Eastern Bering Sea pollock data and assessment for the North Pacific Fishery Management Council

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Alaska Fisheries Science Center

Errata from Nov 5 draft

- Table 34

Table 34: Outcomes of decision (expressed as chances out of 100) given different 2025 catches (first row, in kt). Note that for the 2022 and later year-classes average values were assumed. Constant Fs based on the 2025 catches were used for subsequent years.

	10	325	650	975	1300	1625	1950	2600
$P[F_{2025} > F_{MSY}]$	0	0	0	0	0	0	1	13
$P[F_{2025} > F_{35\%}]$	0	0	0	0	0	0	0	13
$P[B_{2026} < B_{MSY}]$	33	20	24	28	33	39	45	59
$P[B_{2027} < B_{MSY}]$	32	16	20	26	32	40	48	65
$P\left[B_{2026} < \bar{B}\right]$	39	8	16	26	39	53	66	86
$P\left[B_{2029} < \bar{B}\right]$	21	5	9	15	21	28	36	51
$P[B_{2029} < B_{2023}]$	32	12	18	25	32	40	47	60
$P[B_{2027} < B_{20\%}]$	4	1	2	3	4	5	7	12
$P\left[p_{a_5,2027} > \bar{p}_{a_5}\right]$	62	30	42	53	62	68	74	80
$P[D_{2026} < D_{1994}]$	0	0	0	0	0	0	0	0
$P[D_{2029} < D_{1994}]$	10	1	2	5	10	16	24	46
$P[E_{2025} > E_{2024}]$	38	0	0	8	38	64	78	91

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	10	325	650	975	1300	1625	1950	2600
$P[F_{2025} > F_{MSY}]$	0	0	0	0	0	0	1	13
$P[F_{2025} > F_{35\%}]$	0	0	0	0	0	0	0	13
$P[B_{2026} < B_{MSY}]$	17	20	24	28	33	39	45	59
$P[B_{2027} < B_{MSY}]$	12	16	20	26	32	40	48	65
$P\left[B_{2026} < \bar{B}\right]$	4	8	16	26	39	53	66	86
$P\left[B_{2029} < \bar{B}\right]$	2	5	9	15	21	28	36	51
$P[B_{2029} < B_{2023}]$	7	12	18	25	32	40	47	60
$P[B_{2027} < B_{20\%}]$	1	1	2	3	4	5	7	12
$P\left[p_{a_5,2027} > \bar{p}_{a_5}\right]$	18	30	42	53	62	68	74	80
$P[D_{2026} < D_{1994}]$	0	0	0	0	0	0	0	0
$P[D_{2029} < D_{1994}]$	0	1	2	5	10	16	24	46
$P[E_{2025} > E_{2024}]$	0	0	0	8	38	64	78	91

Errata from Nov 5 draft

- Table 37

Table 37: Bycatch estimates (t) of pollock caught in the other non-pollock EBS directed fisheries, 1991–2024 based on then NMFS Alaska Regional Office reports from observers.

Year	Atka.Mackerel	NRock.sole	Other.flats	Other.spp	P.cod	Yellowfin.sole
1991	129	9,711	7,992	661,886	10,695	NA
1992	108	9,824	1,371	520	20,778	13,100
1993	18	18,582	2,581	604	31,292	15,253
1994	0	15,784	6,770	89	26,594	33,200
1995	NA	7,766	5,211	63	25,691	27,041
1996	60	7,698	5,456	744	22,382	22,254
1997	NA	9,123	[illegible]	14	33,658	24,100
1998	58	[illegible]	[illegible]	[illegible]	10,468	15,339
1999	246	[illegible]	4,771	[illegible]	[illegible]	8,701
2000	16	[illegible]	7,068	503	[illegible]	13,425
2001	[illegible]	4,577	4,739	249	[illegible]	16,502
2002	[illegible]	9,942	2,220	49	15,255	14,489
2003	[illegible]	[illegible]	3,672	167	15,926	11,578
2004	[illegible]	[illegible]	6,396	80	18,650	10,383
2005	[illegible]	[illegible]	5,057	25	14,109	10,312
2006	121	[illegible]	3,826	21	15,168	[illegible]
2007	147	3,245	[illegible]	128	20,319	[illegible]
2008	1	4,930	[illegible]	15	9,533	[illegible]
2009	7	6,171	[illegible]	6	7,875	[illegible]
2010	NA	6,074	[illegible]	85	6,575	[illegible]
2011	144	6,931	2,301	157	8,981	[illegible]
2012	41	6,703	1,751	[illegible]	8,377	[illegible]
2013	9	7,326	4,048	[illegible]	9,801	[illegible]
2014	[illegible]	11,258	6,404	[illegible]	11,502	24,712
2015	[illegible]	9,386	4,993	[illegible]	[illegible]	21,281
2016	[illegible]	11,850	3,687	448	[illegible]	22,306
2017	[illegible]	5,616	3,613	494	[illegible]	23,414
2018	137	5,182	3,525	819	[illegible]	28,235
2019	54	[illegible]	7,972	1,311	[illegible]	23,153
2020	57	[illegible]	2,374	[illegible]	[illegible]	31,651
2021	53	[illegible]	[illegible]	[illegible]	4,316	24,844
2022	602	2,976	[illegible]	2,023	6,260	26,514
2023	383	11,047	4,590	2,688	7,181	22,347
2024	41	15,035	4,208	1,426	5,117	13,179

Errata from Nov 5 draft

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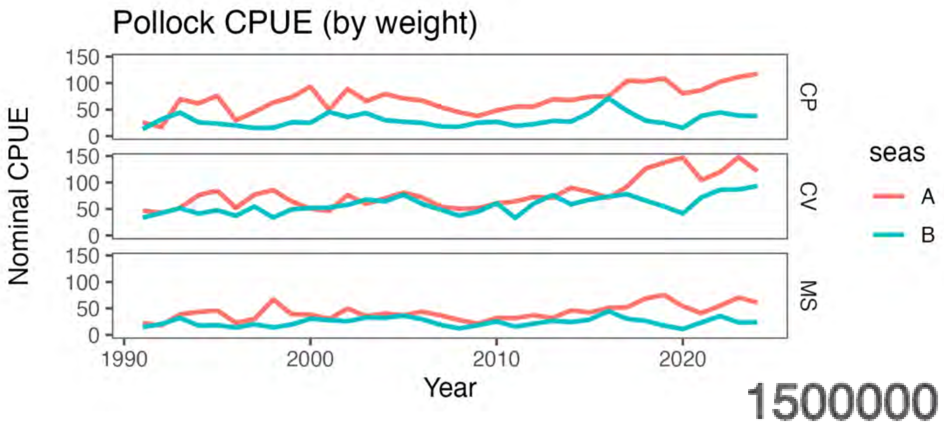
Table 37: Bycatch estimates (t) of pollock caught in the other non-pollock EBS directed fisheries, 1991–2024 based on then NMFS Alaska Regional Office reports from observers.

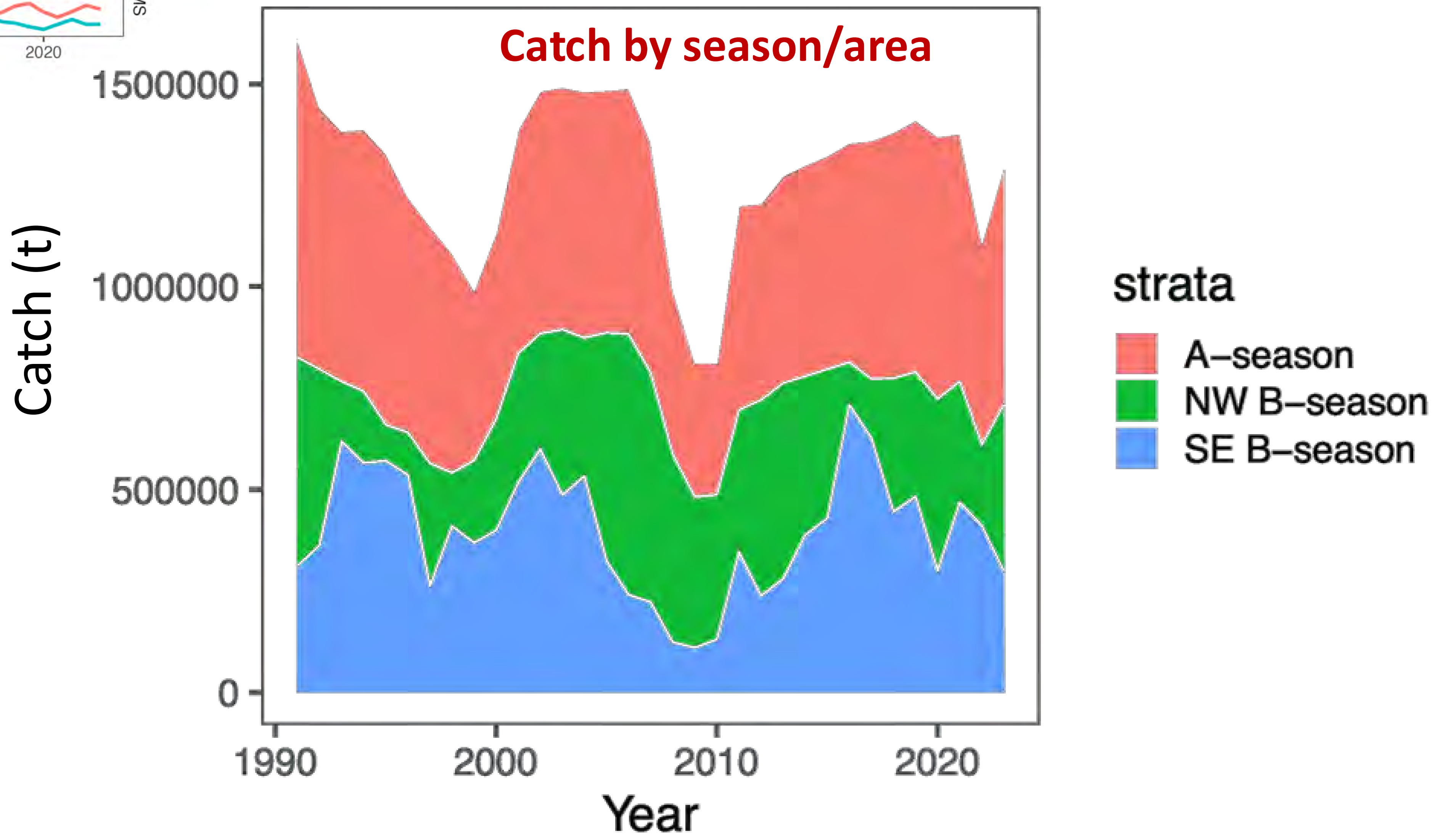
Year	NRock.sole	Other.flats	Other.spp	P.cod	Yellowfin.sole	Total
1991	9,711	6,824	755	10,669	NA	27,961
1992	9,824	1,371	514	20,651	13,100	45,462
1993	18,582	2,581	390	31,252	15,253	68,060
1994	15,784	6,770	89	26,584	33,200	82,429
1995	7,766	5,211	26	25,464	27,041	65,509
1996	7,698	5,456	802	22,377	22,254	58,590
1997	9,123	3,480	14	33,645	24,100	70,364
1998	3,960	3,010	941	10,460	15,339	33,711
1999	5,207	4,771	1,193	21,106	8,701	40,980
2000	5,480	7,067	520	14,480	13,425	40,974
2001	4,577	4,707	488	11,540	16,502	37,816
2002	9,942	2,220	51	15,234	14,489	41,938
2003	4,924	3,672	235	15,926	11,578	36,337
2004	8,975	6,396	194	18,650	10,383	44,599
2005	7,235	5,057	201	14,109	10,312	36,917
2006	6,986	3,826	142	15,168	5,966	32,090
2007	3,245	4,353	276	20,319	4,020	32,214
2008	4,930	4,813	17	9,533	9,827	29,122
2009	6,171	3,432	13	7,875	7,036	24,529
2010	6,074	3,140	85	6,575	5,179	21,055
2011	6,931	2,150	300	8,977	8,673	27,033
2012	6,703	1,685	412	8,377	11,197	28,377
2013	7,326	3,991	238	9,801	20,171	41,529
2014	11,258	6,051	202	11,502	24,712	53,727
2015	9,386	4,266	429	9,062	21,281	44,426
2016	11,850	2,717	449	9,070	22,306	46,394
2017	5,616	3,428	507	8,319	23,414	41,286
2018	5,182	3,516	952	8,008	28,235	45,894
2019	3,176	7,968	1,362	7,593	23,153	43,254
2020	6,401	2,367	724	5,511	31,651	46,656
2021	2,398	5,124	1,381	4,315	24,844	38,065
2022	2,976	5,249	2,623	6,260	26,514	43,625
2023	11,047	4,478	3,059	7,181	22,347	48,113
2024	15,035	4,190	1,463	5,117	13,179	38,985

A concluding theme

1. **Population Status**:
   - Abundance and biomass history
     - Data Collection Methods
     - Key Indicators
     - Case Study Comparison
2. **Biological Productivity**:
   - Reproductive rates
   - Growth and mortality
   - Models for Predictions
   - Case Study Comparison

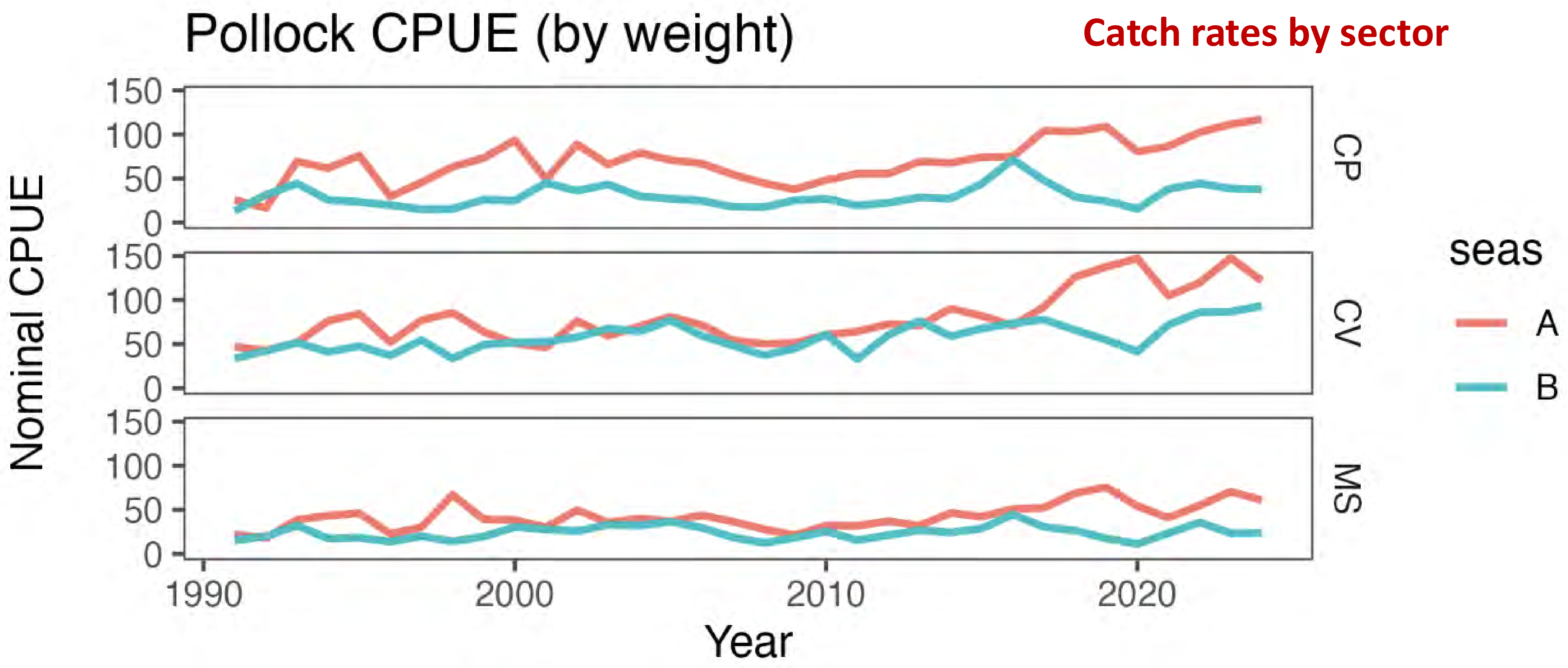
Fishing conditions



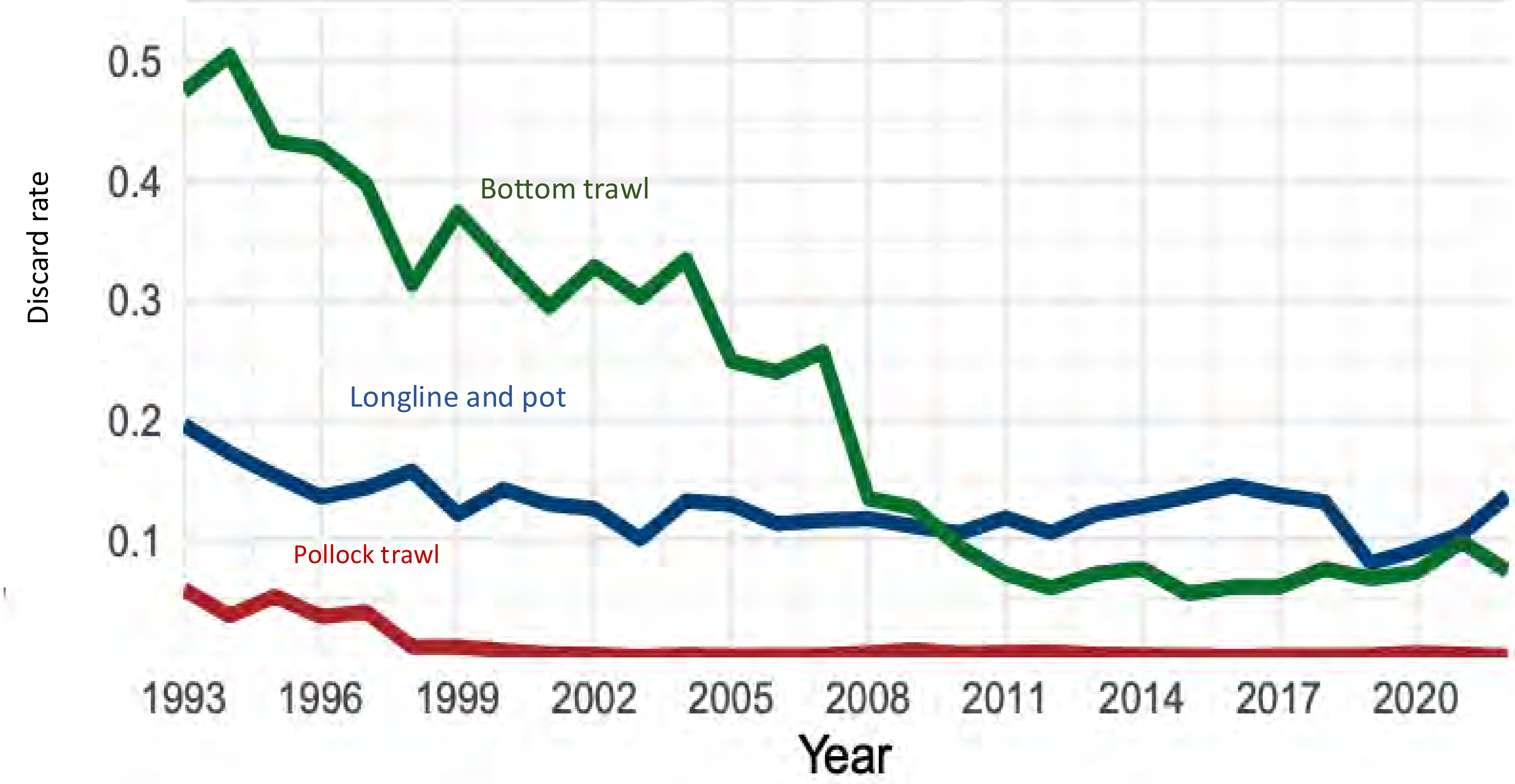


Fishing conditions

Catch rates by sector



Fishery discard rates among “sectors” in the EBS



Tonnage also low in pollock fishery…

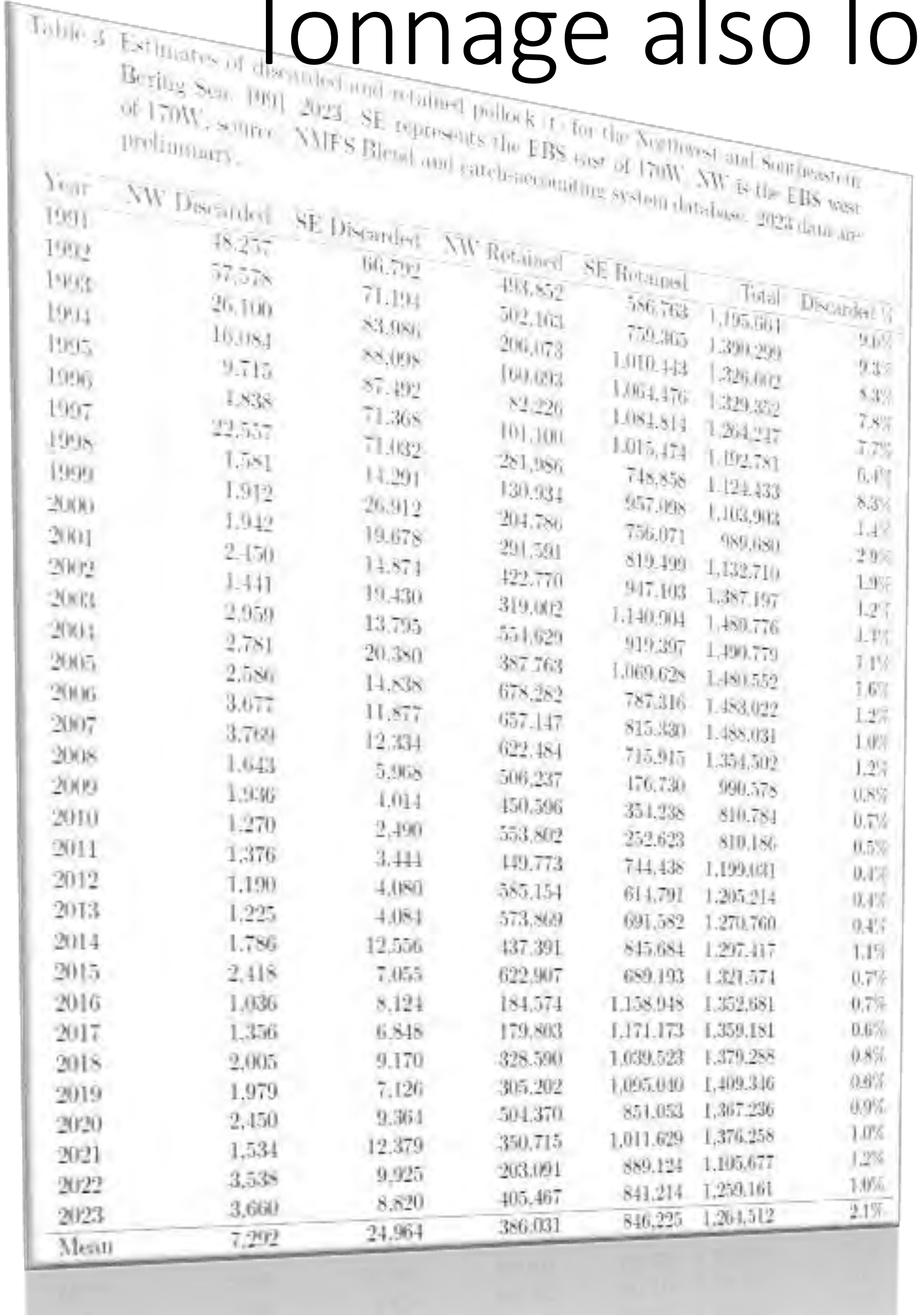
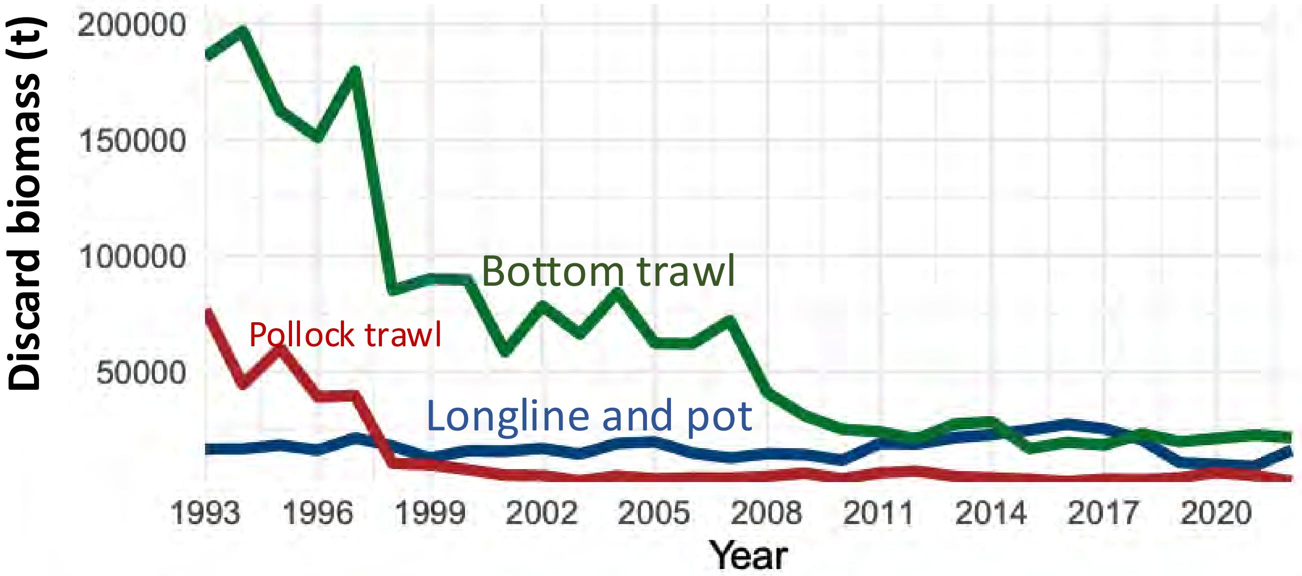
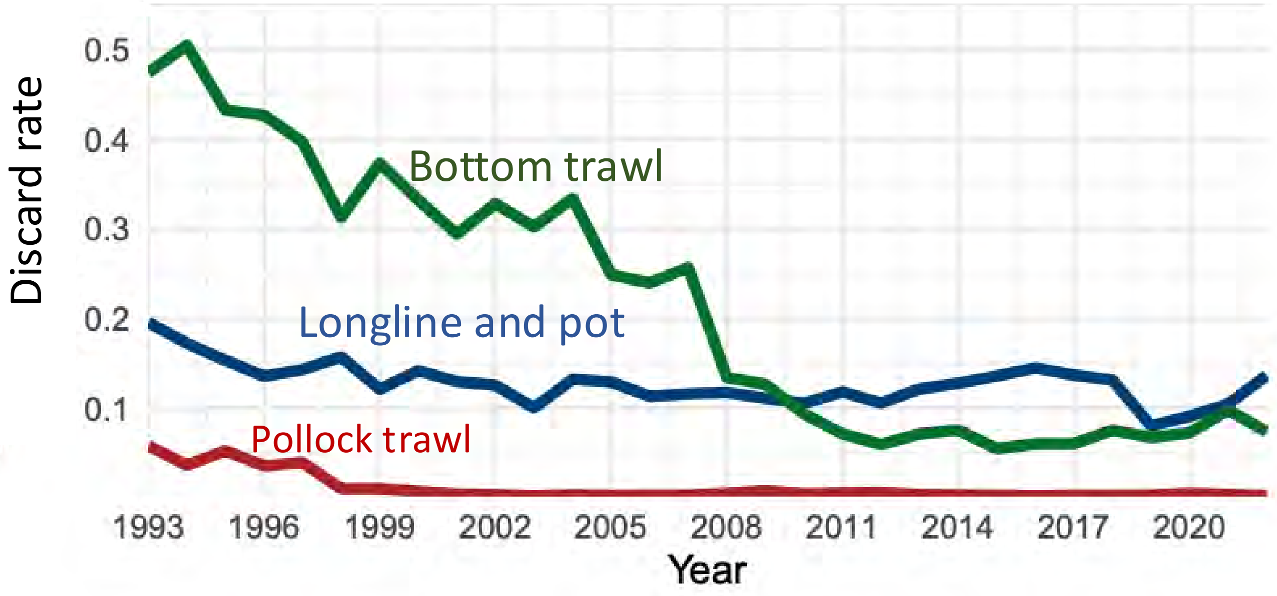


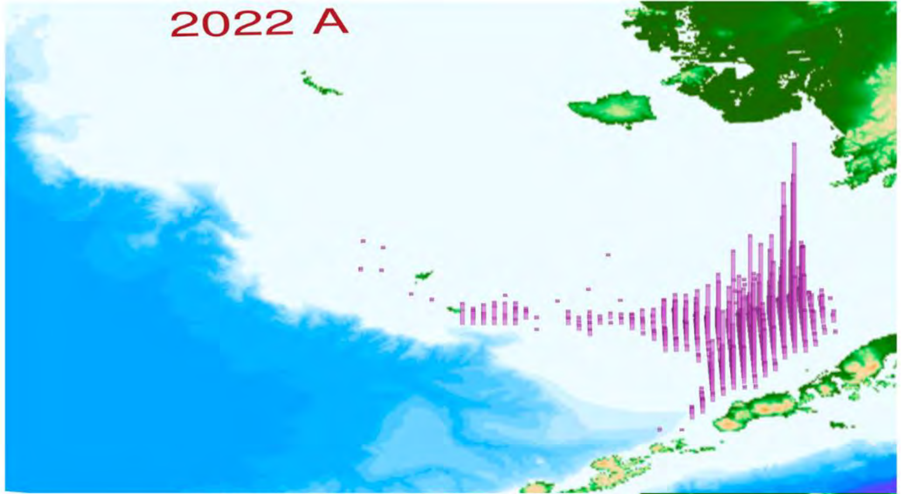
Table 3: Estimates of discarded and retained pollock (t) for the Northwest and Southeastern Bering Sea, 1991–2023. SE represents the EBS east of 170W, NW is the EBS west of 170W, source: NMFS Blend and catch-accounting system database. 2023 data are preliminary.

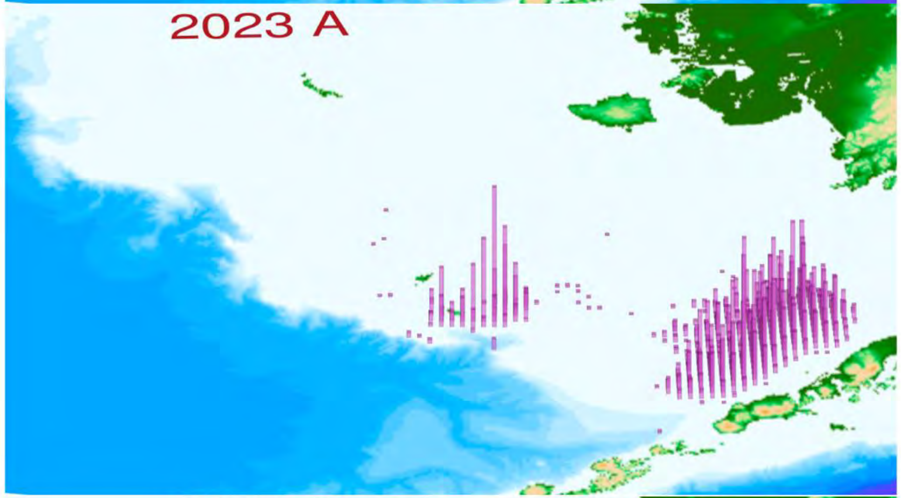
Year	NW Discarded	SE Discarded	NW Retained	SE Retained	Total	Discarded %
1991	48,257	66,792	493,852	586,763	1,195,664	9.6%
1992	57,578	71,194	502,163	759,365	1,390,299	9.3%
1993	26,100	83,986	206,073	1,010,443	1,326,602	8.3%
1994	16,084	88,098	160,093	1,064,476	1,329,352	7.8%
1995	9,715	87,492	82,226	1,084,814	1,264,247	7.7%
1996	4,838	71,368	101,100	1,015,474	1,192,781	6.4%
1997	22,557	71,032	281,986	748,858	1,124,433	8.3%
1998	1,581	14,291	130,934	957,098	1,103,903	1.4%
1999	1,912	26,912	204,786	756,071	989,680	2.9%
2000	1,942	19,678	291,591	819,499	1,132,710	1.9%
2001	2,450	14,874	422,770	947,103	1,387,197	1.2%
2002	1,441	19,430	319,002	1,140,904	1,480,776	1.4%
2003	2,959	13,795	554,629	919,397	1,490,779	1.1%
2004	2,781	20,380	387,763	1,069,628	1,480,552	1.6%
2005	2,586	14,838	678,282	787,316	1,483,022	1.2%
2006	3,077	11,877	657,147	815,330	1,488,031	1.0%
2007	3,769	12,334	622,484	715,915	1,354,502	1.2%
2008	1,643	5,968	506,237	476,730	990,578	0.8%
2009	1,936	4,014	450,596	354,238	810,784	0.7%
2010	1,270	2,490	553,802	252,623	810,186	0.5%
2011	1,376	3,444	449,773	744,438	1,199,031	0.4%
2012	1,190	4,080	585,154	614,791	1,205,214	0.4%
2013	1,225	4,084	573,869	691,582	1,270,760	0.4%
2014	1,786	12,556	437,391	845,684	1,297,417	1.1%
2015	2,418	7,055	622,907	689,193	1,321,574	0.7%
2016	1,036	8,124	184,574	1,158,948	1,352,681	0.7%
2017	1,356	6,848	179,803	1,171,173	1,359,181	0.6%
2018	2,005	9,170	328,590	1,039,523	1,379,288	0.8%
2019	1,979	7,126	305,202	1,095,040	1,409,346	0.6%
2020	2,450	9,364	504,370	851,053	1,367,236	0.9%
2021	1,534	12,379	350,715	1,011,629	1,376,258	1.0%
2022	3,538	9,925	203,091	889,124	1,105,677	1.2%
2023	3,660	8,820	405,467	841,214	1,259,161	1.0%
Mean	7,292	24,964	386,031	846,225	1,264,512	2.1%

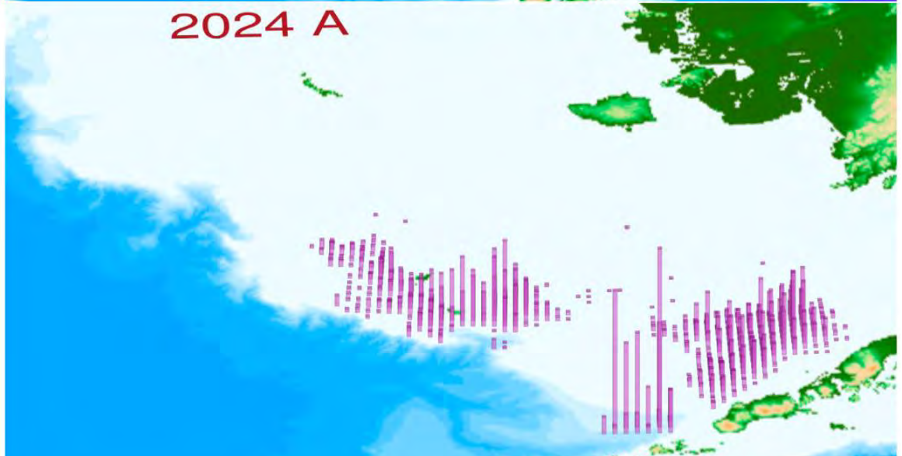


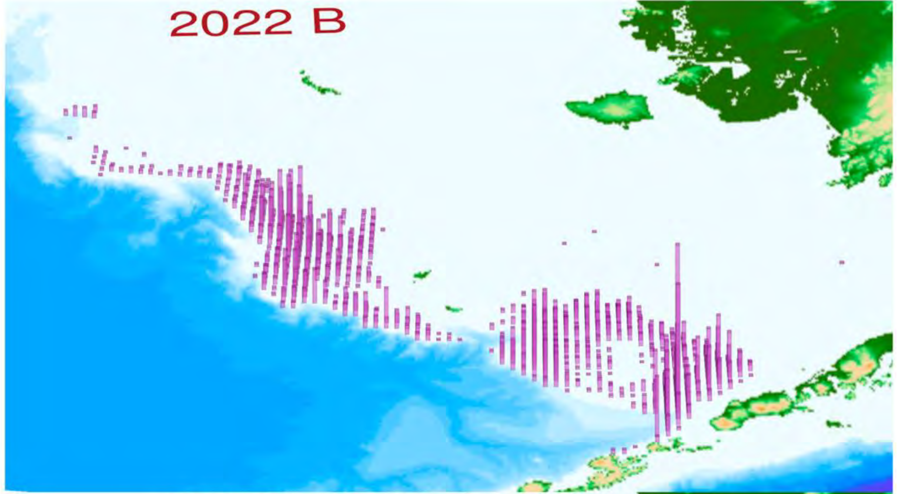


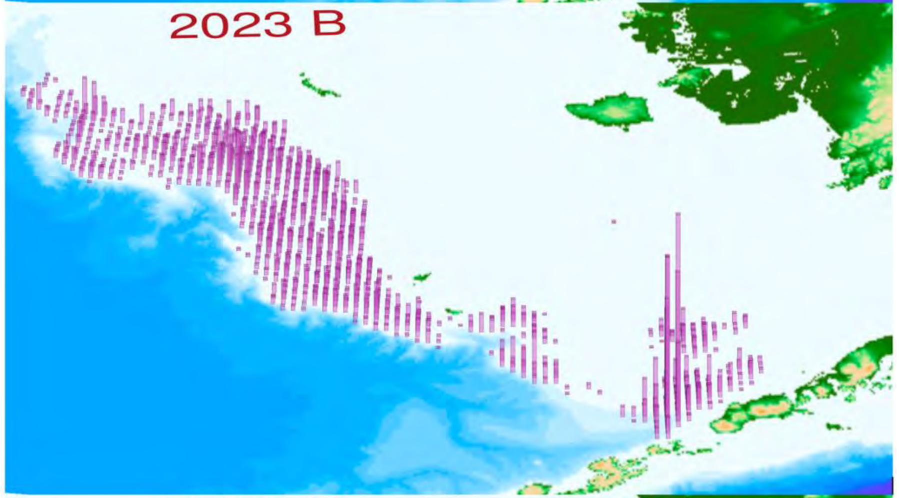
Season catch patterns

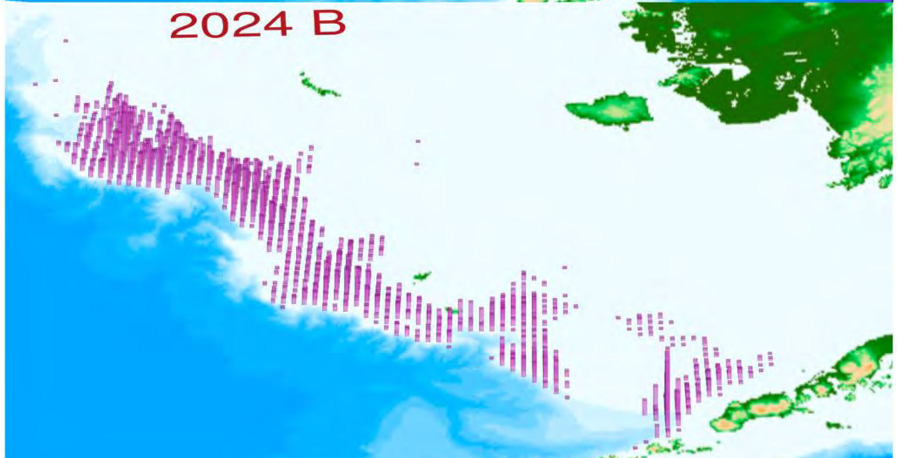






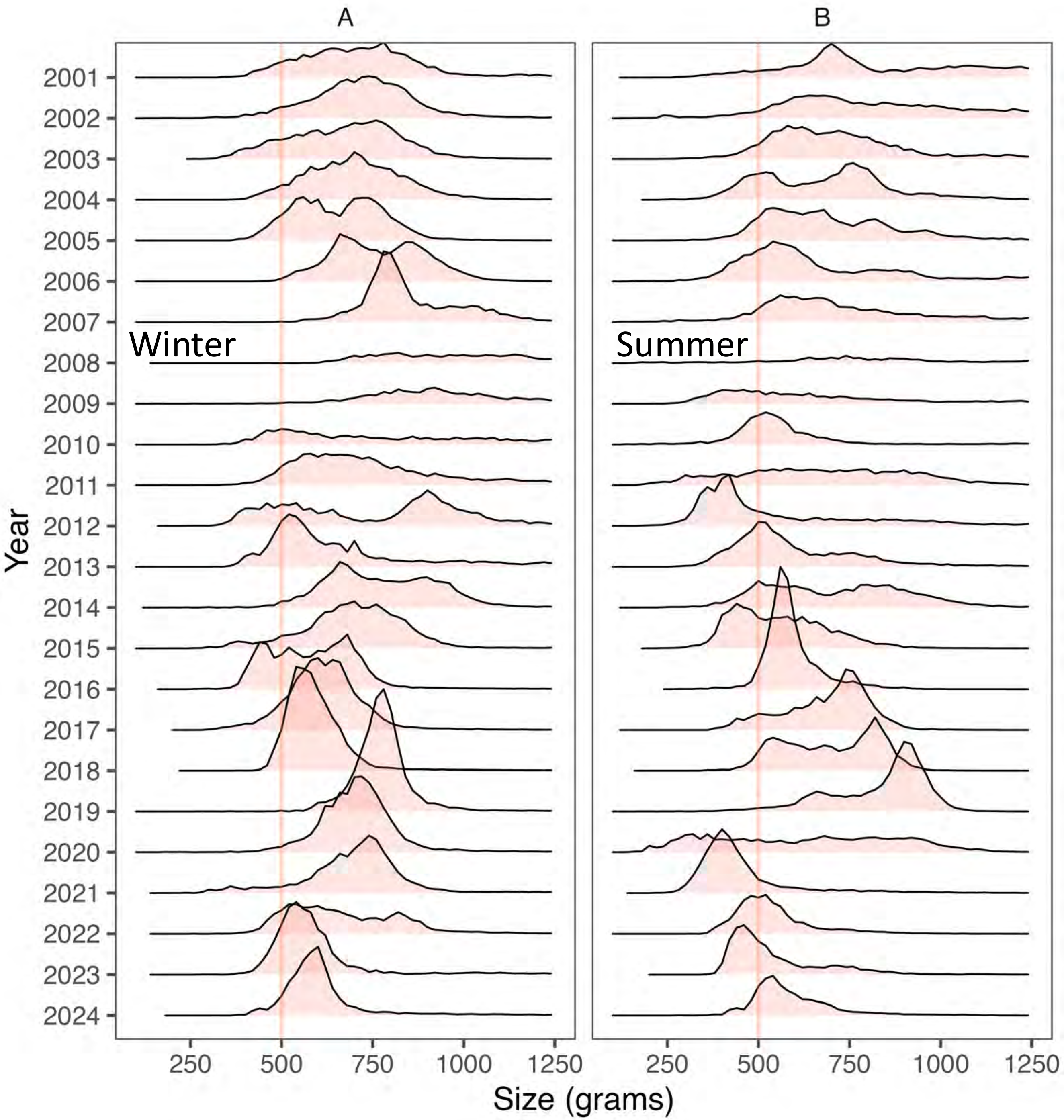






Bering Sea Pollock Fish conditions

Trends in weight frequency of catch

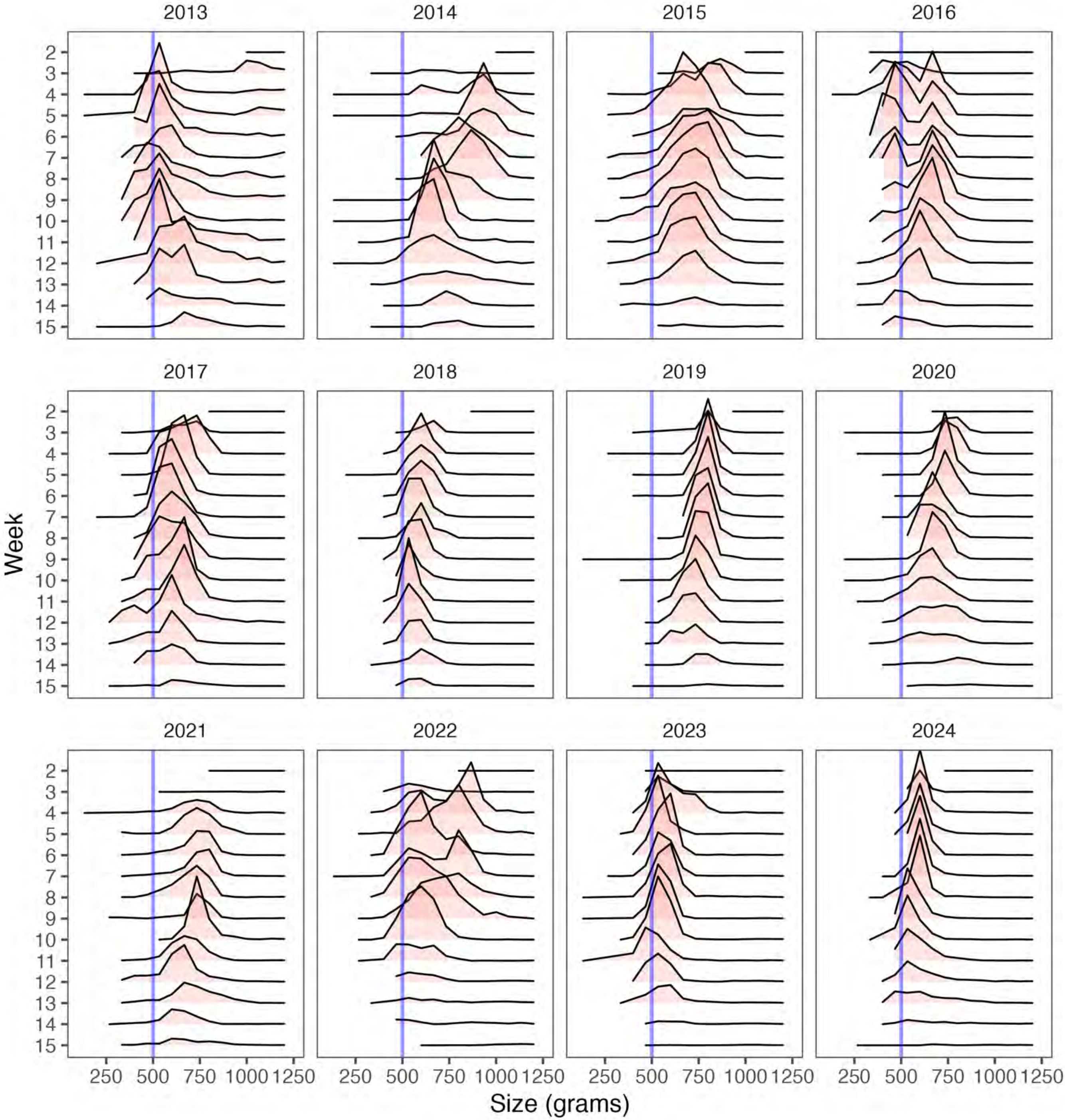


A-season

Tow-by-tow mean weight frequency

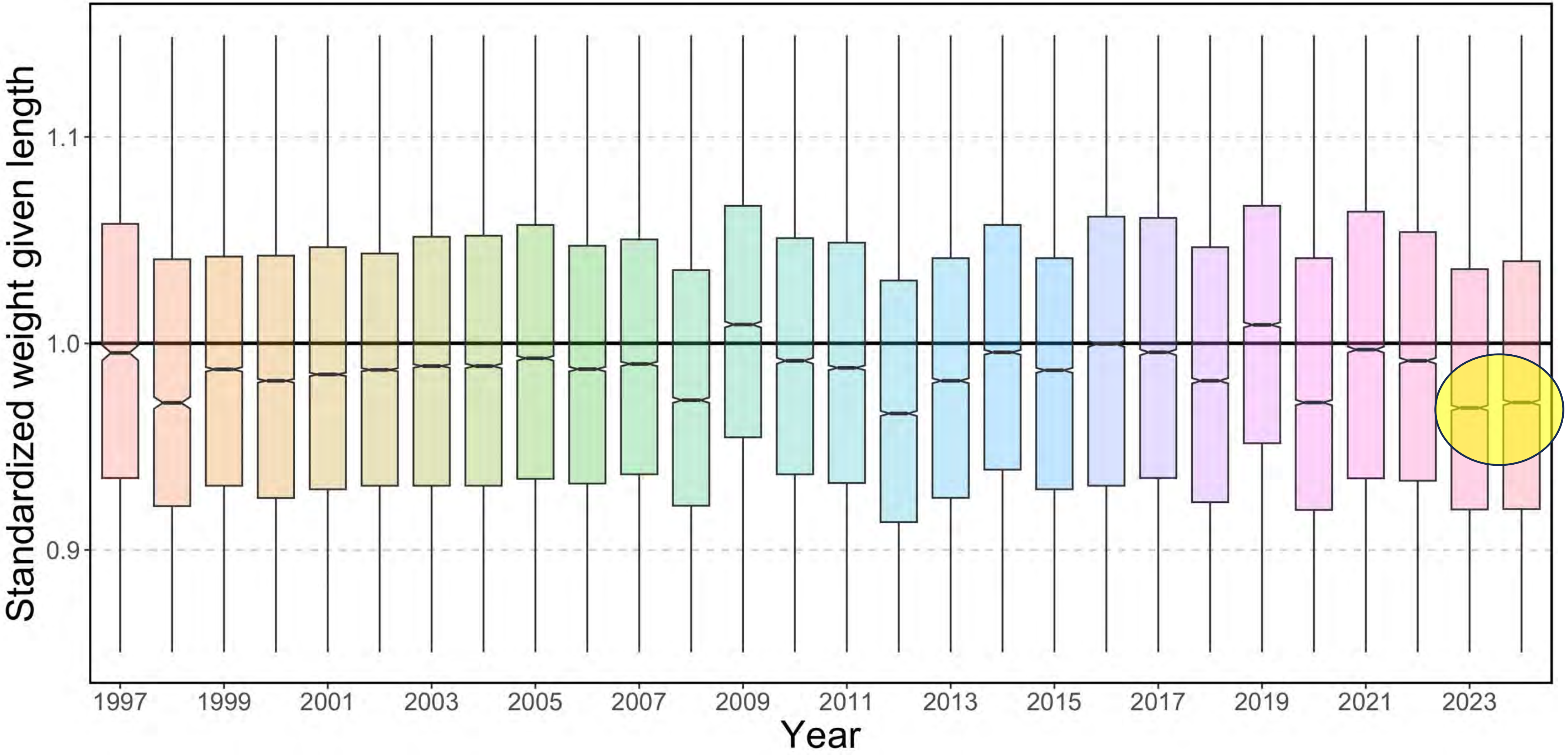
Season progression by week

2024 season
Bit bigger than 2023



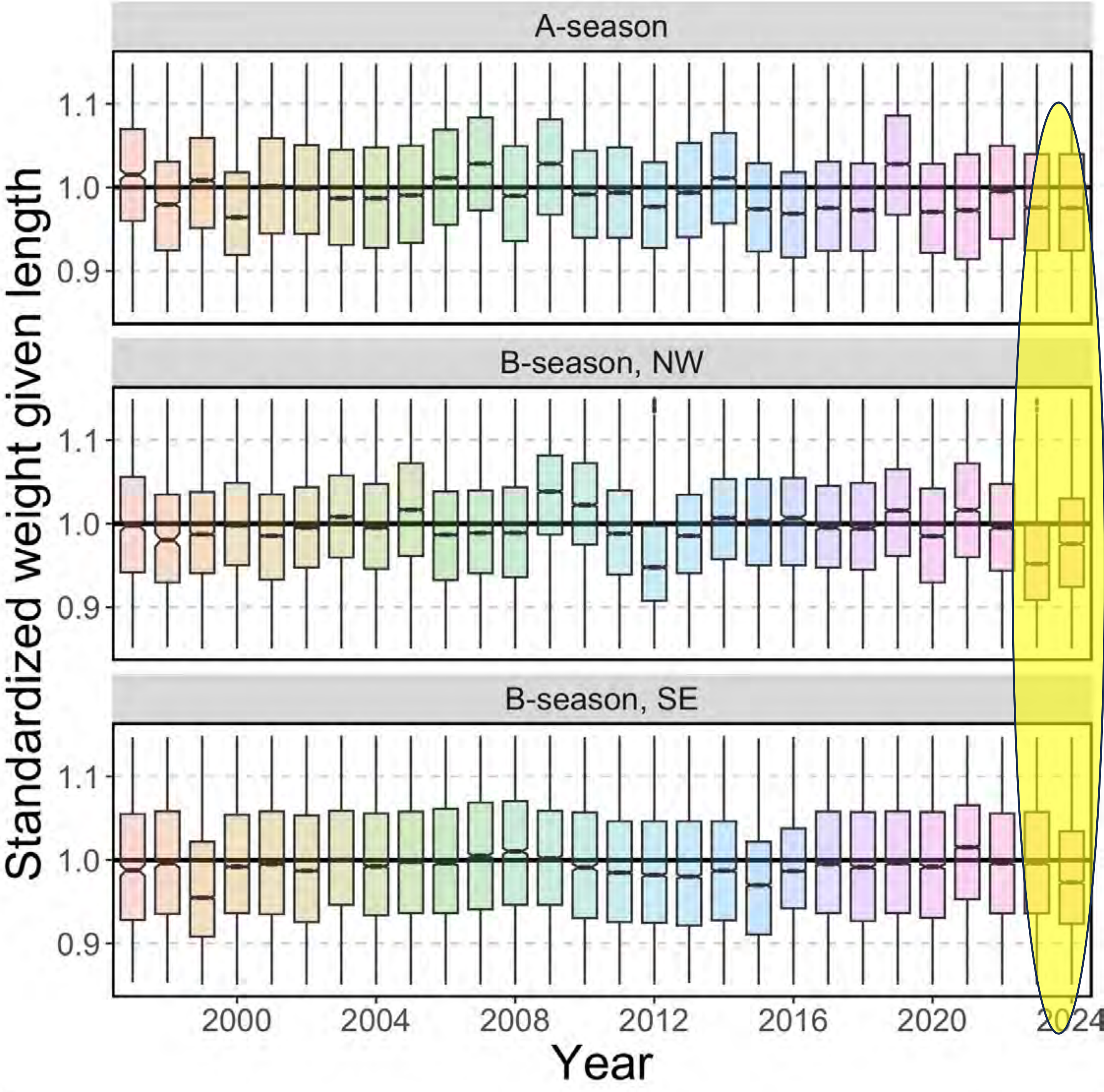
Fishery data on pollock "condition"

- Relative [figure 26 updated in SAFE chapter]



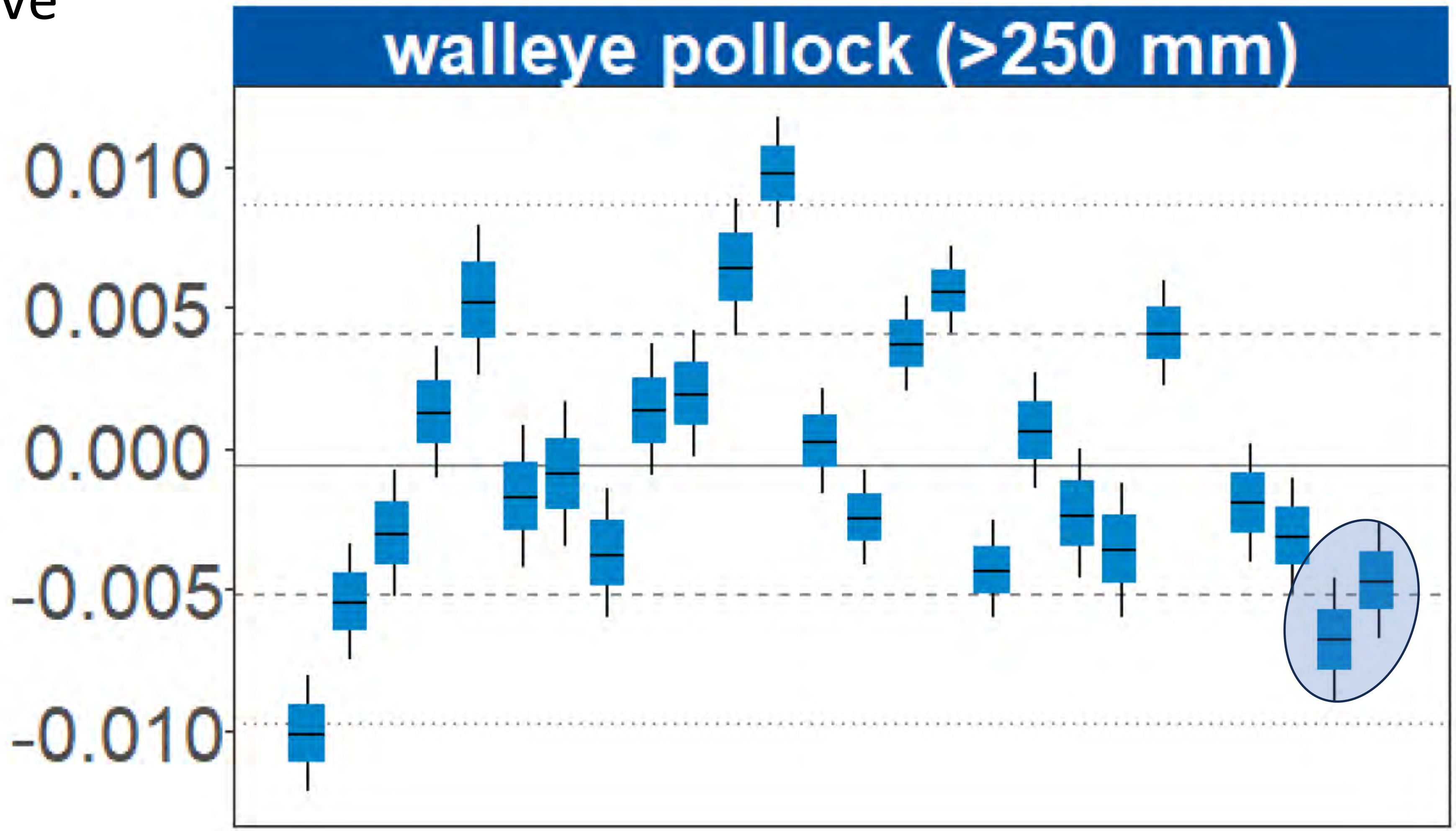
Fishery data on pollock "condition"

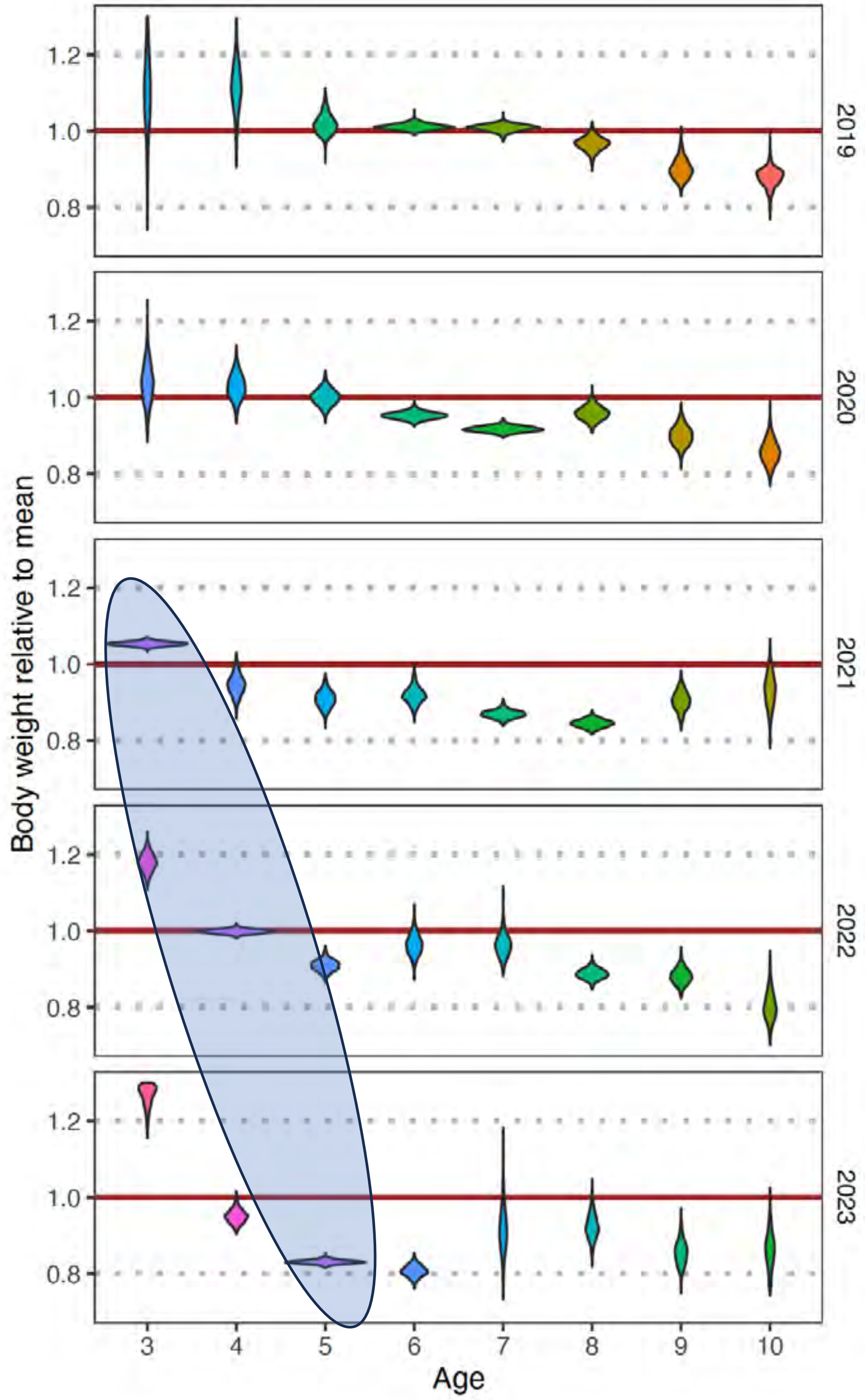
- Relative
  [figure 25 updated in SAFE chapter]



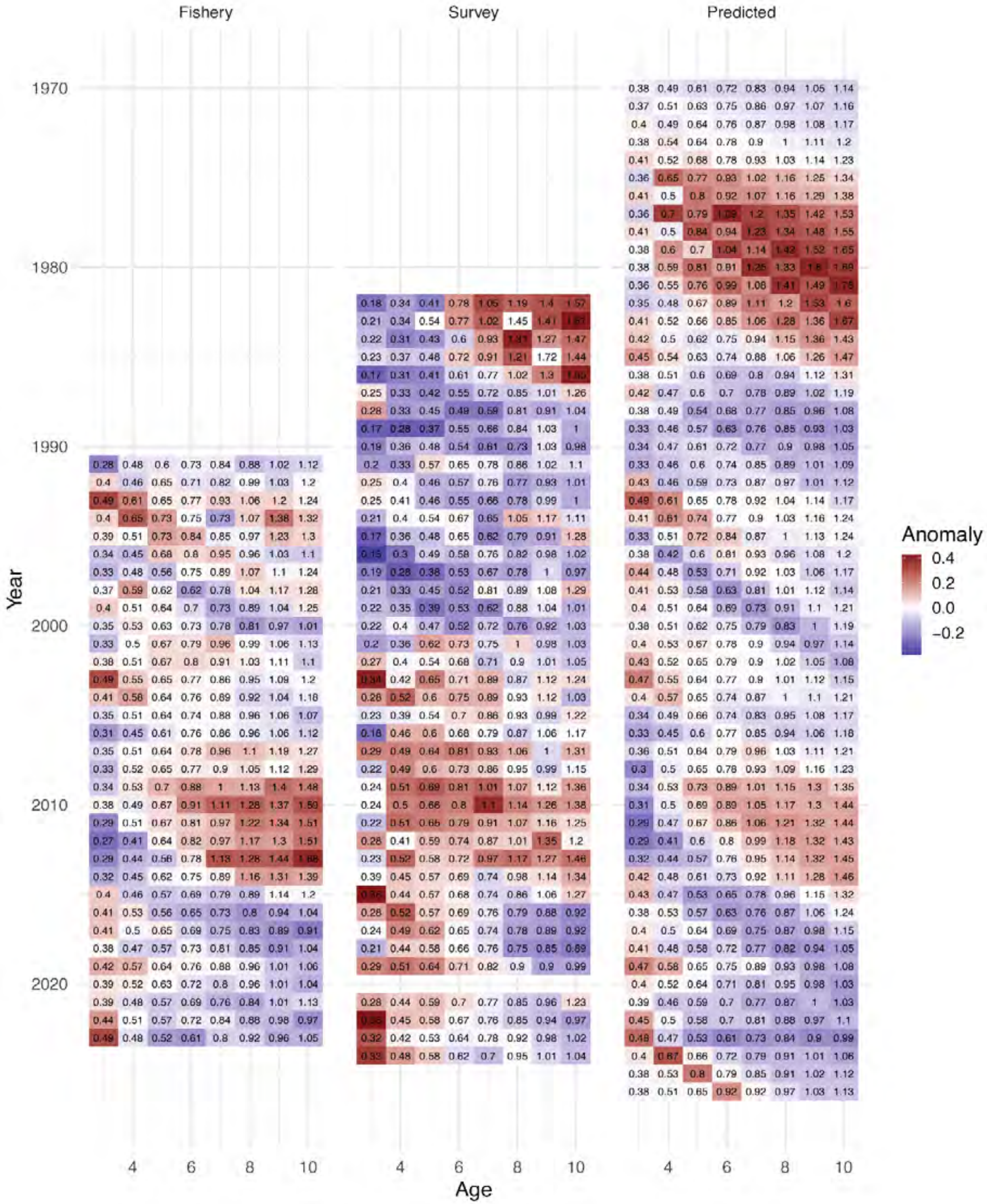
Survey data on pollock condition…

- Relative

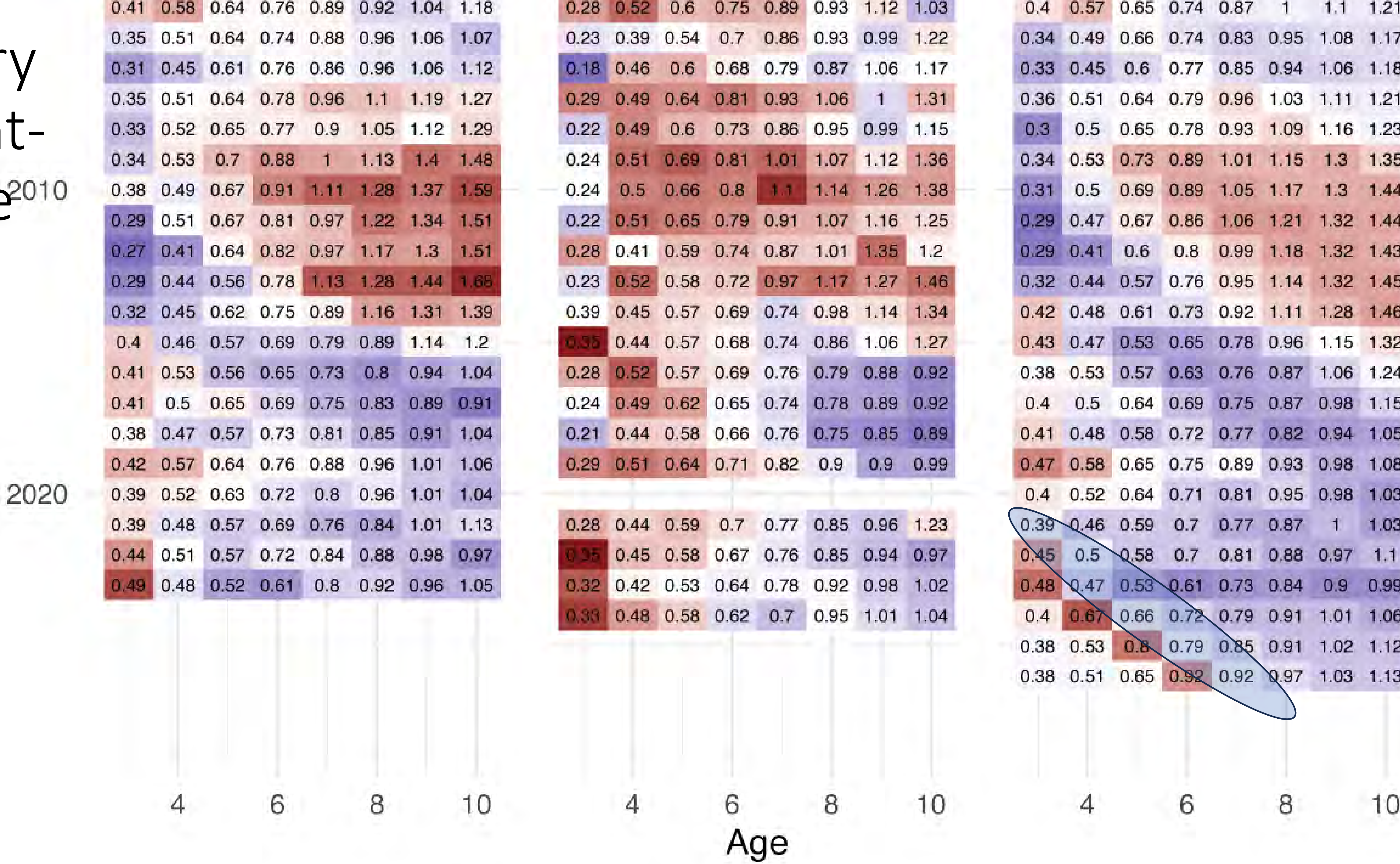


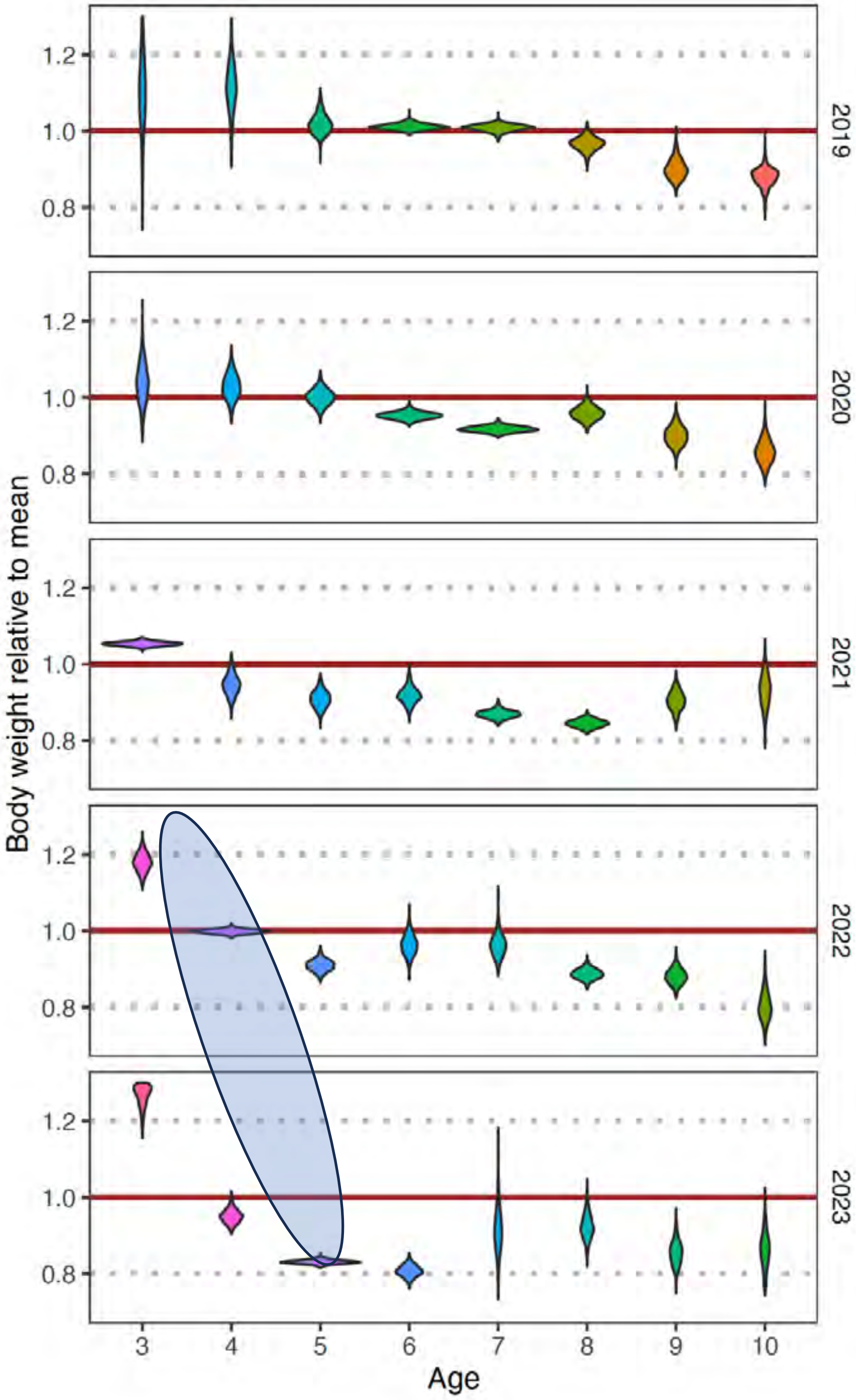


Fishery weight-at-age

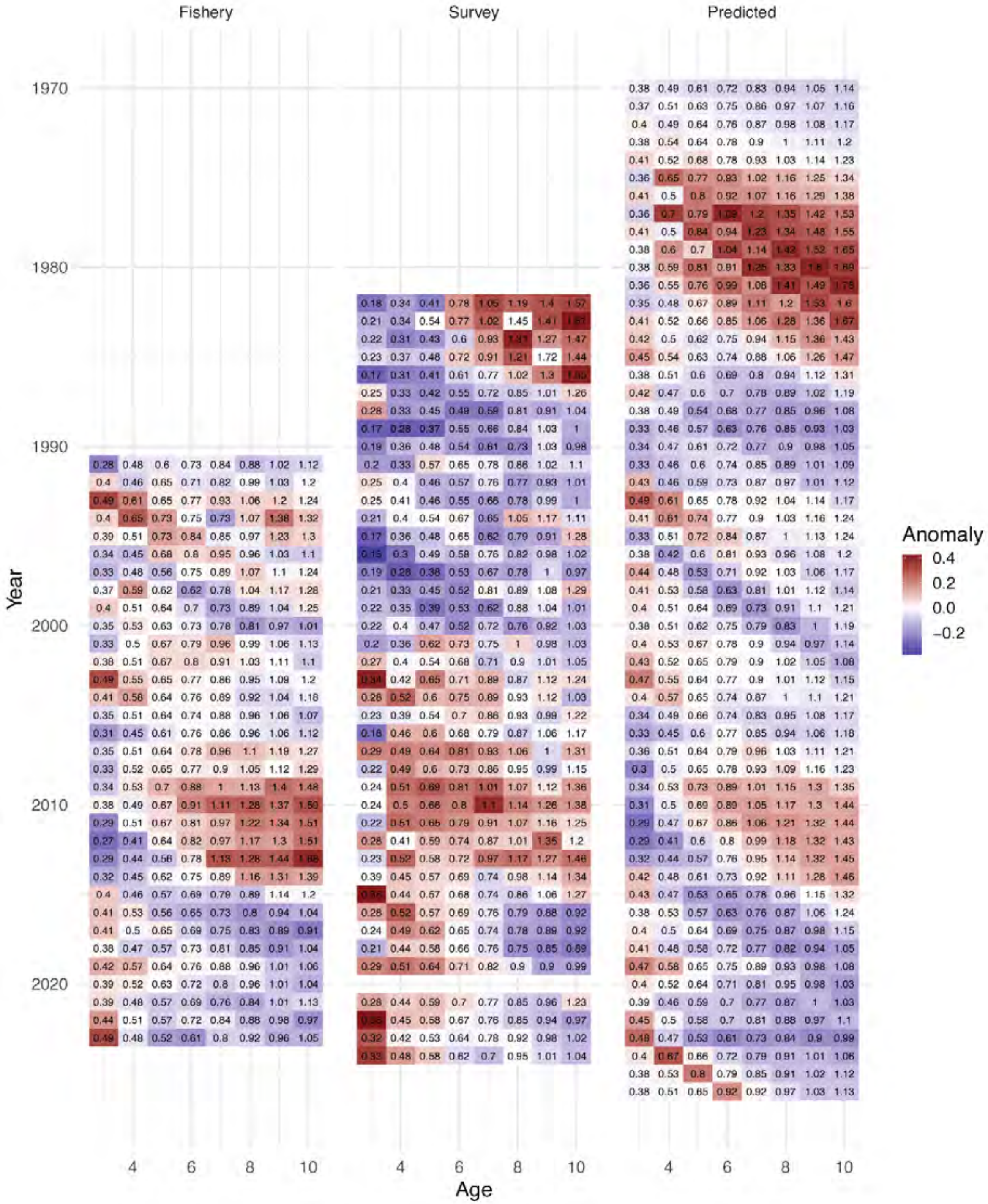


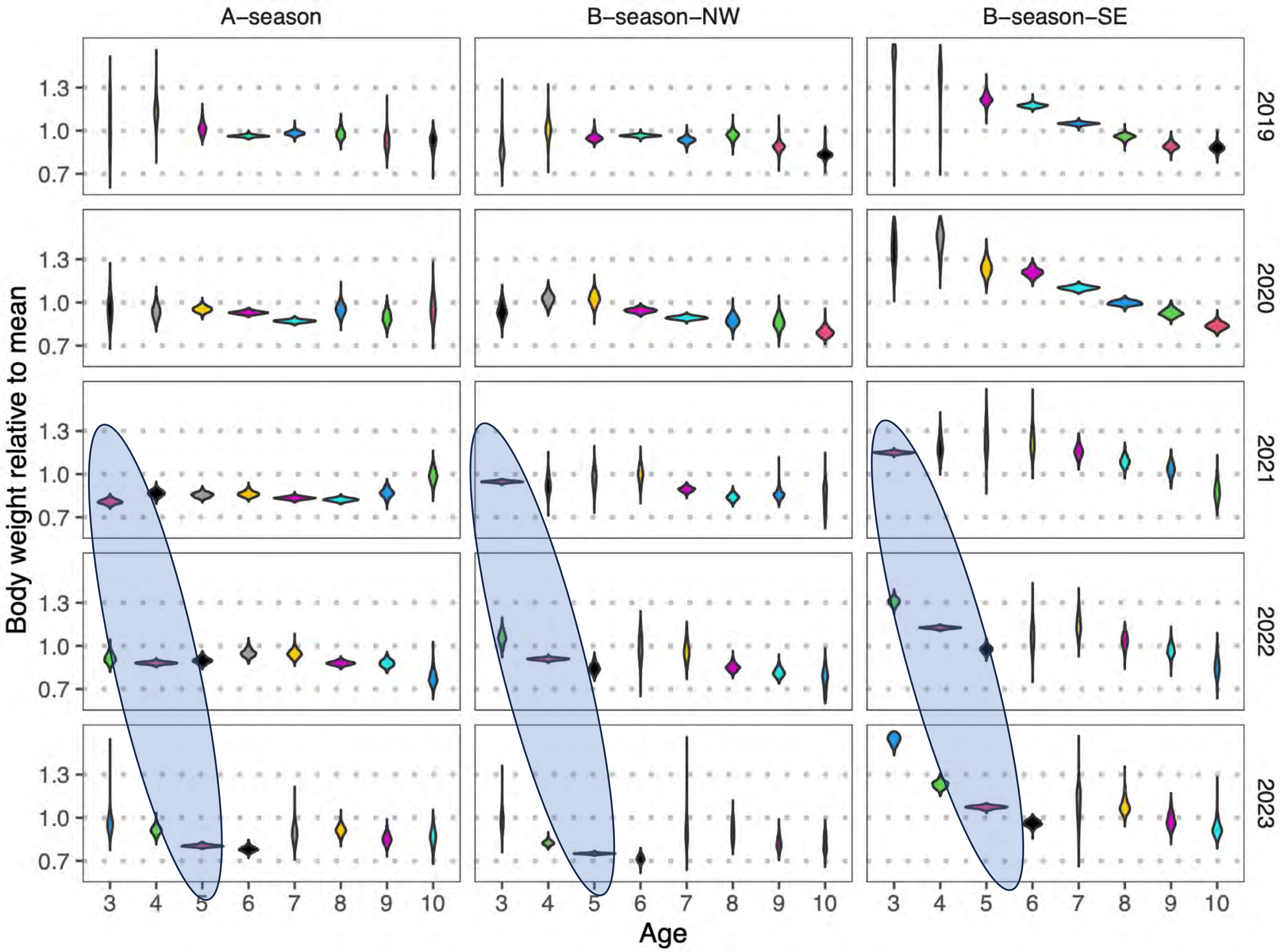
Fishery weight-at-age





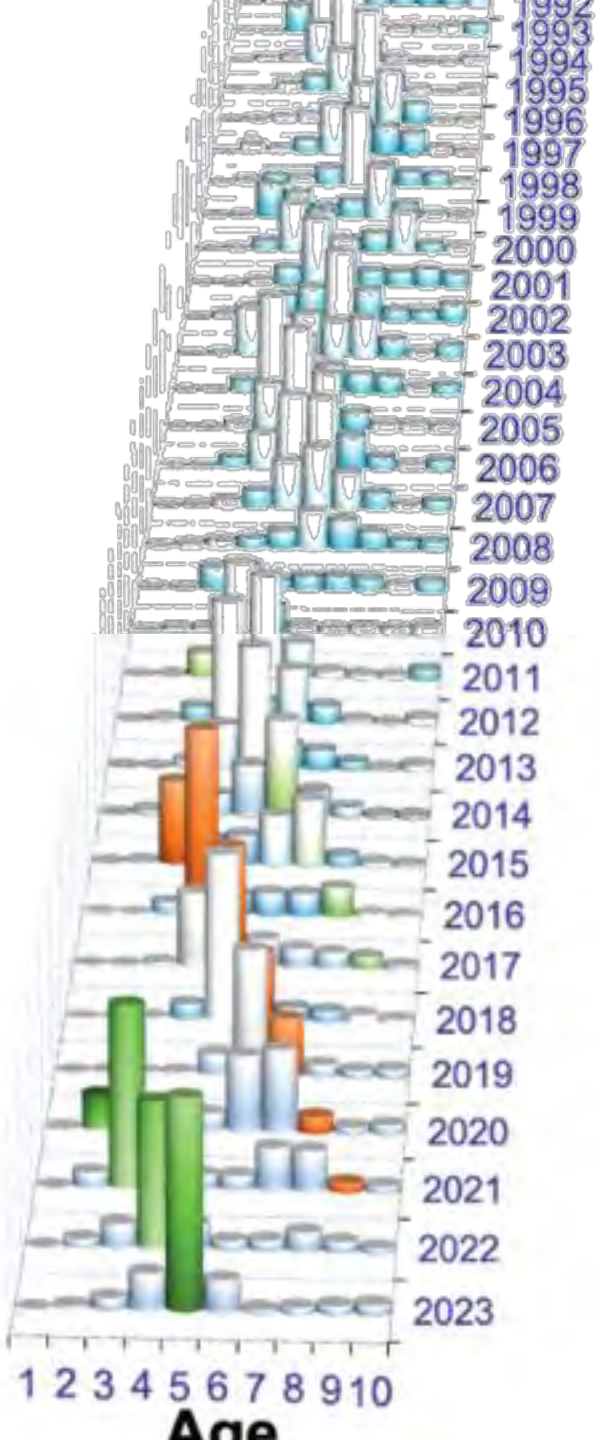
Fishery weight-at-age

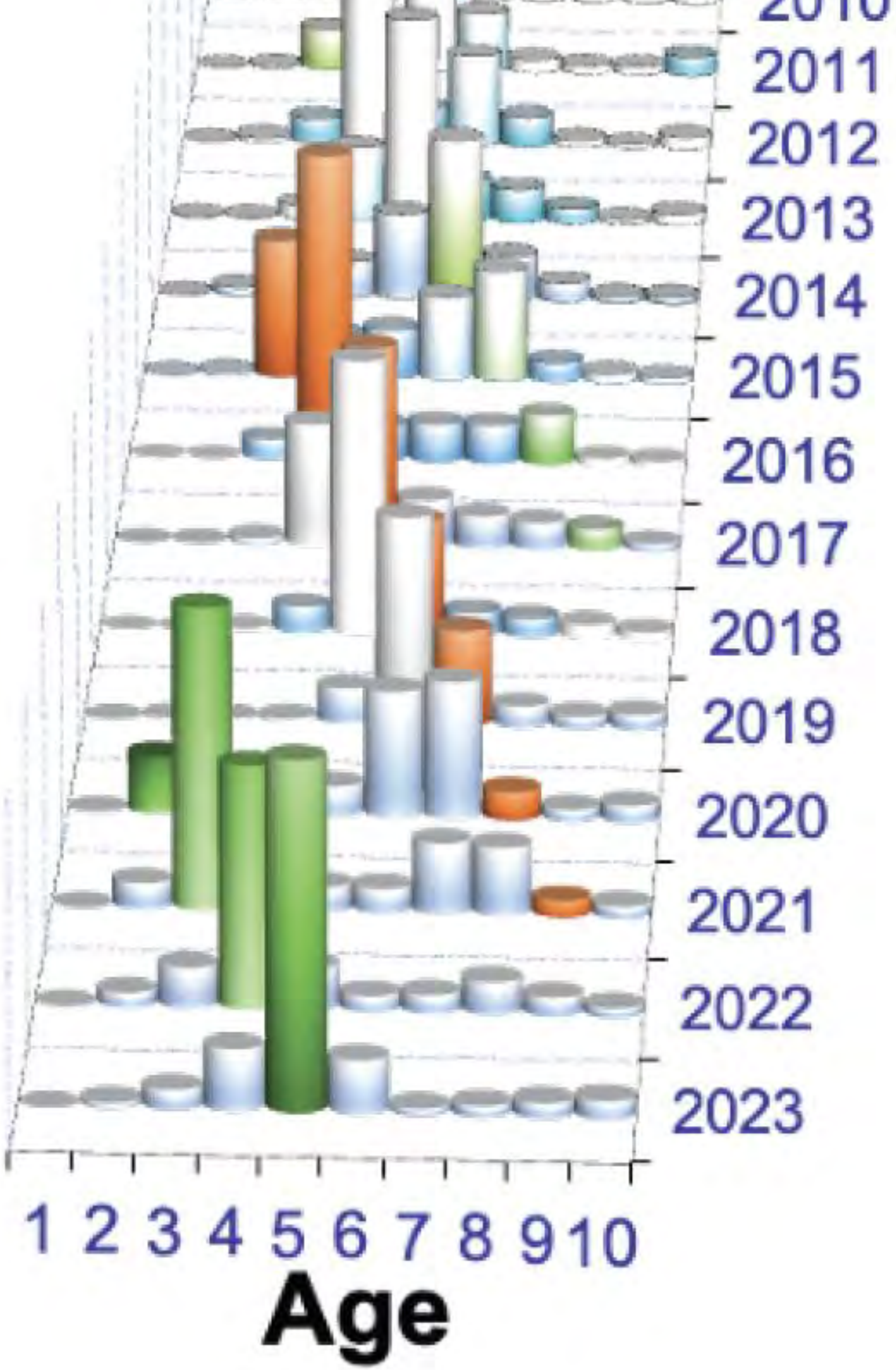




Fishery weight-at-age by season and area

Fishery catch-at-age





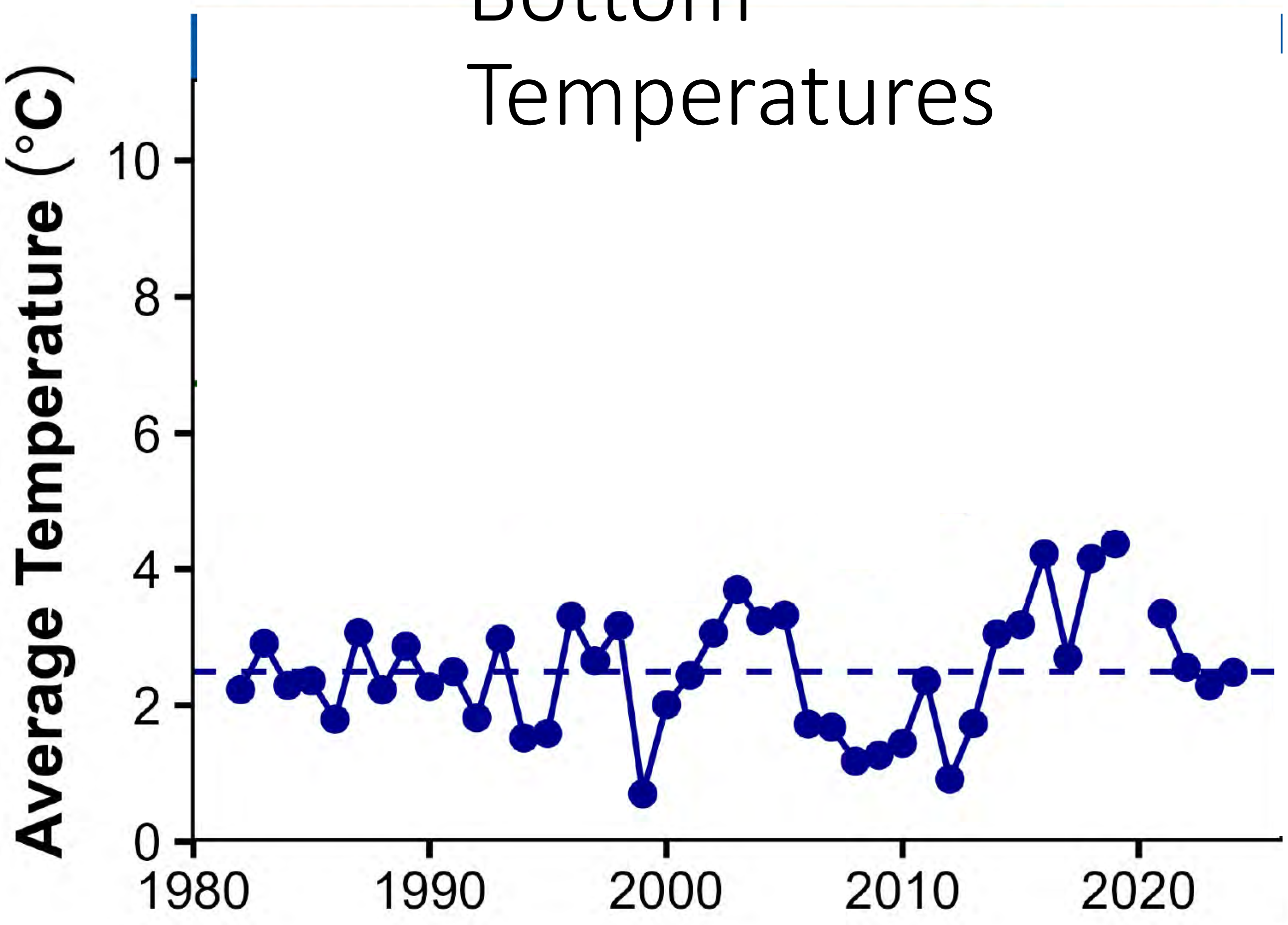
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
1 2 3 4 5 6 7 8 9 10
Age

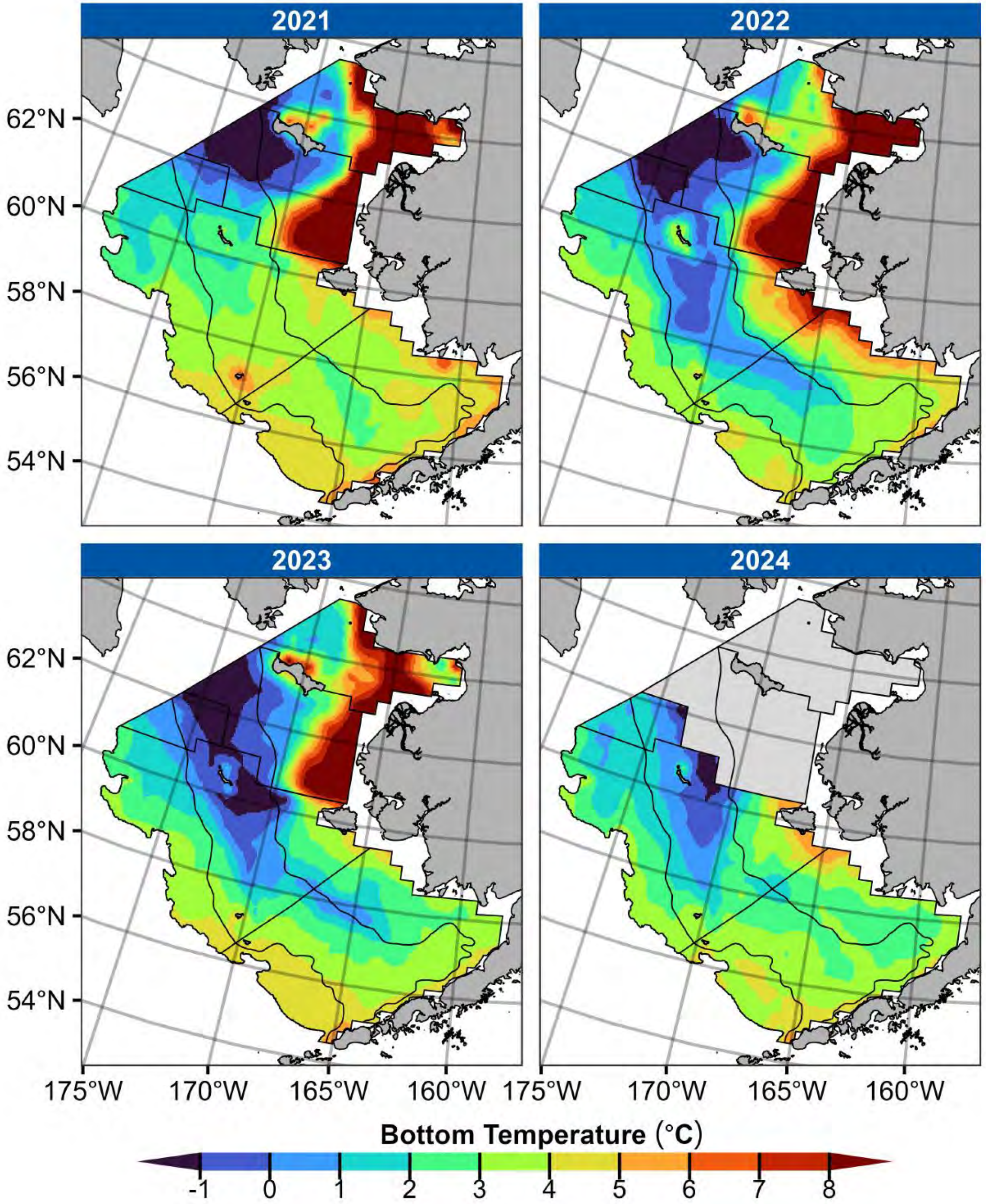
Survey work

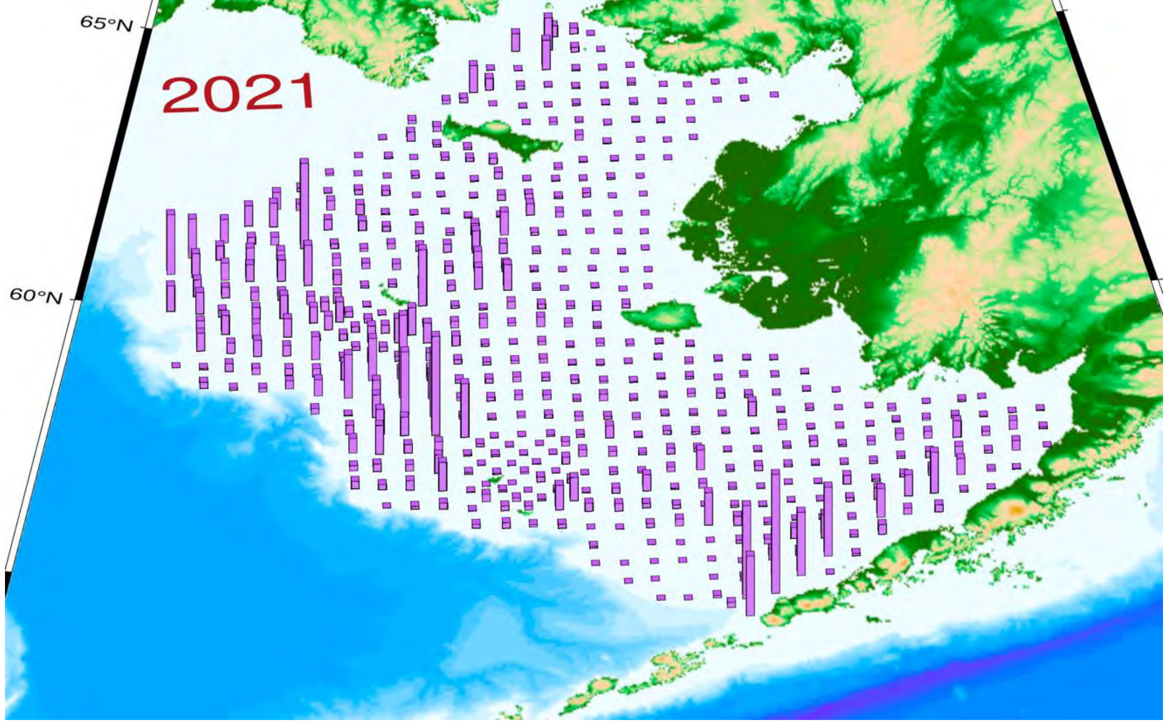
FV *Alaska Knight*
2010-present
12th year

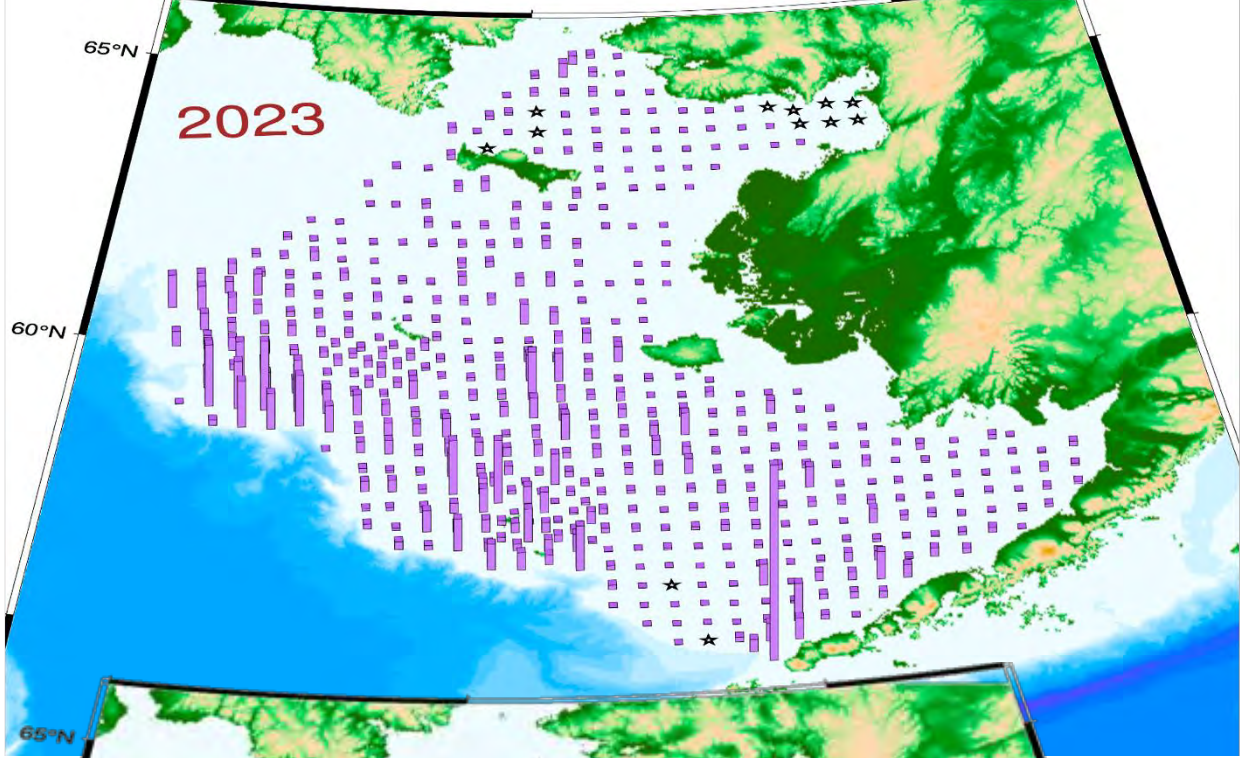
FV *Northwest Explorer*
2023
1st year

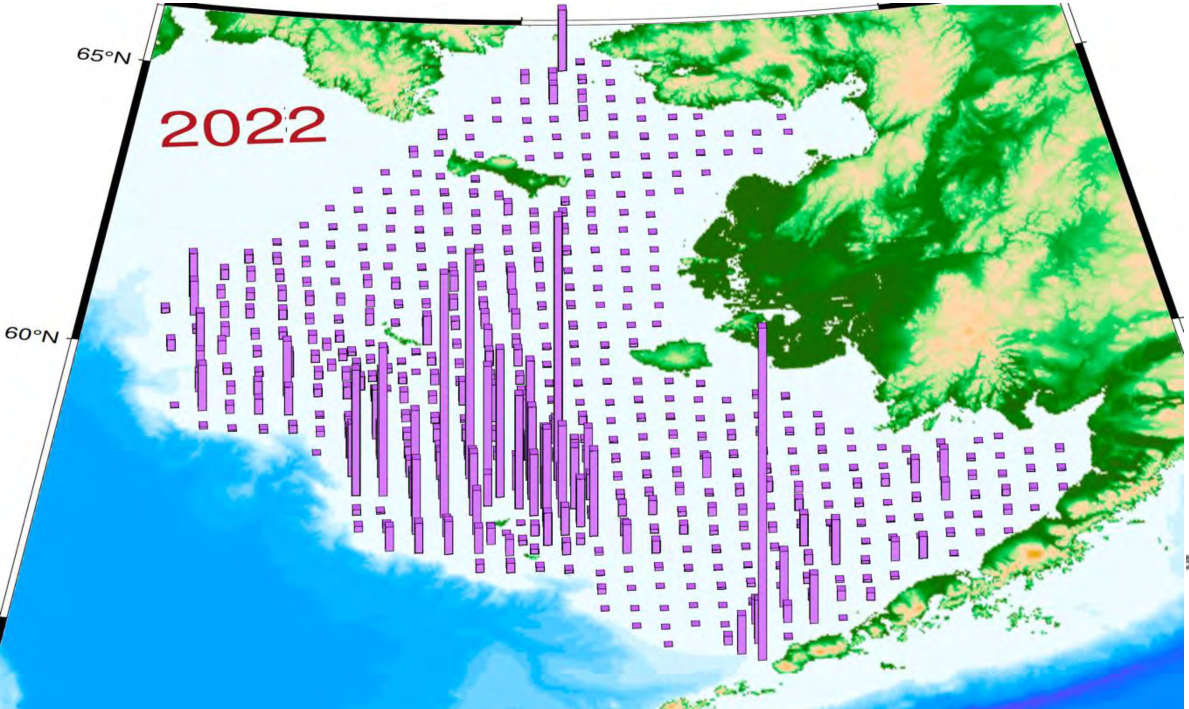
Survey Bottom Temperatures

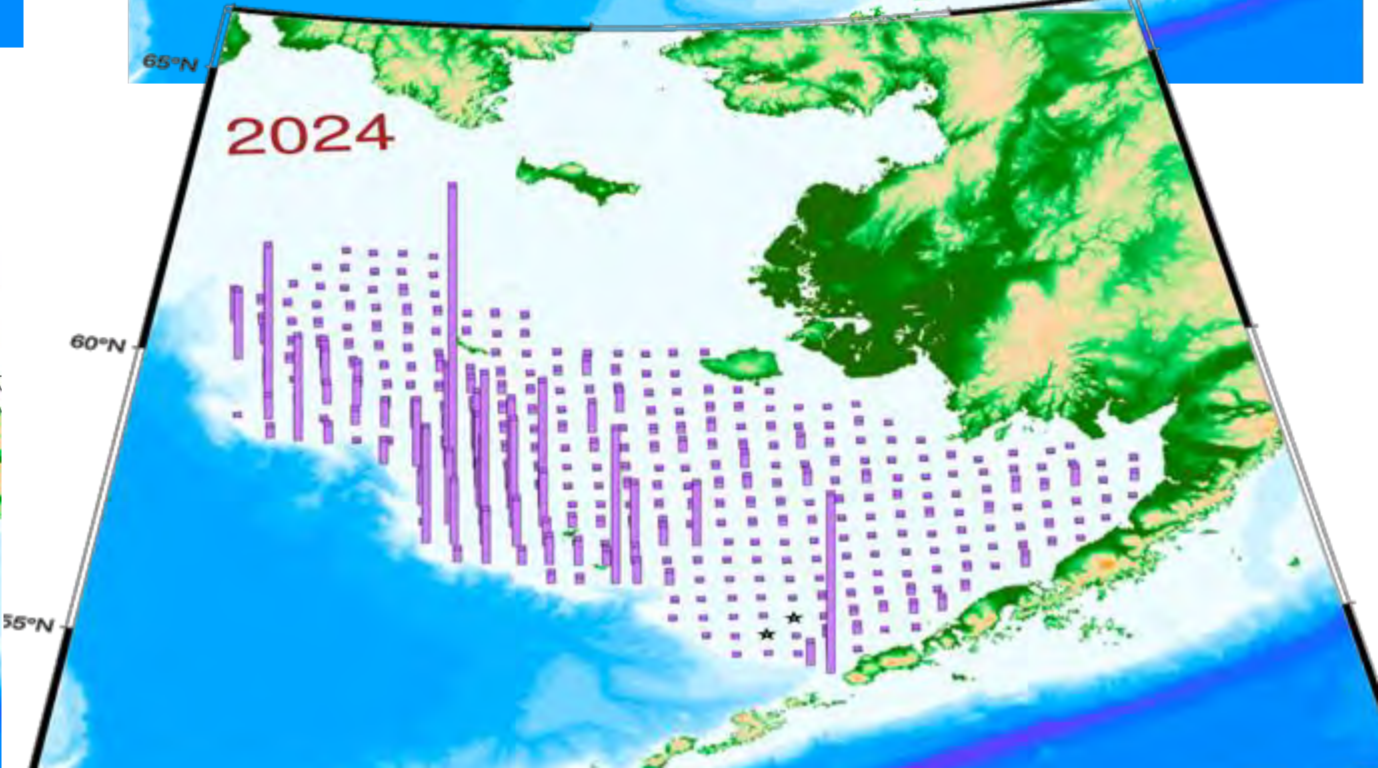





2021
65°N
60°N

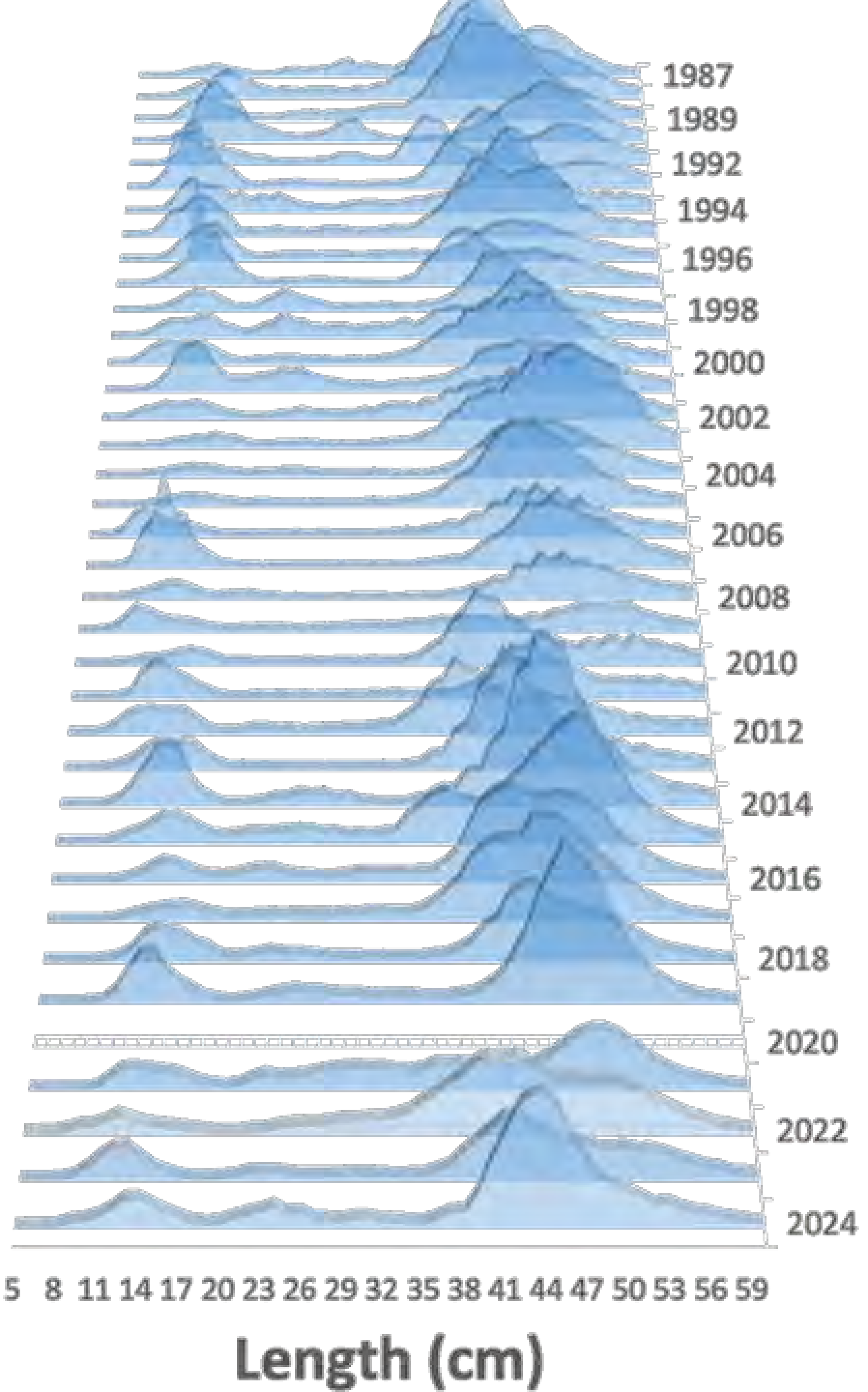

2023
65°N
60°N


2022
65°N
60°N


2024
65°N
60°N
55°N

Bottom-trawl survey

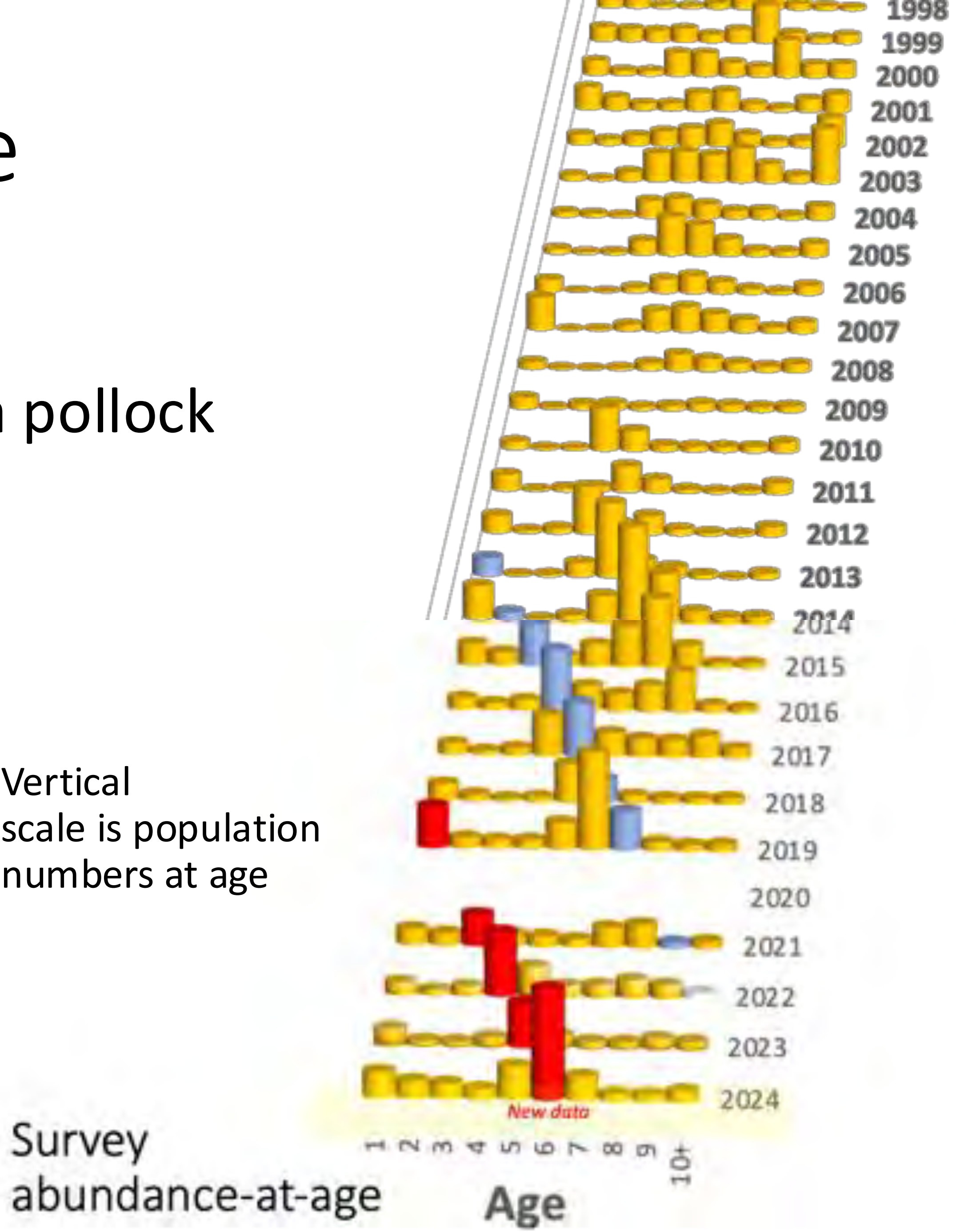
- Abundance at length

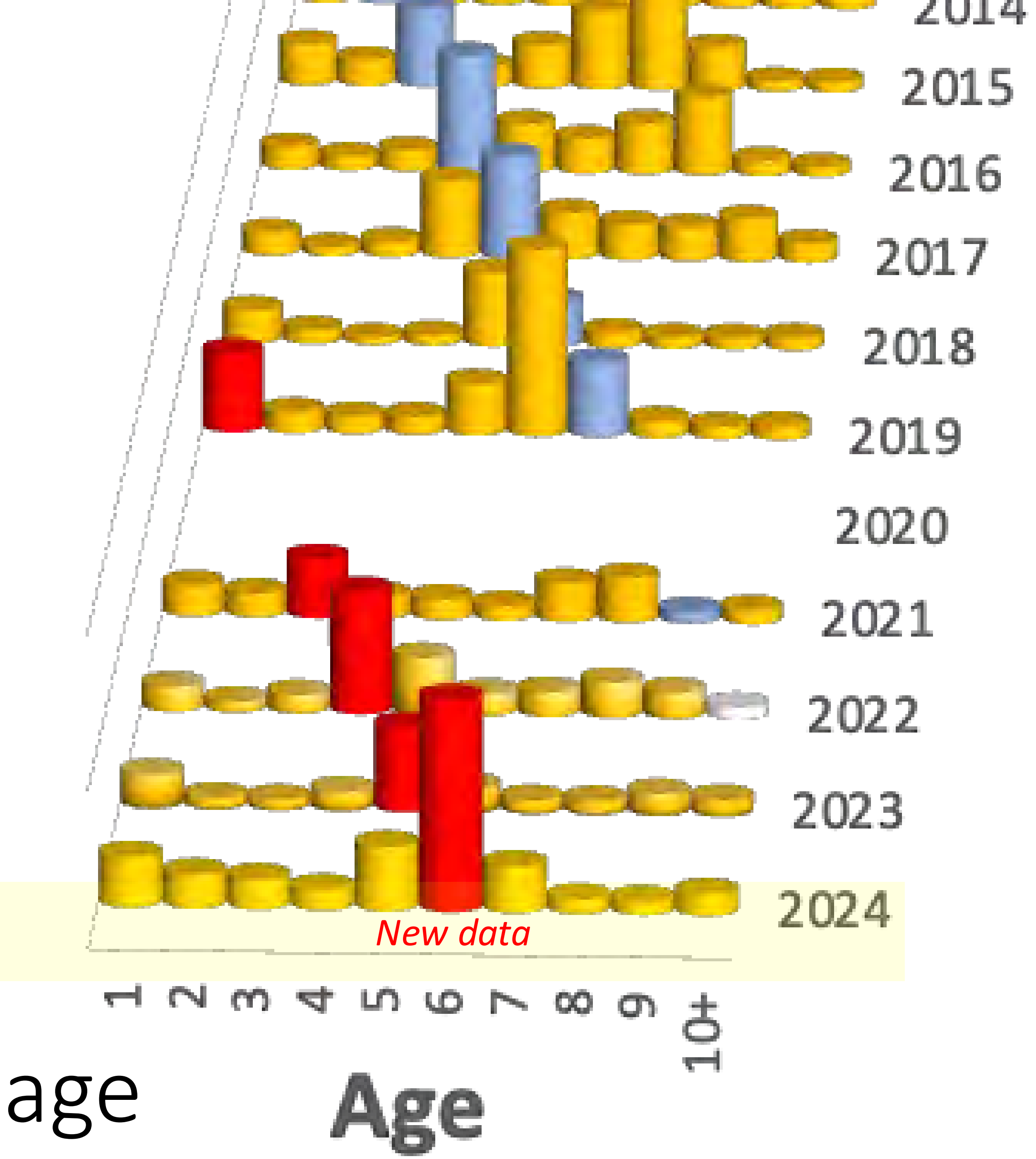


Survey abundance-at-age

- Eastern Bering Sea pollock

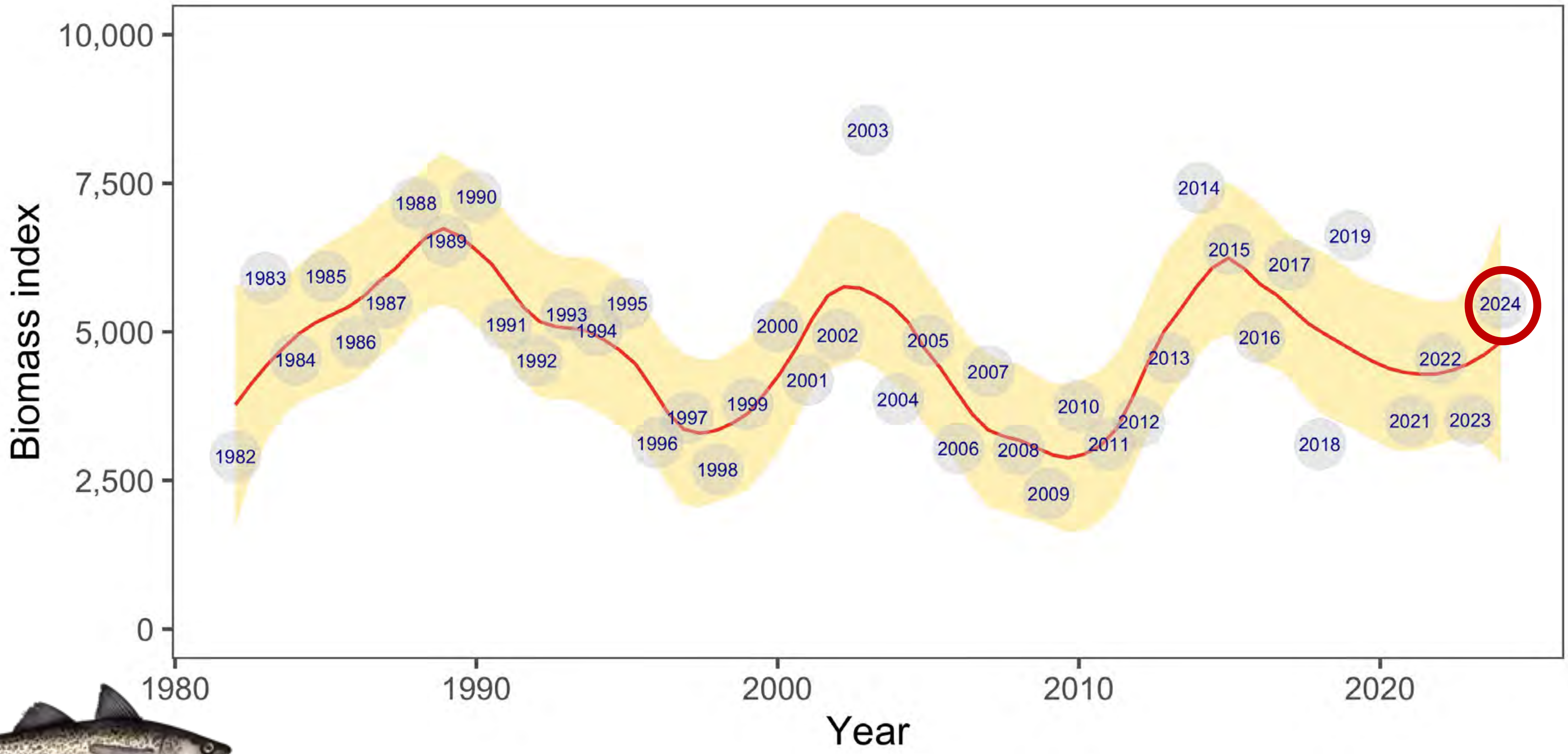
Vertical scale is population numbers at age



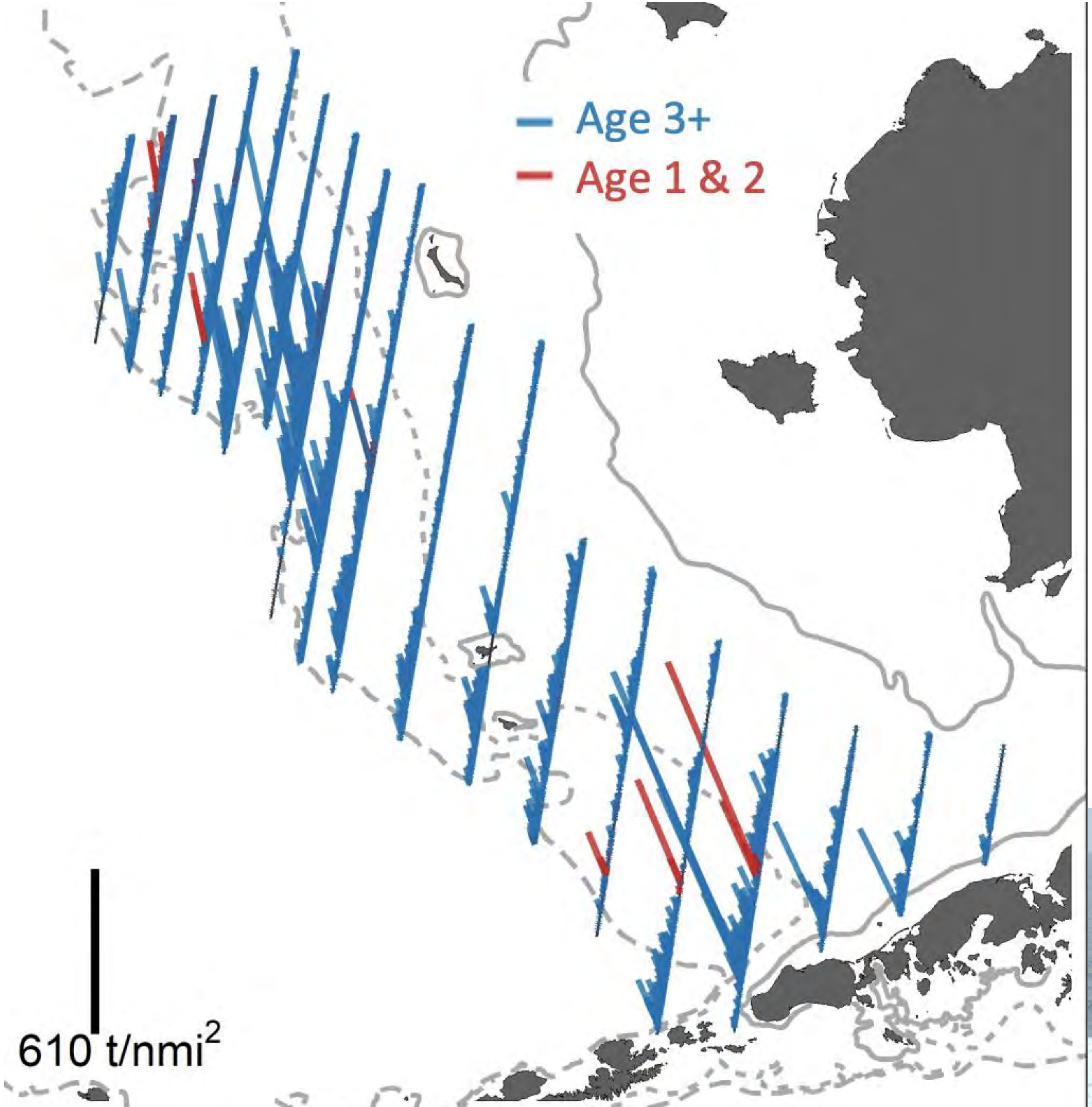


Survey abundance-at-age

E. Bering Sea bottom trawl survey

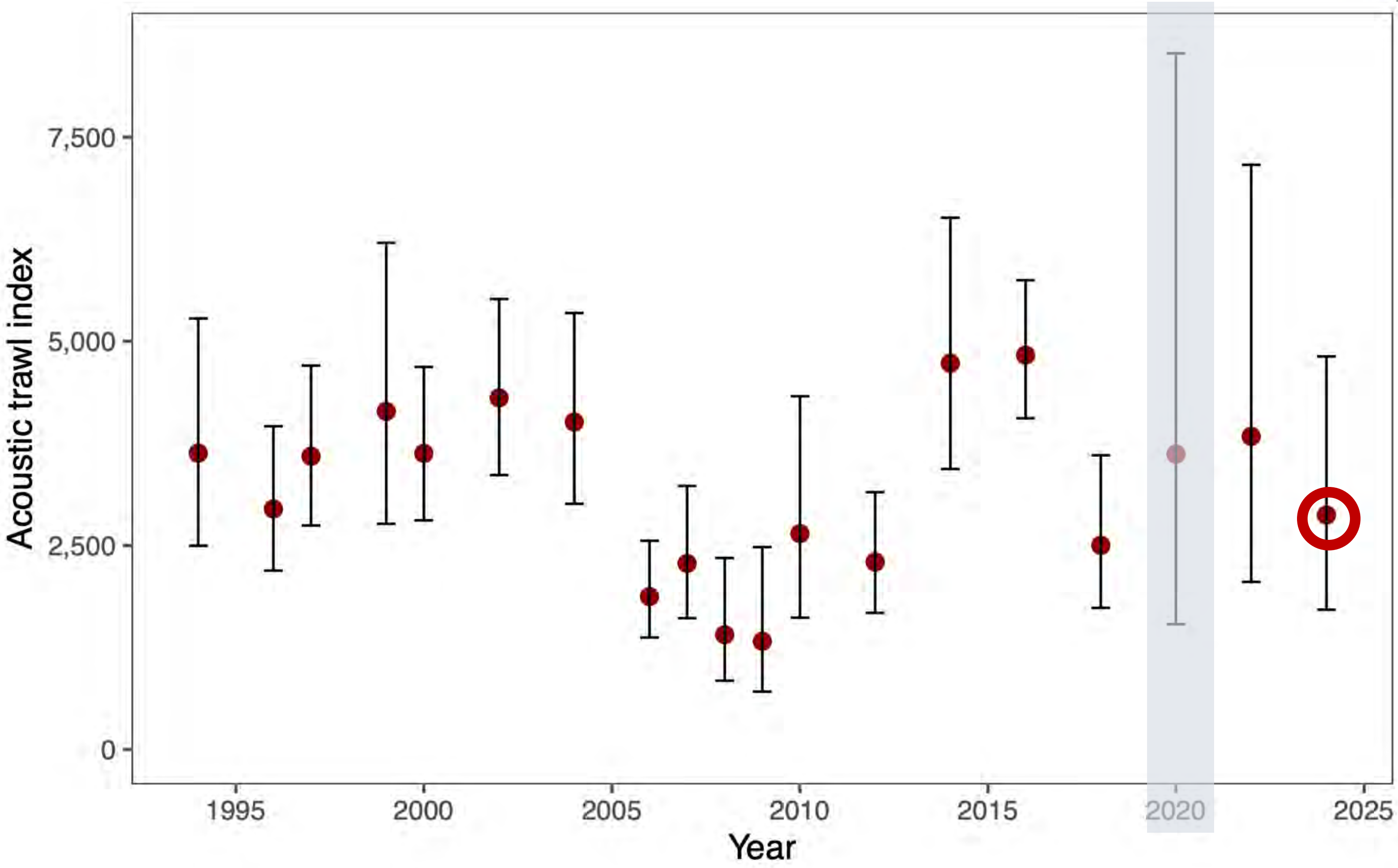


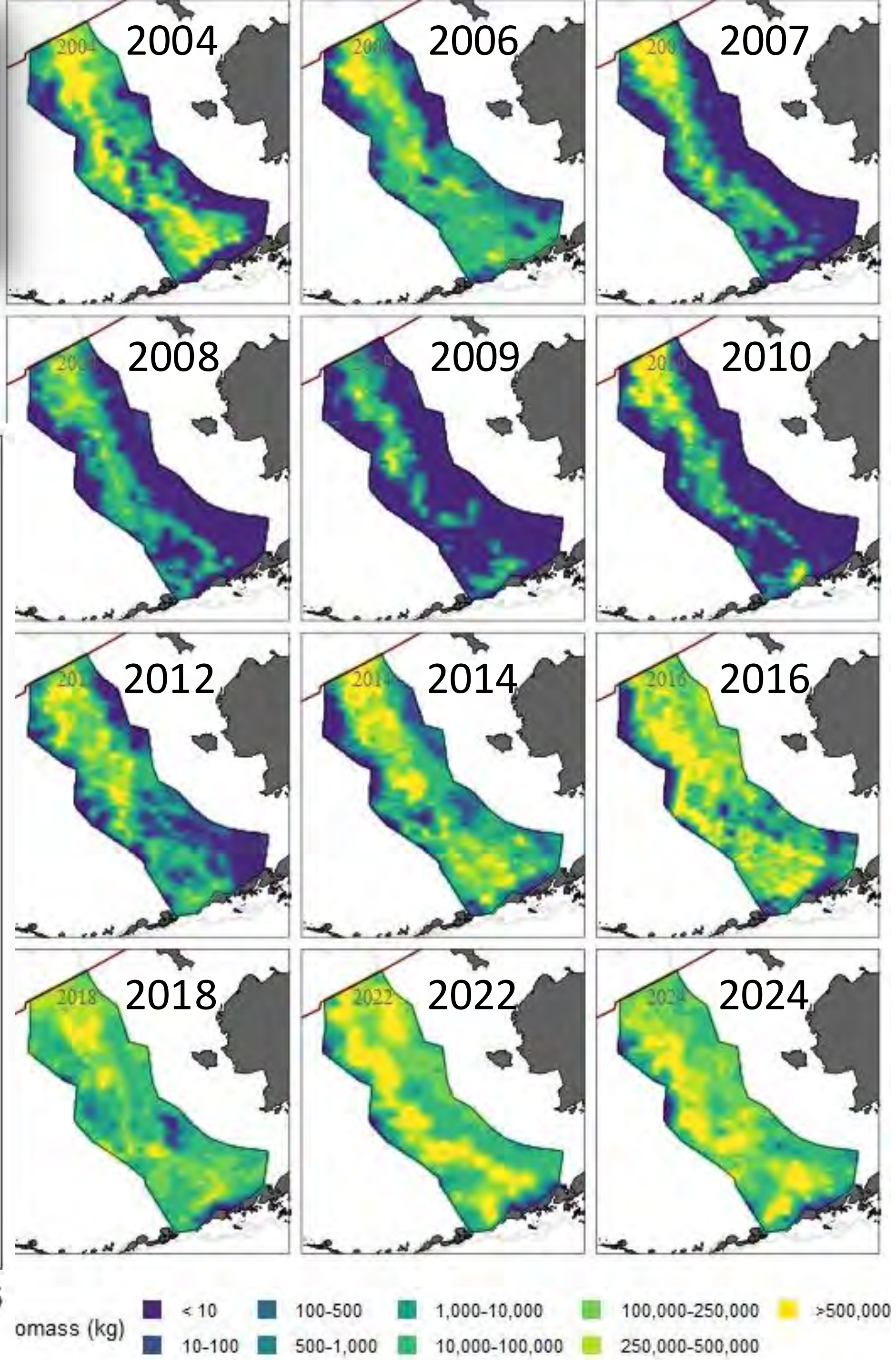
Acoustic survey-NOAA Ship



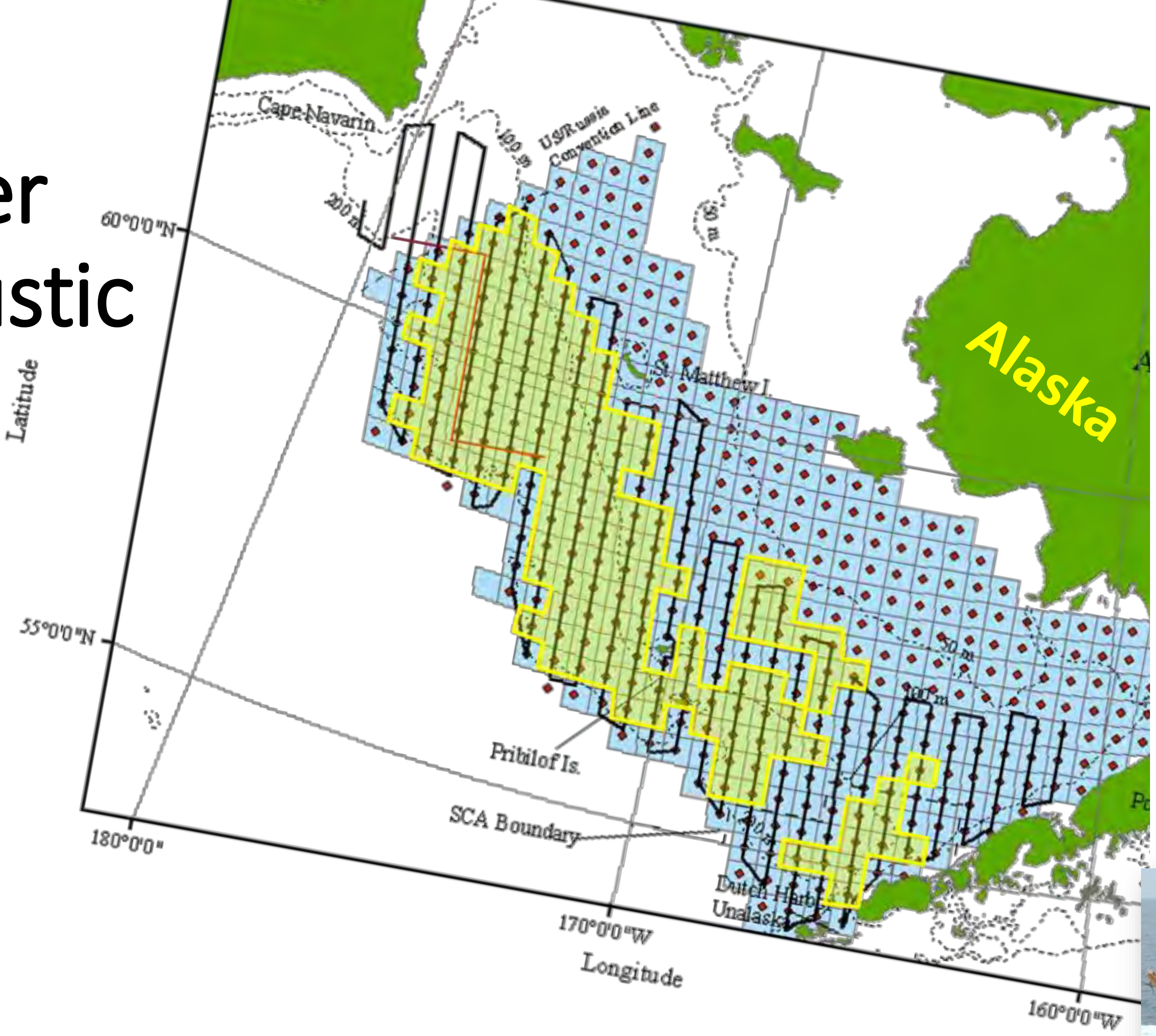
New survey this summer

Acoustic-trawl survey (ATS)

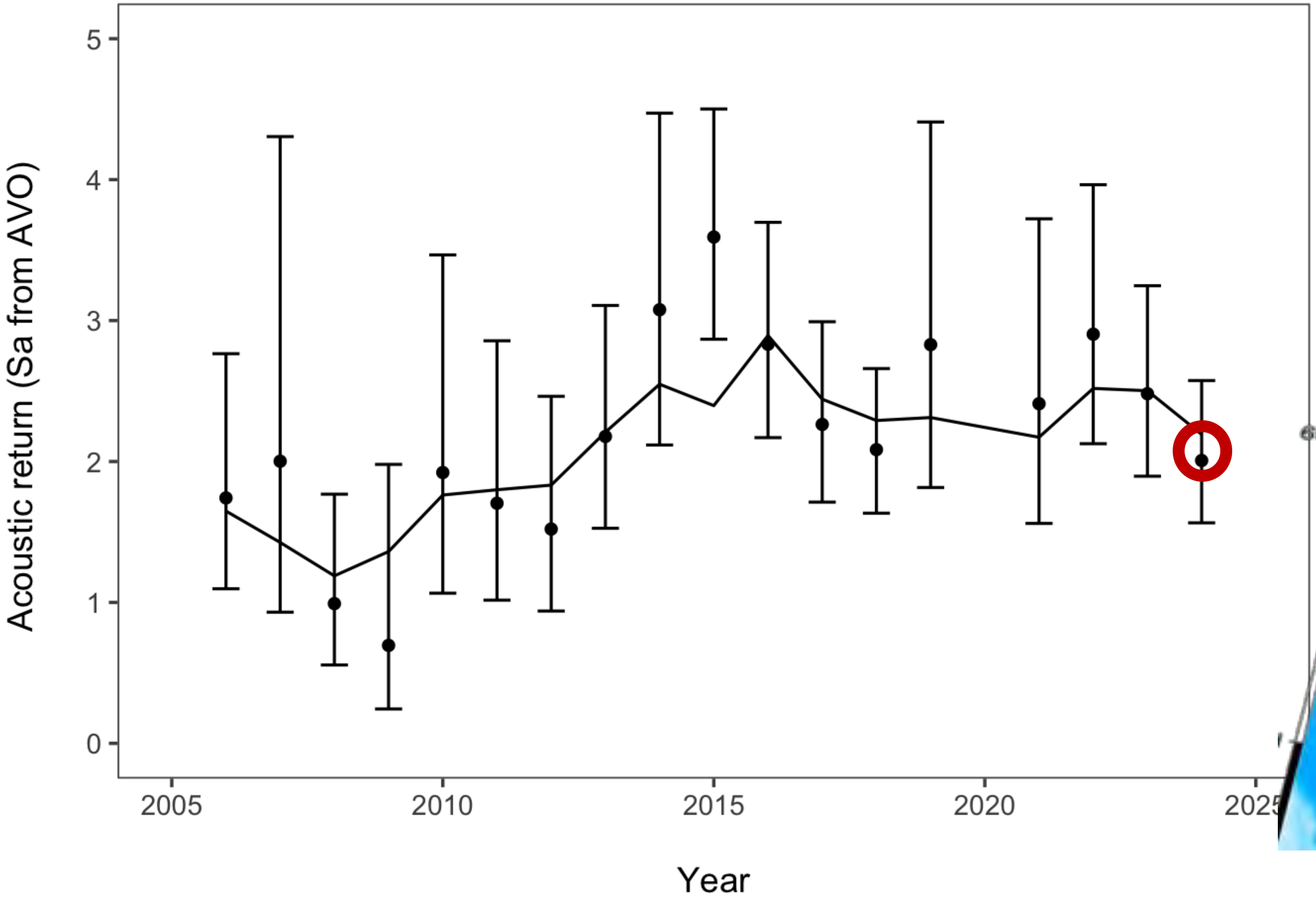


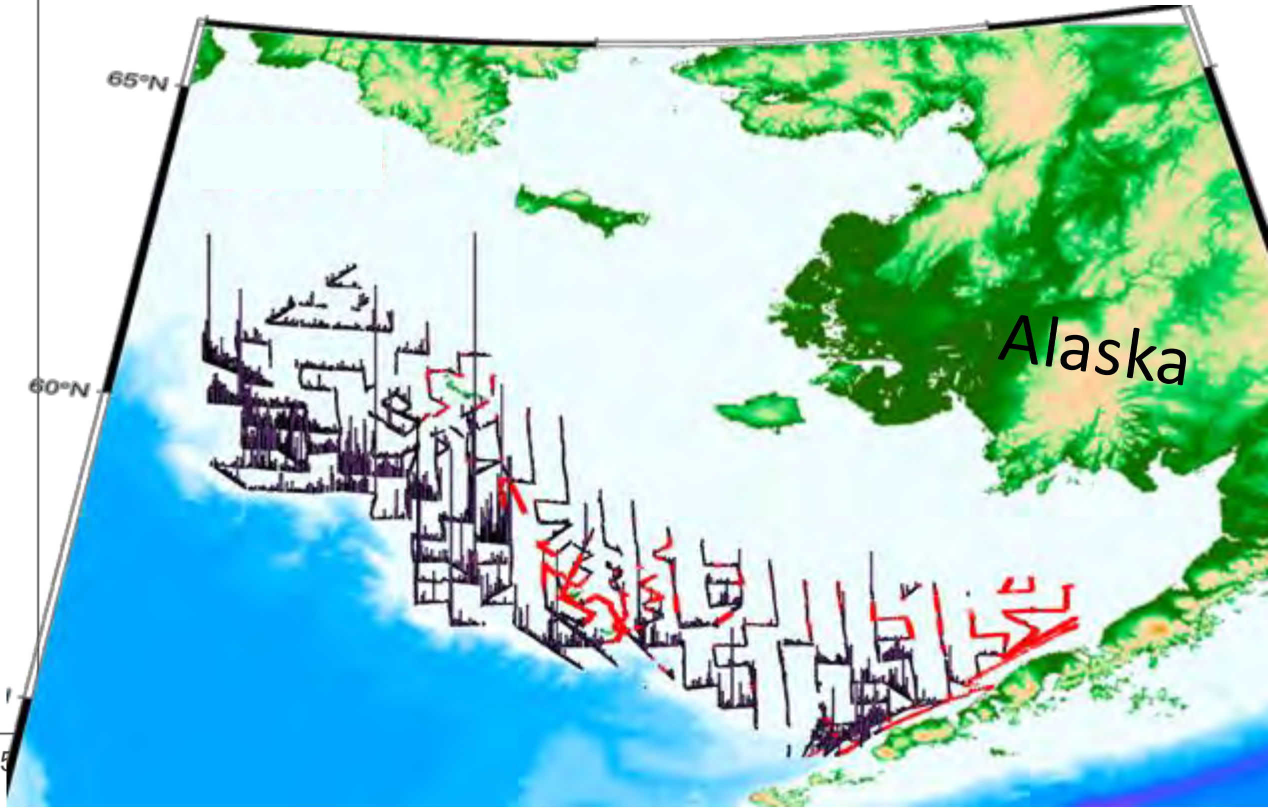


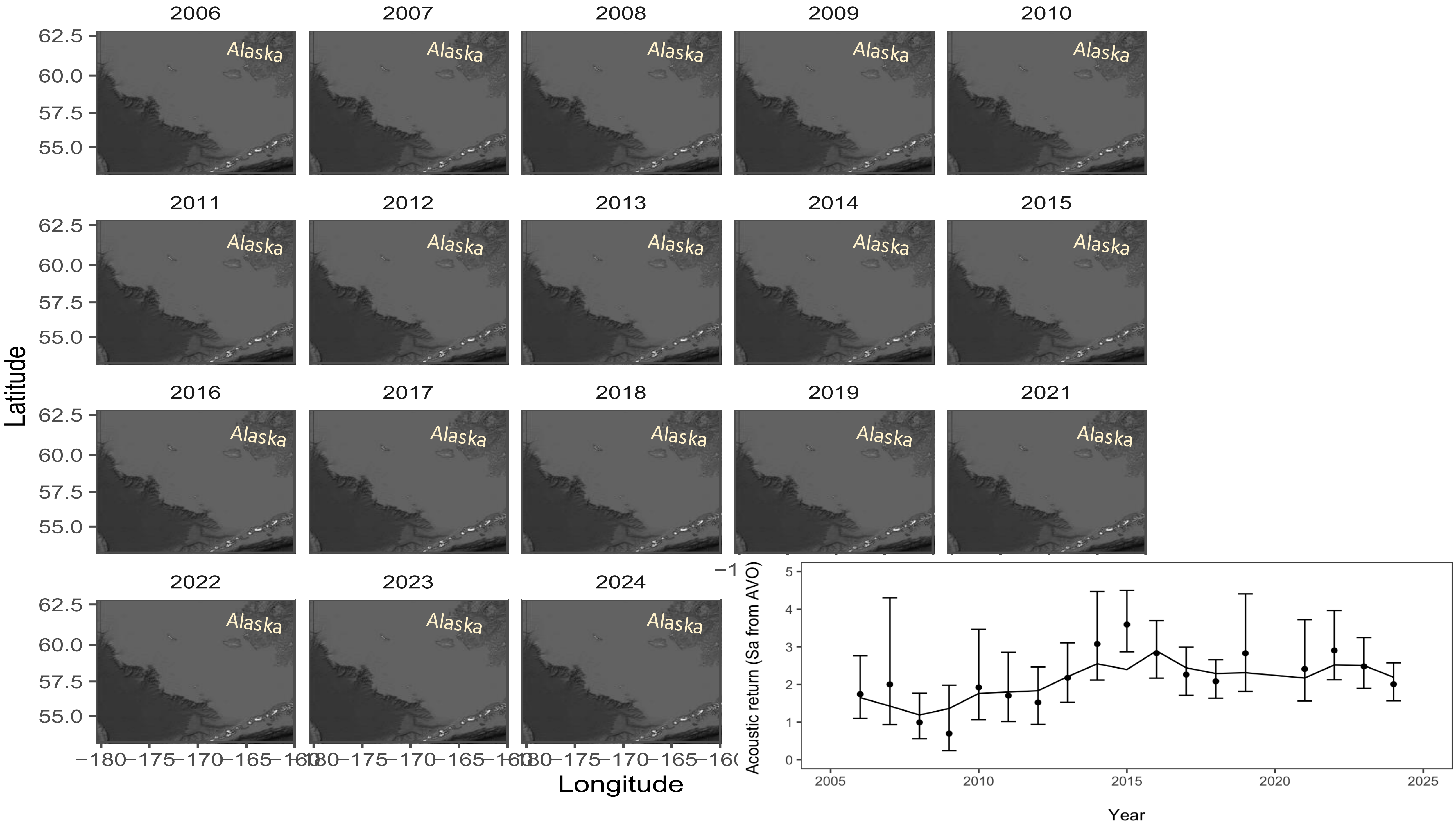
Other acoustic data



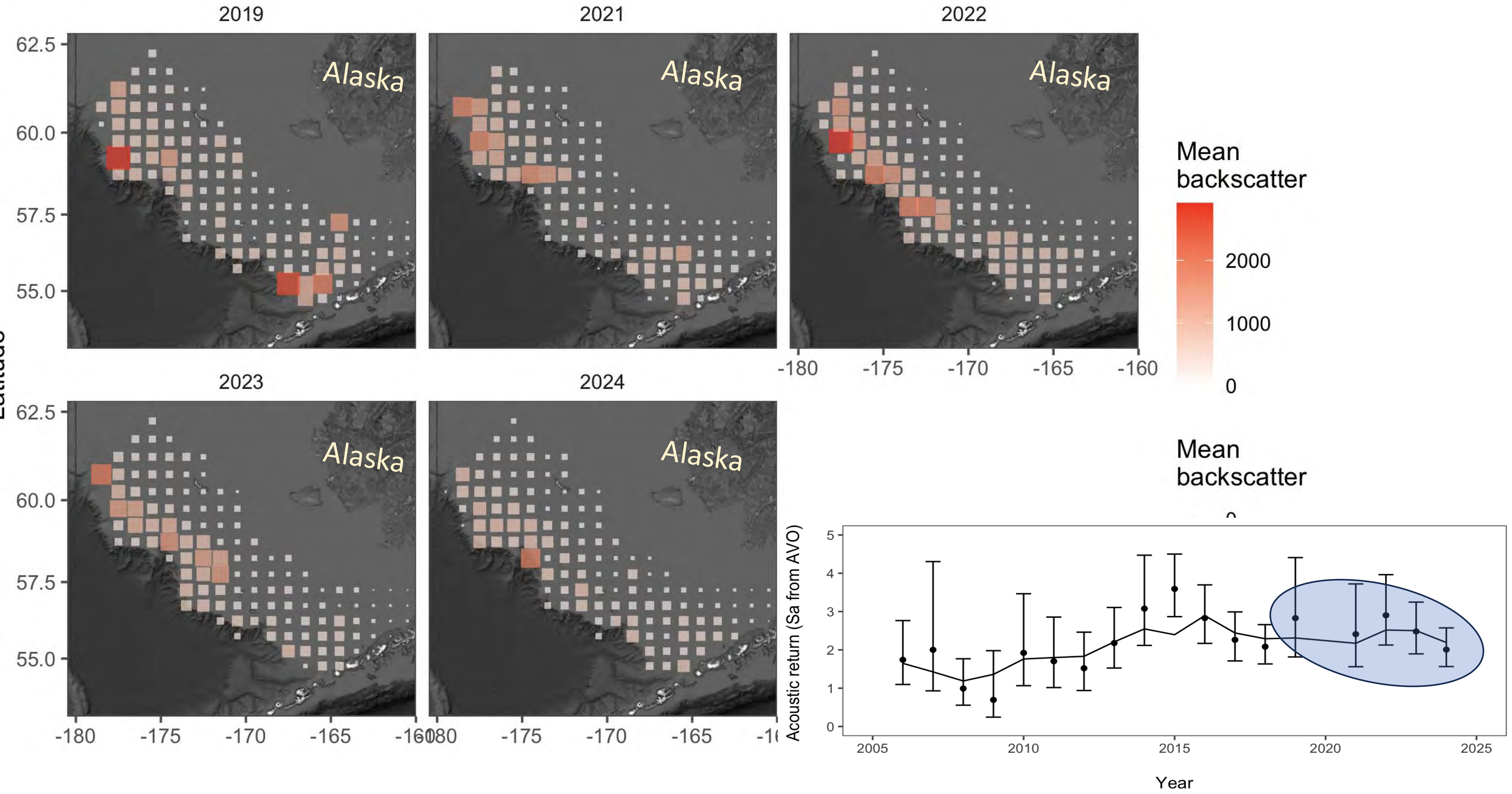
Opportunistic acoustic survey results

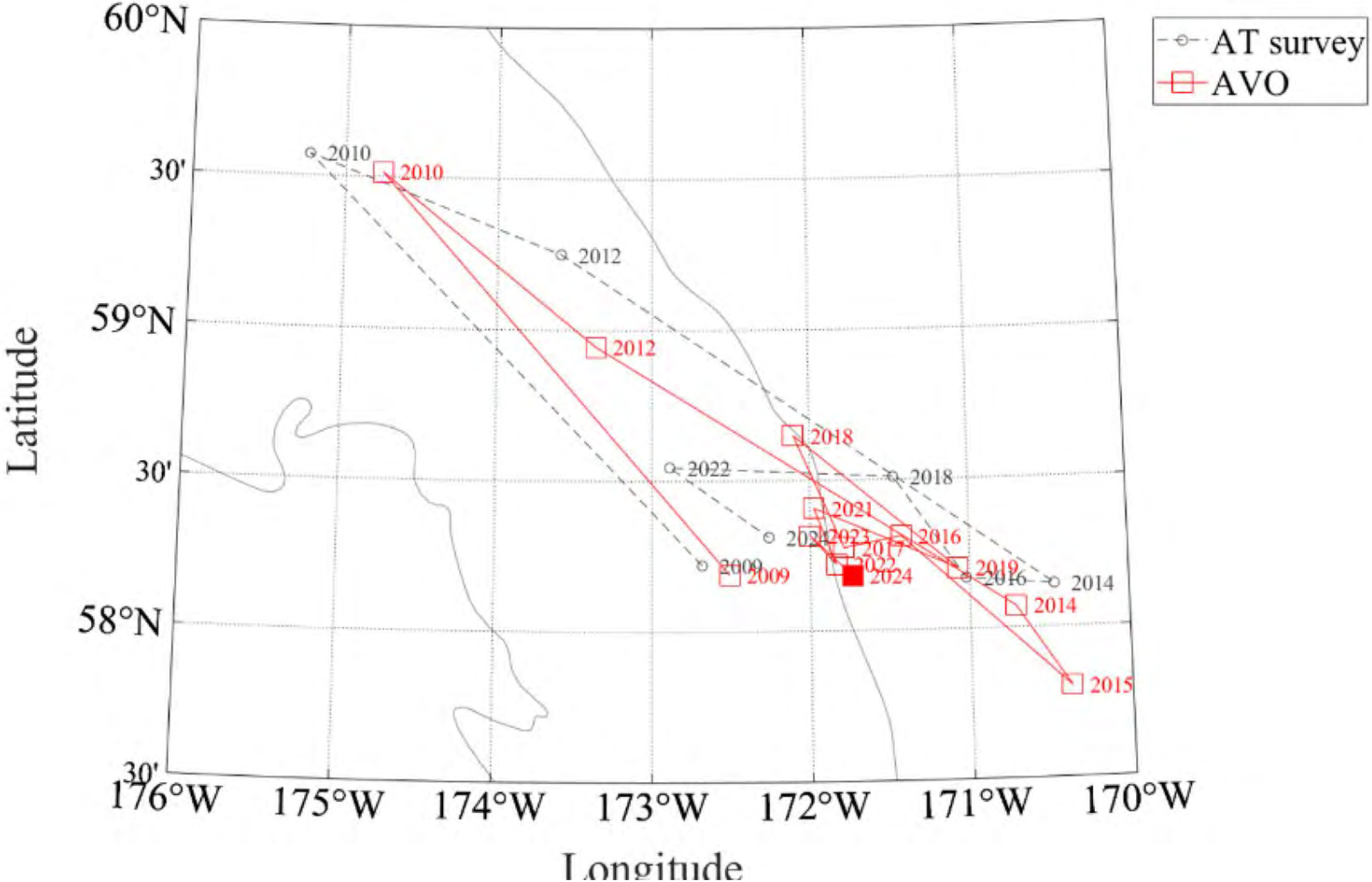






2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2021
2022
2023
2024
Alaska
Latitude
62.5
60.0
57.5
55.0
−180
−175
−170
−165
−160
Longitude
Acoustic return (Sa from AVO)
0
1
2
3
4
5
2005
2010
2015
2020
2025
Year

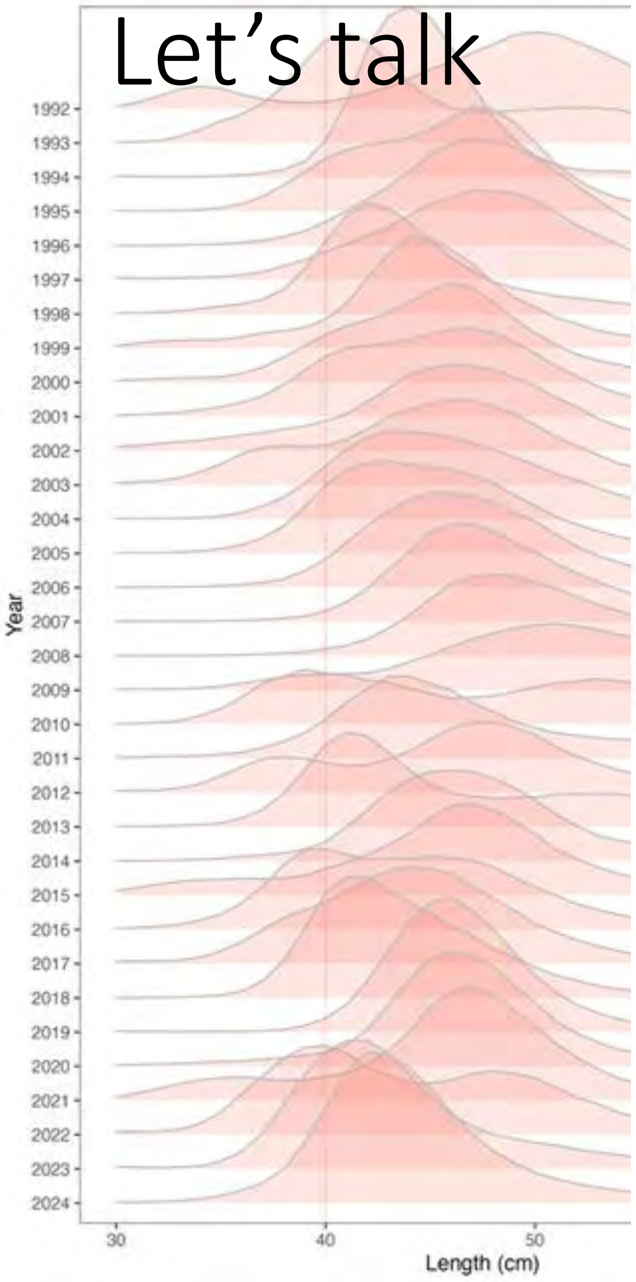

2019
2021
2022
2023
2024
Alaska
62.5
60.0
57.5
55.0
-180
-175
-170
-165
-160
Mean backscatter
2000
1000
0
Acoustic return (Sa from AVO)
0
1
2
3
4
5
2005
2010
2015
2020
2025
Year

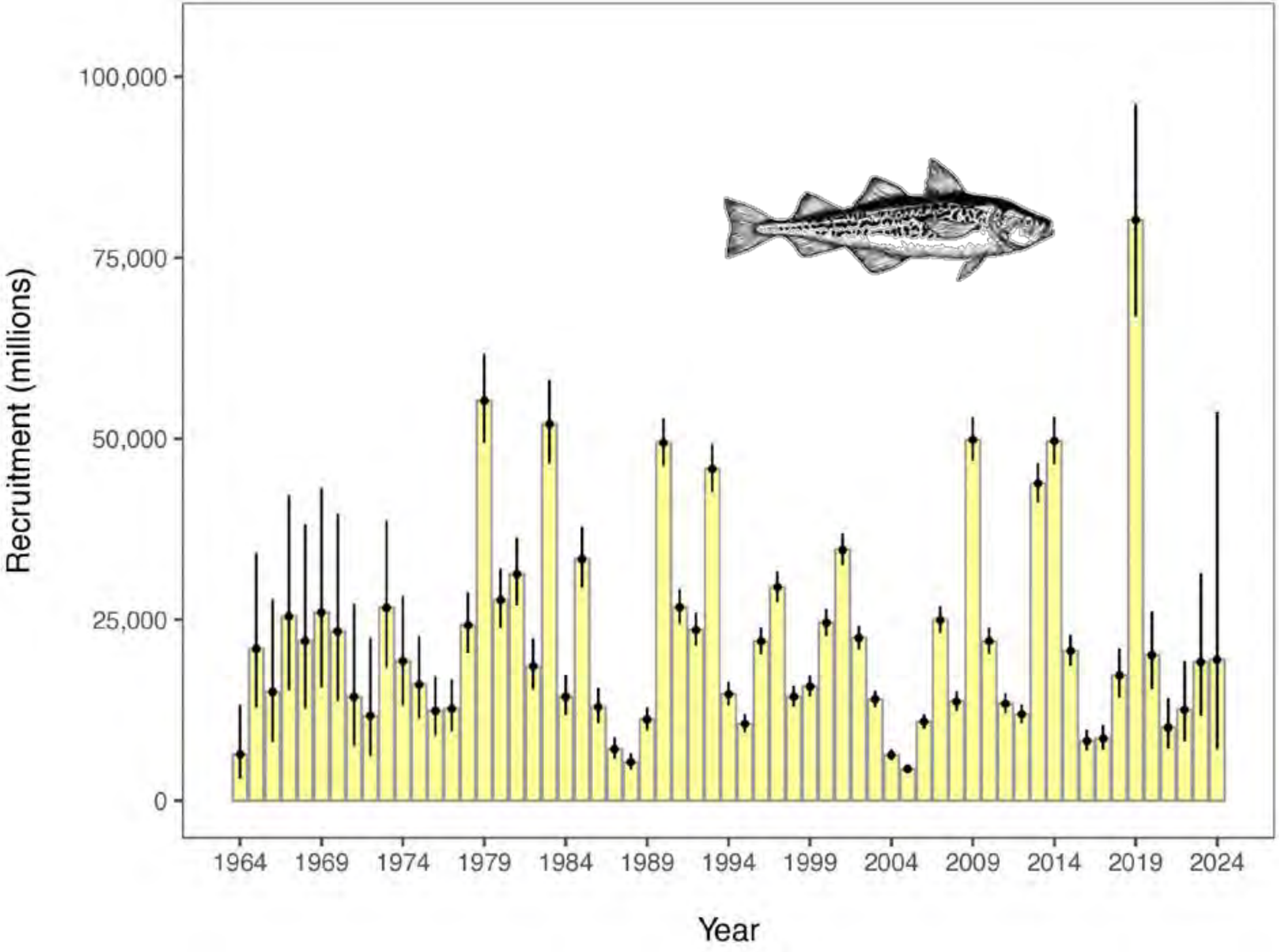

AT survey
AVO
60°N
30'
59°N
30'
58°N
30'
176°W
175°W
174°W
173°W
172°W
171°W
170°W
Latitude
Longitude
2010
2012
2022
2018
2021
2016
2017
2019
2014
2015
2009
2024
2023
2016

Modeling…

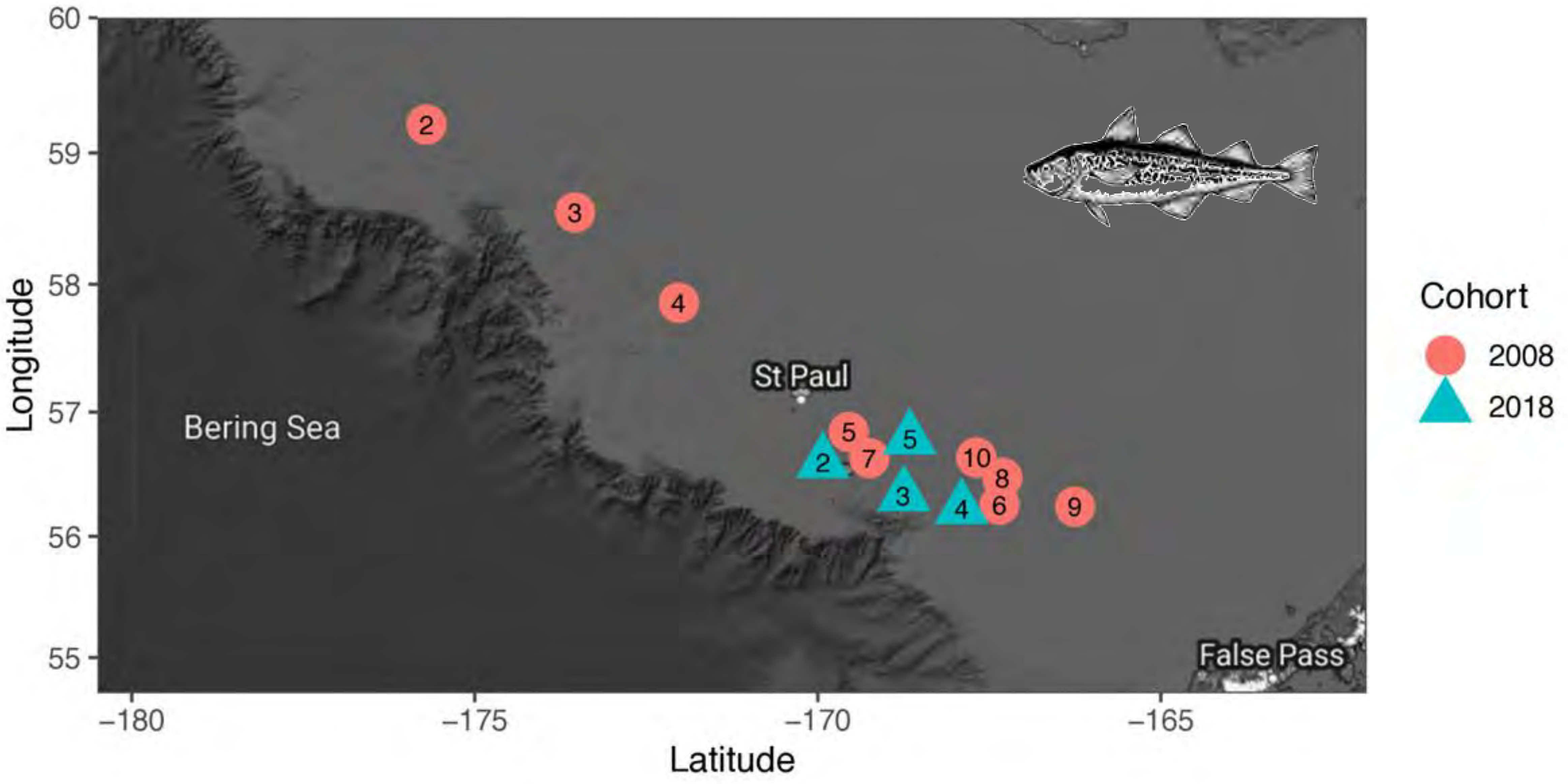
EBS Pollock

Let's talk





EBS Pollock

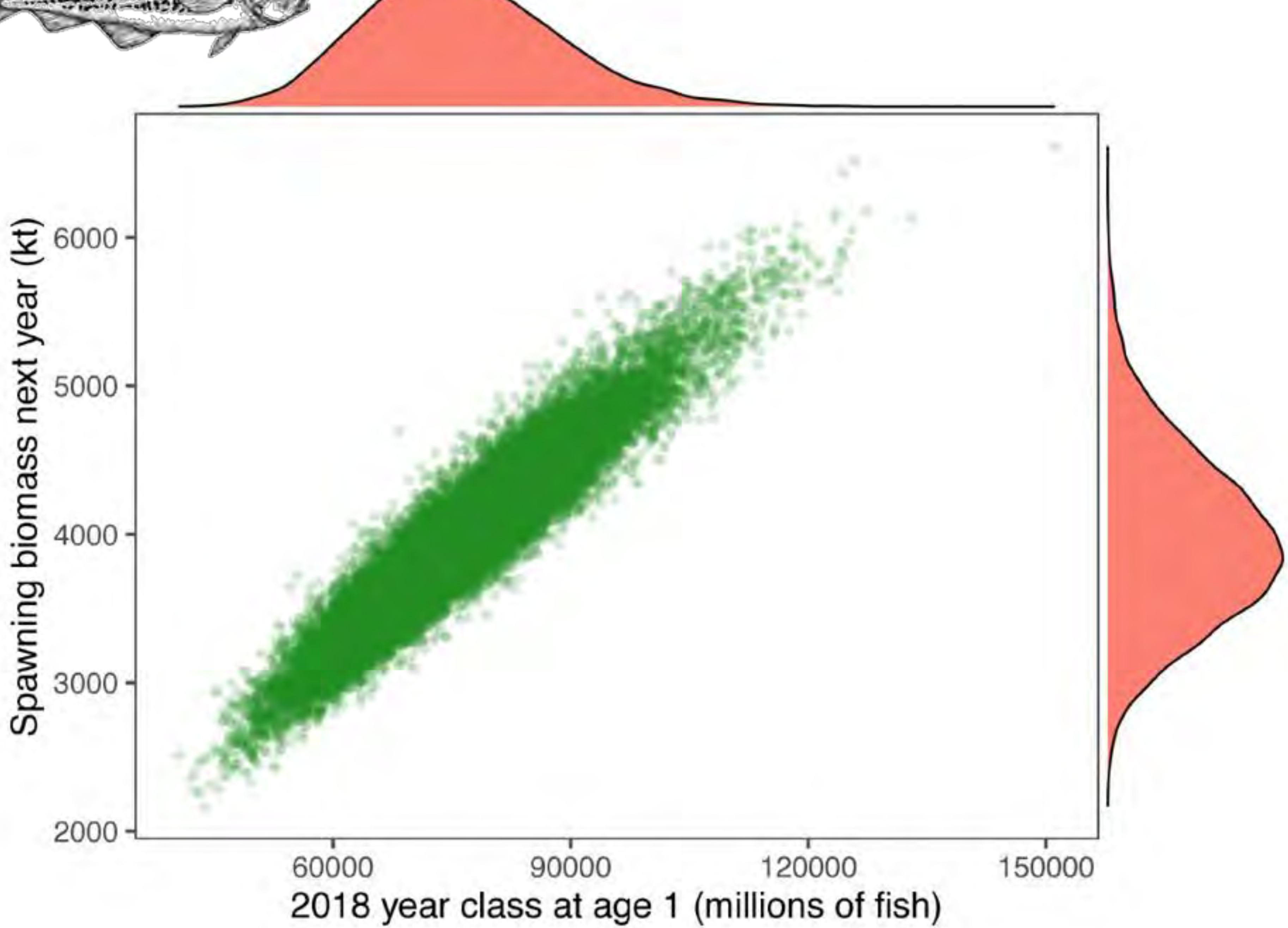


60
59
58
57
56
55
Longitude
−180
−175
−170
−165
Latitude
Bering Sea
St Paul
False Pass
2
3
4
5
7
10
8
6
9
2
5
3
4
Cohort
2008
2018

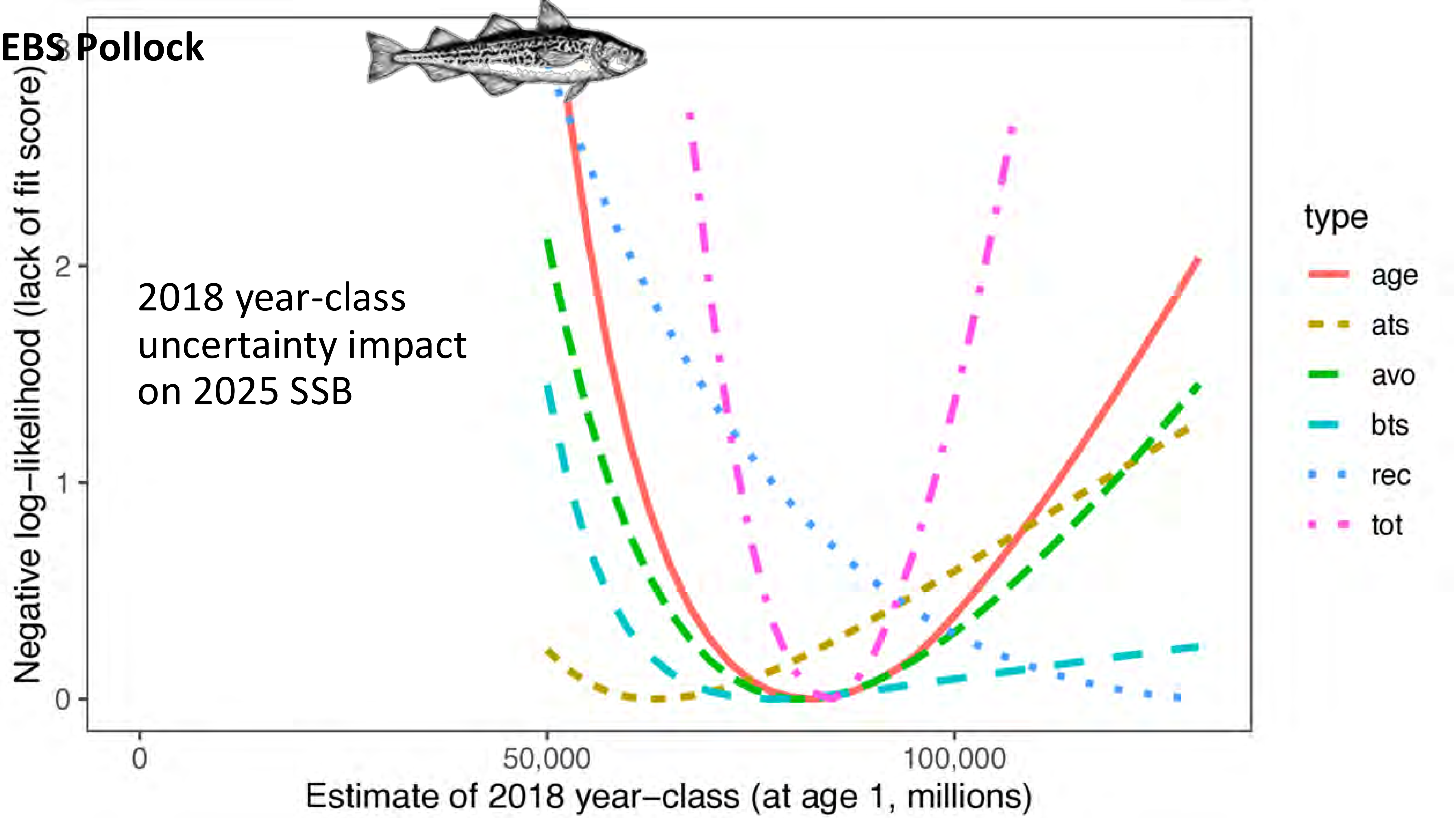
EBS Pollock

Let’s talk

2018 year-class uncertainty impact on 2025 SSB

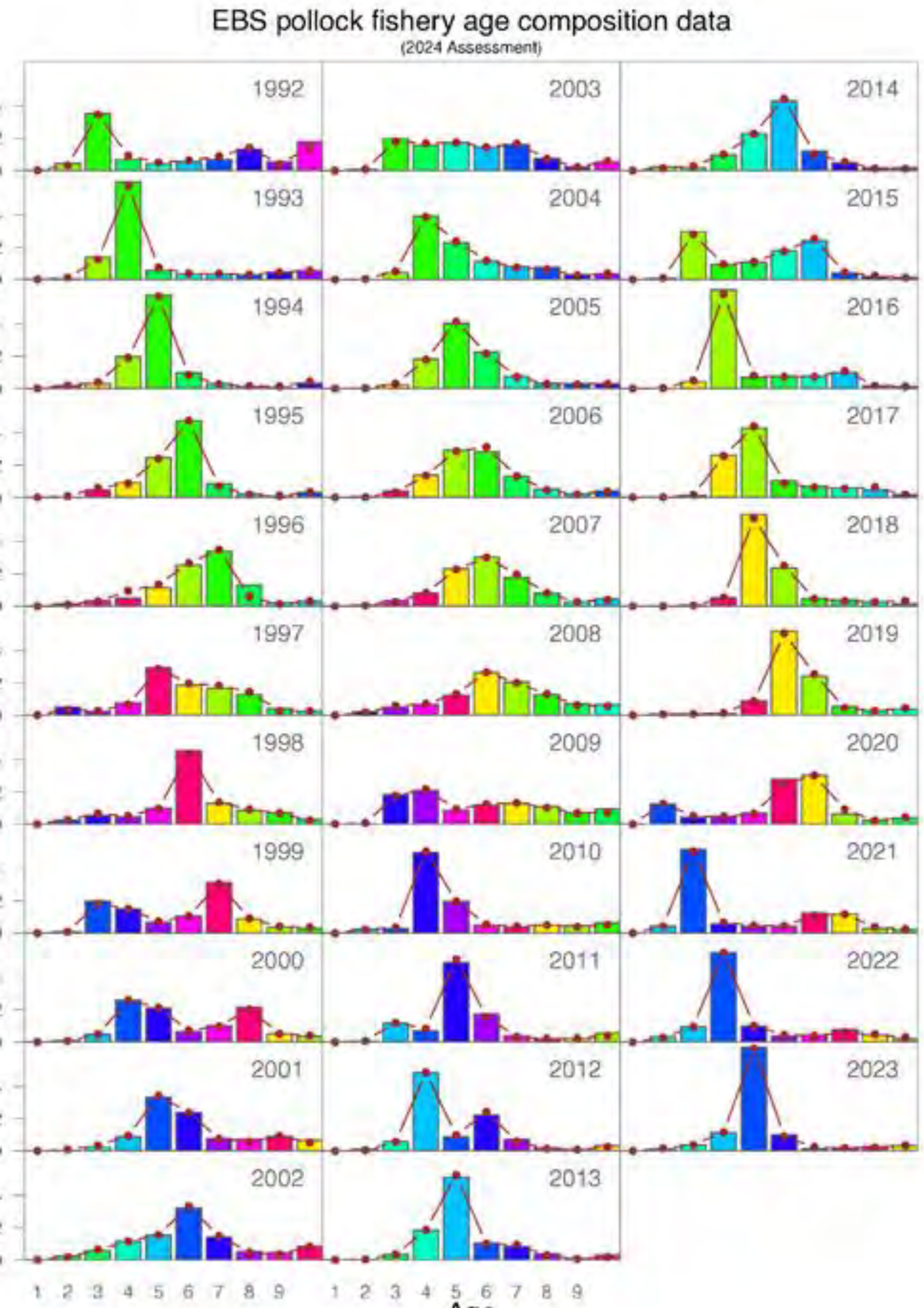


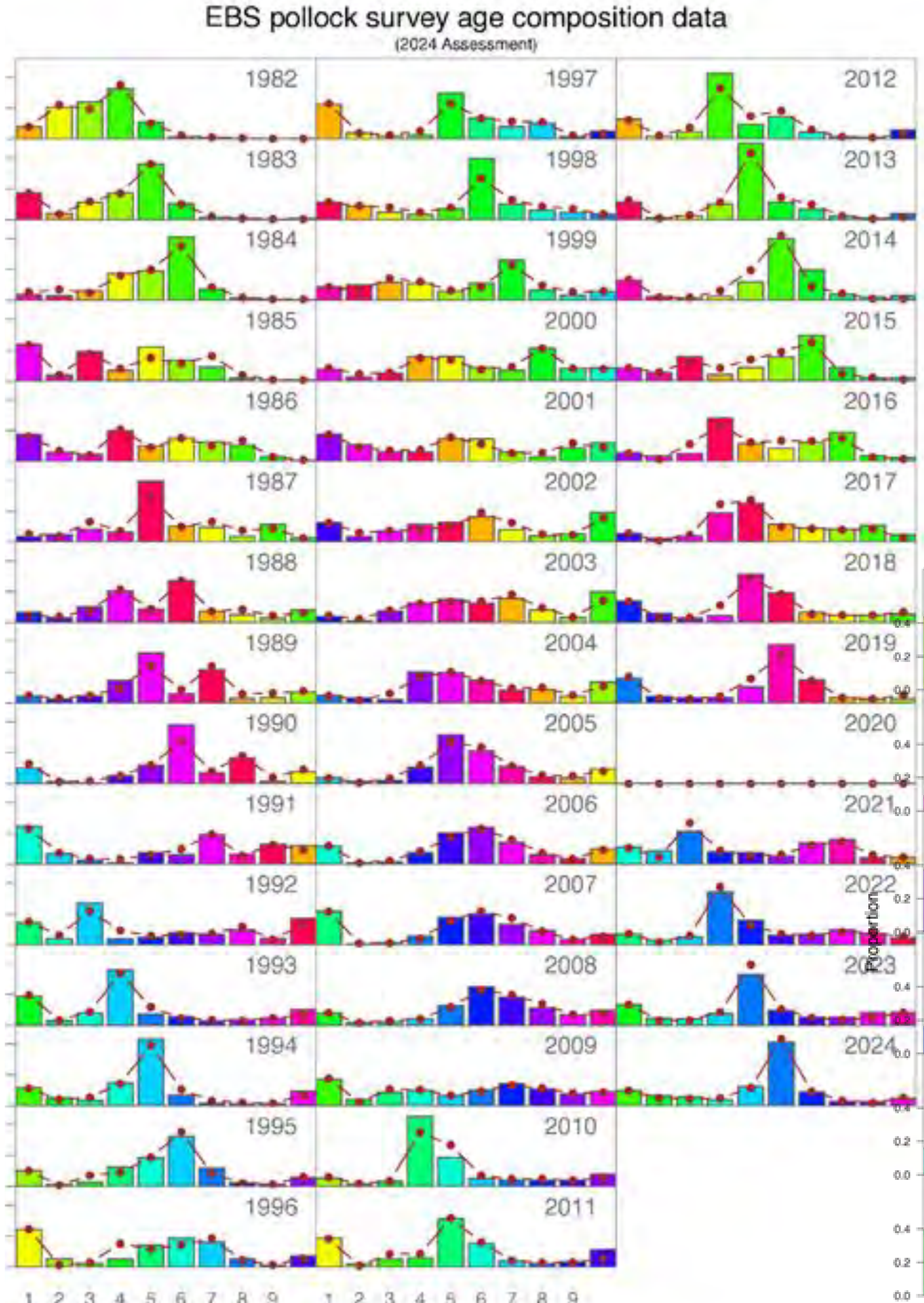
EBS Pollock

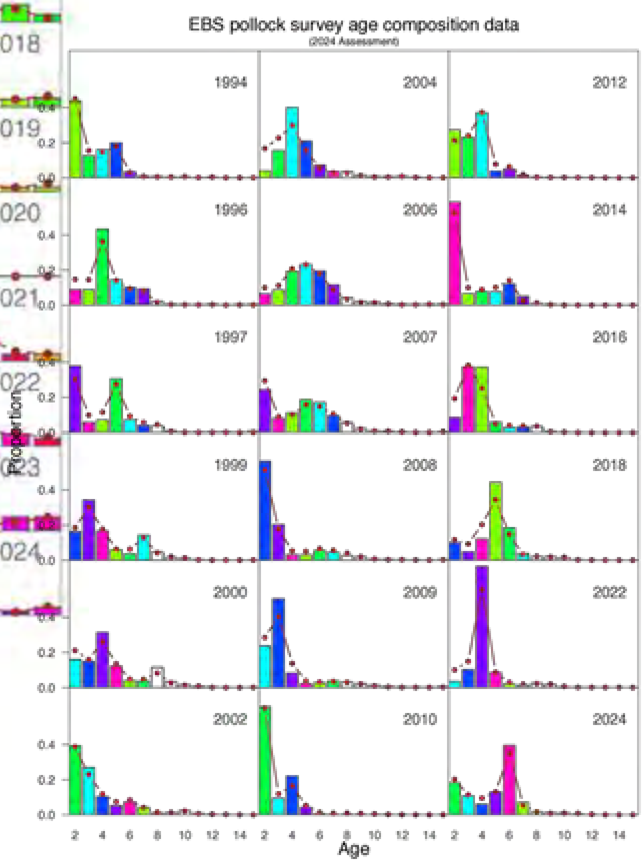


2018 year-class uncertainty impact on 2025 SSB

Model fits



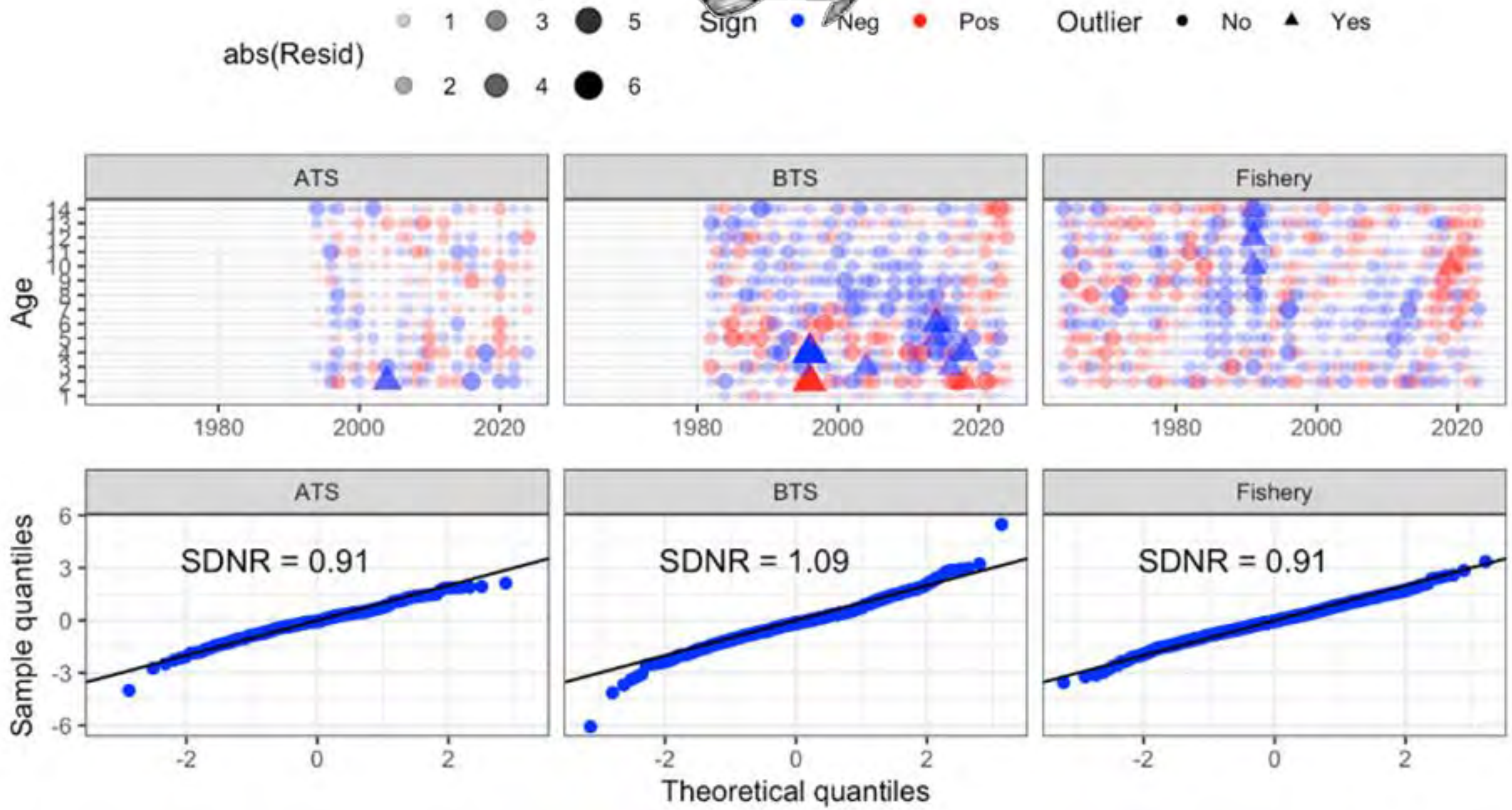




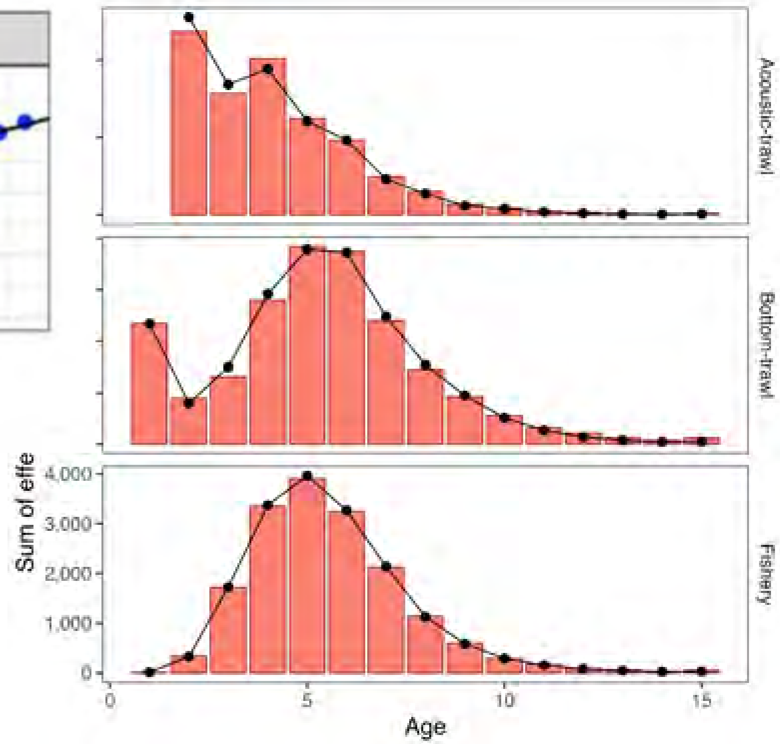
Fishery

Bottom-trawl survey

EBS Pollock

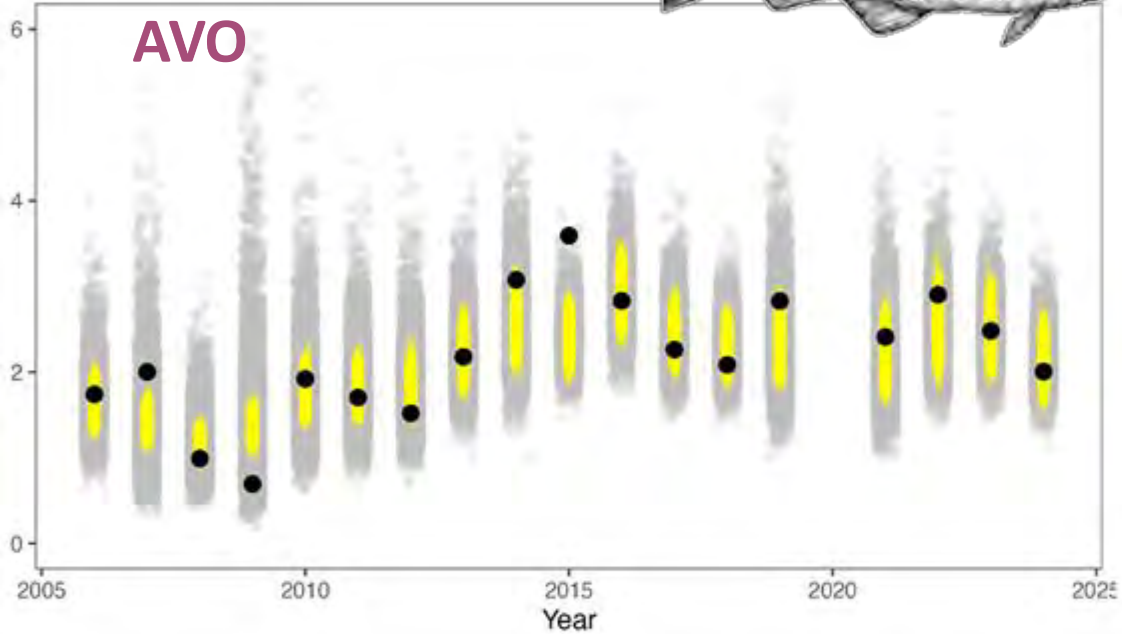


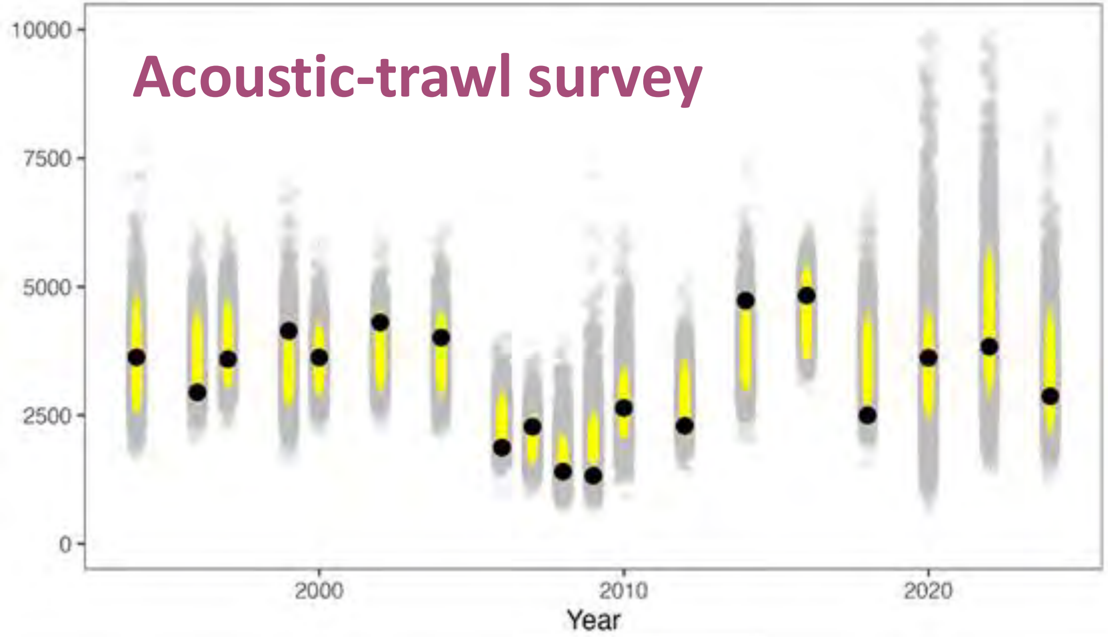
Aggregate model fits

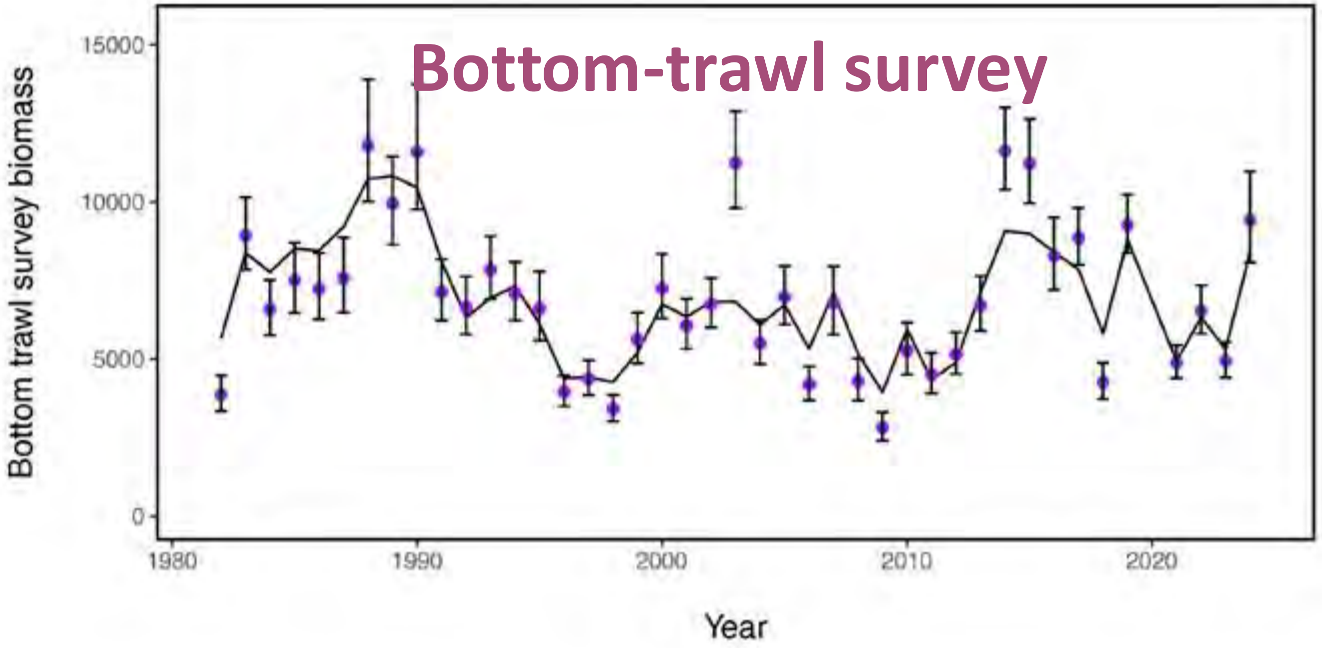


Residual analyses

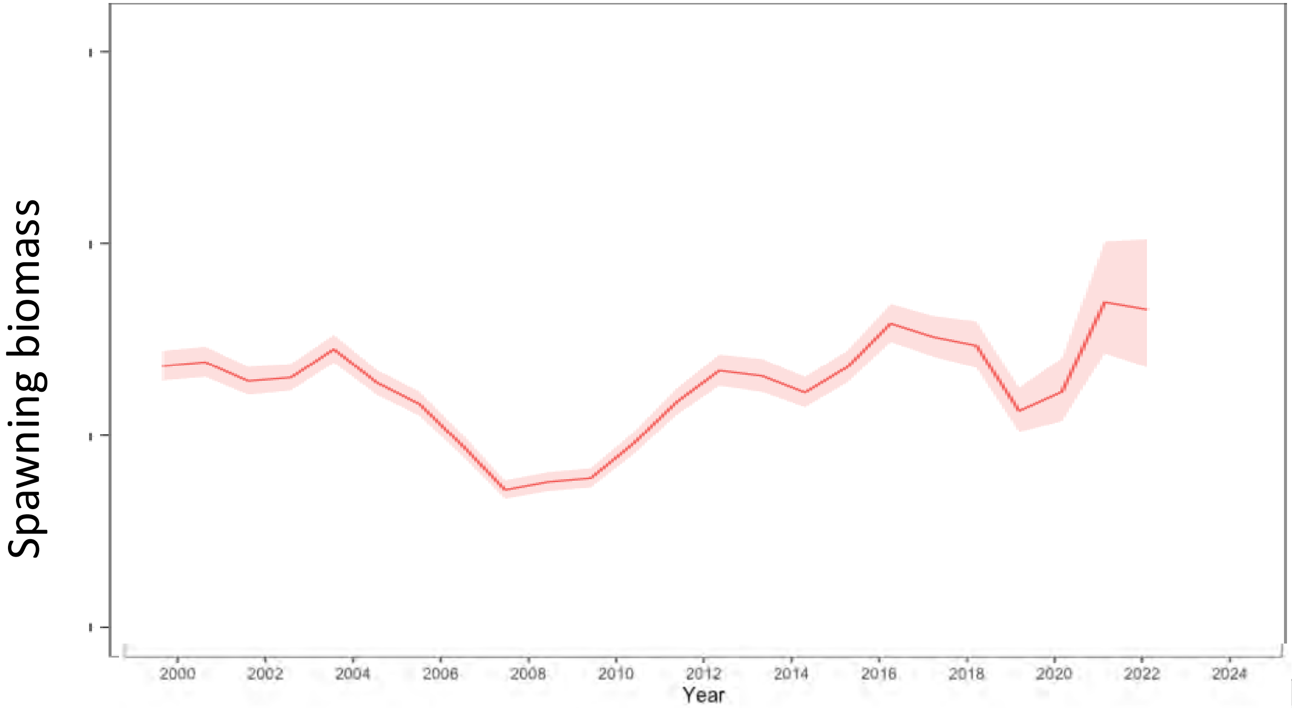
EBS Pollock

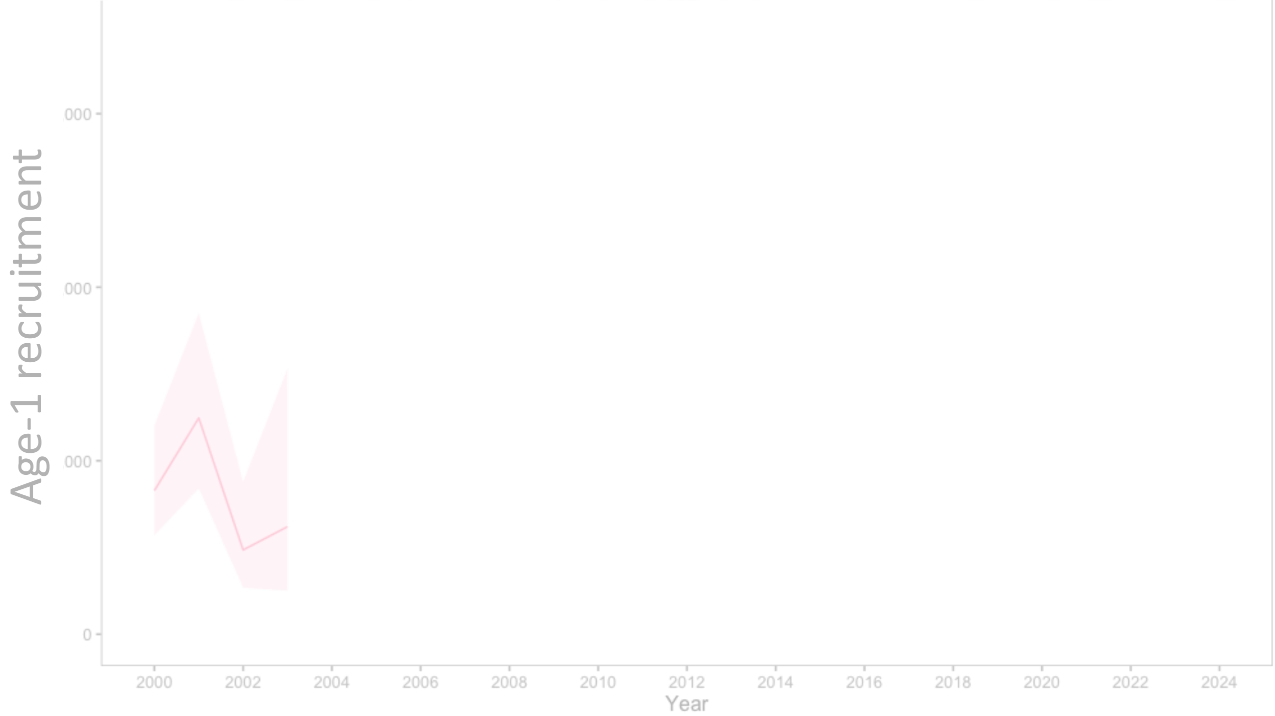

AVO
0
2
4
6
2005
2010
2015
2020
2025
Year


Acoustic-trawl survey
0
2500
5000
7500
10000
2000
2010
2020
Year

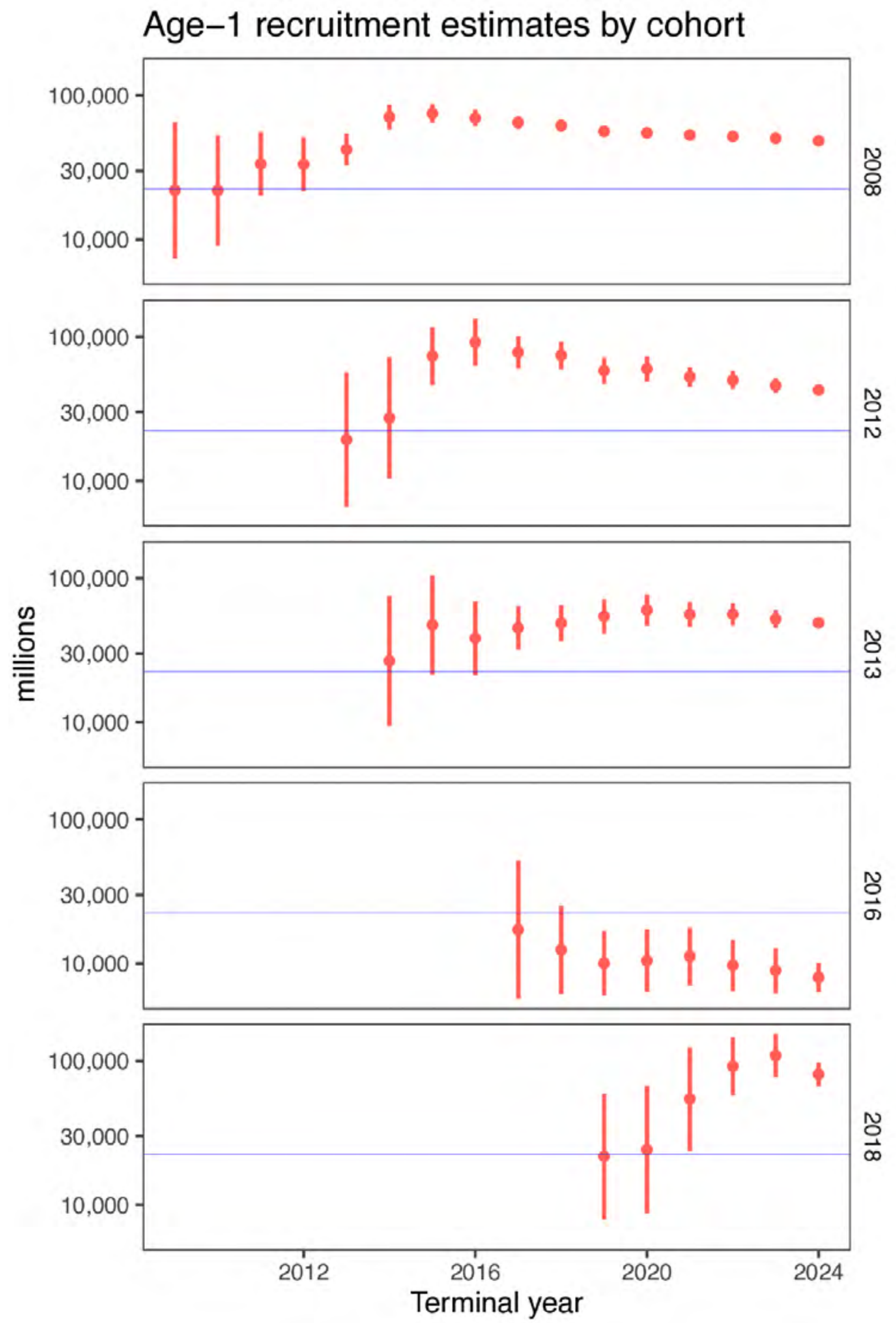

Bottom-trawl survey
Bottom trawl survey biomass
0
5000
10000
15000
1980
1990
2000
2010
2020
Year

Retrospective patterns

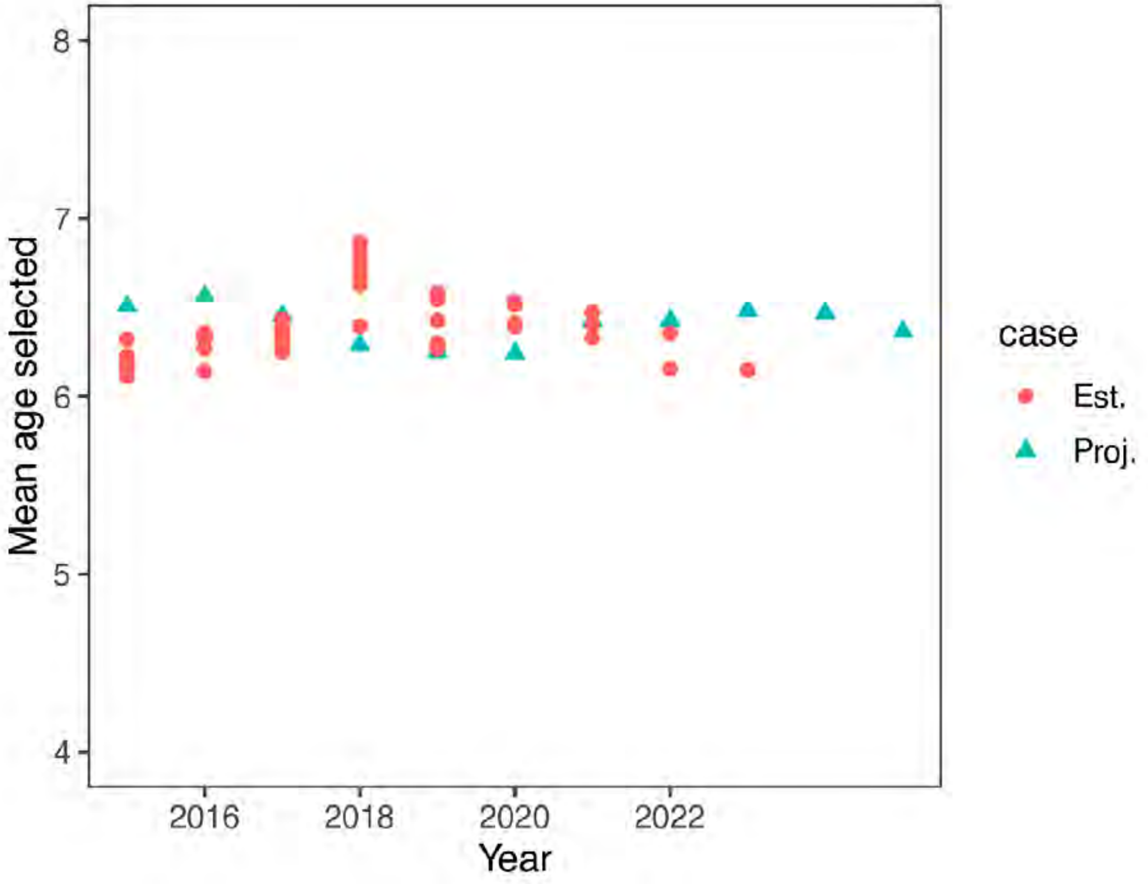


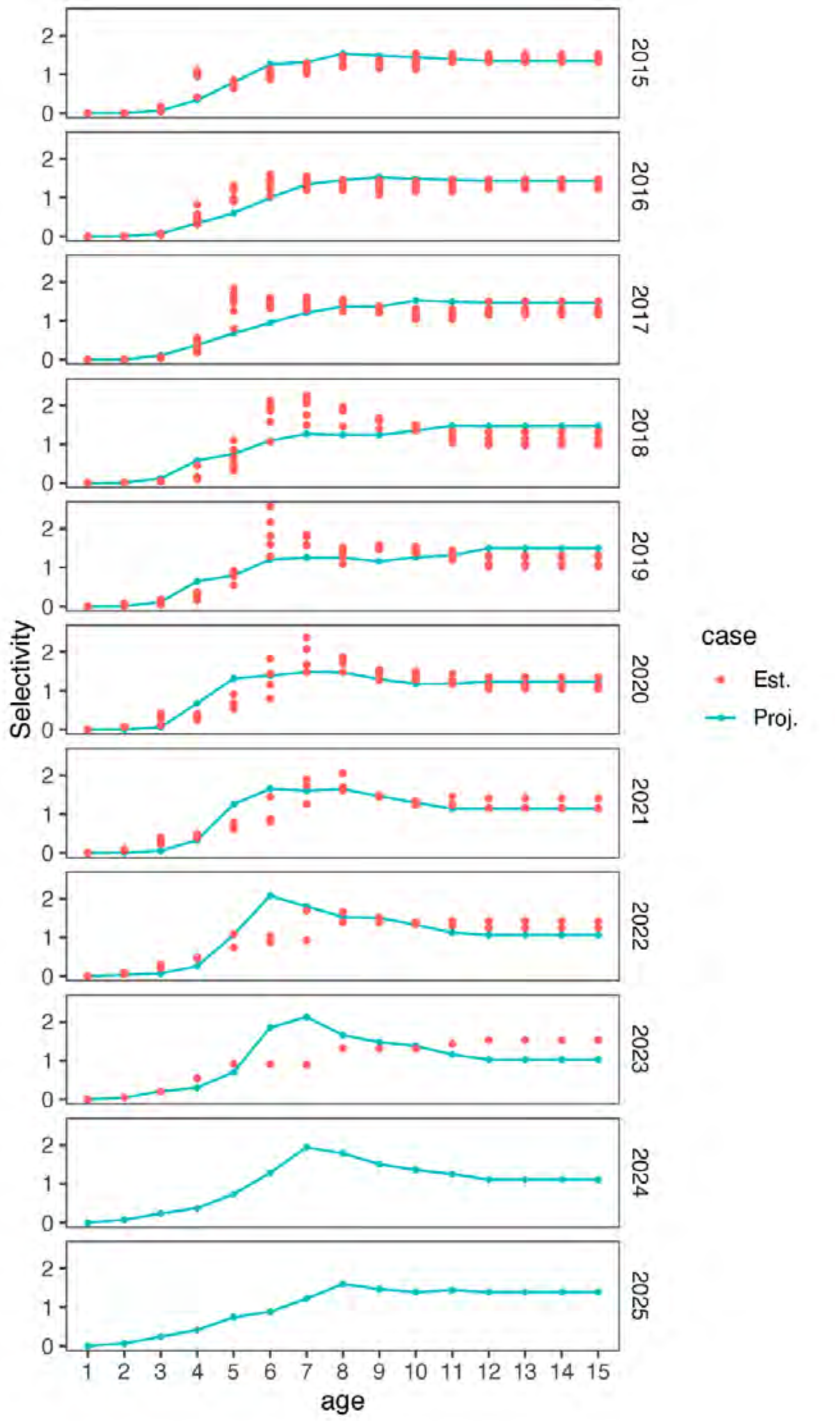


Retrospective patterns by cohort



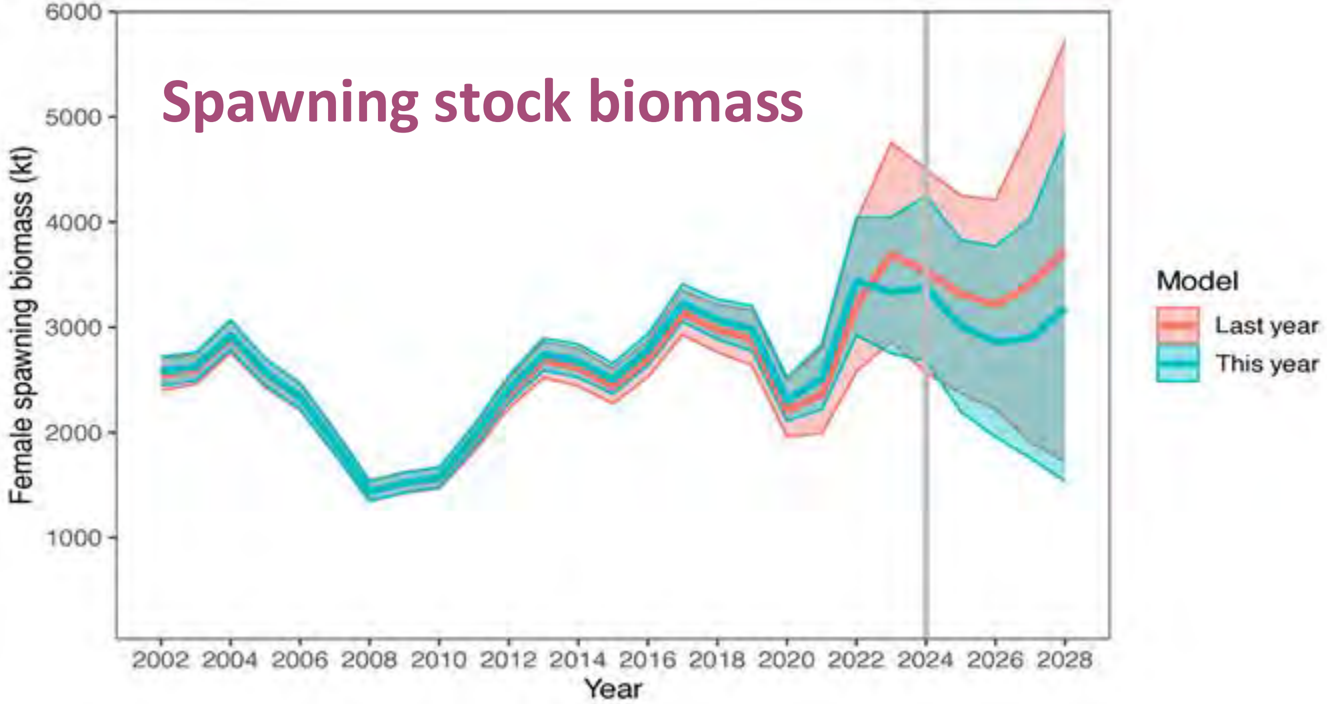
Retrospective selectivities

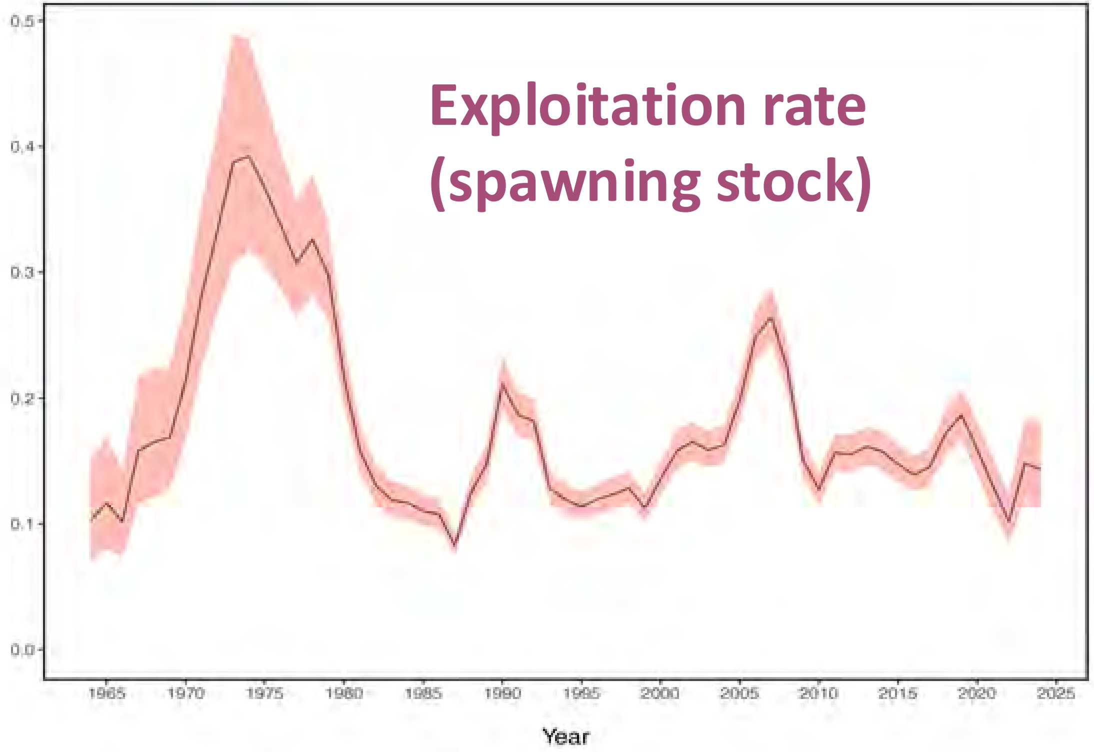




EBS Pollock

Stock status, -fitness level good!!



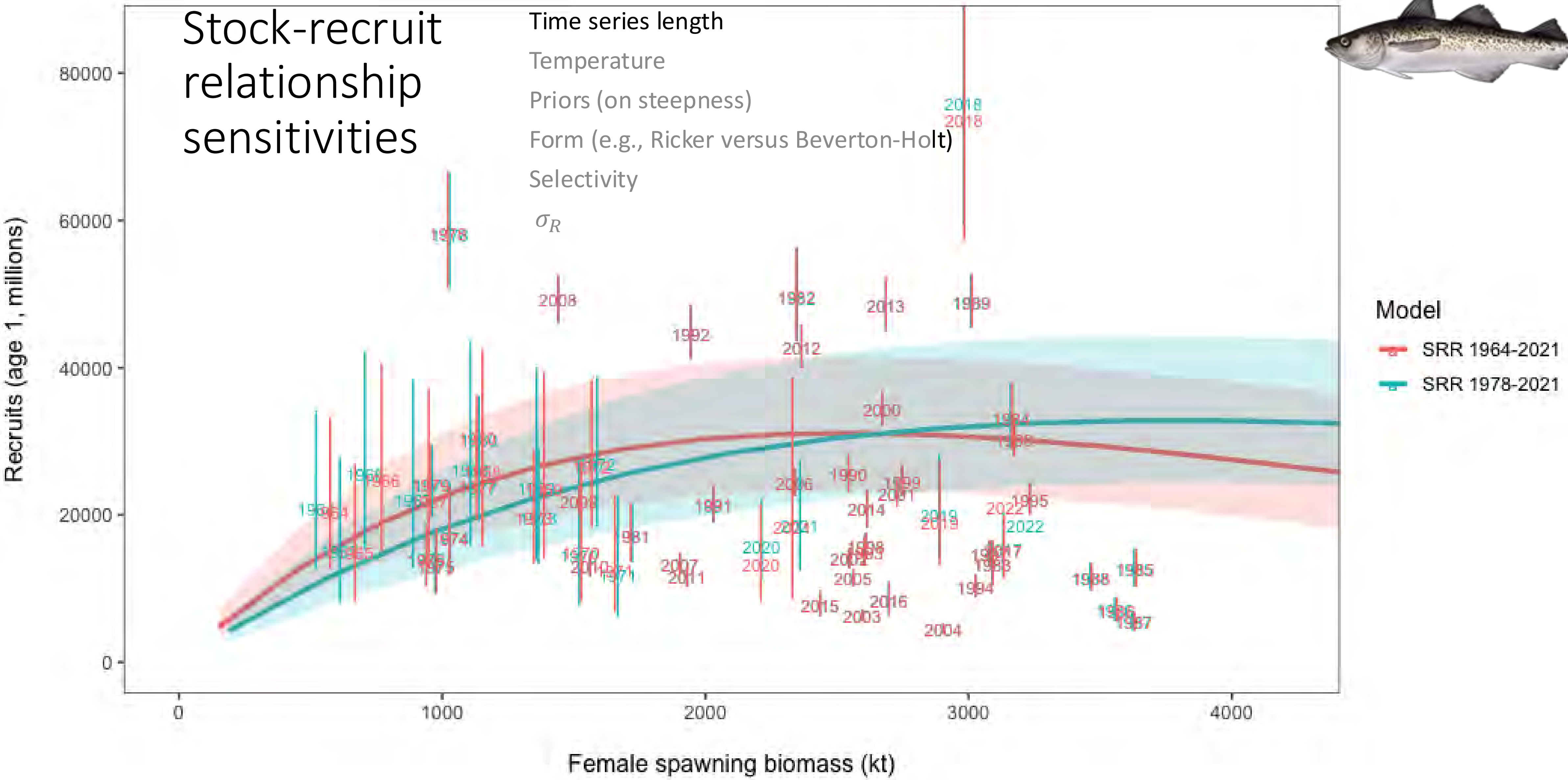


What about productivity estimates?

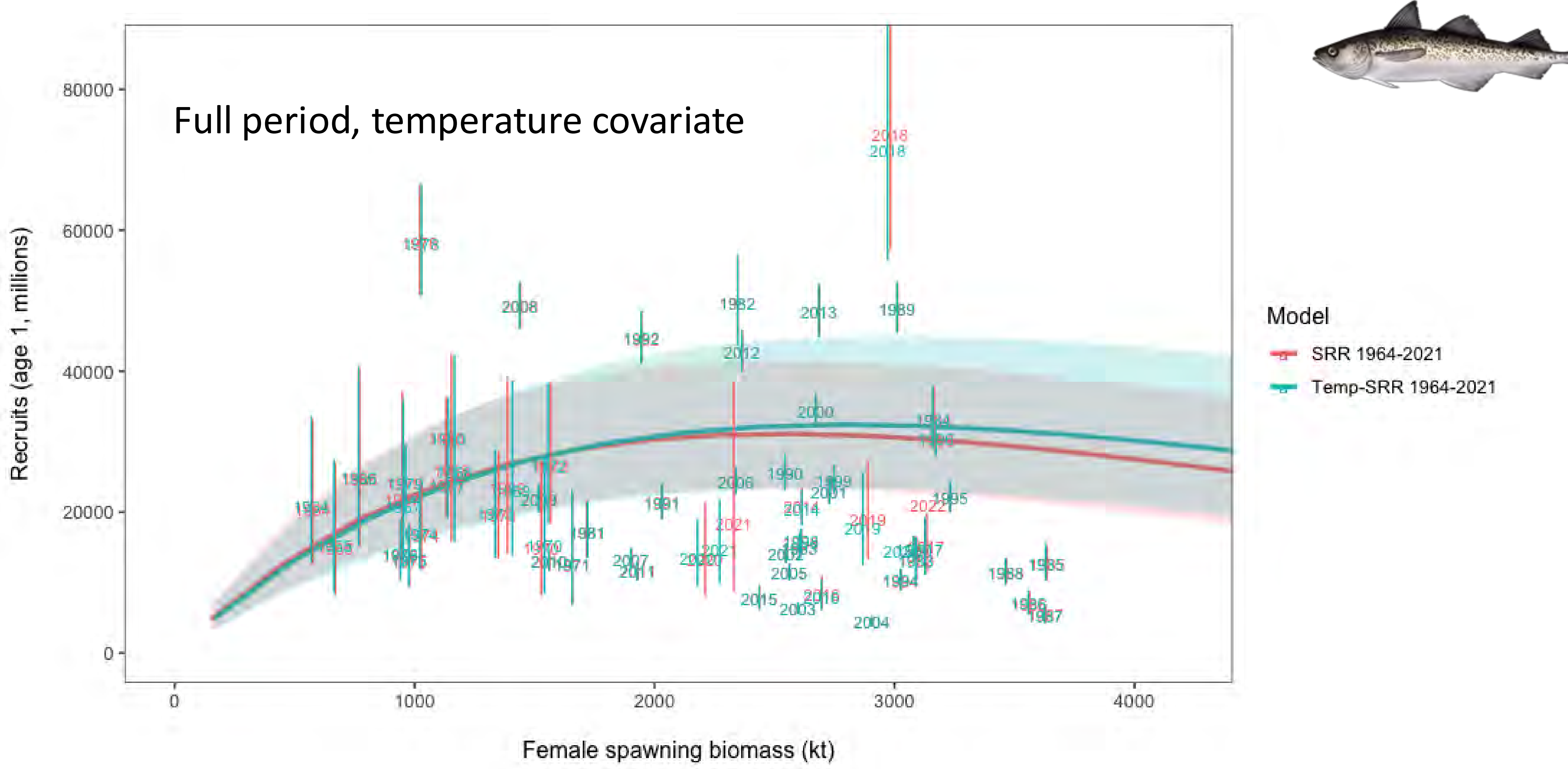
- Tier 1 versus Tier 3?

Stock-recruit relationship sensitivities

- Time series length
- Temperature
- Priors (on steepness)
- Form (e.g., Ricker versus Beverton-Holt)
- Selectivity
- σ_R

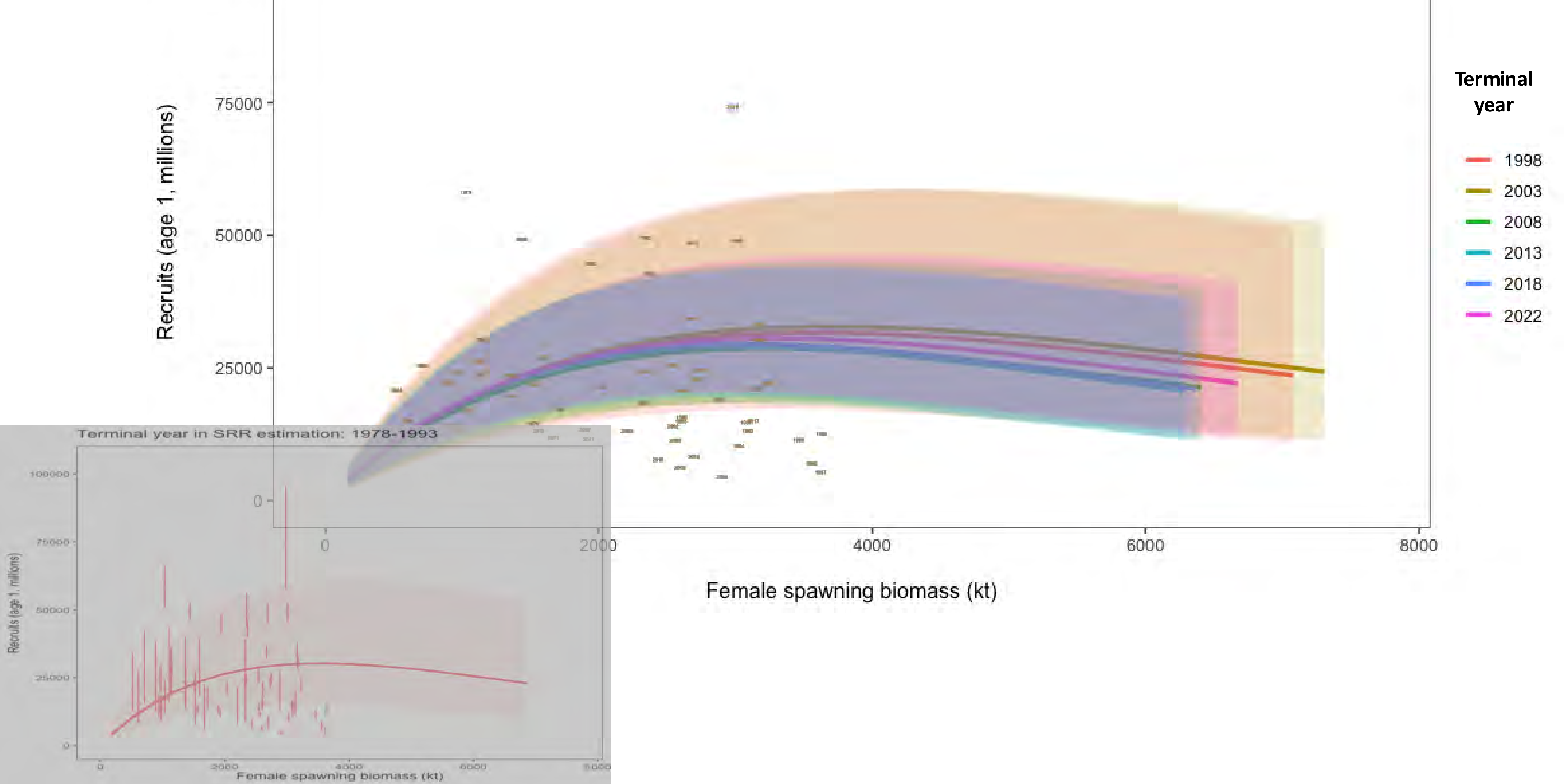


Shorter period model (SRR 1978-2021) compared to full time series

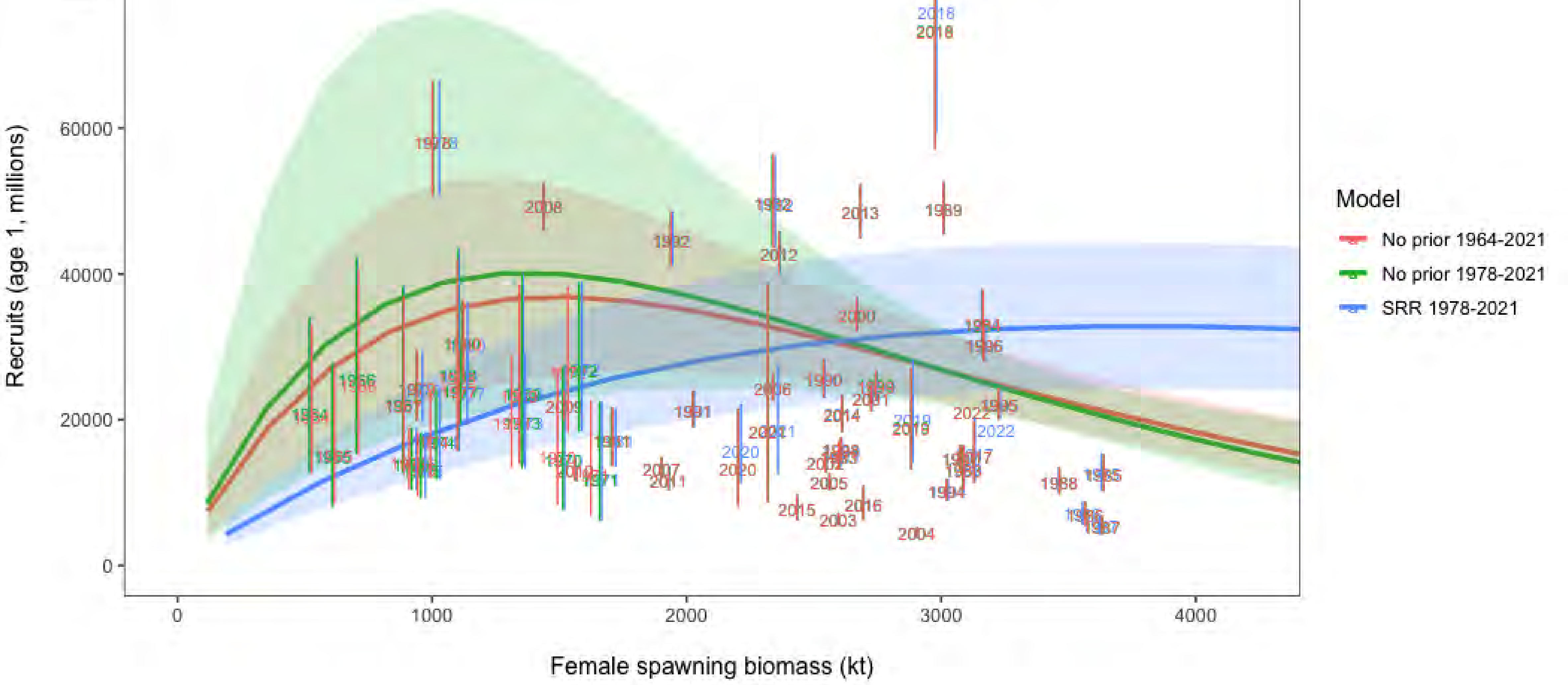


Model with and without temperature covariate

Terminal year impact

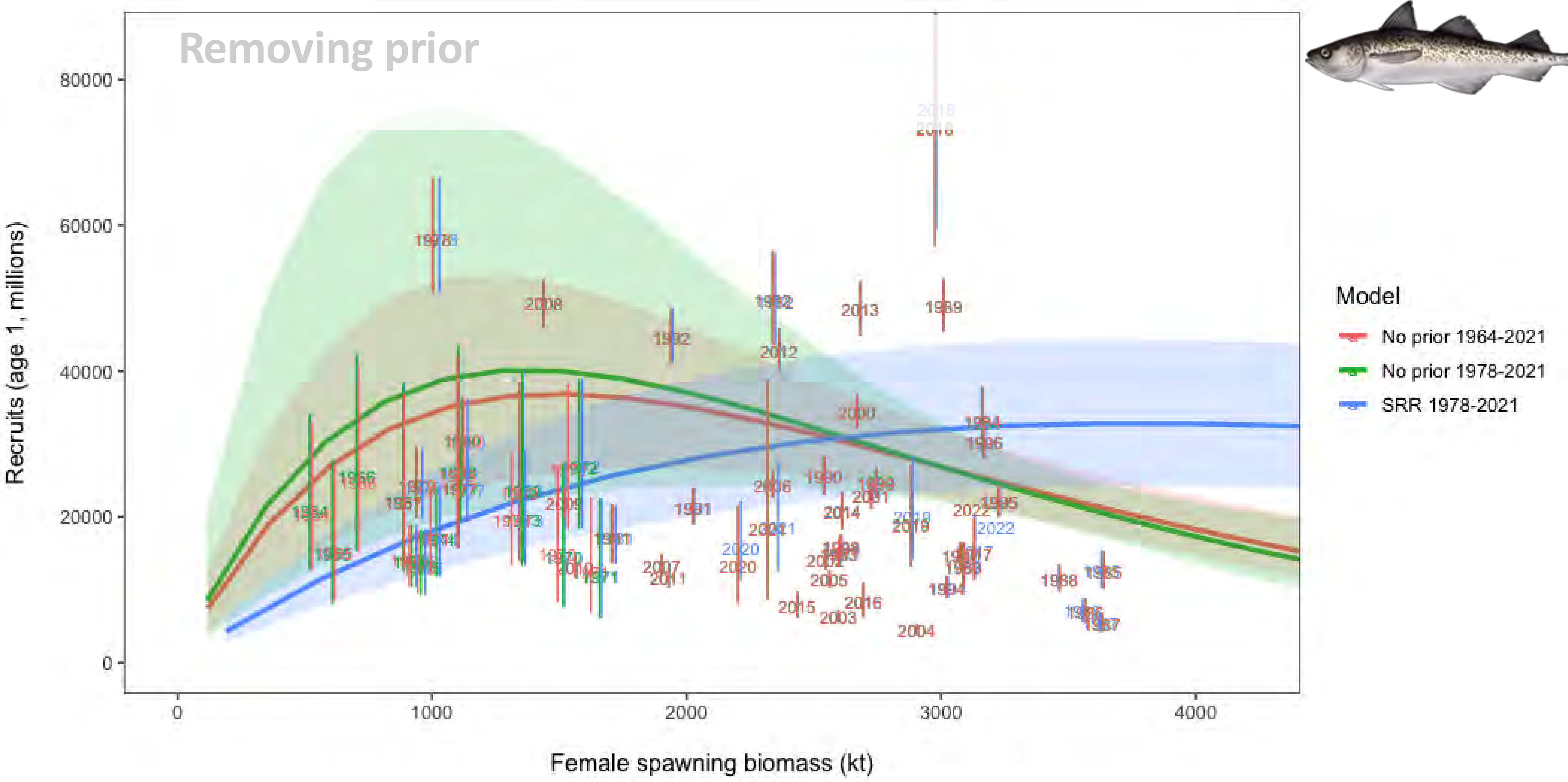


Removing prior



…and estimation period length

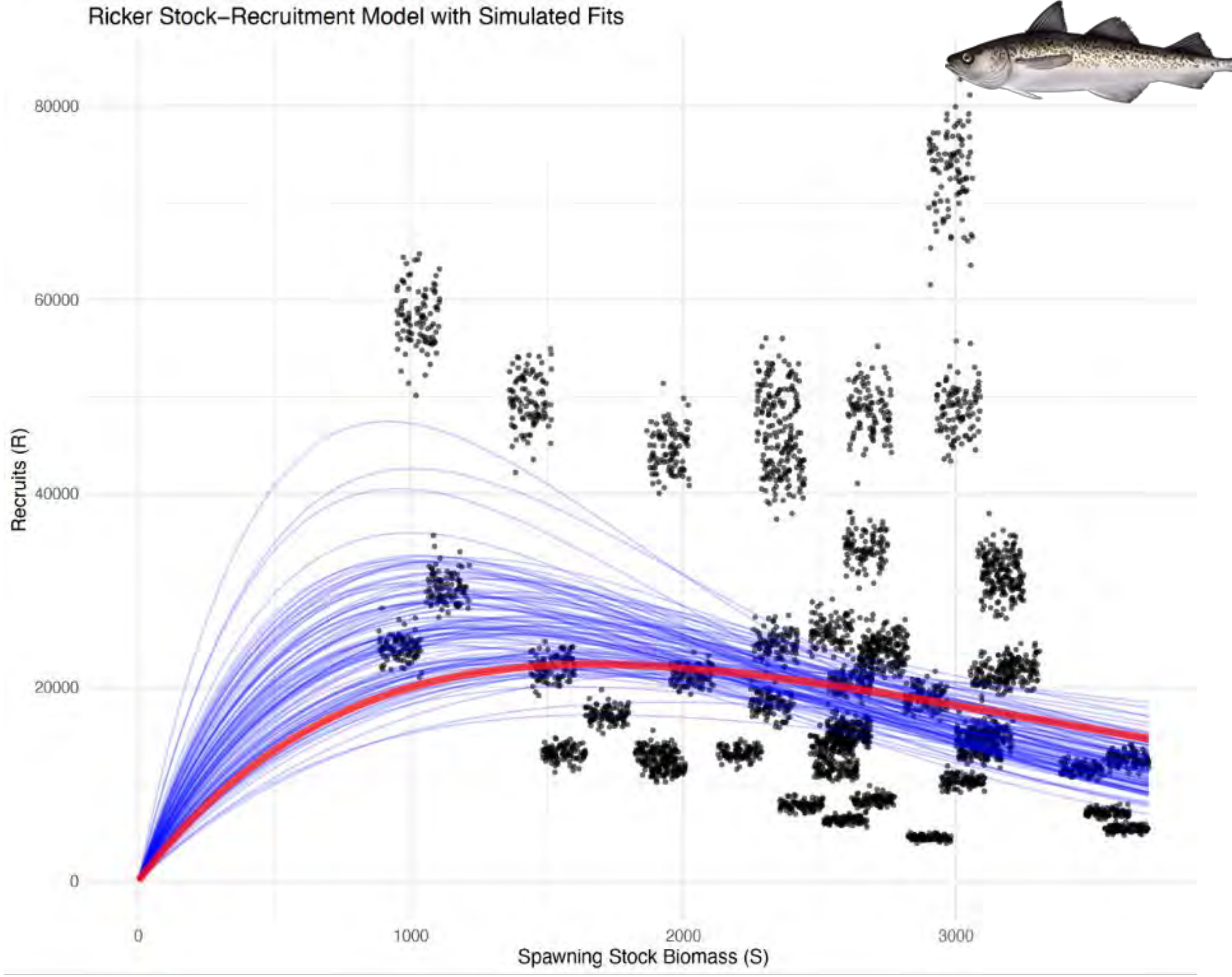
Removing prior



...and estimation period length

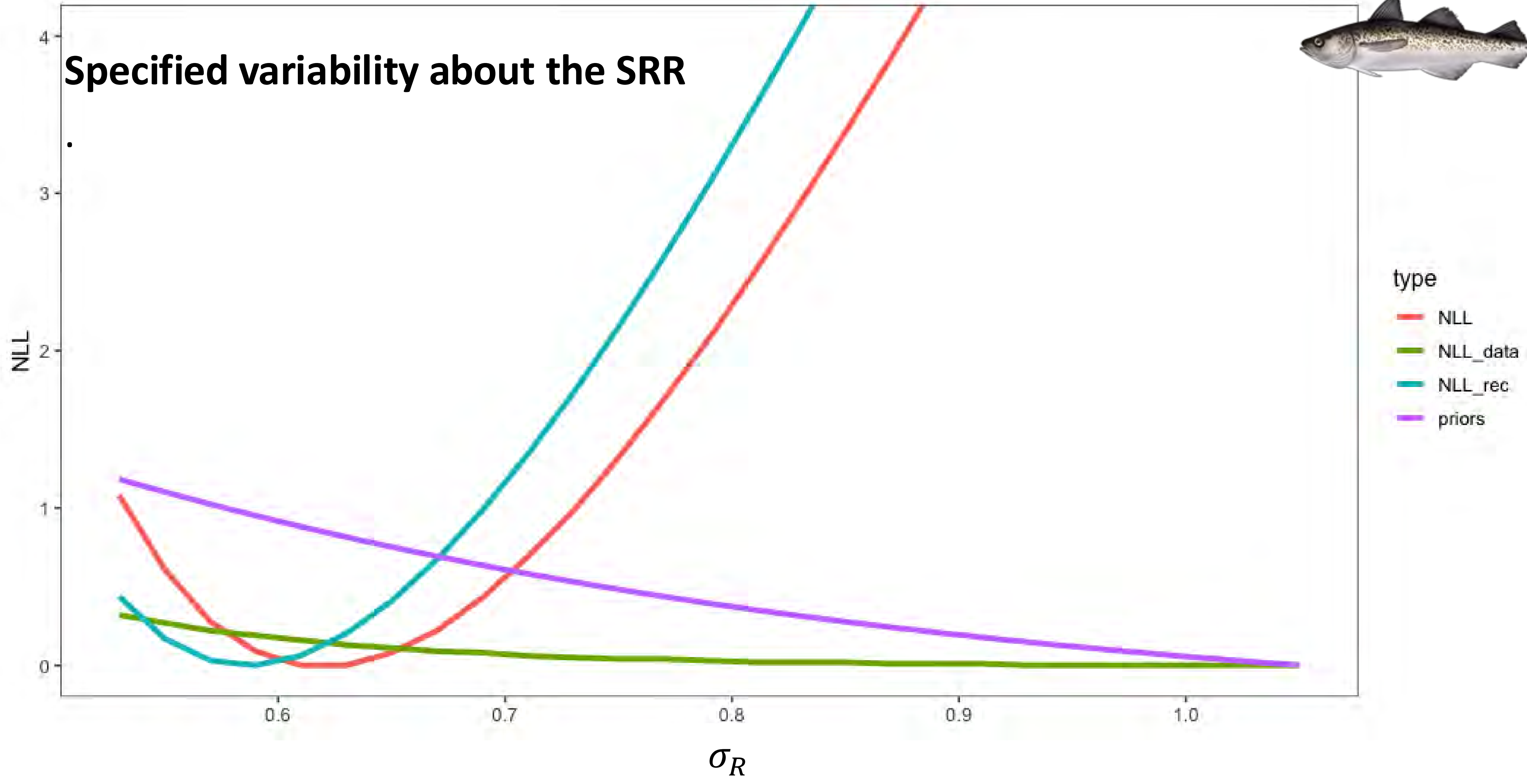
Simulation test

Red: original curve estimated
Dots: simulated random "data" used to fit blue curves

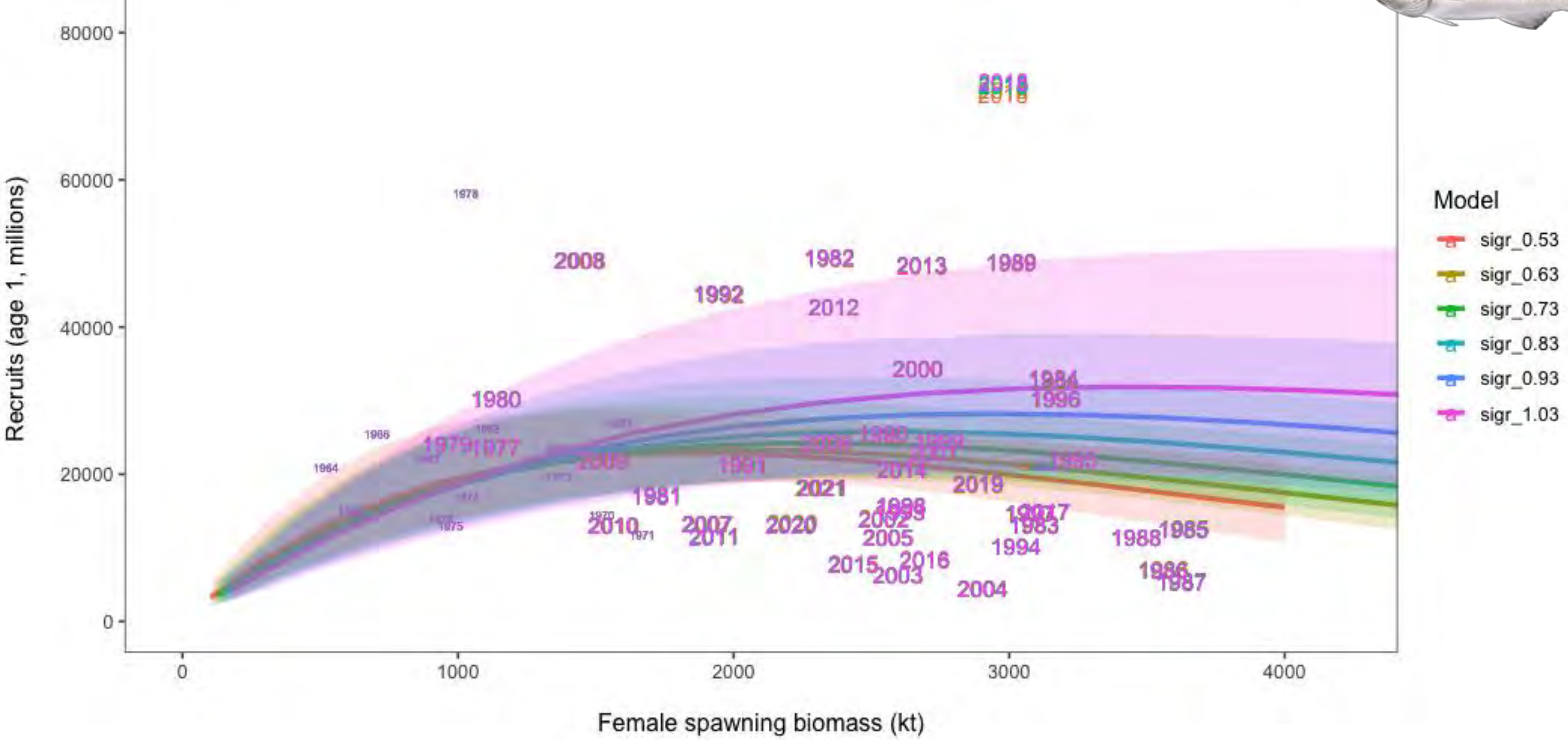


Specified variability about the SRR

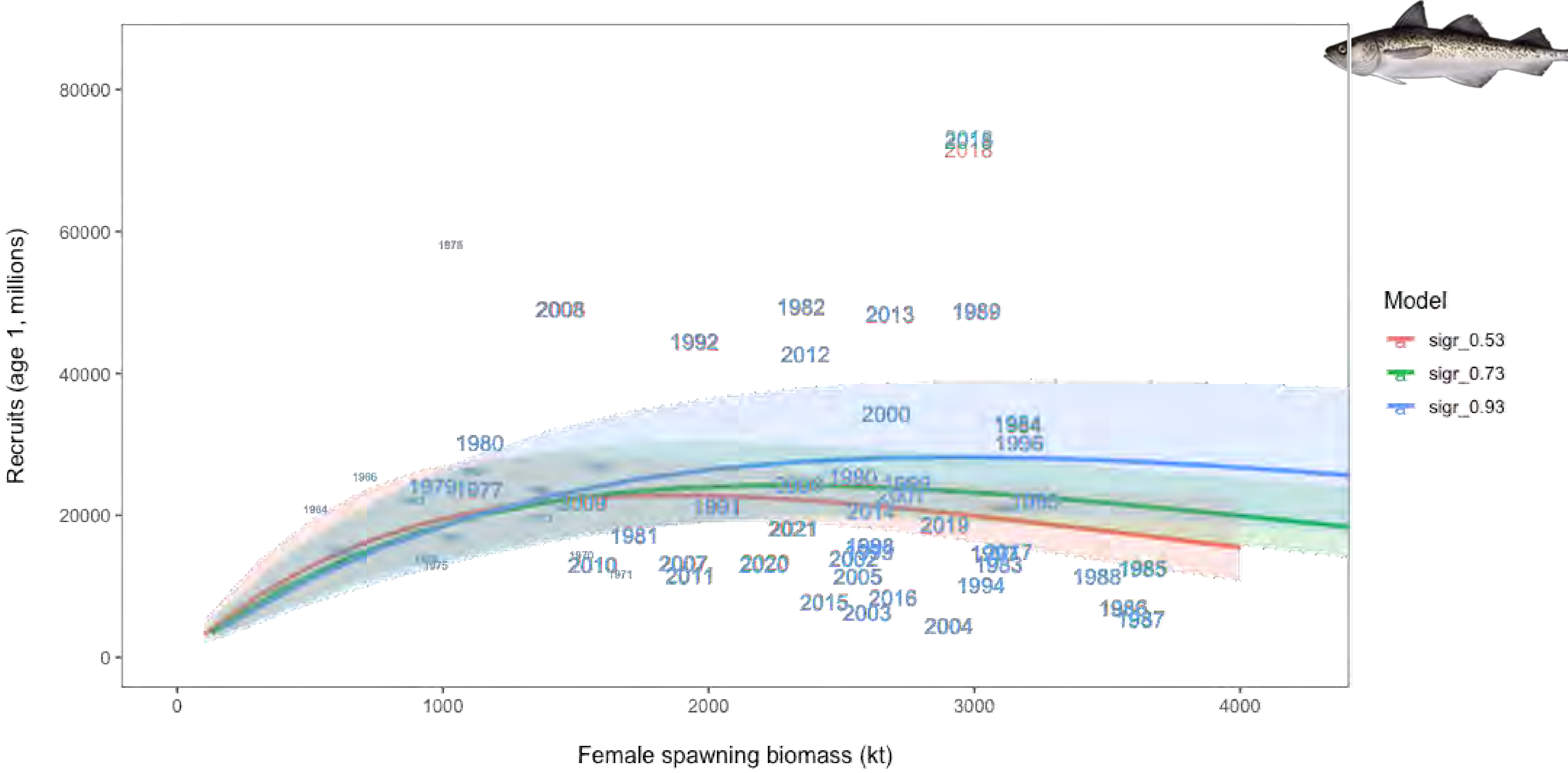
.



Negative log-likelihood profile of σ_R for the different components used to tune the model



SRR curves as estimated in the 2023 assessment for different fixed values of sigmaR.



SRR curves as estimated in the 2023 assessment for different fixed values of sigmaR.

Specified variability about the SRR

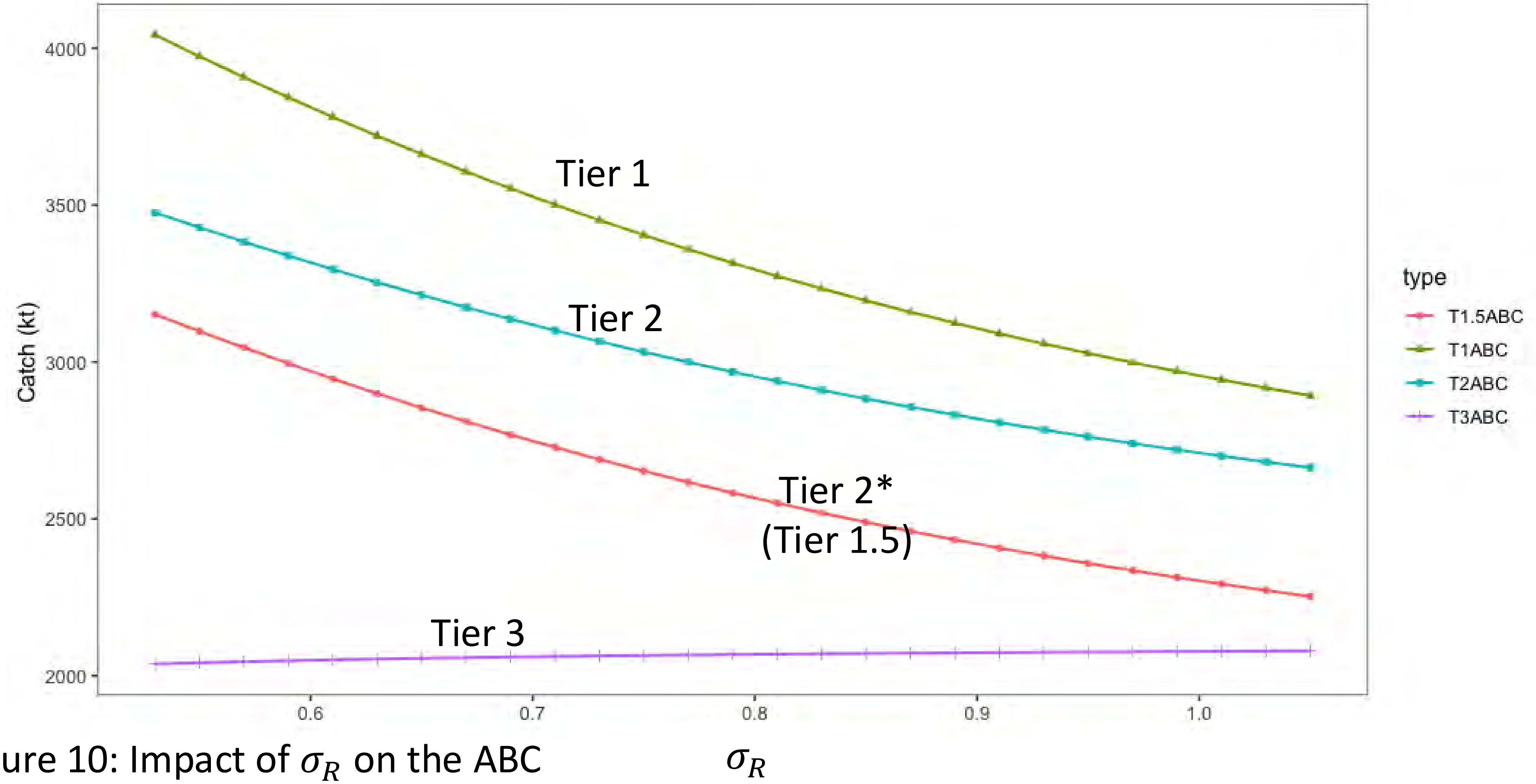


Figure 10: Impact of σ_R on the ABC values from the 2023 assessment.

Conditioning the stock-recruitment relationship to have F_{MSY} equal to $F_{35\%}$

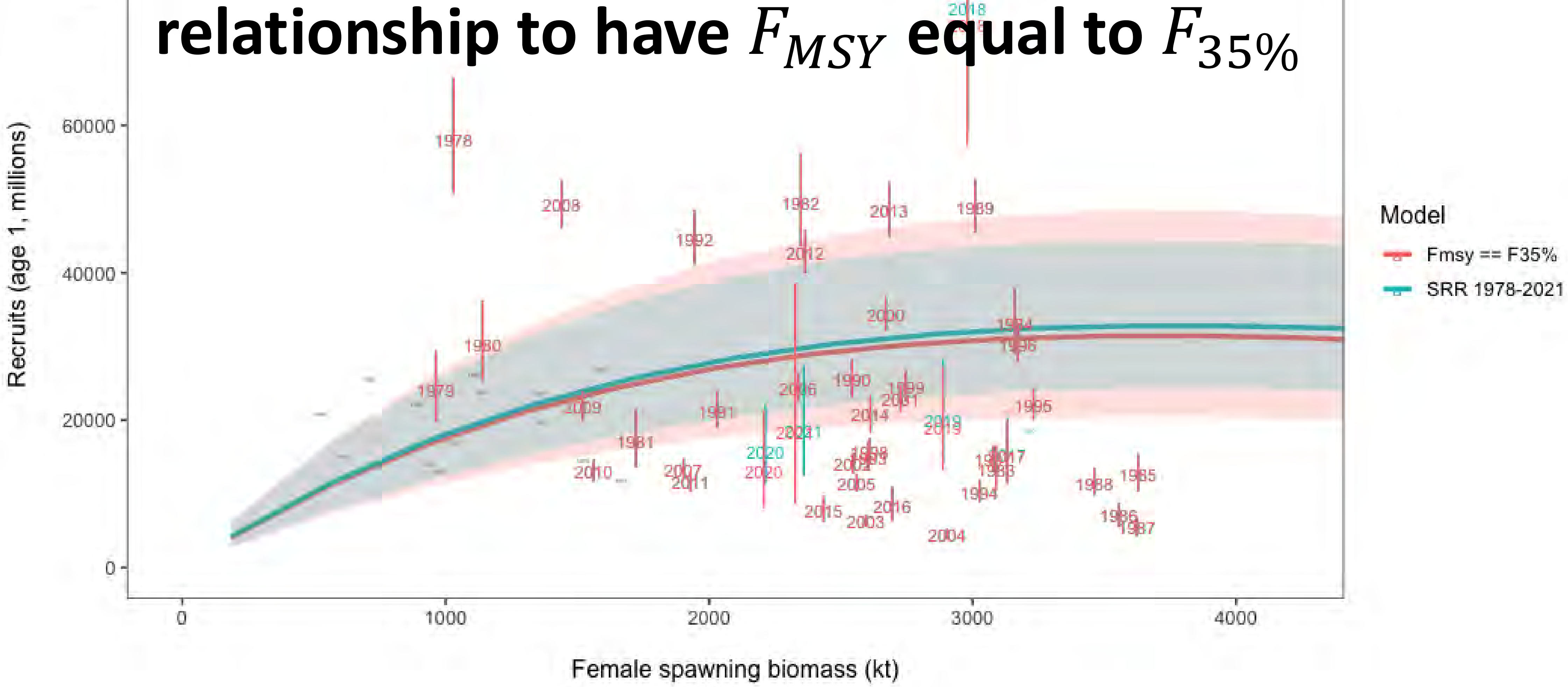
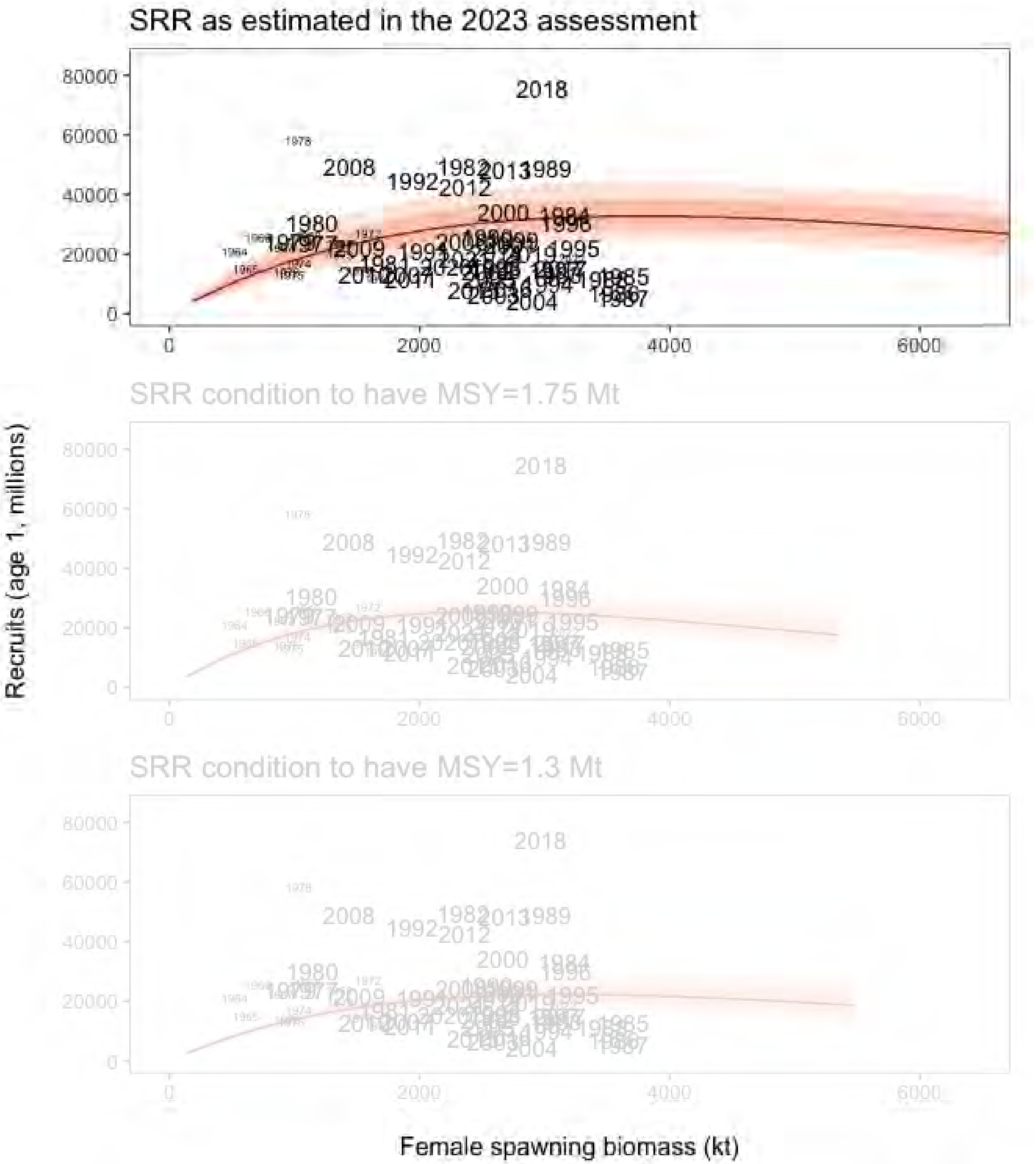


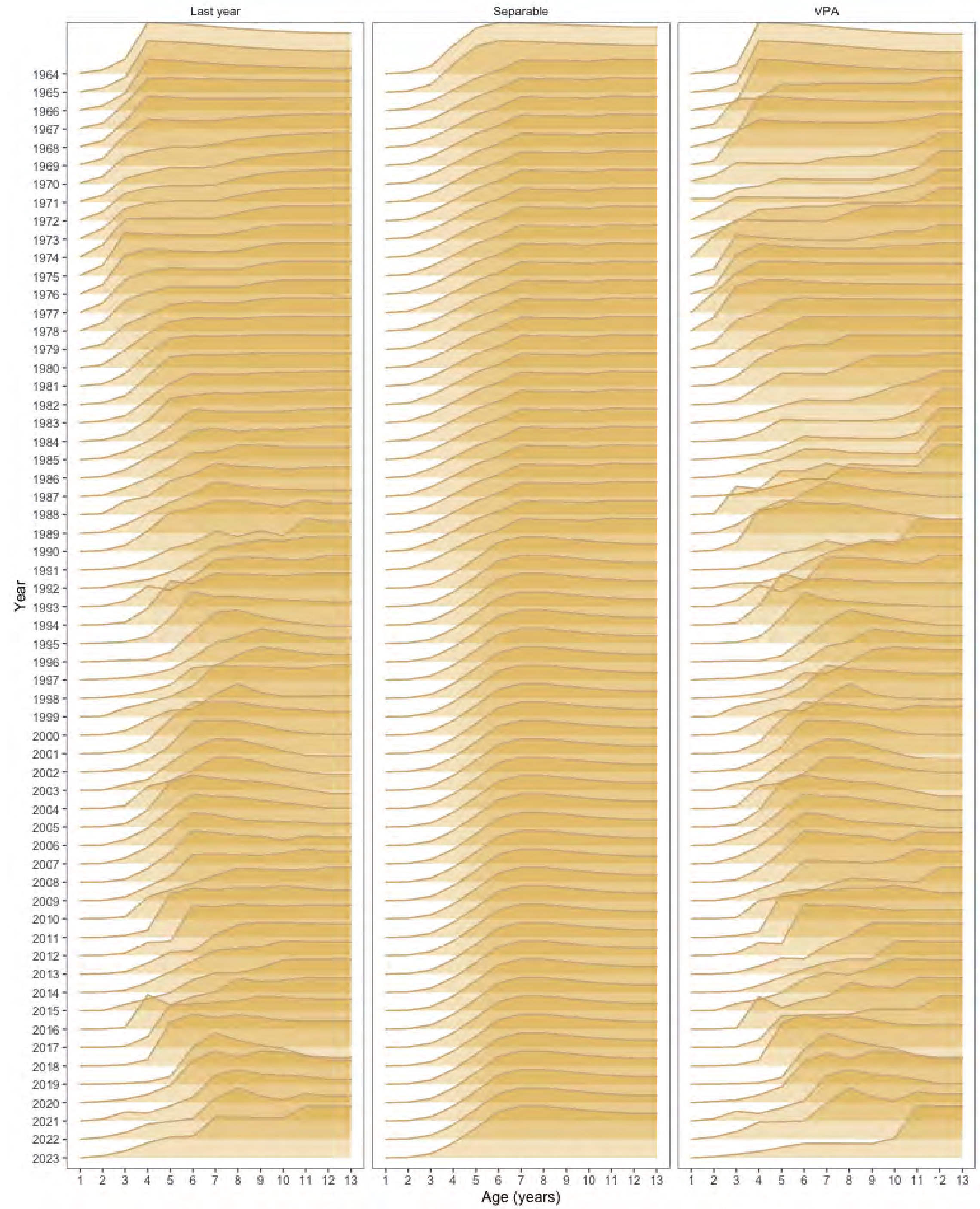
Figure 19: Model results comparing last year's selected model (SRR 1978-2021) with one where the SRR was conditioned such that F_{MSY} was equal to the SPR rate of F_{35}. The vertical bars represent the 95% confidence intervals for the age-1 recruitment.

Considerations of pollock and ecosystem role

Invert the question…what does a productivity curve look like if historical catches at F_{MSY} ?

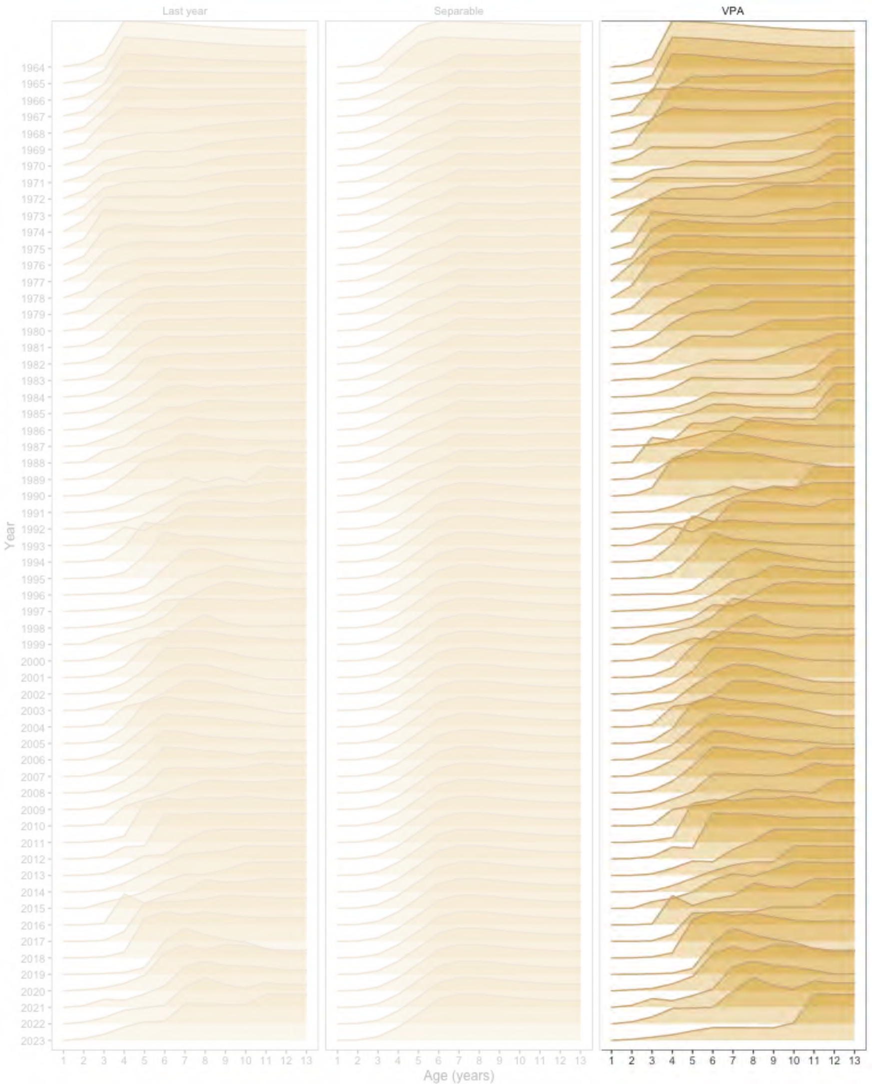


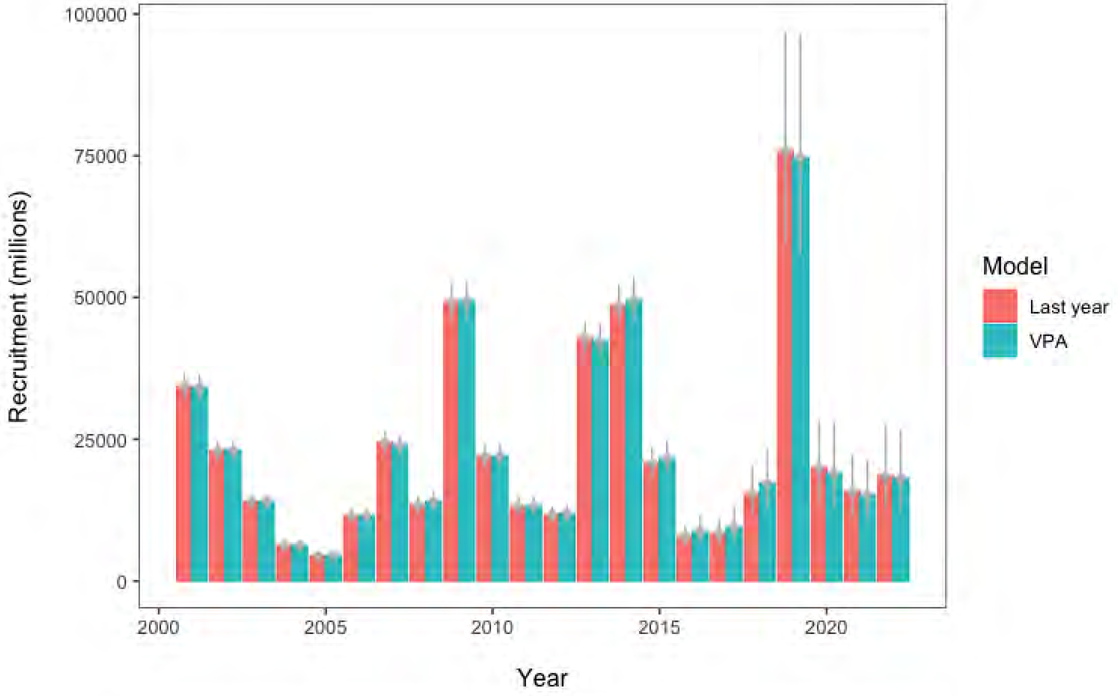
Evaluating the impact of selectivity assumptions on stock recruitment relationships (SRR)

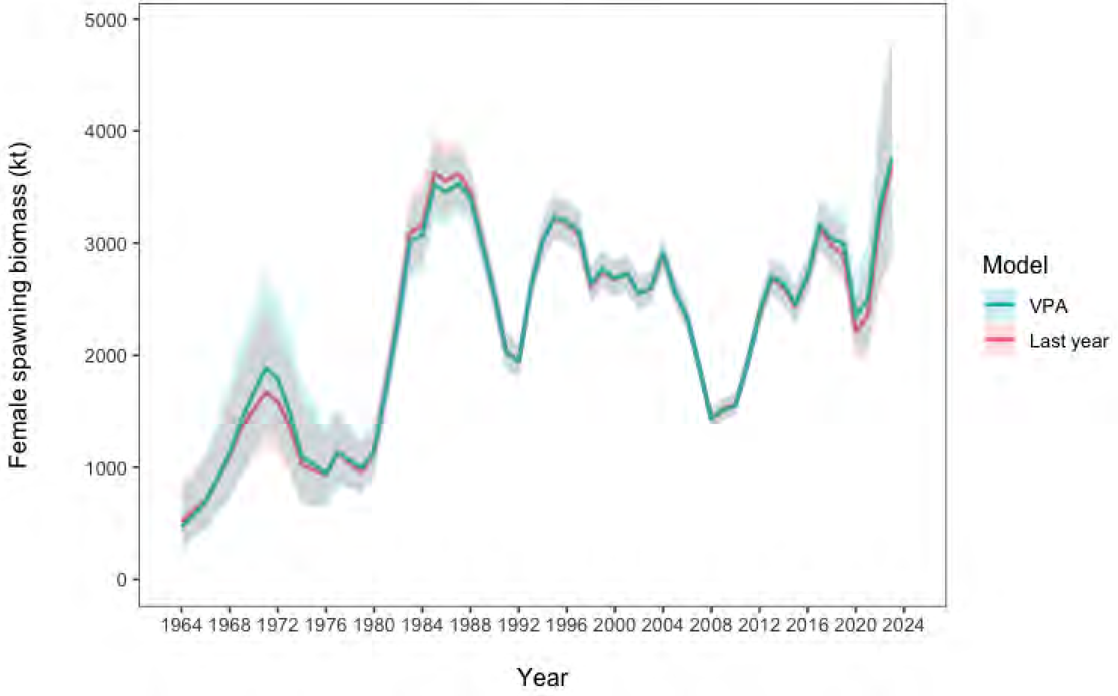


Selectivity-at-age patterns for three models: last-year's, separable, and VPA.

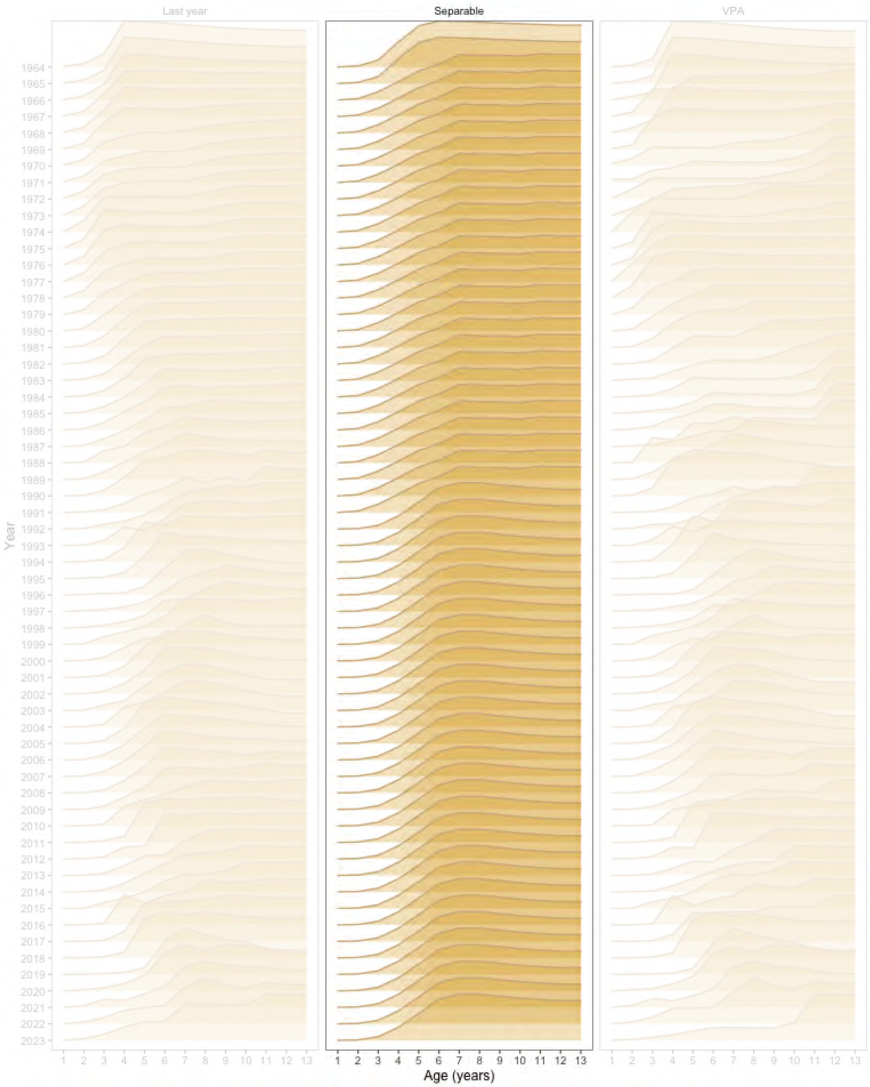
VPA-like versus 2023 model

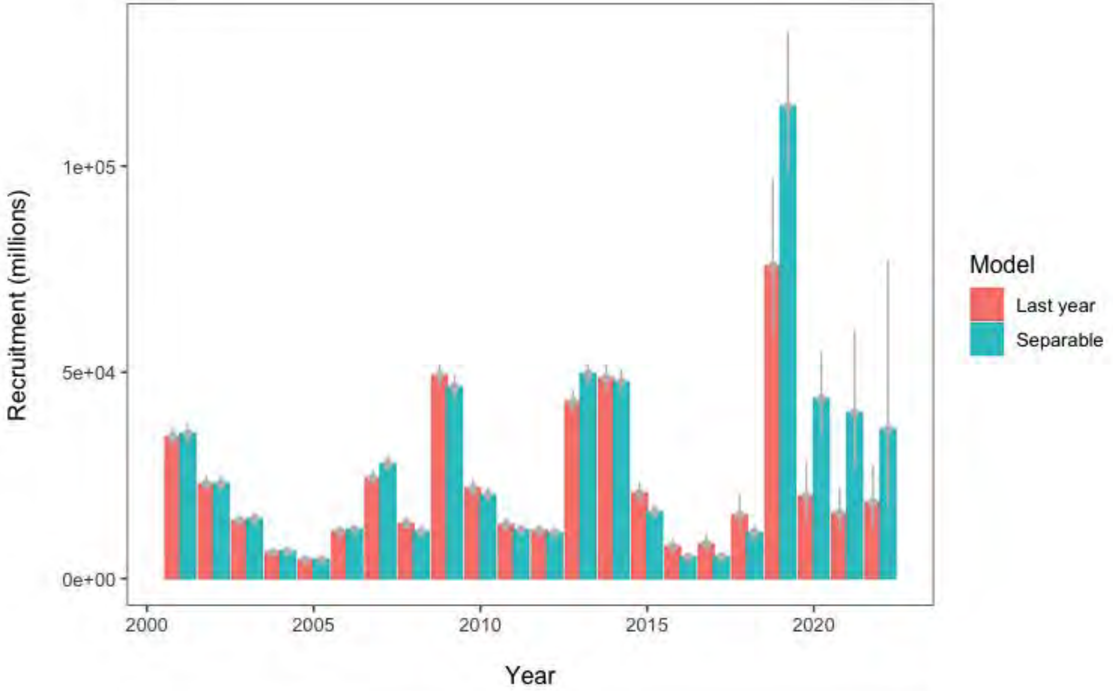


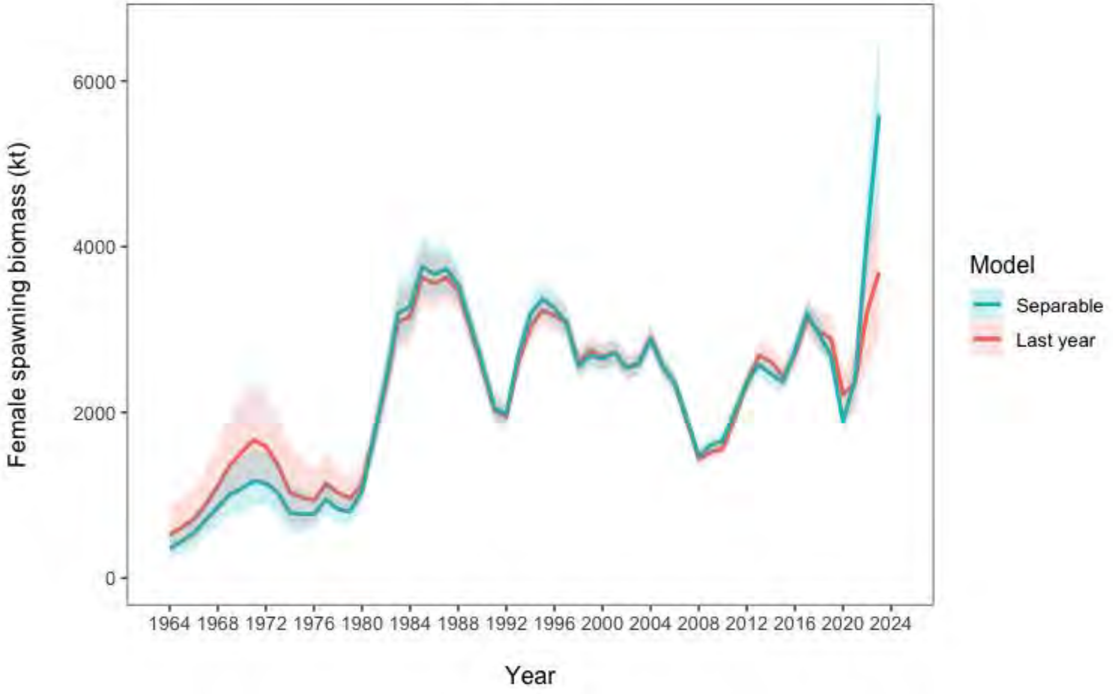


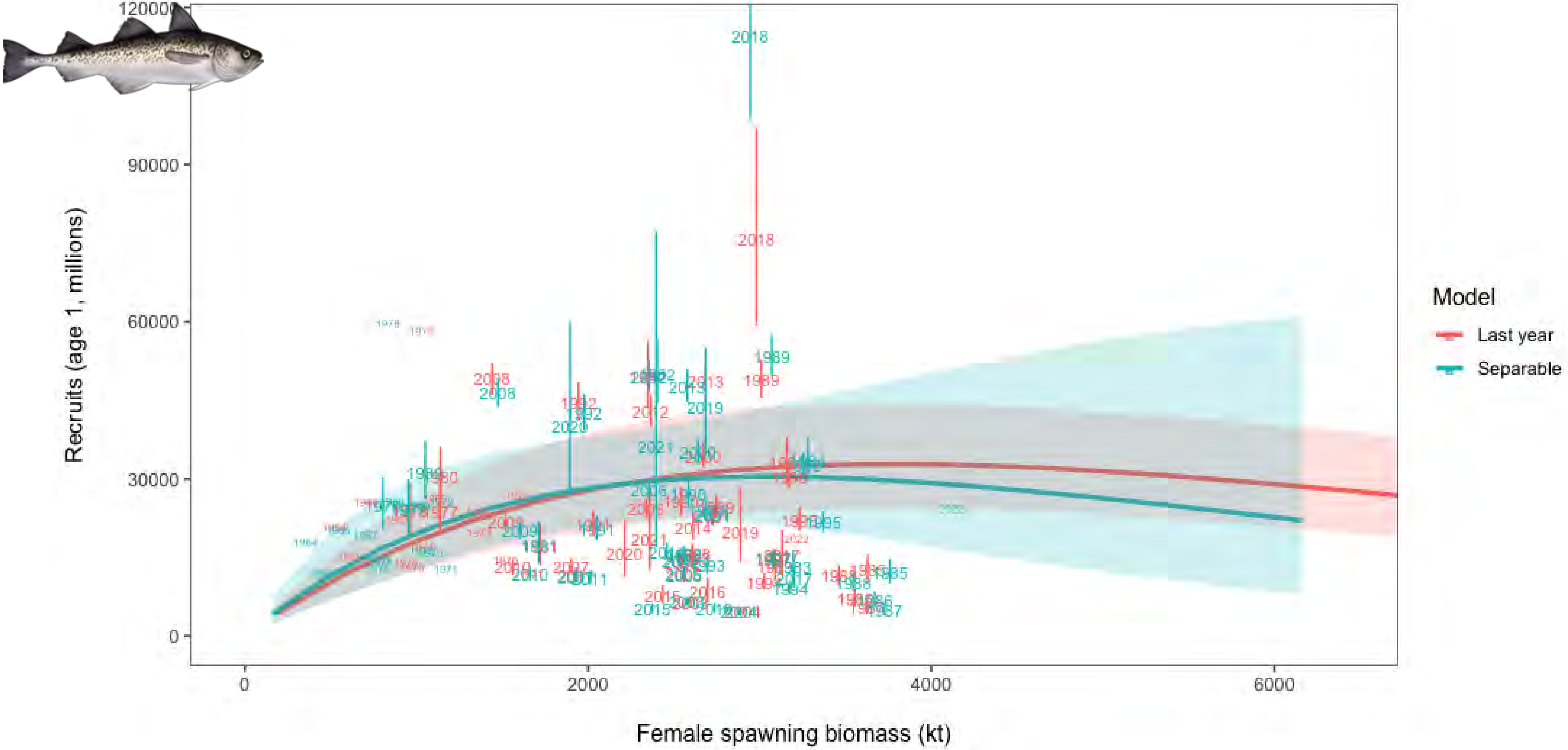


Separable versus 2023 model









Separable (constant fishery selectivity) indicates reduced uncertainty…

Summary

- Aspects of SRR suggest Tier 3 more appropriate
  - No fault of data extent, rather historical stock and recruitment estimates uninformative


¯_(ツ)_/¯

Tier 1 version

Quantity	As estimated or *specified last* year for: 2024	2025	As estimated or *recommended this* year for: 2025	2026
M (natural mortality rate, ages 3+)	0.3	0.3	0.3	0.3
Tier	1a	1a	1a	1a
Projected total (age 3+) biomass (t)	10,184,000 t	9,437,000 t	8,526,000 t	8,075,000 t
Projected female spawning biomass (t)	3,518,000 t	3,255,000 t	3,118,000 t	3,342,000 t
B_0	6,728,000 t	6,728,000 t	5,975,000 t	5,975,000 t
B_{msy}	2,689,000 t	2,689,000 t	2,310,000 t	2,310,000 t
F_{OFL}	0.422	0.422	0.523	0.523
$maxF_{ABC}$	0.379	0.379	0.443	0.443
F_{ABC}	0.33	0.33	0.402	0.402
OFL	3,162,000 t	3,449,000 t	4,383,000 t	3,785,000 t
$maxABC$	2,837,000 t	3,095,000 t	3,715,000 t	3,209,000 t
ABC	2,313,000 t	2,401,000 t	2,417,000 t	2,036,000 t
Status	2022	2023	2023	2024
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

Tier 3 version

Quantity	As estimated or *specified last* year for: 2024	2025	As estimated or *recommended this* year for: 2025	2026
M (natural mortality rate, ages 3+)	0.3	0.3	0.3	0.3
Tier	1a	1a	3a	3a
Projected total (age 3+) biomass (t)	10,184,000 t	9,437,000 t	8,526,000 t	8,075,000 t
Projected female spawning biomass (t)	3,518,000 t	3,255,000 t	3,118,000 t	3,342,000 t
B_0	6,728,000 t	6,728,000 t	5,902,000 t	5,902,000 t
B_{msy}	2,689,000 t	2,689,000 t	2,066,000 t	2,066,000 t
F_{OFL}	0.422	0.422	0.513	0.513
$maxF_{ABC}$	0.379	0.379	0.394	0.394
F_{ABC}	0.33	0.33	0.394	0.394
OFL	3,162,000 t	3,449,000 t	2,957,000 t	2,496,000 t
$maxABC$	2,837,000 t	3,095,000 t	2,417,000 t	2,036,000 t
ABC	2,313,000 t	2,401,000 t	2,417,000 t	2,036,000 t
Status	2022	2023	2023	2024
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No