5. ASSESSMENT OF THE GREENLAND TURBOT STOCK IN THE BERING SEA AND ALEUTIAN ISLANDS

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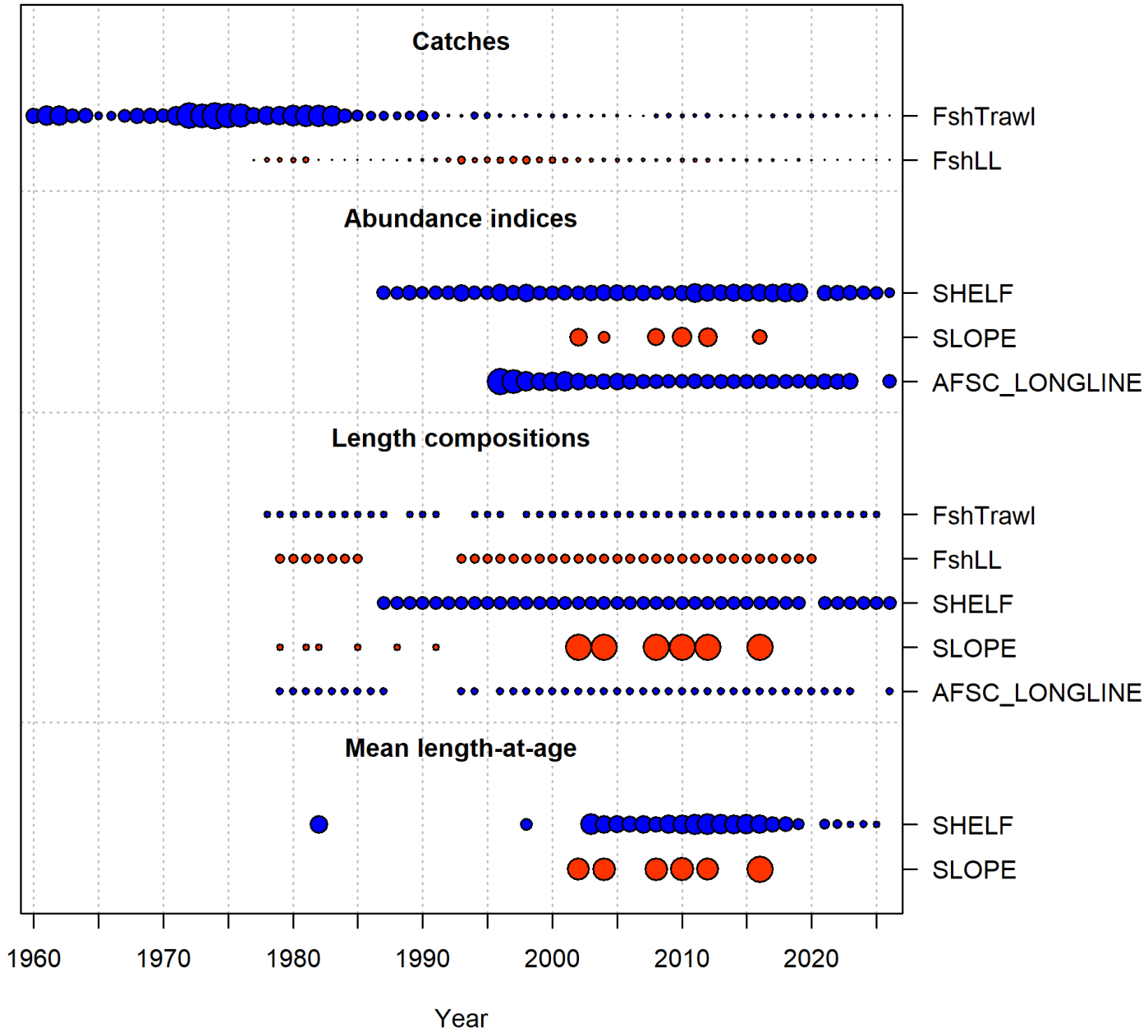
PRESENTATION OUTLINE

- Main take homes
- Data review
- Tier 3 models and outcomes
- Tier 5 models and BRDs
- Risk Table
- Projections and ABCs
- Recommendations for the future

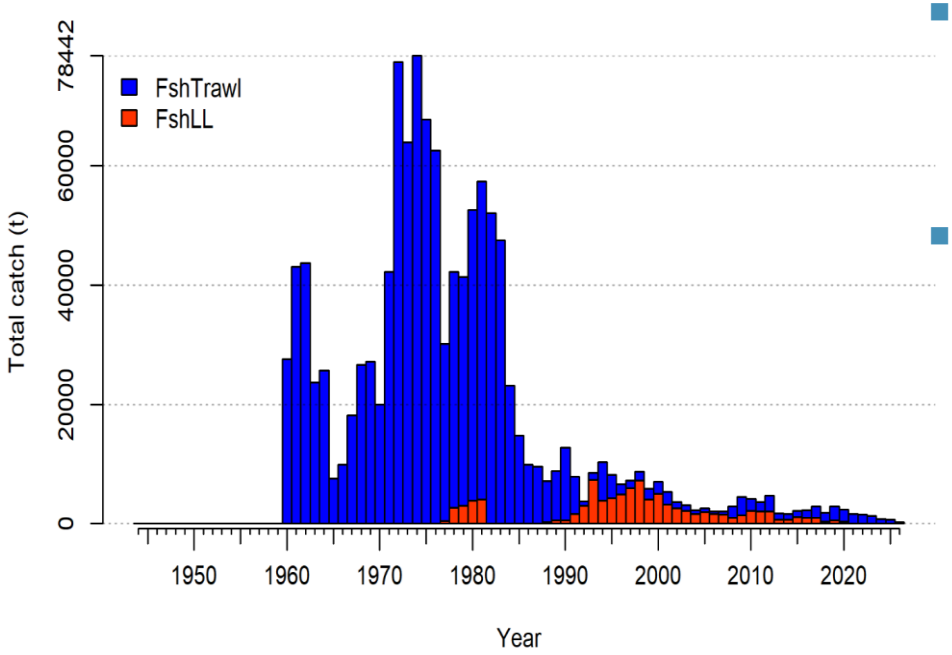
MAIN TAKE HOMES

- Differences between base model and alternatives demonstrate that population trend is estimated reasonably well, but the scale is uncertain
  - Data conflicts make it difficult to determine population scale
    - Weighting towards survey length composition leads to a larger pop in recent years than when weighting towards survey indices (AFSC longline survey RPNs)
  - Initial model conditions are driven by catch data adding to our uncertainty about population scale
- Authors are recommending model 25.0 for management (Tier 3b) and Tier 5 model for Biologically-informed Recommended Distributions (BRDs)
  - 2027 maxABC: 1,165 t (27% decrease from specified 2026 ABC)
  - 2028 maxABC decreases to 1,107 t

DATA REVIEW

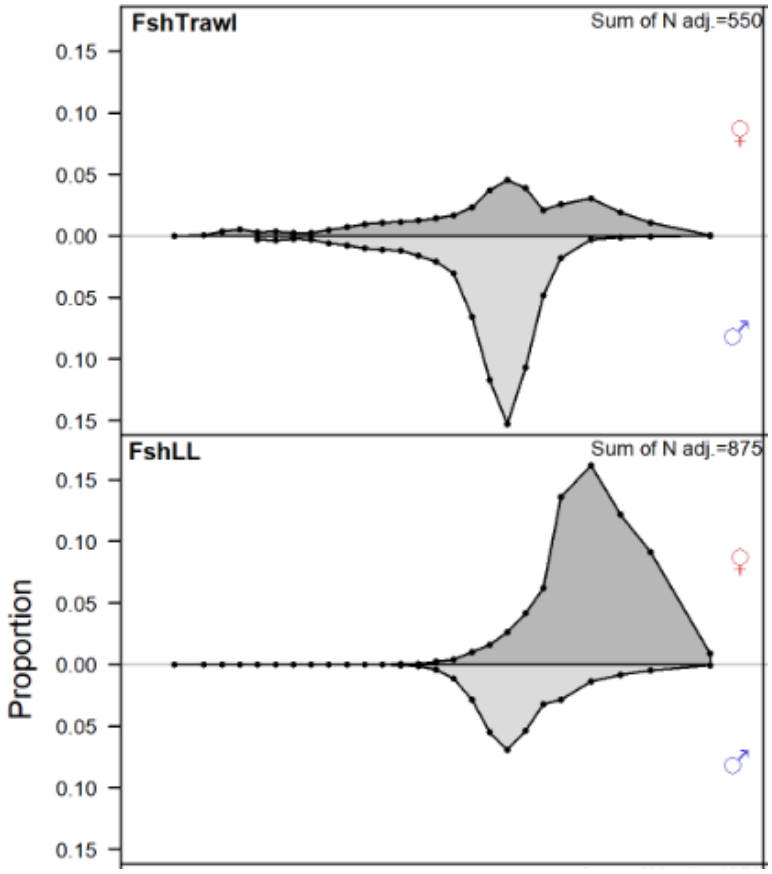

Catches
FshTrawl
FshLL
Abundance indices
SHELF
SLOPE
AFSC_LONGLINE
Length compositions
FshTrawl
FshLL
SHELF
SLOPE
AFSC_LONGLINE
Mean length-at-age
SHELF
SLOPE
1960
1970
1980
1990
2000
2010
2020
Year

COMMERCIAL FISHERIES CATCH



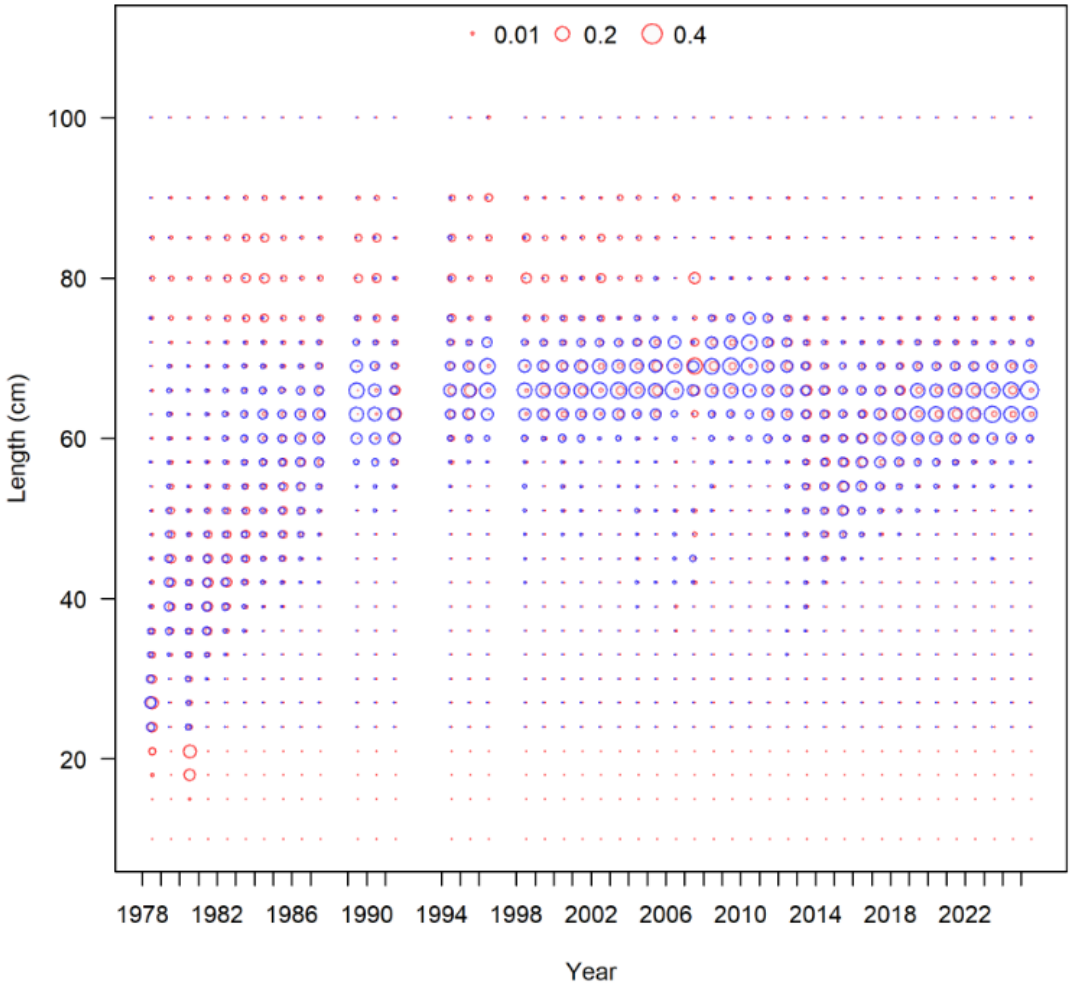
- Before 1985, highest harvest
  - Average (1960 – 1985): 39,481 t
  - Primarily trawl fishery
- After 1985 significant decline in catch
  - Average (1986 – 2025): 4,654 t
  - Longline fleet dominant: 1990s – 2000s
  - Recent 10 years, primarily the trawl fleet
- 2026 on track to be lowest catch in time series
  - Followed by 2006 (361 t)

COMMERCIAL FISHERIES LENGTH COMPOSITION



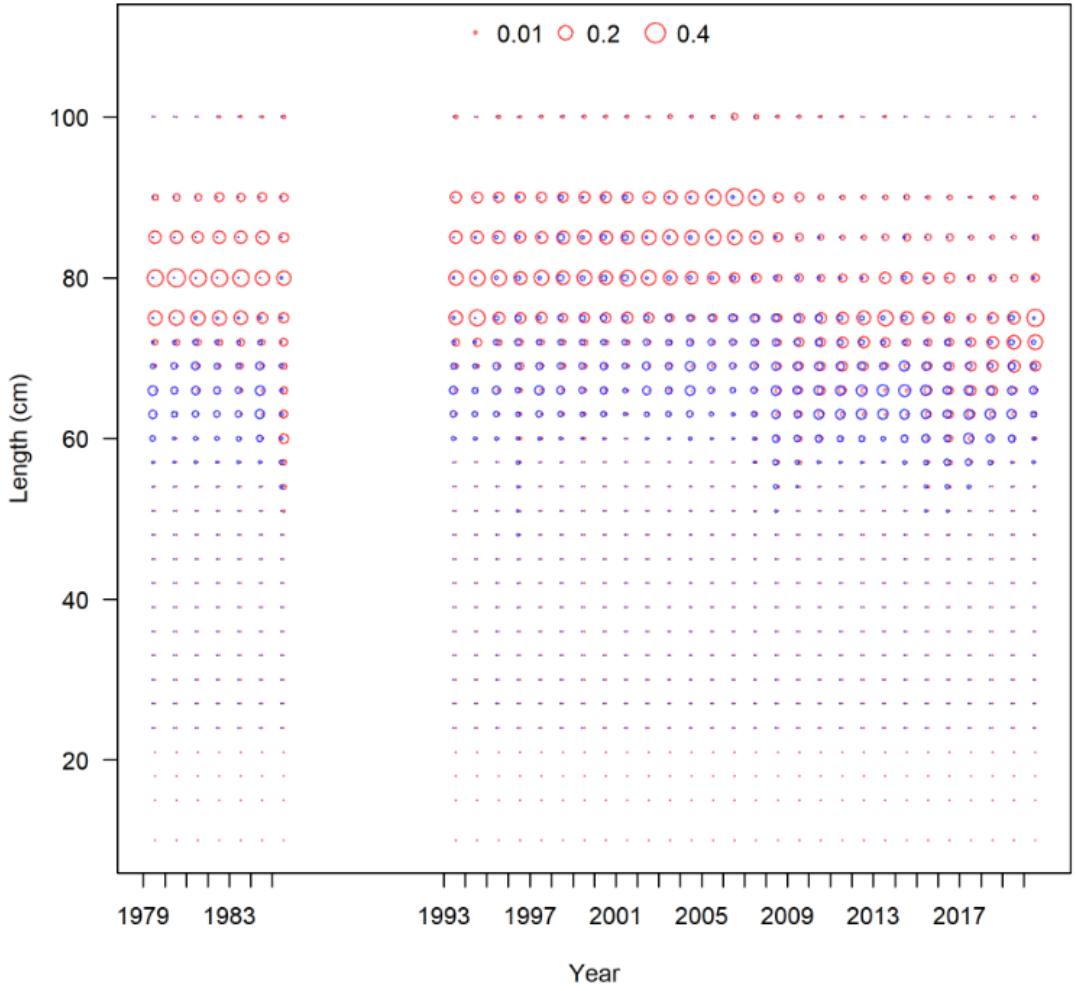
- Female distribution
  - Trawl fishery wider distribution than longline/fixed gear
  - Longline larger proportion of larger females and mode skewed towards larger fish than trawl
- Male distribution
  - Trawl fishery distribution narrower than longline/fixed gear
  - Mode longline > Mode trawl

TRAWL LENGTH COMPOSITION (ANNUAL)



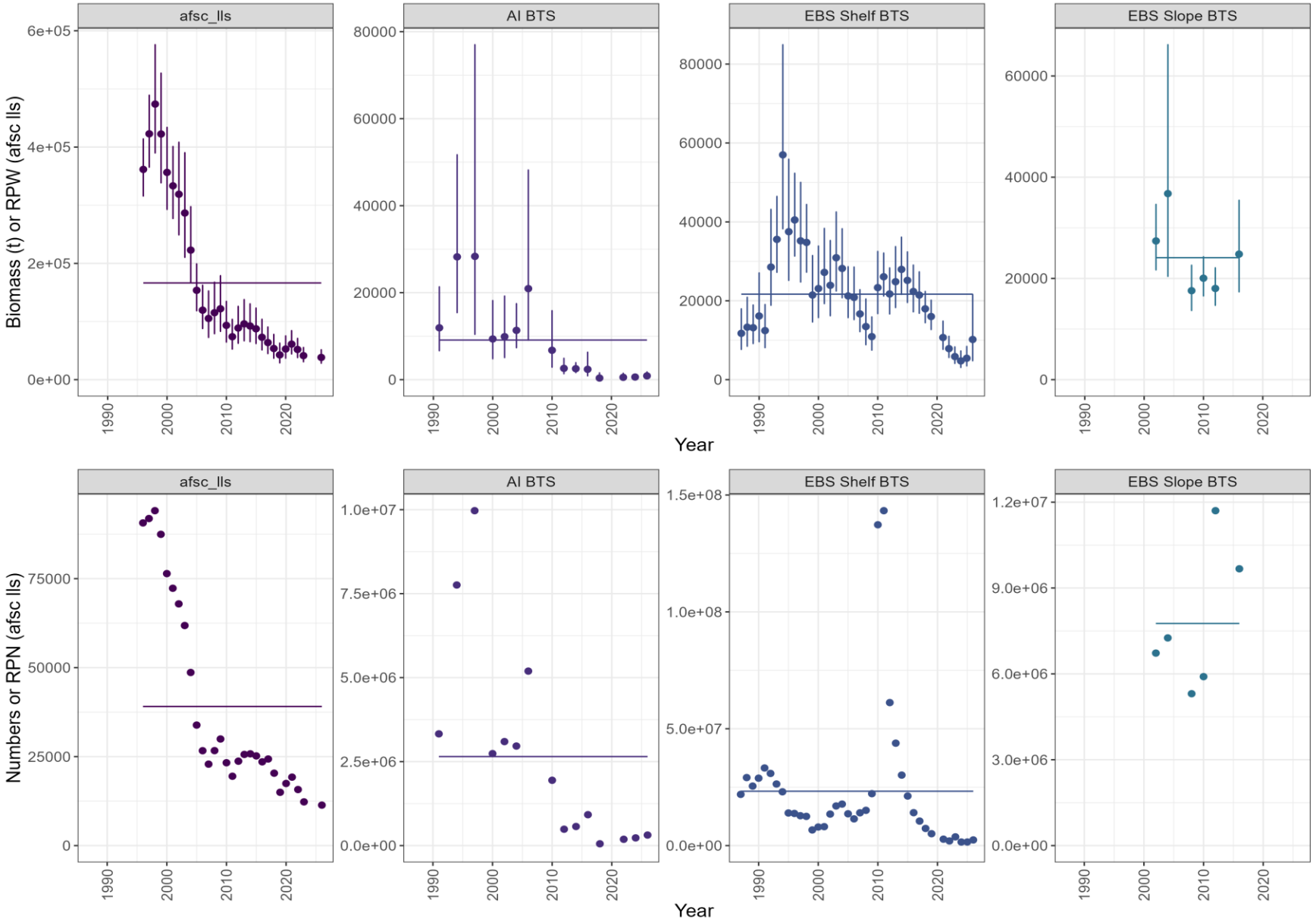
- Shifts over time
- Early years skewed toward smaller fish
- After 1986 see a shift towards larger fish
- See some evidence of recruitment (starting in 2014)

LONGLINE/FIXED GEAR LENGTH COMPOSITION

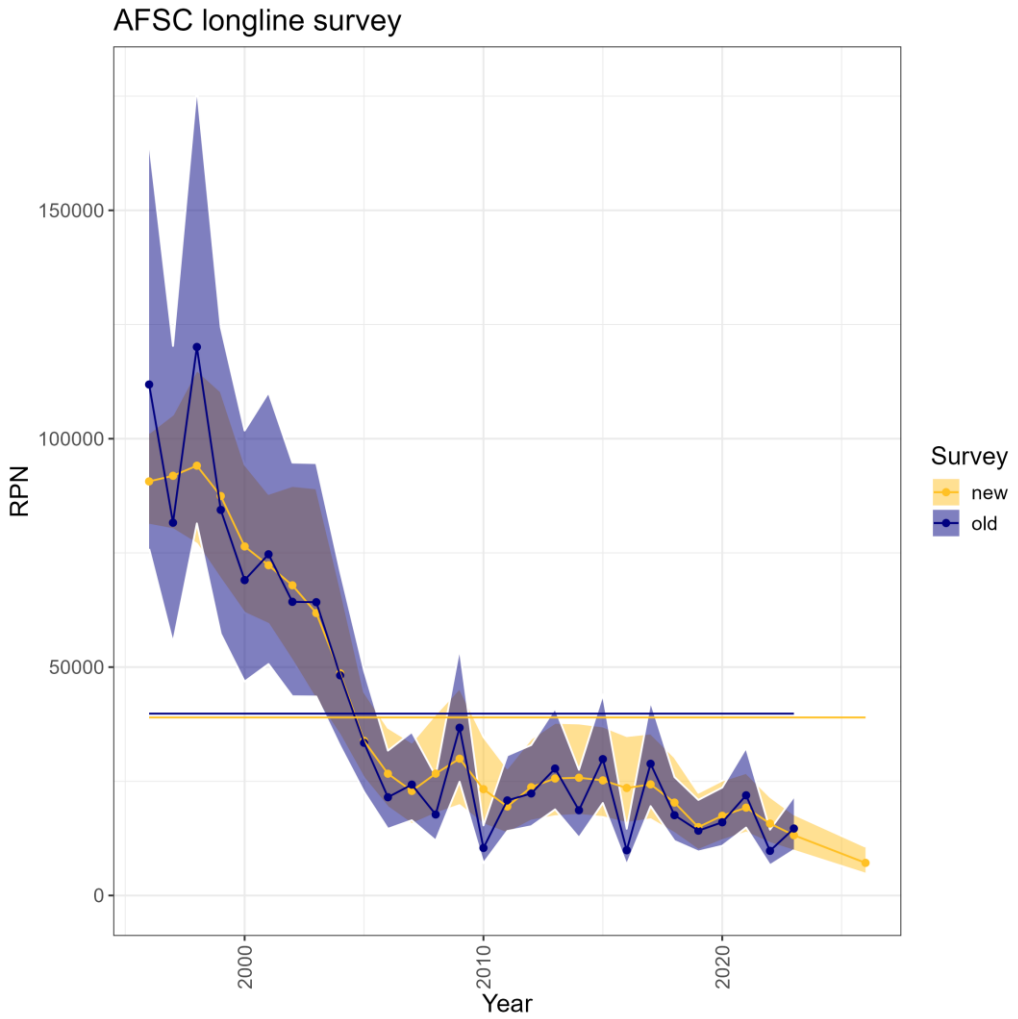


- Male distribution more consistent over time
- Obvious shift in female distribution after 2007
- No length data from this fleet since 2020
- Very few hauls or none given the year

SURVEY INDICES

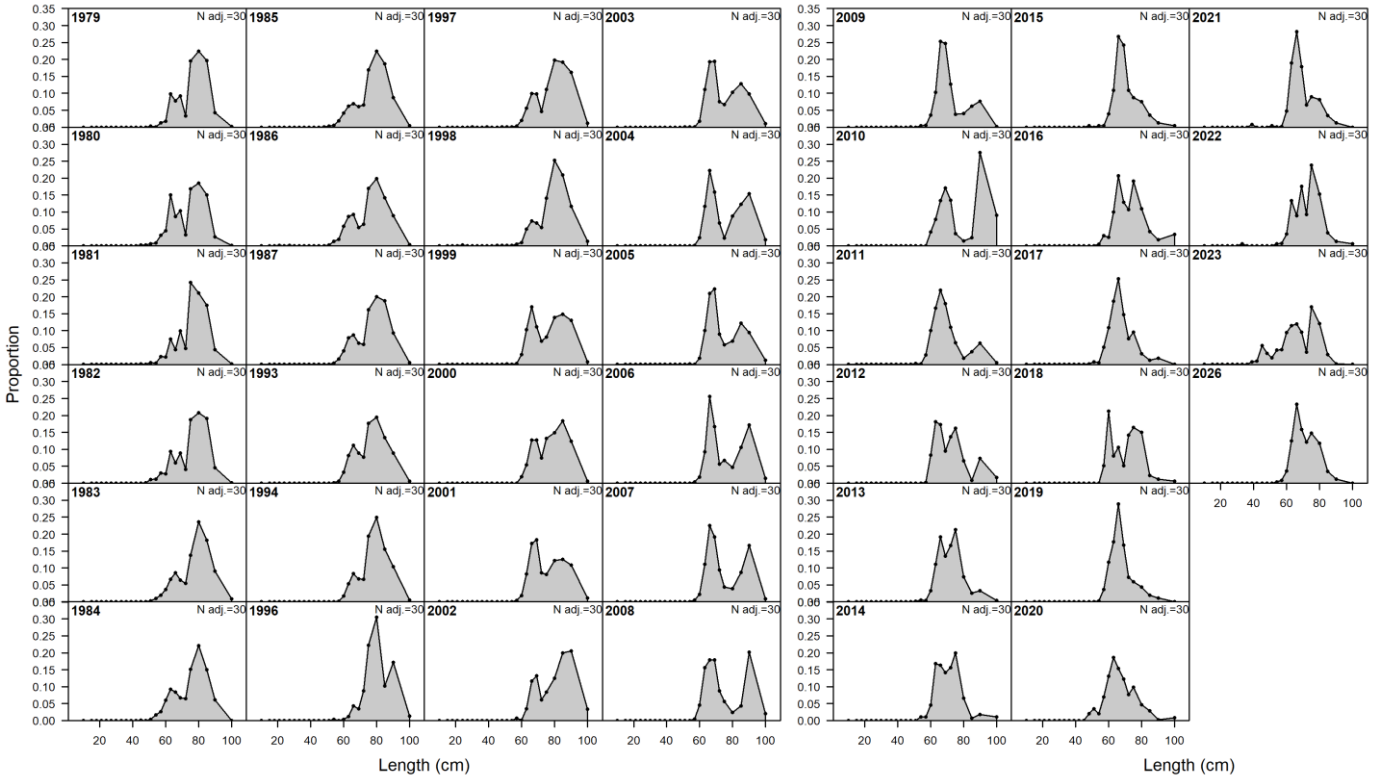


AFSC LONGLINE SURVEY



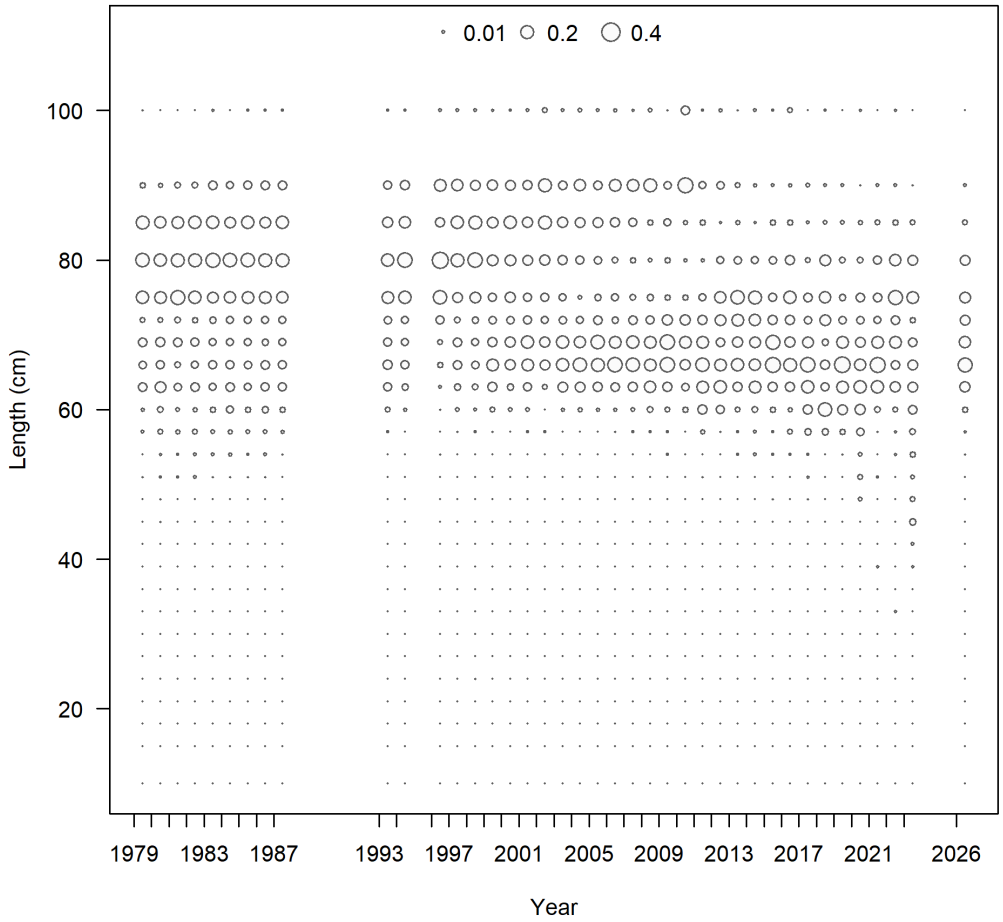
- Prior to 2026: Interpolation method
  - Survey every other year in BS (odd years) or AI (even years)
  - Summed regions for total RPN
- 2026 RPN estimate from BSAI
  - Surveyed both areas in 2026
- 47% decline from 2023 estimate

AFSC LONGLINE SURVEY LENGTH COMP



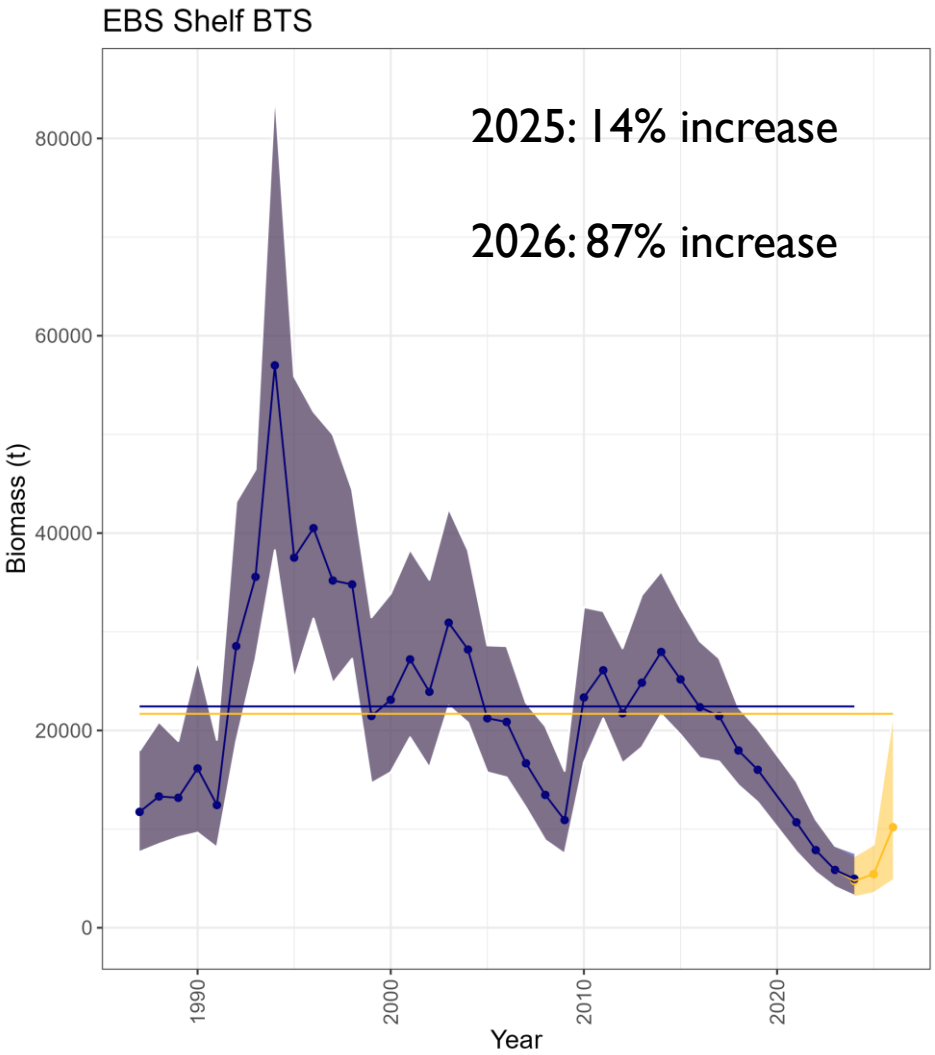
- Annual bimodal distributions
  - Male and female combined
- Truncated since 2012

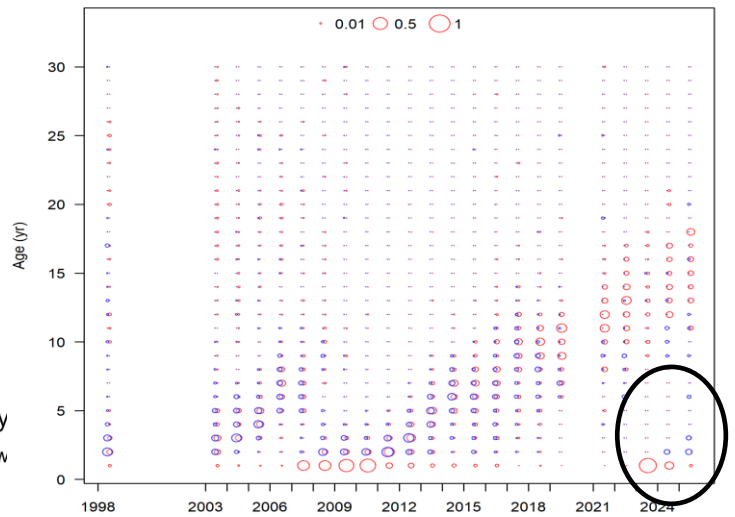
AFSC LONGLINE SURVEY LENGTH COMP

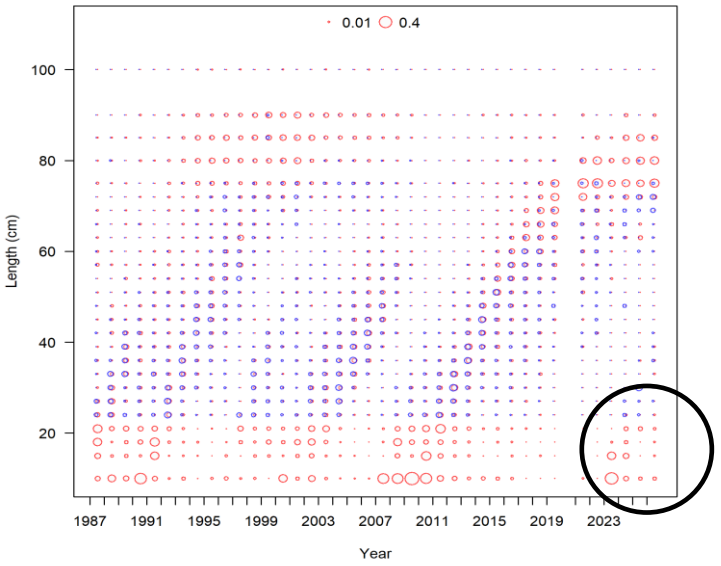


- Annual bimodal distributions
  - Male and female combined
- Truncated since 2012

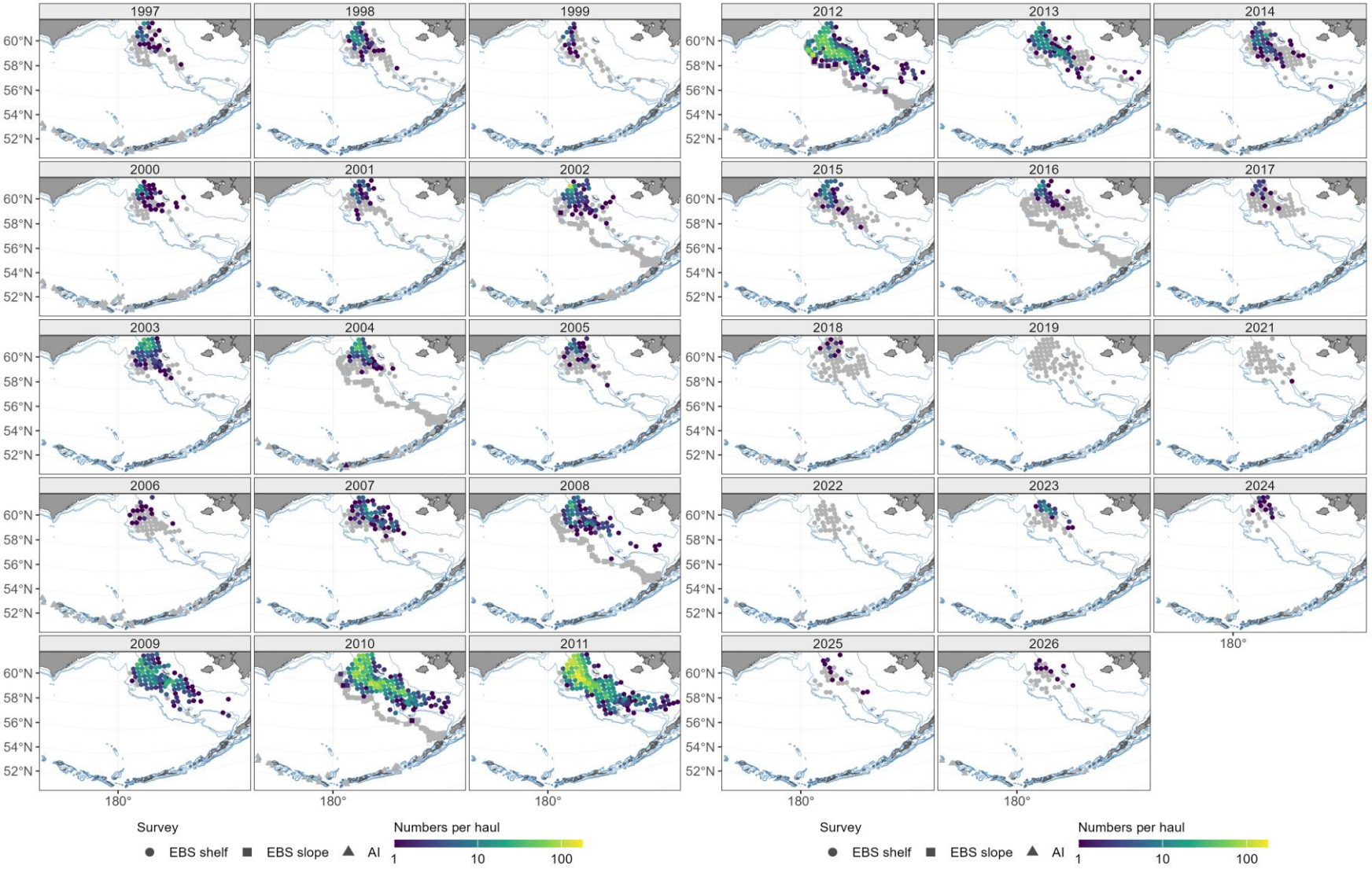
EBS SHELF BOTTOM TRAWL SURVEY INDEX



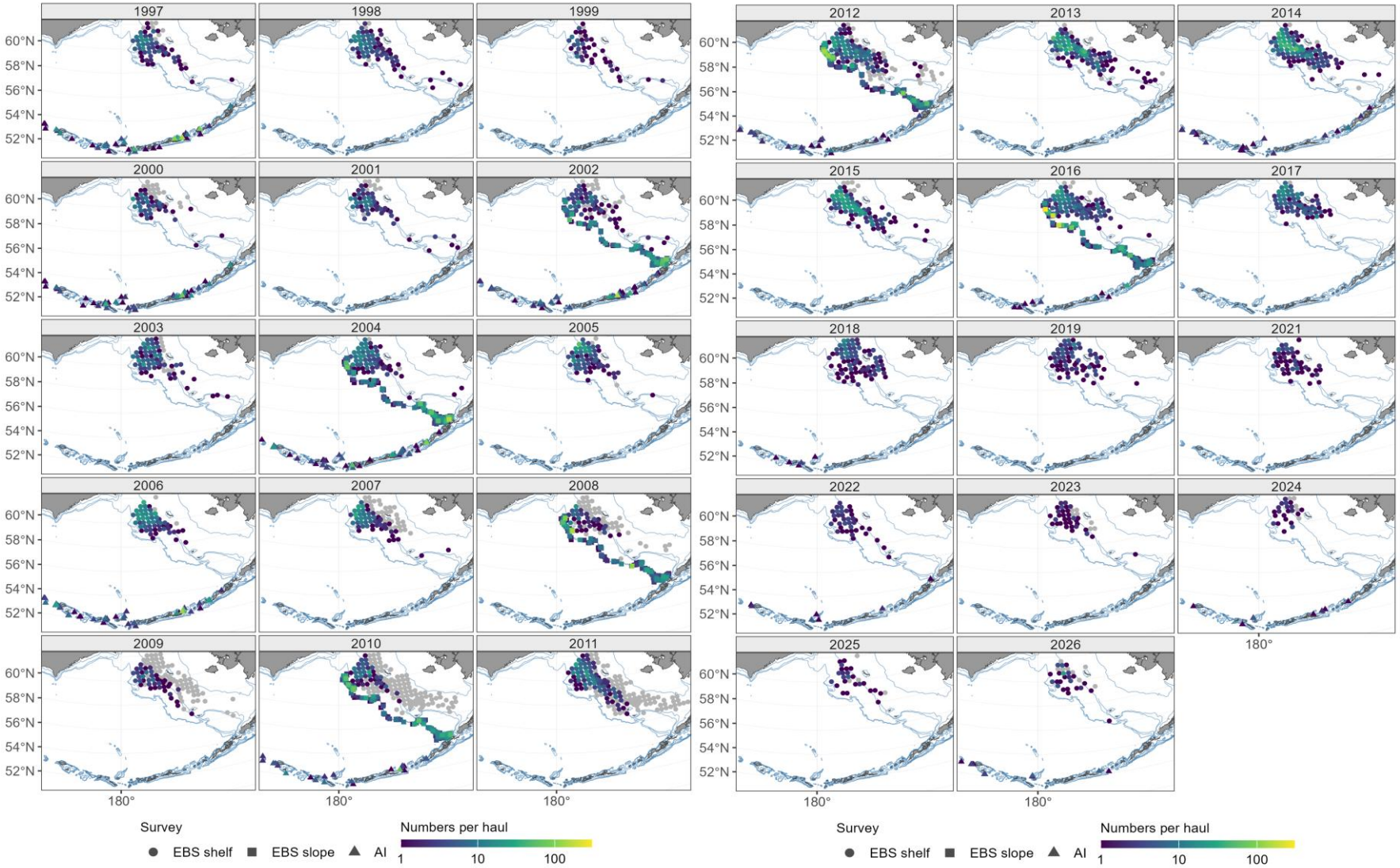




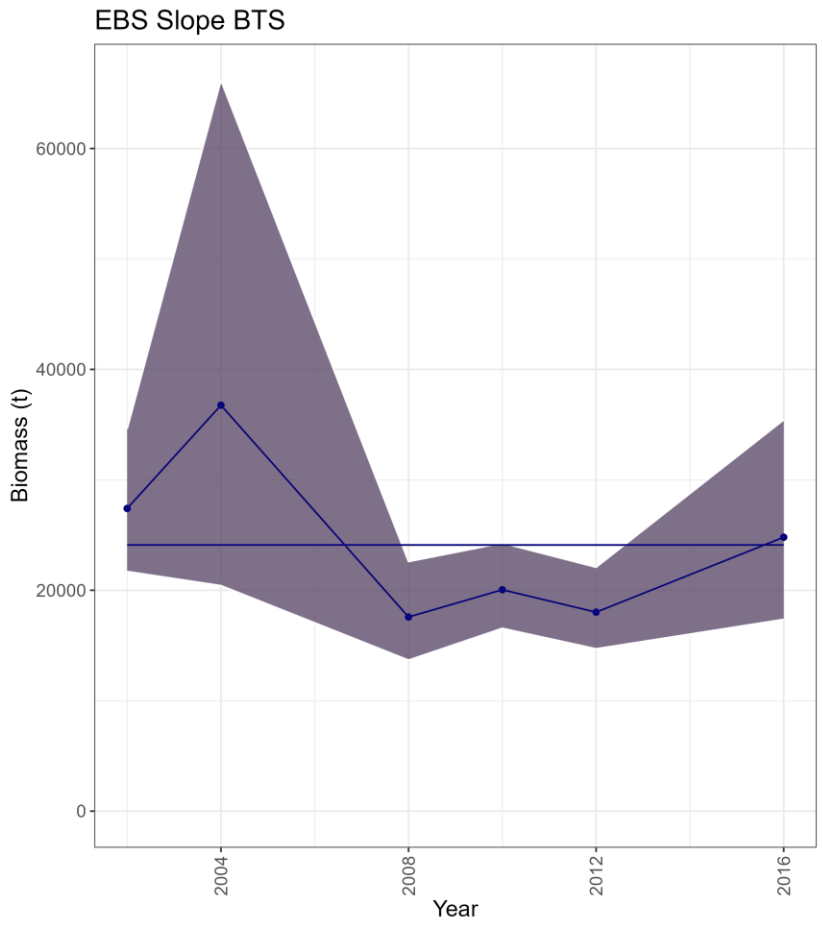
NUMBER OF <35CM FISH FROM BOTTOM TRAWL SURVEYS

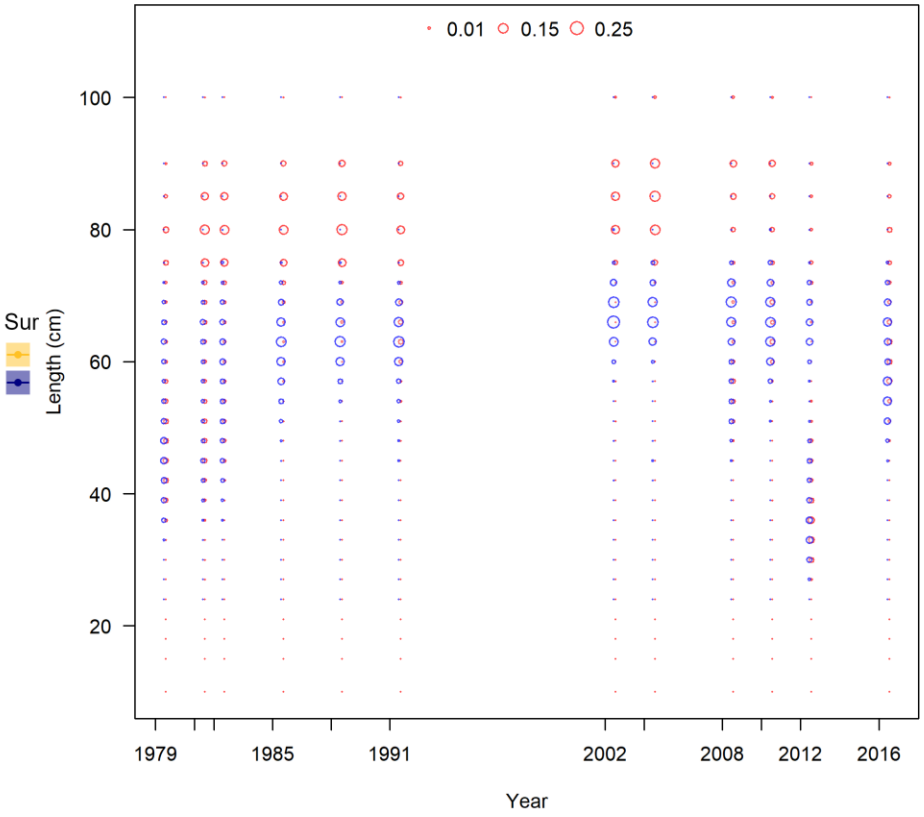


NUMBER OF >=35CM FISH FROM BOTTOM TRAWL SURVEYS



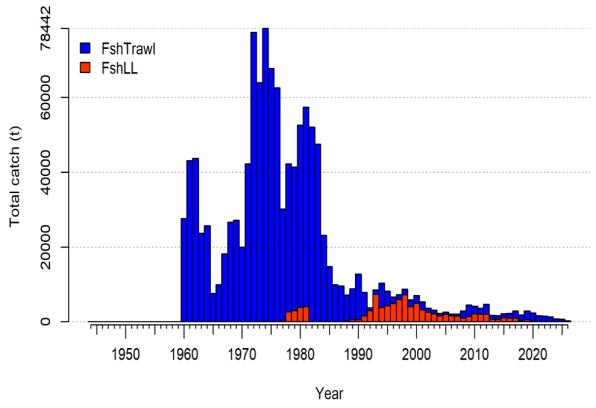
EBS SLOPE BOTTOM TRAWL SURVEY

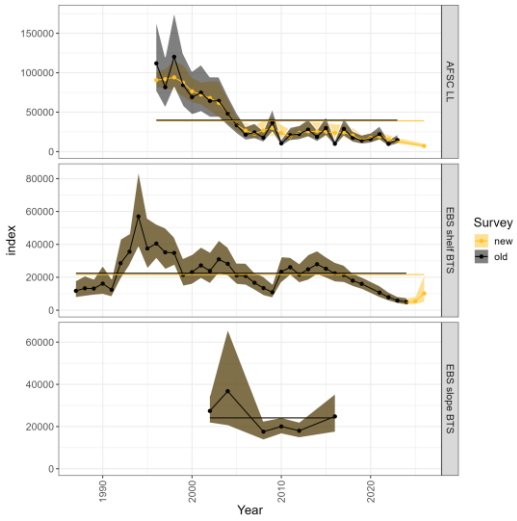


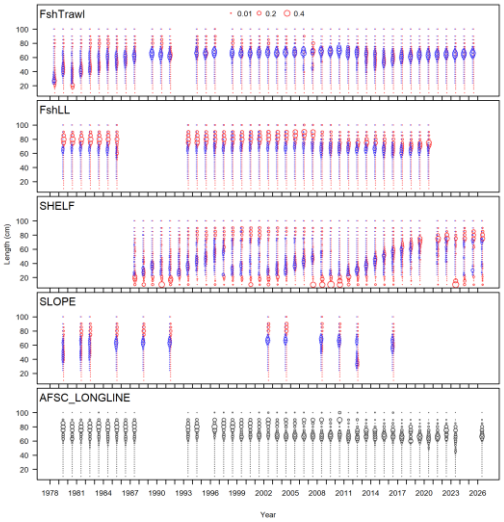


DATA SUMMARY

- Catch remains low in 2026
- All surveys (still in operation) are below average even with some indication of an increase in 2026 for the EBS shelf bottom trawl survey
- EBS shelf BTS length composition data shows a weak recruitment event in 2023







MODELS

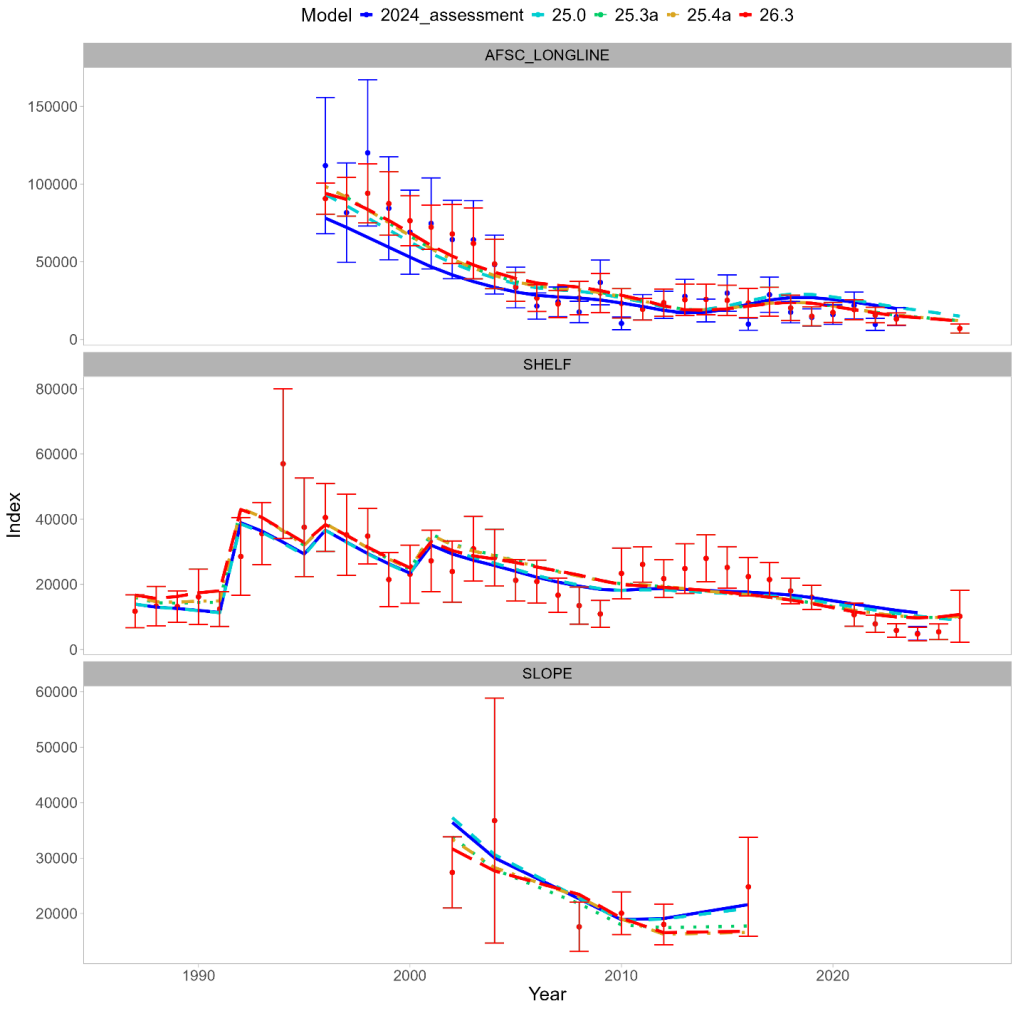
MODELS

Model	Description
25.0	Model 16.4c from 2024 with the following changes: Linear interpolation method to derive AFSC LL RPNs
25.3a	25.0 with the following changes: SRR autocorrelation fixed = 0.437 Analytical solution for survey catchability values New survey multinomial sample size and Francis re-weighting
25.4a	25.3a with the following changes: Two EBS slope BTS time blocks on selectivity (pre-2002 and 2002 – end year of model)
26.3	25.4a with a start year = 1977 and early recruitment deviations 1967 – 1976, equilibrium catch (mean 1960-1976), estimate initial fishing mortality

FITS TO SURVEY INDICES

Label	SHELF	SLOPE	LONGLINE
16.4c	-7.9	-6.0	22.7
25.0	-5.7	-5.3	-7.9
25.3a	-5.8	-5.9	-28.6
25.4a	-5.9	-4.6	-28.9
26.3	-5.8	-5.2	-30.0

Model	Fleet	Q
2024_assessment	AFSC_LONGLINE	2.4
25.0		2.79
25.3a		4.14
25.4a		4.21
26.3		6.04
2024_assessment	SHELF	0.62
25.0		0.62
25.3a		1.12
25.4a		1.26
26.3		1.48
2024_assessment	SLOPE	0.57
25.0		0.57
25.3a		0.65
25.4a		0.63
26.3		0.81



FITS TO LENGTH COMPOSITION DATA

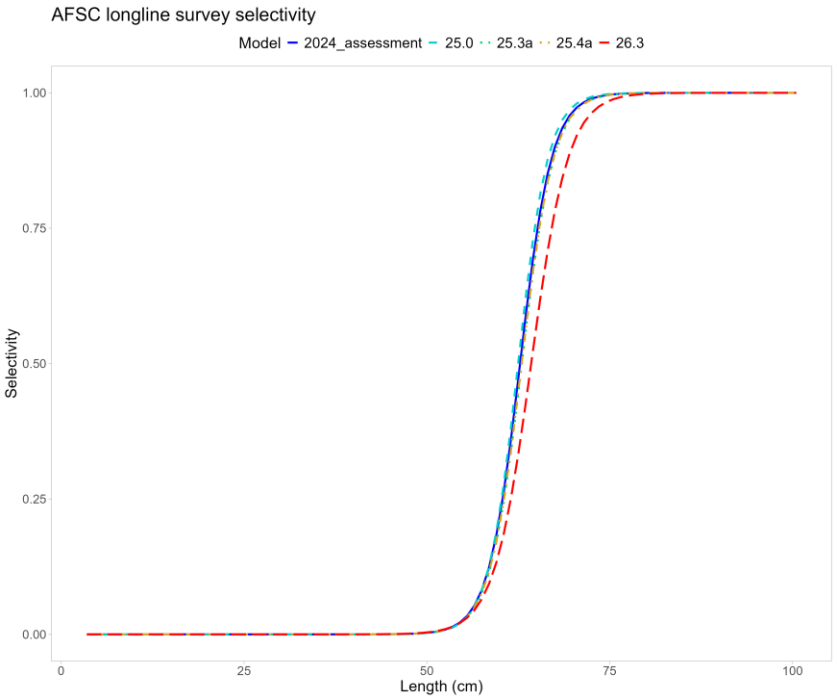


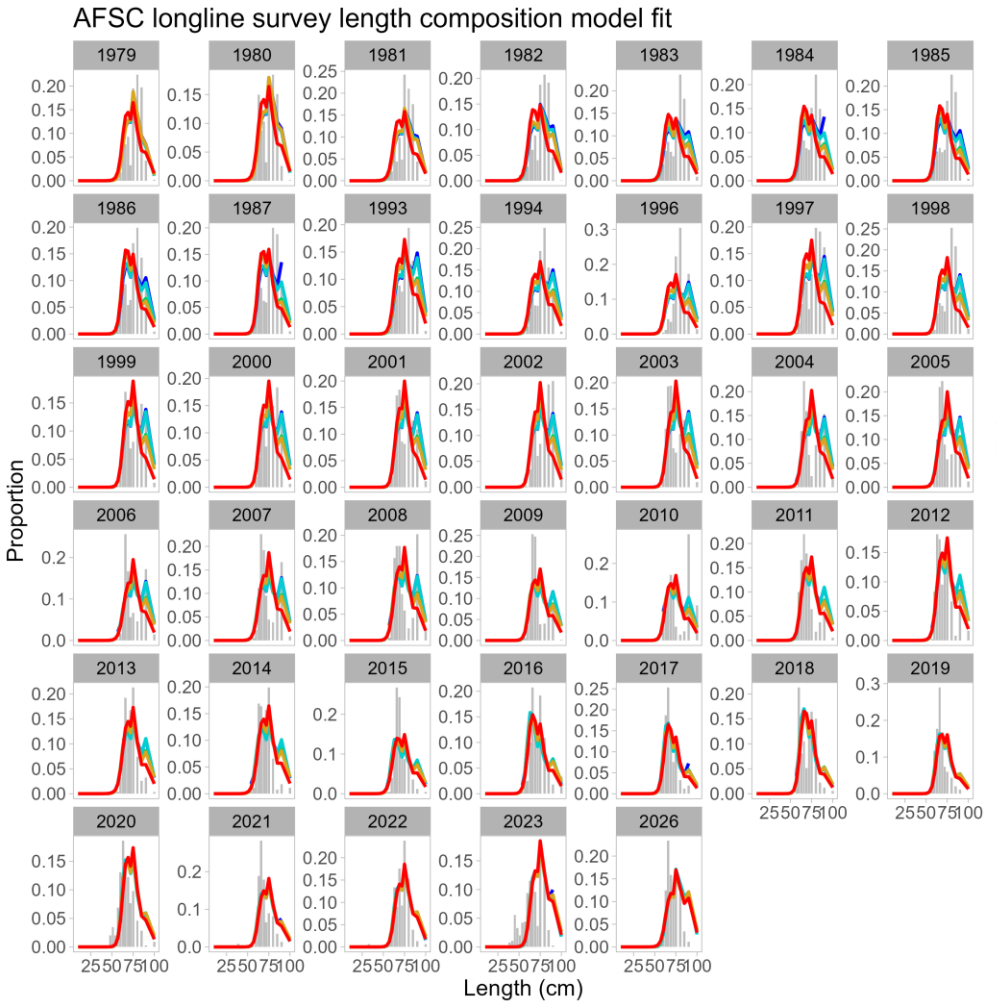


- Model 25.0

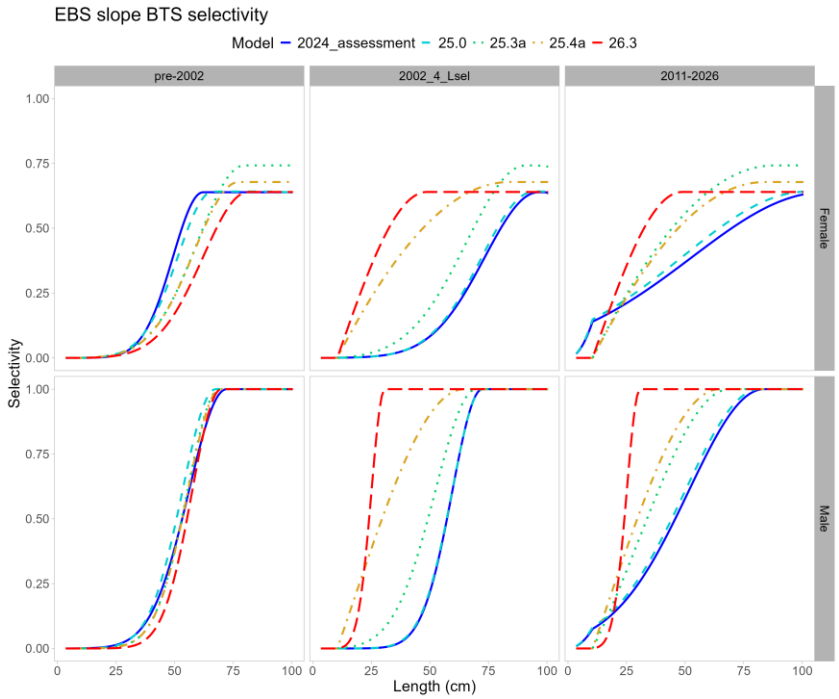
- Model 25.4a
  - Fit was similar for other alternative models

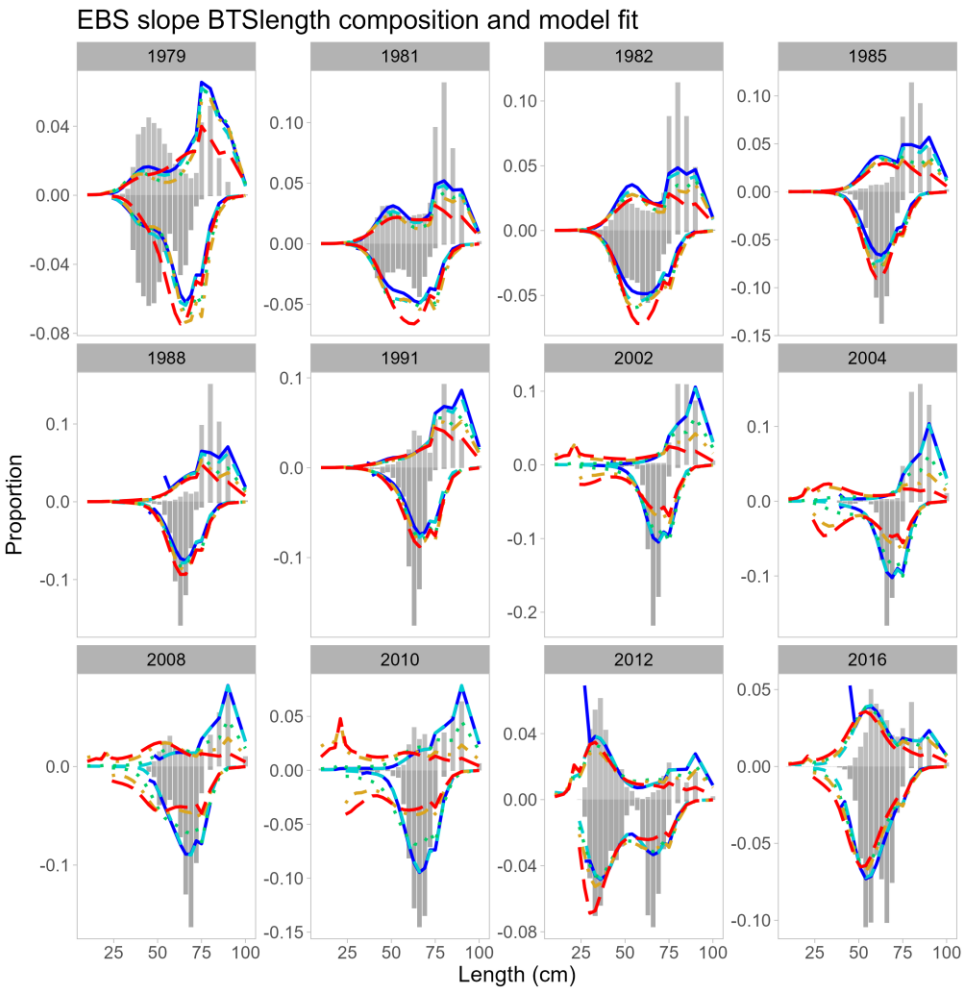
AFSC LONGLINE SURVEY SELECTIVITY



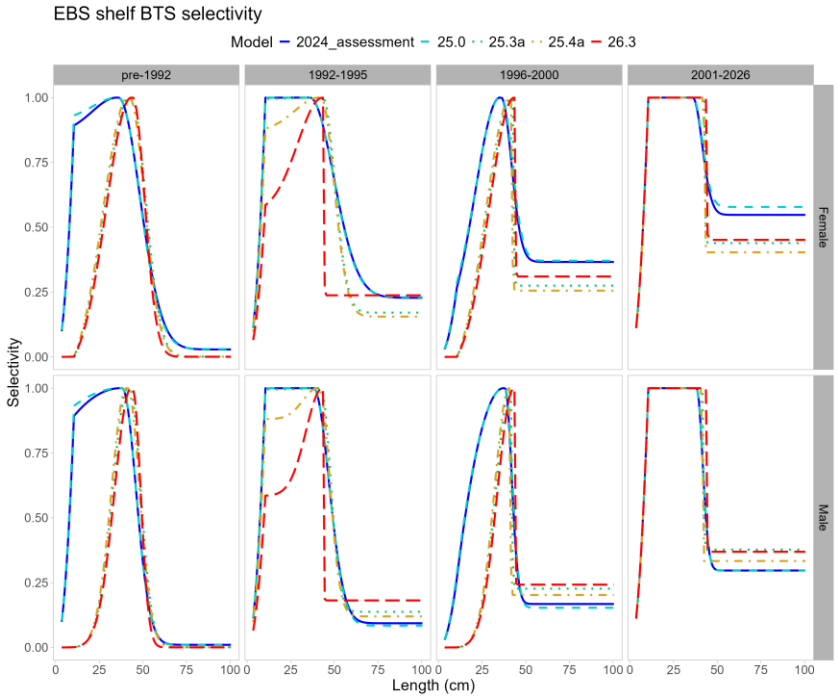


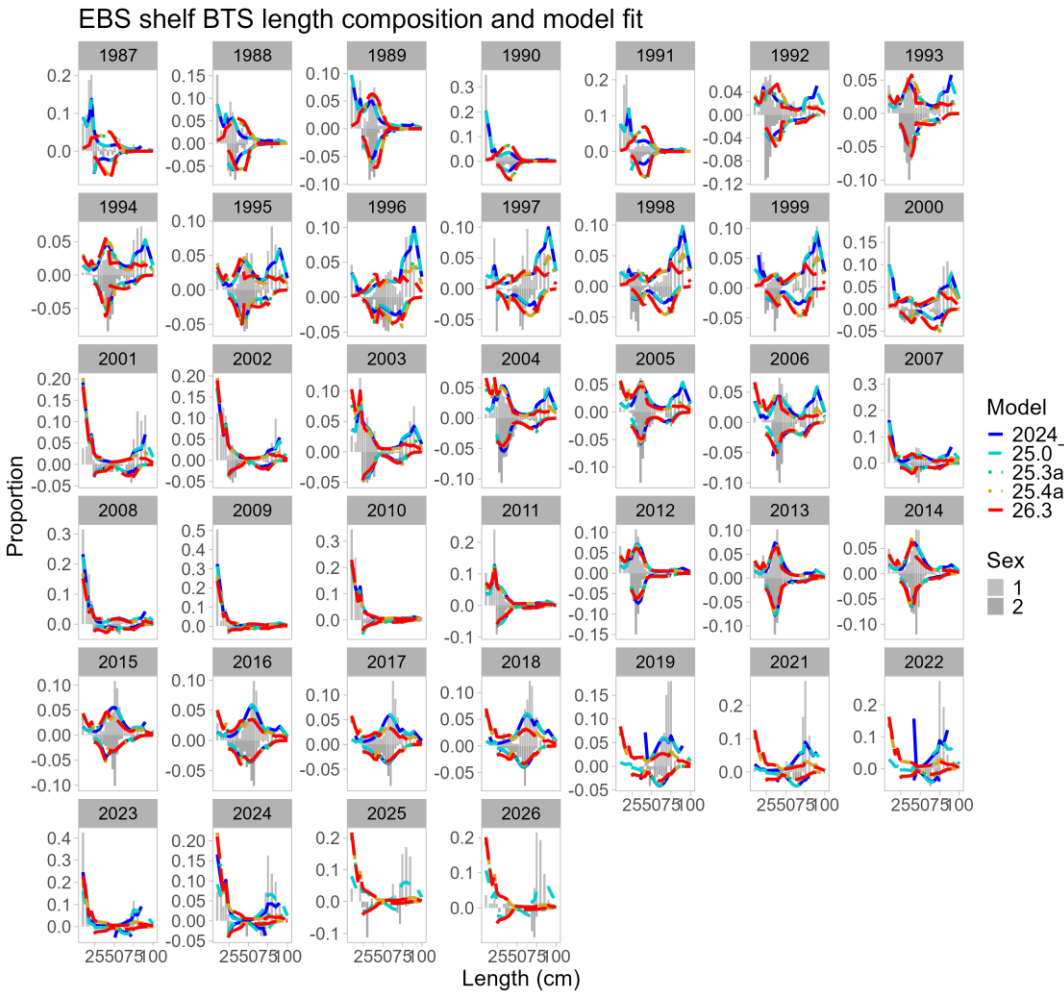
EBS SLOPE BOTTOM TRAWL SURVEY SELECTIVITY





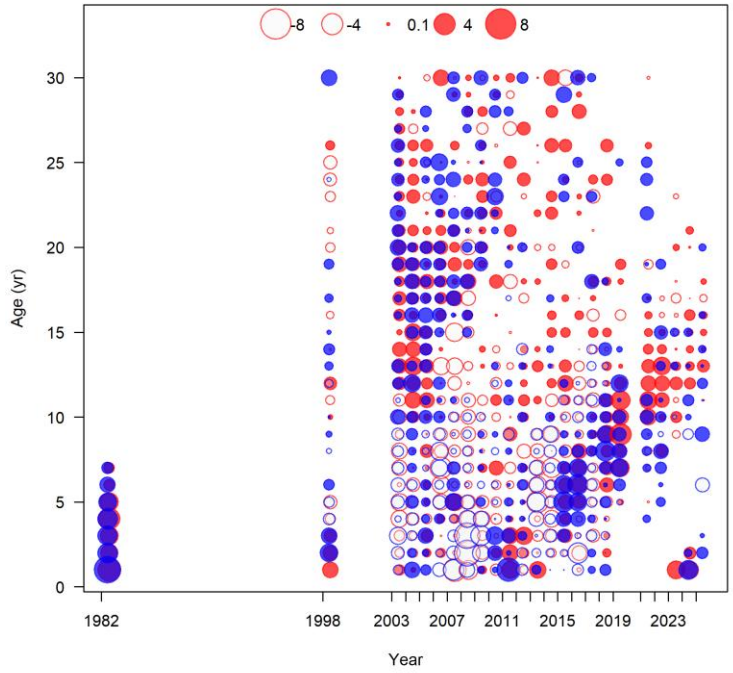
EBS SHELF BOTTOM TRAWL SURVEY SELECTIVITY



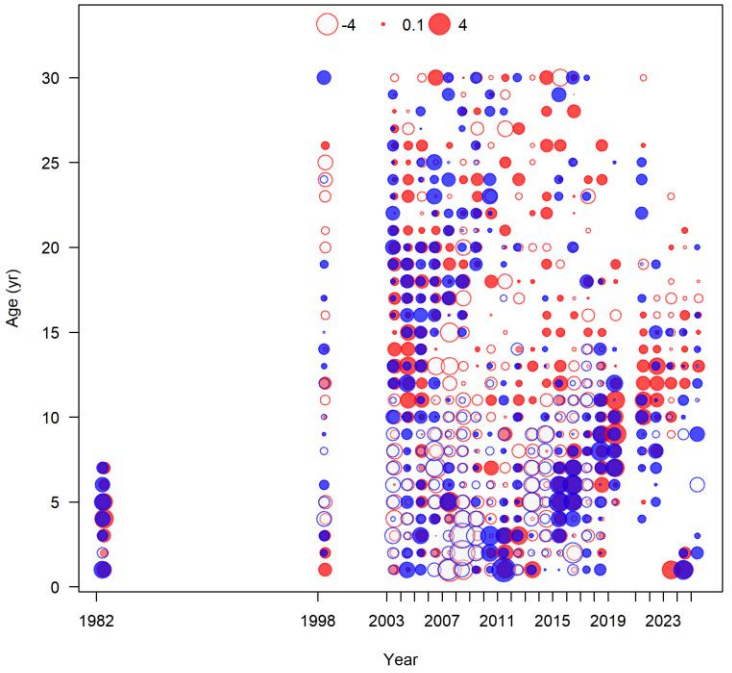


MEAN LENGTH AT AGE

Model 25.0

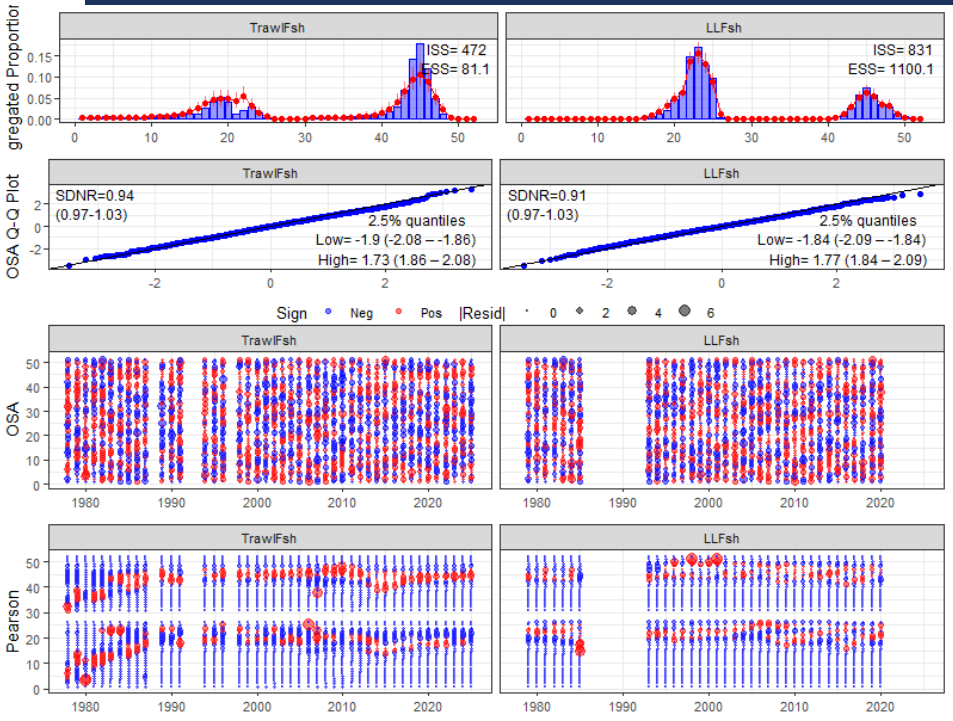


Alternative models

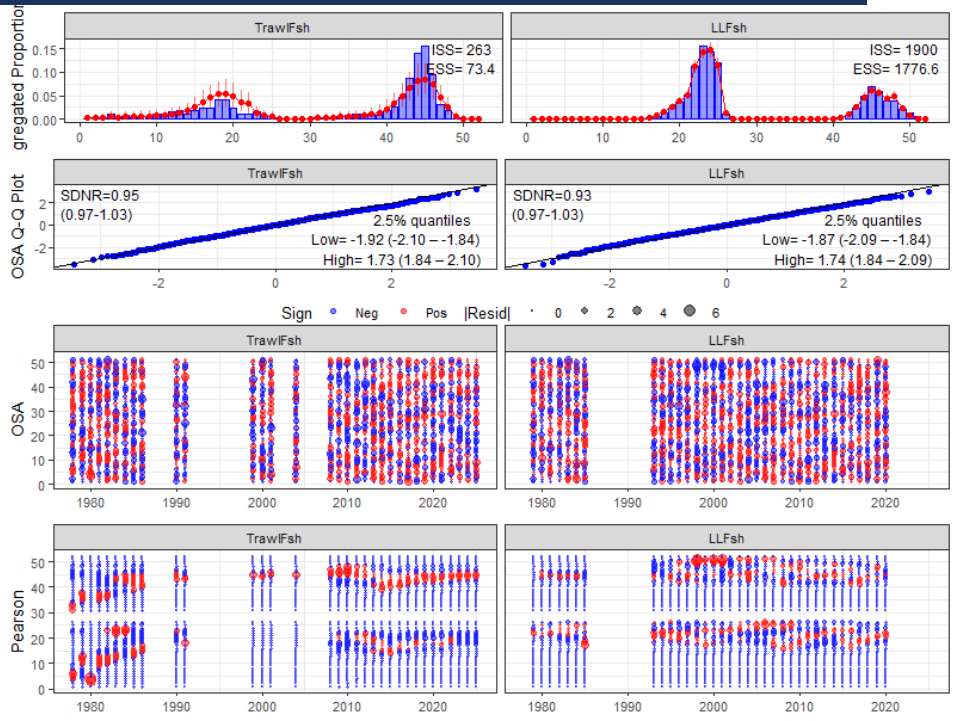


Alternative models fit the mean size at age data better than model 25.0
Similar patterns in residuals (alternative models had smaller residuals)
Smaller size-at-age likelihoods

FITS TO LENGTH COMPOSITION DATA

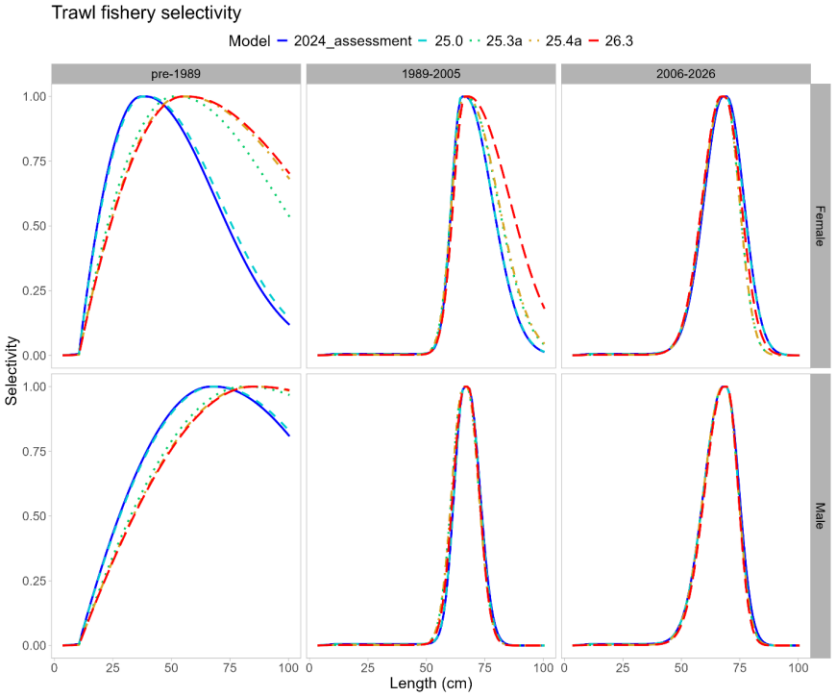


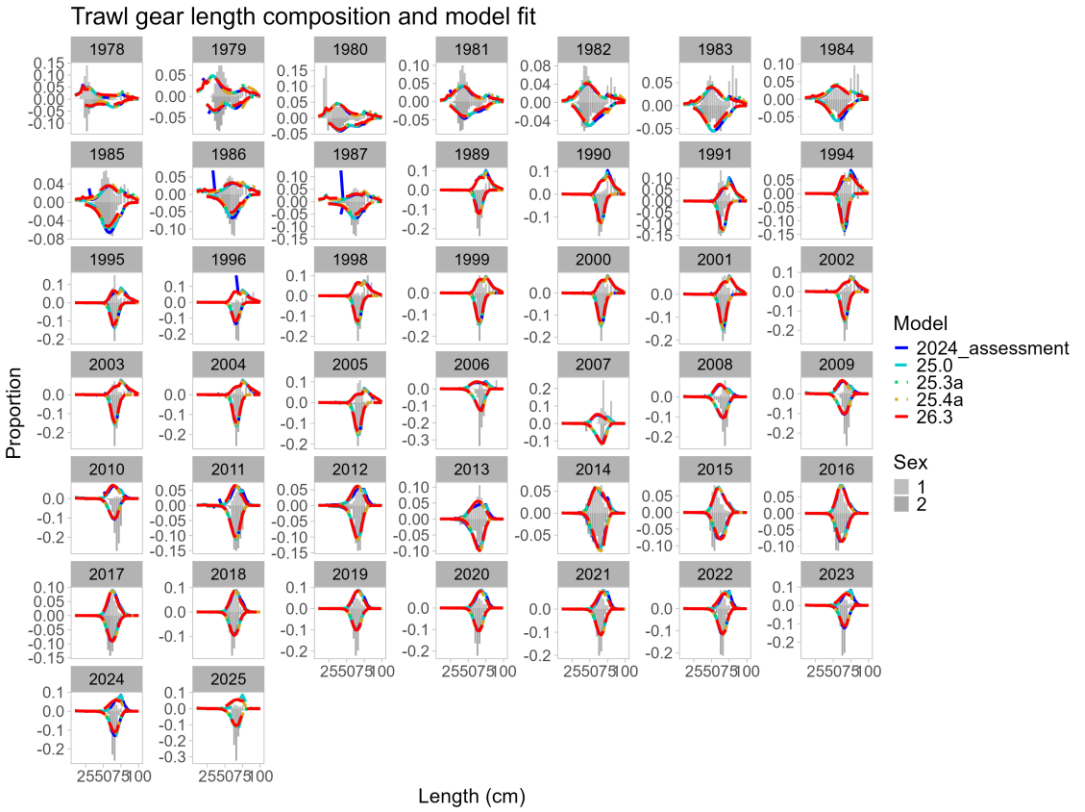
- Model 25.0



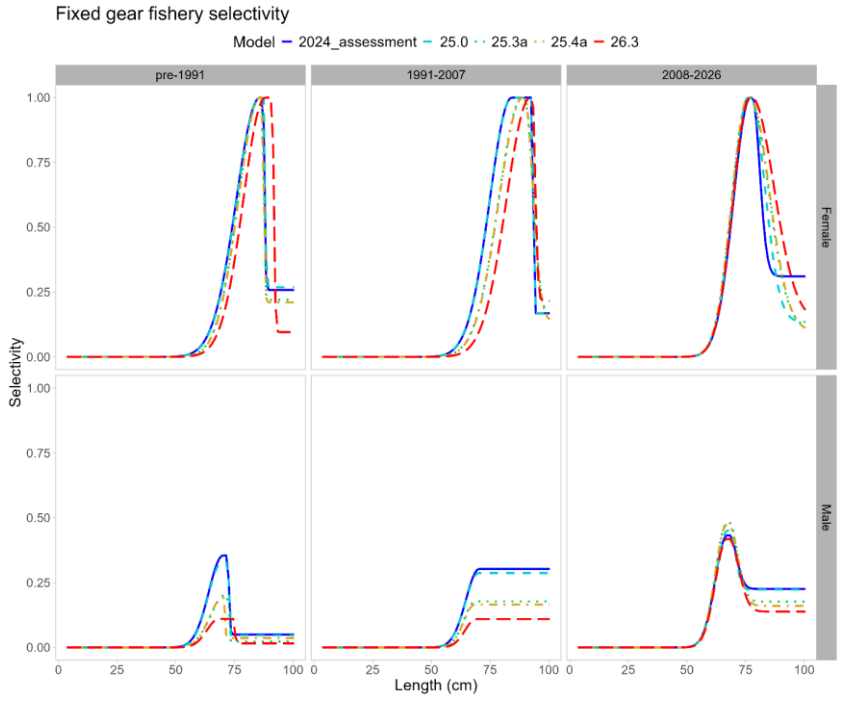
- Model 25.4a
  - Fit was similar for other alternative models

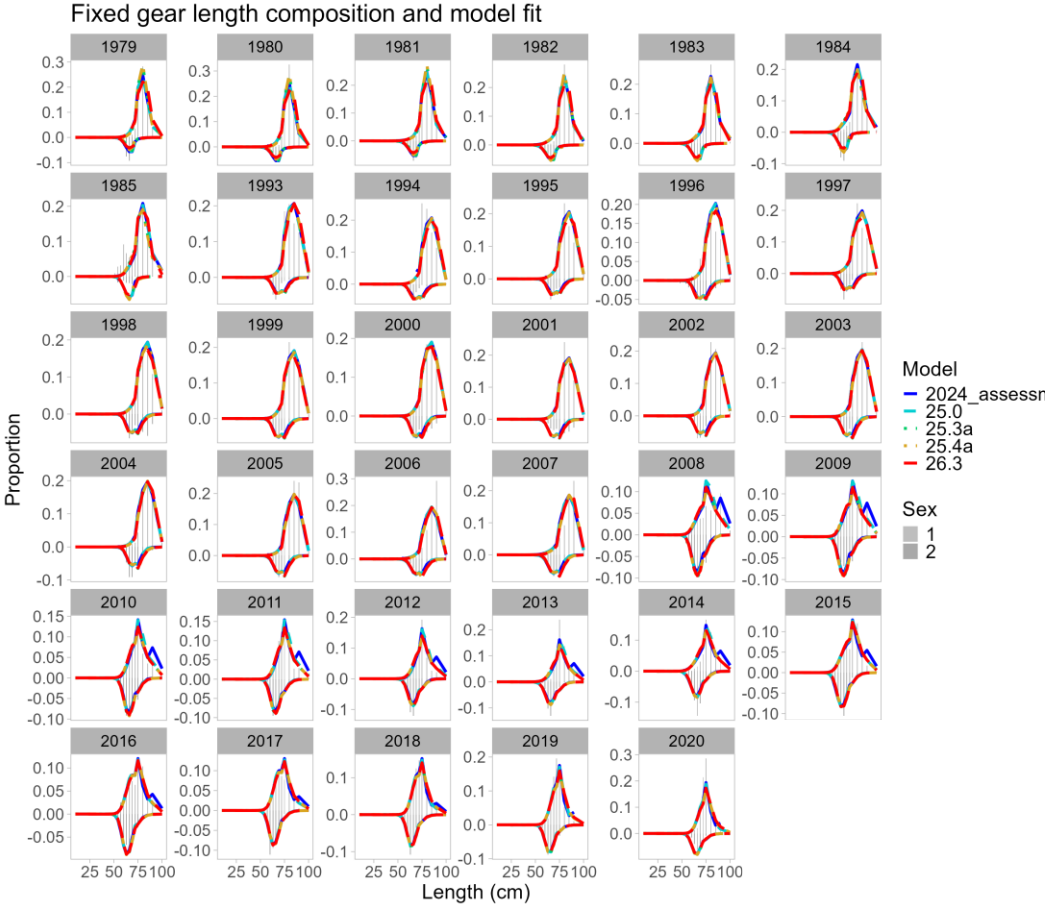
TRAWL FISHERY SELECTIVITY





LONGLINE/FIXED GEAR FISHERY SELECTIVITY

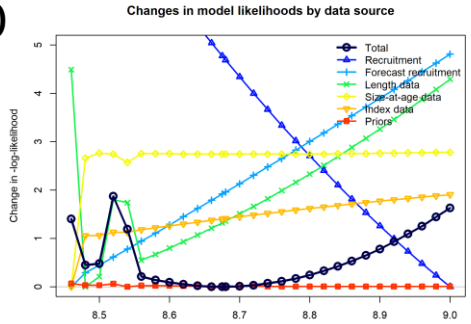


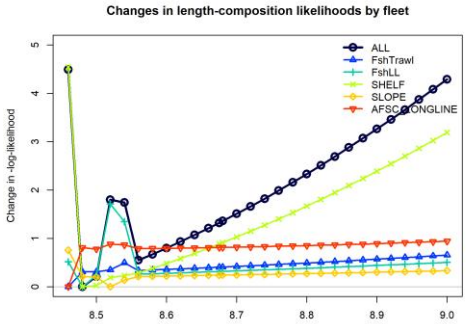


LIKELIHOOD PROFILES: R0

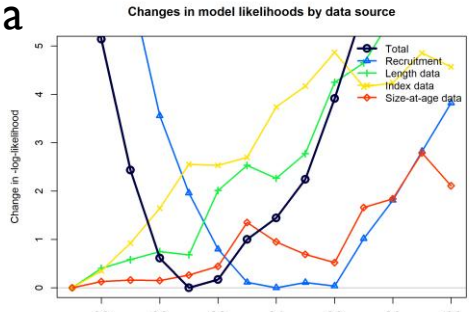
- Likelihood profiles were conducted for R0 and growth parameters
- Likelihood profile for longline survey q (model 25.0)
- R0 profiles demonstrate that the recruitment likelihood would estimate a larger R0 than the length likelihood
  - EBS shelf BTS likelihood minimized at a lower R0 value

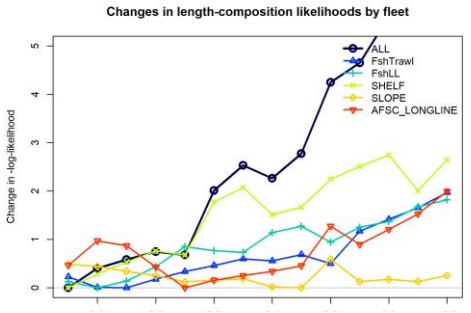
25.0



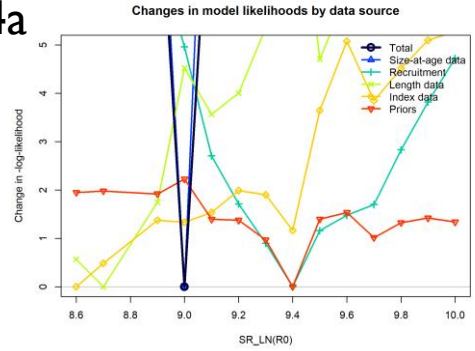


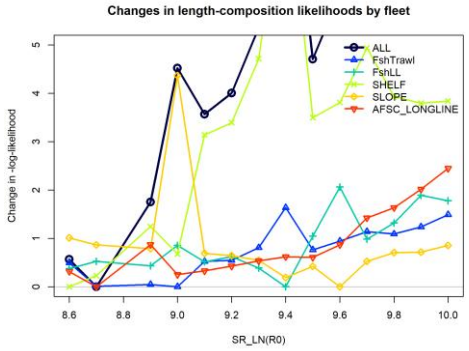
25.3a



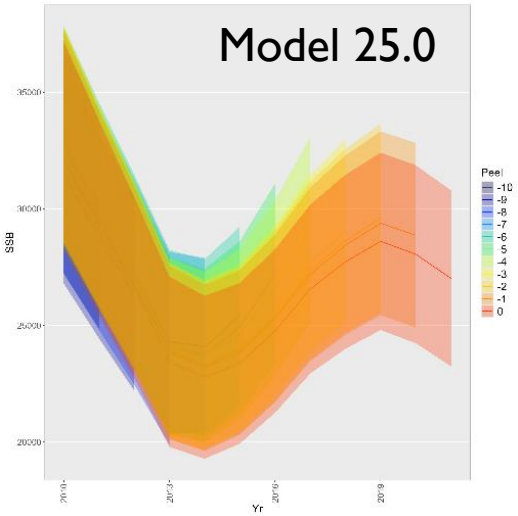


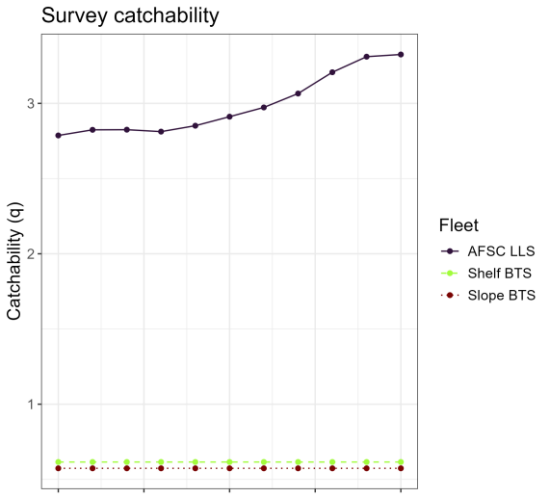
25.4a

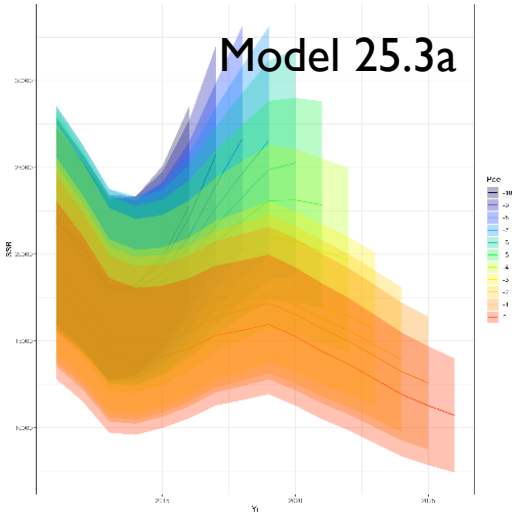


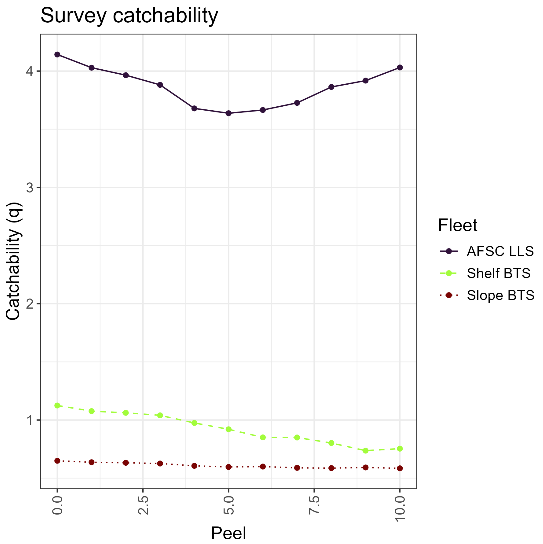


RETROSPECTIVE PATTERN





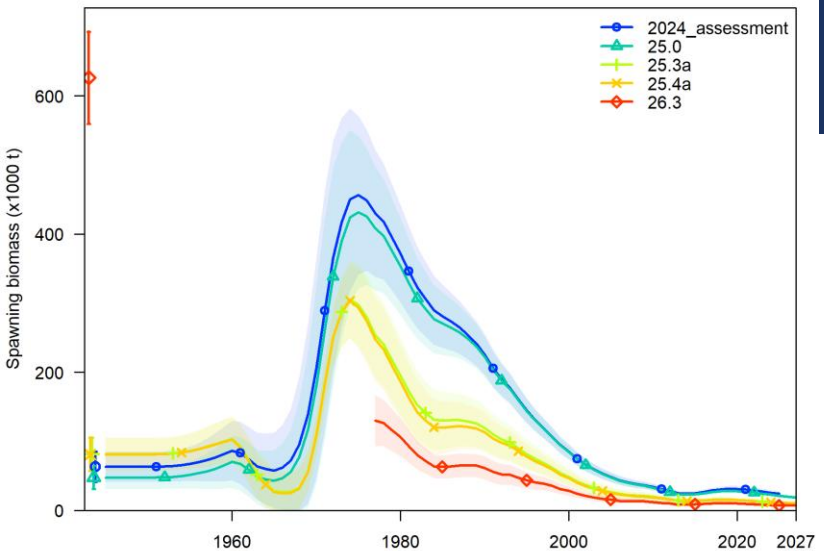


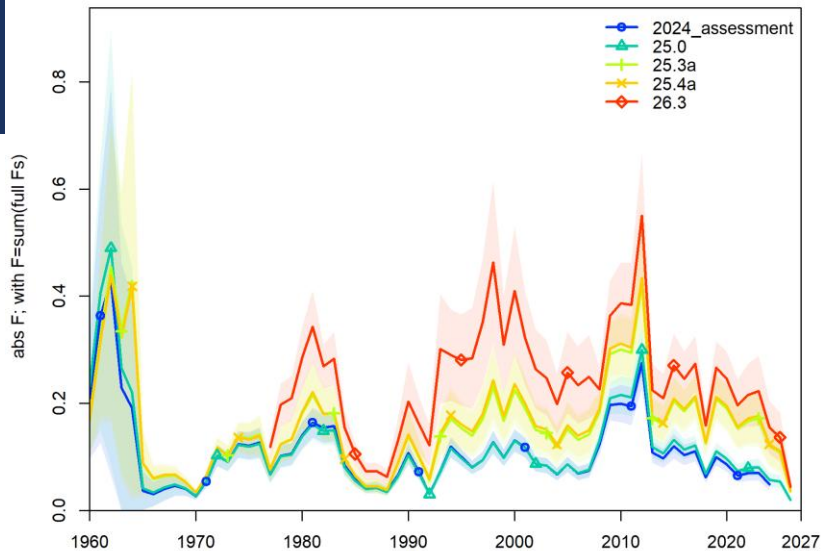


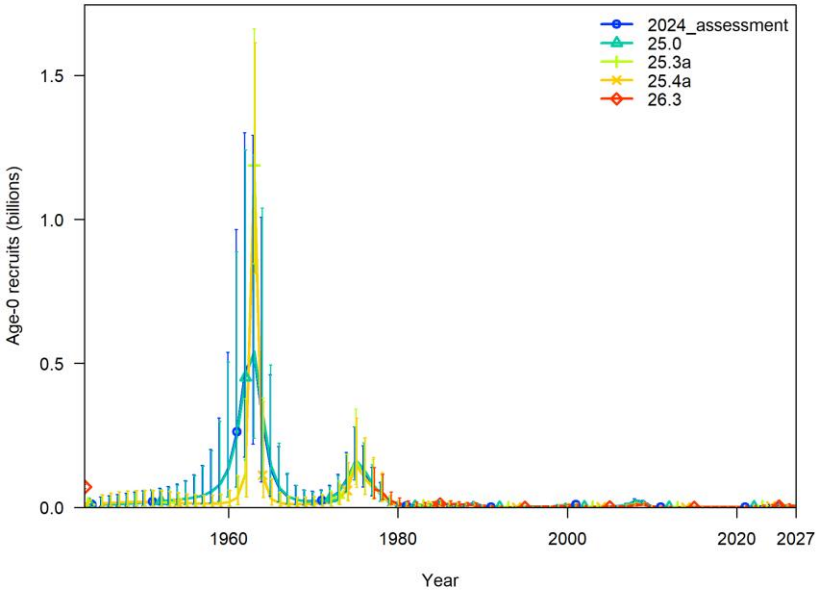
Model	SSB	F
25.0	0.21	-0.25
25.3a	0.48	-0.37
25.4a	0.39	-0.35
26.3	0.71	-0.40

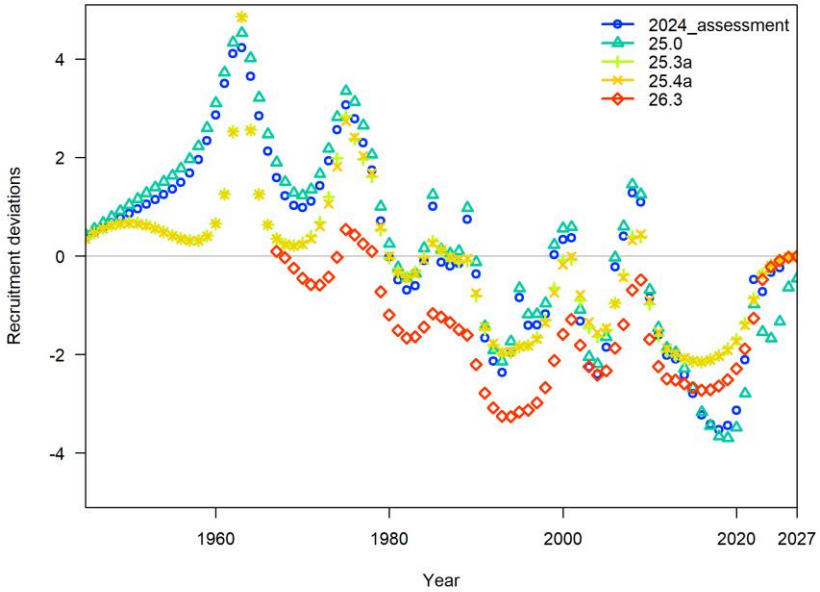
- Model 25.0 had the smallest retrospective patter
  - Increase from last assessment

TIME SERIES


2024_assessment
25.0
25.3a
25.4a
26.3
Spawning biomass (x1000 t)
0
200
400
600
1960
1980
2000
2020
2027


2024_assessment
25.0
25.3a
25.4a
26.3
abs F; with F=sum(full Fs)
0.0
0.2
0.4
0.6
0.8
1960
1970
1980
1990
2000
2010
2020
2027


2024_assessment
25.0
25.3a
25.4a
26.3
Age-0 recruits (billions)
0.0
0.5
1.0
1.5
1960
1980
2000
2020
2027
Year


2024_assessment
25.0
25.3a
25.4a
26.3
Recruitment deviations
-4
-2
0
2
4
1960
1980
2000
2020
2027
Year

SUMMARY

- Differences between base model and alternatives demonstrate that population trend is estimated reasonably well, but the scale is uncertain
  - Data conflicts make it difficult to determine population scale
    - Weighting towards survey length composition leads to a larger pop in recent years than when weighting towards the AFSC longline survey RPNs
- Authors recommend using model 25.0
  - Retrospective pattern is lower than the alternative models
  - Data weighting in the alternative models largely ignored survey length composition data to better fit the AFSC longline survey RPNS
    - Recruitment was smoothed where
    - Estimated lower recruitment when observations support an event

TIER 5 MODELS

- Plan Team requested that tier 5 models be presented as a potential interim alternative to the tier 3 stock assessment model
- This was presented in September and in the November draft we presented several alternatives
- Authors are not recommending using the tier 5 model for management advice
  - We would like to consider other tiers as alternatives in the future
  - We propose to continue using it for BRDs

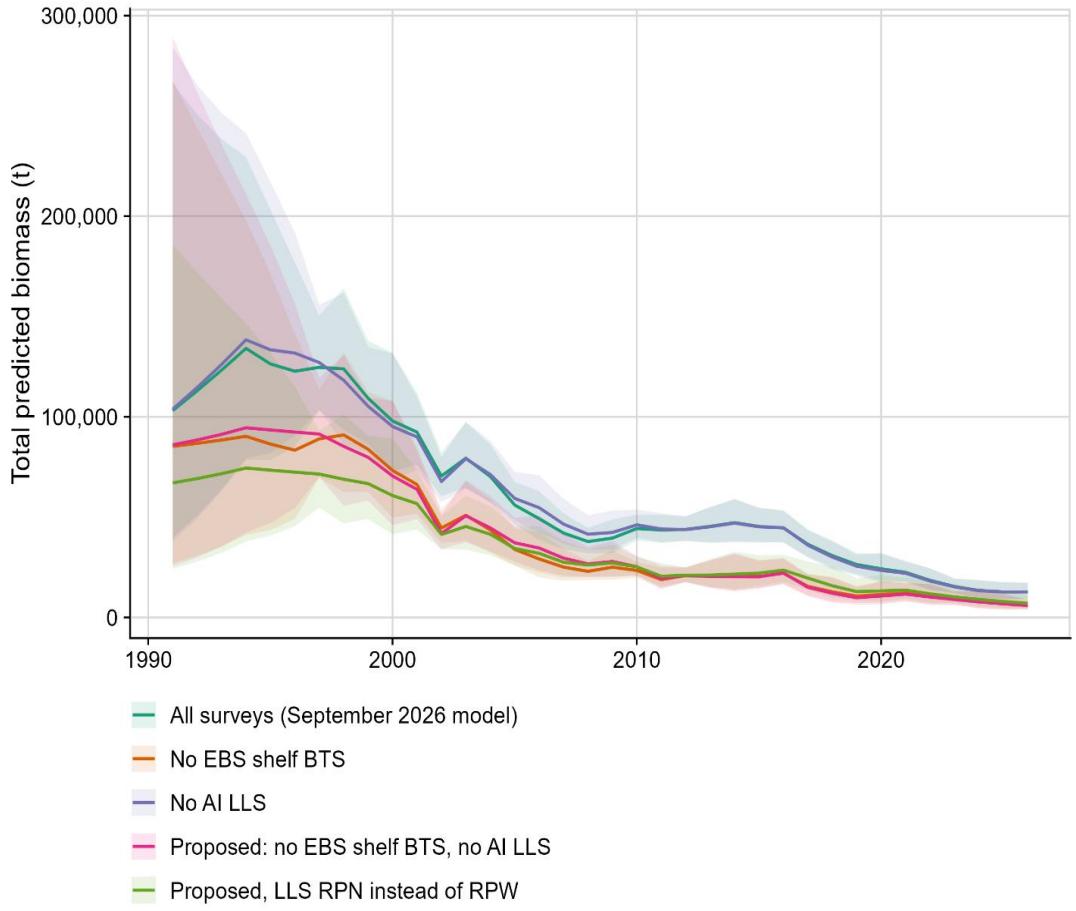
TIER 5 MODELS

- Proposed model (authors recommend this to determine BRDs):
  - Data inputs: EBS slope BTS biomass, AFSC LLS RPWs (Bering Sea), AI BTS biomass
  - Estimation using REMA (Sullivan et al. 2022)
  - Parameters estimated: Single scaling parameter and a single process error (assumes the BS and AI are a mixed adult population)
- Alternative:
  - The proposed model with Bering Sea longline survey relative population numbers (RPNs) instead of RPWs, to evaluate the effect of using a number-based index of abundance.

TIER 5 MODELS

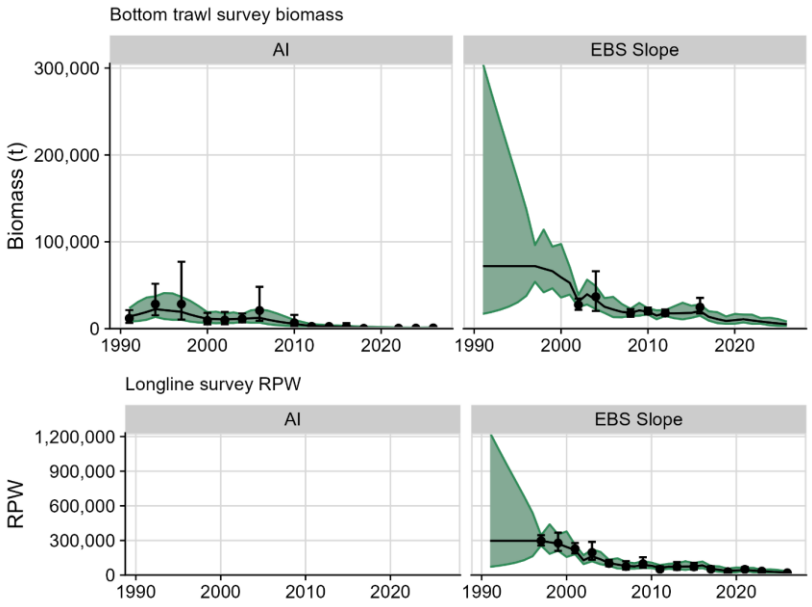
- Additional alternatives:
  - Model presented in September 2026
    - Data inputs: EBS shelf and slope BTS biomass, AFSC LLS RPWs (Bering Sea and AI), AI BTS biomass
    - Estimated 2 scaling parameters (scale BS RPW to BS slope BTS biomass and AI RPW to AI BTS biomass) and 2 process error terms
  - All surveys except the EBS shelf bottom trawl survey, to isolate the contribution to biomass of the EBS shelf population.
    - Data inputs: EBS slope BTS biomass, AFSC LLS RPWs (Bering Sea), AI BTS biomass, AFSC LLS RPWs (AI)
    - Estimated 2 scaling parameters (scale BS RPW to BS slope BTS biomass and AI RPW to AI BTS biomass) and 1 process error term
  - All surveys except the AI longline survey, to evaluate the effect of only including the AI BTS as representative of the entire AI region.
    - Data inputs: EBS slope BTS biomass, AFSC LLS RPWs (Bering Sea), EBS shelf BTS biomass, AI BTS biomass
    - Estimated 1 scaling parameters (scale BS RPW to BS slope BTS biomass and 2 process error terms

COMPARISON OF TIER 5 MODELS



- Models with higher biomass estimate includes EBS shelf (mainly juvenile habitat)
- Not including AI RPWs has little impact
- Model using RPNs similar to models using RPWs, lower biomass early in time series

TIER 5 RESULTS: PROPOSED MODEL



Year	AI	EBS Slope	Total	Total LCI	Total UCI	% AI	% BS
2017	1362	13640	15002	10511	21411	9	91
2018	1043	10991	12033	7299	19839	9	91
2019	944	8856	9800	6396	15015	10	90
2020	855	9801	10656	6415	17699	8	92
2021	775	10846	11621	7950	16986	7	93
2022	701	9451	10152	6182	16673	7	93
2023	693	8235	8929	6238	12780	8	92
2024	686	7047	7733	4518	13236	9	91
2025	735	6031	6765	3926	11659	11	89
2026	787	5161	5948	3952	8951	13	87
Mean						9	91

- Propose that this model is used to determine BRD
- 10-year average (2017 – 2026): 9% Aleutian Islands and 91% Bering Sea

RISK TABLE

Assessment-related considerations	Population dynamics considerations	Environmental/ecosystem considerations	Fishery-informed stock considerations
Level 3	Level 2	Level 1	Level 1

- Assessment related considerations: Uncertainty about population scale, persistent retrospective pattern, lack of fishery ages
- Population dynamics considerations: Lack of strong recruitment events, 2026 wind conditions may favor off shelf and northwestward Ekman transport (potential for advection)
- Ecosystem considerations: 2026 cool oceanographic conditions, which may benefit recruitment; Length-weight residuals above +1SD (high body condition) indicating good prey availability
- Fishery-informed stock considerations: Catch has been low for many years; Catch:TAC= 28% over the last five years; Avoidance due to whale depredation and avoidance of other deep-water species

Quantity	As estimated or *specified* in 2024 for: 2025	2026	As estimated or *recommended this* year* for: 2027	2028
M (natural mortality rate)	0.112	0.112	0.112	0.112
Tier	3a	3b	3b	3b
Projected total (age 1+)	37,615	35,877	28,434	27,604
Female spawning biomass	23,999	22,061	18,414	17,040
Projected				
$B_{100\%}$	58,812	58,812	56,211	56,211
$B_{40\%}$	23,525	23,525	22,485	22,485
$B_{35\%}$	20,584	20,584	19,674	19,674
F_{OFL}	0.20	0.20	0.2	0.2
$maxF_{ABC}$	0.17	0.17	0.17	0.17
F_{ABC}	0.15	0.15		
OFL (t)	2,598	2,059	1,356	1,107
maxABC (t)	2,237	1,771	1,165	951
ABC (t)	2,013	1,594	TBD**	TBD**
Status	As determined *last* year for: 2023	2024	As determined *this* year for: 2025	2026
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

Model 25.0

BIOLOGICALLY-INFORMED RECOMMENDED DISTRIBUTION (BRD)

	2027 maxABC	max2028 ABC
Aleutian Islands BRD	105	86
Eastern Bering Sea BRD	1060	865
Total	1165	951

REDUCTION FROM MAX ABC

Assessment-related considerations	Population dynamics considerations	Environmental/ecosystem considerations	Fishery-informed stock considerations
Level 3	Level 2	Level 1	Level 1

- Risk table is similar to 2024
  - SSC reduced ABC from maxABC
- Authors are not suggesting a specific buffer
  - Suggested using the tier 5 ABC as a maximum threshold

Tier 5	2026 Biomass	OFL	ABC
Proposed model: No EBS shelf BTS, no AI LLS	5,948	666	500

RECOMMENDATIONS

- Strongly advocating for the EBS Survey Modernization Effort to extend into the slope
  - Several deep-water species require depths greater than 400m
  - Sampling the EBS slope and shelf within the same year would provide for a single and more comprehensive and consistent survey of the juvenile and adult habitat.
- Current assessment is dependent on length data. Given persistent conflicts in the length and survey index data and the length and mean length at age data, we recommend ageing the catalog of otoliths from the fishery (authors and Age and Growth Program have discussed a plan) and recommend that the AFSC LLS begin collecting otoliths
- During September 2026, we discussed exploring tier 4 as an option for management for this species. We recommend this be evaluated and presented during the CIE review scheduled for 2027

RECOMMENDATIONS

- The authors will investigate the feasibility of using close-kin mark recapture to develop an absolute index of abundance for this stock. This will help us determine the current scale of the population
  - Could be a short-term solution as other efforts ramp up
- An ESP has been initiated.
  - Depending on team capacity, we intend to present this to the Plan Team in 2027

ACKNOWLEDGEMENTS

- Age and Growth Program: Jon Short and Todd ten Brink
- RACE Groundfish Assessment Program
- AFSC Longline Survey Crew
- Fisheries Monitoring and Analysis Division