2026 Assessment of the Sablefish Stock in Alaska

Joint Groundfish Plan Team

Daniel Goethel and Matt Cheng

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November, 2026







Appendices

The following appendices accompany this document:

Appendix 3A. The Spatial Population over Regional Components (SPoRC) Model: Technical Description of the Assessment Model for Sablefish

Appendix 3B. Model Building and Bridging Exercise for the Sablefish Single Region Models (Bridging from Model *25.12* to *26.1_1Reg*)

Appendix 3C. Development of a Fleets-as-Areas (FAA) Stock Assessment Model for Alaska Sablefish (*Model 26.2_FAA*)

Appendix 3D. Results of Spatial Stock Assessment Models for Alaska Sablefish

Appendix 3E. Evaluating Alternative Assessment Structures for Alaska Sablefish Under Survey Design Changes via Closed-Loop Simulation

Appendix 3F. 2026 Interim Assessment of the Sablefish Stock in Alaska Prepared for the 2026 Center for Independent Experts (CIE) Review

Appendix 3G. Changes to the Alaska-wide Sablefish Stock Assessment for 2026 and Summary of the Center for Independent Experts (CIE) Review of the Assessment Prepared for the 2026 September Joint Groundfish Plan Team

Appendix 3H. CIE Reviewer Report: Klaas Hartmann

Appendix 3I. CIE Reviewer Report: Peter Stephenson

Appendix 3J. CIE Reviewer Report: Samuel Subbey

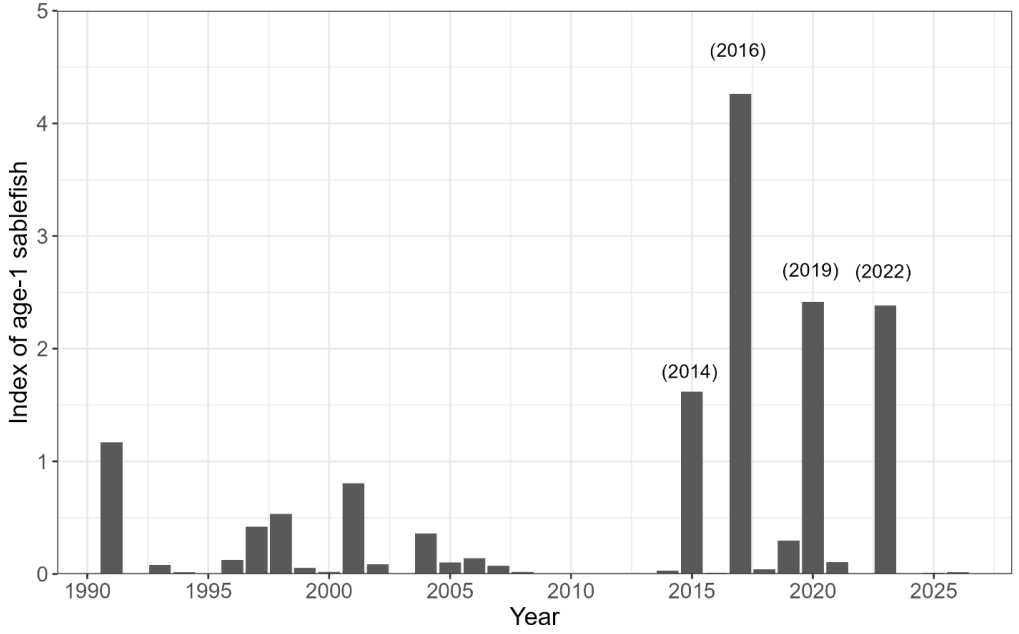
Appendix 3K. Results of the Spatially Explicit Stock Assessment Models for Alaska Sablefish with Data Through 2026

Appendix 3L. Ecosystem and Socioeconomic Profile of the Sablefish stock in Alaska – Update

Sablefish in Eastern Bering Sea Trawl Fisheries Working Paper

Kevin A. Siwicke and Katy B. Echave

November 2026



Summary

- Population biomass has levelled off, but spawning biomass continues to increase rapidly
- **2027 Max ABC = 37,436 t** (-9,500 t from 2026 ABC)
  - Why? -- Biologically realistic natural mortality, not fitting interpolated LLS indices, no aggregation of LLS age data
- Apportionment based on 5-year average survey biomass proportions by area (using carryover interpolation)

Author Recommended BRDs and Whale Adjusted Catch Tables by Region

Year	2026				2027		2028	
Region	OFL_w**	ABC_w**	TAC	Catch*	OFL_w**	ABC_w**	OFL_w**	ABC_w**
BS	--	13,037	8,996	3,339	--	11,231	--	11,291
AI	--	11,421	7,440	632	--	7,487	--	7,527
GOA	--	22,550	22,550	18,191	--	18,718	--	18,818
WGOA	--	4,687	4,687	3,458	--	4,118	--	4,140
CGOA	--	9,622	9,622	7,597	--	7,862	--	7,904
WY	--	2,652	2,652	2,271	--	2,246	--	2,258
SEO	--	5,589	5,589	4,865	--	4,492	--	4,516
Total	57,797	47,008	38,986	22,161	44,333	37,436	44,565	37,636

* As of October 15, 2026 Alaska Fisheries Information Network, (www.akfin.org).
** After whale depredation methods described above.

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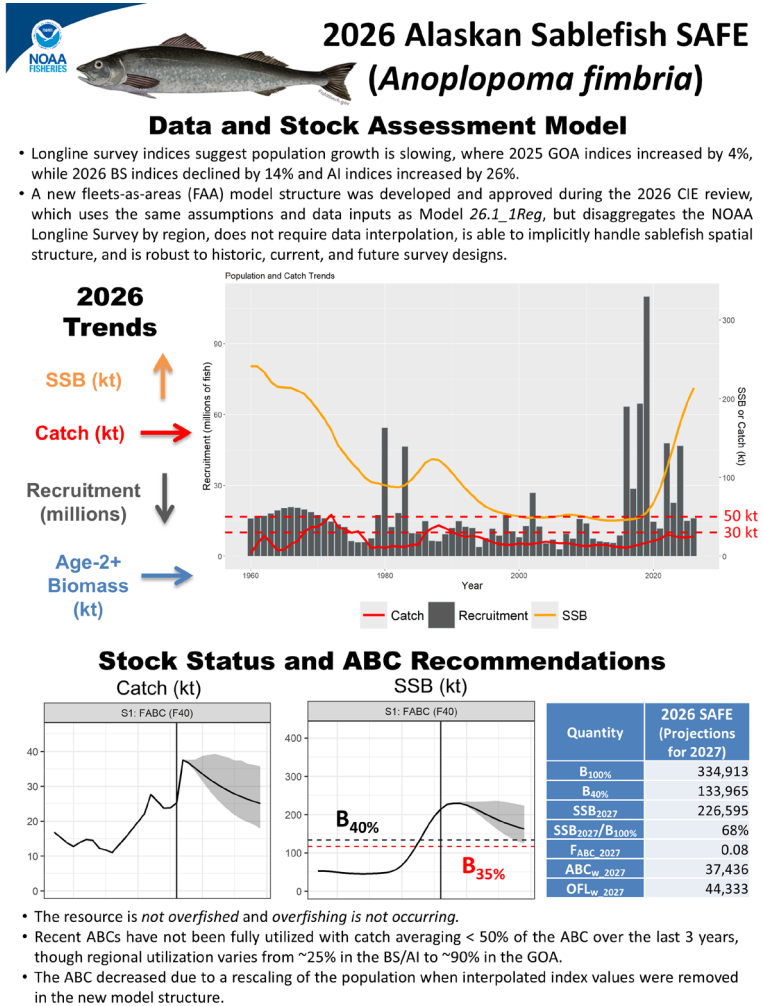
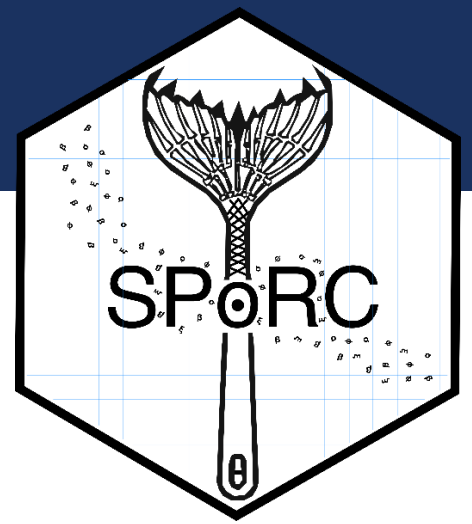


Model Development Timeline

- Last operational assessment (2024): Model *23.5*
  - Bespoke model built in AD Model Builder
- Last JPT/SSC accepted model (Sept/Oct 2025): Model *25.12*
  - Built in the generalized SPoRC assessment platform using RTMB
  - Continuity/Base model
- June 2026 CIE review
  - Model *26.1_1Reg* (Updated single region model)
  - Model ***26.2_FAA*** **(CIE recommended fleets-as-areas, FAA, model)**
- Sept/Oct JPT/SSC requested models:
  - Model *25.12*
  - Model *26.1_1Reg*
  - **Model *26.2_FAA* (author recommended)**
  - Model *26.2_FAA_3LLF_LLS_BS_Dome_DN* (SSC requested model with 3 fixed gear fishery fleets and BS domed selectivity)

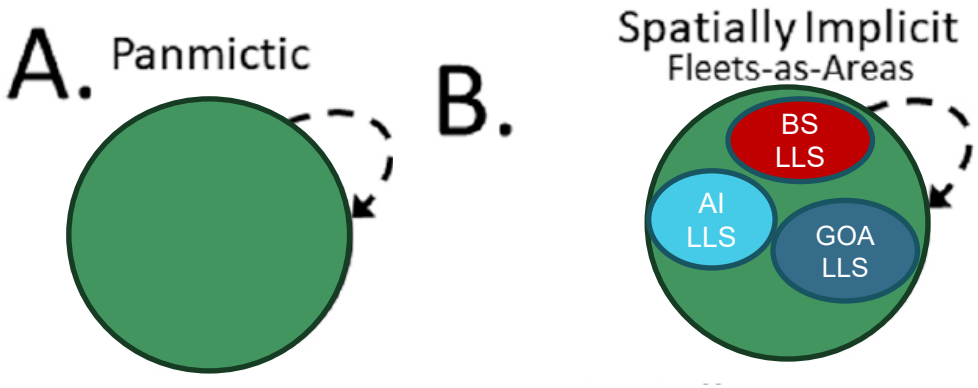




"The review concludes that the FAA assessment provides an appropriate and scientifically defensible basis for operational management…"

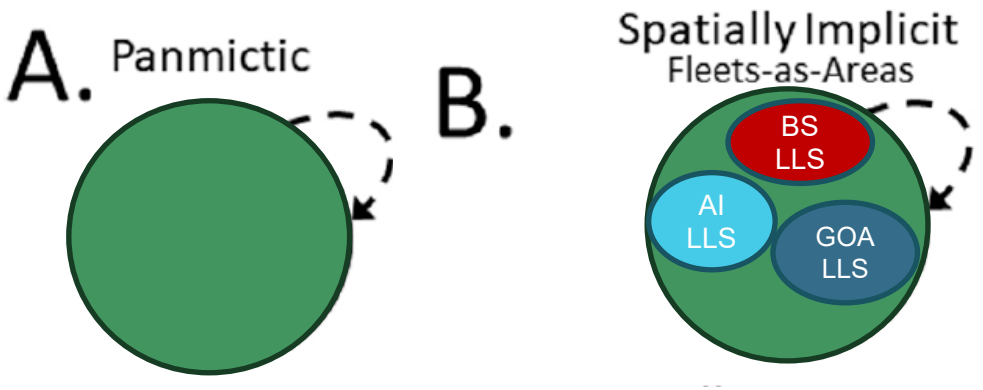
Model Options for 2026

- 2 model versions (reviewed by the CIE):
  - *26.1_1Reg:*
    - Updated single region model
    - Refines data inputs, improves parametrization, and better aligns with best practices
    - Uses 'carryover' NOAA Longline Survey (LLS) index values
  - ***26.2_FAA* (Recommended Model):**
    - New spatially-implicit model (building from *26.1_1Reg*)
    - Disaggregates the LLS into regional fleets (separate indices, age compositions, catchability, and selectivity)
    - All other data sources aggregated to a single region (same as *26.1_1Reg*; i.e., fishery fleets)
    - Explicitly handles survey design change (no imputed values)



Why ‘Fleets-as-Areas’?

- Single region assessment:
  1. Requires a suboptimal data kluge (interpolation)
  2. Primarily reflects GOA dynamics due to age composition aggregation
  3. Overestimates population abundance



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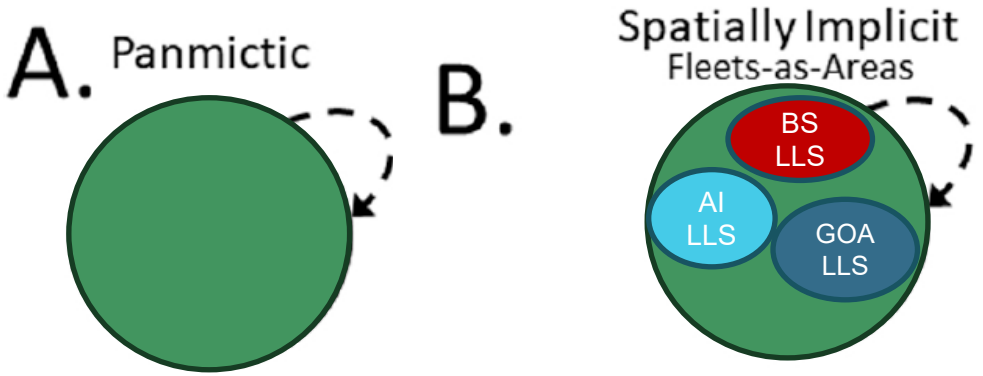
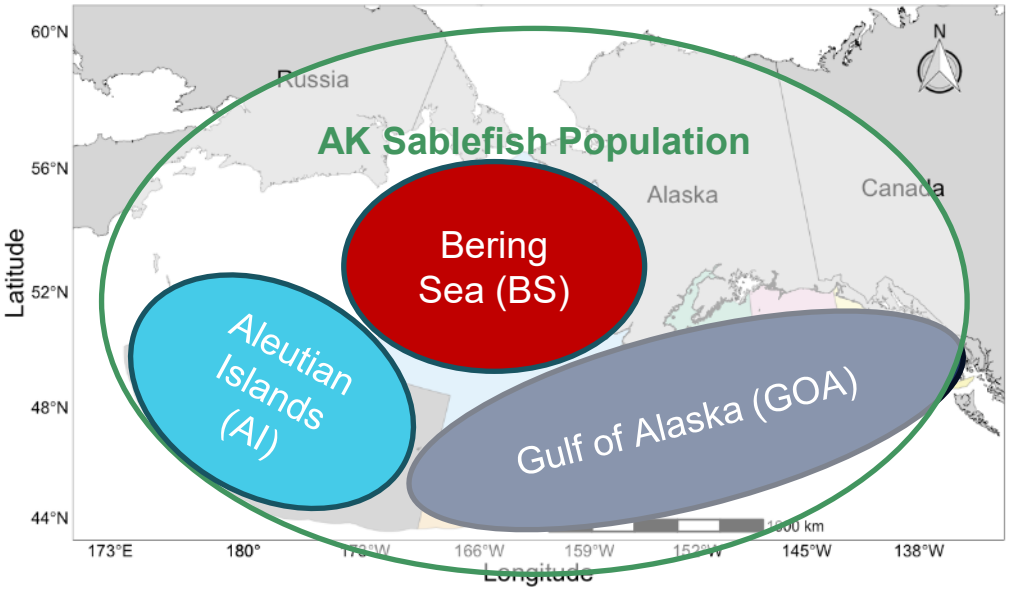
- FAA model:
  1. Implicitly accounts for known spatial dynamics (biological and data)
  2. **Provides a robust approach for handling data under historical, current, and future survey design**
  3. Does not fit interpolated data
  4. Disaggregates regional age compositions
  5. Represents a stepping stone towards a full spatial model



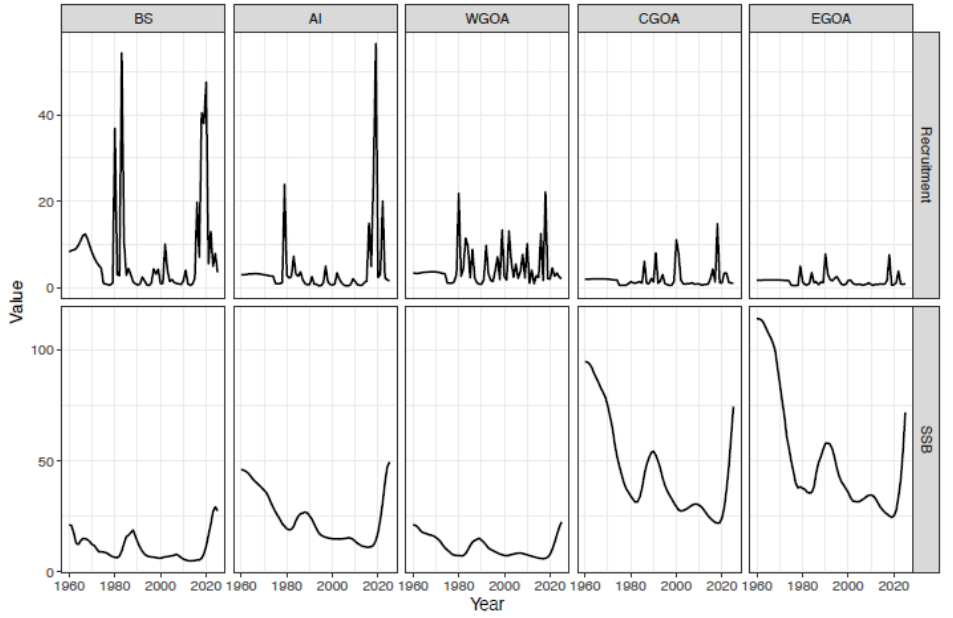


FAA Model Development

- Use spatially explicit simulations to identify robust FAA models (Appendix 3E)
  - Start with minimum necessary complexity (3 LLS fleets)
  - Explore number of fixed gear fishery fleets and shape of selectivity functions
- Implement the most promising structures in SPoRC and fit to real-world data
- Assess **stability, parsimony, and performance** to narrow operationally feasible models

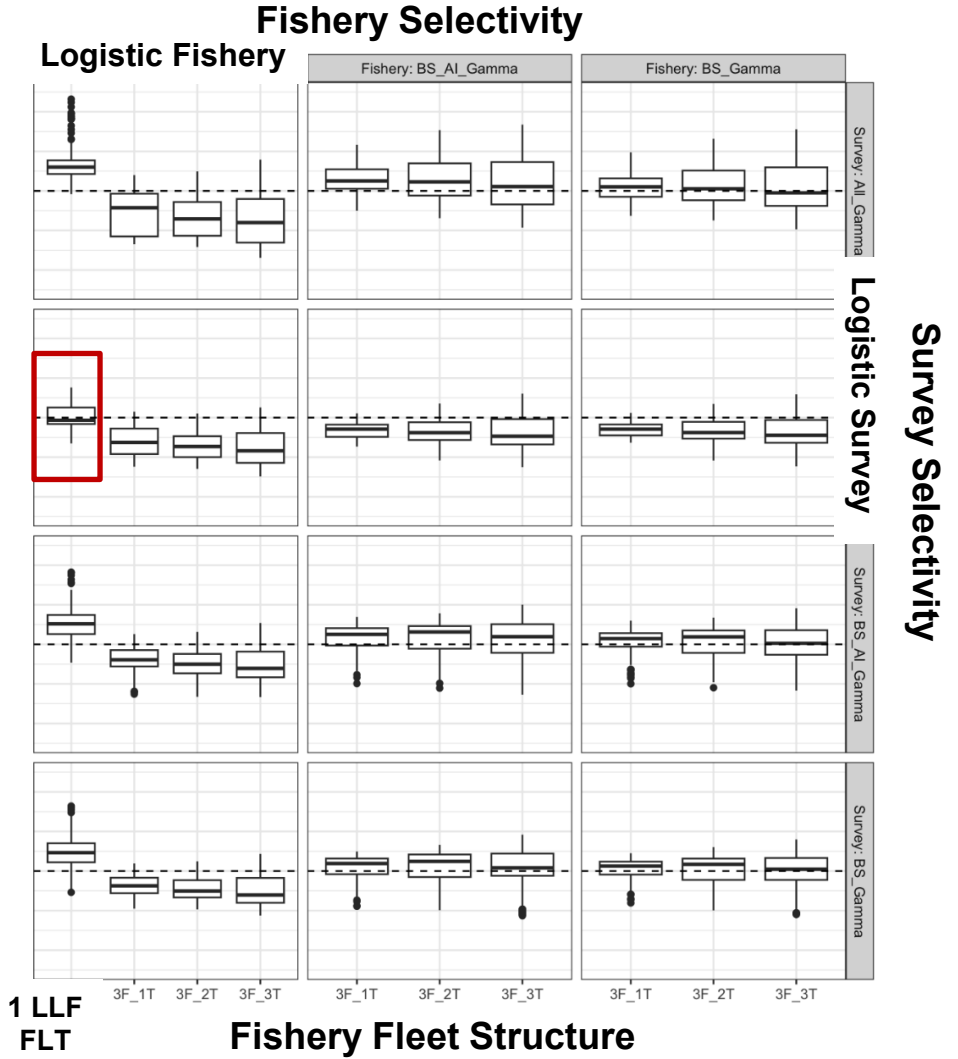
Panmictic Panacea? Demonstrating Good Practices for Developing Spatial Stock Assessments Through Application to Alaska Sablefish (*Anoplopoma fimbria*)

Matthew L. H. Cheng[1] | Craig A. Marsh[2] | Daniel R. Goethel[2] | Peter-John F. Hulson[2] | Katy Echave[2] | Benjamin C. Williams[2] | Aaron M. Berger[3] | Curry J. Cunningham[1]



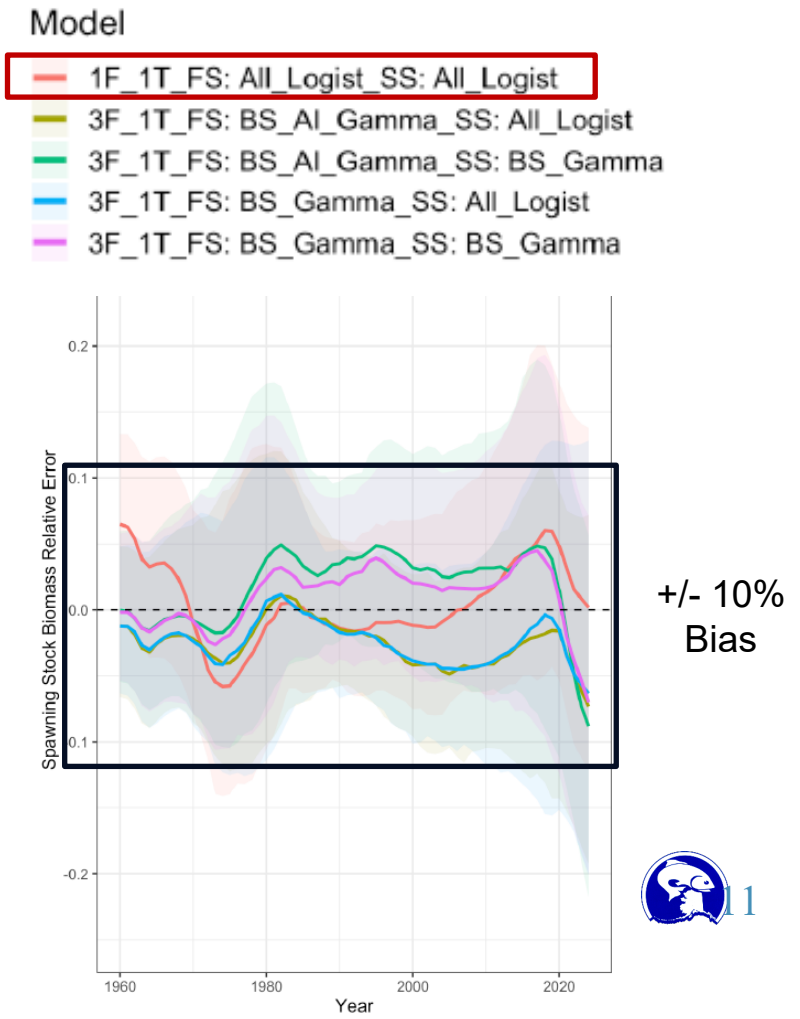
FAA Model Development – Simulations

- **Goal:** Use simulation cross-testing to remove poorly performing FAA configurations
- **Methods:** Implemented a spatially explicit 5-region OM and tested 56 FAA model variants with simulated data across 100 iterations
- **Conclusions:** The ***most parsimonious configuration demonstrated unbiased estimates and robust performance***
  - Single longline fishery fleet (LLF), 3 LLS fleets, logistic selectivity for all fleets



FAA Model Development – Domed Selectivity

- **FAA alternative with 3 fixed gear fishery fleets and/or domed selectivity in fishery or survey did not provide reduced time series bias**
- Increasing fishery fleet structure is hindered by low BS/AI sample sizes
- Data does not support strong domed selectivity (see time-varying selectivity sensitivity run)
- Domed selectivity greatly reduces model stability
- Allowing for BS domes has little model impact
  - Low catch in BS and lack of older fish limits cryptic biomass



Impact of Survey Data Treatment on Single Region Model

1 Pooled age comps aren't representative

- Historical design: GOA + BS or AI, so comps are ~60 – 90% GOA
- Current design (from 2025): comps alternate GOA only / BS + AI only
- Dilutes the BS / AI recruitment signal
- Overestimates AK-wide old/large fish

2 Carryover index lags the population trend

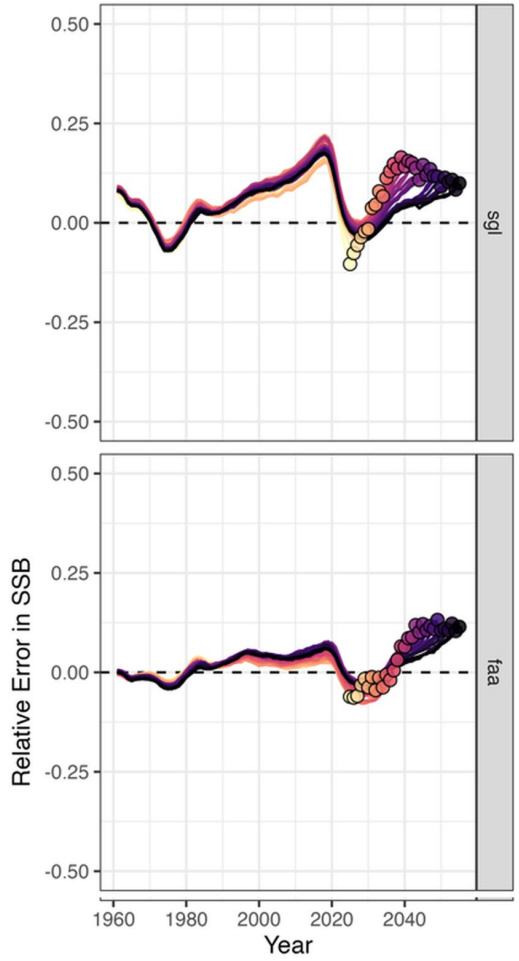
- Unsurveyed regions repeat their last survey value
- ~15% of the index (historical design); ~50% (current design)
- The index lags whenever the stock changes direction

***26.2_FAA* needs does not aggregate LLS age data and does not fit interpolated indices:**

- **Fits LLS data at regional scale**

Closed-Loop Simulation: Bias in SSB

- Assessment models implemented as in real-world
  - Single region model uses the carryover index and aggregated age compositions
  - FAA fits regional data with no interpolation
- Single region model overestimates SSB over the historical period (up to ~20% by 2020)
- FAA bias ≤ 10%
- Positive biases in *SSB* due to fitting unrepresentative Alaska-wide age composition data
- *Single region model aggregated compositions provide less representative sample of AK-wide age structure (and recruitment) than FAA assumption that regional compositions represent entire AK-wide population*
- Why?



Hypothesis: Aggregated Age Compositions Appear Too Old

Comps are mostly GOA → **Comps appear 'older' than AK-wide population** → **Model keeps too many old fish** → **Lower *F* needed to achieve the catch, so SSB biased high**

- GOA has higher proportion of old fish compared to BS/AI and recruitment seen at later ages
  - Recent year classes first observed in BS/AI then eventually move into GOA
- To better fit old fish in aggregated age compositions, single region model estimates a lower *F* (higher SSB)
- Conversely, if used BS-only comps, then model would overestimate recruitment (lower SSB)
- LLS design directly impacts model bias and likely causes interannual issues fitting age compositions:
  - Historical design: age compositions combine GOA ever year (too old) with BS or AI every other year (too young)
  - Current design: age compositions alternate between GOA only (too old) and BS + AI only (too young)

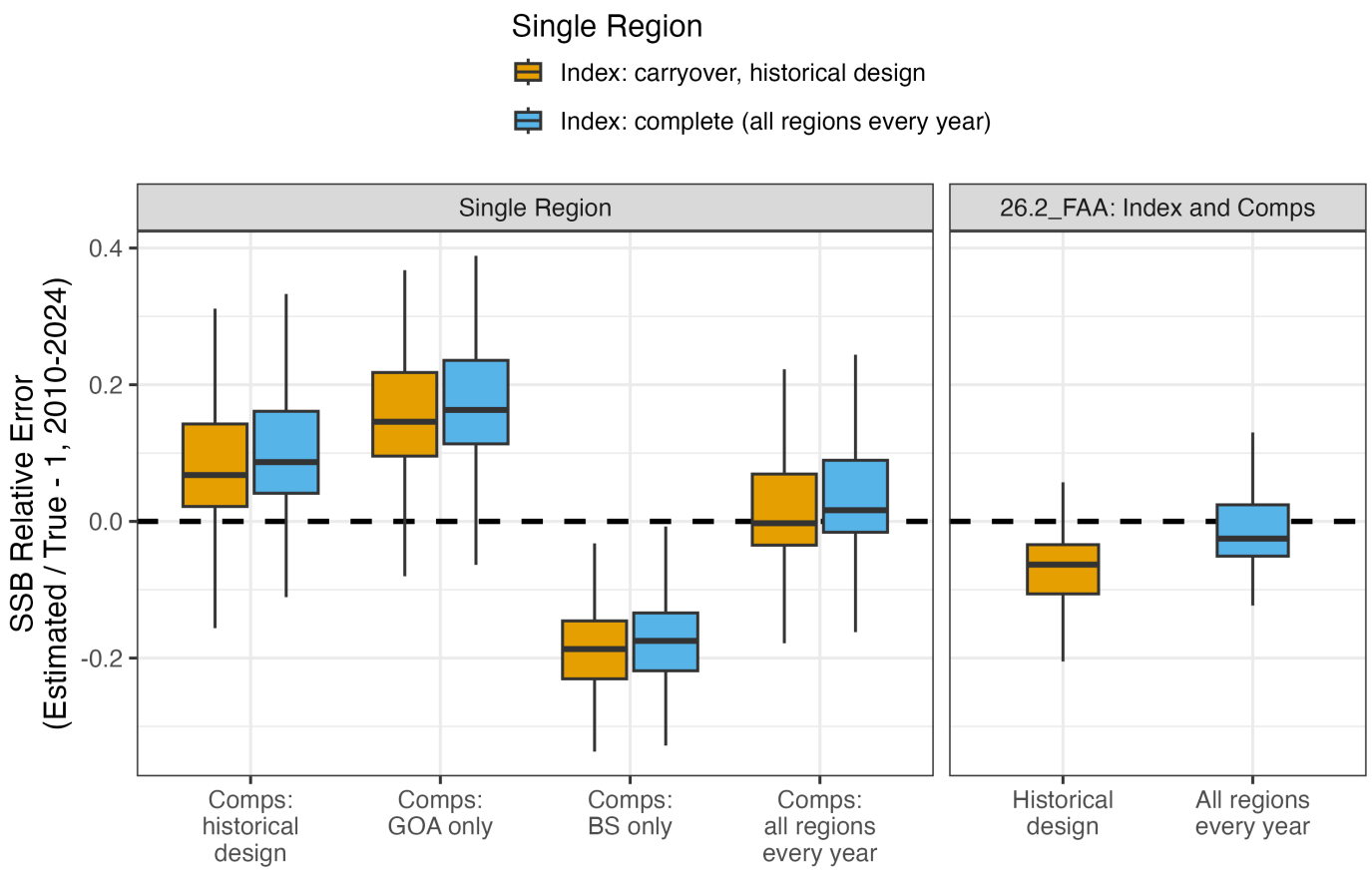
Simulation Testing

Five-region spatial operating model → **100 simulated datasets (through 2024)** → **Fit single region model and *26.2_FAA* to simulated data** → **Compare estimated SSB with the known true SSB**

- Data aggregated as in real-world models
  - *26.1_1Reg* fits a carryover index and aggregated age compositions
  - *26.2_FAA* fits regional indices and age compositions
- Explore stepwise changes in data availability/structure:
  - Age compositions: historical design, GOA only, BS only, or all regions every year
  - Index: carryover or complete/synoptic (all regions every year)
  - Survey design: historical (GOA every year, BS and AI in alternate years) or current (GOA one year, BS + AI the next; applied from 1997)

Simulation Testing: Ages Drive the Average Bias

- The age compositions primarily drive the degree/direction of bias in the single region model (grouping):
  - GOA age comps lead to positive bias
  - BS-only age comps lead to negative bias
  - Age comps from all regions lead to relatively unbiased model
- The index interpolation has limited impact (orange vs. blue), but varies across time series (i.e., during transitions)
- ***26.2_FAA* demonstrates minor negative bias under historical design, but remains unbiased under complete survey/ages every year**
  - Slight overestimation of recruitment (BS) by assuming each regional age comps represents AK



SSC and PT Comments

- Comments prior to 2026 were discussed in September (see SAFE doc)
- Most 2026 comments are addressed via sensitivity runs (covered later in presentation)
- 25 model runs described in text adding to the more than 100 FAA models explored during model development

Model_Names	Model_Group	Model_Description
26.2_FAA	Base (Author Recommended FAA)	The author recommended model for 2026 (fleets-as-areas for the LLS, no interpolated data; see Appendix 3C)
25.12	Base (1Reg Continuity)	The 2025 model accepted for management advice updated with data through 2026 (fits CPUE and historical LLS+LLF lengths, uses GOA interpolation for LLS through 2023)
26.1_1Reg	Base (1Reg Updated)	The updated single region model using the carryover interpolation for the LLS (see Appendix 3B)
26.2_FAA_3LLF_LLS_BS_Dome_DN	Base (SSC Requested FAA)	The FAA model with 3 LLF fleets and a dome in the BS LLF and LLS selectivity estimated using a double normal function
26.1_1Reg_REMA	REMA (1Reg)	The updated single region model with LLS index values interpolated using REMA
26.2_FAA_LLS_BS_Dome_DN	Dome (LLS BS Dome DN)	The FAA model with a dome in the BS LLS selectivity estimated using a double normal function
26.2_FAA_LLS_BS_Dome_Gam	Dome (LLS BS Dome Gamma)	The FAA model with a dome in the BS LLS selectivity estimated using a gamma function
26.2_FAA_3LLF_BS_Dome_DN	Dome (3LLF BS Dome DN)	The FAA model with 3 LLF fleets and a dome in the BS LLF selectivity estimated using a double normal function
26.2_FAA_3LLF_BS_Dome_Gam	Dome (3LLF BS Dome Gamma)	The FAA model with 3 LLF fleets and a dome in the BS LLF selectivity estimated using a gamma function
26.2_FAA_3LLF_LLS_BS_Dome_Gam	Dome (3LLF+LLS BS Dome Gamma)	The FAA model with 3 LLF fleets and a dome in the BS LLF and LLS selectivity estimated using a gamma function
26.2_FAA_3LLF_LLS_BS_Dome_DN_PE_q	Dome (3LLF+LLS BS Dome TV q)	The FAA model with 3 LLF fleets, process error (time-varying) on LLS q, and a dome in the BS LLF and LLS selectivity estimated using a double normal function
26.2_FAA_REMA	REMA (FAA)	The FAA model with LLS index values interpolated using REMA
26.2_FAA_CPUE	Index (CPUE)	The FAA model with CPUE data fit (through the last year of available CPUE data -- 2022)
26.2_FAA_TS	Index (Trawl Survey)	The FAA model with GOA Trawl Survey data fit
26.2_FAA_TS_CPUE	Index (CPUE and Trawl Survey)	The FAA model with GOA Trawl Survey and CPUE data fit
26.2_FAA_M_Pr_0.065	M Prior (Lower)	The FAA model with an M prior mean = 0.065
26.2_FAA_M_Pr_0.075	M Prior (Lower)	The FAA model with an M prior mean = 0.075
26.2_FAA_M_Pr_0.095	M Prior (Higher)	The FAA model with an M prior mean = 0.095
26.2_FAA_M_Pr_0.105	M Prior (Higher)	The FAA model with an M prior mean = 0.105
26.2_FAA_M_Pr_0.115	M Prior (Higher)	The FAA model with an M prior mean = 0.115
26.2_FAA_M_1Reg	M Prior (Fixed M)	The FAA model with the M value fixed at the single region model M estimate
26.2_FAA_Est_M	M Prior (Diffuse Prior)	The FAA model with M estimated with a diffuse prior (sd = 0.75)
26.2_FAA_TV_Selex_LLS	Dome (TV LLS Selectivity)	The FAA model with continuous, semi-parametric, time-varying survey selectivity (see Appendix 3C)
26.3_Spat_5Reg	Spatial (5 Regions)	The 5 region spatial model that fits tagging data and estimates age-varying, but time-invariant movement (See Appendix 3D)
26.4_Spat_3Reg	Spatial (3 Regions)	The 3 region spatial model that fits tagging data and estimates age-varying, but time-invariant movement (See Appendix 3D)

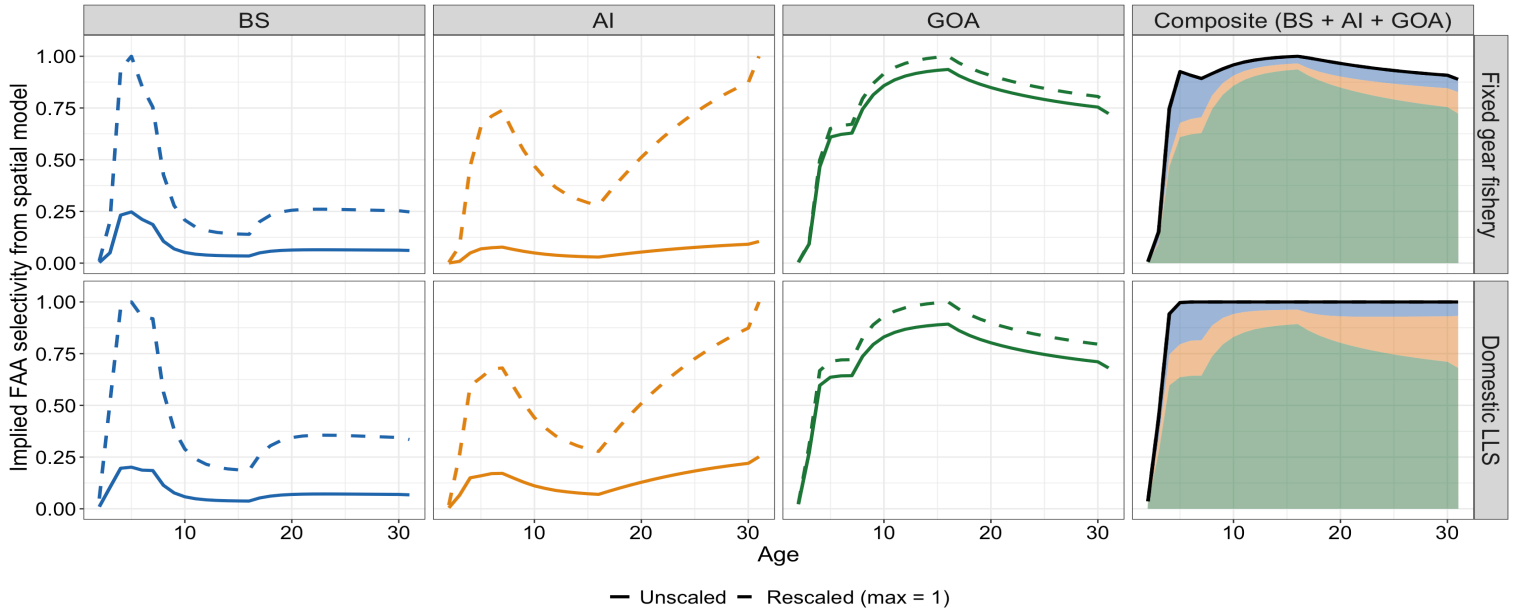
SSC and PT Comments

- *The SSC supports bringing forward the JGPT's proposed models for December, including Model 25.12, the continuity model, Model 26.1_1Reg, and Model 26.2_FAA. (SSC and PT)*
  - Results from all models are provided on the GitHub repo and summary tables for each are provided in the Supplemental Material.
- *Domed-shaped selectivity should be evaluated using more flexible curves such as the double normal that are already implemented in SPoRC. The gamma function is not often used for modeling selectivity because the ascending and descending portions of the curve are linked.*
  - Extensive sensitivity runs with double normal and gamma domed selectivity are provided.
- *The SSC requests that an additional FAA model be provided for the final assessment in December that allows for selectivity for Bering Sea fisheries and surveys to be dome-shaped.*
  - Model *26.2_FAA_3LLF_LLS_BS_Dome_DN* is provided as a sensitivity run.



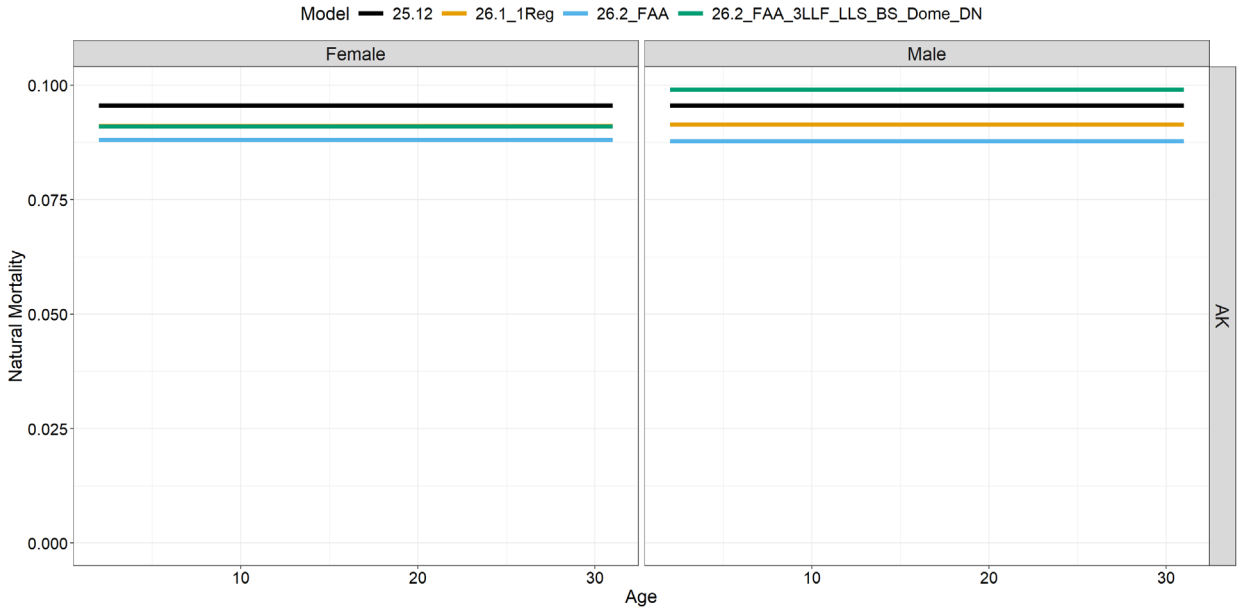
SSC Comments

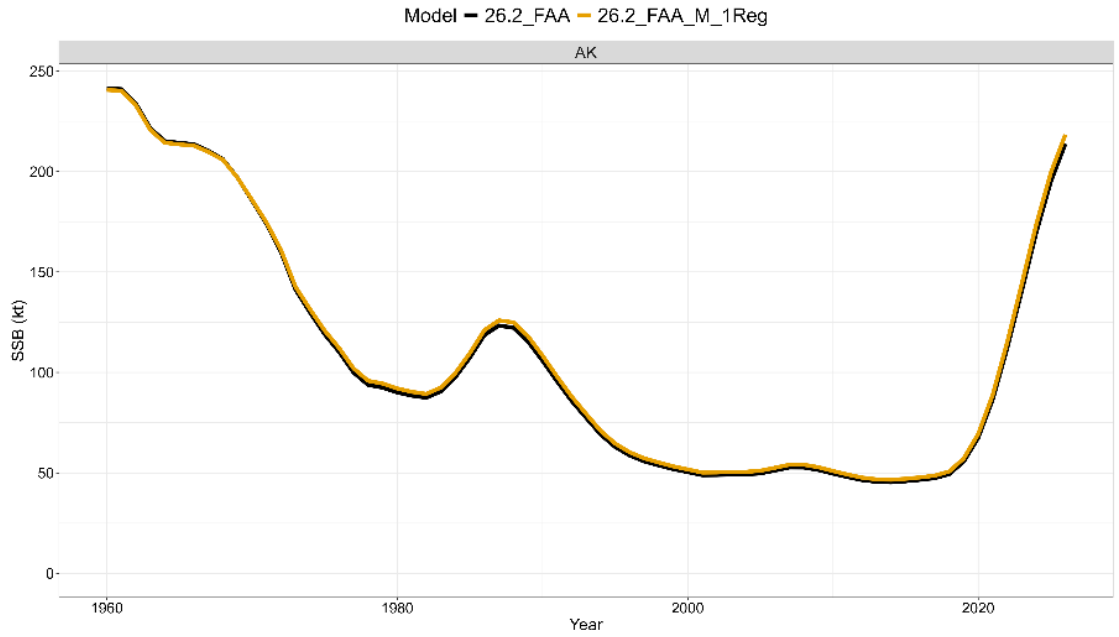
- *Use the 5-region operating model to evaluate emergent empirical selectivities for regional fisheries and surveys by comparing survey and fishery age composition sampled regionally with abundance at the population level.*
  - Following Waterhouse et al. (2014), the selectivity curves were calculated that an FAA model would need in order to reproduce the catch and survey dynamics generated by the spatial model.



SSC Comments

- *The SSC requests that a sensitivity model run be done where the natural mortality estimated in Model 26.1_1Reg is included as fixed values in Model 26.2_FAA to evaluate the impact of the re-estimated natural mortality values in Model 26.2_FAA on model results.*

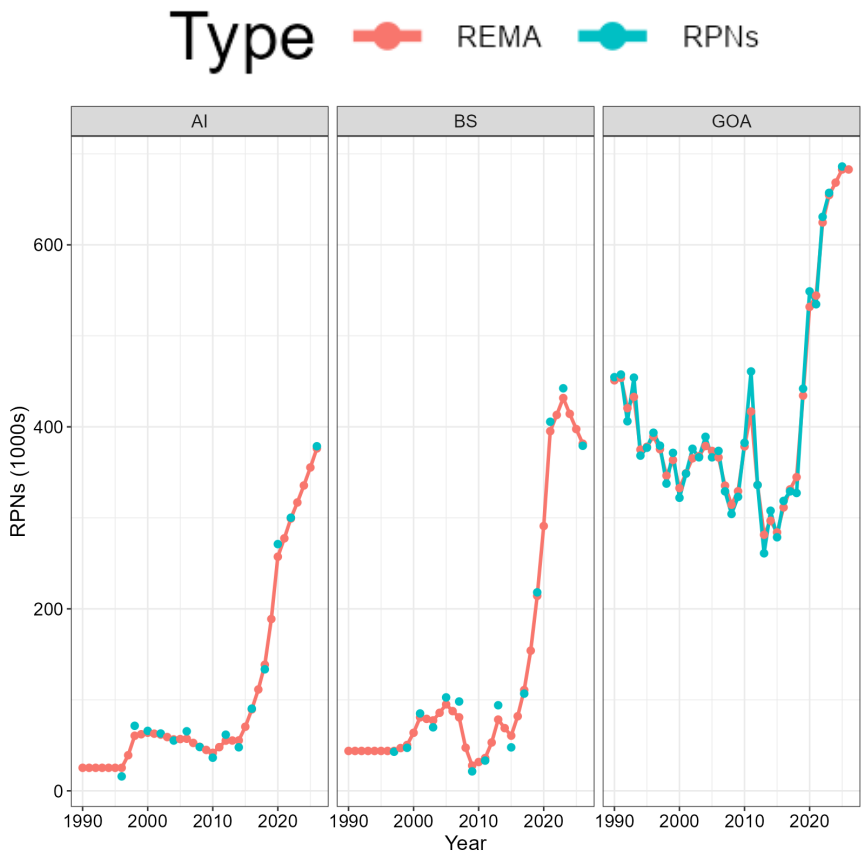




Model	Catch_Advice	B_Status	Terminal_SSB	B_Ref_Pt	B_over_B_Ref	Terminal_F	F_Ref_Pt	F_over_F_Ref
26.2_FAA	37.57	0.64	213.87	133.97	1.60	0.05	0.08	0.68
26.2_FAA_M_1Reg	39.27	0.66	218.40	131.62	1.66	0.05	0.08	0.65

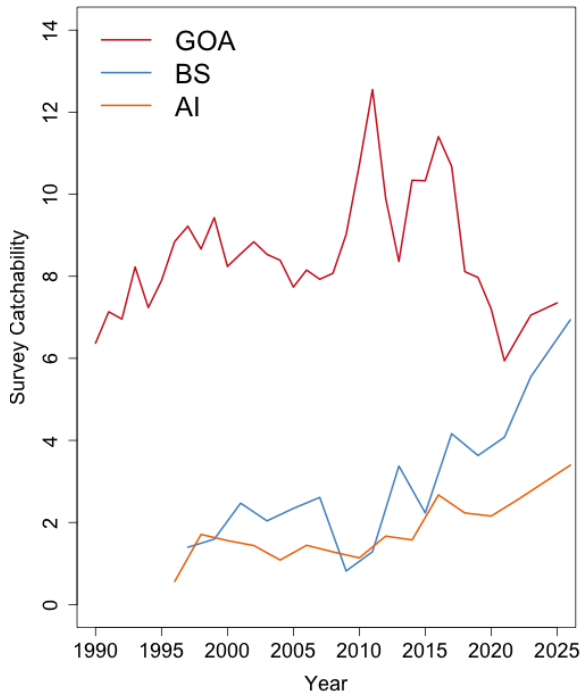
SSC and PT Comments

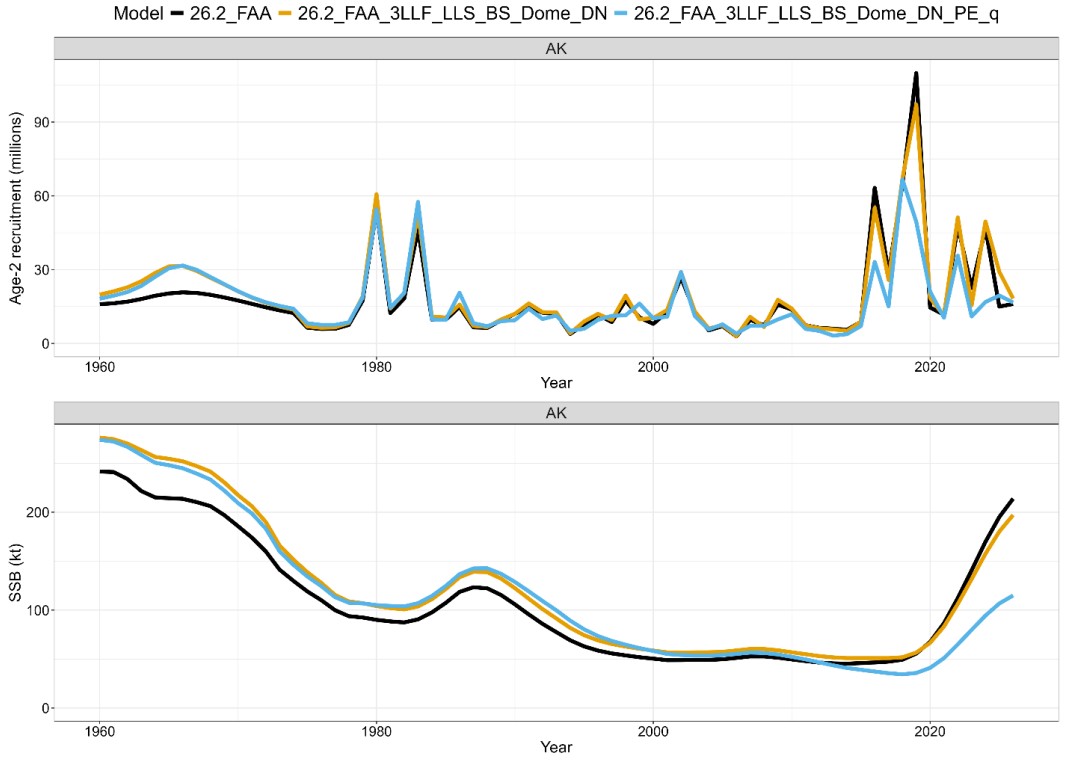
- *The SSC recommends evaluation of spatial-temporal models for the longline surveys that deal appropriately with missing regional surveys to develop an overall estimate of abundance.*
  - A GMRF can fill in the missing regional indices, but the reliability of such abundance estimates is low given the need to interpolate across broad geographic regions where BS+AI and GOA have never been sampled concurrently.
  - If use interpolated indices, then it is best practice to interpolate age compositions, too.
  - Regional age compositions differ, so imputing an unobserved region's composition from another region requires additional assumptions about how those compositions relate.
  - See sensitivity runs.



SSC and PT Comments

- *If the FAA approach becomes the preferred approach for sablefish, the SSC recommends that process error in survey catchability be evaluated to account for density dependence and range expansion.*





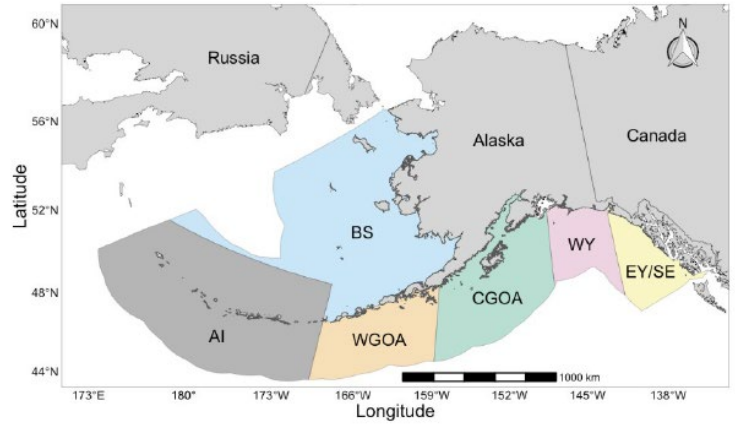
SSC and PT Comments

- *The SSC supports carrying forward the full range of apportionment options into the final assessment. In addition, the SSC recommends use of REMA models with the longline survey data to estimate regional biomass distribution.*
  - Five survey-based apportionment options are provided, which includes a new REMA apportionment and whether or not western AI stations are included (never surveyed so not recommended).
  - The GOA interpolation is no longer feasible (GOA not surveyed annually), so it is fixed at the 2024 level (fixed apportionment is not recommended).
  - The REMA apportionment uses the carryover assumption in the terminal year, which is replaced in the next assessment by an interpolated value, such that the values going into the apportionment calculation will inherently change with every update.
  - The carryover interpolation without wAI stations is the author recommended approach.

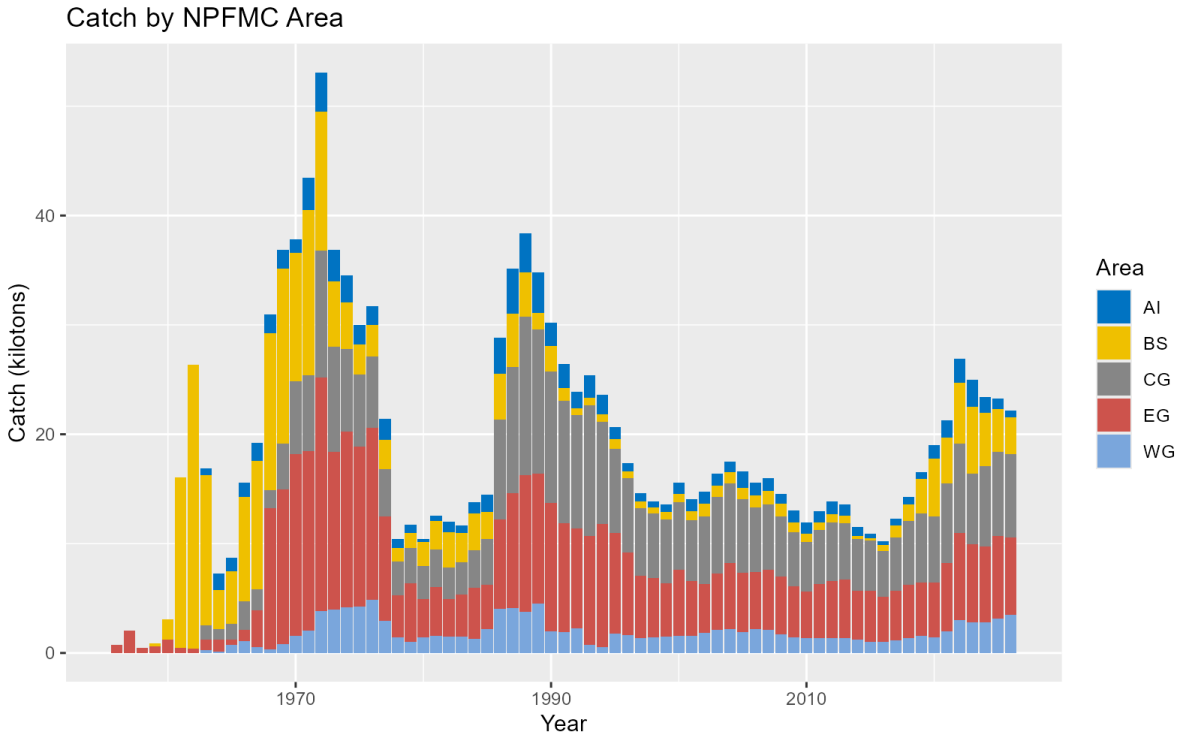
Regional Apportionment Values by Apportionment Method

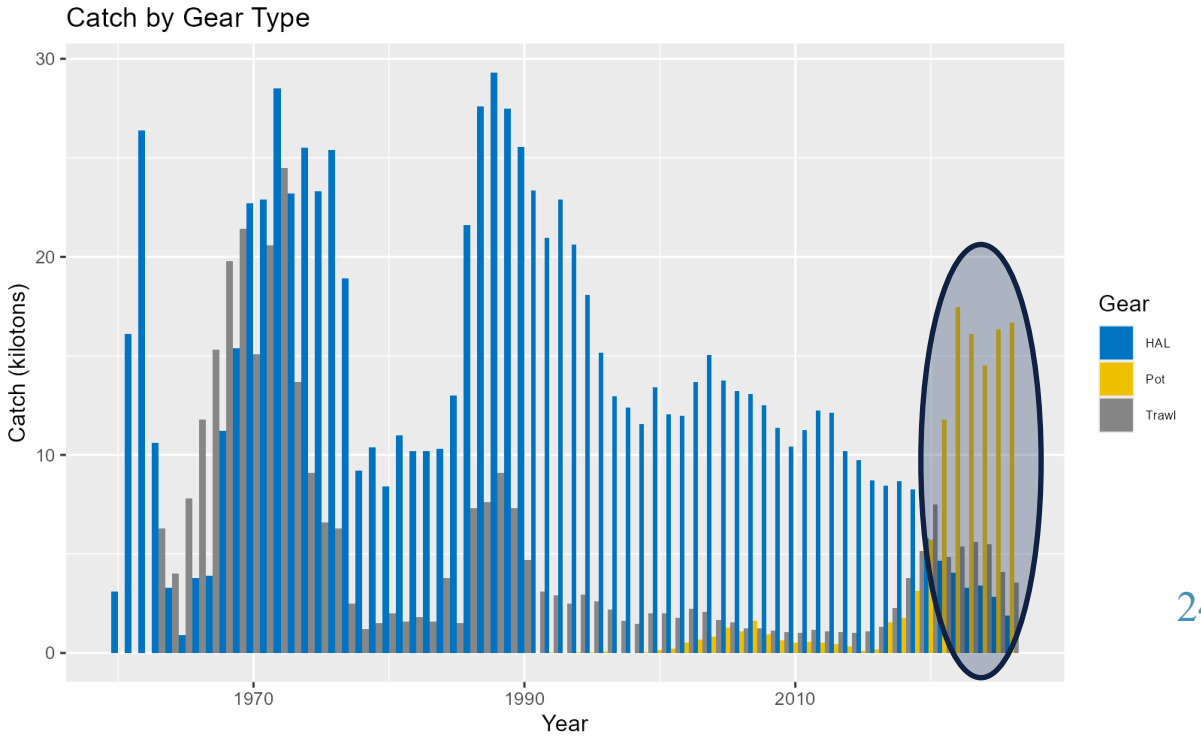
Apportionment Approach	BS	AI	WGOA	CGOA	WY	SEO
Carryover_No_wAI	**0.3**	**0.2**	**0.11**	**0.21**	**0.06**	**0.12**
REMA_LLS_No_wAI	0.28	0.23	0.1	0.21	0.06	0.12
Carryover	0.27	0.26	0.1	0.2	0.06	0.11
REMA_LLS	0.26	0.3	0.09	0.19	0.05	0.11
GOA_Fix	0.3	0.24	0.09	0.2	0.05	0.12

Catch



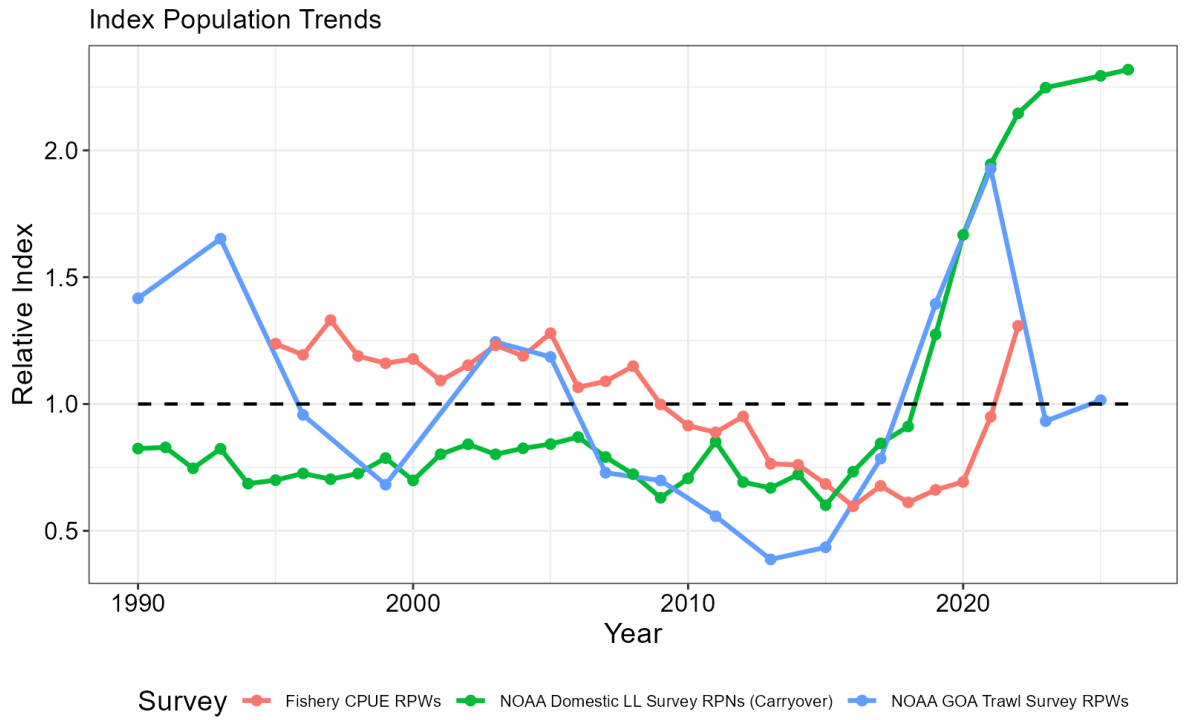
- Catch by pot gear is consistently the primary source of recent removals
- Trawl removals ~20% of total catch over last 5 years (16% in 2026)
- AI and BS catch continues to decline (5% and 25% ABC utilization)





Indices

- LLS updates:
  - For 2025, GOA increased by 4% in 2025 (compared to 2023),
  - For 2026, AI increased by 26% (compared to 2022), and BS decreased by 14% (compared to 2023)
  - First regional divergence since early 2010s
- BSAI constitute > 50% of survey numbers/biomass



LL Survey: Steady (based in carryover interpolation)

CPUE Index: No Update

Trawl Survey: Steady

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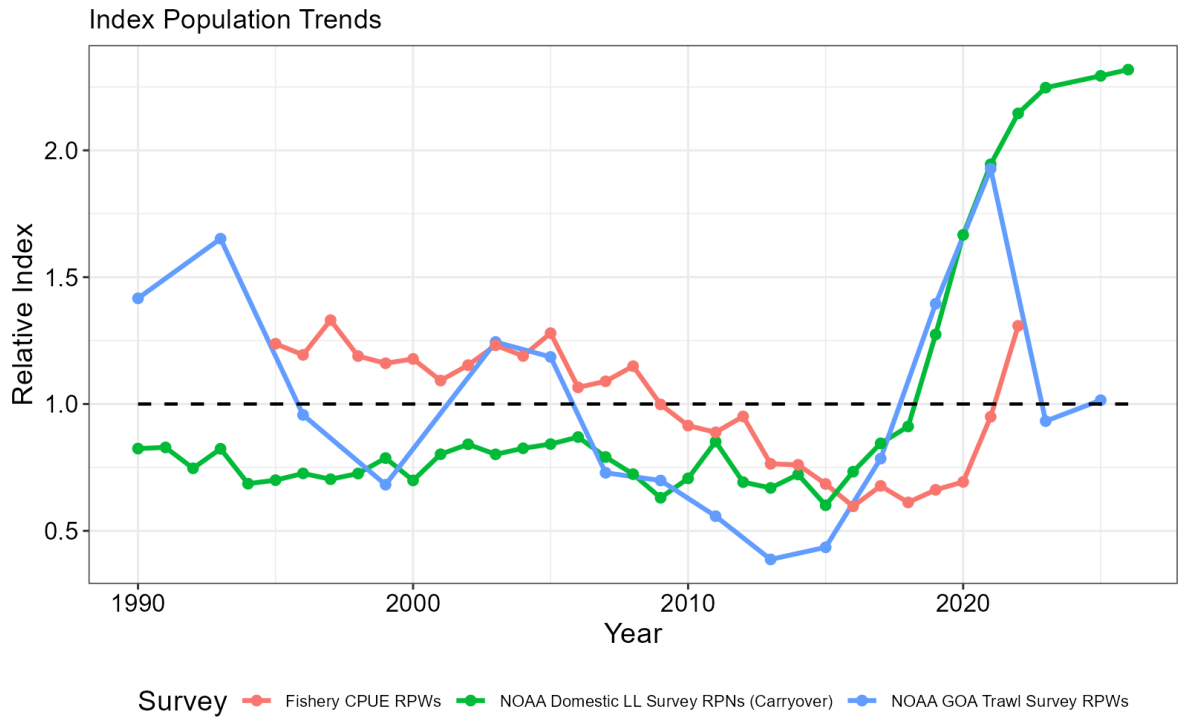

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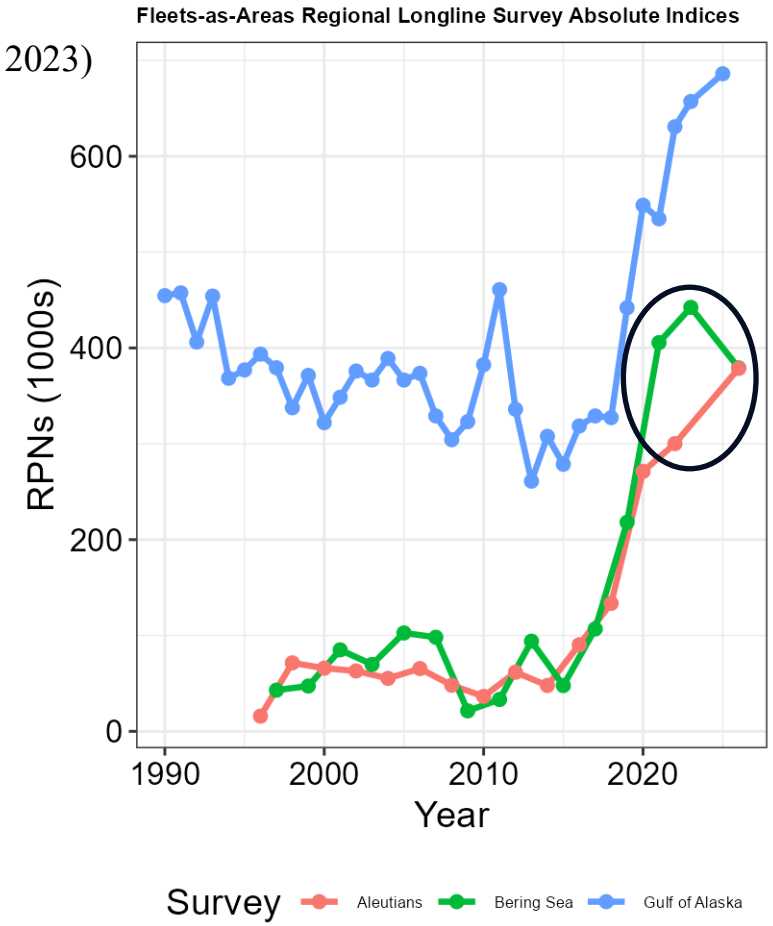


Data Summary



- New data since 2024 in bold; removed data ~~crossed out~~
  - Model *25.12* removed: trawl survey and lengths for data/years with ages
  - 2026 models removed: CPUE and historical lengths (kept for JPN LLS or trawl fishery)
- Whale depredation by area held constant at 2022 levels
- Growth and weight-at-age estimates updated with LLS data through 2025

Source	Data	Years
Fixed Gear Fisheries	Catch	1960 – **2025+2026**
Trawl Fisheries	Catch	1960 – **2025+2026**
Non-Commercial Catch	Catch	1977 – **2025+2026**
~~Japanese Longline Fishery~~	~~Catch-per-Unit-Effort (CPUE)~~	~~1964 – 1981~~
U.S. Fixed Gear Fisheries	~~CPUE~~	~~1990 – 2022~~
	~~Length~~	~~1999 – **2023**~~
	Age	1999 – **2024+2025**
U.S. Trawl Fisheries	Length	1990,1991,1999, 2005 – **2024+2025**
Japan-U.S. Cooperative Longline Survey	RPNs, Length	1979 - 1994
	Age	1981, 1985, 1987, 1989, 1991, 1993
AI NOAA Domestic Longline Survey	RPNs, ~~Length~~	1996 – 2022 (even years), **2026**
	Age	1996 – 2022 (even years)
BS NOAA Domestic Longline Survey	RPNs, ~~Length~~	1997 – 2023 (odd years), **2026**
	Age	1997 – 2023 (odd years)
GOA NOAA Domestic Longline Survey	RPNs, ~~Length~~	1990 – 2023, **2025**
	Age	1996 – 2023, **2025**
~~NOAA GOA Trawl Survey~~	~~Biomass index~~	~~1990, 1993, 1996, 1999, 2003 – 2023 (odd years)~~
	~~Lengths~~	~~1990, 1993, 1996, 1999, 2003 – 2023 (odd years)~~

Model Changes Since 2024

- Changes from the 2024 Model *23.5*, included (data changes noted in previous slide):
  - Transitioning to the SPoRC stock assessment package (reviewed in Model *25.12*).
  - Removing legacy coding errors and implementing appropriate likelihood functions (reviewed in Model *25.12*).
  - Removing all selectivity parameter linkages (reviewed in Model *25.12*).
  - Updating the selectivity parameter priors.
  - Removing the fixed gear fishery early/pre-IFQ (1960 -- 1994) time block to improve stability.
  - Updating the *M* prior to be more biologically realistic: $\sim N(\ln(0.085), 0.1^2)$ (reviewed in Model *25.12*).
  - Estimating sex-specific *M* (reviewed in Model *25.12*).
  - Assuming logistic selectivity for the trawl fishery (instead of domed) to account for bimodal distribution and catch of large/old fish.
  - Moving to the spatially-implicit FAA structure where the NOAA Longline Survey was disaggregated into three regional fleets (BS, AI, and GOA)

General Model Structure

- *All data updated through 2026*
- Single region (AK-wide)
- Sex-specific (males and females) dynamics:
  - Growth (size-age transition)
  - Selectivity
  - Natural Mortality (*M*)
  - 50:50 recruitment sex ratio
- Start year 1960
- Age structured (SCAA), projecting forward from initial ages and recruitment at age-2
- Assume yearly deviations from average recruitment
- Each fleet (fishery and survey) has independent, sex-specific selectivity **(and regional LLS selectivity for the FAA model)**
- Fishing mortality (*F*) estimated with yearly deviations for each fleet (fixed gear and trawl)
- Catchability (*q*) parameters freely estimated for each index (NOAA and Japanese LLS) and **regionally for the FAA model**

Parameter Name	*25.12_1Reg_Cont*	*26.1_1Reg*	*26.2_FAA*	*26.2_FAA_3LLF_LLS_BS_Dome_DN*
Catchability	5	2	4	4
Mean recruitment	1	1	1	1
Natural Mortality	1	2	2	2
Initial Deviations	28	28	28	28
Recruitment Deviations	66	66	66	66
Mean Fishing Mortality	2	2	2	4
Fishing Mortality Deviations	131	131	131	262
Fishery Selectivity	14	12	12	18
Survey Selectivity	11	12	28	32
Total	259	256	274	417

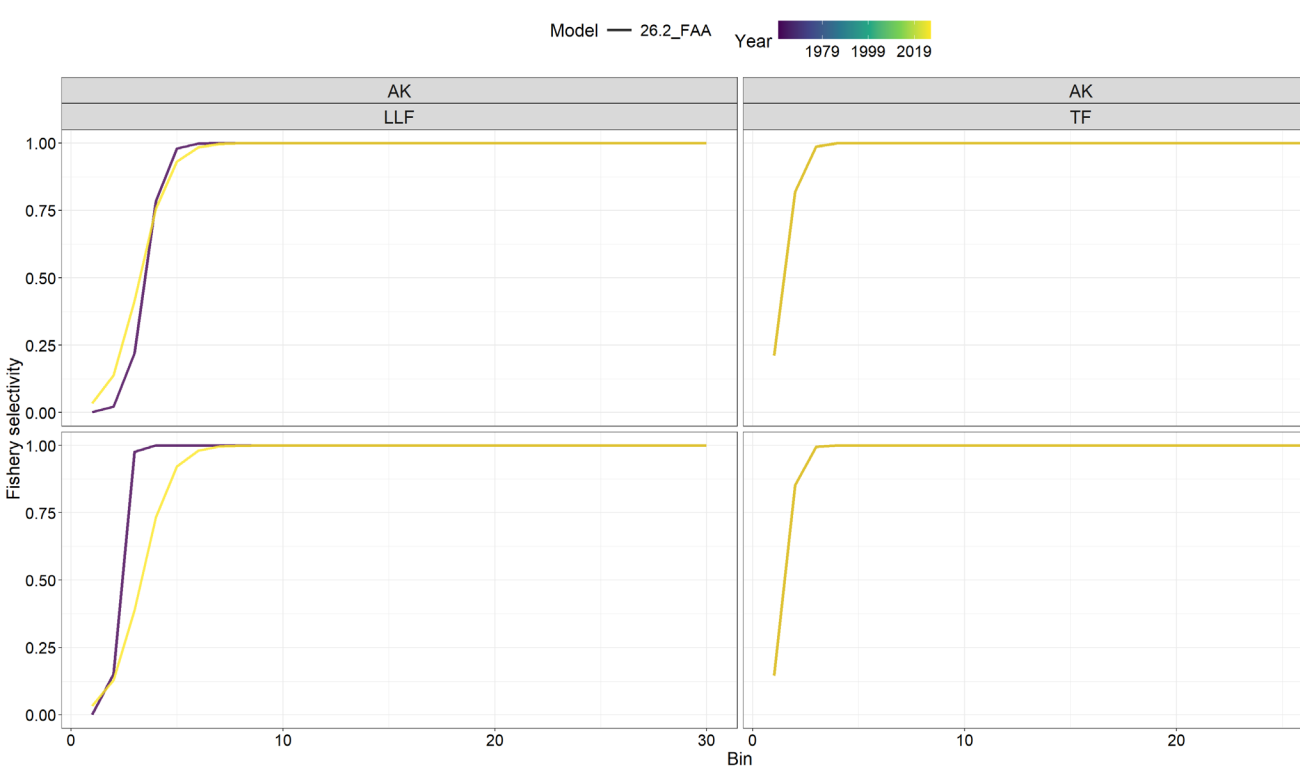
Francis Reweighting and Effective Sample Size

- SE higher for BS and AI surveys
- Composition (age/length) Input Sample Sizes (ISS) scaled within fleets relative to observed yearly samples
  - For FAA model, scaling of NOAA LLS ISS was across regions to maintain information on relative sample sizes across regions
- ESS determined from Francis reweighting
- Strong downweighting of fishery age comps
- For FAA, AI LLS age comps upweighted
  - Better agreement with indices?
  - Intermediary between BS and GOA comps?

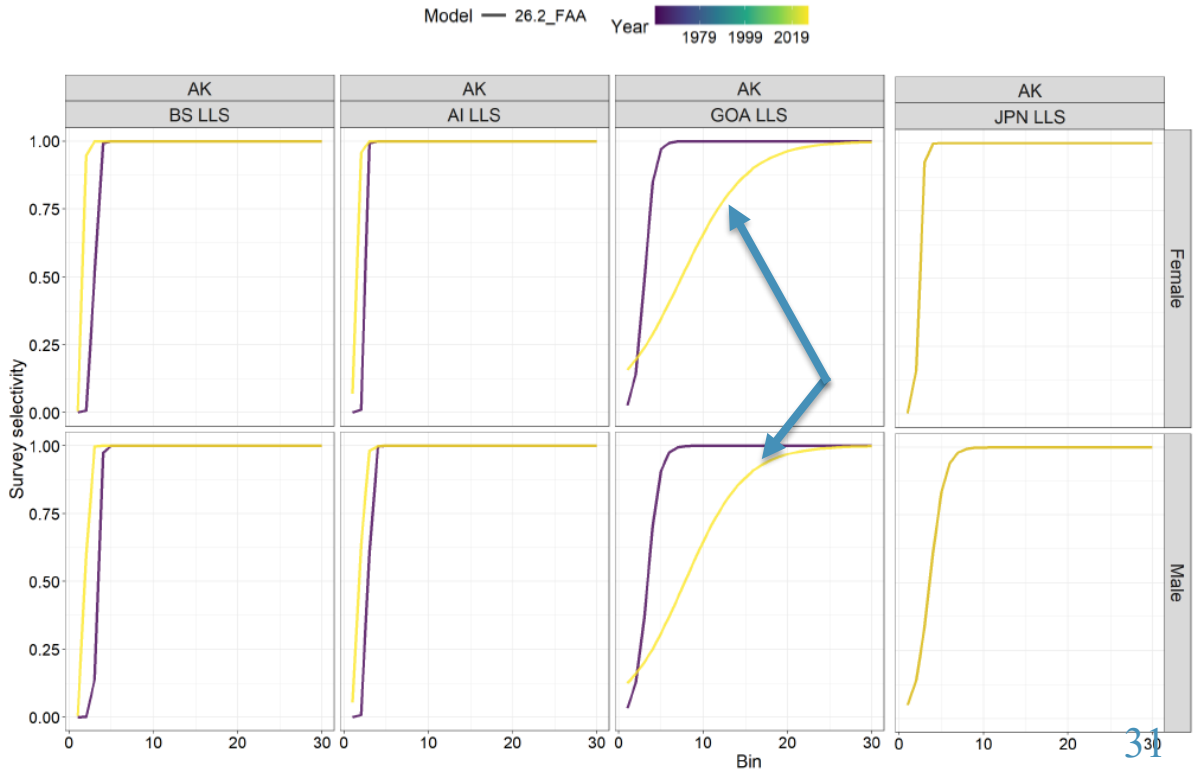
Data Source	*26.2_FAA*			
	SE	Data Wt	ISS	ESS
Fixed Gear Catch	0.05	--	--	--
Trawl Catch	0.05	--	--	--
NOAA Longline Survey RPN BS	0.2	1	-	-
NOAA Longline Survey RPN AI	0.23	1	-	-
NOAA Longline Survey RPN GOA	0.08	1	-	-
Japanese Longline Survey RPN	0.07	1	-	-
Fixed Gear Age Composition	-	0.04	142.85	5.86
NOAA Longline Survey Age Composition BS	-	0.62	34.07	20.96
NOAA Longline Survey Age Composition AI	-	2.01	35.57	71.37
NOAA Longline Survey Age Composition GOA	-	0.36	67.17	24.5
Japanese Longline Survey Age Composition	-	0.2	83.33	16.3
Japanese Longline Survey Size Composition	-	0.32	54.62	17.35
Trawl Fishery Size Composition	-	0.09	47.62	4.16

Model Estimates: Selectivity

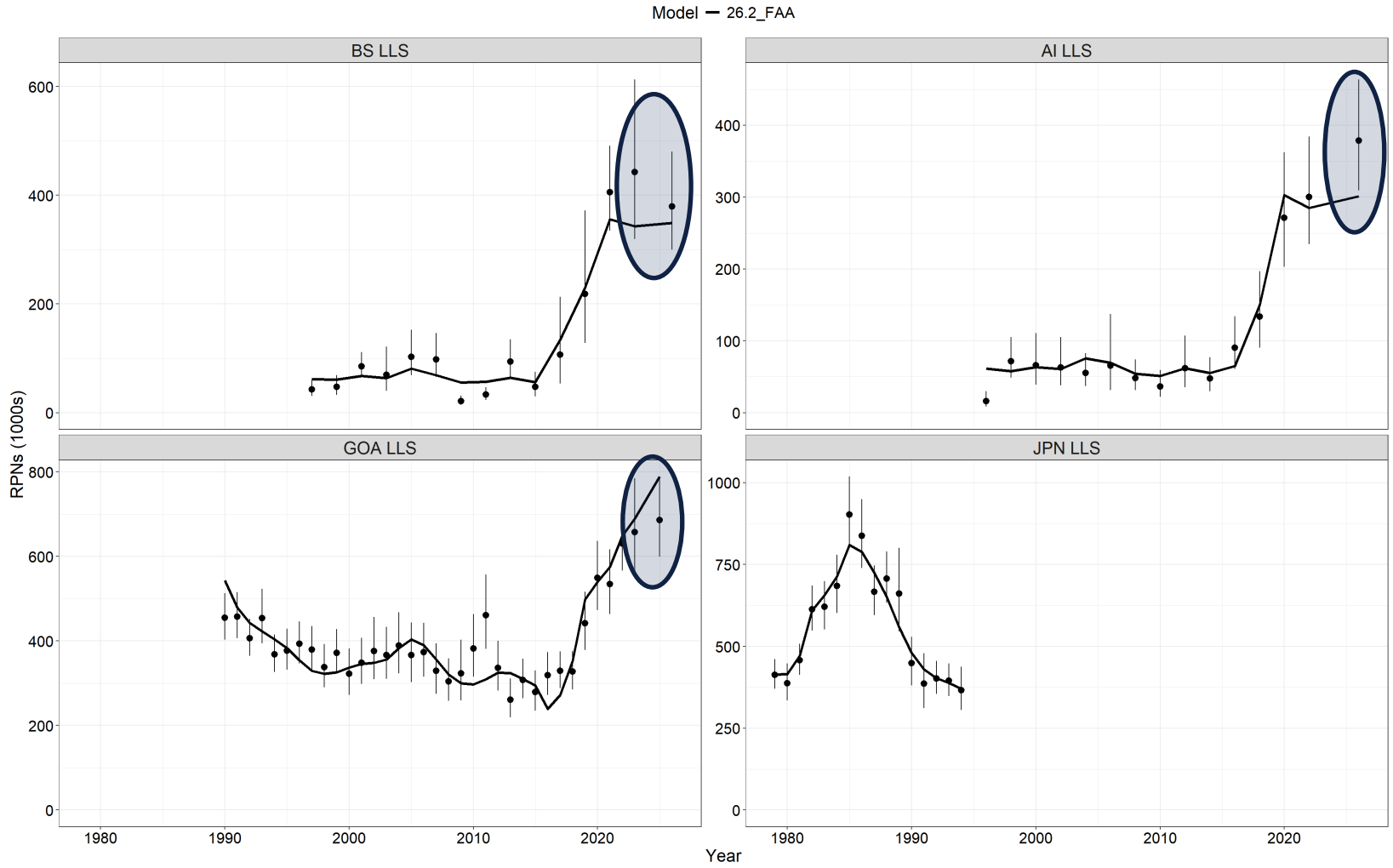
Fishery



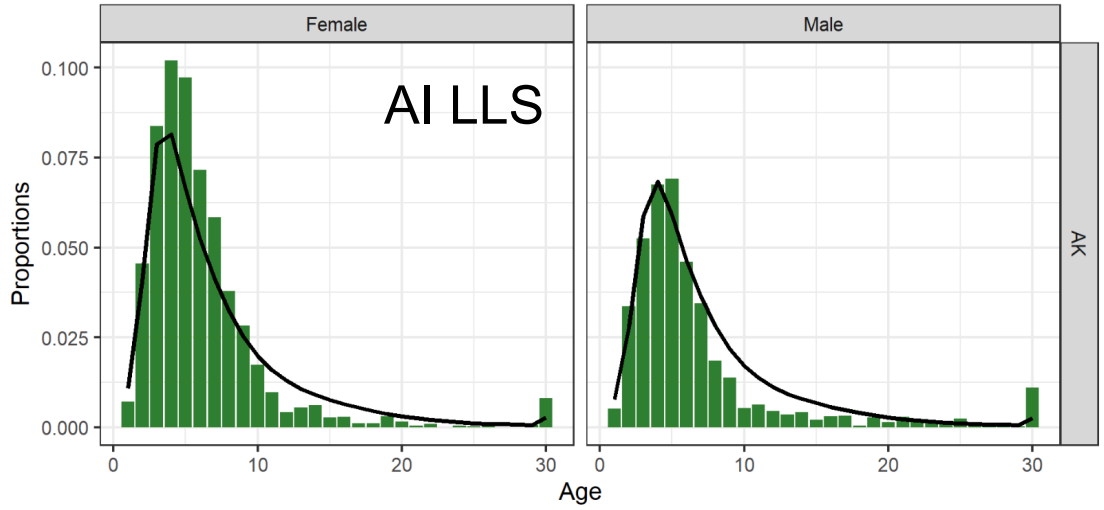
Survey

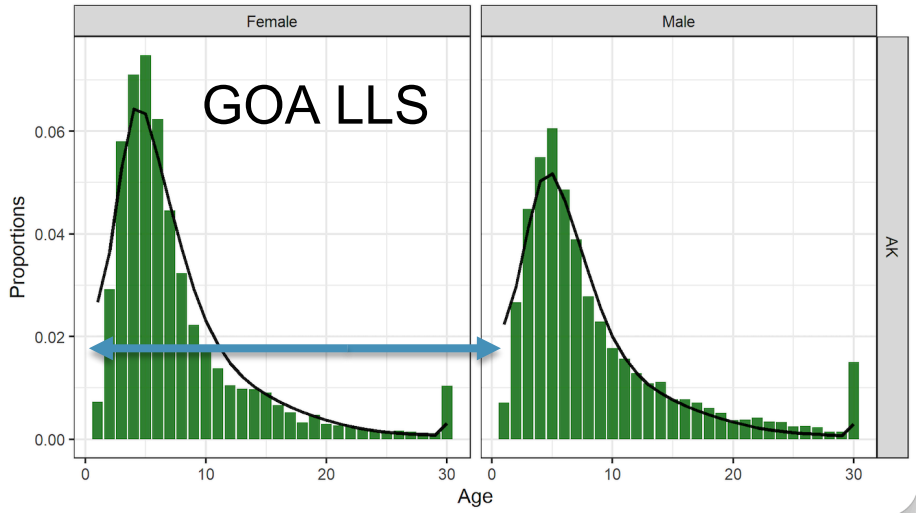


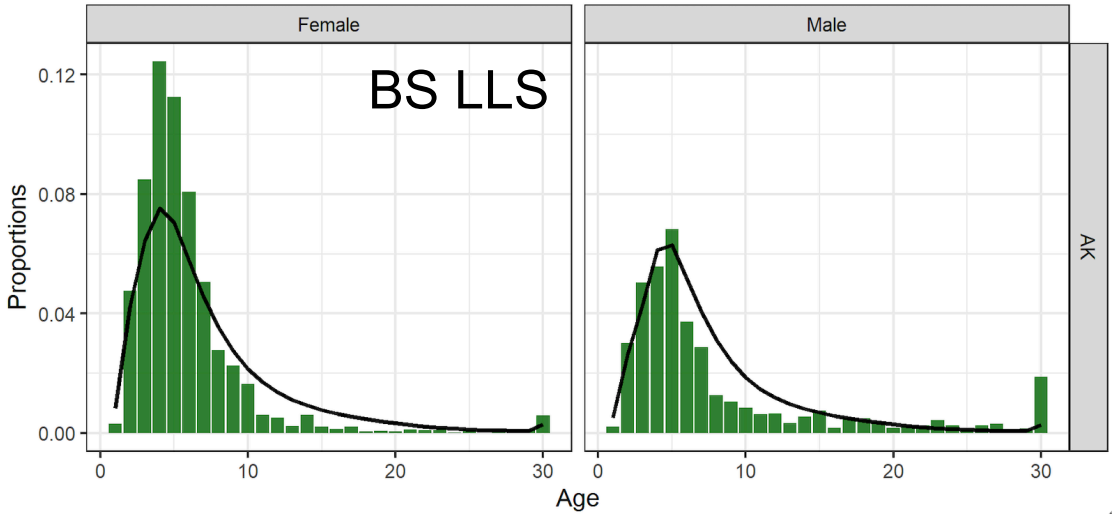
Fit to Indices

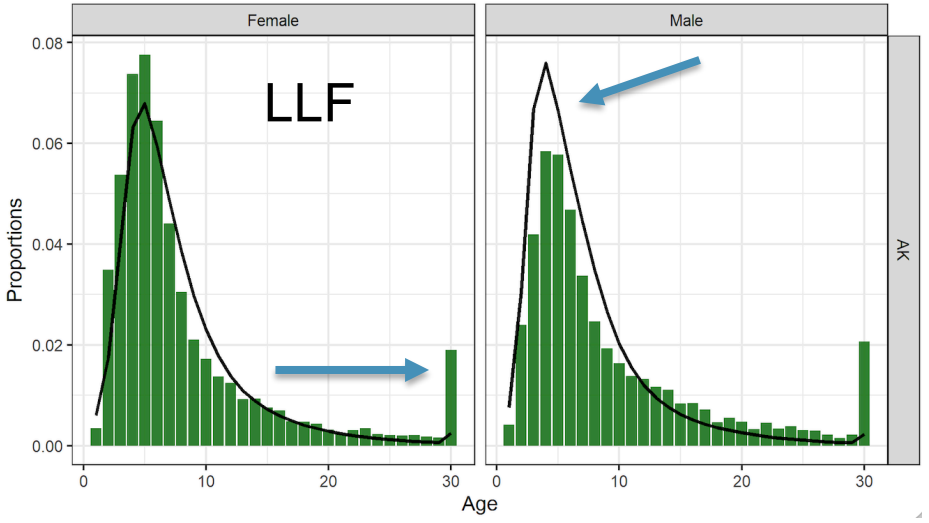


Fit to Compositional Data





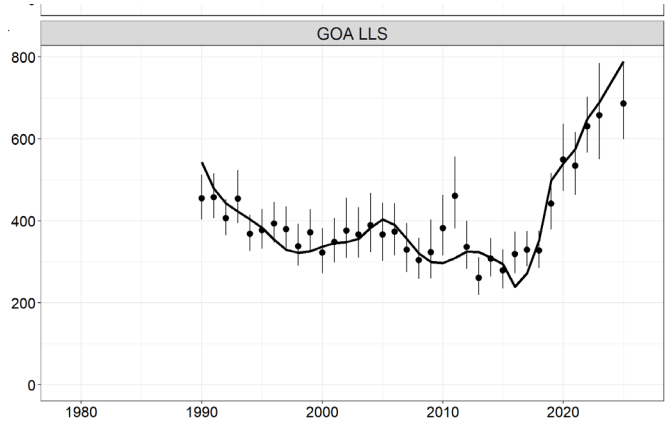


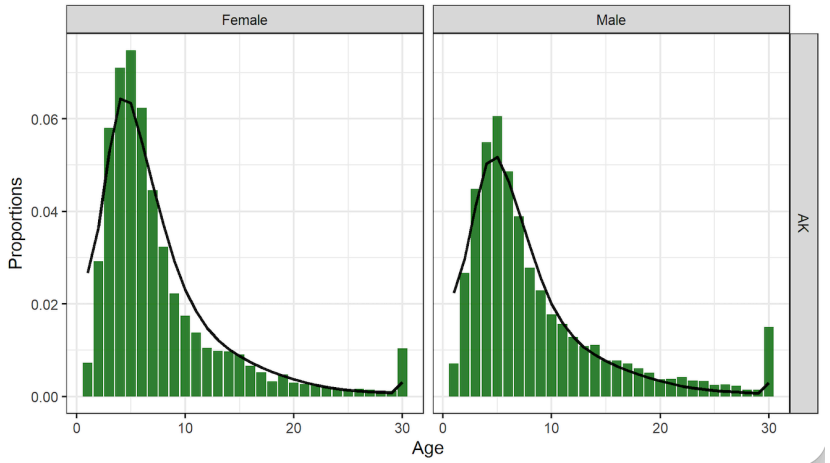


Regional Age vs. Index Tension

- Longstanding issue of simultaneously fitting NOAA Longline Survey indices and age compositions
  - Indices emphasized over compositions due to the Francis reweighting
- Model demonstrates regional tradeoffs in data fits:
  - In the GOA, age compositions suggest more rapid growth than the index
  - In the BS and AI, the indices are more or less consistent with each other

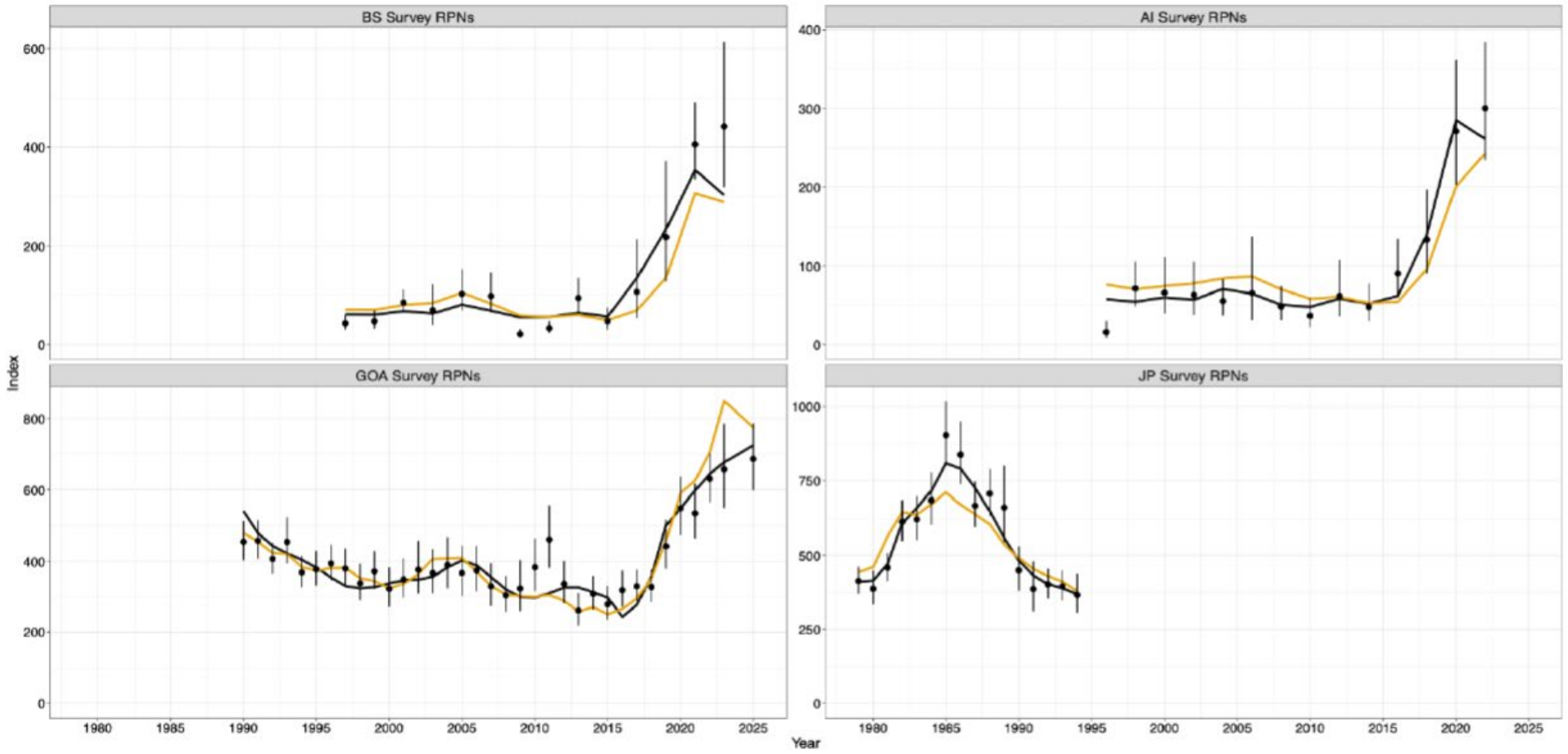
GOA





Regional Age vs. Index Tension

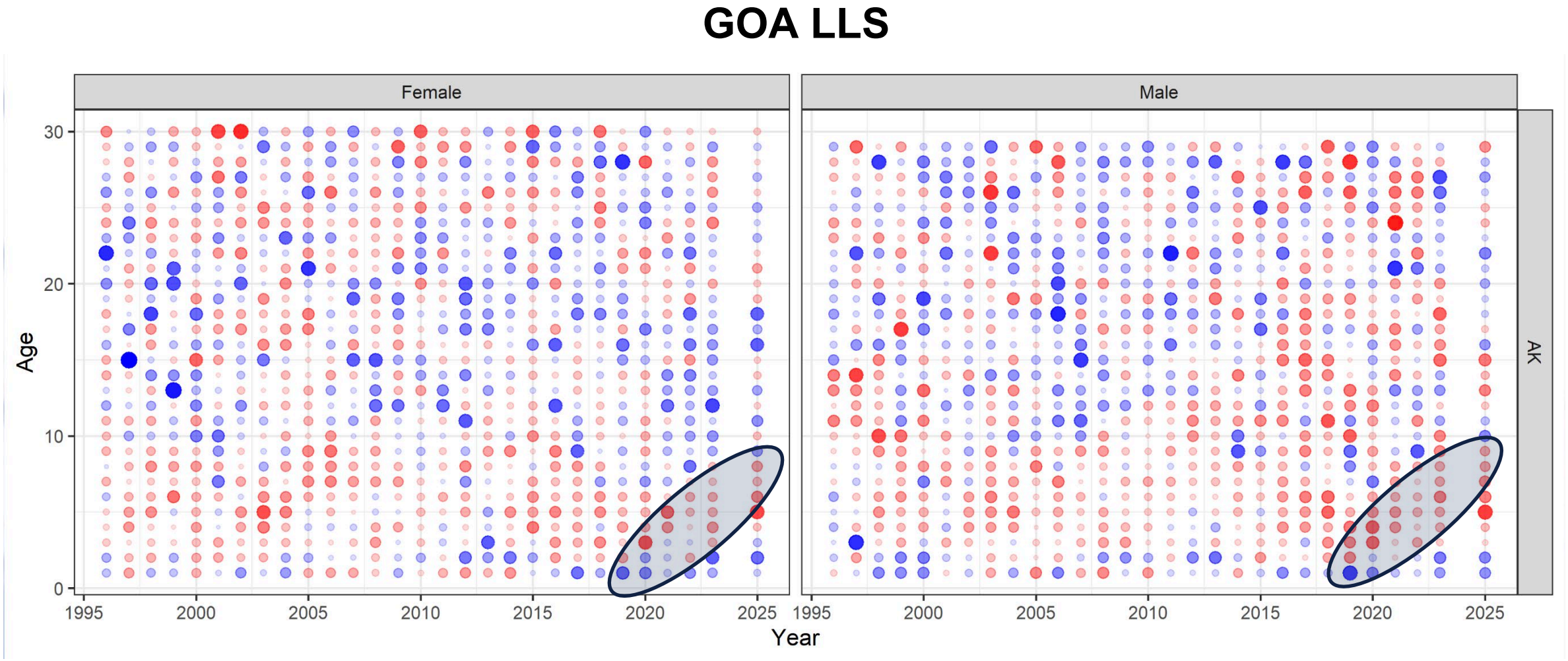
TV Survey Selex w/ Dirichlet Multinomial for Comps



Regional Age vs. Index Tension

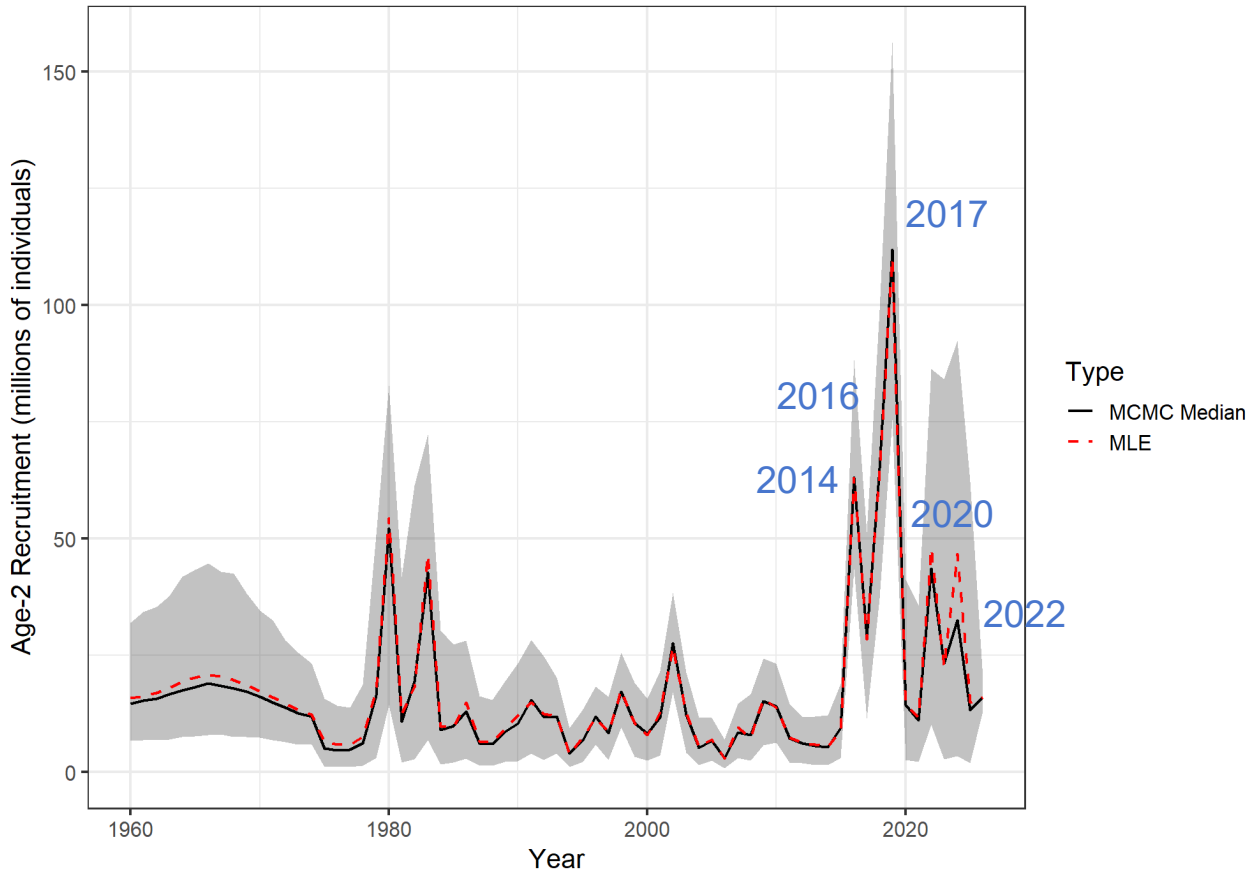
- ‘Shallow’ GOA survey selectivity is FAA model adjusting for ‘availability’
  - To fit the indices and BS/AI comps, the model must assume lower availability of < 20-year-old fish in the GOA
- **Data conflict is a nuanced regional divergence and not just a simple AK-wide issue** (as previously thought when using single region models)
  - Simulation testing showed that age composition availability drives potential SSB bias
  - Model tension likely driven by age composition sparsity and data availability across regions/years
- Fundamentally need more ages and better spatial representation
- Spatial could help by explicitly modeling the underlying spatial drivers of data conflicts, but still limited by available data

Residual Patterns



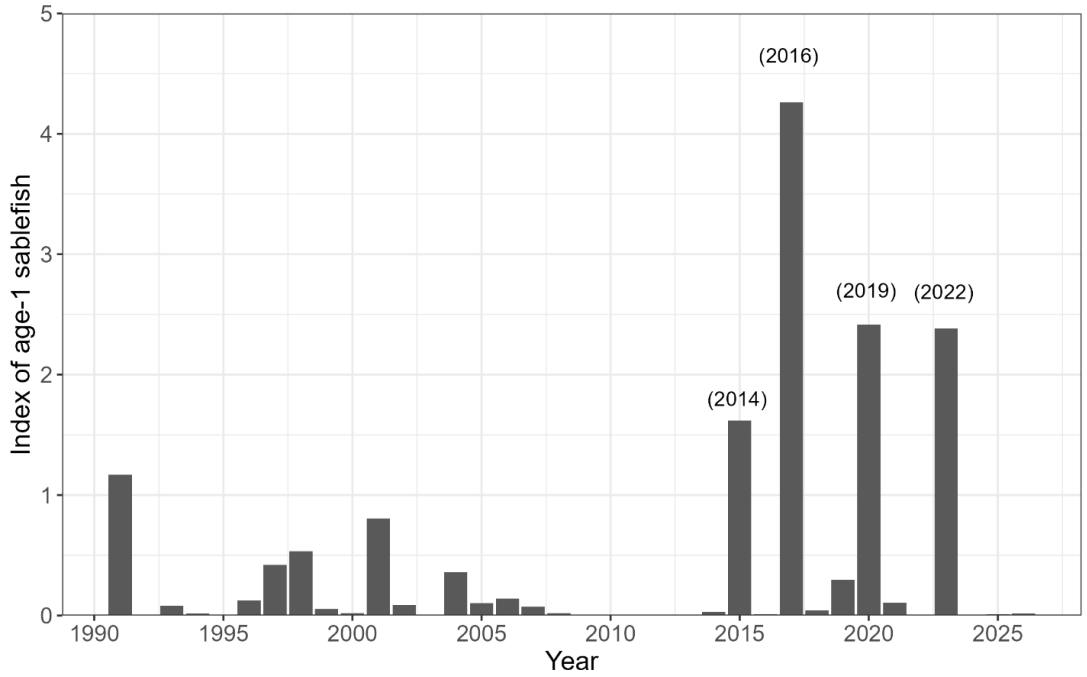
Recruitment

- 2017 year class appears to be largest on record, with 2016 second largest and 2014 the third largest
- Current series of recruitment emulates late 1970s, but at much higher magnitude
- Recent recruitment has returned to more average conditions
- But, 2020 and 2022 year classes appear to be above average



EBS Trawl Catch and Recruitment Signals

- Initial observations from EBS trawl catch indicate recent year classes likely to be nearer to long term average levels
- 2022 year class above average based on 2023 EBS trawl catch (and supported by 2025 LLS age compositions)



Sablefish in Eastern Bering Sea Trawl Fisheries Working Paper

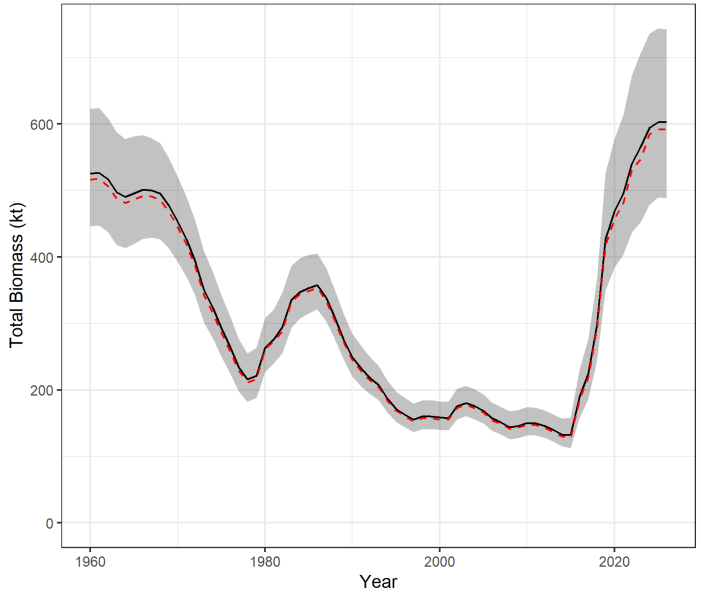
Kevin A. Siwicke and Katy B. Echave

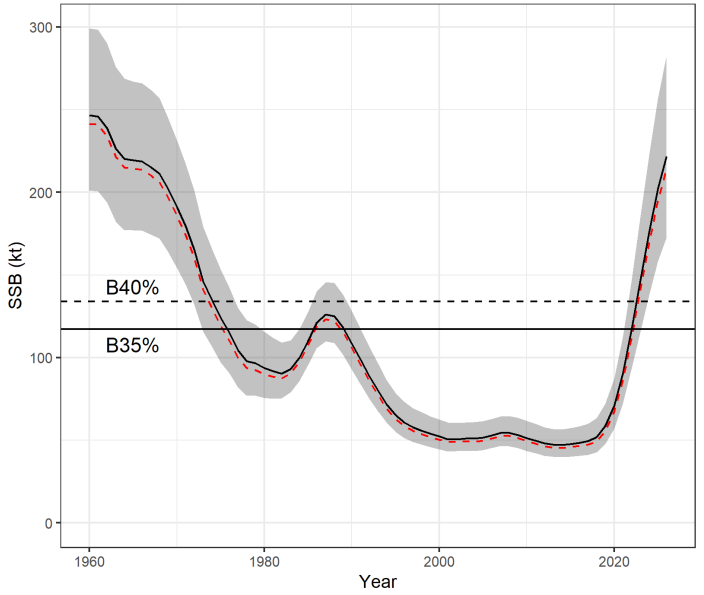
November 2026

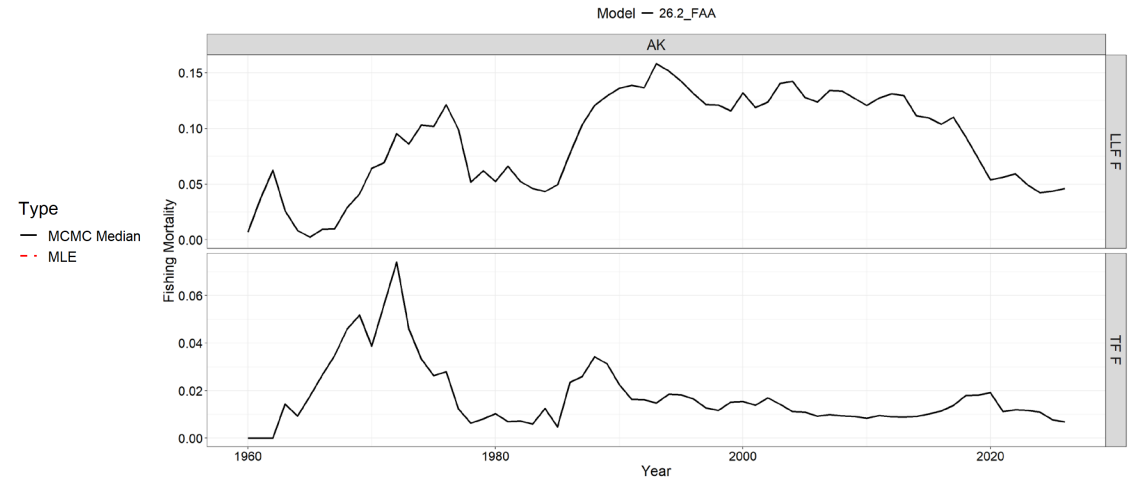
Biomass and Fishing Mortality



- Biomass has levelled off, but SSB continues increasing rapidly
- At $B_{64\%}$ in 2026
- Projected to be at $B_{68\%}$ in 2027
- Fishing mortality remains at low levels ($< F_{ABC}$)

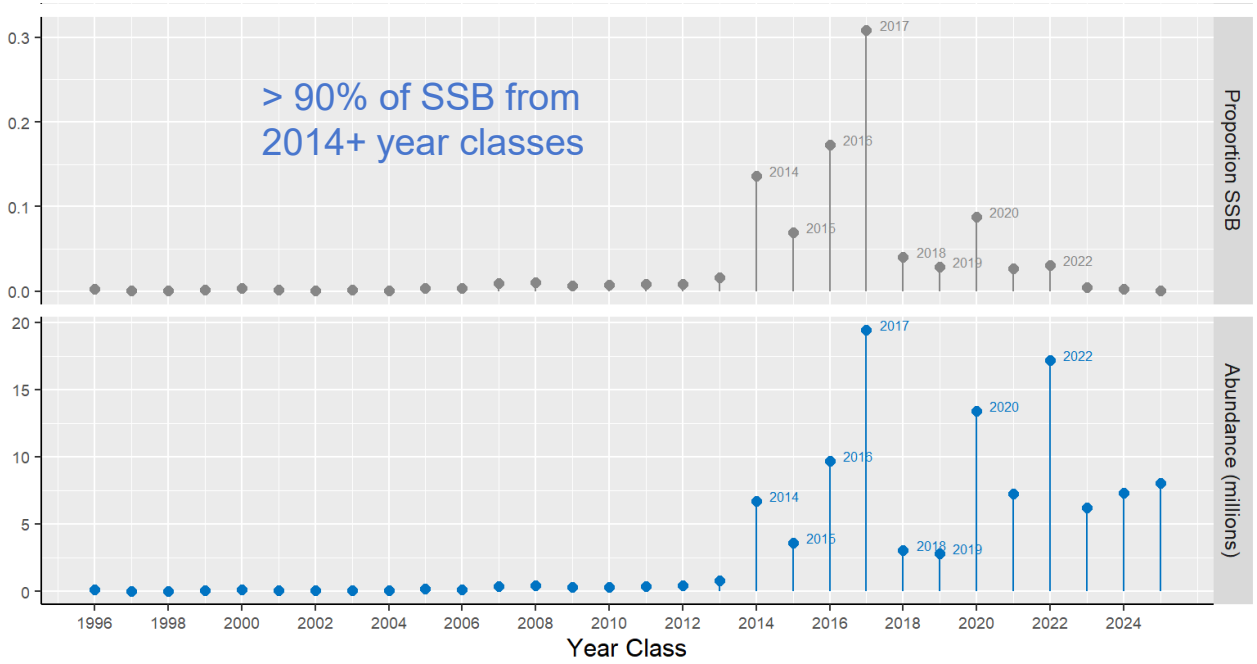


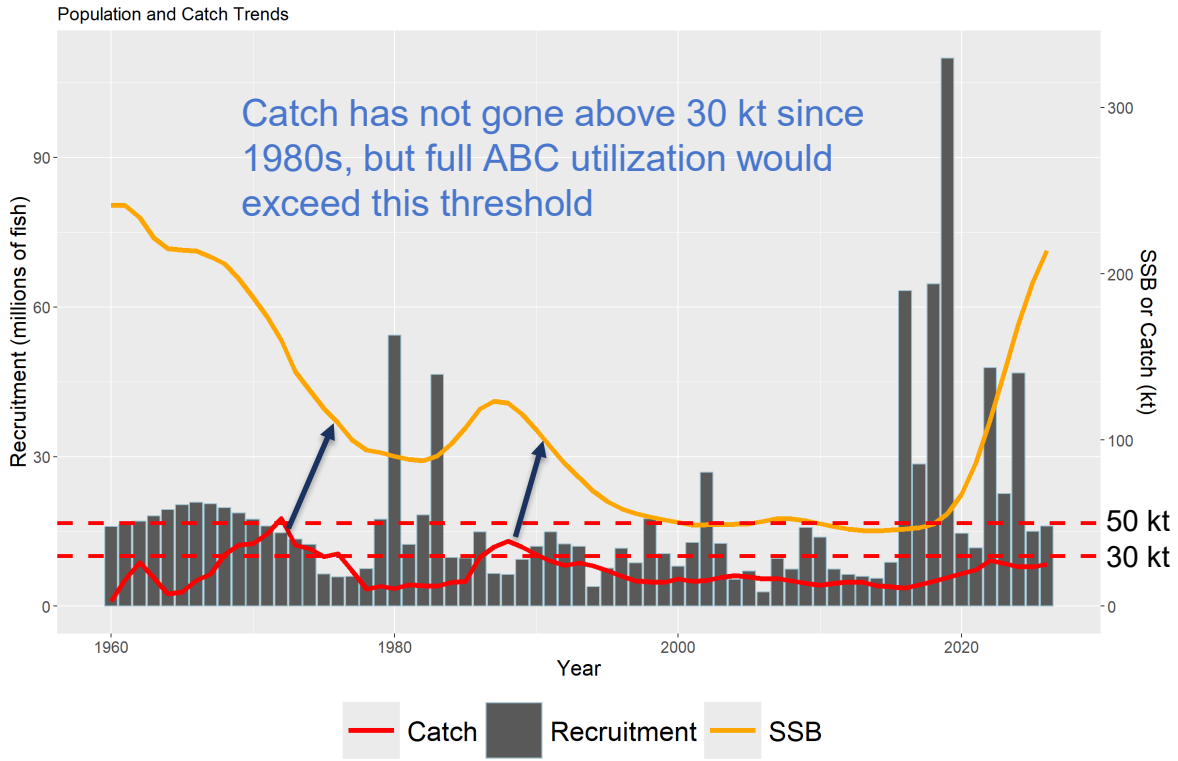




Alternate Metrics

- Age diversity contributing to SSB: robustness of the age structure
- Years with catch > 30 kt: associated with population declines when recruitment returns to long-term mean

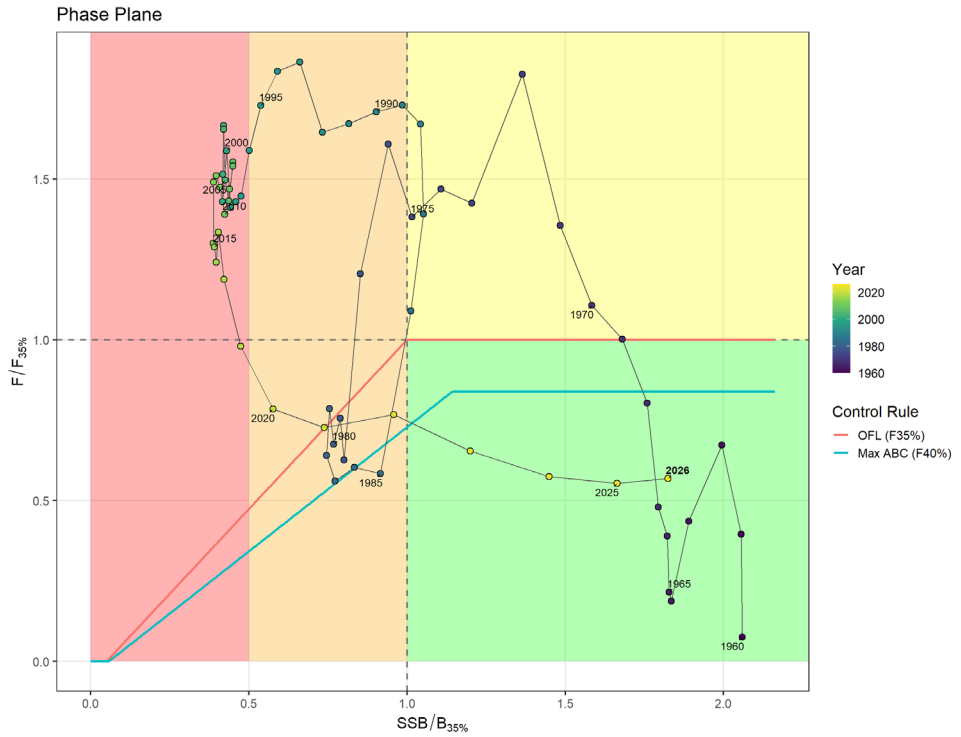




Phase Plane

- Catch was likely too high in much of the 2000s, and biomass may have declined below the minimum stock size threshold (MSST)
- Population rebounded quickly with recent high recruitment (and low ABC utilization)

Based on Current $B_{40\%}$



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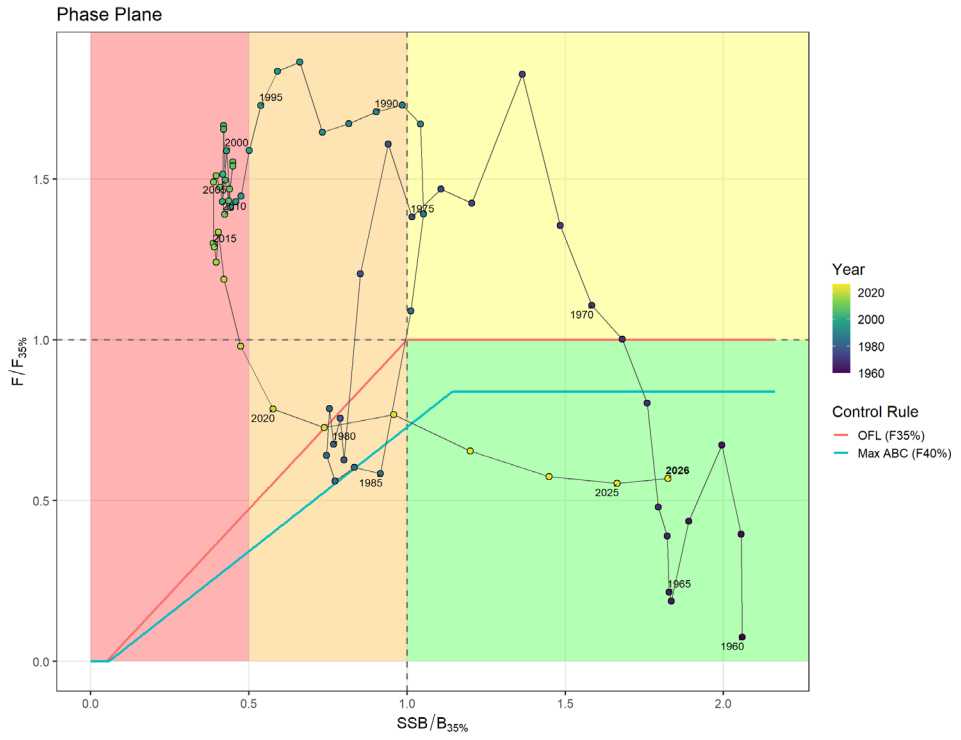
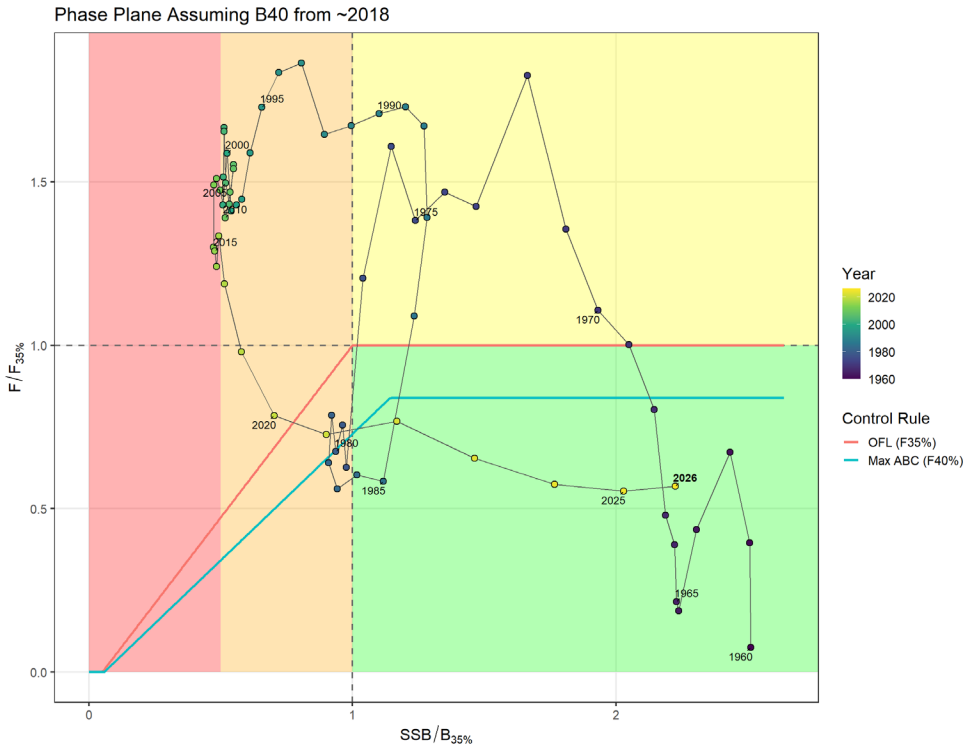
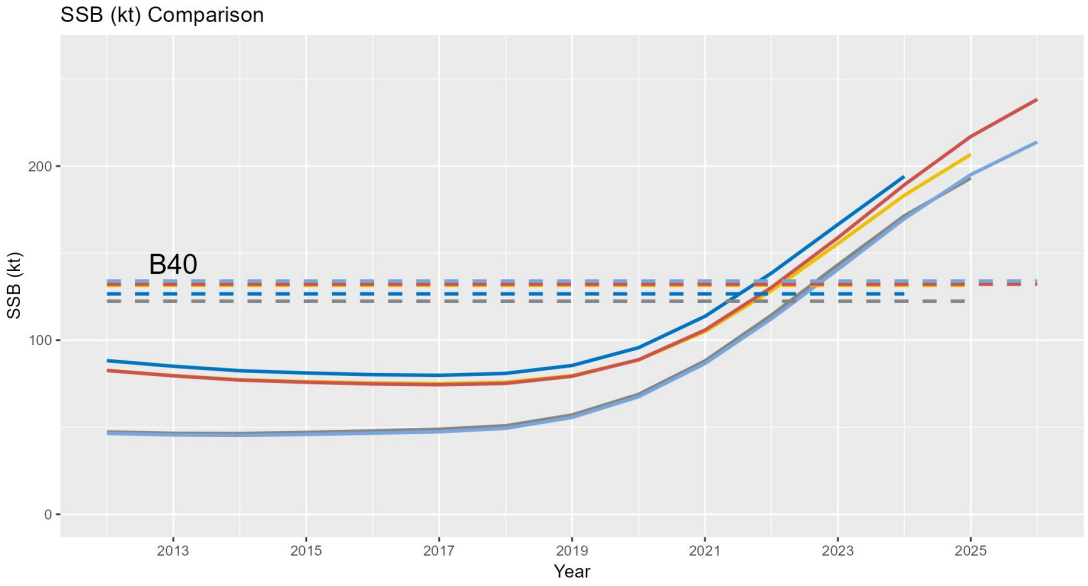


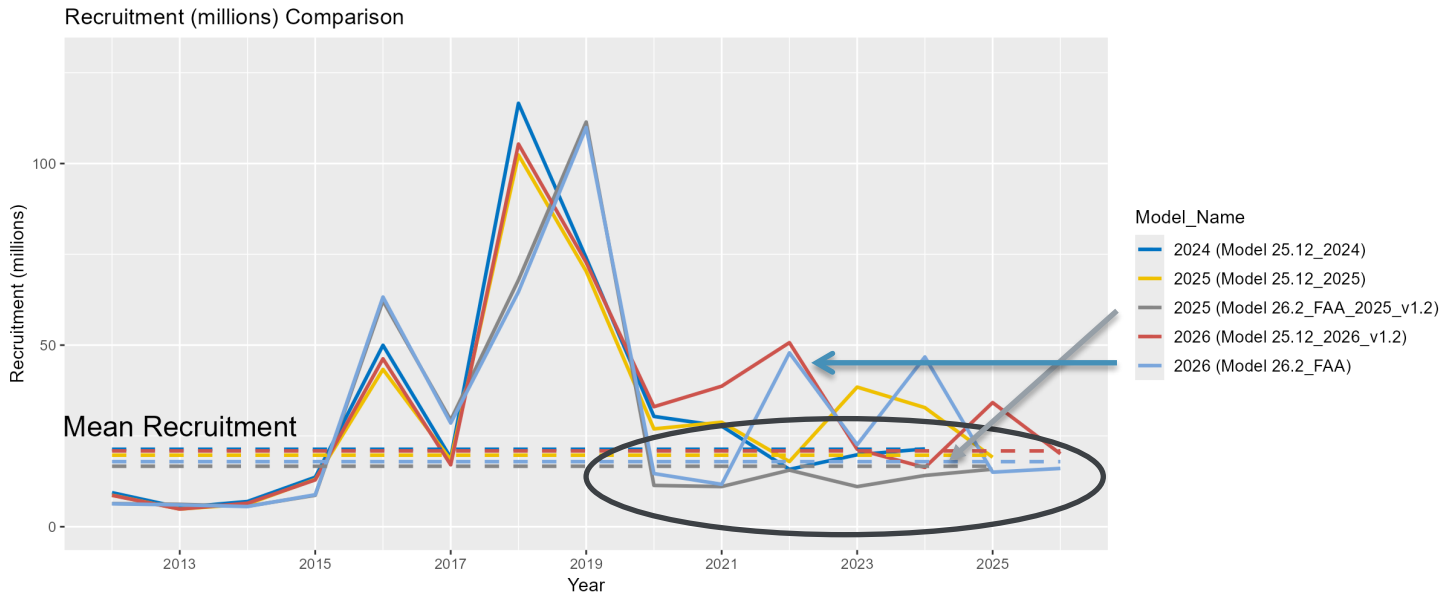


Based on $B_{40\%}$ In 2018

Model Bridging

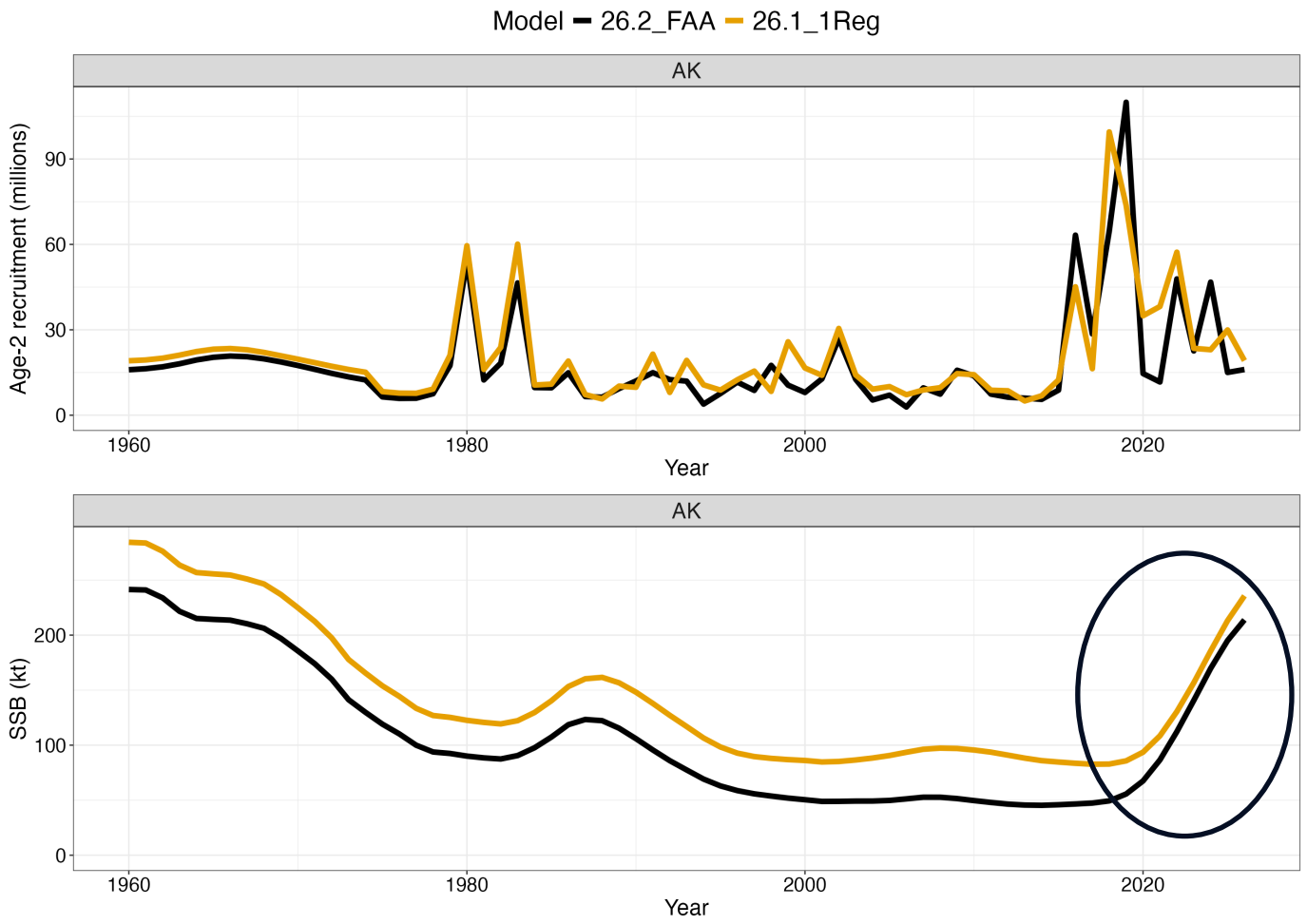
- Downward population scaling from Model *25.12* to Model *26.2_FAA* due to survey data treatment
- Model *26.2_FAA* is more consistent with itself over time
- Clear influence of addition of 2025 LLS age compositions between 2025 and 2026 models





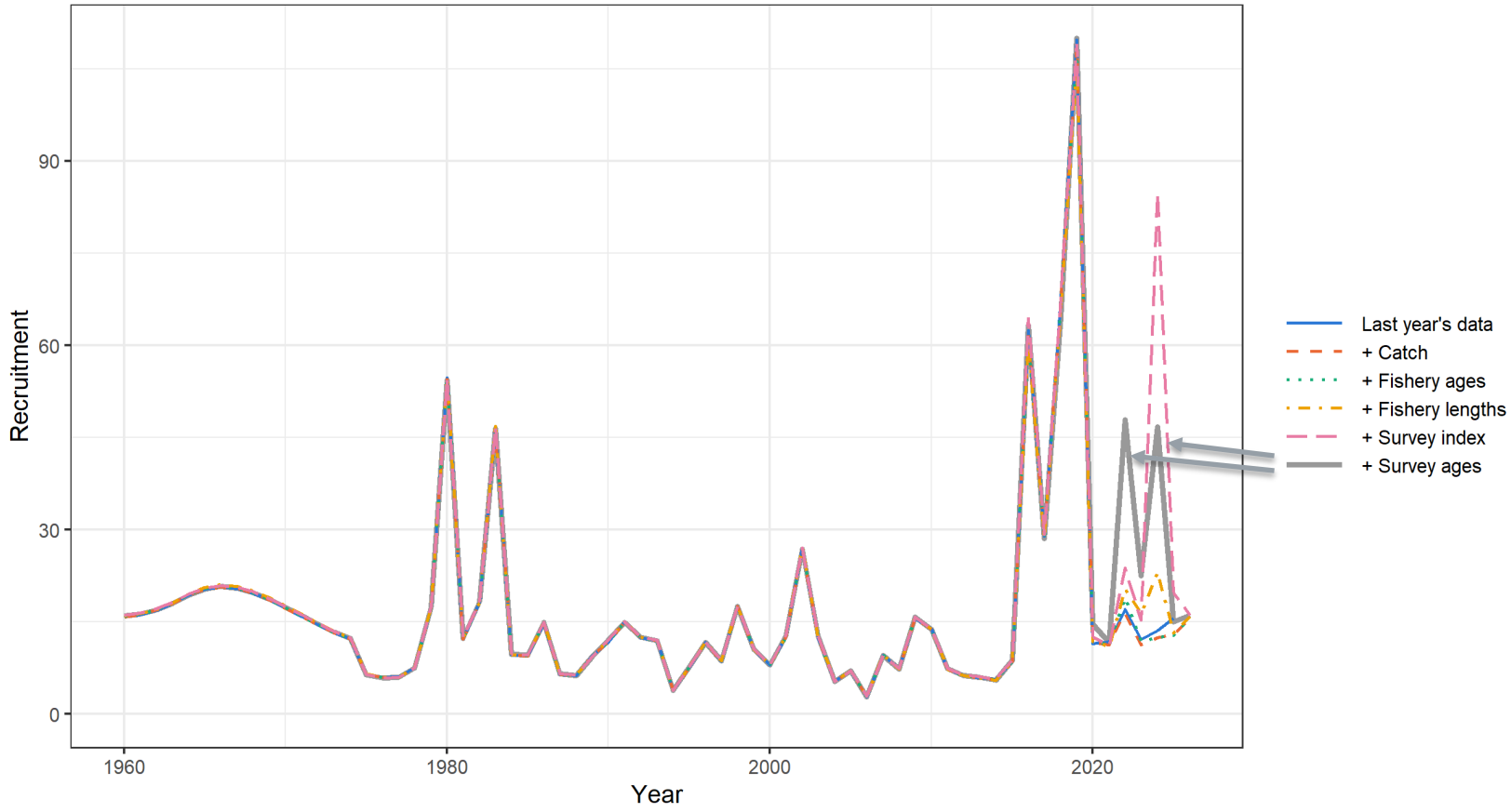
Comparison to Model *26.1_1Reg*

- Lower population scale than single region model
  - Model *26.1_1Reg* over-weights / represents GOA age composition data
  - Simulation work demonstrates this leads to overestimation of SSB
- Increases in abundance are more rapid
  - Model *26.2_FAA* estimates larger 2014 and 2017 year classes, leading to more rapid increases (almost fully mature cohorts)



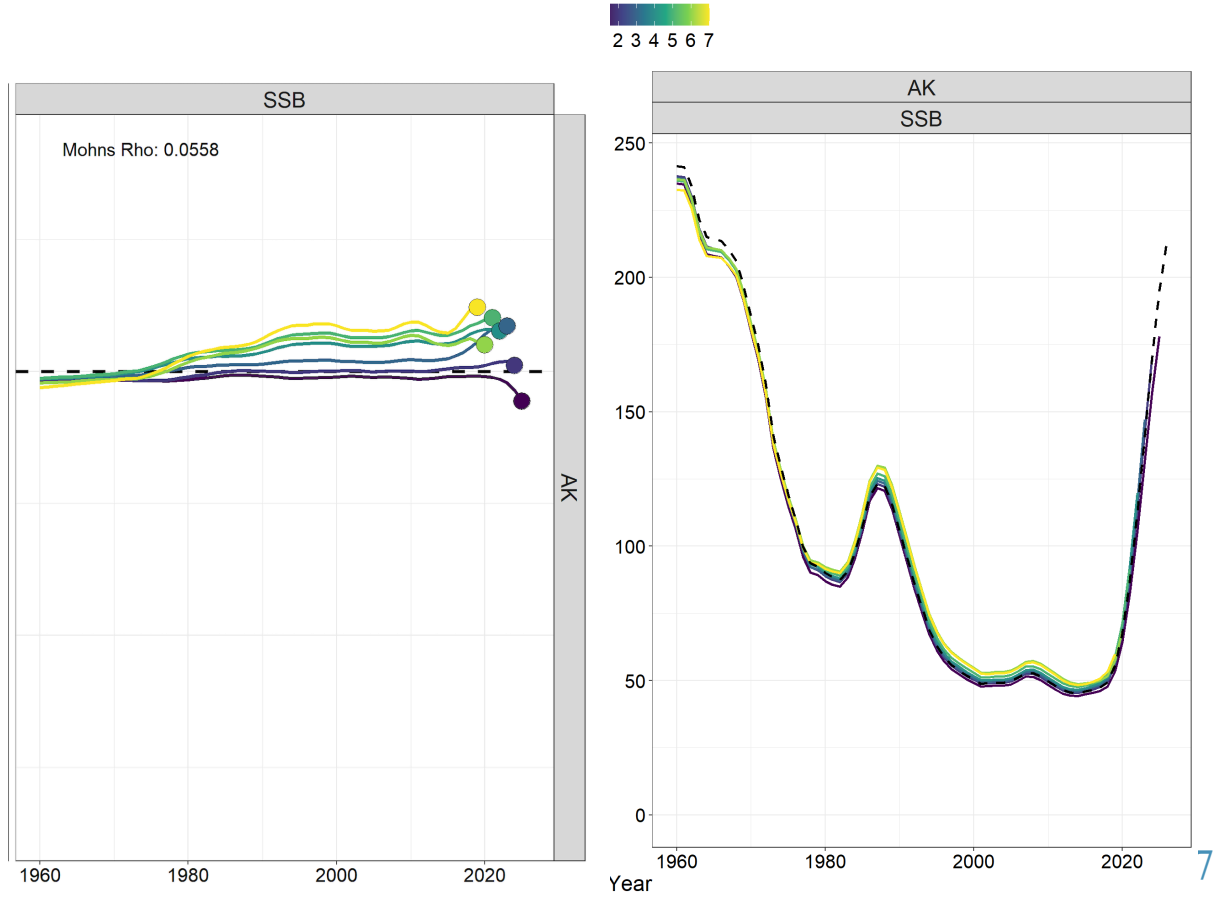
Data Addition

- LLS age compositions have largest impact on recent recruitment estimates
- Loss of 2024 LLS led to 2025 model reverting to mean recruitment for recent years
- Has direct impact on ABC projections



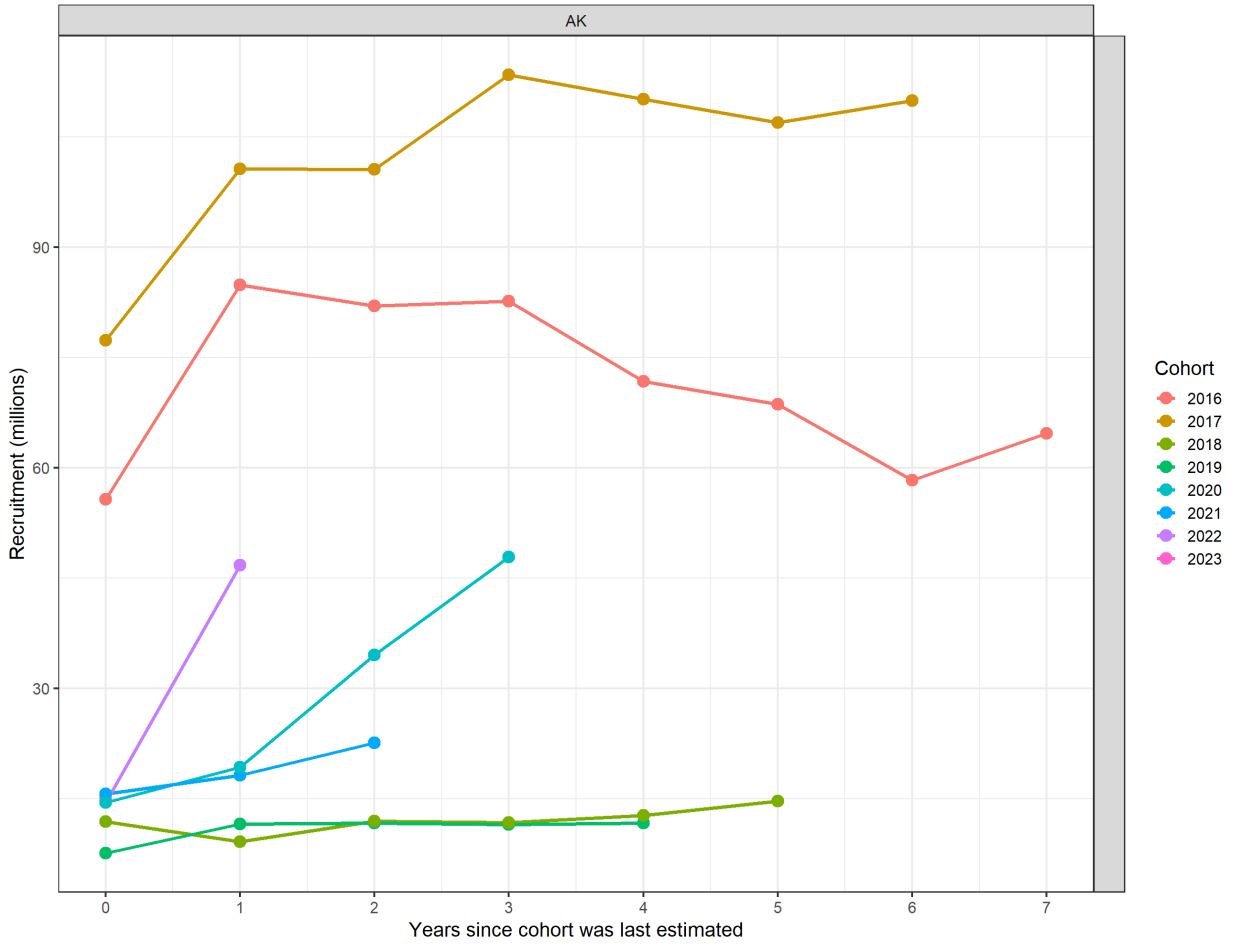
Diagnostics: Retrospective Analysis

- Limited retrospective patterns
- Slight overestimation of SSB
  - Likely due to downward revision of large recruitment events as new data accumulate



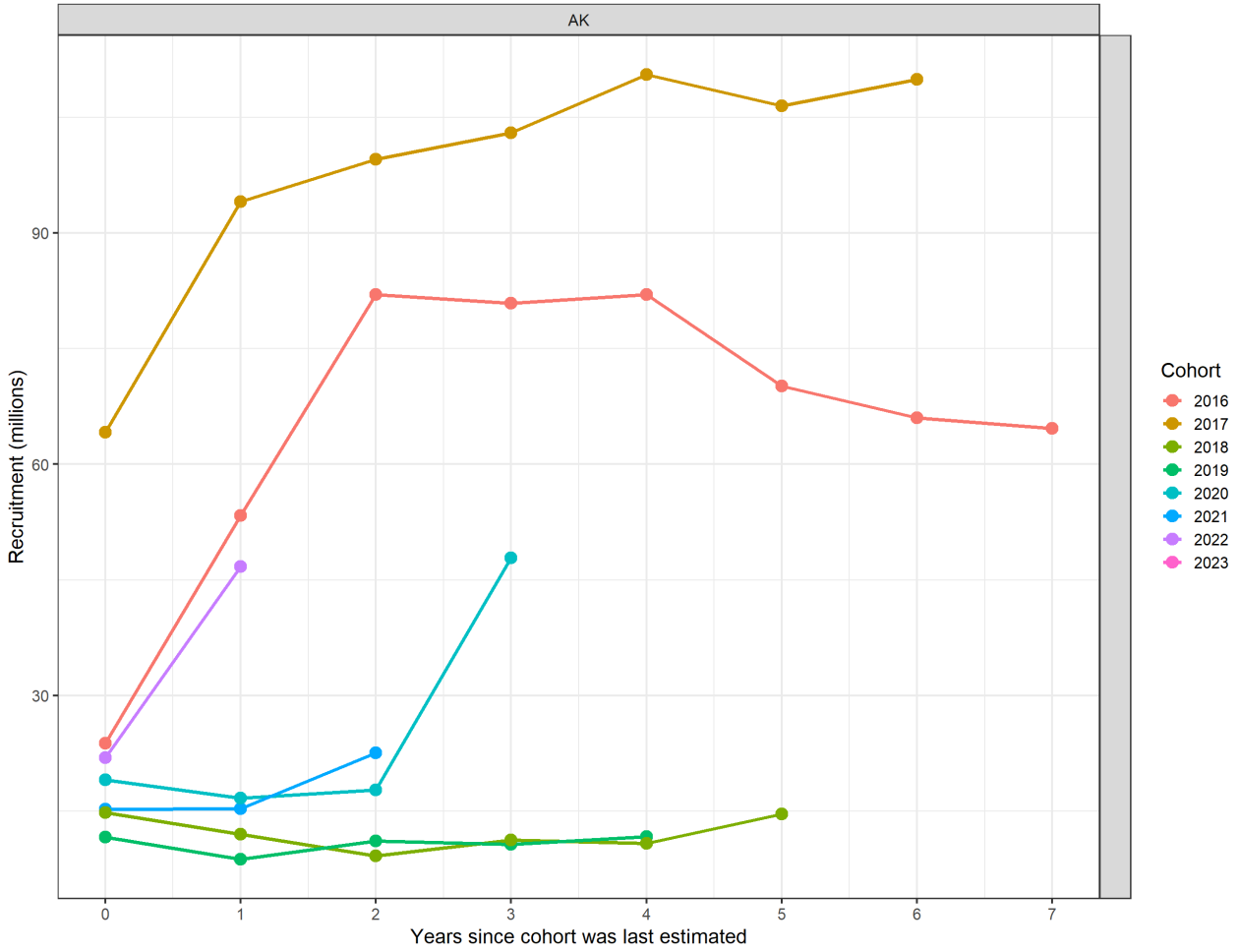
Diagnostics: Retrospective Analysis

- Limited retrospective patterns
- Slight overestimation of SSB
  - Likely due to downward revision of large recruitment events as new data accumulate
- Recruitment estimates influenced by regional sampling and revised as additional data become available
  - Omission of the BS in a year may initially underestimate recruitment for recent year classes, with estimates revised as additional data become available



Diagnostics: ‘Data Lag’ Retrospective Analysis

- Account for time lag in composition data (e.g., 1 year between collection and availability)
- Similar to normal retro, but increased uncertainty in recent recruitment



Diagnostics: Retrospective Analysis

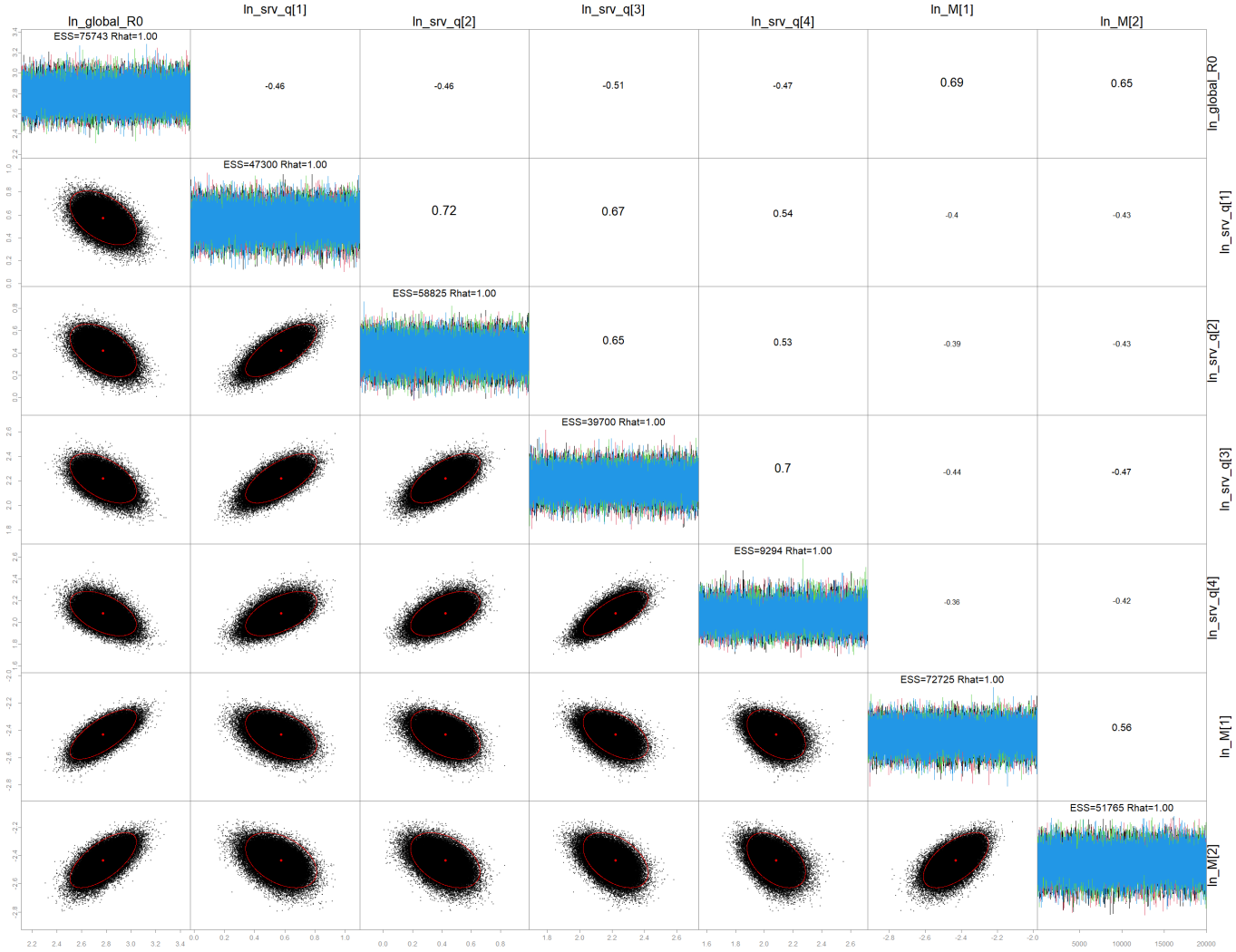
- Account for time lag in composition data (e.g., 1 year between collection and availability)
- Similar to normal retro, but increased uncertainty in recent recruitment
- Associated ABCs from retro peels revealed direct correlation to missing 2024 survey data
  - 2025 peel had average recent recruitment and decline in ABC
  - Availability of 2025 survey data increased recruitment and ABC

Terminal Year	ABC (Next Year)
2026	37.6
2025	30.2
2024	32.1
2023	33.7
2022	31.1
2021	21.9



Diagnostics: MCMC

- MLE and MCMC estimates are generally consistent for Model *26.2_FAA*
- Good MCMC diagnostics (ESS > 400 and Rhat < 1.01 for all parameters)
- By contrast, model variants using dome-shaped selectivity exhibited divergent trends in MLE and MCMC
  - Likely due to overparameterization w/ dome-shaped dynamics that is not well supported by data



Other Analyses, Sensitivity Runs, and Models Explored

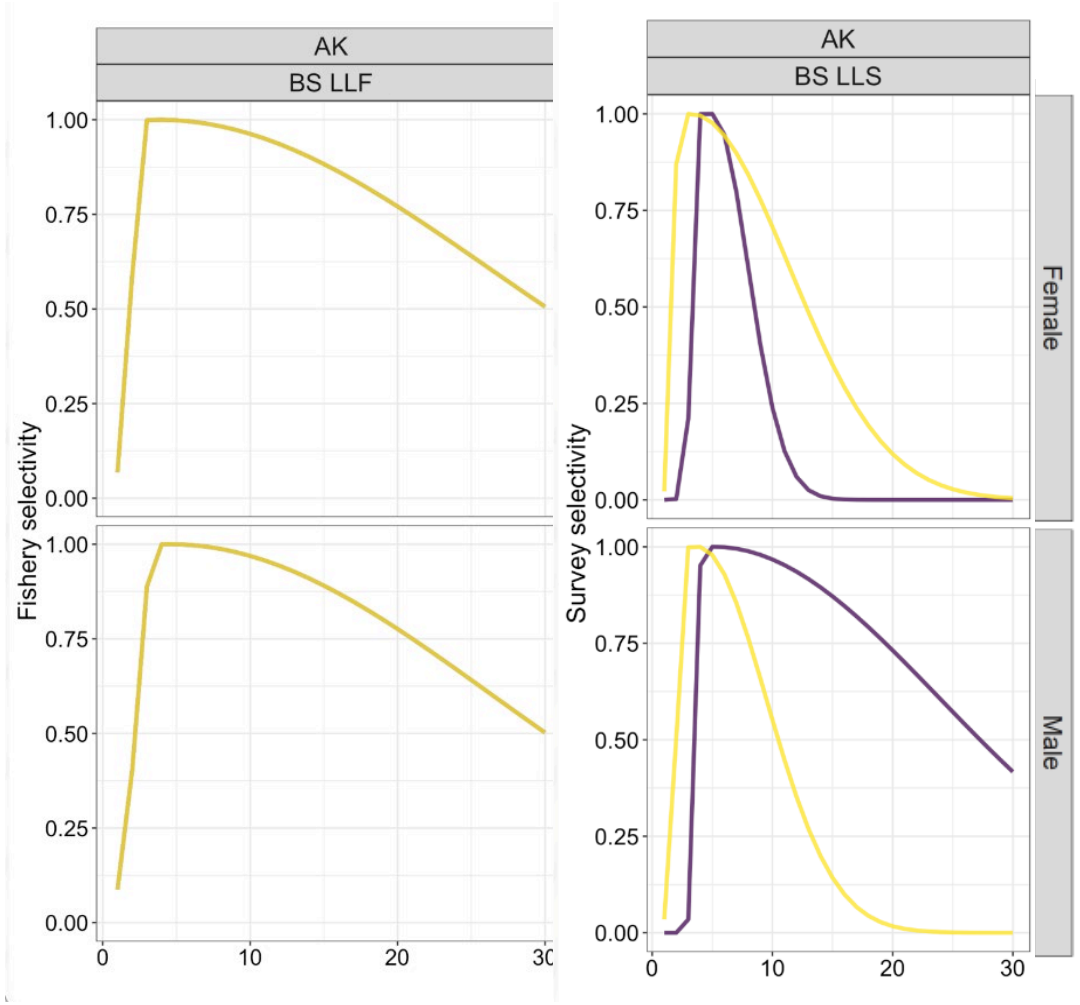
Model / Analyses	Specification and Rationale
Evaluation of FAA curves using spatial model	• Aggregate spatial model results of predicted fishery and survey at-age information to the FAA fleets and solve for selectivities that would result in the same aggregated predicted compositions • To assess assumptions of fleet structure and domed selectivity
26.2_FAA_LLS_BS_Dome_DN	• Same as *26.2_FAA* but allow for double normal selectivity in the BS survey fleet
26.2_FAA_3LLF_LLS_BS_Dome_DN	• Same as *26.2_FAA* but allow for 3 fishery fleets, and allow doming in the BS fishery and survey fleets following a 3 parameter double normal form
26.2_FAA_3LLF_LLS_BS_Dome_DN_PE_q	• Same as *26.2_FAA_3LLF_LLS_BS_Dome_DN*, but allow time-varying catchability for all survey fleets
26.2_FAA_TV_Selex_LLS	• Same as *26.2_FAA* but allow semi-parametric selectivity for survey • Primarily to understand the degree to which data support doming

Note: Also looked at Gamma selectivity, but results are similar to double normal variants



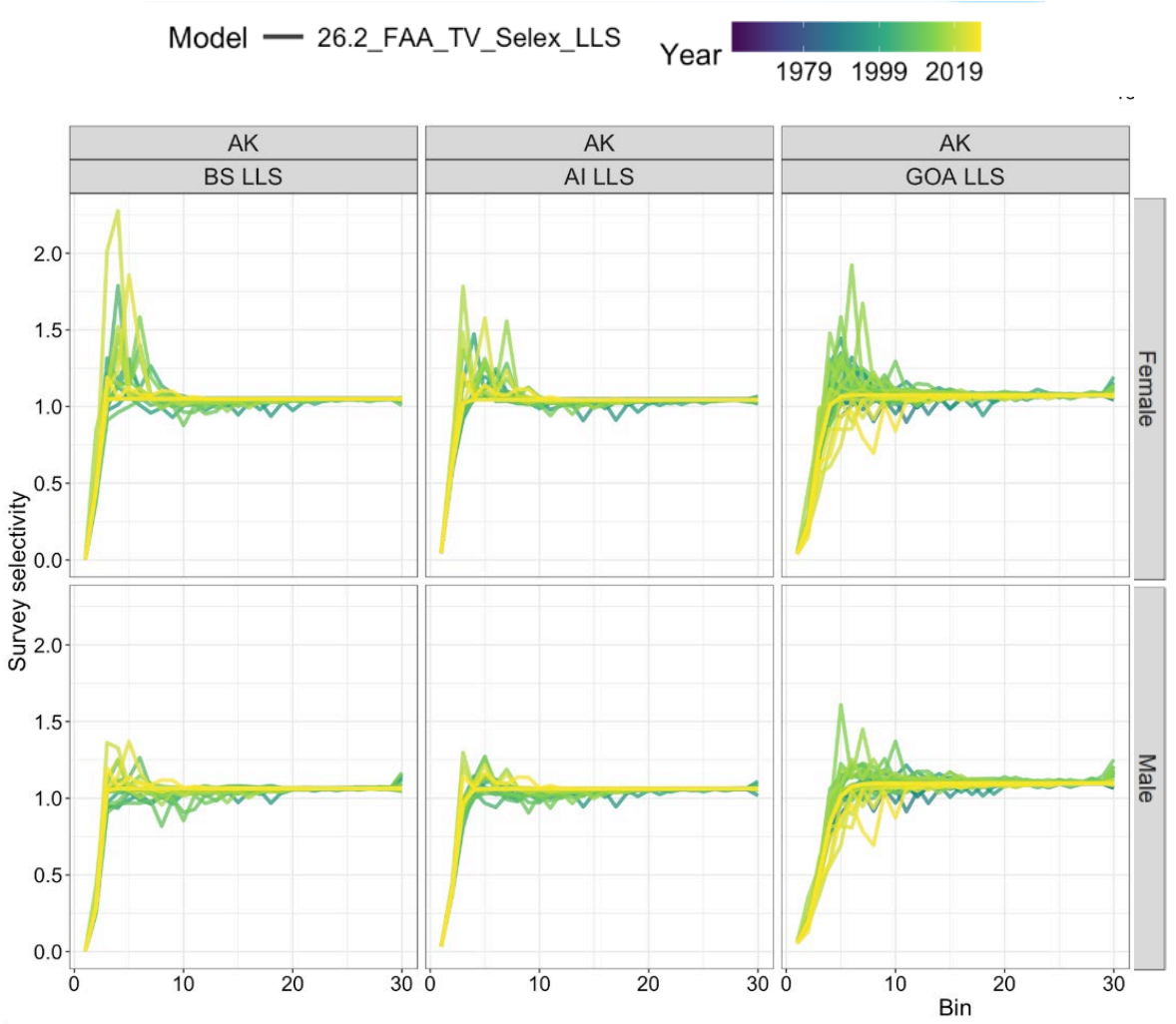
26.2_FAA_3LLF_LLS_BS_Dome_DN

- 3 parameter double normal selectivity function in the BS survey fleet
- Disaggregate fixed gear fishery into 3 fleets with BS dome
- Generally similar estimates to Model *26.2_FAA*
  - GOA removals represent ~80 – 90% of total removals, so BS fleet structure has limited impact
- No appreciable improvement in model fits with poor diagnostics
  - Stability issues in jitter analysis, degraded retrospective pattern, poor MCMC sampling



26.2_FAA_TV_Selex_LLS

- Semi-parametric selectivity (time-and age-varying) for survey fleets
  - Parametric form = logistic, with time-and age-varying deviations
- Semi-parametric structure enables understanding of the degree to which data support domed dynamics
  - If not supported, then model will estimate logistic
- Results generally suggest doming is not well supported by data
  - Generally logistic with sharp peaks at intermediate ages in certain years (primarily only female)



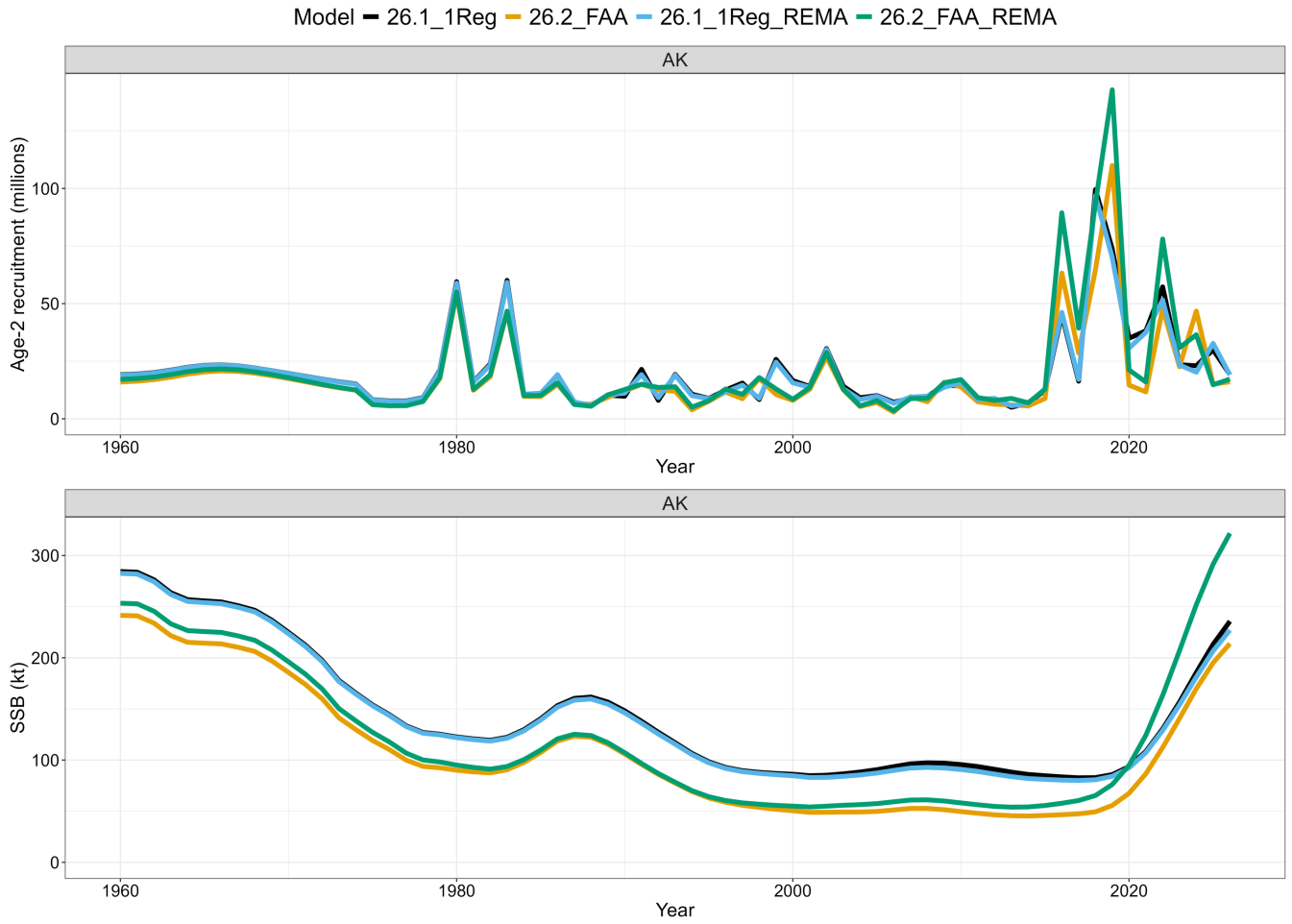
Additional Sensitivity Runs

Model / Analyses	Specification and Rationale
26.2_FAA_CPUE	• Same as *26.2_FAA* but add the fixed gear fishery CPUE index (Japanese 1964 – 1981; domestic 1995 – 2022)
26.2_FAA_TS	• Same as *26.2_FAA* but add the NOAA GOA trawl survey index
26.2_FAA_TS_CPUE	• Same as *26.2_FAA* but add both the CPUE and GOA trawl survey indices
26.2_FAA_M_Pr_XX	• Same as *26.2_FAA* but shift the *M* prior mean from 0.085 to 0.065 – 0.115 (0.01 increments)
26.2_FAA_M_1Reg	• Same as *26.2_FAA* but fix *M* at the *26.1_1Reg* estimates (SSC request)
26.1_1Reg_REMA / 26.2_FAA_REMA	• Fit REMA smoothed and interpolated regional LLS indices to evaluate the impact of index interpolation
26.3_Spat_5Reg	• Five region spatial model that integrates tagging data and estimates movement



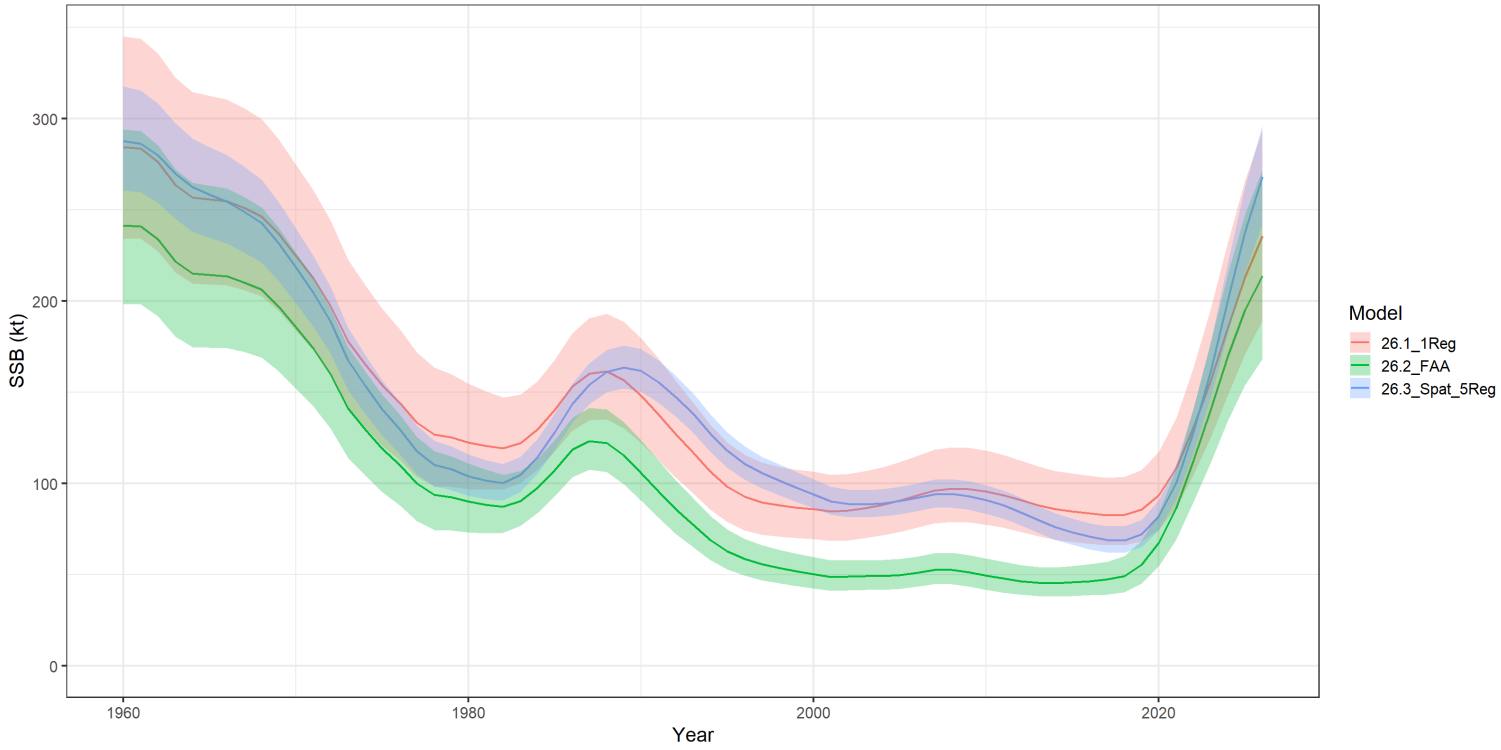
REMA Sensitivity: Single Region vs. FAA

- REMA smoothed and interpolated regional LLS indices fit in both model structures
- *26.1_1Reg_REMA*: little change; index is already annual, so REMA only changes the filled values
- *26.2_FAA_REMA*: extra BS / AI index points with no comps; much larger recent recruitment
  - Terminal SSB 322 vs. 214 kt (+50%)
- Same pattern with carryover in the FAA (Appendix 3C)



Spatial Sensitivity

- 5 region spatial model demonstrated mixed trends between single region and FAA models
  - Increased depletion estimates compared to Model *26.1_1Reg*, but with a higher overall scale than Model *26.2_FAA*
- Should be interpreted with care



Assessment Summary

- Fundamental model tension fitting regional LLS indices and age compositions
- Model fitting (most) indices adequately
- Fit to compositions demonstrate cohort/year residual trends
- No major diagnostic issues, but tend to underestimate recent recruitment
- Spawning population continues to grow rapidly
- Recruitment has decreased from 2014 – 2017 highs, but 2020 and 2022 cohorts appear to be above average
- Age structure is continuing to expand, but SSB diversity remains relatively low for such a long-lived species

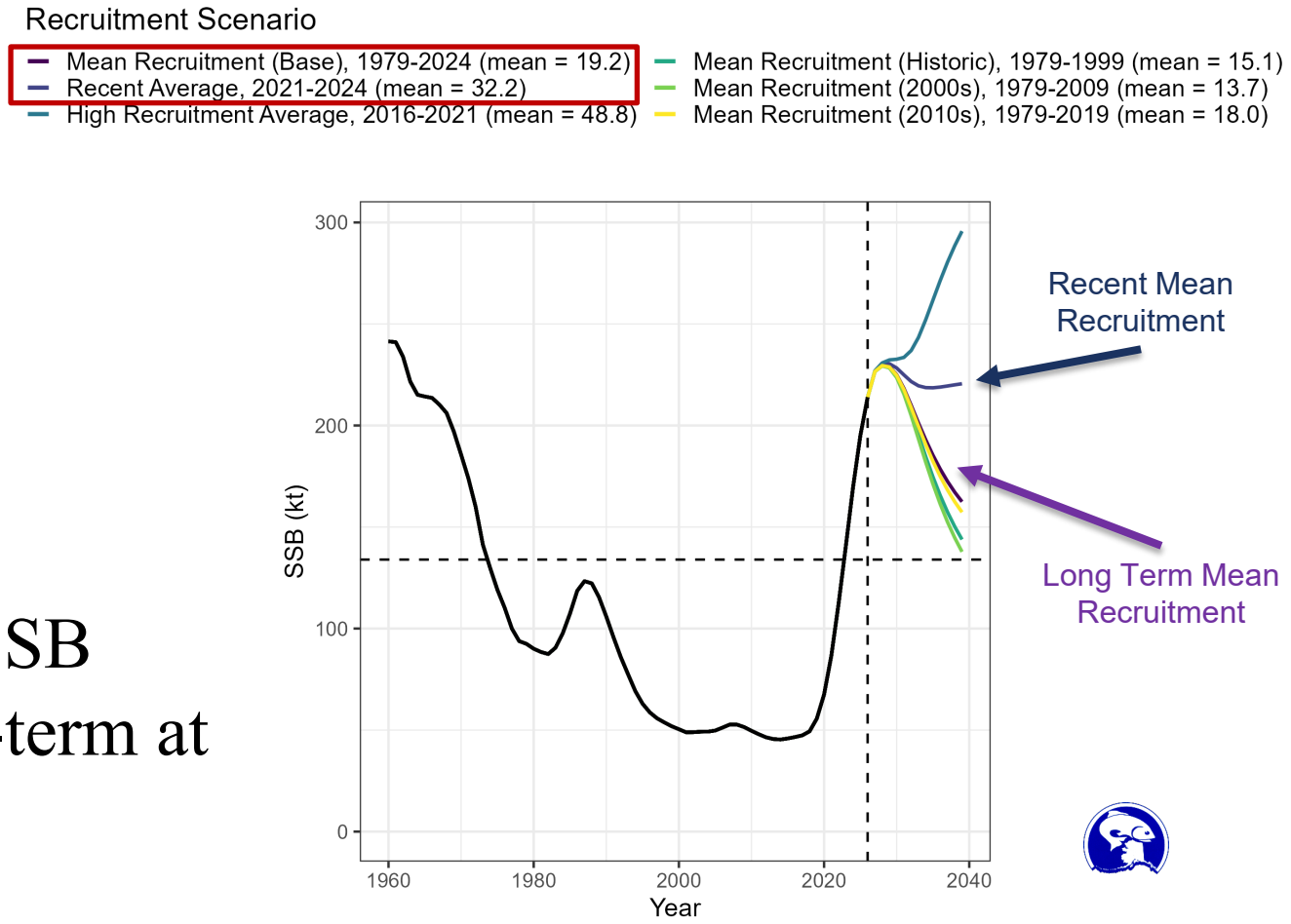
Risk Table

- **Assessment (Level 1)**: Uncertainty in recent year classes, but no retrospective patterns. Lack of a 2024 survey and declining fishery age compositions increases uncertainty in recruitment estimates.
- **Population (Level 1)**: SSB rapidly increasing, but age structure diversity remains relatively low (90% of SSB from 2014+ year classes).
- **Ecosystem (Level 1)**: Sufficient foraging opportunities for juvenile and pre-recruit sablefish, moderate competition due to low returns of pink salmon in the GOA.
- **Fishery (Level 1)**: There is no updated fishery data that is relevant to population trends.

Level 1—Normal

Risk Table: Additional Considerations

- Low utilization of ABC
  - ~5% in the AI
  - ~25% in the BS
  - ~80% across the GOA
    - ~70% in the WG to ~90% in the SEO
  - Creates effective population buffer
- Under continued above average recruitment conditions, current SSB would be maintained in the near-term at relatively high catch levels



Harvest Recommendations

- Projected to be at $B_{68\%}$ in 2027
- **2027 Author's ABC = Max ABC = 37,436 t**
- -9,500 t from 2026 ABC (2026 ABC = 47,008 t)
  - Why?
    - Biologically realistic natural mortality
    - Not fitting interpolated LLS index
    - No aggregation of LLS age data
- If harvested, ABC would represent the 5th *highest* removals all-time
- ABC ~50% harvested in recent years, but varies regionally
- Catch has ranged from 21 kt – 27 kt over last five years

Summary Table (Author Recommended)

Quantity/Status	Specified *last* SAFE for Model *23.5*:		Estimated *this* SAFE for Model *26.2_FAA*:	
	2025	2026*	2027	2028**
M Female (estimated)[#]	0.11		0.09	
M Male (estimated)	--		0.09	
Average Recruitment (millions)	26		19	
Tier	3a		3a	
Projected Total Biomass (Age 2+; t)	704,713	695,681	588,629	586,855
Projected Female Spawning Biomass (t)	219,714	241,217	226,595	237,749
$B_{100\%}$ (t)	302,672	302,672	334,913	334,913
$B_{40\%}$ (t)	121,069	121,069	133,965	133,965
$B_{35\%}$ (t)	105,935	105,935	117,220	117,220
F_{OFL}	0.10	0.10	0.09	0.09
$maxF_{ABC}$	0.09	0.09	0.08	0.08
Whale Depredation (t)	171	169	131	131
OFL (t)	58,731	57,993	44,464	44,696
OFL_w (t)^	**58,532**	**57,797**	**44,333**	**44,565**
max ABC (t)	50,283	49,651	37,567	37,767
ABC (t)	50,283	49,651	37,567	37,767
ABC_w (t)^	**50,111**	**49,482**	**37,436**	**37,636**
Status	As determined *last* year for:		As determined *this* year for:	
	2023	2024	2025	2026
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

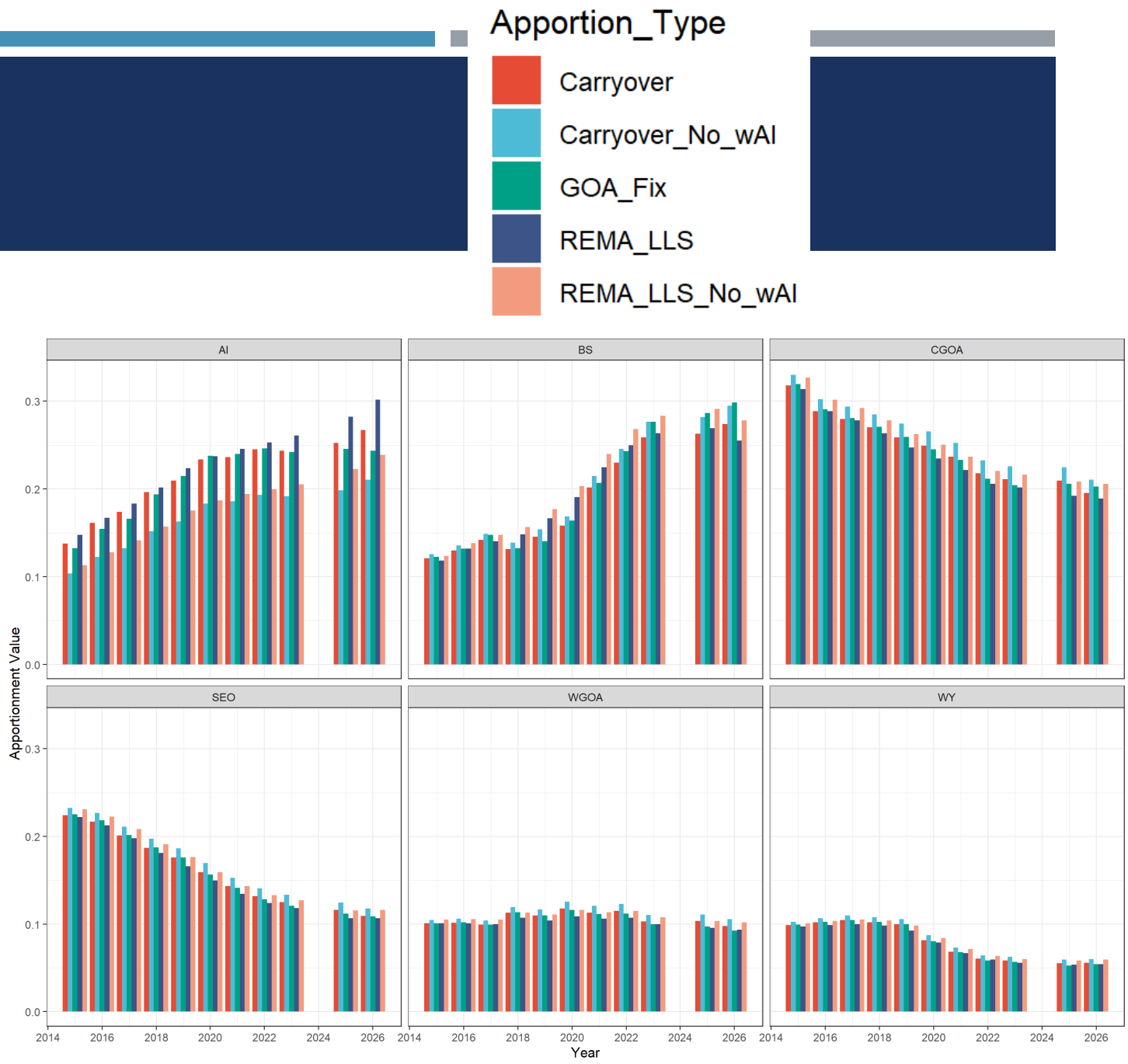
*The 2024 SAFE projections of future SSB and biomass were based on specified catch of 25,000 t in 2025 (a yield ratio of 0.49 was assumed). Specified catch projections are utilized in response to management requests for a more accurate two-year projection. SSB and biomass are less than presented when the maximum ABC is removed in 2025.
**The 2026 SAFE Model *26.2_FAA* projections were based on specified catch of 21,000 t in 2027 (a yield ratio of 0.53 was assumed based on the three-year average of catch to ABC from completed fishing years, 2023 – 2025).
[#]A single female natural mortality parameter is estimated in Model *23.5* and is used for both sexes.
^ABC_w and OFL_w are the final author recommended ABCs and OFLs after accounting for whale depredation.

Apportionment

- Goal:
  - **Distribute catch regionally** in proportion to our best estimates of regional biomass (Longline Survey Biomass)
  - Avoid localized depletion and/or disproportionate harvest of only large, mature fish OR only small, new recruits – **balance harvest across age structure**
- 2020 SAFE rationale:
  - Simulation work indicates that apportionment can be conducted in numerous ways with *little variability in the average implications for the population*.
    - Due to high sablefish movement and the robustness of the existing harvest control rule and management framework.
  - **Our best scientific advice is that catch distribution should not deviate *too far* from survey-estimated biomass proportions across management areas.**

Apportionment

- **Never have a synoptic survey, so apportionment requires interpolation**
- Previous GOA interpolation approach no longer feasible
- Recommend 'carryover' (*Carryover_No_wAI)*
  - Hold values constant from last survey
  - Drop extrapolated western AI stations (never sampled by NOAA)
- All methods similar, removing wAI is biggest difference across methods



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- Recommend 'carryover' (*Carryover_No_wAI)*
  - Hold values constant from last survey
  - Drop extrapolated western AI stations (never sampled by NOAA)
- All methods similar, removing wAI is biggest difference across methods

Regional Apportionment Values by Apportionment Method

Apportionment Approach	BS	AI	WGOA	CGOA	WY	SEO
Carryover_No_wAI	**0.3**	**0.2**	**0.11**	**0.21**	**0.06**	**0.12**
REMA_LLS_No_wAI	0.28	0.23	0.1	0.21	0.06	0.12
Carryover	0.27	0.26	0.1	0.2	0.06	0.11
REMA_LLS	0.26	0.3	0.09	0.19	0.05	0.11
GOA_Fix	0.3	0.24	0.09	0.2	0.05	0.12

Apportionment

Percent Change in BRD by Apportionment Method

Year	Apportionment Approach	BS	AI	GOA	WGOA	CGOA	WY	SEO	ABCw
2026	*GOA_Fix (Model 23.5)*	0%	0%	0%	0%	0%	0%	0%	0%
2027	*Carryover_No_wAI*	-14%	-34%	-17%	-12%	-18%	-15%	-20%	-20%
2027	*REMA_LLS_No_wAI*	-20%	-25%	-19%	-20%	-18%	-15%	-20%	-20%
2027	*Carryover*	-22%	-15%	-22%	-20%	-22%	-15%	-26%	-20%
2027	*REMA_LLS*	-25%	-2%	-27%	-28%	-26%	-29%	-26%	-20%
2027	*GOA_Fix*	-14%	-21%	-24%	-28%	-22%	-29%	-20%	-20%

Apportionment

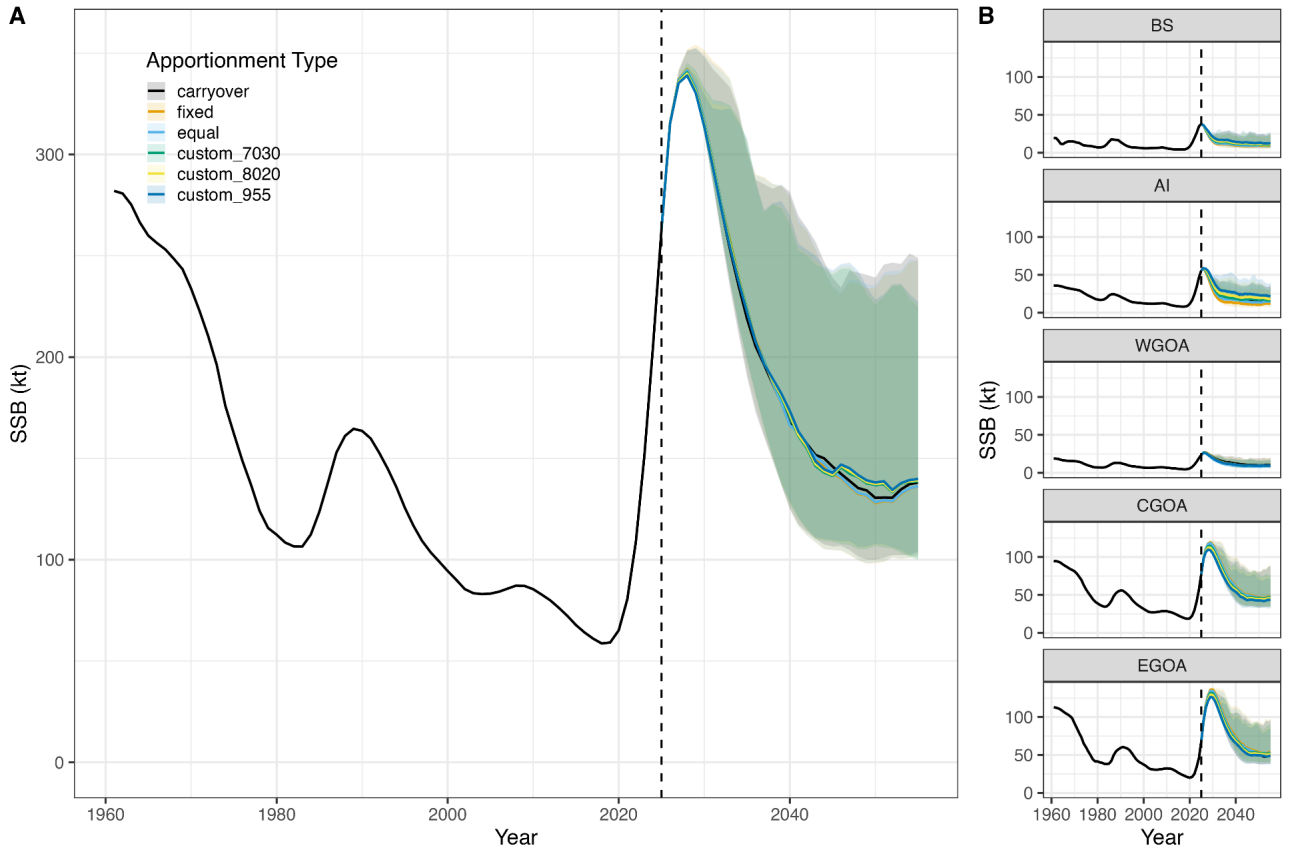
Percent Change in BRD by Apportionment Method

Year	Apportionment Approach	BS	AI	GOA	WGOA	CGOA	WY	SEO	ABCw
2026	*GOA_Fix (Model 23.5)*	0%	0%	0%	0%	0%	0%	0%	0%
2027	*Carryover_No_wAI*	-14%	-34%	-17%	-12%	-18%	-15%	-20%	-20%
2027	*REMA_LLS_No_wAI*	-20%	-25%	-19%	-20%	-18%	-15%	-20%	-20%
2027	*Carryover*	-22%	-15%	-22%	-20%	-22%	-15%	-26%	-20%
2027	*REMA_LLS*	-25%	-2%	-27%	-28%	-26%	-29%	-26%	-20%
2027	*GOA_Fix*	-14%	-21%	-24%	-28%	-22%	-29%	-20%	-20%

Year	Model	Apportion_Type	BS	AI	GOA	WGOA	CGOA	WY	SEO	Total
2026	23.5_2024	Obs_Catch	3,339	632	18,191	3,458	7,597	2,271	4,865	22,161
2026	23.5_2024	TAC	8,996	7,440	22,550	4,687	9,622	2,652	5,589	38,986
2026	23.5_2024	%_TAC_Used	37	8	81	74	79	86	87	57
2026	23.5_2024	GOA_Fix	13,037	11,421	22,550	4,687	9,622	2,652	5,589	47,008
2027	26.2_FAA_2026	Carryover_No_wAI	11,231	7,487	18,718	4,118	7,862	2,246	4,492	37,436
2027	25.12_2026	Carryover_No_wAI	12,878	8,585	21,463	4,722	9,014	2,576	5,151	42,926
2027	26.1_1Reg_2026	Carryover_No_wAI	12,013	8,007	20,021	4,405	8,409	2,403	4,805	40,042

Apportionment – Final Thoughts

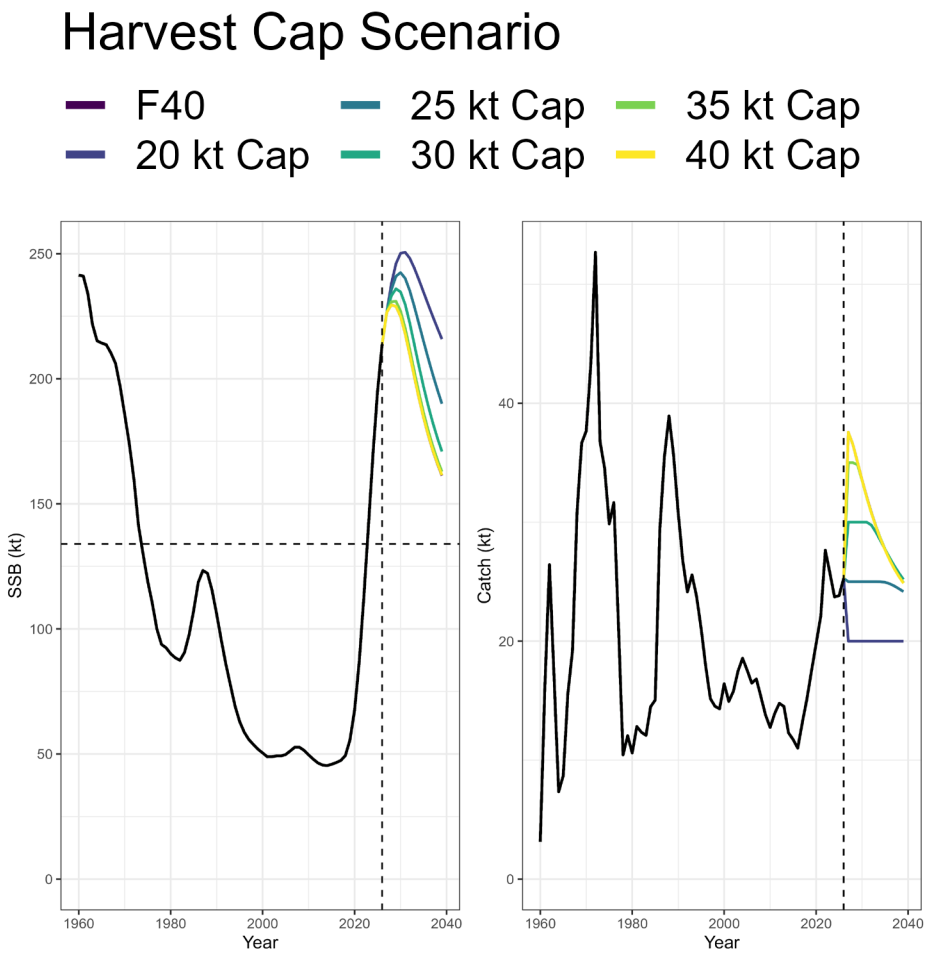
- Lack of a 2024 survey and the reduction in survey footprint beginning in 2025 have inherently **increased uncertainty in regional biomass distributions**
- Considering current ABC utilization rates as well as increased apportionment uncertainty, **short-term deviations from survey apportionment values are unlikely to cause biological harm**



Carryover Represents Proposed Method
Equal Assumes 20% of ABC Harvested from Each Region
70/30 and 80/20 Apportionment Allows 70% or 80% of ABC to be Harvested from GOA

Ongoing Work: Management Strategy Evaluation (MSE)

- A spatially explicit MSE tool has been developed for sablefish
  - Final stakeholder meeting likely during Feb NPFMC meeting
- Harvest caps could help maintain age structure and avoid quota creep (reduce ABC variability)
- Alternate projections with quota caps indicate that stable catch could be maintained for the long-term under the lower quota caps despite assumptions of declining recruitment



Comparing alternative harvest strategies to address robustness to recruitment variability and uncertainty: implications for Alaska sablefish tested with management strategy evaluation

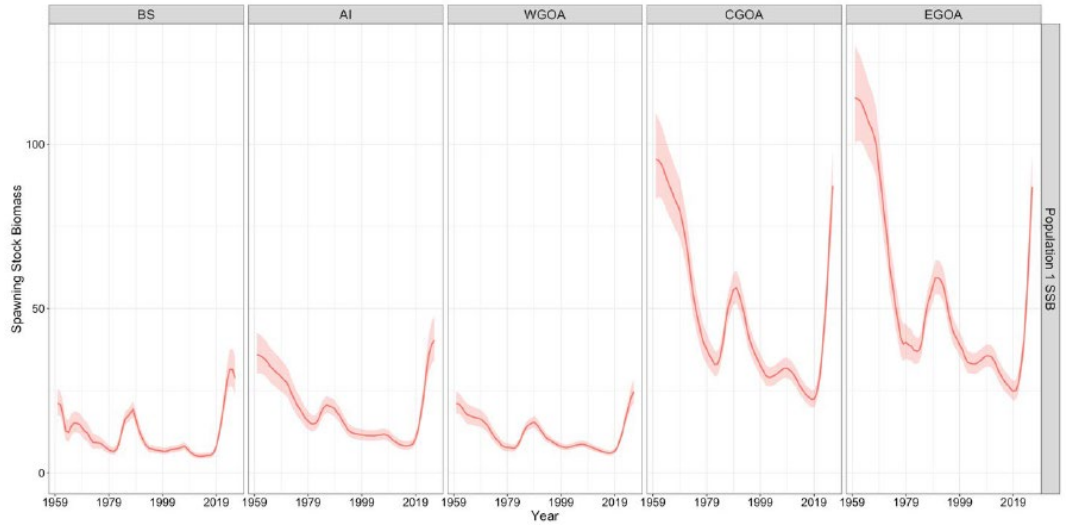
Joshua A. Zahner, Daniel R. Goethel, Curry J. Cunningham, Matthew L.H. Cheng, Benjamin C. Williams, Maia S. Kapur, and Chris Lunsford

One Rule to Rule them All: Hybrid Harvest Control Rules Improve Bio-Economic Outcomes in an MSE Framework

Authors: Joshua A Zahner, M.S., Daniel R. Goethel, Curry James Cunningham, Matthew L.H. Cheng, Benjamin C Williams, and Maia Sosa Kapur | AUTHORS INFO & AFFILIATIONS

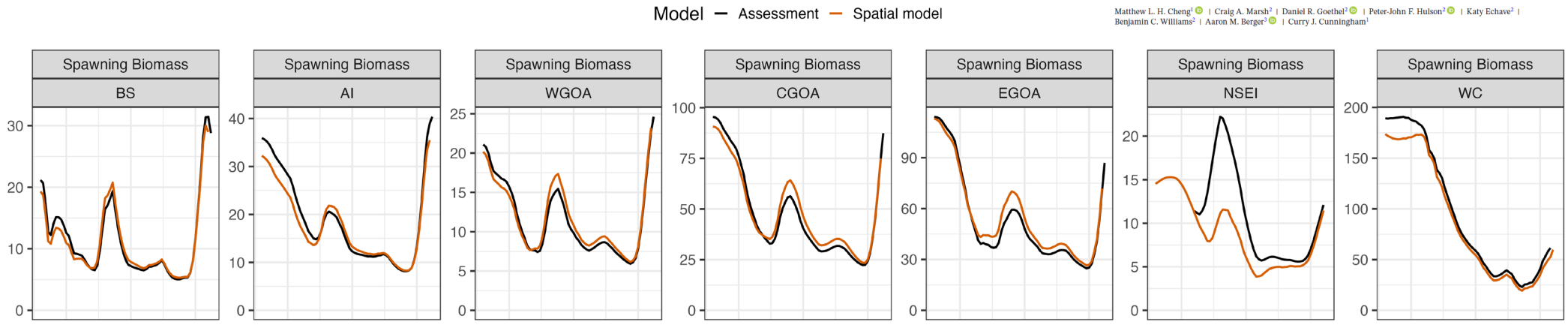
Ongoing Work: Spatial Modeling

- See Appendices 3D and 3K
- Better accounts for underlying spatial processes
- Need to identify to:
  - Handle data weighting (tagging data)
  - Integrate time-varying movement estimates
  - Develop robust spatial diagnostics
- Coast-wide spatial model also in development (not for management)



Panmictic Panacea? Demonstrating Good Practices for Developing Spatial Stock Assessments Through Application to Alaska Sablefish (*Anoplopoma fimbria*)

Matthew L. H. Cheng[1] | Craig A. Marsh[2] | Daniel R. Goethel[2] | Peter-John F. Hulson[2] | Katy Echave[2] | Benjamin C. Williams[2] | Aaron M. Berger[3] | Curry J. Cunningham[1]





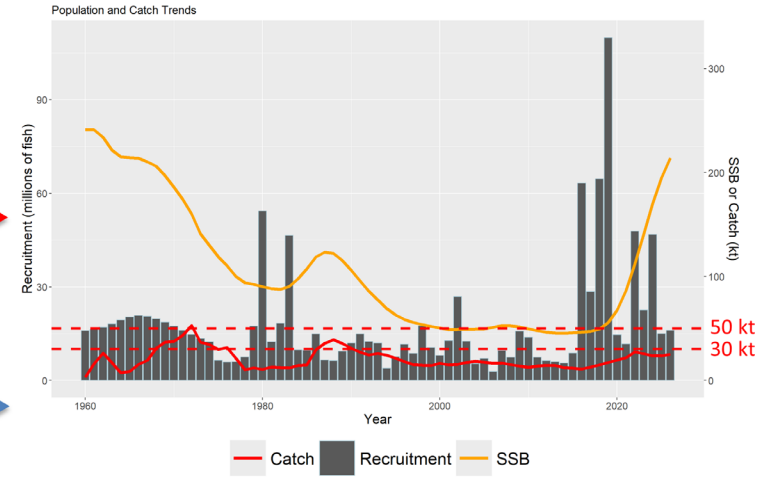
2026 Alaskan Sablefish SAFE (*Anoplopoma fimbria*)

Data and Stock Assessment Model

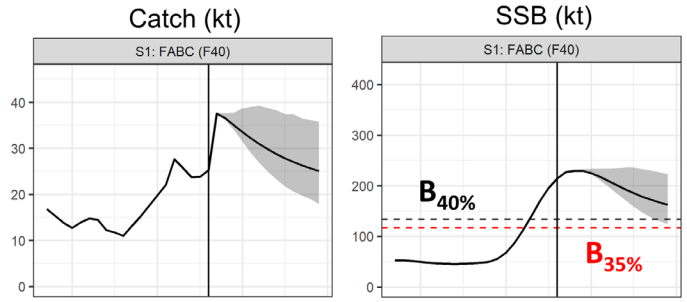
- Longline survey indices suggest population growth is slowing, where 2025 GOA indices increased by 4%, while 2026 BS indices declined by 14% and AI indices increased by 26%.
- A new fleets-as-areas (FAA) model structure was developed and approved during the 2026 CIE review, which uses the same assumptions and data inputs as Model *26.1_1Reg*, but disaggregates the NOAA Longline Survey by region, does not require data interpolation, is able to implicitly handle sablefish spatial structure, and is robust to historic, current, and future survey designs.

2026 Trends

- SSB (kt) ↑
- Catch (kt) →
- Recruitment (millions) ↓
- Age-2+ Biomass (kt) →



Stock Status and ABC Recommendations



Quantity	2026 SAFE (Projections for 2027)
$B_{100\%}$	334,913
$B_{40\%}$	133,965
SSB_{2027}	226,595
$SSB_{2027}/B_{100\%}$	68%
F_{ABC_2027}	0.08
ABC_{w_2027}	37,436
OFL_{w_2027}	44,333

- The resource is *not overfished* and *overfishing is not occurring.*
- Recent ABCs have not been fully utilized with catch averaging < 50% of the ABC over the last 3 years, though regional utilization varies from ~25% in the BS/AI to ~90% in the GOA.
- The ABC decreased due to a rescaling of the population when interpolated index values were removed in the new model structure.

Other PT Tables

Groundfish Plan Team Summary Table by Region

Area	Year	Biomass (4+)*	OFL**	ABC#	TAC	Catch^
GOA	2025	305,000	--	24,038	22,836	18,387
	2026	299,000	--	23,737	22,550	18,191
	2027	254,727	--	18,718	--	--
	2028	252,024	--	18,818	--	--
BS	2025	175,000	--	13,898	8,496	3,909
	2026	172,000	--	13,723	8,996	3,339
	2027	139,483	--	11,231	--	--
	2028	138,002	--	11,291	--	--
AI	2025	153,000	--	12,175	7,940	948
	2026	151,000	--	12,022	7,440	632
	2027	153,559	--	7,487	--	--
	2028	151,929	--	7,527	--	--

Author Recommended BRDs and Whale Adjusted Catch Tables by Region

Year	2026				2027		2028	
Region	OFL_w**	ABC_w**	TAC	Catch*	OFL_w**	ABC_w**	OFL_w**	ABC_w**
BS	--	13,037	8,996	3,339	--	11,231	--	11,291
AI	--	11,421	7,440	632	--	7,487	--	7,527
GOA	--	22,550	22,550	18,191	--	18,718	--	18,818
WGOA	--	4,687	4,687	3,458	--	4,118	--	4,140
CGOA	--	9,622	9,622	7,597	--	7,862	--	7,904
WY	--	2,652	2,652	2,271	--	2,246	--	2,258
SEO	--	5,589	5,589	4,865	--	4,492	--	4,516
Total	57,797	47,008	38,986	22,161	44,333	37,436	44,565	37,636

* As of October 15, 2026 Alaska Fisheries Information Network, (www.akfin.org).
** After whale depredation methods described above.