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FISHERIES**

Alaska Fisheries
Science Center

Assessment of walleye pollock in the Eastern Bering Sea

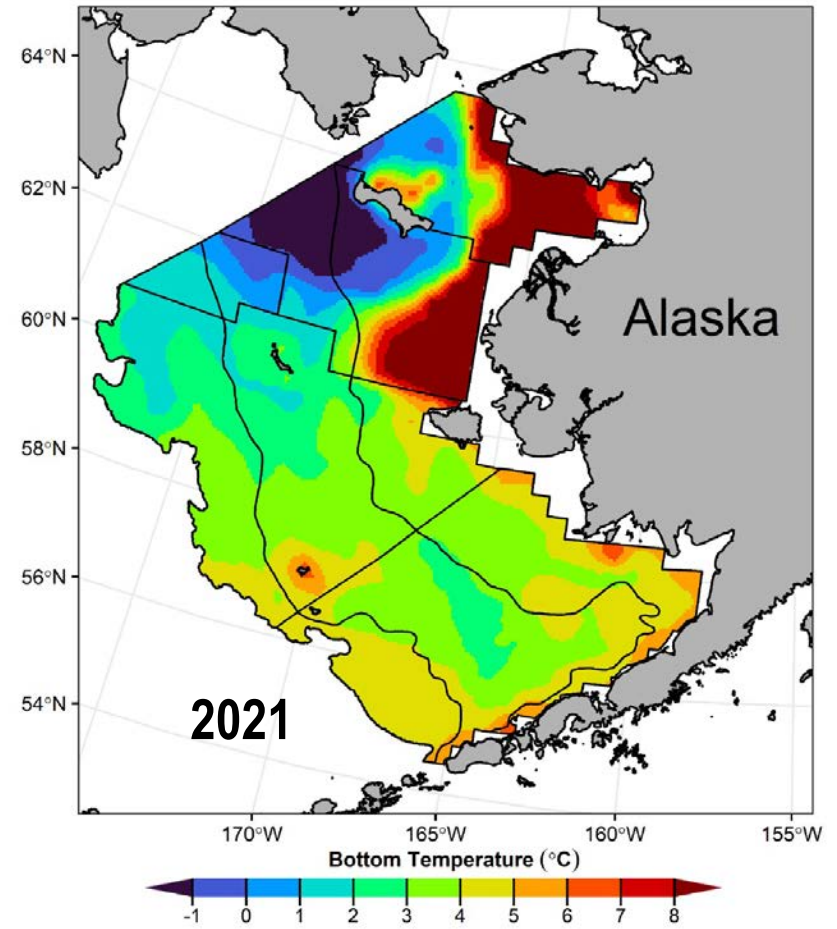
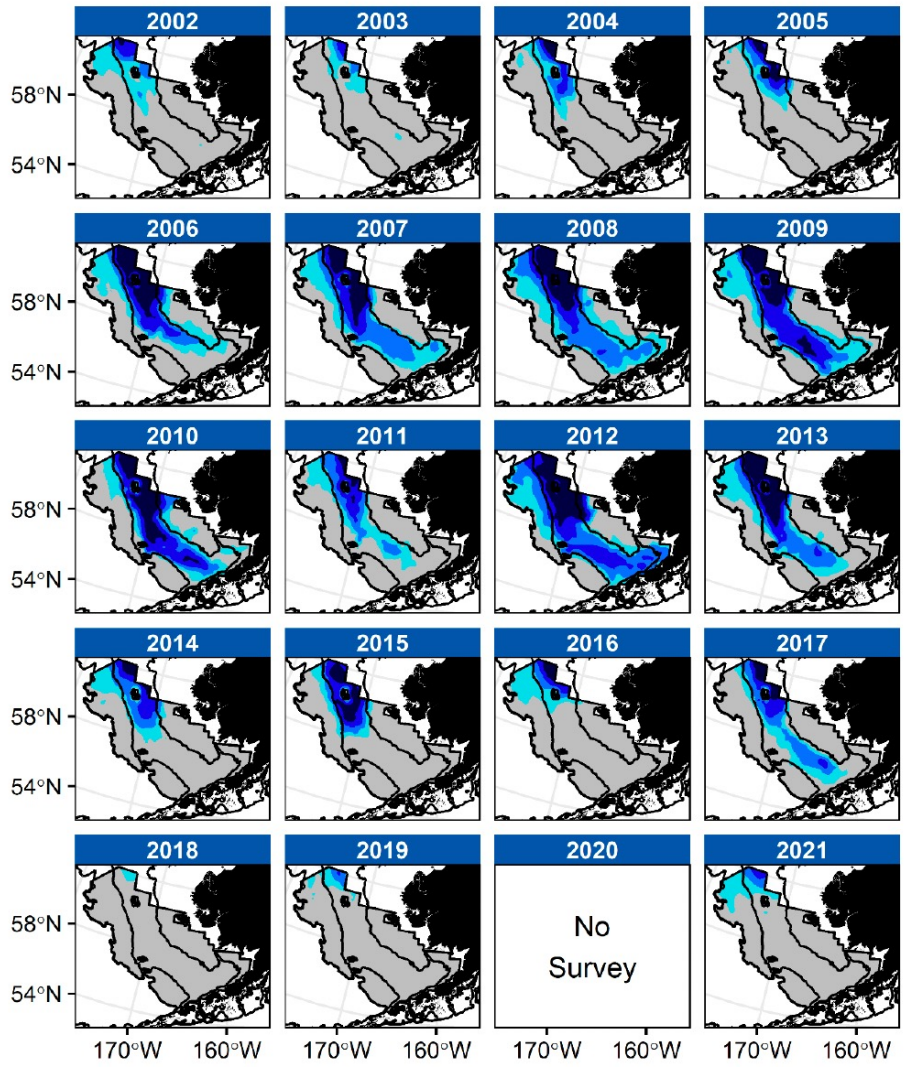
James Ianelli, Ben Fissel,
Sarah Stienessen, Taina Honkalehto,
Elizabeth Siddon, and Caitlin Allen-Akselrud

November 17, 2021



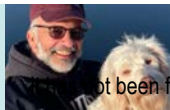
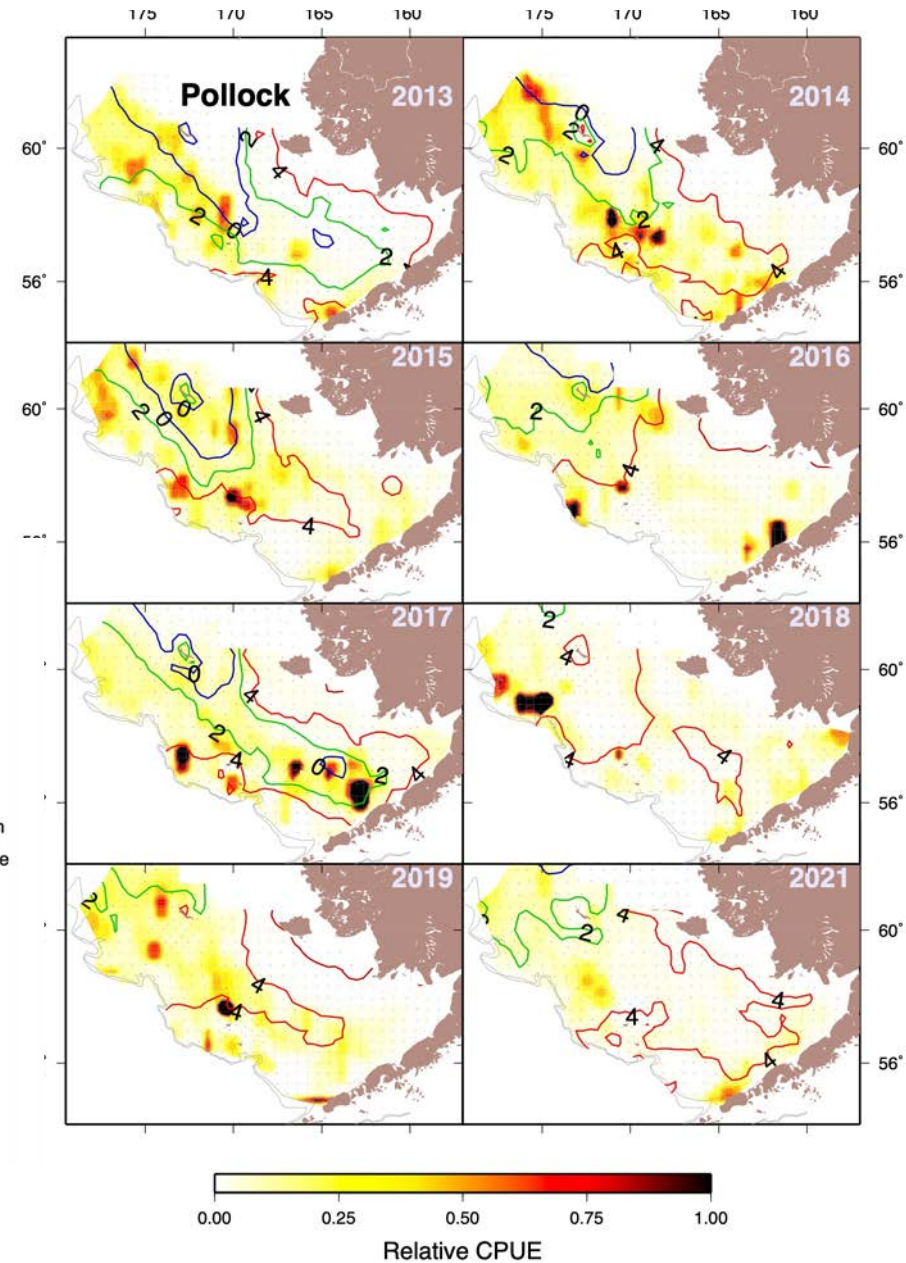
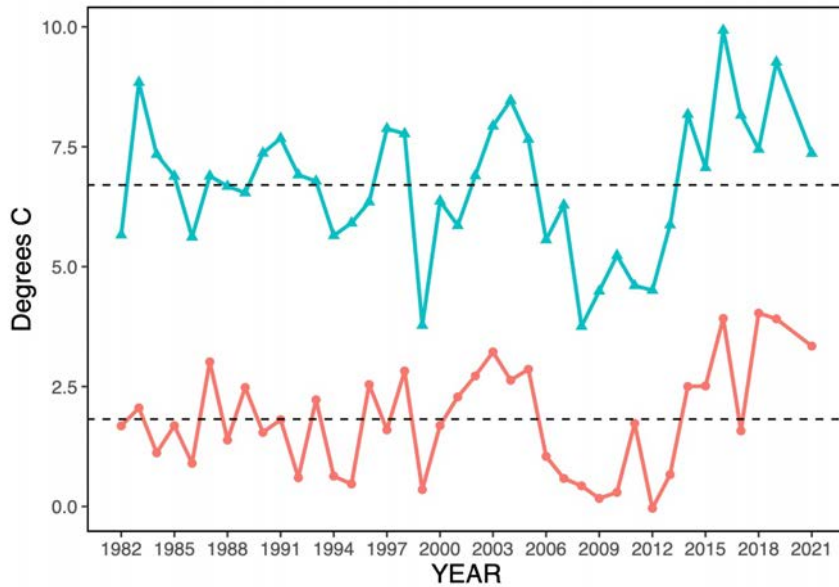
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Pollock density and bottom temperatures

- From the bottom trawl survey



New genetics information

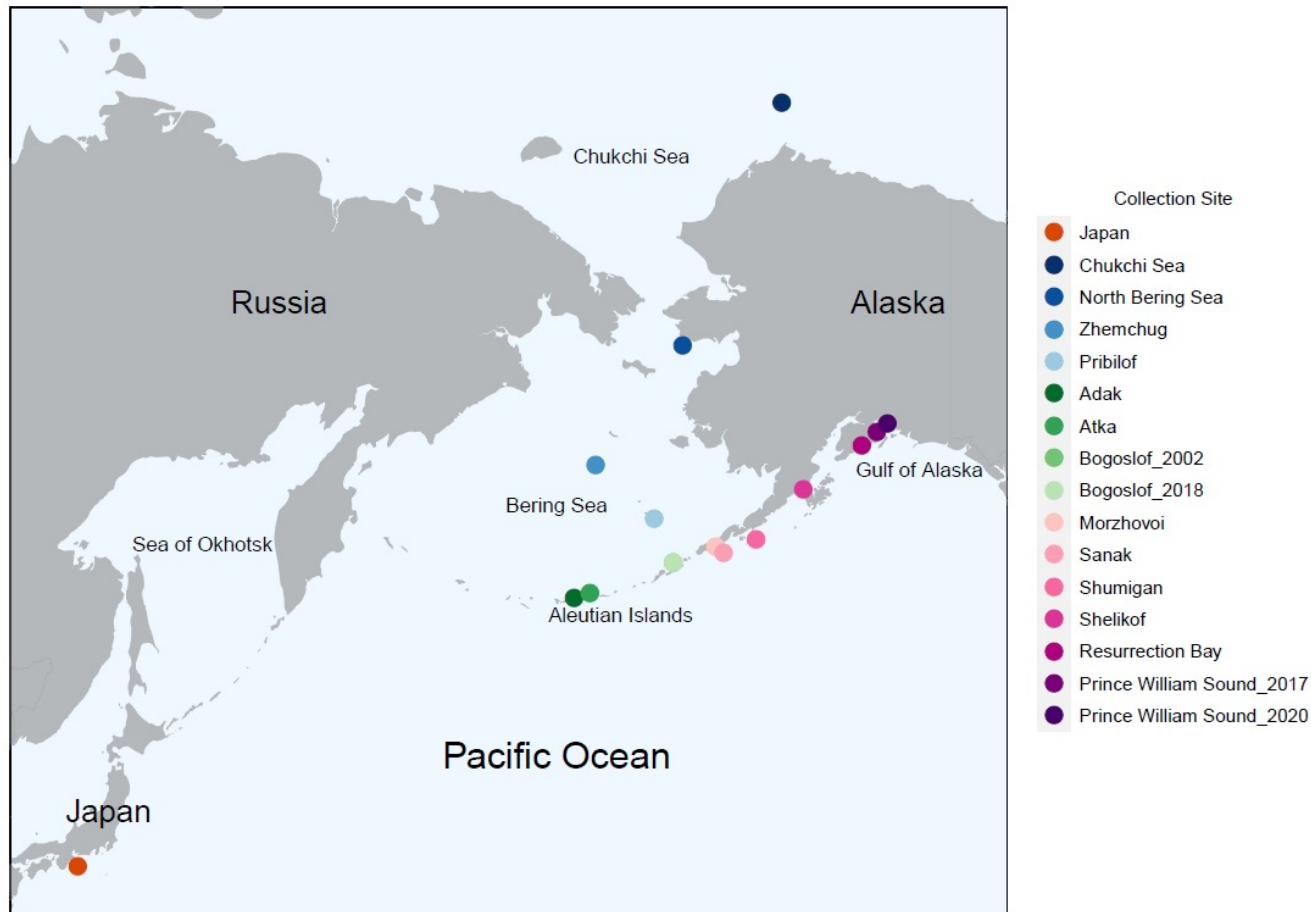
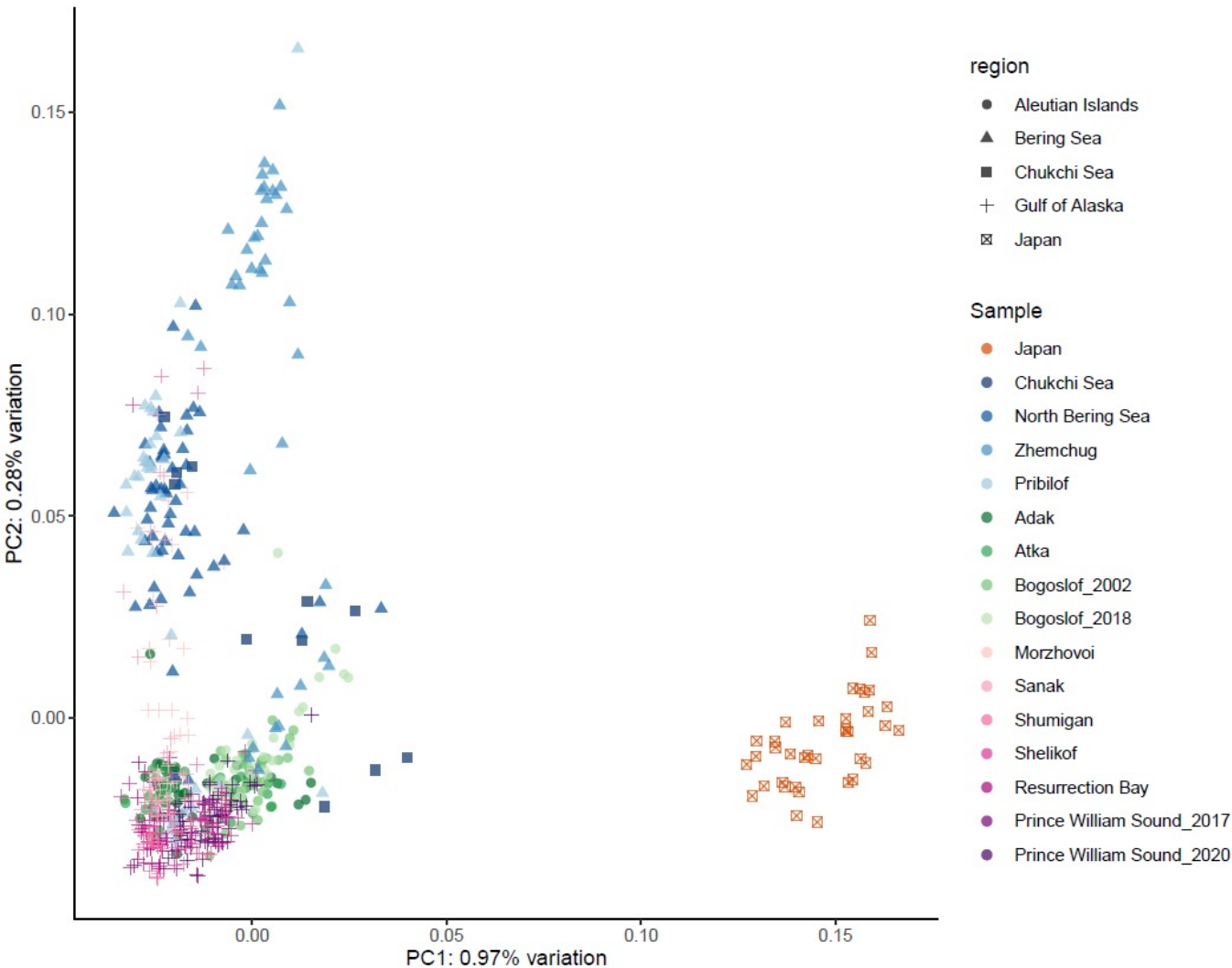


Figure 1. Sampling locations of pollock collected in Japan (orange point), Chukchi Sea and Bering Sea (blue points), Aleutian Islands (green points), Alaska Peninsula and Gulf of Alaska (pink and purple points).



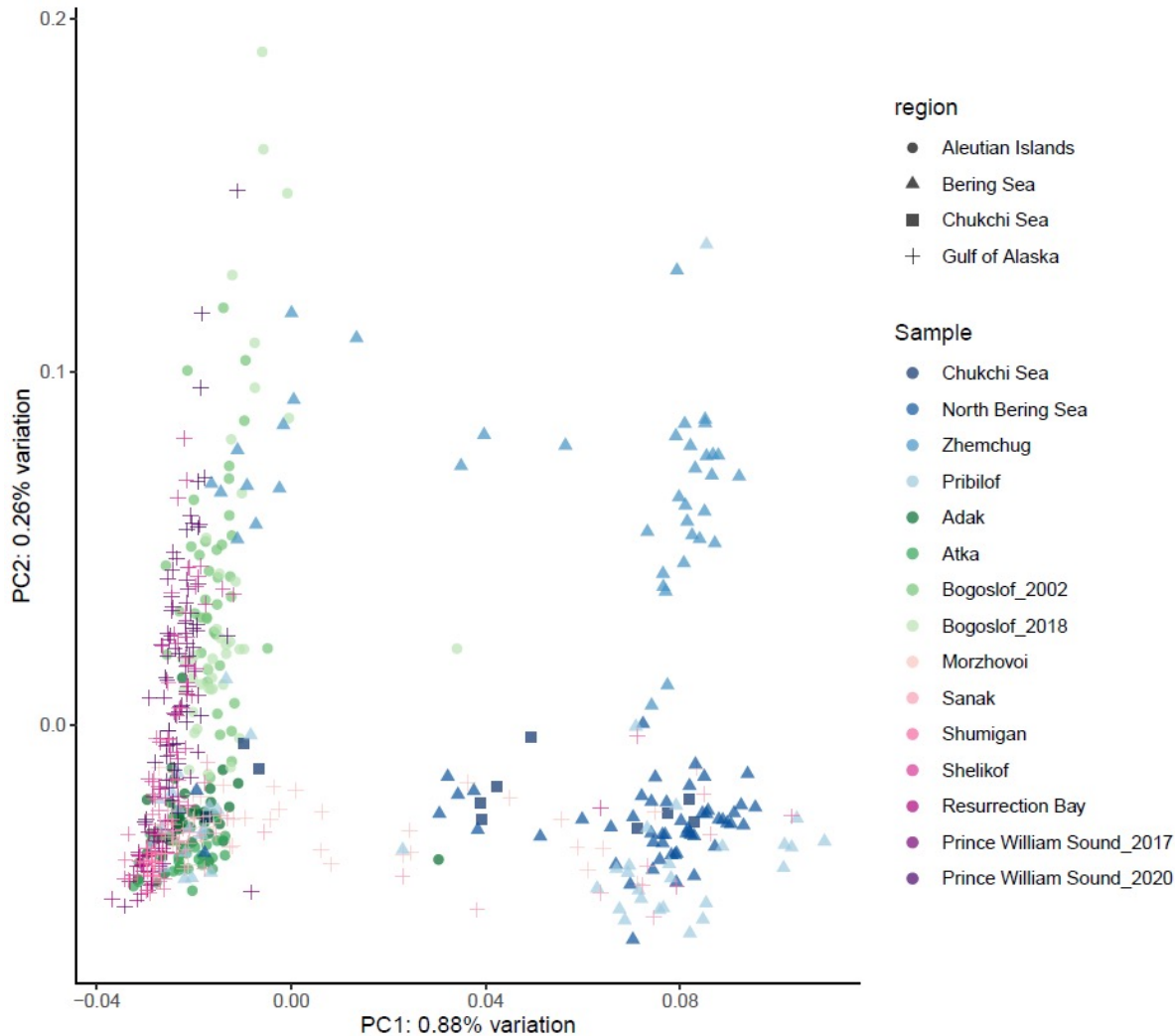
New genetics information



PCA using all samples collected in this study. The color of each point indicates the sampling location and region.



New genetics information



PCA excluding samples collected in Japan. The color of each point indicates the sampling location and region.



New genetics information

- Results promising and consistent with our current management areas
- Future source-spawning ID possible

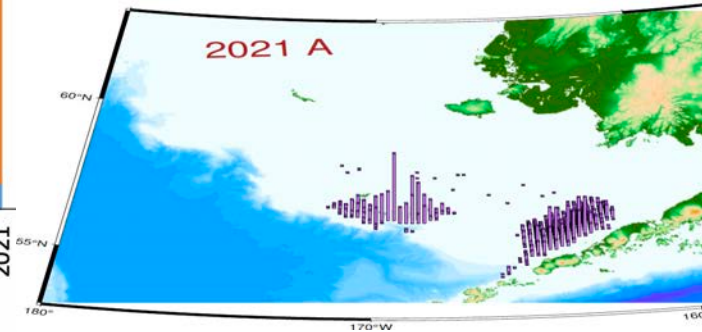
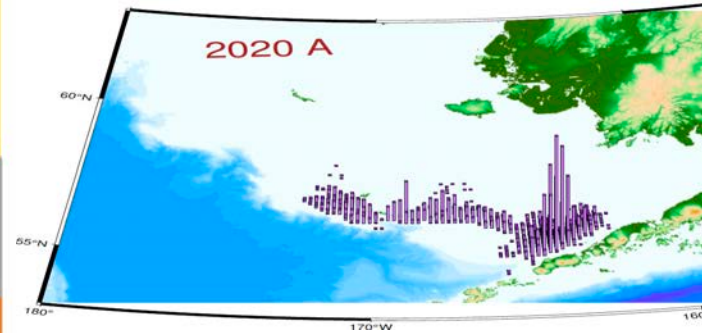
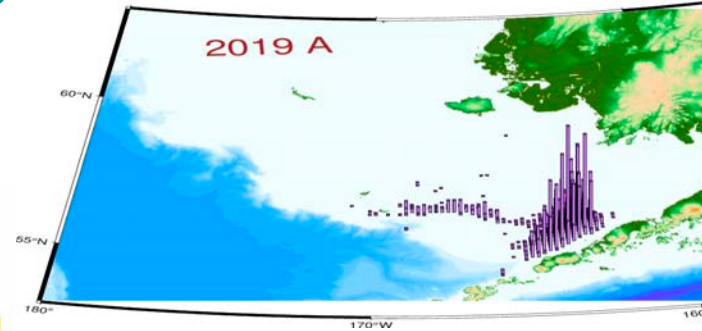
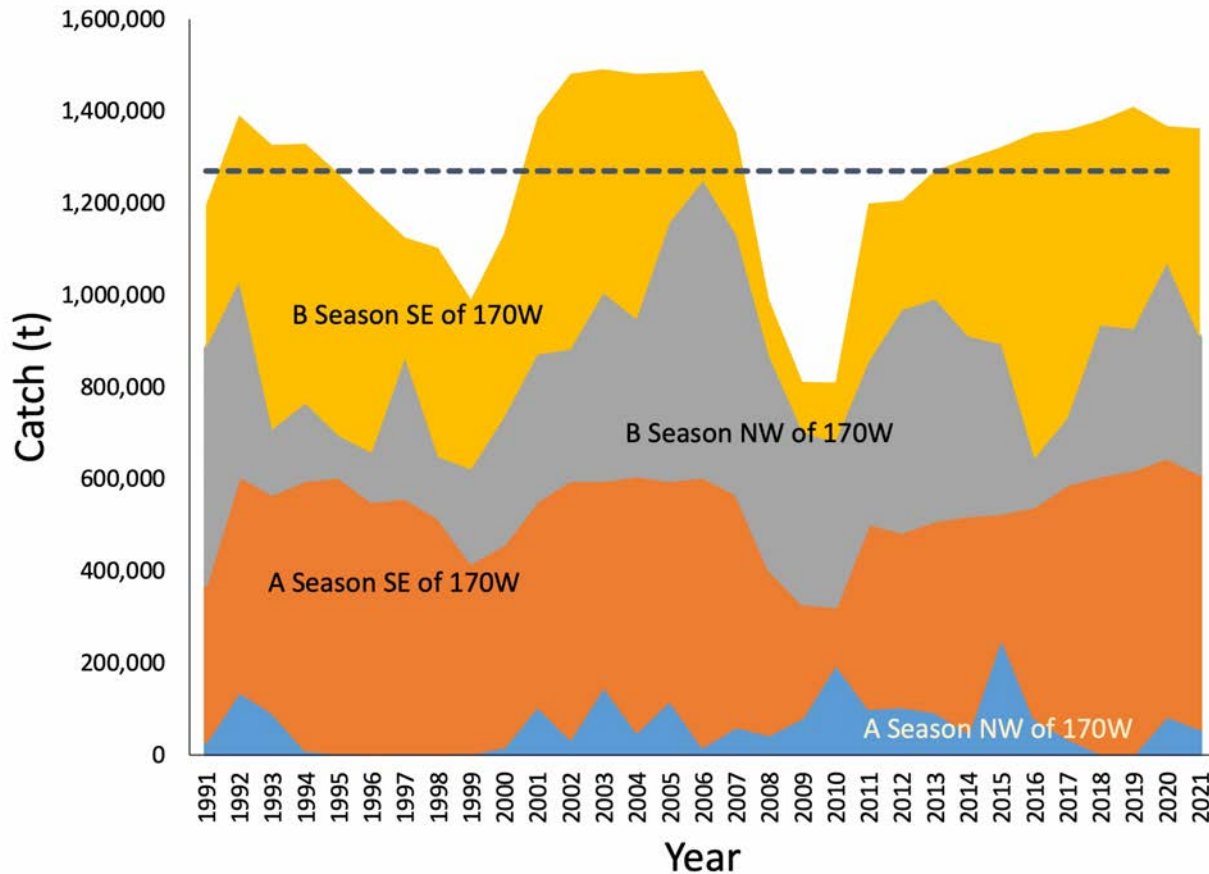


Data



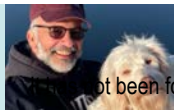
Seasonal and area catch patterns

Eastern Bering Sea pollock

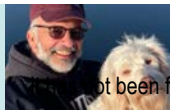
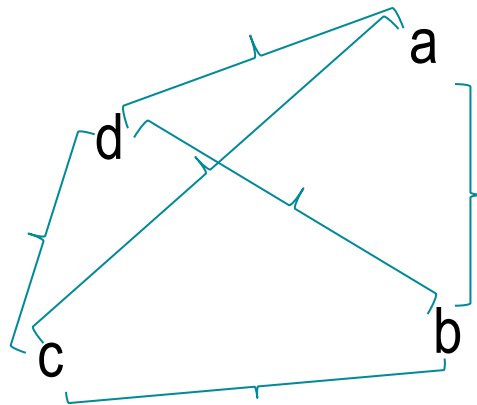


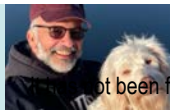
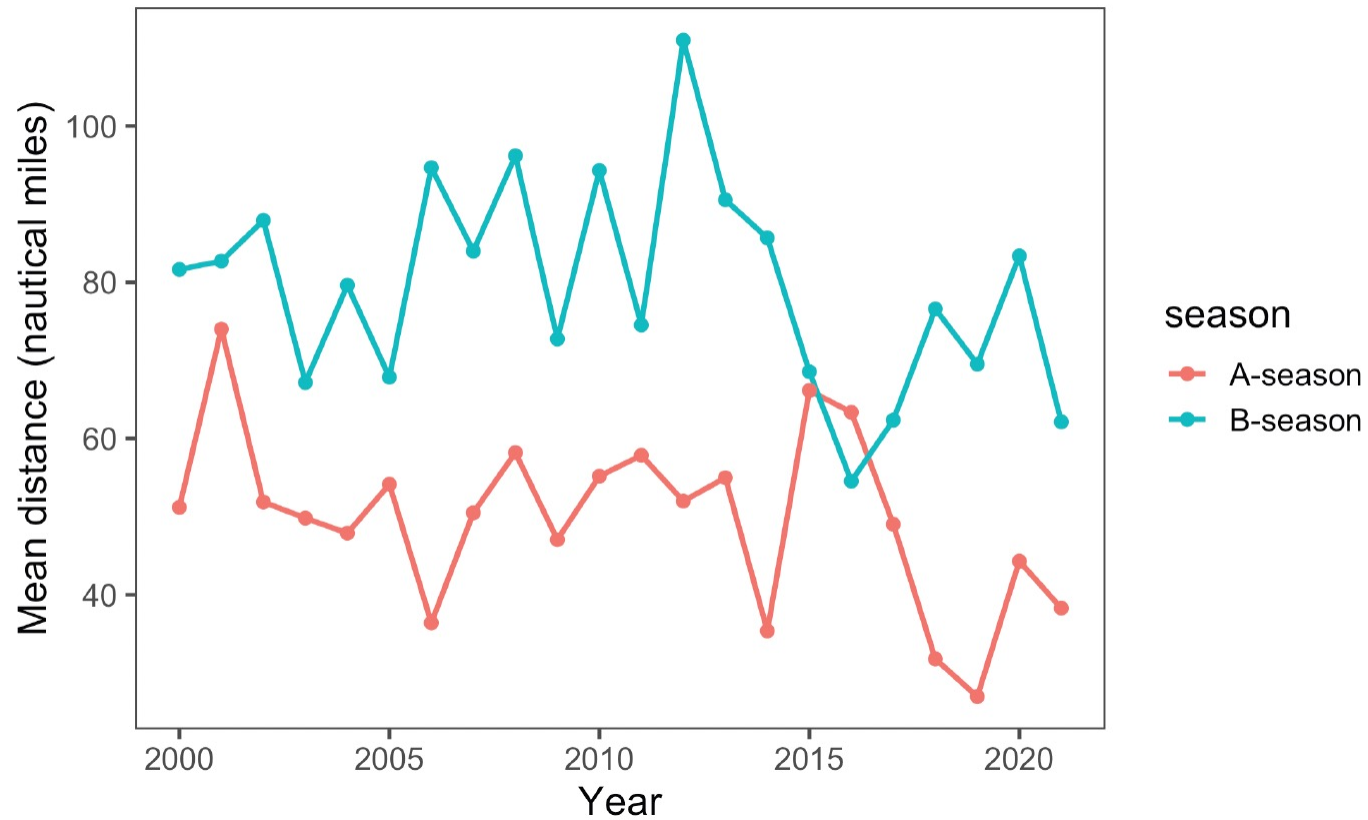
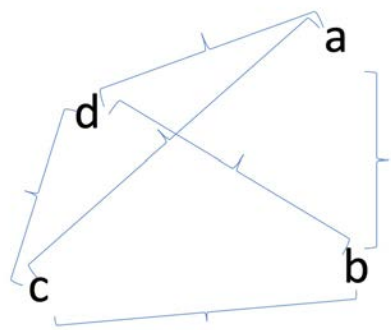
Fleet behavior?

- Fishing harder...but distance wise?



Summarizing spatial fishery patterns

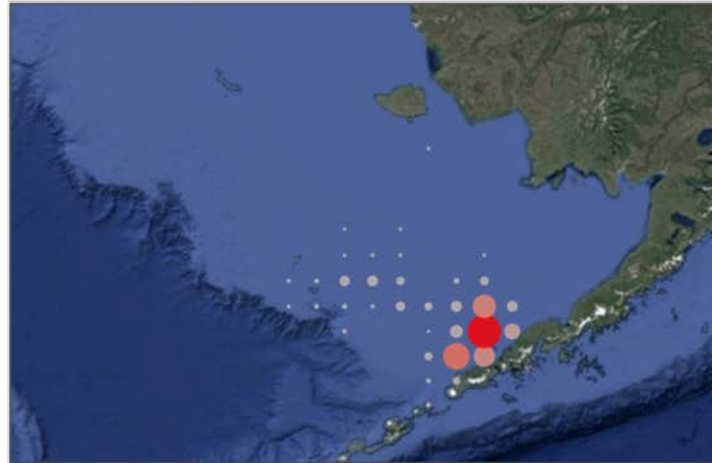
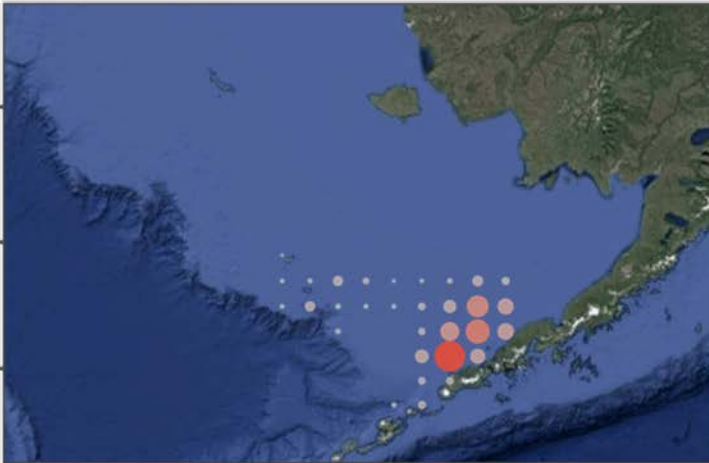




2018

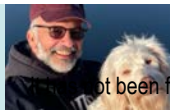
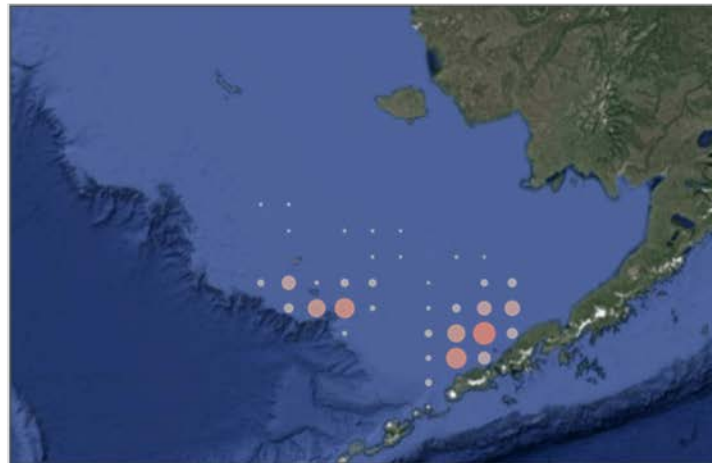
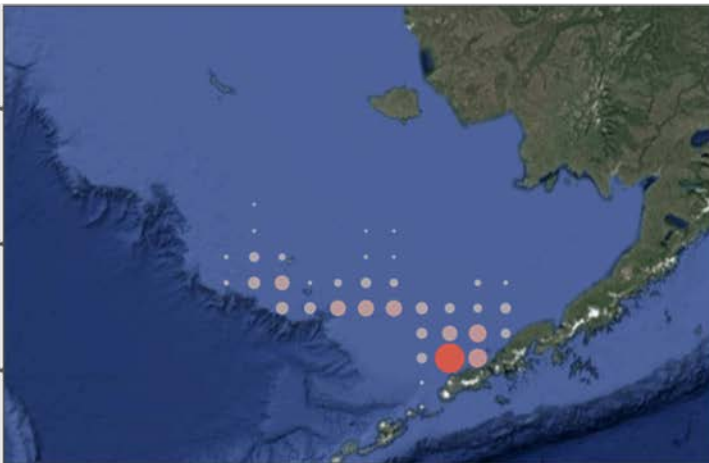
2019

A-season fishery catches



2020

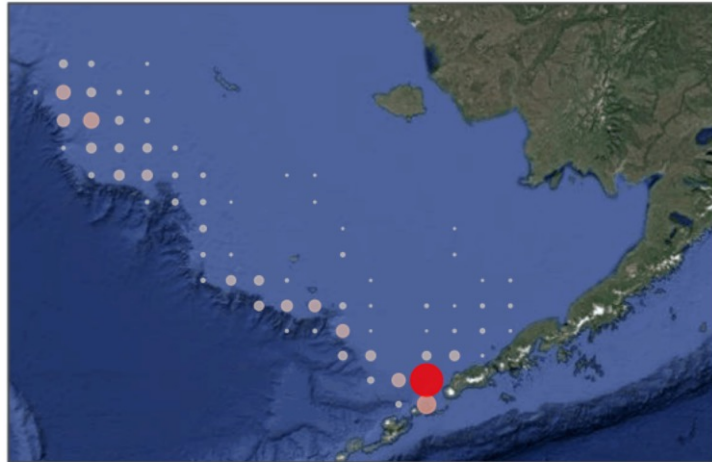
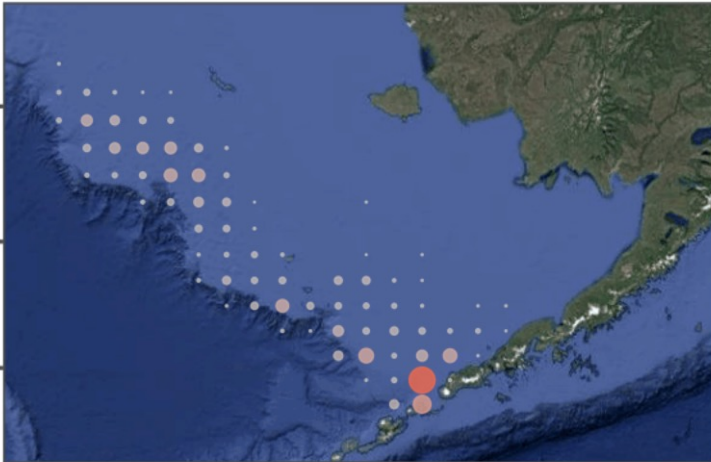
2021



2018

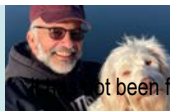
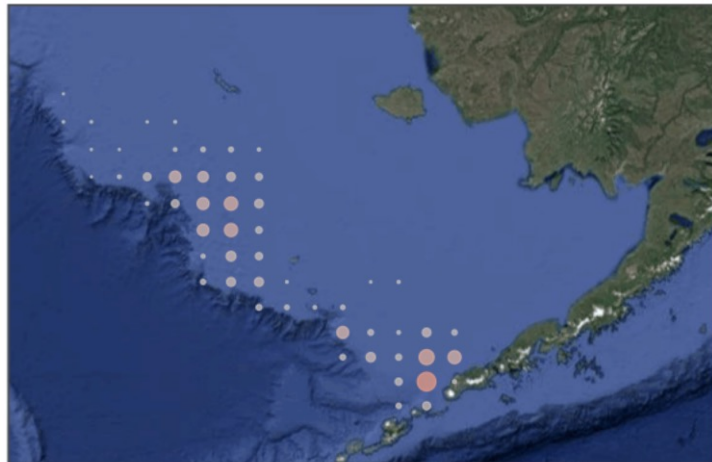
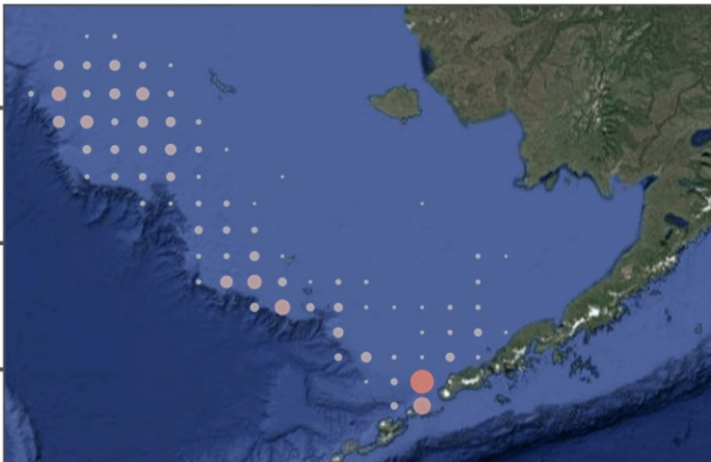
2019

B-season fishery catches

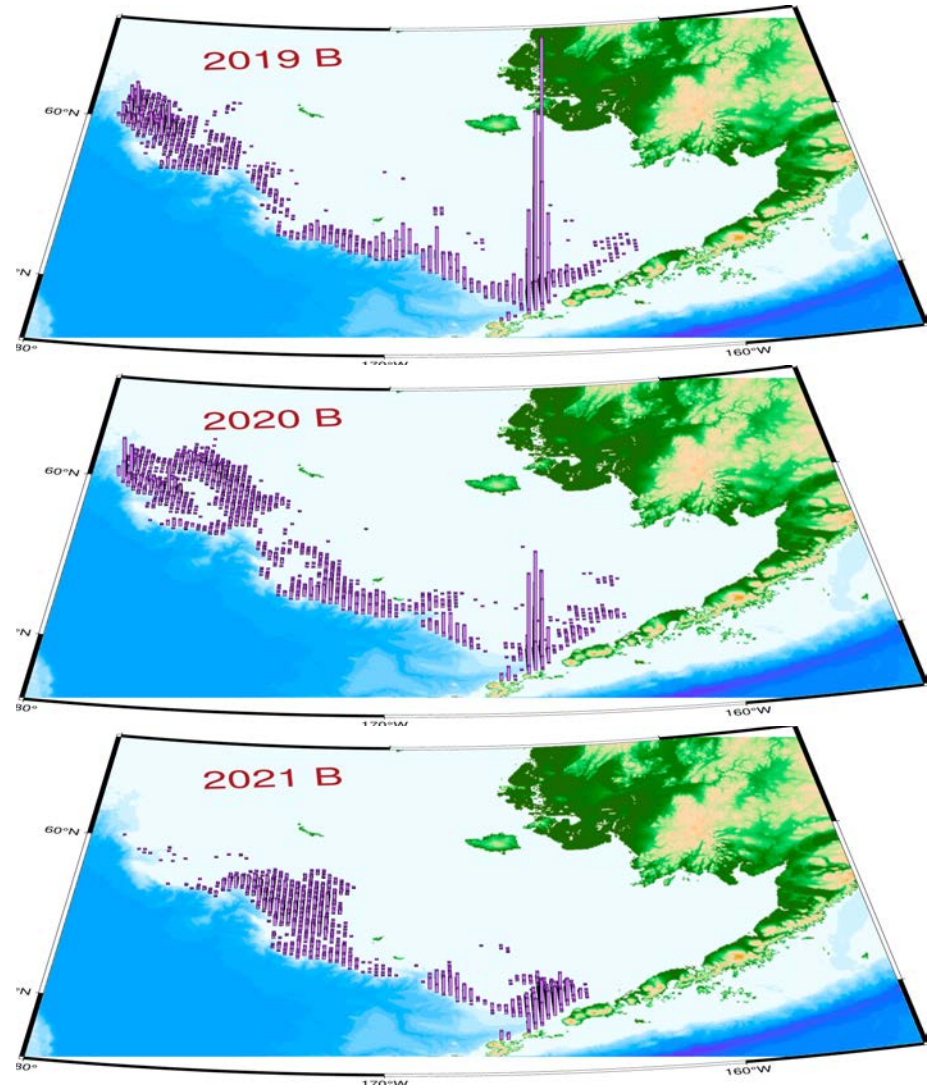


2020

2021

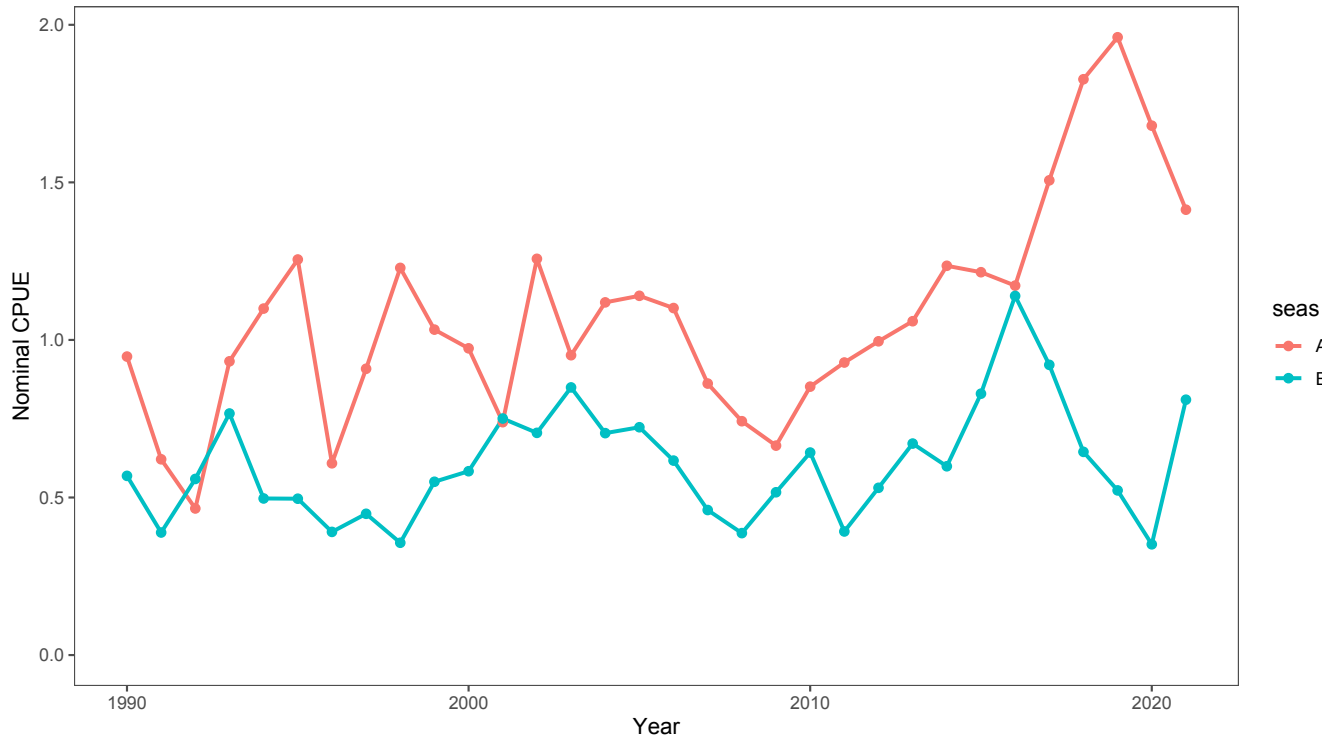


B-season fishery distributions



Pollock fishery CPUE season

Pollock CPUE (by weight)

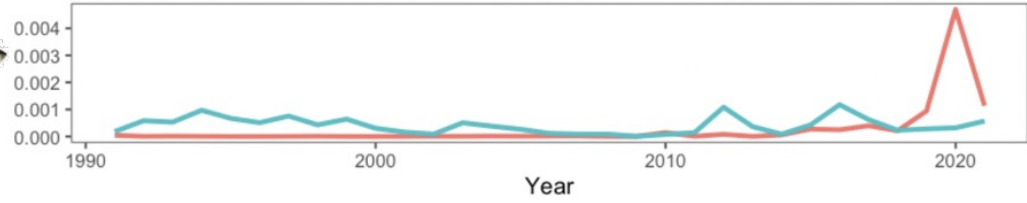


Fishery conditions

Catch rates of pollock and selected bycatch species



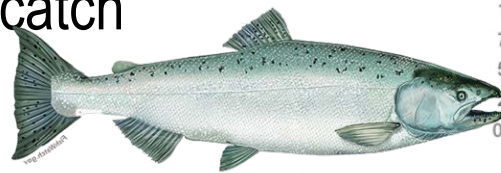
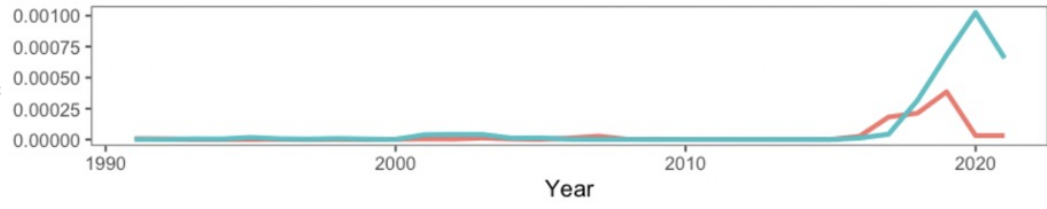
Herring CPUE (by weight)



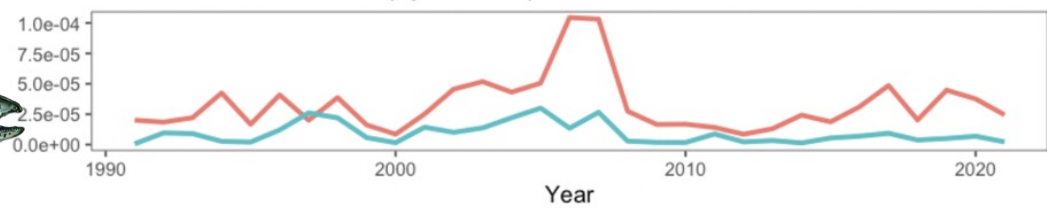
seas
— A
— B



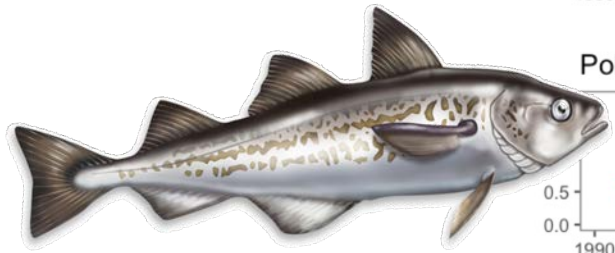
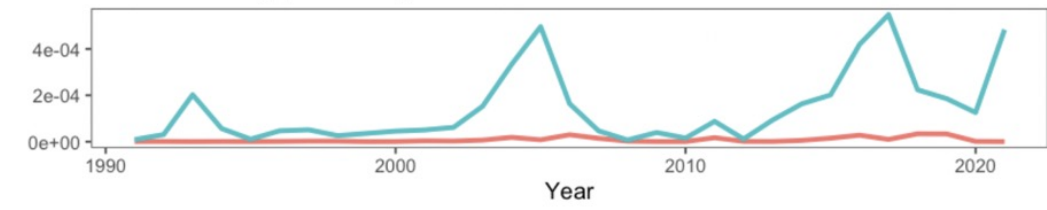
Sablefish CPUE (by weight)



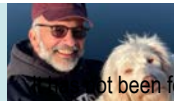
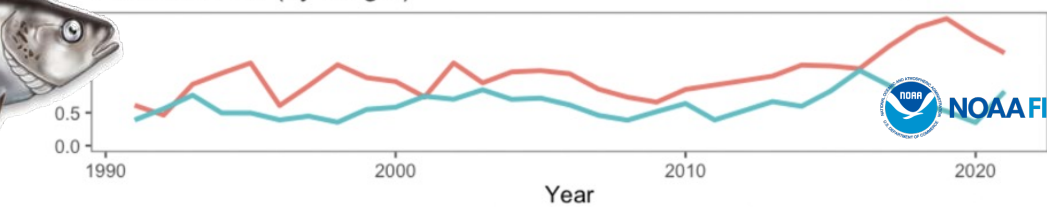
Chinook salmon CPUE (by number)



Chum CPUE (by number)



Pollock CPUE (by weight)



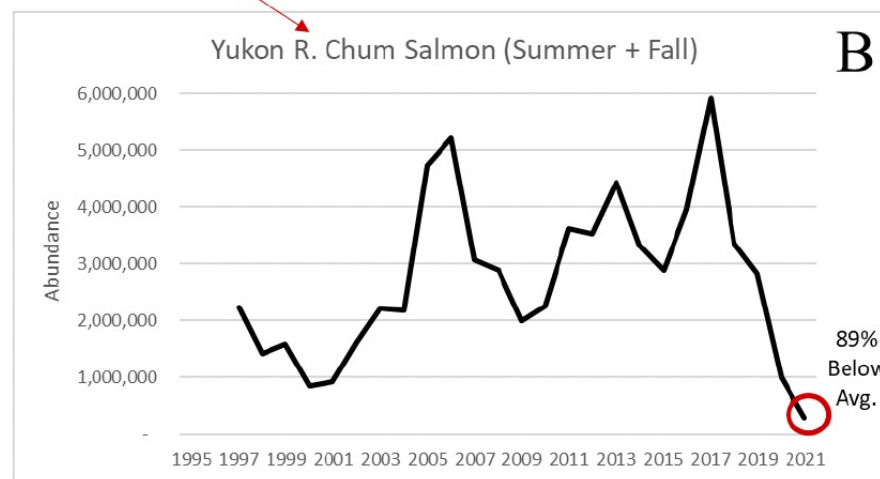
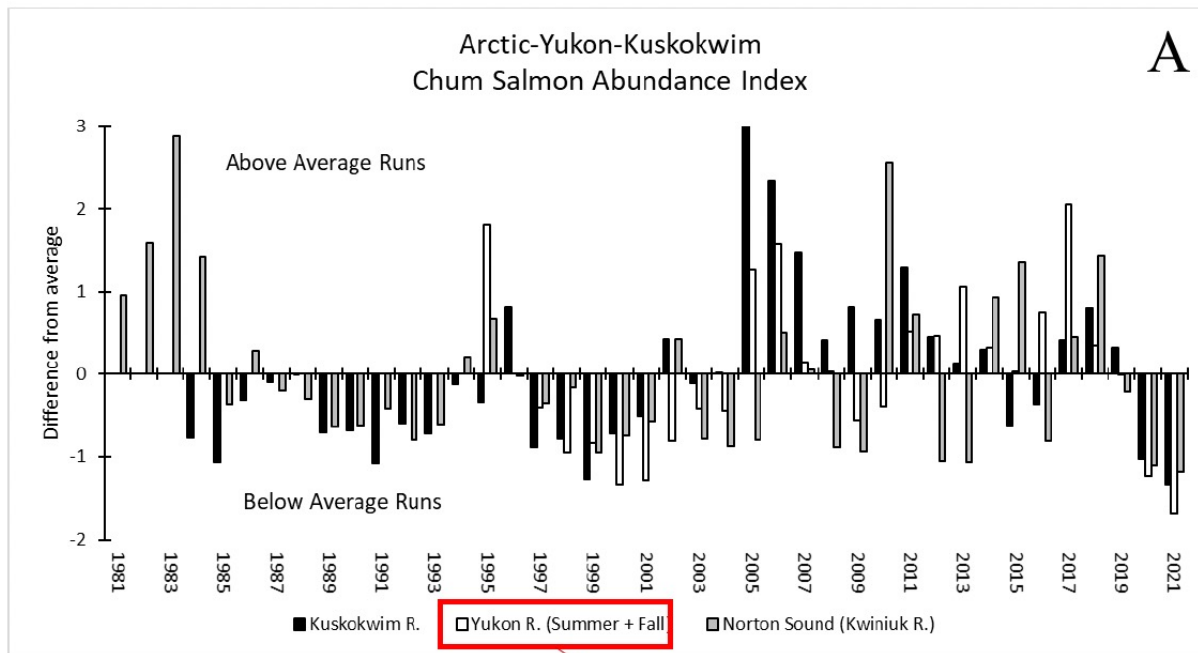
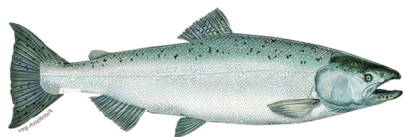
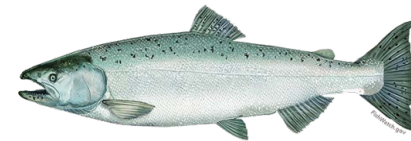
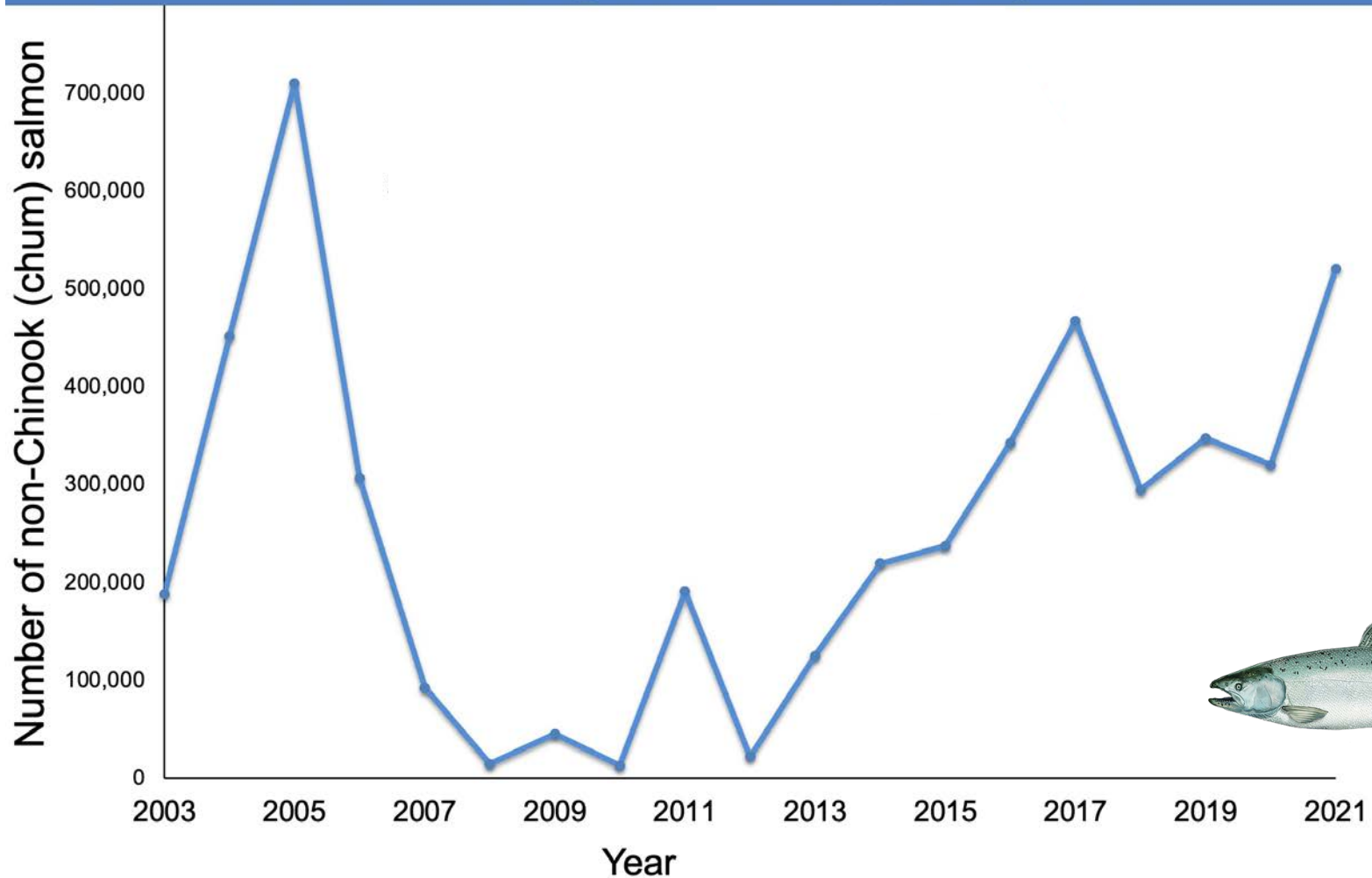


Figure 3: Relative changes in chum salmon adult run abundance throughout the Arctic-Yukon-Kuskokwim Region based on three indicator stocks (A), with a focus on the Yukon River stocks (B).



2003-2021 Bering Sea Chum Salmon Bycatch



Fish size



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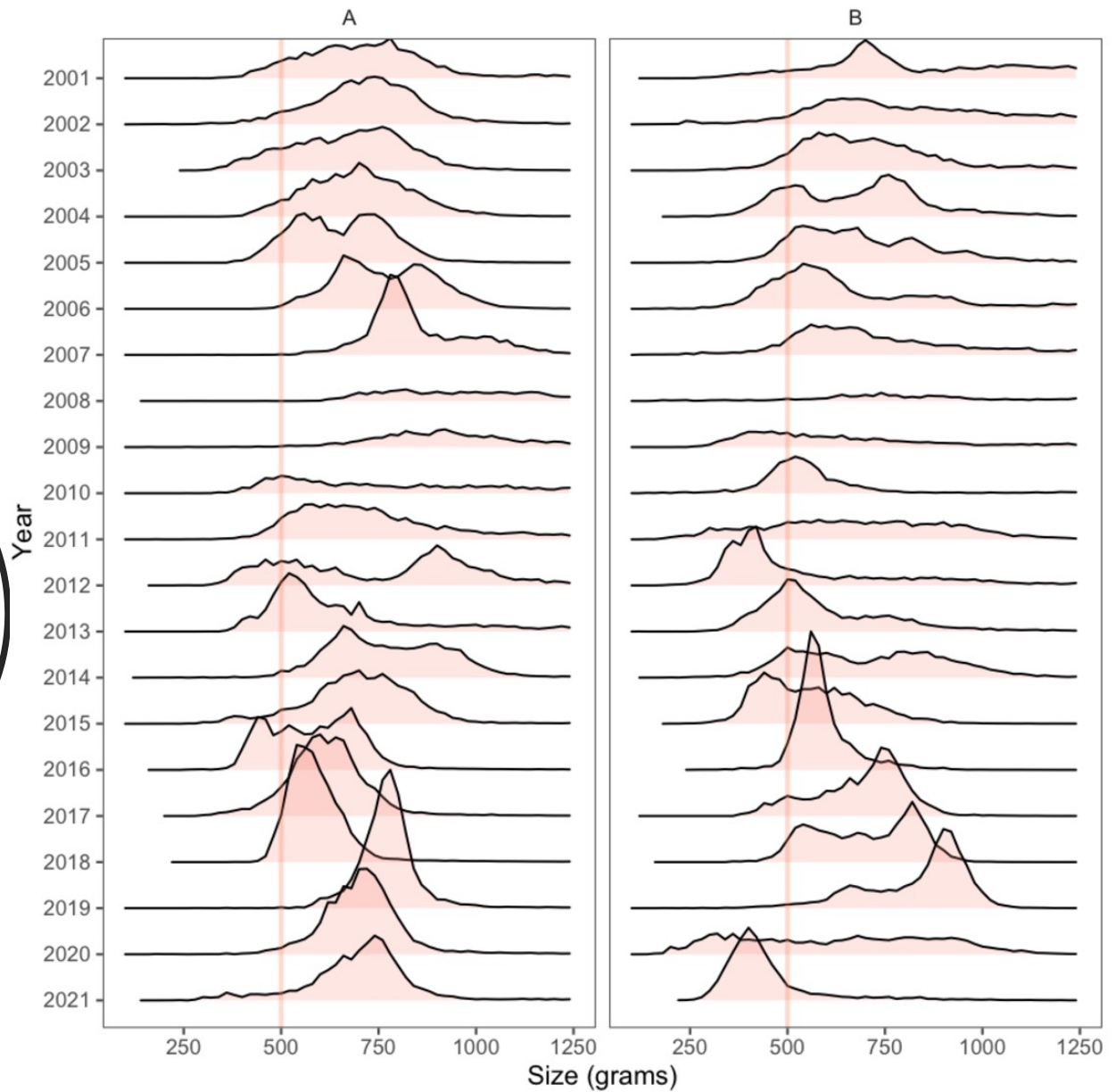


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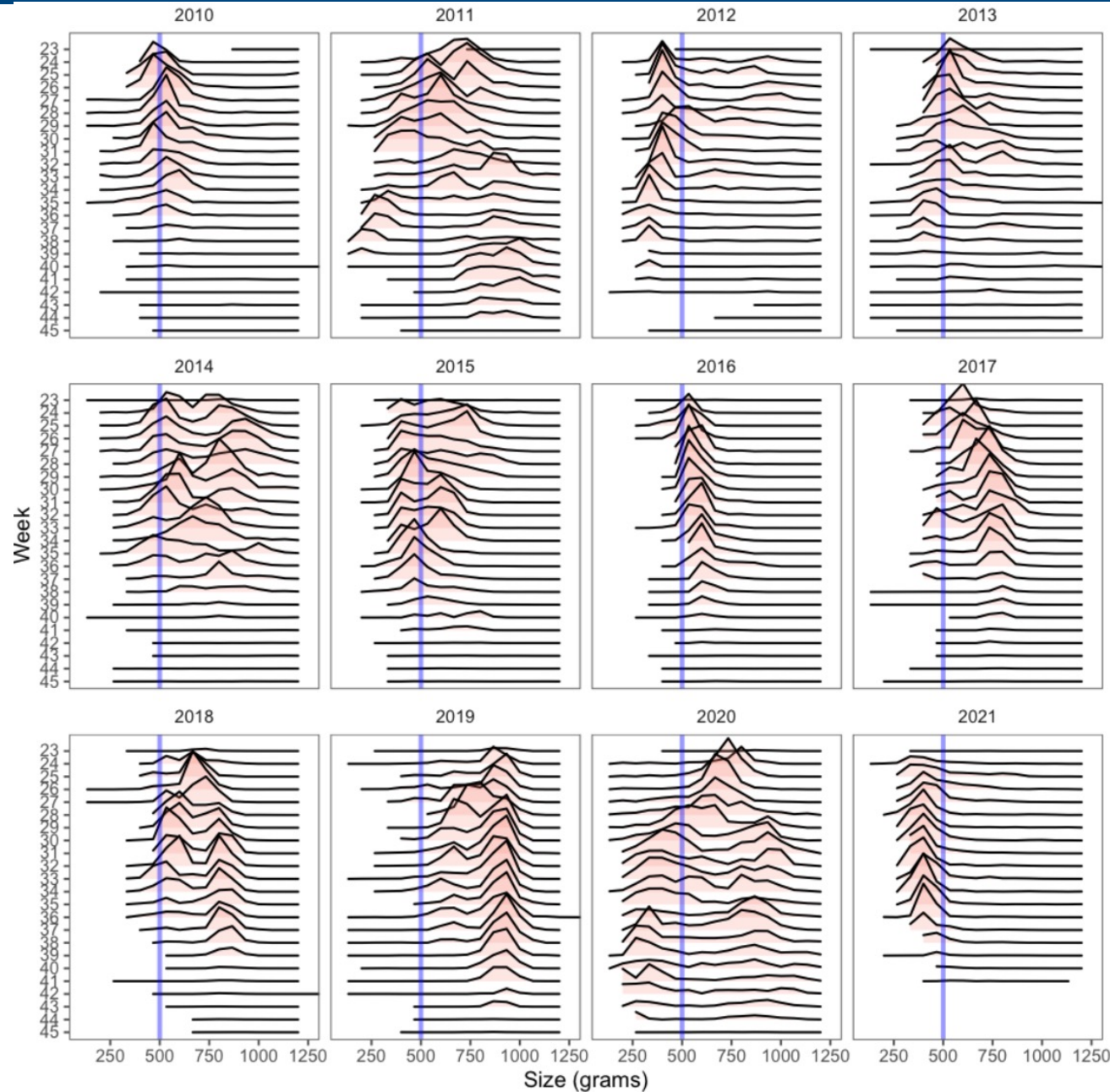


By
season
& year

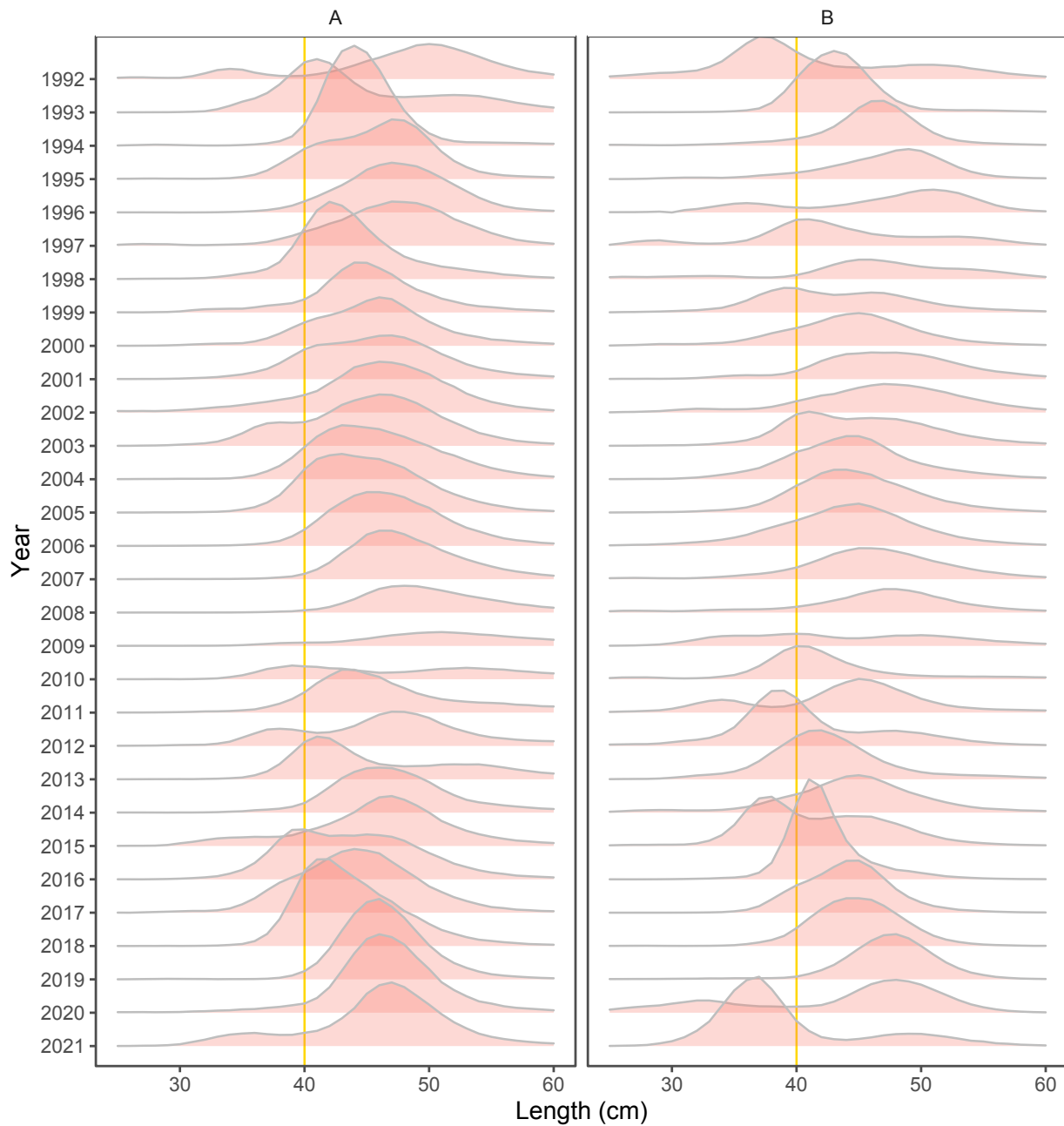
Pollock
fishery mean
weight in
tows



B-season Weekly catch

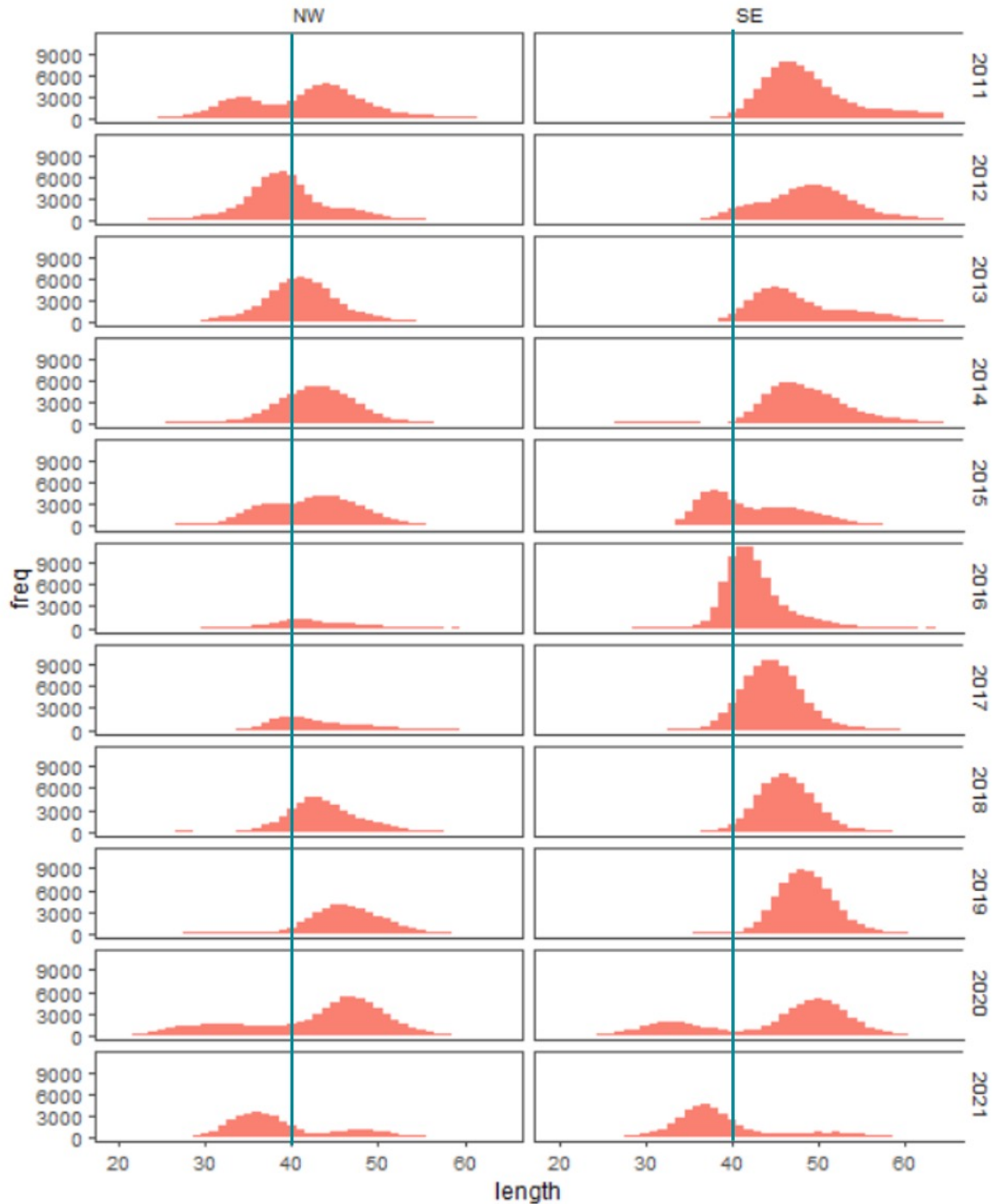


Pollock fishery length frequency by season



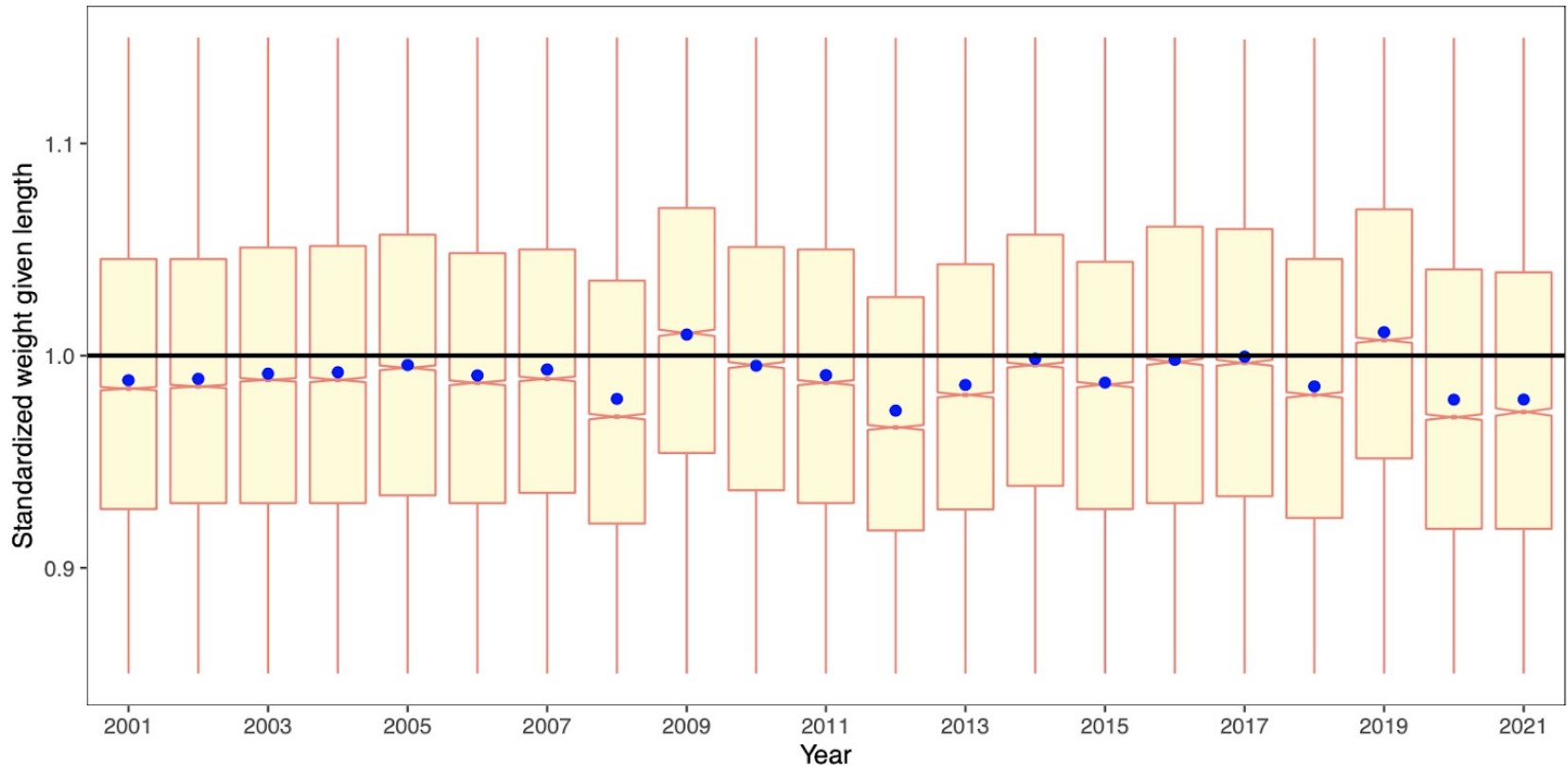
B-season (E and W of 170)

Pollock fishery length frequency by area



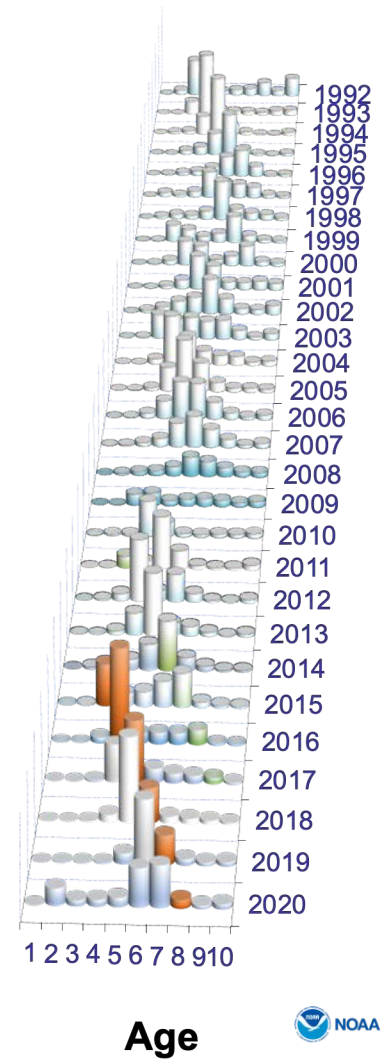
Weight given length—fishery data

Skinny again in 2021!

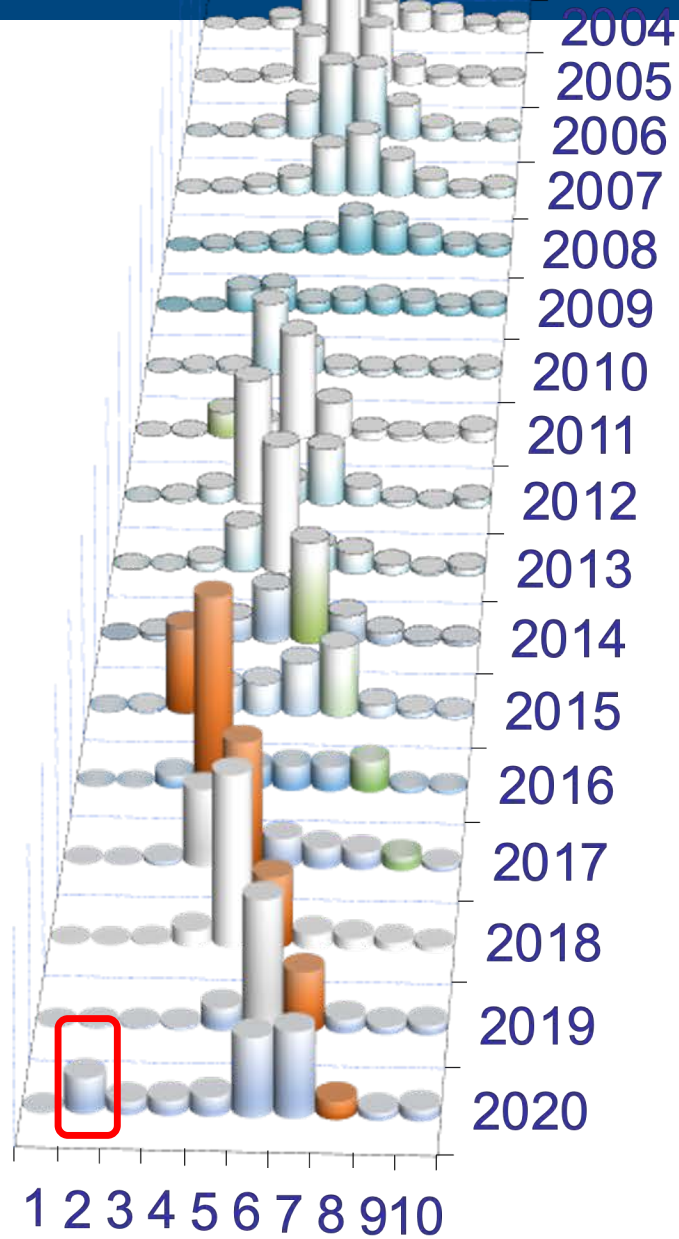




Fishery catch-at-age



Fishery catch-at-age



Survey work

2020 and 2021



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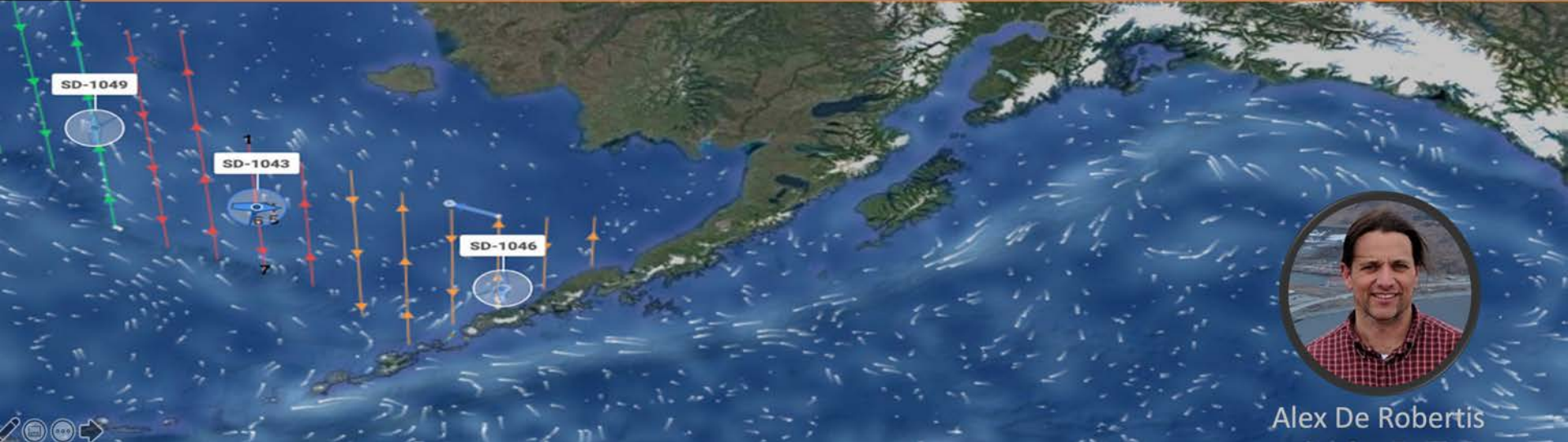


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Alex De Robertis, Mike Levine, Nathan Lauffenburger, Jim Ianelli, Cole Monnahan,
Rick Towler, Taina Honkalehto, Darin Jones, Sarah Stienessen, Denise McKelvey, Saildrone, Inc.

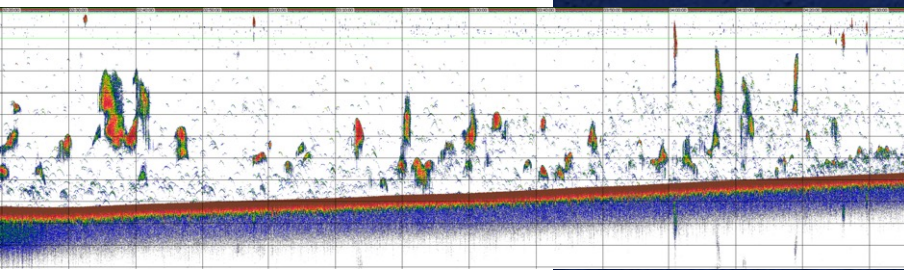
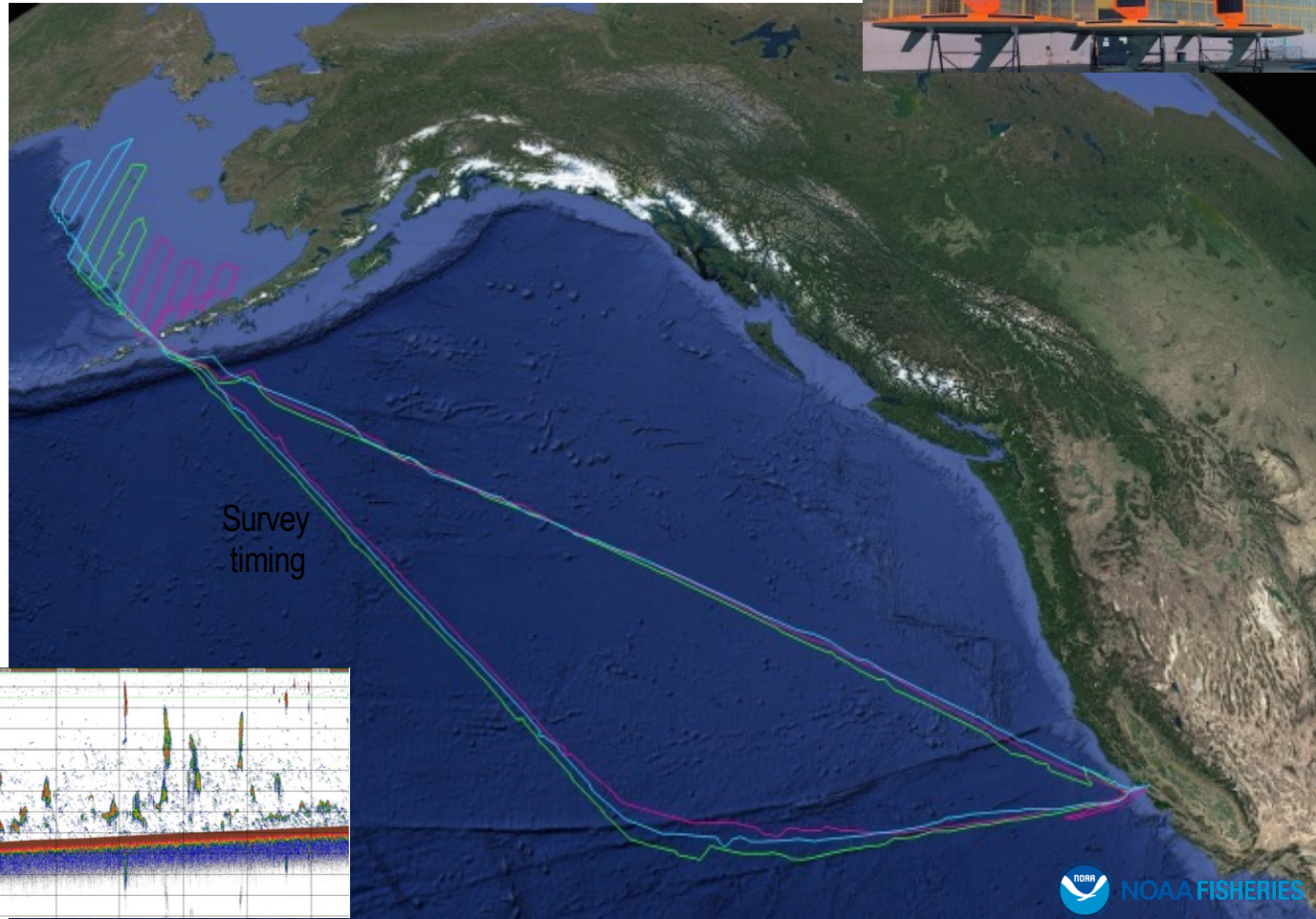
2020 Pollock saildrone survey



Alex De Robertis

2020 Contingency survey

- Sail to/from Alaska
- 3, 7m saildrones
- 40 nmi spacing
- Survey July 4-20 Aug
- Survey during daylight
- Pause at >25 knots

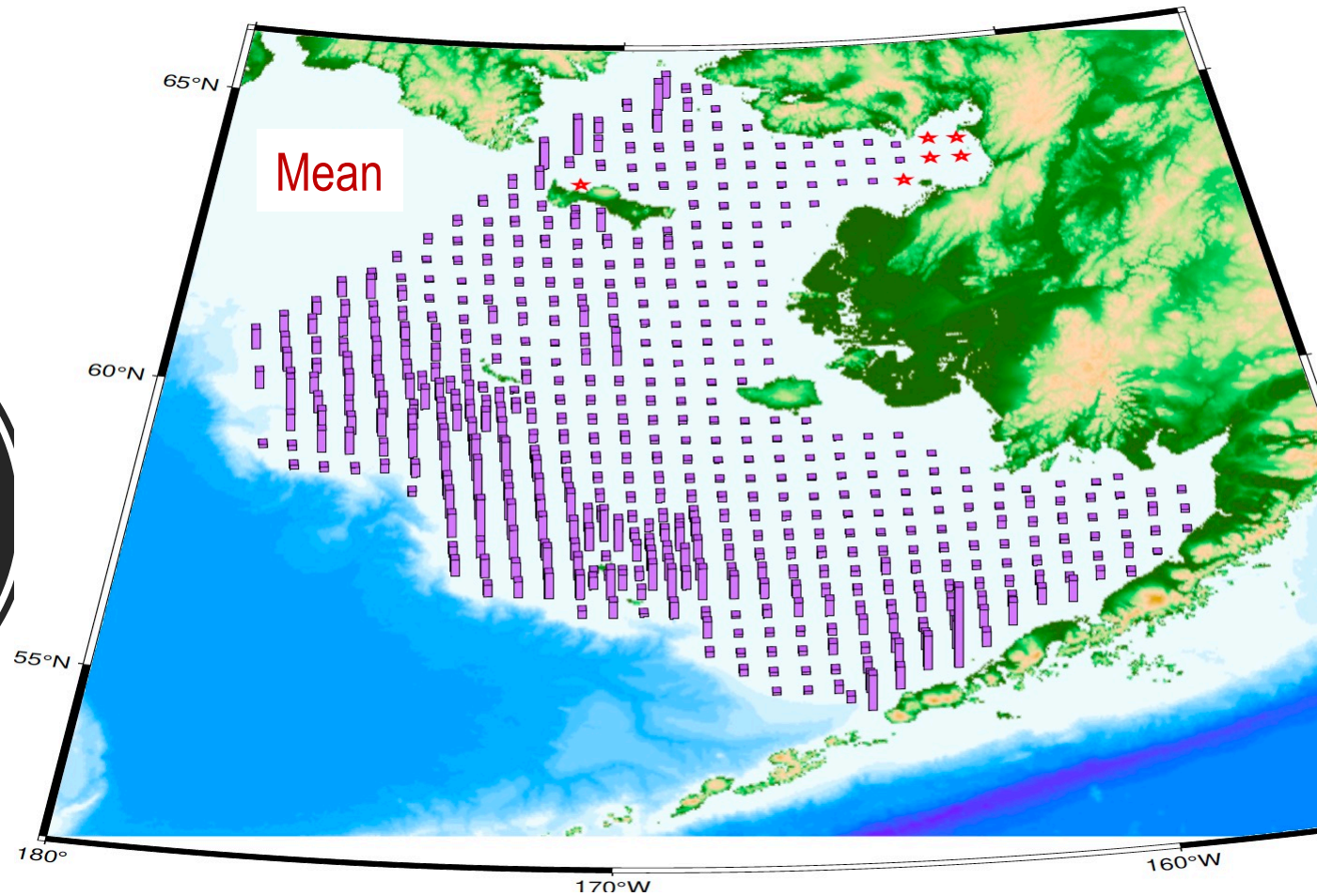


Survey work

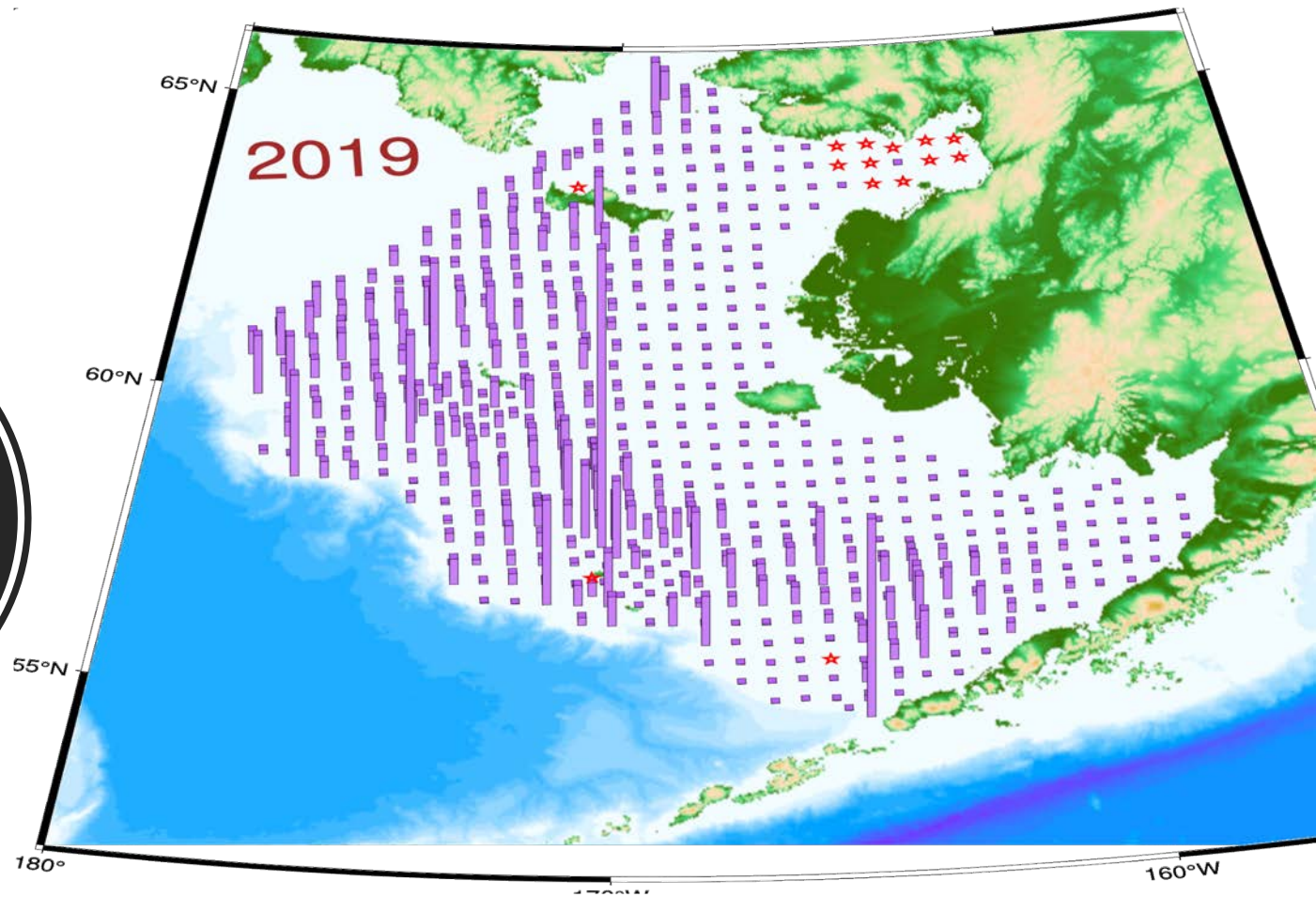
2020 and 2021



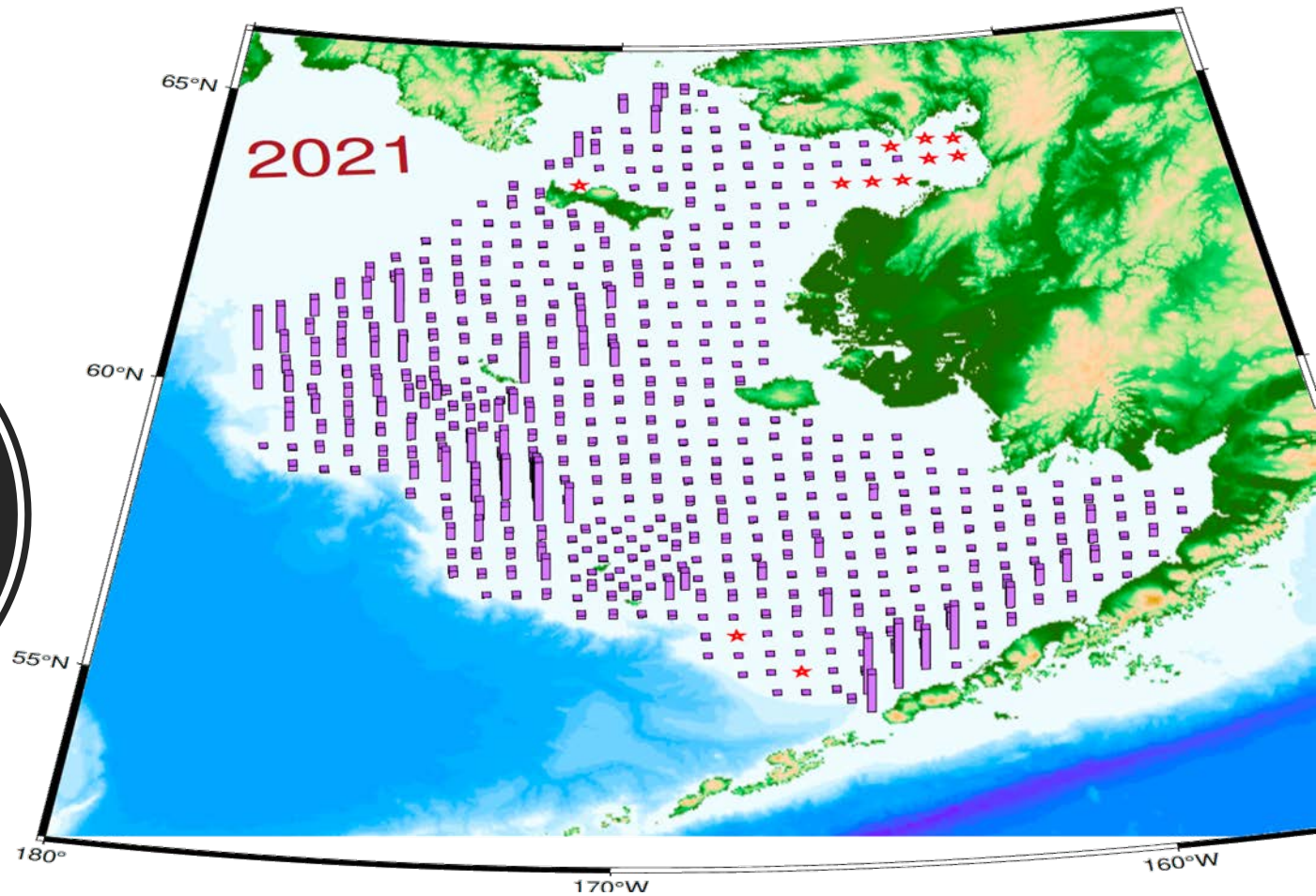
**Pollock
survey
mean density
by station**



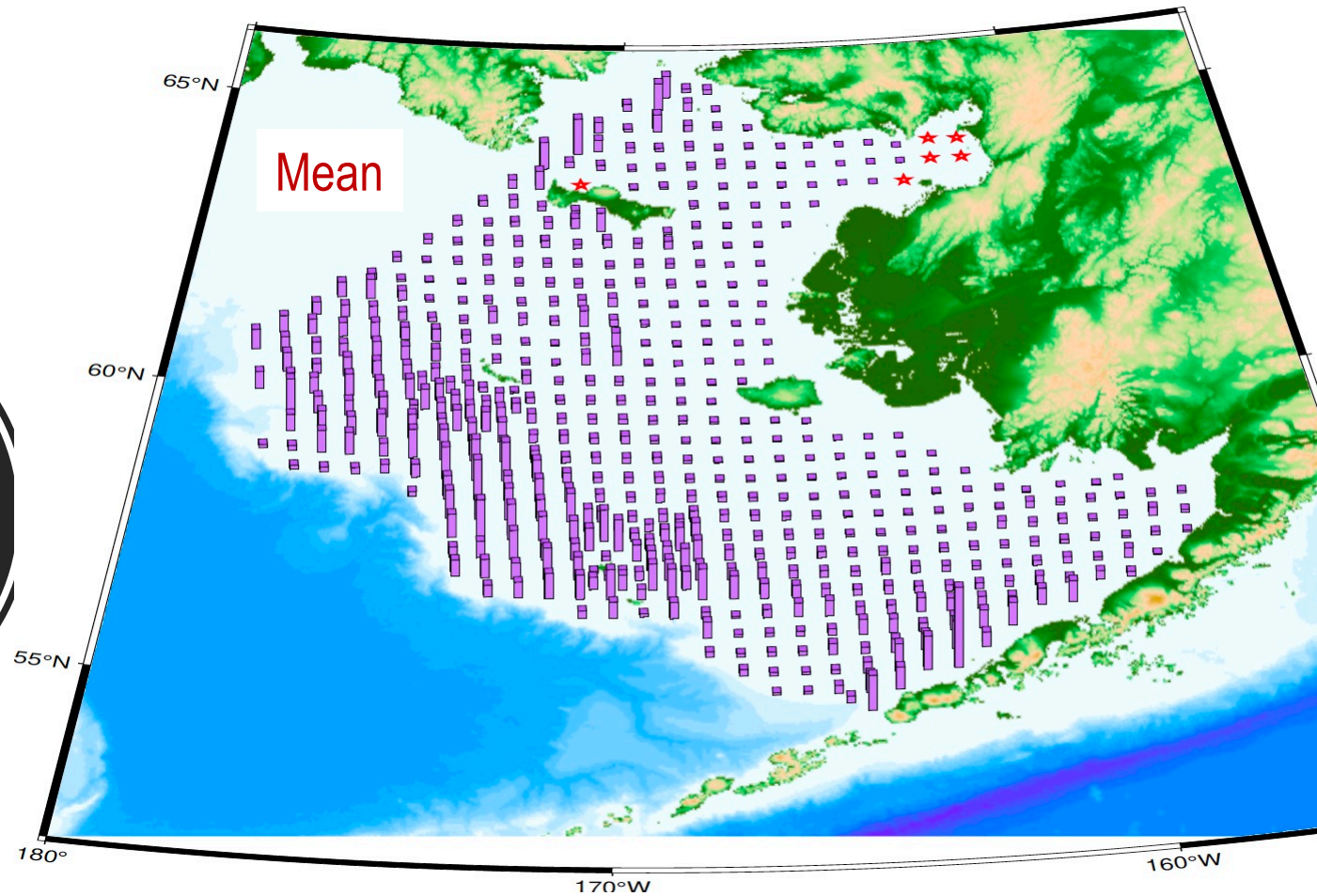
Pollock Survey 2019



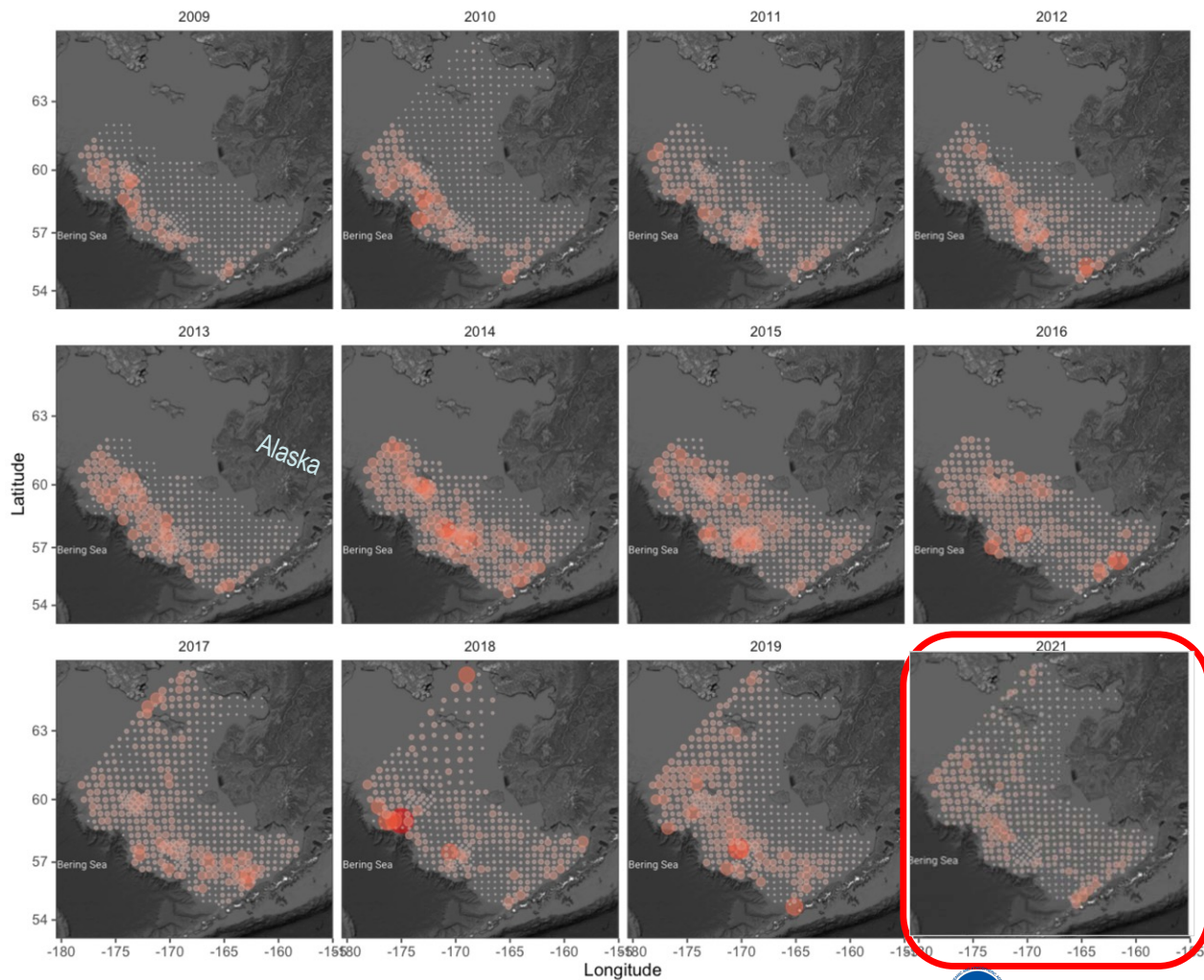
Pollock Survey 2021



Pollock
survey
mean density
by station

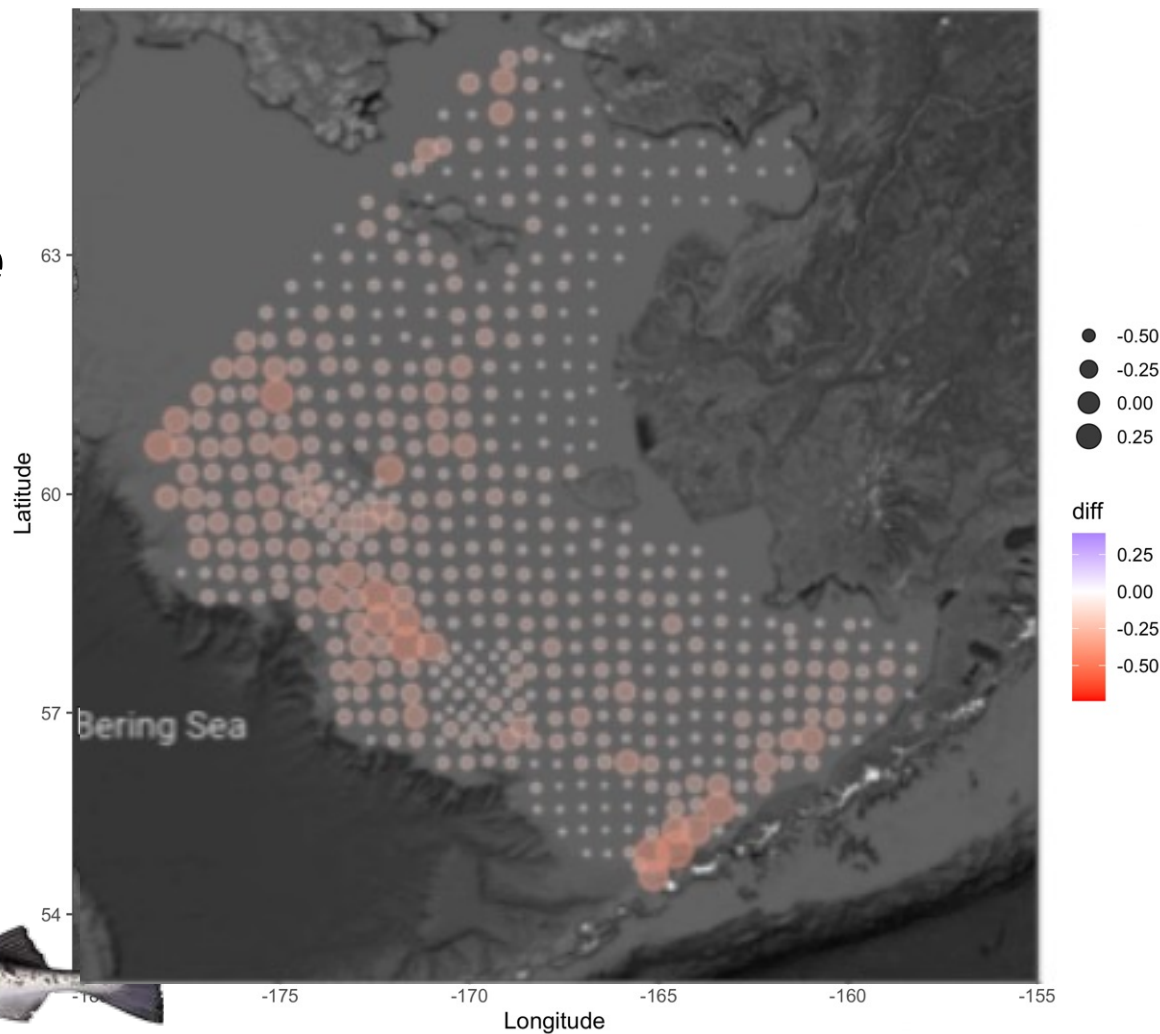


Recent bottom trawl surveys



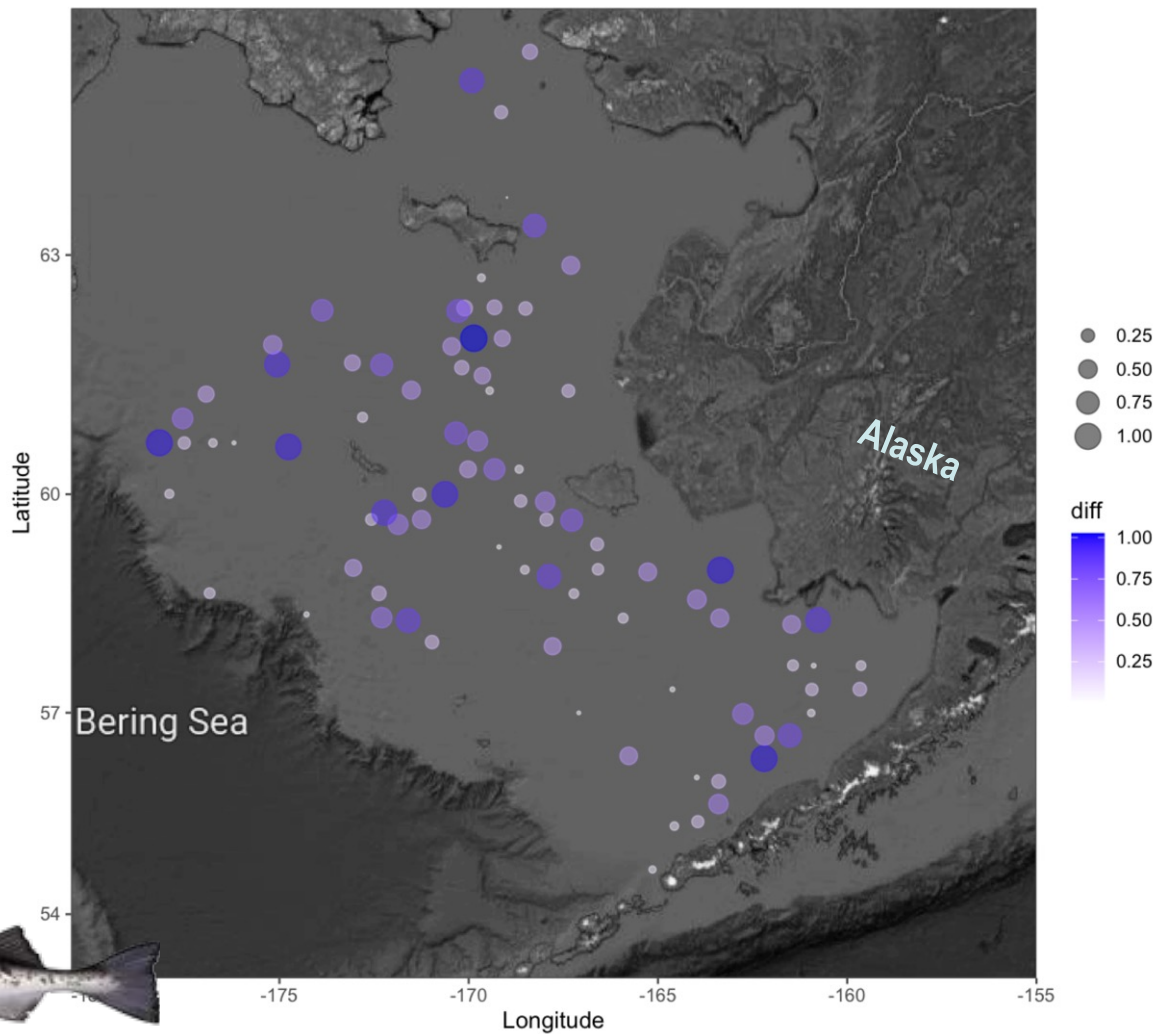
NOAA's 2021 bottom trawl survey relative to the average

2021 survey catch rate difference from mean



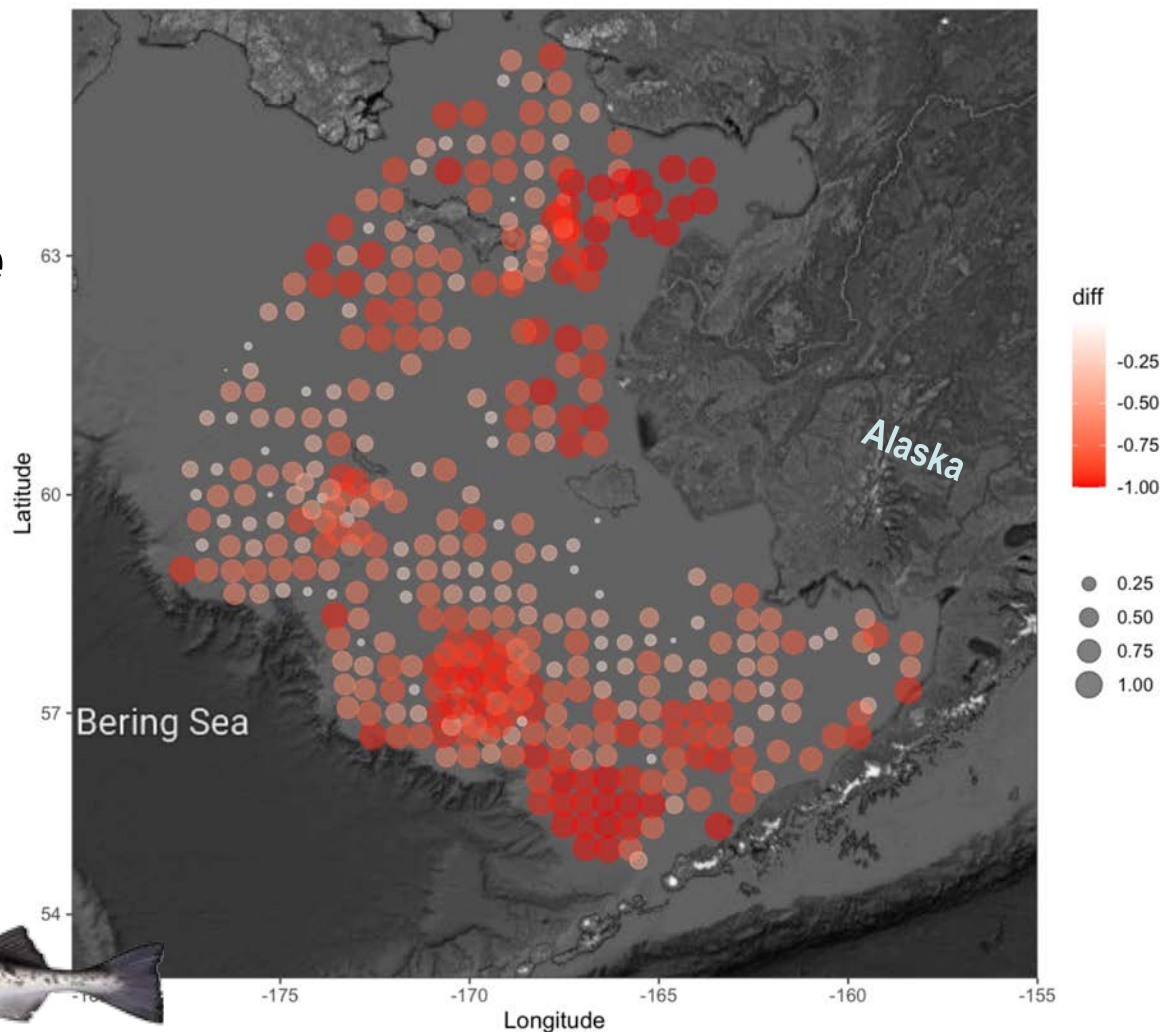
NOAA's 2021 bottom trawl survey relative to the average

2021 survey catch rate difference from mean



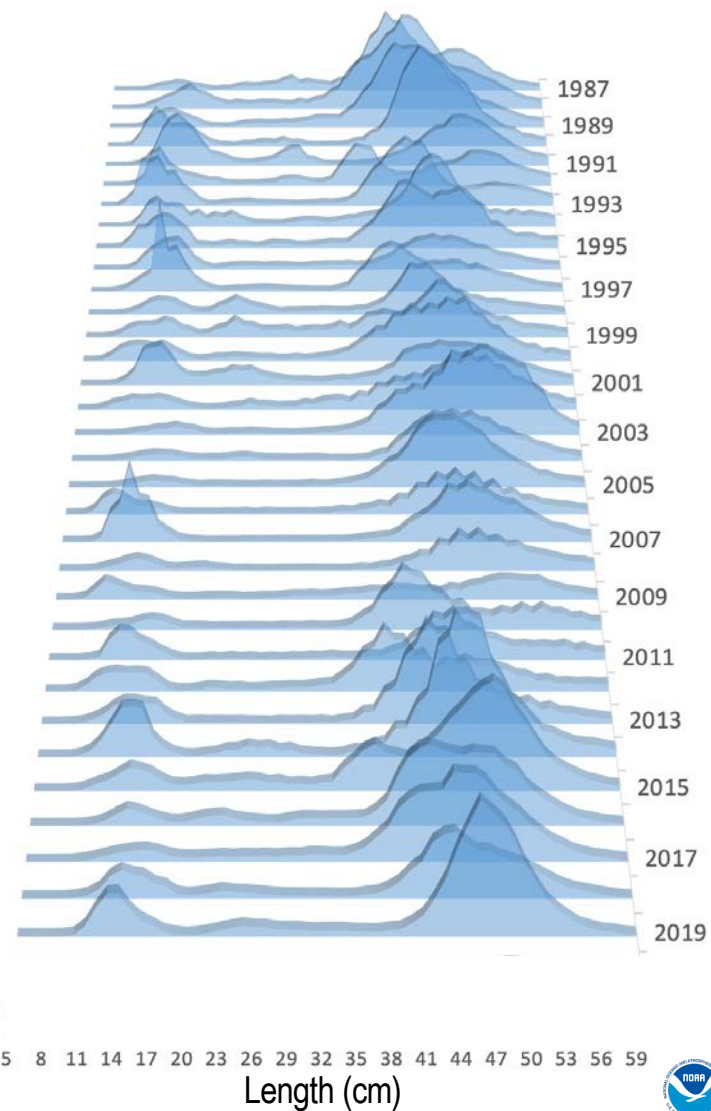
NOAA's 2021 bottom trawl survey relative to the average

2021 survey catch rate difference from mean



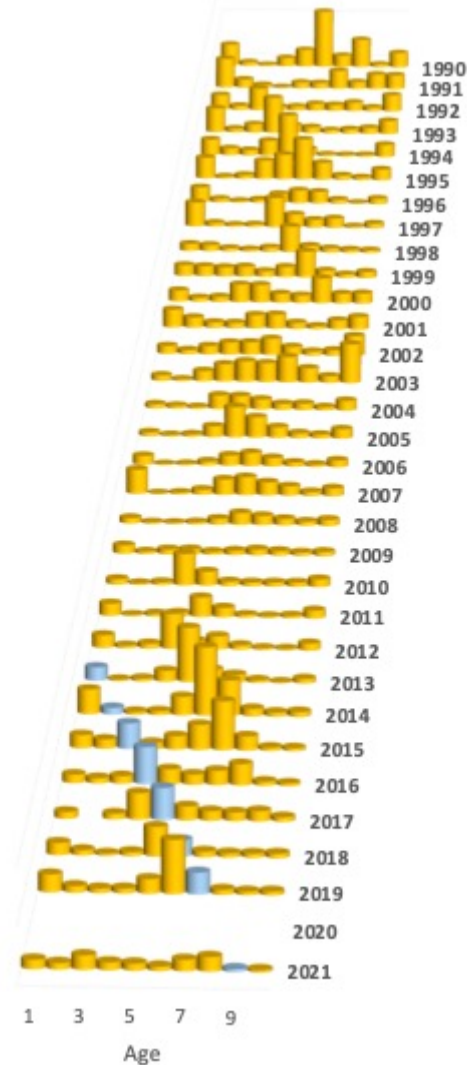
Size distribution

- From NOAA's bottom-trawl survey



Age composition

- From NOAA's bottom-trawl survey

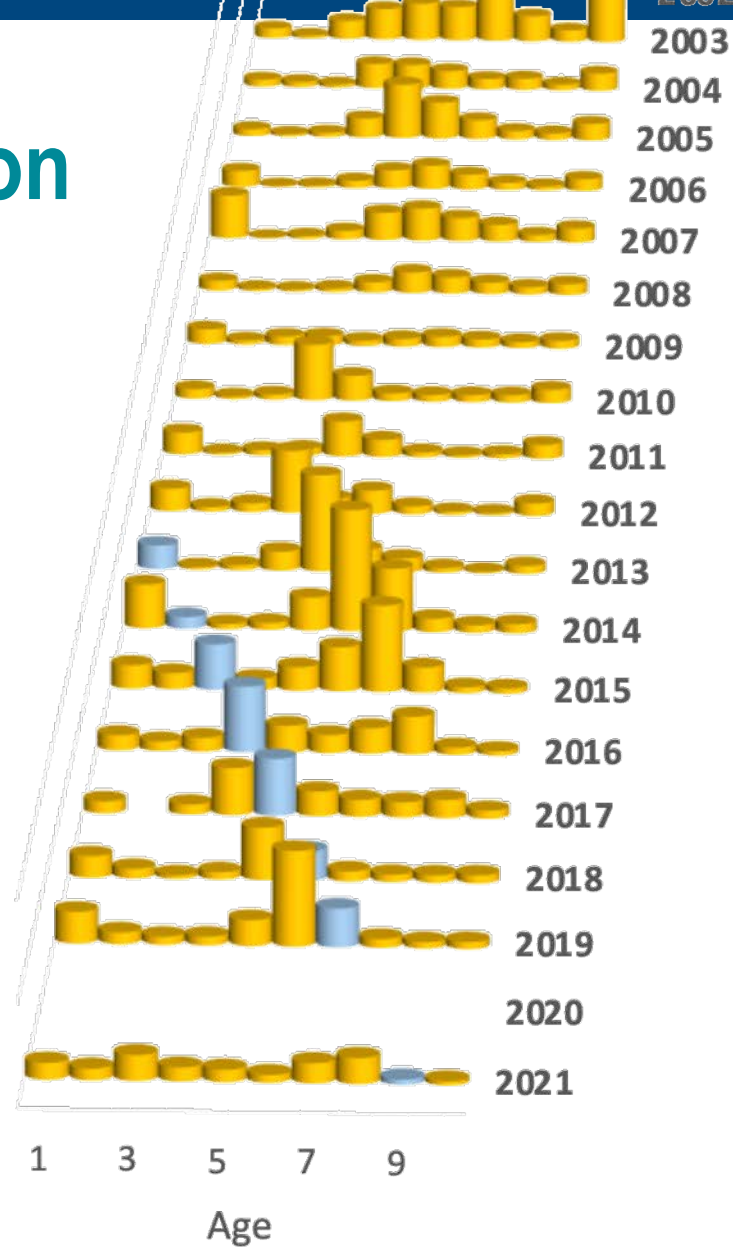


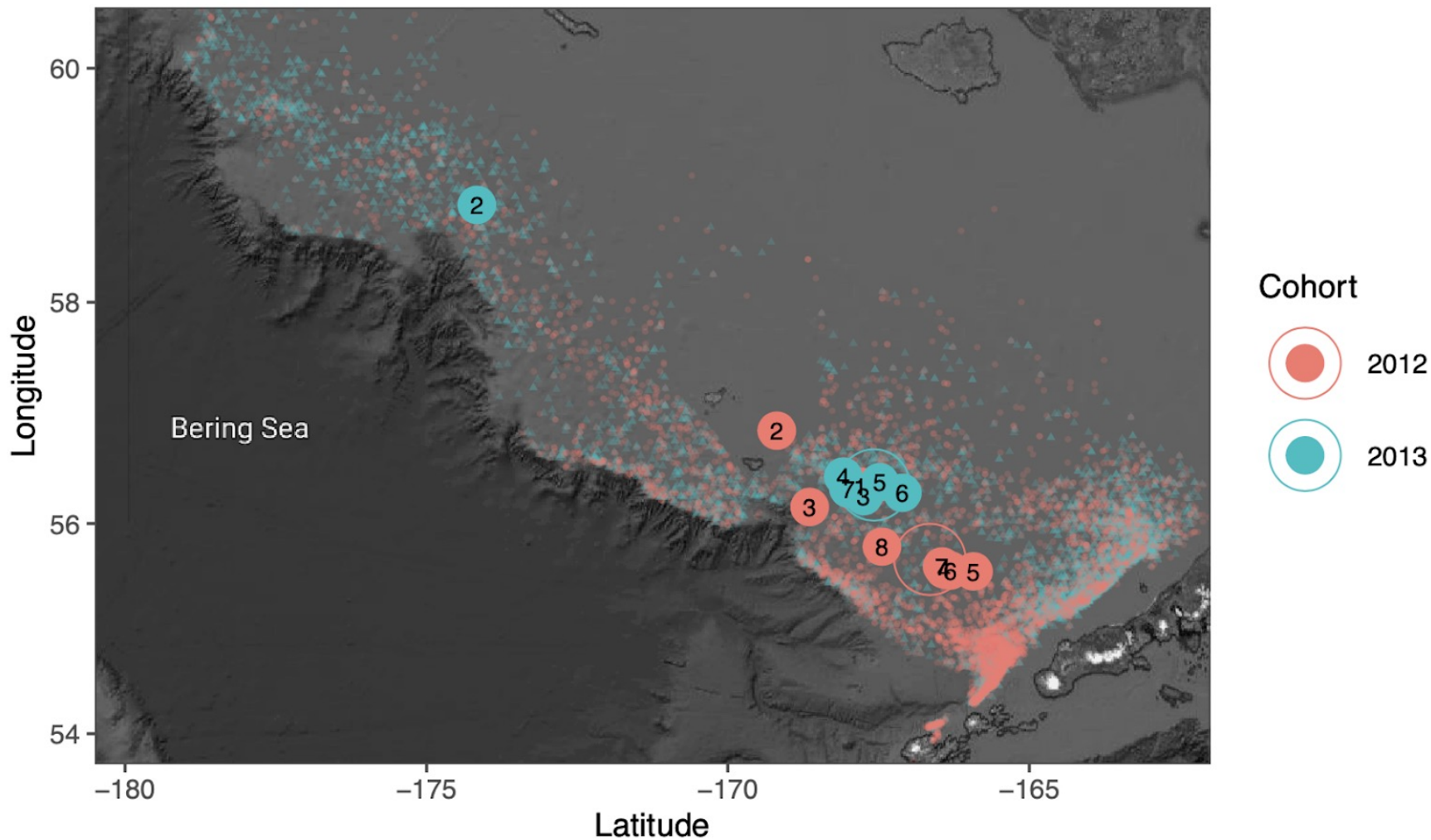
Vertical scale is relative to survey population estimate

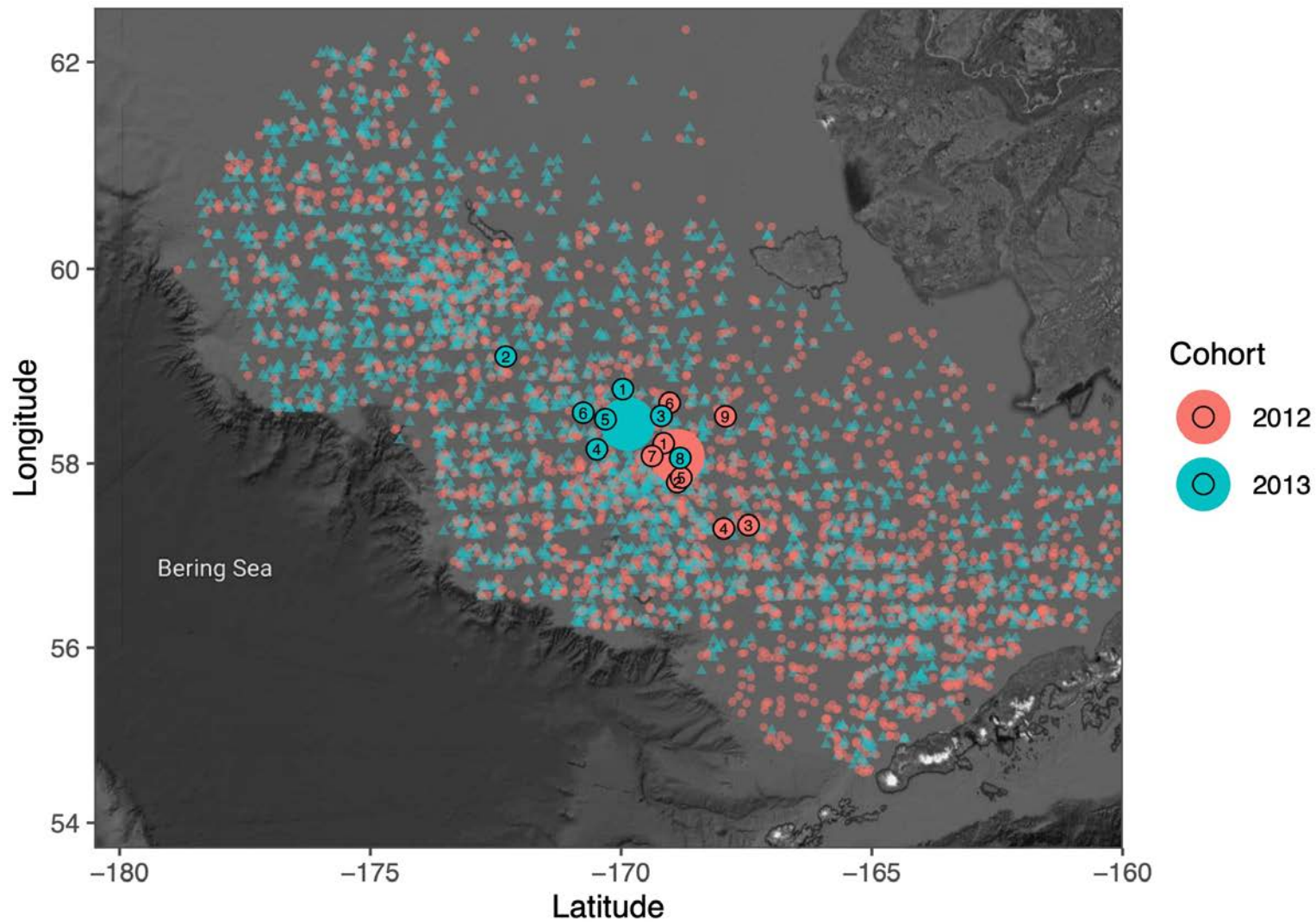


Age composition

- From NOAA's bottom-trawl survey

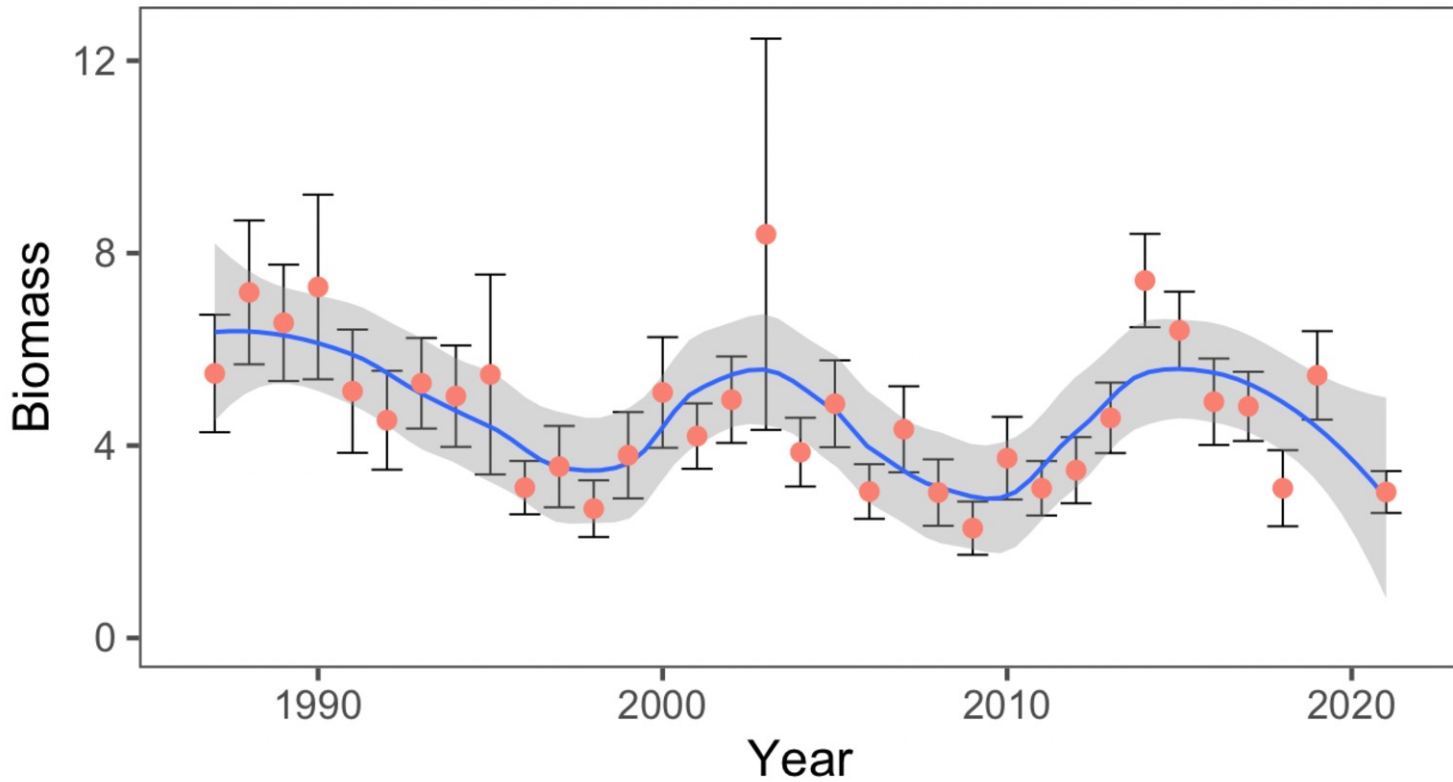






Survey Biomass trend

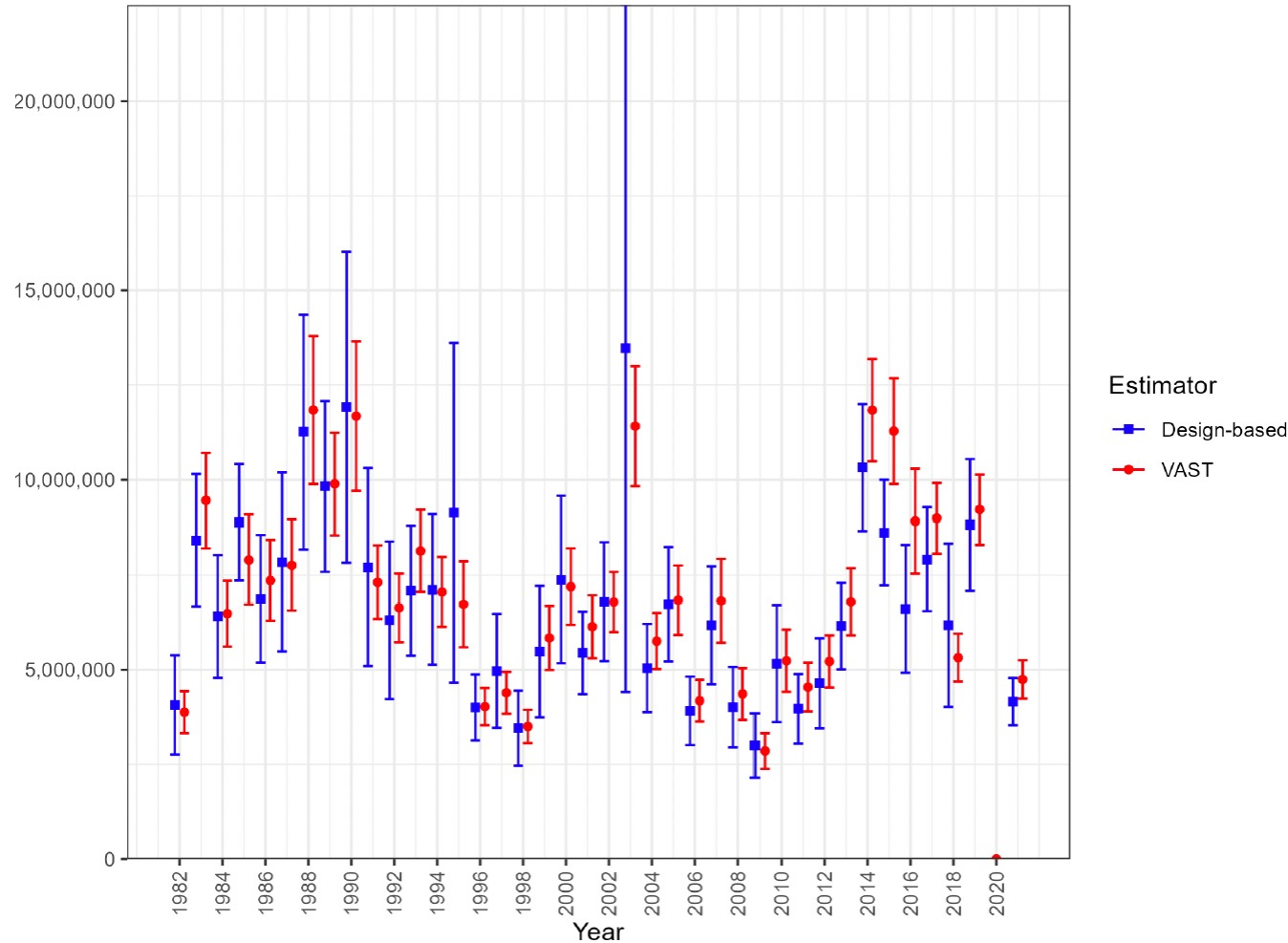
○ E. Bering S
Survey estimates



Design-based trawl survey estimates

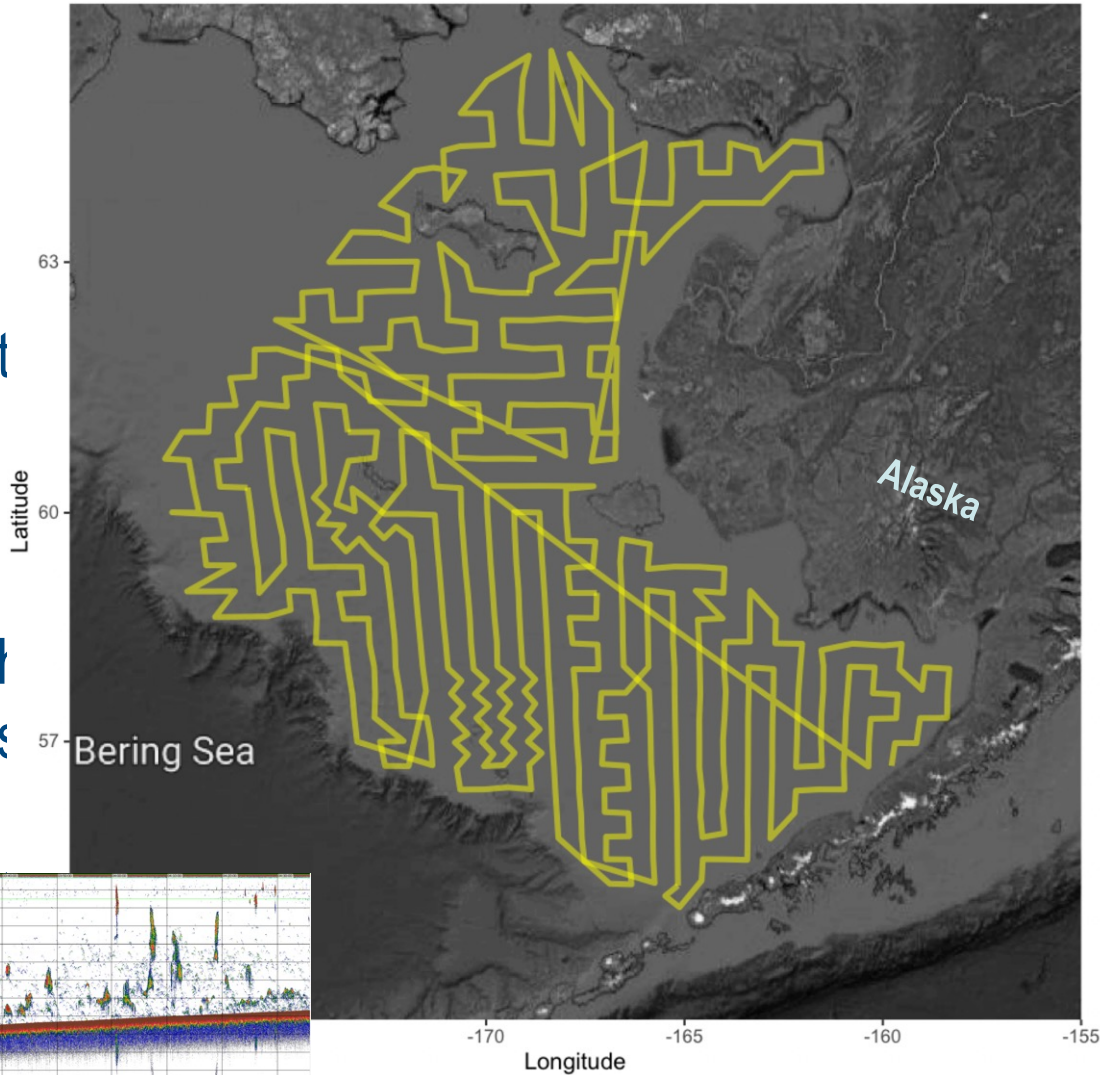


Survey standardizations



Survey

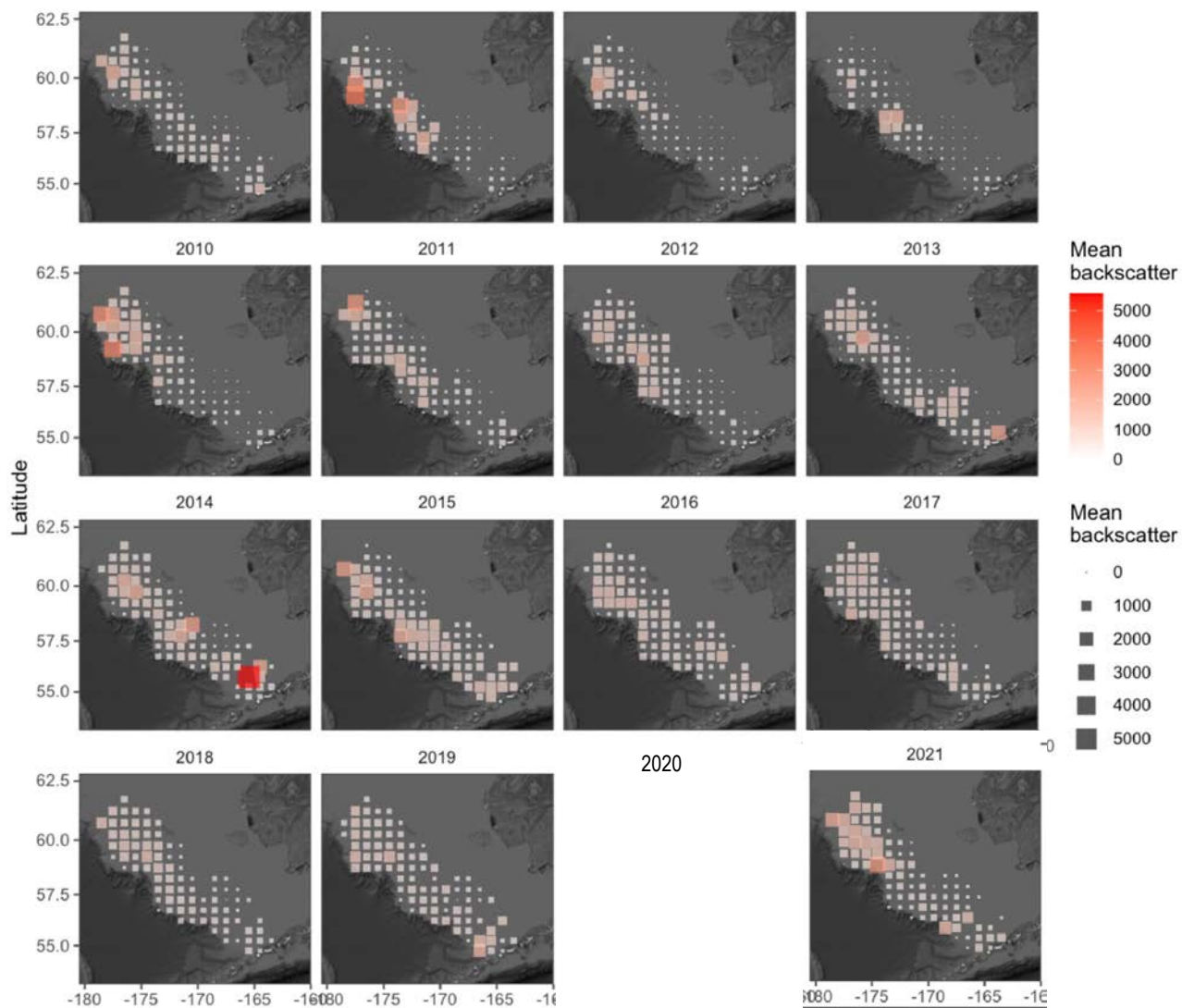
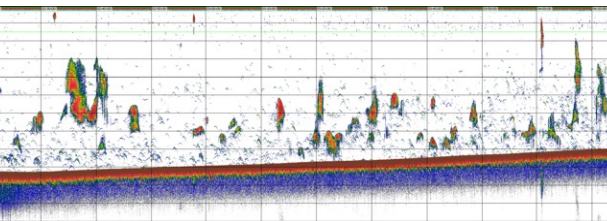
- Opportunist acoustic data collections
- Gives insight on young fish abundance



Opportunistically Acoustic data

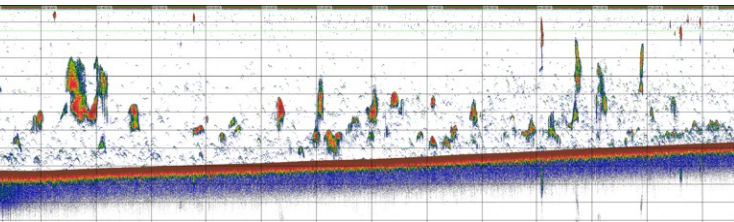
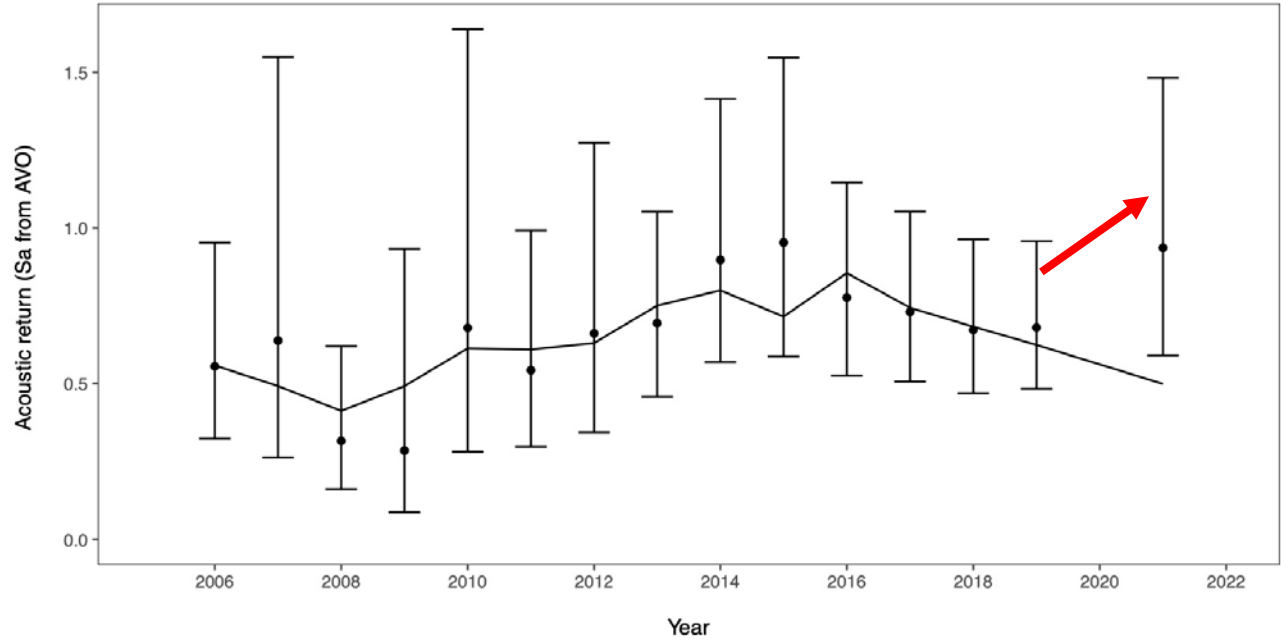
collected from chartered bottom-trawl survey boats

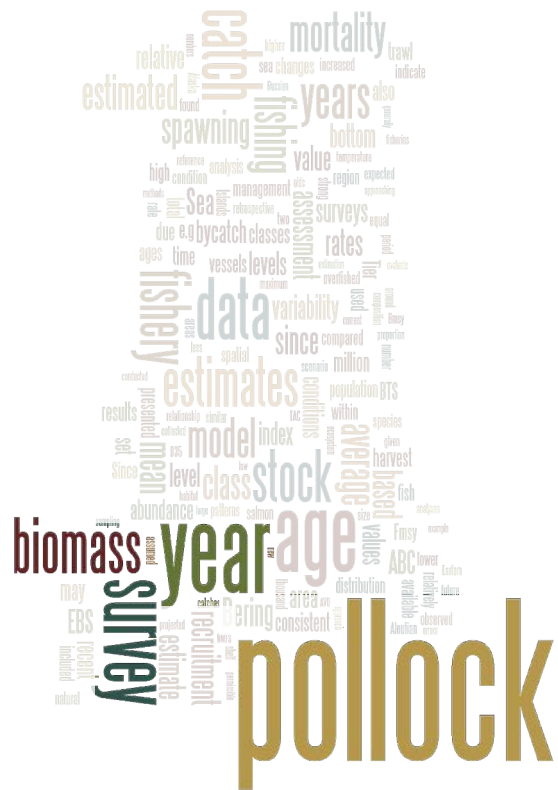
The AVO index



Opportunistic Acoustic Data

collected from
chartered bottom-
trawl survey boats
The AVO index





EBS pollock Assessment Results



Model details (1 of 2)

- Tuning indices
 - Acoustic Trawl survey
 - Available biennially (sailing drones used in 2020, next one summer 2022)
 - Annual fixed-station bottom trawl survey (except 2020)
 - Acoustic vessel of opportunity (AVO index)
 - Foreign trawler CPUE (in 1970s)
- Fishery data
 - Total catch
 - Catch-at-age
 - Mean fishery weights-at-age



Model details (2 of 2)

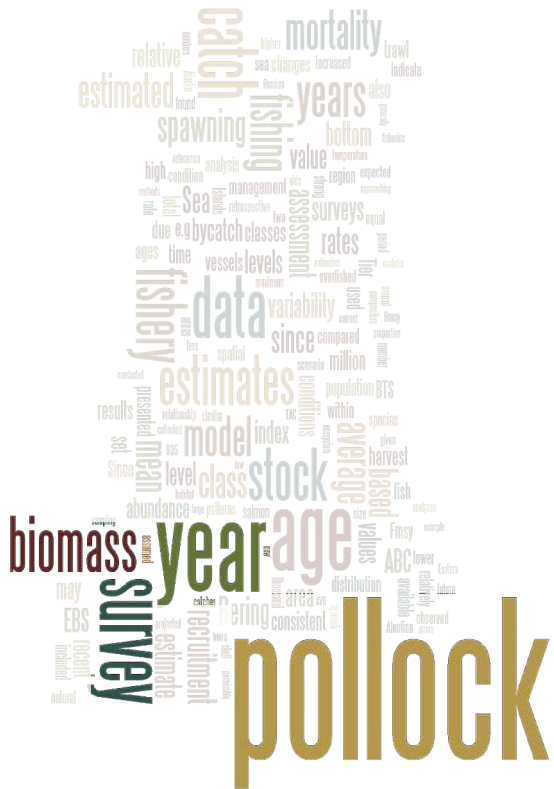
- Age specific schedules
 - Natural mortality
 - Ages 1 and 2 higher, other ages fixed at 0.3
 - Maturity
 - Estimated externally...50% at ~ age 3.5 years
- Other
 - Conditioned on catch biomass (F's estimated)
 - Selectivity varies in fishery
 - Slightly in surveys
 - Stock recruitment model Ricker
 - Affects ABC values, minimal impact on historical trends
 - Projection options built in to evaluate policy trade offs



Model configurations

- Base (as in 2020)
- Include preliminary 2021 fishery data





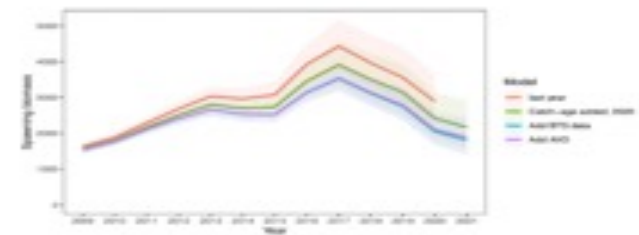
Data Impact on Model



New data impact on model

Data considerations

Name	Updated catch to 2021	2020 fishery age data	Bottom trawl survey	Acoustic from Bottom trawl transits (AVO)
Fishery	X	X		
+ BTS	X	X	X	
+ AVO	X	X	X	X



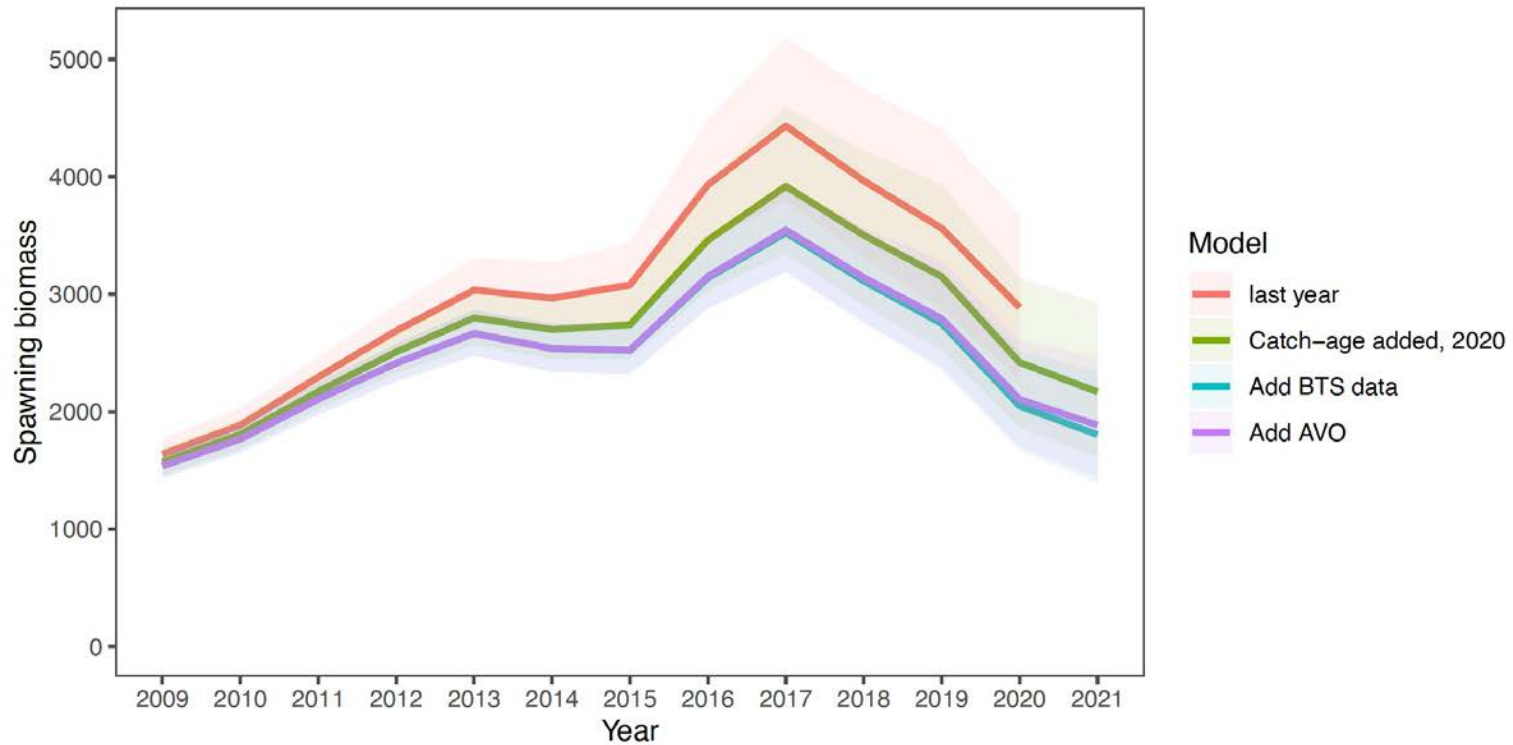
Data
Impact on
Model

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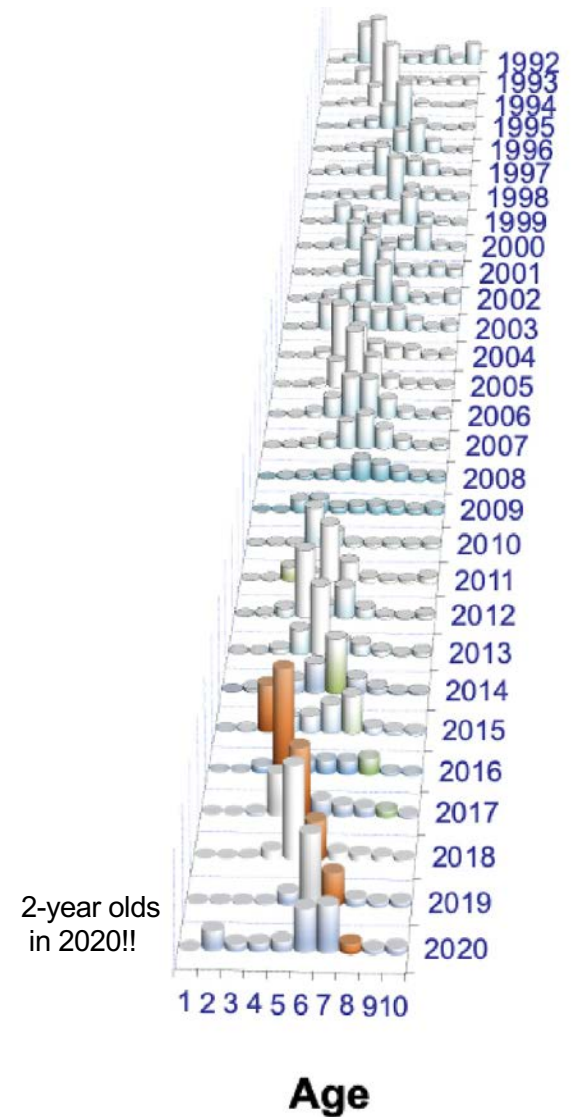
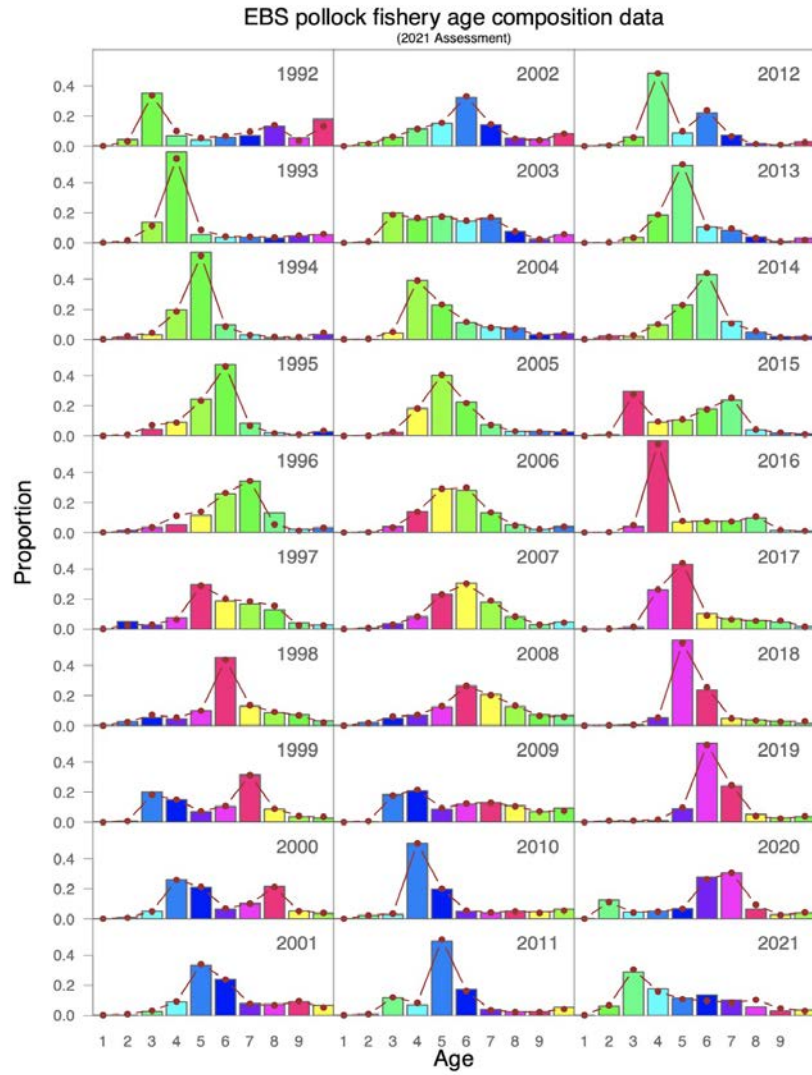




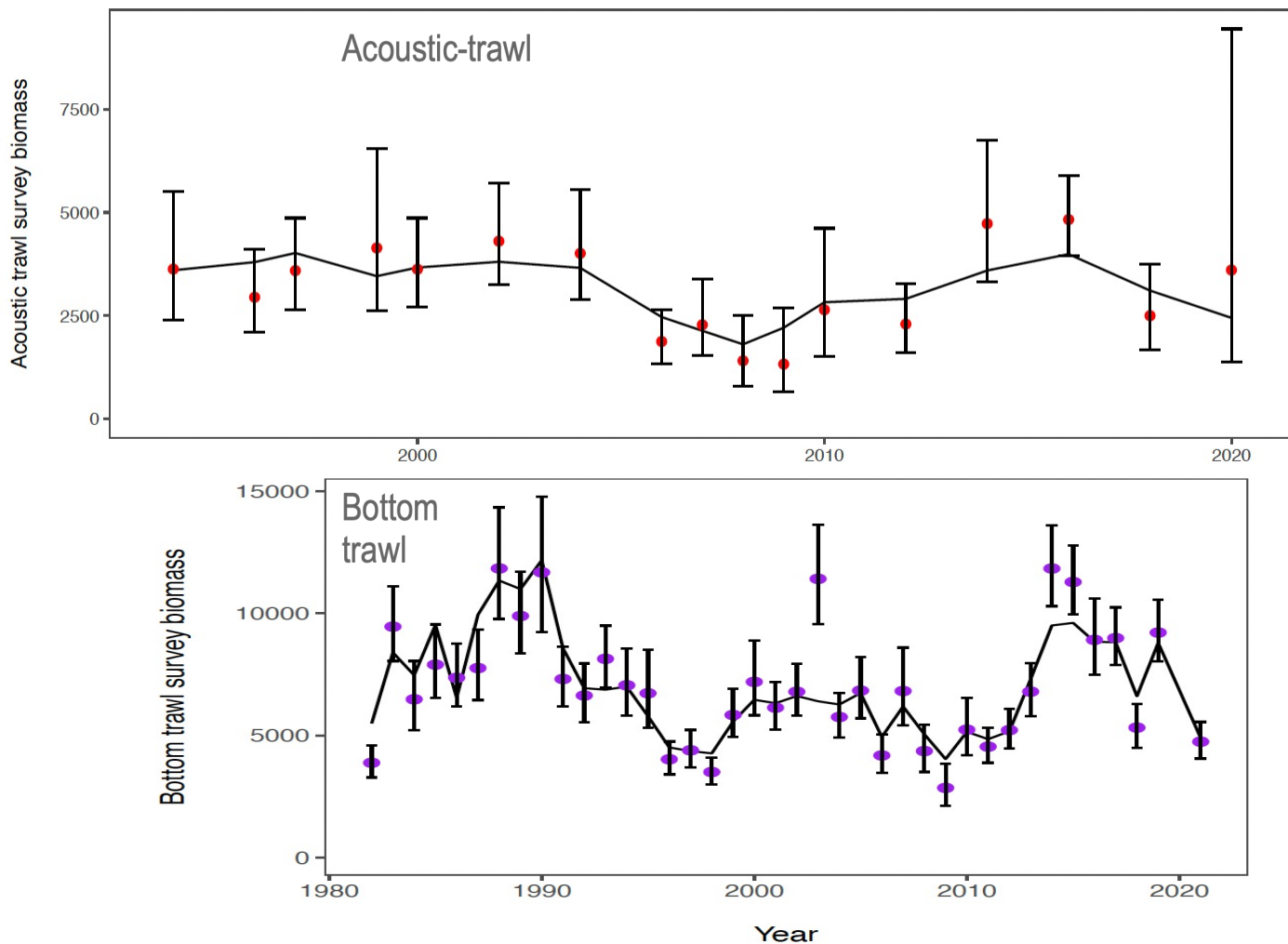
Data Impact on Model



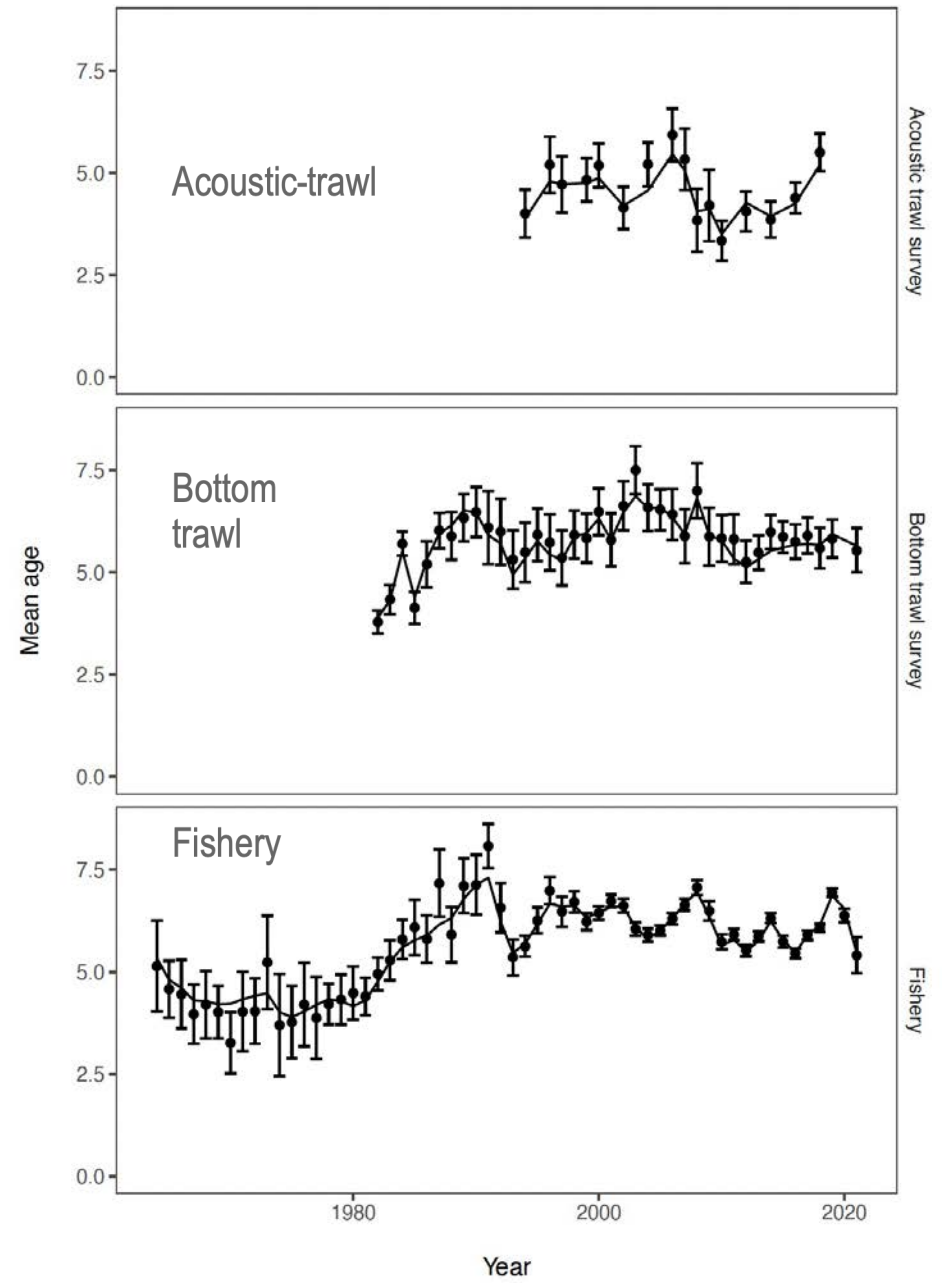
Fishery catch-age



Fit to survey indices

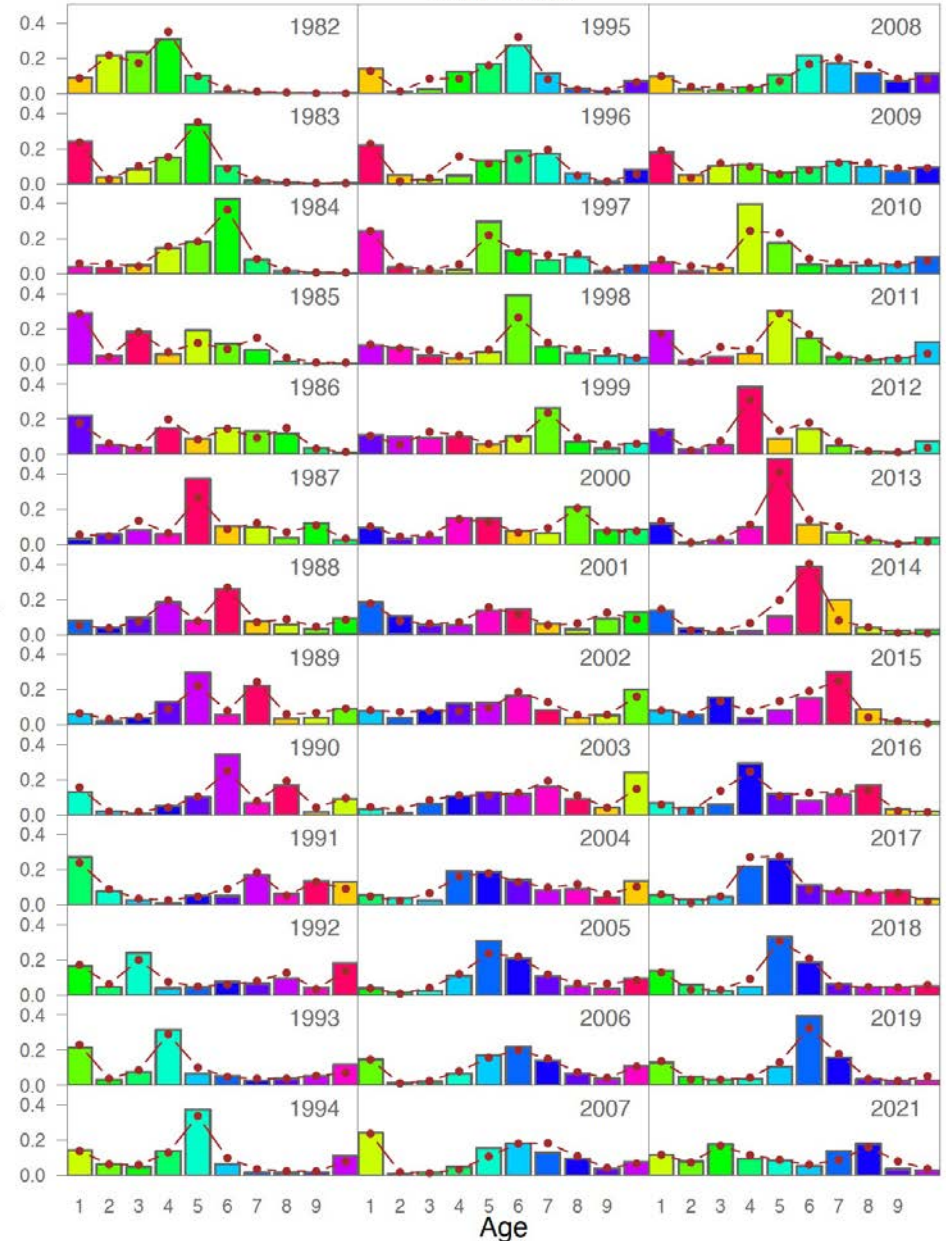


Fit to age compositions

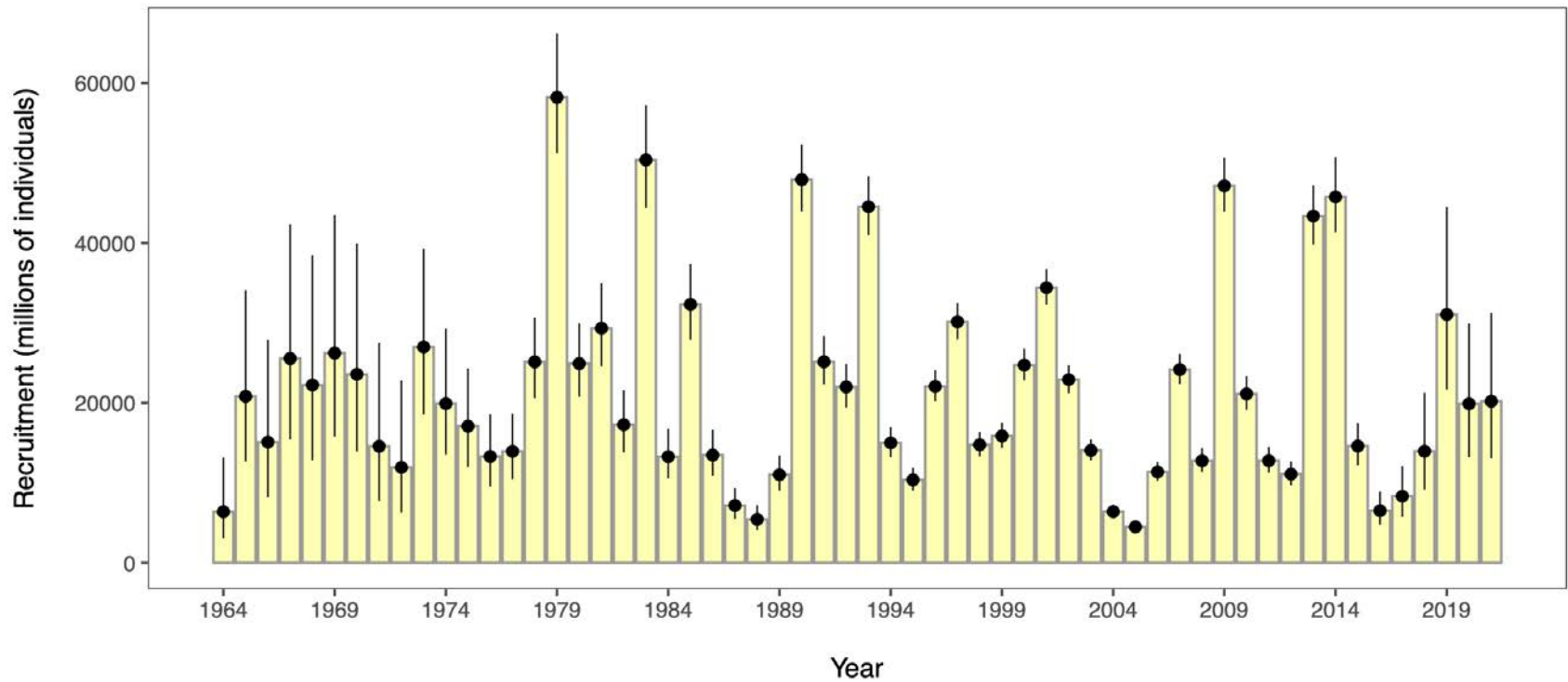


Fit to survey age compositions

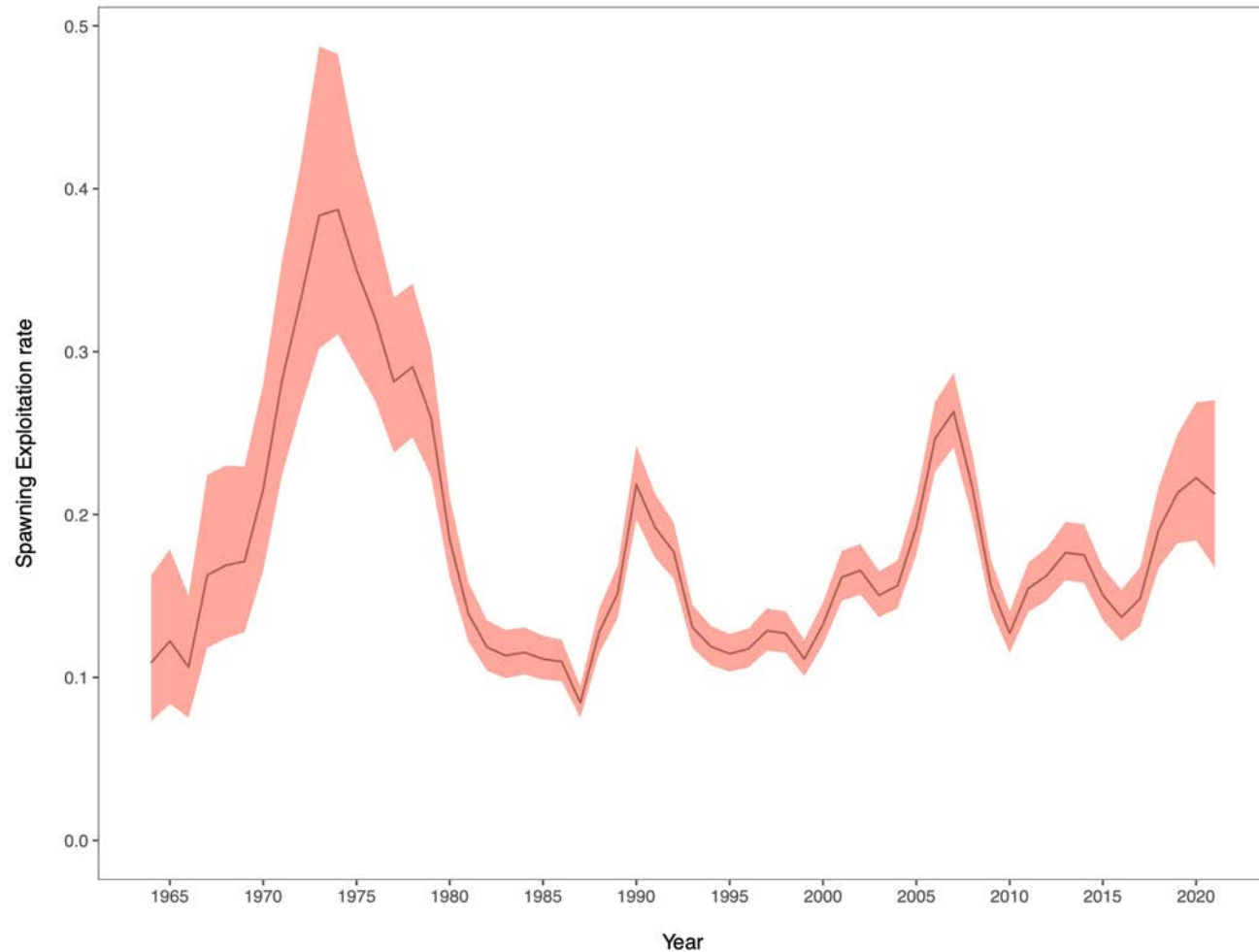
EBS pollock survey age composition data
(2021 Assessment)



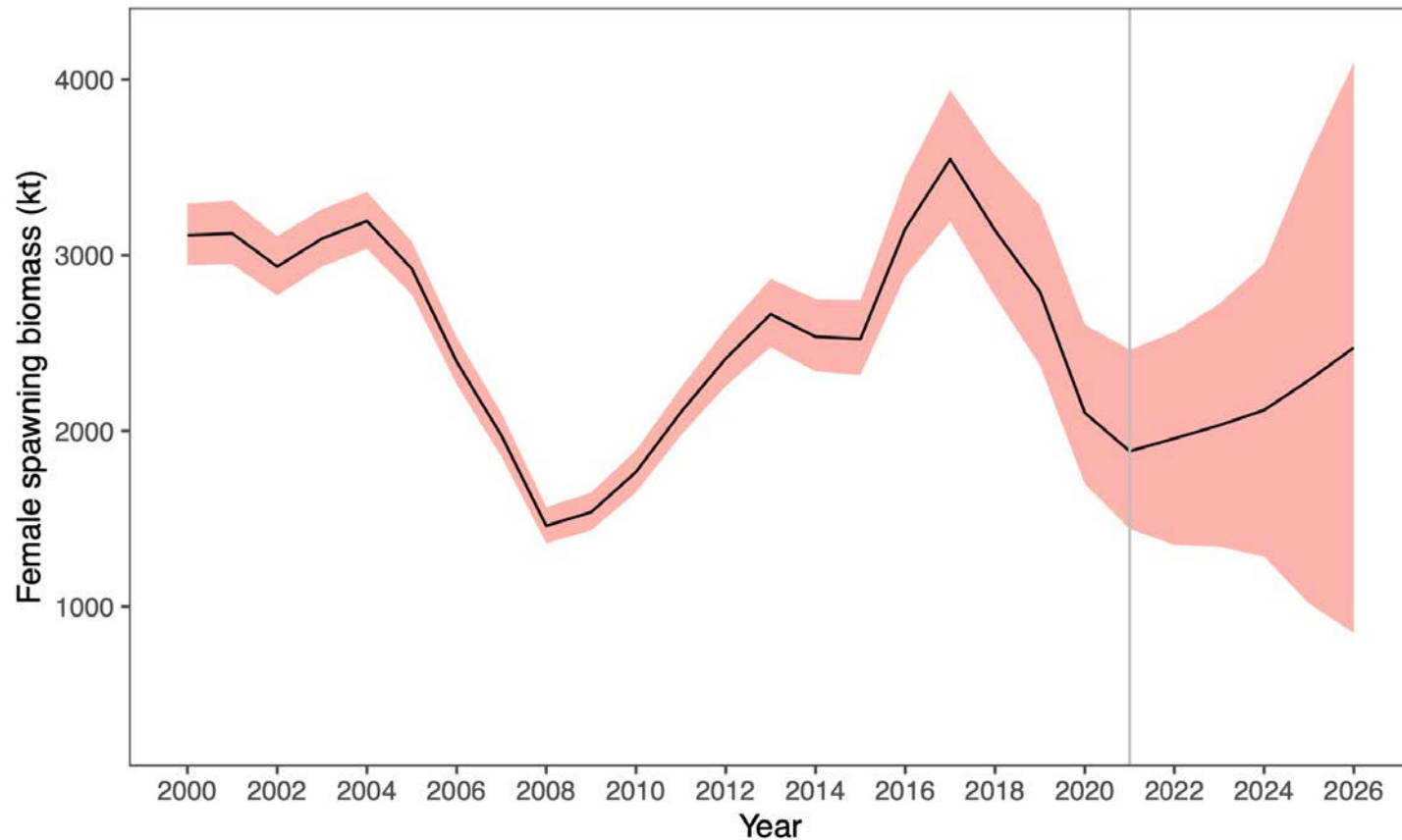
Recruitment



Exploitation rate trend

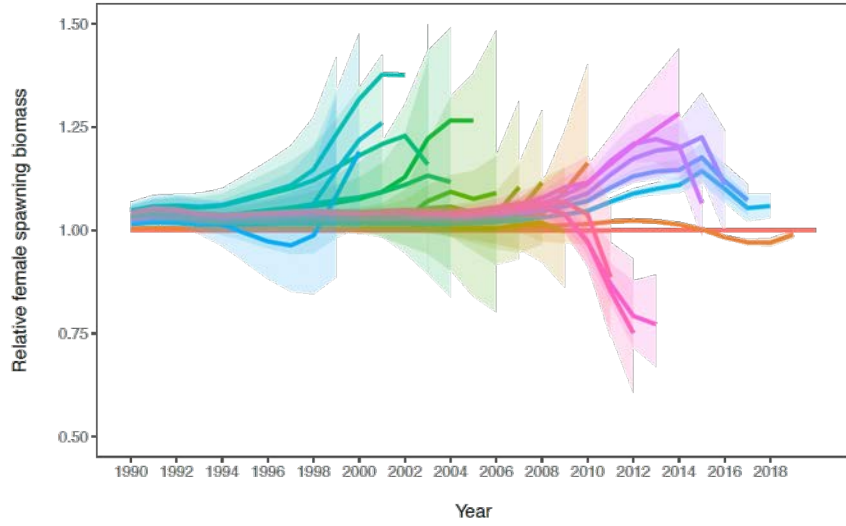
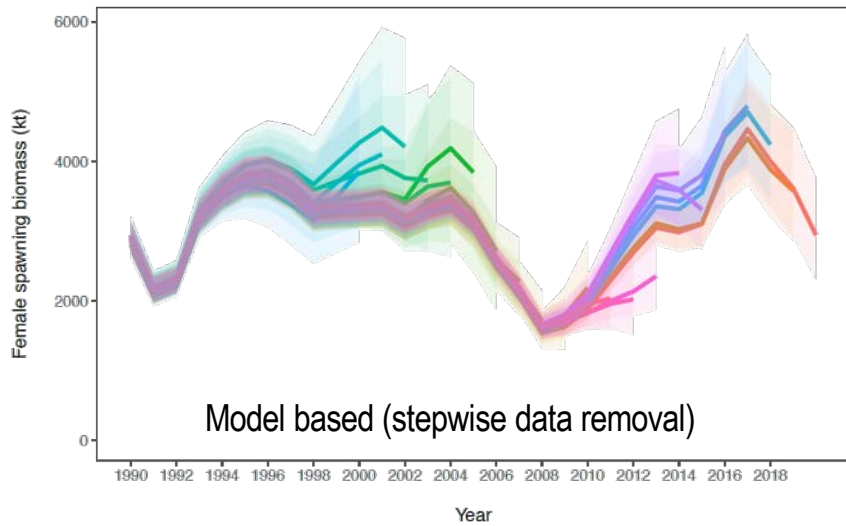


Biomass trend



Retrospectives

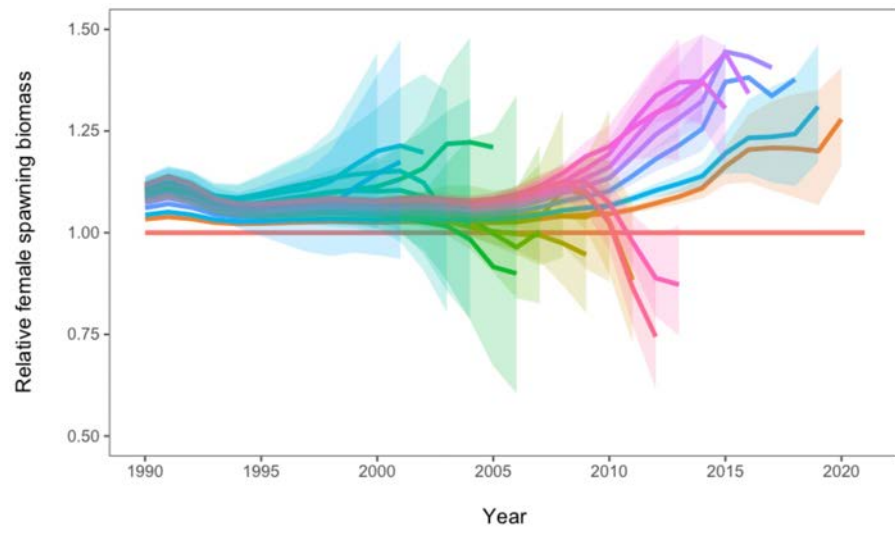
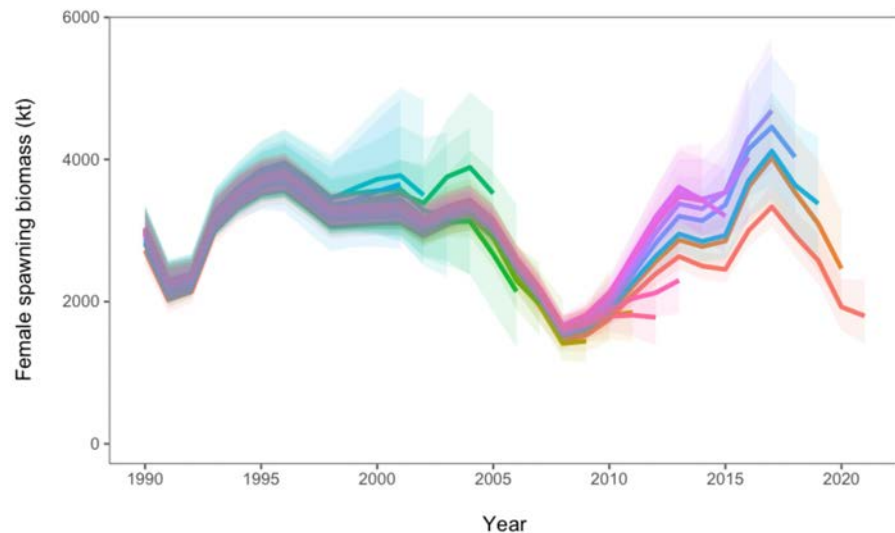
2020 assessment



EBS pollock
Assessment
Results

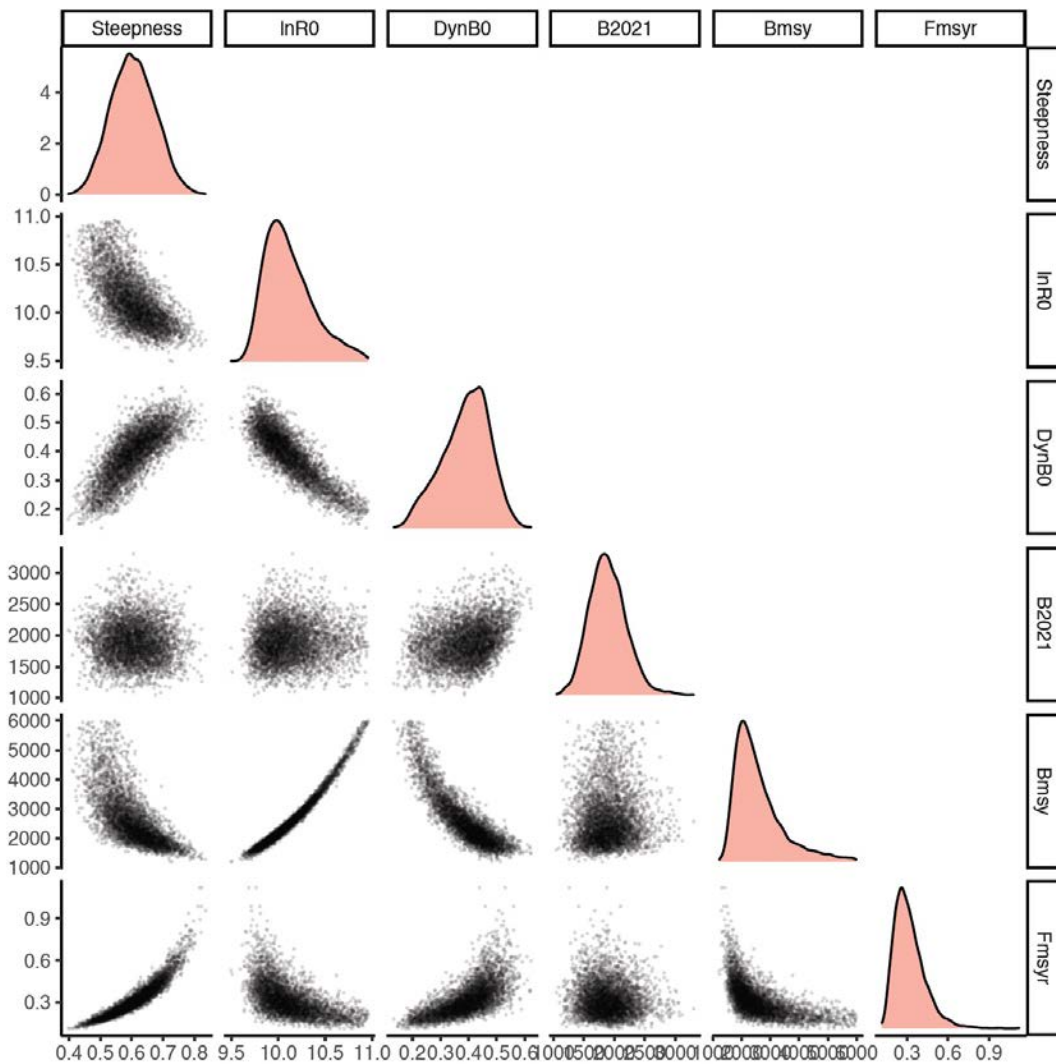
Retrospectives

This year!



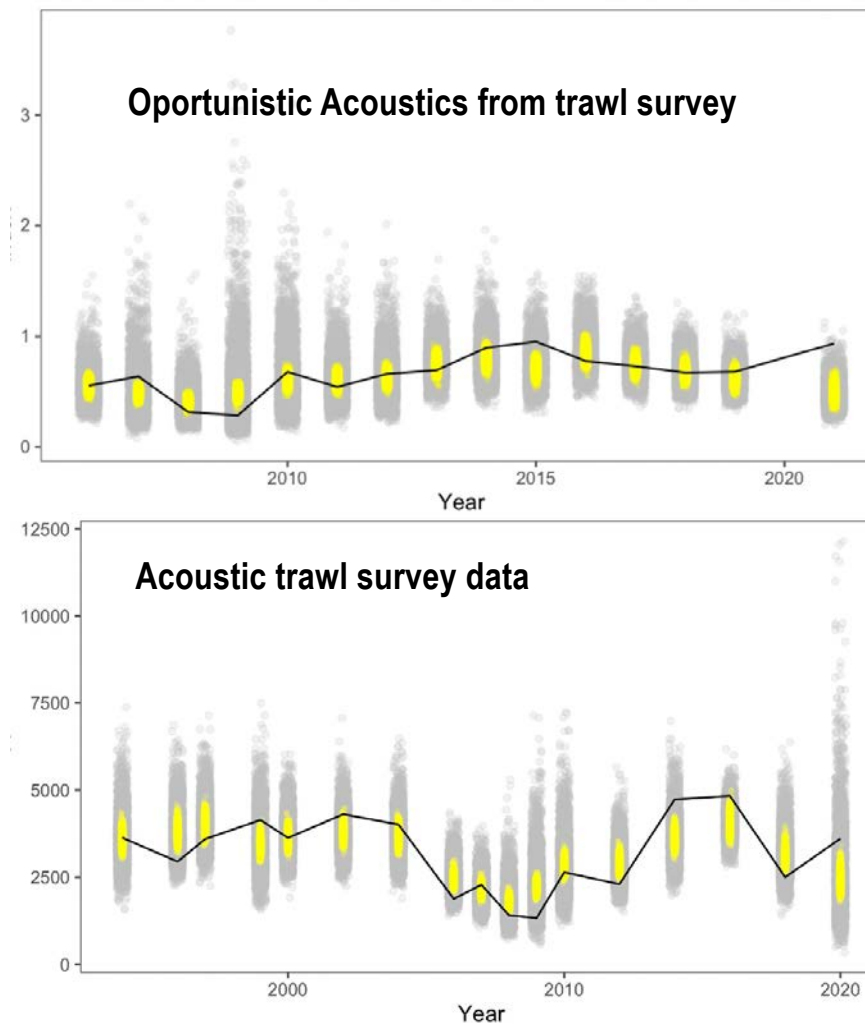
More on uncertainty evaluations

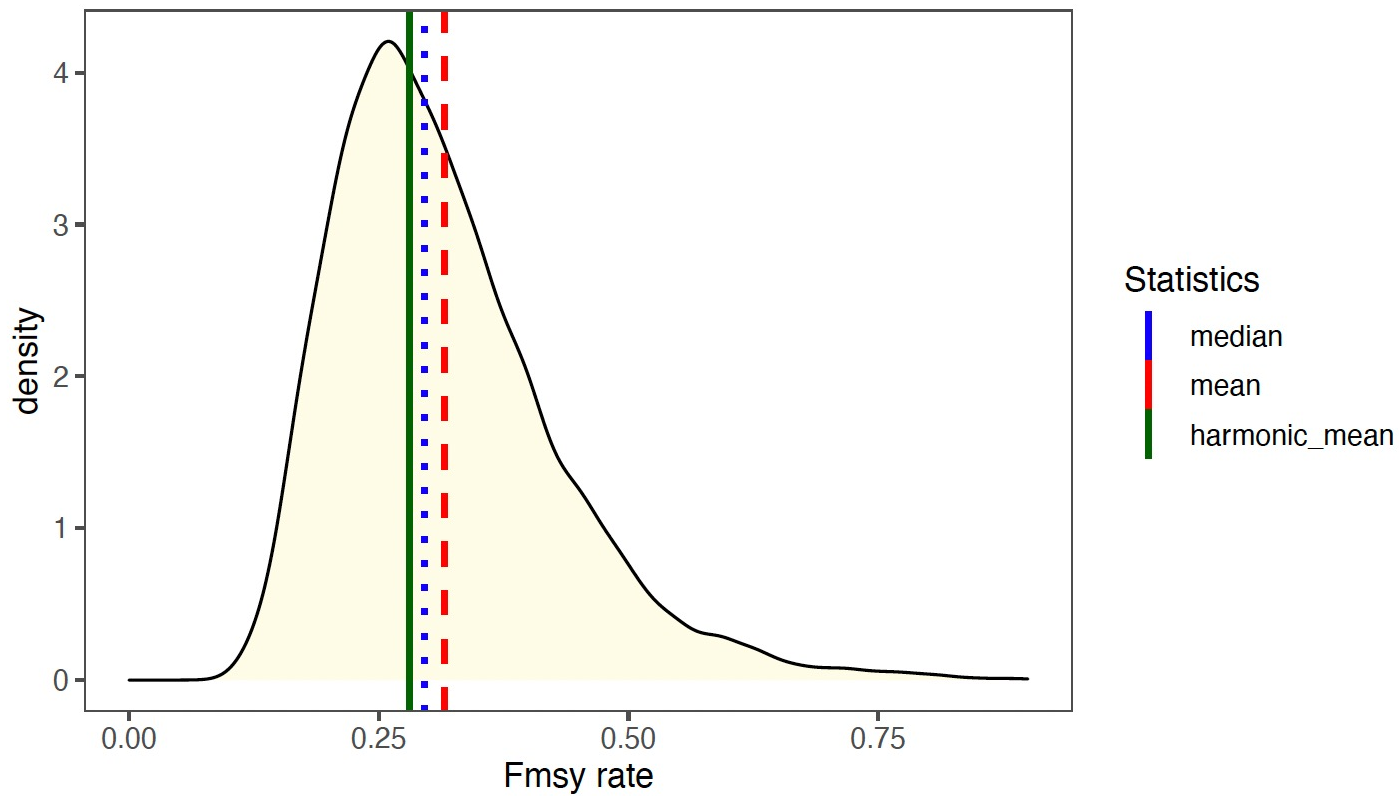




Diagnostics

Posterior predictive distributions





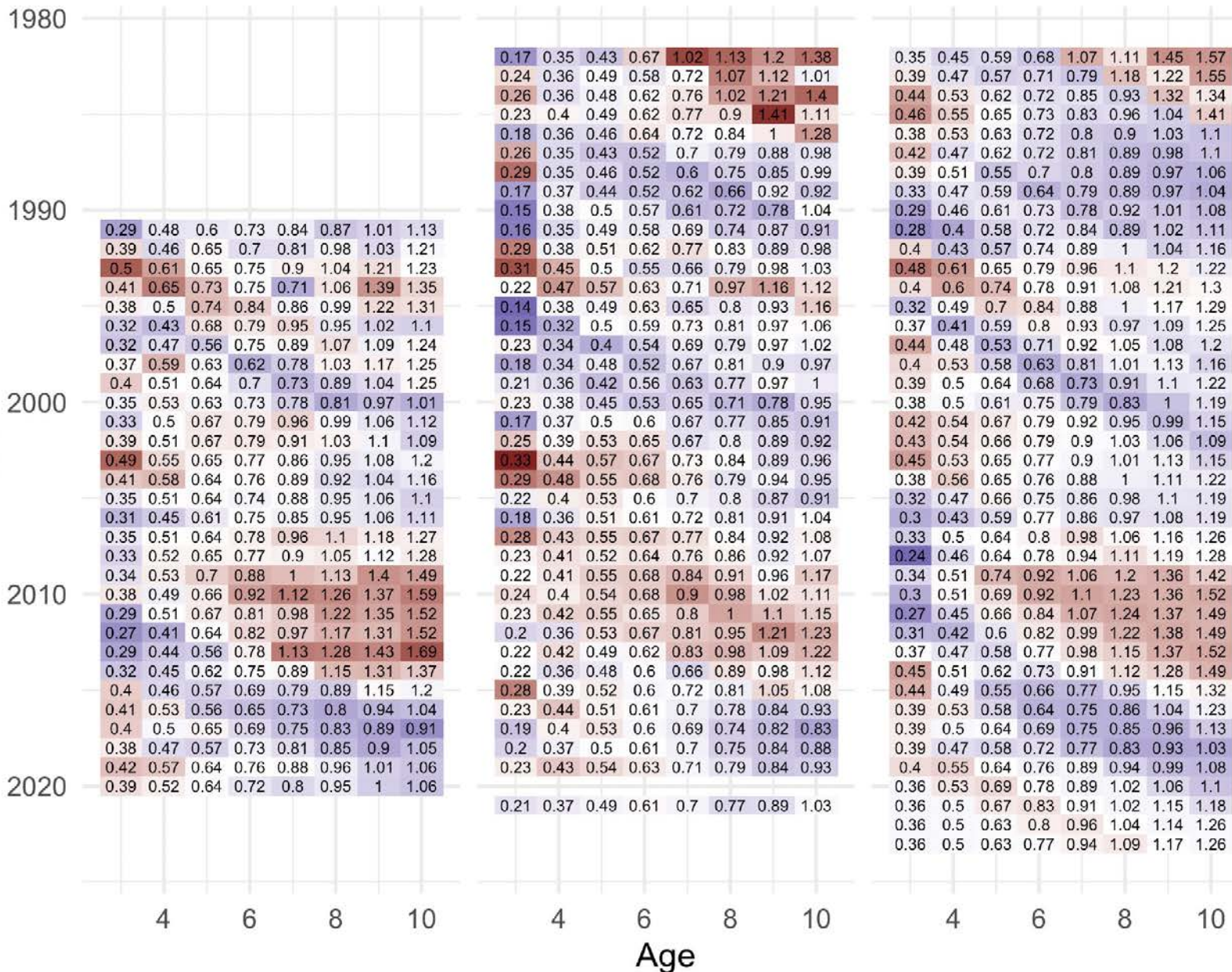
What things affect FMSY?

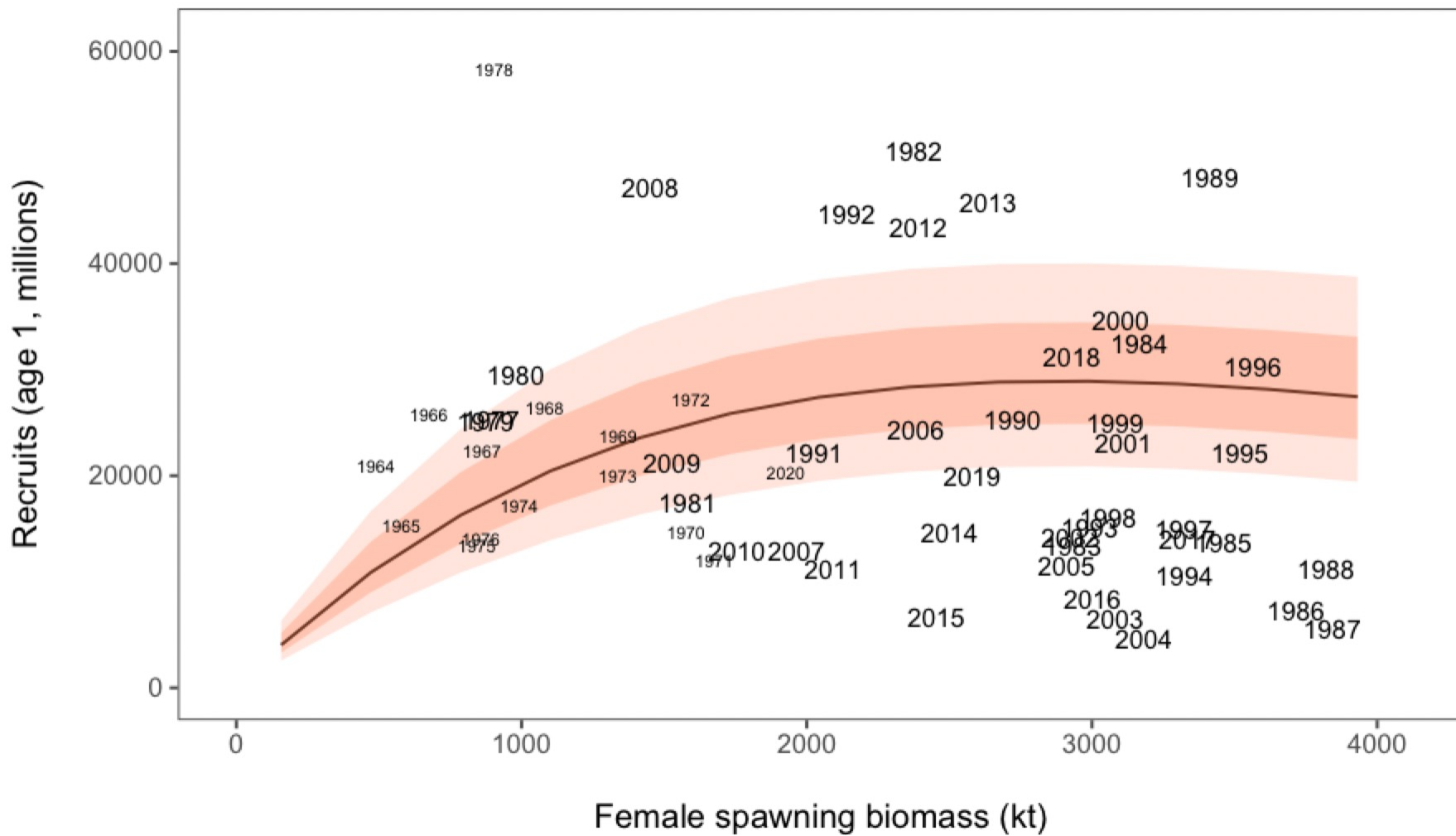


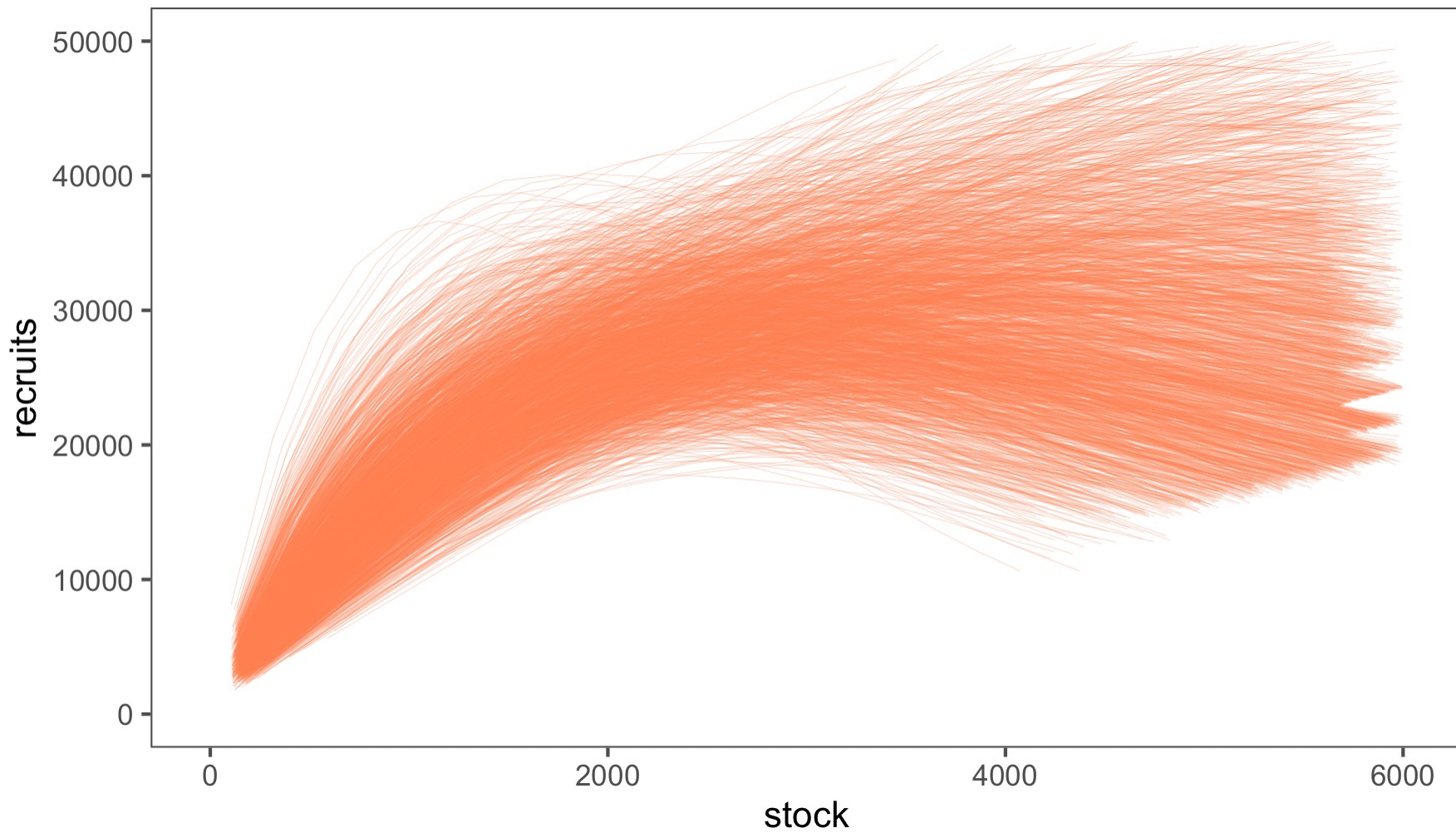
fishery

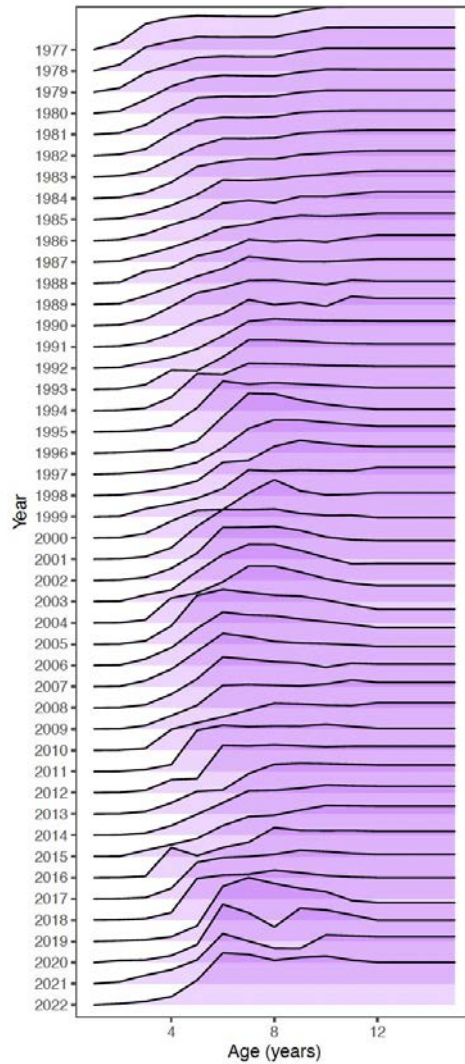
index

model

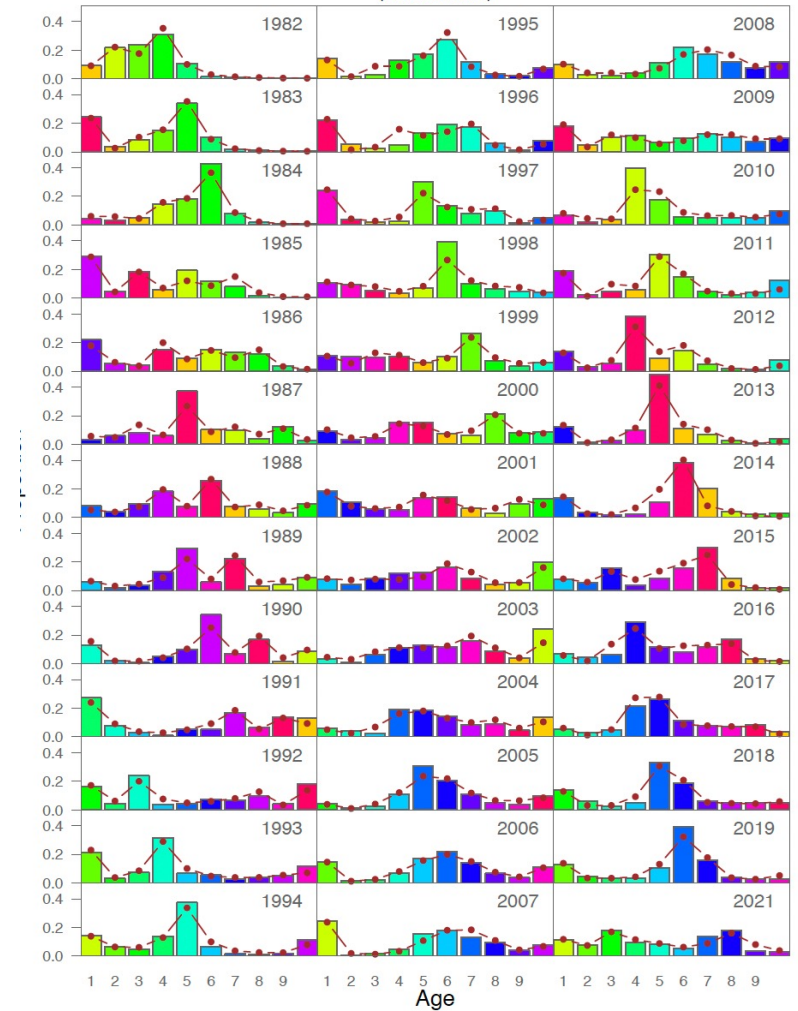


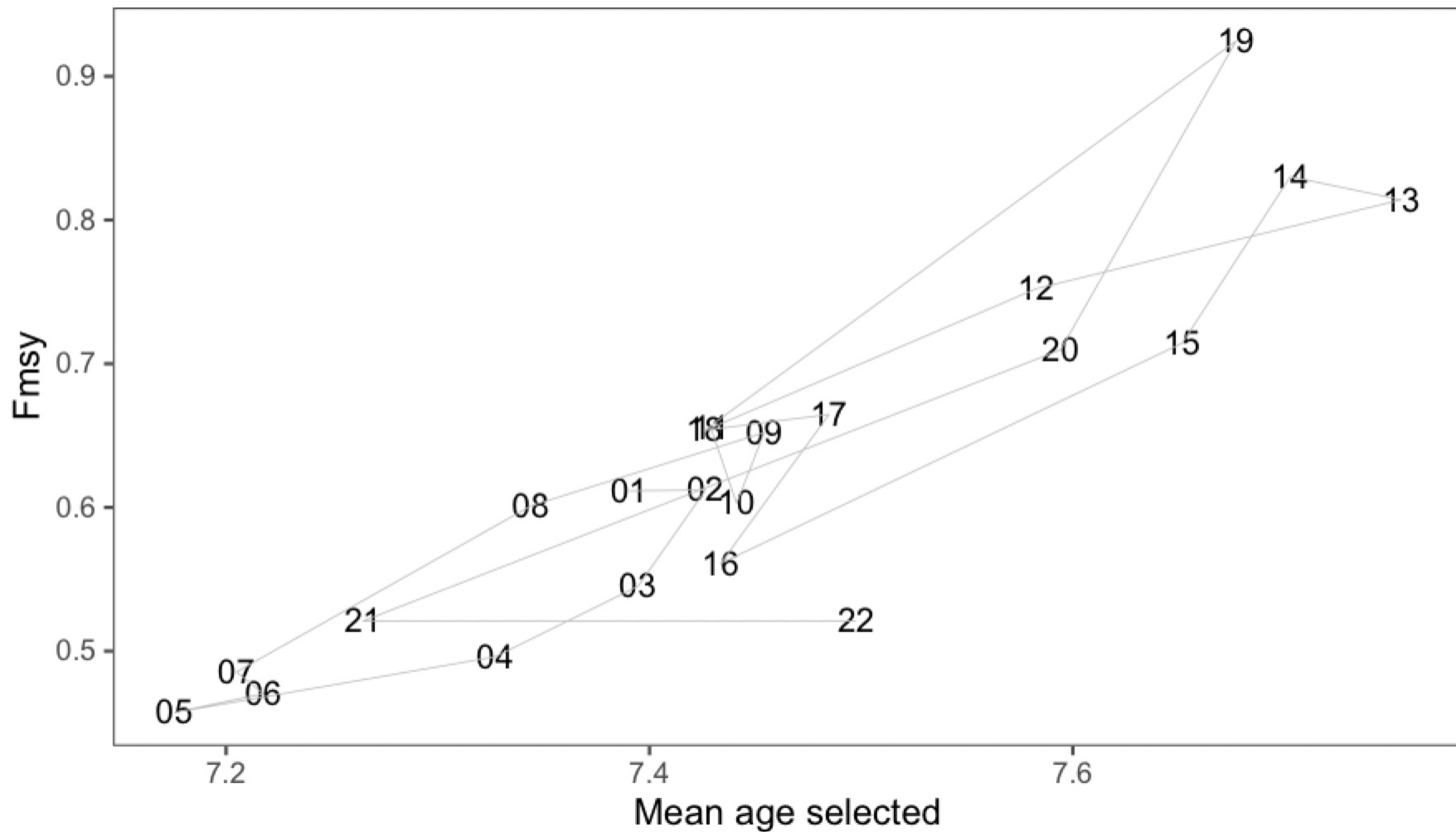




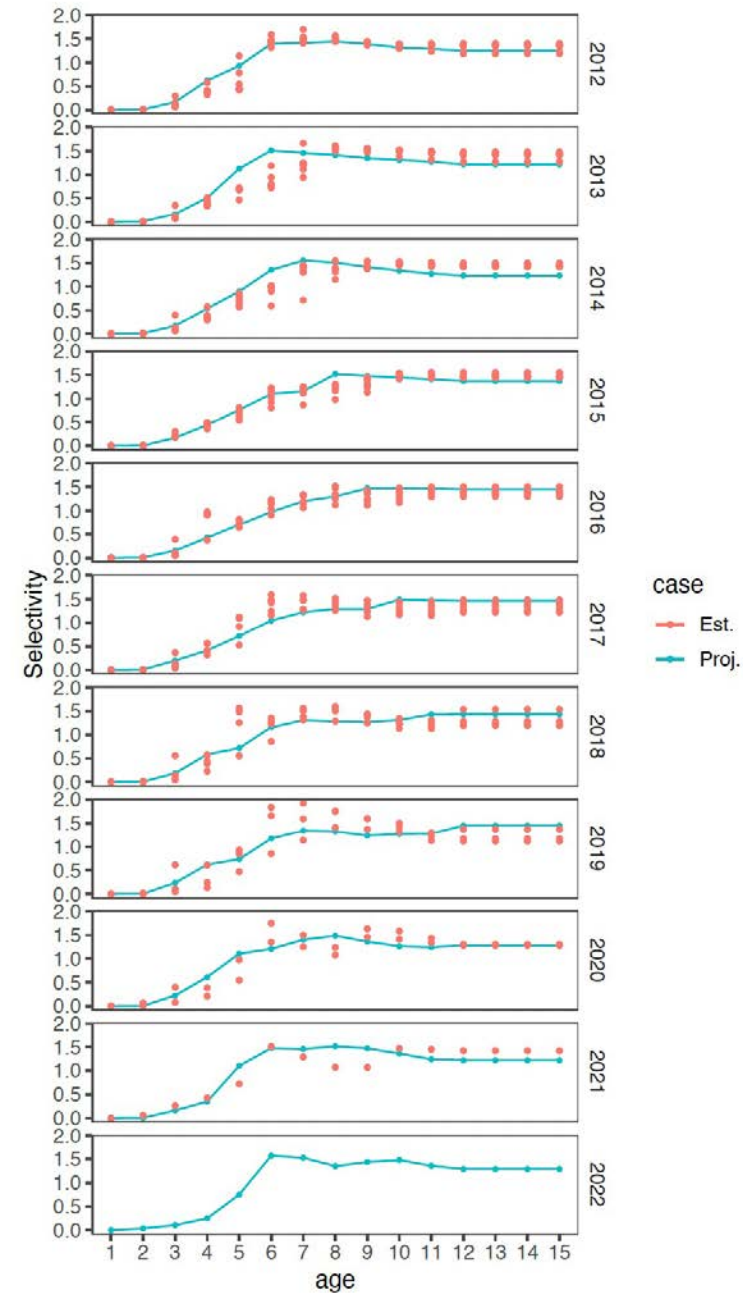


EBS pollock survey age composition data
(2021 Assessment)

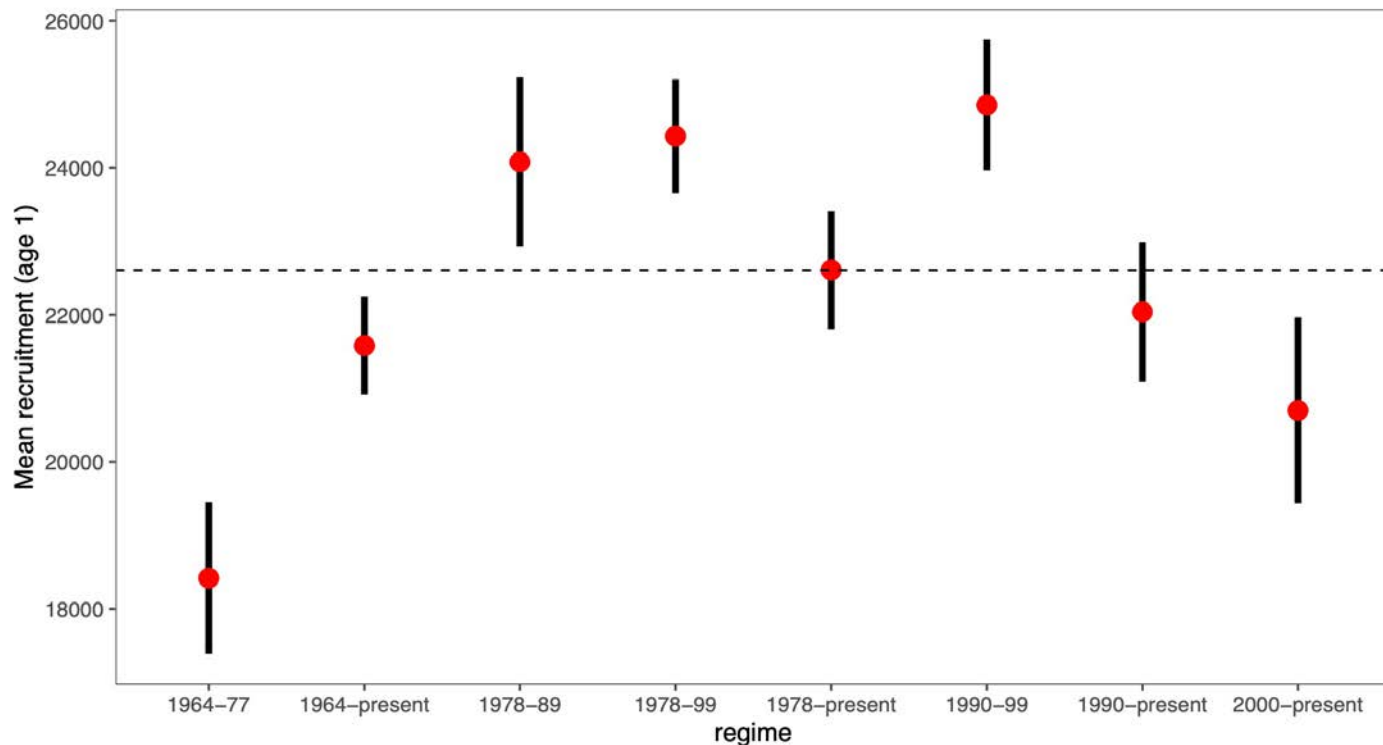




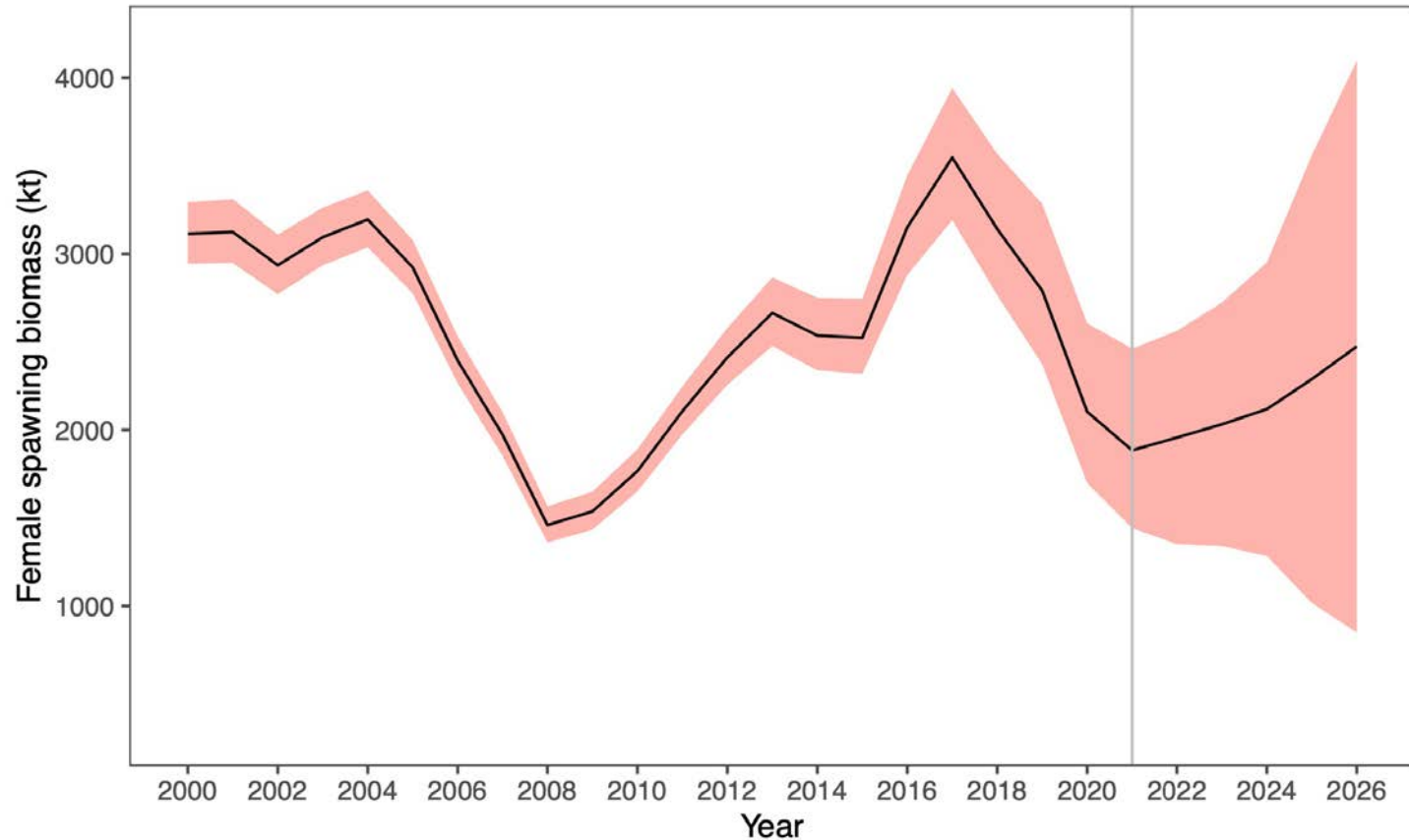
Can we predict selectivity?



Recruitment pattern



Biomass trend



Summary

- New data for 2021:
 - Bottom trawl survey ~65% of mean (8th lowest since 1982)
 - Mid-water pollock (young fish) **Indicate potentially strong recruitment**
 - Fishery 2020 showed poor conditions, improved this year but **small fish**
- Results combining disparate data pending; but
 - Expect decline in spawning biomass through 2022



Recommendations



Risk table summary

Assessment-related	Considerations		
	Population dynamics	Environmental or ecosystem	Fisheries
Level 2: Substantially increased concerns	Level 2: Substantially increased concerns	Level 2: Substantially increased concerns	Level 2: Substantially increased concerns

Tier	Year	MaxABC	OFL
1b	2022	1,251,000	1,469,000
1b	2023	1,451,000	1,704,000
2b	2022	1,111,060	1,469,000
2b	2023	1,288,610	1,704,000
3b	2022	904,000	1,128,000
3b	2023	1,067,000	1,327,000

Coincidentally same (similar to) constant F from 2021



The following table is based on results from Model 20.0c, the same used for last year's assessment (with the addition of preliminary, and usually unavailable, current-year fishery data). The ABC recommendation includes an additional 10% buffer from the arithmetic mean F_{MSY} value under Tier 1 (the OFL). Along with the risk-averse buffer due to uncertainty in the F_{MSY} (about 14% lower because it is based on the harmonic mean) the recommendation results in a buffer of about 24% below F_{MSY} . This corresponds to a Tier 2 ABC. The Tier 3 ABC estimate for 2022 and 2023 would be 904,000 and 1,067,000 t, respectively.

Quantity	As estimated or <i>specified</i> <i>last year for:</i>		As estimated or <i>recommended</i> <i>this year for:</i>	
	2021	2022	2022	2023
M (natural mortality rate, ages 3+)	0.3	0.3	0.3	0.3
Tier	1a	1a	1b	1b
Projected total (age 3+) biomass (t)	8,145,000 t	8,494,000 t	6,839,000 t	6,969,000 t
Projected female spawning biomass (t)	2,602,000 t	2,406,000 t	1,881,000 t	1,905,000 t
B_0	5,792,000 t	5,792,000 t	5,575,000 t	5,575,000 t
B_{msy}	2,257,000 t	2,257,000 t	2,220,000 t	2,220,000 t
F_{OFL}	0.341	0.341	0.46	0.46
$maxF_{ABC}$	0.304	0.304	0.392	0.392
F_{ABC}	0.214	0.214	0.296	0.314
OFL	2,594,000 t	2,366,000 t	1,469,000 t	1,704,000 t
$maxABC$	2,307,000 t	2,105,000 t	1,251,000 t	1,451,000 t
ABC	1,626,000 t	1,484,000 t	1,111,000 t	1,289,000 t
Status	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



Decision table considerations

Table 1-43. Outcomes of decision (expressed as chances out of 100) given different 2022 catches (first row, in kt). Note that for the 2019 and later year-classes average values were assumed. Constant Fs based on the 2022 catches were used for subsequent years.

	10	850	1000	1150	1375	1300	1450	1600
$P [F_{2022} > F_{MSY}]$	0	1	5	15	33	27	39	50
$P [B_{2023} < B_{MSY}]$	28	53	58	63	71	68	73	78
$P [B_{2024} < B_{MSY}]$	14	43	50	57	68	64	71	77
$P [B_{2023} < \bar{B}]$	51	92	95	97	99	98	99	100
$P [B_{2026} < \bar{B}]$	3	45	54	62	73	70	76	82
$P [B_{2026} < B_{2021}]$	0	16	21	26	34	31	37	42
$P [B_{2024} < B_{20\%}]$	1	3	4	5	8	7	9	11
$P [p_{a_5,2024} > \bar{p}_{a_5}]$	10	72	78	82	86	85	87	89
$P [D_{2023} < D_{1994}]$	2	13	19	25	37	33	42	52
$P [D_{2026} < D_{1994}]$	0	15	24	35	54	48	60	72
$P [E_{2022} > E_{2021}]$	0	1	14	49	87	78	92	97



Aleutian Islands Walleye pollock (partial)



Steven J. Barbeaux, Jim Ianelli, and Wayne Palsson

- 19,000 t cap
- 2021 catch = 1,695 t
- Catch has been less than 4,000 t since 1999

	As estimated or specified last year for:		As estimated or recommended this year for:	
	2021	2022	2022	2023*
Quantity				
M (natural mortality rate)	0.21		0.21	
Tier	3a		3a	
Total (age 1+) biomass (t)	292,967	308,671	308,525	330,375
Female spawning biomass (t)				
Projected	89,906	85,785	89,516	87,650
B _{100%}	185,475		185,475	
B _{40%}	74,190		74,190	
B _{35%}	64,916		64,916	
F _{OFL} **	0.390	0.390	0.390	0.390
maxF _{ABC}	0.313	0.313	0.313	0.313
F _{ABC}	0.313	0.313	0.313	0.313
OFL (t)	61,856	61,308	61,264	61,379
maxABC (t)	51,241	50,789	50,752	50,825
ABC (t)	51,241	50,789	50,752	50,825
	As determined this year for:		As determined this year for:	
Status	2019	2020	2020	2021
Overfishing	no	no	no	n/a
Overfished	n/a	n/a	n/a	no
Approaching overfished	n/a	n/a	n/a	no

