Assessment of the Greenland turbot stock in the Bering Sea and Aleutian Islands

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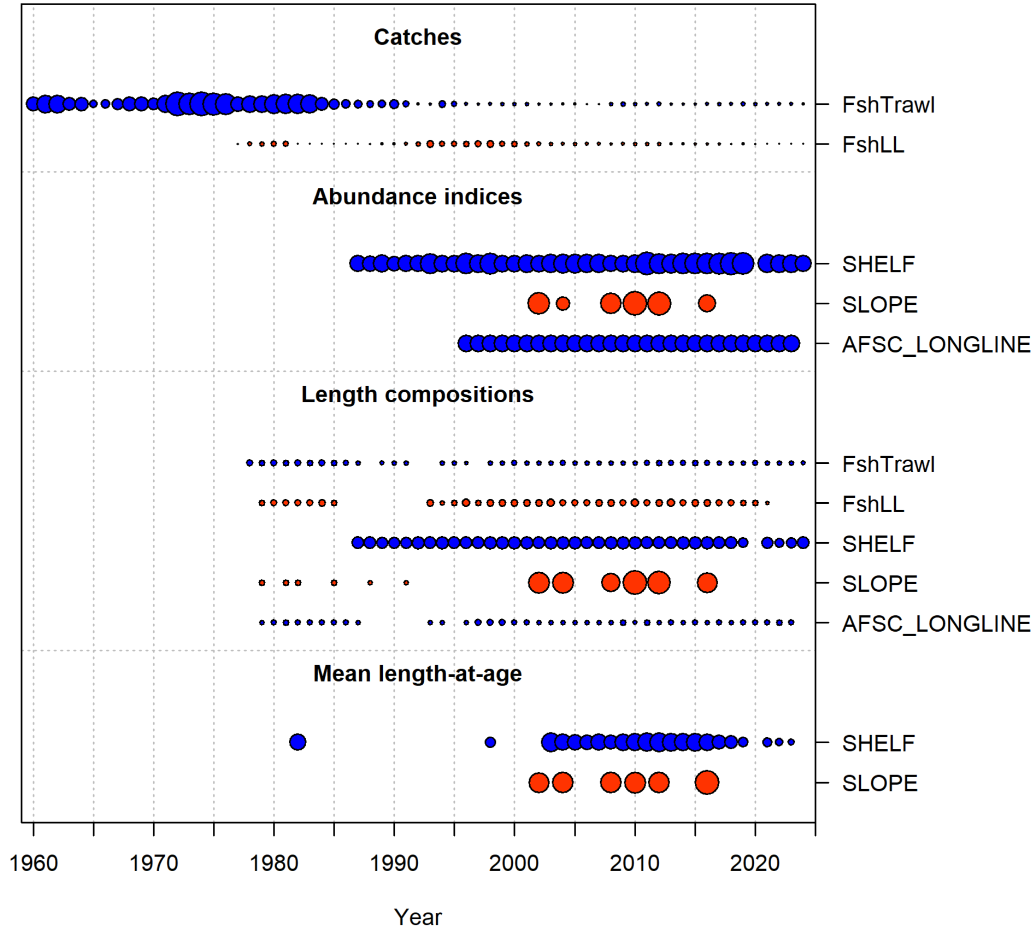
November 2024 BSAI Plan Team Meeting

Outline

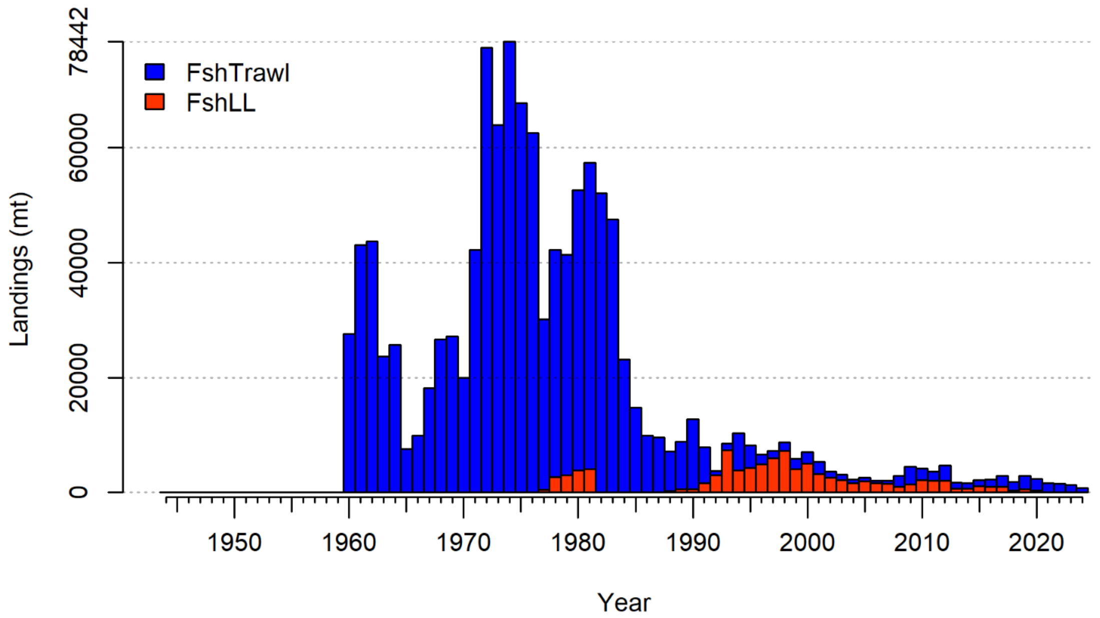
- Data review and updates
- Model description and results
- Harvest projections from recommended model
- Risk table summary
- Future model improvements and research suggestions

Data

- Fleet structure
  - Trawl fishery
  - Longline/fixed gear fishery
  - EBS shelf bottom trawl survey
  - EBS slope bottom trawl survey
  - AFSC longline survey
- Catch data starting in 1960
- Survey biomass (3 surveys)
- Length data starting in the late 1970s



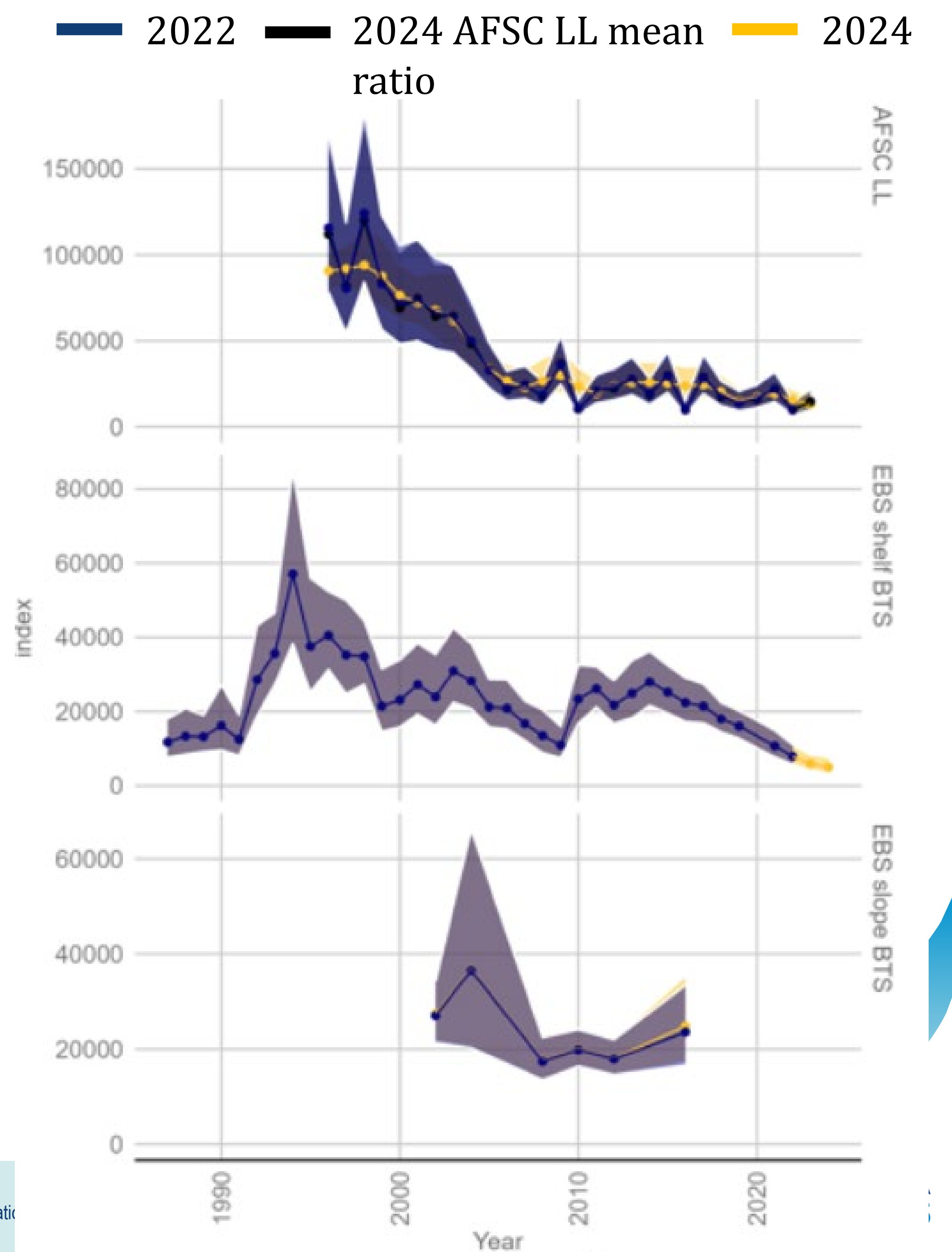
Catch time series



- Catch has been declining since 2019
- 5 year average
  - ~ 36% of TAC obtained
  - ~92% catch from trawl fleet, 8% from longline

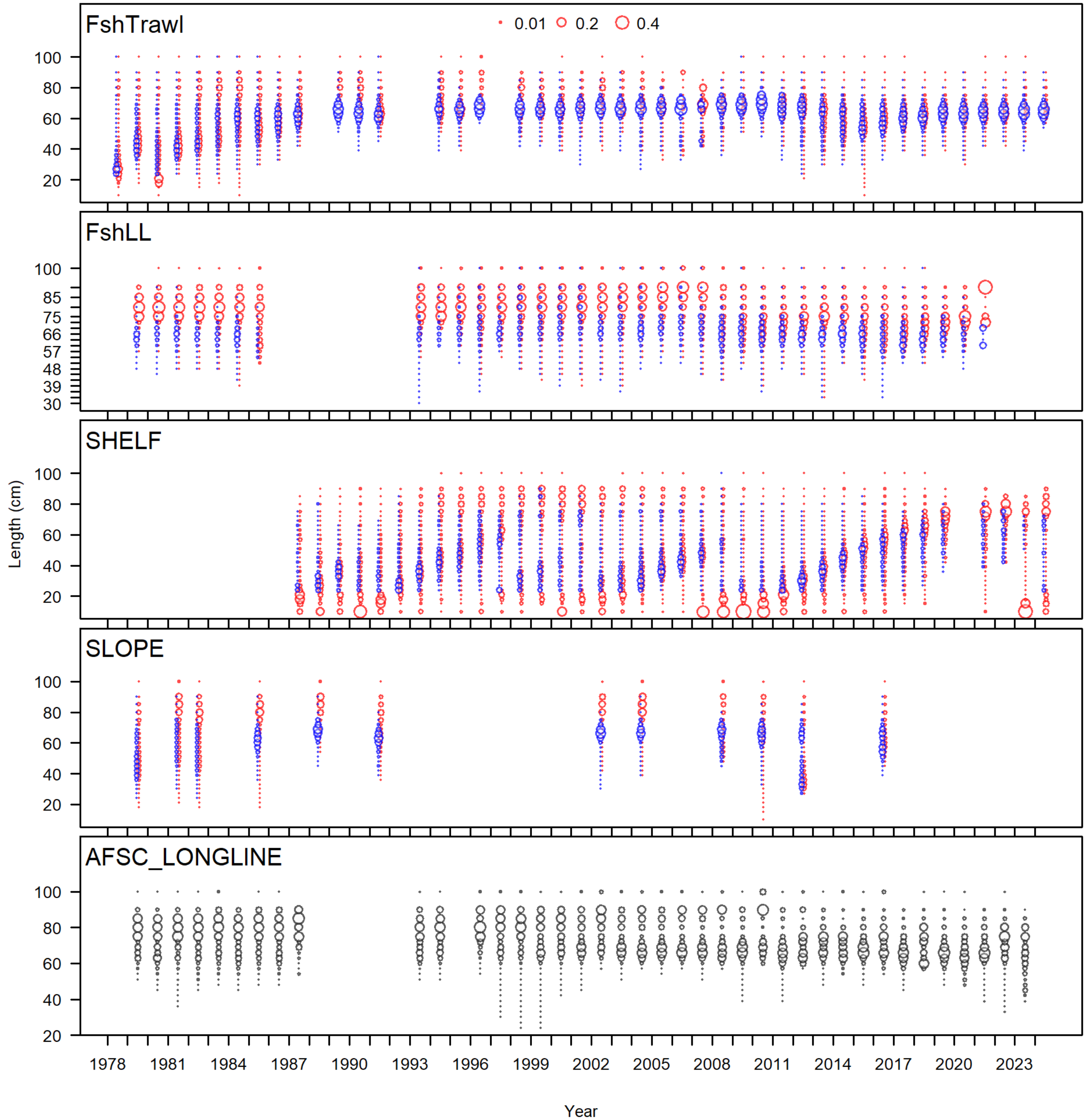
Survey indices

- AFSC longline RPN
  - Linear interpolation approach (yellow)
    - Assumes nearest neighbors are a better approximation of area specific abundance in missing year
    - Combines estimates from AI and BS per year
      - Done for RPN and CV
  - Continued low RPN in 2023
  - 2024 – no survey
- EBS Shelf BTS biomass
  - Declining
    - -25% in 2023
    - -15% in 2024
- EBS Slope BTS biomass
  - Data gap after 2016



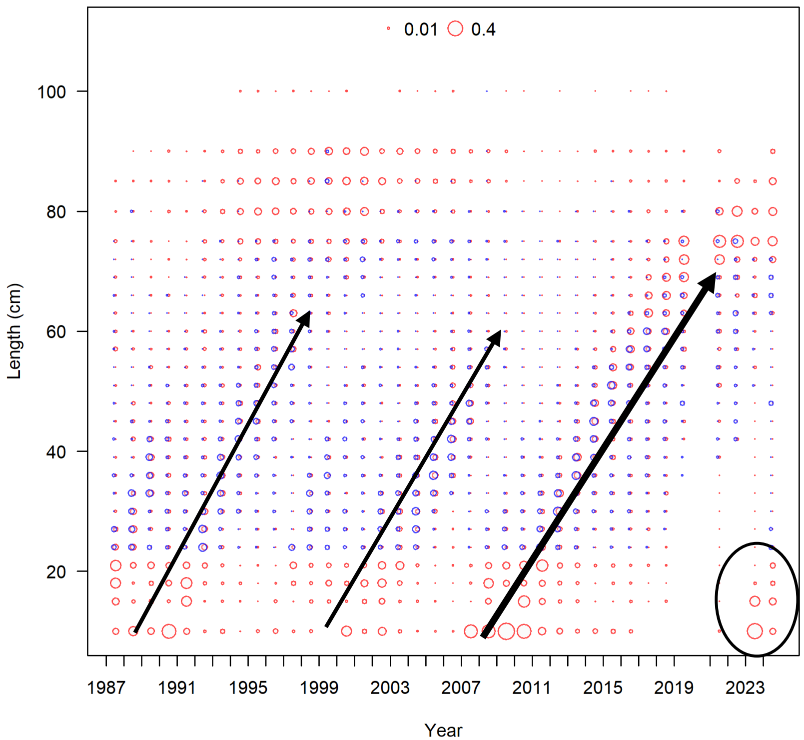
Length composition data

- Fishery
  - Longline – lack of data in recent years
- AFSC LL
  - Added 2023 data
- EBS shelf BTS
  - Added 2023 and 2024

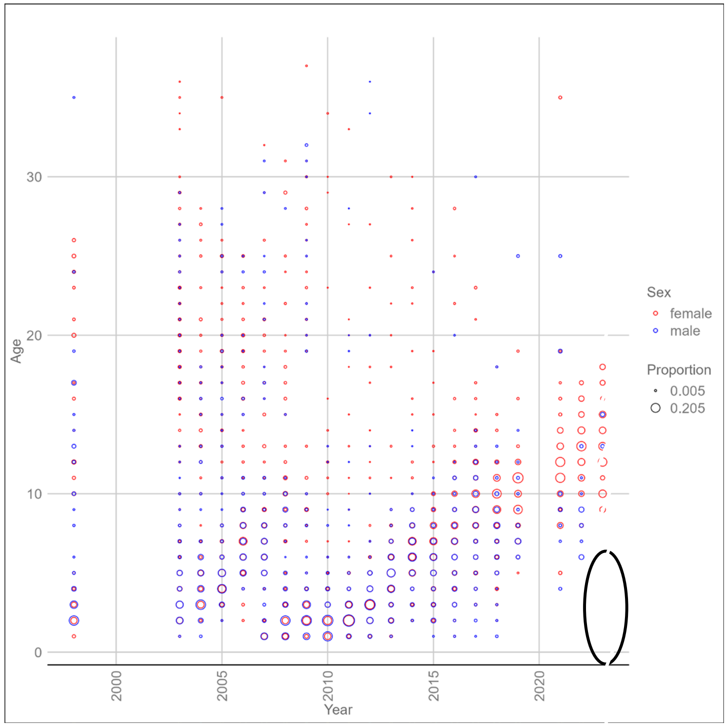


EBS shelf BTS composition data

Length



Age



Data take home

- Loss of information over time
  - Lack of biological data collection from fixed gear fleet since 2021
  - Loss of survey information from adult population
    - No AFSC longline survey data (RPN and lengths) in 2024
    - Loss of EBS slope bottom trawl survey data since 2016 (biomass and lengths)

Models

Models

- In September, agreed on the following models for November:
  - Last accepted model (16.4c)
  - Model 19 (24.1 in report)
    - If possible, explore Francis reweighting/variance adjustment (24.1a)
  - Model 20 (24.2 in report)
    - If possible, explore Francis reweighting/variance adjustment (24.2a)

Model assumptions

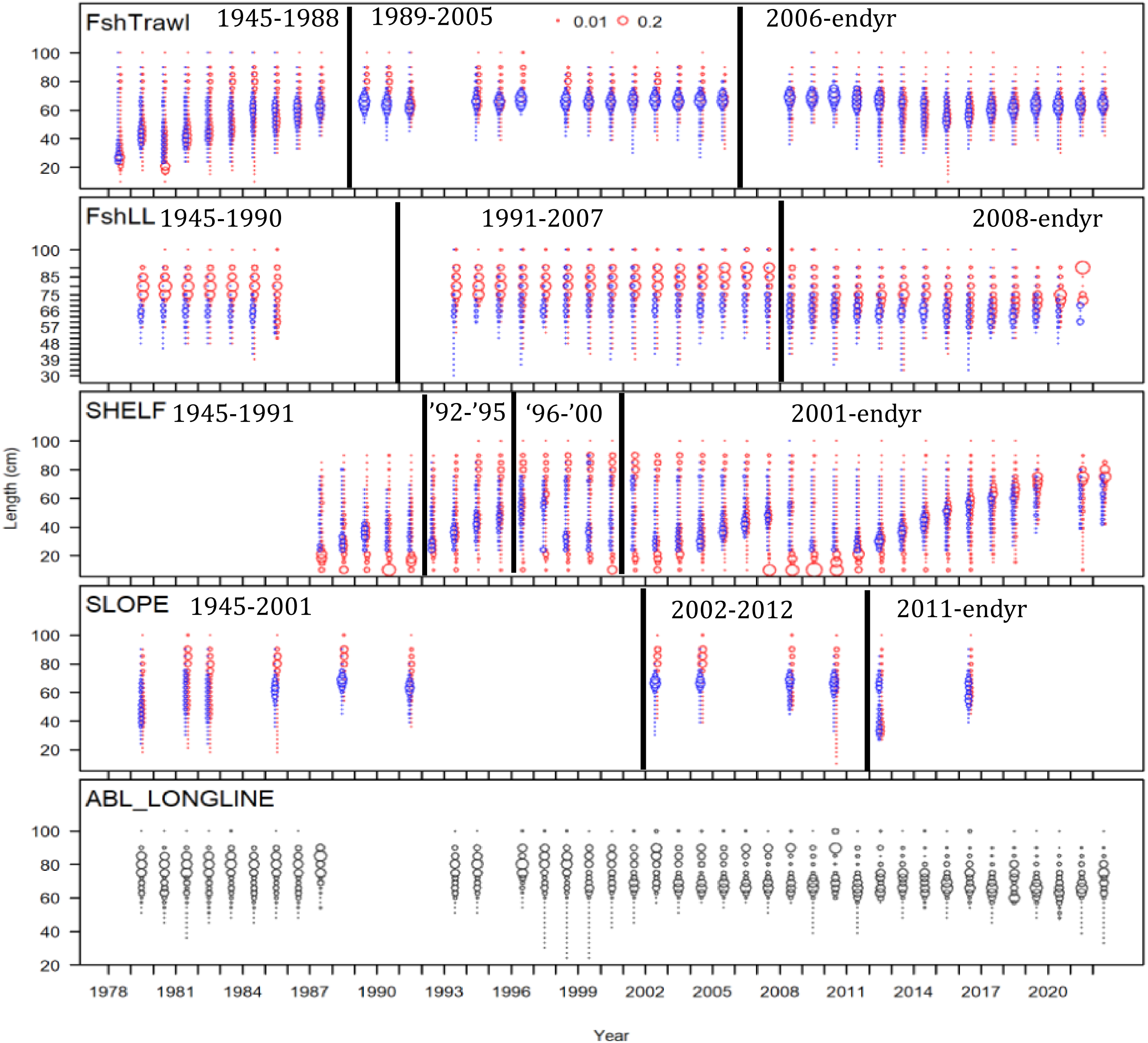
- Sex-specific model
  - von Bertalanffy growth estimated
    - CV associated with young and old fish fixed (15% and 9%)
- Natural mortality fixed and assumed the same for females and males (Cooper et al. 2007)
- Maturity at age externally estimated (D'yakov 1982)
- Stock-recruitment relationship (Beverton – Holt)

Parameter	M16.4c	M24.1	M24.2
R0	Estimated		
Steepness	h = 0.79 (Myers et al. 1999)		
sigmaR	σR = 0.6		
Autocorrelation (ρ)	Estimated	ρ = 0	ρ = 0.45
Recruitment deviations	Early (1945-1970) Main (1970 – 2018) Late (2019-2024)		

Model assumptions

- Survey catchability
  - M16.4c
    - EBS bottom trawl surveys - catchability not estimated
      - Fixed estimates from a 2015 model run
        - Did not include the bottom trawl survey data from 2007-2015
      - Concern is that this approach is using the data twice
    - AFSC longline survey estimated
  - M24.1 and M24.2
    - Analytical solution for all surveys
- Selectivity
  - AFSC longline survey
    - Logistic
    - Not sex-specific – prior to 2021 sex not identified when measuring lengths
  - All other fleets
    - Double normal pattern
    - Sex - specific
    - Time blocks

Time blocks on selectivity

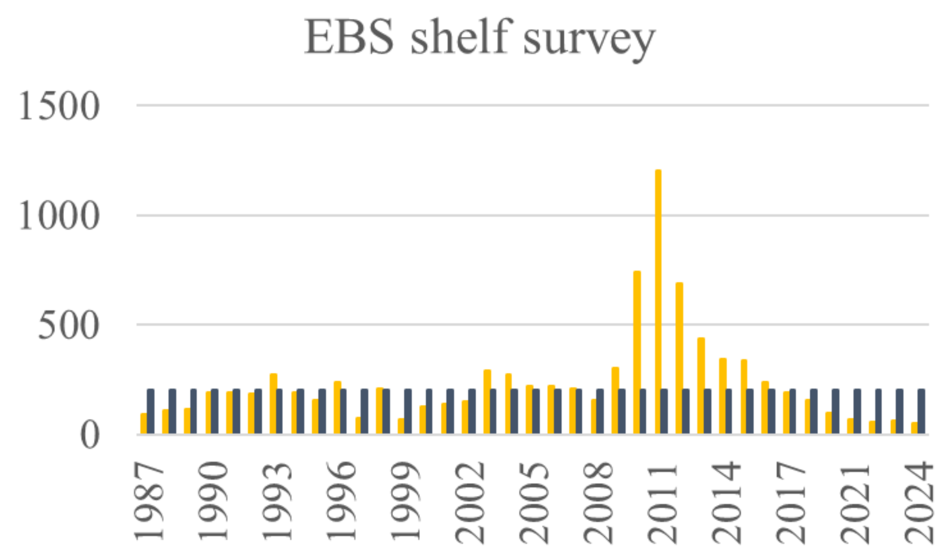


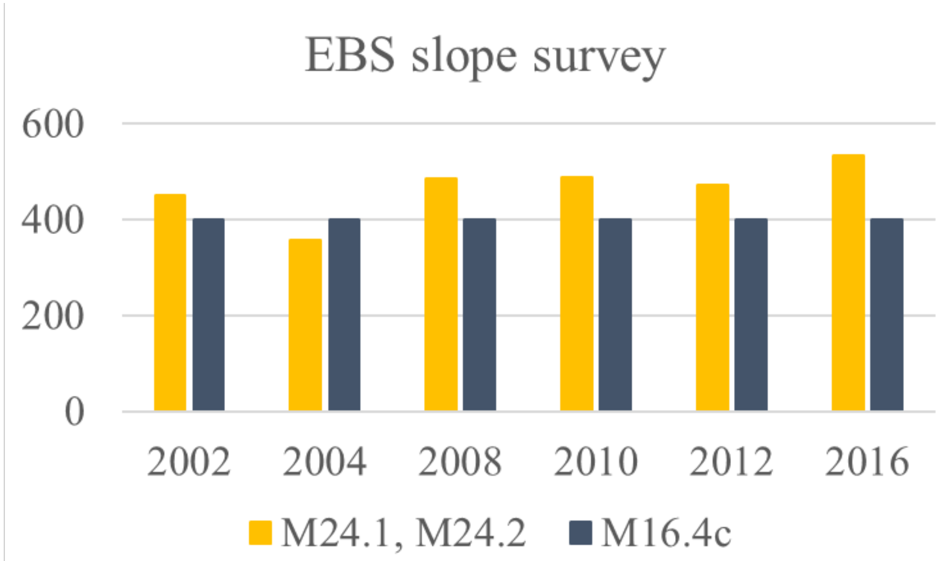
M16.4c
M24.1, M24.1a
M24.2, M24.2a

M16.4c

Length composition input sample size and variance adjustment

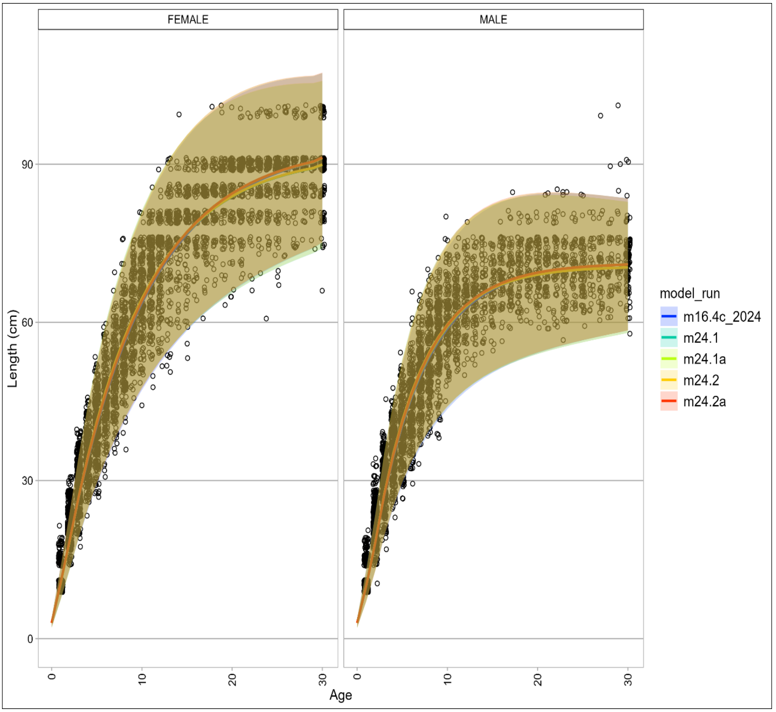
- Model 16.4c
  - Length comp ISS
    - 50 fishery fleets
    - 200 EBS shelf survey
    - 25 (pre-2002) and 400 (2002-) EBS slope survey
    - 60 AFSC longline
  - Variance adjustment
    - 0.25 for Trawl fleet and shelf survey
    - 0.5 for Longline fleet, slope and AFSC longline survey
- Model 24.1 and 24.2
  - Length comp ISS
    - afscISS R package
  - No variance adjustment
- Model 24.1a and 24.2a
  - Same as 24.1 and 24.2
  - Variance adjustment factors from M16.4c



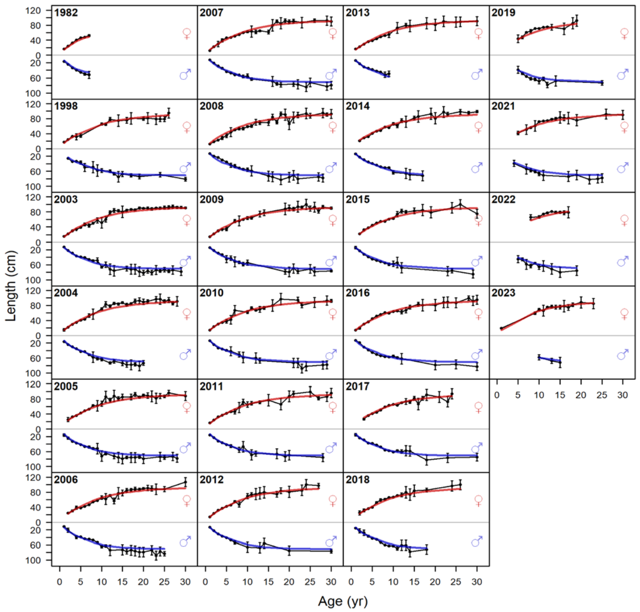


Results

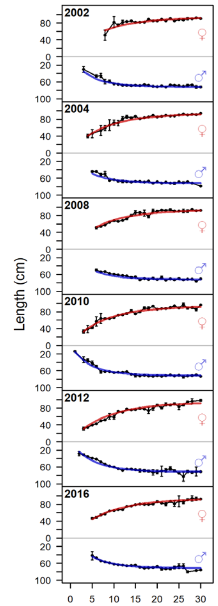
Growth estimation



EBS shelf BTS

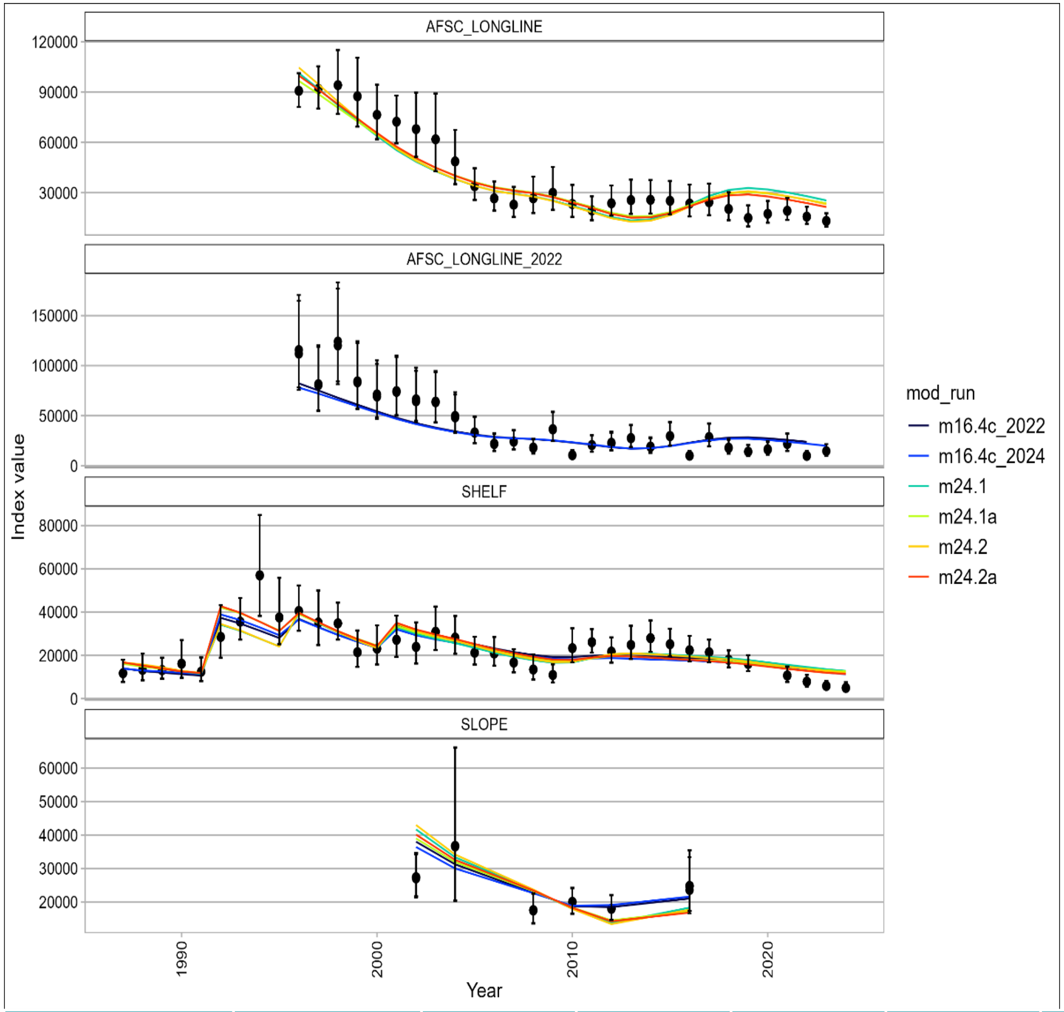


EBS slope BTS



- Growth estimation was similar among models

Fits to survey biomass and RPNs

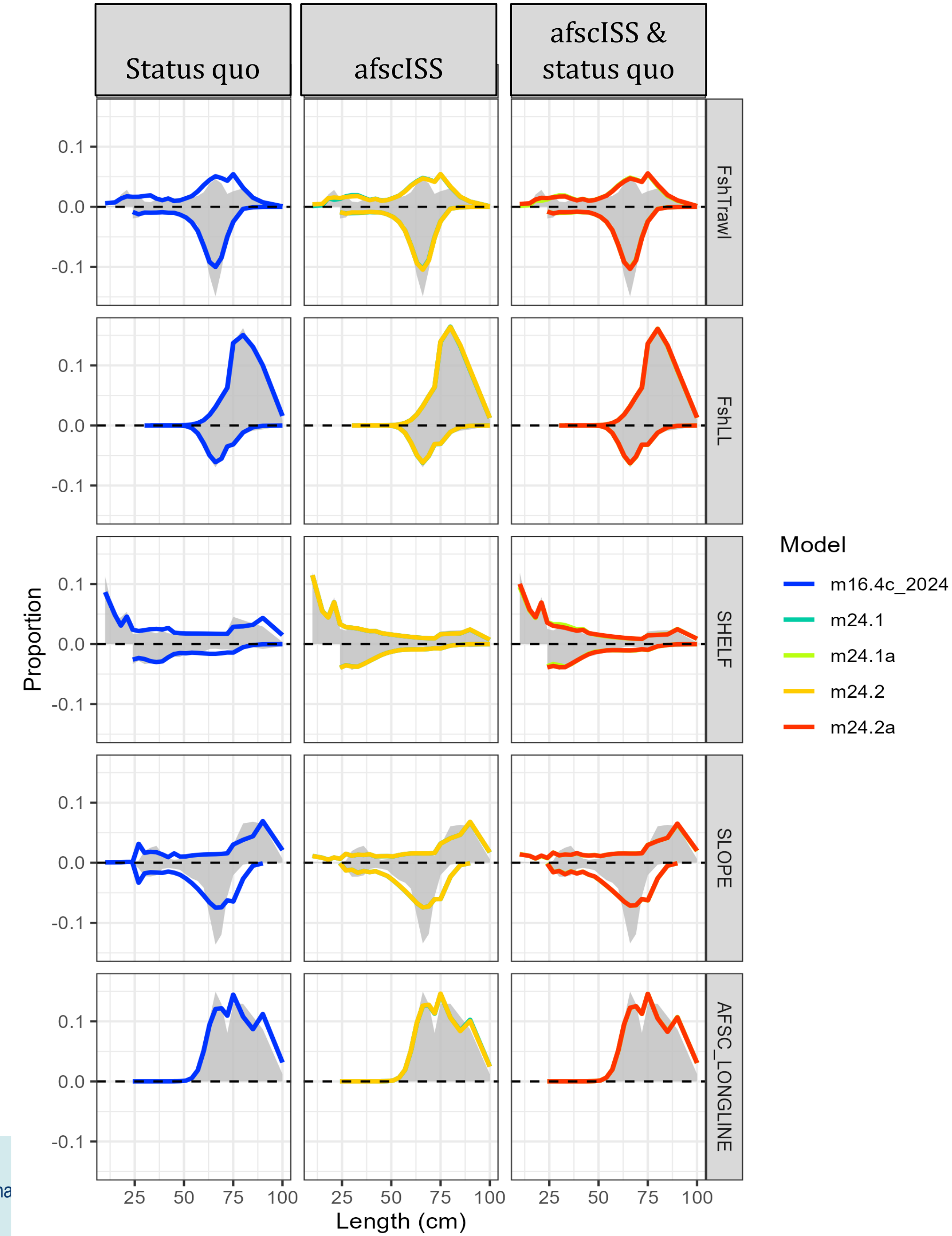


- EBS shelf bottom trawl survey
  - Similar fit among models
    - Catchability fixed 0.61 M16.4c
    - Catchability > 1 for alternative models
- EBS slope bottom trawl survey
  - Poorer fit by alternative models
    - Catchability < 1 for all models, but increase in catchability for alternative models
      - M16.4c fixed 0.57
      - Max from alternatives: 0.7
- AFSC longline survey
  - Improved fit by alternative models
    - Catchability
      - M16.4c: 2.41
      - Alternatives: >3

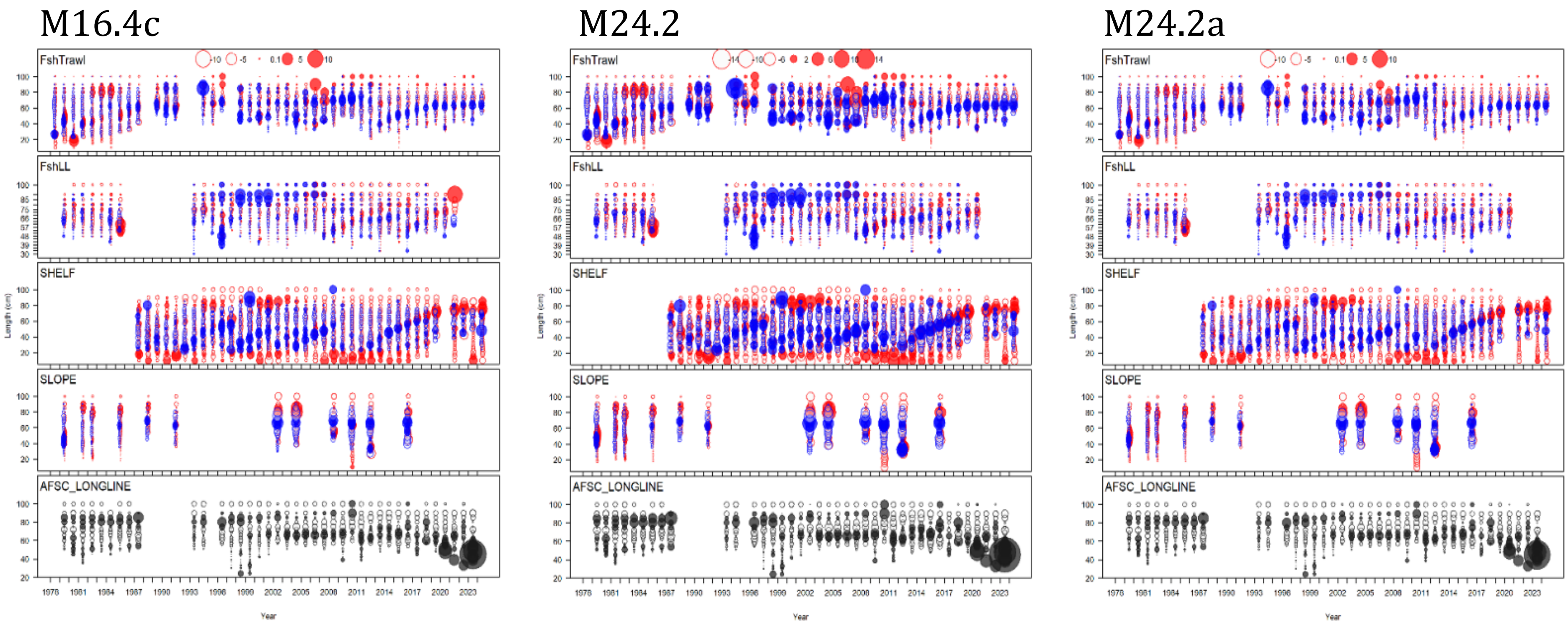
		16.4c (2024)	24.1	24.1a	24.2	24.2a
Index RMSE						
	Shelf	0.31	0.33	0.32	0.32	0.31
	Slope	0.19	0.27	0.26	0.29	0.28
	AFSC LL	0.44	0.37	0.32	0.36	0.30

Fits to length composition data

- Fit to the fishery data fairly consistent among model runs
  - Underestimating peak of male distribution (trawl fleet)
- Improved fit to EBS shelf survey with change in input sample size (M24.1 and M24.2)
  - Similar result when status quo variance adjustment is used (24.1a and 24.2a)
- Subtle difference in fit to the EBS slope survey
  - Consistent underestimation of the peak of the male distribution
- Slight improvement in fit to AFSC longline survey for M24.1 and M24.2



Fits to length composition data



- Patterns in the Pearson residuals are consistent among the models
  - Residuals are larger when variance adjustment is not implemented (M24.1 and M24.2)
  - Trawl fleet: Underestimating peak of male distribution (especially later in time series)
  - EBS shelf survey: Some underestimation of cohorts
  - EBS slope survey: Consistently underestimating peak of male distribution
  - AFSC LL: Difficultly in estimating the bimodal distribution

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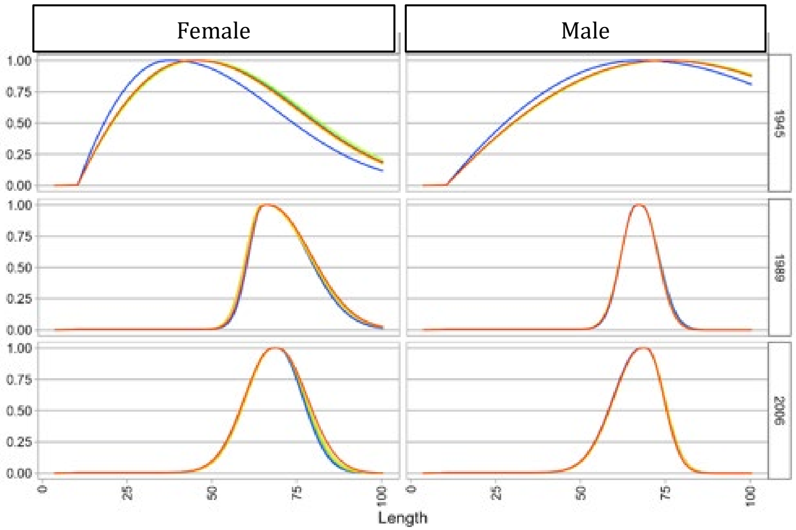
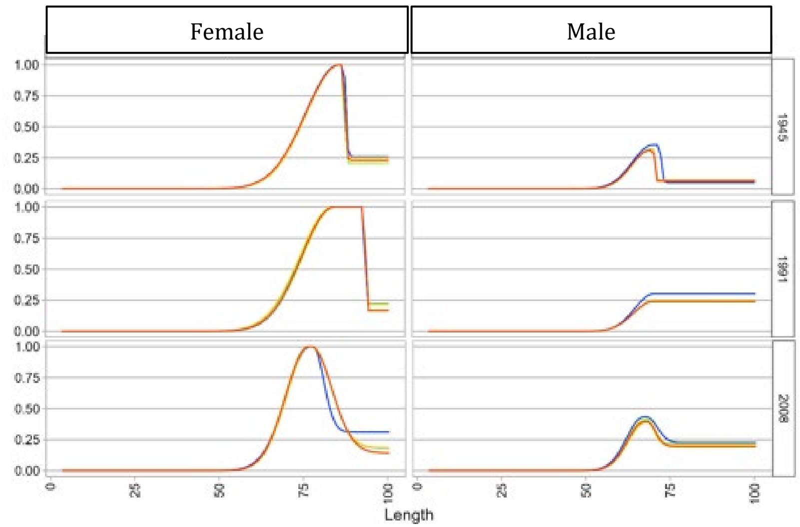
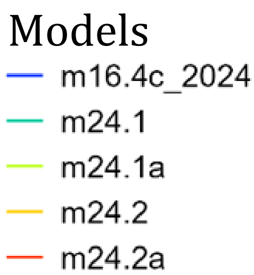
Selectivity

Trawl fishery

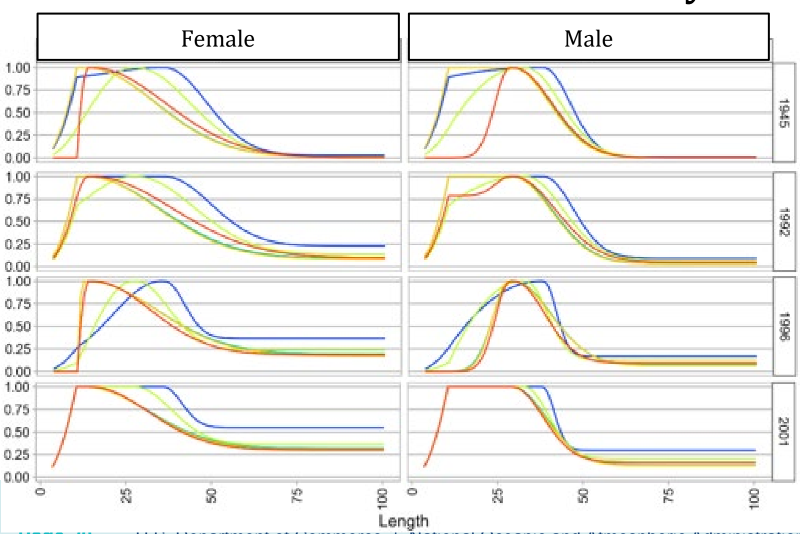


Fixed gear fishery

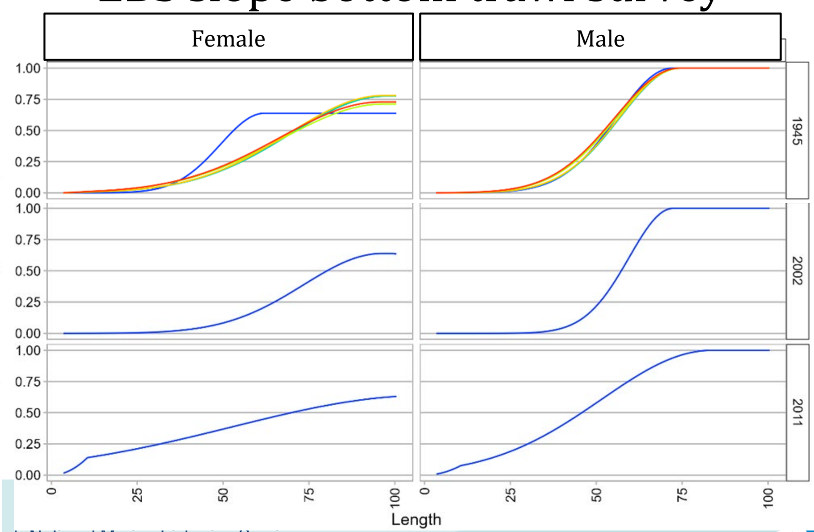




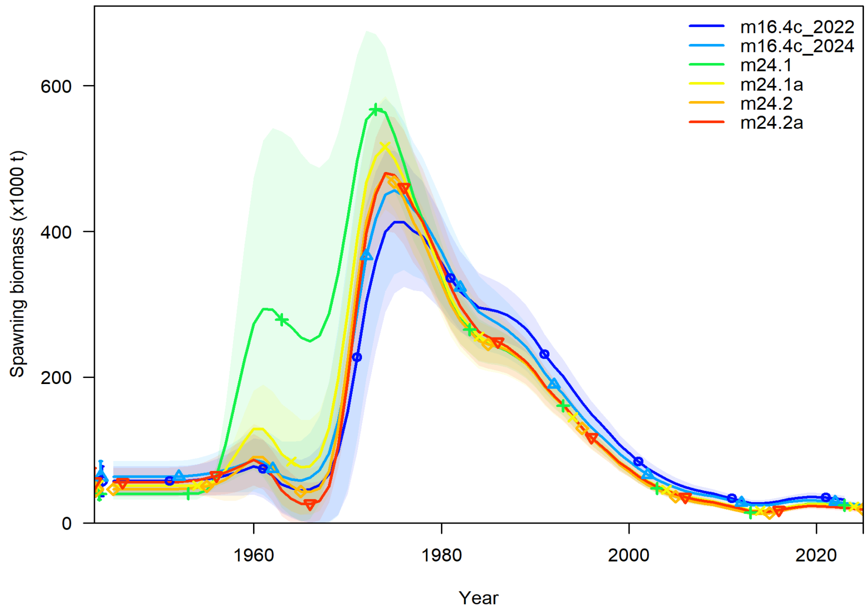
EBS shelf bottom trawl survey

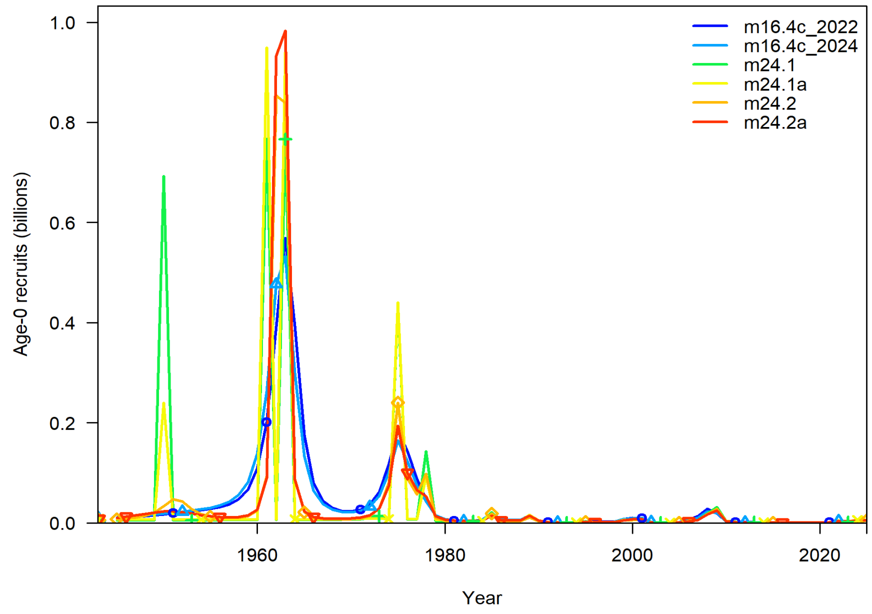


EBS slope bottom trawl survey



Time series



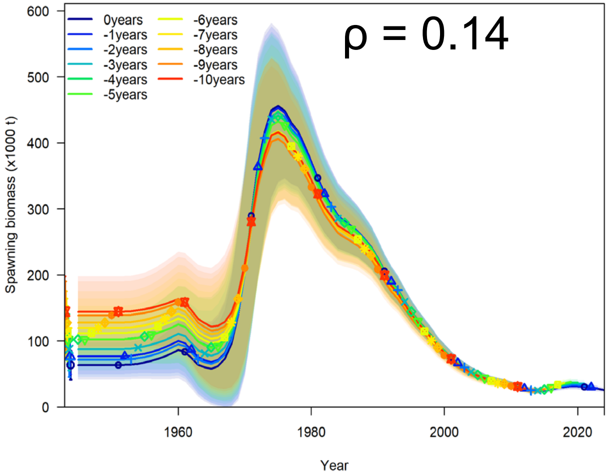


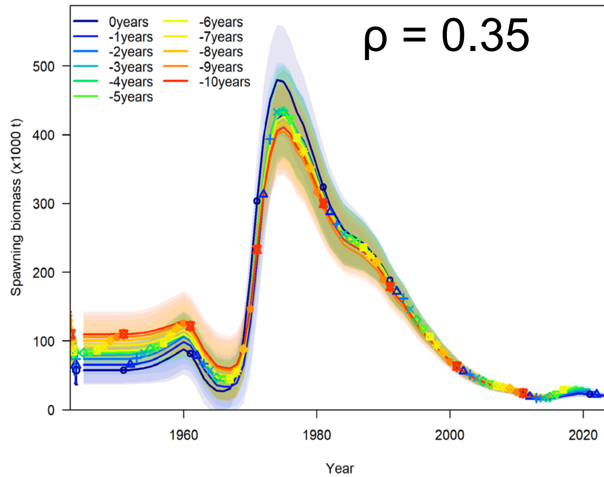
- Models converge to similar low point
  - All model estimate low recruitment
  - Alternative models: SSB ~22% lower than M16.4c
  - M16.4c: 2022 SSB estimate ~18% lower than previous assessment

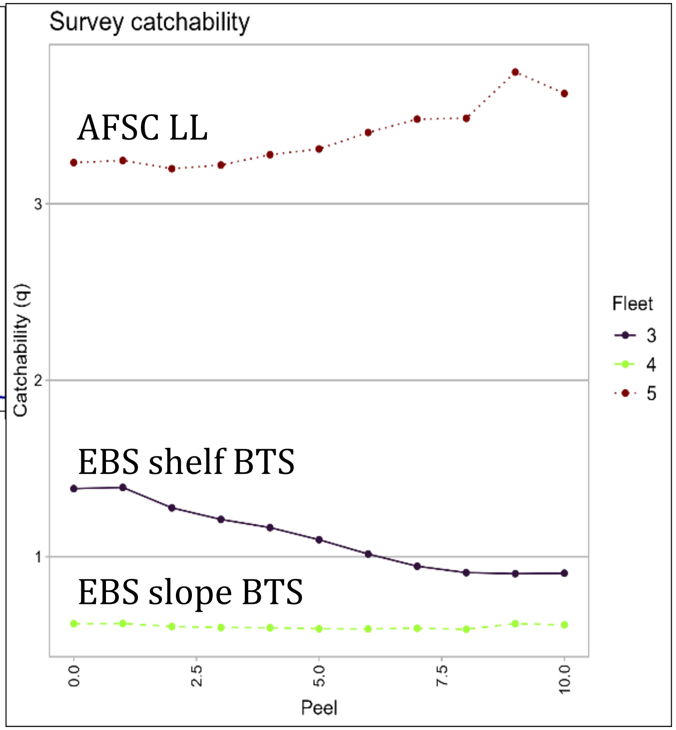
Retrospectives

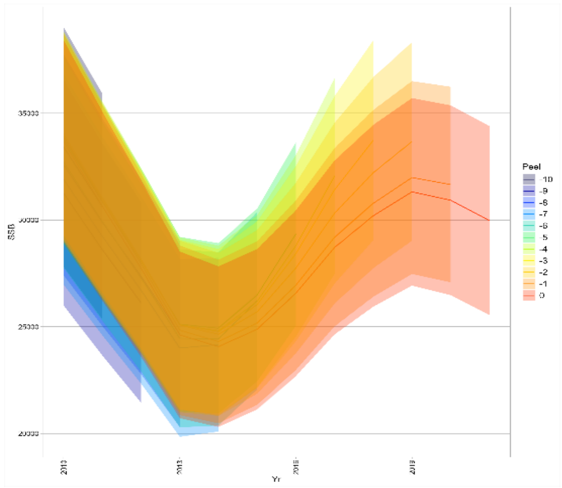
M16.4c

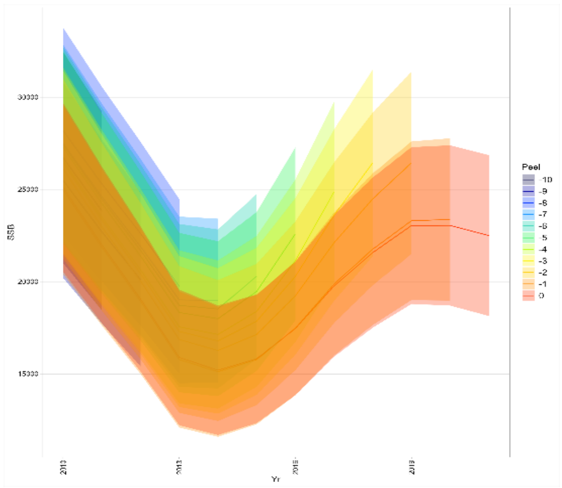
M24.2a











Jitter analysis

Model	Number of runs converged (N=100)
M16.4c	79
M24.1	16
M24.1a	48
M24.2	32
M24.2a	41

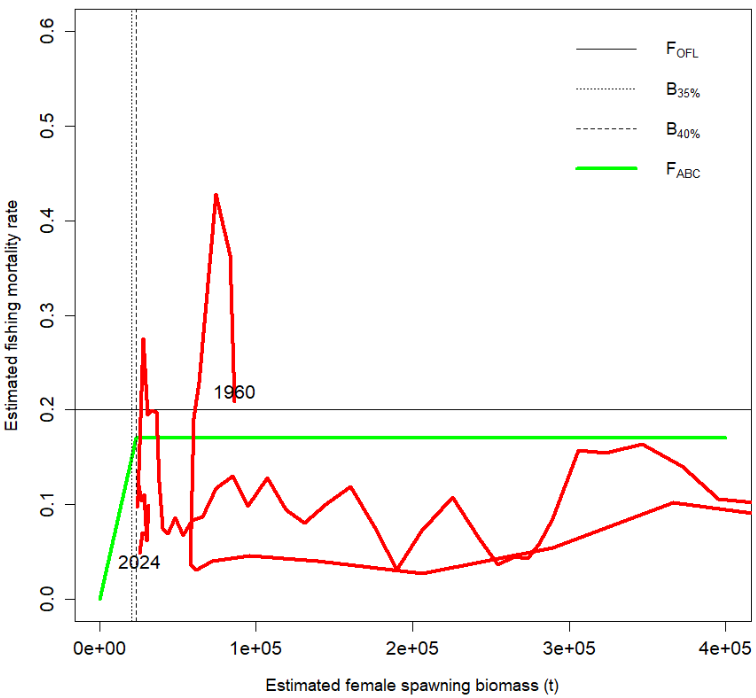
- Convergence issues are mainly due to instability in selectivity parameters
  - Model 16.4c: Catchability is fixed for EBS shelf survey and EBS slope survey
  - Alternative models: Analytical solution for catchability
- Variance adjustment also a factor in stability
  - Without variance adjustment greater lack of stability
  - Francis reweighting led to extreme poor fits to the bottom trawl survey length composition (not presented in report)
    - Implemented the variance adjustment from M16.4c in M24.1a and M24.2a

Recommended model

- Recommend model 16.4c for management
  - Main reason is that it is more stable than the alternatives
- We recommend continued evaluation of the catchability assumptions and simplifying selectivity

Harvest projections

- max ABC 2025
  - 18% lower than expected for 2025
- Recommend a reduction from max ABC
  - 10% reduction

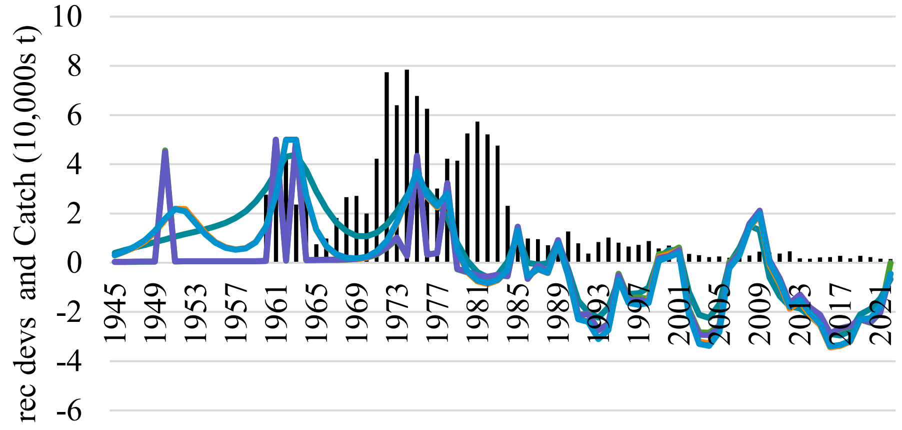


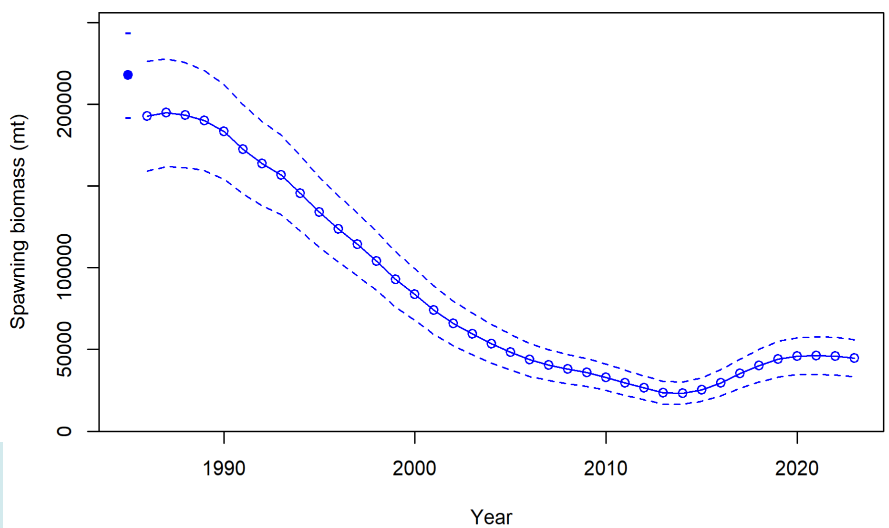
Quantity	As estimated or specified last year for: 2024	2025	As estimated or recommended this year* for: 2025	2026
M (natural mortality rate)	0.112	0.112	0.112	0.112
Tier	3a	3a	3a	3a
Projected total (age 1+) biomass (t)	50,278	47,854	37,615	35,877
Female spawning biomass (t)	31,653	29,439	23,999	22,061
Projected				
$B_{100\%}$	67,647	67,647	58,812	58,812
$B_{40\%}$	27,058	27,058	23,525	23,525
$B_{35\%}$	23,676	23,676	20,584	20,584
F_{OFL}	0.18	0.18	0.20	0.20
$maxF_{ABC}$	0.15	0.15	0.17	0.17
F_{ABC}	0.15	0.15	0.17	0.17
OFL (t)	3,705	3,185	2,598	2,059
maxABC (t)	3,188	2,740	2,237	1,771
ABC (t)	3,188	2,740	2,013	1,594
	As determined last year for:		As determined this year for:	
Status	2022	2023	2023	2024
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

Risk table

Assessment-related considerations	Population dynamics considerations	Ecosystem considerations	Fishery-informed stock considerations
Level 3	Level 2	Level 1	Level 2

- **Assessment related considerations**
  - **Uncertainty about stock status**
  - **Loss of data**
- Population dynamics
  - Continued low recruitment
- Fishery-informed stock considerations
  - Continued decline in catch with declining population





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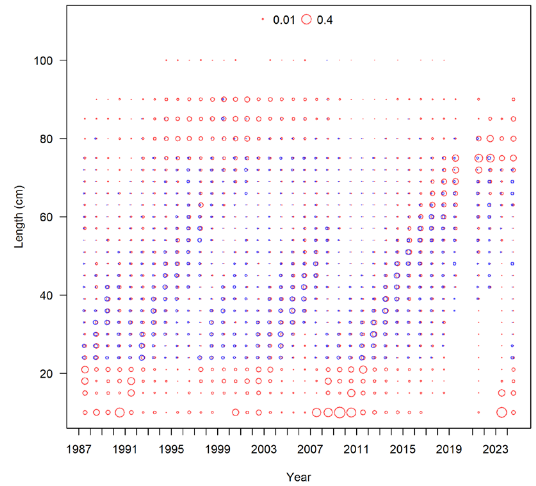
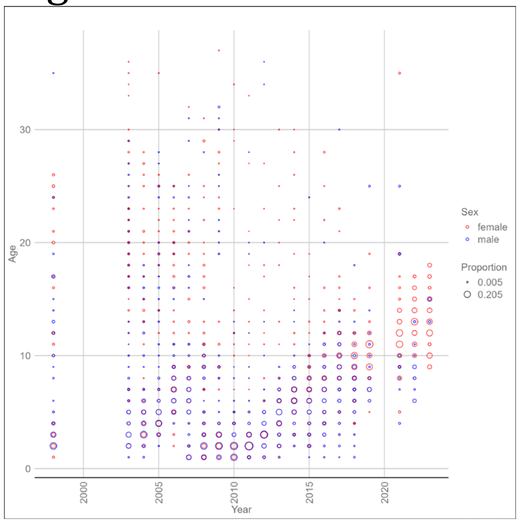
EBS shelf bottom trawl survey

Length



Age



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- **Fishery-informed stock considerations**
  - **Continued decline in catch with declining population**

Region-specific allocation

- Average proportion of biomass from the EBS slope survey and Aleutian Islands survey (overlapping years)
  - 15.7% Aleutian Islands
  - 84.3% Bering Sea

	2025 ABC	2026 ABC
Aleutian Islands ABC	316	250
Eastern Bering Sea ABC	1,697	1,344
Total	2,013	1,594

Potential future research

- Further explore options to identify the most appropriate start year of the model
- Refine fishery and AFSC longline survey input sample sizes
- Simplify the double normal parameterization of selectivity
- Continue exploring options to better parameterize AFSC longline selectivity (difficult to fit bimodal length distribution)
  - Explored using cubic spline – encountered convergence issues; may require changing bin size
- Update maturity ogive (Ten Brink and Bryan)
- Killer whale depredation on the longline survey in the Bering Sea is an issue
  - Cameras on nets to estimate impact on the different species
  - Can we develop a method to account for

Acknowledgments

- John Brogan, Jon Short, and all of the folks in the Age and Growth Program for all of their work
- RACE GAP and the volunteers who work on the Bering Sea bottom trawl survey
- Auke Bay Laboratory and volunteers who work on the AFSC longline survey
- FMA Program and the observers for providing the fishery dependent data

Extra slides

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