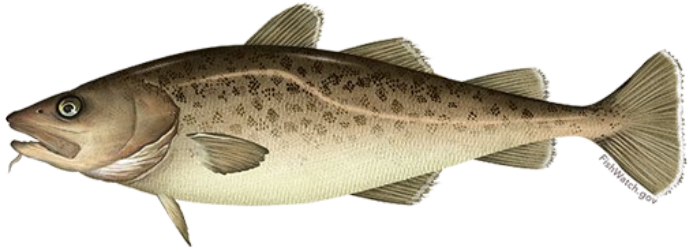


GOA PACIFIC COD

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

NOAA FISHERIES

January 2026, Presentation to the GOA Plan Team

ASSESSMENT OVERVIEW

- BLUF:
  - GOA Pacific cod: Tier 3b
  - 2025 estimated spawning biomass to be at $B_{34.3\%}$, projected in 2026 to be at $B_{33.1\%}$
  - 2026 recommended ABC is a 29% increase from 2025 ABC
  - Do not recommend reduction from maximum ABC

OPERATIONAL UPDATE ASSESSMENT

- 2025 GOA Pacific cod is an 'Operational Update' assessment:

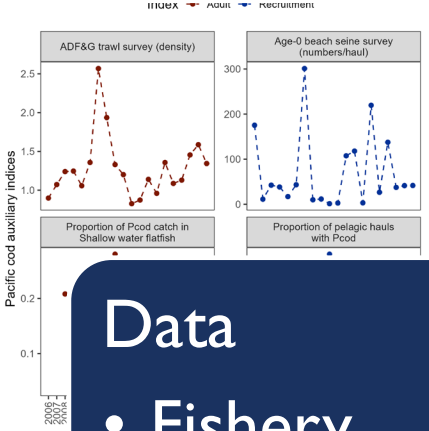
"An operational update assessment is conducted when updating the last full assessment model structure with current data, and maintains the accepted model configuration. This assessment type must carry forward the fundamental structure of the last operational full assessment reviewed and endorsed through the NPFMC review process. Therefore, the content presented in an operational update assessment can be considered an abbreviated version of the last operational full assessment, and the majority of sections that do not directly inform review bodies on making a management decision can be presented in a condensed form and referenced from the last operational full assessment." – Alaska Groundfish Stock Assessment Guidelines

- Distinct from an 'Operational Full' assessment within which alternative models are explored and recommended

OPERATIONAL UPDATE ASSESSMENT

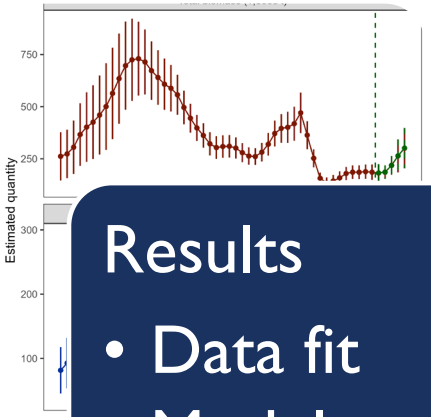
- 2025 GOA Pacific cod is an 'Operational Update' assessment:
- **Only new data through 2025 included, no model changes**
- Abbreviated SAFE document
  - Only sections that have been updated with new information since 2024 assessment included
  - Any missing sections (e.g., full Introduction) can be found in the 2024 SAFE
  - SSC/PT comments and responses not included, will be included and addressed in the next full assessment
  - Additional model files, results, and diagnostics area available electronically at this link

ASSESSMENT EVALUATION OUTLINE



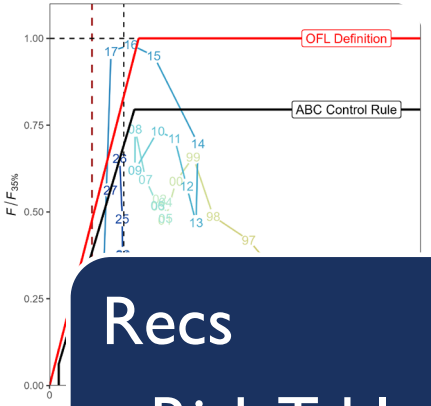
Data

- Fishery
- Survey
- Other



Results

- Data fit
- Model evaluation
- Model estimates

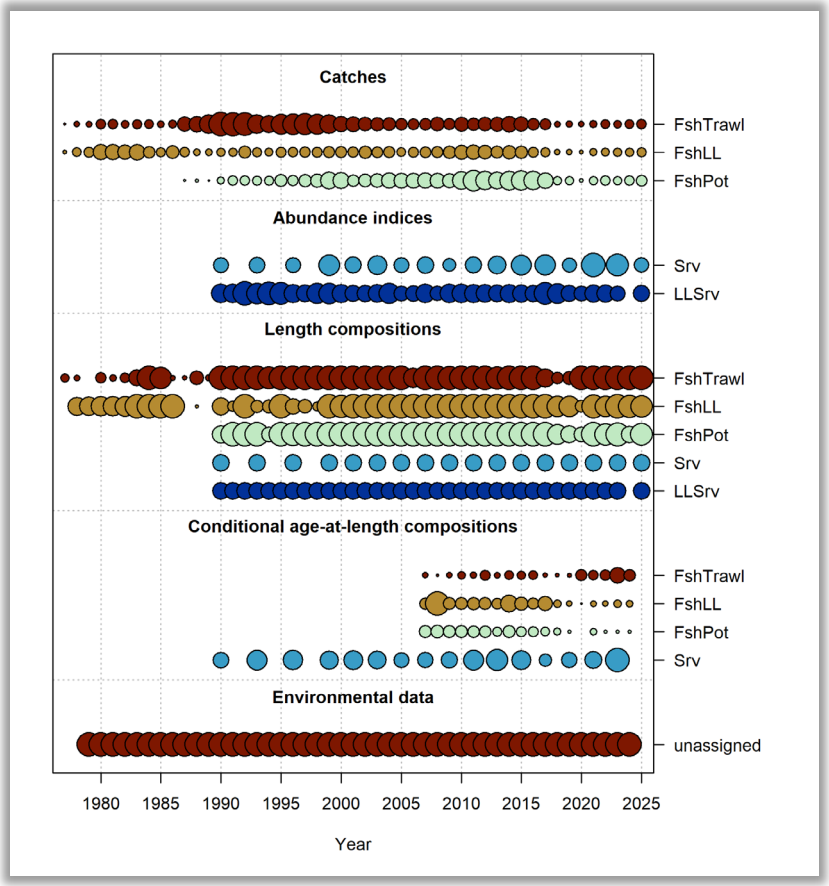


Recs

- Risk Table
- ABC/OFL
- BRD

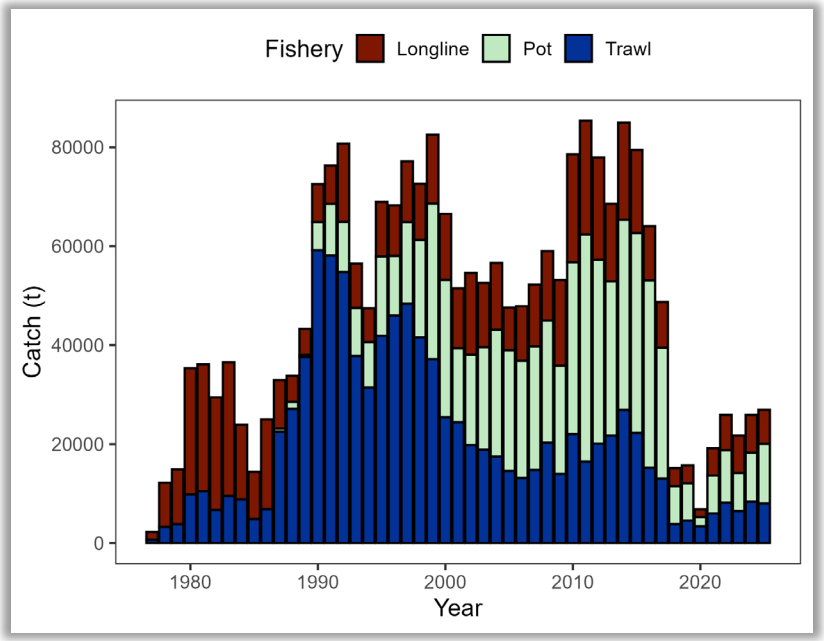
DATA OVERVIEW

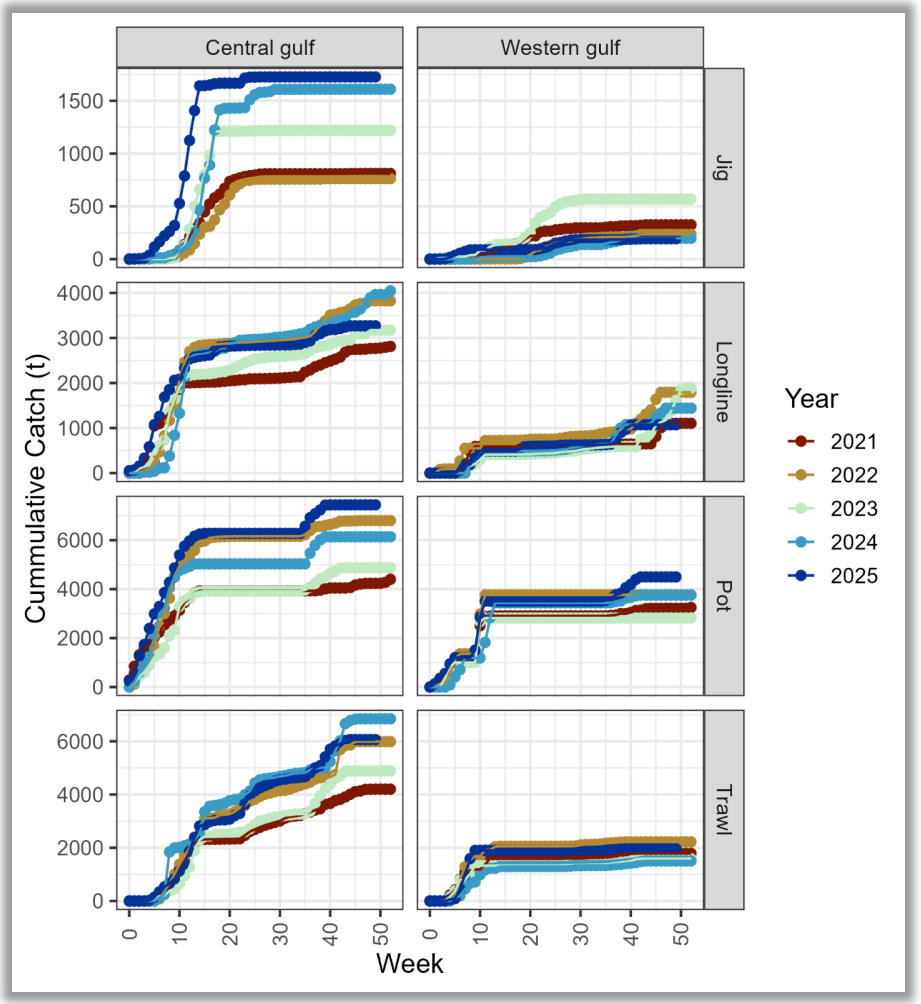
New Data	Years
Federal and state fishery catch, by gear type	2024, 2025
Federal and state fishery length composition, by gear type	2024, 2025
Federal fishery conditional age-at-length	2024
GOA AFSC bottom trawl survey abundance	2025
GOA AFSC bottom trawl survey length composition	2025
GOA AFSC longline survey Relative Population Numbers	2025
GOA AFSC longline survey length composition	2025



DATA - CATCH

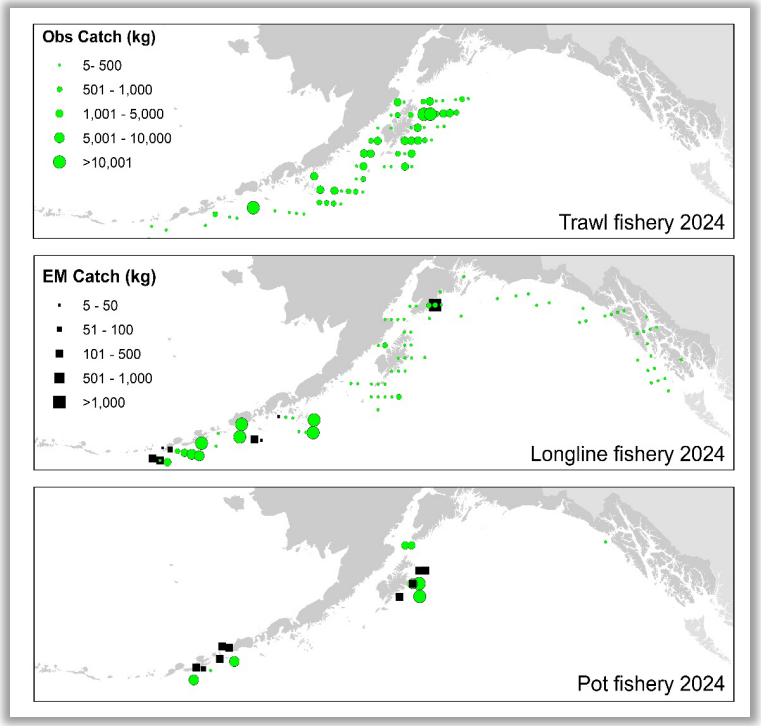
- Pot majority > LL > Trawl
- Nothing inconsistent in cumulative catch to previous years
- Catch through Dec 8, 2025

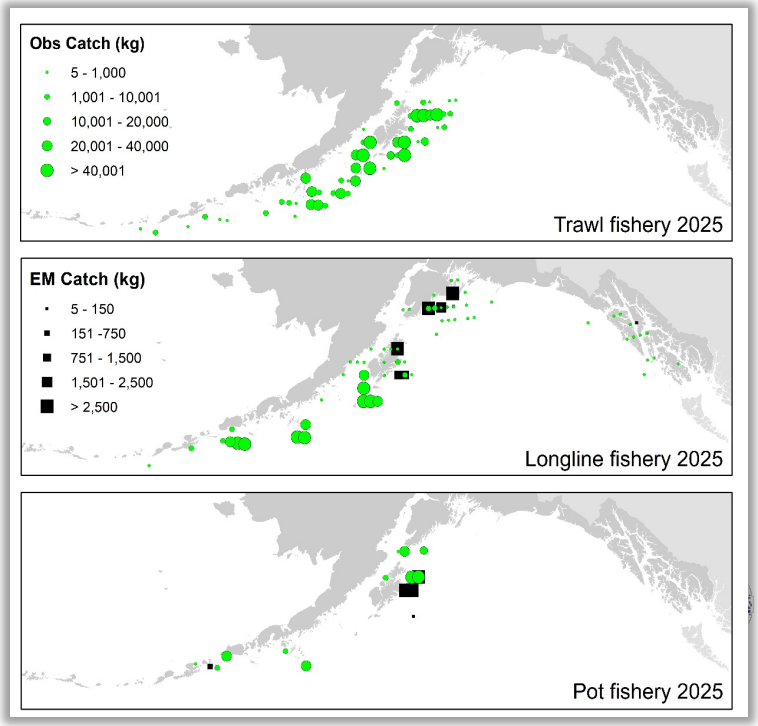




DATA – CATCH DISTRIBUTION

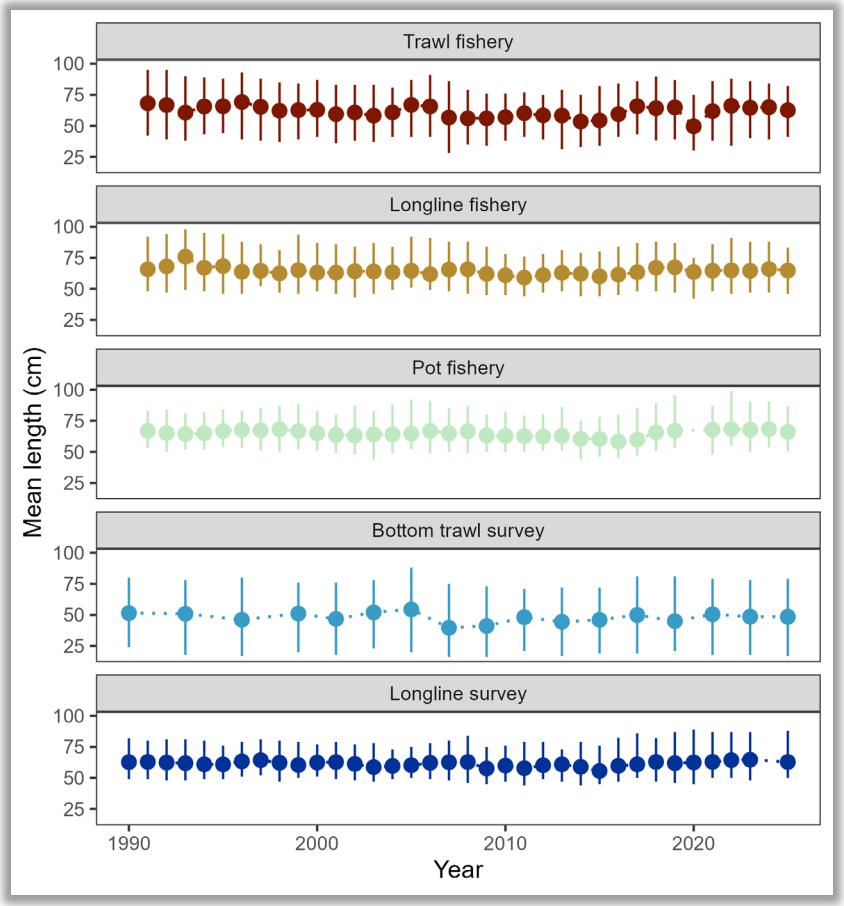
- 2025 distribution similar to previous catch distribution
- For how much relative catch is taken by pot, small # observed hauls



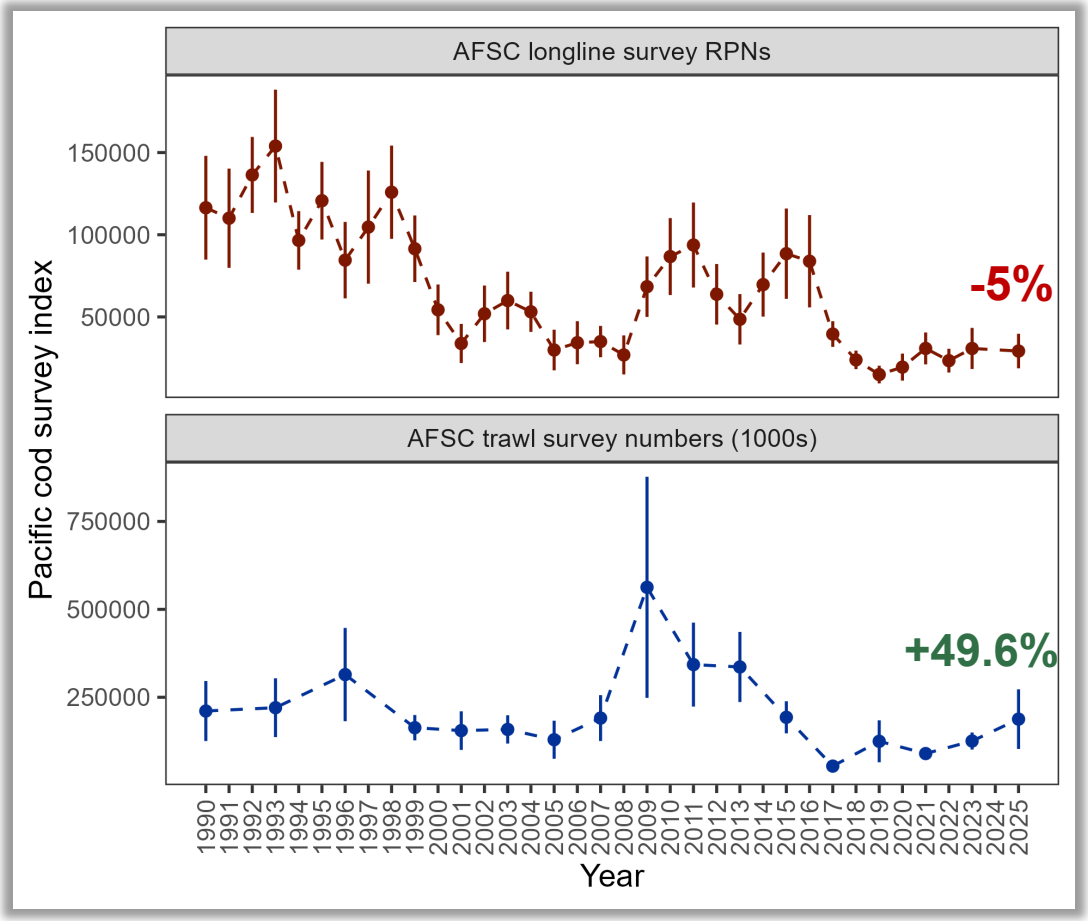


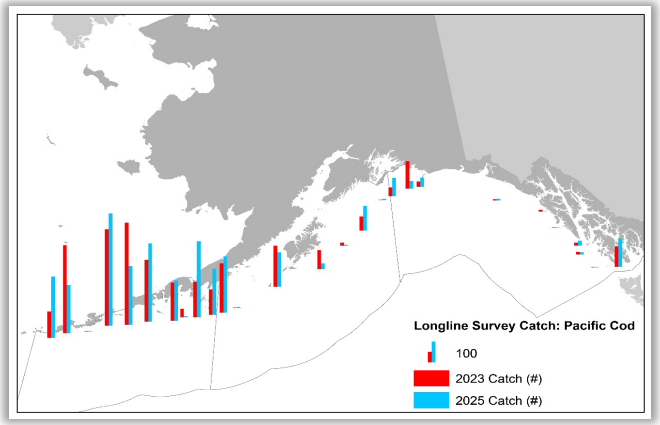
DATA – LENGTH COMPS

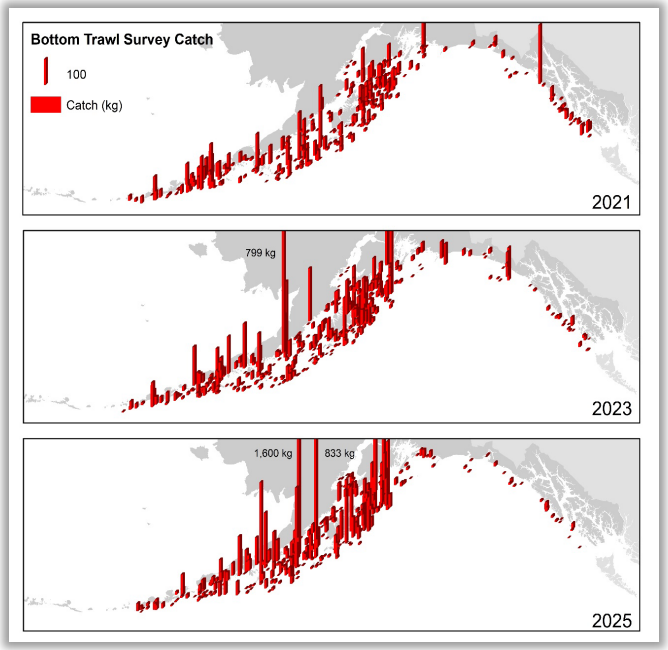
- In general, mean length in 2024 similar to that in previous 4 or so years



DATA – AFSC SURVEYS





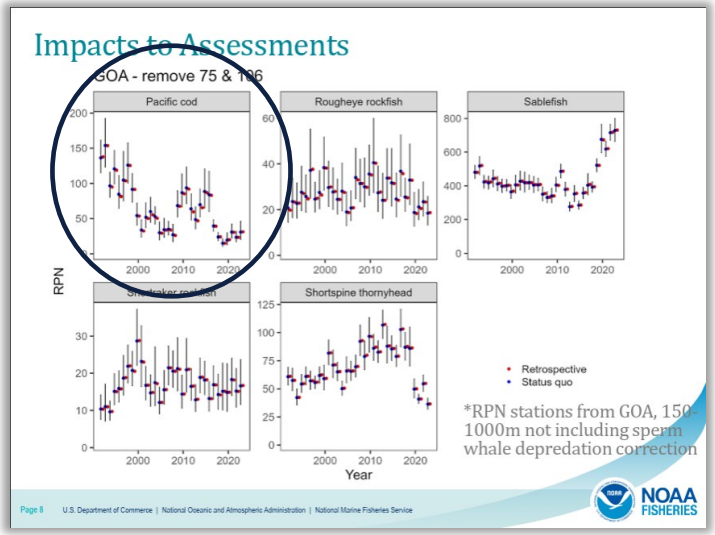


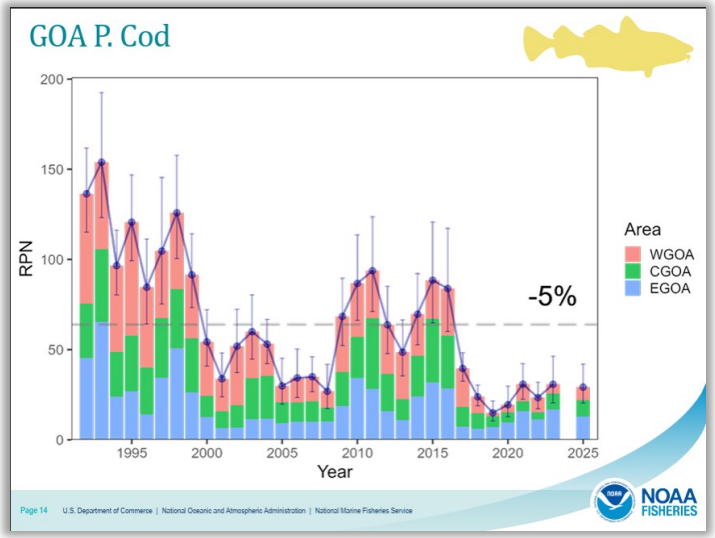
DATA – AFSC SURVEYS

- Adding context to the survey results:
  1. Why was there an observed decline in longline survey RPNs that is inconsistent with trawl survey abundance?
  2. Was there an influence of the GOA bottom trawl survey restratification on 2025 results?

DATA – AFSC SURVEYS

1. Why was there an observed decline in longline survey RPNs?
   - Not due to dropping stations in survey redesign





- Subregion change since 2023: WGOA **+40%**, CGOA **+4.8%**, EGOA **-23.6%**

- This decline in GOA-wide RPN due to EGOA

DATA – AFSC SURVEYS

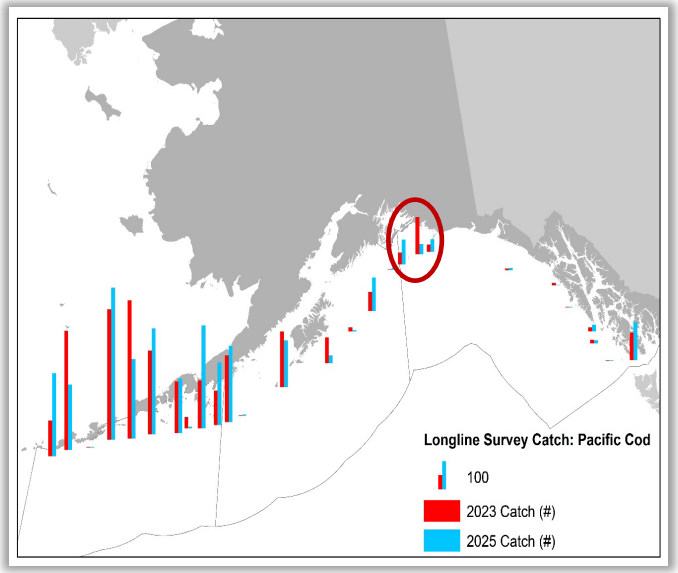
1. Why was there an observed decline in longline survey RPNs?
   - RPN calculation reminder: mean catch per hook (across skates within a strata) multiplied by stratum area size (stratum are 150m and deeper)
   - Drilling down into EGOA:
     - Why is the EGOA RPN so large in comparison to WGOA and CGOA?
     - What was the reason for the EGOA RPN decline?

DATA – AFSC SURVEYS

- Drilling down into EGOA RPN: Why so large?
  - Since 2020 77% of cod in RPN index caught in 151-200m stratum (remainder caught in 201-300m stratum; *note:* 1.3x more cod caught in 101-150m compared to 151-200m)
  - Area size for 151-200m in EGOA 4x larger than WGOA and 3x larger than CGOA
  - Large area size has downstream effect on RPN resulting in >33% of GOA RPN within EGOA across time-series (*AFSC bottom trawl survey observes <5% of cod abundance in EGOA*)

DATA – AFSC SURVEYS

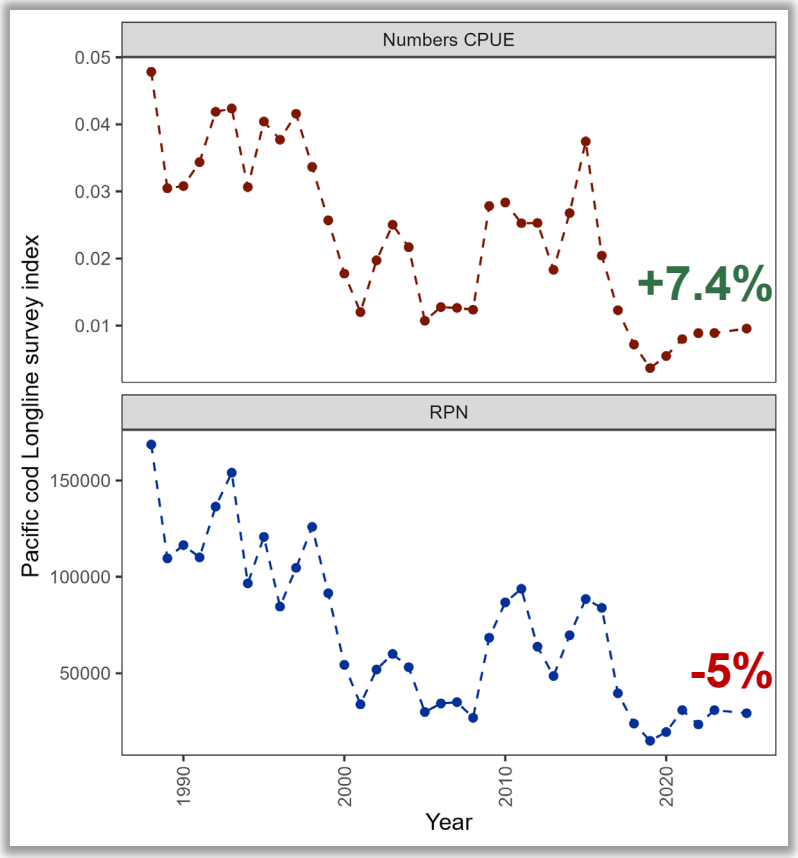
- Drilling down into EGOA:
  - Compared to 2023, only one station's catch of cod declined
  - #90: 2023 catch largest since 1993, 6.5x larger than avg since 2000



- **Bottom line**: a single station from a subregion with disproportionate area size drove the decline in the RPN index
  - The RPN index is *not wrong*, this is a result of the particular stratums we use for this index (which were originally designed with sablefish in mind)

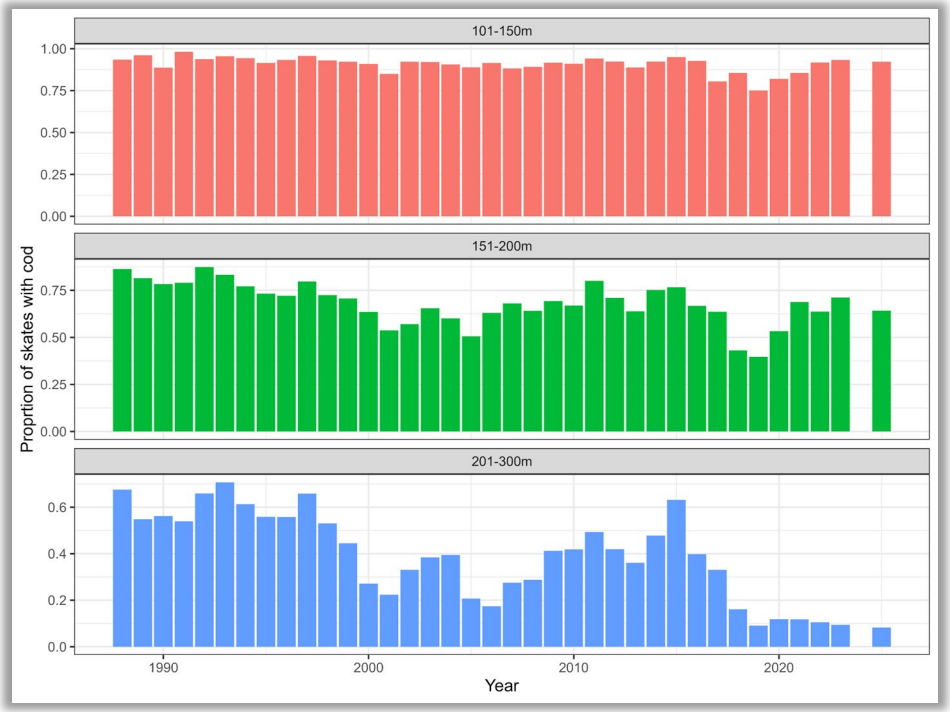
DATA – AFSC SURVEYS

- Taking out area size effect and looking at numbers CPUE:
  - While 5% decrease in RPN index GOA-wide, numbers CPUE increased by more than 7% (even when still including station 90)



DATA – AFSC SURVEYS

- Prior to next full assessment we will be reevaluating how AFSC longline survey RPN index computed
- Update assessment: did **not** change the index used in the model



DATA – AFSC SURVEYS

2. Was there an influence of the GOA bottom trawl survey restratification on 2025 results?
   - Reminder: over the years PT/SSC has reviewed several presentations leading up to application in 2025 of GOA survey redesign, design has been extensively simulation tested
   - Final piece: using real data, what would happen if historical data collected following new survey design?
   - Appendix 2.2: with GAP (Zack Oyafuso and Stan Kotwicki) performed analysis in which historical stations were post-stratified into 2025 strata for GOA cod

DATA – AFSC SURVEYS

- Using real data, what would happen if historical data collected following new survey design?
  - Not a straight-forward question, main problem to overcome is that historical stations were chosen within a grid cell with selection probabilities based on old strata
  - Thought experiment: if we are selecting 10 grid cells randomly within a strata that has 100 grid cells, each grid cell has 1/10 chance of being selected, or, a 0.1 selection probability

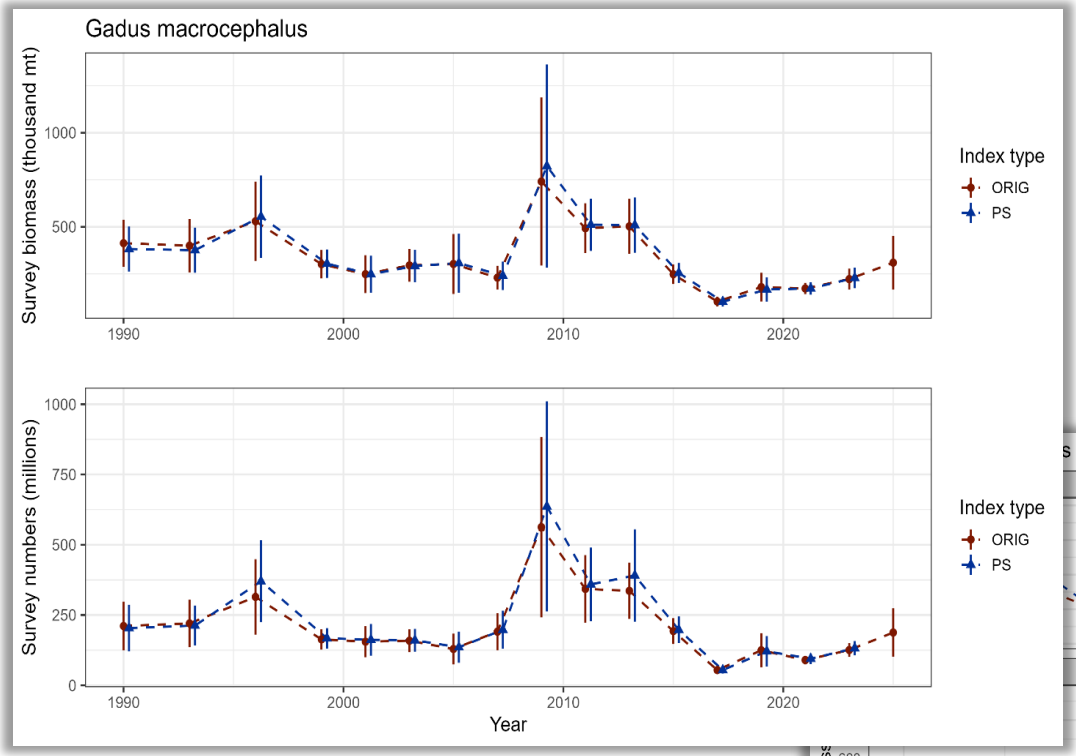
DATA – AFSC SURVEYS

- Thinking about one of those selected grid cells in the original design, under restratification it may find itself in a strata that has 150 grid cells. Under the new design the selection probability would be different than the original 0.1
- Upon post-stratification within new strata, before you calculate design-based indices, you must re-weight to account for the new selection probabilities, otherwise you will introduce bias

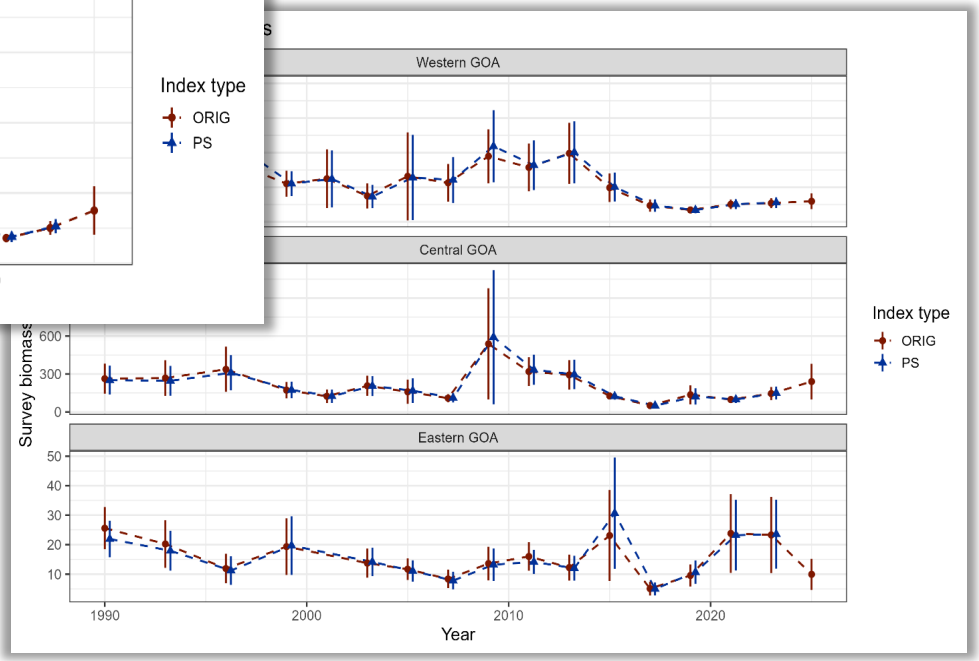
DATA – AFSC SURVEYS

- Using real data, what would happen if historical data collected following new survey design?
  - Utilized survey R-package “Analysis of complex survey samples”
  - survey::postStratify() function follows Rao et al (2002 – analyzing survey data using poststratification) with variance estimates following Valliant (1993)
  - Steps taken in analysis:
    1. Reclassified historical stations within new 2025 stratum boundaries
    2. Post-stratified and re-weighted station observations
    3. Compute design-based index

DATA – AFSC SURVEYS



- Results indicate minor differences between time-series, particularly since 2019



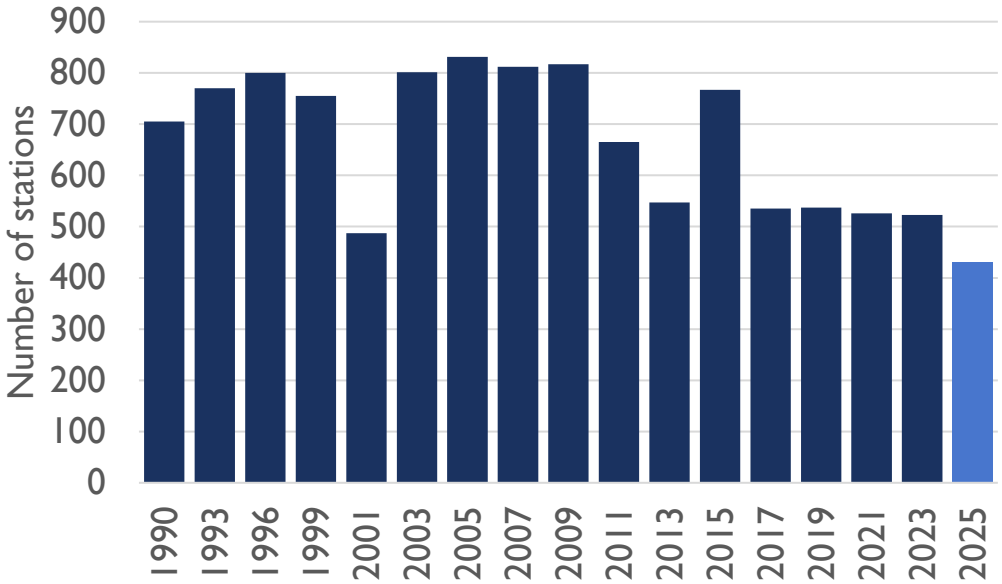
- CVs increase by 0.6% for biomass, 1.4% for numbers, on average

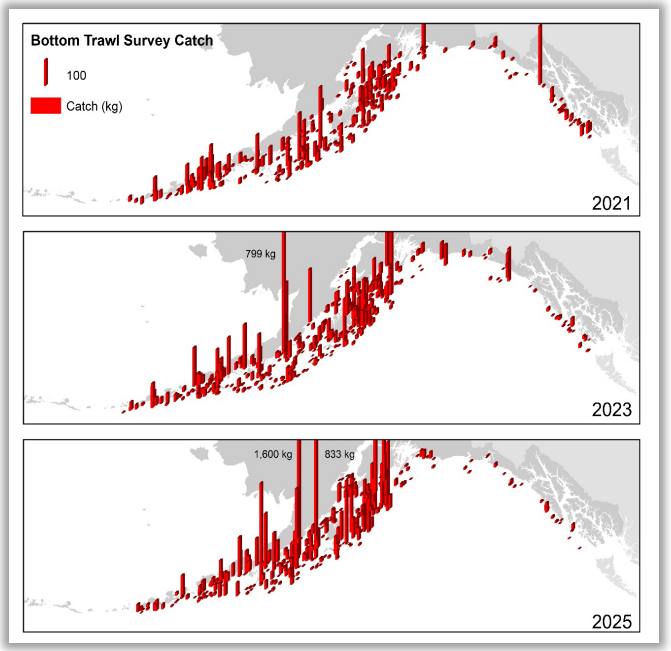
DATA – AFSC SURVEYS

2. Was there an influence of the GOA bottom trawl survey restratification on 2025 results? ***NO***
   - The results from the 2025 survey continue trends we have recently observed and estimates that are within historical ranges
   - This analysis was not intended to create a new time-series of historical data, rather, to compare and verify that the 2025 survey restratification did not have an unintended consequence on historical data
   - GOA cod is one of best test cases, impossible to disentangle effects of post-stratification with sampling variability for stocks that are more difficult to sample (i.e., rockfish)

DATA – AFSC SURVEYS

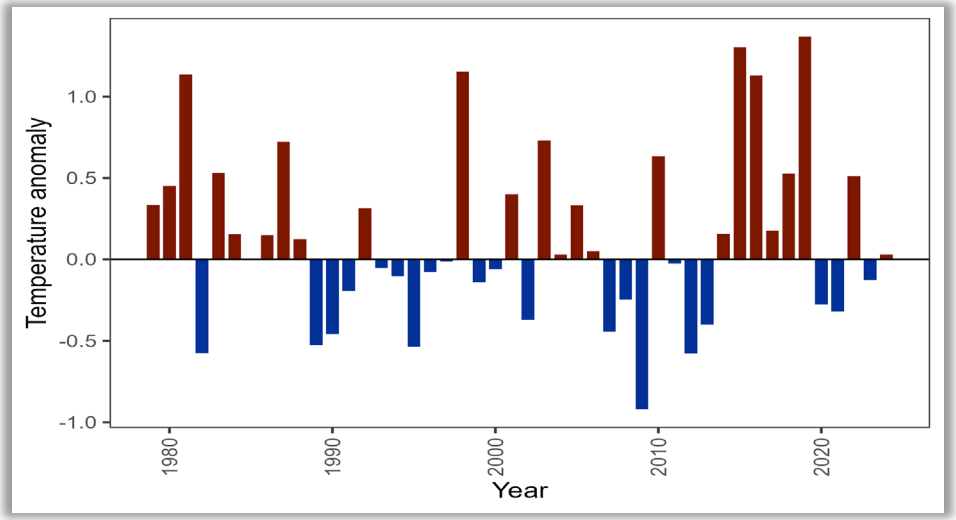
- 2025 AFSC bottom trawl survey index (biomass and numbers) associated with 23% CV
  - Increase in catch variable across stations
  - Number of stations in 2025 fewest in survey since 1990

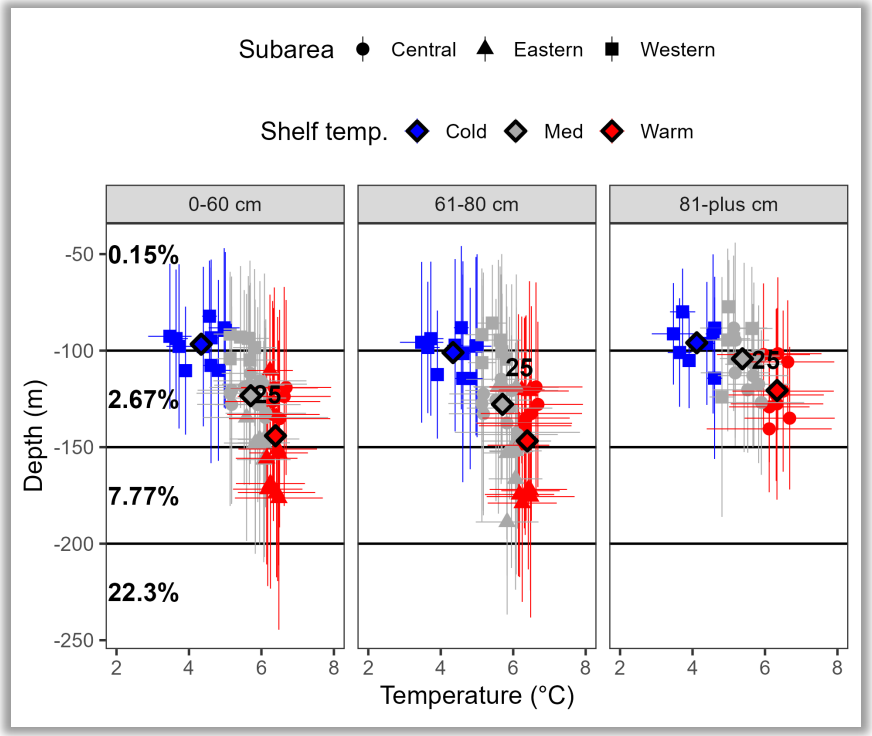




DATA – ENVIRONMENTAL

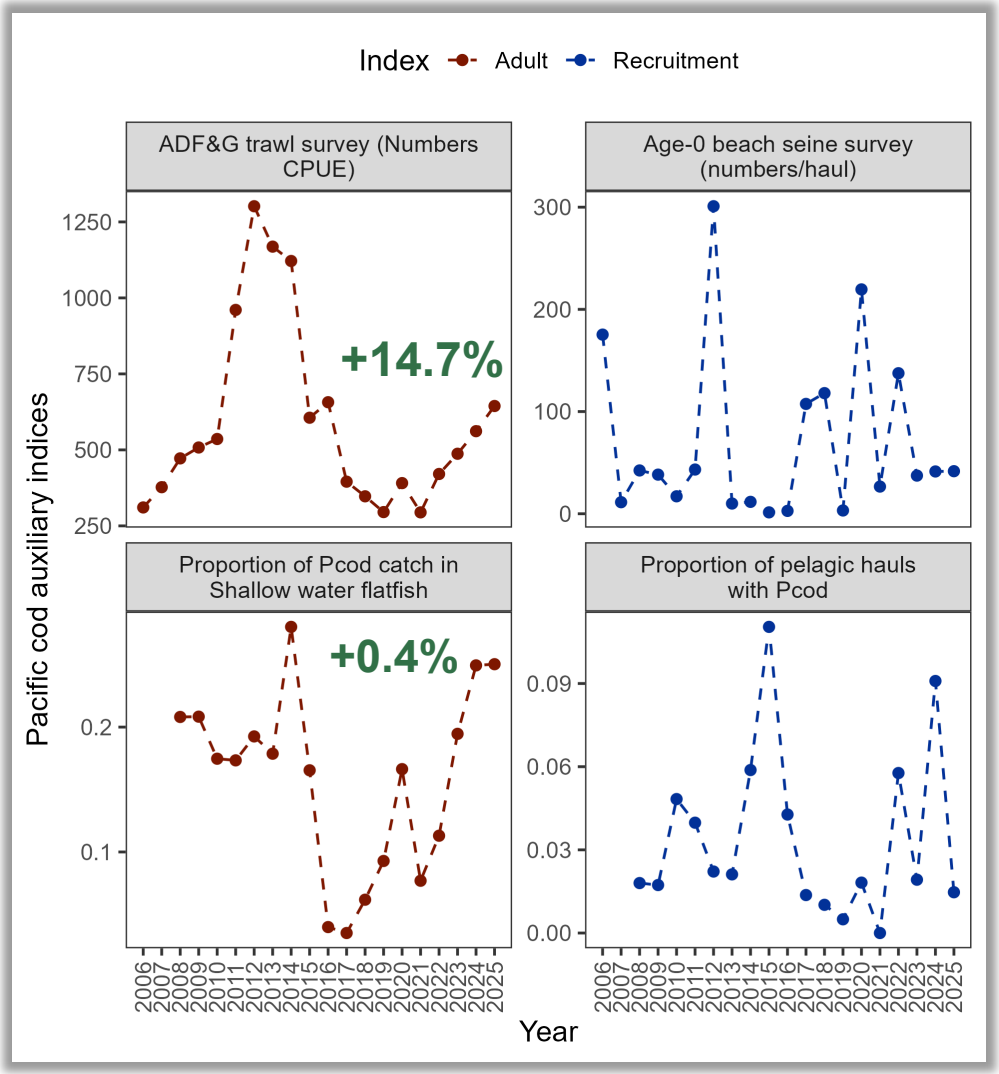
- 2025 CFSR not available – covariate not updated (new index will be used in next full assessment)
- Warmer bottom temps in bottom trawl survey associated with deeper depth on average





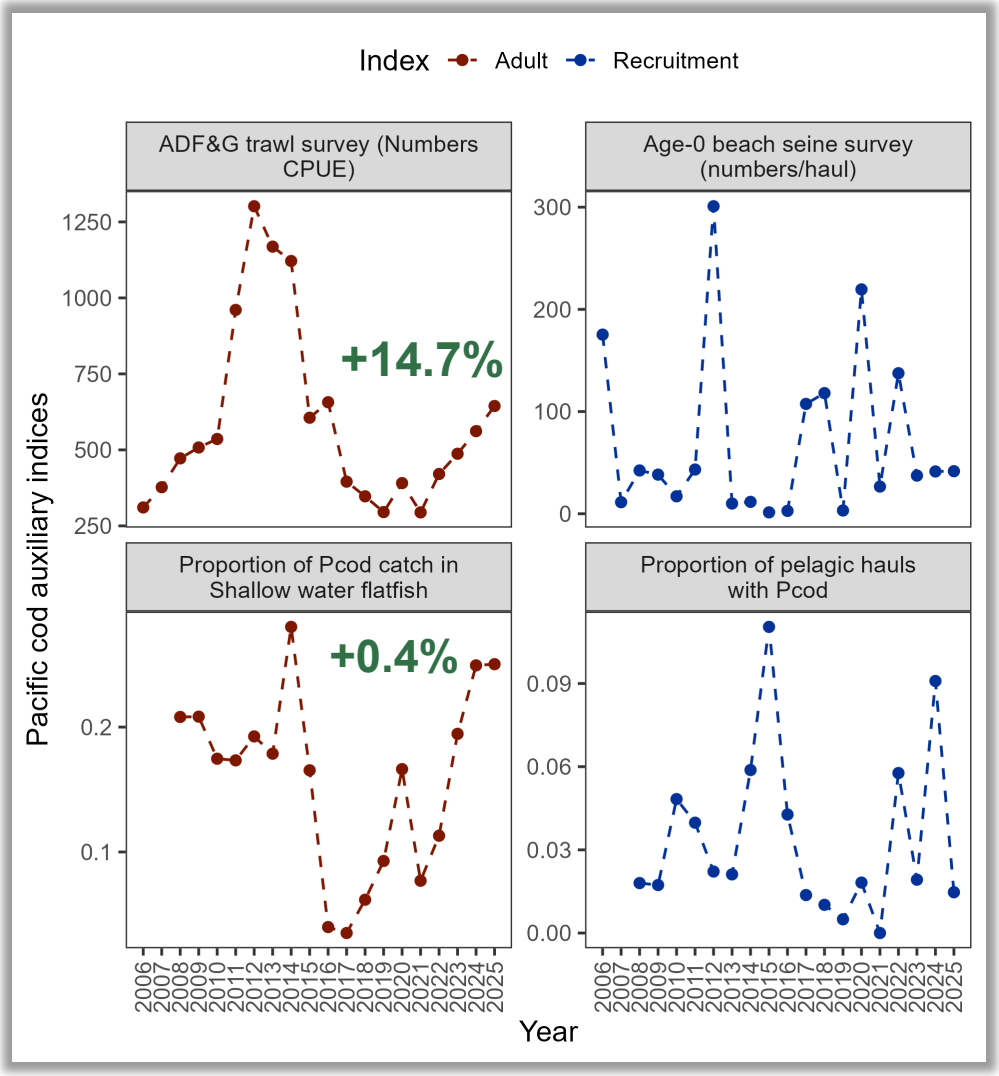
DATA – AUXILIARY INFORMATION

- Adult indices:
  - ADF&G Numbers CPUE increased
  - Proportion of cod in SWF catch stayed at >0.2

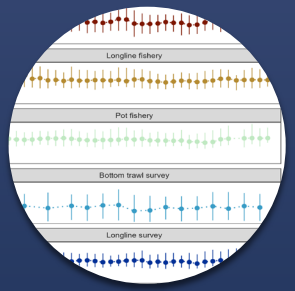


DATA – AUXILIARY INFORMATION

- Recruitment indices:
  - Beach seine 2023-2025 below average
  - 2025 below avg in pelagic hauls with cod (age-2)
- Both agree with above average 2020 and 2022 year classes

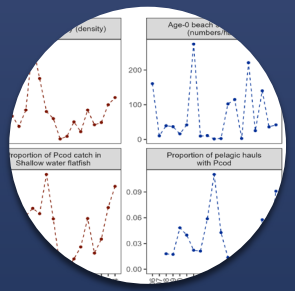


DATA – SUMMARY



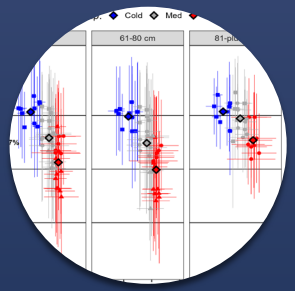
Catch trends:

- No red flags



Index trends:

- General trend is a continued increase in adult population



Environmental trends:

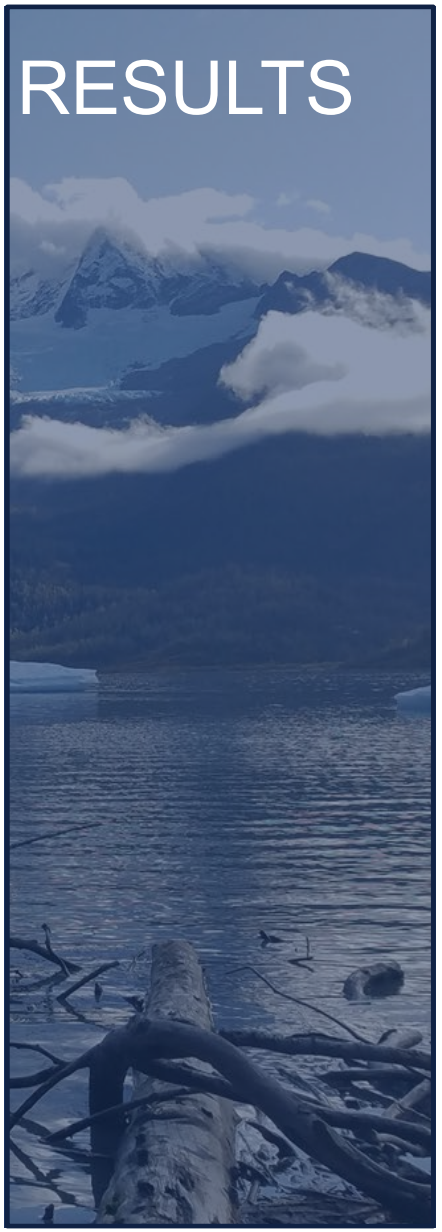
- 2025 warmer than average, cod deeper

Data fits

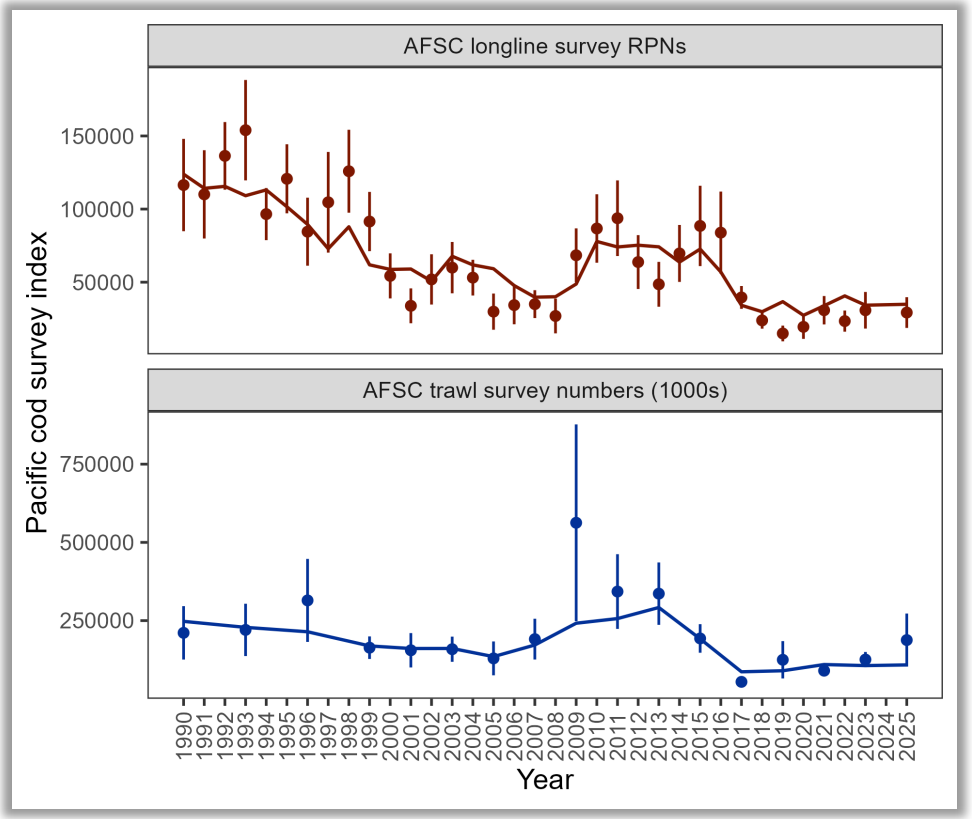
Model diagnostics

Model 24.0 results

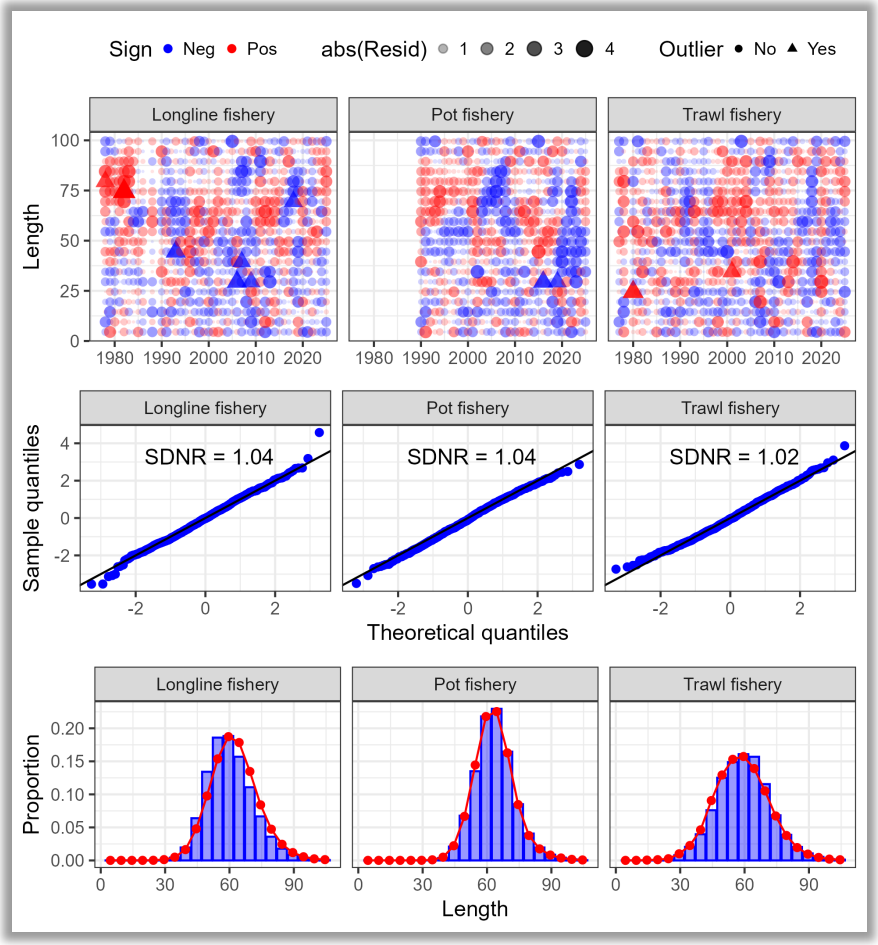
Recommendations

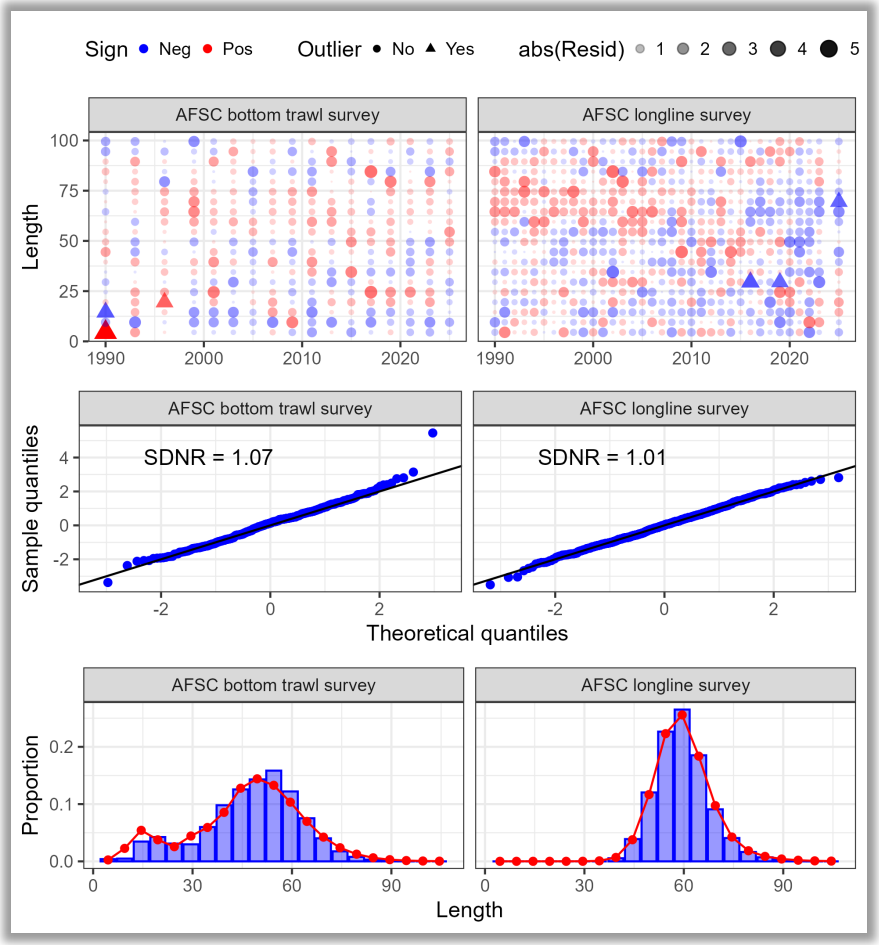


- Pattern of expecting larger RPN from longline survey than observed continues
- Model does not fit increase in 2025 trawl survey increase
- Model estimates represent balance between fitted indices
- Consistent with 2024 assessment



RESULTS: DATA FITS

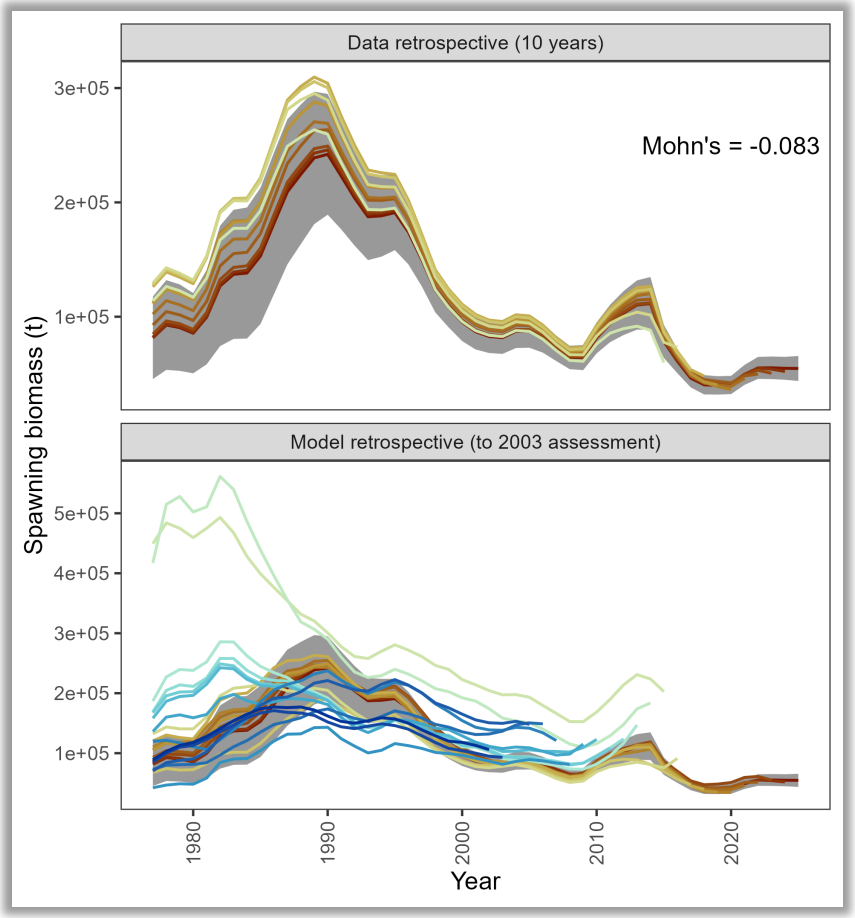




RESULTS: DATA FITS

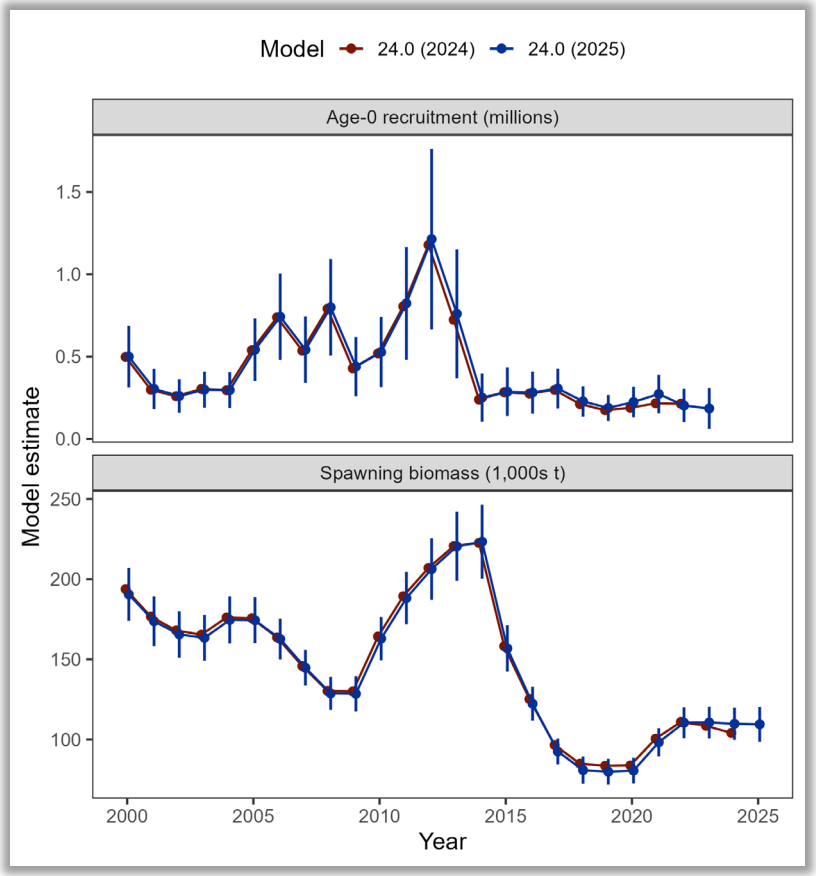
- Presented model diagnostics:
  - Retrospective: data and model
- Convergence diagnostics:
  - Model convergence: final gradient was $6.45e^{-6}$
  - Jitter analysis: 50 at 5% CV, 46 converged, 74% to MLE
- Other diagnostics available in linked document

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



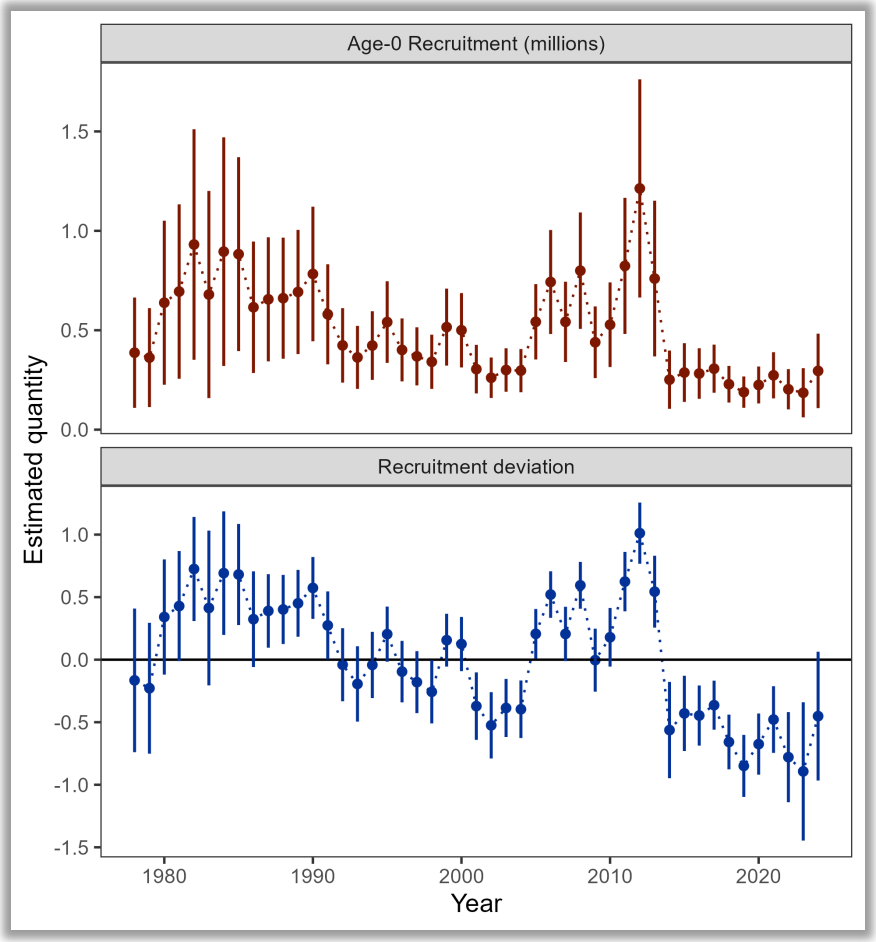
RESULTS: DIAGNOSTICS

- Overall, Model 24.0 in 2025 consistent with all results obtained in 2024
- With new data:
  - Recruitment slightly increases for 2020 and 2021 year classes
  - Spawning biomass slightly decreases from 2017-2021, then increases after 2022



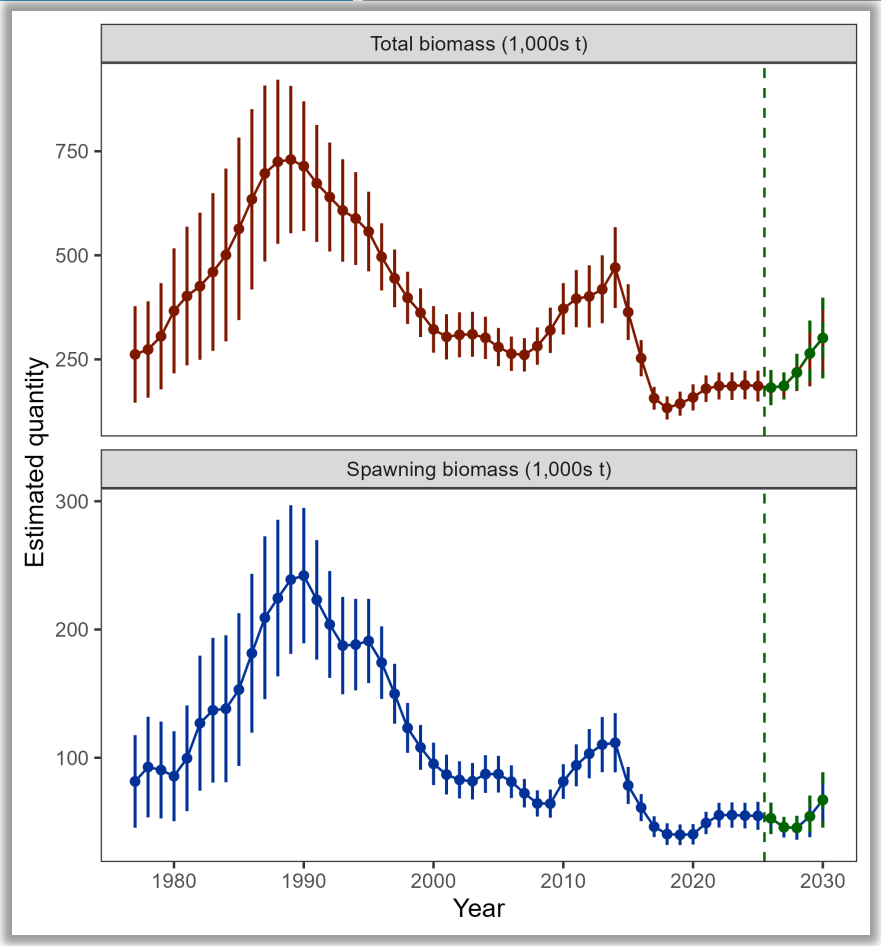
RESULTS: COMPARISON WITH 2024

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



RESULTS: RECRUITMENT ESTIMATES

- Biomass projected to increase by 2030, but, based on realization of average recruitment

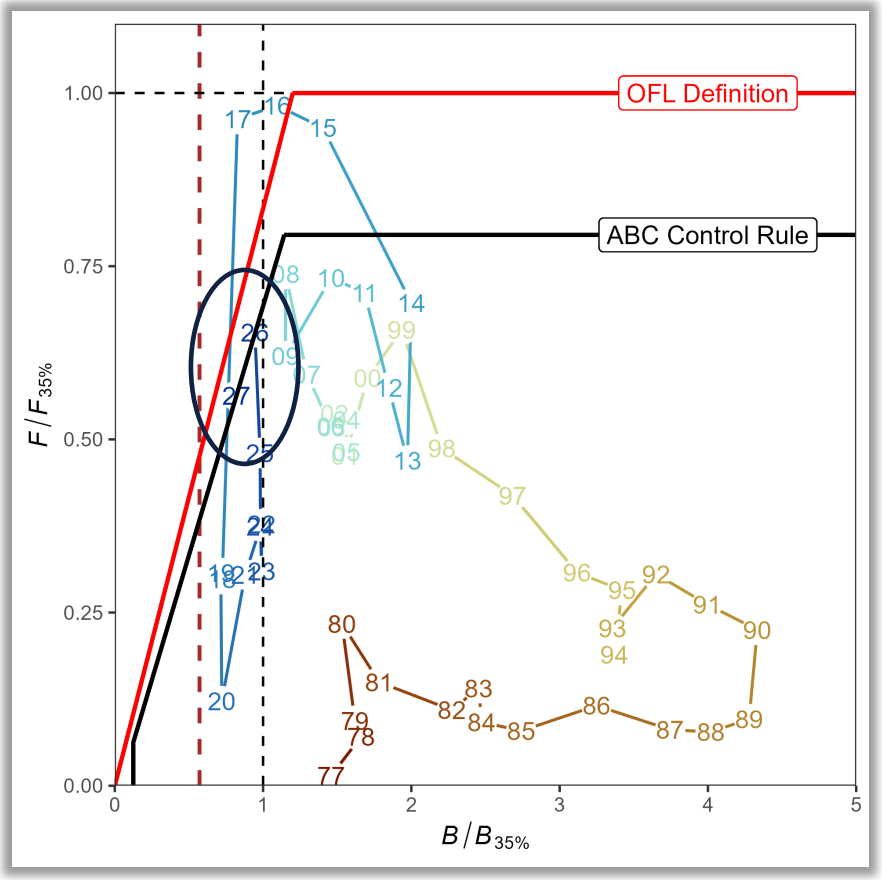


RESULTS: BIOMASS

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

STOCK STATUS

- Tier 3b: on the ramp
- Estimated to be above $B_{20\%}$ (dashed red line), 2026 = $B_{33.1\%}$
- Projected to move down the ramp in 2027



RISK TABLE

Risk table guiding principle: what are the risks, external to the stock assessment, to the recommended 2026 ABC?

Assessment-related Considerations	*Population Dynamics Considerations*	*Ecosystem Considerations*	*Fishery-informed Stock Considerations*
Level 1: Normal	**Level 1:** Normal	**Level 2:** Increased Concern	**Level 1:** Normal
Model 24.0 does not have a concerning retrospective pattern and fits the available data well	Stock continues to experience historically low spawning biomass coupled with below average recruitment	Prolonged warm ocean temperatures throughout the water column in 2025, and concerns of prey base availability, may adversely impact adult Pacific cod biological status in 2026.	Fishery performance indicators are consistent with previous years

RISK TABLE

- Changes from 2024:
- Pop'n dynamics considerations: historically low spawning biomass, below average recruitment, and below average spawning conditions in 2025 are cause for concern.
- However, our understanding of spawning biomass and recruitment comes from assessment model, which, by definition, includes these considerations in any ABC recommendations
- Below average spawning conditions in 2025 will likely lead to poor 2025 year-class, but, this has little effect on 2026 ABC
- While there remains concern over the pop'n dynamics of this stock, reduce the risk level to 1 because these risks are not external to the stock assessment

RISK TABLE

- Changes from 2024:
- Ecosystem considerations: warmer than average ocean conditions in 2025, decrease in adult body condition
- Change from risk level 1 to 2 increased concern

Should the 2026 ABC be reduced from maximum?

- Given our history with this stock, we must think critically about any recommendations that could have unintended impacts on the stock

RISK TABLE

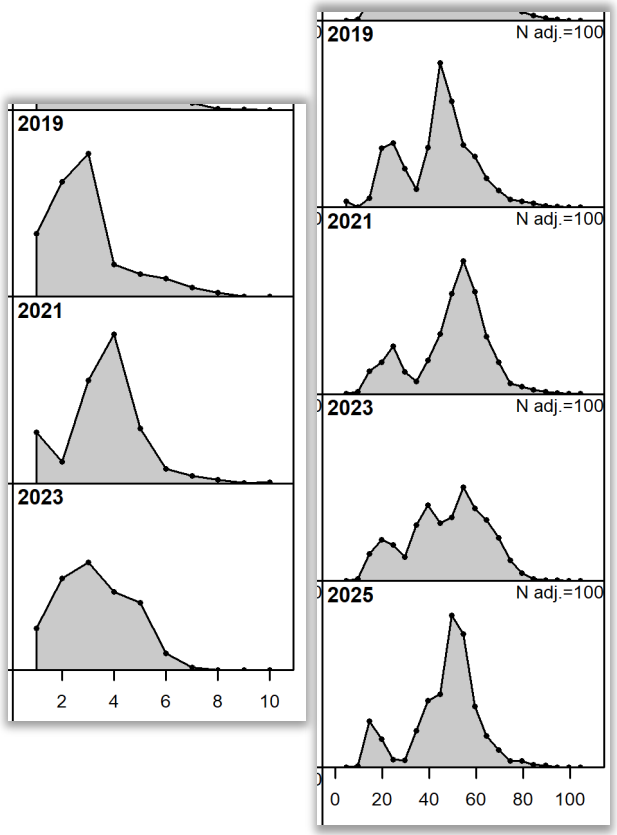
Should the 2026 ABC be reduced from maximum?

- Thinking through this question:
  - Data synthesis
  - Model evaluation
  - Projection considerations
  - Stock status and HCR
  - Have we been here before, and, what happened?

RISK TABLE

Should the 2026 ABC be reduced from maximum?

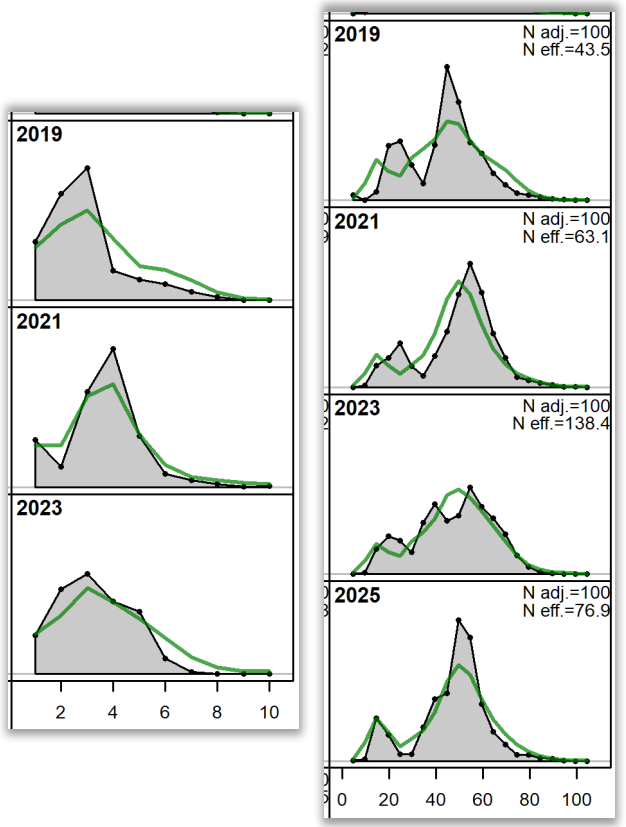
- Data synthesis:
  - Available population index data indicates an increase in the population since 2023/2024
  - AFSC longline survey exception, but, we've discussed why this result occurred, raw catch rates indicates increase
  - Available AFSC bottom trawl survey age and length composition consistently indicates age-1 – age-3 fish in population



RISK TABLE

Should the 2026 ABC be reduced from maximum?

- Model evaluation:
  - Model continues to estimate below average recruitment, but, these estimates do not fit the observed data well, particularly for smaller/younger fish
  - There is a possibility that the model estimates are misrepresenting recruitment
  - Model does not reflect increase in AFSC bottom trawl survey



RISK TABLE

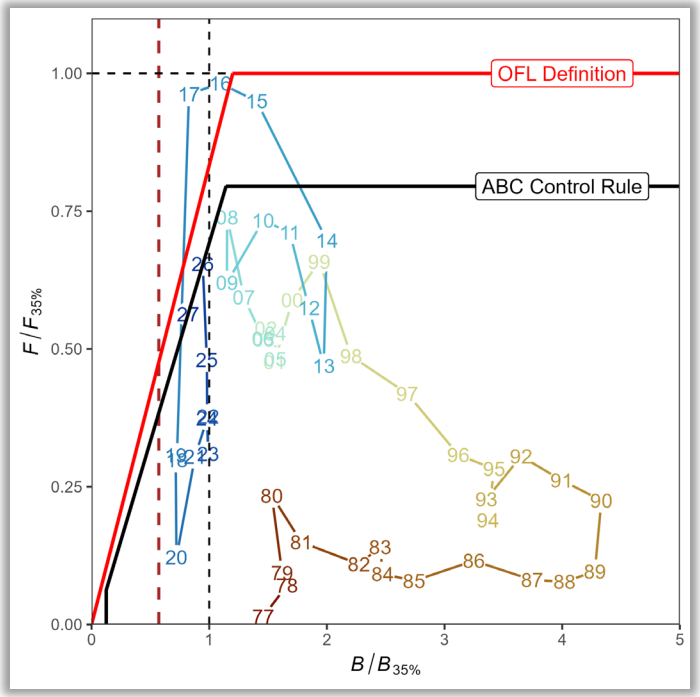
Should the 2026 ABC be reduced from maximum?

- Projection considerations:
  - Continue to note the average recruitment concern in projected biomass, when recent recruitment estimated to be below average since 2014; this potentially results in overly-optimistic long-term projections, but does not have large effect on 2026 ABC
  - Assumption of utilizing full ABC in terminal year of model for projections reduces 2026 recommended ABC by 5% as compared to using observed catch proportions since fishery closure in 2020

RISK TABLE

Should the 2026 ABC be reduced from maximum?

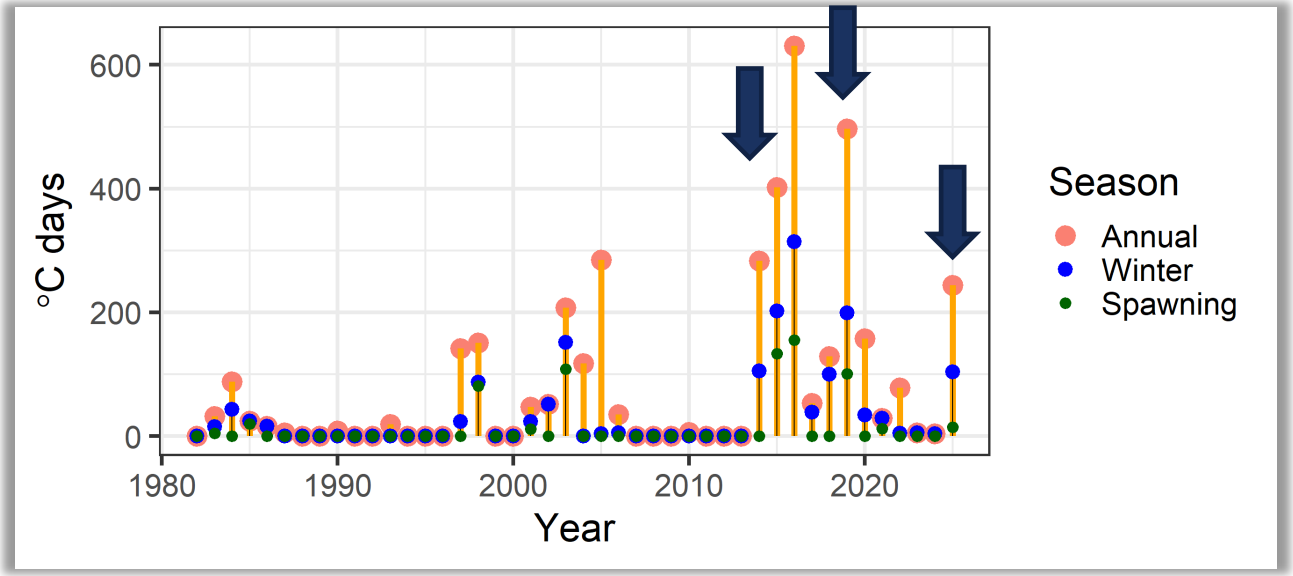
- Stock status and HCR:
  - Stock is currently in Tier 3b, on the ramp of the HCR
  - Based on the HCR and projected stock status, $F_{40\%}$ reduced by 18% to obtain 2026 F_{ABC}



RISK TABLE

Should the 2026 ABC be reduced from maximum?

- Have we been here before, and, what happened?
  - Recognizing that no two years are exactly the same, highlight two recent years in which number of heatwave days similar to 2025: 2014 and 2019



RISK TABLE

Have we been here before, and, what happened?

- 2014: precipitated severe heatwave in 2015 and 2016, following which population collapses
- Model estimates from 2014/2015 much different than current model
  - Spawning biomass in 2014 250% larger than Model 24.0 2014 estimate
  - Adopted 2015 ABC 150% larger than recommended 2026 ABC
- Standardizing ABC as a proportion of total biomass and comparing between 2015 and 2026, recommended 2026 ABC 24% smaller than what was adopted in 2015
- Seasonality and selectivity is the primary difference between the model used in 2014 and Model 24.0

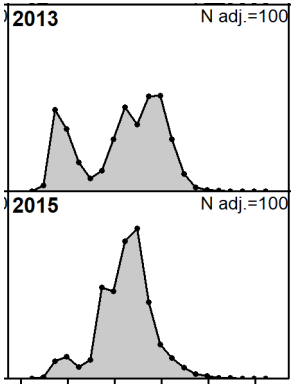
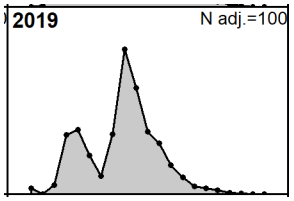
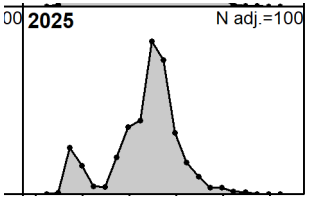
RISK TABLE

Have we been here before, and, what happened?

- 2019: Model recommendation in 2019 resulted in 2020 fishery closure
- After 2019, survey indices have increased, presumably reflecting advantageous conditions for cod population due to improvement in ecosystem conditions after 2019
- 2019 year-class estimated to be smallest in time-series, suspect that 2025 year-class could be of similar magnitude
- While a number of improvements to the model and data have been implemented since 2019, Model 24.0 is fundamentally the same model as used in 2019 to recommend the fishery closure (note: no additional buffers have been applied to recommended ABC since fishery closure)

RISK TABLE

Have we been here before, and, what happened?

	2014	2019	2025
Biomass conditions	Largest biomass in recent time series	Lowest biomass in time series	Continuing to increase since historical low
Recruitment trends	At end of period of above average recruitment	In midst of below average recruitment	10 years worth of below average recruitment
Demographics (survey length)			

RISK TABLE

Should the 2026 ABC be reduced from maximum?

- Summary: There are several aspects of the current stock assessment that mitigate risk, including catch assumptions in projections, stock status and the HCR, and model development over time
- But, do these serve to mitigate the risk identified for the 2026 ABC?
  - It is not clear to what extent increased risk highlighted in 2025 is mitigated by stock assessment
  - It remains unknown if environmental conditions in 2025 will persist into 2026, and whether they had significant impact on the GOA cod stock

RISK TABLE

Should the 2026 ABC be reduced from maximum?

- An additional buffer to the 2026 ABC could be considered, however,
  - There is no quantitative method available with clear objectives from which to derive the additional buffer, it remains a subjective decision
  - There is no understanding of any measurable risk reductions that have occurred due to buffers that have been implemented across stocks to inform the magnitude of buffers

RISK TABLE

Should the 2026 ABC be reduced from maximum?

Taken together, a reduction from maximum ABC in 2026 is <u>not</u> recommended, while at the same time acknowledge the ***increased risk*** associated with this recommendation

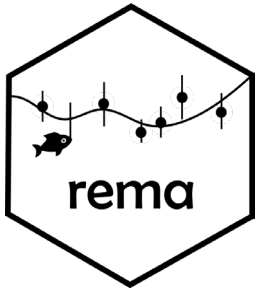
ABC/OFL RECOMMENDATIONS

Model 24.0 recommended ABC: 29% increase in 2026 ABC

Quantity	As estimated or *specified last* year for: 2025	2026	As estimated or *specified this* year for: 2026	2027
M (natural mortality rate)	0.49*	0.49*	0.5*	0.5*
Tier	3b	3b	3b	3b
Projected total (age 0+) biomass (t)	177,497	200,521	182,156	186,118
Female spawning biomass (t)				
Projected	46,920	44,674	52,772	45,838
$B_{100\%}$	163,585	163,585	159,595	159,595
$B_{40\%}$	65,434	65,434	63,838	63,838
$B_{35\%}$	57,255	57,255	55,858	55,858
F_{OFL}	0.57	0.51	0.68	0.54
$maxF_{ABC}$	0.46	0.43	0.54	0.47
F_{ABC}	0.46	0.43	0.54	0.47
OFL (t)	38,688	33,099	**49,782**	38,812
maxABC (t)	32,141	30,193	41,520	32,209
ABC (t)	32,141	30,193	**41,520**	32,209
Status	As determined *last* year for:		As determined *this* year for:	
	2023	2024	2024	2025
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

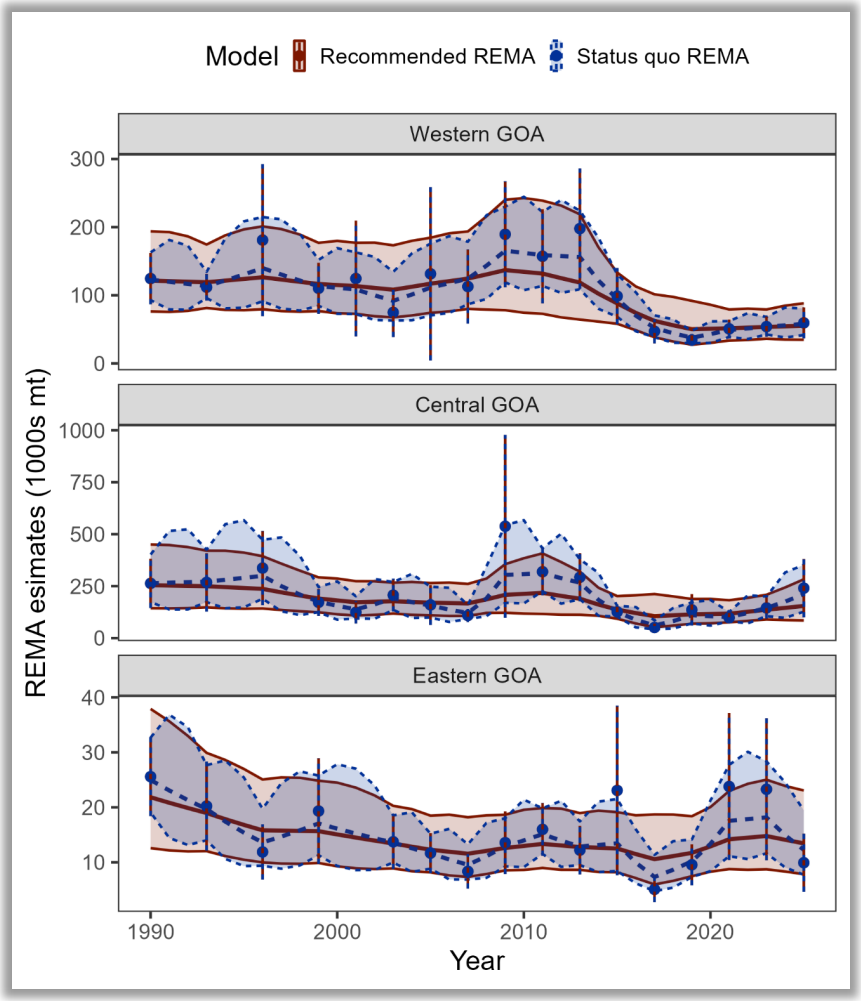
APPORTIONMENT

- Two REMA model configuration changes recommended for GOA Biologically informed Recommended Distributions (BRD)
  1. Estimate single process error parameter across GOA subregions
  2. Estimate additional observation error parameter for GOA bottom trawl survey
- These REMA model configurations previous adopted for GOA Thornyhead stock complex (Echave et al. 2022, Siwicke et al. 2024)



APPORTIONMENT

- Recommended REMA configuration changes serve to:
  1. Smooth estimates of subregion biomass and uncertainty that is reflective of primary assessment model estimates of biomass,
  2. Provide apportionment estimates that do not result in drastic and improbable shifts in distribution that are inconsistent with our understanding of cod life history and movement



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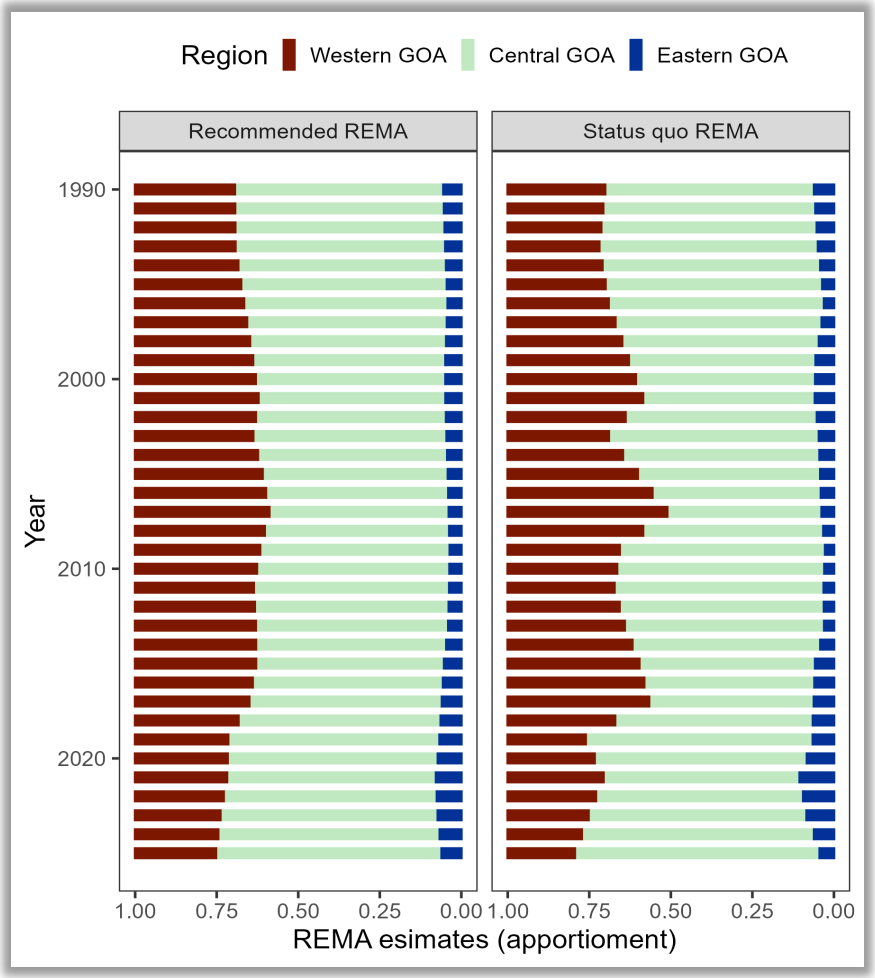
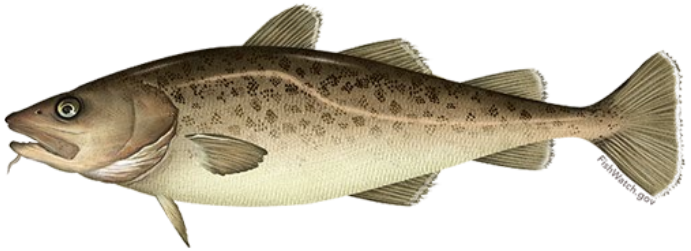


APPORTIONMENT

- Comparison among adopted BRDs from 2025, BRDs from status quo REMA model, and BRDs from recommended REMA model:

	Western	Central	Eastern	Total
Previous apportionment	27.1%	63.8%	9.1%	100%
2025 BRD	8,710	20,506	2,925	32,141
Status quo apportionment	20.6%	75.1%	4.3%	100%
2026 BRD	8,553	31,182	1,785	41,520
Recommended apportionment	24.8%	69.2%	6%	100%
2026 BRD	10,297	28,732	2,491	41,520

- 2-year projected BRDs from recommended REMA model

	Western	Central	Eastern	Total
Area apportionment	24.8%	69.2%	6%	100%
2026 BRD	10,297	28,732	2,491	41,520
2027 BRD	7,987	22,289	1,933	32,209

QUESTIONS?