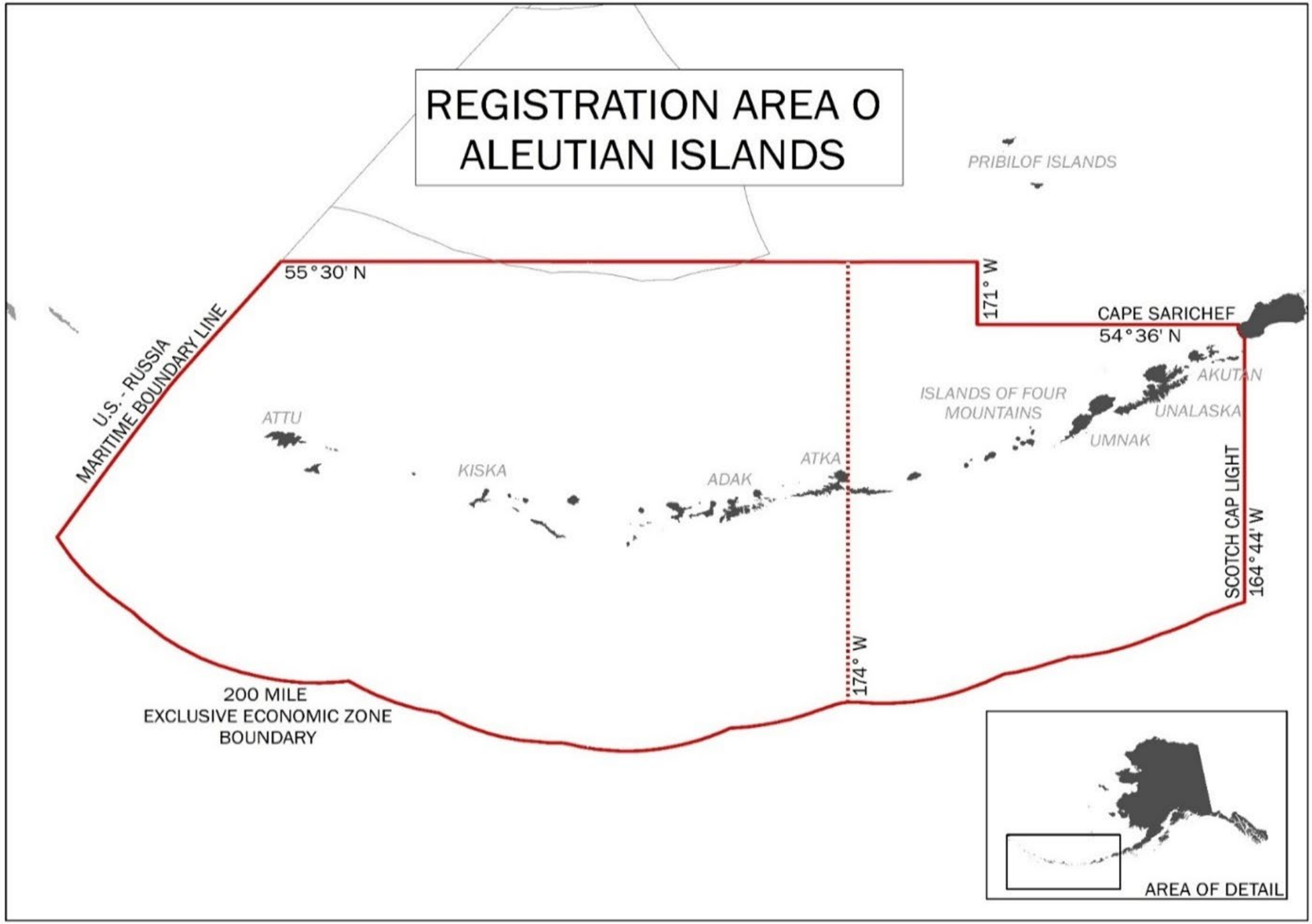
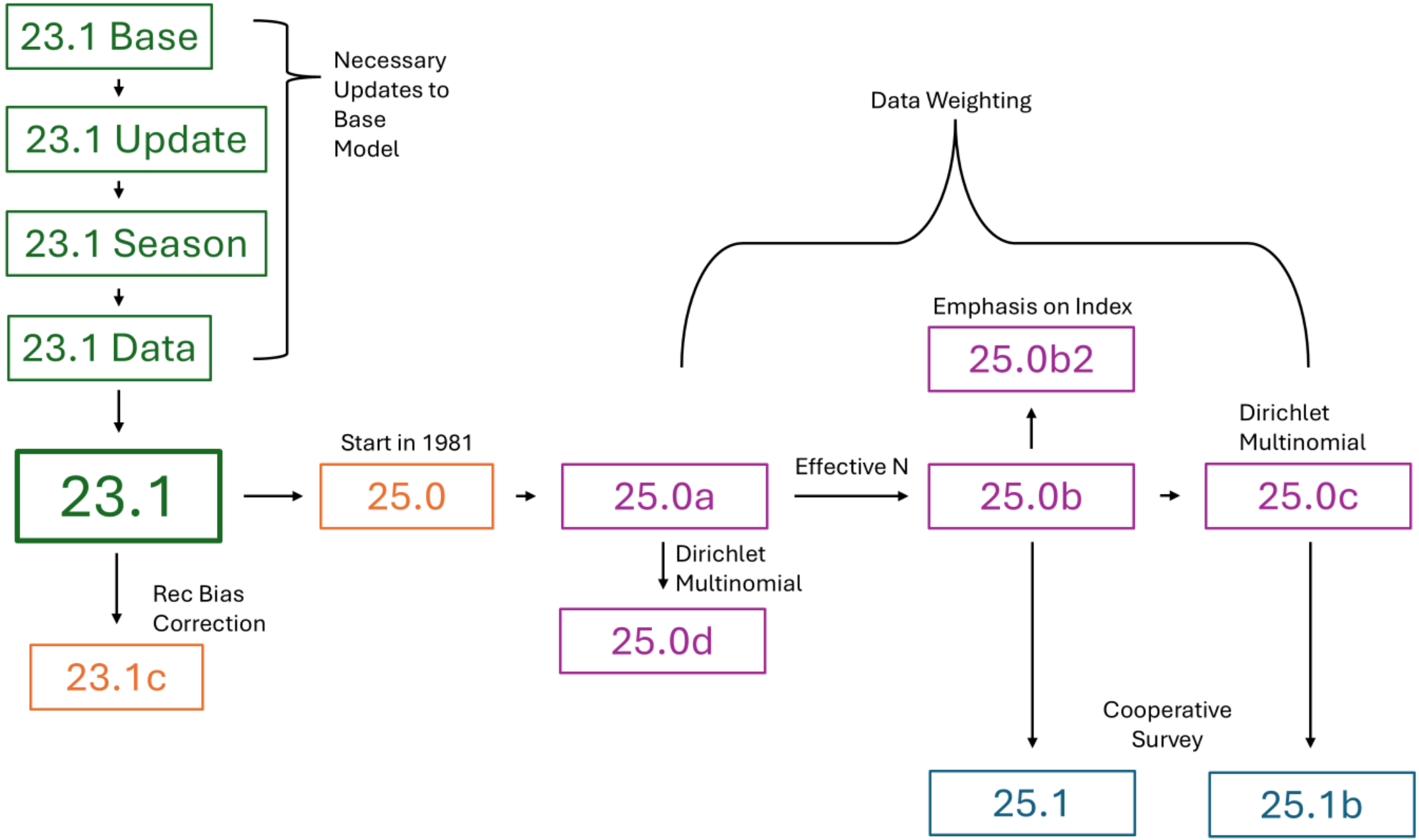
AIGKC
2025 Final Assessment

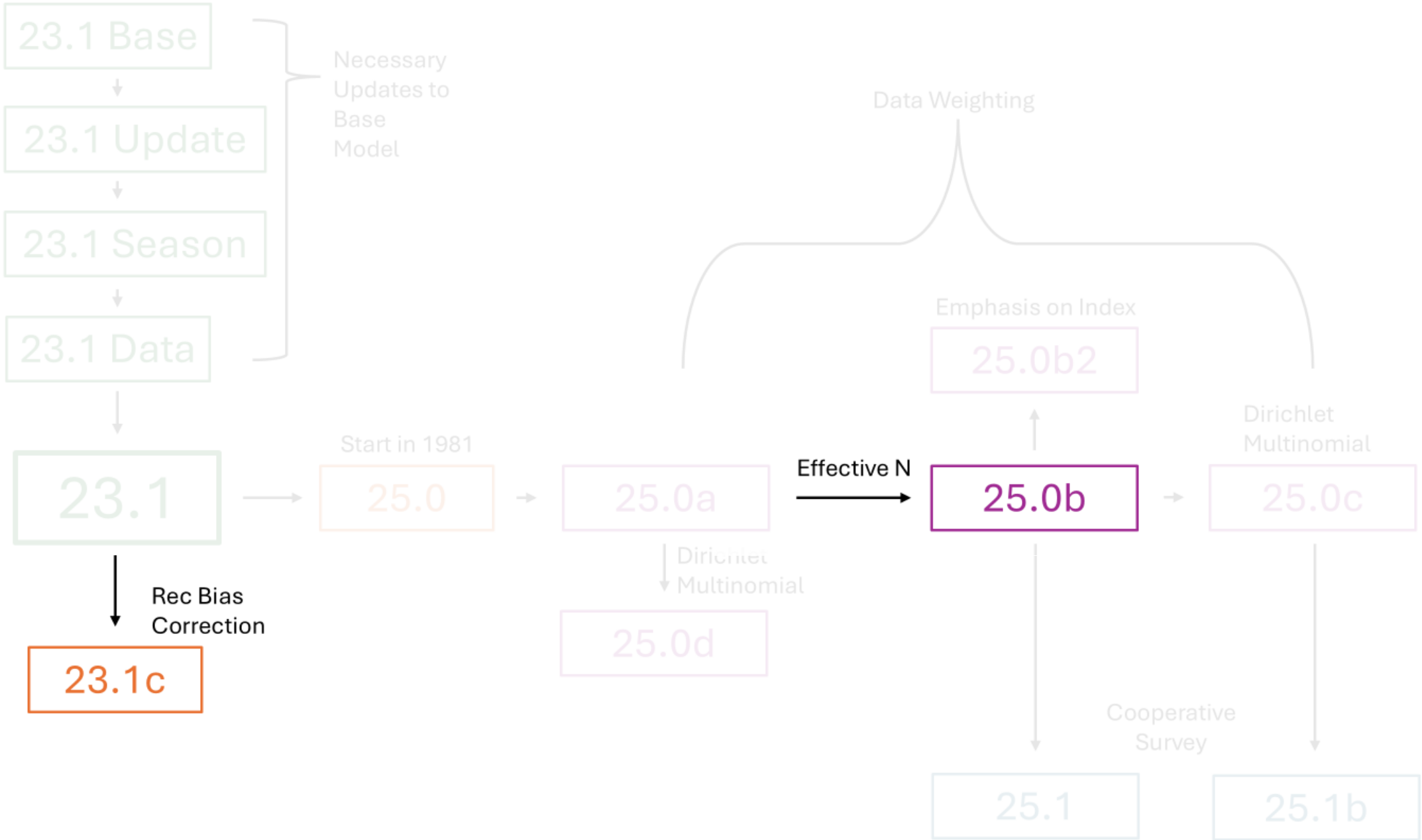
Tyler Jackson, ADF&G

May 2025 Crab Plan Team

Note: This presentation has been revised from the original version released on May 5, 2025. Minor changes were made to figures and text to comply with confidentiality rules for the 2024 fishing year.


REGISTRATION AREA O
ALEUTIAN ISLANDS
PRIBILOF ISLANDS
55°30' N
U.S. - RUSSIA
MARITIME BOUNDARY LINE
171° W
CAPE SARICHEF
54°36' N
AKUTAN
ISLANDS OF FOUR
MOUNTAINS
UNALASKA
UMNAK
ATTU
KISKA
ADAK
ATKA
SCOTCH CAP LIGHT
164°44' W
174° W
200 MILE
EXCLUSIVE ECONOMIC ZONE
BOUNDARY
AREA OF DETAIL


23.1 Base
23.1 Update
23.1 Season
23.1 Data
Necessary Updates to Base Model
23.1
Rec Bias Correction
23.1c
Start in 1981
25.0
25.0a
Dirichlet Multinomial
25.0d
Effective N
Data Weighting
Emphasis on Index
25.0b2
25.0b
Dirichlet Multinomial
25.0c
Cooperative Survey
25.1
25.1b


23.1 Base
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Effective N
Data Weighting
Emphasis on Index
25.0b2
25.0b
Dirichlet Multinomial
25.0c
Cooperative Survey
25.1
25.1b

Data Changes from 2024 Final Assessment

EAG 1993/94 Season

1. 1993/94 EAG (171° W) was open from Sept 1, 1993 – Mar 1, 1994. **There was no observer coverage.**
2. 1993/94 observer data here was actually from the (then) 1992/93 season in the WAG: Nov 1, 1992 – Aug 15, 1993
3. **These data were included in retained catch / size, but not total catch / size**

Data Changes from 2024 Final Assessment

WAG 1993/94 Season

1. Exclusion of odd pots shapes and rectangular pots in the following dimensions: 9’x9’, 8.5’x8.5’, 9.5’x9.5’, 8’x9’, 8’x10’, 9’x10’, 7’x8’, or **unknown**.
2. Most (160/174) observer pots from 1993/94 are rectangular pots with unknown size
3. **Solution: Use all rectangular pots for size composition, status quo for CPUE**

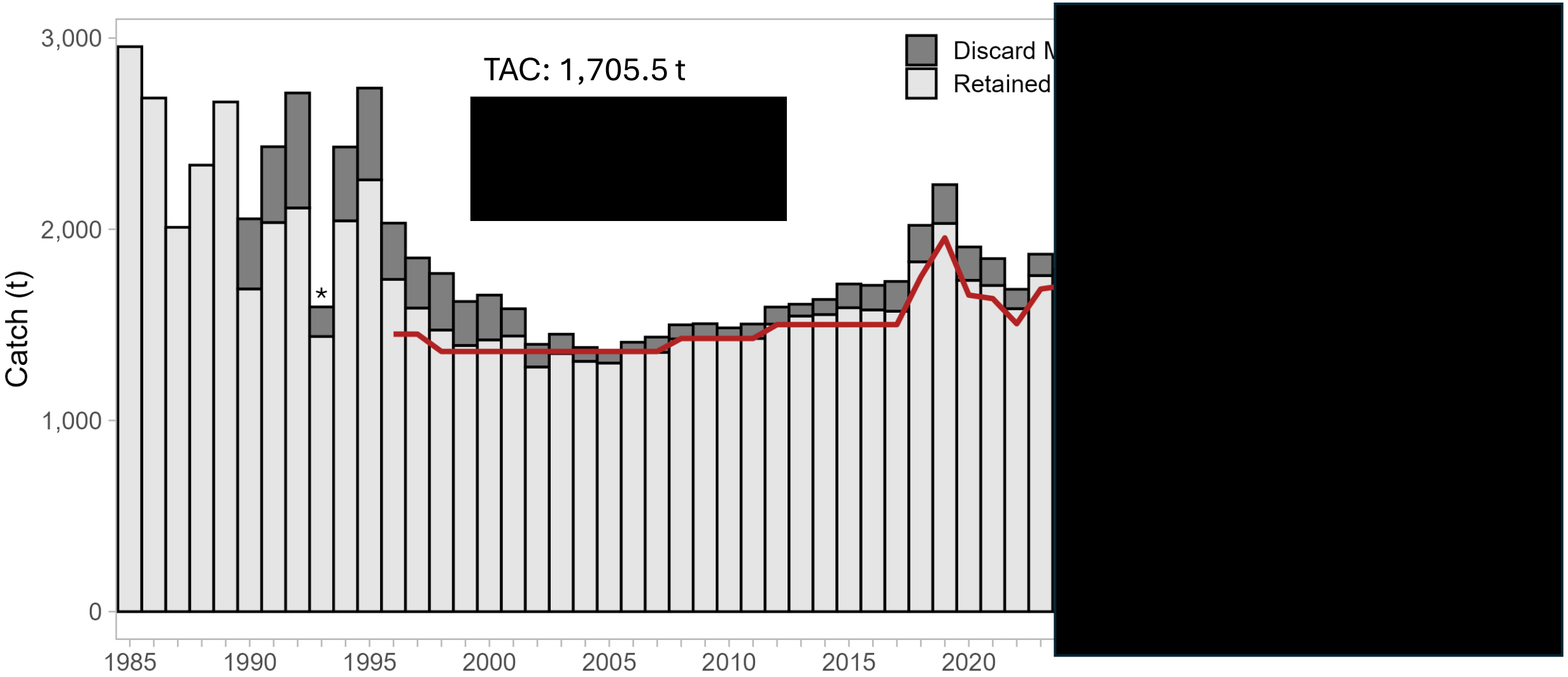
Data Changes from 2024 Final Assessment

- Standardization of BSAI crab fishery estimation resulted in minor changes to AIGKC total catch and size composition data

- Very minor, applied to both final assessment models – Appendix A

- See BSAIcrabR, aigkc_BSAIcrabR.R

2024/25 Fishery EAG



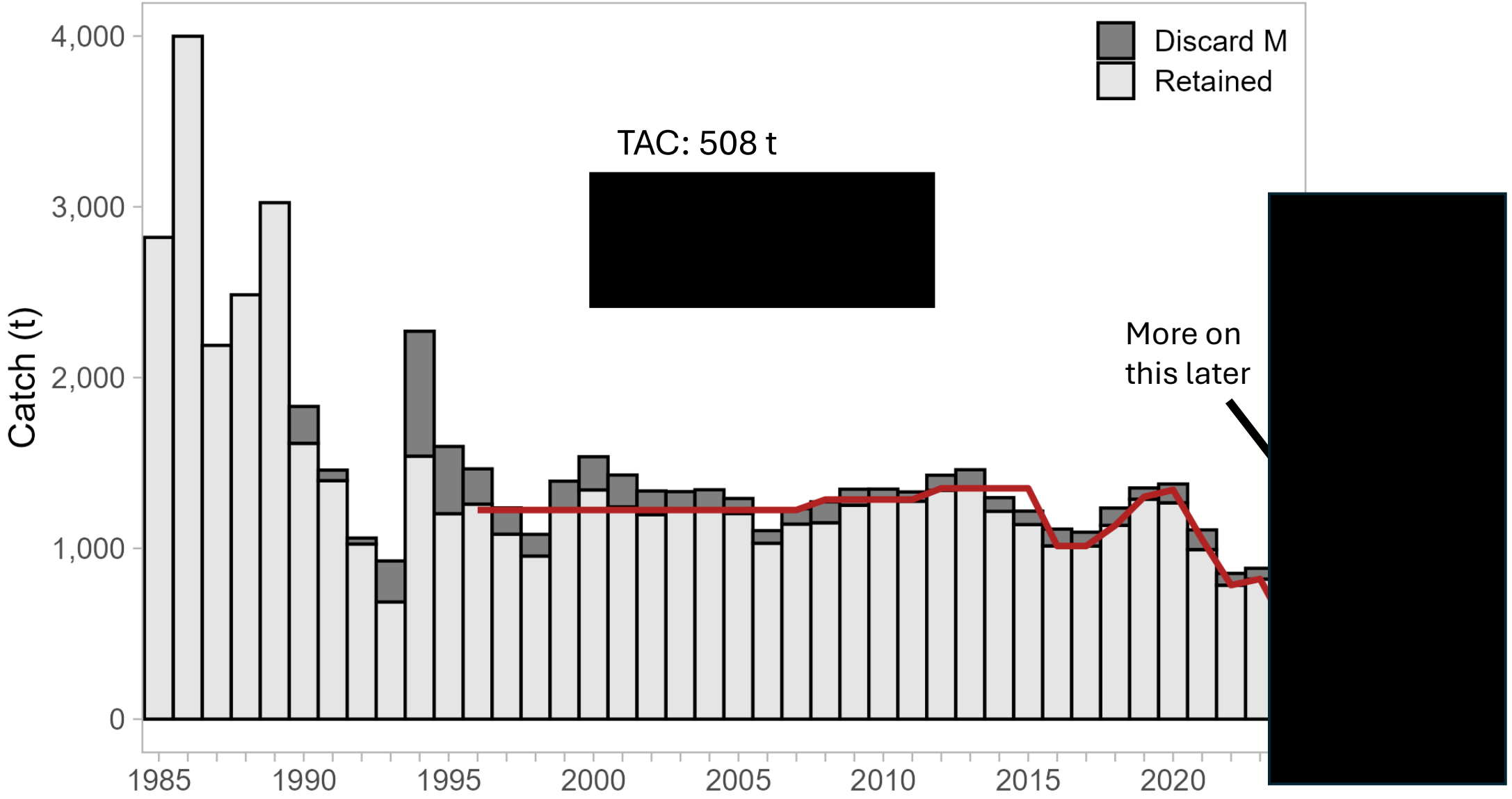
Protocol for Incomplete Fishery (SAFE D.2.f)

- Retained catch equals the total allowable catch (TAC);
- Total catch is estimated as usual, though using the observer CPUE ($U_{obs,group}$, crab per pot lift) to-date and total directed effort (N) as

$$N = \frac{\text{TAC}}{wU_{ft}} \tag{1}$$

  where w is the average calculated weight of legal males in the fishery based on observer samples to-date, and U_{ft} is the retained legal male CPUE to date;
- Retained catch size composition is estimated based on dockside samples to-date;
- Total catch size composition is estimated based on observer samples to-date.

2024/25 Fishery WAG



CPUE Standardization (Appendix B)

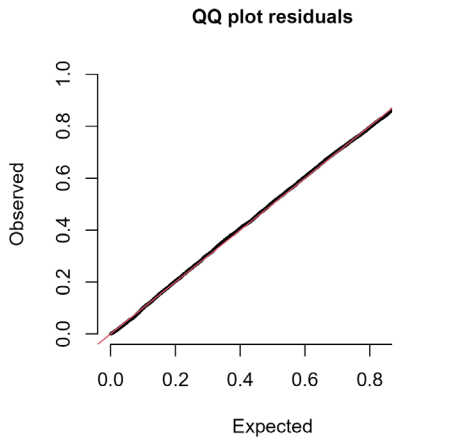
- No change in method from 2024, only update to post-rationalized period (i.e., 2024/25 data)

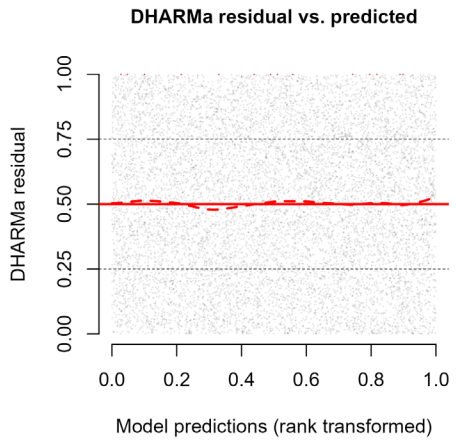
- Tweedie GAM
  - Forward/Backward model selection with AIC & deviance explained
  - Permit holder, vessel, month, block, s(depth), s(soak time), s(slope)
  - Year coefficients scaled by geometric mean

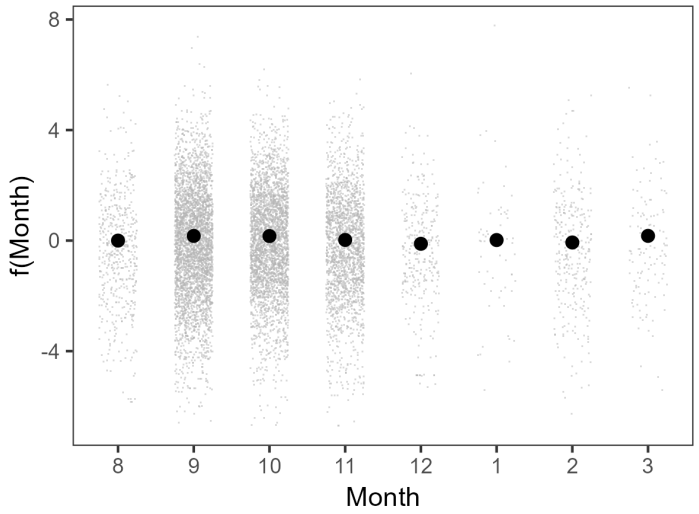
EAG CPUE Standardization

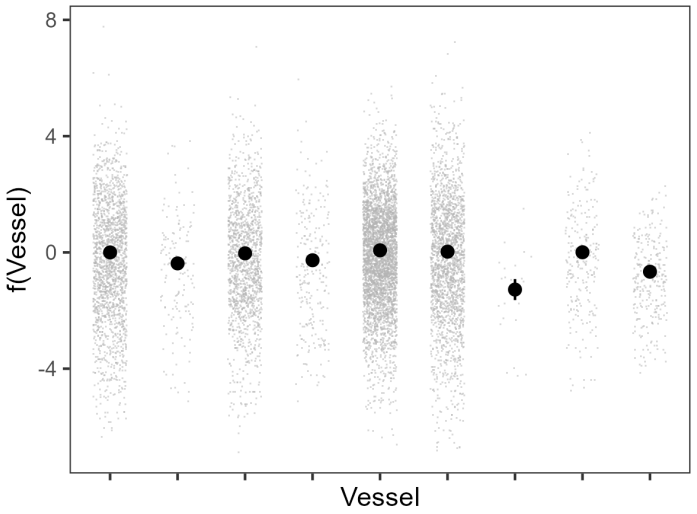
Form ($p = 1.384$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + s(soak time, 4.44) + Mon + Ves + Gr	10,471.56	91,962	0.14
+ s(depth)	-3.81	15.13	0.002
+ s(slope)	-2.89	7.70	0.002
+ Block	-3.00	23.01	0.001
- Permit Holder	-12.5	46	0.006

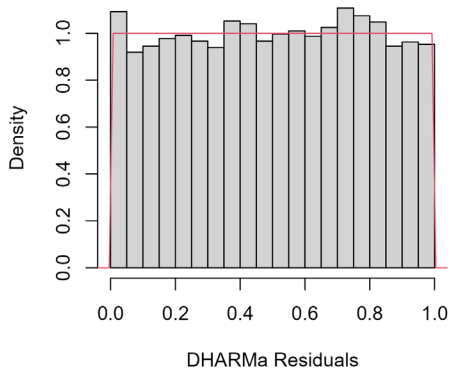
EAG CPUE Standardization

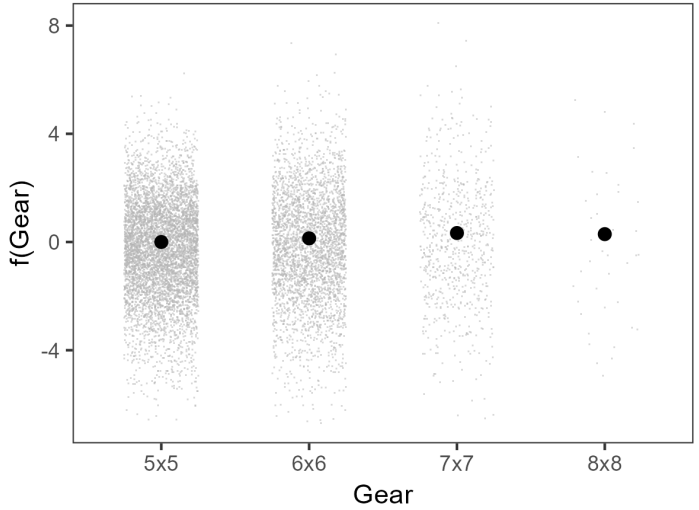


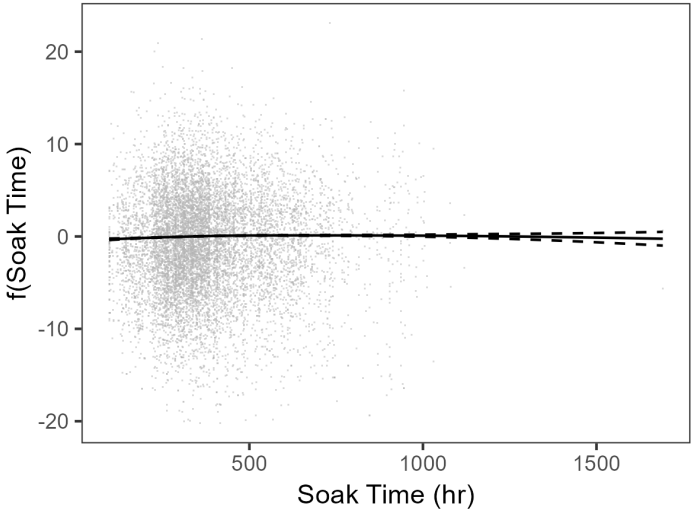






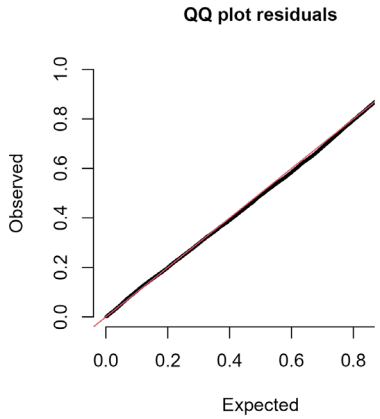


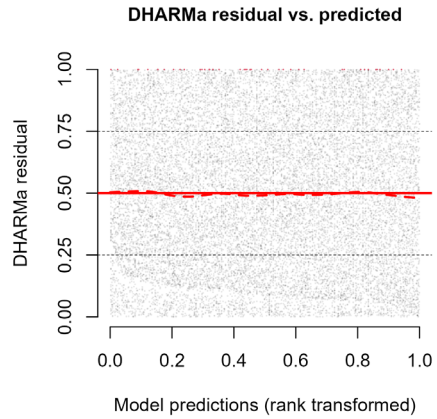


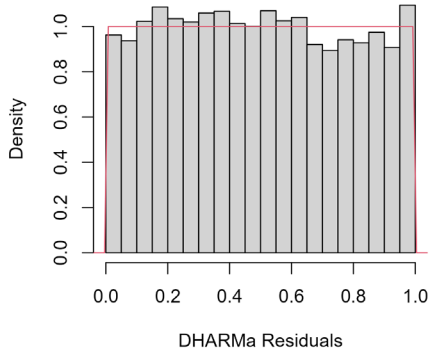


WAG CPUE Standardization

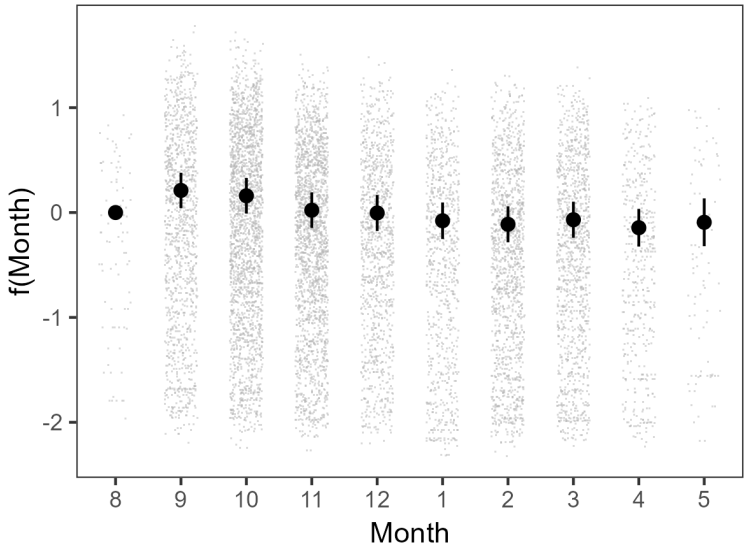
Form ($p = 1.495$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + Mo + PH + Gr	17,008	142,306	0.099
+ s(soak time)	-8.03	-30.95	0.005
+ s(depth)	-4.20	-32.96	0.003
+ s(slope)	-2.97	4.48	0.001
+ Block	-5.00	14.28	0.002
- Vessel	-2	-14.9	0.000

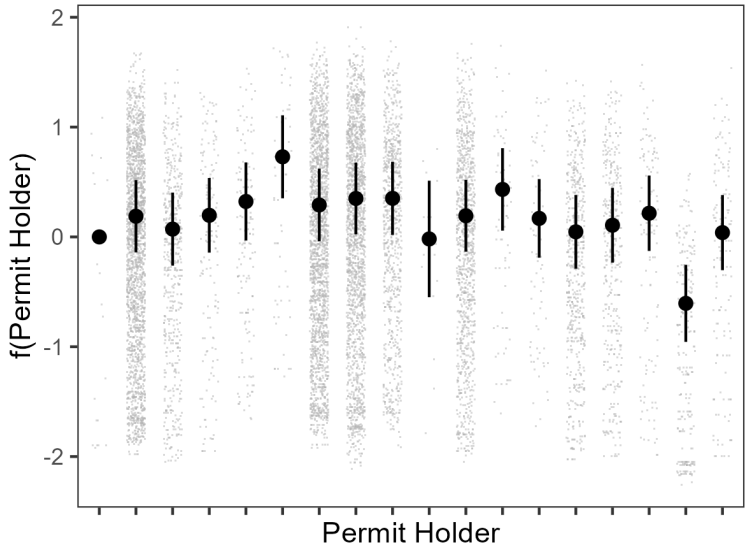


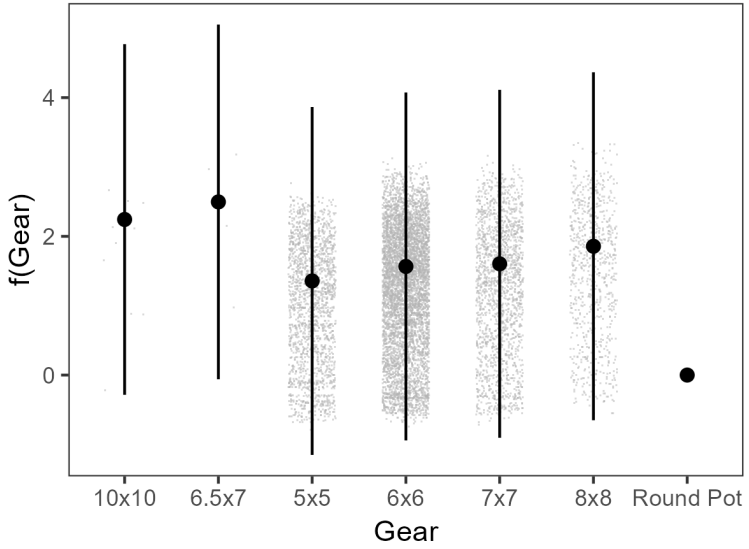




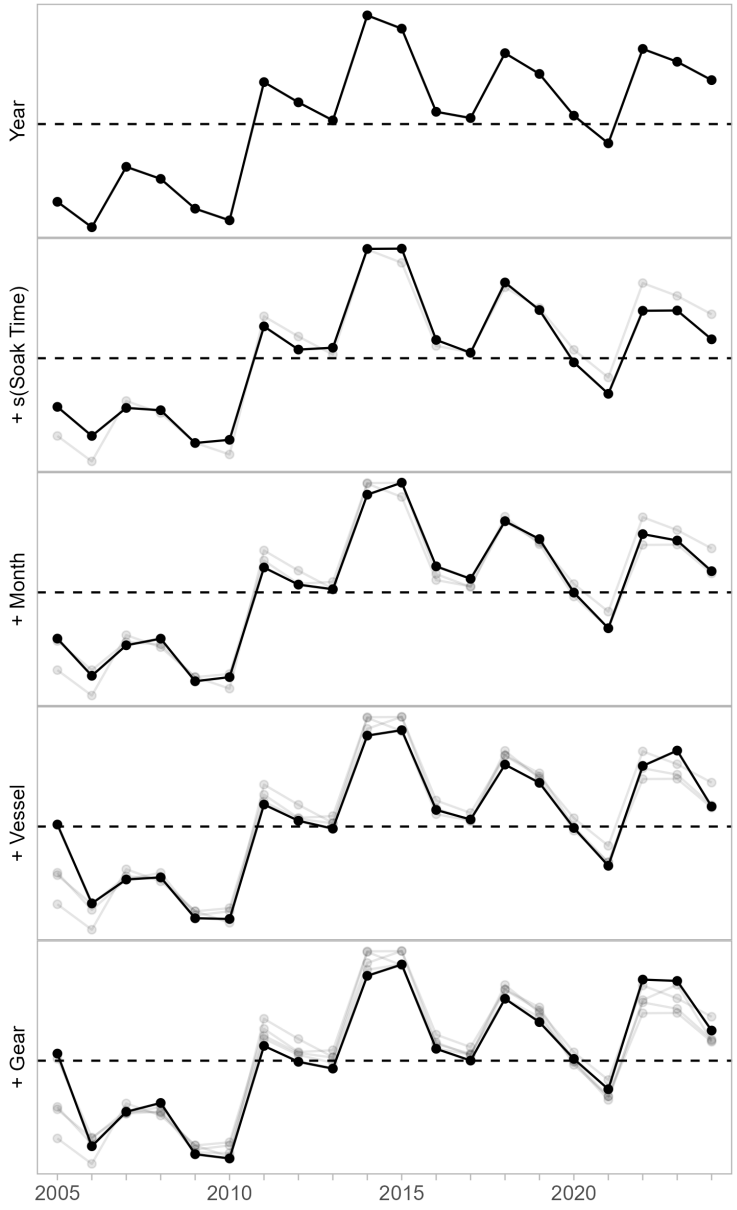
WAG CPUE Standardization



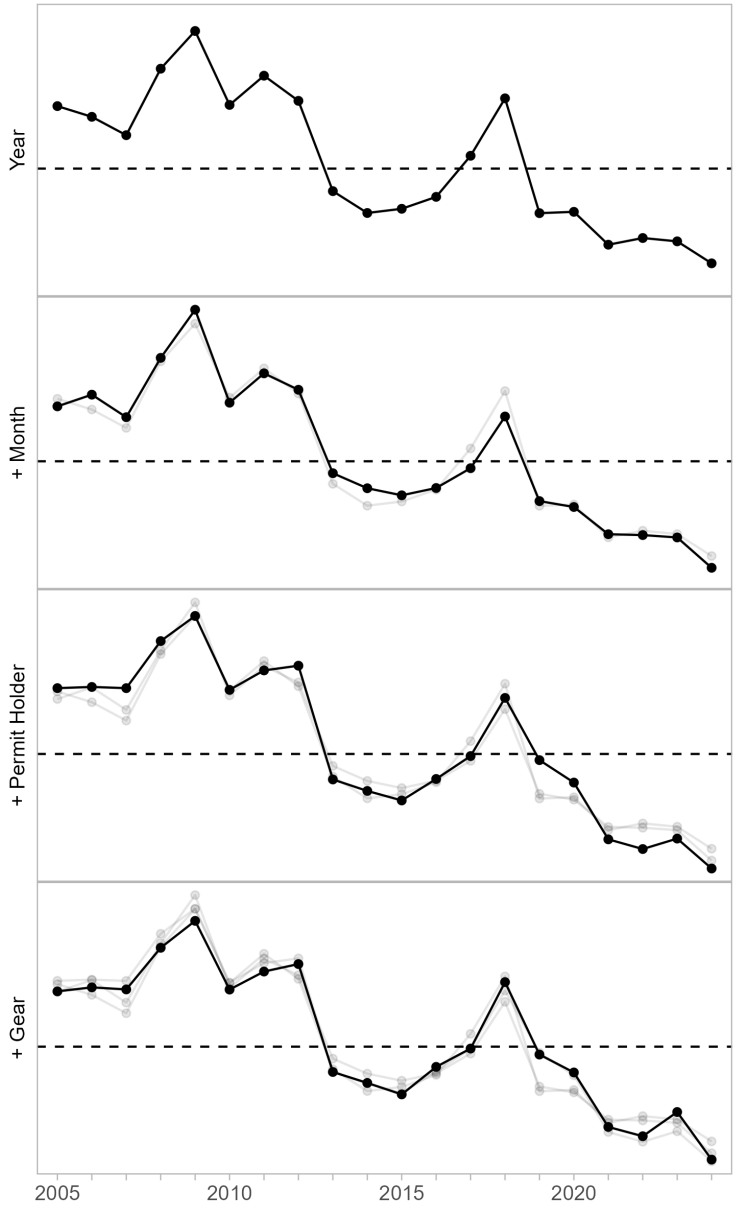


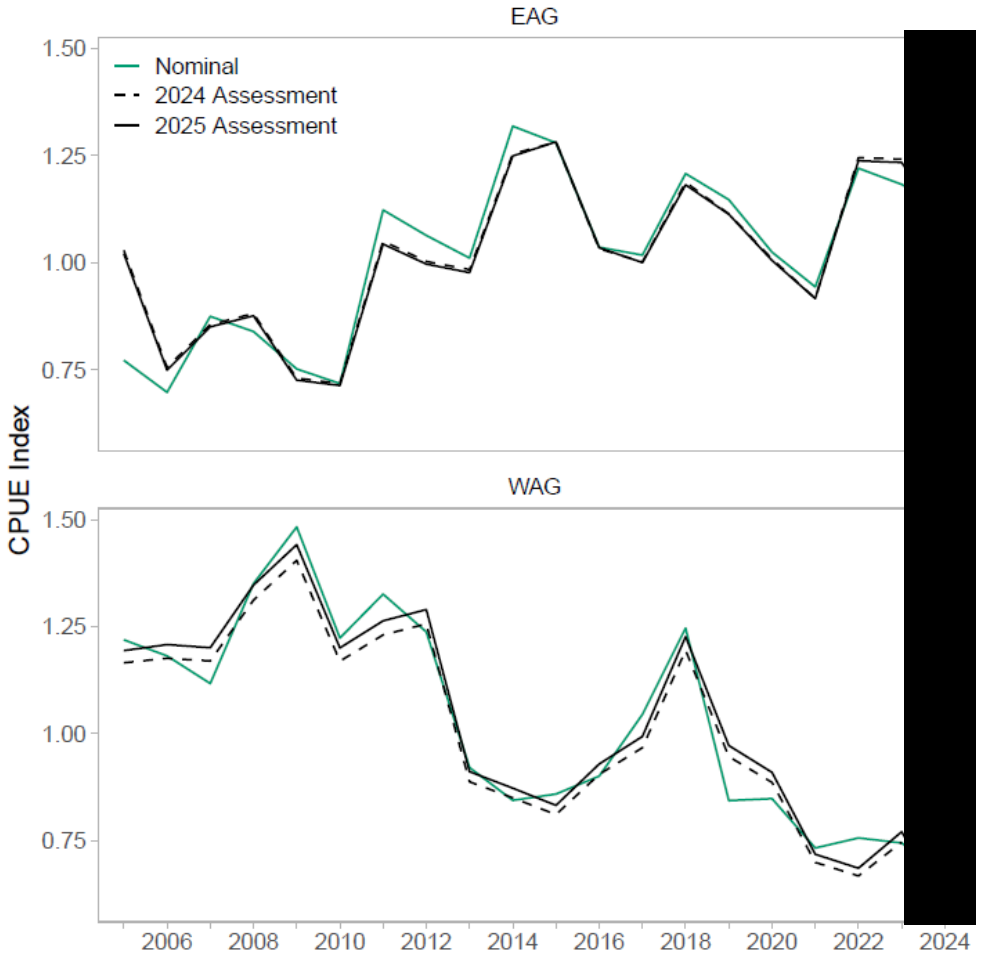


EAG


Year
+ s(Soak Time)
+ Month
+ Vessel
+ Gear
2005
2010
2015
2020

WAG


Year
+ Month
+ Permit Holder
+ Gear
2005
2010
2015
2020


EAG
WAG
Nominal
2024 Assessment
2025 Assessment
CPUE Index
1.50
1.25
1.00
0.75
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024

Models

23.1c (Base Model) 2024 accepted model with corrected bias correction on recruitment deviations before 1981 (i.e. first data)

$$b_t e^{\frac{\sigma^2}{2}}$$

where b_t is a vector of 0 from 1960 – 1980 and 1 from 1981 - 2024

Models

23.1c (Base Model) 2024 accepted model with corrected bias correction on recruitment deviations before 1981 (i.e. first data)

25.0b 23.1c +

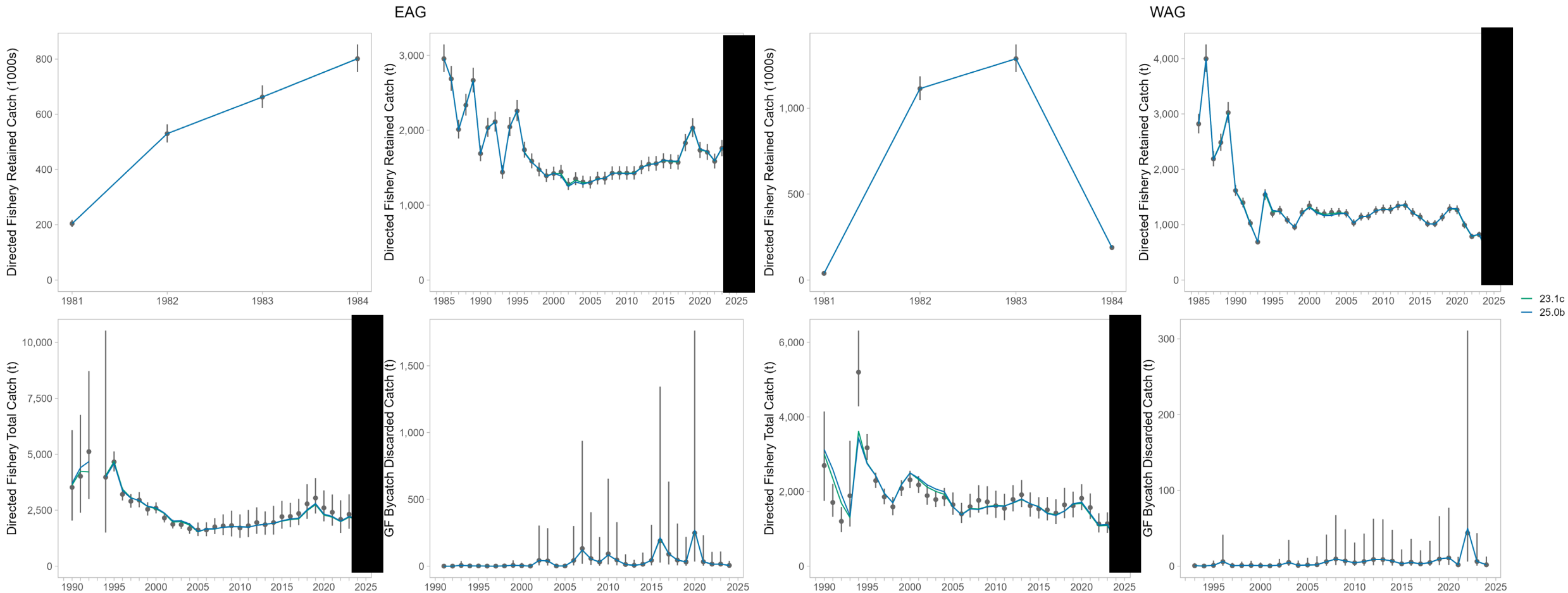
- Start model in 1981 in non-equilibrium state
- Equal likelihood emphasis on catch data (λ = 1)
- Bootstrap estimated input sample size for size composition data

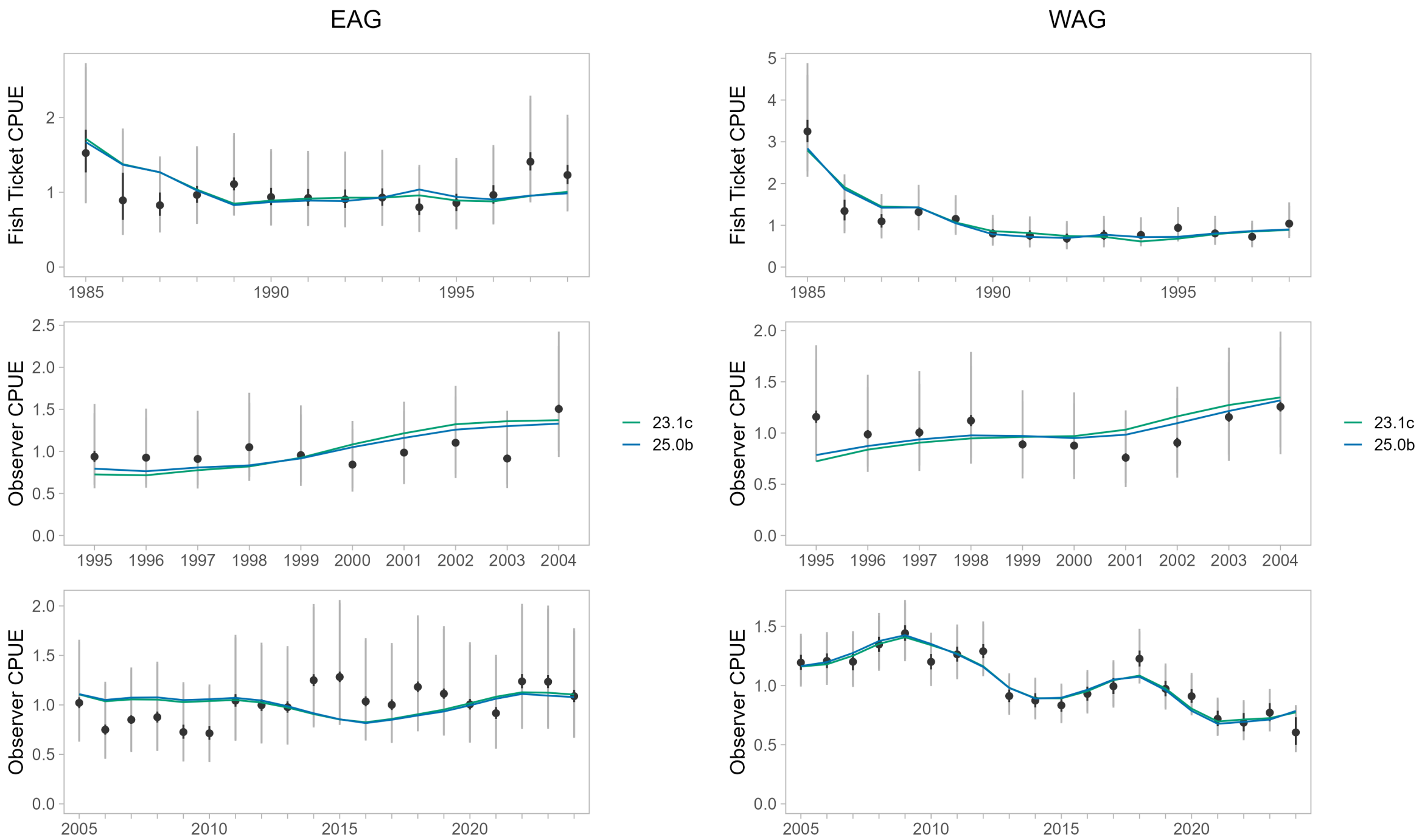
Bootstrapping

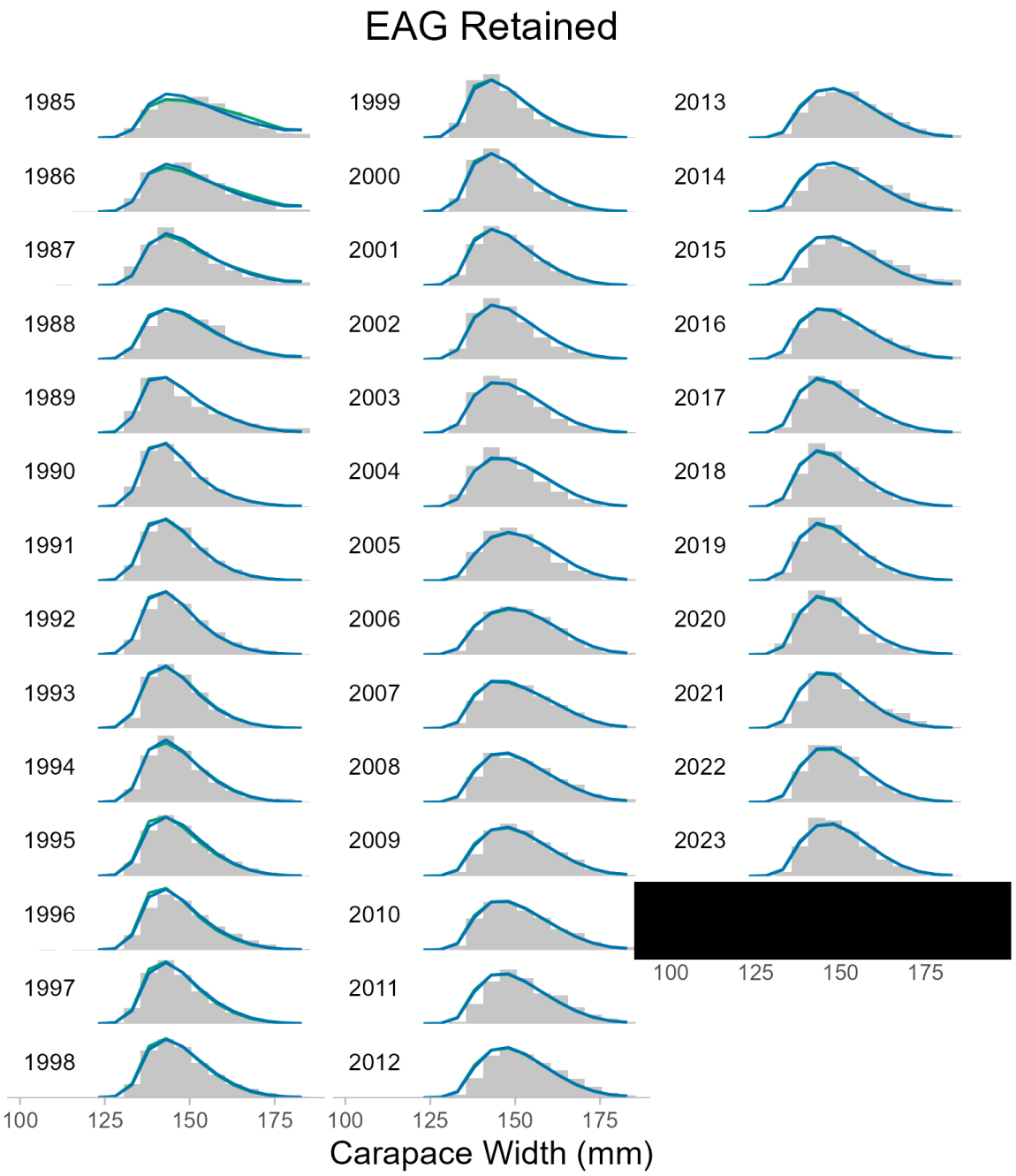
- Based on Stewart and Hamel (2014)
- Non-parametric, with replacement
- Two-stage approach
  1. Delivery (retained) or observer pot (total)
  2. Individual crab
- 1,000 replicates per year
- SAFE Tables 7 & 8

$$N_{eff} = \frac{\sum_l P_l(1-P_l)}{\sum_l (P_l - B_l)^2}$$

$$N'_{eff} = \min(2000, \overline{N_{eff}})$$


EAG
WAG
Directed Fishery Retained Catch (1000s)
Directed Fishery Retained Catch (t)
Directed Fishery Total Catch (t)
GF Bycatch Discarded Catch (t)
23.1c
25.0b


EAG
WAG
Fish Ticket CPUE
Observer CPUE
23.1c
25.0b


EAG Retained
1985
1986
1987
1988
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1998
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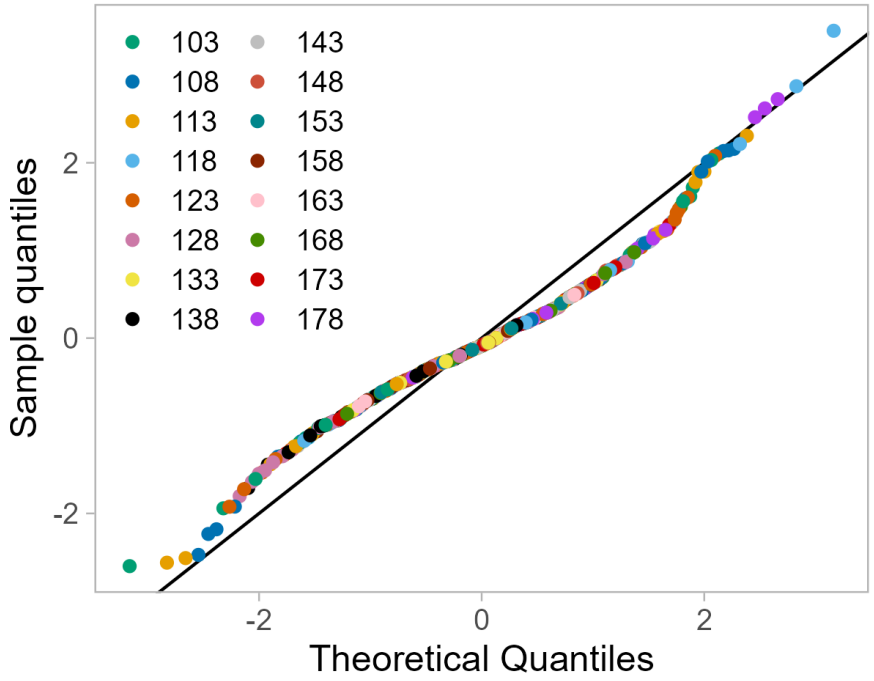
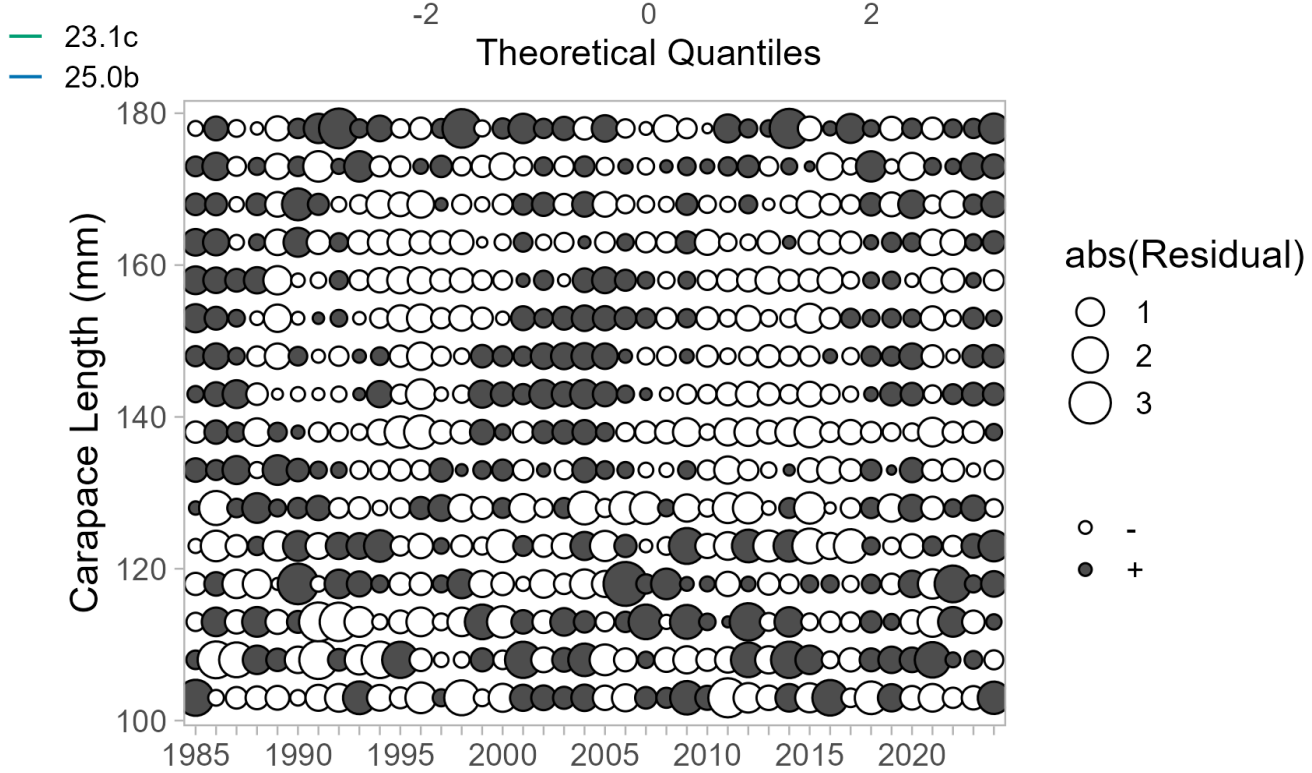
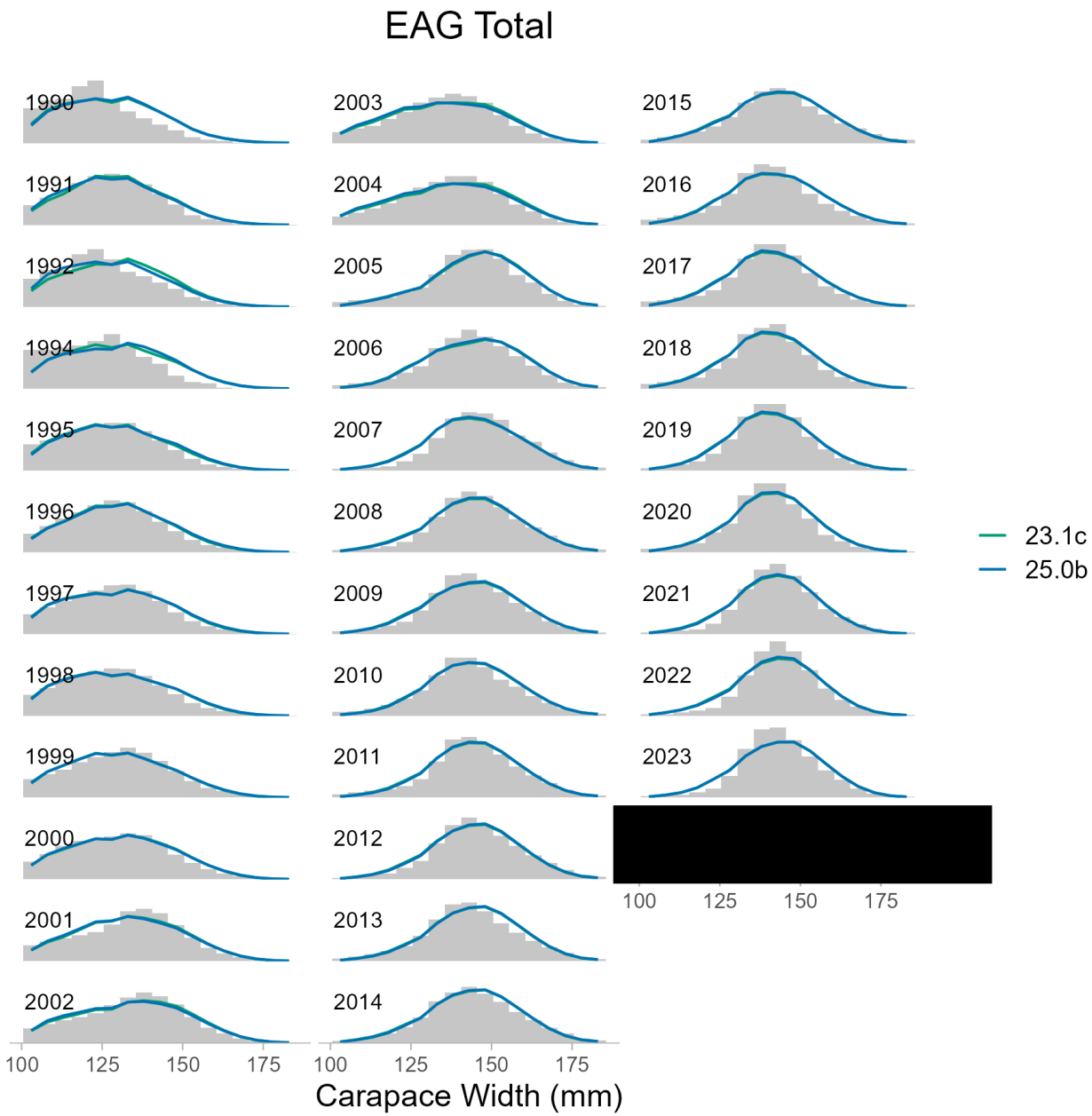
2015
2016
2017
2018
2019
2020
2021
2022
2023
100
125
150
175
Carapace Width (mm)


103
108
113
118
123
128
133
138
143
148
153
158
163
168
173
178
Sample quantiles
Theoretical Quantiles
2
0
-2


23.1c
25.0b
Carapace Length (mm)
180
160
140
120
100
1985
1990
1995
2000
2005
2010
2015
2020
abs(Residual)
1
2
3
-
+


EAG Total
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2014
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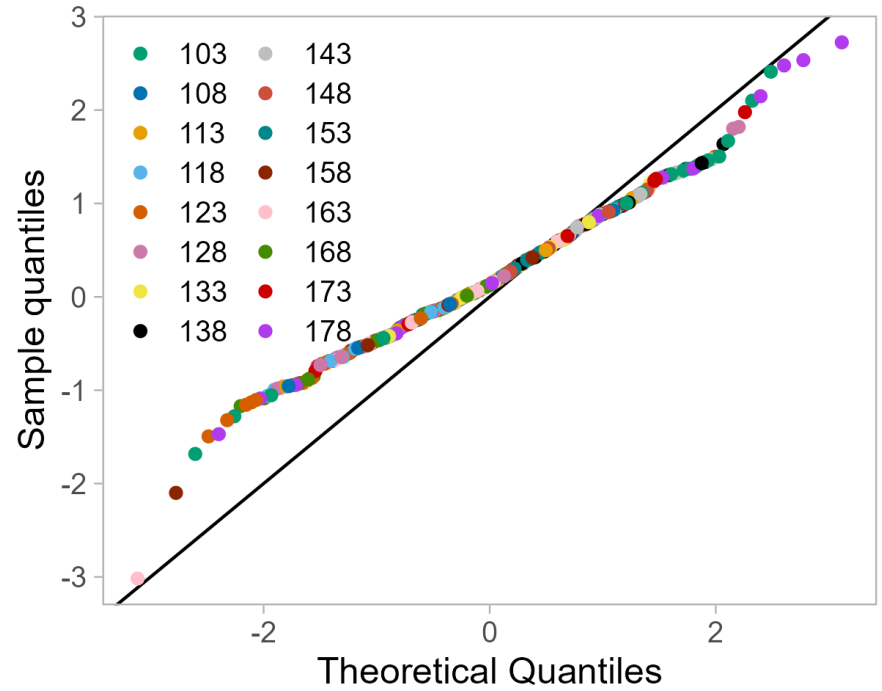
2020
2021
2022
2023
100
125
150
175
Carapace Width (mm)
23.1c
25.0b


Sample quantiles
Theoretical Quantiles
103
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113
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123
128
133
138
143
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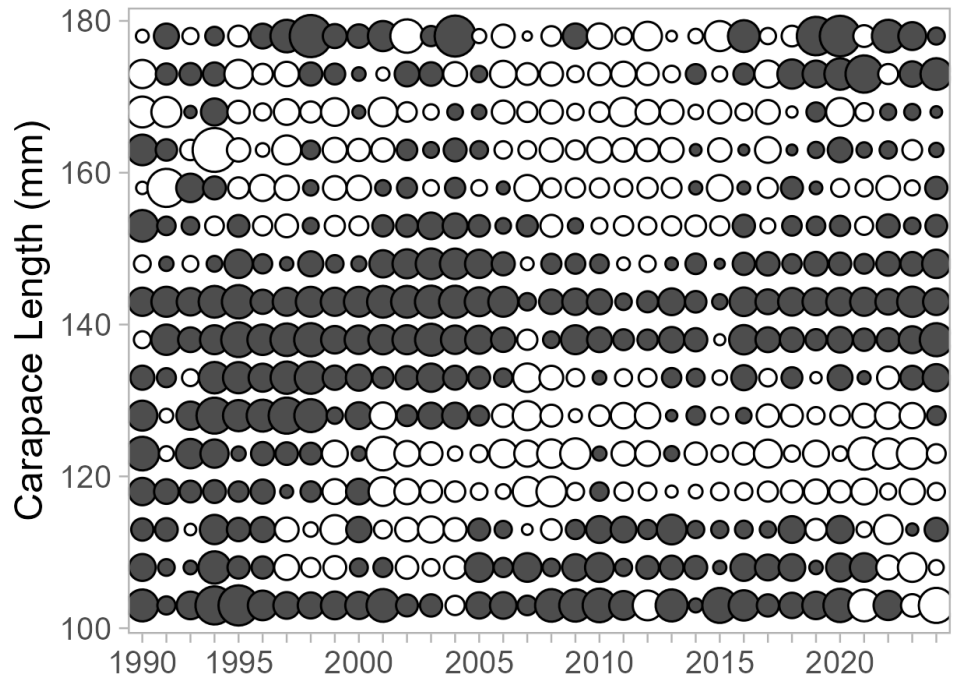
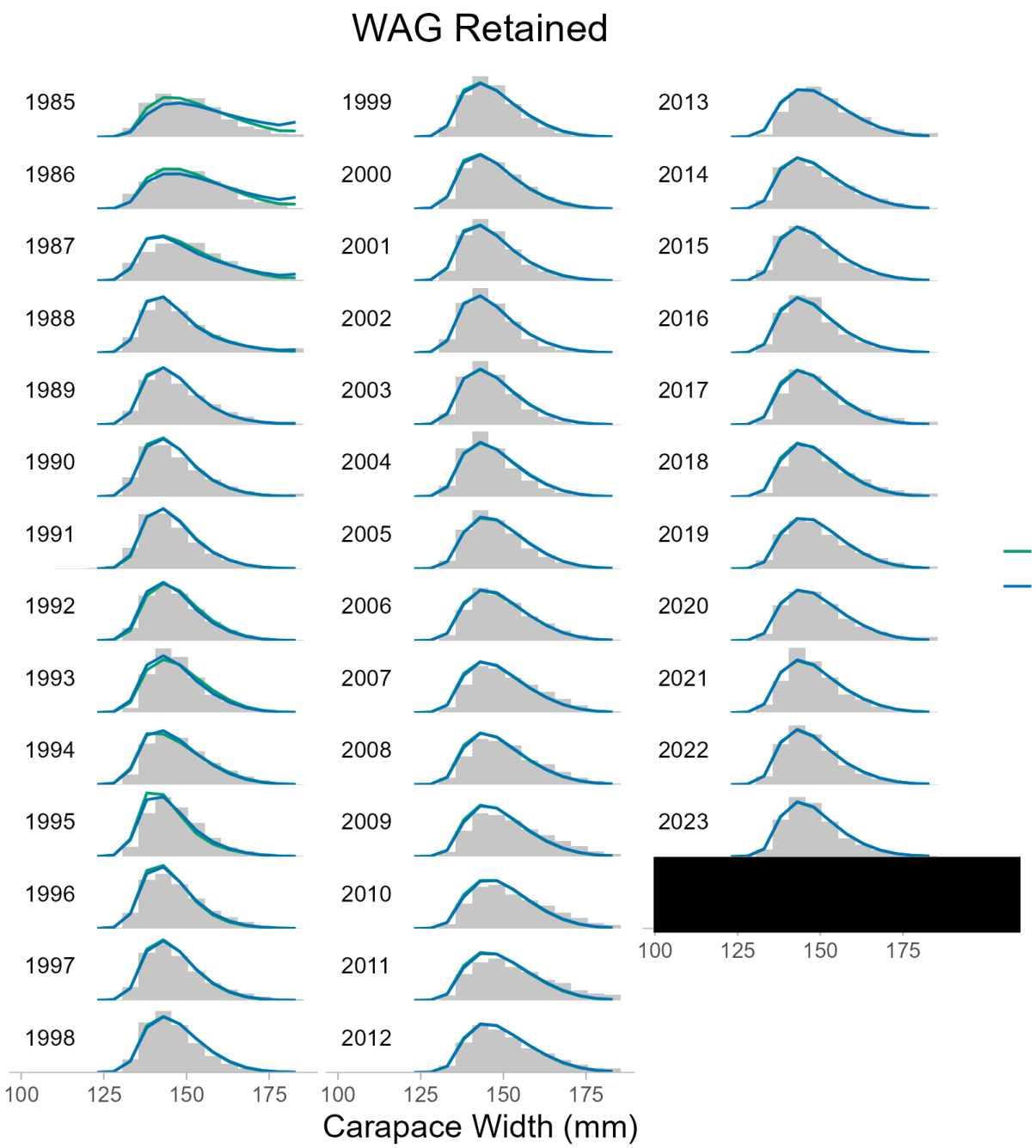
153
158
163
168
173
178


Carapace Length (mm)
1990
1995
2000
2005
2010
2015
2020
abs(Residual)
1
2
3
-
+


WAG Retained
1985
1986
1987
1988
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1990
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1992
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2004
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2017
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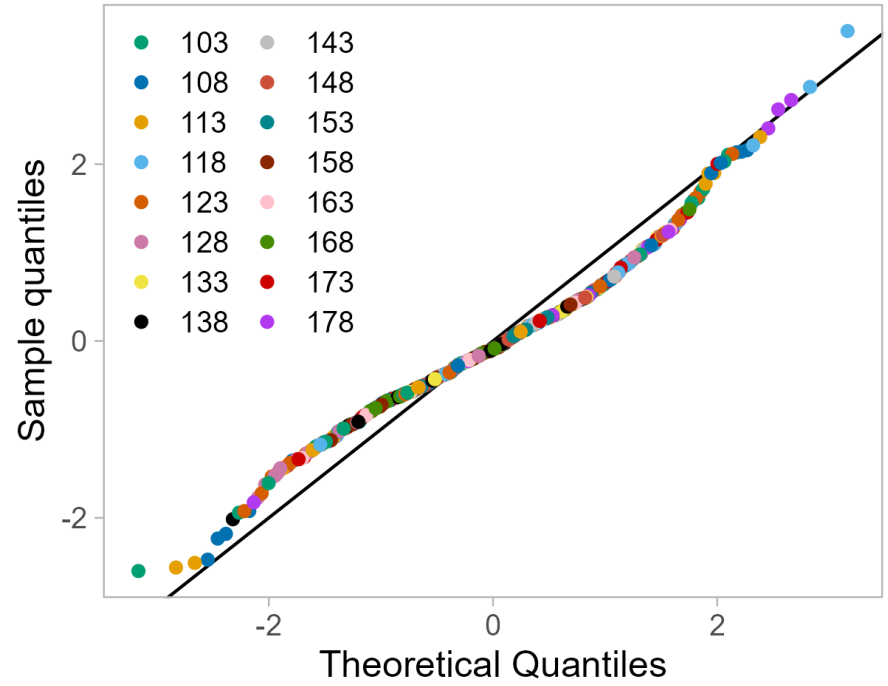
2019
2020
2021
2022
2023
100
125
150
175
Carapace Width (mm)
23.1c
25.0b


103
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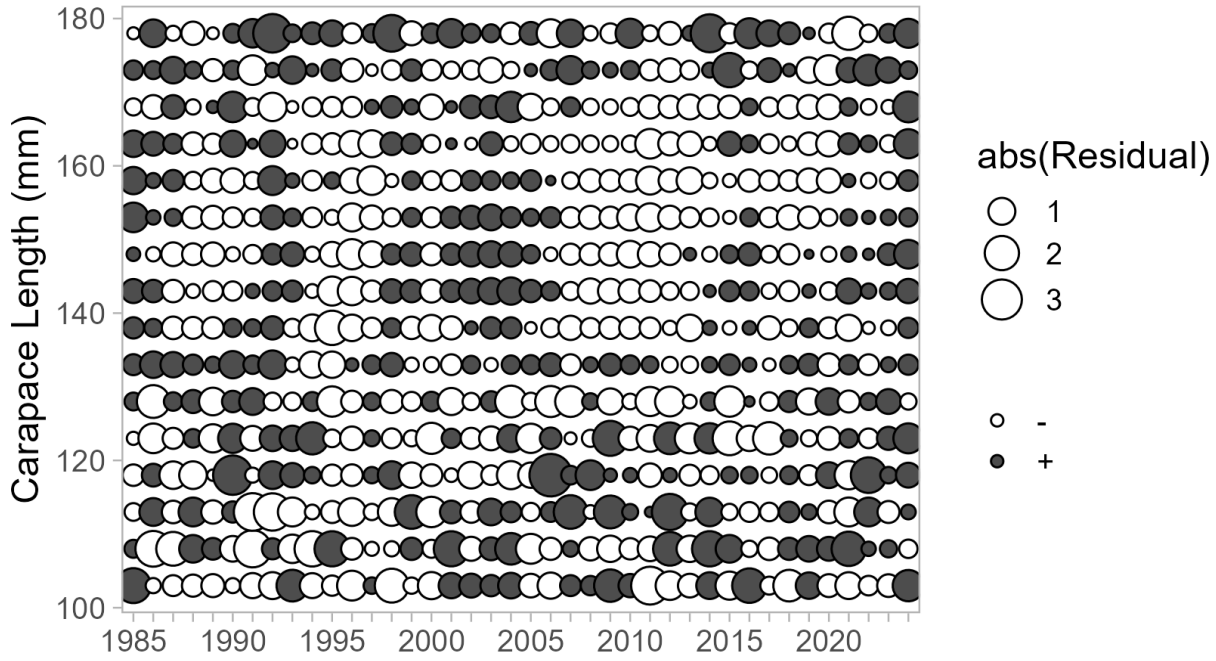
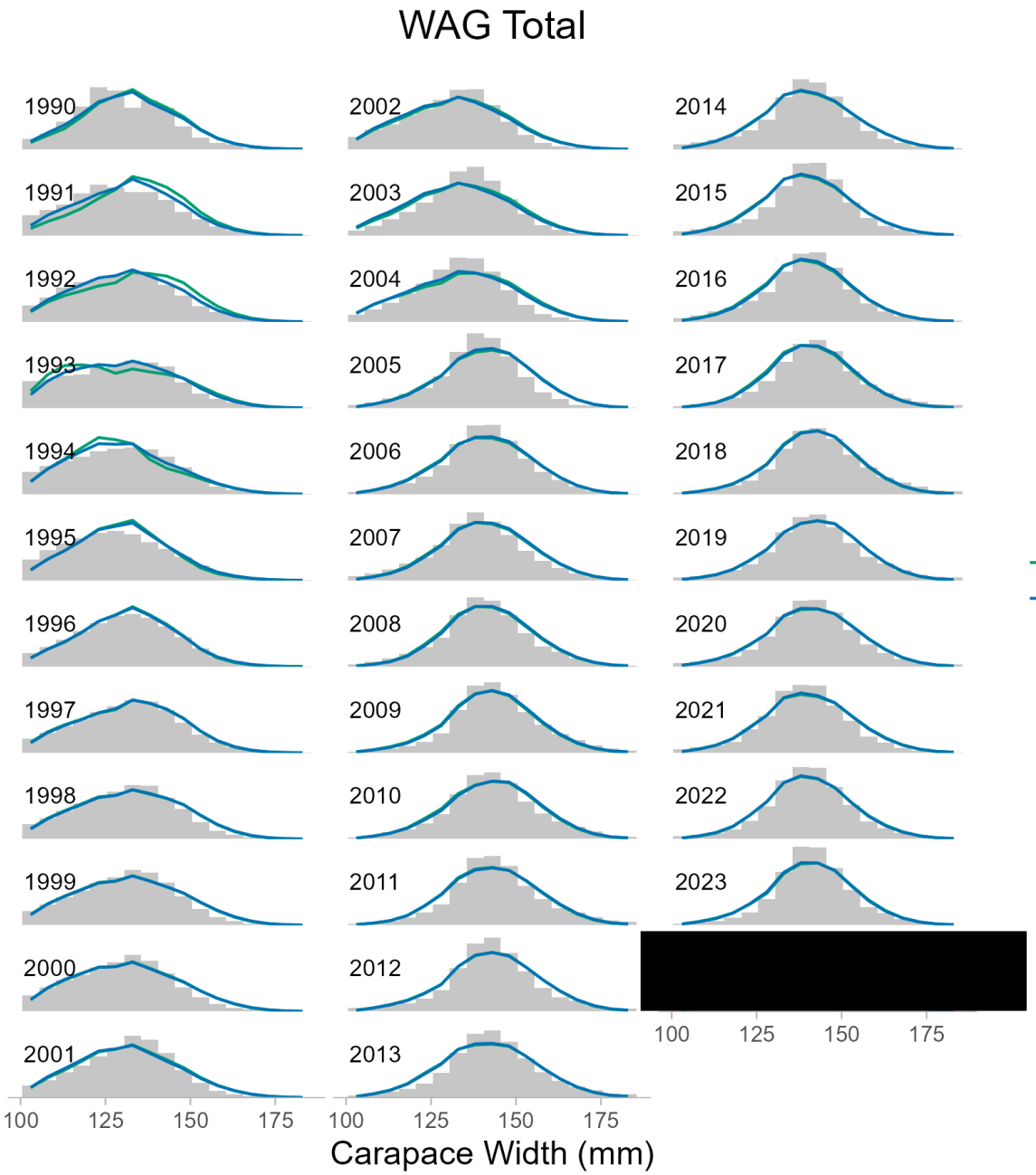
133
138
143
148
153
158
163
168
173
178
Sample quantiles
Theoretical Quantiles
2
0
-2


Carapace Length (mm)
180
160
140
120
100
1985
1990
1995
2000
2005
2010
2015
2020
abs(Residual)
1
2
3
-
+


WAG Total
1990
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1993
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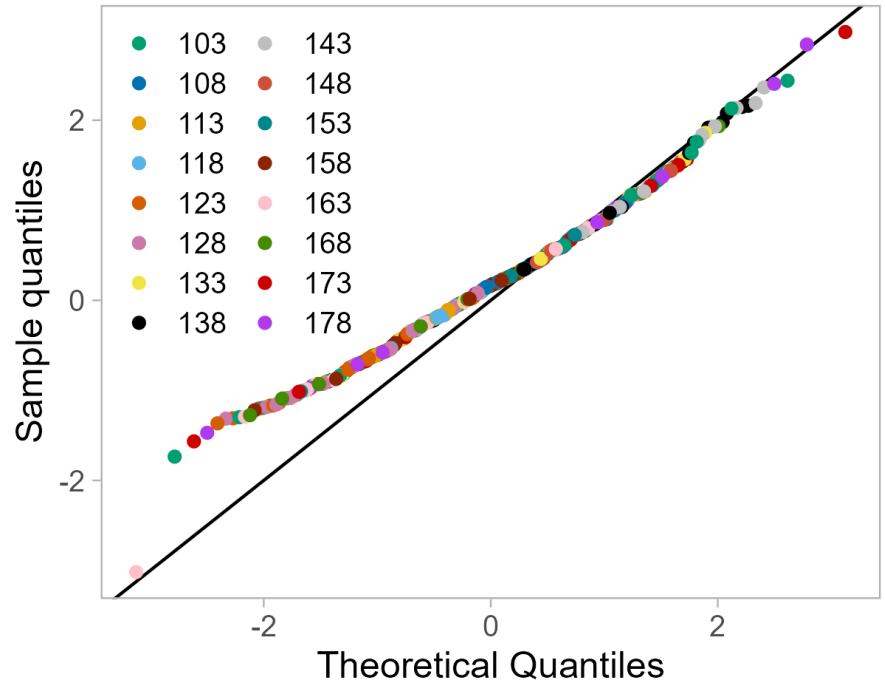
2020
2021
2022
2023
100
125
150
175
Carapace Width (mm)


23.1c
25.0b


103
108
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143
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153
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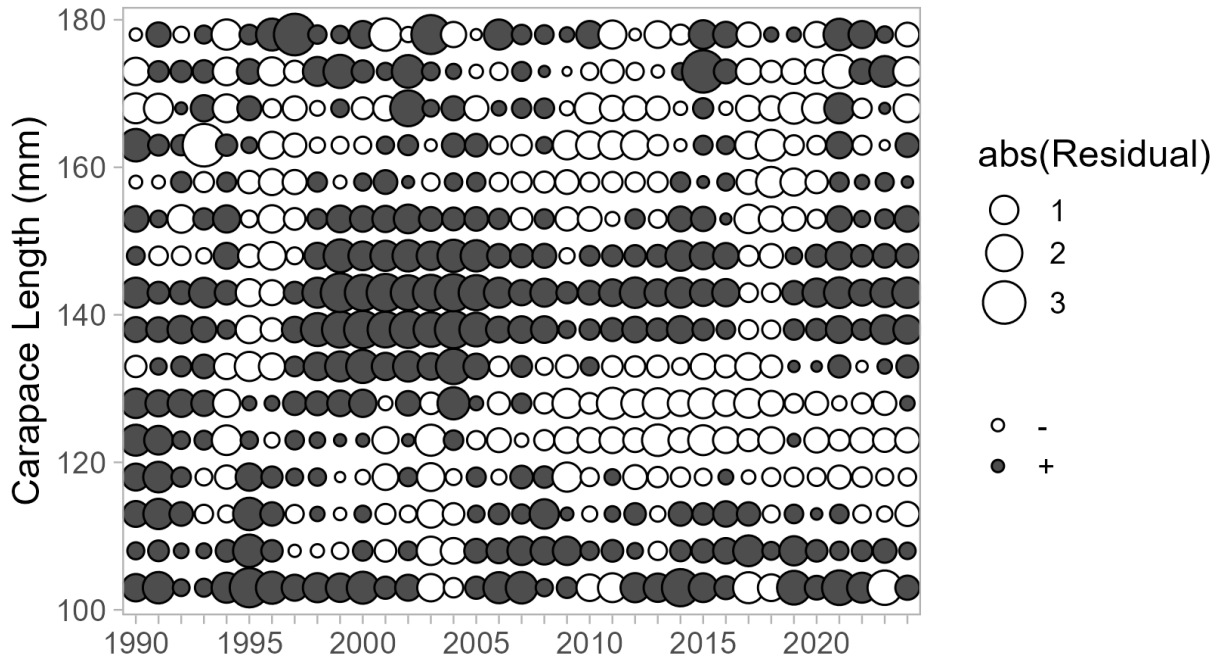
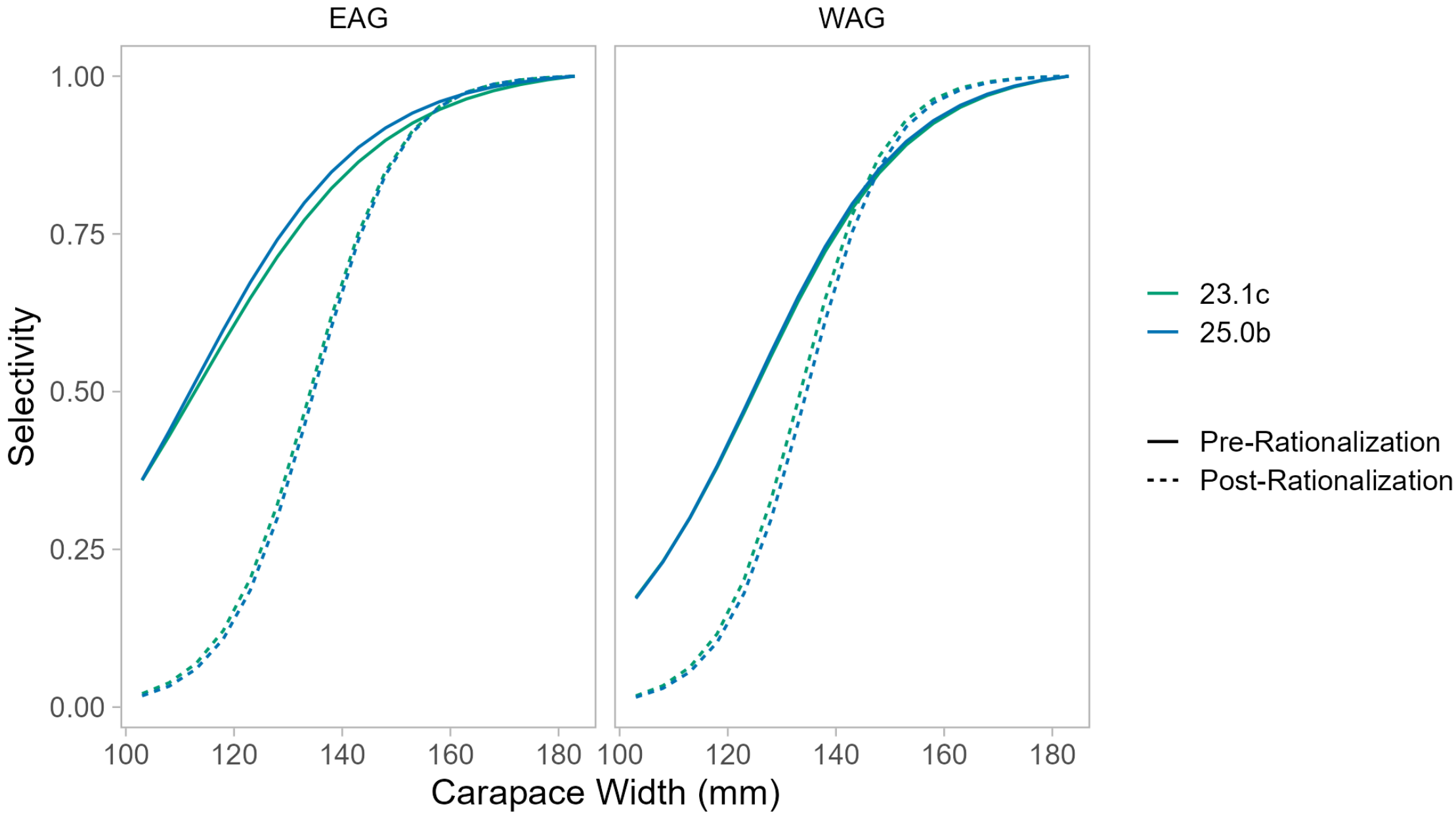
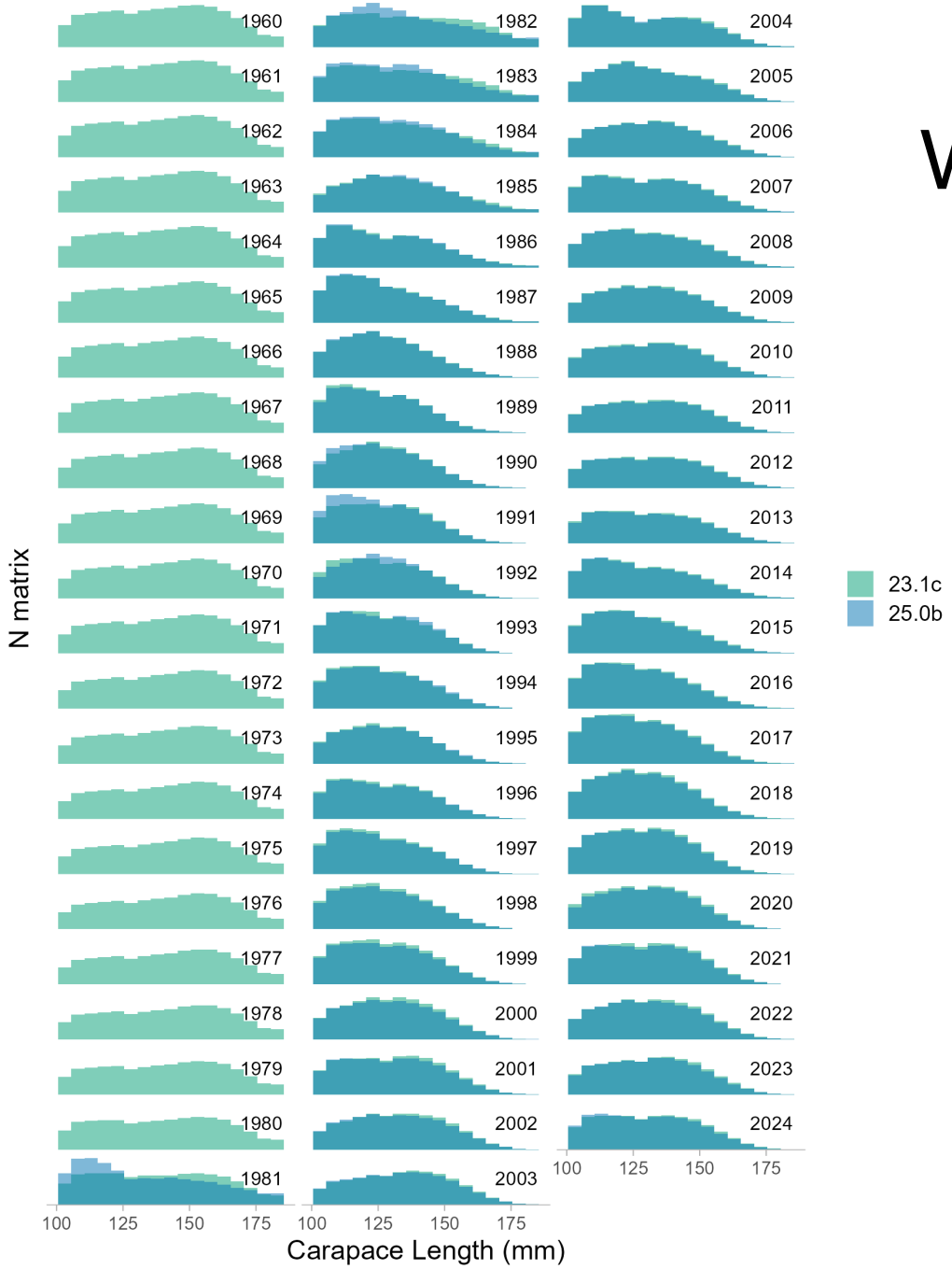
163
168
173
178
Sample quantiles
Theoretical Quantiles
2
0
-2


Carapace Length (mm)
180
160
140
120
100
1990
1995
2000
2005
2010
2015
2020
abs(Residual)
1
2
3
-
+


EAG
WAG
1.00
0.75
0.50
0.25
0.00
Selectivity
100
120
140
160
180
Carapace Width (mm)
23.1c
25.0b
Pre-Rationalization
Post-Rationalization

EAG


N matrix
1960
1961
1962
1963
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1965
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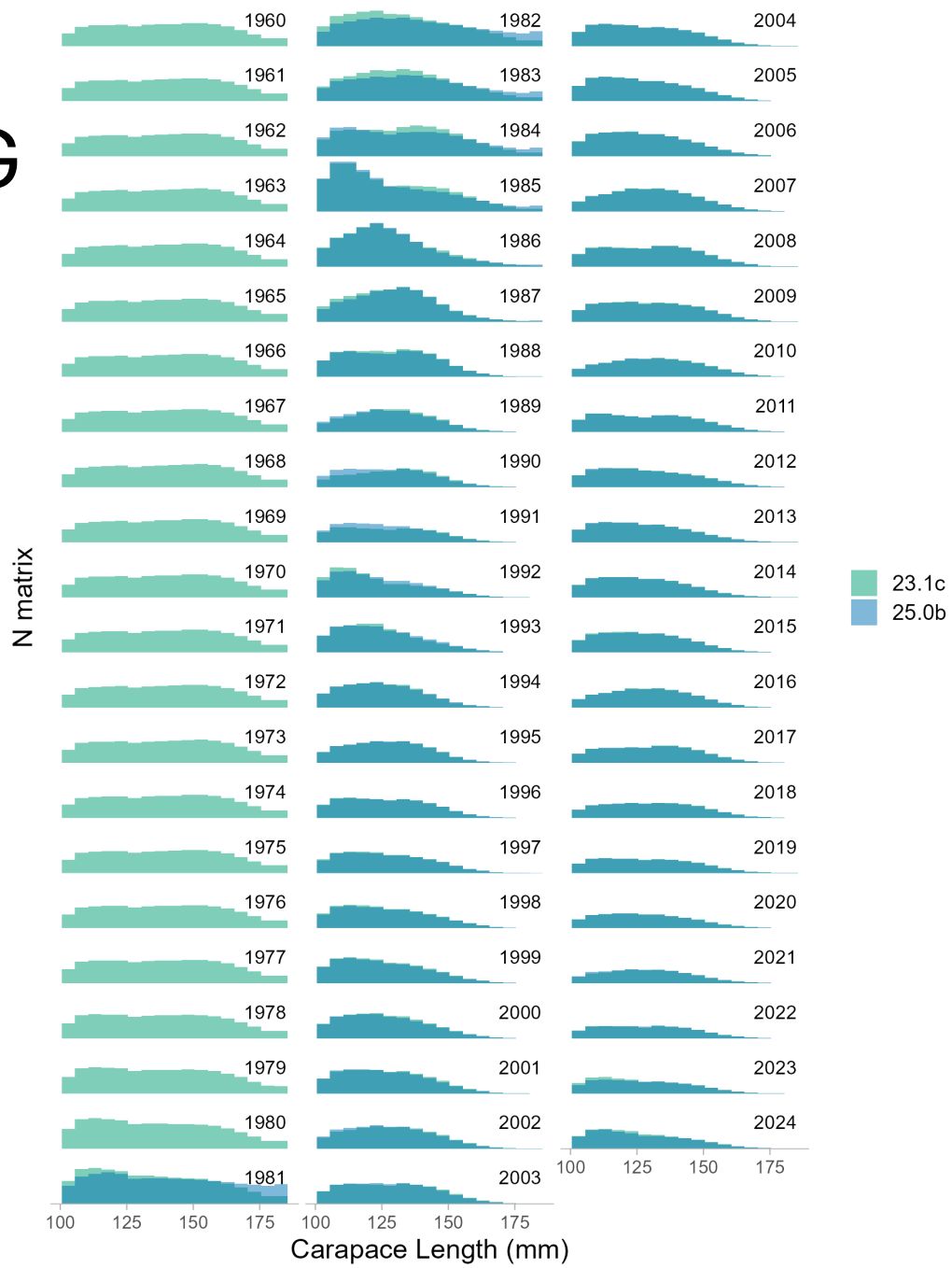
2017
2018
2019
2020
2021
2022
2023
2024
100
125
150
175
Carapace Length (mm)
23.1c
25.0b

WAG


N matrix
1960
1961
1962
1963
1964
1965
1966
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1968
1969
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1978
1979
1980
1981
1982
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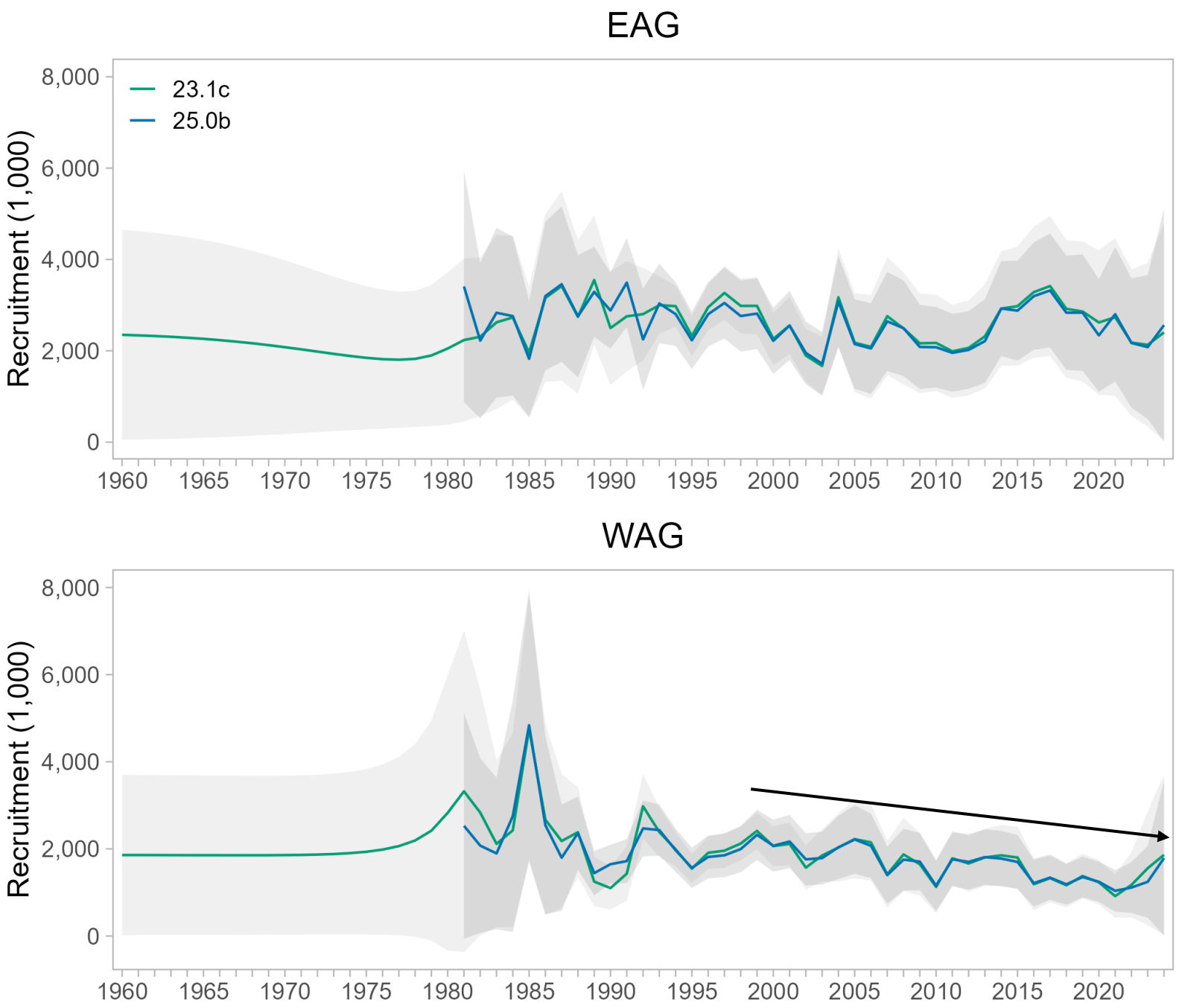
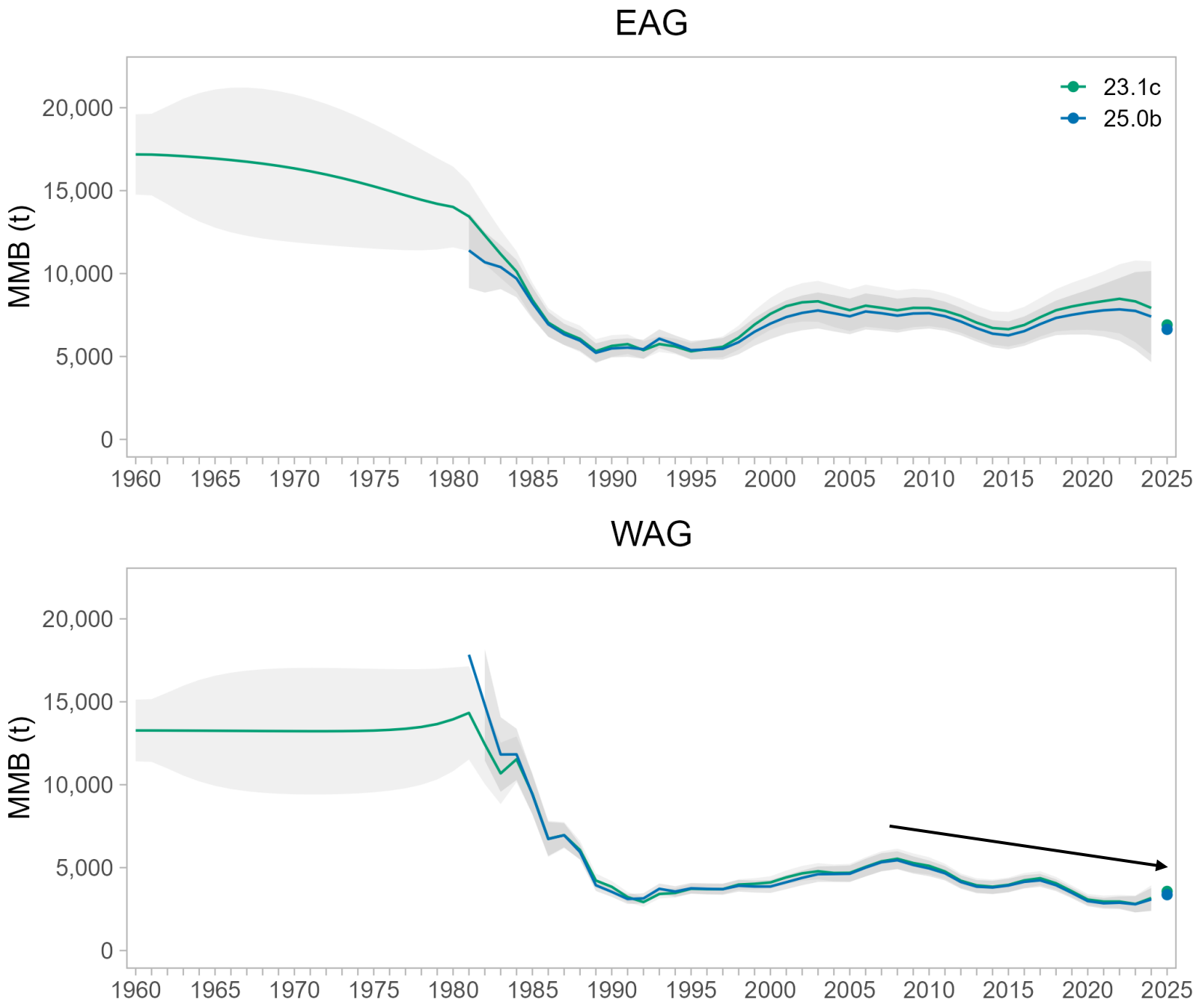
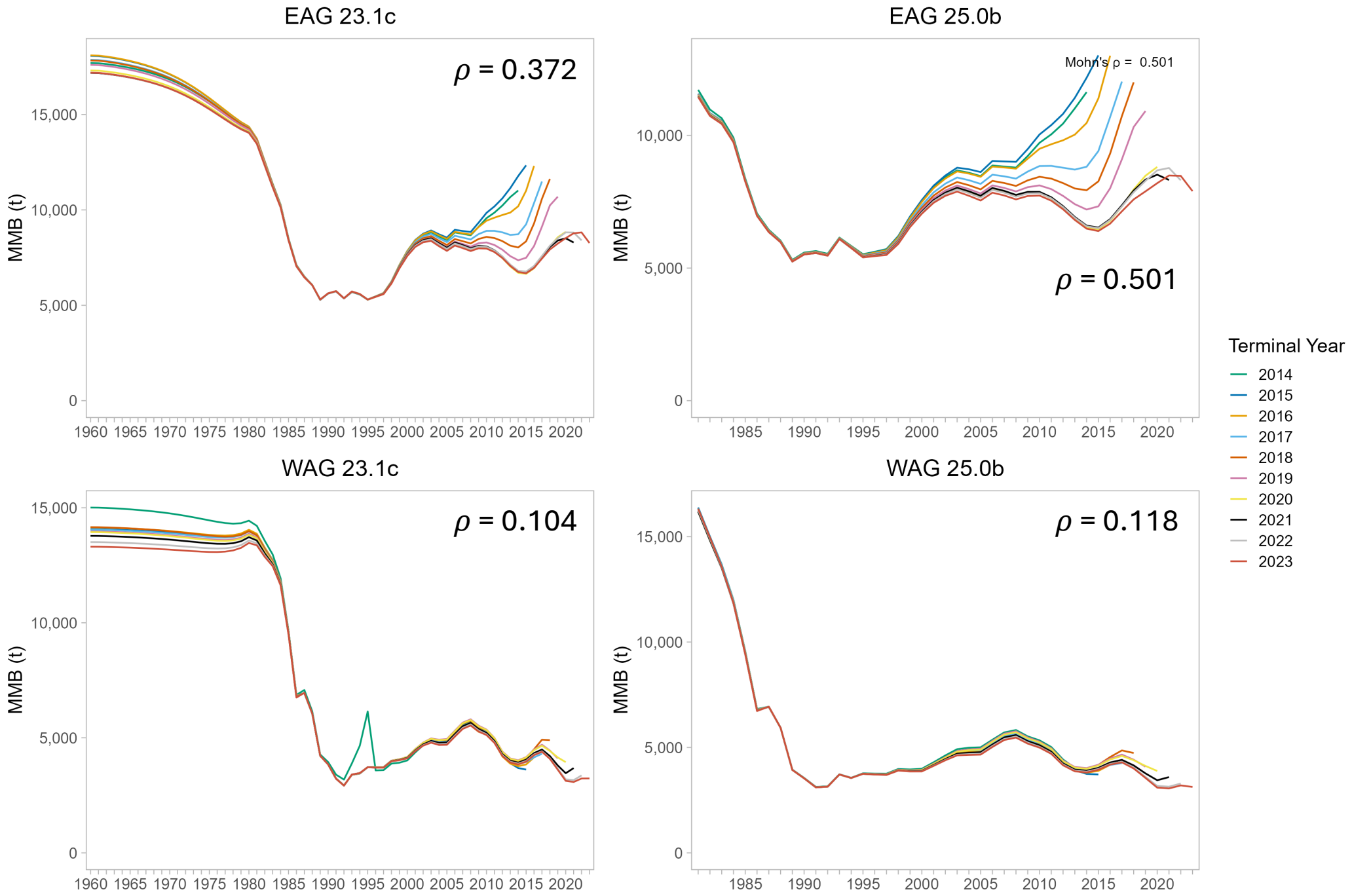
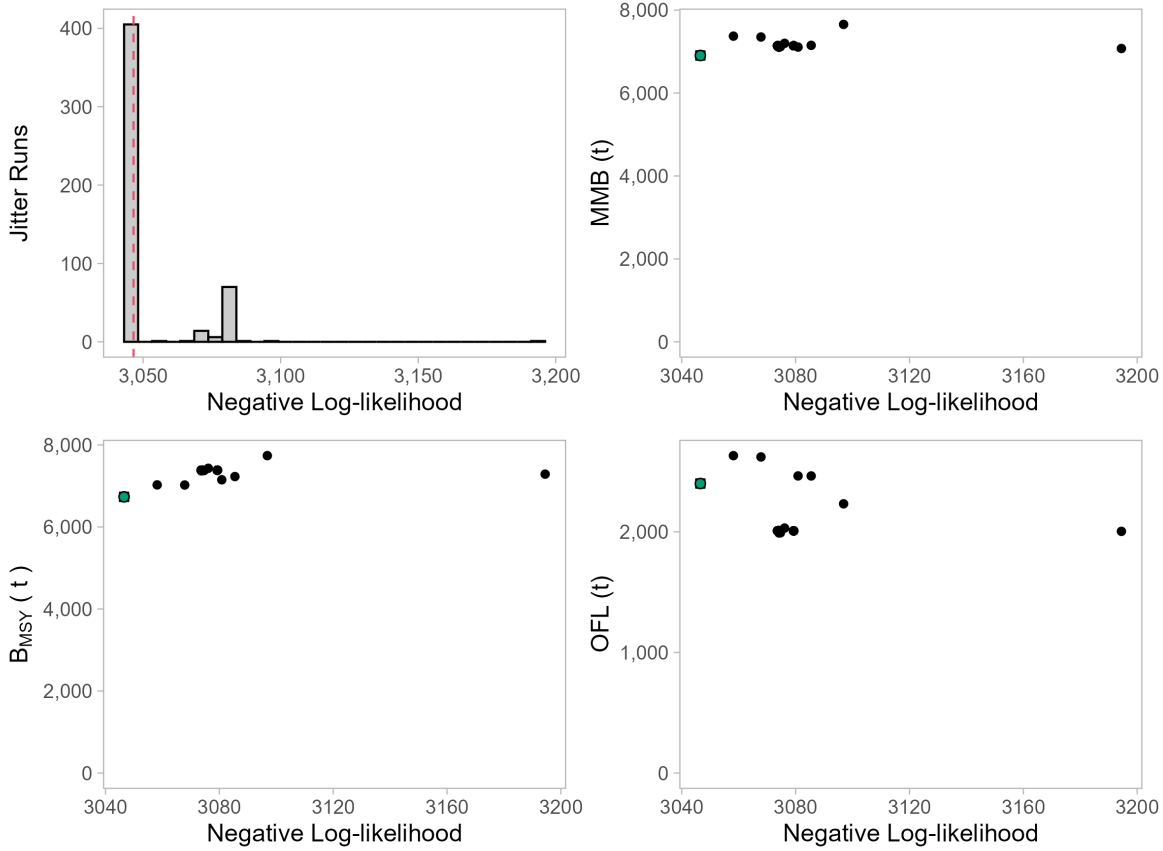
2020
2021
2022
2023
2024
100
125
150
175
Carapace Length (mm)
23.1c
25.0b


EAG
23.1c
25.0b
Recruitment (1,000)
8,000
6,000
4,000
2,000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
WAG
Recruitment (1,000)
8,000
6,000
4,000
2,000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

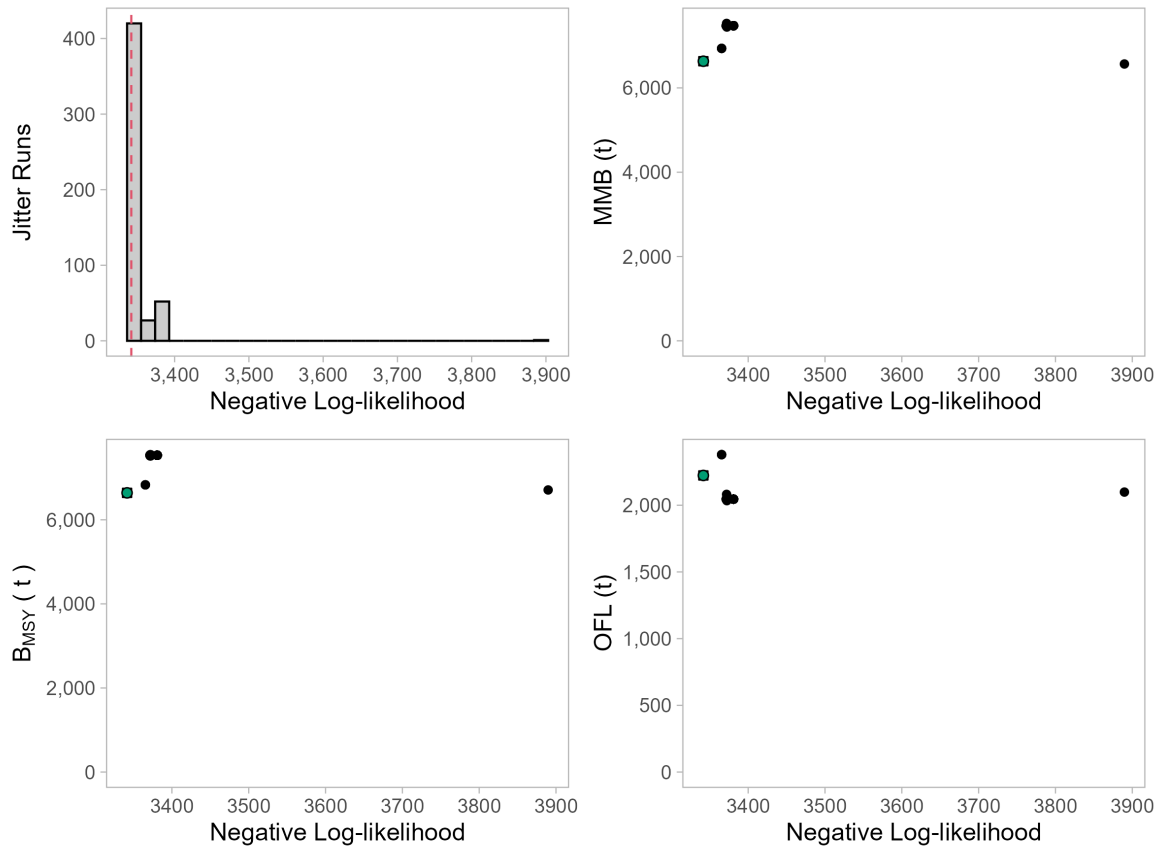

EAG
23.1c
25.0b
MMB (t)
20,000
15,000
10,000
5,000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
WAG
MMB (t)
20,000
15,000
10,000
5,000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025


EAG 23.1c
ρ = 0.372
EAG 25.0b
Mohn's ρ = 0.501
ρ = 0.501
WAG 23.1c
ρ = 0.104
WAG 25.0b
ρ = 0.118
MMB (t)
0
5,000
10,000
15,000
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
1985 1990 1995 2000 2005 2010 2015 2020
Terminal Year
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023

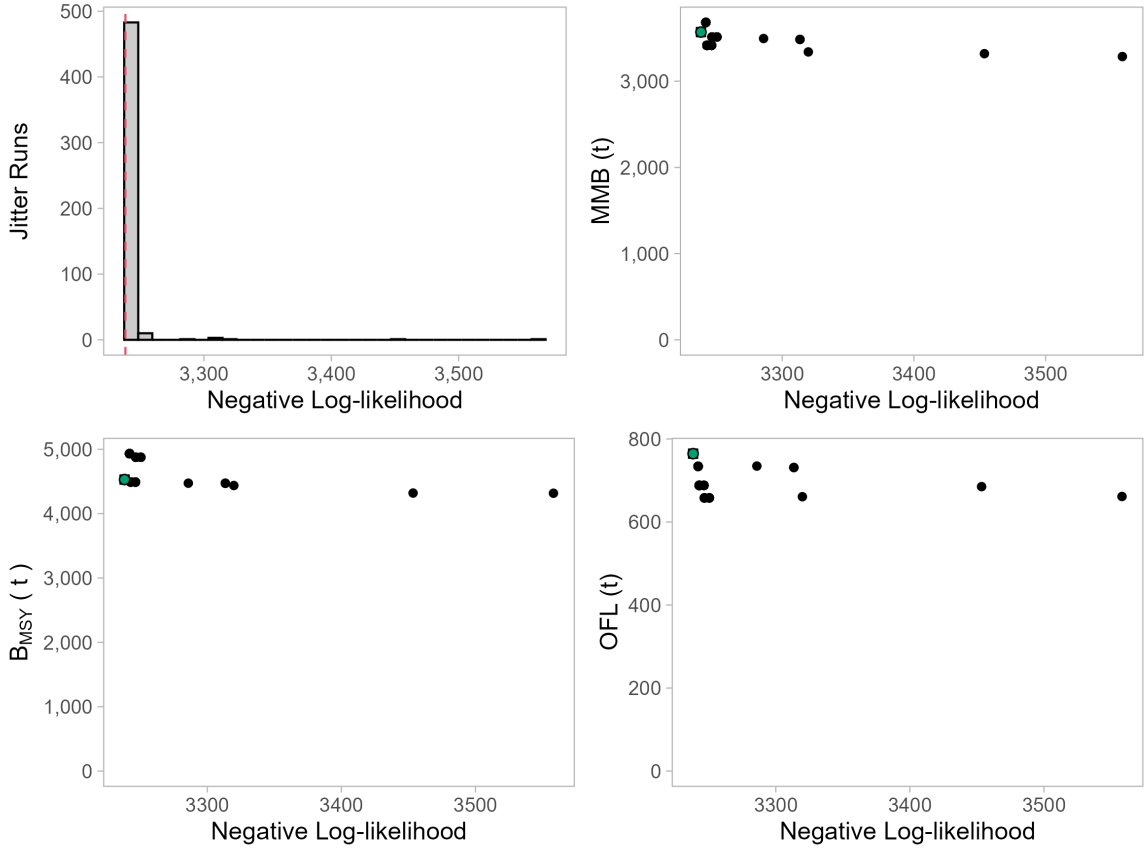
EAG 23.1c



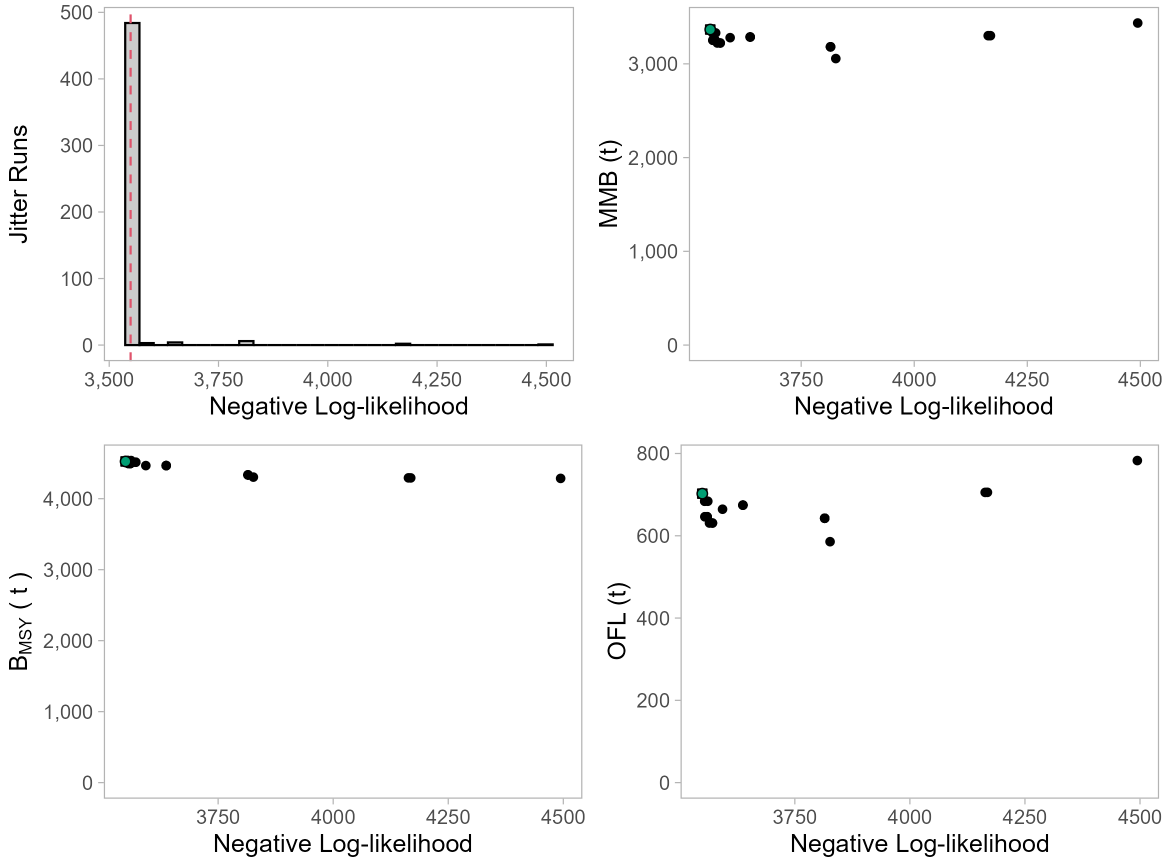
EAG 25.0b



WAG 23.1c



WAG 25.0b



Author Recommendation

Use 23.1c

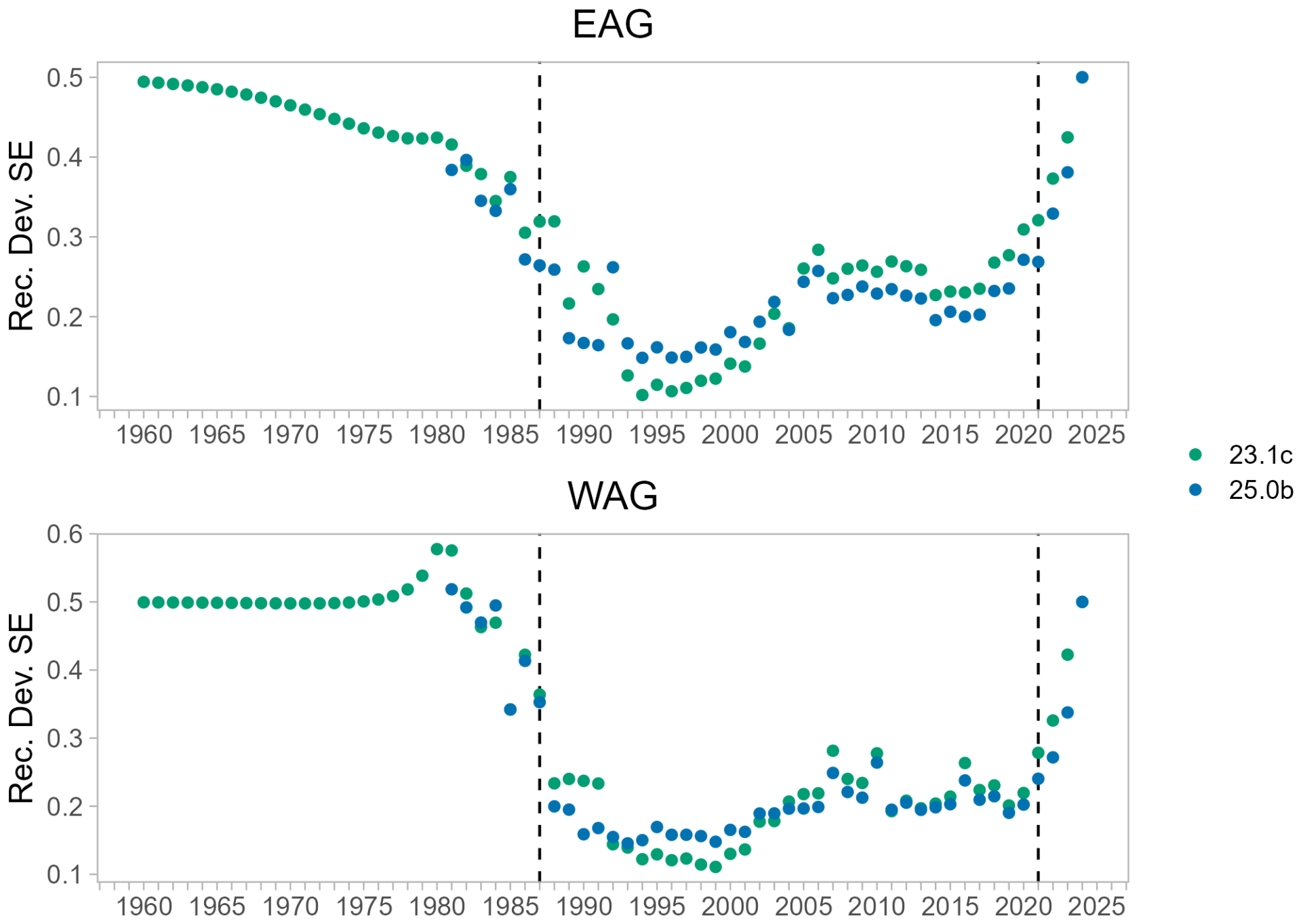
Derived quantities appear to be somewhat sensitive to composition data weighting, without improved model performance

Reference Points

Subdistrict	Model	MMB (t)	$B_{35\%}$ (t)	Status	*R '87-'21*	$F_{35\%}$	F_{OFL}	OFL (t)
EAG	23.1c	6,906	6,734	1.03	2,691	0.52	0.52	2,401
	25.0b	6,633	6,641	1.00	2,639	0.52	0.52	2,223
WAG	23.1c	3,570	4,530	0.79	1,817	0.51	0.39	765
	25.0b	3,366	4,525	0.74	1,805	0.53	0.38	702

Combined OFL = 3,166 t (6.98 mil lb)

ABC (25% buffer) = 2,374 t (5.234 mil lb)


EAG
Rec. Dev. SE
0.5
0.4
0.3
0.2
0.1
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025
WAG
Rec. Dev. SE
0.6
0.5
0.4
0.3
0.2
0.1
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025
23.1c
25.0b

Risk Table (Appendix C)

Assessment Model – Level 1: No *new* concerns

- Poor fit to index data, primarily in the EAG

- Considerable retrospective pattern associated with MMB in the EAG, due to poor fit to index data

Risk Table (Appendix C)

Population Dynamics – Level 2: Substantially increased concerns

- Continuing downward MMB trajectory in the WAG
- Recruitment estimates have undergone a slowly decreasing trend in the WAG since prior to rationalization
- The WAG has been below B_{MSY} since the 2022/23, while the EAG has remained above B_{MSY}

Risk Table (Appendix C)

Ecosystem– Level 1: No new concerns

- North Pacific Index returned to neutral conditions in 2024

- Aleutian Islands ecosystem showed signs of a gradient of poor productivity in the west to high productivity in the east in 2024

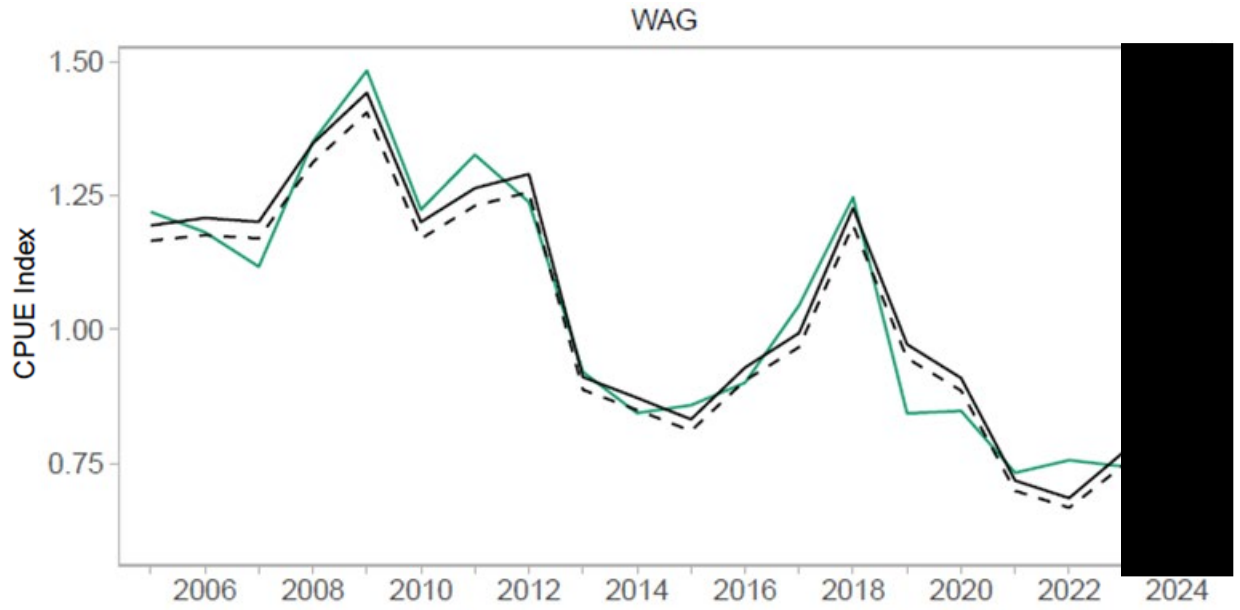
- The western and central Aleutians experienced a marine heat wave at the beginning of the 2024 crab year, though bottom temperatures remained cooler near the 1991 - 2012 average. The eastern Aleutians were less affected

- Groundfish condition remains low across the ecosystem possibly due to a range of factors including prey quality, availability, competition, and metabolic demands

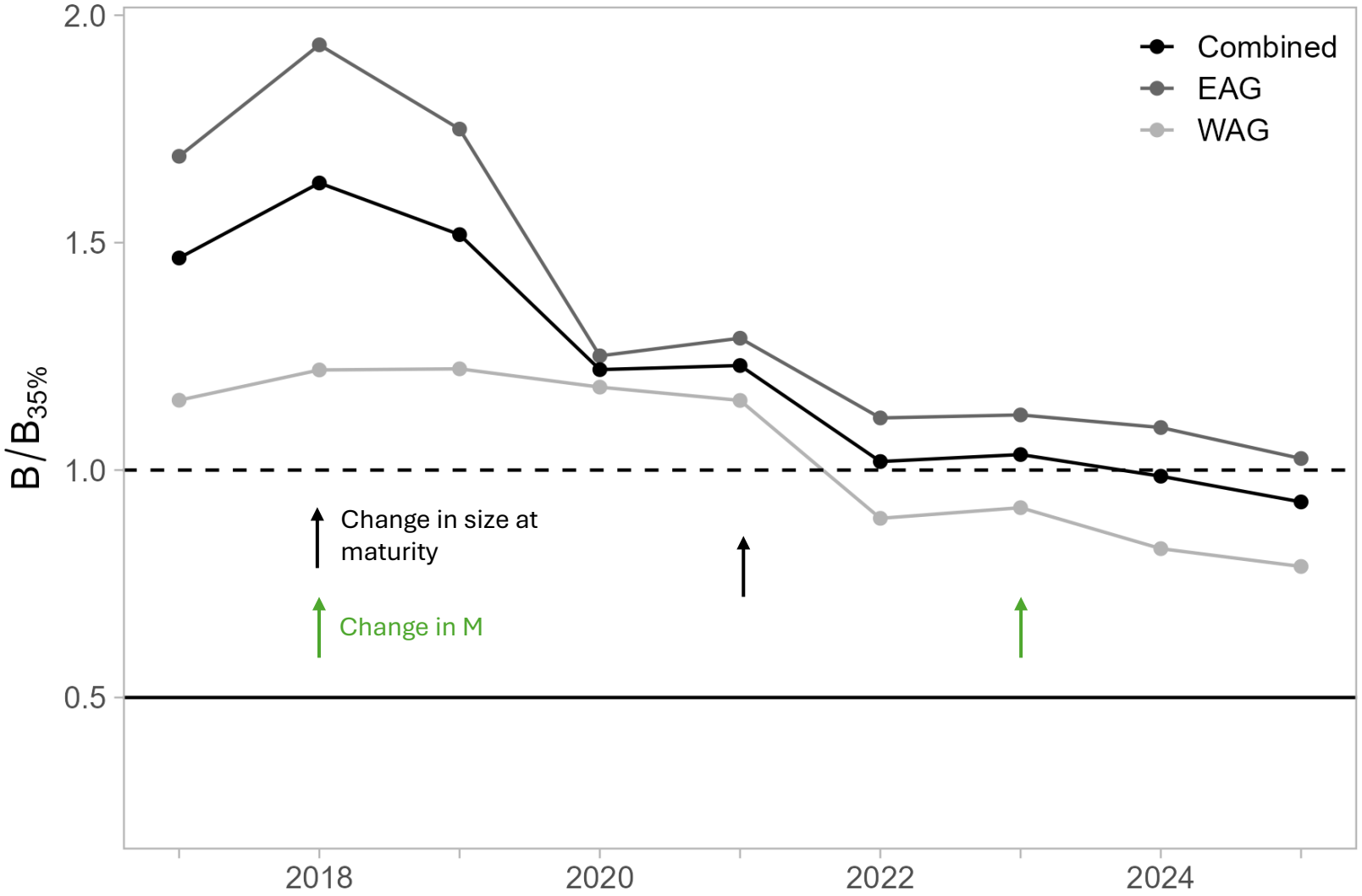
Risk Table (Appendix C)

Fishery Performance – Level 2: Substantially increased concerns

- Continuing decrease in fishery CPUE in the WAG



Looking back on stock status…



What's going on in the WAG?

Declining recruitment trend since 1999

Declining MMB trend since 200[redacted]

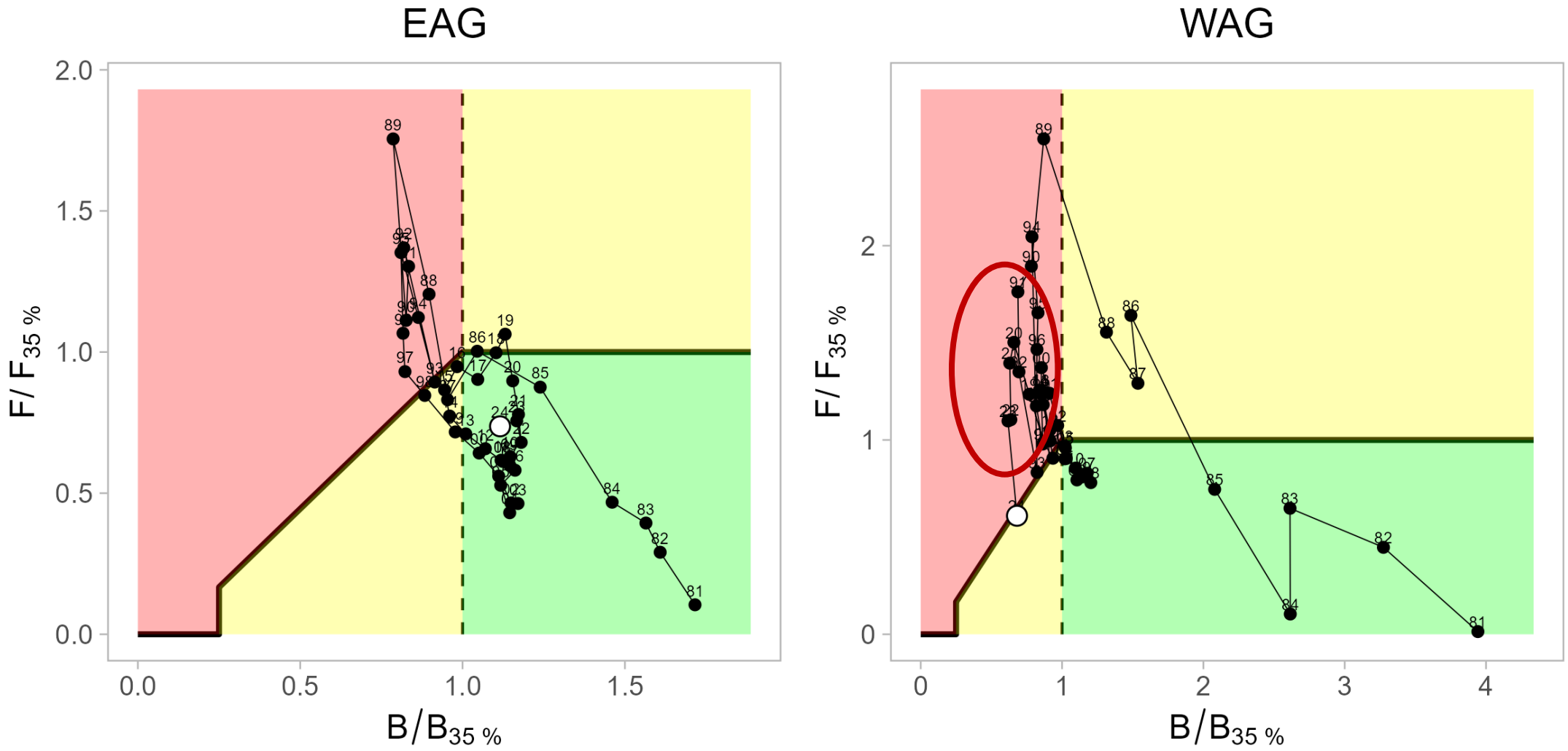
Below $B_{35\%}$ since 2022 assessment, and declining (79%)

CPUE remains near post-rationalization low [redacted]

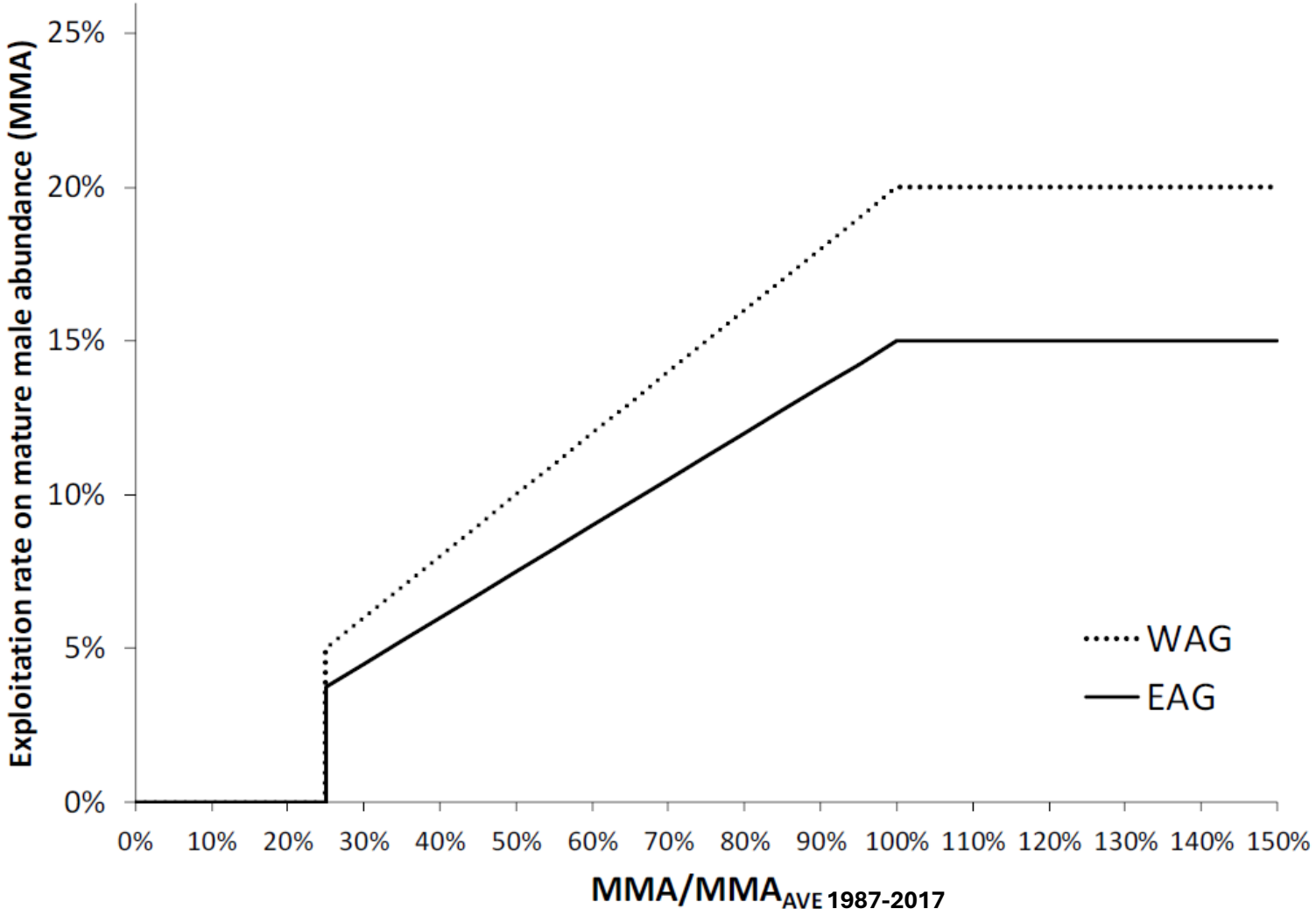
[redacted]

[redacted]

Aggressive Management



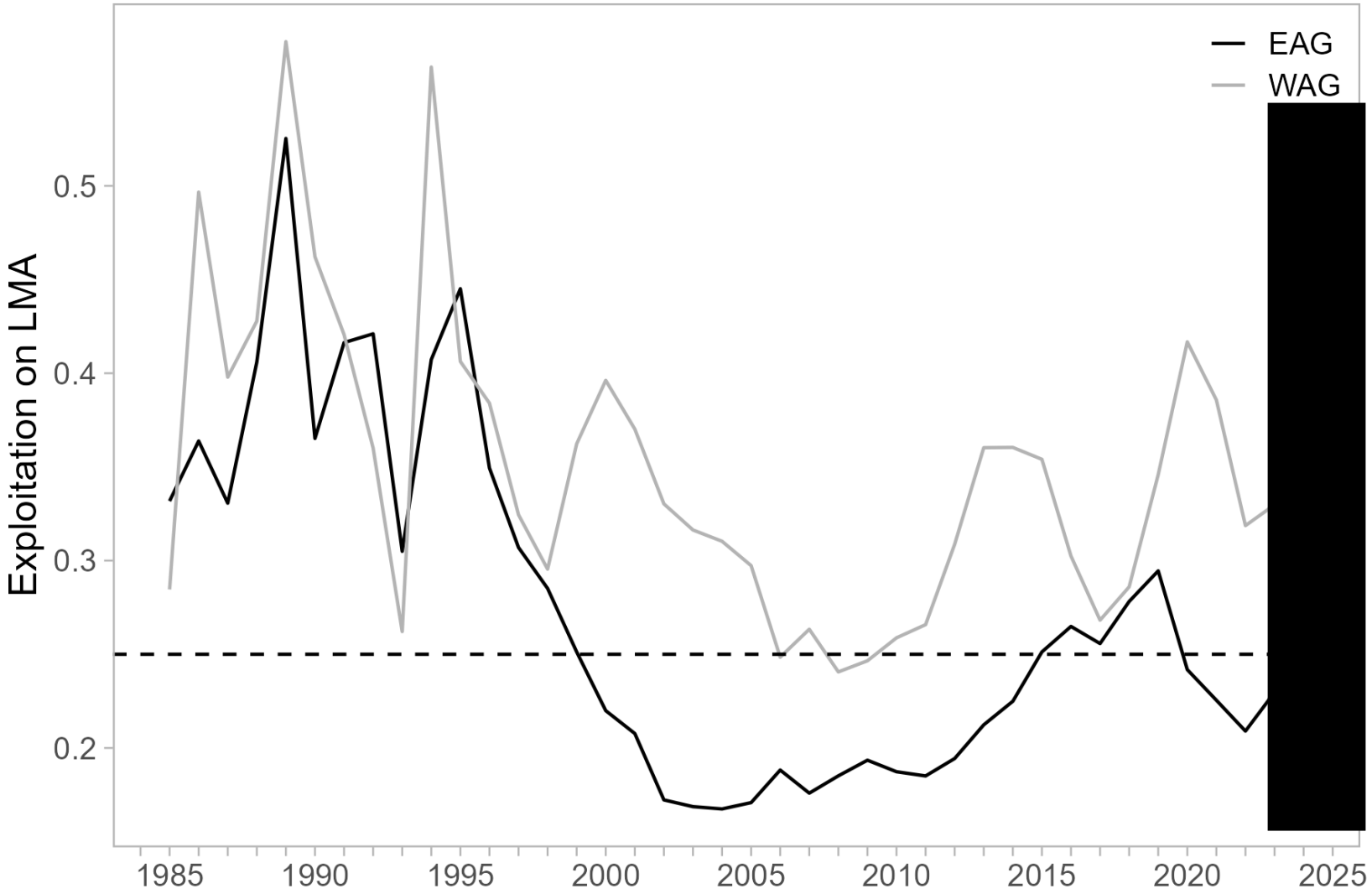
Harvest Strategy

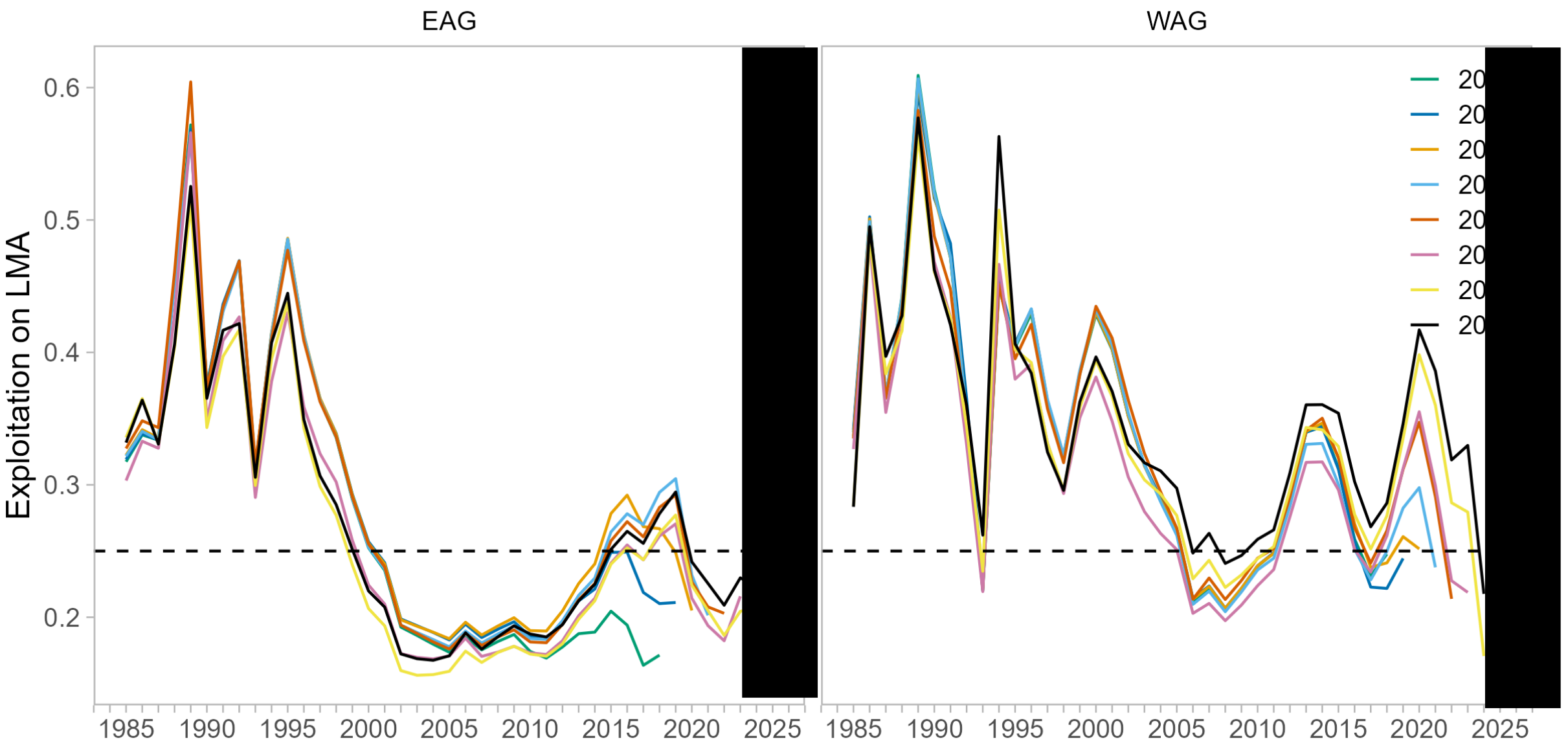


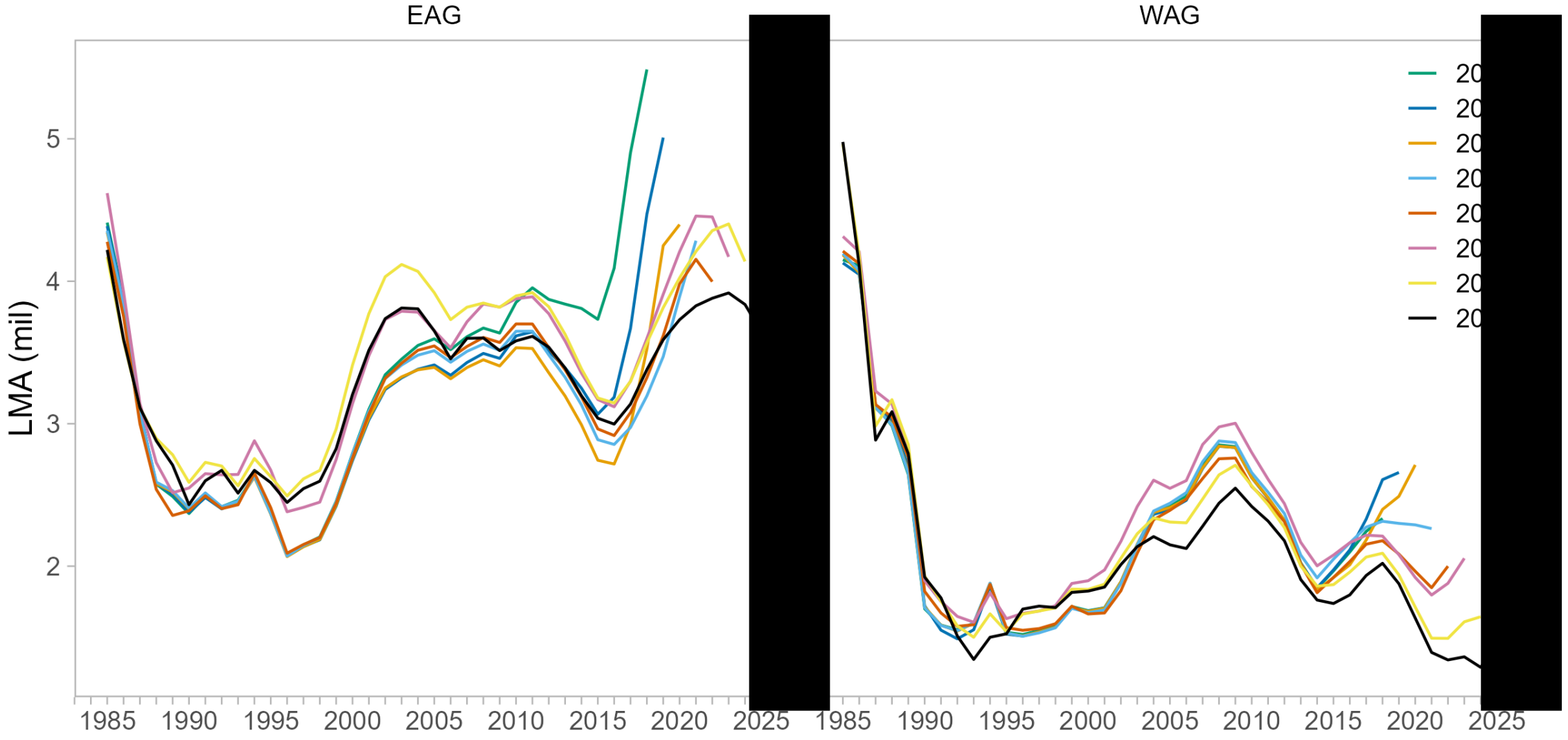
25% cap on legal male exploitation

High Exploitation in WAG

Realized exploitation rate suggests max cap is often overshot




EAG
WAG
Exploitation on LMA
0.6
0.5
0.4
0.3
0.2
1985
1990
1995
2000
2005
2010
2015
2020
2025
20
20
20
20
20
20
20
20



Updated view of terminal year LMA tends to be lower in WAG, not *always* the case in the EAG

Maturity

Size at maturity in WAG likely larger than assumed in model and ADF&G harvest strategy (116 mm CL) based on Siddeek et al. (2022)

Influences harvest strategy threshold and computed TAC when below legal cap

Will bring forward new analysis in September

Table C.3. Mean, median, and upper and lower 95% confidence limits of breakpoints (knife-edge maturity) for various chela height (CH) and carapace length (CL) data sets for Aleutian Islands male golden king crab.

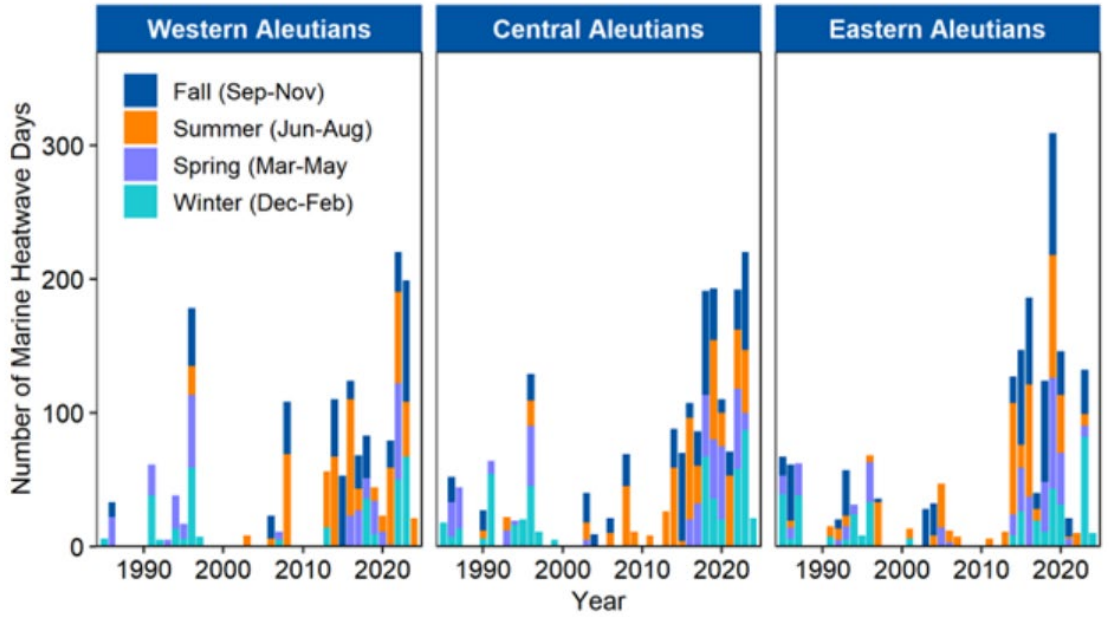
Source and Season	Region	Method	Breakpoint					
			Mean	Median	SE	Upper Bound	Lower Bound	Remarks
NMFS samples (1984/85)	WAG	Ln (CH/CL) ~CL	108.825	107.564	0.162	126.000	103.847	CPT accepted method since 2007/08
	AI	Ln (CH/CL) ~CL	109.024	108.344	0.106	116.488	104.260	ditto
ADFG pot survey samples (1991/92)	EAG	Ln (CH/CL) ~CL	104.140	107.000	0.233	111.821	84.527	ditto
Co-operative survey, Observer and retained catch samples (2018/19 – 2020/21)	EAG	CH~CL	108.322	110.460	0.427	126.504	88.405	CPT suggested method since 2020/21
ditto	WAG	CH~CL	120.812	120.378	0.105	126.102	112.573	ditto
ditto	AI	CH~CL	116.795	118.105	0.147	122.804	105.757	ditto
All samples combined (1984/85 – 2020/21)	AI	CH~CL	122.908	122.783	0.039	125.097	120.455	ditto

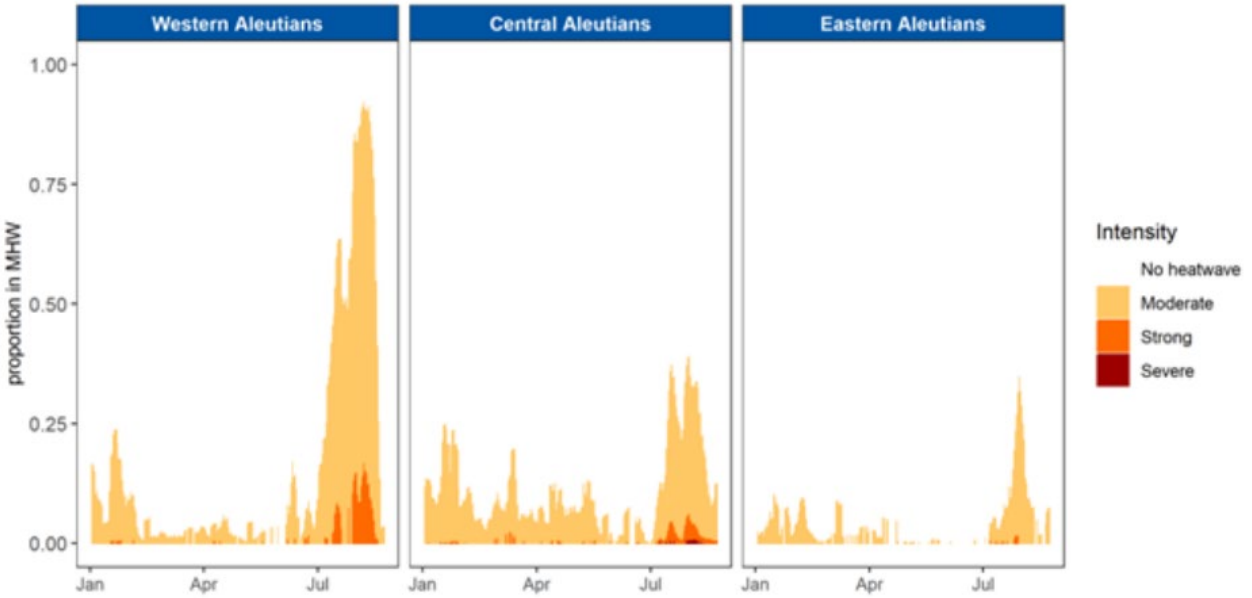
Ecosystem Change

Recent, repeating heat wave conditions in western Aleutians

Heatwaves based on SST, not bottom temperature

Gradient of low productivity in Western Aleutians to higher productivitiy in Eastern Aleutians





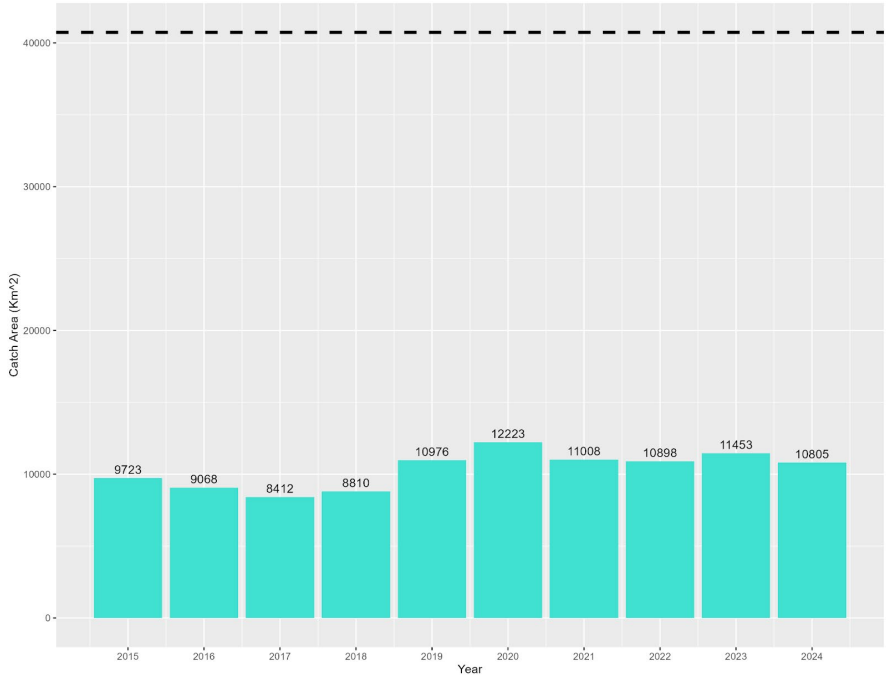
Ortiz and Zador 2024

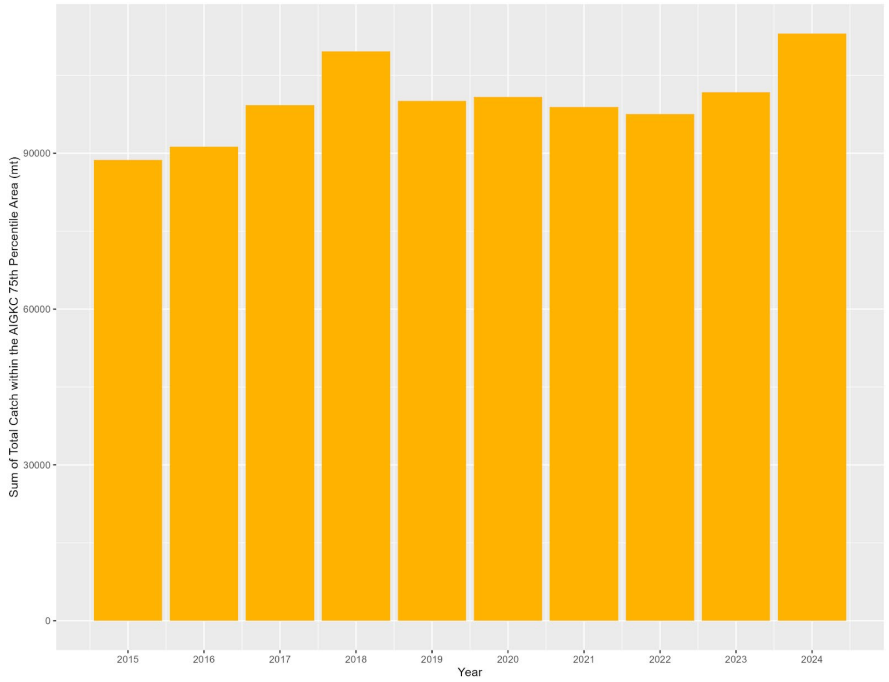
Gear Overlap

F/V AK Trojan brought up concerns over trawling in WAG fishing grounds to ADF&G in Nov 2023 & 2024, letter to CPT April 2025

ADF&G requested from NMFS an initial look at overlap between trawl fisheries and GKC EFH

Meager trend in trawl catch area, trawl catch within principal GKC EFH over last 10 yrs





Jahn et al., *unpublished*

Spatiotemporal CPUE Std (Appendix B)

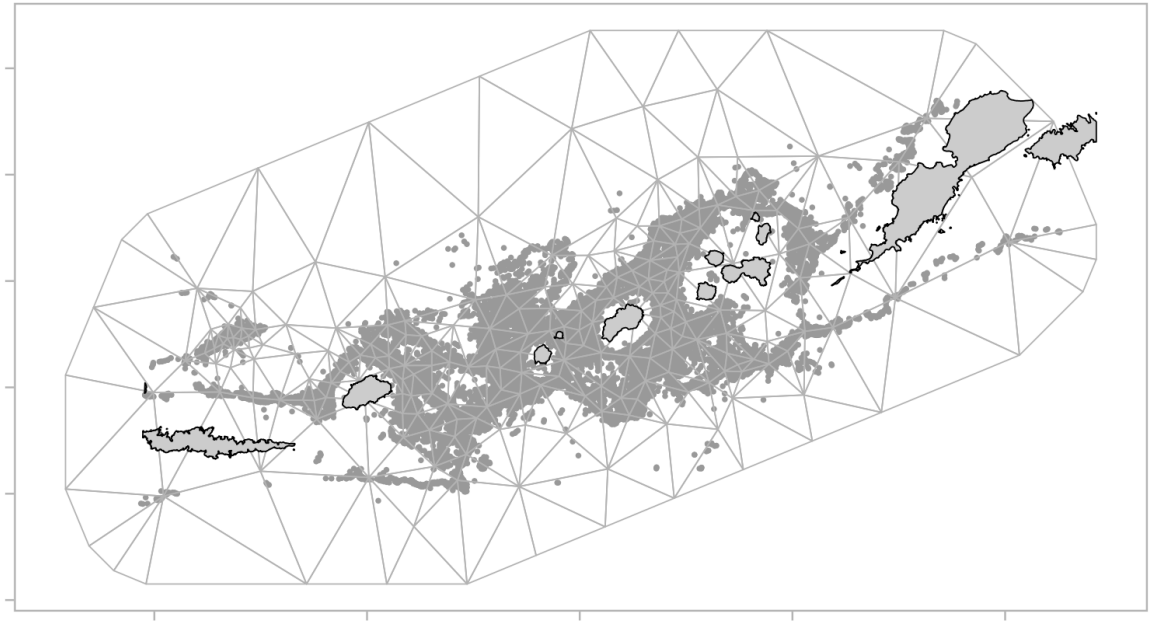
Presentation to CPT modelling workshop in Jan

- Update to response variable (legal CPUE)
- More coarse prediction grid for visualization, add SE on spatial predictions
- IID only

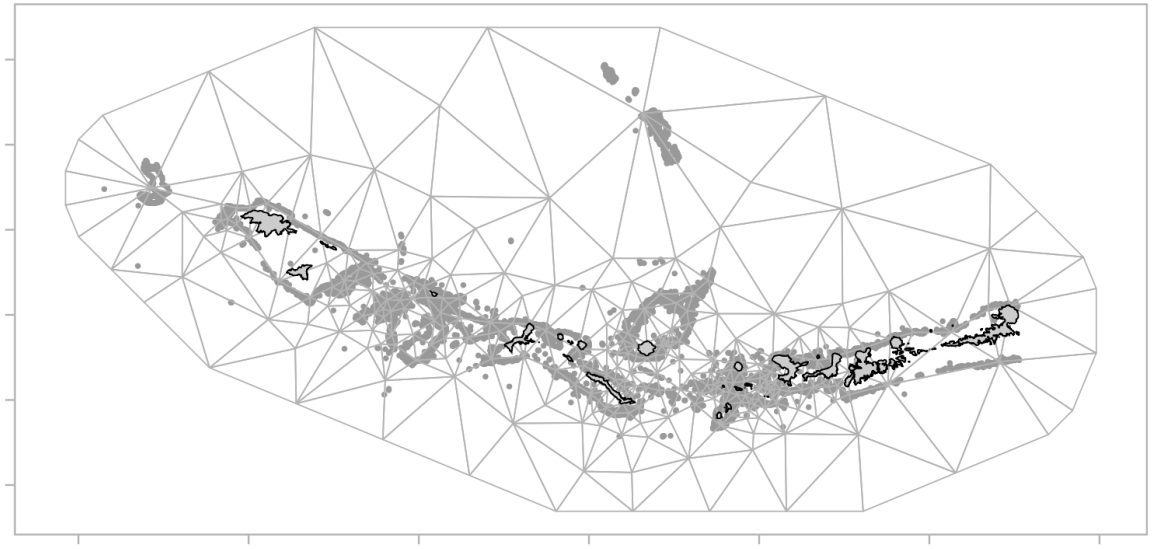
sdmTMB GAMM

- CPUE ~ Year + Gear + s(soak time) + s(depth) + (1|Vessel)
- CPUE ~ Year + Gear + s(soak time:Year) + s(depth) + (1|Vessel) **EAG**
- Tweedie, estimate *p*
- Full time series, handle catchability as time block in model

EAG



WAG

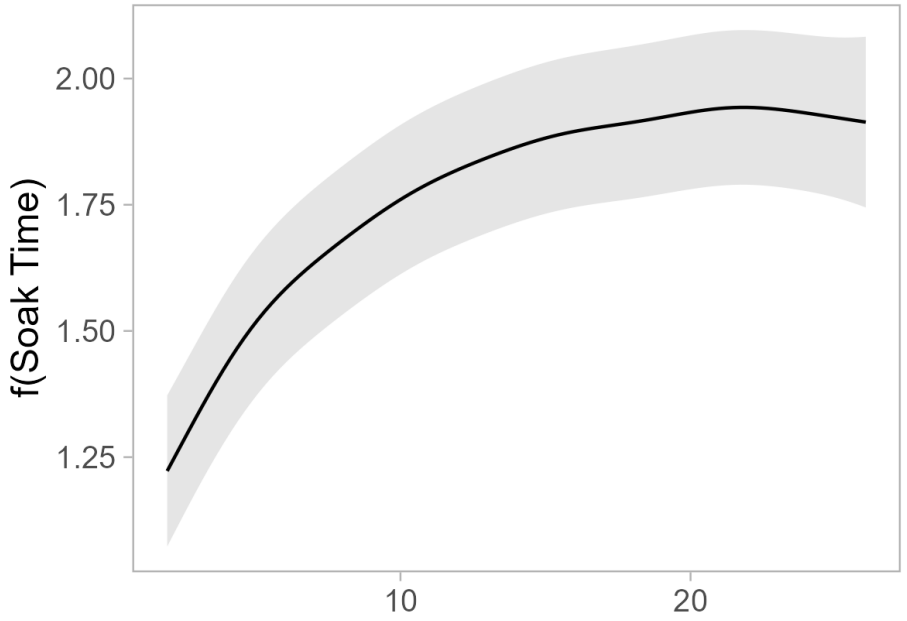


Used kmeans method with 150 knots

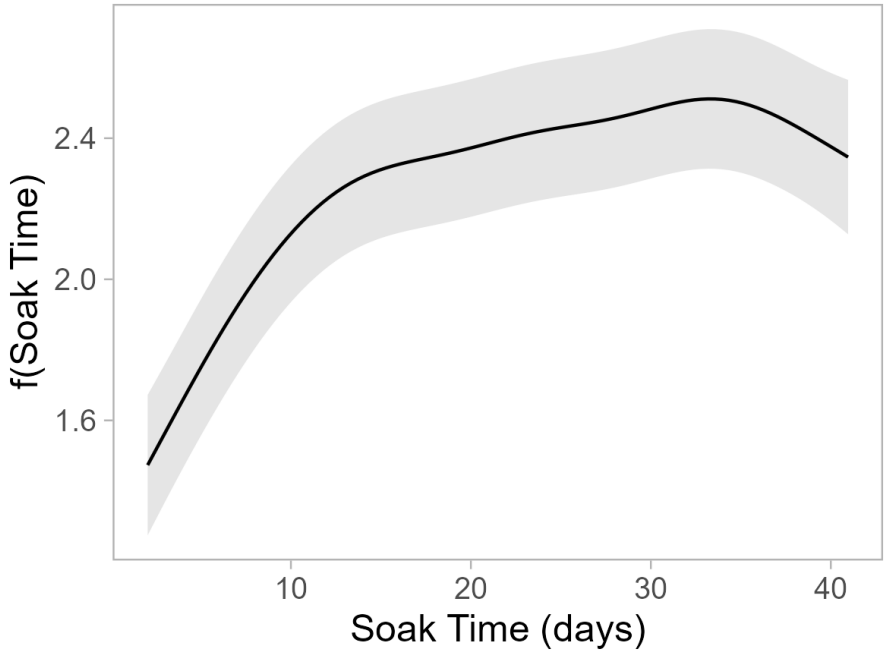
Islands as barrier to spatial correlation

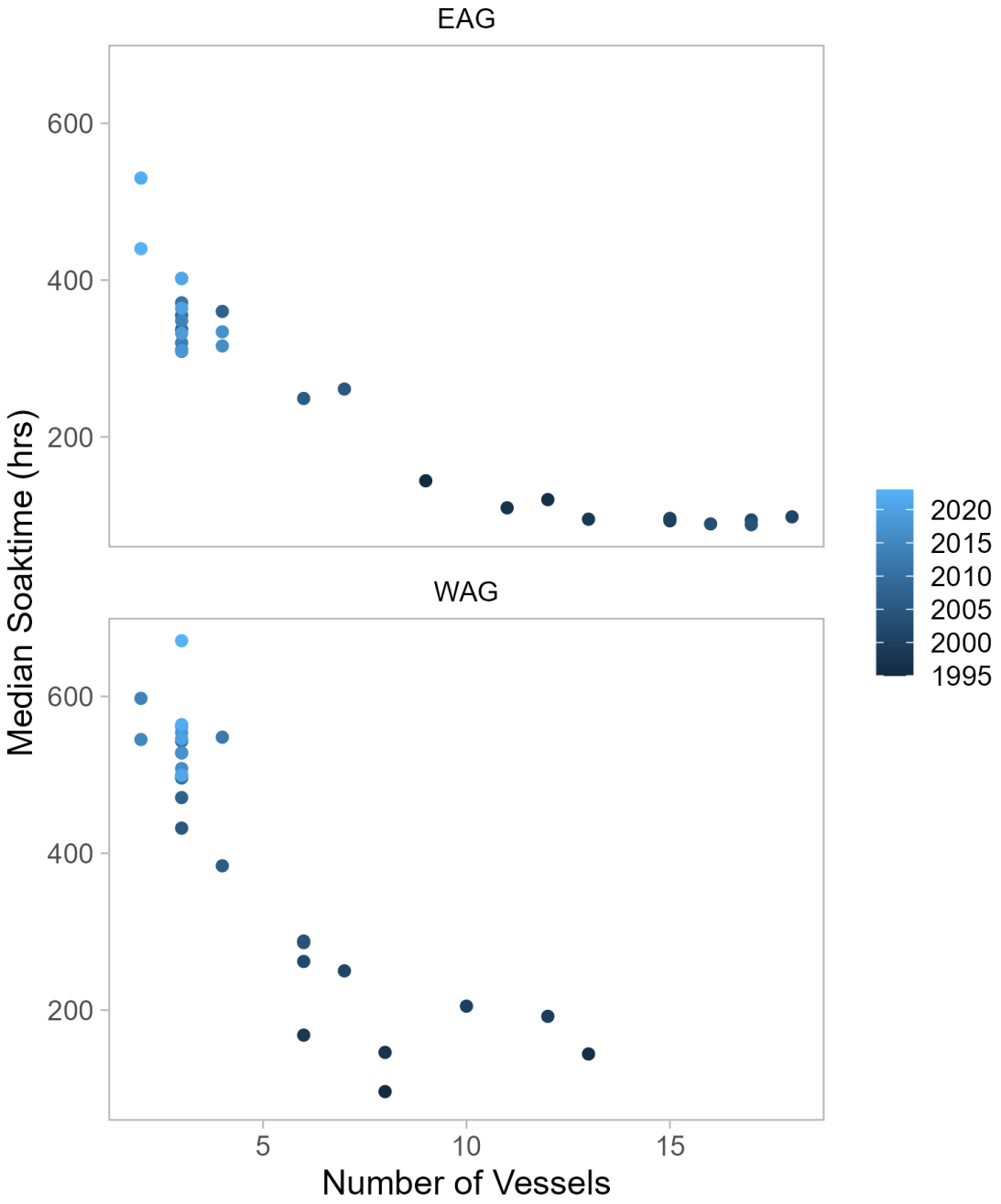
Did not develop this rigorously, differed number of knots until vertices seemed OK

EAG


2.00
1.75
1.50
1.25
f(Soak Time)
10
20

WAG

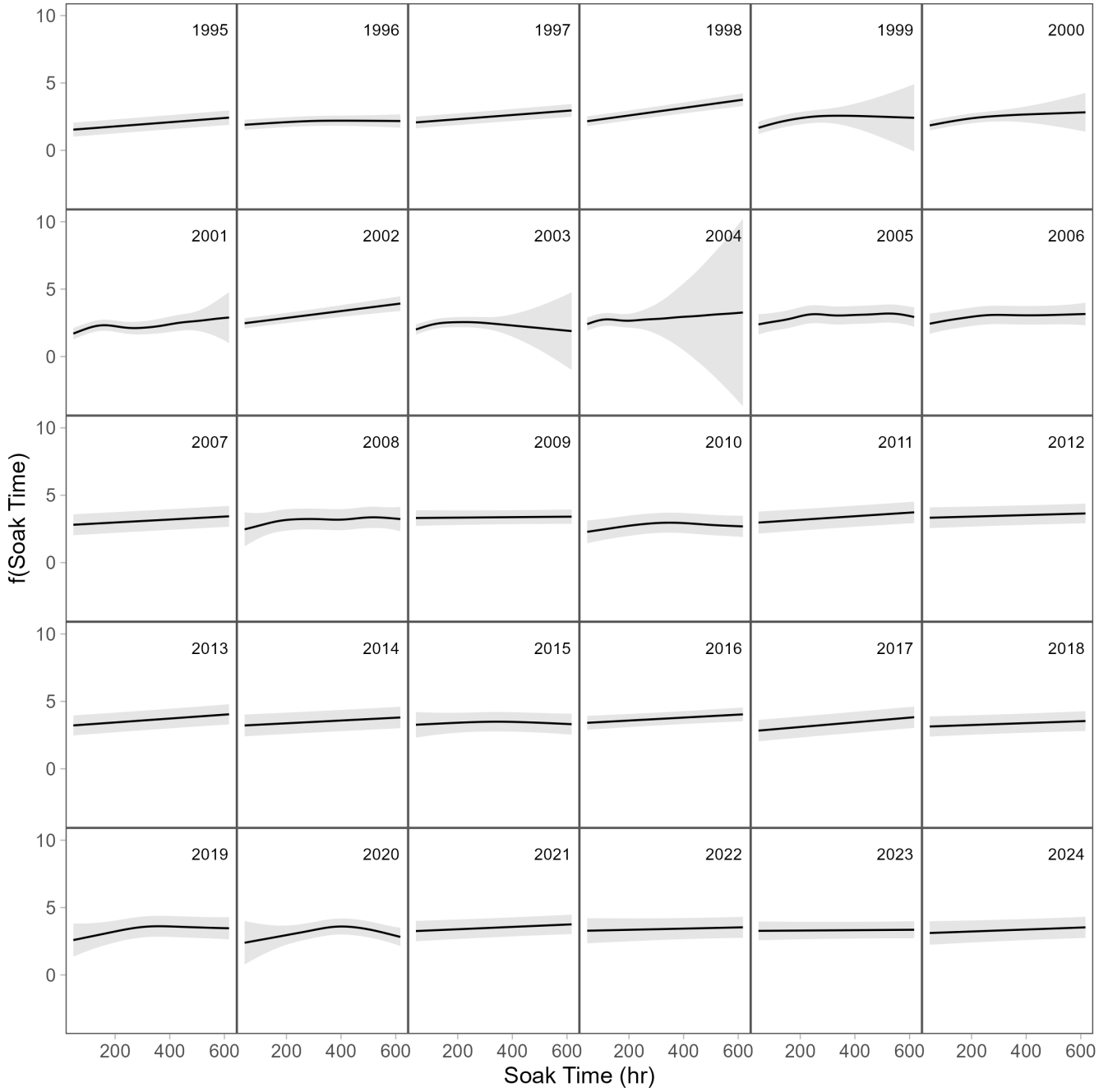

2.4
2.0
1.6
f(Soak Time)
10
20
30
40
Soak Time (days)


EAG
600
400
200
WAG
600
400
200
Median Soaktime (hrs)
5
10
15
Number of Vessels
2020
2015
2010
2005
2000
1995

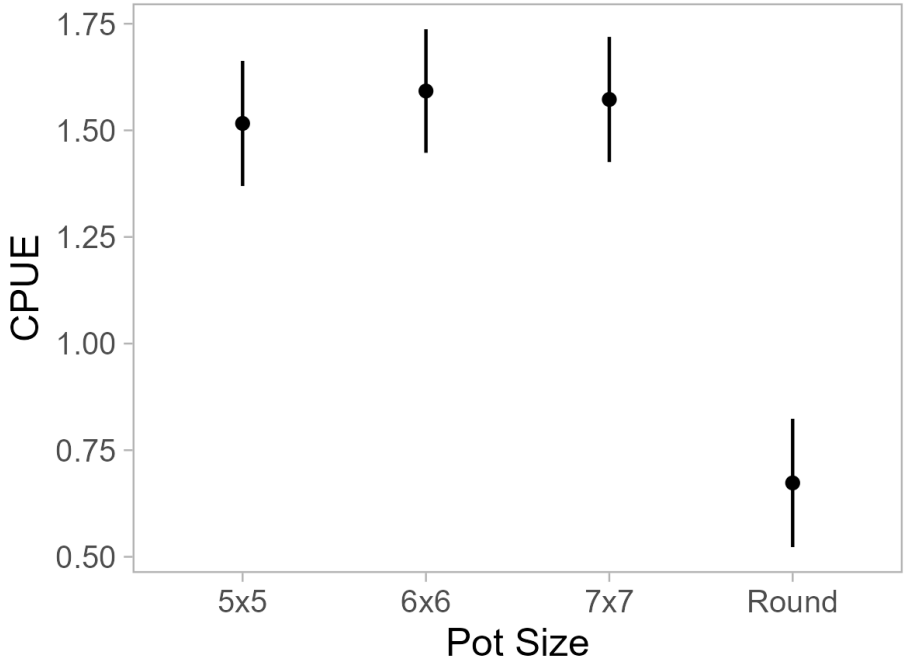
EAG soak time by year is often linear

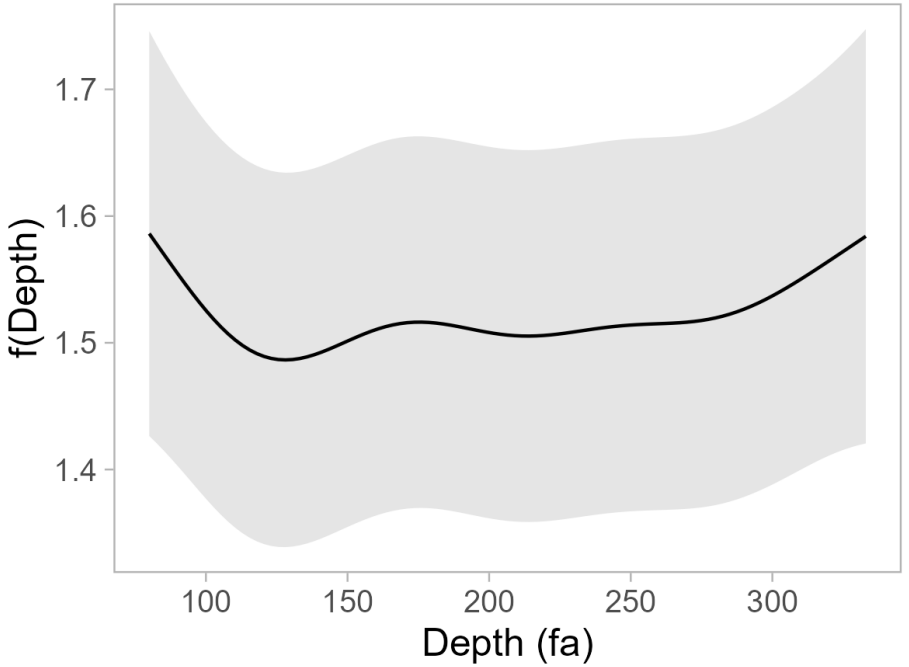
Flagged high

WAG model did not converge, didn't have time to resolve, will revisit over the summer…

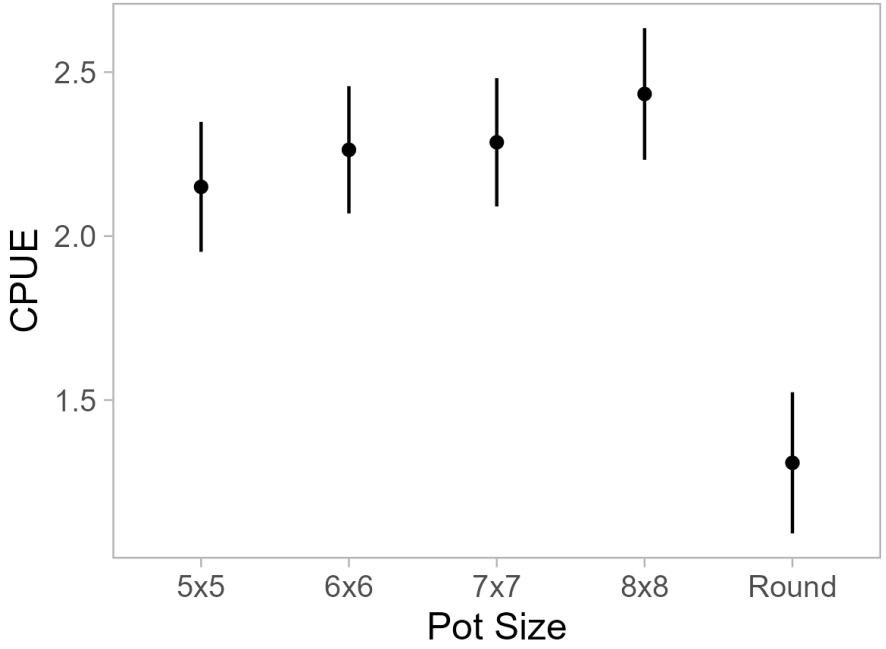


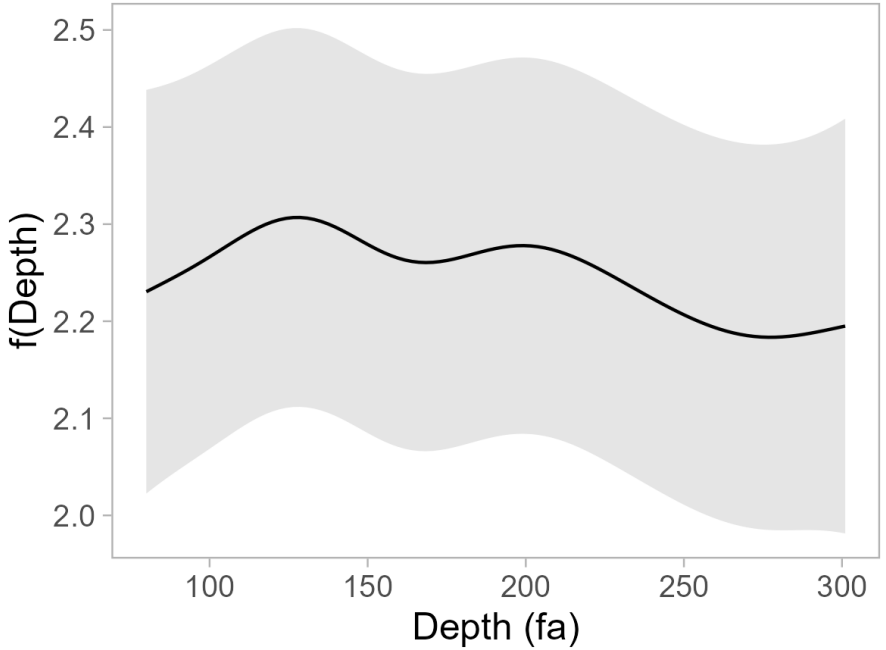
EAG

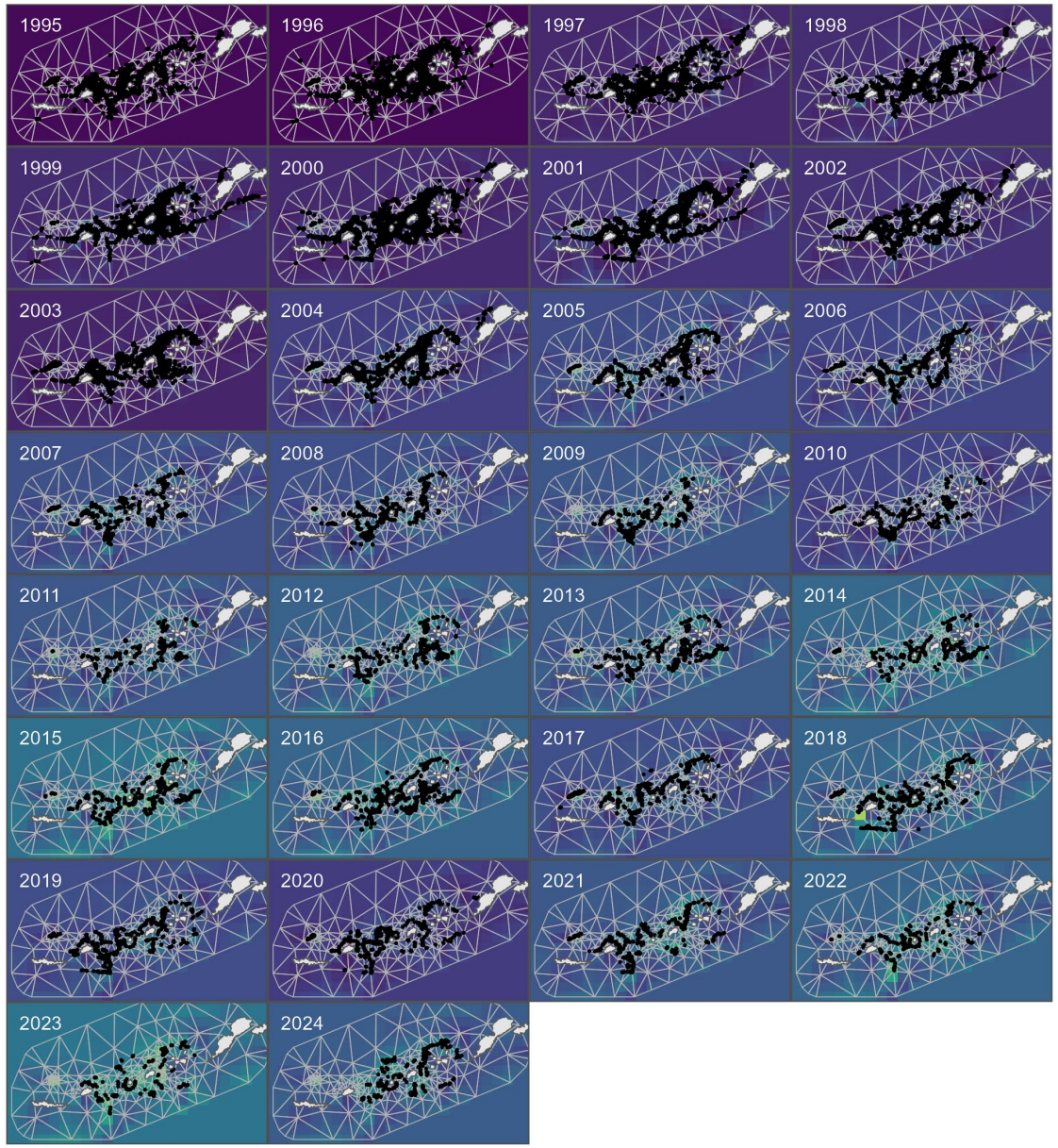

1.75
1.50
1.25
1.00
0.75
0.50
CPUE
5x5
6x6
7x7
Round
Pot Size


1.7
1.6
1.5
1.4
f(Depth)
100
150
200
250
300
Depth (fa)

WAG


2.5
2.0
1.5
CPUE
5x5
6x6
7x7
8x8
Round
Pot Size


2.5
2.4
2.3
2.2
2.1
2.0
f(Depth)
100
150
200
250
300
Depth (fa)


1995
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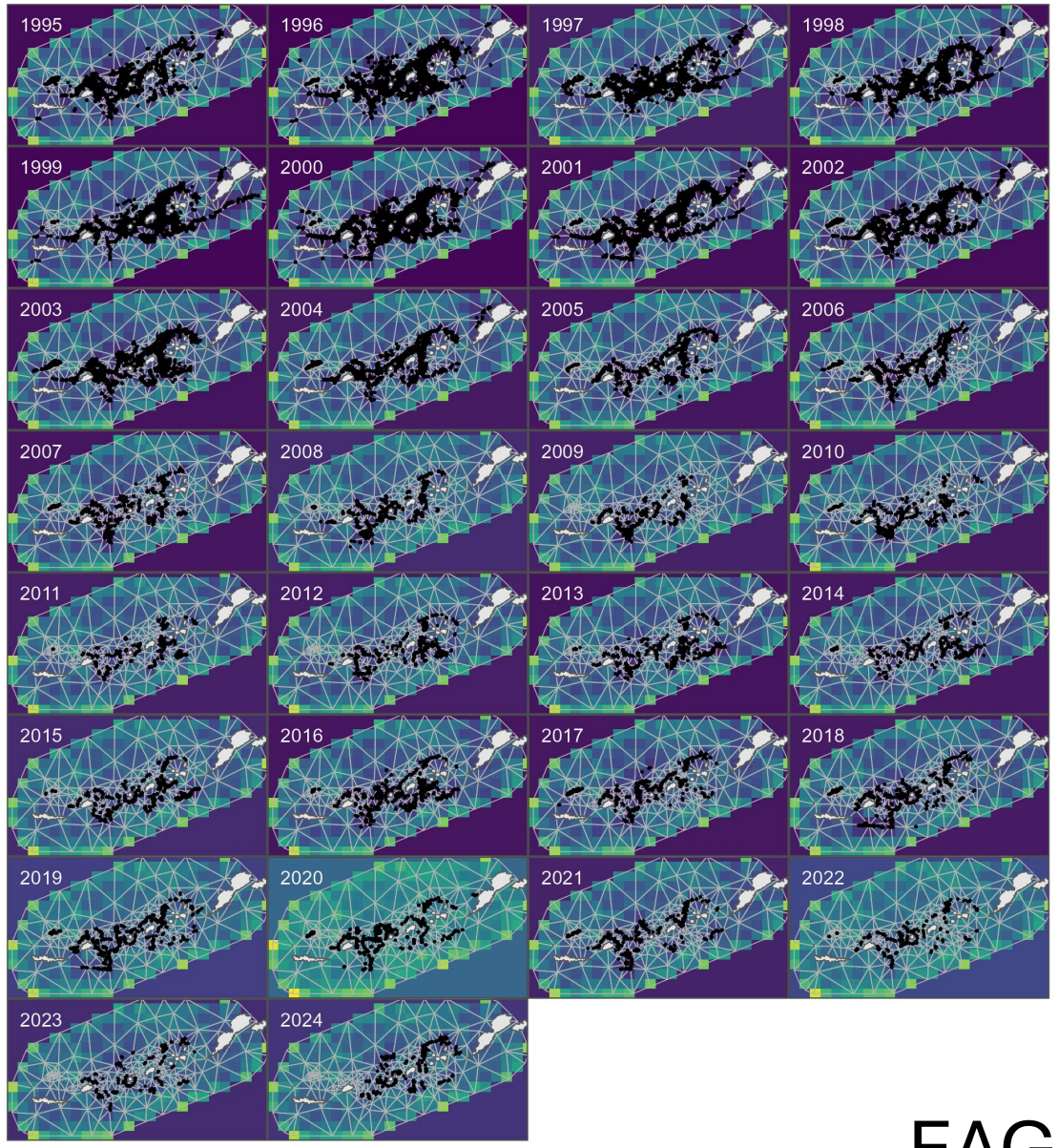
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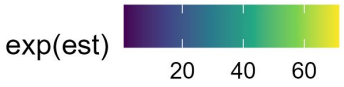
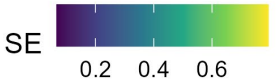
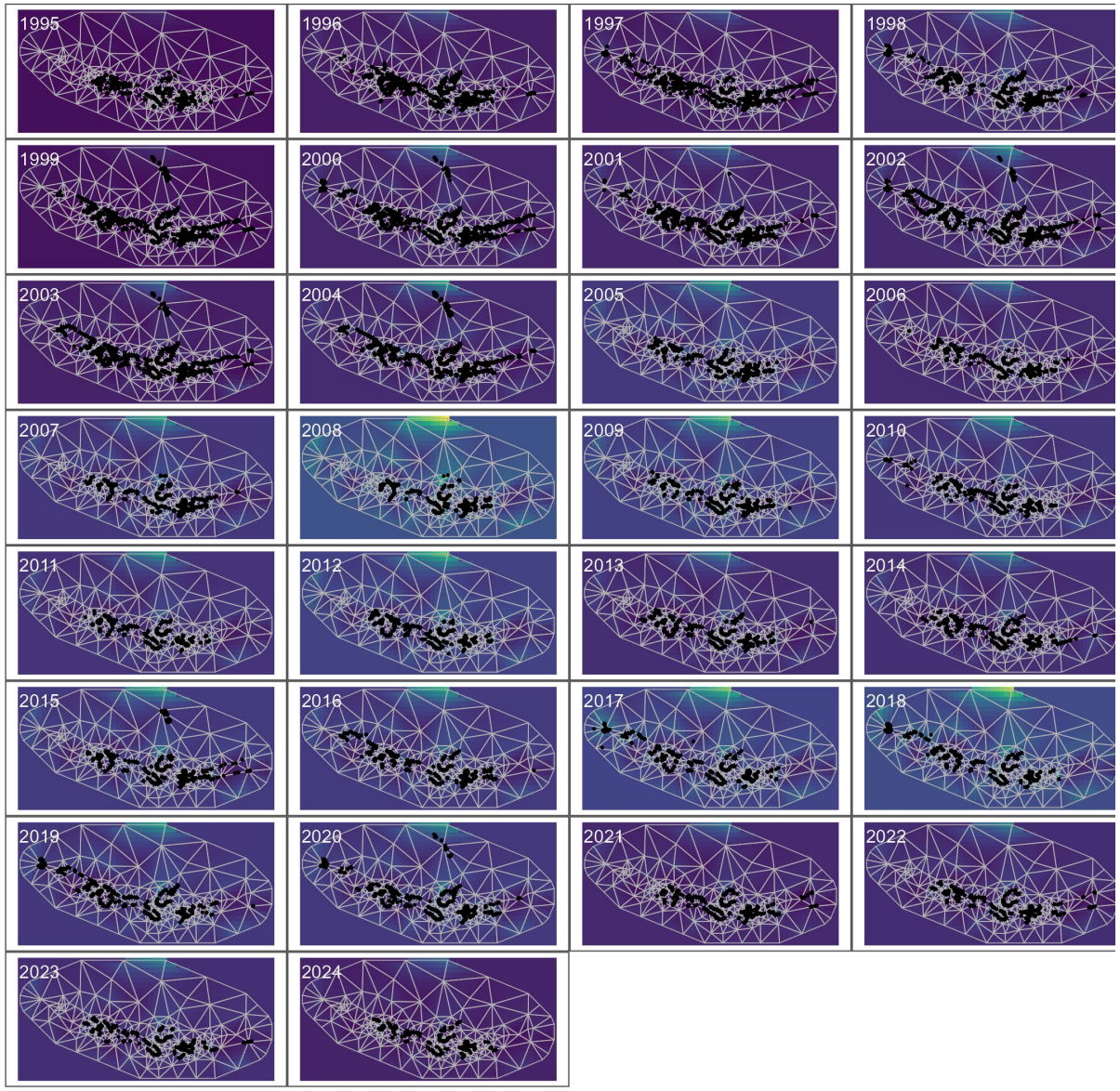

exp(est)
20
40
60


SE
0.2
0.4
0.6

EAG


1995
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2011
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2013
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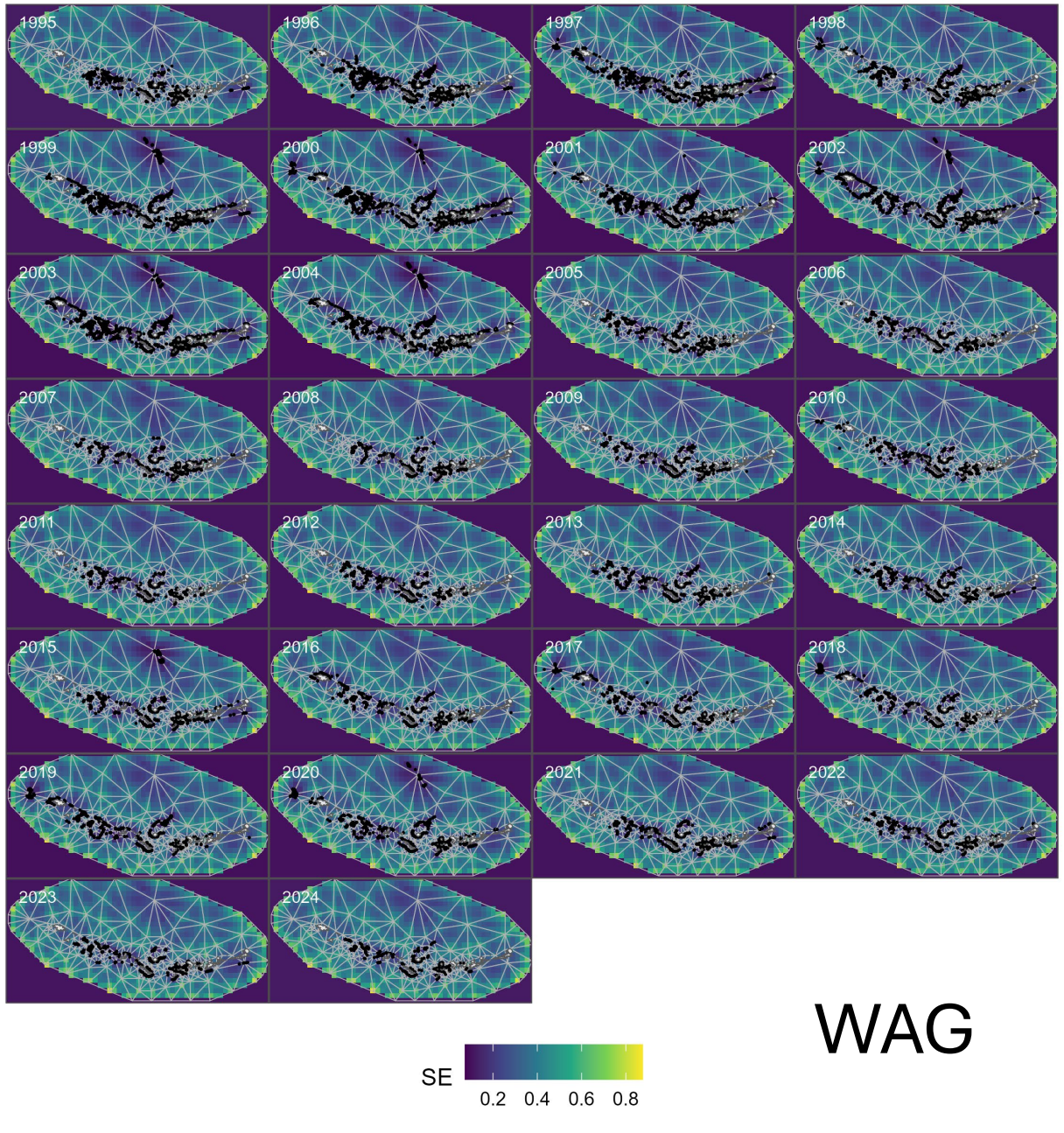
2017
2018
2019
2020
2021
2022
2023
2024
exp(est)
20
40
60
80


1995
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2006
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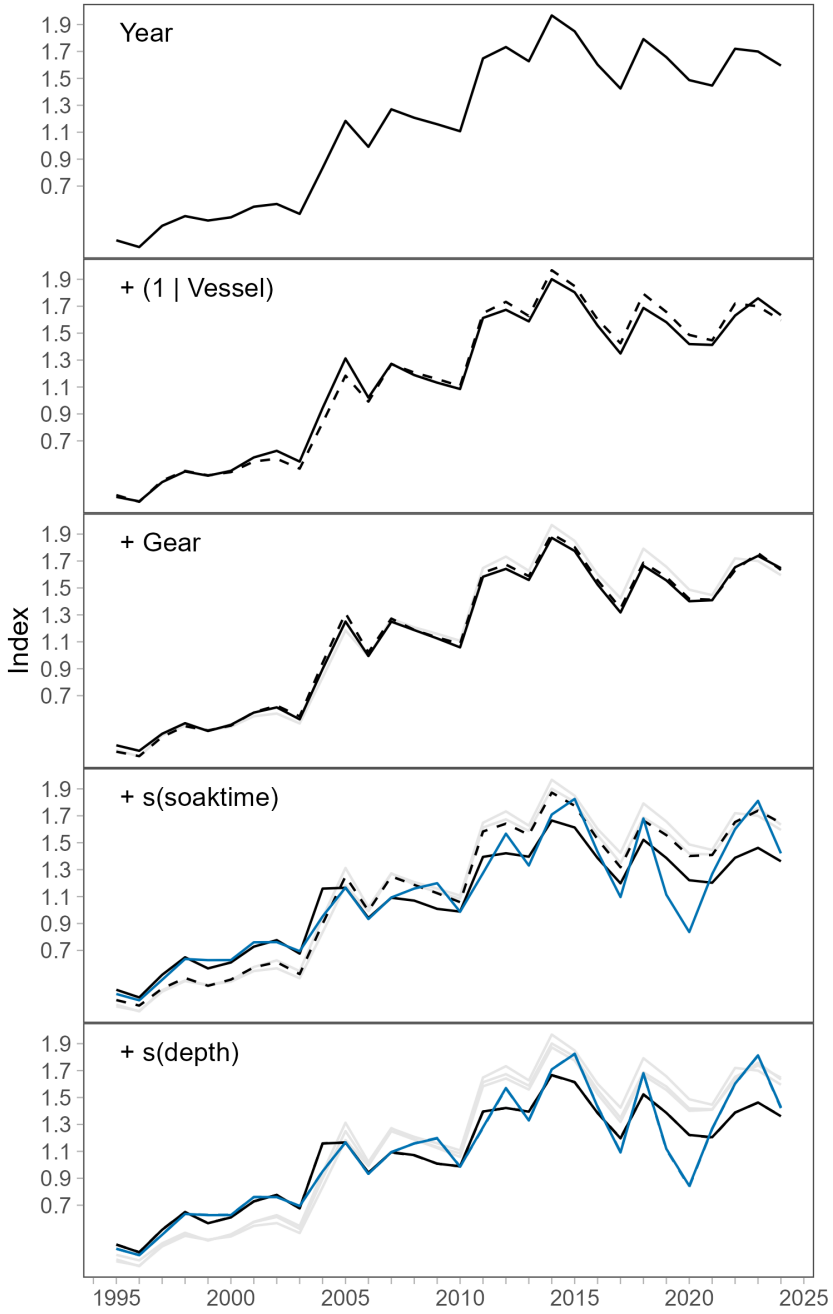
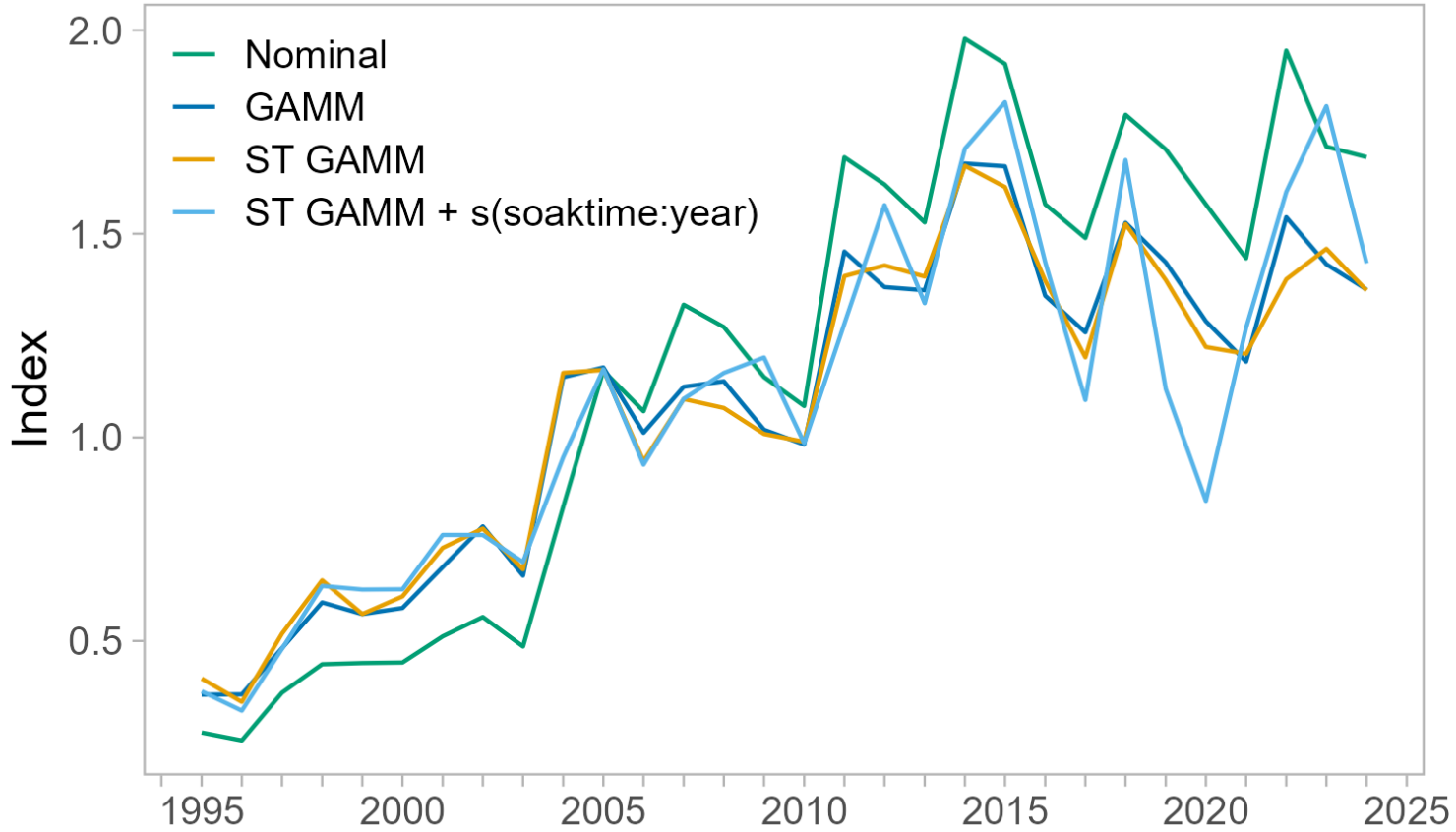
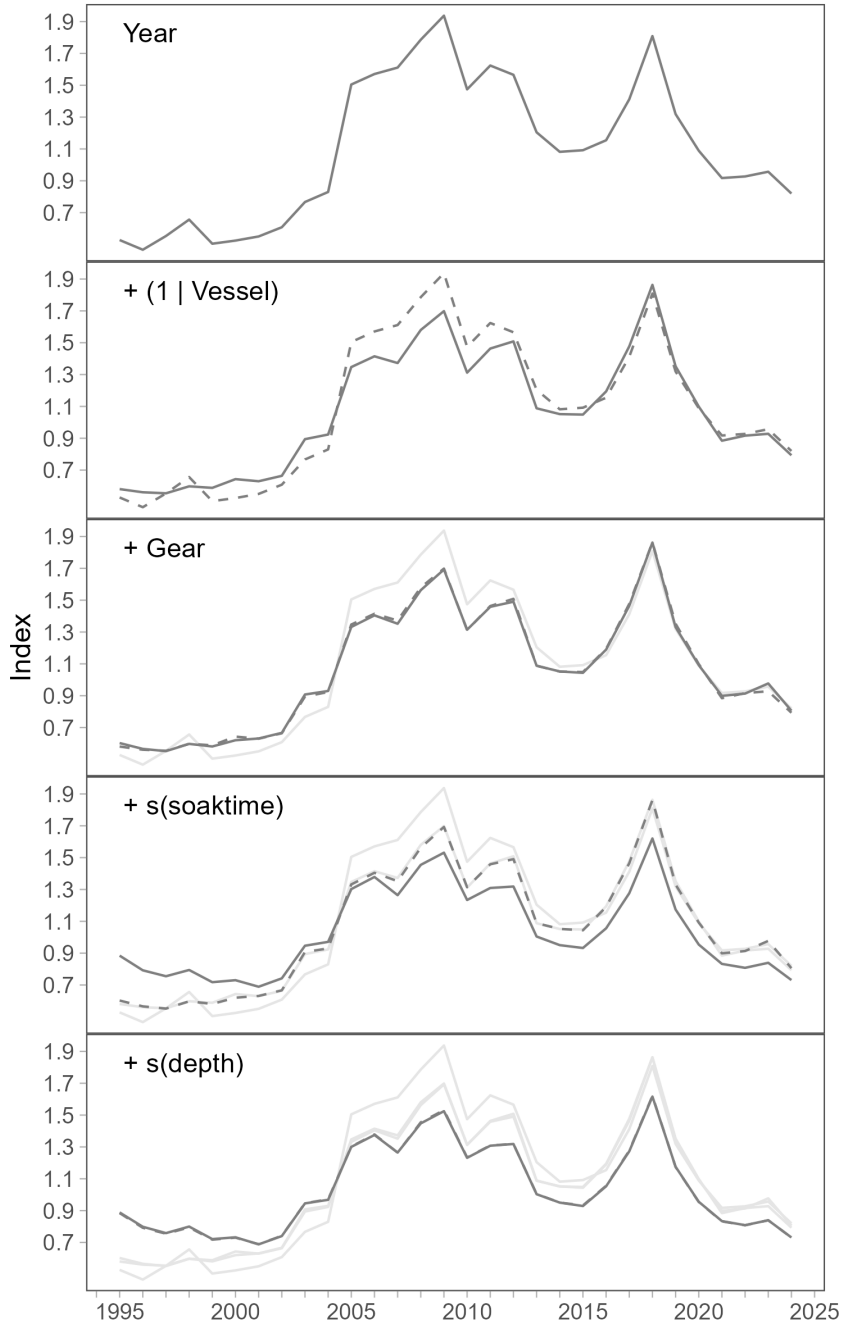
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
SE
0.2
0.4
0.6
0.8

WAG

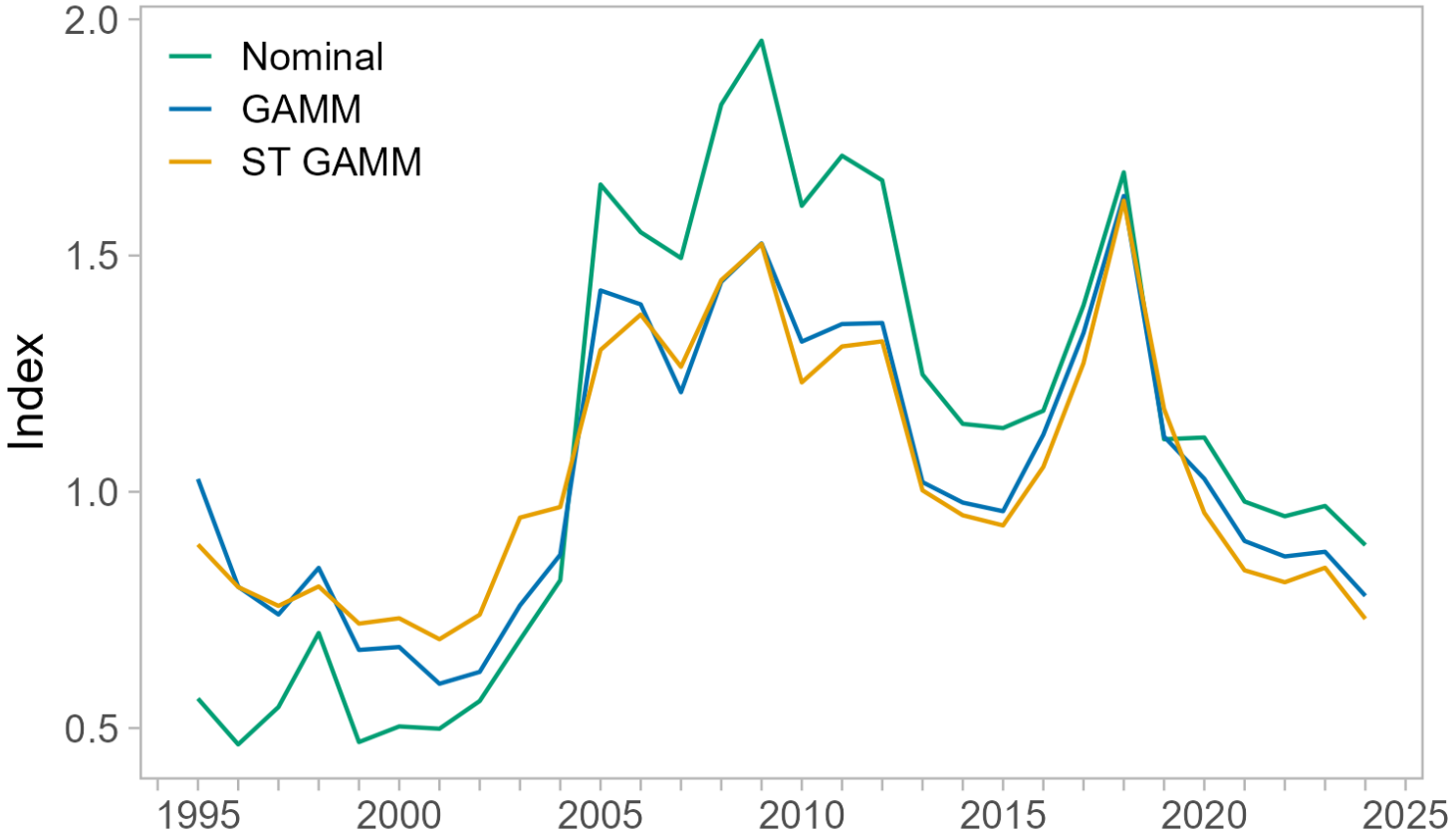
EAG


Year
+ (1 | Vessel)
+ Gear
+ s(soaktime)
+ s(depth)
Index
1.9
1.7
1.5
1.3
1.1
0.9
0.7
1995
2000
2005
2010
2015
2020
2025


Nominal
GAMM
ST GAMM
ST GAMM + s(soaktime:year)
Index
2.0
1.5
1.0
0.5
1995
2000
2005
2010
2015
2020
2025


Year
+ (1 | Vessel)
+ Gear
+ s(soaktime)
+ s(depth)
Index
1.9
1.7
1.5
1.3
1.1
0.9
0.7
1995
2000
2005
2010
2015
2020
2025

WAG


Nominal
GAMM
ST GAMM
Index
2.0
1.5
1.0
0.5
1995
2000
2005
2010
2015
2020
2025

Spatiotemporal CPUE Std (Appendix B)

Specific comments / recommendations for September??