AIGKC

Proposed models for 2024 assessment

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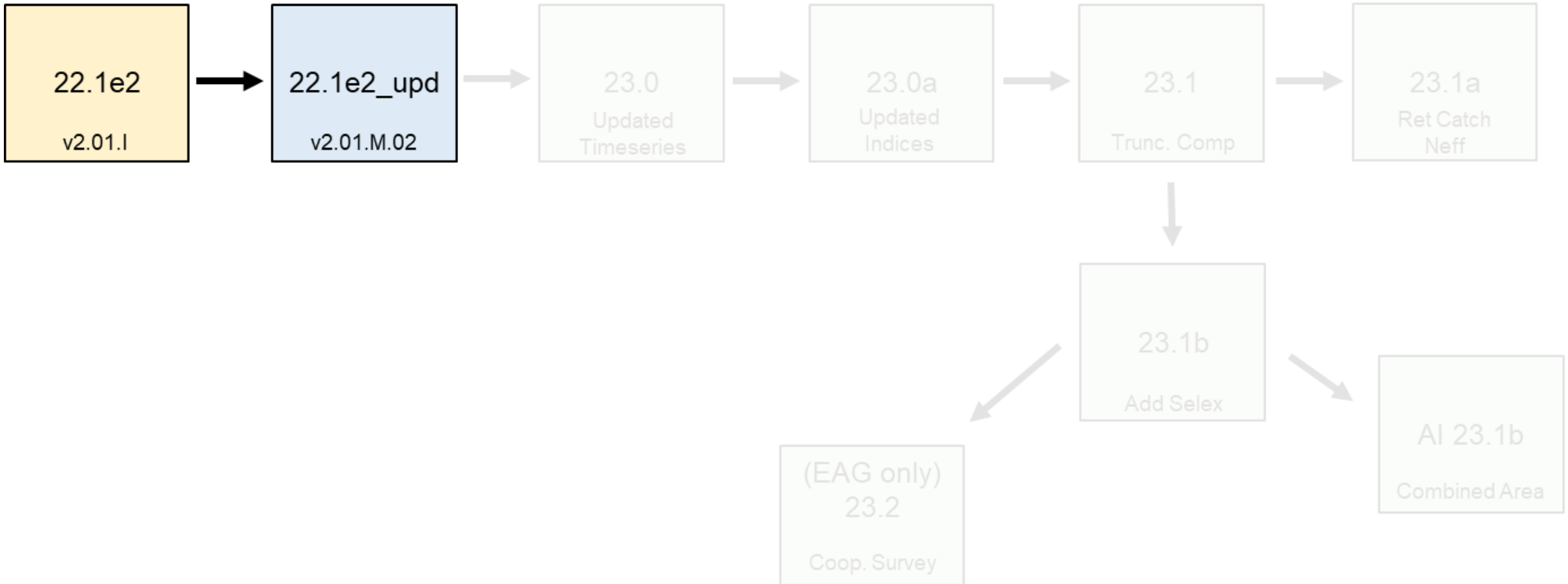
Summary

- TACs in decline since 2019/2020 in both subdistricts
  - Near mid-2010s steady state in EAG
  - All-time low in WAG
- Nominal CPUE slow downward trajectory in WAG, stationary in EAG, up from 2021
- Assessment moved to GMACS in 2023
- Work from May to now:
  - Data workflow / reproducibility (Appendix A)
  - Updates to CPUE standardization (Appendix B)
  - Update to GMACS
  - Cooperative survey (Appendix C)
  - Combined area model

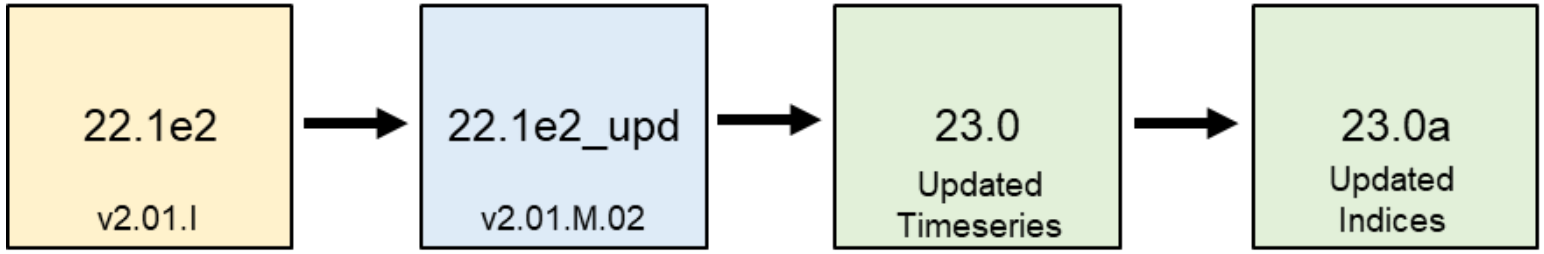

22.1e2
v2.01.I
22.1e2_upd
v2.01.M.02
23.0
Updated Timeseries
23.0a
Updated Indices
23.1
Trunc. Comp
23.1a
Ret Catch Neff
23.1b
Add Selex
(EAG only)
23.2
Coop. Survey
AI 23.1b
Combined Area

	EAG		WAG	
Component	v2.01.I	v2.02.M2	v2.01.I	v2.02.M2
Catch data	-436.540	-436.540	-375.988	-375.988
Index data	-42.975	-42.975	-58.234	-58.234
Size data	928.878	928.878	798.238	798.238
Stock recruitment	20.380	20.380	19.584	19.584
Tagging data	2,699.021	2,699.021	2,705.586	2,705.586
Penalties	0.037	0.037	0.069	0.069
Priors	25.724	25.724	25.031	25.724
Total	3,194.526	3,194.526	3,114.286	3,114.980

Likelihood components identical to 6 decimal places except for priors in WAG

Subdistrict	Version	MMB (t)	$B_{35\%}$ (t)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2017}$	$F_{35\%}$	F_{OFL}	OFL (t)
EAG	v2.01.I	7,584	6,651	1.14	2,611	0.57	0.57	2,882
	v2.01.M2	7,584	6,651	1.14	2,611	0.57	0.57	2,861
WAG	v2.01.I	4,572	4,979	0.92	1,977	0.55	0.50	1,242
	v2.01.M2	4,572	4,979	0.92	1,977	0.55	0.50	1,232

10 – 20 t difference in OFL, all other reference points are the same



- Updated fishery data using same method as all other stocks (Daly 2020 CPT)
  - Retained & total catch, GF bycatch
  - Size composition
  - Associated weights based on data
- All inputs based on data are reproducible from ‘raw’ form (see GitHub)
- **Notation for estimates in Appendix A**
- **CPUE Standardization in Appendix B**

Necessity for updates – Appendix A

- Legacy model input was N at size matrix for all catch types

- Observer and fish ticket data were joined on annual basis to get permit holder for CPUE std (i.e. proxy for Captain)
  - No straightforward link between observer and fish ticket data
  - Penguilly developed a protocol for joining data manually – *very tedious, many special cases*
  - Gaeuman wrote script to automate process for recent data (2021-2022) – *not backwards compatible to earlier years*
  - Data in ‘master’ file not consistent with fresh data query

Fish Ticket / Observer Joinery

- Simpler approach for getting Permit Holder in observer data
  1. Join fish ticket and CFEC data to get unique combinations of trip start and end dates, permit holder, by vessel and season (no ADF&G)
  2. Adjust date ranges so there are no gaps
  3. Assign permit holder to observer data based on vessel and date

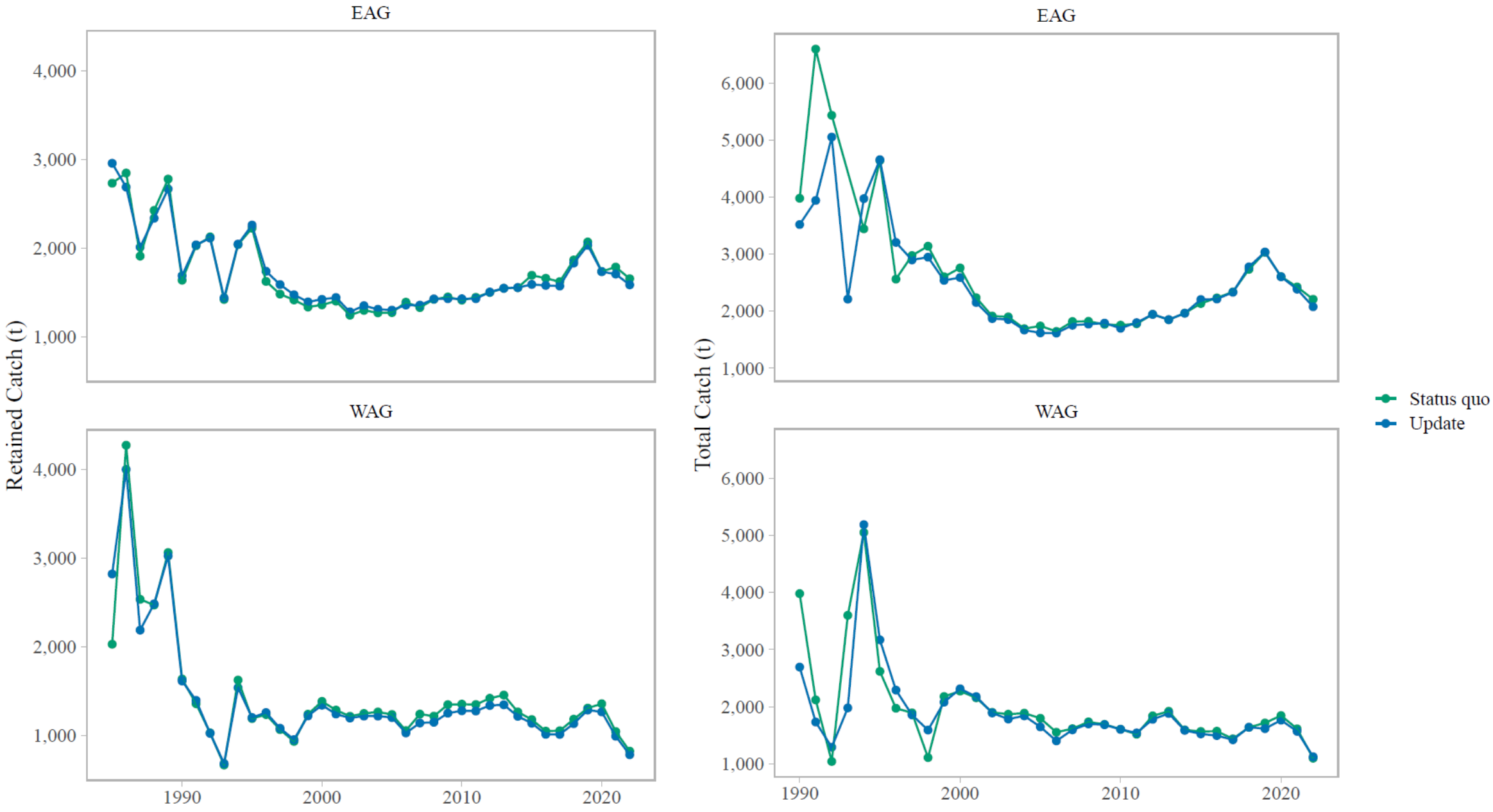
- Don’t attempt to join landed catch to observer pots, etc

Season Dates

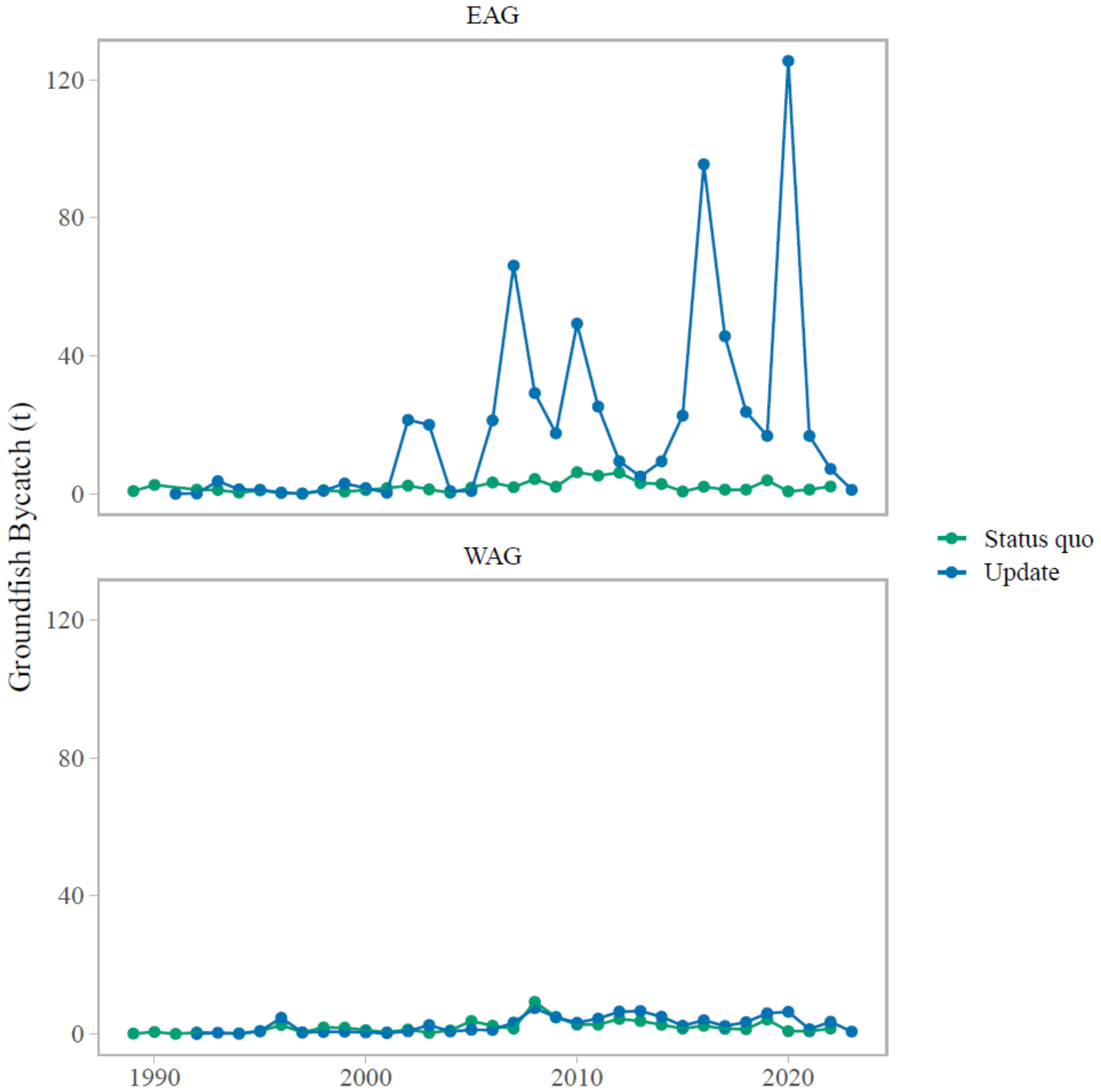
- Early AIGKC season dates do not align with rationalization crab year
  - Opened later (Sep / Nov) and extended beyond July the following calendar year

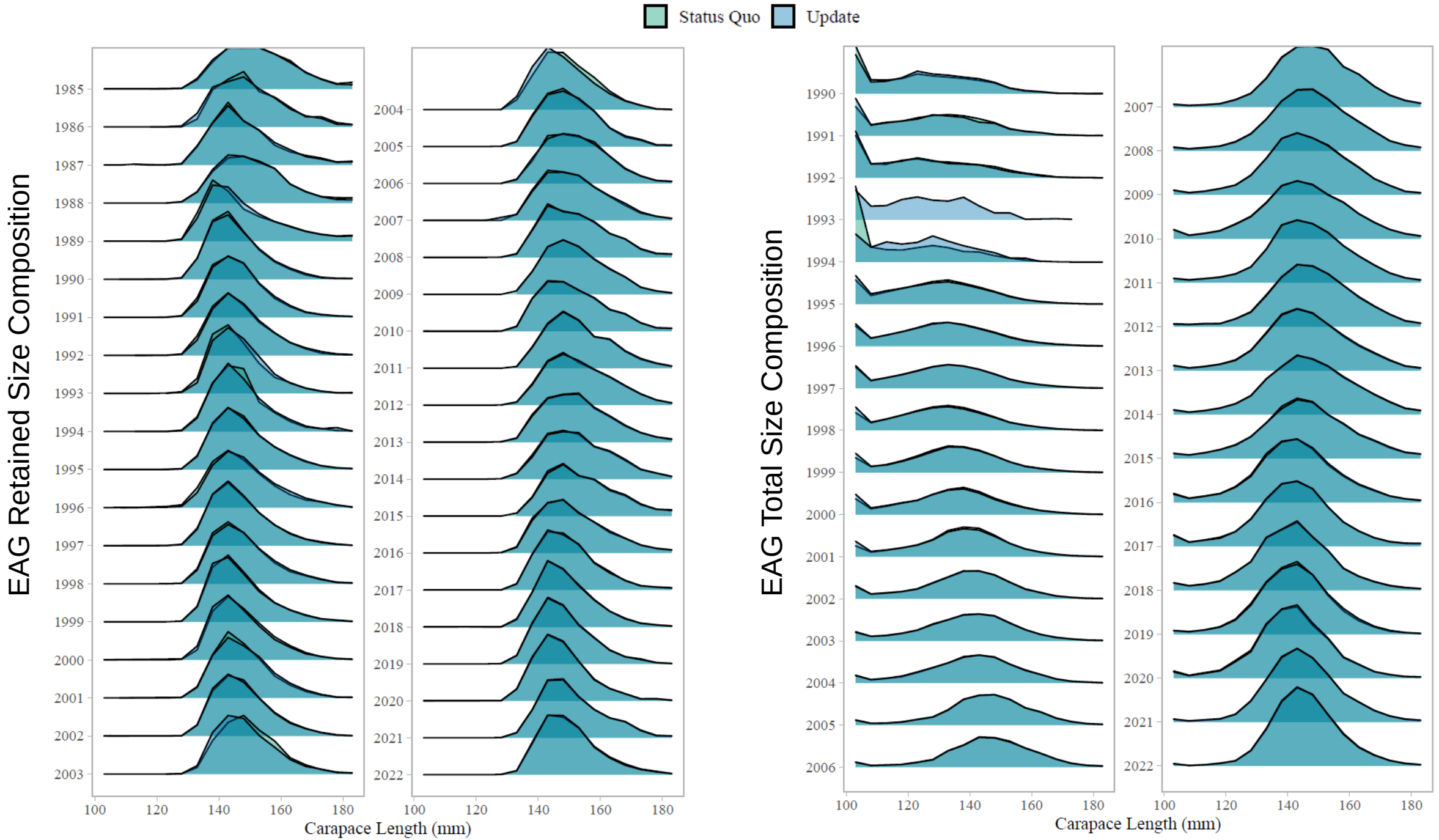
- All data confined to rationalized crab year (Jul 1 – Jun 30)

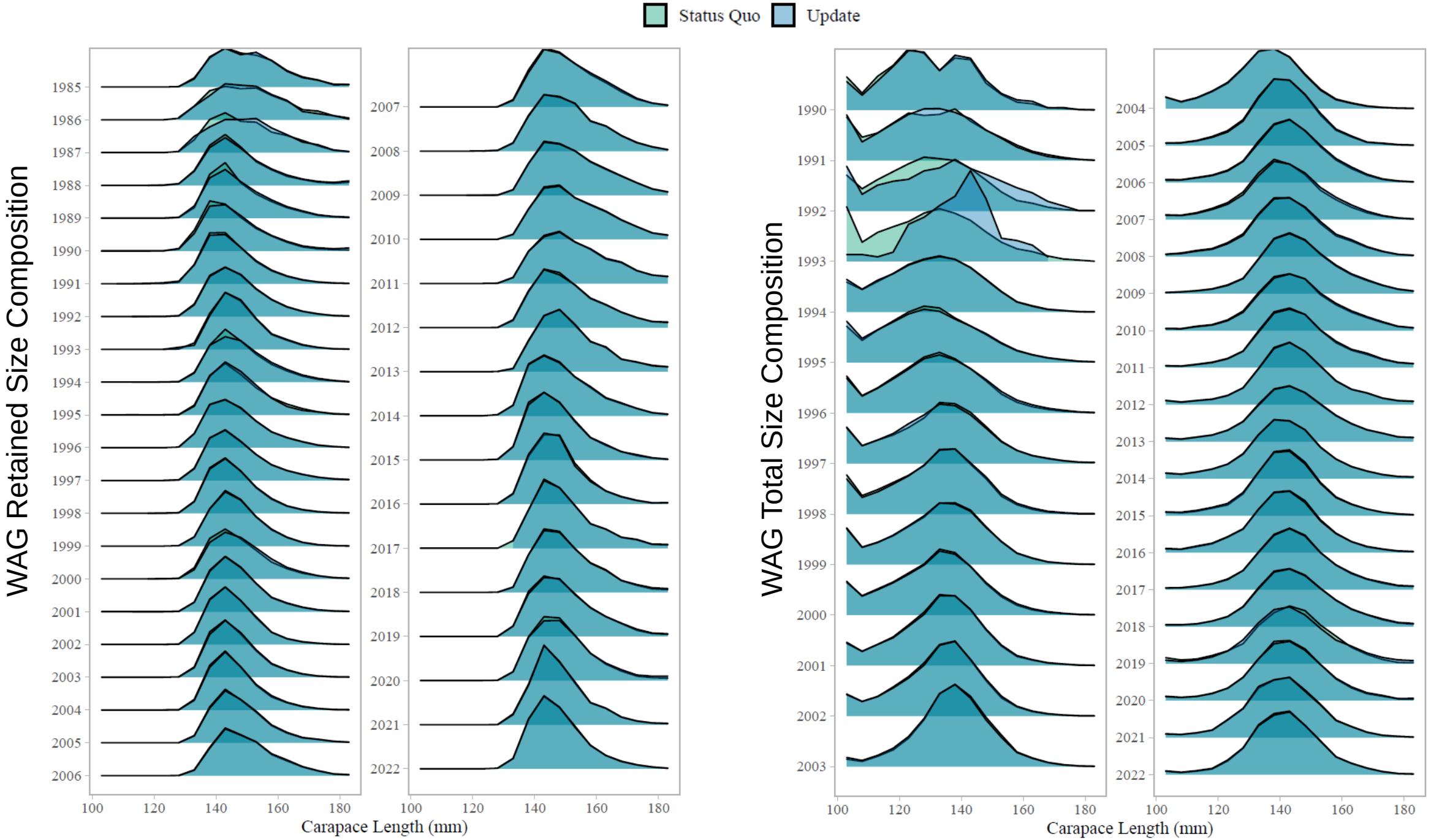
- Data after June 30, applied to next season (consistent with Siddeek)
  - Example: July 1, 1985 (originally 1984/85 season) is applied to 1985/86 season


EAG
EAG
WAG
WAG
Retained Catch (t)
Total Catch (t)
4,000
3,000
2,000
1,000
6,000
5,000
1990
2000
2010
2020
Status quo
Update

- Status quo used unexpanded bycatch (i.e., numbers at size)




Status Quo
Update
EAG Retained Size Composition
EAG Total Size Composition
Carapace Length (mm)
Carapace Length (mm)


Status Quo
Update
WAG Retained Size Composition
WAG Total Size Composition
Carapace Length (mm)
Carapace Length (mm)

Appendix B – Observer CPUE Standardization

‘Core’ data

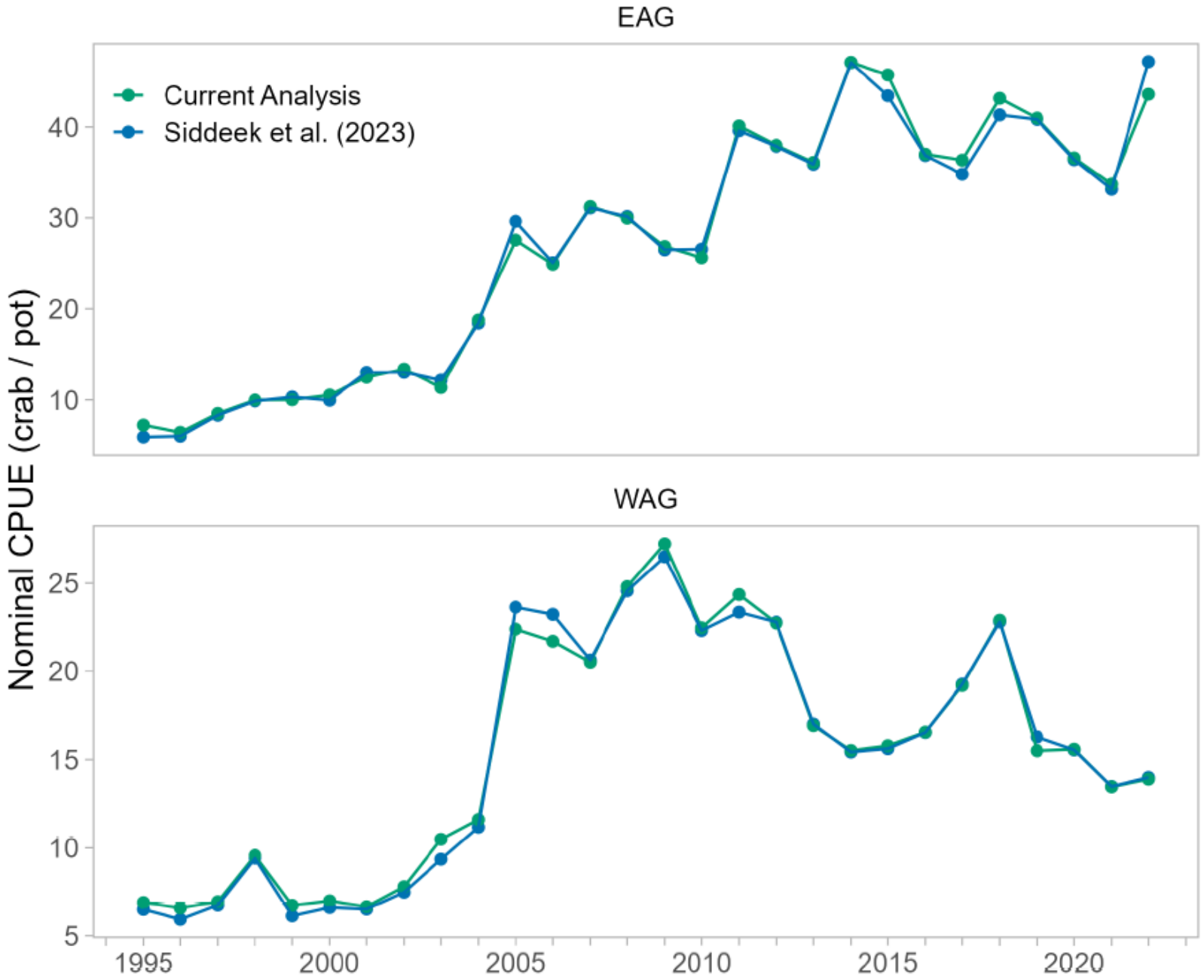
- Previously – only include vessels that made 5 trips in at least 3 seasons
- Updated – permit holders and vessels occur in > 1 season, no limit in post-rationalized period
- Inner 95% of soak time, 99% of depth
- Several gear types combined following Siddeek et al. (2016, 2023)

Model Fitting

- Use GAM (*mgcv*) instead of GLM
- Negative binomial error, log-link, overdispersion (θ) estimated

Dependent Variable

- Legal males (Siddeek et al. 2016, 2023)
- Total males (see appendix B – no model scenario here)


EAG
Current Analysis
Siddeek et al. (2023)
40
30
20
10
WAG
25
20
15
10
5
Nominal CPUE (crab / pot)
1995
2000
2005
2010
2015
2020

Appendix B – Observer CPUE Standardization

‘Core’ data

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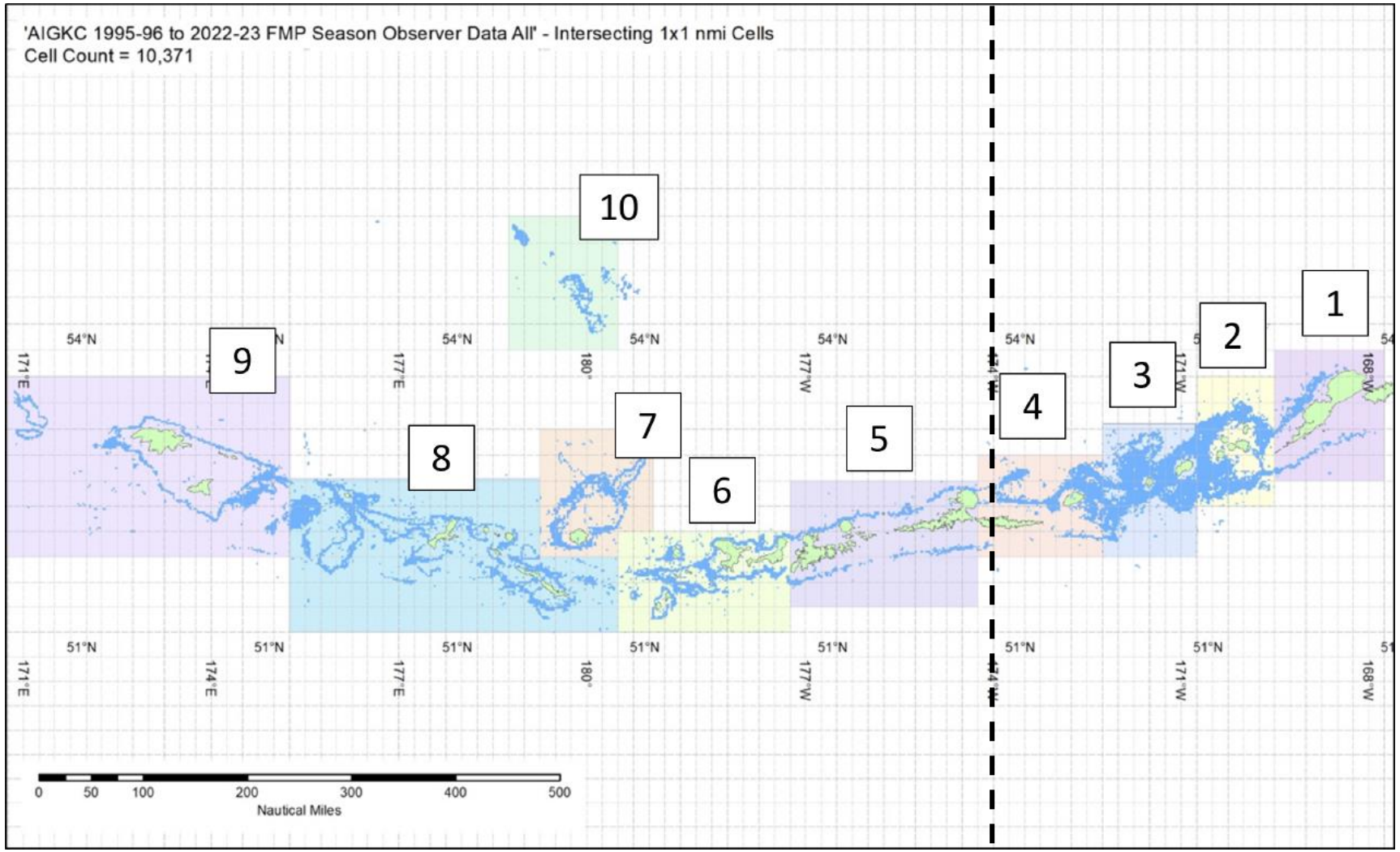
Appendix B – Observer CPUE Standardization

- Null model included only Year or Year:Block



Appendix B – Observer CPUE Standardization

- Null model included only Year or Year:Block
- Covariates evaluated
  - Vessel
  - Permit Holder
  - Month
  - Block (if not in yr:Block)
  - Gear Type
  - s(soaktime)
  - s(depth)
  - s(slope) – estimated from 100m x 100m raster
  - s(lon, lat) – followed up with ti(lon, lat)
- Model selection followed Siddeek et al. (2016, 2023)
  - Δ CIAC ≥ 2 per df lost
  - $R^2 \geq 0.01$

$$\mathrm{R}^2 = \frac{D_{Null} - D_{Resid}}{D_{Null}}$$

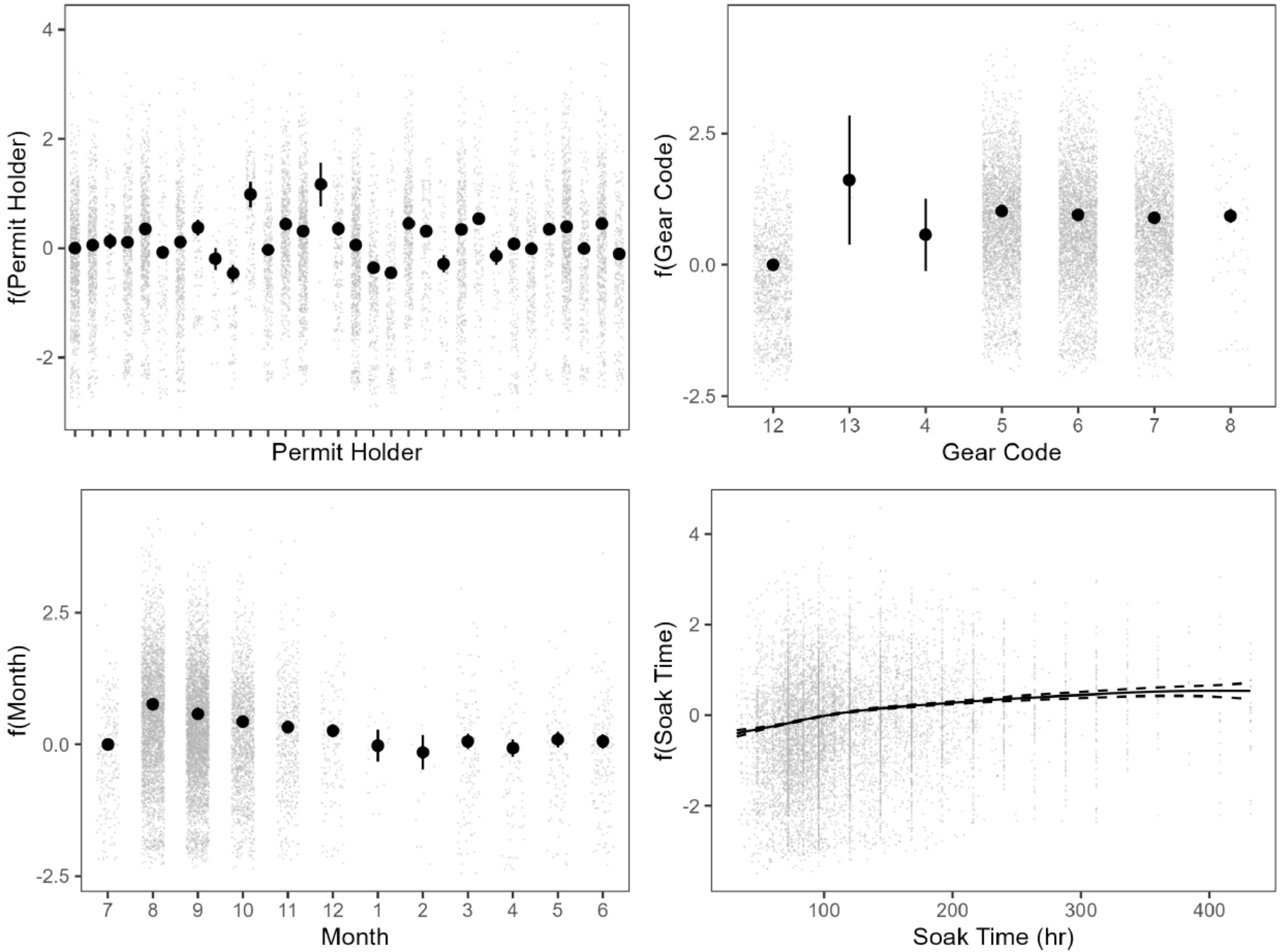
Pre-Rationalized EAG

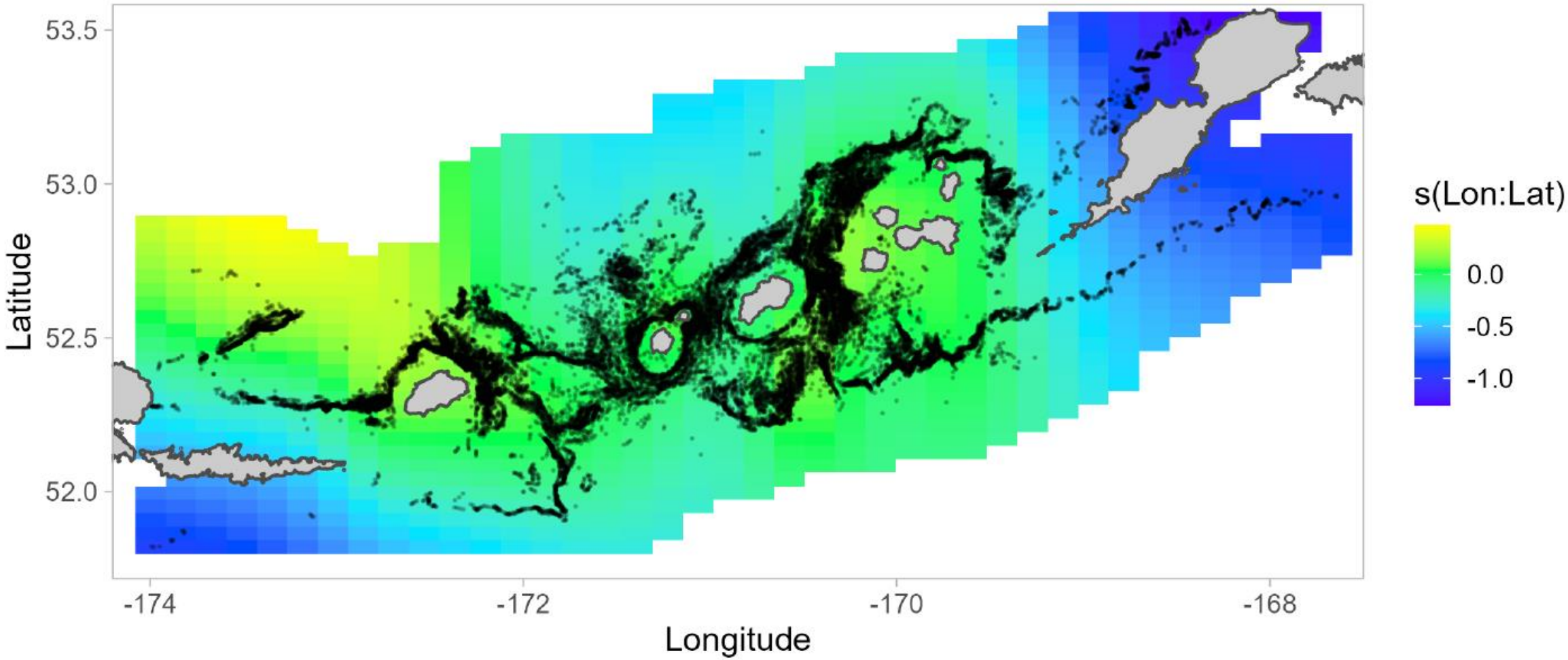
Null: ln(CPUE) = Year

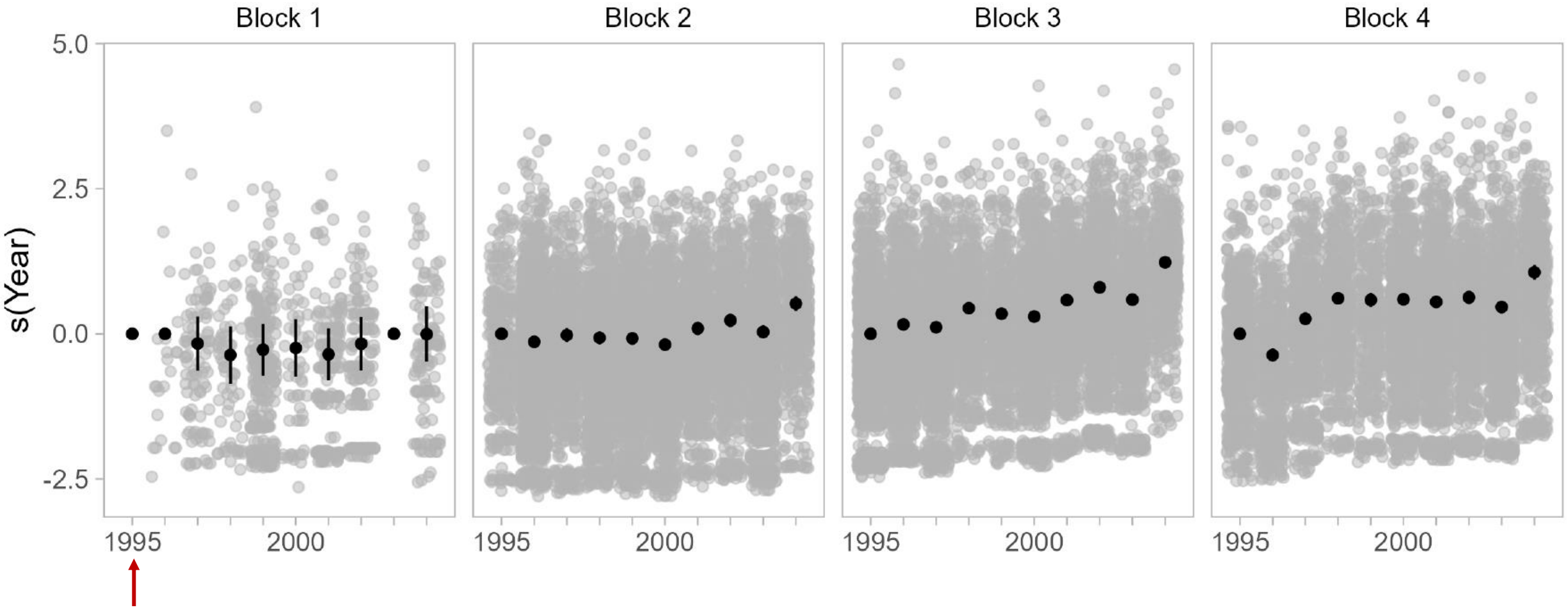
Form ($\theta = 1.4$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + Gr + PH + Mon + s(soak time, 5.03) + s(lon, lat, 26.72)	30,967.25	203,712	0.23
+ Vessel	-10.97	-83.21	0.005
+ s(depth)	-6.04	29.11	0.001
+ s(slope)	-2.65	-42.53	0.002

Null: ln(CPUE) = Year:Block

Form ($\theta = 1.385$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr:B + Gr + PH + s(soak time, 4.67)	30,976.33	203,867	0.22
+ Month	-11.09	-211.60	0.008
+ Vessel	-11.03	-0.48	0.003
+ s(depth)	-5.59	28.34	0.001
+ s(slope)	-0.98	-31.91	0.001


f(Permit Holder)
4
2
0
-2
Permit Holder
f(Gear Code)
2.5
0.0
-2.5
12
13
4
5
6
7
8
Gear Code
f(Month)
2.5
0.0
-2.5
7
8
9
10
11
12
1
2
3
4
5
6
Month
f(Soak Time)
4
2
0
-2
100
200
300
400
Soak Time (hr)


53.5
53.0
52.5
52.0
Latitude
-174
-172
-170
-168
Longitude
s(Lon:Lat)
0.0
-0.5
-1.0



Removed due to lack of data, N = 1

Post-Rationalized EAG

Null: ln(CPUE) = Year

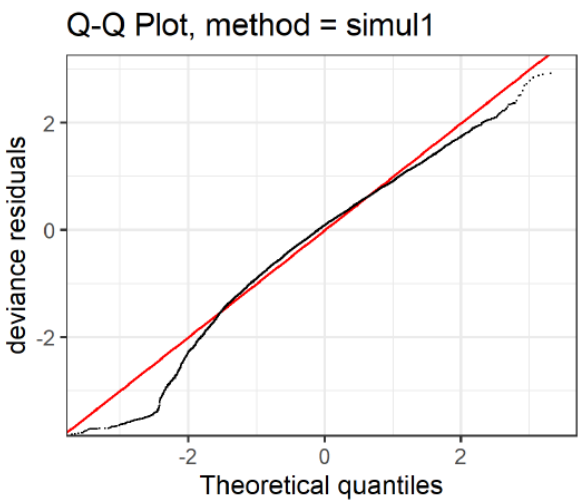
Form ($\theta = 2.321$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + Gr + PH + s(soak time, 5.12)	9,728.88	85,976	0.12
+ Month	-6.87	-7.23	0.006
+ Vessel	-3.14	27.45	0.000
+ s(depth)	-3.09	21.51	0.001
+ s(slope)	-2.04	9.92	0.002
+ s(longitude,latitude)	-22.46	135.20	0.008

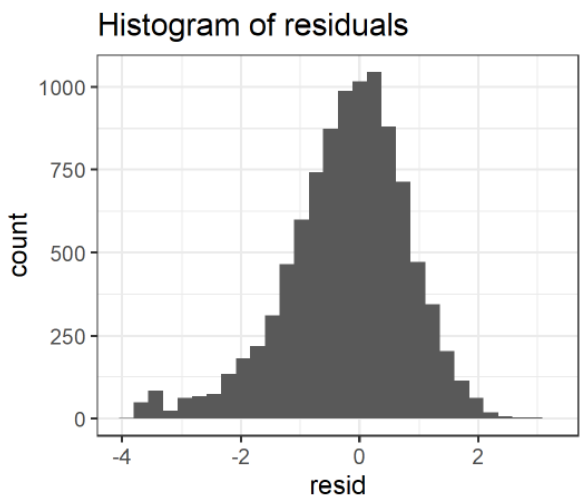
Null: ln(CPUE) = Year:Block

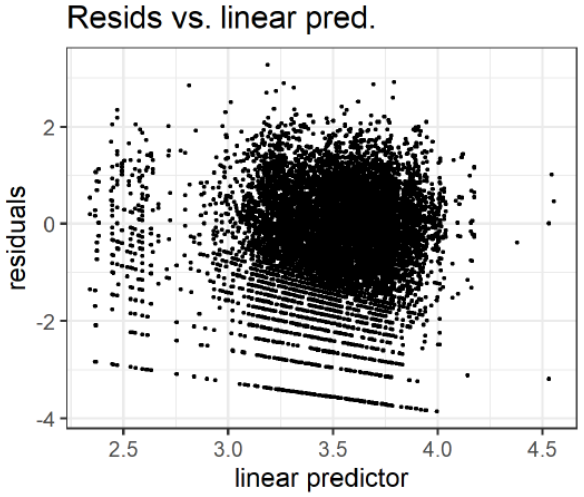
Form ($\theta = 2.338$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr:B + Gr + Ves	9,695	86,123	0.12
+ s(soak time)	-5.20	-46.66	0.008
+ Month	-7.00	-22.66	0.008
+ Permit Holder	-10.00	35.65	0.005
+ s(depth)	-2.77	20.47	0.001
+ s(slope)	-2.26	-1.23	0.002

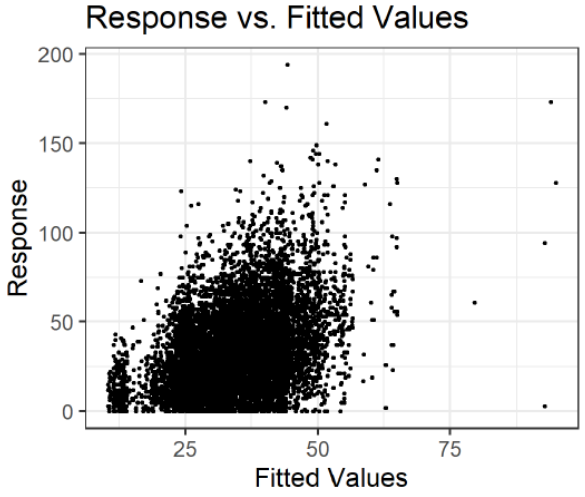
Block 1 removed, fished in 3 years only, N < 6 pots per year

Year

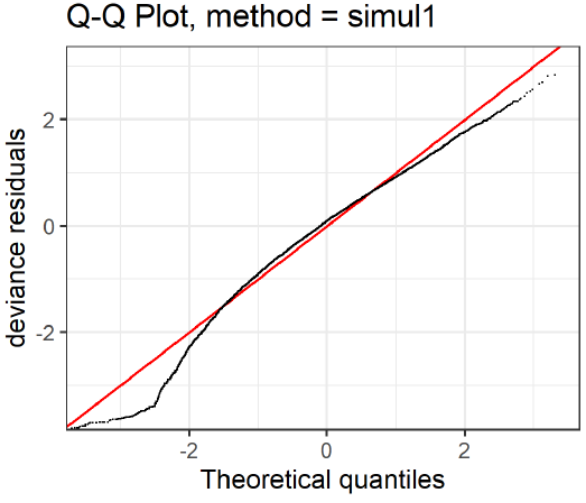


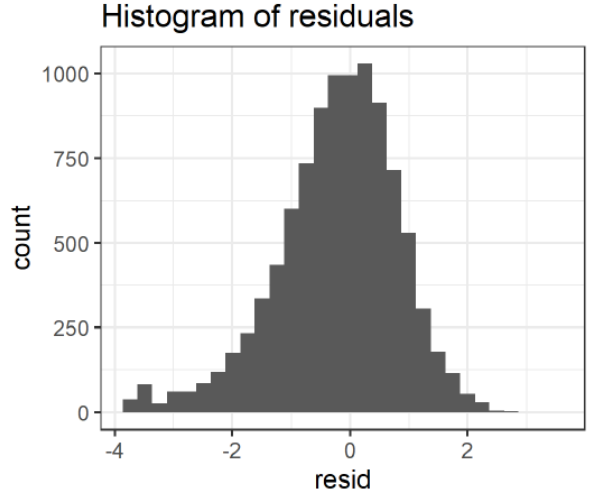


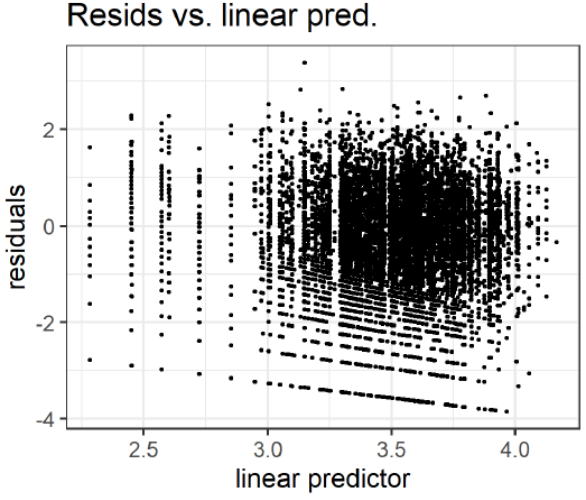


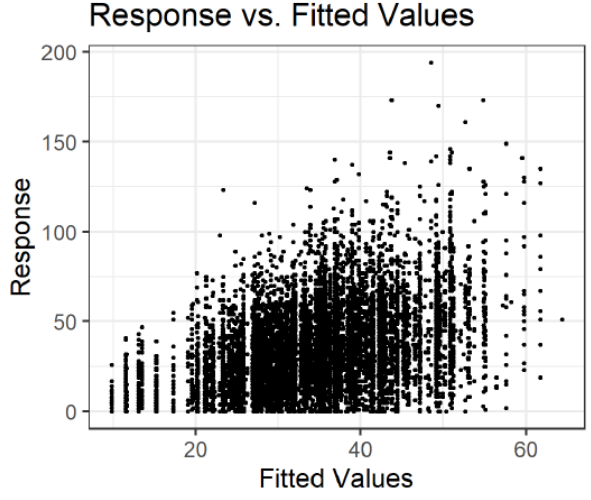


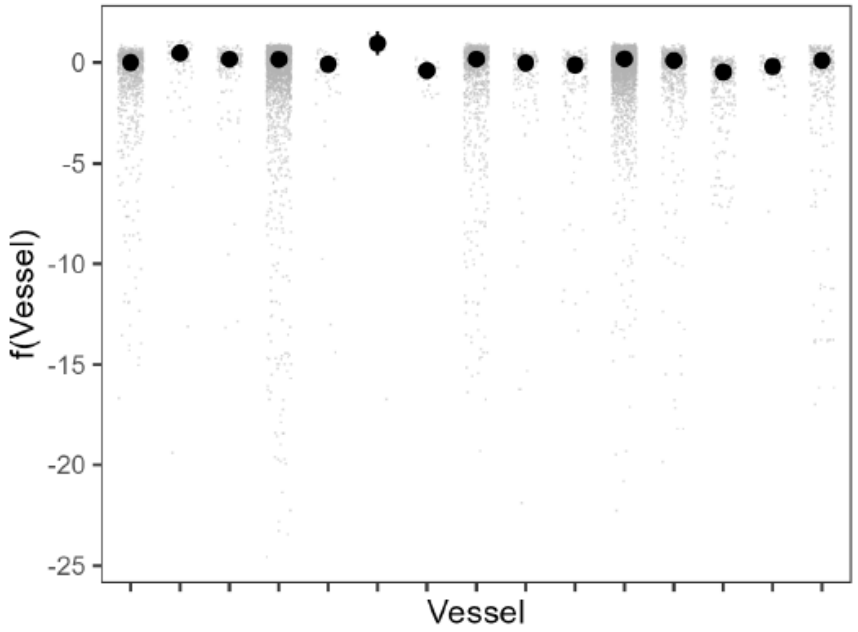
Year:Block

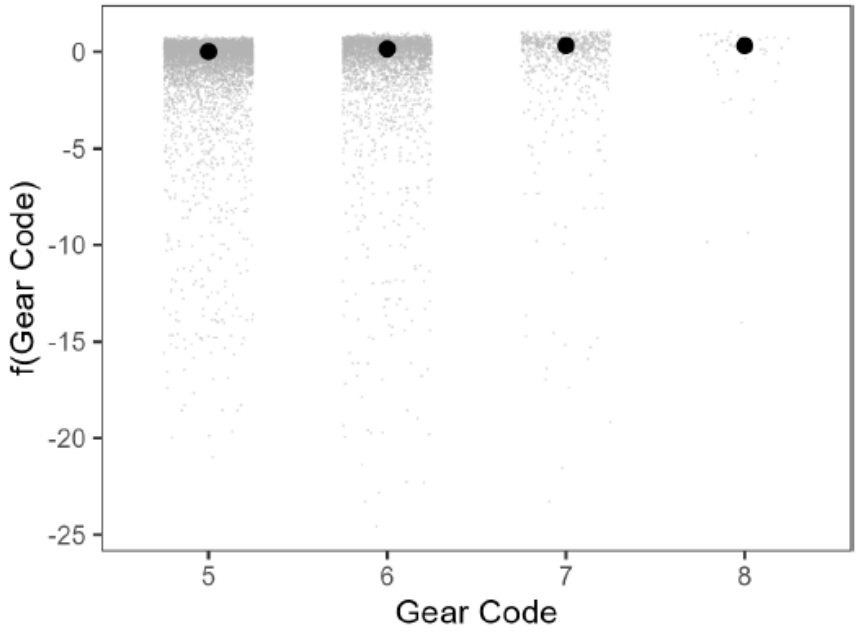


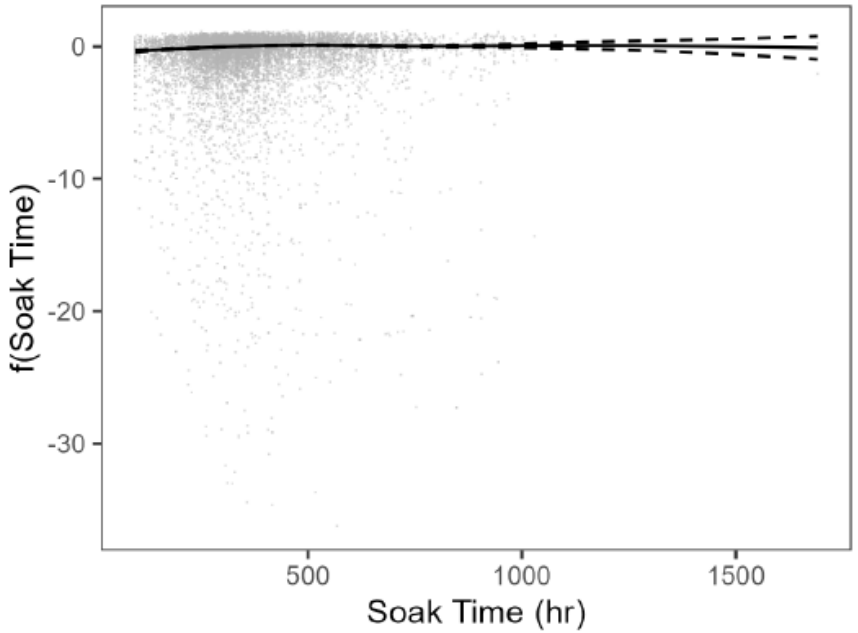




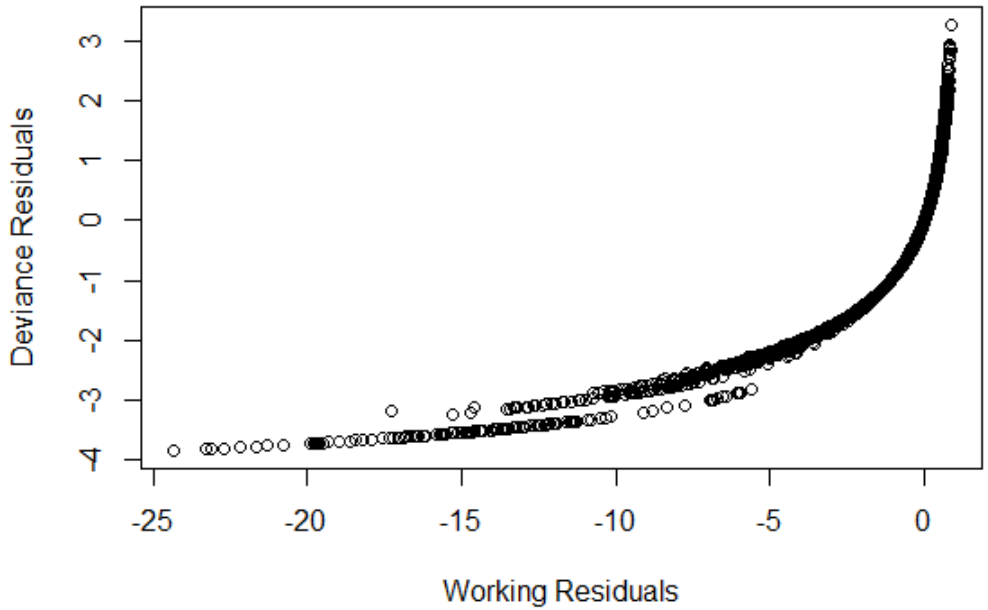


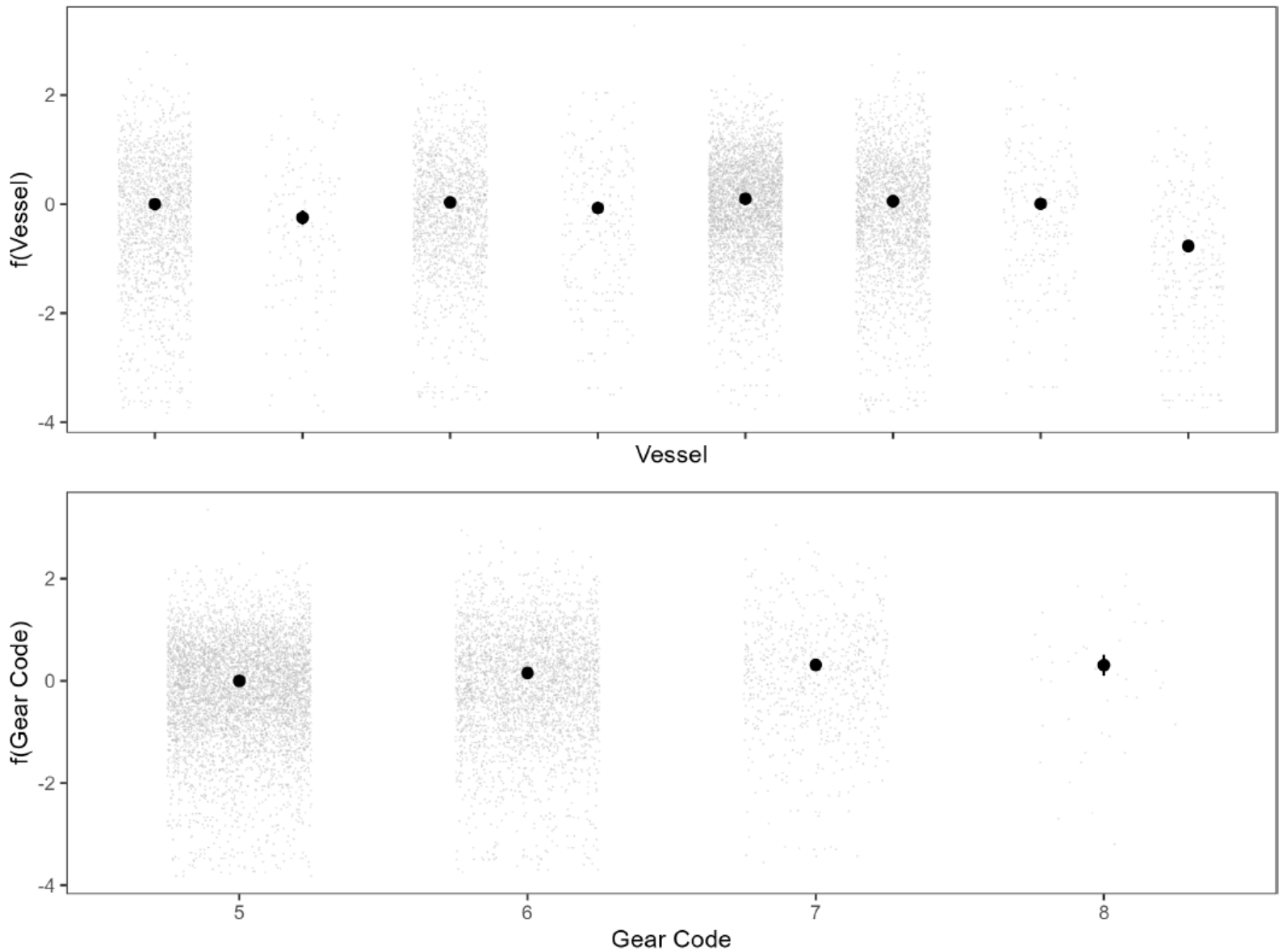


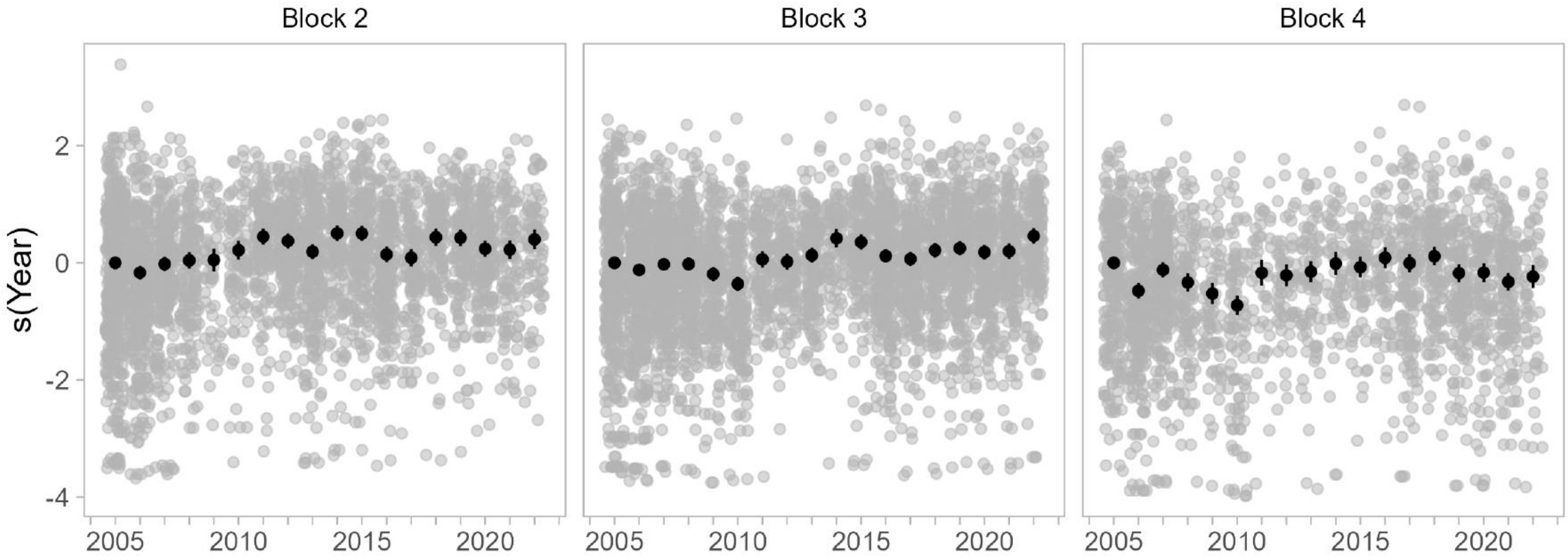


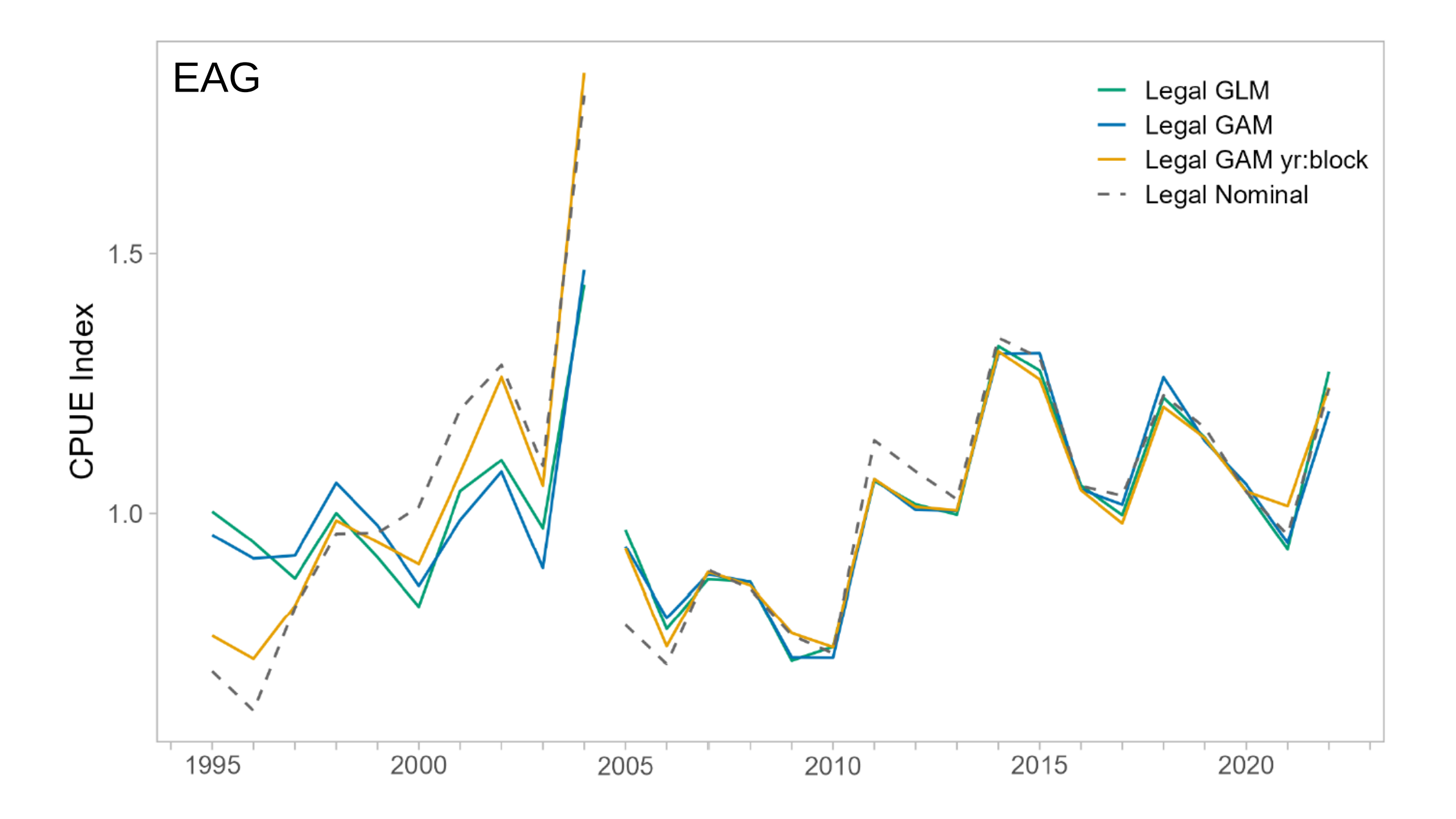


Very skewed working residuals, unclear why…




f(Vessel)
2
0
-2
-4
Vessel
f(Gear Code)
2
0
-2
-4
5
6
7
8
Gear Code


Block 2
Block 3
Block 4
s(Year)
2
0
-2
-4
2005
2010
2015
2020


EAG
Legal GLM
Legal GAM
Legal GAM yr:block
Legal Nominal
CPUE Index
1.5
1.0
1995
2000
2005
2010
2015
2020

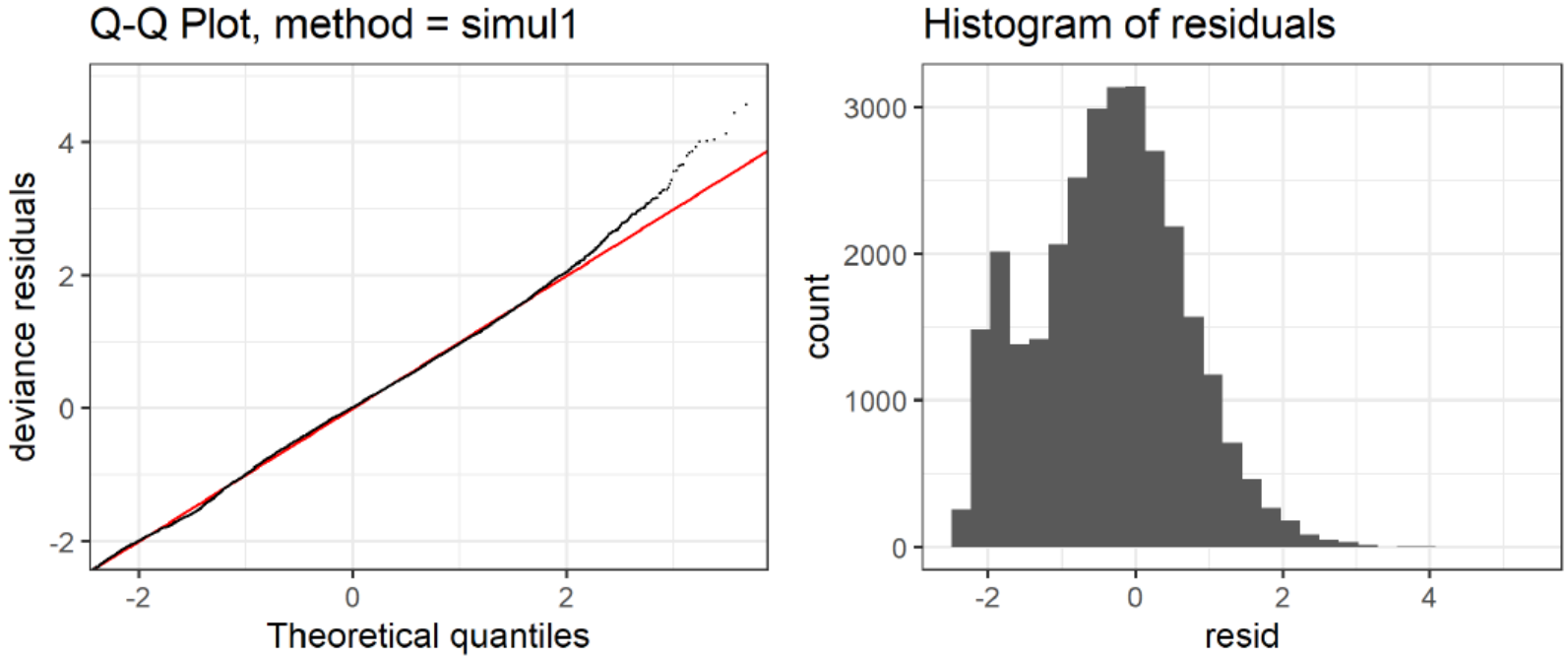
Pre-Rationalized WAG

Null: ln(CPUE) = Year

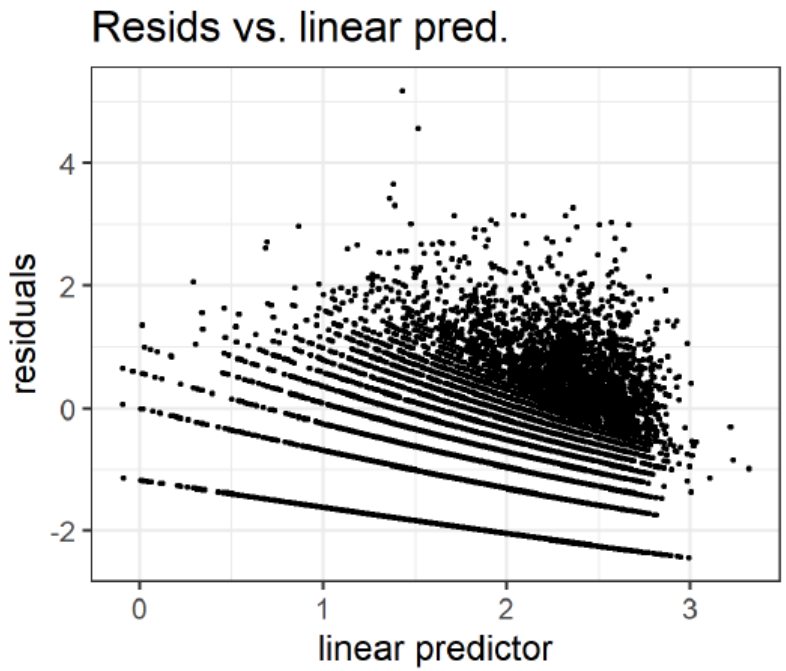
Form ($\theta = 0.97$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + Gr + PH + s(soak time, 7.97) + s(lon, lat, 26.08)	29,812.95	179,942	0.15
+ Month	-10.21	-124.30	0.006
+ Vessel	-6.54	-102.10	0.005
+ s(depth)	-7.07	-19.12	0.003
+ s(slope)	-3.02	41.83	0.000

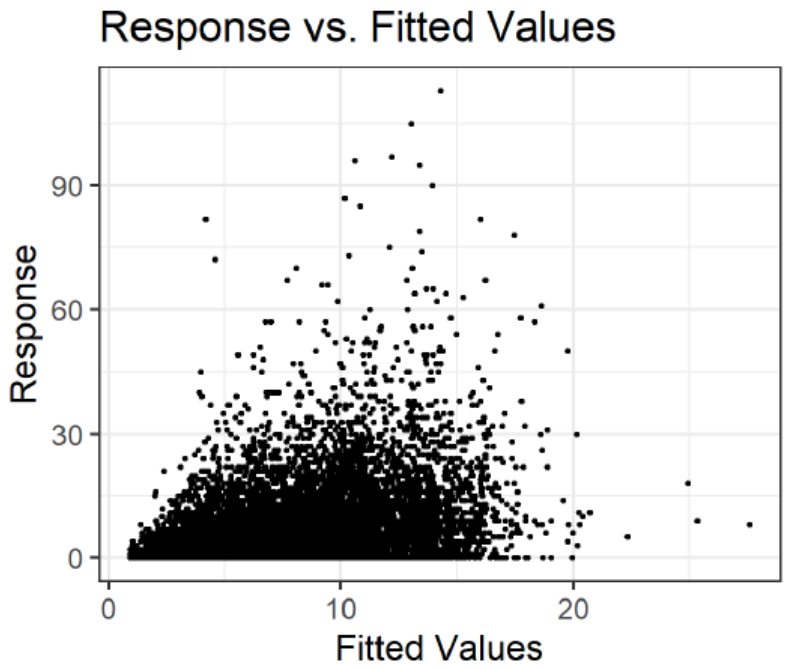
Null: ln(CPUE) = Year:Block

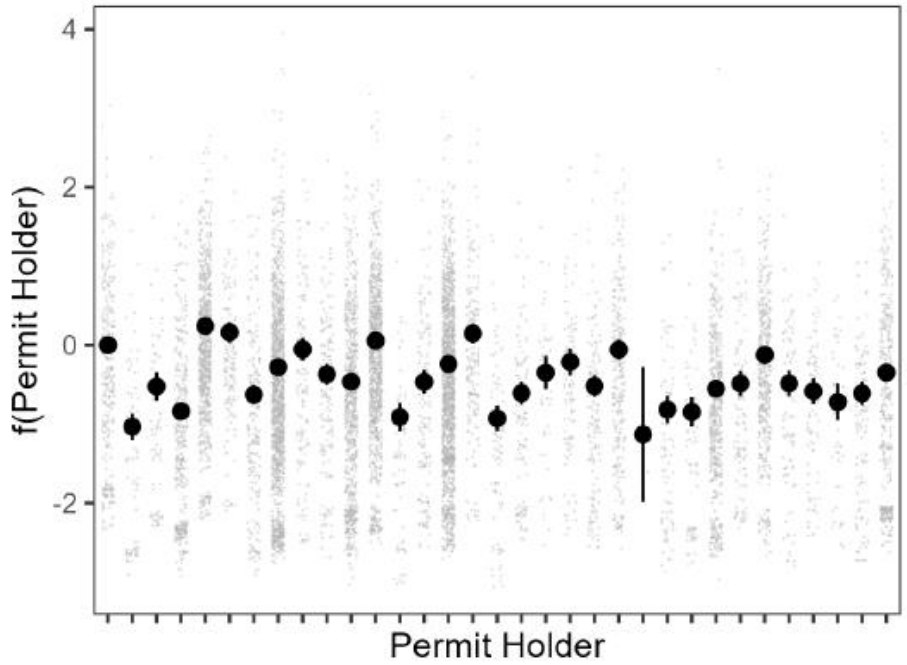
Form ($\theta = 0.972$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr:B + Gr + PH + s(soak time, 7.83)	29,792.17	180,116	0.15
+ Month	-10.19	-174.89	0.008
+ s(depth)	-6.82	-31.10	0.003
+ s(slope)	-2.34	25.76	0.000

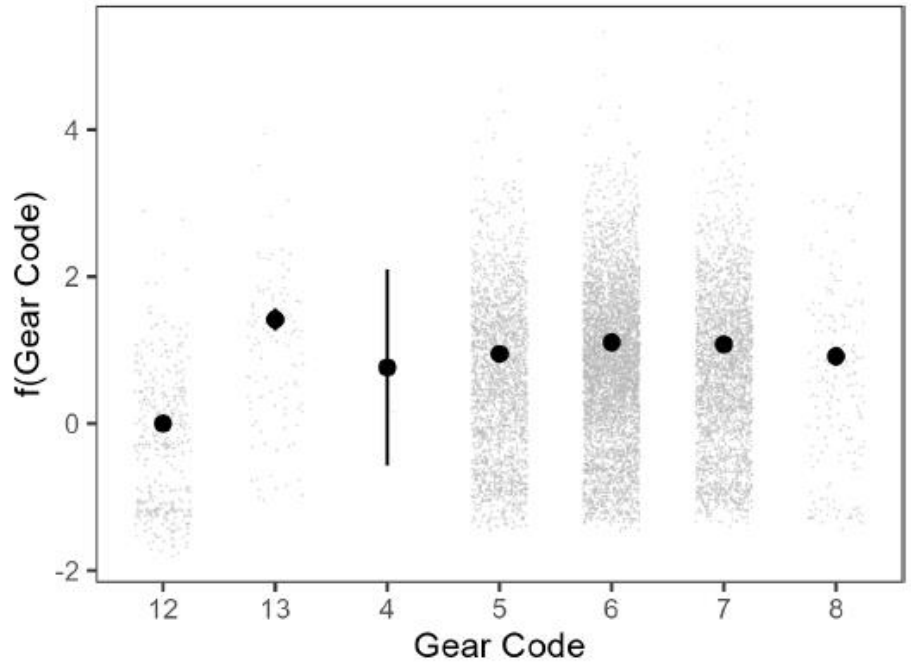

Q-Q Plot, method = simul1
deviance residuals
Theoretical quantiles
4
2
0
-2
-2
0
2

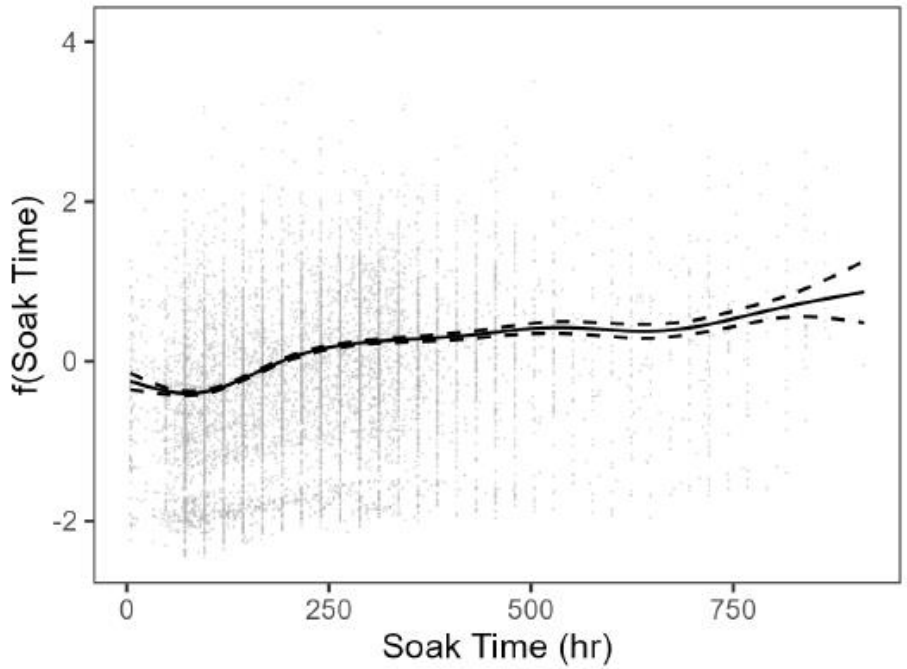
Histogram of residuals
count
resid
3000
2000
1000
0
-2
0
2
4

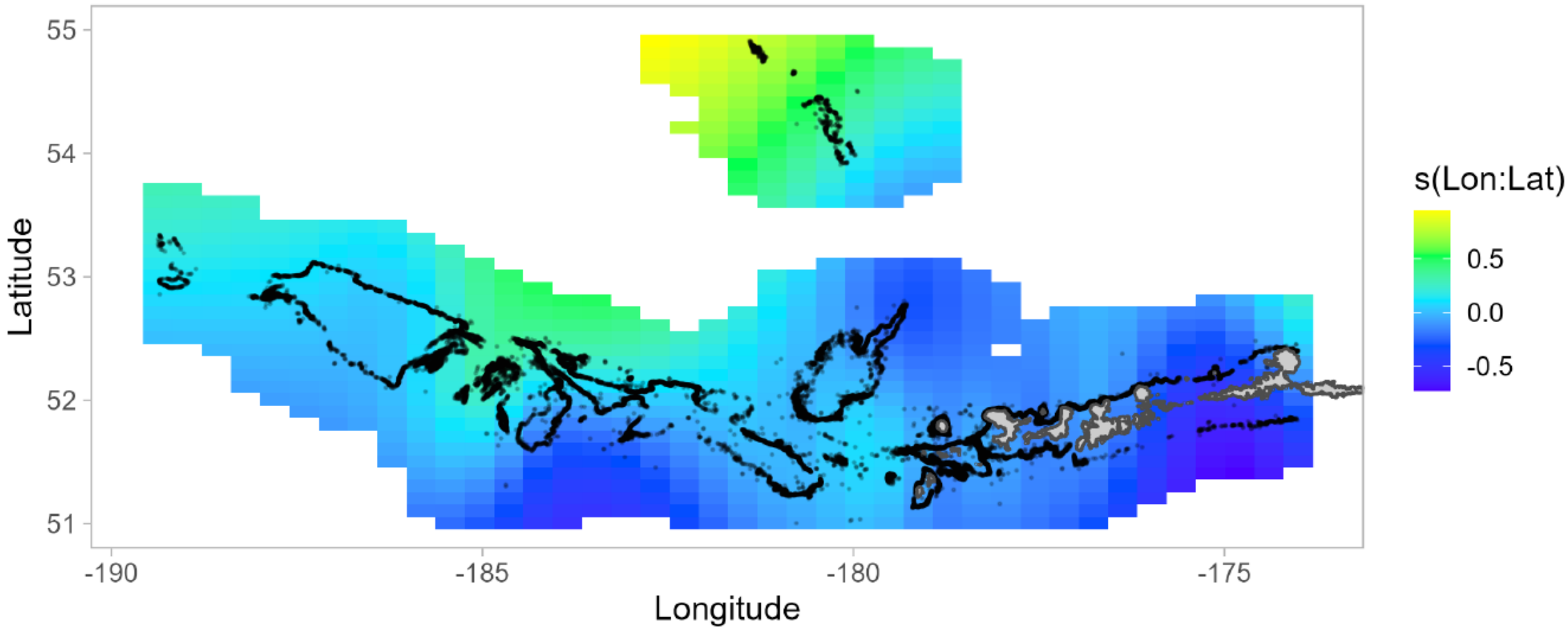

Resids vs. linear pred.
residuals
linear predictor
4
2
0
-2
0
1
2
3

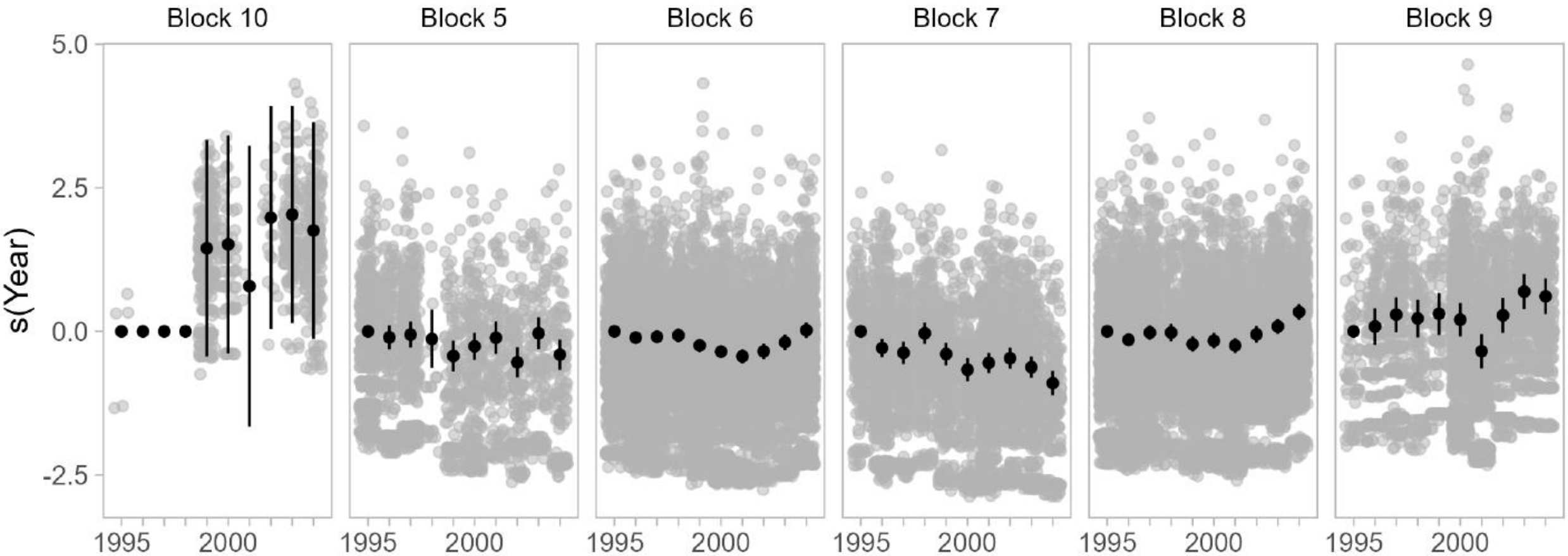

Response vs. Fitted Values
Response
Fitted Values
90
60
30
0
0
10
20


f(Permit Holder)
4
2
0
-2
Permit Holder


f(Gear Code)
4
2
0
-2
12
13
4
5
6
7
8
Gear Code


f(Soak Time)
4
2
0
-2
0
250
500
750
Soak Time (hr)


55
54
53
52
51
Latitude
-190
-185
-180
-175
Longitude
s(Lon:Lat)
0.5
0.0
-0.5


Block 10
Block 5
Block 6
Block 7
Block 8
Block 9
s(Year)
5.0
2.5
0.0
-2.5
1995
2000

Post-Rationalized WAG

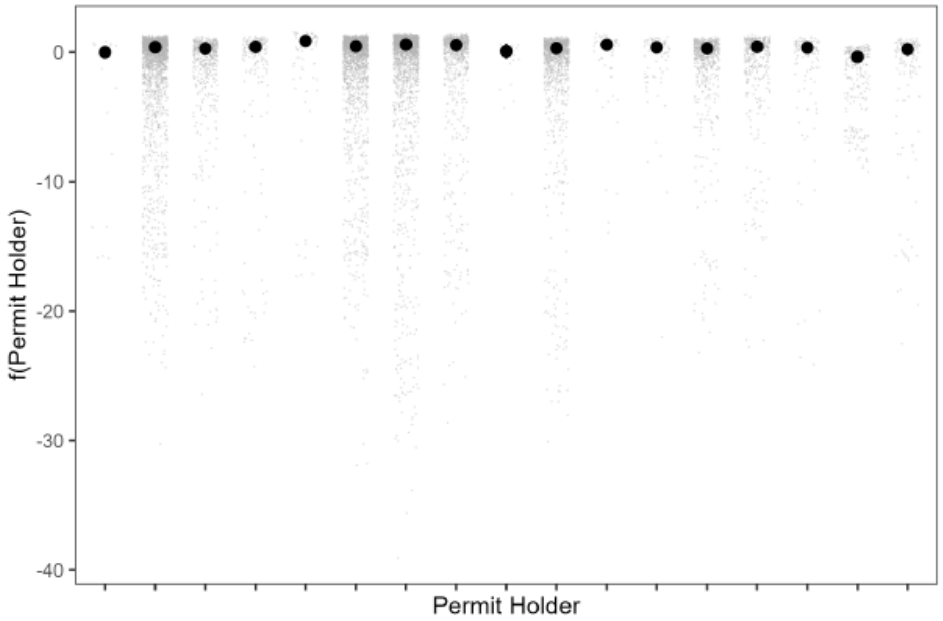
Null: ln(CPUE) = Year

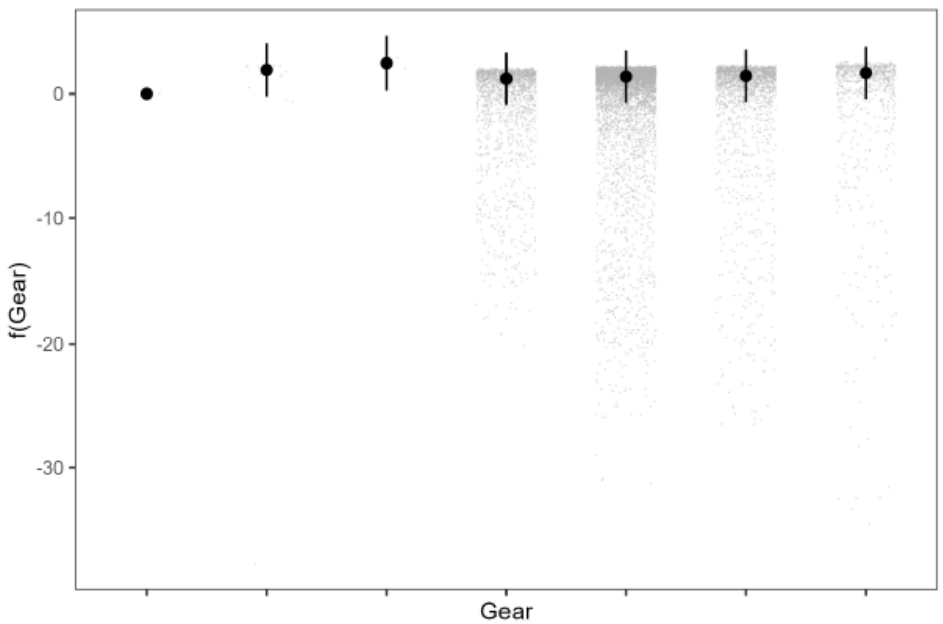
Form ($\theta = 1.109$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + Gr + PH + s(lon, lat, 27)	16,911.02	134,244	0.09
+ s(soak time)	-7.29	-70.58	0.007
+ Month	-9.01	-89.86	0.009
+ Vessel	-2.15	-46.39	0.003
+ s(depth)	-2.55	-3.14	0.002
+ s(slope)	-1.53	23.94	0.000

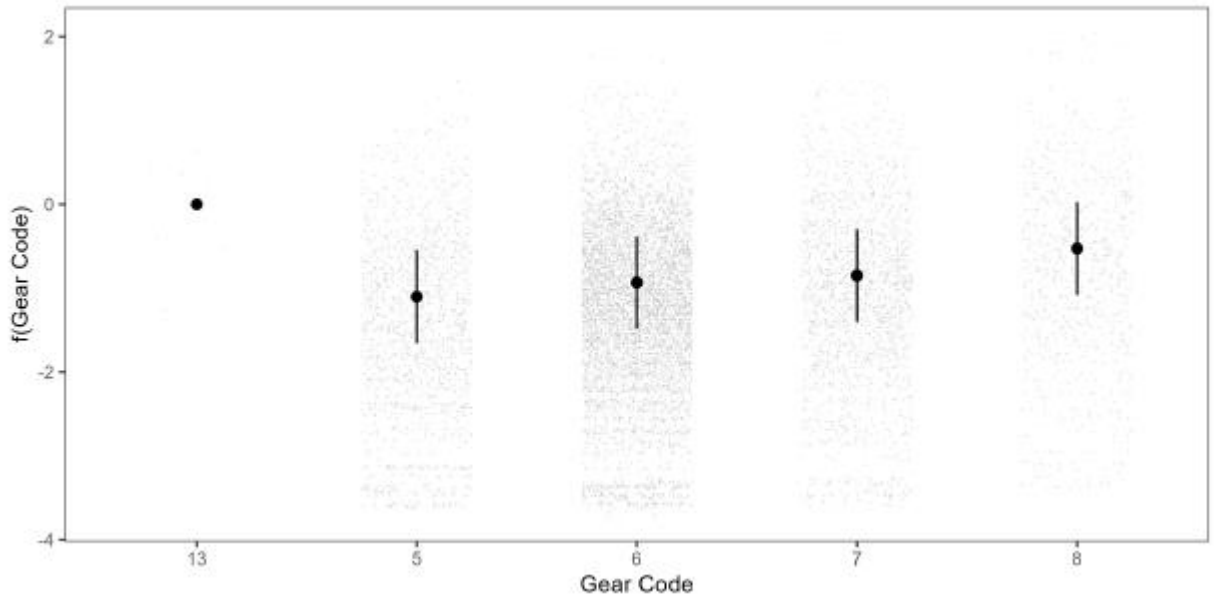
Null: ln(CPUE) = Year:Block

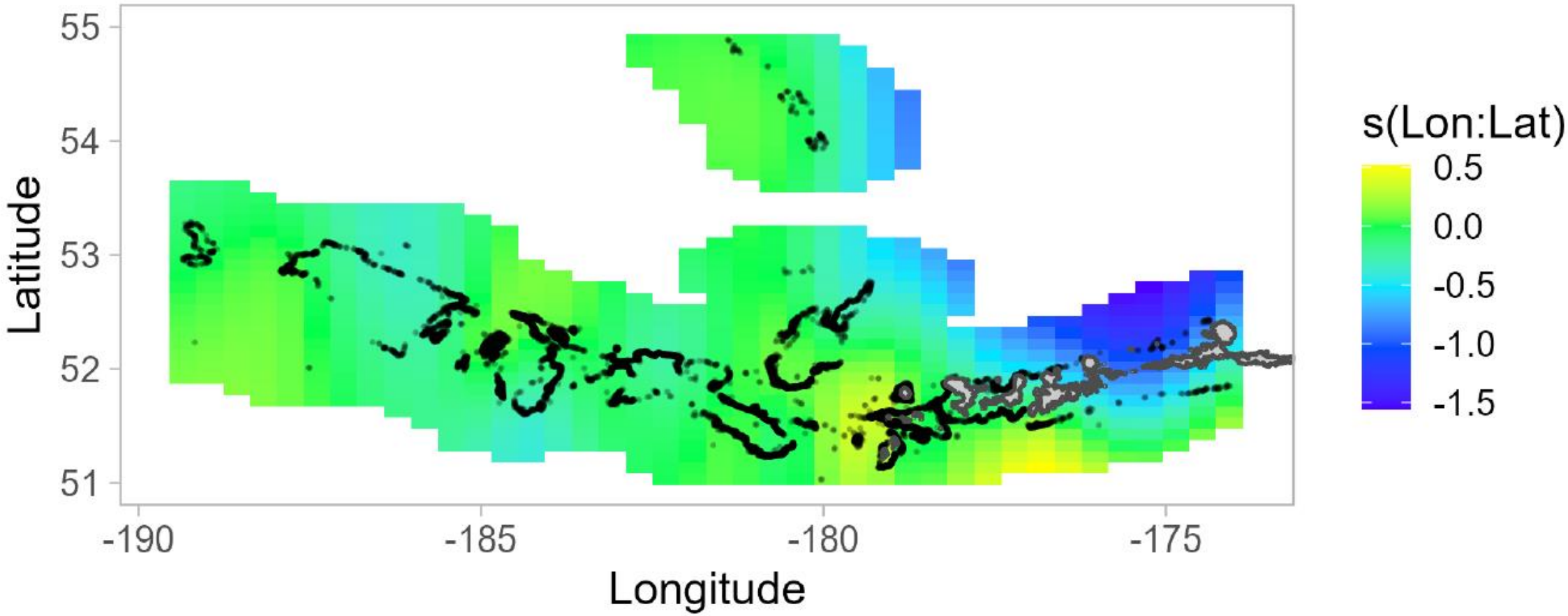
Form ($\theta = 1.102$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr:B + Gr	15,905	180,116	0.15
+ s(soak time)	-7.49	-62.46	0.007
+ Month	-9.00	-88.48	0.008
+ Vessel	-6.00	-68.81	0.006
+ Permit Holder	-16.00	-5.55	0.008
+ s(depth)	-2.85	-40.88	0.003
+ s(slope)	-1.99	-4.45	0.001

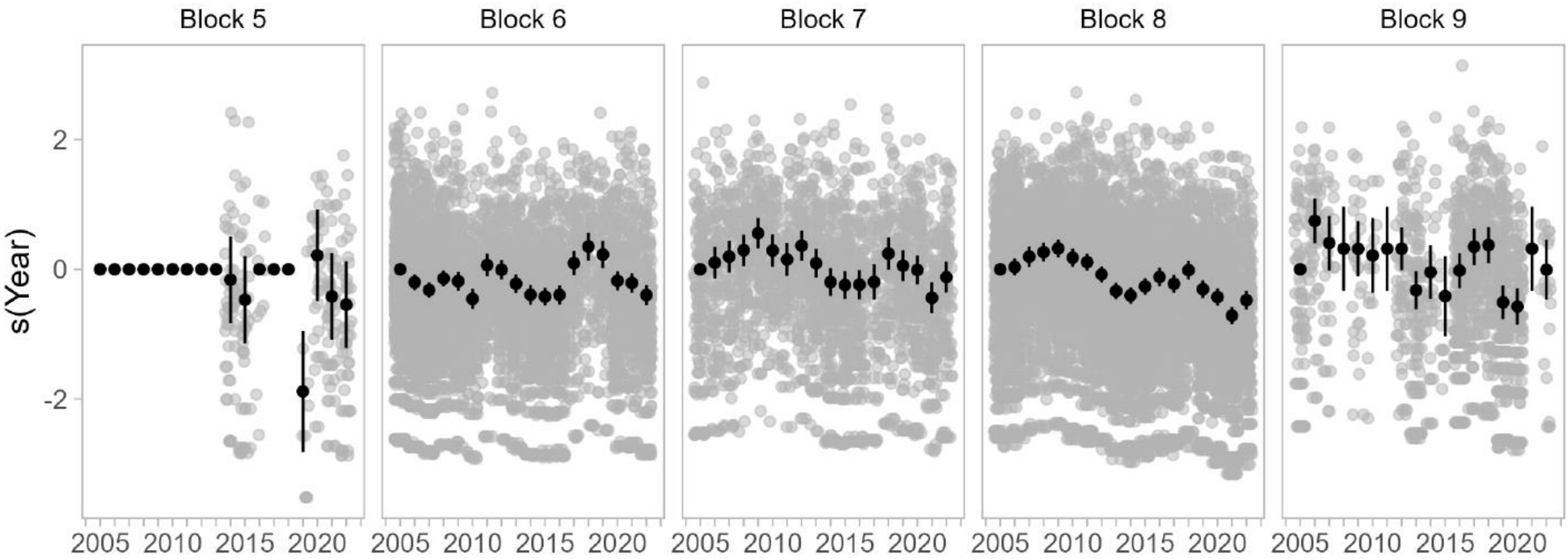
Models with block 10 data resulted in null deviance, data removed


0
-10
-20
-30
-40
f(Permit Holder)
Permit Holder


0
-10
-20
-30
f(Gear)
Gear


2
0
-2
-4
f(Gear Code)
13
5
6
7
8
Gear Code


55
54
53
52
51
Latitude
-190
-185
-180
-175
Longitude
s(Lon:Lat)
0.5
0.0
-0.5
-1.0
-1.5


Block 5
Block 6
Block 7
Block 8
Block 9
s(Year)
2
0
-2
2005
2010
2015
2020


WAG
Legal GLM
Legal GAM
Legal GAM yr:block
Legal Nominal
CPUE Index
1.4
1.2
1.0
0.8
1995
2000
2005
2010
2015
2020

Observer CPUE Standardization

- Observer indices would need to update nominal data, regardless of estimation method
- Permit Holder likely fits more to noise than Vessel, but accounts for similar process
- s(lon, lat) is possibly overfitting data (high df), but has small influence on index
- Excess zeros for negative binomial, hurdle model may be appropriate
  - Zero-truncated negative binomial not available in *mgcv*
  - Available in *VGAM* package, but need more time to get acquainted – estimation of df on smooth terms not equivalent to *mgcv*
- Move on without Year:Block
  - Did not improve deviance explained
  - Required subsetting data
  - Block design not biologically meaningful

Appendix B – Fish Ticket CPUE Std 1985-1998

- Core data selection - Vessels and permit holders in > 5 seasons

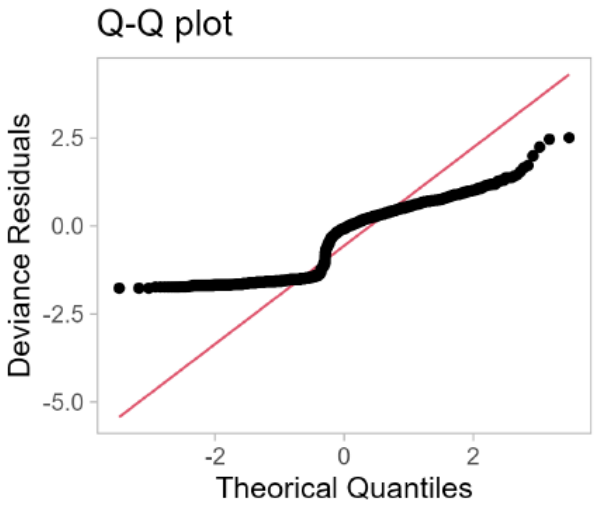
EAG

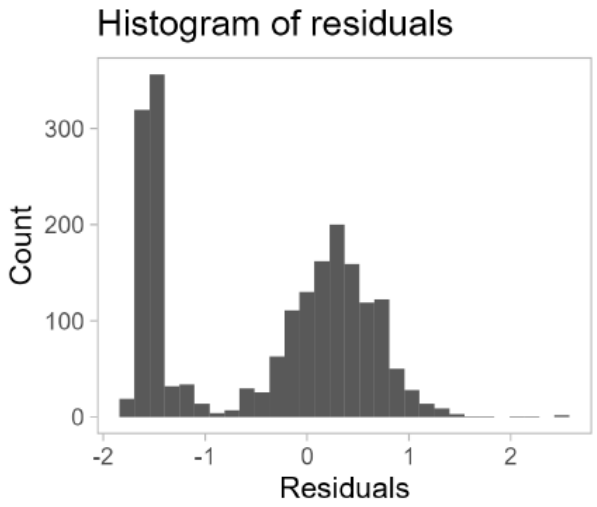
Form ($\theta = 0.557$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + Vessel	1,985	10,993	0.079
+ Permit Holder	-19	-2	
+ Month	-11	65	
+ Stat Area	-38	251	

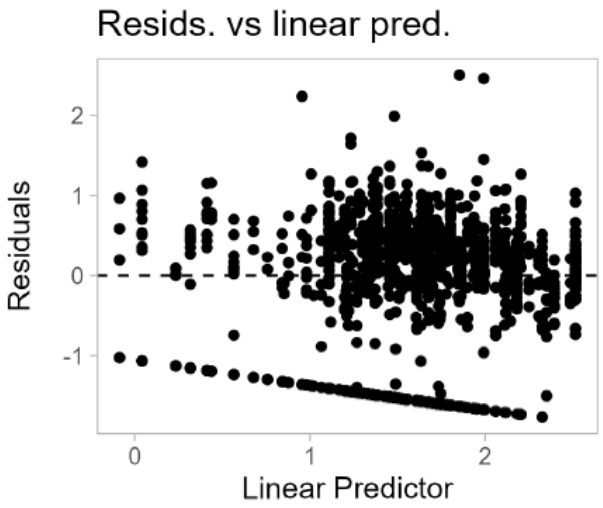
WAG

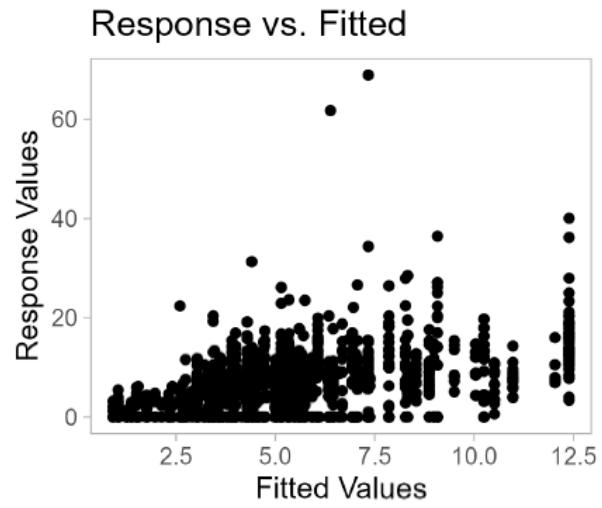
Form ($\theta = 0.88$)	Residual DF (Δ DF)	AIC (Δ AIC)	R^2 (Δ R^2)
Yr + Vessel	3,323	19,775	0.152
+ Permit Holder	-9	55	
+ Month	-11	31	
+ Stat Area	-88	705	

EAG

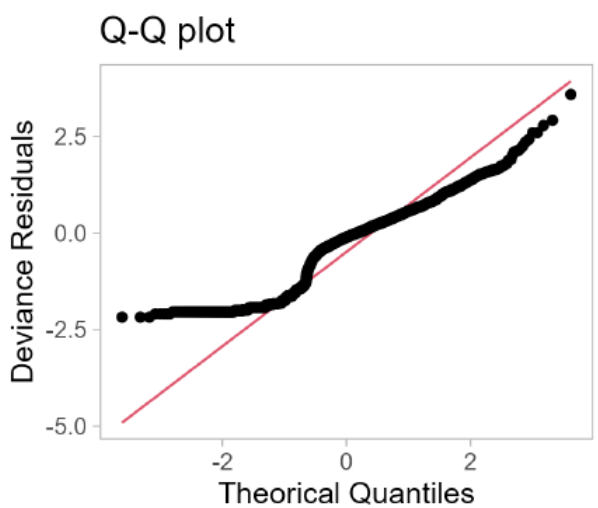

Q-Q plot
Deviance Residuals
2.5
0.0
-2.5
-5.0
-2
0
2
Theorical Quantiles

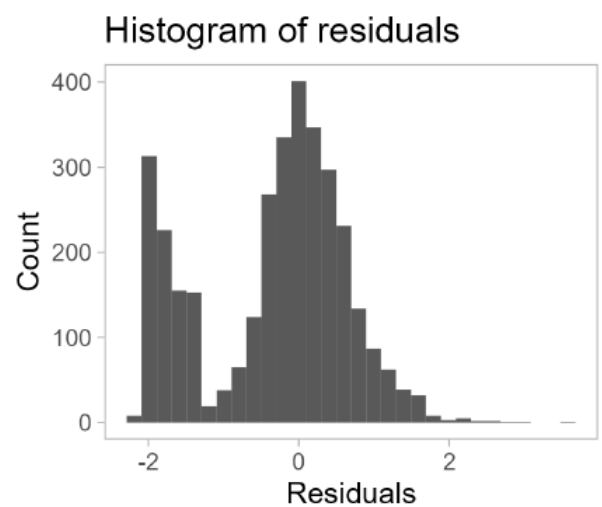

Histogram of residuals
Count
300
200
100
0
-2
-1
0
1
2
Residuals

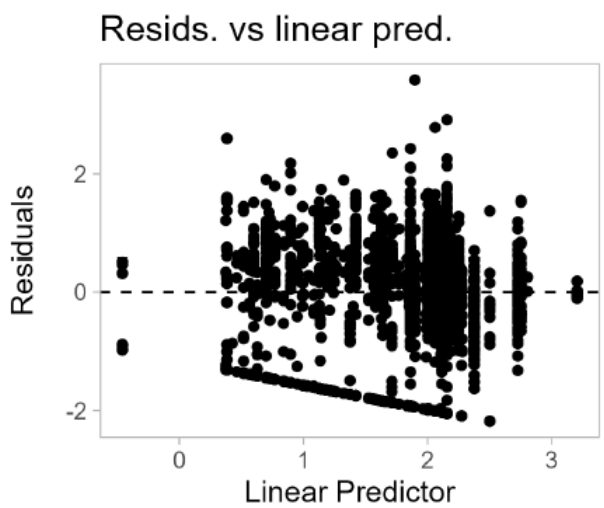

Resids. vs linear pred.
Residuals
2
1
0
-1
0
1
2
Linear Predictor

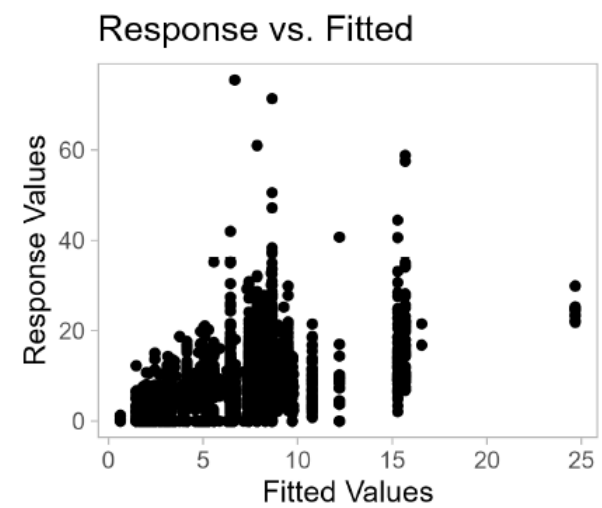

Response vs. Fitted
Response Values
60
40
20
0
2.5
5.0
7.5
10.0
12.5
Fitted Values

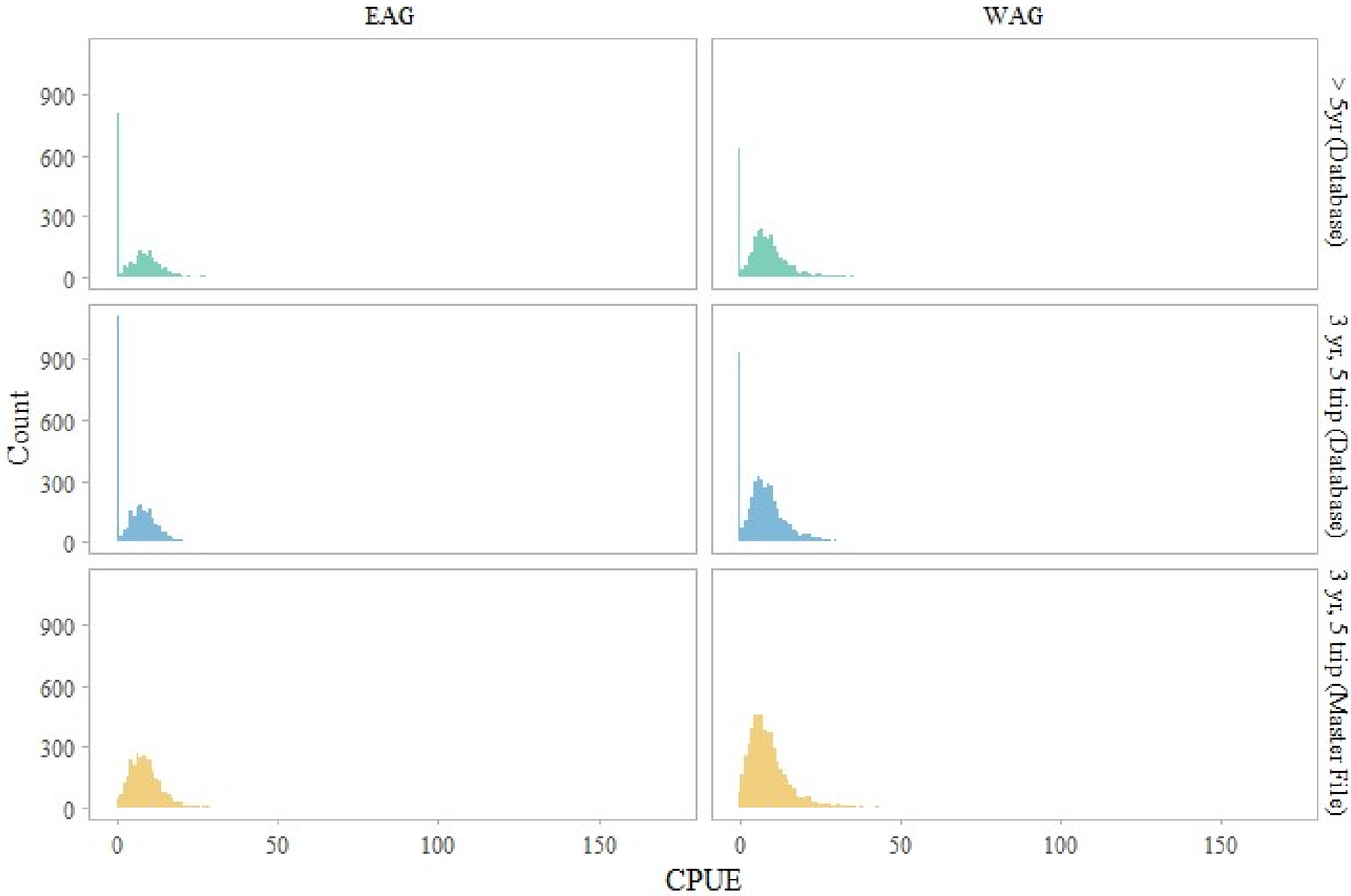
WAG


Q-Q plot
Deviance Residuals
2.5
0.0
-2.5
-5.0
-2
0
2
Theorical Quantiles

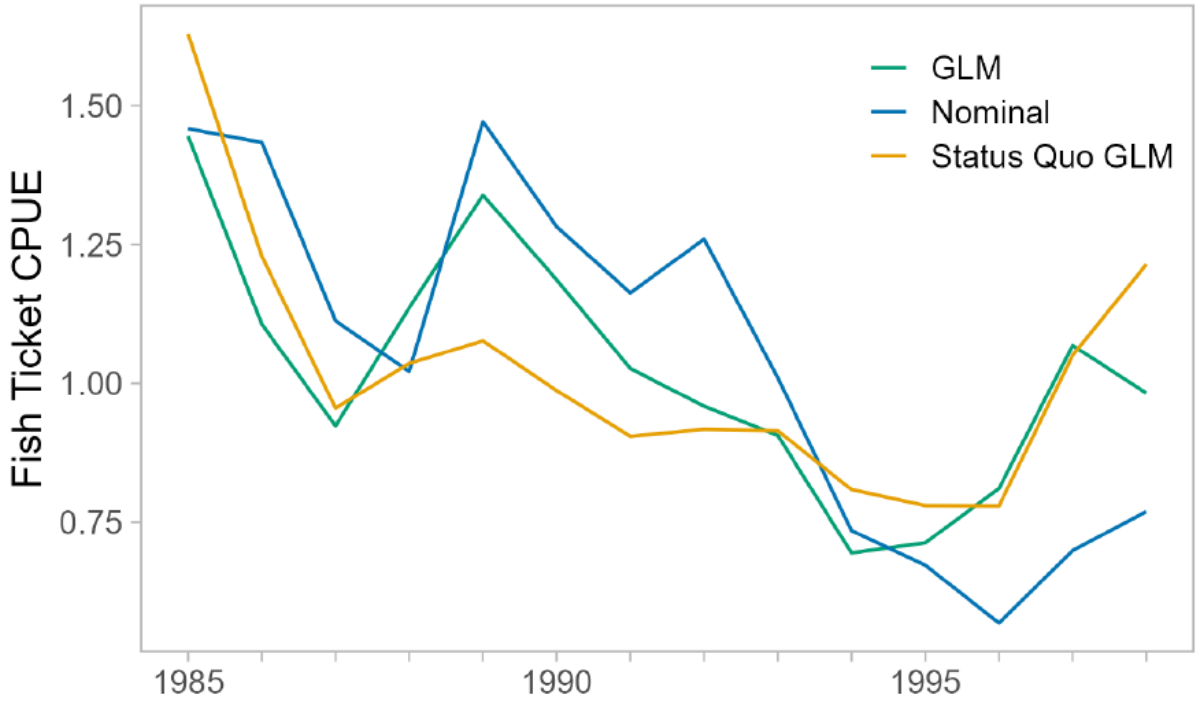

Histogram of residuals
Count
400
300
200
100
0
-2
0
2
Residuals


Resids. vs linear pred.
Residuals
2
0
-2
0
1
2
3
Linear Predictor

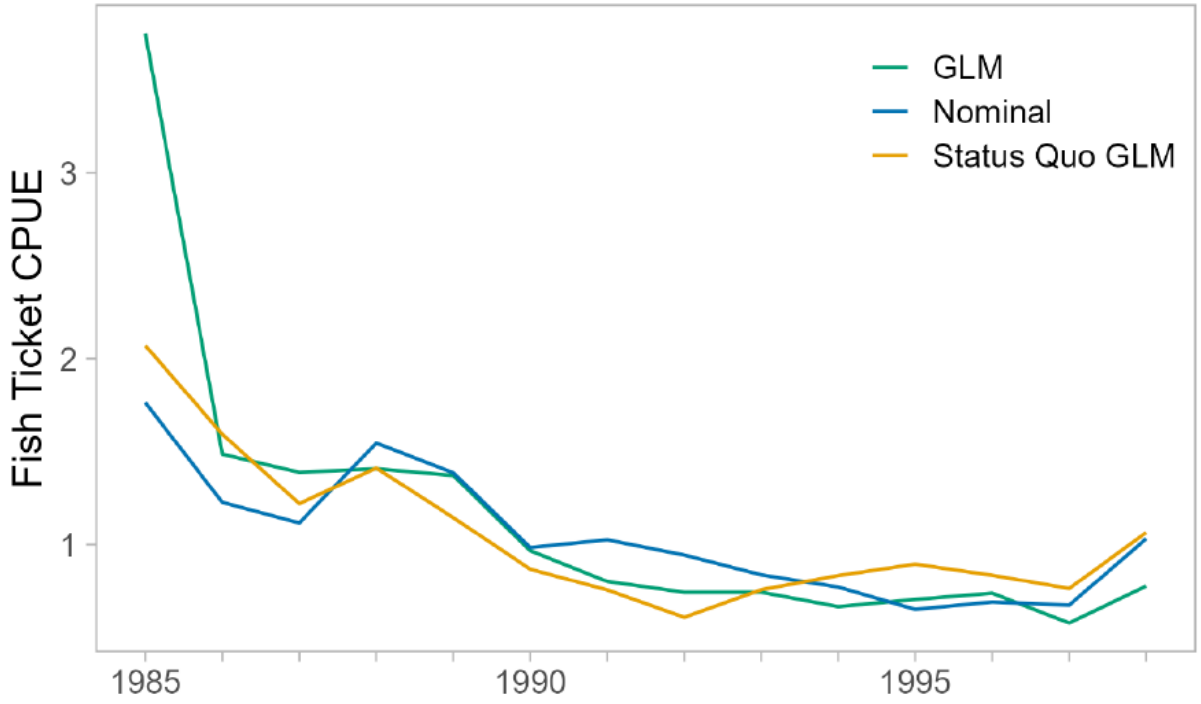

Response vs. Fitted
Response Values
60
40
20
0
0
5
10
15
20
25
Fitted Values

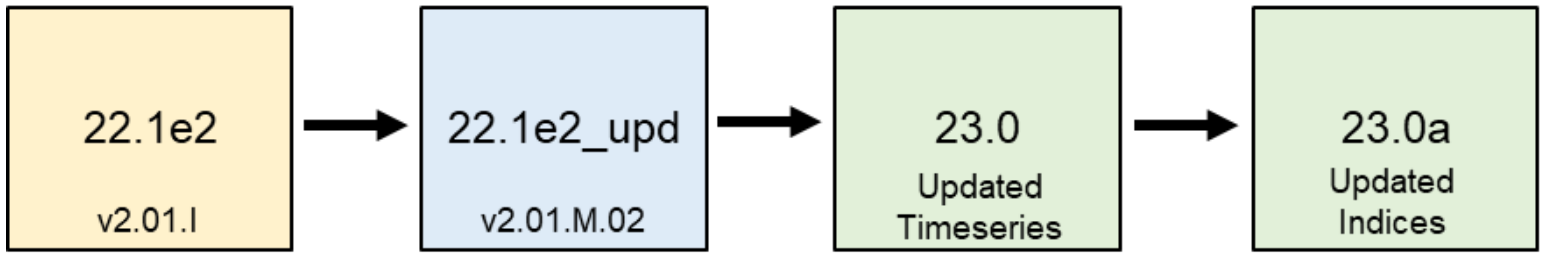

EAG
WAG
< 5yr (Database)
3 yr, 5 trip (Database)
3 yr, 5 trip (Master File)
Count
900
600
300
0
0
50
100
150
CPUE

EAG

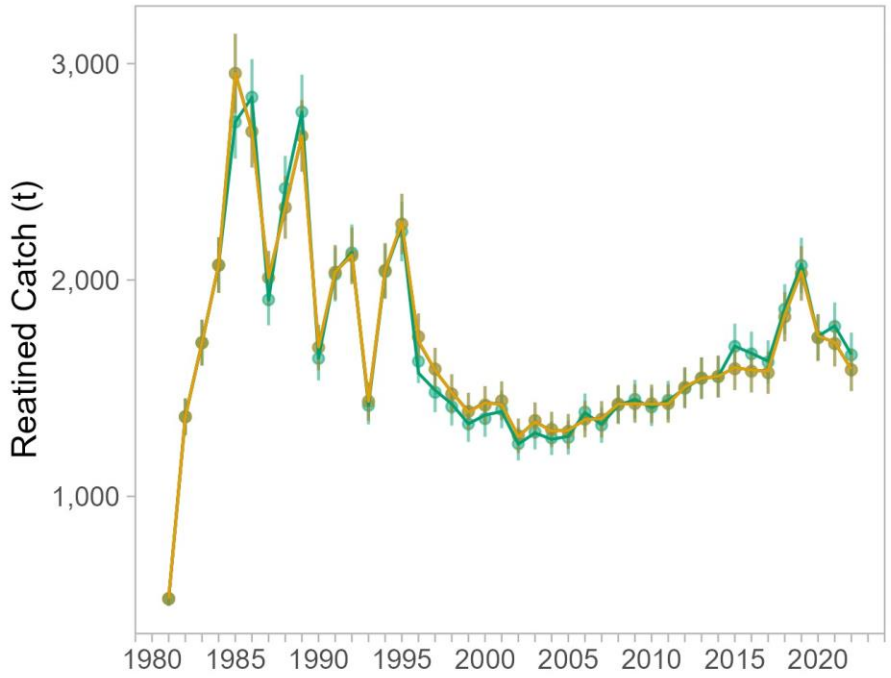

GLM
Nominal
Status Quo GLM
Fish Ticket CPUE
1.50
1.25
1.00
0.75
1985
1990
1995

WAG

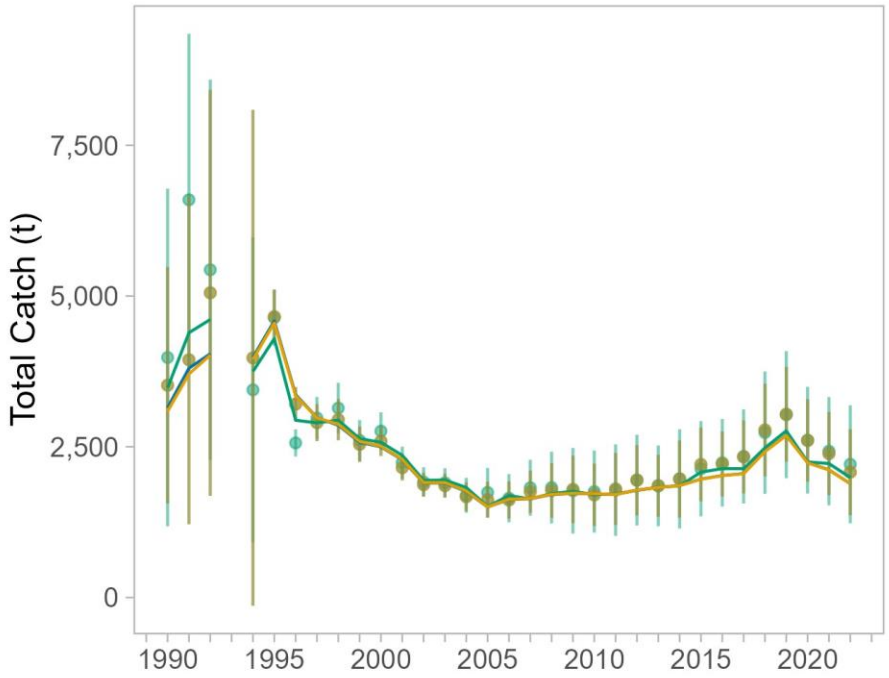

GLM
Nominal
Status Quo GLM
Fish Ticket CPUE
3
2
1
1985
1990
1995


22.1e2
v2.01.I
22.1e2_upd
v2.01.M.02
23.0
Updated
Timeseries
23.0a
Updated
Indices

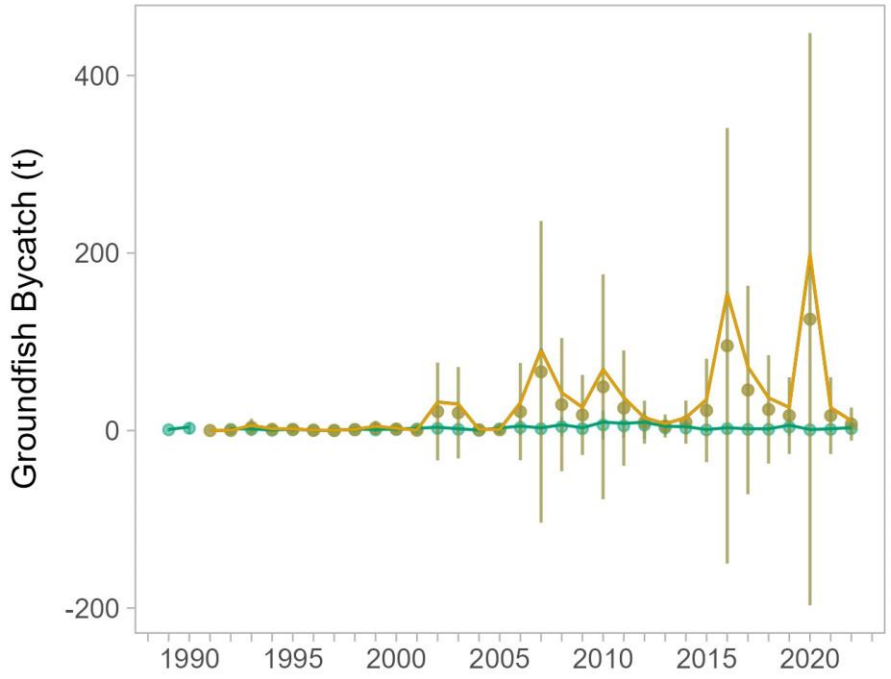
EAG


Reatined Catch (t)
3,000
2,000
1,000
1980
1985
1990
1995
2000
2005
2010
2015
2020


22.1e2
23.0
23.0a

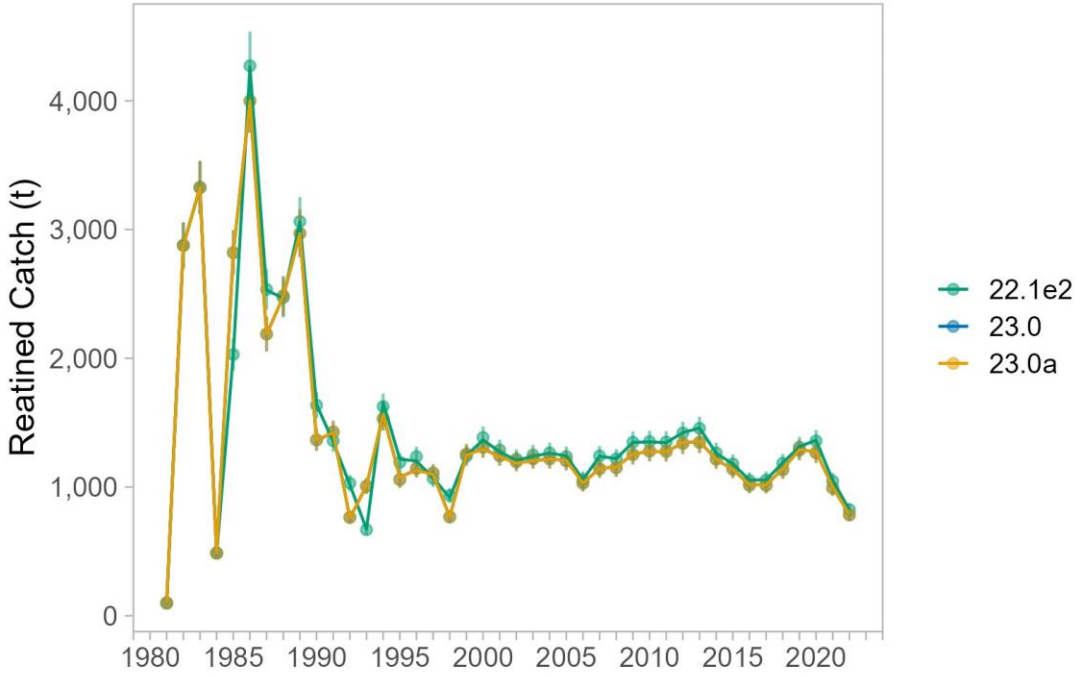

Total Catch (t)
7,500
5,000
2,500
0
1990
1995
2000
2005
2010
2015
2020

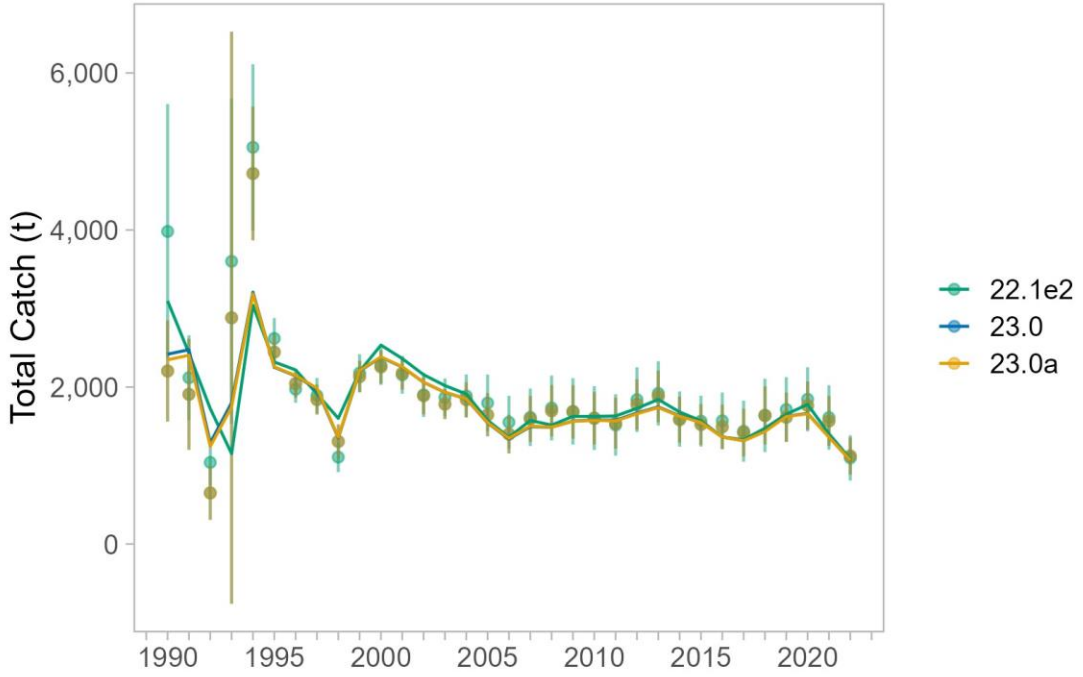

22.1e2
23.0
23.0a

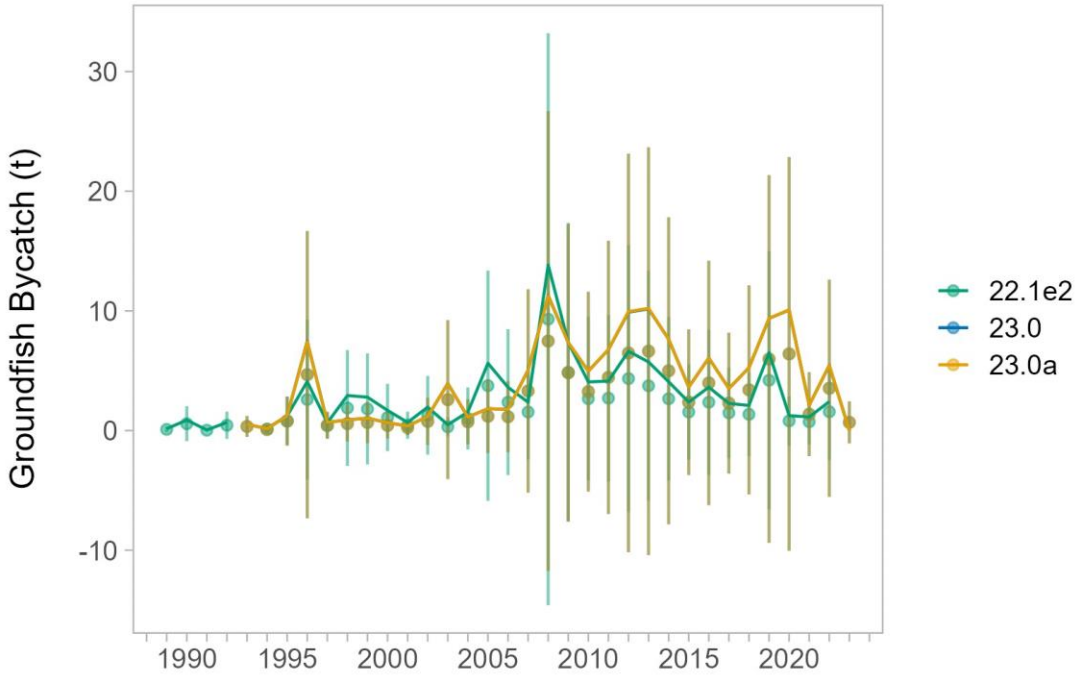

Groundfish Bycatch (t)
400
200
0
-200
1990
1995
2000
2005
2010
2015
2020


22.1e2
23.0
23.0a

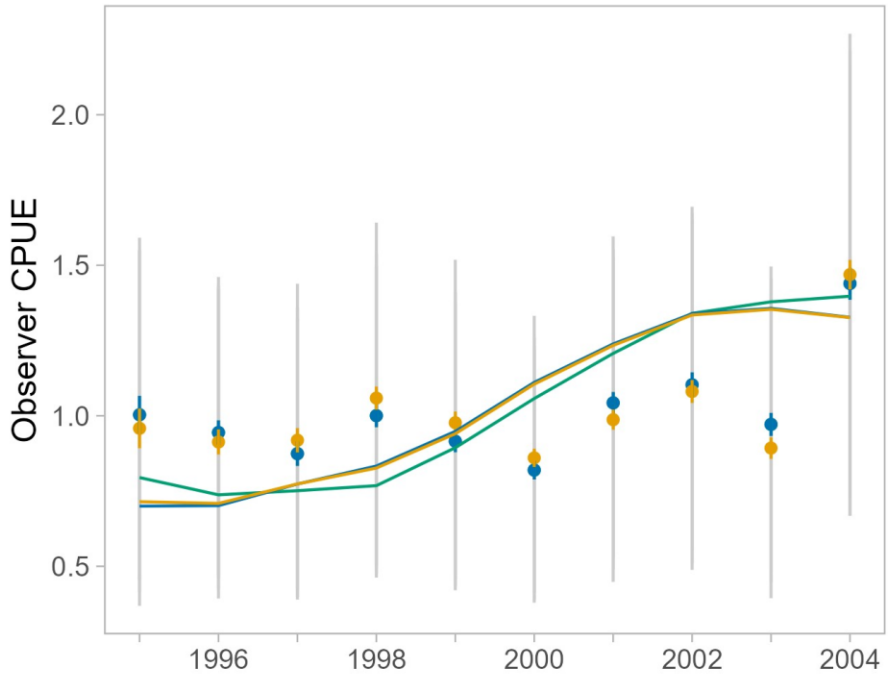
WAG

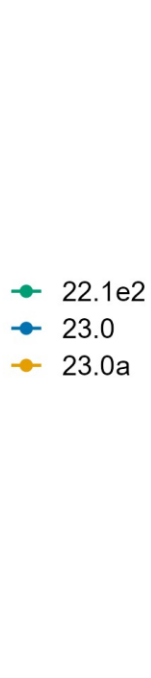

Reatined Catch (t)
4,000
3,000
2,000
1,000
0
1980
1985
1990
1995
2000
2005
2010
2015
2020
22.1e2
23.0
23.0a

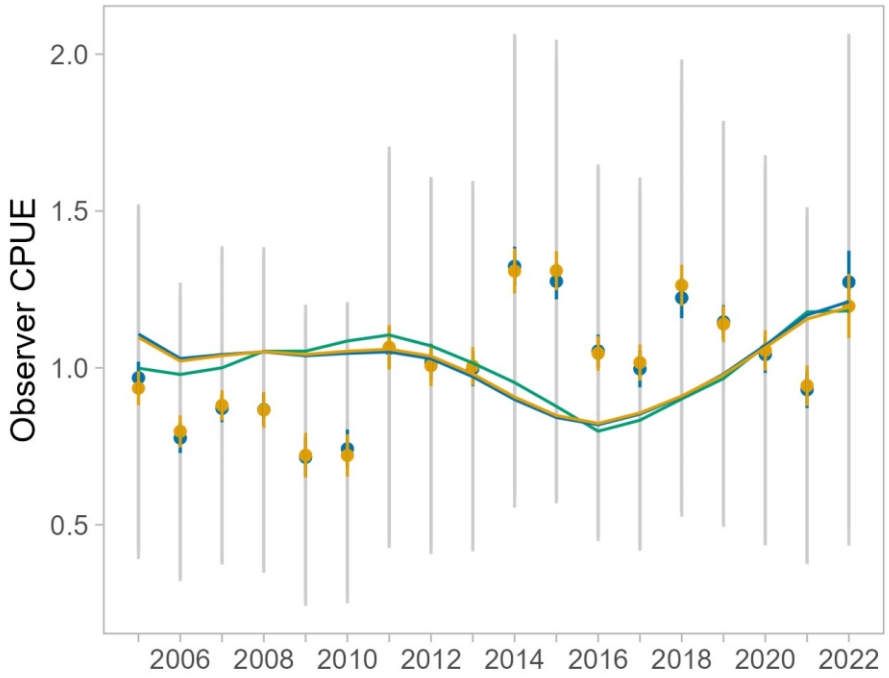

Total Catch (t)
6,000
4,000
2,000
0
1990
1995
2000
2005
2010
2015
2020
22.1e2
23.0
23.0a

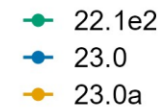

Groundfish Bycatch (t)
30
20
10
0
-10
1990
1995
2000
2005
2010
2015
2020
22.1e2
23.0
23.0a

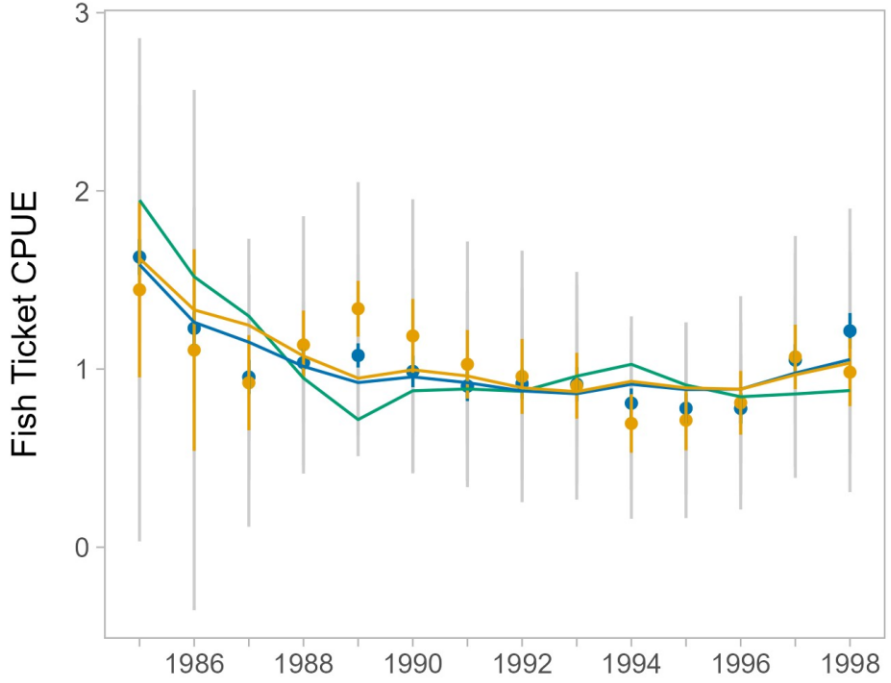
EAG

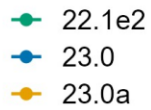

Observer CPUE
2.0
1.5
1.0
0.5
1996
1998
2000
2002
2004


22.1e2
23.0
23.0a

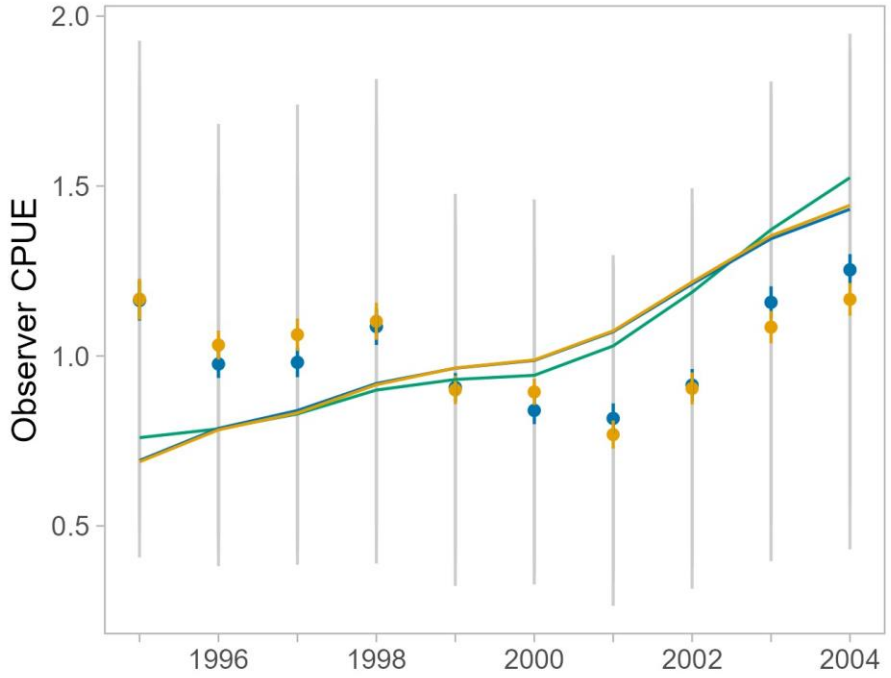

Observer CPUE
2.0
1.5
1.0
0.5
2006
2008
2010
2012
2014
2016
2018
2020
2022

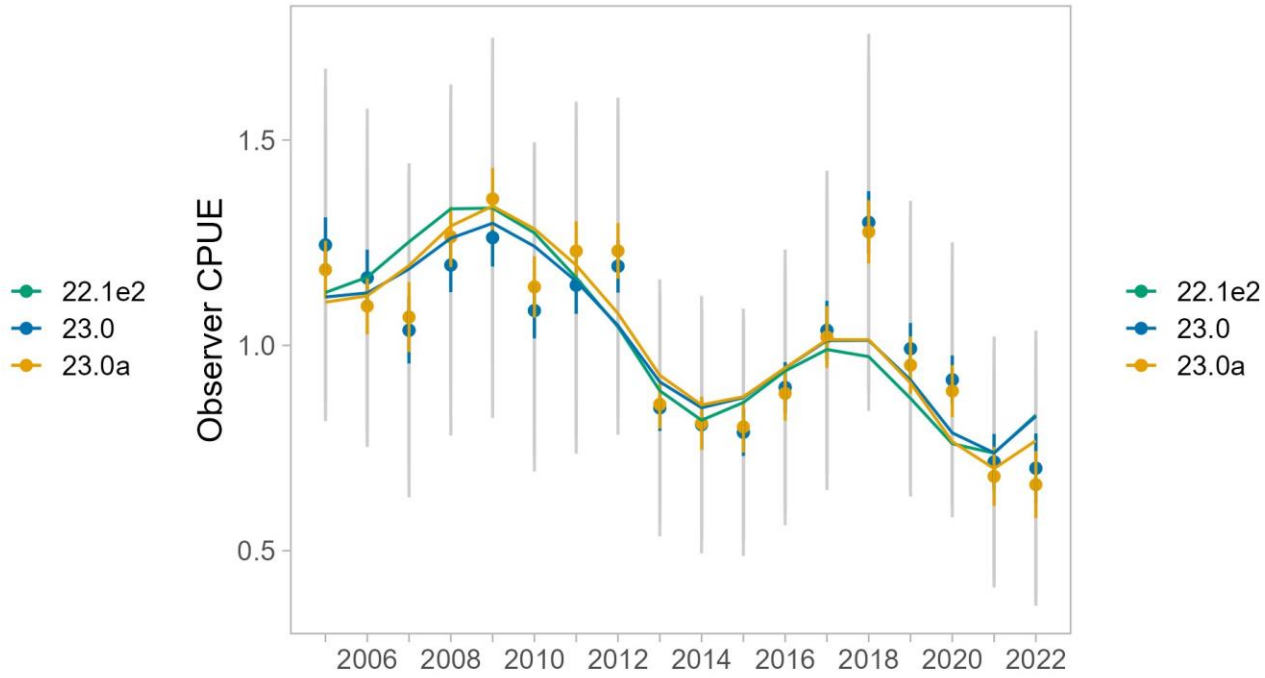

22.1e2
23.0
23.0a

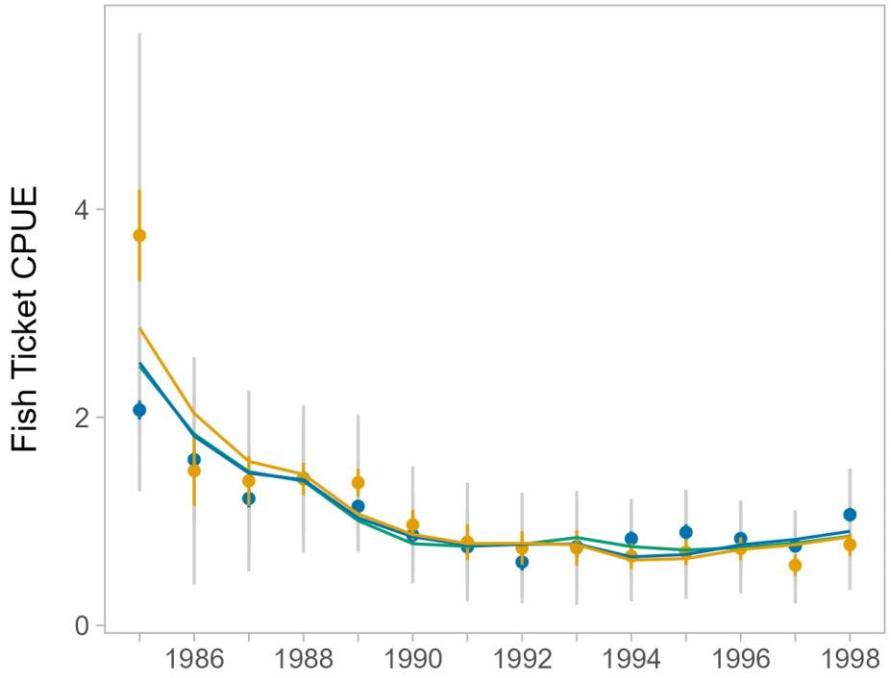

Fish Ticket CPUE
3
2
1
0
1986
1988
1990
1992
1994
1996
1998


22.1e2
23.0
23.0a

WAG

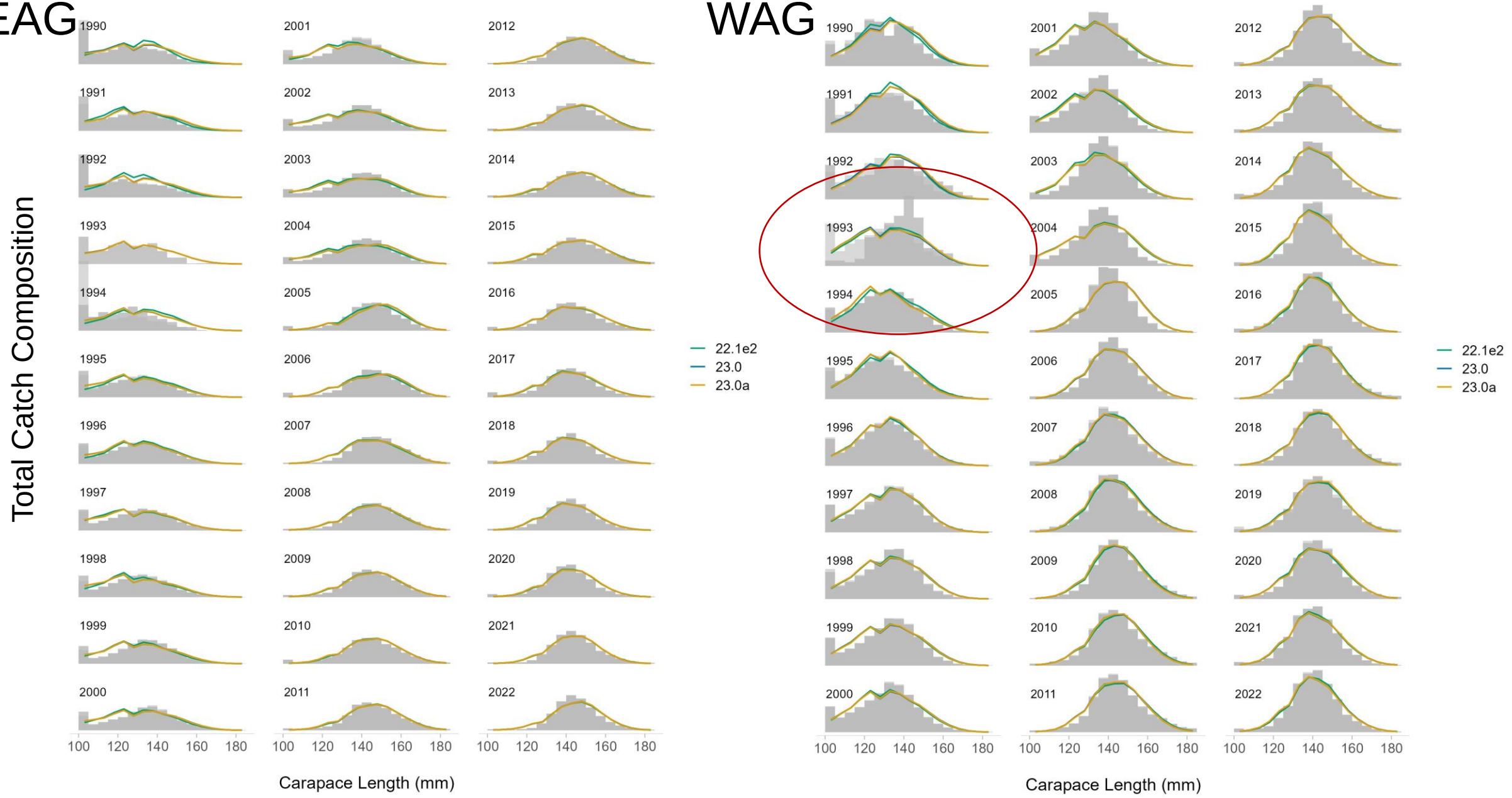

Observer CPUE
2.0
1.5
1.0
0.5
1996
1998
2000
2002
2004


Observer CPUE
1.5
1.0
0.5
2006
2008
2010
2012
2014
2016
2018
2020
2022
22.1e2
23.0
23.0a

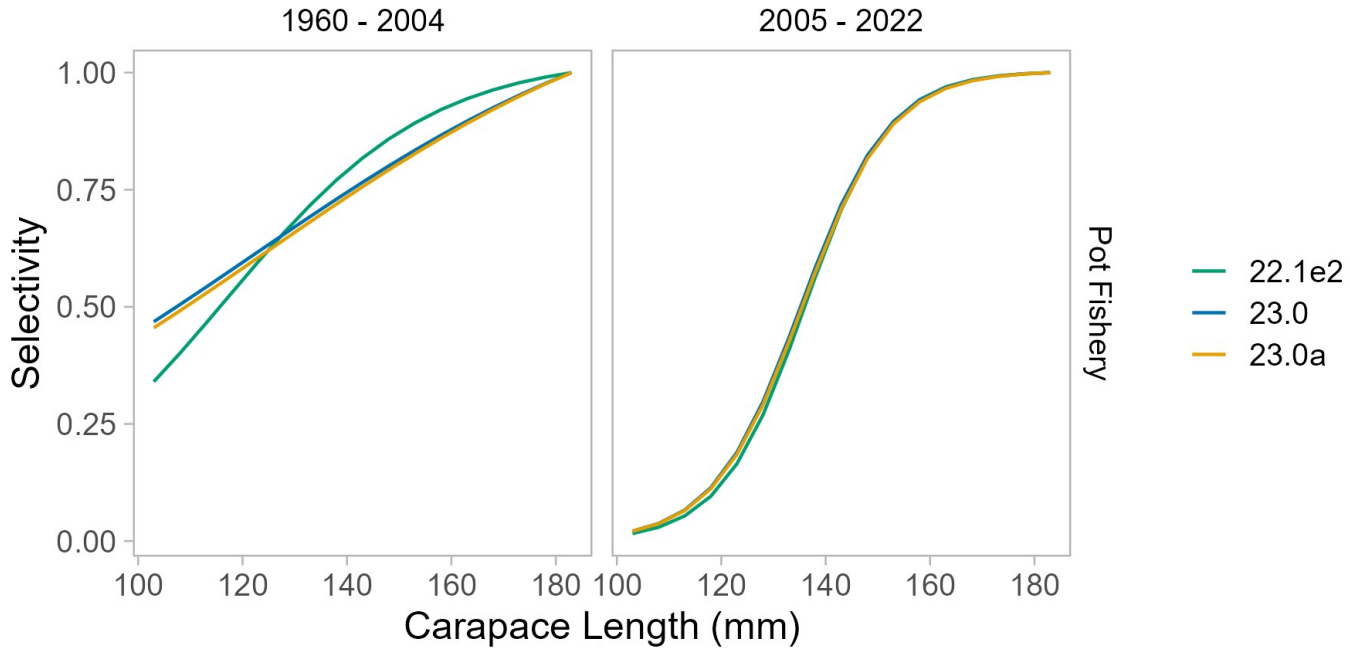

Fish Ticket CPUE
4
2
0
1986
1988
1990
1992
1994
1996
1998
22.1e2
23.0
23.0a

EAG

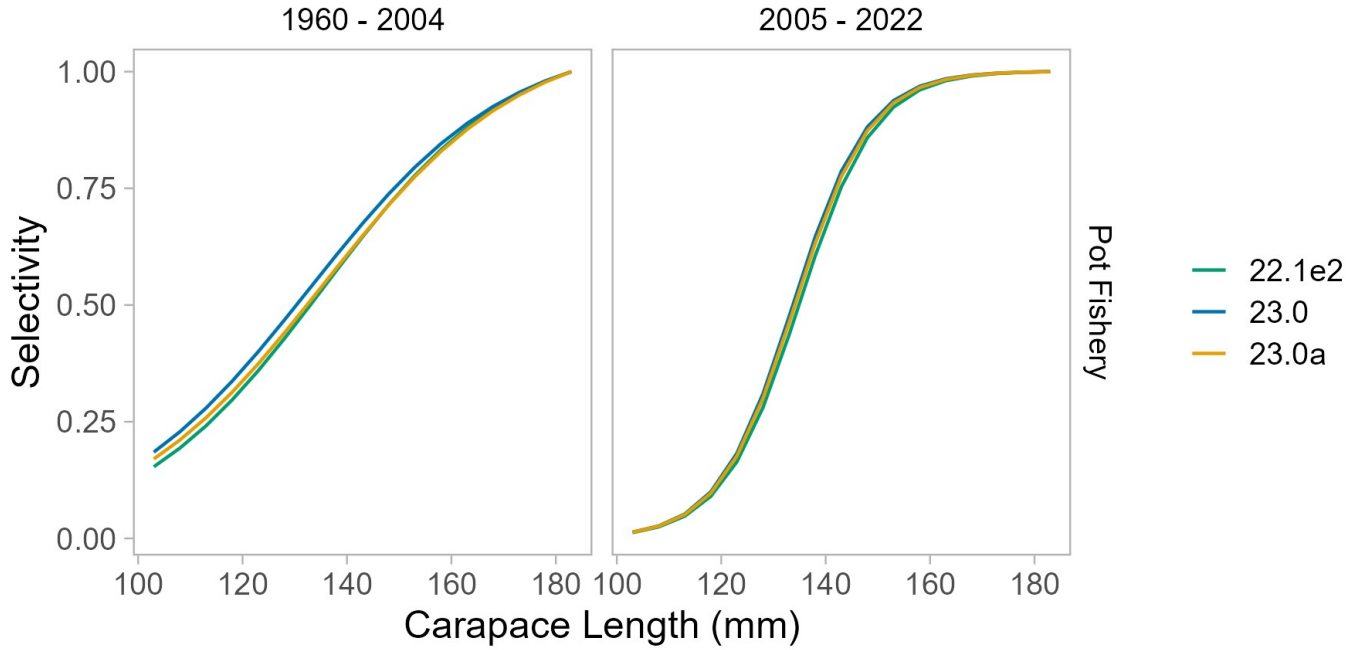
WAG


Total Catch Composition
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
100
120
140
160
180
Carapace Length (mm)
22.1e2
23.0
23.0a

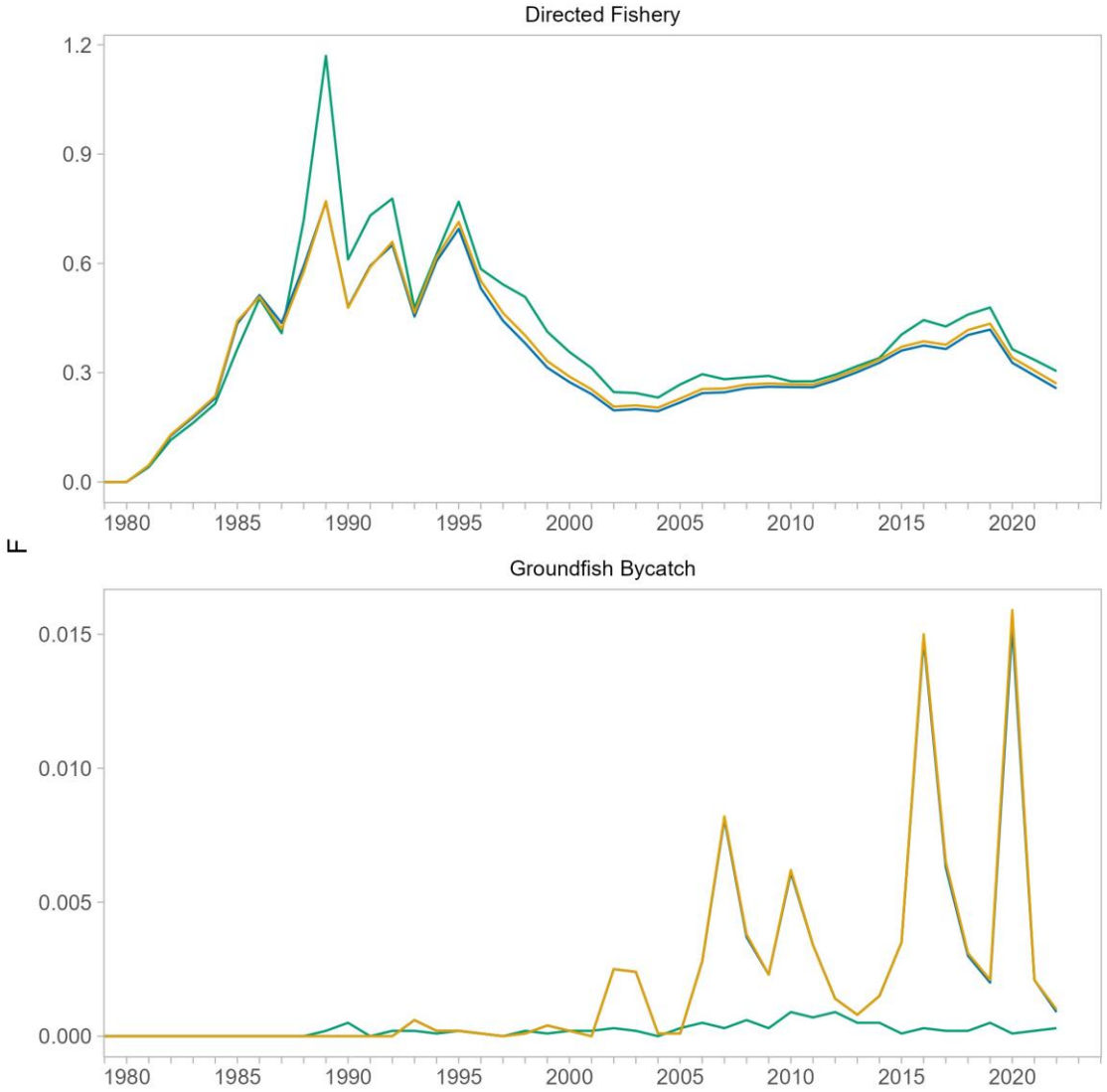
EAG


1960 - 2004
2005 - 2022
Selectivity
1.00
0.75
0.50
0.25
0.00
100
120
140
160
180
Carapace Length (mm)
Pot Fishery
22.1e2
23.0
23.0a

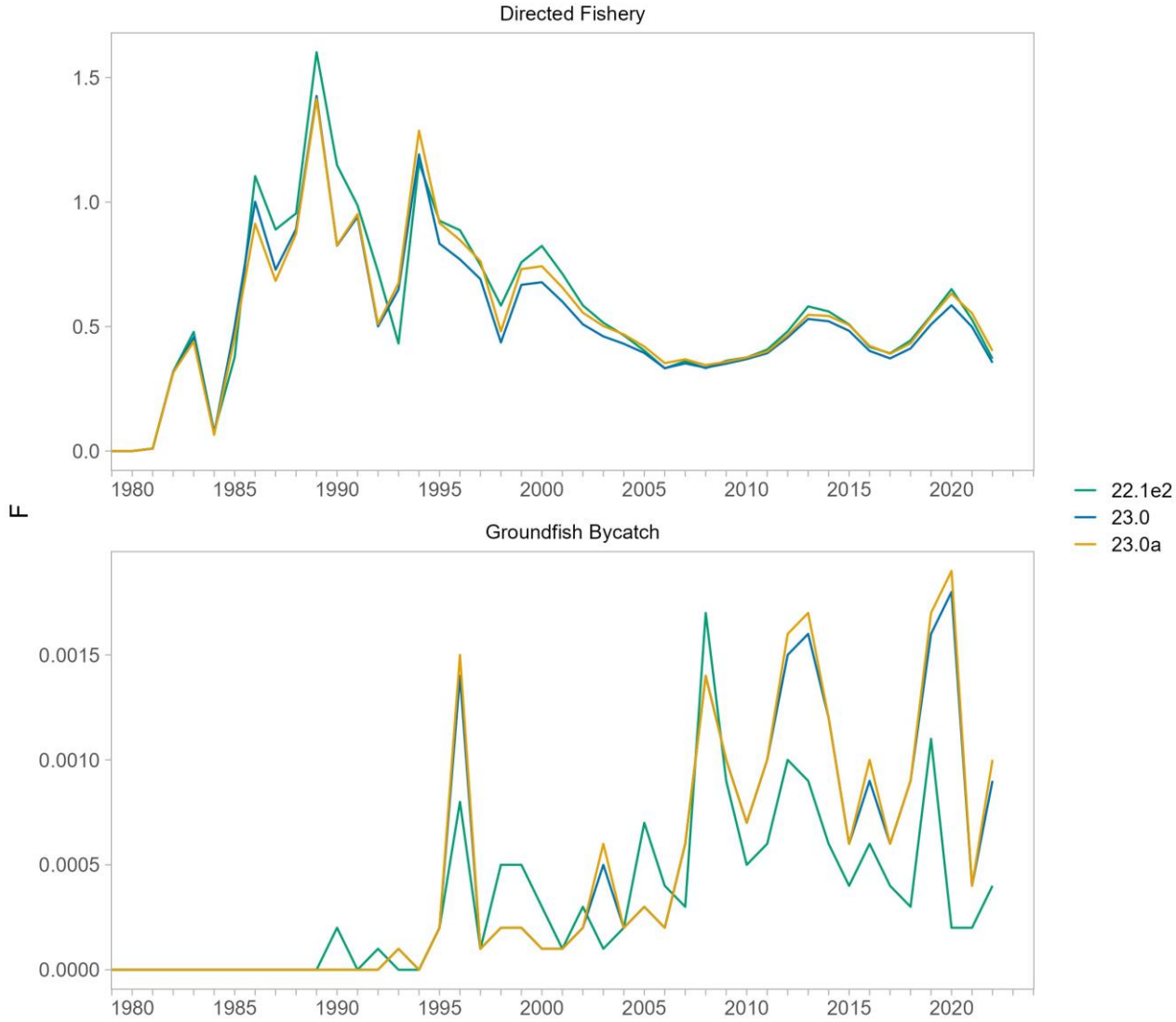
WAG


1960 - 2004
2005 - 2022
Selectivity
1.00
0.75
0.50
0.25
0.00
100
120
140
160
180
Carapace Length (mm)
Pot Fishery
22.1e2
23.0
23.0a

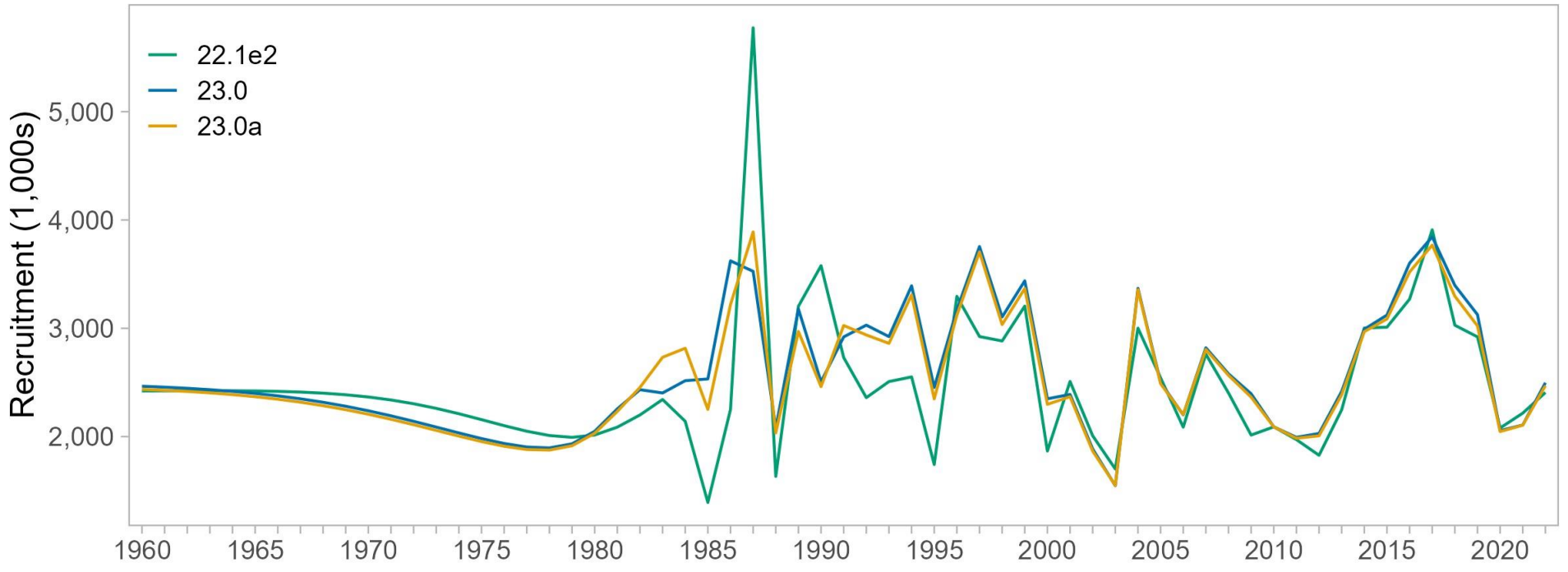
EAG


Directed Fishery
F
1.2
0.9
0.6
0.3
0.0
1980
1985
1990
1995
2000
2005
2010
2015
2020
Groundfish Bycatch
0.015
0.010
0.005
0.000

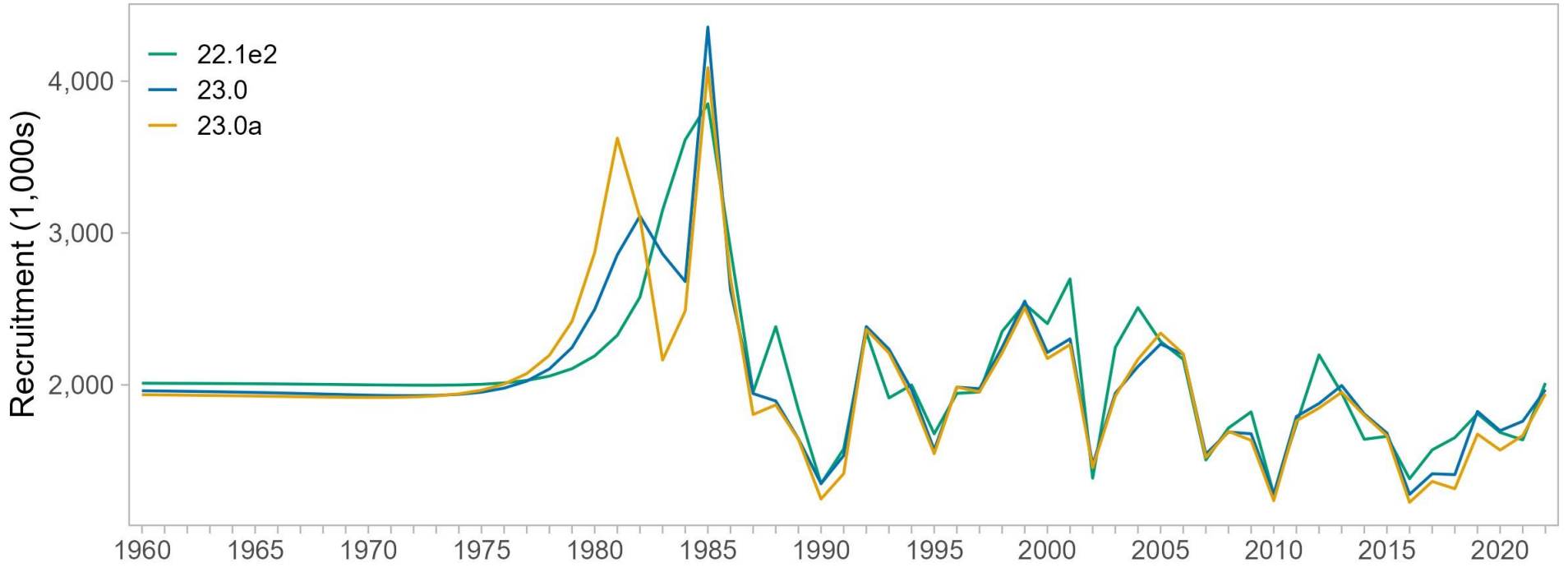
WAG


Directed Fishery
F
1.5
1.0
0.5
0.0
1980
1985
1990
1995
2000
2005
2010
2015
2020
Groundfish Bycatch
0.0015
0.0010
0.0005
0.0000
22.1e2
23.0
23.0a

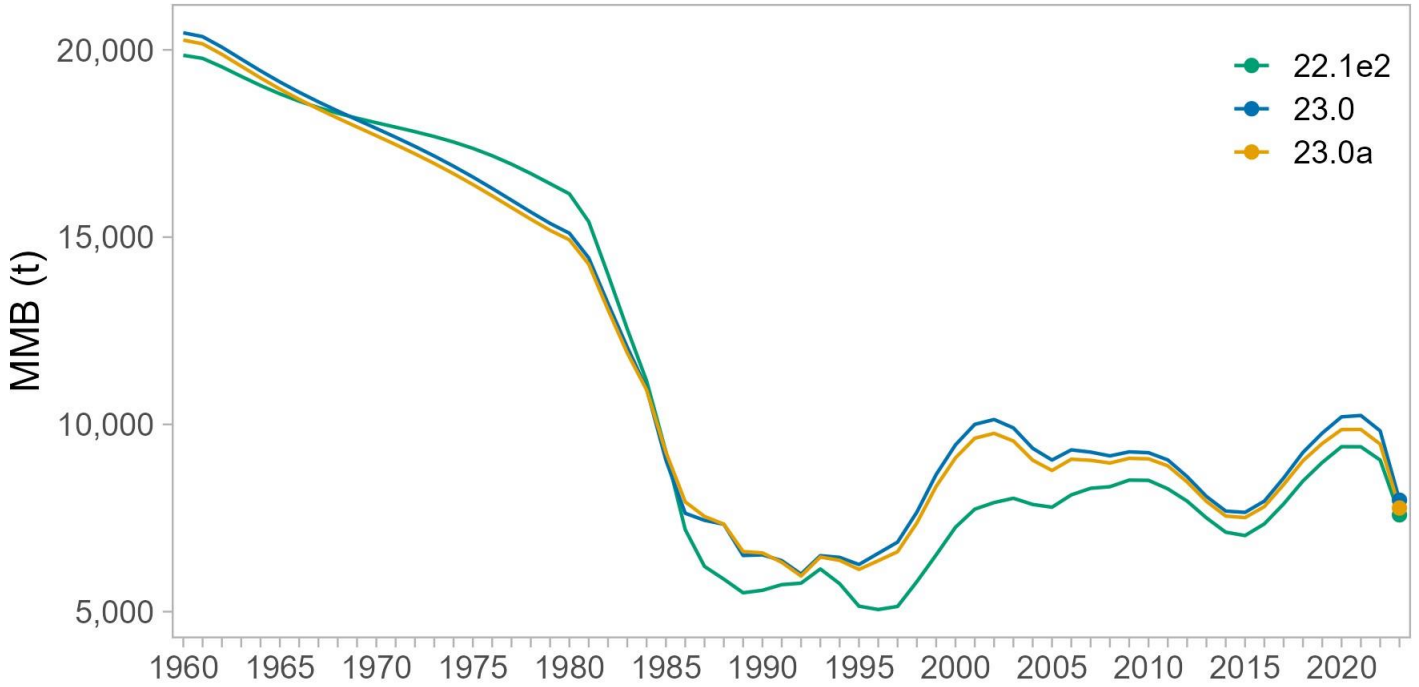
EAG


22.1e2
23.0
23.0a
Recruitment (1,000s)
5,000
4,000
3,000
2,000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

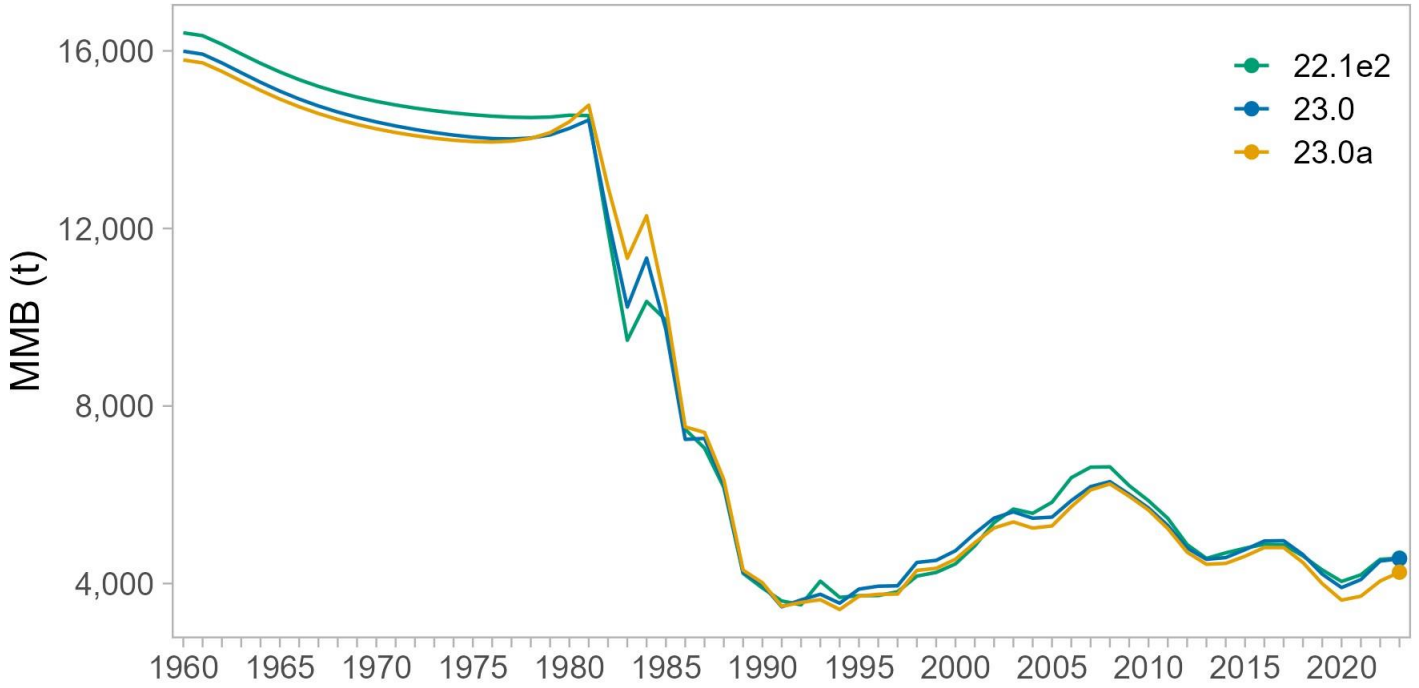
WAG


22.1e2
23.0
23.0a
Recruitment (1,000s)
4,000
3,000
2,000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

EAG


MMB (t)
20,000
15,000
10,000
5,000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
22.1e2
23.0
23.0a

WAG

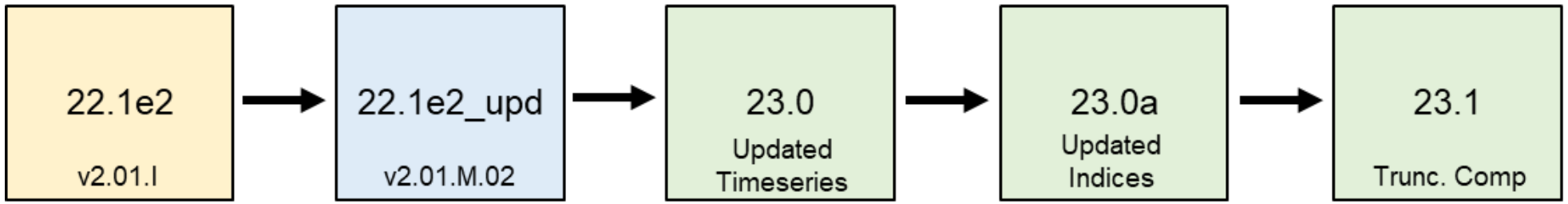

MMB (t)
16,000
12,000
8,000
4,000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
22.1e2
23.0
23.0a

EAG

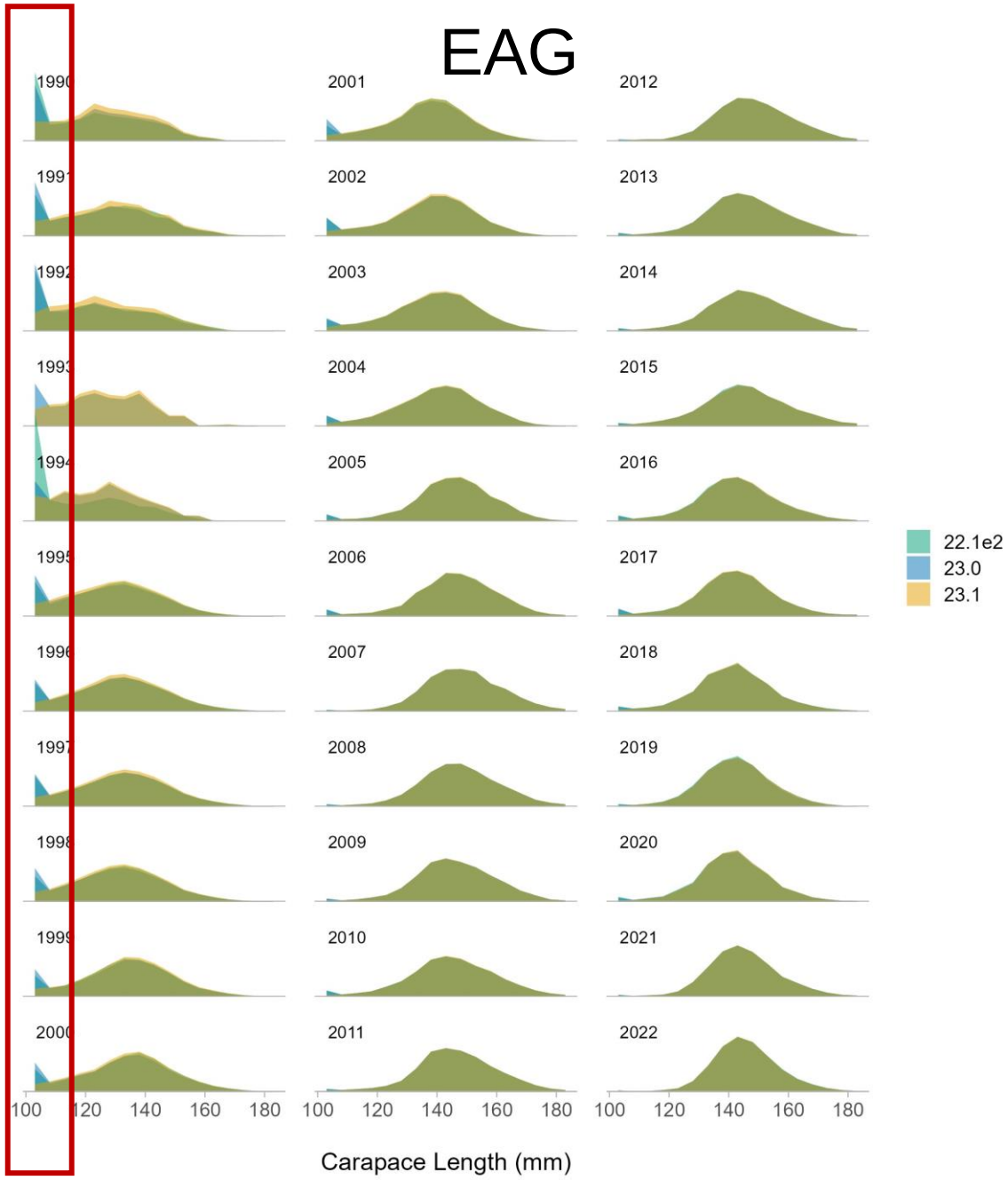
Model	MMB (t)	$B_{35\%}$ (t)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2017}$	$F_{35\%}$	F_{OFL}	OFL (t)
22.1e2	7,584	6,651	1.14	2,611	0.57	0.57	2,861
23.0	7,976	6,966	1.14	2,754	0.55	0.55	3,131
23.0a	7,767	6,877	1.13	2,716	0.56	0.56	3,012

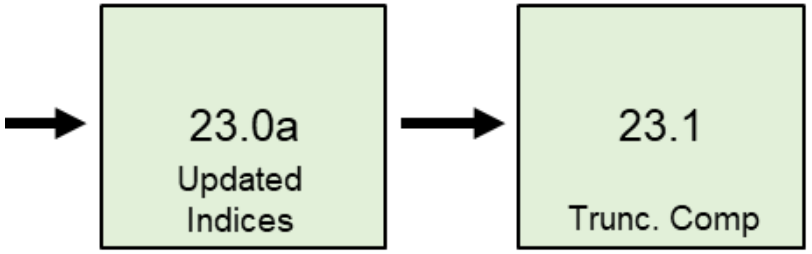
WAG

Model	MMB (t)	$B_{35\%}$ (t)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2017}$	$F_{35\%}$	F_{OFL}	OFL (t)
22.1e2	4,572	4,979	0.92	1,977	0.55	0.50	1,232
23.0	4,556	4,780	0.95	1,905	0.54	0.51	1,268
23.0a	4,256	4,721	0.90	1,879	0.54	0.48	1,078

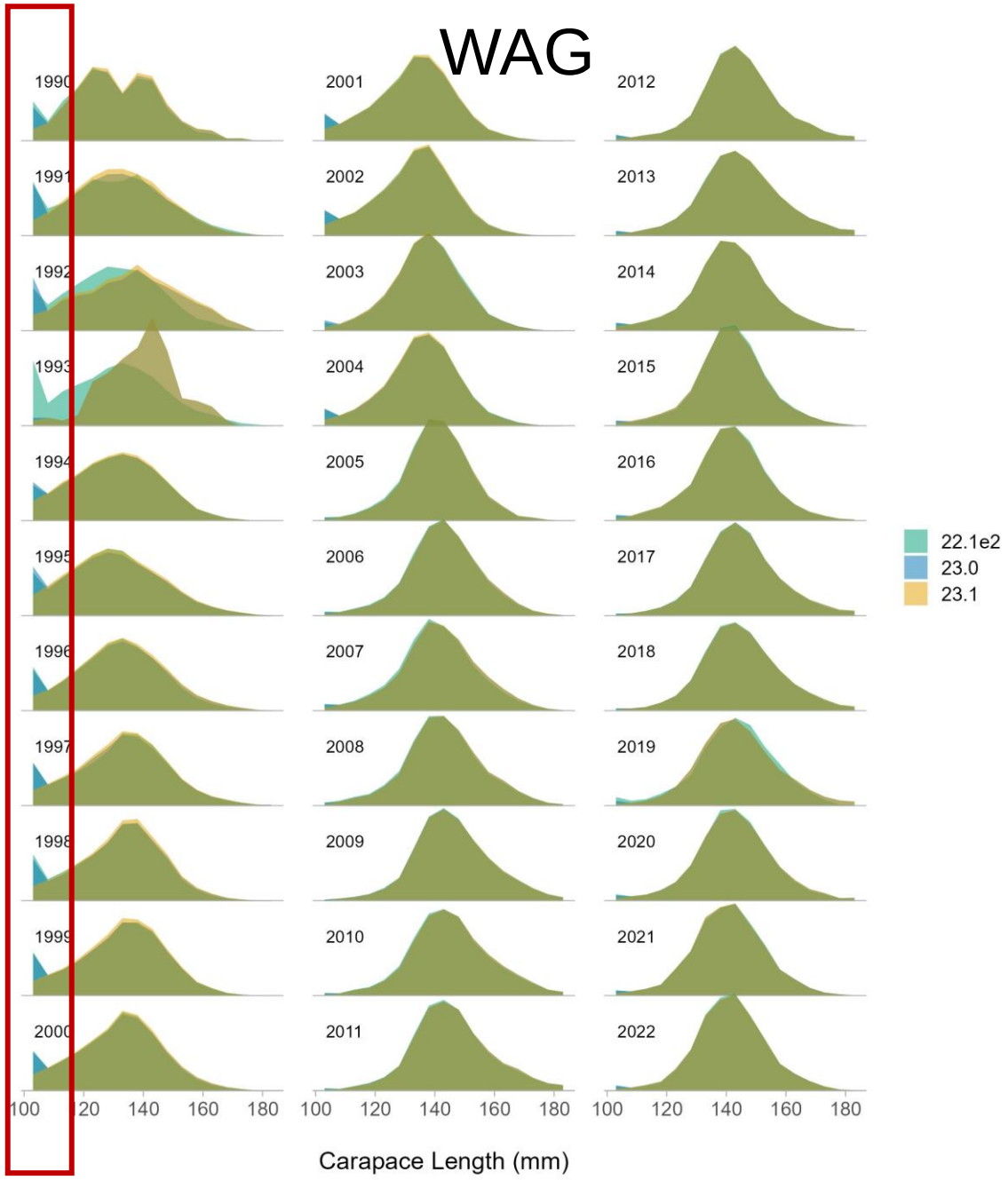

22.1e2
v2.01.I
22.1e2_upd
v2.01.M.02
23.0
Updated
Timeseries
23.0a
Updated
Indices
23.1
Trunc. Comp

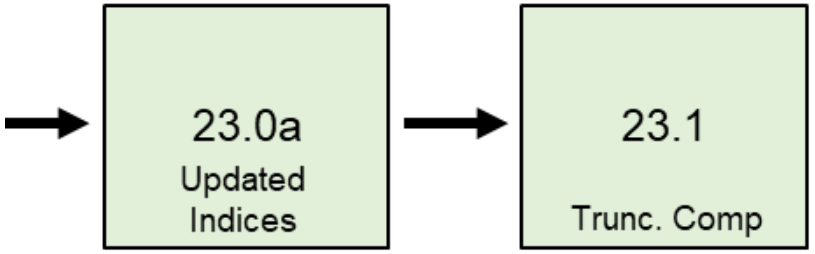
EAG



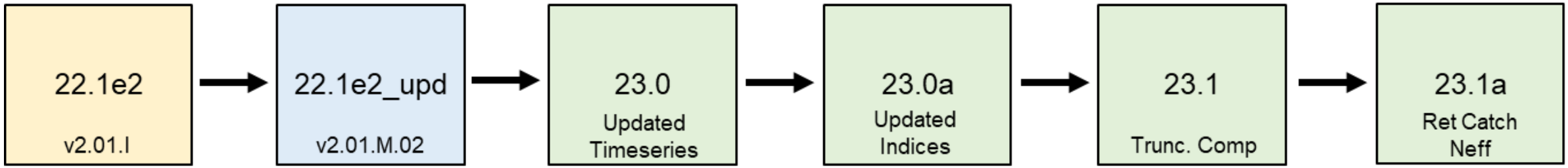


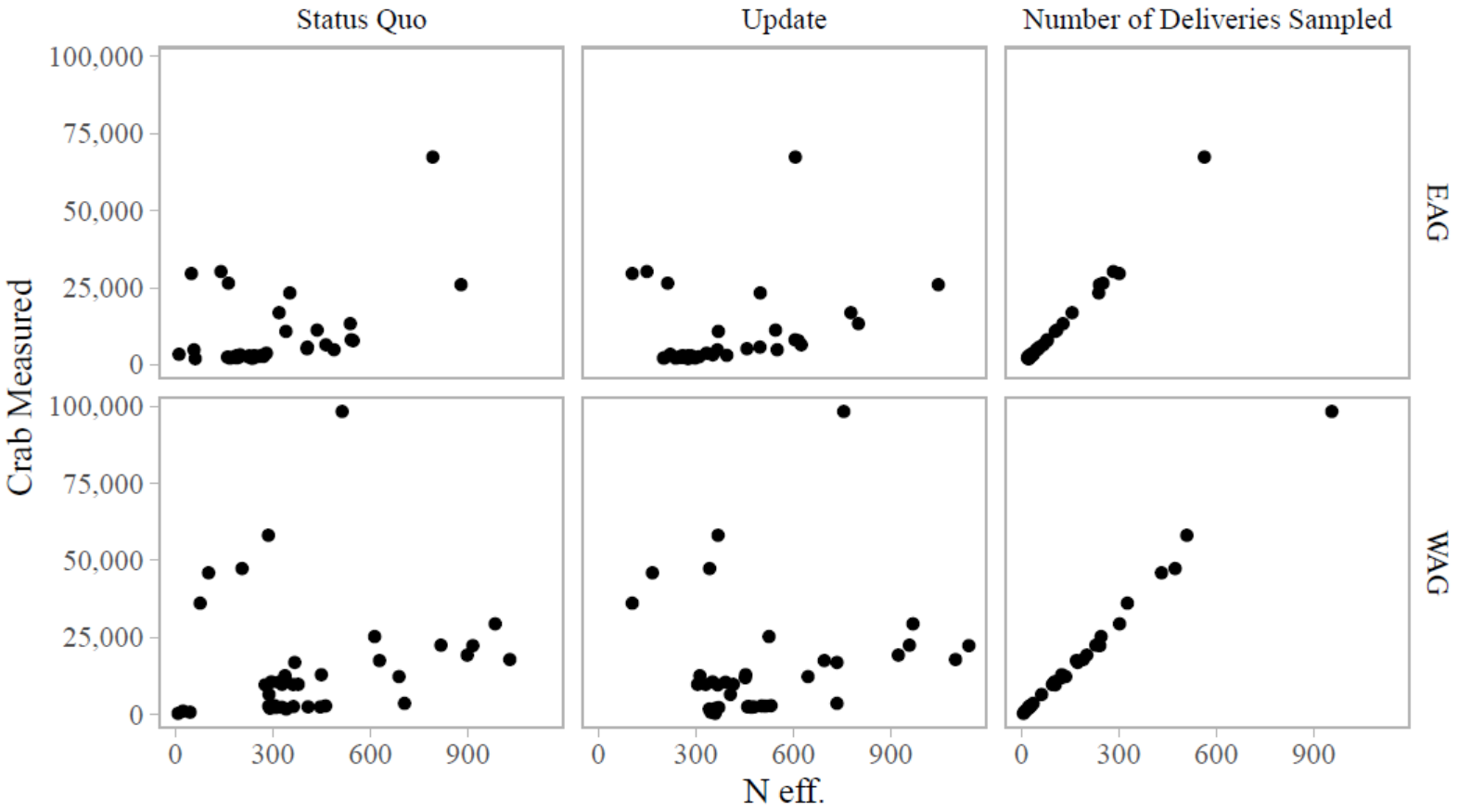
- Model 22.1e2 – 23.0a include minus group, first bin ≤ 105
- Truncated data still has large proportion of small crab in early years



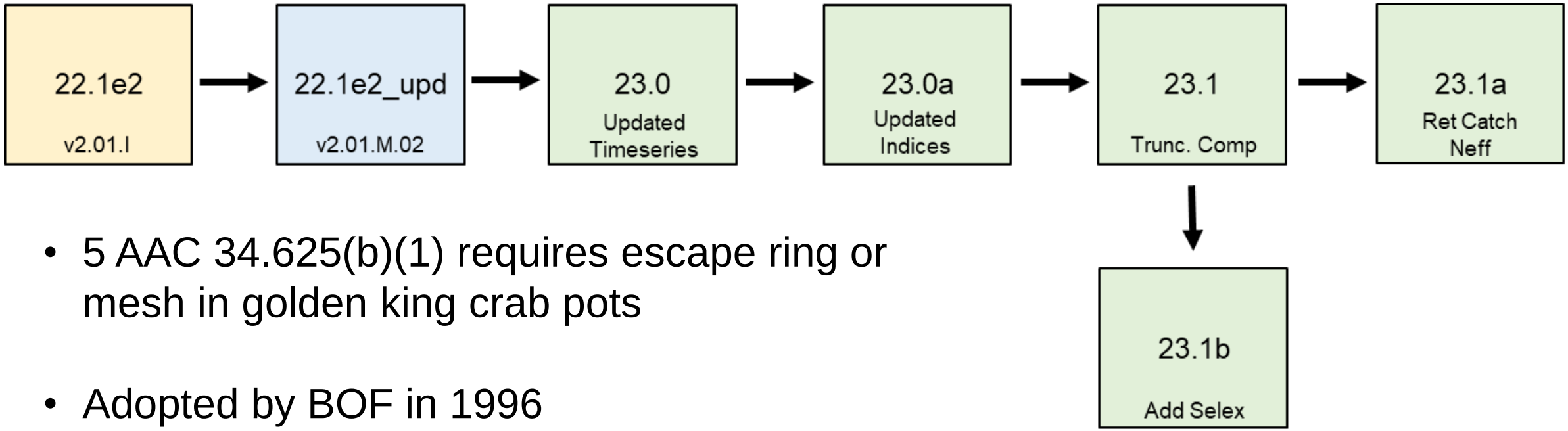


- Model 22.1e2 – 23.0a include minus group, first bin ≤ 105
- Truncated data still has large proportion of small crab in early years





- Retained catch Neff based on number of vessel days
- Use unit of sampling effort instead



- 5 AAC 34.625(b)(1) requires escape ring or mesh in golden king crab pots
- Adopted by BOF in 1996
- Two pre-rationalization selectivity periods
  - 1981 – 1996
  - 1997 – 2004

- 5 AAC 34.625(b)(1) requires escape ring or mesh in golden king crab pots
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- Two pre-rationalization selectivity periods
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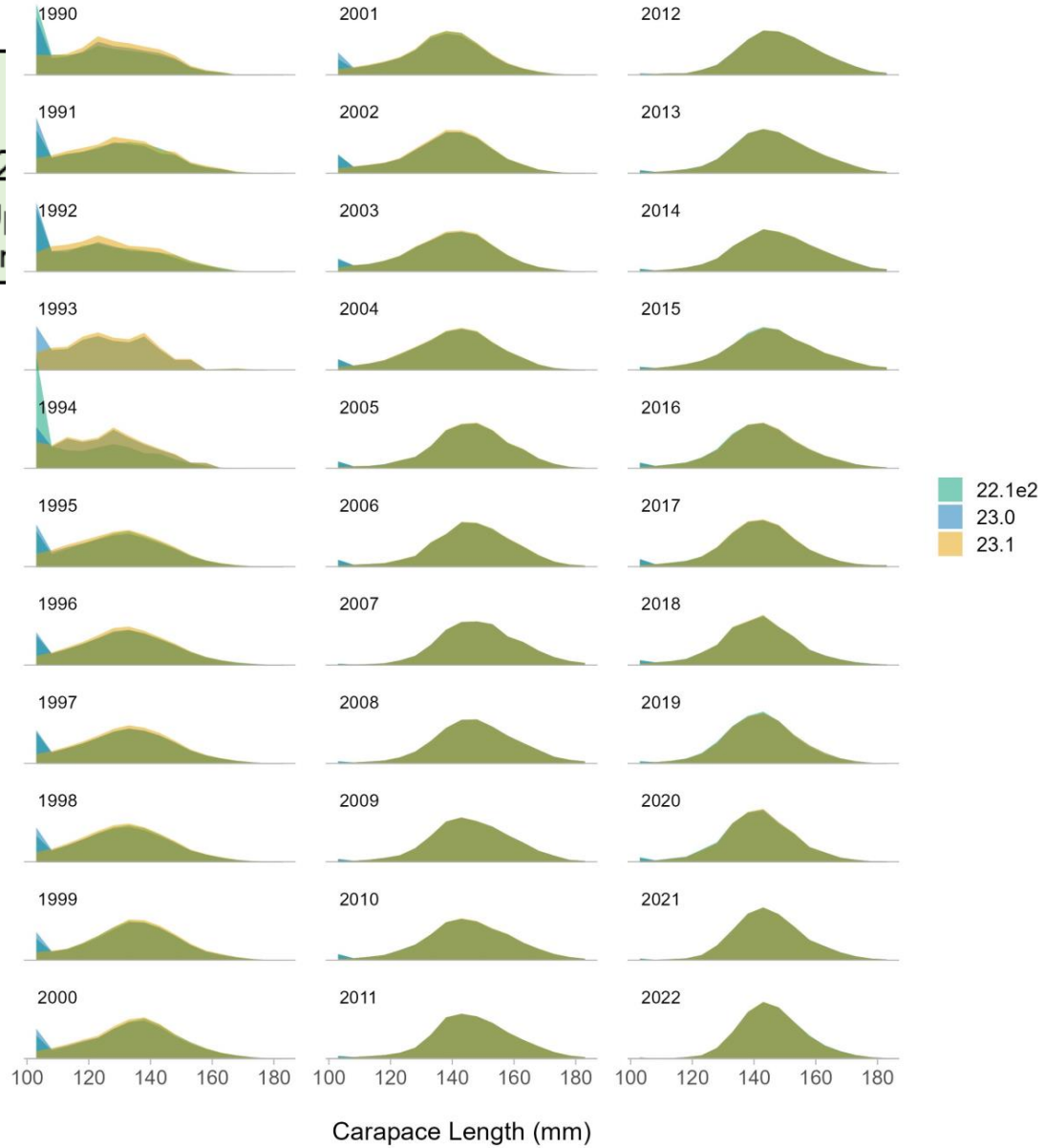
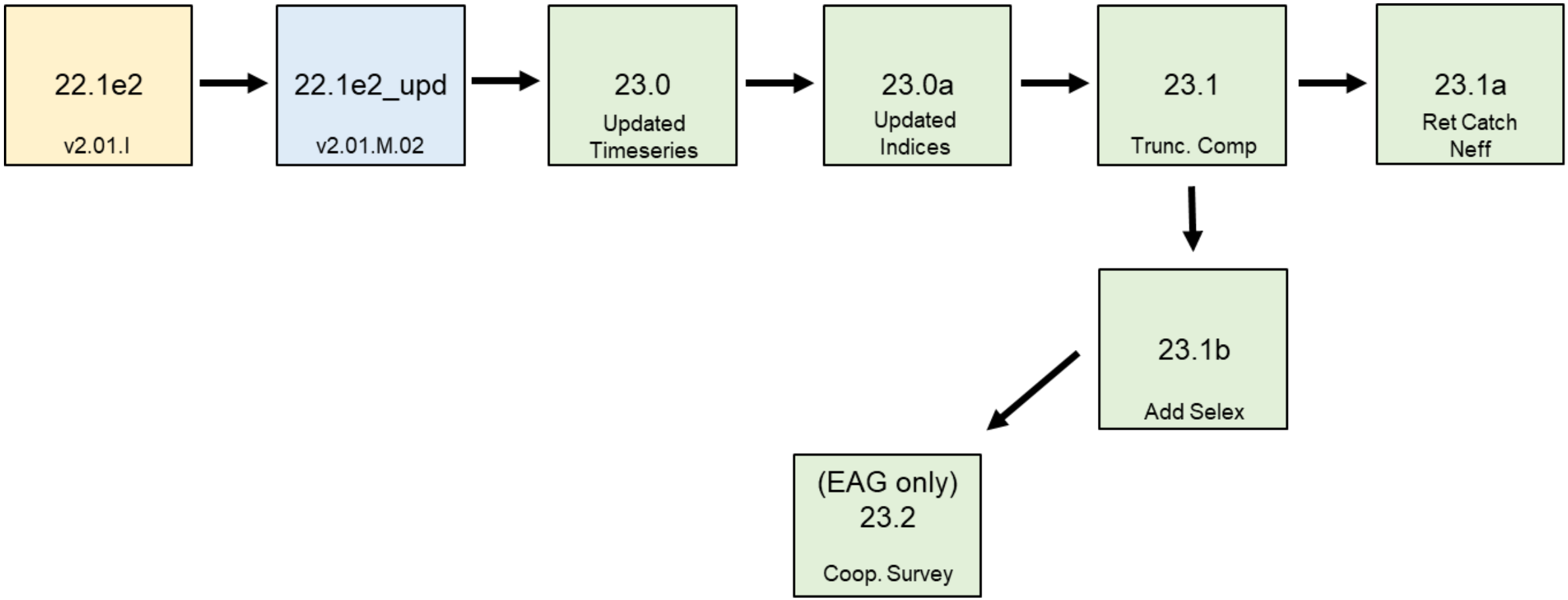
  - 1997 – 2004



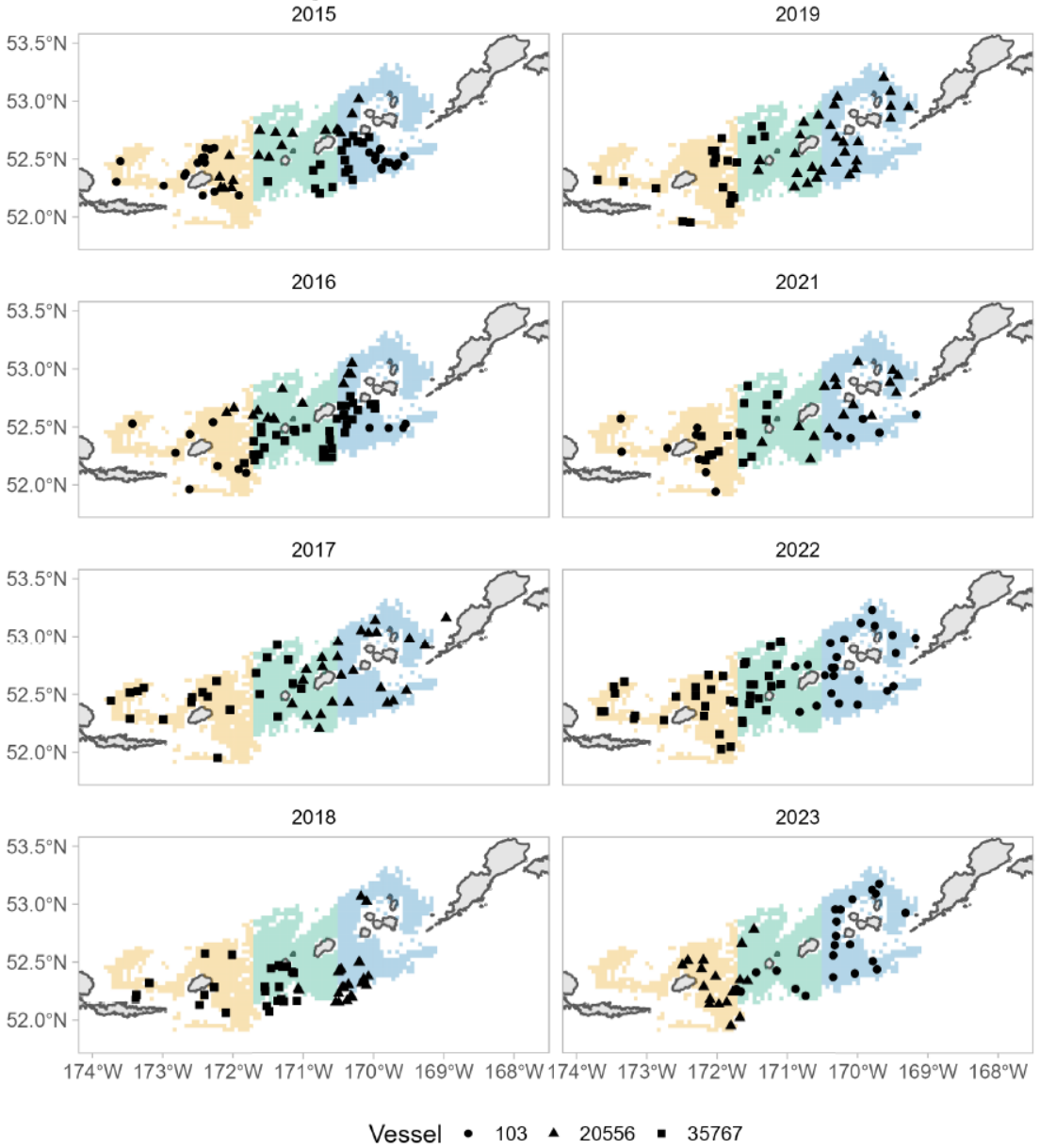

22.1e2
v2.01.I
22.1e2_upd
v2.01.M.02
23.0
Updated Timeseries
23.0a
Updated Indices
23.1
Trunc. Comp
23.1a
Ret Catch Neff
23.1b
Add Selex
(EAG only)
23.2
Coop. Survey

Appendix C – Cooperative Survey

- Data available for
  - EAG: 2015 – 2022 (not 2020)
  - WAG: 2018 & 2019

EAG

Suvrey Year	Strings Sampled	Pots Sampled
2015	63	339
2016	62	304
2017	47	212
2018	48	235
2019	47	293
2021	46	298
2022	55	374

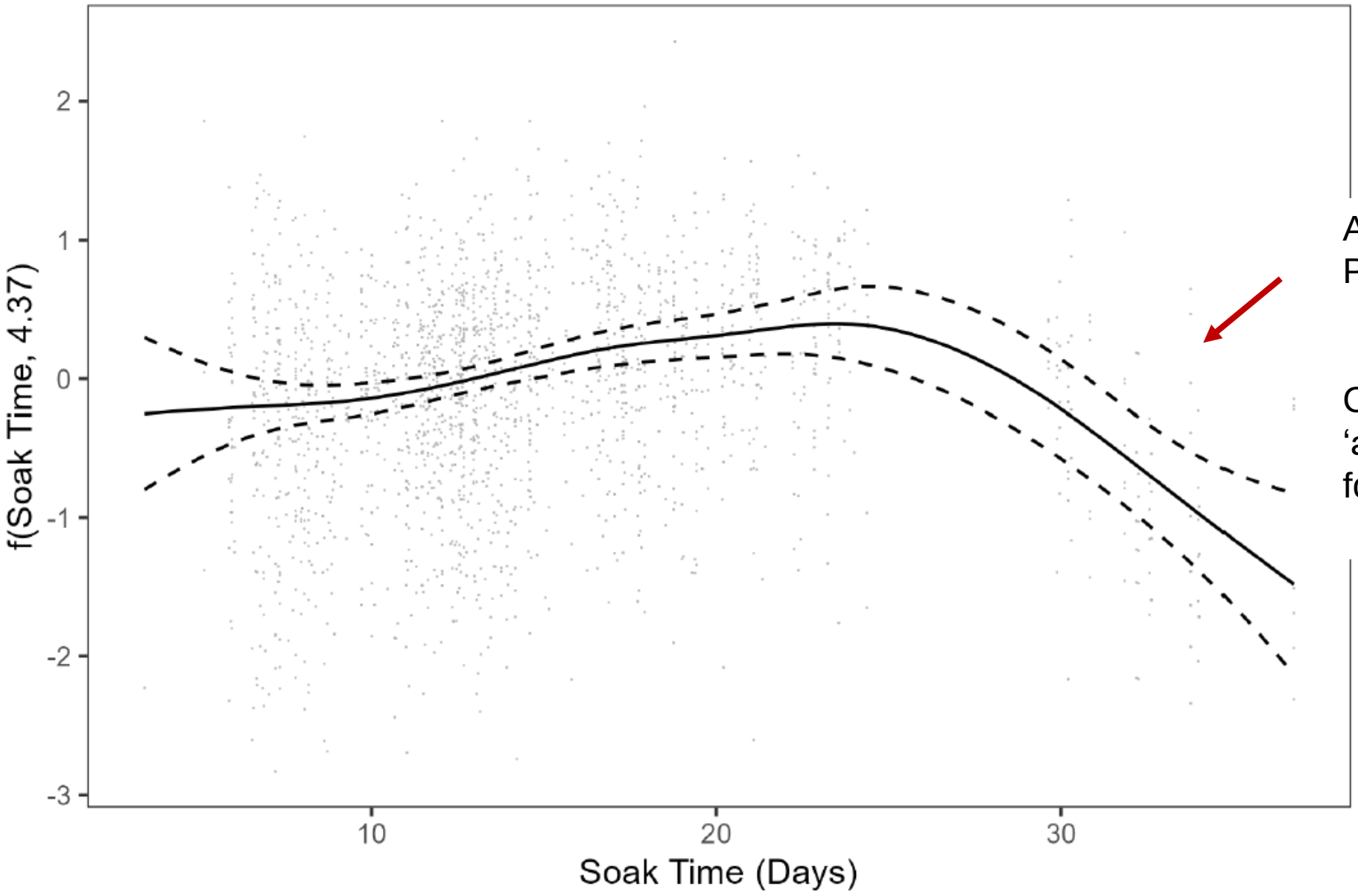


Appendix C – Cooperative Survey

- Estimated design-based CPUE index (ie. Nominal)
- Model-based index

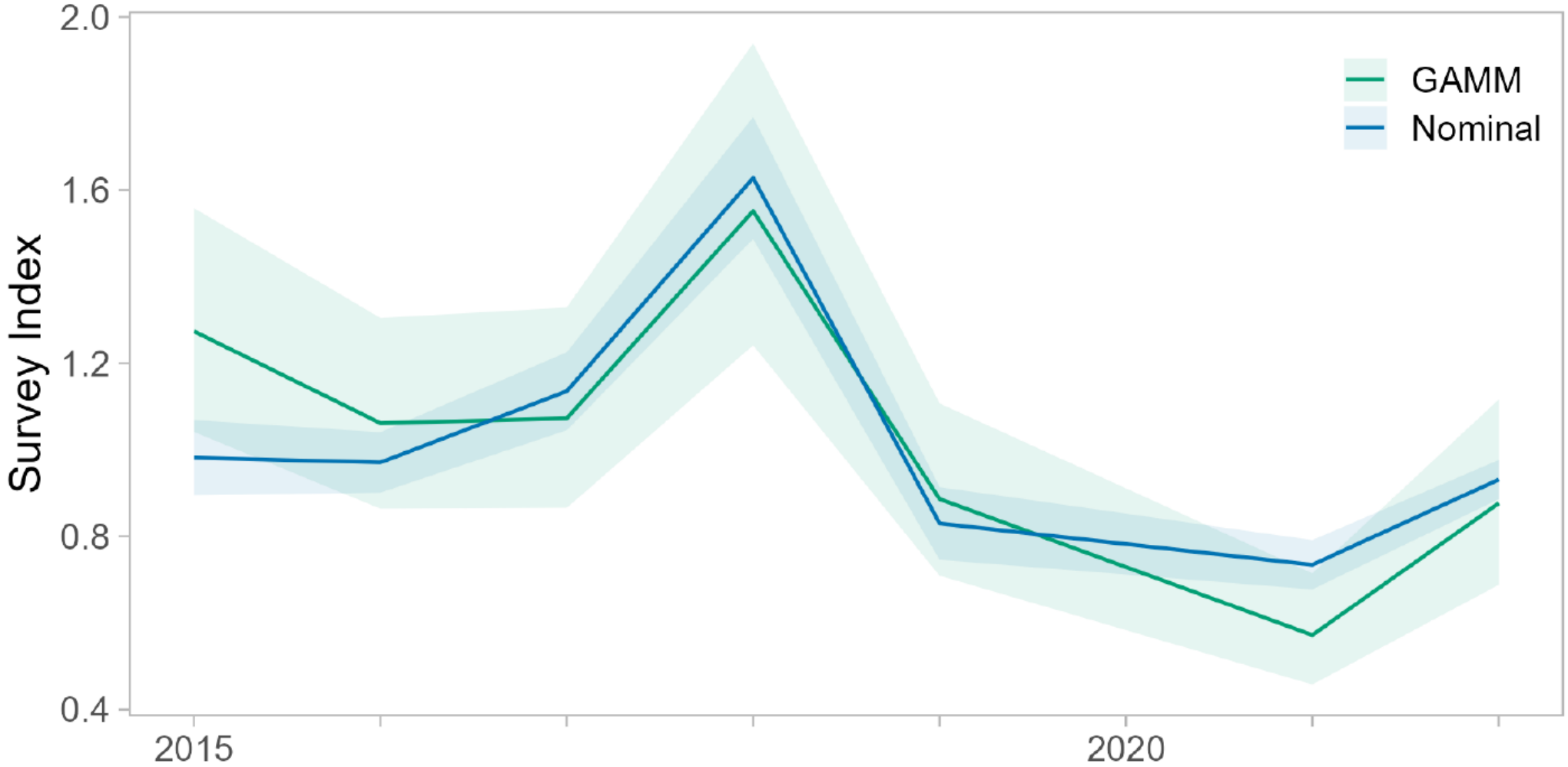
$$\ln(U_j) = \text{Year}_y + s(\text{soak time}) + (1|\text{Stratum}_h/\text{String}_{i,y}) + \epsilon$$

- Negative binomial error, with θ = 1.318 (estimated via ML)
- Annual index computed as scaled year effect (see App B or Siddeek et al. 2016, 2023)

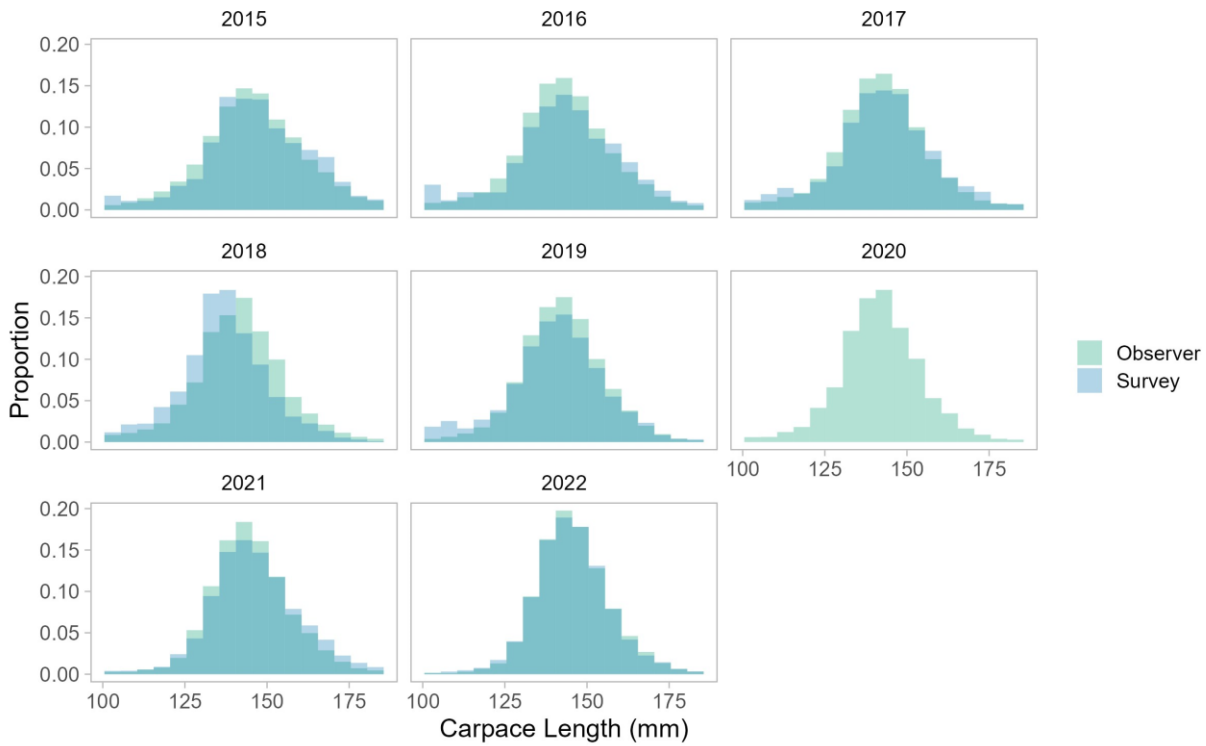


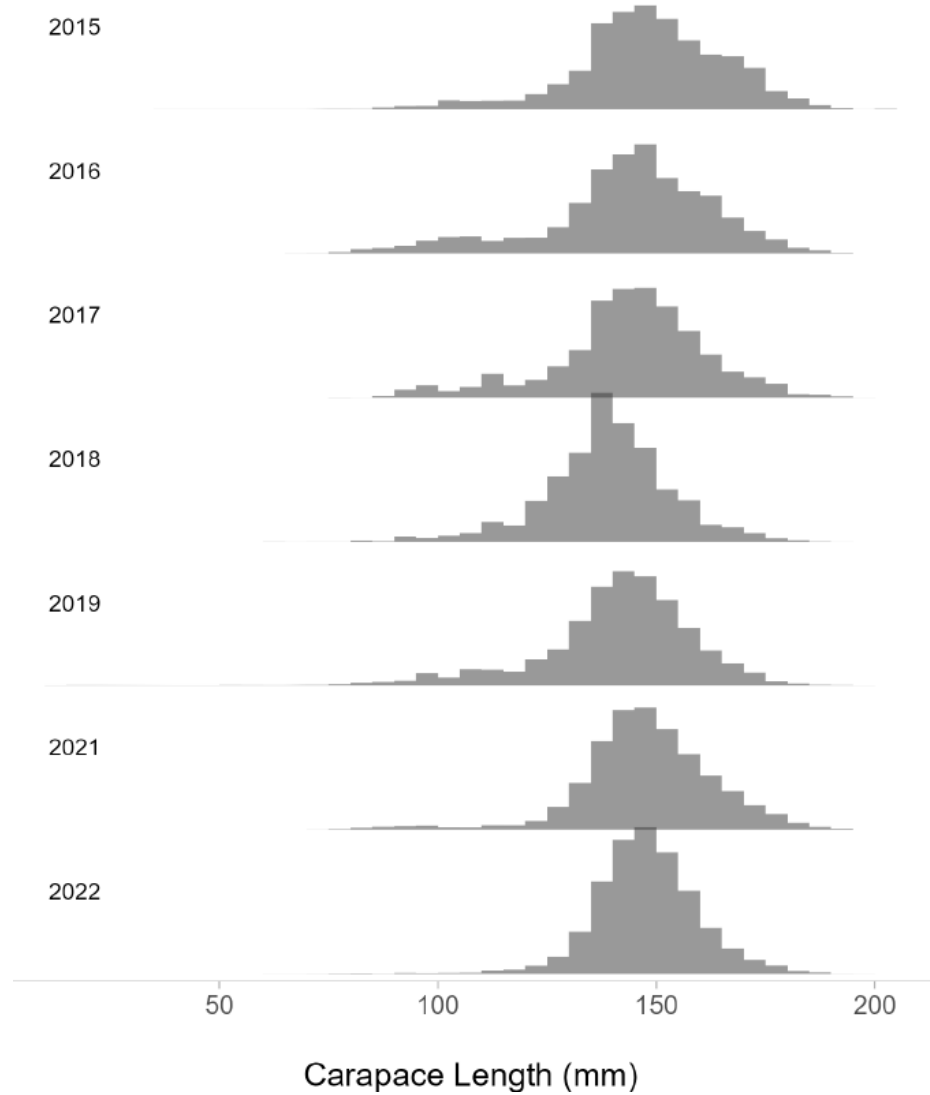
All from 12 strings by Pat Lee in 2022

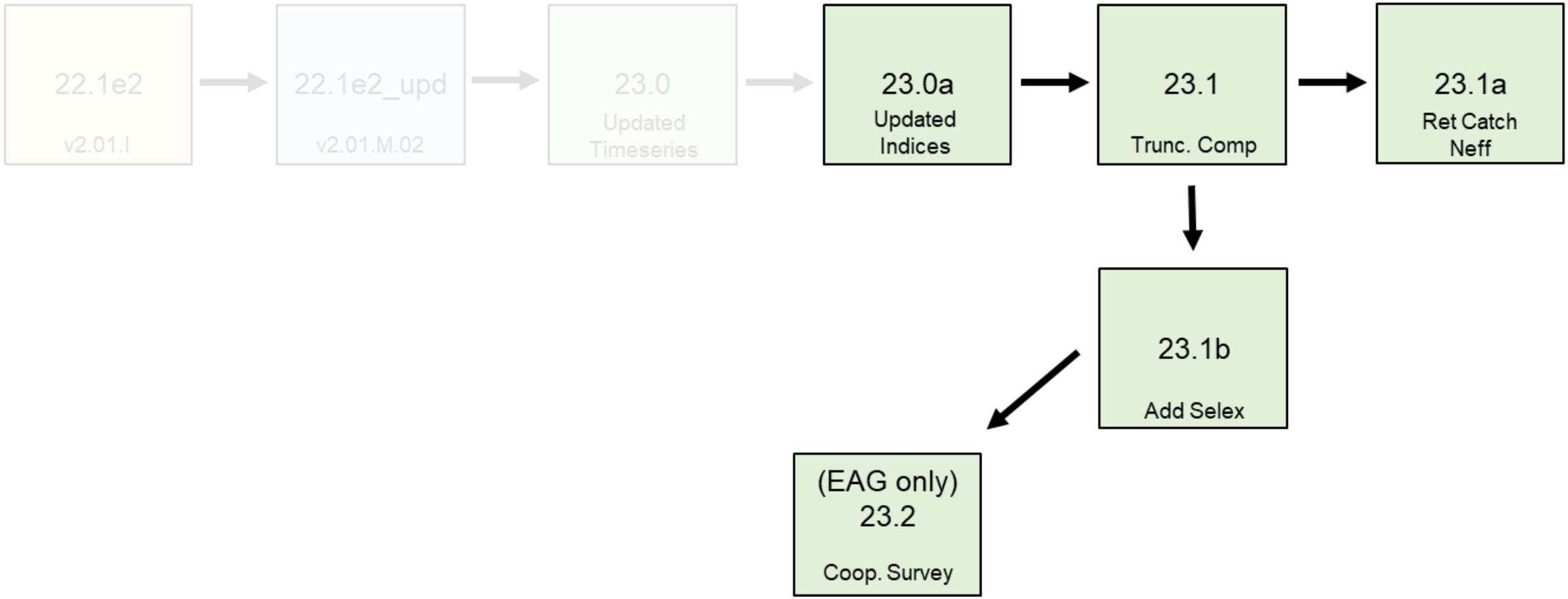
Currently no bounds on ‘acceptable’ soak time for survey


2.0
1.6
1.2
0.8
0.4
Survey Index
2015
2020
GAMM
Nominal

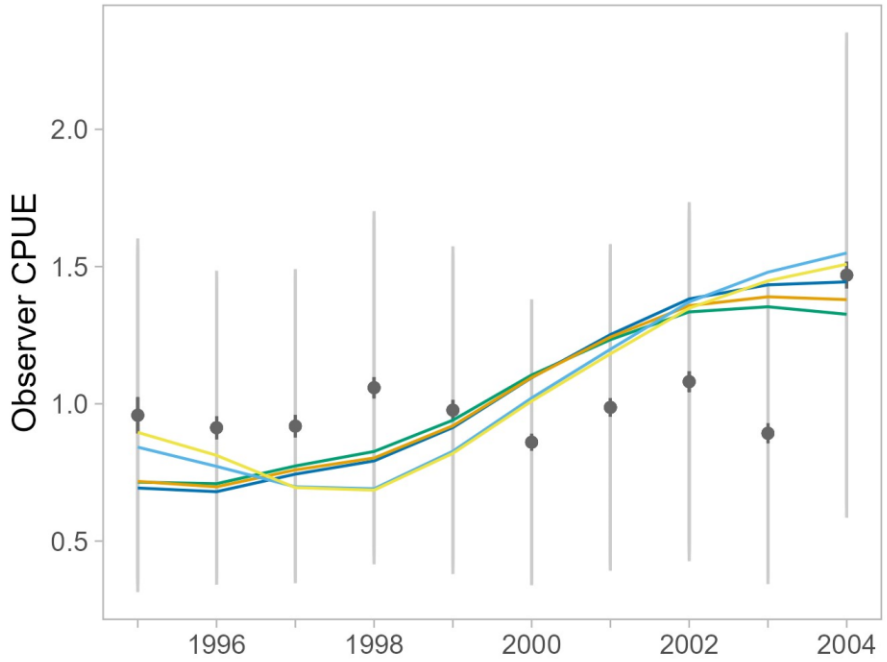
Suvrey Year	Males Measured	Proportion Measured Legal	Sublegal
2015	5,089	0.34	0.44
2016	3,998	0.33	0.27
2017	3,849	0.40	0.33
2018	3,323	0.26	0.18
2019	6,190	0.68	0.60
2021	6,665	0.81	0.85
2022	10,276	0.72	0.88

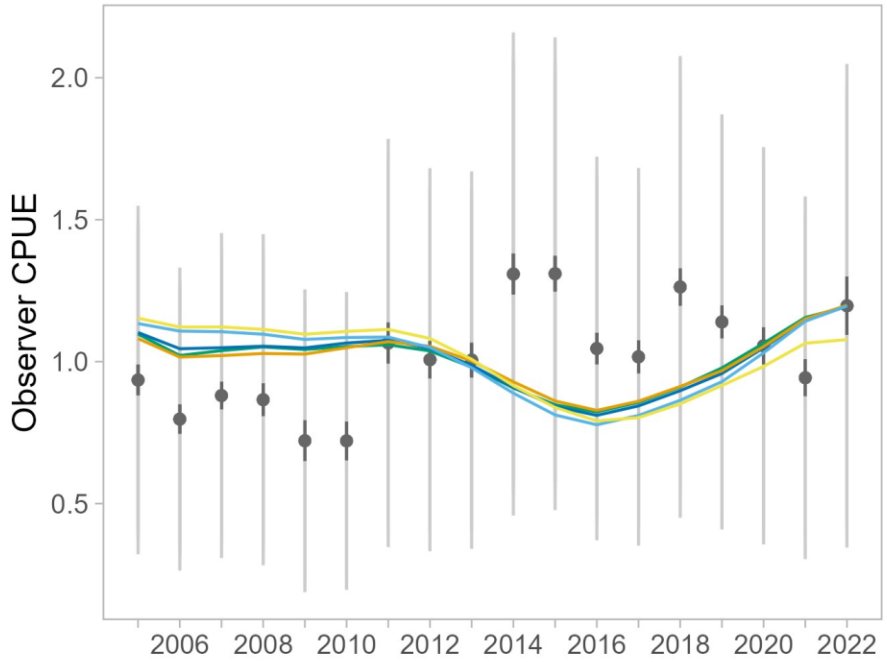





22.1e2
v2.01.I
22.1e2_upd
v2.01.M.02
23.0
Updated Timeseries
23.0a
Updated Indices
23.1
Trunc. Comp
23.1a
Ret Catch Neff
23.1b
Add Selex
(EAG only)
23.2
Coop. Survey

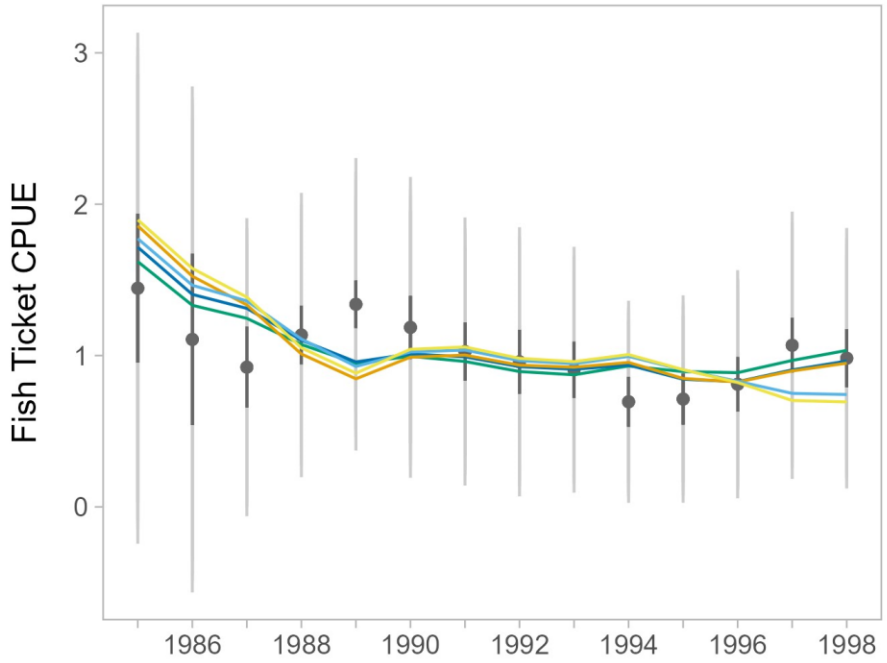
EAG

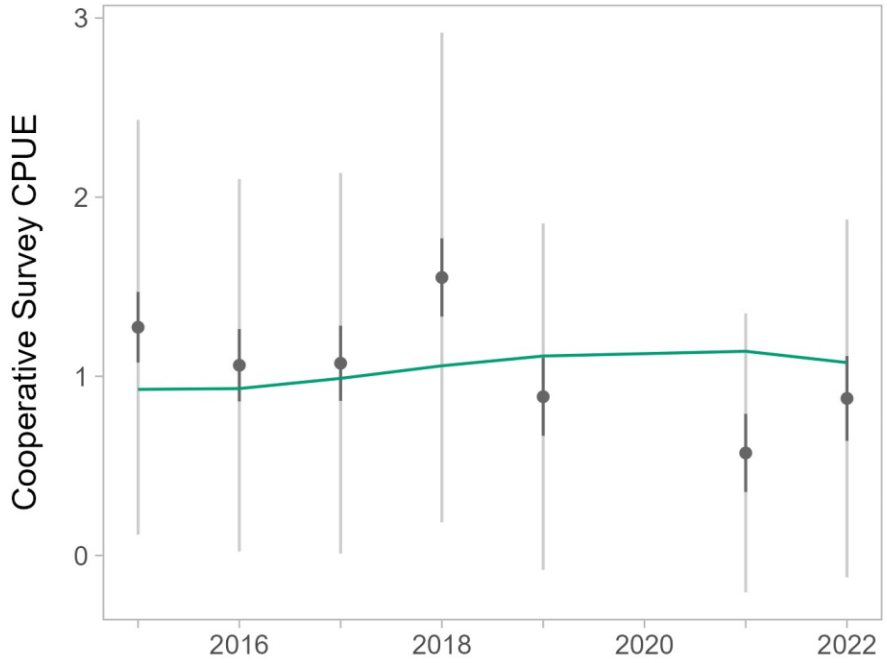

Observer CPUE
2.0
1.5
1.0
0.5
1996
1998
2000
2002
2004


Observer CPUE
2.0
1.5
1.0
0.5
2006
2008
2010
2012
2014
2016
2018
2020
2022


23.0a
23.1
23.1a
23.1b
23.2


23.0a
23.1
23.1a
23.1b
23.2

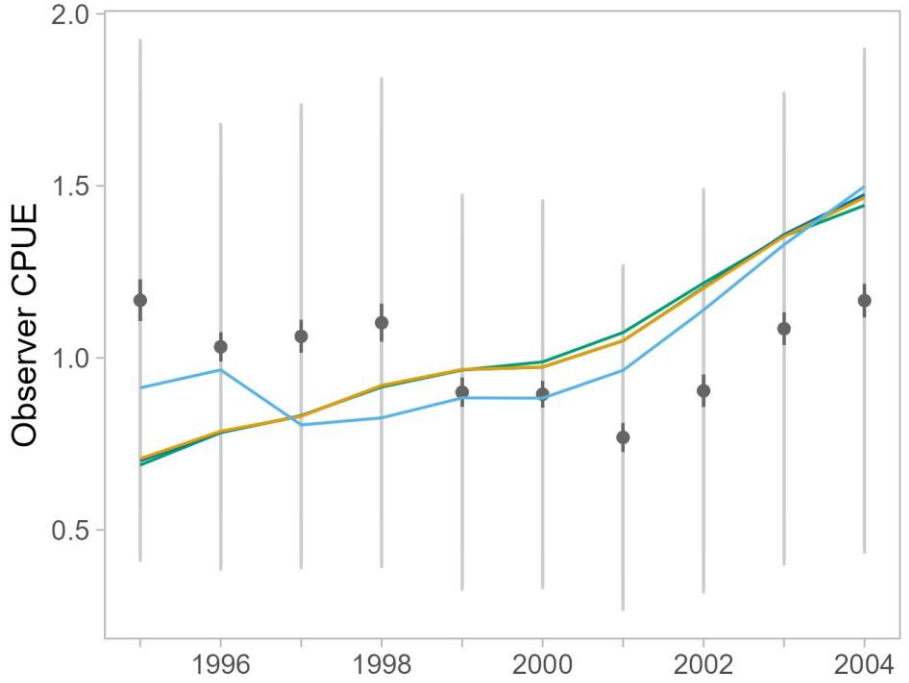

Fish Ticket CPUE
3
2
1
0
1986
1988
1990
1992
1994
1996
1998

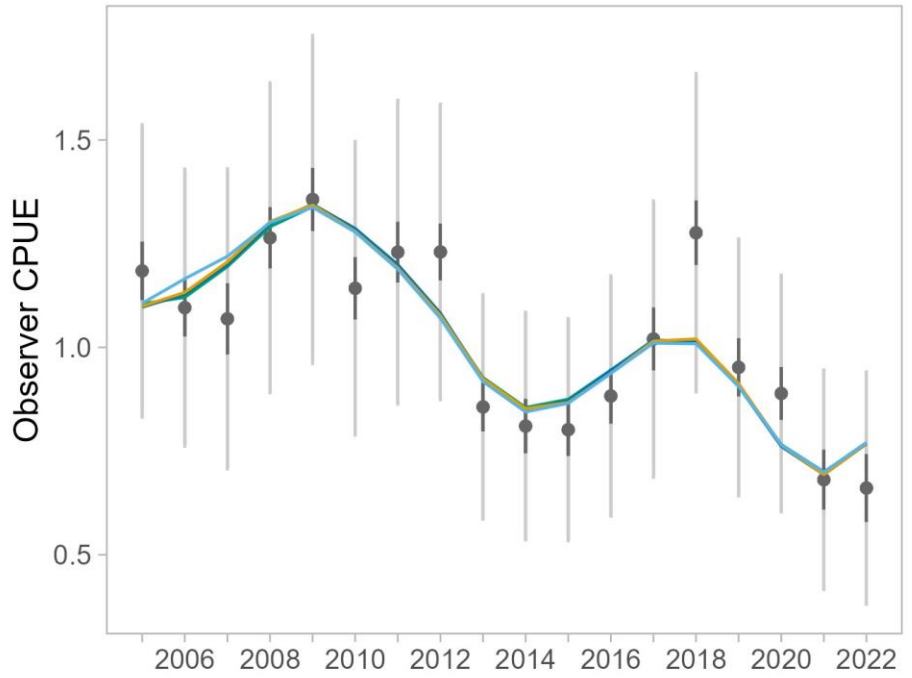

Cooperative Survey CPUE
3
2
1
0
2016
2018
2020
2022

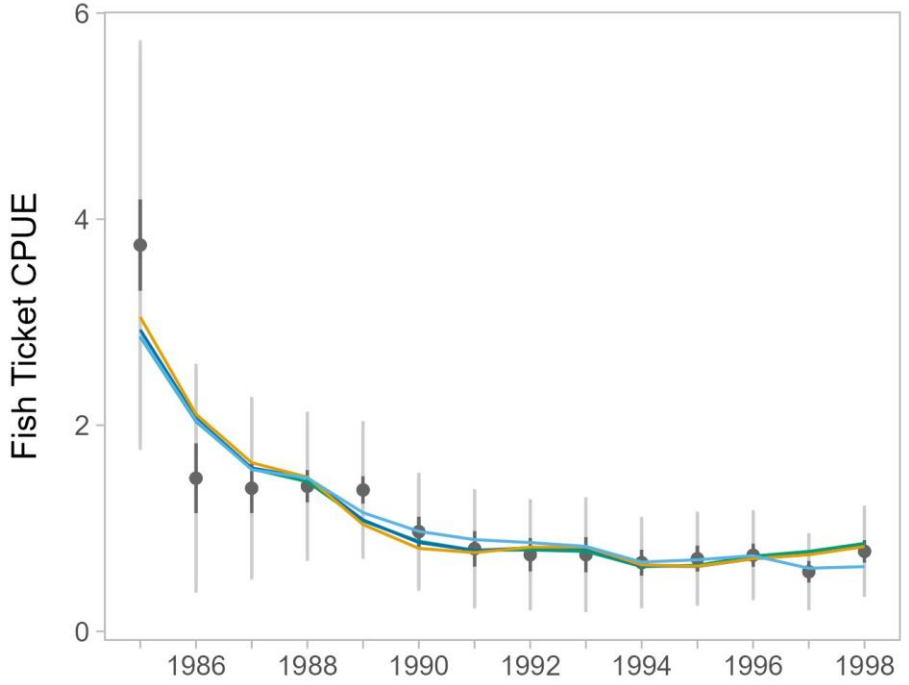

23.0a
23.1
23.1a
23.1b
23.2

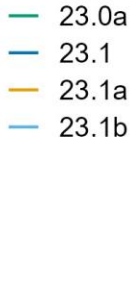

23.2

WAG


Observer CPUE
2.0
1.5
1.0
0.5
1996
1998
2000
2002
2004


Observer CPUE
1.5
1.0
0.5
2006
2008
2010
2012
2014
2016
2018
2020
2022

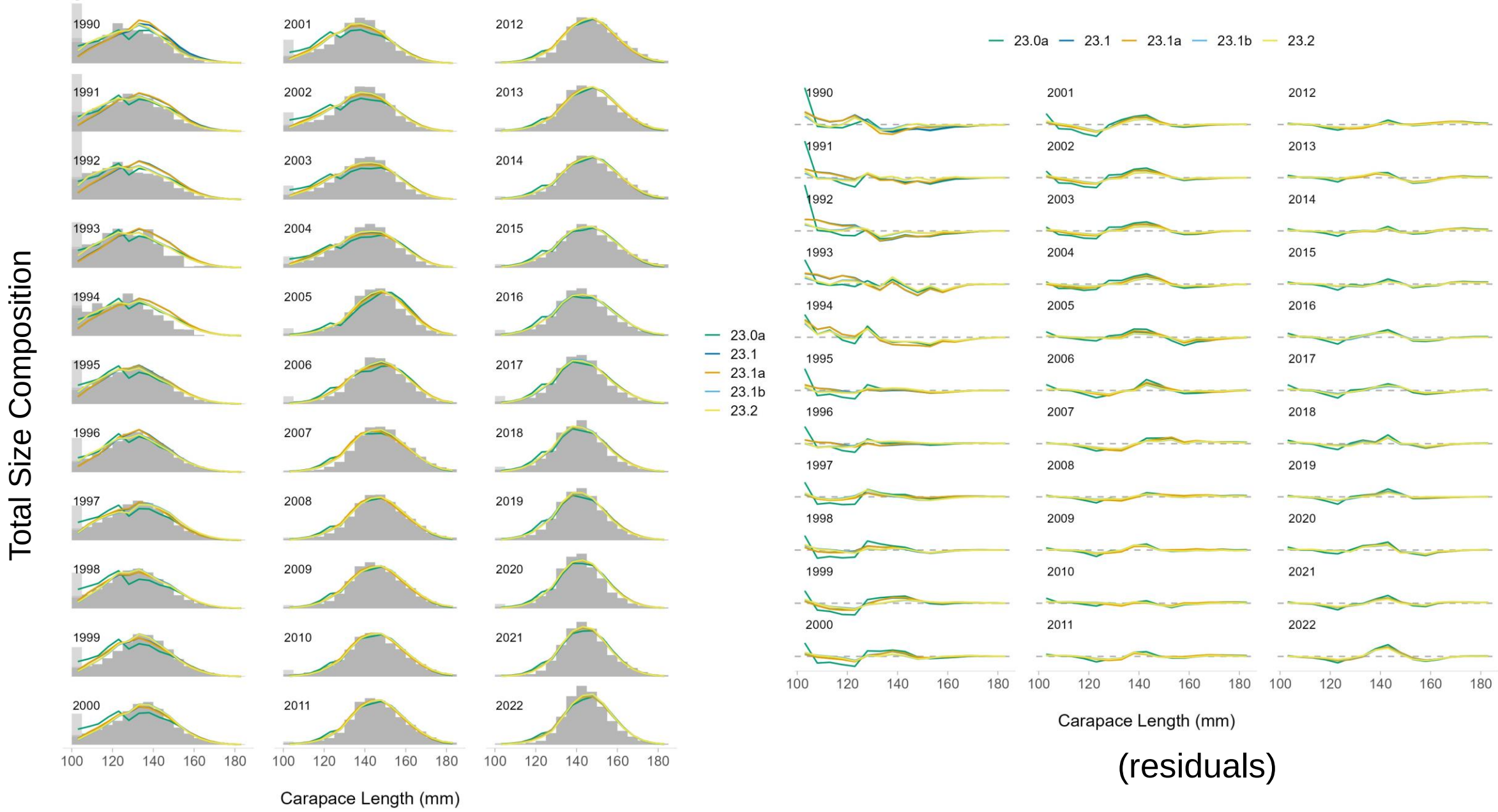

Fish Ticket CPUE
6
4
2
0
1986
1988
1990
1992
1994
1996
1998


23.0a
23.1
23.1a
23.1b


23.0a
23.1
23.1a
23.1b

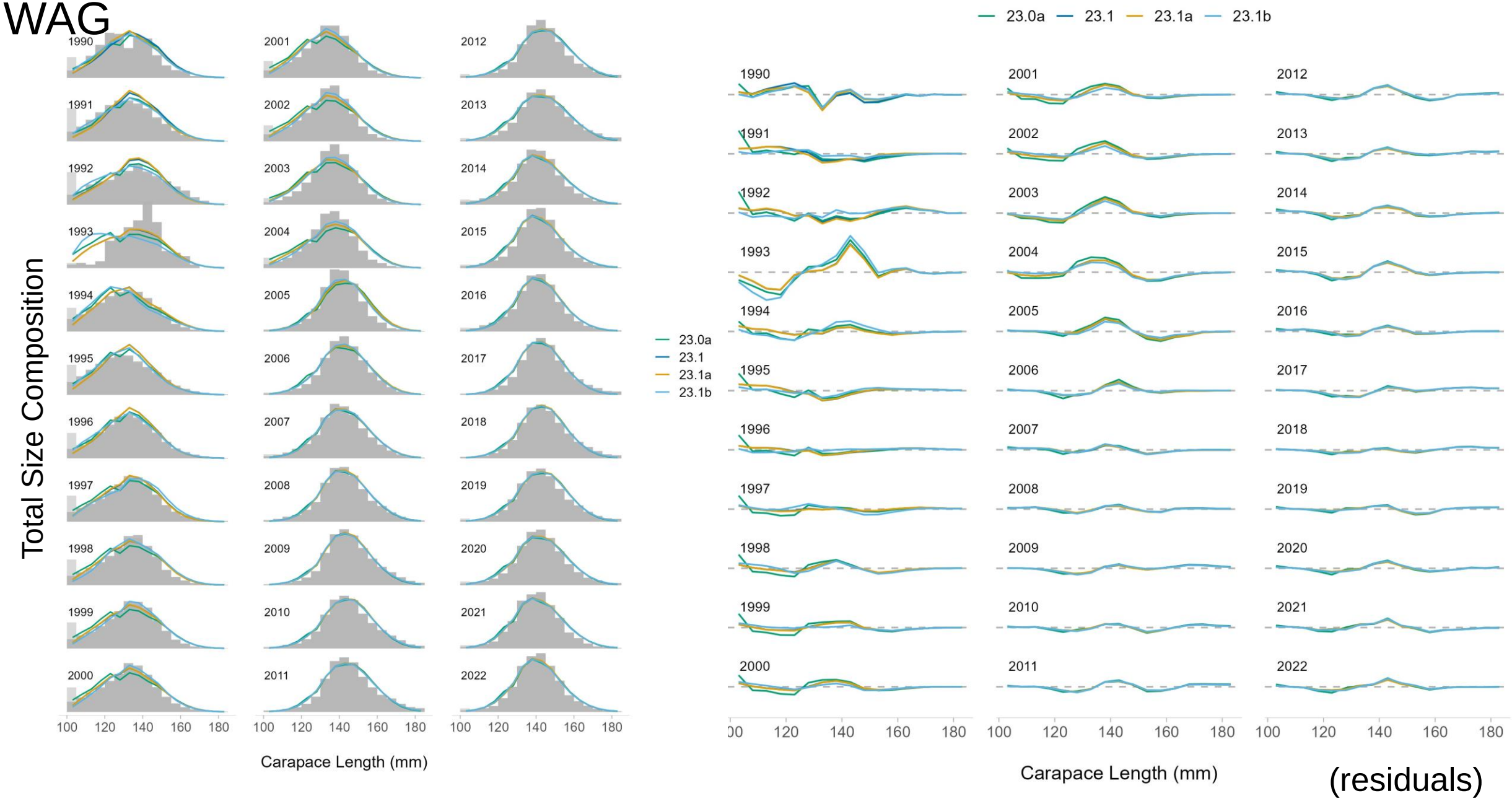

23.0a
23.1
23.1a
23.1b

EAG

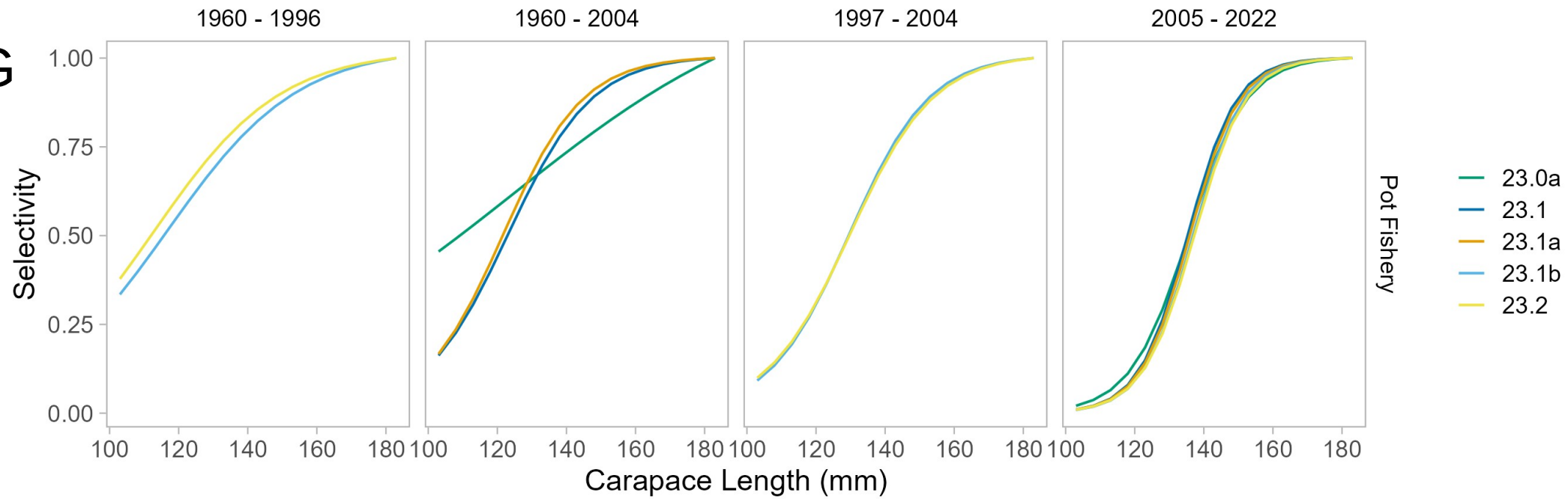


(residuals)

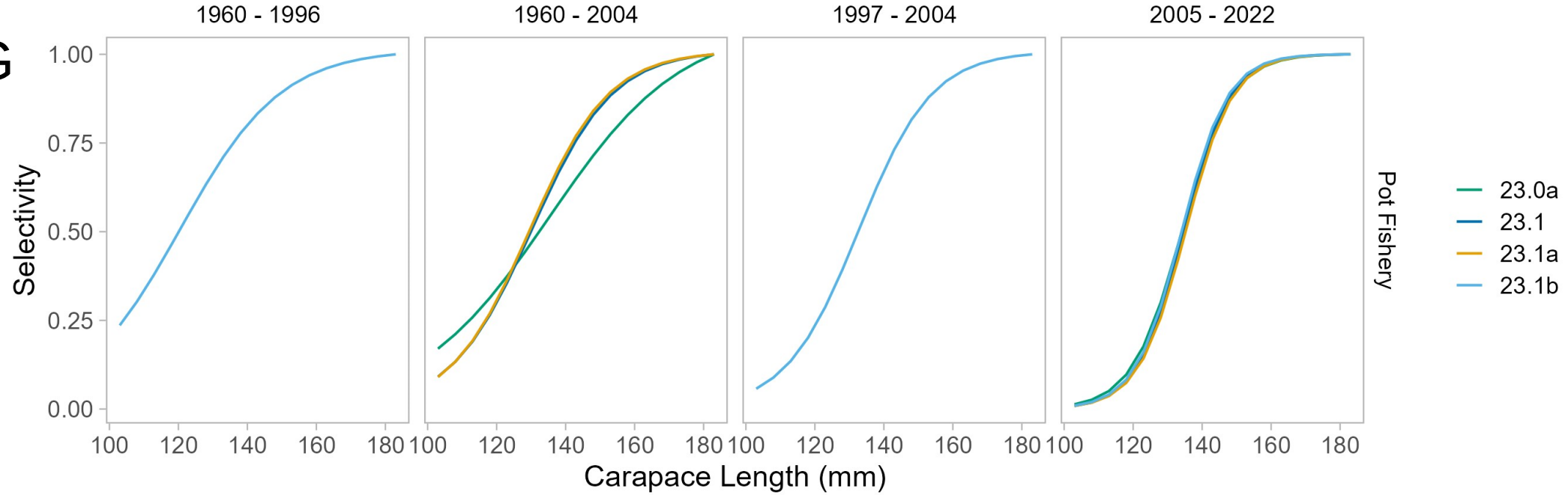
WAG


Total Size Composition
23.0a
23.1
23.1a
23.1b
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
100
120
140
160
180
Carapace Length (mm)
(residuals)

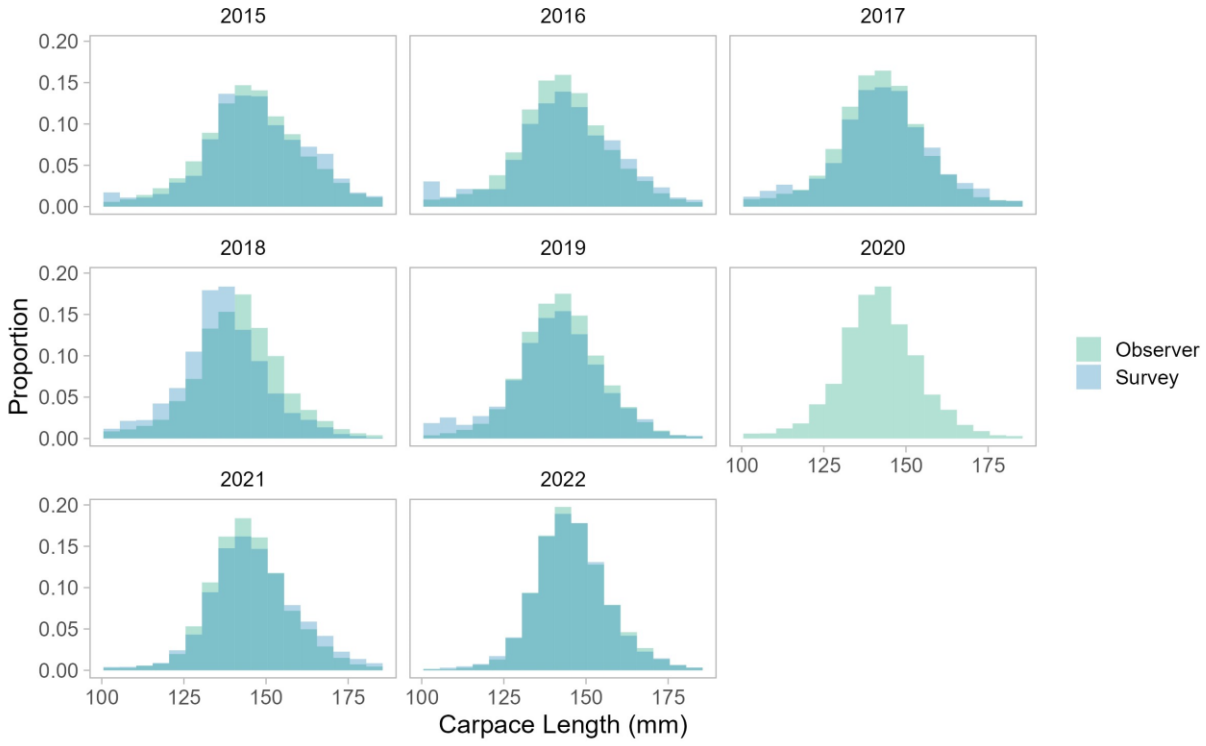
EAG

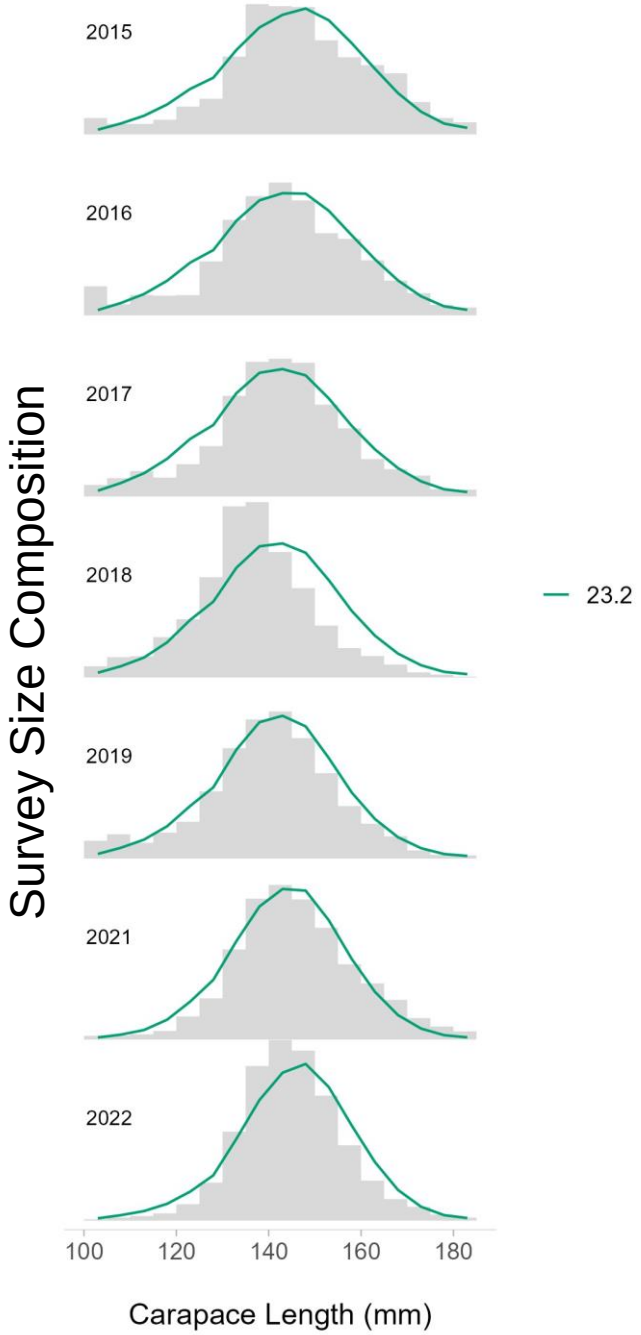

1960 - 1996
1960 - 2004
1997 - 2004
2005 - 2022
Selectivity
1.00
0.75
0.50
0.25
0.00
100
120
140
160
180
Carapace Length (mm)
Pot Fishery
23.0a
23.1
23.1a
23.1b
23.2

WAG

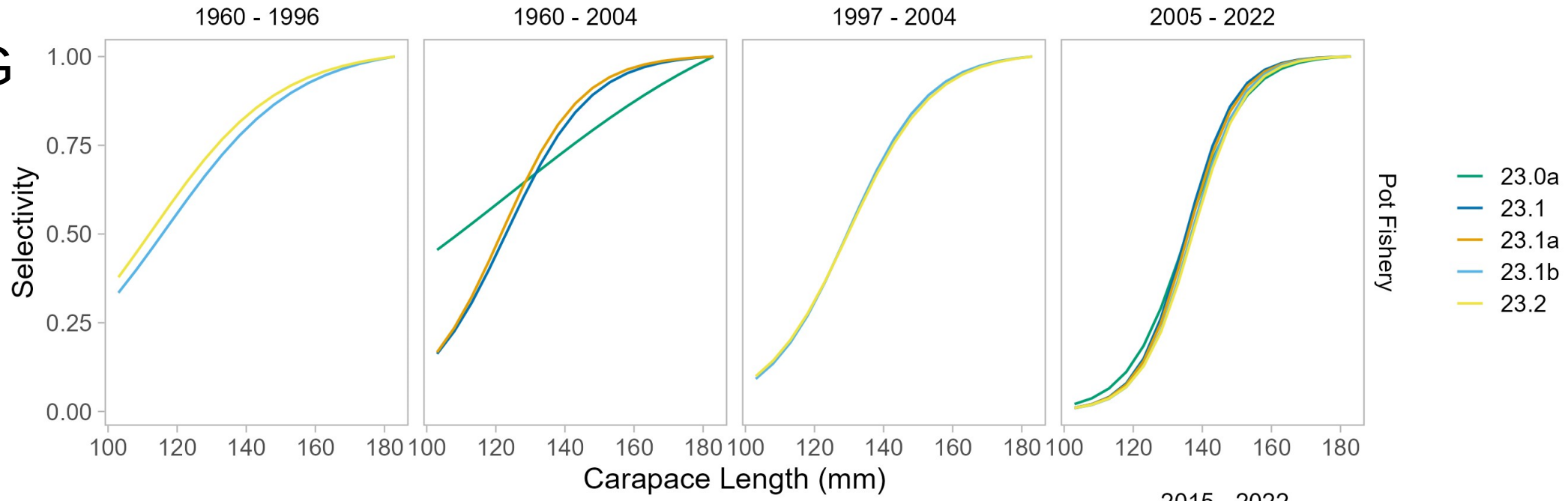

1960 - 1996
1960 - 2004
1997 - 2004
2005 - 2022
Selectivity
1.00
0.75
0.50
0.25
0.00
100
120
140
160
180
Carapace Length (mm)
Pot Fishery
23.0a
23.1
23.1a
23.1b

- Fits to survey size composition adequate
- Underpredicted dominant cohort in 2018, not as prominent in observer data

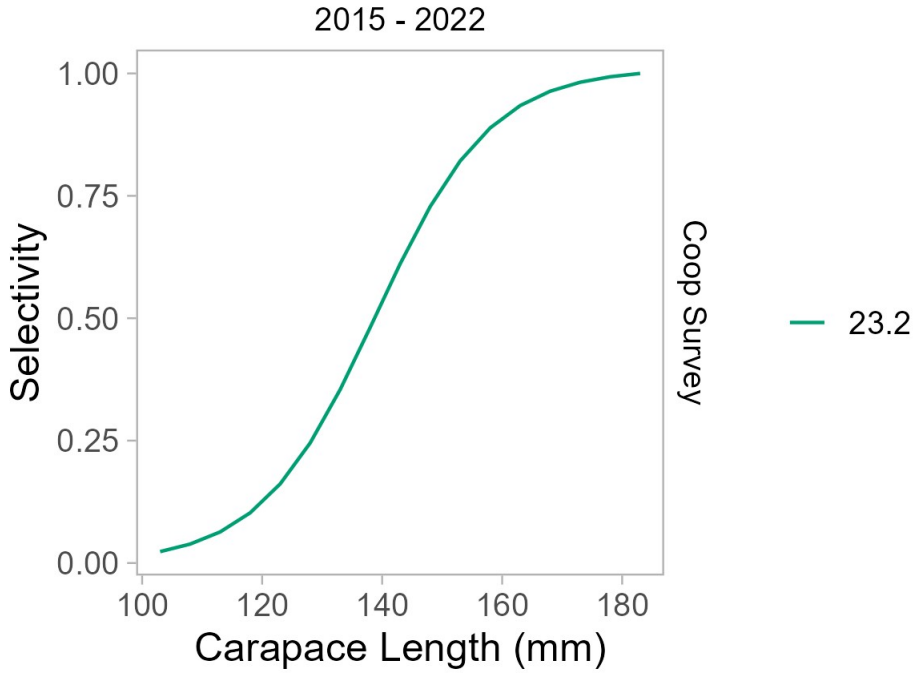




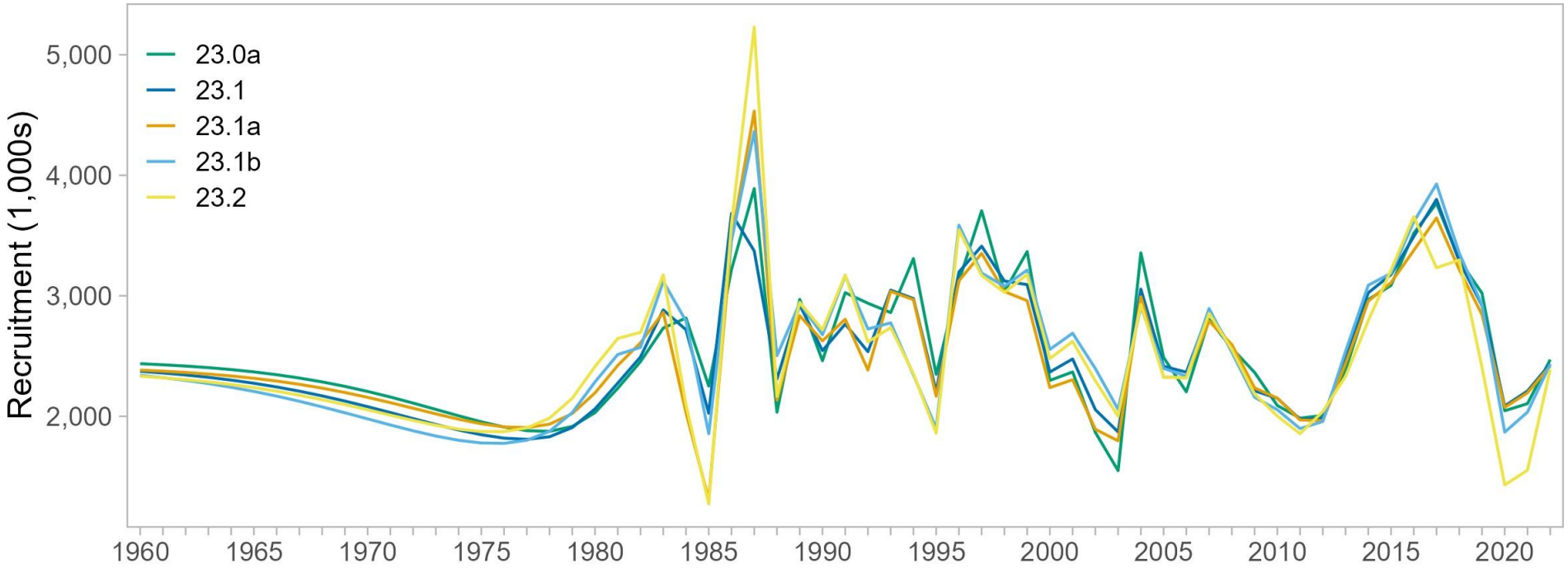
EAG



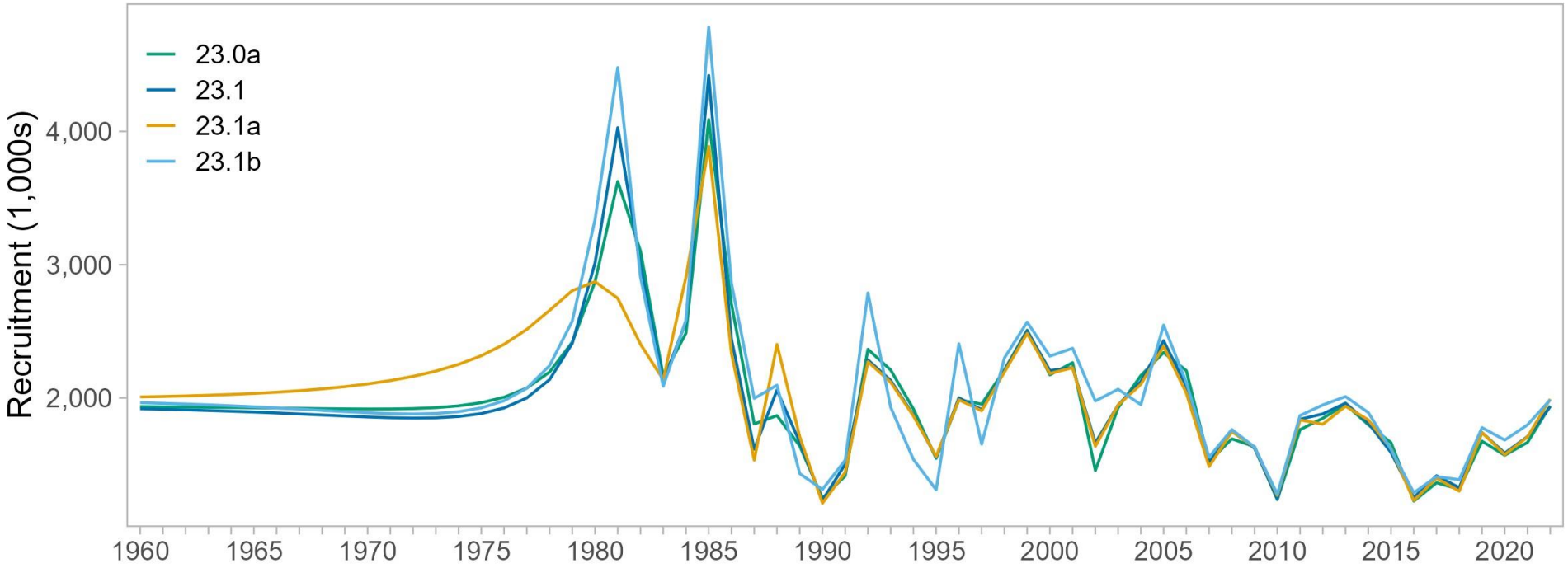
- Survey Selectivity similar to post-rationalized fishery



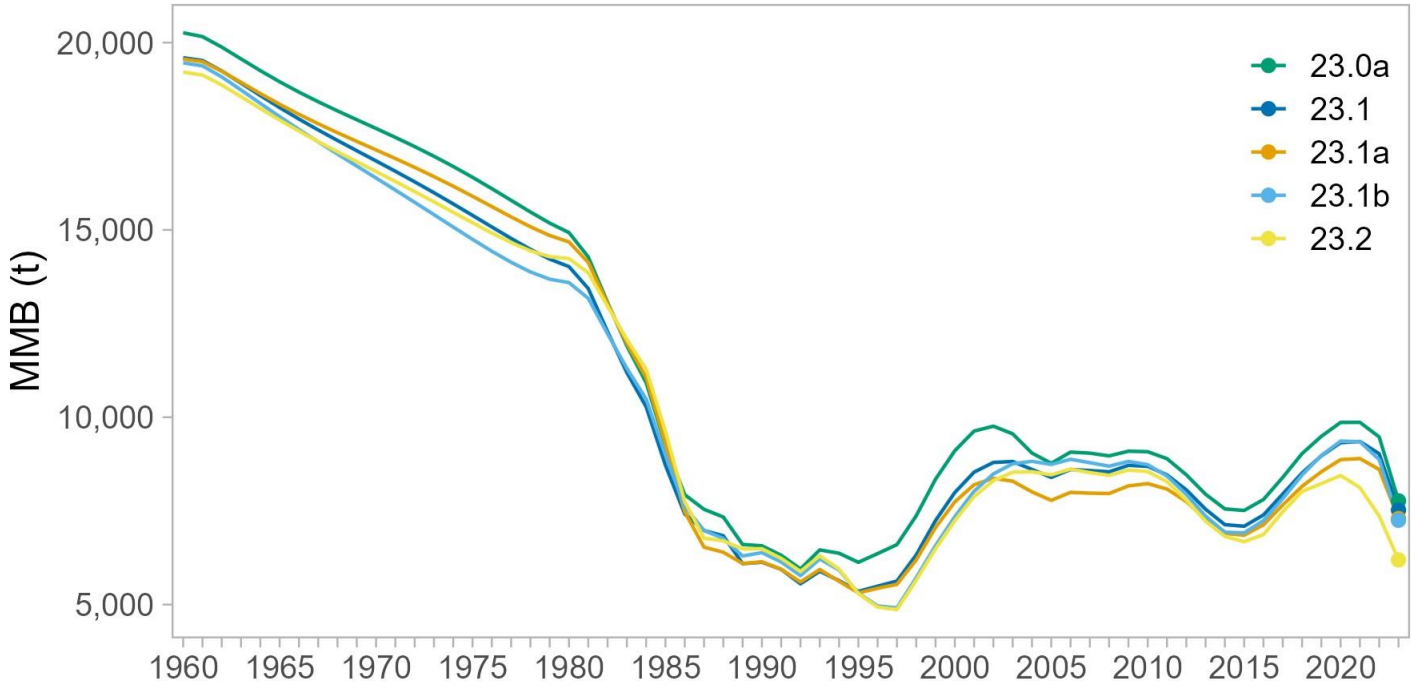
EAG


23.0a
23.1
23.1a
23.1b
23.2
Recruitment (1,000s)
5,000
4,000
3,000
2,000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

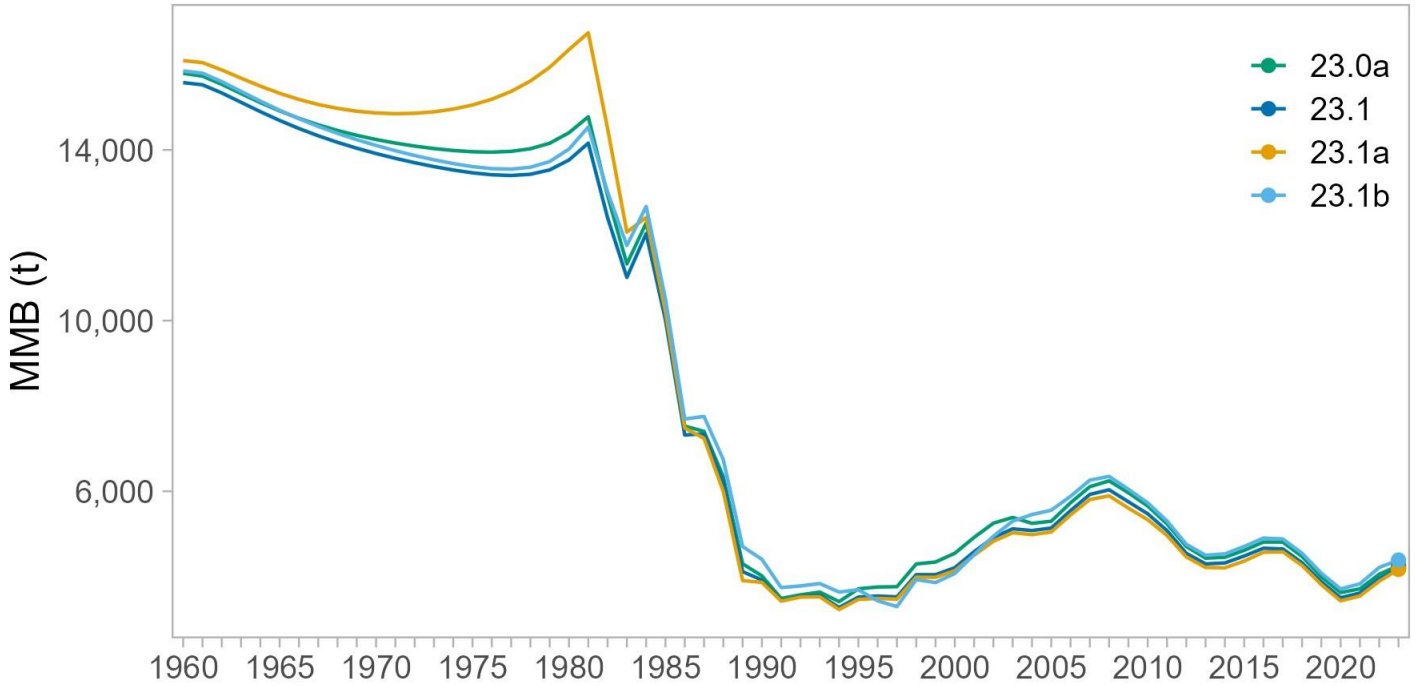
WAG


23.0a
23.1
23.1a
23.1b
Recruitment (1,000s)
4,000
3,000
2,000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

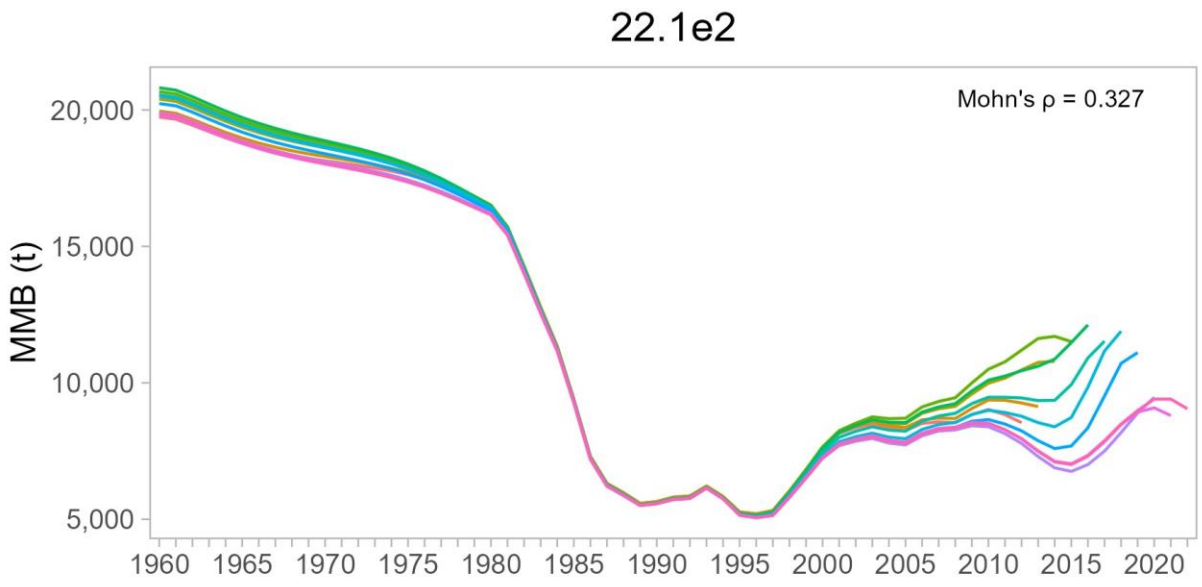
EAG

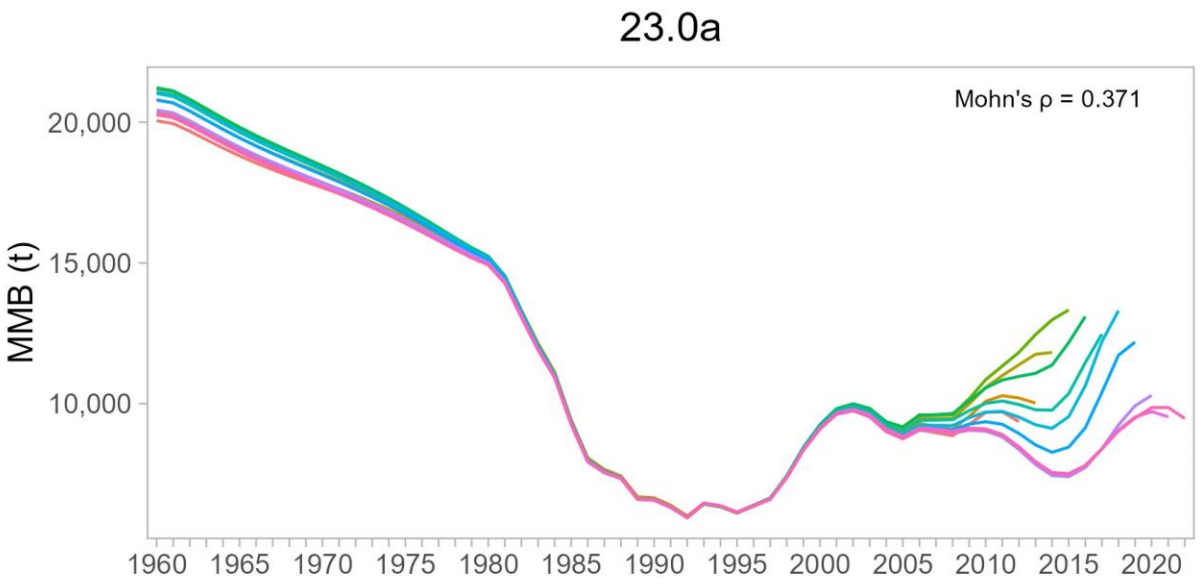

20,000
15,000
10,000
5,000
MMB (t)
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
23.0a
23.1
23.1a
23.1b
23.2

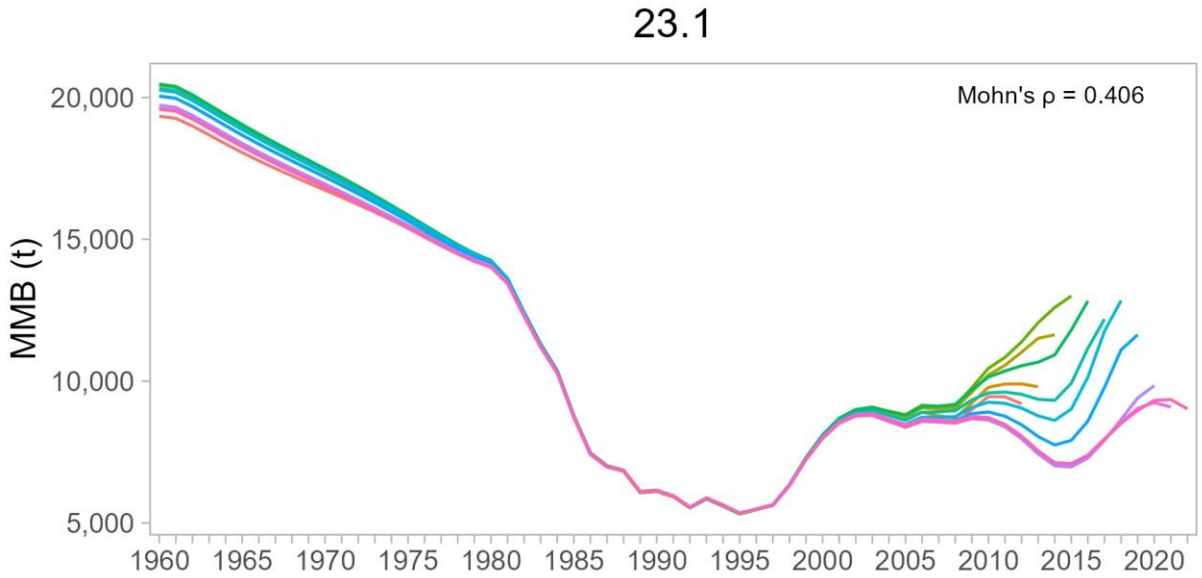
WAG

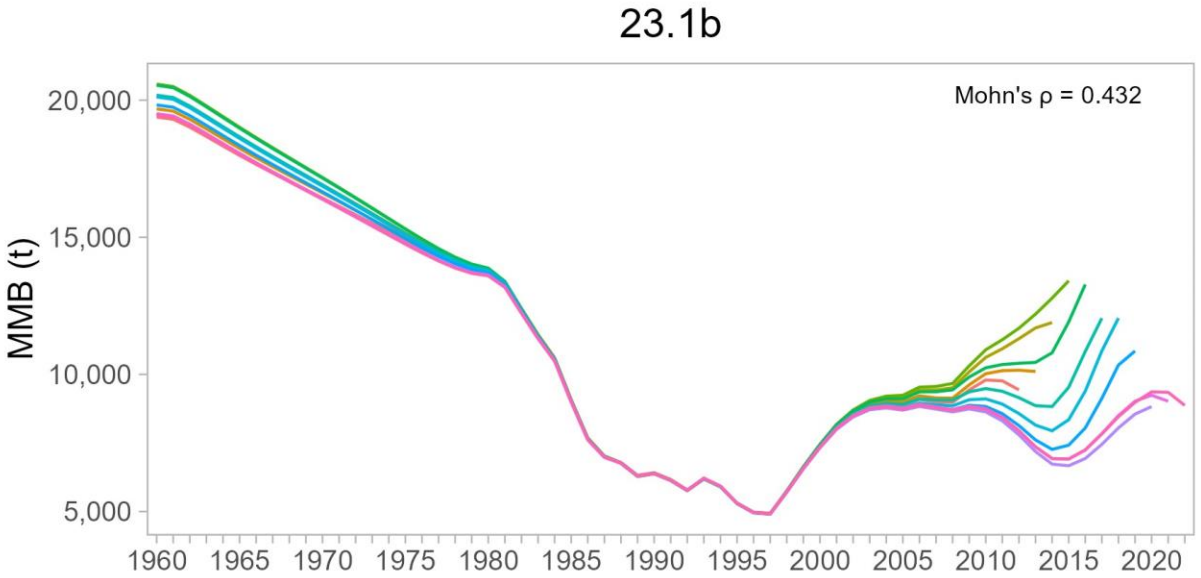

14,000
10,000
6,000
MMB (t)
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
23.0a
23.1
23.1a
23.1b

EAG

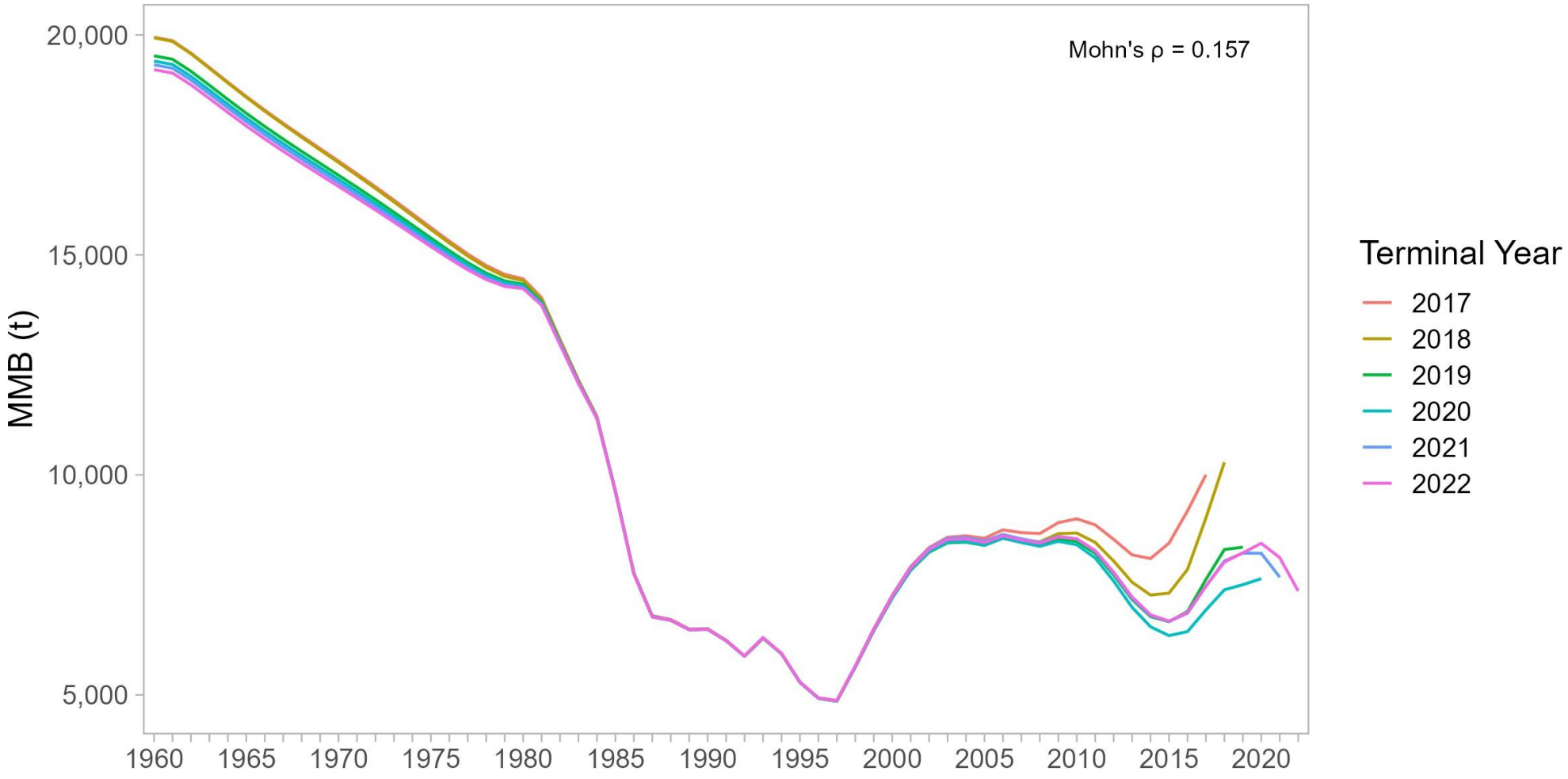

22.1e2
Mohn's ρ = 0.327
MMB (t)
20,000
15,000
10,000
5,000
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020


23.0a
Mohn's ρ = 0.371
MMB (t)
20,000
15,000
10,000
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020


23.1
Mohn's ρ = 0.406
MMB (t)
20,000
15,000
10,000
5,000
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020


23.1b
Mohn's ρ = 0.432
MMB (t)
20,000
15,000
10,000
5,000
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020

EAG 23.2


Mohn's ρ = 0.157
MMB (t)
20,000
15,000
10,000
5,000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Terminal Year
2017
2018
2019
2020
2021
2022

EAG

Model	MMB (t)	$B_{35\%}$ (t)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2017}$	$F_{35\%}$	F_{OFL}	OFL (t)
22.1e2	7,584	6,651	1.14	2,611	0.57	0.57	2,861
23.0	7,976	6,966	1.14	2,754	0.55	0.55	3,131
23.0a	7,767	6,877	1.13	2,716	0.56	0.56	3,012
23.1	7,524	6,713	1.12	2,701	0.55	0.55	2,841
23.1a	7,296	6,679	1.09	2,674	0.55	0.55	2,688
23.1b	7,251	6,788	1.07	2,748	0.59	0.59	2,837
23.2	6,192	6,786	0.91	2,735	0.59	0.54	2,182

WAG

Model	MMB (t)	$B_{35\%}$ (t)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2017}$	$F_{35\%}$	F_{OFL}	OFL (t)
22.1e2	4,572	4,979	0.92	1,977	0.55	0.50	1,232
23.0	4,556	4,780	0.95	1,905	0.54	0.51	1,268
23.0a	4,256	4,721	0.90	1,879	0.54	0.48	1,078
23.1	4,193	4,661	0.90	1,876	0.54	0.48	1,031
23.1a	4,171	4,661	0.89	1,869	0.55	0.48	1,000
23.1b	4,388	4,763	0.92	1,933	0.54	0.50	1,127

EAG Likelihoods

Component	22.1e2	23.0	23.0a	23.1	23.1a	23.1b	23.2
Retained catch	-422.553	-424.817	-424.873	-424.707	-424.627	-424.526	-424.438
Total catch	-44.311	-66.540	-66.365	-66.097	-64.693	-65.835	-64.767
Groundfish Bycatch	30.325	29.423	29.425	29.421	29.422	29.418	29.423
Obs CPUE 1995 - 2004	-10.433	-9.548	-9.212	-8.124	-8.773	-8.204	-8.600
Obs CPUE 2004 - 2022	-17.471	-16.984	-16.898	-16.367	-17.532	-14.496	-14.374
FT CPUE 1985 - 1998	-15.071	-25.330	-16.613	-16.430	-13.849	-12.863	-11.169
Survey CPUE							-4.195
Retained size comp.	299.593	518.572	501.459	445.238	395.111	357.201	324.606
Total size comp.	629.285	530.996	542.878	428.854	440.385	228.191	250.629
Survey size comp.							104.115
Stock recruitment	20.380	19.453	19.394	19.048	19.575	20.304	21.349
Tagging data	2,699.021	2,698.581	2,698.296	2,694.676	2,696.111	2,694.830	2,696.471
Penalties	0.037	0.141	0.141	0.140	0.142	0.139	0.142
Priors	25.724	25.724	25.724	25.724	25.724	33.730	35.745
Total	3,194.526	3,279.672	3,283.356	3,111.378	3,076.997	2,837.889	2,934.938

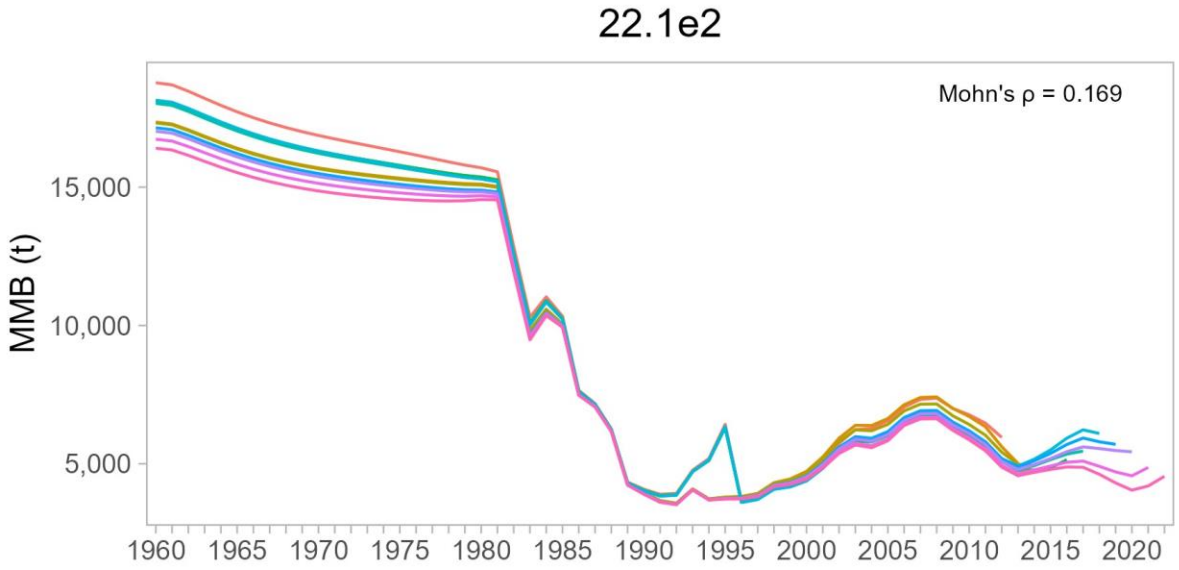
*Not all models use the same data (see above for details).

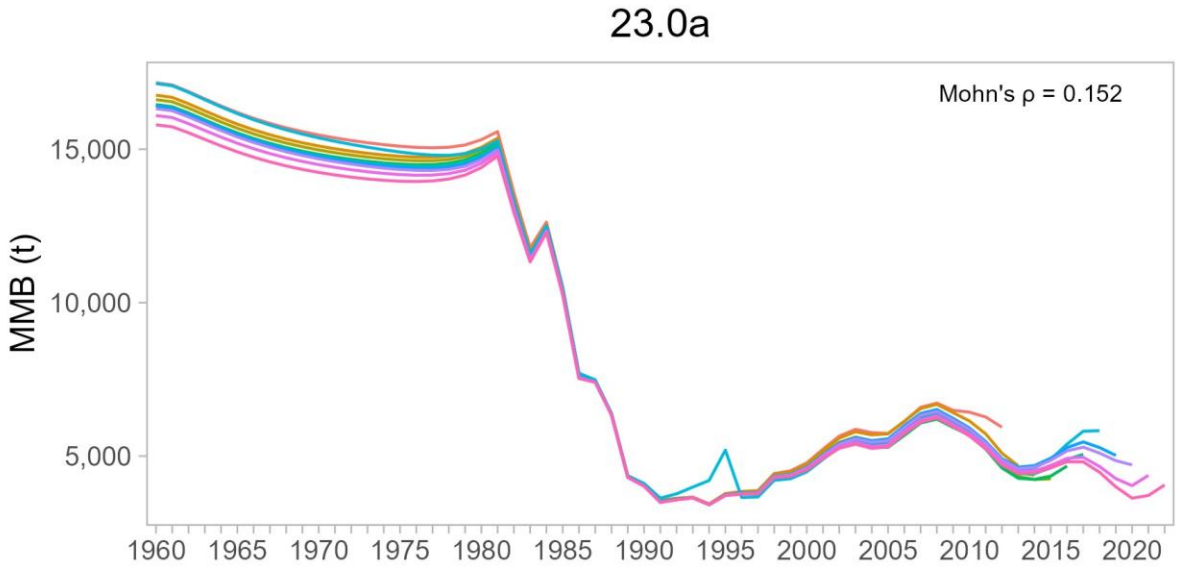
WAG Likelihoods

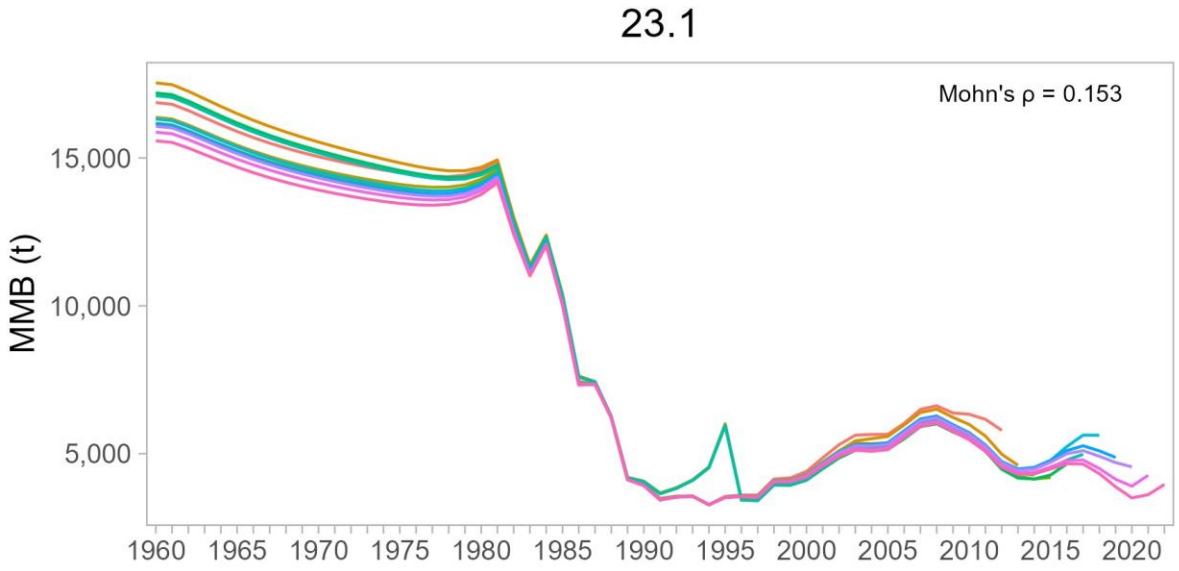
Component	22.1e2	23.0	23.0a	23.1	23.1a	23.1b
Retained catch	-420.433	-422.721	-422.516	-422.031	-421.843	-423.483
Total catch	14.119	-47.101	-47.070	-40.776	-36.965	-58.083
Groundfish Bycatch	30.326	28.488	28.488	28.489	28.489	28.488
Obs CPUE 1995 - 2004	-10.019	-9.148	-7.899	-8.120	-8.230	-10.689
Obs CPUE 2004 - 2022	-28.376	-31.074	-32.845	-32.803	-32.992	-32.415
FT CPUE 1985 - 1998	-19.839	-19.246	-18.198	-18.531	-17.684	-19.538
Retained size comp.	363.282	532.102	534.253	484.522	538.464	446.098
Total size comp.	434.956	412.726	409.554	274.943	250.332	356.137
Stock recruitment	19.584	19.716	20.619	20.780	20.256	22.173
Tagging data	2,705.586	2,699.875	2,700.526	2,698.487	2,700.309	2,694.503
Penalties	0.069	0.062	0.063	0.062	0.065	0.062
Priors	25.724	25.724	25.724	25.724	25.724	33.730
Total	3,114.980	3,189.404	3,190.699	3,010.747	3,045.926	3,036.982

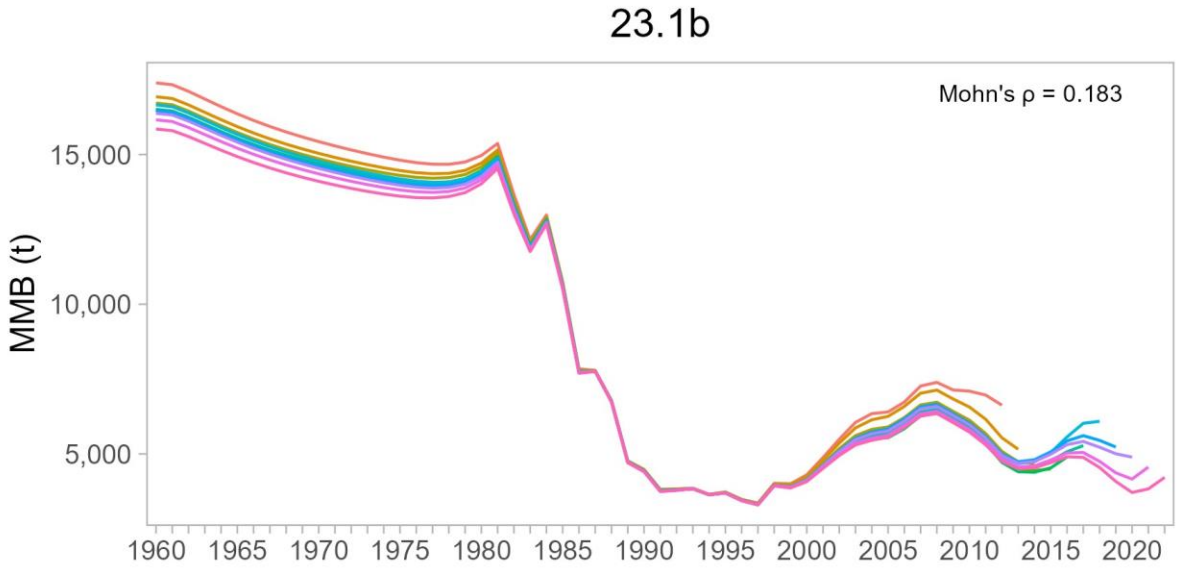
*Not all models use the same data (see above for details).

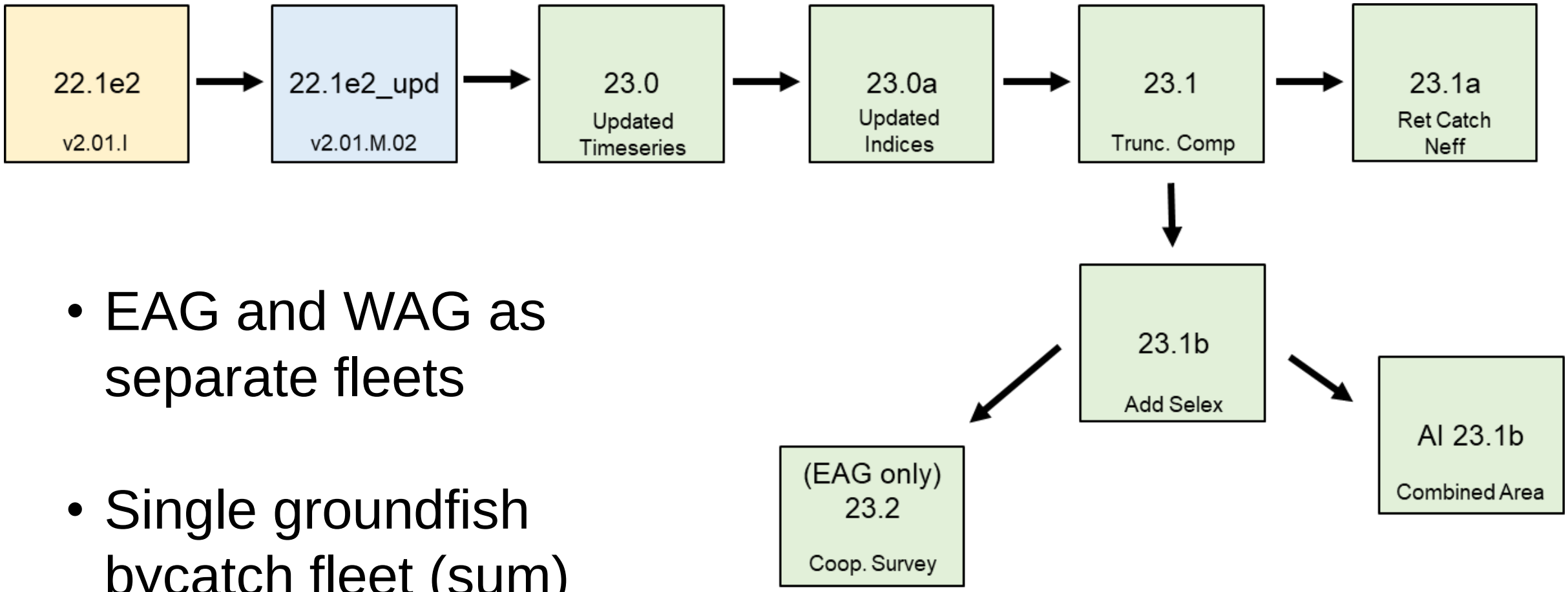
WAG


22.1e2
Mohn's ρ = 0.169
MMB (t)
15,000
10,000
5,000
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020

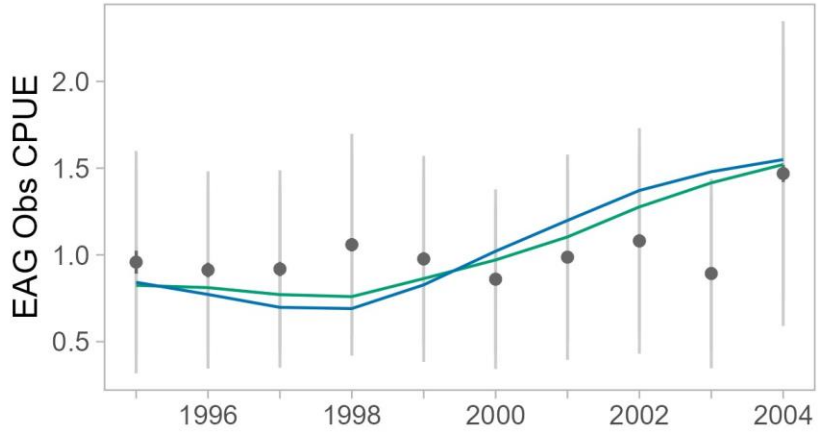

23.0a
Mohn's ρ = 0.152
MMB (t)
15,000
10,000
5,000
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020


23.1
Mohn's ρ = 0.153
MMB (t)
15,000
10,000
5,000
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020

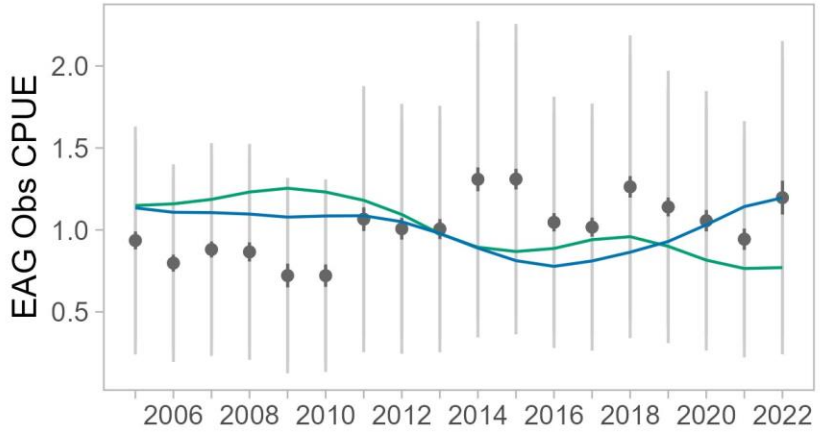

23.1b
Mohn's ρ = 0.183
MMB (t)
15,000
10,000
5,000
1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020

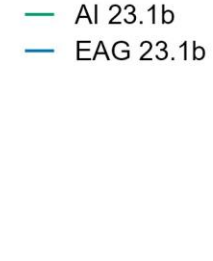


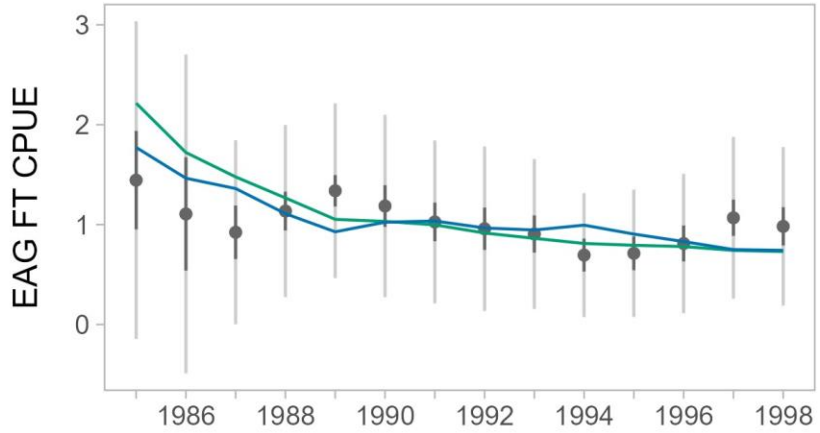
- EAG and WAG as separate fleets
- Single groundfish bycatch fleet (sum)

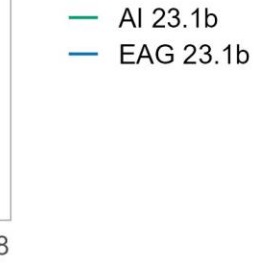

EAG Obs CPUE
2.0
1.5
1.0
0.5
1996
1998
2000
2002
2004

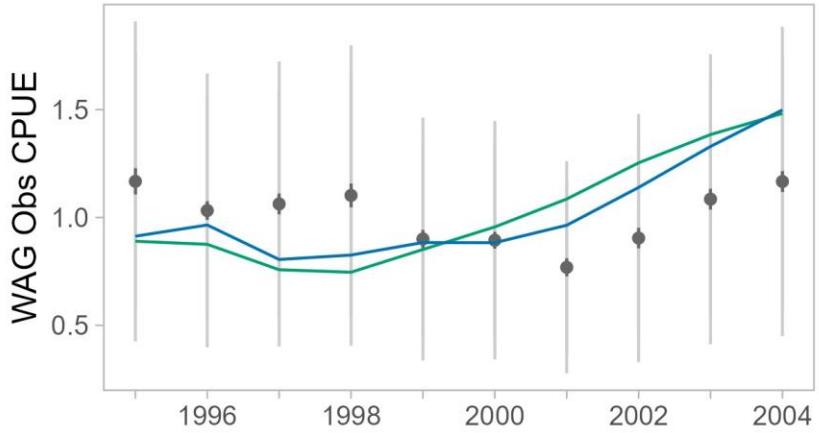

AI 23.1b
EAG 23.1b

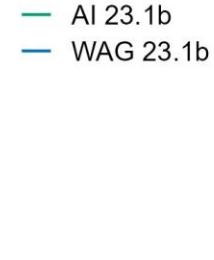

EAG Obs CPUE
2.0
1.5
1.0
0.5
2006
2008
2010
2012
2014
2016
2018
2020
2022

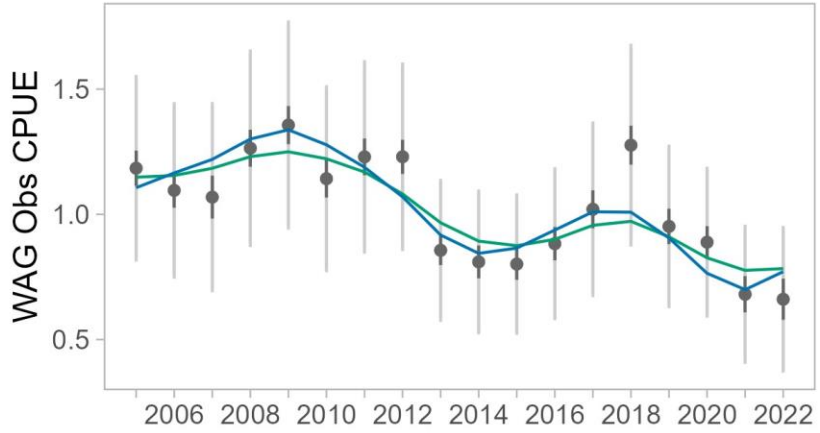

AI 23.1b
EAG 23.1b

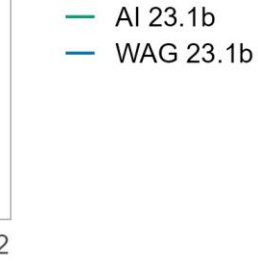

EAG FT CPUE
3
2
1
0
1986
1988
1990
1992
1994
1996
1998

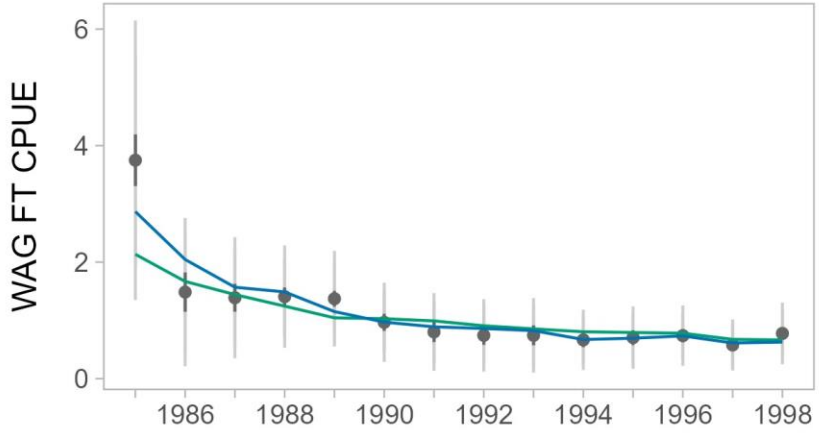

AI 23.1b
EAG 23.1b

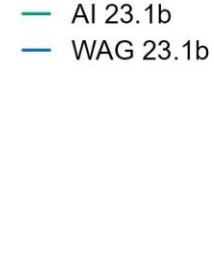

WAG Obs CPUE
1.5
1.0
0.5
1996
1998
2000
2002
2004

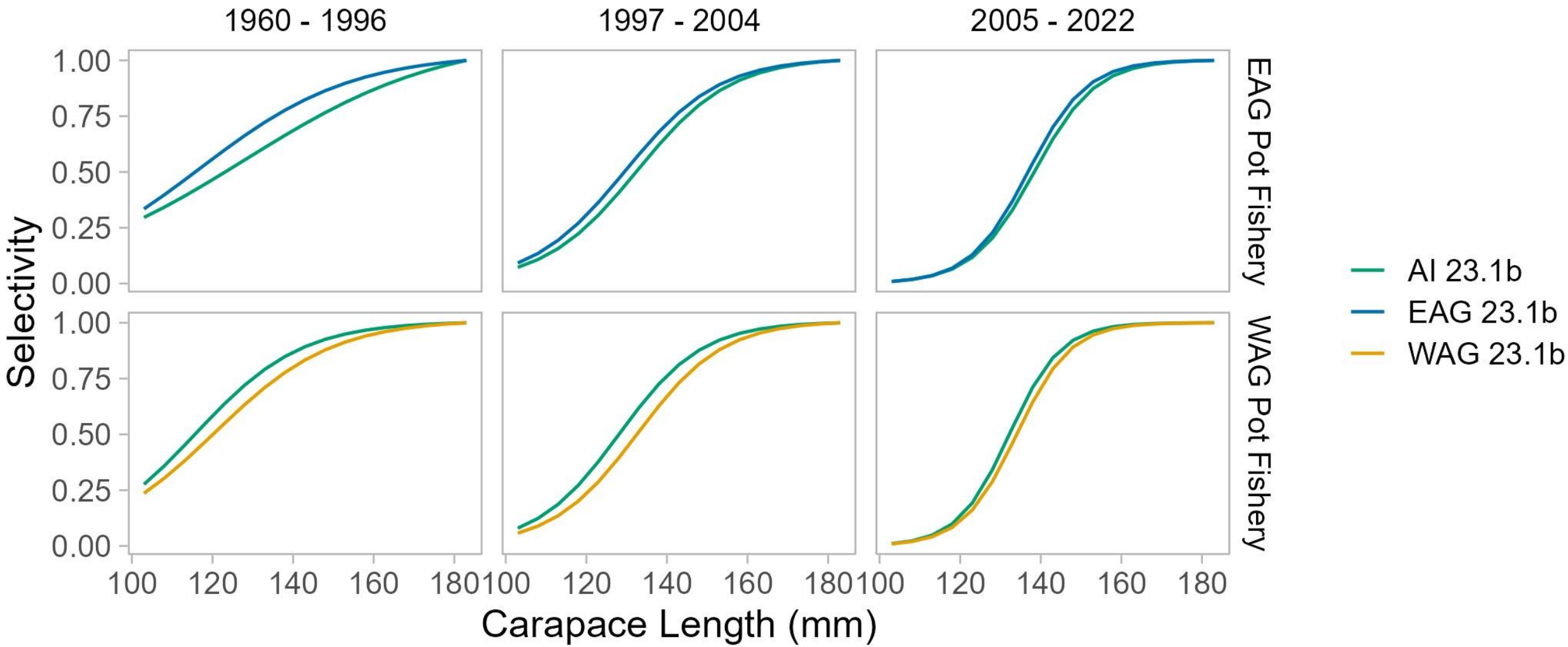

AI 23.1b
WAG 23.1b

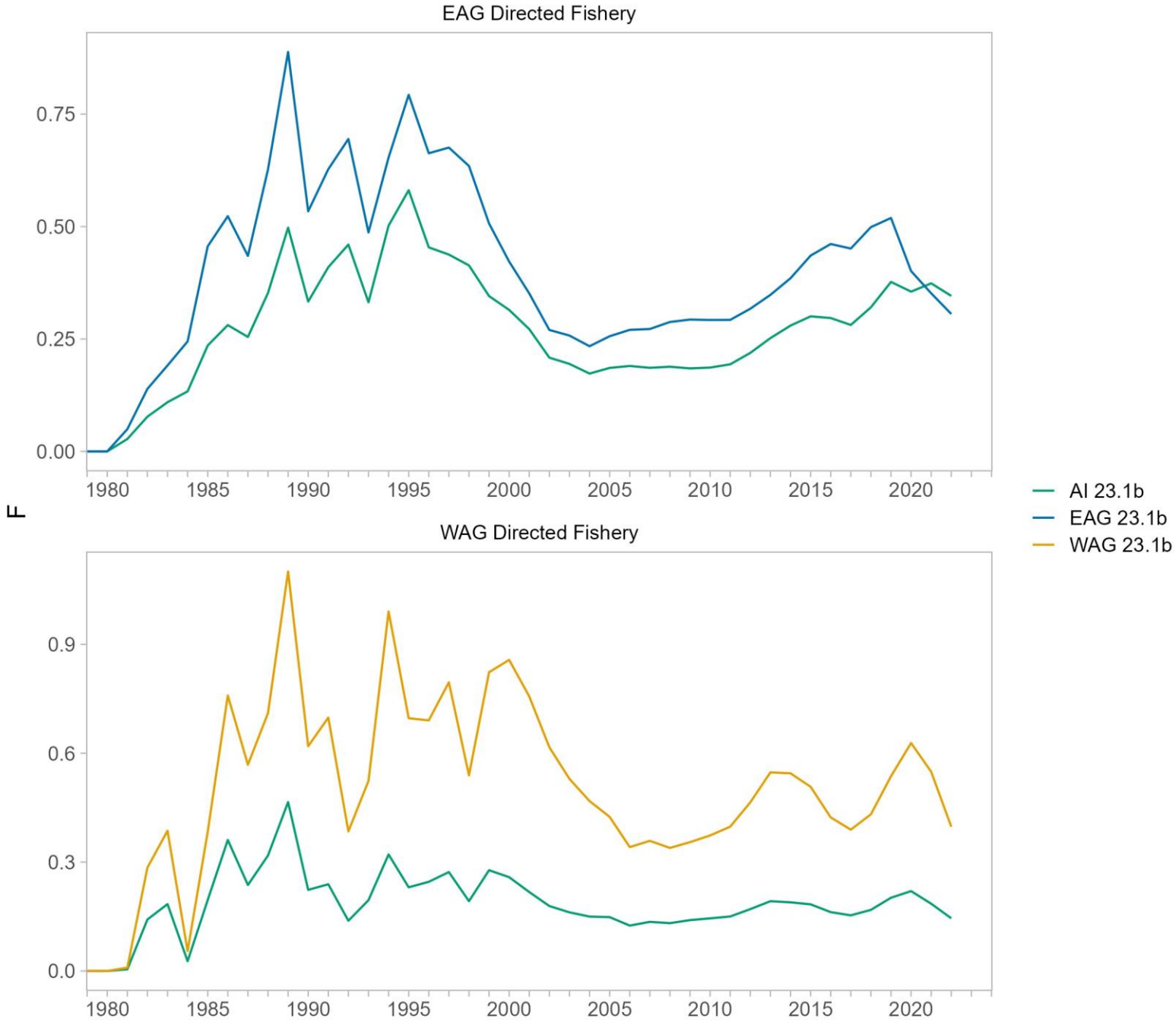

WAG Obs CPUE
1.5
1.0
0.5
2006
2008
2010
2012
2014
2016
2018
2020
2022

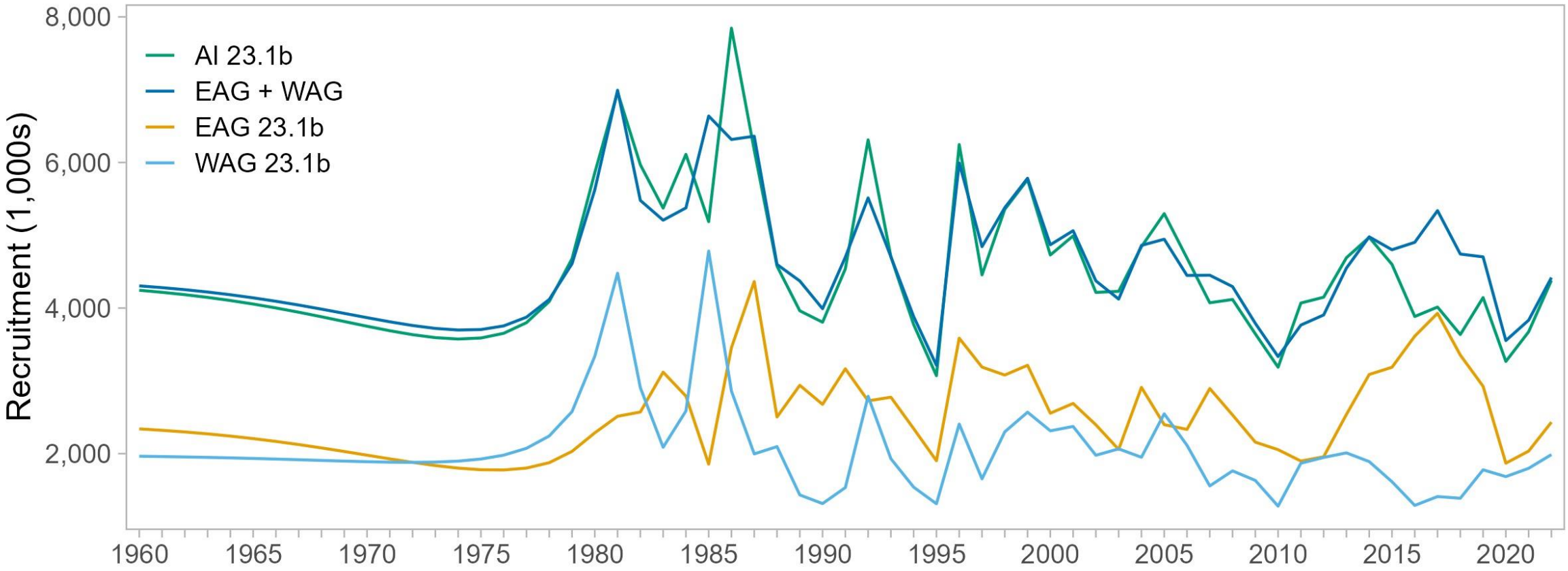

AI 23.1b
WAG 23.1b

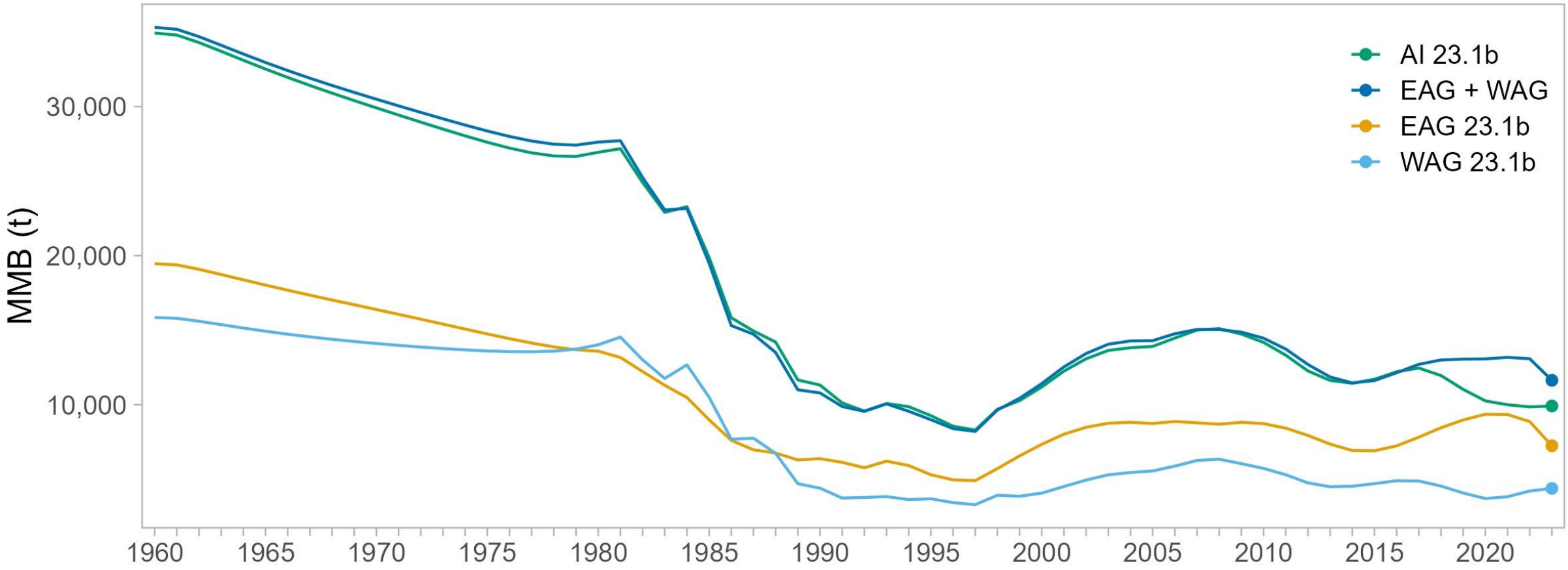

WAG FT CPUE
6
4
2
0
1986
1988
1990
1992
1994
1996
1998

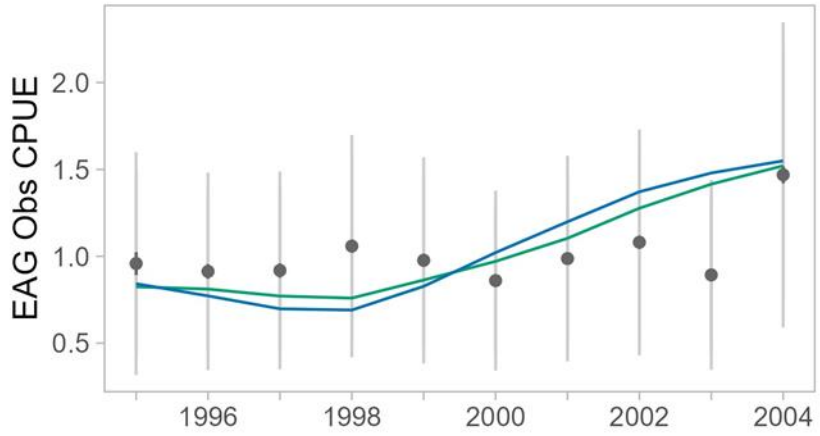

AI 23.1b
WAG 23.1b

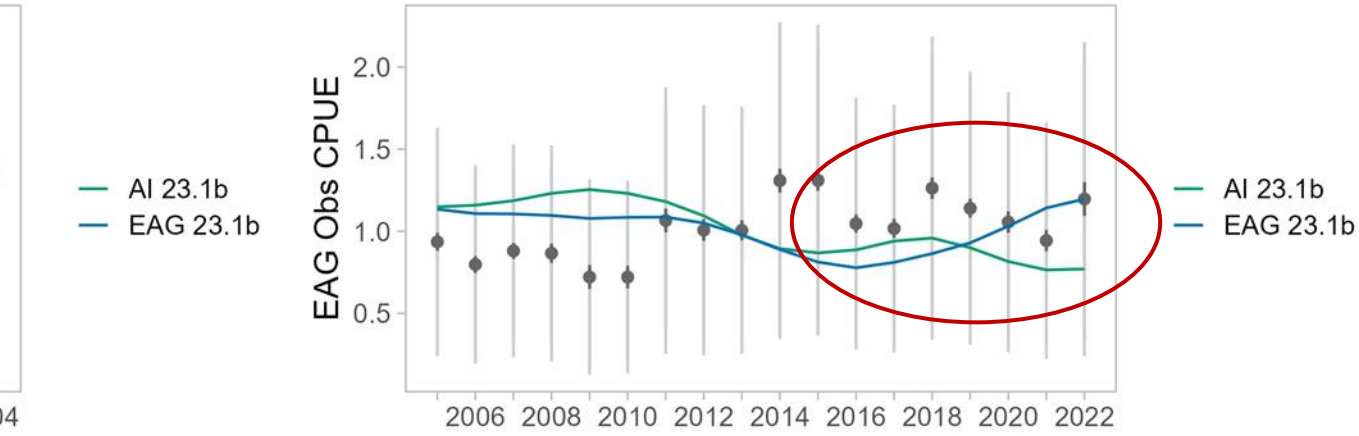

1960 - 1996
1997 - 2004
2005 - 2022
Selectivity
1.00
0.75
0.50
0.25
0.00
EAG Pot Fishery
WAG Pot Fishery
100
120
140
160
180
Carapace Length (mm)
AI 23.1b
EAG 23.1b
WAG 23.1b


EAG Directed Fishery
0.75
0.50
0.25
0.00
1980
1985
1990
1995
2000
2005
2010
2015
2020
F
WAG Directed Fishery
0.9
0.6
0.3
0.0
1980
1985
1990
1995
2000
2005
2010
2015
2020
AI 23.1b
EAG 23.1b
WAG 23.1b

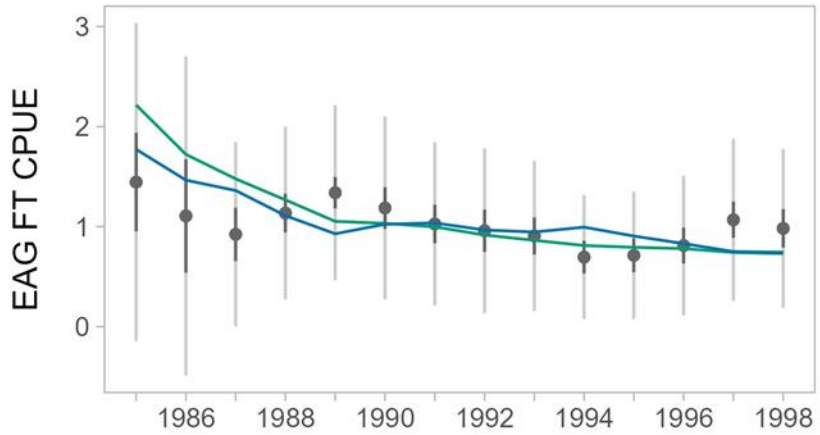

Recruitment (1,000s)
8,000
6,000
4,000
2,000
AI 23.1b
EAG + WAG
EAG 23.1b
WAG 23.1b
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020

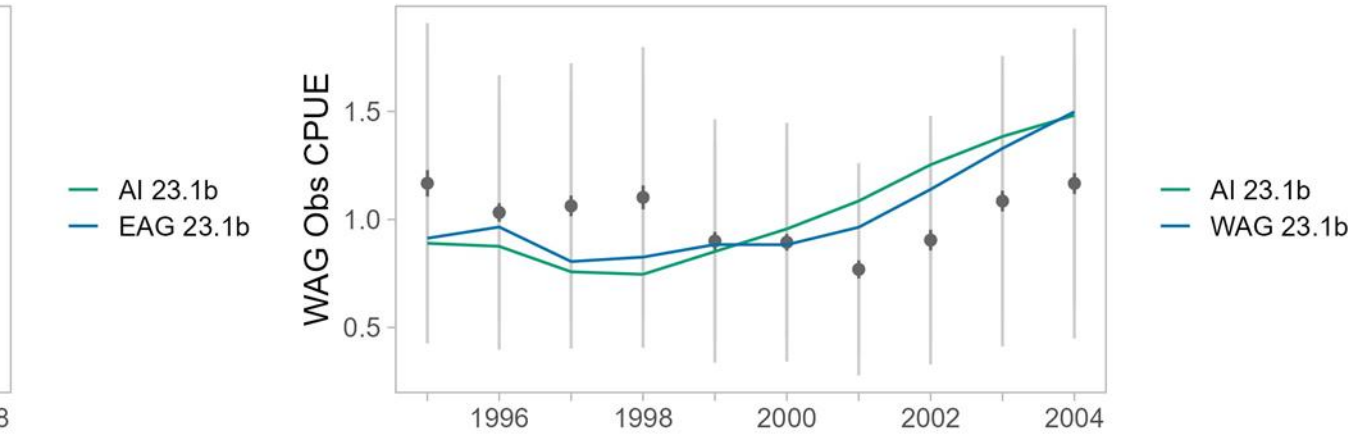

AI 23.1b
EAG + WAG
EAG 23.1b
WAG 23.1b
MMB (t)
30,000
20,000
10,000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020


EAG Obs CPUE
2.0
1.5
1.0
0.5
1996
1998
2000
2002
2004


AI 23.1b
EAG 23.1b

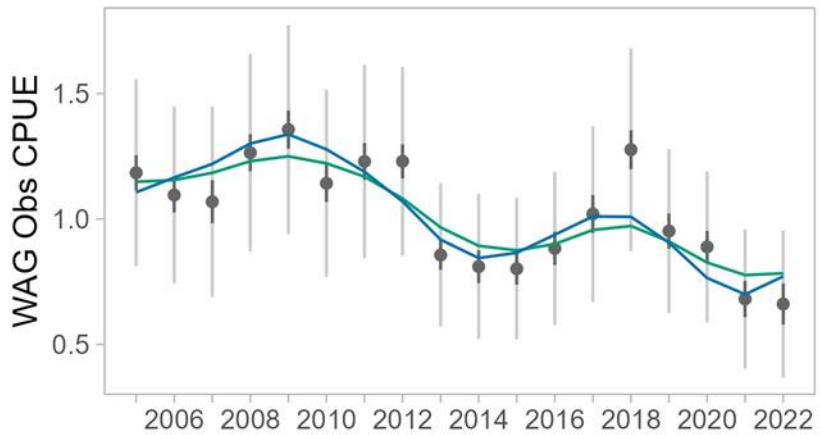
EAG Obs CPUE
2.0
1.5
1.0
0.5
2006
2008
2010
2012
2014
2016
2018
2020
2022

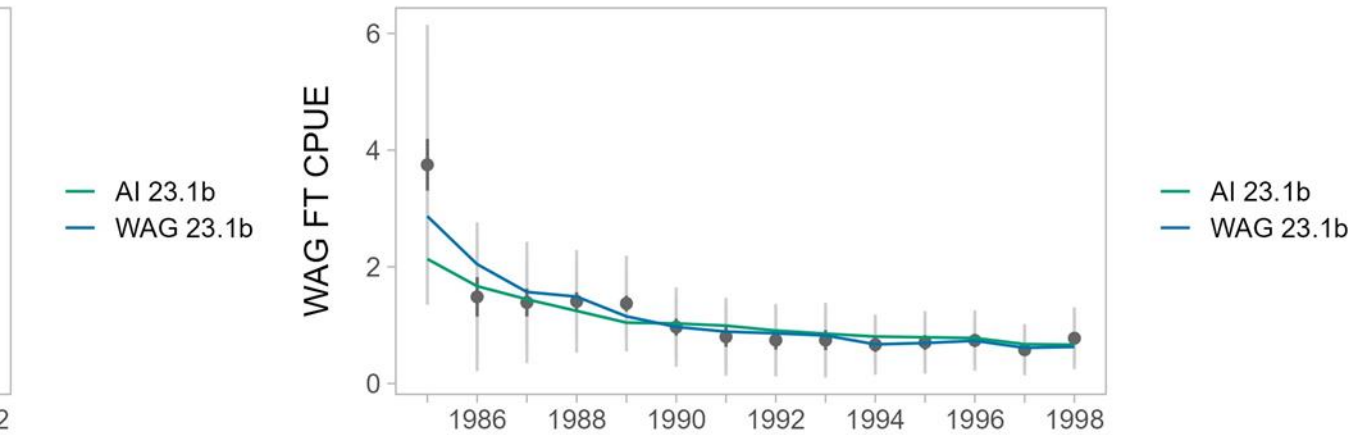

EAG FT CPUE
3
2
1
0
1986
1988
1990
1992
1994
1996
1998


AI 23.1b
EAG 23.1b

WAG Obs CPUE
1.5
1.0
0.5
1996
1998
2000
2002
2004

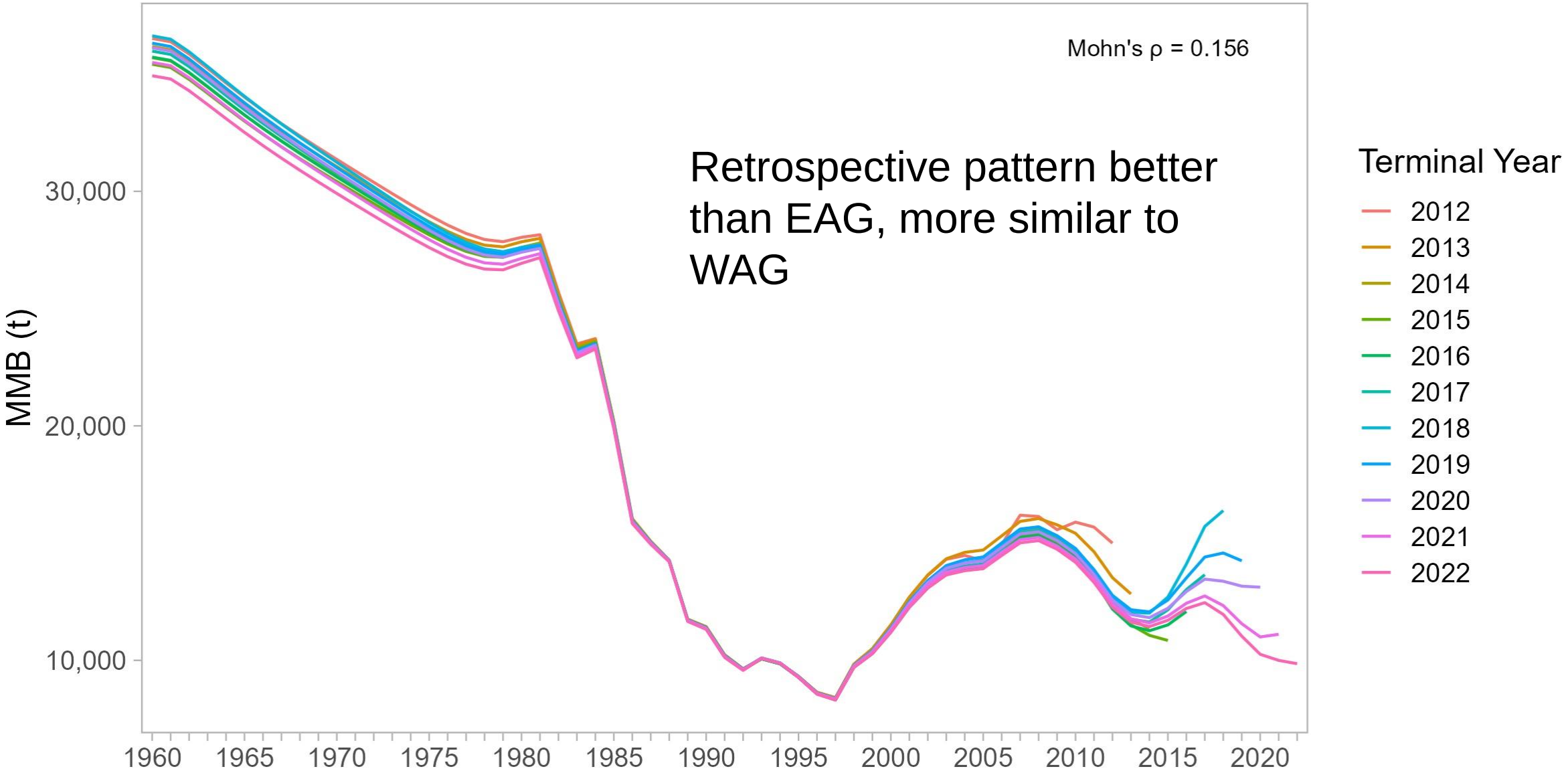
AI 23.1b
WAG 23.1b


WAG Obs CPUE
1.5
1.0
0.5
2006
2008
2010
2012
2014
2016
2018
2020
2022


AI 23.1b
WAG 23.1b

WAG FT CPUE
6
4
2
0
1986
1988
1990
1992
1994
1996
1998

AI 23.1b
WAG 23.1b


Mohn's ρ = 0.156
Retrospective pattern better than EAG, more similar to WAG
MMB (t)
30,000
20,000
10,000
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
Terminal Year
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022

Single area models tend to fit most processes better

Component	AI 23.1b	EAG 23.1b	WAG 23.1b
EAG retained catch	-423.052	-424.526	
EAG total catch	-55.941	-65.835	
WAG retained catch	-423.248		-423.483
WAG total catch	-55.193		-58.083
Groundfish bycatch	30.366	29.418	28.488
EAG obs CPUE 1995-2004	-10.378	-8.204	
EAG obs CPUE 2005-2022	-11.813	-14.496	
EAG FT CPUE 1985 - 1998	-12.638	-12.863	
WAG obs CPUE 1995-2004	-8.178		-10.689
WAG obs CPUE 2005-2022	-31.209		-32.415
WAG FT CPUE 1985 - 1998	-14.384		-19.538
EAG retained size comp	450.031	357.201	
EAG total size comp	461.950	228.191	
WAG retained size comp	520.423		446.098
WAG total size comp	451.716		356.137
Stock recruitment	18.951	20.304	22.173
Tagging data	2,695.982	2,694.830	2,694.503
Penalties	0.141	0.139	0.062
Priors	48.474	33.730	33.730
Total	3,632.002	2,837.889	3,036.982

Model	MMB (t)	$B_{35\%}$ (t)	$\frac{MMB}{B_{35\%}}$	$\bar{R}_{1987-2017}$	$F_{35\%}$	F_{OFL}	OFL (t)
AI 23.1b	9,917	11,516	0.86	4,676	0.37	0.31	2,562
EAG 23.1b	7,251	6,788	1.07	2,748	0.59	0.59	2,837
WAG 23.1b	4,388	4,763	0.92	1,933	0.54	0.50	1,127

- $B_{35\%}$ is slightly larger than sum
- Projected MMB is slightly less than sum

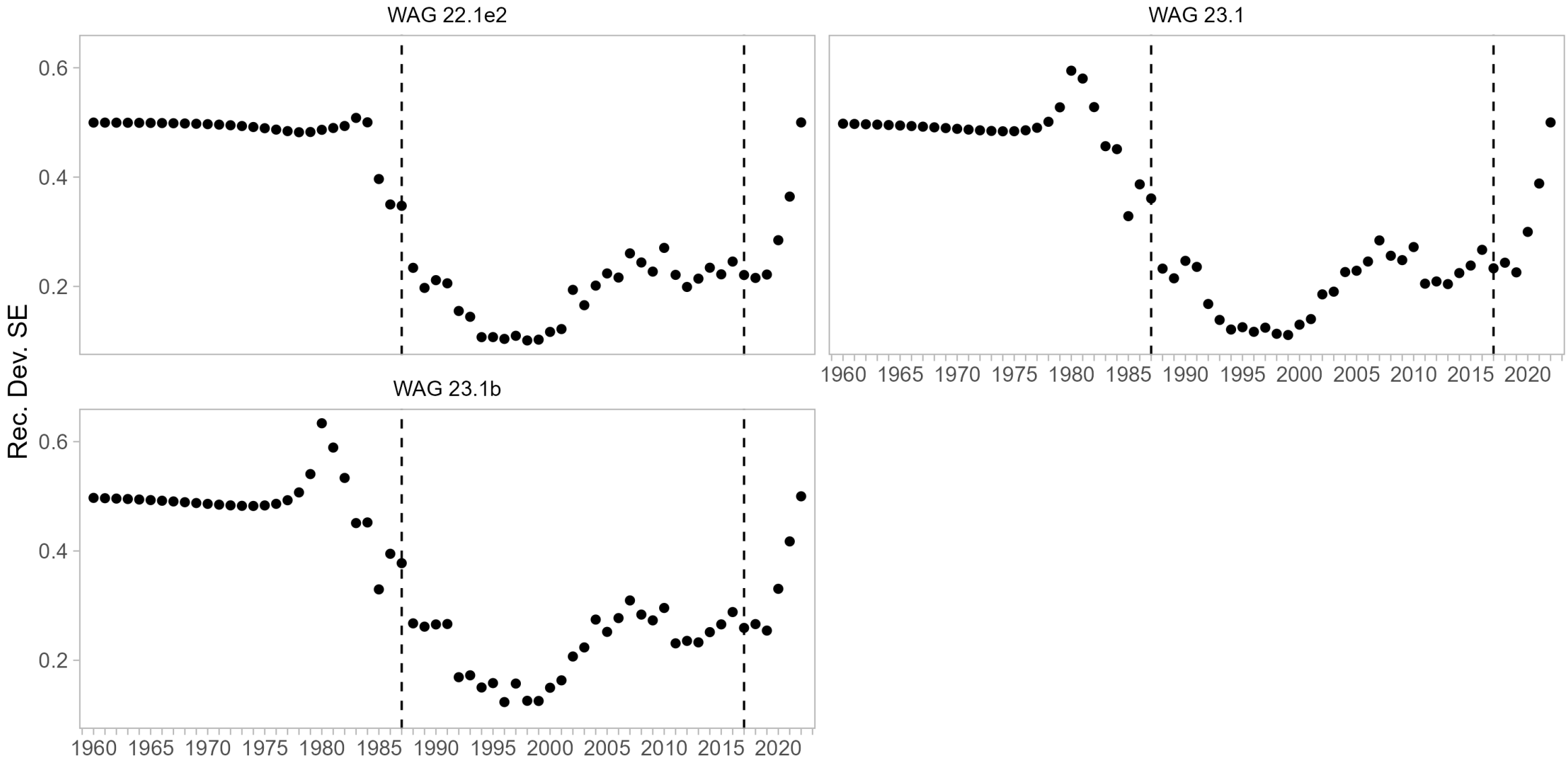
- Combined area model has large impact on reference points

- Set aside combined area model for now…
  - Tends to not fit as well as single area models
  - Large impact on reference points

Conclusions

- Data updates are necessary, 22.1e2 only evaluated in May for comparison
- Models 23.1 and 23.1b improve fits to size comp, without compromise to index fits
- No models improved fits to size comp in EAG, likely drives retrospective bias
  - Need to better explore time varying catchability
  - Data weighting
- Coop survey was not very informative to the model
  - Larger recruitment swings, higher recent F, lower MMB
  - More work needed
- Author recommendation for final assessment
  - Models 22.1e2, 23.1, 23.1b, 23.2

Response to CPT Comment – mean recruitment timeseries

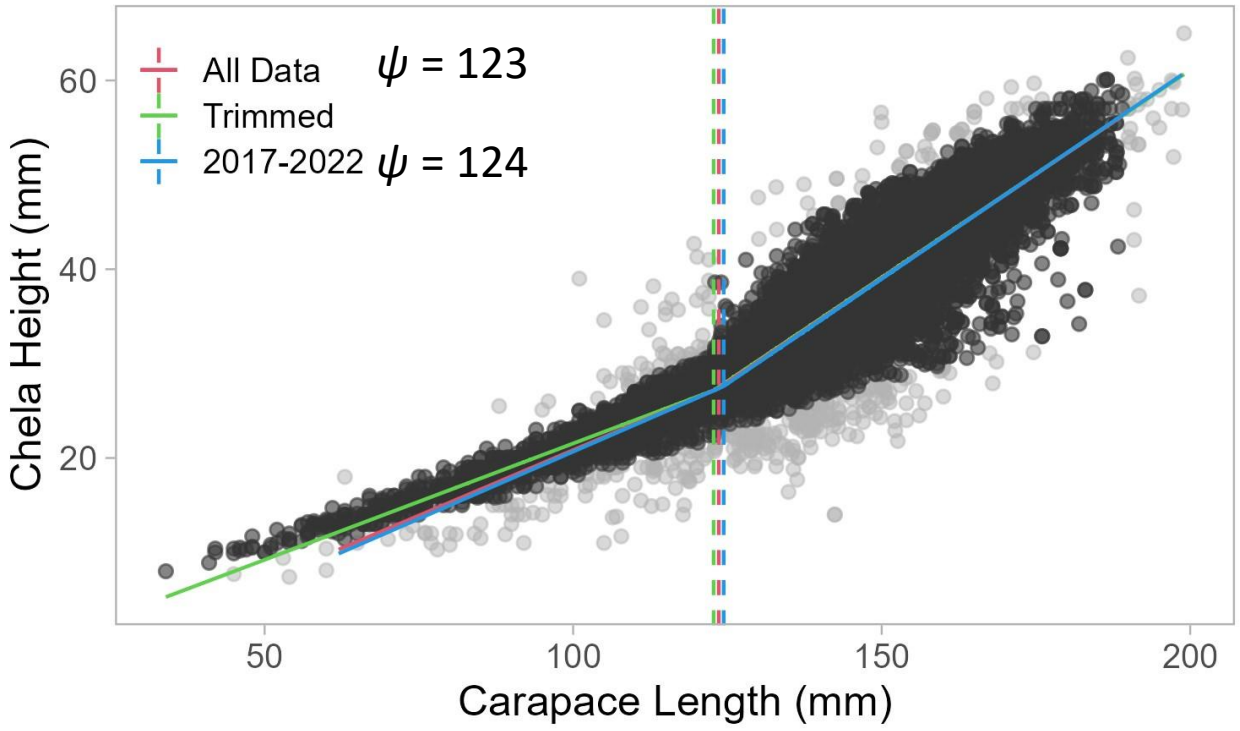


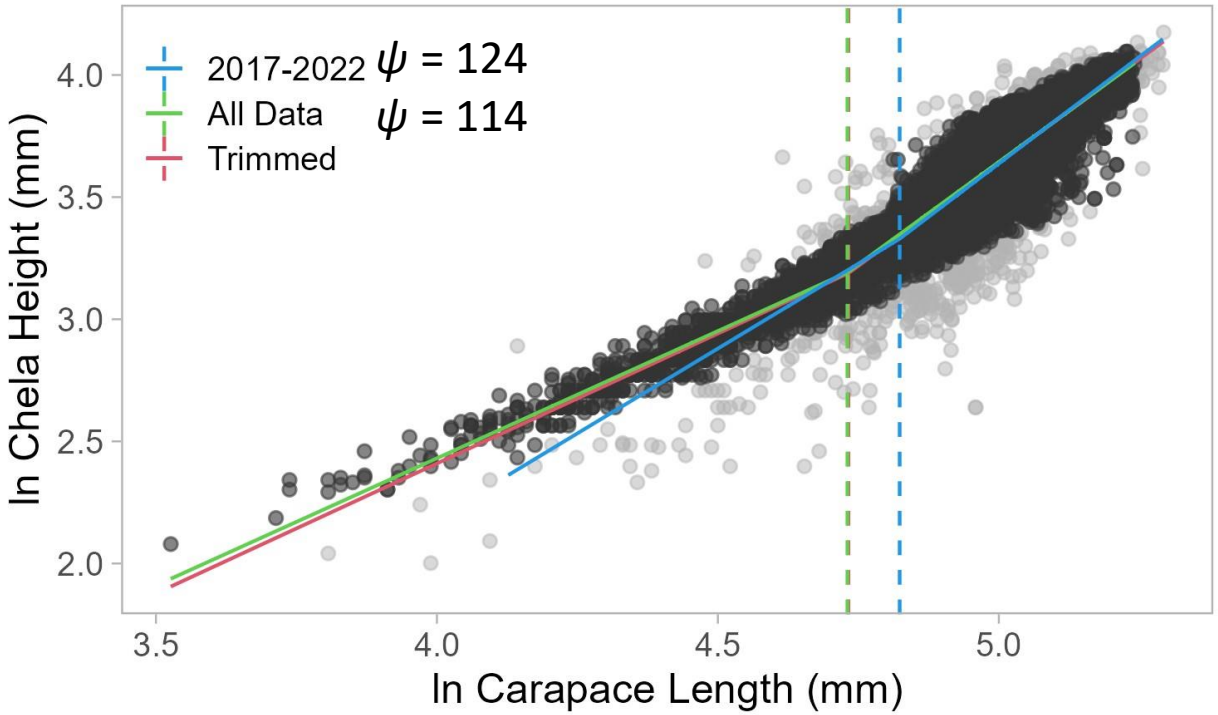
Size at maturity – Work in Progress

CPT 2023: "*Calculate reference points using both combined-area and area-specific size-at-maturity values.*"

- Siddeek et al. (2022) used 2018/19 – 2020/21 ADF&G and observer data
  - Fit segmented regression to CH ~ CL, bootstrapped 1,000 iterations
  - 108 mm EAG, 120 mm WAG, **116 mm AI**

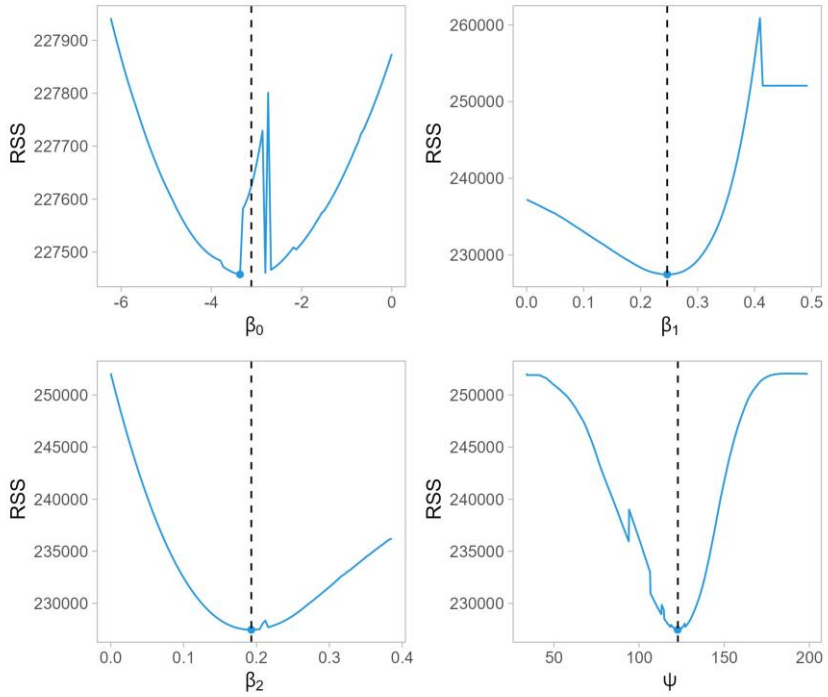
- Re-analysis with 2018/19 – 2020/21 data, and full data set, yield different results



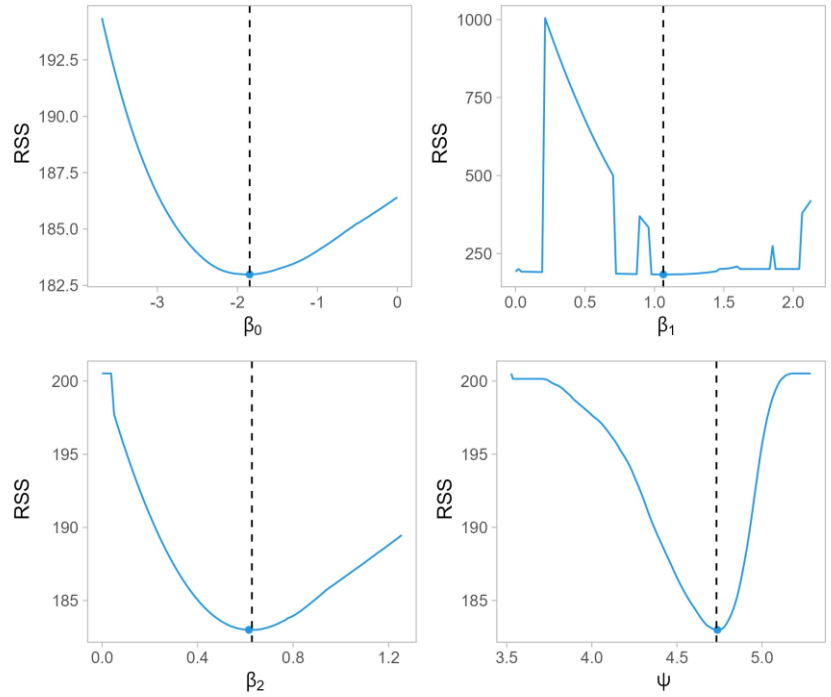


**Only Siddeek et al. (2022) and Olson et al. (2018) used untransformed data

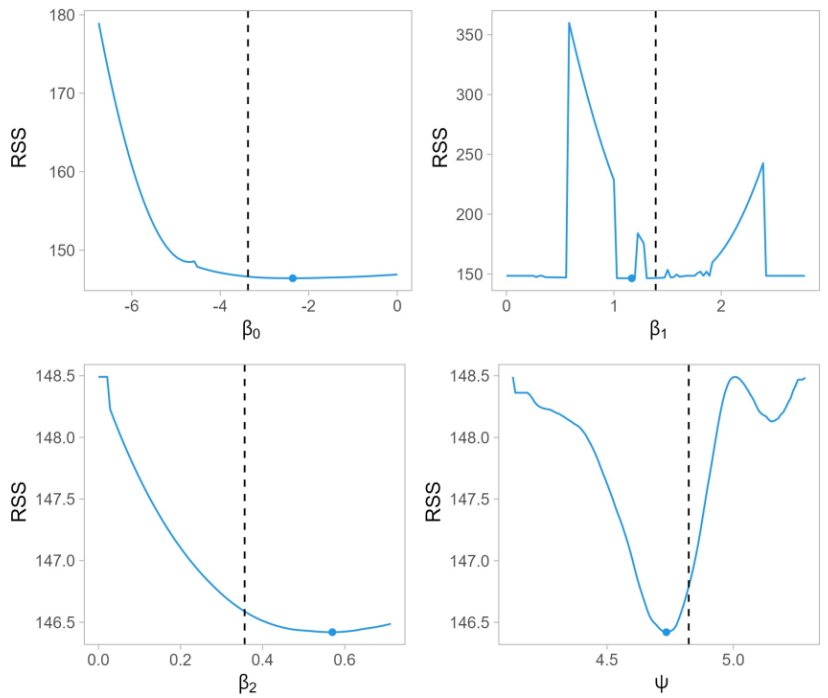
All Data



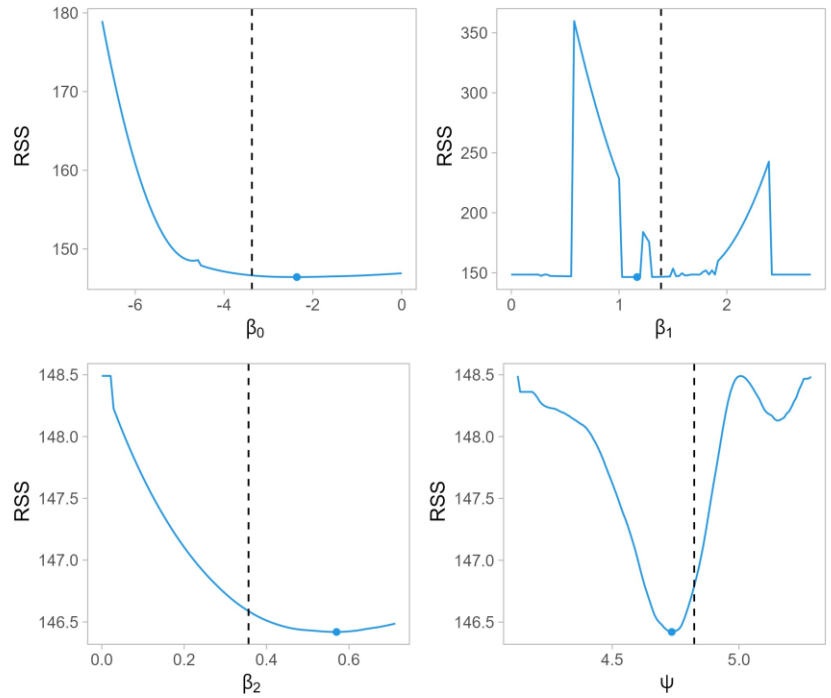
Log All Data

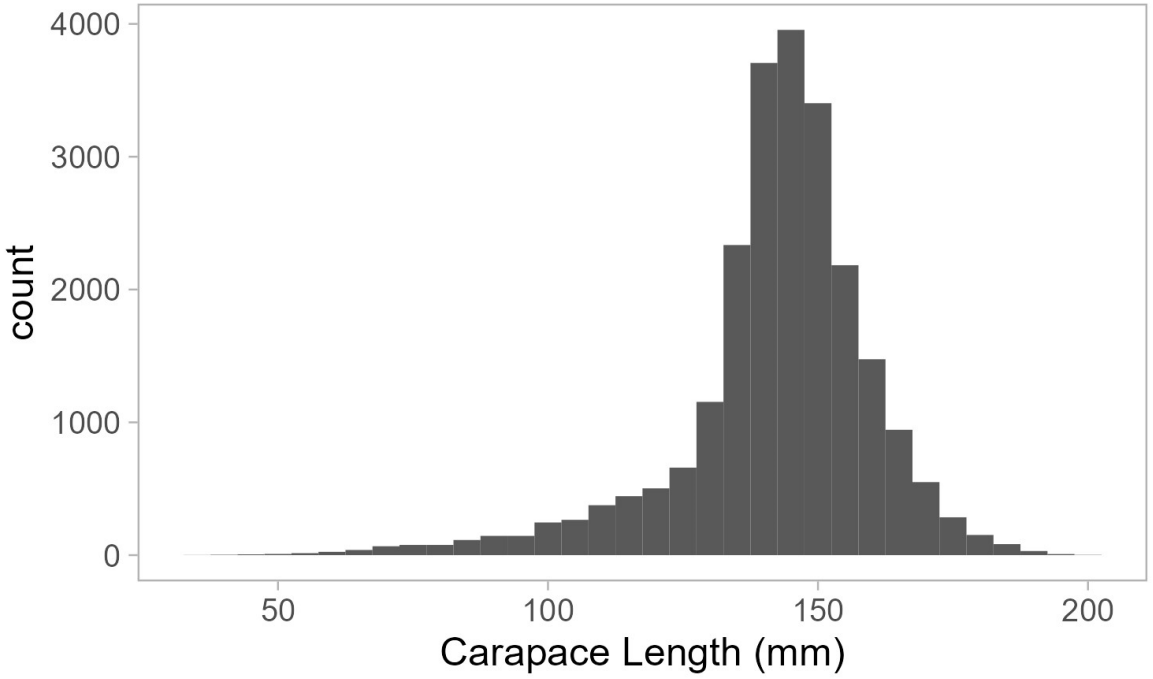


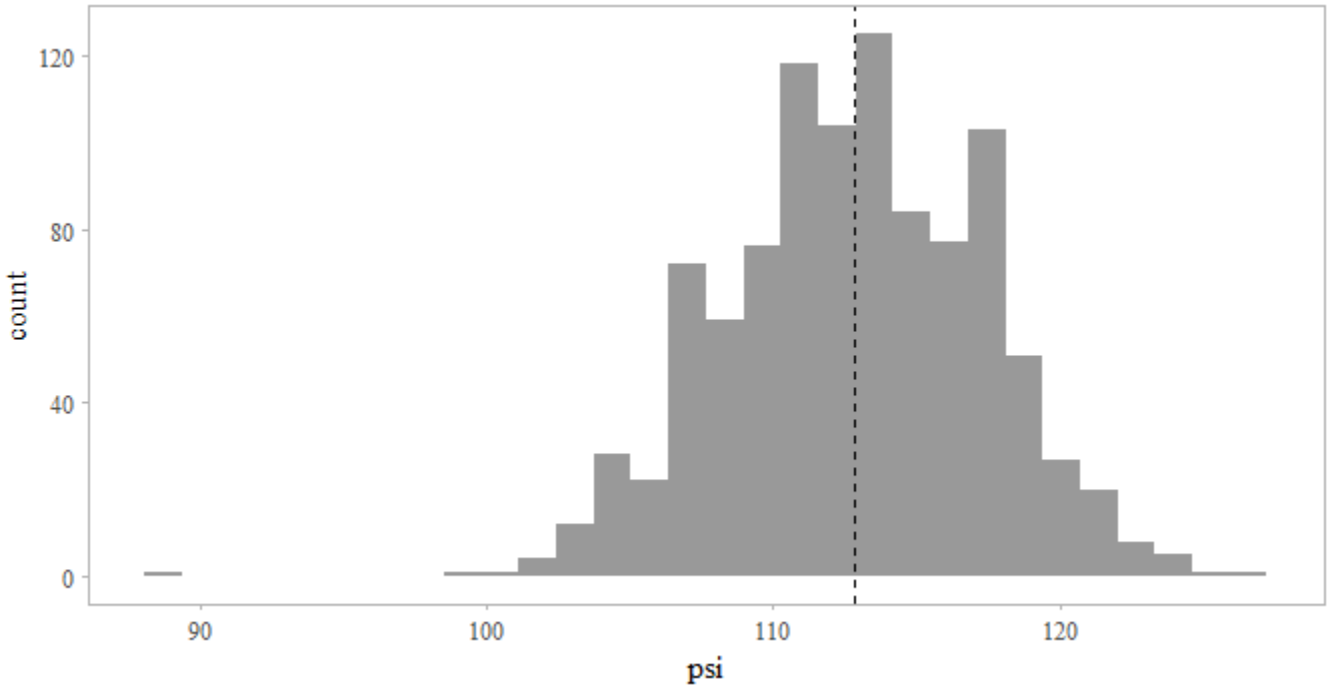
2017-2022



Log 2017-2022



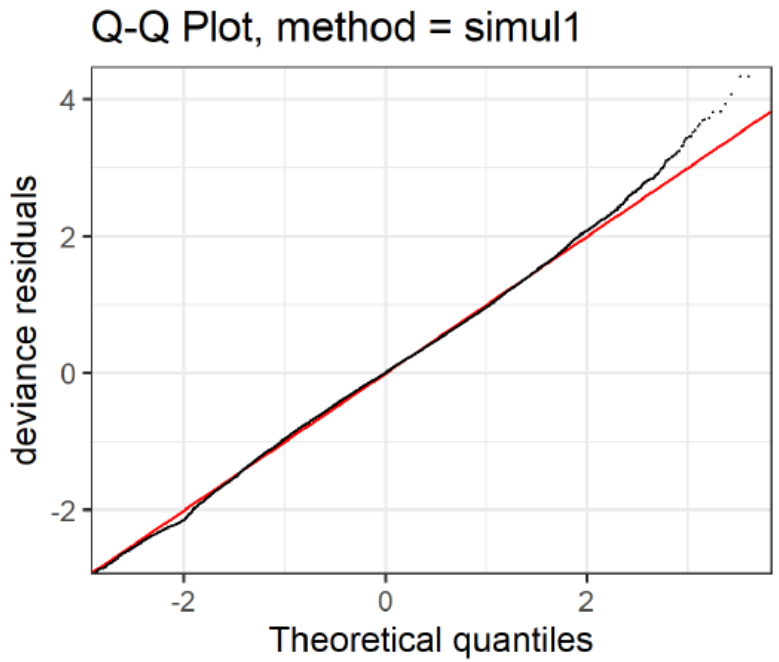


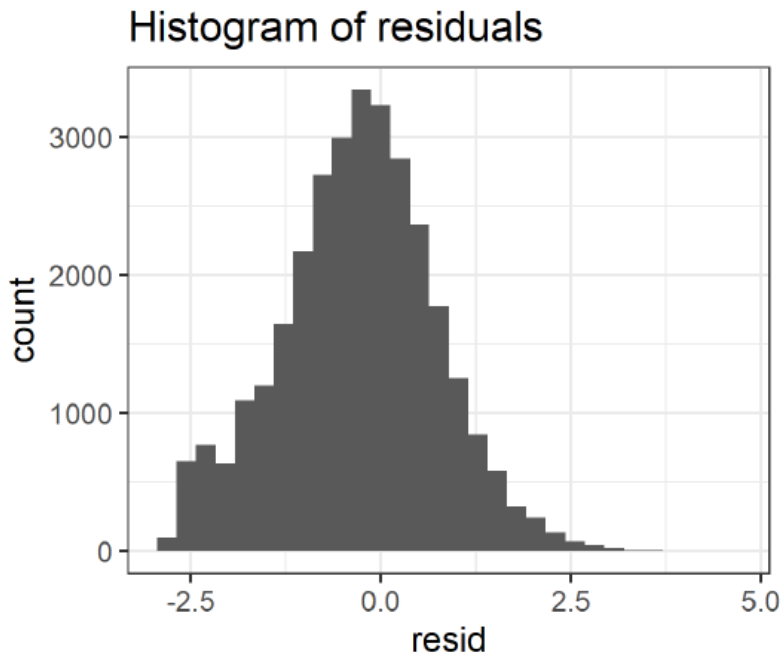


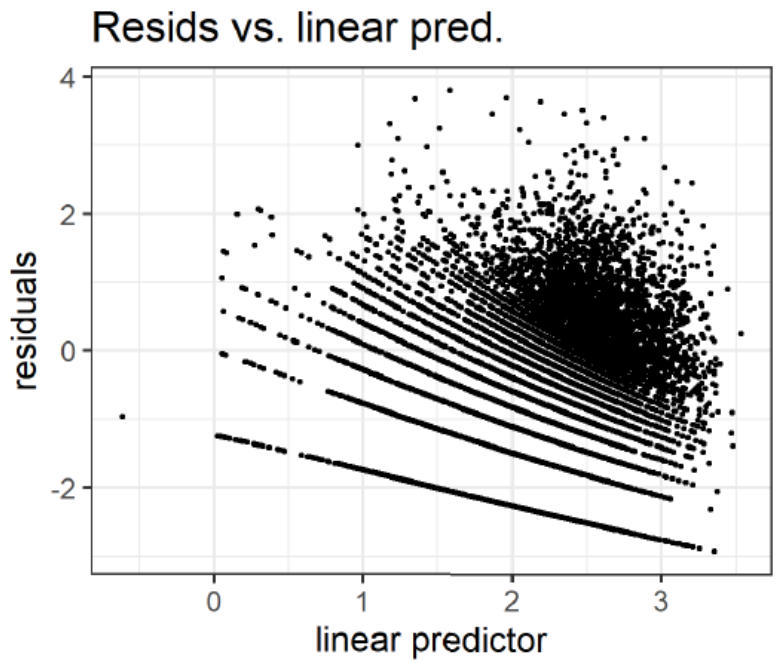
- Disproportionate amount of data close to breakpoint, less informing ends of lines
- Bootstrapping at uniform distribution in CL bins yields similar result to log transformed data, $\bar{\psi}$ = 112.8
- *Before computing different reference points,* ***the analysis should be revisited***
- *Use 116 mm for now*

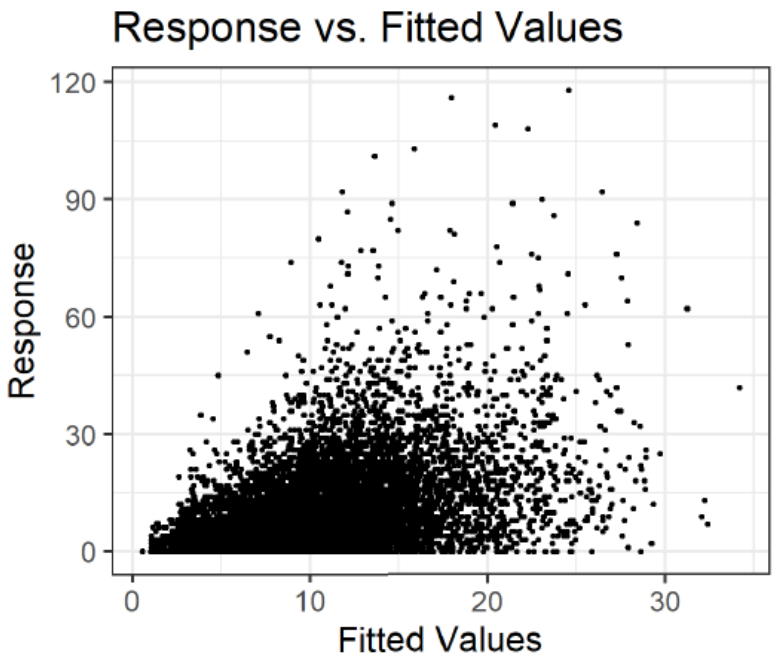
End

Pre-EAG

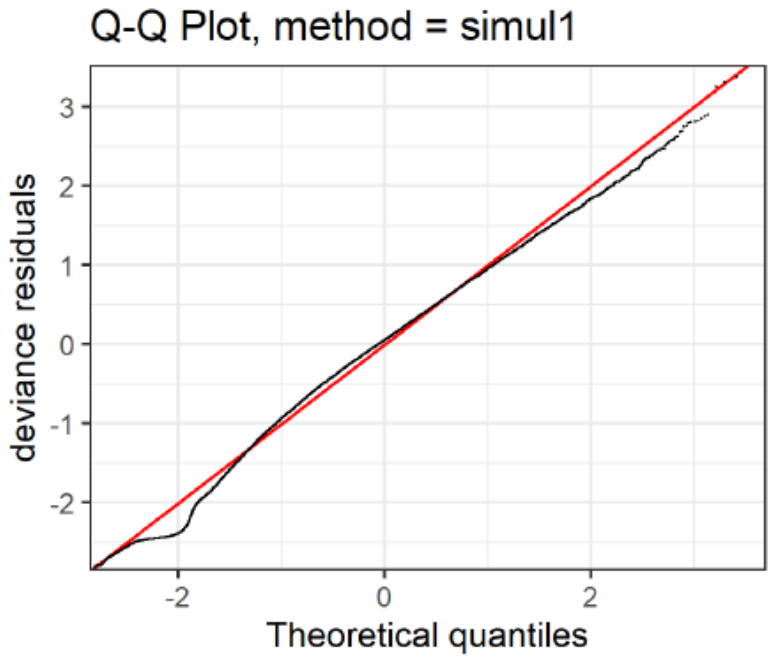

Q-Q Plot, method = simul1
deviance residuals
Theoretical quantiles
4
2
0
-2
-2
0
2

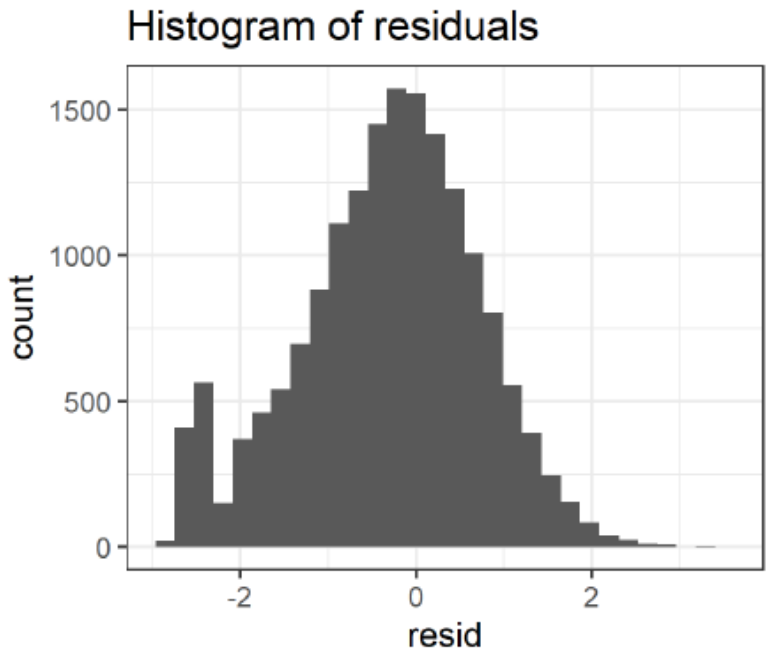

Histogram of residuals
count
resid
3000
2000
1000
0
-2.5
0.0
2.5
5.0

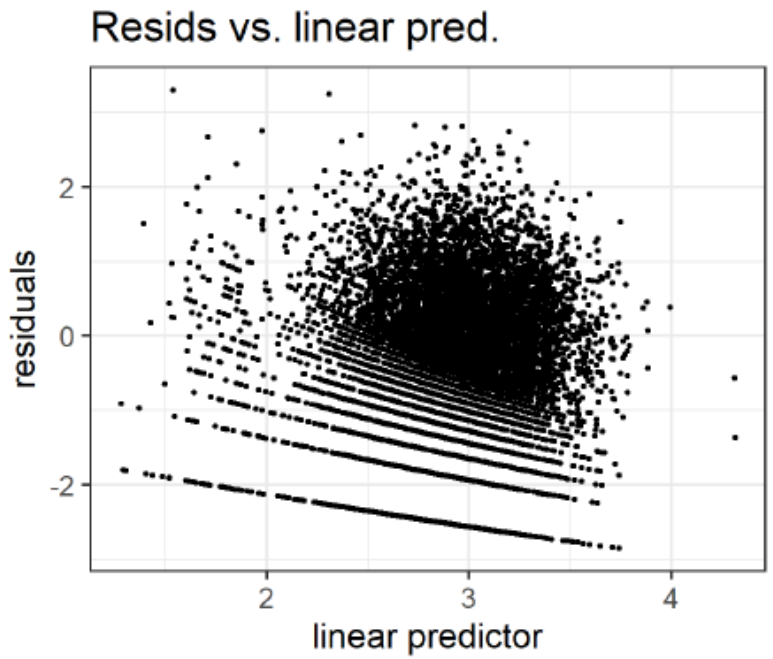

Resids vs. linear pred.
residuals
linear predictor
4
2
0
-2
0
1
2
3

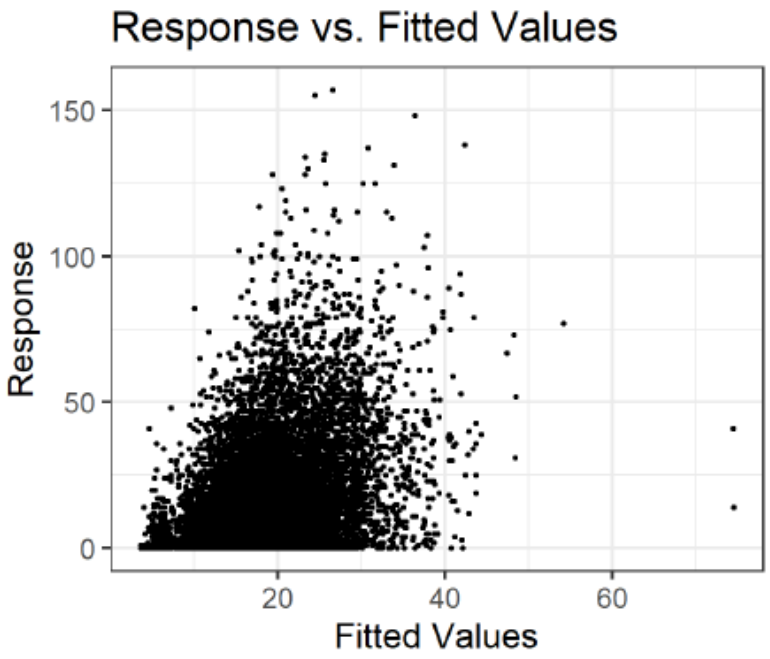

Response vs. Fitted Values
Response
Fitted Values
120
90
60
30
0
0
10
20
30

Post-EAG

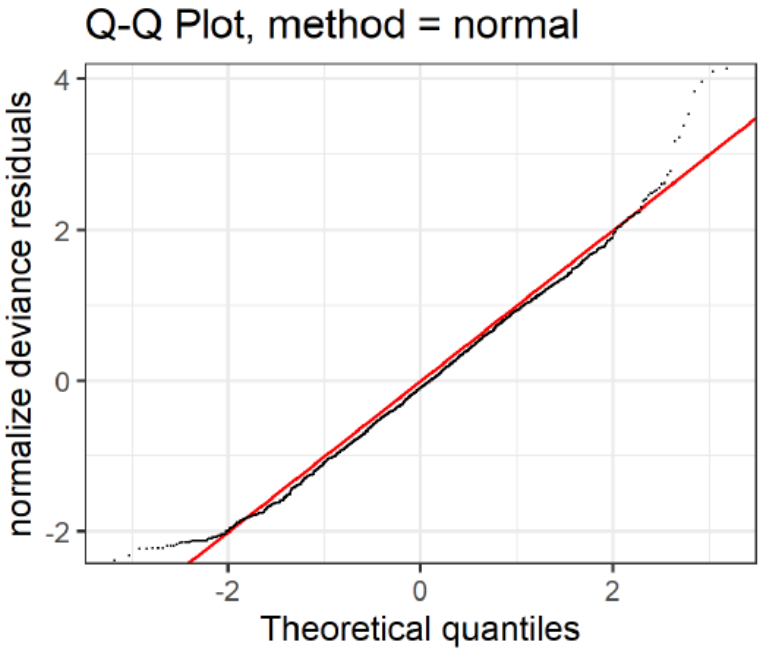

Q-Q Plot, method = simul1
deviance residuals
Theoretical quantiles
3
2
1
0
-1
-2
-2
0
2

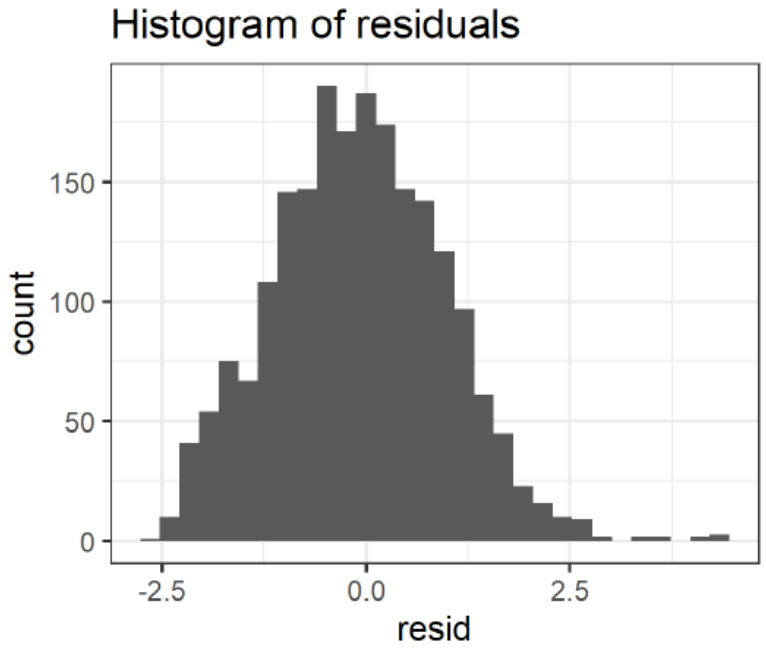

Histogram of residuals
count
resid
1500
1000
500
0
-2
0
2

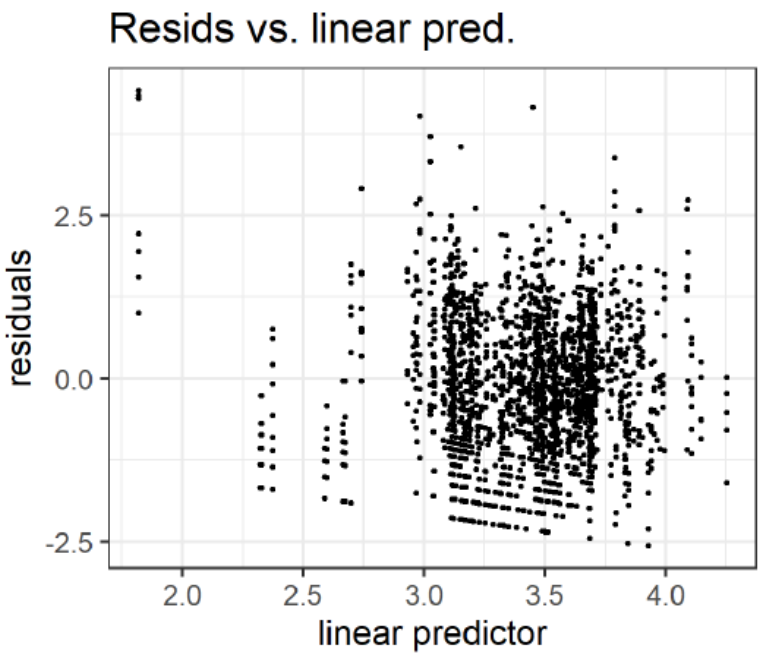

Resids vs. linear pred.
residuals
linear predictor
2
0
-2
2
3
4

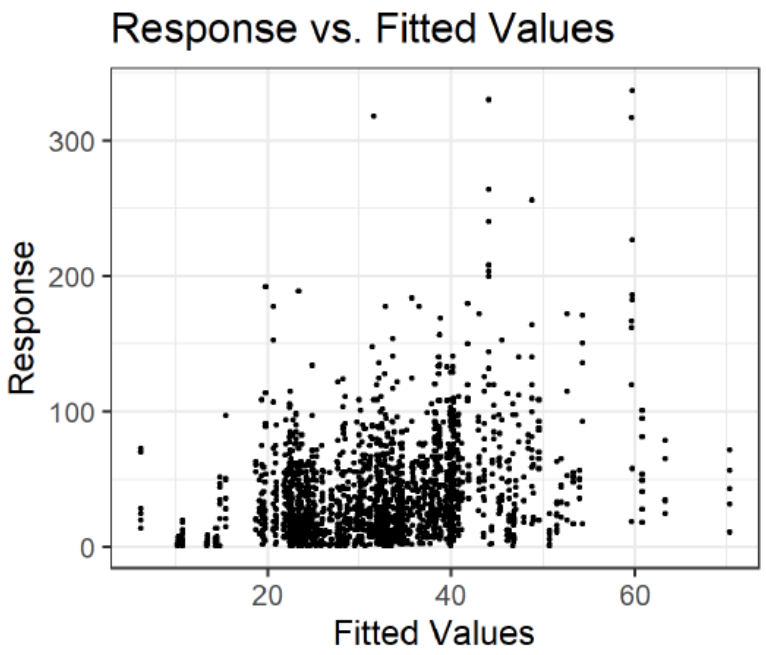

Response vs. Fitted Values
Response
Fitted Values
150
100
50
0
20
40
60

Survey


Q-Q Plot, method = normal
normalize deviance residuals
4
2
0
-2
-2
0
2
Theoretical quantiles


Histogram of residuals
count
150
100
50
0
-2.5
0.0
2.5
resid


Resids vs. linear pred.
residuals
2.5
0.0
-2.5
2.0
2.5
3.0
3.5
4.0
linear predictor


Response vs. Fitted Values
Response
300
200
100
0
20
40
60
Fitted Values