NOAA FISHERIES

Alaska Fisheries Science Center

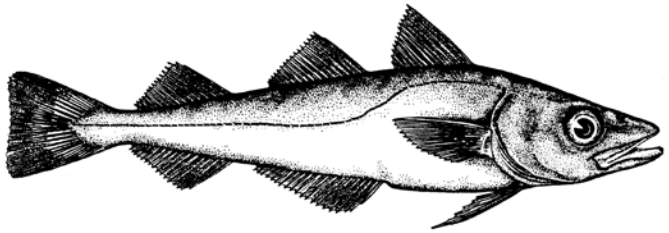
Gulf of Alaska pollock

Martin Dorn

Gulf of Alaska Plan Team meeting

Nov 17, 2020

Online Public Meeting



Gulf of Alaska pollock
Overview of assessment results

Changes to the assessment model

- None

Author's 2021 ABC 105,722 t

- Decrease of 3% from the 2020 ABC
- 2022 ABC decreases to ~91,000 t

•**Concerns:**

- Large drop in Shelikof Strait acoustic survey biomass
- Vanishing 2018 year class
- Generally more pessimistic short-term stock projections
- Will there be GOA assessment surveys in 2021?

•**Positives**:

- More diverse age structure in population
- Environmental conditions more typical in 2020 than previously

Plan Team and SSC comments

Responses to SSC and Plan Team Comments in General

SSC in its December 2019 minutes provided responses to ten specific inquiries regarding how to appropriately fill out the risk table and develop ABC recommendations using the table.

- In this assessment, we have again used the risk matrix table to evaluate stock assessment, population dynamics, ecosystem, and fishery performance concerns relevant to Gulf of Alaska pollock. We followed the SSC's helpful advice in evaluating concerns and developing ABC recommendations.

Responses to SSC and Plan Team Comments Specific to this Assessment

The GOA plan team in its November 2019 minutes recommended the author examine fishery selectivity, as persistent patterns in the catch-at-age residuals may represent artifacts of the selectivity functional form used.

- We did not do this in this assessment due to lack of time, but will plan to do so in future assessments.

Plan Team and SSC comments (continued)

Responses to SSC and Plan Team Comments Specific to this Assessment

The GOA plan team in its November 2019 minutes recommended the author ensures adequate fishery data is collected and available due to the observer program implementation of Electronic Monitoring.

- We worked with Julie Bonney and Ruth Christiansen, the leads for the Electronic Monitoring EFP, to ensure continued monitoring of the pollock fishery in the GOA. As usual in the first year of a major program, there have been some unanticipated difficulties, but the collection of biological information for pollock appears to be adequate for stock assessment needs.

The GOA plan team in its November 2019 minutes recommended the author explore better methods for constraining the time varying catchability parameter to be under 1 for the Shelikof Strait acoustic survey.

- We were unable to come up with a better way of constraining time-varying catchability to be less than one for the Shelikof Strait acoustic survey. There seemed to be less of a need of constrain catchability to be less than one given the decline in survey biomass in 2020.

Plan Team and SSC comments (continued)

Responses to SSC and Plan Team Comments Specific to this Assessment

The GOA plan team in its November 2019 minutes recommended an exploration of combining the acoustic summer survey and the GOA bottom trawl survey using a VAST framework, similar to the approach used by Cole Monahan for EBS pollock surveys.

- We explored models that used VAST estimates in place of area-swept biomass estimates for the NMFS bottom trawl survey. The VAST estimates did not fit as well as the area-swept estimates when given similar weighting, and we concluded that additional model evaluation was needed before using the VAST estimates. Methods for analyzing acoustic data using VAST are under development for the Shelikof Strait and the summer acoustic survey. Methods to combine both acoustic and bottom trawl surveys are long-term research objective.

The GOA plan team in its November 2018 minutes recommended investigating model behavior sensitivity to abundance indices by incrementally dropping survey indexes to clarify how the data affect the model(s).

- We did not do this in this assessment due to lack of time, but will plan to do so in future assessments. We have done this exercise in several previous assessments, so we feel we have a good understanding of model sensitivity to different surveys.

Plan Team and SSC comments (continued)

Responses to SSC and Plan Team Comments Specific to this Assessment

The SSC in its December 2019 minutes supported including GOA pollock in the ongoing genetic studies to better understand the relationship between pollock in the NBS and EBS, specifically to evaluate support for continued separation of SE outside waters in the OFL specifications.

- A whole genome sequencing project is underway for pollock throughout its range in Alaska waters. This study will provide a critical baseline for future studies of genetic differentiation and adaptation.

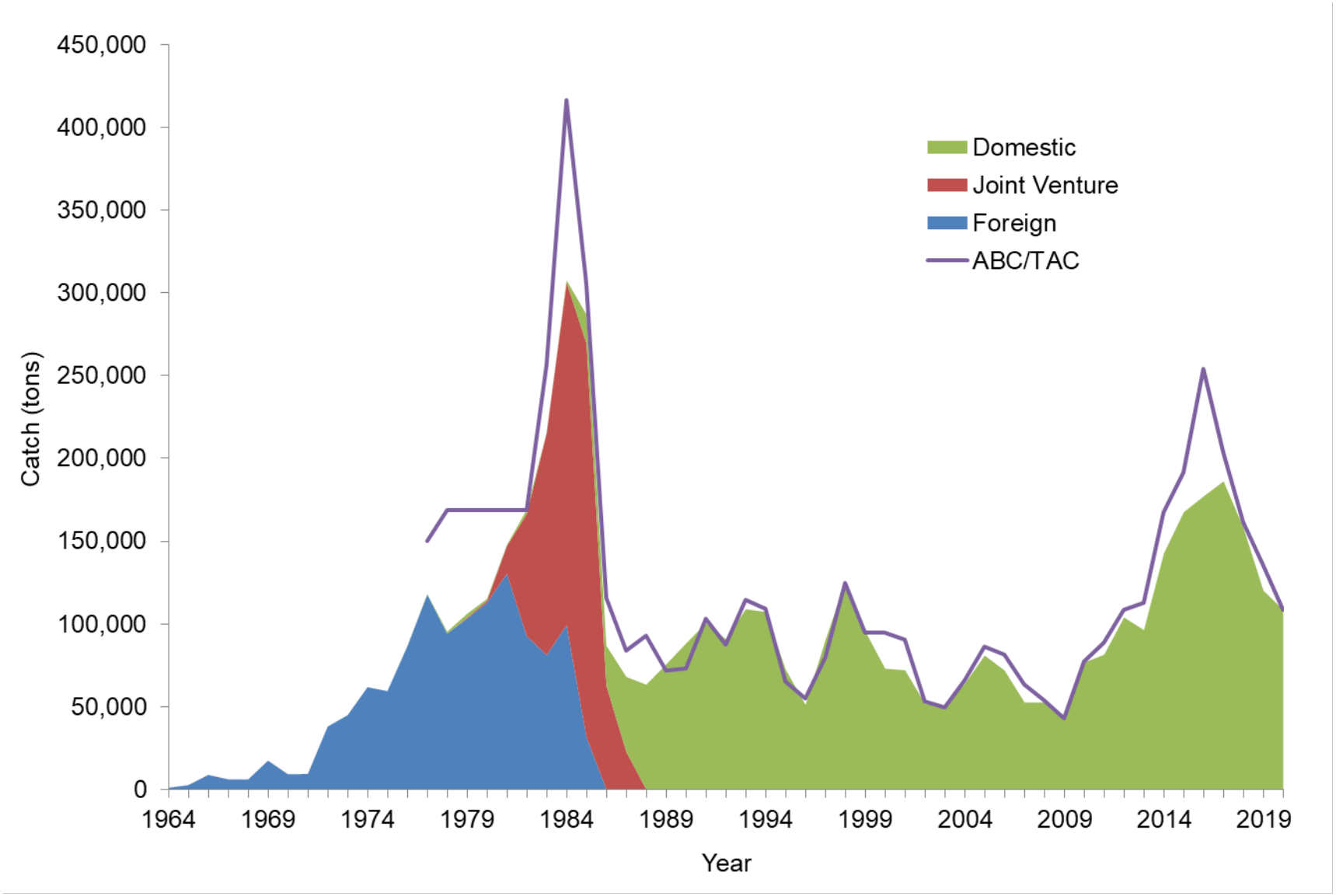
The GOA plan team in its November 2019 minutes recommended a re-analysis of maturity at length and age be made for individual cohorts, which would prevent poor estimates for years where age and size diversity is low, such as 2004 and 2017.

- A draft analysis estimates the proportion mature by length and age for individual cohorts was developed in response to this recommendation.

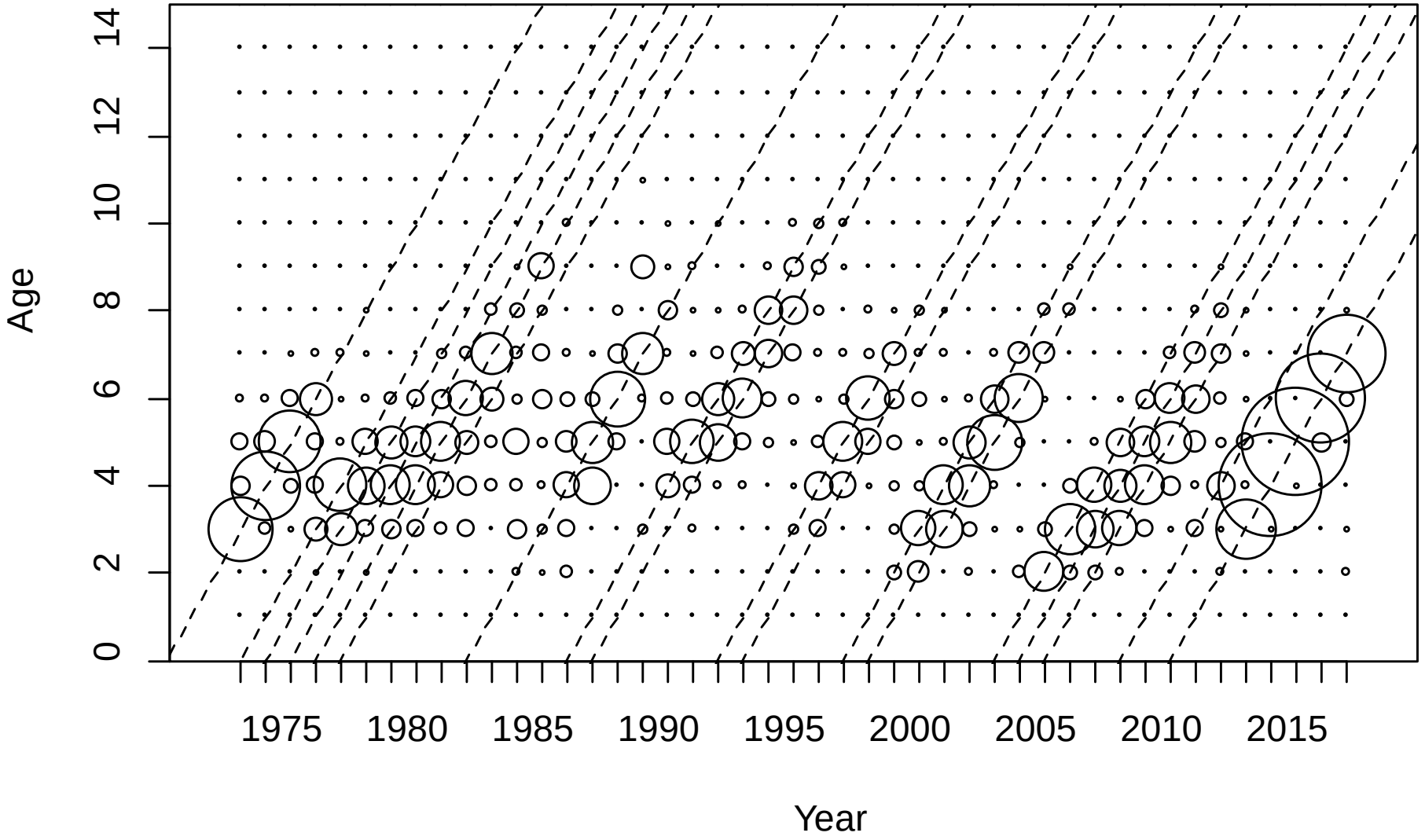
Data used in the assessment

Source	Data	Years
Fishery	Total catch	1970-2019
Fishery	Age composition	1975-2019
Shelikof Strait acoustic survey	Biomass	1992-2020
Shelikof Strait acoustic survey	Age composition	1992-2020
Summer acoustic survey	Biomass	2013-2019
Summer acoustic survey	Age composition	2013-2019
NMFS bottom trawl survey	Area-swept biomass	1990-2019
NMFS bottom trawl survey	Age composition	1990-2019
ADF&G trawl survey	Delta-GLM index	1988-2020
ADF&G survey	Age composition	2000-2018

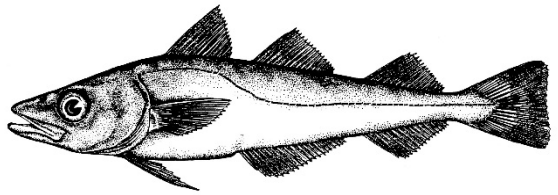
Total catch 1970-2019



Catch at age, 1975-2019



Gulf of Alaska pollock
Overview: Surveys

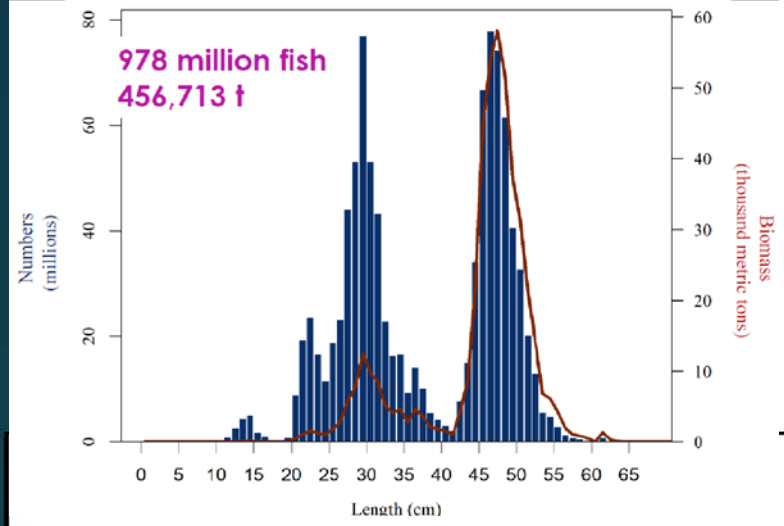


- **2020 is “off” on year for surveys in the GOA. Additional winter acoustic surveys had been planned, many were cancelled due Oscar Dyson scheduling issues.**

- **Important: there was no loss of survey or fishery information for GOA pollock due to the COVID-19 pandemic**

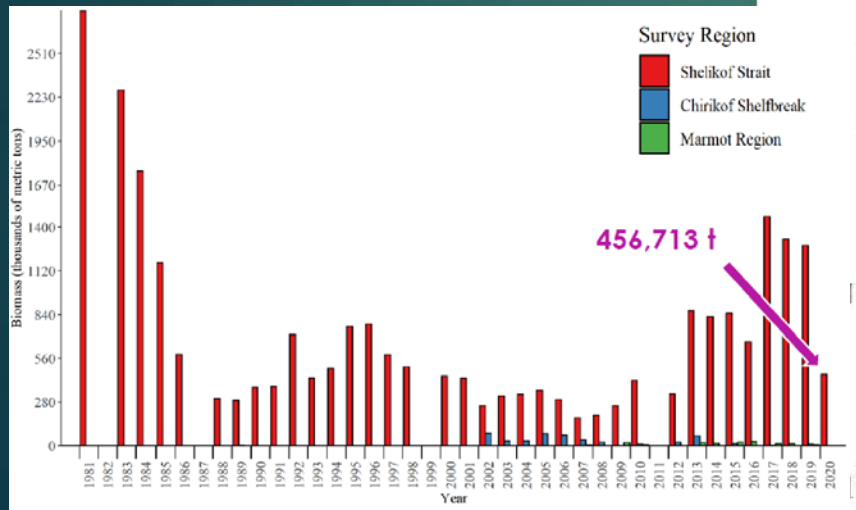
- **2020 Shelikof Strait acoustic survey biomass is 0.456 million t**
  –64% decrease from 2019 (but not far from long term average).

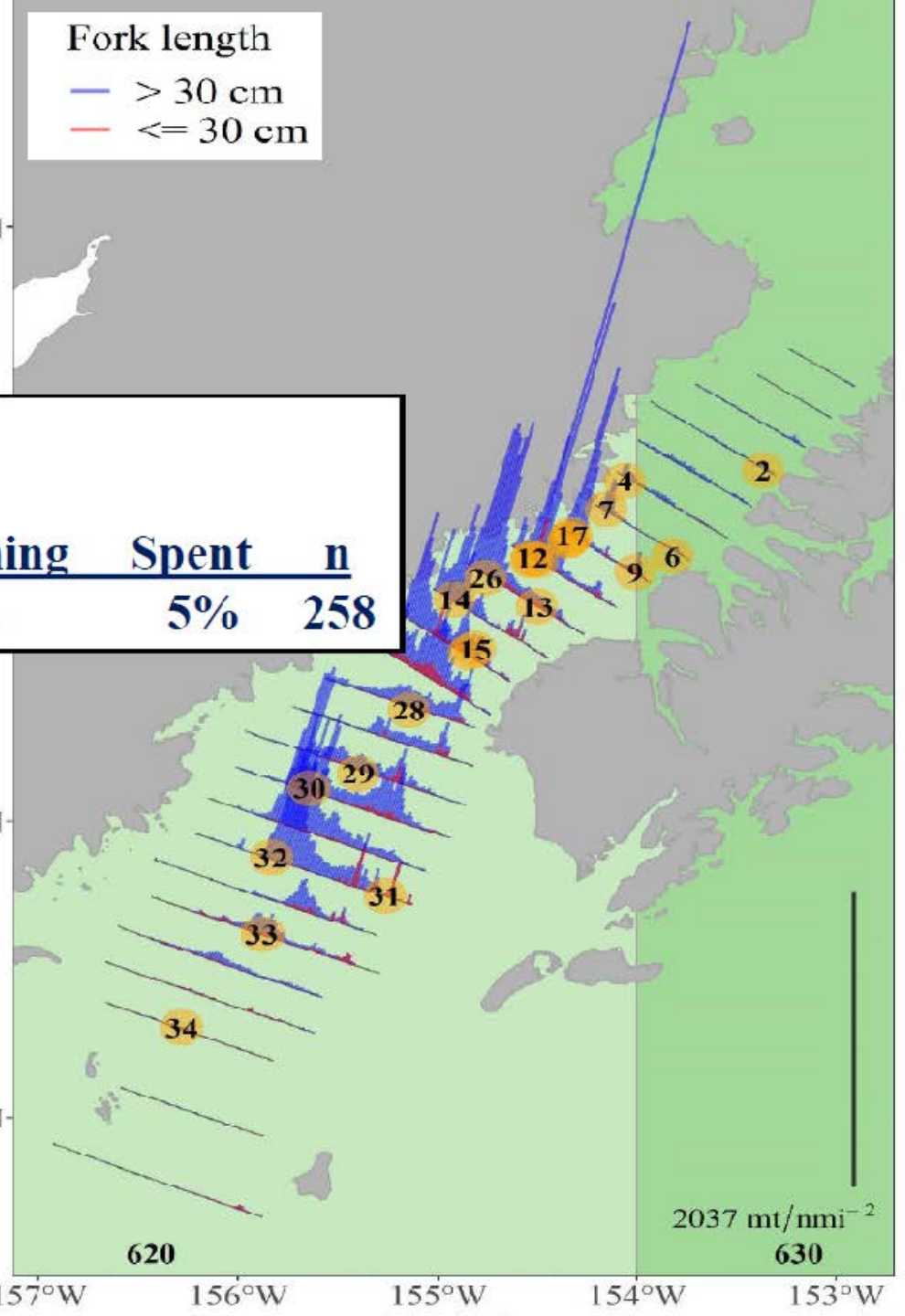
- **2020 ADFG survey biomass is 60,000 t**
  –16.5% increase from 2019



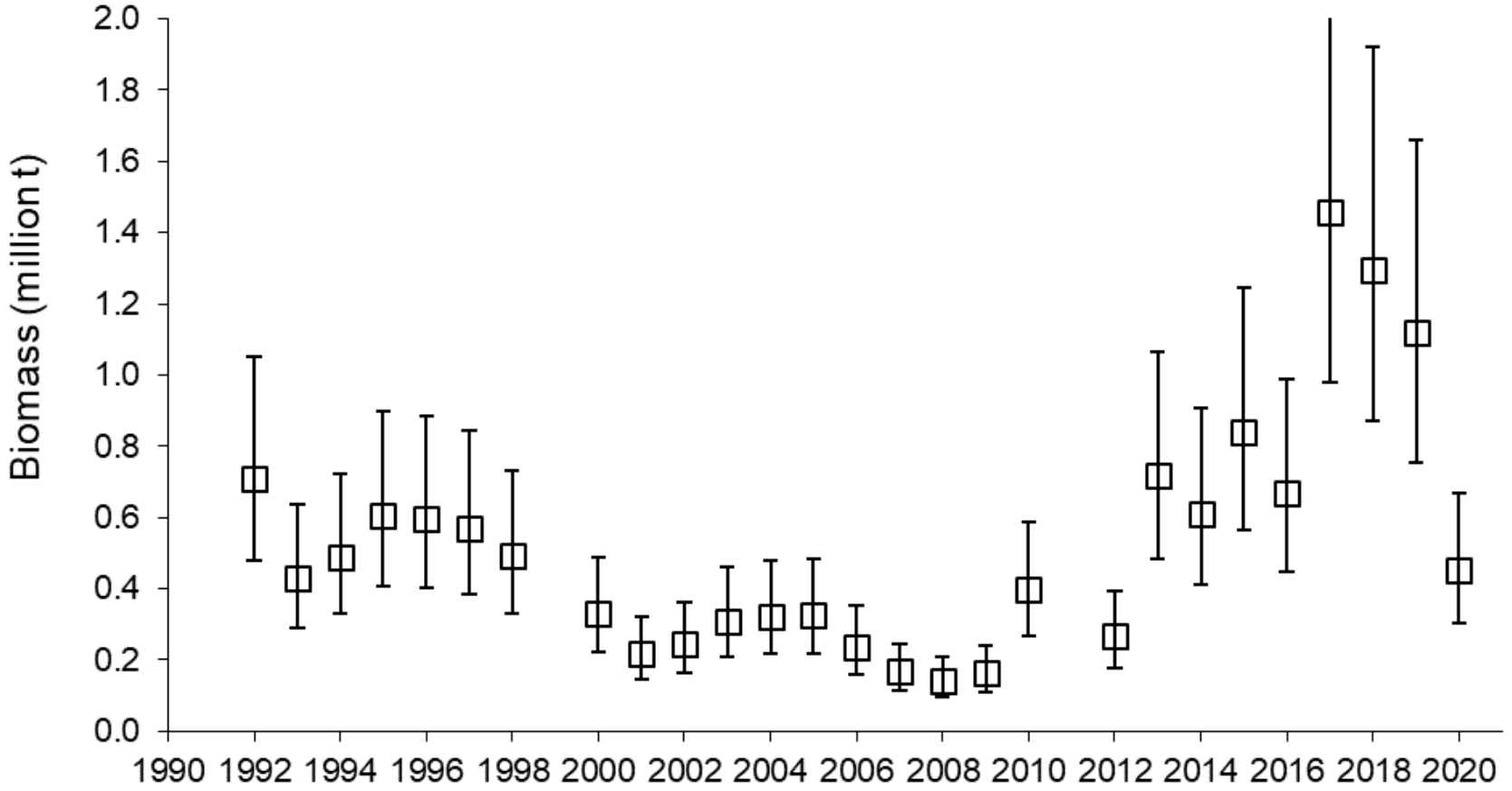
	Prespawning	Spawning	Spent	n
Shelikof	88%	1%	5%	258

2020 Shelikof Strait acoustic survey

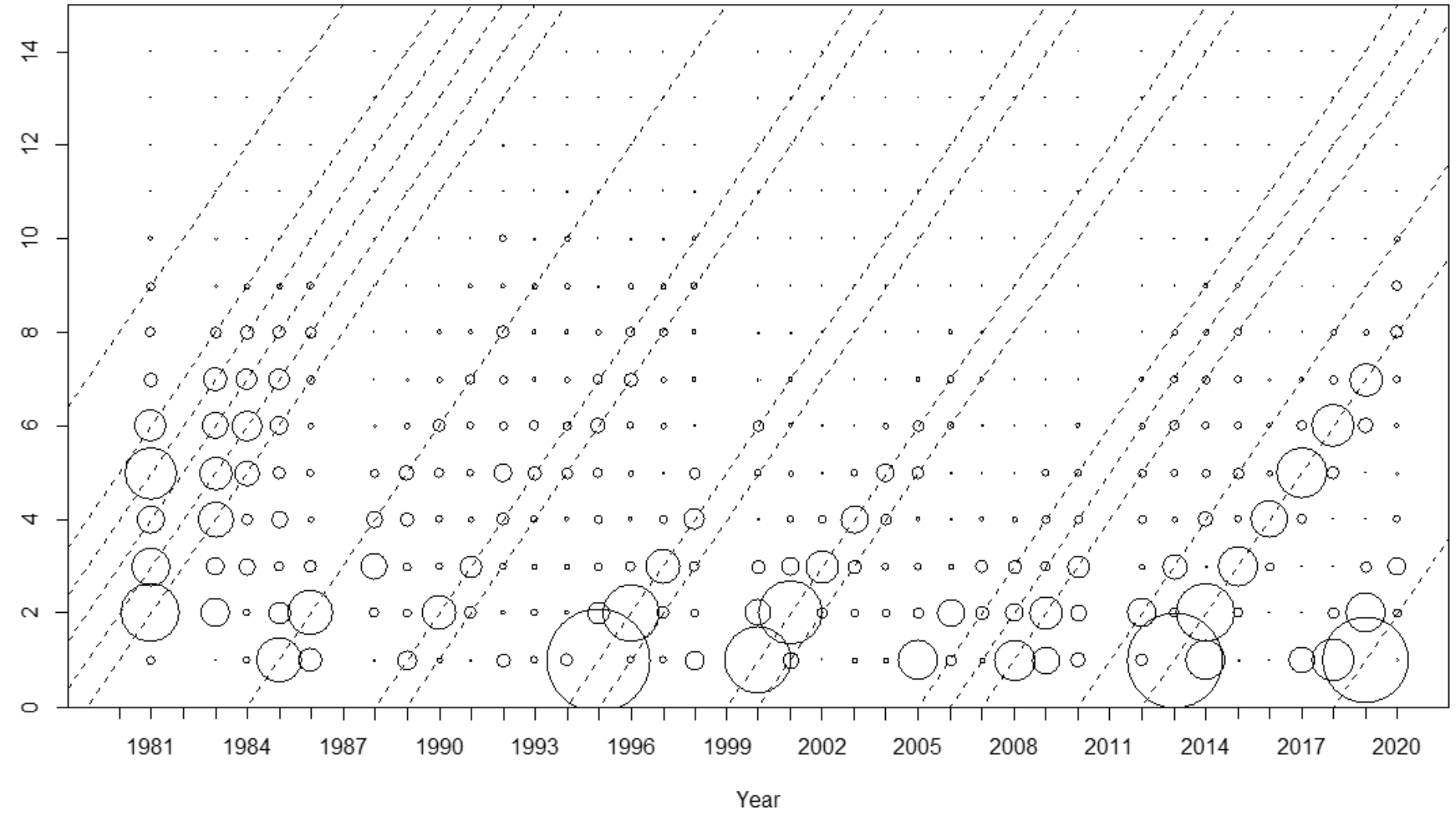




Shelikof Strait acoustic survey, 1992-2020



Shelikof Strait survey age comp, 1992-2020



Spawn timing and availability of pollock to the winter Shelikof Strait survey

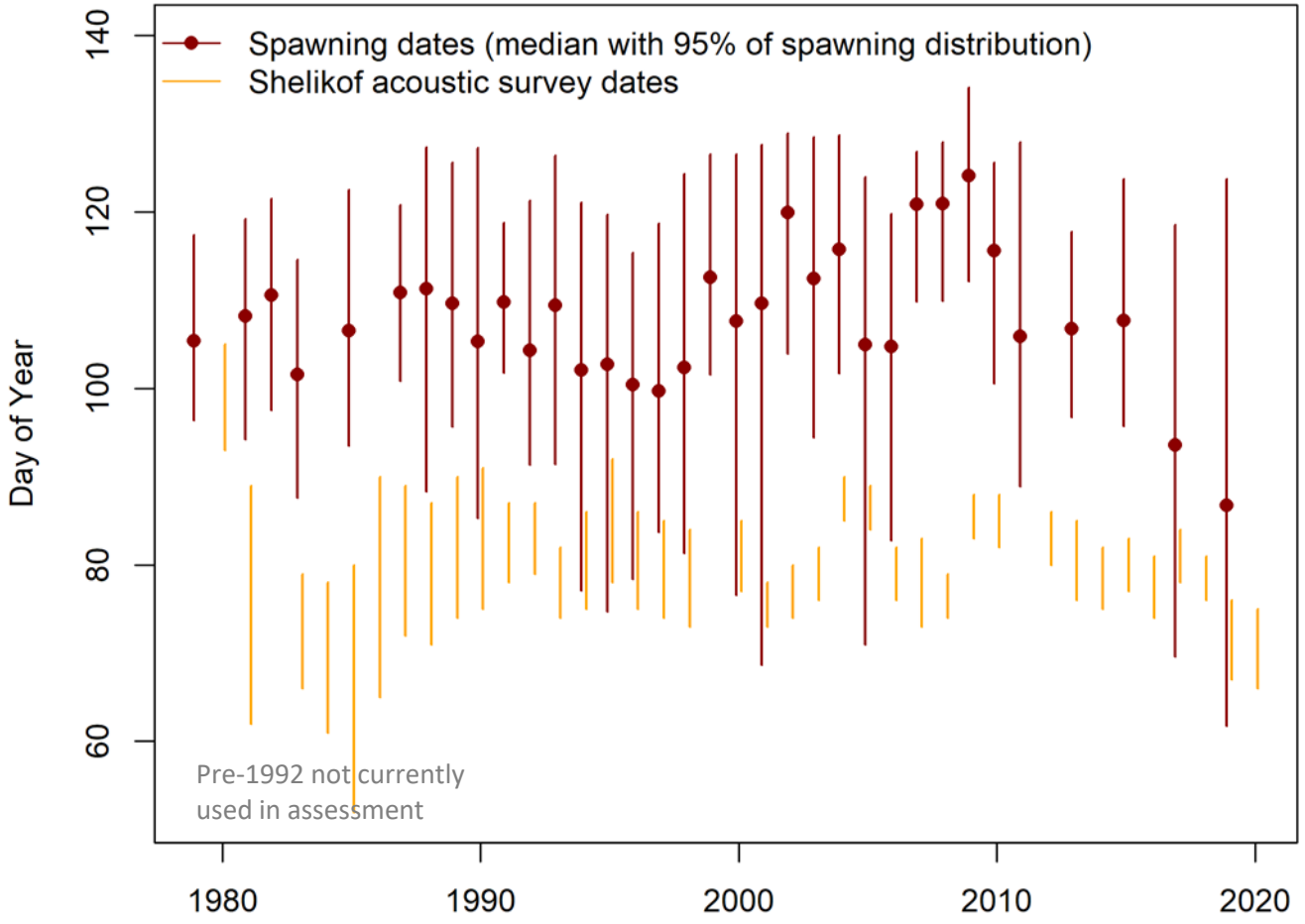
- Analysis of larval pollock showed spawn timing varies year to year by up to ~4 weeks.
- Spawning occurs earlier when temperatures are warmer and the spawning stock is older.

Questions:

- How do changes in survey timing relative to spawn timing affect availability of pollock to the winter Shelikof survey?
- What is the expectation for 2020 in terms of relative availability of pollock to the survey (based on timing)?

Rogers and Dougherty (2019) *Global Change Biology*

Survey timing and estimated spawn timing



Spawning dates from Rogers and Dougherty 2019 (with 2017 & 2019 added). Reconstructed from EcoFOCI larval surveys.

Survey dates from Darin Jones, MACE. Shows only the survey passes which were used for the biomass estimate in the stock assessment.

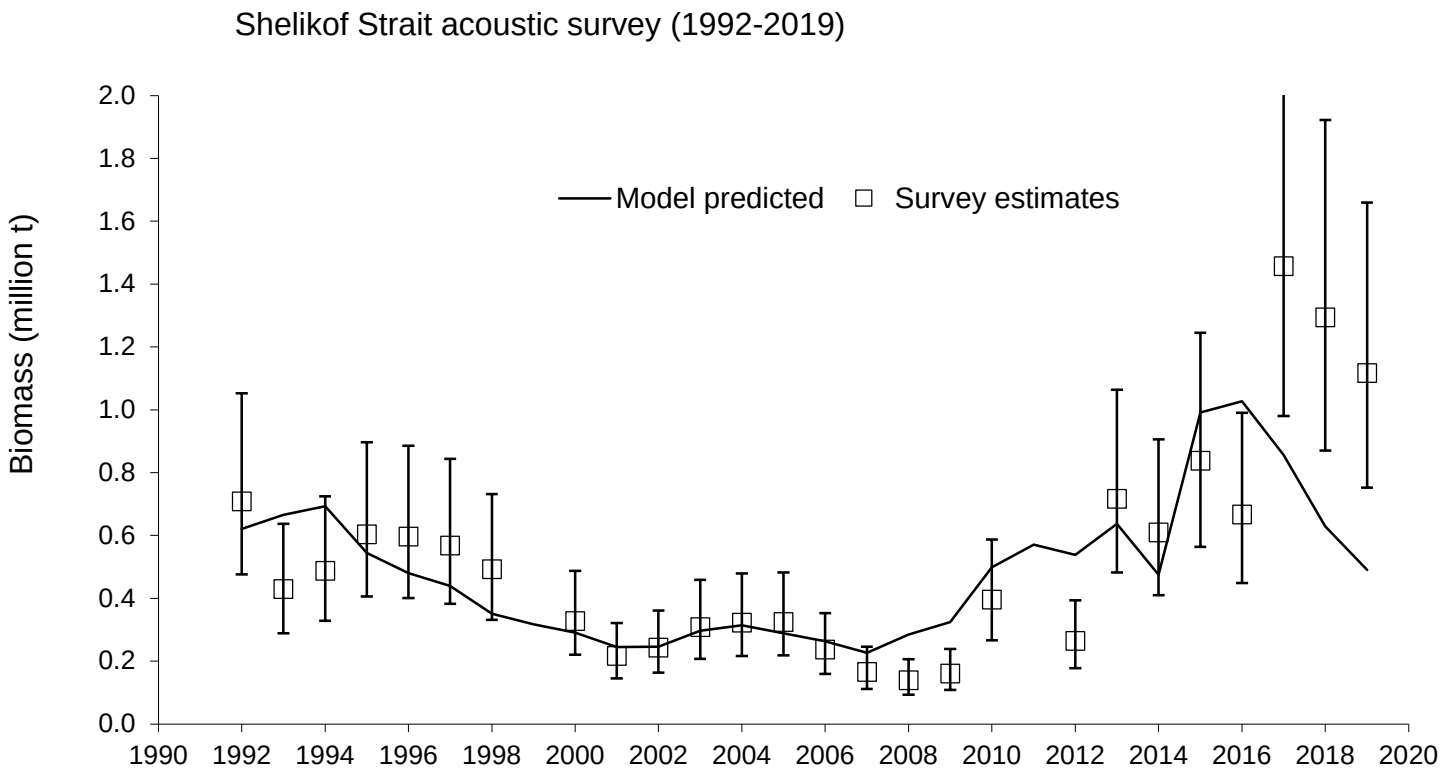
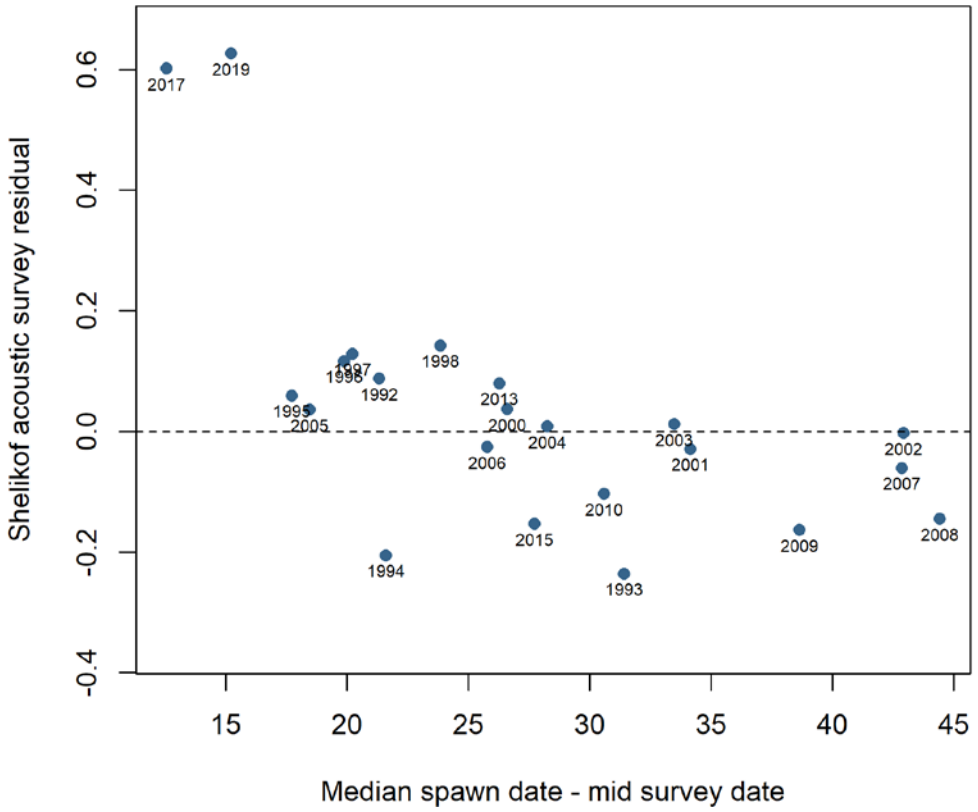


Figure from 2019 stock assessment

Residuals from model-predicted survey biomass versus actual survey estimates were used as an indicator of potential changes in pollock availability to the Shelikof survey.

Spawn timing and availability of pollock to the winter Shelikof Strait survey

Survey estimates tend to be high relative to the model (positive residuals) in years when the survey is closer in timing (i.e. later) relative to peak spawning.



Spawn timing and availability of pollock to the winter Shelikof Strait survey

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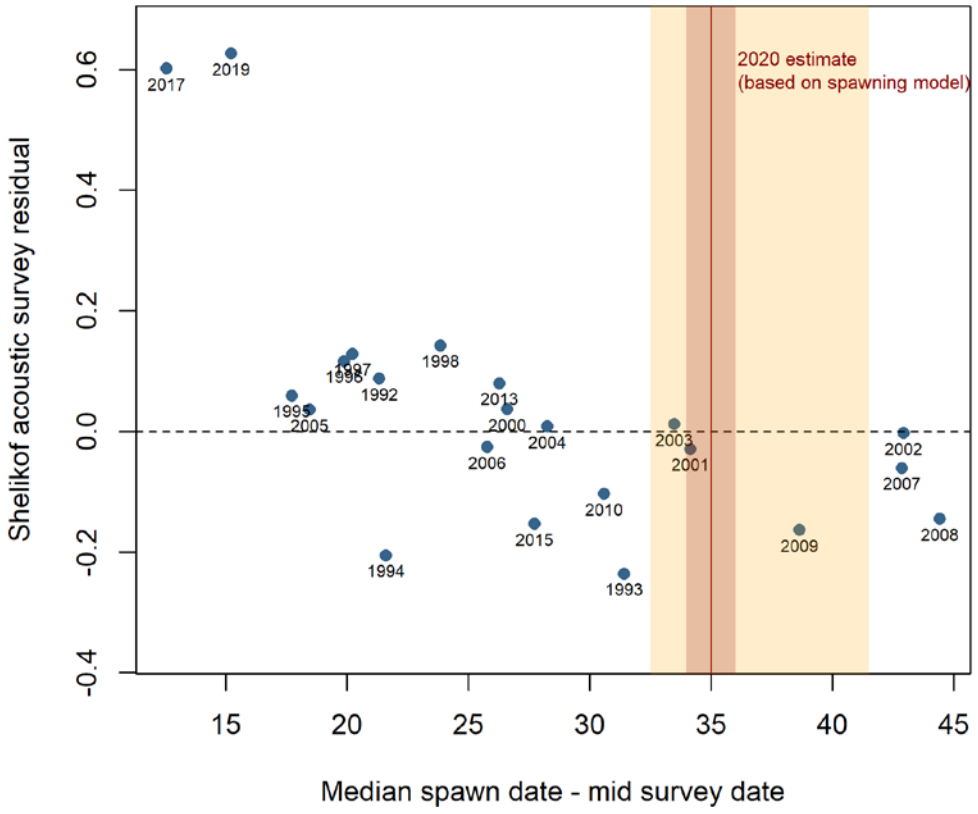
2020: No larval survey. Estimate of timing mismatch is predicted based on the best (red line) and top six supported (yellow) models of spawn timing using thermal conditions and spawner age.

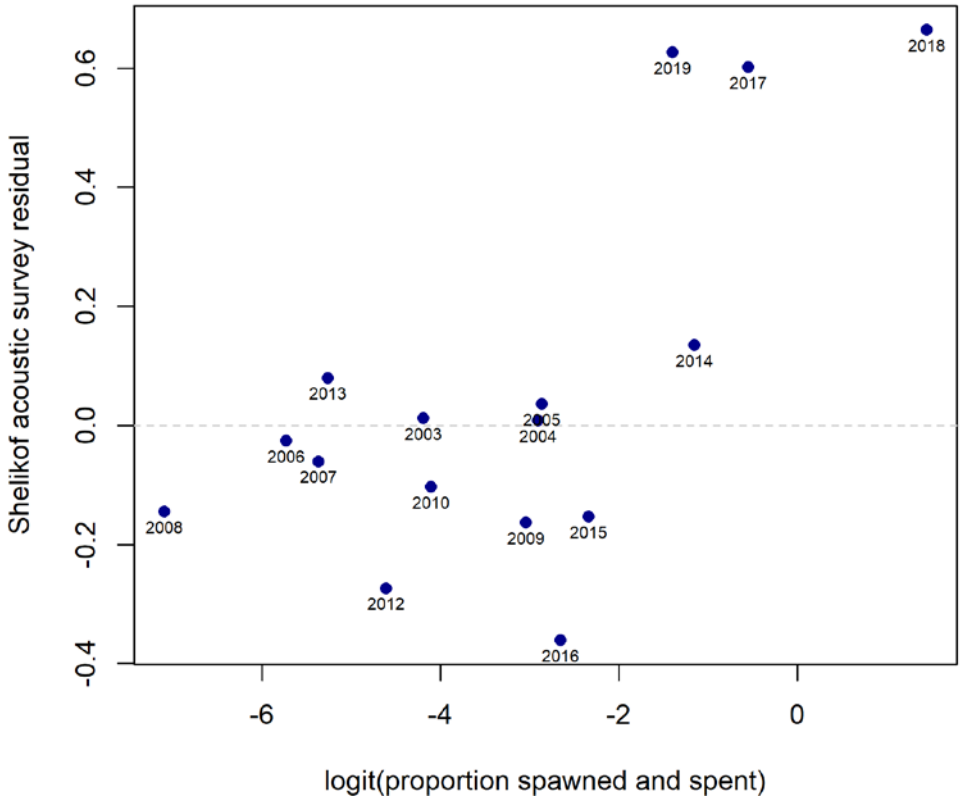
Suggests 2020 survey was relatively early compared to spawning. Biomass estimate may be low to average relative to other data sources.



Spawning/spent females as an indicator of survey vs spawn timing

Proportion of females (>30cm) in spawning or spent stages during the acoustic surveys is used to assess the relative timing of the survey.

Historically, biomass estimate has been high relative to model when more females are spawning or spent during survey.



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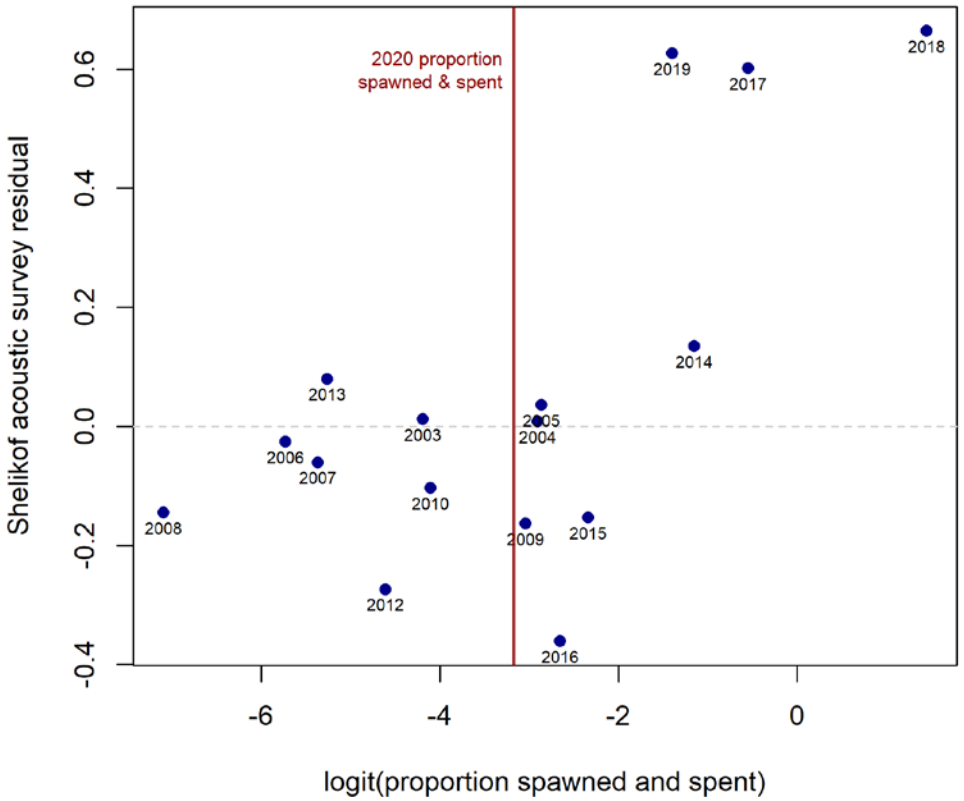
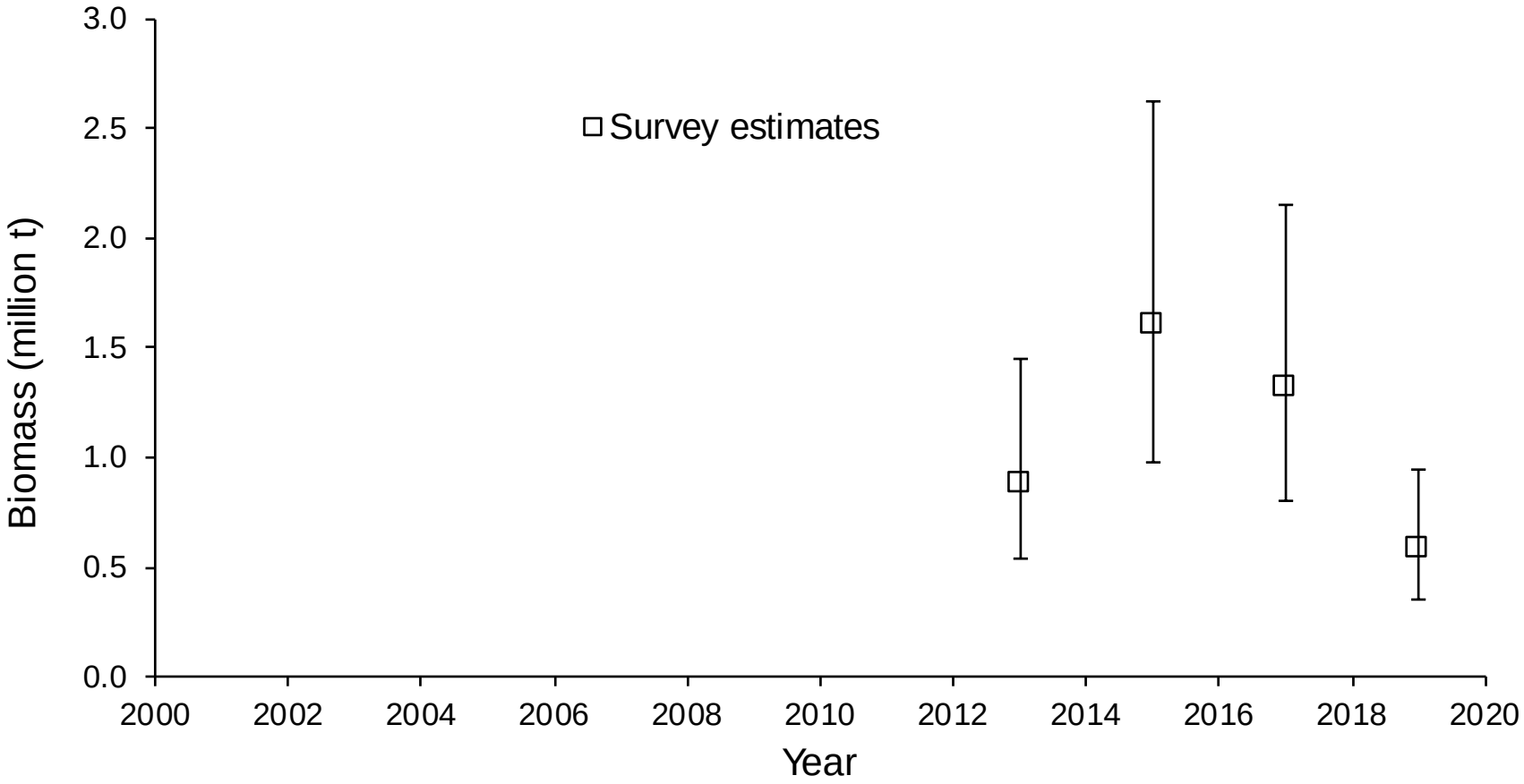
Historically, biomass estimate has been high relative to model when more females are spawning or spent during survey.

2020: Proportion spawning or spent was approx average.

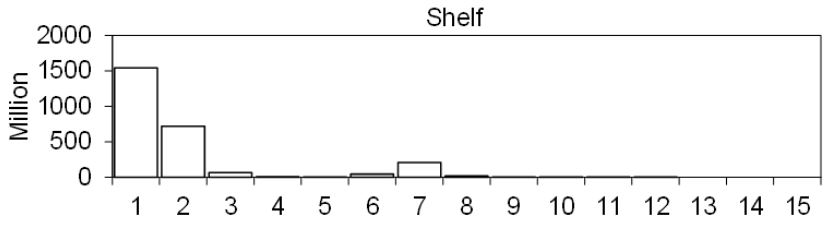


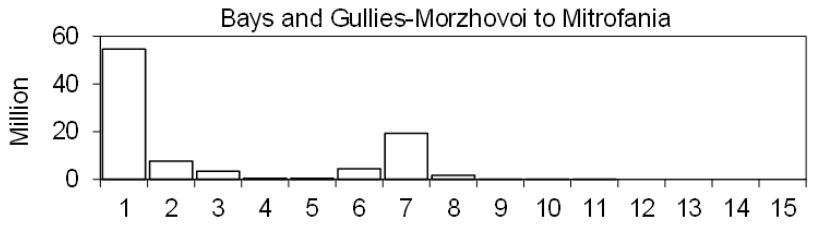
Together, indicators of spawn timing relative to survey timing suggest the Shelikof survey biomass estimate in 2020 is likely to be low to average (relative to true stock biomass), in contrast to the previous 3 years.

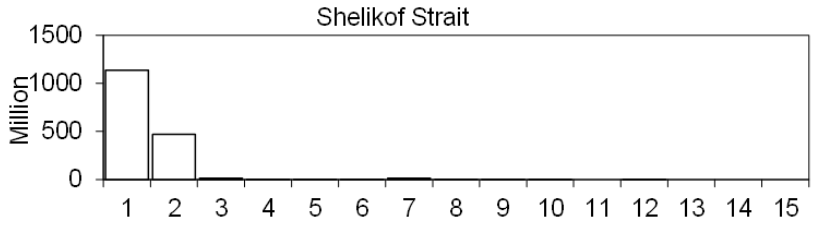
Summer acoustic survey, 2013-2019

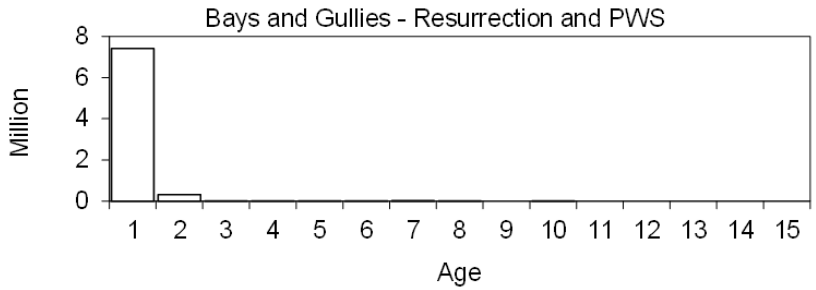


2019 Summer acoustic survey

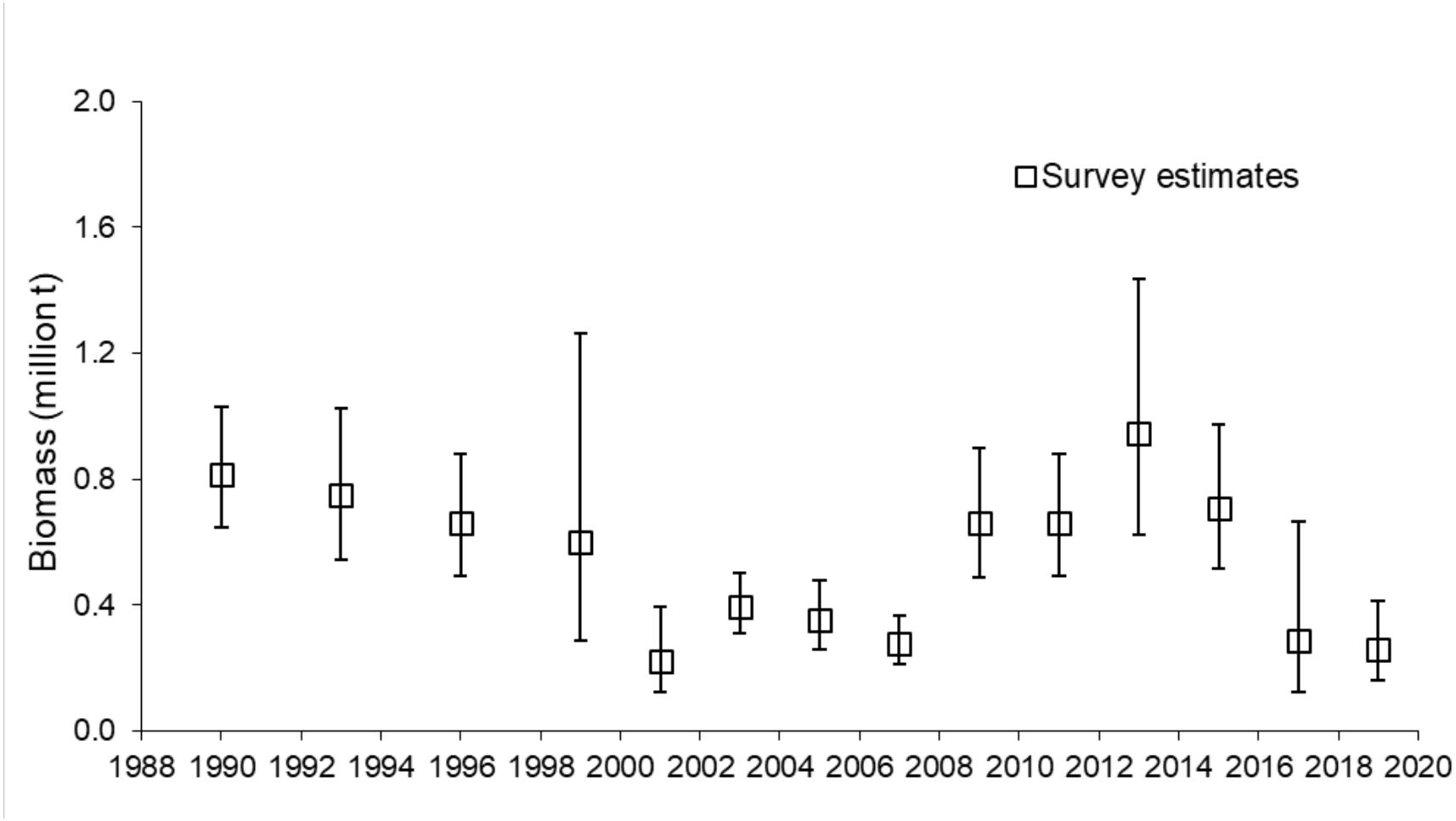




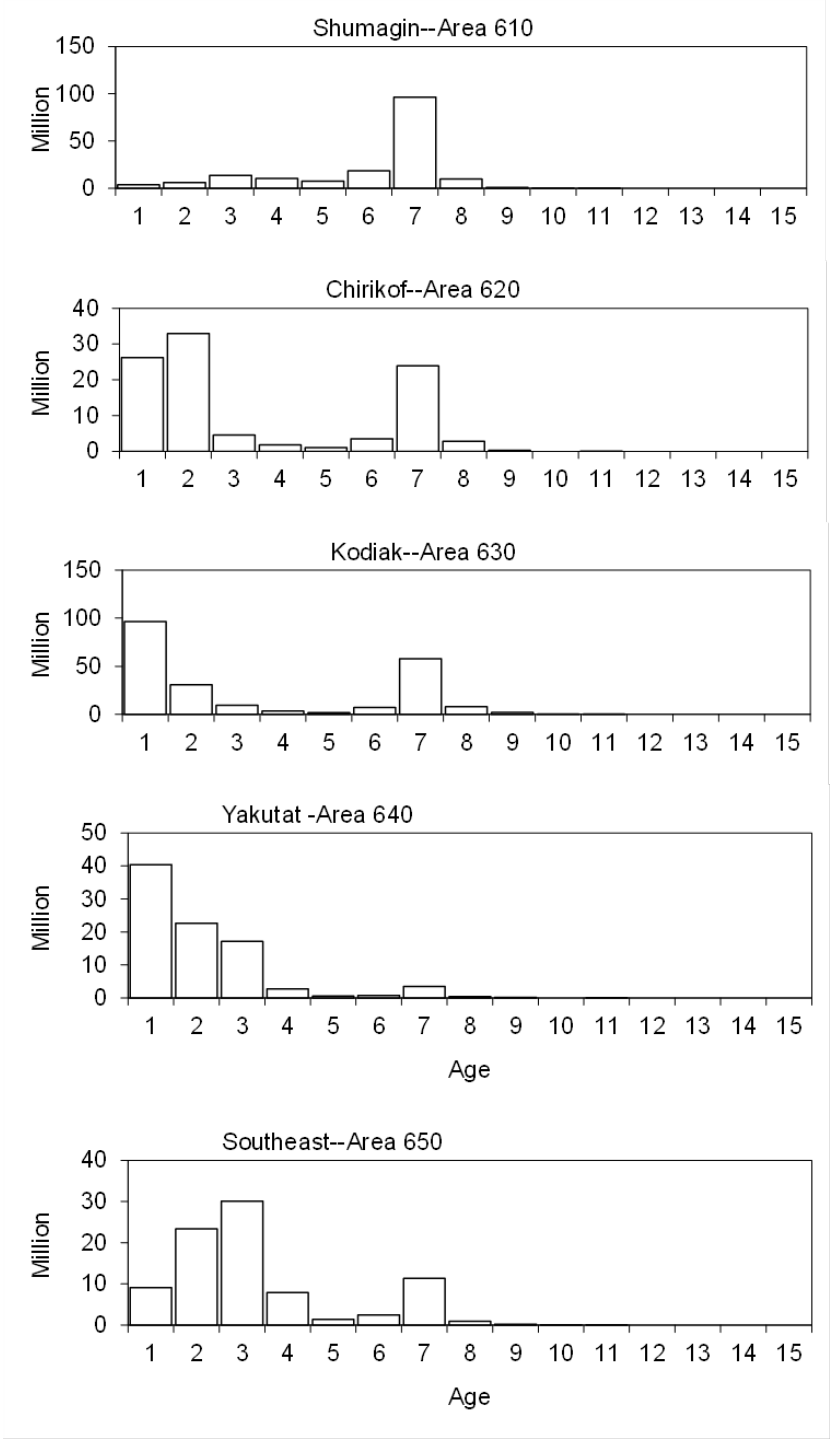




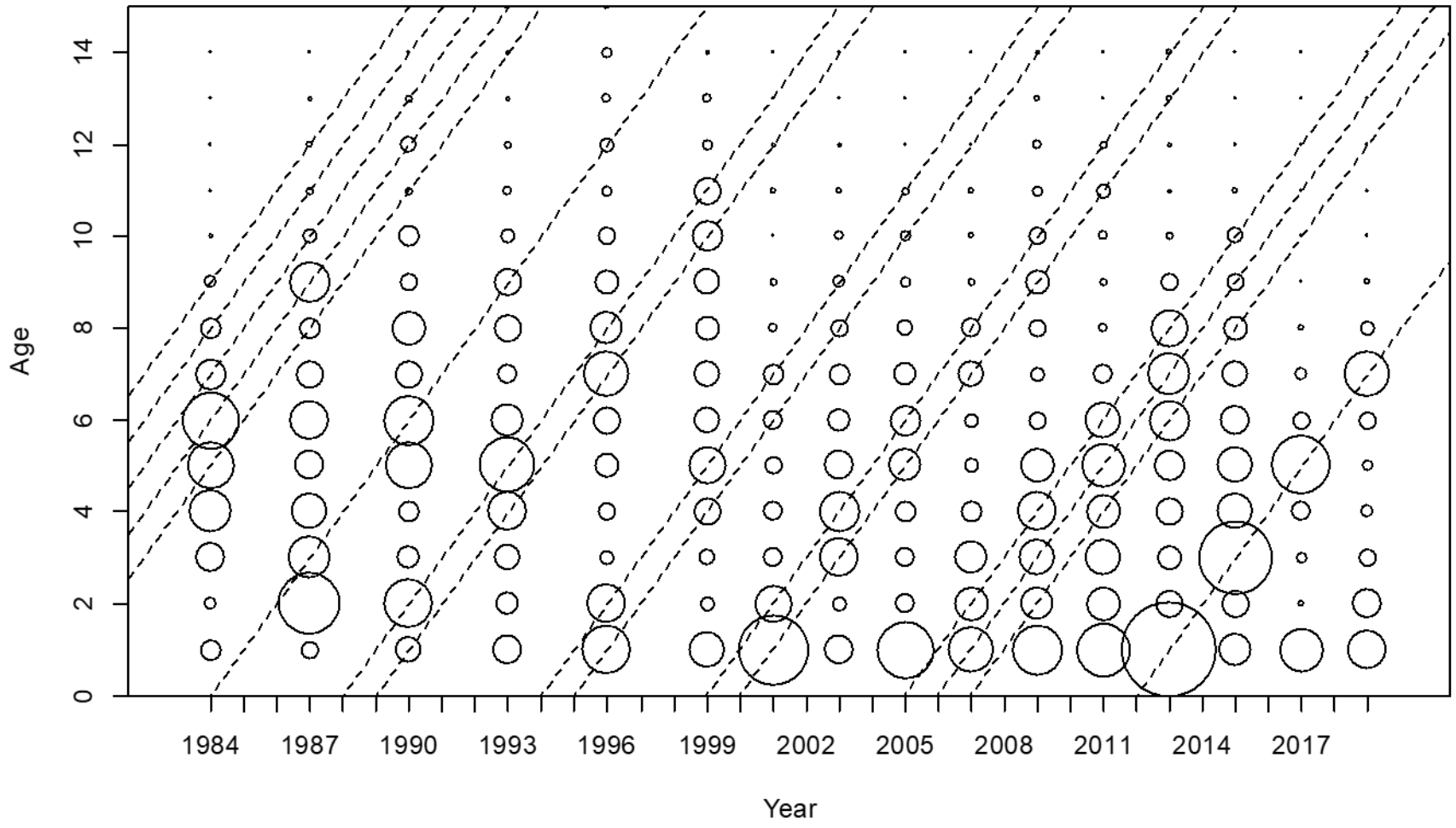
NMFS bottom trawl survey (1990-2019)



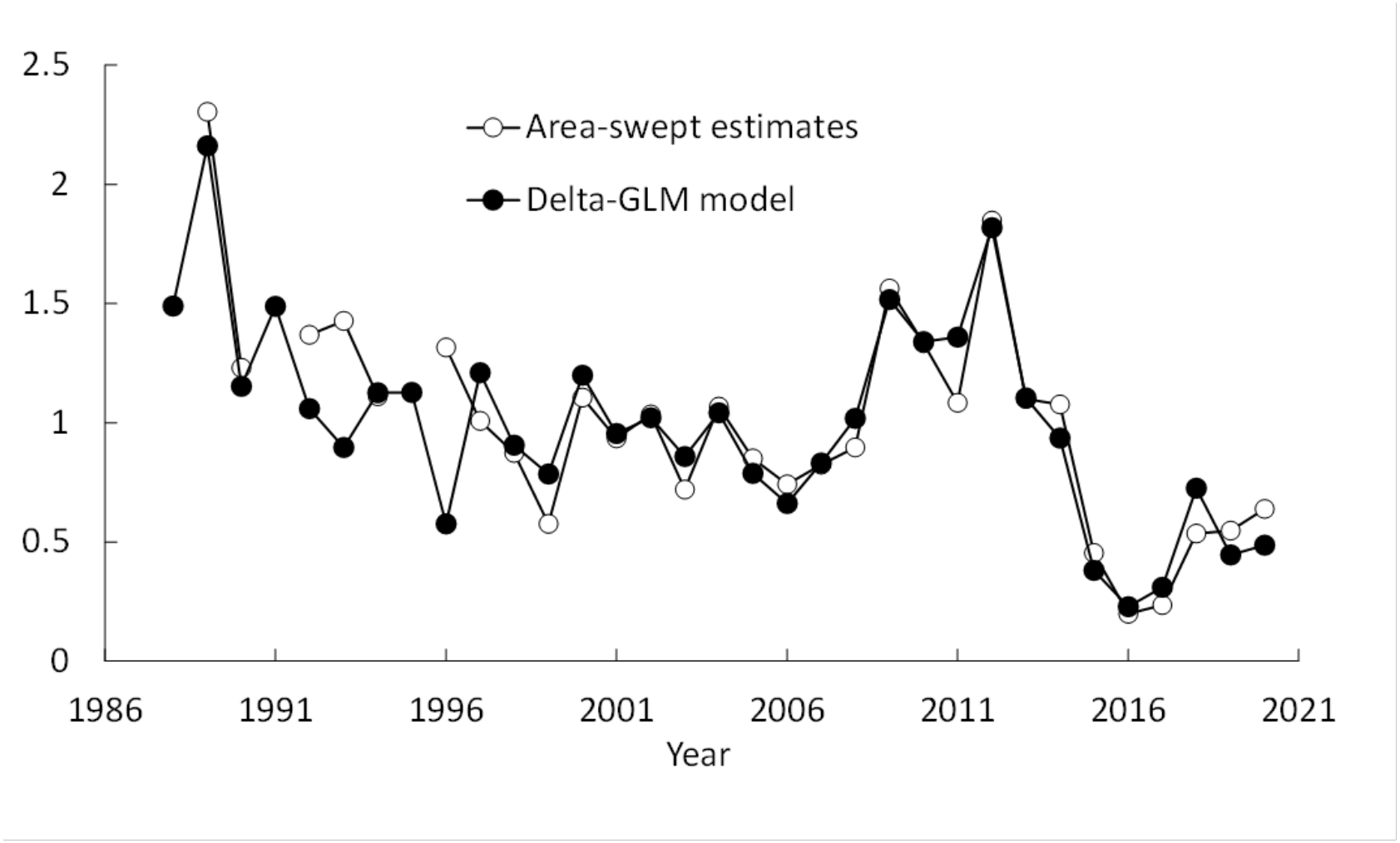
2019 NMFS bottom trawl survey



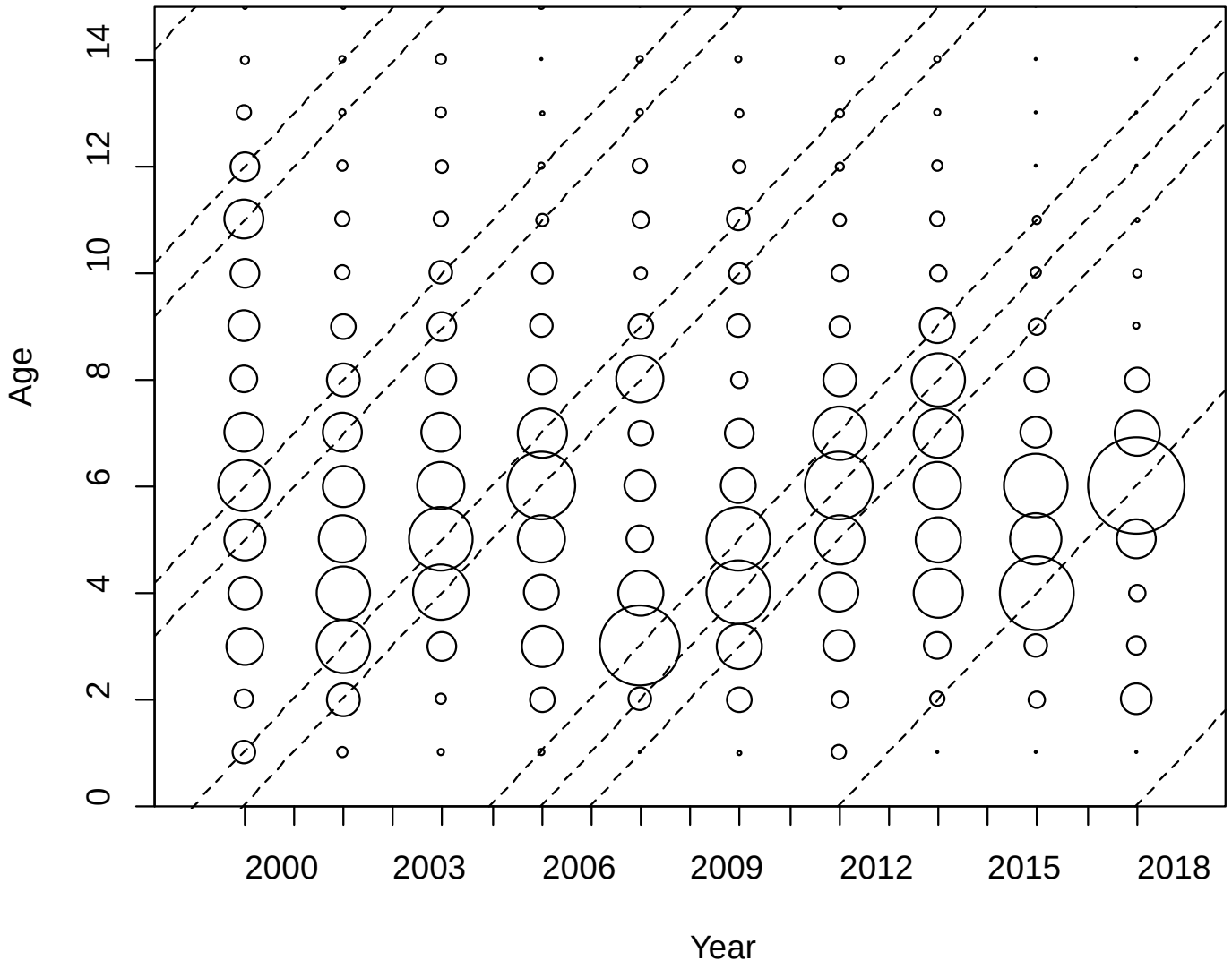
NMFS Bottom trawl survey age comp (1990-2019)



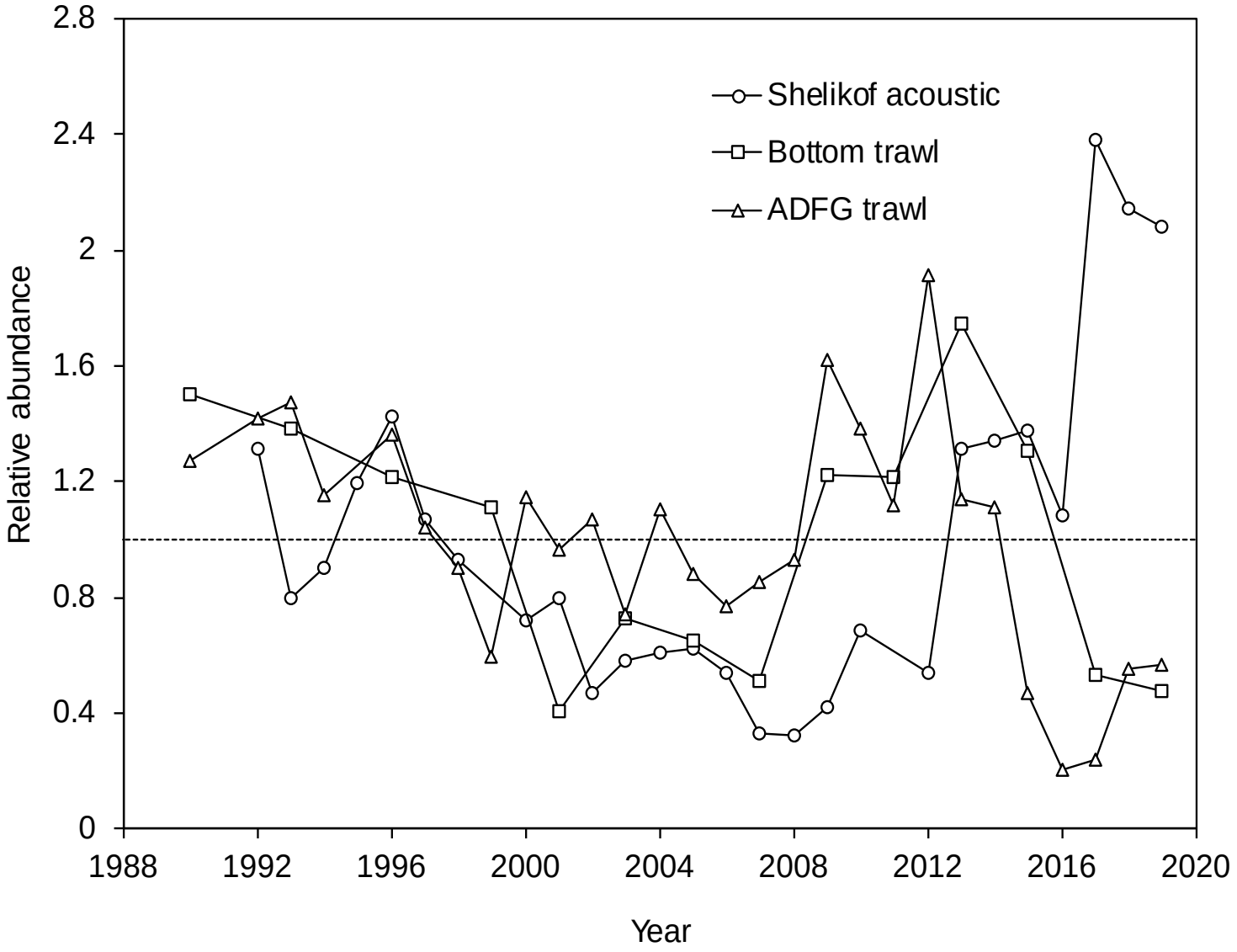
Comparison between area-swept estimates and delta-GLM estimates for ADF&G crab/groundfish survey



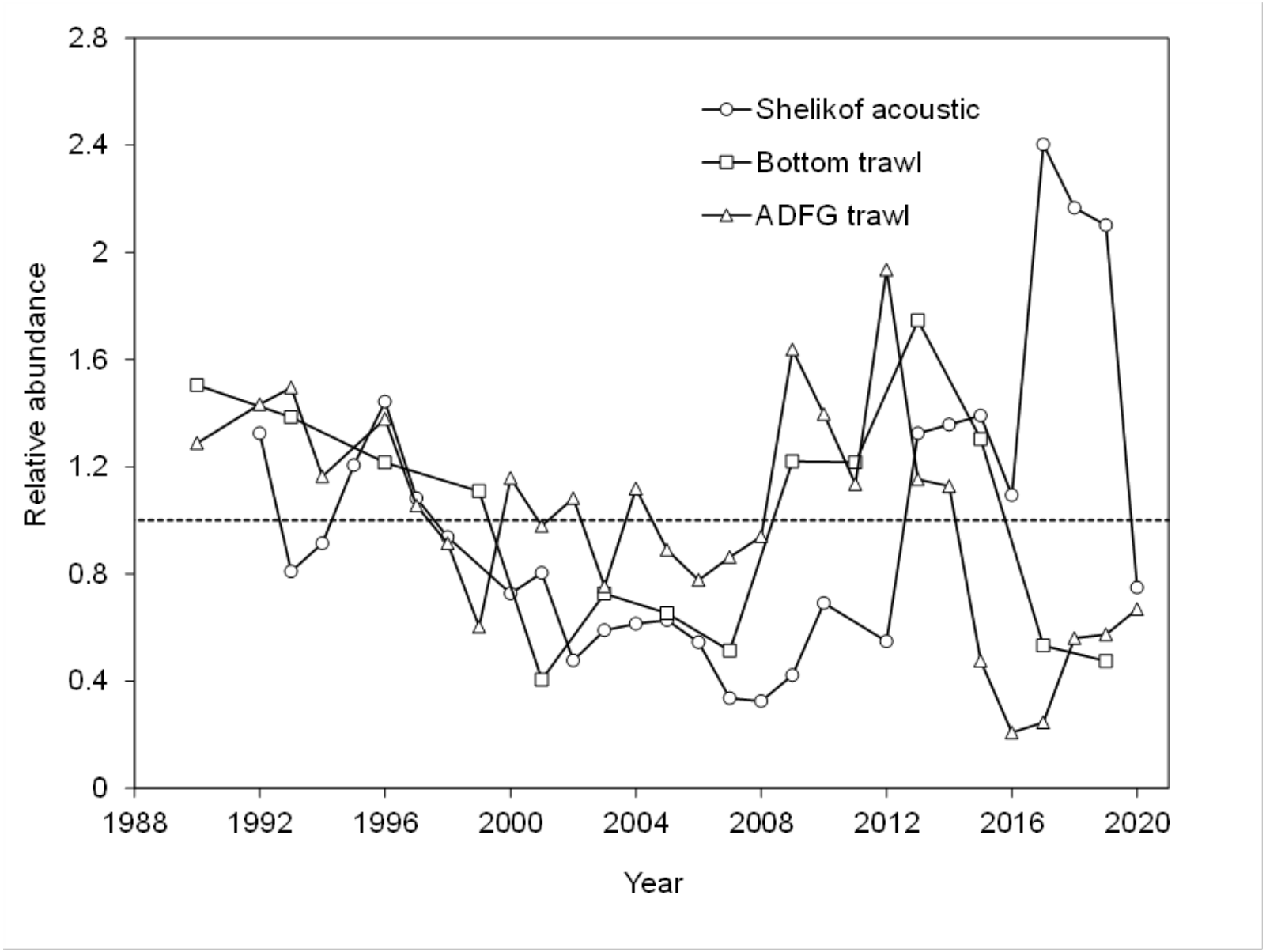
ADFG crab/groundfish trawl survey age comp (2000-2018)



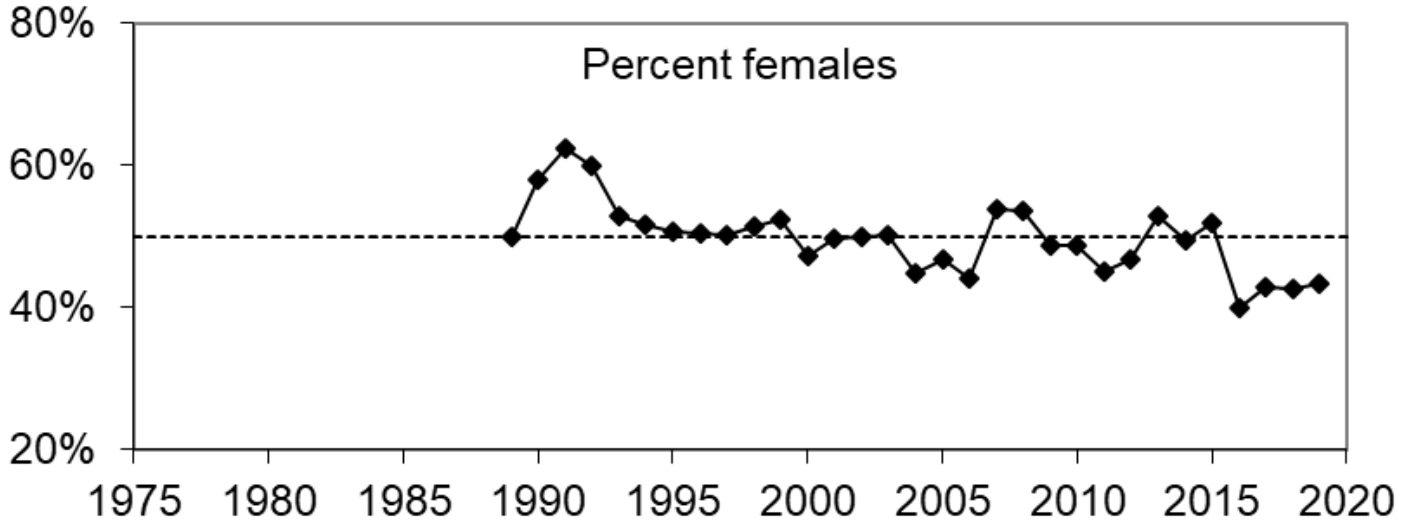
Relative trends in abundance indices last year (1990-2019)

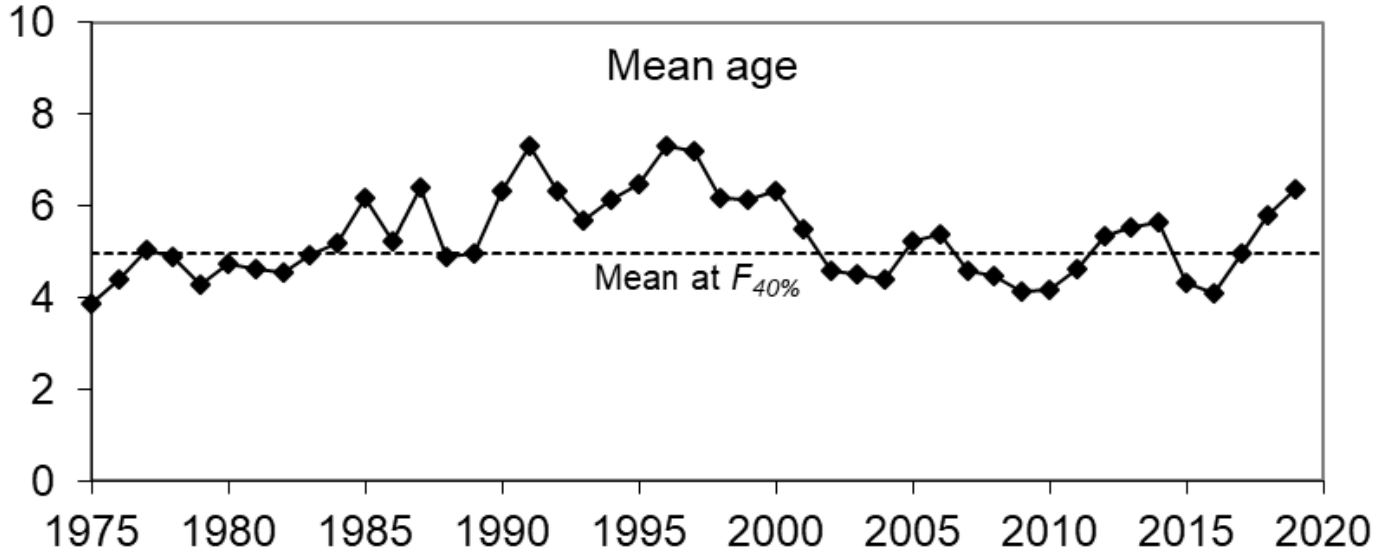


Relative trends in abundance indices this year (1990-2020)

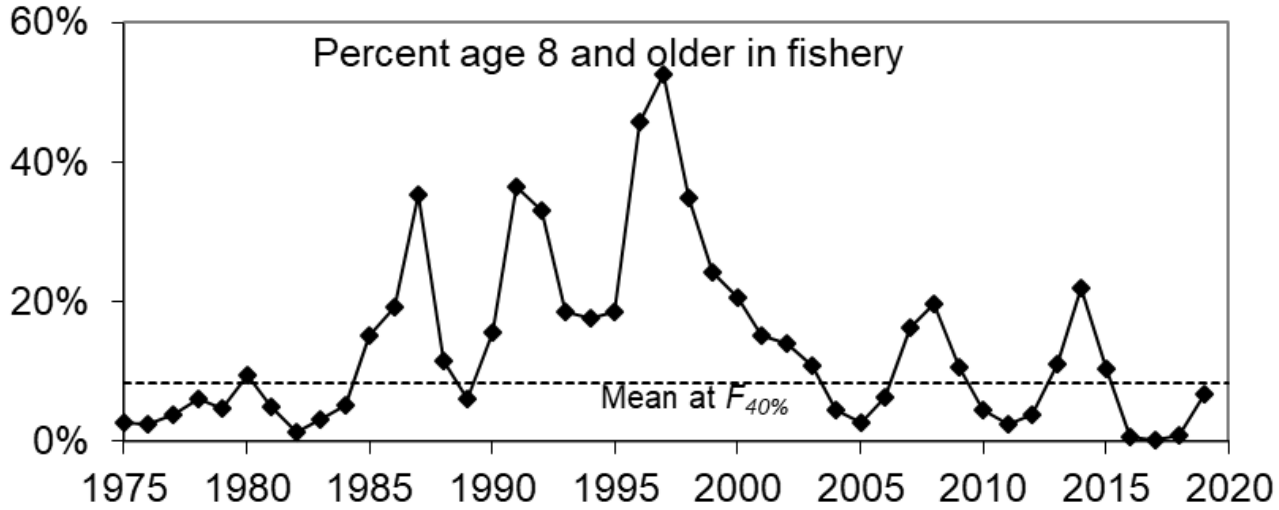


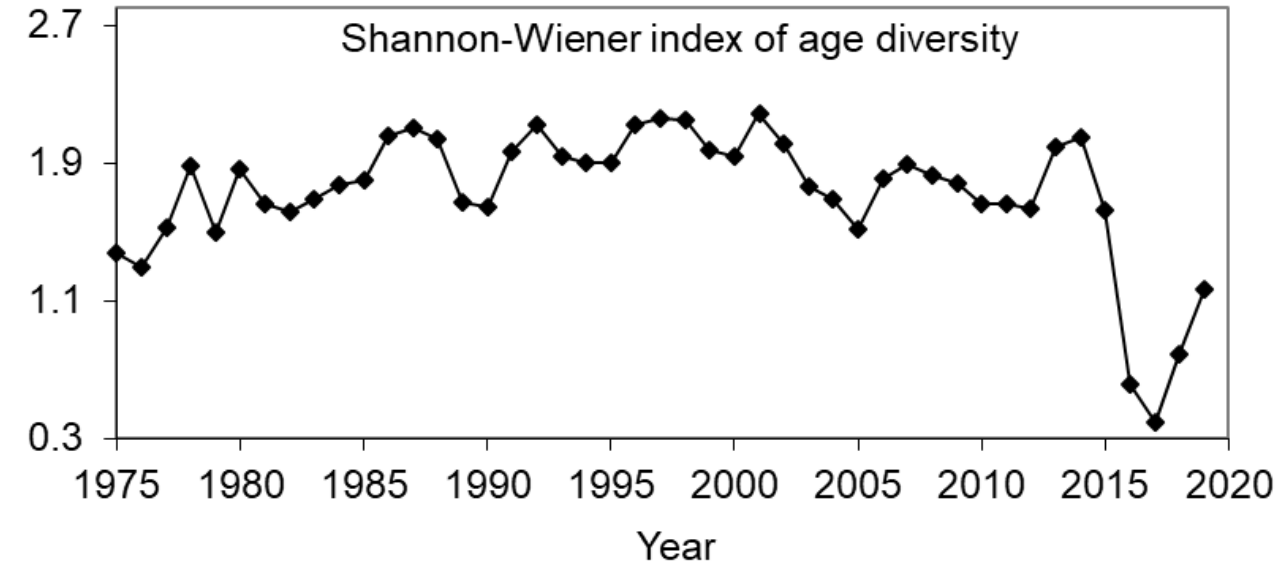
Fishery catch indicators



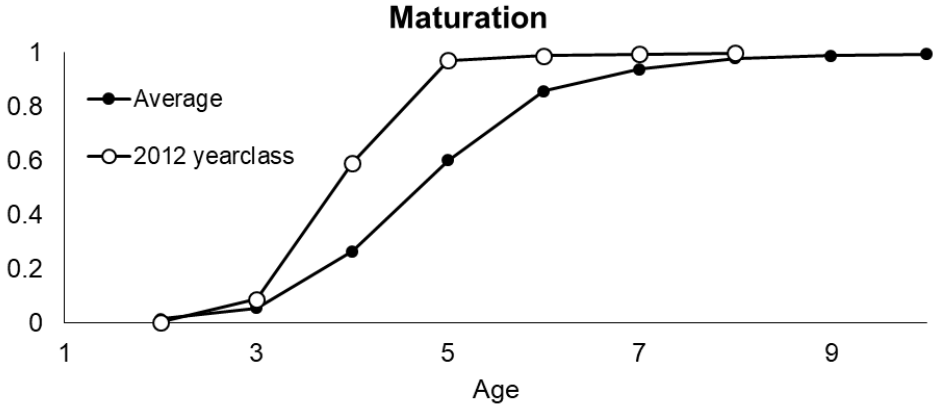


Fishery catch indicators





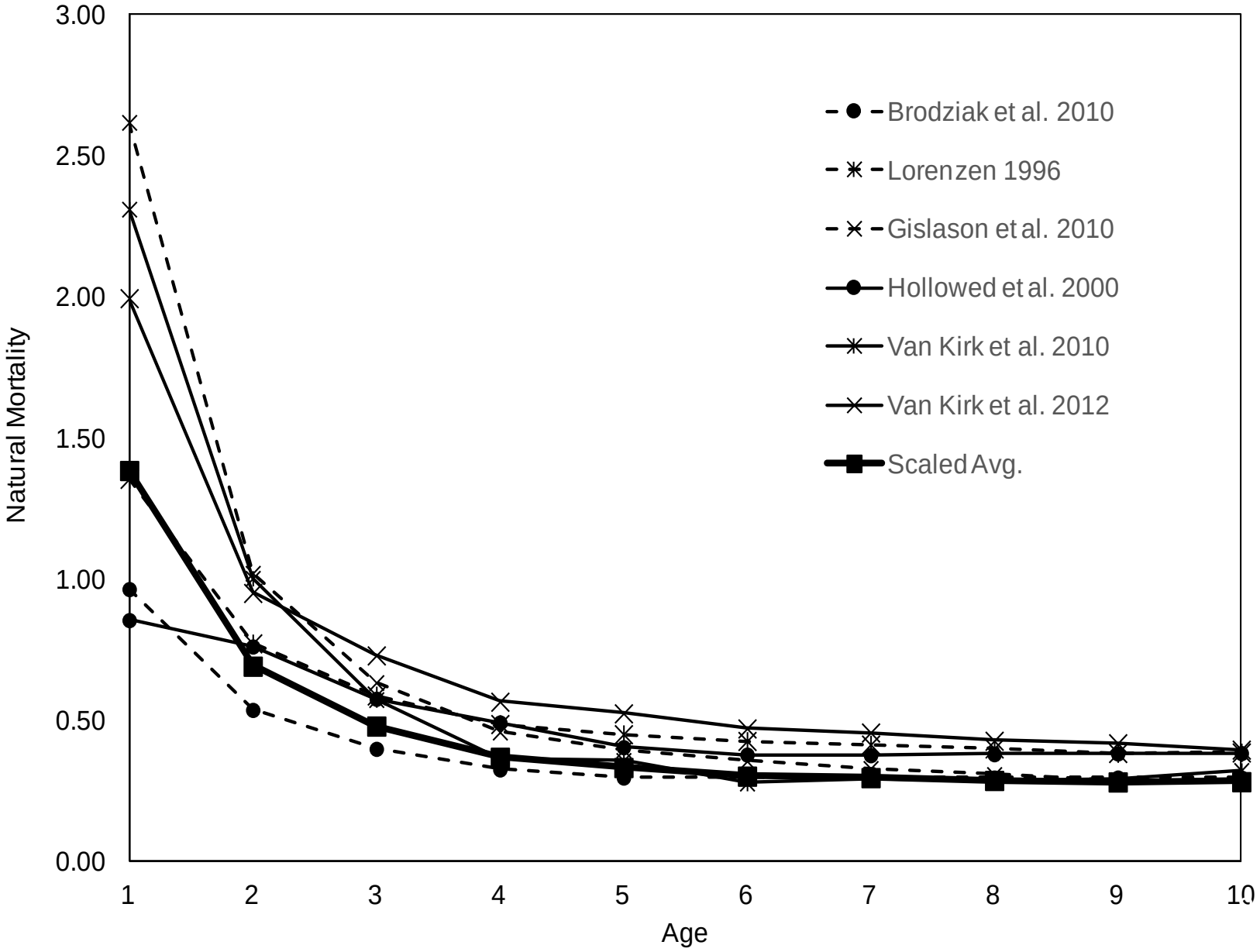
Unusual features of the 2012 year class life history characteristics



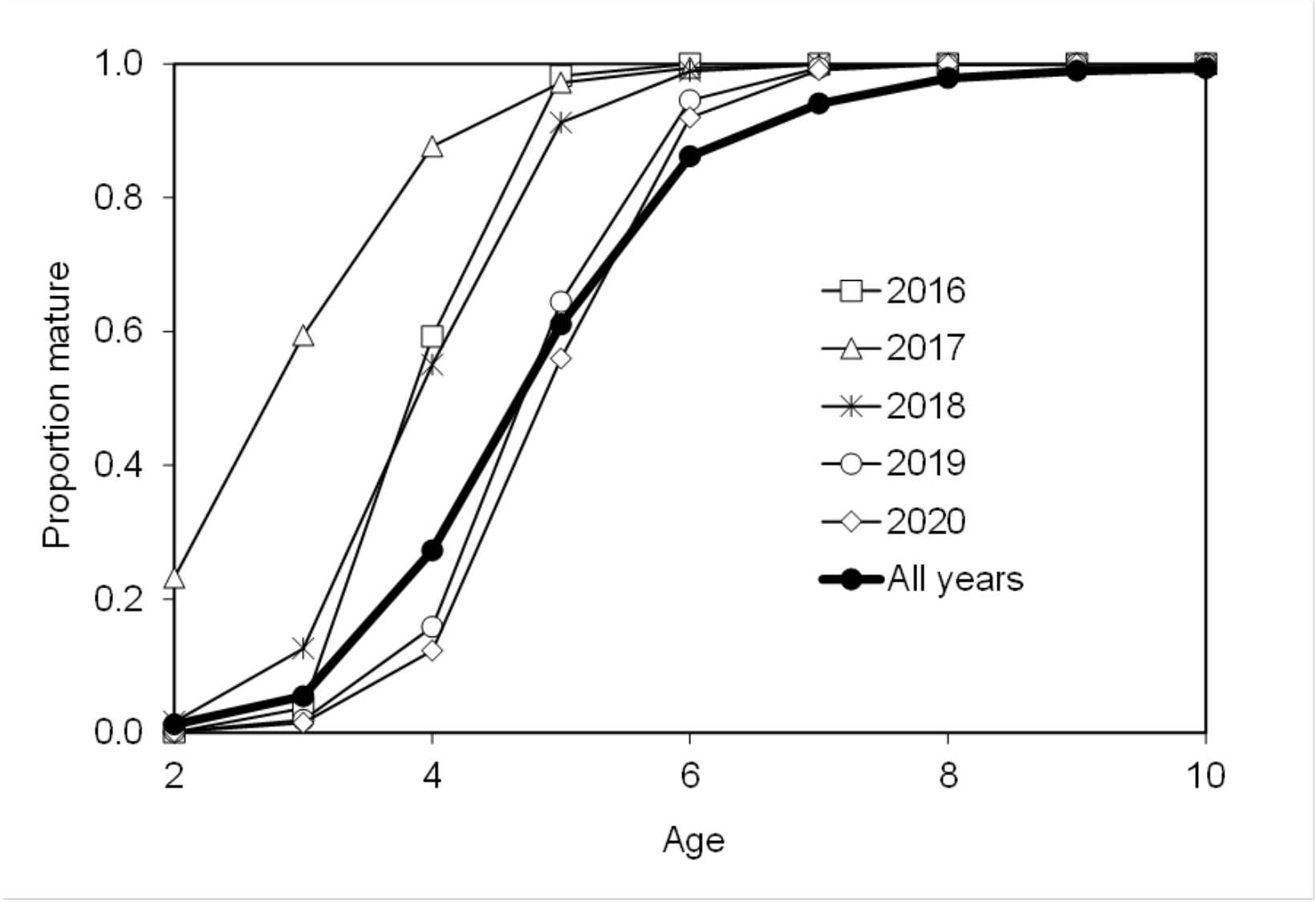
Parameters estimated independently

- Natural mortality: age-specific pattern (in 2014 assessment)
- Weight at age by fishery and survey
- RE model fishery weights at age in 2019.
- Proportion mature at age (and evaluation of cohort based estimates)

Natural mortality estimates

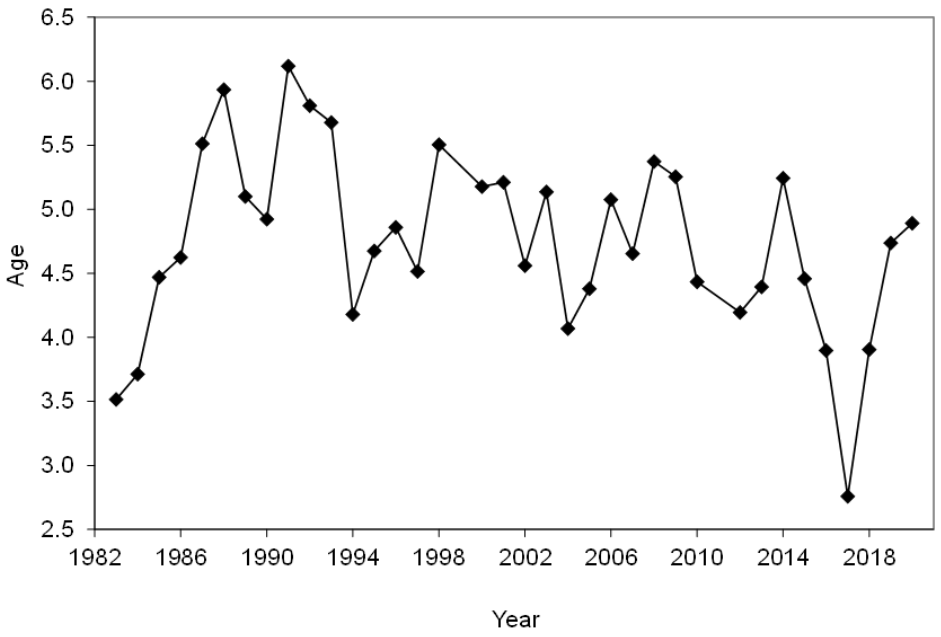


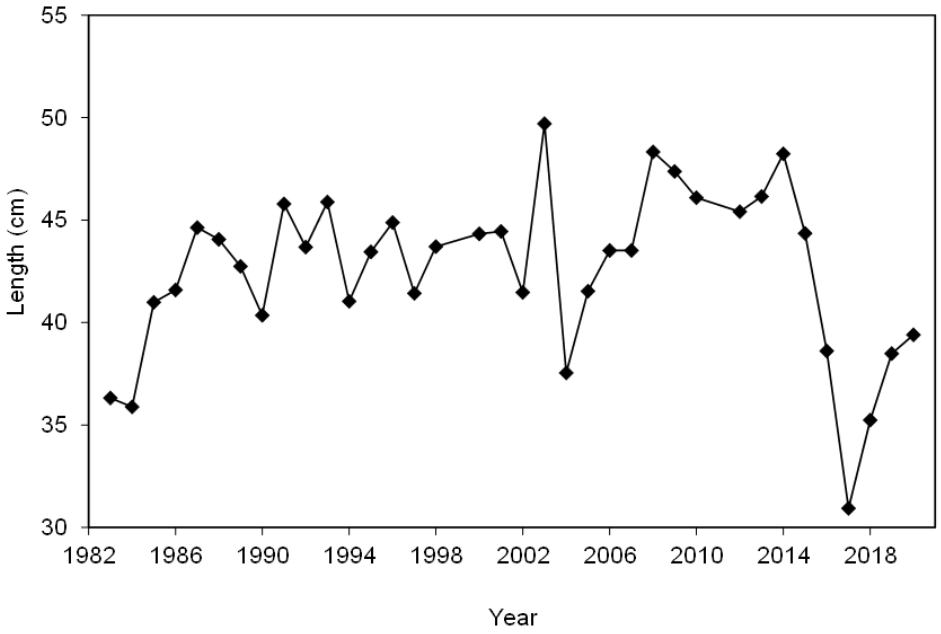
Recent maturity curves



Changes in maturity

In 2019 estimates were revised form 2003 onwards using local abundance weighting





Maturity estimates by cohort

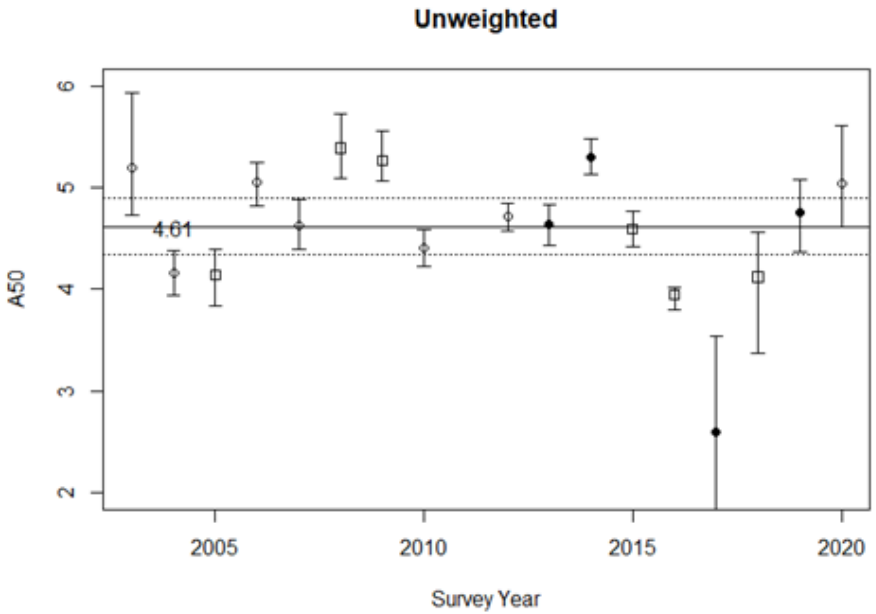
Kresimir Williams – MACE/AFSC

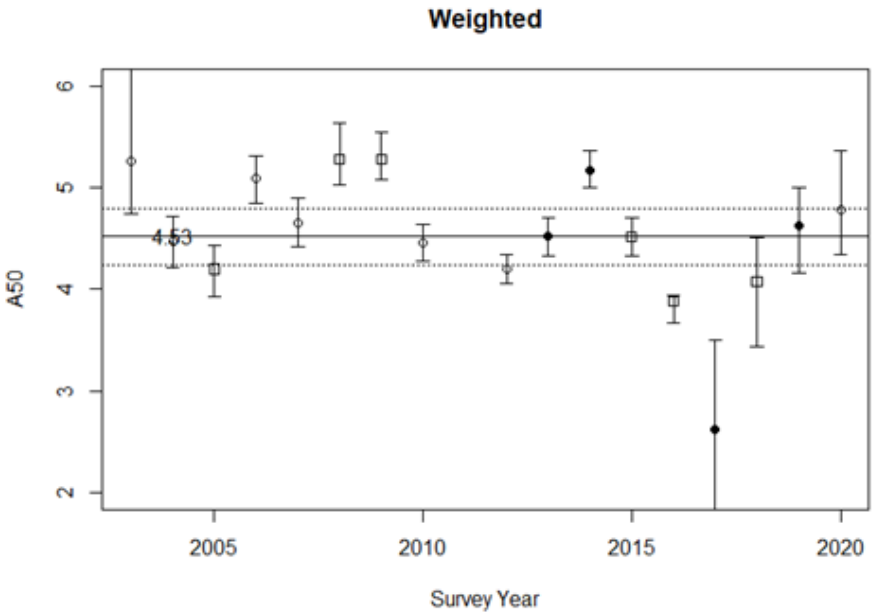
Maturity data weighting by local abundance same as with maturity at length
- Adult abundance (# of fish > 30 cm) associated with each haul was used to scale specimen data and derive a weighted proportion mature at age.

Maturity by survey year:
- Total number sampled at age and proportion mature at age for each survey year (2003-2020) used in a GLM (binomial with logit link) to estimate A50, age at 50% mature.

Maturity by cohort:
- Total number sampled at age and proportion mature at age are taken for each cohort across survey years, e.g. age 1 pollock in 2013 are grouped with age 2 pollock in 2014, etc. Same GLM model used to then estimate A50 for each cohort. Last cohort to be analyzed is 2012, as there are insufficient data on younger cohorts.

Maturity at age by survey year

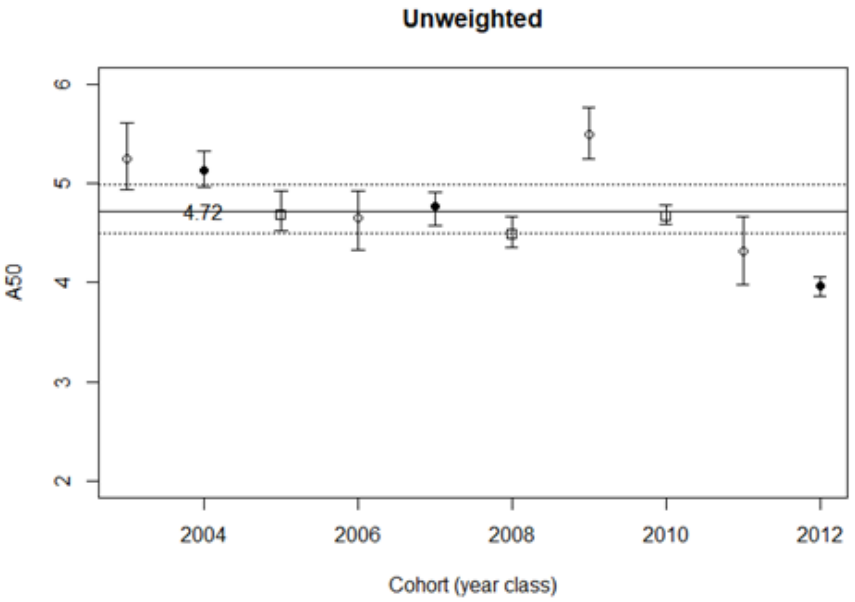


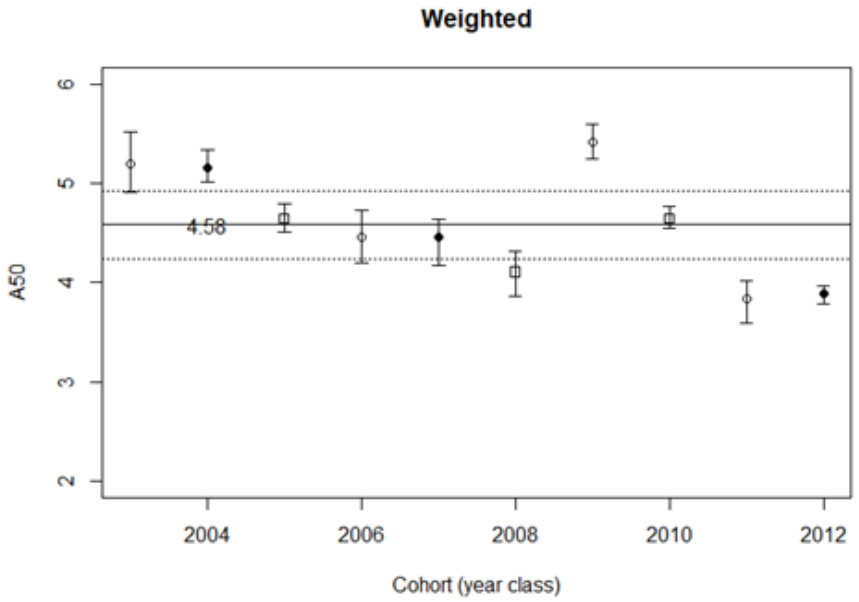


solid circles = five most abundant survey years
open squares = middle abundance five years
open circles = lowest abundance seven years

- Weighting not very influential (~0.08 age units lower on average)
- Oscillating pattern with high variability
- 2017 estimate anomalously low and variable (not many younger fish)

Maturity at age by cohort (2003-2012 year classes)

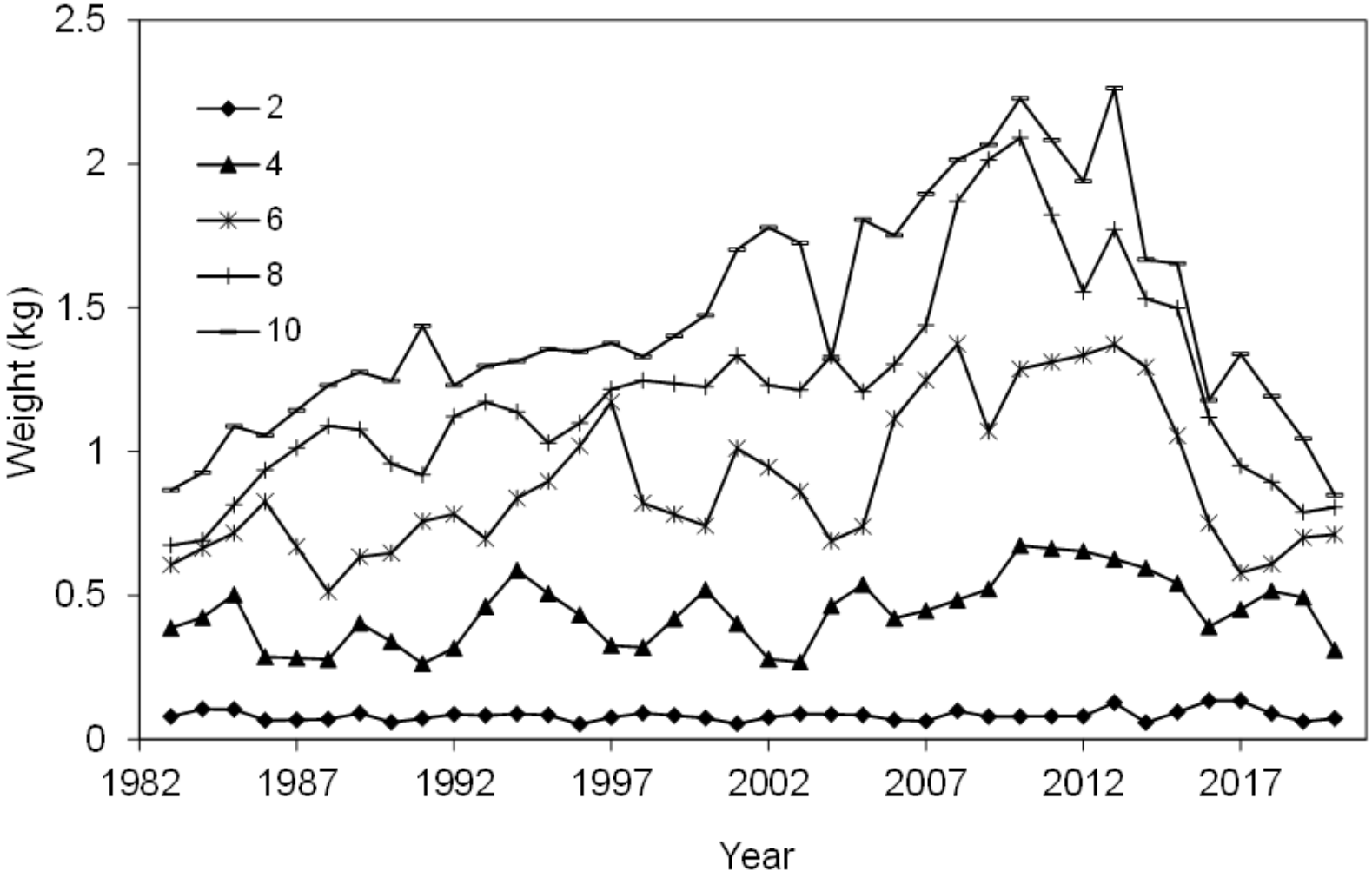




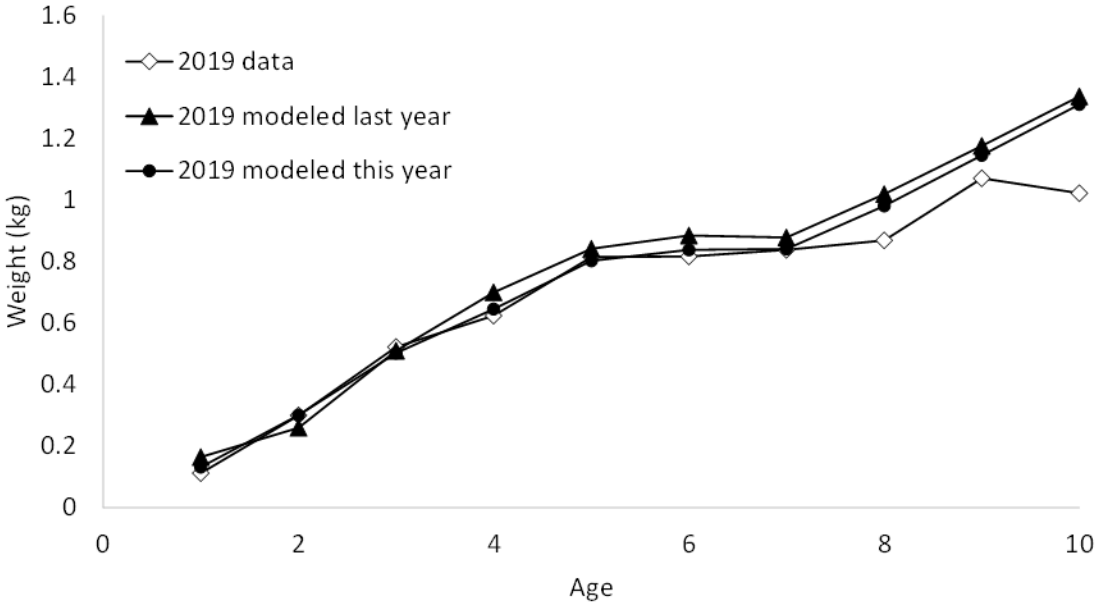
solid circles = three most abundant survey years
open squares = middle abundance three years
open circles = lowest abundance three years

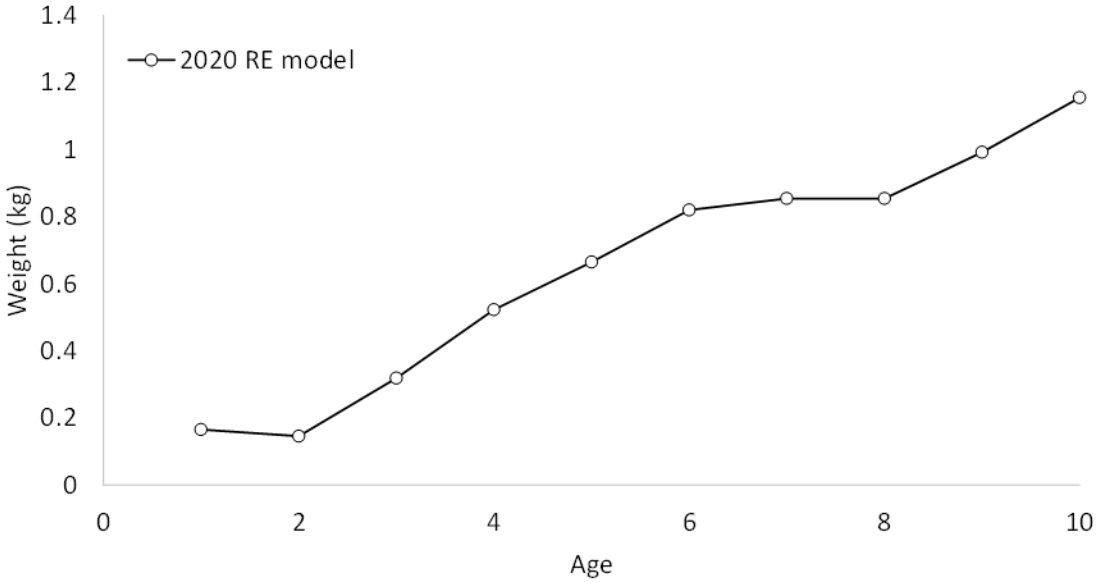
- Weighting “slightly” more influential (~0.14 age units lower on average)
- Overall reduction in variability
- Trend in reducing A50 (first two cohorts above overall mean, last two below mean)

Shelikof survey changes in weight at age



RE model for fishery weight at age





Likelihood components

Likelihood component	Statistical model for error	Variance assumption
Fishery total catch (1970-2020)	Log-normal	CV = 0.05, 2020 catch is projected
Fishery age comp. (1975-2019)	Multinomial	Initial sample size: 200 or the number of tows/deliveries if less than 200
Shelikof acoustic survey biomass (1992-2020)	Log-normal	CV = 0.20
Shelikof acoustic survey age comp. (1992-2020)	Multinomial	Initial sample size = 60
Shelikof acoustic survey age-1 and age-2 indices (1994-2020)	Log-normal	Tuned CVs = 0.45 and 0.45
Summer acoustic survey biomass (2013-2019)	Log-normal	CV = 0.25
Summer acoustic survey age comp. (2013, 2015, 2017, 2019)	Multinomial	Initial sample size = 10
NMFS bottom trawl survey biom. (1990-2019)	Log-normal	Survey-specific CV from random-stratified design = 0.12-0.38
NMFS bottom trawl survey age comp. (1990-2019)	Multinomial	Initial sample size = 60
ADF&G trawl survey index (1989-2020)	Log-normal	Survey-specific CV from delta GLM model rescaled so mean is 0.25=0.20-0.35
ADF&G survey age comp. (2000-2018)	Multinomial	Initial sample size = 30
Recruit process error (1970-1977, 2019, 2020)	Log-normal	σ_R =1.0

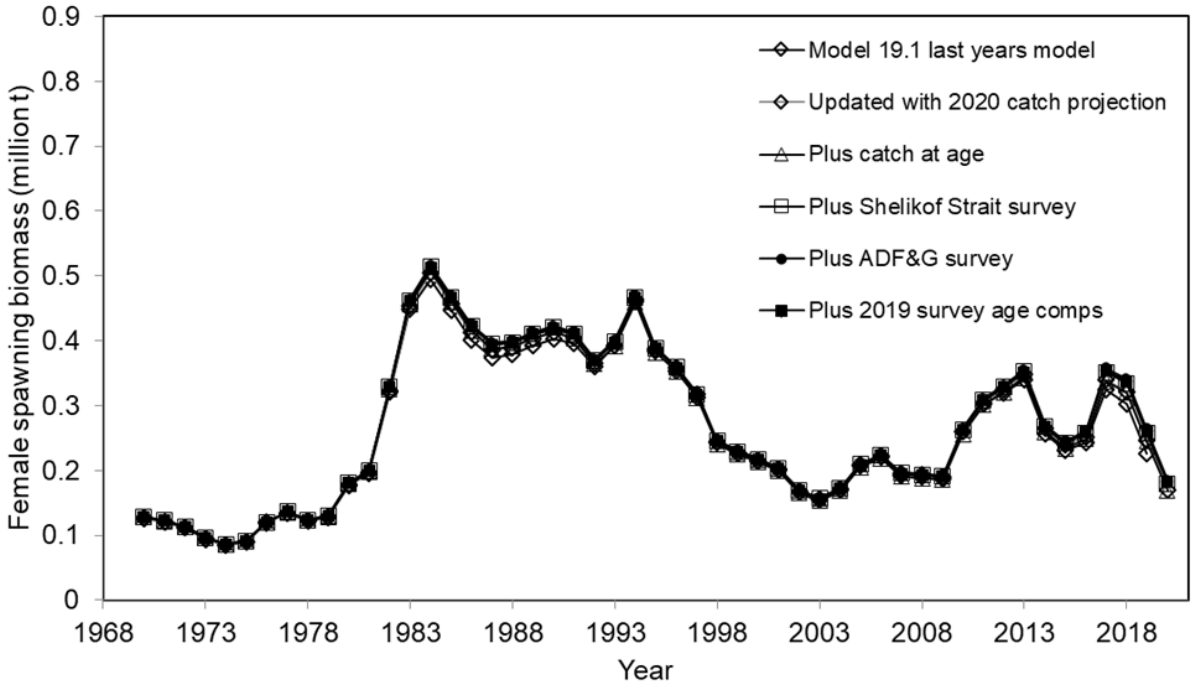
Model parameters

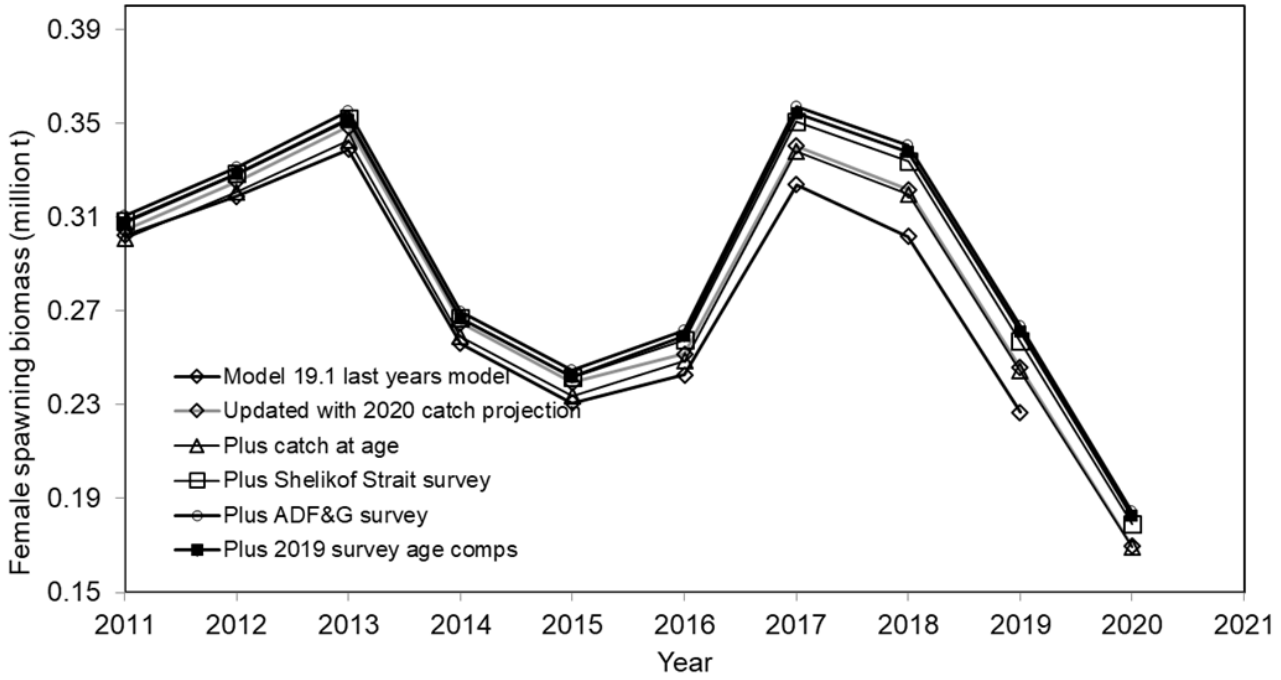
Population process modeled	Number of parameters	Estimation details
Recruitment	Years 1970-2020 = 51	Estimated as log deviances from the log mean; recruitment in 1970-77, and 2018 and 2019 constrained by random deviation process error.
Natural mortality	Age-specific= 10	Not estimated in the model
Fishing mortality	Years 1970-2020 = 51	Estimated as log deviances from the log mean
Mean fishery selectivity	4	Slope parameters estimated on a log scale, intercept parameters on an arithmetic scale
Annual changes in fishery selectivity	2 * (No. years-1) = 100	Estimated as deviations from mean selectivity and constrained by random walk process error
Mean survey catchability	No. of surveys = 6	Catchabilities estimated on a log scale. Separate catchabilities were also estimated for age-1 and age-2 winter acoustic indices.
Annual changes in survey catchability	2 * (No. years-1) = 100	Annual catchability for winter acoustic surveys and ADF&G surveys estimated as deviations from mean catchability and constrained by random walk process error
Survey selectivity	6 (Shelikof acoustic survey: 2, BT survey: 2, ADF&G survey: 2)	Slope parameters estimated on a log scale.
Total	118 estimated parameters + 200 process error parameters + 10 fixed parameters = 328	

Model input changes

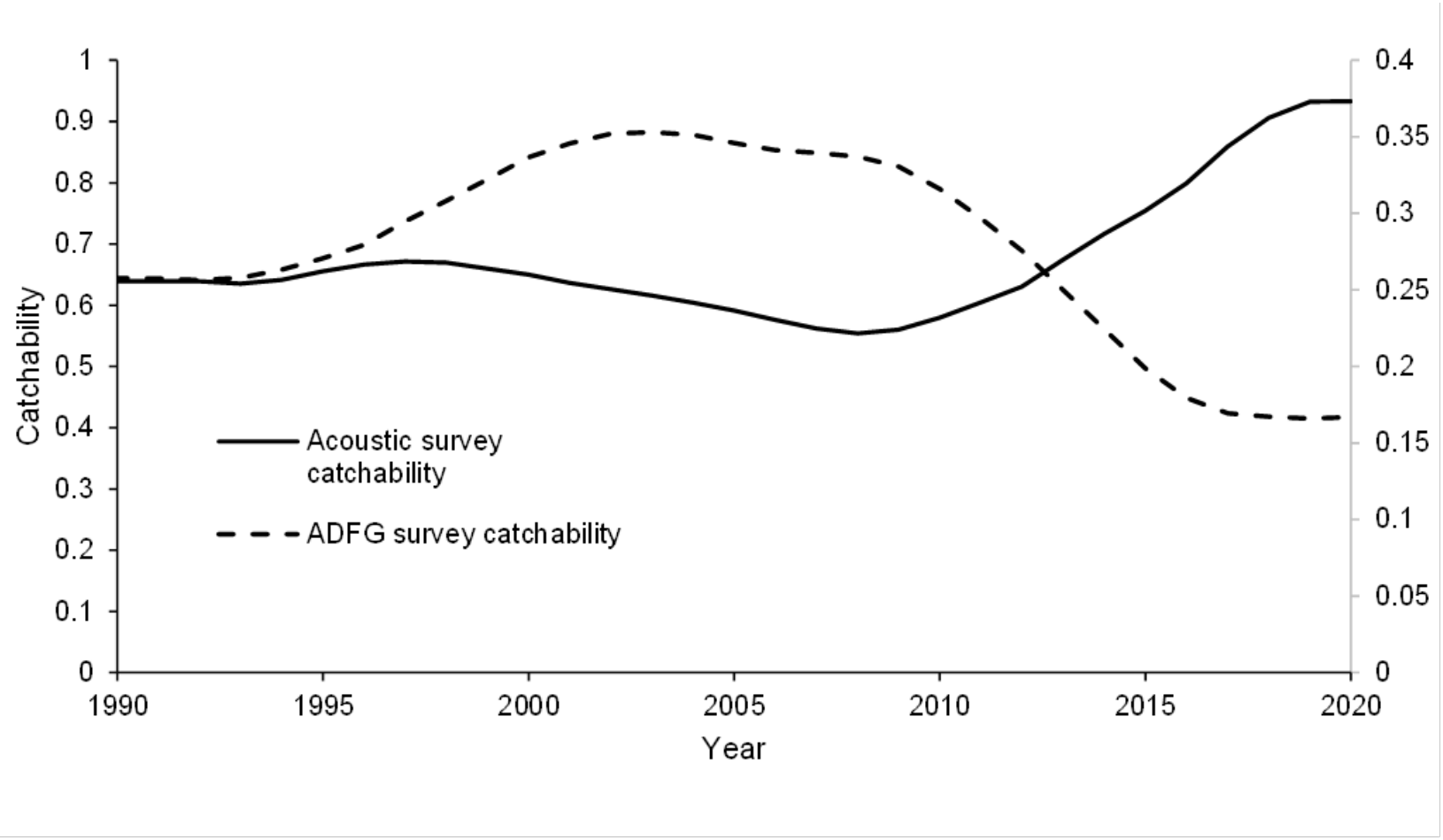
- Fishery: 2019 total catch and catch at age.
- Shelikof Strait acoustic survey: 2020 biomass and age composition.
- NMFS bottom trawl survey: 2019 age composition.
- Summer acoustic survey: 2019 age composition.
- ADF&G crab/groundfish trawl survey: 2020 biomass.

Sequential addition of new data

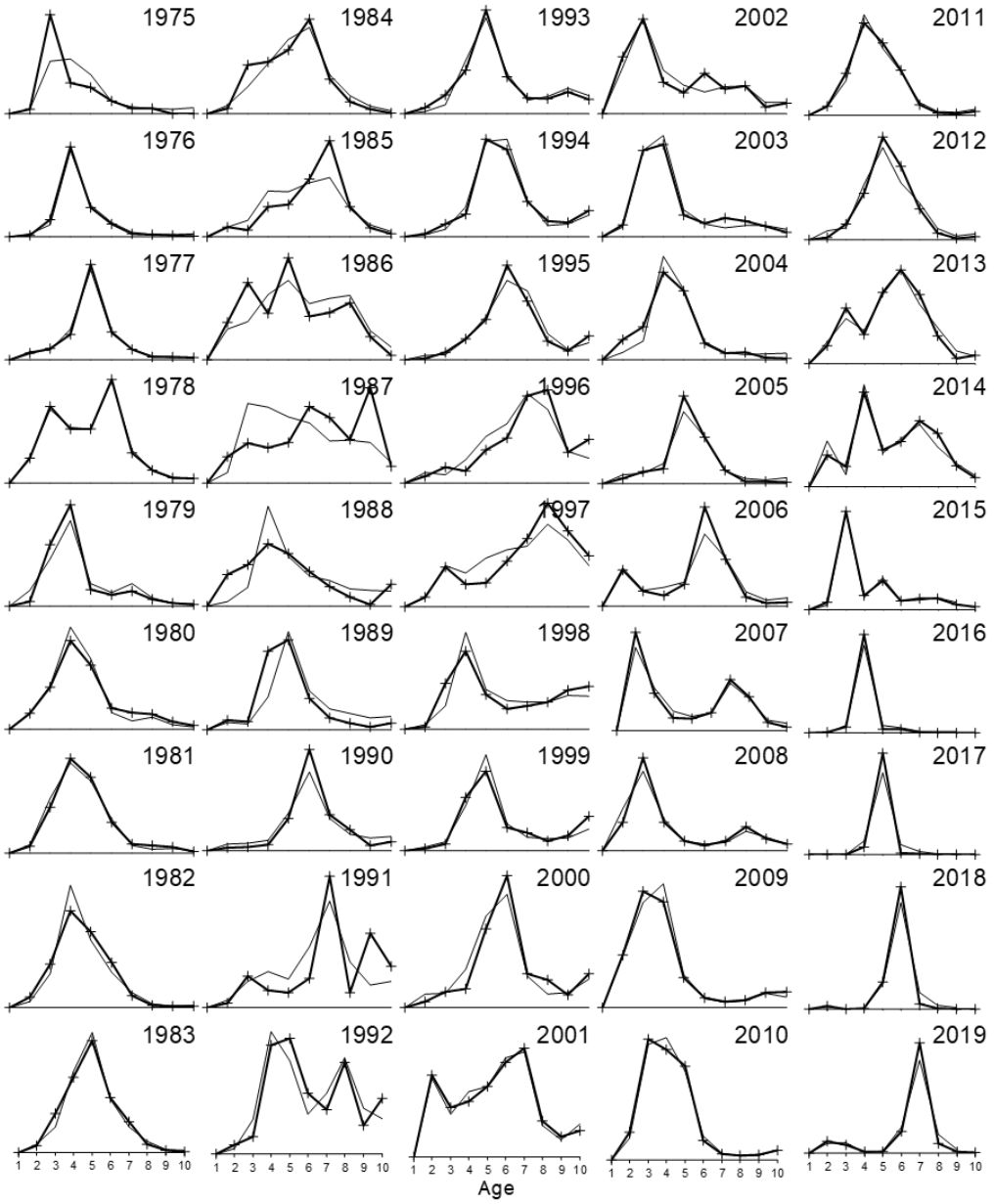




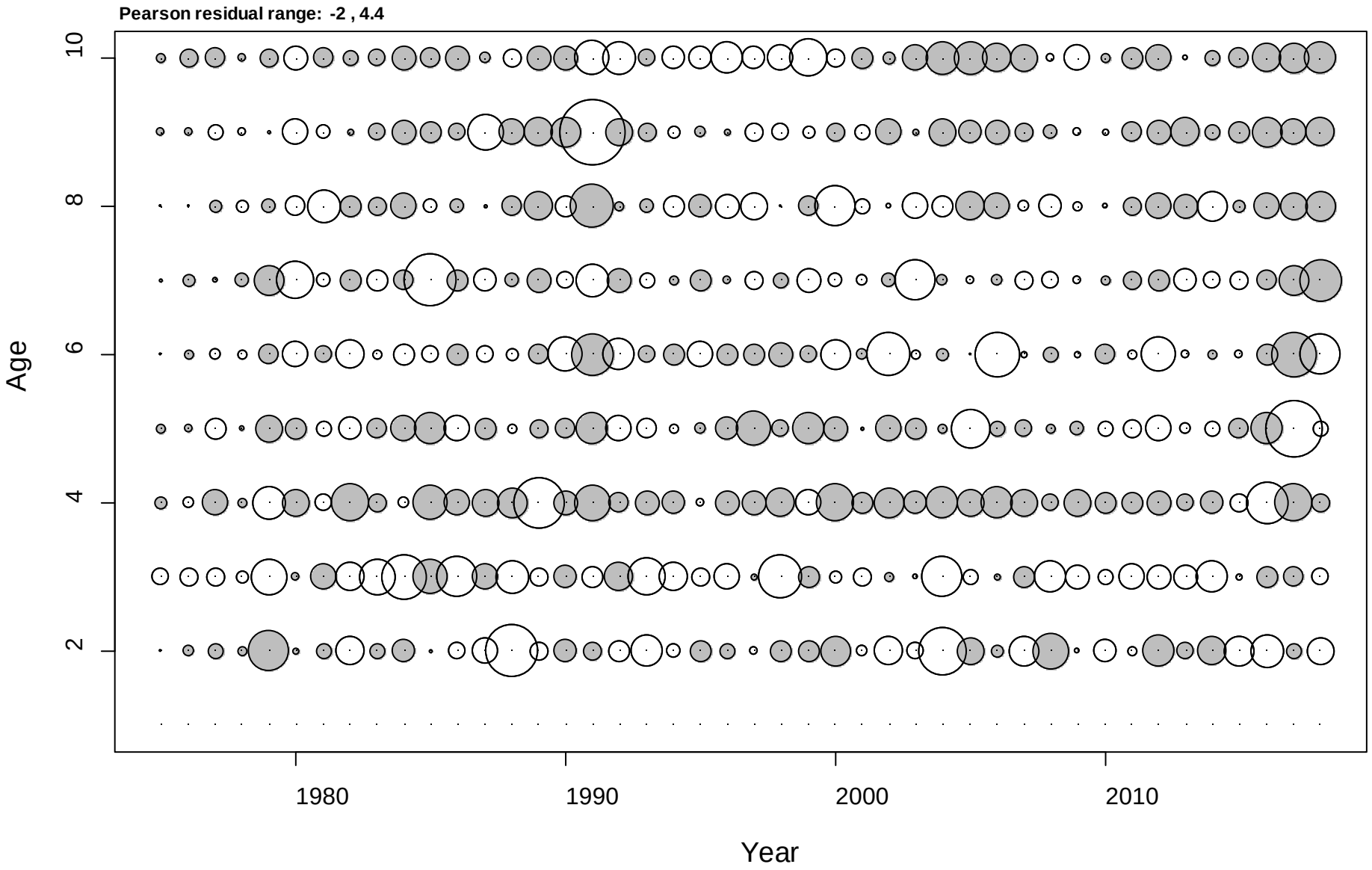
Random walk in catchability for Shelikof Strait survey and ADFG survey



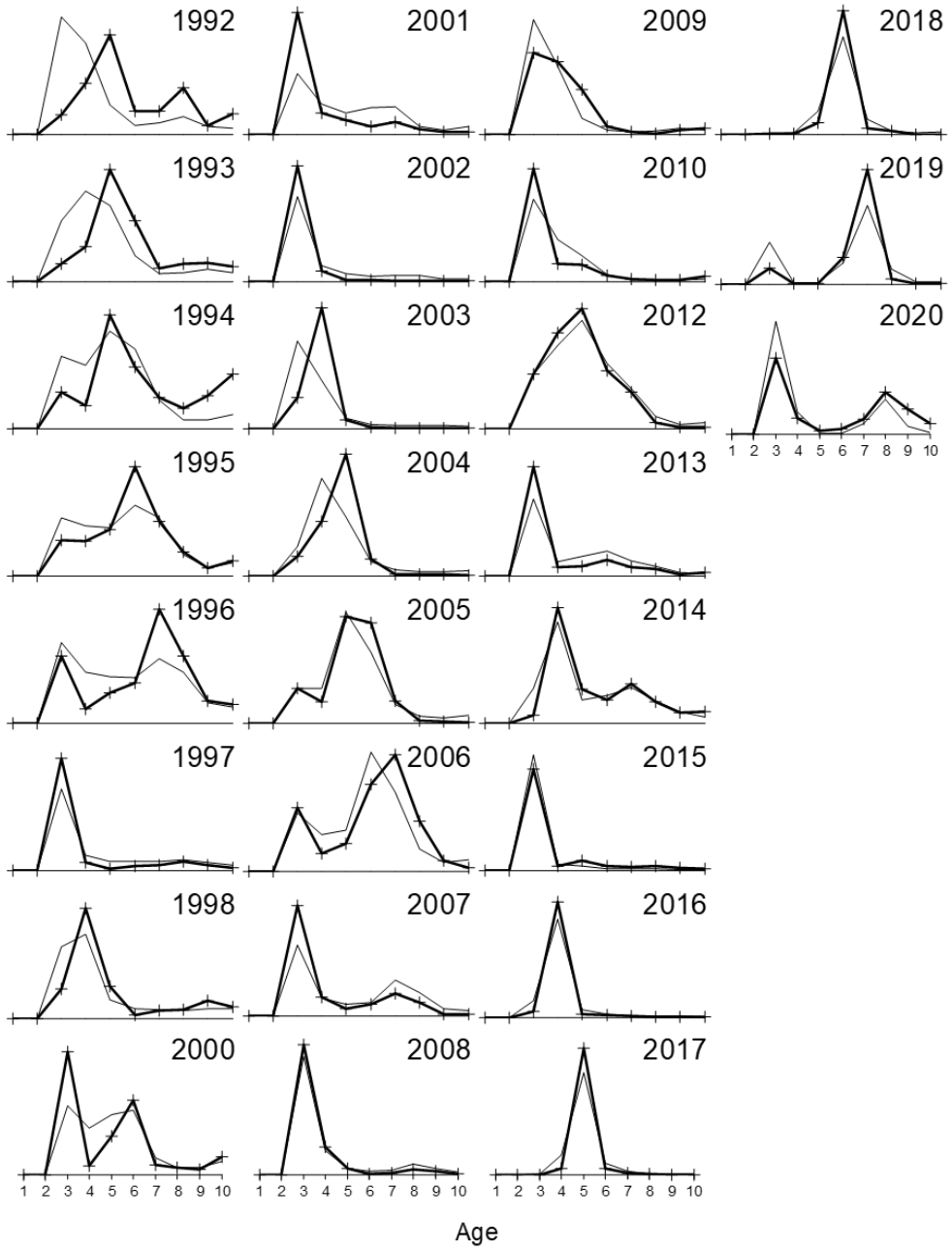
Fishery age composition (predicted vs observed)



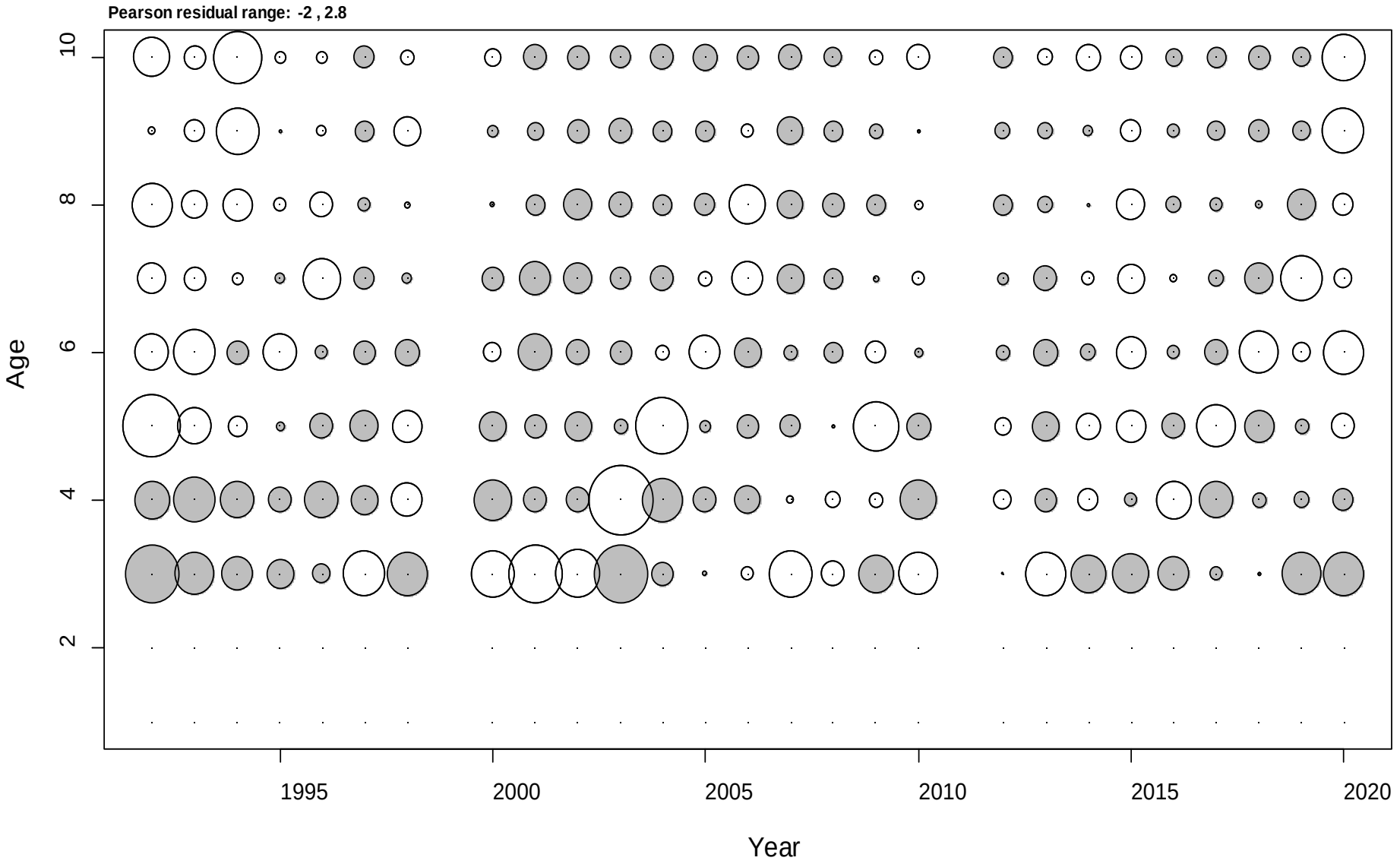
Fishery age composition (residuals)



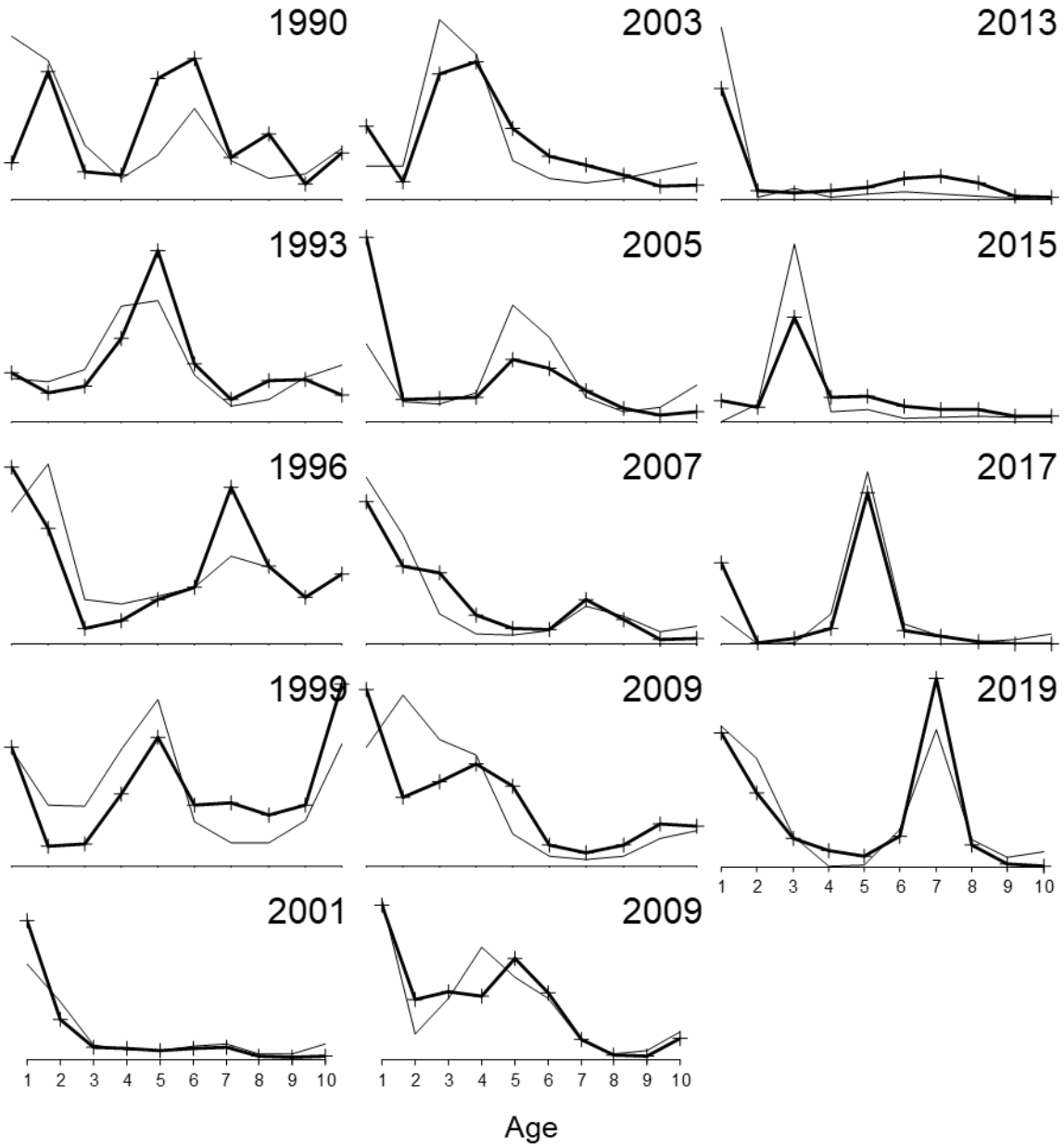
Shelikof Strait EIT age composition (predicted vs observed)



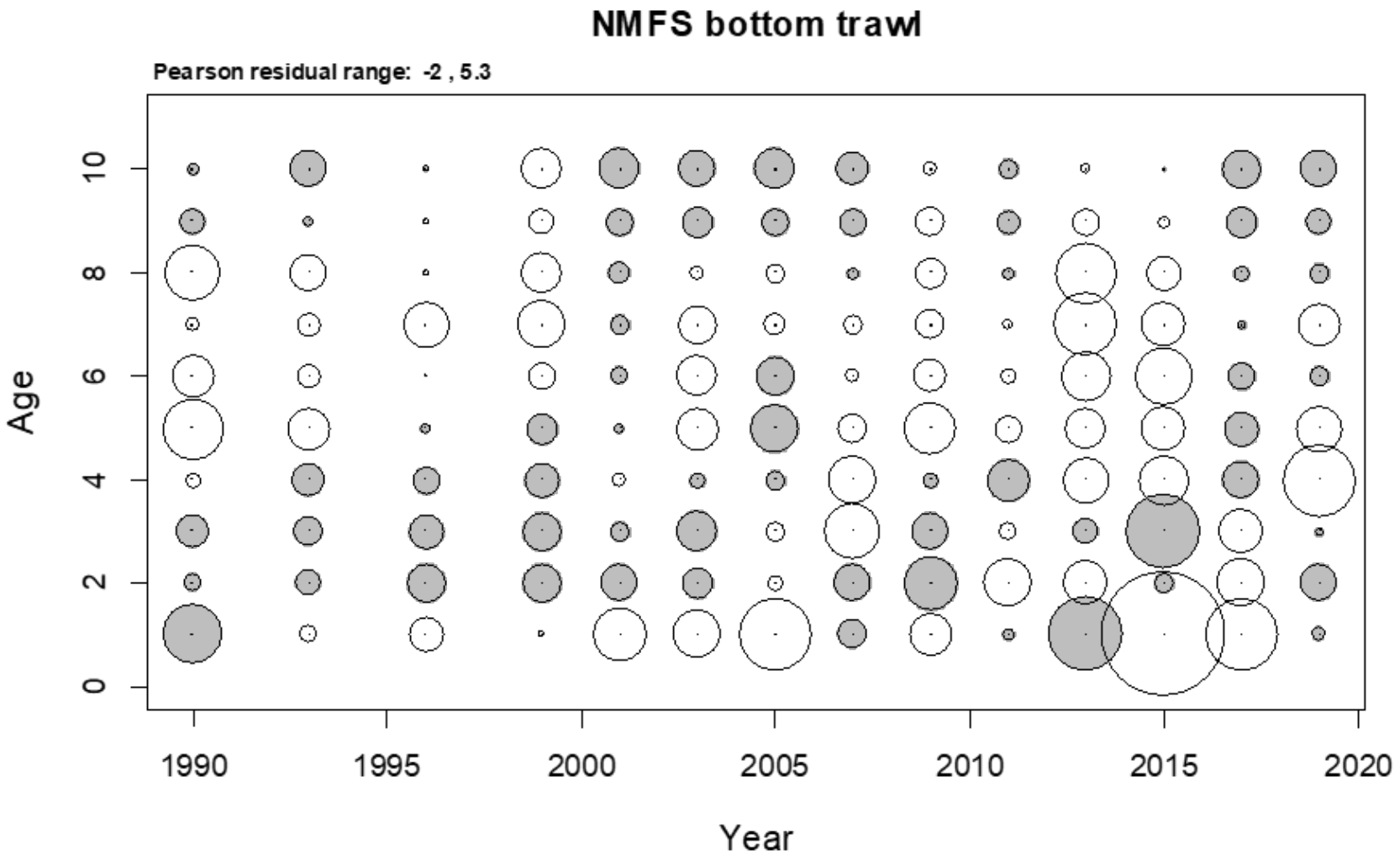
Shelikof Strait EIT age composition (residuals)



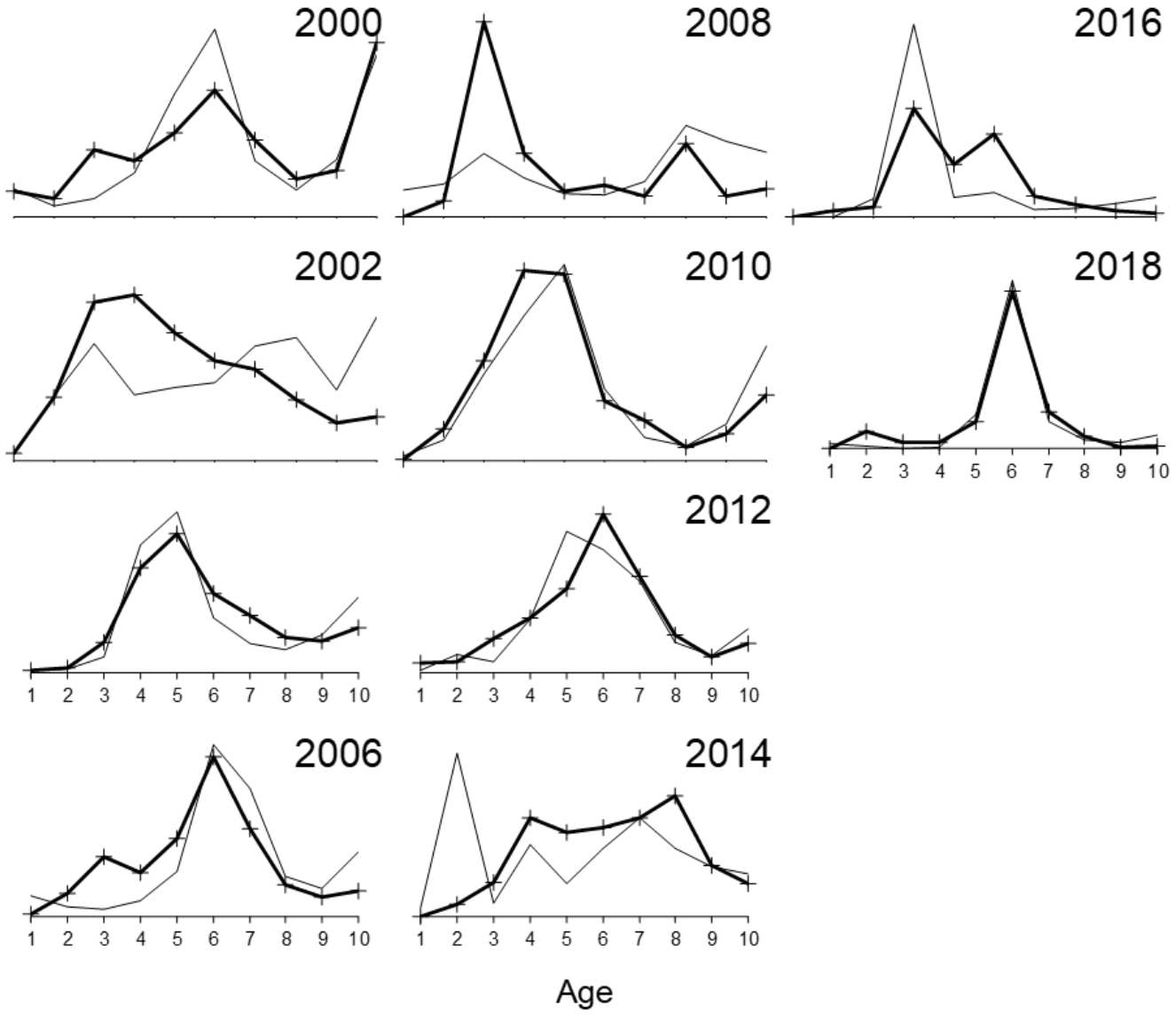
NMFS bottom trawl age composition (predicted vs observed)



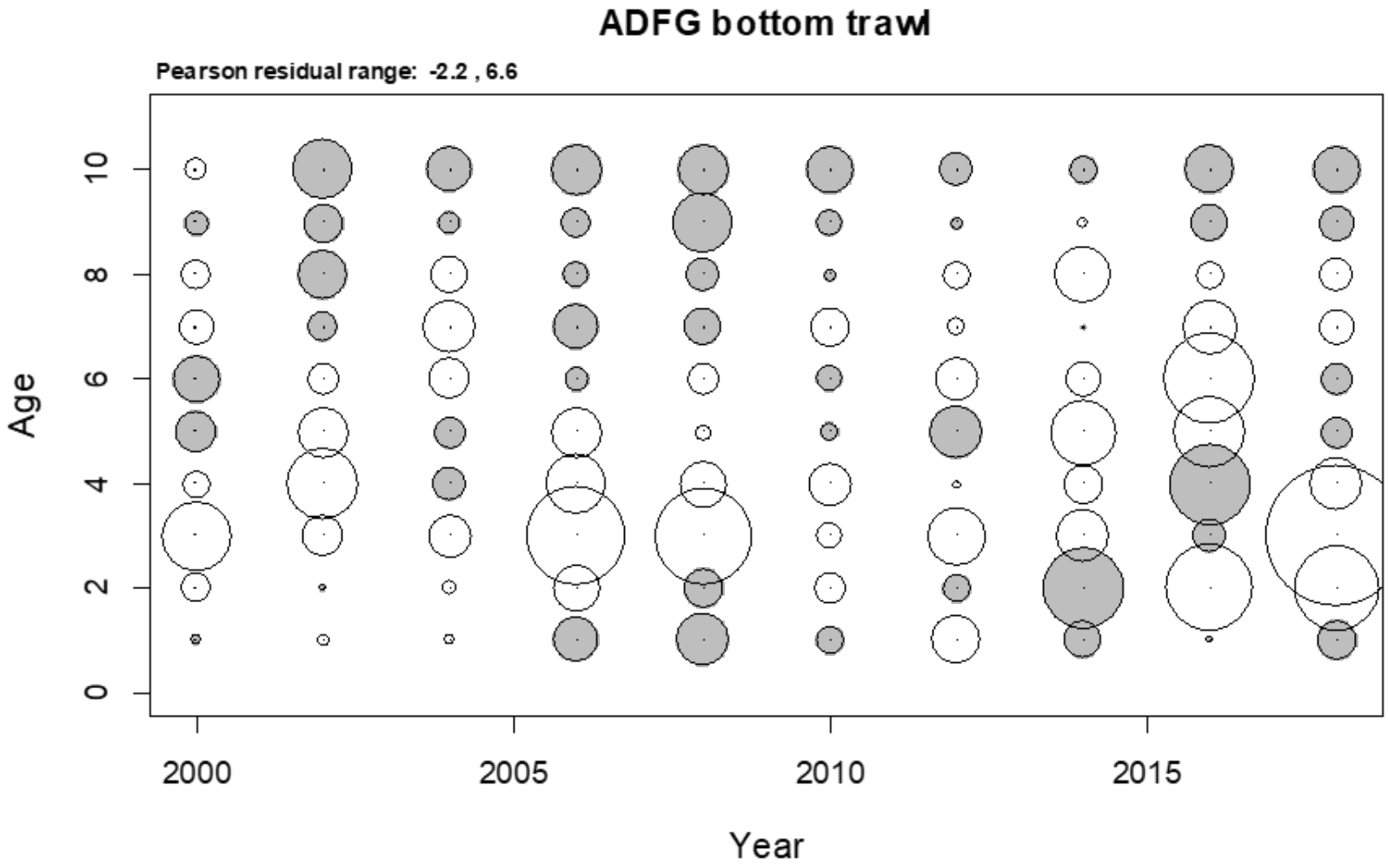
NMFS bottom trawl age composition (residuals)



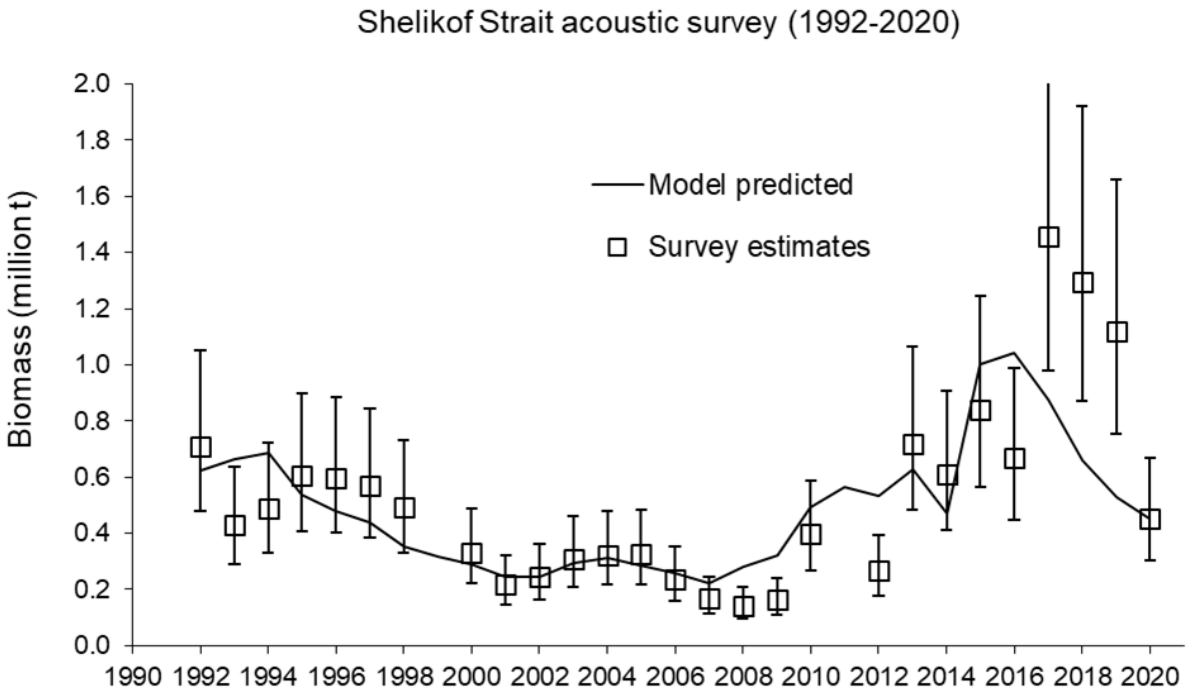
ADFG bottom trawl age composition (predicted vs observed)



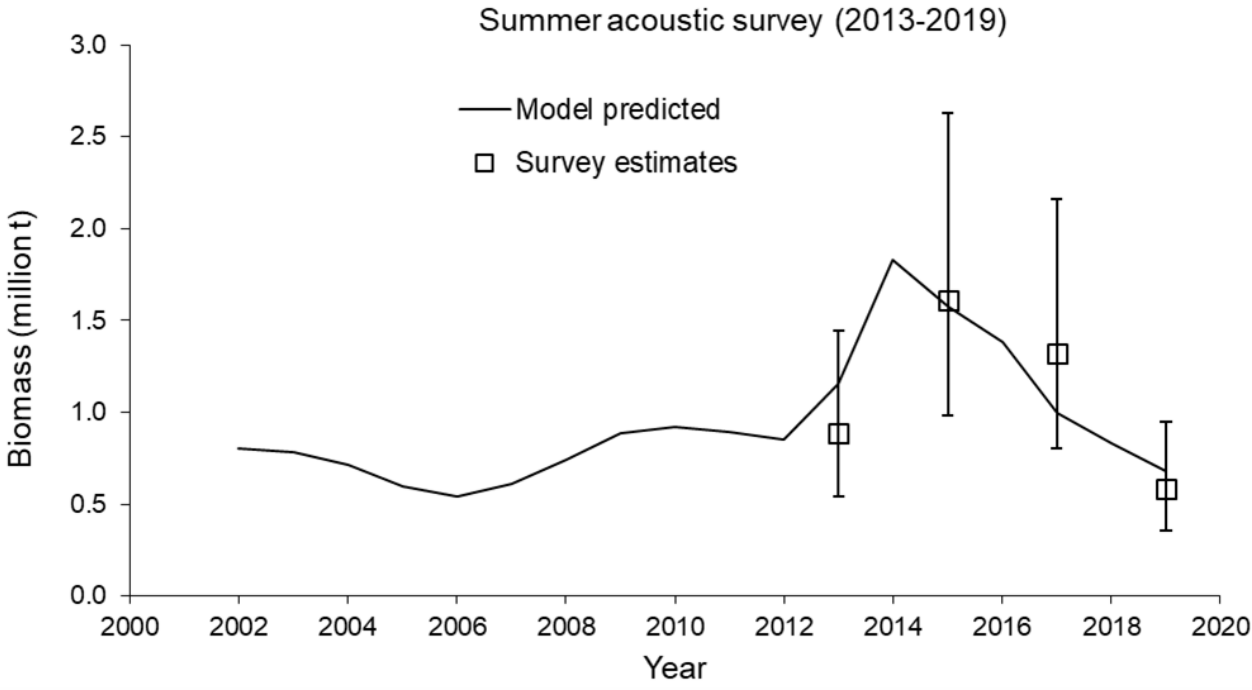
ADFG bottom trawl age composition (residuals)



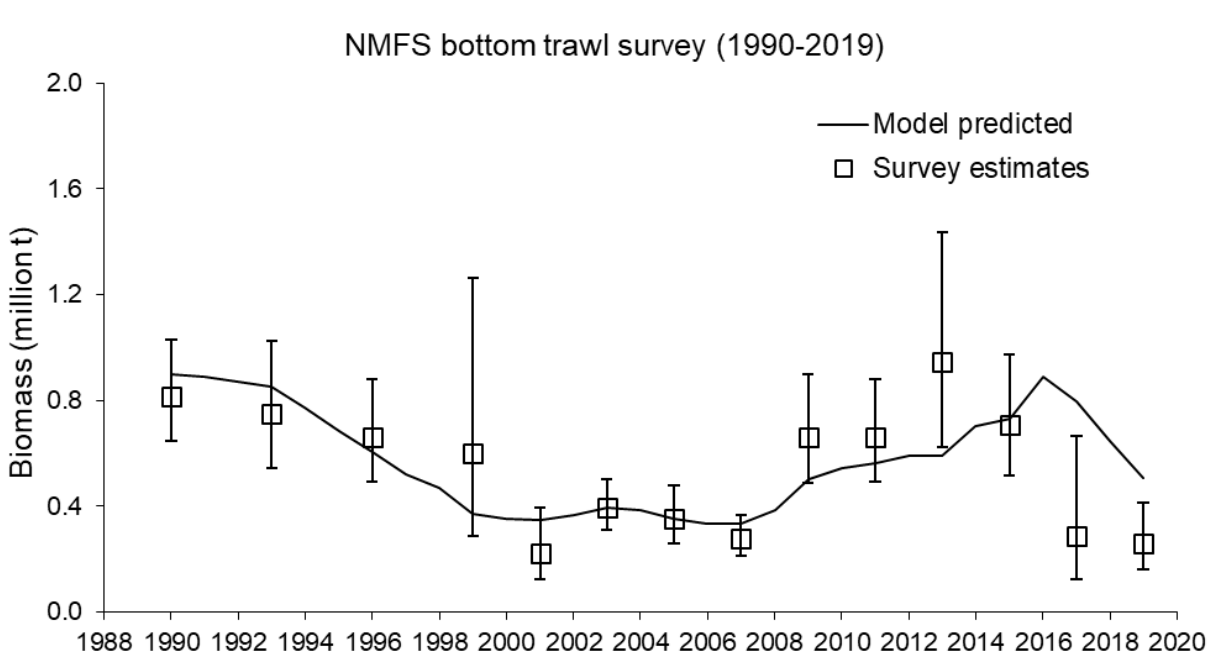
Fit to Shelikof Strait acoustic survey



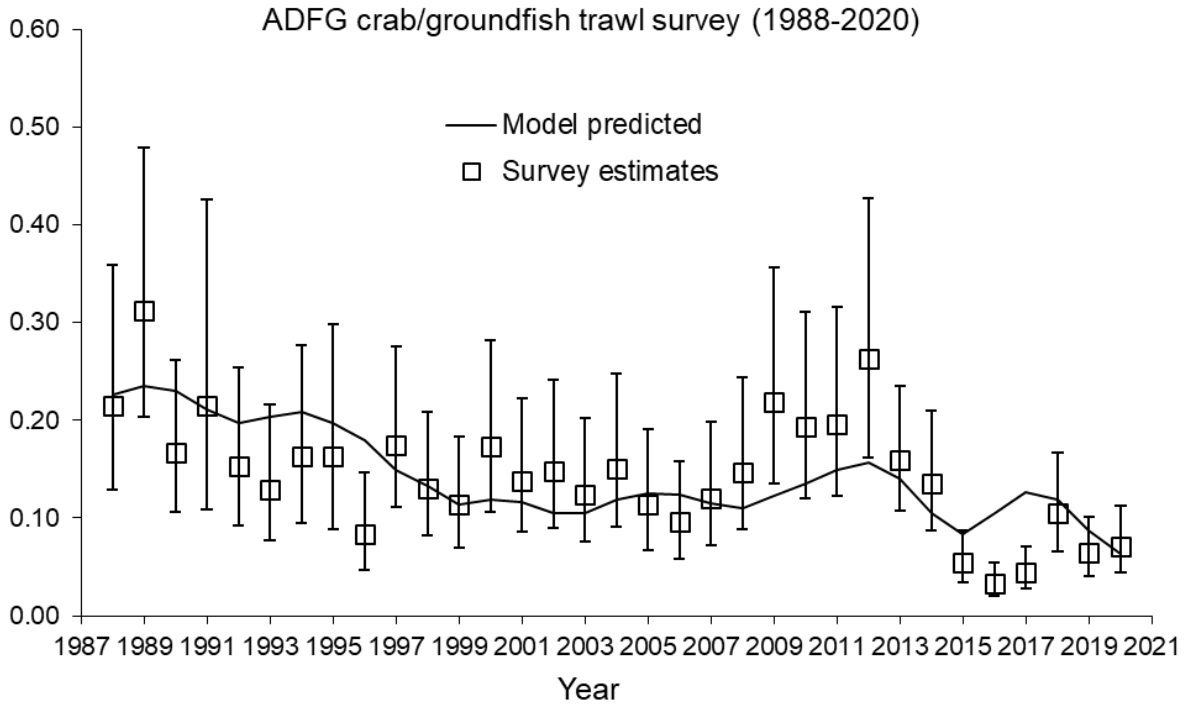
Fit to summer Acoustic survey



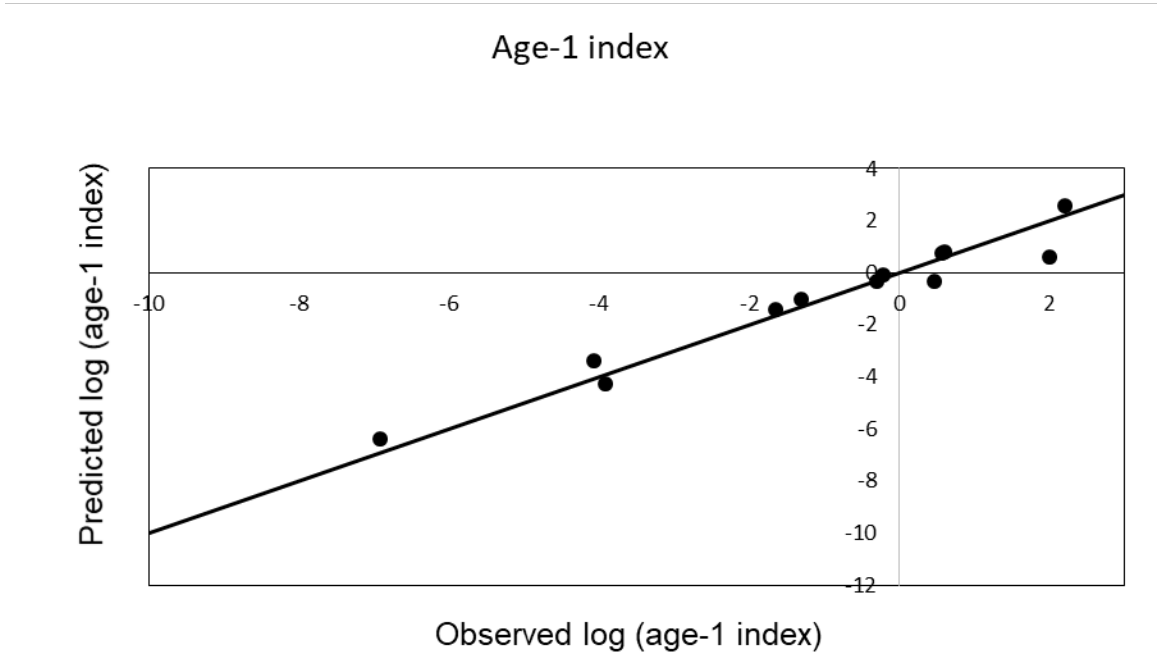
Fit to NMFS bottom trawl survey



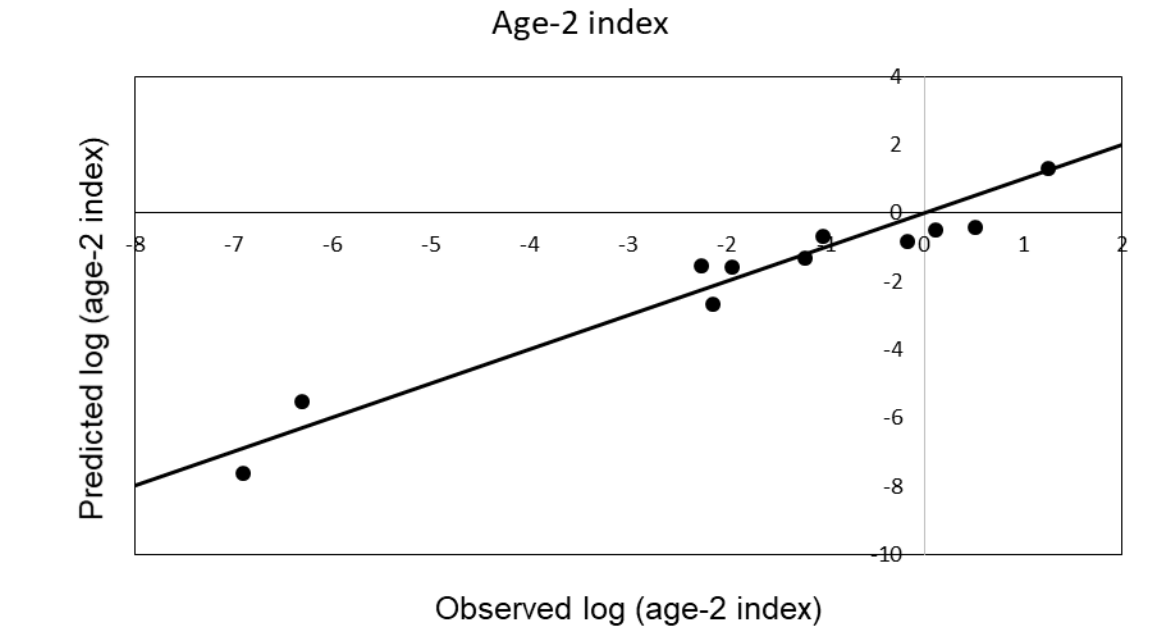
Fit to ADFG survey



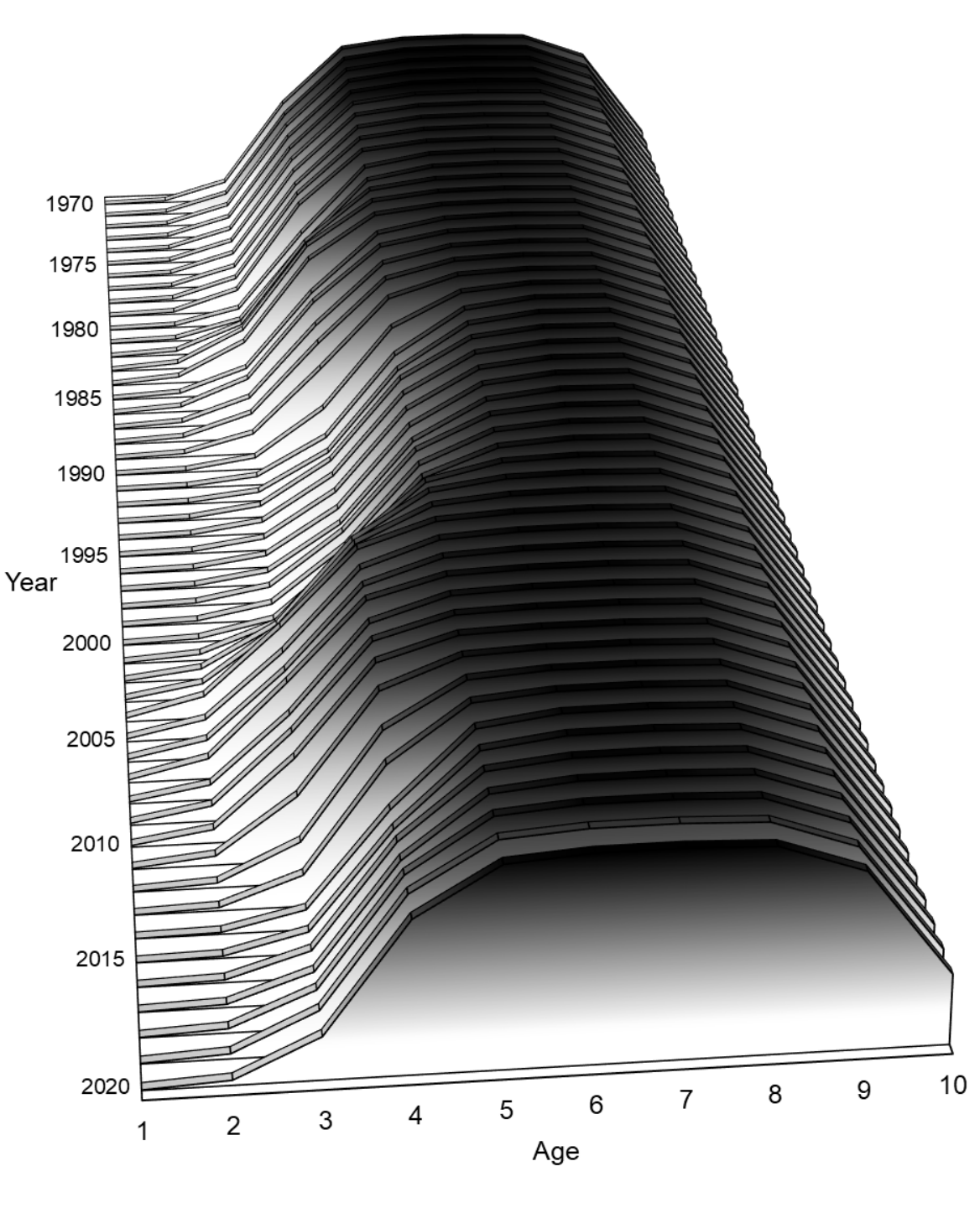
Fit to Age-1 index



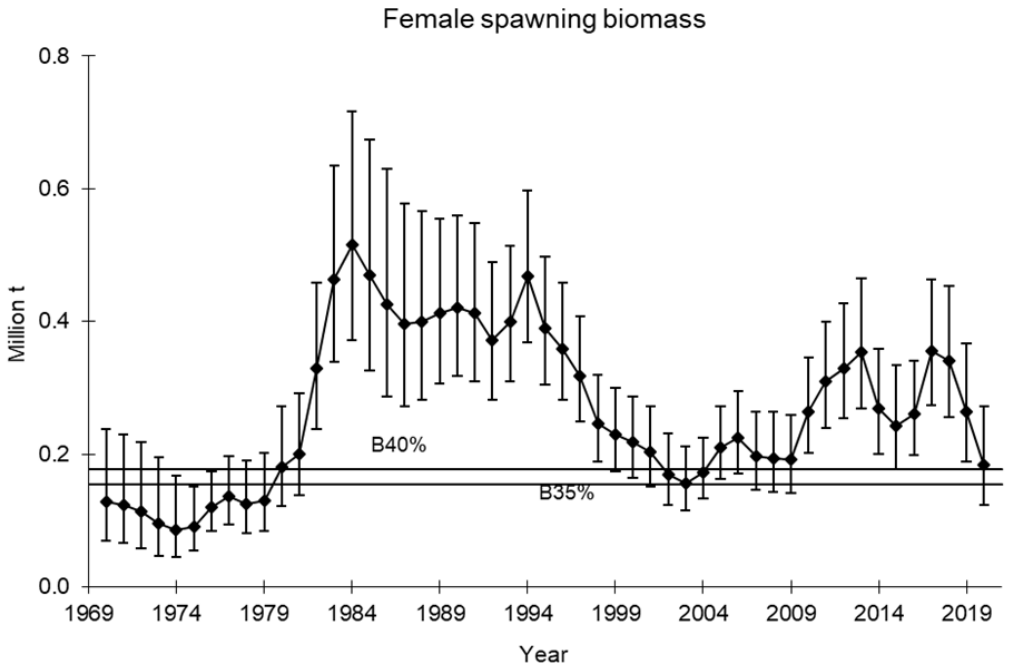
Fit to Age-2 index



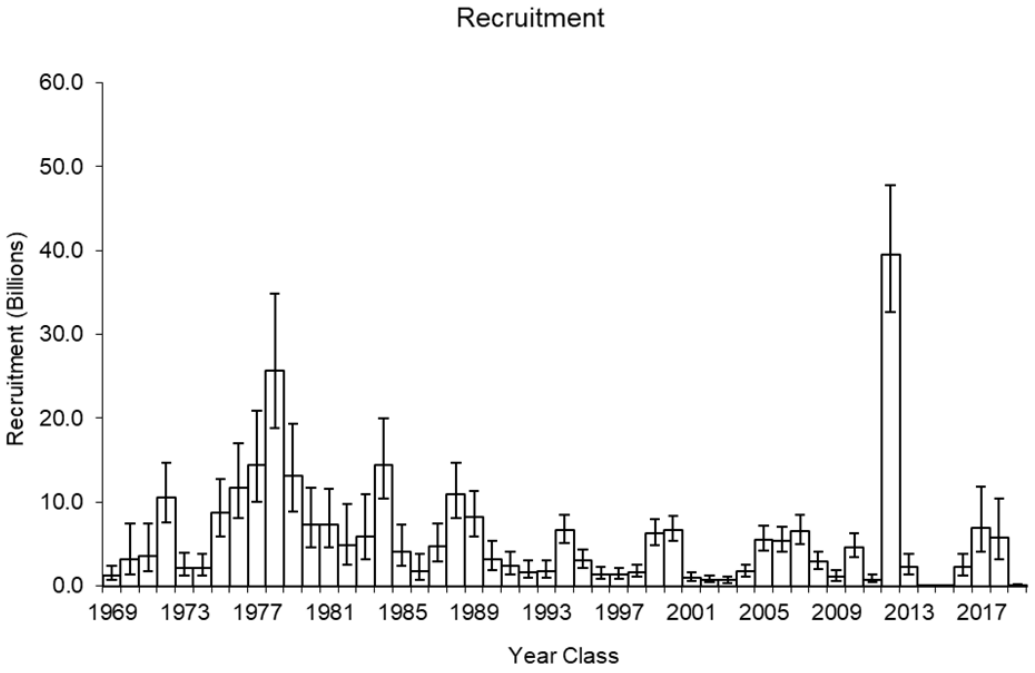
Fishery selectivity



Spawning biomass

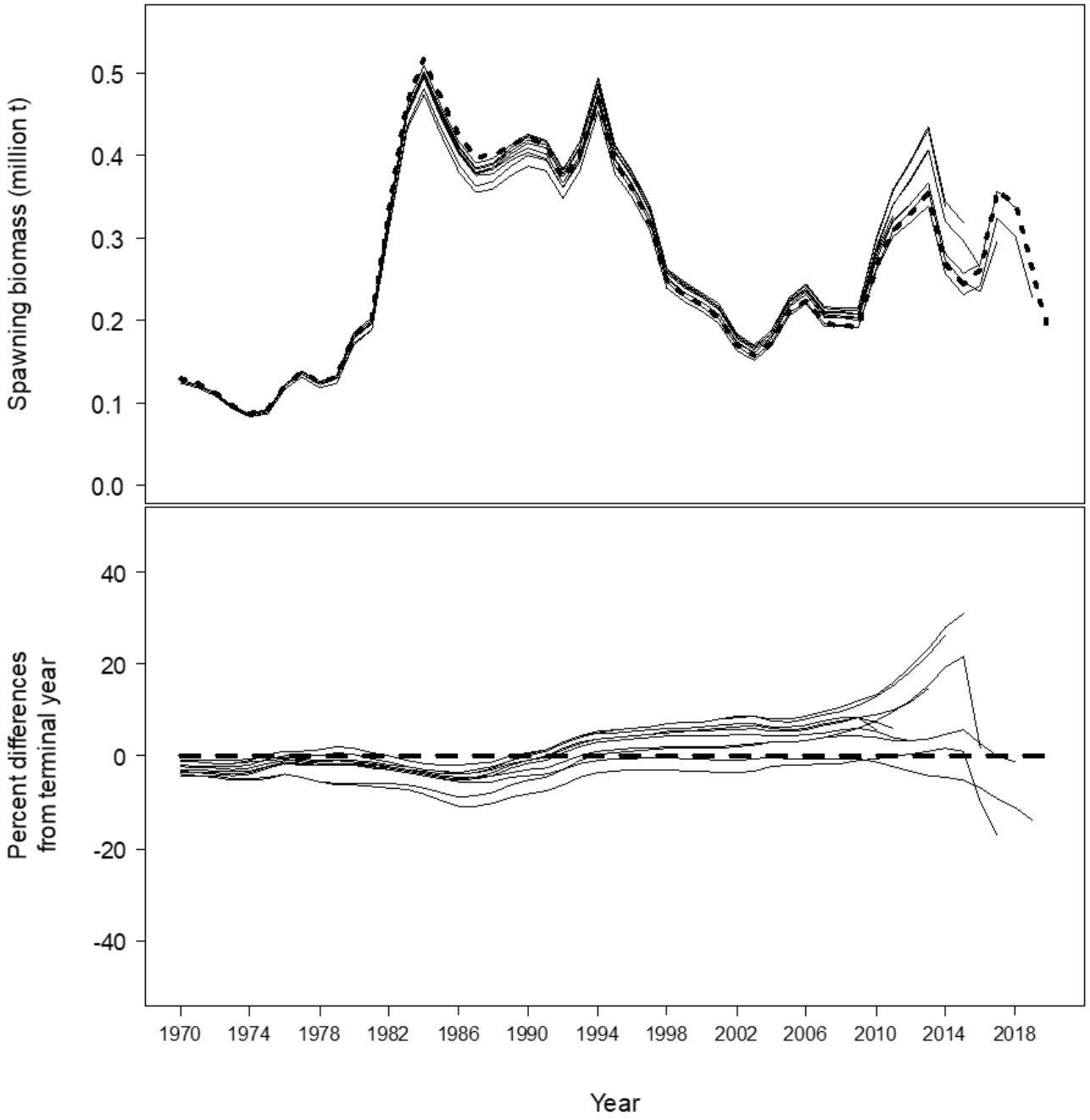


Recruitment

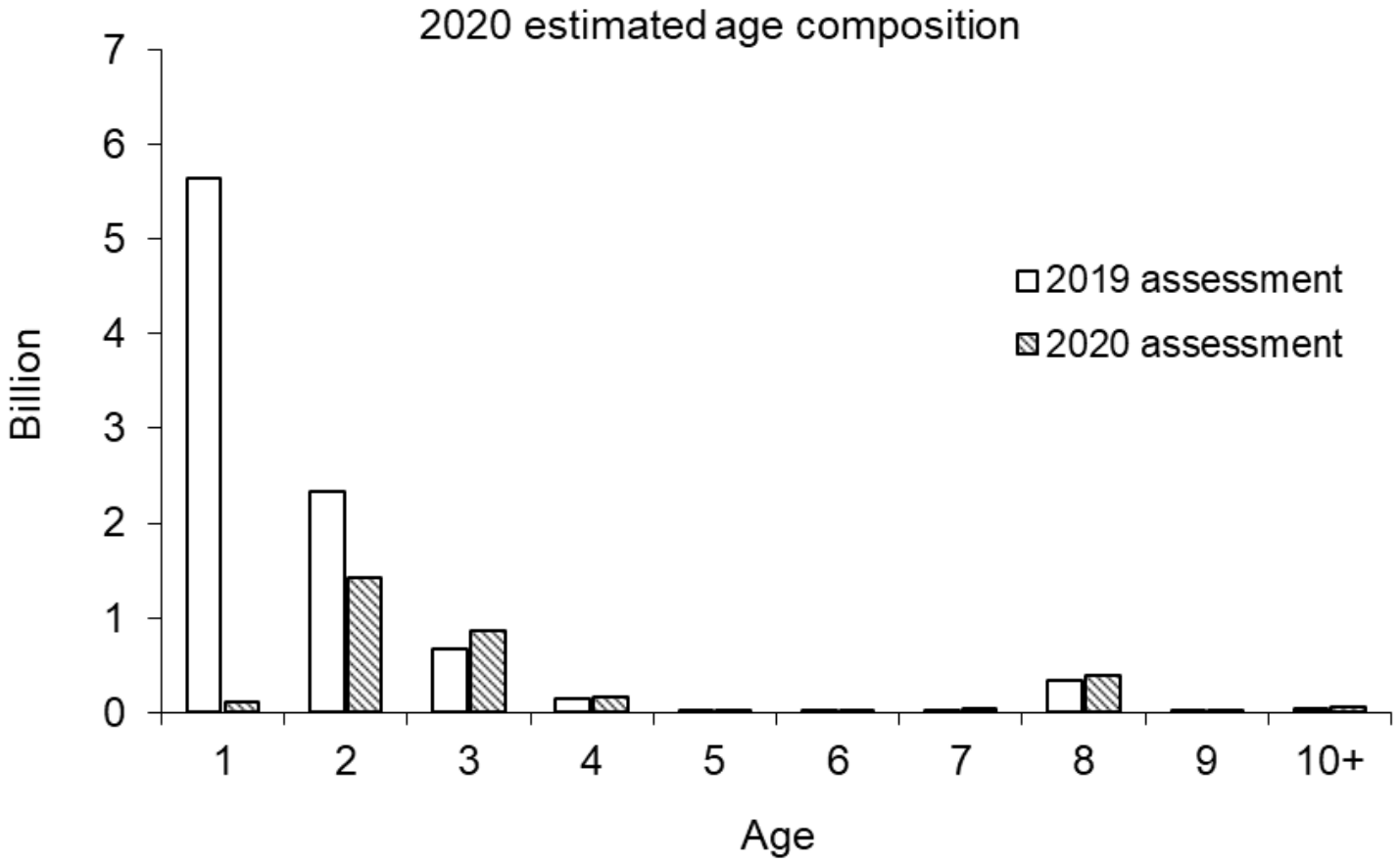


Retrospective plot

Mohn's ρ = 0.057

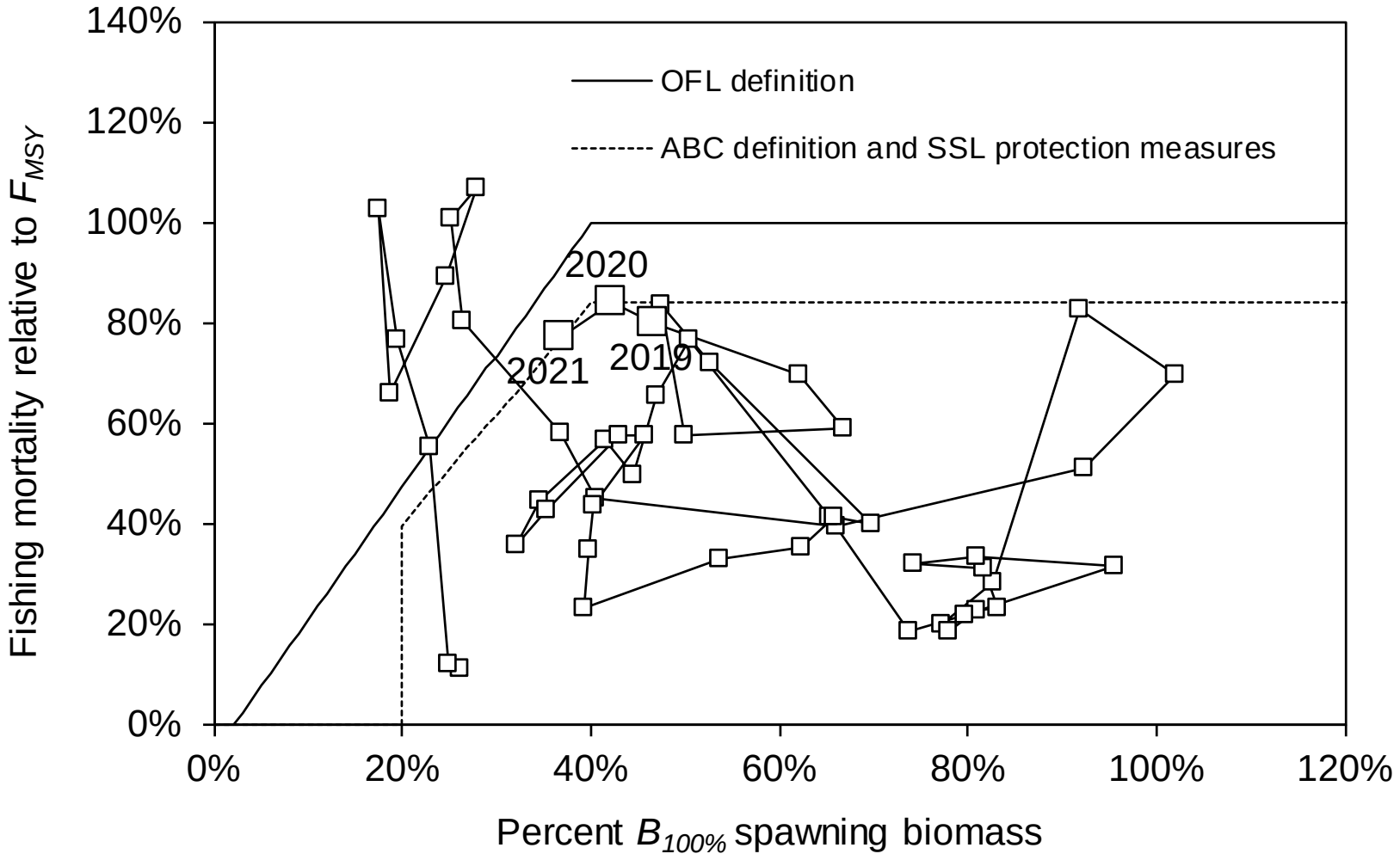


Changes in estimated age composition

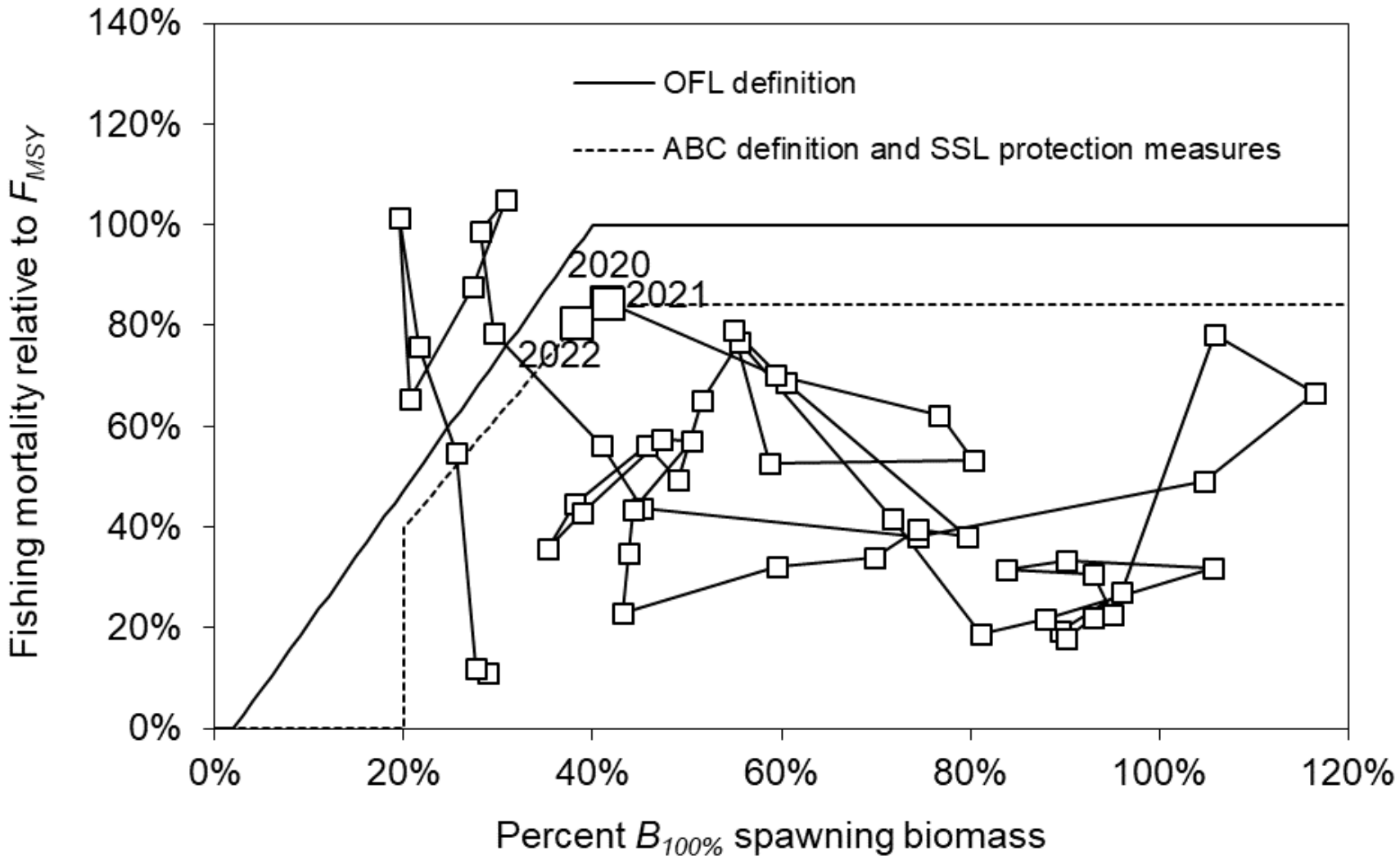


From 2019 GOA pollock ESP: *"Early indicators of 2019 year-class strength suggest a weak year class, following average to moderately large year-classes in 2017 and 2018."*

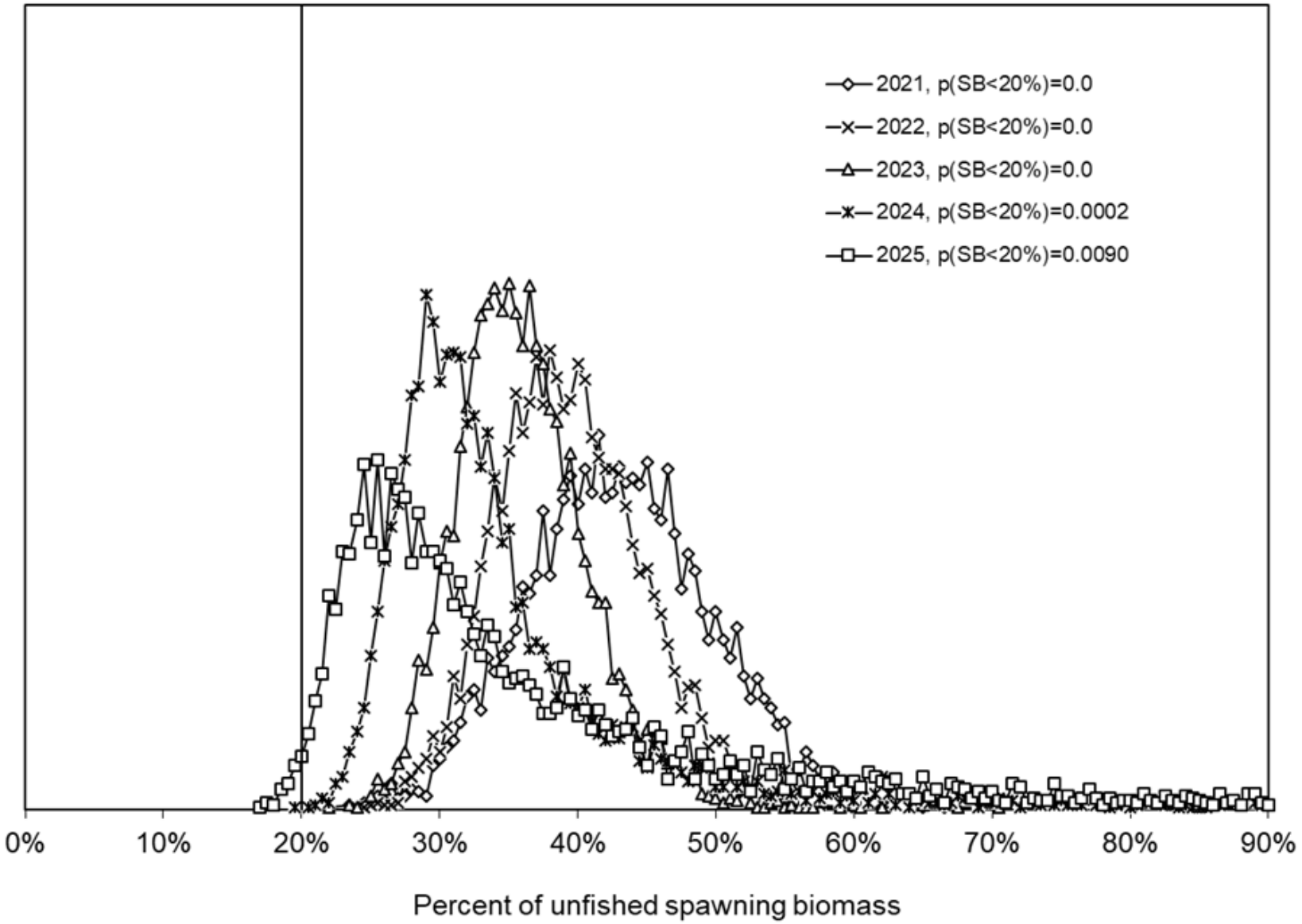
Spawning biomass vs fishing mortality (last year)



Spawning biomass vs fishing mortality (this year)

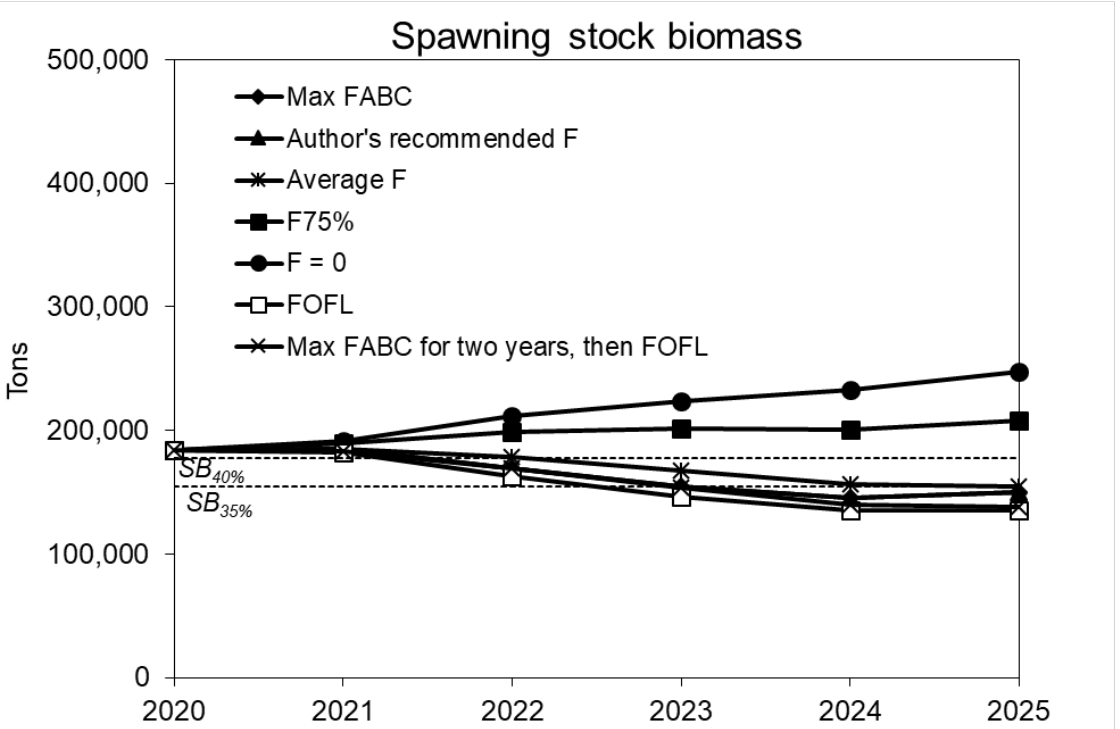


5-year pr(SB<B20%)

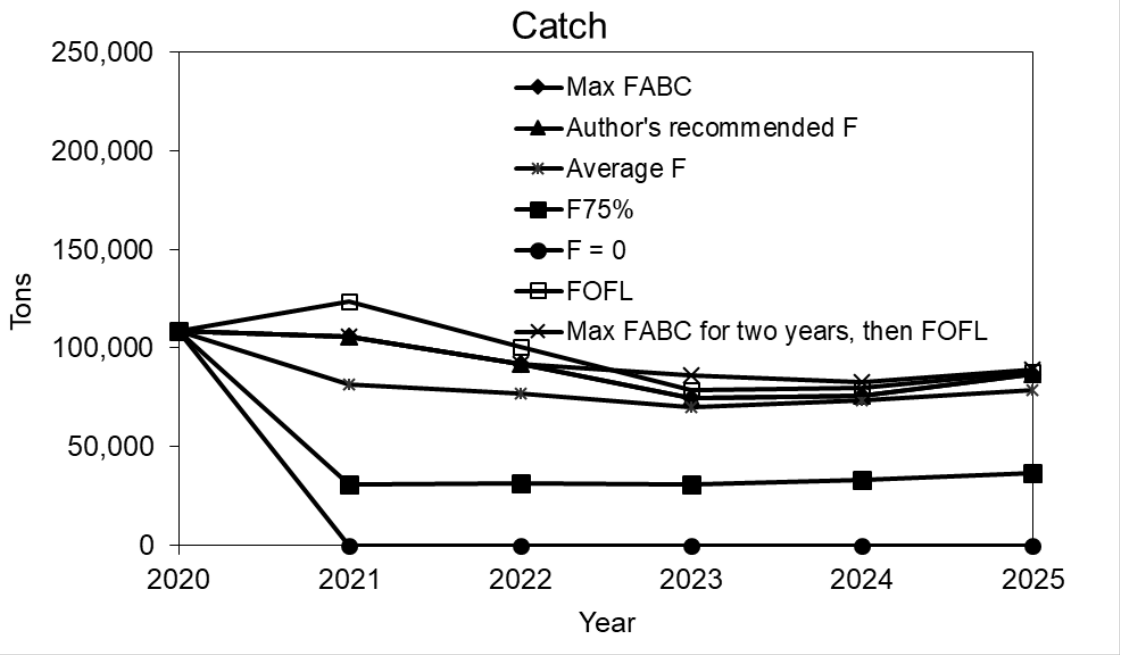


5-year projections

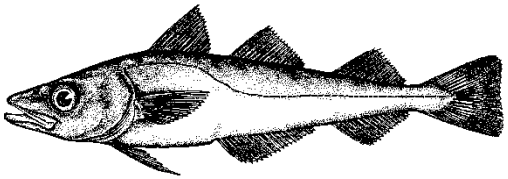
Mean spawning biomass



Mean yield

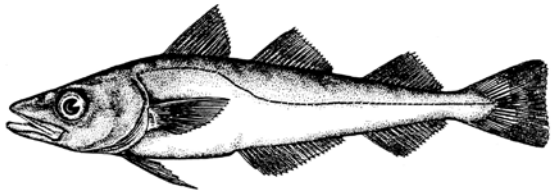


Gulf of Alaska pollock
Risk Matrix Criteria



	Assessment-related considerations	Population dynamics considerations	Environmental/ecosystem considerations	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 relevant to the stock but the pattern is not consistent across all indicators.	Some indicators showing adverse signals but the pattern is not consistent 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 as the stock, and/or b) up or down trophic levels (i.e., predators and prey of the 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 likely to impact the stock

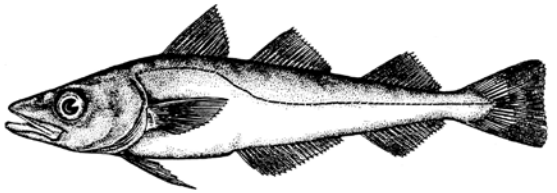
Gulf of Alaska pollock
Risk Matrix Evaluation



Assessment-related considerations	**Population dynamics considerations**	**Environmental/ecosystem considerations**	**Fishery performance**
2020 surveys conducted showed consistent relative trends, and were fit well. Severe decline in the 2018 year class abundance between the 2019 and 2020 Shelikof Strait acoustic surveys. Reason for decline is uncertain. **Conclusion: Level 1: no increased concerns**	The 2017 and 2018 year classes are estimated to be close to the long-term average, and population age structure is continuing to shift away from the extreme dominance of the 2012 year class. **Conclusion: Level 1: no increased concerns**	Sea surface temperatures returned to the mean during 2020, except for the western GOA, where summer temperatures periodically met the heatwave threshold. Zooplankton biomass was moderate for both euphausiids and large copepods suggesting no prey limitation. **Conclusion: Level 1: no increased concerns**	CPUE has been high but has declined in the last two years. Now above or close to long-term average and very consistent with exploitable biomass from the assessment. Numerous reports of undersize pollock being caught in season in 2020. **Conclusion: Level 1: No increased concerns**

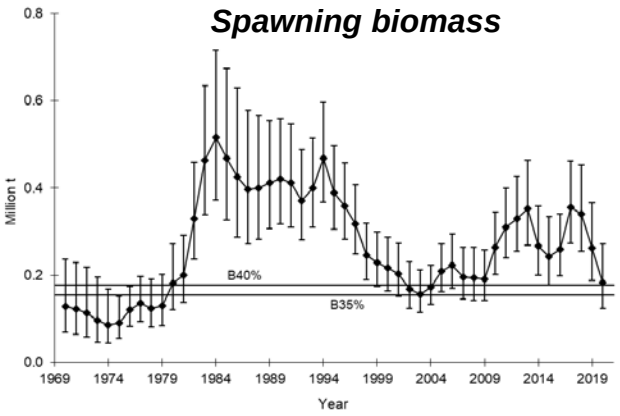
Author's recommended ABC = maximum permissible ABC
(no additional buffer recommended).

Gulf of Alaska pollock
Summary

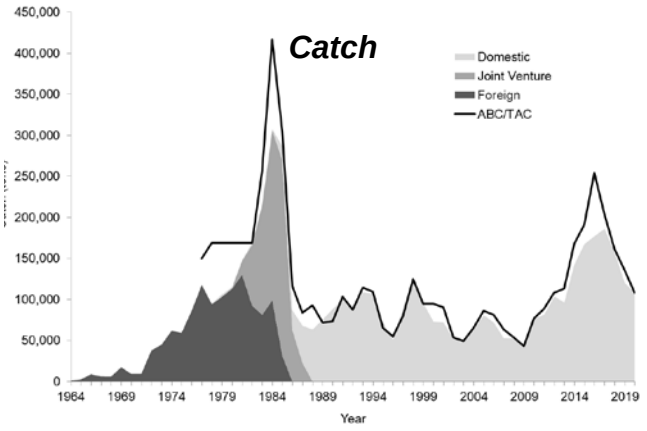


- **Changes to the assessment model**
  - None
- **Author's 2021 ABC 105,722 t**
  - Decrease of 3% from the 2020 ABC
  - 2022 ABC decreases to ~91,000 t
- **Concerns:**
  - Big drop Shelikof Strait survey
  - Big drop in 2018 year class from 2019 to 2020
  - Projections indicating a period of lower abundance and reduced harvests.
- **Positives**:
  - Environmental conditions are relatively "normal"
  - Conditions somewhat favorable for recruitment this year.

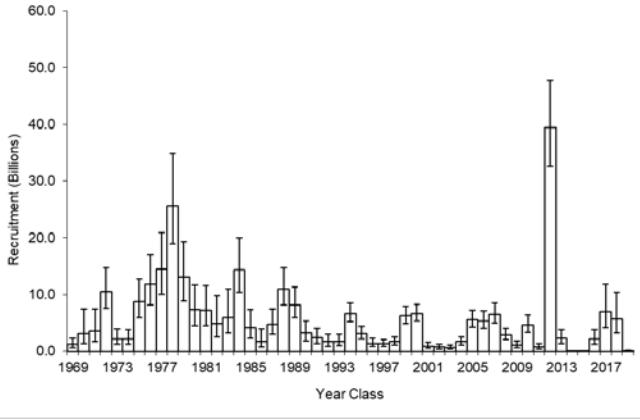
Spawning biomass



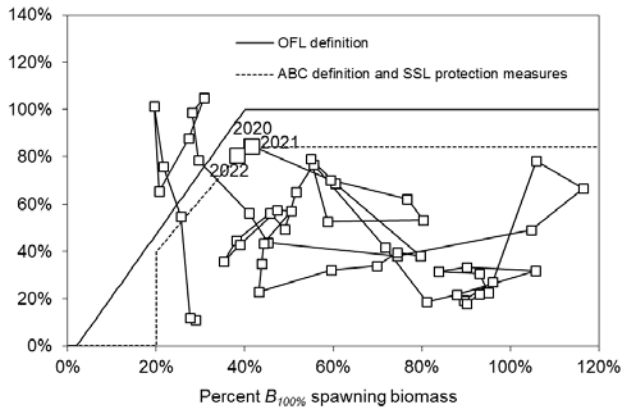
Catch



Recruitment



Status phase plot



Summary table

Quantity/Status	As estimated or specified *last* year for 2020	2021	As estimated or recommended *this* year for 2021	2022
M (natural mortality rate)	0.3	0.3	0.3	0.3
Tier	3a	3a	3a	3b
Projected total (age 3+) biomass (t)	1,007,850	1,270,080	1,097,340	812,182
Female spawning biomass (t)	206,664	184,094	184,530	169,577
$B_{100\%}$	485,000	485,000	443,000	443,000
$B_{40\%}$	194,000	194,000	177,000	177,000
$B_{35\%}$	170,000	170,000	155,000	155,000
F_{OFL}	0.33	0.30	0.33	0.30
$maxF_{ABC}$	0.28	0.26	0.28	0.26
F_{ABC}	0.23	0.28	0.28	0.26
OFL (t)	140,674	149,988	123,455	106,767
maxABC (t)	120,549	124,320	105,722	91,934
ABC (t)	108,494	111,888	105,722	91,934
Status	As determined *last* year for 2018	2019	As determined *this* year for 2019	2020
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

Summer apportionment table (**no change**):

Weights of 1.0, 0.5, and 0.25 for 2019, 2017, and 2015, respectively

Summer acoustic estimates

Biomass (t)

Year	*Area 610*	*Area 620*	*Area 630*	*Area 640*
2015	425,952	476,006	632,316	63,955
2017	408,334	338,923	498,460	72,679
2019	119,502	201,711	207,058	43,204

Percent

	Area 610	*Area 620*	*Area 630*	*Area 640*
2015	26.65%	29.78%	39.56%	4.00%
2017	30.97%	25.71%	37.81%	5.51%
2019	20.91%	35.30%	36.23%	7.56%

Bottom trawl estimates

Biomass (t)

Year	*Area 610*	*Area 620*	*Area 630*	*Area 640*
2015	403,884	98,001	181,482	24,408
2017	214,605	23,658	43,803	6,878
2019	119,312	36,450	90,921	10,921

Percent

	Area 610	*Area 620*	*Area 630*	*Area 640*
2015	57.06%	13.85%	25.64%	3.45%
2017	74.27%	8.19%	15.16%	2.38%
2019	46.32%	14.15%	35.29%	4.24%

Options for allocation

Option 5: Weighted average of acoustic plus bottom trawl biomass (2015-2019)

Area 610	*Area 620*	*Area 630*	*Area 640*
432,996	321,688	441,463	66,282
34.30%	25.48%	34.97%	5.25%

Winter apportionment table (example calculations for one area)

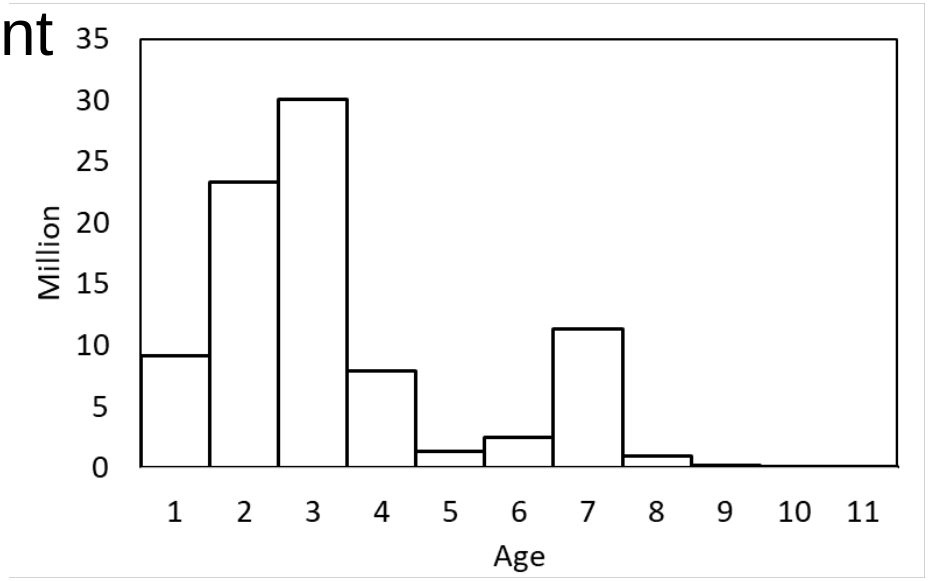
Survey	*Year*	*Model estimates of total 2+ biomass at spawning*	*Survey biomass estimate*	*Percent*	*Percent by management area*		
					Area 610	*Area 620*	*Area 630*
Shelikof	2017	1,092,970	1,457,295	133.3%	0.0%	99.1%	0.9%
Shelikof	2018	827,716	1,306,107	157.8%	0.0%	93.9%	6.1%
Shelikof	2019	701,356	1,219,160	173.8%	0.0%	97.1%	2.9%
Shelikof	2020	622,300	456,457	73.3%	0.0%	97.7%	2.3%
Shelikof	Average			134.6%	0.0%	96.9%	3.1%
	Percent of total biomass				0.0%	130.5%	4.1%

Winter apportionment table

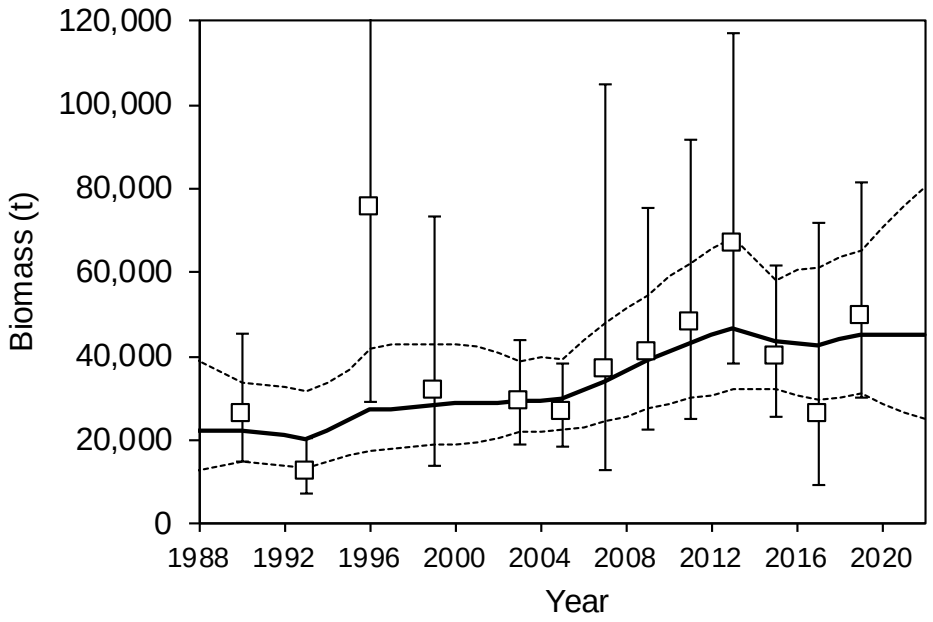
Survey	Year	Model estimates of total 2+ biomass at spawning	Survey biomass estimate	Percent	Percent by management area: Area 610	Area 620	Area 630
Shelikof	Average			134.6%	0.0%	96.9%	3.1%
	Percent of total biomass				0.0%	130.5%	4.1%
Chirikof	Average			2.2%	0.0%	33.3%	66.7%
	Percent of total biomass				0.0%	0.7%	1.4%
Marmot	Average			1.3%	0.0%	0.0%	100.0%
	Percent of total biomass				0.0%	0.0%	1.3%
Shumagin	Average			1.5%	80.9%	19.1%	0.0%
	Percent of total biomass				1.2%	0.3%	0.0%
Sanak	Average			0.4%	100.0%	0.0%	0.0%
	Percent of total biomass				0.4%	0.0%	0.0%
Mozhovoi	Average			0.4%	100.0%	0.0%	0.0%
	Percent of total biomass				0.4%	0.0%	0.0%
Pavlof	Average			0.3%	100.0%	0.0%	0.0%
	Percent of total biomass				0.3%	0.0%	0.0%
Total				140.65%	2.30%	131.47%	6.88%
Rescaled total				100.00%	1.64%	93.47%	4.89%

Southeast Alaska Assessment

2019 age composition



Biomass trend



Southeast Pollock Summary Table

Quantity	As estimated or *specified last* year for: 2020	2021	As estimated or *recommended this* year for: 2021	2022
M (natural mortality rate)	0.3	0.3	0.3	0.3
Tier	5	5	5	5
Biomass (t)	45,103	45,103	45,103	45,103
F_{OFL}	0.30	0.30	0.30	0.30
$maxF_{ABC}$	0.23	0.23	0.23	0.23
F_{ABC}	0.23	0.23	0.23	0.23
OFL (t)	13,531	13,531	13,531	13,531
maxABC (t)	10,148	10,148	10,148	10,148
ABC (t)	10,148	10,148	10,148	10,148
Status	As determined *last* year for: 2018	2019	As determined *this* year for: 2019	2020
Overfishing	No	n/a	No	n/a

Extras