EBS Pollock stock assessment

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November 30th, 2020

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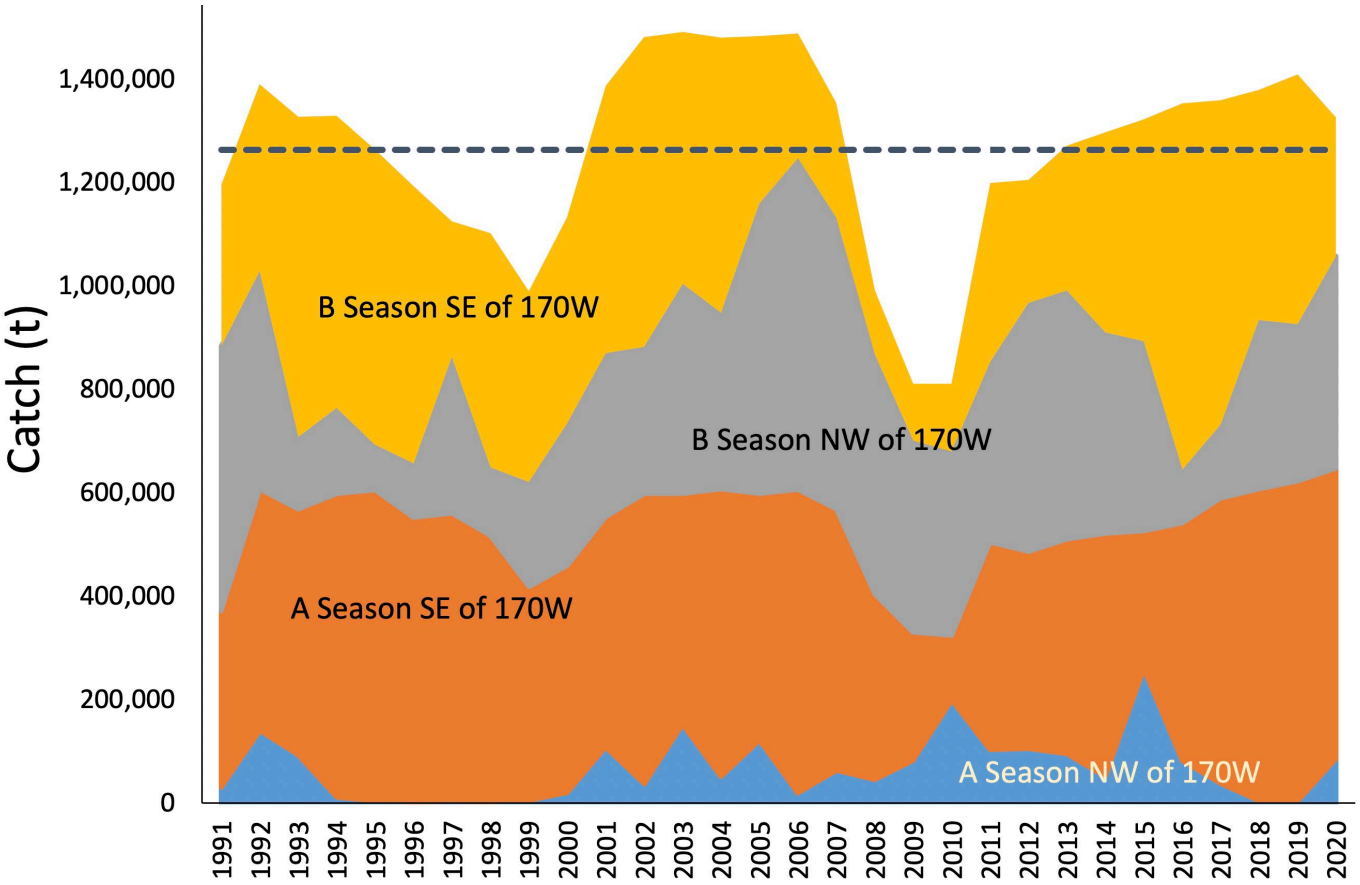
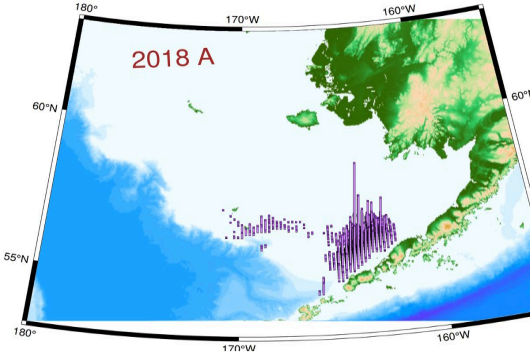
EBS Pollock

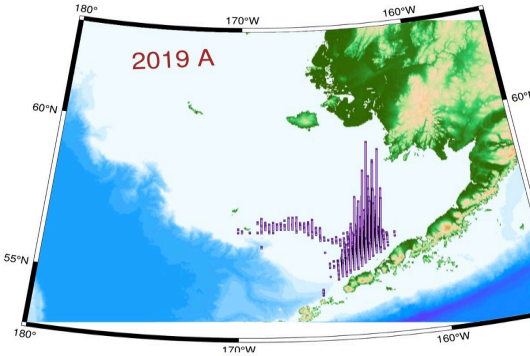
Fishery data

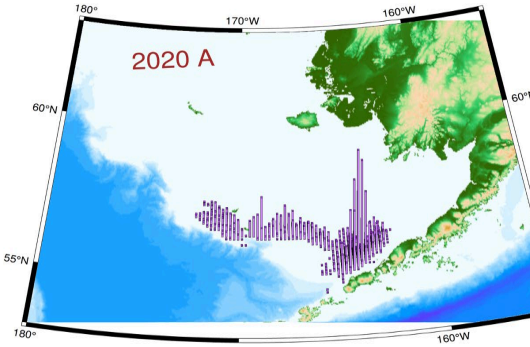
Seasonal and area catch patterns

Eastern Bering Sea pollock

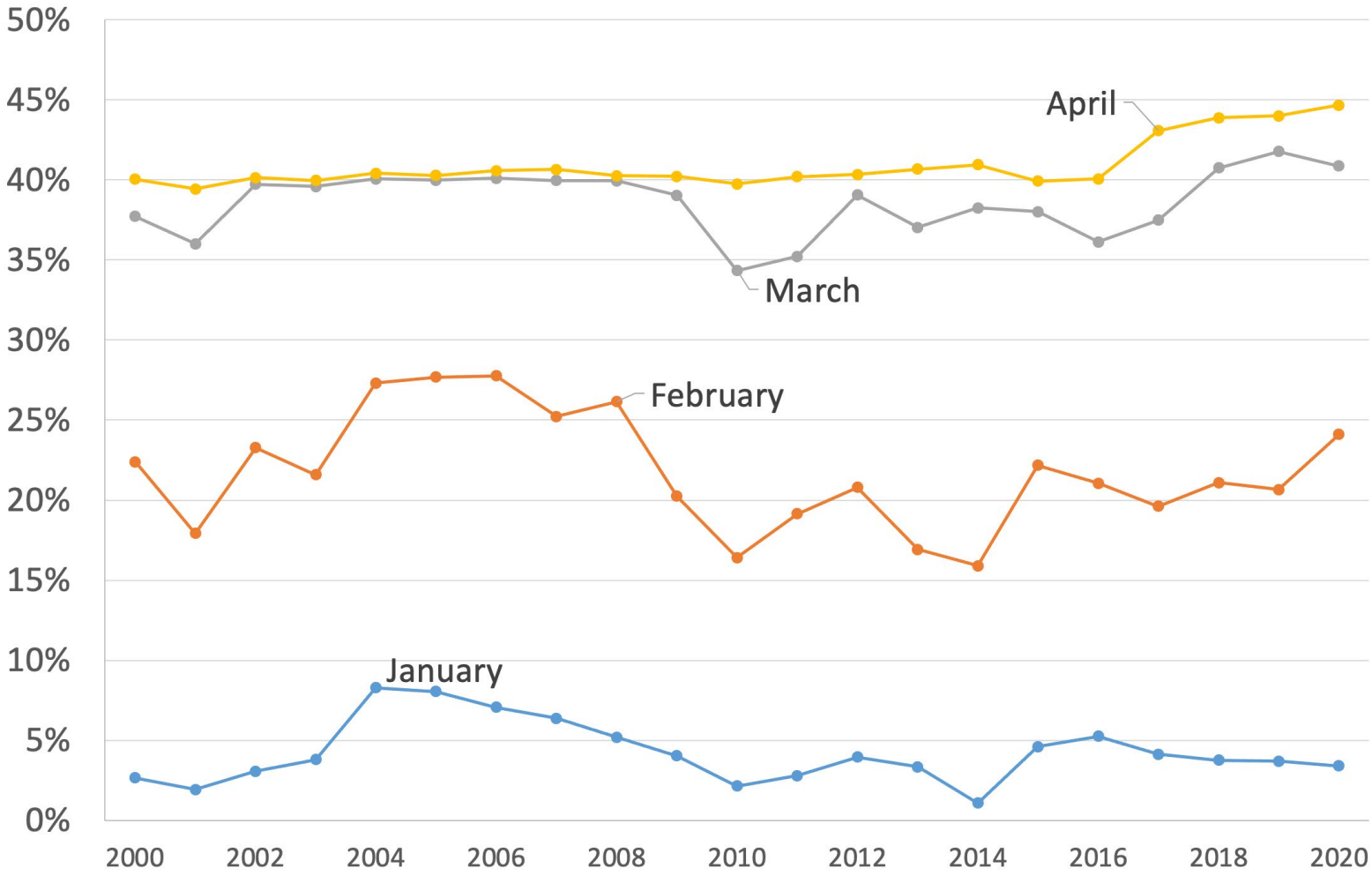


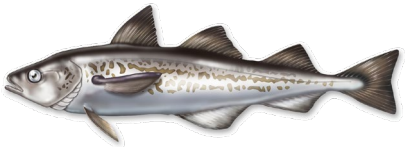




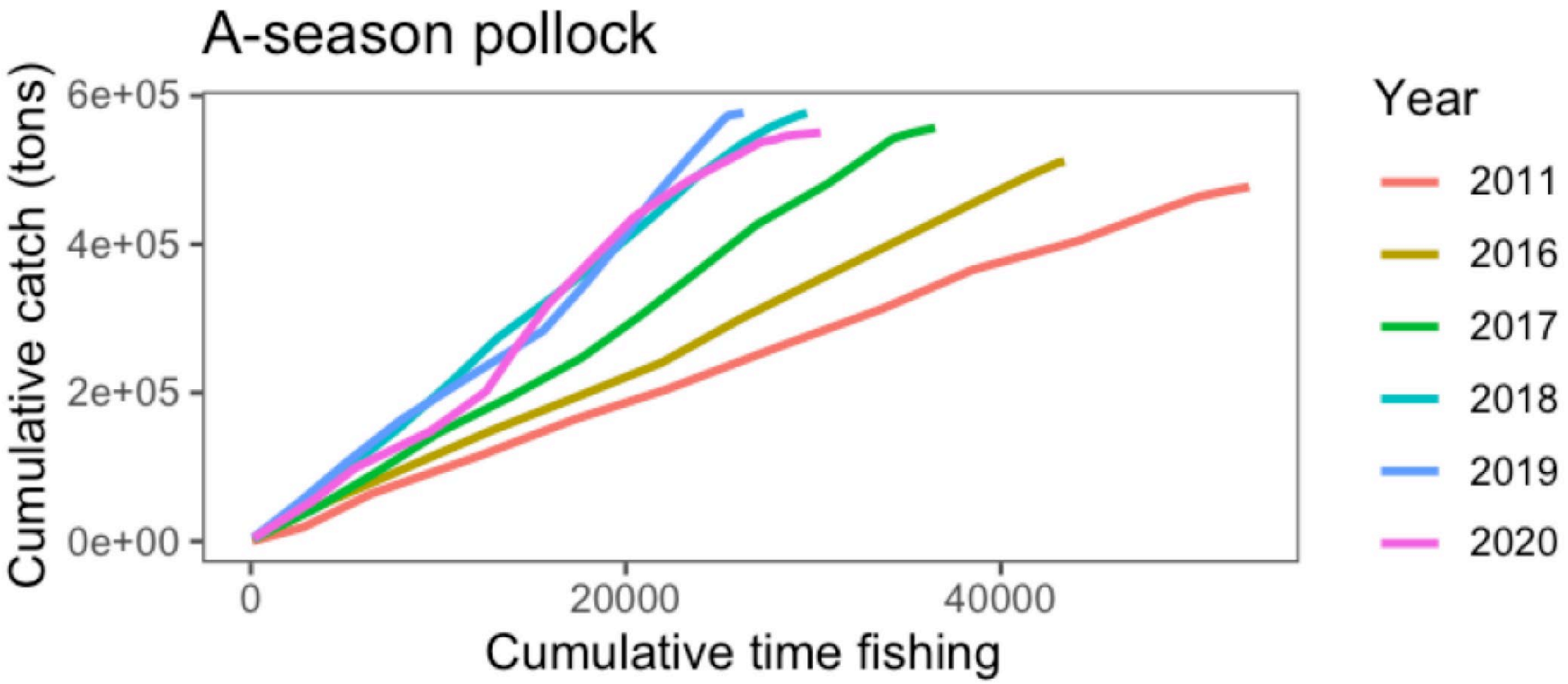


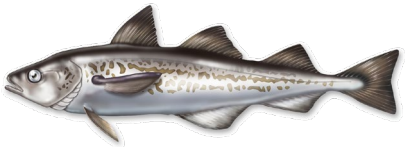
Cumulative pollock catch by month as proportion of TAC



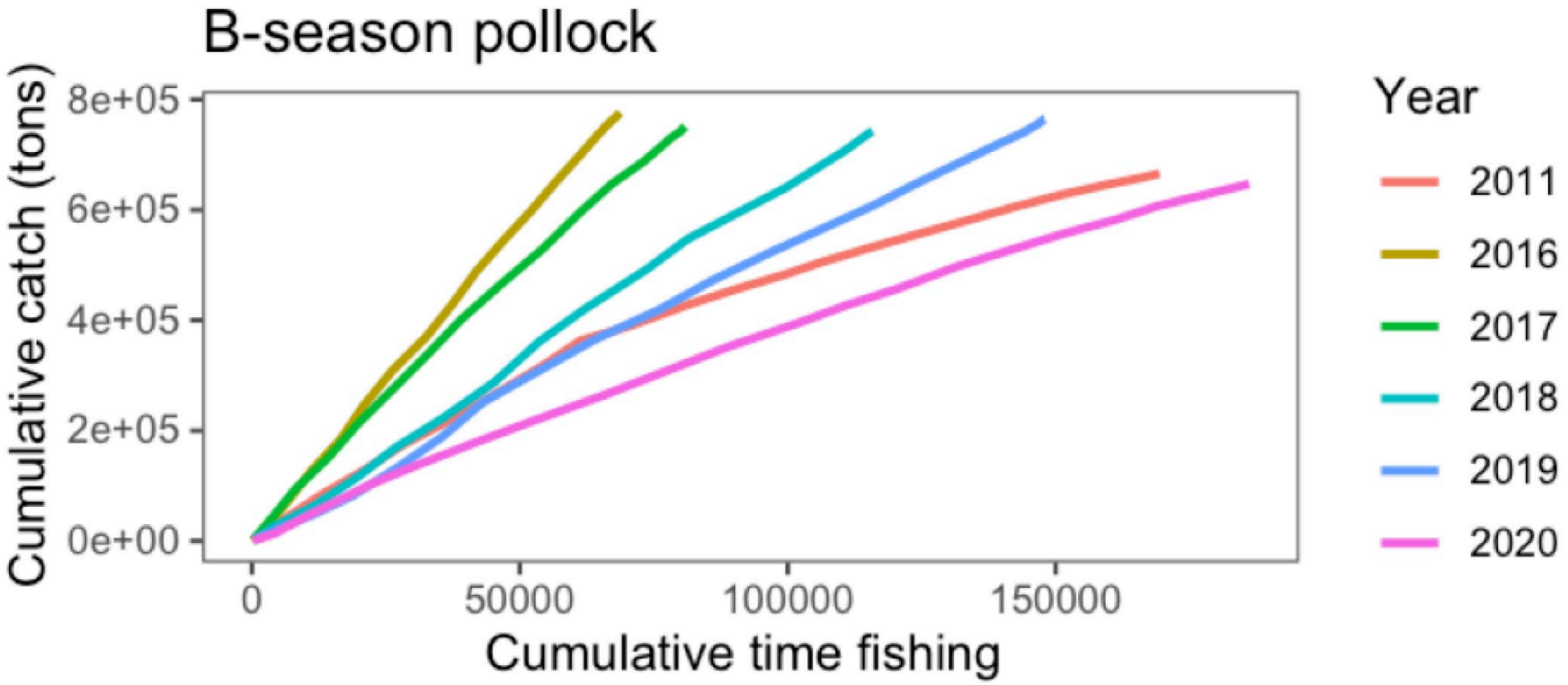


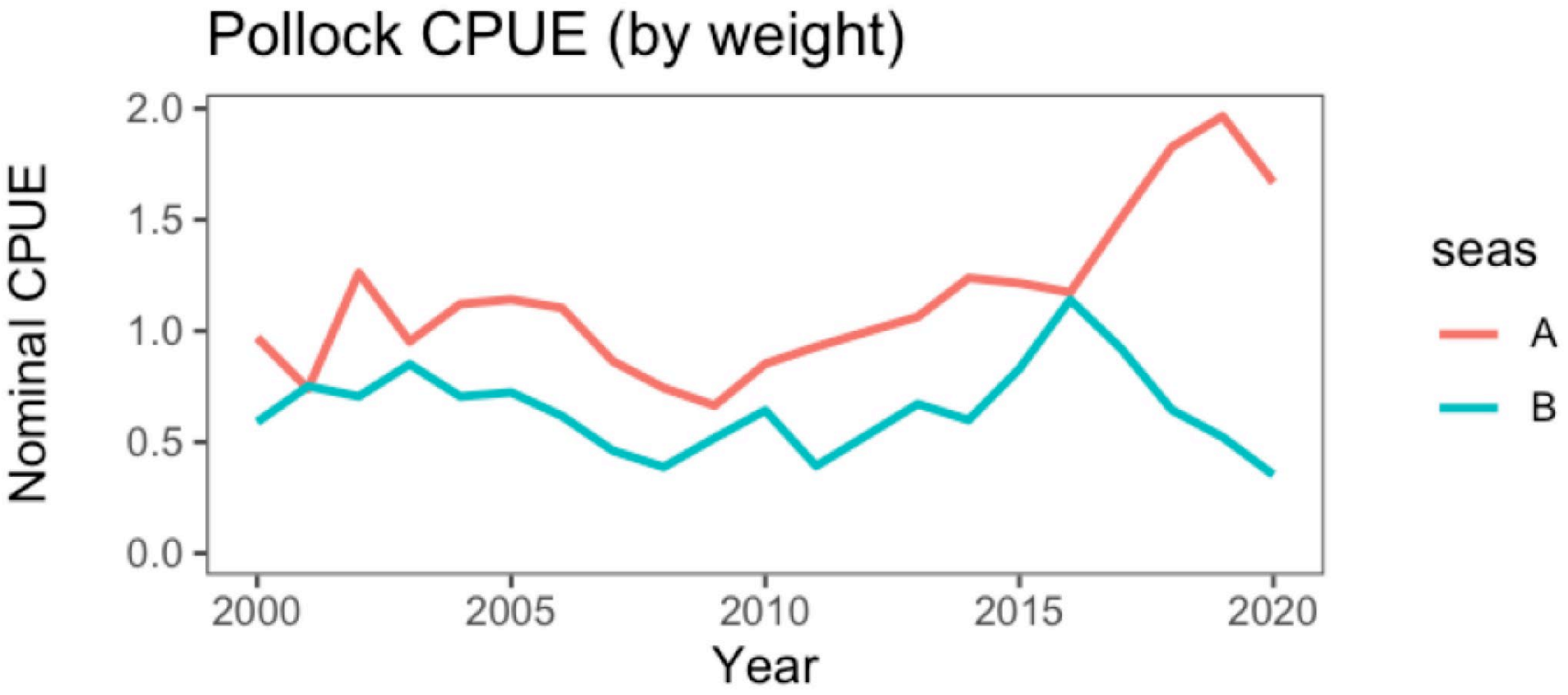
Fishing conditions



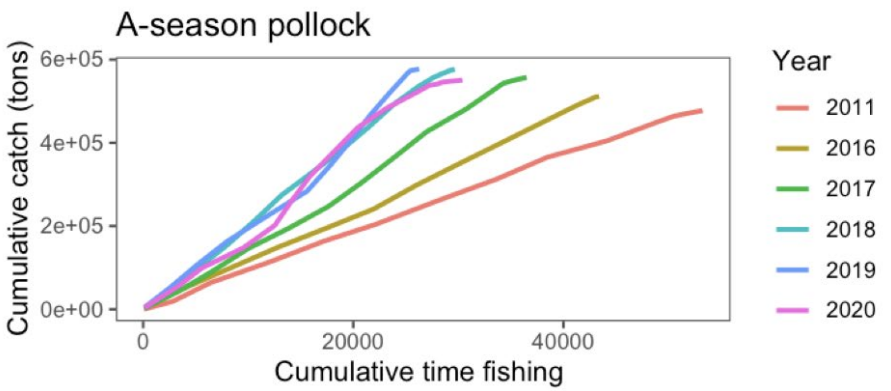


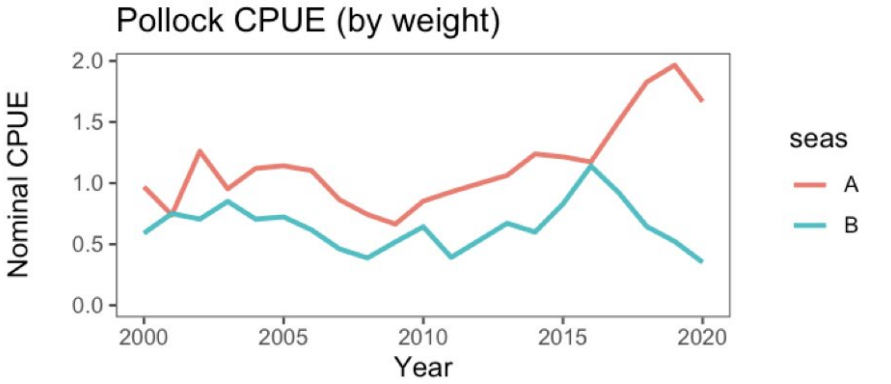
Fishing conditions

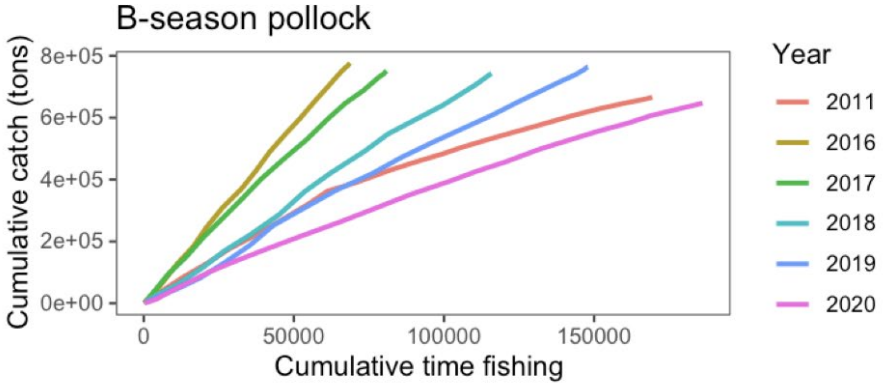



Pollock CPUE (by weight)
Nominal CPUE
2.0
1.5
1.0
0.5
0.0
2000
2005
2010
2015
2020
Year
seas
A
B

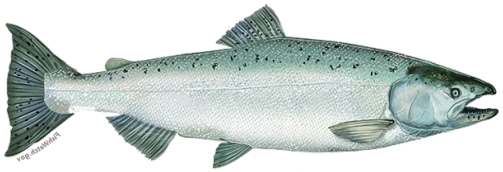
Fishing conditions

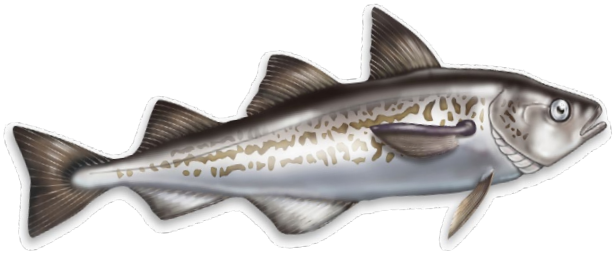


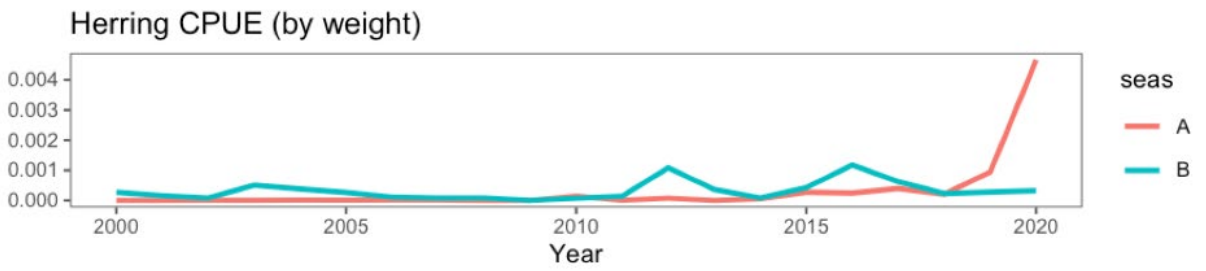


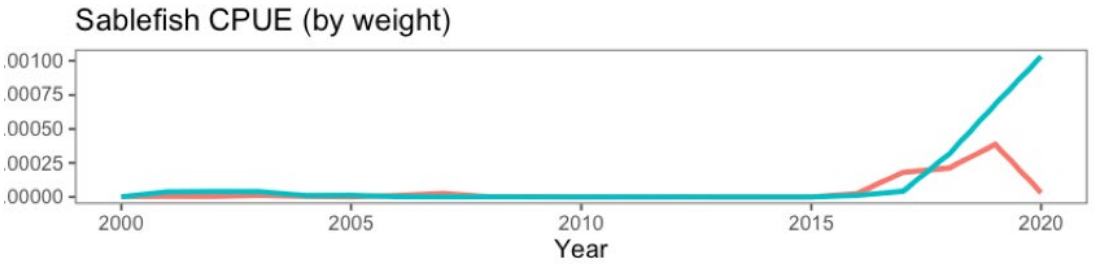


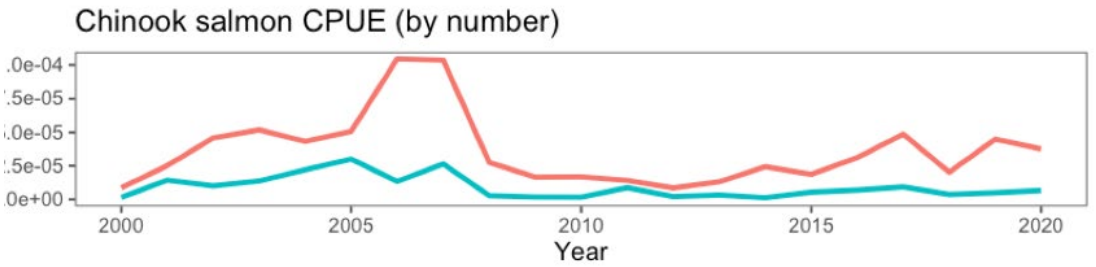
CPUE

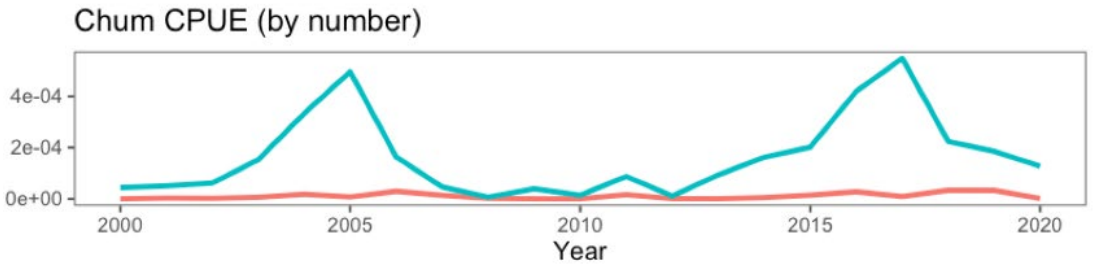


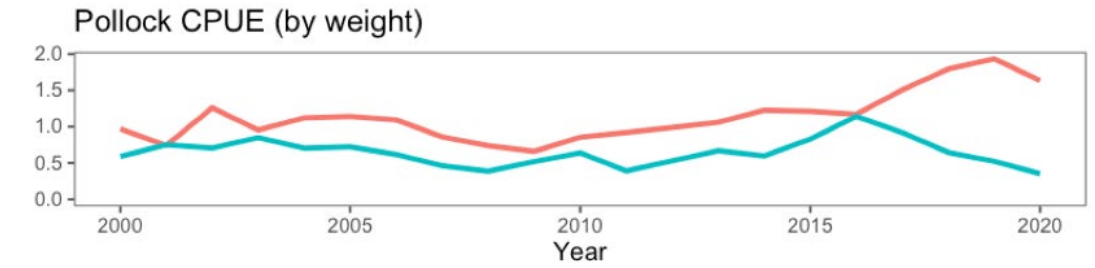



Herring CPUE (by weight)
0.004
0.003
0.002
0.001
0.000
2000
2005
2010
2015
2020
Year
seas
A
B

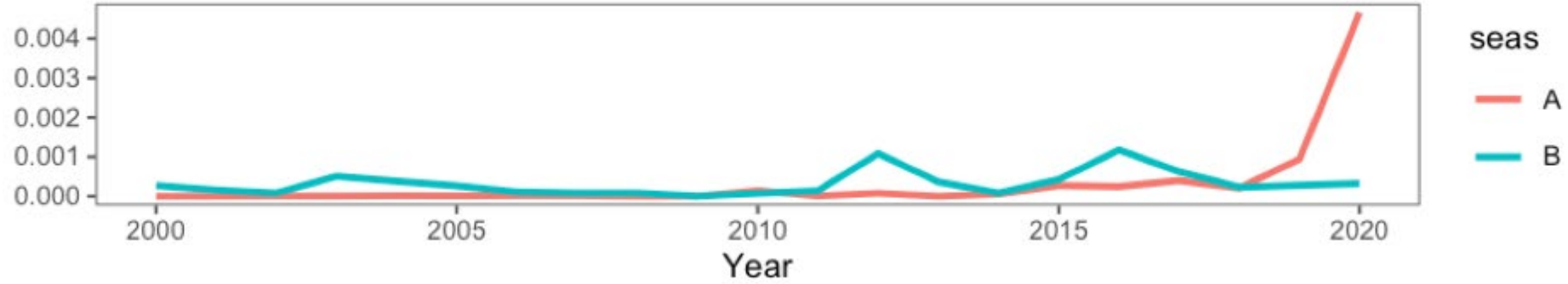

Sablefish CPUE (by weight)
.00100
.00075
.00050
.00025
.00000
2000
2005
2010
2015
2020
Year


Chinook salmon CPUE (by number)
.0e-04
.5e-05
.0e-05
.5e-05
.0e+00
2000
2005
2010
2015
2020
Year

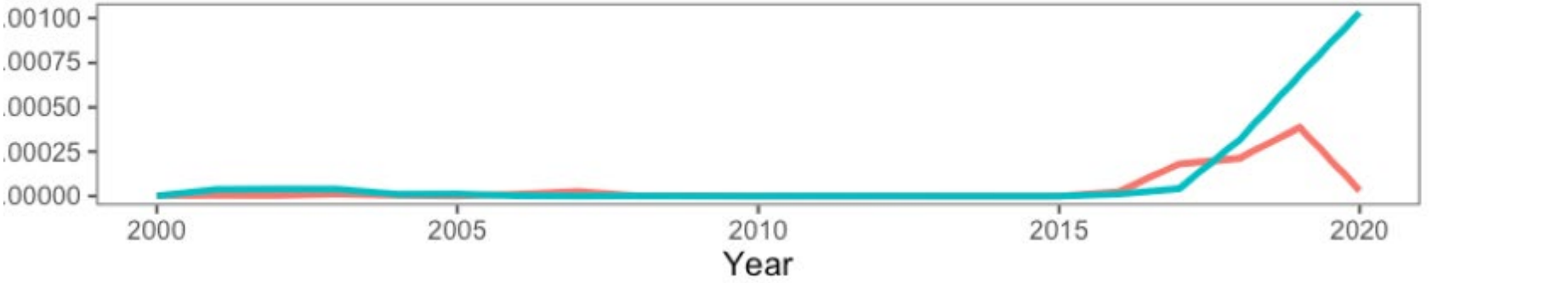

Chum CPUE (by number)
4e-04
2e-04
0e+00
2000
2005
2010
2015
2020
Year


Pollock CPUE (by weight)
2.0
1.5
1.0
0.5
0.0
2000
2005
2010
2015
2020
Year

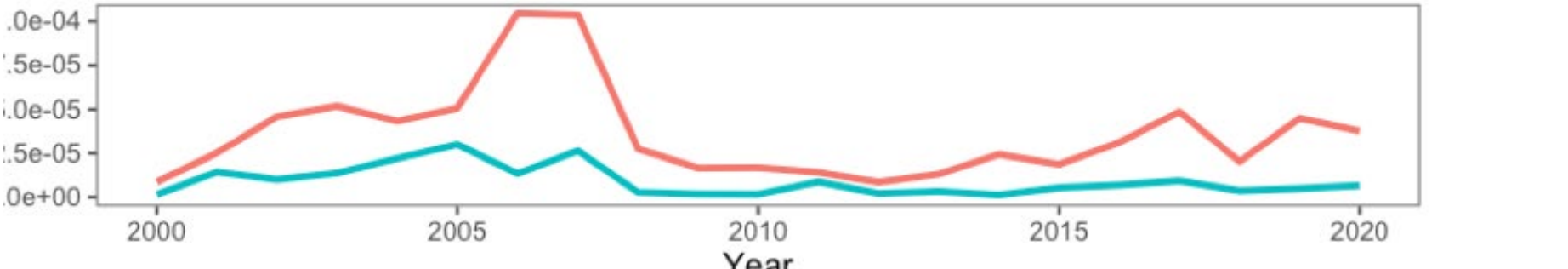
Herring CPUE (by weight)



Sablefish CPUE (by weight)

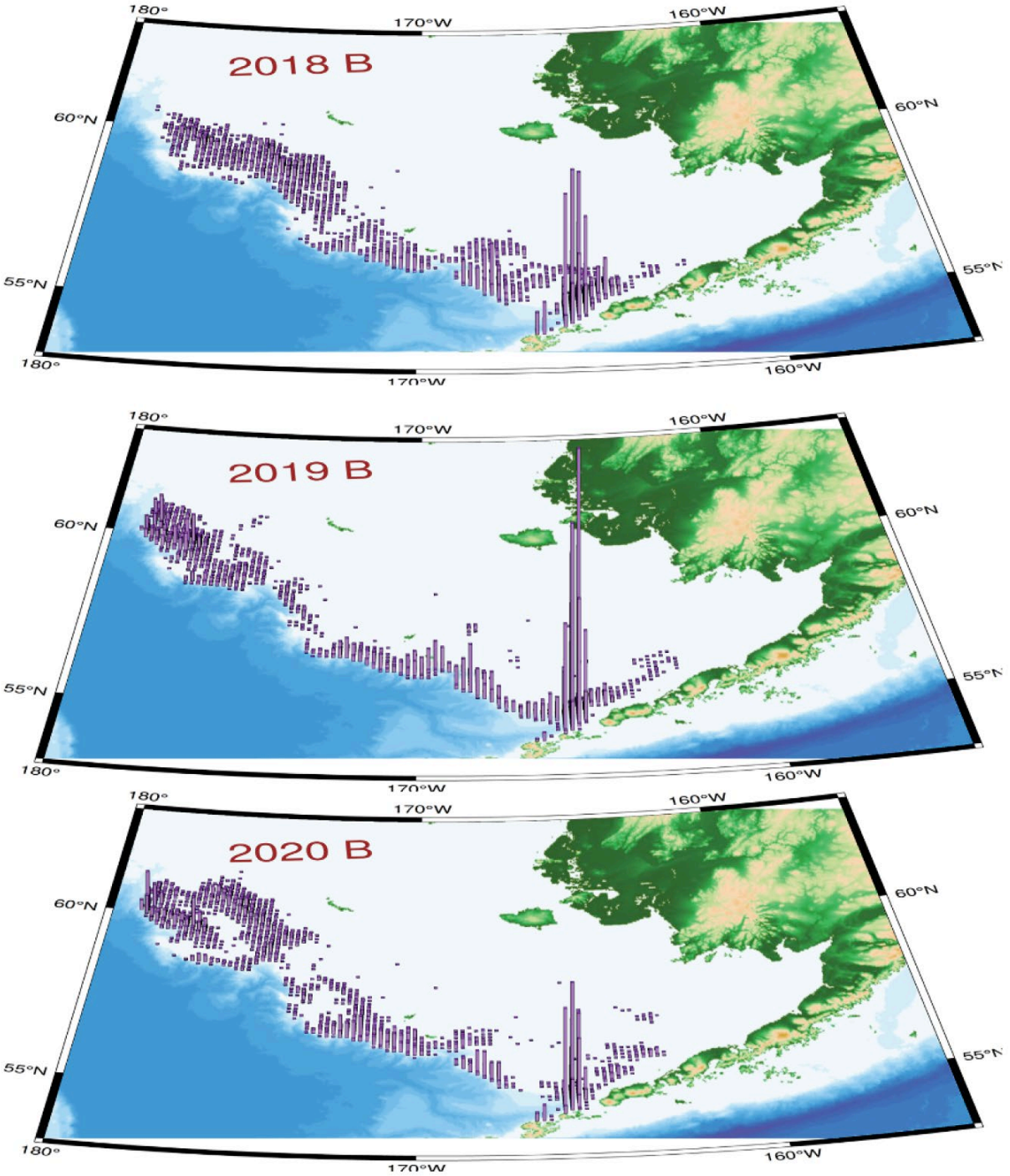


Chinook salmon CPUE (by number)



B-season

Fishery locals

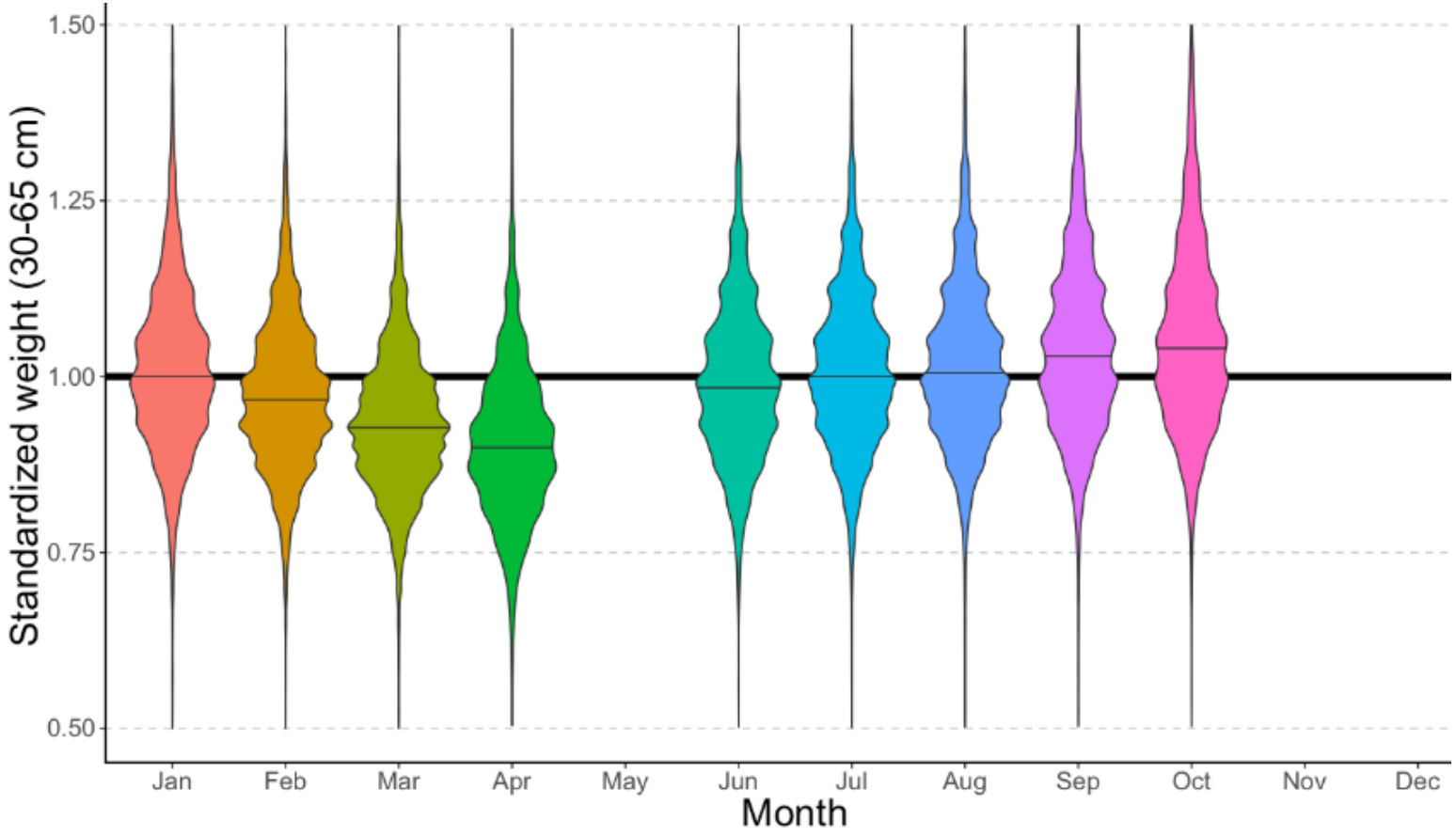


2020 Fish condition

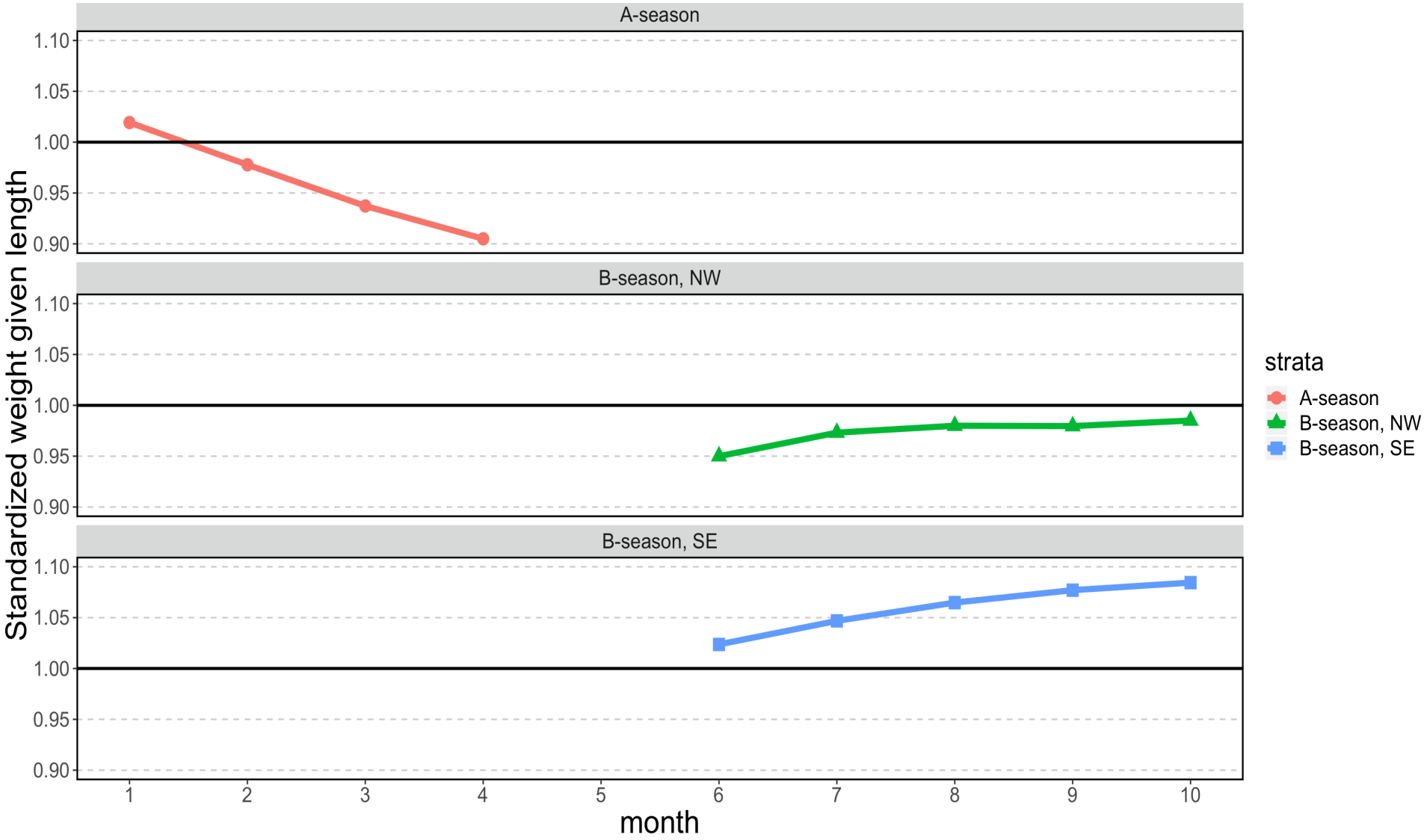
Alaska Pollock…

- Fishery observer sampling…
  - Patterns in pollock growth

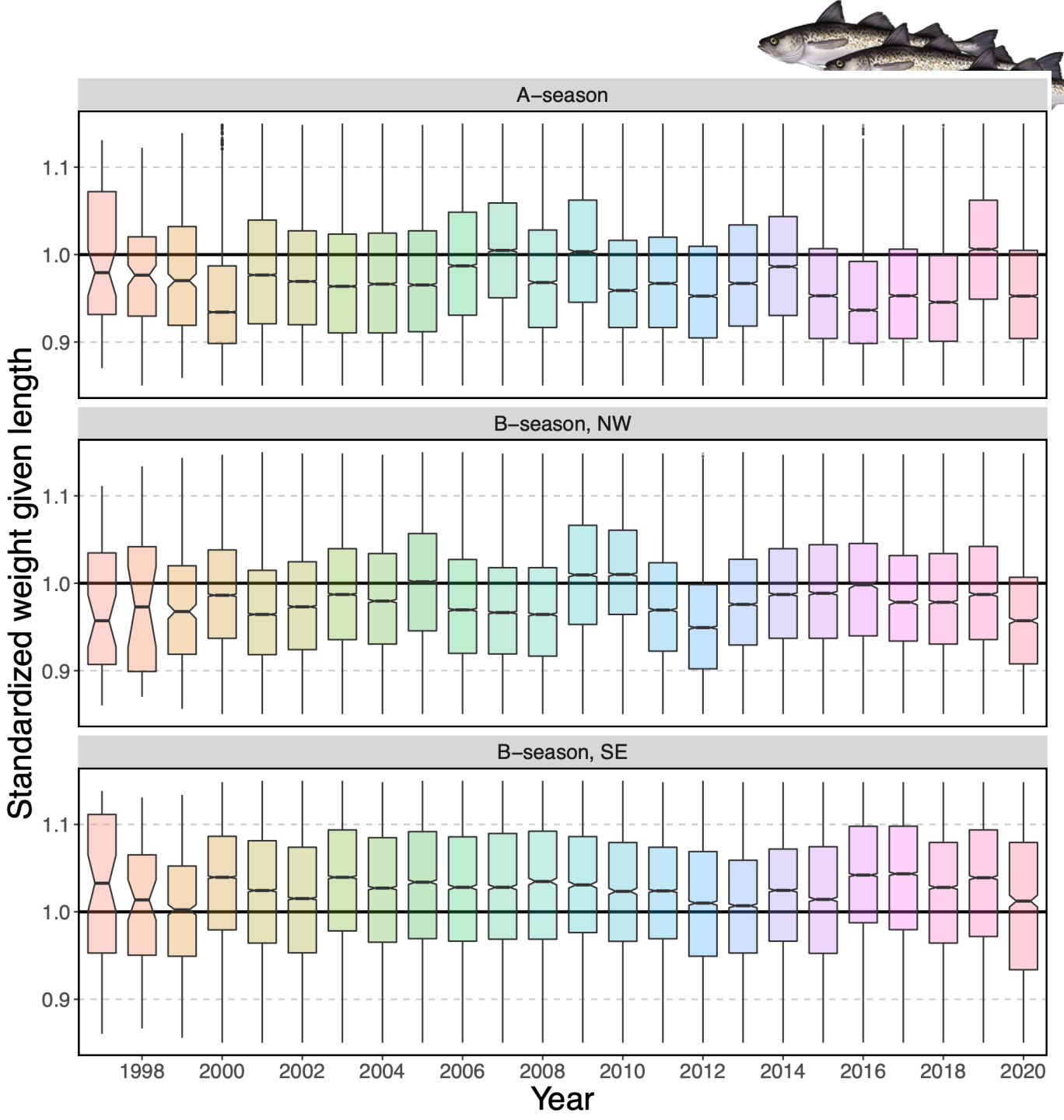
Climatology on pollock
“fatness” (given length) by month

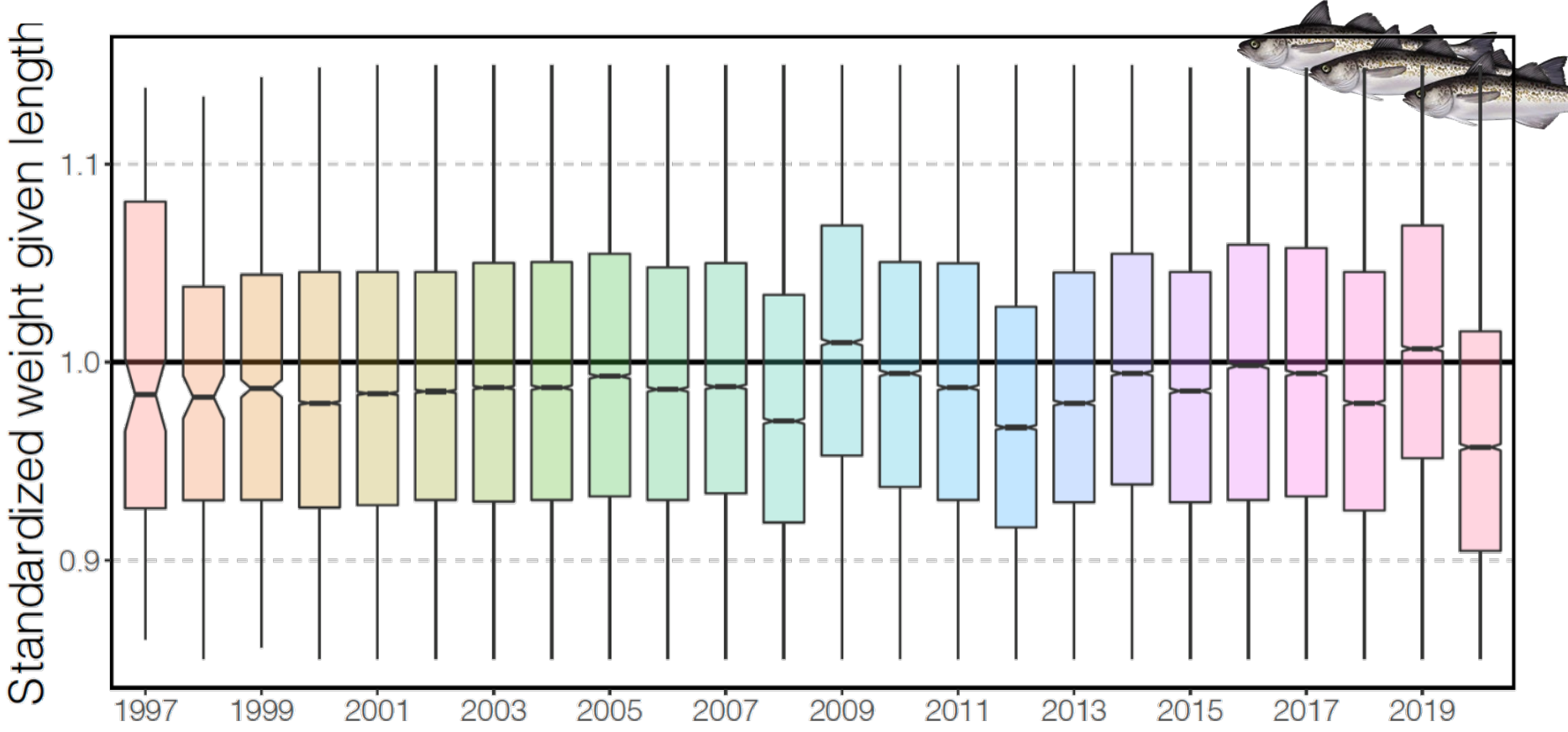


Pollock climatology on “fatness” (given length) by month and season/area



Pollock “fatness” (given length) by year and season



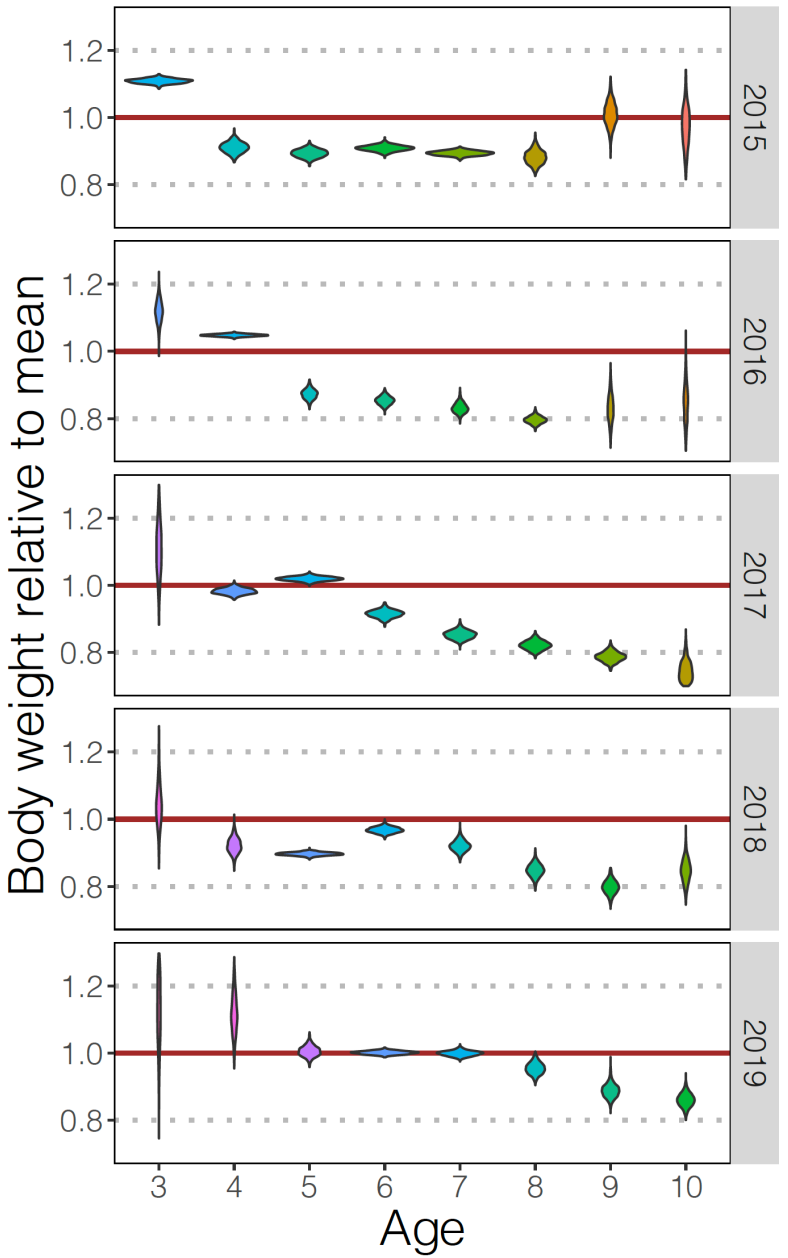


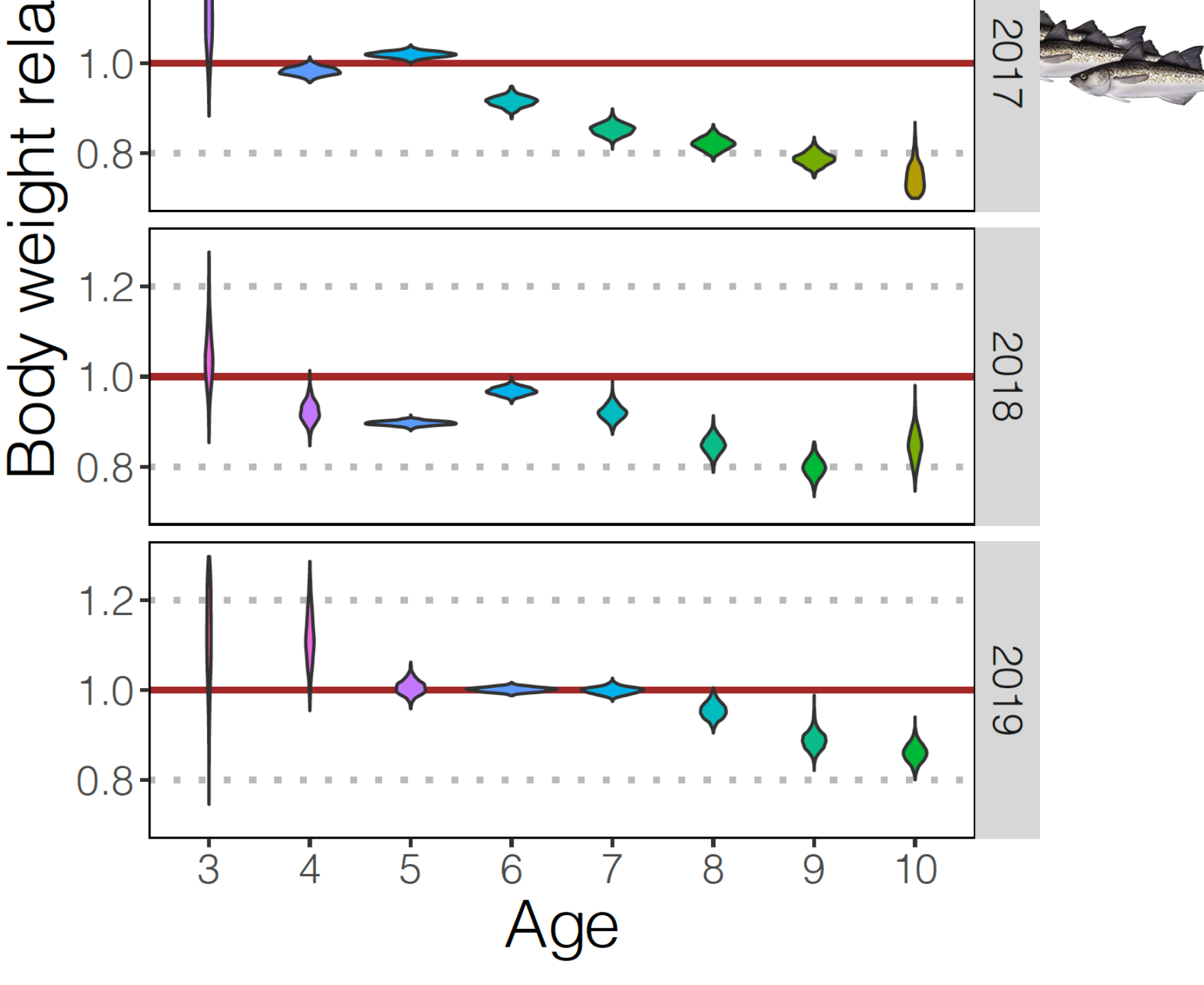
Summary on fish fatness (given length)

2020 generally skinny!

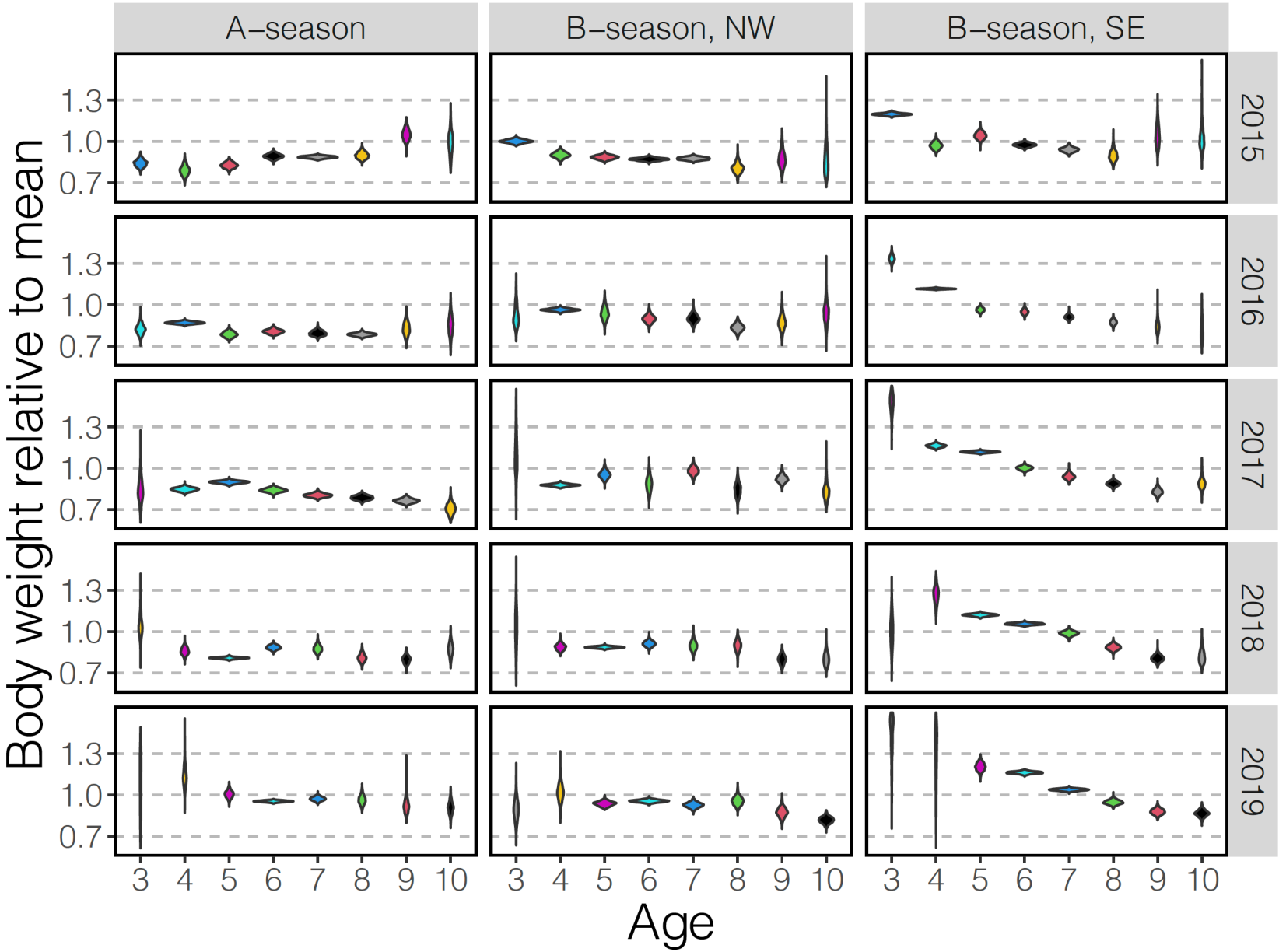
What about size at age?

- 2012 and 2013 year classes about
  average weight in 2019

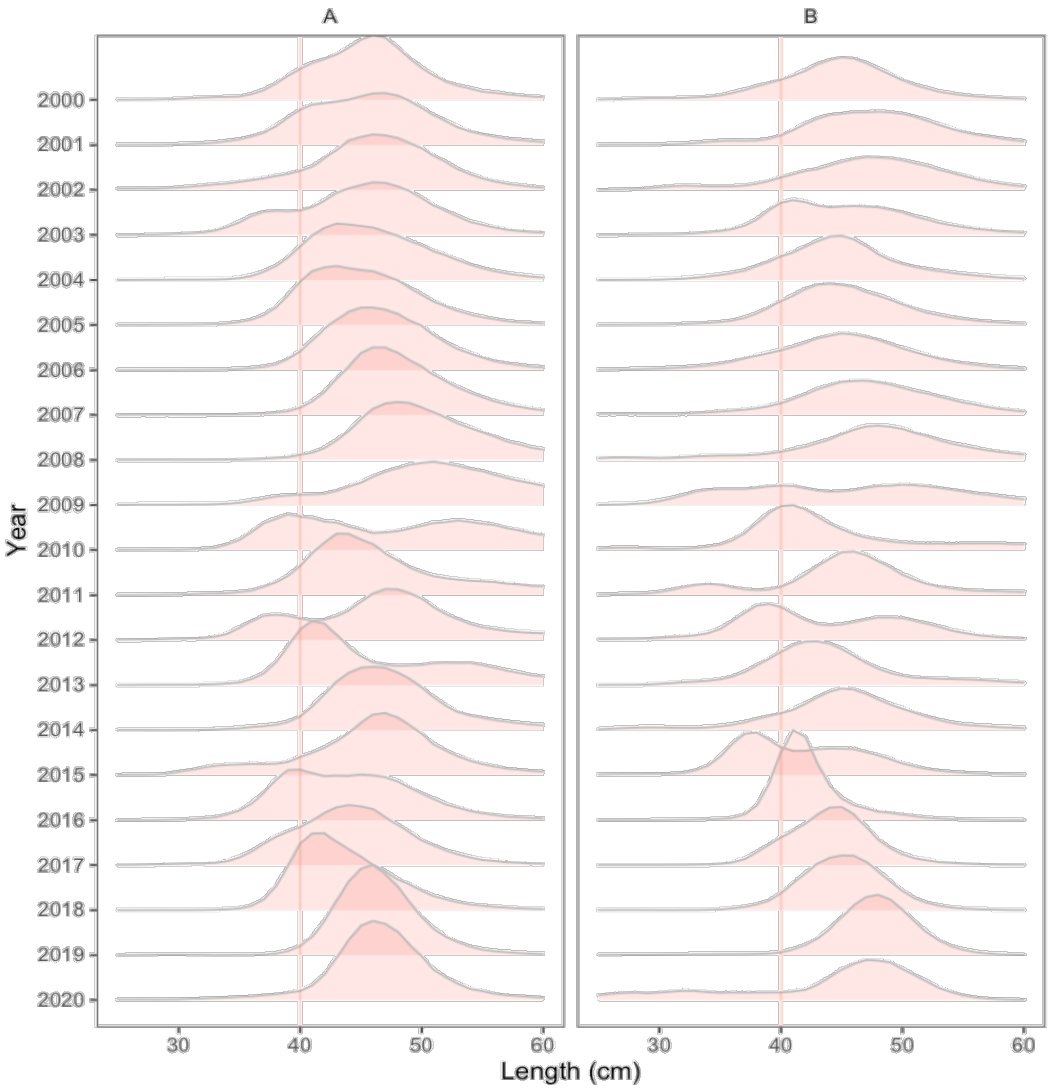


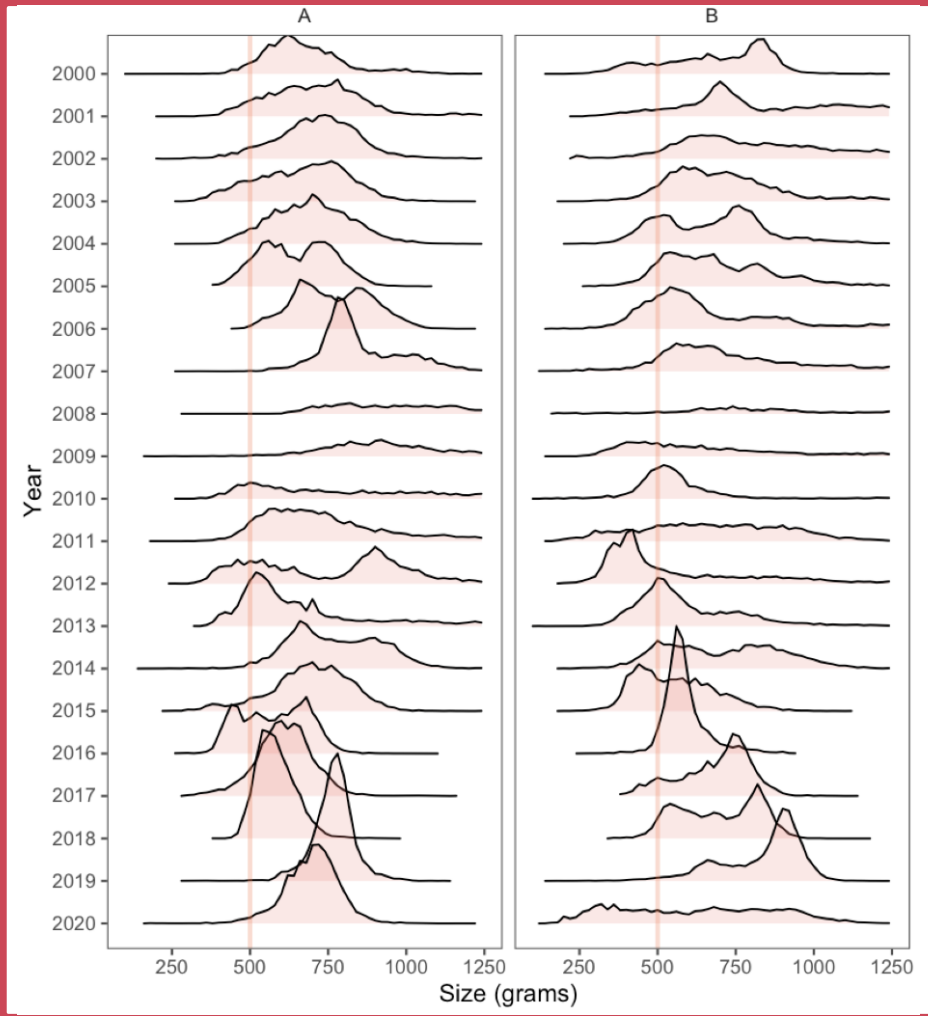

Body weight rela
1.2
1.0
0.8
2017
2018
2019
3
4
5
6
7
8
9
10
Age

Average fishery weight-at-age by season, area, and year…



Fishery length frequency from observers





Size distributions by sample mean weight in tows…

Binned weight frequency

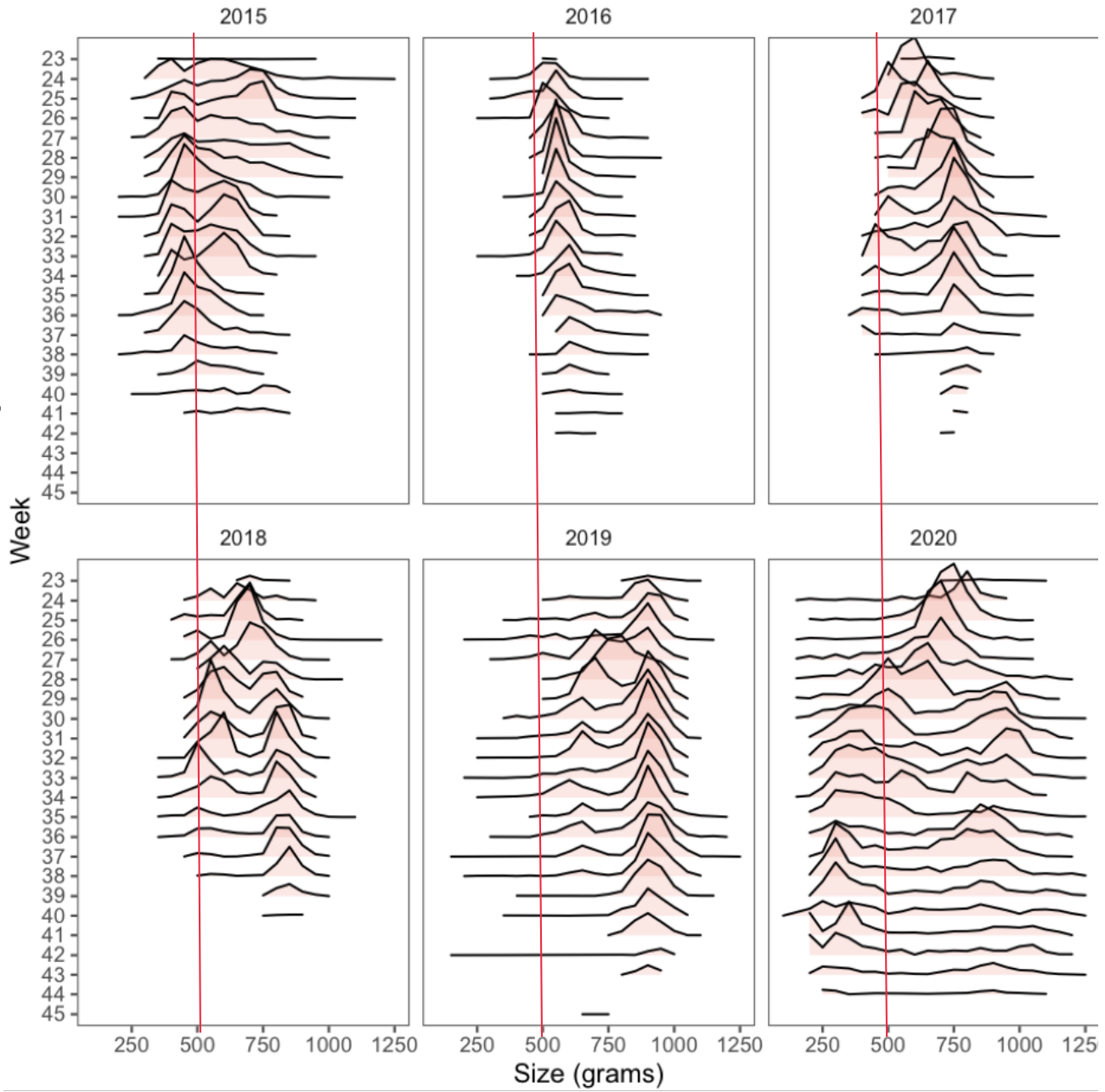
Tow sample mass

divided by

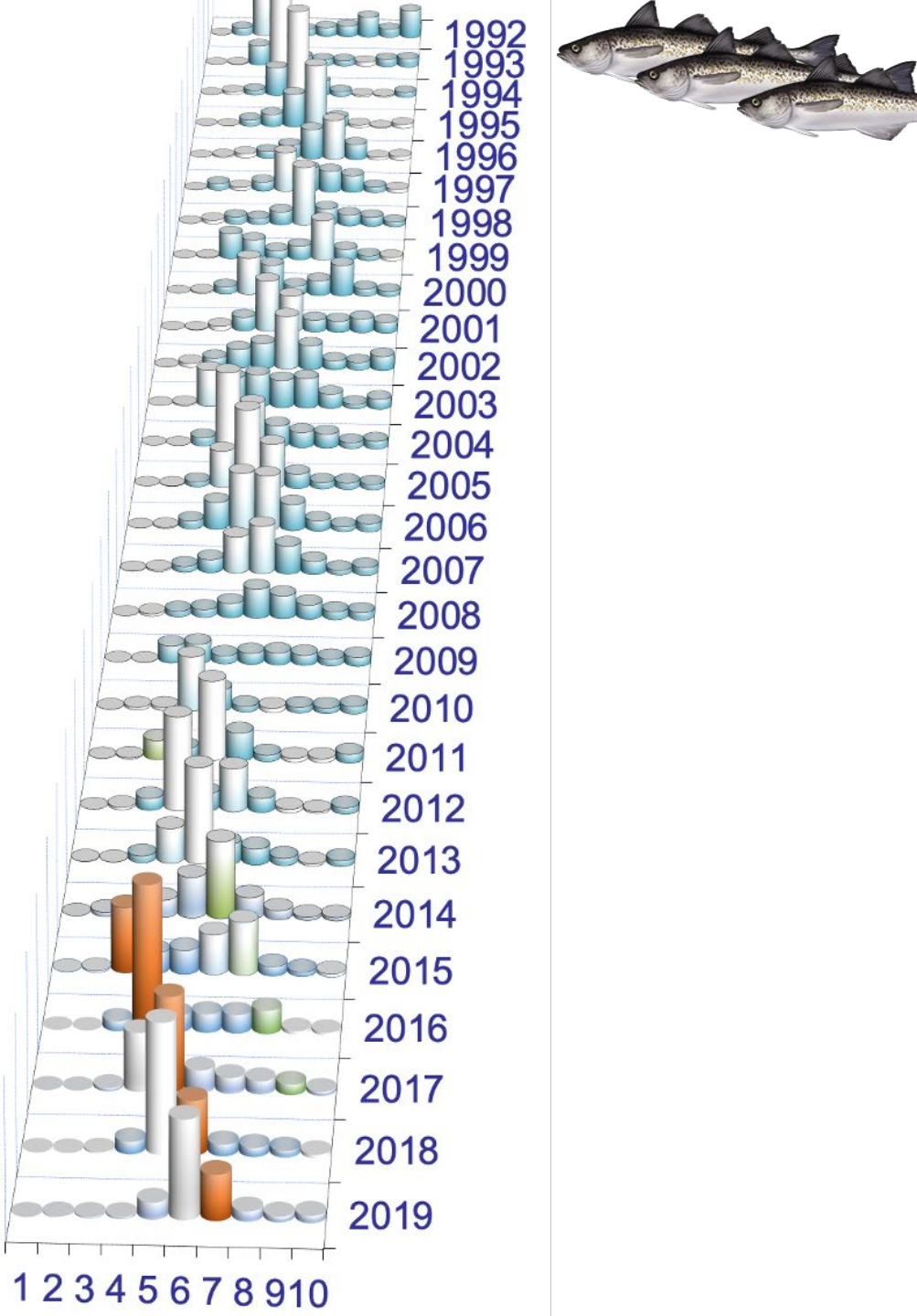
Tow sample N

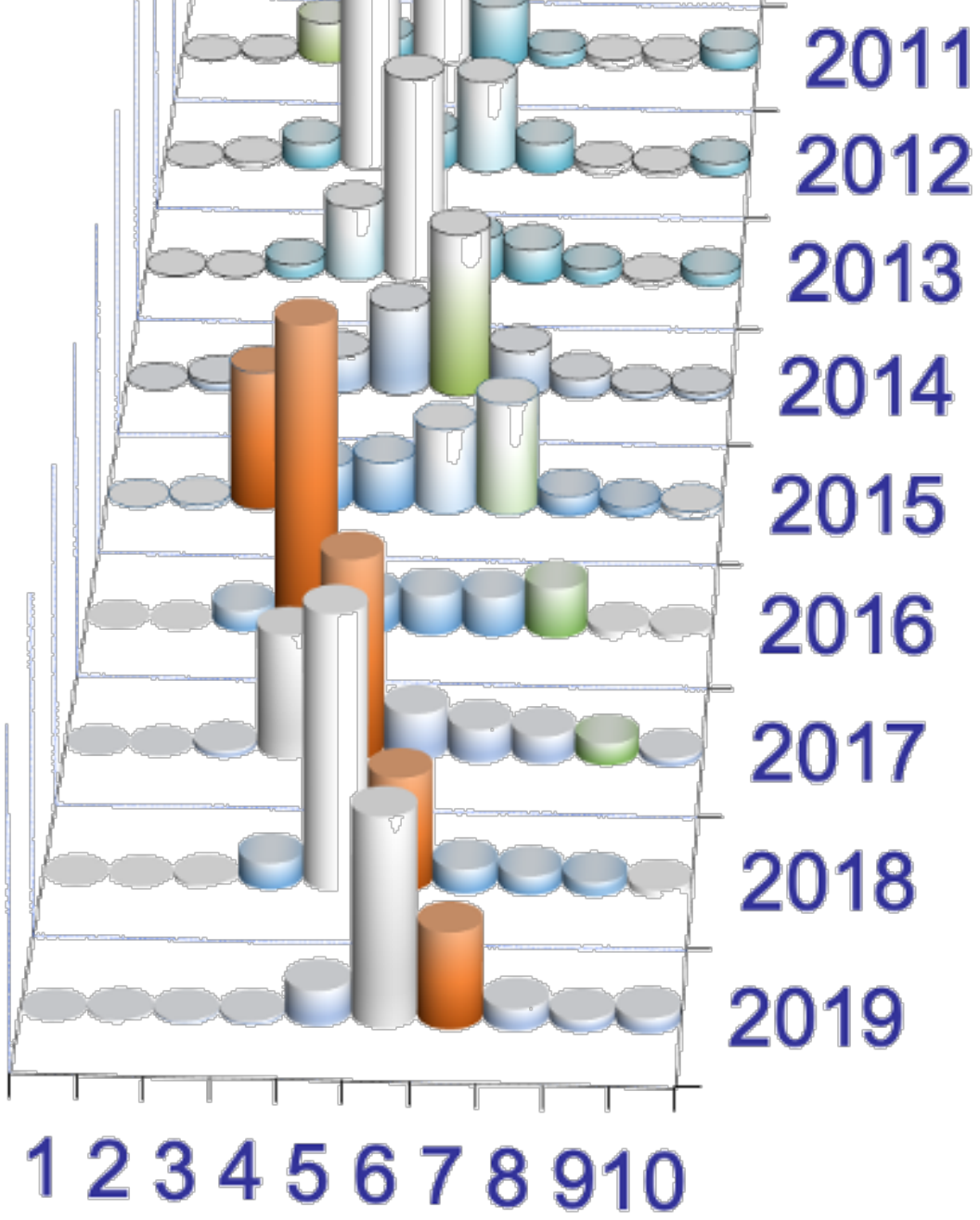
Weekly catch by si bin

2020 seems unusual!



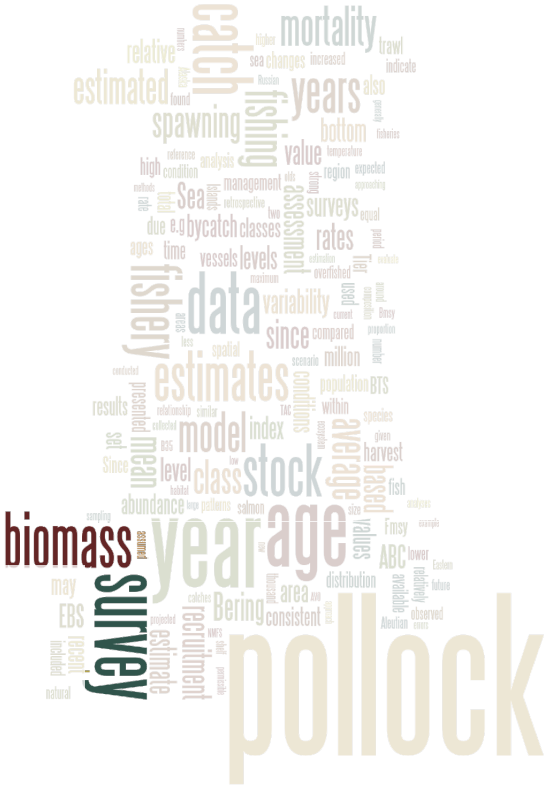
Fishery catch-at-age




2011
2012
2013
2014
2015
2016
2017
2018
2019
1 2 3 4 5 6 7 8 9 10

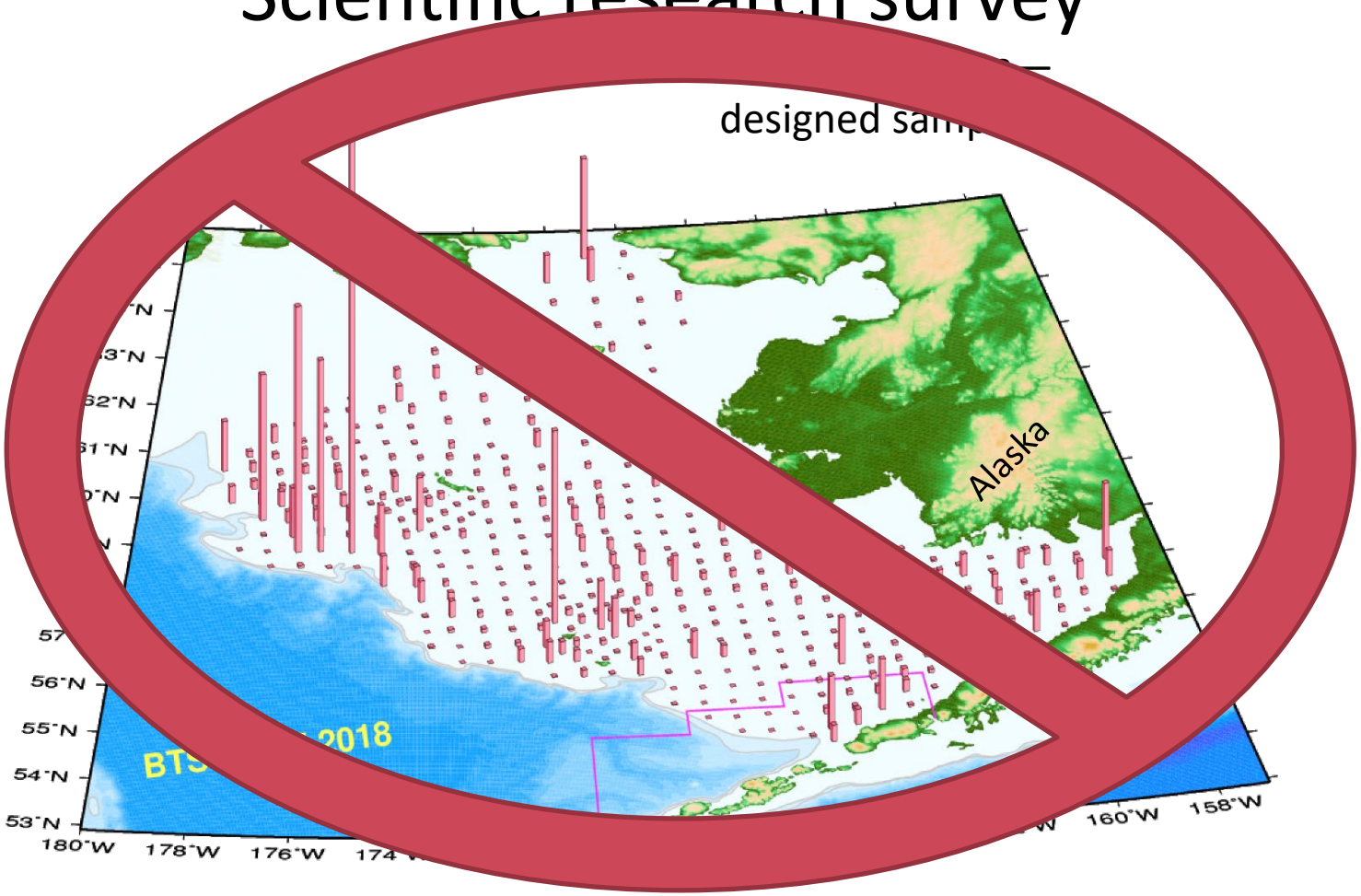
Eastern Bering Sea pollock

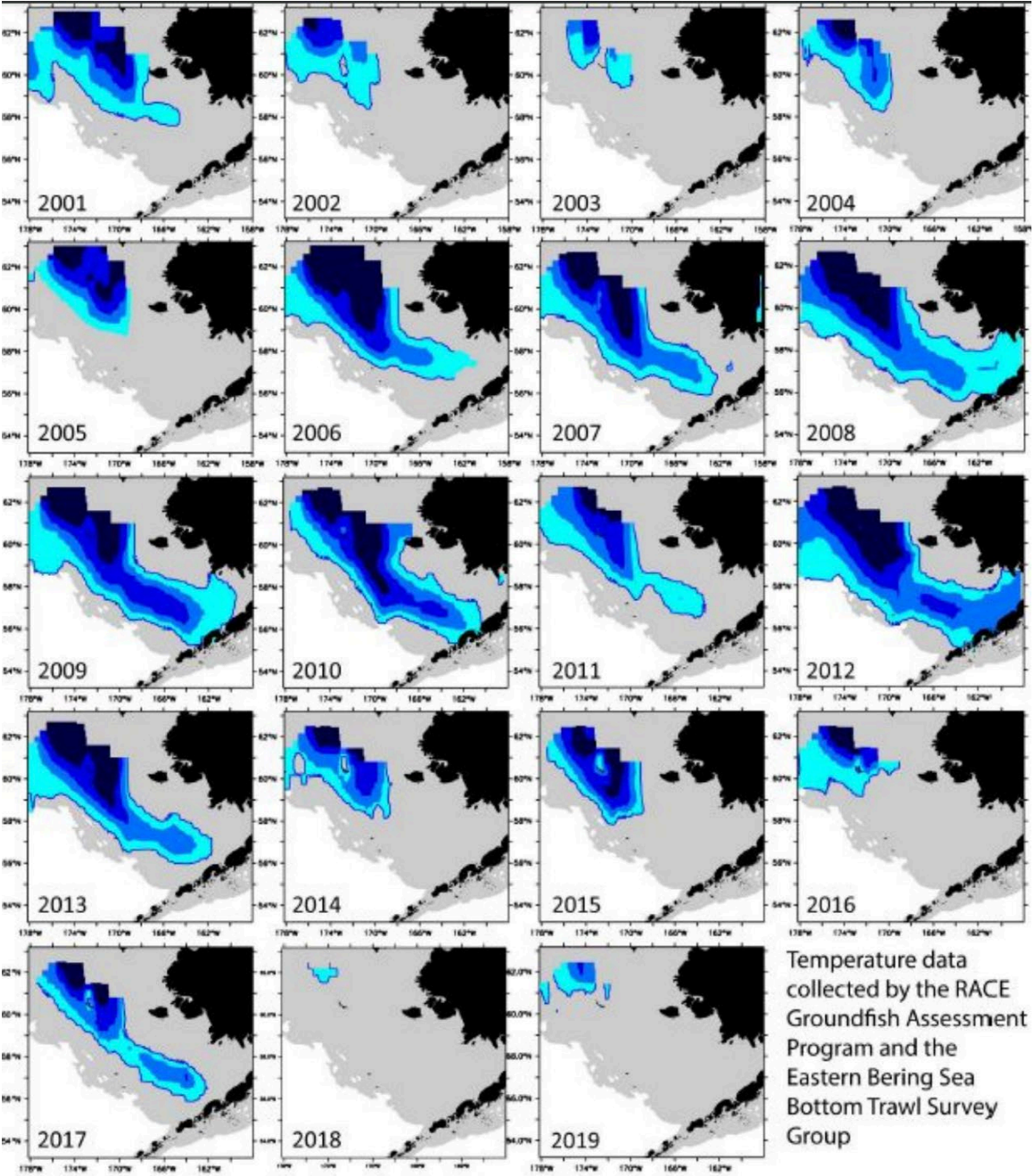
surveys



Scientific research survey

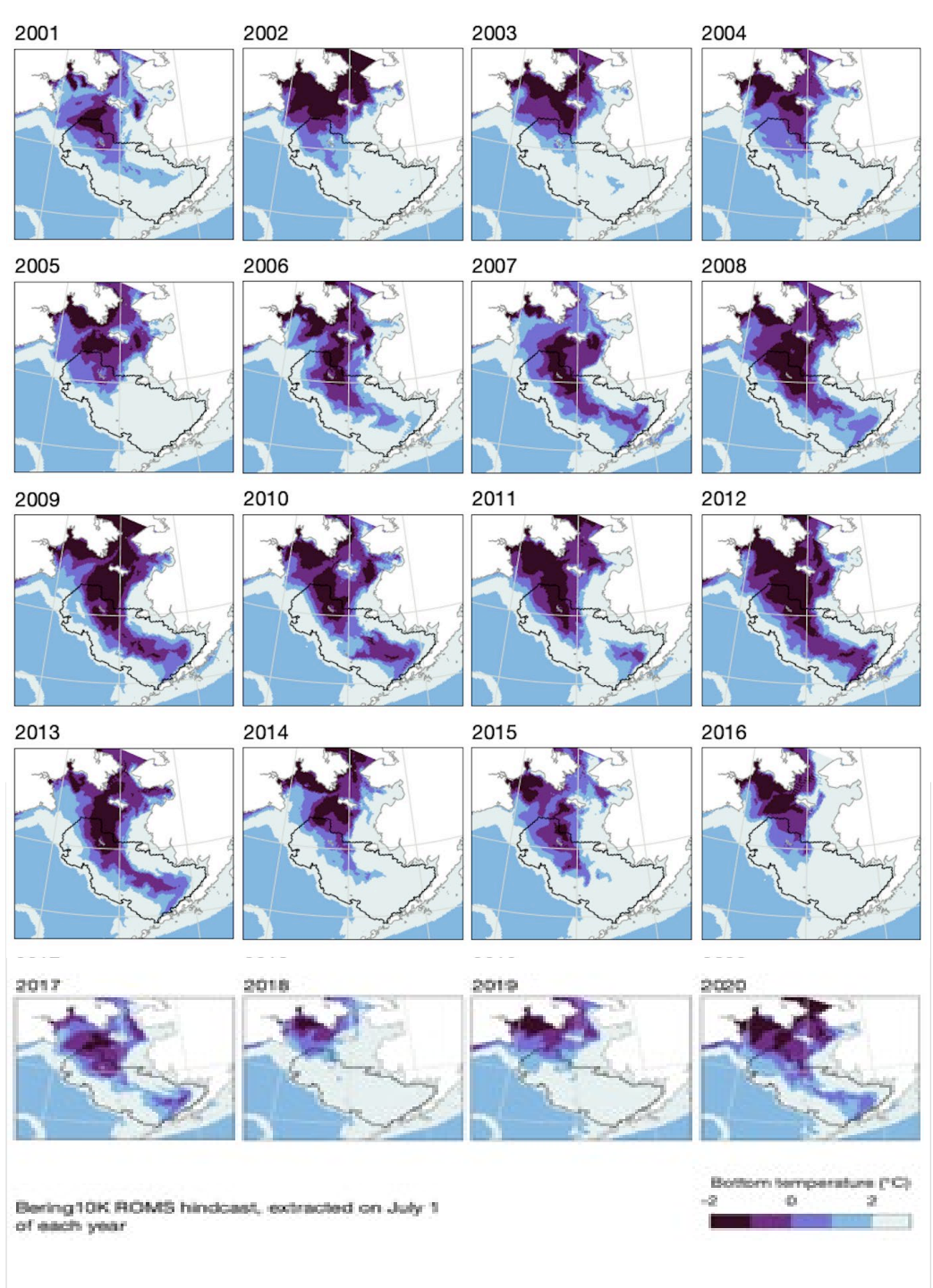
designed samp





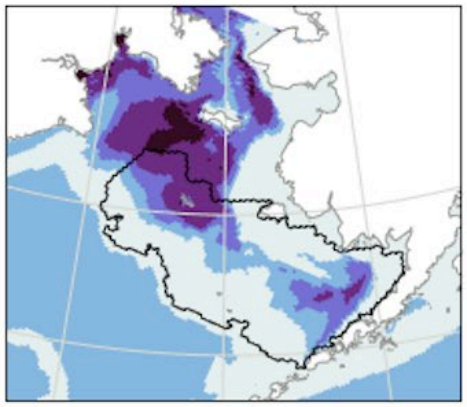
Temperature data collected by the RACE Groundfish Assessment Program and the Eastern Bering Sea Bottom Trawl Survey Group

Cold pool extent…based on data…

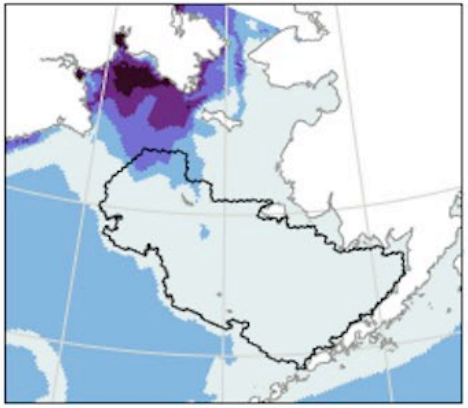


Cold pool extent…based on physical models (ROMs)

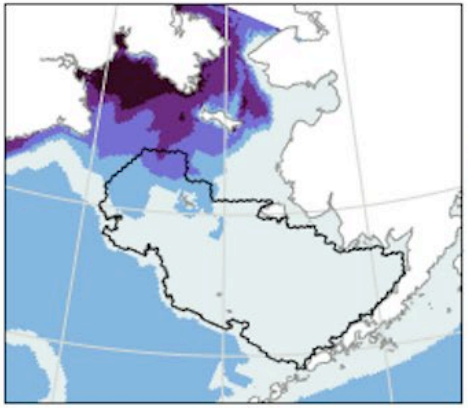
2017



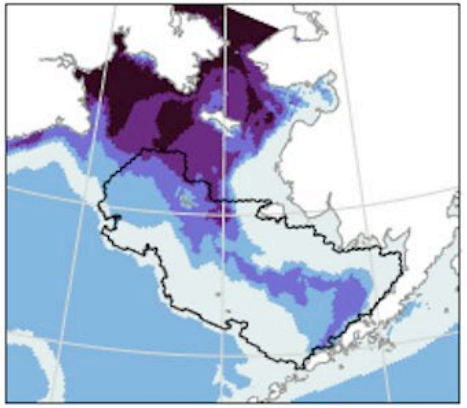
2018



2019



2020



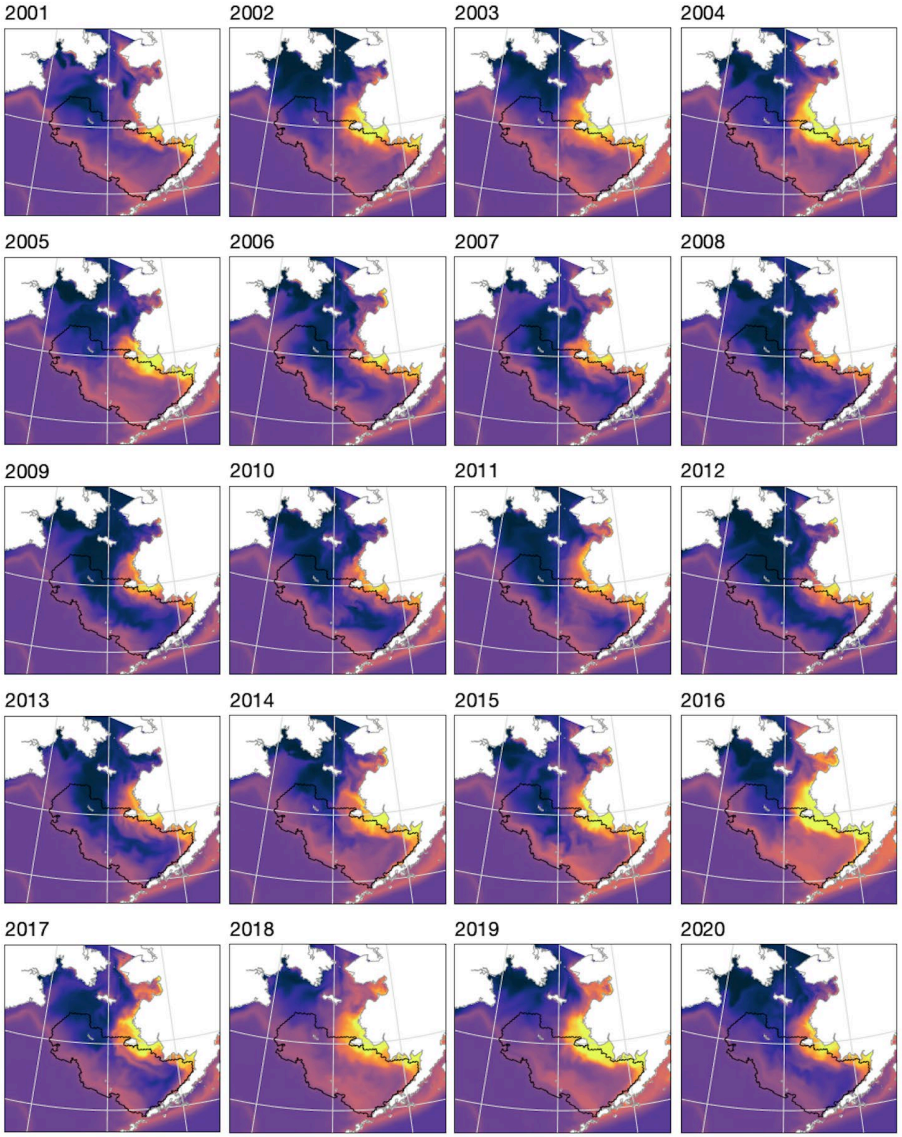
Bering10K ROMS hindcast, extracted on July 1 of each year

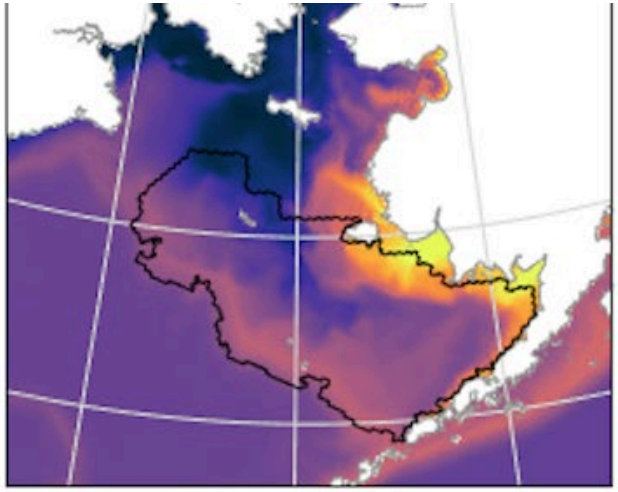
Bottom temperature (°C)

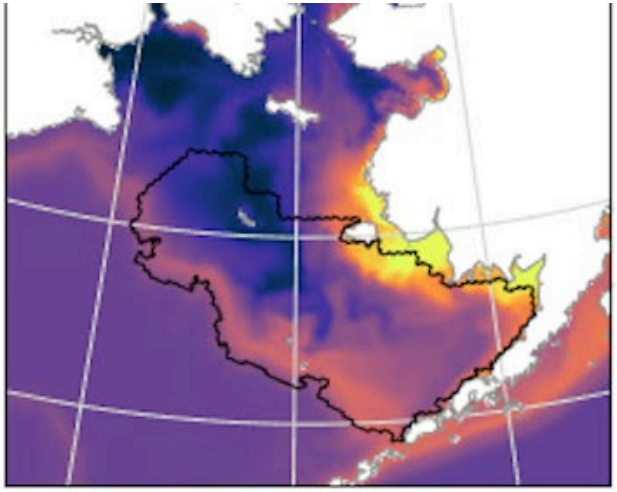
-2 0 2

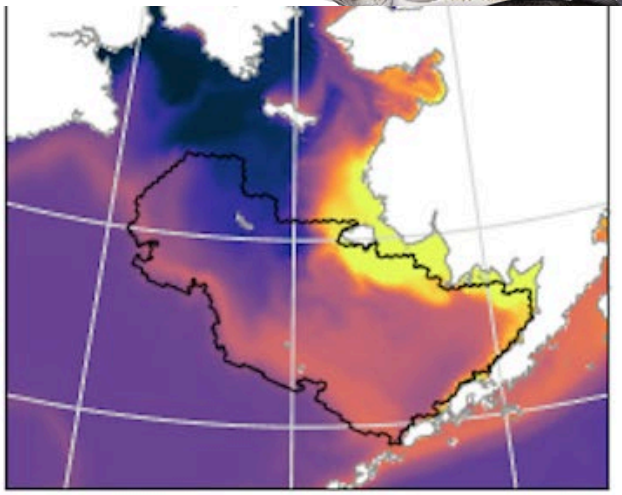
Summer bottom temperatures

- Hindcasts from ROMs
  - Courtesy Dr. Kelly Kearney, AFSC
- More like average!

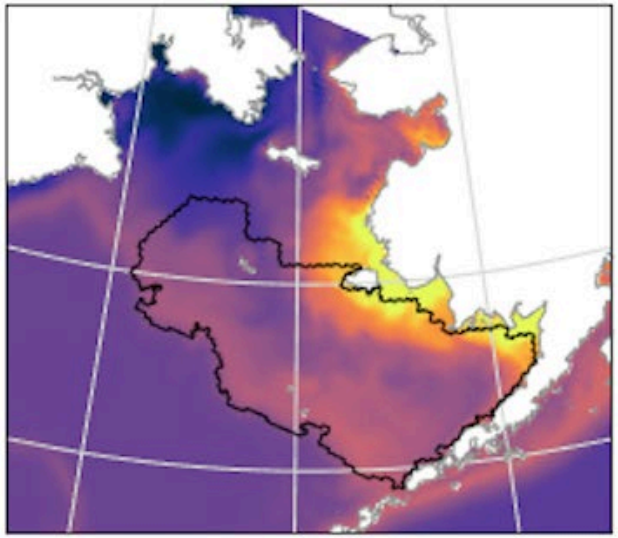




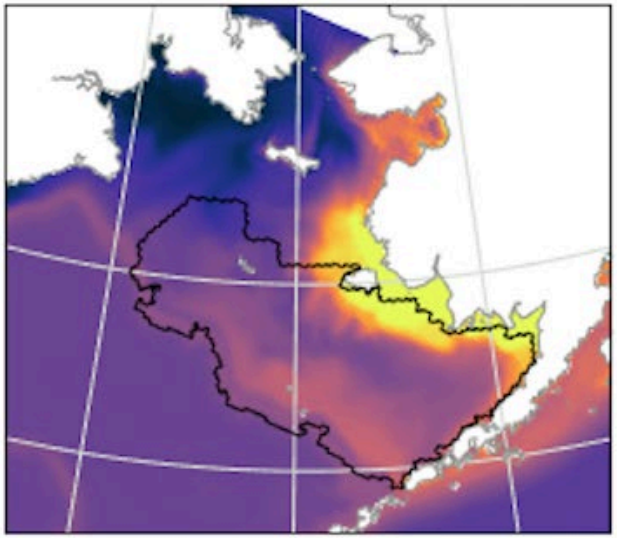




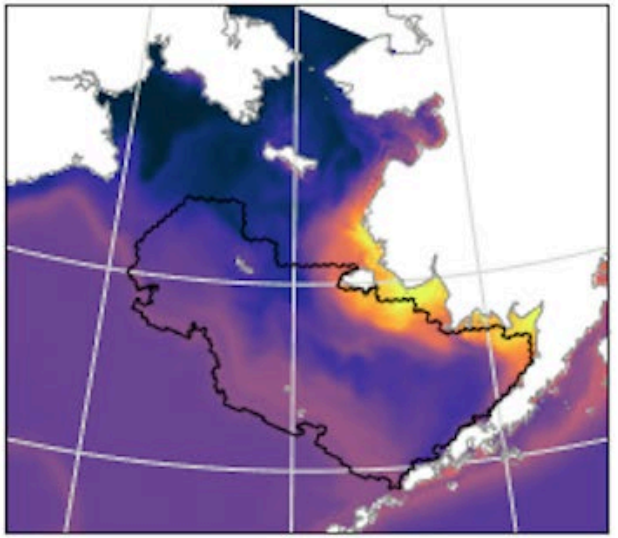
2018



2019

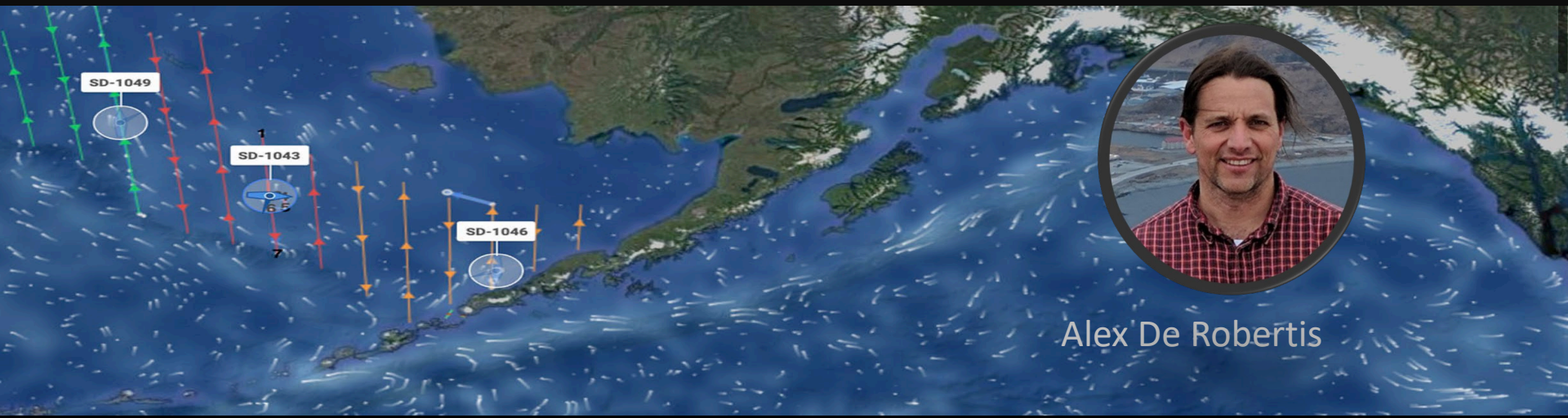


2020



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

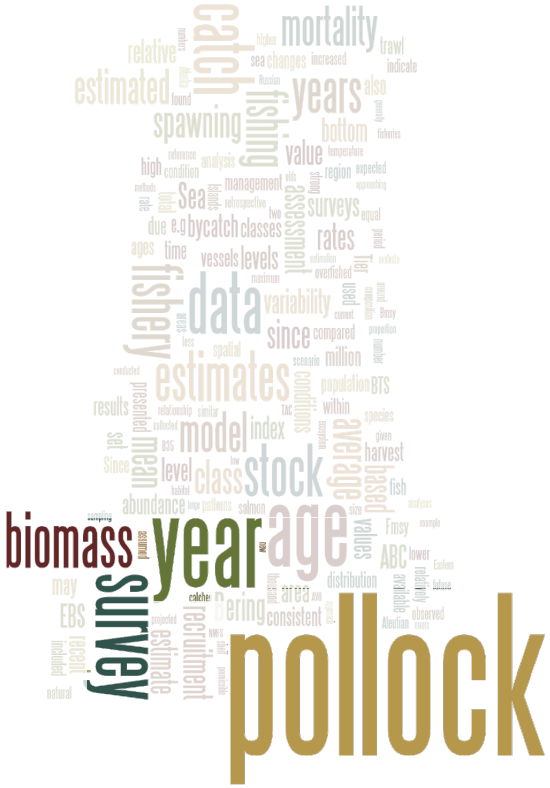


Alex De Robertis

EBS pollock

Assessment

Results



Data

The following lists the data used in this assessment:

Source	Type	Years
Fishery	Catch biomass	1964–2020
Fishery	Catch age composition	1964–2019
Fishery	Japanese trawl CPUE	1965–1976
EBS bottom trawl	Area-swept biomass and age-specific proportions	1982–2019
Acoustic trawl survey	Biomass index and age-specific proportions	1994, 1996, 1997, 1999, 2000, 2002, 2004, 2006–2010, 2012, 2014, 2016, 2018, 2020
Acoustic vessels of opportunity (AVO)	Biomass index	2006–2019

Note the 2020 acoustic survey data based on unmanned surface vessel (USV) transects

Model details (1 of 2)

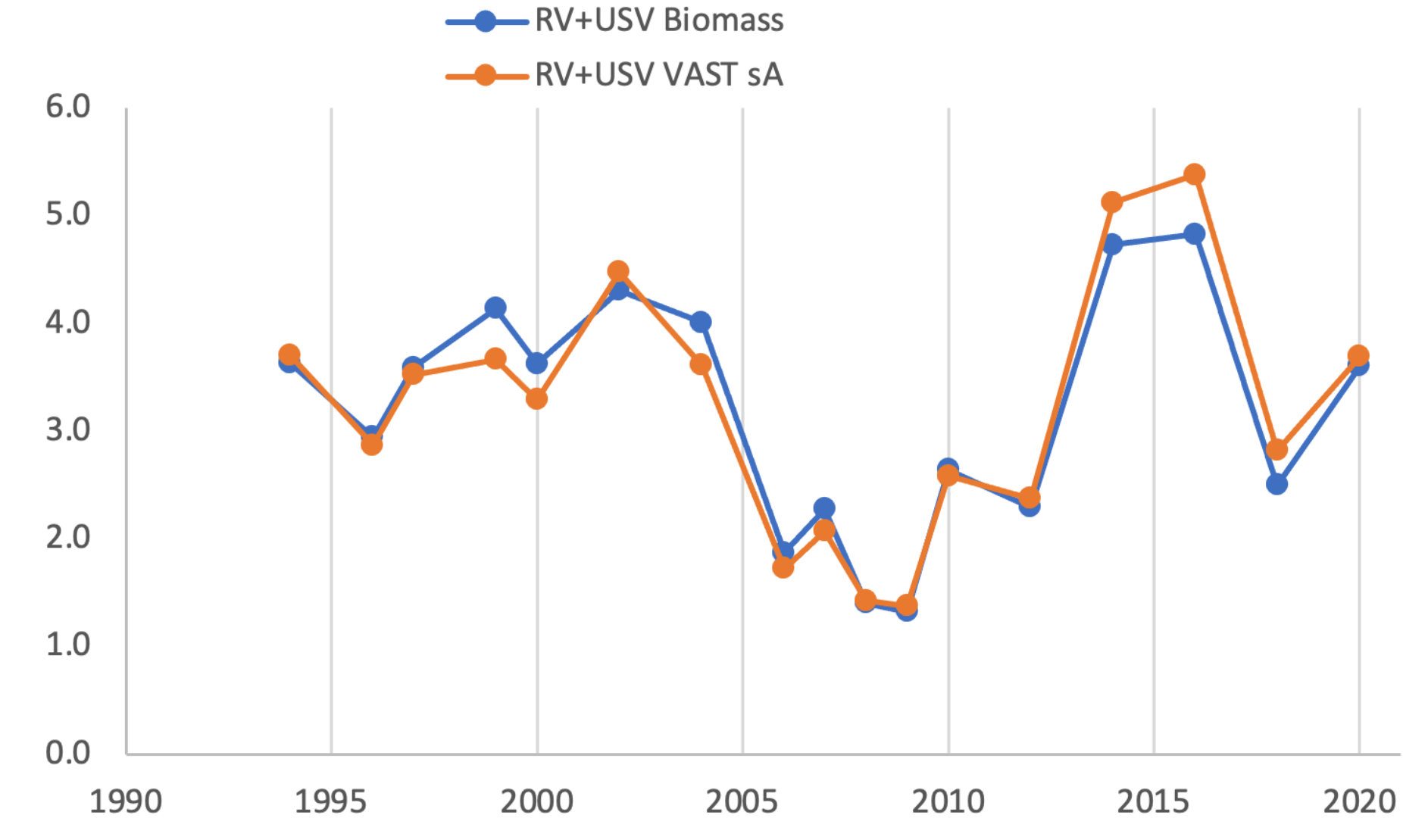
- Tuning indices
  - Acoustic Trawl survey
    - Available biennially (usually!!)
  - Annual fixed-station bottom trawl survey (normally)
  - Acoustic vessel of opportunity (AVO index)
    - Normally Two new years of data every other year
  - Old foreign trawler CPUE (in 1970s)

- Fishery data
  - Total catch
  - Catch-at-age
  - Mean fishery weights-at-age

Model details (2 of 2)

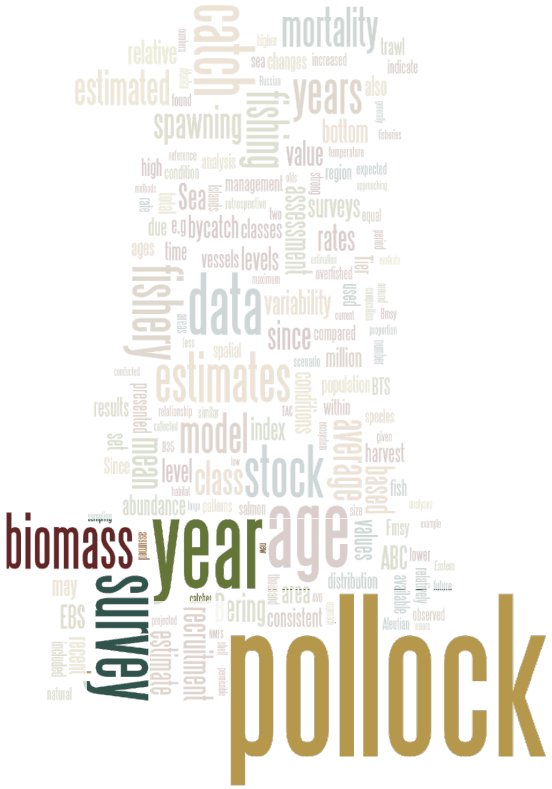
- Age specific schedules
  - Natural mortality
    - Ages 1 and 2 higher, other ages fixed at 0.3
  - Maturity
    - Estimated externally…50% at ~ age 3.5 years
- Other
  - Conditioned on catch biomass (F's estimated)
  - Selectivity varies in fishery
    - Slightly in surveys
  - Stock recruitment model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

Applying survey data in assessment model



Model configurations

- Base (as in 2019)
  - Model 16.2
- Extend acoustic time series with drone data
  - As biomass converted from 2020 back-scatter
  - (Model 20.0)
- Analyze all historical data from research vessels combined with the 2020 drone data
  - All data treated as acoustic back-scatter
  - Uses VAST model for modeling unbalanced data (spatio-temporal aspects)
  - (Model 20.1)



Data

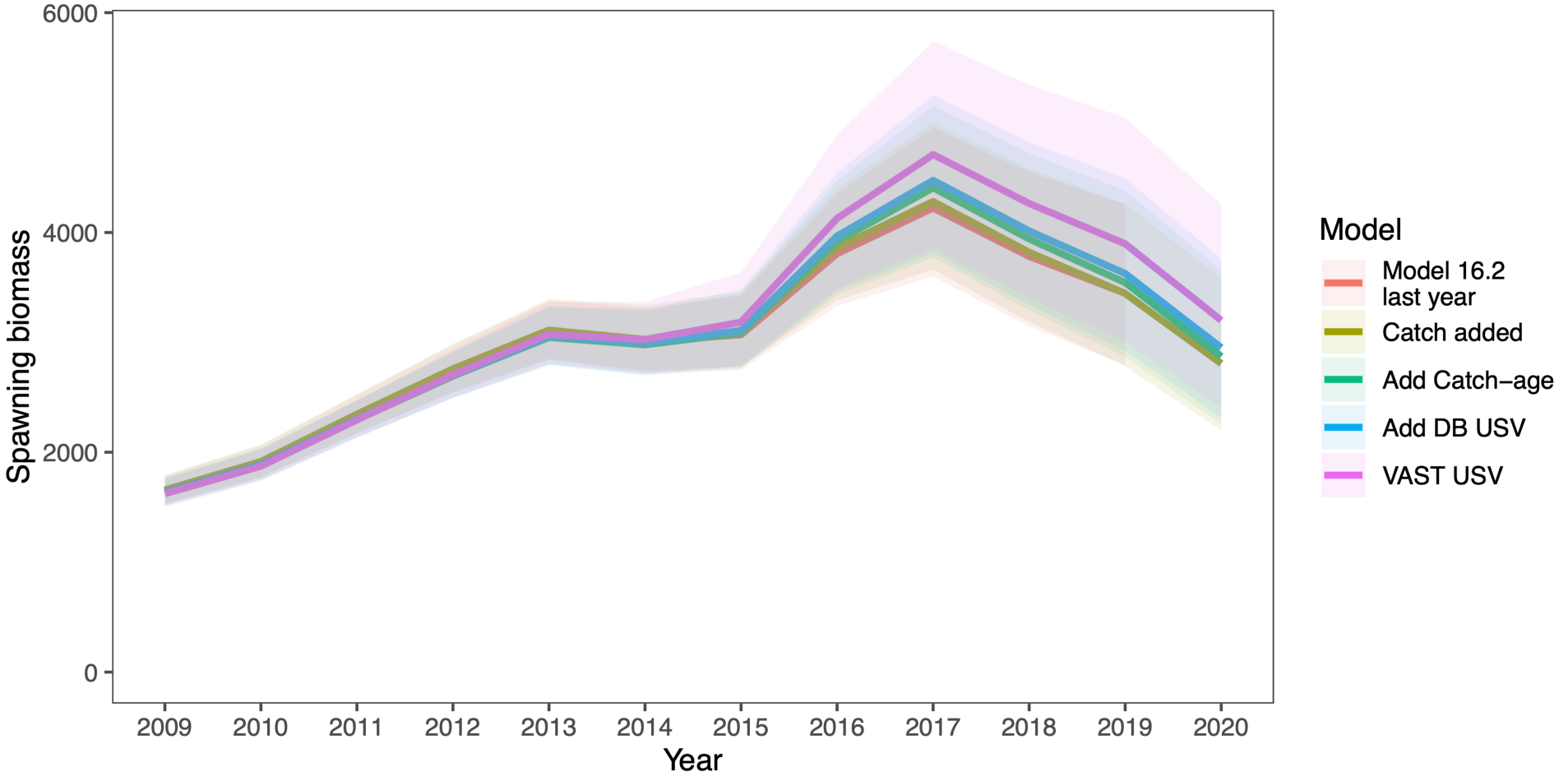
Impact on

Model

New data impact on model…

Data considerations				
Name	**Updated catch to 2020**	**2019 fishery age data**	**2020 Drone biomass (design based)**	**2020 Drone backscatter (VAST)**
Catch	X			
+ Age Fishery	X	X		
+ Drone (DB)	X	X	X	
+ Drone (VAST)	X	X		X

Data
Impact on
Model


6000
4000
2000
0
Spawning biomass
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Year
Model
Model 16.2 last year
Catch added
Add Catch−age
Add DB USV
VAST USV

Selected model with USV for management advice

- Converted to biomass (in 2020)
- Similar to results from VAST
  - Was only backscatter

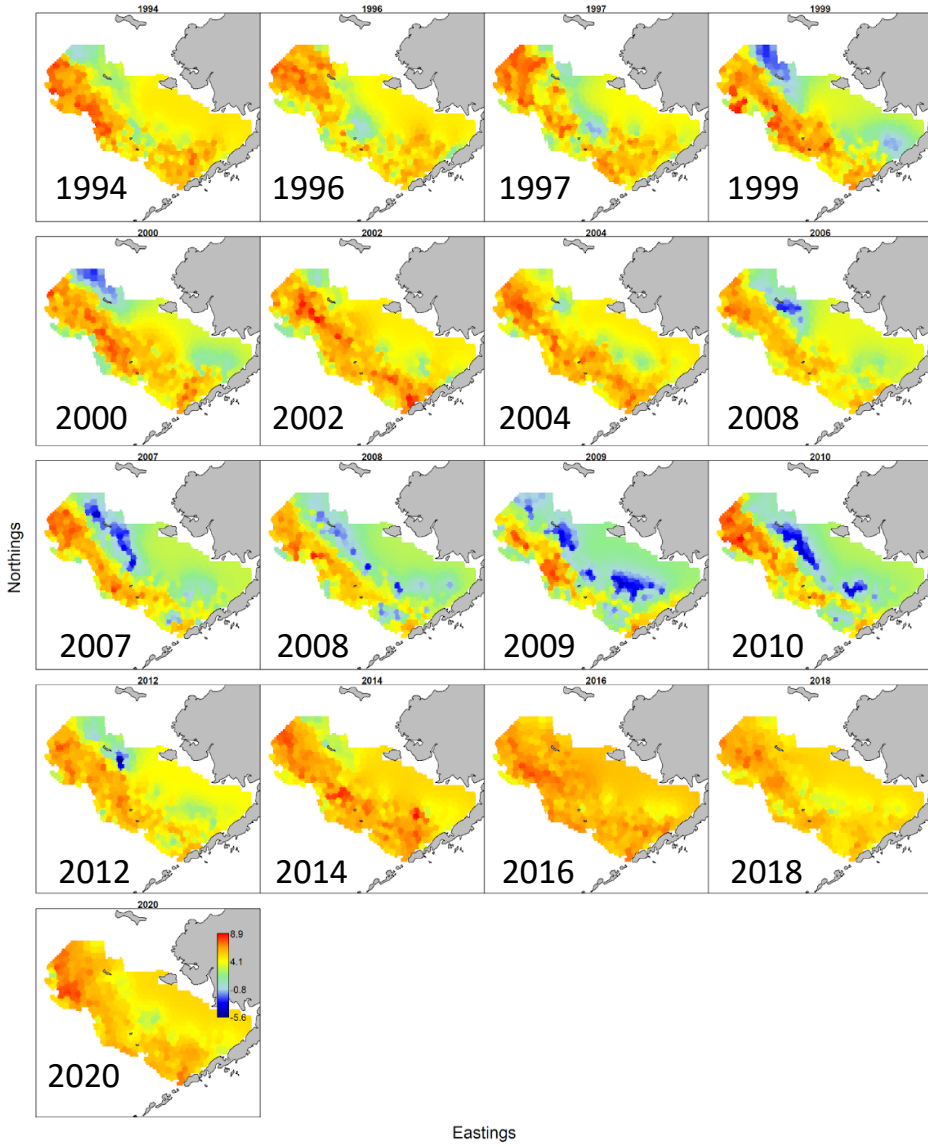
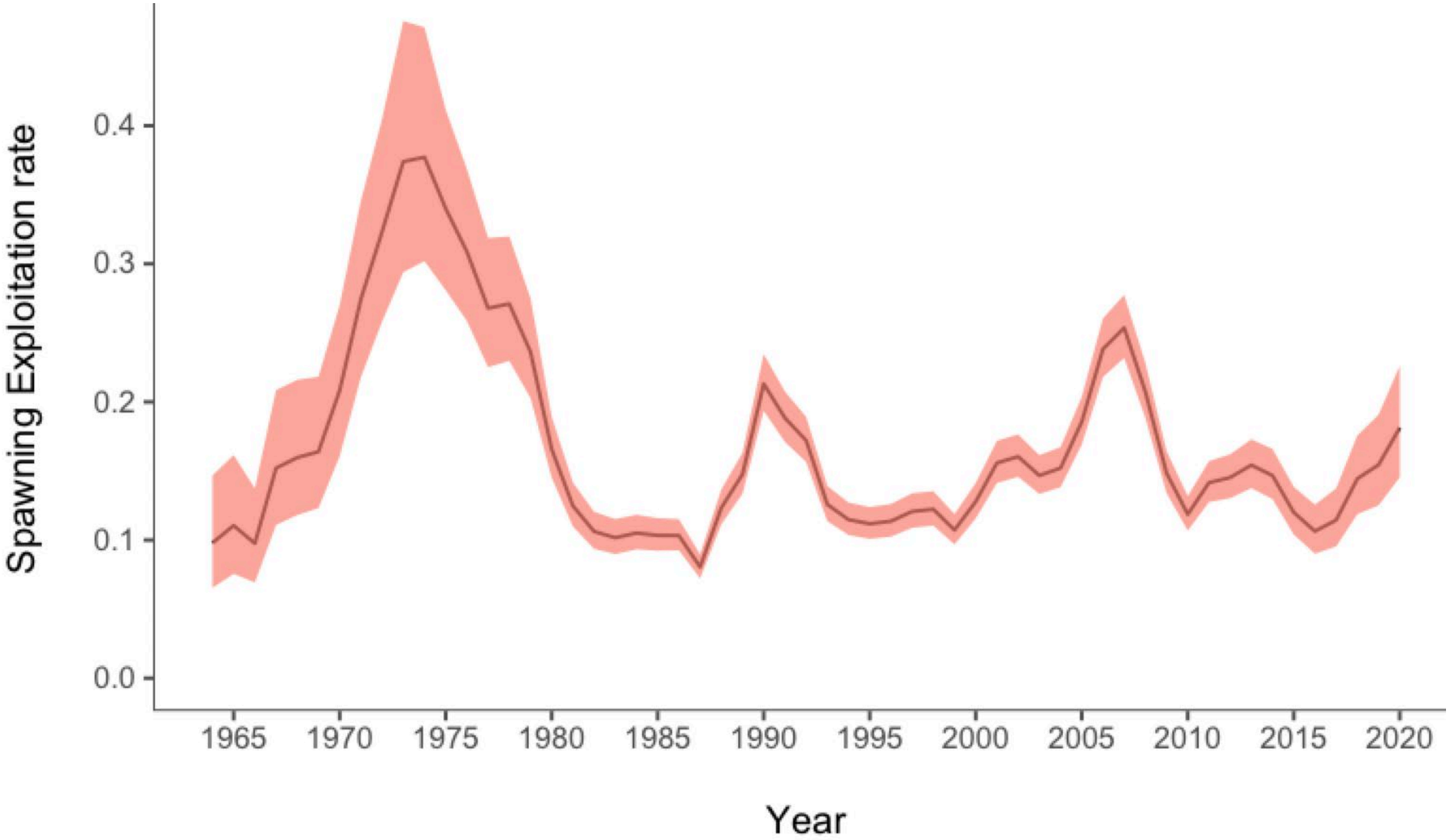


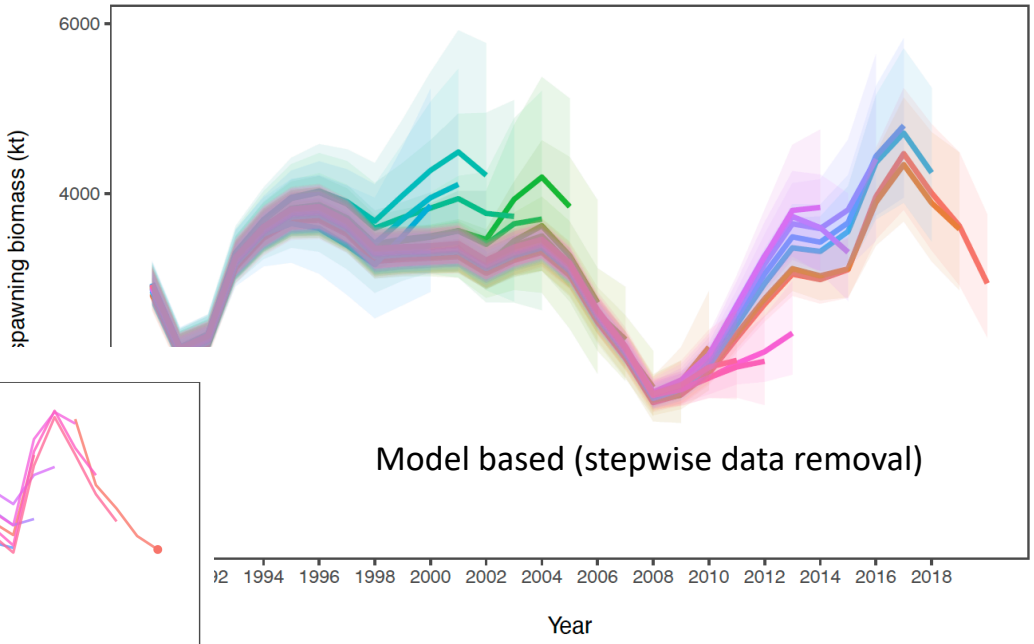
Figure 19: VAST model predicted log-density of pollock abundance based on acoustic backscatter from NMFS acoustic-trawl surveys (1994–2018) and from the 2020 USV transects.

Spawning exploitation rate

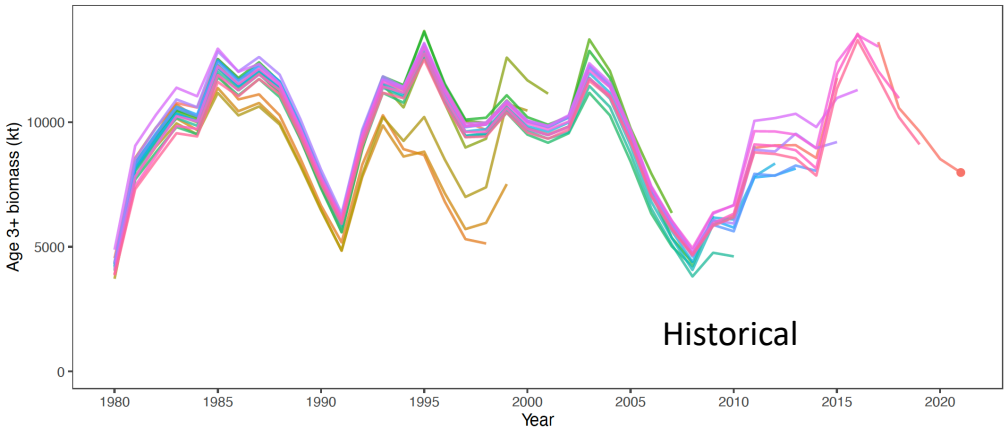


EBS pollock
Assessment
Results

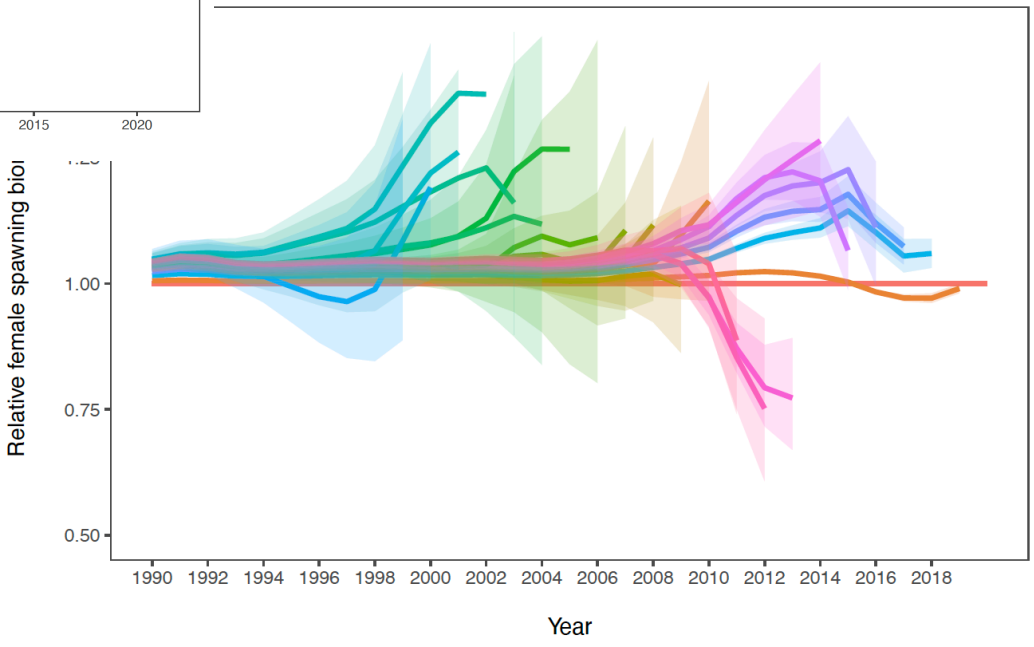
Retrospectives



Model based (stepwise data removal)

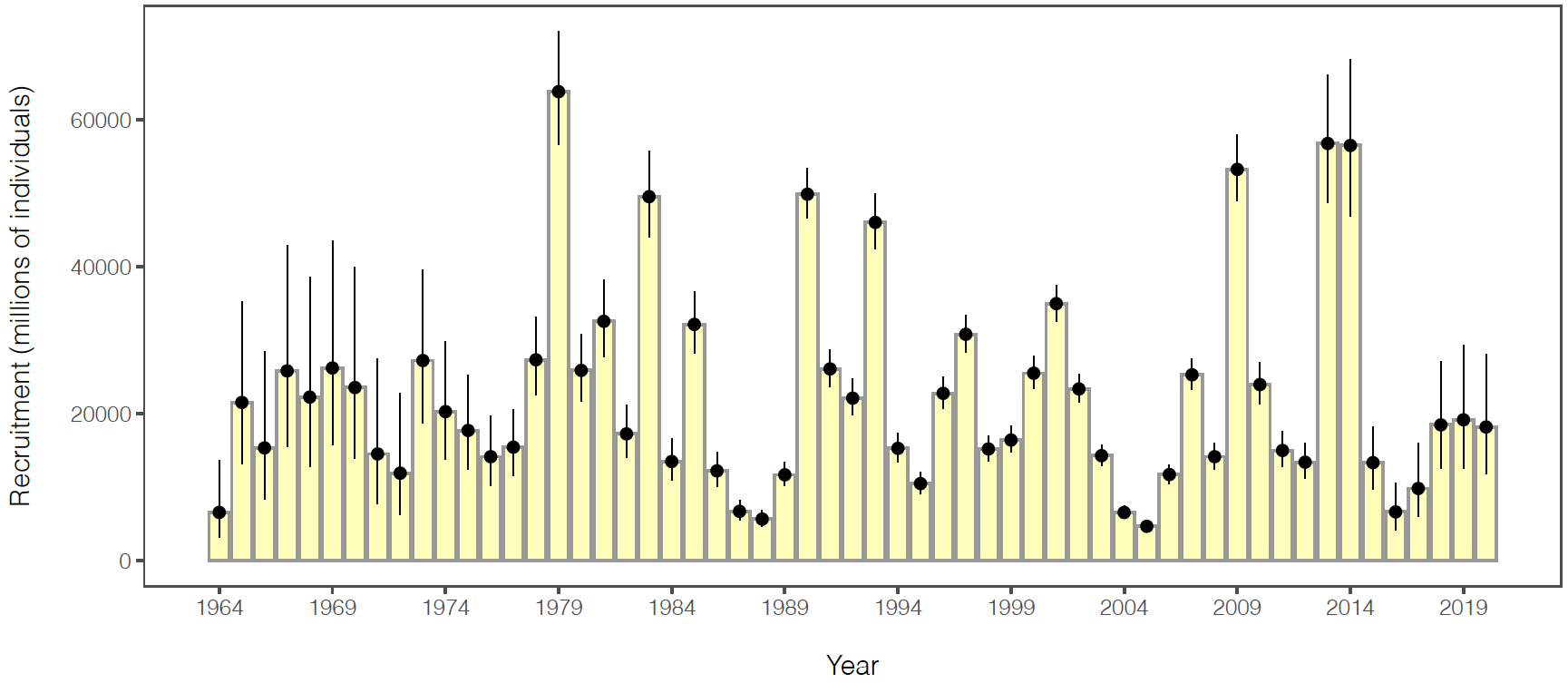


Historical



EBS pollock
Assessment
Results

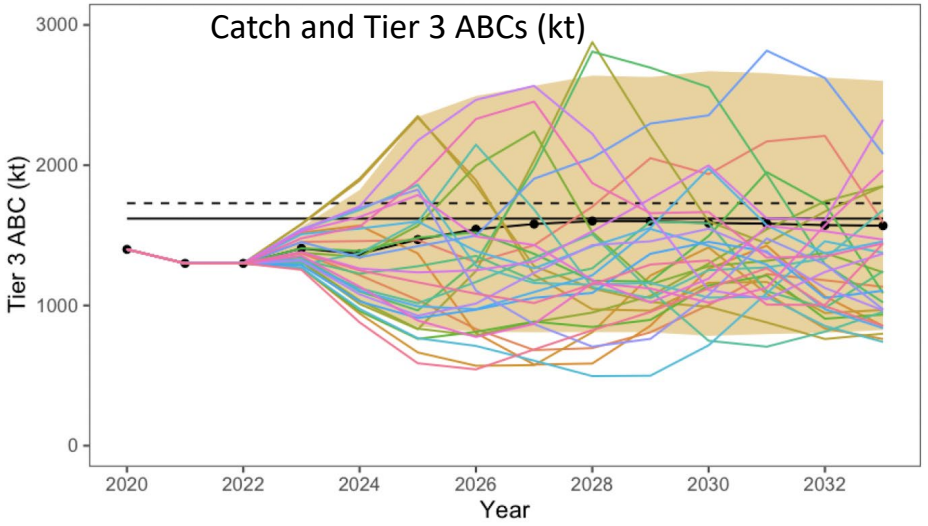
Estimated recruitment

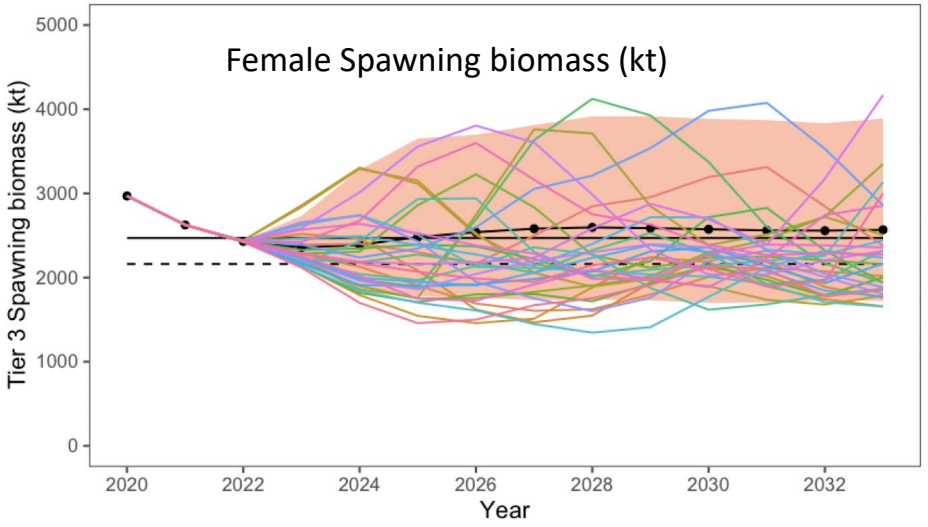


Projections

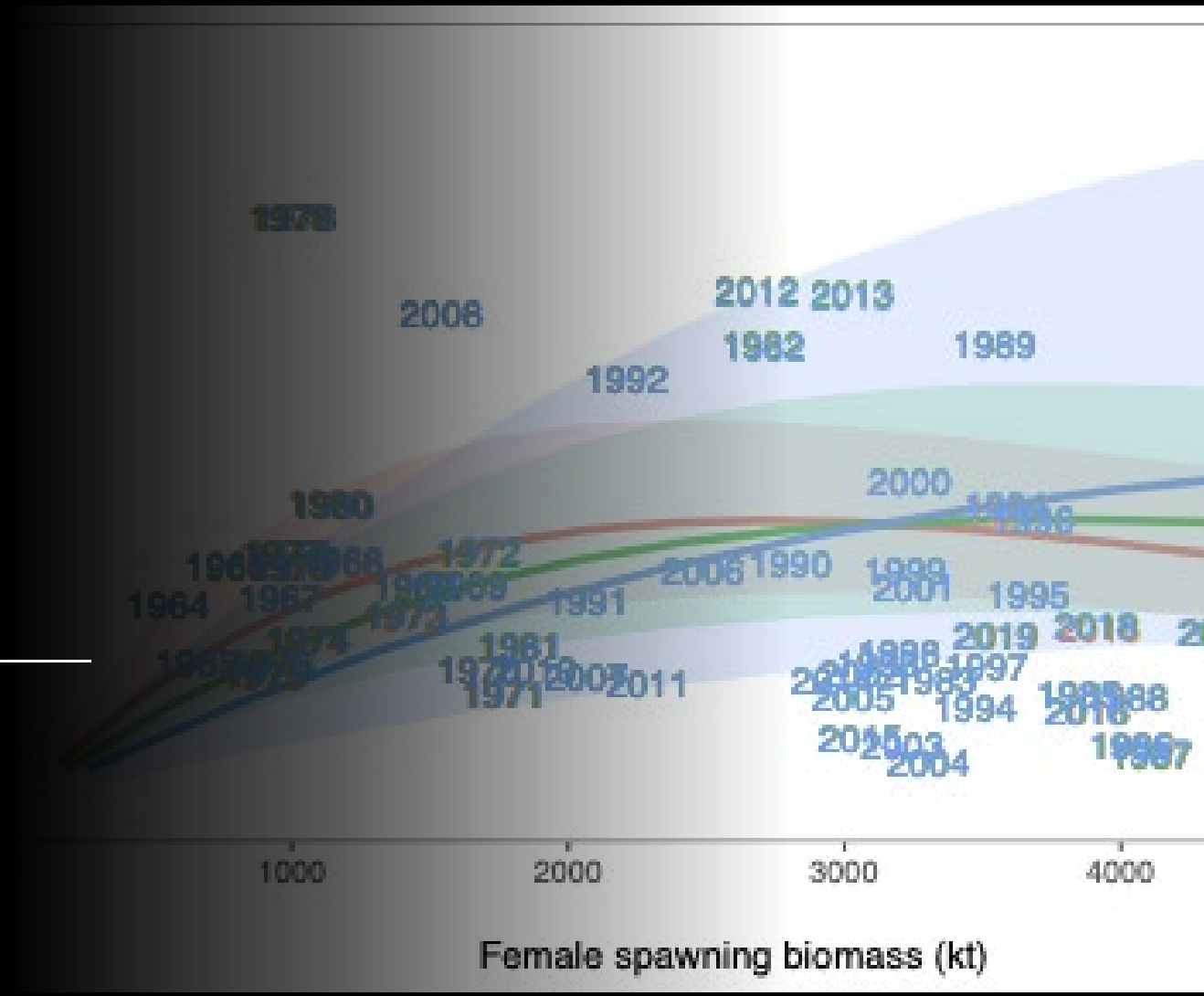
Cautions:

- Current absolute biomass uncertain
- Future weight-at-age may add uncertainty
- Actual year-year fluctuations in catch unrealistic

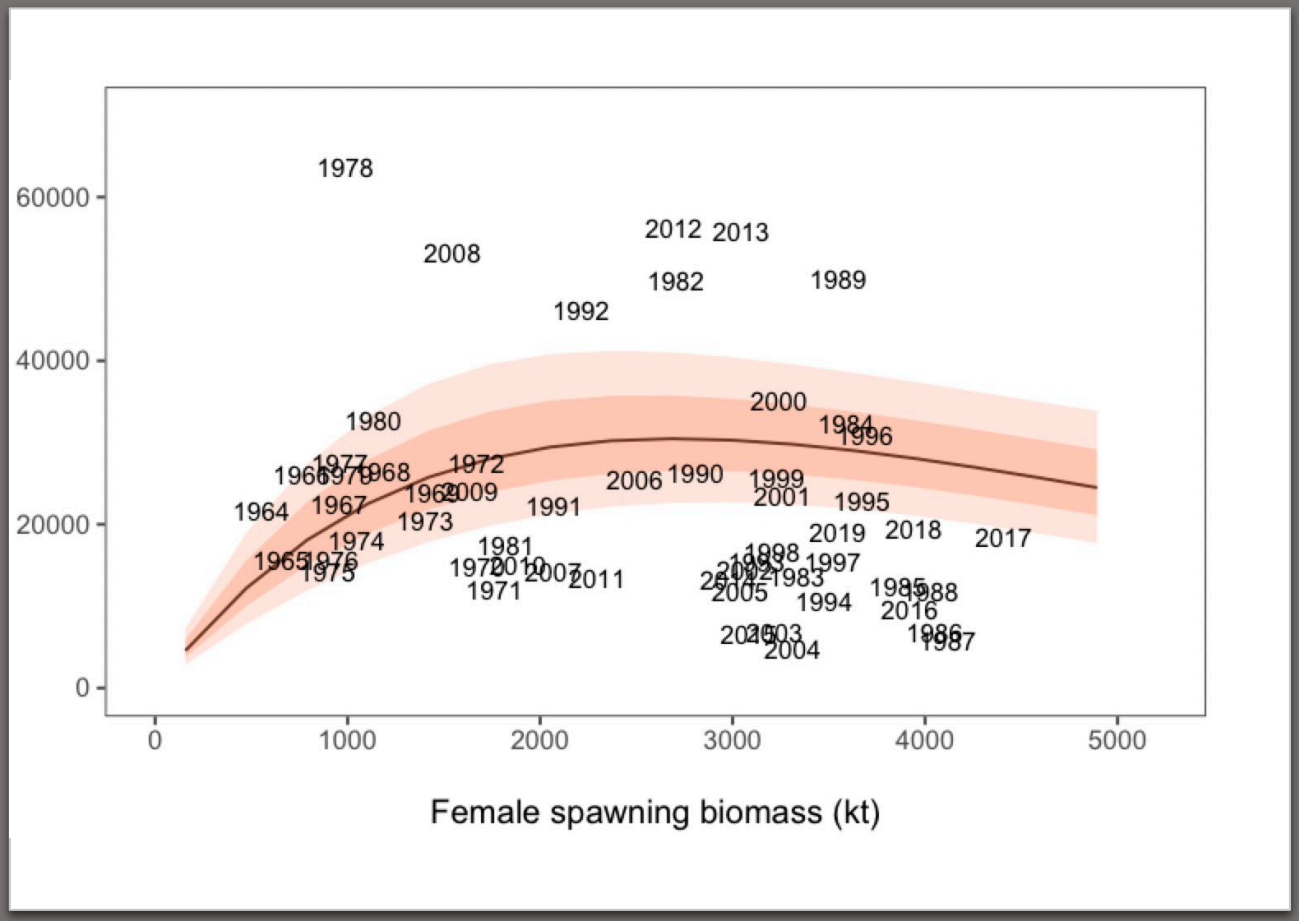


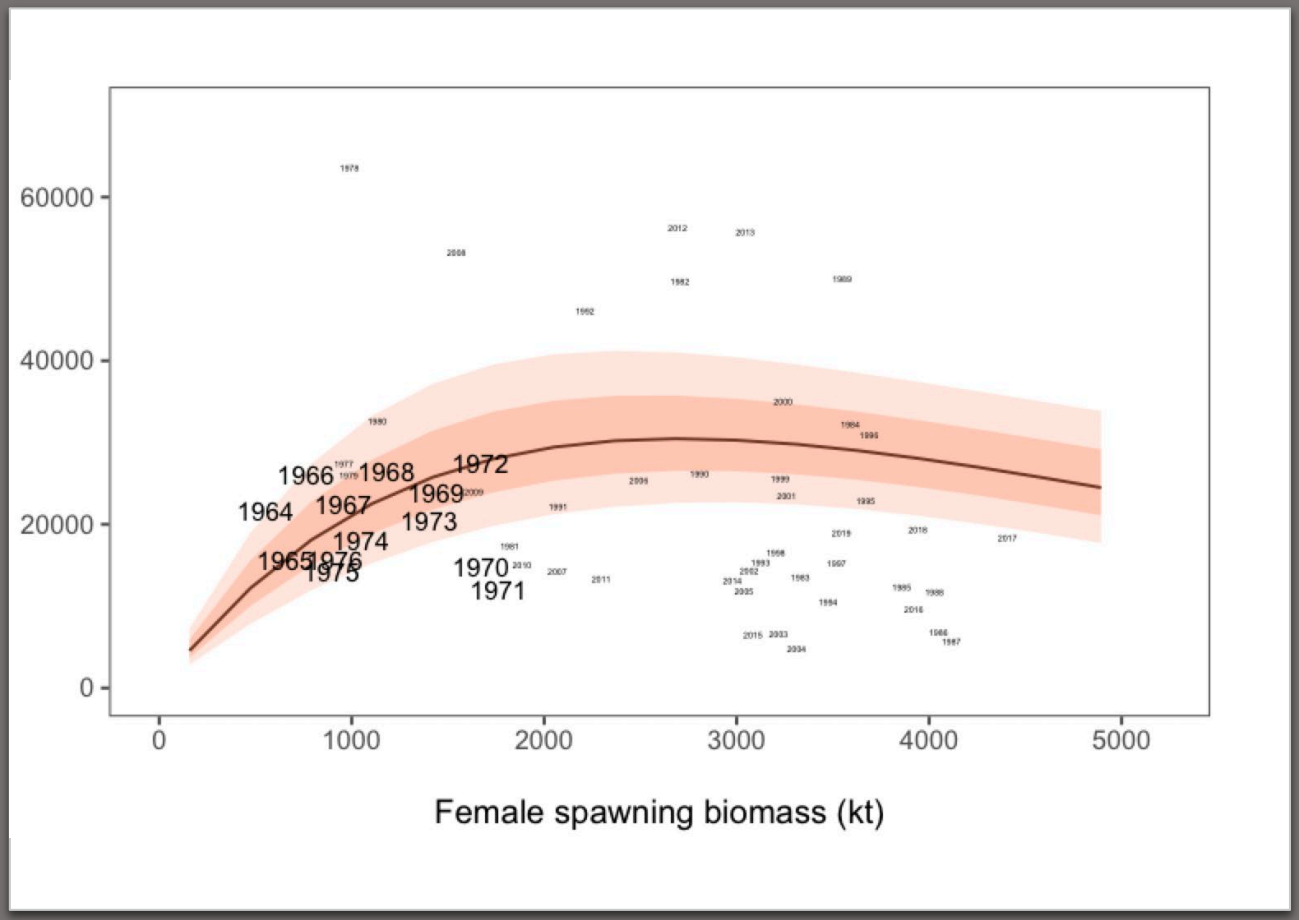


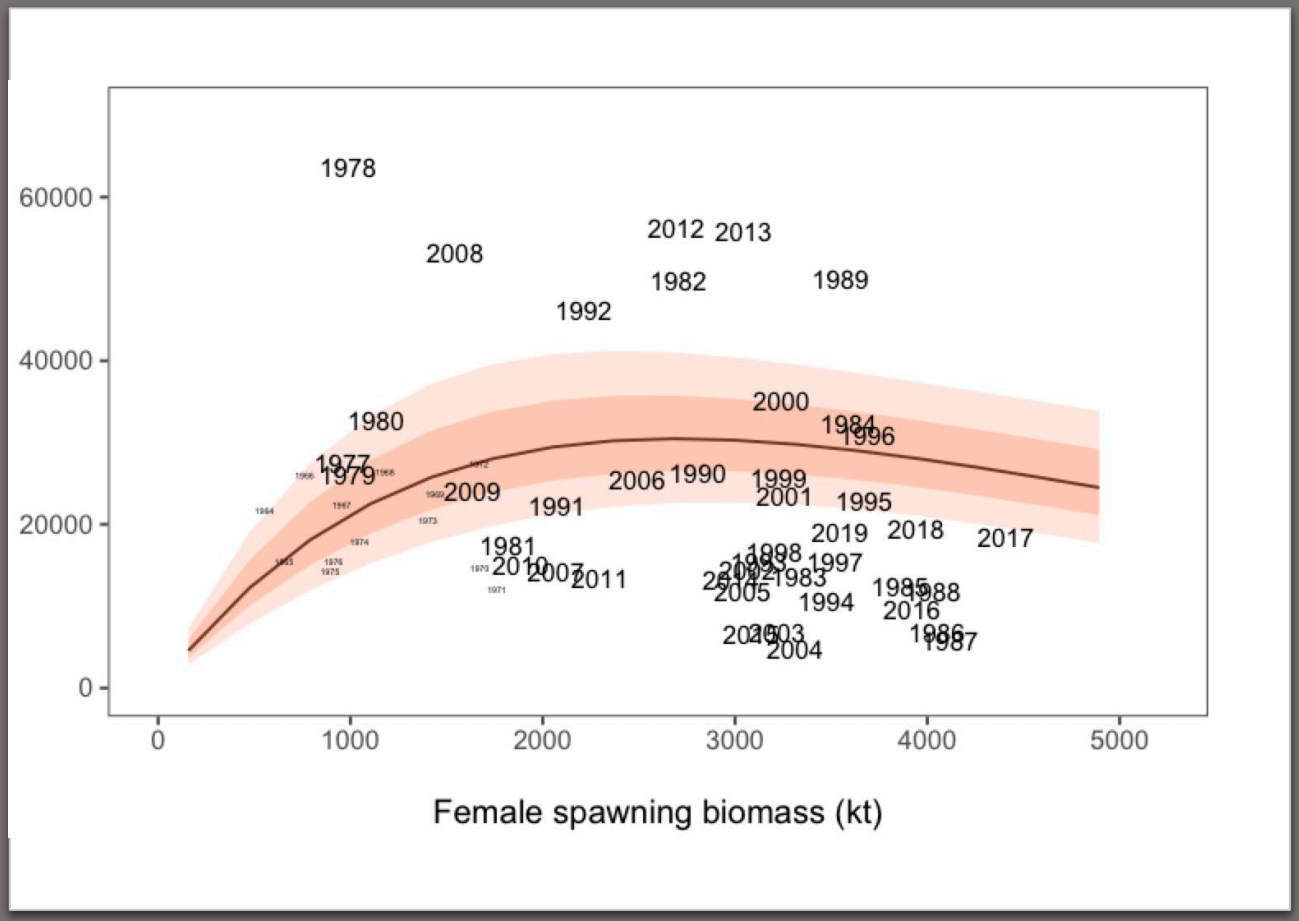
BSAI FMP Tiers…



EBS pollock
Assessment
Results




60000
40000
20000
0
0
1000
2000
3000
4000
5000
Female spawning biomass (kt)
1966
1968
1972
1964
1967
1969
1973
1974
1965
1976
1975
1970
1971


60000
40000
20000
0
0
1000
2000
3000
4000
5000
Female spawning biomass (kt)
1978
2012
2013
2008
1982
1989
1992
2000
1980
1984
1996
1977
1979
2006
1990
1999
2009
2001
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2016
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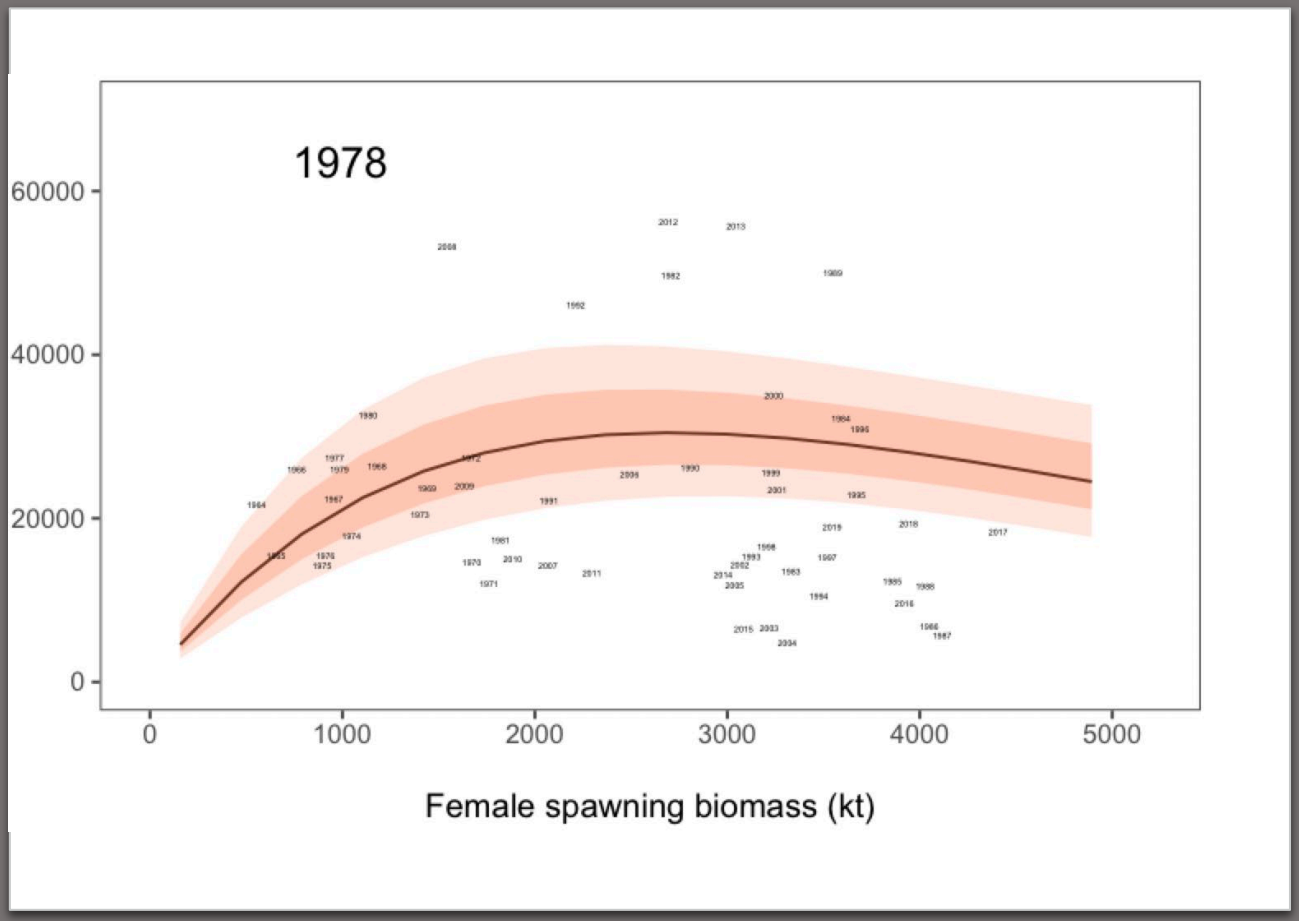
1987
2004


1978
60000
40000
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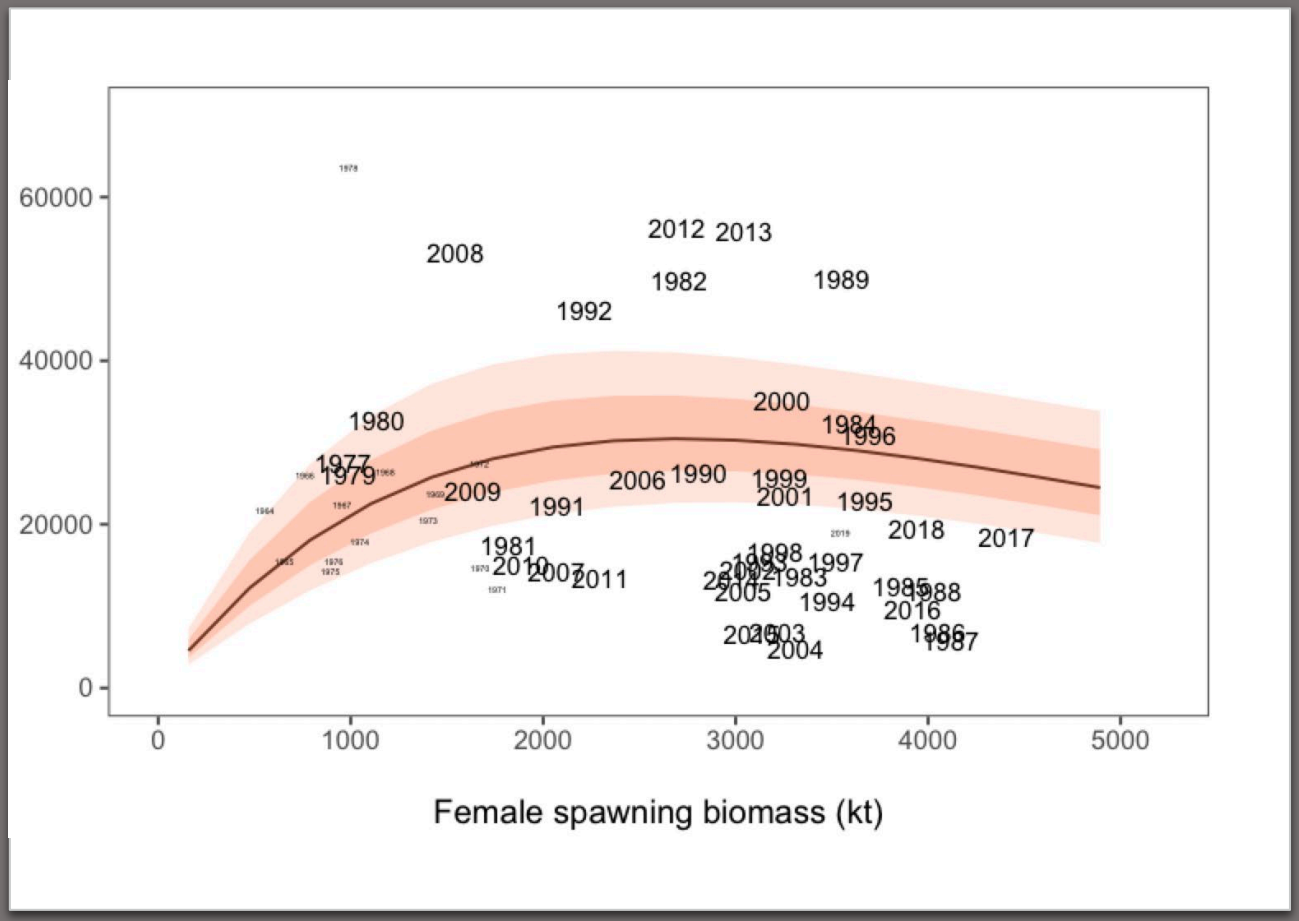
0
0
1000
2000
3000
4000
5000
Female spawning biomass (kt)


60000
40000
20000
0
0
1000
2000
3000
4000
5000
Female spawning biomass (kt)
2012
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2008
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1992
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1984
1996
1977
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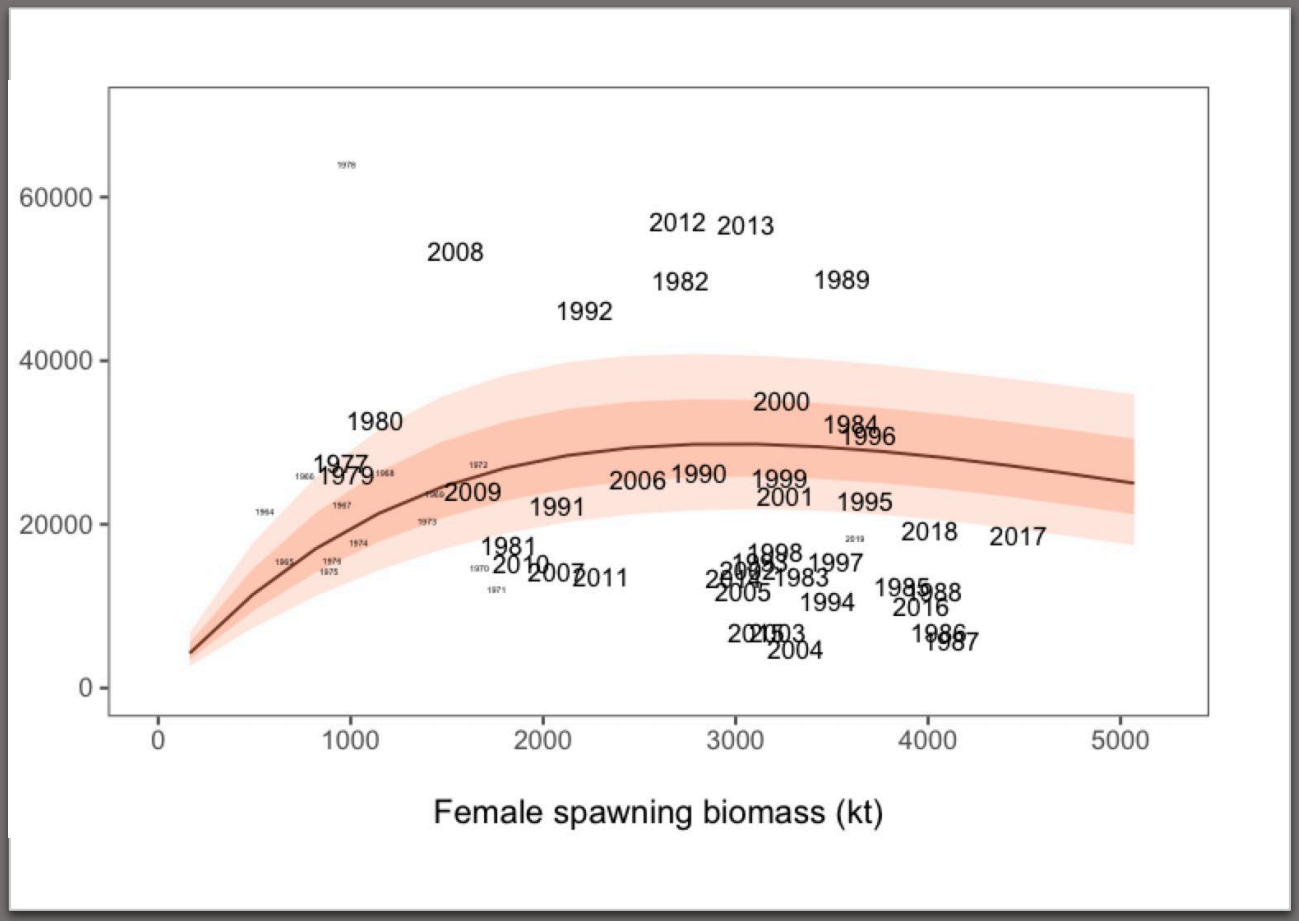
2004


60000
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Female spawning biomass (kt)
2012
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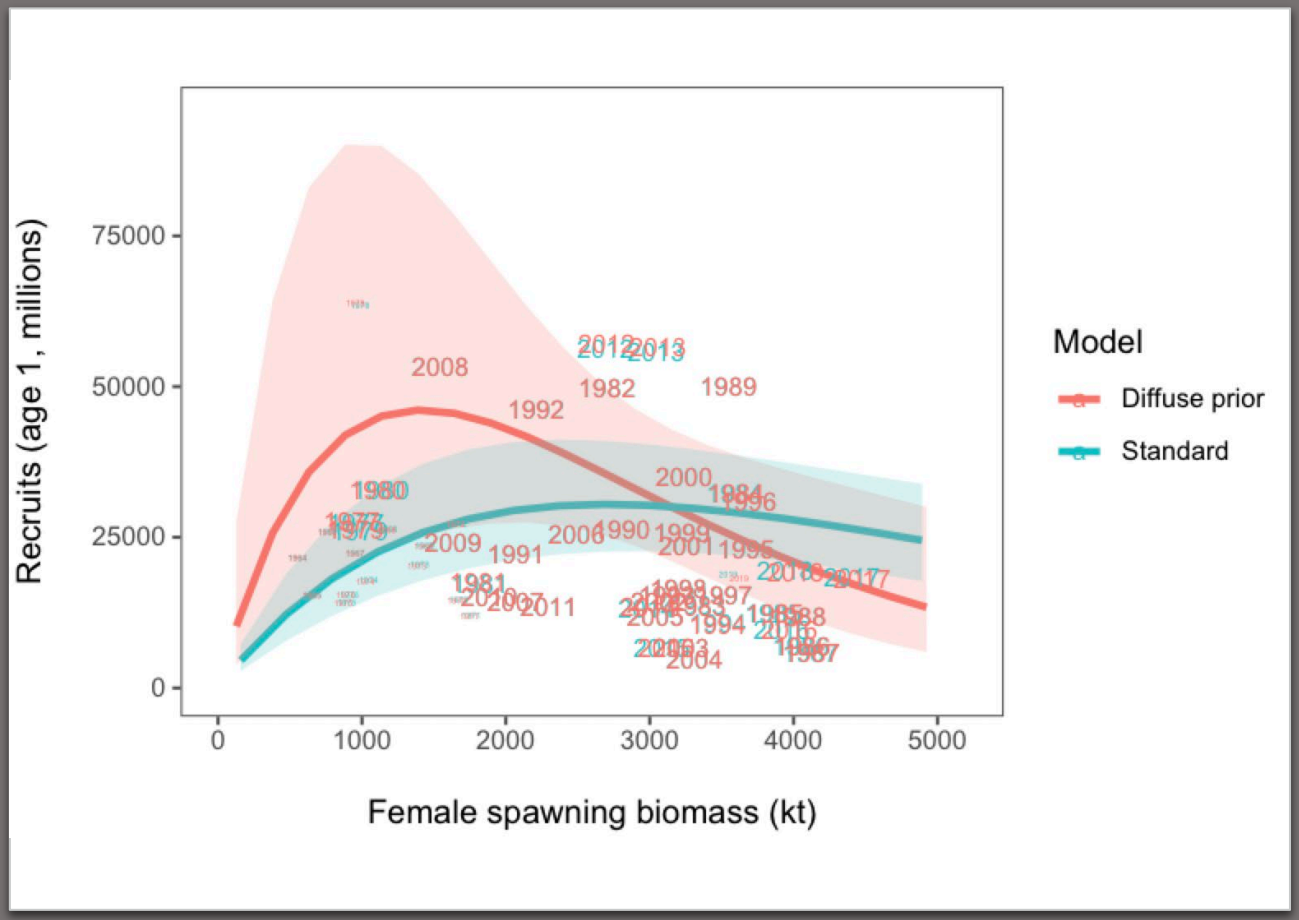
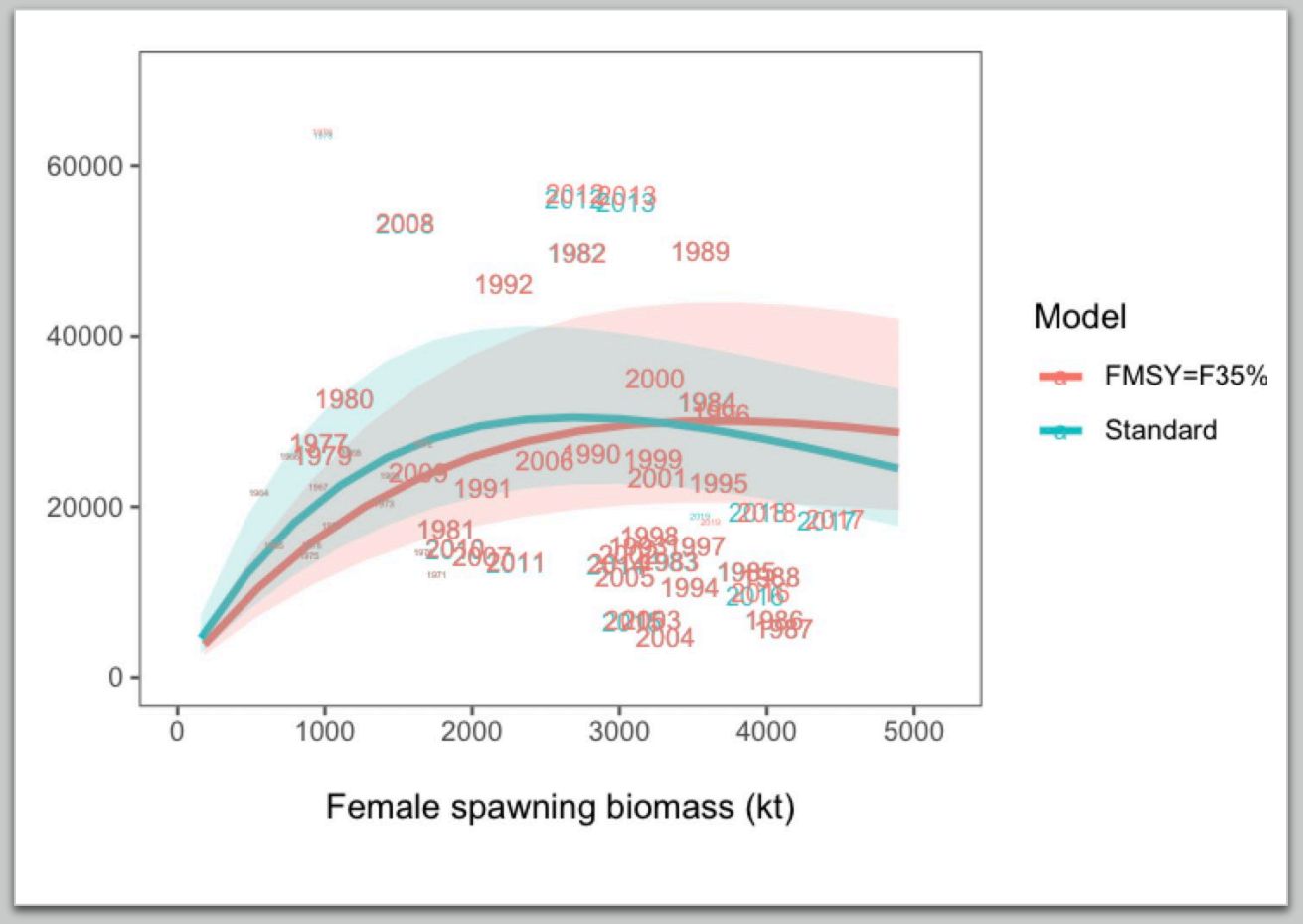


Relaxing assumptions…

“Tier 3” Stock-recruit relationship



Factors for reducing ABC

	Considerations			
	Assessment-related	**Population dynamics**	**Environmental & ecosystem**	Fishery performance
Level 1 Normal	Typical to moderately increased uncertainty & minor unresolved issues in assessment	Stock trends are typical for the stock; recent recruitment is within normal range.	No apparent environmental & ecosystem concerns	No apparent fishery/resource-use performance and/or behavior concerns
Level 2 Substantially increased concerns	Substantially increased assessment uncertainty unresolved issues.	Stock trends are unusual; abundance increasing or decreasing faster than has been seen recently, or recruitment pattern is atypical.	Some indicators showing an adverse signals but the pattern is inconsistent across all indicators.	Some indicators showing adverse signals but the pattern is inconsistent across all indicators.
Level 3 Major Concern	Major problems with the stock assessment, very poor fits to data, high level of uncertainty, strong retrospective bias.	Stock trends are highly unusual; very rapid changes in stock abundance, or highly atypical recruitment patterns.	Multiple indicators showing consistent adverse signals a) across the same trophic level, and/or b) up or down trophic levels (i.e., predators and prey of stock)	Multiple indicators showing consistent adverse signals a) across different sectors, and/or b) different gear types
Level 4 Extreme concern	Severe problems with the stock assessment, severe retrospective bias. Assessment considered unreliable.	Stock trends are unprecedented. More rapid changes in stock abundance than have ever been seen previously, or a very long stretch of poor recruitment compared to previous patterns.	Extreme anomalies in multiple ecosystem indicators that are highly likely to impact the stock. Potential for cascading effects on other ecosystem components	Extreme anomalies in multiple performance indicators that are highly like to impact the stock.

Summary for Environmental/Ecosystem considerations

- The eastern Bering Sea returned to near-normal climatic conditions in 2020;
- Sea ice extent exceeded the historical median in parts of February and March 2020;
- Ice thickness was low and retreated quickly in spring 2020;
- The spatial extent of the cold pool was average;
- The eastern Bering Sea is experiencing a persistent warm stanza, greater in both magnitude and duration than that of the early 2000s;
- The 2019 year class experienced unfavorable temperature conditions from age-0 to age-1 and is predicted to have below-average recruitment to age-4 in 2023.
- Winter 2019/2020 had an average wind speed direction (north/south) near the long-term average;
- The 2020 springtime drift pattern was mixed indicating larvae may have been retained over the southern middle shelf;
- The spring bloom over the southern shelf occurred about a week earlier than the long-term mean;
- Chlorophyll concentrations over the southern shelf have been below the long-term mean since 2016;
- Low abundance of large copepods during late-summer in 2017-2019 indicate poor overwinter survival and recruitment to age-3 in 2020-2022;
- Condition (weighted length-weight residuals) of juvenile pollock (100-250 mm TL) in 2019 was at the long-term mean indicating moderate foraging conditions;
- Condition of adult pollock (>250 mm TL) in 2019 was above-average indicating good foraging conditions (including cannibalism of juvenile pollock);
- Predation pressure from cannibalism may have been mitigated by the average spatial extent of the cold pool (i.e., thermal barrier);
- The decoupling of abundance timeseries for Pacific cod and walleye pollock suggests a shift in drivers of survival in these two populations and may indicate broad-scale transitions in the ecosystem (e.g., from pelagic- to benthic-dominated production);
- The widespread die-off event of short-tailed shearwaters slowed in 2020 and may reflect better feeding conditions (i.e., euphausiids) over the shelf in 2019.

Risk table

- Ecosystem and fishery performance score of 2

Considerations			
Assessment-related	Population dynamics	Environmental or ecosystem	Fisheries
Level 1: No concern	Level 1: No concern	Level 2: Substantially increased concerns	Level 2: Substantially increased concerns

Table 47: Details and explanation of the decision table factors selected in response to the Plan Team requests (as originally proposed in the 2012 assessment).

Term	Description	Rationale
$P\left[F_{2021} > F_{MSY}\right]$	Probability that the fishing mortality in 2021 exceeds F_{MSY}	OFL definition is based on F_{MSY}
$P\left[B_{2022} < B_{MSY}\right]$	Probability that the spawning biomass in 2022 is less than B_{MSY}	B_{MSY} is a reference point target and biomass in 2021 provides an indication of the impact of 2021 fishing
$P\left[B_{2023} < B_{MSY}\right]$	Probability that the spawning biomass in 2023 is less than B_{MSY}	B_{MSY} is a reference point target and biomass in 2023 provides an indication of the impact of fishing in 2021 and 2022
$P\left[B_{2023} < \bar{B}\right]$	Probability that the spawning biomass in 2022 is less than the 1978–2020 mean	To provide some perspective of what the stock condition might be relative to historical estimates after fishing in 2021.
$P\left[B_{2025} < \bar{B}\right]$	Probability that the spawning biomass in 2025 is less than the long term mean	To provide some perspective of what the stock condition might be relative to historical estimates after fishing in 2021.
$P\left[B_{2025} < B_{2021}\right]$	Probability that the spawning biomass in 2025 is less than that estimated for 2021	To provide a medium term expectation of stock status relative to 2021 levels
$P\left[B_{2023} < B_{20\%}\right]$	Probability that the spawning biomass in 2023 is less than $B_{20\%}$	$B_{20\%}$ had been selected as a Steller Sea Lion lower limit for allowing directed fishing
$P\left[p_{a_5,2023} > \bar{p}_{a_5}\right]$	Probability that in 2023 the proportion of age 1–5 pollock in the population exceeds the long-term mean	To provide some relative indication of the age composition of the population relative to the long term mean.
$P\left[D_{2022} < D_{1994}\right]$	Probability that the diversity of ages represented in the spawning biomass (by weight) in 2022 is less than the value estimated for 1994	To provide a relative index on the abundance of different age classes in the 2022 population relative to 1994 (a year identified as having low age composition diversity)
$P\left[D_{2025} < D_{1994}\right]$	Probability that the diversity of ages represented in the spawning biomass (by weight) in 2025 is less than the value estimated for 1994	To provide a medium-term relative index on the abundance of different age classes in the population relative to 1994 (a year identified as having low age composition diversity)
$P\left[E_{2021} > E_{2020}\right]$	Probability that the theoretical fishing effort in 2021 will be greater than that estimated in 2020.	To provide the relative effort that is expected (and hence some idea of costs).

- Decision table explanation

(Table 47)

Decision table diagnostics included

Table 48: Outcomes of decision (expressed as chances out of 100) given different 2021 catches (first row, in kt). Note that for the 2018 and later year-classes average values were assumed. Constant Fs based on the 2021 catches were used for subsequent years.

	10	850	1000	1150	1350	1300	1450	1600
$P\left[F_{2021} > F_{MSY}\right]$	0	1	5	13	29	25	36	47
$P\left[B_{2022} < B_{MSY}\right]$	14	28	32	35	41	39	44	48
$P\left[B_{2023} < B_{MSY}\right]$	8	23	27	32	39	37	43	49
$P\left[B_{2022} < \bar{B}\right]$	34	84	89	93	96	96	97	98
$P\left[B_{2025} < \bar{B}\right]$	4	28	35	41	50	48	54	60
$P\left[B_{2025} < B_{2021}\right]$	3	19	23	28	34	33	38	42
$P\left[B_{2023} < B_{20\%}\right]$	0	1	1	1	2	2	2	3
$P\left[p_{a_5,2023} > \bar{p}_{a_5}\right]$	20	66	72	76	81	80	83	85
$P\left[D_{2022} < D_{1994}\right]$	0	0	0	0	0	0	0	0
$P\left[D_{2025} < D_{1994}\right]$	0	4	5	8	12	11	14	19
$P\left[E_{2021} > E_{2020}\right]$	0	4	22	47	74	69	82	90

EBS pollock summary

- Outlook
  - Spawning biomass declining
    - From high levels
    - Fishing challenges ~~likely to~~ have increased
  - Recommend stabilization of effort
    - ***ABC > 1.2 million t means likely more effort than 2020***
  - Stock projected to drop below B_{msy} by 2021
    - could affect 2021 ABC (and TAC)