Dusky Rockfish
GOA Groundfish Plan Team

Ben Williams, Pete Hulson, Chris Lunsford, and Bridget Ferriss

November, 2022

Teams or SSC Comments

- *The Team recommends all GOA authors evaluate any bottom trawl survey information used in their assessment prior to 1990 including the 1984 and 1987 surveys and conduct sensitivity analyses to evaluate their usefulness to the assessment" (PT, November 2021)*
  - The 1980s survey data has been removed – iterative model evaluations were completed.

- *"...Finally, the SSC requests that design-based estimates of survey biomass be included in comparisons with VAST model estimates.*
  The SSC requests the assessment author justify the use of the new parameterization of VAST specifically as it relates to dusky rockfish. Past SSC discussions regarding the general implementation of VAST in assessments precluded a highly prescriptive approach and specifically recommended allowing for some species-specific adaptations of the VAST framework "(October 2020)
  - A suite of VAST parameterizations, associated diagnostics and design-based survey estimates have been explored and are provided as an appendix. The author's recommended model uses a lognormal error model instead of the GAP default model.

- *"The SSC registers concern with the large positive retrospective pattern in the recommended model and suggests that further investigation of this be a very high priority." (January 2020)*
  - Issues with the retrospective pattern are addressed with the author's recommended model, changing the Mohn's rho value from 0.51 to -0.123.

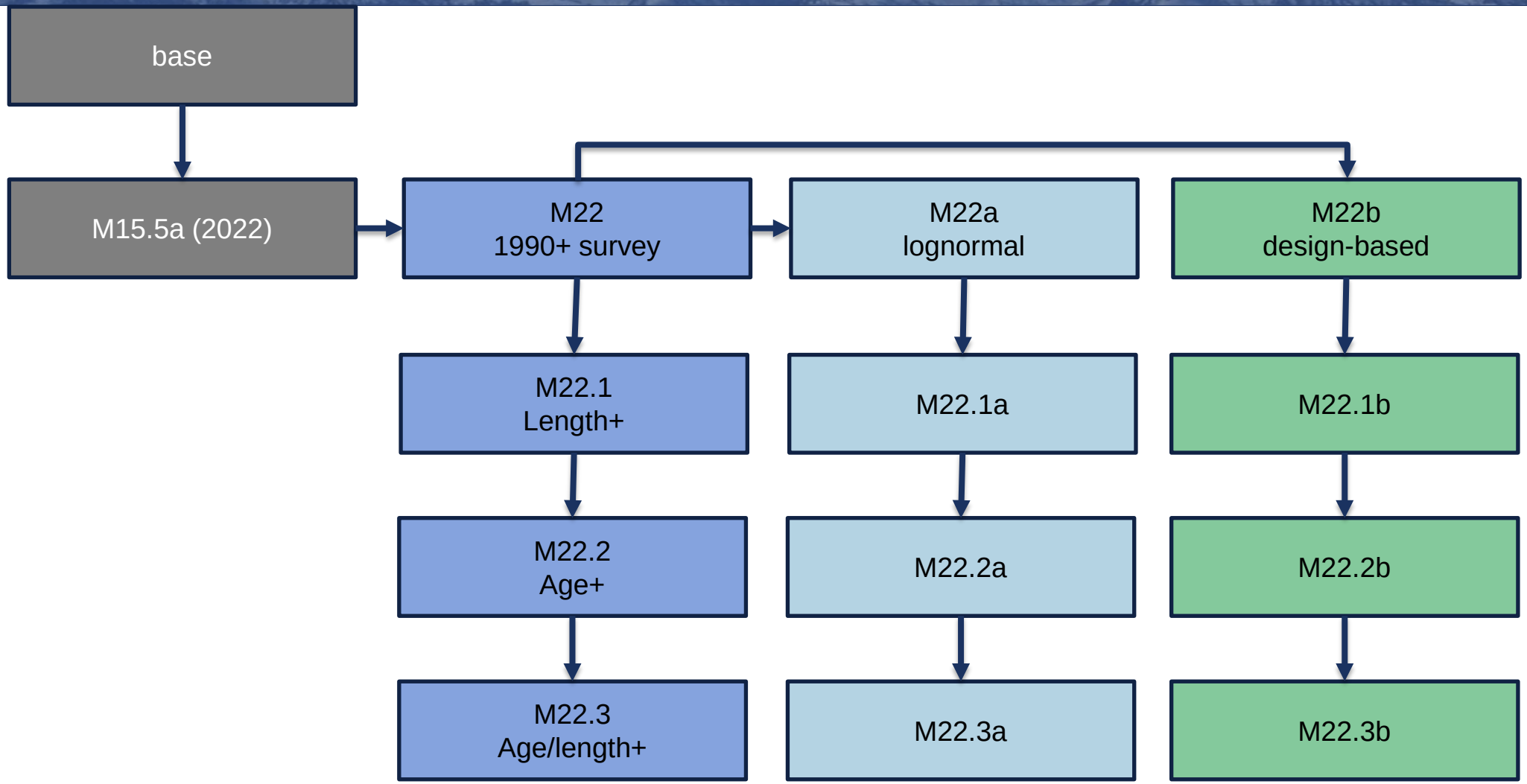
Data Summary

Source	Data	Years
NMFS Groundfish survey	Survey biomass	1990-1999 (triennial), 2001-2019 (biennial), **2021**
	Age composition	1990-1999 (triennial), 2003-2019 (biennial), **2021**
U.S. trawl fishery	Catch	1961-2020, **2021-2022**
	Age composition	1998-2002, 2004-2006, 2008-2018 (biennial), **2020**
	Length composition	1991-1997, 2003, 2007-2019 (biennial), **2021**

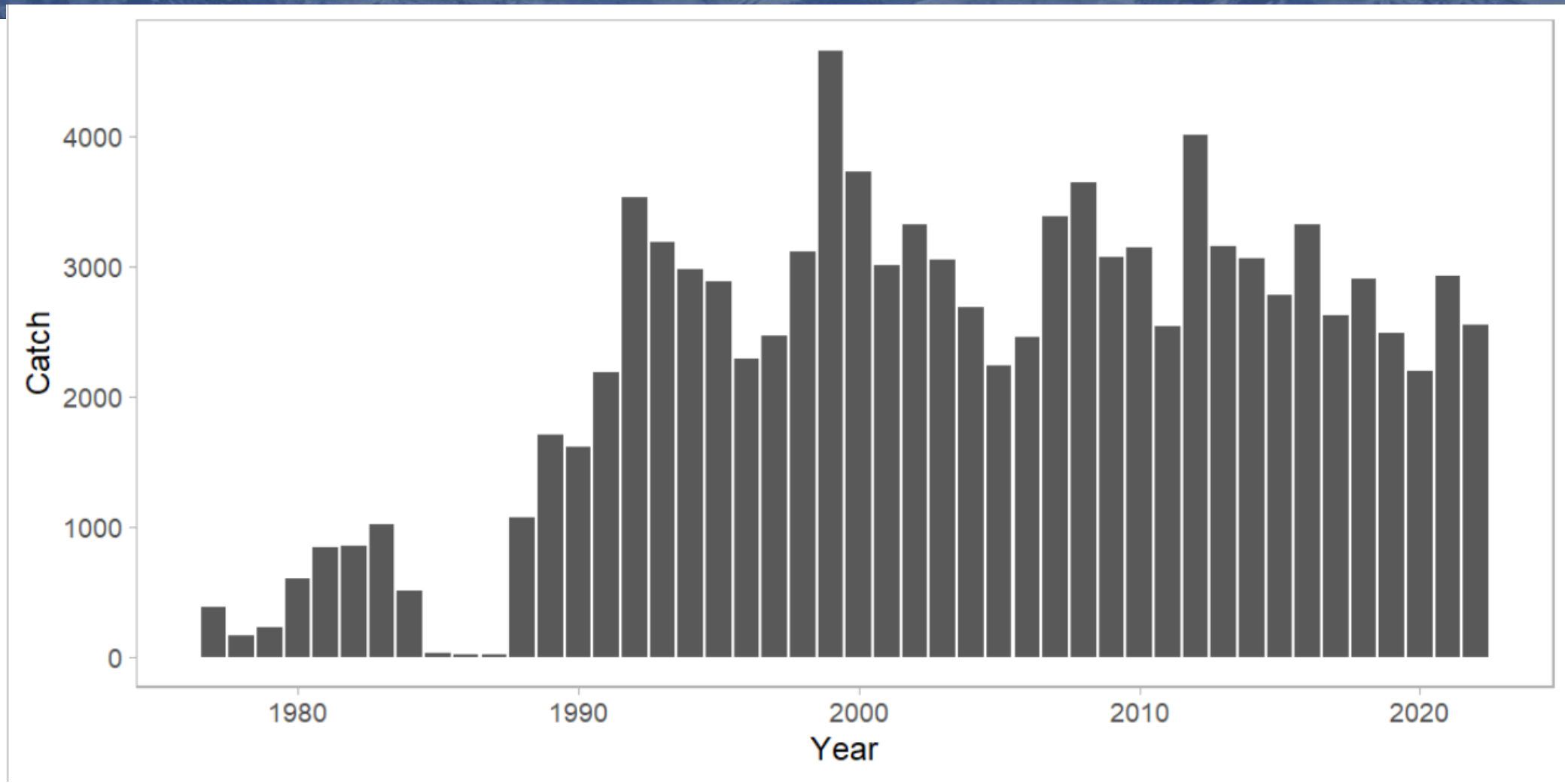
Model Variants

Model	Description
base	2020 model (m15.5a) and results (includes 1980s survey data)
m15.5a	base model w/data updated through 2022, using GAP default VAST
m22	**m15.5a using GAP default VAST (survey data 1990+)**
m22.1	m22 w/increased length plus group
m22.2	m22 w/increased age plus group
m22.3	m22 w/increased age & length plus groups
m22a	m22 using lognormal error VAST (survey data 1990+)
m22.1a	M22.1 w/lognormal VAST
m22.2a	M22.2 w/lognormal VAST
m22.3a	M22.3 w/lognormal VAST
m22b	m22 using design-based survey abundance (1990+)
m22.1b	M22.1 w/db survey
m22.2b	M22.2 w/db survey
m22.3b	M22.3 w/db survey

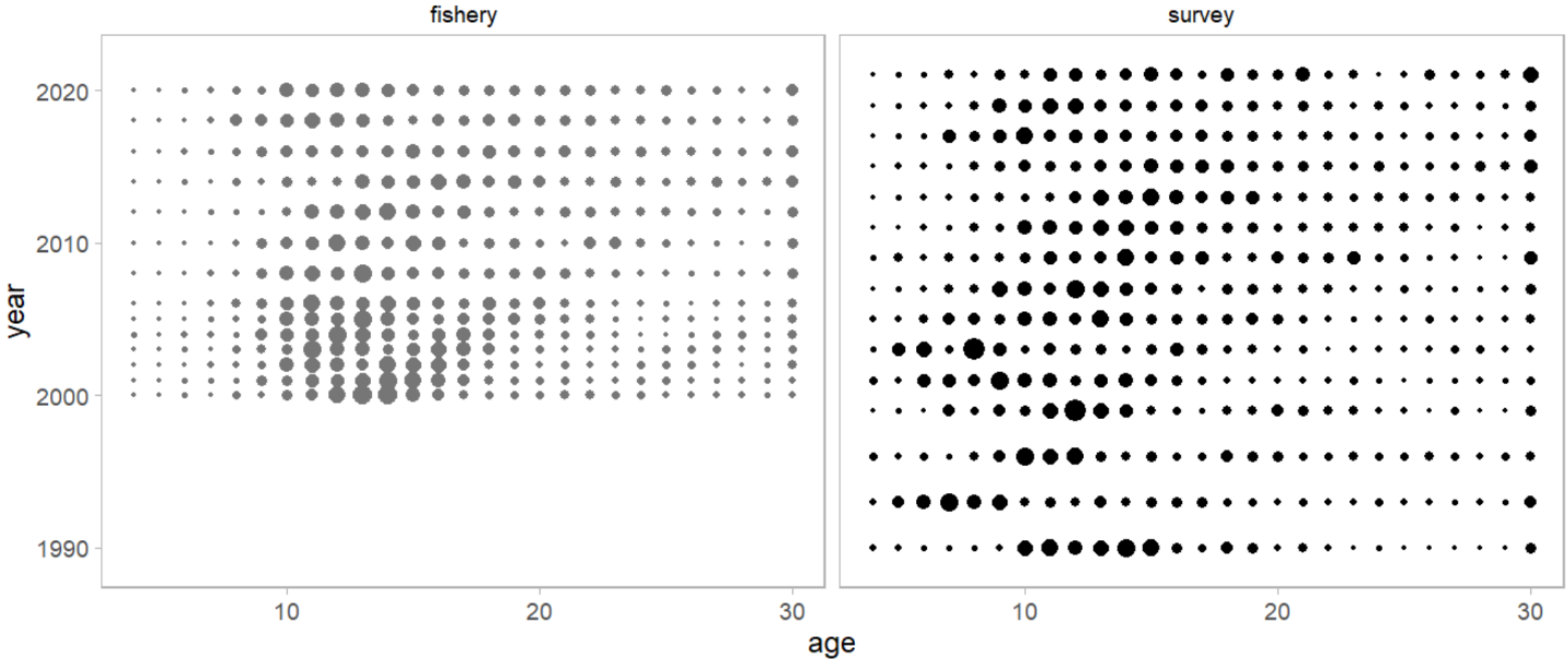
Model Variants



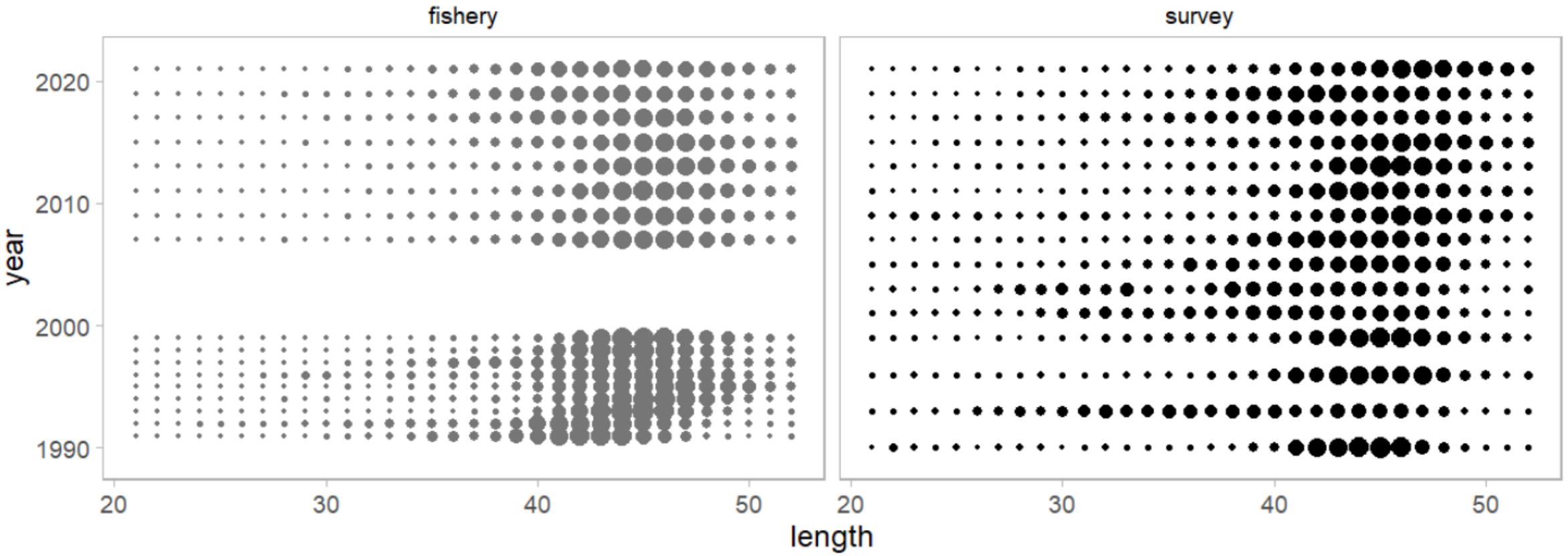
Inputs - Catch



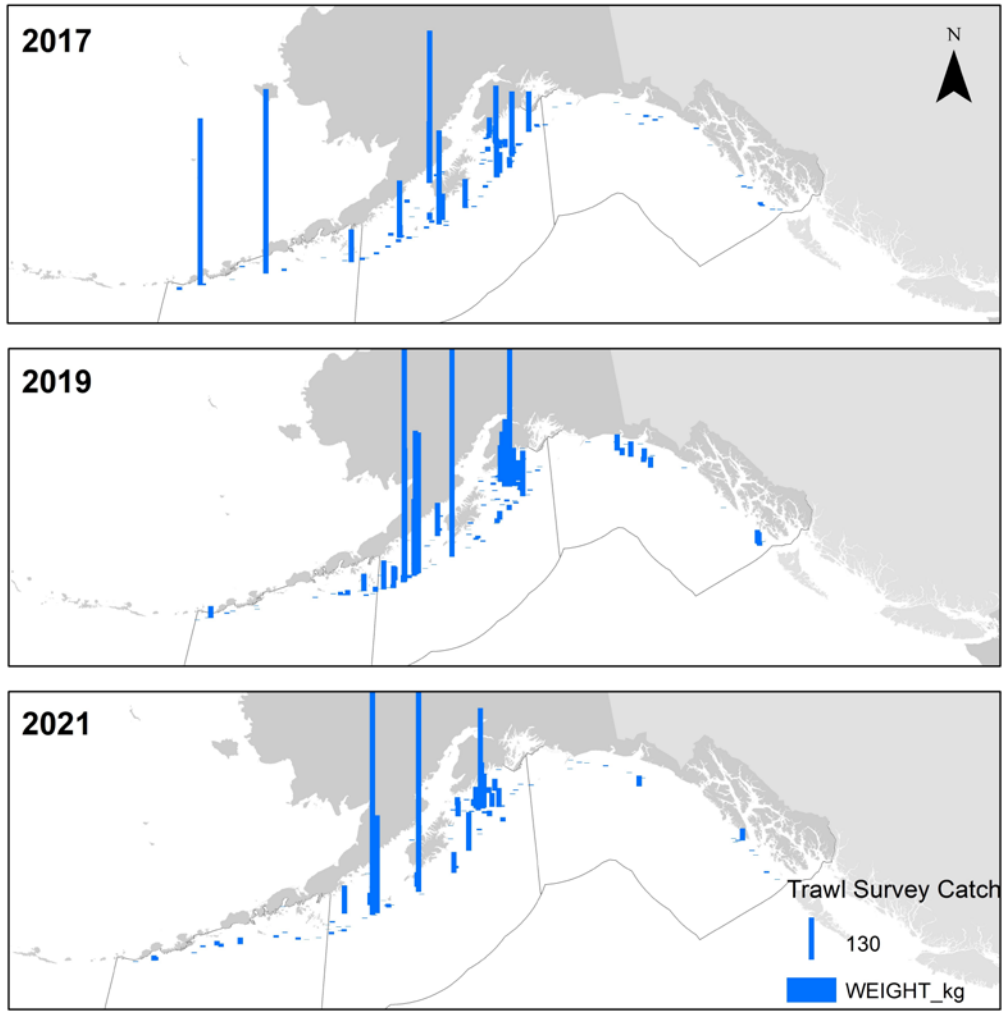
Inputs -Age Composition



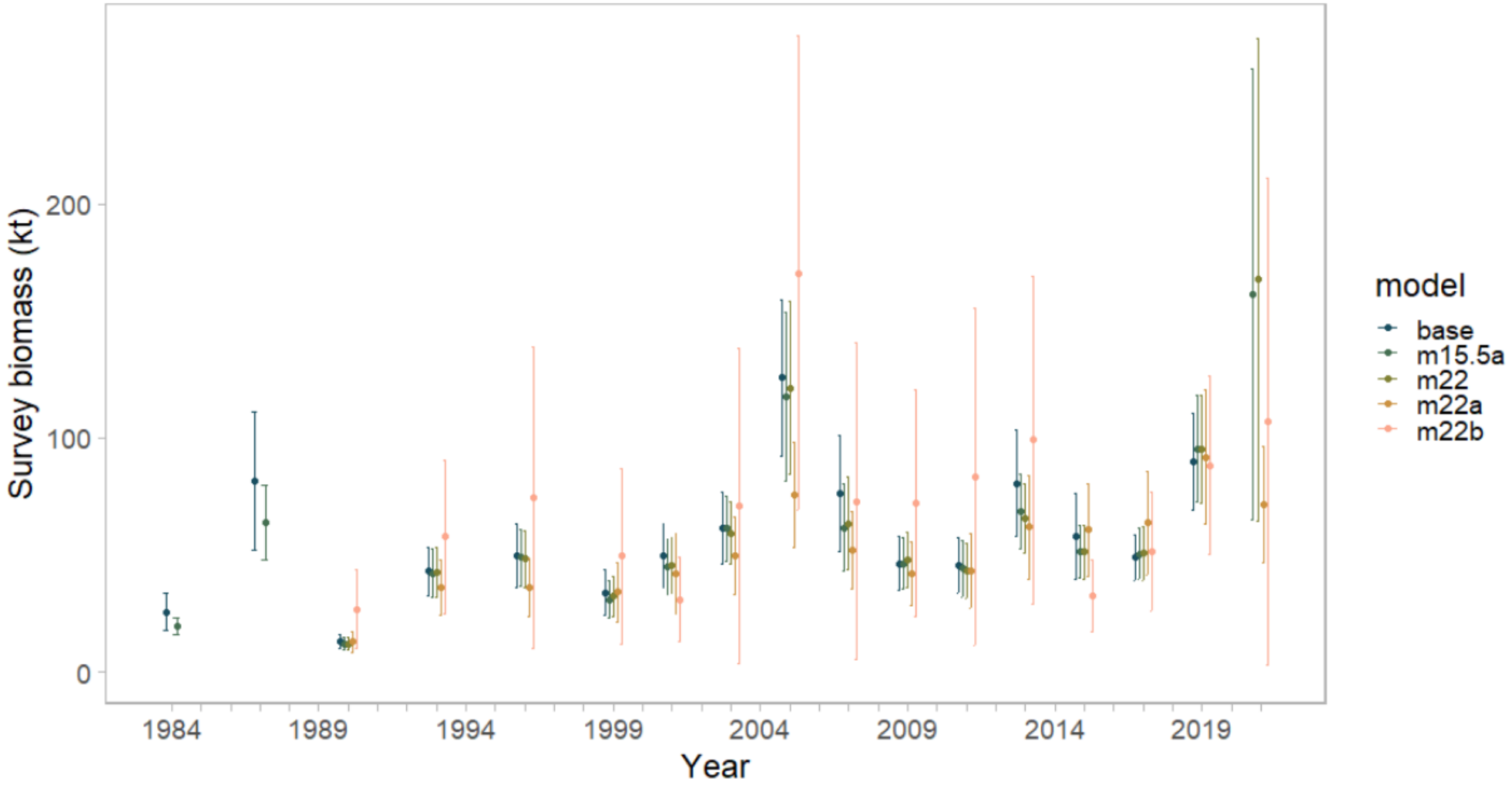
Inputs - Size Composition



Inputs - GOA Bottom Trawl Survey



Inputs - GOA Bottom Trawl Survey



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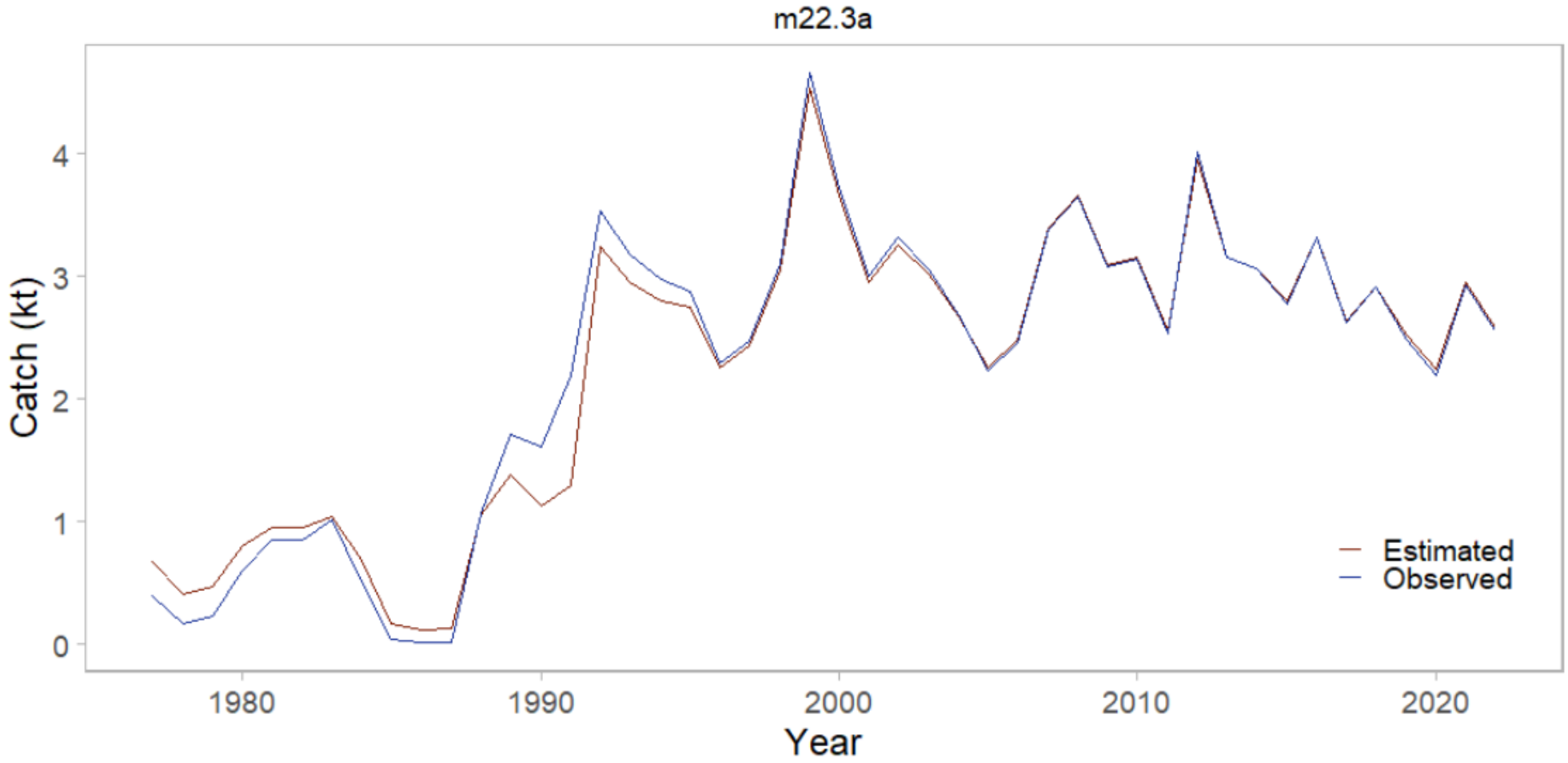
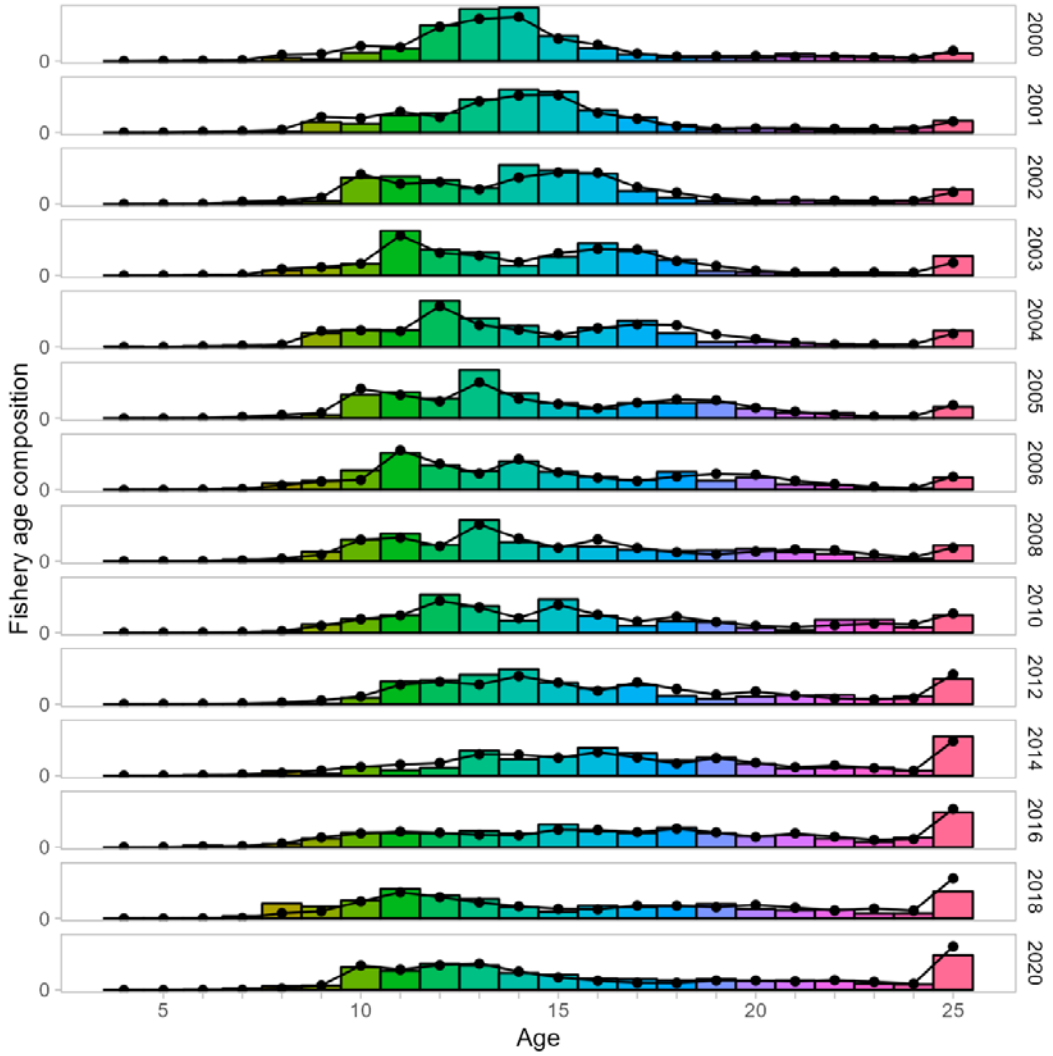
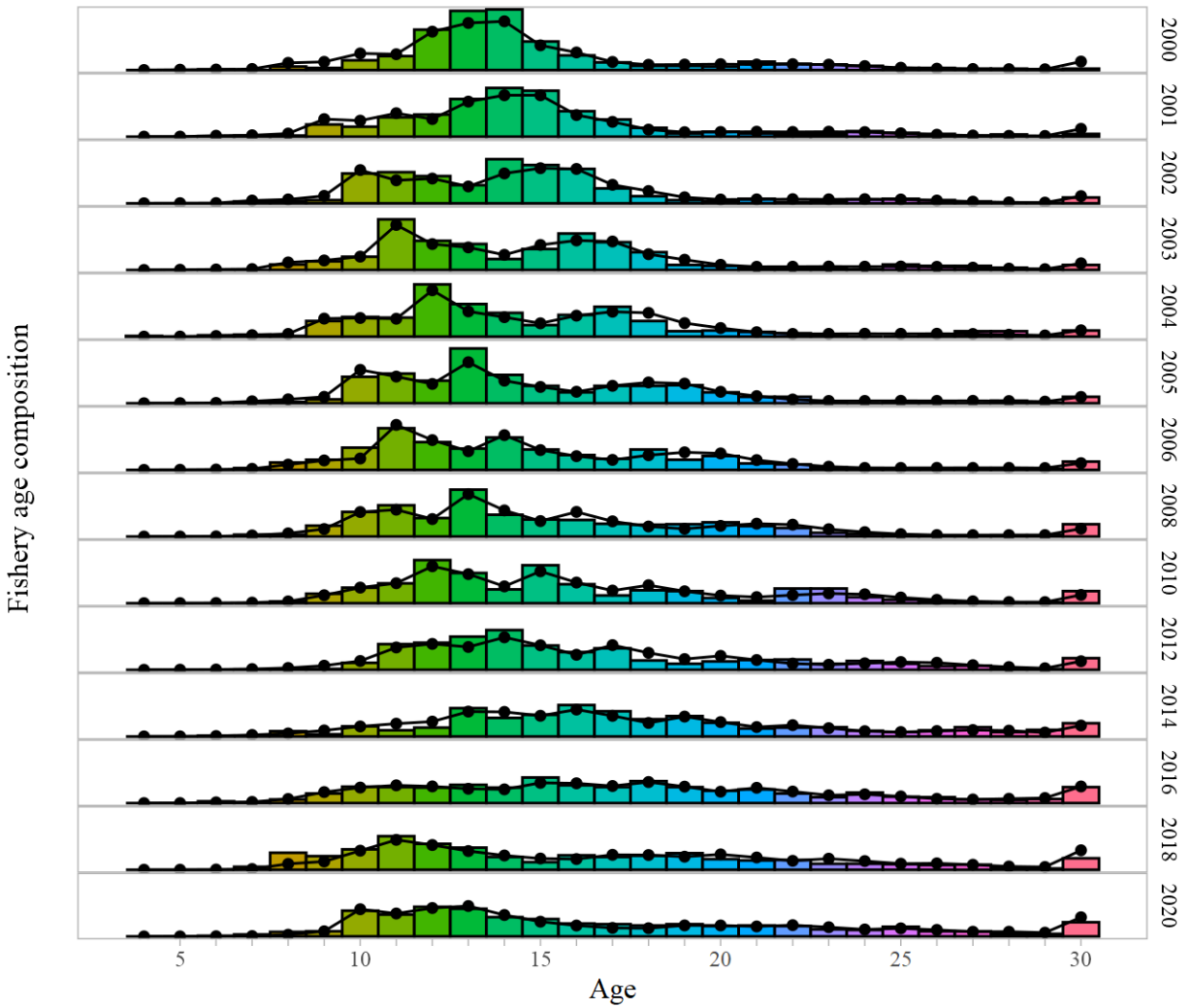
m22.1b	M22.1 w/db survey
m22.2b	M22.2 w/db survey
m22.3b	M22.3 w/db survey

Model Fit - Catch

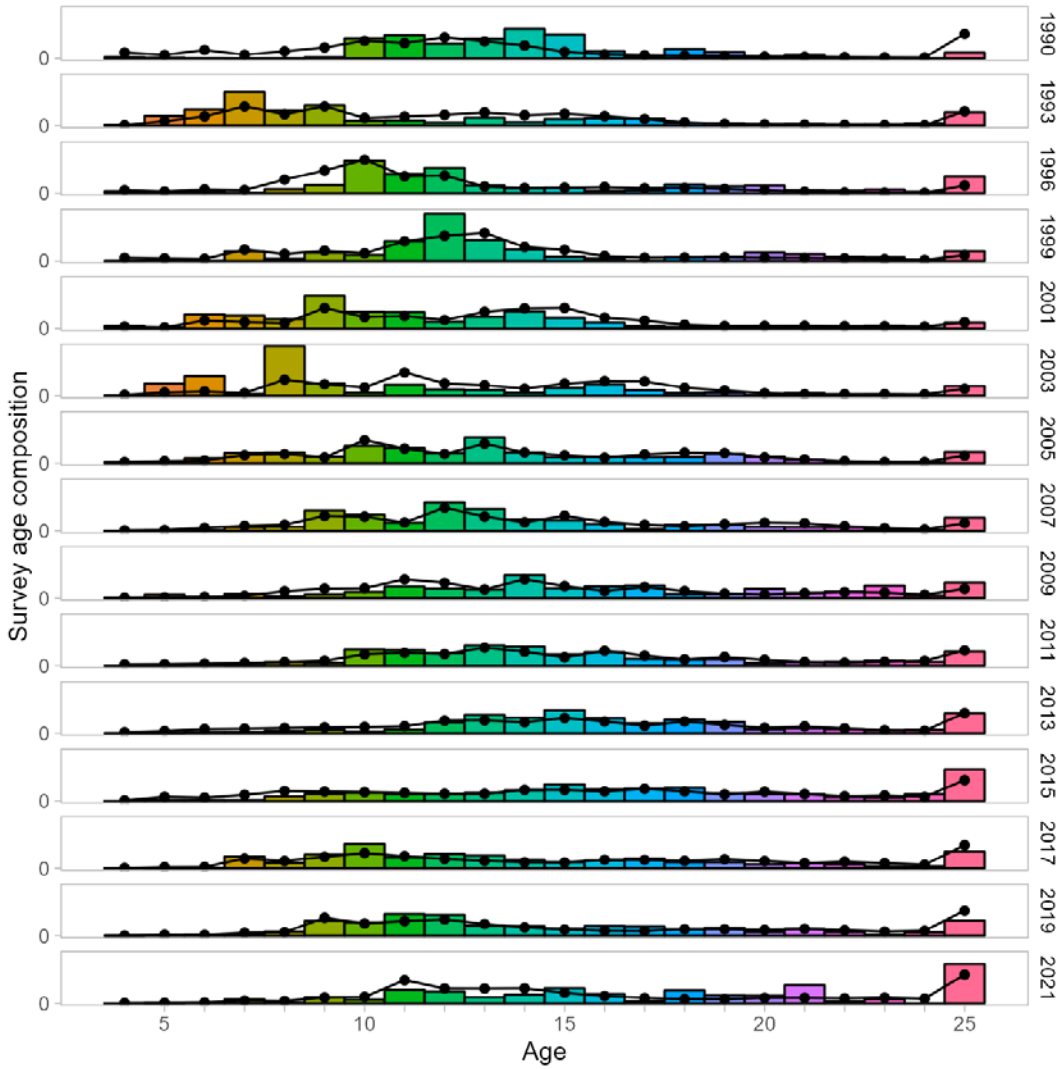


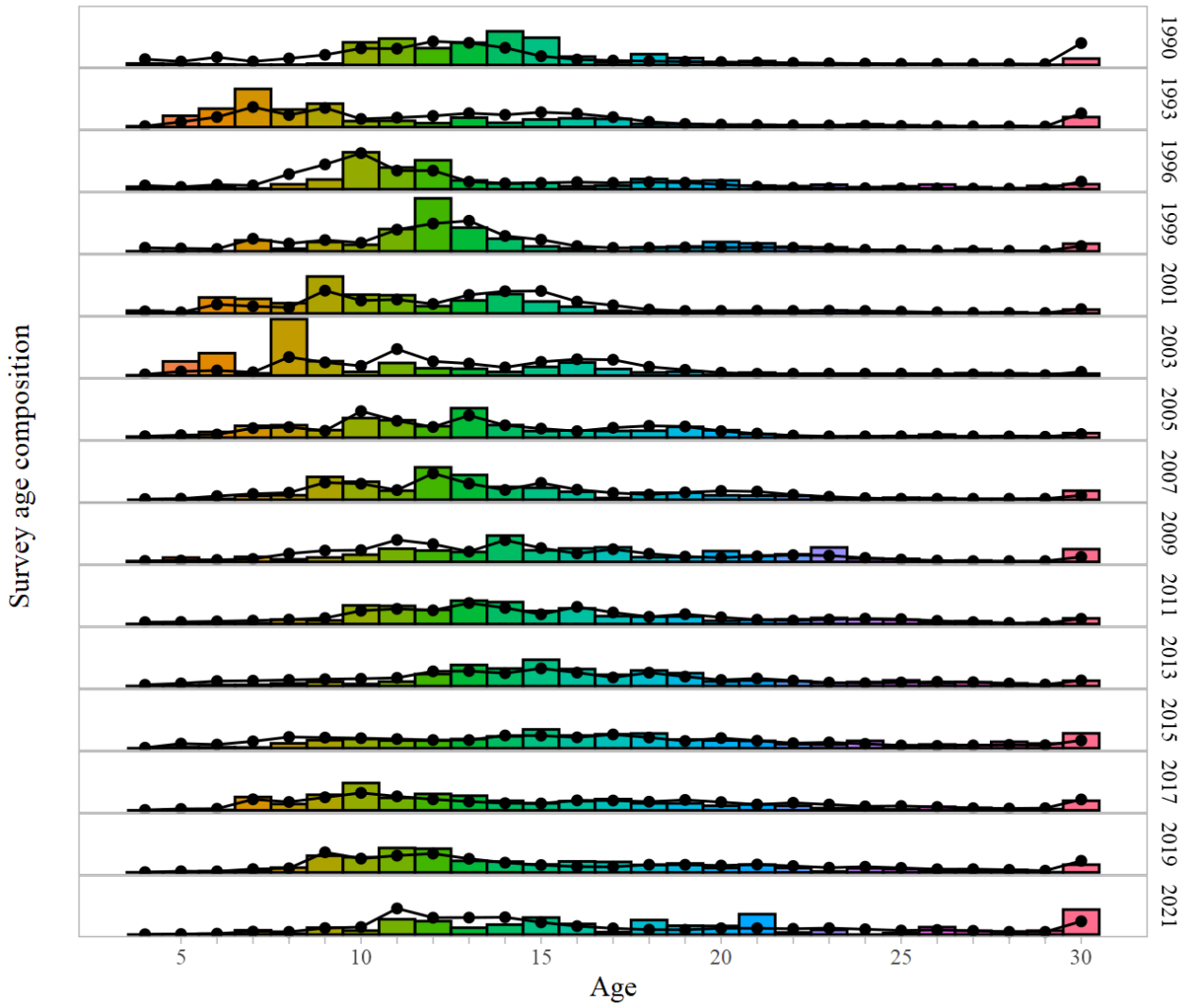
Model Fit - Fishery Size Composition



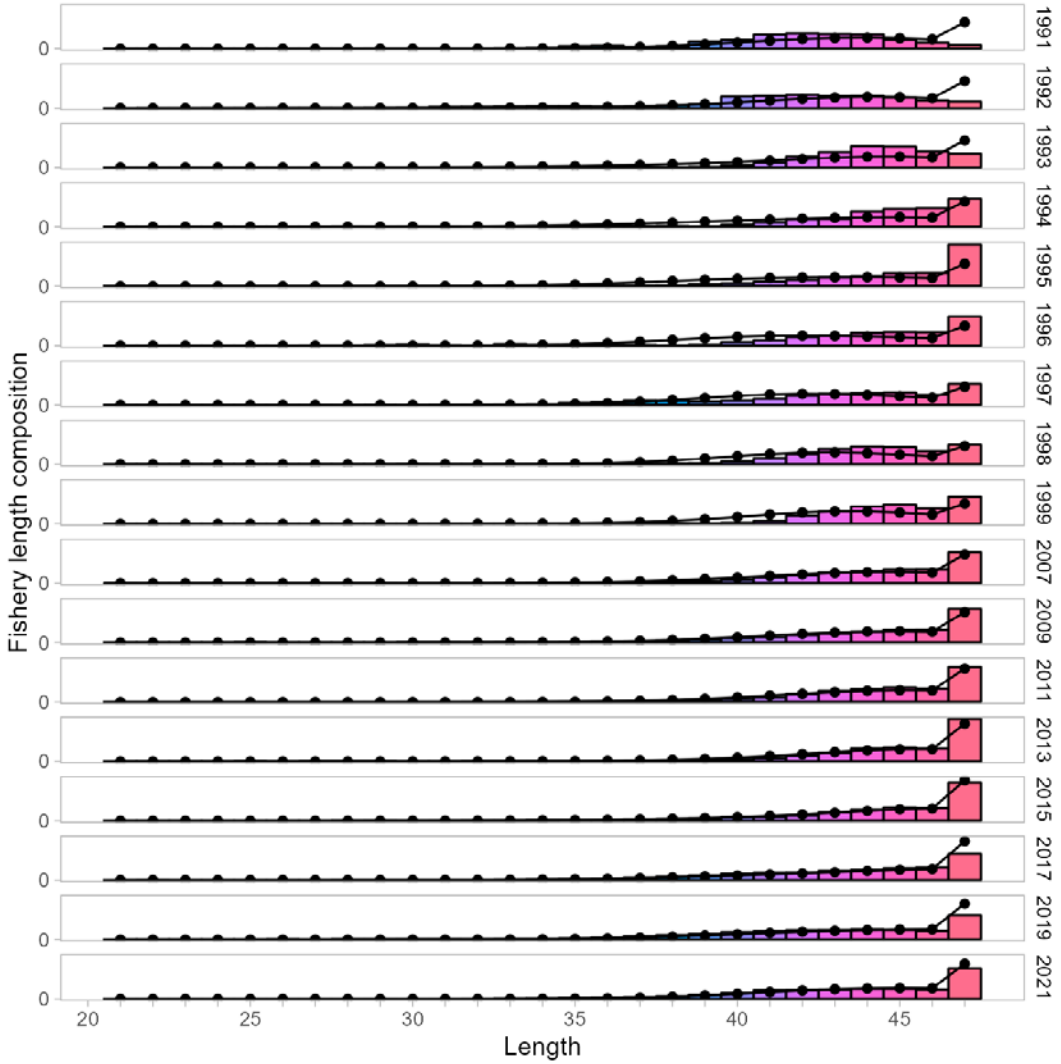


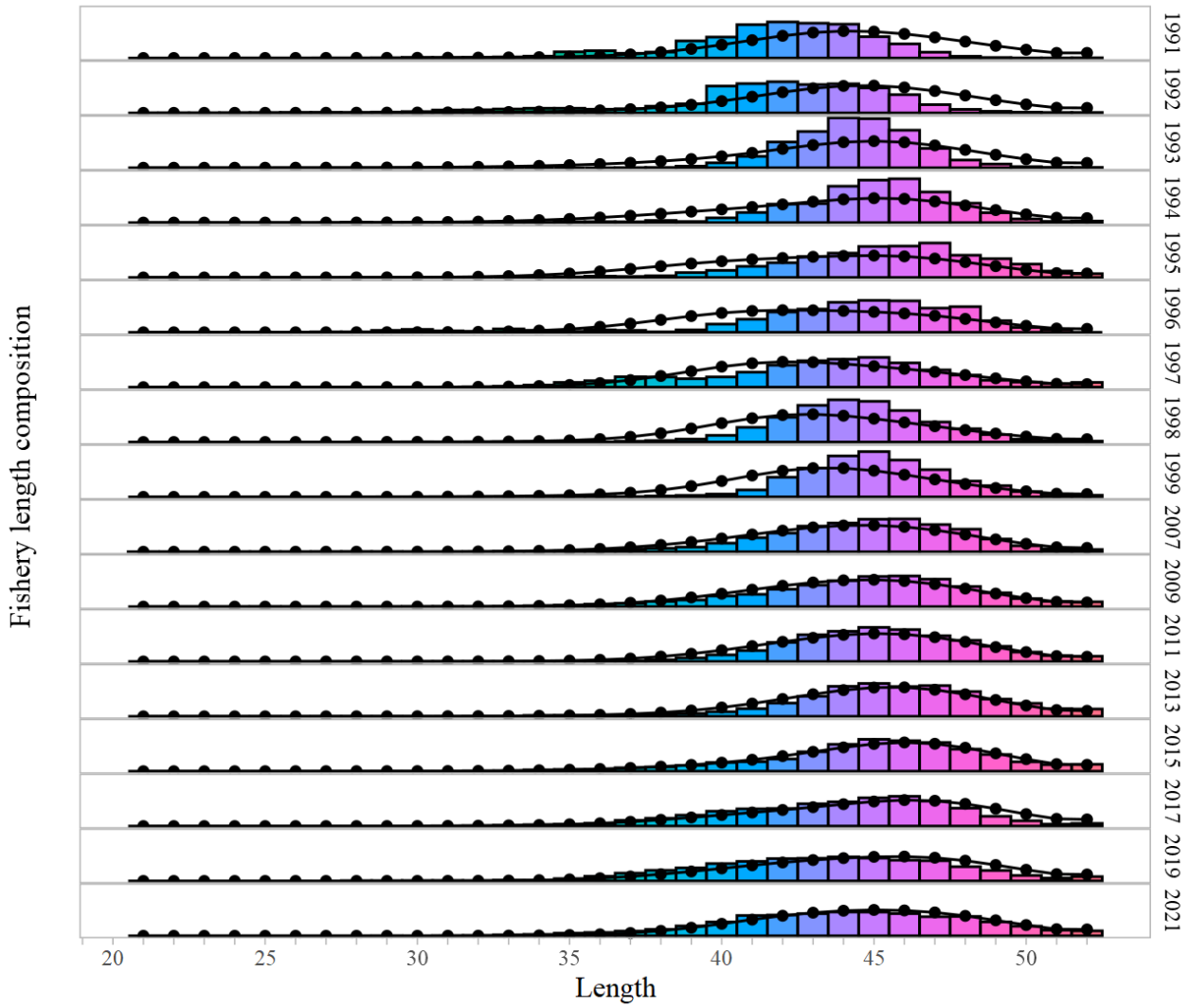
Model Fit - Survey Age Composition



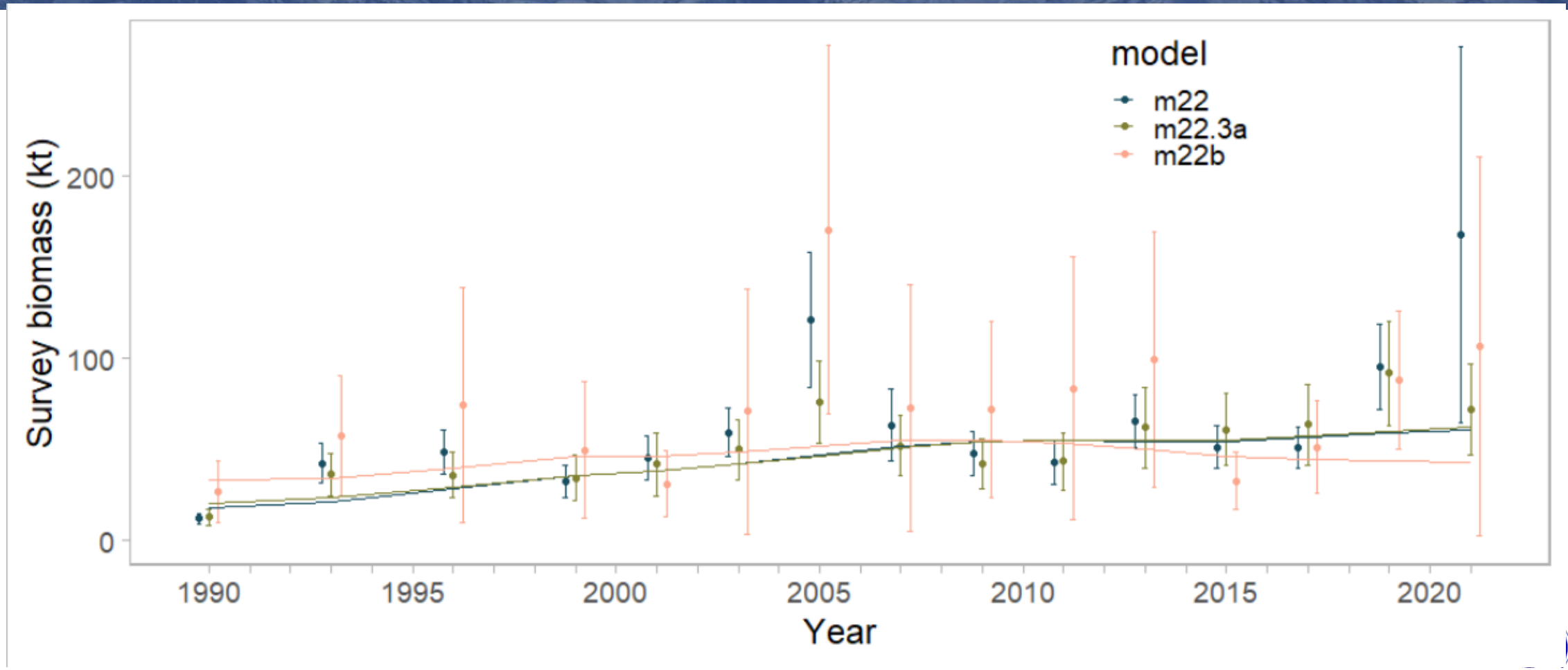


Model Fit - Fishery Length Composition

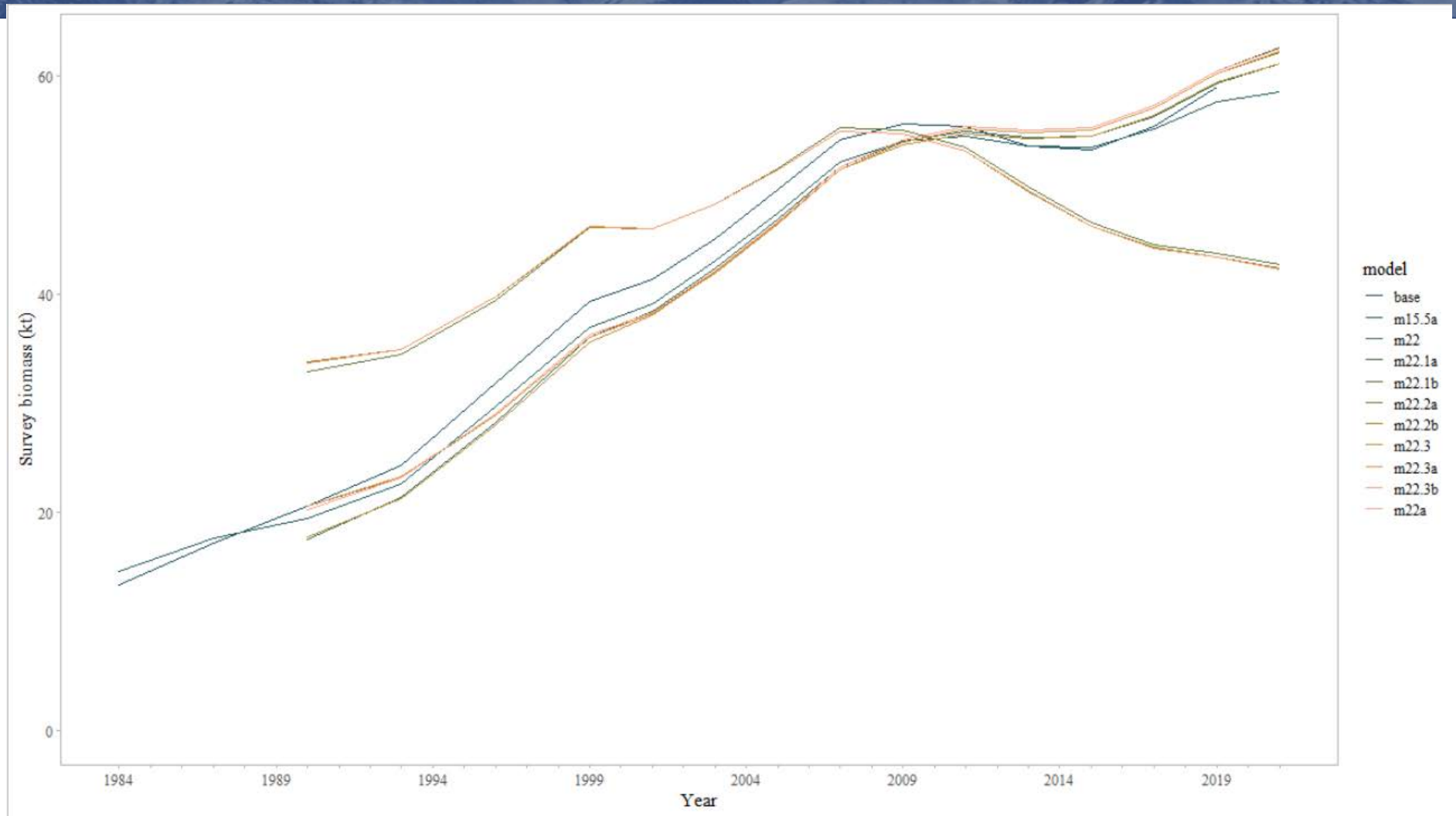




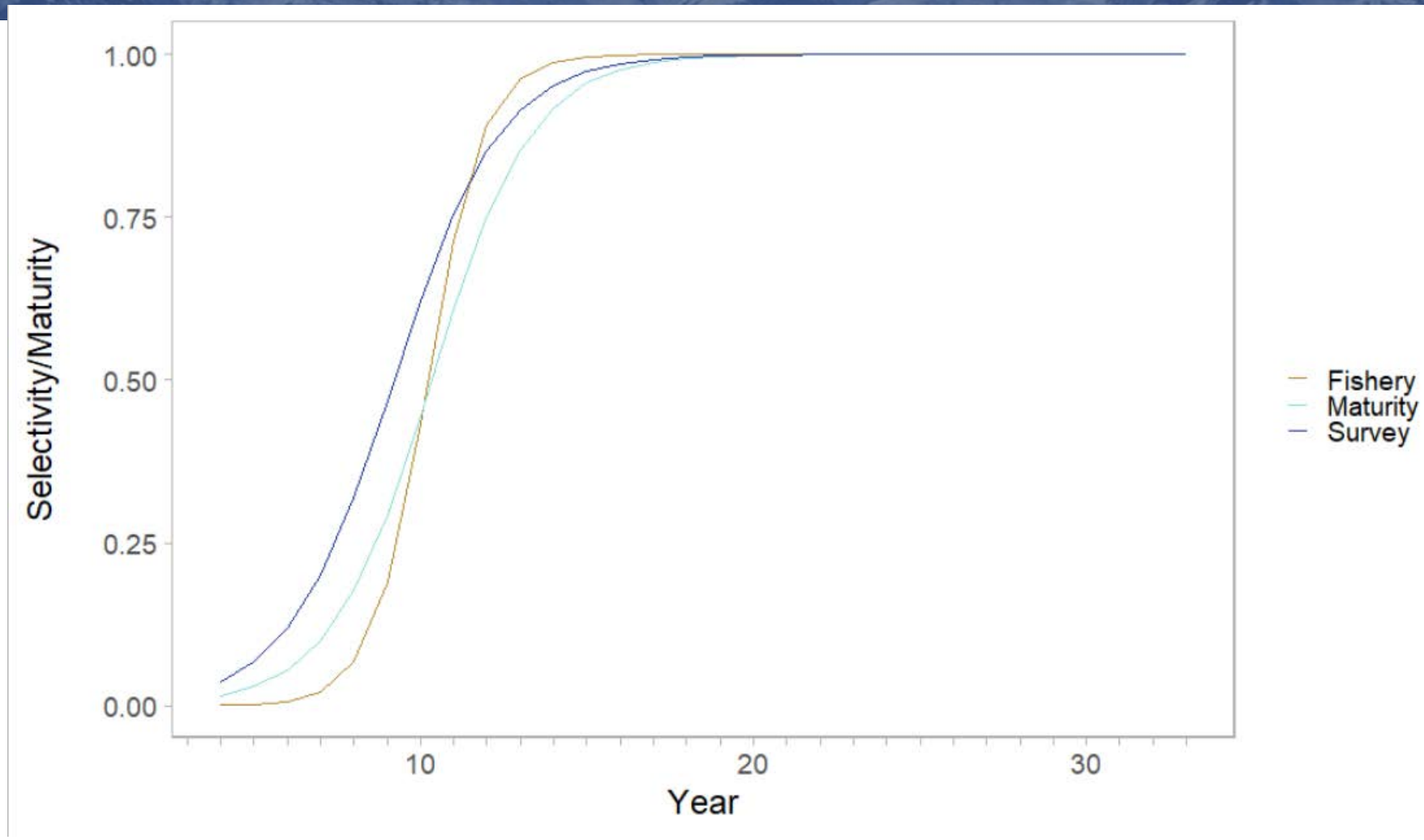
Model Fit - Survey Biomass



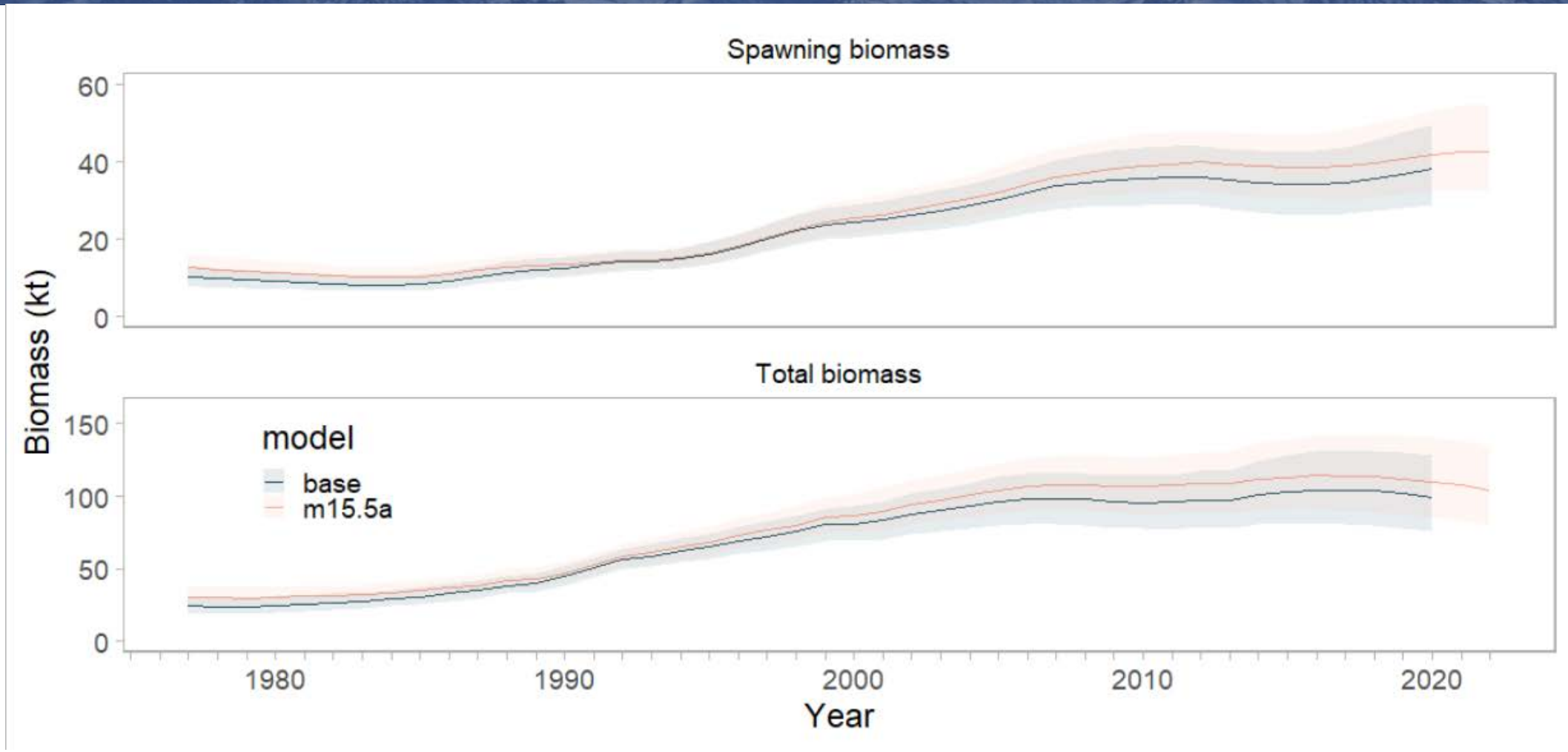
Model Fit - Survey Biomass



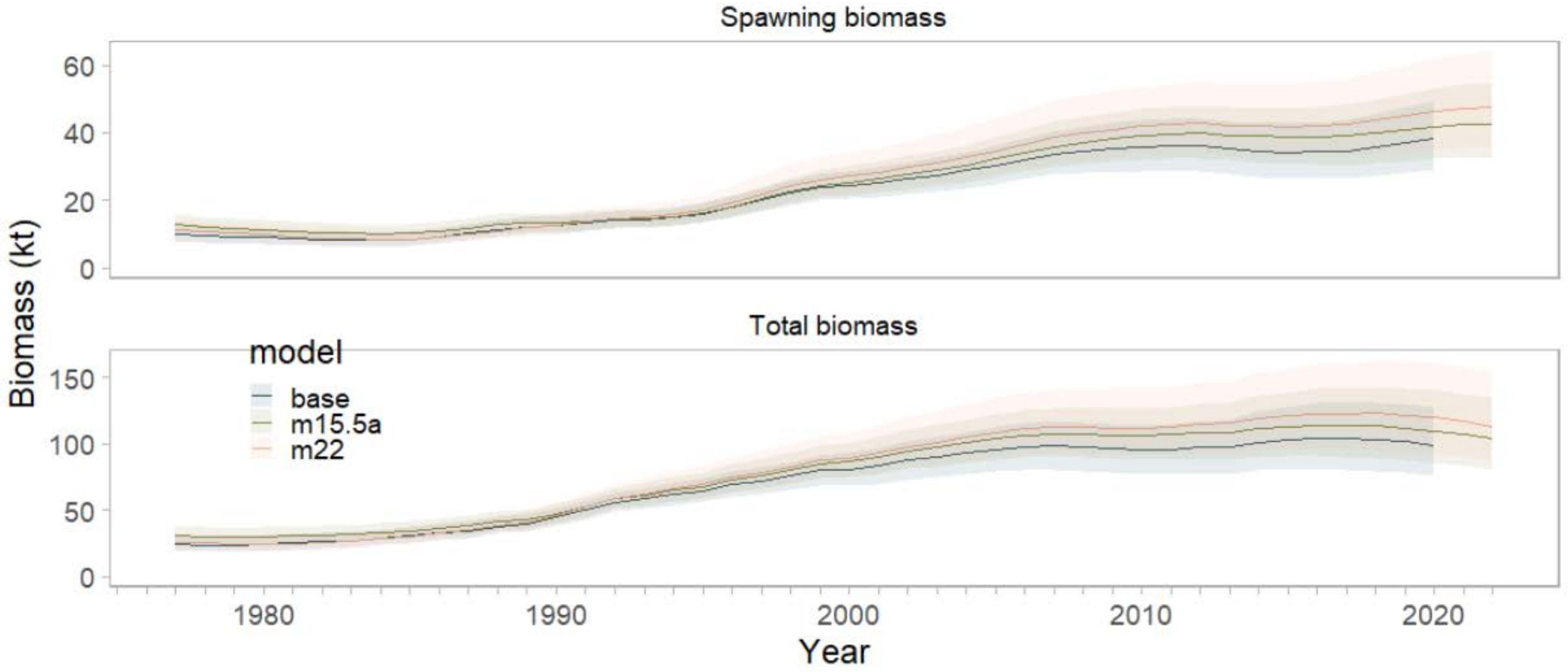
Selectivity



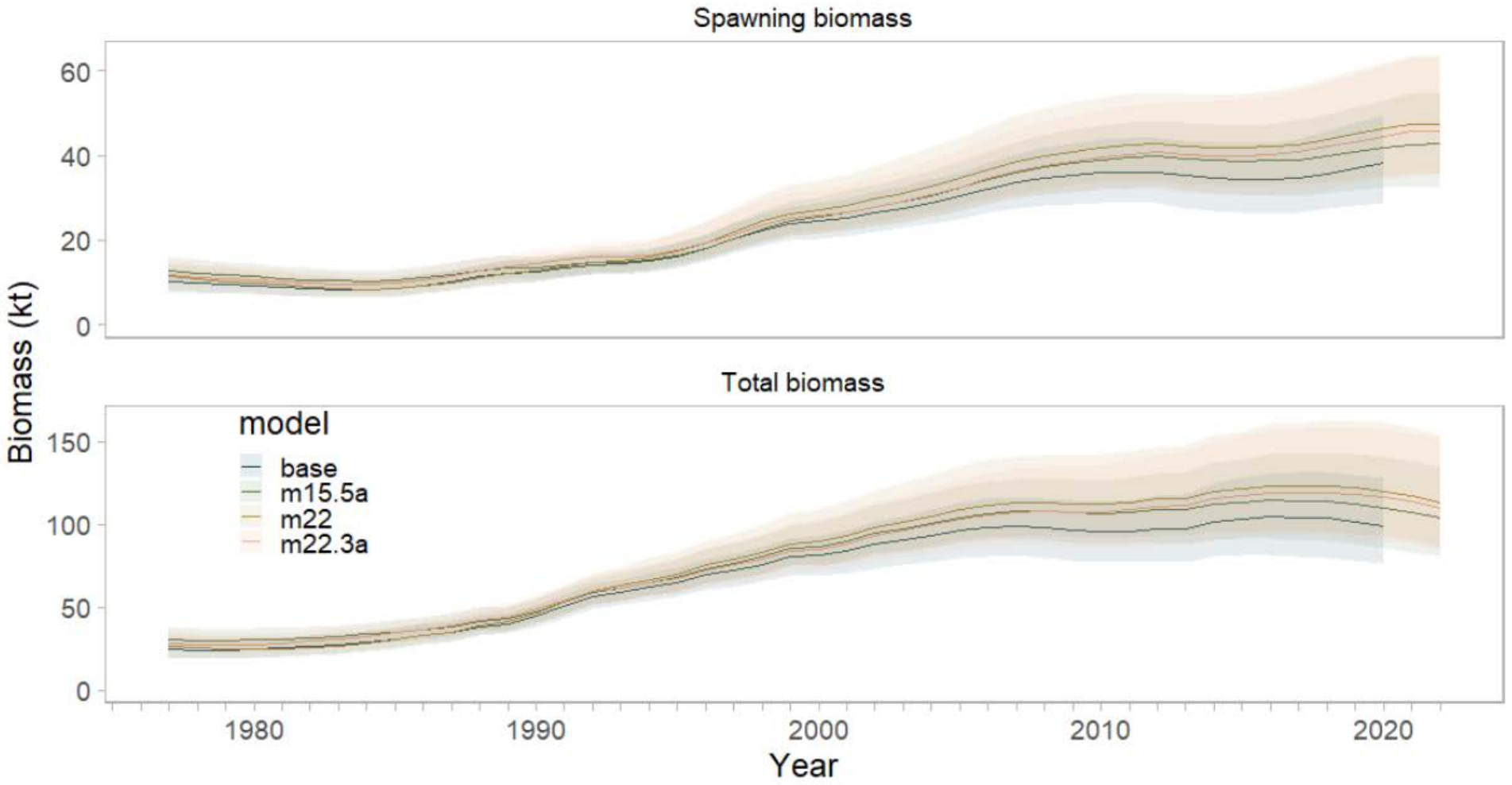
Time Series - Spawning Stock Biomass



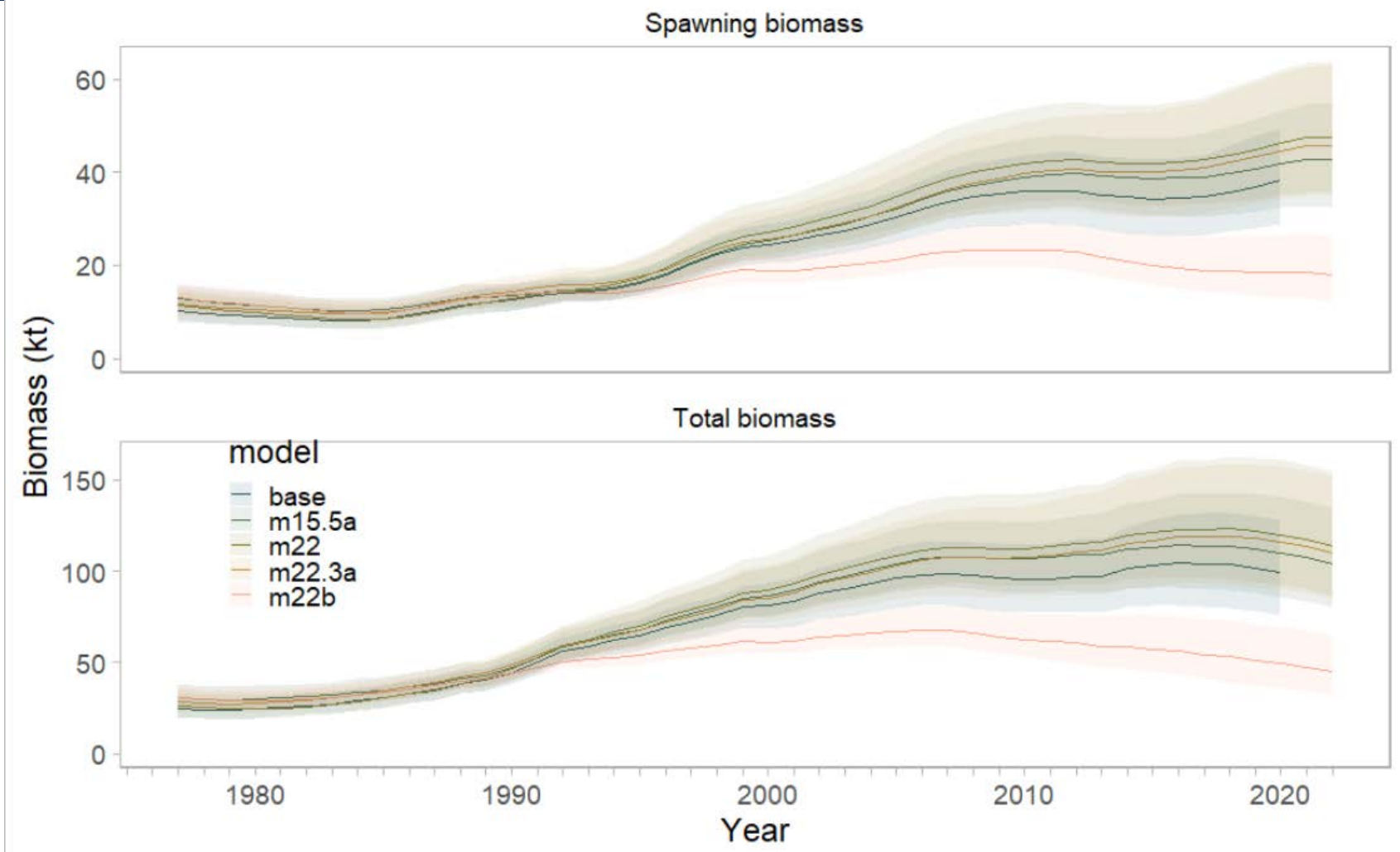
Time Series - Spawning Stock Biomass



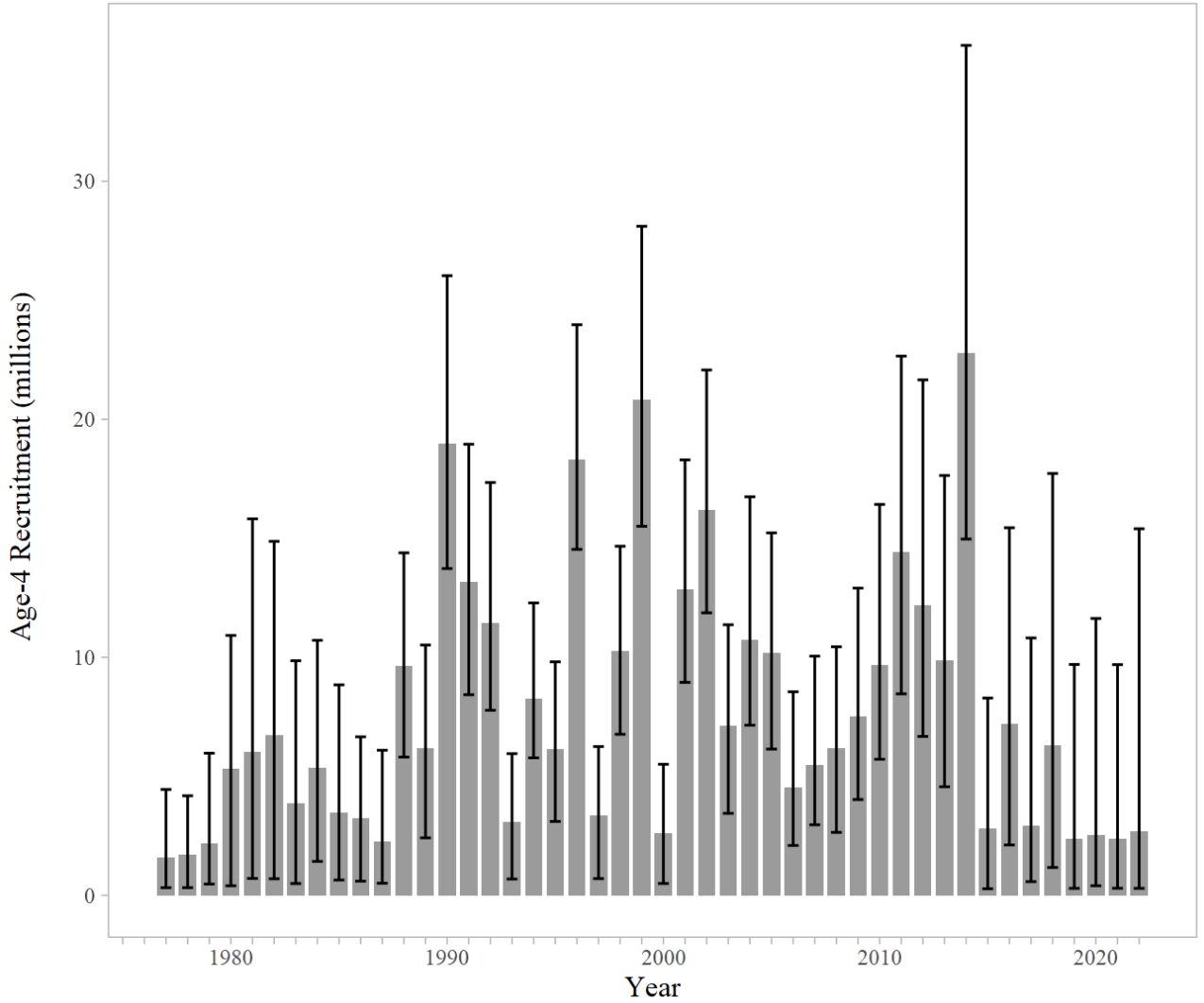
Time Series - Spawning Stock Biomass



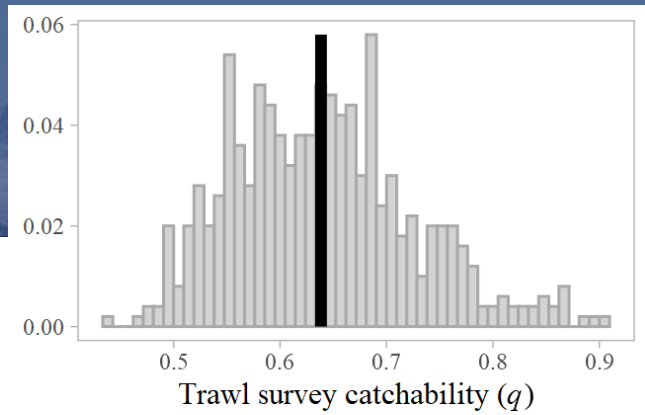
Time Series - Spawning Stock Biomass

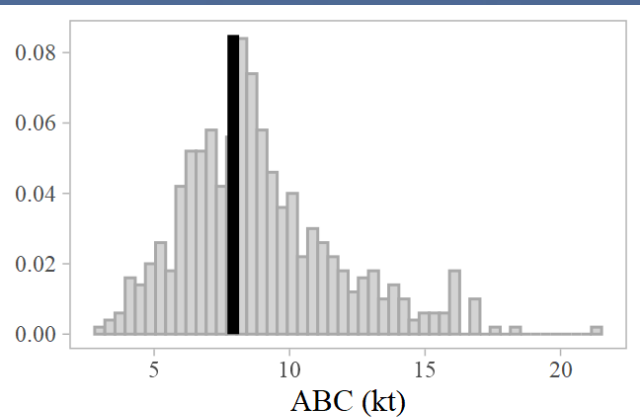


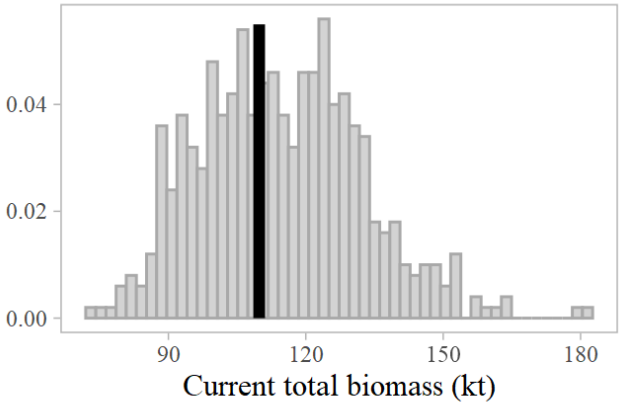
Time Series - Recruitment

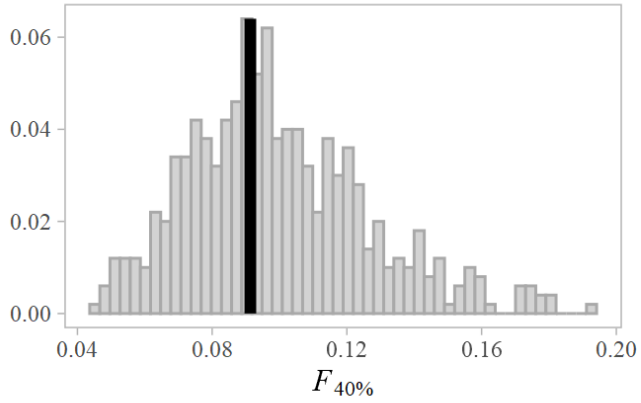


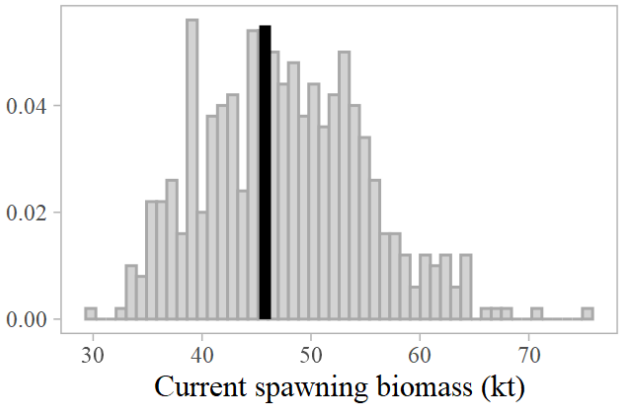
Parameters


0.06
0.04
0.02
0.00
0.5
0.6
0.7
0.8
0.9
Trawl survey catchability (q)


0.08
0.06
0.04
0.02
0.00
5
10
15
20
ABC (kt)


0.04
0.02
0.00
90
120
150
180
Current total biomass (kt)


0.06
0.04
0.02
0.00
0.04
0.08
0.12
0.16
0.20
$F_{40\%}$


0.04
0.02
0.00
30
40
50
60
70
Current spawning biomass (kt)

Likelihoods	base	m15.5a	m22	m22.1	m22.2	m22.3	m22a	m22.1a	m22.2a	m22.3a
Catch	26.96	29.70	25.06	24.94	25.24	25.16	25.57	25.40	25.85	25.72
Survey biomass	98.95	118.58	74.21	74.19	75.70	75.70	29.23	29.21	30.05	30.03
Fishery ages	32.84	36.73	36.60	36.41	43.76	43.52	35.06	34.90	41.74	41.52
Survey ages	124.75	145.09	130.01	130.40	140.01	140.32	127.16	127.49	137.85	138.14
Fishery lengths	49.29	57.92	53.82	58.57	55.15	60.12	53.86	58.66	55.04	60.03
Data	332.80	388.03	319.70	324.51	339.86	344.82	270.89	275.66	290.54	295.43
Penalties/Priors										
Recruitment devs	38.83	33.91	41.34	42.09	40.88	41.58	36.30	37.13	35.43	36.21
F regularity	31.62	35.51	32.60	32.34	32.91	32.71	34.16	33.87	34.21	33.98
σ_r prior	0.25	0.40	0.22	0.20	0.29	0.28	0.34	0.31	0.43	0.41
q prior	0.32	0.60	0.64	0.59	0.83	0.77	0.45	0.41	0.54	0.50
Objective function	468.81	523.65	459.28	464.53	479.47	484.87	406.80	412.08	425.72	431.13
Parameter estimates										
# parameters	124	126	128	128	133	133	128	128	133	133
q	0.70	0.61	0.60	0.62	0.56	0.57	0.65	0.67	0.63	0.64
σ_r	1.10	1.01	1.12	1.13	1.07	1.08	1.04	1.05	0.99	1.00
Mean recruitment	2.22	0.99	0.90	0.87	0.97	0.95	0.96	0.94	1.02	0.99
$F_{40\%}$	0.93	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Projected total biomass	97,702	101,171	110,493	108,291	117,133	115,044	105,736	103,929	108,833	107,160
Projected spawning biomass	38,362	41,453	46,083	45,142	48,951	48,056	43,847	43,083	45,164	44,495
$B_{100\%}$	60,855	63,038	67,517	66,669	70,174	69,358	64,914	64,249	66,181	65,565
$B_{40\%}$	24,342	25,215	27,007	26,667	28,070	27,743	25,966	25,699	26,473	26,226
ABC	7,101	7,279	8,187	8,030	8,660	8,511	7,829	7,702	8,037	7,917

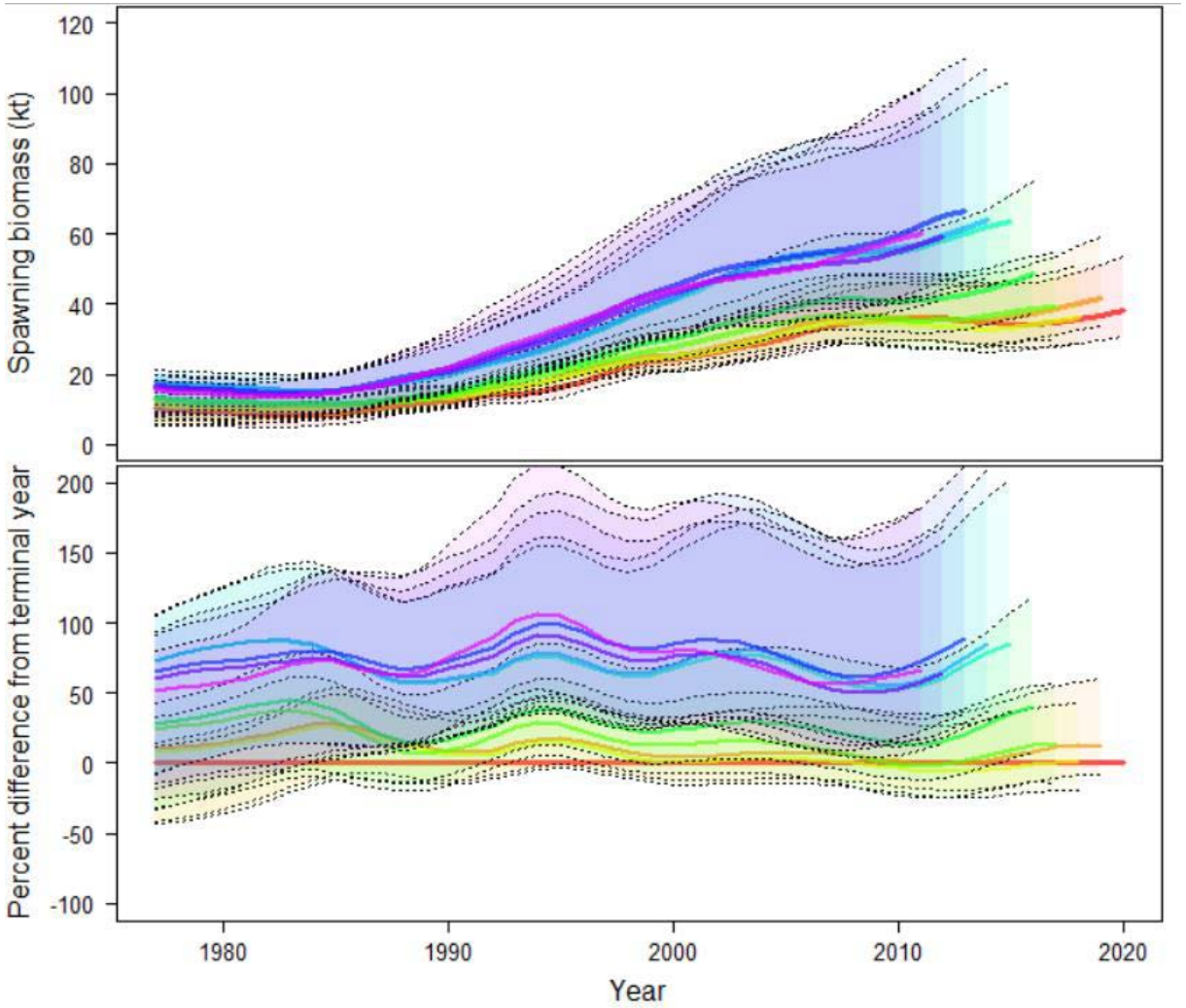
Parameters

Design-based survey inputs

Likelihoods	m22b	m22.1b	m22.2b	m22.3b
Catch	33.04	32.76	33.99	33.76
Survey biomass	20.99	21.00	21.10	21.11
Fishery ages	34.75	34.59	41.02	40.79
Survey ages	125.73	125.94	137.18	137.36
Fishery lengths	53.86	58.68	54.91	59.92
Data	268.37	272.97	288.20	292.93
Penalties/Priors				
Recruitment devs	15.31	16.50	12.04	13.14
F regularity	6.36	35.94	36.54	36.19
σ_r prior	1.09	1.03	1.29	1.24
q prior	0.01	0.02	0.01	0.01
Objective function	386.15	391.45	403.08	408.51
Parameter estimates				
# parameters	128	128	133	133
q	1.08	1.09	1.06	1.07
σ_r	0.78	0.79	0.73	0.74
Mean recruitment	0.89	0.87	0.93	0.91
$F_{40\%}$	0.09	0.09	0.09	0.09
Projected total biomass	43,553	42,883	43,576	42,990
Projected spawning biomass	16,839	16,583	16,780	16,556
$B_{100\%}$	42,320	42,140	42,316	42,153
$B_{40\%}$	16,928	16,856	16,926	16,861
ABC	2,984	2,909	2,955	2,890

Mohn's rho 0.51

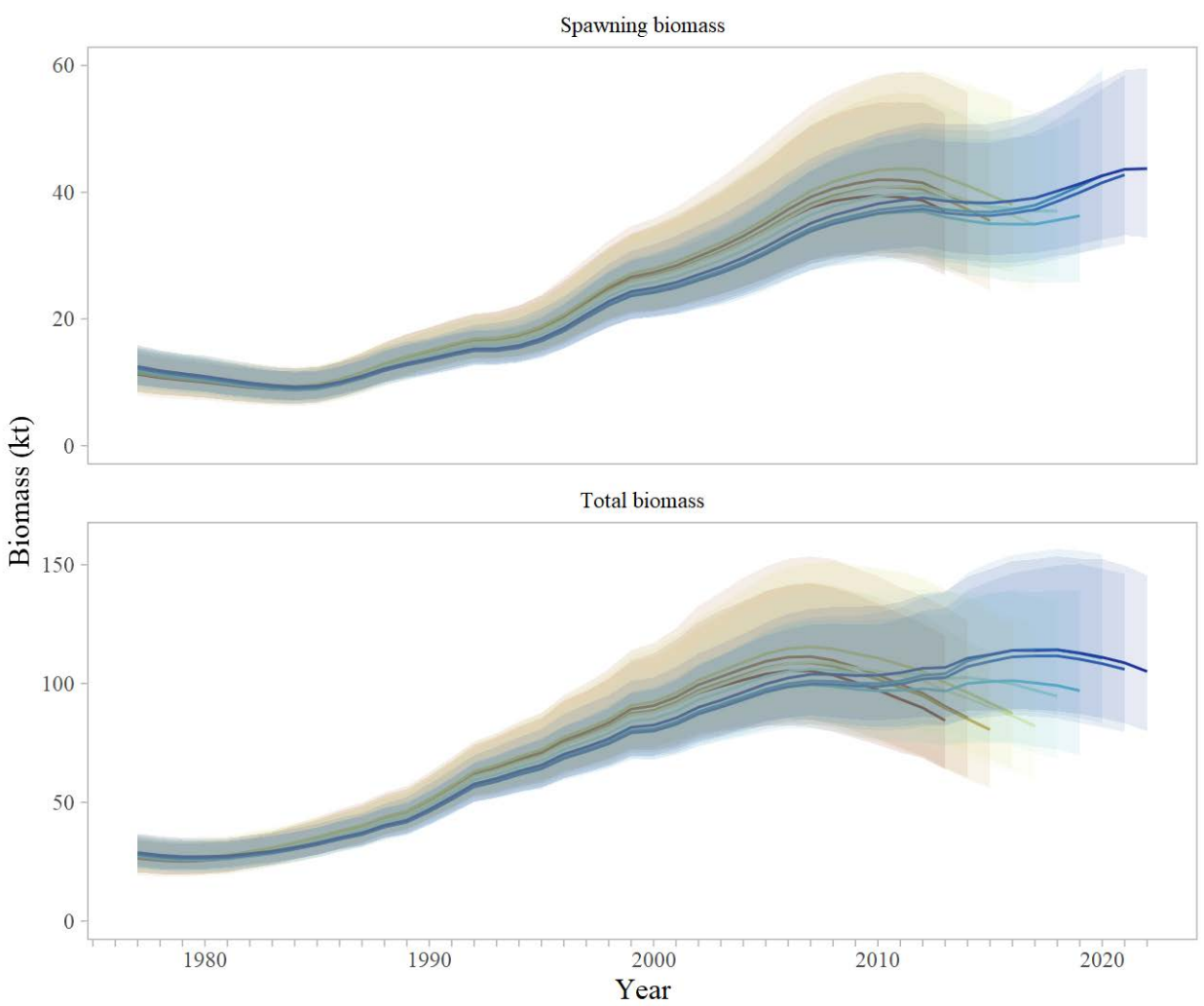
Retrospective – Base model (2020)

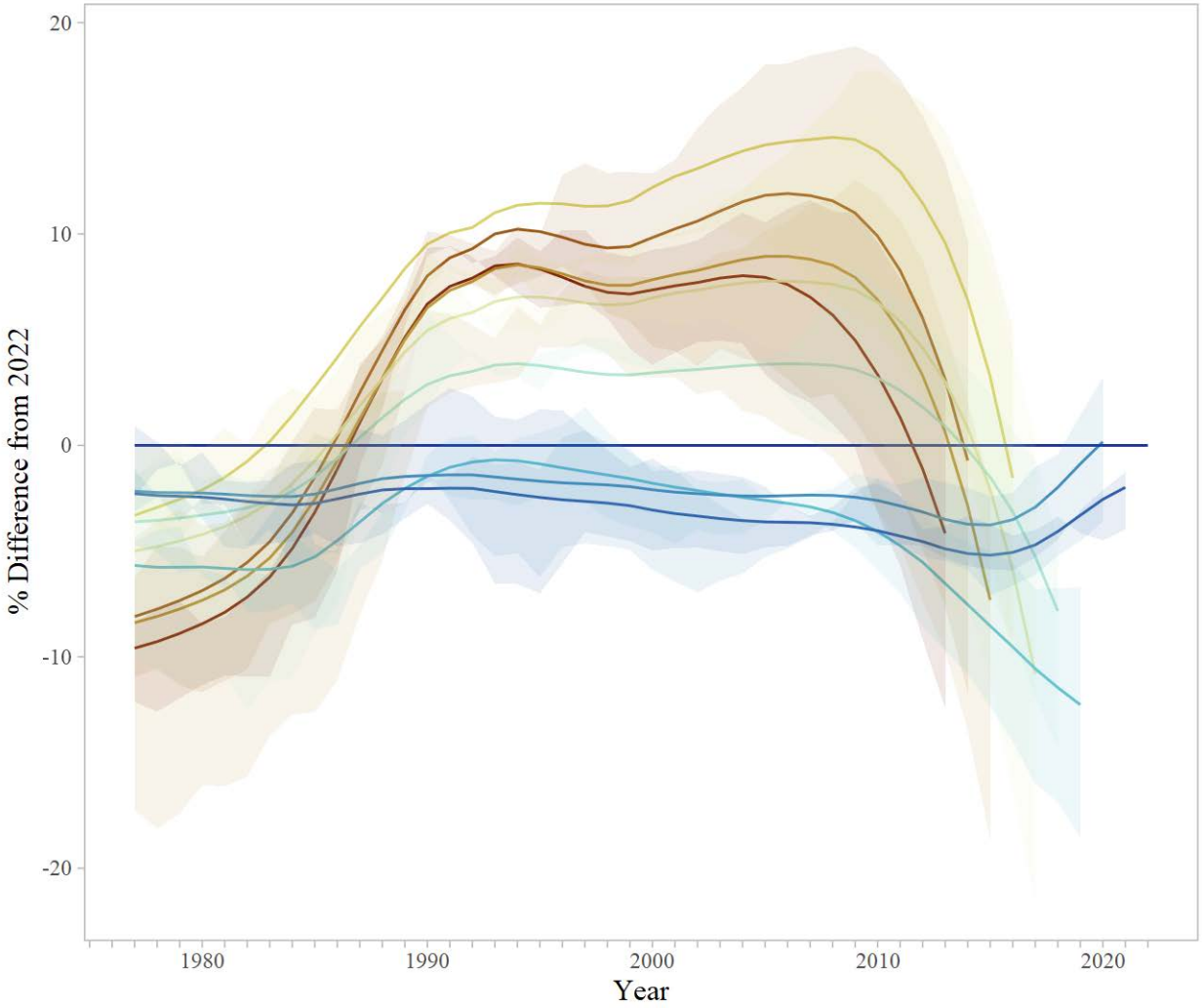


Retrospective – m22.3a

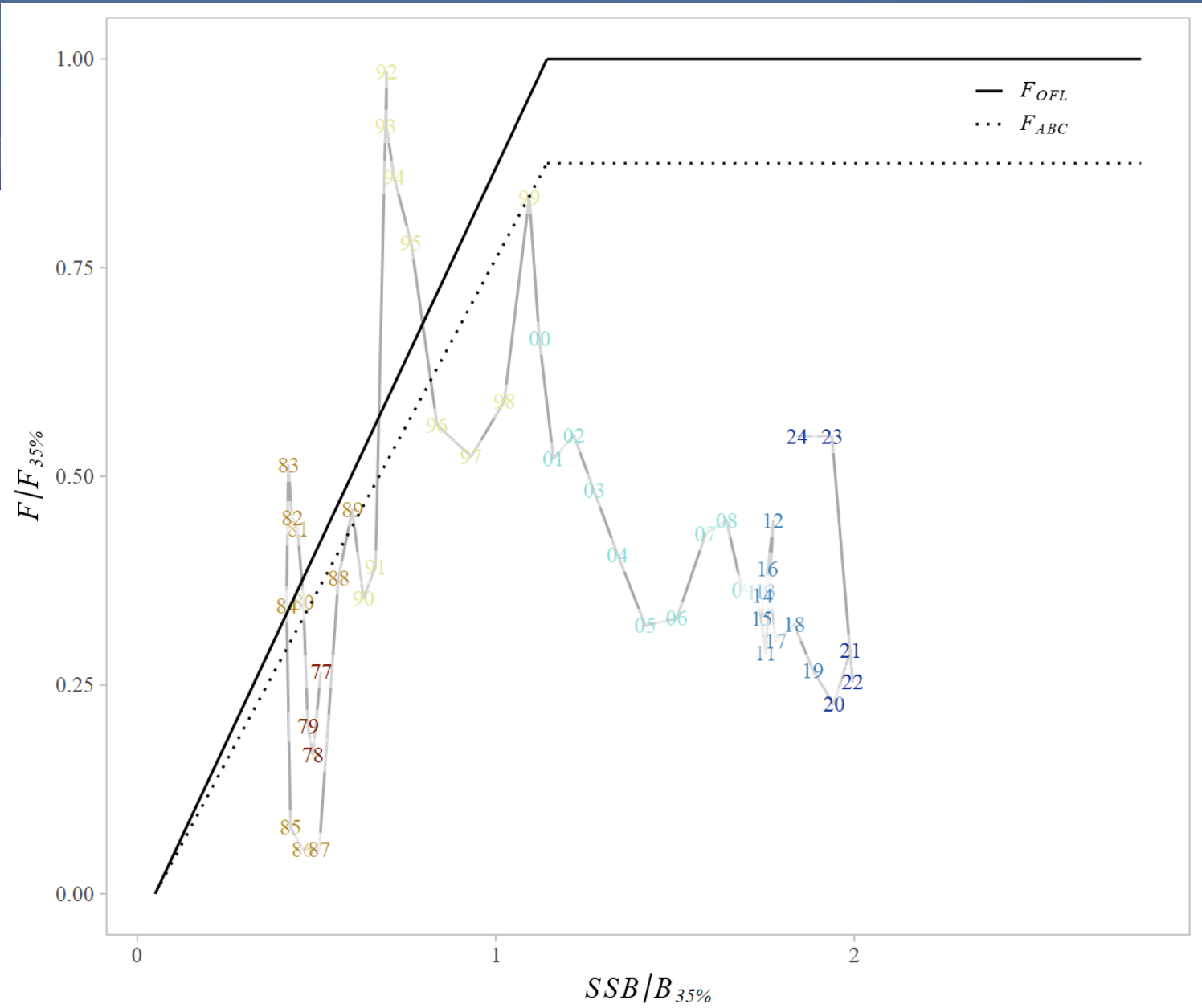
Mohn's rho -0.123

Base = 0.51





Phase Plane


1.00
0.75
0.50
0.25
0.00
0
1
2
$F/F_{35\%}$
$SSB/B_{35\%}$
F_{OFL}
F_{ABC}
92
93
94
95
96
97
98
99
00
01
02
03
04
05
06
07
08
12
16
14
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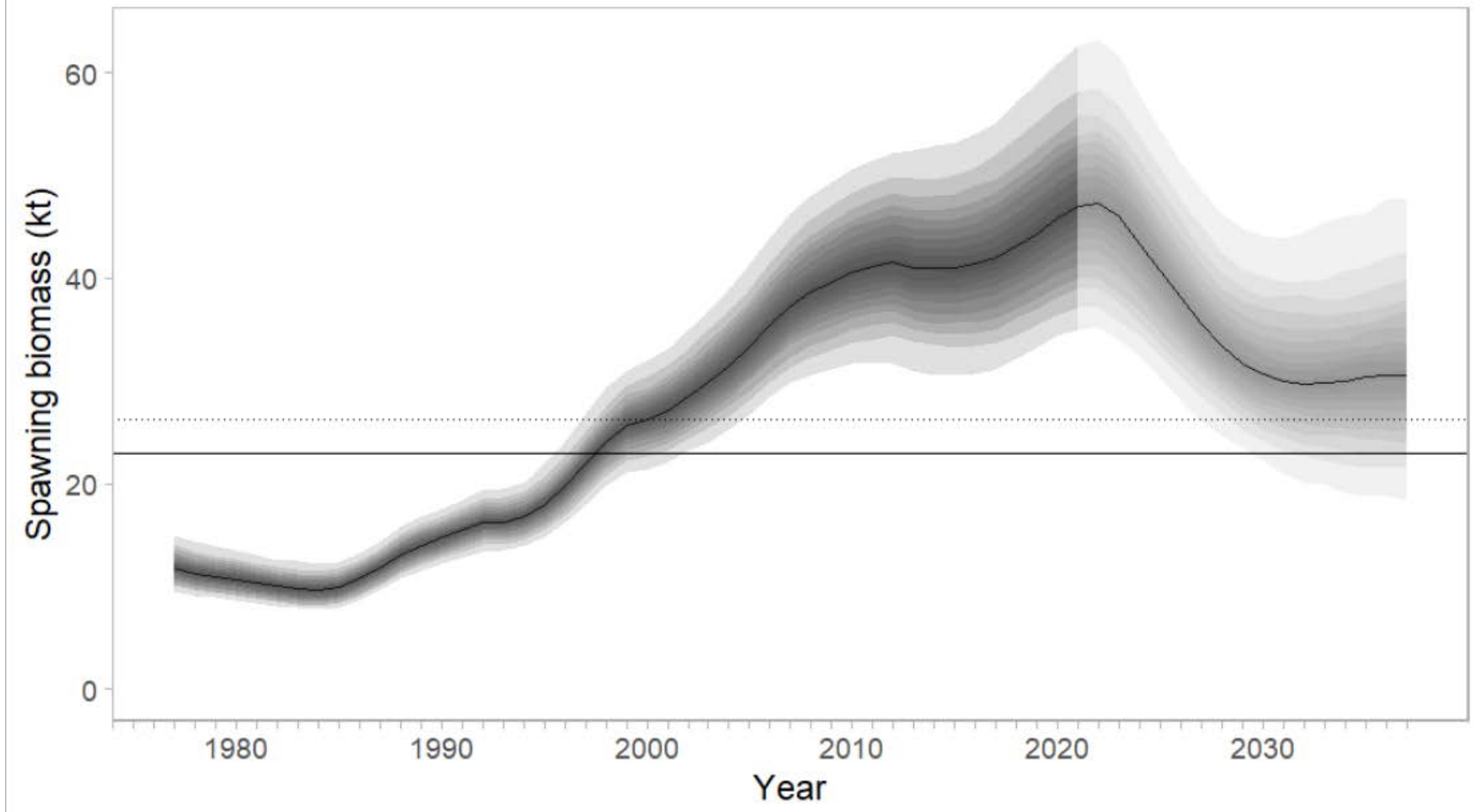
Projection


Spawning biomass (kt)
60
40
20
0
1980
1990
2000
2010
2020
2030
Year

Risk Table

Assessment-related considerations	Population dynamics considerations	Environmental/ ecosystem considerations	Fishery Performance
Level 2: Substantially increased concerns	**Level 2**: Substantially increased concerns	Level 1: No increased concerns	Level 1: No increased concerns

Assessment - sensitivity of the model to the scale of the VAST model biomass estimates, as well as the low uncertainty from VAST

Population dynamics –skip spawning has been observed for this stock, levels unknown

Environmental - environmental mechanisms for changes in survival and productivity of dusky rockfish remain unknown, though indication that structural epifauna habitat may be decreasing

Fishery performance - catches are well below ABC

Harvest Recommendation

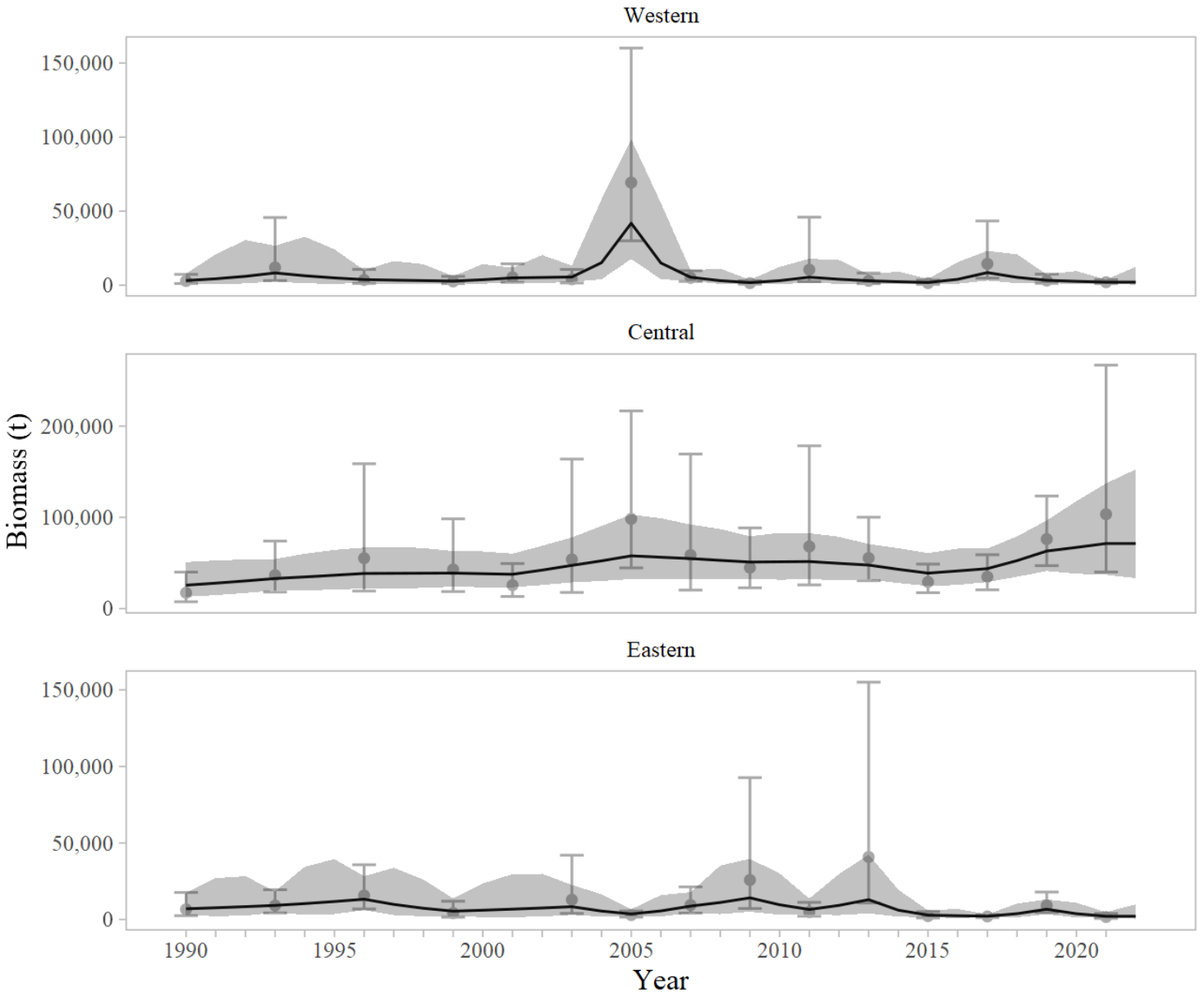
	As estimated or specified last year for:		As estimated or recommended this year for:	
Quantity/Status	2022	2023	2023*	2024*
M (natural mortality)	0.07	0.07	0.07	0.07
Tier	3a	3a	3a	3a
Projected total (age 4+) biomass (t)	95,682	92,310	107,160	104,627
Projected female spawning biomas (t)	38,371	36,853	44,651	44,651
$B_{100\%}$	60,855	60,855	65,565	65,565
$B_{40\%}$	24,342	24,342	26,226	26,226
$B_{35\%}$	21,299	21,299	22,948	22,948
F_{OFL}	0.114	0.114	0.11	0.11
$maxF_{ABC}$	0.093	0.093	0.09	0.09
F_{ABC}	0.093	0.093	0.09	0.09
OFL (t)	8,614	8,146	**9,638**	9,154
maxABC (t)	7,069	6,686	7,917	7,520
ABC (t)	5,372	5,181	**7,917**	7,520
	As determined last year for:		As determined this year for:	
Status	2021	2022	2022	2023
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

Apportionment

Western 5.0% → 1.9%

Central 84.4% → 96.6%

Eastern 10.6% → 1.5%



Apportionment

		Western	Central	Eastern	Total
Area Apportionment		1.9%	96.6%	1.5%	100%
2023	ABC (t)	149	7,647	121	7,917
2023	OFL (t)				9,638
2024	ABC (t)	141	7,264	115	7,520
2024	OFL (t)				9,154

		W. Yakutat	E. Yakutat/Southeast
2023	ABC (t)	90	31
2024	ABC (t)	85	30

Conclusions

- Recommendation
  - Increase age and length plus groups, change to lognormal error in VAST (model 22.3a)
- Data Gaps and Future Research Priorities
  - We have no information on larval, post-larval, or early-stage juvenile dusky rockfish
  - Habitat requirements are either unknown or anecdotal – research to identify HAPC
  - Aging is a continual issue (challenging to age well)
  - Reproductive biology is poorly understood, though skip spawning has been observed – the spatial and temporal extent of skip spawning should be a research priority
  - Exploration of data weighting, possibly the inclusion of a variance inflation parameter to increase the variance on VAST estimated trawl surveys

QUESTIONS?

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