AIGKC

2024 Final Assessment

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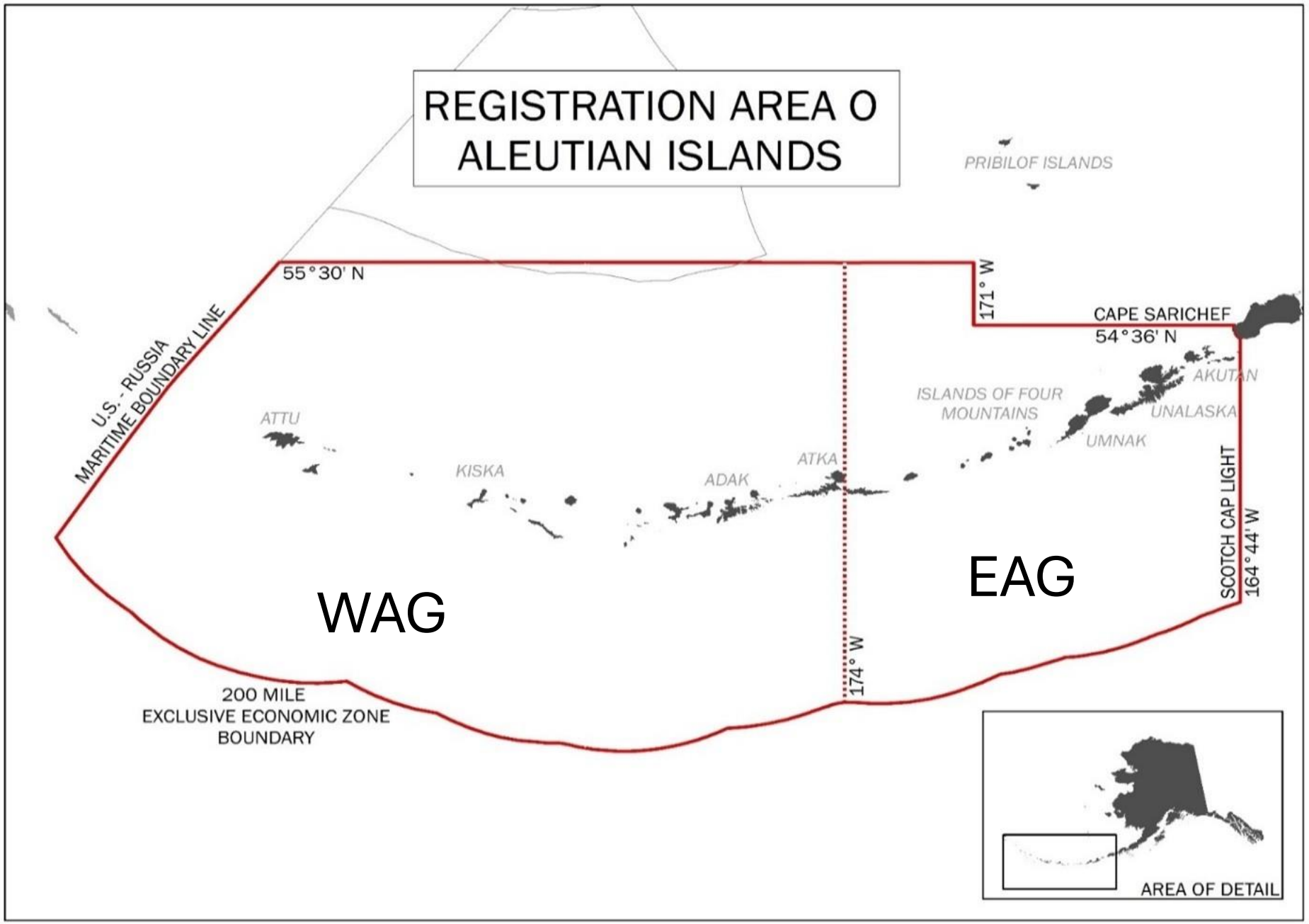
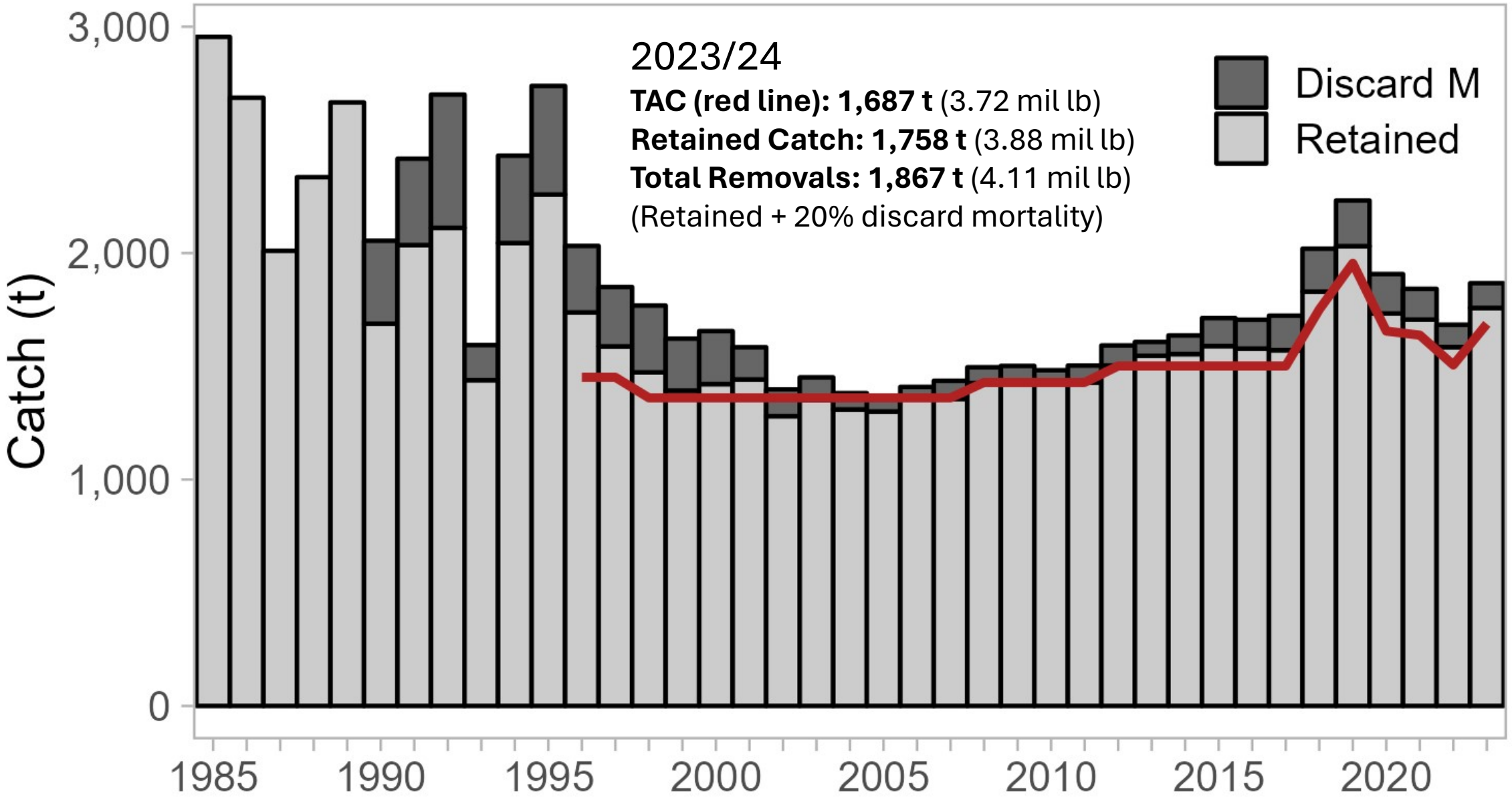
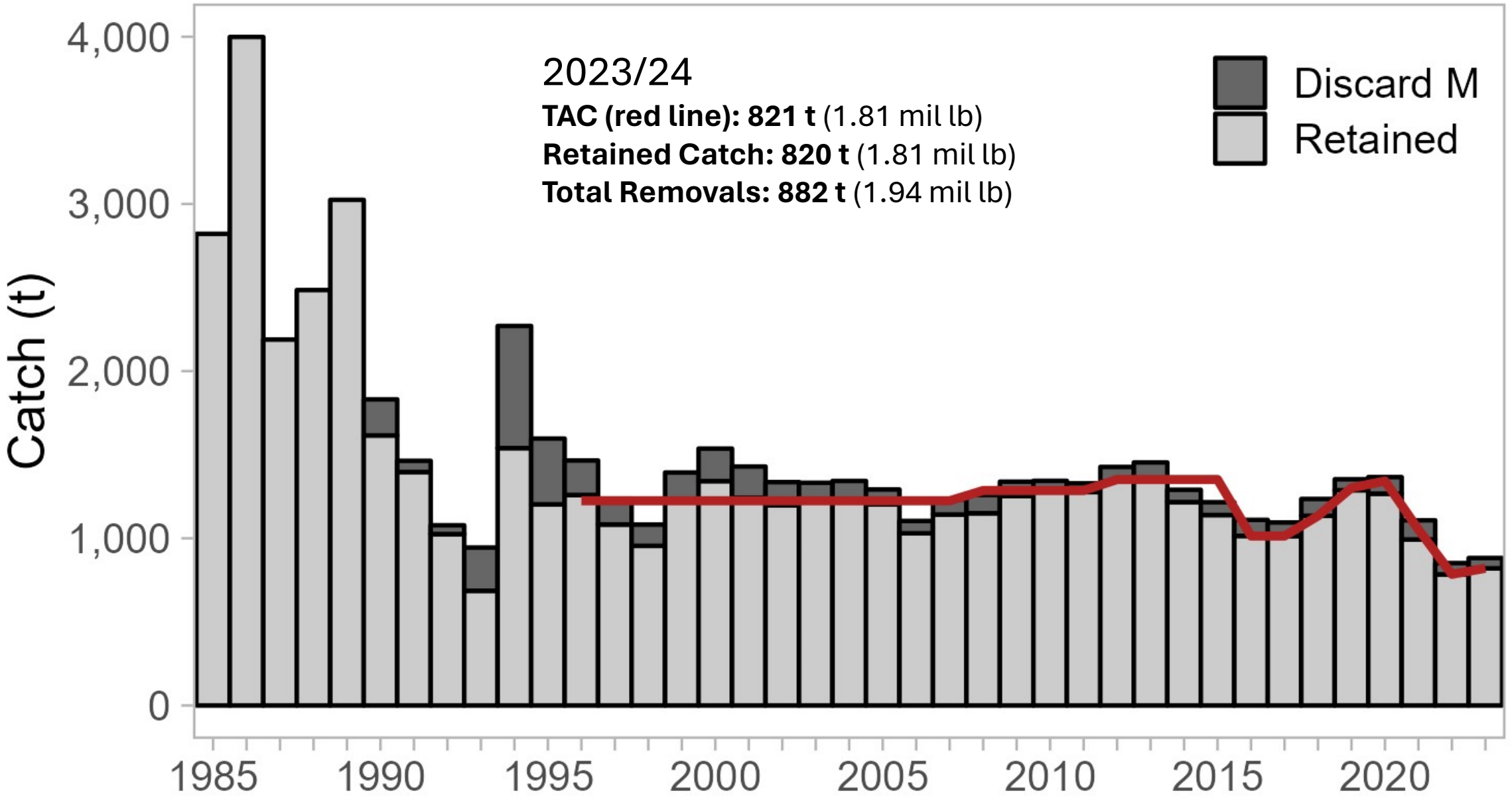
CPT May 2024


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
WAG
EAG
174° W
200 MILE
EXCLUSIVE ECONOMIC ZONE
BOUNDARY
AREA OF DETAIL

EAG


2023/24
TAC (red line): 1,687 t (3.72 mil lb)
Retained Catch: 1,758 t (3.88 mil lb)
Total Removals: 1,867 t (4.11 mil lb)
(Retained + 20% discard mortality)
Discard M
Retained
Catch (t)
3,000
2,000
1,000
0
1985
1990
1995
2000
2005
2010
2015
2020

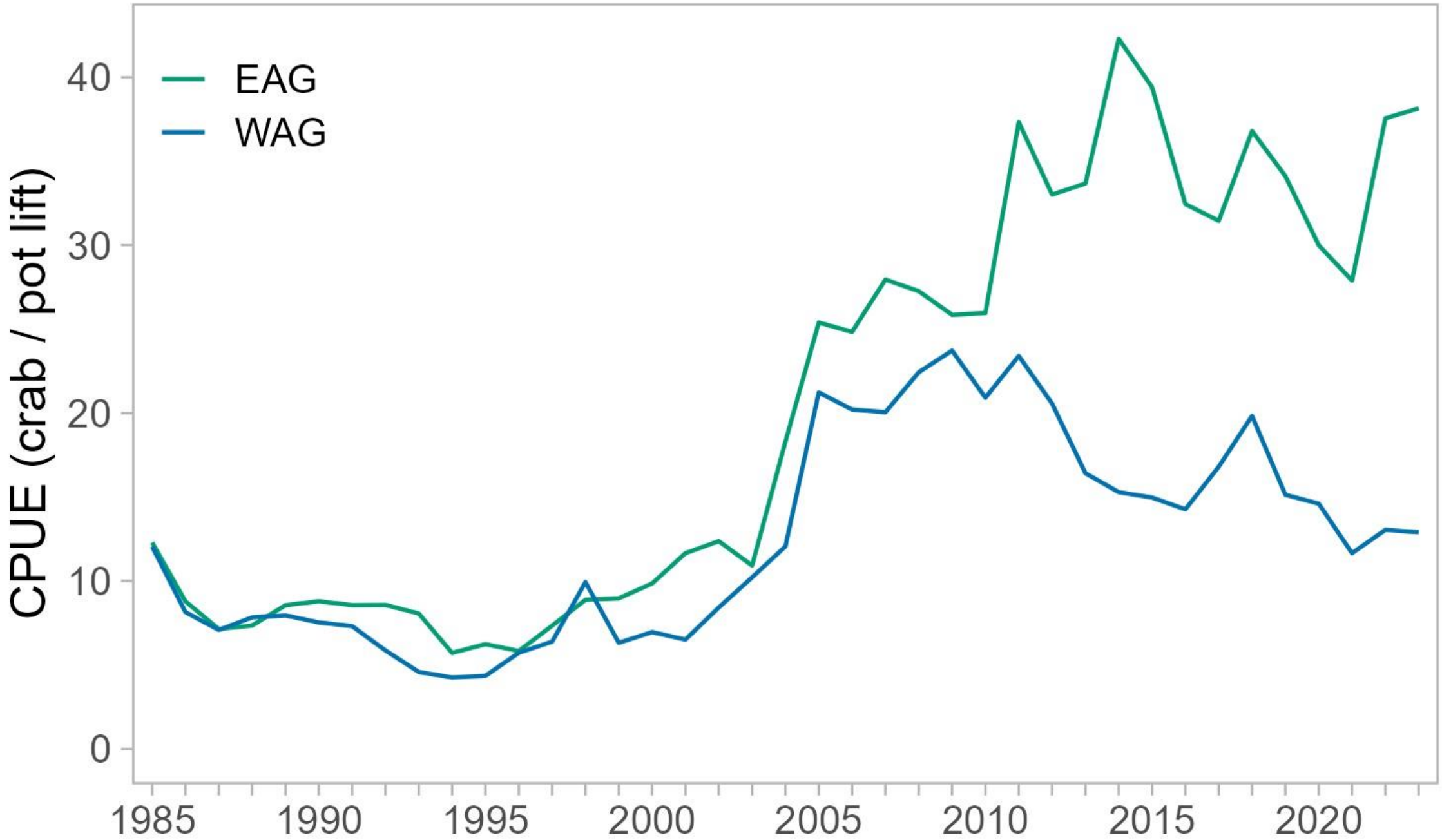
WAG

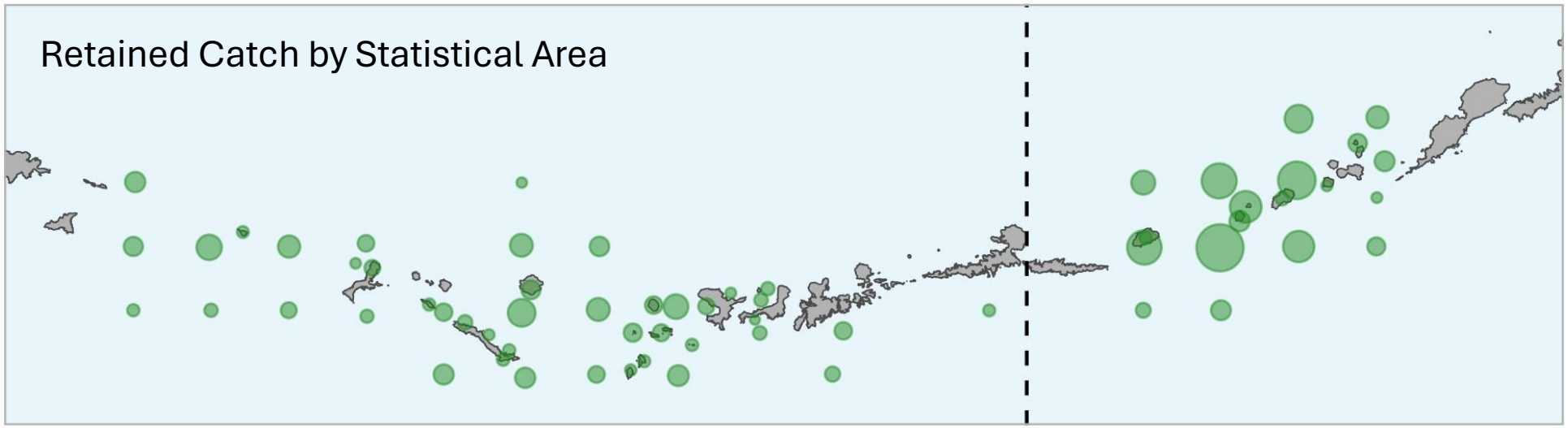

2023/24
TAC (red line): 821 t (1.81 mil lb)
Retained Catch: 820 t (1.81 mil lb)
Total Removals: 882 t (1.94 mil lb)
Discard M
Retained
Catch (t)
4,000
3,000
2,000
1,000
0
1985
1990
1995
2000
2005
2010
2015
2020

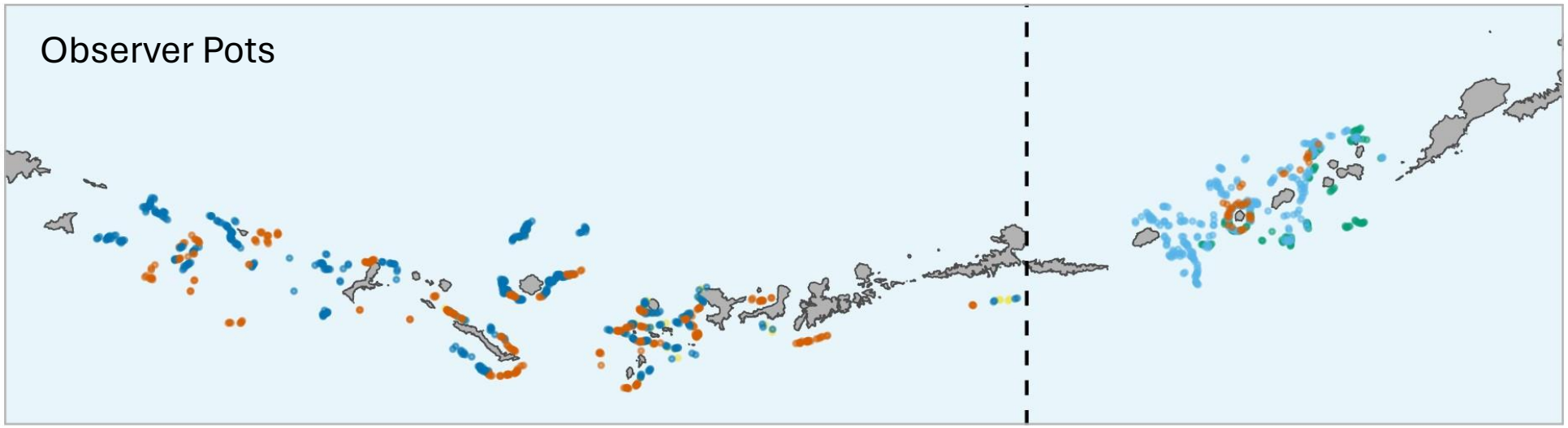
	EAG	WAG	Total
Total Directed Removals	1,867	8,82	2,749
GF Byctach Mortality	2.92	3.11	6.03
Total Fishery Removals	1,870	885	2,755

2023/24 OFL = 4,182 t

Overfishing did not occur in 2023/24


EAG
WAG
CPUE (crab / pot lift)
0
10
20
30
40
1985
1990
1995
2000
2005
2010
2015
2020



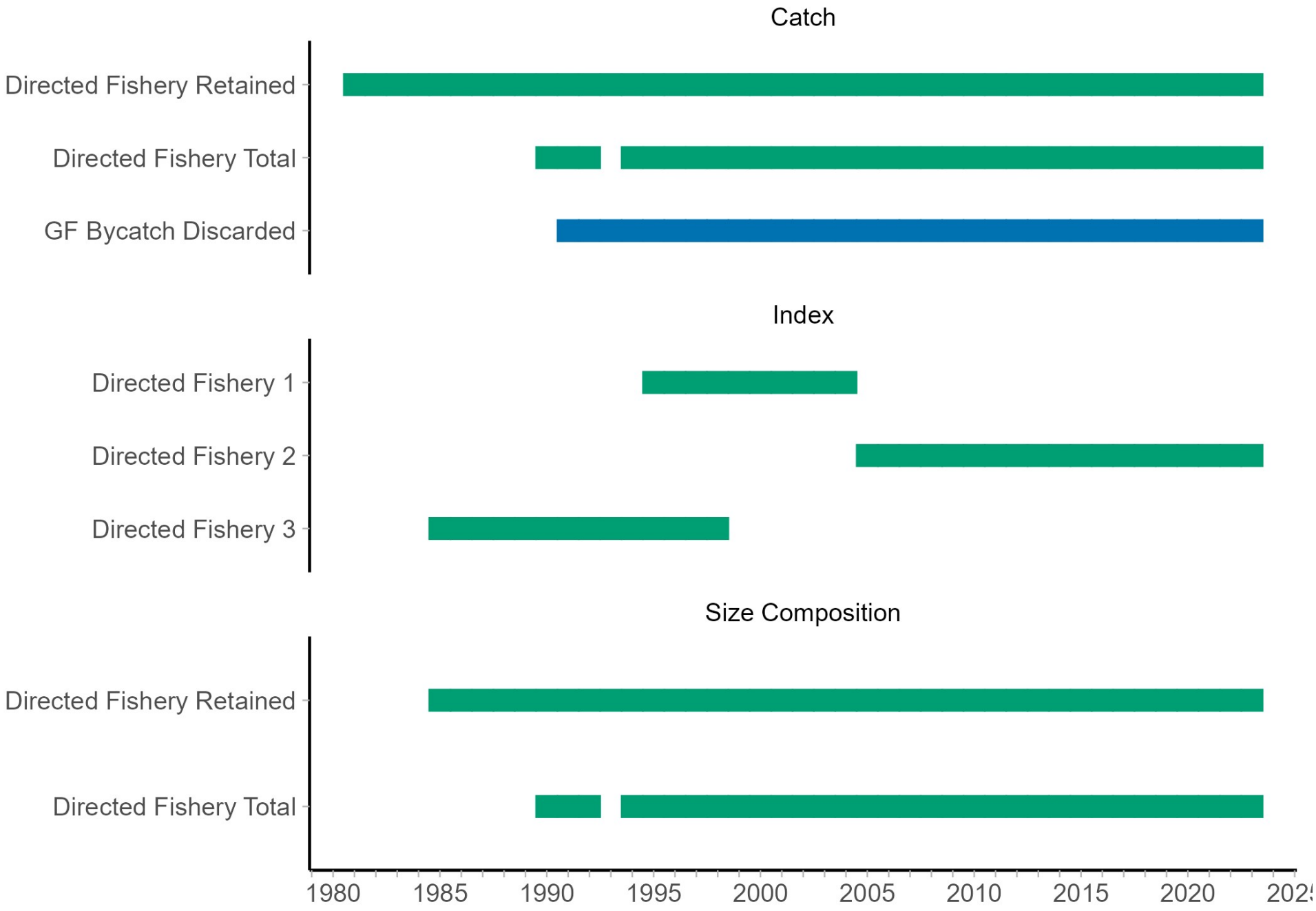


Landed lb (mil)

- 0.25
- 0.50
- 0.75

Vessel

- 103
- 5992
- 20556
- 35767
- 37887



+ tagging data from:

- 1991
- 1997
- 2000
- 2003
- 2006

Models

- **23.0a (base model)** – 2023 accepted model 22.1e2 w/:
  - Updated time series data (Jan. document; Appendix A)
  - CPUE standardization using GAMs
  - Only difference from Jan. – groundfish bycatch input to GMACS w/o mortality applied.

- **23.1** – 23.0a + truncated size composition (no minus sizes in smallest bin)

- **23.1b** – 23.1 + two selectivity periods in pre-rationalization (1960 – 1996, 1997 – 2004)

CPUE Standardization (Appendix A)

CPT (Jan 2024)

- *Explore the use of a Tweedie instead of the negative binomial distribution;*
- *Dropping the data for gear types 4 and 13 which have few observations;*
- *Reporting DHARMa residuals and providing influence plots as additional diagnostics;*
- *Exploring the basic data used for the fish ticket CPUE index because the data on which the standardization is based for the current analyses include many zero observations*

CPUE Standardization (Appendix A)

SSC (Feb 2024)

- *The SSC recommends that any new substantial standardization changes should be reviewed during the next cycle, not during specifications in May/June 2024*

Changes from January to May:

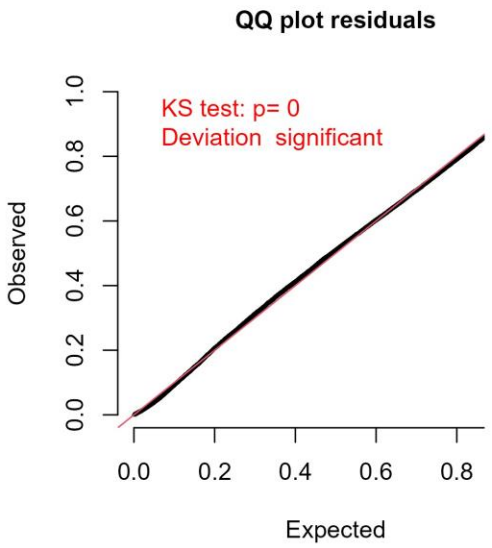
1) Explore Tweedie distributions
2) Remove s(Lon, Lat) as covariate
3) Correct fish ticket data pull for 1985 – 1998 standardization

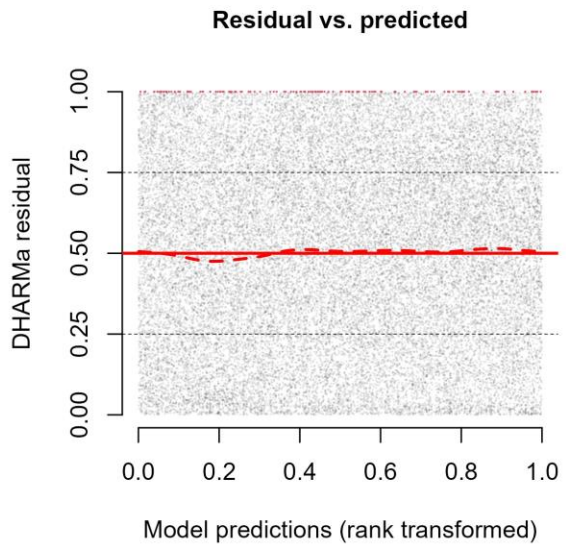
Pre-rationalization EAG

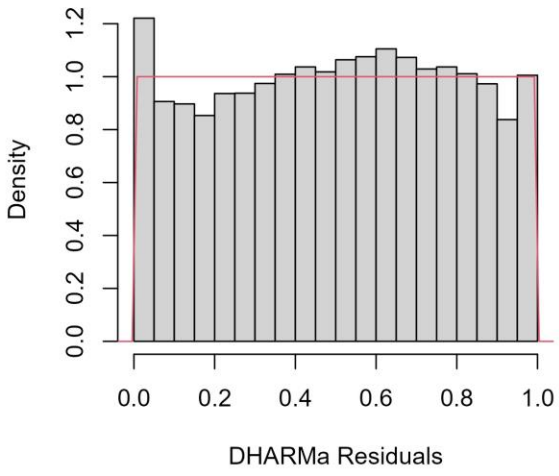
Form ($\theta = 1.37$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + Gr + PH + s(soak time, 4.801) + Mon	30,994.2	203,924	0.20
+ Vessel	-10.98	-100.53	0.005
+ s(depth)	-5.62	24.28	0.001
+ s(slope)	-1.31	10.46	0.000
+ Block	-3.03	-211.86	0.006

*Tweedie model had same form (p = 1.442)

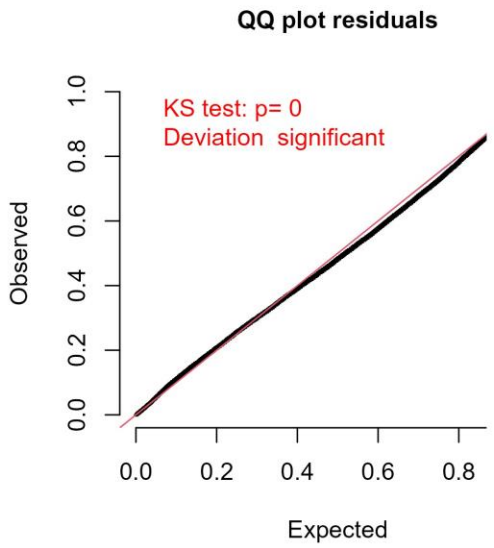
Neg Binomial (θ = 1.373)

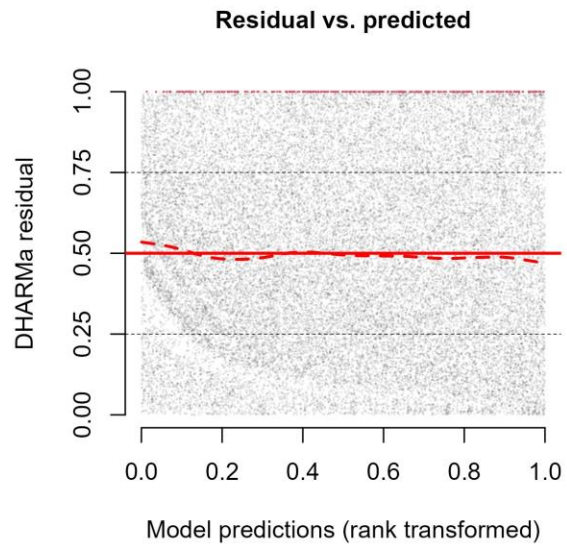


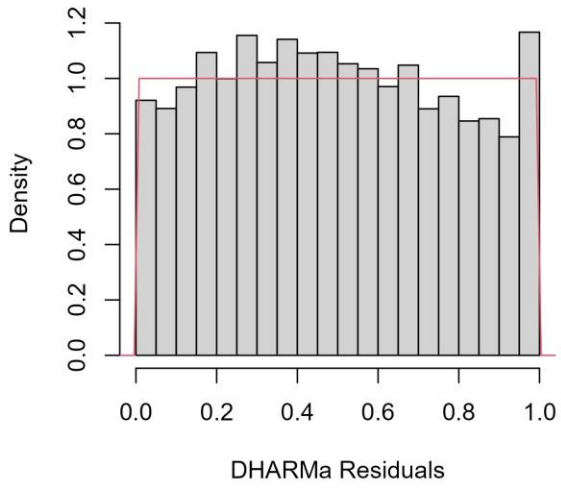




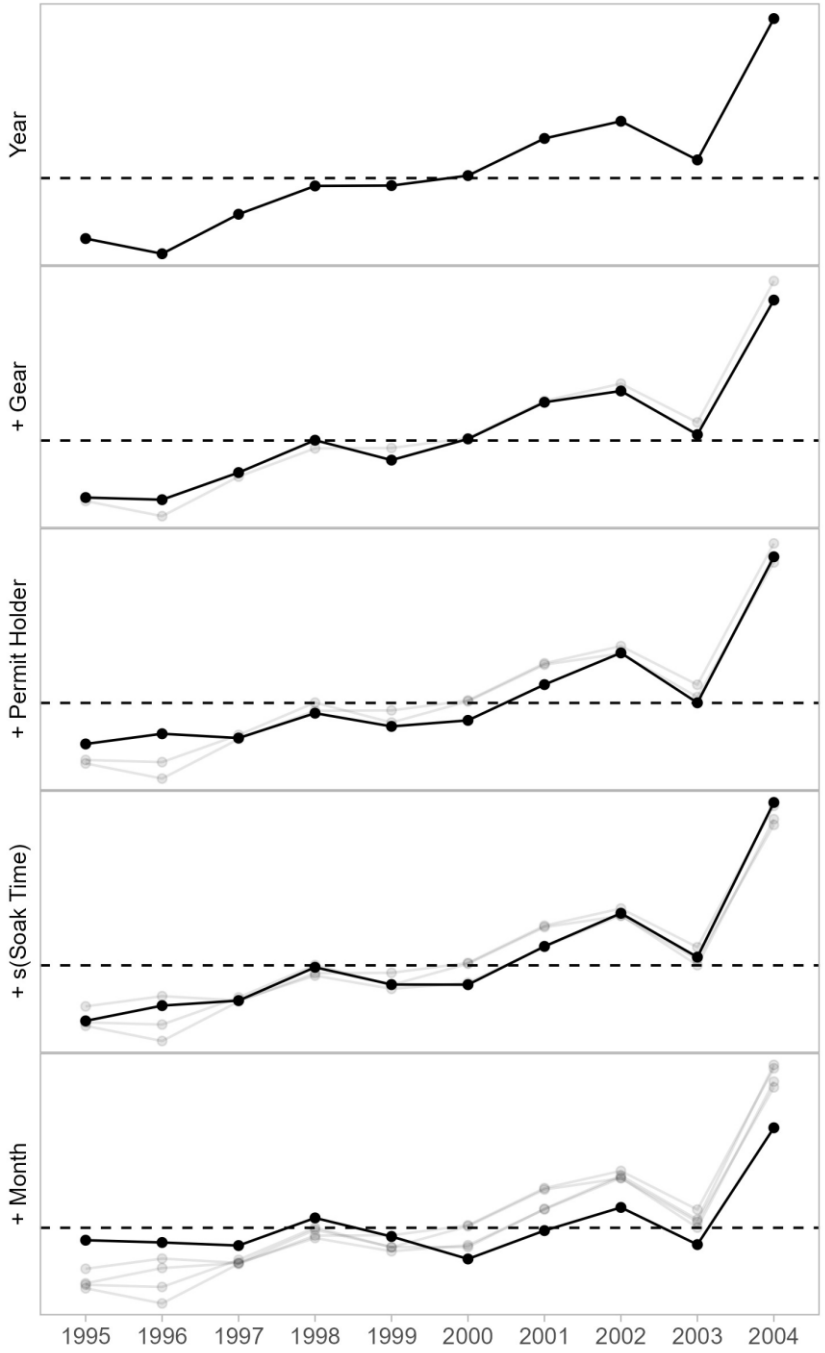
Tweedie (p = 1.442)

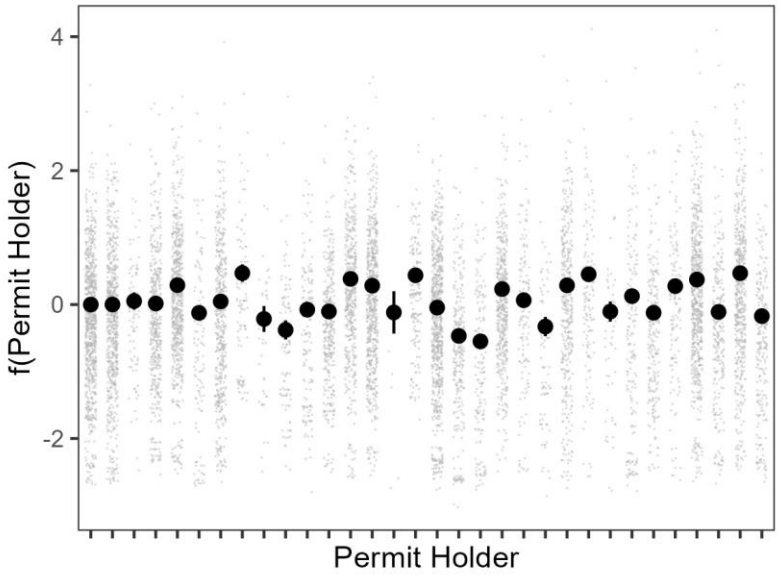


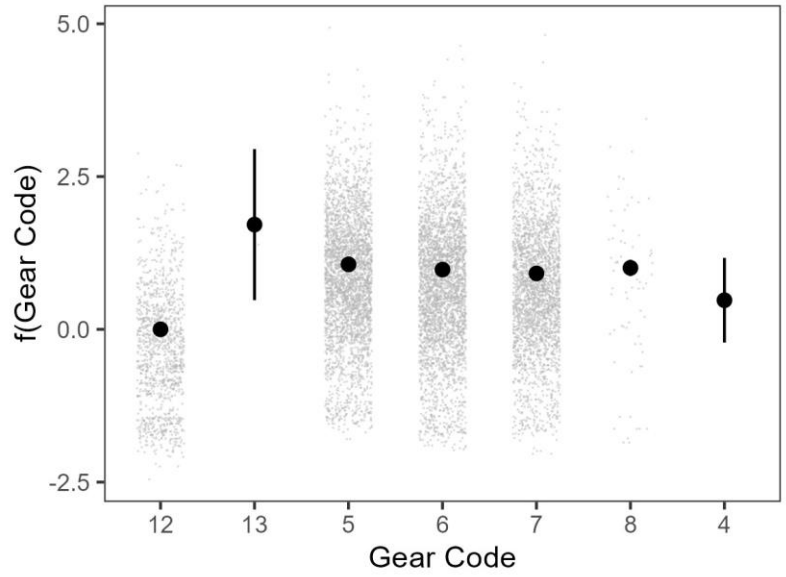


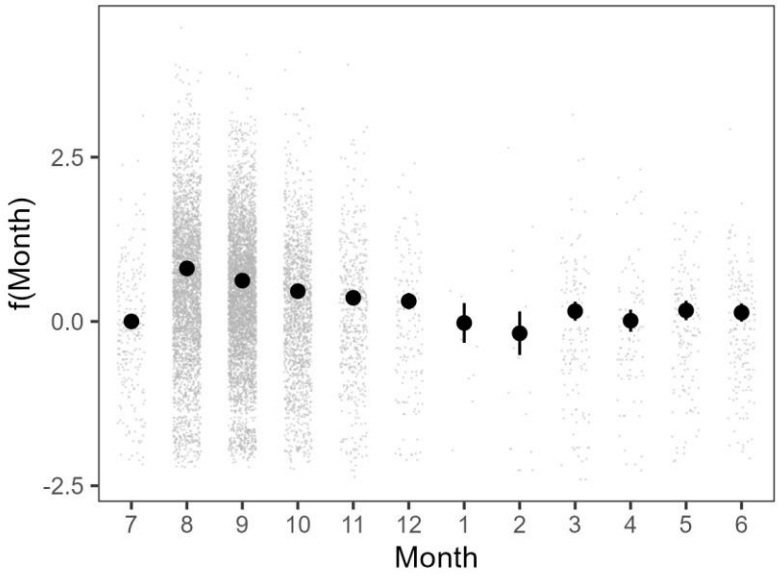


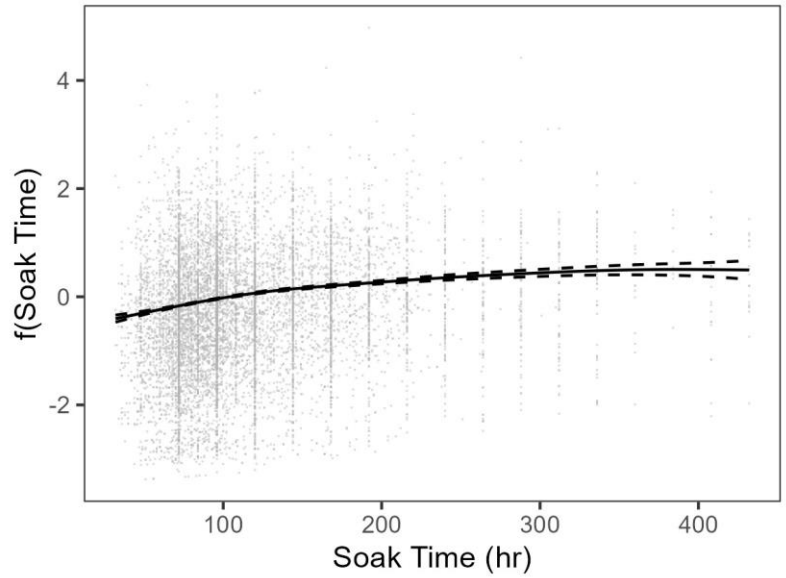
Pre-rationalization EAG











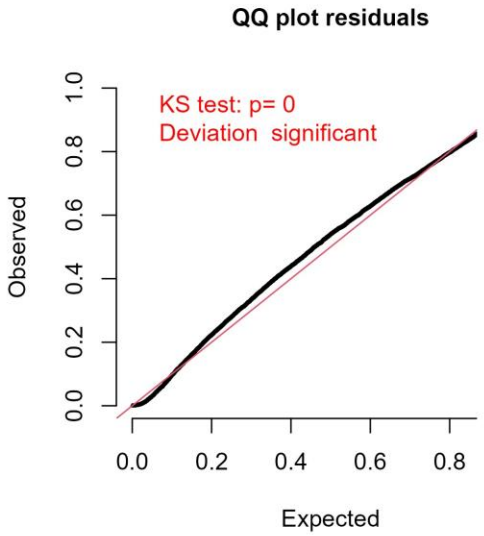
Post-rationalization EAG

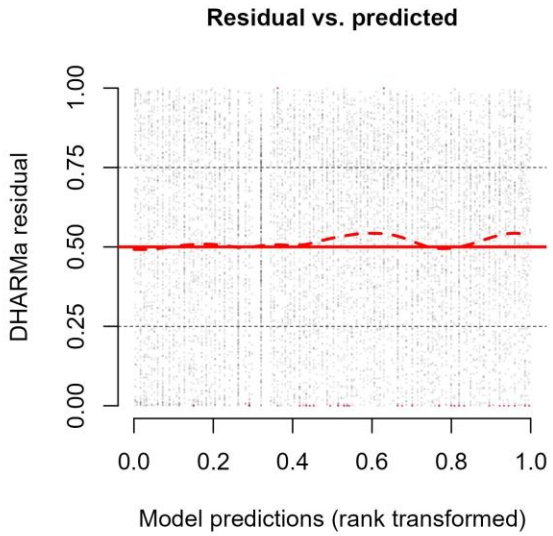
Form ($p = 1.386$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + s(soak time, 4.512) + Mon + Ves + Gr	10,066.5	88,323	0.15
+ Permit Holder	-11.19	37	0.006
+ s(depth)	-3.58	14.19	0.002
+ s(slope)	-3.08	8.70	0.002
+ Block	-3.00	22.83	0.001

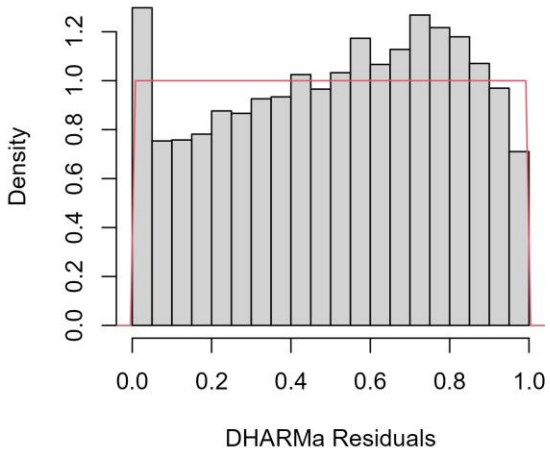
*Neg Binomial (θ = 2.274)

Yr + Ves + Gr

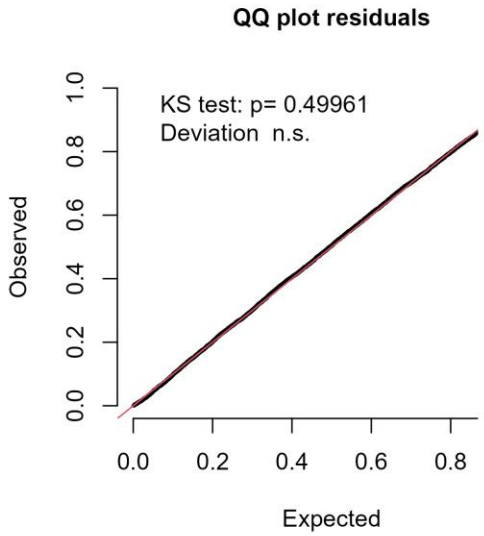
Neg Binomial (θ = 2.274)

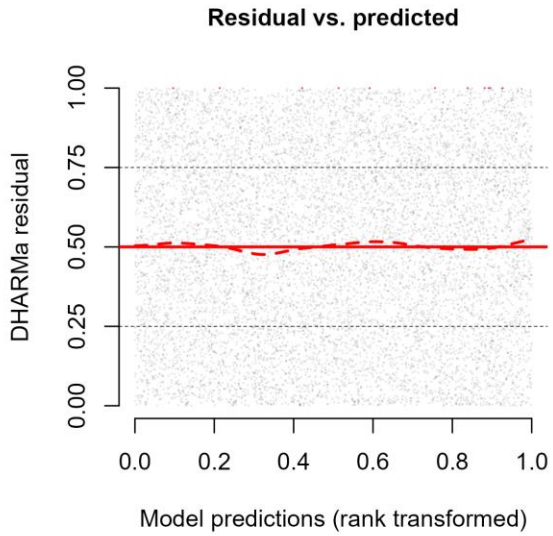


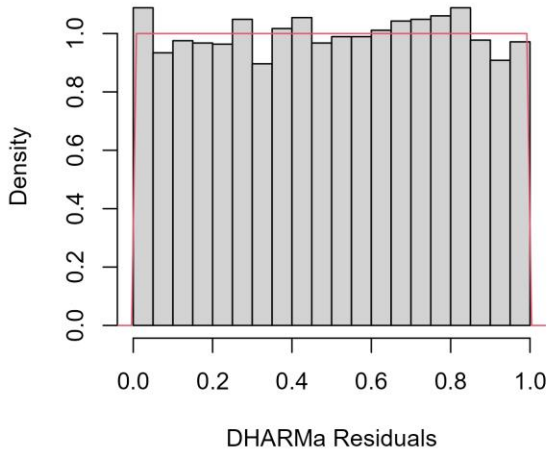




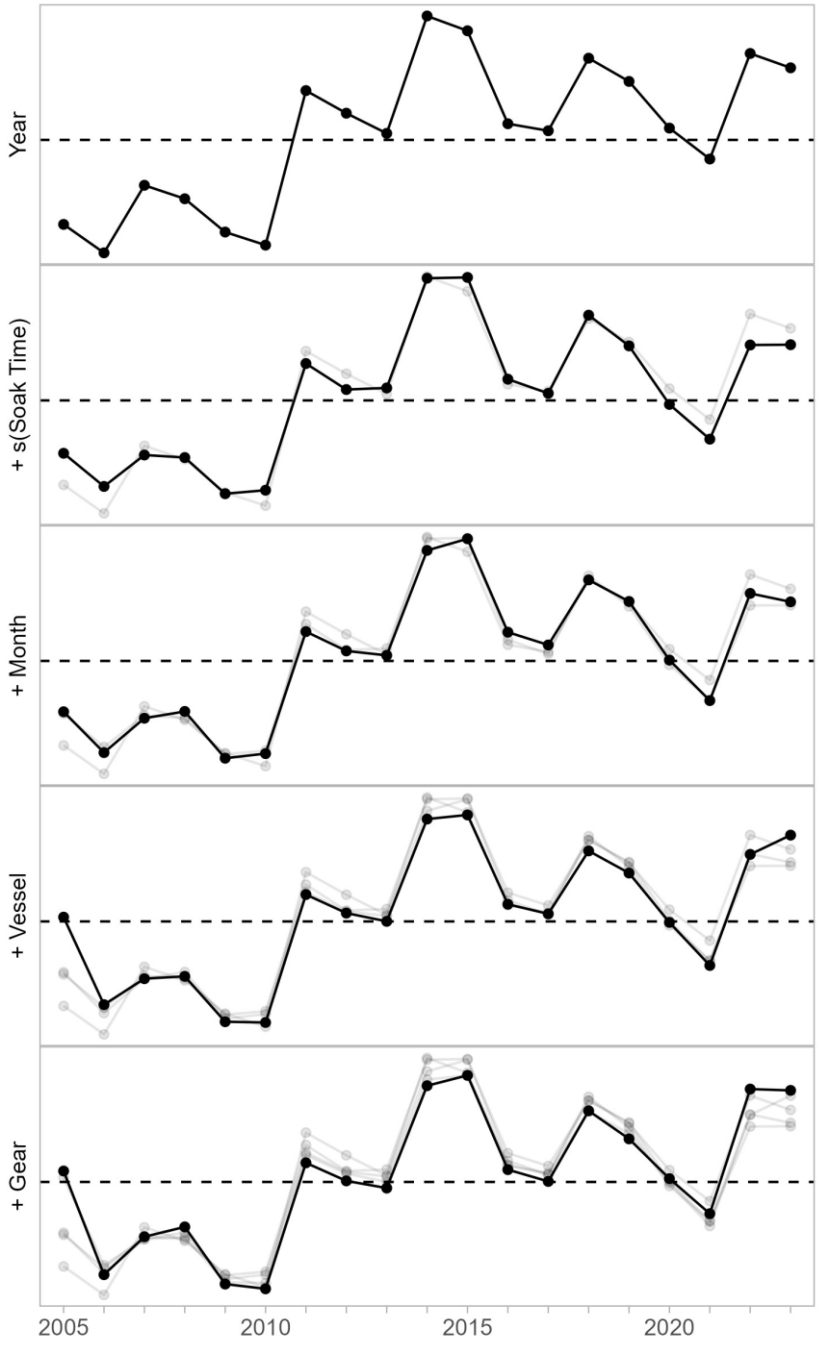
Tweedie (p = 1.386)

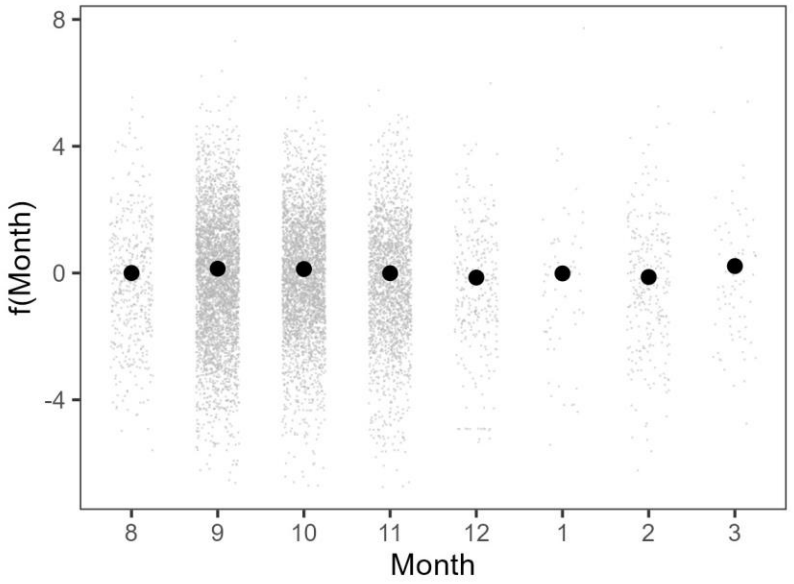


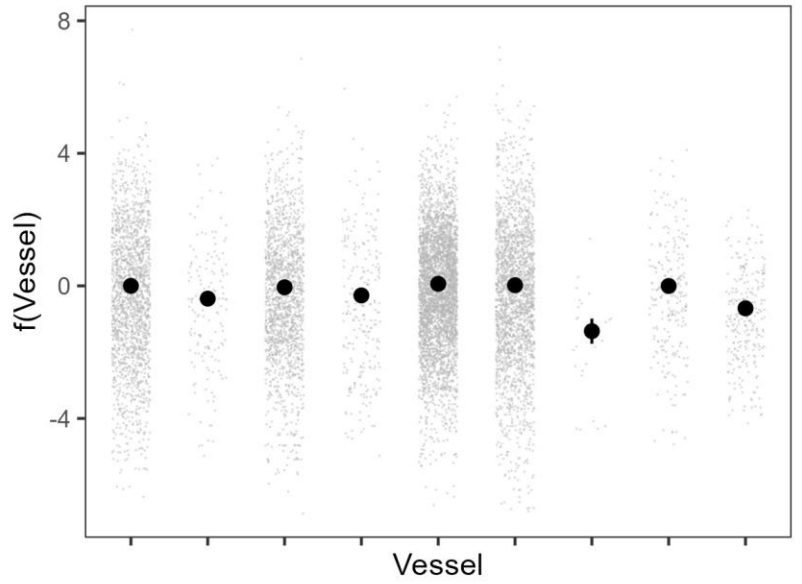


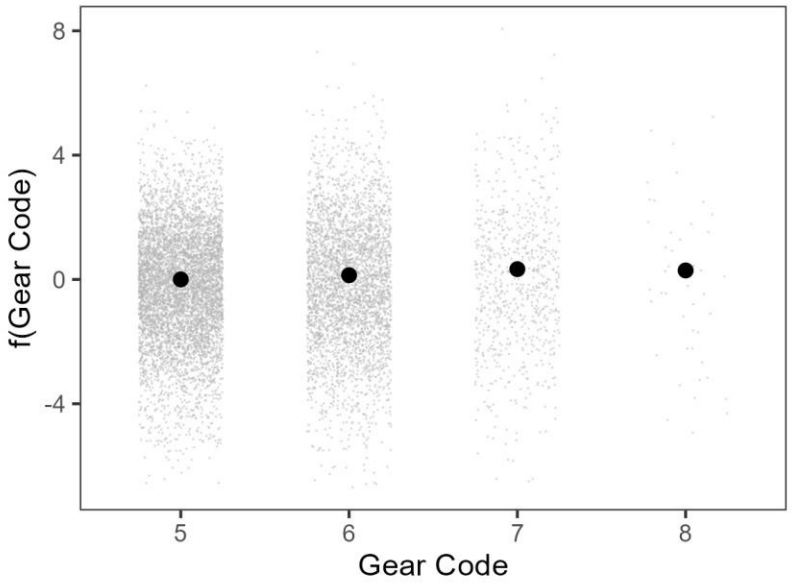


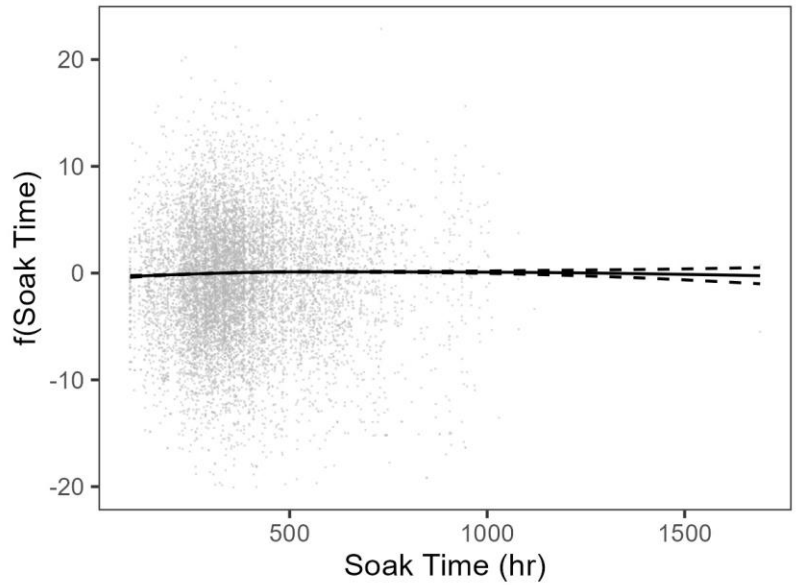
Post-rationalization EAG









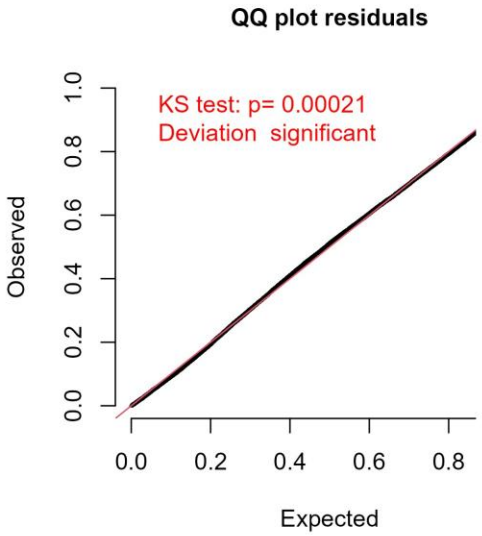


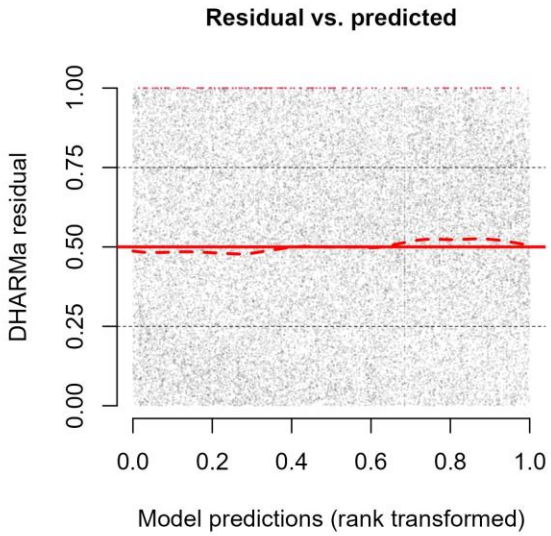
Pre-rationalization WAG

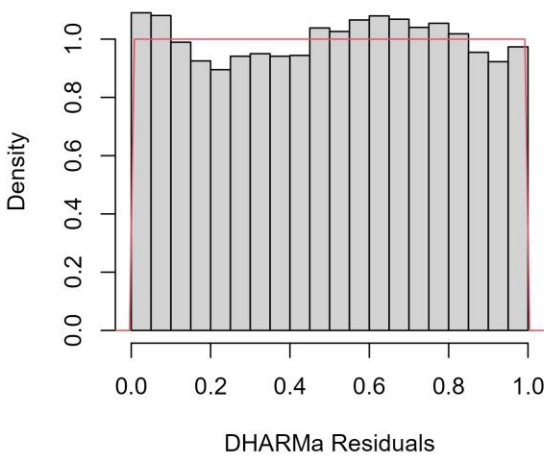
Form ($\theta = 0.95$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + Gr + PH + s(soak time, 7.95)	29,839.05	180,139	0.15
+ Month	-10.54	-153.85	0.007
+ Vessel	-6.44	-118.74	0.005
+ s(depth)	-7.04	-40.43	0.003
+ s(slope)	-3.50	-1.71	0.001
+ block	-4.97	-156.93	0.005

*Tweedie model had same form (p = 1.426)

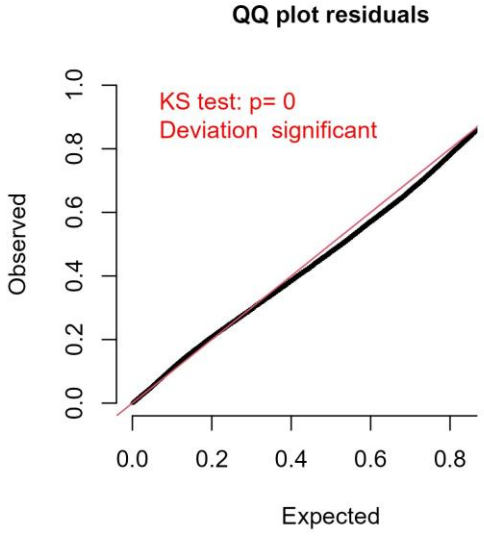
Neg Binomial (θ = 0.95)

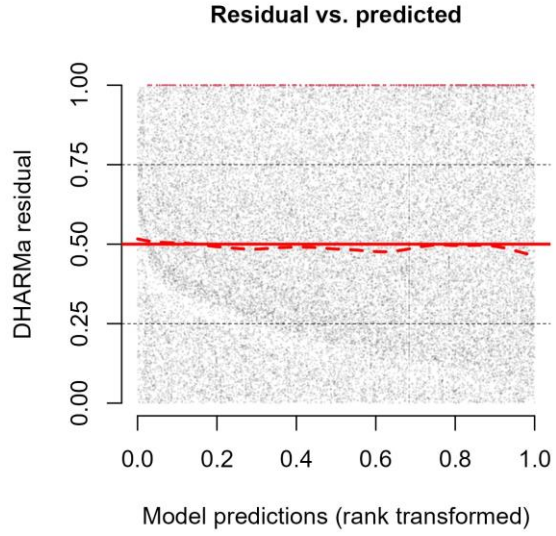


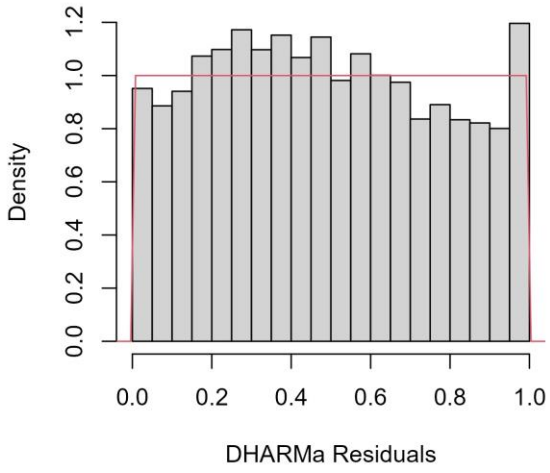




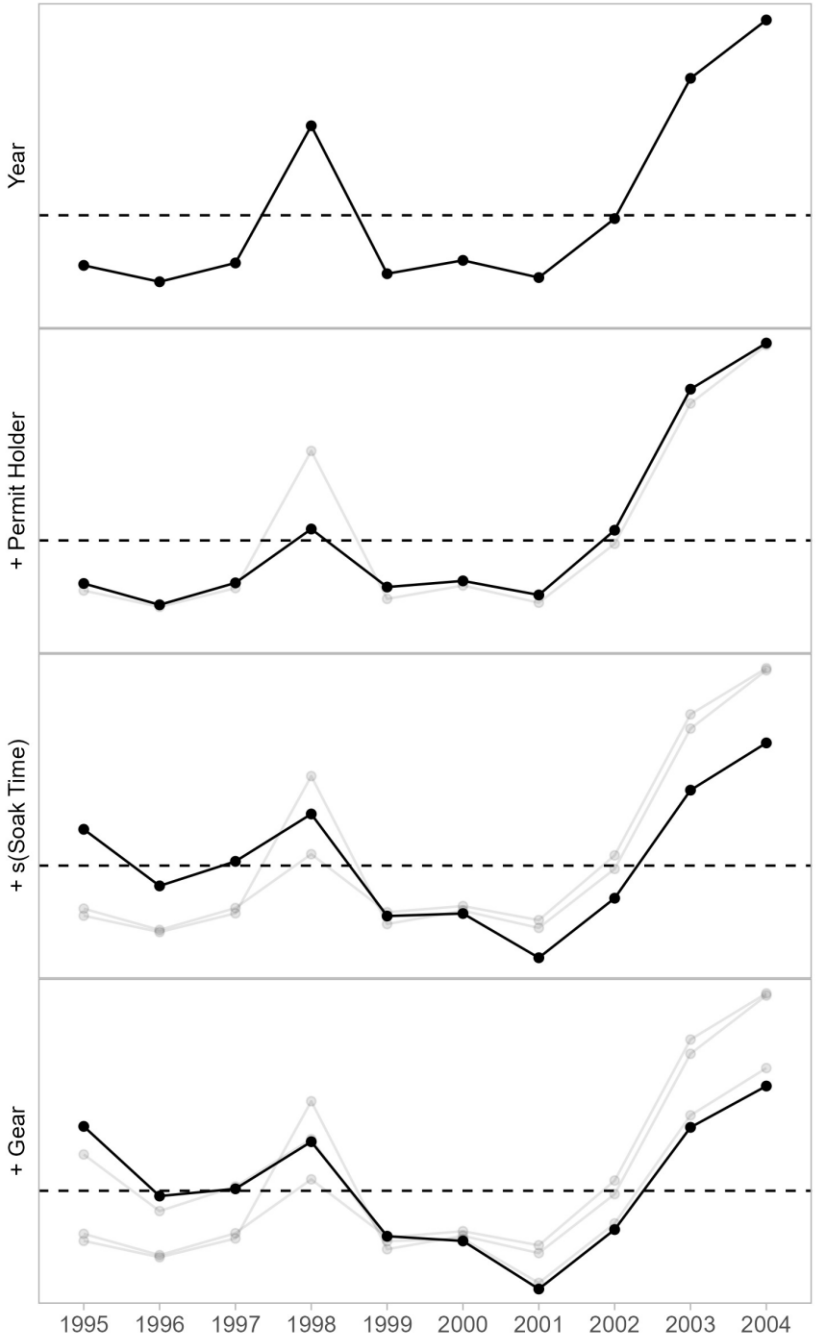
Tweedie (p = 1.426)

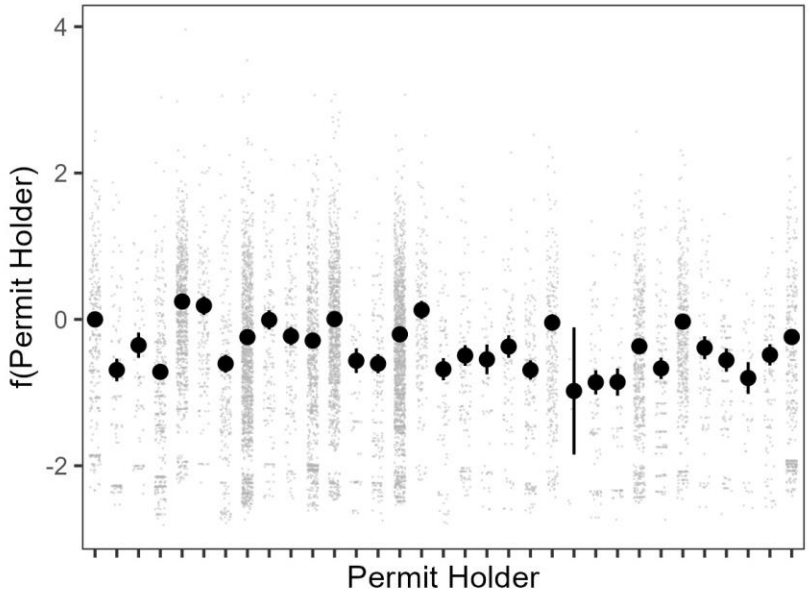


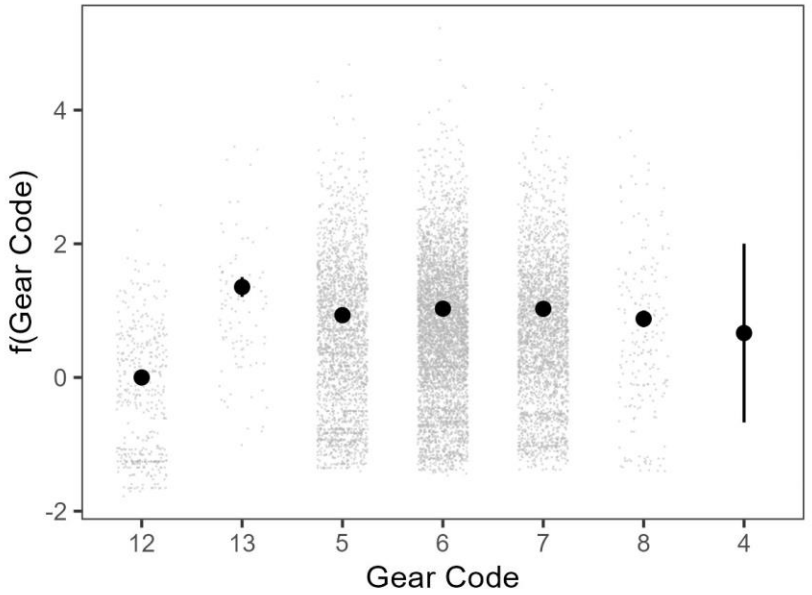


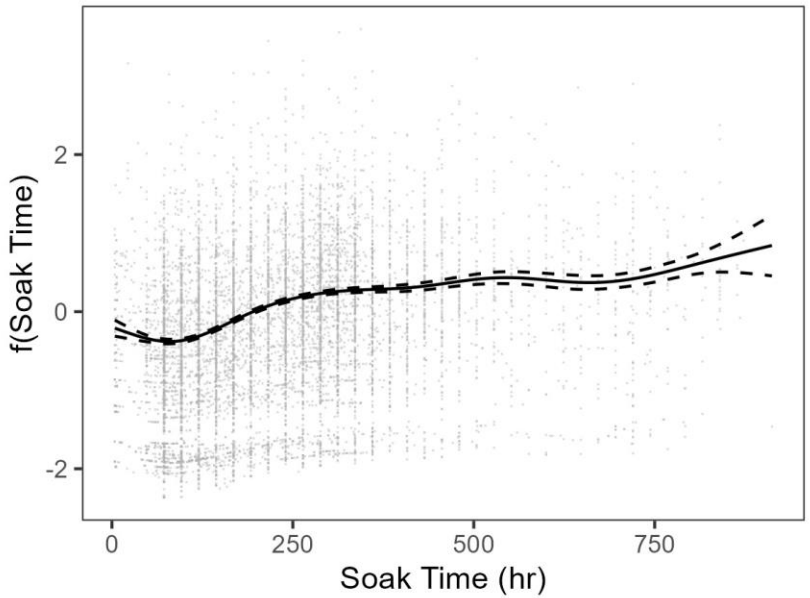


Pre-rationalization WAG







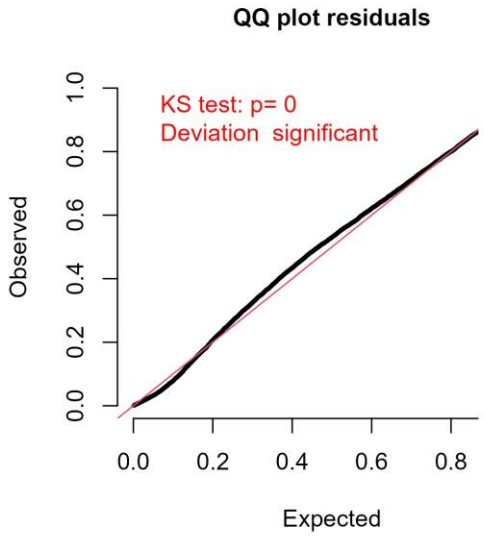


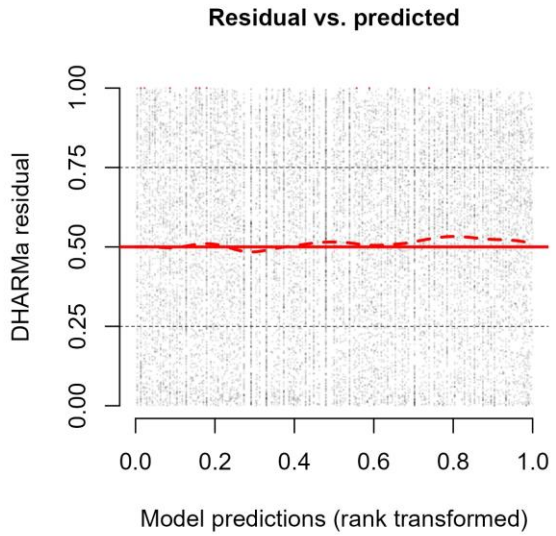
Post-rationalization WAG

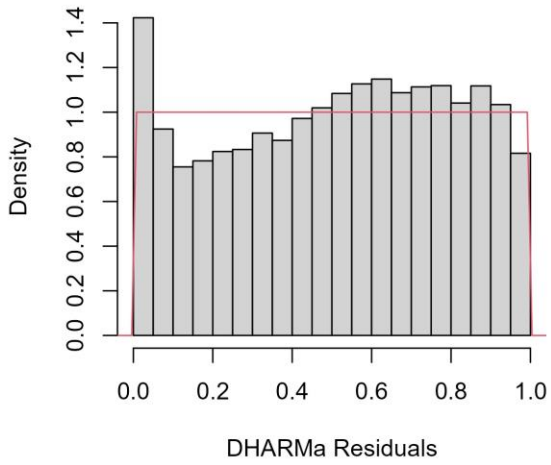
Form ($p = 1.495$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + Mo + PH + Gr	17,645	139,672	0.10
+ s(soak time)	-8.03	-30.09	0.005
+ s(depth)	-4.17	-27.20	0.003
+ s(slope)	-3.15	4.27	0.002
+ Block	-5.00	16.82	0.002
+ Vessel	-2	11	0.000

*Neg Binomial model did not include month (p = 1.084)

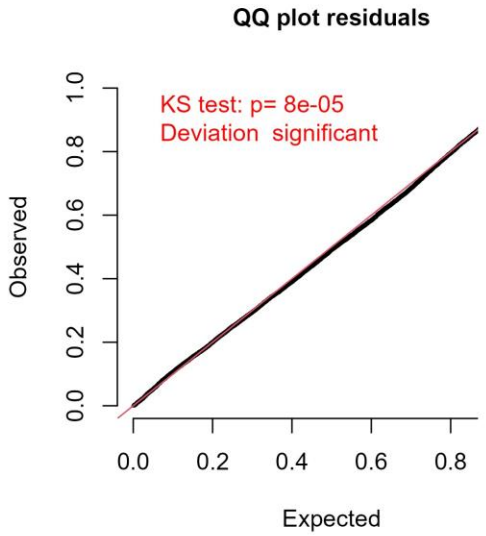
Neg Binomial (θ = 1.084)

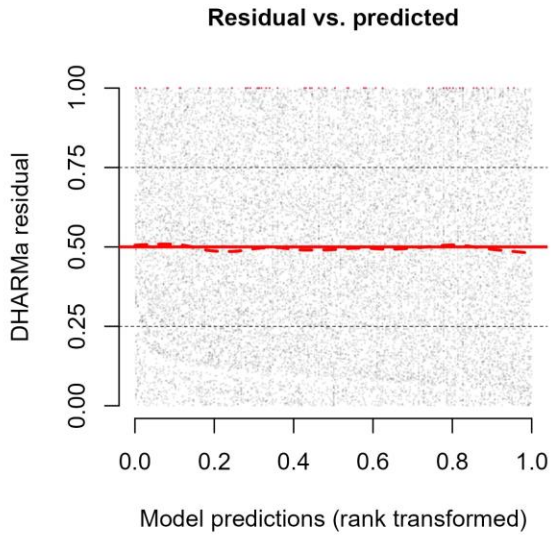


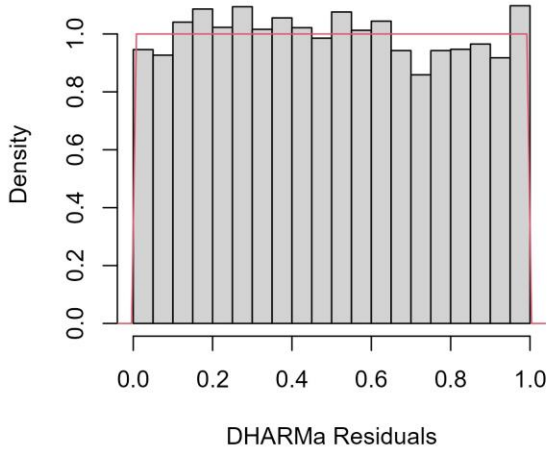




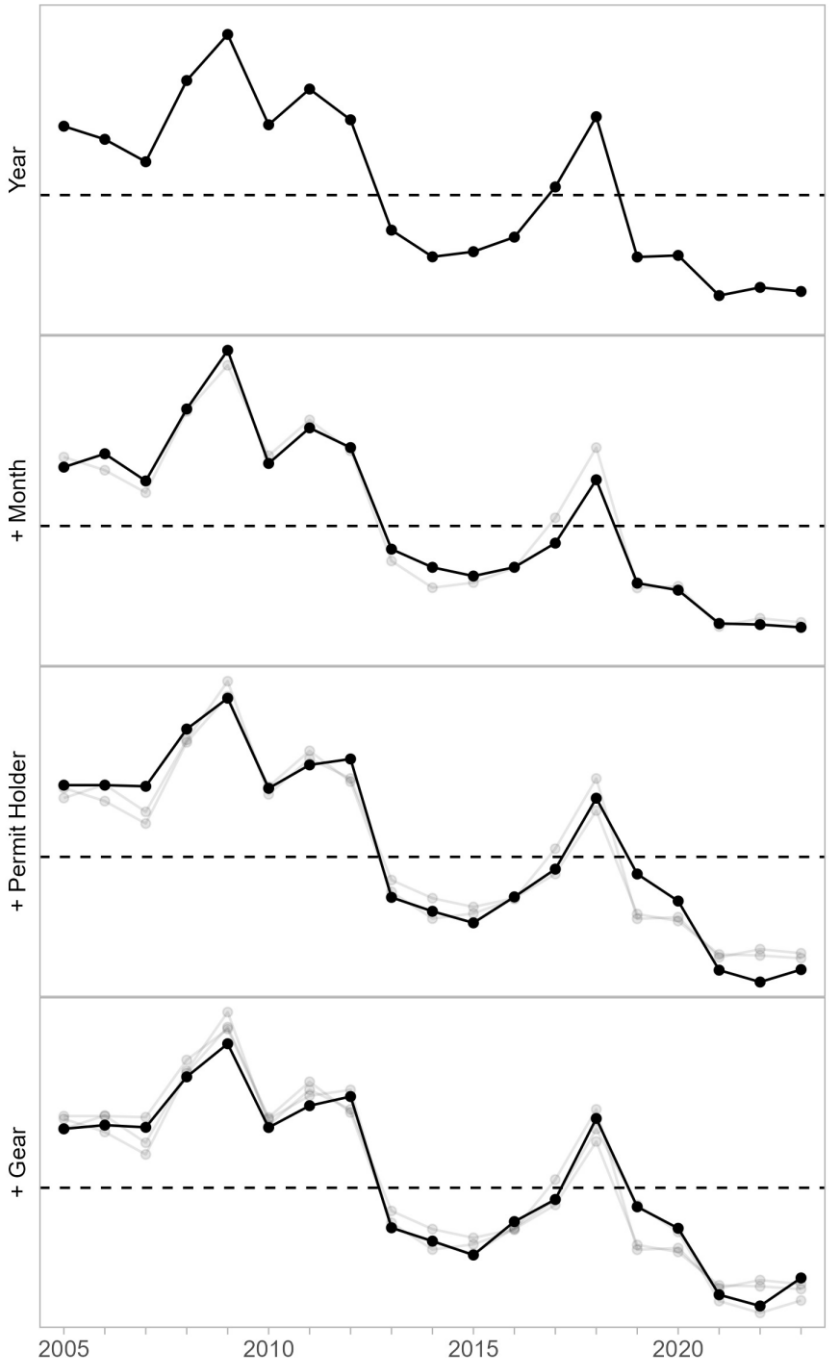
Tweedie (p = 1.495)

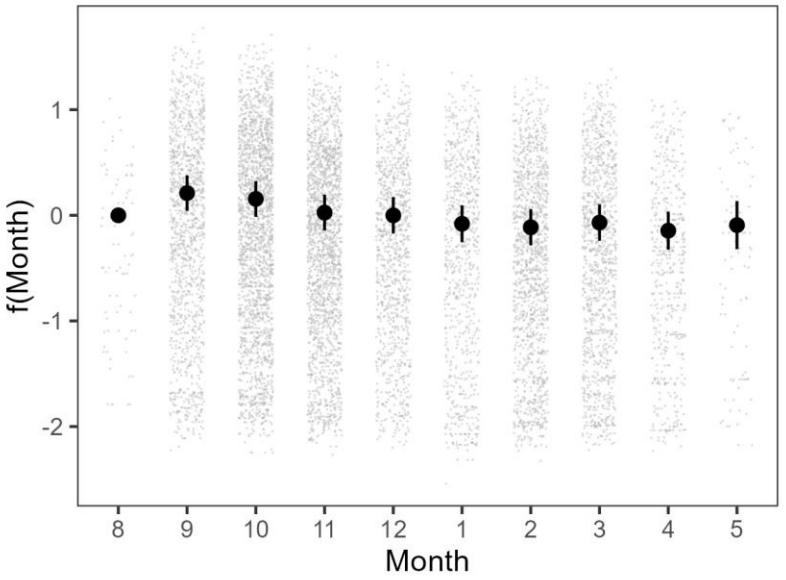


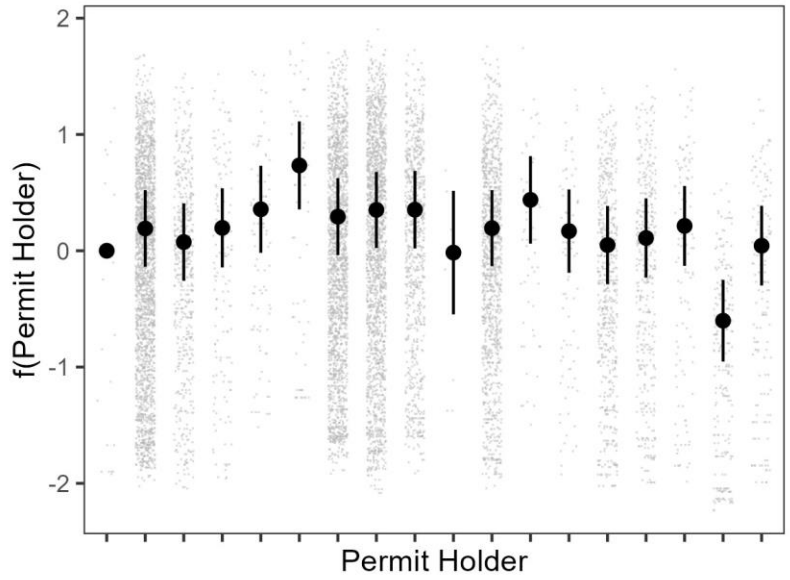


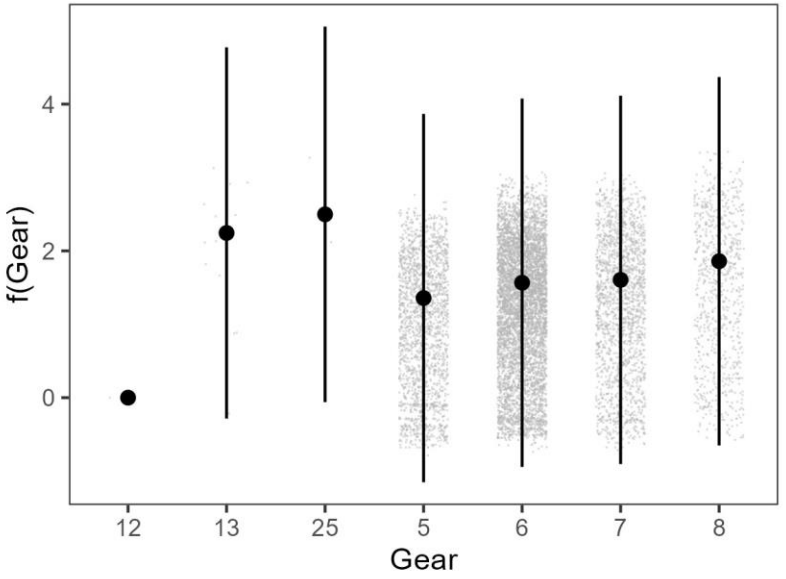


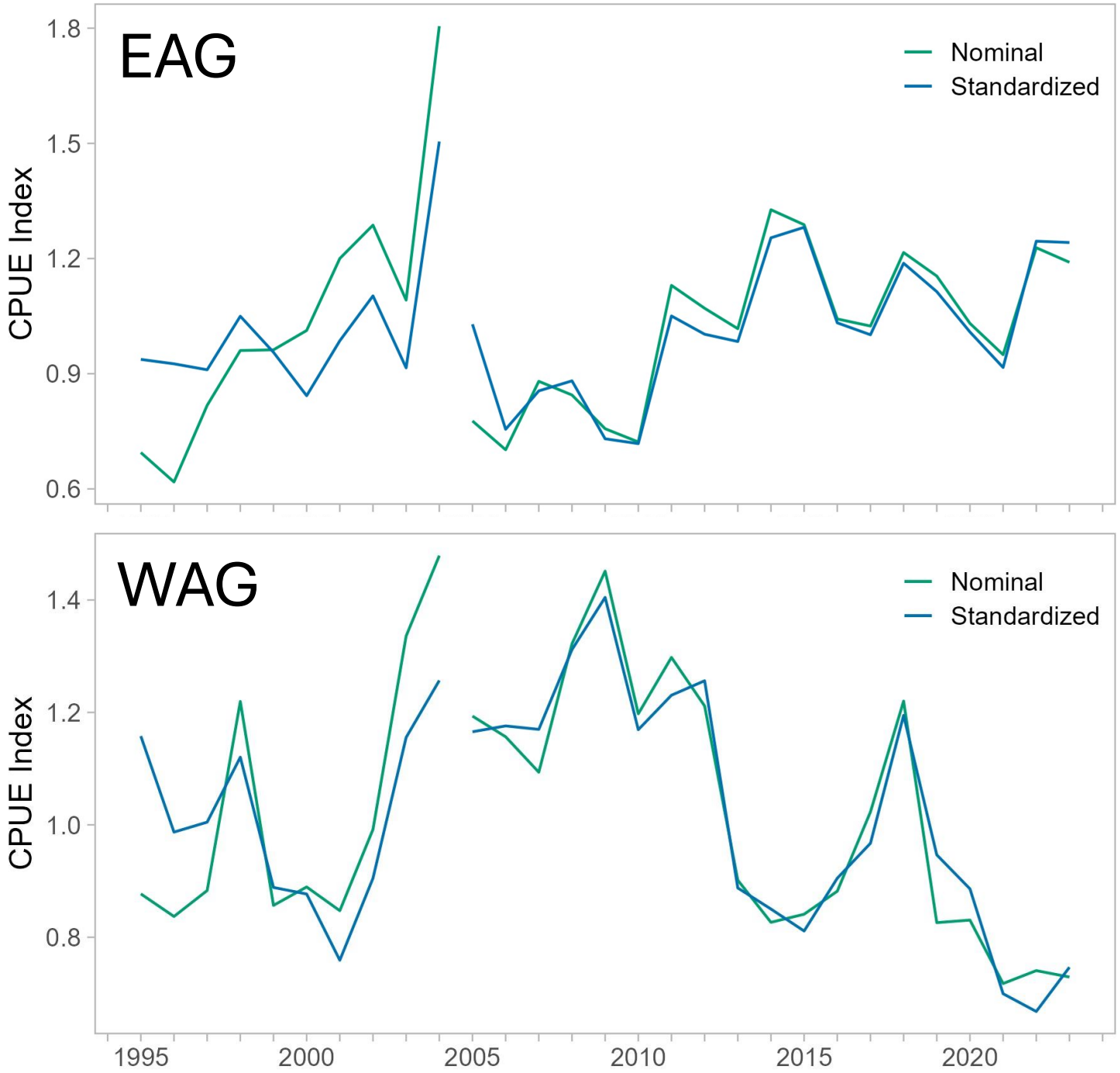
Post-rationalization WAG







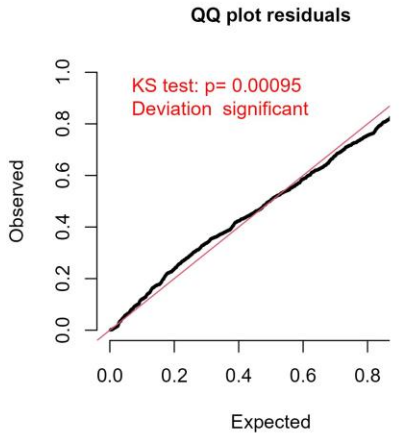


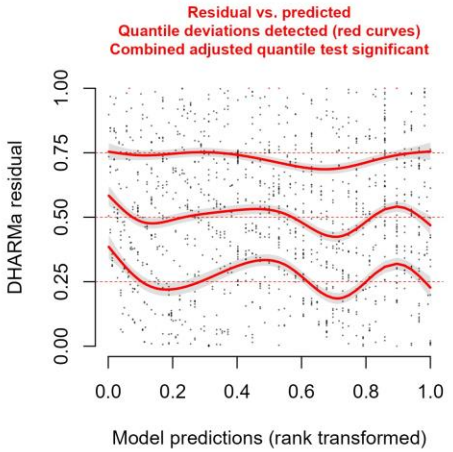

EAG
Nominal
Standardized
CPUE Index
1.8
1.5
1.2
0.9
0.6
WAG
Nominal
Standardized
CPUE Index
1.4
1.2
1.0
0.8
1995
2000
2005
2010
2015
2020

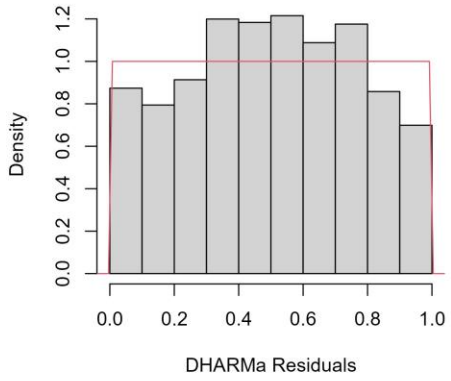
EAG Fish Ticket CPUE 1985 - 1998

Previously had many zeros in data – **issue: deadloss and personal use**

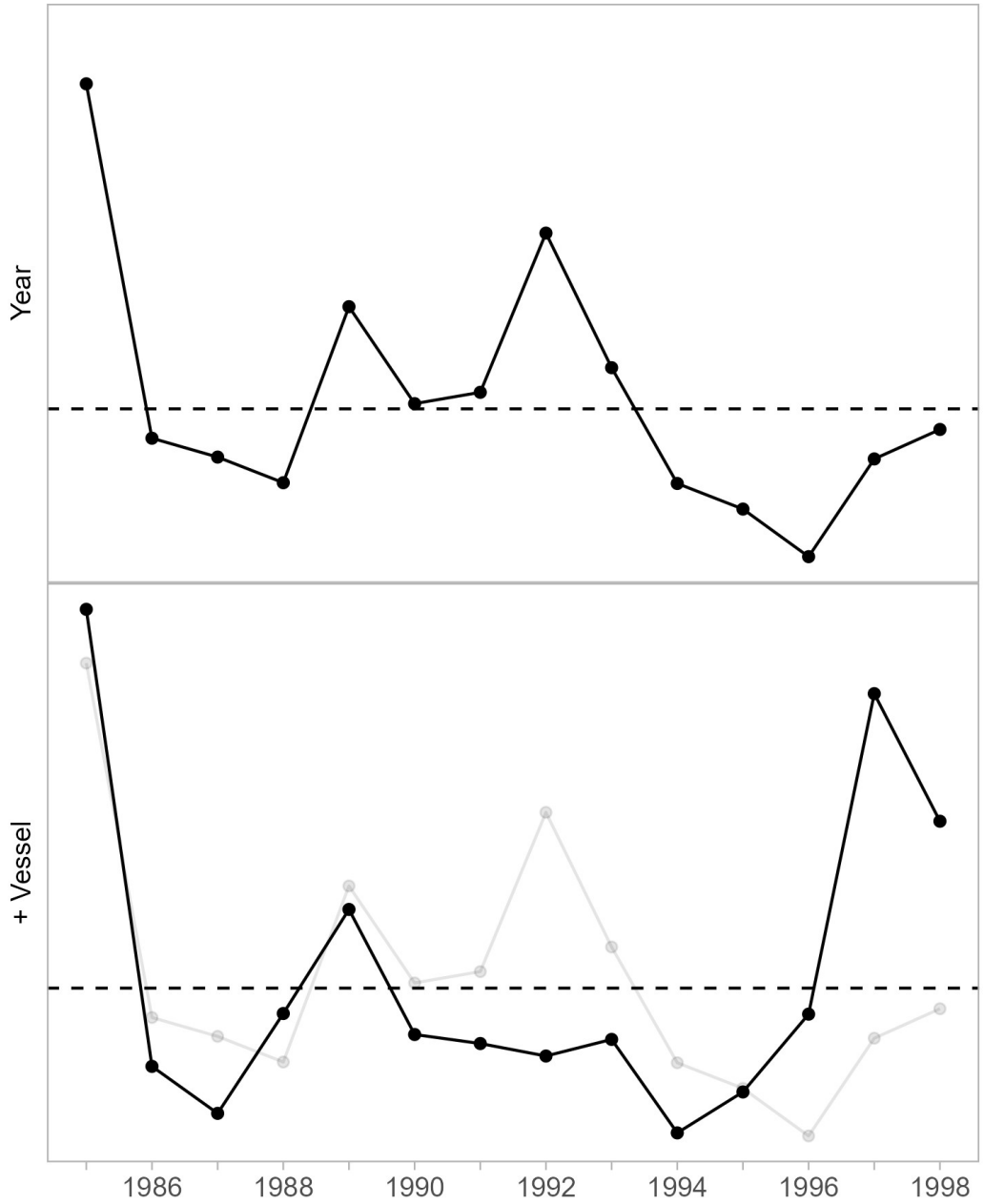
Form ($\theta = 9.169$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + Vessel	1,227	7,152	0.347
+ Month	-11	11	
+ Permit Holder	-13	38	
+ Stat Area	-38	203	

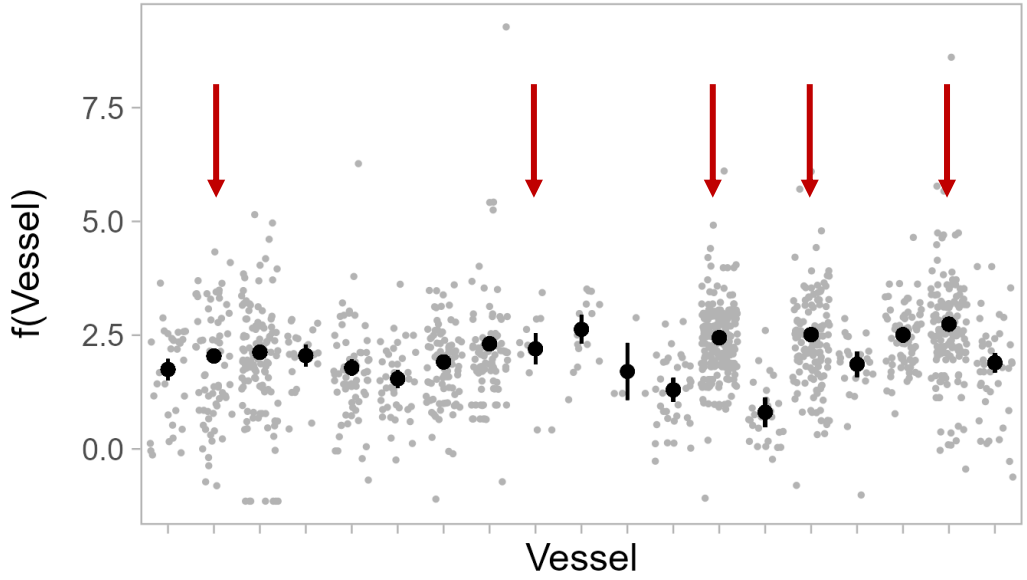


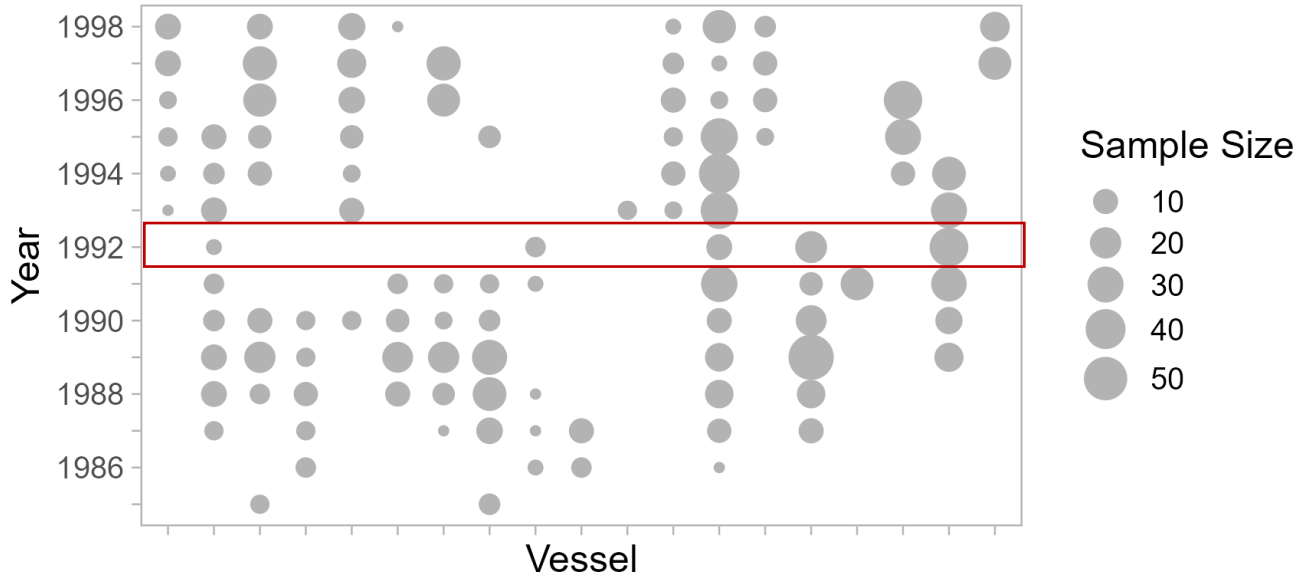




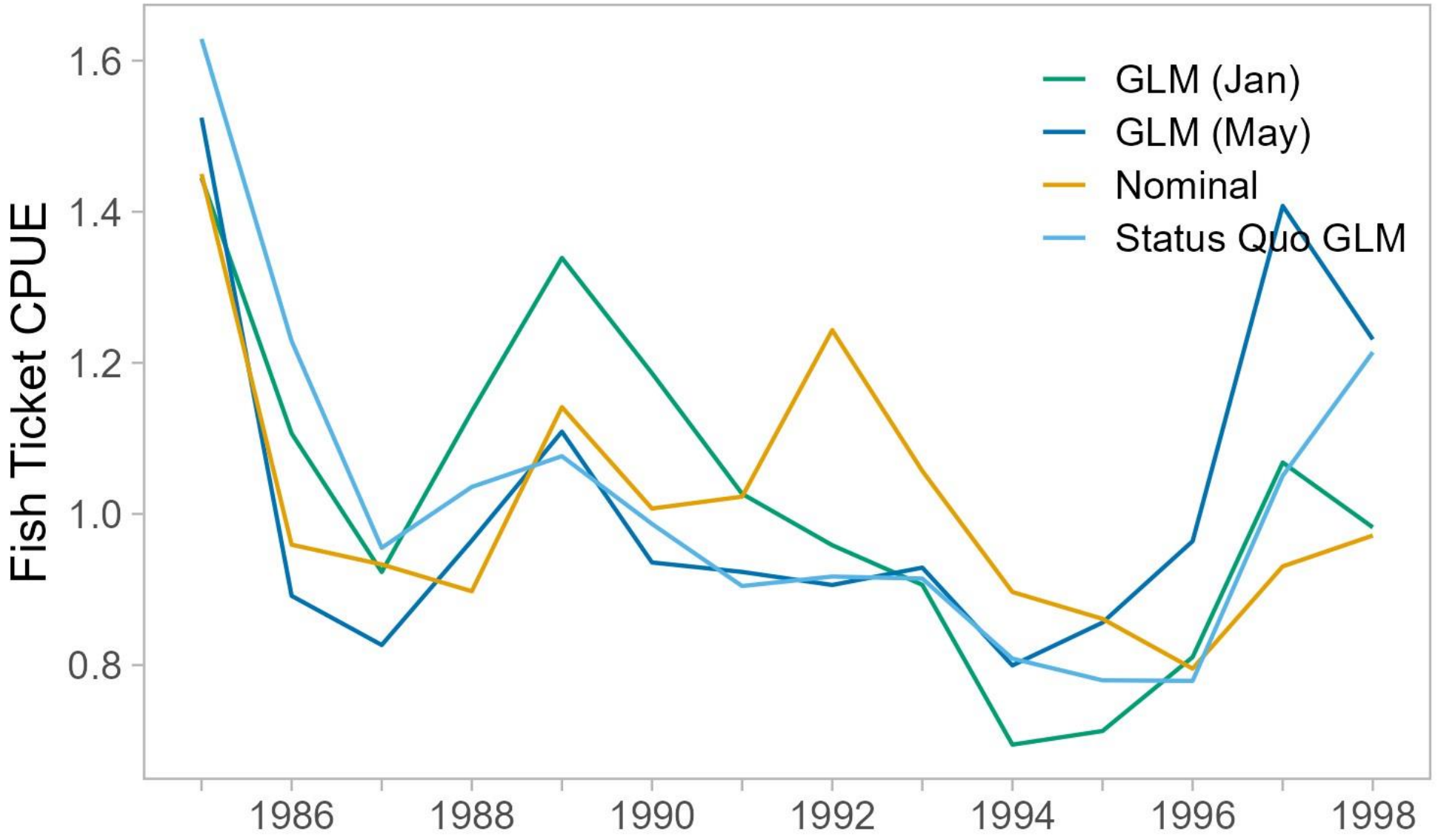
EAG


Year
+ Vessel
1986
1988
1990
1992
1994
1996
1998


f(Vessel)
7.5
5.0
2.5
0.0
Vessel

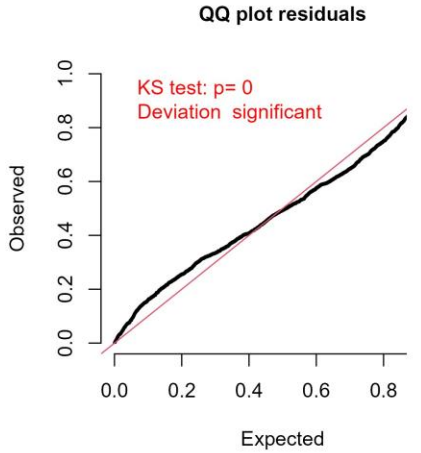

Year
1998
1996
1994
1992
1990
1988
1986
Vessel
Sample Size
10
20
30
40
50

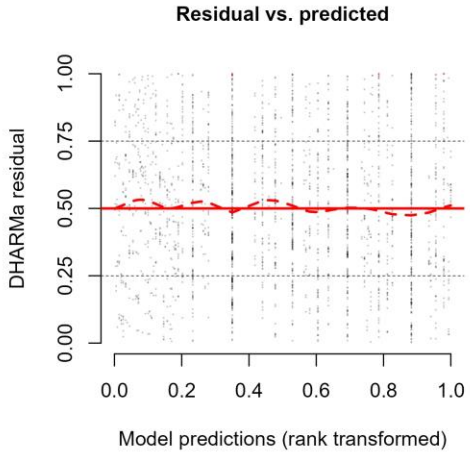
EAG Fish Ticket CPUE

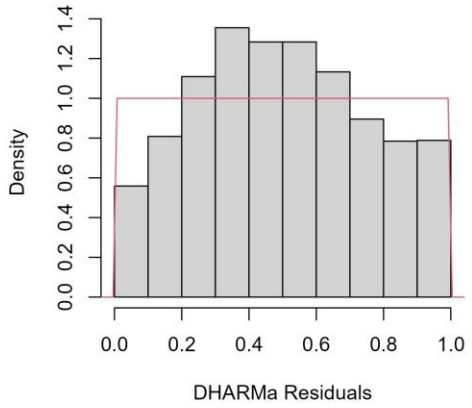


WAG Fish Ticket CPUE 1985 - 1998

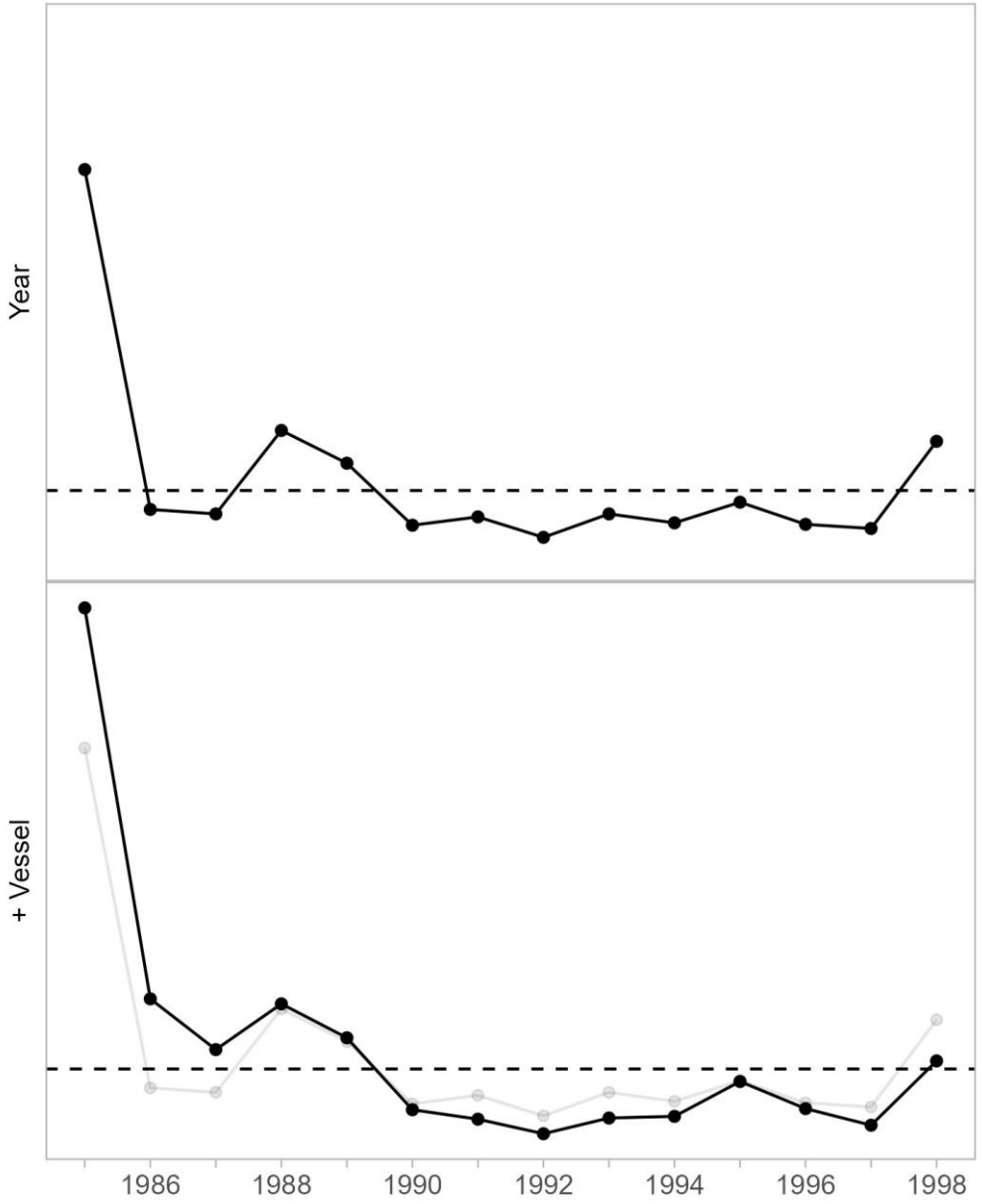
Form ($\theta = 0.88$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + Vessel	2,490	14,935	0.270
+ Month	-11	-6	
+ Permit Holder	-9	26	
+ Stat Area	-88	615	

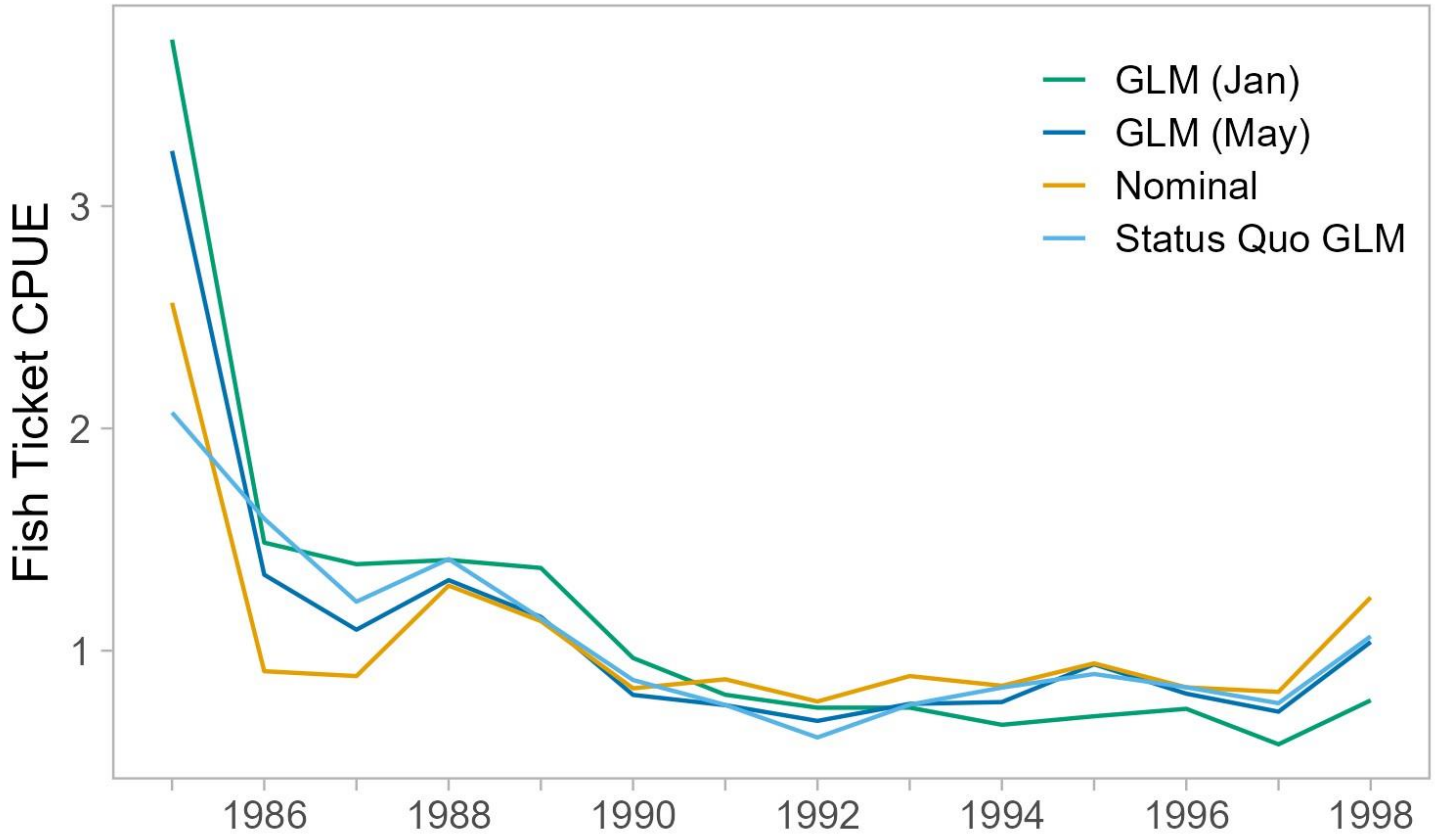






WAG Fish Ticket CPUE





Models

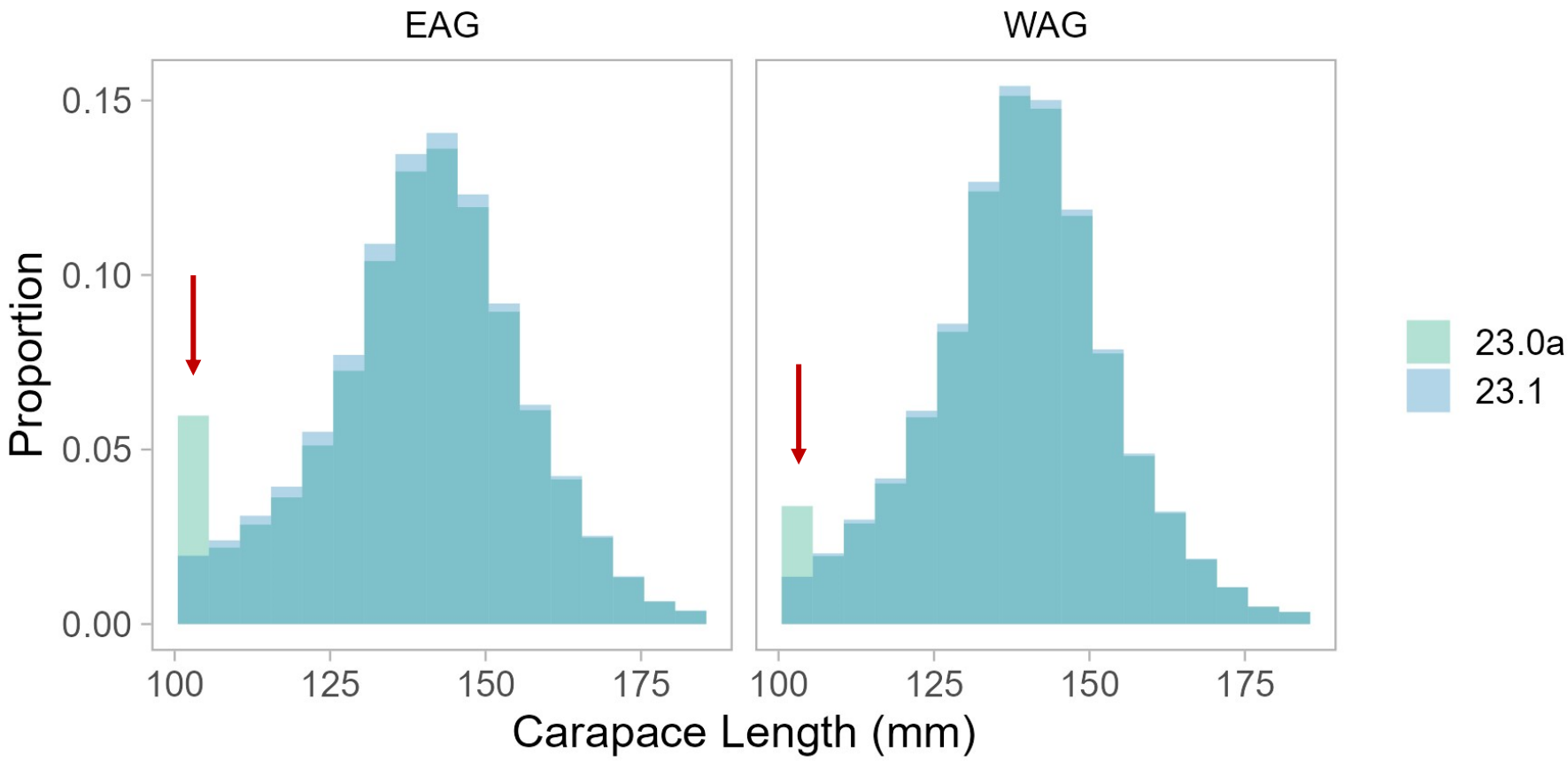
- **23.0a (base model)** – 2023 accepted model 22.1e2 w/:
  - Updated time series data (Jan. document; Appendix A)
  - CPUE standardization using GAMs
  - Only difference from Jan. – groundfish bycatch input to GMACS w/o mortality applied.

- **23.1** – 23.0a + truncated size composition (no minus sizes in smallest bin)

- **23.1b** – 23.1 + two selectivity periods in pre-rationalization (1960 – 1996, 1997 – 2004)

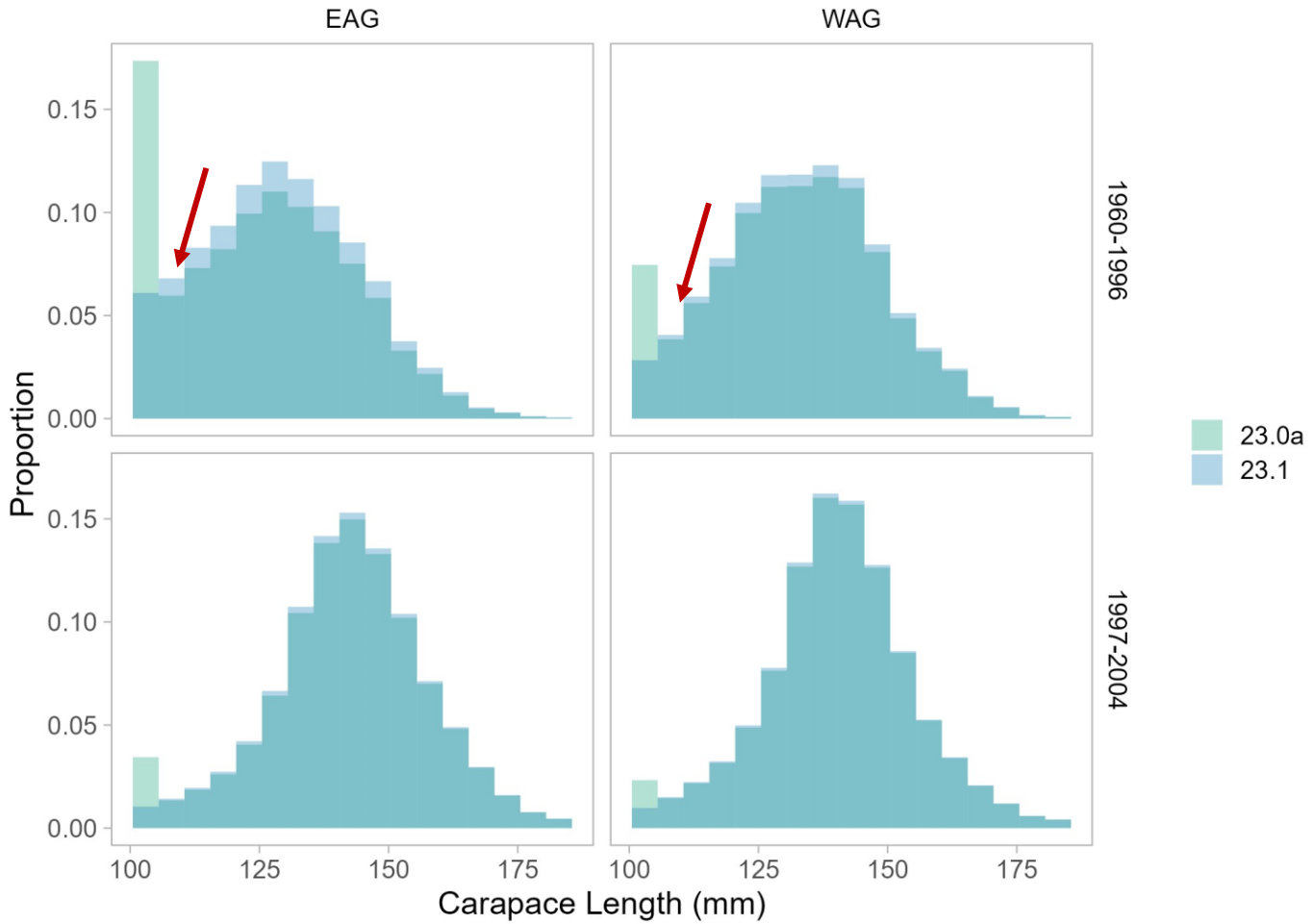
Truncated Size Composition – 23.1

Previously, crab < 101 mm, were grouped in 101-105 mm bin



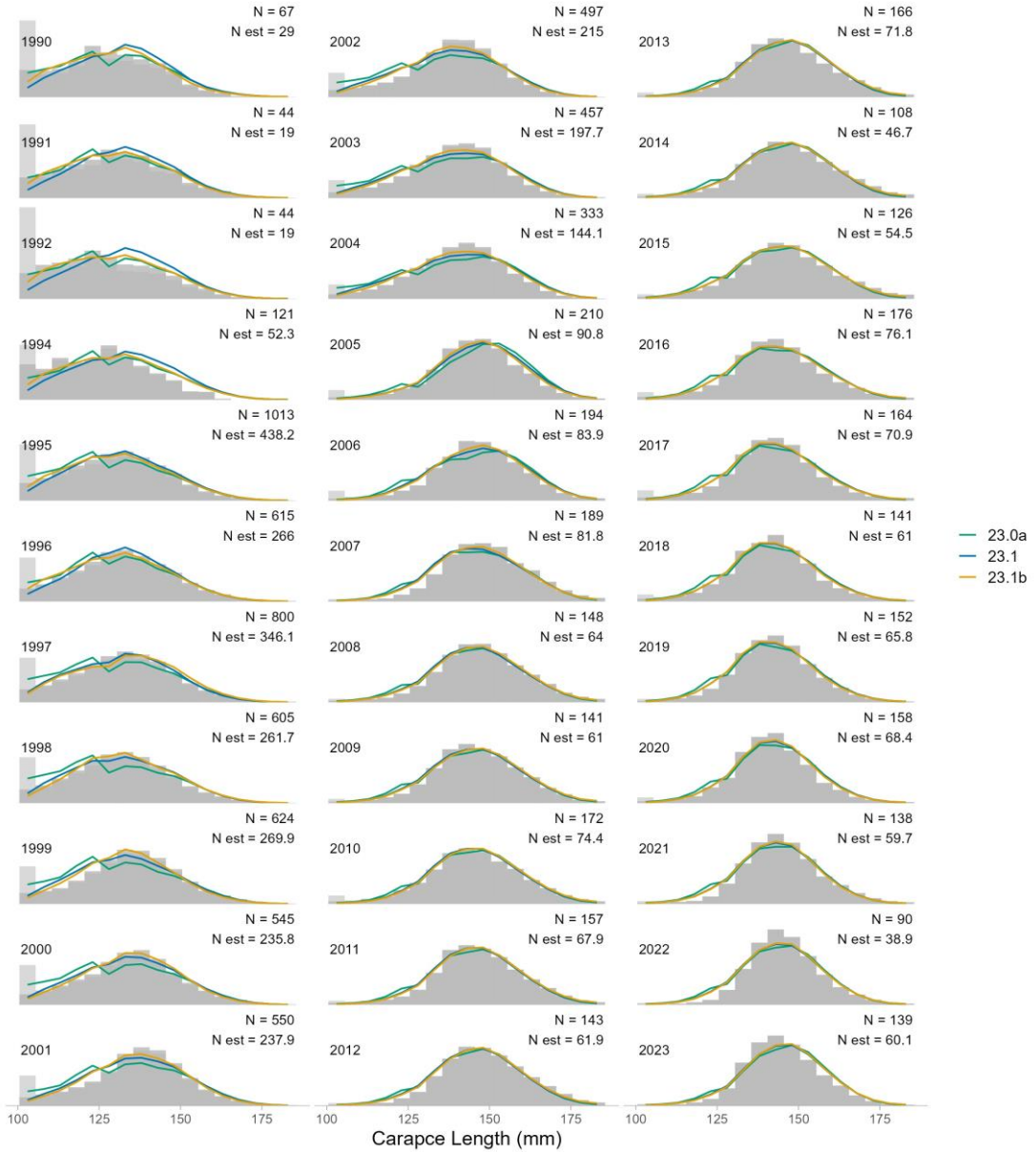
Additional Selectivity Period – 23.1b

Split pre-rationalization into 1960 – 1996 and 1997 - 2004

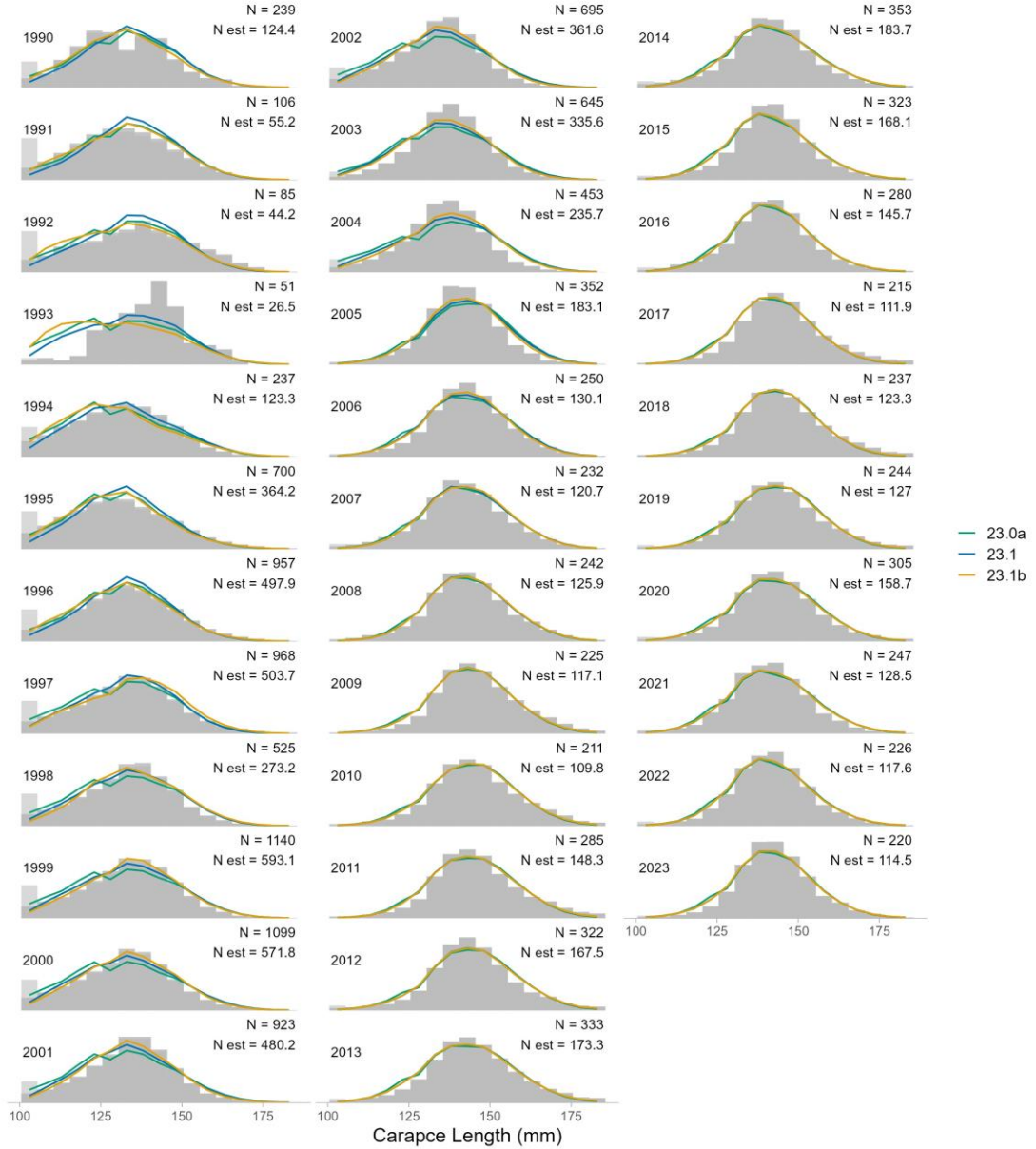


Escape mesh adopted by BOF in 1996 (SOA 5 AAC 34.625(b)(1))

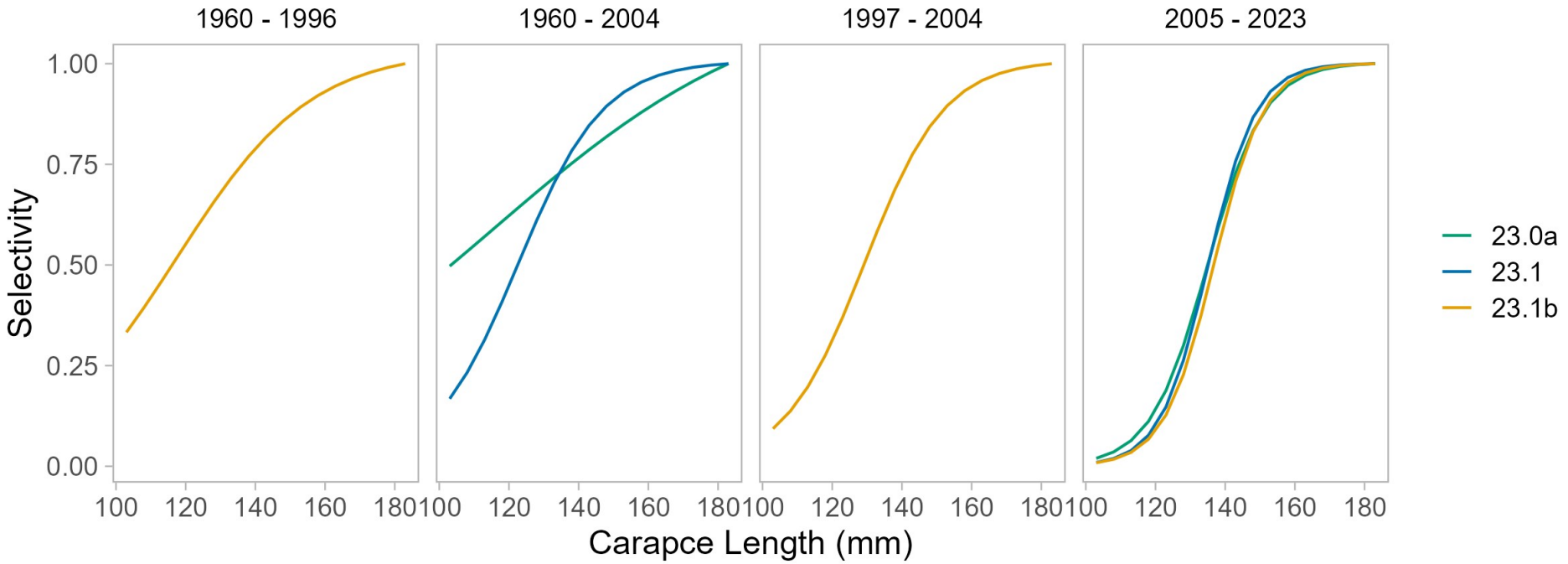
EAG Total Comp



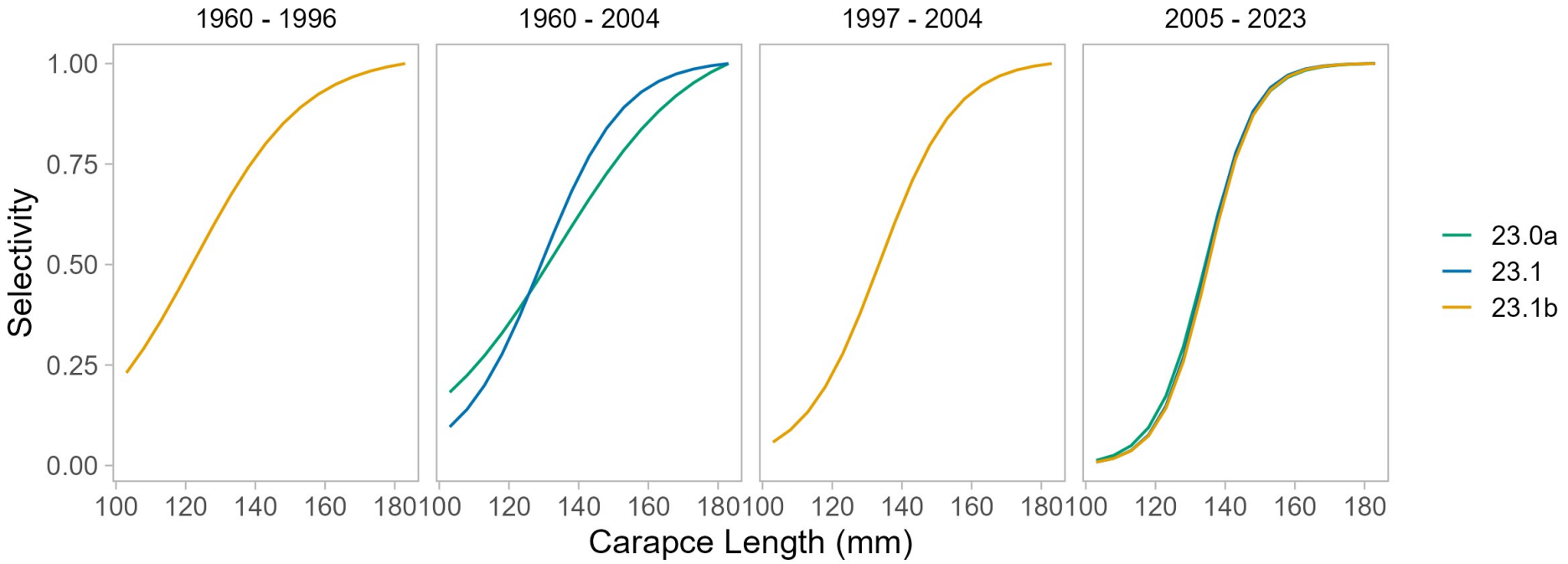
WAG Total Comp



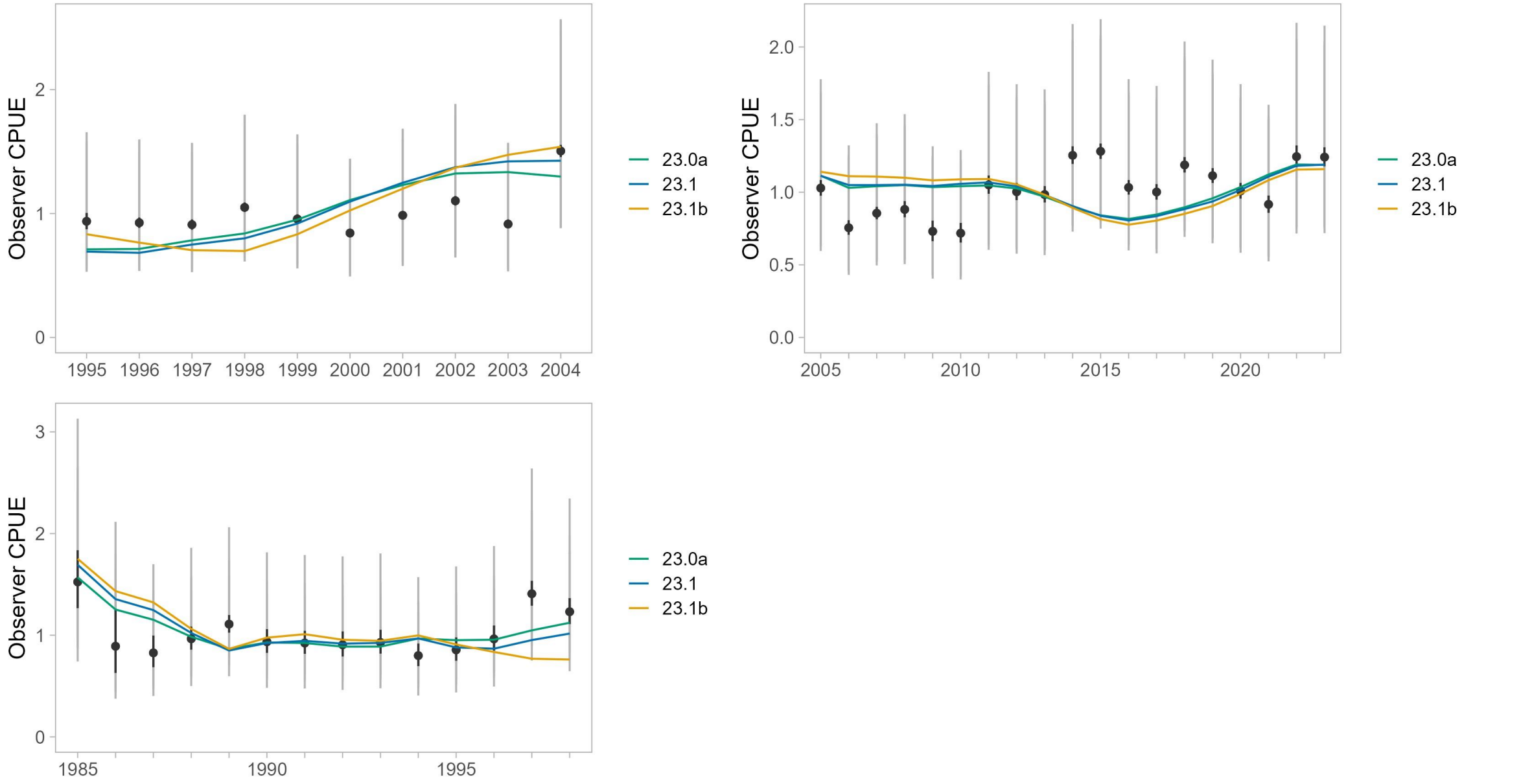
EAG


1960 - 1996
1960 - 2004
1997 - 2004
2005 - 2023
Selectivity
1.00
0.75
0.50
0.25
0.00
100
120
140
160
180
Carapce Length (mm)
23.0a
23.1
23.1b

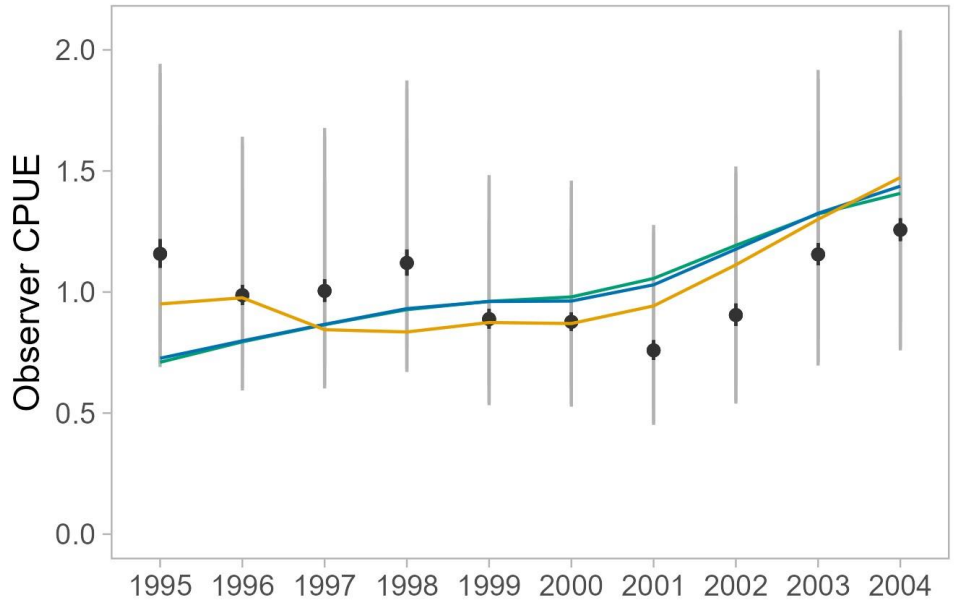
WAG

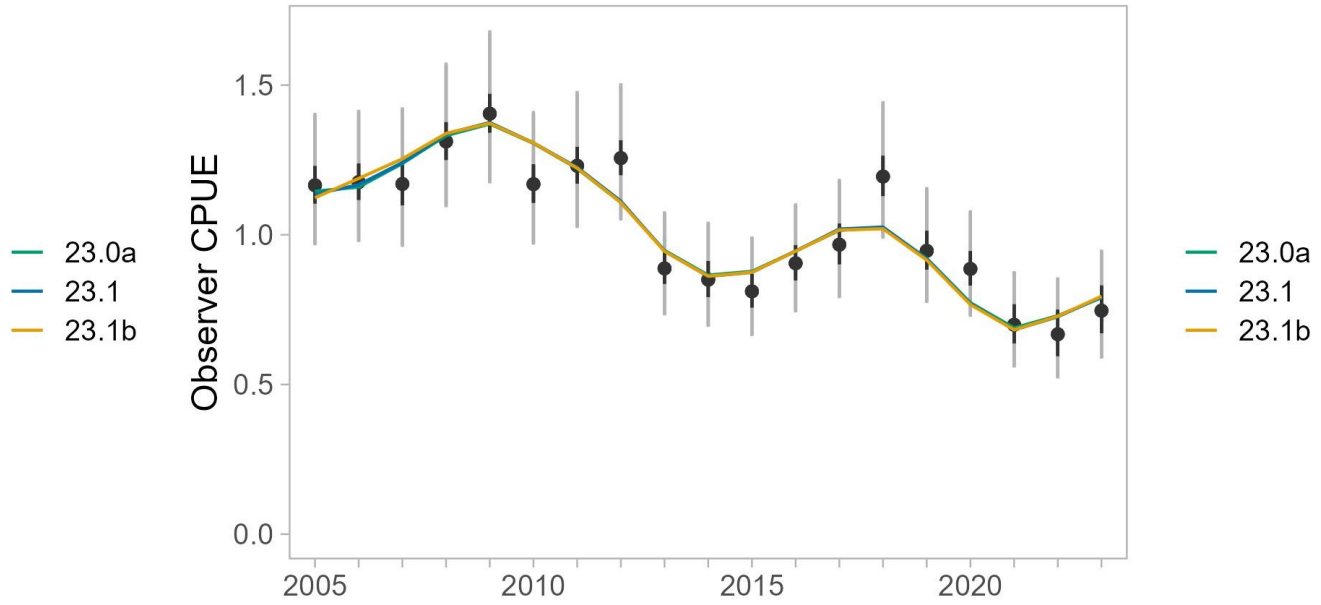

1960 - 1996
1960 - 2004
1997 - 2004
2005 - 2023
Selectivity
1.00
0.75
0.50
0.25
0.00
100
120
140
160
180
Carapce Length (mm)
23.0a
23.1
23.1b

EAG


Observer CPUE
0
1
2
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
23.0a
23.1
23.1b
Observer CPUE
0.0
0.5
1.0
1.5
2.0
2005
2010
2015
2020
23.0a
23.1
23.1b
Observer CPUE
0
1
2
3
1985
1990
1995
23.0a
23.1
23.1b

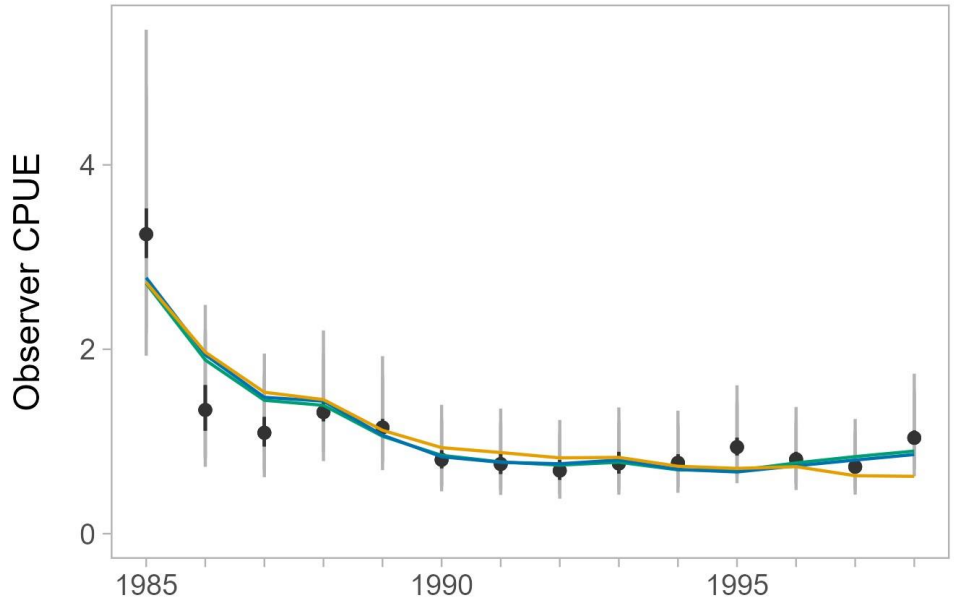
WAG


Observer CPUE
2.0
1.5
1.0
0.5
0.0
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004


23.0a
23.1
23.1b

Observer CPUE
1.5
1.0
0.5
0.0
2005
2010
2015
2020

23.0a
23.1
23.1b


Observer CPUE
4
2
0
1985
1990
1995


23.0a
23.1
23.1b

Table 8: Likelihood components for EAG models.

Component	23.0a	23.1	23.1b
Retained Catch	-435.036	-434.809	-434.666
Total Catch	-68.775	-68.389	-67.651
GF Bycatch	30.343	30.341	30.339
Observer CPUE 1995-2004	-9.623	-8.544	-8.633
Observer CPUE 2005-2023	-18.961	-18.452	-16.383
Fish Ticket CPUE 1985-1998	-17.985	-14.821	-10.227
Retained Size Composition	532.534	461.122	366.593
Total Size Composition	504.408	380.729	215.223
Recruitment	19.957	19.447	20.441
Tagging	2,698.889	2,694.969	2,694.856
Number of Parameters	161	161	163
Total NLL	3,261.626	3,067.467	2,823.078
AIC	6,845.252	6,456.935	5,972.156

Table 9: Likelihood components for WAG models.

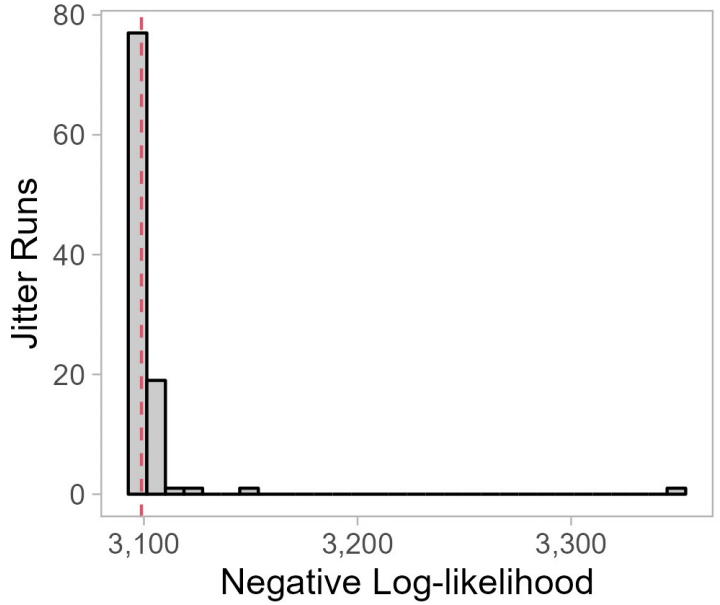
Component	23.0a	23.1	23.1b
Retained Catch	-432.406	-431.919	-433.179
Total Catch	-38.275	-31.113	-53.828
GF Bycatch	28.491	28.492	28.490
Observer CPUE 1995-2004	-9.251	-9.677	-12.912
Observer CPUE 2005-2023	-39.949	-39.995	-40.889
Fish Ticket CPUE 1985-1998	-18.073	-17.149	-14.576
Retained Size Composition	543.213	489.609	458.046
Total Size Composition	416.625	280.016	417.273
Recruitment	21.724	21.844	23.311
Tagging	2,700.861	2,698.615	2,693.998
Number of Parameters	159	159	161
Total NLL	3,198.743	3,014.507	3,098.832
AIC	6,715.486	6,347.013	6,519.665

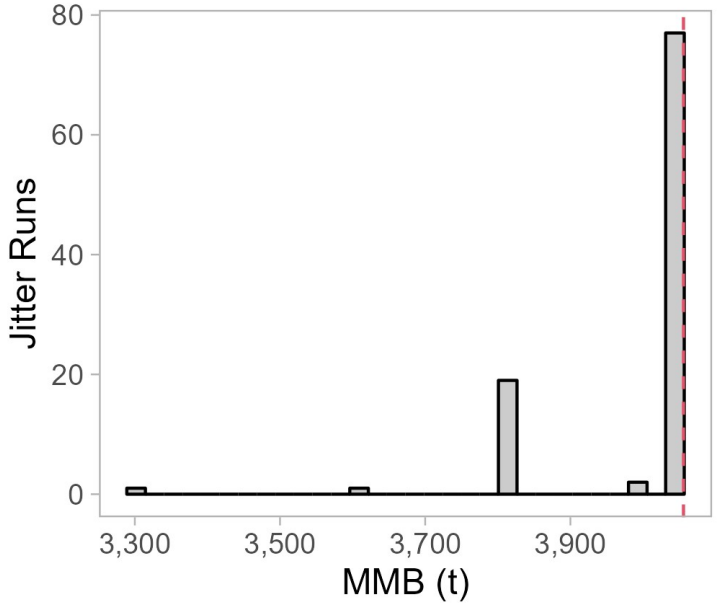
WAG 23.1b

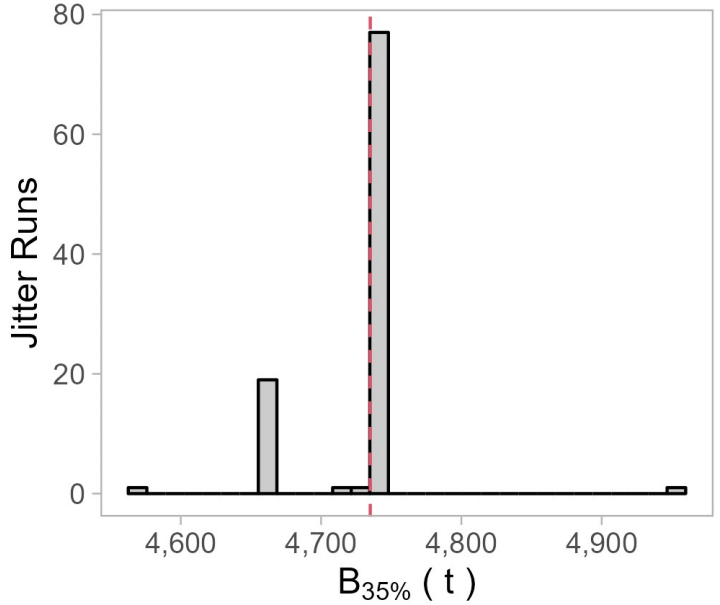
Jittering
- 100 runs
- Jitter factor = 0.3

Re-ran WAG 23.1b, estimating only selectivity 1997-2004
- *Same issue*

Re-ran WAG 23.1b, using Francis wts from 23.1
- *Resolved*







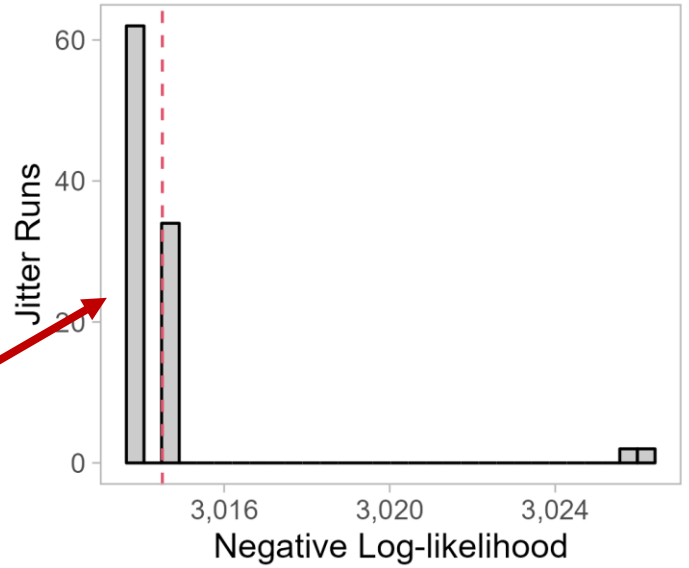
Component	23.1	23.1b	23.1b (23.1 wts)
Retained Catch	-431.919	-433.179	-432.448
Total Catch	-31.113	-53.828	-43.357
GF Bycatch	28.492	28.490	28.490
Observer CPUE 1995-2004	-9.677	-12.912	-12.808
Observer CPUE 2005-2023	-39.995	-40.889	-39.396
Fish Ticket CPUE 1985-1998	-17.149	-14.576	-13.346
Retained Size Composition	489.609	458.046	485.537
Total Size Composition	280.016	417.273	254.820
Recruitment	21.844	23.311	22.968
Tagging	2,698.615	2,693.998	2,696.683
Number of Parameters	159	161	161
Total NLL	3,014.507	3,098.832	2,980.238
AIC	6,347.013	6,519.665	6,282.475

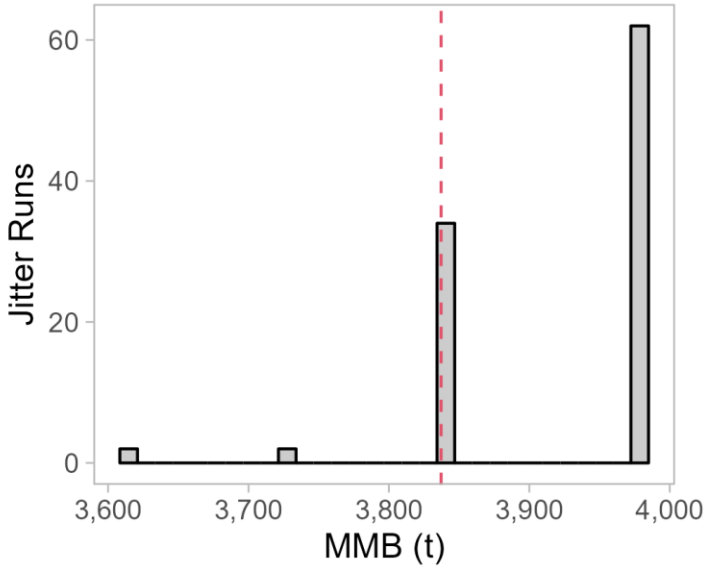
Jittering WAG 23.1

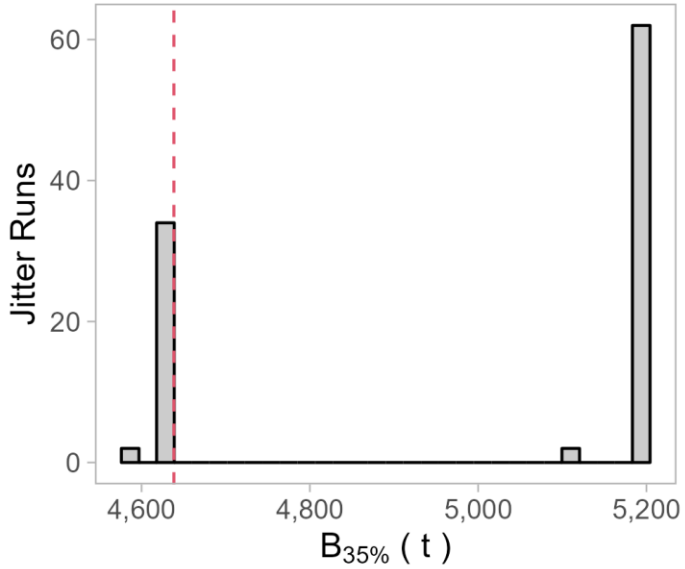
- 100 Jitter Runs
- Jitter factor – 0.3

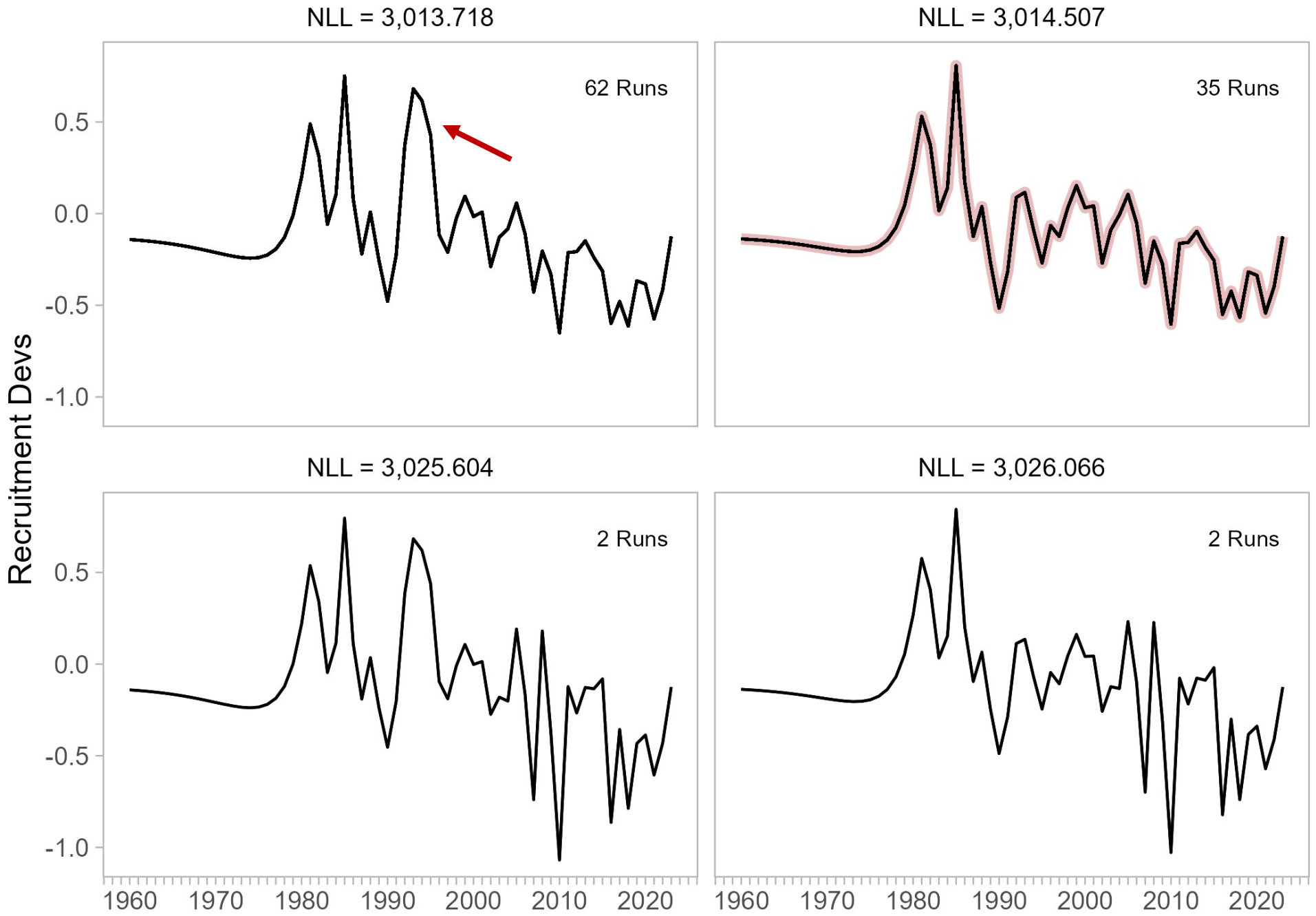
- 66 runs not at MLE
  - Not a suitable outcome

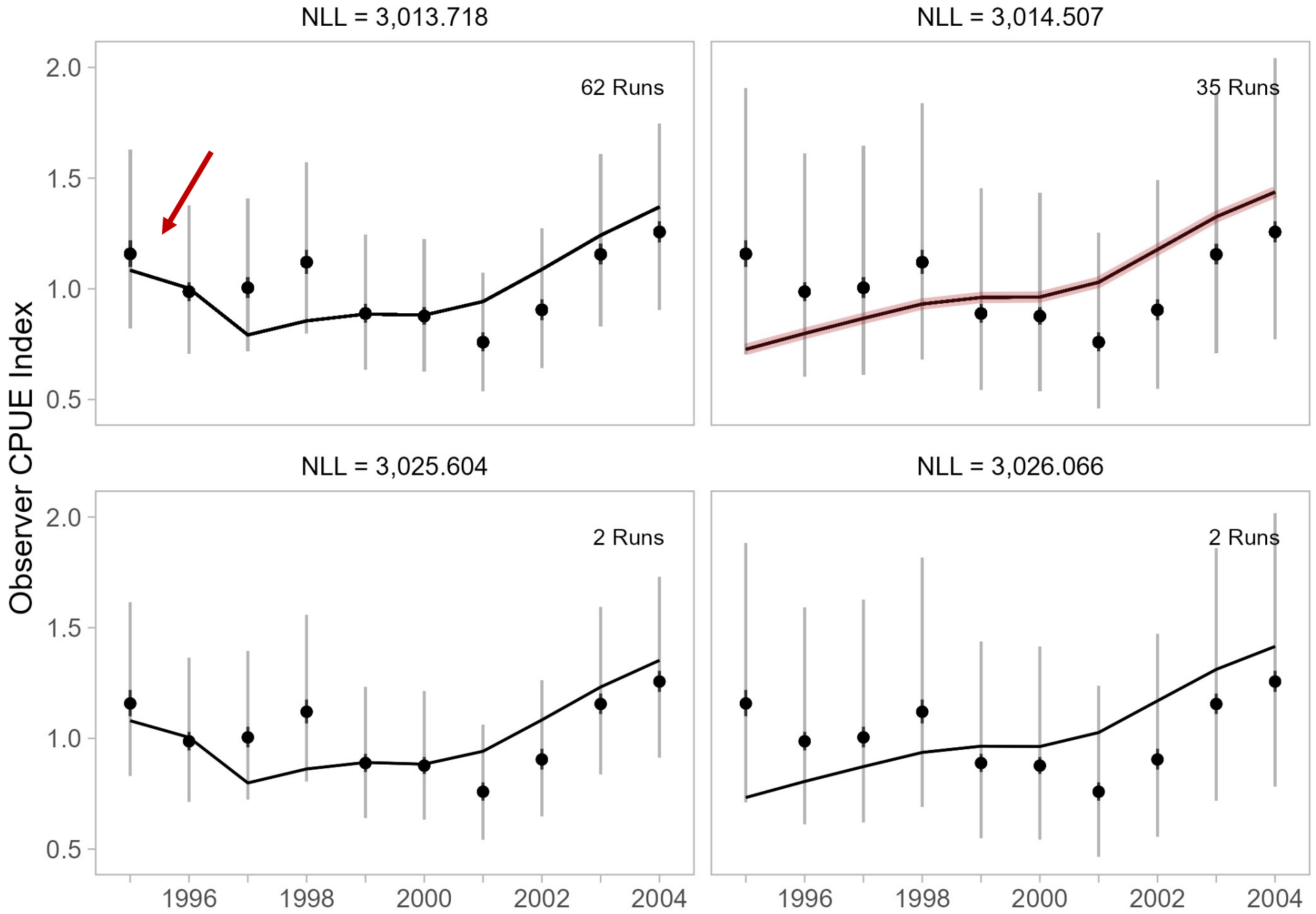
- 34 runs at MLE

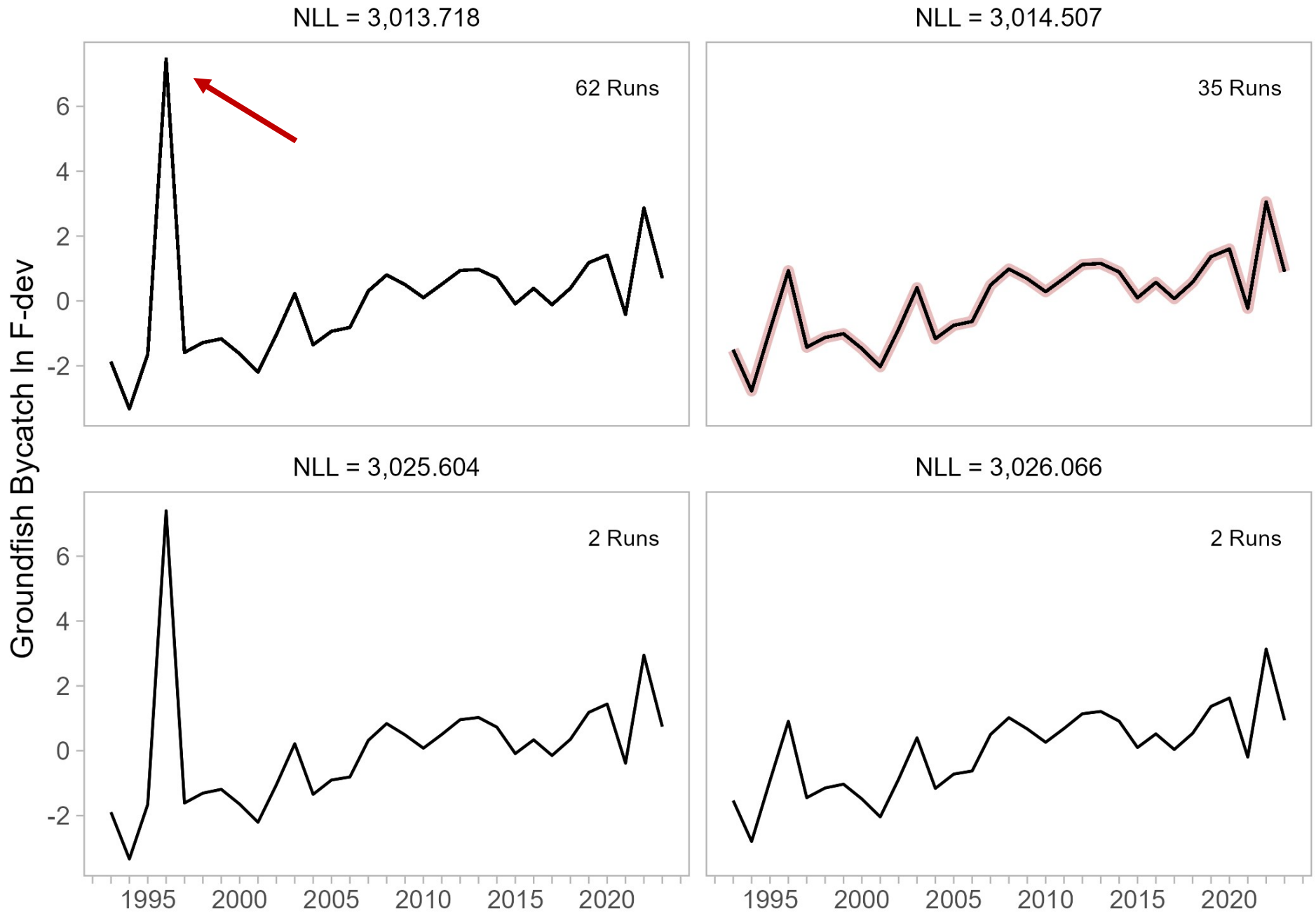


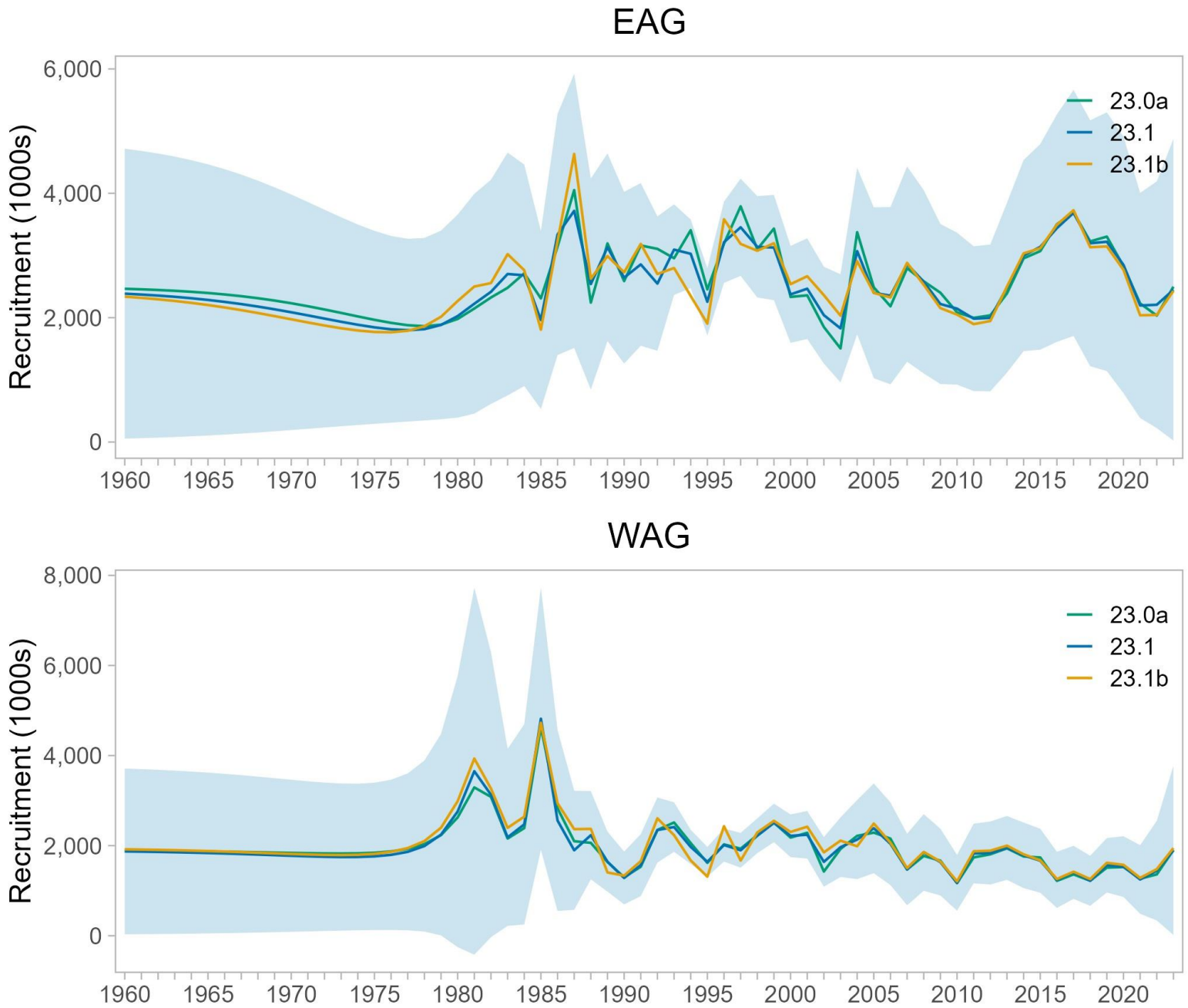


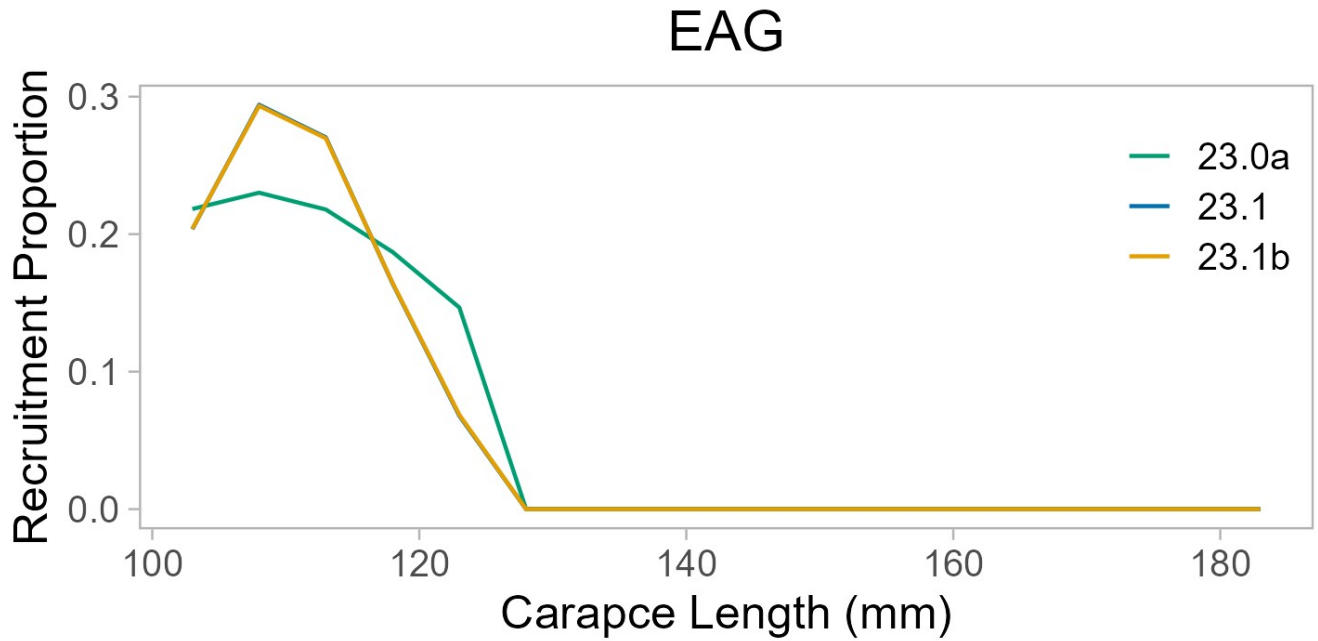


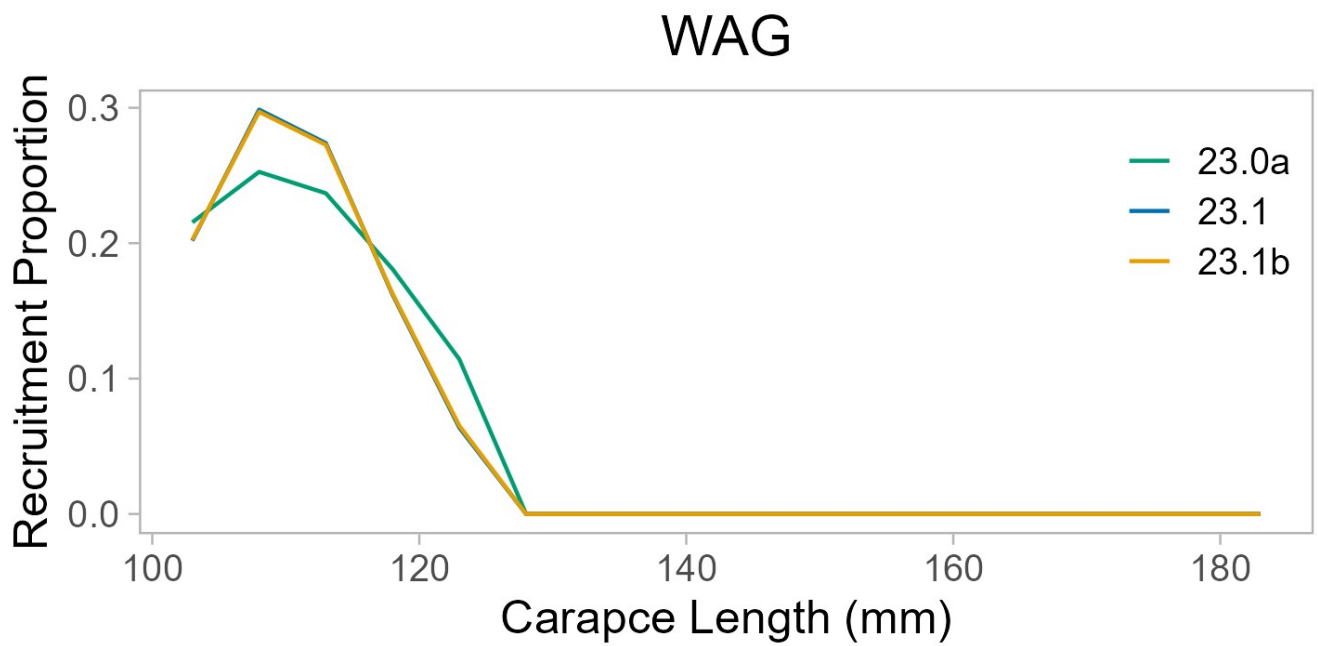

NLL = 3,013.718
62 Runs
NLL = 3,014.507
35 Runs
NLL = 3,025.604
2 Runs
NLL = 3,026.066
2 Runs
Recruitment Devs
0.5
0.0
-0.5
-1.0
1960
1970
1980
1990
2000
2010
2020

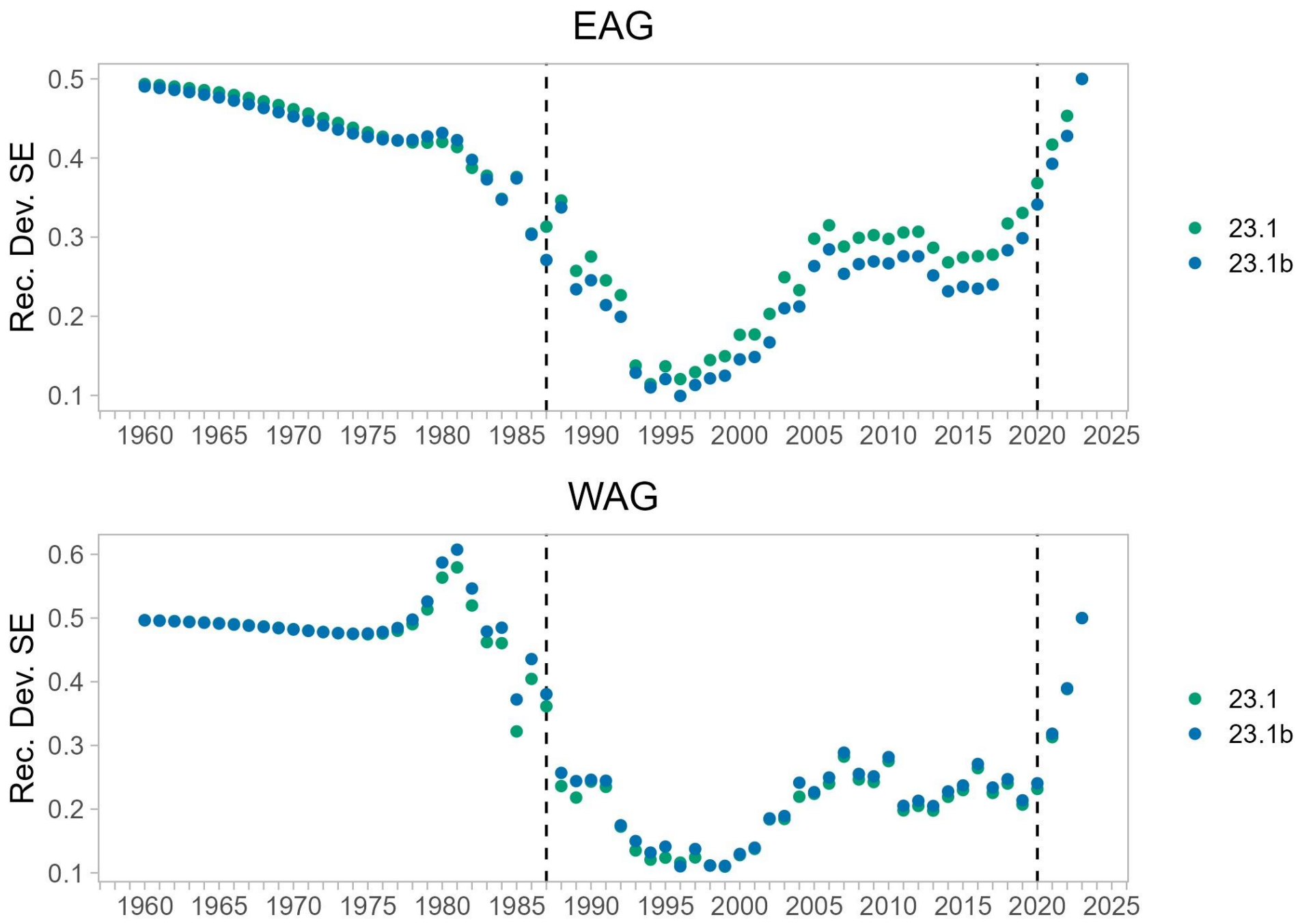

NLL = 3,013.718
62 Runs
NLL = 3,014.507
35 Runs
NLL = 3,025.604
2 Runs
NLL = 3,026.066
2 Runs
Observer CPUE Index
2.0
1.5
1.0
0.5
1996
1998
2000
2002
2004

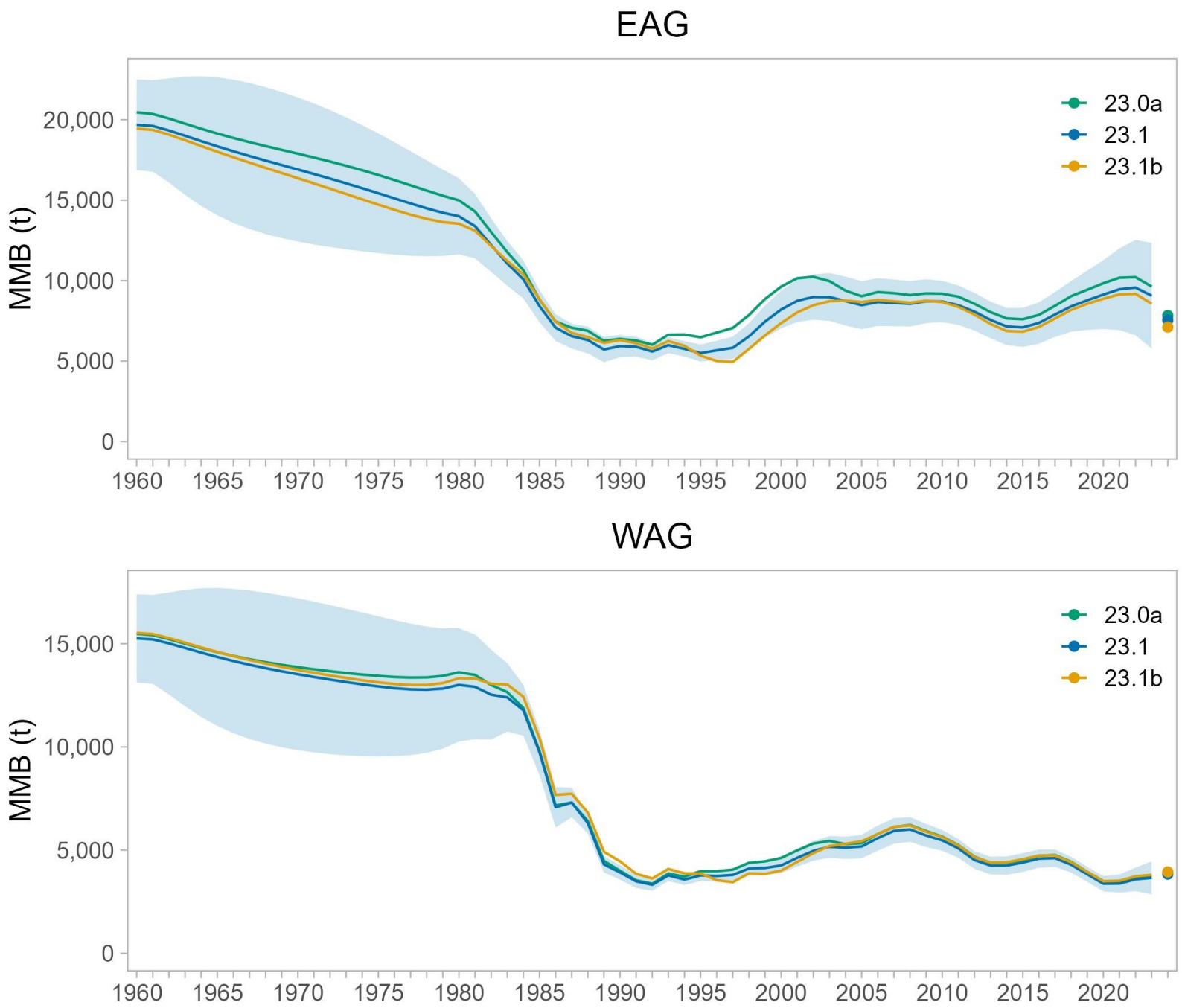

NLL = 3,013.718
62 Runs
NLL = 3,014.507
35 Runs
NLL = 3,025.604
2 Runs
NLL = 3,026.066
2 Runs
Groundfish Bycatch ln F-dev
6
4
2
0
-2
1995
2000
2005
2010
2015
2020


EAG
Recruitment (1000s)
6,000
4,000
2,000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
23.0a
23.1
23.1b
WAG
Recruitment (1000s)
8,000
6,000
4,000
2,000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
23.0a
23.1
23.1b

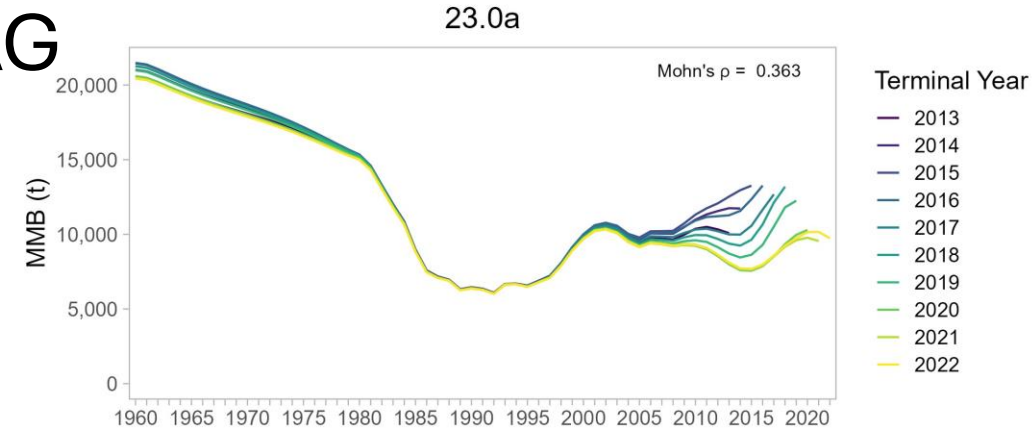

EAG
Recruitment Proportion
0.3
0.2
0.1
0.0
100
120
140
160
180
Carapce Length (mm)
23.0a
23.1
23.1b

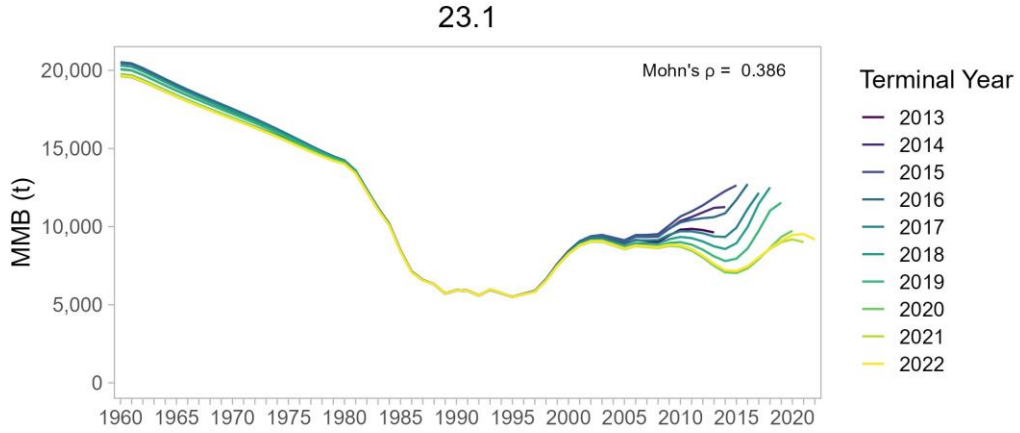

WAG
Recruitment Proportion
0.3
0.2
0.1
0.0
100
120
140
160
180
Carapce Length (mm)
23.0a
23.1
23.1b

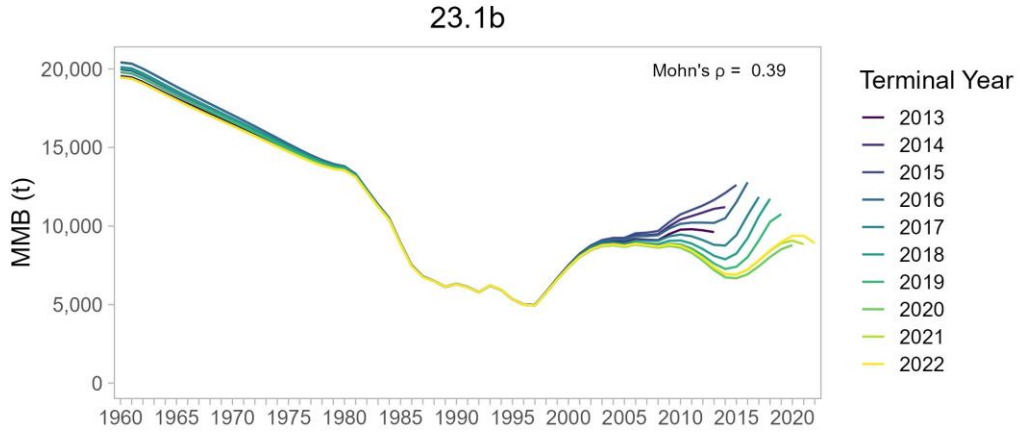

EAG
Rec. Dev. SE
0.5
0.4
0.3
0.2
0.1
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
23.1
23.1b
WAG
Rec. Dev. SE
0.6
0.5
0.4
0.3
0.2
0.1
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
2025
23.1
23.1b


EAG
MMB (t)
20,000
15,000
10,000
5,000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
23.0a
23.1
23.1b
WAG
MMB (t)
15,000
10,000
5,000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
23.0a
23.1
23.1b

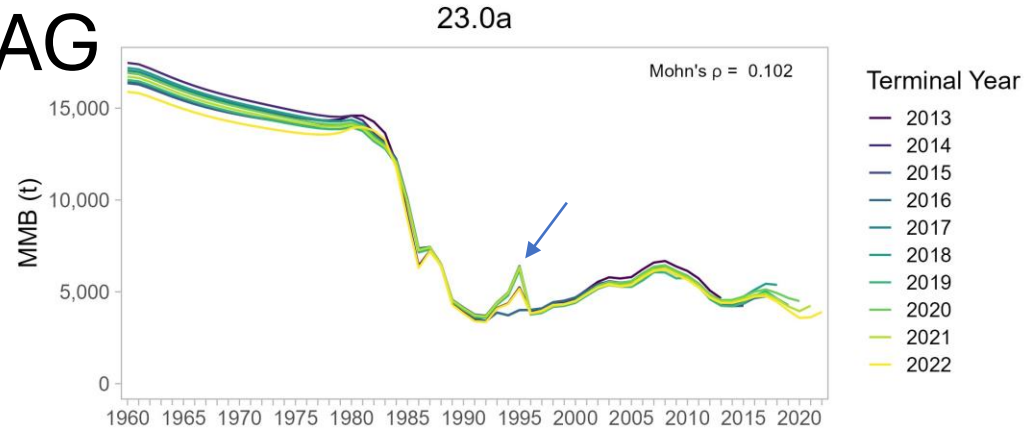
EAG

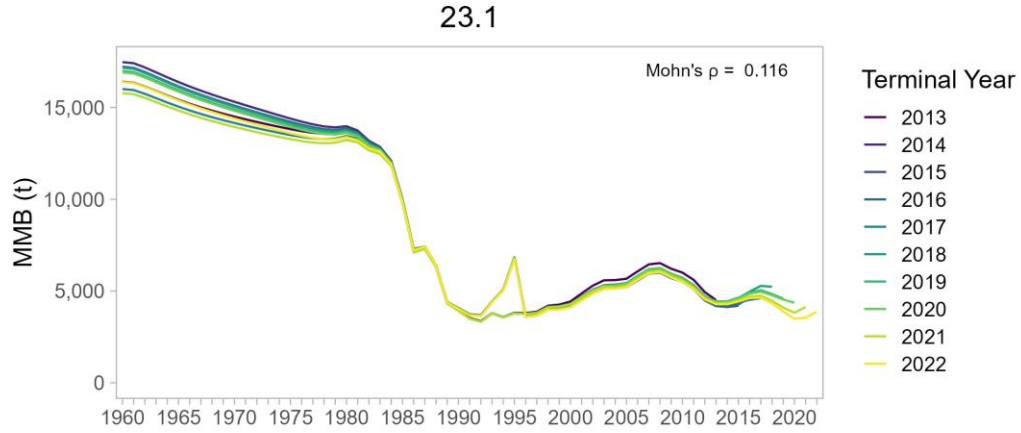

23.0a
Mohn's ρ = 0.363
MMB (t)
20,000
15,000
10,000
5,000
0
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
Terminal Year
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022


23.1
Mohn's ρ = 0.386
MMB (t)
20,000
15,000
10,000
5,000
0
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
Terminal Year
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022


23.1b
Mohn's ρ = 0.39
MMB (t)
20,000
15,000
10,000
5,000
0
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
Terminal Year
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

WAG


23.0a
Mohn's ρ = 0.102
MMB (t)
15,000
10,000
5,000
0
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
Terminal Year
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022


23.1
Mohn's ρ = 0.116
MMB (t)
15,000
10,000
5,000
0
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
Terminal Year
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

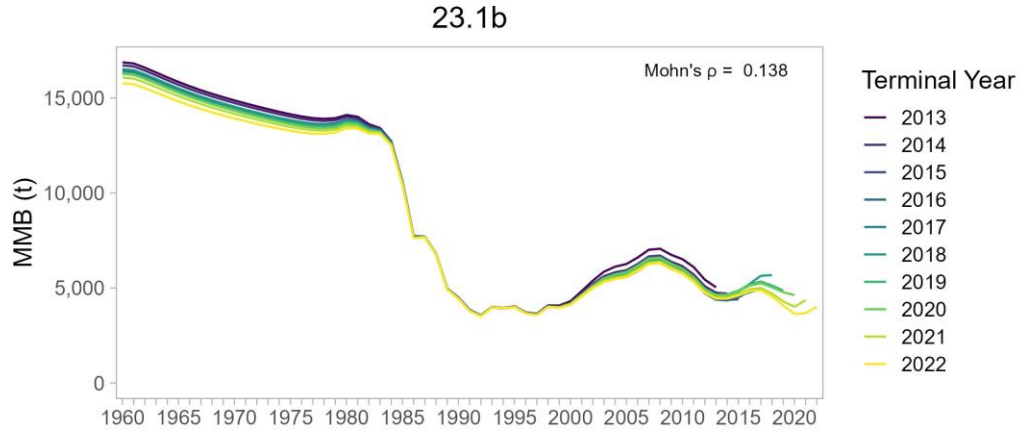

23.1b
Mohn's ρ = 0.138
MMB (t)
15,000
10,000
5,000
0
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020
Terminal Year
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

Table 14: Comparison of biological reference points for EAG models.

Model	MMB (t)	$B_{35\%}$ (t)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2017}$	$F_{35\%}$	F_{OFL}	OFL (t)
23.0a	7,834	7,138	1.10	2,822	0.55	0.55	3,035
23.1	7,551	6,905	1.09	2,781	0.55	0.55	2,825
23.1b	7,112	6,906	1.03	2,795	0.59	0.59	2,699

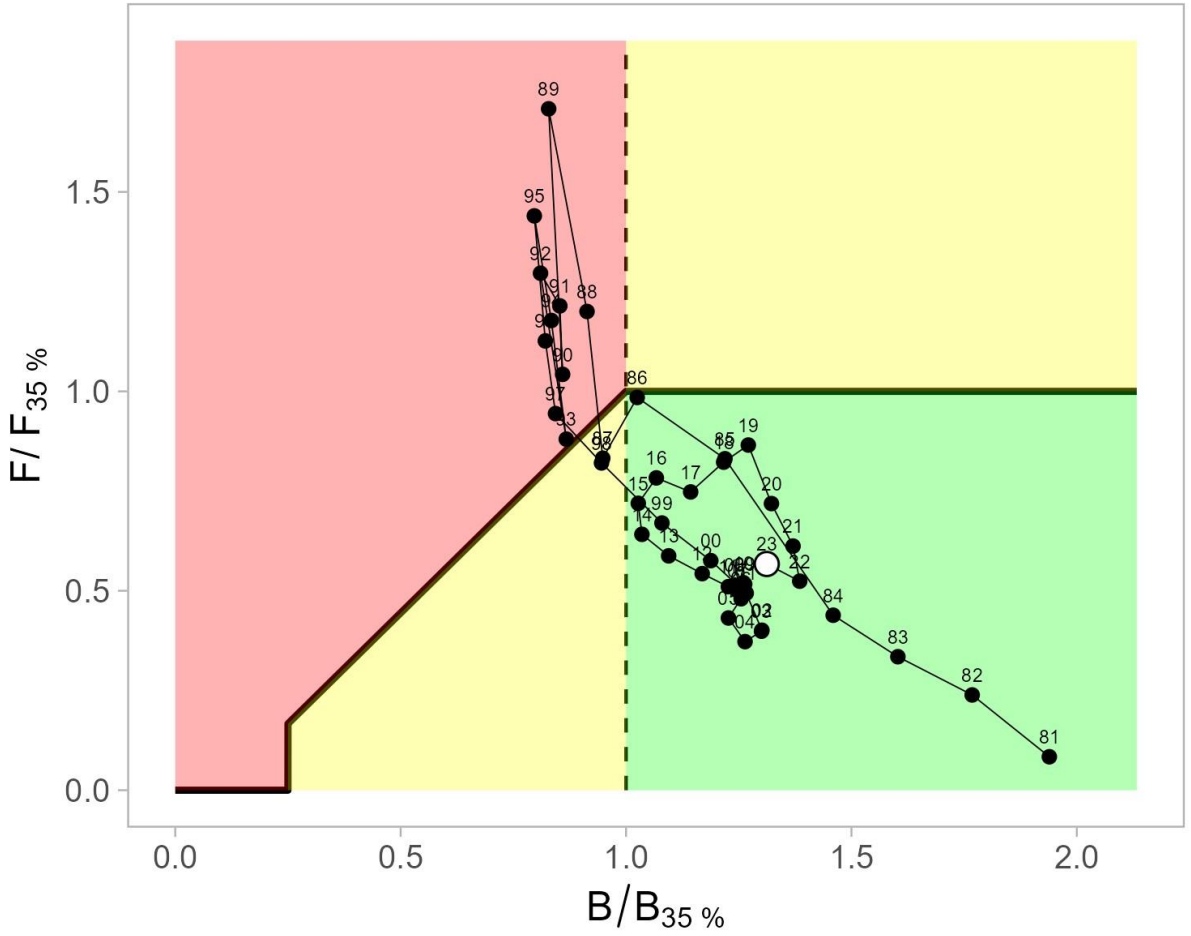
Model	MMB (mil lb)	$B_{35\%}$ (mil lb)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2017}$	$F_{35\%}$	F_{OFL}	OFL (mil lb)
23.0a	17.27	15.74	1.10	2,822	0.55	0.55	6.69
23.1	16.65	15.22	1.09	2,781	0.55	0.55	6.23
23.1b	15.68	15.23	1.03	2,795	0.59	0.59	5.95

Table 15: Comparison of biological reference points for WAG models.

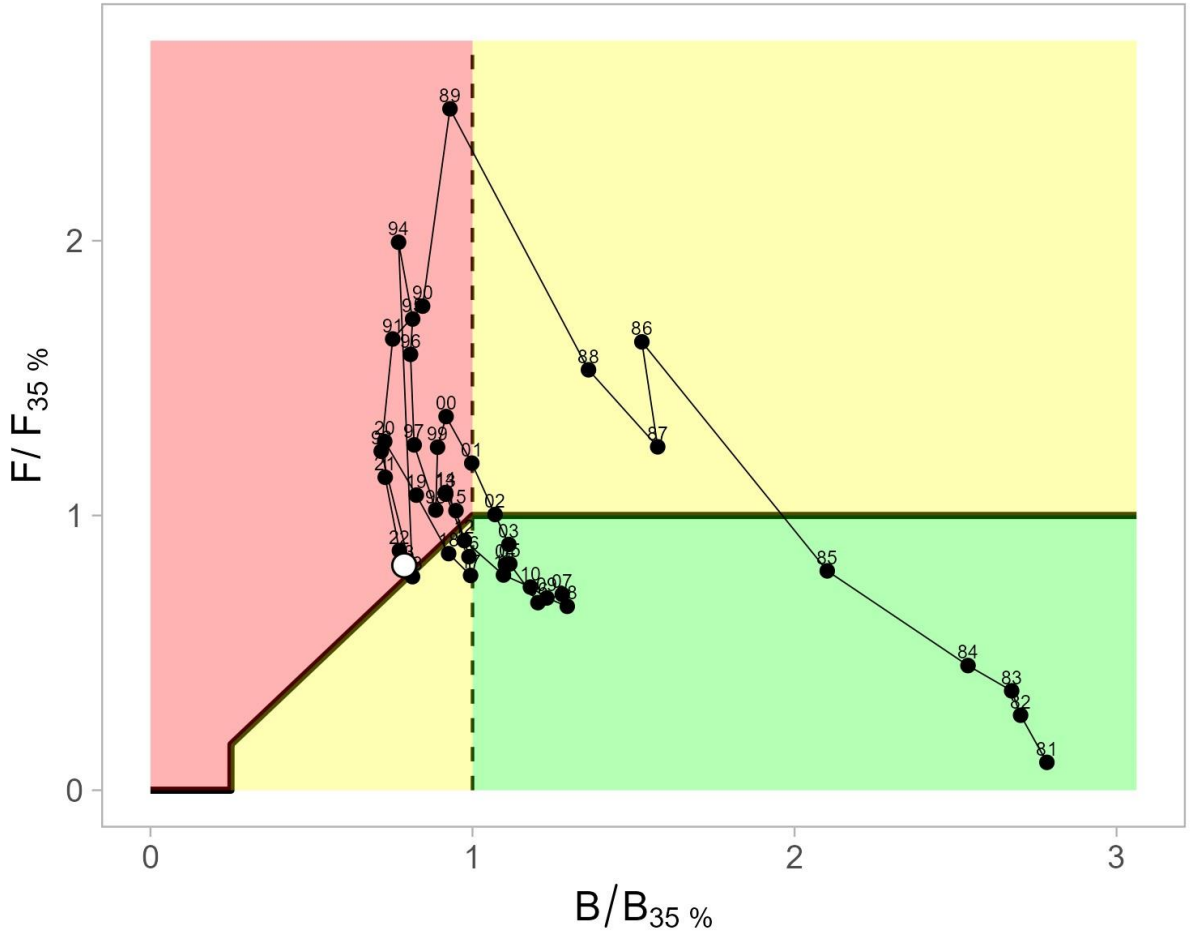
Model	MMB (t)	$B_{35\%}$ (t)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2017}$	$F_{35\%}$	F_{OFL}	OFL (t)
23.0a	3,904	4,698	0.83	1,869	0.54	0.44	945
23.1	3,837	4,638	0.83	1,866	0.54	0.44	900
23.1b	3,944	4,716	0.84	1,914	0.57	0.46	951

Model	MMB (mil lb)	$B_{35\%}$ (mil lb)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2017}$	$F_{35\%}$	F_{OFL}	OFL (mil lb)
23.0a	8.61	10.36	0.83	1,869	0.54	0.44	2.08
23.1	8.46	10.23	0.83	1,866	0.54	0.44	1.98
23.1b	8.70	10.40	0.84	1,914	0.57	0.46	2.10

EAG 23.1



WAG 23.1



Author Recommendation

None of these models resolve the main issue – not fitting index data

Model 23.1 is best model for both areas

Model 23.1b is the better model for the EAG, but I don't see a need to choose separate models by subdistrict *now*

Model 23.1 Combined OFL = 3,725 t (8.212 mil lb)

ABC Recommendation

25% buffer consistent with 2023 assessment

Unresolved:

- Poor fit to index data in EAG
- Poor MMB retrospective pattern (EAG)

Model 23.1 Combined OFL = 2,794 t (6.159 mil lb)

Modelling Outlook

Need to explore better fit to EAG CPUE **– time varying catchability?**

- As blocks or RE
- Standardization is noisy, doesn't explain everything. $R^2 < 0.2$
- Changes in number of vessels, quota share, fishing grounds, observer coverage

Length comp weights are very high, try Dirichlet multinomial

Re-revisit size at maturity, some new data since last analysis

Use EAG survey data or bust

Back Burner

Improvements to CPUE standardization

- Block : Year
- Definition of blocks
- Geostatistical models

Combined Area Model