2020 BSAI Blackspotted/Rougheye Rockfish Assessment

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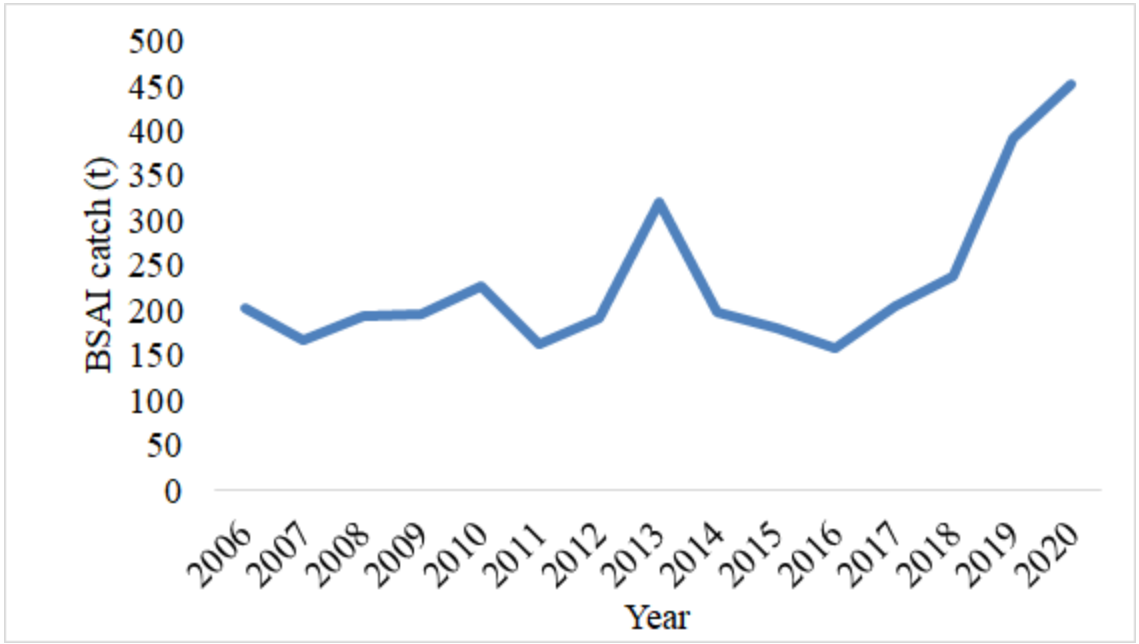
Overall summary

- Results sensitive to data weighting. We recommend Francis weighting (greater stability).
- Francis weighting results in lower biomass and ABCs (recommended ABC for 2021 of 482 t)
- 3 modeling changes
  - Natural mortality, ageing error, proportion mature at age
- Several concerns noted in risk table
- Spatially disproportionate harvesting a continued concern

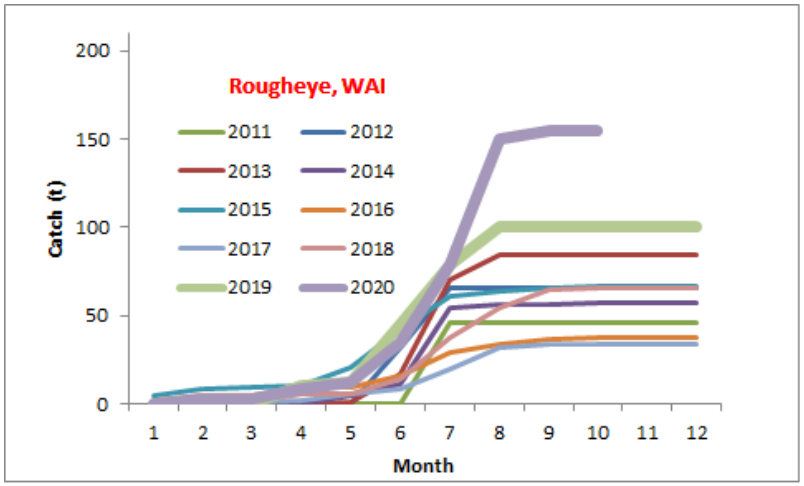
Outline

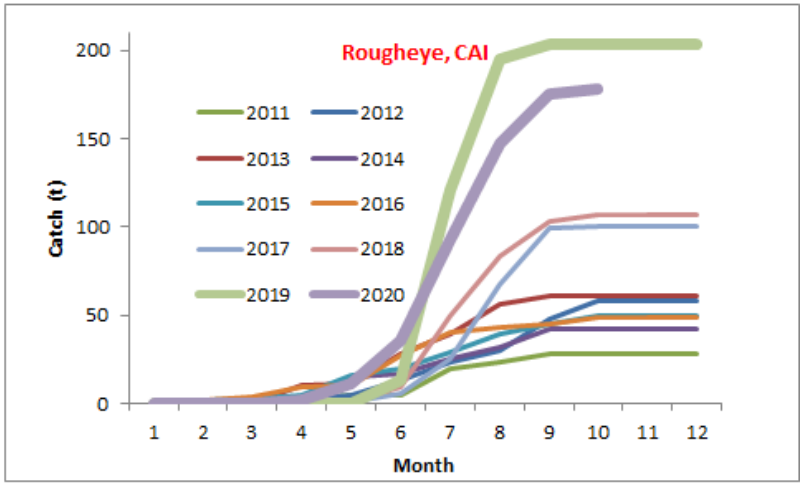
1) Catch information
2) Survey and fishery data
3) Model changes
4) Model description and evaluation
5) Monitoring of catch
6) Risk table
7) Management recommendations

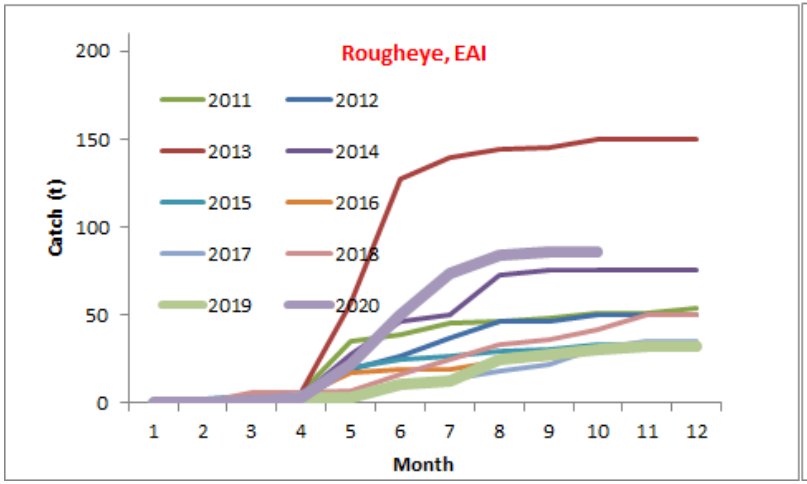
BSAI catch has increased in 2019-2020

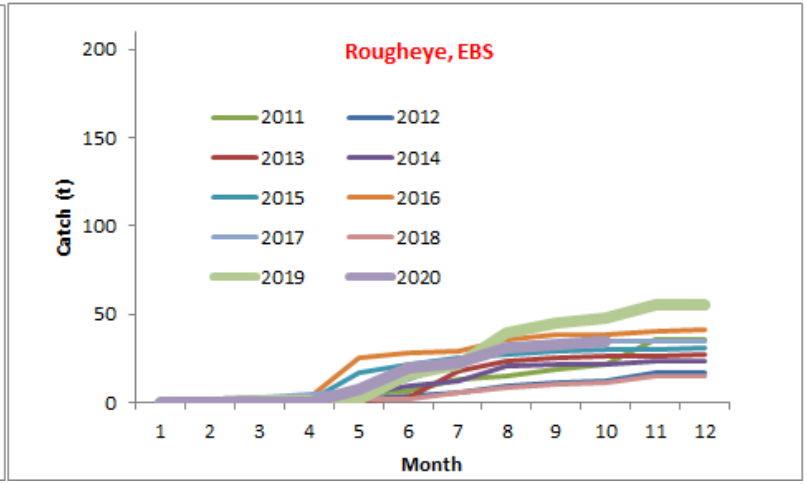


BSAI Blackspotted/Rougheye catch by month and area, 2011-2020

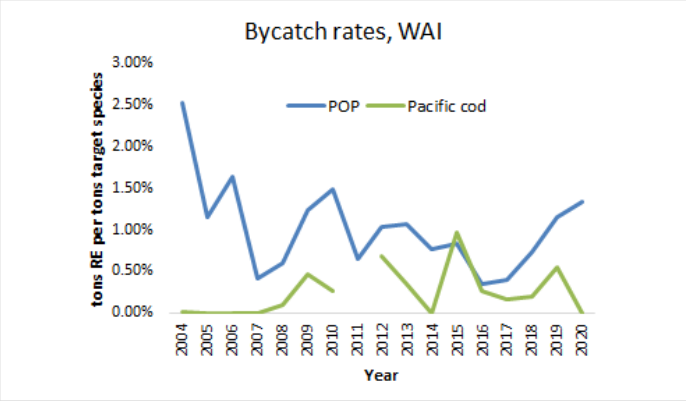


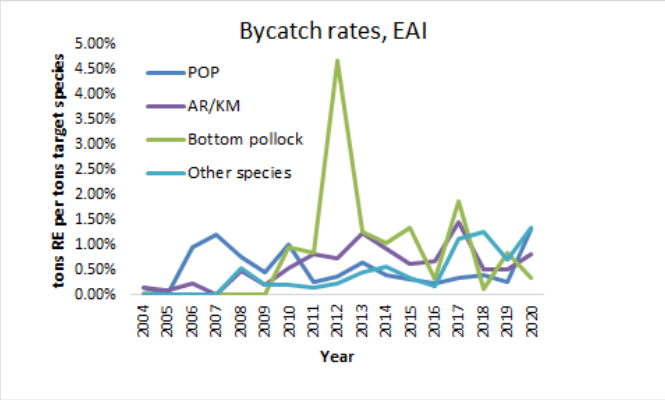


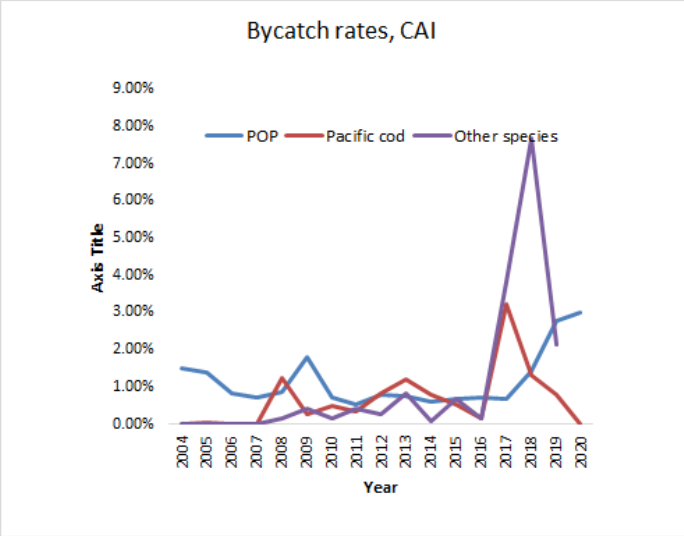


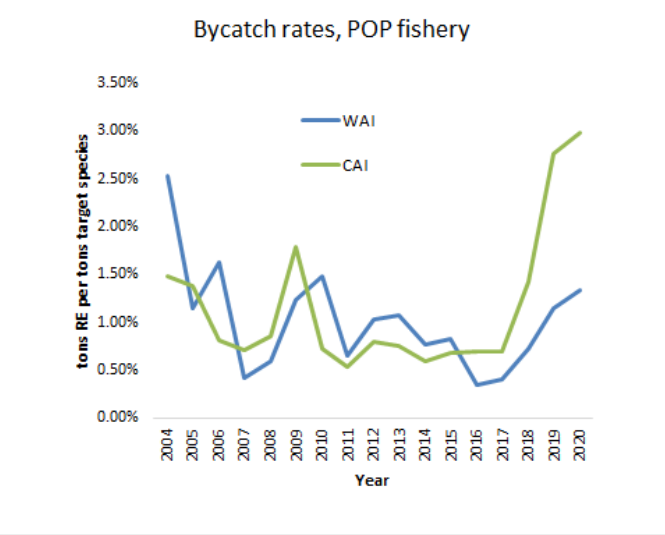


Bycatch rates, by target and area







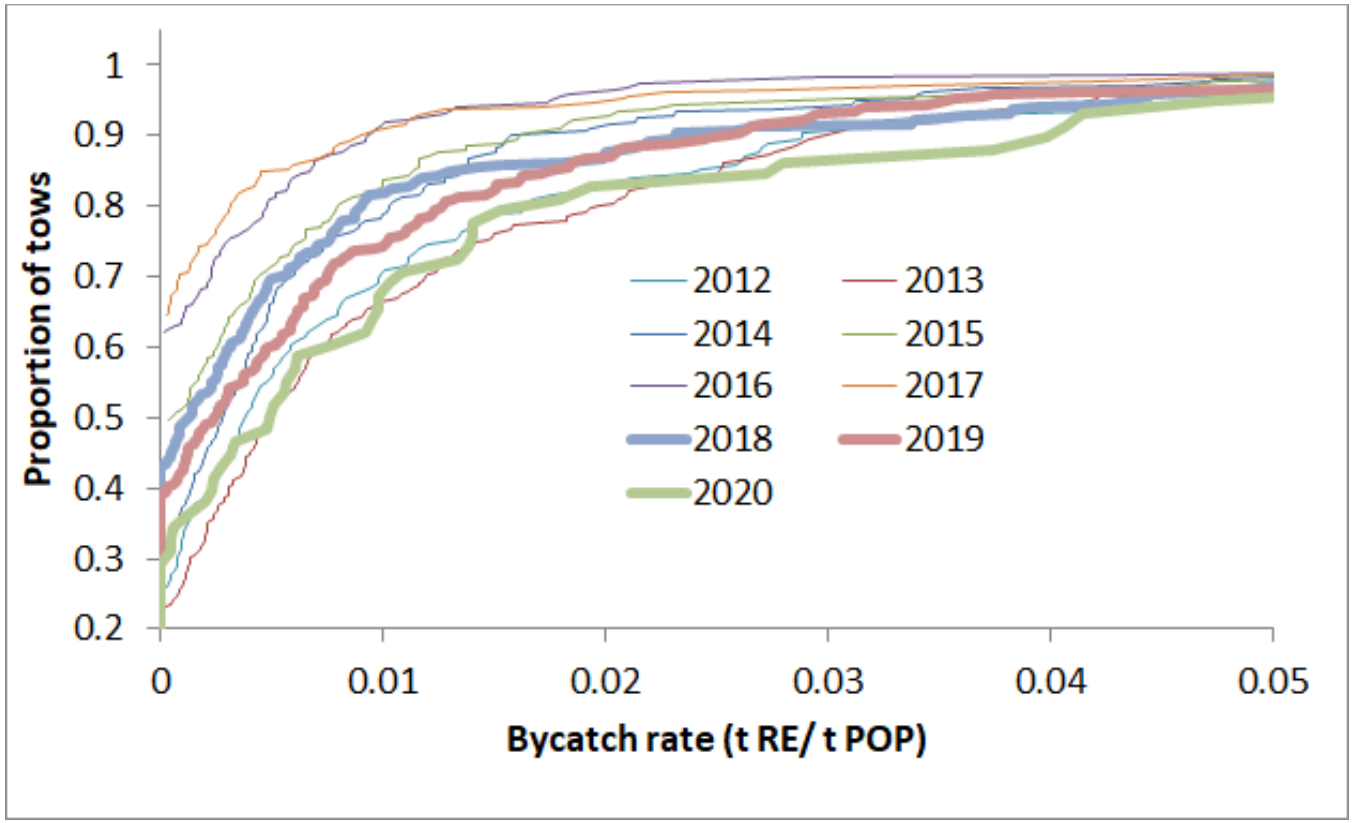


Bycatch is tons of rougheye per t of target species

Fishery targets assigned per haul based on species composition in Observed hauls

Source: North Pacific groundfish observer program

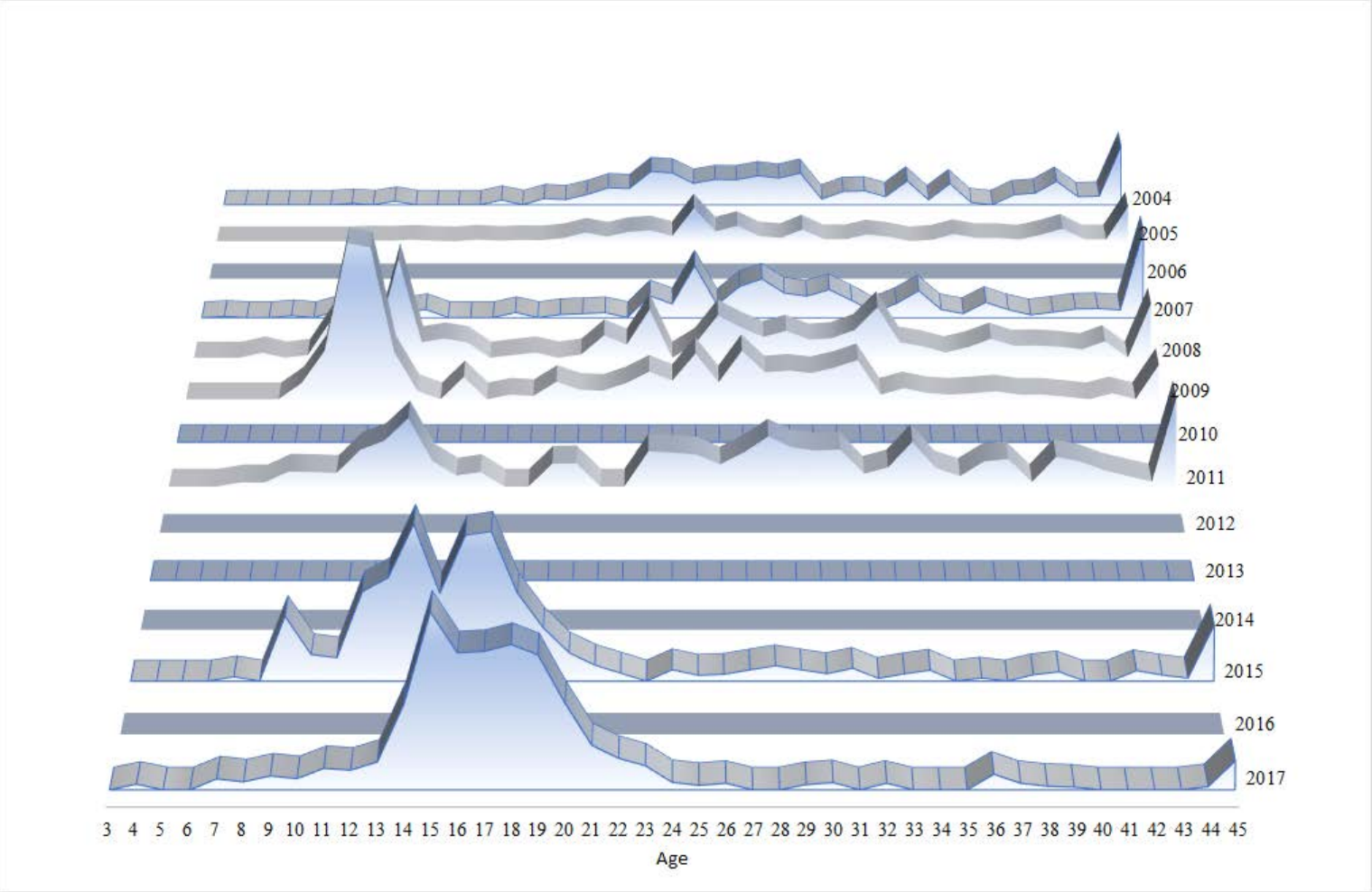
Distribution of bycatch rates (WAI, POP target, A80 vessels)



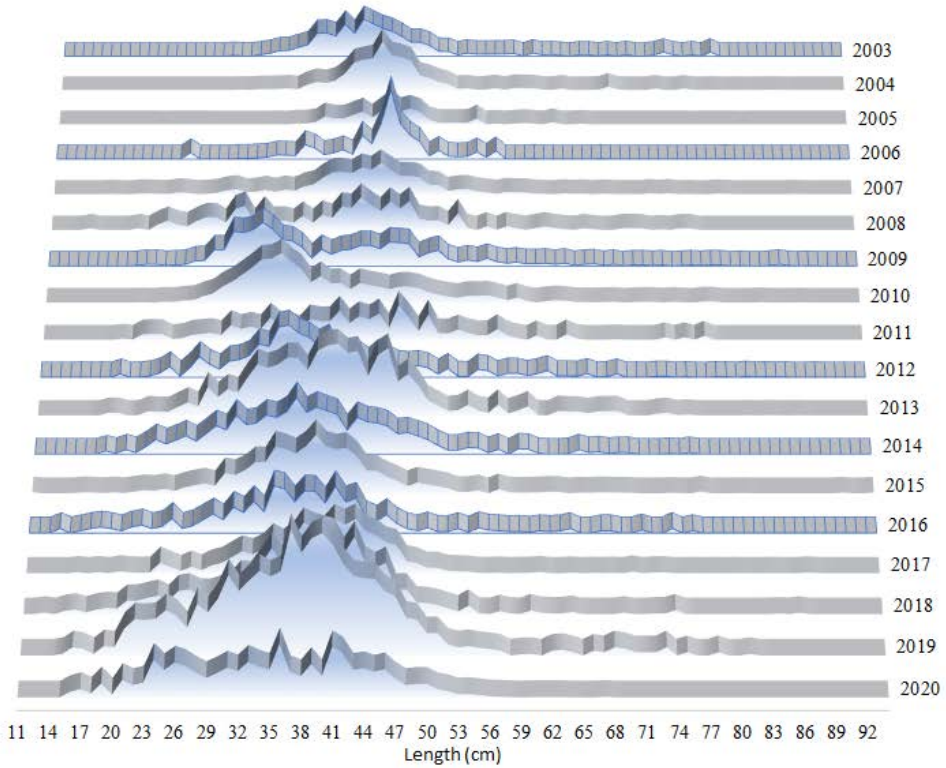
Data in assessment model

Component	Years
Fishery catch	1977-**2020**
Fishery age composition	2004-2005, 2007-2009, 2011, 2015, 2017
Fishery size composition	1979, 1990, 1992-1993, 2003, 2010, 2012-2014, 2016, **2018-2019**
AI Survey age composition	1991, 1994, 1997, 2000, 2002, 2004, 2006, 2010, 2012, 2014, 2016, **2018**
AI Survey biomass estimates	1991, 1994, 1997, 2000, 2002, 2004, 2006, 2010, 2012, 2014, 2018

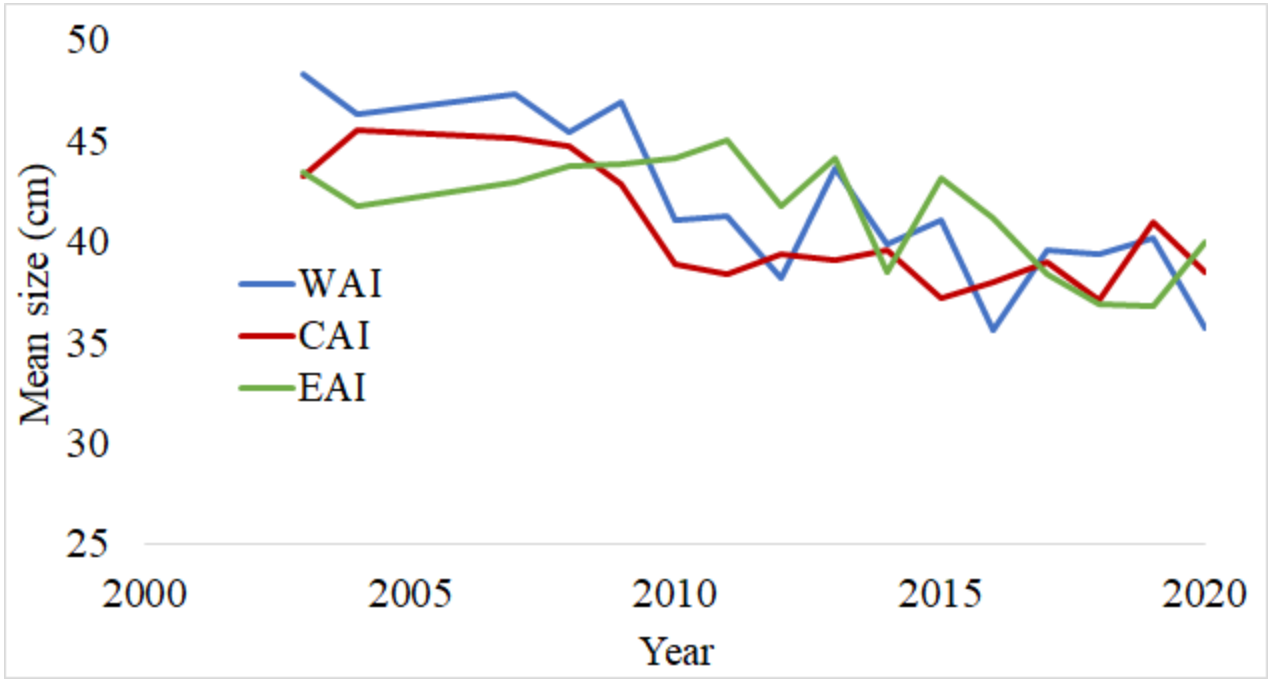
BSAI blackspotted/rougheye fishery age composition data



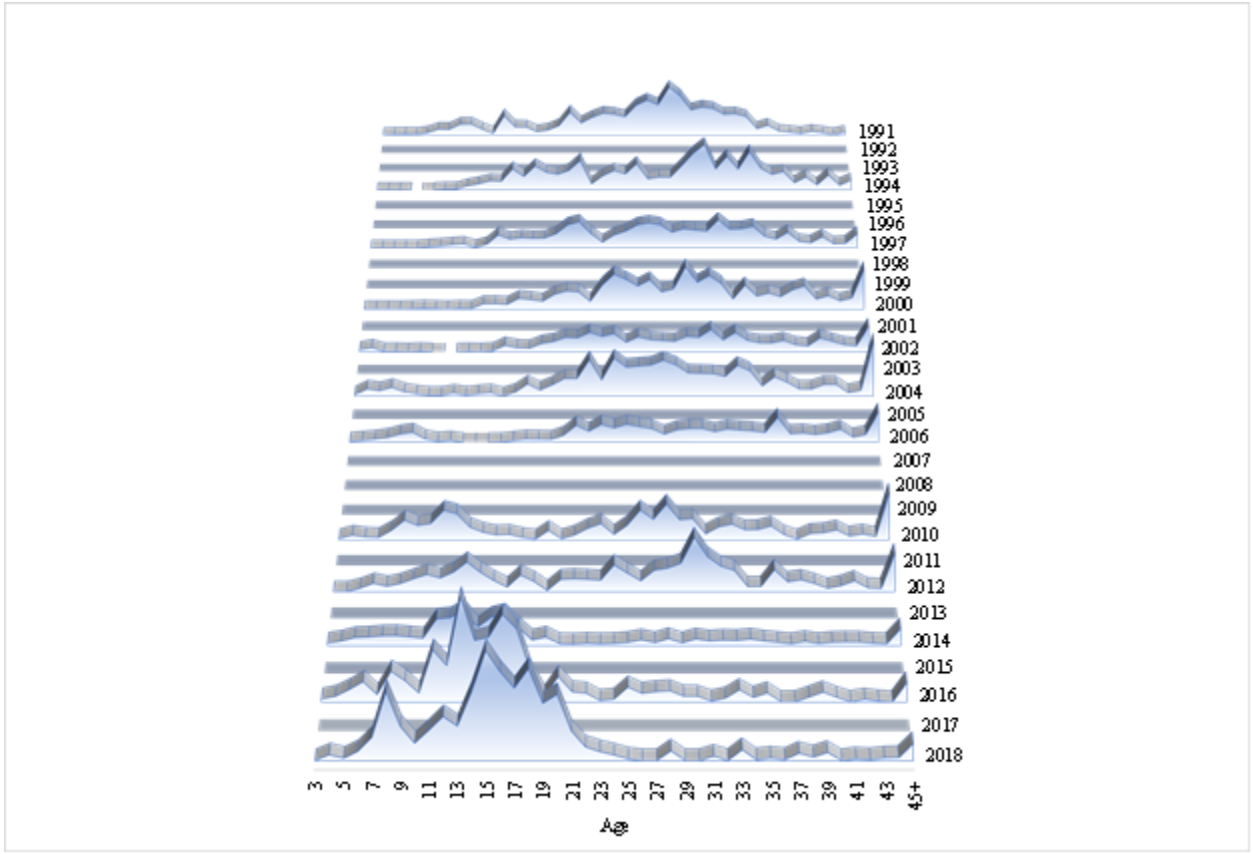
BSAI blackspotted/rougheye fishery length composition data



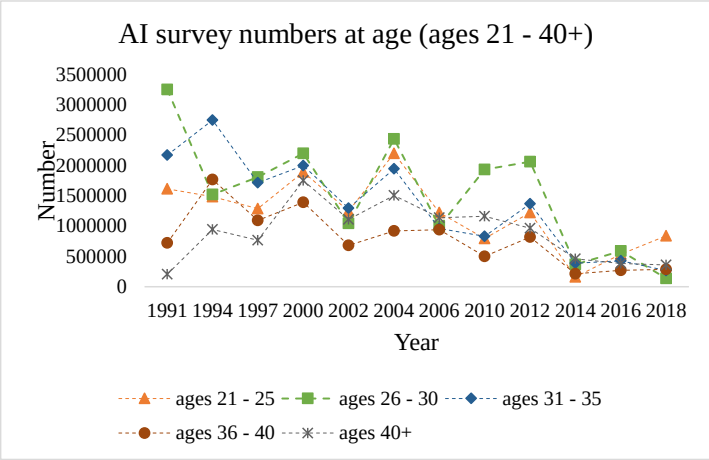
Decline in mean size caught in the fishery

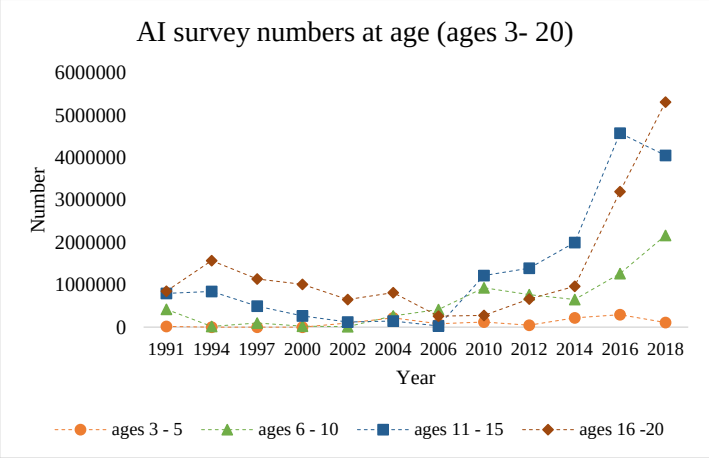


Absence of older fish in recent AI survey



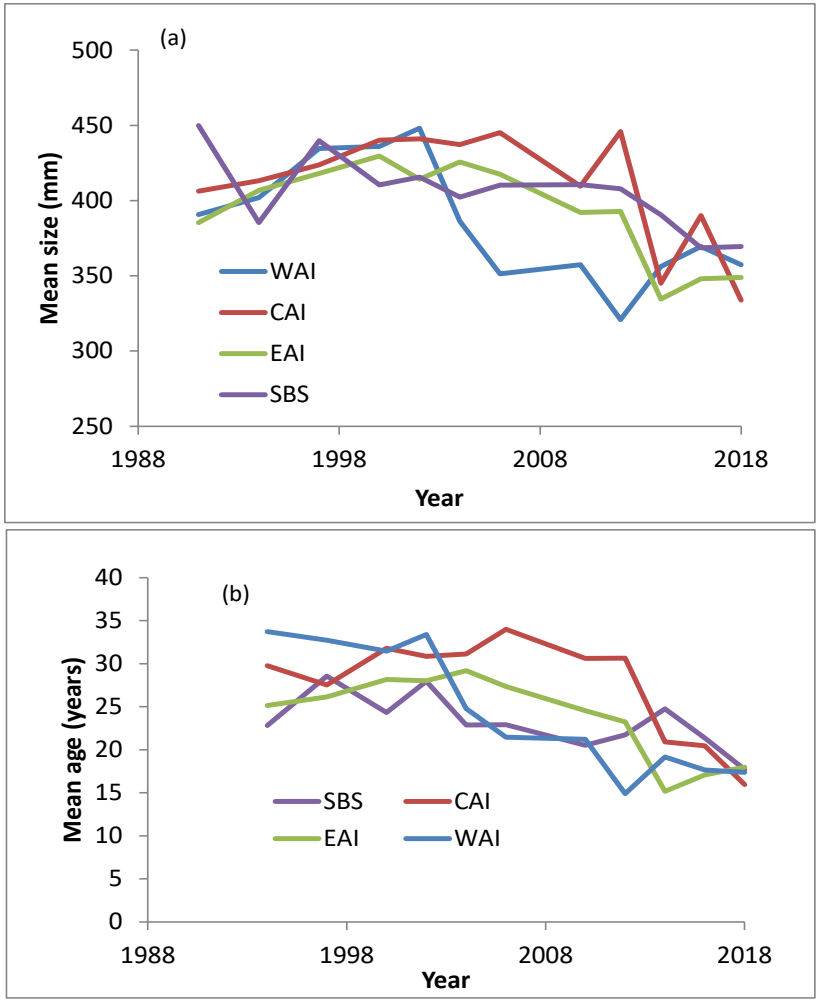
Decline of older fish, and increase of younger fish





Decline from 2012-2014	
Age group	Rate of decline
21-25	87%
26-30	82%
31-35	72%
36-40	74%
40+	52%

Reductions in fish size and age in AI survey



Modeling updates

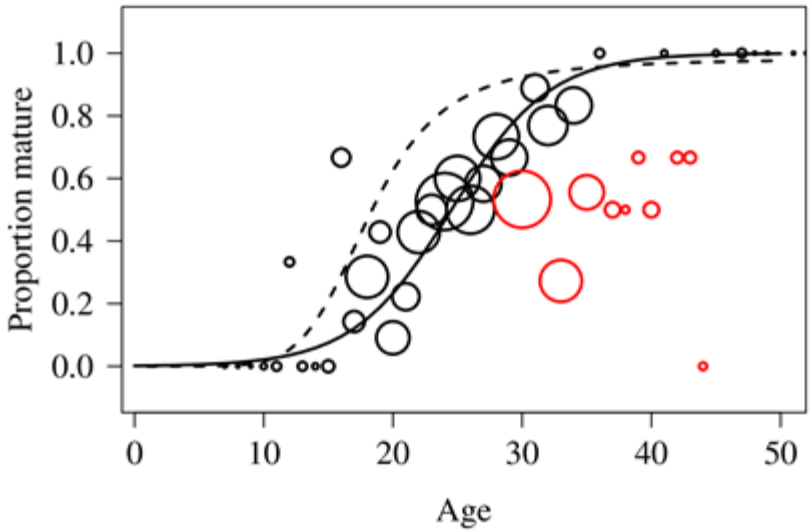
- Ageing error matrix
- Natural mortality
- Proportion mature at age

Method	Model	Maximum Age 109	134	159
$\text{Then}_{1\text{parm}}$	$M = a/t_{max}$	0.047	0.038	0.032
Then_{lm}	$\log(M) = a + b * \log(t_{\max})$	0.049	0.040	0.033
Then_{nls}	$M = at_{max}^{b}$	0.067	0.055	0.047

Average of 0.045; the estimate from the 2020 recommended model is 0.049. (2018 model estimate = 0.036)

Proportion mature at age

- Updated based on data from Dr. Christina Conrath



Estimated age at 50% = 24.5 years
(2018 model estimate = 18.4 years)

Data-weighting

- Strong conflict between the age/length composition data and the AI survey biomass index. Two different procedures for weighting the composition data

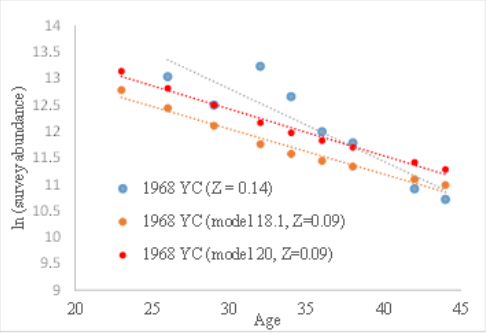
- *McAllister-Ianelli* – gives relatively more weight to the composition data
- *Francis* – gives relatively less weight to the composition data

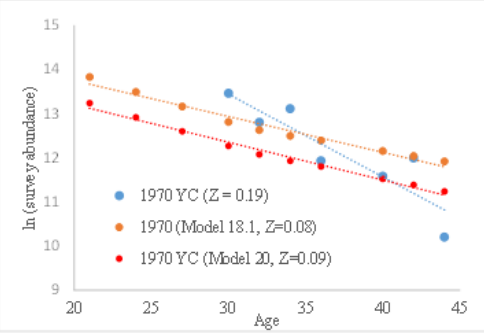
Models considered

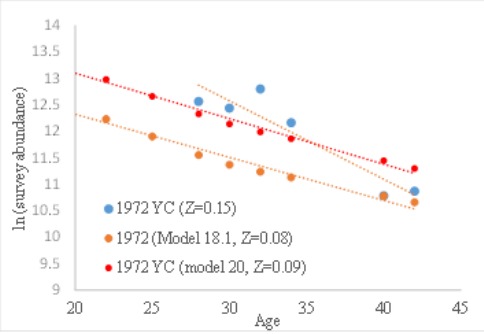
- Model 18.1 (2020) run, has updated data
- Other models have the 3 modeling changes mentioned above, and differ only in the data-weighting and inclusion of length composition data

Model	Differences from accepted 2018 model
Model 18.1 (2020)	Updated catch and and/length composition data, transition matrix, and weight-at-age
Model 20	Updated catch and and/length composition data, transition matrix, and weight-at-age. Updated prior distribution for natural mortality, updated ageing error matrix, and updated estimation of proportion mature at age. Iteratively reweight the composition data with the Francis method
Model 20a	Model 20, but iteratively reweight the composition data with the McAllister-Ianelli method.
Model 20b	Model 20, but remove the fishery length composition data
Model 20c	Model 20a, but remove the fishery length composition data

Mismatch in data vs model total mortality



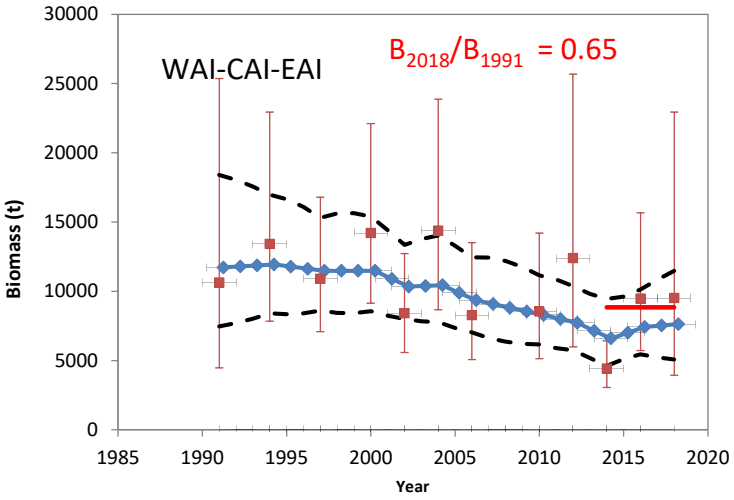




Cohort-specific mortality rates from the assessment models are smaller than those estimated directly from survey data (via catch curves).

The models do not have a mechanism for explaining less than expected number of older fish in recent years.

Mismatch in biomass trends



A Tier 5 model shows a decreasing trending in the last decade

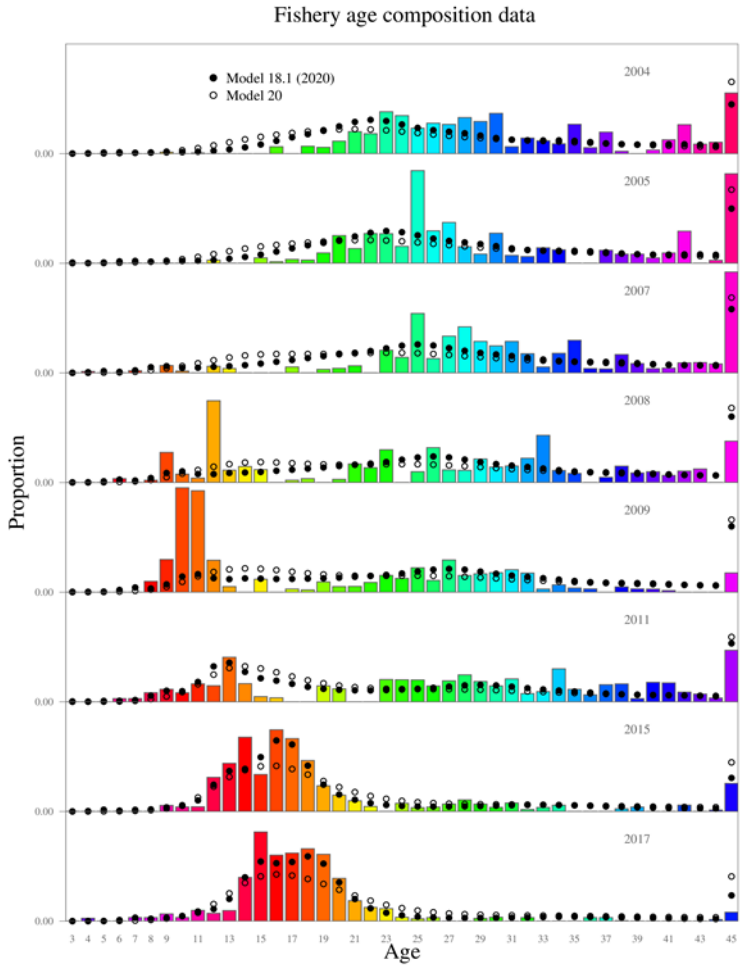
Adding the composition degrades the fit to the biomass trend, indicating the data conflict

Models 18.1, 20.a, and 20.c – McAllister-Ianelli weighting

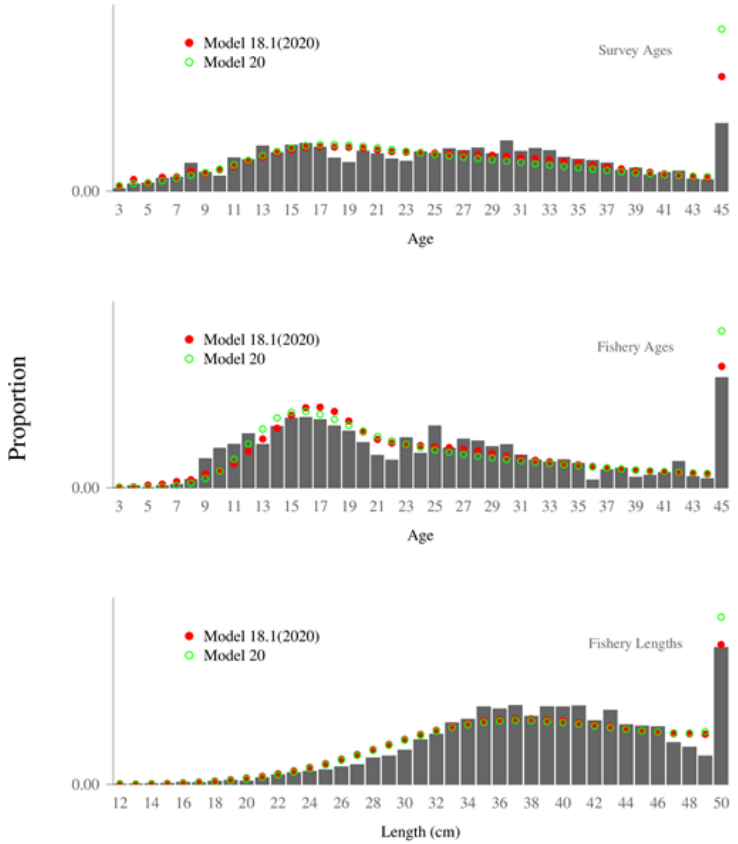
Model 20, 20.c – Francis weighting

Better fit to the survey biomass with Francis weighting

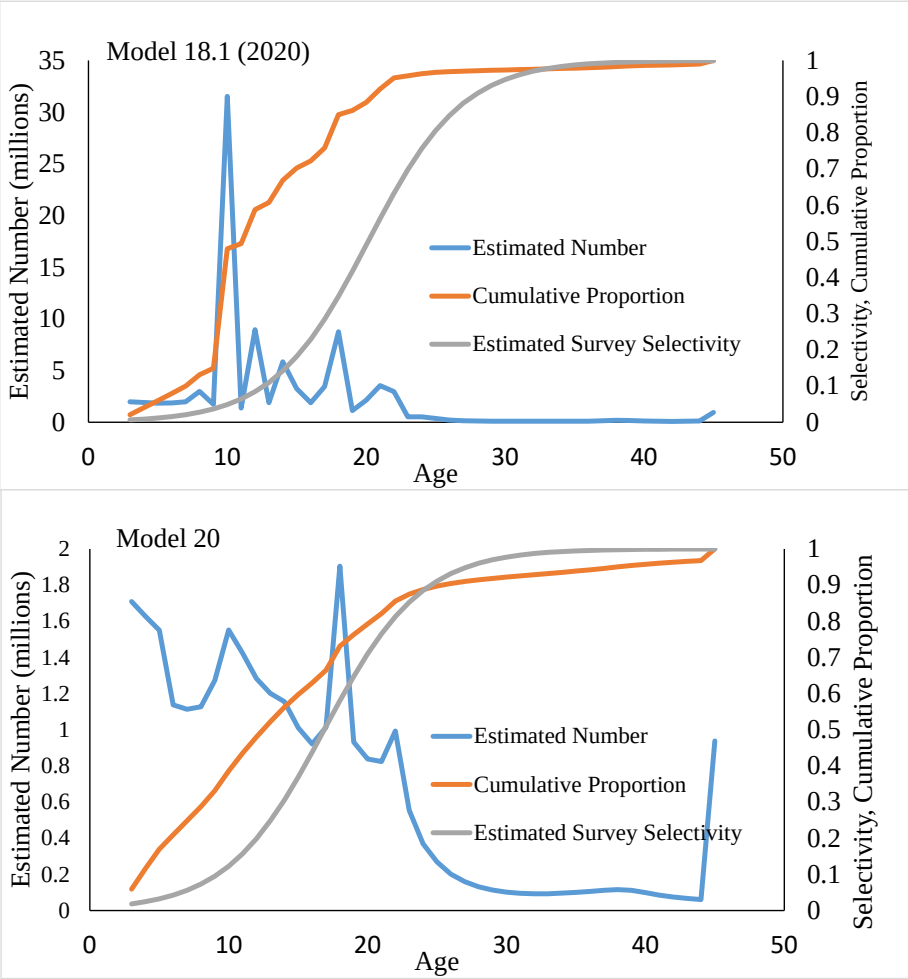
Improved fit to some year classes in recent years with McAllister-Ianelli weighting



However, average fits within a data type are relatively similar



The “improvement” in fit to recent year classes results from unusual estimates of year class strength



Estimated population for 2020

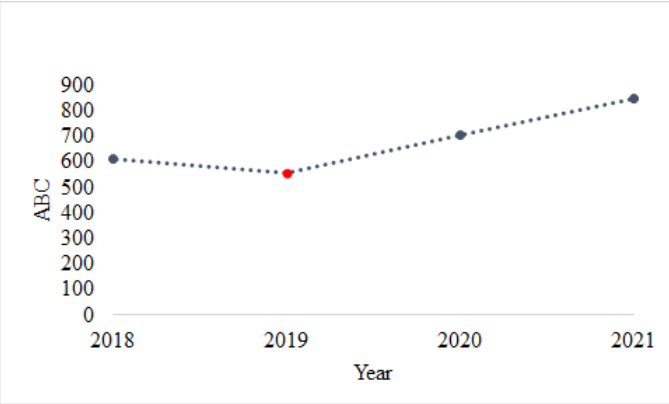
Model 18.1(2020):

2010 year class is 21% of total biomass

2010, 2002, and 1999 year classes are 41% of total biomass

70% of 2020 abundance is at ages <=15, which have less than 20% survey selectivity

Management implications – large inter-assessment changes in ABC



These large percentage increases in ABC may not be warranted for a long-lived stock that has exhibited less than expected older fish in recent surveys and fishery catch, and has not shown a definitive increase in the survey biomass estimates.

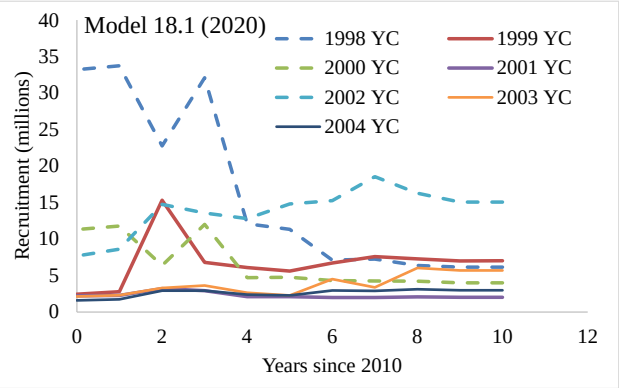
Annual BSAI ABC increases under model 18.1

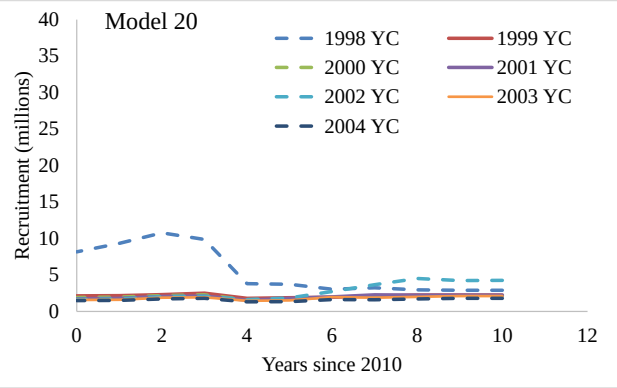
2020: 28% (from 2019)

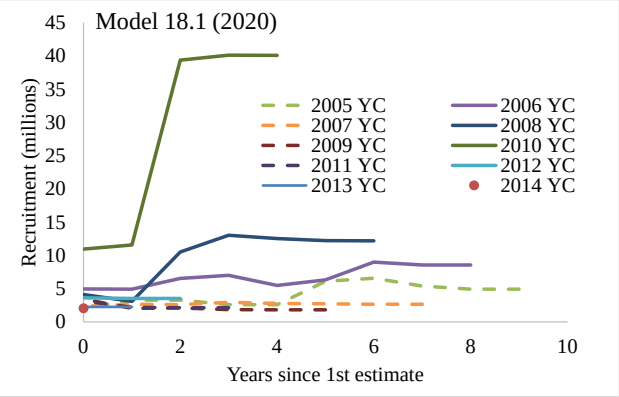
2021: 20% (from 2020)

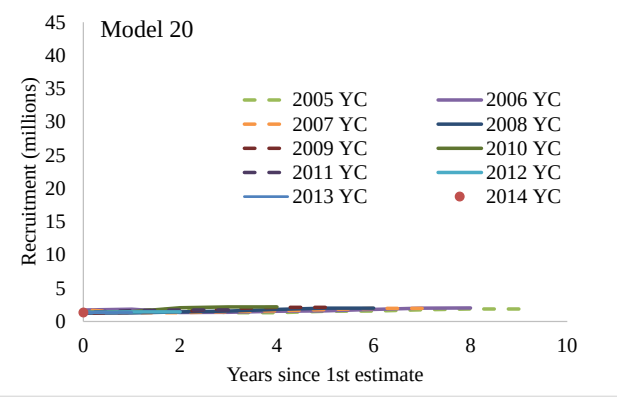
As these young fish in Model 18.1 increase in age and grow larger, they become more selected by the fishery and the ABC increases.

Much larger recruitment variability and retrospective bias with McAllister-Ianelli weighting









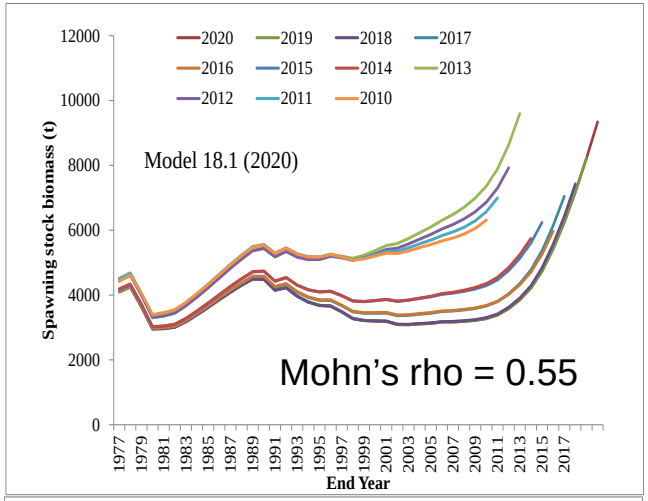
Some key year classes [Model 18.1(2020)]

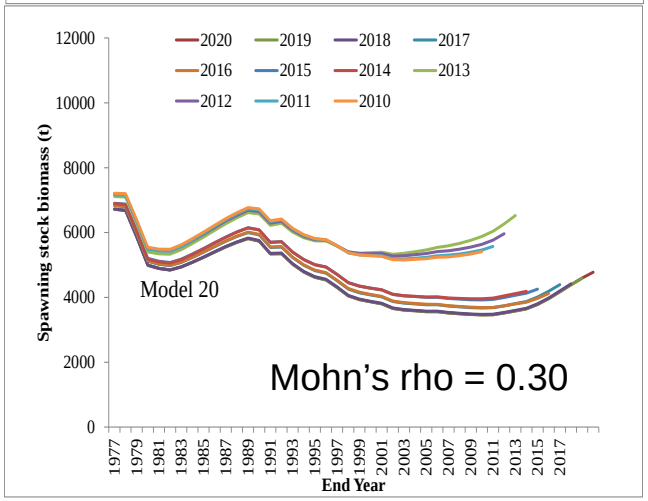
2000 year class:
11.3 M (2010 peel)
4.0 M (2020 peel)

1998 Year class:
33.2 M (2010 peel),
6.2 M (2020 peel)

2010 Year class
11.0 (2016 peel)
40. 1 (2020 peel)

Stronger retrospective bias with McAllister-Ianelli weighting





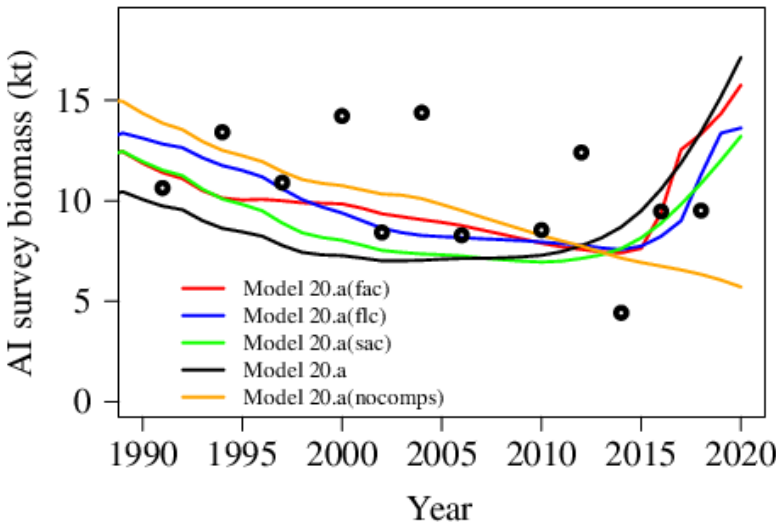
We recommend Model 20 due to:

1) Decreased retrospective bias in SSB
2) Decreased recruitment variability
3) Improved fit to the AI survey index
4) Estimated recent biomass trend is more consistent with AI survey index
5) Greater stability in inter-assessment ABC advice.

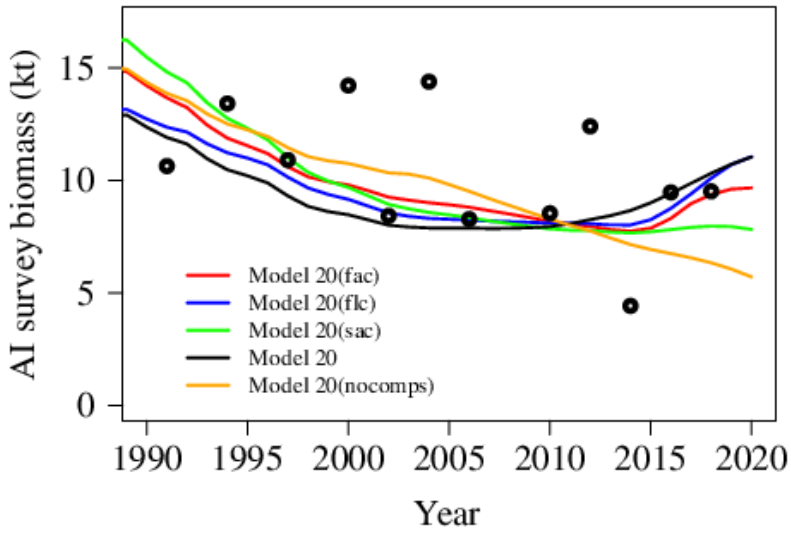
Sensitivity runs

How does each of the age/length compositional data components affect the fit to the AI survey?

Model 20.a (McAllister-Ianelli)



Model 20 (Francis)



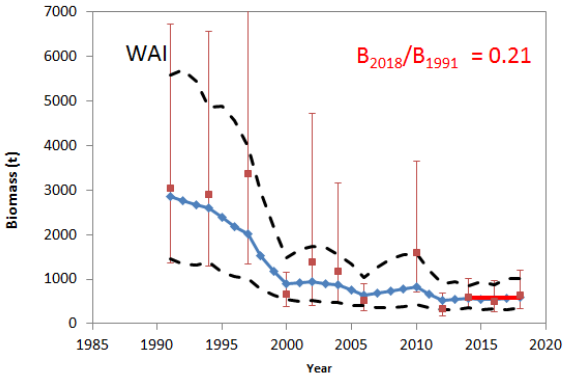
The rapid recent increase in estimated biomass cannot be attributed to any particular data set.

Summary of concerns/observations

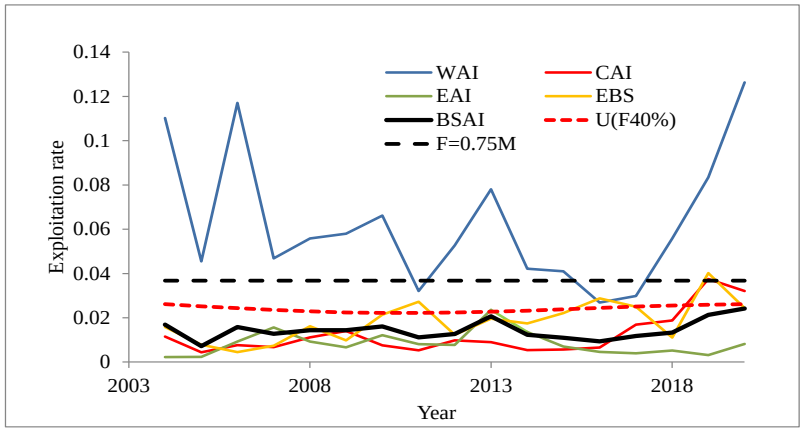
1) Drop in abundance of older fish
2) Mismatch in data vs model total mortality
3) Poor residual pattern for the AI survey biomass
4) Mismatch in model biomass vs survey biomass trend
5) Changes in magnitude of year class estimates (Model 18.1)
6) Large inter-assessment changes in ABC (Model 18.1)
7) Population shifts younger, and estimated to be concentrated in a small number of age classes (Model 18.1)
8) Positive retrospective bias in biomass

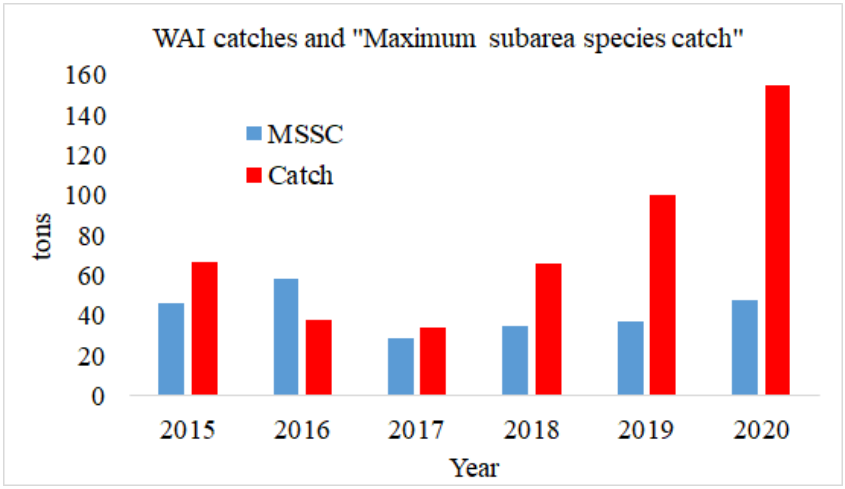
Monitoring of WAI catch relative to MSSC

Requested by SSC (Oct 2016, Dec 2016)



Year	MSSC	Catch	Catch/MSSC
2015	46	67	1.46
2016	58	38	0.65
2017	29	34	1.17
2018	35	66	1.89
2019	37	100	2.70
2020	48	155	3.23





Risk table considerations

- Assessment considerations: “data-inputs: biased ages, skipped surveys, lack of fishery-independent trend data; model fits: poor fits to fits to fishery or survey data, inability to simultaneously fit multiple data inputs; model performance: poor model convergence, multiple minima in the likelihood surface, parameters hitting bounds; estimation uncertainty: poorly-estimated but influential year classes; retrospective bias in biomass estimates.

- Level 3: Major Concern. Very poor fits to data; high level of uncertainty; strong retrospective bias.

Risk table considerations

- Population dynamics considerations: “decreasing biomass trend, poor recent recruitment, inability of the stock to rebuild, abrupt increase or decrease in stock abundance.

- Level 2: Substantially increased concerns. Stock trends are unusual; abundance increasing or decreasing faster than has been seen recently, or recruitment pattern is atypical.

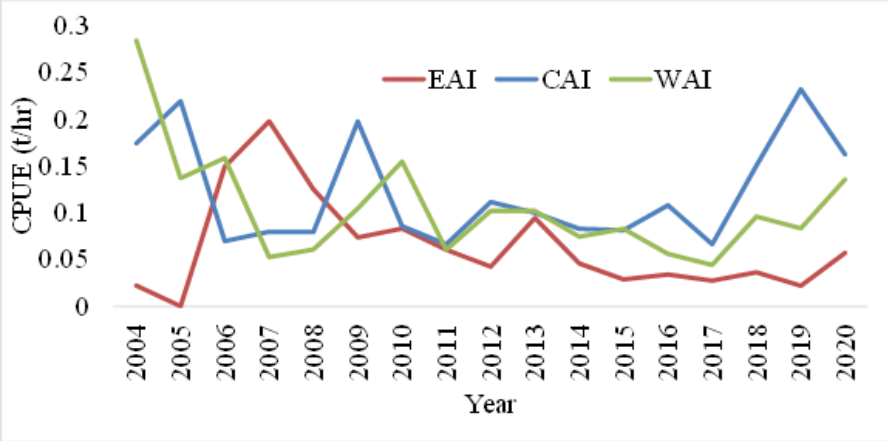
  Also, existing spatial management measures are generally inconsistent with the relatively smaller spatial structure of Pacific rockfish

Risk table considerations

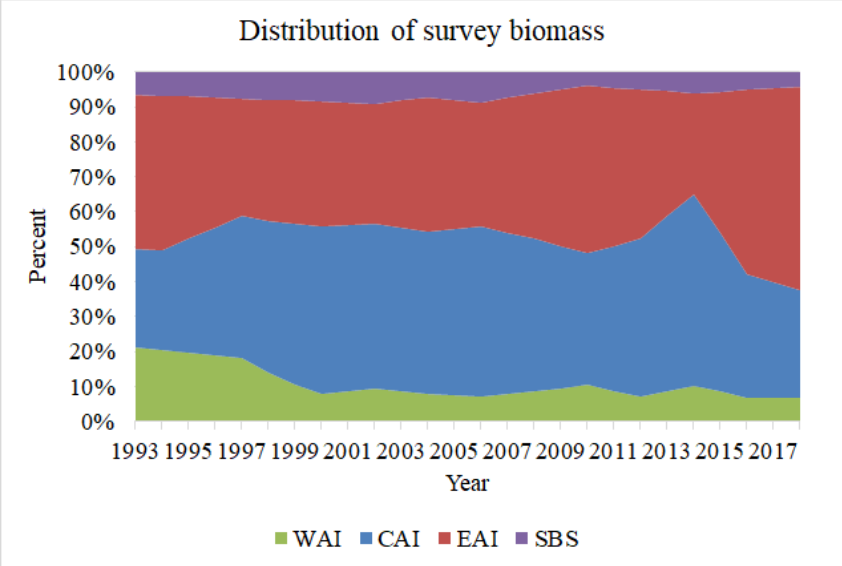
- Environmental/ecosystem considerations: "*adverse trends in environmental/ecosystem indicators, ecosystem model results, decreases in ecosystem productivity, decreases in prey abundance or availability, increases or increases in predator abundance or productivity.*"

- Level 1: Normal. "*Taken together, these indicators suggest no clear concerns for the rougheye/blackspotted rockfish stocks aside from the recent stretch of increased temperatures. However, both the lack of ecological data relevant to the stocks (particularly blackspotted rockfish) as well as lack of data in 2020 limits our assessment of potential recent ecosystem impacts on this stock.*"

Fishery CPUE by subarea



Tons/hr, from tows targeting POP based on haul species composition. Source: North Pacific Groundfish Observer Program.



Fishery CPUEs are higher in the WAI than one would expect from the distribution of survey biomass

Risk table considerations

- Fishery performance considerations: "fishery CPUE is showing a contrasting pattern from the stock biomass trend, unusual spatial pattern of fishing, changes in the percent of TAC taken, changes in the duration of fishery openings."

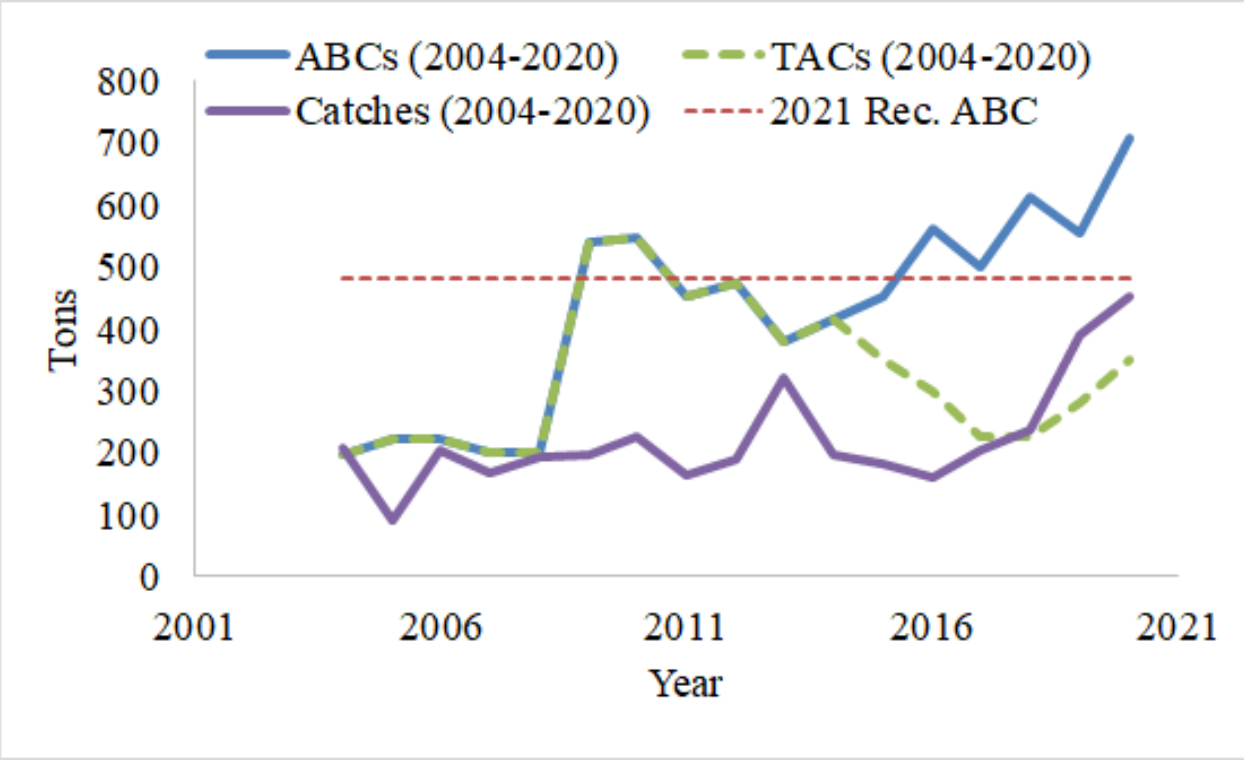
- For a bycatch stock, fishery performance can be evaluated with respect to how well the target fishery can avoid bycatch.

- Level 2: Substantially increased concerns. Fishery CPUE in the WAI subarea are larger than would be expected based on the spatial distribution of survey biomass estimates. Also, the WAI catches have consistently exceeded the MSSC, and these overages have increased over time. The catches in the WAI/CAI subarea have also exceeded the subarea ABC in 2019 and 2020.

Reasons for not recommending reduction from maximum ABC

- One of the major concerns (disproportionate spatial harvesting for a stock with relatively small spatial structure) would not be addressed by the reducing the BSAI ABC
- Bycatch stock, and MSSCs and subarea ABC have been exceeded in recent years

Recommended 2021 ABC relative to recent ABCs, TACs, and catches



Conclusions

- The model results and management specifications depend on the choice for data-weighting
- How much weight do we want to give the biomass trend, and how much to the composition data?
- In our view, we should not base our management and projected harvest specifications on recruitment estimates with large uncertainty (which occur with McAllister-Ianelli weighting).

Harvest spec table, AI subarea

Quantity	As estimated or *specified* last year for: 2020	2021	As estimated or *recommended* this year for: 2021*	2022*
M (natural mortality rate)	0.032	0.032	0.049	0.049
Tier	3b	3b	3b	3b
Projected total (age 3+) biomass (t)	49,005	51,451	17,632	17,729
Female spawning biomass (t)				
Projected	10,213	11,551	3,372	3,457
$B_{100\%}$	29,287	29,287	8,811	8,811
$B_{40\%}$	11,715	11,715	3,524	3,524
$B_{35\%}$	10,250	10,250	3,083	3,083
F_{OFL}	0.042	0.047	0.038	0.038
$maxF_{ABC}$	0.034	0.039	0.032	0.033
F_{ABC}	0.034	0.039	0.032	0.033
OFL (t)	817	1046	509	528
maxABC (t)	675	866	432	450
ABC (t)	675	866	432	450
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

Recommended 2021 BSAI ABCs and OFLs

BSAI ABC: 482 t (decrease from 2020 ABC of 708 t)

BSAI OFL: 576 t (decrease from 2020 OFL of 861 t)

EBS portion table

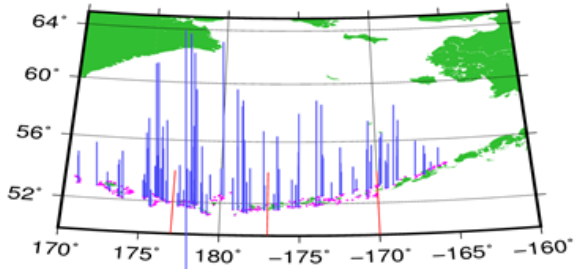
Quantity	As estimated or *recommended* last year for: 2020	2021	As estimated or *recommended* this year for: 2021	2022
M (natural mortality rate)	0.032	0.032	0.049	0.049
Tier	5	5	5	5
Biomass (t)	1371 1371		1371	1371
F_{OFL}	0.032	0.032	0.048	0.048
$maxF_{ABC}$	0.024	0.024	0.037	0.037
F_{ABC}	0.024	0.024	0.037	0.037
OFL (t)	44	44	67	67
maxABC (t)	33	33	50	50
ABC (t)	33	33	50	50
Status	As determined *this* year for: 2018	2019	As determined *this* year for: 2019	2020
Overfishing	No	No	No	n/a

Plan Team table

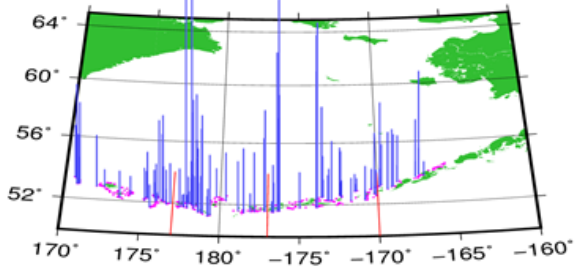
Area/subarea	Year	Total Biomass (t)[1]	OFL	ABC	TAC	Catch[2]
BSAI	2019	47,853	676	555	279	391
	2020	50,376	861	708	349	453
	2021	19,003	576	482	n/a	n/a
	2022	19,100	595	500	n/a	n/a
Western/Central Aleutian Islands	2019			204	204	304
	2020			264	264	333
	2021			169	n/a	n/a
	2022			176	n/a	n/a
Eastern AI/Eastern Bering Sea	2019			351	75	88
	2020			444	85	120
	2021			313	n/a	n/a
	2022			324	n/a	n/a

AI survey CPUE, 2014 – 2018 AI surveys

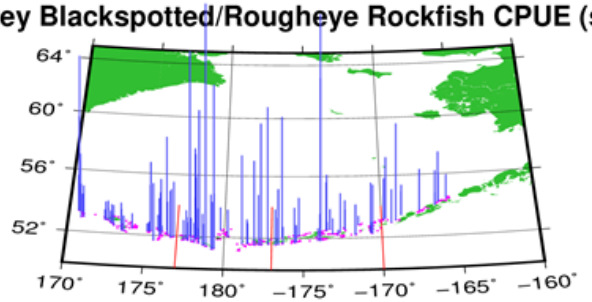
2014 AI Survey Blackspotted/Rougheye Rockfish CPUE (scaled wgt/km^2)



2016 AI Survey Blackspotted/Rougheye Rockfish CPUE (scaled wgt/km^2)



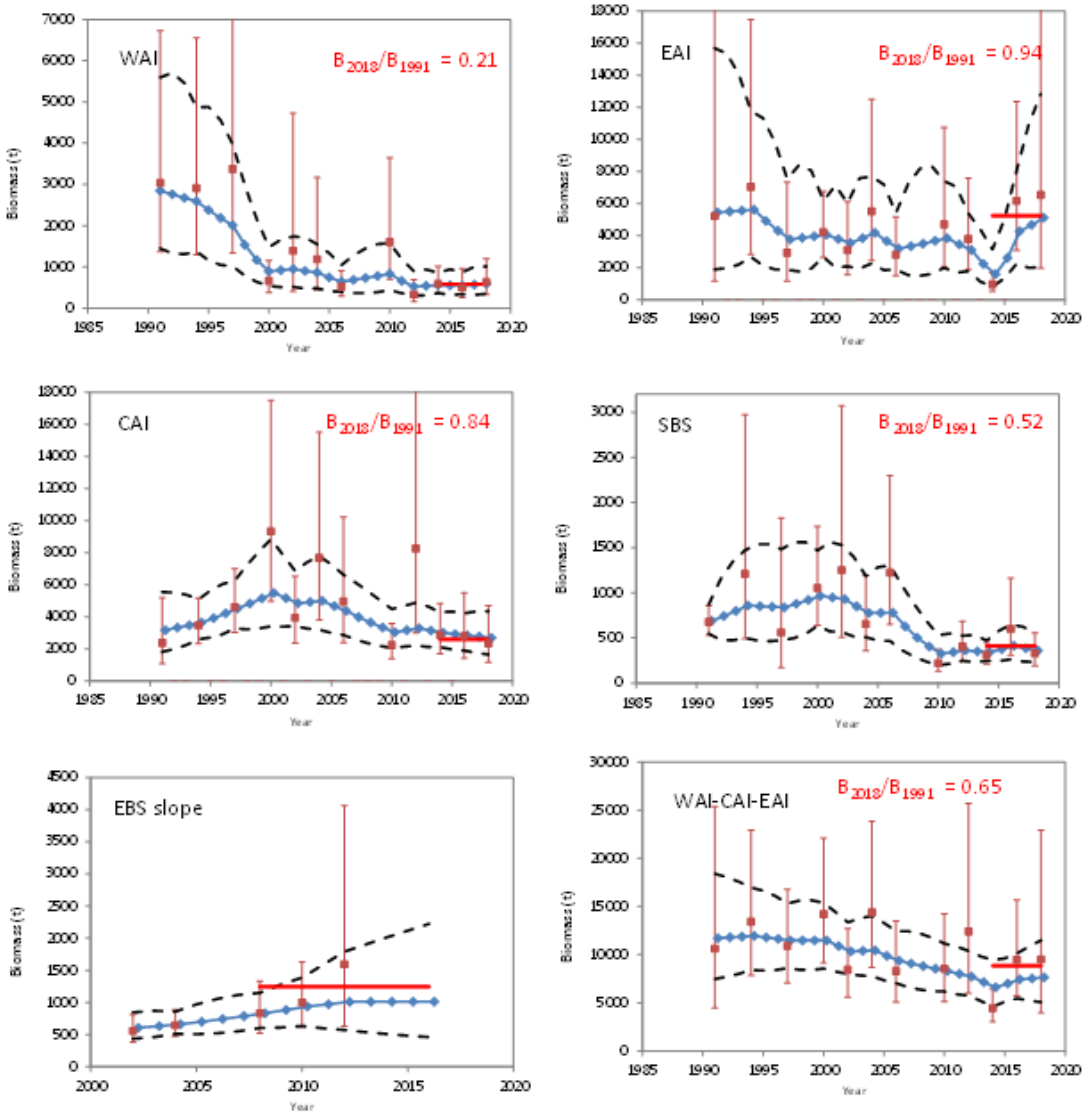
2018 AI Survey Blackspotted/Rougheye Rockfish CPUE (scaled wgt/km^2)



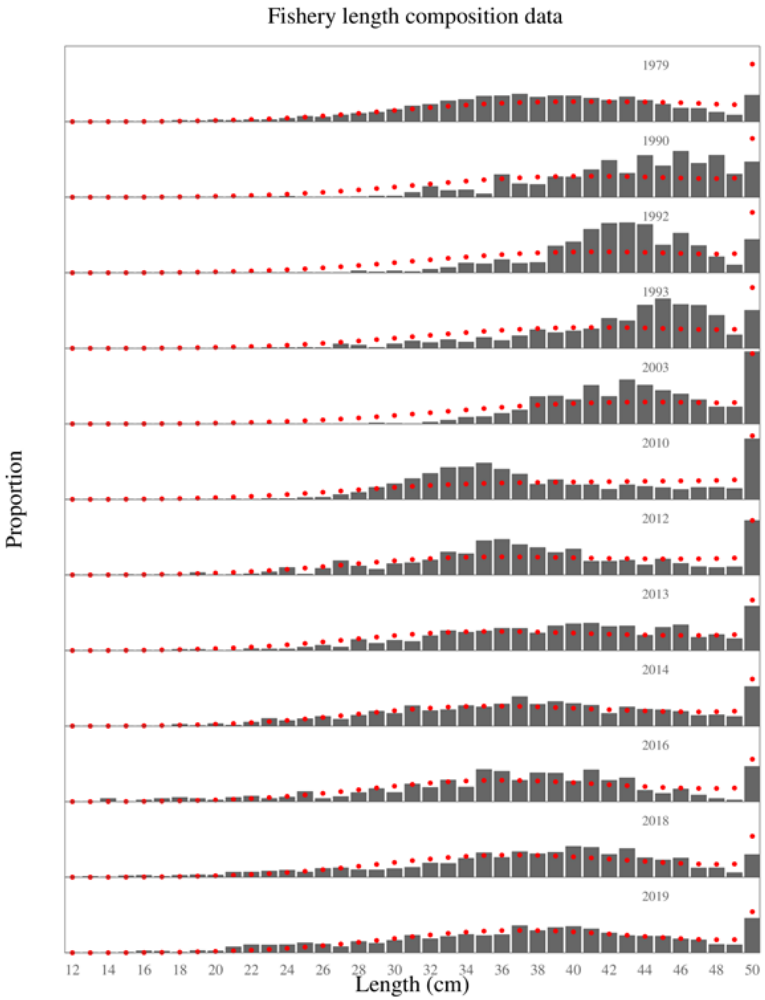
Survey biomass estimates and CVs

Year	Western	Central	Eastern	southern BS	Total AI survey
2014	589 (0.28)	2,878 (0.27)	958 (0.30)	311 (0.20)	4,736 (0.18)
2016	501 (0.34)	2,803 (0.35)	6,165 (0.37)	600 (0.35)	10,069 (0.25)
2018	632 (0.34)	2,438 (0.36)	6,535 (0.68)	328 (0.27)	9,843 (0.46)

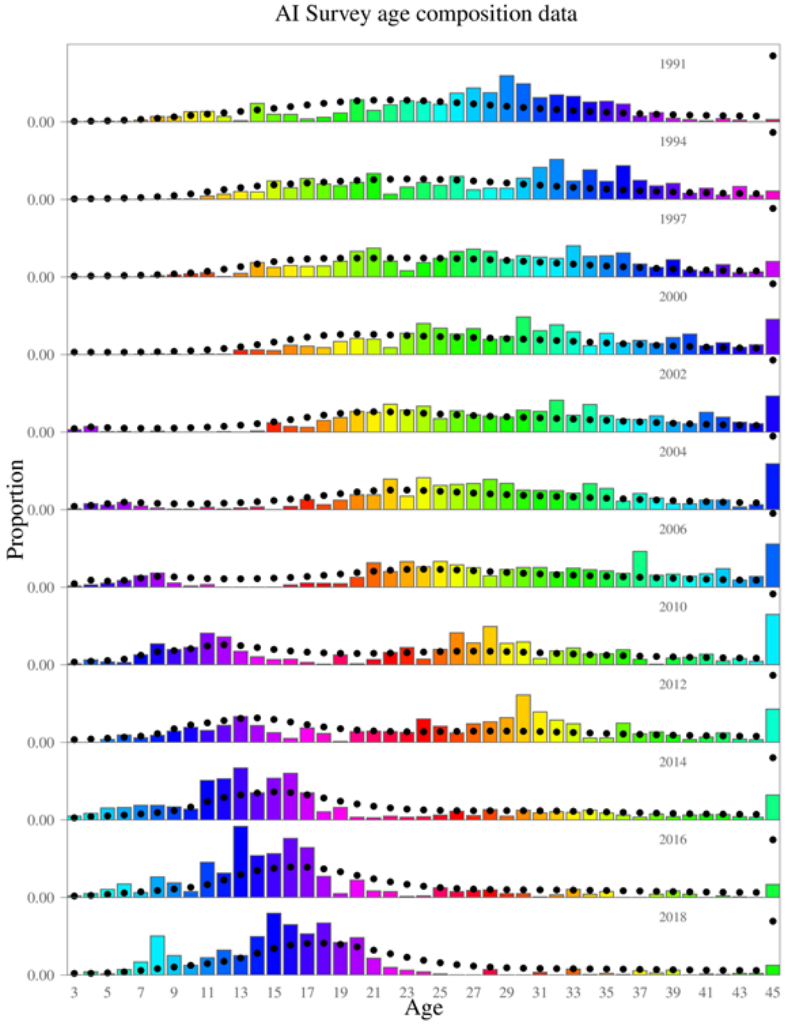
Smoothed survey biomass estimates



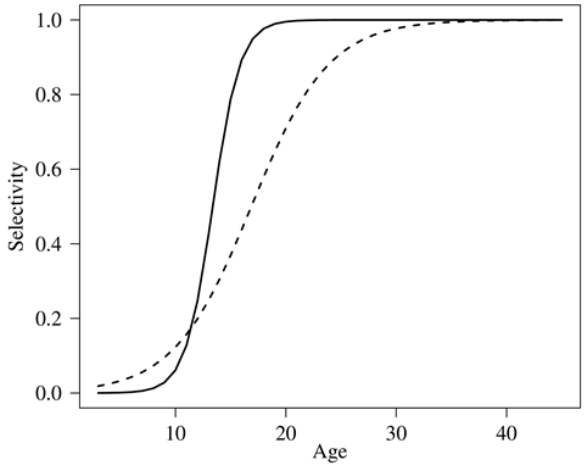
Fishery length compositions



Survey age compositions

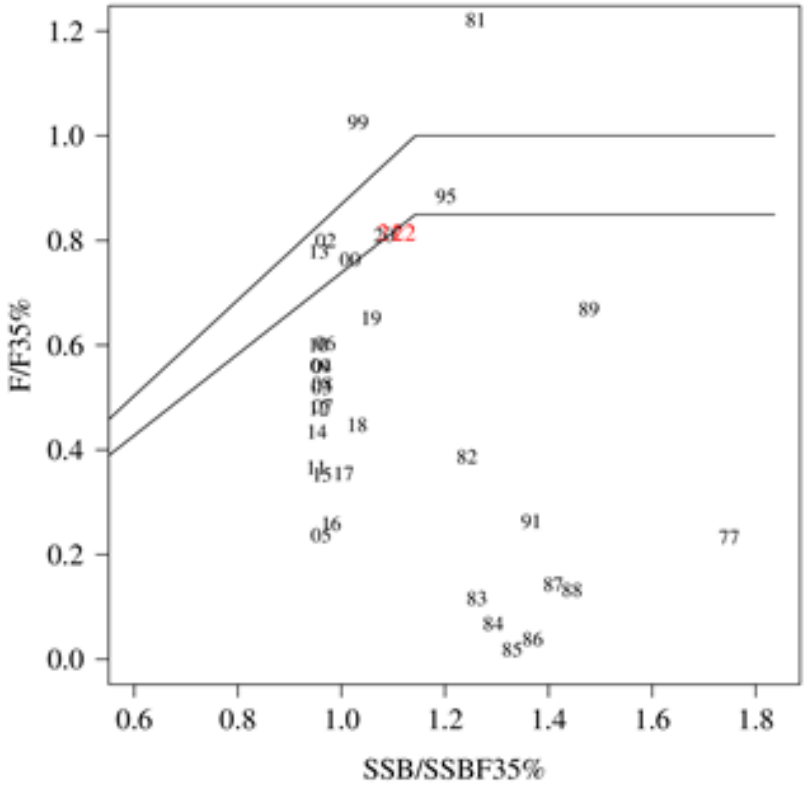


Selectivities

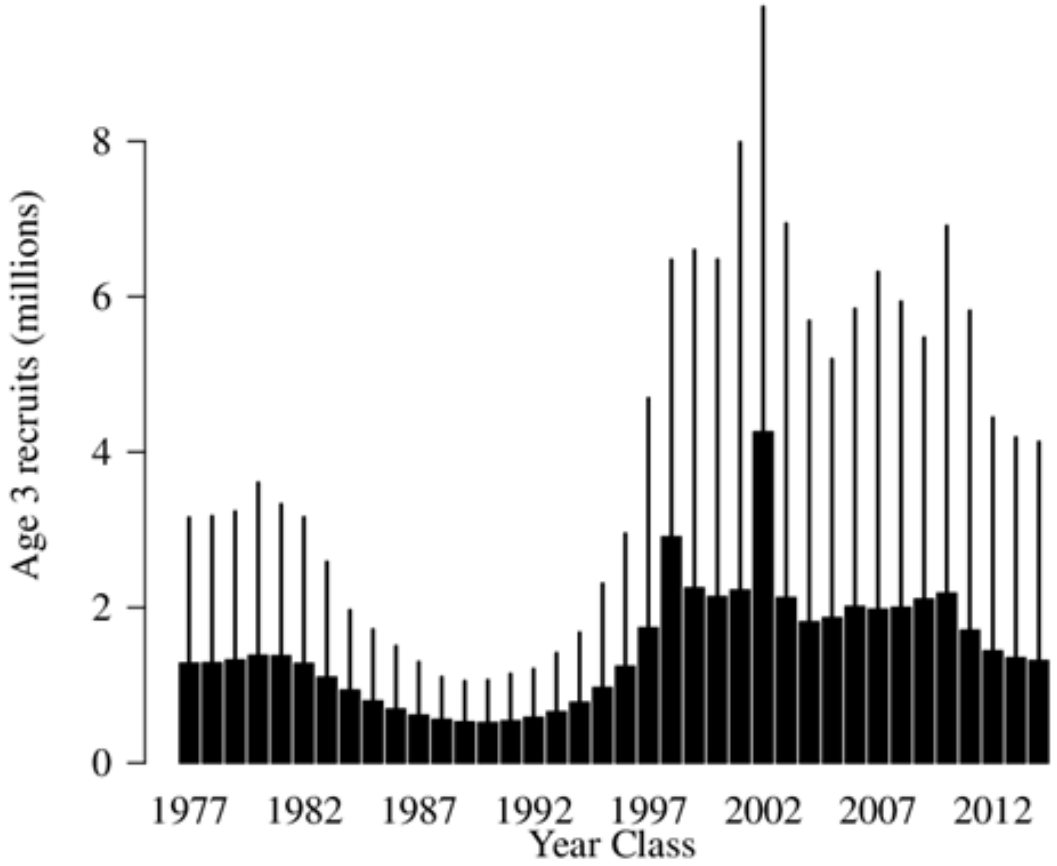


Fishery : solid line
Survey: dashed line

Phase plane


F/F35%
SSB/SSBF35%
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.6
0.8
1.0
1.2
1.4
1.6
1.8
81
99
95
89
19
18
82
91
77
87
88
83
84
85
86
17
16
05

Recruitment



Methods for re-weighting composition data (from Francis 2011)

General approach is that the "second stage" sample sizes ($N_{j,y}$) are the product of a "first stage" sample sizes ($\tilde{N}_{j,y}$) and a weight

$$N_{j,y} = w_j \tilde{N}_{j,y}$$

A single weight for each data type (*j*)

The weights are updated with each model run, and iterated until they converge

Methods of data weighting

McAllister-Ianelli (method TA1.1 in Francis 2011)

Weight by the harmonic mean of the ratios of effective sample size to the stage 1 sample size

"The Francis method" (method TA1.8 in Francis 2011)

Weight by the inverse of the variance of standardized residual between the means of observed and predicted ages (or lengths). One data point per year.