# 2016 BSAI Tier 3 rockfish presentations

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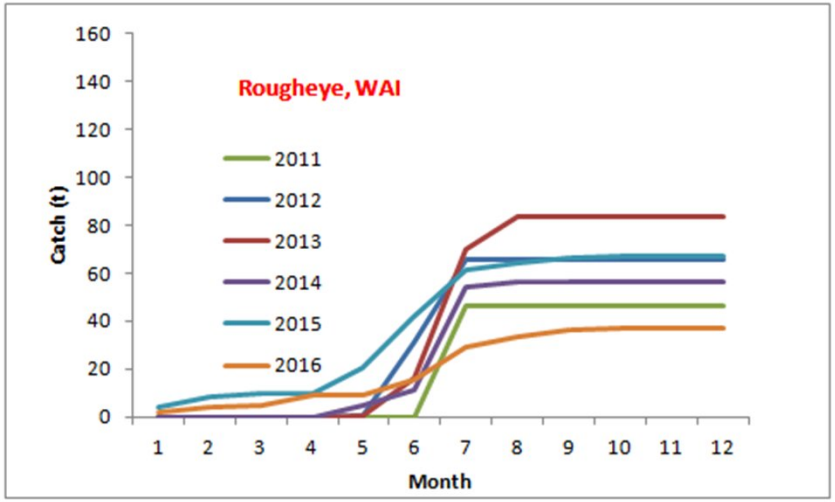
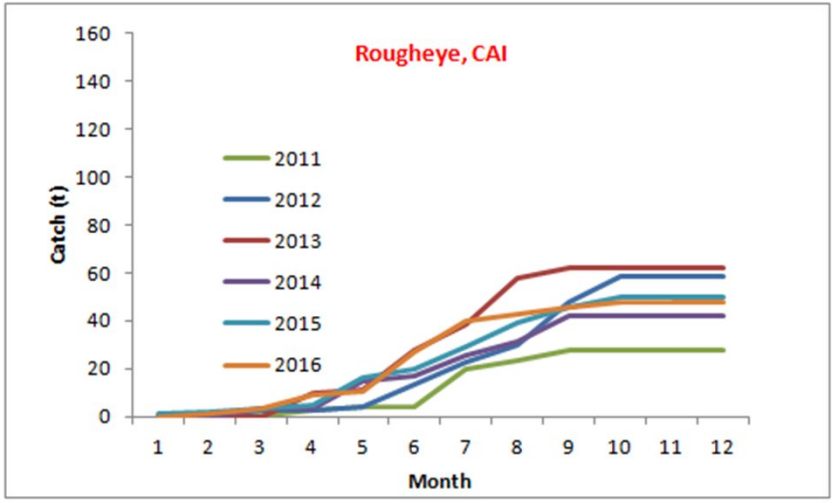
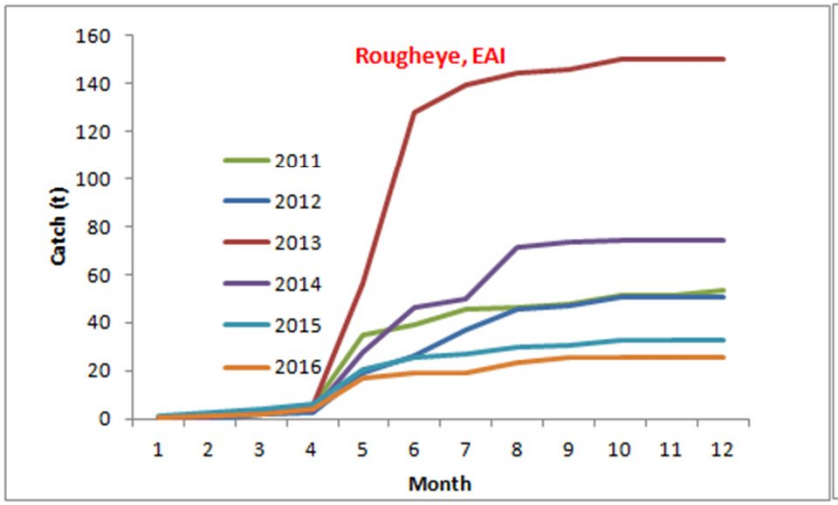
# Outline

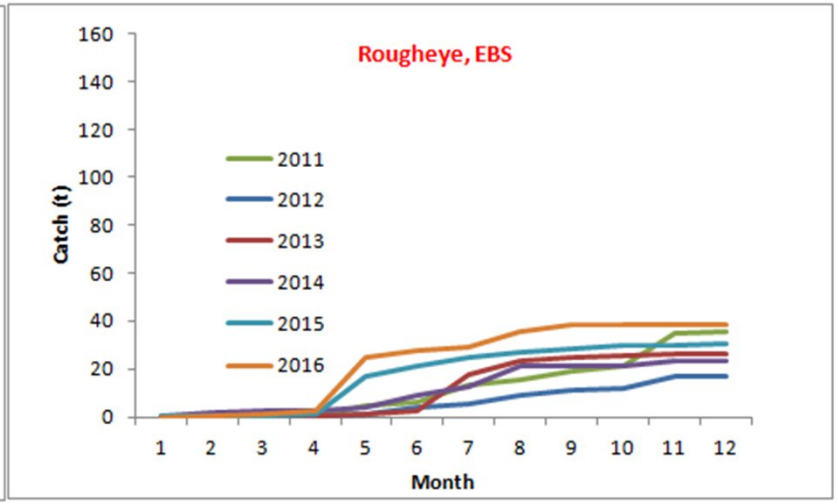
1) Catch information
2) Survey and fishery data
3) Iterative reweighting of composition data, modeling availability
4) Model evaluation
5) Retrospective analysis
6) Model fits to data
7) Calculation of B40%
8) Management recommendations

# BSAI Blackspotted/Rougheye catch by month and area, 2011-2016

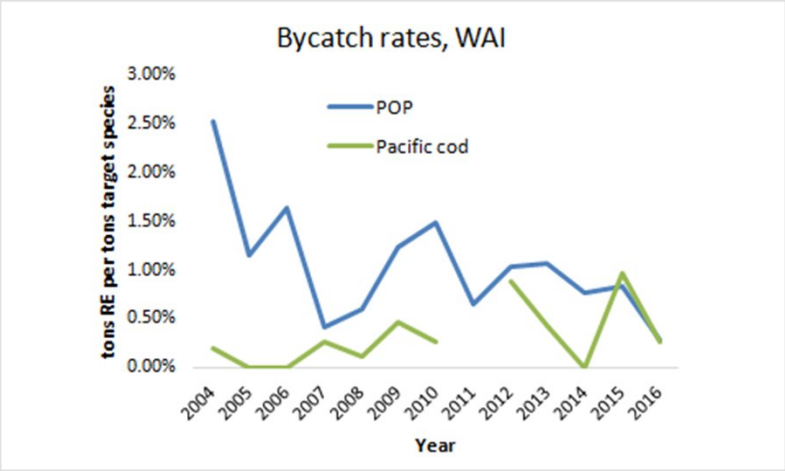


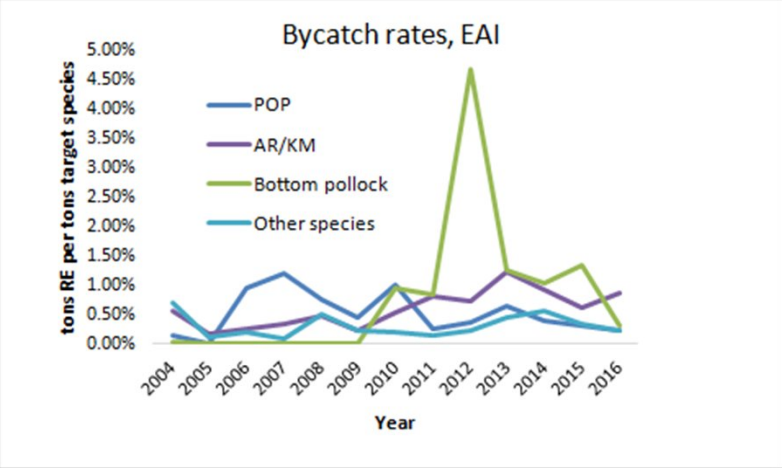



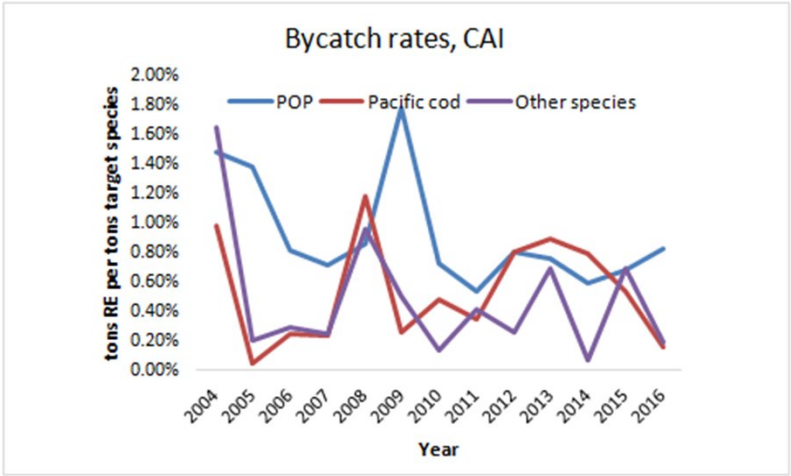



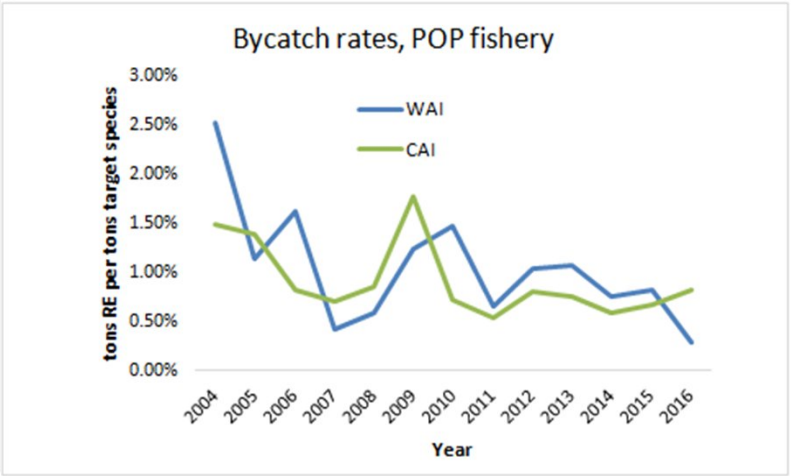



# BSAI Blackspotted/Rougheye bycatch rates by target fishery and area, 2004-2016

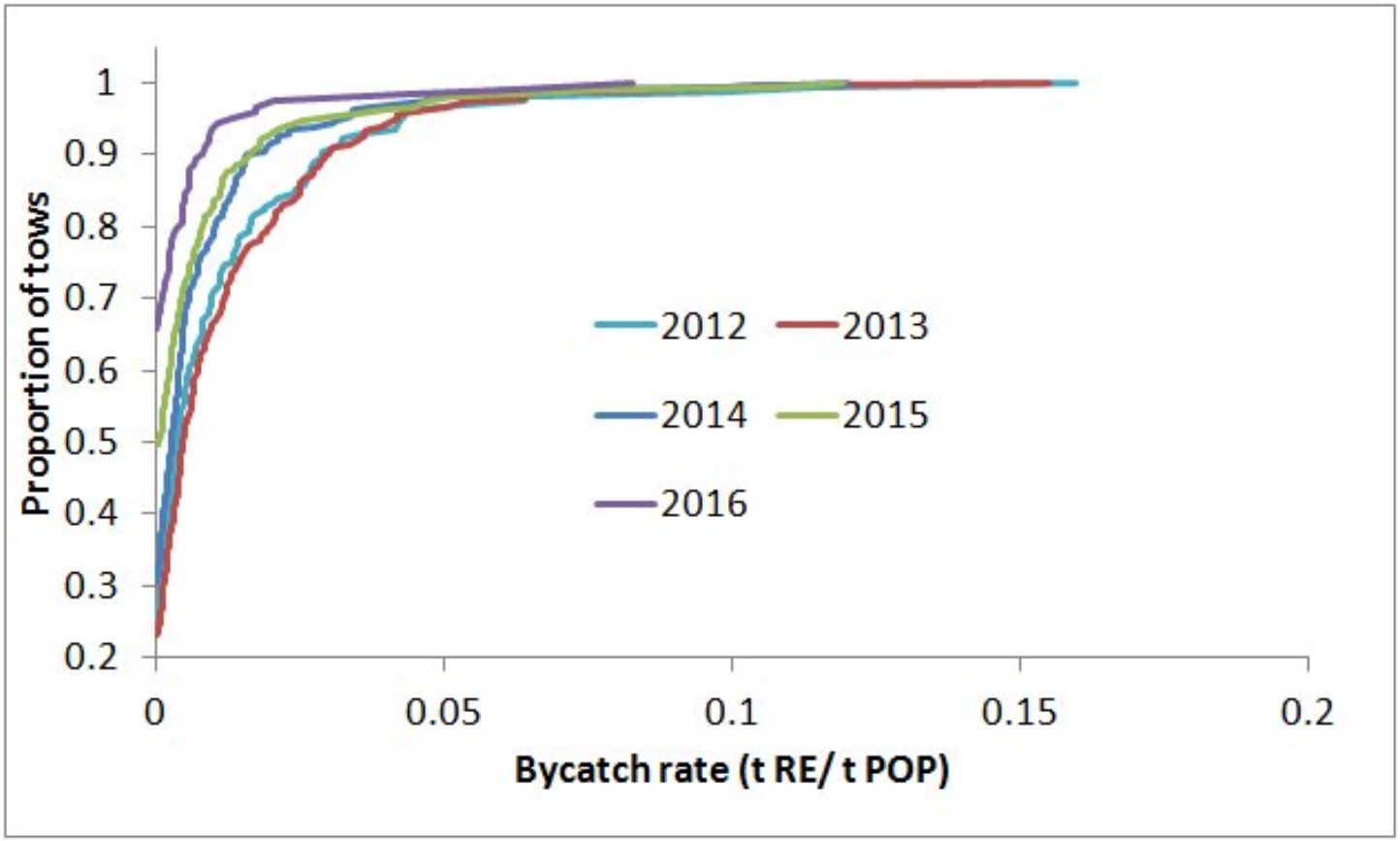


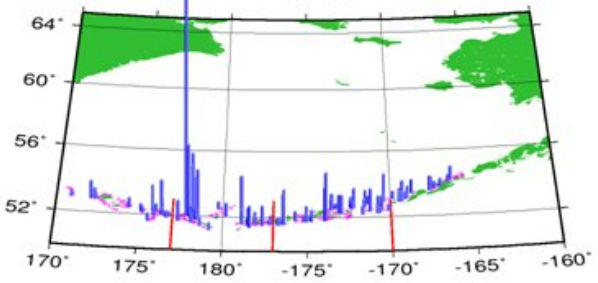



# Distributions of bycatch rates in the POP fishery in the WAI area, 2012-2016

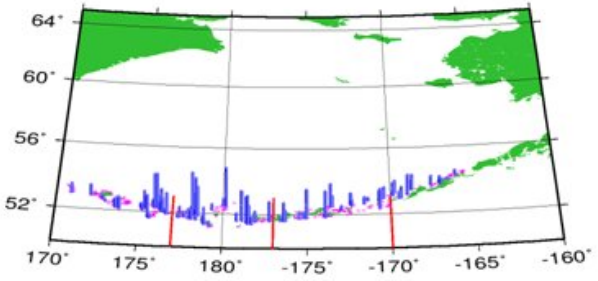


# Square root of survey CPUE, 2012 – 2016 AI surveys

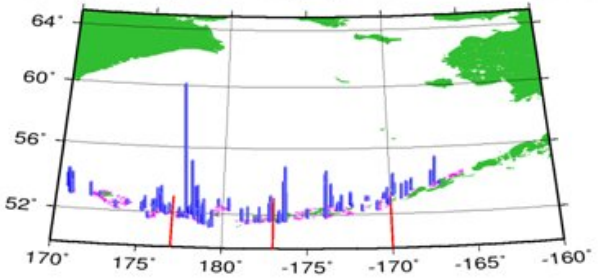
2012 AI Survey Blackspotted/Rougheye Rockfish CPUE (scaled wgt/km$^2$)




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



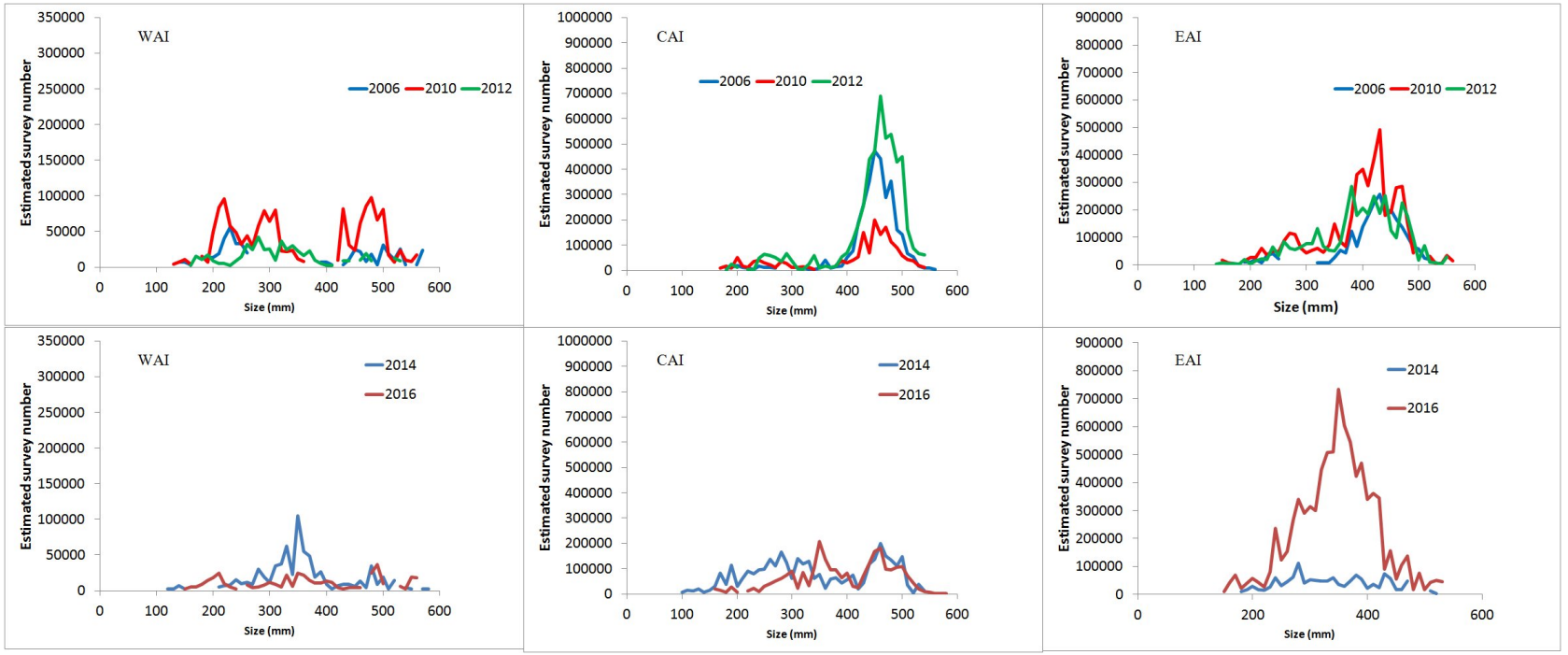

2016 AI Survey Blackspotted/Rougheye Rockfish CPUE (scaled wgt/km$^2$)



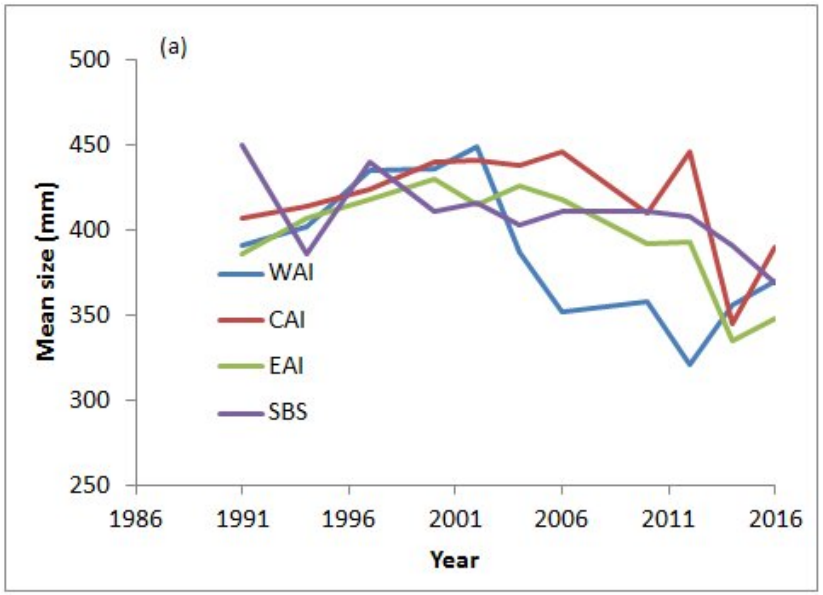

## Survey biomass estimates and CVs

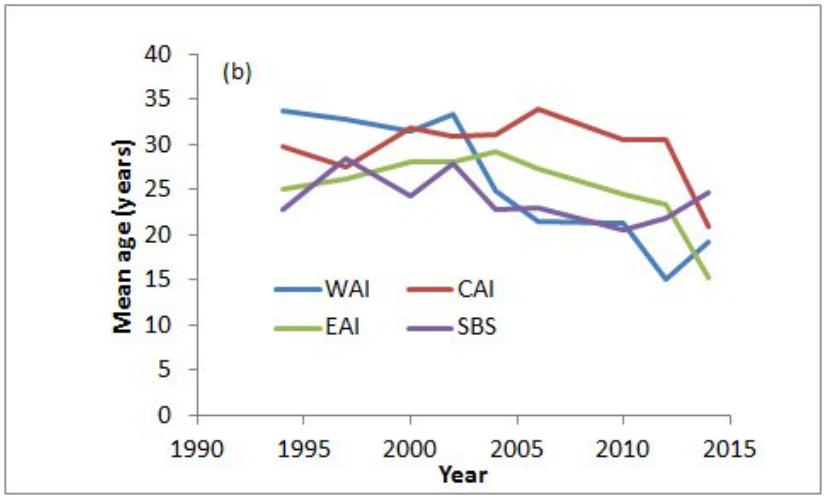
| Year | Western | Central | Eastern | southern BS | Total AI survey |
|---|---|---|---|---|---|
| 2012 | 335 (0.38) | 8,268 (0.55) | 3,798 (0.36) | 405 (0.27) | 12,807 (0.37) |
| 2014 | 589 (0.34) | 2,878 (0.27) | 958 (0.30) | 311 (0.20) | 4,736 (0.18) |
| 2016 | 501 (0.34) | 2,803 (0.35) | 6,165 (0.37) | 600 (0.35) | 10,069 (0.25) |

# Size compositions from recent AI surveys

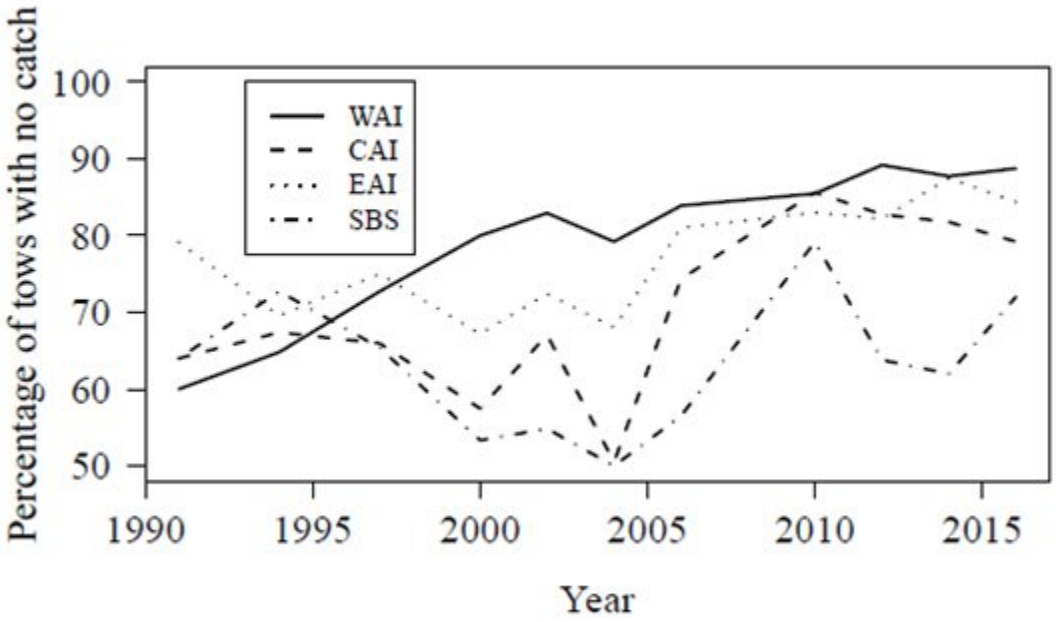


# Mean size and age in the AI survey



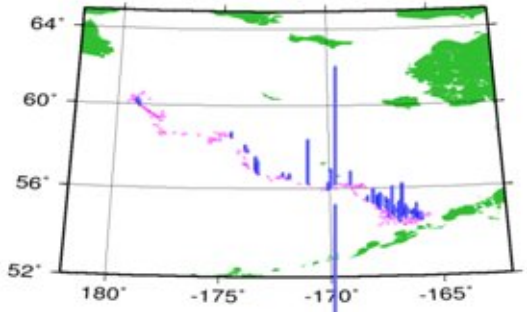



# Proportion of tows with no catch

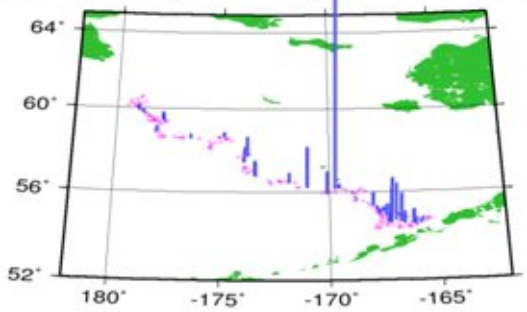


# Square root of 2012 – 2016 EBS surveys

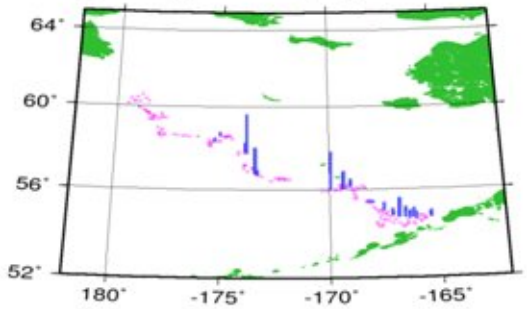
2010 EBS Survey Blackspotted/Rougheye Rockfish CPUE (wgt/km$^2$)




2012 EBS Survey Blackspotted/Rougheye Rockfish CPUE (wgt/km$^2$)



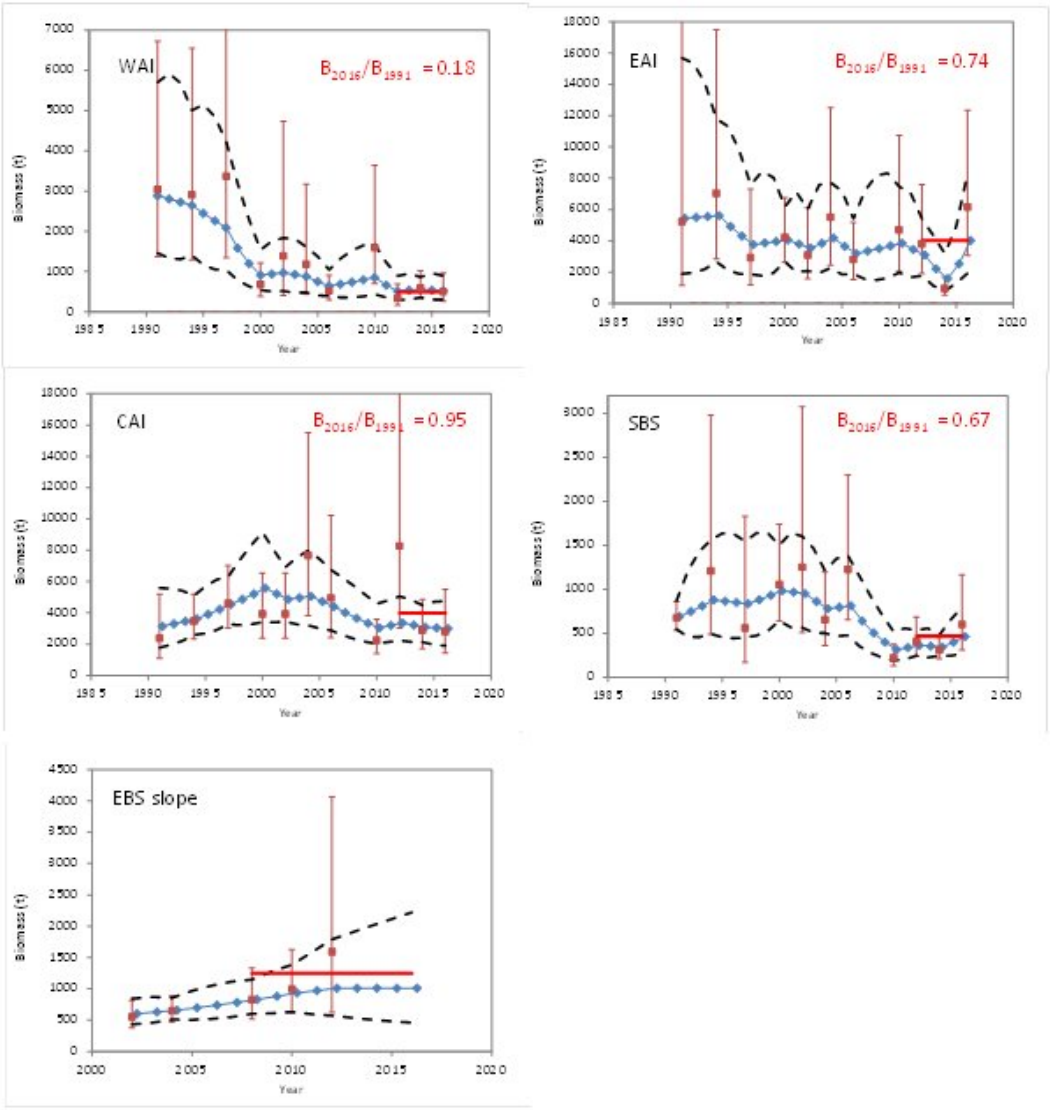

2016 EBS Survey Blackspotted/Rougheye Rockfish CPUE (wgt/km$^2$)



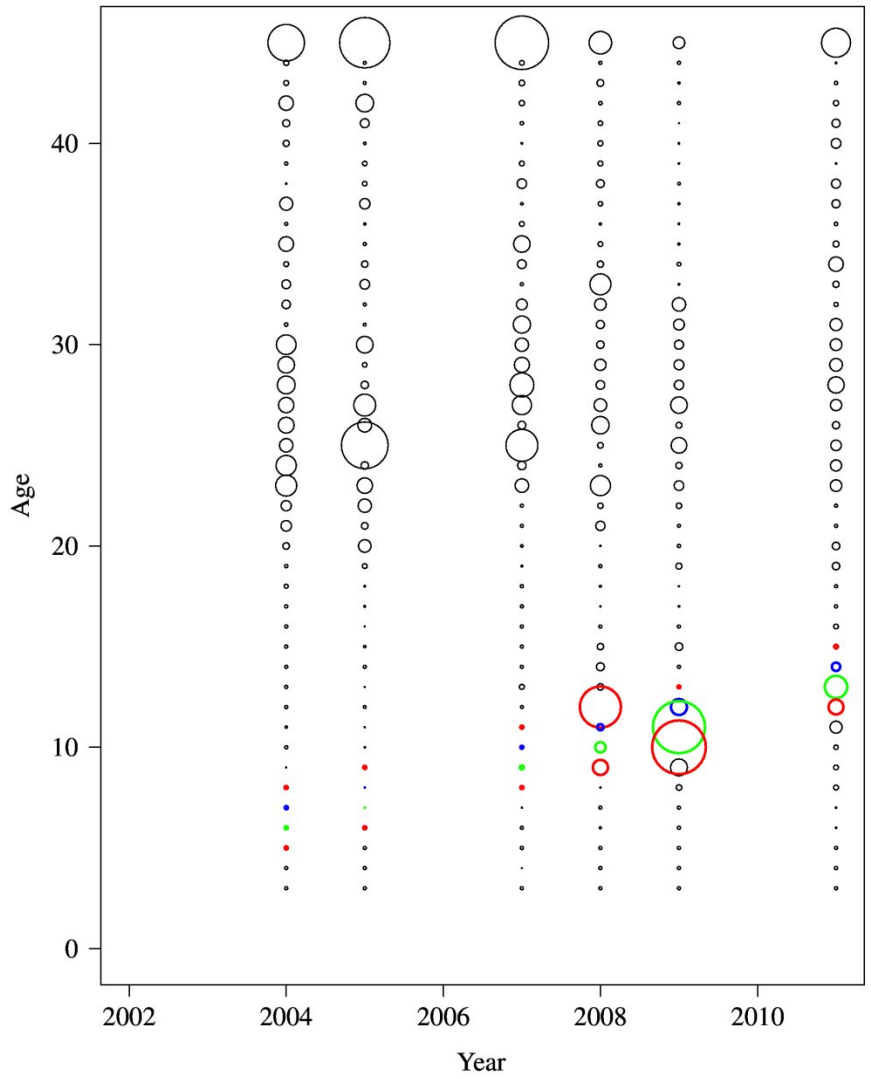

## EBS survey biomass estimates and CVs

| 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) |

# Smoothed survey biomass estimates



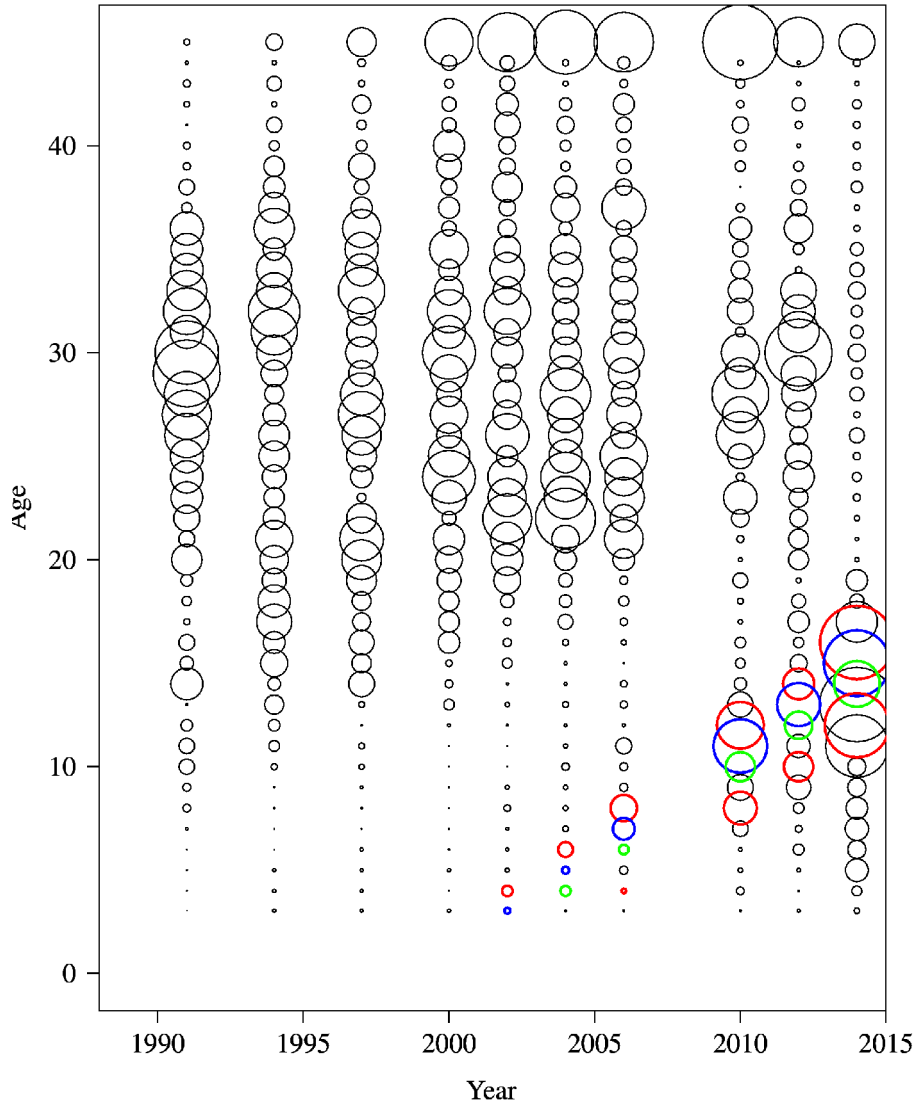
# BSAI blackspotted/rougheye fishery age composition data




1998 cohort appears to be stronger in 2009 than in 2011

1996
1997
1998
1999

# BSAI blackspotted/rougheye AI survey age composition data

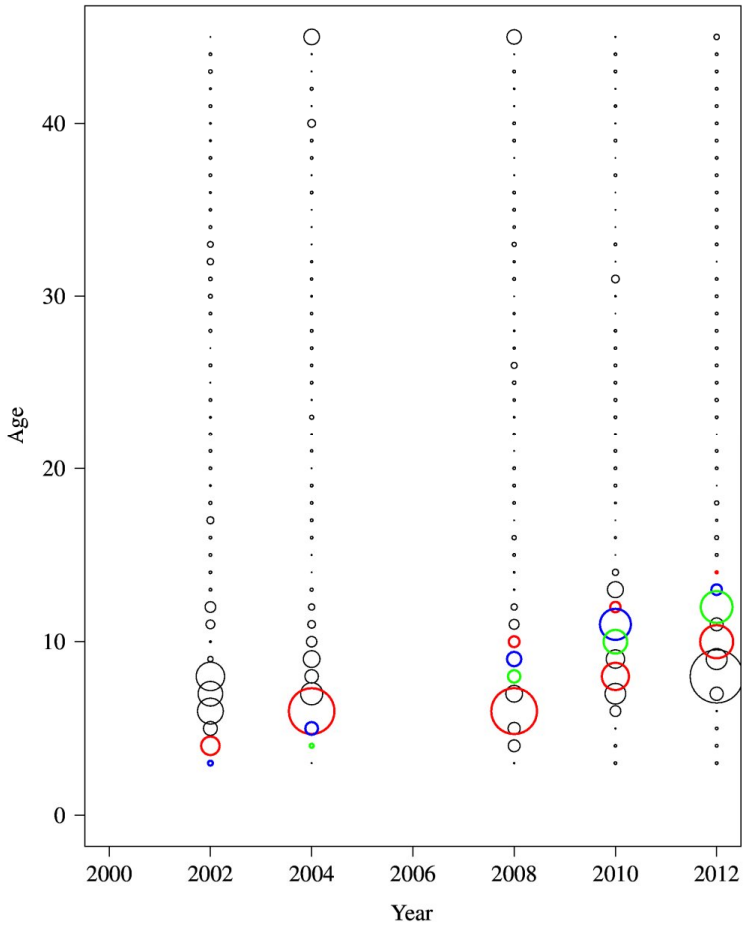



1998 and 1999 still appear to be relatively strong cohorts

1998
1999
2000
2002

# BSAI blackspotted/rougheye EBS survey age composition data

1998 cohort is appears to be low




1998
1999
2000
2002

# Updates to Assessment Model

- Recent comments from the BSAI Plan Team has encouraged evaluation of including EBS slope survey data into Tier 3 BSAI rockfish models
- For the BSAI blackspotted/rougheye rockfish model, this would require expanding the area of the model from AI to the BSAI

# General approach for survey catchability

- 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

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

New approach

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

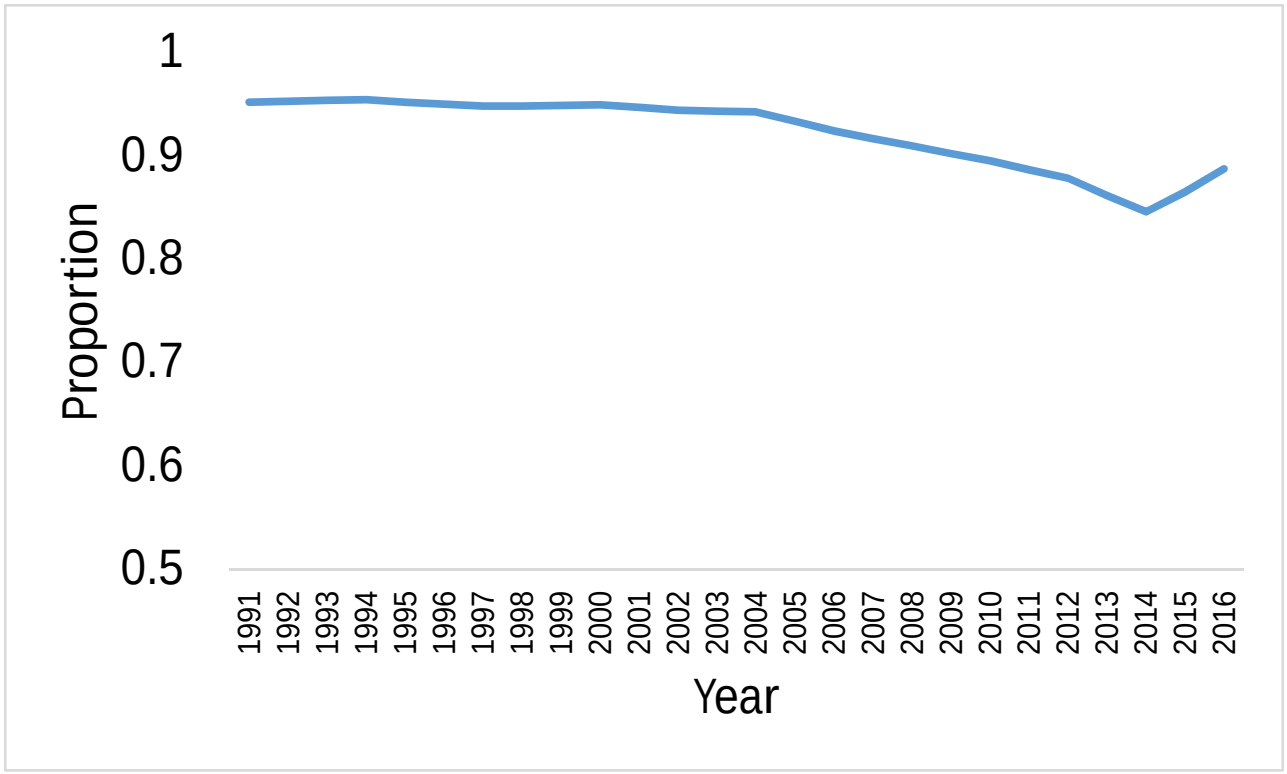
$B_{a,t}$ = modeled biomass at age $a$ in year $t$ (after adjusting for survey selectivity).

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

$q$ = survey catchability

$p_{AI}$ = proportion of stock in the AI area

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



# 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

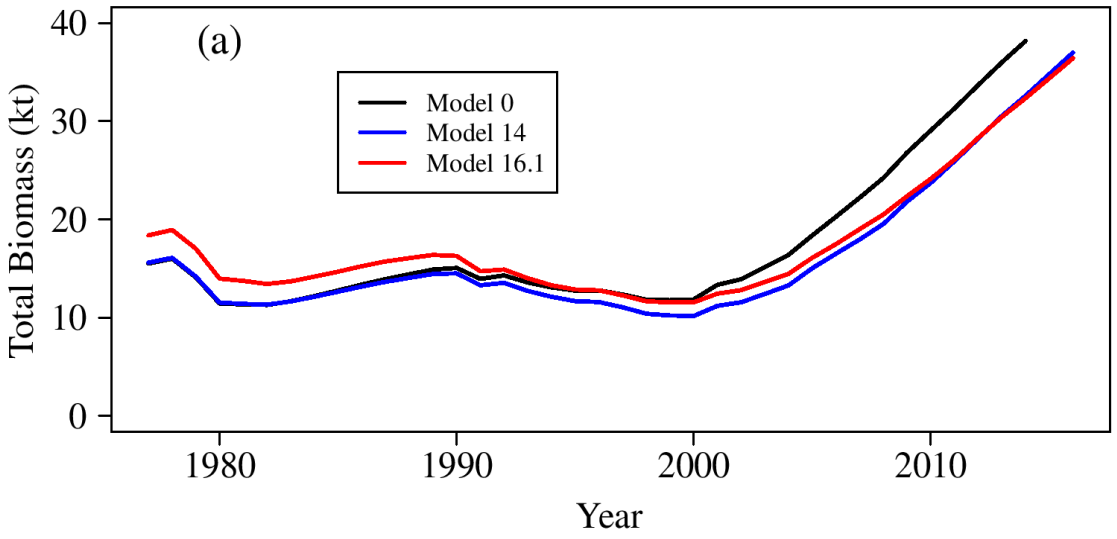
*"The Francis method" (method TA1.8 in Francis 2011)*

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.

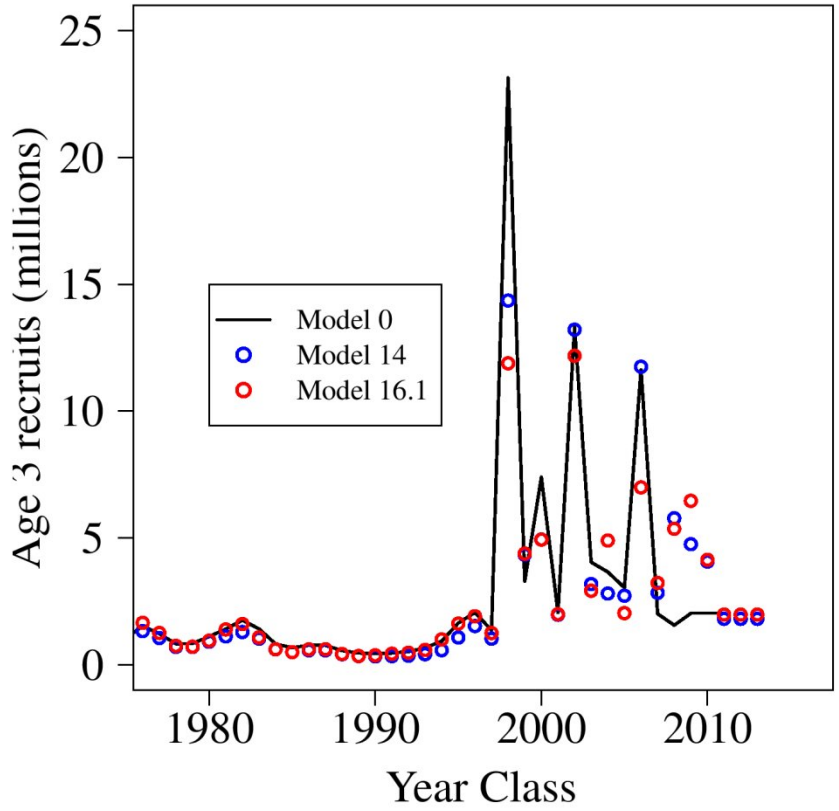
# Models evaluated (AI and BSAI models)

- *Model 0* The 2014 AI model results
- *Model 14* The 2014 model with AI data updated through 2016
- *Model 16.1* BSAI model, with EBS slope survey data, age/length data weights set to 2014 values
- *Model 16.2* Model 14, but reweighting with McAllister-Ianelli method
- *Model 16.3* Model 14, but with reweighting with SDNR method
- *Model 16.4* Model 14, but with reweighting with Francis method
- *Model 16.5* Model 16.1, but reweighting with McAllister-Ianelli method
- *Model 16.6* Model 16.1, but with reweighting with SDNR method
- *Model 16.7* Model 16.1, but with reweighting with Francis method

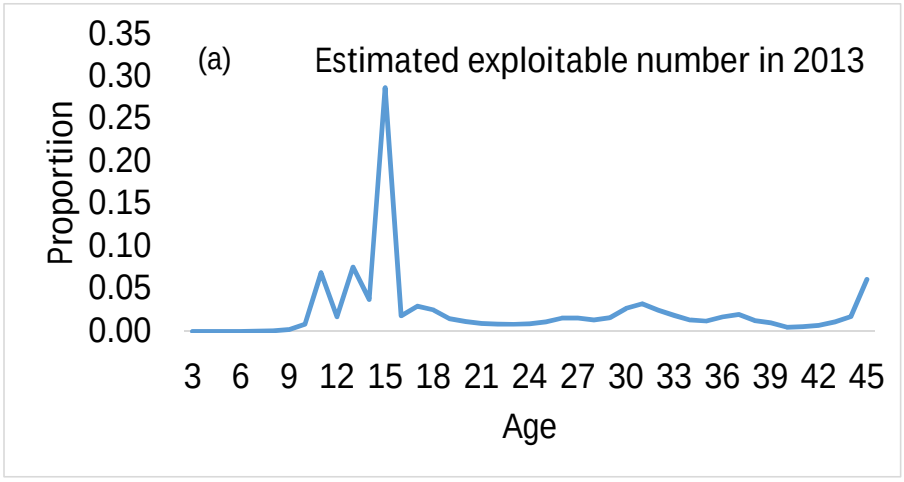
# Comparison with the 2014 assessment (with the age/length comps weights used in 2014)

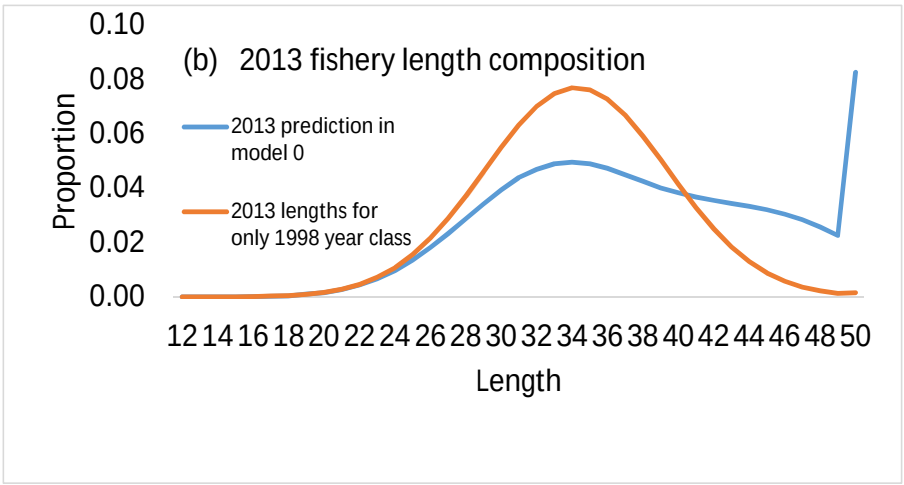


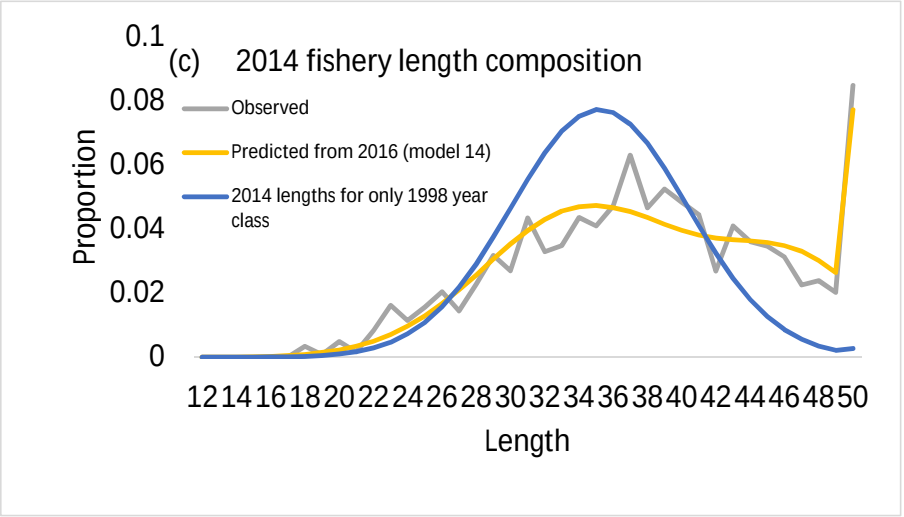
# Difference in updated models is due to reduced estimate of 1998 year class

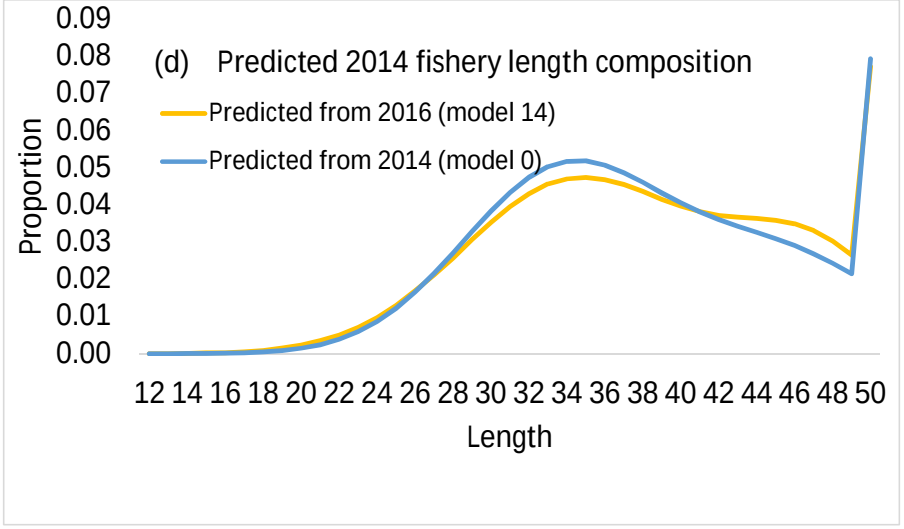


# Recent fishery length comp data do not support the high estimate of the 1998 year class in the 2014 assessment



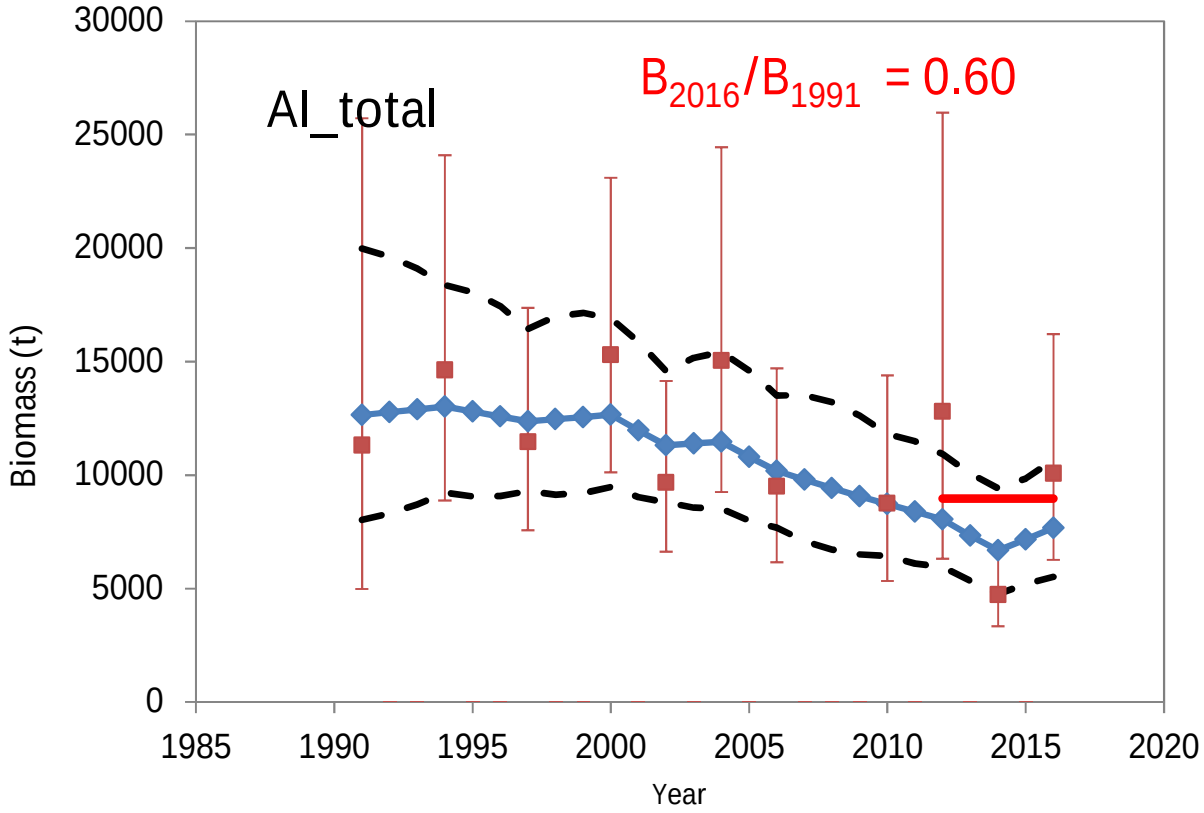



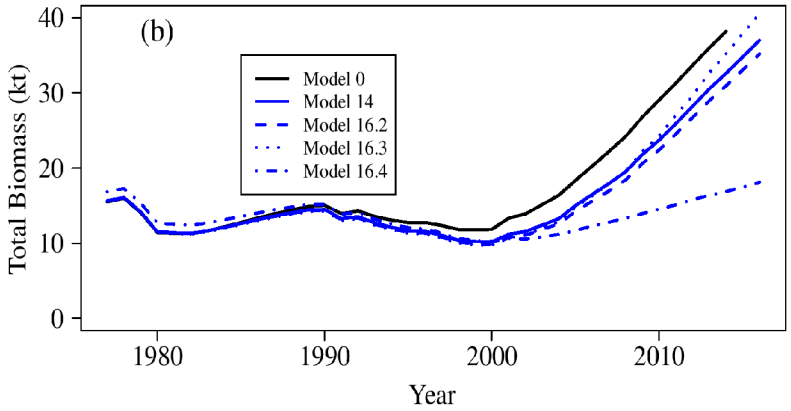
## 2016 AI survey estimate also does not support the high estimate of the 1998 year class in the 2014 assessment

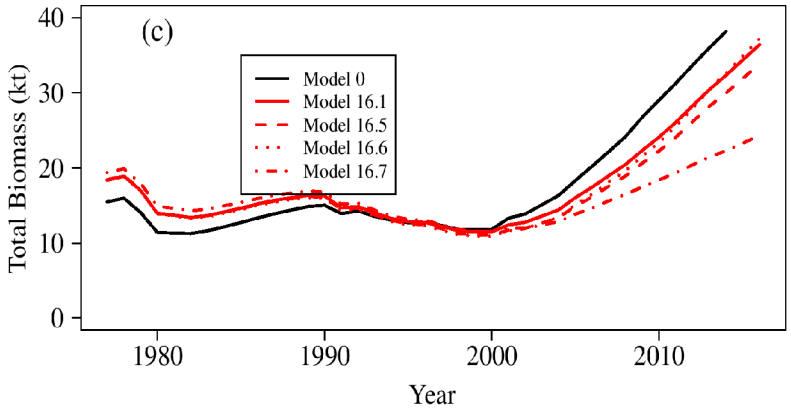
- The 2016 AI survey estimate was projected from estimated 2014 numbers at age from the 2014 assessment
- Projected 2016 AI survey biomass (for AI area)
  12996 t
- Observed 2016 AI survey biomass (for AI area)
  9469 t

# Biomass index for AI survey



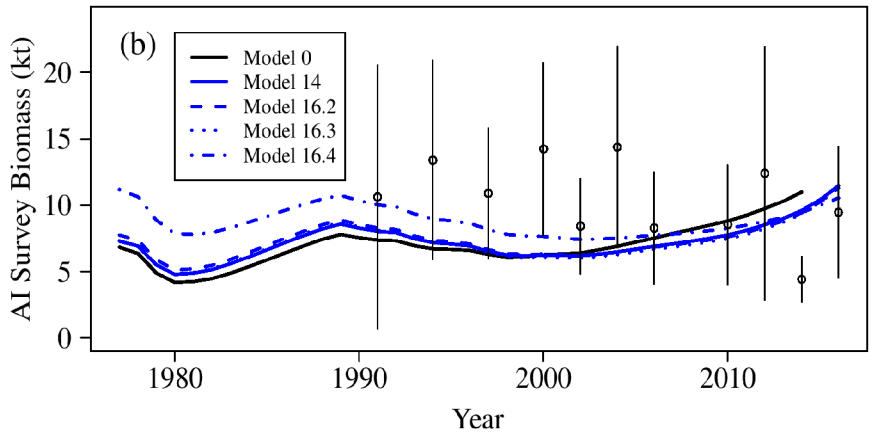
# AI and BSAI models were similar

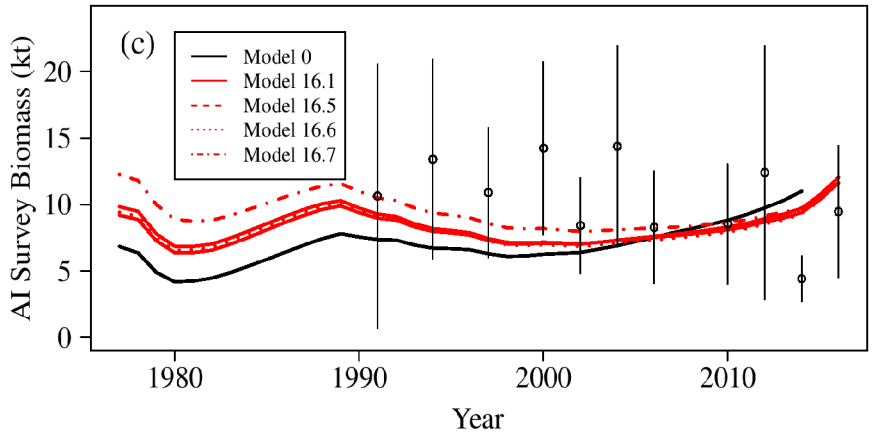



Total biomass

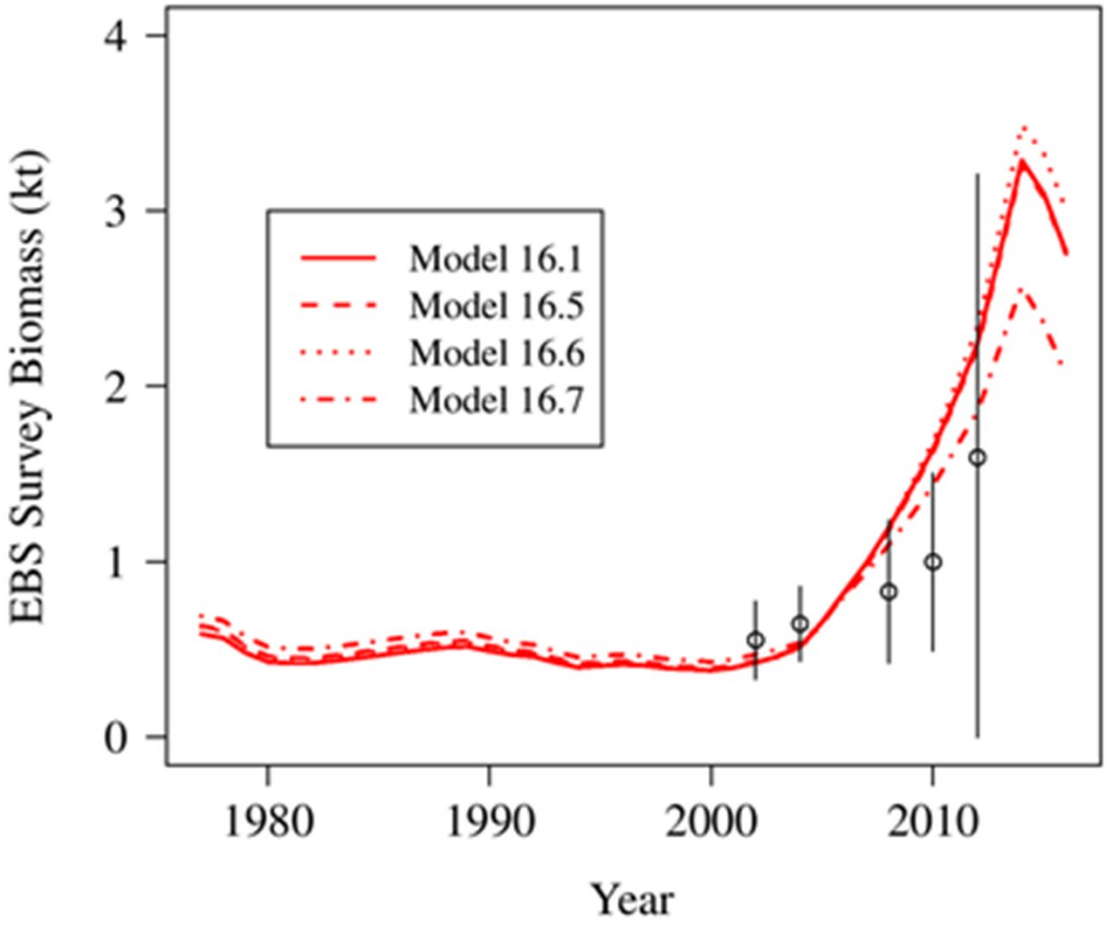
# AI and BSAI models were similar



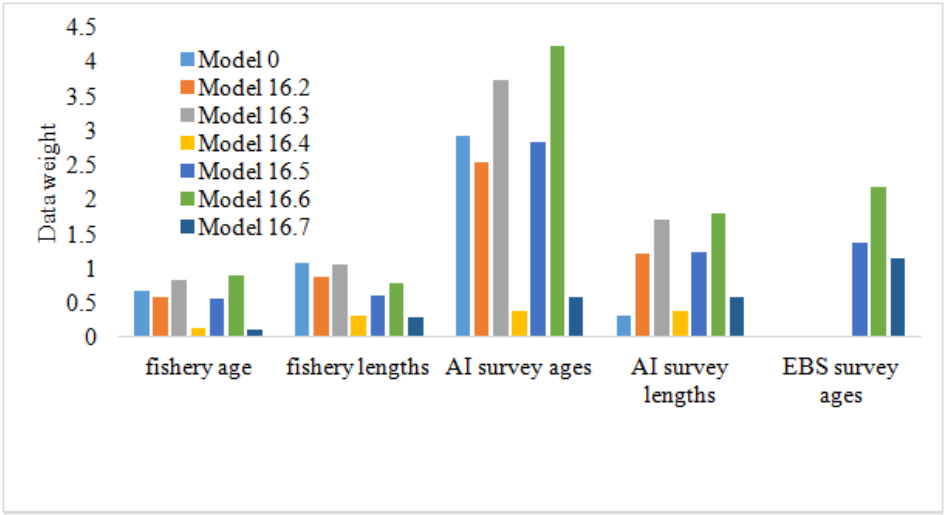




Fit to AI survey

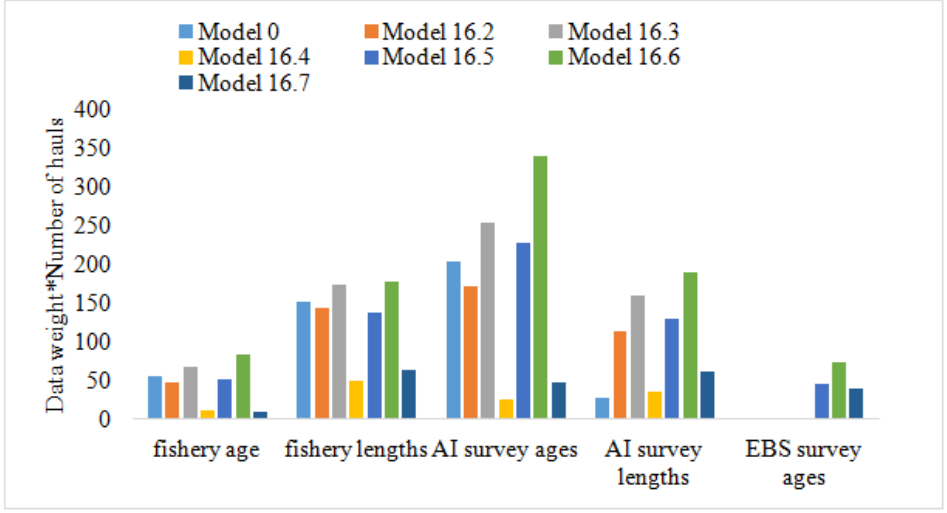
# Fit to EBS survey



# Age/length comp weights

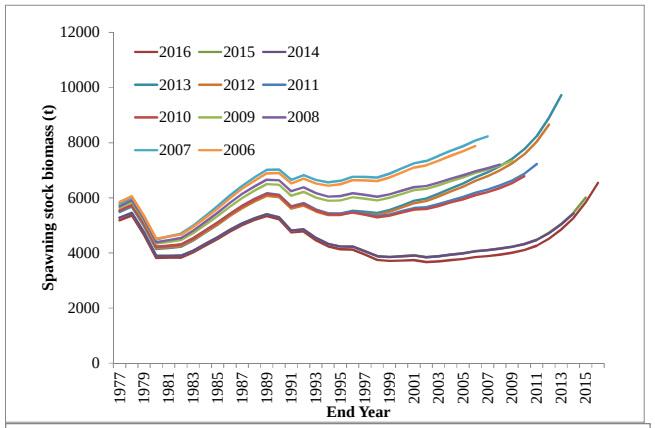


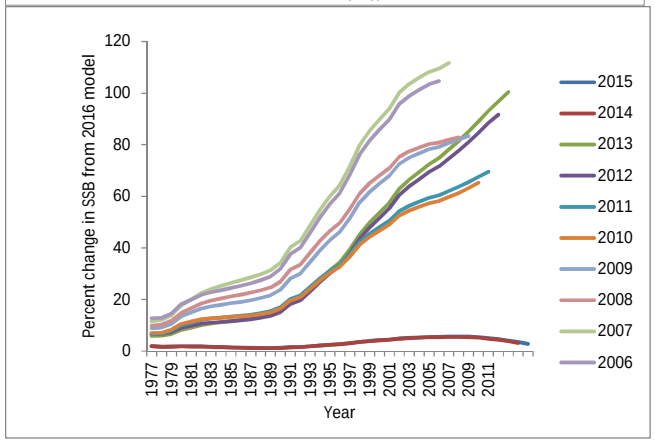

Data weights




Data weights * mean # of hauls

# BSAI Blackspotted/Rougheye retrospective pattern, Model 16.5

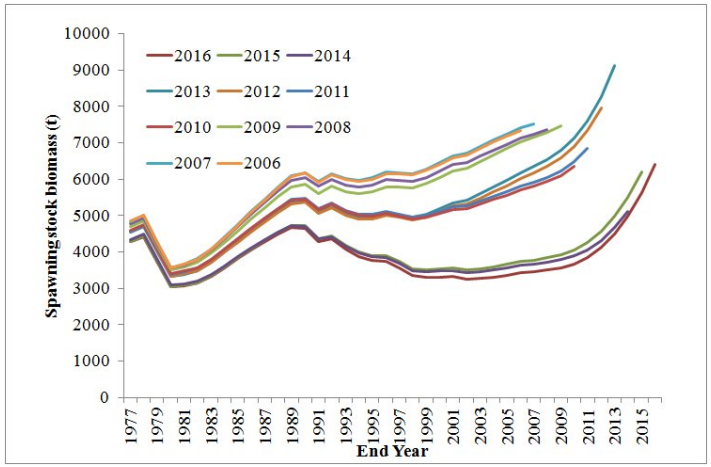


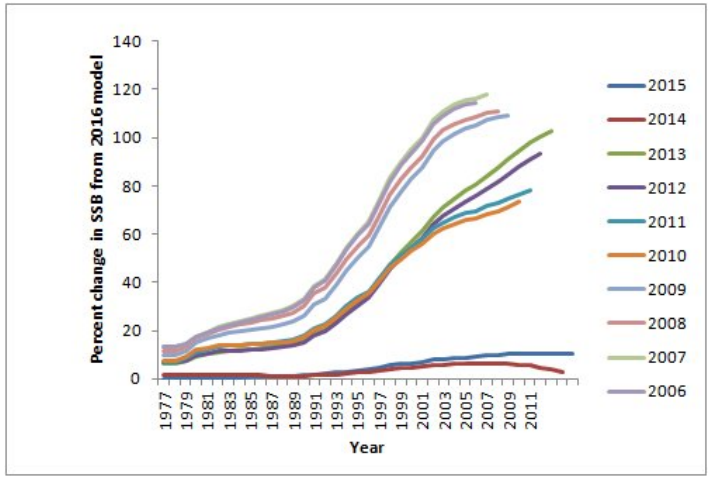




Mohn's rho = 0.72

(0.78 in 2014 assessment)

# BSAI Blackspotted/Rougheye retrospective pattern, Model 16.2



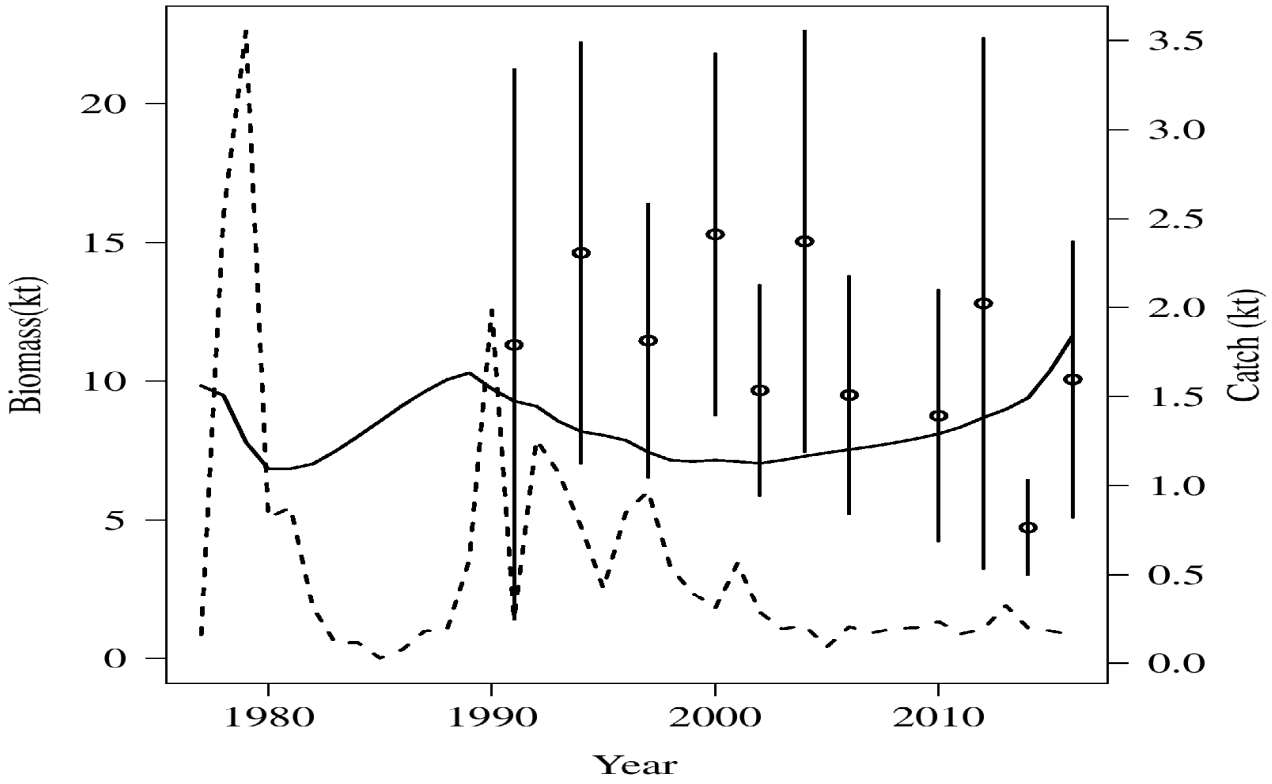

Mohn's rho = 0.81

(0.78 in 2014 assessment)

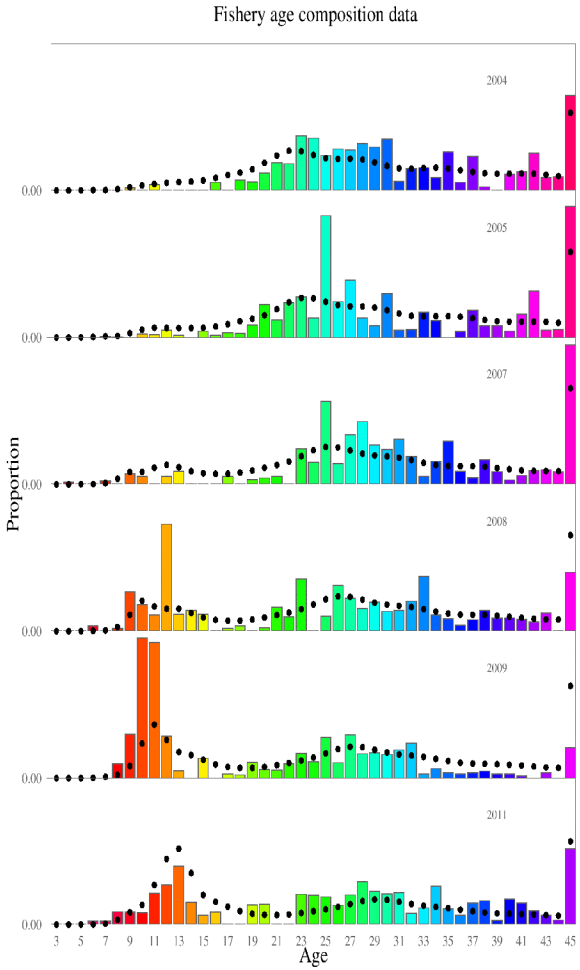
# Recommended model is 16.5 (BSAI model with McAllister-Ianelli weights

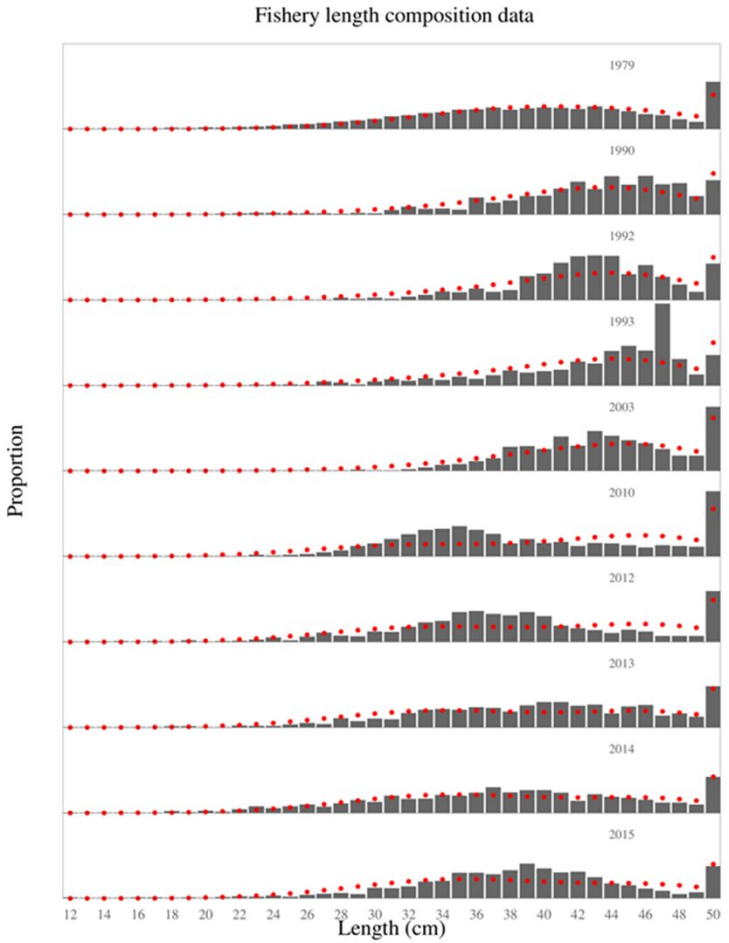
- Trend in the EBS survey biomass index is consistent with model 0 and earlier assessments
- Recruitment from BSAI models are broadly consistent with the AI-only models, although some year-class strengths differ.
- Models with the Francis weights have marginal improvements to the survey indices, but large differences in biomass.

# Fit to AI survey

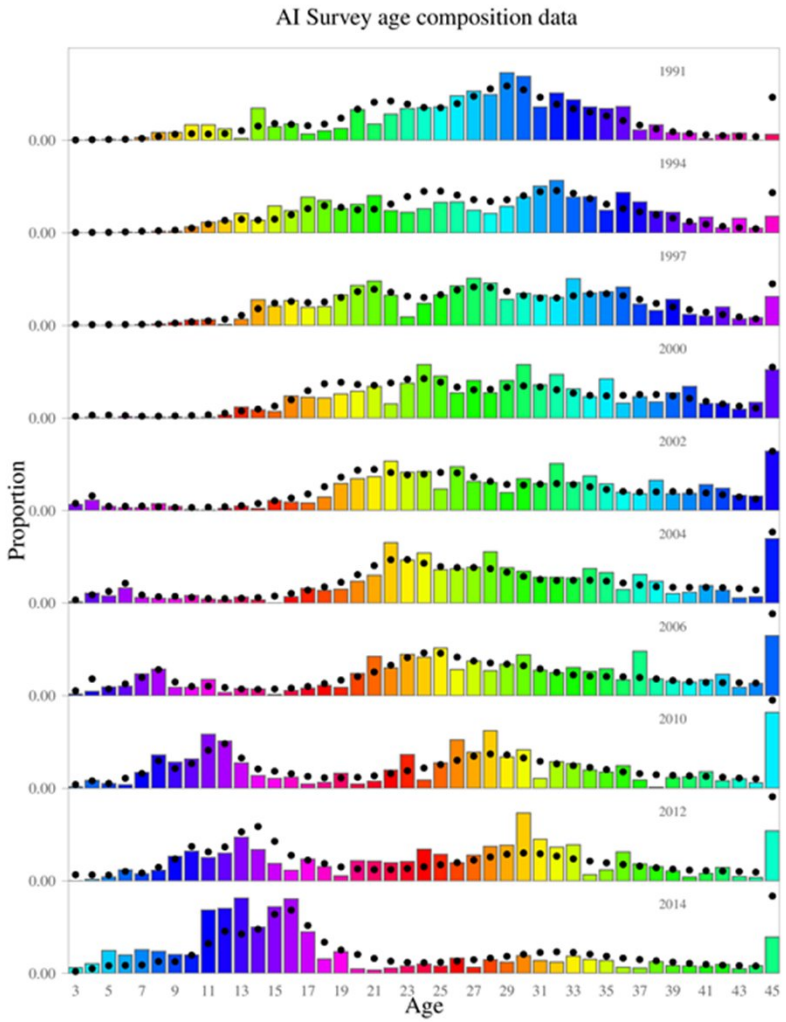


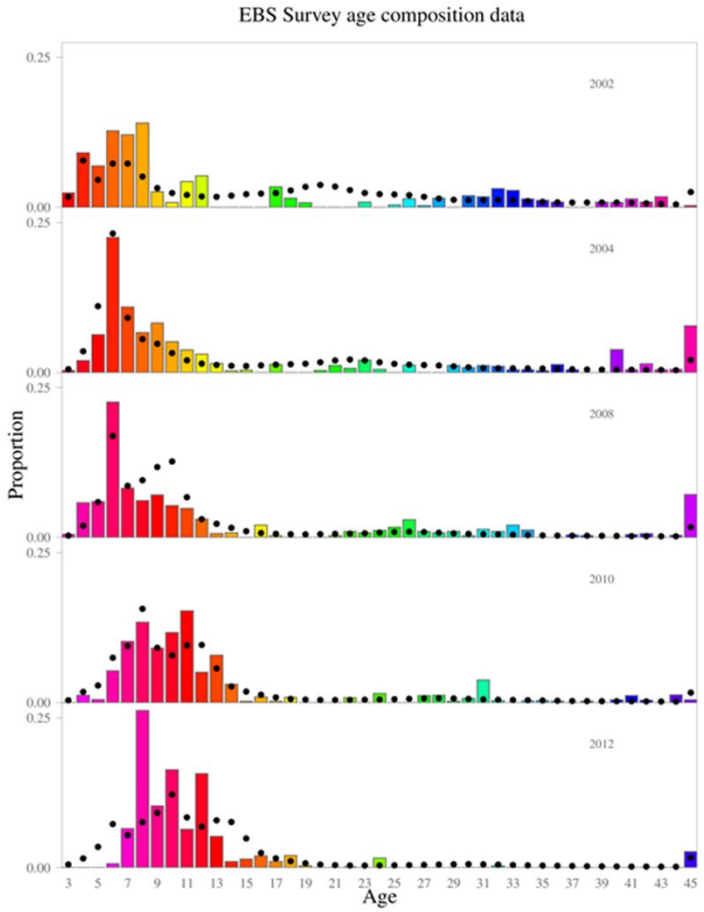
# Fit to fishery age and length compositions



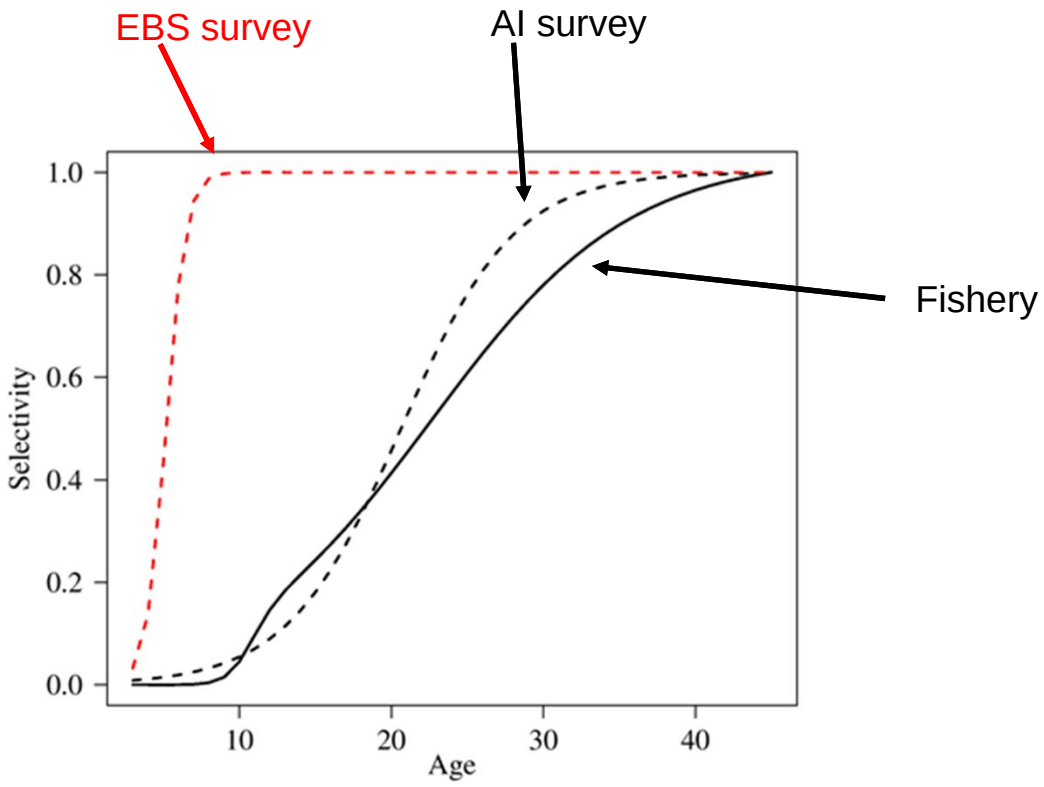



# Fit to survey age compositions

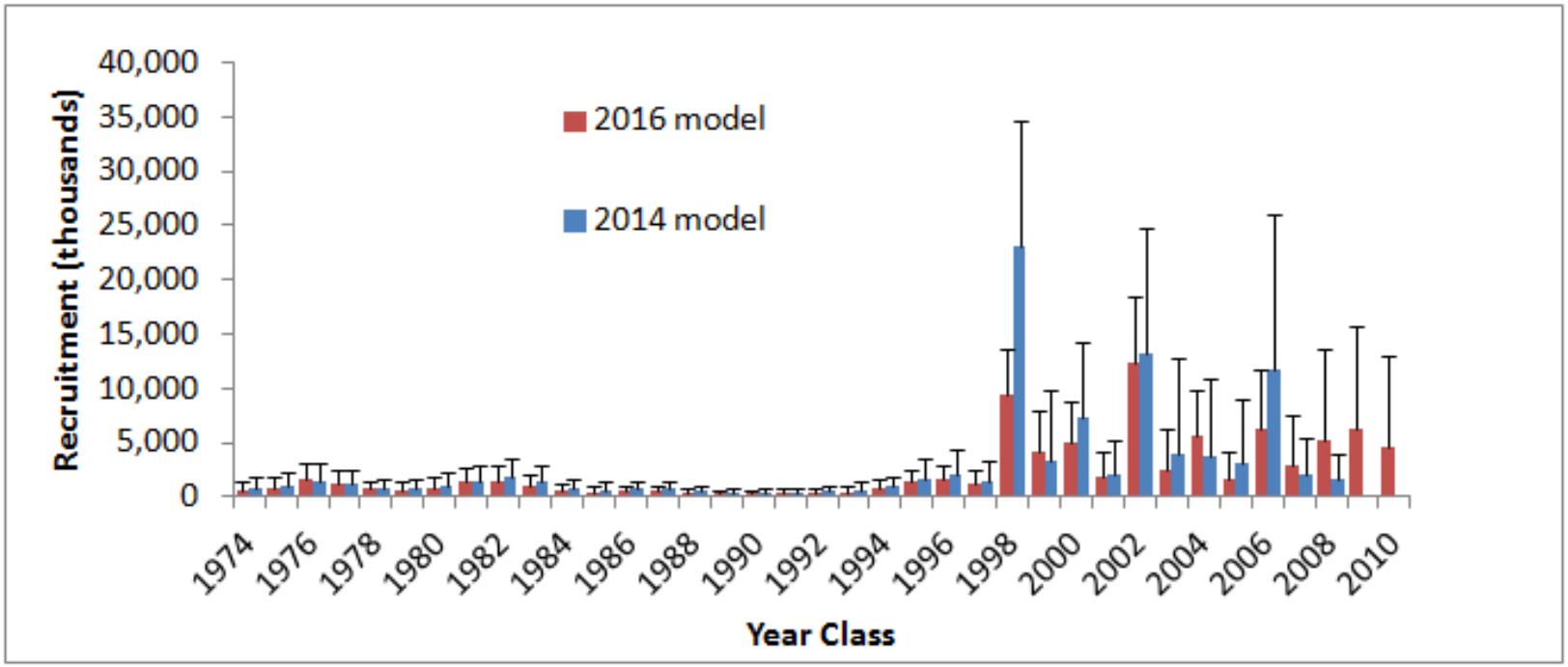


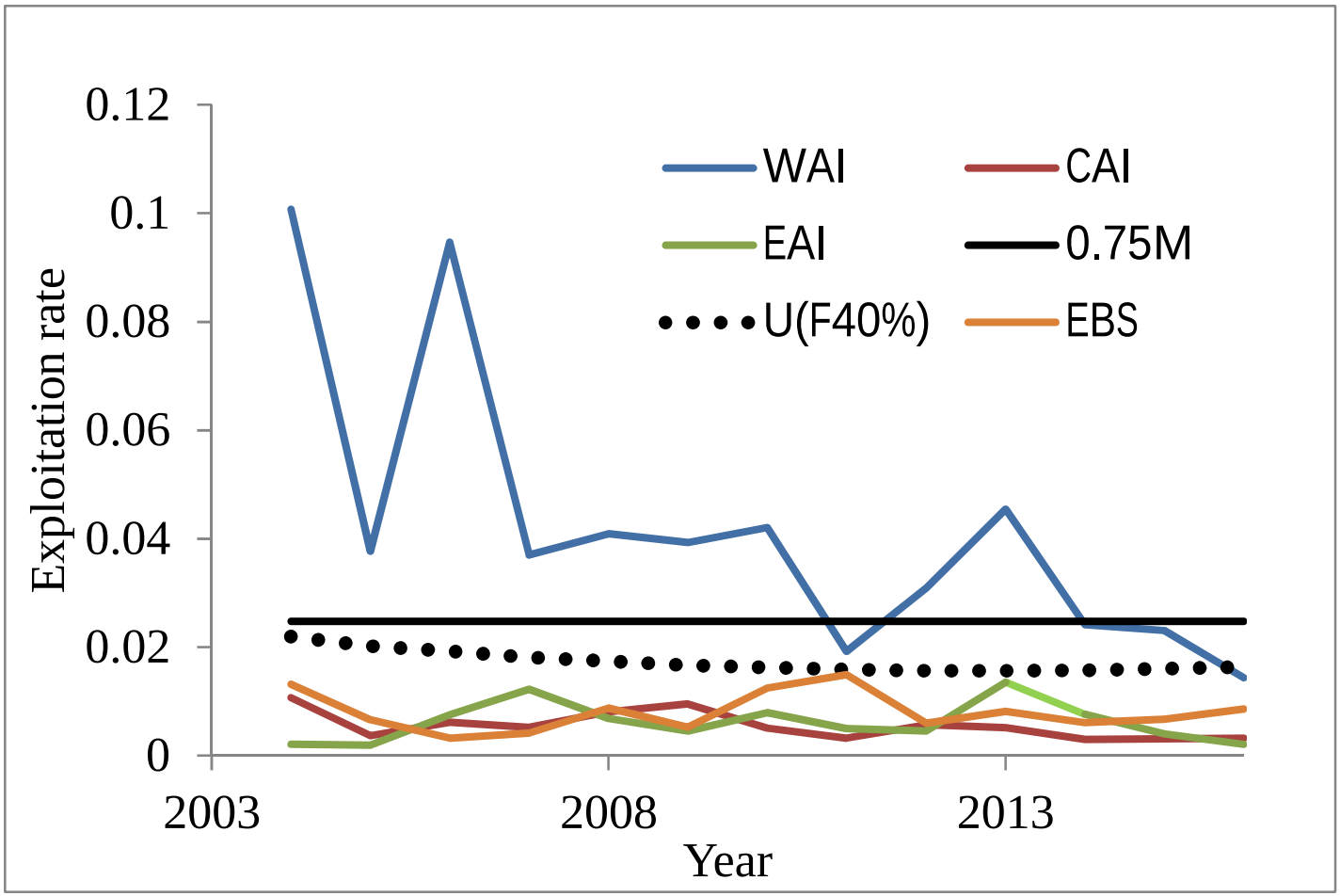
# Fishery and survey selectivity curves



# Estimated recruitment



# Exploitation rates by area

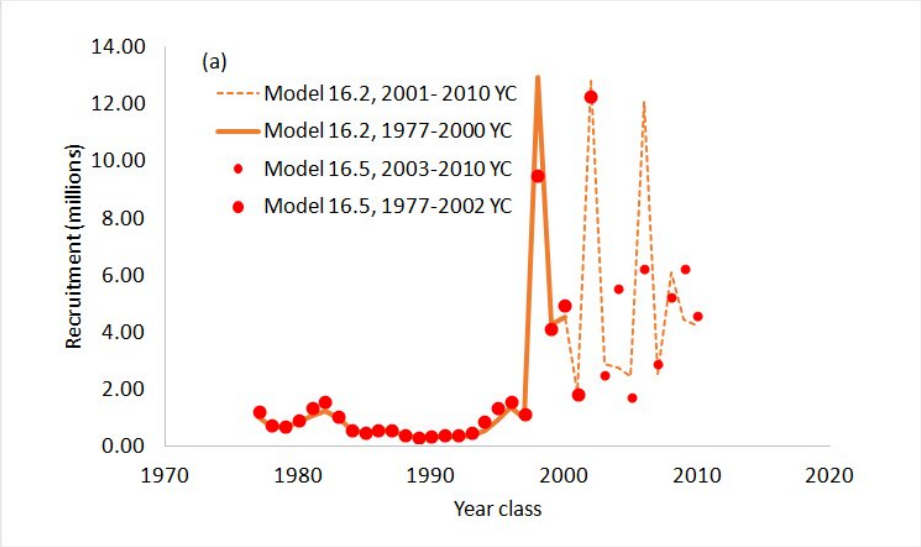


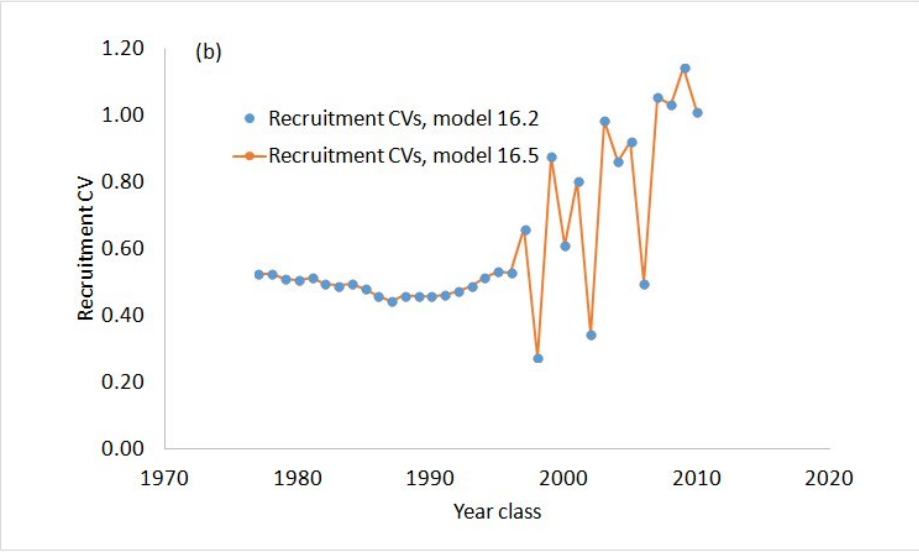
# How do we define $B_{40\%}$?

Stock status = $\frac{B}{\overline{R} * SPR_{F\,40\%}} = \frac{B}{B_{40\%}}$

- 2010 – Mean recruitment based on 1977 – 1995 year classes
- 2012 -- Mean recruitment was based on all estimated year classes (1977-2006)
- 2014 -- Mean recruitment was based on the 1977 - 1998 year classes (Rationale: 10% selection in the AI survey)
- 2016 – Proposed mean recruitment based on 1977 – 2000 year classes (Rationale: excludes 2002 year class, which is large and may be relatively uncertain)

# Estimated recruitment and CVs

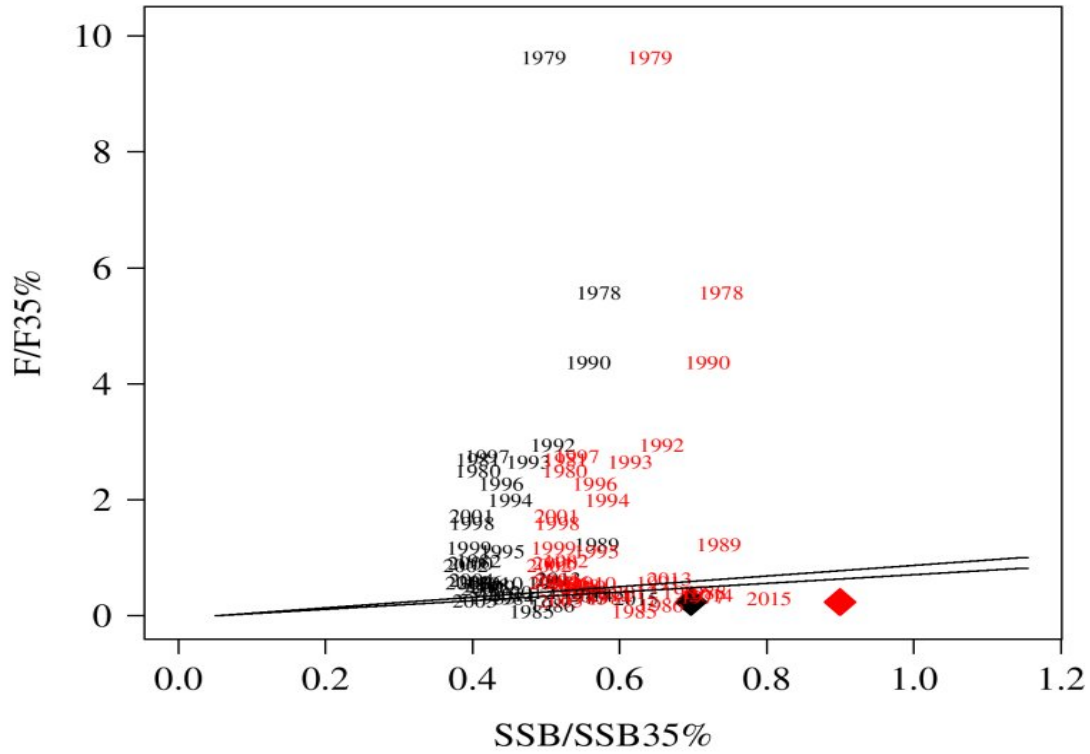



Recommended rule for choosing year classes is the cohorts that correspond to the age at 10% selection, plus (0.05/M)

This rule would include the 2002 year class in some models, but exclude it in other, even though the estimates of this year class (and its variability) are similar)

# Relative stock status (Model 16.5)




Year classes 1977 – 2000:
2016 SSB = $B_{31\%}$

Year classes 1977 – 2002:
2016 SSB = $B_{24\%}$

# Effect of cohorts used for mean recruitment on depletion and ABC

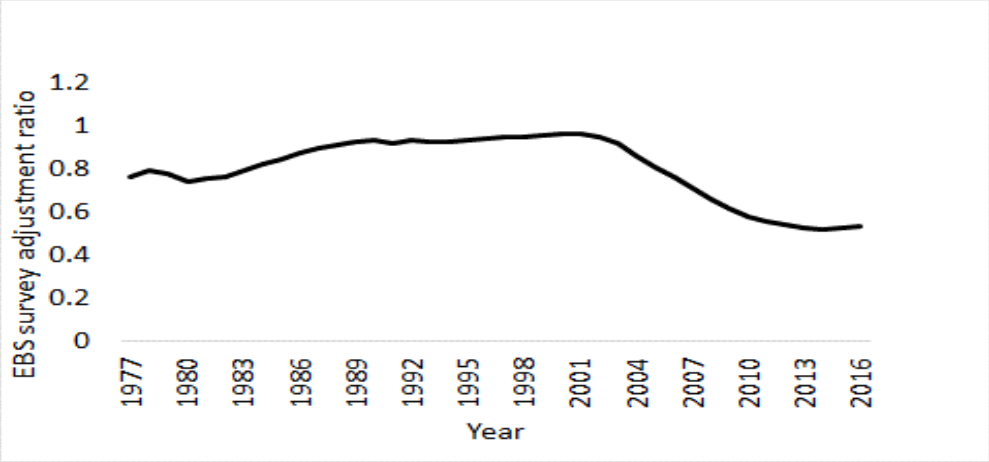
| | Model 16.2 | Model 16.3 | Model 16.4 | Model 16.5 | Model 16.6 | Model 16.7 |
|---|---|---|---|---|---|---|
| Final year class for mean recruitment | 2000 | 2000 | 2006 | 2002 | 2002 | 2003 |
| Mean recruitment (millions) | 1.513 | 1.630 | 1.077 | 1.905 | 2.040 | 1.448 |
| $B_{40\%}$ (t) | 8632 | 9147 | 6545 | 10728 | 11299 | 8554 |
| $B(2016)/B_{40\%}$ | 0.743 | 0.733 | 0.748 | 0.610 | 0.591 | 0.687 |
| 2017 ABC | 469 | 488 | 318 | 383 | 381 | 391 |
| 2017 ABC, recs from 1977-2000 YC | 469 | 488 | 357 | 501 | 511 | 489 |

# Subarea ABCs

- In previous assessments, combining the survey biomass estimates from the EBS and AI surveys assumed equivalent selectivities and catchabilities
- In this assessment, the estimated selectivities and catchabilities can be used to produce an 'adjusted' EBS slope survey

$$B_{adj,t} = B_t \left( \frac{\sum_a q_{AI} s_{AI,a} w_a N_{a,t}}{\sum_a q_{EBS} s_{EBS,a} w_a N_{a,t}} \right)$$

# EBS survey adjustment ratio




For 2016, the ratio is 0.53.

Suggest that the biomass for the EBS slope is increased (relative to the AI) because of higher selectivity at younger ages

| | Area | | | | |
|---|---|---|---|---|---|
| | WAI | CAI | EAI | SBS | EBS slope |
| Unadjusted smoothed biomass | 520 | 2,995 | 4,022 | 462 | 1,010 |
| percentage | 5.78% | 33.24% | 44.64% | 5.13% | 11.21% |
| | | | | | |
| Adjusted smoothed biomass | 520 | 2,995 | 4,022 | 462 | 538 |
| percentage | 6.10% | 35.08% | 47.11% | 5.41% | 6.30% |

# Recommended ABC and OFL

| Area/subarea | Year | Total Biomass (t)[1] | OFL | ABC | TAC | Catch[2] |
|---|---|---|---|---|---|---|
| BSAI | 2015 | 41,780 | 560 | 453 | 349 | 173 |
| | 2016 | 43,944 | 693 | 561 | 300 | 149 |
| | 2017 | 35,669 | 612 | 501 | n/a | n/a |
| | 2018 | 37,474 | 750 | 614 | n/a | n/a |
| Western/Central Aleutian Islands | 2015 | | | 304 | 200 | 117 |
| | 2016 | | | 382 | 200 | 85 |
| | 2017 | | | 207 | n/a | n/a |
| | 2018 | | | 252 | n/a | n/a |
| Eastern AI/Eastern Bering Sea | 2015 | | | 149 | 149 | 64 |
| | 2016 | | | 179 | 100 | 64 |
| | 2017 | | | 294 | n/a | n/a |
| | 2018 | | | 362 | n/a | n/a |

# Recommended maximum subarea species catch (MSSC)

| | Area | | | | |
|---|---|---|---|---|---|
| | WAI | CAI | EAI | SBS | EBS slope |
| Unadjusted smoothed biomass | 520 | 2,995 | 4,022 | 462 | 1,010 |
| percentage | 5.78% | 33.24% | 44.64% | 5.13% | 11.21% |
| Adjusted smoothed biomass | 520 | 2,995 | 4,022 | 462 | 538 |
| percentage | 6.10% | 35.08% | 47.11% | 5.41% | 6.30% |

| | WAI MSSC | CAI MSSC |
|---|---|---|
| 2017 MSSCs | 31 | 176 |
| 2018 MSSCs | 37 | 215 |

# Other methods for apportioning the MSSC

***Model 16.5***

| | WAI | CAI | EAI | SBS | EBS slope |
|---|---|---|---|---|---|
| Weighted average | | | | | |
| biomass | 494 | 3977 | 4023 | 468 | 663 |
| proportion | 0.051 | 0.413 | 0.418 | 0.049 | 0.069 |
| Unweighted average | | | | | |
| biomass | 475 | 4650 | 3641 | 439 | 608 |
| proportion | 0.048 | 0.474 | 0.371 | 0.045 | 0.062 |

***Model 16.2 (AI only, ABC = 469 t)***

| | WAI | CAI | EAI | WAI MSSC |
|---|---|---|---|---|
| Random effects model | | | | |
| biomass | 520 | 2995 | 4022 | |
| proportion | 0.069 | 0.397 | 0.534 | 32 |
| Weighted average | | | | |
| biomass | 494 | 3977 | 4023 | |
| proportion | 0.058 | 0.468 | 0.474 | 27 |
| Unweighted average | | | | |
| biomass | 475 | 4650 | 3641 | |
| proportion | 0.054 | 0.530 | 0.415 | 25 |

# Reasons for reduction in WAI MSSC

- Reduction in estimated stock size and BSAI ABC (from 561 t to 501 t)
- With the 2016 model, the WAI percentage is relative to the entire BSAI area, not the AI subarea
- Increased survey abundance in the EAI, and reduced abundance in the WAI
- ‘Small’ changes in small percentages can have relatively large proportional differences

# ‘Small’ changes in small percentages can have relatively large proportional differences

## From 2014 assessment

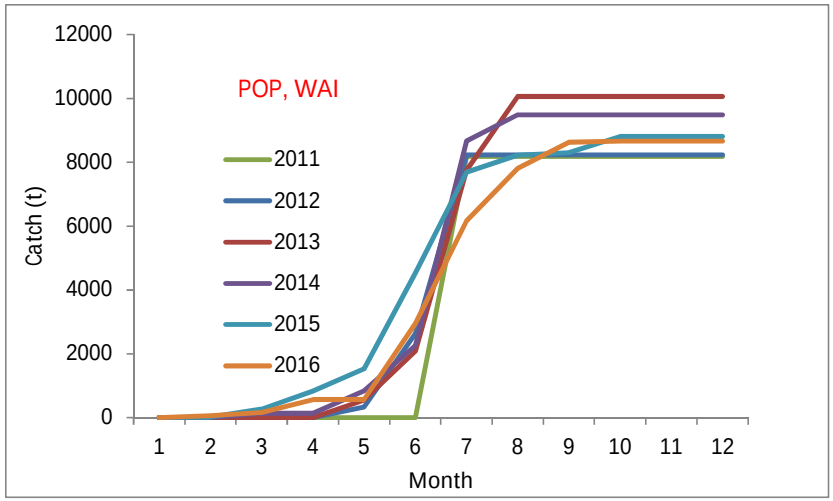
| | Area | | | |
|---|---|---|---|---|
| | WAI | CAI | WAI+CAI | EAI |
| Weighted average biomass (t) | 722 | 4,446 | 5,167 | 2,643 |
| Proportion of biomass | 9.2% | 56.9% | 66.2% | 33.8% |
| Estimated 2014 biomass (from random effects model) | 566 | 3,152 | 3,718 | 1,425 |
| Proportion of biomass | 11.0% | 61.3% | 72.3% | 27.7% |

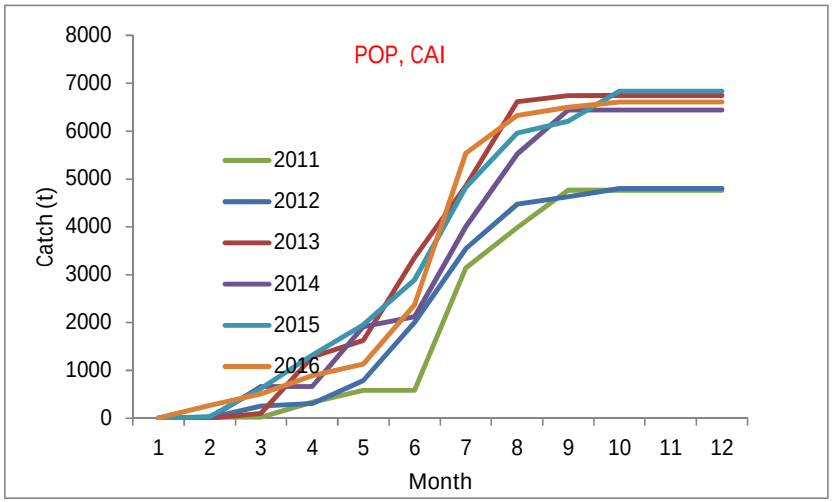
| | WAI | CAI | WAI-CAI |
|---|---|---|---|
| ABC (2015, weighted average) | 39 | 239 | 278 |
| ABC (2015, RE model) | 46 | 257 | 304 |
| ABC (2016, weighted average) | 48 | 297 | 345 |
| ABC (2016, RE model) | 57 | 320 | 377 |

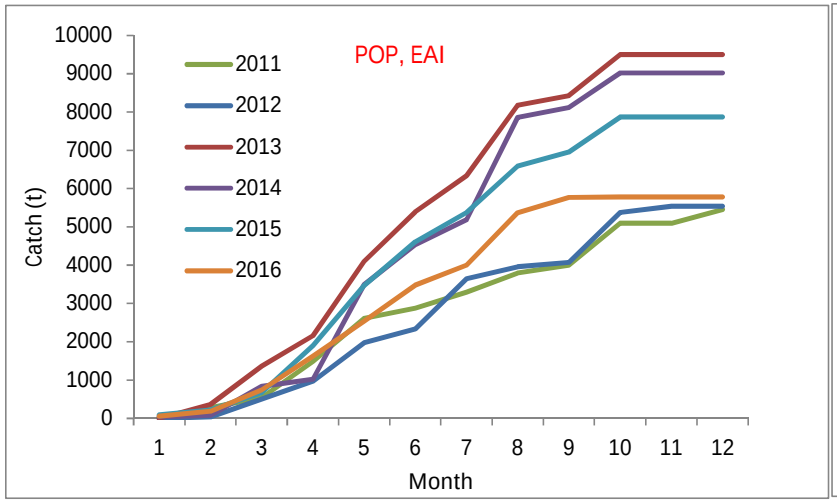
# BSAI POP Outline

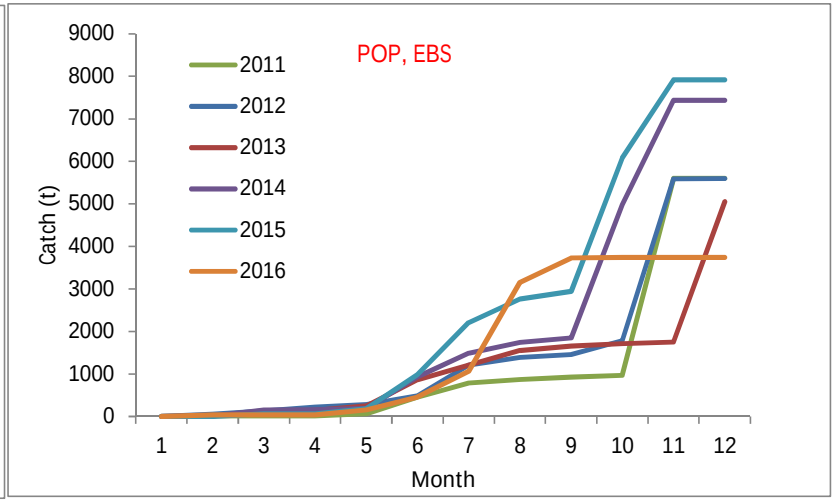
1) Catch information
2) Survey and fishery data
3) Iterative reweighting of composition data, modeling availability, removal of CPUE index
4) Model evaluation
5) Retrospective analysis
6) Model fits to data
7) Management recommendations

# BSAI POP catch by month and area, 2011-2016

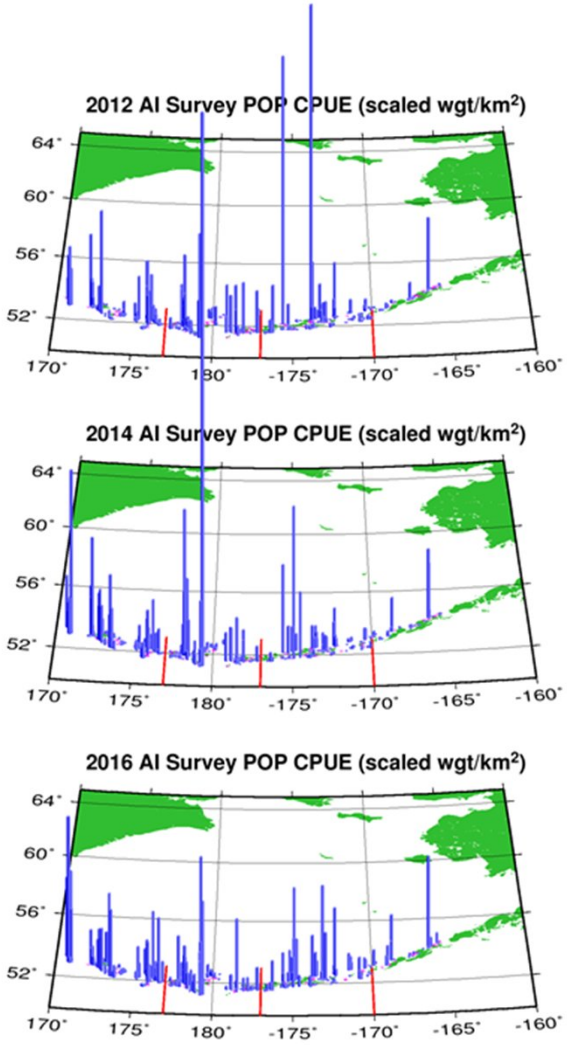


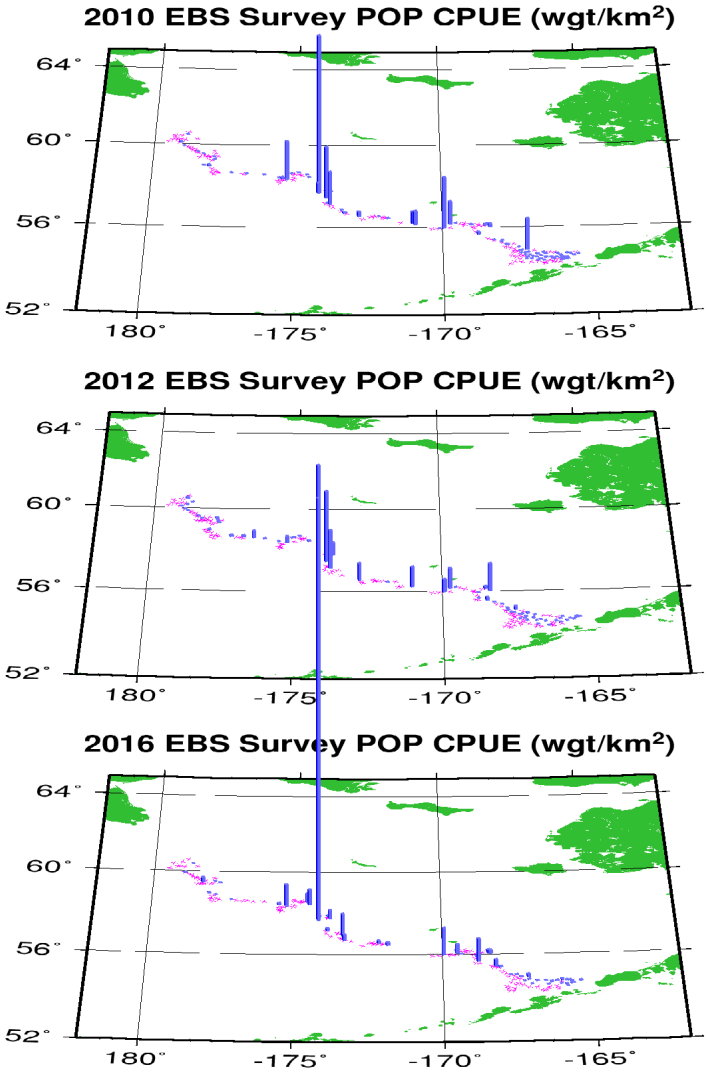



# Survey CPUE, 2012 – 2016 AI surveys



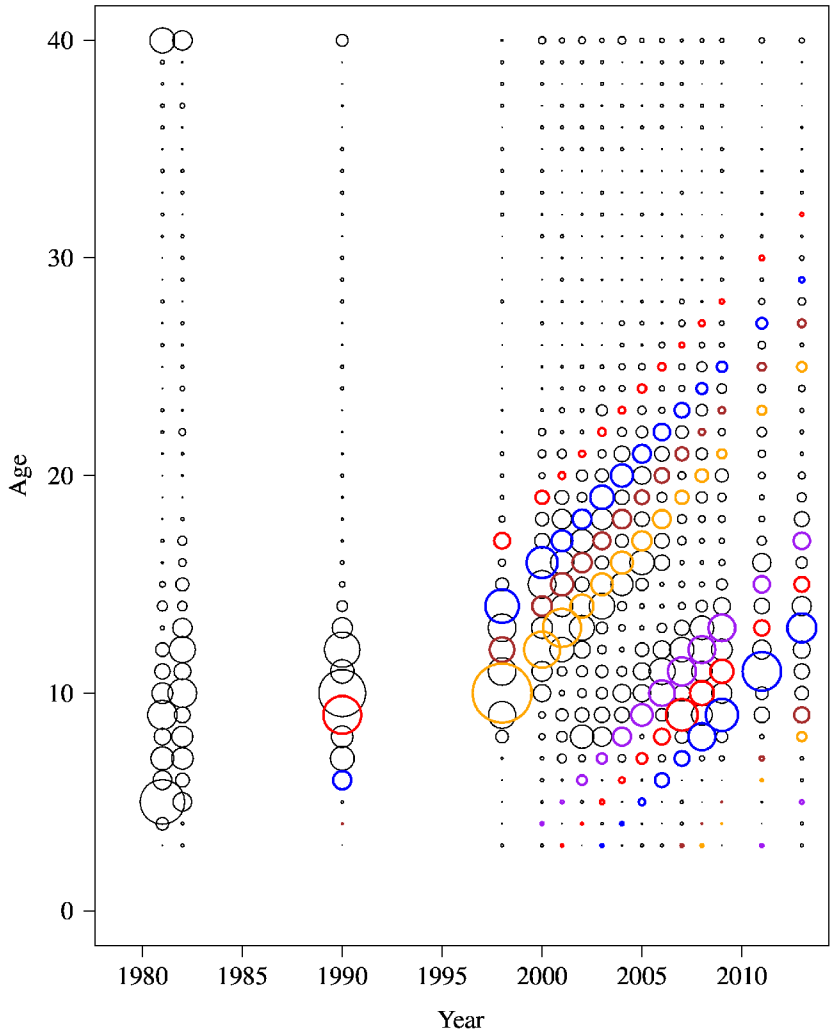

| Year | Western | Central | Eastern | southern BS | Total AI survey |
|---|---|---|---|---|---|
| 2012 | 263,661 (0.23) | 233,666 (0.17) | 366,413 (0.36) | 38,658 (0.63) | 902,398 (0.17) |
| 2014 | 338,455 (0.21) | 315,544 (0.49) | 233,560 (0.28) | 83,409 (0.50) | 970,968 (0.19) |
| 2016 | 403,049 (0.19) | 206,593 (0.19) | 284,909 (0.17) | 87,952 (0.47) | 982,503 (0.11) |

# Survey CPUE, 2010 – 2016 EBS surveys




| Year | EBS slope survey |
|---|---|
| 2002 | 72,665 (0.53) |
| 2004 | 112,273 (0.38) |
| 2008 | 107,886 (0.41) |
| 2010 | 203,421 (0.38) |
| 2012 | 231,046 (0.38) |
| 2016 | 357,369 (0.68) |

# POP fishery age composition data

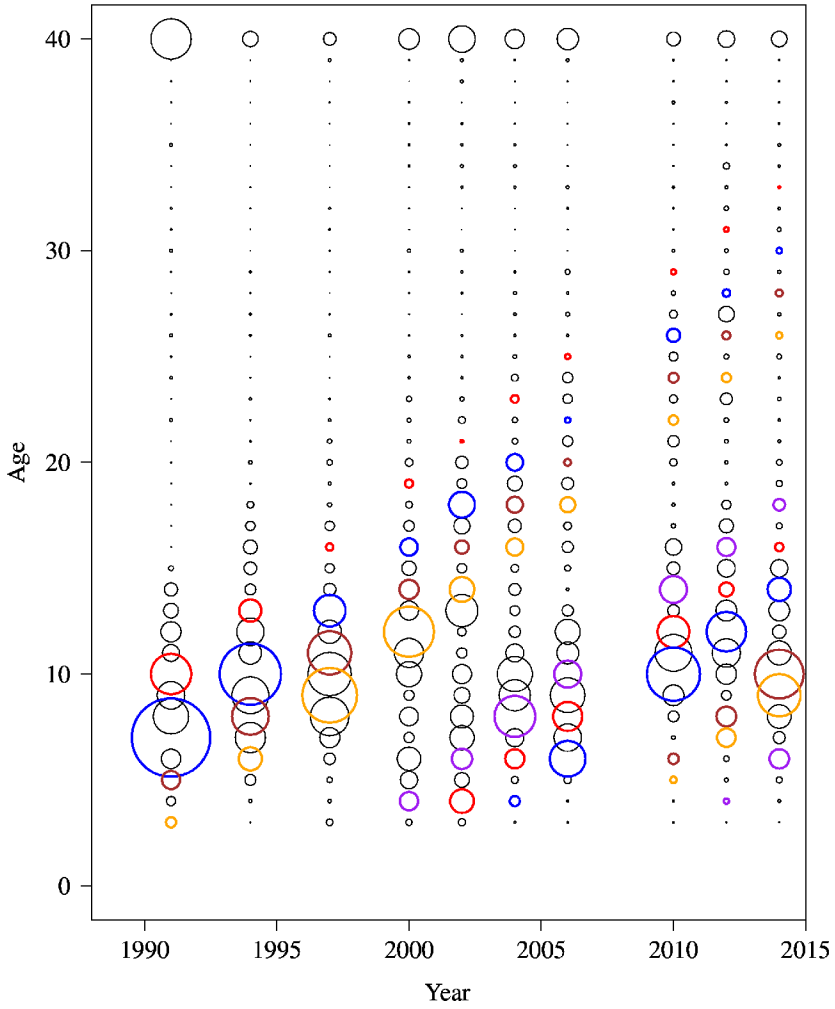



Top 10 year classes since 1977

1981
1984
1986
1988

1996
1998
2000
2004
2005
2008

# POP AI survey age composition data

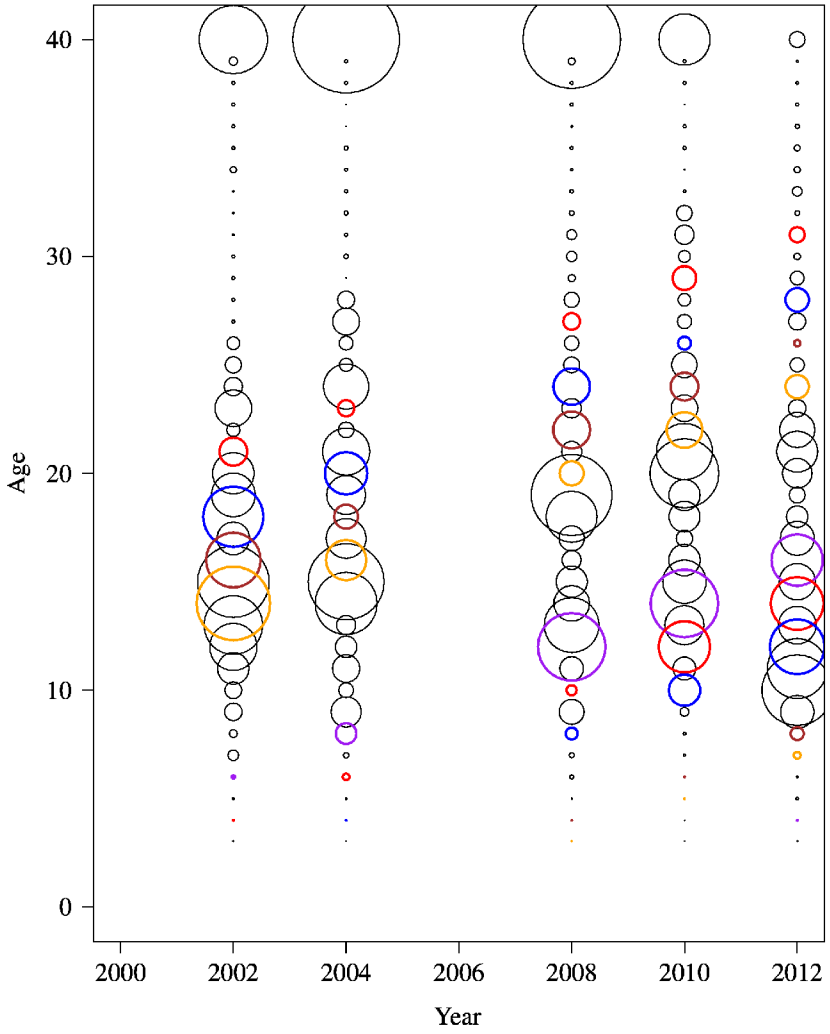



Top 10 year classes since 1977

1981
1984
1986
1988

1996
1998
2000
2004
2005
2008

# POP EBS survey age composition data

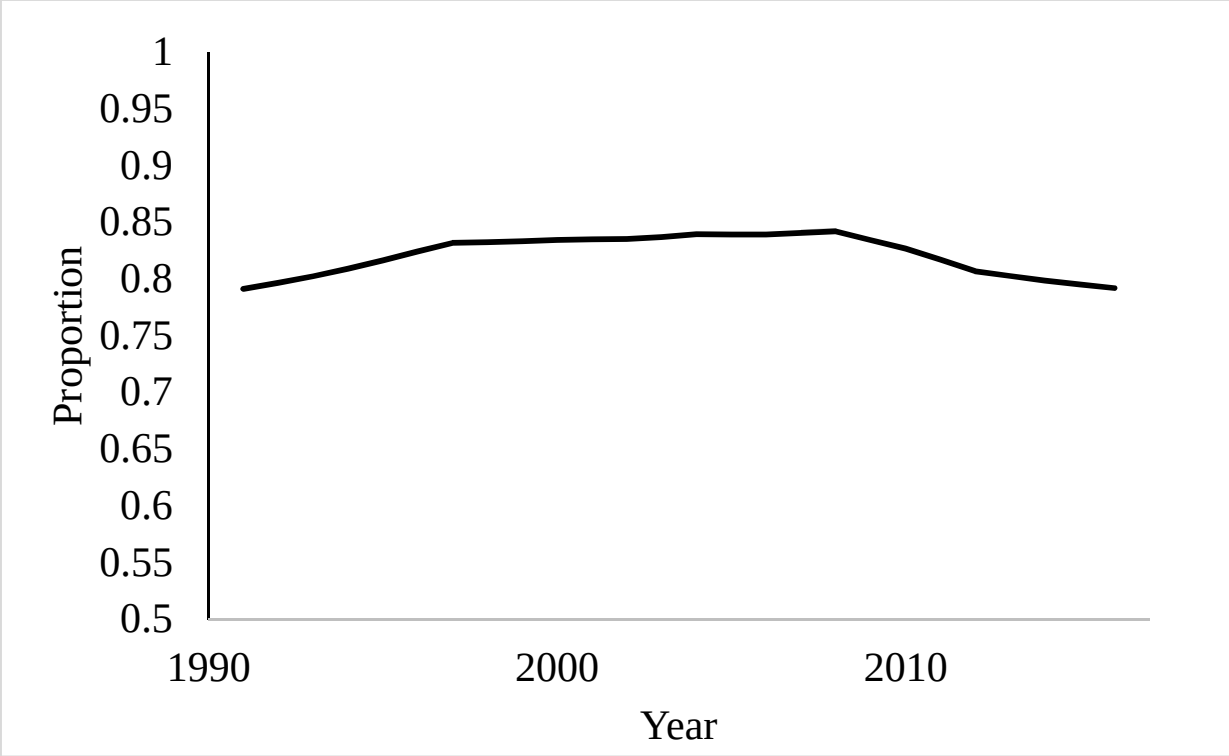



Top 10 year classes since 1977

1981
1984
1986
1988

1996
1998
2000
2004
2005
2008

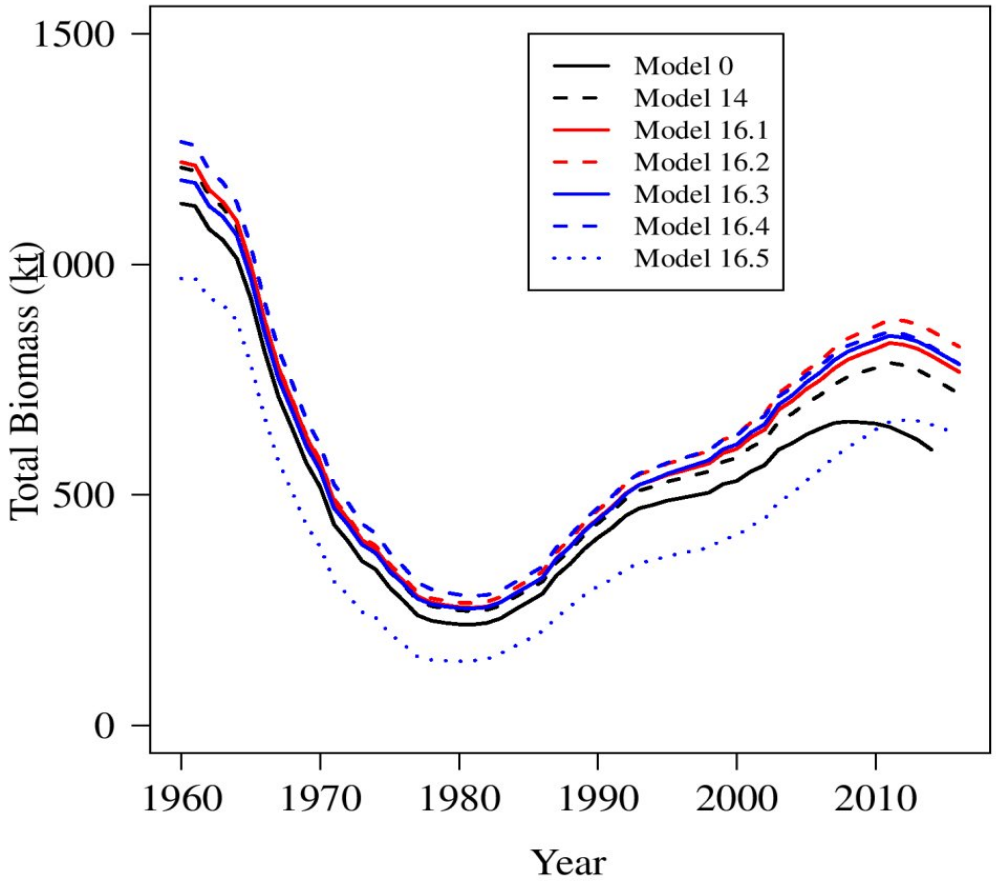
# Time series of relative proportion of BSAI survey biomass in AI subarea



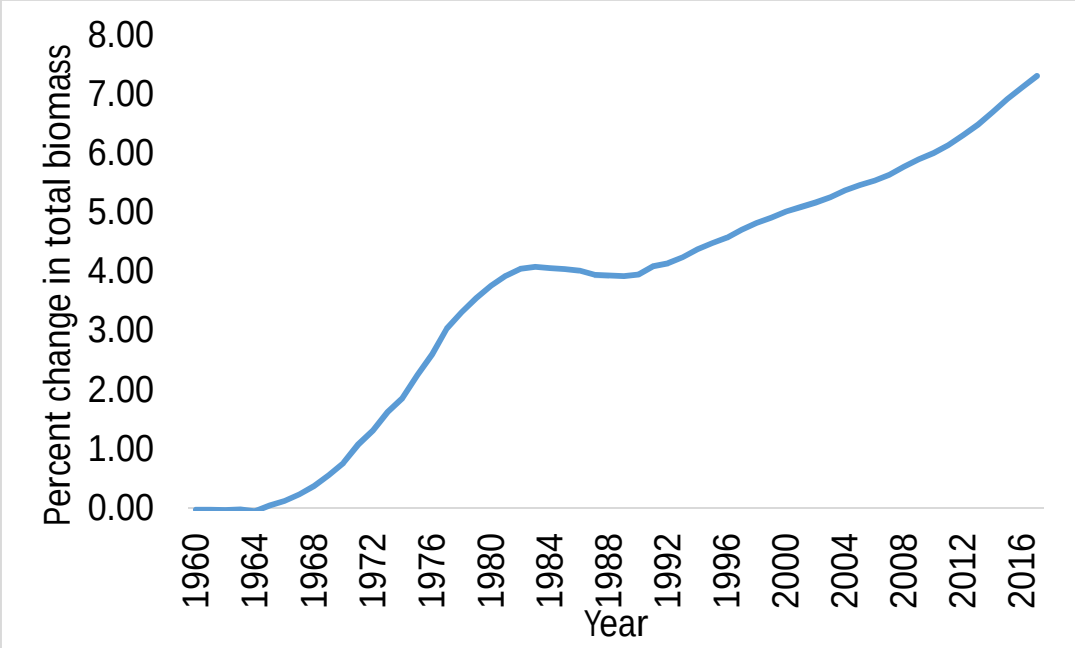
# Models evaluated

- *Model 0* The 2014 AI model results
- *Model 14* The 2014 model with AI data updated through 2016
- *Model 16.1* Model 14, but with EBS slope survey data, age/length data weights set to 2014 values
- *Model 16.2* Model 16.1, but removal of CPUE time series
- *Model 16.3* Model 16.2, but with reweighting age/length compositions with McAllister-Ianelli method
- *Model 16.4* Model 16.2, but reweighting with SDNR
- *Model 16.5* Model 16.2, but reweighting with Francis method

# Estimates of total biomass



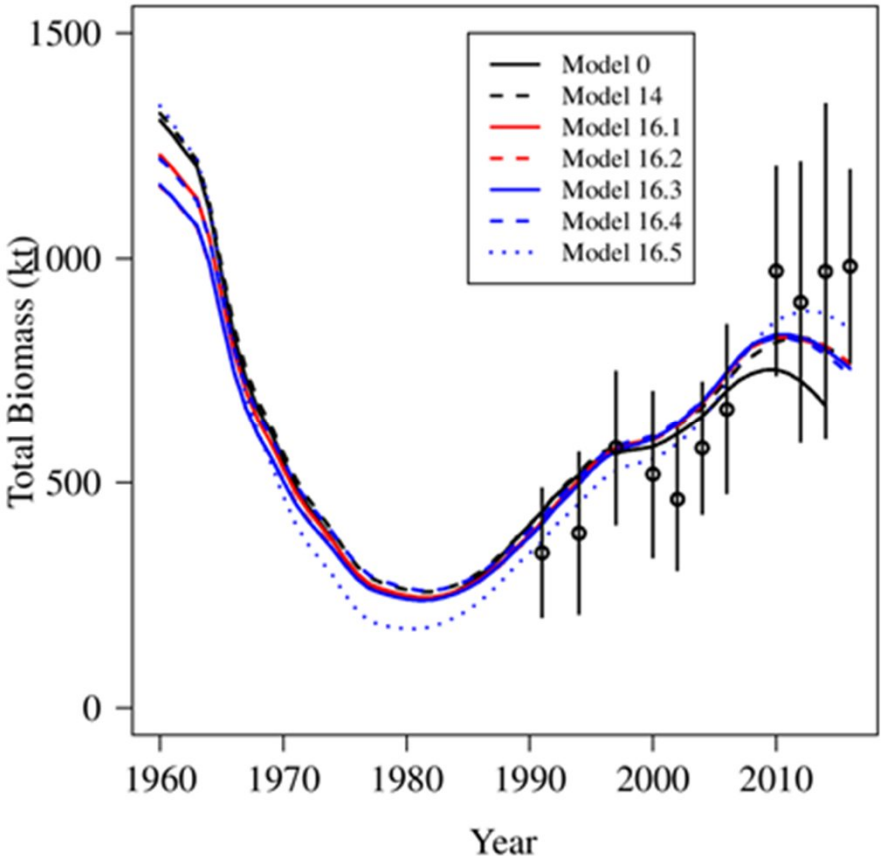
# Percent change in total biomass between models 16.1 (with CPUE index) and 16.2 (without CPUE index)



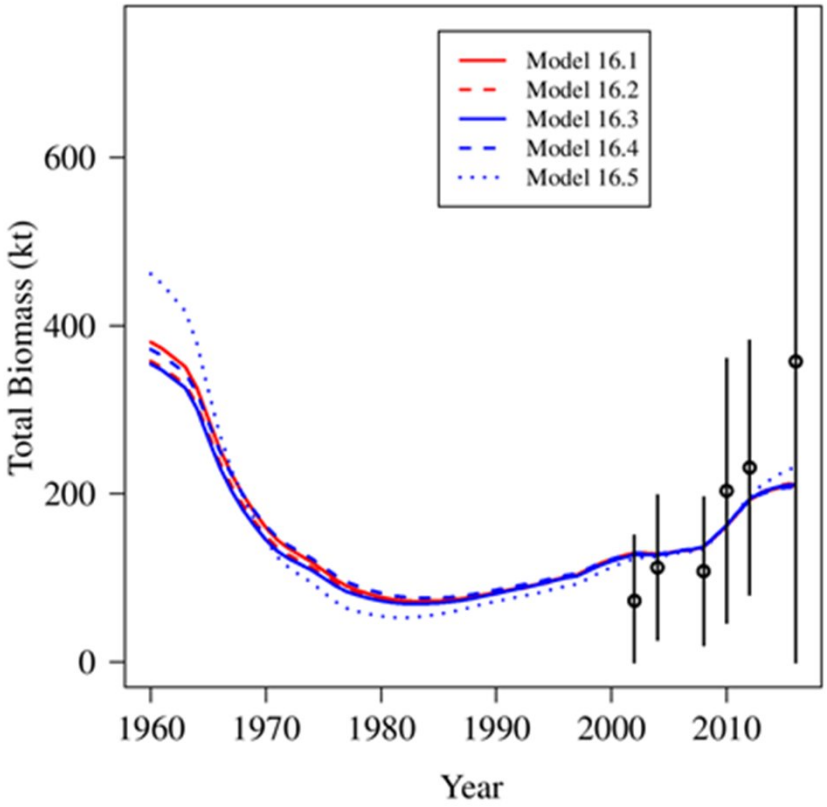

AI survey model catchability

| | |
|---|---|
| Model 16.1: | 1.41 |
| Model 16.2 | 1.33 |

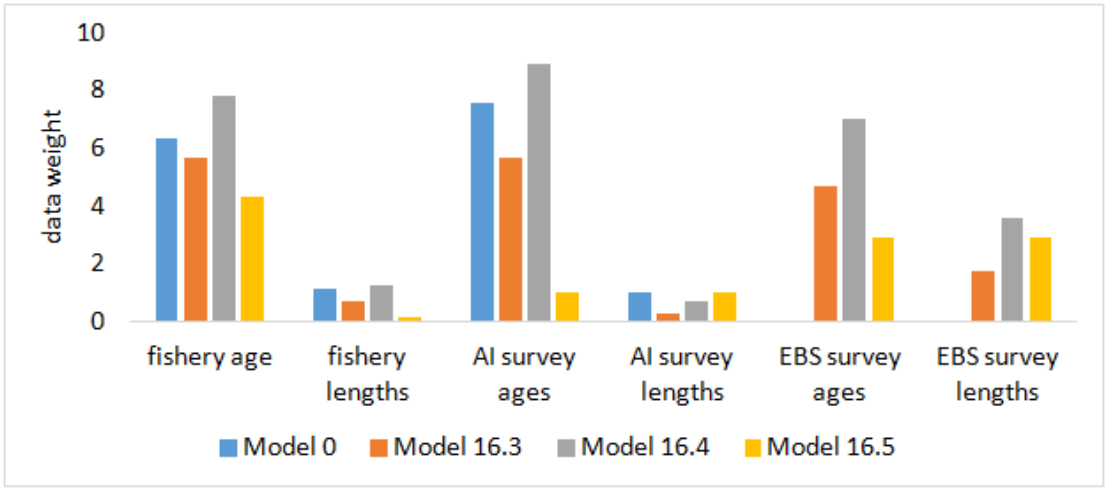
# Fit to the AI survey



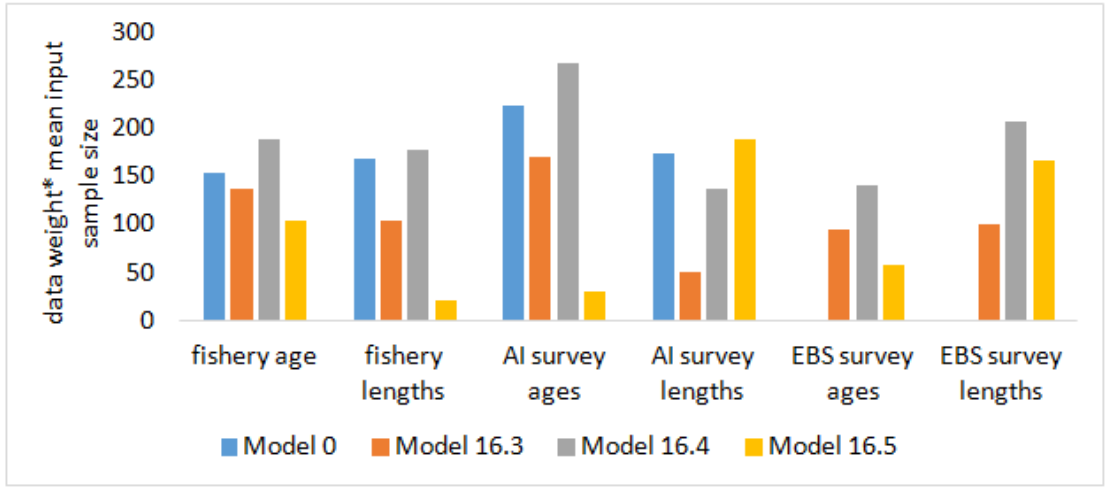
# Fit to the EBS survey index



# Age/length composition weights

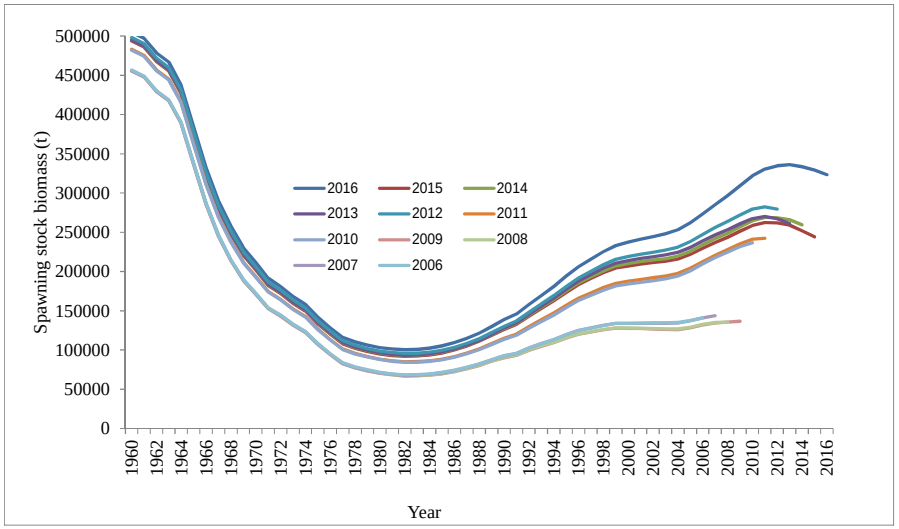


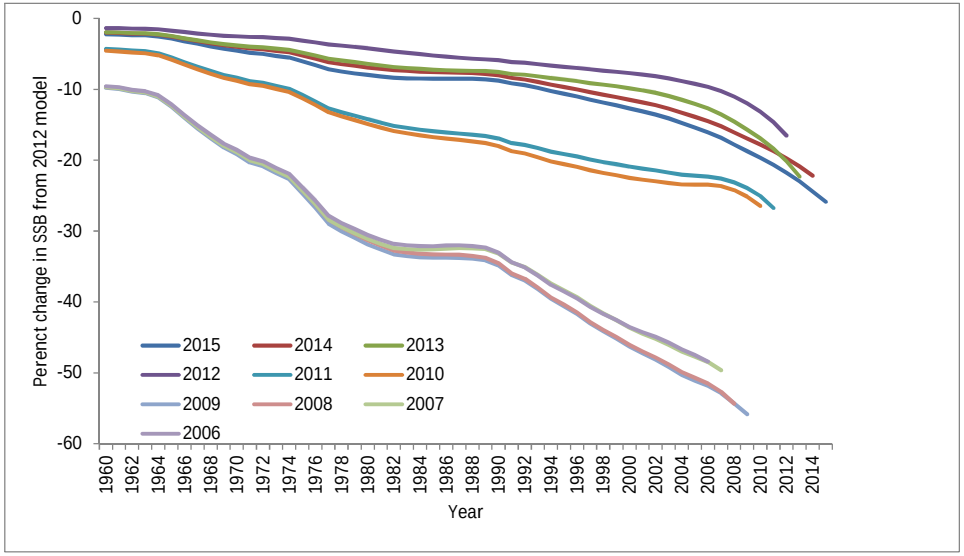

Data weights




Data weights * mean input sample size

# BSAI POP retrospective pattern



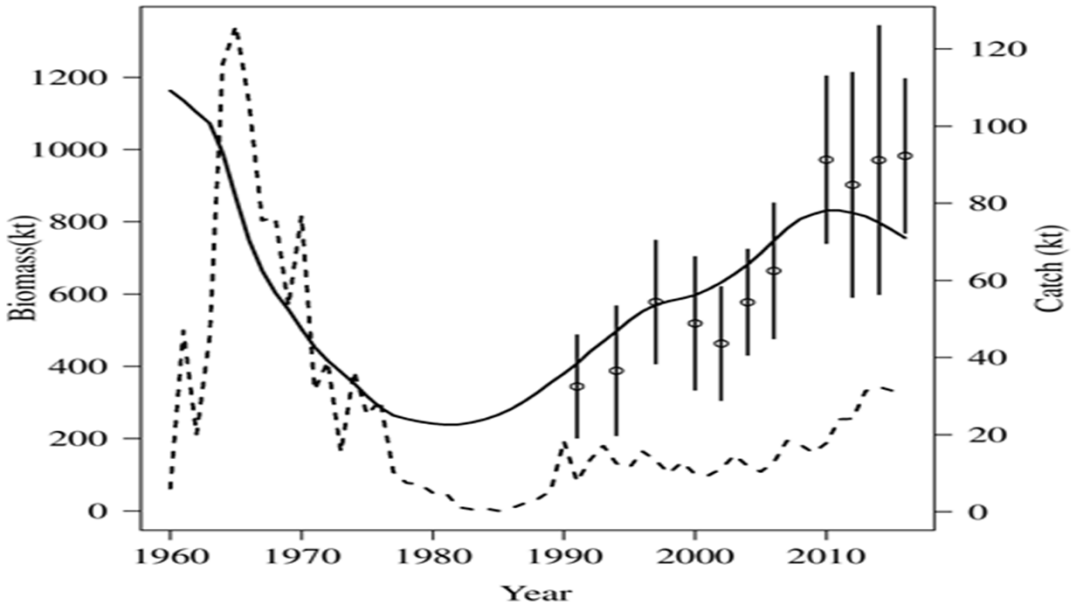

Mohn's rho = -0.35

(-0.34 in 2014 assessment)

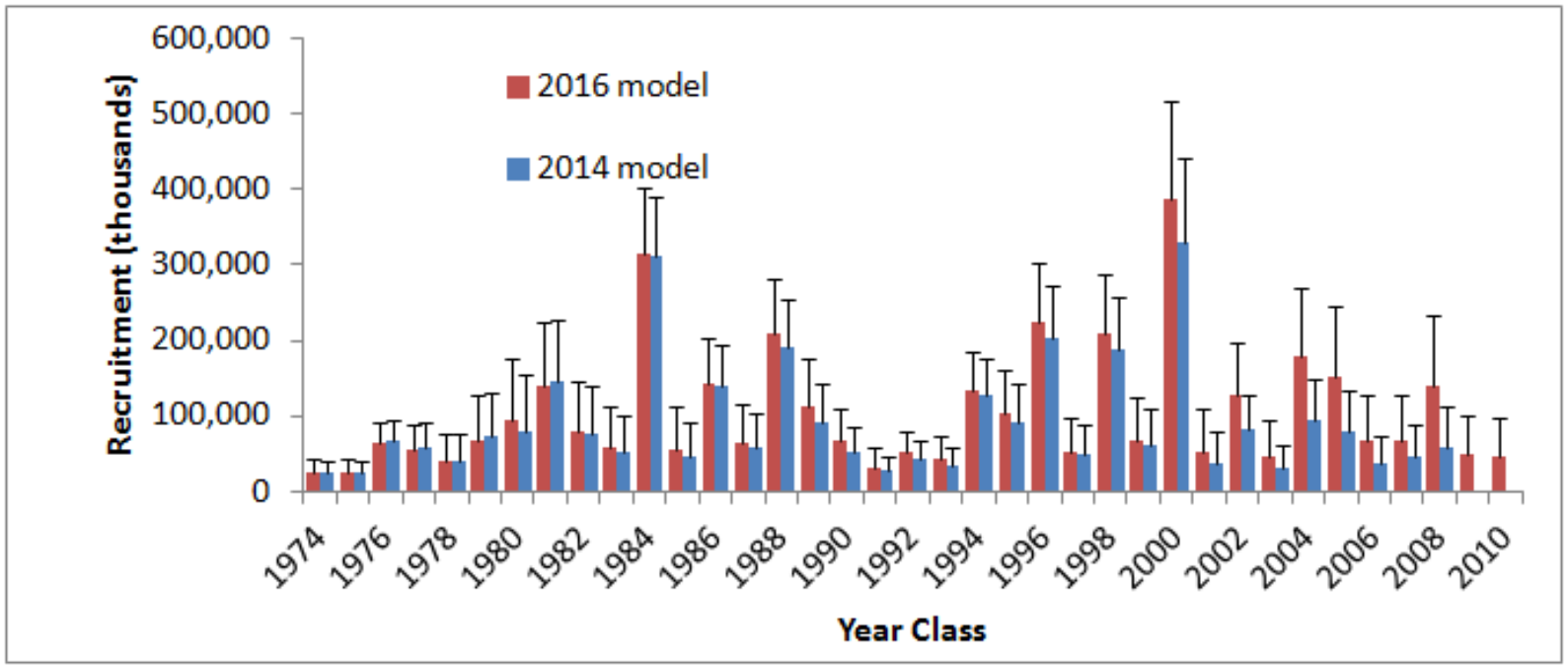
# Recommended model is 16.3 (McAllister-Ianelli weights)

- Trend in the EBS survey biomass index is consistent trend in AI survey biomass index
- Removal of historical CPUE index had relatively little effect on model dynamics, and the methodology for these data is not well documented
- Models with the Francis weights have marginal improvements to the survey indices, but large differences in biomass

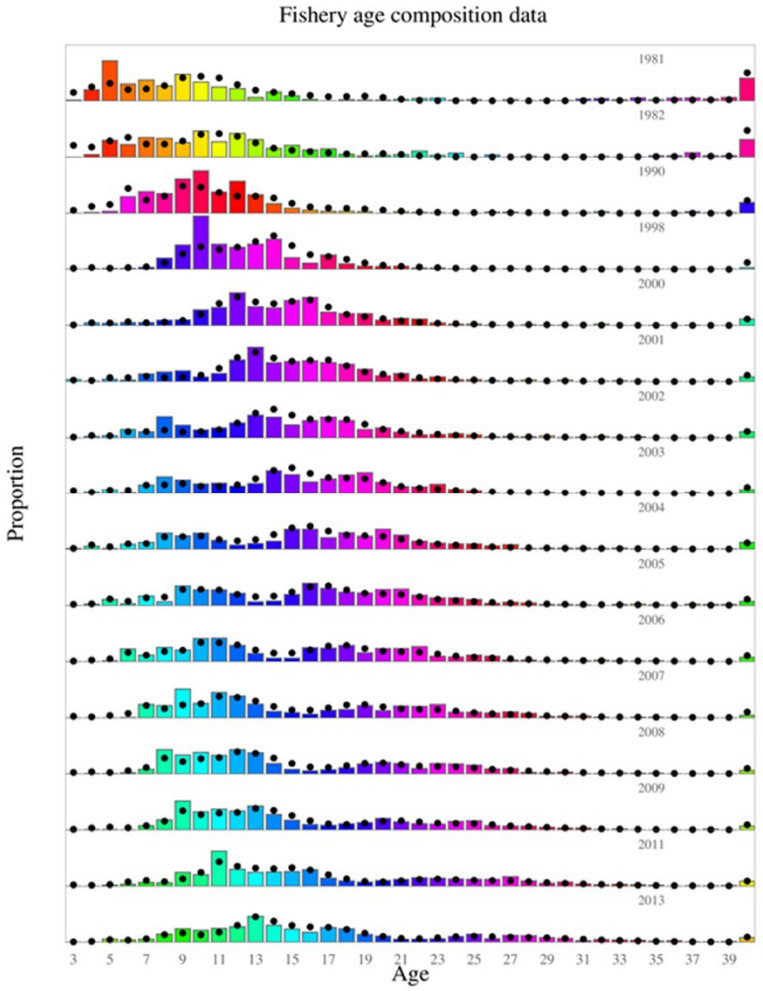
# BSAI POP catch and fit to AI survey biomass



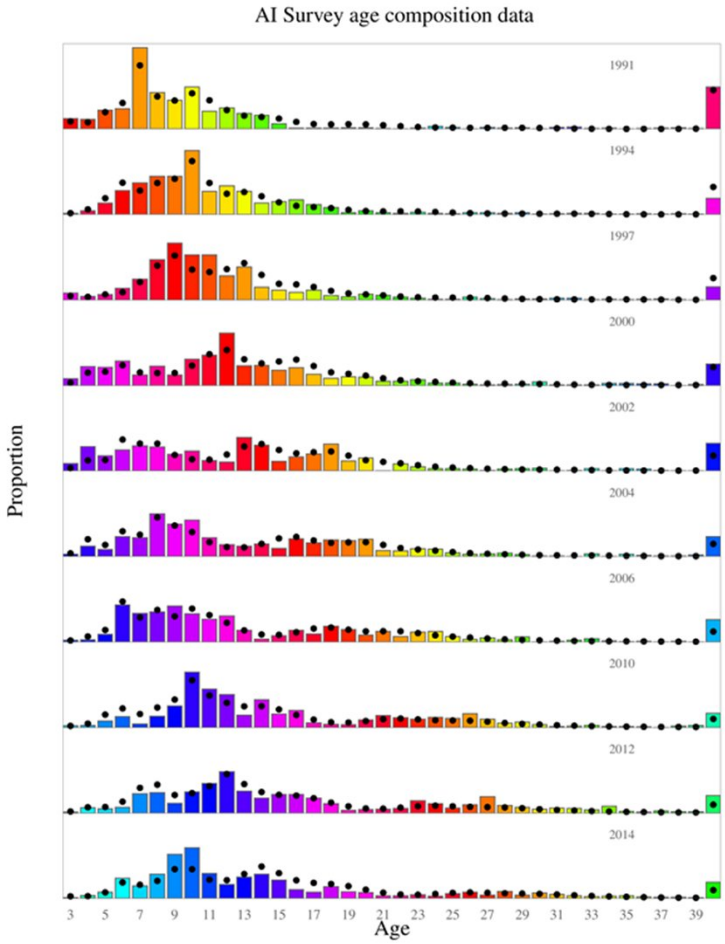
# BSAI POP recruitment



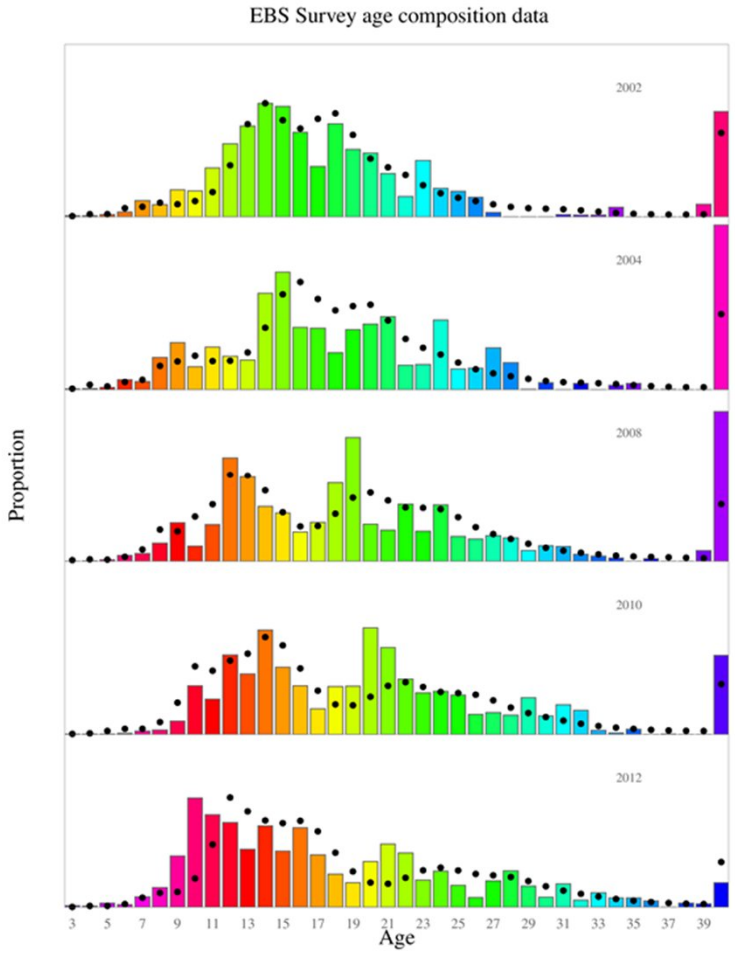
# BSAI fishery age composition



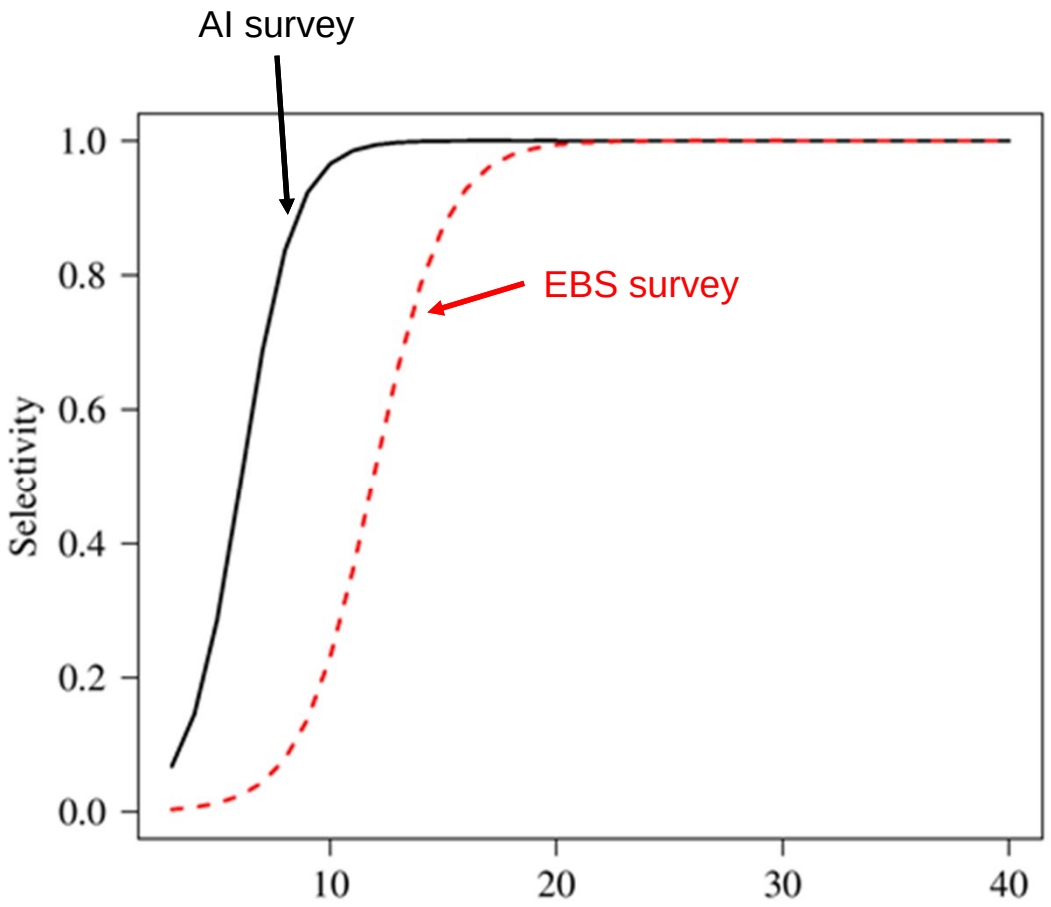
# AI survey age composition



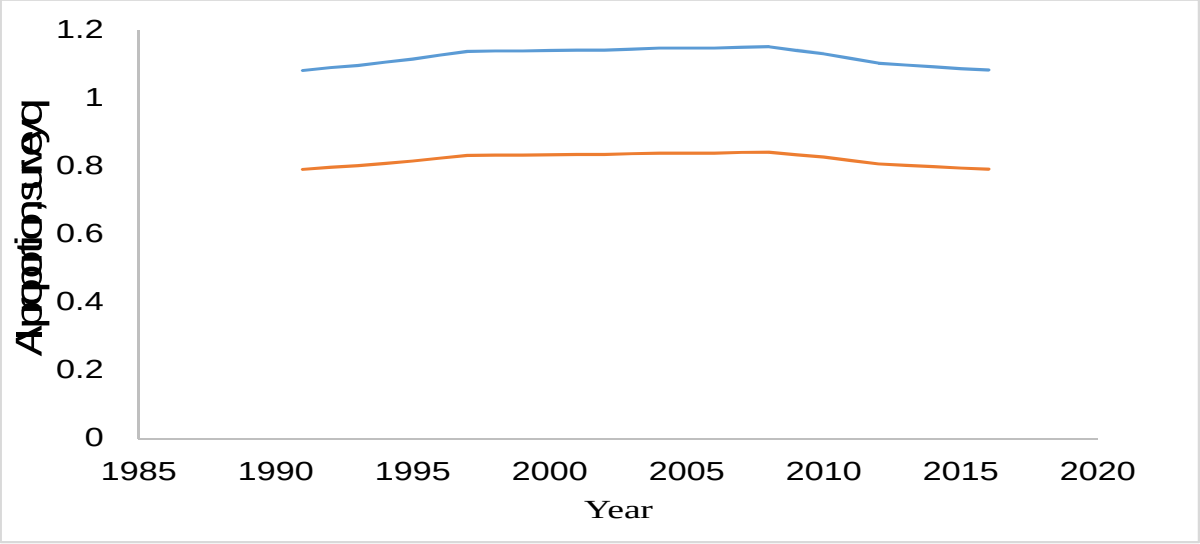
# EBS survey age composition



# EBS and AI survey selectivity



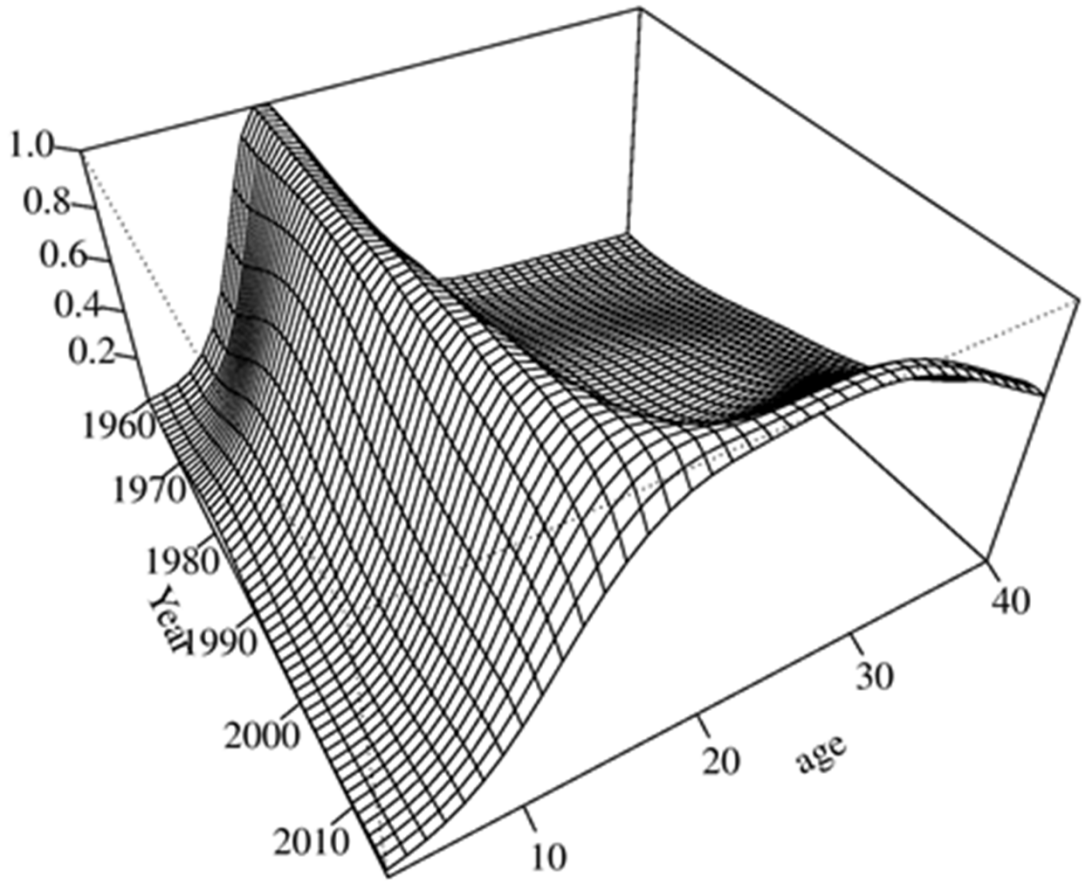
# Survey catchability



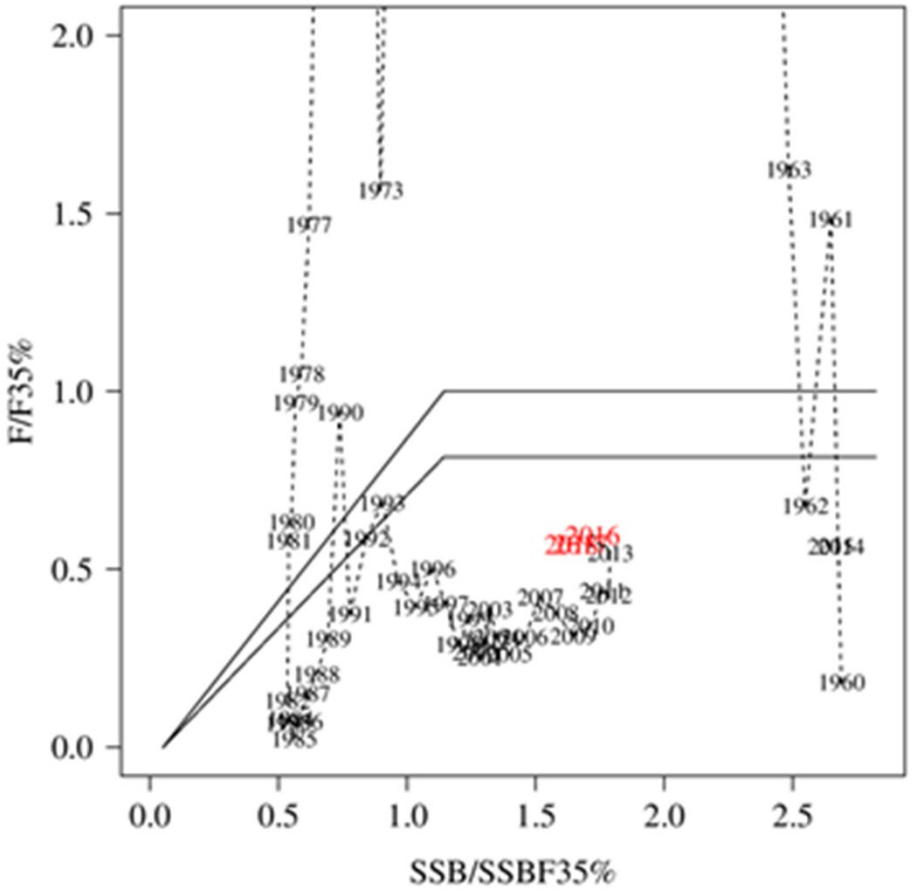

Survey catchability (unadjusted for availability)

AI: 1.37
EBS: 1.88

# Fishery selectivity



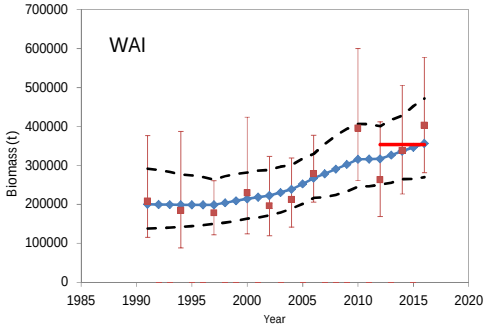
# Phase plane plot

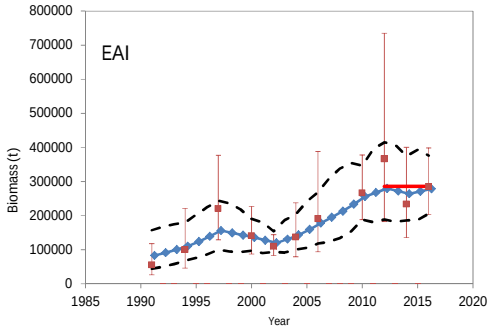


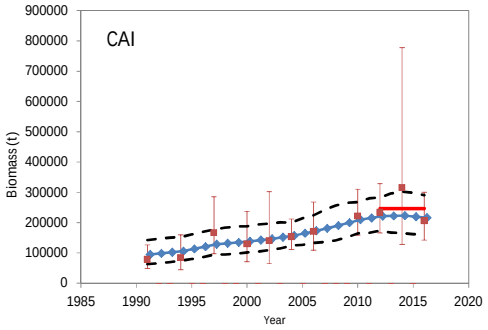
# Reference points and ABCs

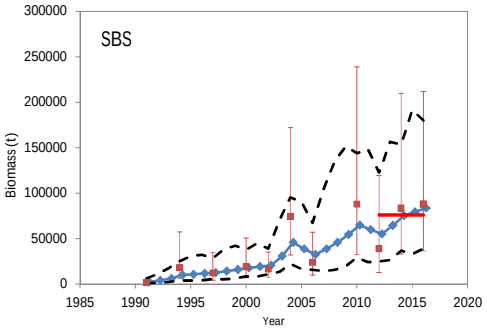
| Quantity | As estimated or specified last year for: 2016 | 2017 | As estimated or recommended this year for: 2017 | 2018 |
|---|---|---|---|---|
| *M* (natural mortality rate) | 0.062 | 0.062 | 0.058 | 0.058 |
| Tier | 3a | 3a | 3a | 3a |
| Projected total (age 3+) biomass (t) | 557,886 | 542,162 | 767,767 | 753,302 |
| Female spawning biomass (t) | | | | |
| Projected | 222,369 | 211,339 | 314,489 | 307,808 |
| $B_{100\%}$ | 423,008 | 423,008 | 536,713 | 536,713 |
| $B_{40\%}$ | 169,203 | 169,203 | 214,685 | 214,685 |
| $B_{35\%}$ | 148,053 | 148,053 | 187,849 | 187,849 |
| $F_{OFL}$ | 0.109 | 0.109 | 0.101 | 0.101 |
| $maxF_{ABC}$ | 0.089 | 0.089 | 0.082 | 0.082 |
| $F_{ABC}$ | 0.089 | 0.089 | 0.082 | 0.082 |
| OFL (t) | 40,529 | 38,589 | 53,152 | 51,950 |
| maxABC (t) | 33,320 | 31,724 | 43,723 | 42,735 |
| ABC (t) | 33,320 | 31,724 | 43,723 | 42,735 |
| **Status** | As determined last year for: 2014 | 2015 | As determined this year for: 2015 | 2016 |
| Overfishing | No | n/a | No | n/a |
| Overfished | n/a | | n/a | No |
| Approaching overfished | n/a | | n/a | No |

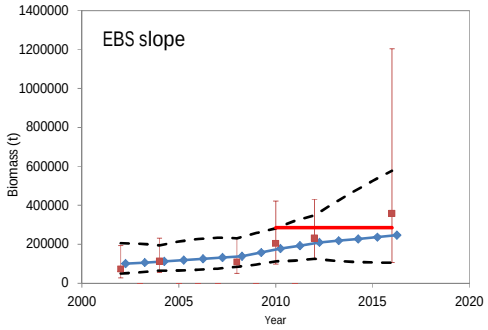
# Smoothed survey time series by subarea



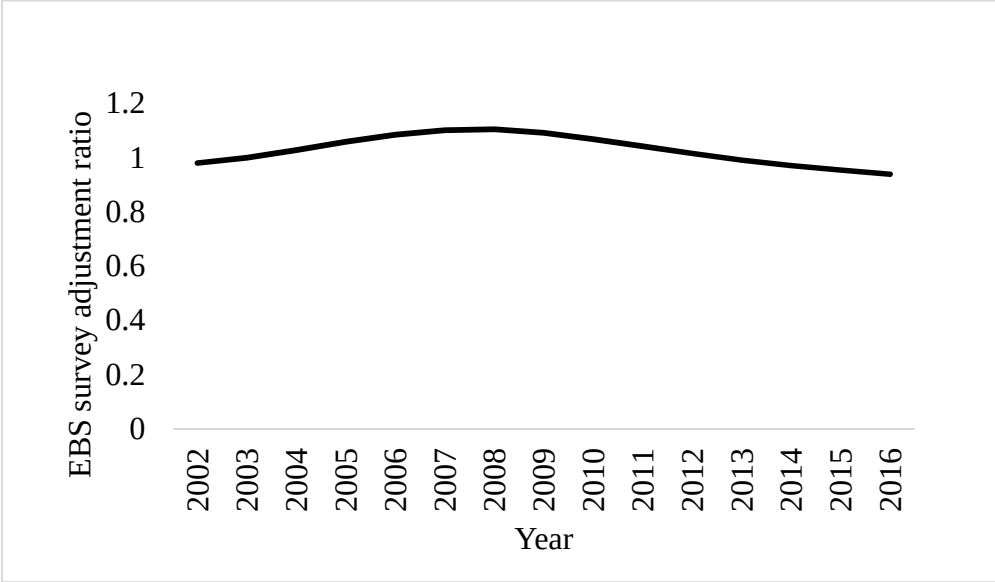



# EBS survey adjustment ratio




For 2016, the ratio is 0.94.

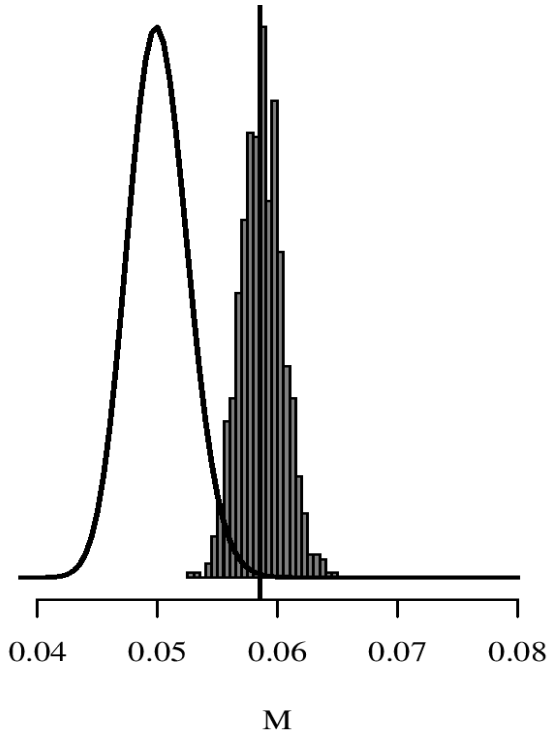
| | Area | | | | |
|---|---|---|---|---|---|
| | WAI | CAI | EAI | SBS | EBS slope |
| Unadjusted smoothed biomass | 356,896 | 216,425 | 278,507 | 83,742 | 245,905 |
| percentage | 30.21% | 18.32% | 23.57% | 7.09% | 20.81% |
| | | | | | |
| Adjusted smoothed biomass | 356,896 | 216,425 | 278,507 | 83,742 | 230,736 |
| percentage | 30.60% | 18.56% | 23.88% | 7.18% | 19.78% |

# Subarea ABCs

| Area | Year | Age 3 Bio (t) | OFL | ABC | TAC | Catch[1] |
|---|---|---|---|---|---|---|
| BSAI | 2015 | 577,967 | 42,558 | 34,988 | 32,021 | 31,425 |
| | 2016 | 557,886 | 40,529 | 33,320 | 31,900 | 24,796 |
| | 2017 | 767,767 | 53,152 | 43,723 | | |
| | 2018 | 753,302 | 51,950 | 42,735 | | |
| Eastern Bering Sea | 2015 | | | 8,771 | 8,021 | 7,918 |
| | 2016 | | | 8,353 | 8000 | 3,743 |
| | 2017 | | | 11,789 | n/a | n/a |
| | 2018 | | | 11,523 | n/a | n/a |
| Eastern Aleutian Islands | 2015 | | | 8,312 | 8,000 | 7,865 |
| | 2016 | | | 7,916 | 7900 | 5,780 |
| | 2017 | | | 10,441 | n/a | n/a |
| | 2018 | | | 10,205 | n/a | n/a |
| Central Aleutian Islands | 2015 | | | 7,723 | 7,000 | 6,834 |
| | 2016 | | | 7,355 | 7000 | 6,608 |
| | 2017 | | | 8,113 | n/a | n/a |
| | 2018 | | | 7,930 | n/a | n/a |
| Western Aleutian Islands | 2015 | | | 10,182 | 9,000 | 8,808 |
| | 2016 | | | 9,696 | 9000 | 8,663 |
| | 2017 | | | 13,380 | n/a | n/a |
| | 2018 | | | 13,077 | n/a | n/a |

# Research topics

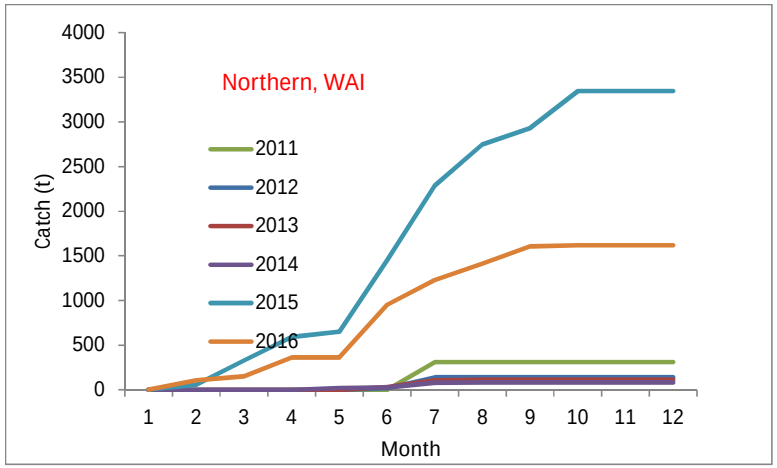
- Evaluate natural mortality for POP

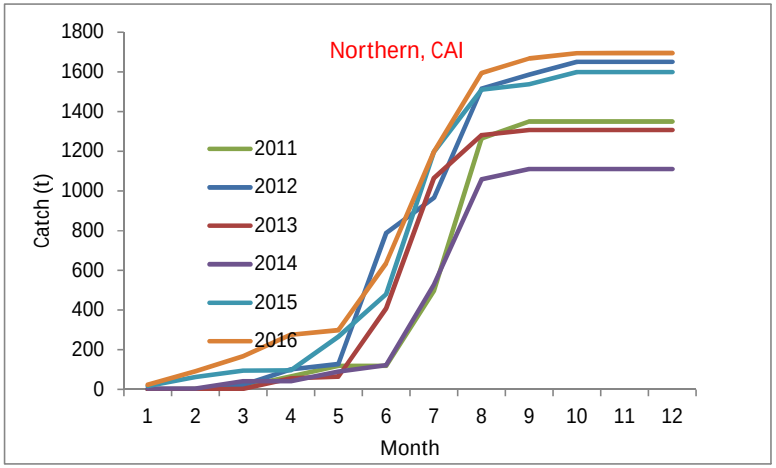


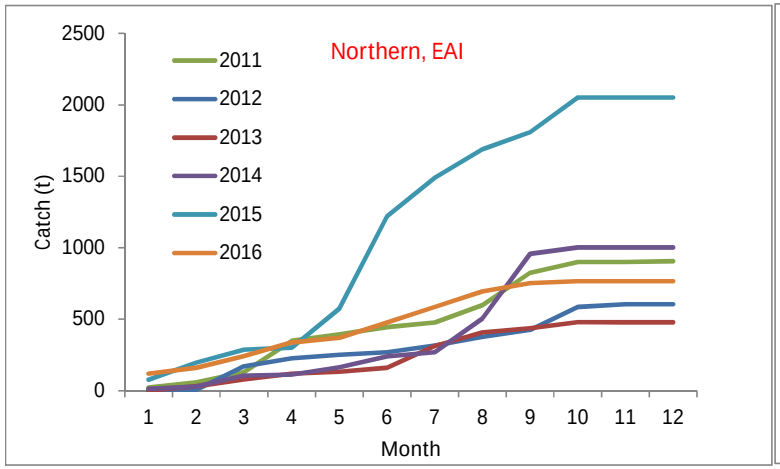
# BSAI Northern Rockfish Outline

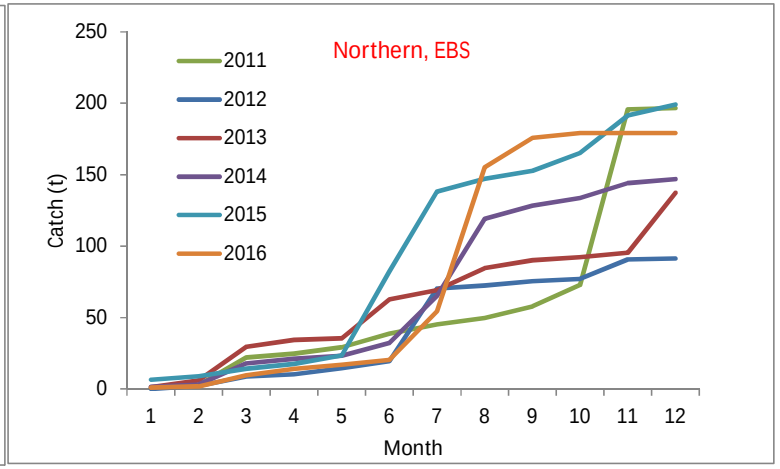
1) Catch information
2) Survey and fishery data
3) Iterative reweighting of composition data, modeling availability
4) Model evaluation
5) Model fits to data
6) Retrospective analysis
7) Management recommendations

# BSAI northern rockfish catch by month and area, 2011-2016



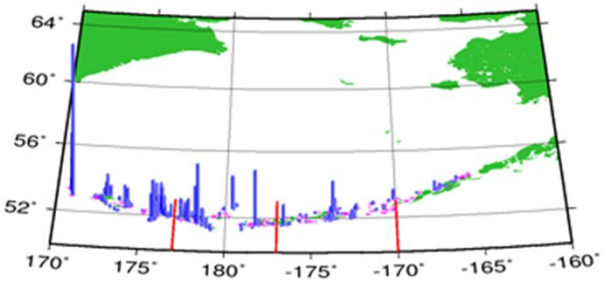



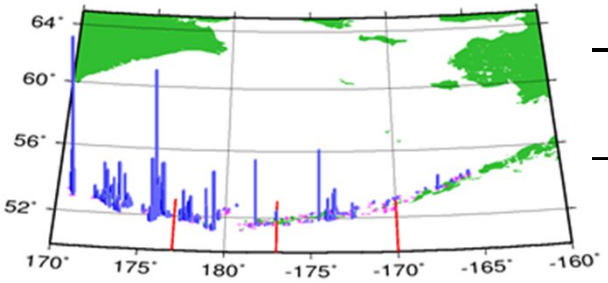



# Square root of survey CPUE, 2012 – 2016 AI surveys

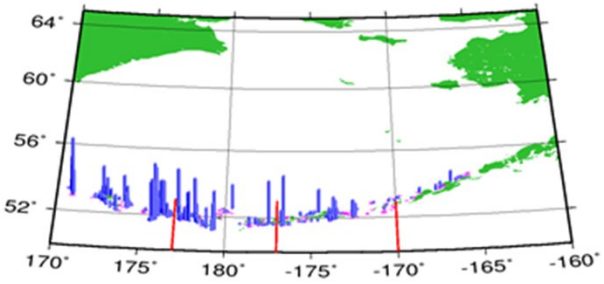
2012 AI Survey Northern Rockfish CPUE (scaled wgt/km$^2$)




2014 AI Survey Northern Rockfish CPUE (scaled wgt/km$^2$)

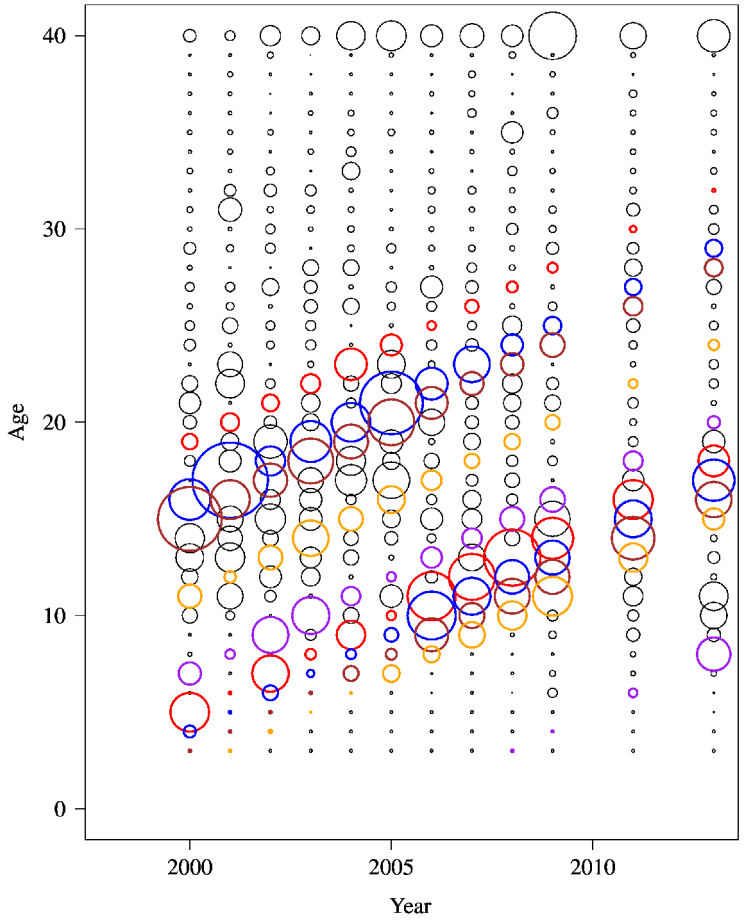



2016 AI Survey Northern Rockfish CPUE (scaled wgt/km$^2$)



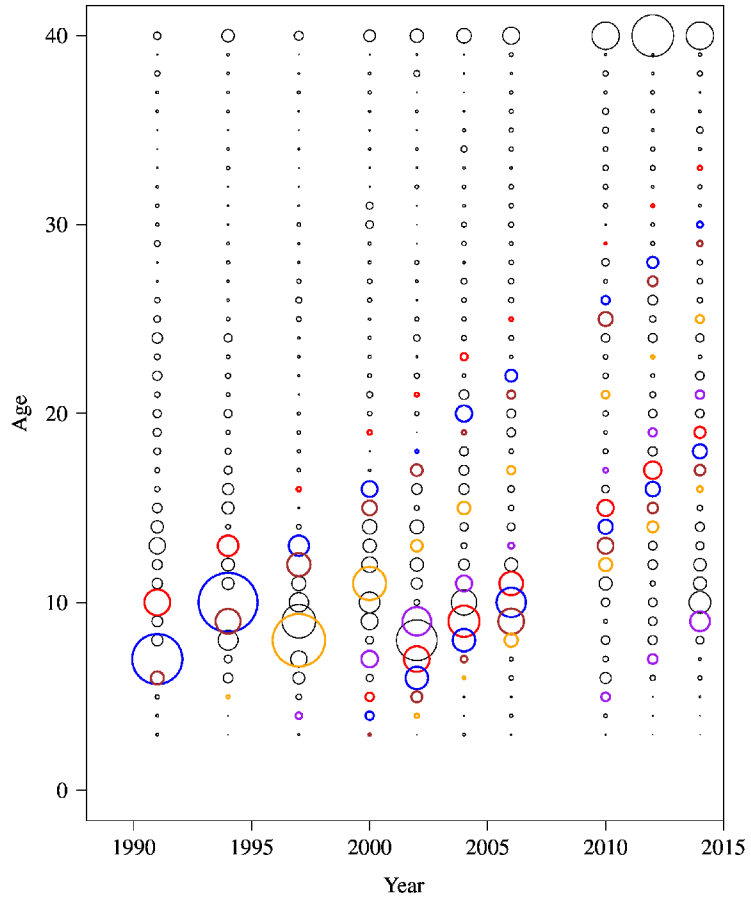

| Year | Western | Central | Eastern | southern BS | Total AI survey |
|---|---|---|---|---|---|
| 2012 | 216,325 (0.65) | 52,674 (0.40) | 15,615 (0.60) | 550 (0.73) | 285,164 (0.50) |
| 2014 | 346,392 (0.38) | 48,049 (0.44) | 76,787 (0.79) | 1,668 (0.80) | 472,895 (0.31) |
| 2016 | 124,310 (0.21) | 78,869(0.37) | 48,382 (0.52) | 1,656 (0.55) | 253,217 (0.18) |

# BSAI northern rockfish fishery age compositions




1981
1984
1985
1989
1993
1995
1996
1997
1998
2005

# BSAI northern rockfish survey age compositions

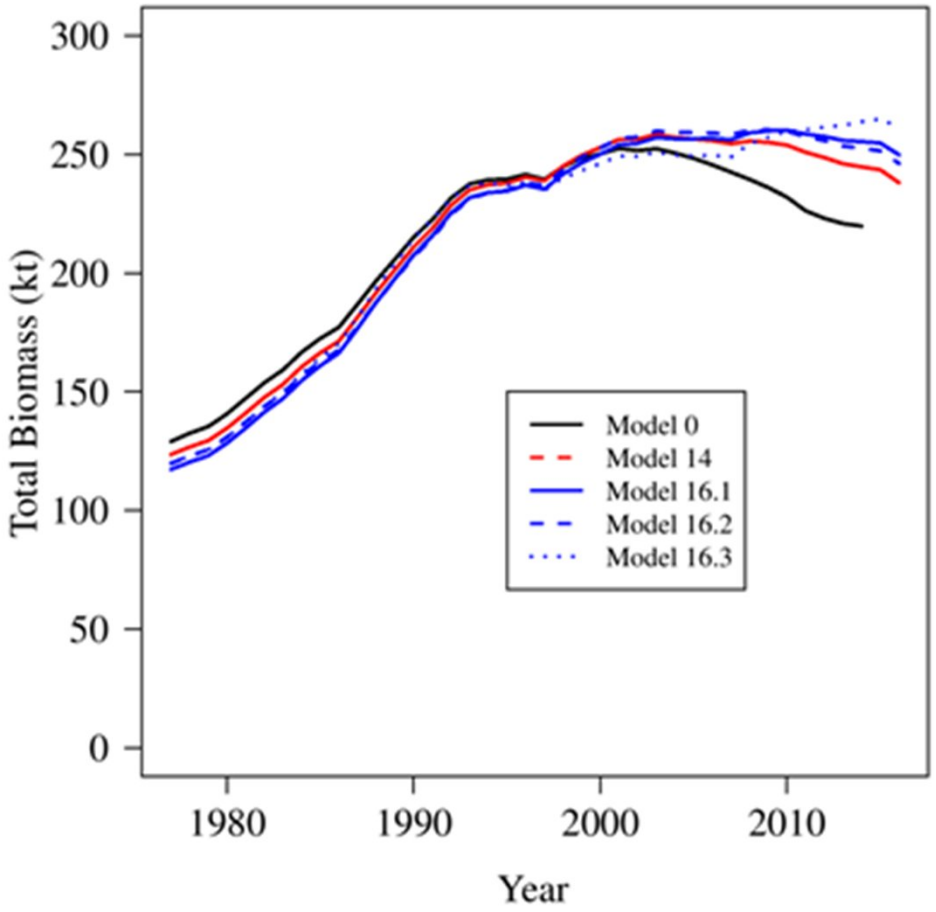



1981
1984
1985
1989
1993
1995
1996
1997
1998
2005

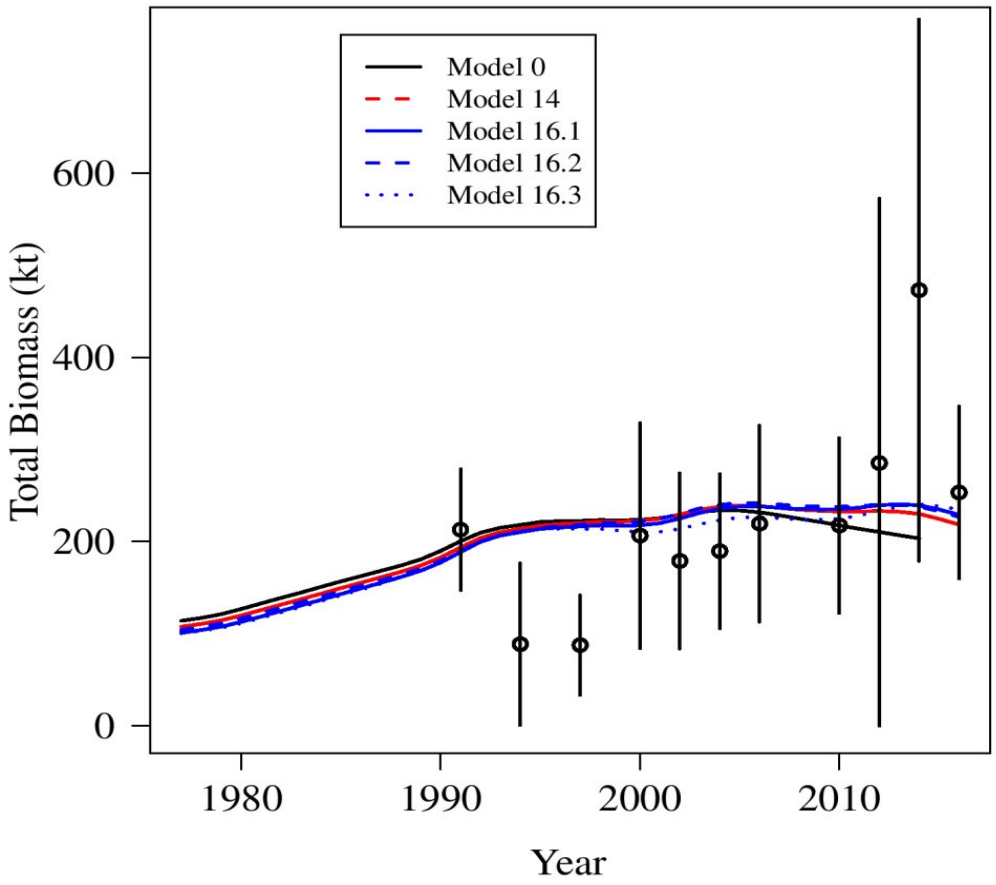
# Models evaluated

- *Model 0* The 2014 AI model results
- *Model 14* The 2014 model with data updated through 2016
- *Model 16.1* Model 14, but with reweighting age/length compositions with McAllister-Ianelli method
- *Model 16.2* Model 14, but reweighting with SDNR
- *Model 16.3* Model 14, but reweighting with Francis method

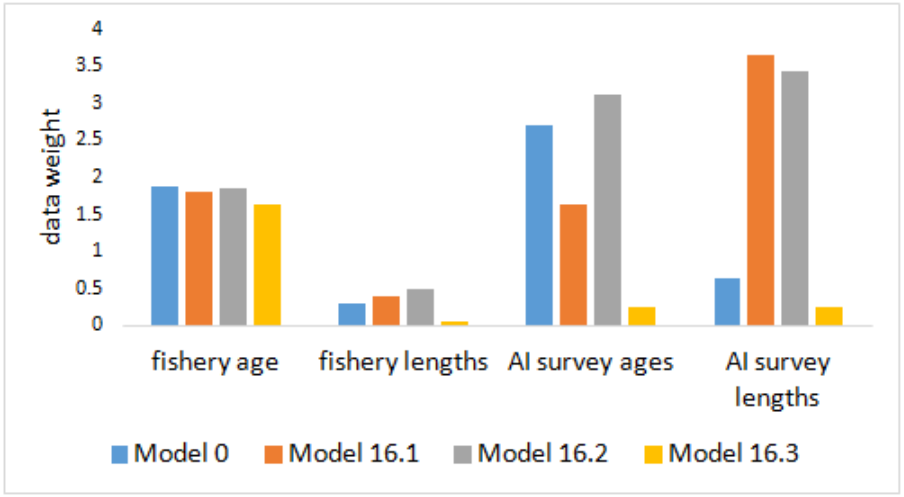
# Estimates of total biomass



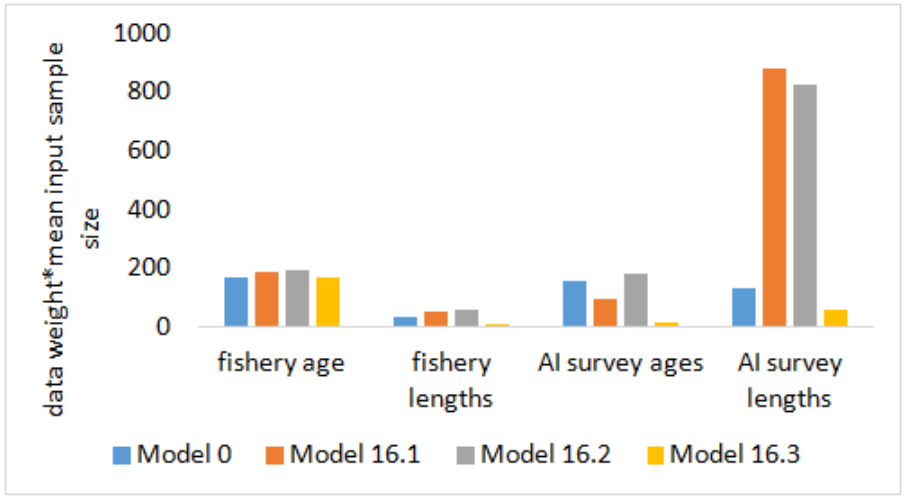
# Fit to the AI survey



# Weights for age/length composition data



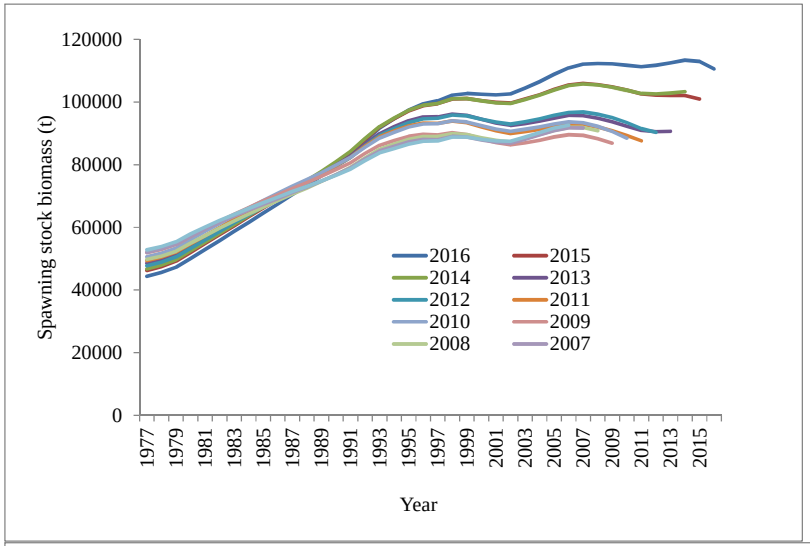

Data weights

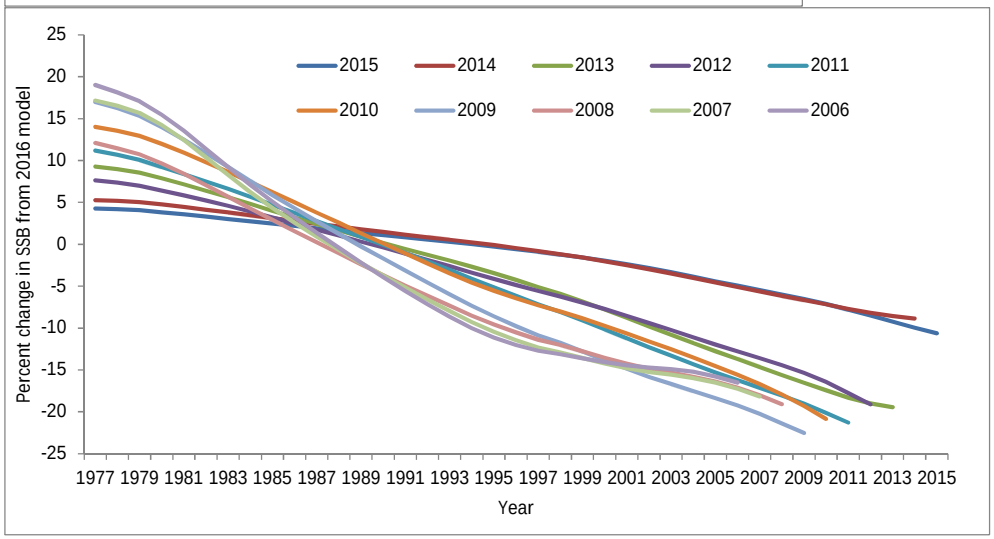



Data weights * mean input sample size

Recommended model is 16.1 (McAllister-Ianelli weights)

# Retrospective pattern

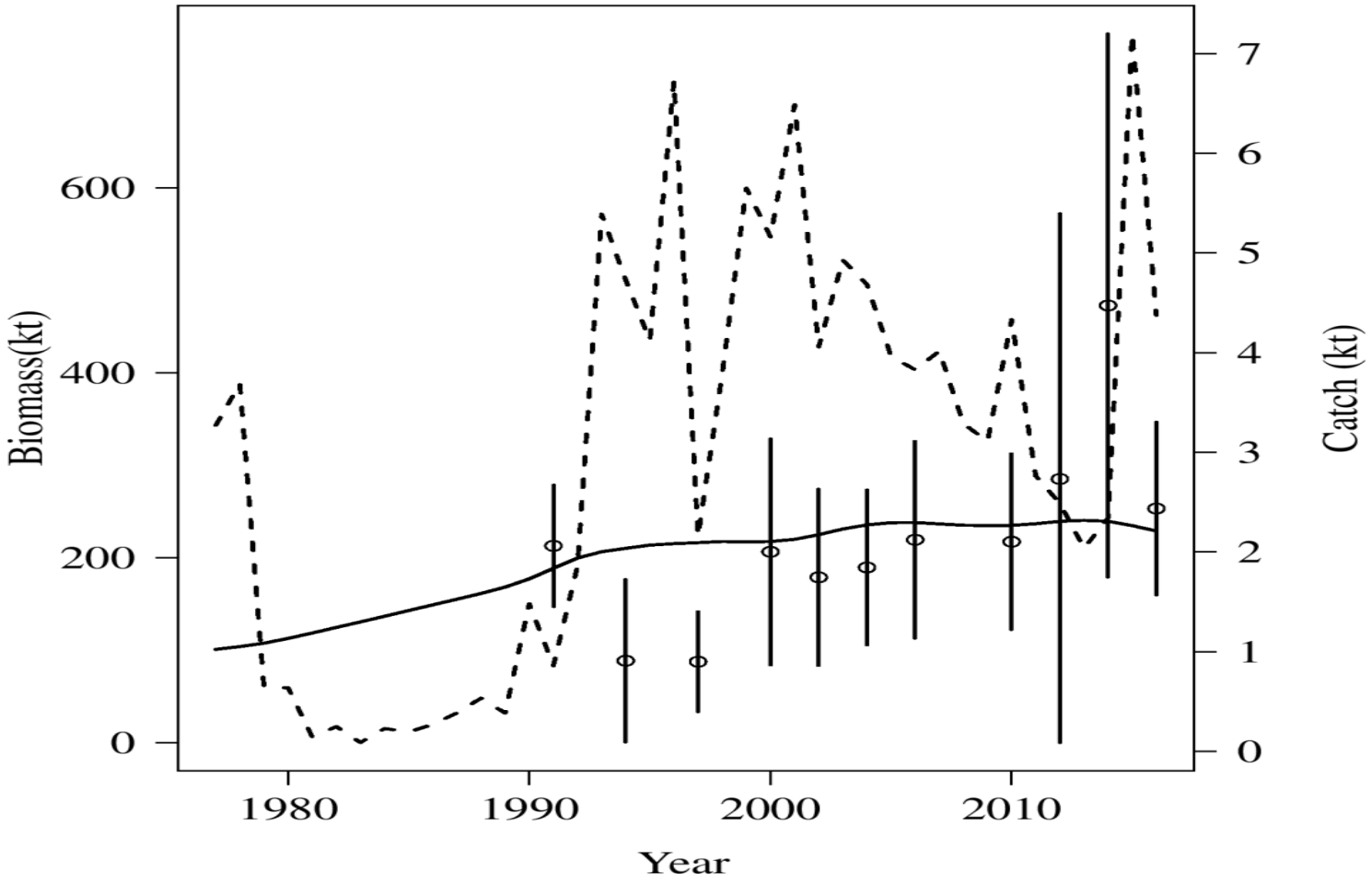


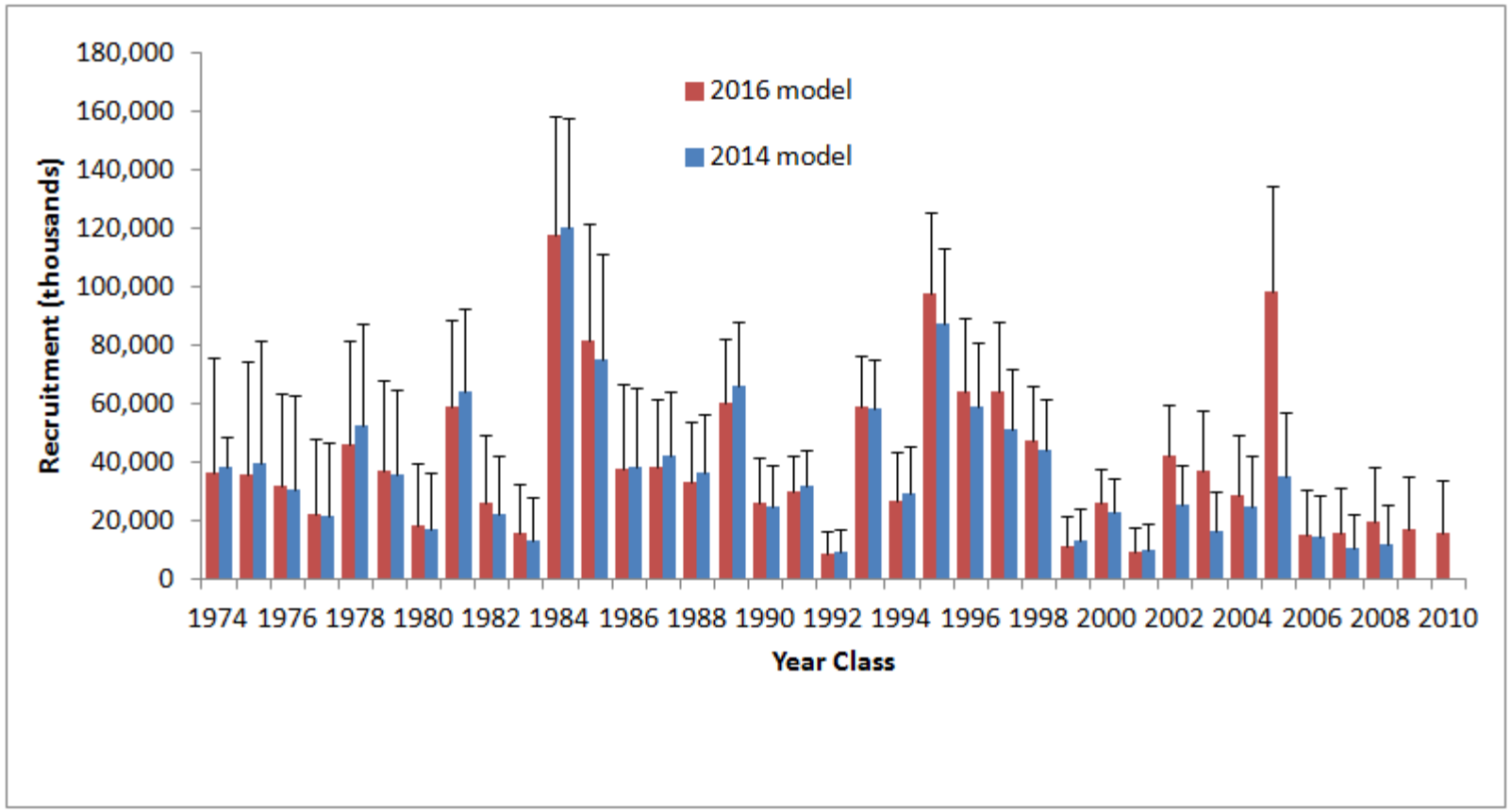

Mohn's rho = -0.18

(2014 assessment: -0.15)

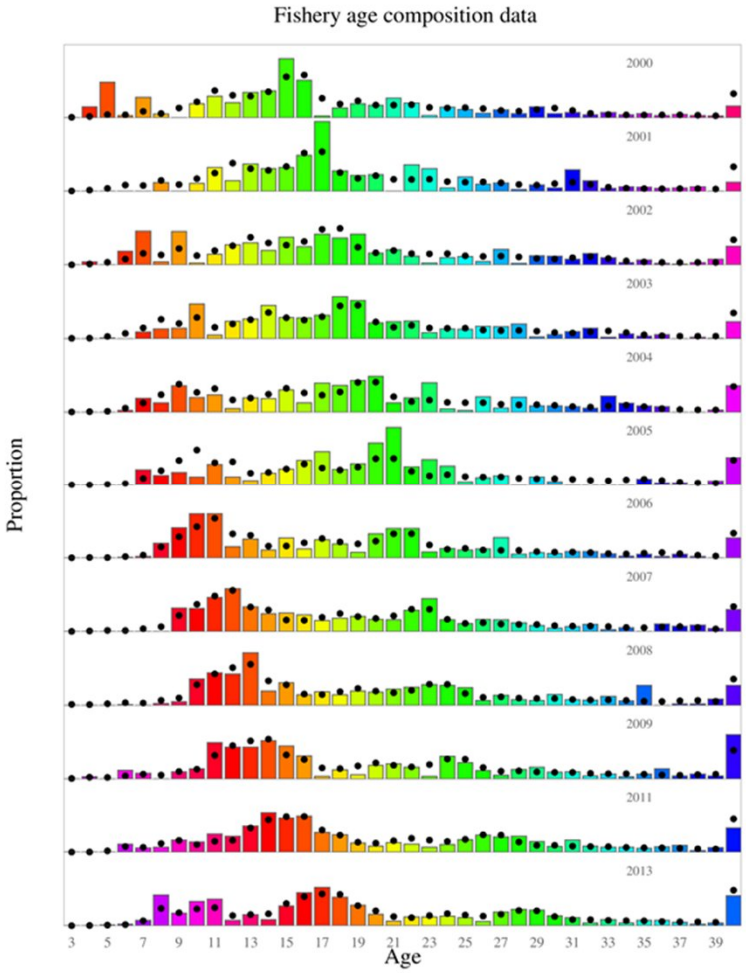
# Catch, and fit to AI survey



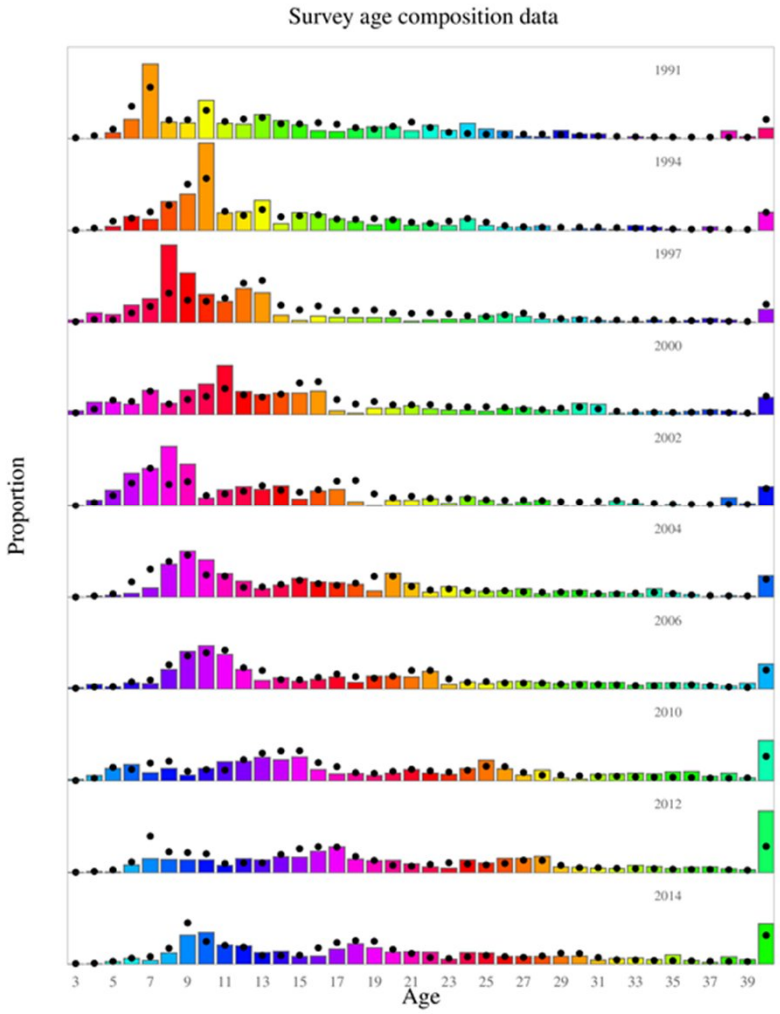
# Recruitment



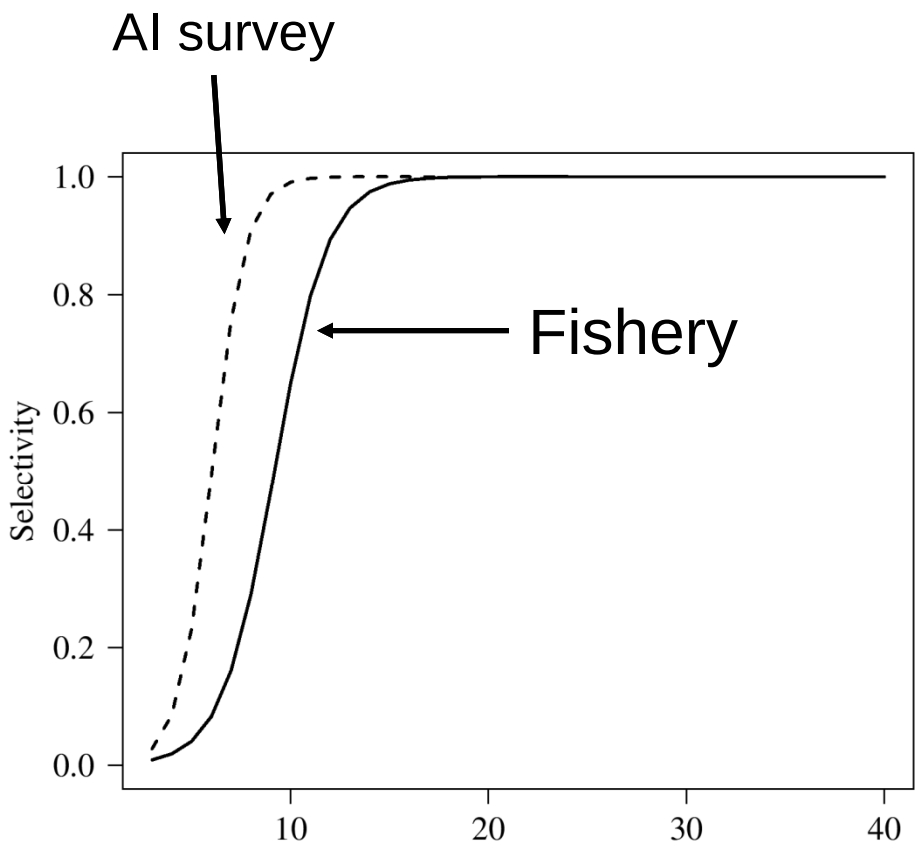
# Fishery age composition



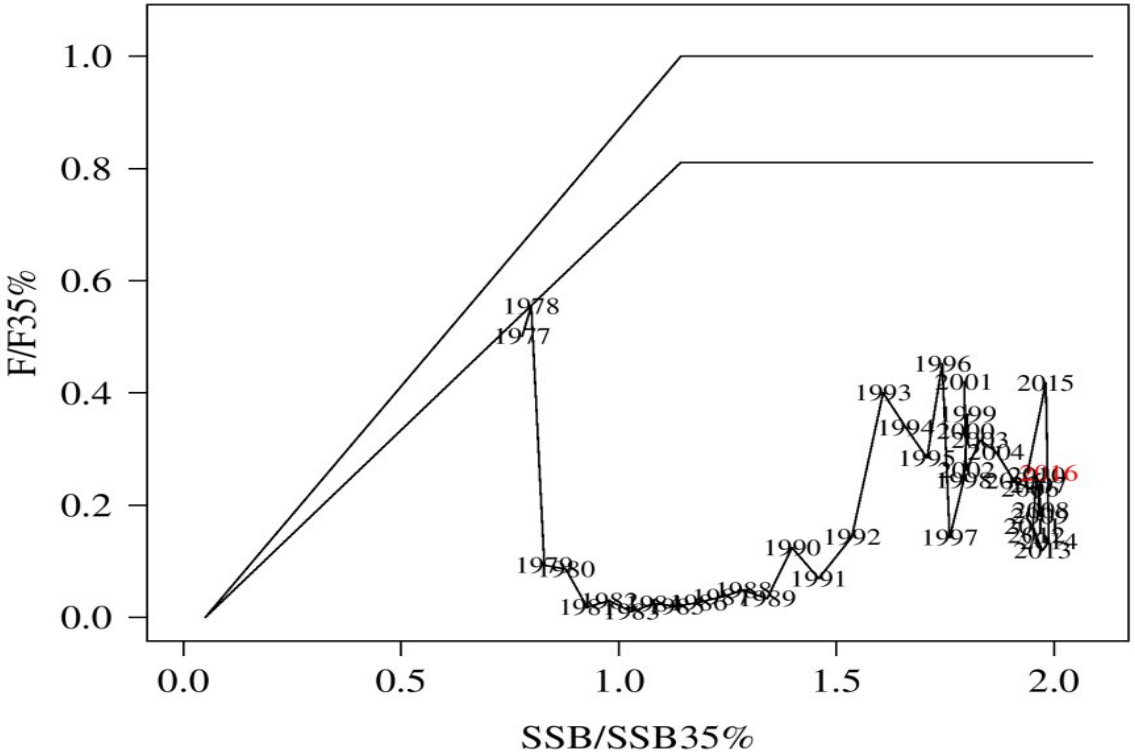
# AI survey age composition



# Fishery and AI survey selectivity



# Phase plane plot

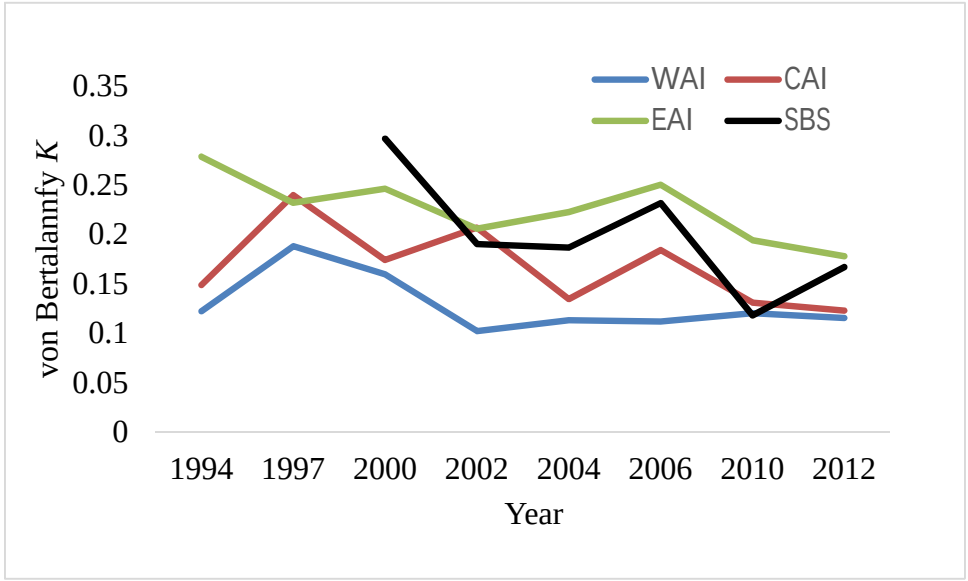


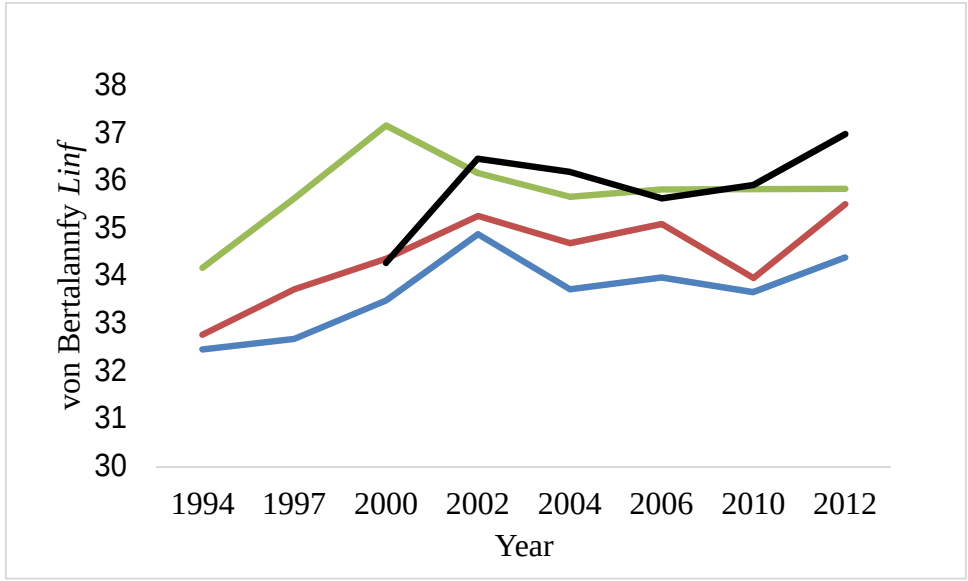
# Reference points and ABCs

| Quantity | As estimated or specified last year for: 2016 | 2017 | As estimated or recommended this year for: 2017* | 2018* |
|---|---|---|---|---|
| *M* (natural mortality rate) | 0.049 | 0.049 | 0.046 | 0.046 |
| Tier | 3a | 3a | 3a | 3a |
| Projected total (age 3+) biomass (t) | 213,674 | 209,369 | 248,160 | 245,693 |
| Female spawning biomass (t) | | | | |
| Projected | 91,648 | 88,326 | 107,660 | 106,184 |
| $B_{100\%}$ | 144,420 | 144,420 | 164,674 | 164,674 |
| $B_{40\%}$ | 57,768 | 57,768 | 65,870 | 65,870 |
| $B_{35\%}$ | 50,547 | 50,547 | 57,636 | 57,636 |
| $F_{OFL}$ | 0.087 | 0.087 | 0.080 | 0.080 |
| $maxF_{ABC}$ | 0.070 | 0.070 | 0.065 | 0.065 |
| $F_{ABC}$ | 0.070 | 0.070 | 0.065 | 0.065 |
| OFL (t) | 14,689 | 14,085 | 16,242 | 15,854 |
| maxABC (t) | 11,960 | 11,468 | 13,264 | 12,947 |
| ABC (t) | 11,960 | 11,468 | 13,264 | 12,947 |
| **Status** | As determined last year for: for: 2014 | 2015 | As determined this year for: 2015 | 2016 |
| Overfishing | No | n/a | No | n/a |
| Overfished | n/a | No | n/a | No |
| Approaching overfished | n/a | No | n/a | No |

# Future research plans

- Size at age differs between AI subarea, but the model does not incorporate this
- Slow-growing fish may also affect aging error matrix
- Examine whether different growth curves should be used for the fishery and population (most of the stock is in the western AI, but most of the catch is in the eastern and central AI)
- Options:
  a) use weighted average when computing length at age
  b) apply age-length keys by subarea




# Growth

Generally, lower values of *K* and $L_{inf}$ in the western AI compared to the central and eastern AI

# Sampling of fishery length compositions by subarea may be disproportionate to fishery catch