Assessment of the Yellowfin Sole Stock in the Bering Sea and Aleutian Islands

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November 19, 2026 Presentation to the Bering Sea and Aleutian Islands Plan Team

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Selected SSC comments (SSC October 2026)

SSC:

- The SSC requests that an operational full assessment be prioritized for yellowfin sole in 2026.
- Consistent with its October 2025 report, the SSC continues to support use of Tier 3 reference points for the 2026 assessment.
- The SSC supports bringing forward models 25.0, 25.0a and 25.0b for consideration.

Response:

The 2026 assessment contains these features.

Selected SSC comments (SSC October 2026)

SSC:

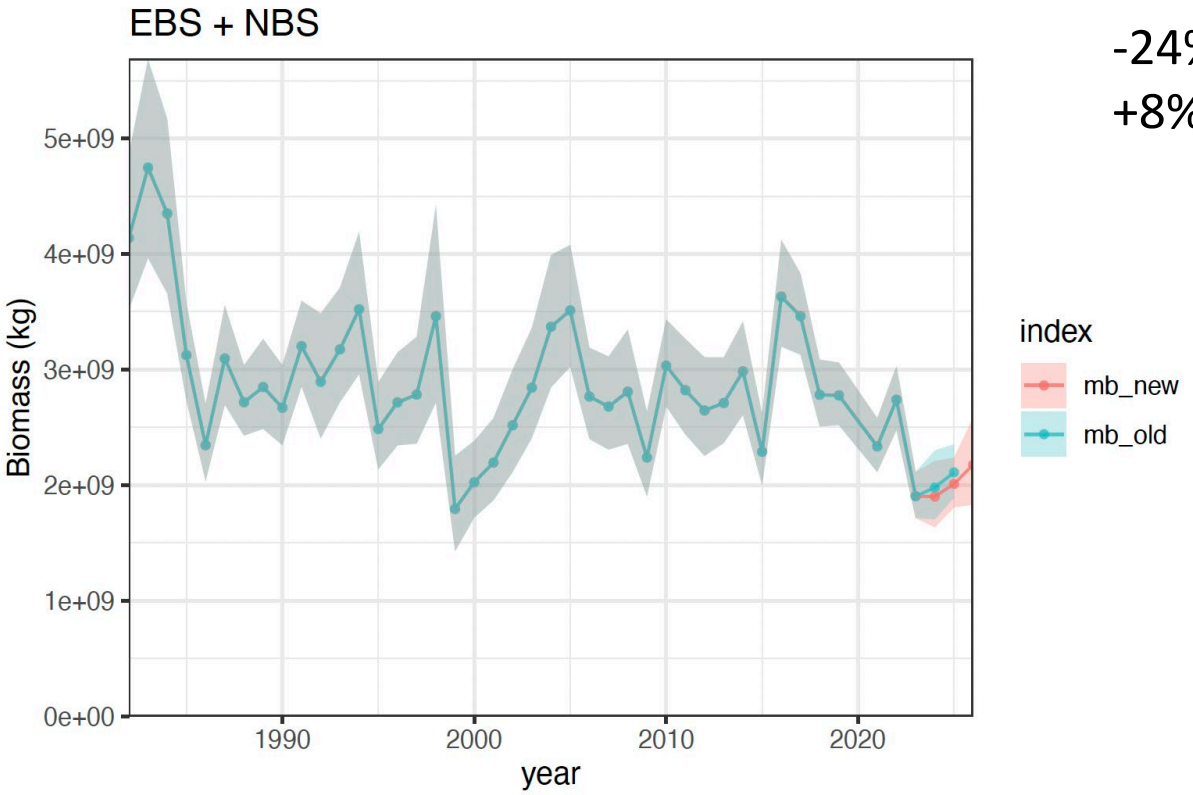
- The SSC continues to support evaluation of the sampleISS approach used in Models 25.0a and 25.0b.
- Diagnostics for initial model runs indicate that effective and observed sample sizes differ substantially and survey age-composition residuals show some evidence of misspecification.
- Therefore, the SSC recommends clearly documenting the input sample sizes and effective sample sizes for the survey age compositions and providing sufficient diagnostics to determine whether the compositions are appropriately weighted or whether the low survey-index SDNR and discrepancies between observed and effective composition sample sizes indicate excessive weighting of survey information.

Response:

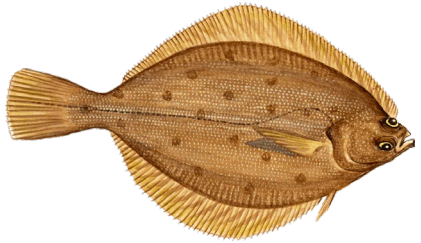
Sample weighting was documented in the report, and is highlighted in this presentation.

Survey

Bridging from EBS+NBS estimates, 2025 to 2026, both sdmTMB with 250 knots



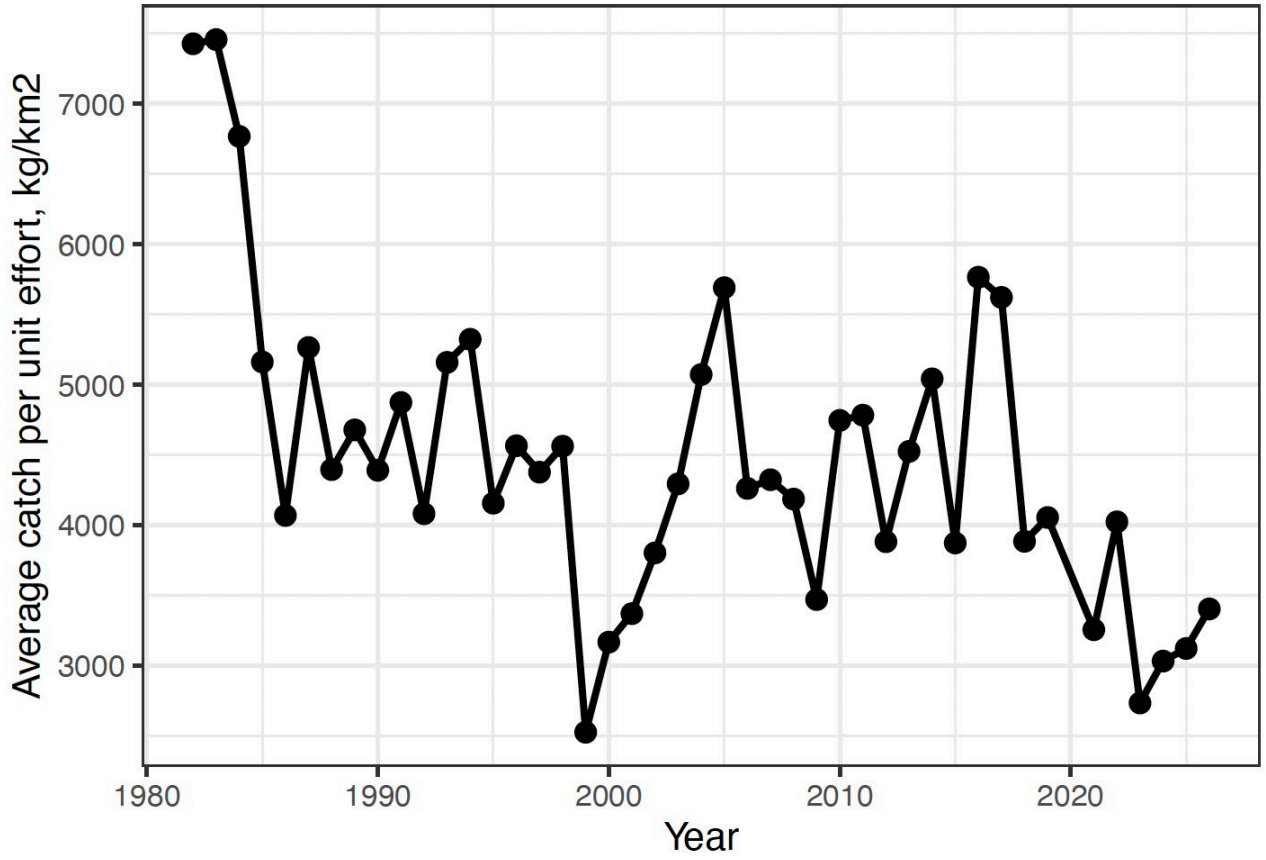
-24% change from the long term
+8% change from previous year



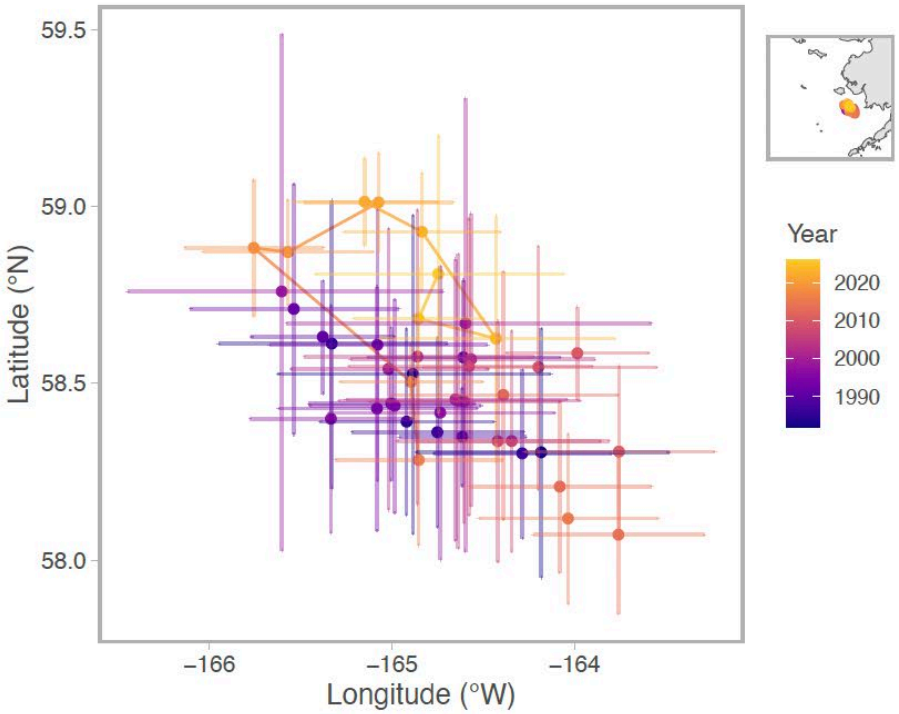
This analysis includes net measurement correction (M2N).

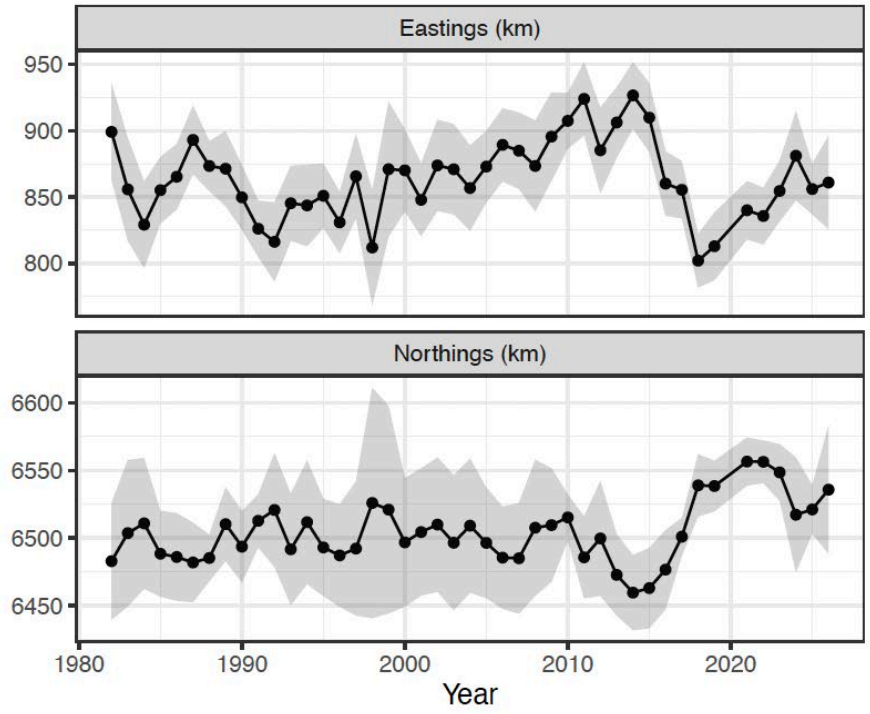
For the 2024 assessment, the model-based survey index was generated using VAST and 750 knots. The 2026 index model used sdmTMB and 250 knots.

Survey CPUE has increased 3 years in a row.



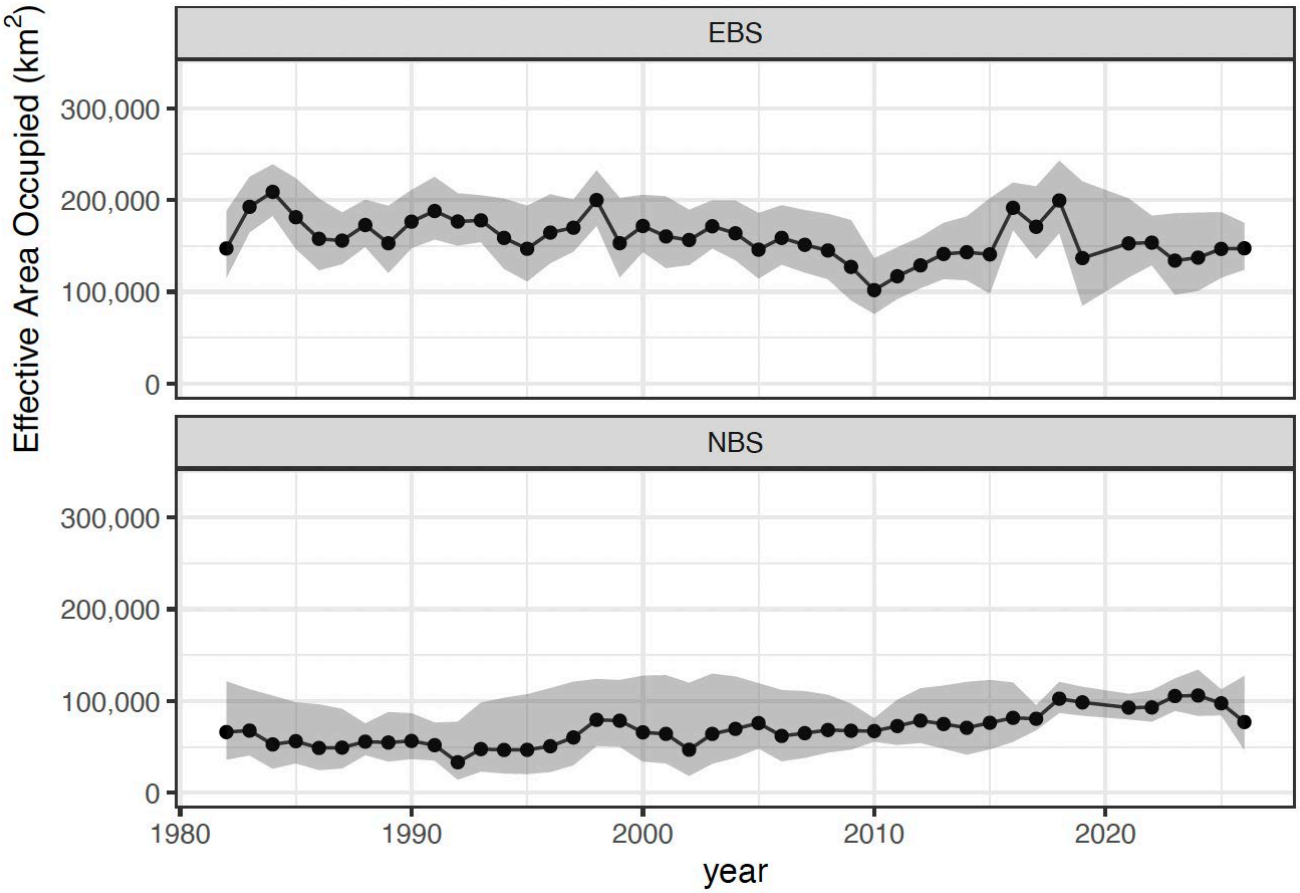
Center of gravity plot with eastings (Longitude) above right and northings (Latitude) lower right, for sdmTMB index estimate (EBS+NBS)



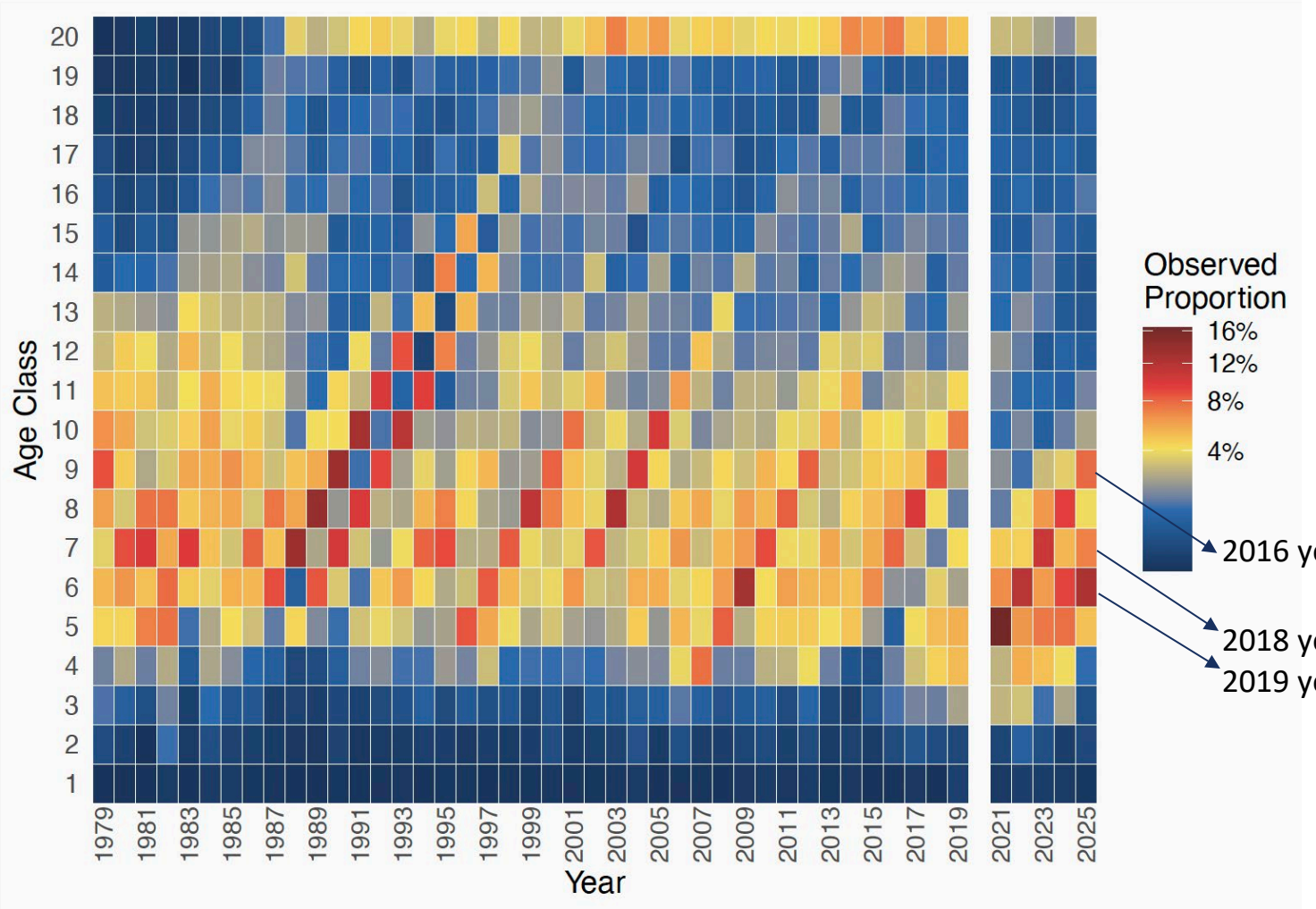


Trend indicates northward and westward.

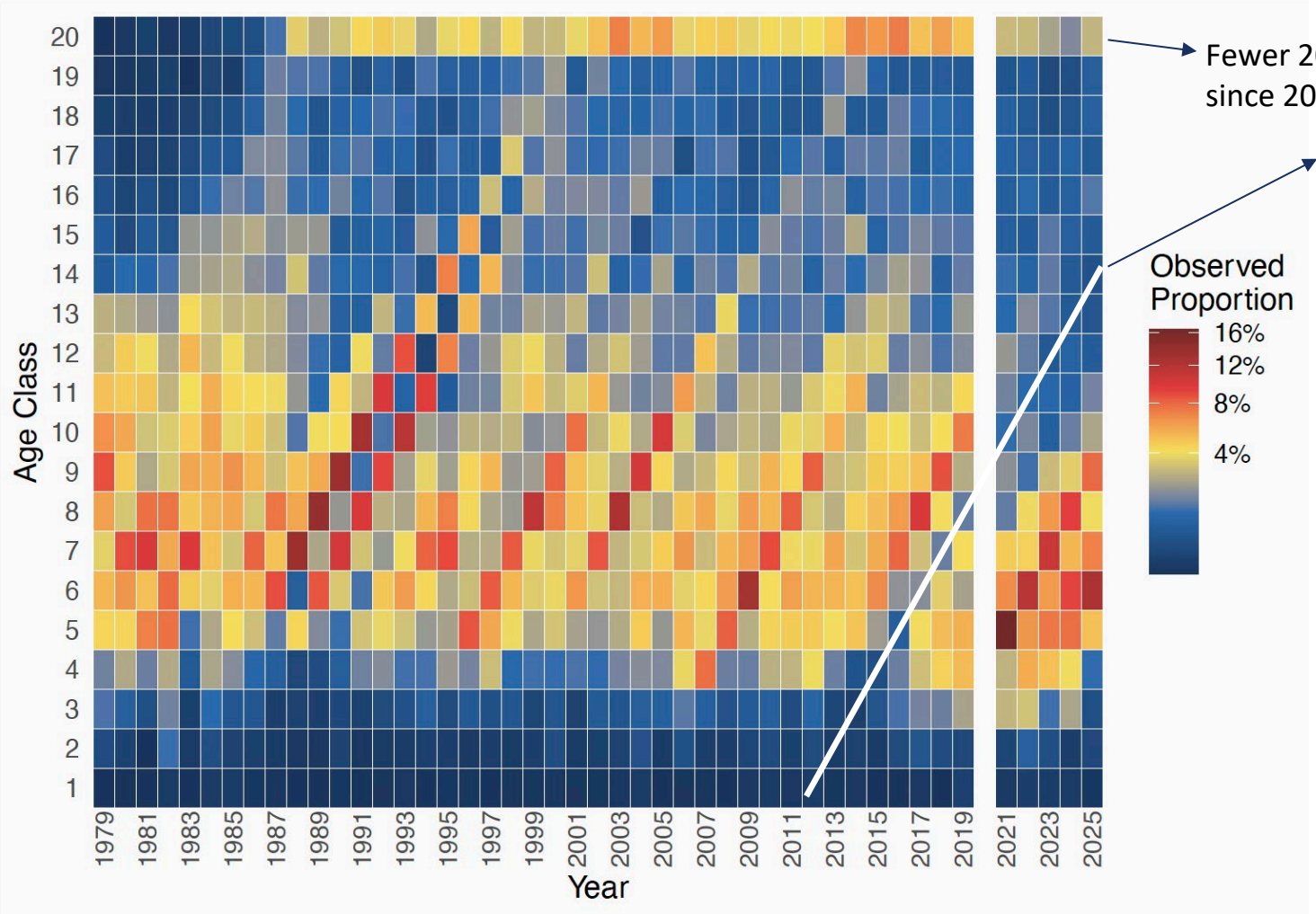
Effective area occupied indicates lower abundance in the NBS in 2026 (although no NBS survey was conducted in 2026)



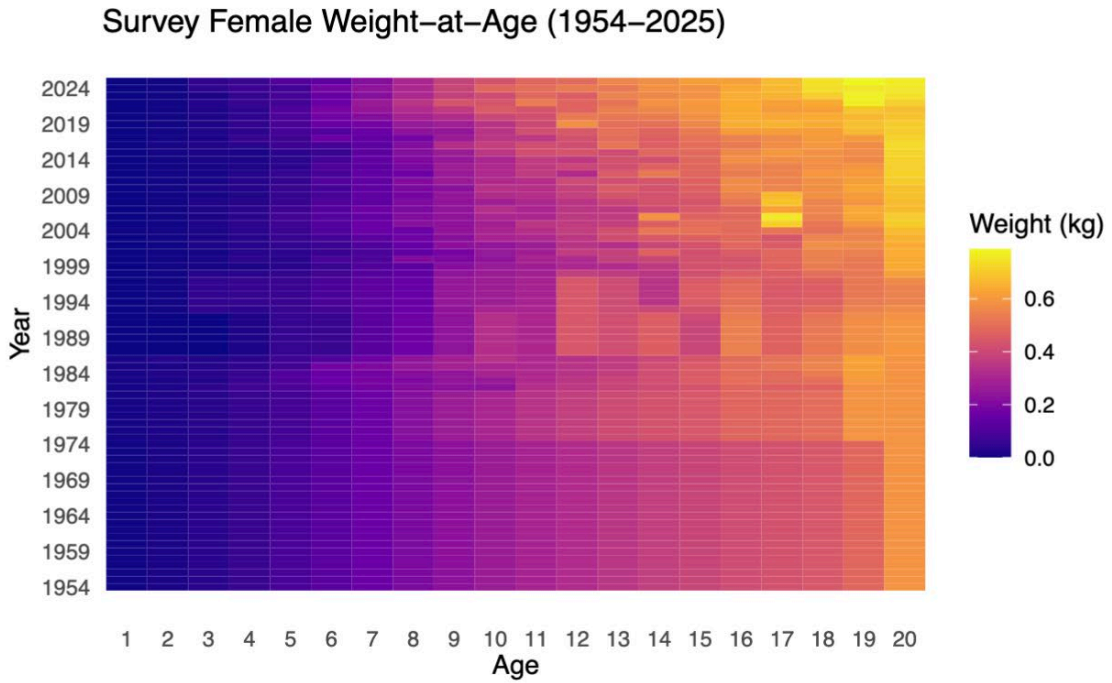
Age frequency of yellowfin sole (females and males) from the AFSC/NMFS research surveys, 1979-2025



Age frequency of yellowfin sole (females and males) from the AFSC/NMFS research surveys, 1979-2025



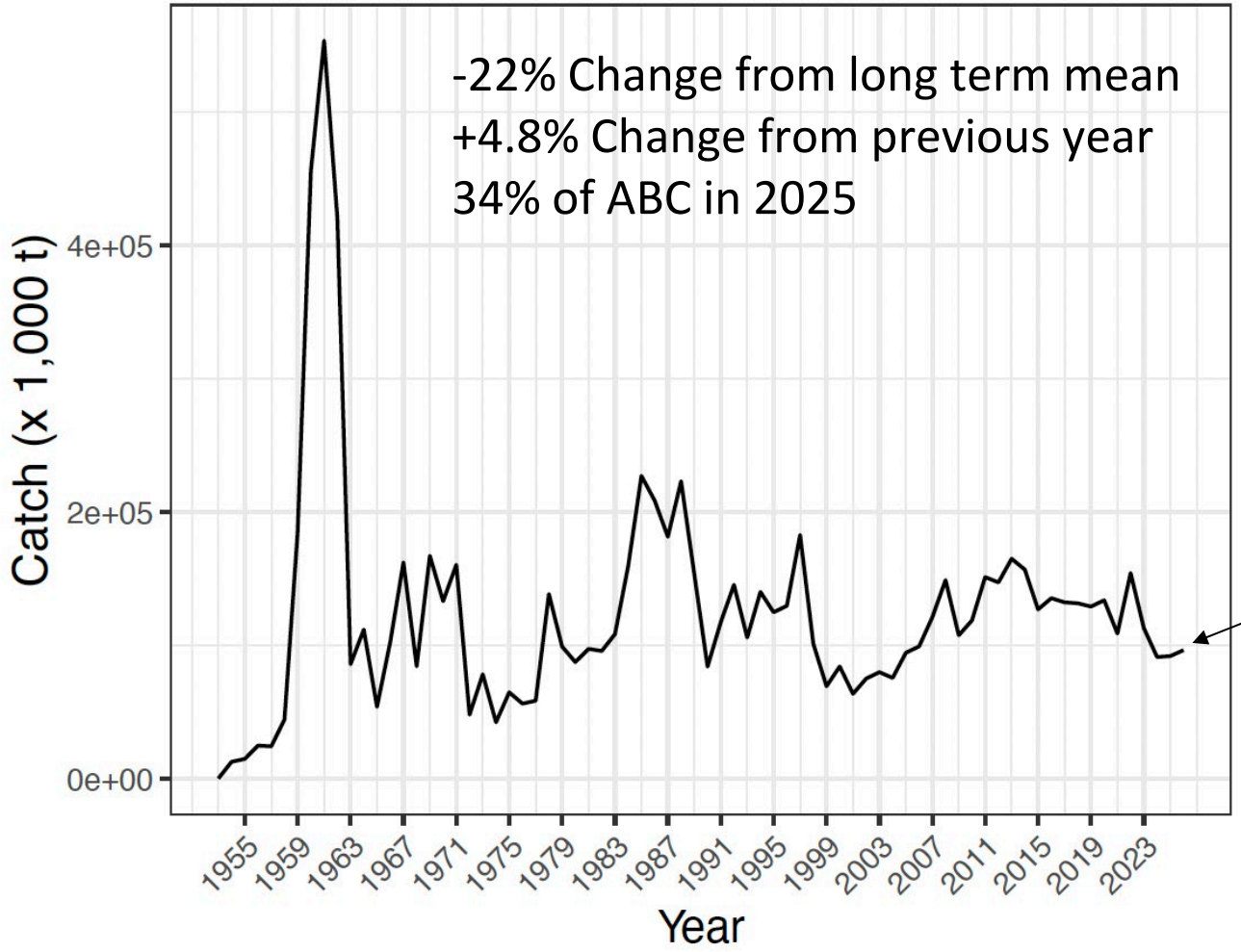
Survey weight-at-age is increasing.





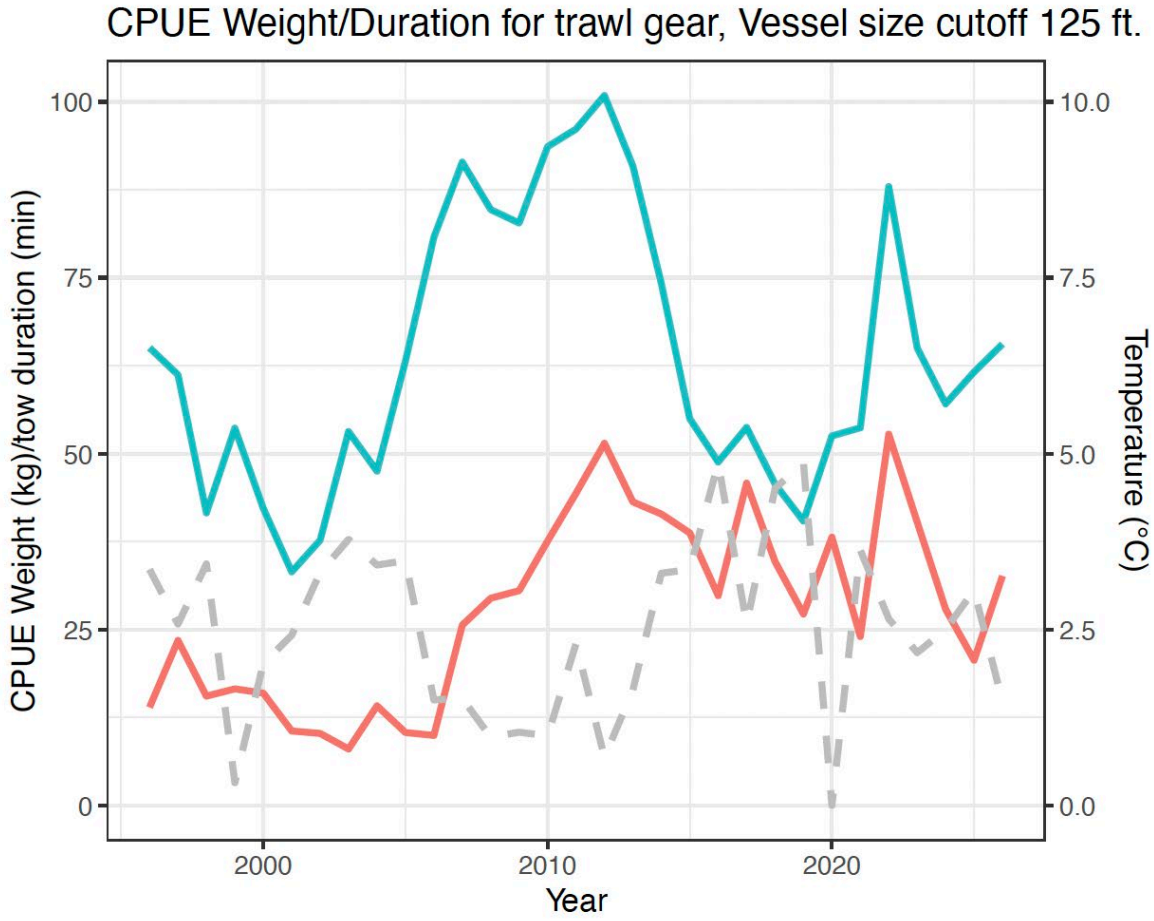
Fishery and catch

Yellowfin sole annual total catch (1,000s t) in the eastern Bering Sea from 2003-2026



2026 catch +4.8% since 2025.

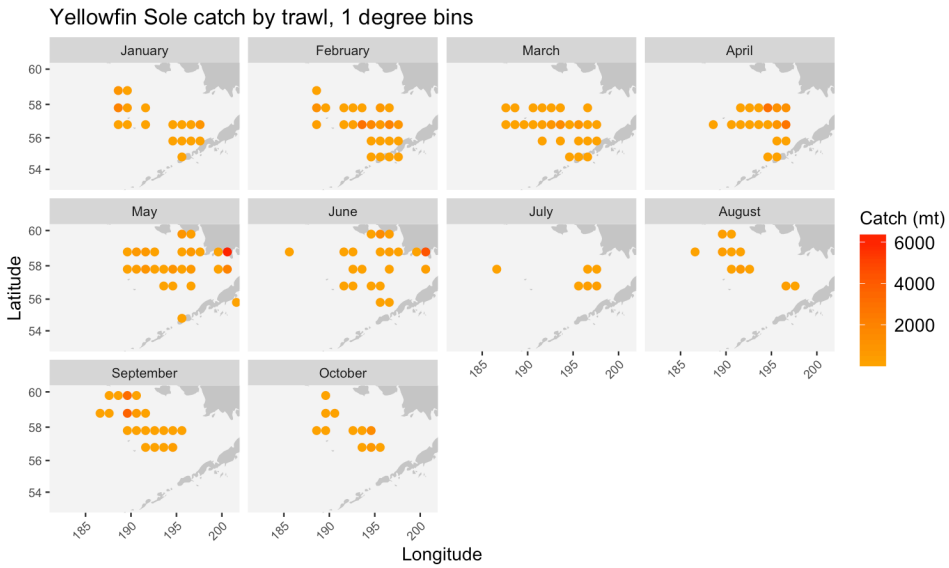
Catch per unit effort based on yellowfin sole fishery data, 1996-2026

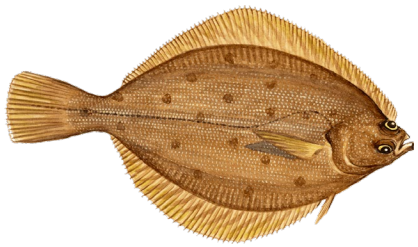


The EBS bottom temperature anomalies from 1996-2026 (x10 for visualization) are shown as a dashed line.

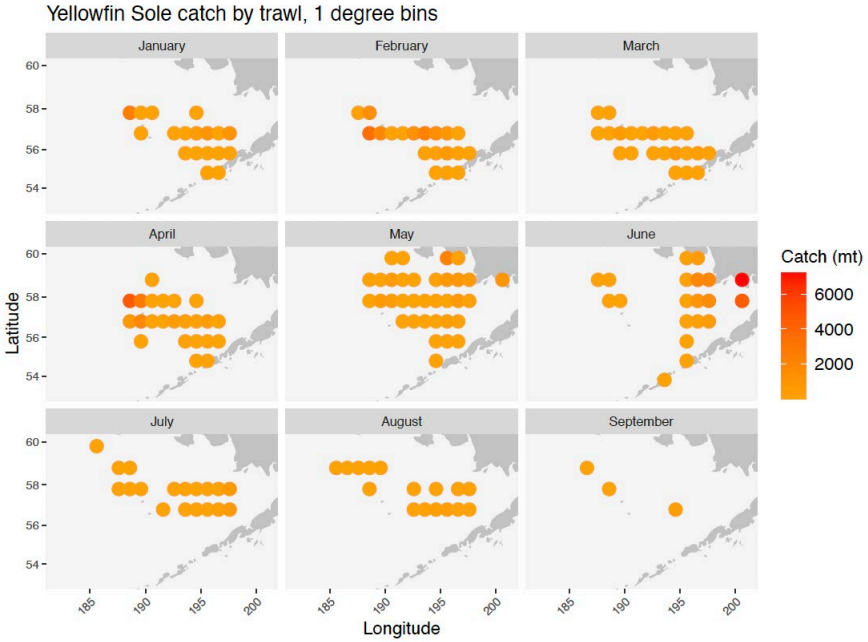
Catch and CPUE in 2024 vs. 2026

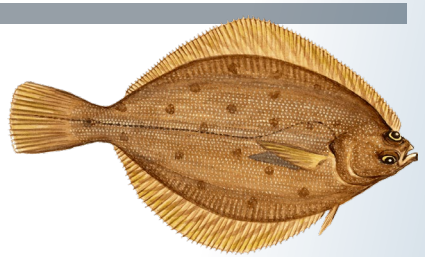
2024

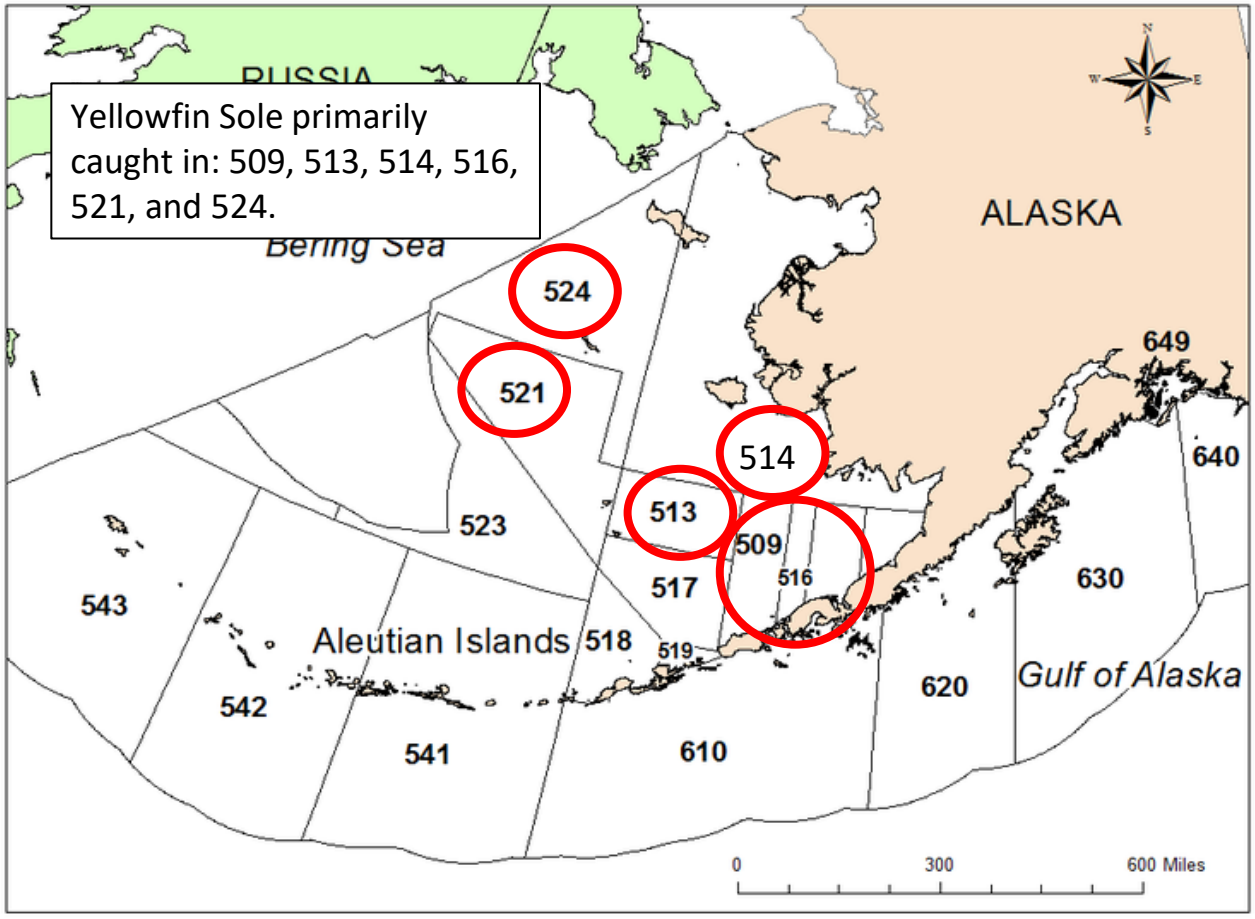




2026







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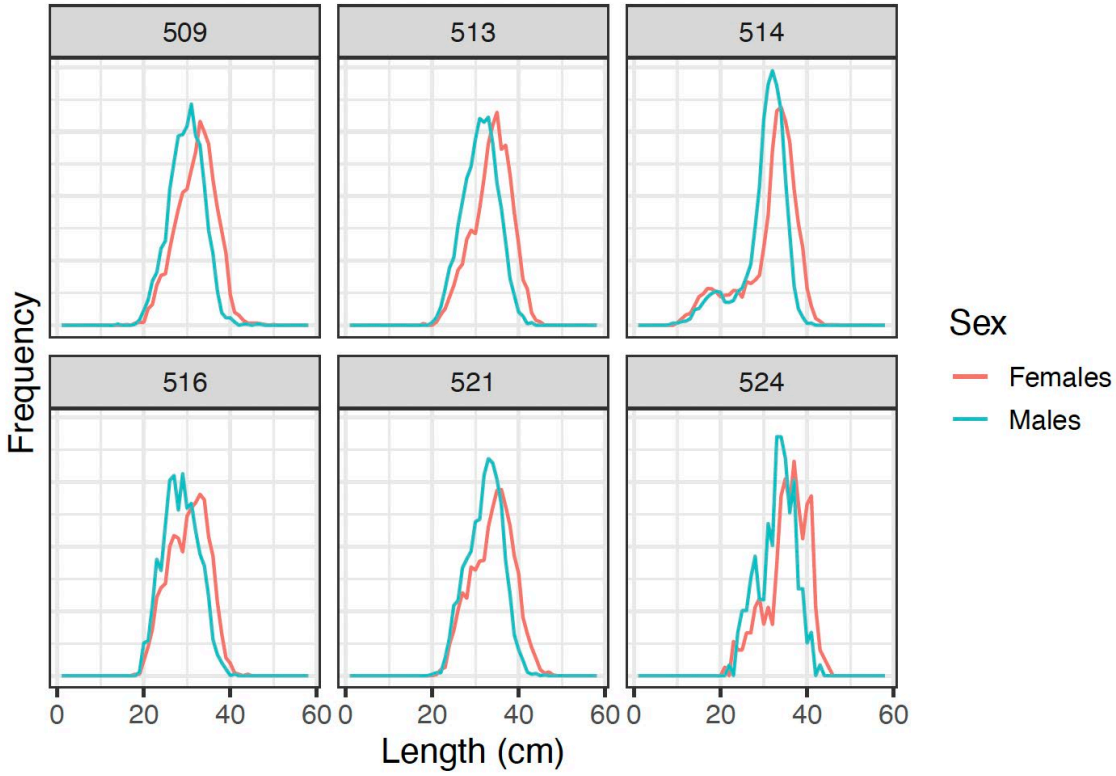
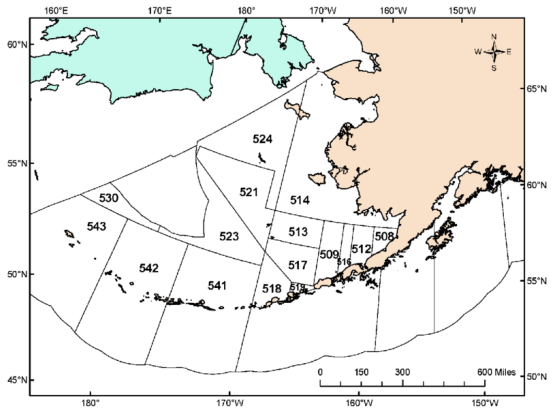
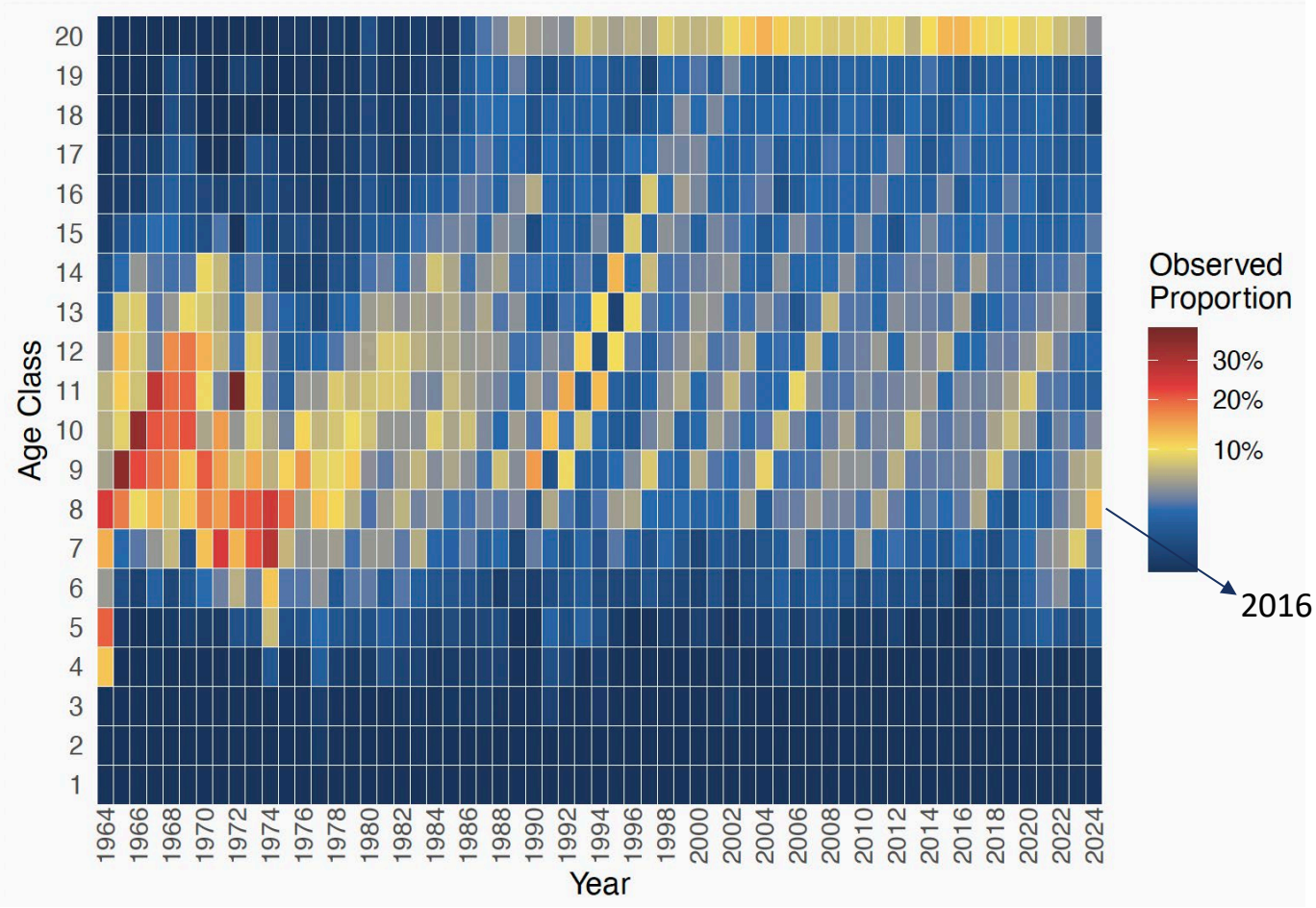
Size composition of the yellowfin sole catch in 2026 caught by trawl gear, by subarea



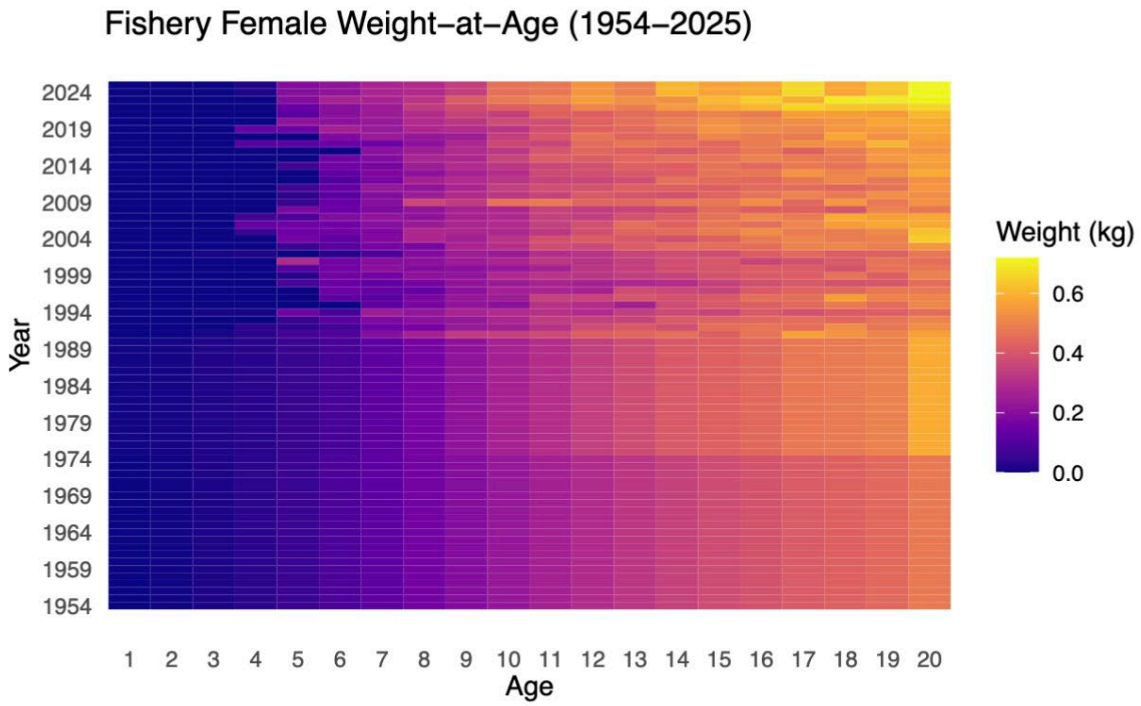


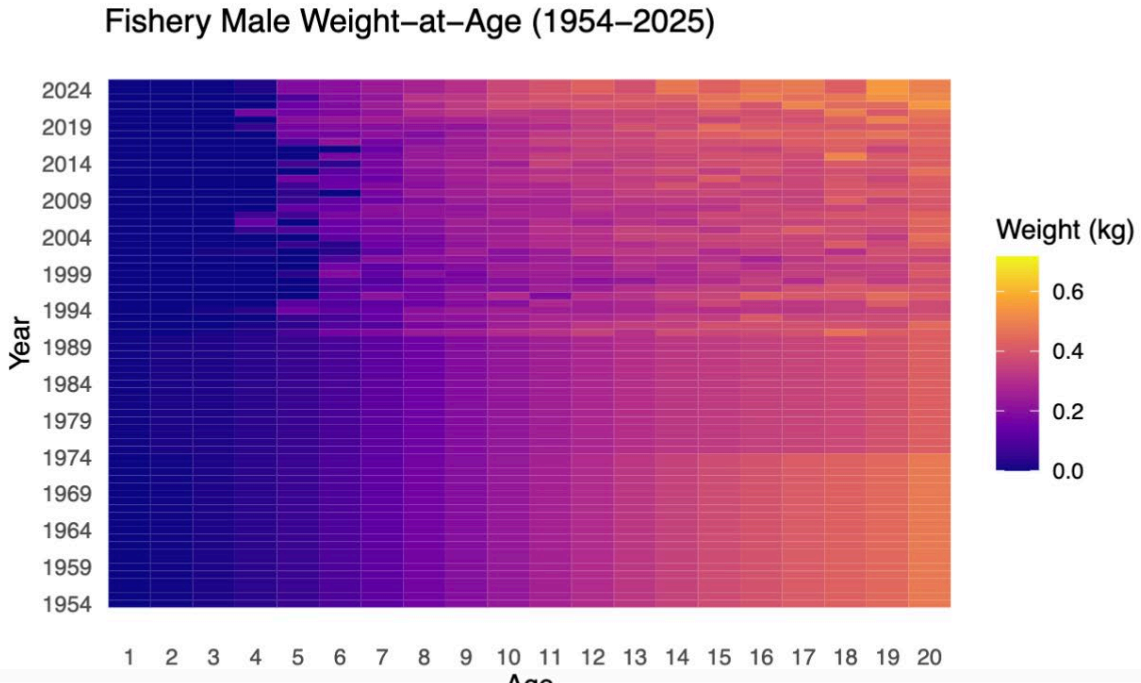
Primary areas where yellowfin sole are caught: 509, 513, 514, 516, 521, and 524.

Age frequency of yellowfin sole (females and males) from the fishery, 1977-2025



Fishery weight-at-age is increasing.

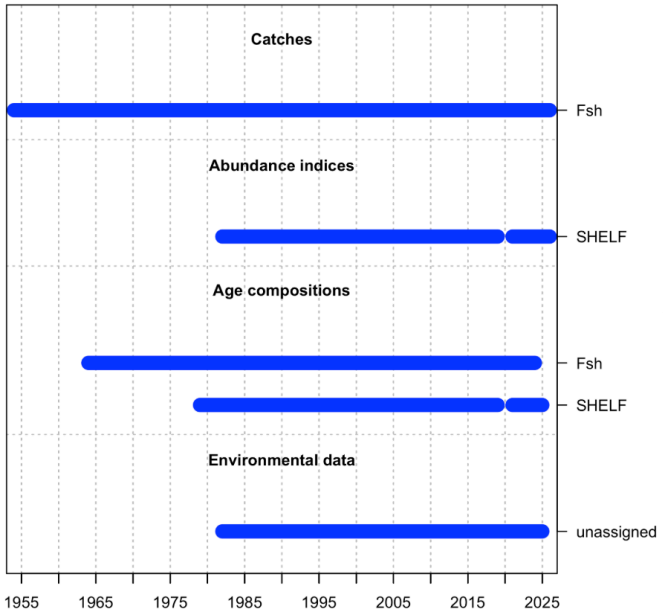




Data

Data used in Model 25.0, 25.0a, and 25.0b

Data source	Year
Fishery catch	1954 – 2026
Fishery age composition	1975 – 2024
Fishery weight-at-age	1954 – 2024
Survey biomass and standard error	1982 – 2026 (not 2020)
Bottom temperature	1982 – 2026
Survey age composition	1979 – 2025 (not 2020)
Annual length-at-age and weight-at-age from surveys	1979 – 2025 (not 2020)
Age at maturity	Combined 1992 and 2012 samples



New this year:
Survey age and weight: 2024 and 2025
Catch: 2025 and 2026 through October 1.
Survey biomass, SE for 2025 and 2026.

Index model: The model-based survey index was generated using VAST and 750 knots for the last full assessment in 2024. The 2026 index model used sdmTMB and 250 knots.

Survey age composition, survey biomass, standard error estimated using sdmTMB, tinyVAST.

Models

2026 Models – BSAI yellowfin sole



All models run in SS3 (vSS_V3_30_25)

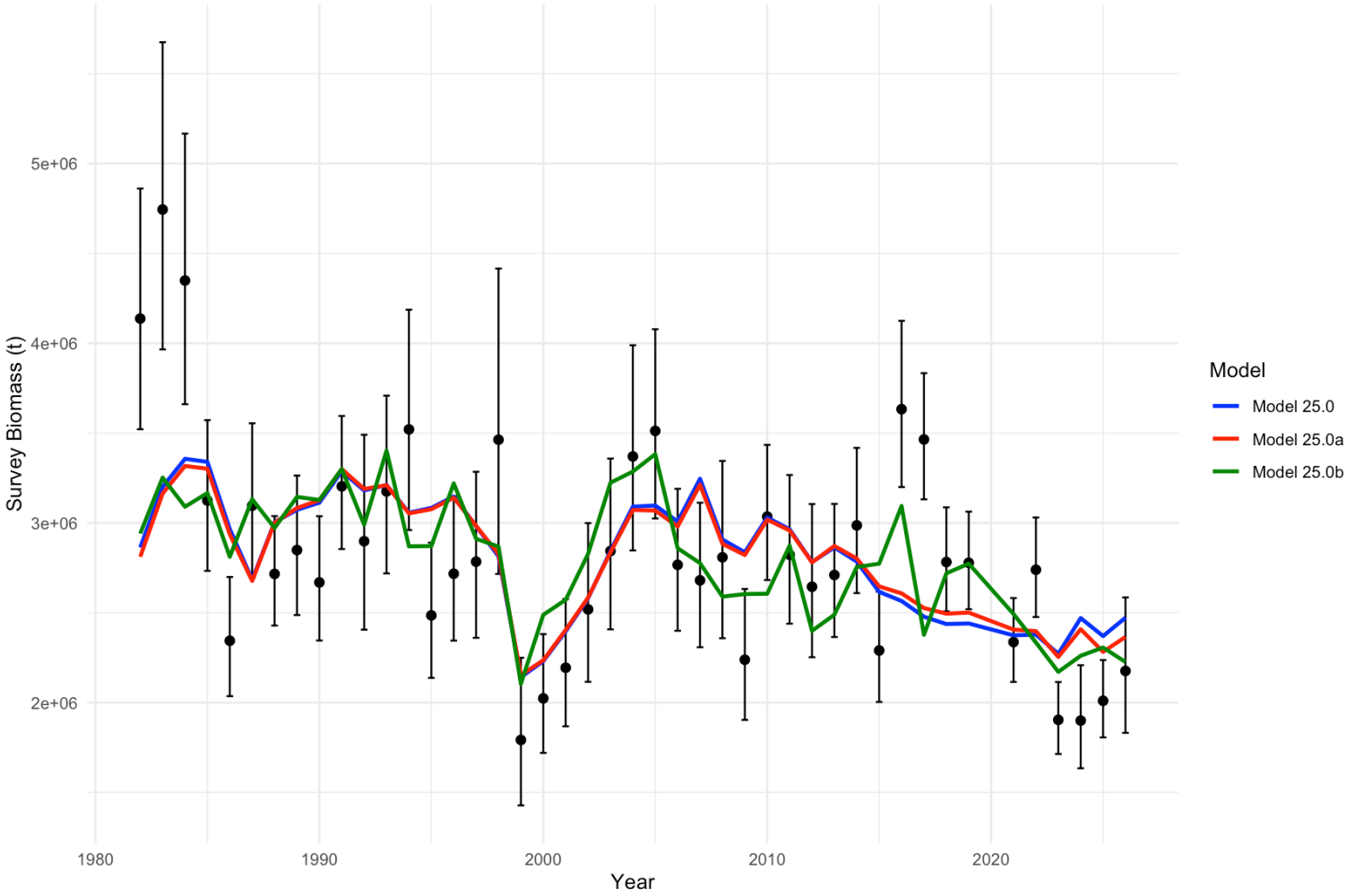
Base Model 25.0
Bridged from the 2024 ADMB model.

Model 25.0a
Incorporated ISS data weighting (Hulson et al. 2024). Survey start date covariate on catchability.

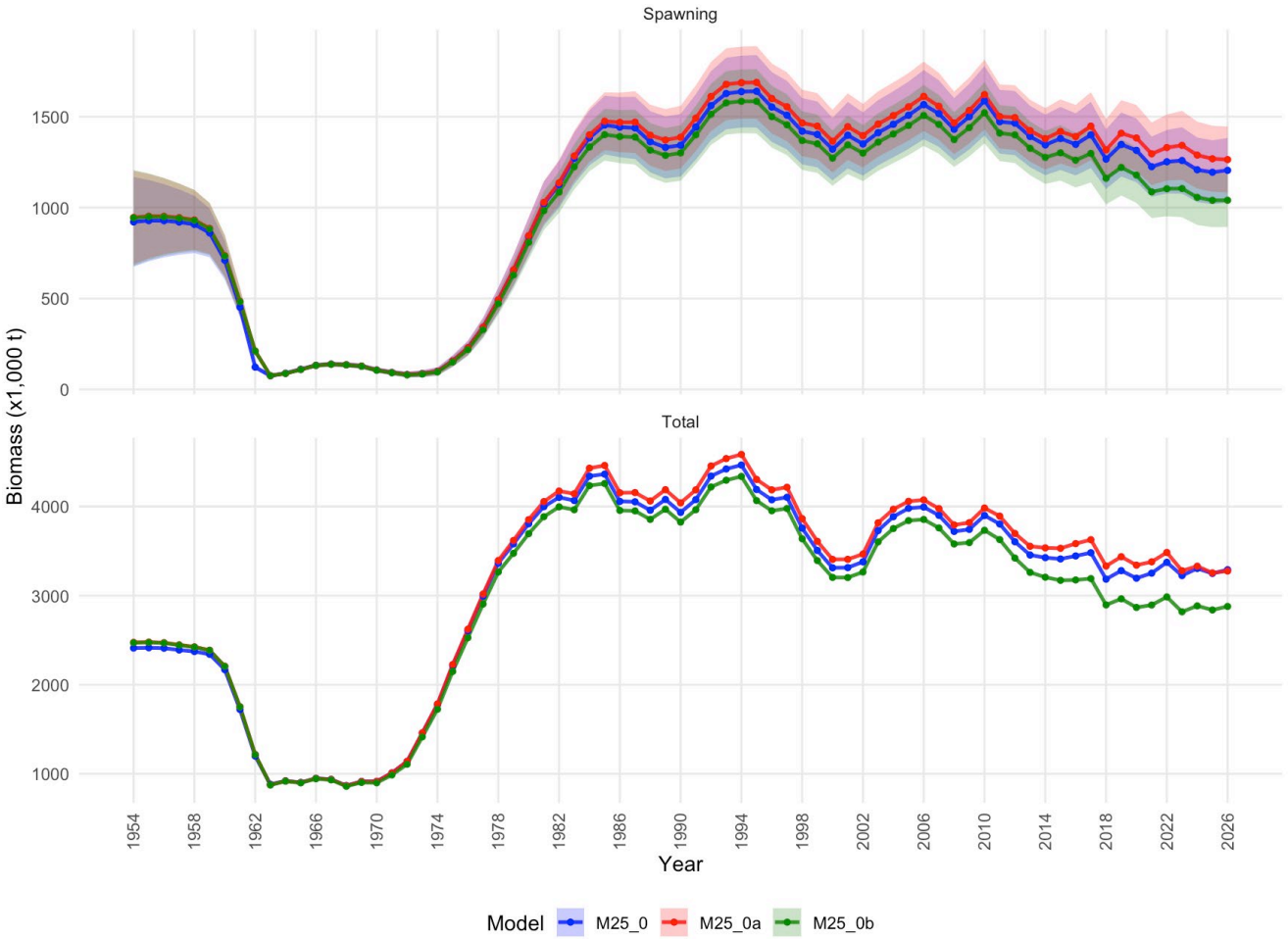
Model 25.0b (preferred)
Building on Model 25.0a, adds temperature covariate on catchability.

Results

Annual EBS bottom trawl survey biomass and 95% CI for yellowfin sole, 1982-2026, Model 25.0, 25.0a, and 25.0b.



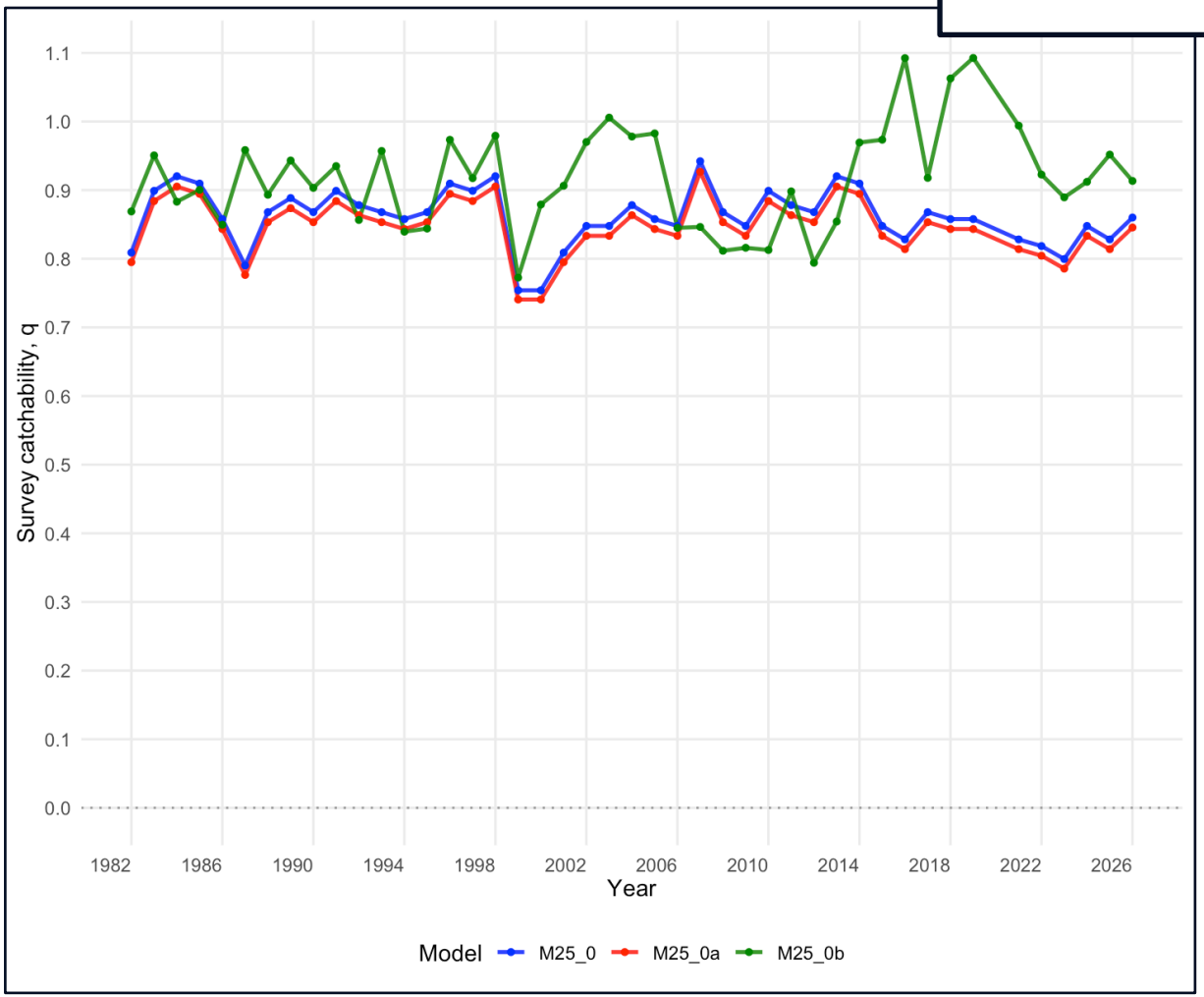
Estimates of yellowfin sole total (age 1+) and female spawning biomass with 95% confidence intervals, 1954-2026, all models.



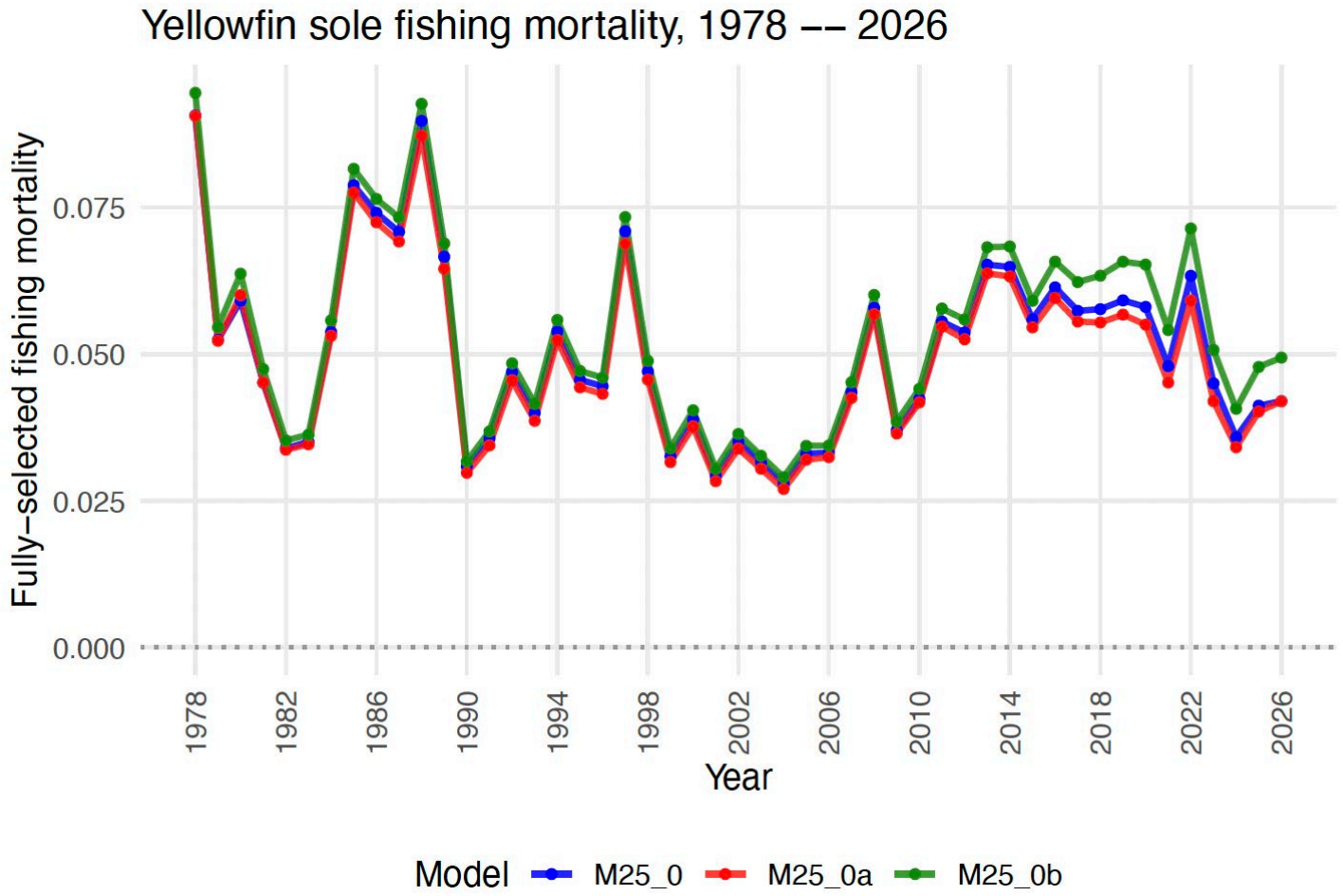
Catchability

SS3 uses an additive log-space environmental link:

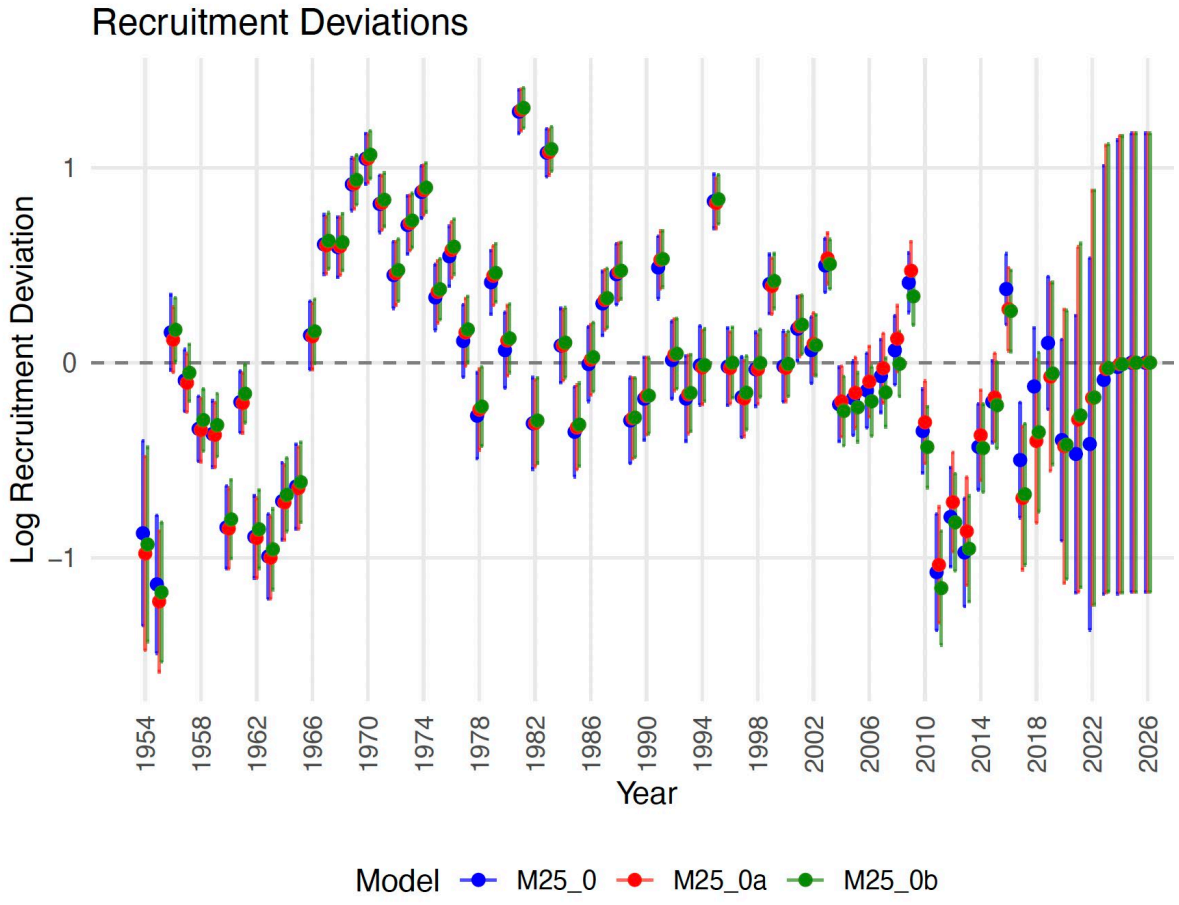
$$q_y = q_{base} + P_t env_y,$$ rather than: $$q_t = e^{-\alpha+\beta S}$$ $$q_t = e^{-\alpha+\beta T}$$



Fishing mortality



Recruitment deviations for age 1 yellowfin sole, for each of the three models, 25.0, 25.0a, and 25.0b.



Model comparison – stock status and reference points

	Last assessment		Model 25.0		Model 25.0a		Model 25.0b	
	As estimated or *specified in 2024*∗ for:		As estimated or *recommended this* year for:		As estimated or *recommended this* year for:		As estimated or *recommended this* year for:	
Quantity	2025	2026	2027	2028	2027	2028	2027	2028
M (natural mortality rate)	0.12, 0.128	0.12, 0.128	0.12, 0.132	0.12, 0.132	0.12, 0.132	0.12, 0.132	0.12, 0.132	0.12, 0.132
Tier	3a	3a	3a	3a	3a	3a	3a	3a
Projected total (age 1+) biomass	2,308,550	2,353,240	3,006,350	2,870,560	2,944,530	2,853,780	2,583,910	2,533,910
Projected female spawning bioma	748,076	758,695	1,206,920	1,164,970	1,243,340	1,180,670	1,032,620	993,225
$B_{100\%}$	1,383,020	1,383,020	2,139,500	2,139,500	2,149,880	2,149,880	2,036,510	2,036,510
$B_{40\%}$	-	-	855,801	855,801	859,953	859,953	814,605	814,605
$B_{35\%}$	479,711	479,711	748,826	748,826	752,459	752,459	712,779	712,779
F_{OFL}	0.13	0.13	0.099	0.099	0.096	0.096	0.097	0.097
$maxF_{ABC}$	0.114	0.114	0.084	0.084	0.081	0.081	0.083	0.083
F_{ABC}	0.114	0.114	0.084	0.084	0.081	0.081	0.083	0.083
OFL	299,247	305,039	243,338	235,789	233,407	227,070	204,846	201,766
$maxABC$	262,557	267,639	208,046	201,597	199,803	194,370	175,231	172,592
ABC	262,557	267,639	208,046	201,597	199,803	194,370	175,231	172,592
	As determined in 2024 for							
Status	2023	2024	2025	2026	2025	2026	2025	2026
Overfishing	No	n/a	No	n/a	No	n/a	No	n/a
Overfished	n/a	No	n/a	No	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No	n/a	No	n/a	No

Why differences in the 3 new models?

- Survey biomass increase.
- Average weight-at-age increase.
- Catchability configuration change.
- Francis weighting (standard in SS3).

Negative log-likelihood (NLL) comparison across candidate models (lower values indicate a better fit). Note: Data weighting differs between base Model 25.0 and the 25.0a/25.0b models. For direct comparability in this table, Model 25.0a was run using the same Francis weights as Model 25.0b.

Label	M25_0	M25_0a	M25_0b
TOTAL_like	673.316	749.417	733.857
Survey_like	9.108	1.699	-9.417
Age_comp_like	631.987	711.014	707.678
Recruitment_like	-1.178	-0.634	-1.306
Forecast_Recruitment_like	0.558	0.171	0.147
Parm_priors_like	0.004	0.006	0.000
Recr_Virgin_billions	3.144	3.166	2.993
SR_BH_steep	1.000	1.000	1.000
NatM_uniform_Fem_GP_1	0.120	0.120	0.120
NatM_uniform_Mal_GP_1	0.132	0.132	0.132
LnQ_base_SHELF(2)	-0.151	-0.170	-0.091
LnQ_base_SHELF(2)_ENV_add	0.049	0.050	0.080
SSB_Virgin	1,808,500	1,820,760	1,721,440
SSB_2026	1,204,630	1,266,730	1,040,200
Bratio_2026	0.563	0.588	0.511
SPRratio_2026	0.356	0.353	0.397
Ret_Catch_MSY	170,605	170,422	161,906
Dead_Catch_MSY	170,605	170,422	161,906
SR_LN(R0)	14.961	14.968	14.912

Correlated parameter pairs – baseQ and log(R0)

Table 4.18: Highly correlated parameter pairs for Model 25.0.

label.i	label.j	corr
LnQ_base_SHELF(2)	SR_LN(R0)	-0.905953

Table 4.19: Highly correlated parameter pairs for Model 25.0a.

label.i	label.j	corr
LnQ_base_SHELF(2)	SR_LN(R0)	-0.896123

Table 4.20: Highly correlated parameter pairs for Model 25.0b.

label.i	label.j	corr
LnQ_base_SHELF(2)	SR_LN(R0)	-0.880896



Is the use of the temperature covariate for Model 25.0b 'double counting'?

CIE Review:

- The use of bottom temperature in VAST is not an issue because it is not used there to address annual variation in availability.
- Mean bottom temperature used as a "density covariate".
- VAST (sdmTMB) distinguishes between "density" and "catchability" covariates (Thorson 2023).
- Low temperature:
  - Affects mobility of the fish, and therefore herding is reduced.
  - Delays the migration of the fish returning from spawning (availability);
  - Inhibits growth.

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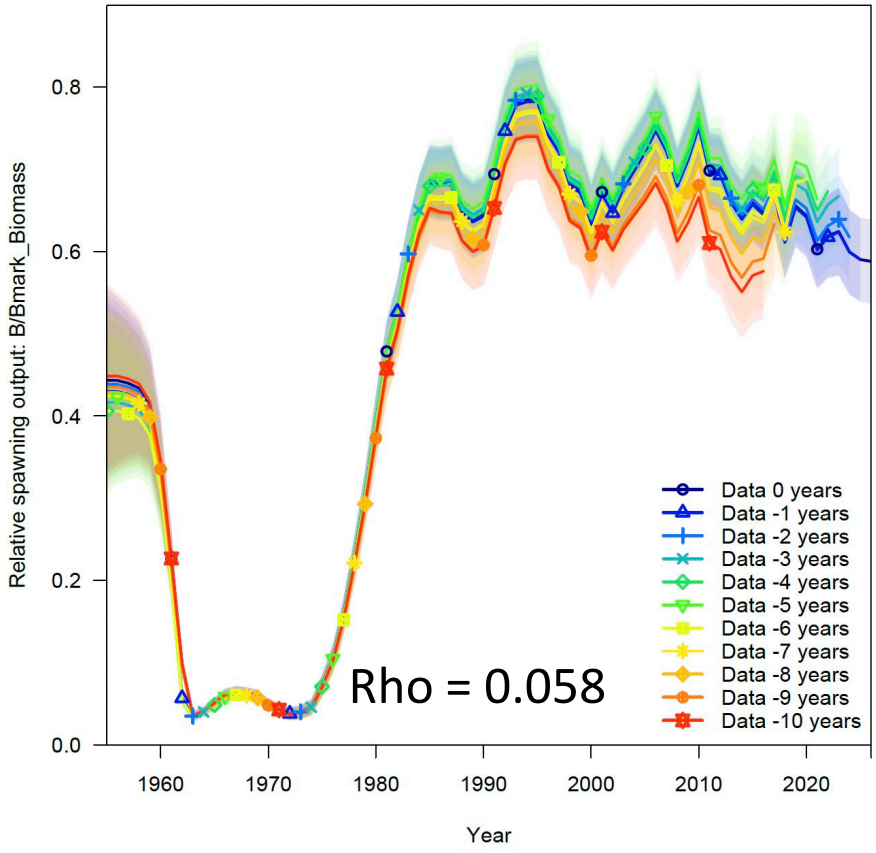
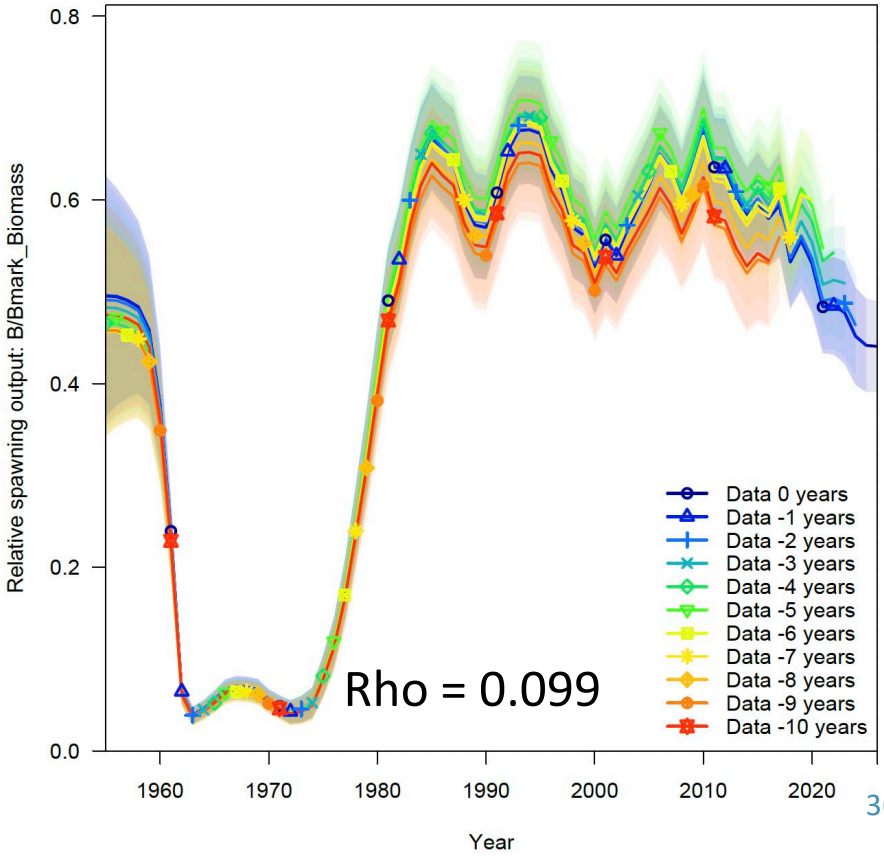
Model Diagnostics
(Only Models 25.0a and 25.0b)

Retrospective plot of female spawning biomass for yellowfin sole, Models 25.0a and 25.0b.

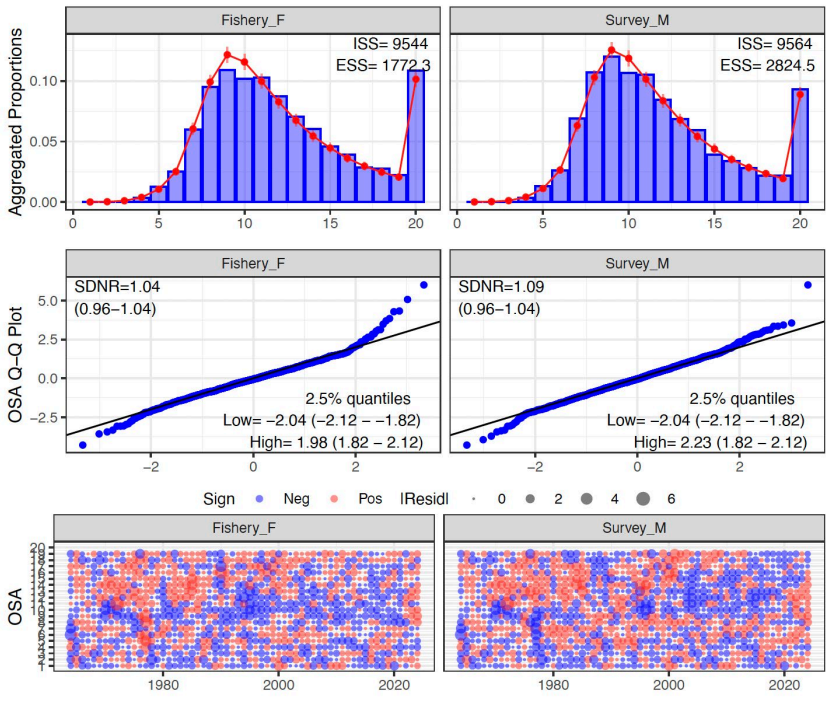
Model 25.0a



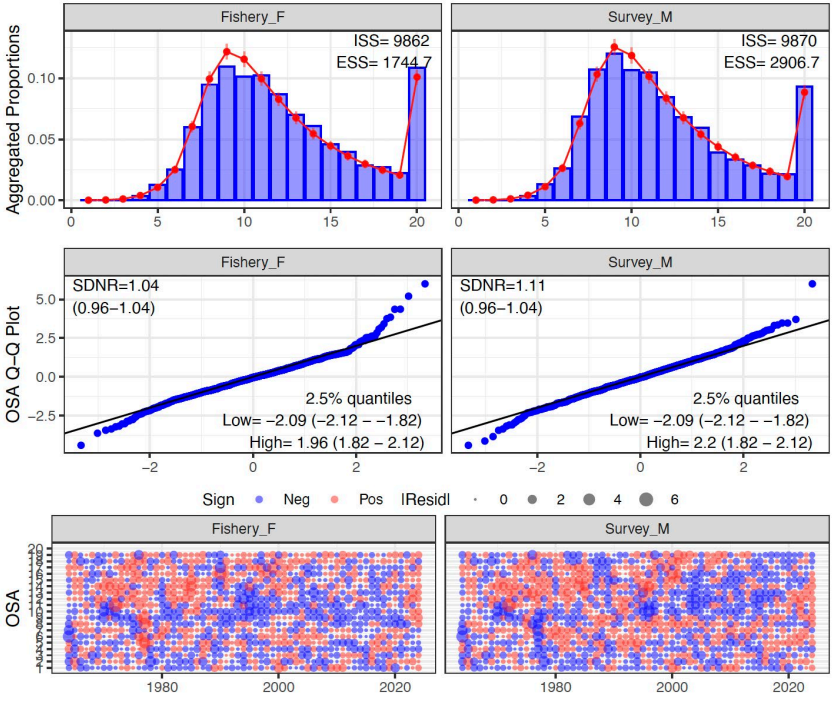
Model 25.0b



One-step-ahead residuals for the yellowfin sole fishery ages, Model 25.0a (left) 25.0b (right).

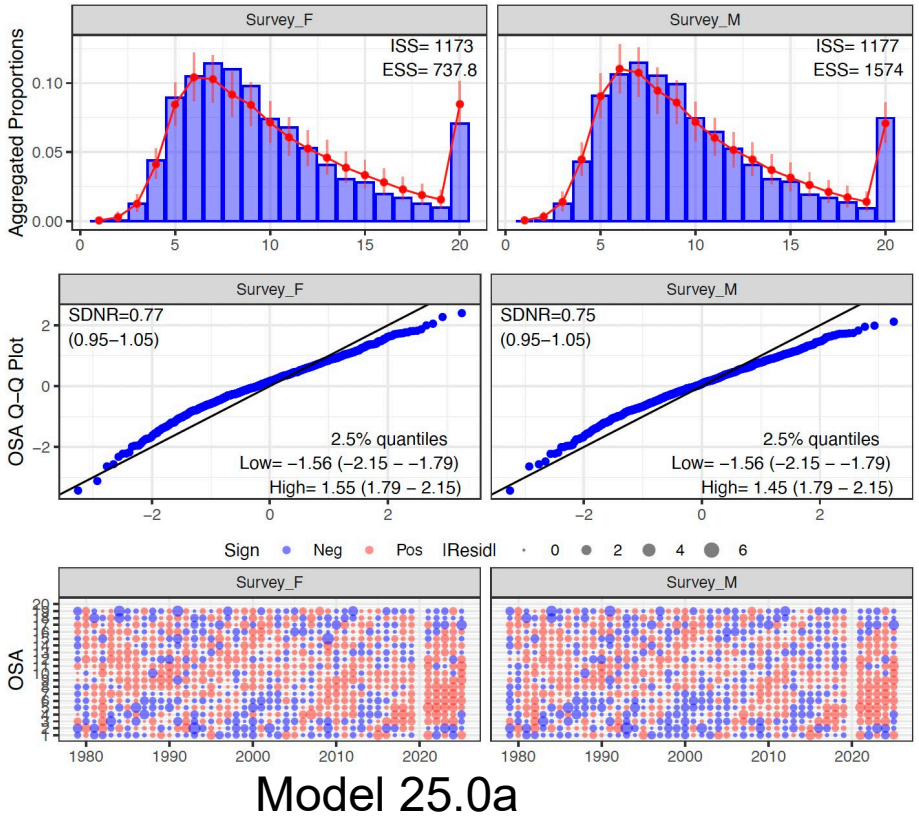


Model 25.0a

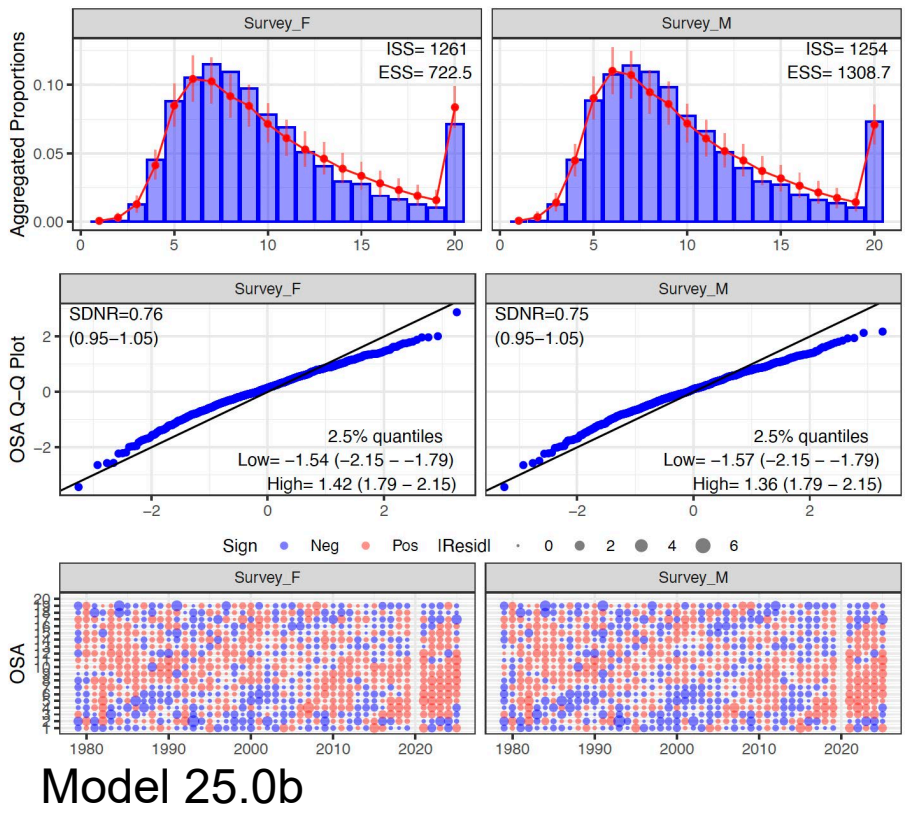


Model 25.0b

One-step-ahead residuals for the yellowfin sole survey ages, Model 25.0a (left) 25.0b (right).



Model 25.0a



Model 25.0b

Data weighting

Data weighting differences make a large difference to the model estimates of $B_{100\%}$, R0, and downstream reference points.

ADMB bespoke model and bridging models used identical weighting for the fishery and the survey.

Table 4.13: Iterative Francis reweighting values for the fishery and survey age composition data for Models 25.0, 25.0a, 25.0b.

Iteration	Model 25.0		Model 25.0a		Model 25.0b	
	Fishery	Survey	Fishery	Survey	Fishery	Survey
1	1.703737	0.327496	1.041923	0.165561	1.016508	0.175408
2	2.287648	0.322269	1.007138	0.165270	1.024927	0.176640
3	2.599925	0.320573	0.995017	0.165315	1.027910	0.176747

SS3 Francis weighting indicates that the fishery adjusted N is ~160, while the mean survey weights for Model 25.0b = 27.

Francis weighting within SS3 results in 'adjusted N'.

Francis weighting was performed in ADMB on survey data, and final weights were set identical for the fishery.

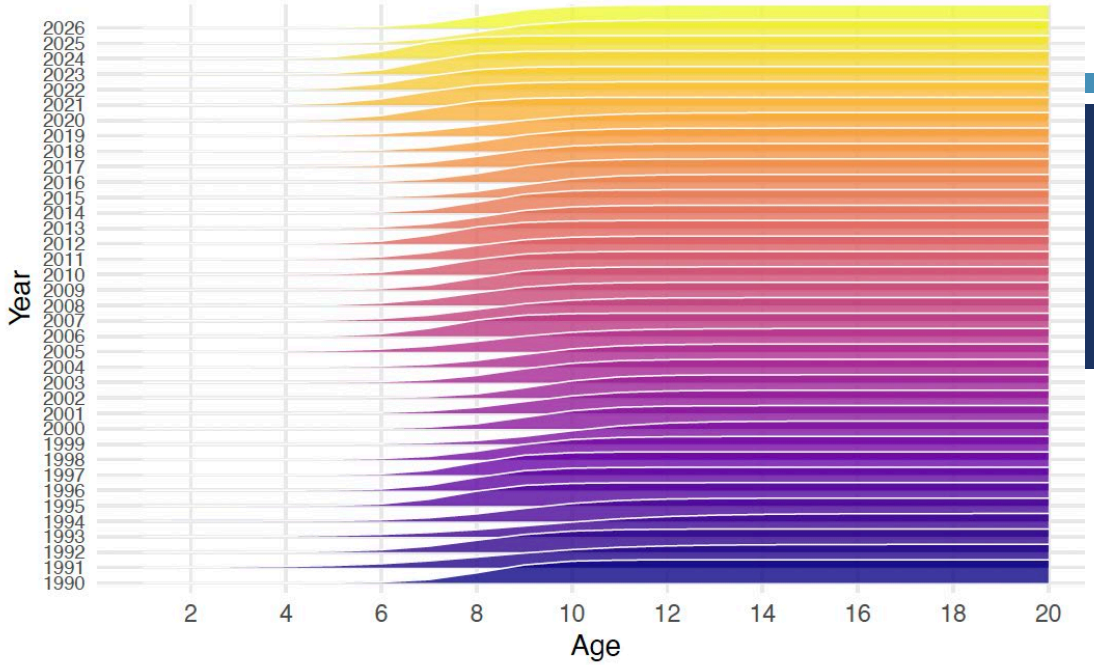
Table 4.14: Data weights for age compositions for fishery (fleet = 1), raw and adjusted after Francis reweighting for Models 25.0, 25.0a, 25.0b. All years of fishery data used the same weights.

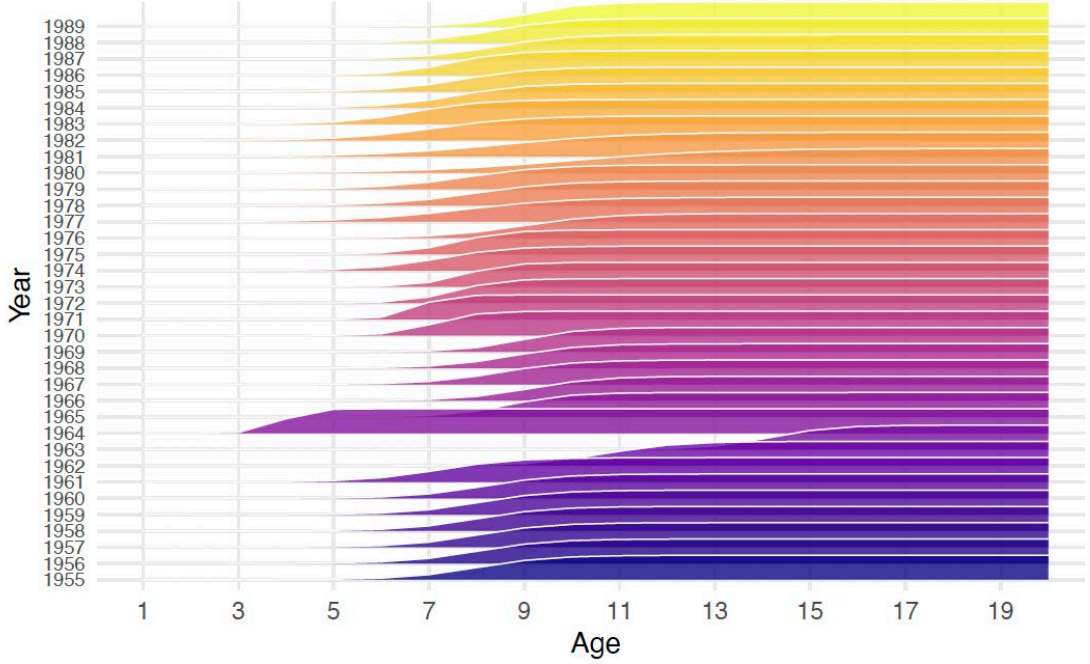
Fleet	Year	Model 25.0		Model 25.0a		Model 25.0b	
		Initial N	Adjusted N	Initial N	Adjusted N	Initial N	Adjusted N
1	1964	56.9302	148.014	157.419	156.634	157.419	161.812

Survey weights

Fleet	Year	Model 25.0		Model 25.0a		Model 25.0b	
		Initial N	Adjusted N	Initial N	Adjusted N	Initial N	Adjusted N
2	1979	56.9302	18.25030	157.419	26.02370	157.419	27.8233
2	1980	56.9302	18.25030	157.419	26.02370	157.419	27.8233
2	1981	56.9302	18.25030	157.419	26.02370	157.419	27.8233
2	2019	67.0000	21.47840	192.000	31.74050	192.000	33.9354
2	2021	200.0000	64.11460	108.000	17.85400	108.000	19.0887
2	2022	195.0000	62.51170	122.000	20.16840	122.000	21.5631
2	2023	172.0000	55.13860	152.000	25.12790	152.000	26.8655
2	2024	160.0000	51.29170	100.000	16.53150	100.000	17.6747
2	2025	160.0000	51.29170	103.000	17.02740	103.000	18.2049

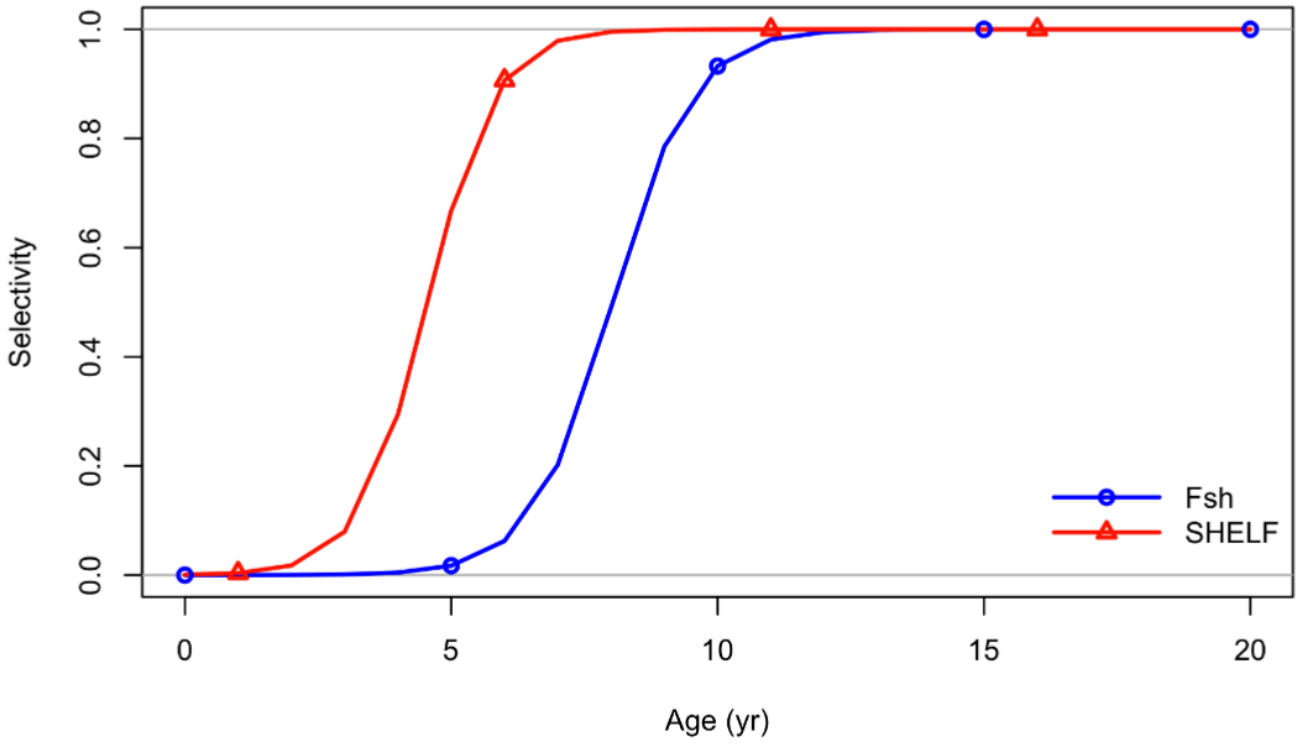
Results and Sensitivity testing (Preferred Model 25.0b)





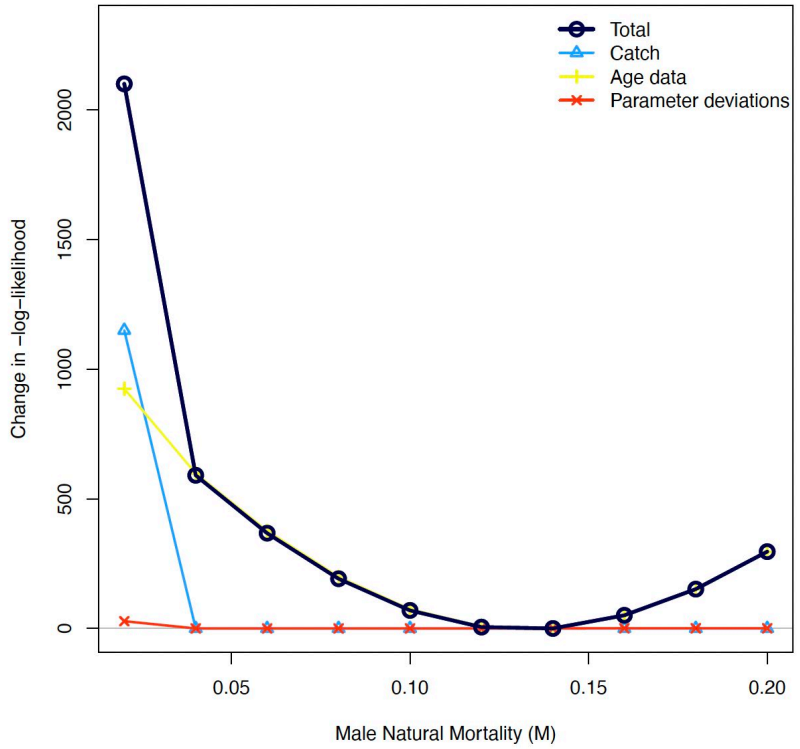
Yellowfin sole fishery selectivity for males and females, 1954-2026, Model 25.0b

Model 25.0b survey selectivity (last year of fishery selectivity is shown)

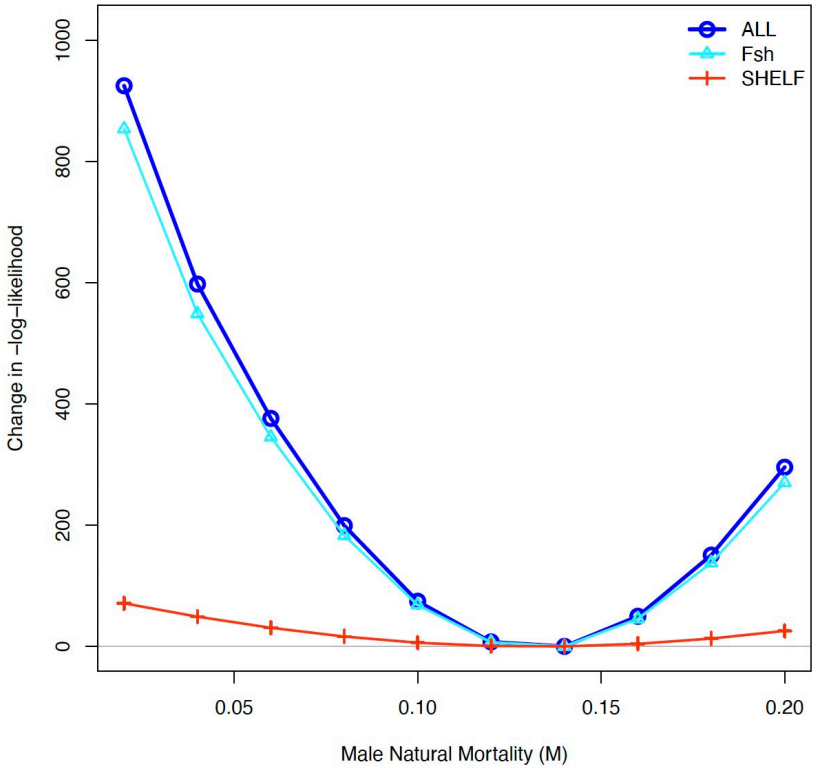


Likelihood profile for male natural mortality in Model 25.0b, female natural mortality fixed at 0.12.

Likelihood profile



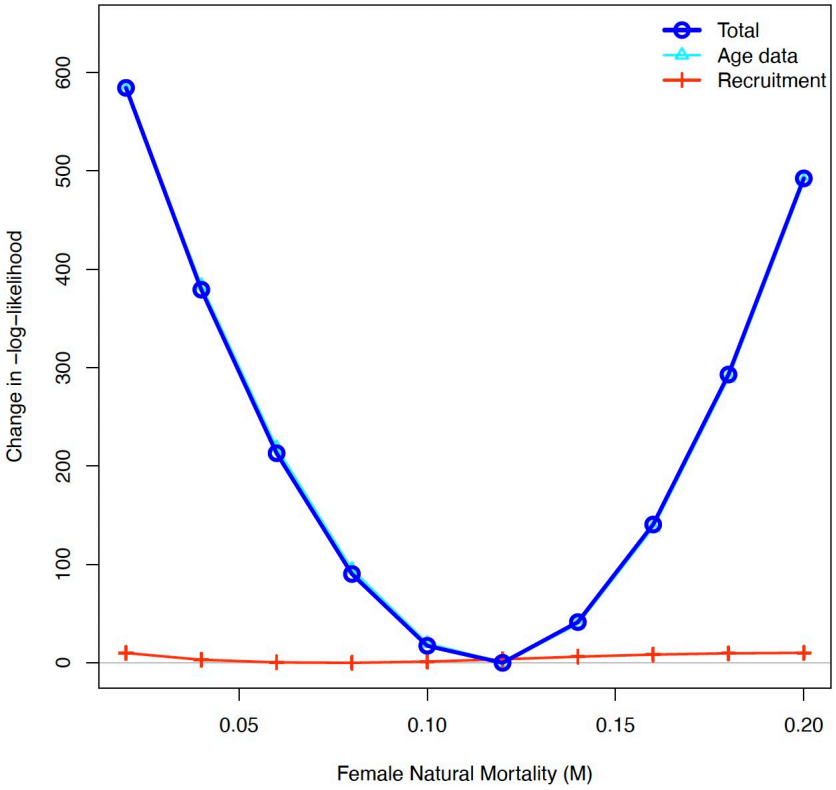
Piner plot



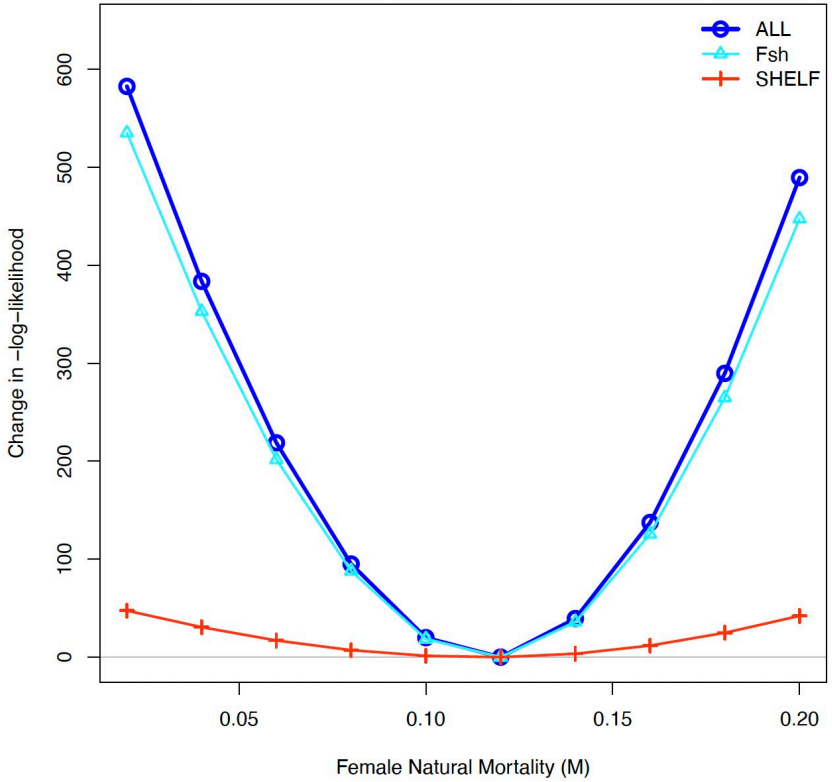
Model 25.0b

Likelihood profile for female natural mortality in Model 25.0b, male natural mortality fixed at its MLE of 0.132.

Likelihood profile



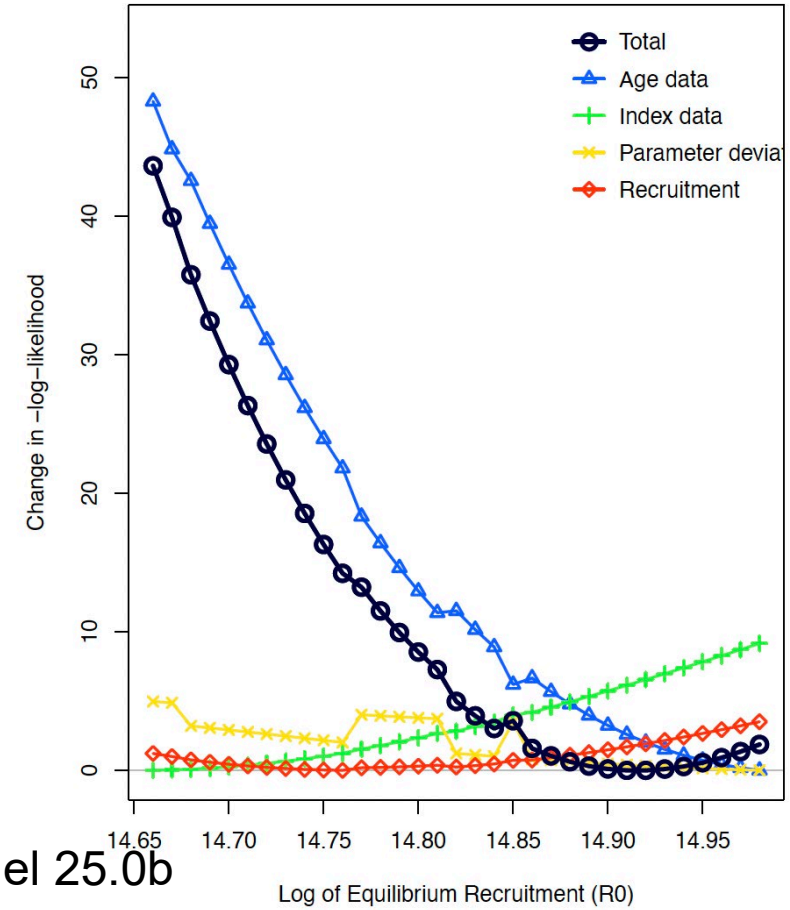
Piner plot



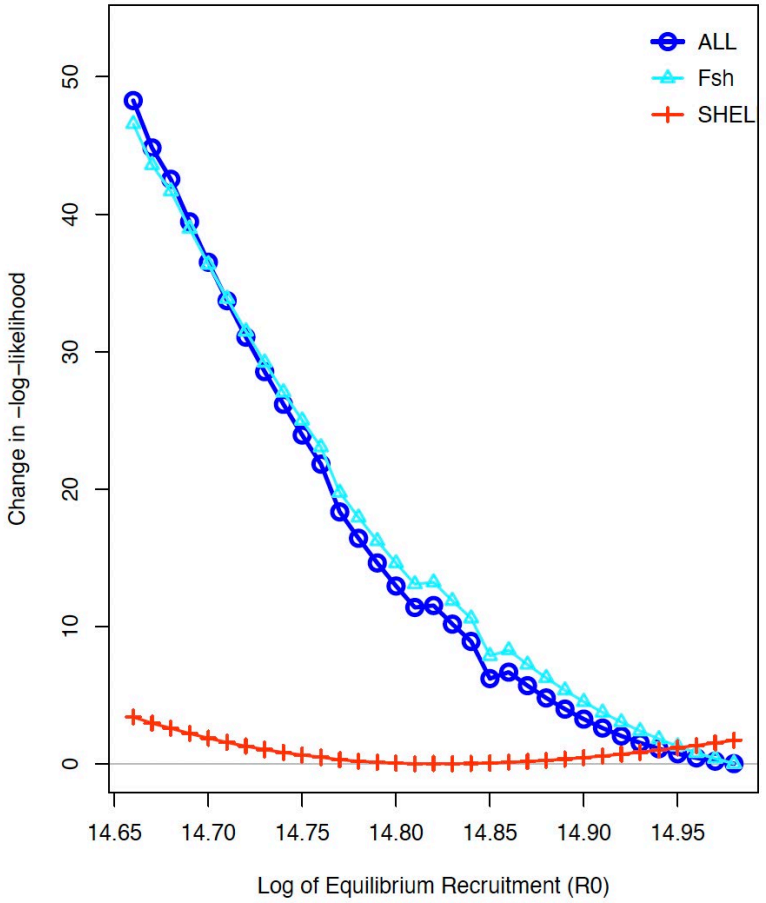
Model 25.0b

Likelihood profile for log(R0) – initial recruitment. MLE is 14.912

Likelihood profile



Piner plot

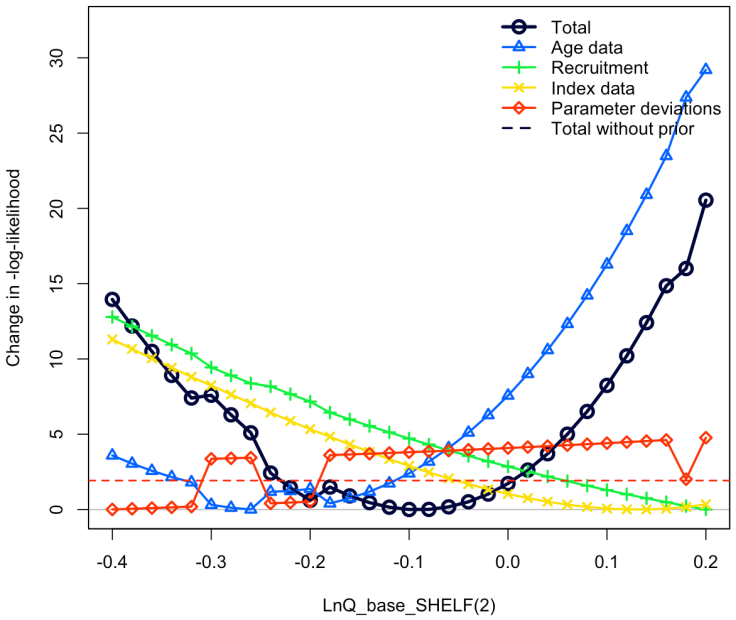


Model 25.0b

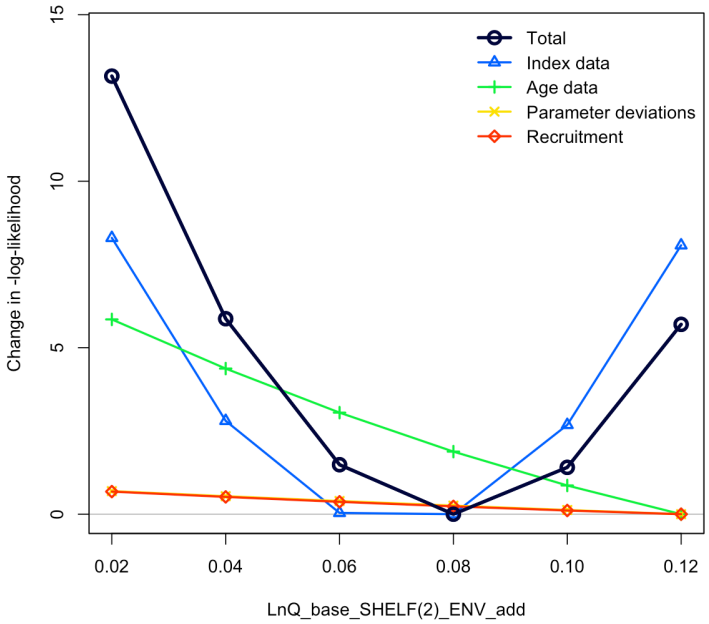
Likelihood profile for base q - catchability. MLE is -0.091.

Likelihood profile for q environmental covariate MLE is 0.08.

$$q_y = q_{base} + P_t env_y,$$



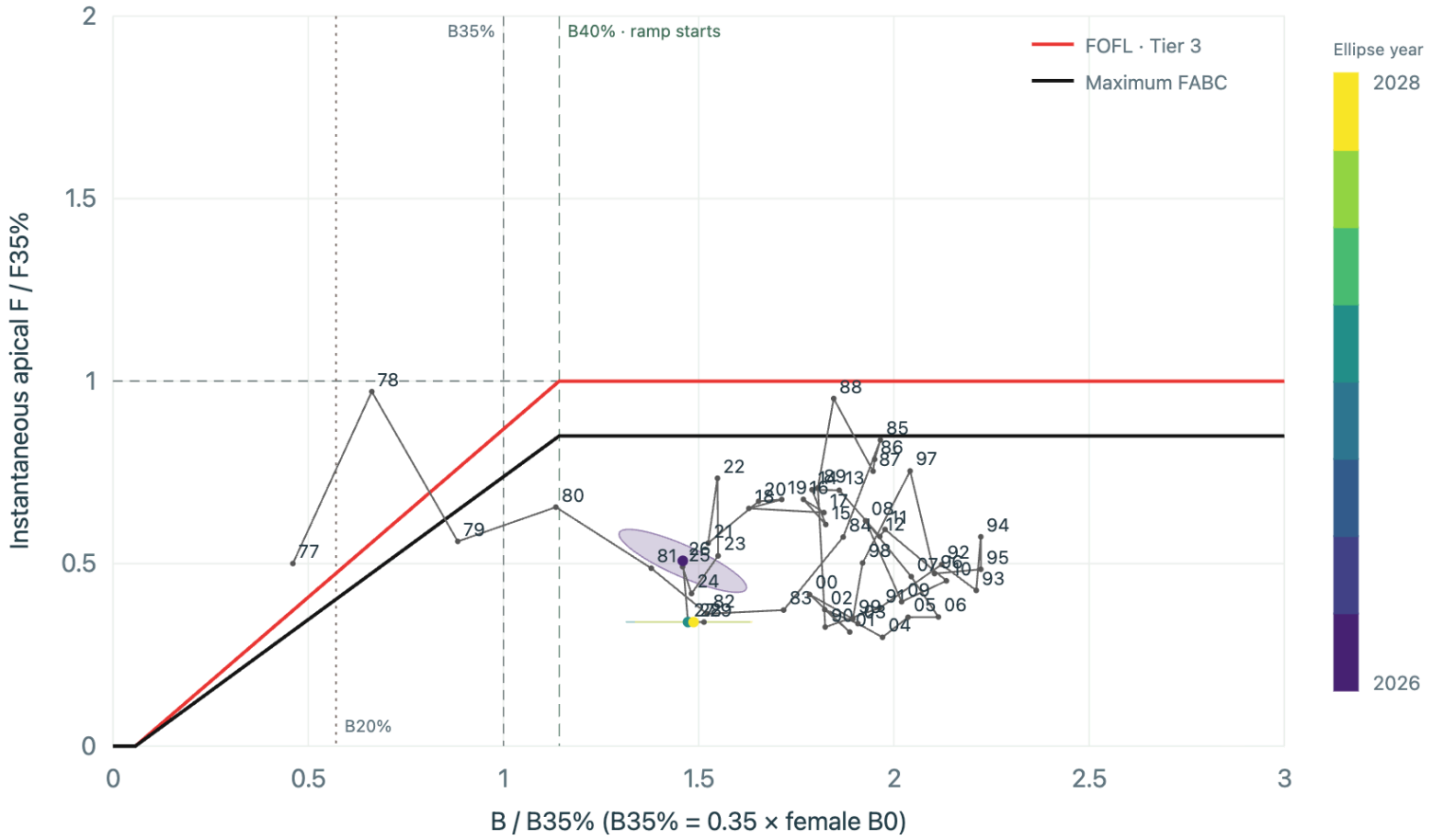
$$q_y = q_{base} + P_t env_y,$$



Model 25.0b

Summary for Model 25.0b

Yellowfin sole fishing mortality rate and female spawning biomass from 1977 to 2026 compared to the $F_{35\%}$ and $F_{40\%}$ control rules, based on Model 25.0b. 95% uncertainty elipses for 2026. $B_{51\%}$



Summary Table

Summary Table for Model 25.0b.

Quantity	As estimated or *specified in 2024*∗ for: 2025	2026	As estimated or *recommended this* year for: 2027	2028
M (natural mortality rate)	0.12, 0.128	0.12, 0.128	0.12, 0.132	0.12, 0.132
Tier	3a	3a	3a	3a
Projected total (age 1+) biomass (t)	2,308,550	2,353,240	2,583,910	2,533,910
Projected female spawning biomass (t)	748,076	758,695	1,032,620	993,225
$B_{100\%}$	1,383,020	1,383,020	2,036,510	2,036,510
$B_{40\%}$	-	-	814,605	814,605
$B_{35\%}$	479,711	479,711	712,779	712,779
F_{OFL}	0.13	0.13	0.097	0.097
$maxF_{ABC}$	0.114	0.114	0.083	0.083
F_{ABC}	0.114	0.114	0.083	0.083
OFL	299,247	305,039	204,846	201,766
$maxABC$	262,557	267,639	175,231	172,592
ABC	262,557	267,639	175,231	172,592
	As determined in 2024 for			
Status	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



Risk Table

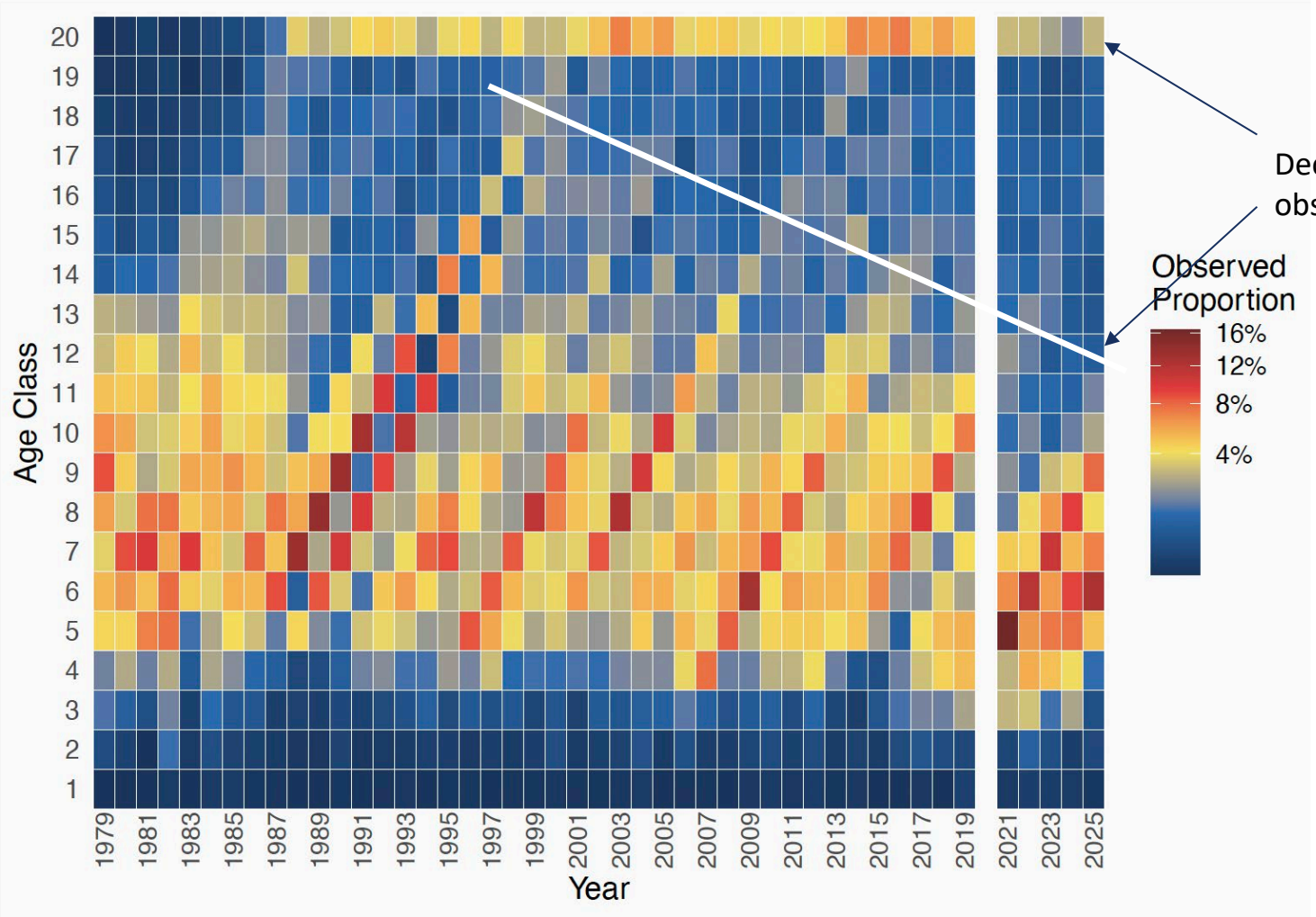
Assessment Considerations

- The current Stock Synthesis (SS3) model performs well based on diagnostics.
- We have thoroughly evaluated the structural choices made during this transition.
- The CIE review process was conducted in 2026 to resolve outstanding questions and clarify remaining uncertainties. The review supported the models presented here.
- The data time series used in this assessment is extensive.
- Transitioning to a Tier 3 assessment provides a more robust and balanced framework than the potentially over-extended Tier 1 approach.

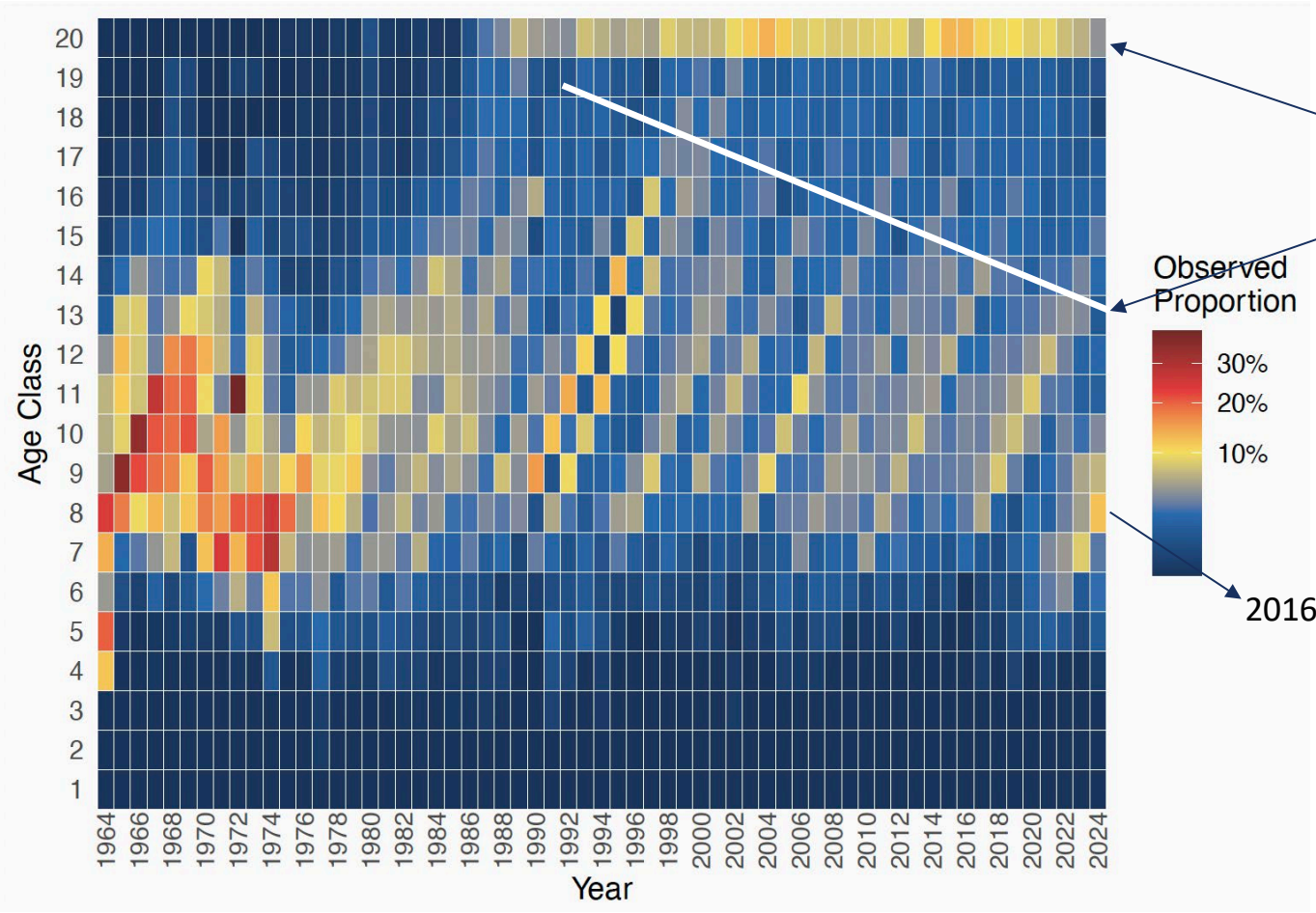
Level 1: Normal' risk level rating for population dynamics

Population Dynamics Considerations

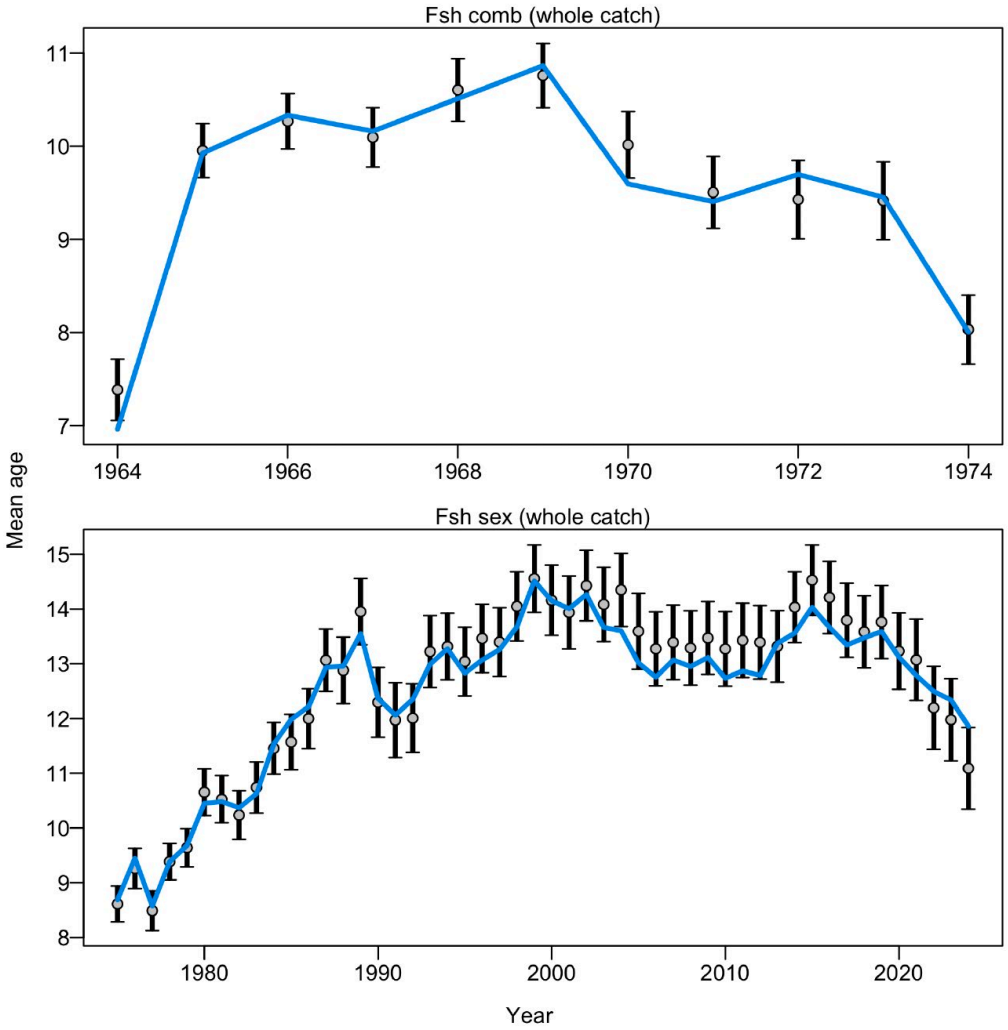
Age frequency of yellowfin sole (females and males) from the AFSC/NMFS research surveys, 1979-2025



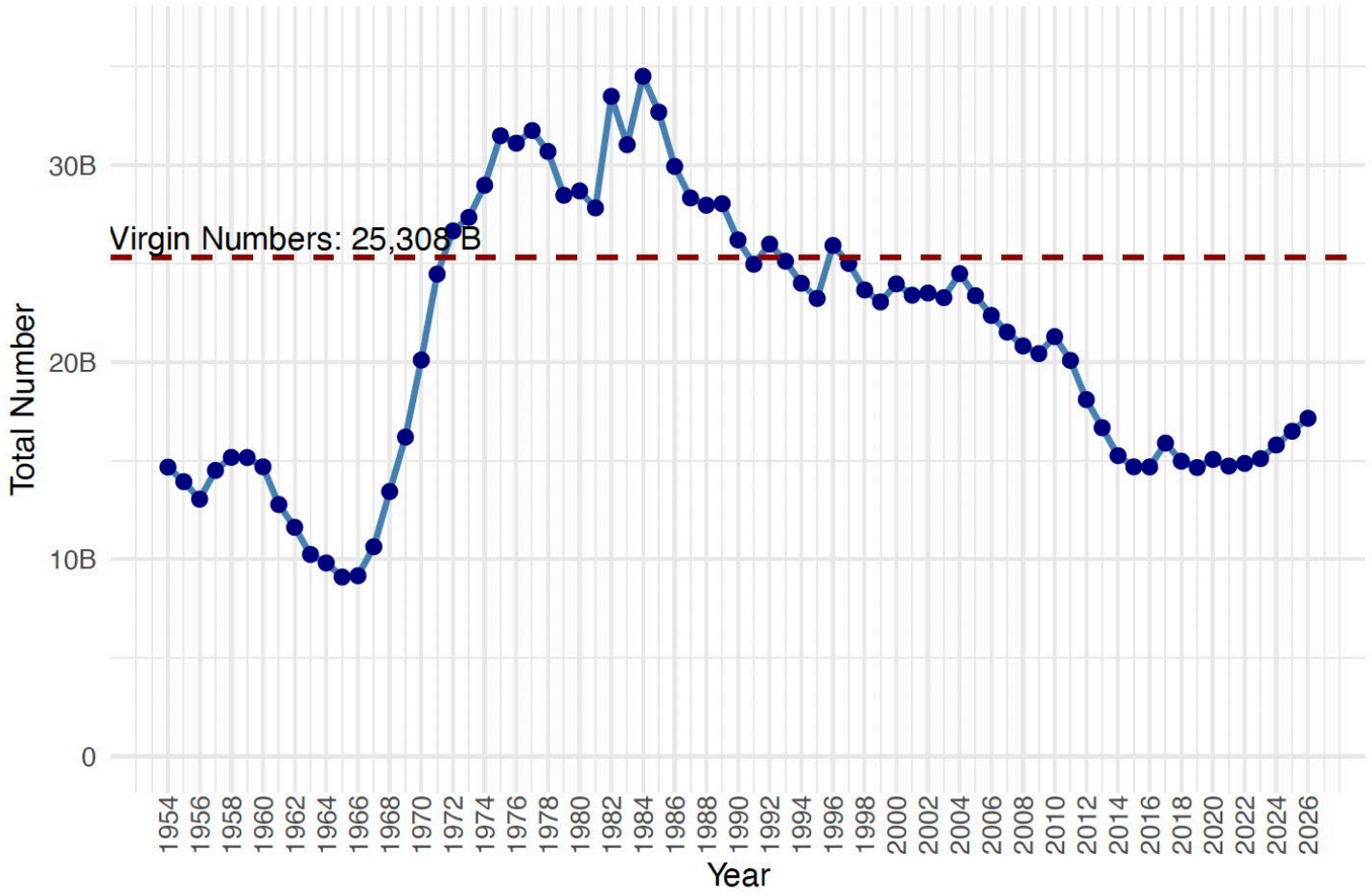
Age frequency of yellowfin sole (females and males) from the fishery, 1977-2025



Mean fishery age of yellowfin sole remained constant ~1995 – 2025, and has declined since 2015.



Total number in the population has declined since a peak in 1984, and leveled off at ~60% of unfished since ~2014.



Source: Model 25.0b.

Population Dynamics Considerations

- As described in this document, the population remains healthy, with biomass well over
- $B_{40\%}$ ($B_{44\%}$), total population numbers ~ 60% of their unfished abundance.

- However, the stock has declined steadily over the past few decades, with lower overall numbers, potentially lower survival rates, and lower mean age.

- This may be balanced somewhat by faster growth, larger weight-at-age, and a recent uptick in population biomass and steady population sizes since 2024.

- Because of recent improvements and steady population sizes, we retain a:

Level 1: Normal' risk level rating for population dynamics

Ecosystem Considerations

- Following a warm period (2014-2021), then average thermal conditions (2022-2025), 2026 transitioned to cool oceanographic conditions across the eastern Bering Sea shelf.

- For early life stages, cooler spring and summer temperatures may result in lower metabolic demands.

- For adult fishable biomass, standard bottom trawl survey biomass increased from 2025, adult morphometric condition (based on L/W residuals) in the SEBS
- remained above the long-term mean, and indicators of benthic prey availability were strong.

- Furthermore apex predator biomass remains below historical time-series means, resulting in low predation pressure.

Level 1: Normal' risk level rating for population dynamics

Fishery Considerations

- The 2026 fishery CPUE has increased slightly since 2024, but overall CPUE is within the range observed over
- the past several decades.

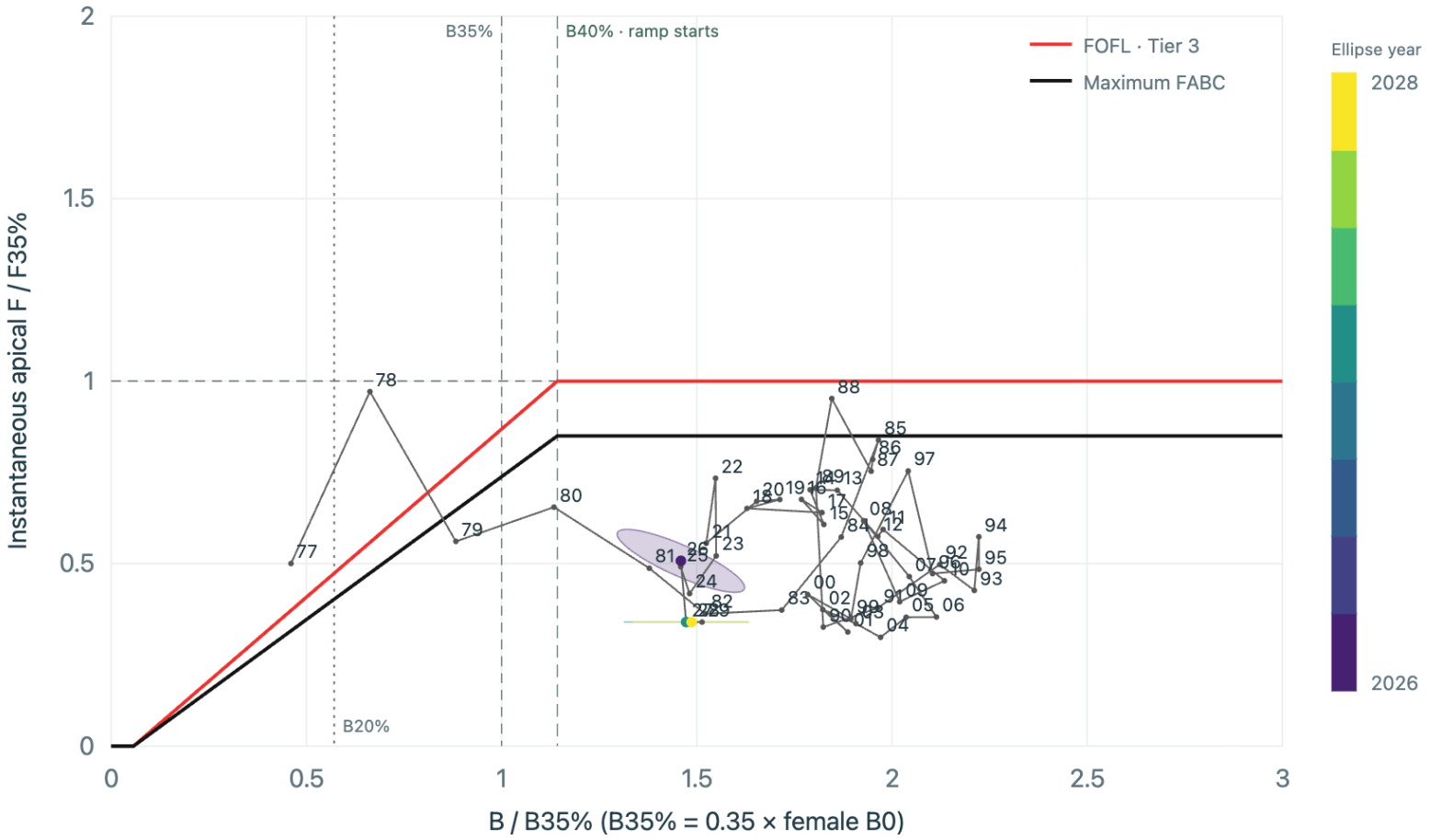
- There are no specific concerns regarding stock biomass trend, unusual spatial pattern of fishing, changes in the percent of TAC taken, or changes in the duration of fishery openings.

Level 1: Normal' risk level rating for population dynamics

Risk Table

Assessment consideration	Population dynamics	Environmental ecosystem	Fishery performance
Level 1: Normal	Level 1: Normal	Level 1: Normal	Level 1: Normal

Yellowfin sole fishing mortality rate and female spawning biomass from 1977 to 2026 compared to the $F_{35\%}$ and $F_{40\%}$ control rules, based on Model 25.0b. 95% uncertainty elipses for 2026.



Summary Table – Model 25.0b

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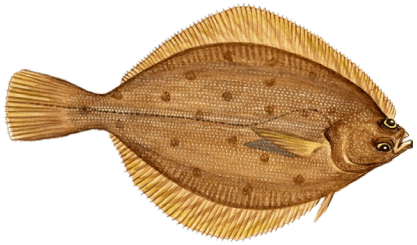
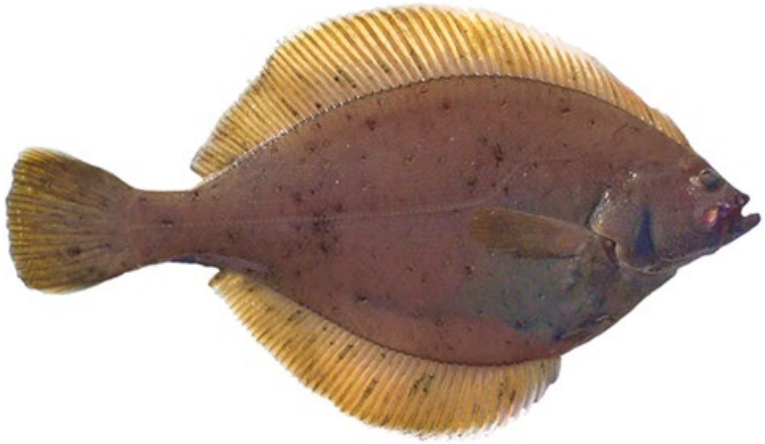
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

Acknowledgments

We thank the age and growth lab for all their work, RACE GAP and volunteers on the EBS trawl survey, and the FMA program and observers for providing fishery dependent data.



Questions?



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