# Assessment of BSAI Kamchatka flounder

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Data

| Data Source	Years
Fishery catch	1991 - 2020
Fishery lengths	2008-2011, 2018-2020
Survey biomass	
EBS shelf	1991-2019
EBS slope	2002, 2004, 2008, 2010, 2012, 2016
Aleutian Islands	1991, 1994, 1997, 2000-2018 (biennial)
Survey length composition	
EBS shelf	1991-2018
EBS slope	2004, 2008, 2010, 2016
Aleutian Islands	Same as above without 2010
Survey age composition	
EBS slope	2002, 2012, 2016
Aleutian Islands	2010, 2016, 2018

Catch

2008: 34% from 31%
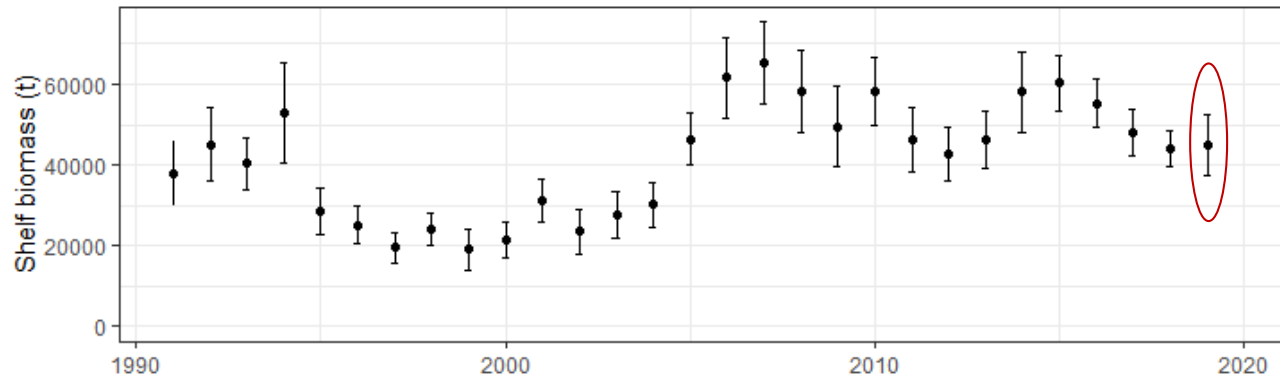2009: 42% from 45%
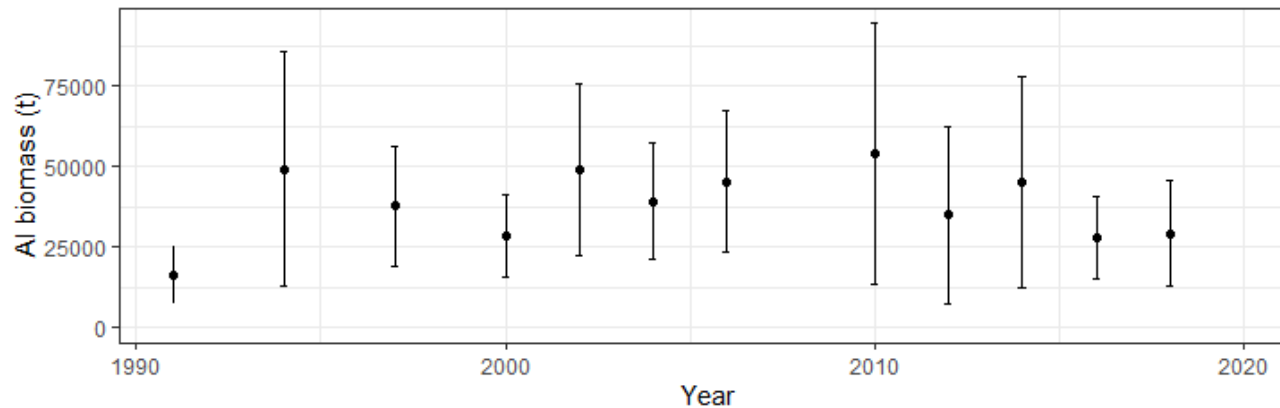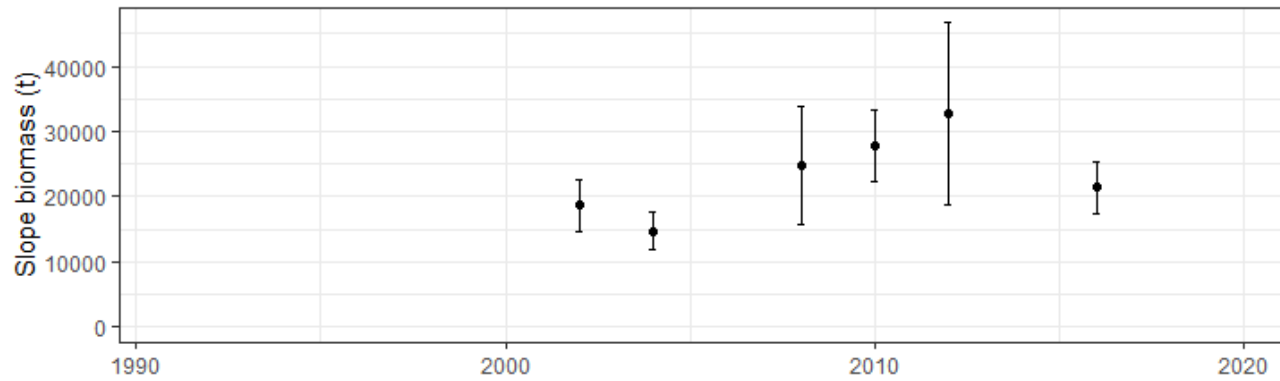2010: 54% from 55%

1997 – 2007: 10%
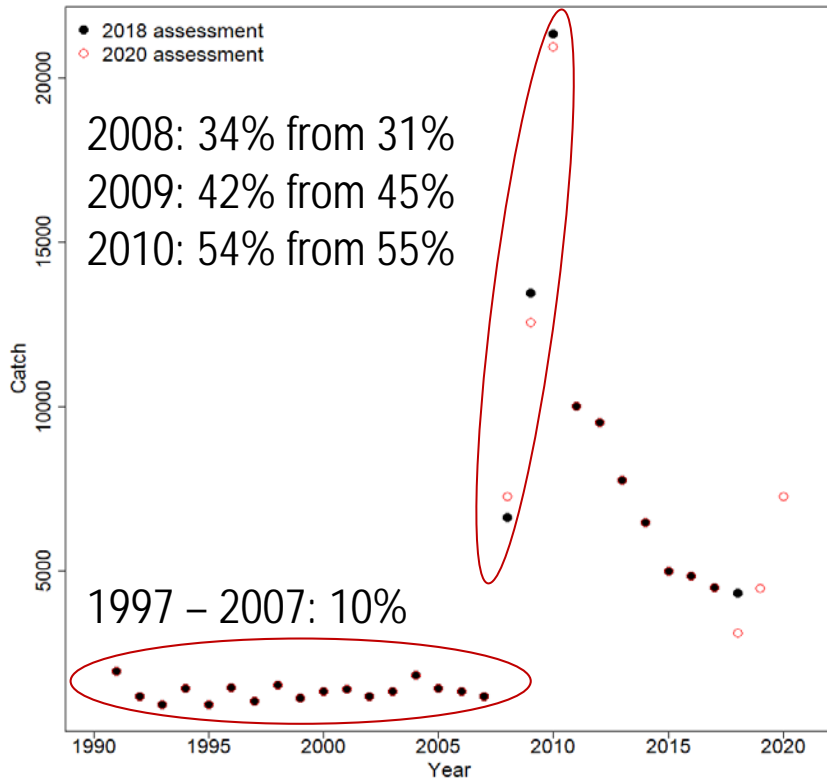
- Catch has been increasing since 2018
- As of October 26th, catch was 7,249 t > 6.800 t TAC
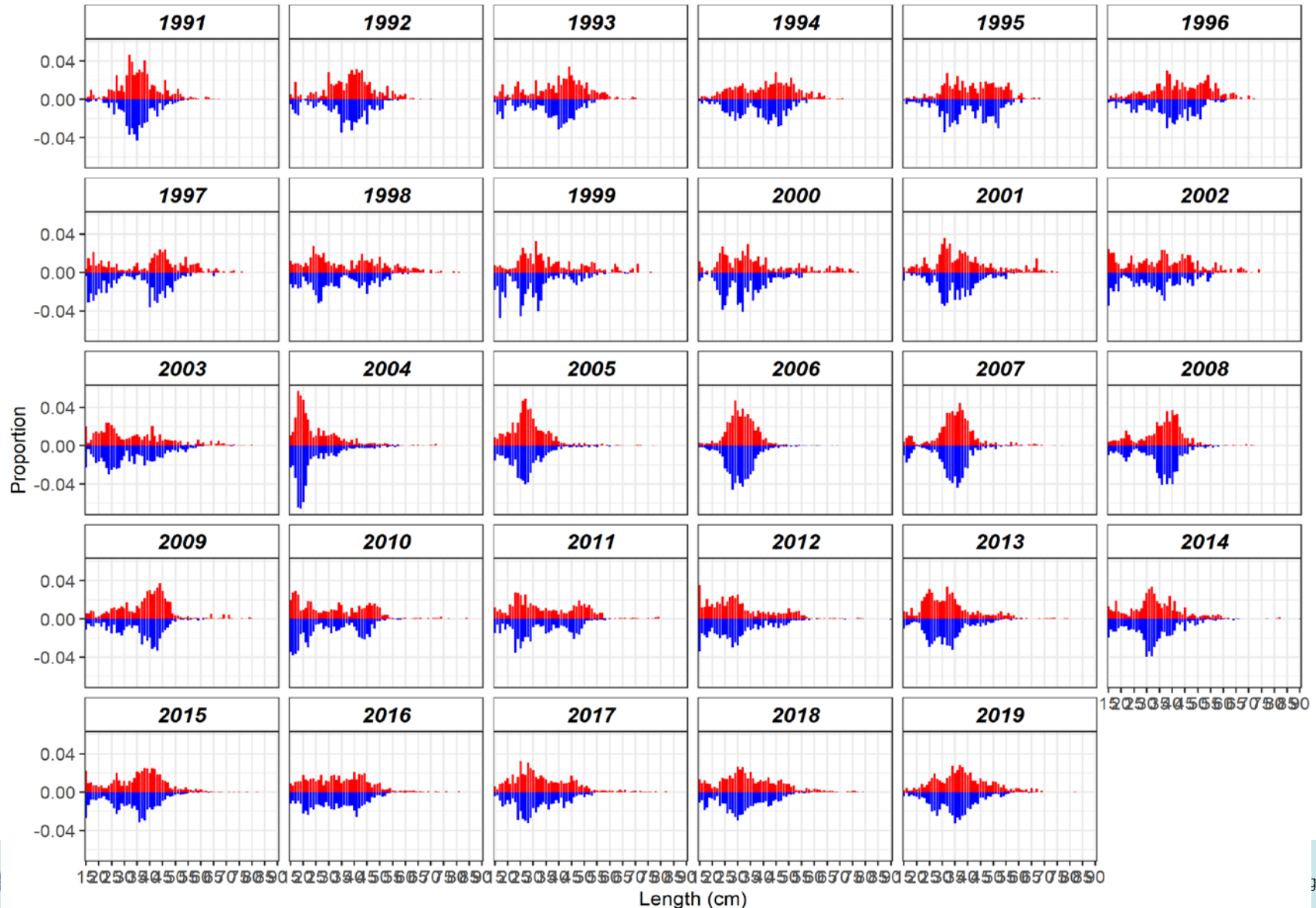- On average since 2011, 77% of TAC has been captured
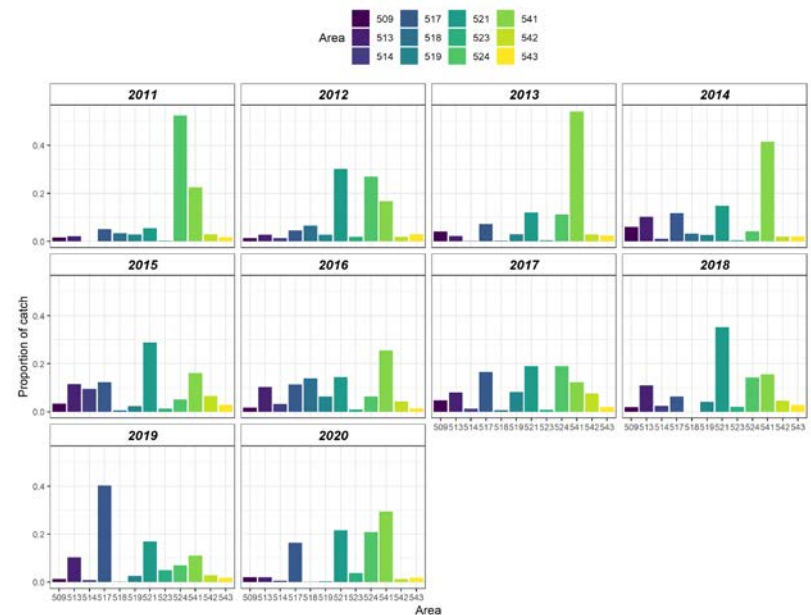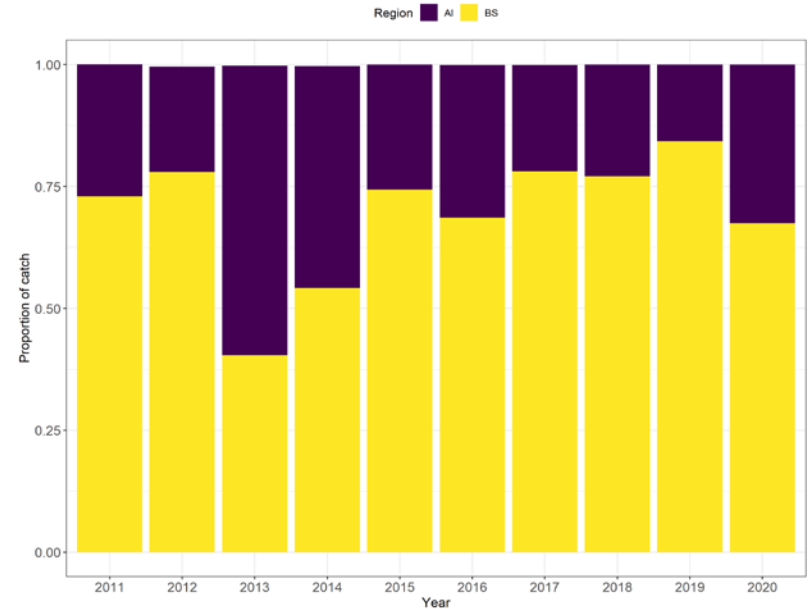
Survey biomass

+2% in 2019

Shelf survey length composition

Fishery length composition
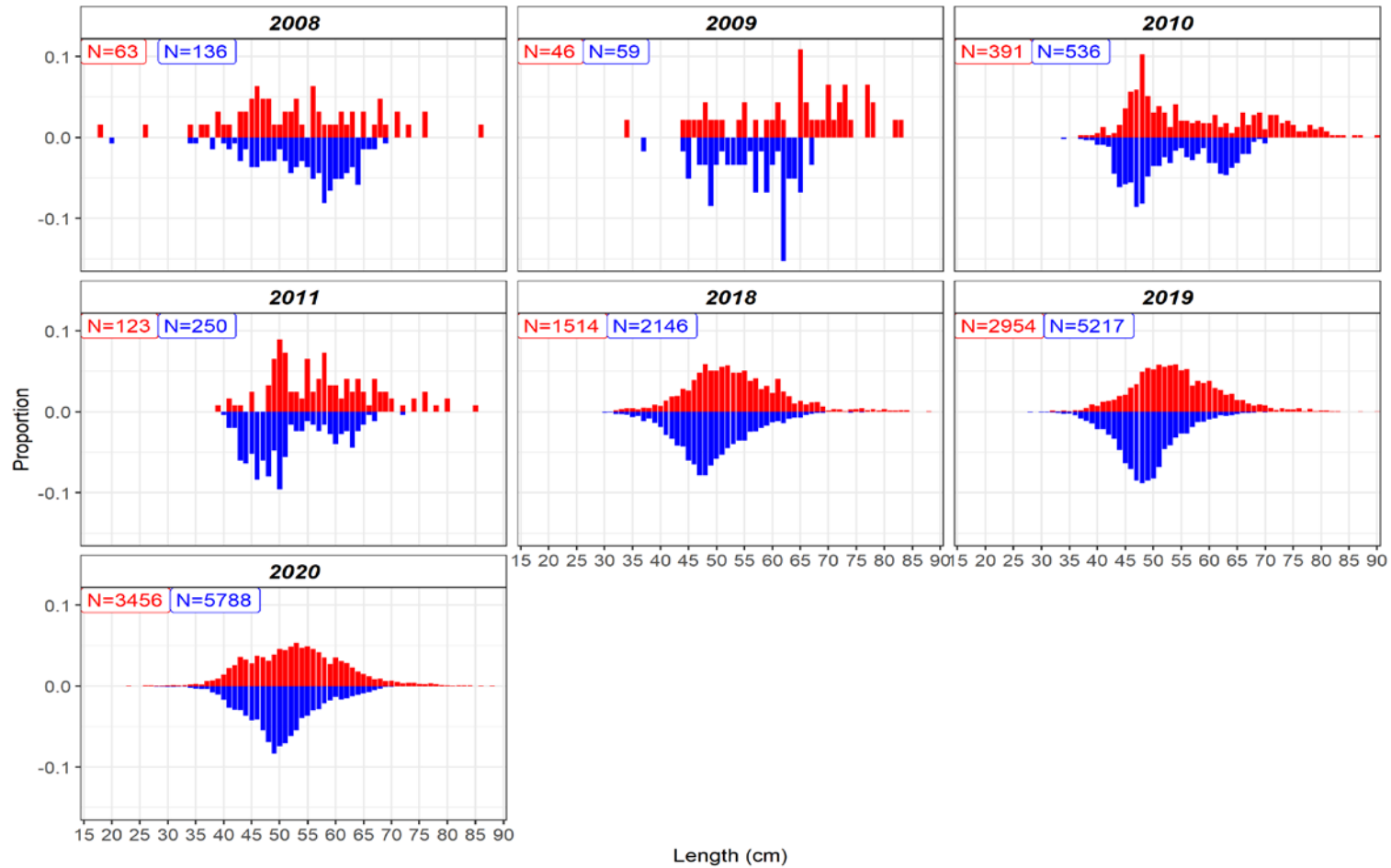
Age composition
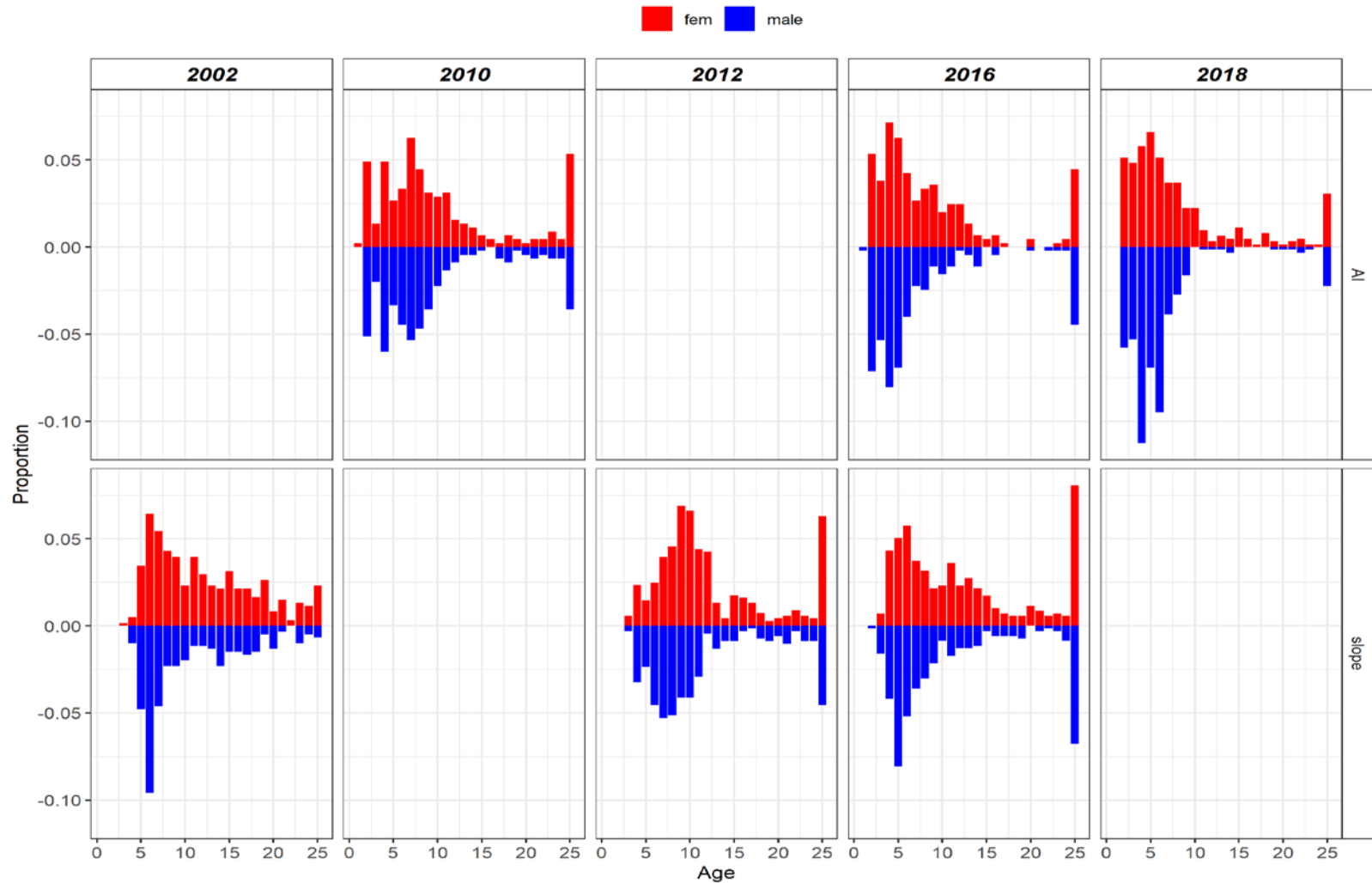
Base model structure

- Age structured model
  - Fishery and survey length observations were transformed by an age-length transition matrix
    - Growth estimated outside of the model
    - Data – RACE bottom trawl survey data from 2010 to present

Assessment year	2018			2020		
Sex	L_∞	k	t_0	L_∞	k	t_0
Female	82.59	0.084	-1.10	79.60	0.098	-0.802
Males	64.68	0.120	-0.959	60.73	0.149	-0.452
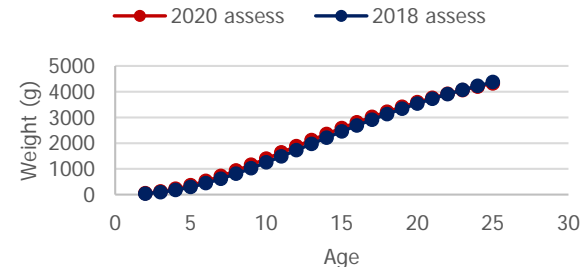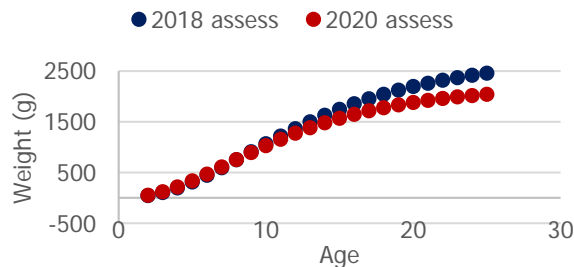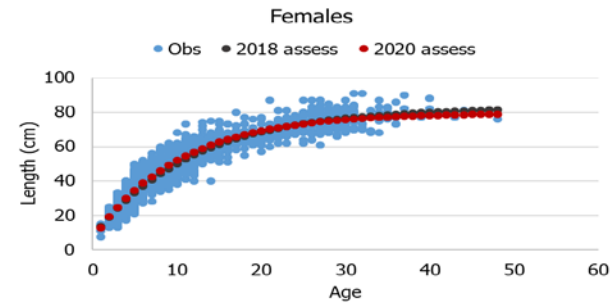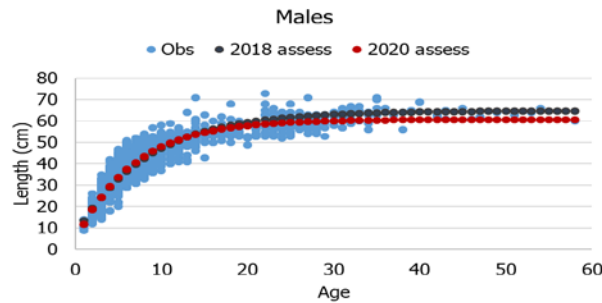
Female age-length transition matrix
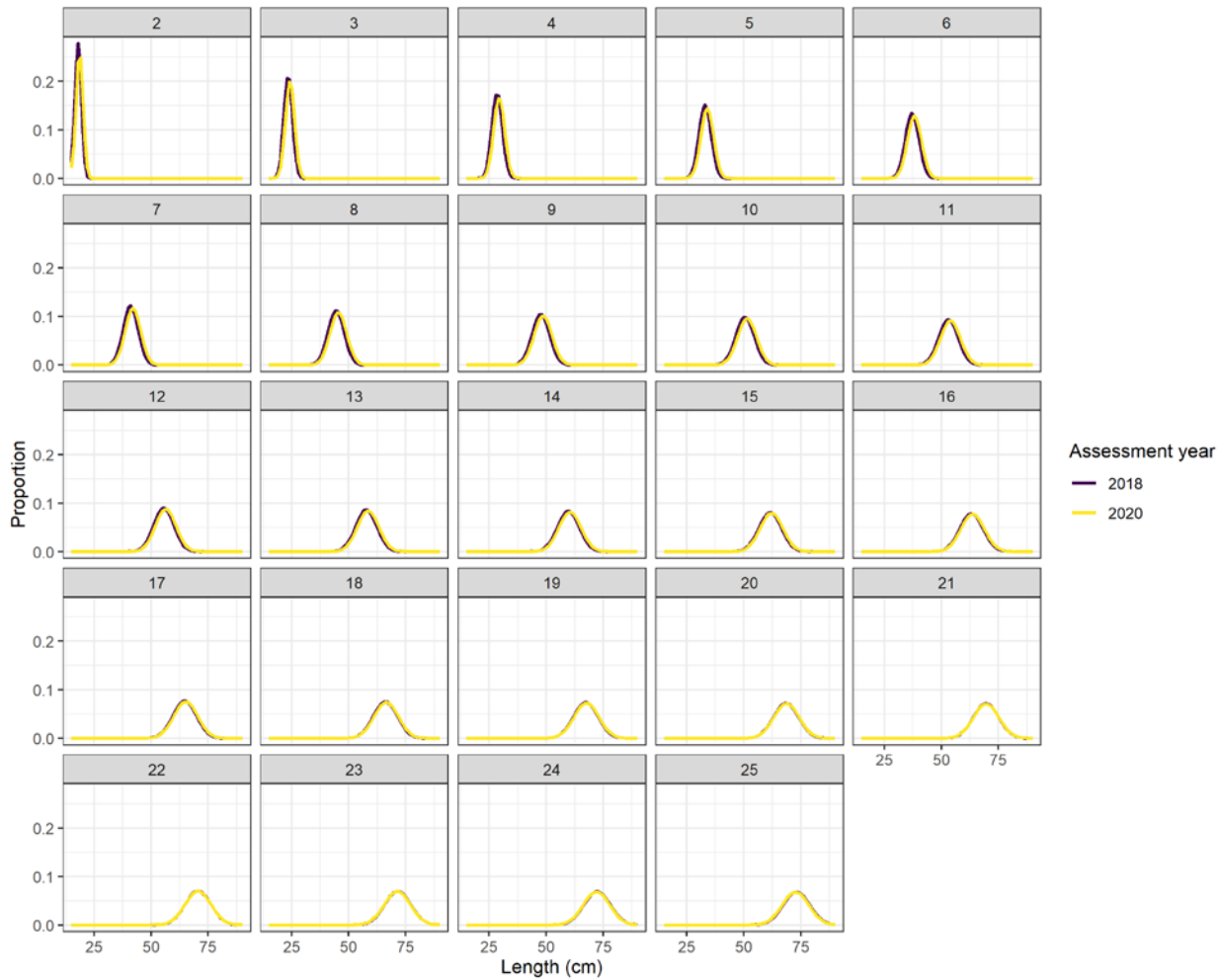
Male age-length transition matrix
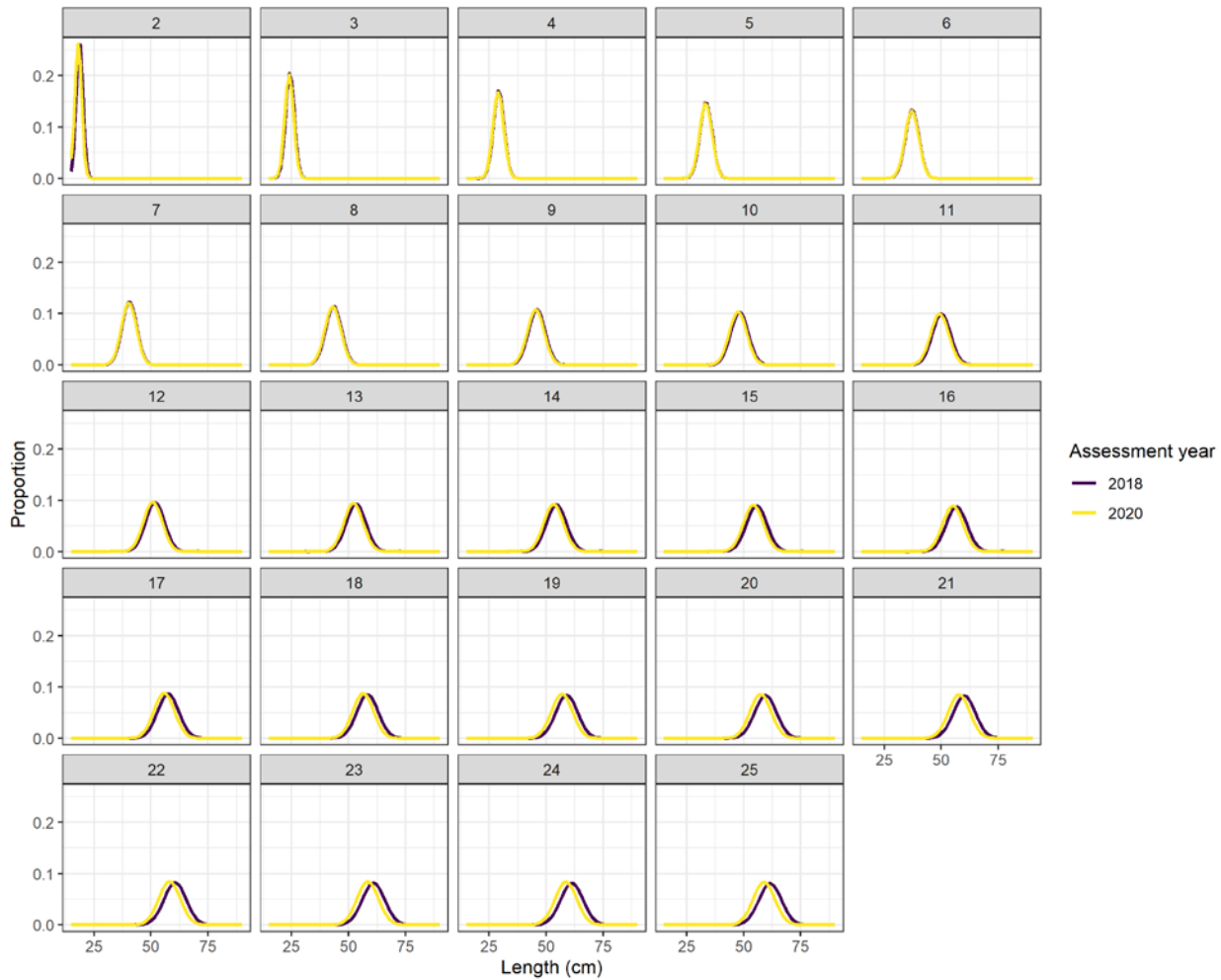
Models

- Model 16.0a (2018) – 2018 assessment
- Model 16.0a (2020) – Same as above with updated data
- **Model 16.0b – updated data and age-length transition matrix**

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Model fit to survey biomass indices
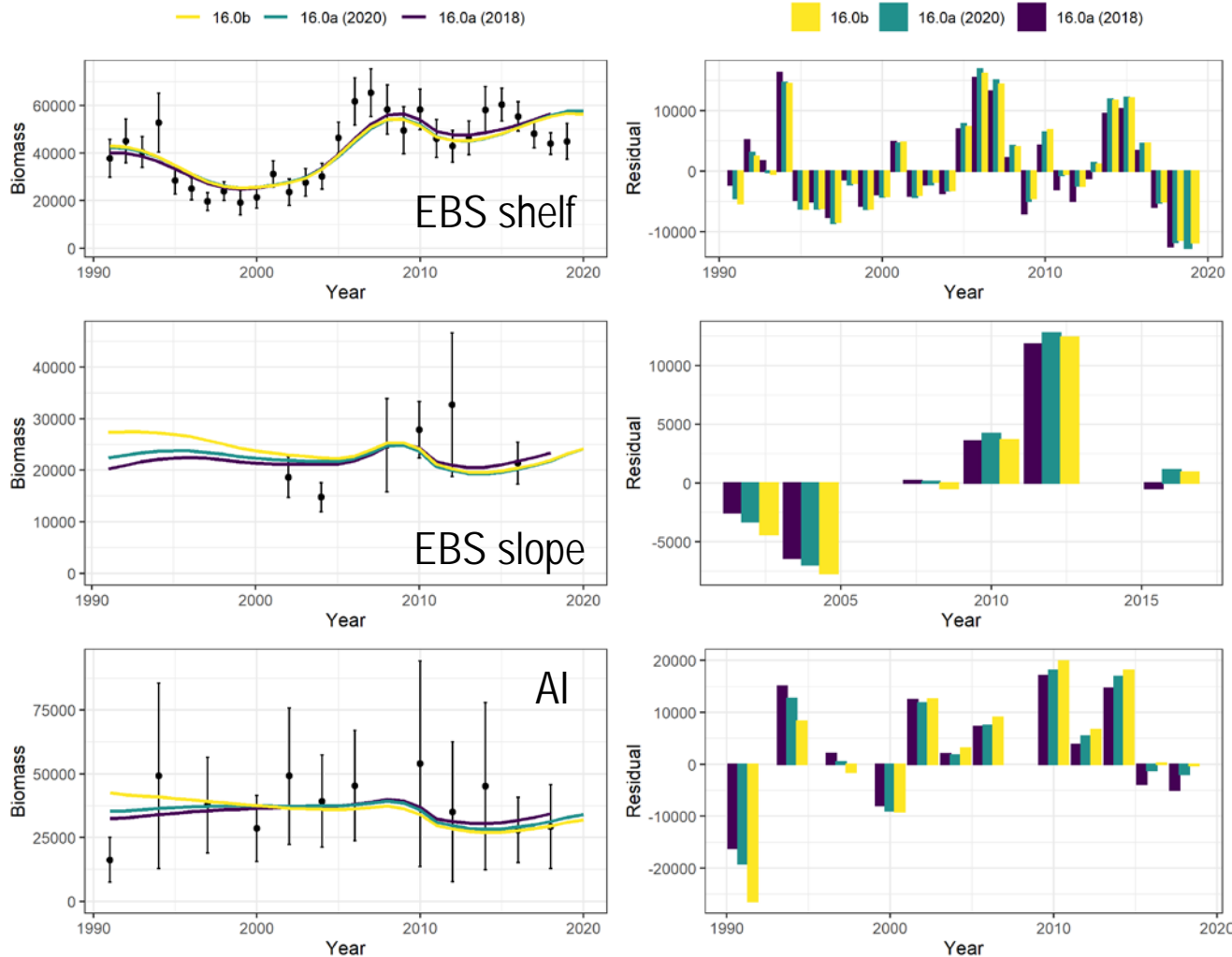
		RMSE	
Trawl survey	16.0a (2018)	16.0a (2020)	16.0b
EBS shelf	0.17	0.19	0.18
EBS slope	0.25	0.34	0.34
Aleutian Islands	0.31	0.33	0.38

EBS shelf survey length estimates

Model	Length	EBS shelf
16.0b	7351.95	5158.97
16.0a (2020)	7406.43	5224.13

Females   16.0b   16.0a (2020)   16.0a (2018)   Males
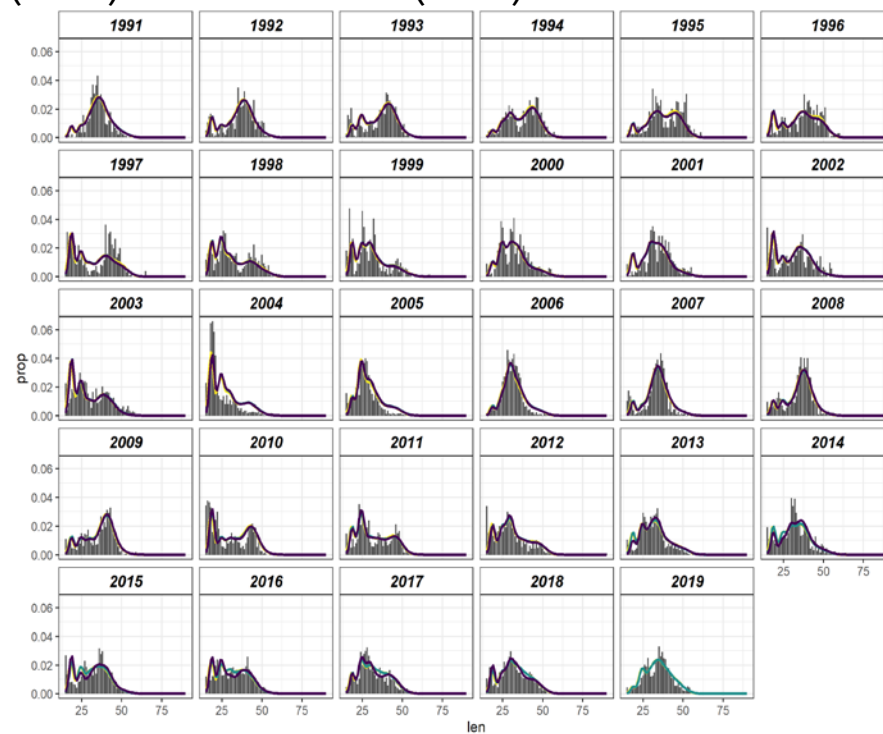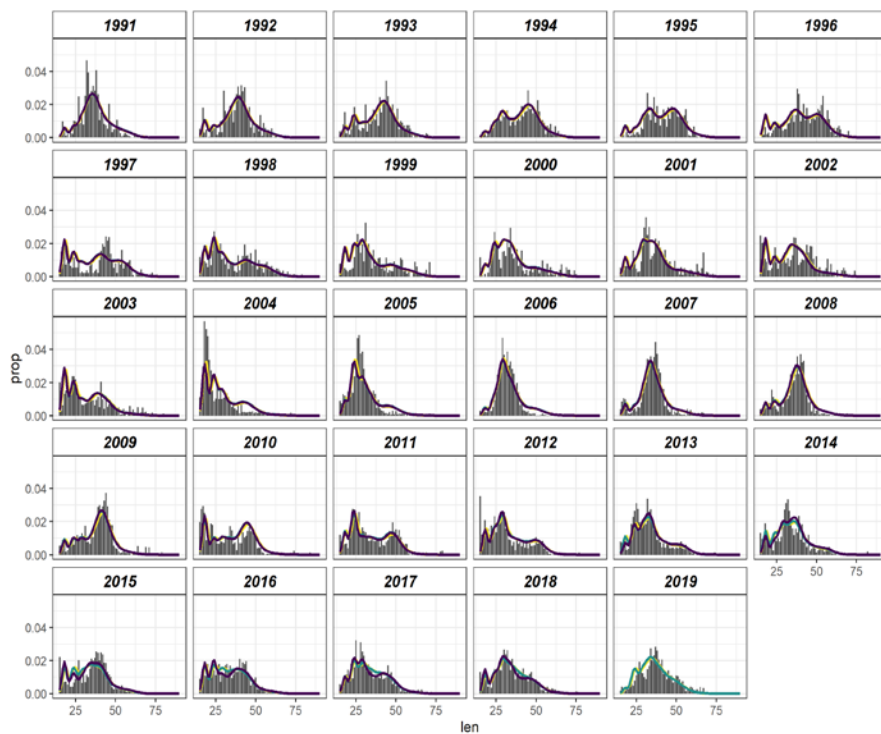
EBS slope survey length estimates

Model	Length	EBS slope
16.0b	7351.95	536.96
16.0a (2020)	7406.43	549.08
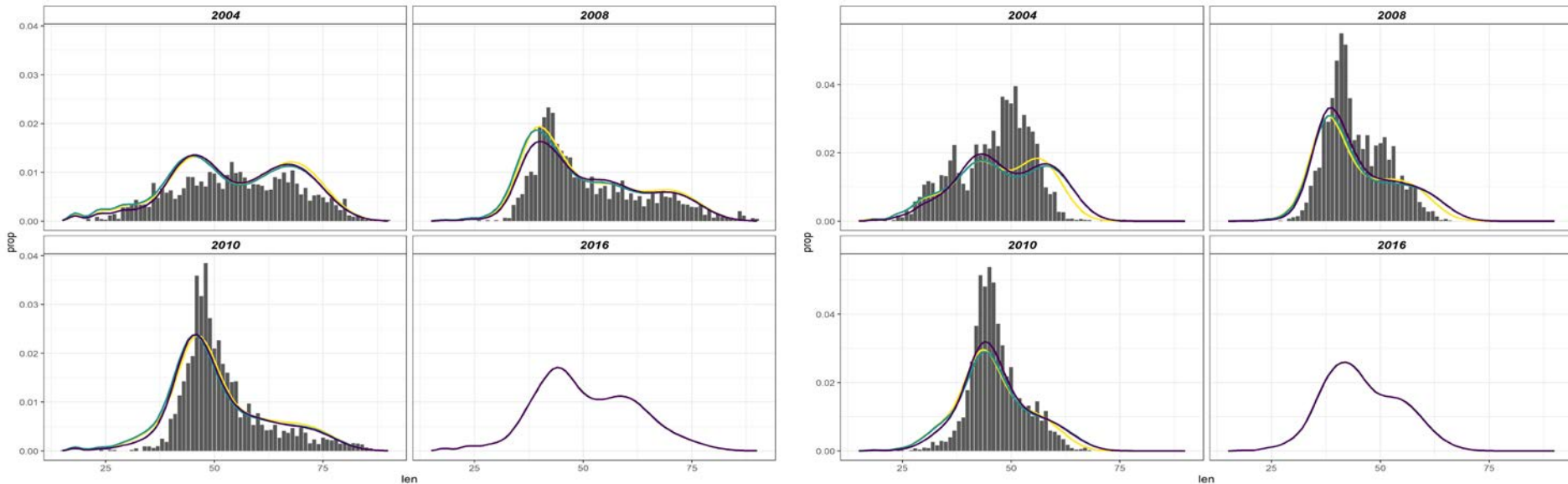
Aleutian Islands survey length estimates

Model	Length	AI
16.0b	7351.95	1559.25
16.0a (2020)	7406.43	1538.92
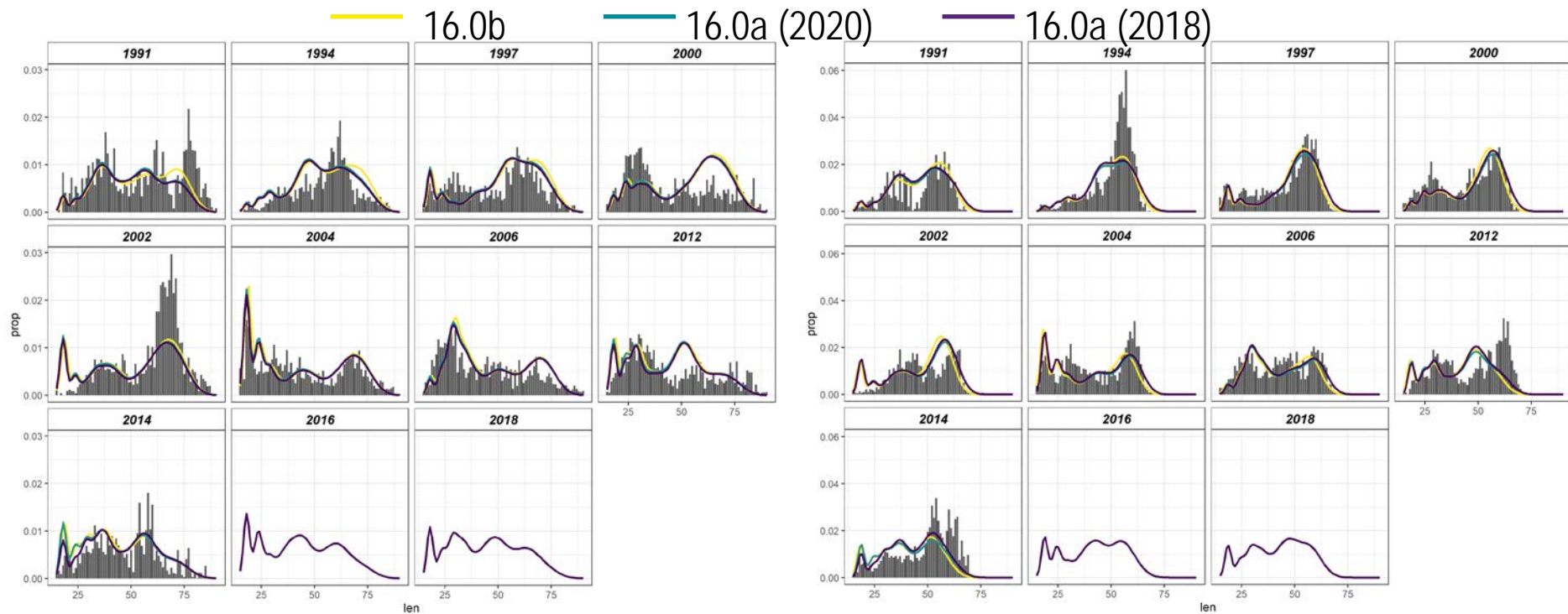
Model fit to age composition
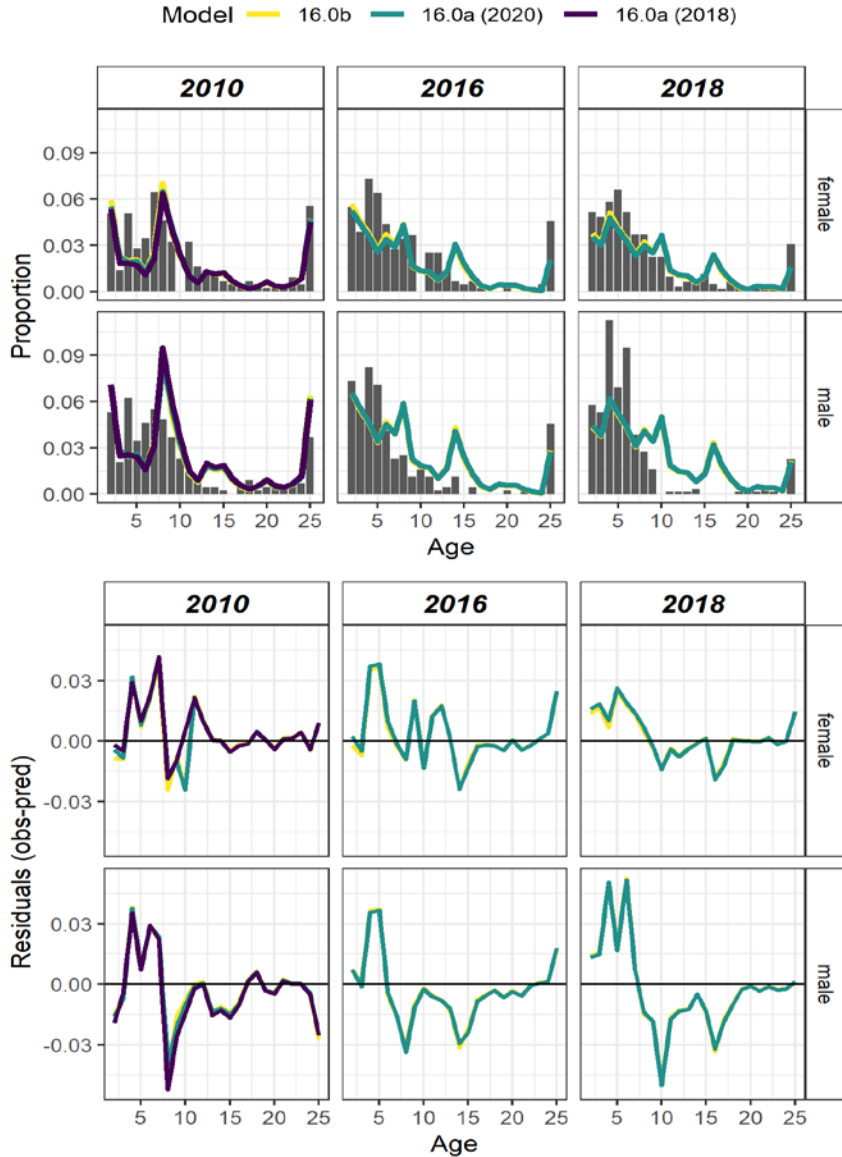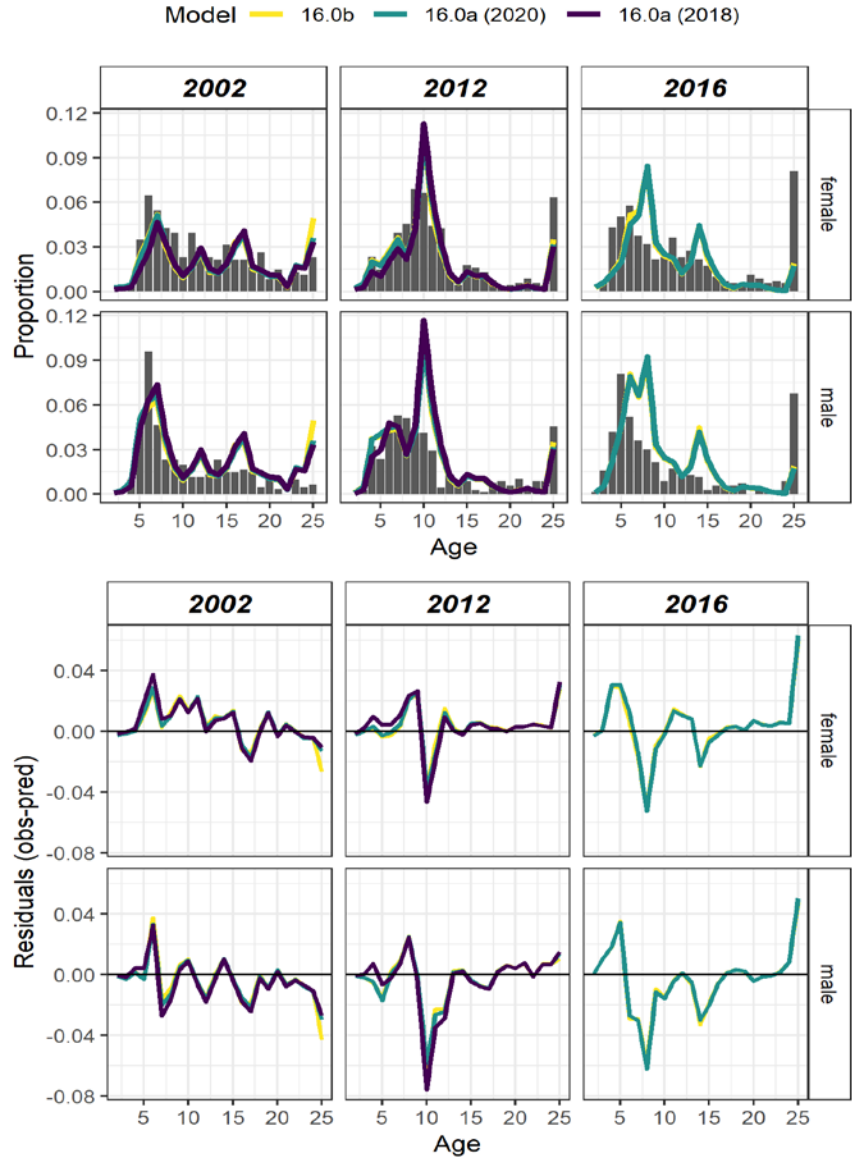
Selectivity
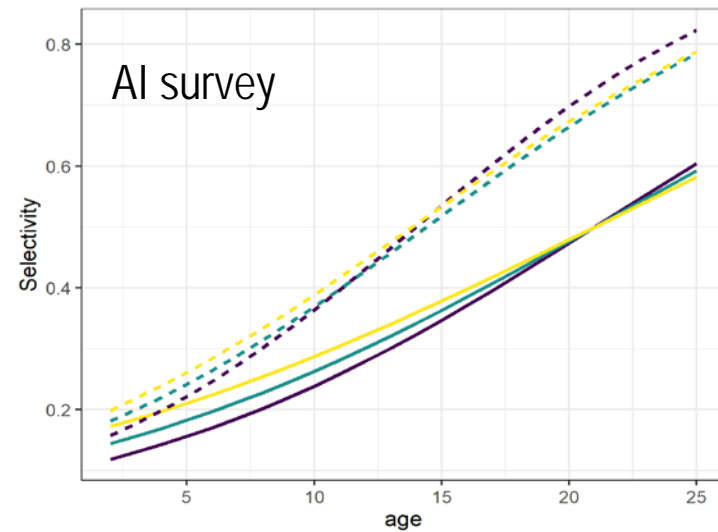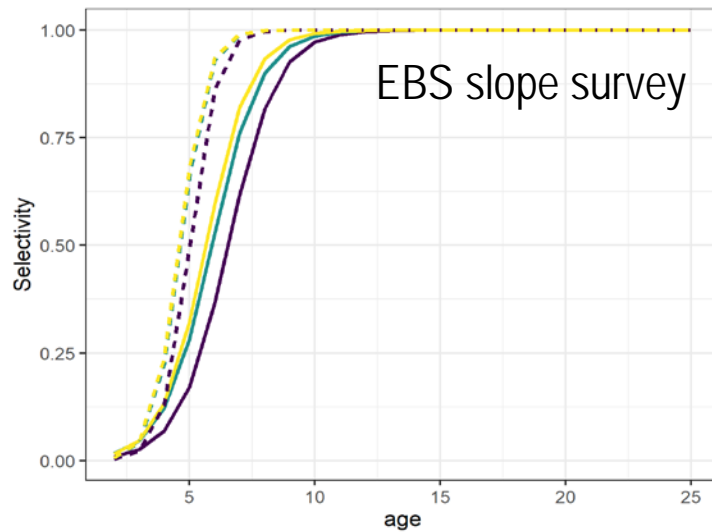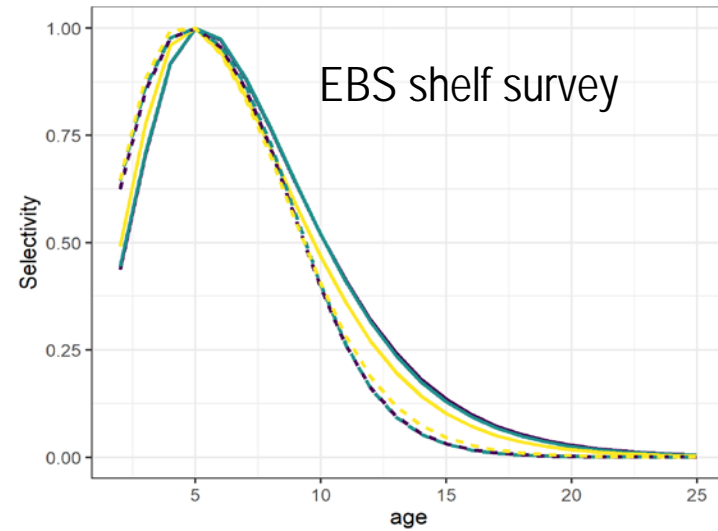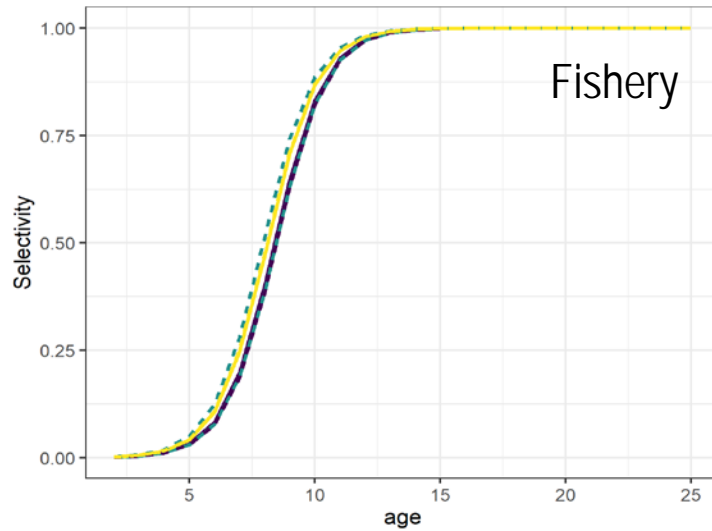
Likelihood comparison

Likelihood component	Model 16.0a	Model 16.0b
Total	3944.15	3886.28
Survey		
Shelf	70.81	66.92
Slope	12.93	14.53
AI	7.38	10.03
Length composition		
Shelf	5224.13	5158.97
Slope	549.08	536.96
AI	1538.92	1559.25
Fishery	94.30	96.78
Catch	0.00	0.00
Age composition		
Slope	-1730.65	-1730.20
AI	-1825.86	-1829.81

- Model 16.0b has a lower total likelihood
- Trade-offs are apparent
  - Model 16.0a has a better fit to the AI and fishery length composition estimates
  - Model 16.0b better fits the shelf and slope length data
  - Model 16.0b has a subtly better fit to the AI age composition data

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Time series results

Legend: 16.0b (yellow), 16.0a (2020) (teal), 16.0a (2018) (purple)

- Decline in 2010 is associated with the increase in F due to increased targeting
- Biomass estimates follow the trend in the model fit to the Aleutian Islands biomass estimates
  - Increase is due to growing cohort from 2010

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Retrospective analysis
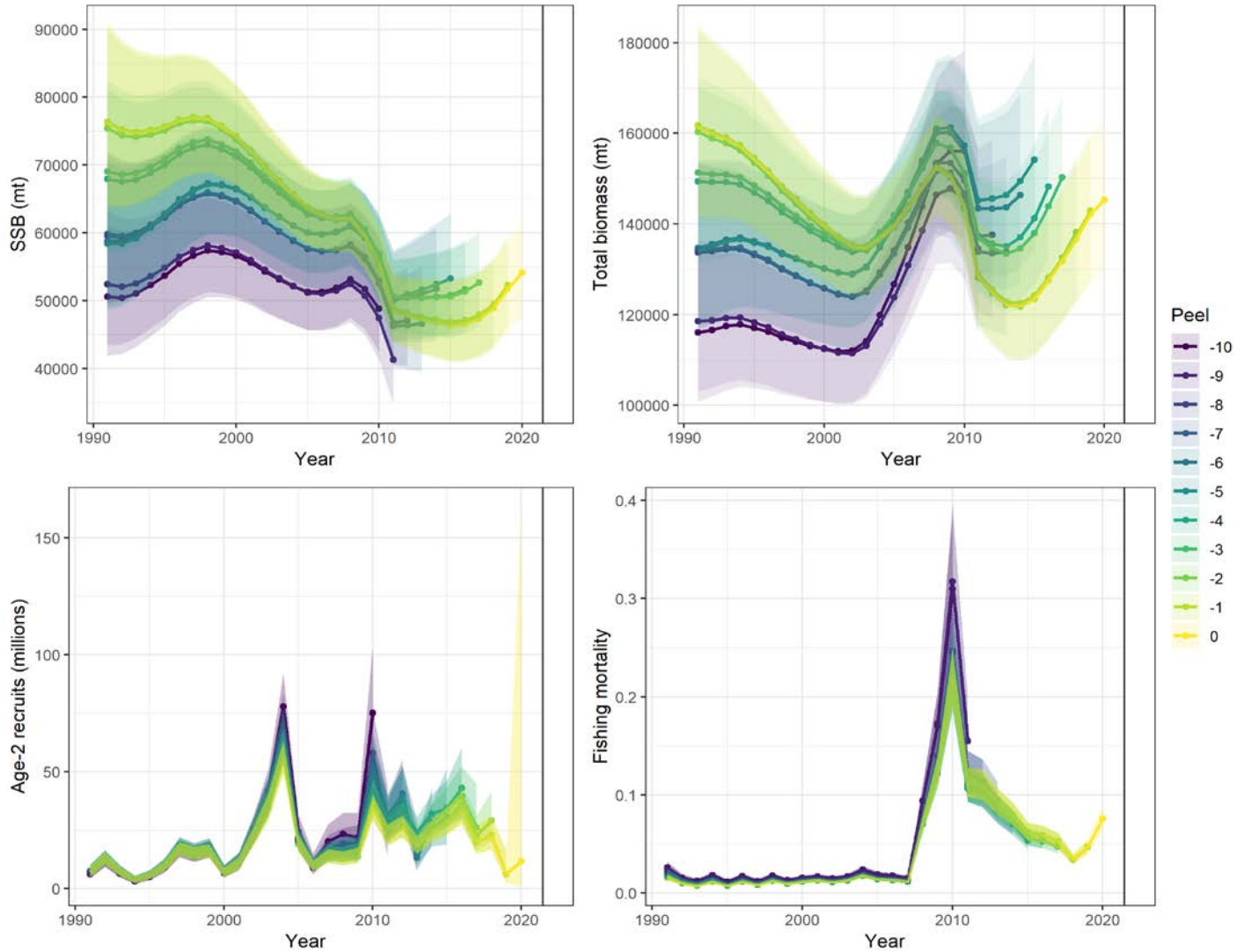
Mohn's rho			
SSB	Total biomass	Recruitment	F
0.020	0.111	0.262	0.034

Harvest recommendations

Quantity	As specified last year for		As estimated this year for	
	2020	2021	2021	2022
M (natural mortality rate)	0.11	0.11	0.11	0.11
Tier	3	3	3	3
Projected total (age 2+) biomass (t)	162,709	163,158	144,671	143,248
Projected female spawning biomass (t)	57,948	57,892	54,341	55,256
$B_{100\%}$	107,673	107,673	101,376	101,376
$B_{40\%}$	43,069	43,069	40,550	40,550
$B_{35\%}$	37,685	37,685	35,482	35,482
F_{OFL}	0.108	0.108	0.108	0.108
$maxF_{ABC}$	0.090	0.090	0.090	0.090
F_{ABC}	0.090	0.090	0.090	0.090
OFL (t)	11,495	11,472	10,630	10,843
maxABC (t)	9,708	9,688	8,982	9,163
ABC (t)	9,708	9,688	8,982	9,163
	As determined *last* year for:		As determined *this* year for:	
Status	2018	2019	2019	2020
Overfishing	no	n/a	no	n/a
Overfished	n/a	no	n/a	no
Approaching overfished	n/a	no	n/a	no

Risk table

Assessment-related considerations	Population dynamics considerations	Environmental/ ecosystem considerations	Fishery Performance considerations
Level 1: no increased concerns	Level 1: no increased concerns	Level 1: no increased concerns	Level 1: no increased concerns

- **Assessment related concerns**
  - ".. , fits to the length composition data from the EBS slope and Aleutian Islands trawl survey show consistent patterns that need to be addressed in the future. Age data from the EBS slope survey and Aleutian Islands survey are fairly limited for this stock and there is some conflict between the age and length data."
  - Survey uncertainty
    - "…the EBS slope survey has not been conducted since 2016 and adult Kamchatka are frequently encountered on the upper slope potentially leading to some uncertainty about the adult portion of the population in the Bering Sea."
    - Assessment used EBS shelf and Aleutian Islands bottom trawl surveys. The combined effect may lead to higher uncertainty than what was demonstrated in Bryan et al. (2020).

- **Population dynamics**
  - Population numbers have been declining the past few years, but overall numbers have been higher than average for the last decade or so and there is evidence of fairly regular recruitment

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Future directions

- Model may be overfitting the EBS shelf bottom trawl length composition data and creating patterns in the survey biomass residuals and other composition data. A formal data weighting method (e.g., Francis or McAllister-Ianelli) should be evaluated.

- Ageing error is not accounted for in this assessment and should be considered during the next assessment and may help to resolve conflicts between the length and age data.

- The RACE bottom trawl surveys (2010 – present) age and length data were aggregated given that there were no obvious differences between regions (Bering Sea and Aleutian Islands). There was some conflict between the length and age data and the data should be re-examined to ensure that regional differences in growth are not being obscured.

Divider Title

Additional Divider Information

	Age																							
Year	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1991	3.52	3.44	4.86	9.35	9.90	4.26	3.89	2.98	2.82	0.88	4.93	4.58	0.87	0.86	0.72	0.56	0.47	0.41	0.38	0.36	0.36	0.39	0.43	8.50
1992	6.37	3.15	3.08	4.36	8.37	8.85	3.80	3.46	2.64	2.50	0.77	4.35	4.04	0.76	0.76	0.64	0.50	0.41	0.36	0.33	0.32	0.32	0.34	7.88
1993	3.59	5.70	2.82	2.76	3.90	7.49	7.91	3.39	3.08	2.35	2.22	0.69	3.86	3.59	0.68	0.68	0.57	0.44	0.36	0.32	0.30	0.28	0.28	7.29
1994	1.80	3.21	5.11	2.53	2.47	3.49	6.70	7.06	3.02	2.74	2.09	1.97	0.61	3.43	3.19	0.60	0.60	0.50	0.39	0.32	0.28	0.26	0.25	6.74
1995	2.78	1.61	2.88	4.57	2.26	2.21	3.12	5.97	6.28	2.68	2.43	1.85	1.75	0.54	3.04	2.83	0.53	0.53	0.45	0.35	0.29	0.25	0.23	6.19
1996	4.76	2.49	1.44	2.58	4.10	2.03	1.98	2.78	5.32	5.59	2.39	2.16	1.64	1.55	0.48	2.70	2.51	0.48	0.47	0.40	0.31	0.26	0.22	5.71
1997	8.39	4.26	2.23	1.29	2.31	3.67	1.81	1.76	2.47	4.72	4.95	2.11	1.91	1.46	1.37	0.43	2.39	2.23	0.42	0.42	0.35	0.27	0.23	5.26
1998	7.45	7.52	3.82	2.00	1.16	2.07	3.28	1.61	1.57	2.20	4.19	4.40	1.88	1.70	1.29	1.22	0.38	2.13	1.98	0.37	0.37	0.31	0.24	4.87
1999	7.94	6.67	6.74	3.42	1.79	1.03	1.84	2.92	1.43	1.39	1.95	3.71	3.89	1.66	1.50	1.15	1.08	0.33	1.88	1.75	0.33	0.33	0.28	4.53
2000	3.31	7.11	5.98	6.03	3.06	1.60	0.92	1.65	2.60	1.27	1.23	1.73	3.29	3.46	1.47	1.34	1.02	0.96	0.30	1.67	1.55	0.29	0.29	4.26
2001	5.24	2.97	6.37	5.35	5.40	2.74	1.43	0.82	1.46	2.30	1.13	1.09	1.53	2.92	3.06	1.31	1.18	0.90	0.85	0.26	1.48	1.38	0.26	4.03
2002	11.05	4.70	2.66	5.71	4.79	4.83	2.45	1.28	0.73	1.30	2.04	1.00	0.97	1.36	2.58	2.71	1.16	1.05	0.80	0.75	0.23	1.31	1.22	3.80
2003	17.32	9.90	4.21	2.38	5.11	4.29	4.32	2.18	1.13	0.65	1.15	1.81	0.89	0.86	1.20	2.29	2.40	1.02	0.93	0.71	0.67	0.21	1.16	4.44
2004	28.03	15.51	8.87	3.77	2.13	4.57	3.83	3.85	1.94	1.00	0.57	1.02	1.60	0.78	0.76	1.06	2.02	2.12	0.91	0.82	0.62	0.59	0.18	4.96
2005	9.56	25.10	13.90	7.94	3.37	1.91	4.08	3.40	3.40	1.71	0.89	0.51	0.90	1.41	0.69	0.67	0.94	1.78	1.87	0.80	0.72	0.55	0.52	4.53
2006	4.73	8.56	22.49	12.45	7.11	3.02	1.70	3.63	3.02	3.01	1.51	0.78	0.45	0.79	1.24	0.61	0.59	0.83	1.57	1.65	0.70	0.64	0.49	4.46
2007	6.86	4.23	7.67	20.14	11.14	6.36	2.69	1.52	3.22	2.67	2.66	1.34	0.69	0.40	0.70	1.10	0.54	0.52	0.73	1.39	1.46	0.62	0.56	4.37
2008	6.37	6.15	3.79	6.87	18.03	9.97	5.68	2.40	1.35	2.86	2.37	2.36	1.18	0.61	0.35	0.62	0.97	0.48	0.46	0.65	1.23	1.29	0.55	4.37
2009	6.99	5.70	5.51	3.39	6.14	16.04	8.79	4.94	2.06	1.14	2.41	1.99	1.98	0.99	0.51	0.29	0.52	0.82	0.40	0.39	0.54	1.04	1.09	4.14
2010	17.30	6.26	5.10	4.92	3.02	5.42	13.91	7.40	4.03	1.64	0.90	1.89	1.57	1.56	0.78	0.40	0.23	0.41	0.64	0.31	0.30	0.43	0.81	4.10
2011	11.25	15.49	5.60	4.56	4.37	2.64	4.59	11.21	5.65	2.97	1.19	0.65	1.36	1.12	1.11	0.56	0.29	0.17	0.29	0.46	0.23	0.22	0.31	3.51
2012	13.07	10.08	13.87	5.01	4.06	3.87	2.30	3.90	9.27	4.59	2.39	0.95	0.52	1.09	0.90	0.89	0.45	0.23	0.13	0.23	0.37	0.18	0.17	3.06
2013	9.10	11.71	9.02	12.40	4.46	3.60	3.37	1.96	3.23	7.55	3.71	1.92	0.77	0.42	0.87	0.72	0.72	0.36	0.19	0.11	0.19	0.30	0.14	2.59
2014	12.12	8.15	10.48	8.07	11.07	3.96	3.15	2.89	1.64	2.67	6.19	3.03	1.57	0.63	0.34	0.71	0.59	0.58	0.29	0.15	0.09	0.15	0.24	2.24
2015	14.13	10.85	7.30	9.38	7.21	9.83	3.48	2.72	2.45	1.37	2.22	5.13	2.51	1.30	0.52	0.28	0.59	0.49	0.48	0.24	0.13	0.07	0.13	2.05
2016	16.77	12.66	9.72	6.53	8.38	6.41	8.67	3.02	2.33	2.08	1.16	1.87	4.32	2.11	1.09	0.44	0.24	0.50	0.41	0.41	0.20	0.11	0.06	1.83
2017	9.97	15.02	11.33	8.70	5.83	7.46	5.66	7.55	2.60	1.98	1.76	0.98	1.58	3.65	1.78	0.92	0.37	0.20	0.42	0.35	0.34	0.17	0.09	1.60
2018	11.38	8.93	13.45	10.14	7.77	5.20	6.60	4.95	6.52	2.22	1.69	1.50	0.83	1.34	3.10	1.52	0.78	0.31	0.17	0.36	0.29	0.29	0.15	1.43
2019	3.09	10.19	8.00	12.05	9.07	6.94	4.62	5.81	4.33	5.67	1.93	1.46	1.30	0.72	1.16	2.68	1.31	0.68	0.27	0.15	0.31	0.25	0.25	1.37
2020	5.87	2.77	9.13	7.16	10.77	8.09	6.14	4.04	5.04	3.72	4.86	1.65	1.25	1.11	0.62	0.99	2.29	1.12	0.58	0.23	0.13	0.26	0.22	1.38

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