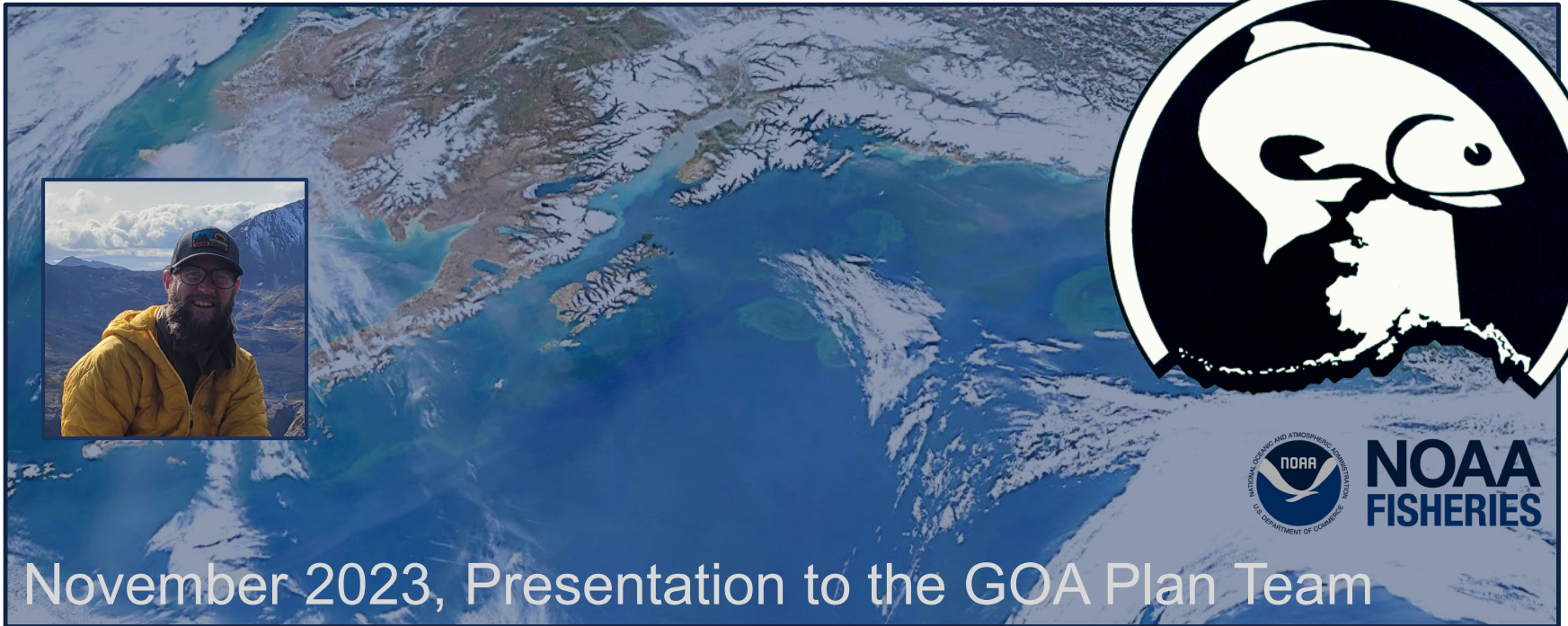


GOA PACIFIC COD

PETE HULSON, STEVE BARBEAUX, BRIDGET FERRISS, KATY ECHAVE, JULIE NIELSEN, S. KALEI SHOTWELL, BEN LAUREL, AND INGRID SPIES



November 2023, Presentation to the GOA Plan Team

STOCK & PRESENTATION OVERVIEW

- BLUF:
 - GOA Pacific cod: Tier 3b
 - 2024 projected spawning biomass to be at $B_{29.7\%}$
- Outline:
 - SSC/Plan Team comments
 - Changes from 2022 assessment
 - 2023 recommended model results



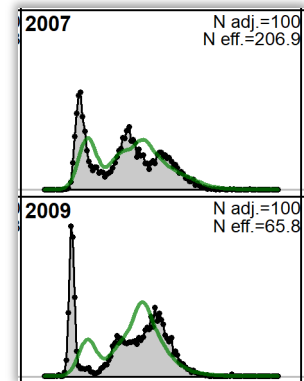
SSC/PLAN TEAM COMMENTS: GENERAL

- *“The SSC supports the JGPT’s recommendation that stock assessment authors transition from the ADMB RE variants to the rema framework, which implements the same model variants in a single framework with several improvements.”(SSC, Oct 2022)*
- *“The SSC reiterates its previous recommendation that the number of levels should be collapsed from four to three to make the choices easier for the authors.” (SSC, Dec 2022)*
- *“The SSC supports the JGPT recommendation to make reporting of fish condition routine and standardized across assessments.” (SSC, Dec 2022)*



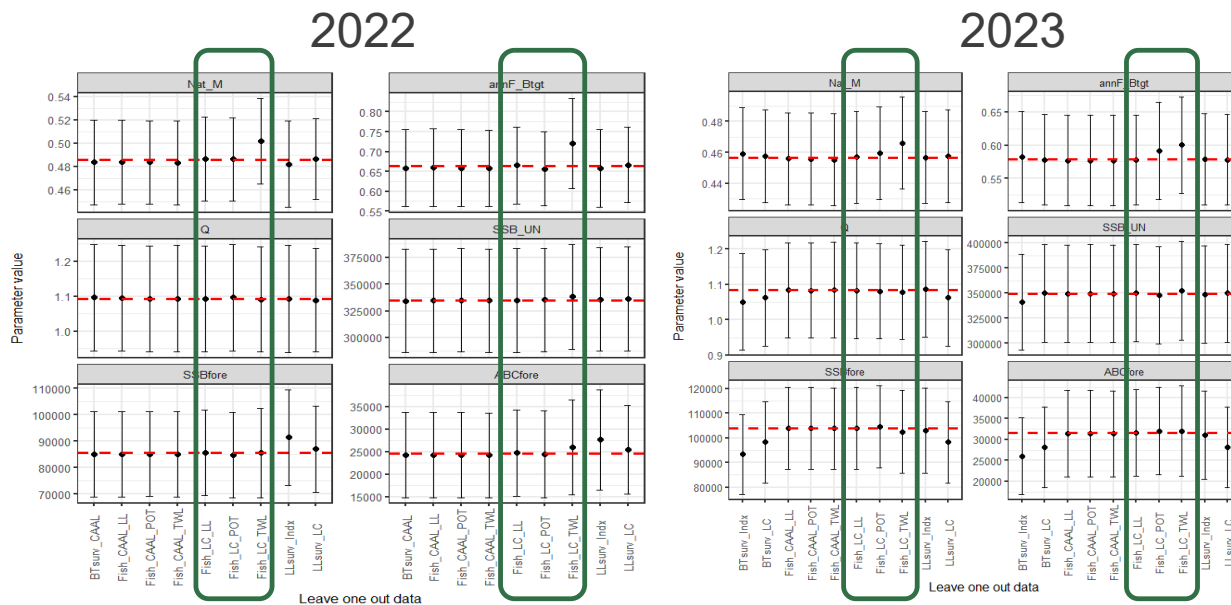
SSC/PLAN TEAM COMMENTS: SPECIFIC

- *Specific additional recommendations include:*
 - *Provide a discussion of whether the period of elevated M estimated in recent models, and other environmentally-driven dynamics should be included in the calculation of reference points and/or stock status (see General Stock Assessment Comments)*
 - *Provide an explanation as to whether all age-classes should be expected to be affected equally by marine heat waves, and over which time periods and by what mechanism they may be affected*
 - *Please elaborate on how the Dirichlet-multinomial method verified that the current weights are “correct”*
 - *Address implausibly large standardized residuals observed for smaller fish in the fit to NMFS bottom trawl length frequency data*
 - *Provide more details about the spatial-temporal correlation that informs the historical beach-seine index where no historical data exist*
 - *Include standard MCMC diagnostics for all model parameters and derived quantities if posterior distributions are to be evaluated as part of the model results. These should include tests for burn-in, auto-correlation and mixing of the MCMC chain(s).*
 - *Explore the potential for hook-competition in the IPHC index if it is to be incorporated (SSC, Dec 2021)*



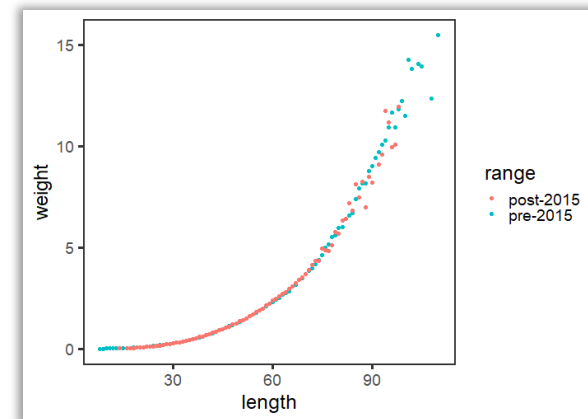
SSC/PLAN TEAM COMMENTS: SPECIFIC

- “The authors noted that incomplete fishery length compositions are used for the current year in the assessment. It appears that a fairly substantial amount of catch occurs after October, at least in 2022. The SSC requests that the authors evaluate the benefit of including these data by showing the complete versus incomplete length compositions for the past few years and a retrospective of the assessment including and excluding these data.”* (SSC, Dec 2022)



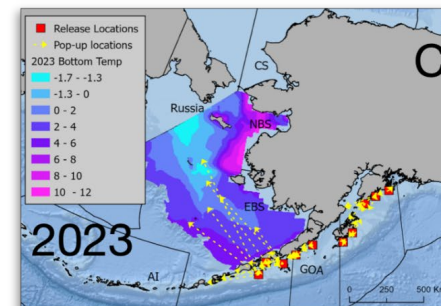
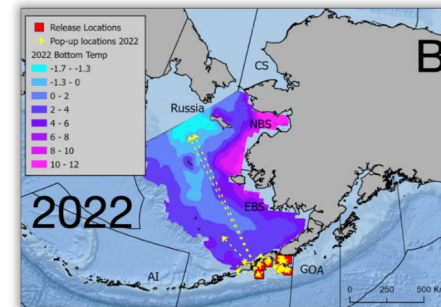
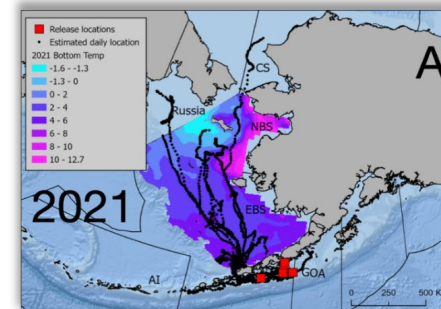
SSC/PLAN TEAM COMMENTS: SPECIFIC

- *“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)*



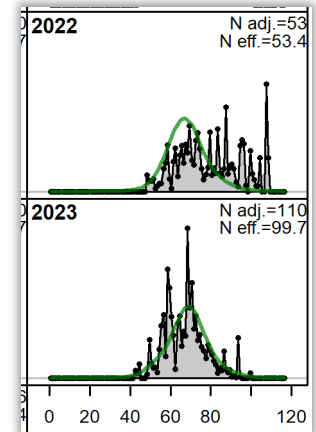
SSC/PLAN TEAM COMMENTS: SPECIFIC

- *“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

- *Specific additional recommendations include:*
 - *The SSC reiterates their 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.*
 - *Along with analyses addressing other previous recommendations, the SSC looks forward to an investigation of large residuals in the fit to pot fishery data and for smaller fish in the fit to bottom trawl survey data.*
 - *The SSC suggests including information on changes in fishing practices that may explain the increase in the mean length of cod caught in pot fisheries (Figure 2.14).*
 - *The SSC requests the authors provide the mean catchability used in the calculation of the temperature-adjusted and time-varying q (SSC, Dec 2022)*



SSC/PLAN TEAM COMMENTS: SPECIFIC

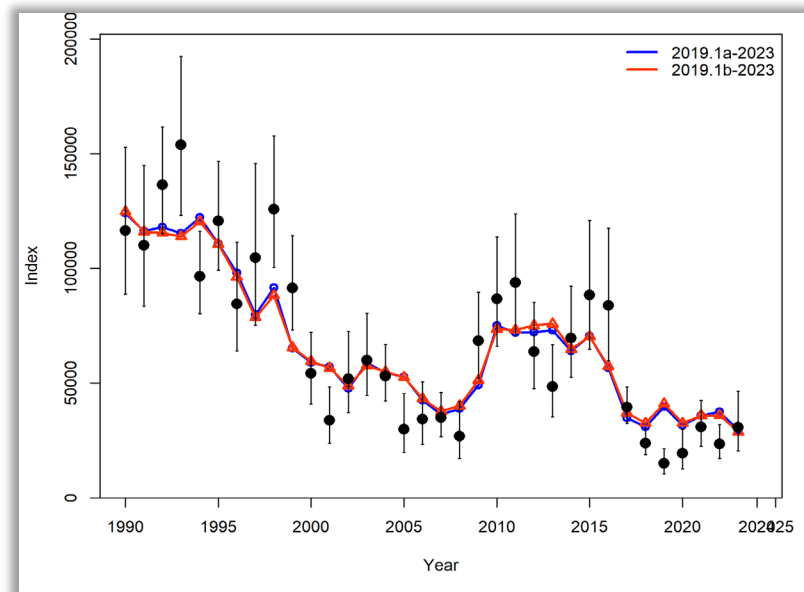
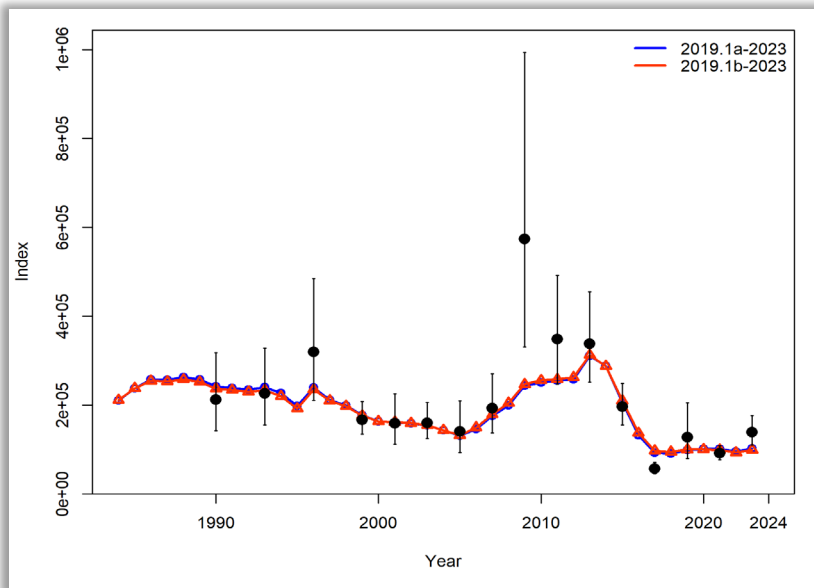
- *The Team recommended adding confidence intervals on the mean lengths by depth strata. Additionally, the Team recommended that the authors compare total fishing effort or catch (in addition to total sample size) to be sure that the observer coverage is capturing effort appropriately. (Plan Team, Nov 2022)*
- *“The Team recommended examining the updated MCMC tools (e.g., adnuts) and diagnostics.” (Plan Team, Nov 2022)*
- *“Relative to the time-varying longline survey catchability being linked to an environmental covariate, the Team recommended that it be re-examined against a fixed value for comparison.” (Plan Team, Nov 2022)*

CHANGES FROM 2022 ASSESSMENT

- Weighting of conditional age-at-length
- Changed minimum sample size from 1 (19.1a) to 0.001 (19.1b)

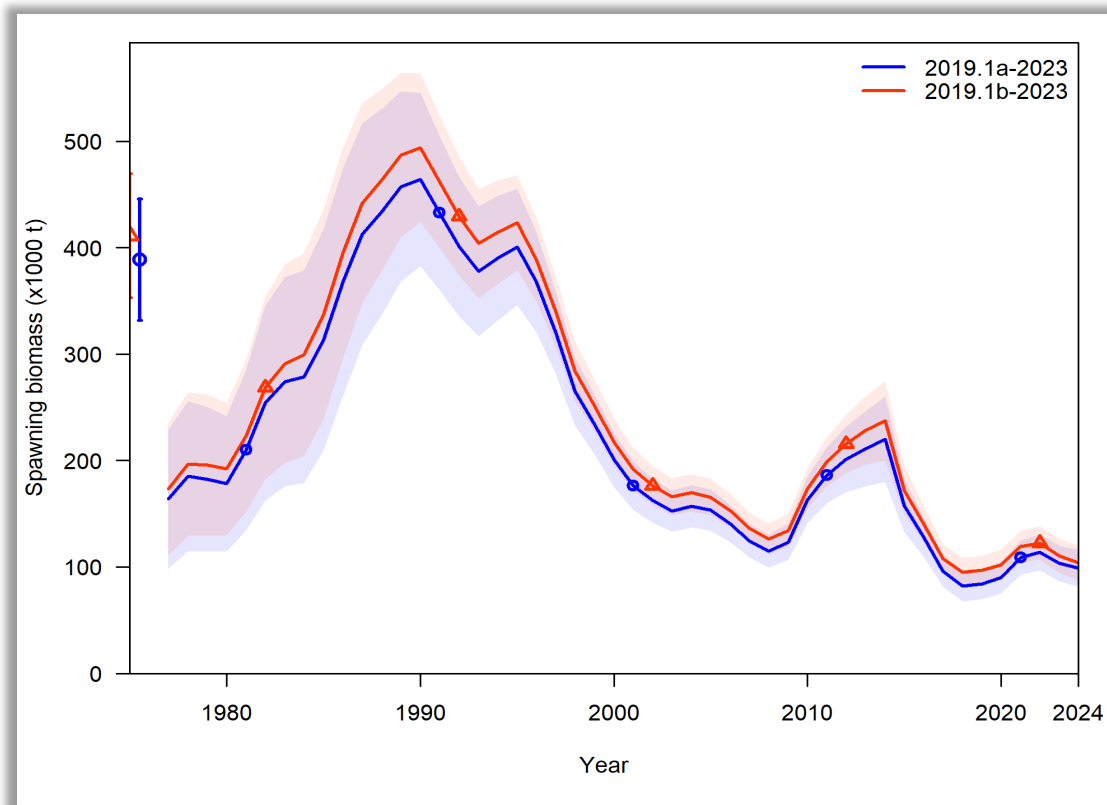
Likelihood component	Model 19.1a	Model 19.1b
TOTAL_like	4084.3	2931.0
Survey_like	-7.9	-3.3
Length_comp_like	1821.9	1817.9
Age_comp_like	2256.2	1102.0
Recruitment	-0.5	-0.5
InitEQ_Regime	3.1	3.1
Forecast_Recruitment	3.9	4.3
Parm_priors_like	1.2	1.0

CHANGES FROM 2022 ASSESSMENT

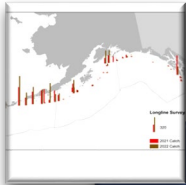


CHANGES FROM 2022 ASSESSMENT

- Recommend Model 19.1b to use for 2023 assessment

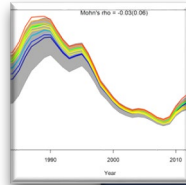


ASSESSMENT EVALUATION OUTLINE



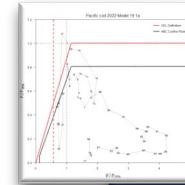
Data

- Fishery
- Surveys
- Other



Results

- Model fits
- Params
- Derived quantities

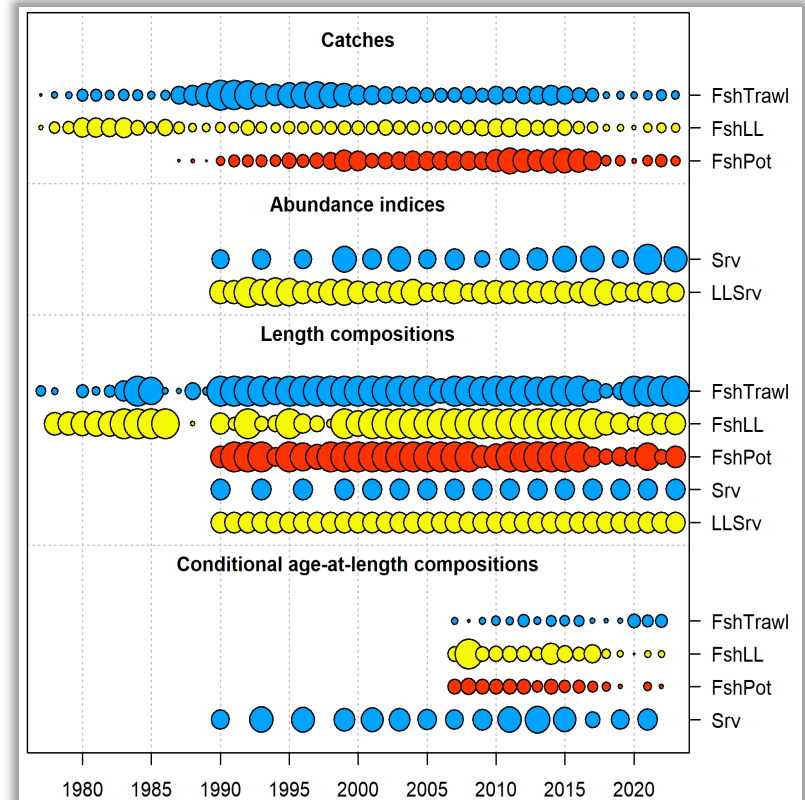


Recommendations

- Risk table
- ABC/OFL

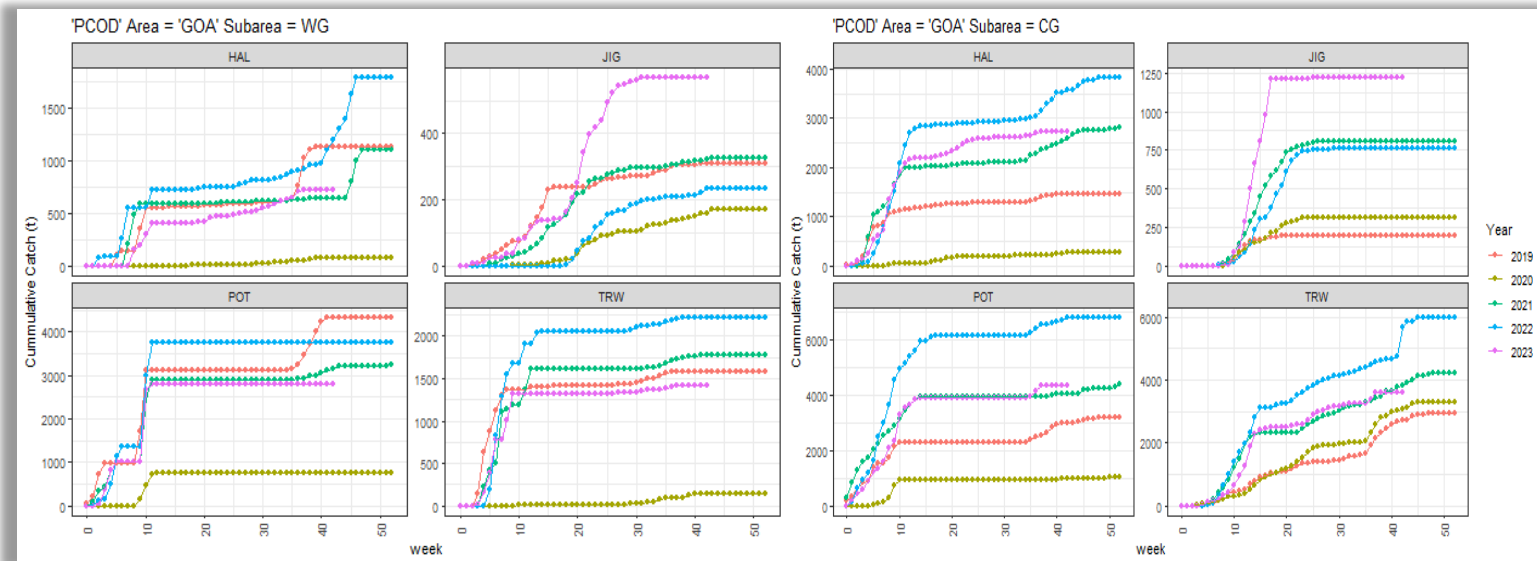
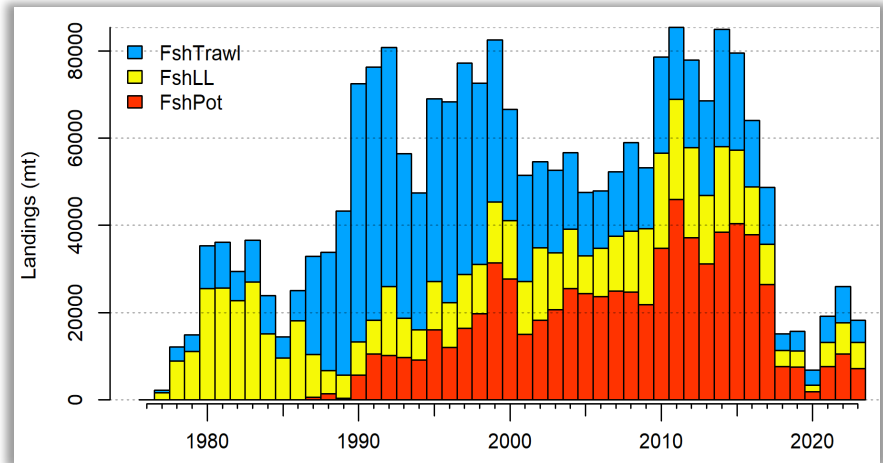
DATA OVERVIEW

Data	Years
Federal and state fishery catch, by gear type	2022, 2023
Federal and state fishery length composition, by gear type	2022, 2023
Federal fishery conditional age-at-length	2022
GOA NMFS bottom trawl survey abundance and length composition	2023
AFSC Sablefish Longline survey Pacific cod RPNs and length composition	2023
CFSR bottom temperature indices	2023



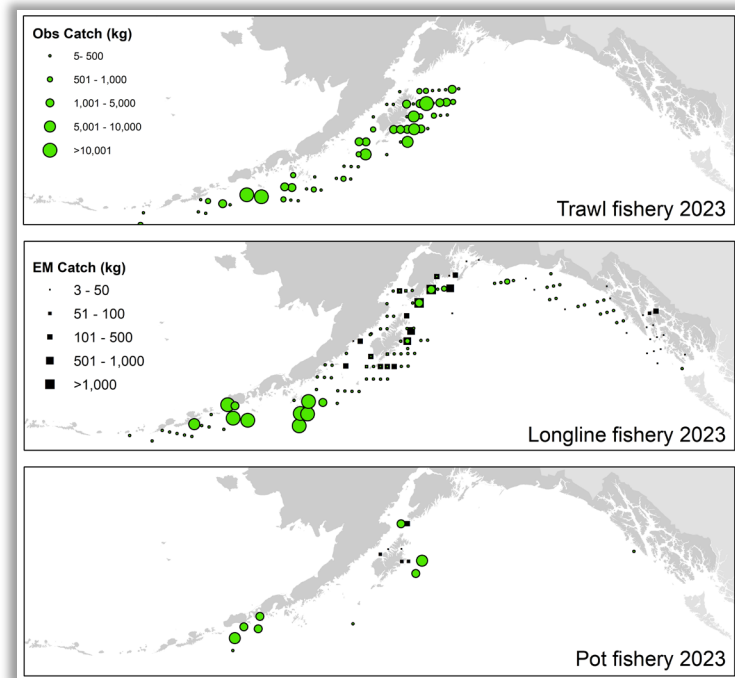
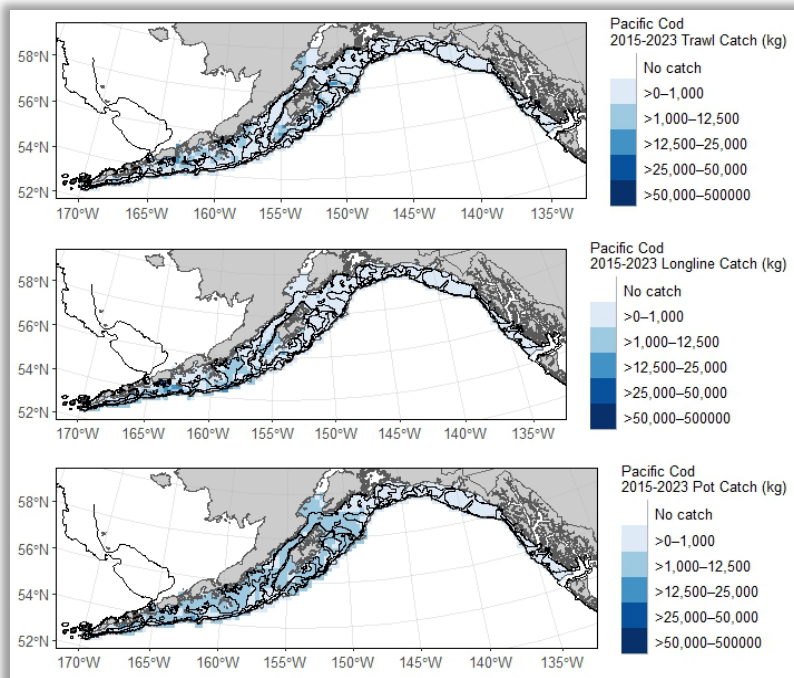
DATA - CATCH

- Decreased since 2022
- Pot majority > LL > Trawl
- Large jig increase compared to previous years, others similar to what was seen in 2021



DATA – CATCH DISTRIBUTION

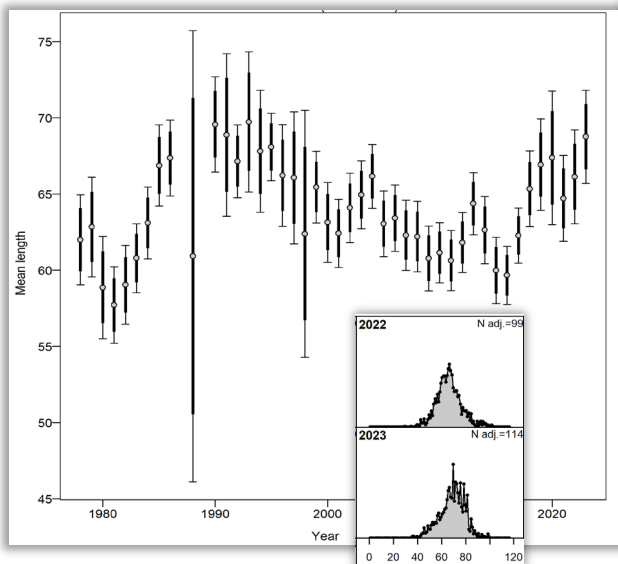
- 2023 distribution similar to catch distribution since 2015
- For how much relative catch is taken by pot, small # observed hauls



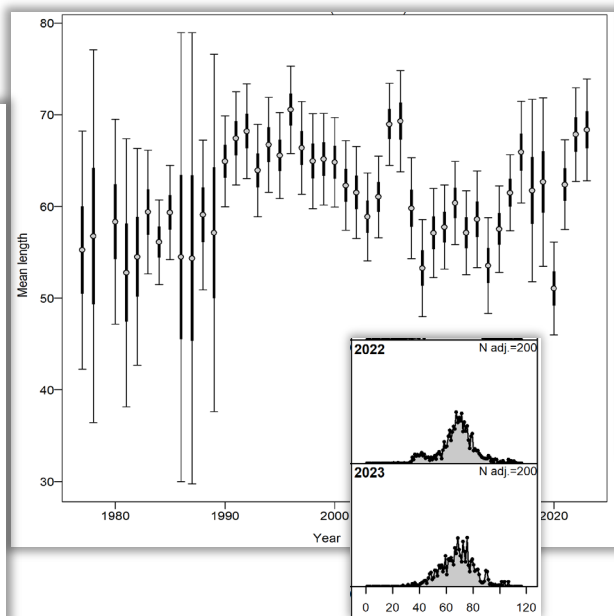
DATA – CATCH COMPS

- In general, mean length since 2015 larger than recent time periods (but on scale of that seen in 1990s)
- Larger mean length that resulted in Pot fishery for 2022 has come back down in 2023, likely a sampling artefact
- Dug into pot sampling

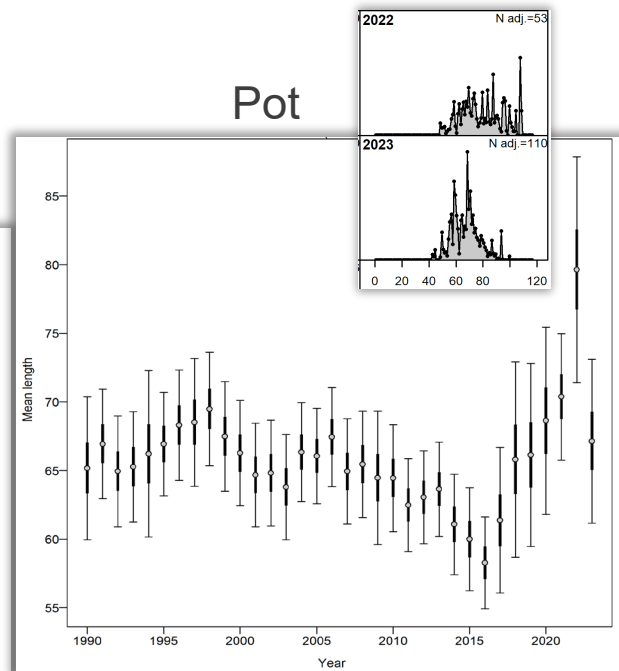
Longline



Trawl

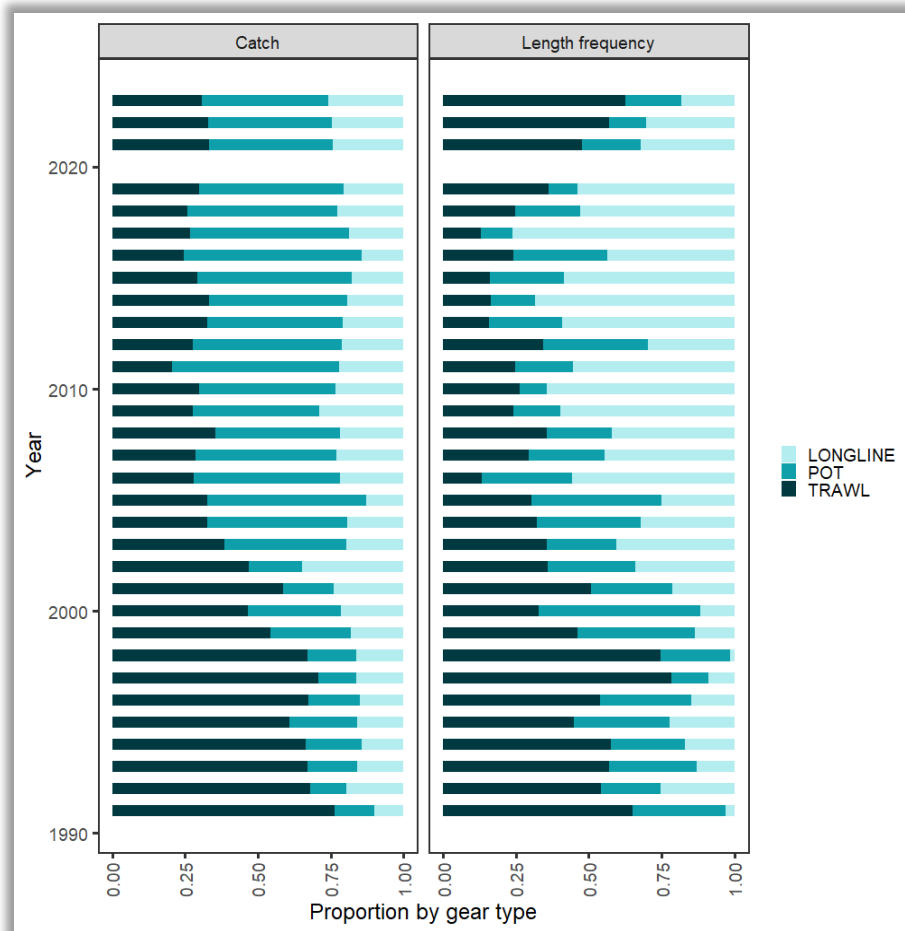


Pot



DATA – CATCH COMPS

- 1st pass evaluating observed effort of Pot fleet: distribution of length samples



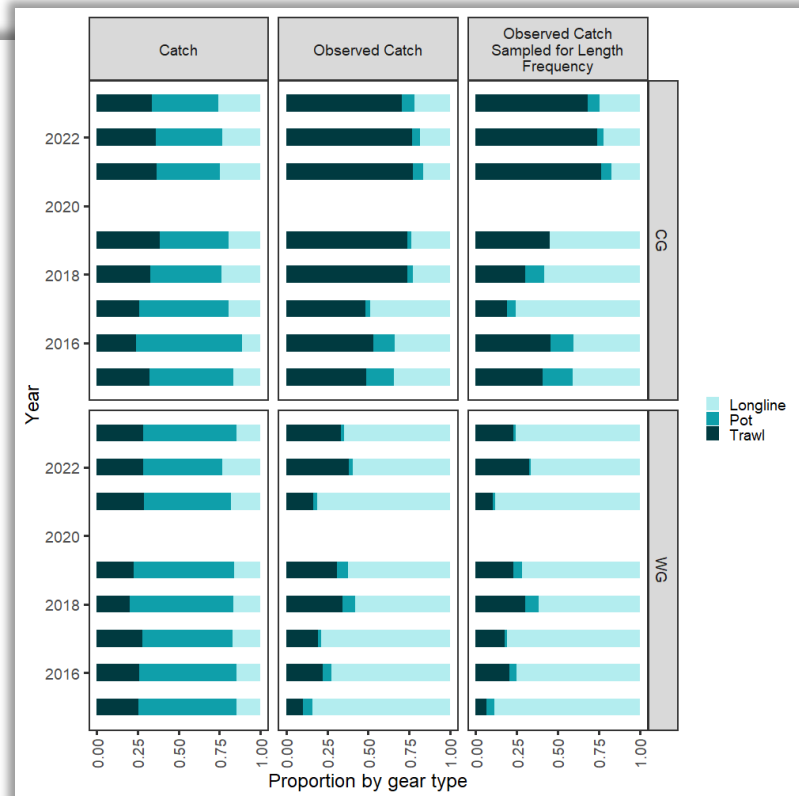
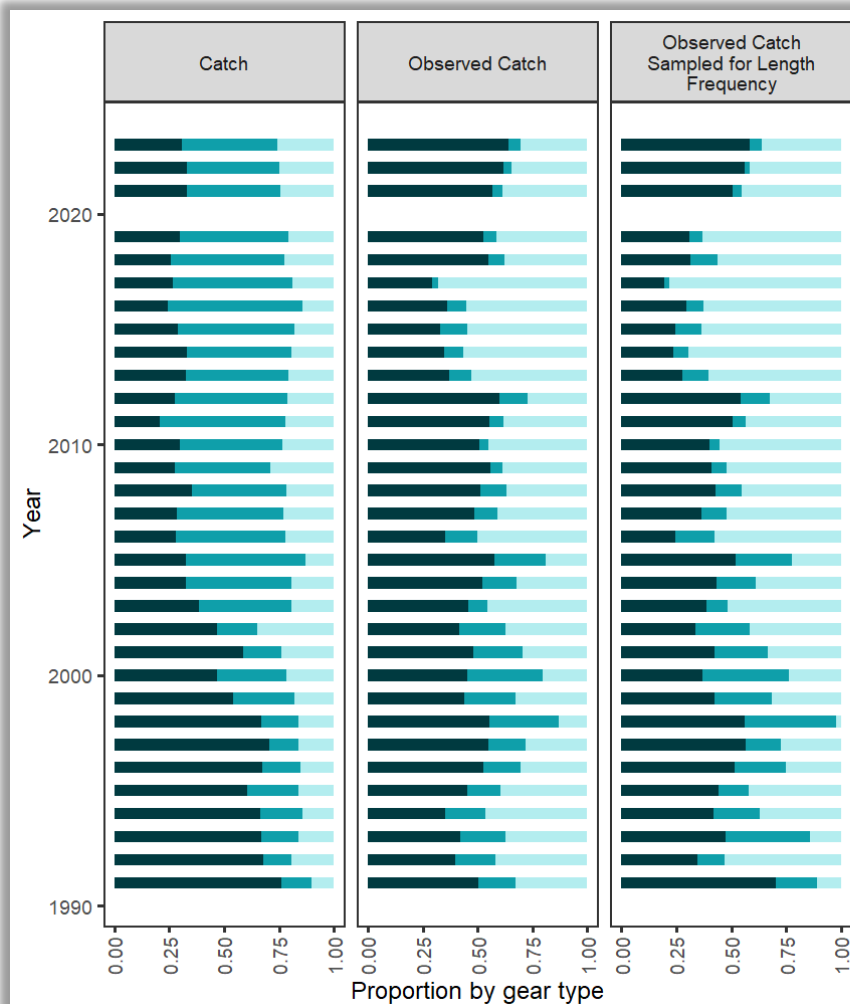
DATA – CATCH COMPS

- 2nd pass evaluating observed effort by gear type (Trawl, Longline, Pot):
 - Relative proportion of catch by gear type: gear specific catch divided by total annual catch
 - Relative proportion of observed catch by gear type:
 - Step 1: for each gear type, divide observed catch (extrapolated weight summed across hauls, converted to mt) by total catch
 - Step 2: with proportions from Step 1, compute relative proportions across gear types
 - Simple example: 10% of total catch observed for gear type 1, 5% of total catch observed for gear type 2 => 66% of relative proportion of observed catch is for gear type 1, 33% for gear type 2. If the observed catch rates were the same (i.e., 50/50), then the catch is observed proportional to the overall relative catch by gear type – so what we're looking for is an even split among gear types
 - Relative proportion of observed catch sampled for length frequency by gear type:
 - Same procedure as for observed catch, but use observed catch from hauls that have length frequency sampling



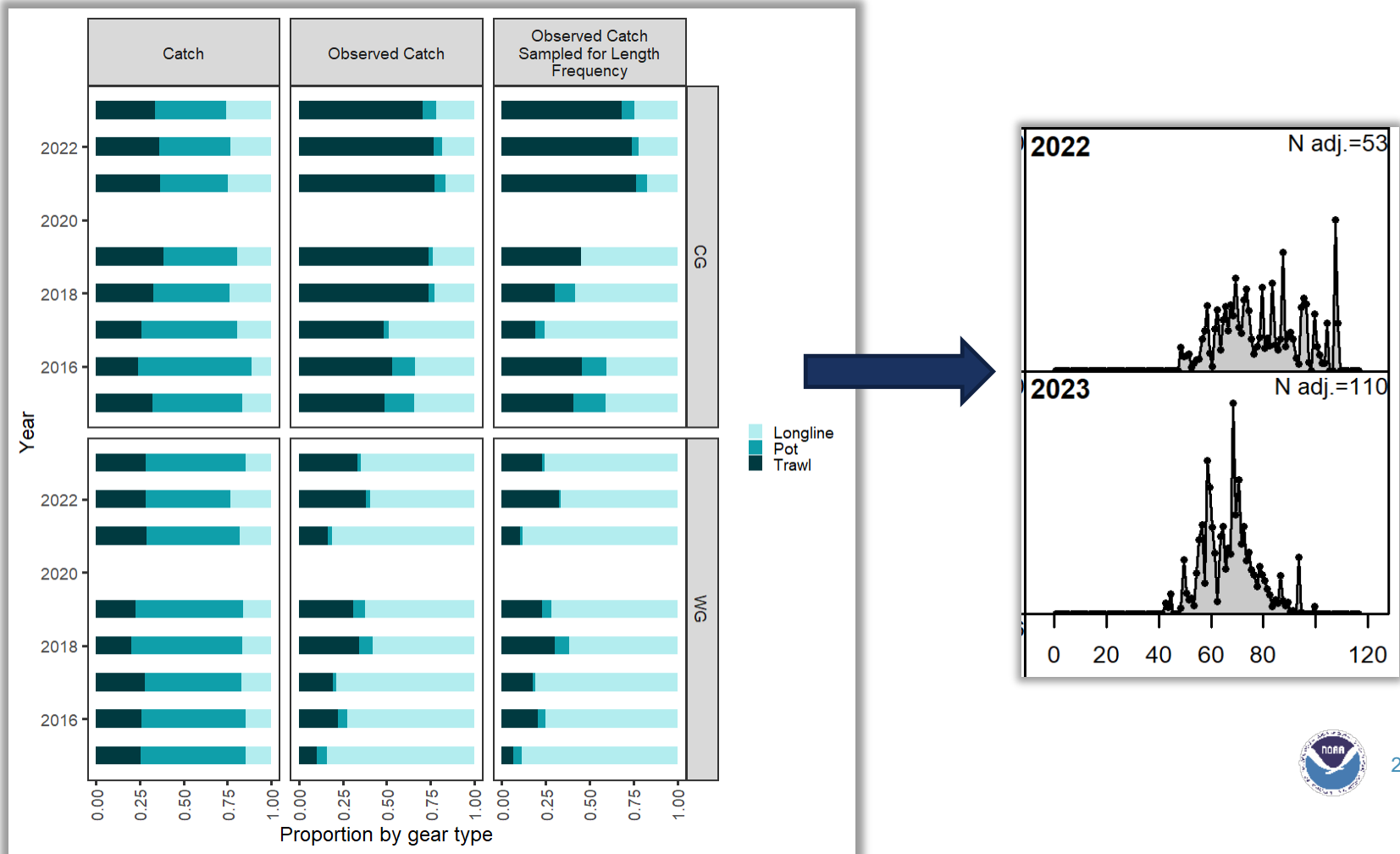
DATA – CATCH COMPS

- Pot fleet underrepresented in both observed catch and length frequency

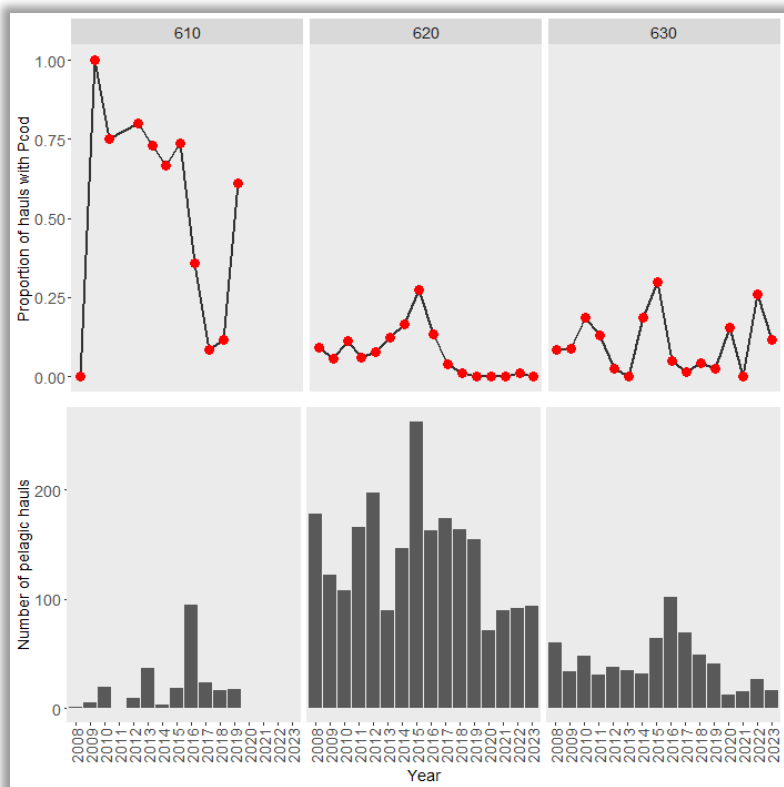


DATA – CATCH COMPS

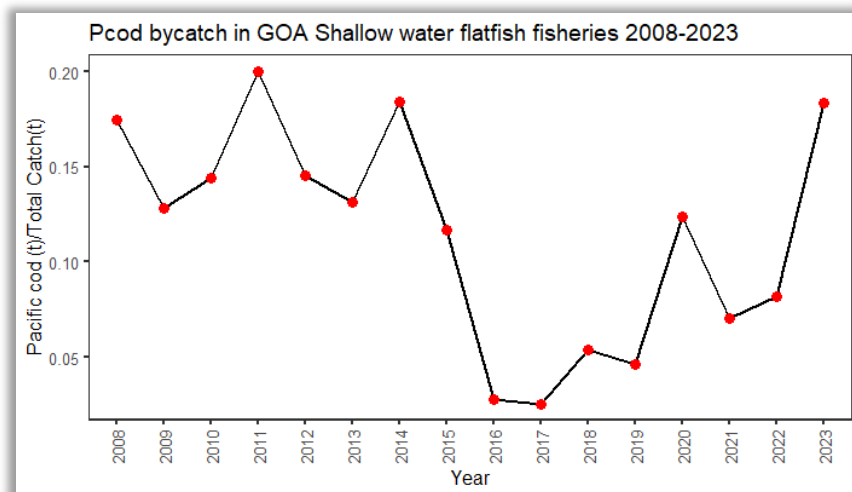
- Pot fleet underrepresented in both observed catch and length frequency



DATA – UNINTENTIONAL CATCH

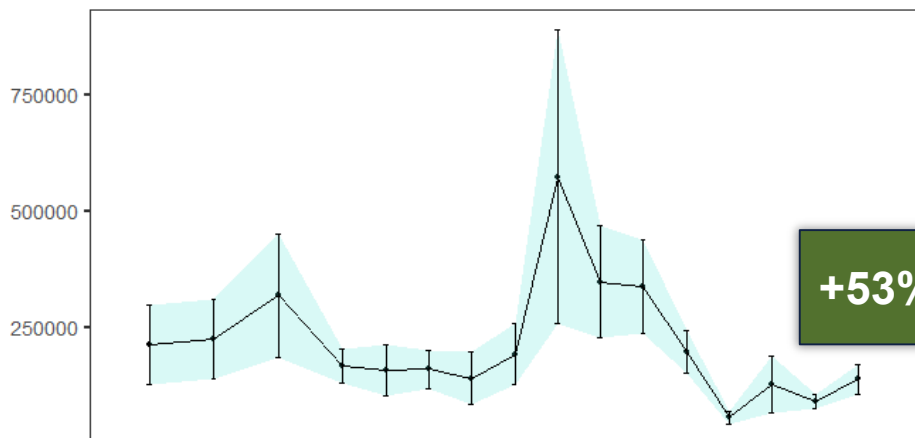


- Getting Pcod in pelagic trawls (can be thought of as index of juveniles)
- SWF bycatch on increasing trend (index of adults)



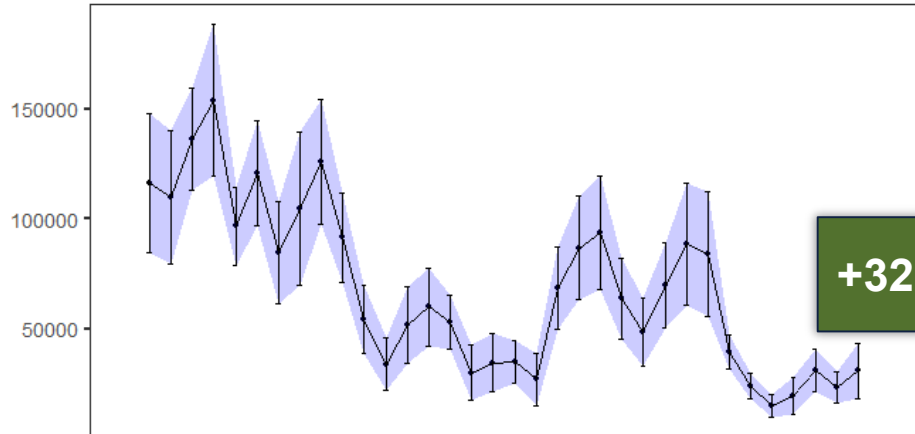
SURVEYS – FITTED

AFSC trawl survey numbers (1000s)

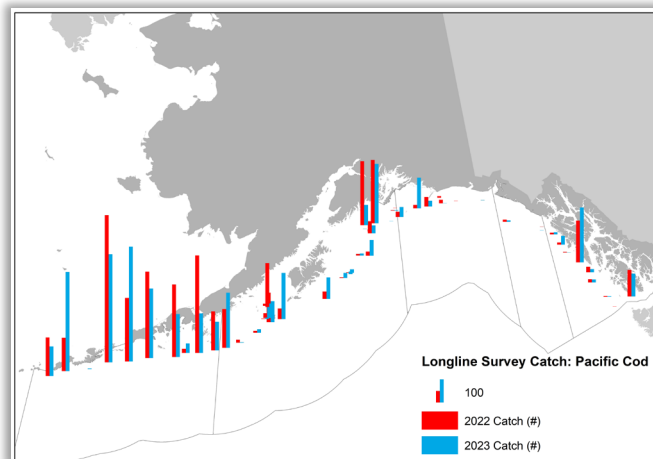
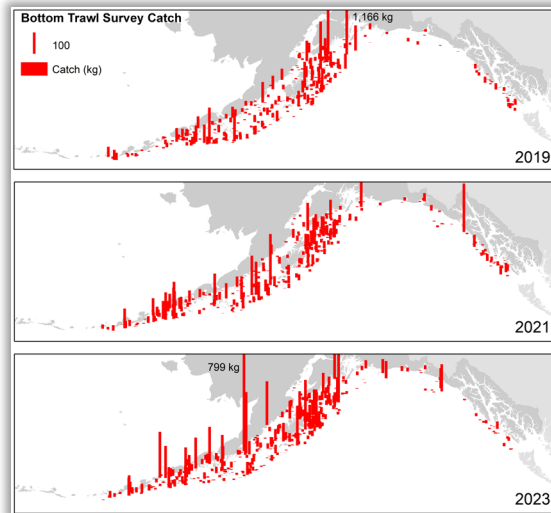


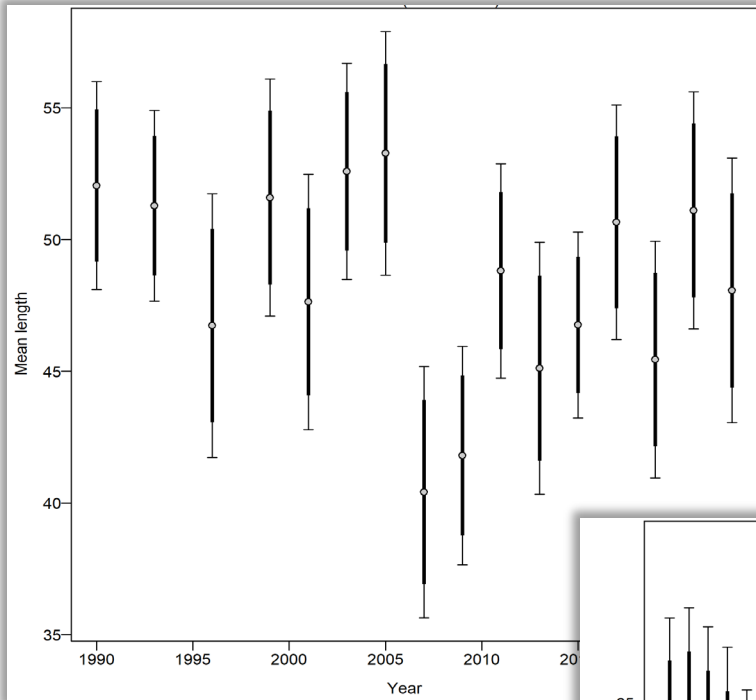
+53%

AFSC longline survey RPNs

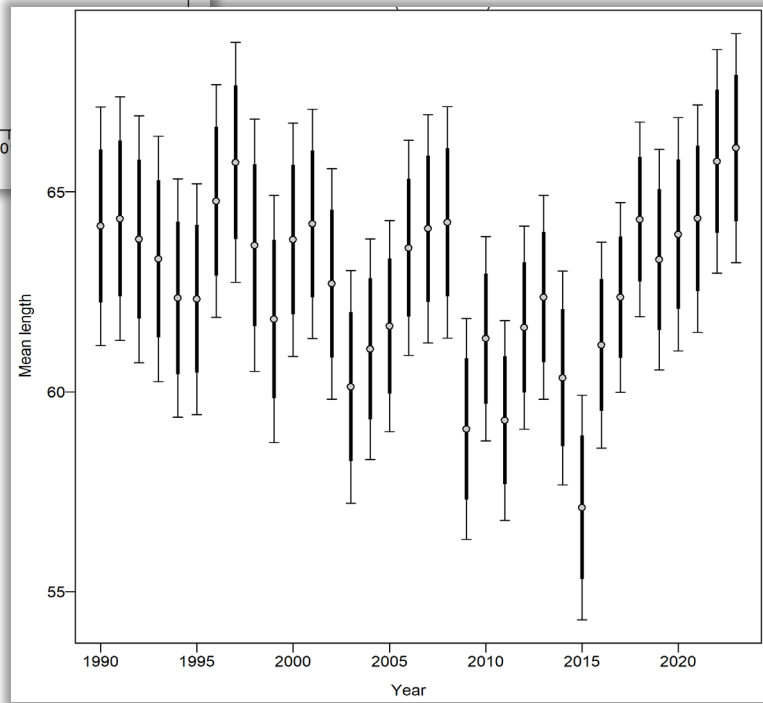
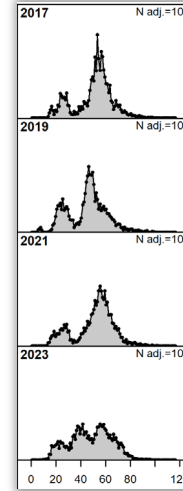


+32%

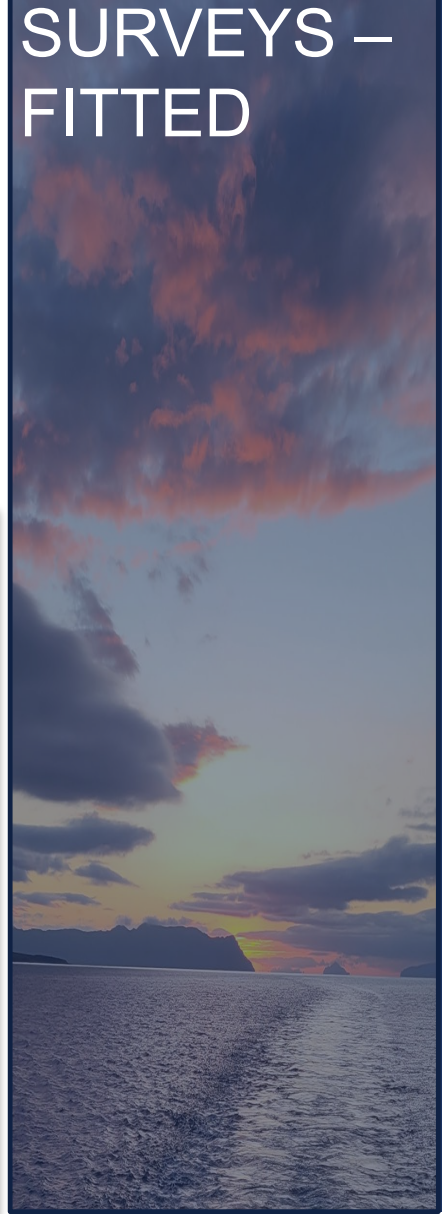
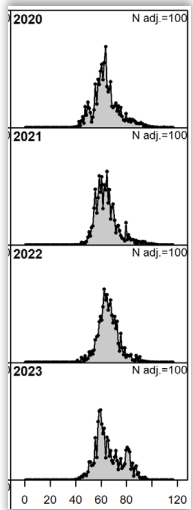




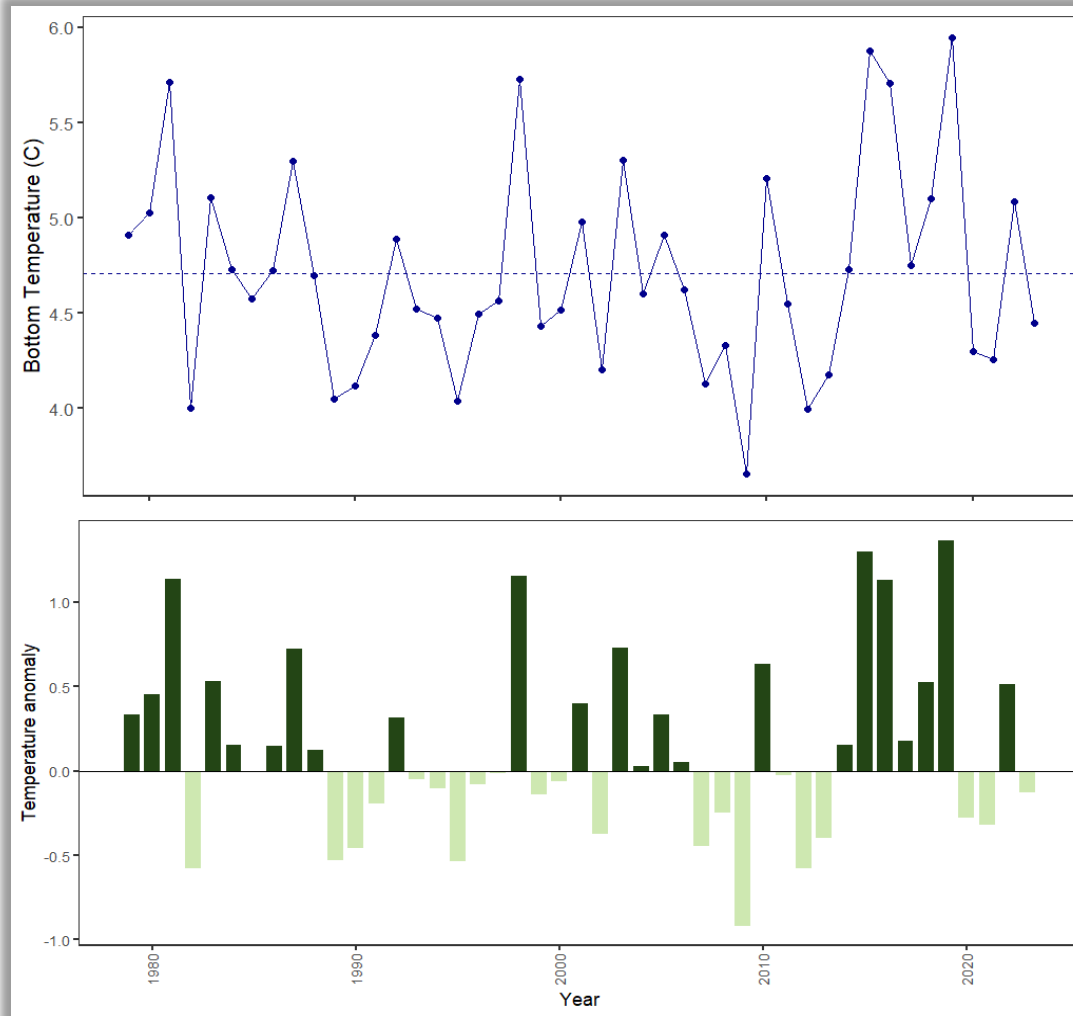
■ Trawl survey mean length variable



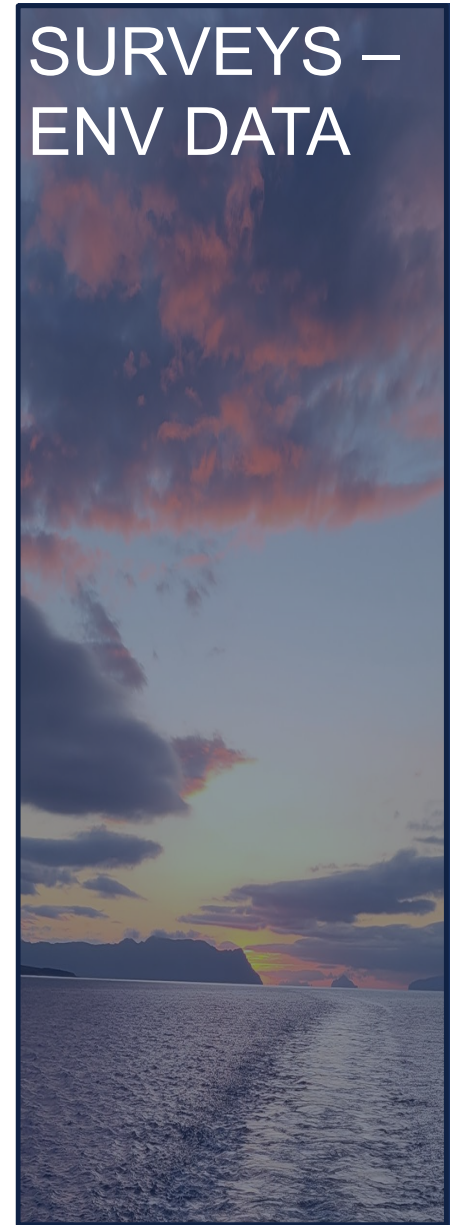
■ Longline survey mean length increasing



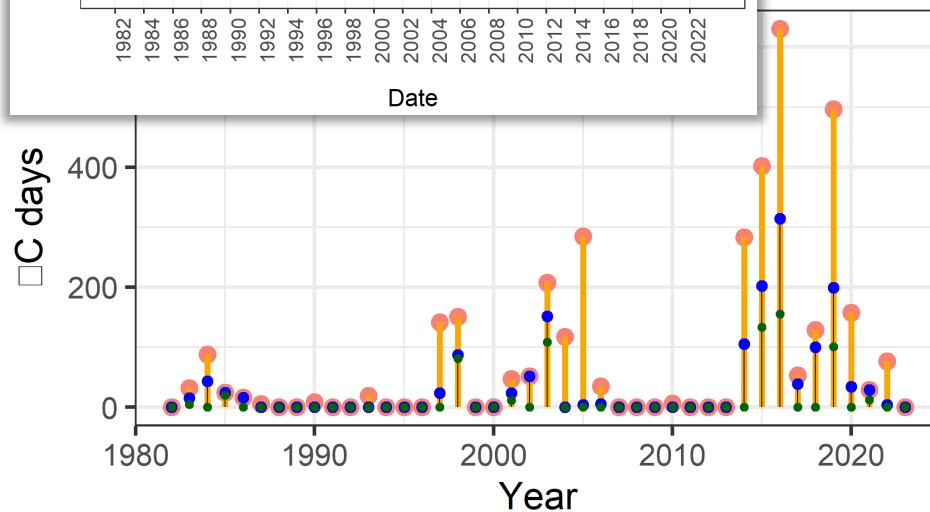
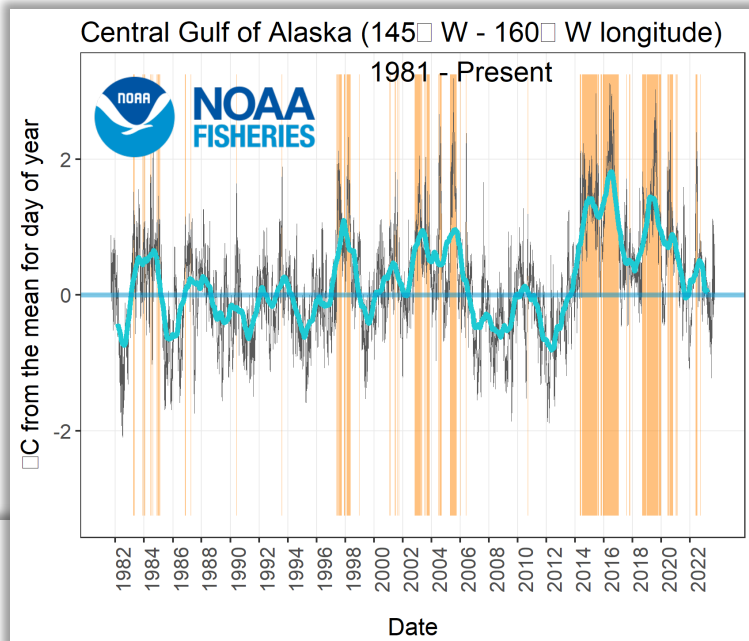
- Bottom temperature below mean in 2023



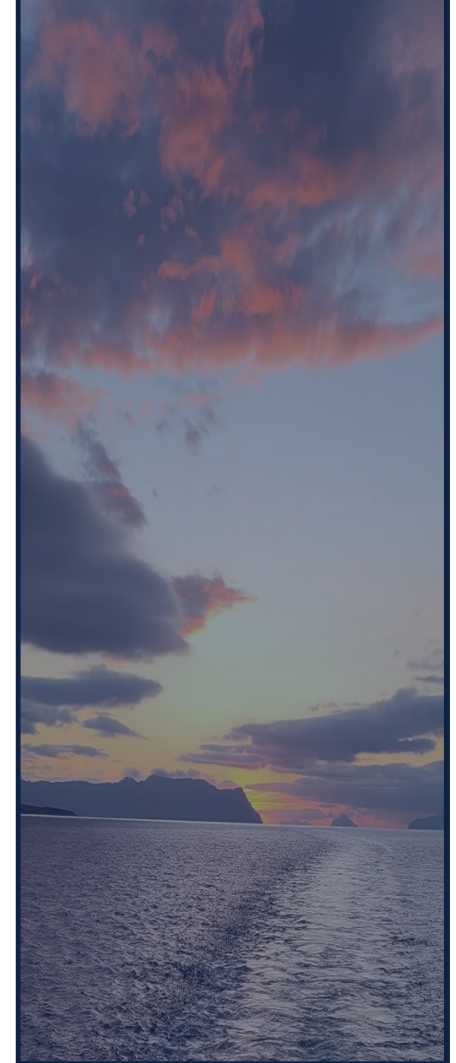
SURVEYS – ENV DATA



- Avg sea surface temperature
- No marine heat wave days

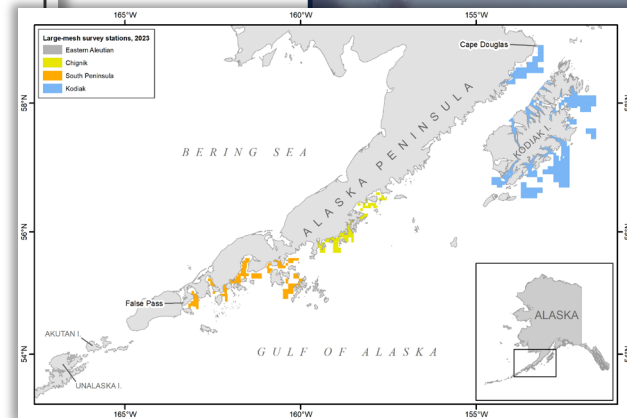
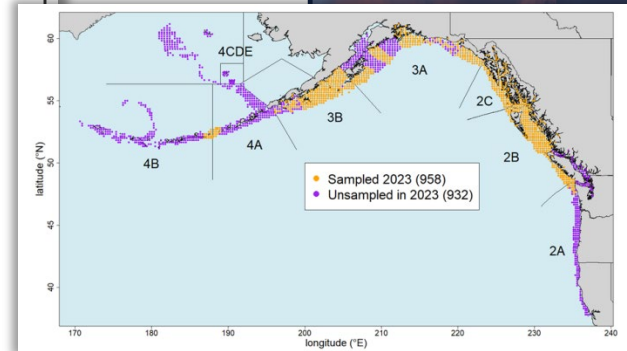
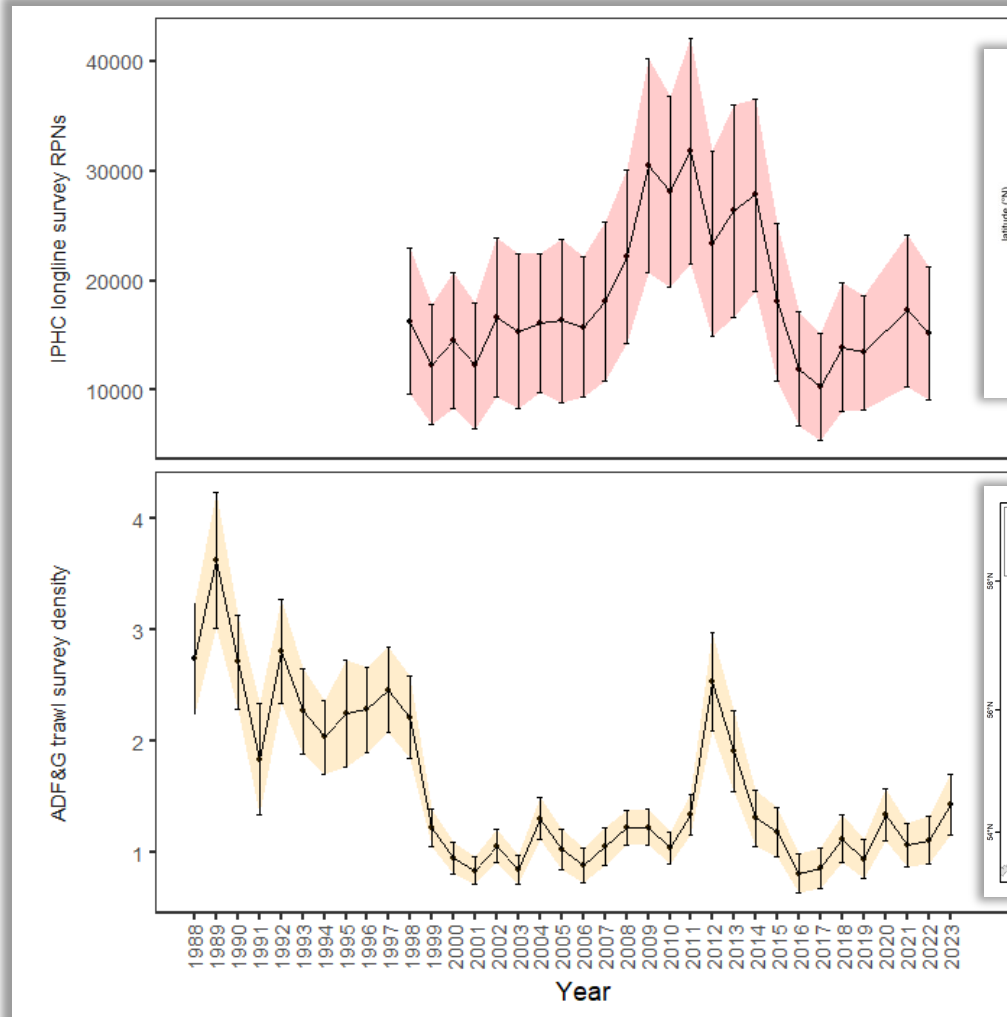


SURVEYS – ENV DATA

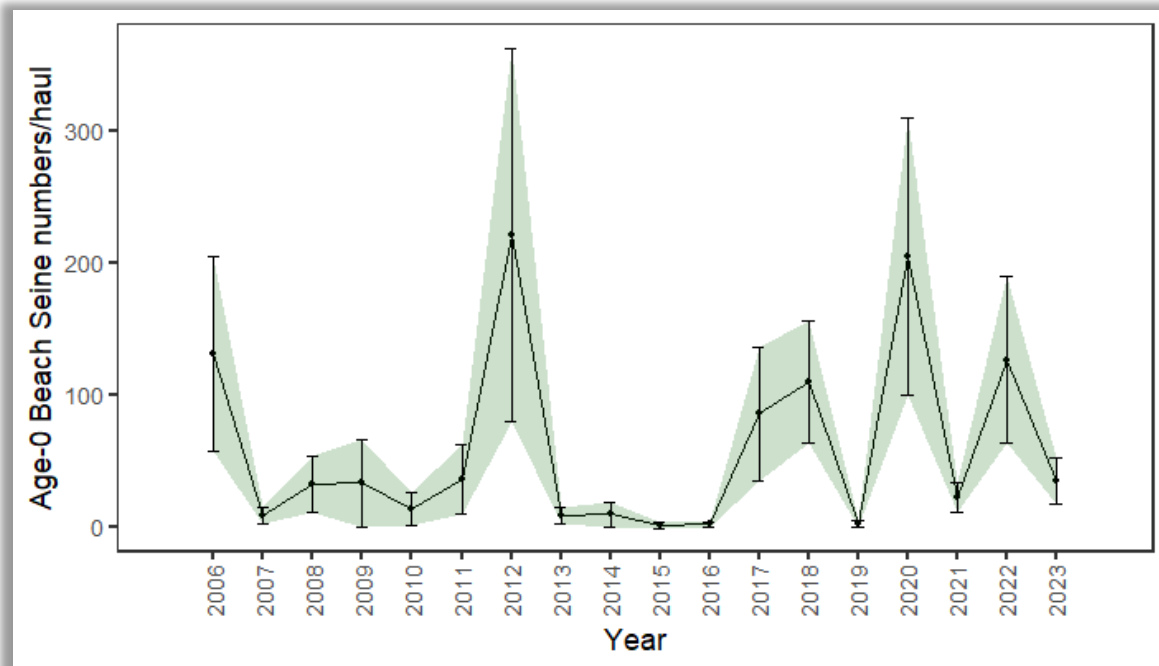


- Both IPHC and ADF&G on increasing trend

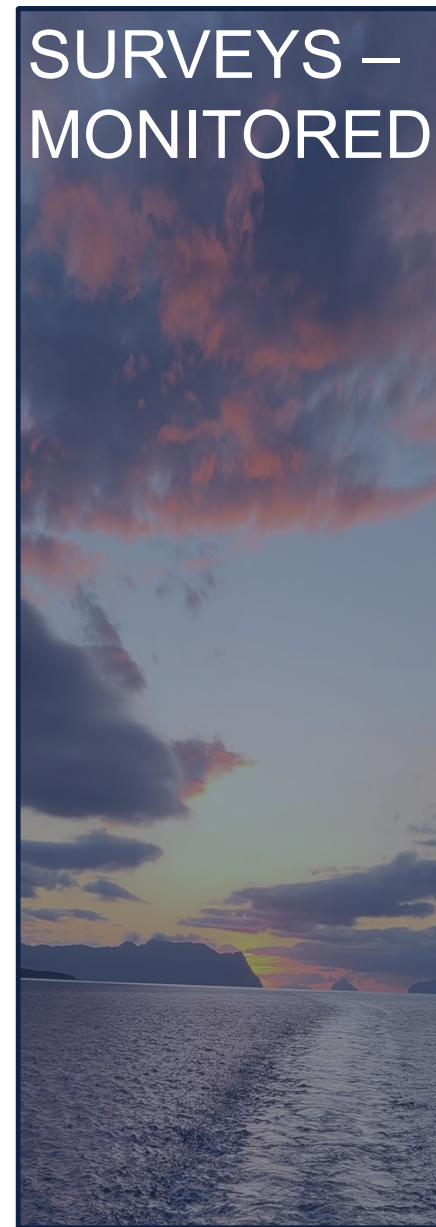
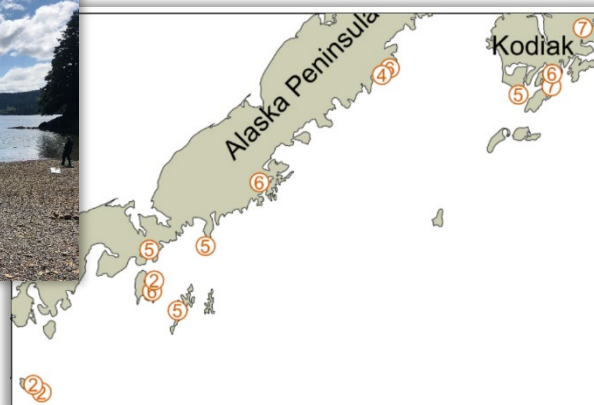
SURVEYS – MONITORED



- Larger 2017/2018, 2020, and 2022 year classes

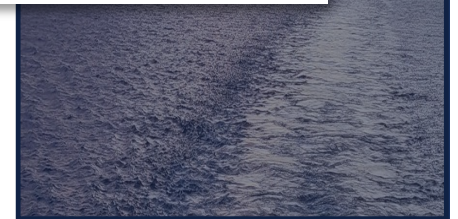
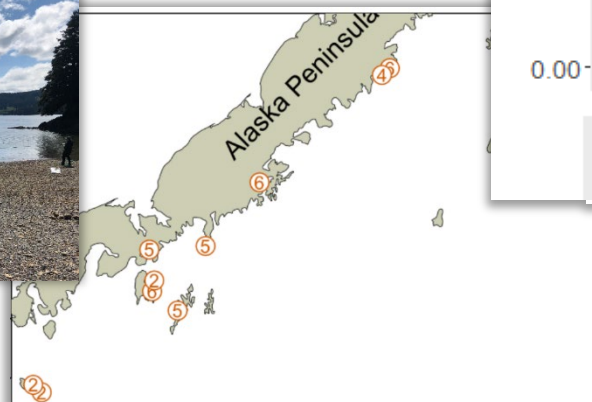
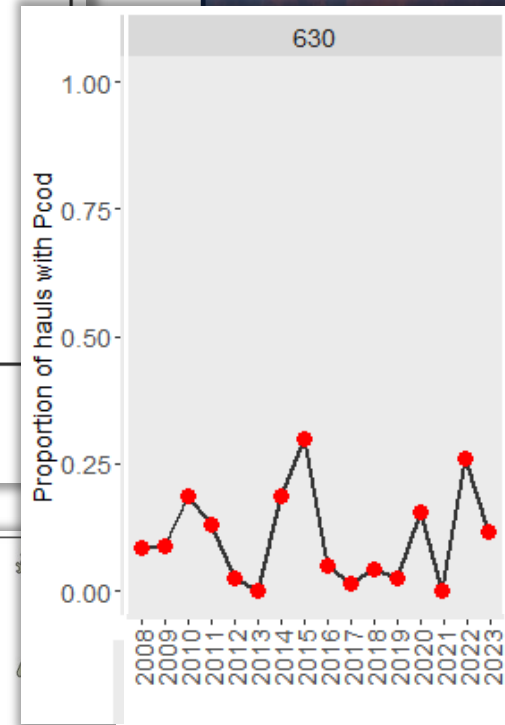
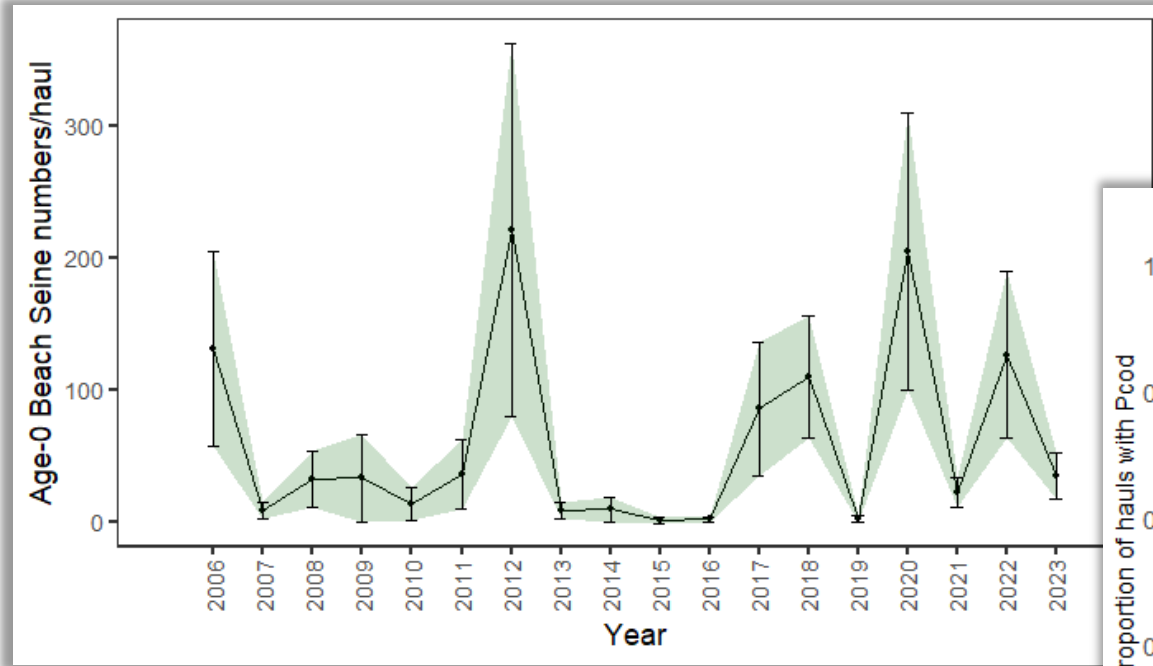


SURVEYS – MONITORED

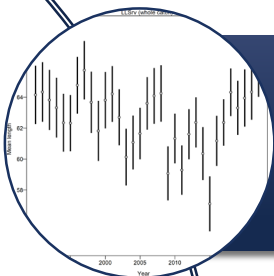


- Larger 2017/2018, 2020, and 2022 year classes

SURVEYS – MONITORED

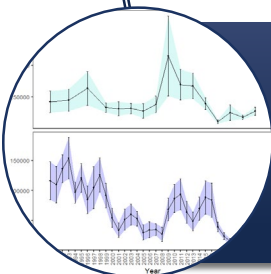


DATA – SUMMARY



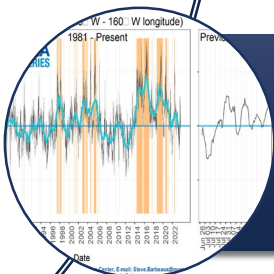
Length comp trends:

- No red flags, other than Pot fleet underrepresented
- Younger year classes do show up in trawl survey



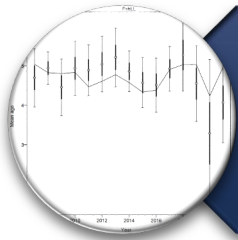
Index trends:

- For all sources (fitted and monitored), that have 2023 data available, increased from previous year

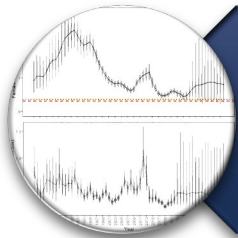


Environmental trends:

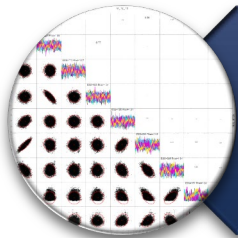
- 2023 average year, no red flags



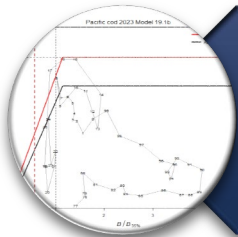
Data fits



Parameter/Time Series
Estimates

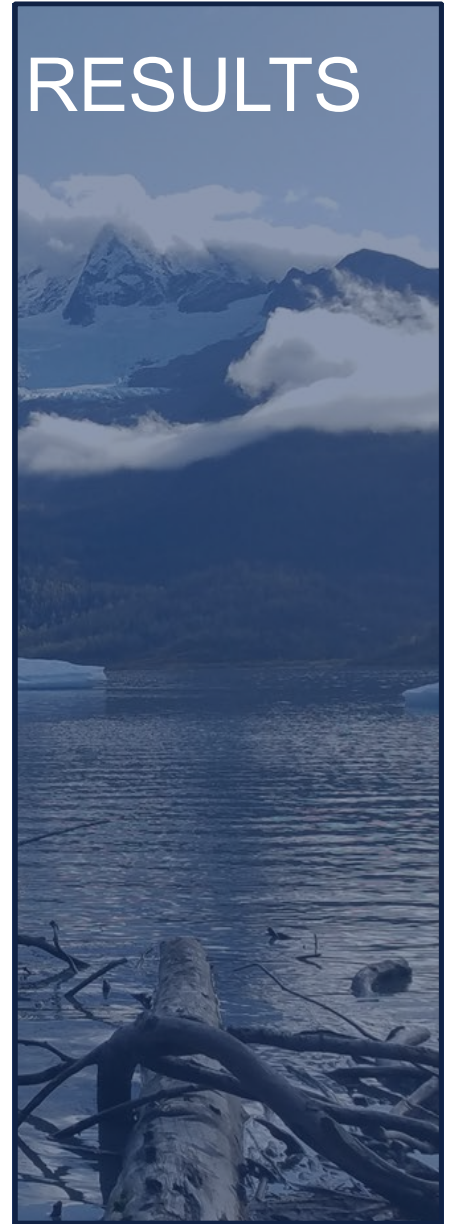


Model diagnostics

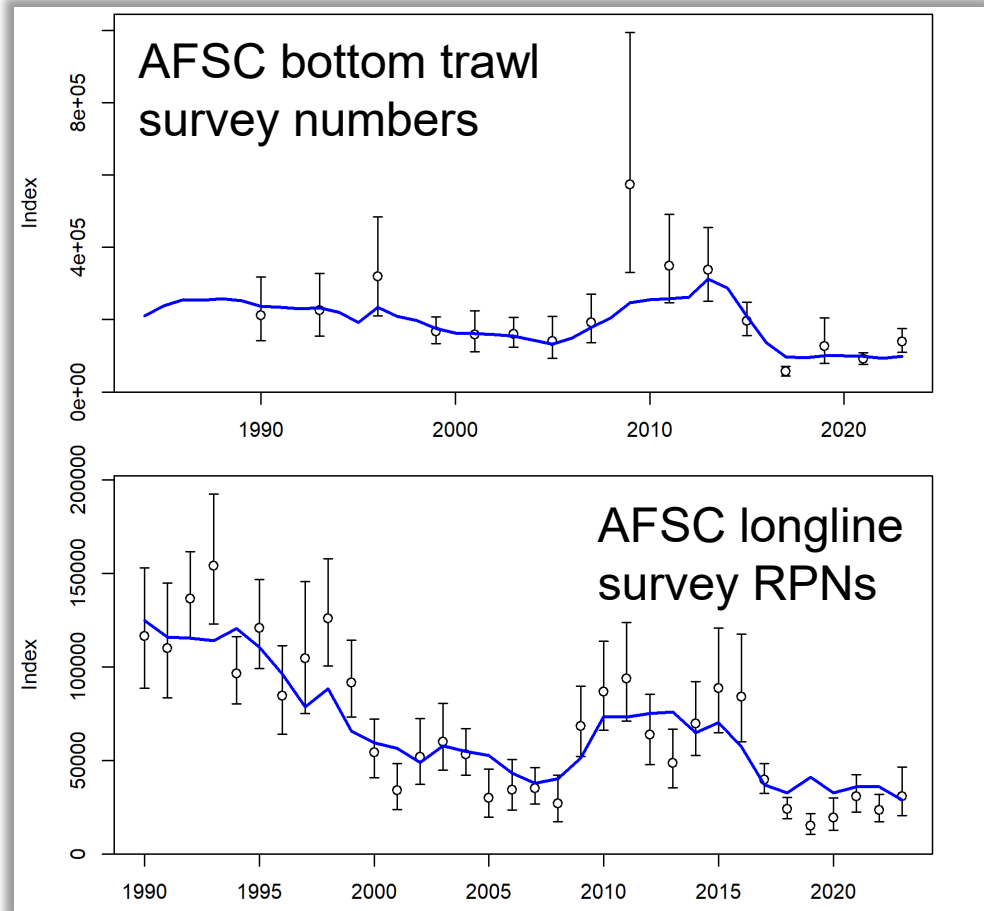


Recommendations

RESULTS

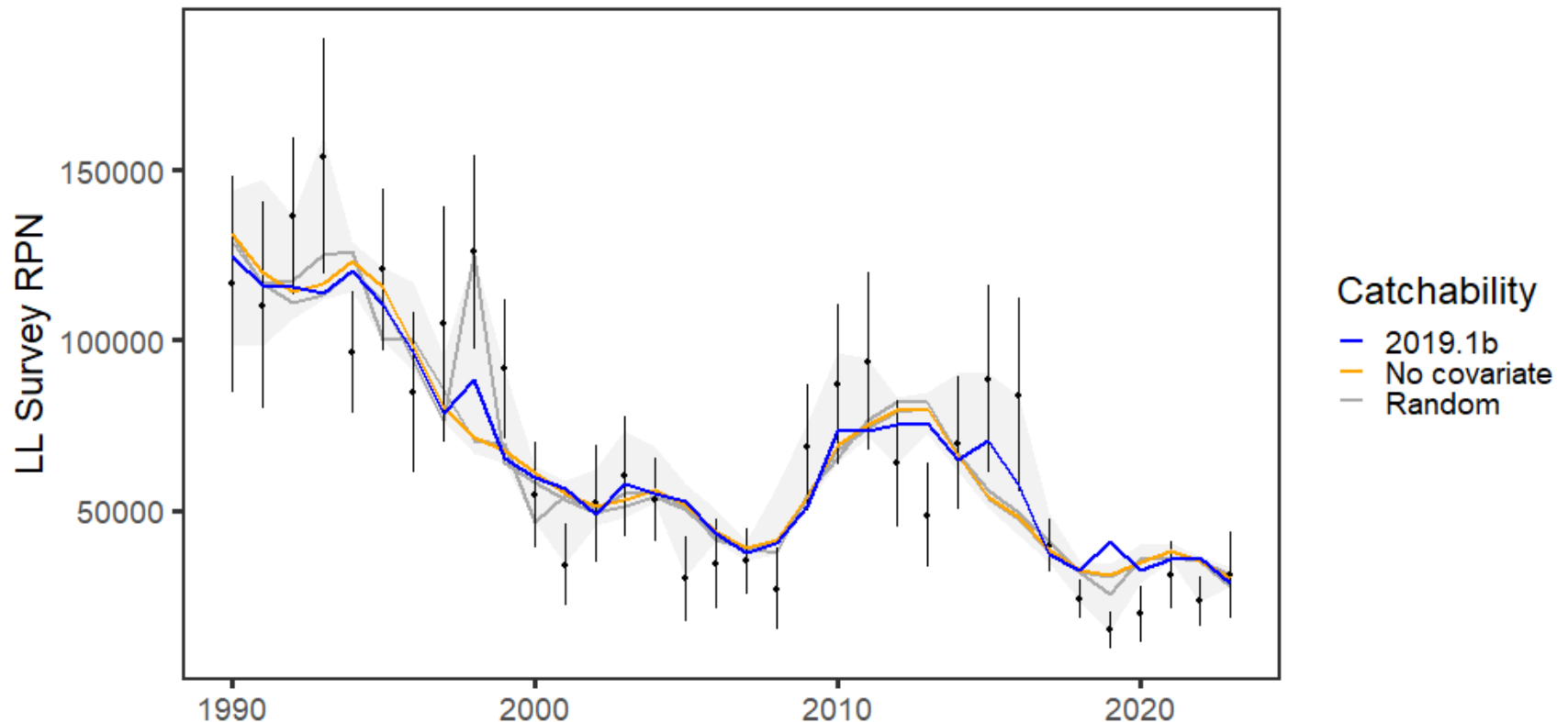


- Trawl survey fit between lows in 2017 & 2021 and larger in 2019 & 2023 – model expects less abundance than observed in 2023
- Pattern of expecting larger RPN from longline survey in 5 of last 6 years, but, model expects less abundance than observed in 2023

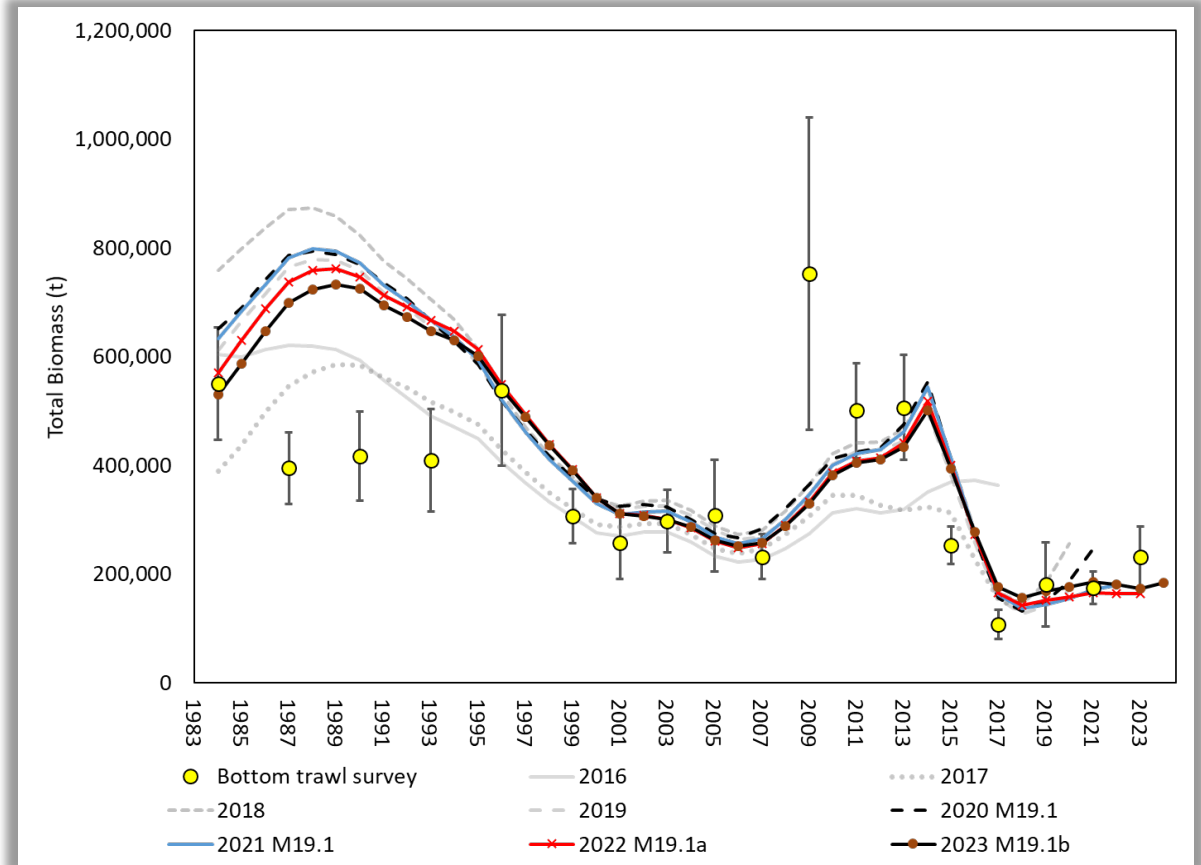


RESULTS: DATA FITS

- Evaluated longline survey environmental link with 2 tests (use AIC for comparison):
 1. Remove environmental link
 2. Generate 'white noise' with $N(0,1)$ and use as environment
- Test 1 $\Delta AIC = 11.4$, Test 2 average $\Delta AIC = 6.9$ (45 of 50 runs 19.1b AIC smaller than white noise)

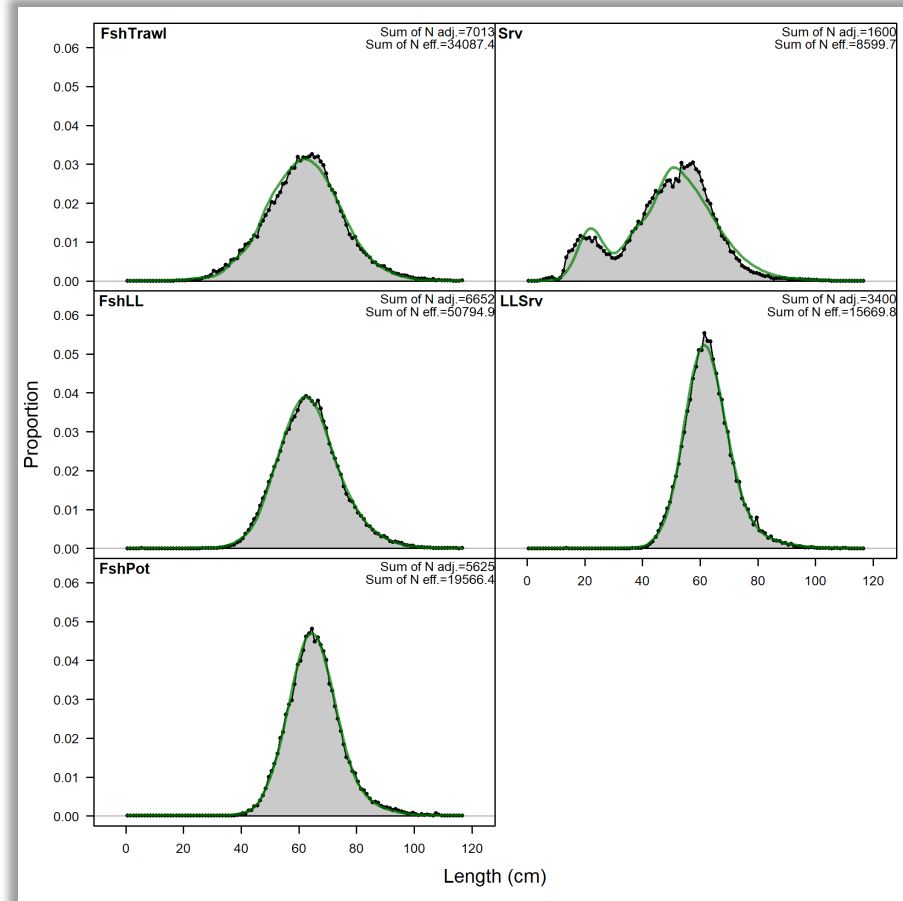


- Model retrospective 'fit' to biomass variable across assessments
- Slight upward shift in 2023 assessment



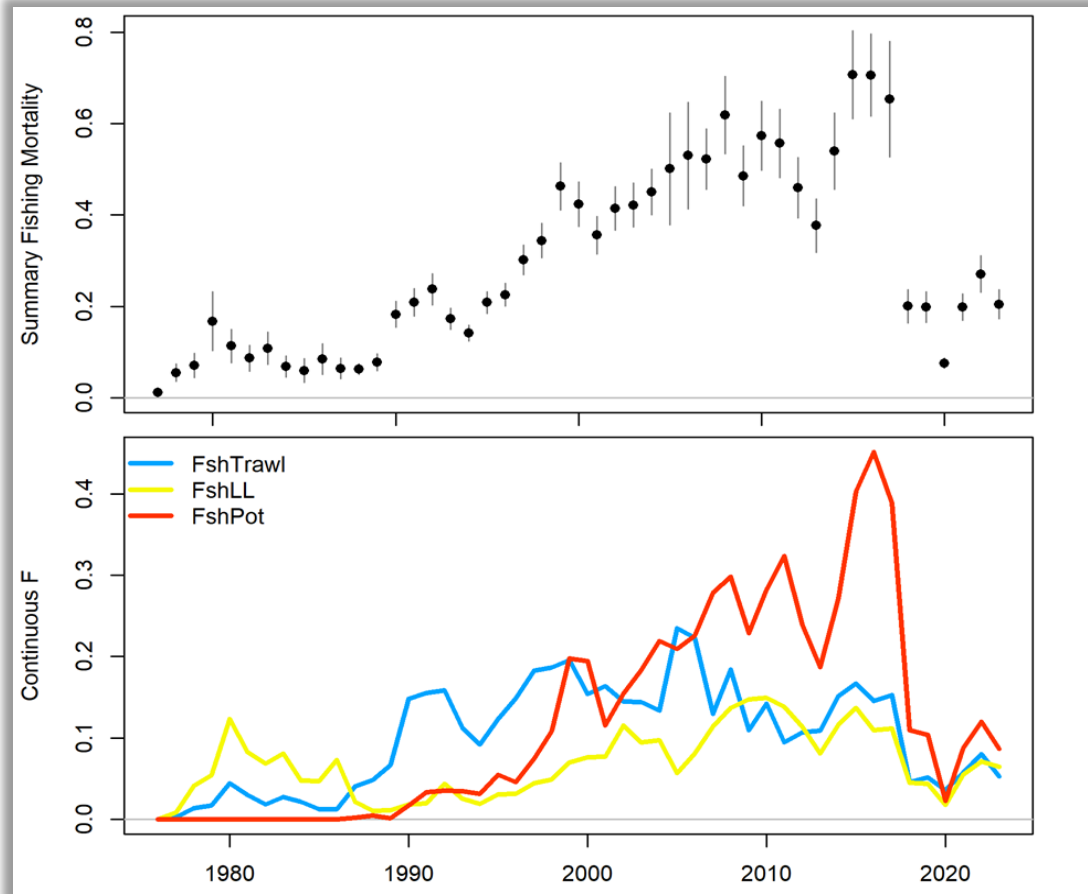
RESULTS: DATA FITS

- In general, model fit to length comp data reasonable
- Slight misfit for survey length comp
- Keep in mind: weighted $\frac{1}{2}$ of fishery



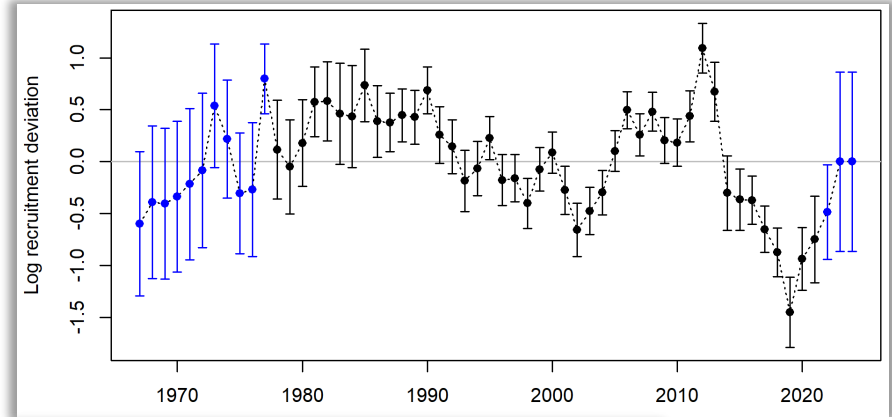
RESULTS: DATA FITS

- F decreased in 2022 for all fleets, Pot fleet continues to have largest F (keep in mind selex though)

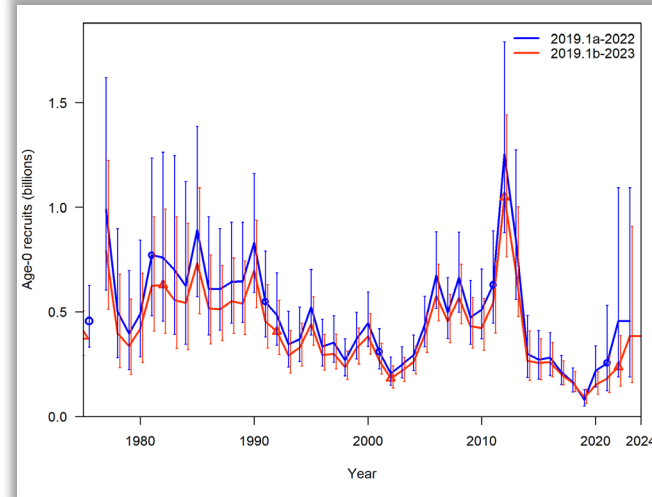


RESULTS: PARAMETER ESTIMATES

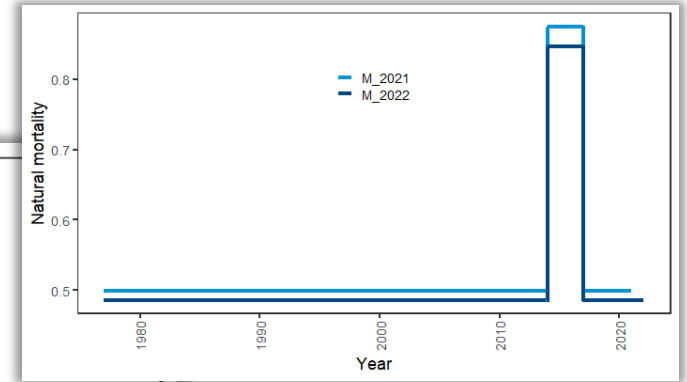
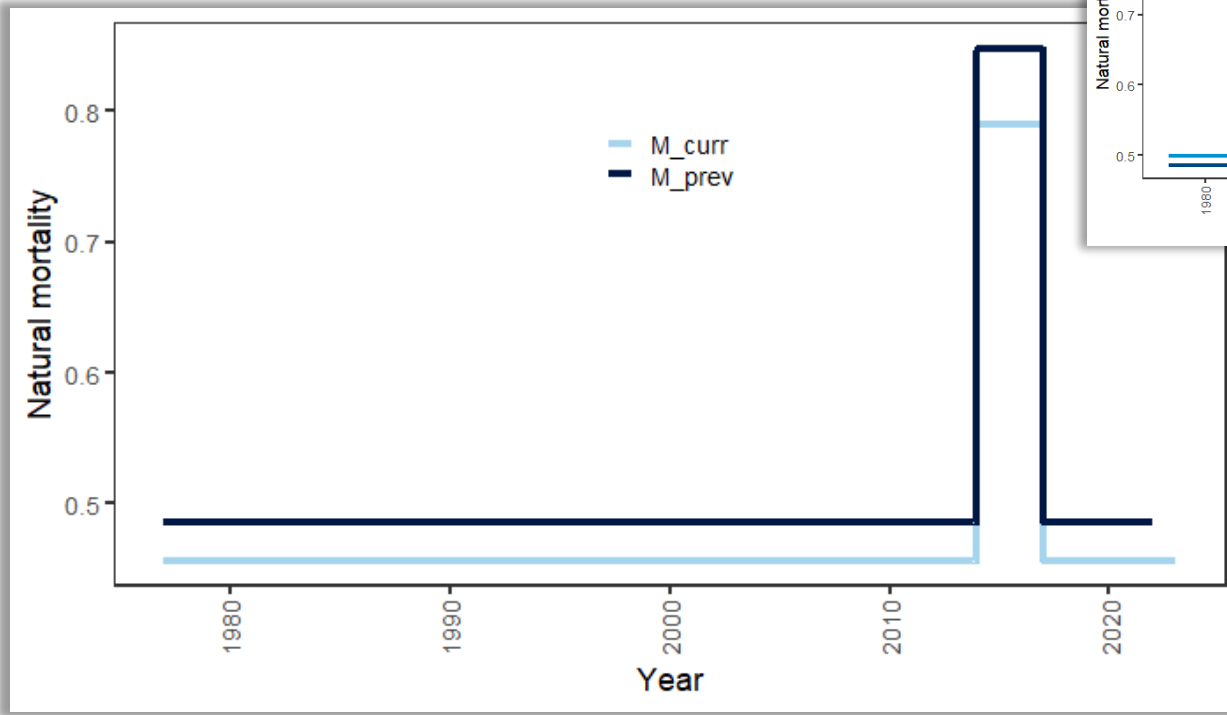
- Below average recruitment since 2014 (following a stanza of above avg recruitment)



- Recruitment decreased in the 2023 assessment compared to 2022



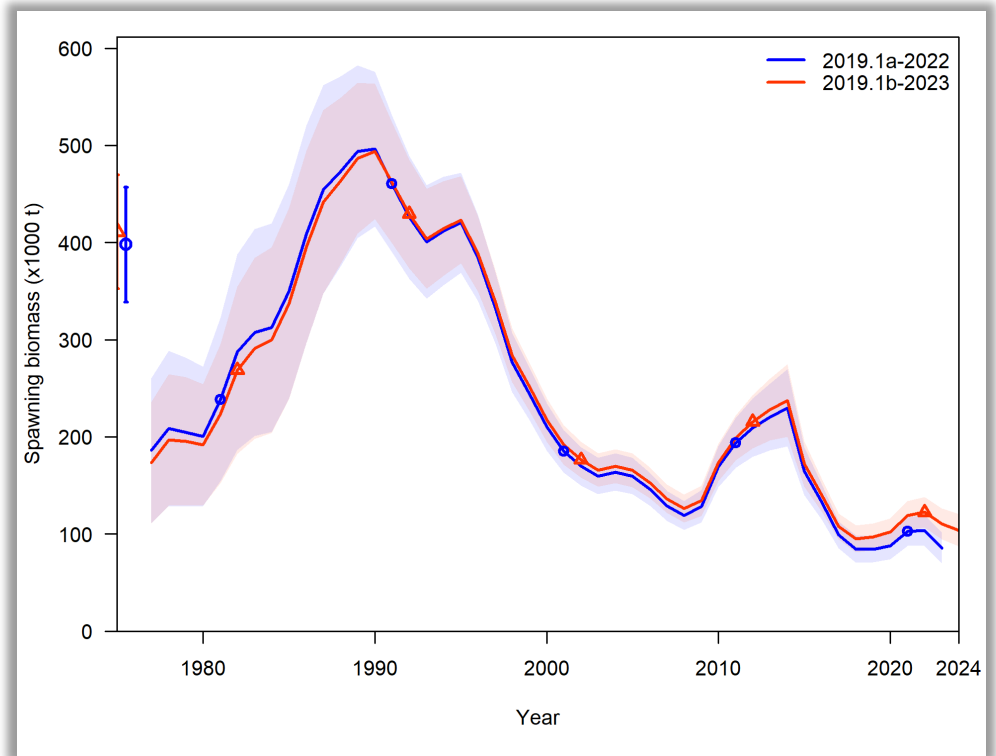
RESULTS: PARAMETER ESTIMATES



- M decreased in 2023 assessment compared to 2022

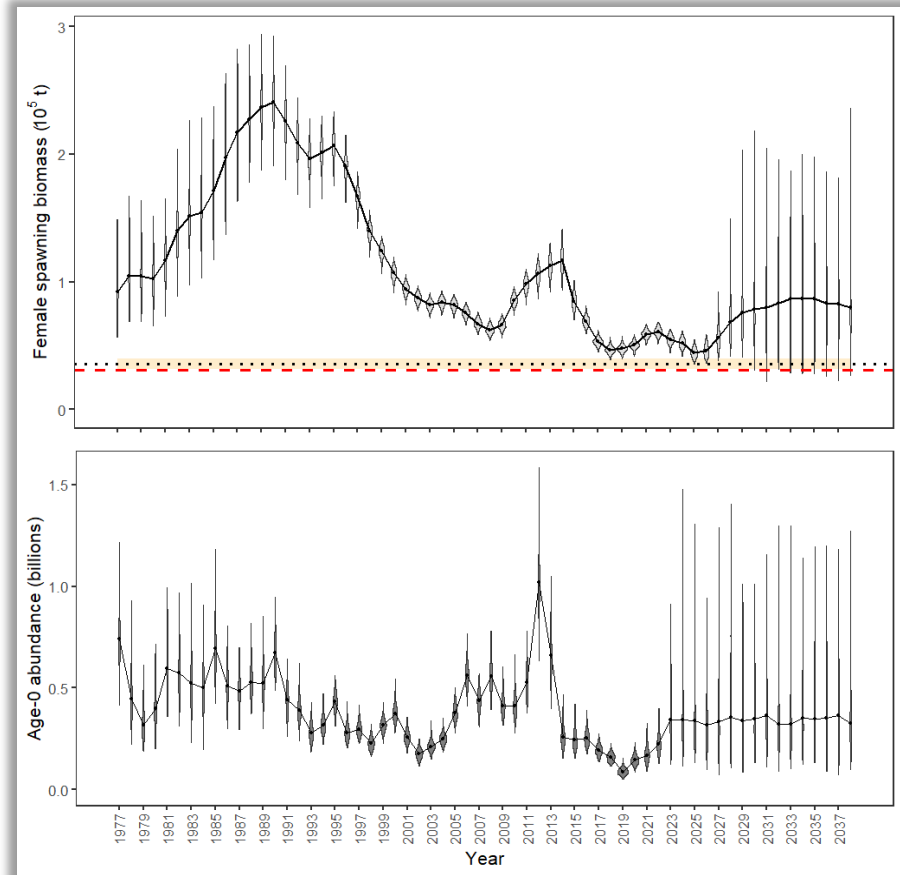
RESULTS: PARAMETER ESTIMATES

- Compared to 2022 model, 2023 assessment increases estimated SSB in recent time series



RESULTS: TIME SERIES

- SSB projected to decrease in near term, then increase (<0.1% MCMC replicates have $SSB < B_{20\%}$ in 2024 and 2025)
- Low recent recruitment estimates with precision, projected average recruitment larger than recent recruitments (since 2014)



RESULTS: TIME SERIES

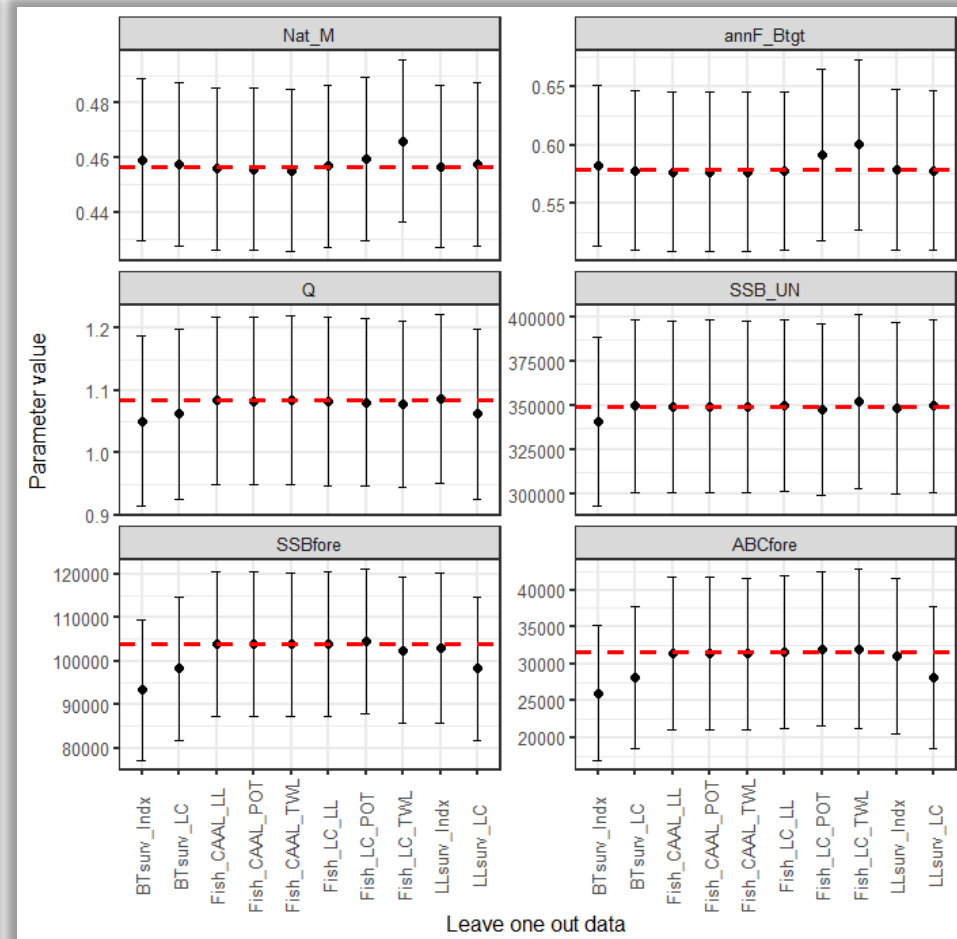
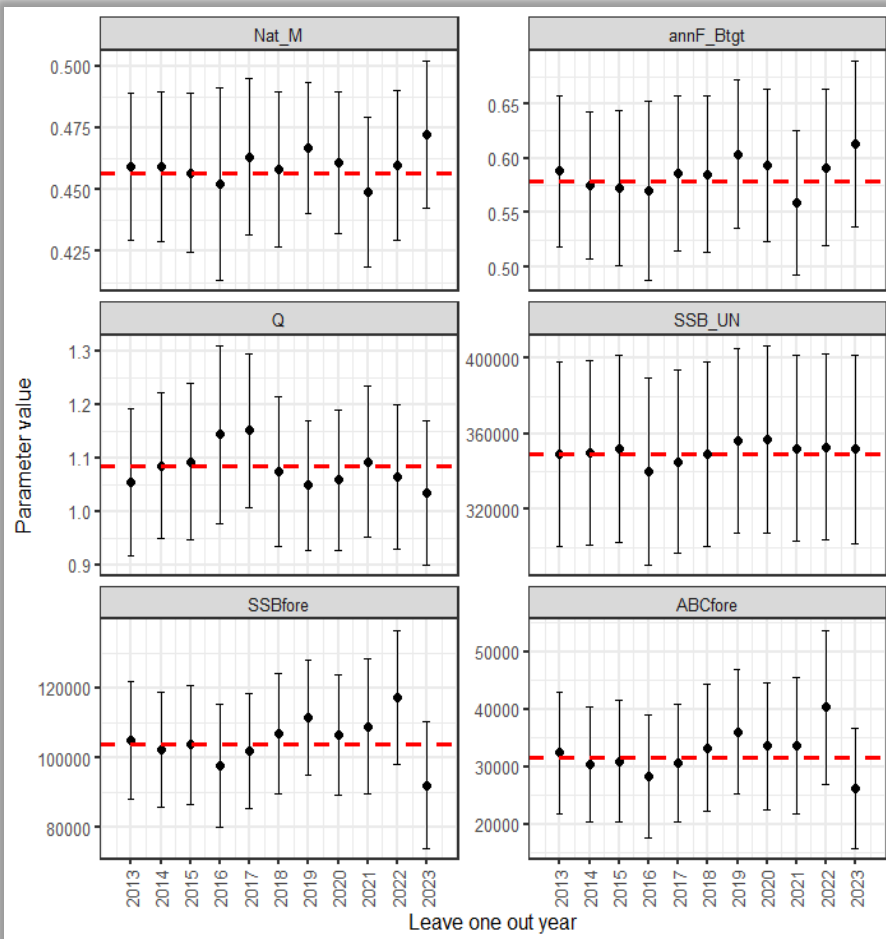
- Model diagnostics:
 - Leave-one-out: leave a year of data out, leave an updated data source out for current year
 - MCMC: key parameter histograms, mixing, correlation
 - Retrospective: data and model for SSB, data for recruitment



RESULTS: MODEL DIAGNOSTICS

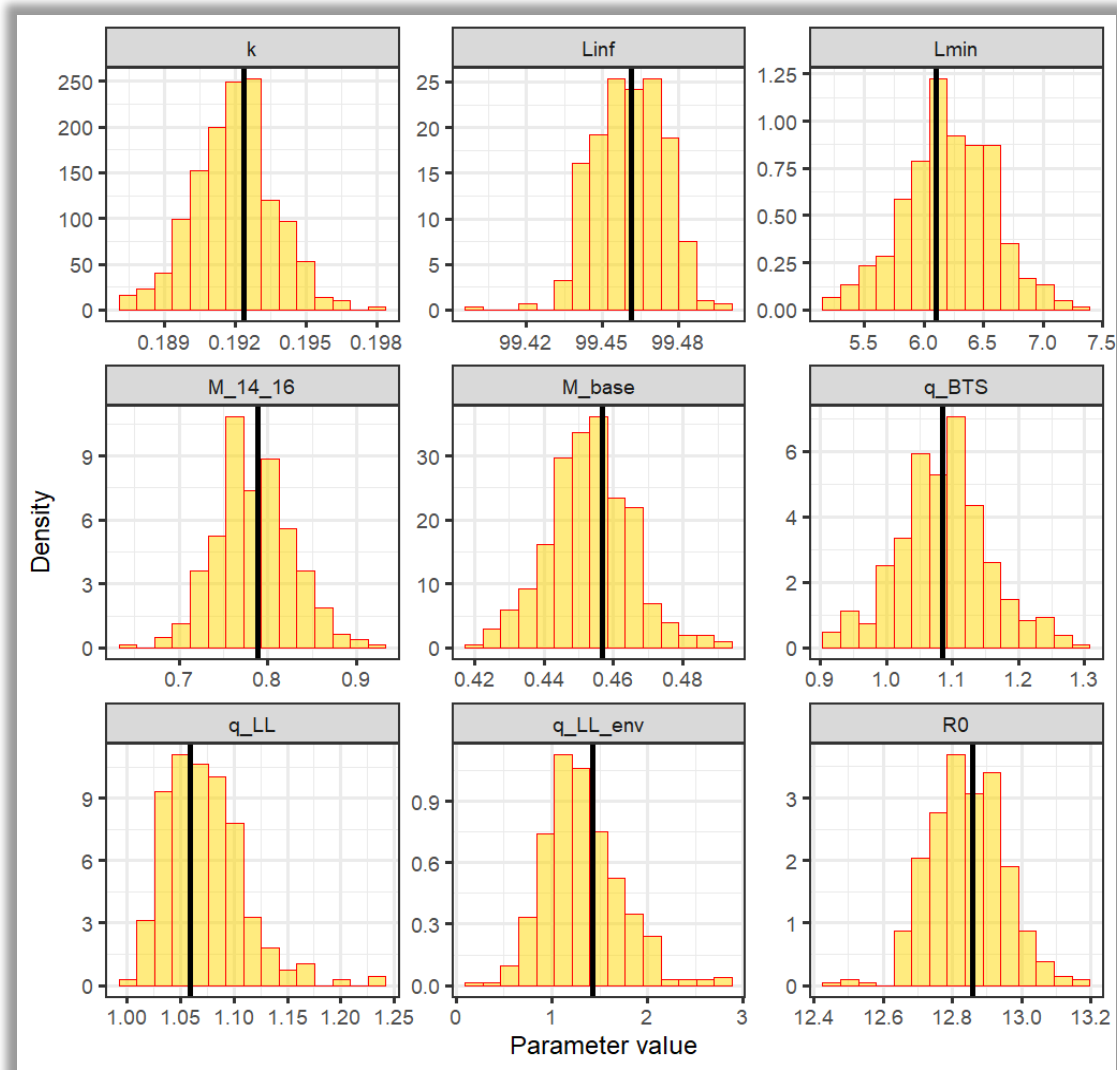
Model diagnostics:

- Leave-one-out: In terms of forecasts, 2022 & 2023 data most influential in last 10 years, driven by index data sources
- Jitter: (CV of 0.05 and 50 runs) 49 of the 50 converged; 80% at MLE



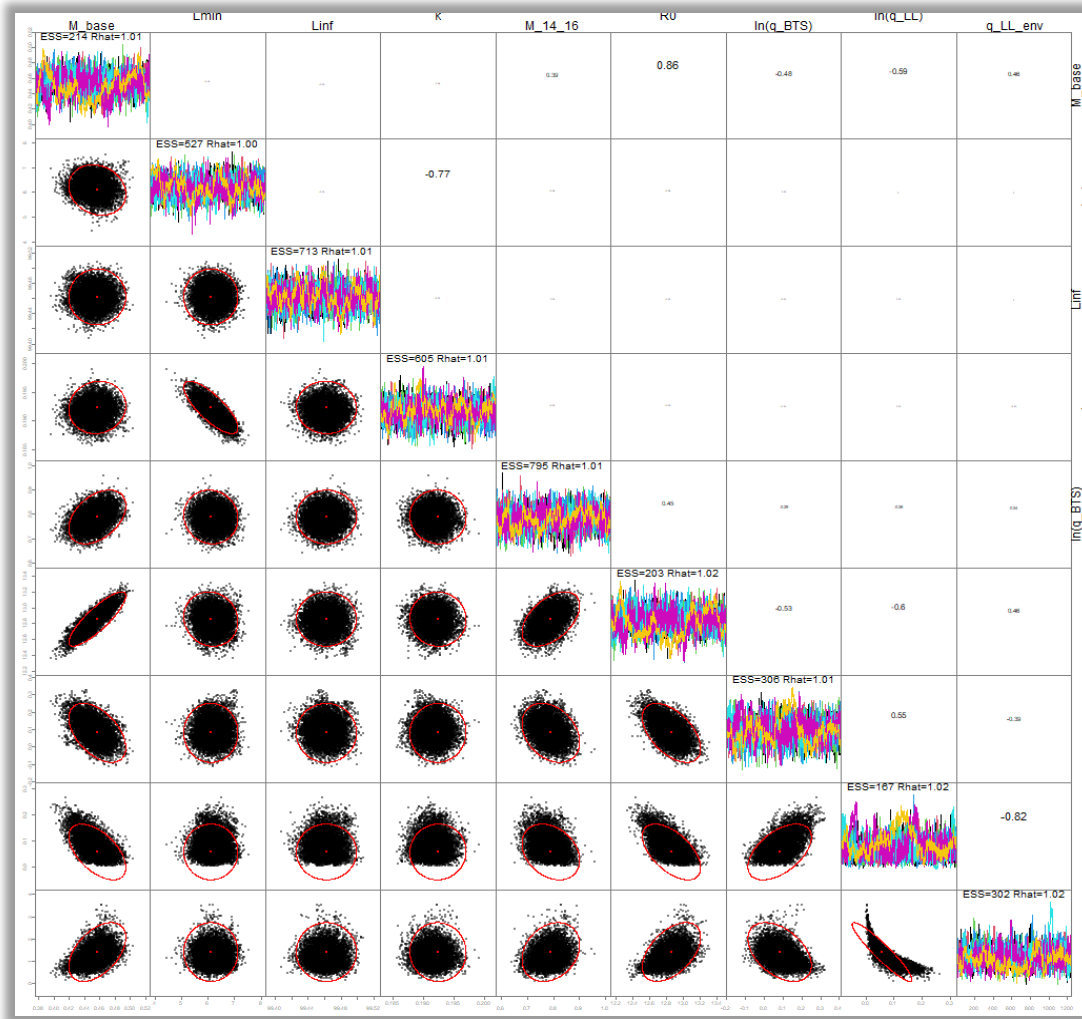
- Model diagnostics: MCMC

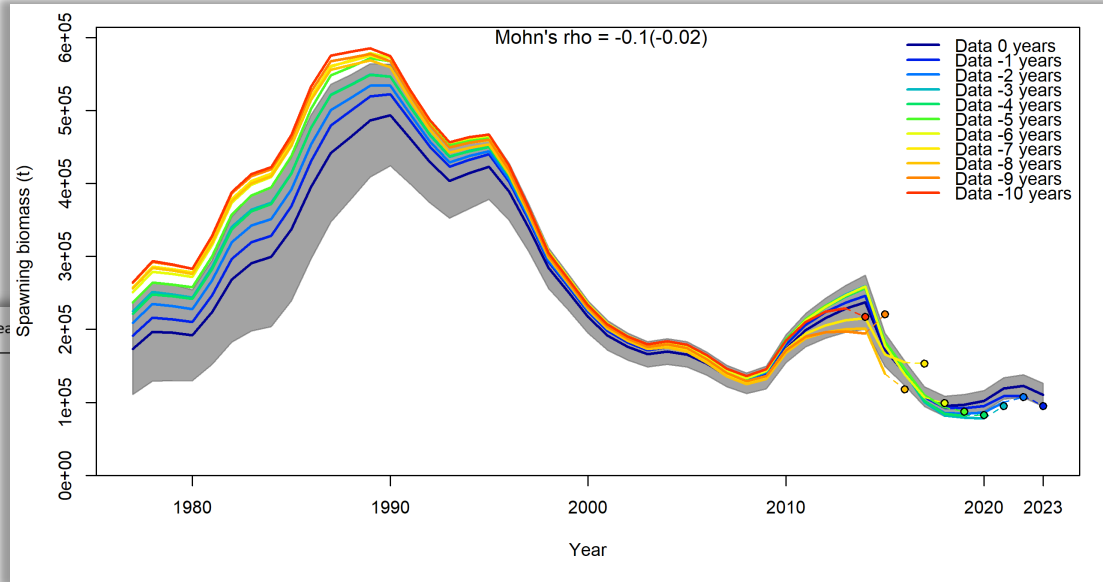
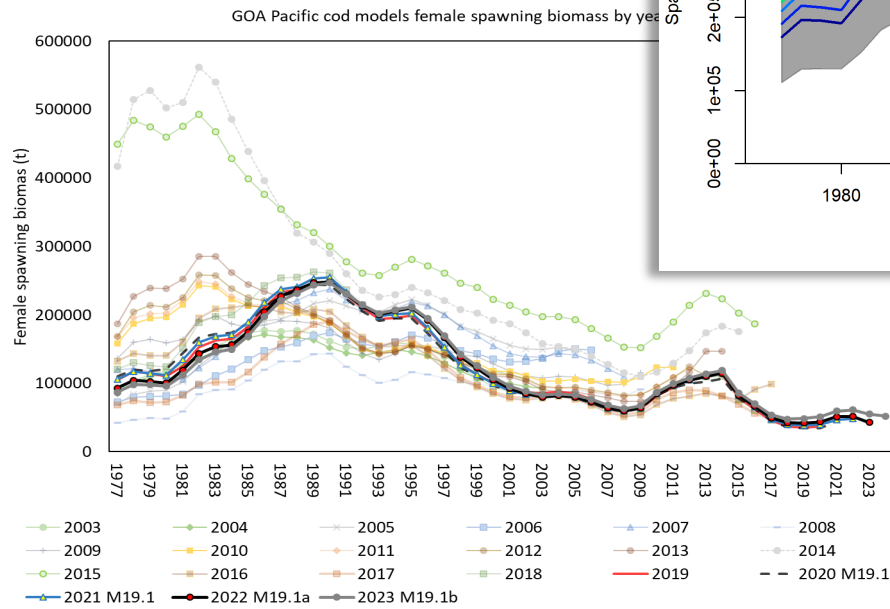
- MLE and MCMC estimates of key parameters in agreement



- Model diagnostics: MCMC

- Chains are mixed, correlations that come up are what we would expect

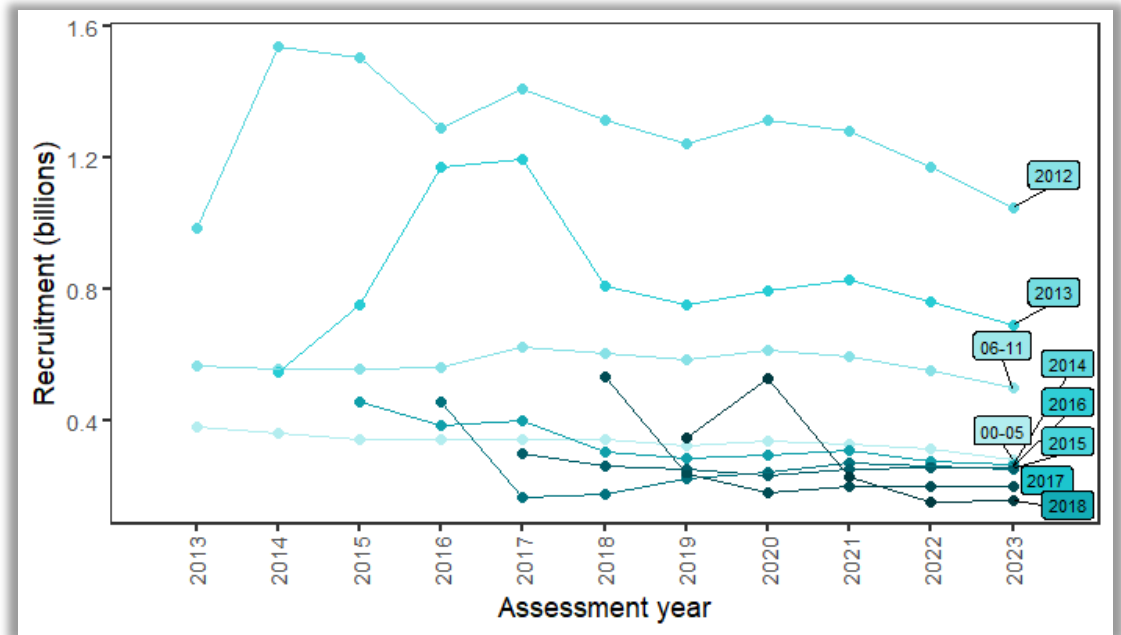




- Low recent SSB retrospective pattern in both model and data (but increased from 2022)

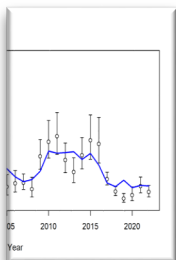
RESULTS: RETROSPECTIVES

- Positive retrospective pattern in recruitment: continues to decrease year-class strength as data added

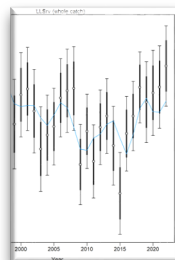


RESULTS: RETROSPECTIVES

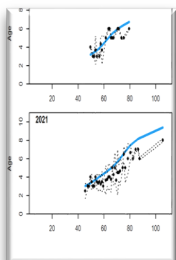
RESULTS - SUMMARY



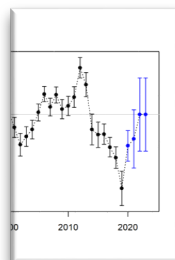
Model fits to indices reasonable, model expects lower index than observed in 2023



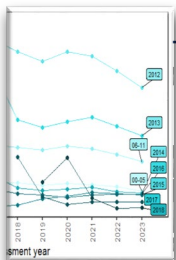
Fitting comp data relatively well, not fitting increase in mean length for some data



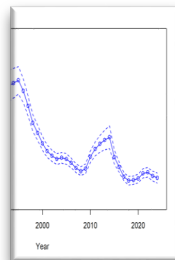
Model expects larger length-at-age in fit to recent conditional age-at-length data



Continuing to estimate below average year-class strength since 2014



Retrospective pattern in estimated year-class strength, continues to decrease with each assessment



Projecting spawning biomass to decrease through 2025, then increase

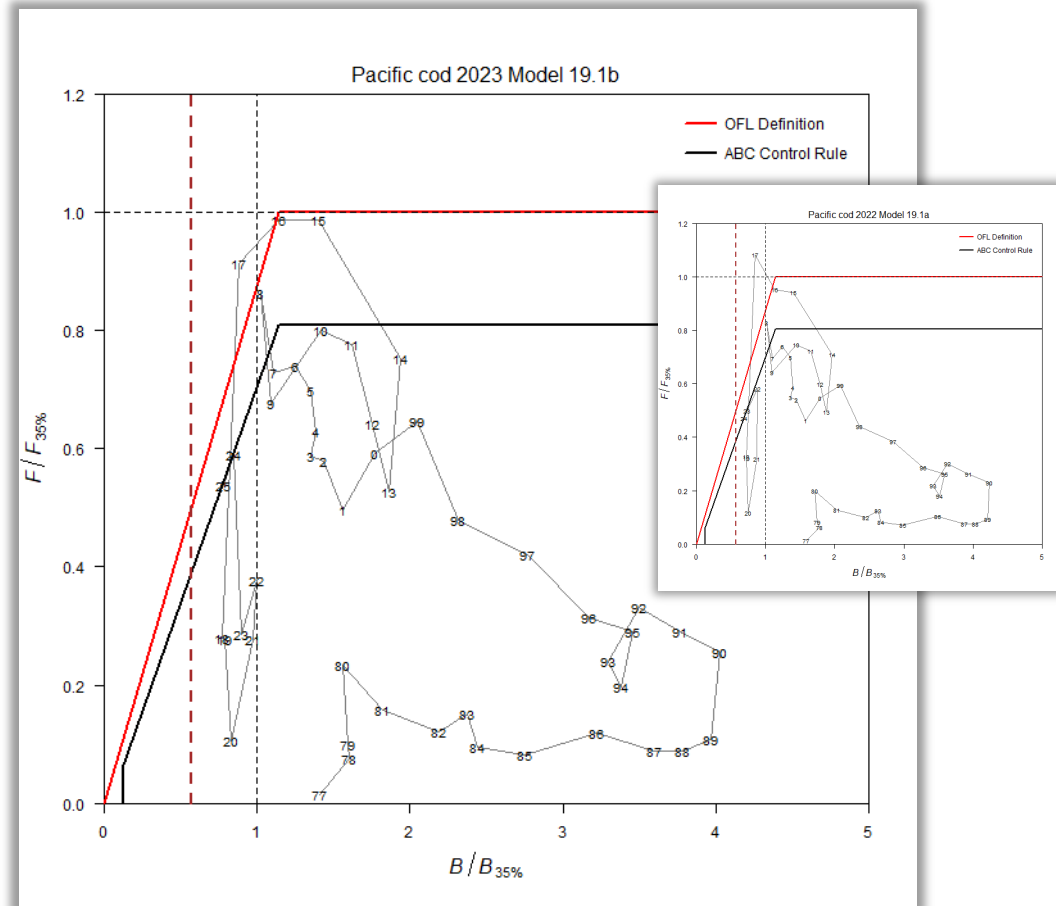
-
- Stock status
 - Risk table
 - ABC/OFL recommendations
 - Apportionment



RESULTS: RECOMMENDATIONS

STOCK STATUS

- Tier 3b: on the ramp
- Moving down the ramp from 24 to 25 (but up the ramp from 2022 assessment)
- Estimated to be above $B_{20\%}$ (dashed red line), 2024 = $B_{29.6\%}$
- Projected to decrease to $B_{27\%}$ in 2025



RISK TABLE

- **Assessment considerations:**

- Fits to data reasonable – keep eye on LL survey fit
- Below average recruitment estimated in last 7 years, and has undesirable retrospective pattern (balanced by decreasing M estimates) – projections sensitive to these results, but not in the short term
- Negative SSB retrospective pattern – but that’s not bad, and not large
- There are sources of uncertainty in this assessment, but nothing that is outside the norm for any of our assessments
- Description of level 2: *“Major problems with the stock assessment; very poor fits to data; high level of uncertainty; strong retrospective bias.”* – not the case here
- Lower Assessment considerations from Level 2 to Level 1

RISK TABLE

- **Pop dy considerations:**

- Low levels of biomass persists – this continues to be a **major** concern, primarily because of how close to biomass reference limits we are
- As estimated by the model, recruitment has been below average since 2014
- We've learned population is sensitive to environmental conditions

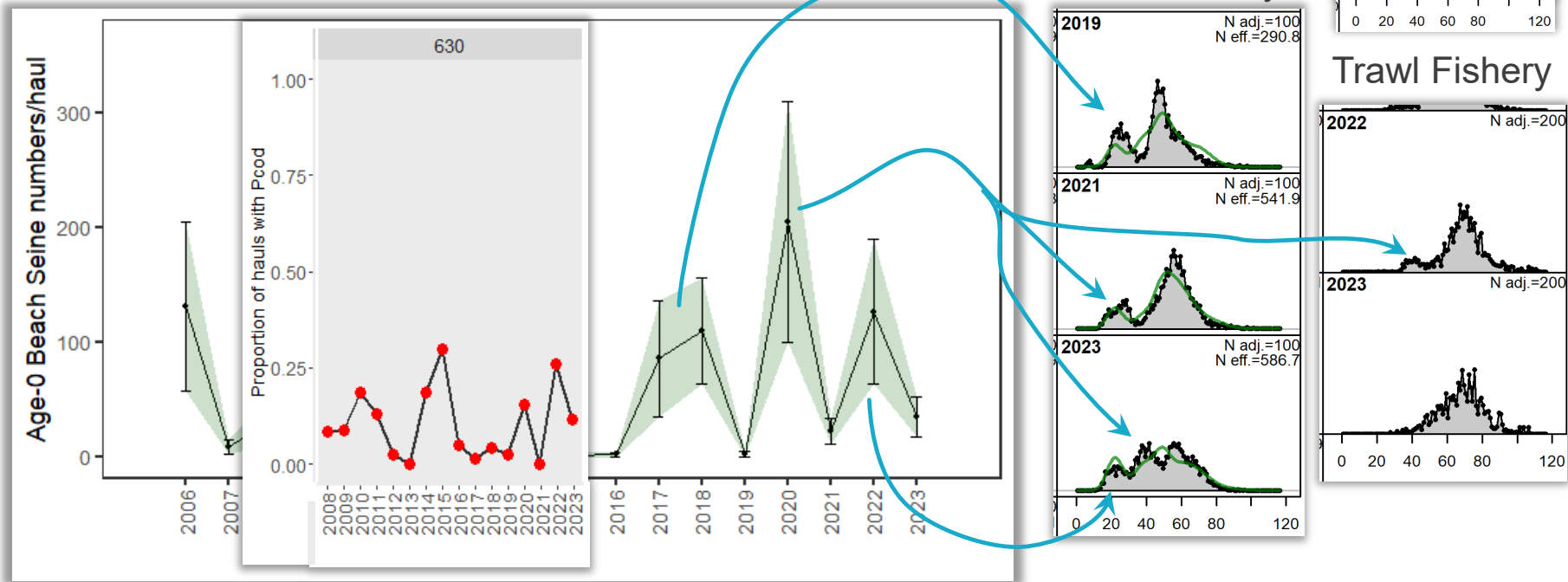
- **Discussion:**

1. Dig into recruitment: is there any evidence of recent recruitment in data, have we been here before, and what are the consequences?
2. Dig into relationship between pop'n size/recruitment with past environmental conditions, how has the pop'n responded?

RISK TABLE

- **Pop dy considerations: Recruitment**

- Is there any evidence of recent recruitment in data?



- 2017/18, 2020, and 2022 shows up in length comps, notably in trawl fishery

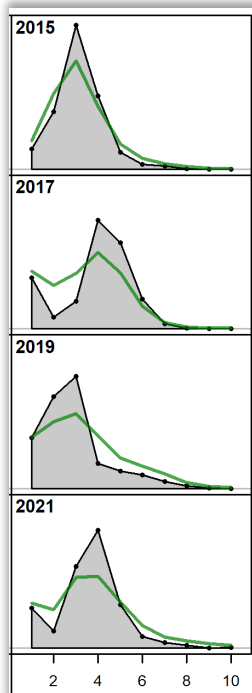


RISK TABLE

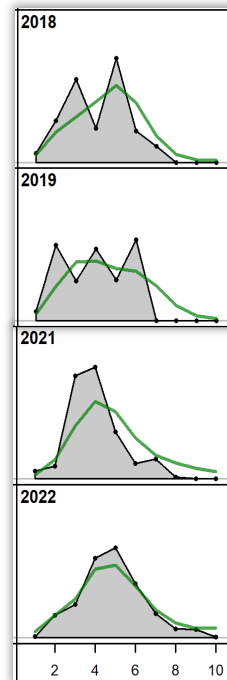
- **Pop dy considerations: Recruitment**

- Is there any evidence of recent recruitment in data?

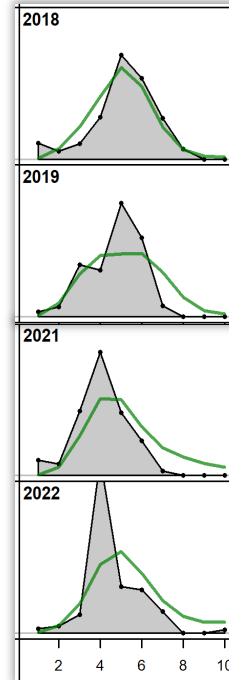
Trawl Survey



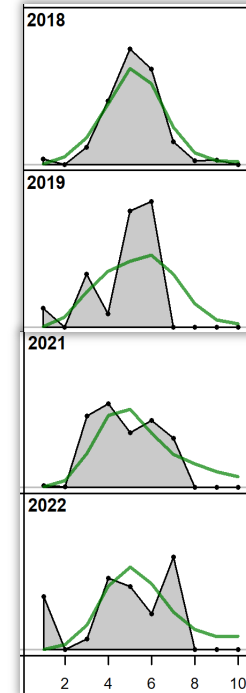
Trawl Fishery



Longline



Pot



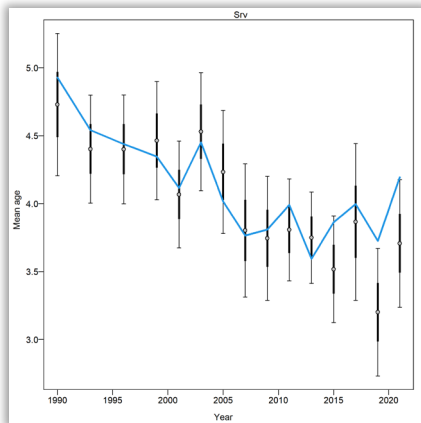
- Consistent underestimation of recent age +3 abundance

RISK TABLE

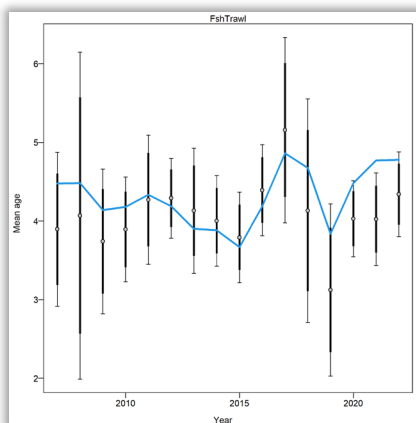
- **Pop dy considerations: Recruitment**

- Is there any evidence of recent recruitment in data?

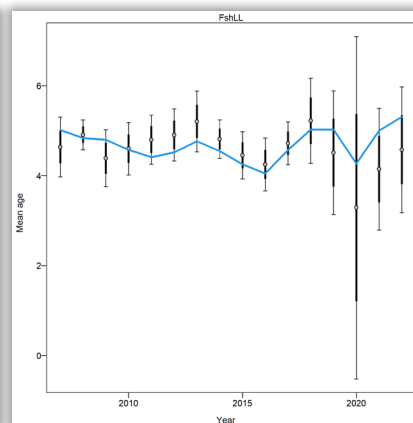
Trawl Survey



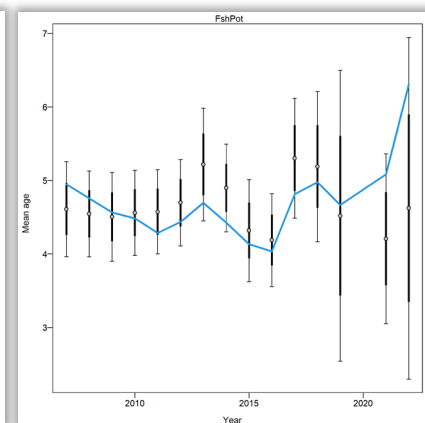
Trawl



Longline



Pot



- Estimated mean age > observed mean age

RISK TABLE

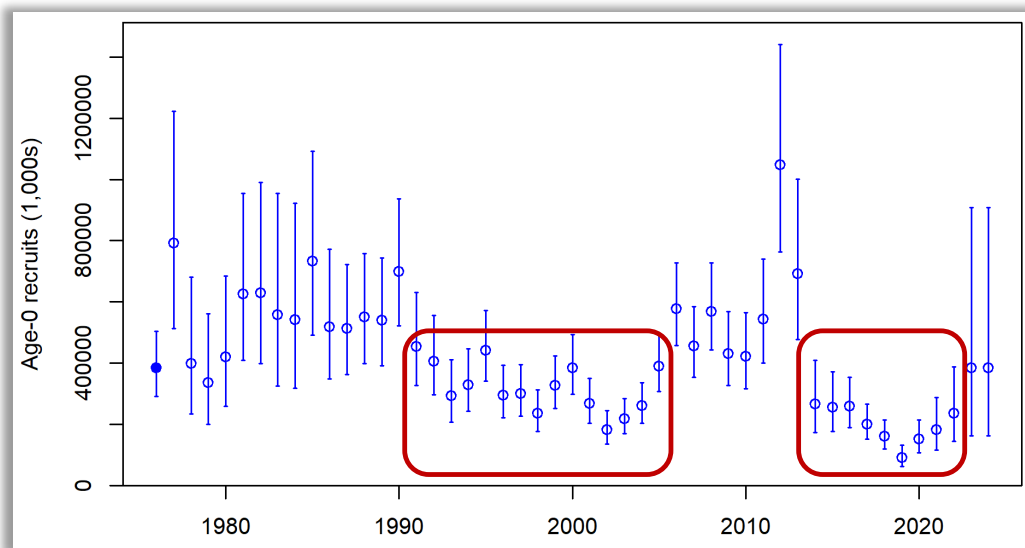
■ Pop dy considerations: Recruitment

- Is there any evidence of recent recruitment in data? Yes
 - Age-0 index and mid-water Pollock line up for at least the 2020 and 2022 year classes
 - These year classes are also seen in Trawl survey length comp data (with 2017/2018 as well), 2020 emerged in Trawl fishery
- Is the model fitting it? No
 - Fit to recent year classes in Trawl length comp data fit poorly (mostly in sense that model expects less than what is in data)
 - Consistent underestimation of abundance of age 3-4 in age comp data for all data sources
 - Consistent overestimation of mean age (meaning, the model estimates less younger fish than observed)
- Summary: considerable uncertainty in accuracy of model estimates of recent recruitment

RISK TABLE

- **Pop dy considerations: Recruitment**

- Have we been here before?



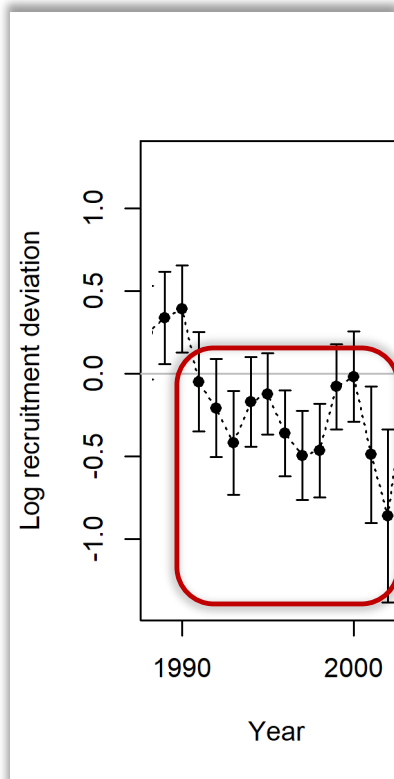
- 2019 draws eye to how low it is, but others similar in scale to what was seen in late 90s – early 00s

RISK TABLE

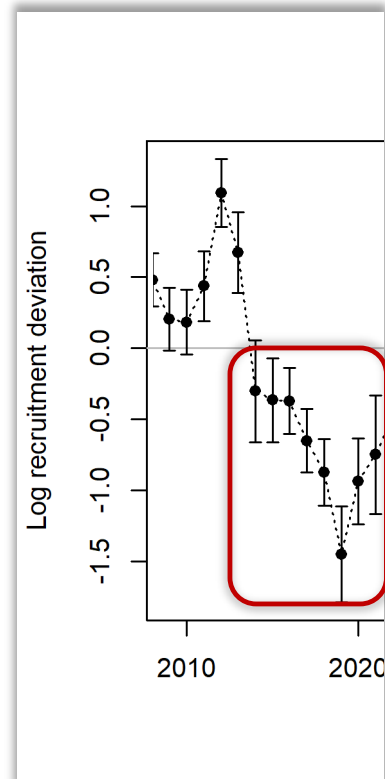
- **Pop dy considerations: Recruitment**

- Have we been here before?
- Data retrospective: 12 consecutive below avg recruitment with data through 2004

2004 assessment



2023 assessment



RISK TABLE

■ Pop dy considerations: Recruitment

- Have we been here before?
- Model retrospective: 11 of 14 years with below avg recruitment in 2005 assessment

2005 assessment

(Thompson and Dorn, 2005)

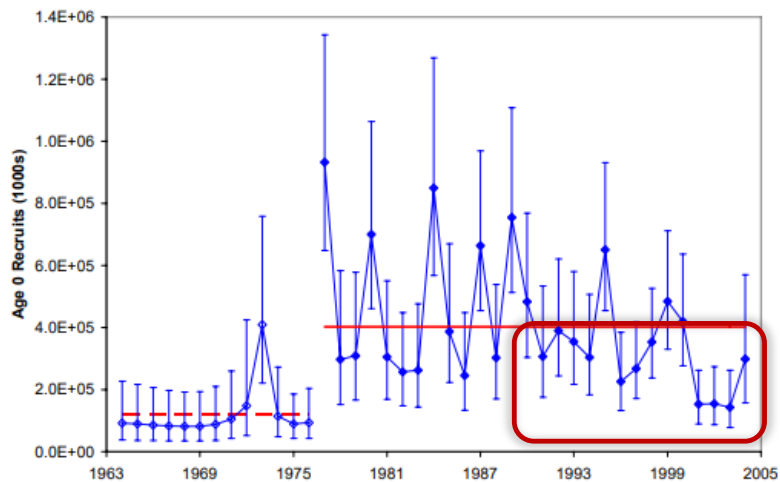
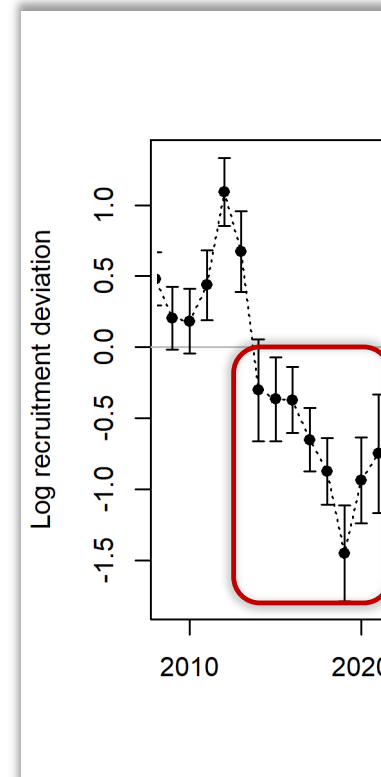


Figure 2.13—Time series of GOA Pacific cod recruitment at age 0, with 95% confidence intervals, as estimated by Model 3.

2023 assessment



RISK TABLE

- **Pop dy considerations: Recruitment**

- Have we been here before?
- Model retrospective: 11 of 14 years with below avg recruitment in 2005 assessment

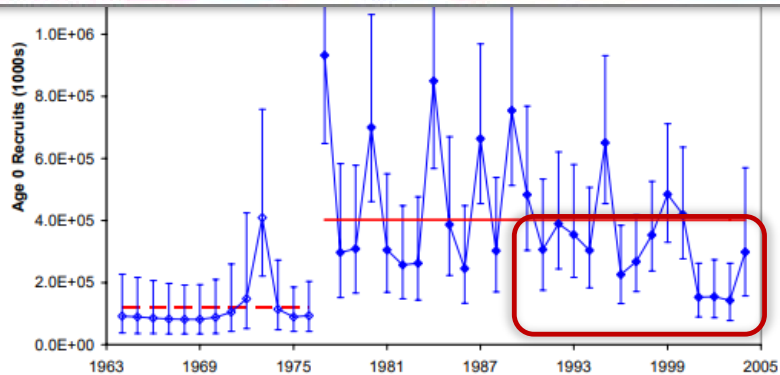
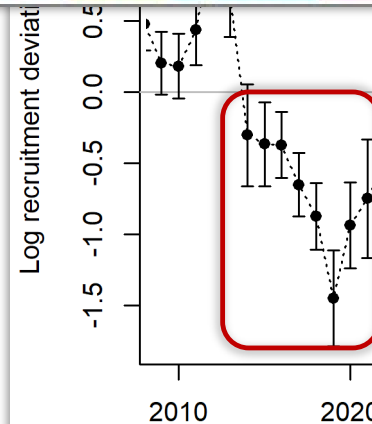
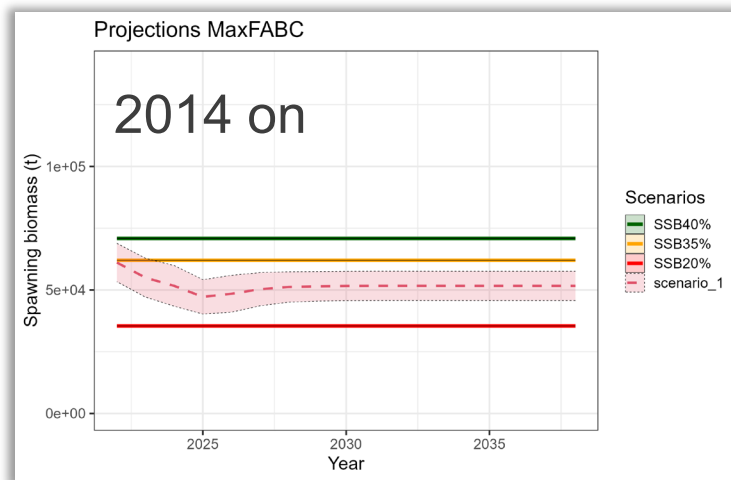
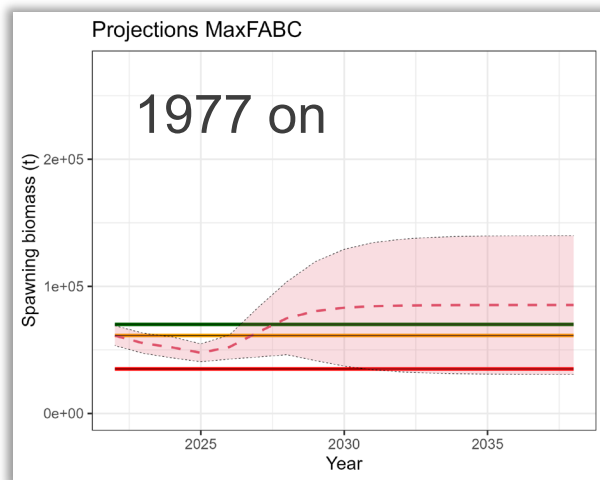


Figure 2.13—Time series of GOA Pacific cod recruitment at age 0, with 95% confidence intervals, as estimated by Model 3.



RISK TABLE

- Pop dy considerations: Recruitment
 - What are the consequences? SSB
 - Use mean recruitment from 2014 on in projections

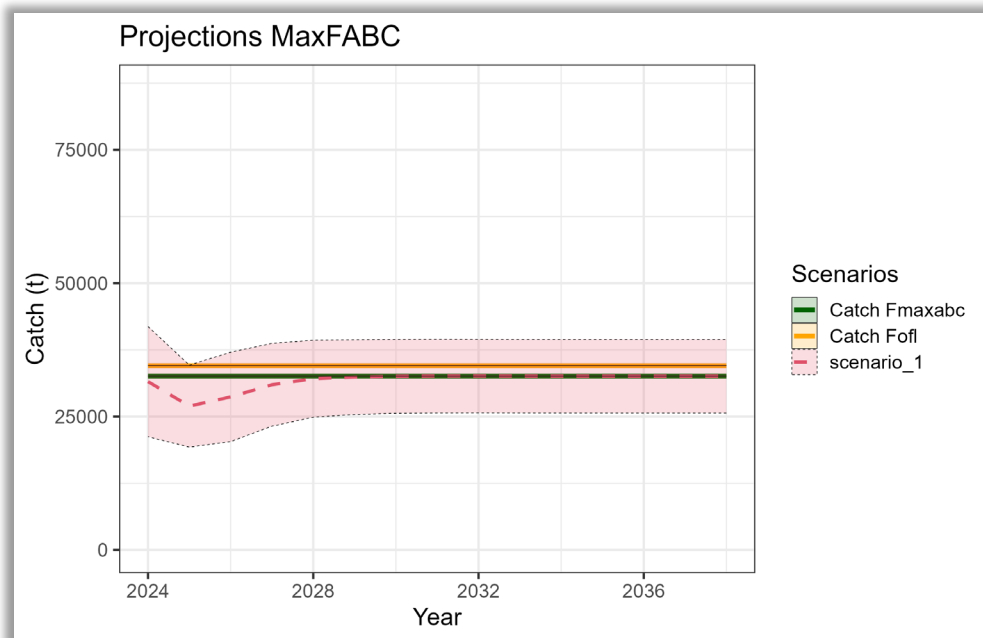


- Short term consequences: ~ 2% difference in 2024 ABC
- Long term consequences: never get back to $B_{35\%}$, hover around $B_{29\%}$

RISK TABLE

- **Pop dy considerations: Recruitment**

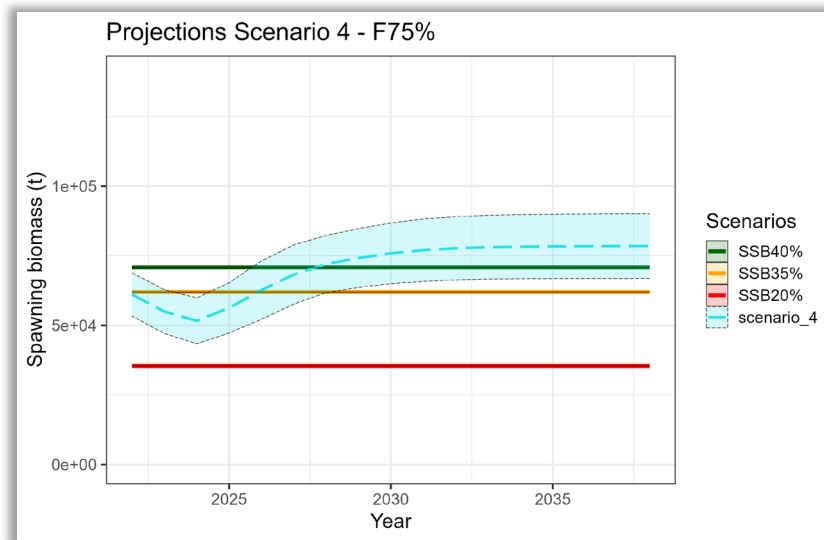
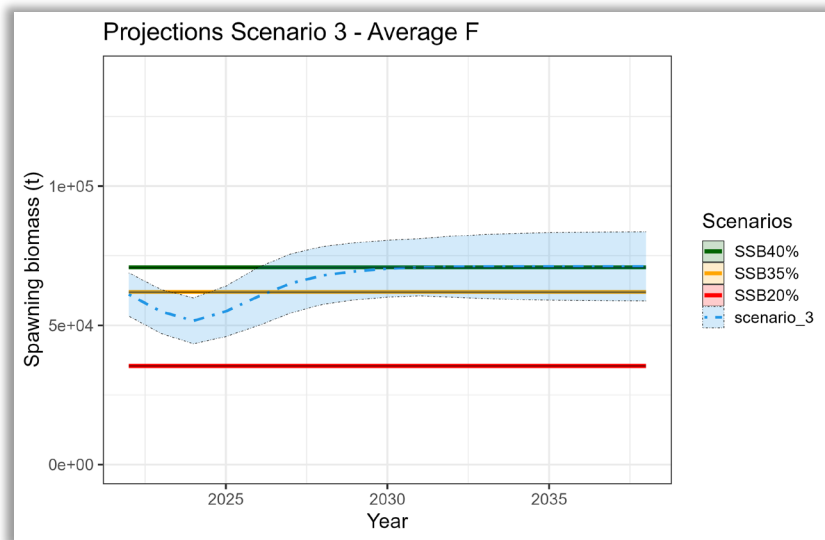
- What are the consequences? ABC
- With recent mean recruitment, projected ABC dips in short term, then hovers around 30,000 t



RISK TABLE

■ Pop dy considerations: Recruitment

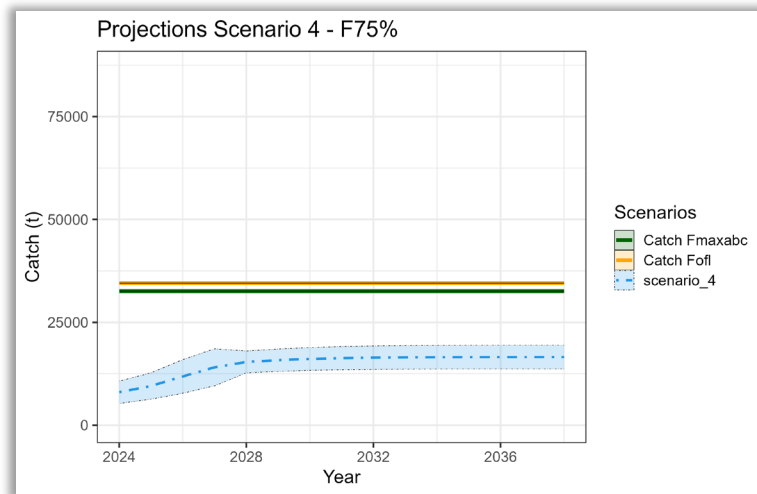
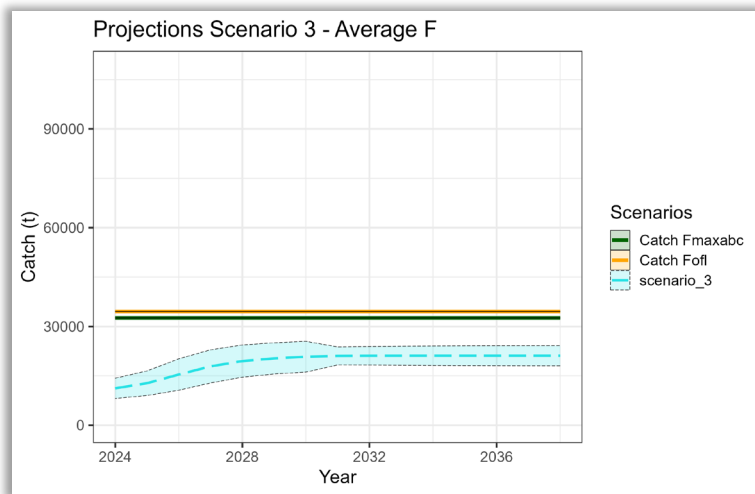
- 1 recent mean recruitment here to stay, is there a way to rebuild?
- 2 scenarios rebuild to at or above $B_{40\%}$



RISK TABLE

■ Pop dy considerations: Recruitment

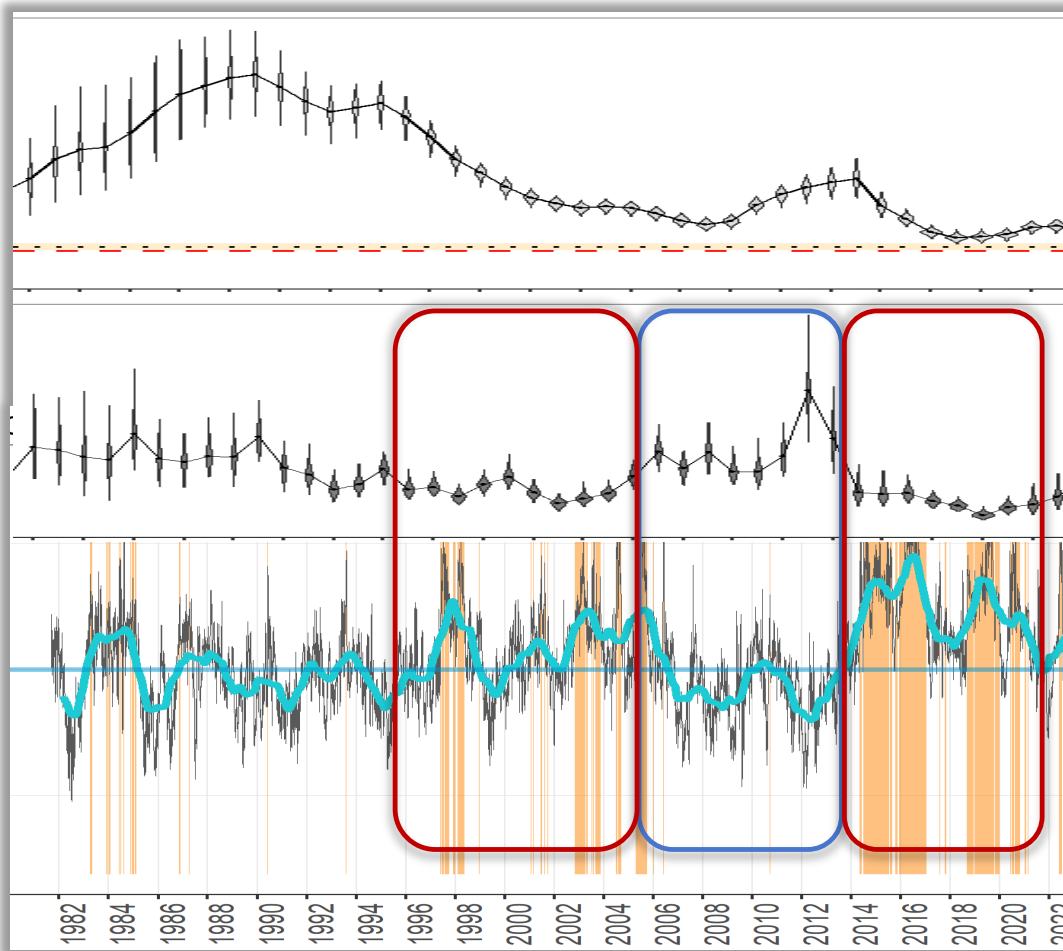
- I recent mean recruitment here to stay, is there a way to rebuild?
- 2 scenarios rebuild to at or above $B_{40\%}$



- Avg F: 2024 ABC ~ 11,000 t, long term ~21,000 t
- F75%: 2024 ABC ~ 8,000 t, long term ~ 16,500 t
- But, is recent mean recruitment here to stay?

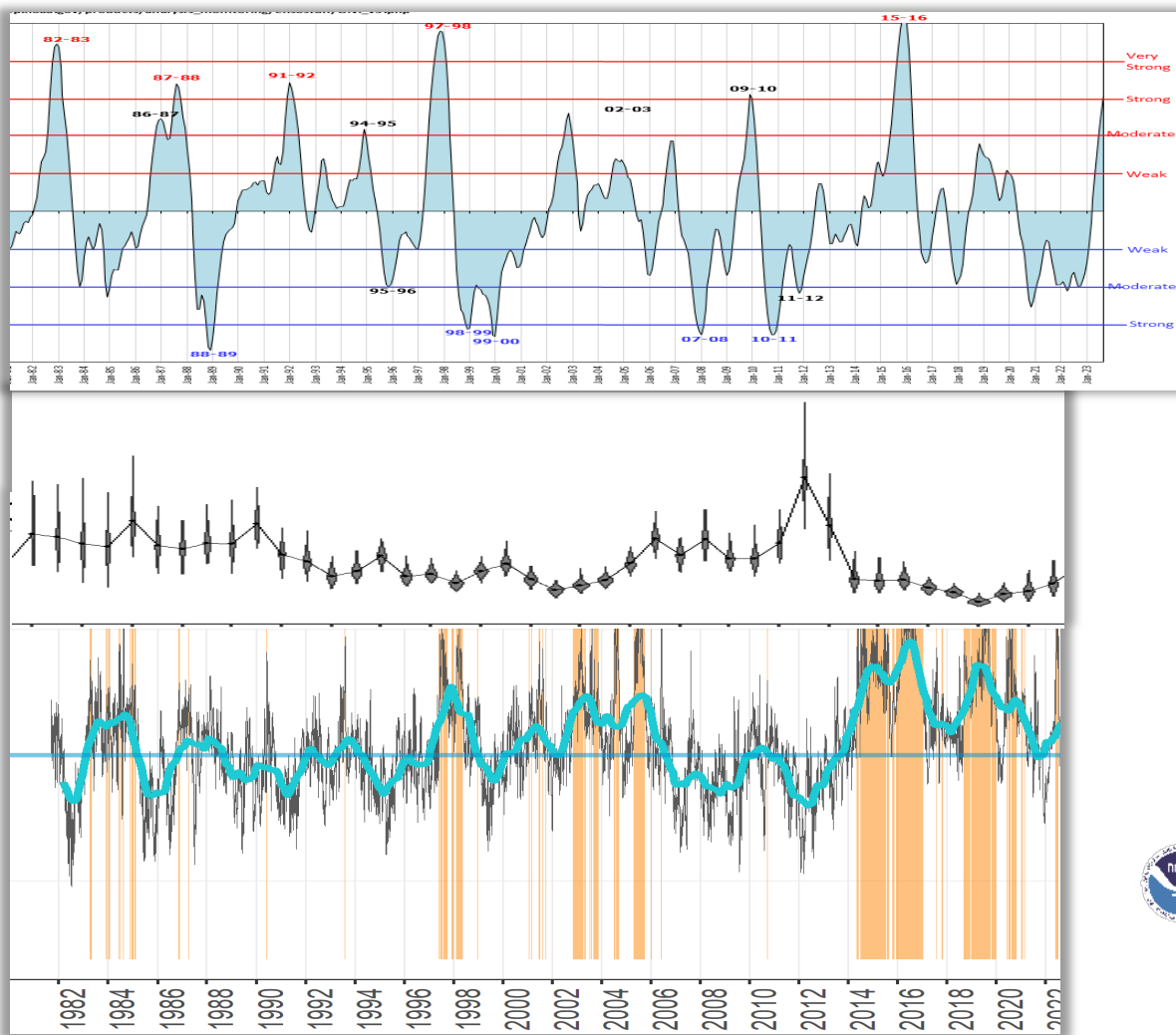
RISK TABLE

- Pop dy considerations: Relationships with environmental conditions



RISK TABLE

- Pop dy considerations: Relationships with environmental conditions
- El Nino:



RISK TABLE

- **Pop dy considerations:**

- Low levels of biomass persists – this continues to be a **major** concern, primarily because of how close to biomass reference limits we are
- As estimated by the model, recruitment has been below average since 2014
- We've learned population is sensitive to environmental conditions
- Level 2: *“Stock trends are highly unusual; very rapid changes in stock abundance, or highly atypical recruitment patterns.”*
- Level 3: *“Stock trends are unprecedented; More rapid changes in stock abundance than have ever been seen previously, or a very long stretch of poor recruitment compared to previous patterns.”*
- Based on evidence available, rank at Level 2



RISK TABLE

- Environmental/ecosystem considerations:
 - Conditions have improved compared to recent past
 - Level 1
- Fishery performance:
 - No signals of adverse performance/behavior
 - Level 1
 - But, we have a fleet (pot) that constitutes a large amount of catch that has relatively low observer sampling

RISK TABLE: SUMMARY

Assessment-related considerations	Population dynamics considerations	Environmental /ecosystem considerations	Fishery Performance
Level 1: Normal	Level 2: Major concern	Level 1: Normal	Level 1: Normal

ABC/OFL RECOMMENDATIONS

- Do we reduce from maxABC?
 - Low levels of biomass will remain a concern until (if) pop'n rebuilds
 - Recent recruitment estimates concerning, but, there's evidence model isn't fitting recent year classes well, and, in terms of magnitude of recruitment, we've been here before
 - Information provided as to consequences of low recent recruitment becoming the norm, and associated catches to rebuild, but, there is substantial uncertainty associated with long term projections
 - What is risk to stock of doing major damage based on the 2024 ABC recommendation?
 - If we have a major environmental event in the next year or two, is reducing ABC this year going to mitigate the pop'n decline? Would reduction in catches around 2015 have mitigated pop'n crash?
 - Will pop'n decrease next year? Possibly, but the model will track any decrease or increase
 - Keep in mind: stock in Tier 3b, reduction in ABC has already occurred



ABC/OFL RECOMMENDATIONS

- Historical context:
 - Short-term (with Model 2019.1 series): 2021 → 2022 ↑**39%**, 2022 → 2023 ↓**25%**, was model used to determine stock $<B_{20\%}$ in 2020
 - Long-term (with what we estimate from model now): Avg SSB from 2018-2023 24% smaller than 2006-2010, Avg ABC from 2018-2023 (taking out 2020) 64% smaller than 2006-2010
- **Recommendation:** no reduction from maxABC

ABC/OFL RECOMMENDATIONS

- Recommend Model 19.1b: 31% increase in 2024 ABC compared to 2023

Quantity	As estimated or <i>specified last</i> year for:		As estimated or <i>specified this</i> year for:	
	2023	2024	2024	2025
<i>M</i> (natural mortality rate)	0.49*	0.49*	0.46*	0.46*
Tier	3b	3b	3b	3b
Projected total (age 0+) biomass (t)	163,477	193,510	184,242	203,207
Female spawning biomass (t)				
Projected	42,764	40,489	51,959	47,931
<i>B</i> _{100%}	167,414	167,414	175,187	175,187
<i>B</i> _{40%}	66,966	66,966	70,075	70,075
<i>B</i> _{35%}	58,595	58,595	61,315	61,315
<i>F</i> _{OFL}	0.51	0.48	0.52	0.48
<i>maxF</i> _{ABC}	0.41	0.39	0.42	0.38
<i>F</i> _{ABC}	0.41	0.39	0.42	0.38
OFL (t)	29,737	27,507	38,712	33,970
<i>maxABC</i> (t)	24,634	22,683	32,272	28,184
ABC (t)	24,634	22,683	32,272	28,184
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

*Base natural mortality *M* varies between 0.46 and 0.79
 ** Assumed 2023 catch to be the 2023 ABC. For 2025 projections, the 2024 catch was assumed to be at the projected ABC.



APPORTIONMENT

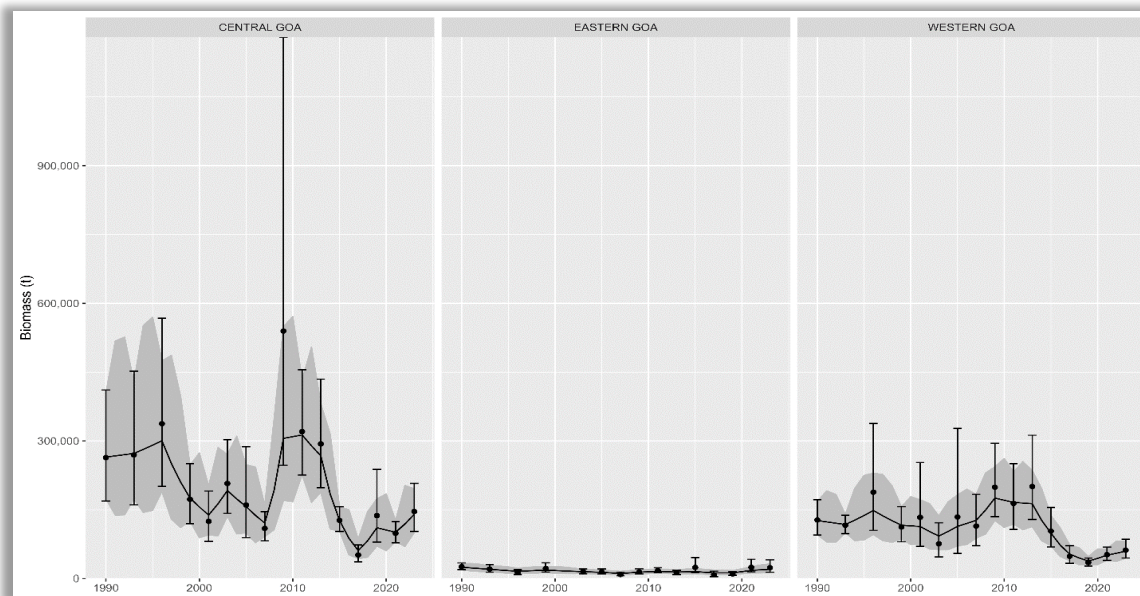
- Updated with 2023 bottom trawl survey

↑17%

↑39%

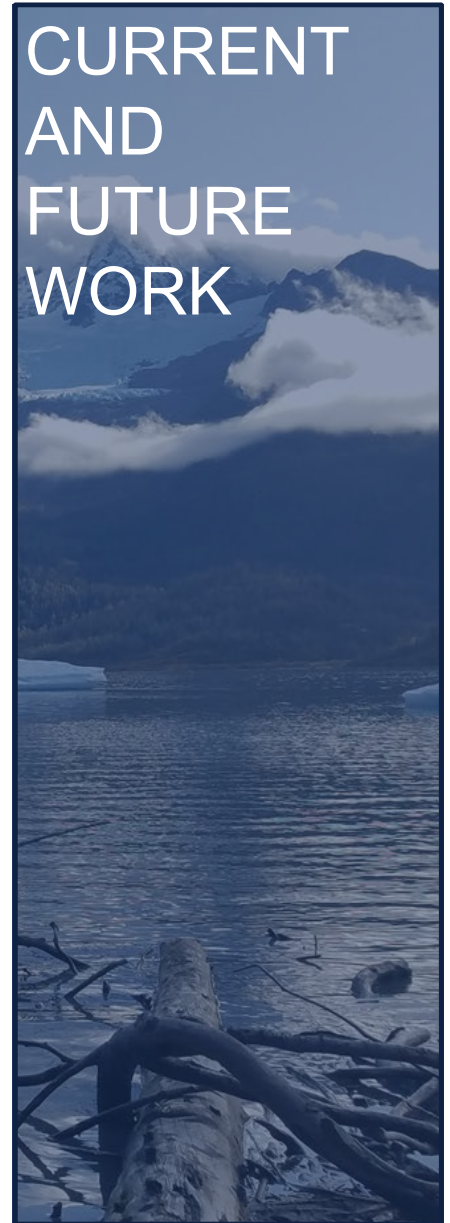
↑26%

	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



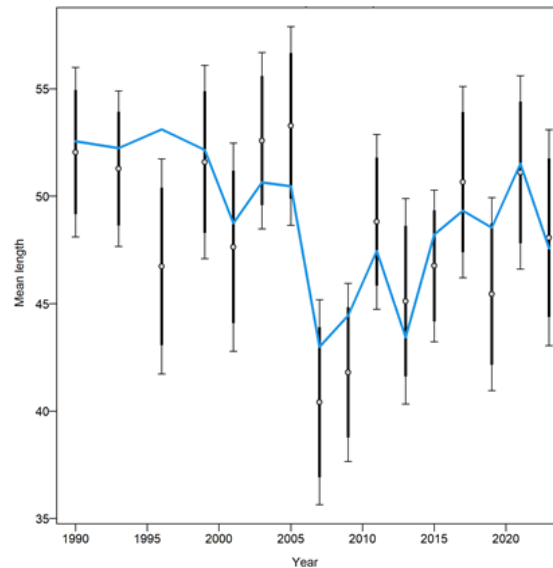
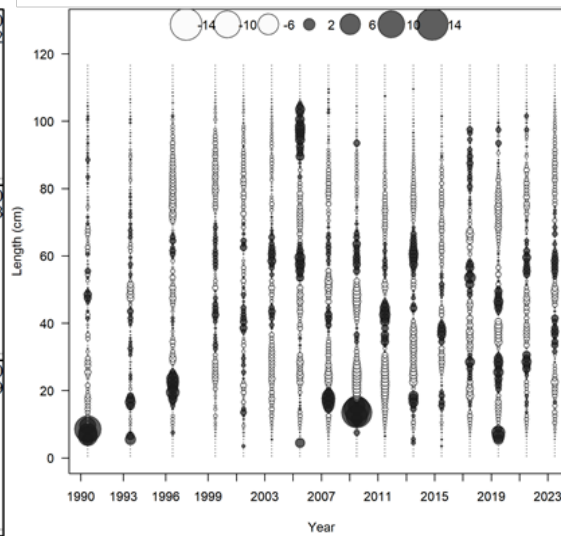
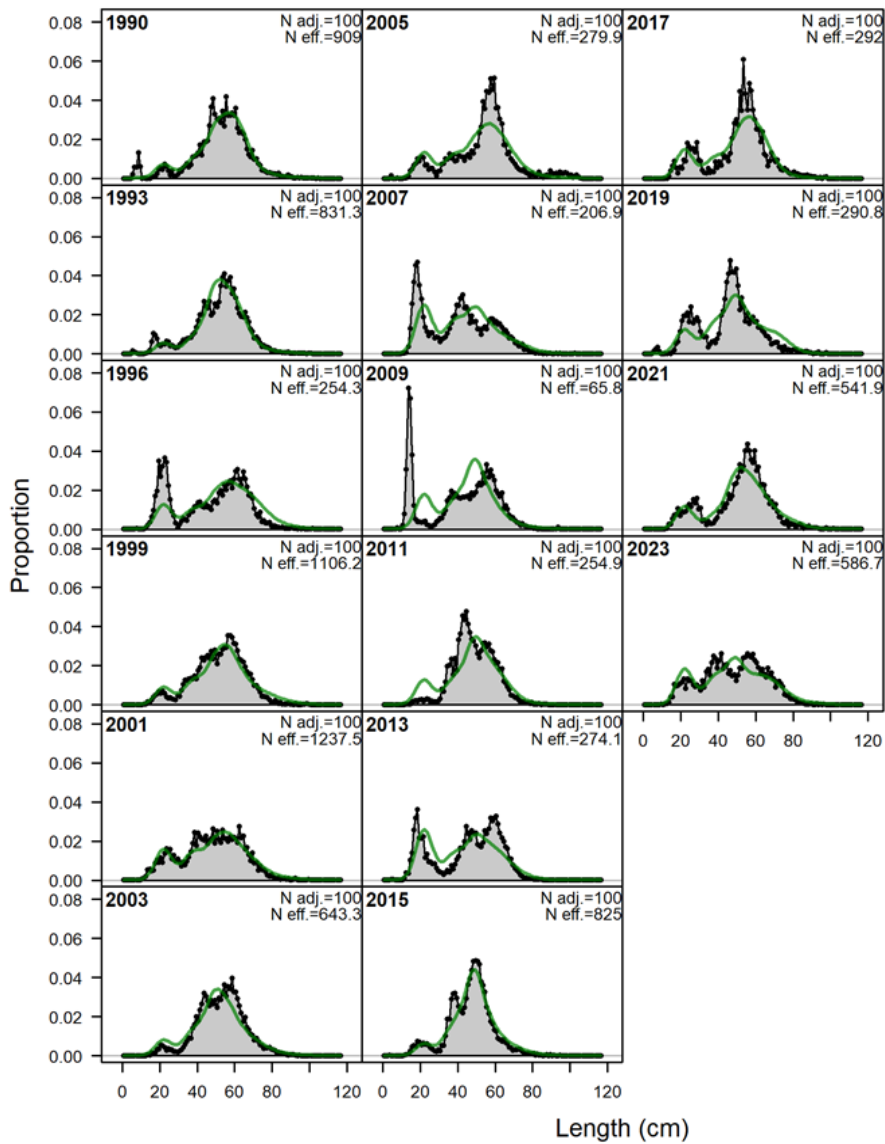
- Current research:
 - Krista Oke: env links
 - OSU: spatial model for WGOA/EBS
- Assessment to do:
 - Look at 2 index REMA model for apportionment
 - Bin structure
 - Input sample size for comp data
 - Look at what data used for conditional age-at-length
 - Start looking at TMB
 - Growth evaluations
- Something else to consider:
 - Maturity information

CURRENT AND FUTURE WORK



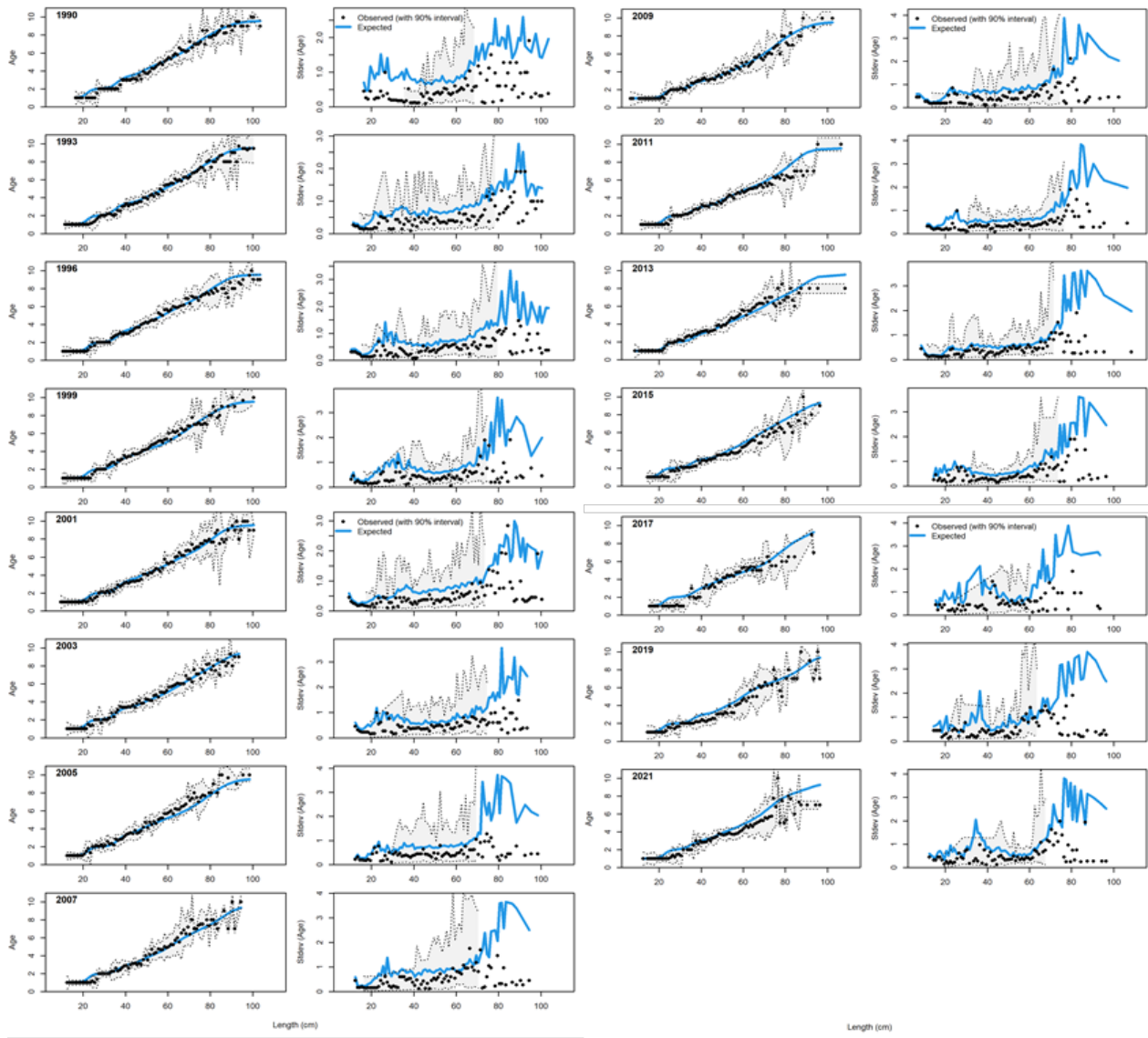
QUESTIONS?





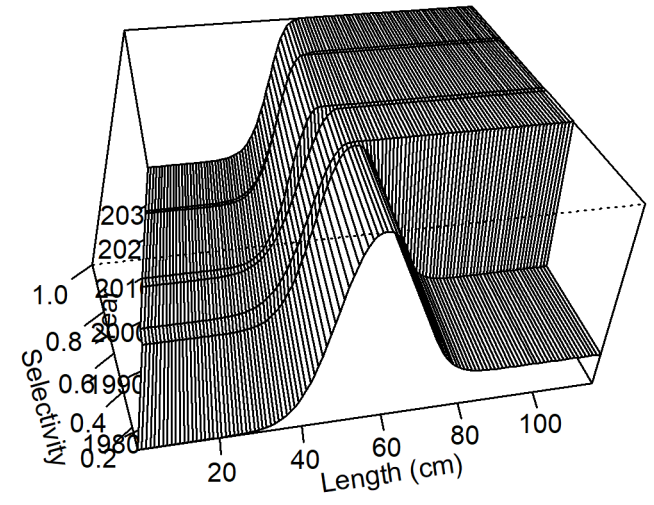
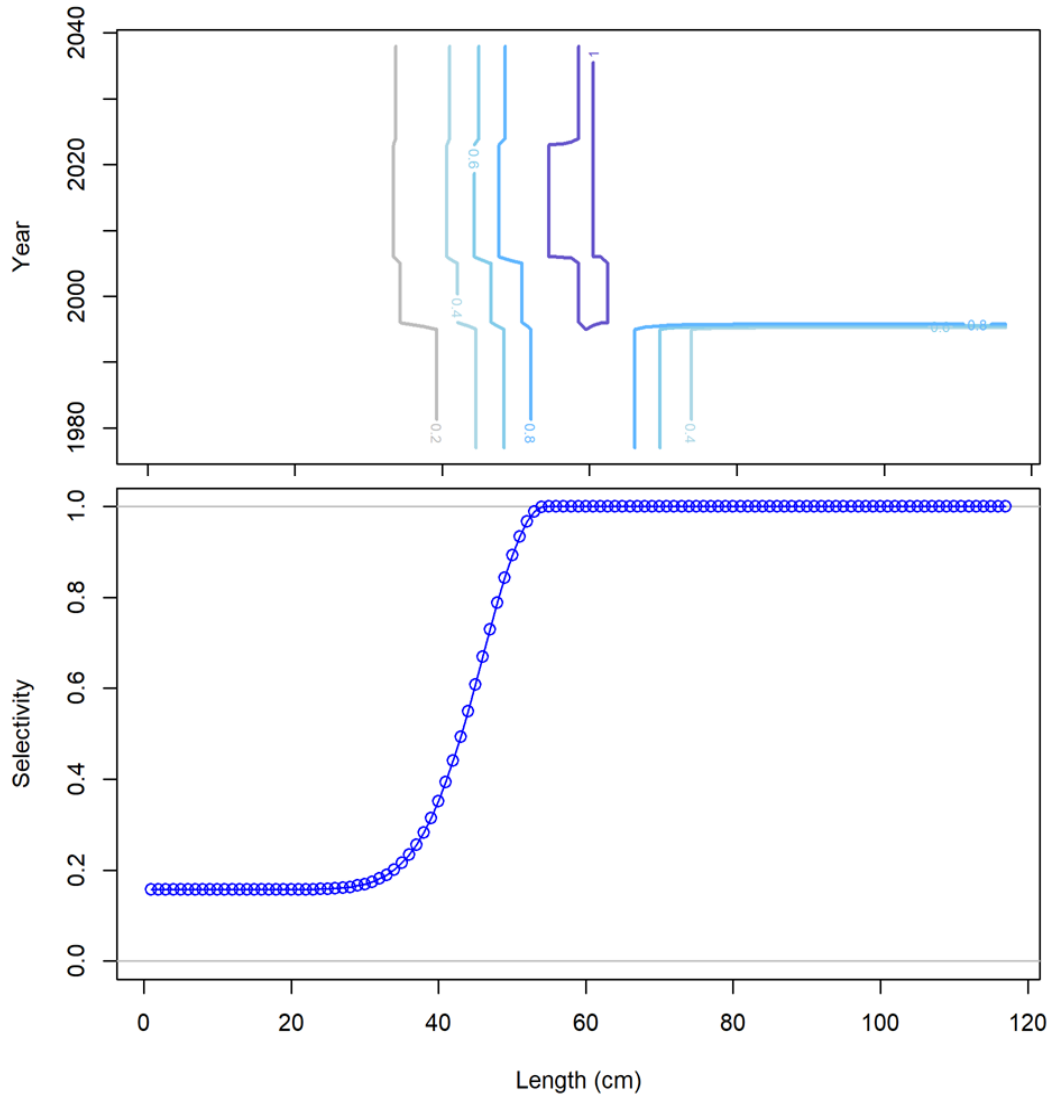
■ AFSC bottom trawl survey length comps



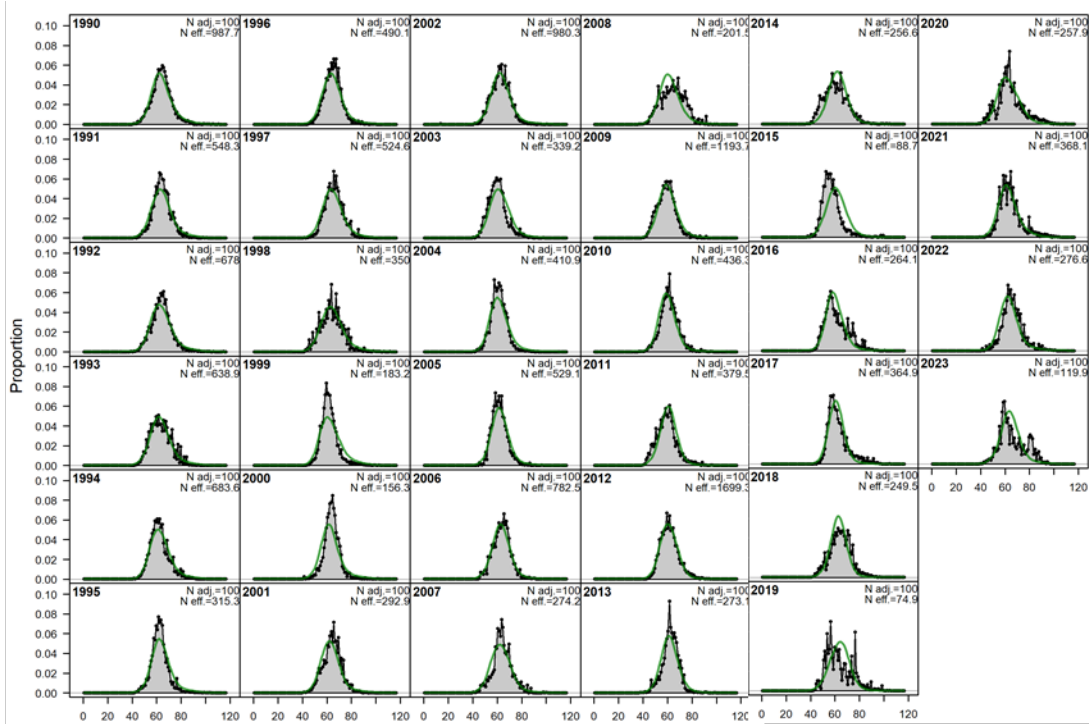


■ AFSC bottom trawl survey conditional age-at-length

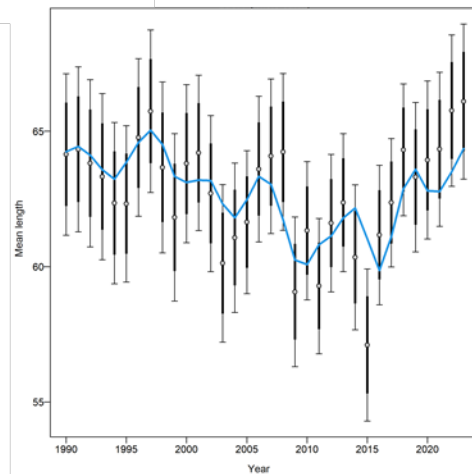
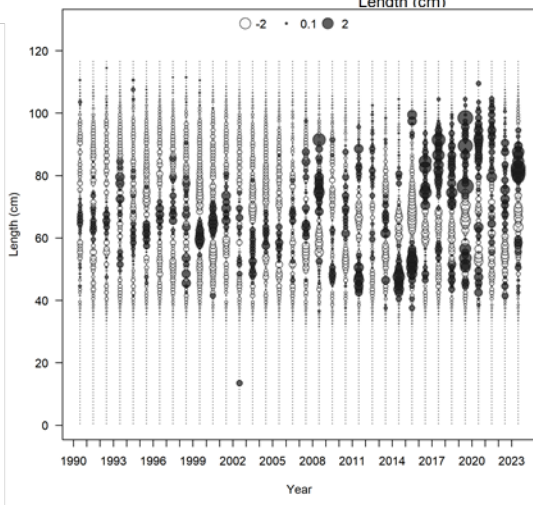


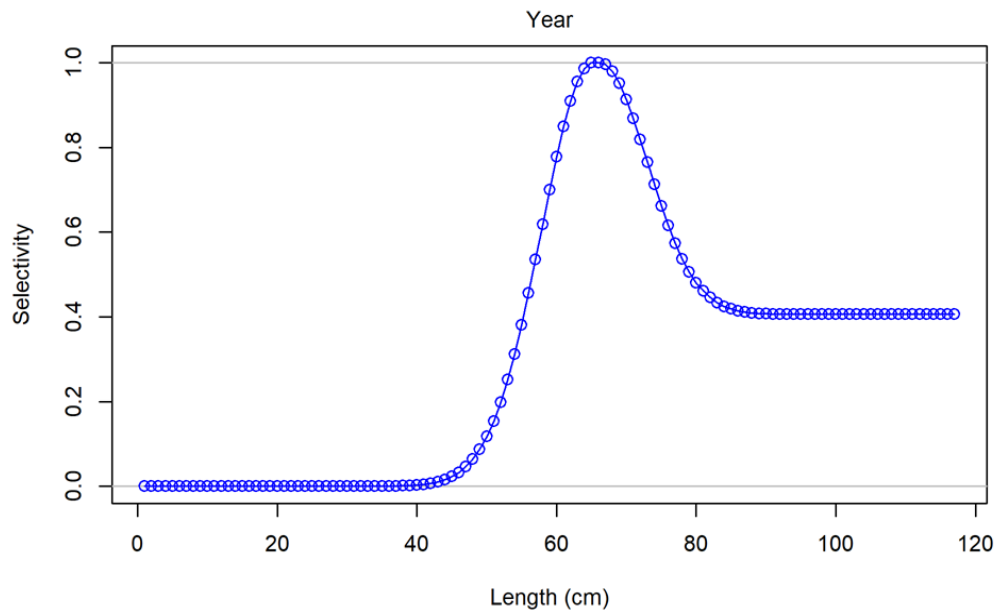
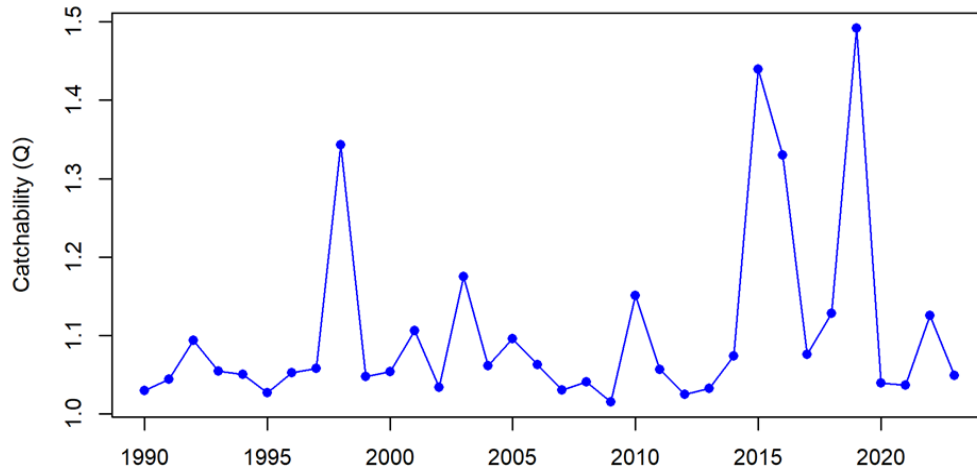


- AFSC bottom trawl survey selectivity

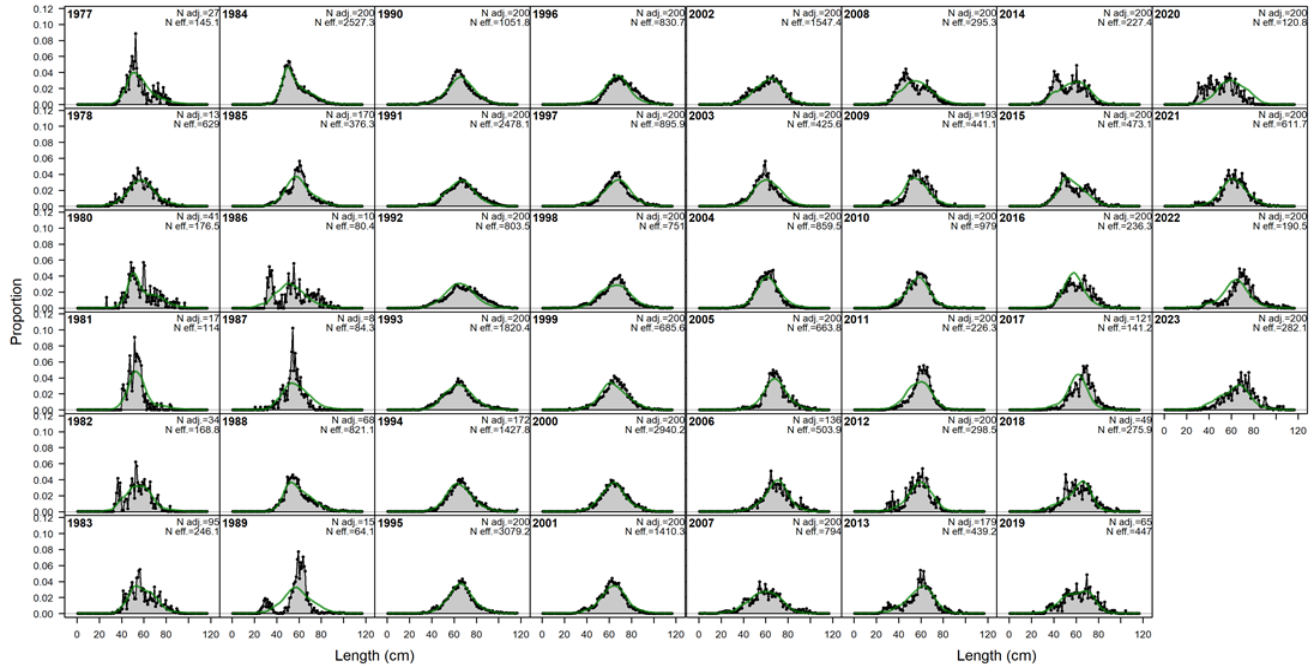


- AFSC longline survey length comps

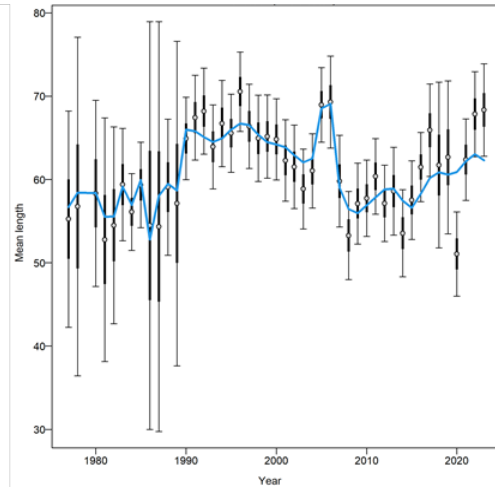
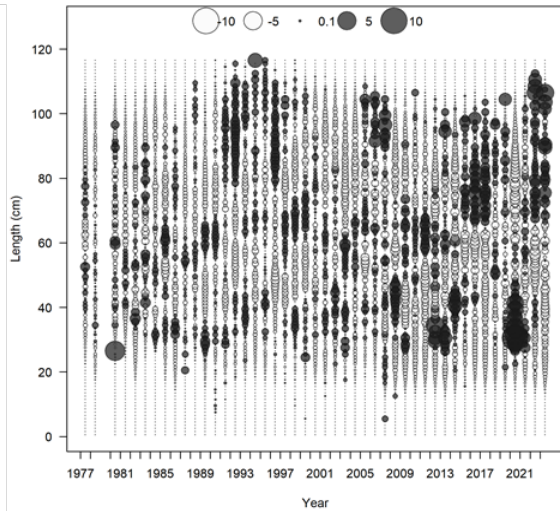


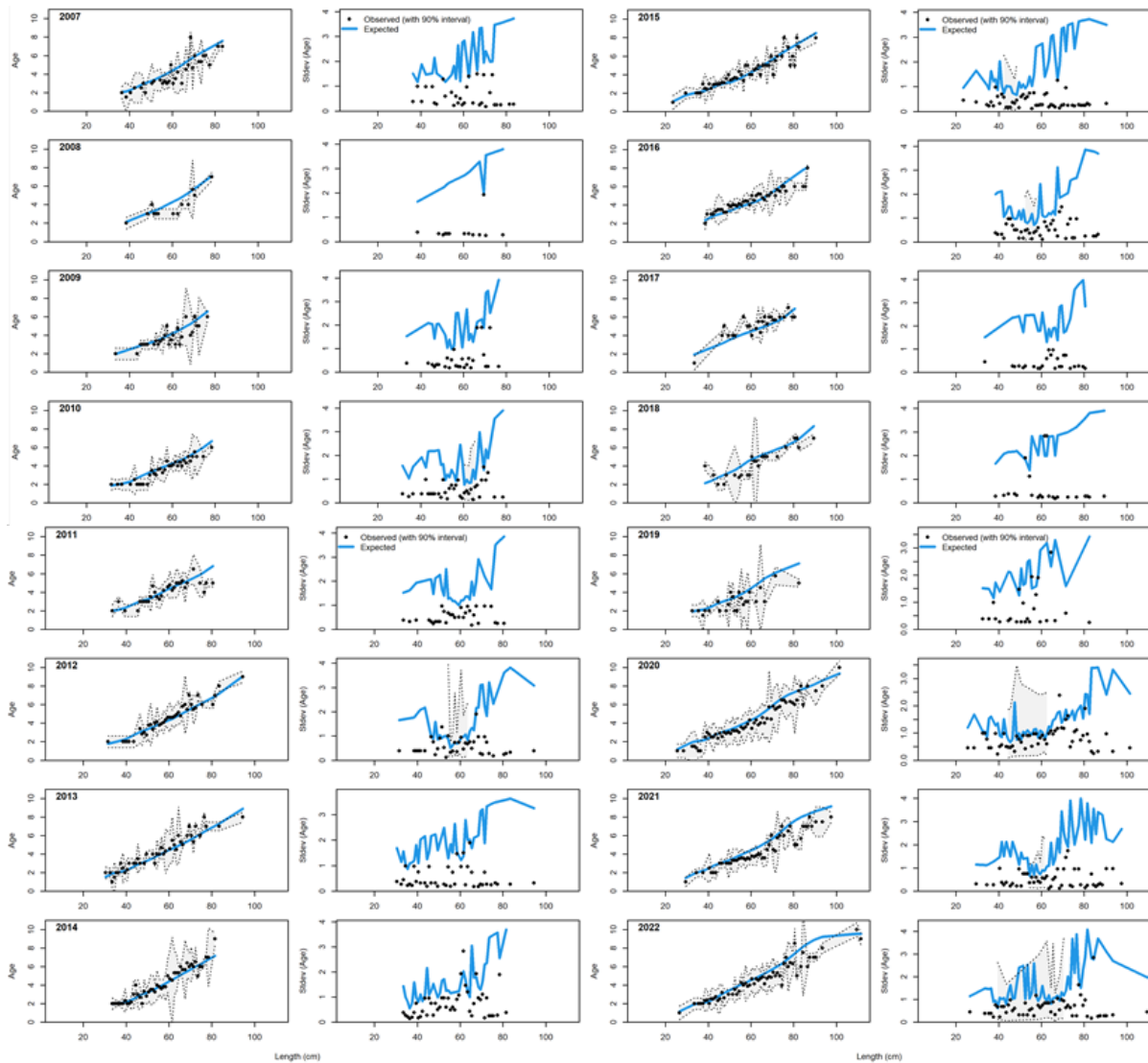


- AFSC longline survey catchability and selectivity

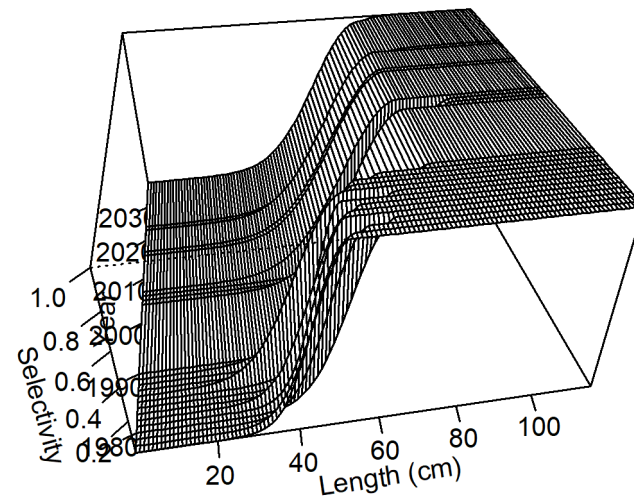
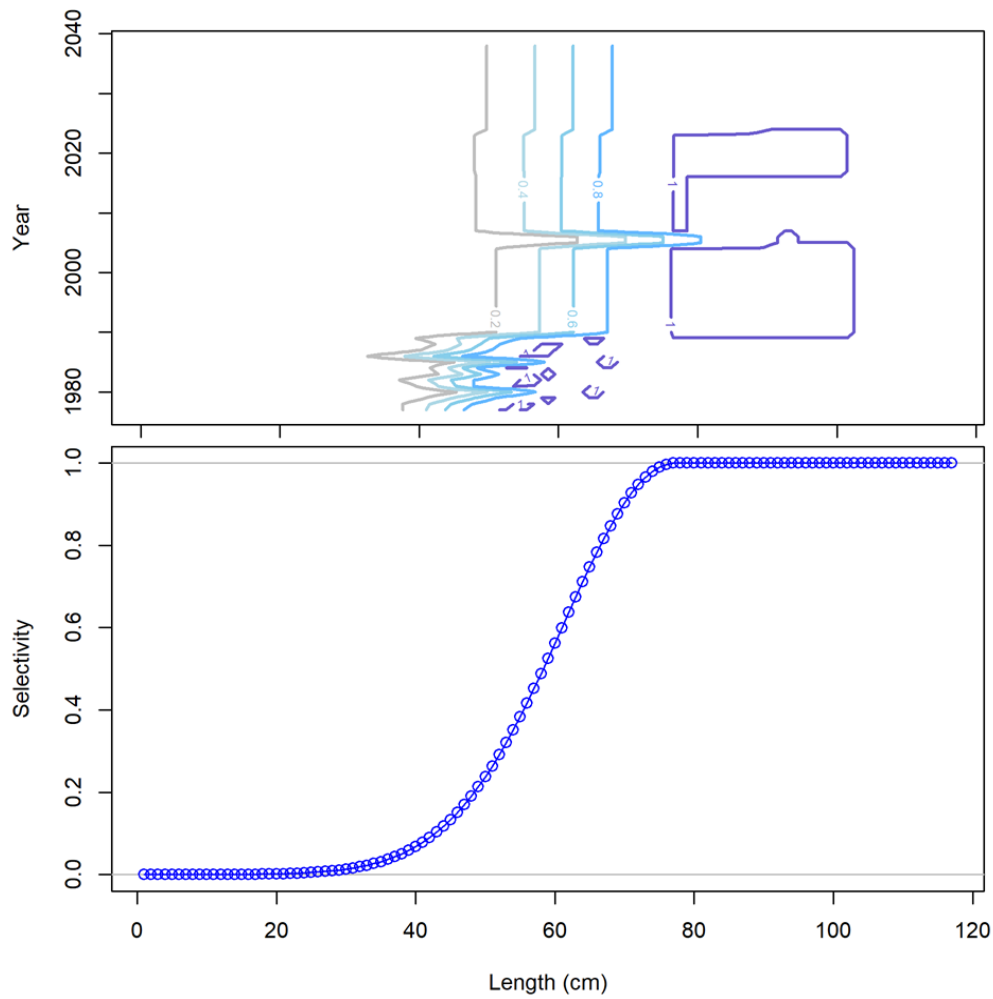


- Trawl fishery length comps



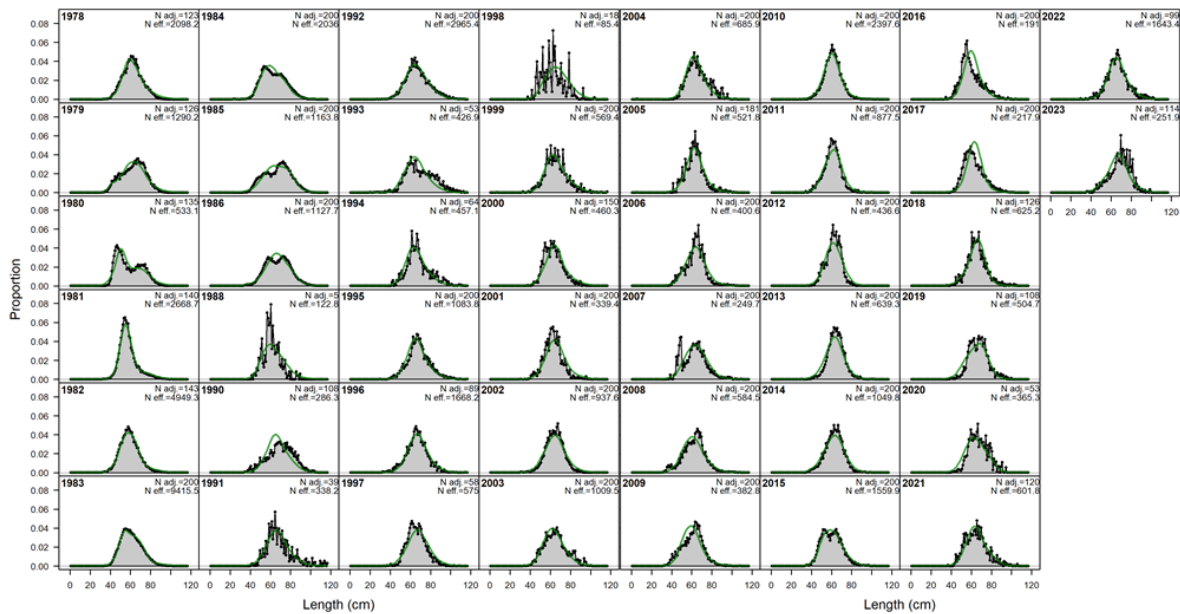


- Trawl fishery conditional age-at-length

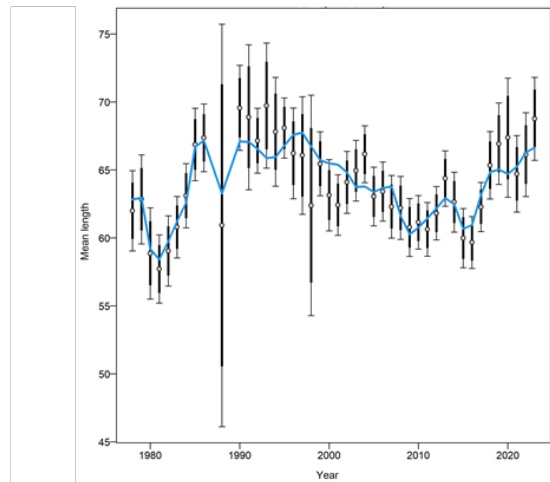
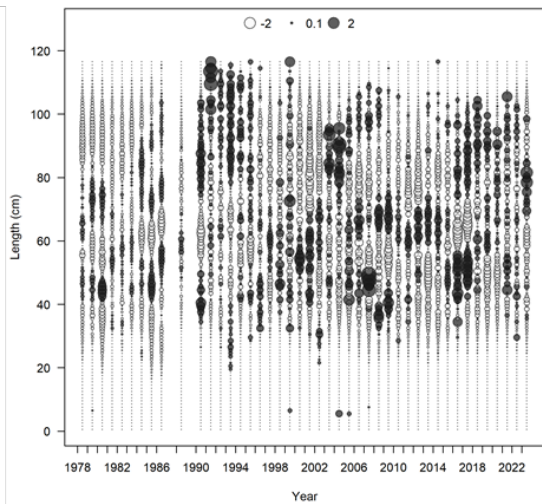


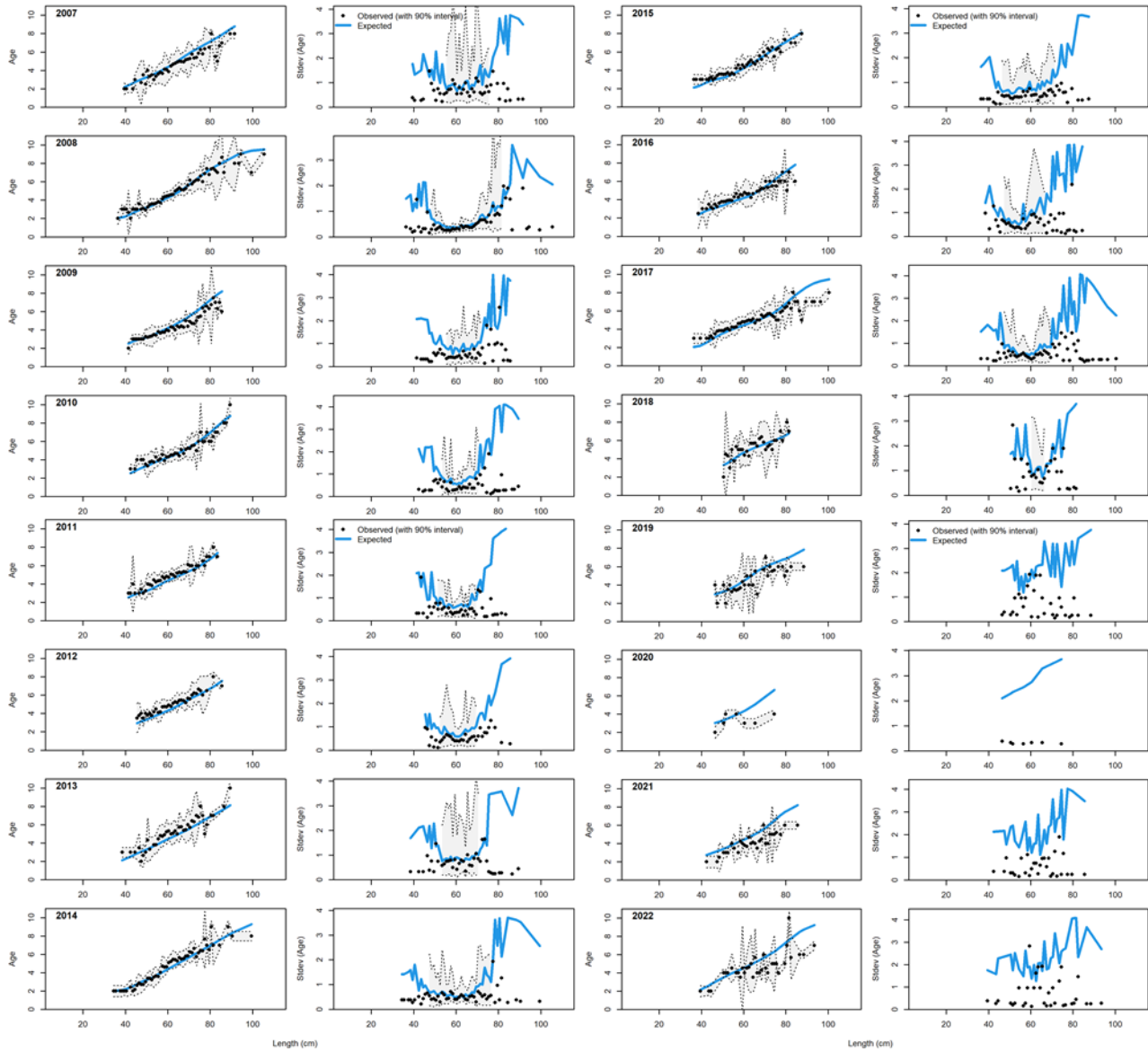
■ Trawl fishery selectivity





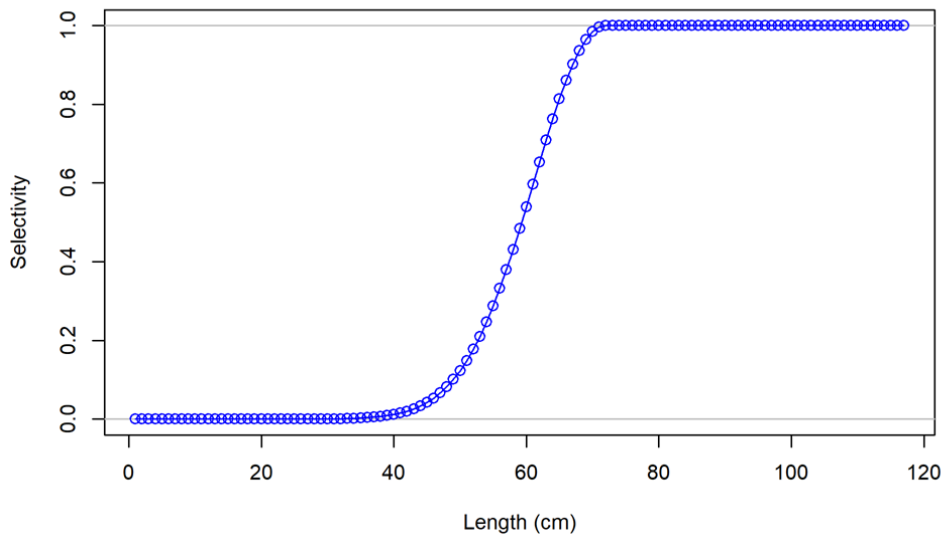
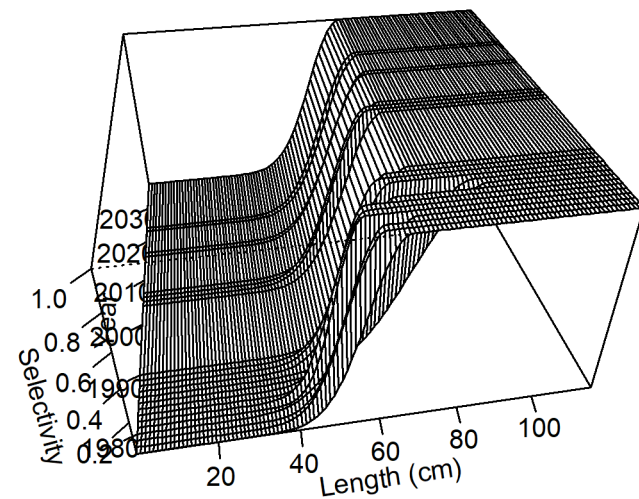
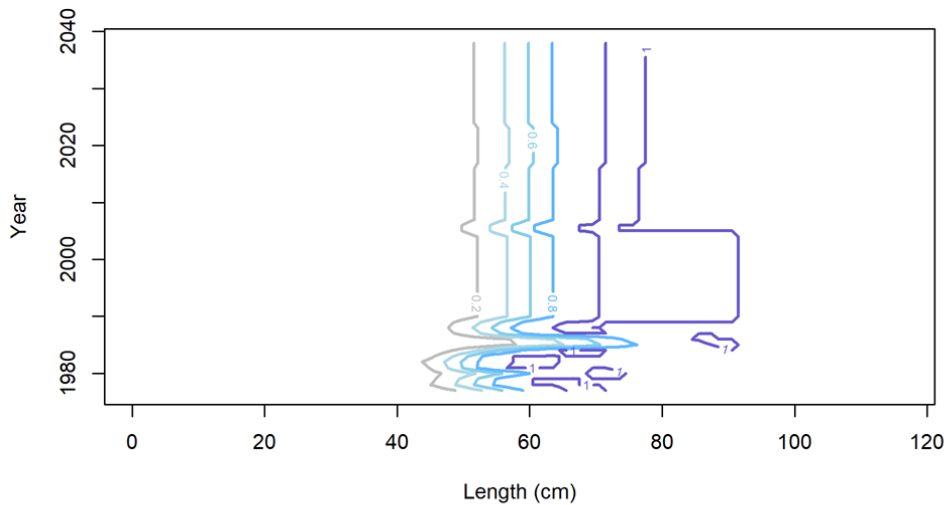
- Longline fishery length comps





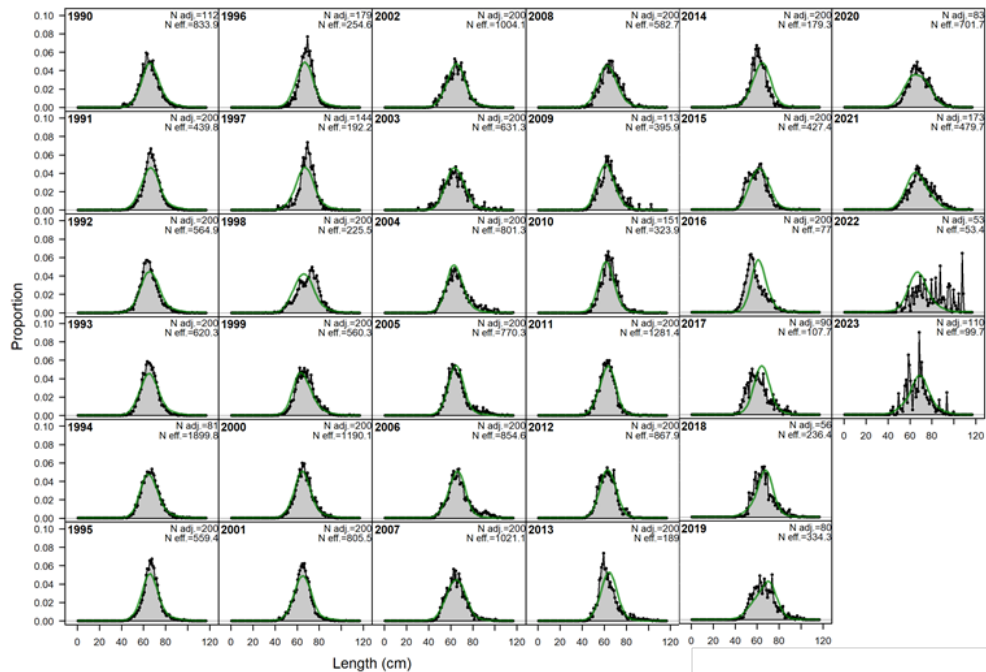
- Longline fishery conditional age-at-length



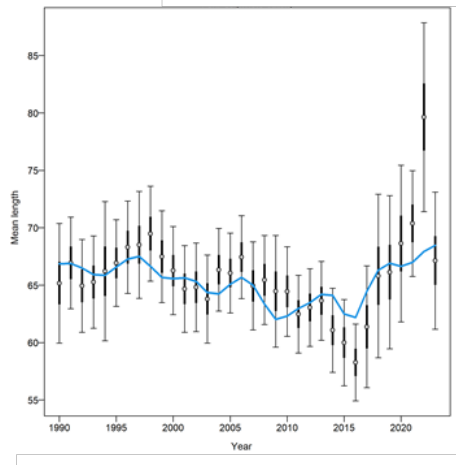
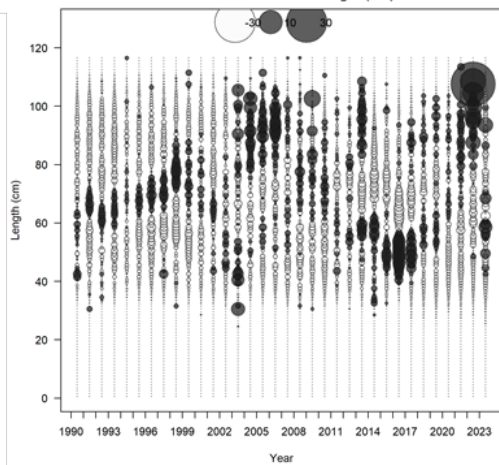


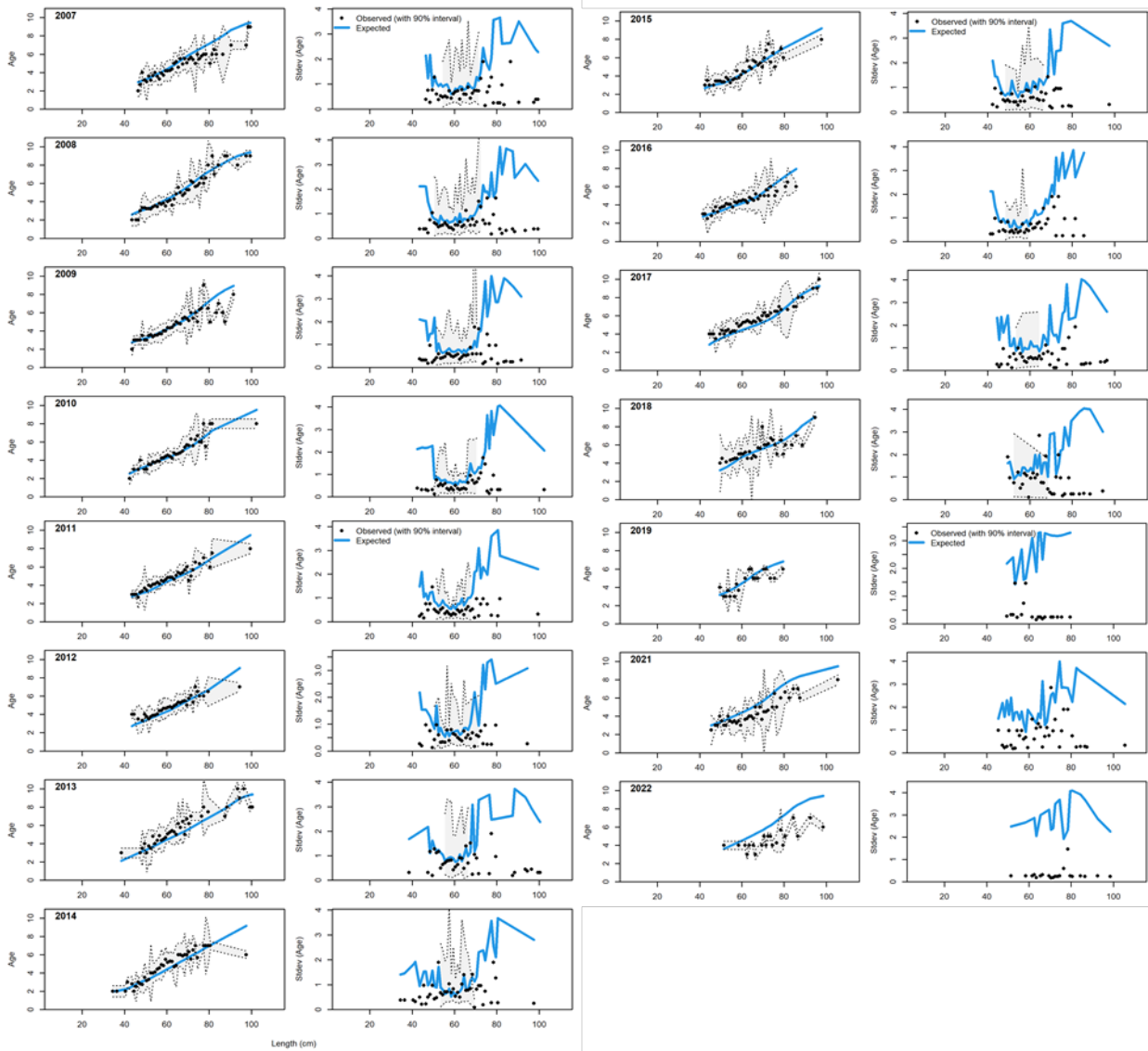
■ Longline fishery selectivity





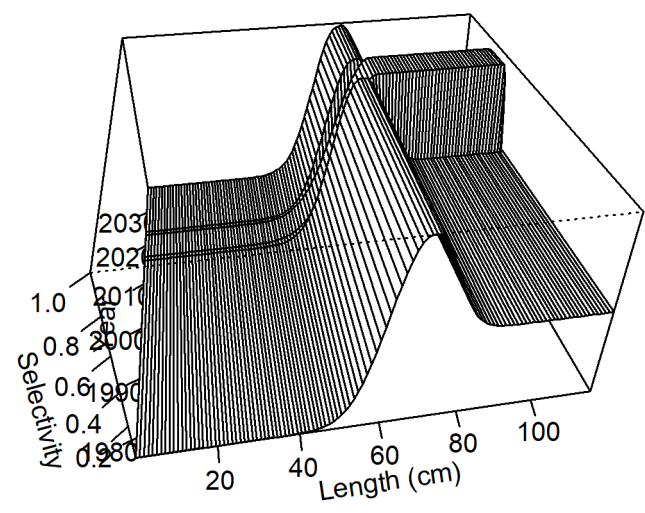
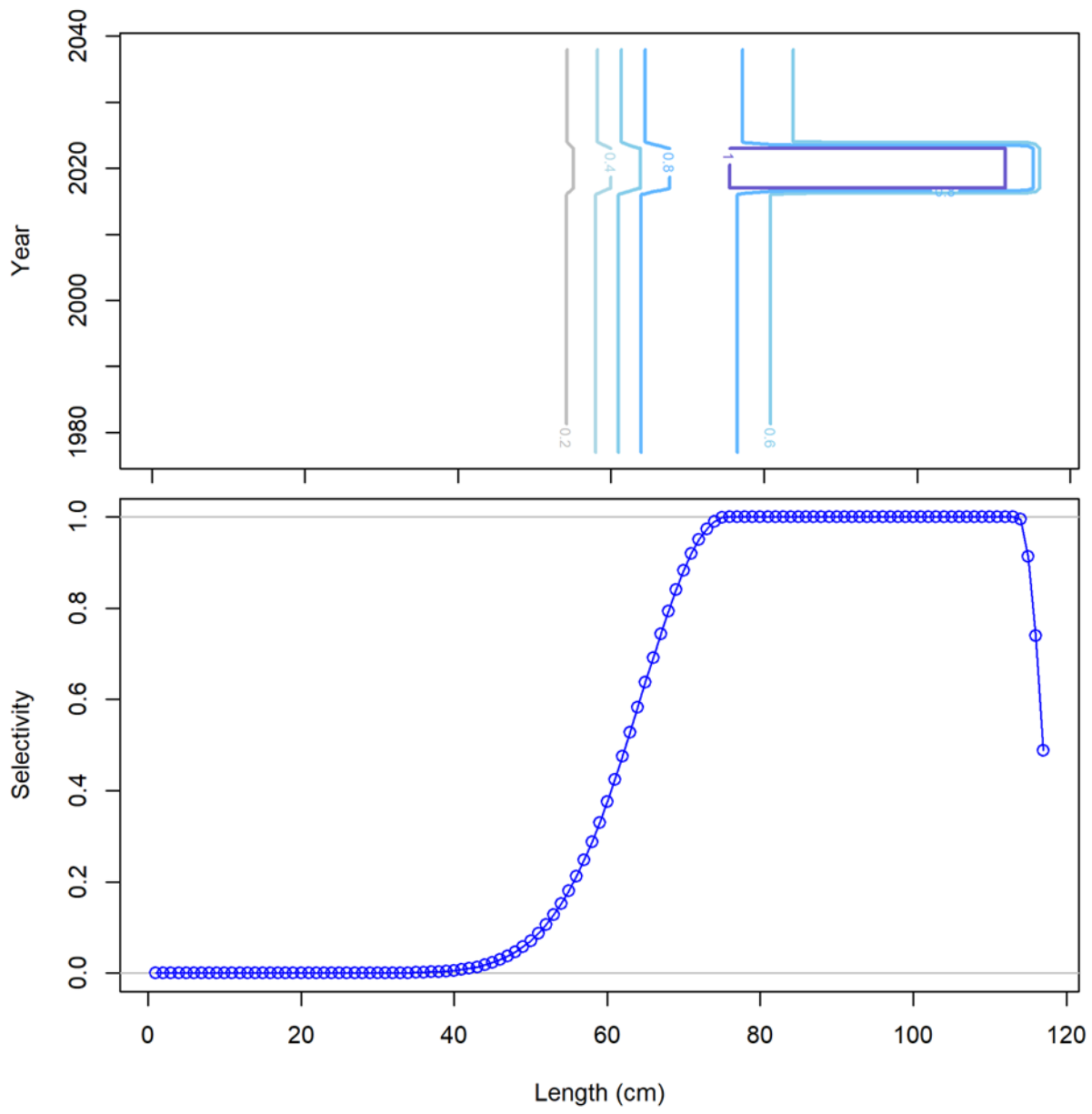
- Pot fishery length comps





- Pot fishery condition age-at-length





■ Pot fishery selectivity

