2018 BSAI Blackspotted/Rougheye Rockfish Assessment

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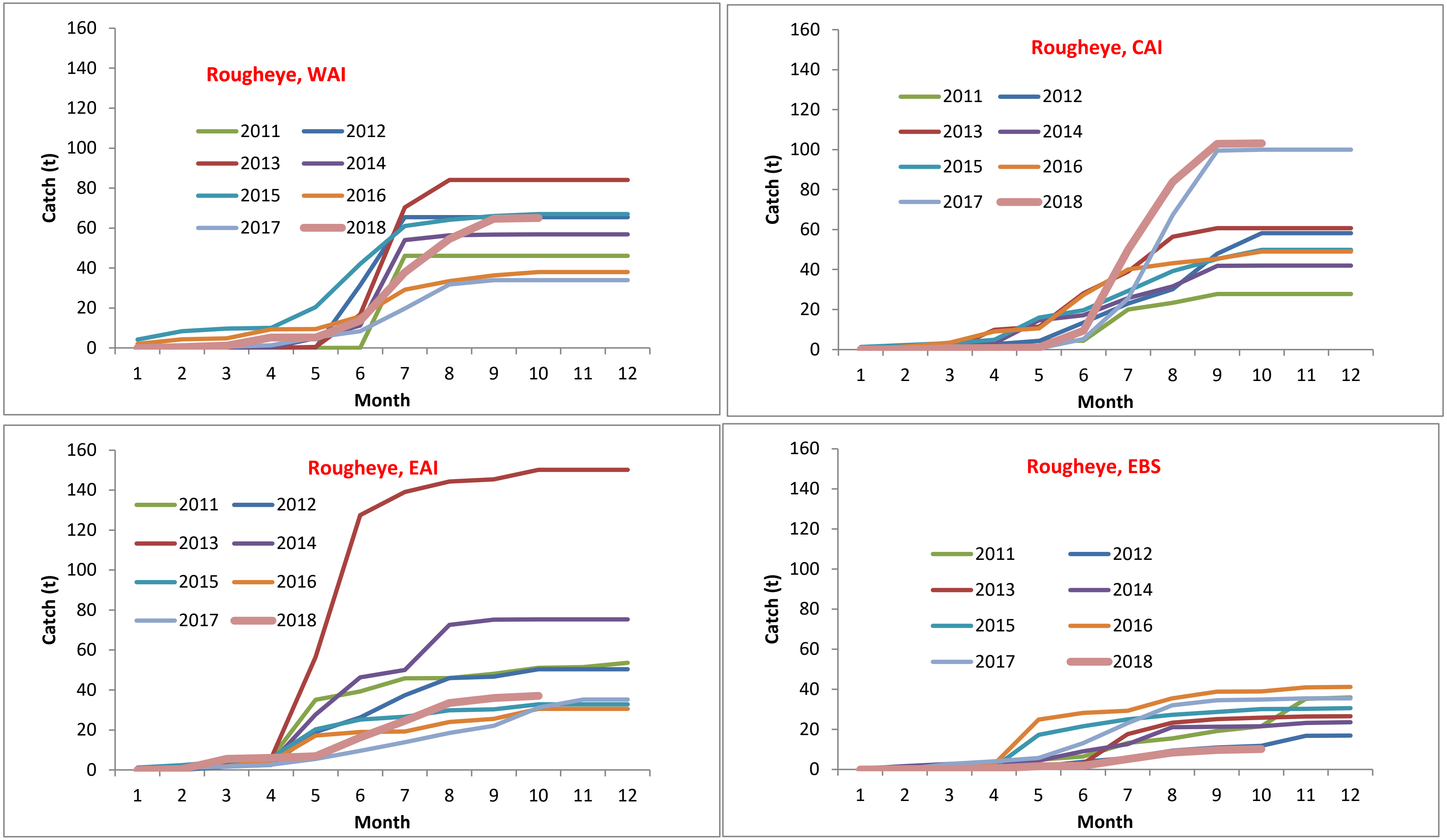
Outline

1) Catch information
2) Survey and fishery data
3) Model evaluation
4) Retrospective analysis
5) Model fits to data
6) Monitoring of catch
7) Management recommendations

BSAI Blackspotted/Rougheye catch by month and area, 2011-2018



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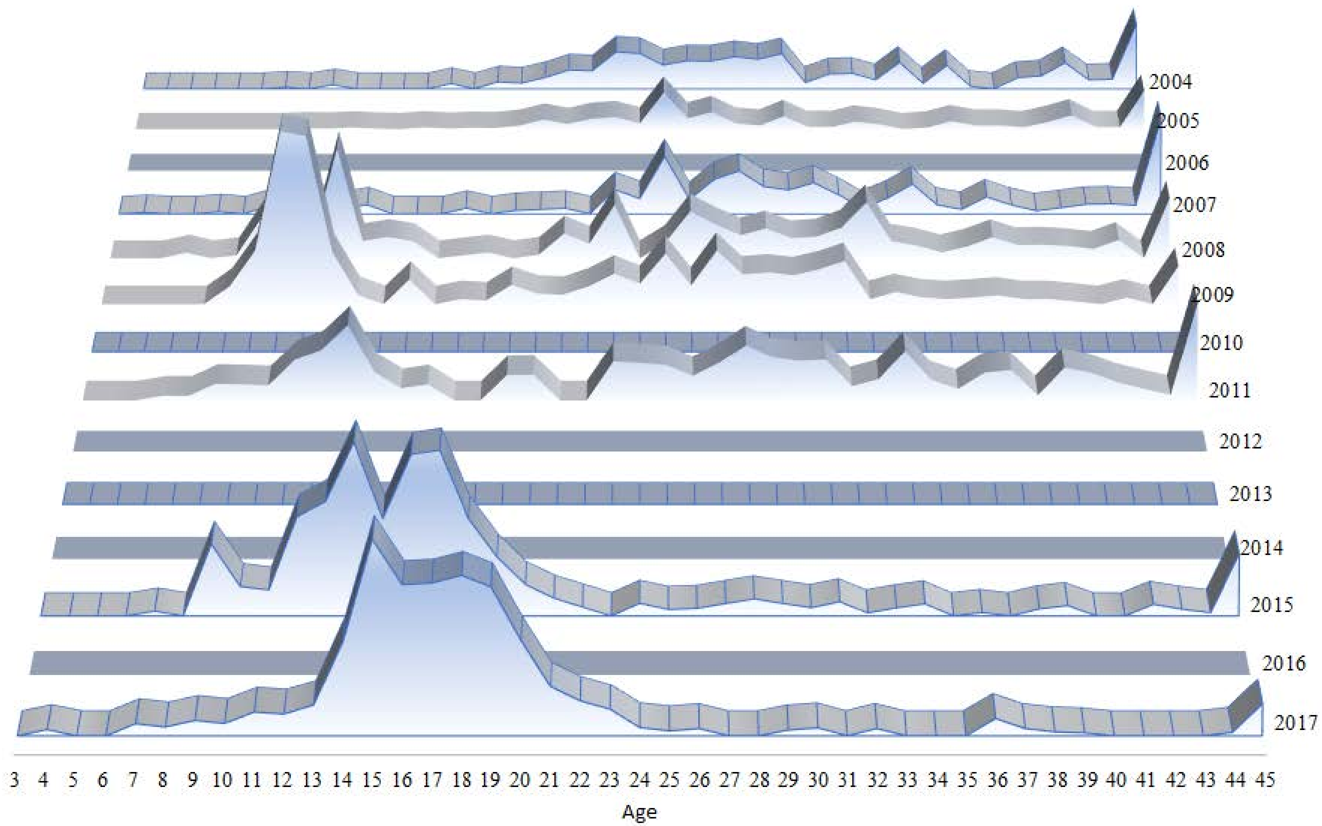
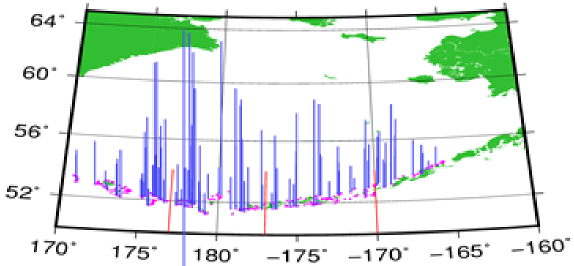
BSAI blackspotted/rougheye fishery age composition data

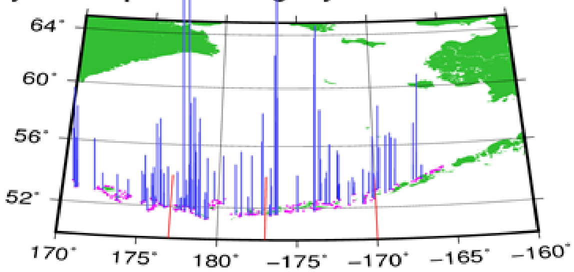


AI survey CPUE, 2014 – 2018 AI surveys

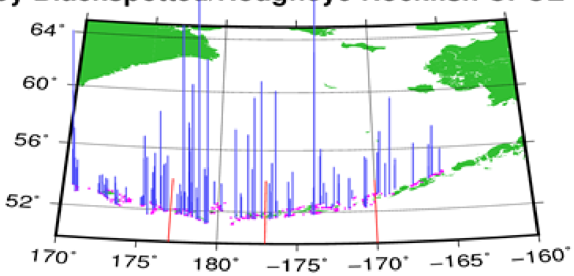
2014 AI Survey Blackspotted/Rougheye Rockfish CPUE (scaled wgt/km^2)



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



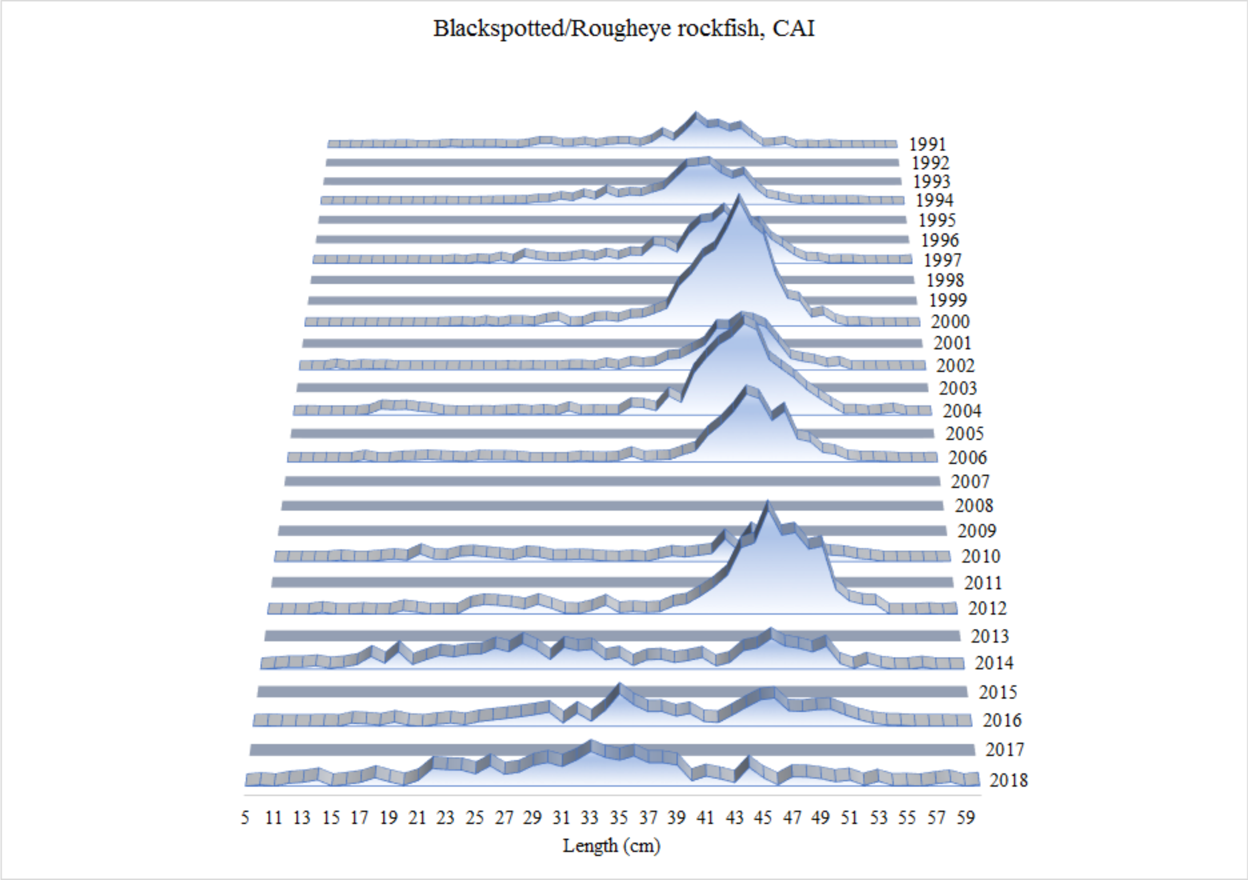
2018 AI Survey Blackspotted/Rougheye Rockfish CPUE (scaled wgt/km^2)



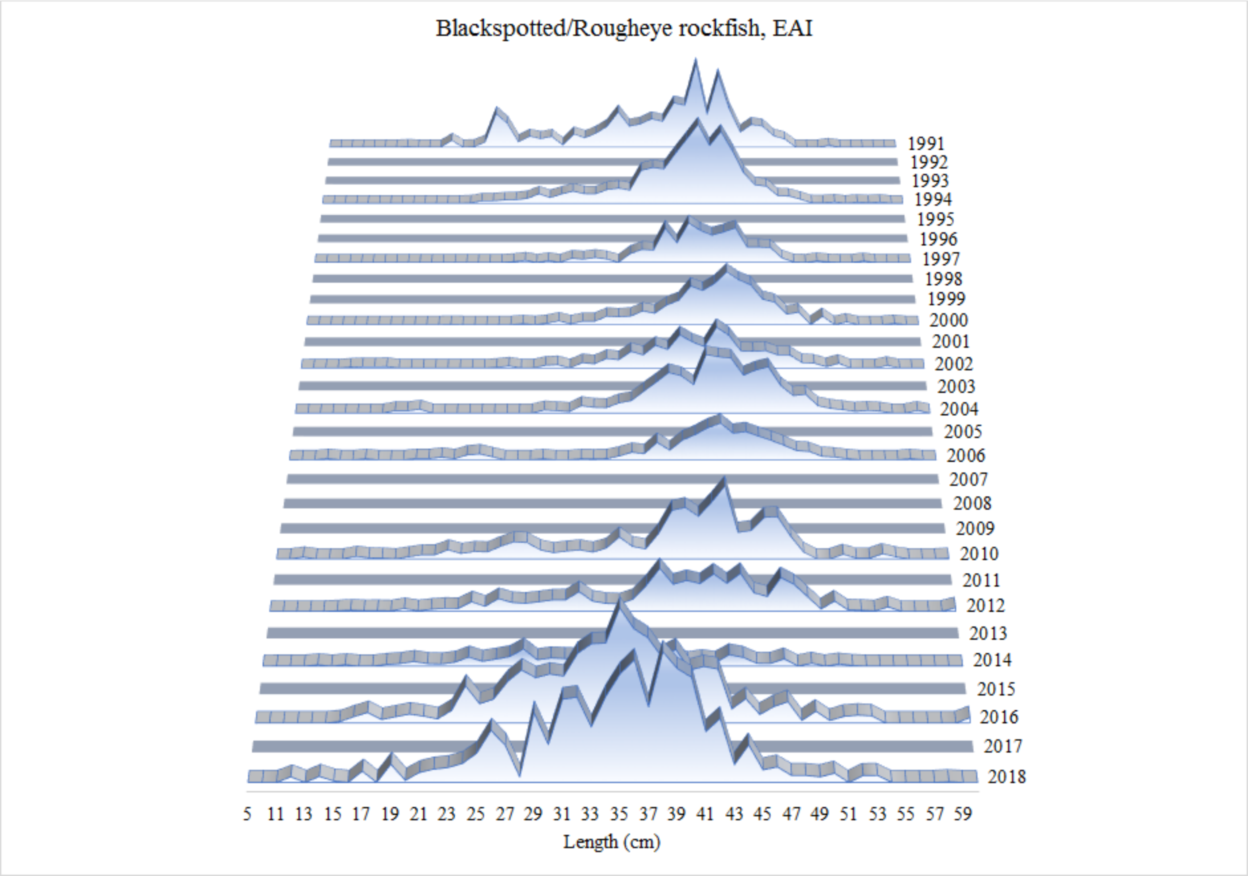
Survey biomass estimates and CVs

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)

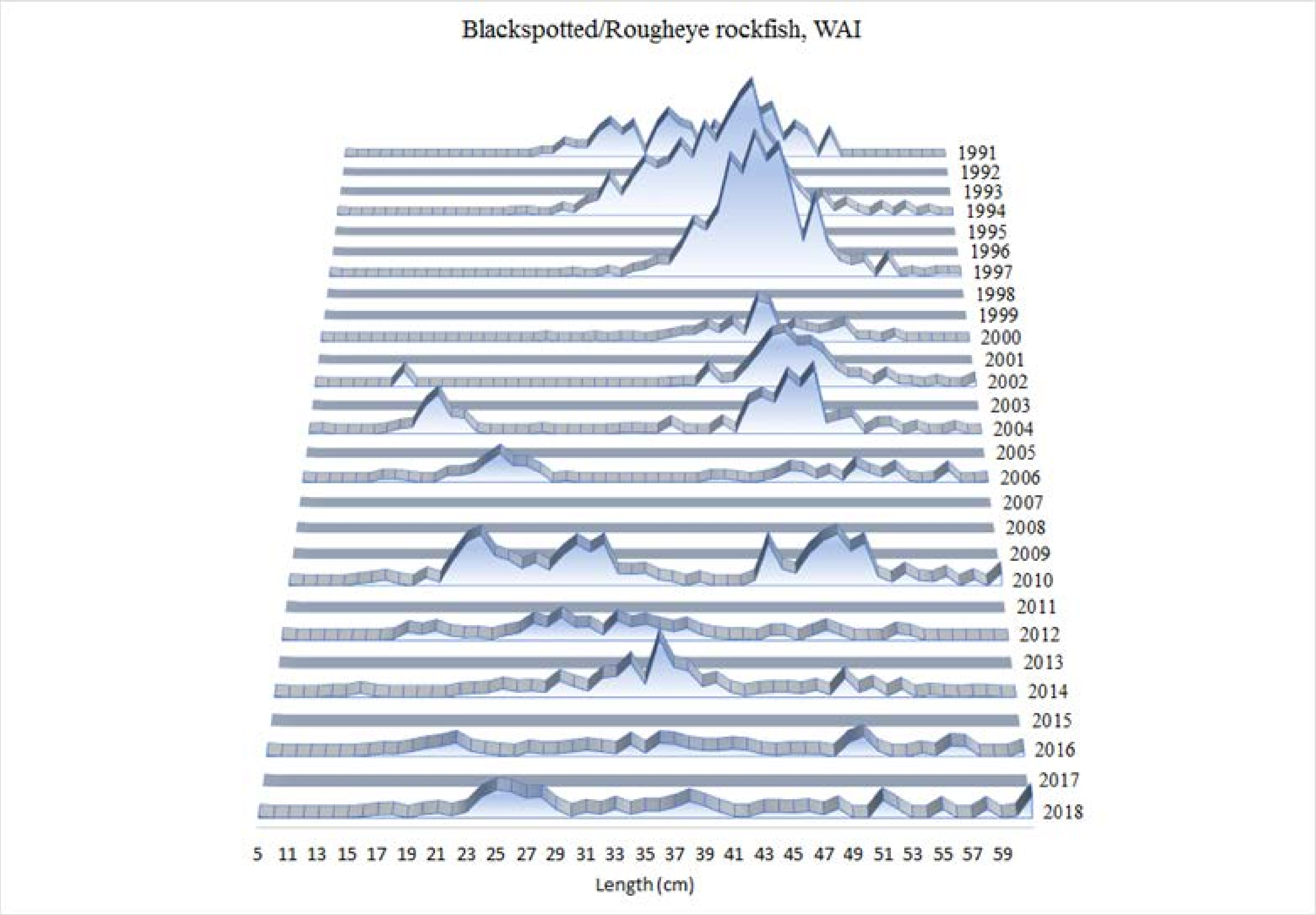
Survey size compositions, CAI



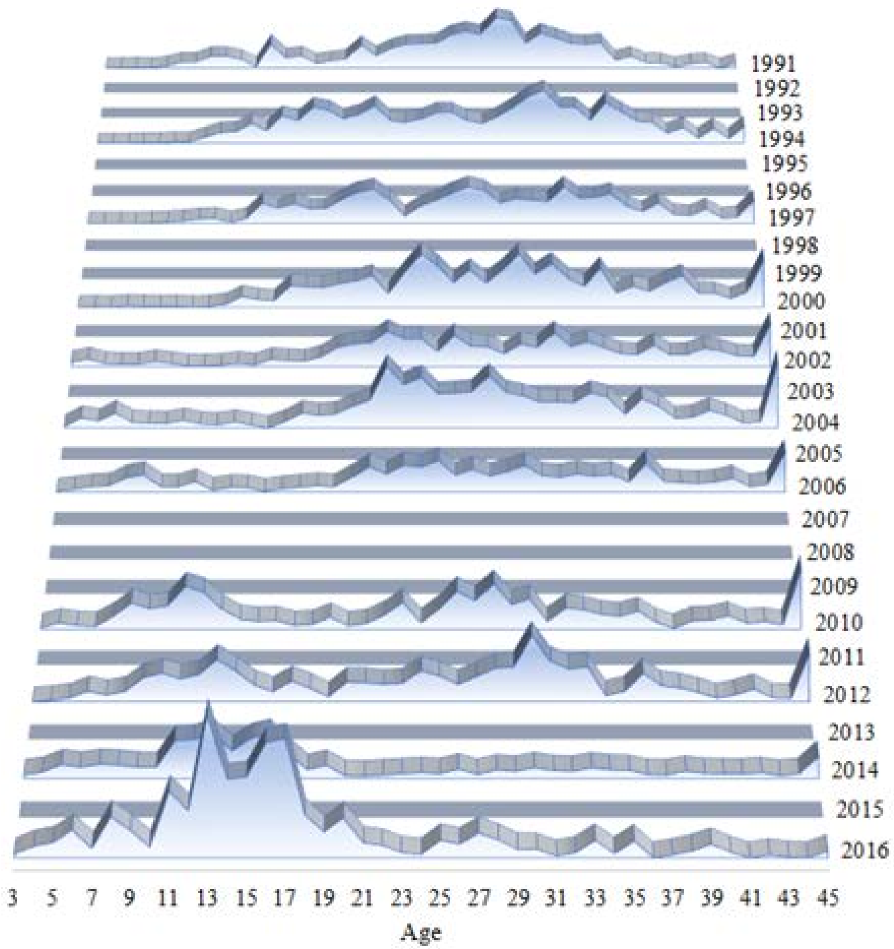
Survey size compositions, EAI



Survey size compositions, WAI



AI Survey age composition



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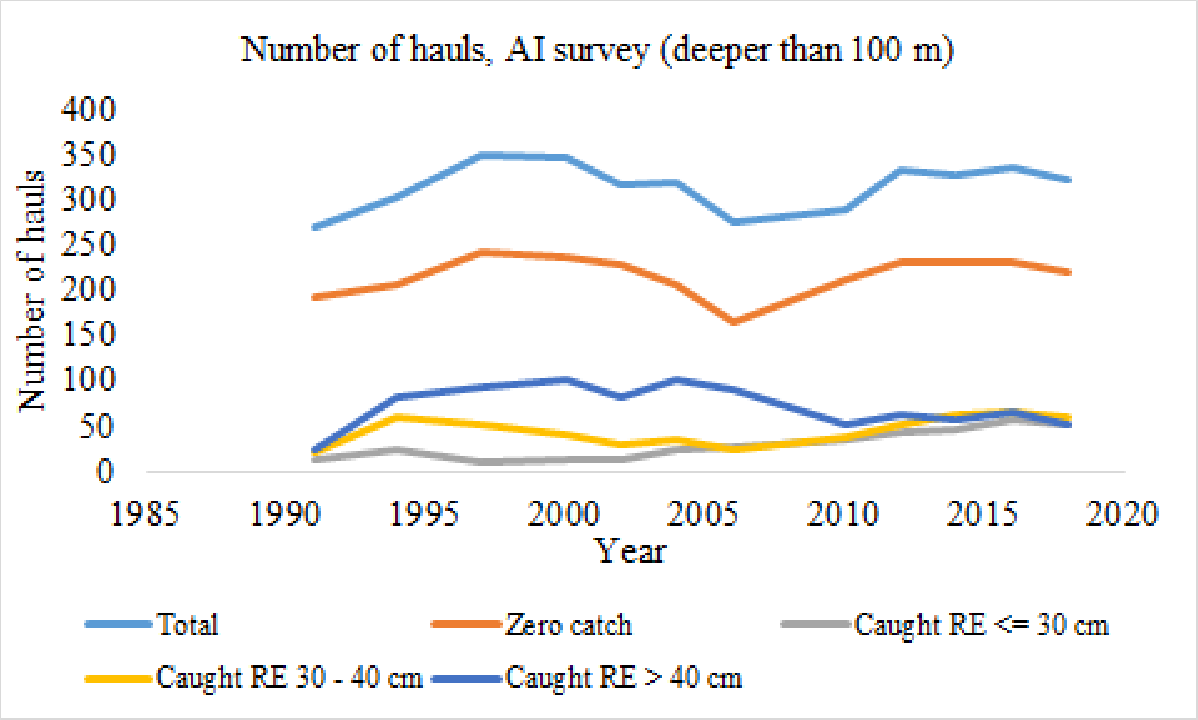
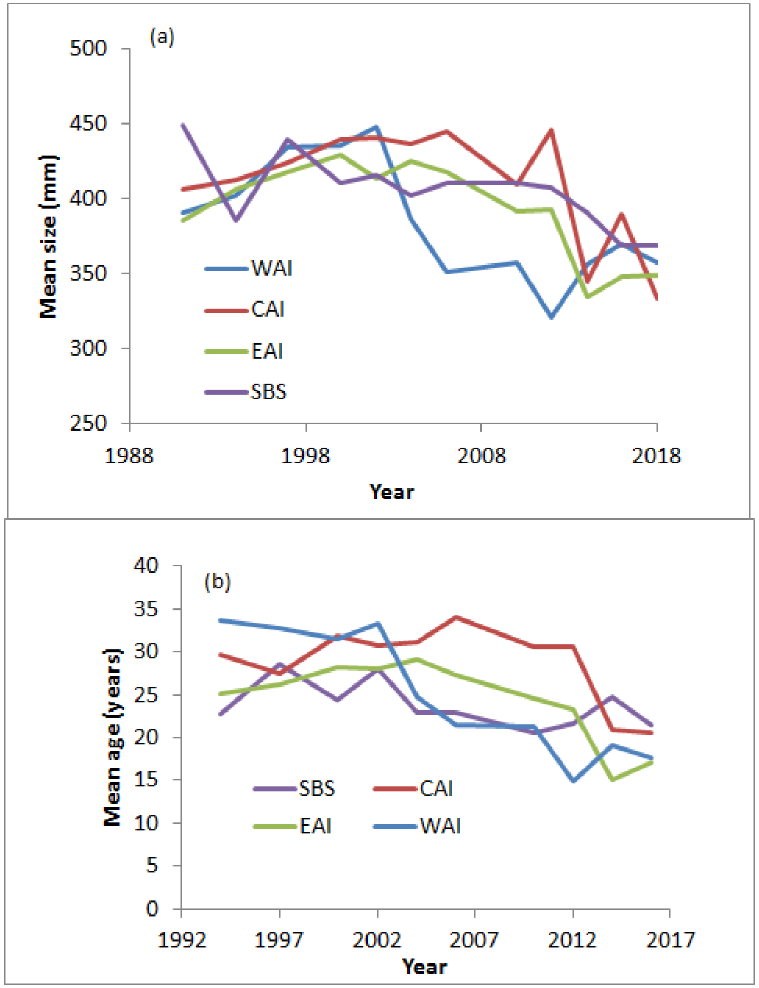
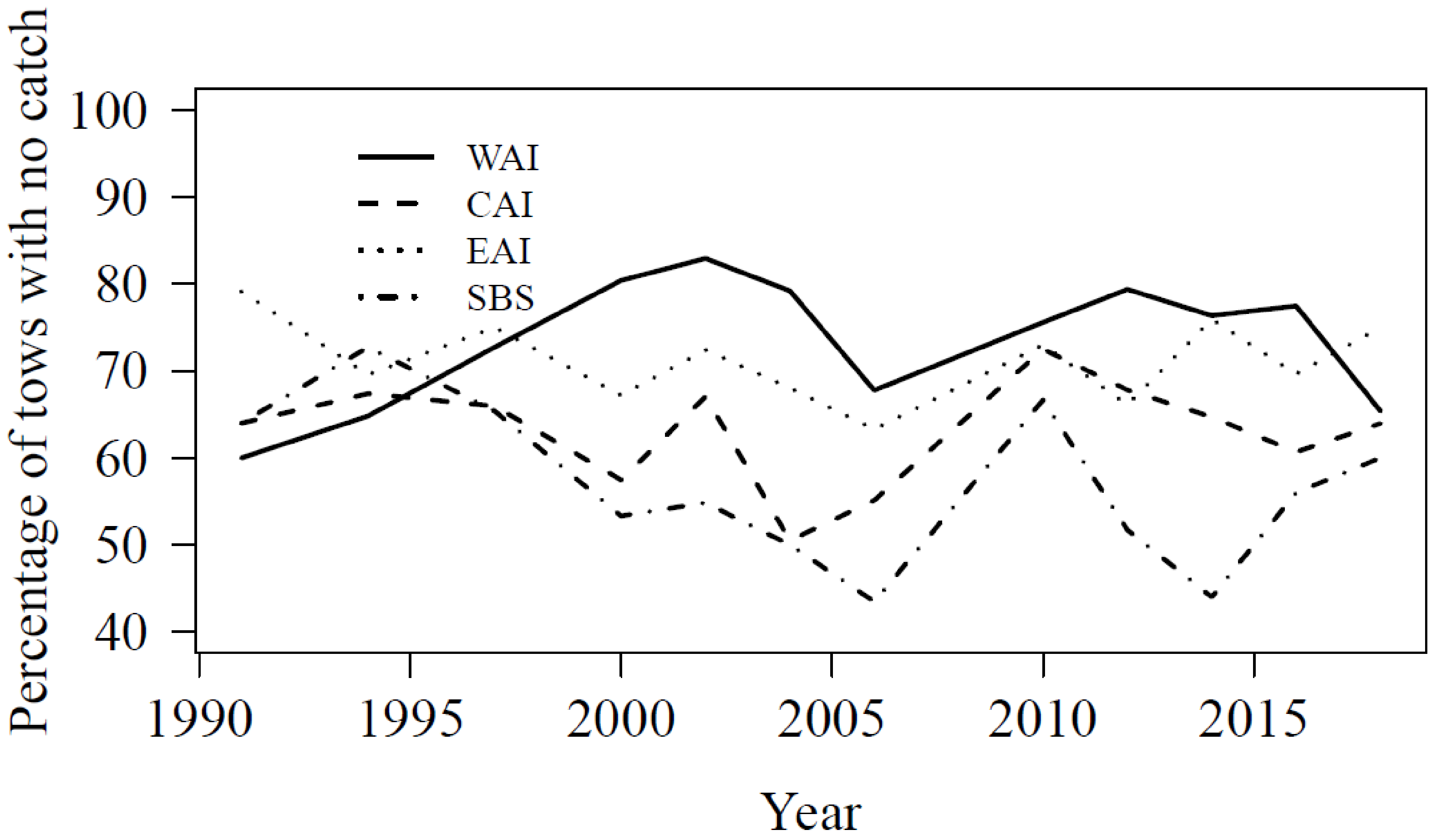
Occurrence in AI hauls, by size group



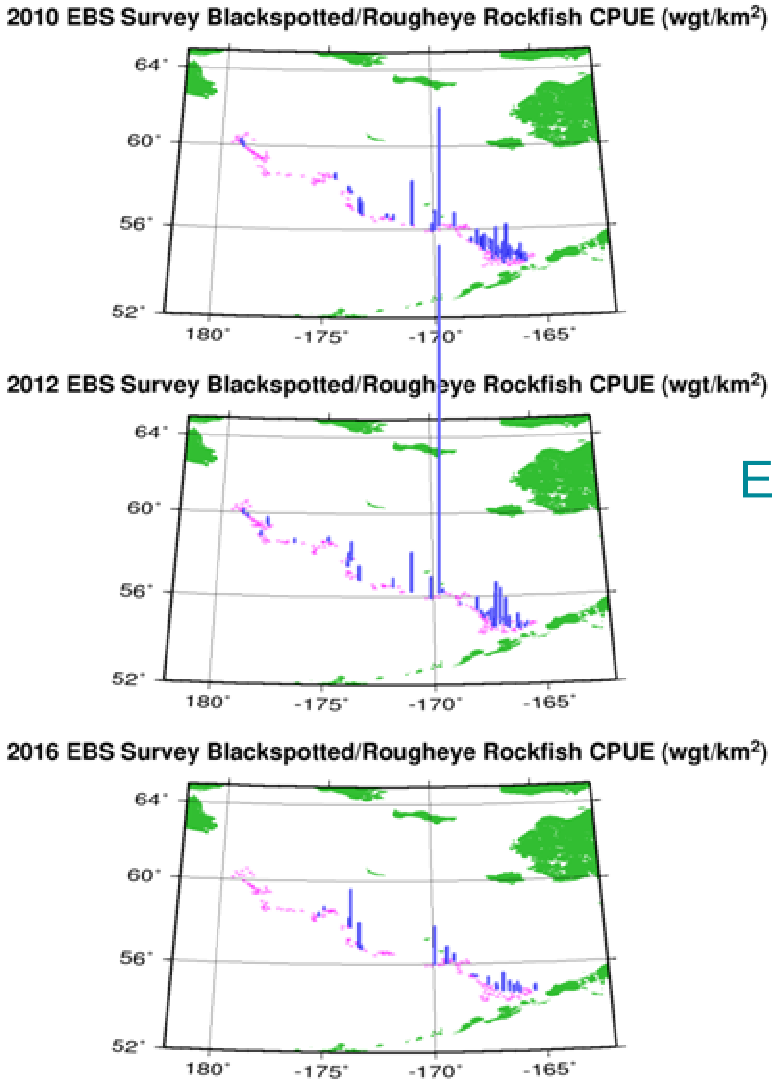
Mean size and age in the AI survey



Percentage of tows with no catch



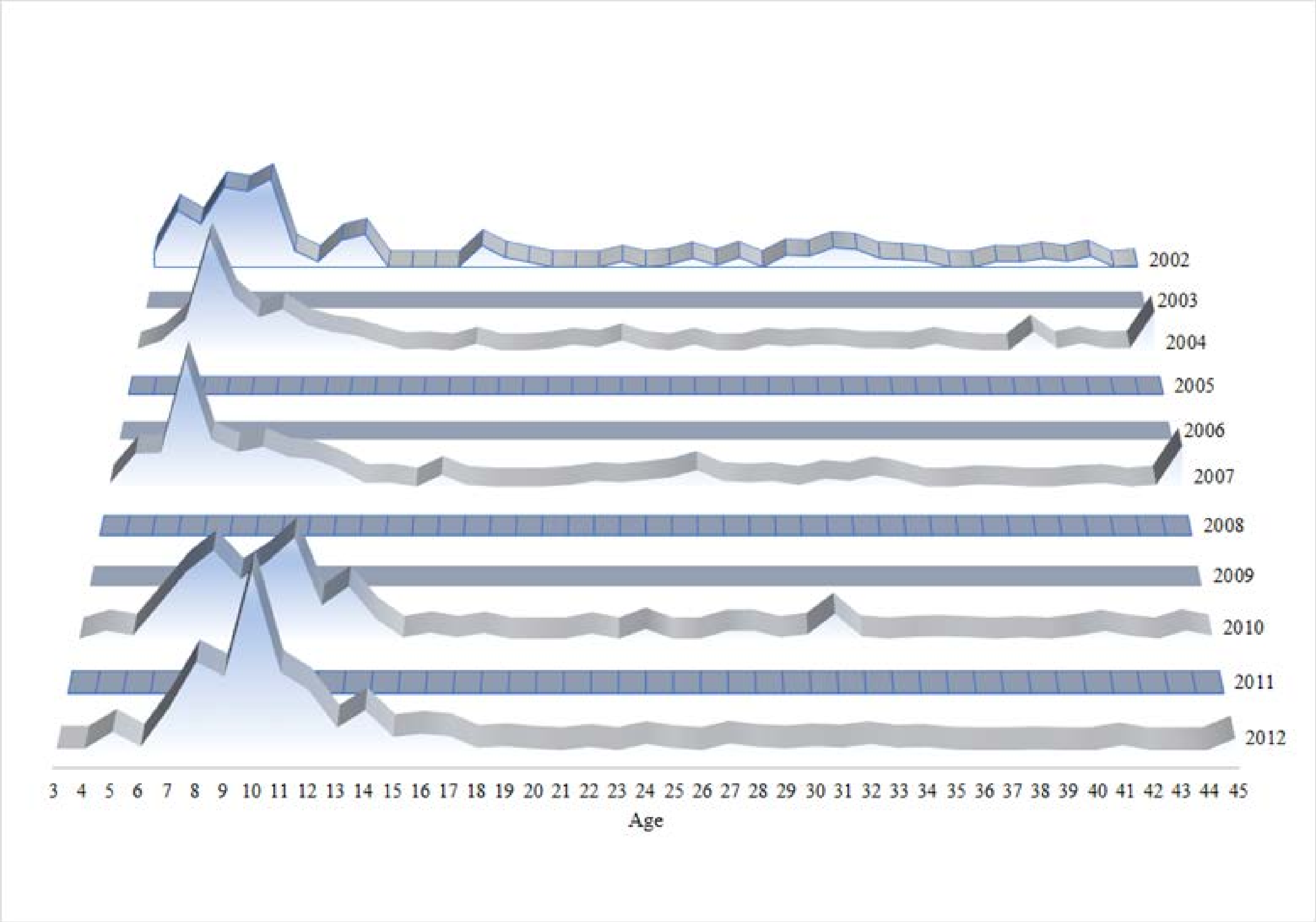
2010 – 2016 EBS surveys



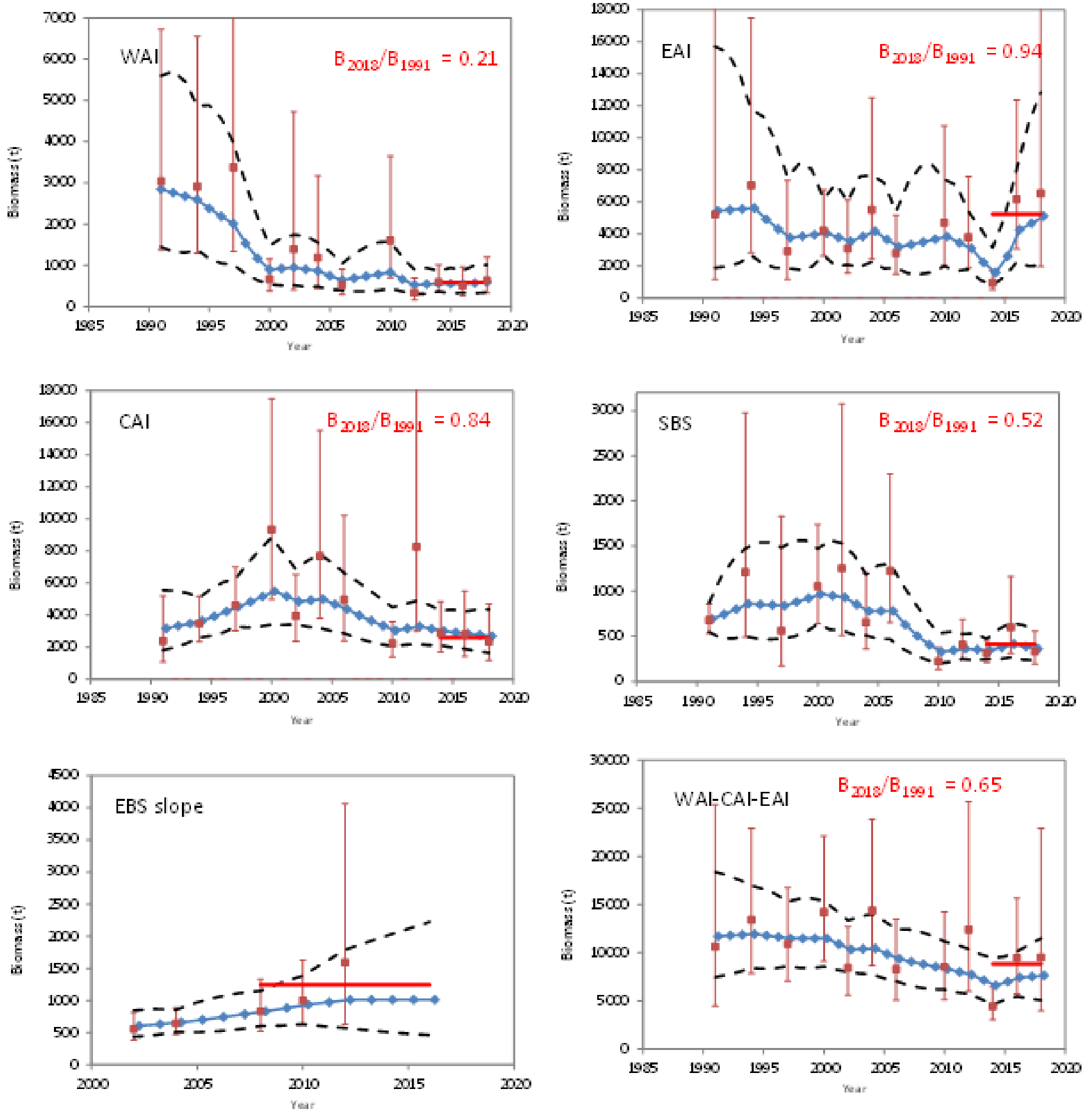
EBS survey biomass estimates and CVs

Year	EBS slope survey
2002	553 (0.20)
2004	646 (0.16)
2008	829 (0.24)
2010	999 (0.25)
2012	1,594 (0.51)
2016	458 (0.27)

EBS survey age composition data



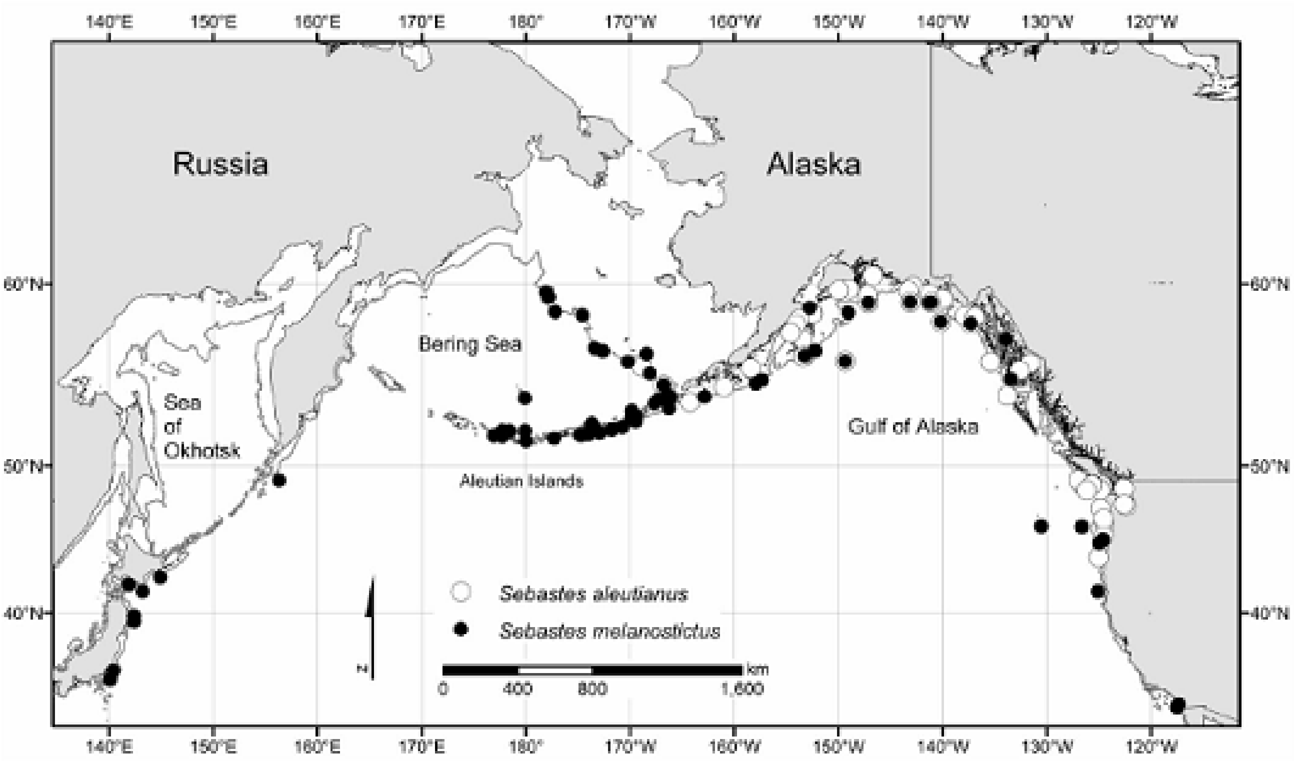
Smoothed survey biomass estimates



Model evaluation

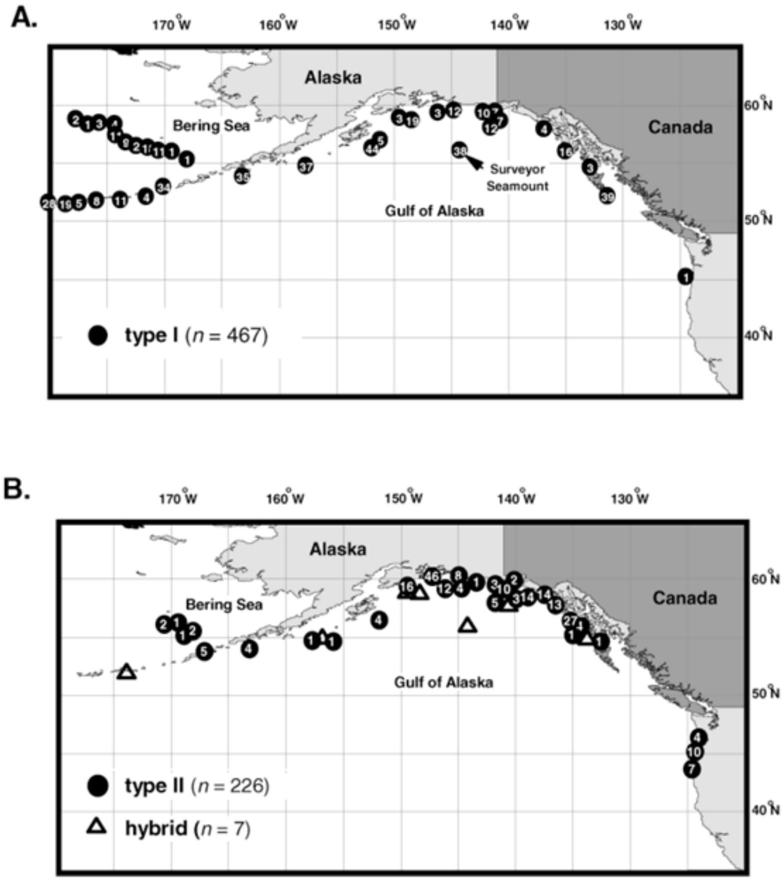
- Are the rougheye complexes in the EBS and AI sufficiently similar to each other (i.e., population dynamics, species composition) to warrant a single BSAI model?
- Is the age-structured model adequate (particularly the fit to the AI survey biomass time series)?

Spatial distribution of blackspotted and rougheye rockfish in the BSAI



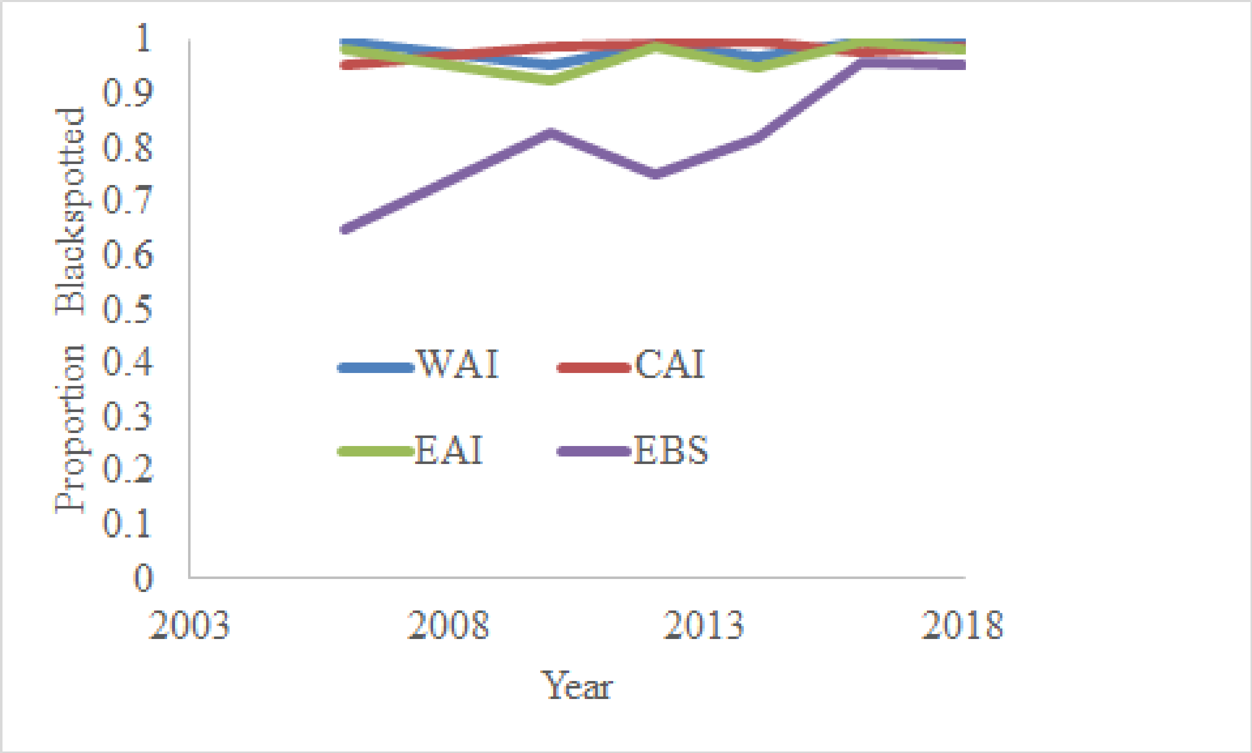
(Orr and Hawkins, 2008)

Spatial distribution of blackspotted and rougheye rockfish in the BSAI



(Gharrett et al., 2005)

AI trawl survey data indicate that rougheye rockfish are uncommon in the AI subarea



Spatial distribution of blackspotted and rougheye rockfish in the BSAI

- An Aleutian Islands age-structured model is essentially a single-species model.
- A BSAI age-structured model is applied to two-species, which could increase uncertainty if recruitment strengths, stock productivity, etc. differ between the species.

Inferring the ratio of the catchabilities for the EBS and AI surveys is complicated

- In the current AI-only model for blackspotted/rougheye rockfish, the area of the AI survey matches the area of the modeled stock
- With a BSAI model, some portion of the modeled stock would not be "available" to the AI survey
- The "availability" of the stock was modeled from the relative proportions of smoothed estimates of survey biomass

Modification to survey catchability

Old approach (2014 assessment)

$$S_{a,t} = qB_{a,t}$$

New approach

$$S_{a,t} = p_{AI,t}qB_{a,t}$$

$B_{a,t}$ = modeled biomass at age a in year t (after adjusting for survey selectivity).

$S_{a,t}$ = Predicted AI survey biomass at age a and year t.

q = survey catchability

p_{AI} = proportion of stock in the AI area (based on nominal survey biomass estimates as measure of true biomass)

Inferring the ratio of the catchabilities for the EBS and AI surveys is complicated

- Confounding of true abundance with survey design and gear (Table below from 2017 flatfish CIE review)

Survey	Survey Design	Depths (m)	Vessels	Sampling Density mean (km²/haul)	Towing Duration (min)	Towing Speed (knots)	Towing Dynamics	Trawl Net	Doors	Door Connection	Footrope
EBS SLOPE	Random stratified	200-1200	1	200	30	2.5	Dynamic mode	Poly Nor' Eastern	6 x 9 v 2200 lbs	4-point	mud sweep gear-8" discs
EBS SHELF	Fixed stations	20-197	2	1300	30	3	Brakes locked	83-112 Eastern	6 x9 v1800 lbs	2-point	Fiber core wire wrapped with rubber fire hose
EBS NORTHERN	Fixed stations	20-100	2	1410	30	3	Brakes locked	83-112 Eastern	6 x9 v1800 lbs	2-point	Fiber core wire wrapped with rubber fire hose
ALEUTIAN ISLANDS	Random stratified	20-500	2	157	15	3	Dynamic mode	Poly Nor' Eastern	6 x9 v1800 lbs	2-point	Bobbins and Roller Gear
GULF OF ALASKA	Random stratified	20-1000	3	560	15	3	Dynamic mode	Poly Nor' Eastern	6 x9 v1800 lbs	2-point	Bobbins and Roller Gear

Inferring the ratio of the catchabilities for the EBS and AI surveys is complicated

Catchability (q) is often simply treated as a scaling parameter to fit data. As such, given the only information on M is also in the survey data, q is aliased with M. If all q's were estimated given a fixed M, then a good starting place for fitting may well be the proportions of biomass estimated in each survey. However, assuming well-behaved models and likelihood surfaces, final estimated q's might well be very different. Given the surveys cover different portions of the stock(s) at different life history stages, and all have different gear and operational attributes (see table below copied from Ref 10, slide 5), there is no a priori reason to expect relative stock distributions to be reflected directly by the surveys.

Kevin Stokes, 2017 flatfish CIE review

There may be uncertainty in our estimates of *q*, but with a single-area model at least we do not have to worry about the areal availability

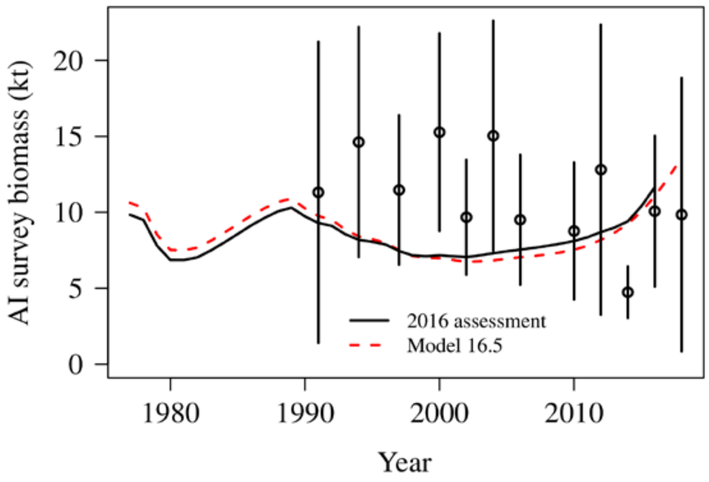
Models evaluated (AI and BSAI models)

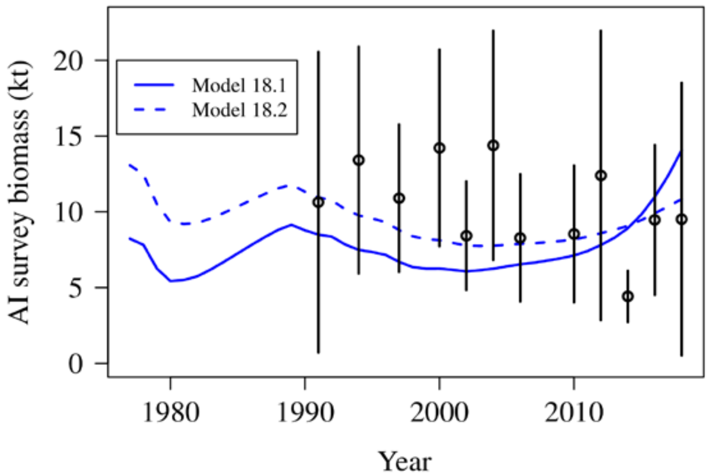
- *Model 16.5* From 2016 assessment, updated data and iterative reweighting with McAllister-Ianelli method
- *Model 18.1* AI model, updated data and iterative reweighting with McAllister-Ianelli method
- *Model 18.2* AI, iterative reweighting with Francis method

Data in assessment model

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

Fits to AI survey biomass

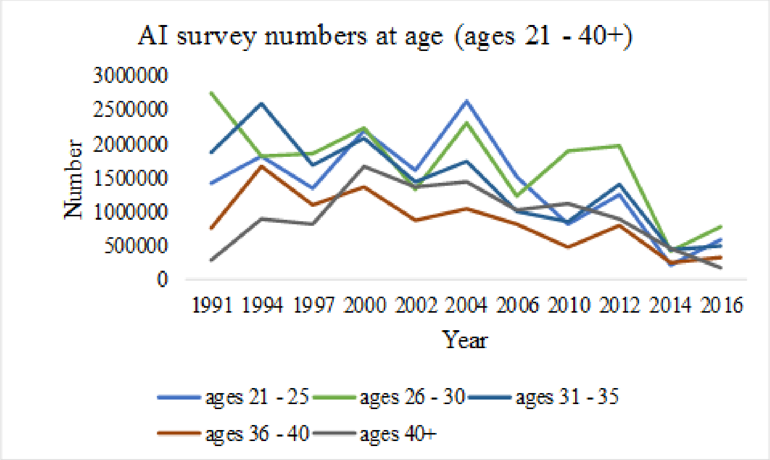


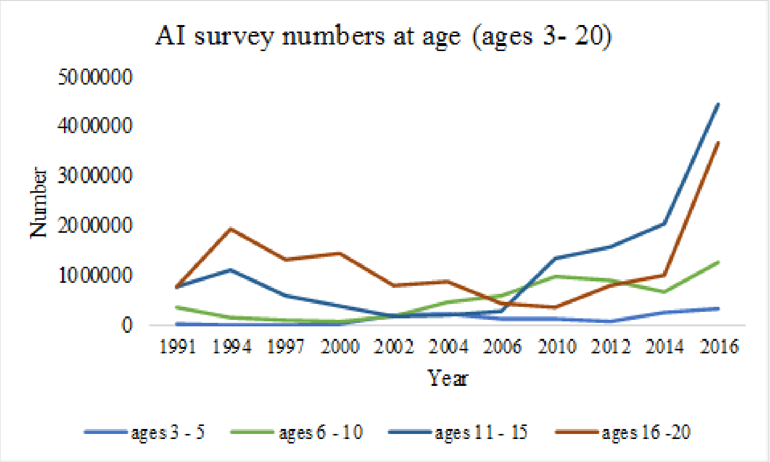


The models are not fitting the AI survey biomass very well, and this is not improved by adding EBS data to the model

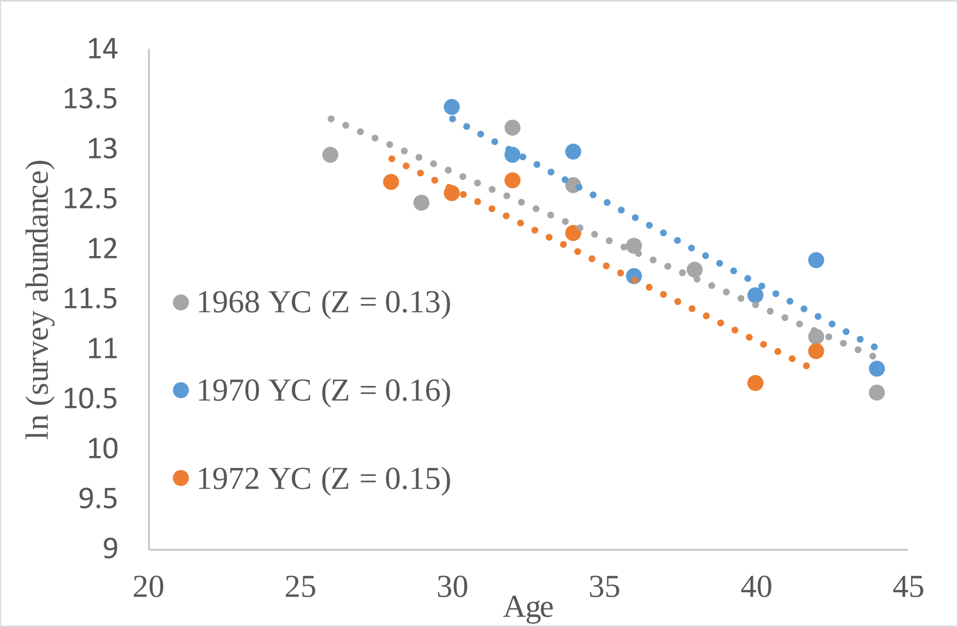
What is it about the composition data that suggests that the stock is increasing, whereas the survey biomass data suggests it is decreasing?

Decline over time of older fish in AI survey





Catch curves from AI survey



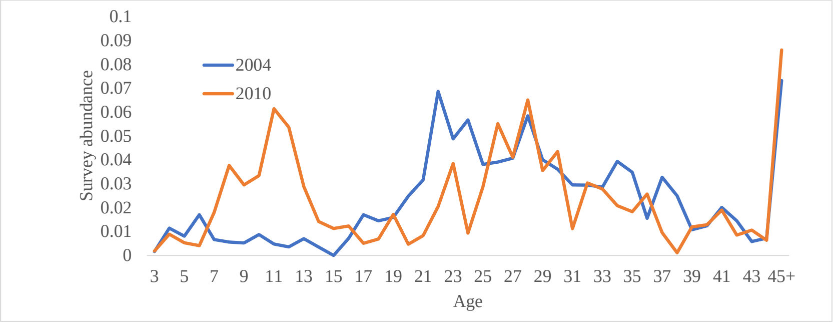
Potential sources of mortality:

Fishing, but only if the survey catchability is really high (i.e., population is low).

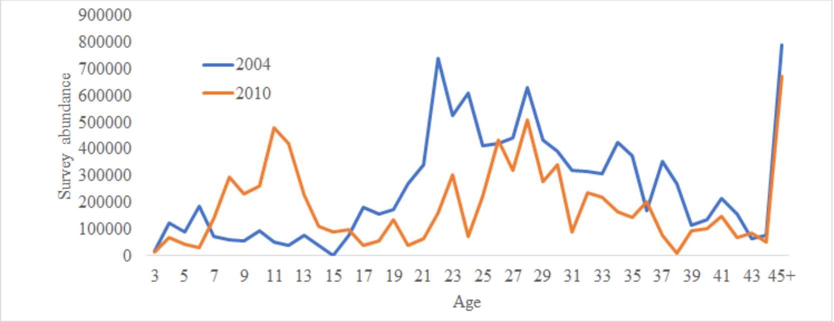
Natural Mortality (but only if *M* is much higher than expected, and inconsistent with the observed maximum ages).

M and *q* are locked down in this model with pretty tight priors, so the model cannot change mortality that much. The only thing the model can do to match the composition data is ramp up recruitment.

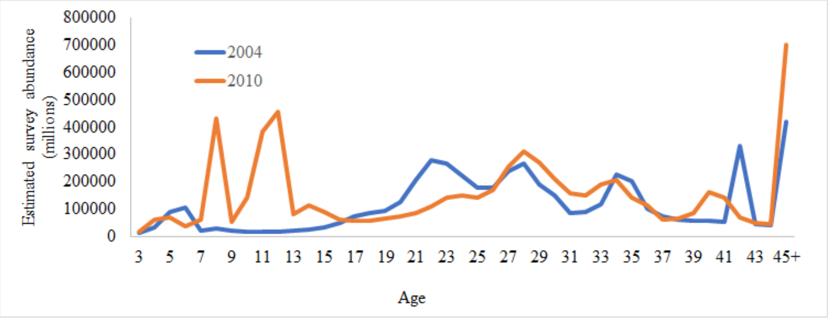
AI survey estimated abundance at age, 2004 and 2010



Proportions that the model is attempting to fit

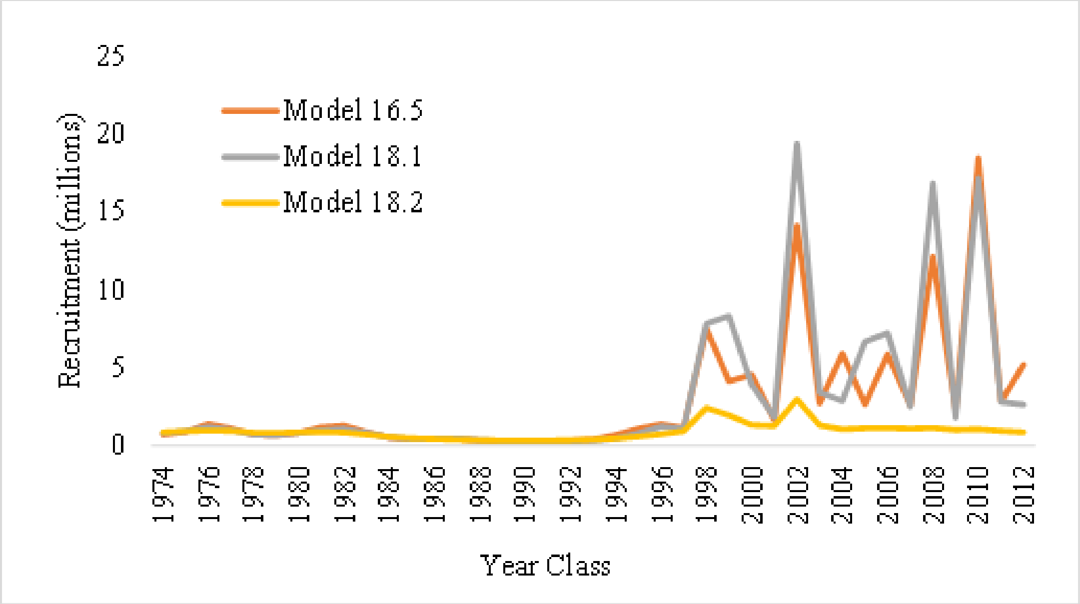


Numbers at age from the survey.

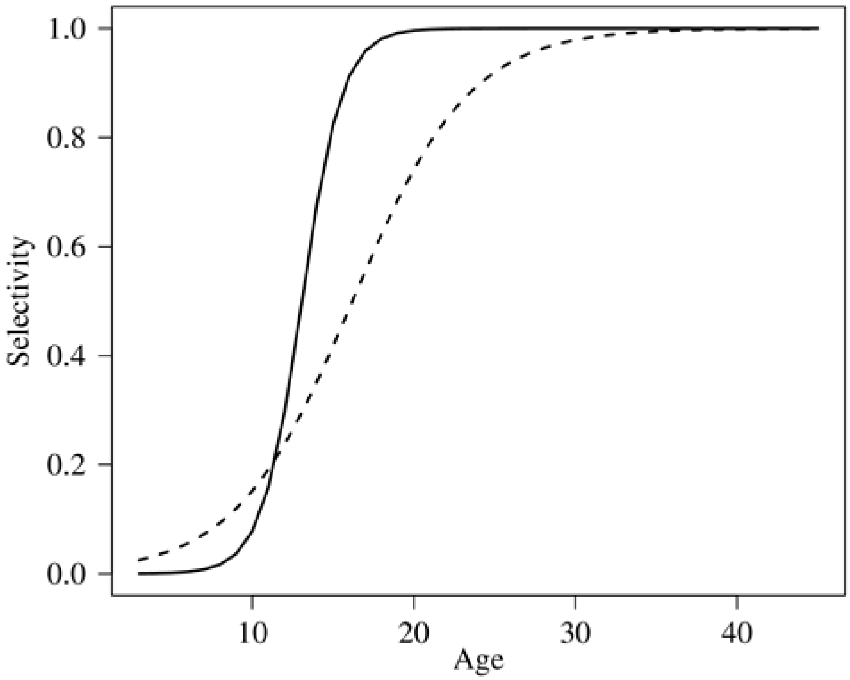


Modeled survey numbers at age, Model 18.1. Does not match the mortality for older fish.

Estimated recruitment strengths (age 3)

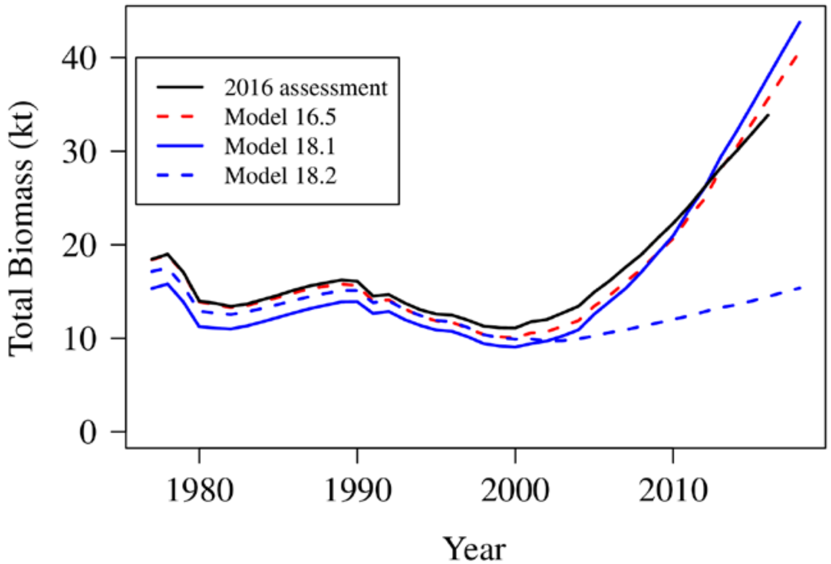


Estimated Selectivity



Survey – solid line
Fishery – dashed line

Estimated total biomass



Model 18.2 is the preferred model

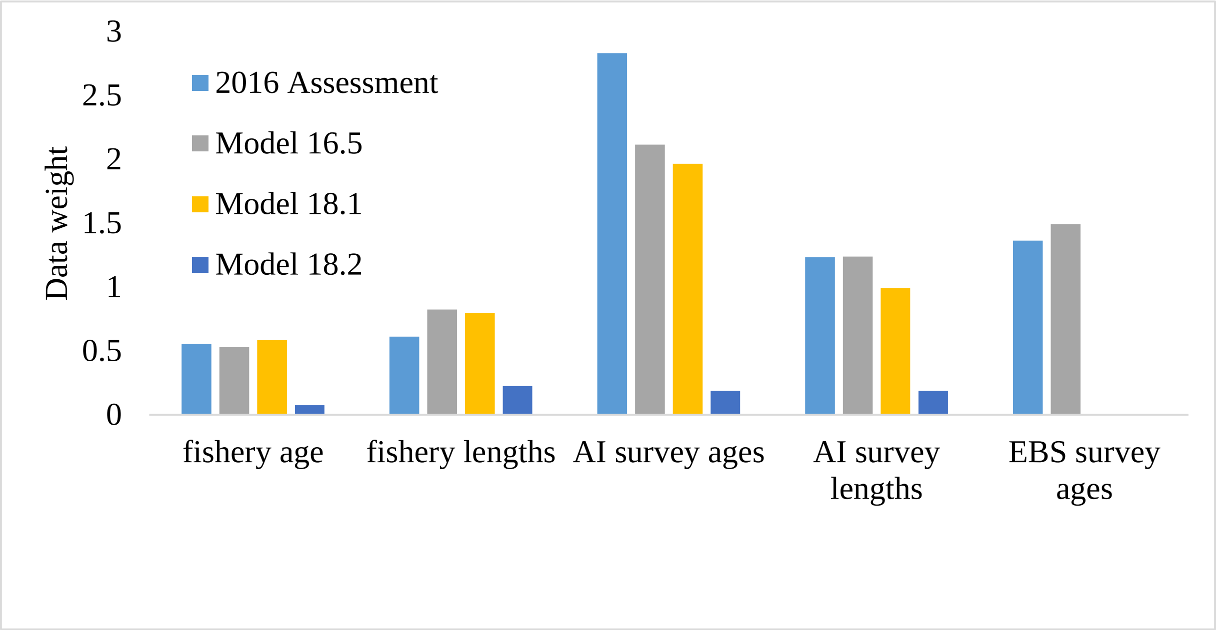
Models that do not downweight the age and length composition data suggest the total biomass is ~ 3- 4 times the current survey biomass, and composed mostly of young fish partially selected by the survey.

With the new survey biomass estimates and composition data, this seems increasingly implausible.

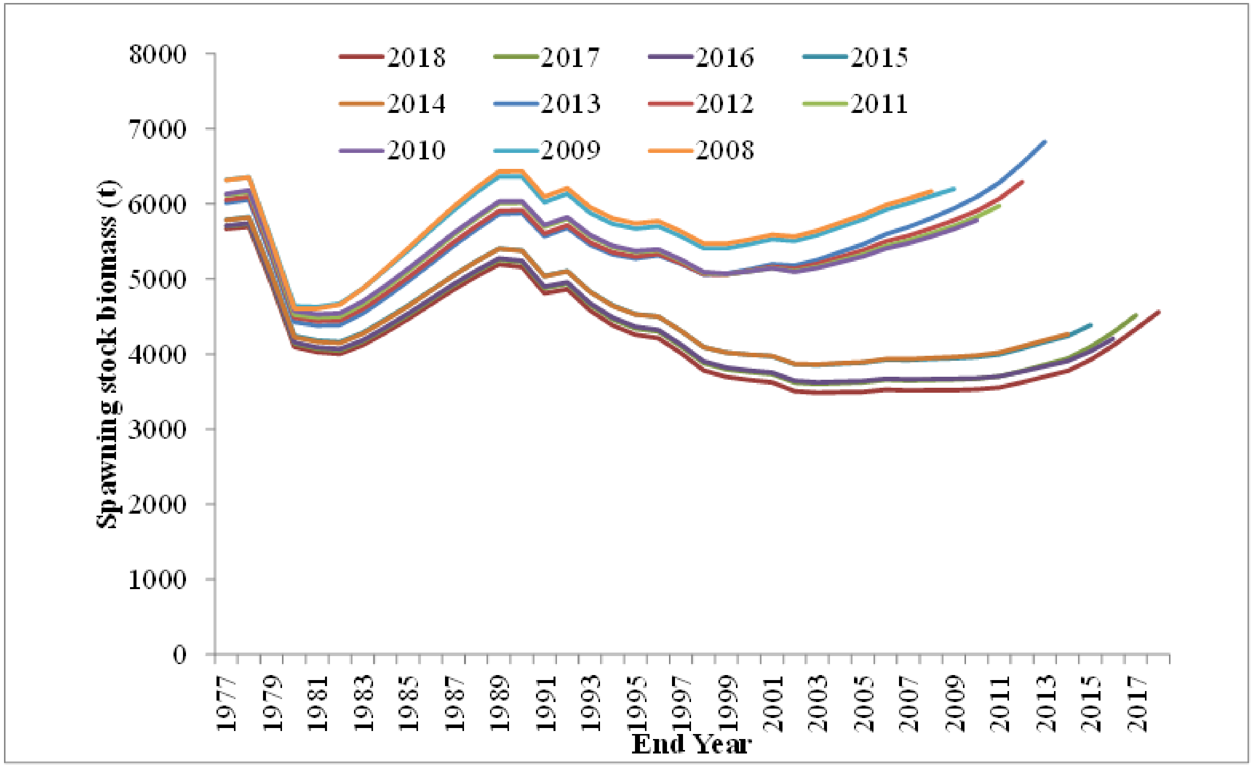
The uncertainty in the recruitment estimates was noted in 2016. Downweighting of the composition data was not selected because the fit to the biomass index was still poor.

Downweighting the composition data does not explain the mortality of older fish, but does avoid the problem of ramping up recruitment to explain the comp data.

Data weights

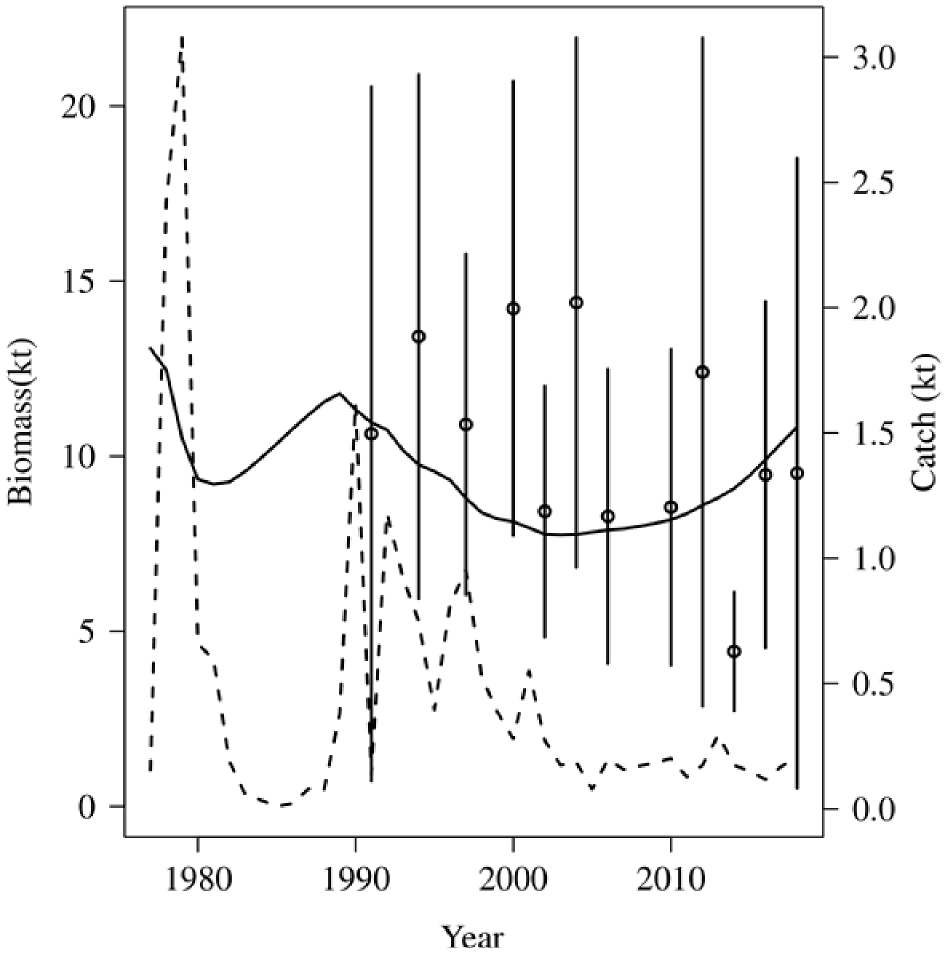


Retrospective pattern

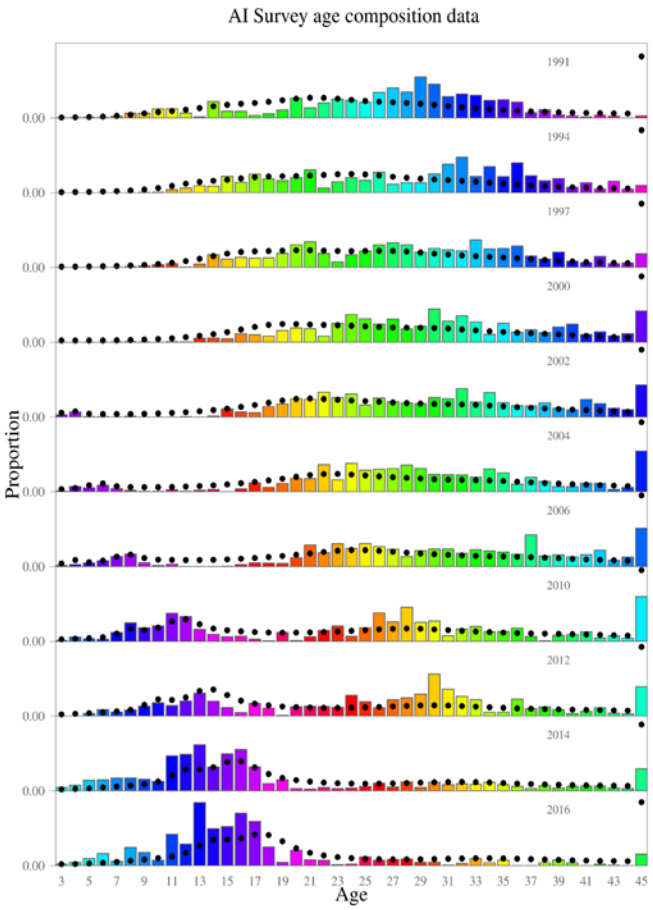


Still bad, but hinges on 2014 data point.

Catch time series, and fit to AI survey

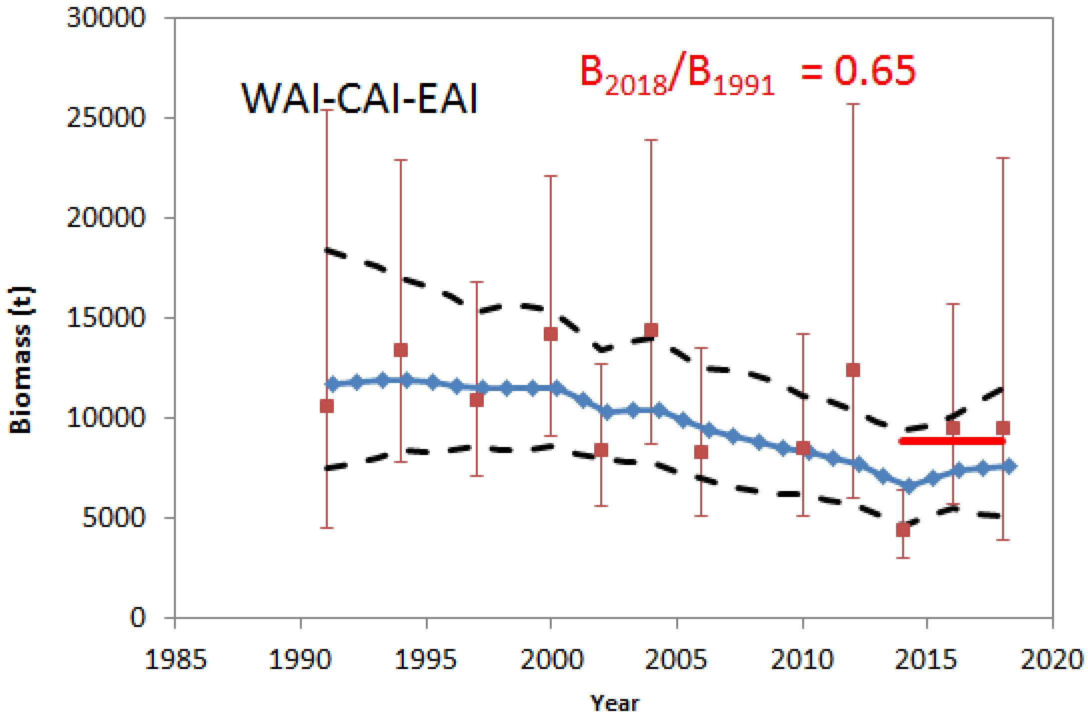


Fit to AI survey age comps



Overestimation of the plus group

What about Tier 5 for the AI?



Might be considered because the Tier 3 model does not fit either the survey or the composition data very well.

2019 ABC, Tier 5	183 t
2019 ABC, Tier 3	314 t

Changes in Observer sampling

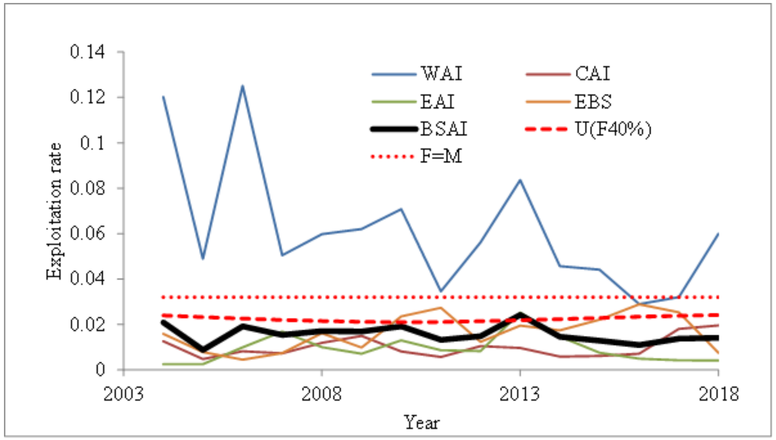
Predominant Species	Sex/Length Data	Biological Data (All specimen fish must have an associated s/l/w specimen)	Halibut Condition
Bering Sea Flatfish * Species Ranking List 1. Yellowfin Sole 1. N/S Rocksole 2. Turbot (Greenland) 3. Flathead sole 3. Alaska Plaice 4. Kamchatka/ Arrowtooth	**Every Sampled Haul** ~ 16 of the most predominant species in the list, chosen by rank in cases of equal predominance **and** ~ 4 from the next most predominant species on the flatfish Species Ranking List **and** ~ 5 skates of any species **and** ~ 5 great/plain sculpin	**Every 5th Sampled Haul** 4 otolith pairs from the ~16 flatfish s/l fish. If yellowfin sole is the predominant species, collect 2 otolith pairs **and** 1 otolith pair from the ~ 4 flatfish s/l fish	**Every 2nd Sampled Haul** ~ 10 Viability or Injury Assessments
Bering Sea Pollock	**Every Sampled Haul** ~ 20 pollock **and** ~ 20 squid (unsexed)	**Every 5th Sampled Haul** 2 pollock otolith pairs with maturity scan for all female otolith fish **and** ~ 8 pollock sex/length/weight specimens (must not be from an otolith fish)	**CV: Every Sampled Haul** **CP: Every 2nd Sampled Haul** ~10 Viability Assessments

Collect 5 rougheye lengths and 3 otolith pairs in hauls with rougheye. Collect 5 great/plain sculpin lengths in hauls without rougheye.

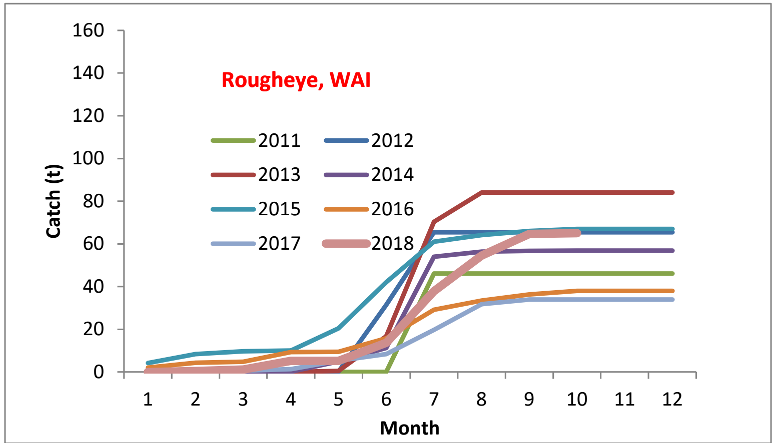
Collect 5 rougheye lengths and otolith pairs from hauls with rougheye rockfish.

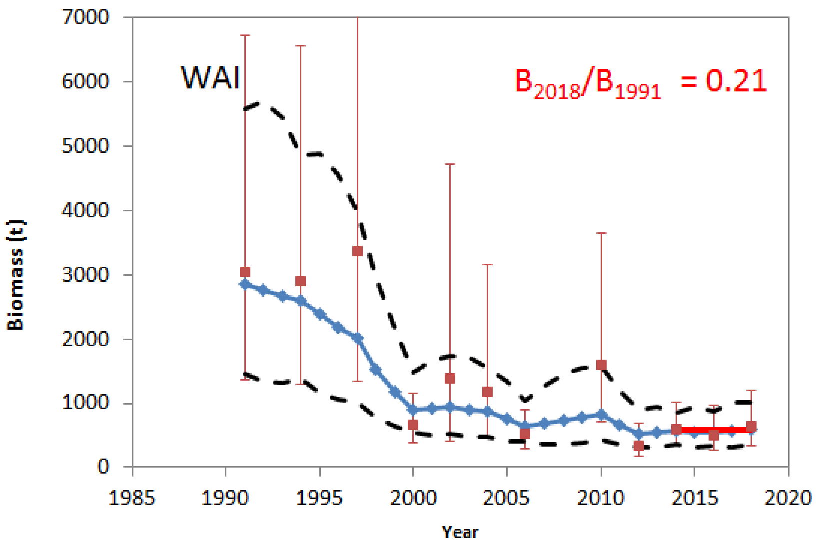
Monitoring of WAI catch relative to MSSC

Requested by SSC (Oct 2016, Dec 2016)

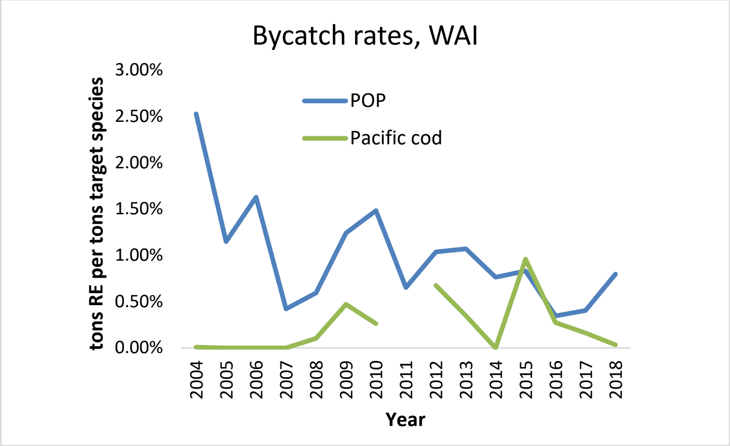


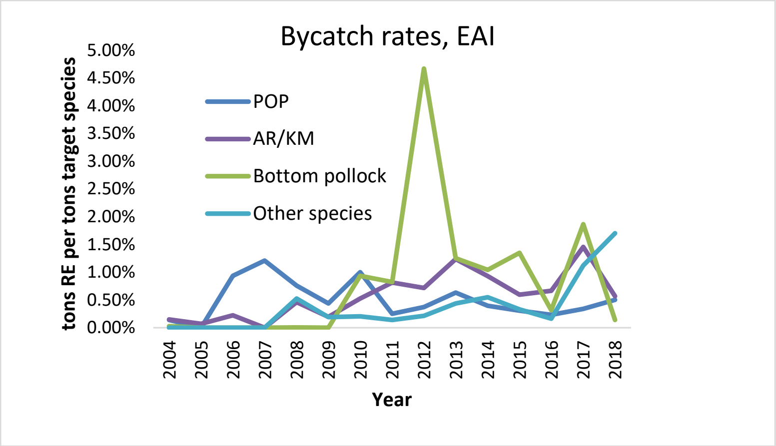
Year	WAI MSSC	WAI Catch	Catch/MSSC
2015	46	67	1.46
2016	58	38	0.65
2017	29	34	1.17
2018	35	65	1.86

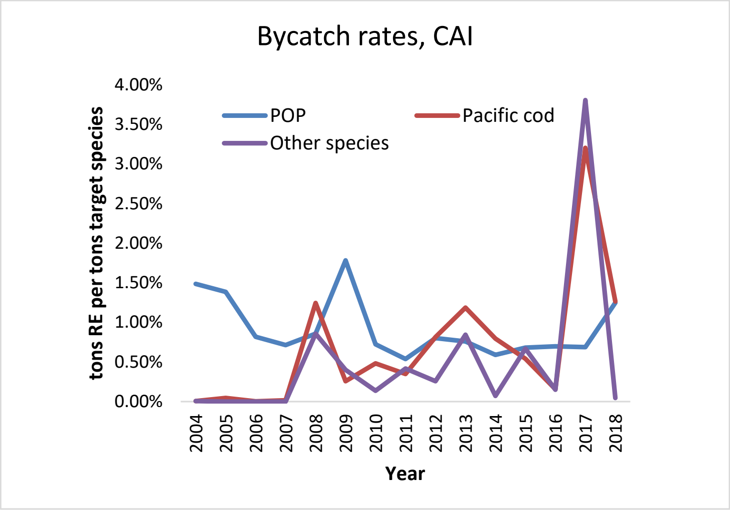


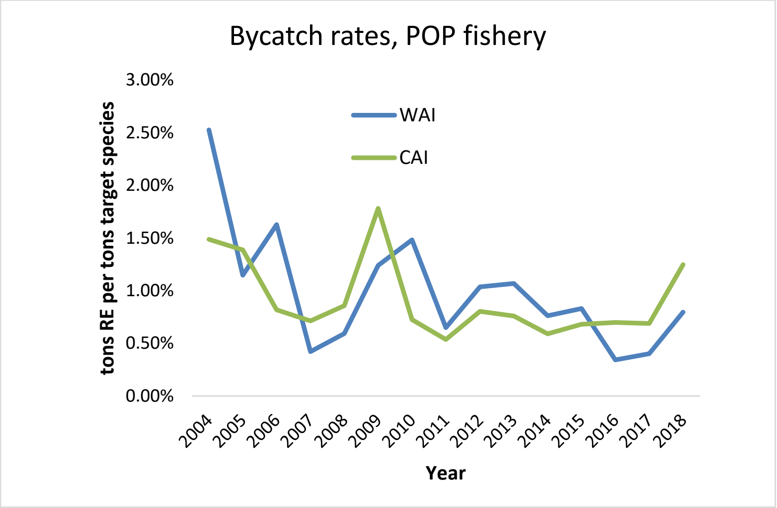


BSAI Blackspotted/Rougheye bycatch rates by target fishery and area, 2004-2018

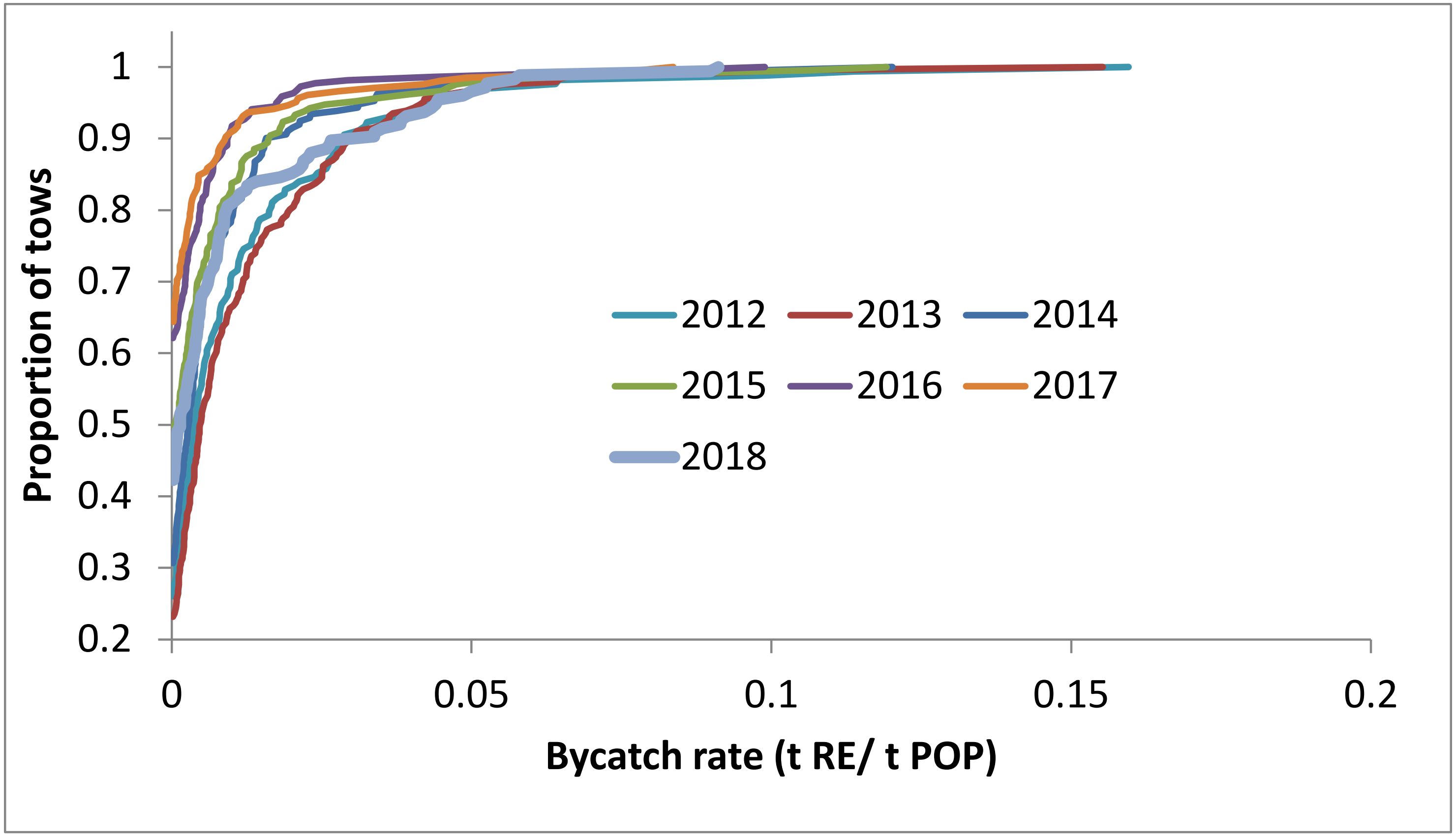








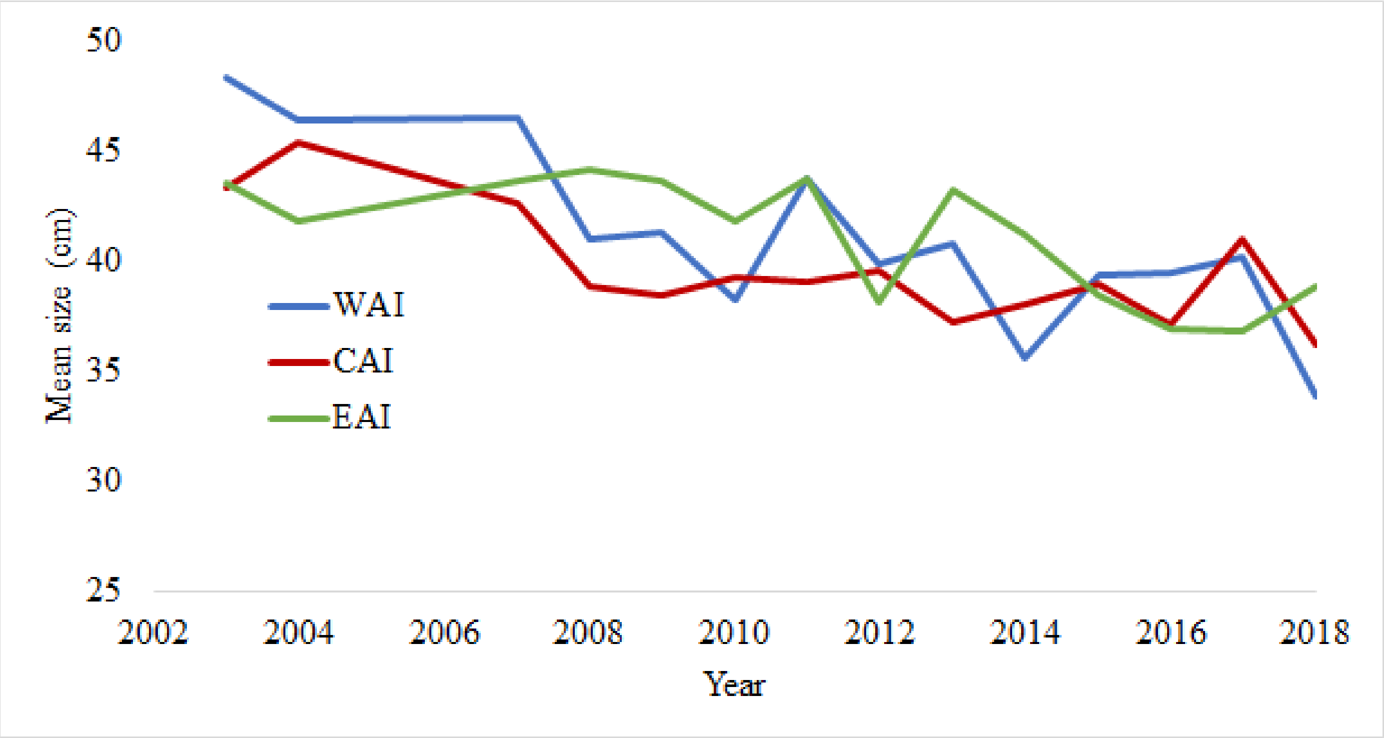
Distributions of bycatch rates in the POP fishery in the WAI area, 2012-2018



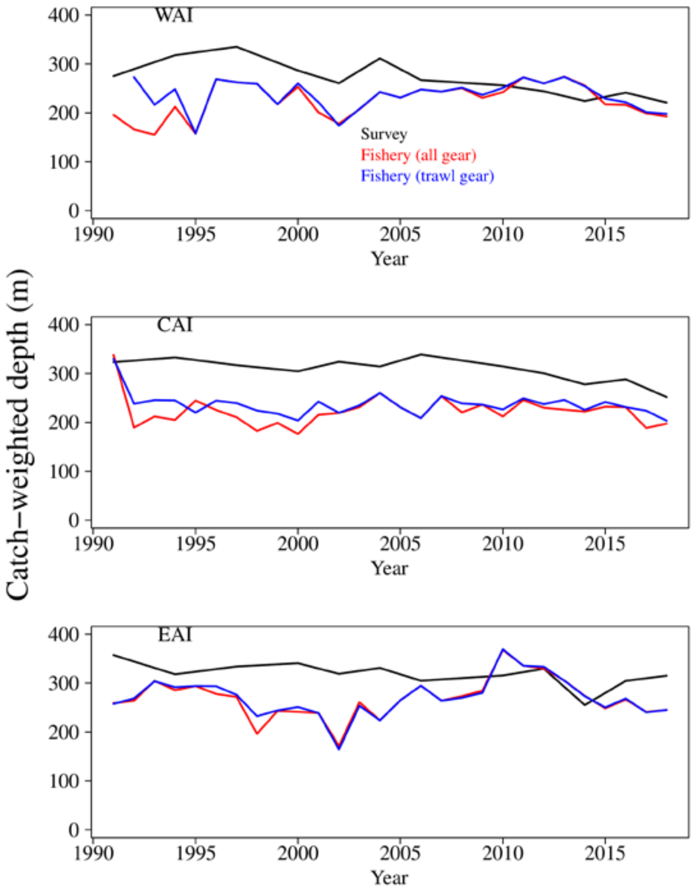
Anything different about tows with high bycatch rates?

Bycatch rate	Number of tows	Mean depth
top 20%	36	227
positive , not top 20%	66	222
0	73	204

Mean size of fishery catches



Depth of capture, fishery and survey



In recent years, depth of capture has been similar in the WAI between the fishery and survey (~ 200 m).

The survey depth of capture has decreased over time in the WAI and CAI, likely related to lack of older fish.

Tier 3 vs Tier 5

Jim I: *"Are those our only choices?"*

Tier 5

Simpler, fits the survey time series better.
More conservative, which may be appropriate given any concern about loss of older fish.

Tier 3

We do not usually drop down from Tier 3 to 5, and this case may not be drastic enough to consider this.

There may be a disincentive to read otoliths in the future for a Tier 5 stock. Even if the model cannot explain the age composition data very well, continuing the age readings does add information on the dynamics.

We might get more informative data/models in the future, and we probably do not want to be switching back and forth between Tier 3 and Tier 5.

Recommendation of Tier 5 over Tier 3 is based more on "institutional" considerations than superior model performance.

Harvest spec table, AI subarea

Quantity	As estimated or *specified* last year for: 2018	2019	As estimated or *recommended* this year for: 2019*	2020*
M (natural mortality rate)	0.033	0.033	0.032	0.032
Tier	3b	3a	3b	3b
Projected total (age 3+) biomass (t)	37,453	39,169	15,647	16,002
Female spawning biomass (t)				
Projected	8,208	9,163	4,736	4,962
$B_{100\%}$	20,777	20,777	13,767	13,767
$B_{40\%}$	8,311	8,311	5,507	5,507
$B_{35\%}$	7,272	7,272	4,818	4,818
F_{OFL}	0.054	0.055	0.029	0.030
$maxF_{ABC}$	0.044	0.045	0.024	0.025
F_{ABC}	0.044	0.045	0.024	0.025
OFL (t)	749	829	373	404
maxABC (t)	613	678	314	341
ABC (t)	613	678	314	341
Status	As determined *last* year for: 2016	2017	As determined *this* year for: 2017	2018
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No

Harvest spec table, EBS subarea

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

Subarea allocations

Smoothed biomass estimates similar to those obtained in the 2016 assessment

	Area				
	WAI	CAI	EAI	SBS	EBS slope
Smoothed biomass	595	2,691	5,114	361	1,010
percentage (within AI subarea)	7.1%	32.0%	60.9%		

In recent years the subarea ABC for the western and central Aleutians Islands has partitioned into "maximum subarea species catch" in order to guide voluntary efforts from the fishing fleet to reduce harvest in the WAI.

	Area				
	WAI MSSC	CAI MSSC	WAI/CAI ABC	EAI/EBS ABC	Total ABC
2019 ABCs-MSSCs	22	101	123	224	347
2020 ABCs-MSSCs	24	109	133	241	374

Conclusions

- Recommend applying a single-species age structured model to blackspotted rockfish in the AI subarea.
- New survey data suggest mortality on older fish is higher than previously estimated.
- Survey abundance in the western AI continues to be low, with high exploitation rates.

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

Inverse of residual variance (method TA1.2 in Francis 2011)

Weight by the inverse of the variance of the standardized residuals

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.

Time series of relative proportion of BSAI survey biomass in AI subarea