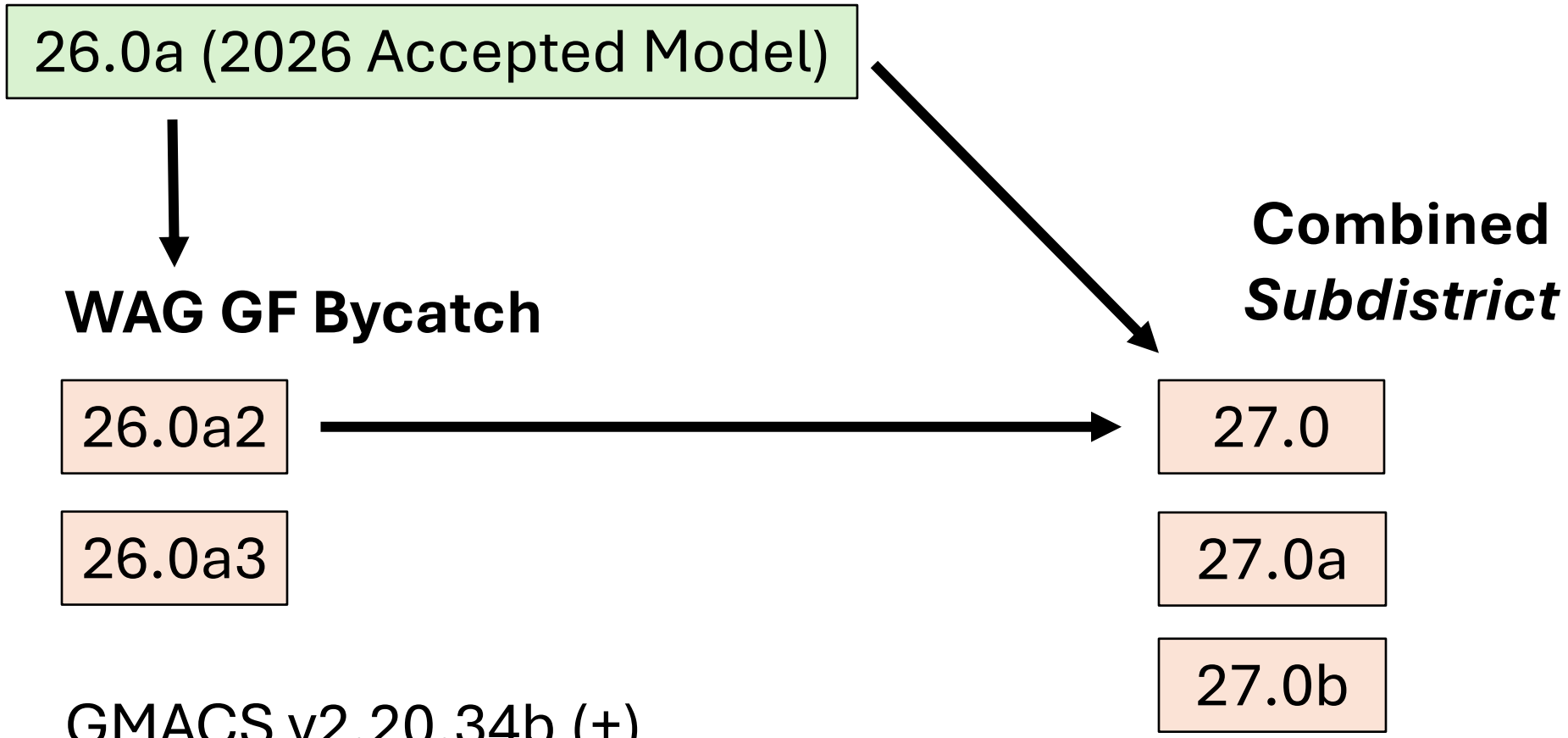
Aleutian Islands Golden King Crab 2027 Proposed Models

Tyler Jackson, ADF&G

Nov 2026 CPT



GMACS v2.20.34b (+)

Update sometime ~ January or after final assessment

CPUE Standardization

CPT May 2026: *"…it is not necessary at present to further attempt to refine the index standardization method so that research efforts can be directed at other tasks."*

SSC June 2026: "*Evaluate whether depth is necessary as a fixed effect in the ST-GLMM and assess sensitivity to mesh resolution and soak-time assumptions"*

SSC June 2026: *"Exploration of a spatially-varying soak time effect within the ST-GLMM"*

No CPUE standardization updates this cycle

Time Varying Selectivity

SSC June 2026: "*The SSC recommends using direct CPUE reliability diagnostics and covariates, including vessel effects, spatial contraction, soak time, fishing-ground shifts, and post-rationalization behavior, as an alternative to fishery selectivity time blocks for addressing retrospective bias*"

SSC June 2026: "*Continue investigating the EAG retrospective pattern using objective, data-driven criteria for selectivity time-block placement.*"

Do both approaches? No progress here

Combined OFL Calculation

SSC June 2026: "*The SSC recommends developing a clearer area-specific risk accounting framework for EAG and WAG, even if ABC remains specified at the stock level (i.e., is a larger buffer appropriate for an area that has more uncertainty, like the retrospective bias in EAG).*"

Return to subdistrict-specific reference point calculations or consider in risk table

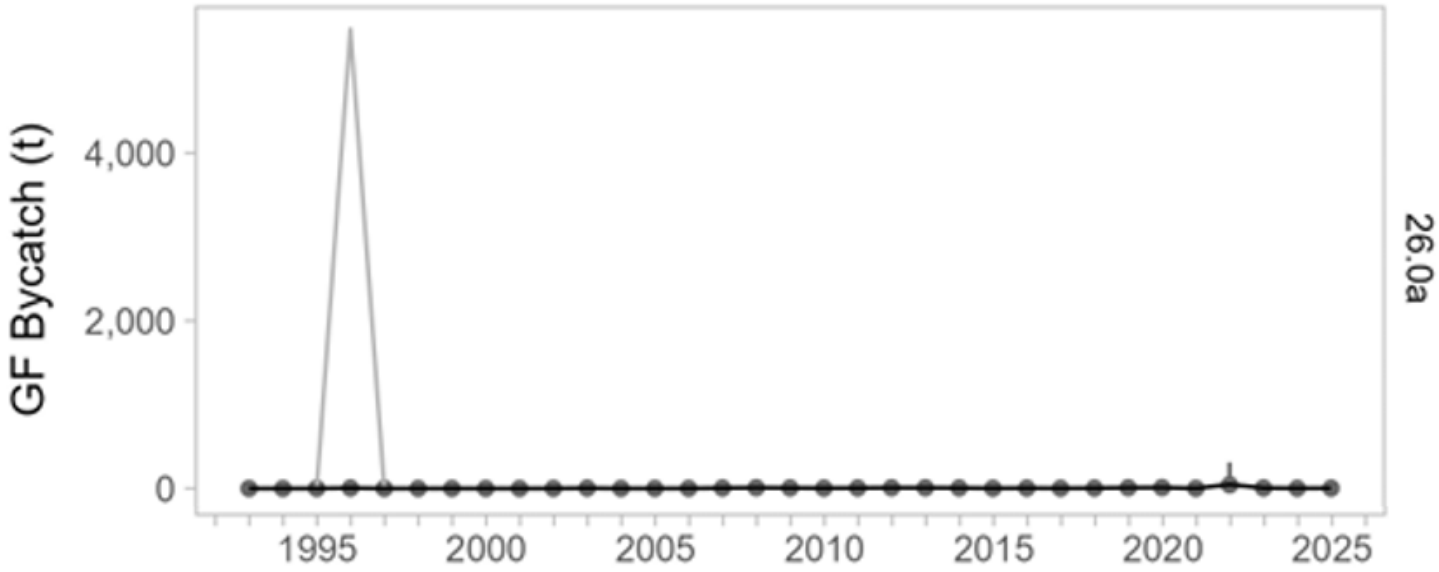
Maturity

CPT May 2026: "*Address past CPT/SSC comments on maturity data.*"

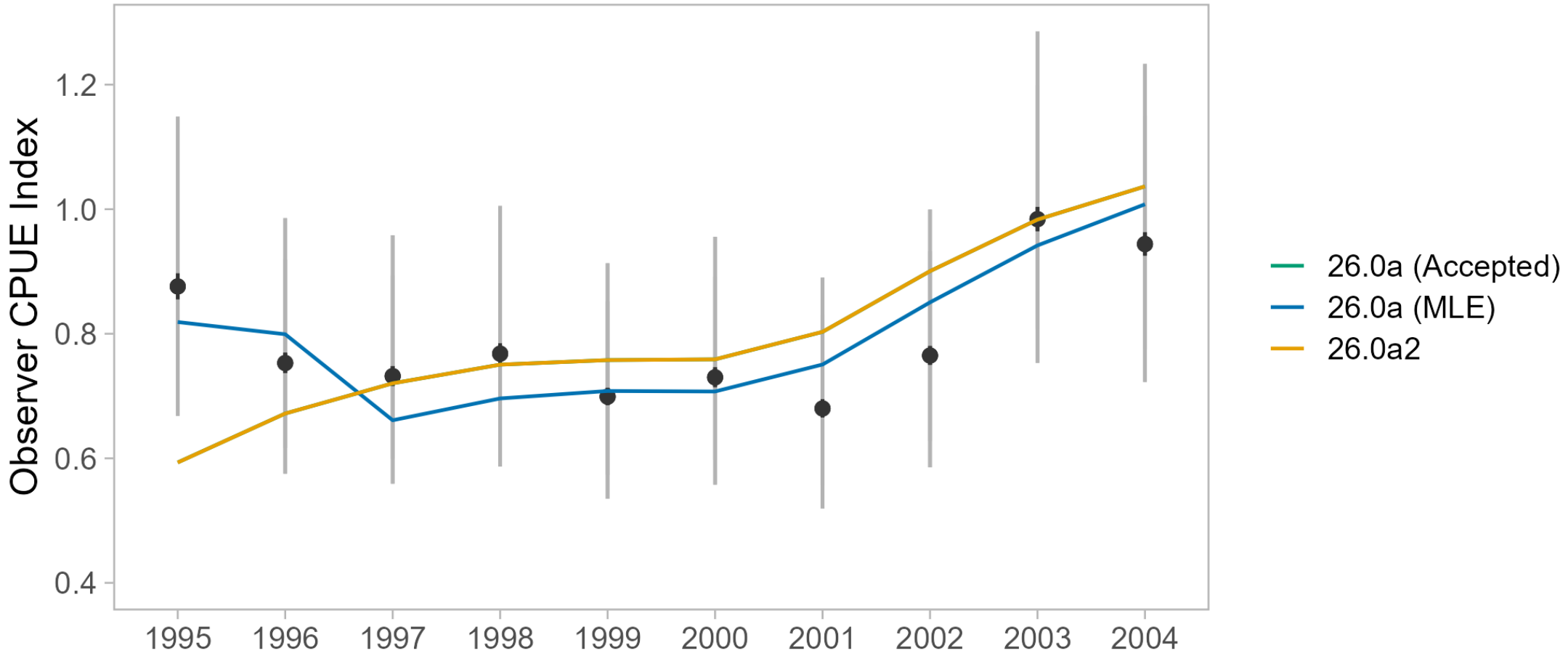
Cut for time, will revisit in future cycle

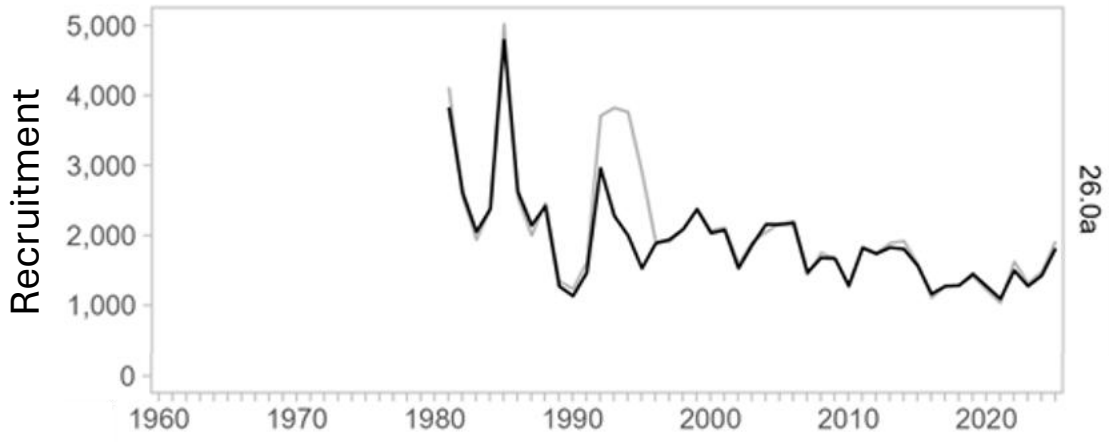
WAG MLE Convergence

SSC June 2026: "*Investigate and report the source of the WAG convergence failure and evaluate alternative model parameterizations to resolve convergence issues.*"

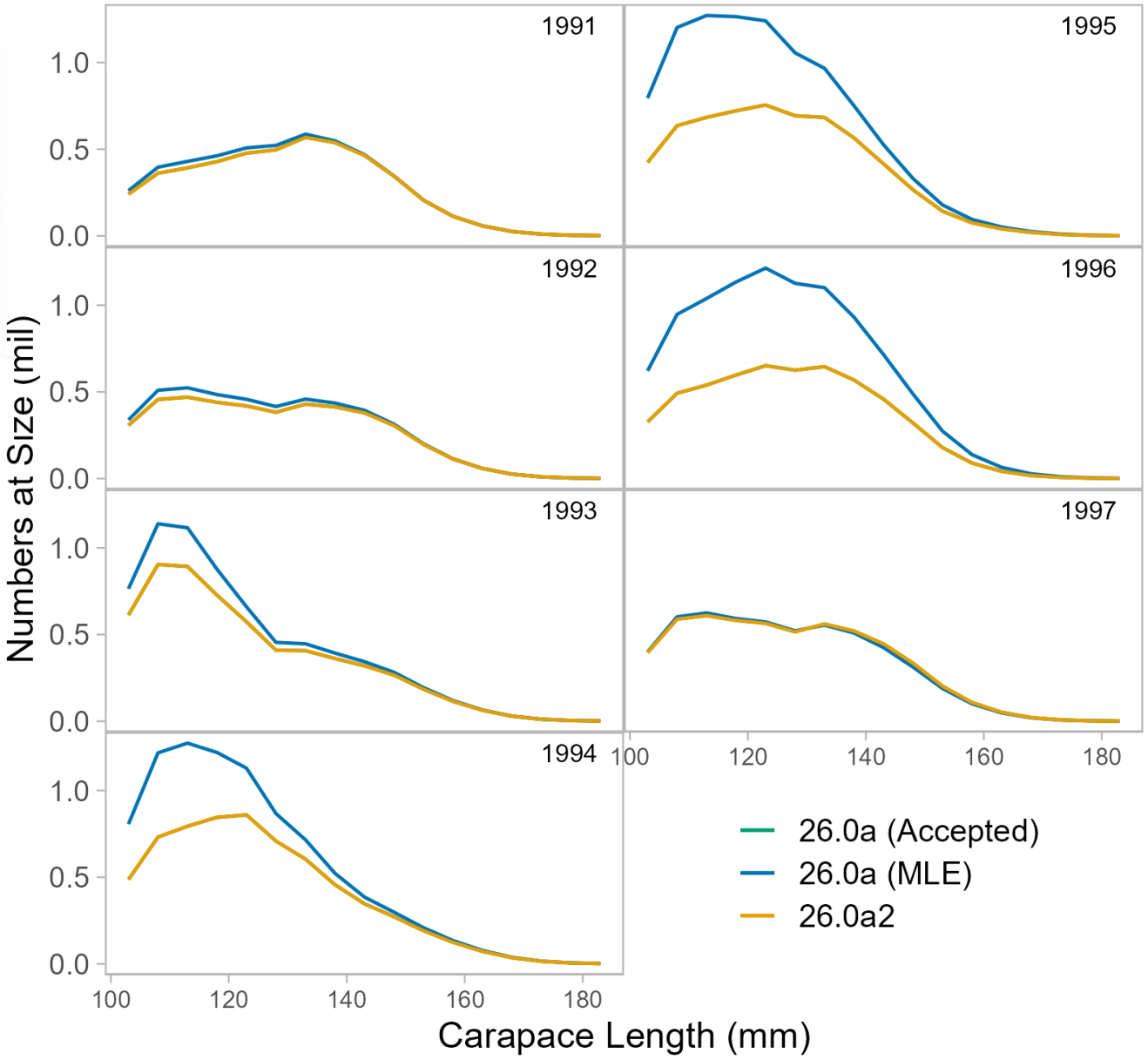


WAG MLE better fits observer CPUE in 1995 & 1996

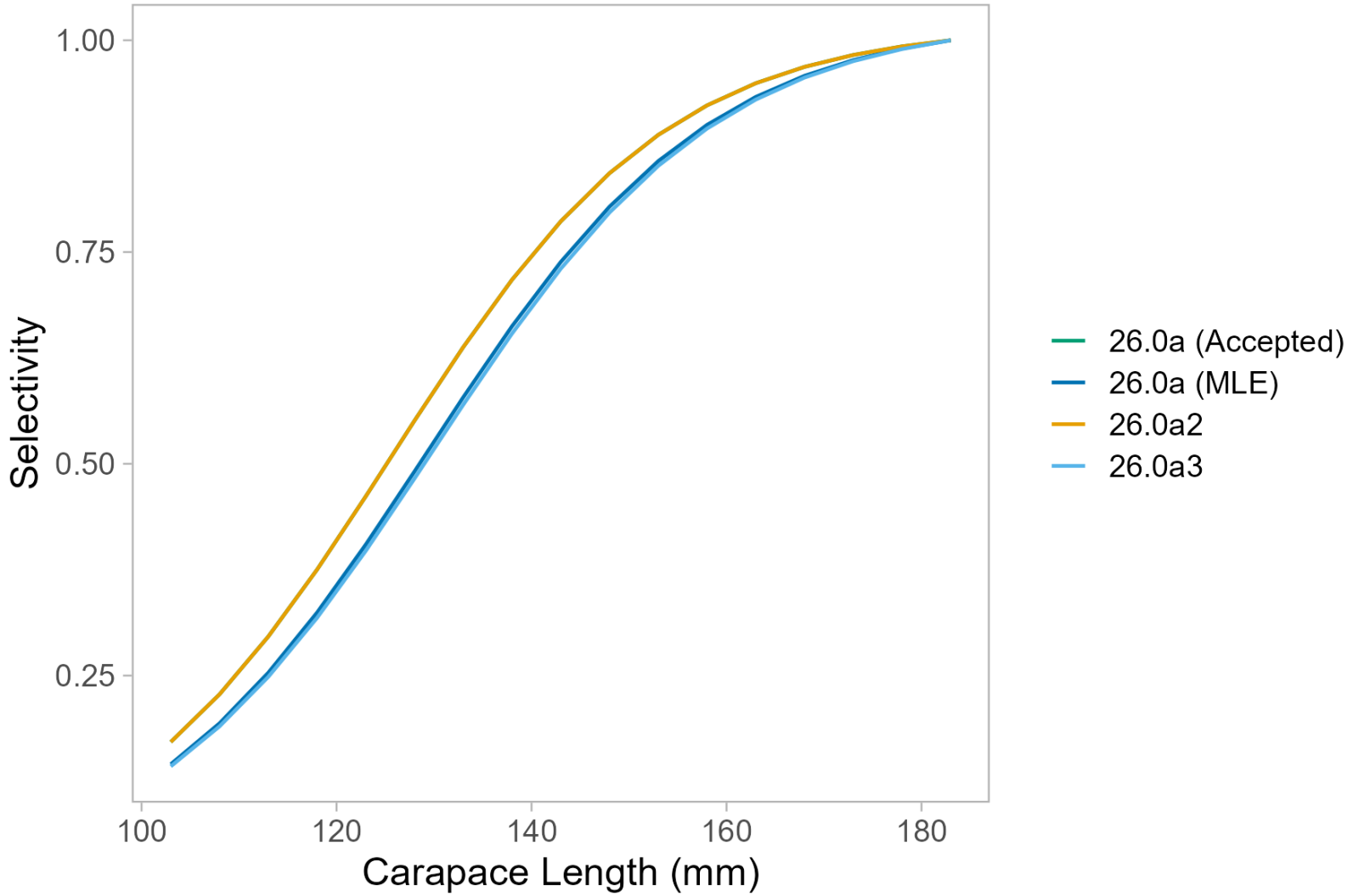


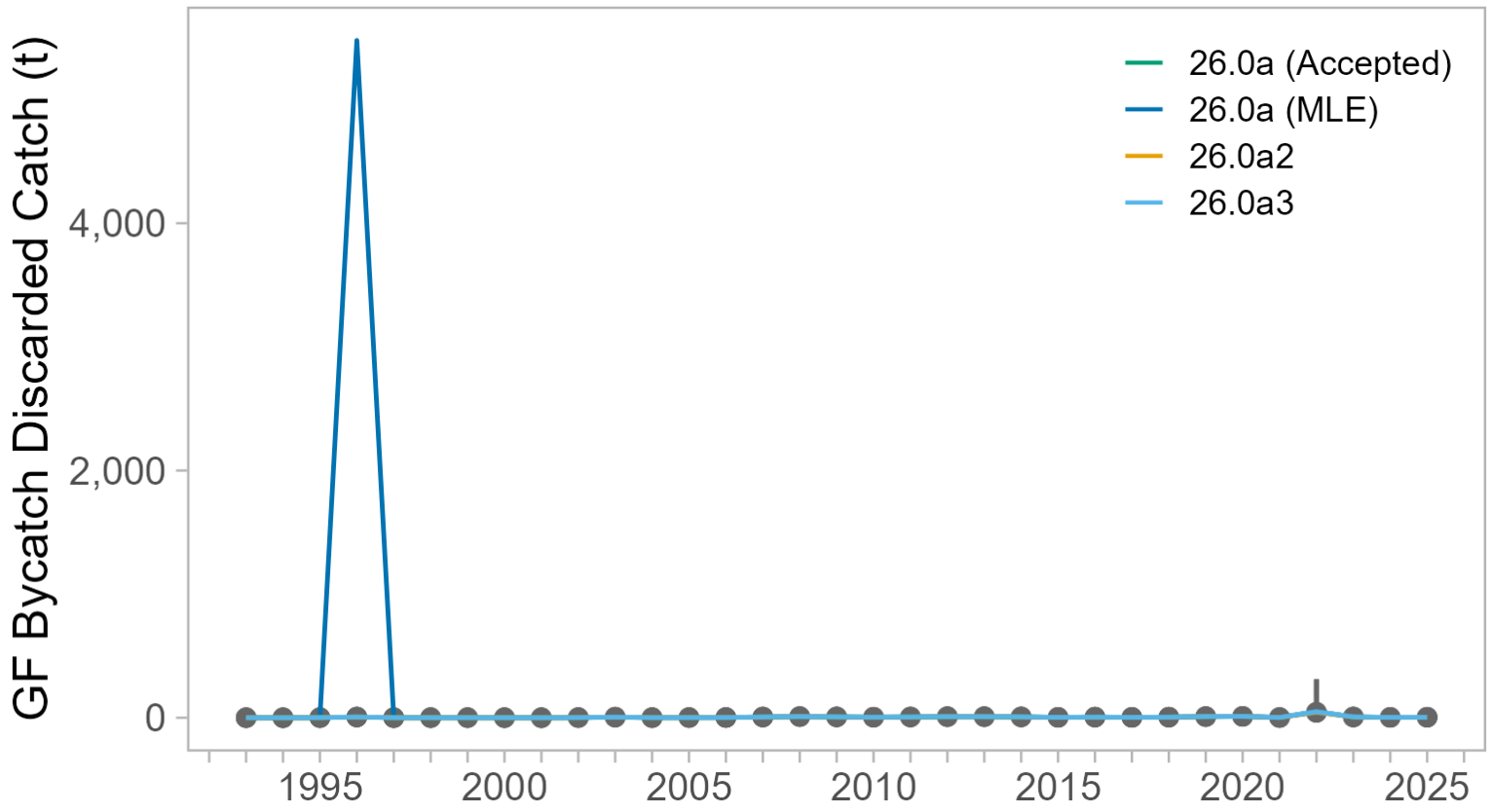


Increased recruitment pulse during early 90's, propagates through to 1995 and 1996



WAG 26.0 (MLE) hides some of these crab in lower selectivity





After 1996, the model cannot reconcile this many crab, so it uses GF bycatch as a mortality sink

Bycatch cheapest in likelihood

- ***High discard mortality rate***
- ***Fixed selectivity = 1***
- ***No size composition***

Solutions

1. Use better starting value, bounds

Solutions

1. ~~Use better starting value~~ **Jittering finds it or puts parameter at bound**
2. Increase *F*-dev penalty

Solutions

1. ~~Use better starting value~~ Jittering finds it or puts parameter at bound
2. ~~Increase *F*-dev penalty~~ **restricts fit to data in actual high bycatch years**
3. Data weighting

   Base GF Bycatch CV = 1.3108, σ =1 $\quad \mathrm{CV} = \sqrt{\mathrm{e}^{\sigma^2} - 1}$

   Model 26.0a2

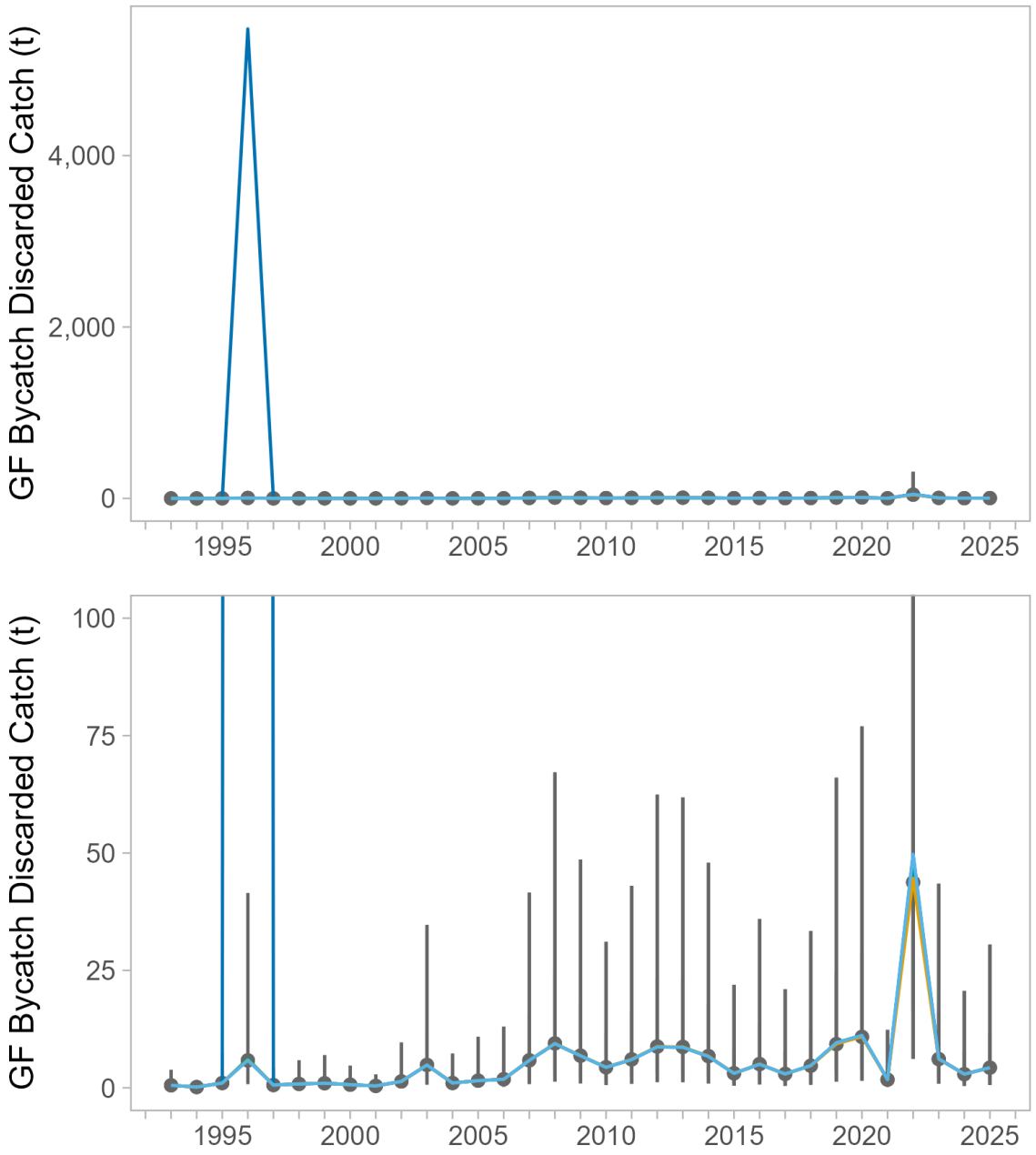
   CV = 0.53, σ =0.5

Solutions

1. ~~Use better starting value~~ Jittering finds it or puts parameter at bound
2. ~~Increase *F*-dev penalty~~ restricts fit to data in actual high bycatch years
3. Data weighting

   Model 26.0a2 – GF Bycatch CV = 0.53, σ =0.5
4. Natural Mortality Event

   Model 26.0a3 – Estimate mortality event in 1996



Both models avoid high bycatch

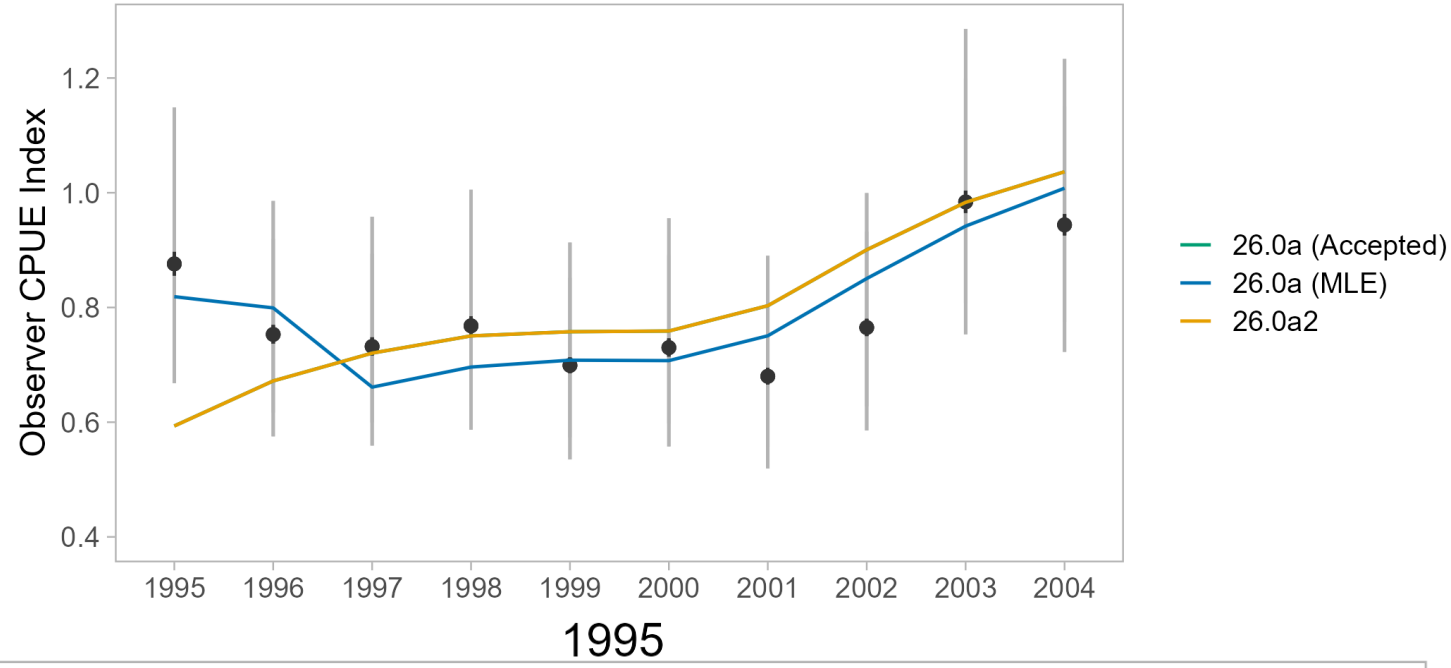
Model 26.0a3
Higher recruitment, high mortality event $M = 0.98$ yr^{-1}

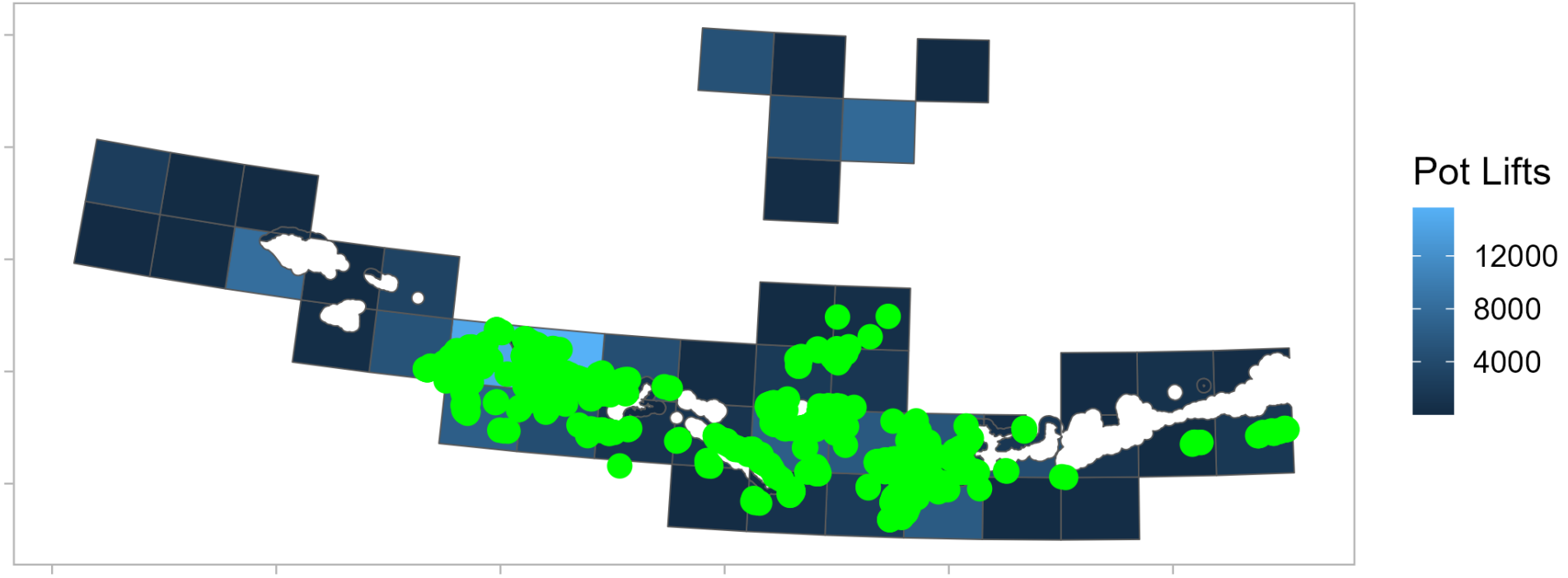
No evidence of mortality event of that scale in fishery data. ***Model 26.0a3 is not supported…***

Jittering

	Model	Objective Function	Δ NLL	Catch	Index	Size	MMB_{prj}	$B_{35\%}$	Max. Gradient	N
WAG	26.0a2	3,242.801	0.000	-484.050	-65.740	1,006.250	3,991	4,470	1.88e-05	91
		3,586.828	344.028	-397.110	-60.590	1,259.990	3,739	4,255	1.26e-03	1
									NA	8
WAG	26.0a	3,264.626	0.000	-445.540	-78.610	998.890	4,126	4,852	8.91e-05	40
		3,265.831	1.205	-461.010	-65.740	1,006.250	3,990	4,470	6.58e-05	45
		3,346.922	82.296	-445.710	-78.280	1,081.330	4,040	4,801	6.65e-02	1
		3,348.546	83.920	-461.280	-64.040	1,088.090	3,905	4,410	2.87e-02	1
		3,609.860	345.234	-374.070	-60.590	1,259.990	3,738	4,255	6.38e-04	2
									NA	11

WAG 26.0a2 – no local minima in proximity of putative MLE


Observer CPUE Index
1.2
1.0
0.8
0.6
0.4
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
26.0a (Accepted)
26.0a (MLE)
26.0a2


1995
Pot Lifts
12000
8000
4000

Combined Model

Model 27.0: EAG 26.0a + WAG 26.0a2

- Subdistrict specified in sex domain
- Four fleets: EAG Directed, WAG Directed, EAG Bycatch, WAG Bycatch
- Bridging Analysis: *Construct model with parameter values equivalent to EAG 26.0a and WAG 26.0a2, run single function call*

Bridging Analysis Re-Parameterization

Annual structure: 6 seasons → 8 seasons to preserve EAG / WAG season timing

Parameters transformed: Transform theta parameters and WAG devs

Selectivity: WAG selectivity is 0 for the EAG fleets and *vice versa*. All deviations input as *F-devs* (i.e., EAG), *F-dovs* = 0

Tagging: Tagging data duplicated for Model 27.0

Process	27.0	EAG 26.0a	WAG 26.0a2
EAG Retained Catch	-453.92933	-453.92933	
EAG Total Catch	-66.20746	-66.20746	
EAG GF Byatch	32.19359	32.19359	
WAG Retained Catch	-451.85304		-451.85304
WAG Total Catch	-39.49054		-39.49054
WAG GF Byatch	7.29074		7.29074
EAG Obs CPUE 1995-2004	-12.68812	-12.68812	
EAG Obs CPUE 2005-2025	-21.04257	-21.04257	
EAG FT CPUE 1985-1998	-14.16731	-14.16731	
WAG Obs CPUE 1995-2004	-13.30693		-13.30693
WAG Obs CPUE 2005-2025	-35.16644		-35.16644
WAG FT CPUE 1985-1998	-17.26408		-17.26408
EAG Retained Size Comp.	462.23712	462.74579	
EAG Total Size Comp.	368.17862	368.14175	
WAG Retained Size Comp.	612.96210		612.73024
WAG Total Size Comp.	393.56412		393.51719
Recruitment Penalty	13.94405	12.78584	18.30792
EAG Tagging	2,698.18895	2,698.18895	
WAG Tagging	2,697.92153		2,697.92153
Objective Function	6,162.22969	3,076.26893	3,242.80055

Process	27.0	EAG 26.0a	WAG 26.0a2
EAG Retained Catch	-453.92933	-453.92933	
EAG Total Catch	-66.20746	-66.20746	
EAG GF Byatch	32.19359	32.19359	
WAG Retained Catch	-451.85304		-451.85304
WAG Total Catch	-39.49054		-39.49054
WAG GF Byatch	7.29074		7.29074
EAG Obs CPUE 1995-2004	-12.68812	-12.68812	
EAG Obs CPUE 2005-2025	-21.04257	-21.04257	
EAG FT CPUE 1985-1998	-14.16731	-14.16731	
WAG Obs CPUE 1995-2004	-13.30693		-13.30693
WAG Obs CPUE 2005-2025	-35.16644		-35.16644
WAG FT CPUE 1985-1998	-17.26408		-17.26408
EAG Retained Size Comp.	462.23712	462.74579	
EAG Total Size Comp.	368.17862	368.14175	
WAG Retained Size Comp.	612.96210		612.73024
WAG Total Size Comp.	393.56412		393.51719
Recruitment Penalty	13.94405	12.78584	18.30792
EAG Tagging	2,698.18895	2,698.18895	
WAG Tagging	2,697.92153		2,697.92153
Objective Function	6,162.22969	3,076.26893	3,242.80055

Bridging Blunder – I copied the Francis weights from the output, not the input. *There was a 0.0001 place difference*

Process	27.0	EAG 26.0a	WAG 26.0a2
EAG Retained Catch	-453.92933	-453.92933	
EAG Total Catch	-66.20746	-66.20746	
EAG GF Bycatch	32.19359	32.19359	
WAG Retained Catch	-451.85304		-451.85304
WAG Total Catch	-39.49054		-39.49054
WAG GF Bycatch	7.29074		7.29074
EAG Obs CPUE 1995-2004	-12.68812	-12.68812	
EAG Obs CPUE 2005-2025	-21.04257	-21.04257	
EAG FT CPUE 1985-1998	-14.16731	-14.16731	
WAG Obs CPUE 1995-2004	-13.30693		-13.30693
WAG Obs CPUE 2005-2025	-35.16644		-35.16644
WAG FT CPUE 1985-1998	-17.26408		-17.26408
EAG Retained Size Comp.	462.74579	462.74579	
EAG Total Size Comp.	368.14175	368.14175	
WAG Retained Size Comp.	612.73024		612.73024
WAG Total Size Comp.	393.51719		393.51719
Recruitment Penalty	13.94405	12.78584	18.30792
EAG Tagging	2,698.18895	2,698.18895	
WAG Tagging	2,697.92153		2,697.92153
Objective Function	6,162.42269	3,076.26893	3,242.80055

Alternative Combined Models

Model 27.0: Base EAG 26.0a + WAG 26.0a2

Model 27.0a: WAG growth mirrored EAG growth

- Tagging studies exclusively conducted in EAG
- Data only input once
- WAG data (e.g., catch/comps) only influence growth in that they directly influence shared processes that inform the tagging likelihood (e.g., recruitment)

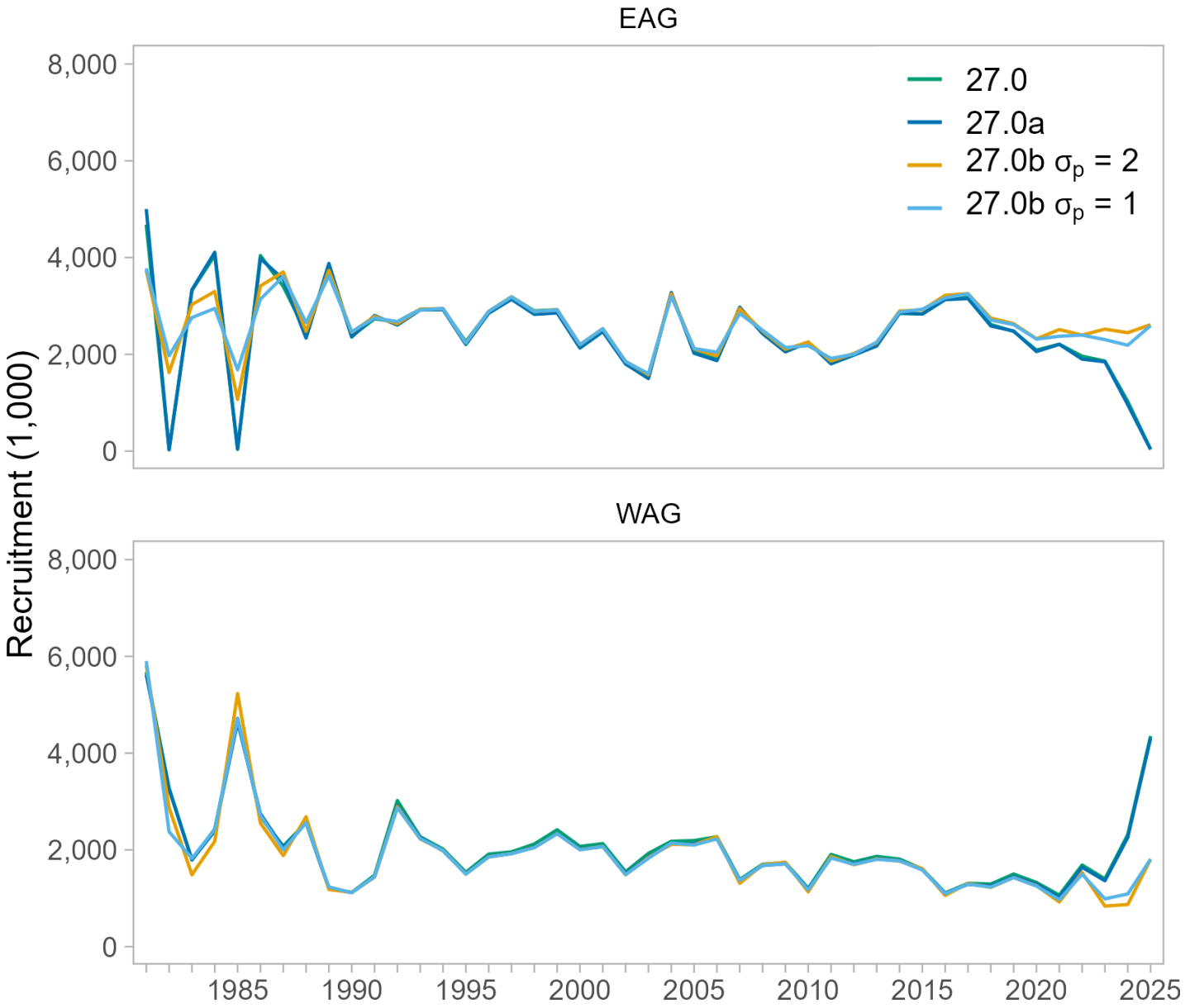
Alternative Combined Models

Model 27.0: Base EAG 26.0a + WAG 26.0a2

Model 27.0a: WAG growth mirrored EAG growth

Model 27.0b: Estimate mean recruitment proportion, adjust σ_p

- EAG gets proportionally more recruitment
- Move R_p and σ_p to theta parameters
- Estimated R_p, fixed σ_p=1

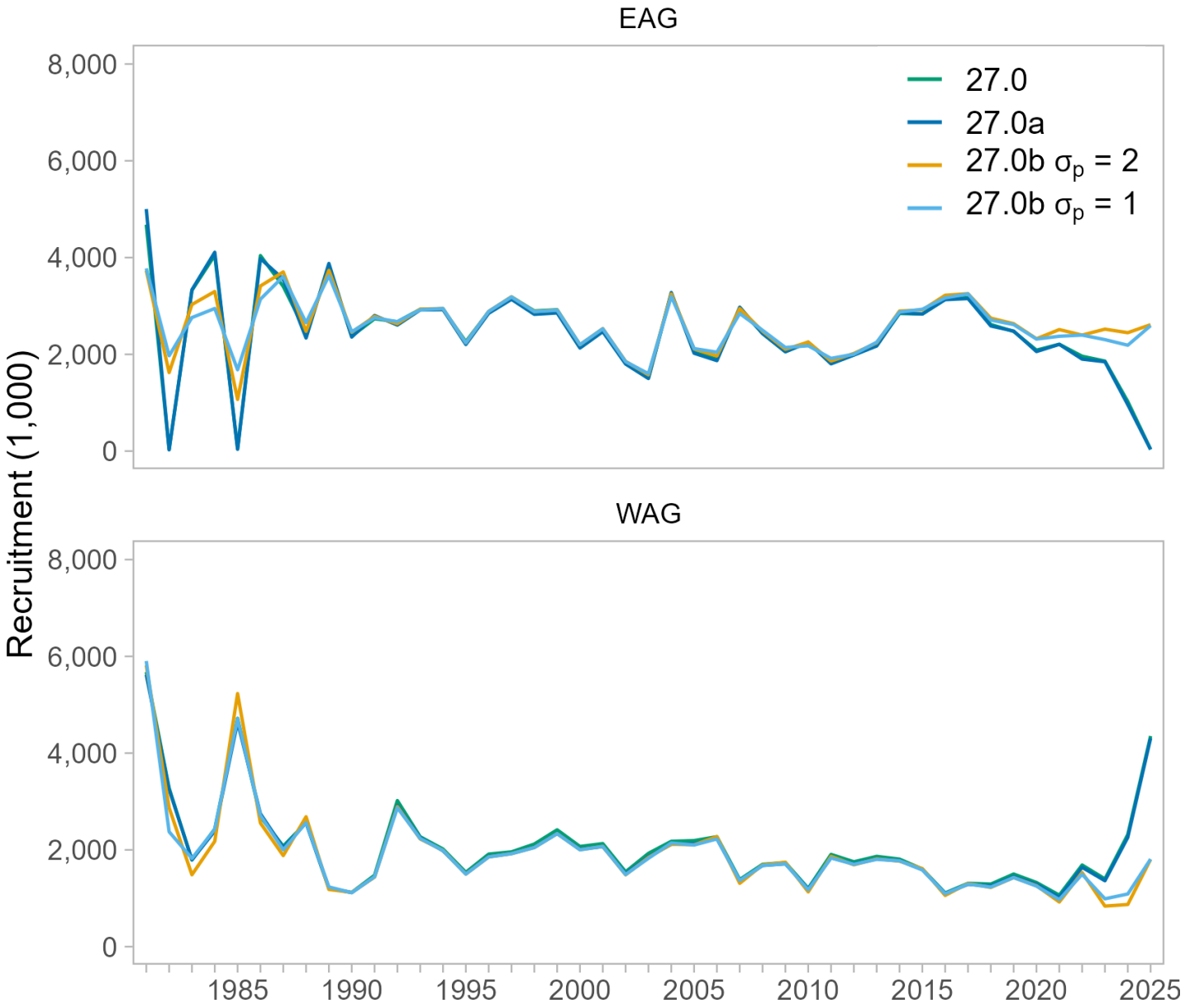


Recruit defined by

- Mean Recruitment, $\bar{R}$
- Rec Devs, $\varepsilon_t^R \sim \mathrm{N}(0, \sigma_R^2)$
- Mean Rec Proportion, R_p
- Rec Prop Devs, $\varepsilon_t^p \sim \mathrm{N}(0, \sigma_p^2)$

ε_t^p sum to zero, centered on 50% in 27.0 and 27.0a

Recruitment favors EAG (R_p = 0.59), must offset time series of positive devs with large negative devs



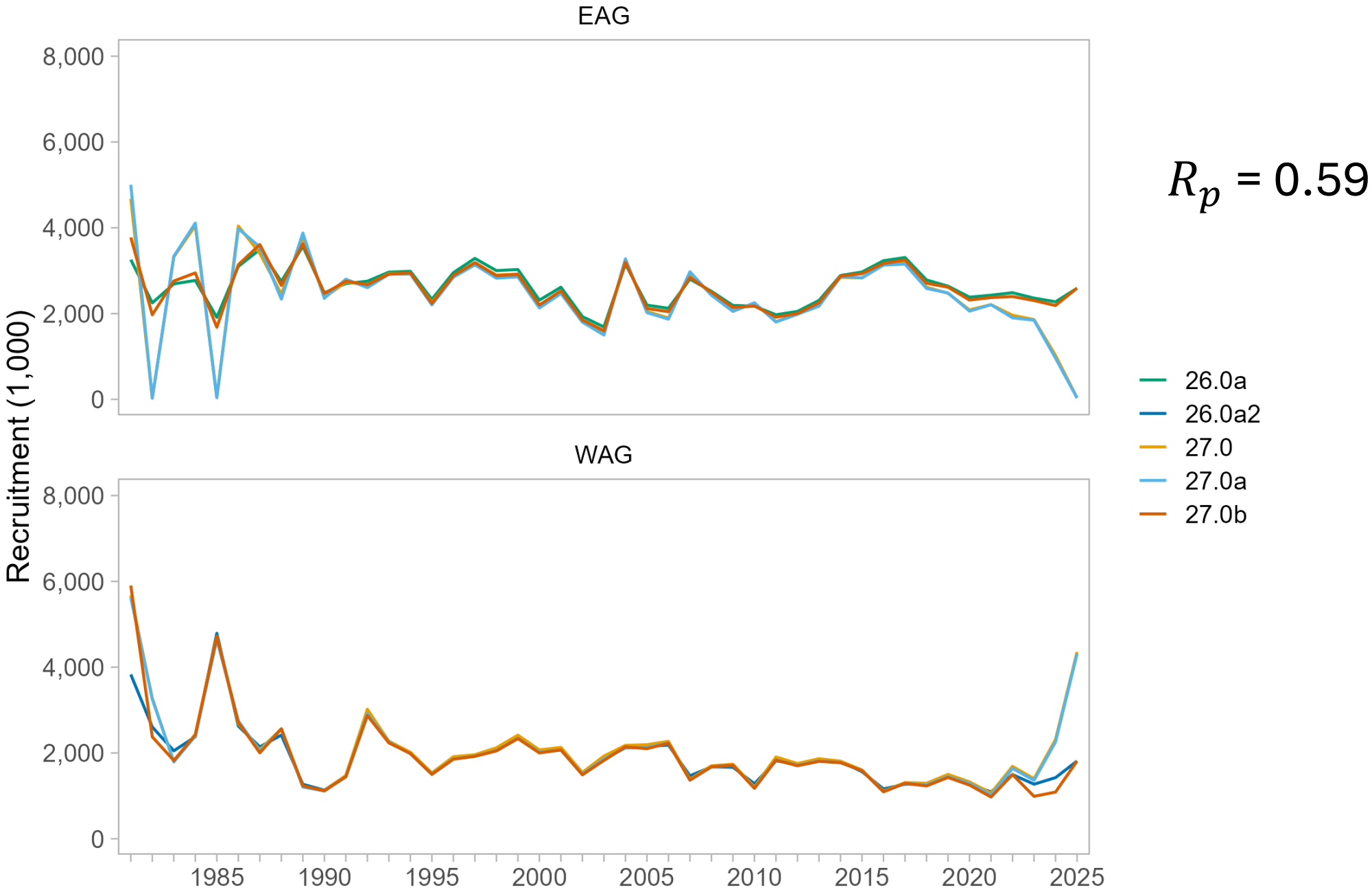
Recruit defined by

- Mean Recruitment, $\bar{R}$
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- Mean Rec Proportion, R_p
- Rec Prop Devs, $\varepsilon_t^p \sim \mathrm{N}(0, \sigma_p^2)$

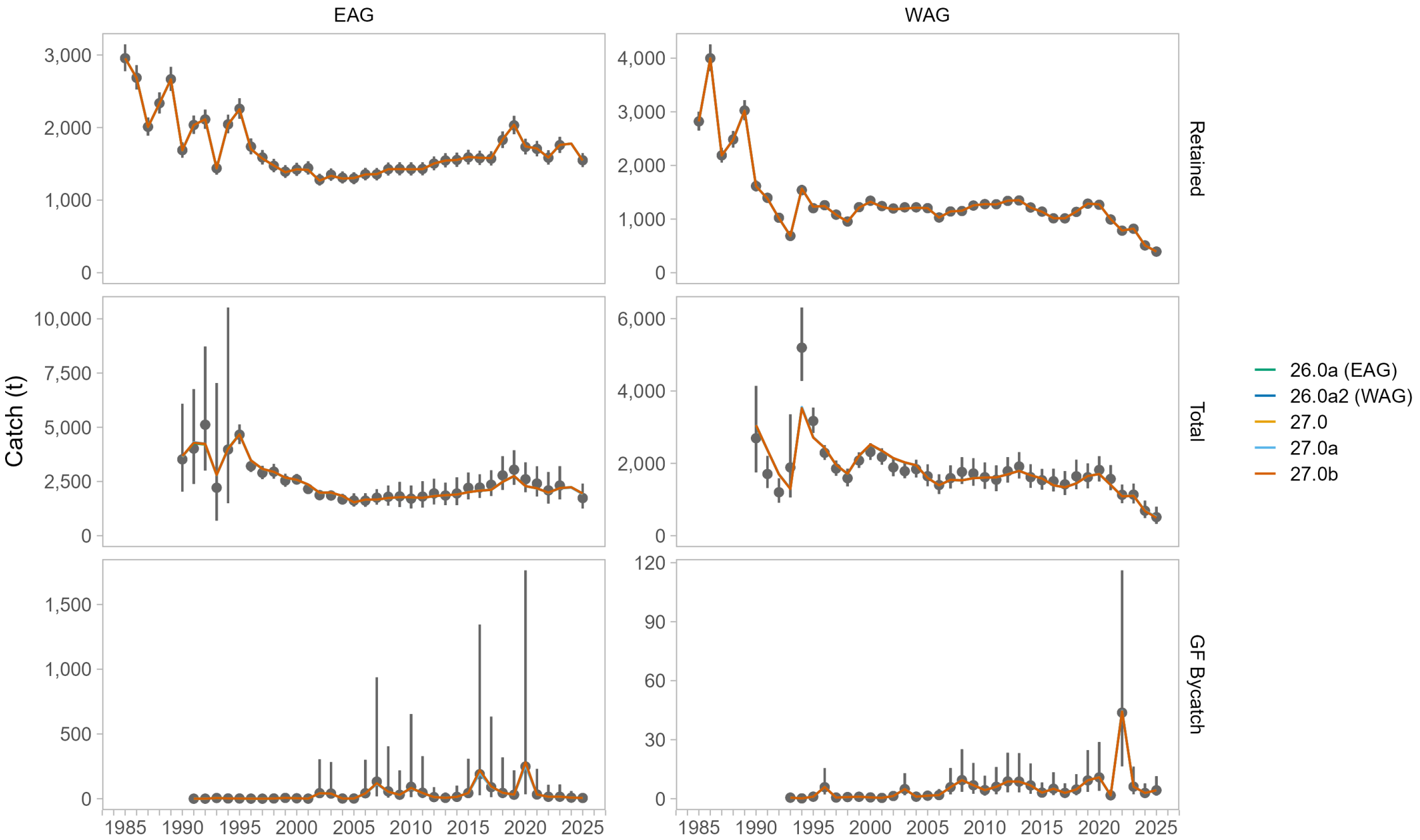
Correlation of EAG / WAG determined by ratio of σ_R^2 to σ_p^2

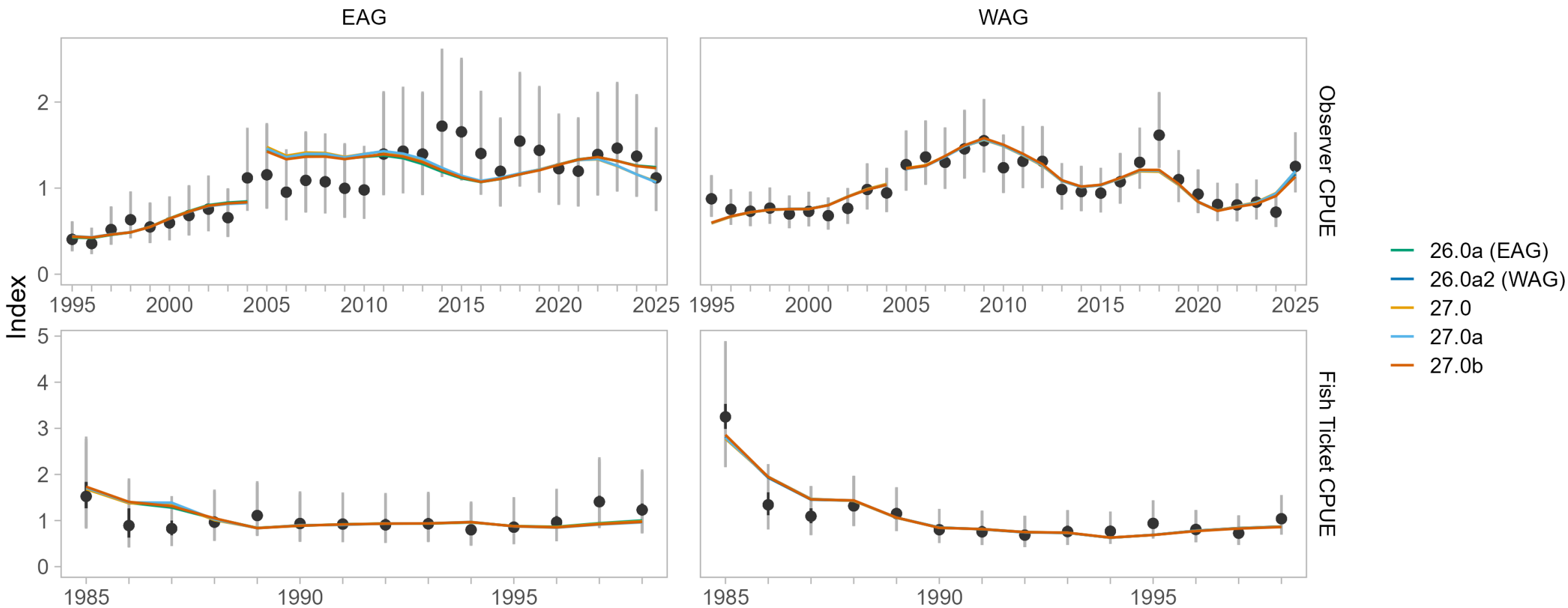
Correlation ≈ 0 when σ_p is 2x σ_R

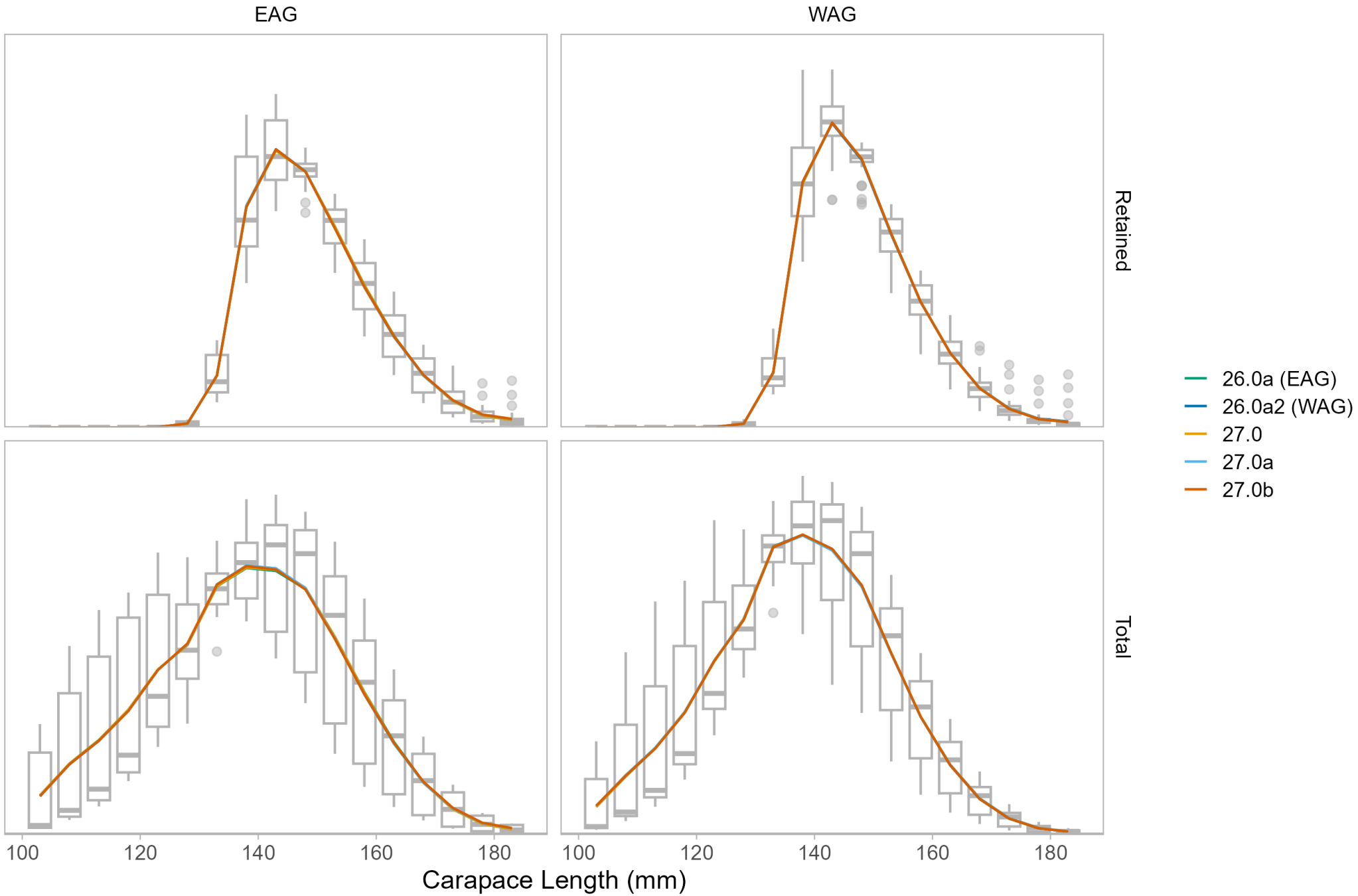
Only matters when data are sparse


EAG
WAG
Recruitment (1,000)
8,000
6,000
4,000
2,000
0
1985
1990
1995
2000
2005
2010
2015
2020
2025
26.0a
26.0a2
27.0
27.0a
27.0b

R_p = 0.59

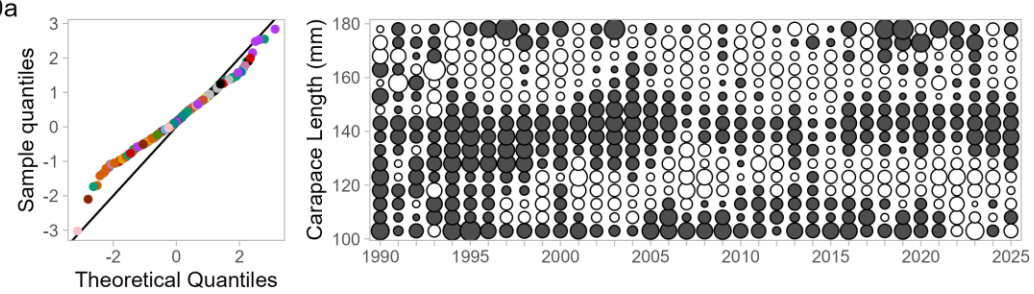

EAG
WAG
Retained
Total
GF Bycatch
Catch (t)
3,000
2,000
1,000
0
4,000
10,000
7,500
5,000
2,500
6,000
1,500
500
120
90
60
30
1985
1990
1995
2000
2005
2010
2015
2020
2025
26.0a (EAG)
26.0a2 (WAG)
27.0
27.0a
27.0b


EAG
WAG
Index
Observer CPUE
Fish Ticket CPUE
0
1
2
3
4
5
1985
1990
1995
2000
2005
2010
2015
2020
2025
26.0a (EAG)
26.0a2 (WAG)
27.0
27.0a
27.0b

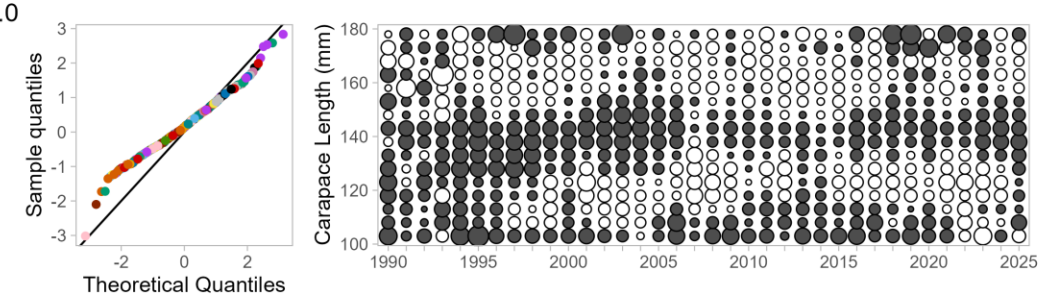

EAG
WAG
Retained
Total
100
120
140
160
180
Carapace Length (mm)
26.0a (EAG)
26.0a2 (WAG)
27.0
27.0a
27.0b

EAG Total Comp

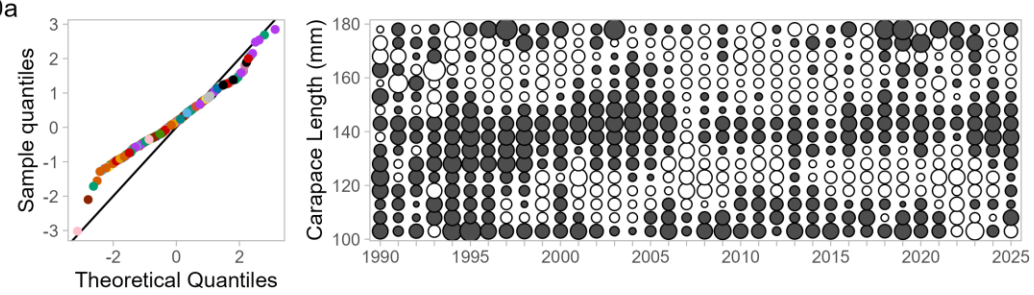
26.0a



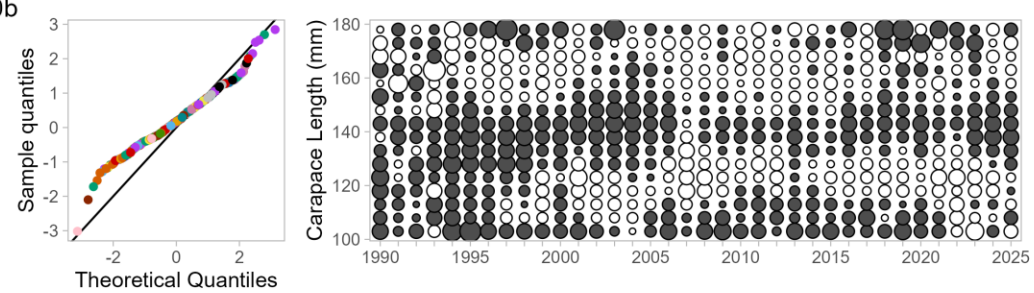
27.0



27.0a

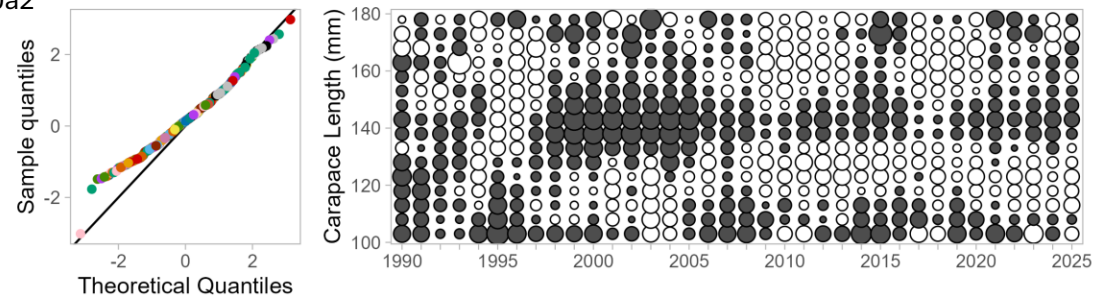


27.0b

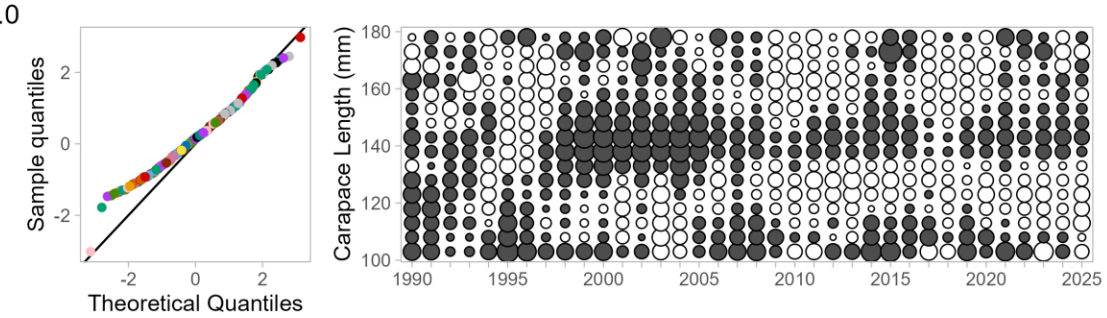


WAG Total Comp

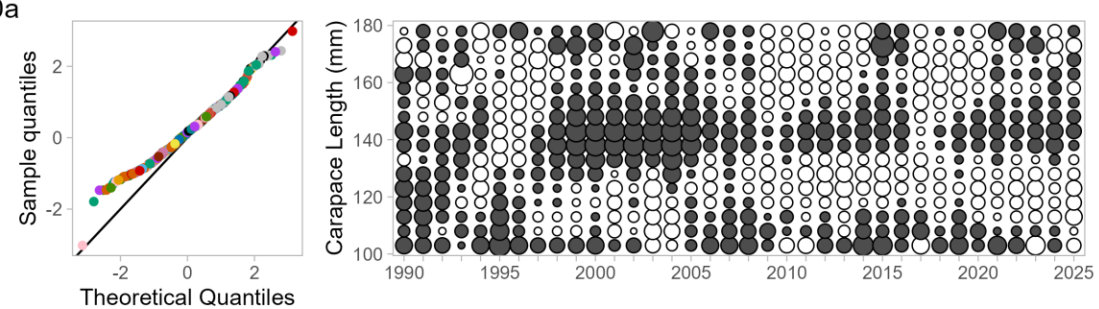
26.0a2



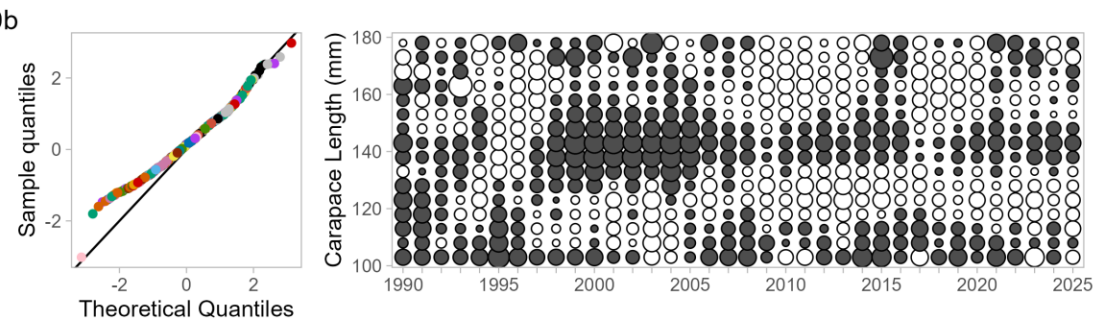
27.0



27.0a

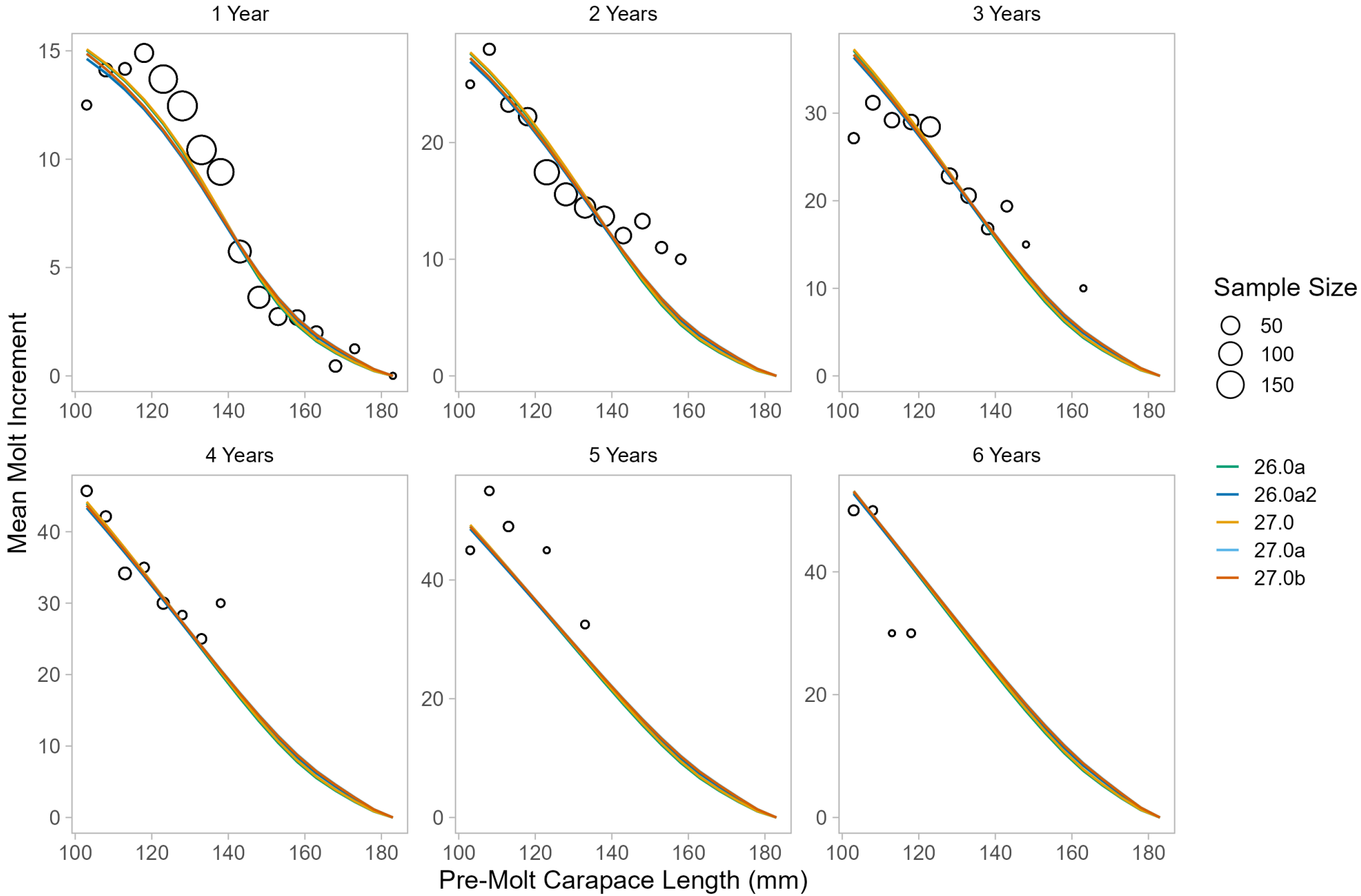


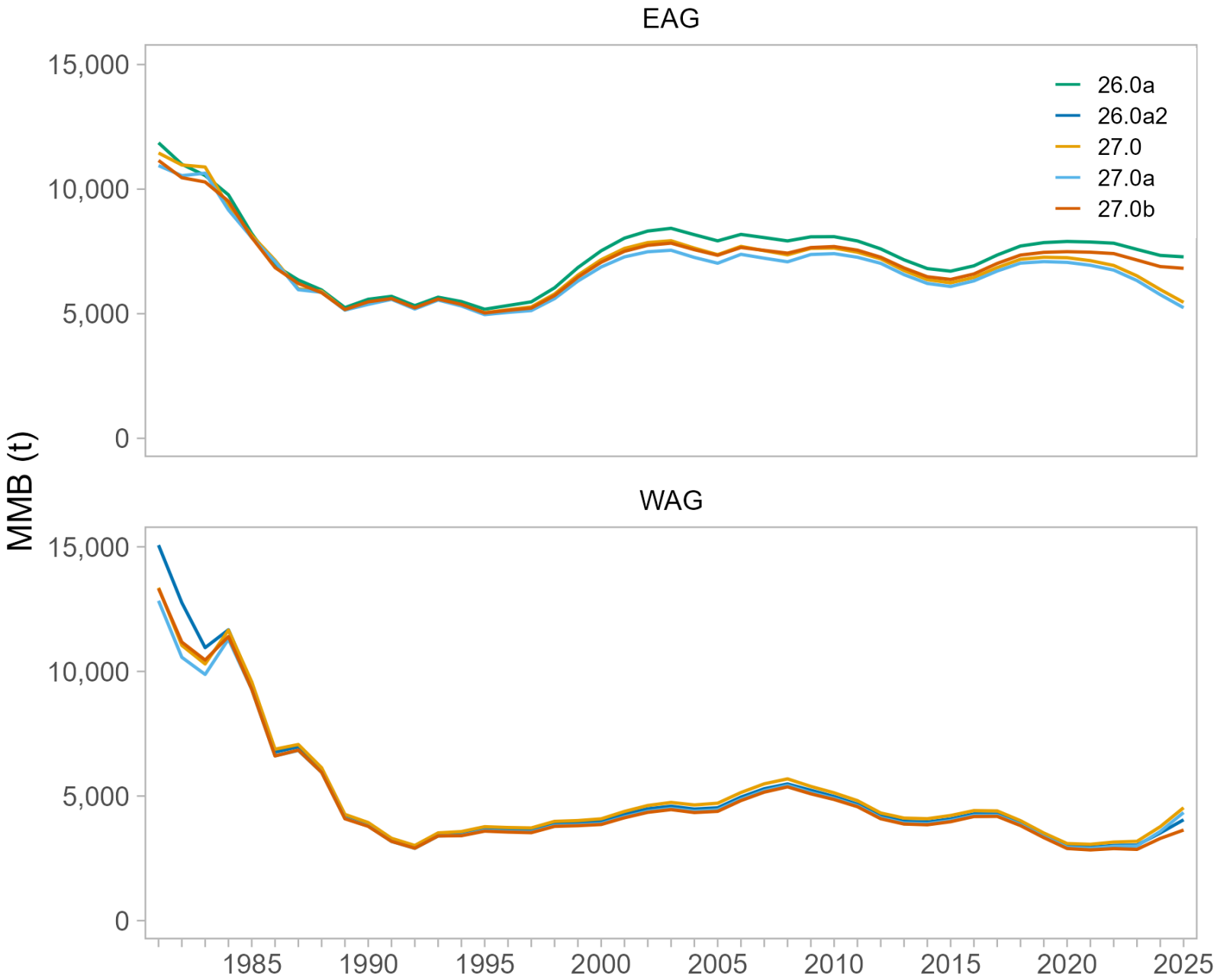
27.0b



Size Composition Weighting

	26.0a(2)	27.0	27.0a	27.0b	
EAG Retained	0.227	0.223	0.222	0.233	+ 2.6%
EAG Total	0.609	0.588	0.574	0.573	- 5.9%
WAG Retained	0.106	0.120	0.114	0.115	+ 8.5%
WAG Total	0.419	0.416	0.437	0.465	+ 11.0%


1 Year
2 Years
3 Years
4 Years
5 Years
6 Years
Mean Molt Increment
Pre-Molt Carapace Length (mm)
Sample Size
50
100
150
26.0a
26.0a2
27.0
27.0a
27.0b

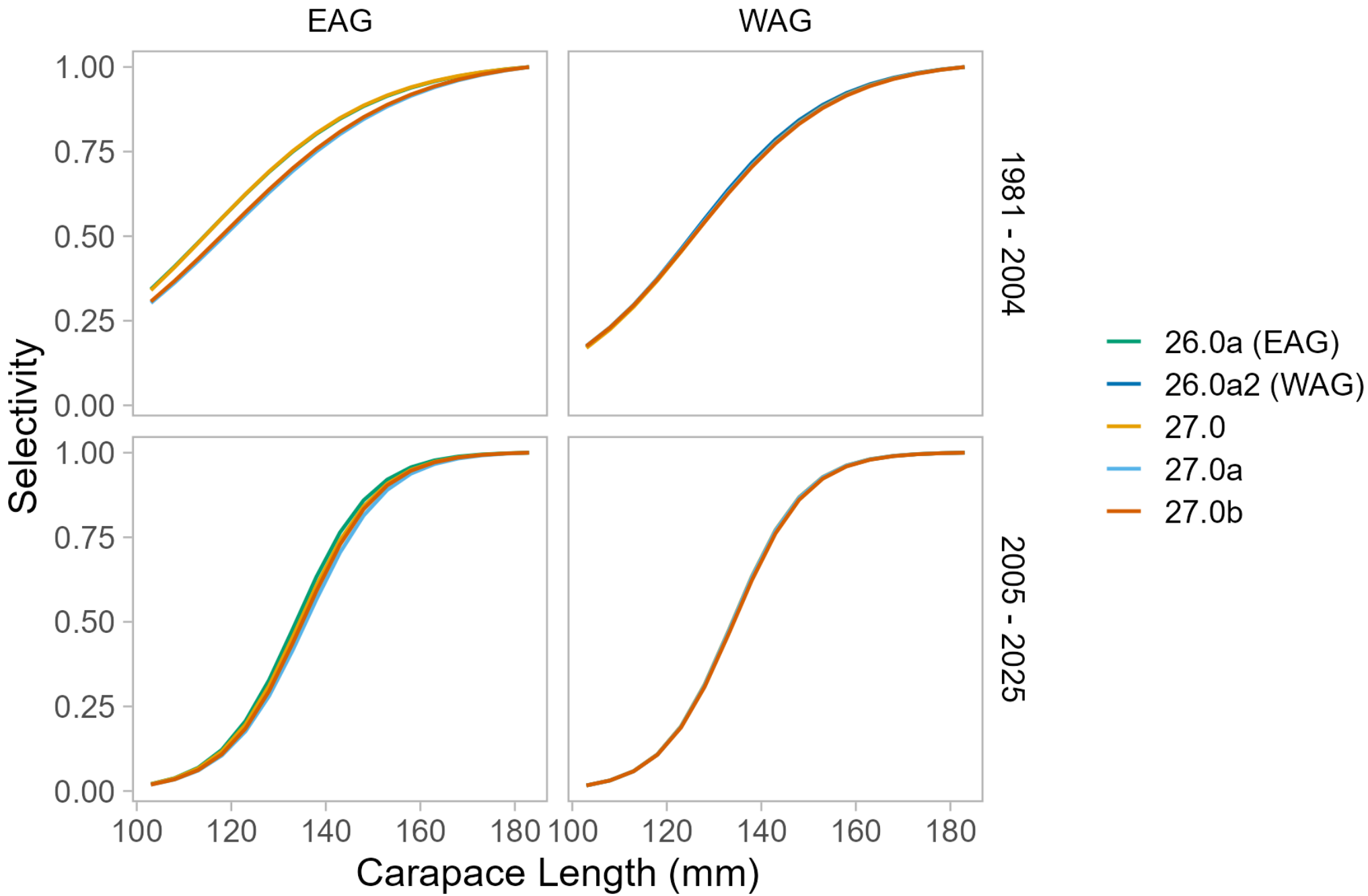


Scale difference between 26.0a(2) and 27.0b

Catchability	26.0a(2)	27.0b
EAG CPUE 94-04	2.88e-4	3.22e-4
EAG CPUE 05-25	5.86e-4	6.55e-4
EAG FT 85-98	5.94e-4	6.45e-4
WAG CPUE 94-04	7.99e-4	8.36e-4
WAG CPUE 05-25	1.04e-3	1.08e-3
WAG FT 85-98	9.29e-4	9.58e-4

~11% decrease in EAG catchability

~4% decrease in WAG catchability


EAG
WAG
1981 - 2004
2005 - 2025
Selectivity
1.00
0.75
0.50
0.25
0.00
100
120
140
160
180
Carapace Length (mm)
26.0a (EAG)
26.0a2 (WAG)
27.0
27.0a
27.0b

Process	27.0 (bridge)	27.0b	27.0b (size wt)
EAG Retained Catch	-453.929	-453.836	-453.787
EAG Total Catch	-66.207	-65.66	-65.395
EAG GF Bycatch	32.194	32.197	32.197
WAG Retained Catch	-451.853	-451.703	-451.958
WAG Total Catch	-39.491	-37.062	-40.824
WAG GF Bycatch	7.291	7.291	7.29
EAG Obs CPUE 1995-2004	-12.688	-12.707	-12.706
EAG Obs CPUE 2005-2025	-21.043	-21.601	-21.473
EAG FT CPUE 1985-1998	-14.167	-13.367	-13.391
WAG Obs CPUE 1995-2004	-13.307	-13.505	-13.421
WAG Obs CPUE 2005-2025	-35.166	-35.53	-35.777
WAG FT CPUE 1985-1998	-17.264	-17.126	-17.278
EAG Retained Size Comp.	462.237	455	460.552
EAG Total Size Comp.	368.179	380.366	365.193
WAG Retained Size Comp.	612.962	591.445	612.847
WAG Total Size Comp.	393.564	369.942	393.395
Recruitment Deviation Penalty	13.944	13.57	13.569
Recruitment Proportion Deviation Penalty		44.88	44.884
EAG Tagging	2698.189	2703.98	2703.558
WAG Tagging	2697.922		
Number of Parameters	321	317	317
Objective Function	6162.23	3605.263	3642.369

Largest likelihood differences mostly due to weighting

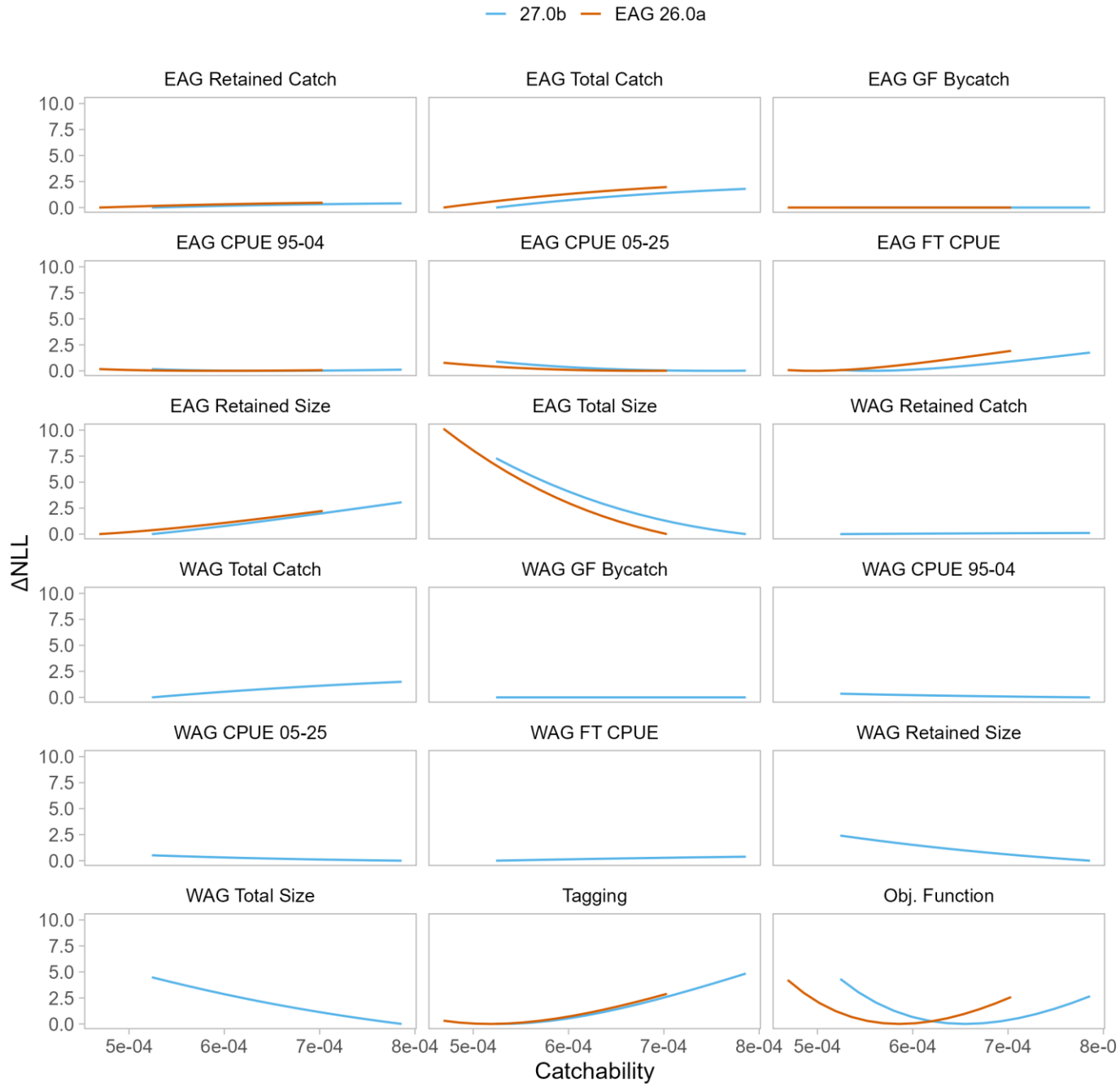
Catchability Profile

Fix all 3 catchability parameters, vary by multiplier from 0.8 – 1.2

EAG total size composition has most pull

WAG size composition data influences EAG *q* through *recruitment*? Favors higher *q*

Small NLL change over broad range in catchability



Jittering

Model	Objective Function	Δ NLL	Catch	Index	Size	MMB_{prj}	$B_{35\%}$	Max. Gradient	N
27.0	6,365.430	0.000	-972.060	-111.570	1,816.440	9,762	11,075	5.64e-04	29
	6,365.918	0.488	-972.210	-112.010	1,817.940	9,812	11,085	3.55e-04	8
	6,366.151	0.721	-972.130	-111.690	1,817.680	9,765	11,078	1.70e-02	1
	6,367.627	2.197	-972.060	-111.350	1,818.200	9,759	11,038	7.30e-04	5
	6,368.826	3.396	-972.090	-111.460	1,819.550	9,761	11,042	1.93e-03	1
								NA	1
27.0a	3,667.197	0.000	-970.860	-112.240	1,822.450	9,510	11,009	2.18e-04	63
	3,667.913	0.716	-971.110	-112.560	1,824.230	9,574	11,018	3.24e-04	16
	3,669.303	2.105	-970.890	-111.950	1,824.080	9,521	10,977	1.09e-03	12
	3,670.742	3.544	-971.010	-112.070	1,825.610	9,536	10,988	4.68e-04	1
								NA	2
27.0b	3,605.263	0.000	-968.770	-113.840	1,796.750	10,031	11,058	3.61e-04	91
	3,695.046	89.782	-969.250	-112.190	1,885.940	9,978	11,003	9.62e-04	2
	3,744.617	139.354	-970.390	-112.710	1,937.130	9,872	10,943	4.85e-02	1

Reference Points

GMACS changes

1. SPR lambda – negative for full EAG / WAG contribution, wasn't changed everywhere SPR lambda was called
2. Fishing season for OFL calculation
   - GMACS previous applied F_{OFL} in every season that a fleet has ever fished in
   - Change → specify season x fleet matrix

Reference Points

			$\bar{R}$ 1986–2021						
Model	Subdistrict	MMB_{prj}	EAG	WAG	$F_{35\%}$	$B_{35\%}$	Status	F_{OFL}	OFL
26.0a	EAG	6,680	2,669		0.52	6,687	0.96	0.49	3,491
26.0a2	WAG	3,991		1,790	0.52	4,470		0.50	
27.0		9,762	2,605	1,813	0.53	11,075	0.88	0.46	2,724
27.0a		9,510	2,591	1,776	0.54	11,009	0.86	0.46	2,551
27.0b		10,031	2,625	1,766	0.50	11,058	0.91	0.45	2,909

Reference points for 27.0b follow scale difference

Author Recommendations

Bring EAG 26.0a, WAG 26.0a2, and 27.0b

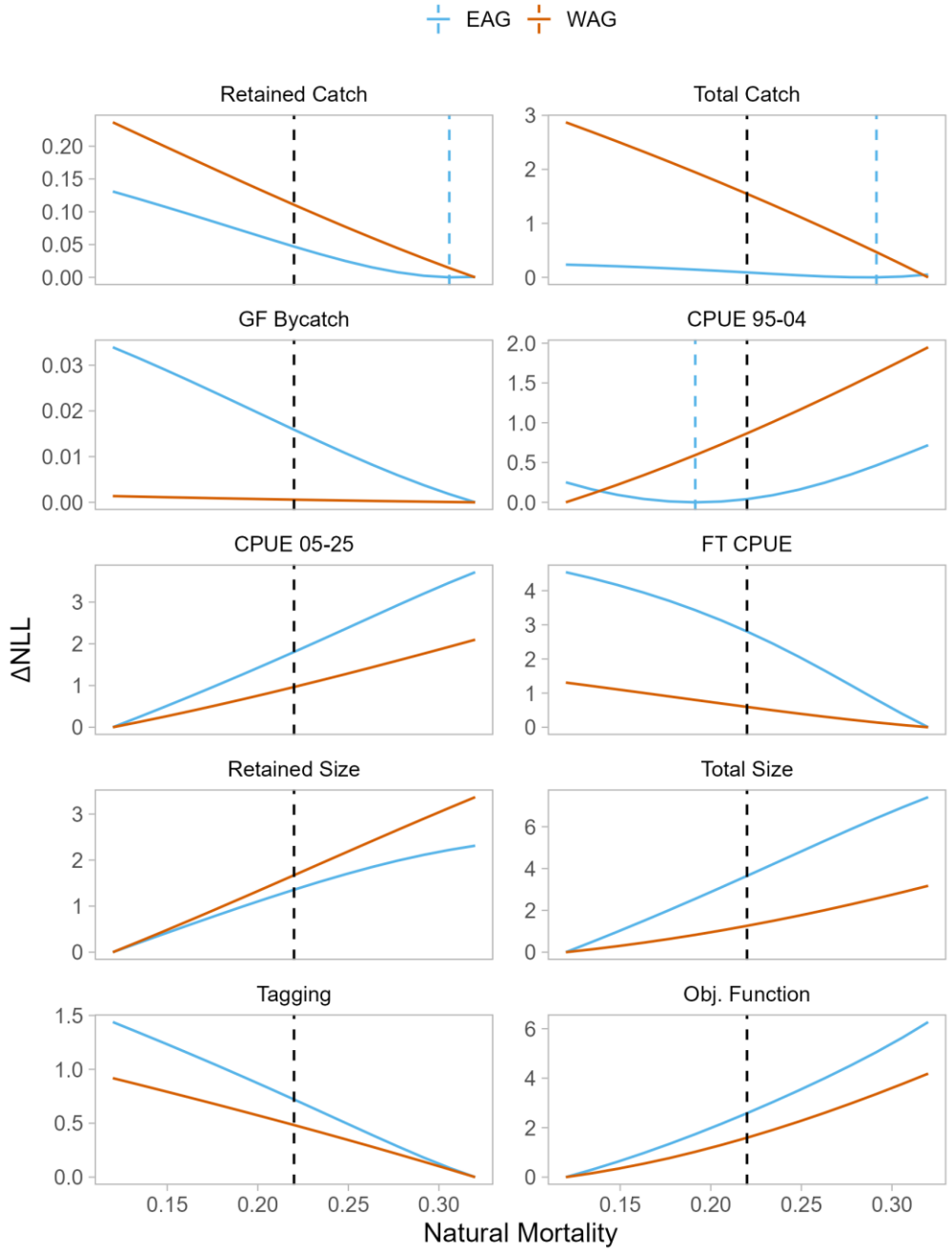
Is a combined model best? *Depends on the goal…*

Stock structure unclear, subdistricts share biological data in assessment

Need to better understand scale difference

Shared Natural Mortality

CPT May 2026: *"The author should continue developing a combined EAG/WAG model framework, including a diagnostic evaluation of whether natural mortality M is expected to be similar across the two subdistricts, as recommended by the SSC in December 2025."*



Questions?