# GOA Rex Sole

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November 2021

- Rex sole is caught by bottom trawl only (no substantial catches by any other gear have occurred)

- Trawling in most of the Eastern GOA is not permitted (almost no catches there)

- 8-40% of the TAC and ABC are caught each year (except 1995-1996, potentially 2021)

- ABCs have been generally low due to use of a Tier 5 approach for management (FABC = 0.75*M) used prior to 2017

- Tier 5 was used because F40% and F35% from old models were thought to be unrealistically high

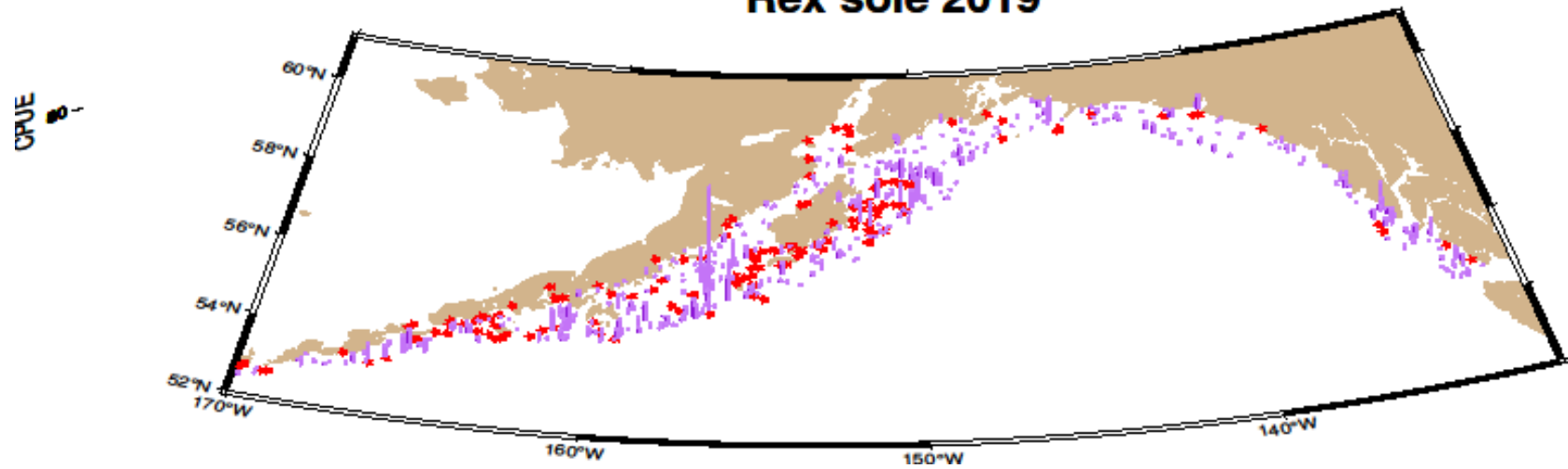- Catches for 1982-1994 calculated by multiplying deepwater flatfish catch by fraction of rex in observed catch
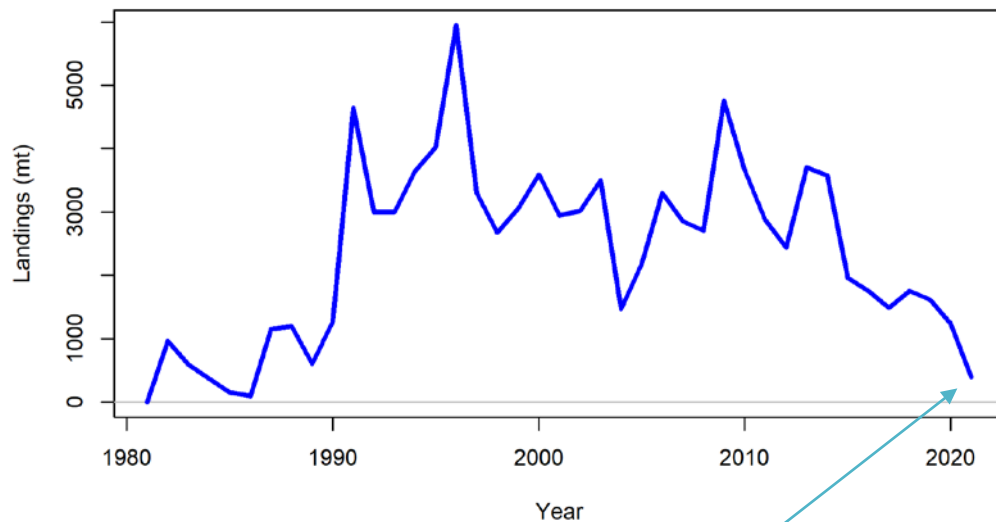
This year's catch is VERY low:
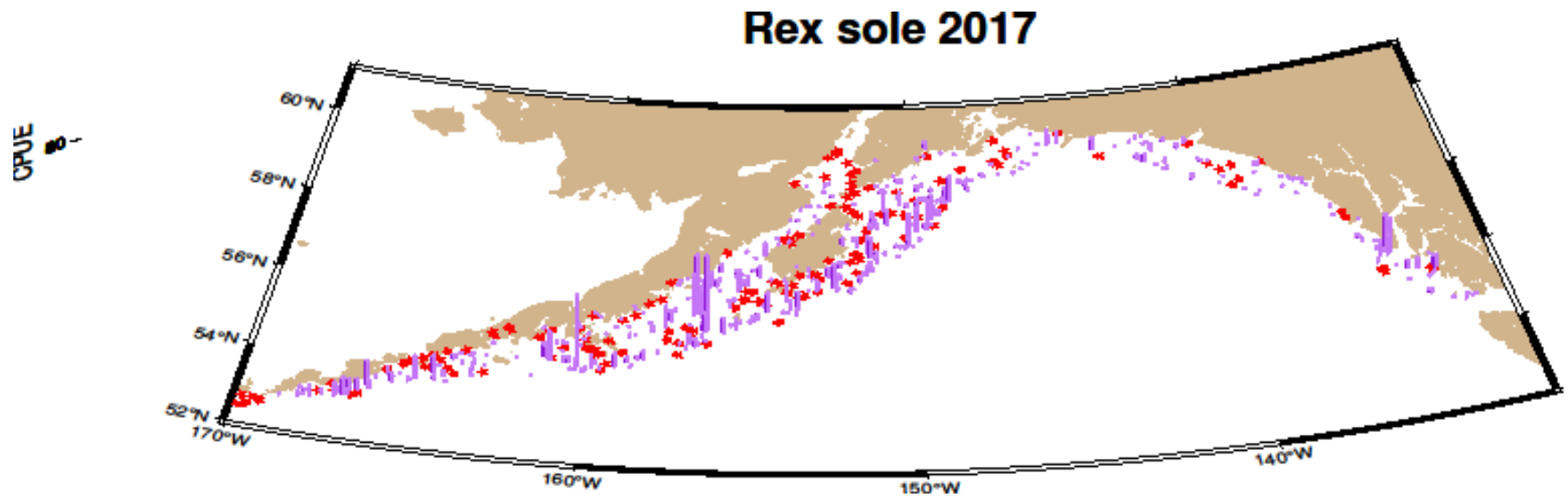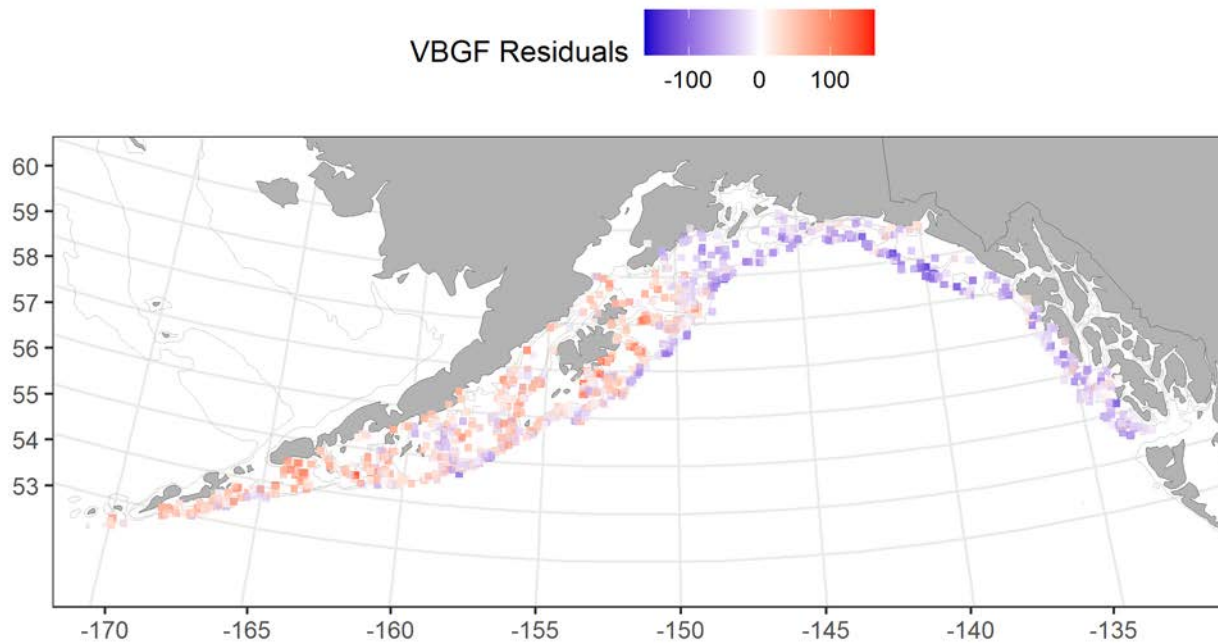Closure of non-Pollock, non-Rockfish Program CVs March – August

Survey CPUE
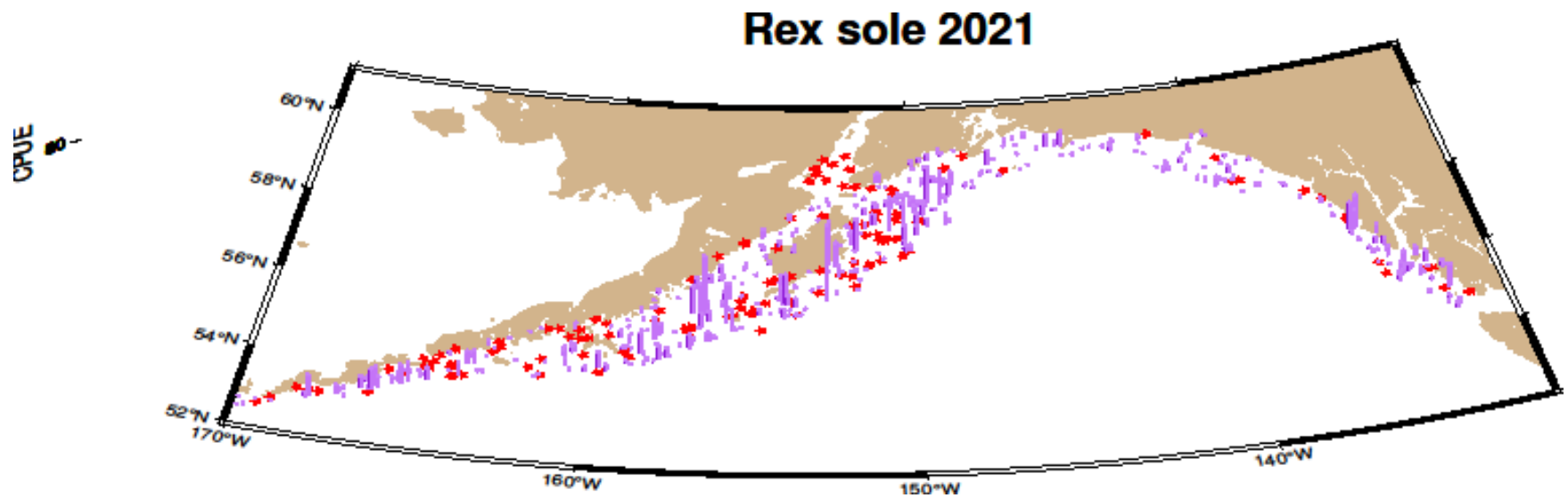
Rex sole 2021

Survey CPUE

Rex sole 2019

Survey CPUE

Rex sole 2017

Spatial differences in growth rates

Data

| Source	Data	Years
NMFS Groundfish Survey	Survey Biomass	1984-1999 (triennial); 2001-2021 (biennial)
	Ages Conditioned on Length	1984, 1987, 1993, 1999; 2001-2019 (biennial)
	Age Composition*	1984, 1987, 1993, 1999; 2001-2019 (biennial)
	Length Composition	1984-1999 (triennial); 2001-2021 (biennial)
U.S. Trawl Fisheries	Catch	1982-2021 (Sept 26, 2021-Dec 31, 2021 projected)
	Length Composition[+]	1982-1984, 1990-2021
	Age Composition	1992,1995,1999,2003,2005,2007,2009,2010,2012 2014-2020

Model structure (from 2017)

- Two area model
- Growth estimated (internally) within each area to account for differences in length-at-age between the Eastern GOA and the Western-Central GOA.
- A recruitment allocation parameter (non-time-varying) was estimated to distribute recruitment between the Eastern GOA and Western-Central GOA and otherwise no movement between areas was modeled.
- Fishery selectivity was estimated only for the Western-Central region where the fishery occurs.
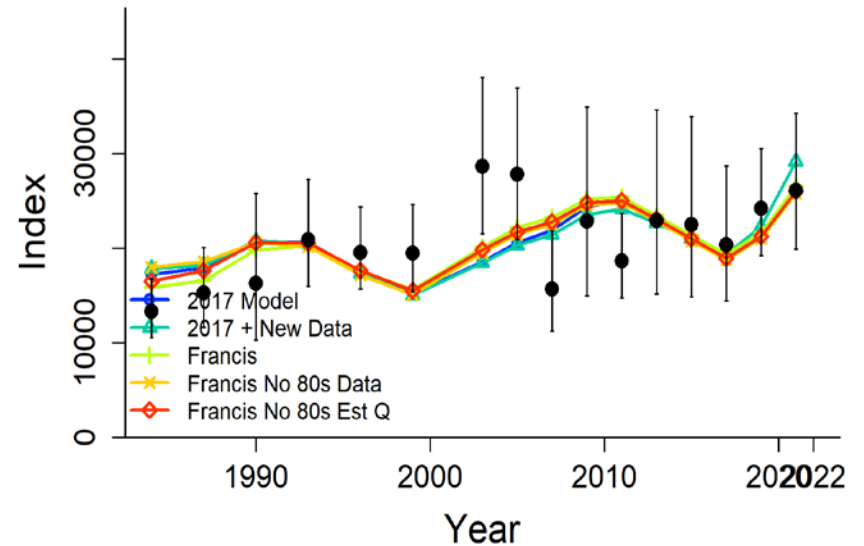
A few small updates (Model 21.0)

- Francis (2011) data weighting methods

- Omit 1984 and 1987 survey data

- Estimate survey catchability with a normal prior based on survey efficiency studies by Somerton and Munro (2001)

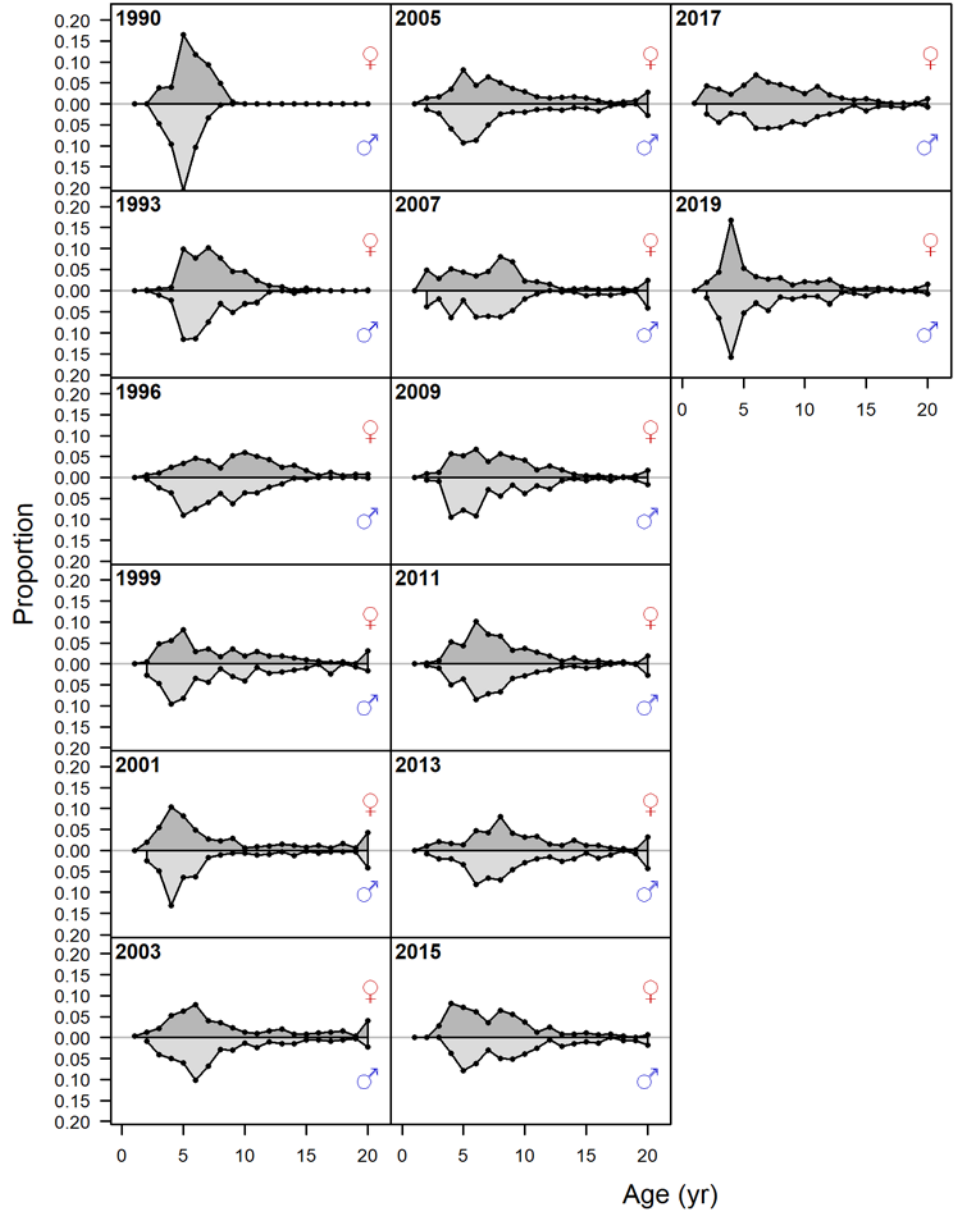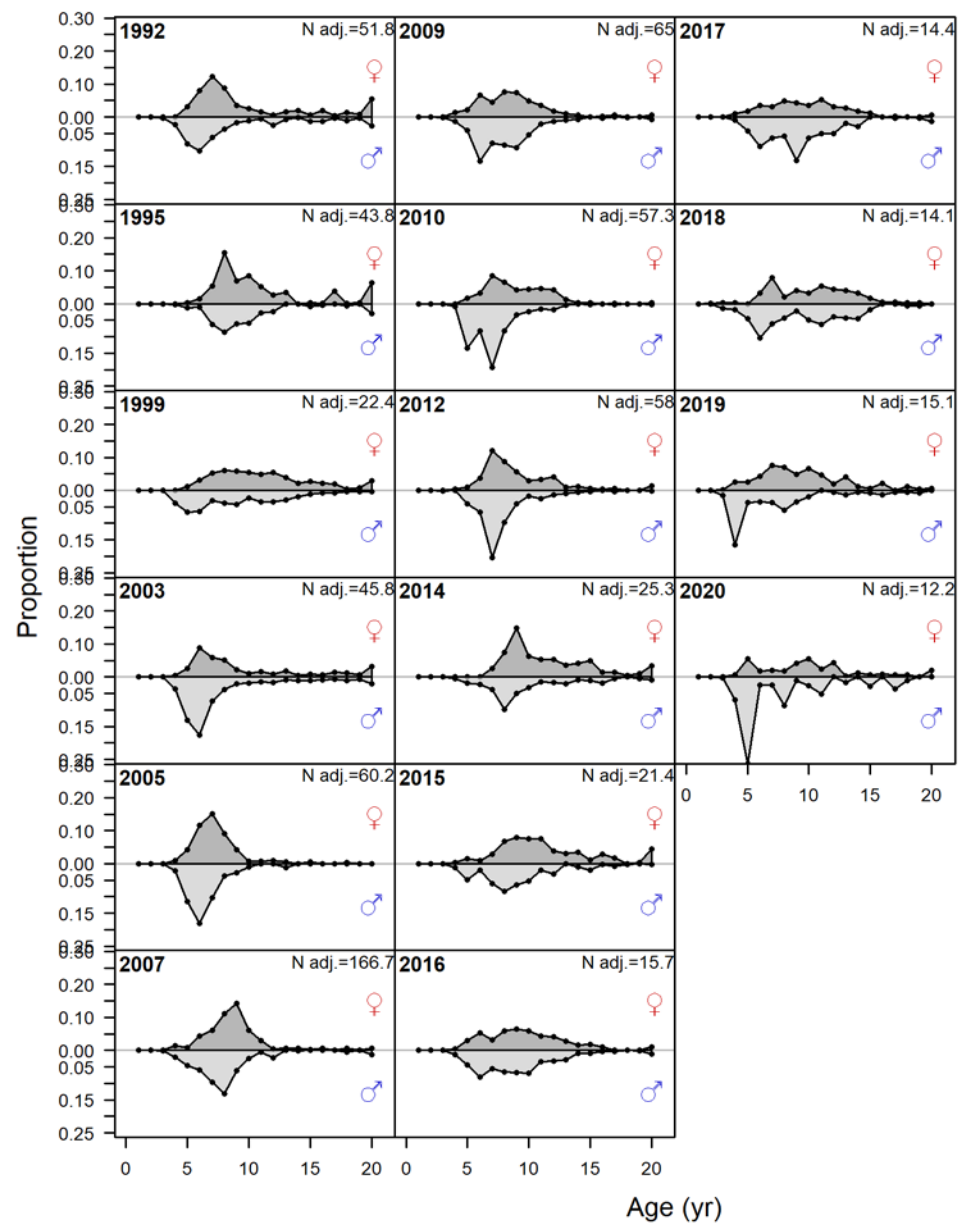# Mini bridging analysis: survey indices

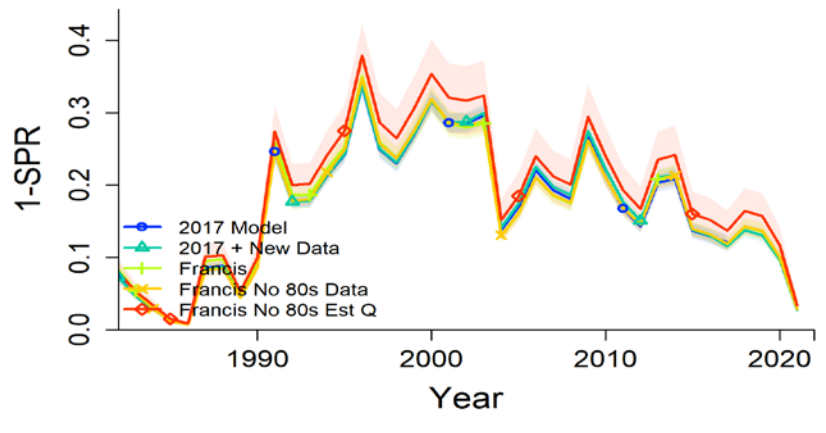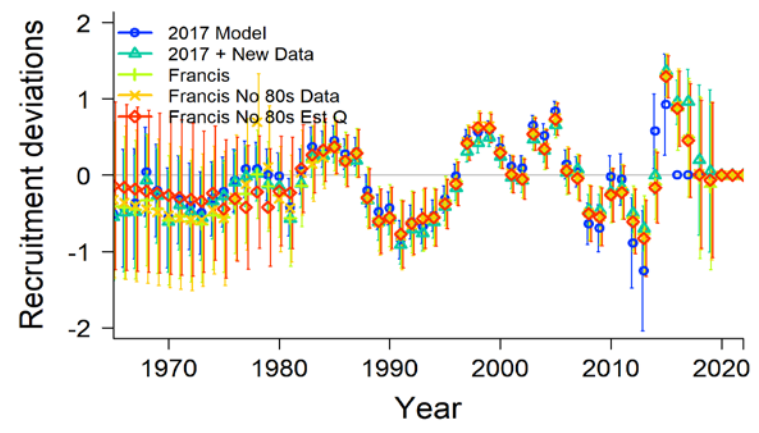### Western-Central GOA
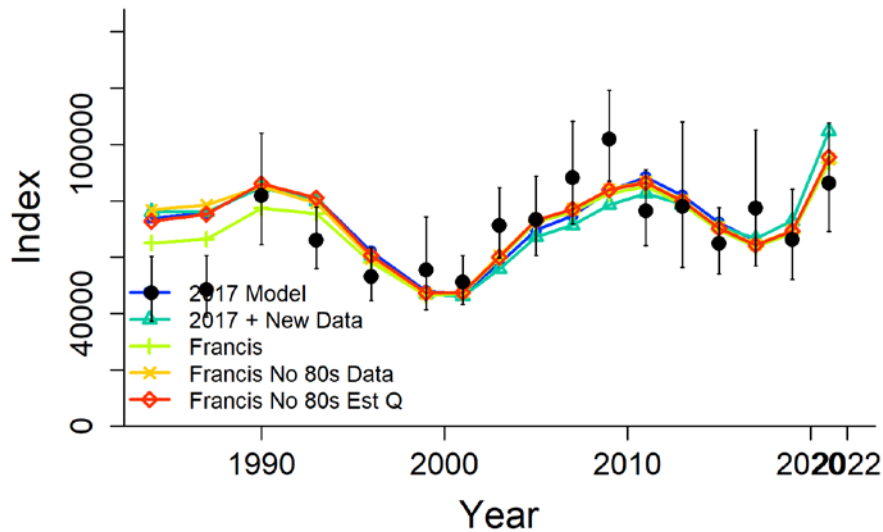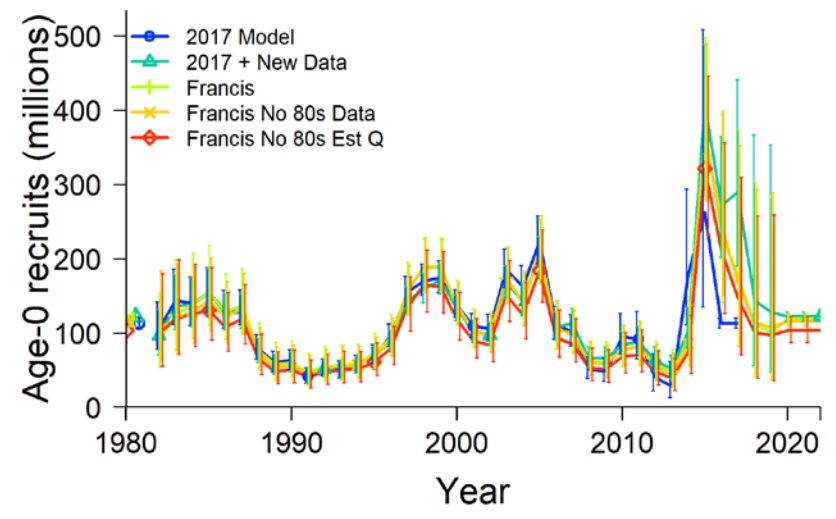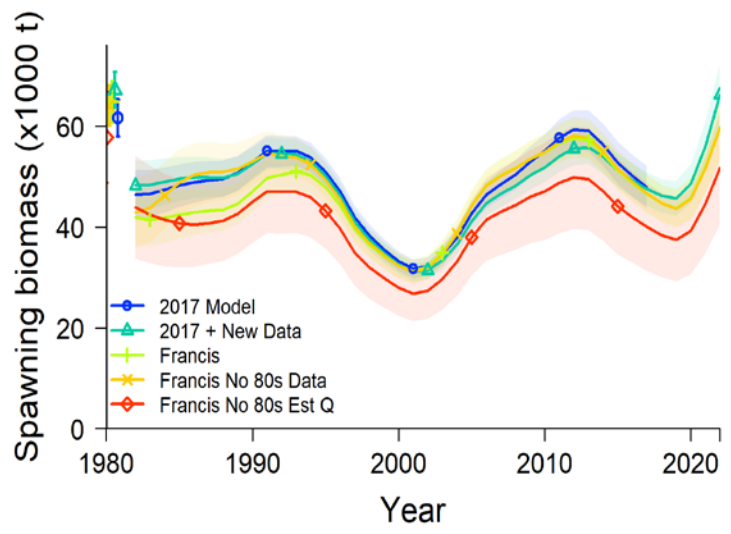
Eastern GOA

Recent, large year class in survey data

Recent, large year classes in fishery data

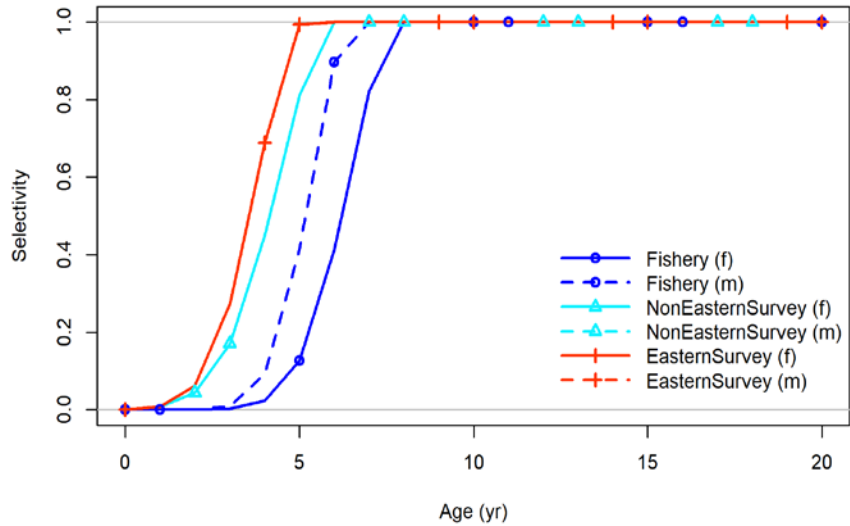# Mini bridging analysis

Selectivity-at-age

Model 17.2

Model 21.0
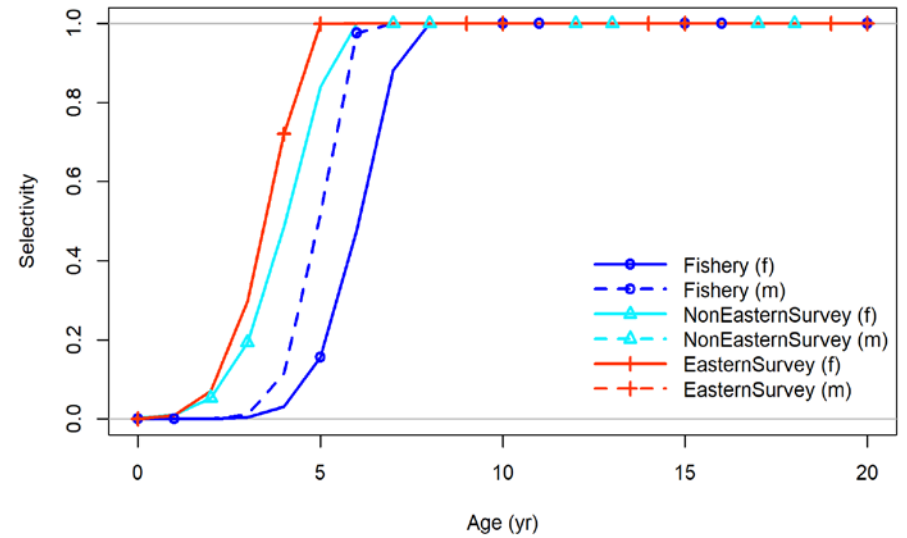
Selectivity-at-age vs Maturity-at-age

Old one-area model, no fishery age data
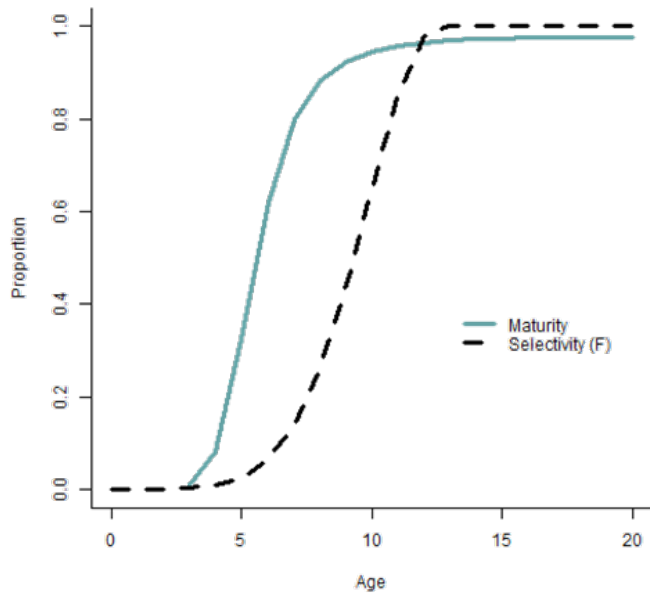
Model 21.0
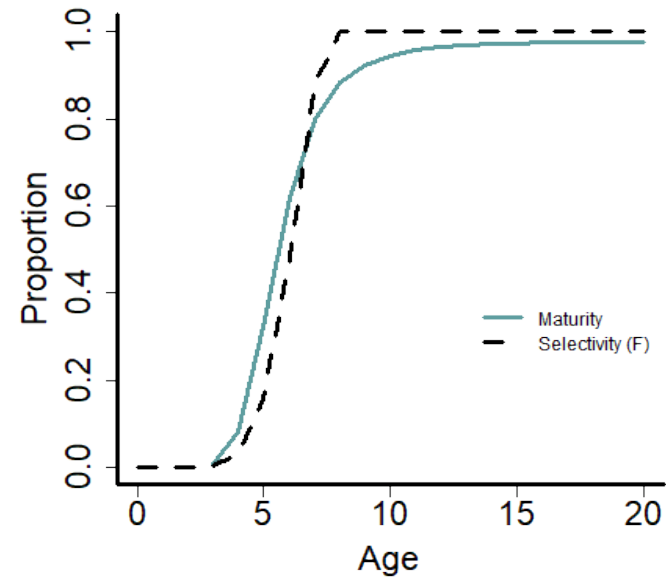
Biomass and recruitment distribution (Model 21.0)
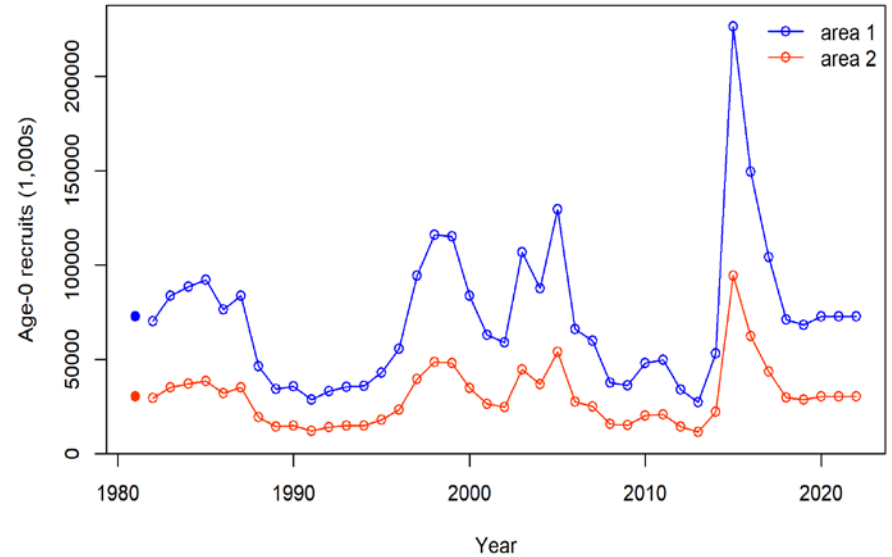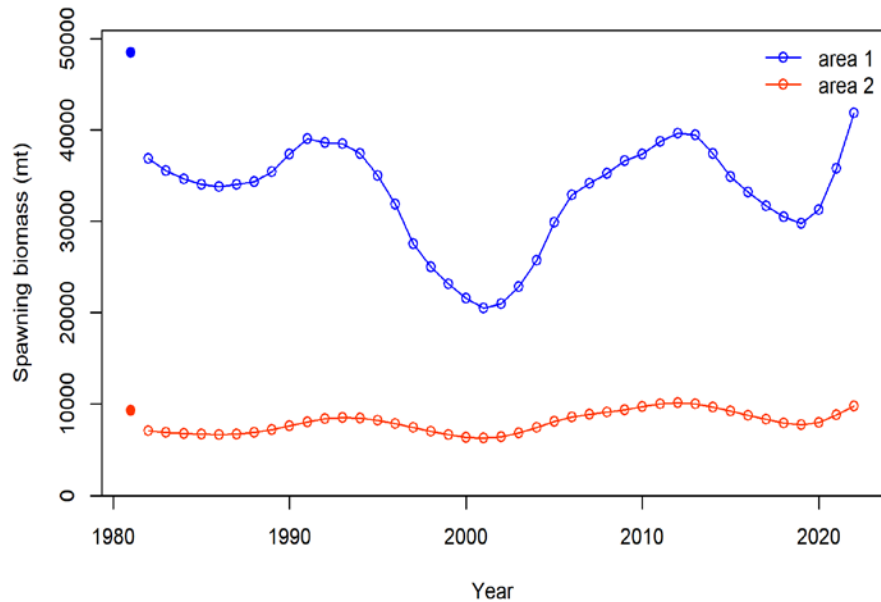
Fits to length composition data, aggregated over years

Model 17.2

Model 21.0

Fits to fishery age data, aggregated over years

Model 17.2

Model 21.0

Fits to age-length data, aggregated over years, Model 21.0
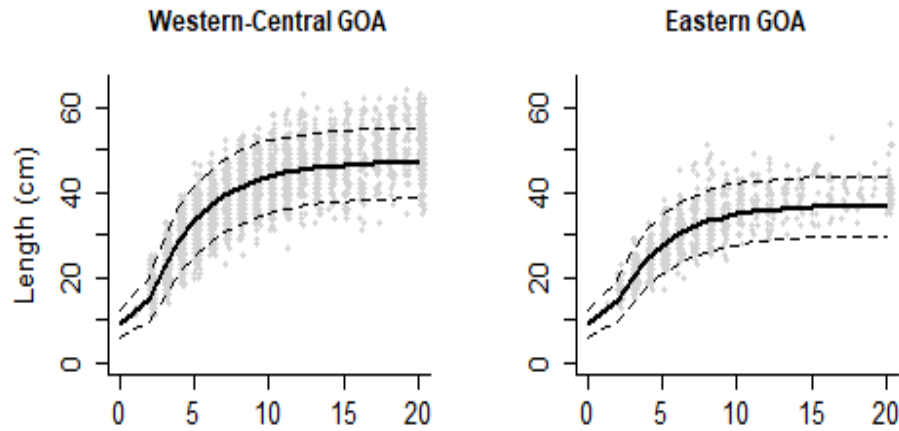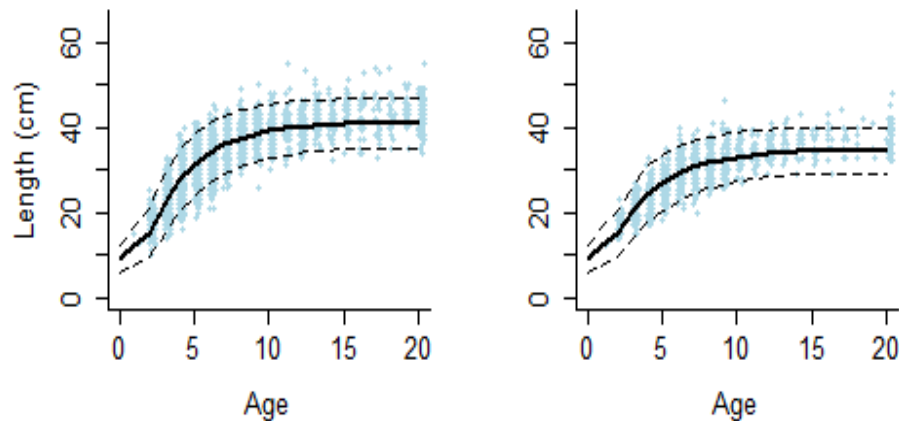
Retrospective analysis
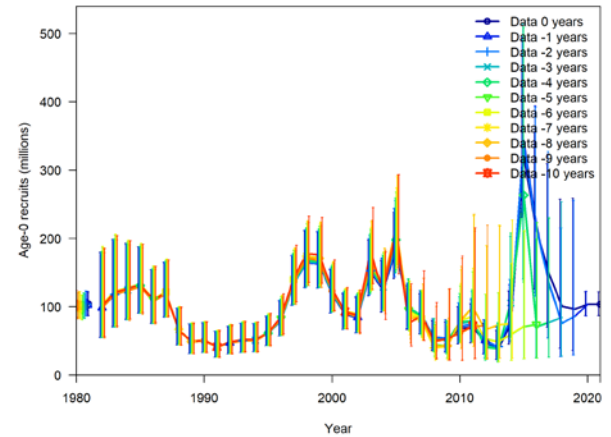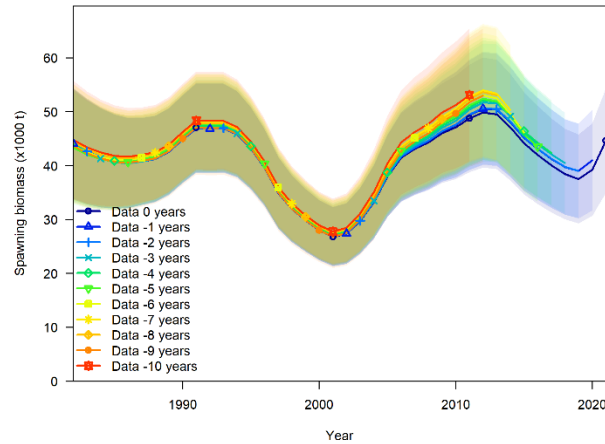
Mohn's rho

Spawning Biomass	Recruitment	Fishing Mortality
0.057	-0.073	-0.055
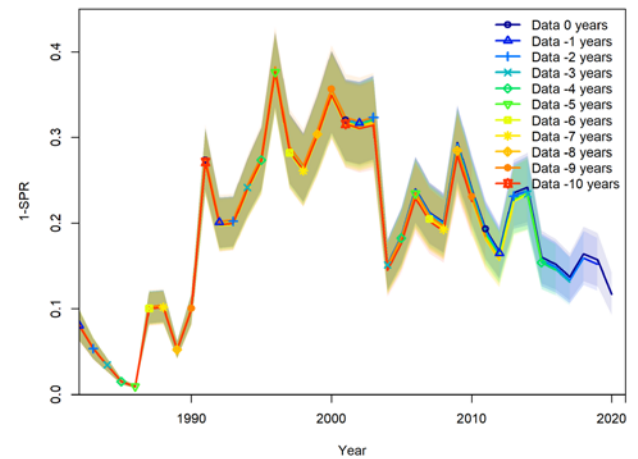
Executive summary tables (Model 21.0)

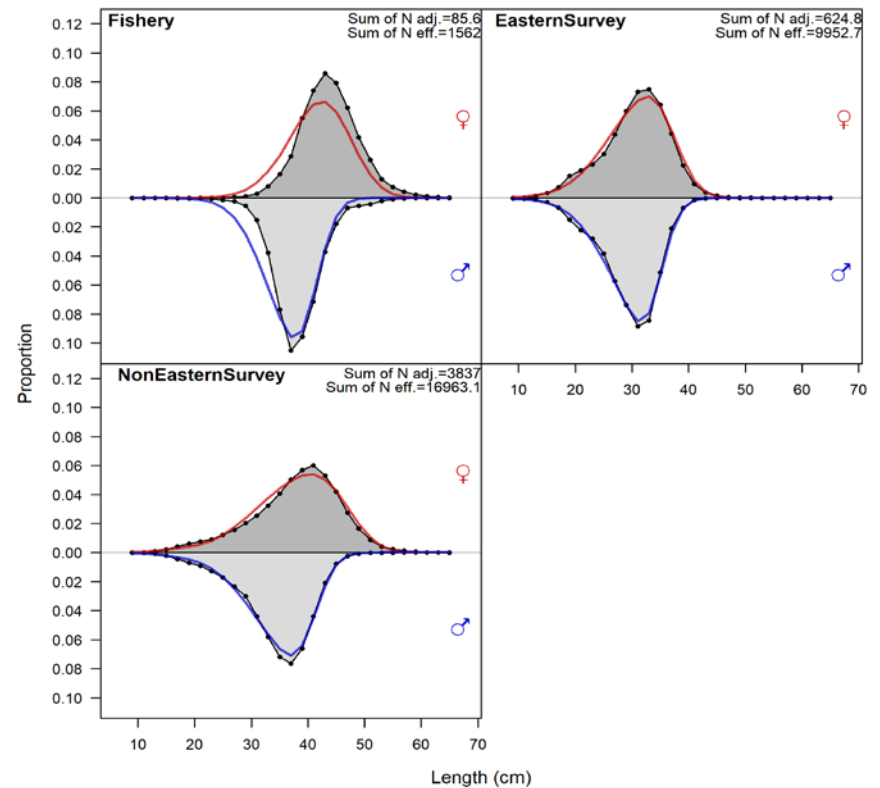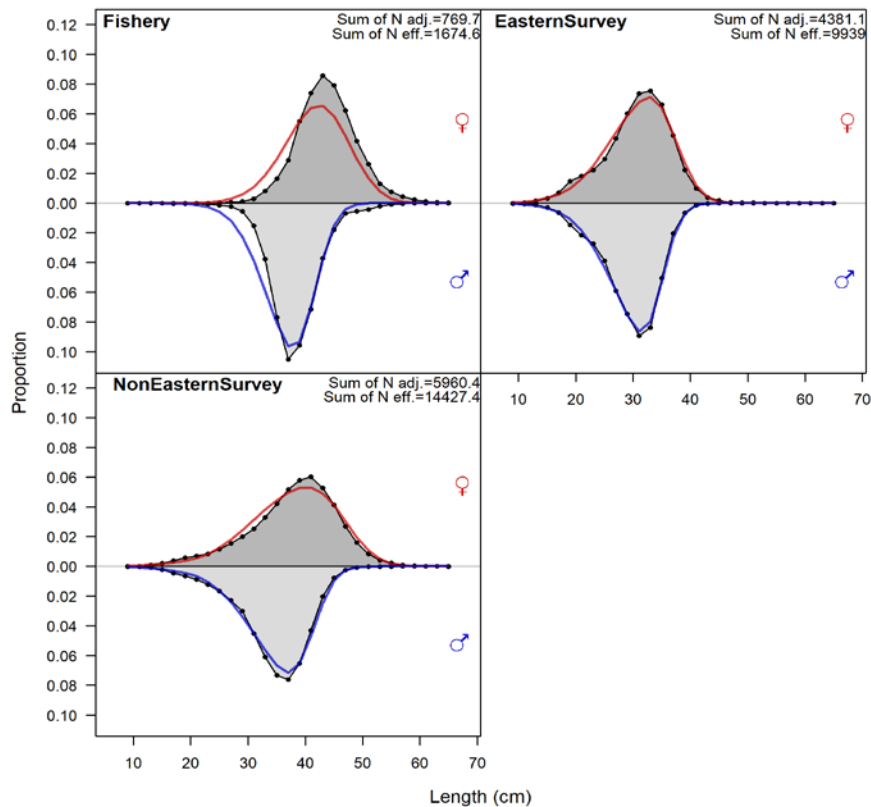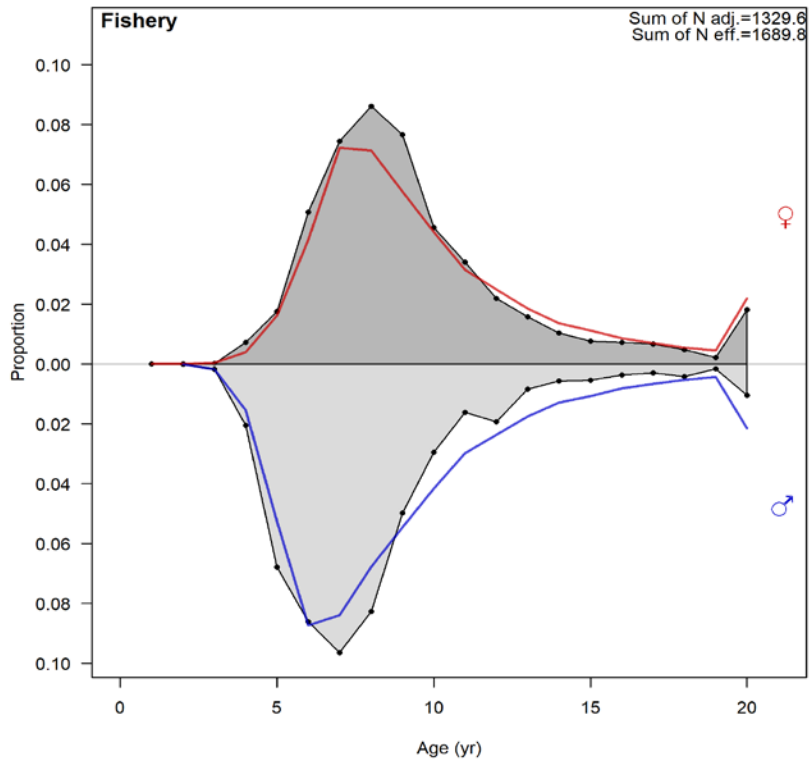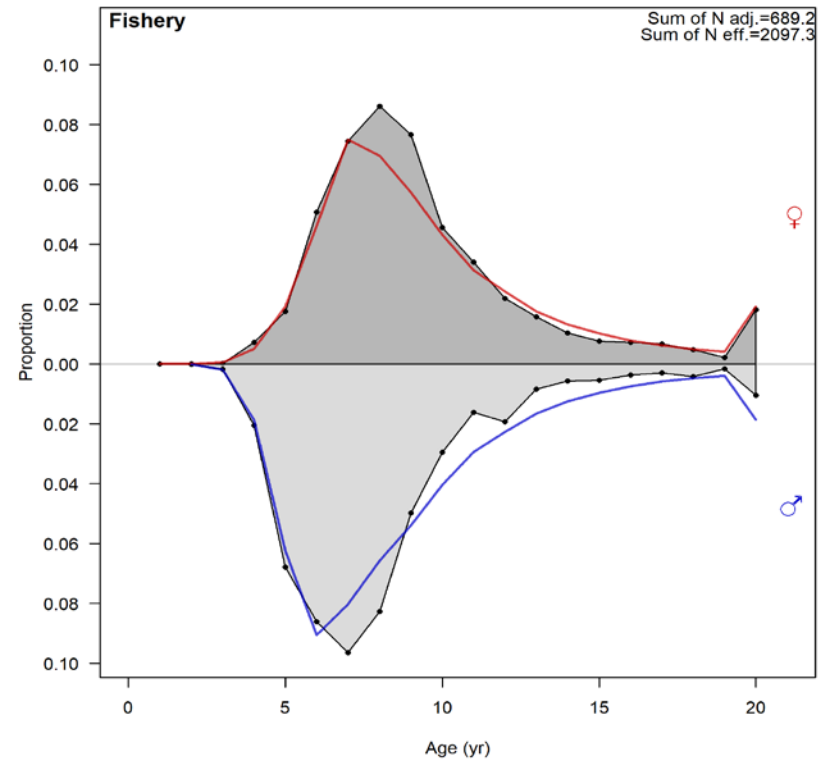| Quantity	As estimated or specified this year for:		As estimated or recommended this year for:	
	2021	2022	2022*	2023*
M (natural mortality rate)	0.17	0.17	0.17	0.17
Tier	3a	3a	3a	3a
Projected total (3+) biomass (t)	101,244	101,244	124,543	126,939
Female spawning biomass (t)	44,500	44,500	51,713	56,777
$B_{100\%}$				
$B_{40\%}$				
$B_{35\%}$	See area-specific tables below		See area-specific tables below	
F_{OFL}				
$maxF_{ABC}$				
F_{ABC}				
OFL (t)	18,779	18,779	23,302	25,049
maxABC (t)	15,416	15,416	19,141	20,594
ABC (t)	15,416	15,416	19,141	20,594
Status	As determined last year for:		As determined this year for:	
	2019	2020	2020	2021
Overfishing	no	n/a	no	n/a
Overfished	n/a	no	n/a	no
Approaching overfished	n/a	no	n/a	no

Western-Central GOA

- Projections are based on estimated catches of 392 t and 1,567 t that was used in place of maximum permissible ABC for 2021 and 2022-2023, respectively.

- The 2021 projected catch was calculated as the current catch of GOA rex sole as of September 26, 2021 added to the average September 27 – December 31 GOA rex sole catches over the 5 previous years.

- The 2022-2023 projected catch was calculated as the average catch from 2016-2020

Quantity: (Western-Central GOA)	As estimated or *specified this* year for:		As estimated or *recommended this* year for:	
	2021	2022	2022*	2023*
M (natural mortality rate)	0.17	0.17	0.17	0.17
Tier	3a	3a	3a	3a
Projected total (3+) biomass (t)	79,666	79,666	99,428	101,606
Female spawning biomass (t)	35,506	35,506	41,906	46,224
$B_{100\%}$	48,138	48,138	46,850	46,850
$B_{40\%}$	19,255	19,255	18,740	18,740
$B_{35\%}$	16,848	16,848	16,398	16,398
F_{OFL}	0.29	0.29	0.28	0.28
$maxF_{ABC}$	0.23	0.23	0.23	0.23
F_{ABC}	0.23	0.23	0.23	0.23
OFL (t)	14,512	14,512	18,314	19,779
maxABC (t)	11,925	11,925	15,057	16,276
ABC (t)	11,925	11,925	15,057	16,276
Status	As determined *last* year for:		As determined *this* year for:	
	2019	2020	2020	2021
Overfishing	no	n/a	no	n/a
Overfished	n/a	no	n/a	no
Approaching overfished	n/a	no	n/a	no

Eastern GOA

- The 2021-2023 projected catch was calculated as the average catch from 2016-2020.

- Catches from the Eastern GOA are small and many are confidential

Quantity: (Eastern GOA)	As estimated or *specified this* year for:		As estimated or *recommended this* year for:	
	2021	2022	2022*	2023*
M (natural mortality rate)	0.17	0.17	0.17	0.17
Tier	3a	3a	3a	3a
Projected total (3+) biomass (t)	21,578	21,578	25,115	25,333
Female spawning biomass (t)	8,994	8,994	9,807	10,553
$B_{100\%}$	9,597	9,597	8,998	8,998
$B_{40\%}$	3,839	3,839	3,599	3,599
$B_{35\%}$	3,359	3,359	3,149	3,149
F_{OFL}	0.31	0.31	0.31	0.31
$maxF_{ABC}$	0.25	0.25	0.25	0.25
F_{ABC}	0.25	0.25	0.25	0.25
OFL (t)	4,267	4,267	4,988	5,270
maxABC (t)	3,491	3,491	4,084	4,318
ABC (t)	3,491	3,491	4,084	4,318
Status	As determined *last* year for:		As determined *this* year for:	
	2019	2020	2020	2021
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 2: substantially increased concerns	Level 2: substantially increased concerns	Level 1: no increased concerns	Level 1: no increased concerns

Assessment-related concerns:
- Maturity curve and fishery selectivity curves are similar
- New, large year class has only been observed a couple of times
- Fits to conditional age-at-length data suggest potential time-variation in growth

Population dynamics considerations:
- Recruitment estimates for ages 4 and 5 are higher than seen historically

Area Apportionment

Quantity	Western	Central	Total Western-Central	West Yakutat	Southeast	Total Eastern
Area Apportionment	19.80%	80.20%	100.00%	33.34%	66.66%	100.00%
2022 ABC (t)	2,981	12,076	15,057	1,361	2,723	4,084
2023 ABC (t)	3,222	13,054	16,276	1,439	2,879	4,318

Data gaps and research priorities

- Ageing error matrix
- Improved maturity-at-age (but this is a difficult task)
- Explore/analyze natural mortality rates
- Why do growth rates differ by area?
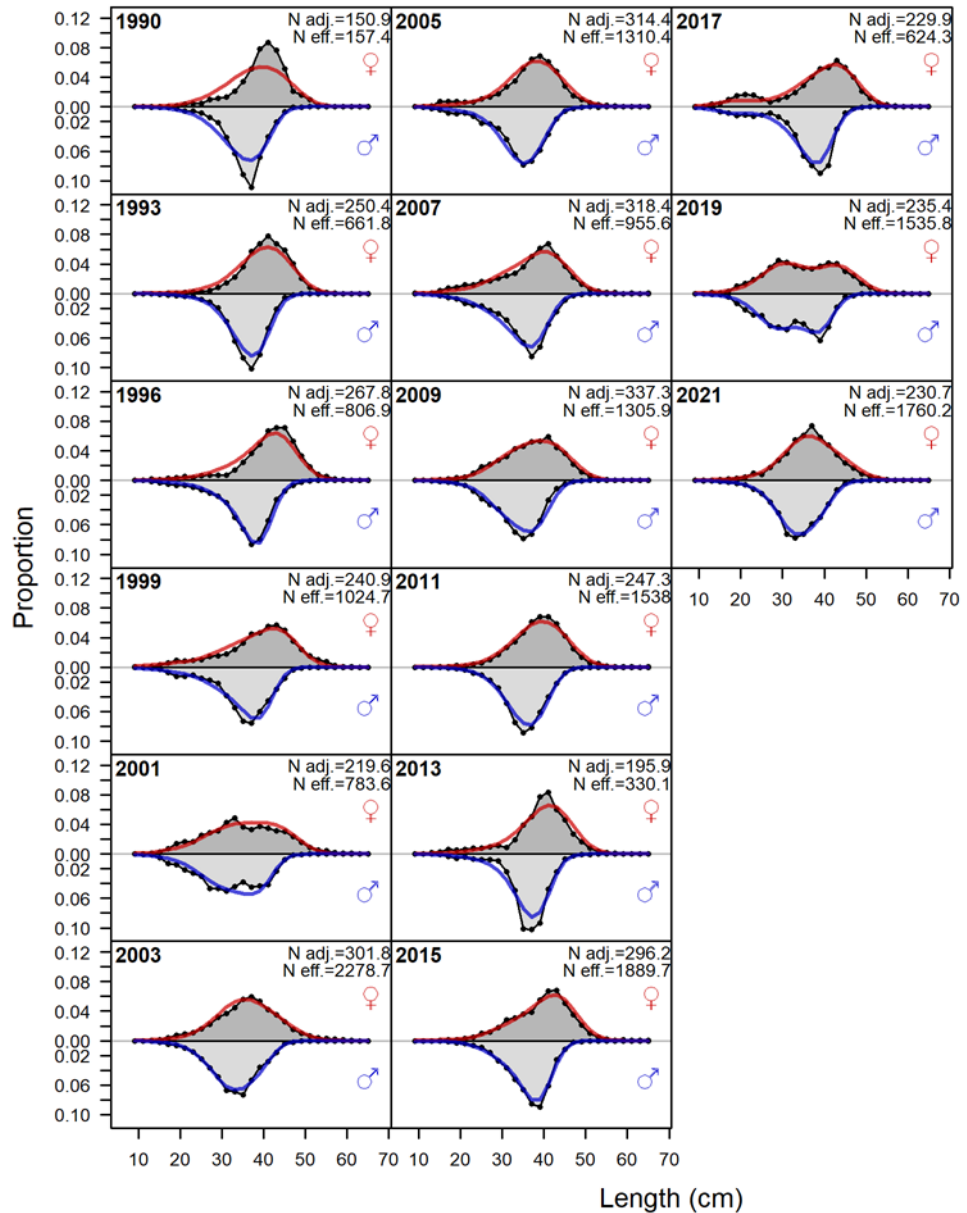- Is there time-varying growth as well?
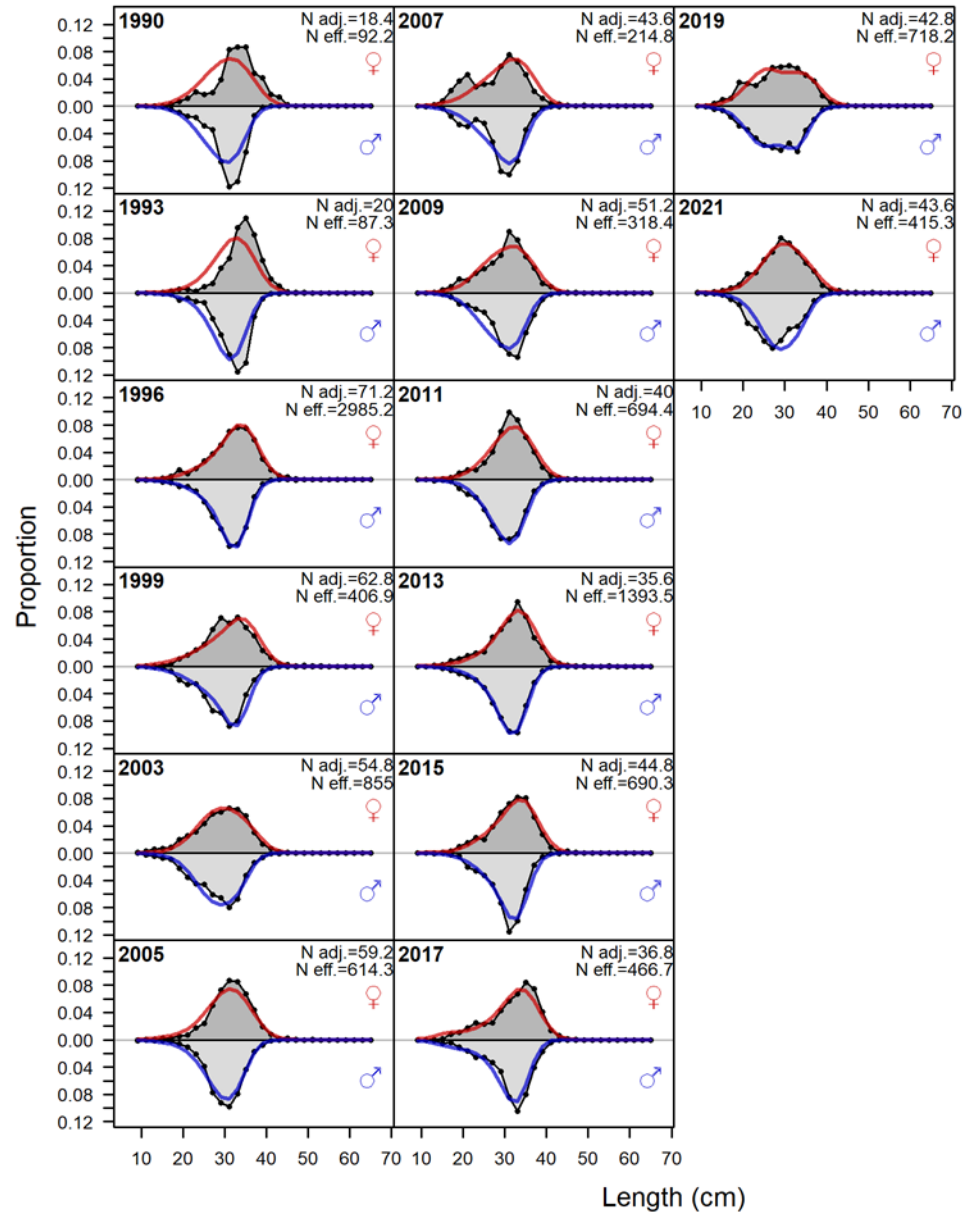
Yearly fits to fishery length composition data
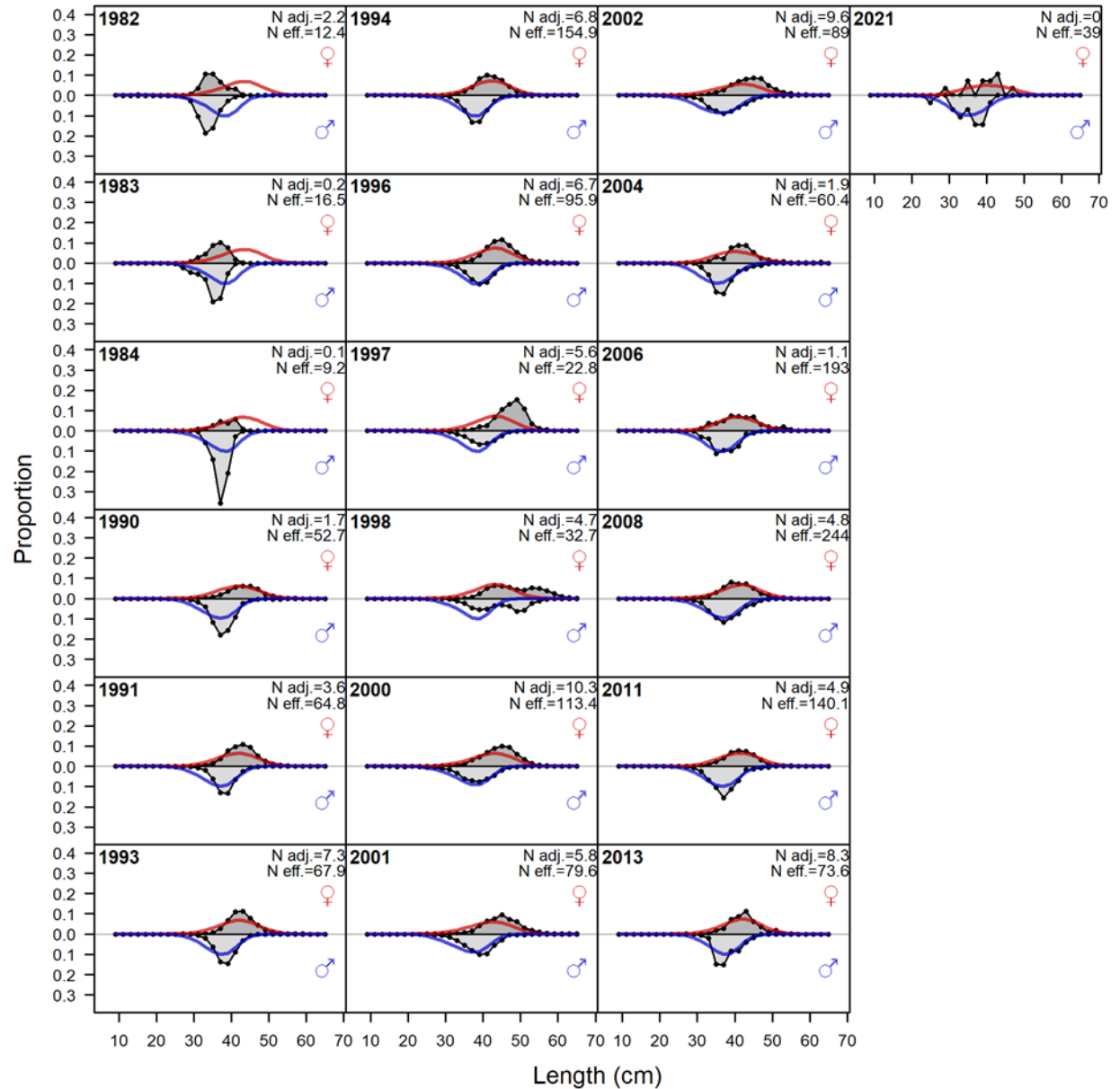
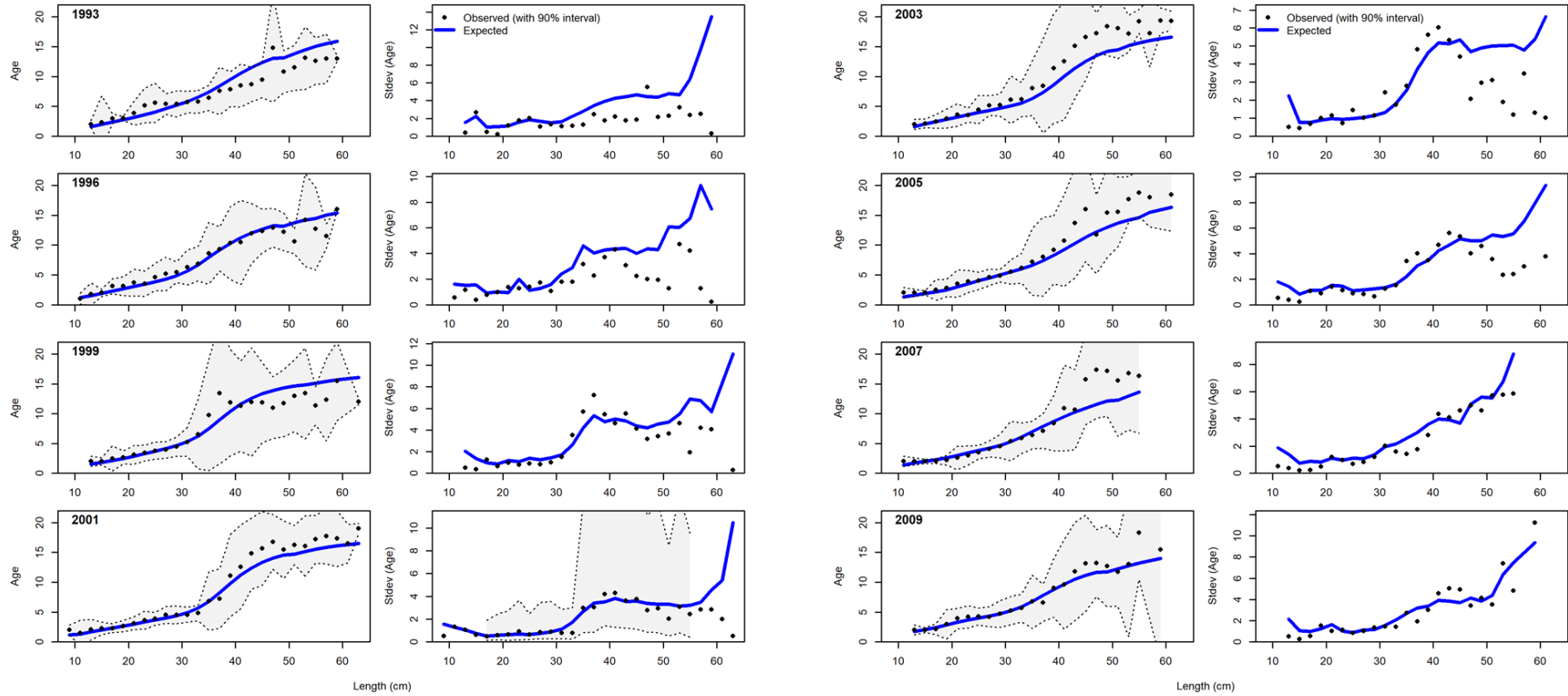# Yearly fits to fishery age composition data
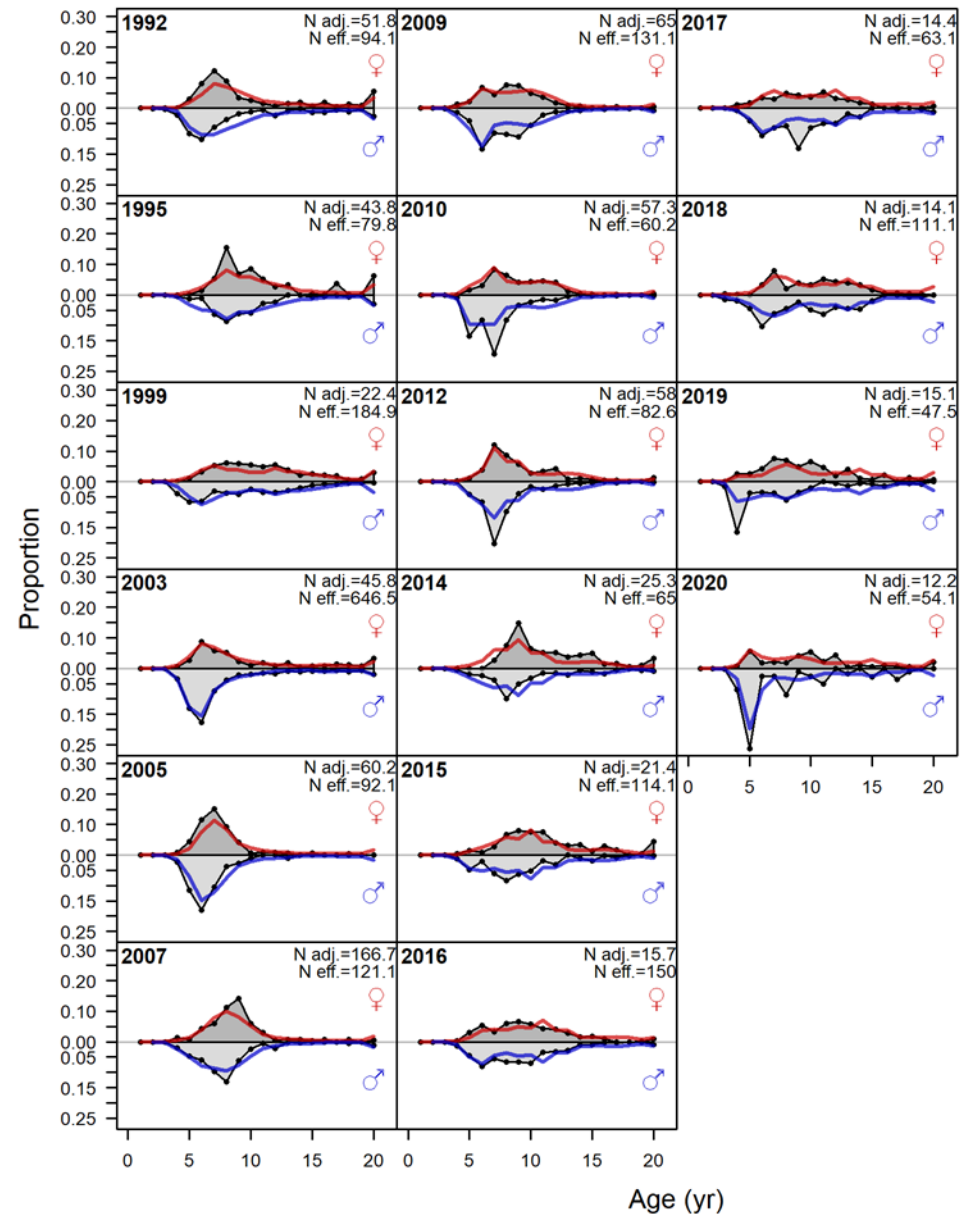
Yearly fits to Western-Central survey length composition data
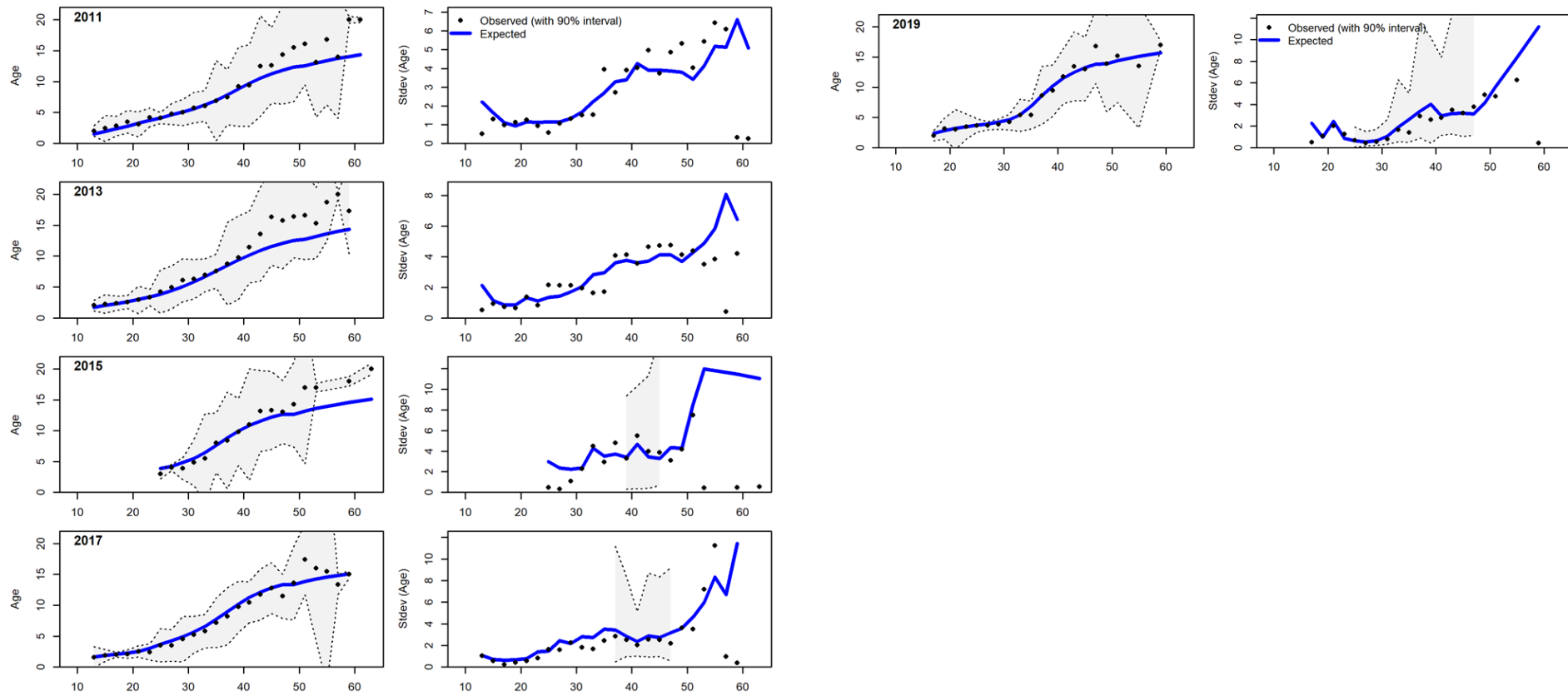
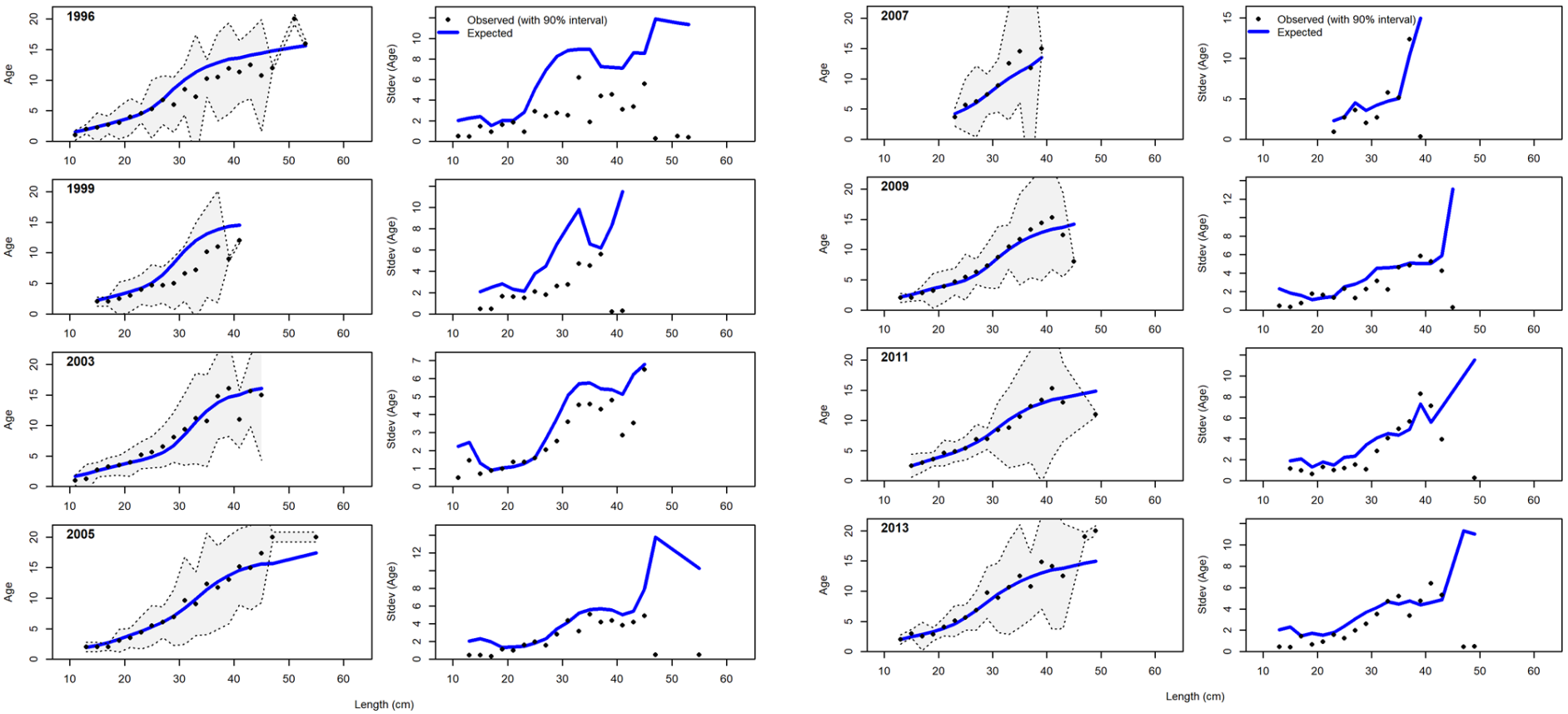# Yearly fits to Eastern survey length composition data

Yearly fits to Western-Central survey age-length data

Yearly fits to Western-Central survey age-length data, continued

Yearly fits to Eastern survey age-length data

Yearly fits to Eastern survey age-length data, continued