2014 BSAI rockfish presentations

1) Blackspotted/rougheye rockfish
2) Pacific ocean perch
3) Northern rockfish

Common to all three models

1) Dropping the cooperative 1980s surveys (SSC request)
2) Reweighting the age and length composition sample sizes (recommendation from 2016 and 2013 CIE reviews)

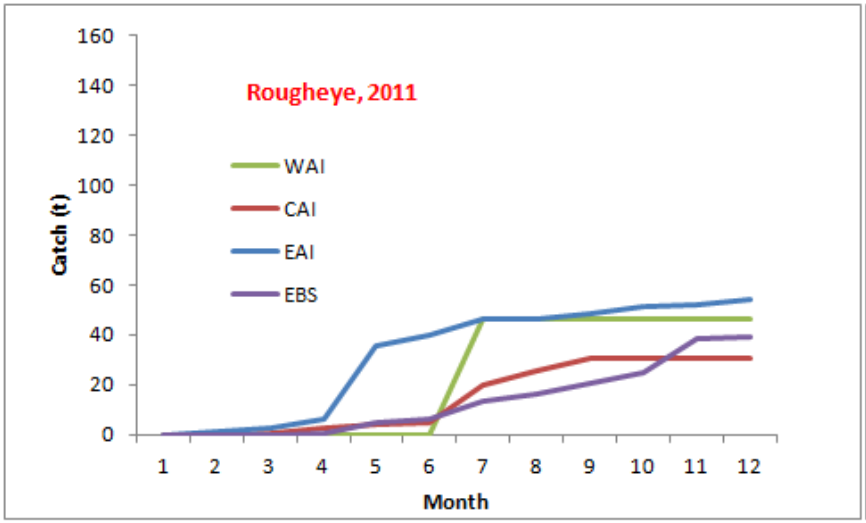
Outline

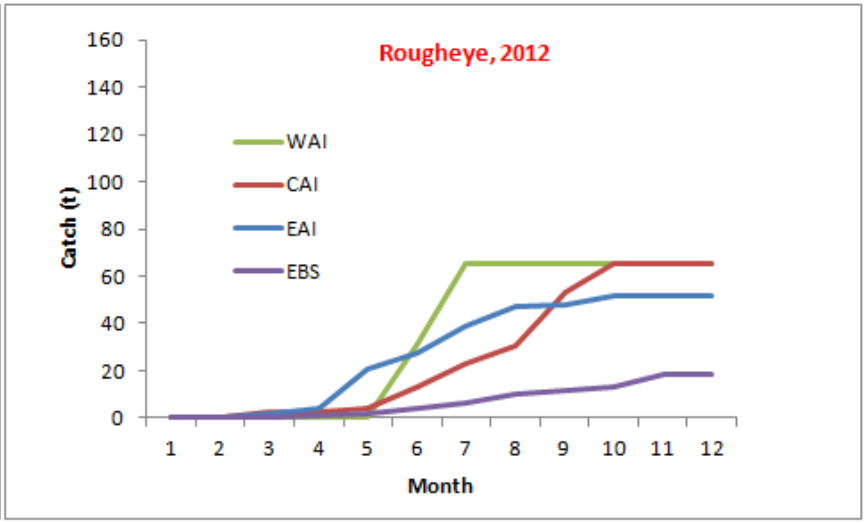
1) Catch information
2) Survey and fishery data
3) Spline methodology
4) Iterative reweighting of composition data
5) Evaluation of fishery selectivity
6) Model fits to data
7) Retrospective analysis
8) M and q sensitivity analyses
9) Calculation of B40%
10) Management recommendations

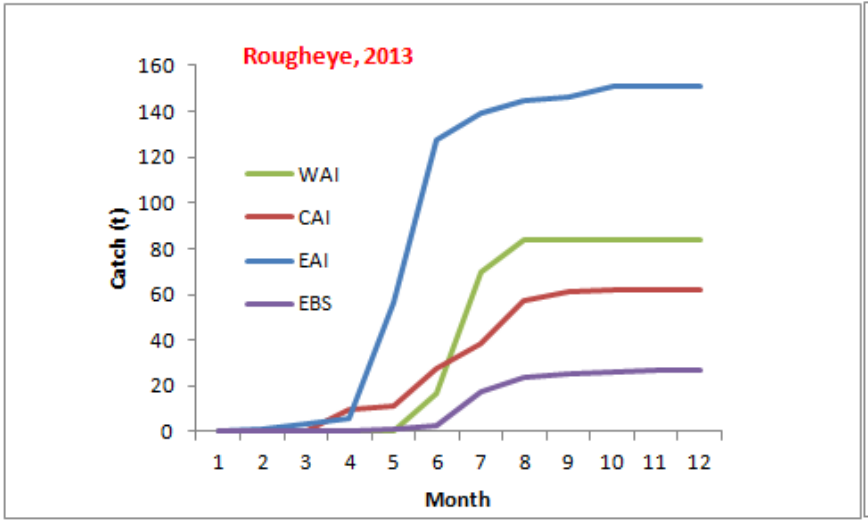
11) Update on the "7 attributes" for blackspotted/rougheye, and the potential WAI ABC

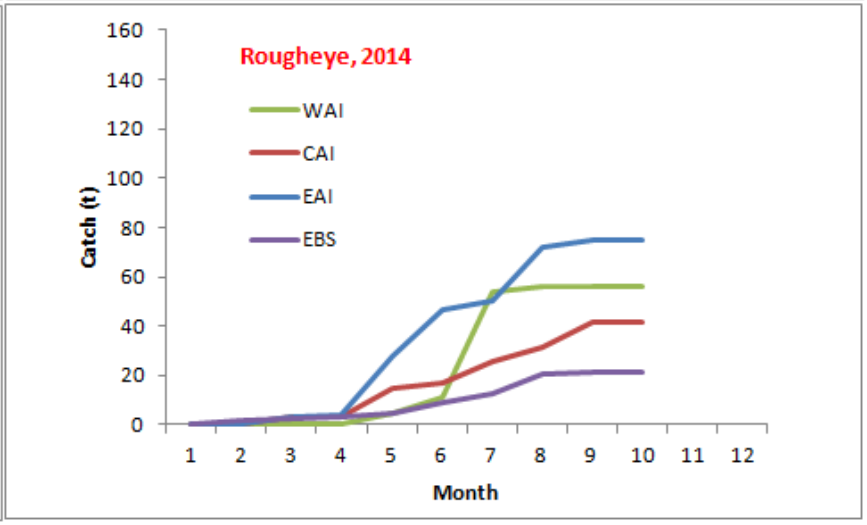
Reminder – AI portion is assessed with Tier 3 methods, EBS portion with Tier 5 methods

BSAI Blackspotted/Rougheye catch by month and area, 2011-2014

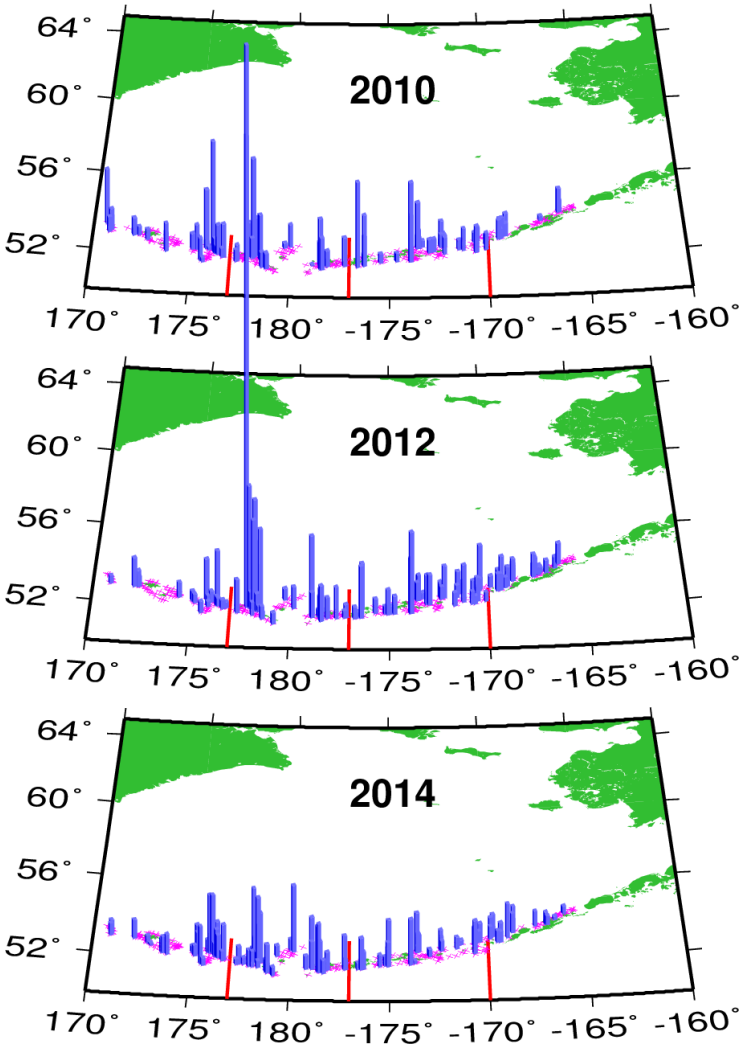








Square root of 2010 – 2014 AI surveys



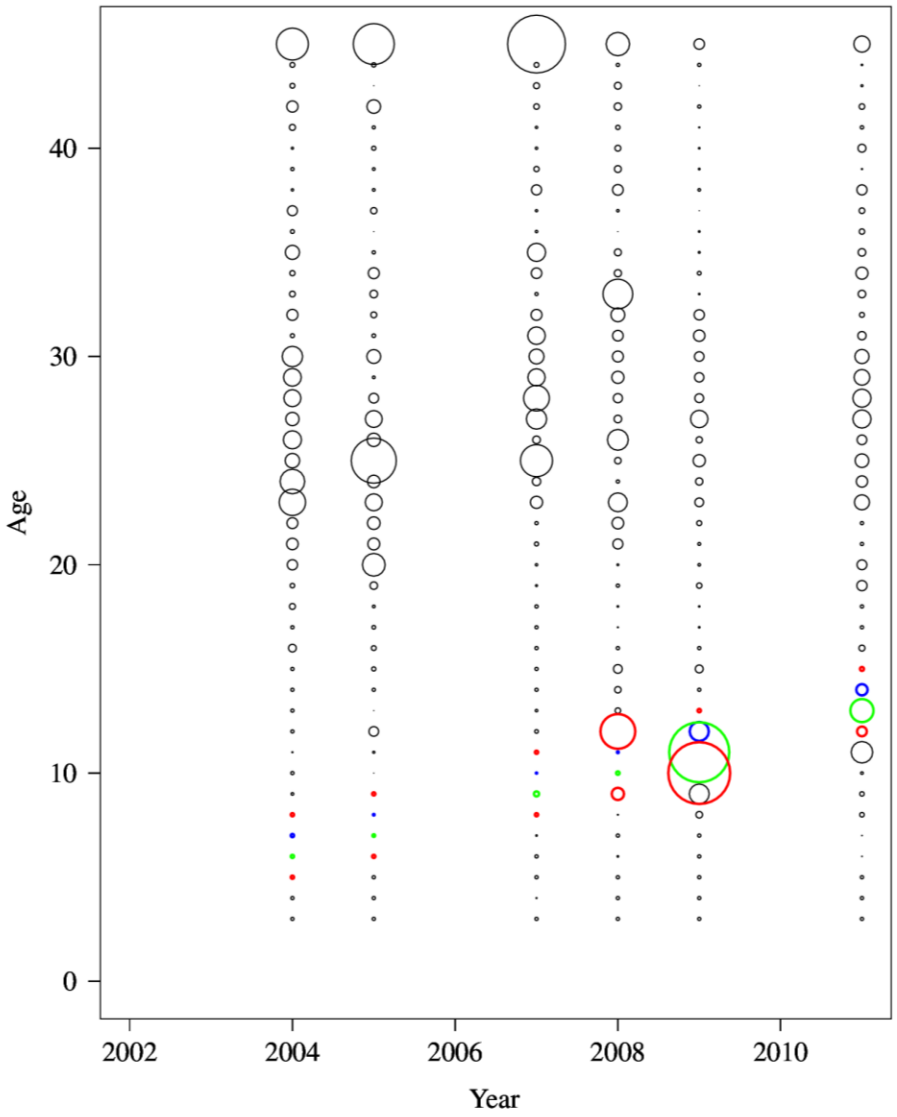
Survey biomass estimates and CVs

Year	WAI	CAI	EAI	SBS	Total
2010	1601 (0.44)	2238 (0.24)	4702 (0.44)	221 (0.28)	8541 (0.26)
2012	335 (0.38)	8268 (0.55)	3798 (0.36)	405 (0.27)	12401 (0.37)
2014	589 (0.28)	2878 (0.27)	958 (0.30)	311 (0.20)	4425 (0.19)

EBS survey biomass estimates and CVs

Year	Biomass	CV
2002	553	0.20
2004	646	0.16
2008	829	0.24
2010	999	0.25
2012	1613	0.50

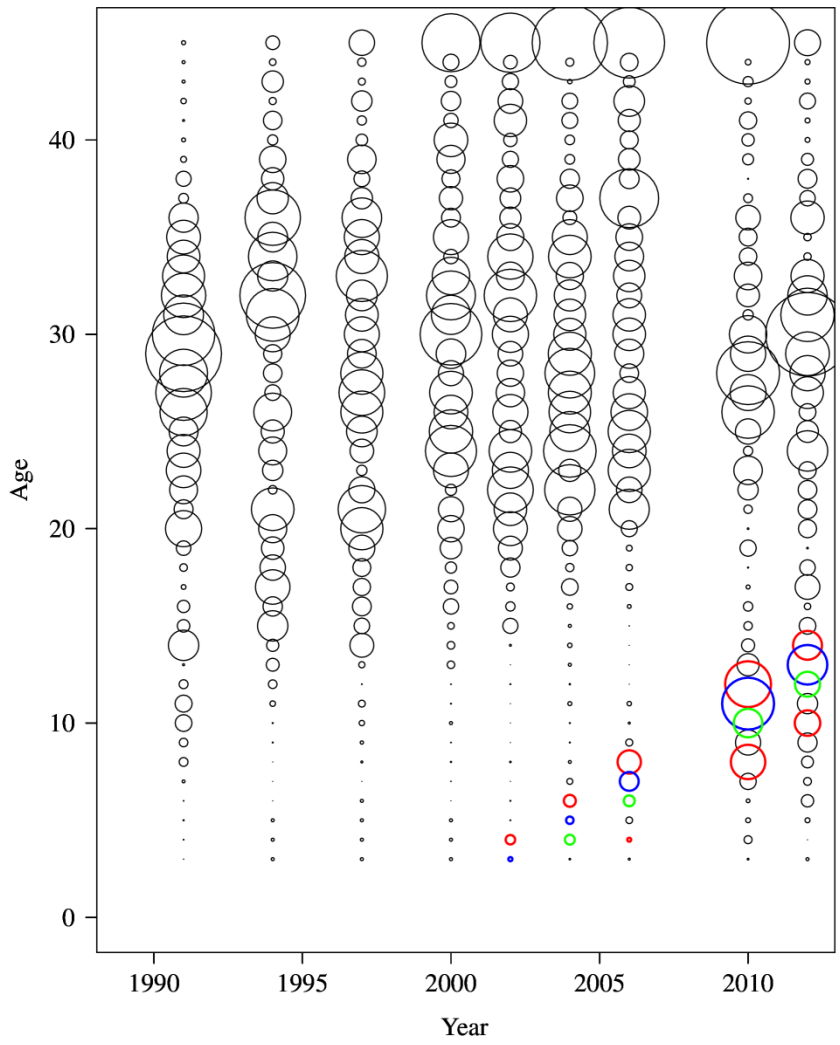
BSAI blackspotted/rougheye fishery age composition data



1998 appears to be strong cohort

1996
1997
1998
1999

BSAI blackspotted/rougheye survey age composition data



1998 and 1999 still appear to be relatively strong cohorts

Other recent cohorts are observed in relatively high numbers, although at the low end of survey selectivity

1998
1999
2000
2002

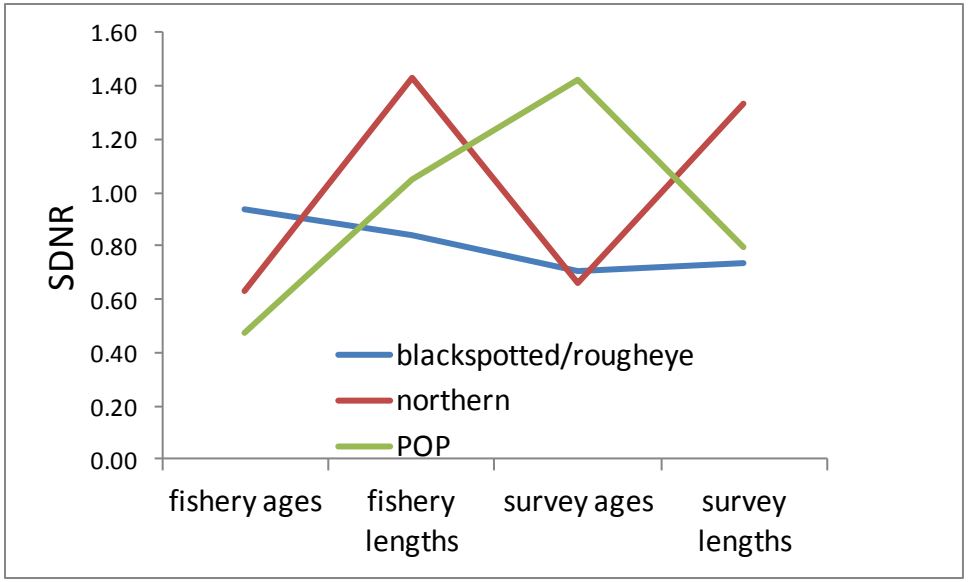
The age and length composition multinomial sample sizes

Current approach

Blackspotted/rougheye and northern rockfish

Use number of hauls with lengths or read otoliths, with fishery data given ½ the weight of the survey data

POP -- Square root of read otoliths



Normalized residual:

$$\delta_{i,a} = \frac{(y_{i,a} - \hat{y}_{i,a})}{\sqrt{\hat{y}_{i,a}(1-\hat{y}_{i,a})/n_i}}$$

Standard deviation of normalized residuals -- reveals some mismatch between input variances and model fits.

Iterative re-weighting procedure to obtain 'sample sizes' for age and length composition data

Intent – to make the sample sizes (i.e., the data weights) consistent with the model output (Francis 2011). Can be considered a way to recognize that our model residuals reflect both process error and observation error.

Why it is important – model results (i.e. biomass, recruitment) are sensitive to data-weighting. Previous methods for setting multinomial sample sizes have been ad-hoc and resulted in mismatches between input variances and modeled variances.

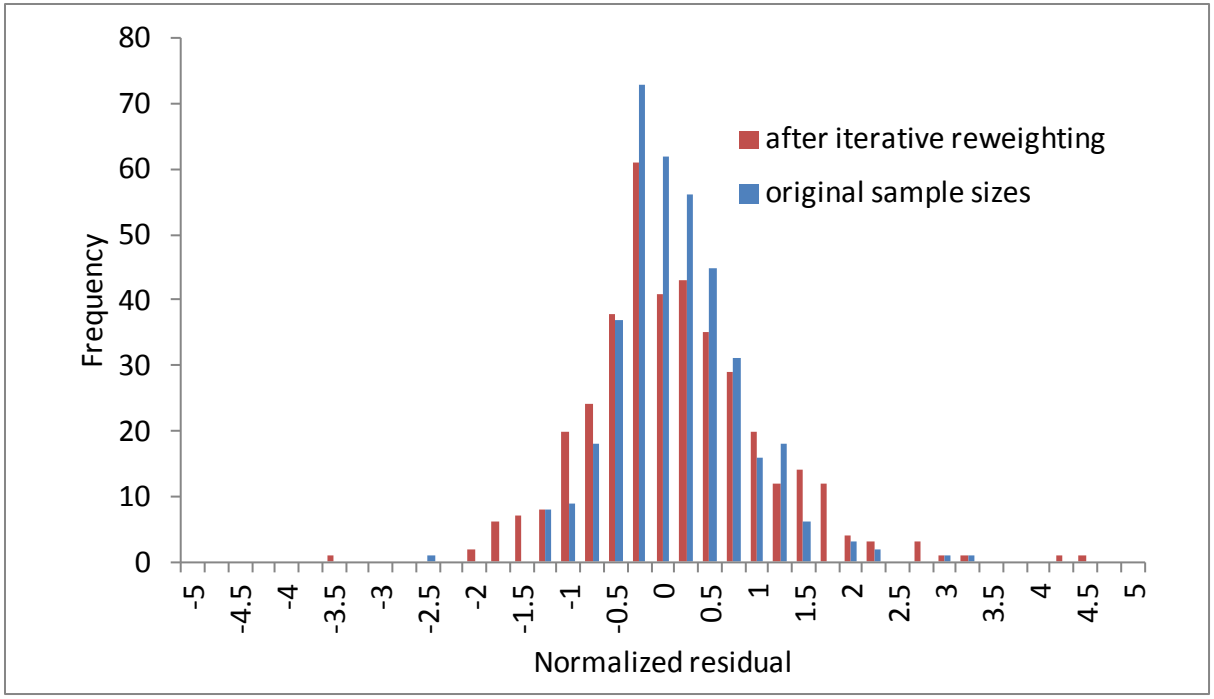
Procedure (TA1.2 in Francis 2011)

1) Use the number of hauls, or square root of samples, as the initial samples sizes (depending on data availability).

2) Determine a weight based on the inverse of the variance of the standardized residuals within a composition type

3) Use the weight to obtain new input sample sizes, and iterate until the weights converge (usually <10 steps, in my experience)

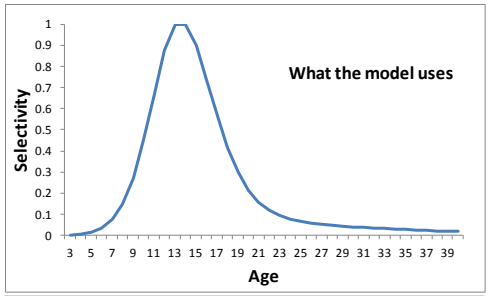
Normalized residuals

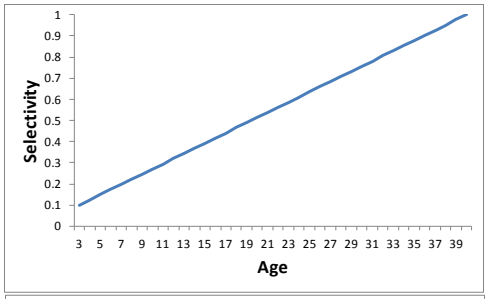


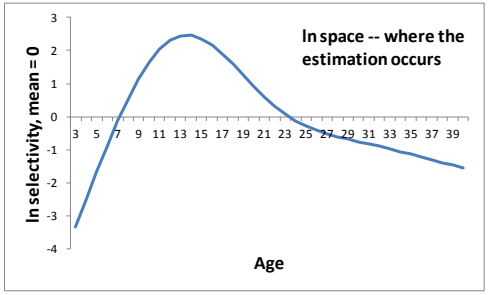
Normalized residual:

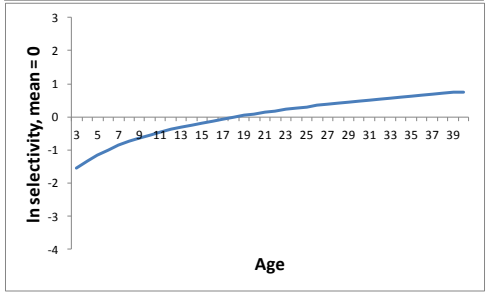
$$\delta_{i,a} = \frac{(y_{i,a} - \hat{y}_{i,a})}{\sqrt{\hat{y}_{i,a}(1-\hat{y}_{i,a})/n_i}}$$

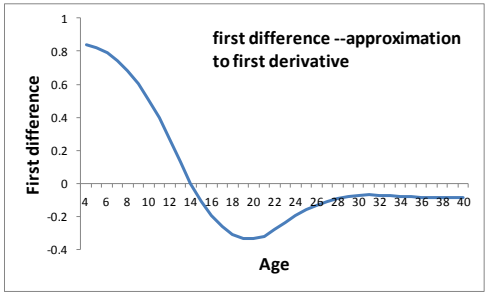
How the spline penalties work

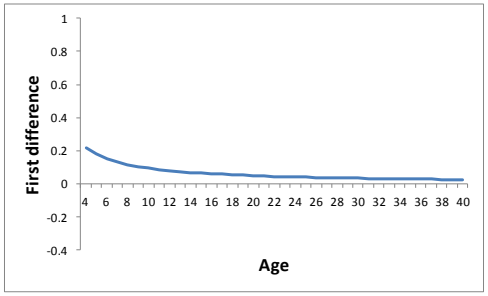


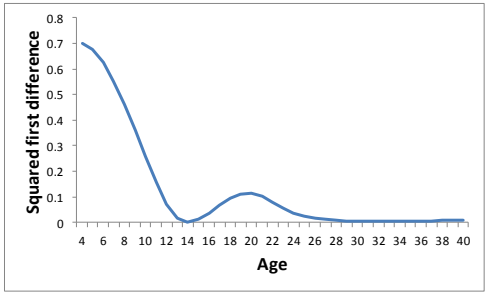


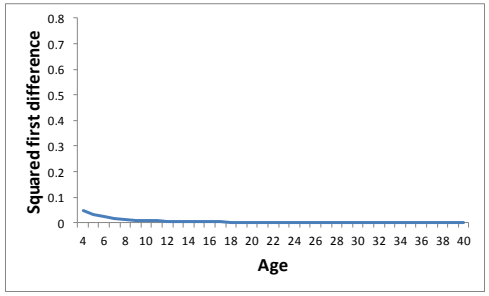




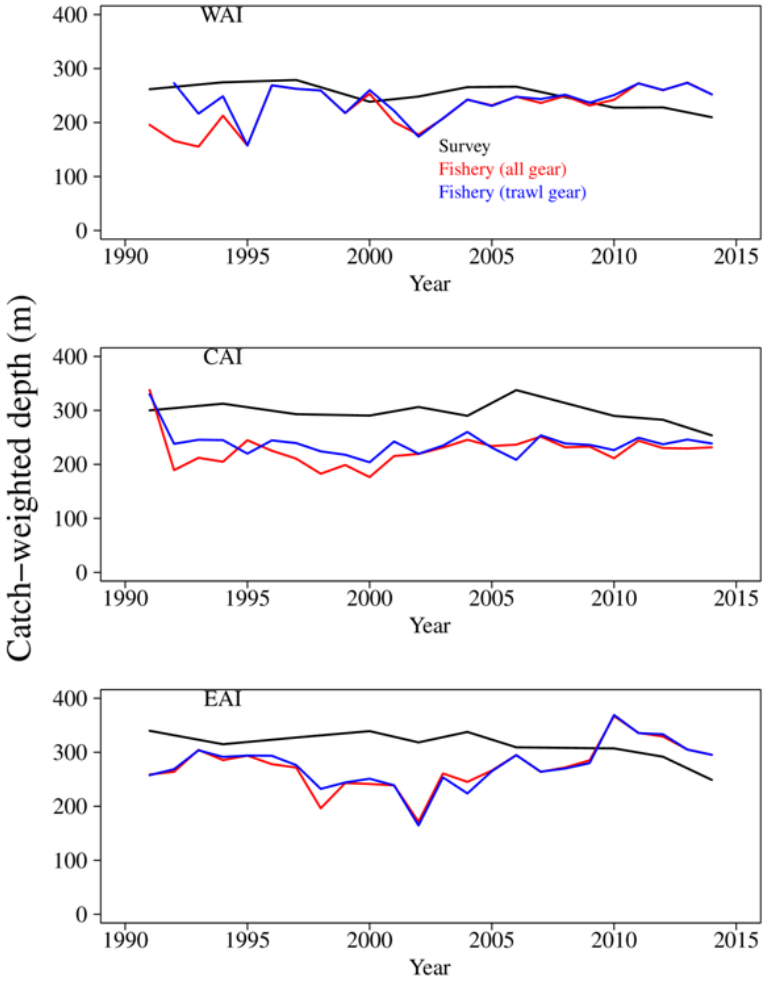








Information on temporal variability in fishery selectivity



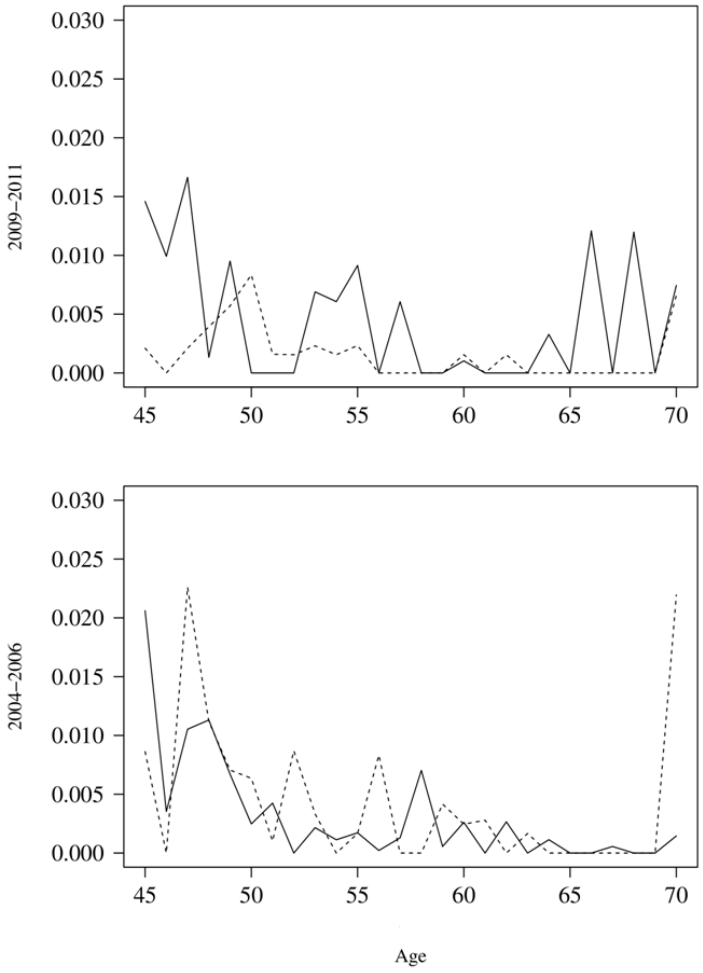
These data suggest that the potential for temporal variation between the overlap of the population and fishing effort

(i.e., temporal variability in fishery selectivity).

Information on dome-shaped fishery selectivity

Information from fishery and survey age composition data, for ages in the plus group (ages 45 – 70+)

Survey – solid lines
Fishery – dashed lines

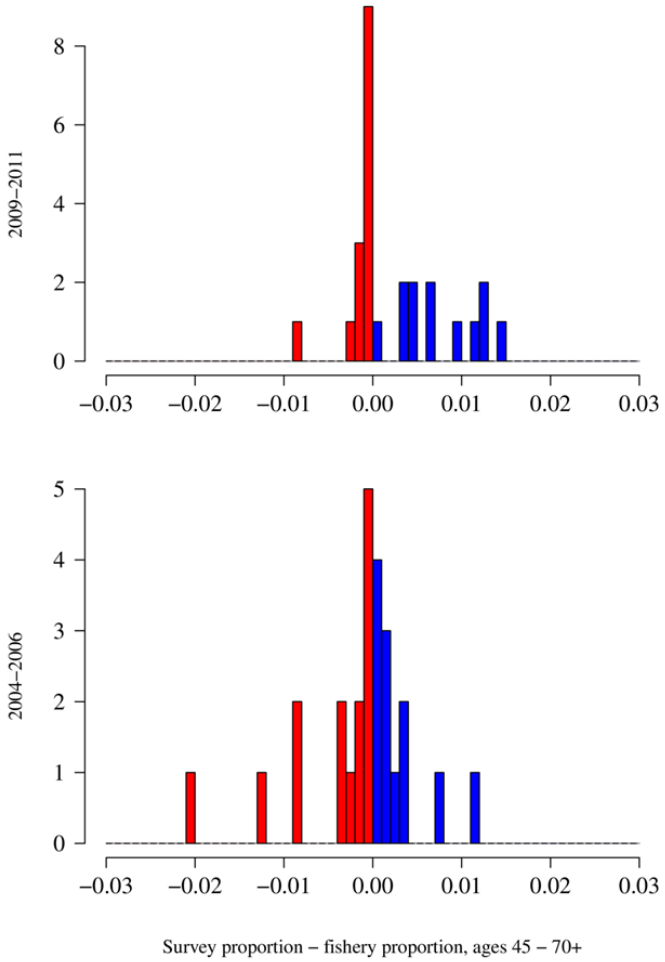


Proportion of age comp in the plus group

2010 survey 9%
2009, 2011 fishery 3% - 5%

2004, 2006 surveys 8%
2004, 2005 fishery 10% - 12%

Information on dome-shaped fishery selectivity



Survey proportion – fishery proportion

positive differences (in blue) indicate higher frequencies in the survey

I do not see much of a pattern here

Models evaluated

Model 0) Data updated through 2014, logistic fishery selectivity, age/length composition weights not reiteratively estimated (i.e., the 2012 model)

Model 0.1) Model 0, with the 1980s cooperative survey data removed.

Model 1) Logistic fishery selectivity, cooperative survey data removed, age/length composition weights reiteratively estimated

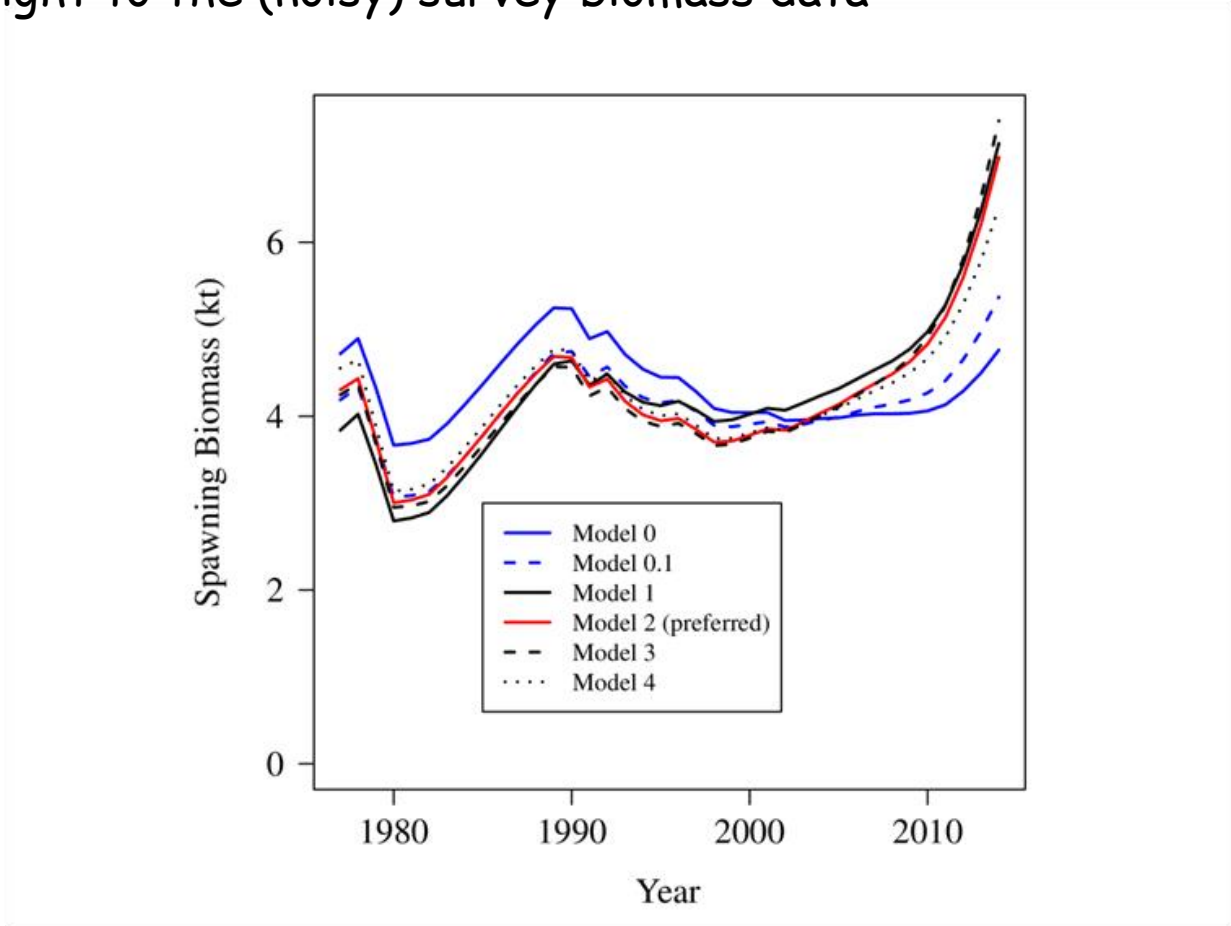
Model 2) Model 1, but with double logistic selectivity.

Model 3) Model 1, but a time-invariant cubic spline

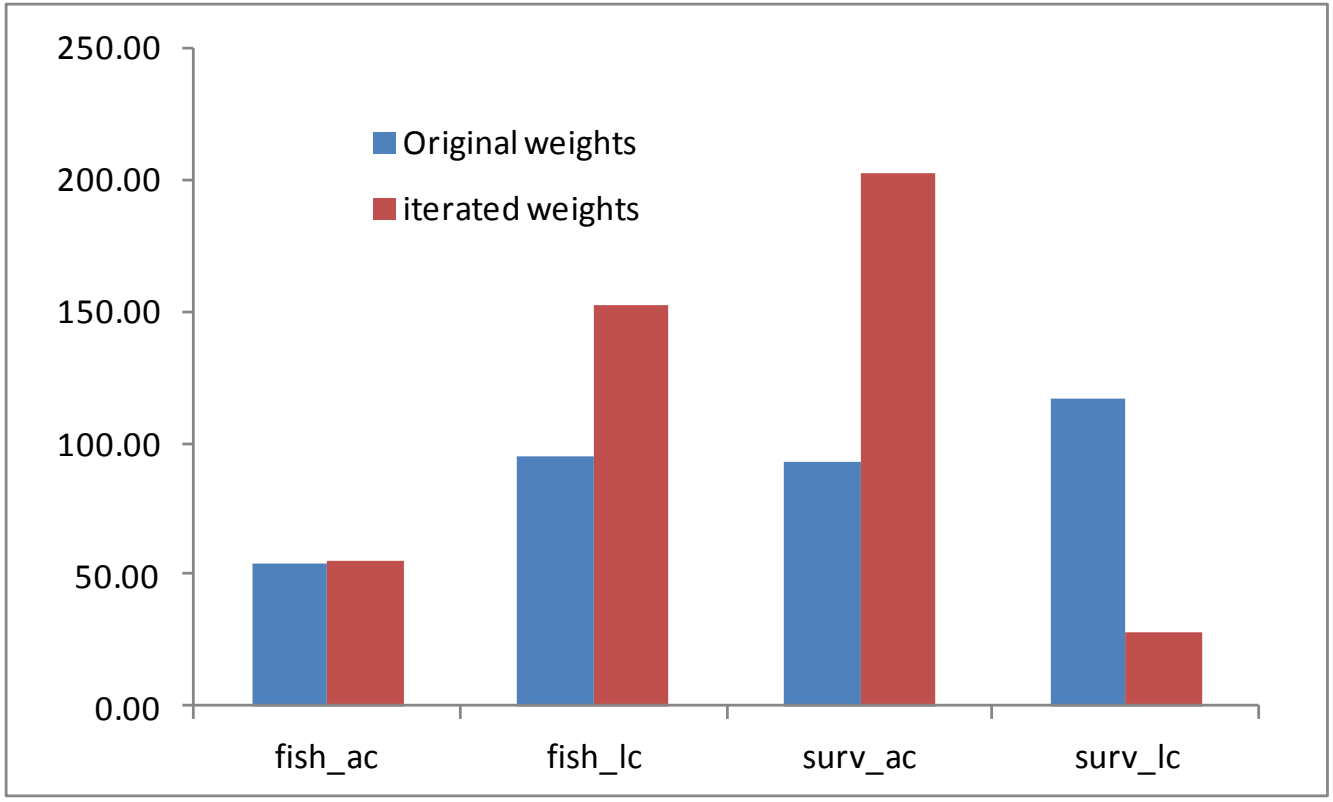
Model 4) Model 1, but with a bicubic spline

Effect of the models on spawning stock biomass

Iterative reweighting give more weight to the composition data, and less weight to the (noisy) survey biomass data

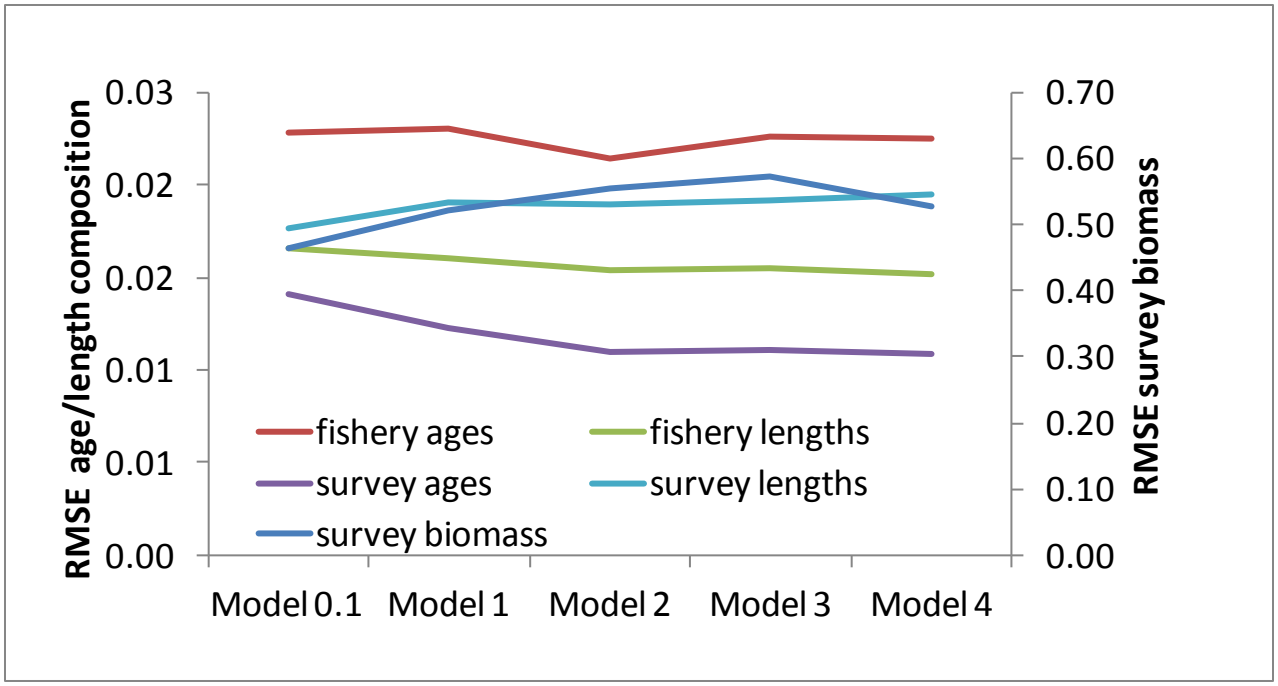


How did the sample sizes change after iterated reweighting?

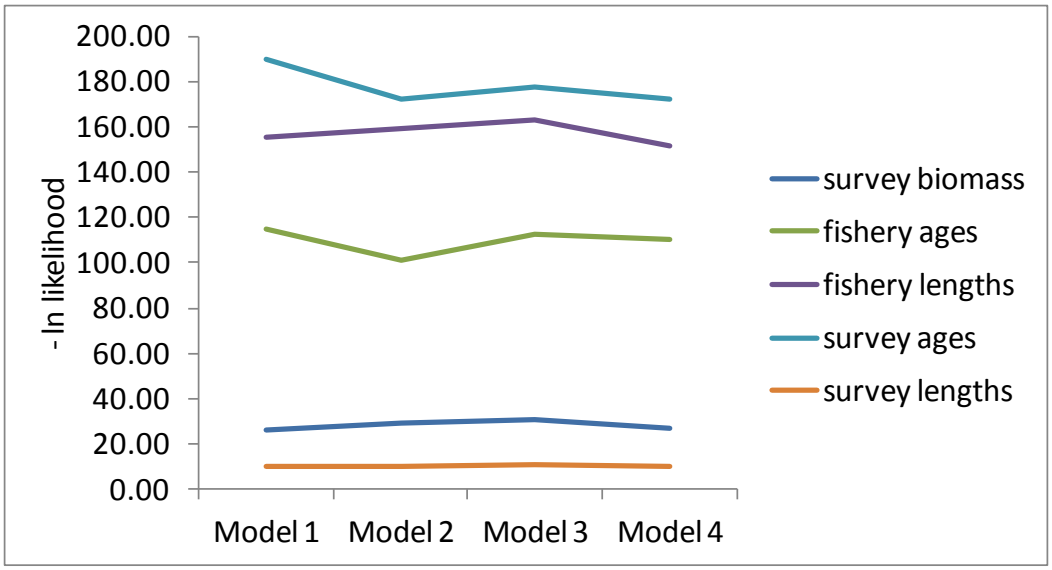


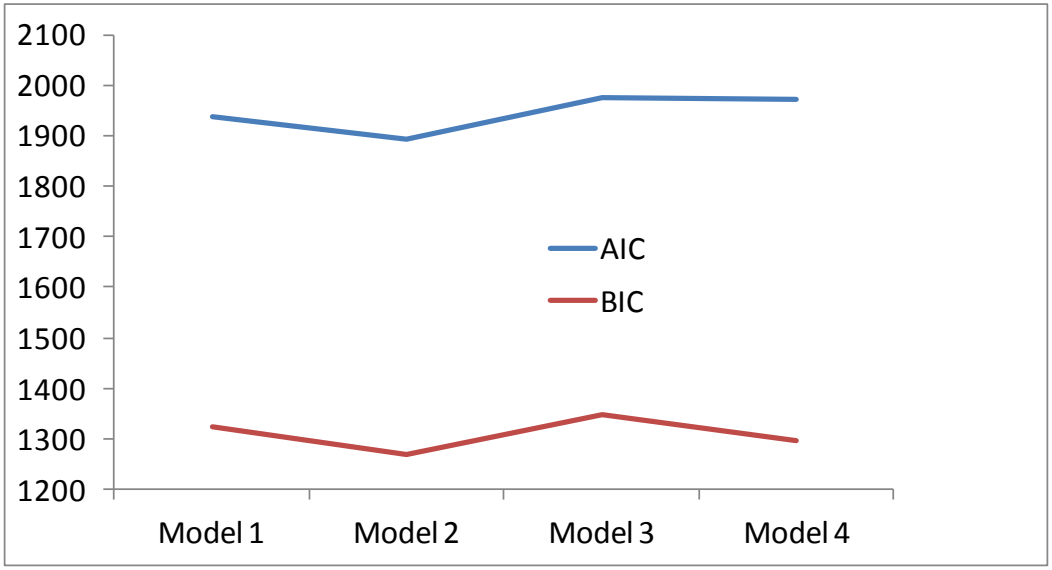
Root mean squared error to various data components

The models considered here produce tighter fits to the survey age comp data, and a degraded fit to the survey biomass (relative to the bridging model 0.1)

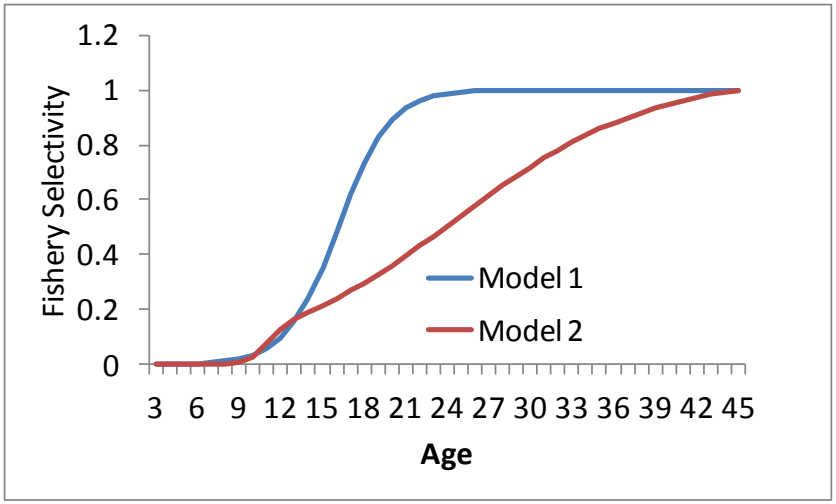


Model fits to data components

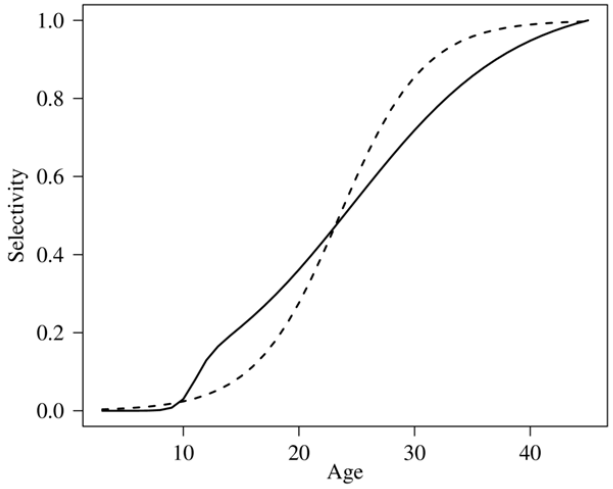




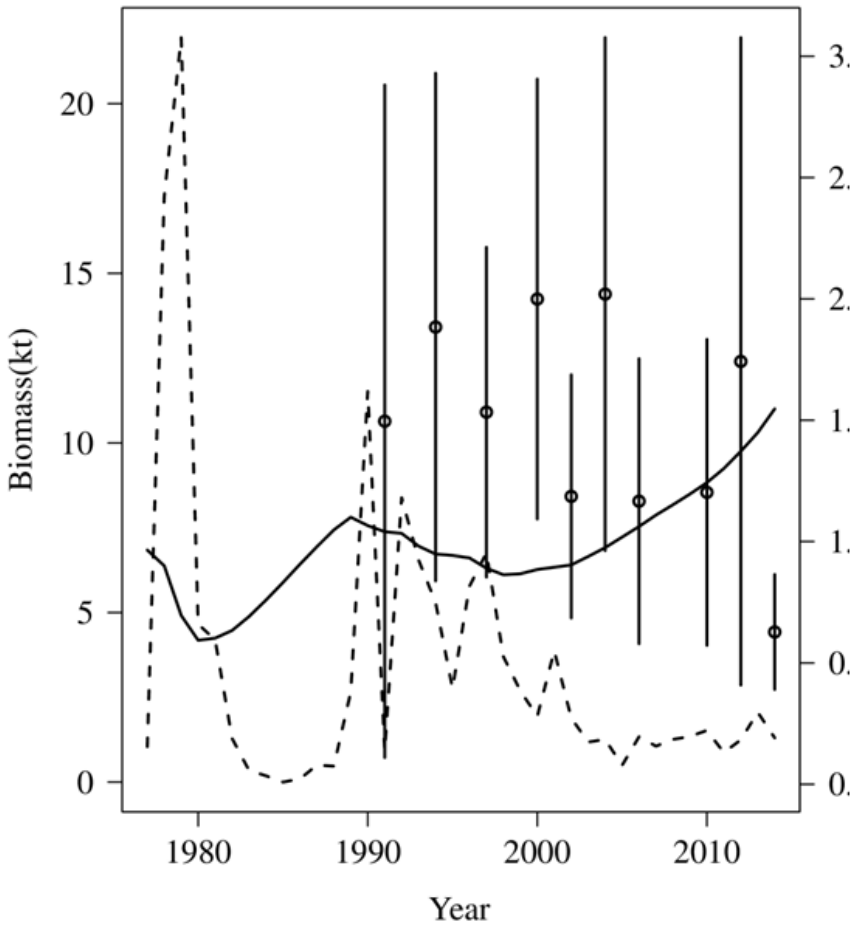
Fishery selectivity for Models 1 and 2



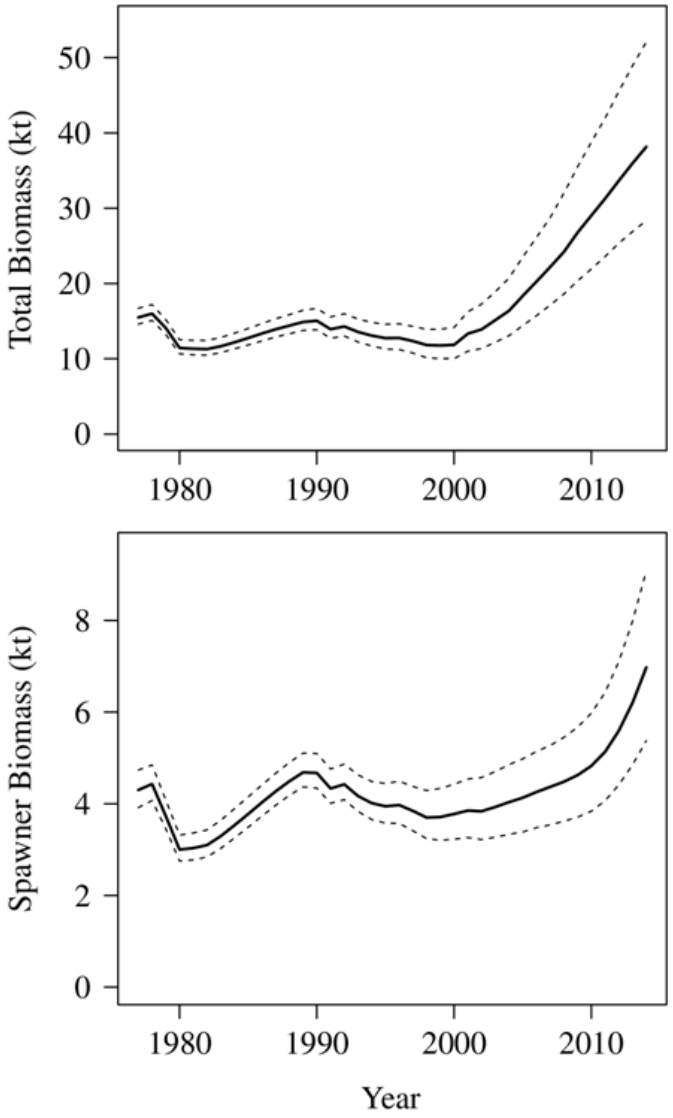
Model 2, fishery and survey selectivity



BSAI Blackspotted/Rougheye catch and fit to survey biomass

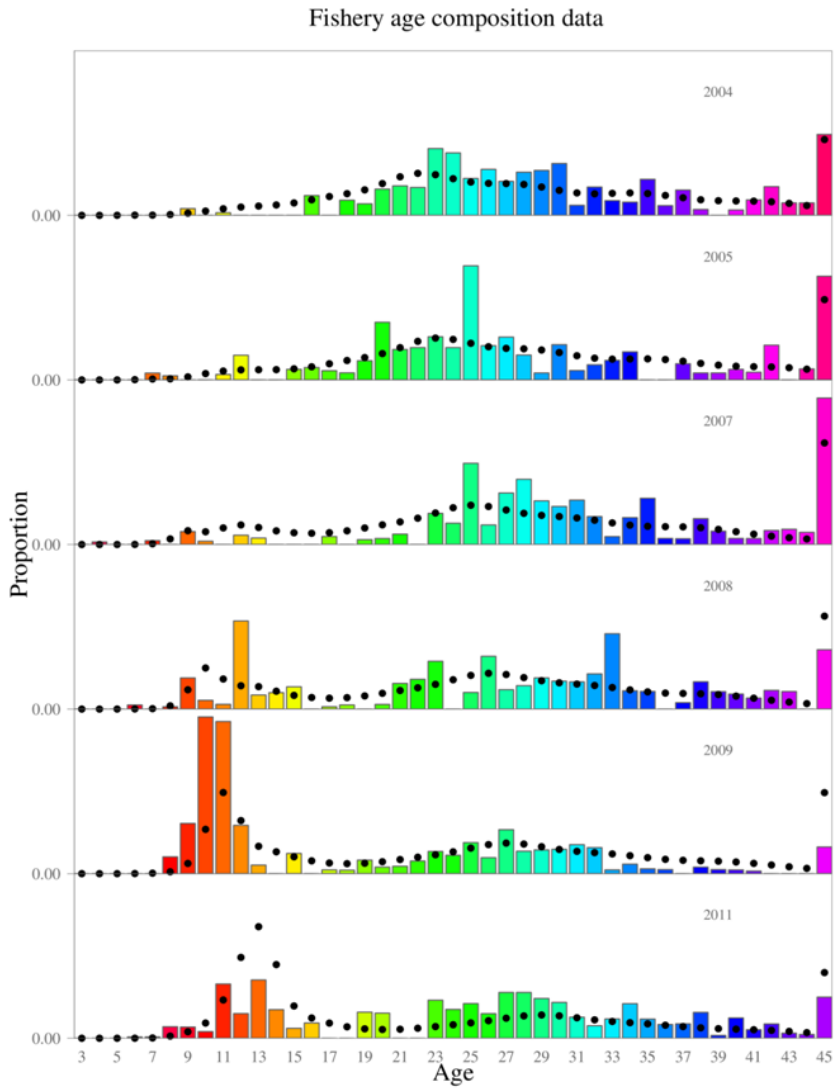


BSAI Blackspotted/Rougheye total and spawning biomass

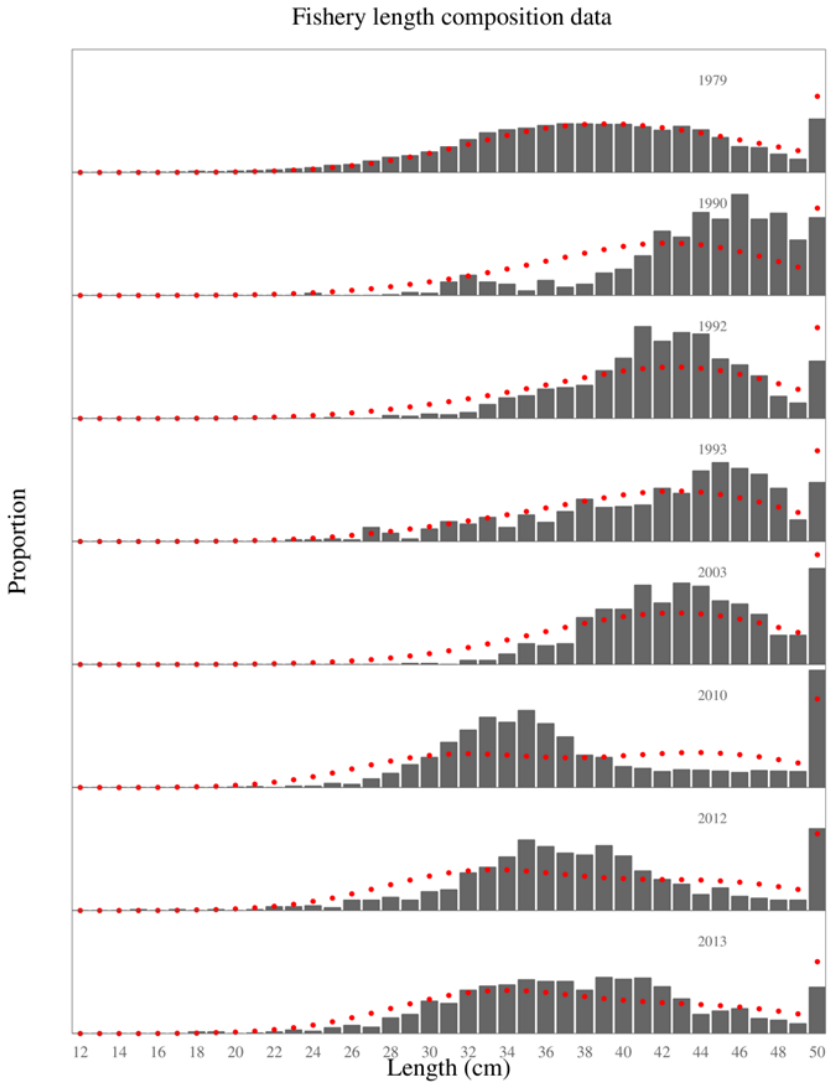


The 1998 year class is entering the accelerating part of the maturity curve

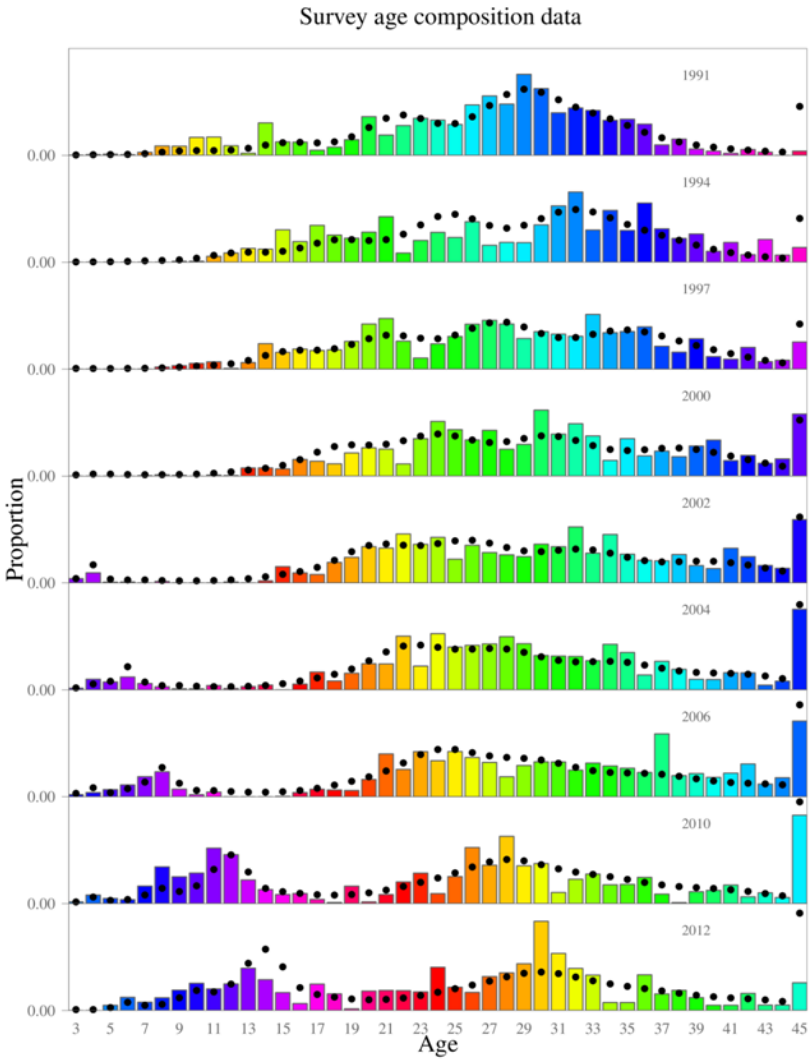
BSAI Blackspotted/Rougheye fishery age composition



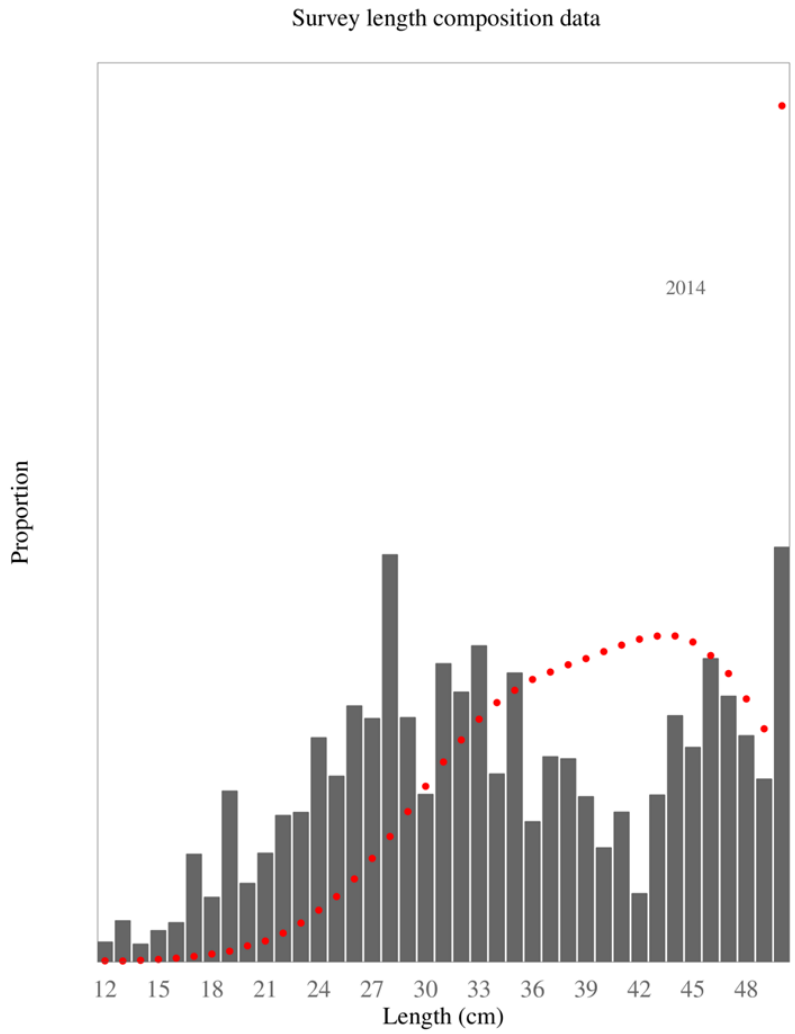
BSAI Blackspotted/Rougheye fishery length composition



BSAI Blackspotted/Rougheye survey age composition



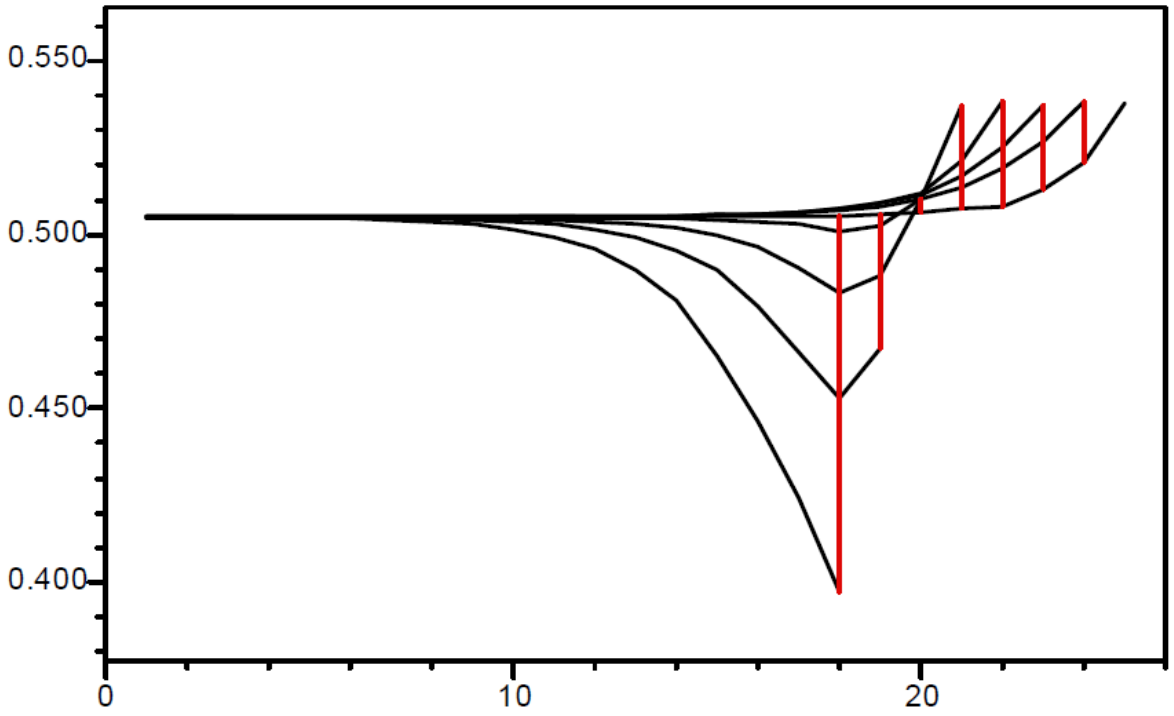
The 2014 survey did not observe many fish between 35 – 45 cm (i.e., ~ ages 15 and greater)



Retrospective analysis

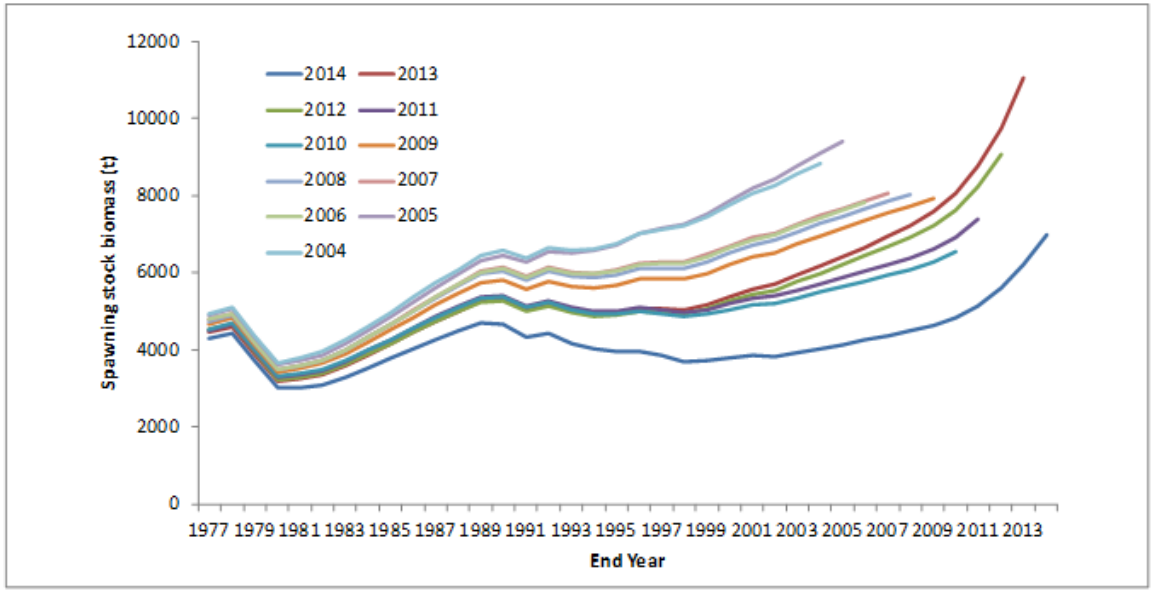
Revised Mohn's rho $$\rho = \frac{1}{n}\sum_{y=1}^{n}\frac{X_{y,term} - X_{y,ref}}{X_{y,ref}}$$

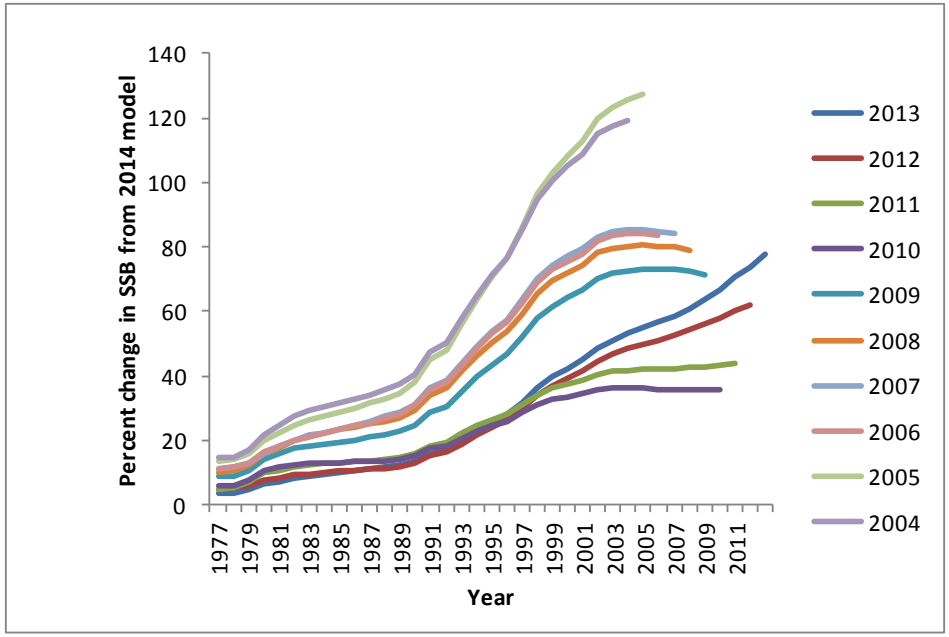
$X_{y,term}$ = terminal estimate from a reduced model



From GARM 2008 Working paper 4.1

BSAI Blackspotted/Rougheye retrospective pattern

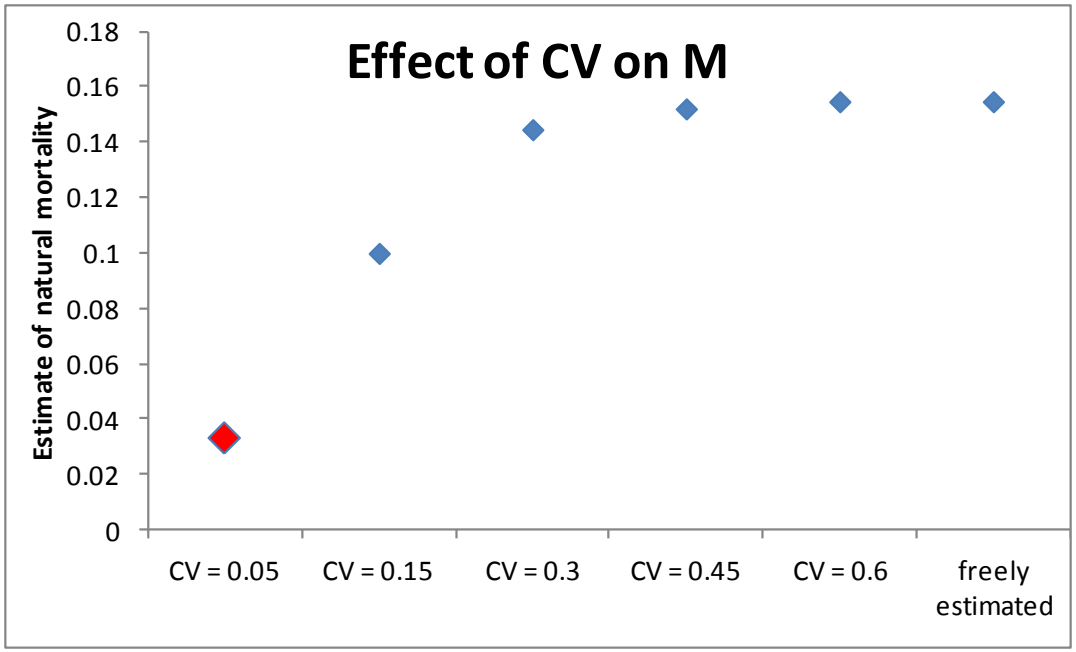




Mohn's rho = 0.78

Can we estimate *M* or *q* in the model ? No!

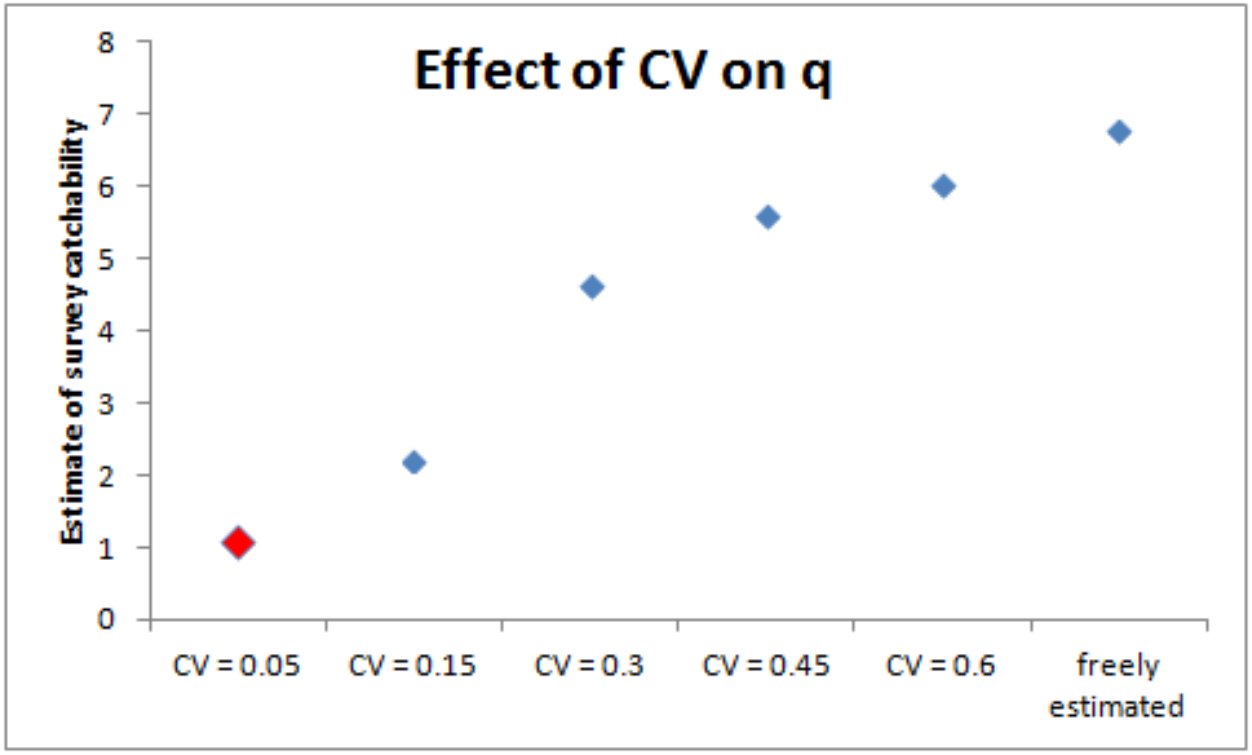
Fix *q* at the 2014 estimate, and relax the prior on *M*



The estimate of M with no prior is 0.16, which appears implausible.

Recent research on empirical estimators for *M* (Then et al. 2014) suggests using a power relationship of t_{max} , and produces an estimate of 0.06. However, even this appears to be too high – estimates of M based on the GSI index produces estimates from 0.03 – 0.04 (McDermott 1994)

Fix *M* at the 2014 estimate, and relax the prior on *q*



The estimate of *q* with no prior is 6.78, which seems unrealistic.

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

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

When mean recruitment increases faster than biomass, relative stock status declines *even when the stock is actually increasing*

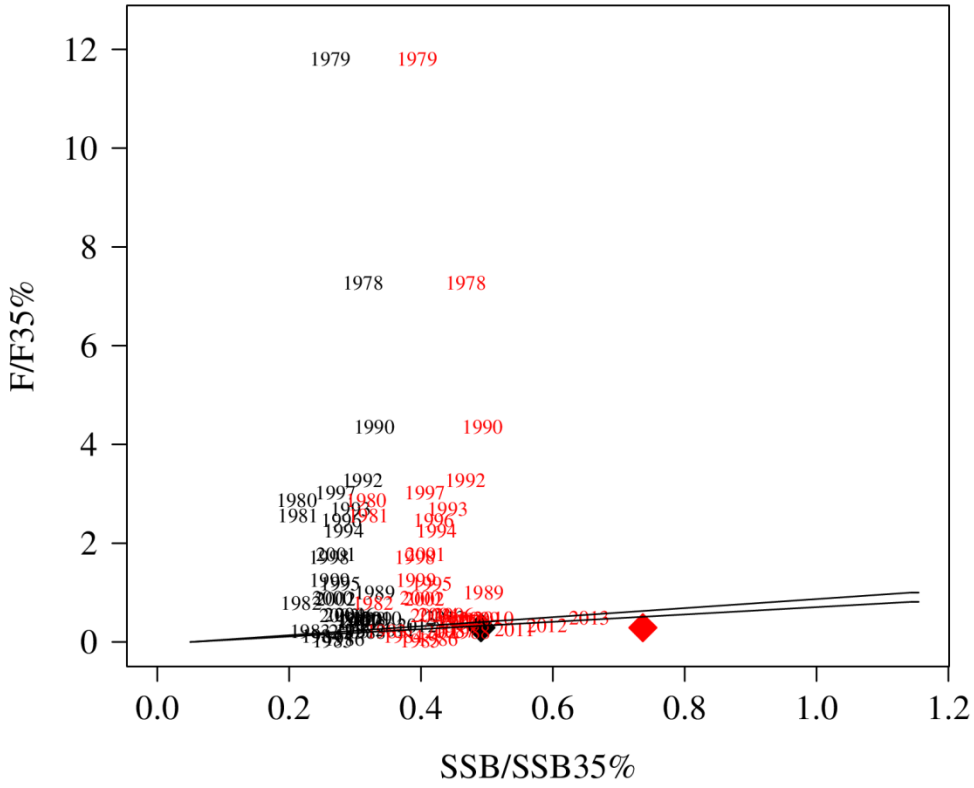
What year classes should be used to estimate mean recruitment?

2010 -- Year classes from 1996 – 2004 were excluded due to perceived uncertainty (BSAI Plan Team decision)

2012 -- Mean recruitment was based on all estimated year classes (1977-2006) (SSC decision)

2014 -- Propose using the 1977 – 1998 year classes. These year classes have reached the age where they are 10% selected by the AI trawl survey

Stock status with different methods for estimating mean recruitment



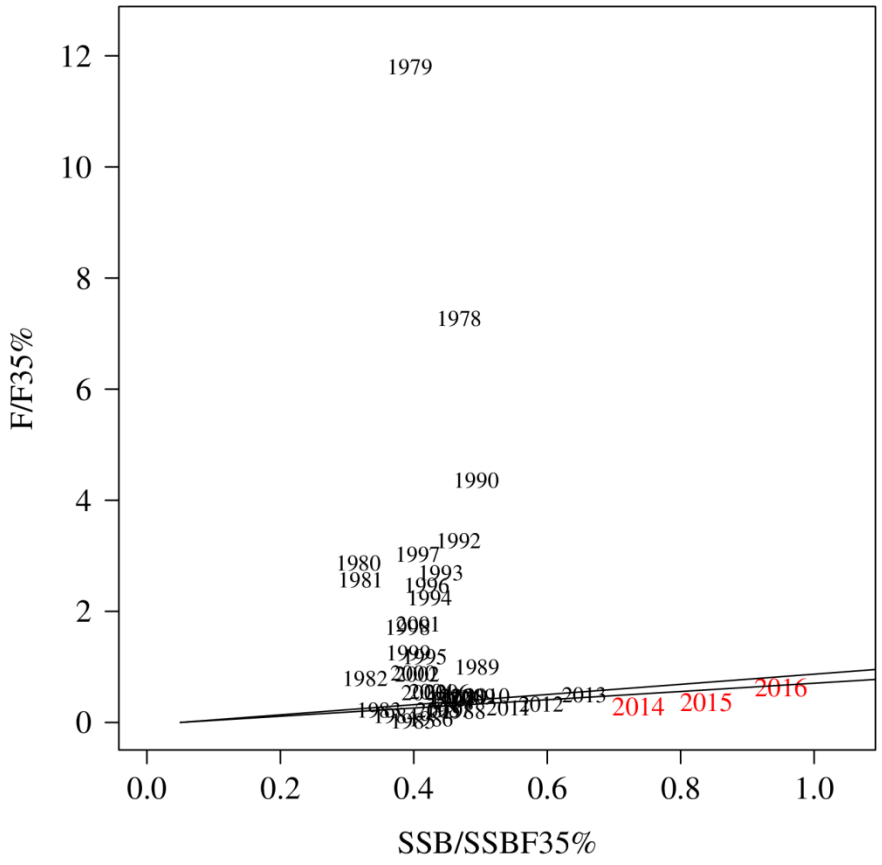
If we use the 1977-2008 year classes, the stock would be overfished ($B_{16\%}$, with 2015 ABC of 270 t)

If we use the 1977- 1998 year classes, the stock is in Tier 3b ($B_{24\%}$, with 2015 ABC of 420 t), similar to 2012

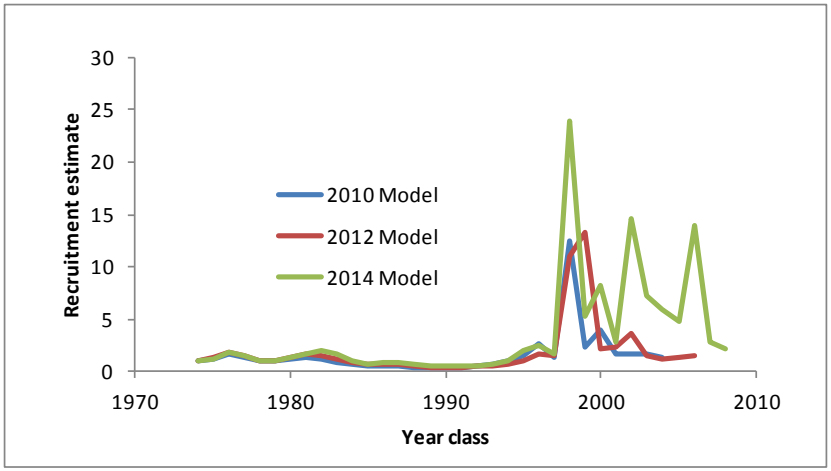
If we additionally exclude the 1997 and 1998 year classes, the stock is in Tier 3a (with 2015 ABC of 615 t). However, the 1998 year class appears to be well estimated.

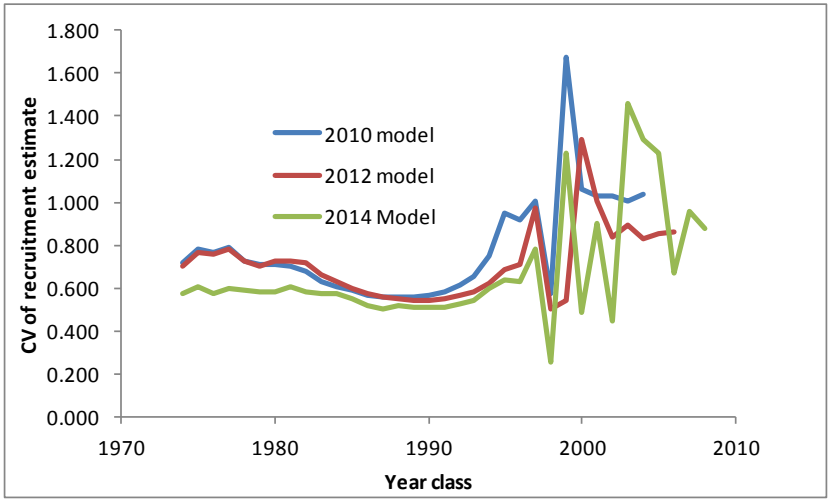
Phase plane, with 2015-2016 projections

Uses 1977 – 1998 year classes



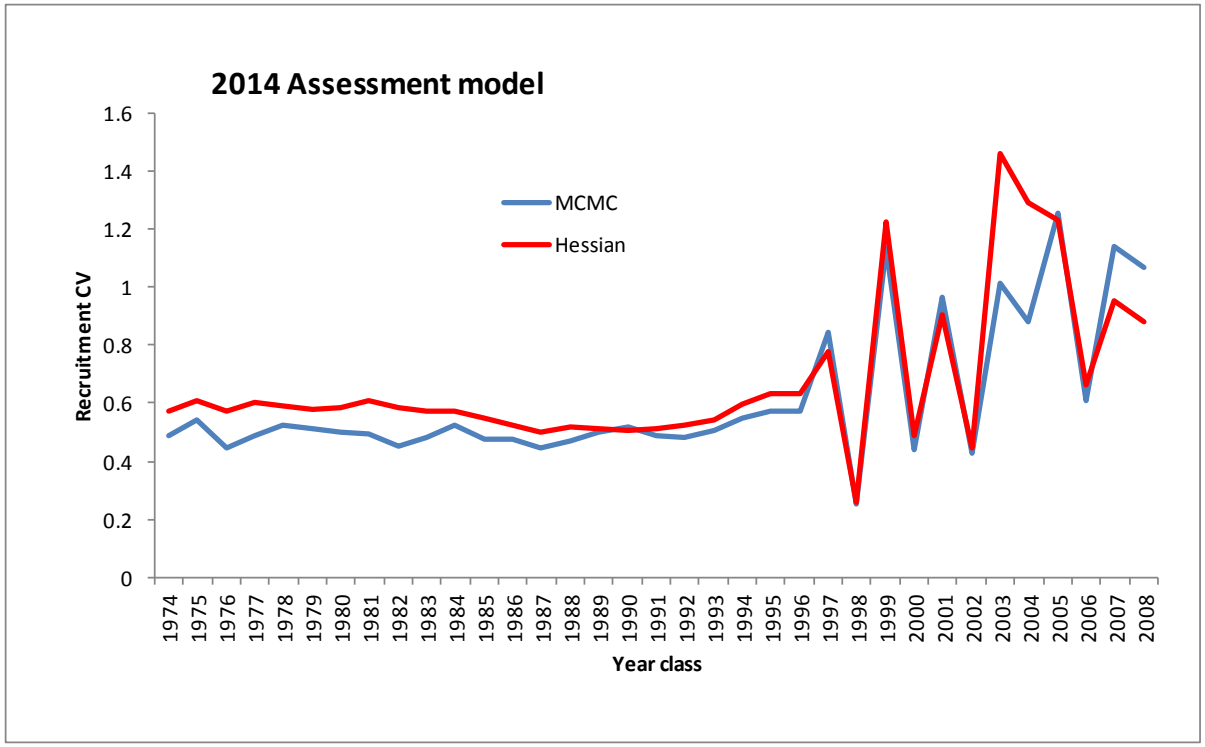
How do we define $B_{40\%}$?





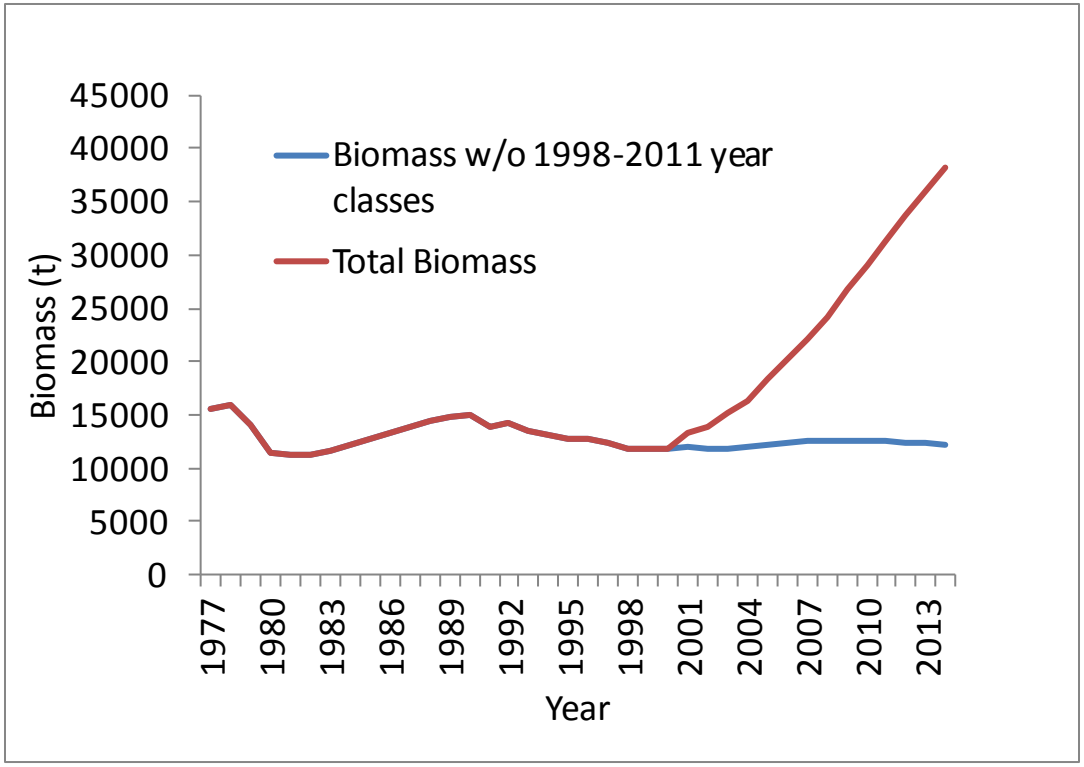
1998 year class is estimated as strong in the 2010, 2012, and 2014 assessments, with relatively low CVs

Recruitment uncertainty – Hessian and MCMC



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

The 1998-2011 year classes now comprise 68% of the total biomass, and fish 34 cm and smaller were about 30% of the 2013 fishery length composition.



BSAI Blackspotted/Rougheye rockfish

Estimated reference points (for AI portion of stock)

F_{abc} = 0.032
F_{ofl} = 0.039
$B_{40\%}$ = 11,403 t (increase from 2013 estimate of 10,502t)
$B_{35\%}$ = 9,977 t (increase from 2013 estimate of 9,189 t)

Recommended 2015 ABC and OFLs (entire BSAI)

ABC: 453 t (increased from 2014 value of 416 t)
OFL: 560 t (increased from 2014 value of 505 t)

ABCs for the BSAI subareas

	BSAI	WAI+CAI	EAI+EBS	Total
OFL (2013)	462			462
ABC (2013)		209	169	378
TAC (2013)		209	169	378
Catch (2013)		146	178	324
OFL (2014)	505			576
ABC (2014)		239	177	416
TAC (2014)		239	177	416
Catch (2014)[1]		98	96	194
OFL (2015)	560			560
ABC (2015, weighted average)		278	175	453
ABC (2015, RE model)		304	149	453
OFL (2016)	686			686
ABC (2016, weighted average)		345	210	555
ABC (2016, RE model)		377	178	555

Attributes of blackspotted/rougheye rockfish (as modified by the Plan Team)

1) Genetic information showing spatial structure at scales < 500 km, which is roughly the scale of one of AI subareas.

2) High catch levels in the 1990s in the WAI that were followed by a sharp decline in WAI survey biomass estimates.

3) Estimated exploitation rates have exceed $U_{F35\%}$ (the exploitation rate that would result from applying a fishing rate of $F_{35\%}$ to the estimated beginning-year numbers at age) in 6 out of 10 years in the WAI from 2004-2013.

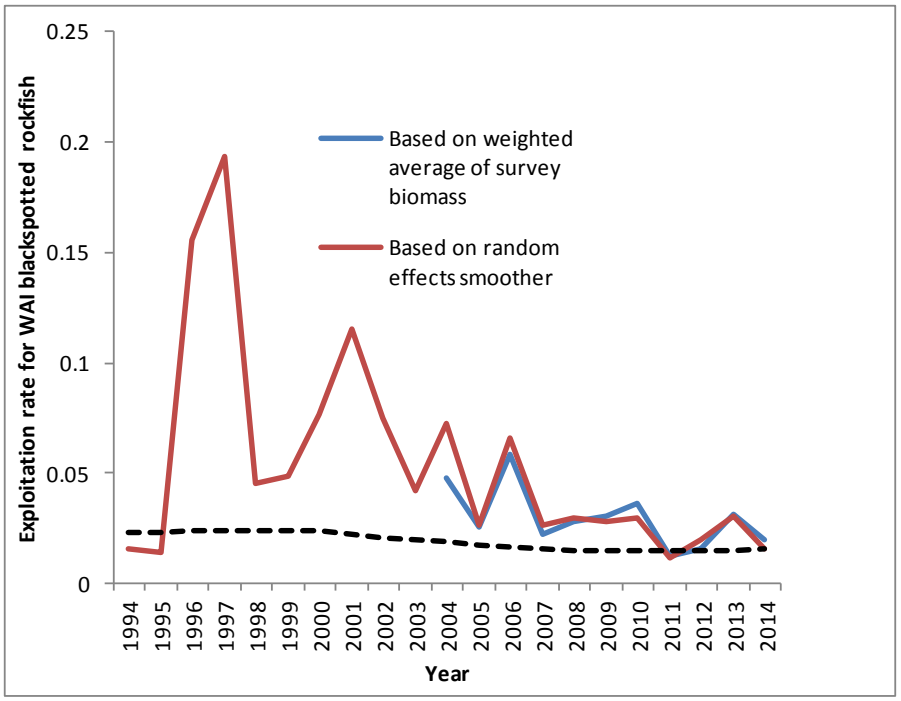
4) Overall, an 85% decline in survey biomass estimates in the WAI from 1991-2012, as estimated by a random effects time series model.

5) An increase in the proportion of survey tows which have not caught blackspotted/rougheye in the WAI, and within each WAI survey stratum deeper than 100 m.

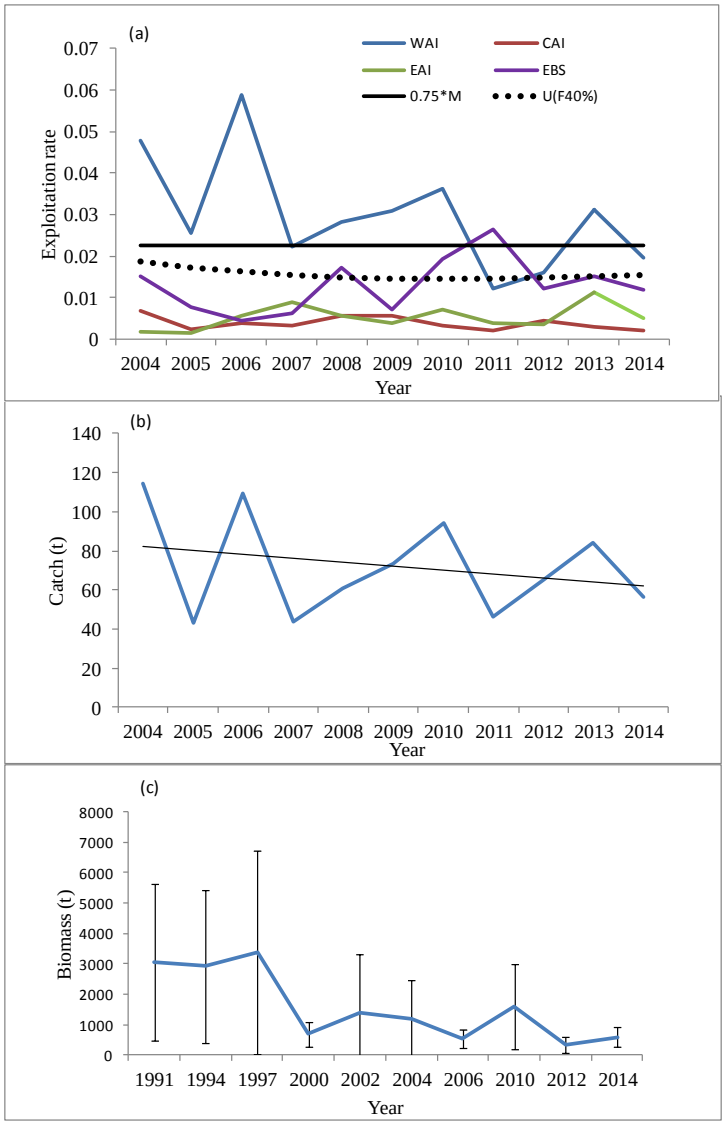
6) A large percentage of the total harvest occurring in the WAI.

7) A decline in mean size in the WAI but not in other BSAI subareas.

WAI Exploitation rates from 1994 - 2014

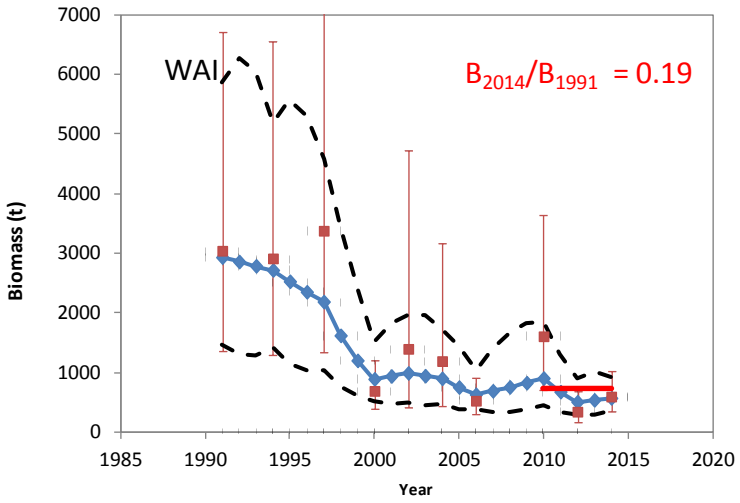


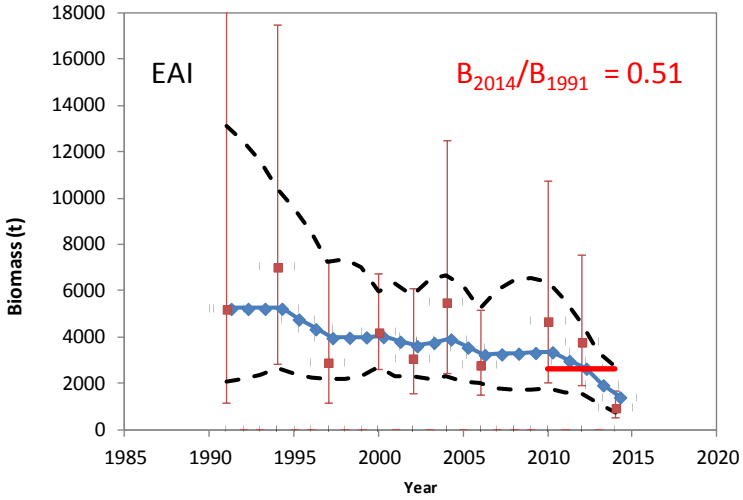
Exploitation rates from 2004 – 2014, with WAI catch and survey biomass

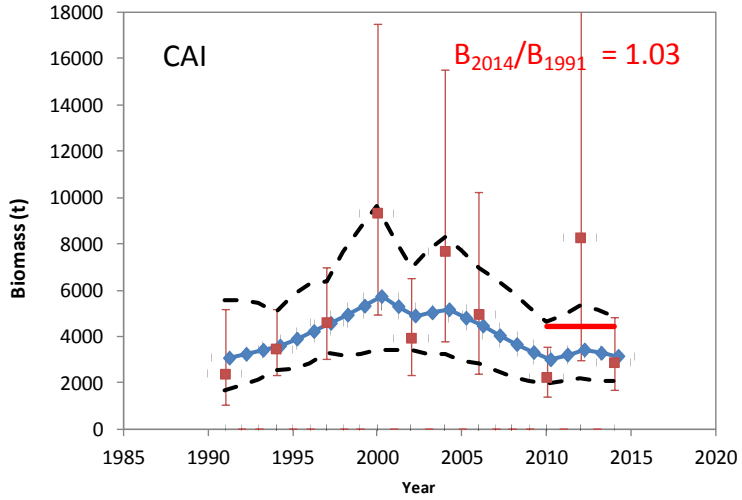


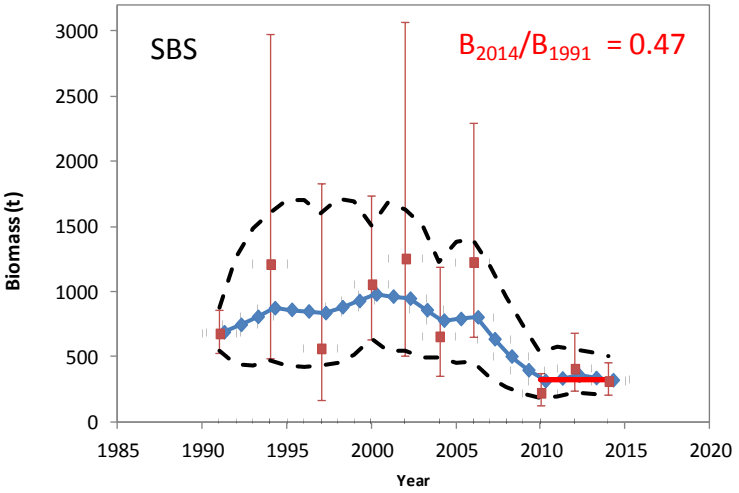
The $U_{F40\%}$ rates are lower because the new fishery selectivity curve has lower selection for many young ages

Smoothed survey biomass estimates – now a 81% decline in the WAI from 1991

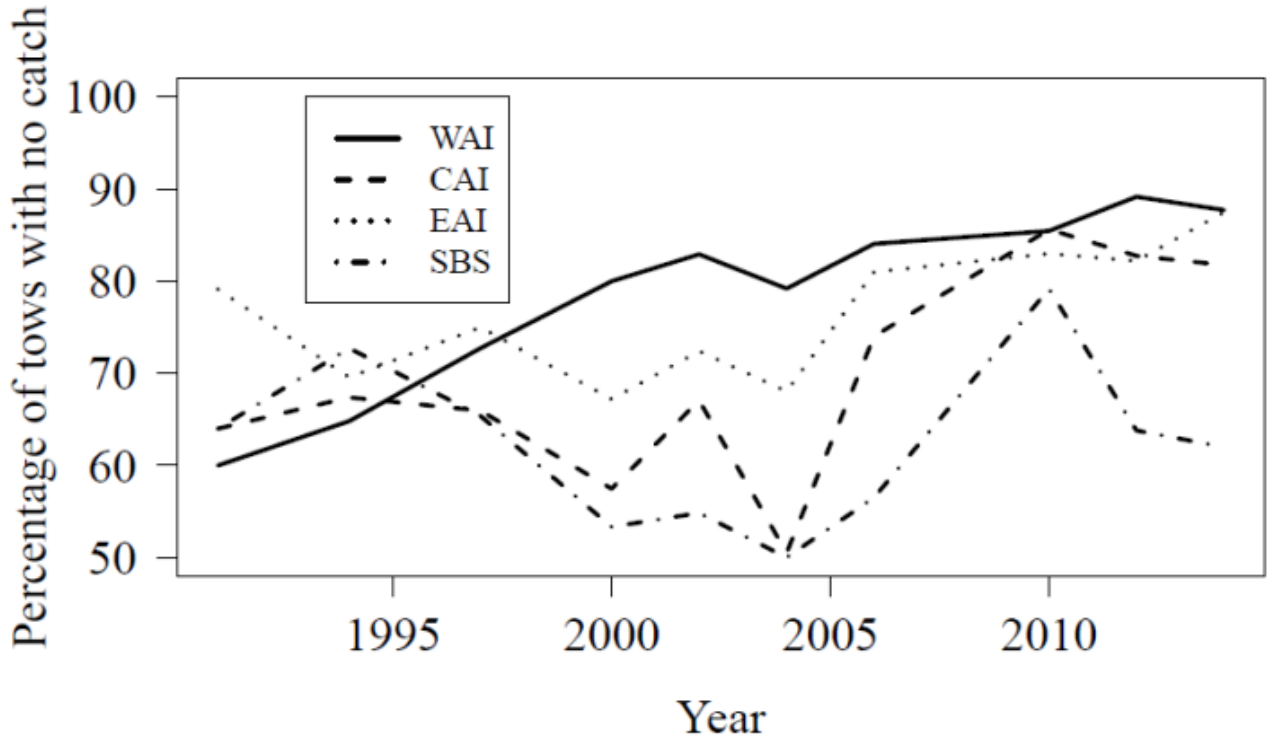






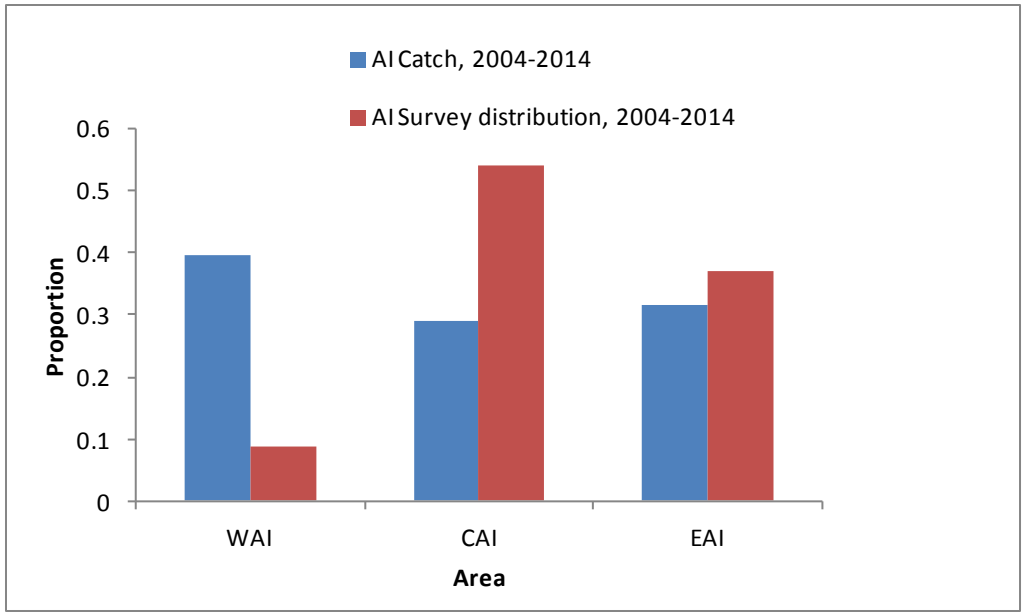


Tows with no catch of blackspotted/rougheye
(2014 survey data looks similar to 2012)



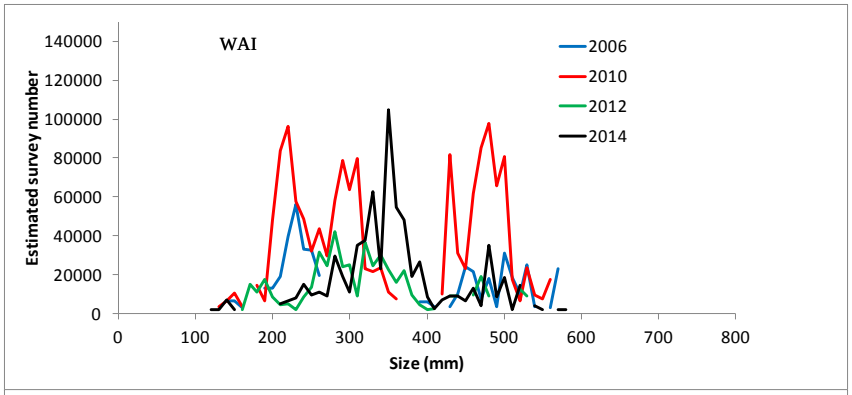
Disproportionate harvesting in the western AI

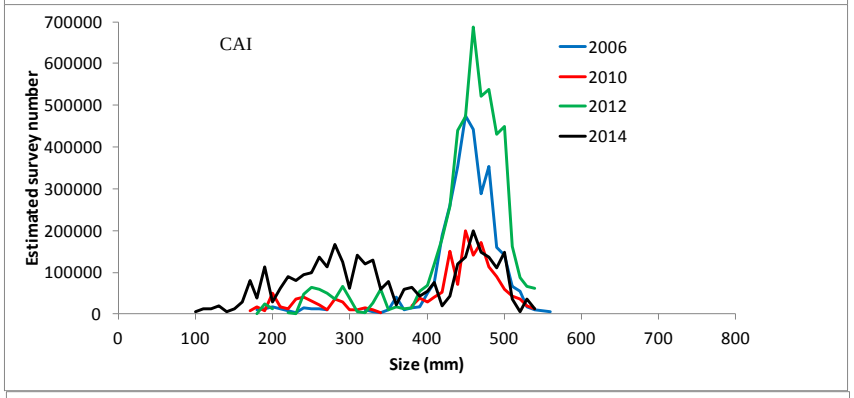
From 2004-2014, 40% of the AI harvest comes from an area with 9% of the AI survey biomass

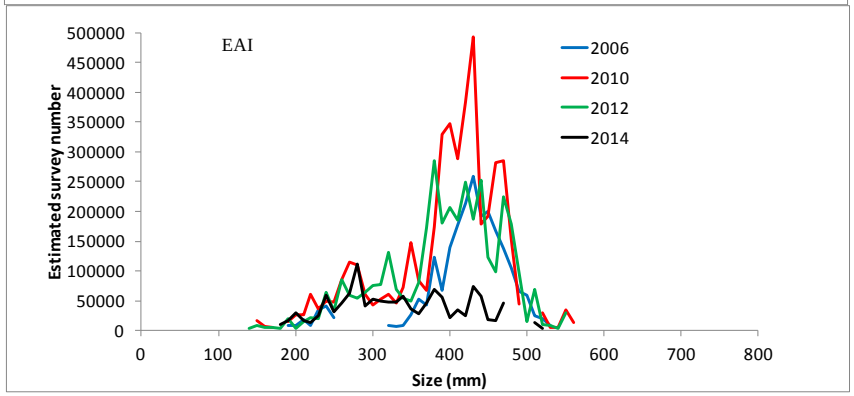


	Catches by area		
Year	WAI	CAI	EAI
2004	115	61	10
2005	43	24	11
2006	109	45	42
2007	44	42	71
2008	61	74	50
2009	74	84	39
2010	94	52	76
2011	46	31	54
2012	65	65	52
2013	84	62	151
2014	56	42	75

Size distributions by area



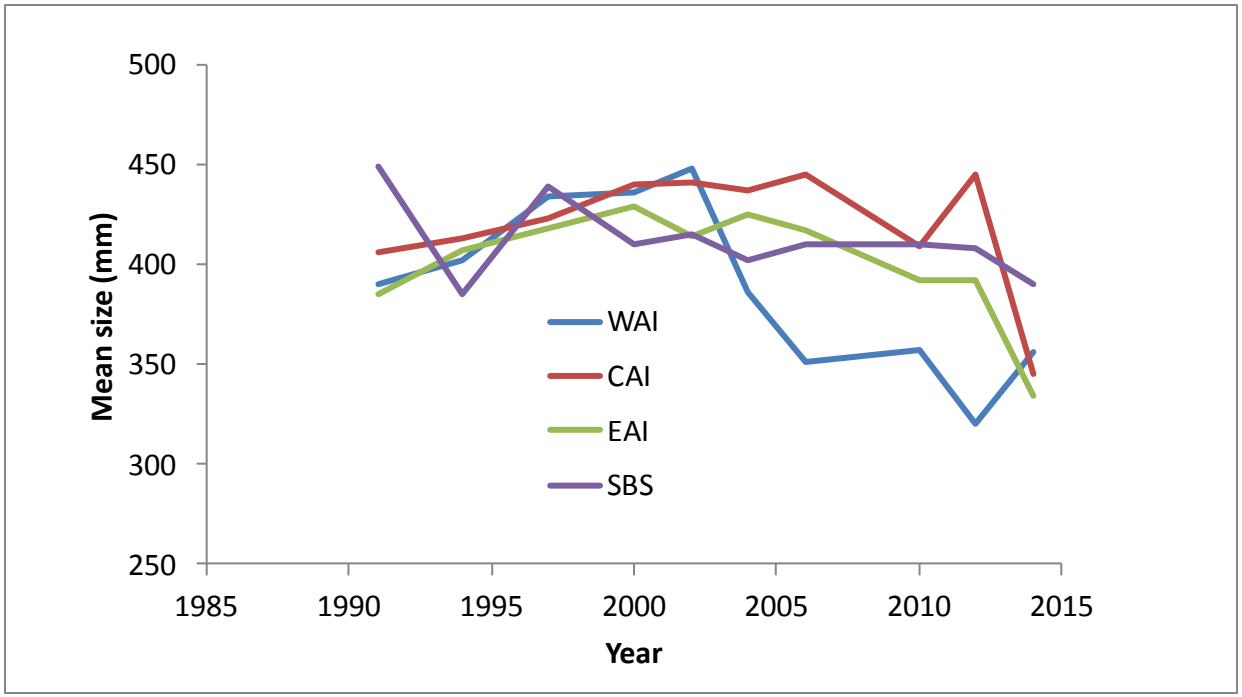




Still not many big (i.e. >= 40 cm) fish in the WAI in the 2014 survey . . .

. . . but also not many big fish seen in the CAI and EAI

Mean size by area



What about "the number" for the WAI?

I have been asked to document a potential subarea ABC for the WAI

Estimates of AI subarea biomass from the weighted average, and the random effects models

	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%

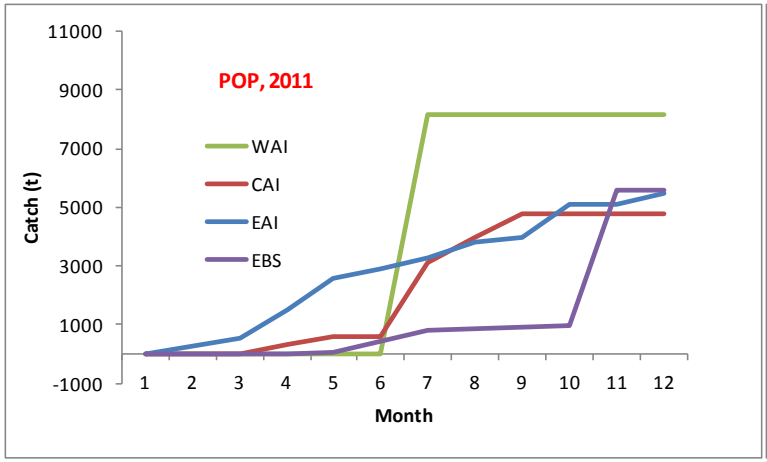
Estimates of potential WAI and CAI ABCs

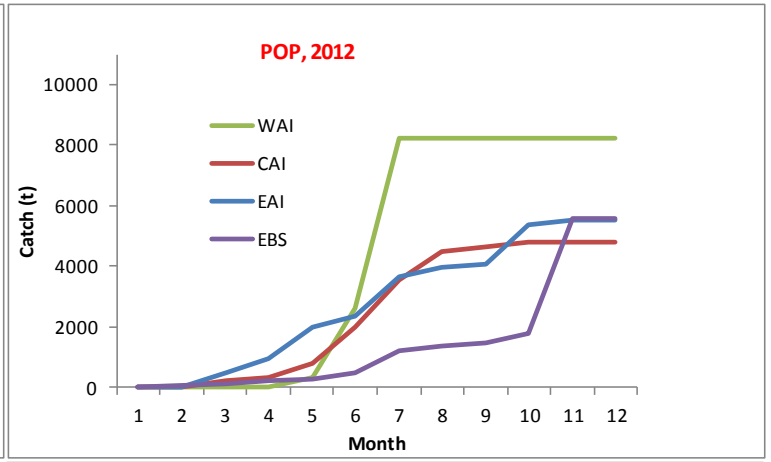
	WAI	CAI	WAI-CAI
ABC (2015, weighted average)	39	239	278
ABC (2015, RE model)	46	257	304
ABC (2016, weighted average)	48	297	345
ABC (2016, RE model)	57	320	377

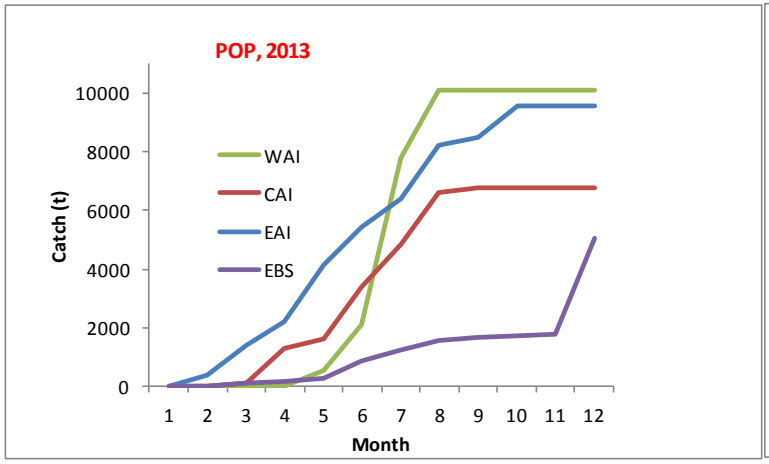
BSAI POP Outline

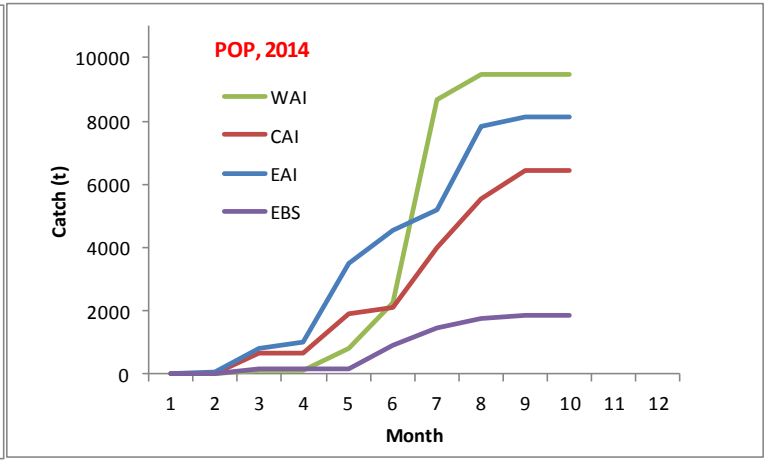
1) Catch information
2) Survey and fishery data
3) Model evaluation of fishery selectivity
4) Model fits to data
5) Retrospective analysis
6) Management recommendations

BSAI POP catch by month and area, 2011-2014

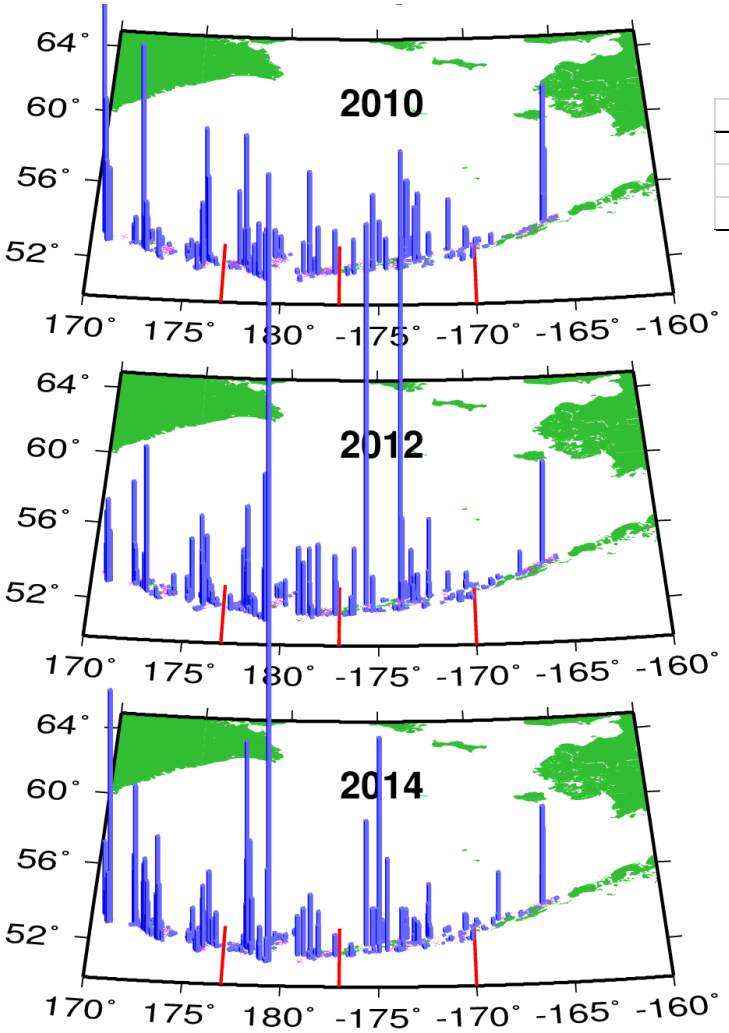








2010 – 2014 AI surveys



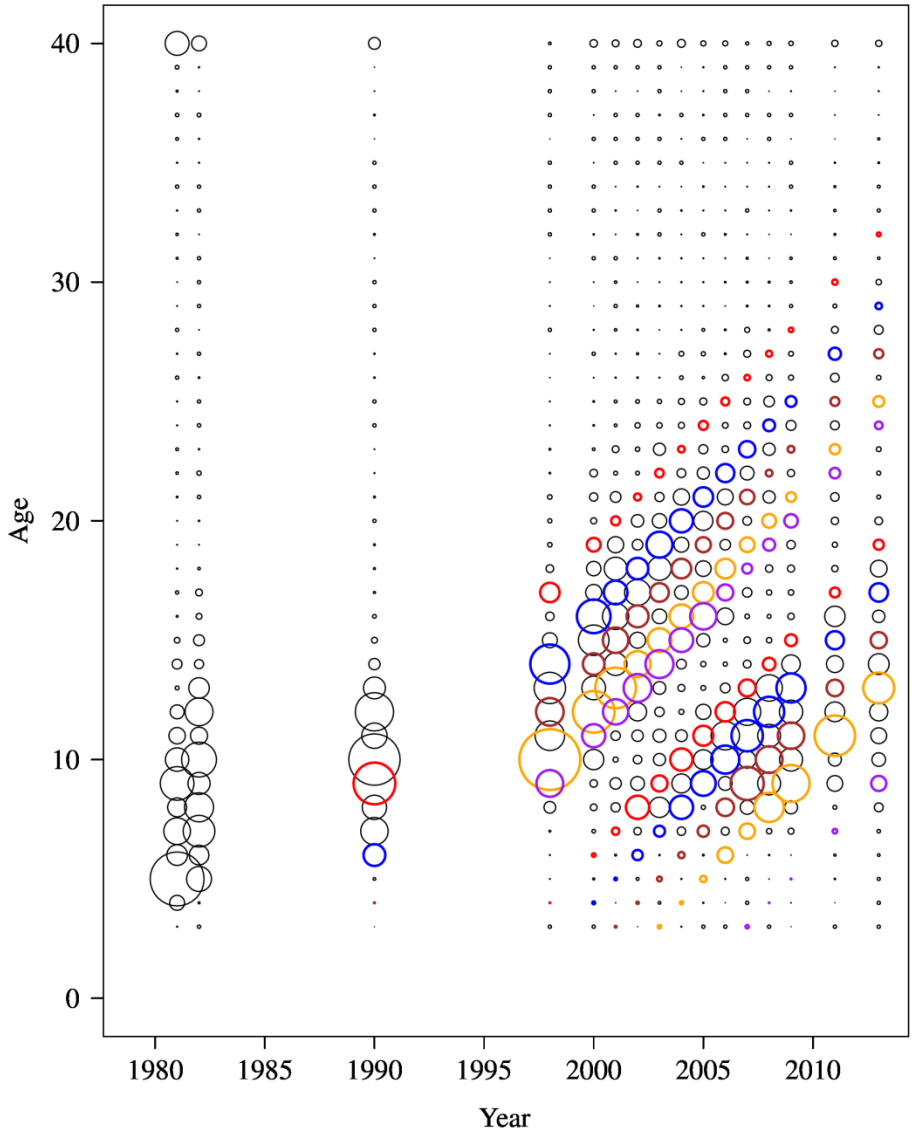
Survey biomass estimates and CVs

Year	WAI	CAI	EAI	SBS	Total
2010	395,944 (0.21)	221,700 (0.17)	266,607 (0.18)	87,794 (0.55)	972,046 (0.12)
2012	263,661 (0.23)	233,666 (0.17)	366,413 (0.37)	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)

EBS survey biomass estimates and CVs

Year	Biomass	CV
2002	72,665	0.53
2004	112,273	0.38
2008	107,886	0.41
2010	203,421	0.38
2012	231,383	0.33

BSAI POP fishery age composition data

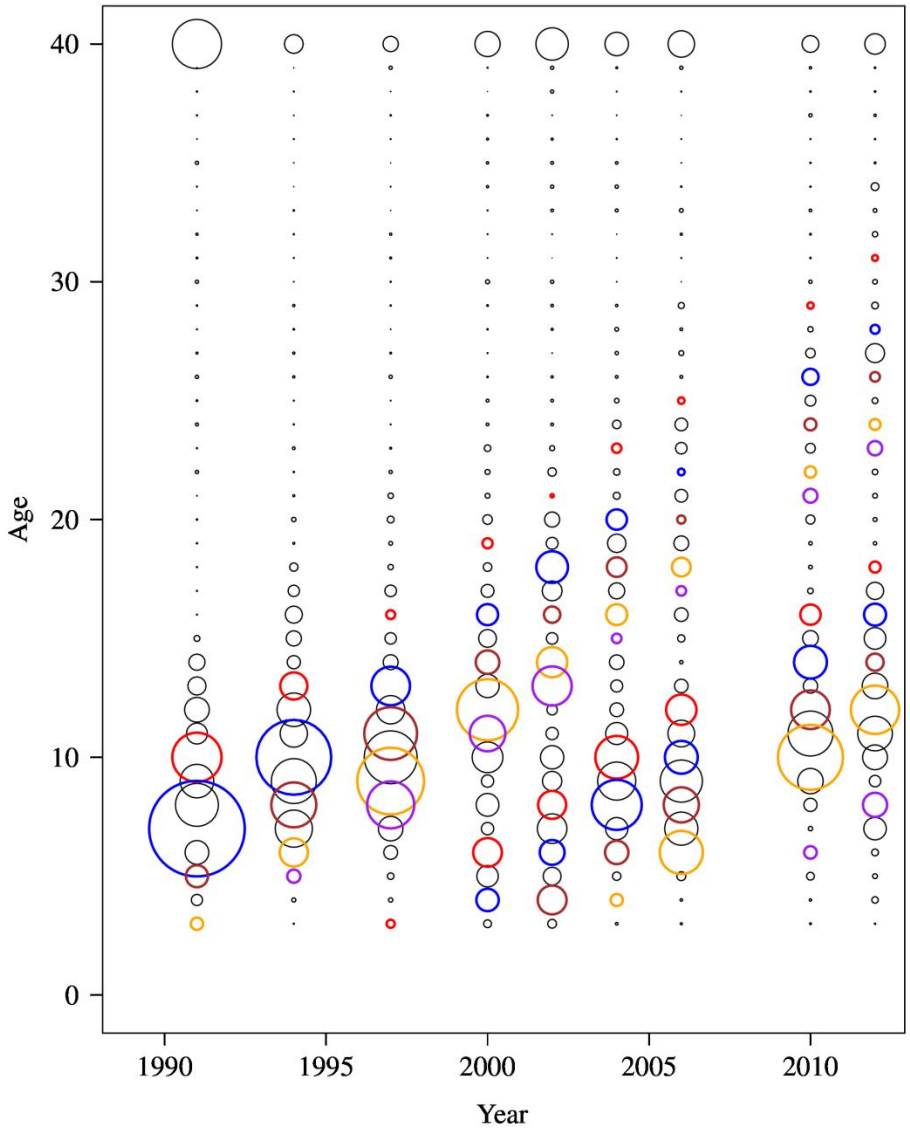


Top 10 year classes since 1977

1981
1984
1986
1988
1989

1994
1996
1998
2000
2004

BSAI POP survey age composition data



Top 10 year classes since 1977

1981
1984
1986
1988
1989

1994
1996
1998
2000
2004

Models evaluated

Model 0) Data updated through 2012, logistic fishery selectivity in four-year blocks, age/length composition weights not reiteratively estimated (i.e., the 2012 model)

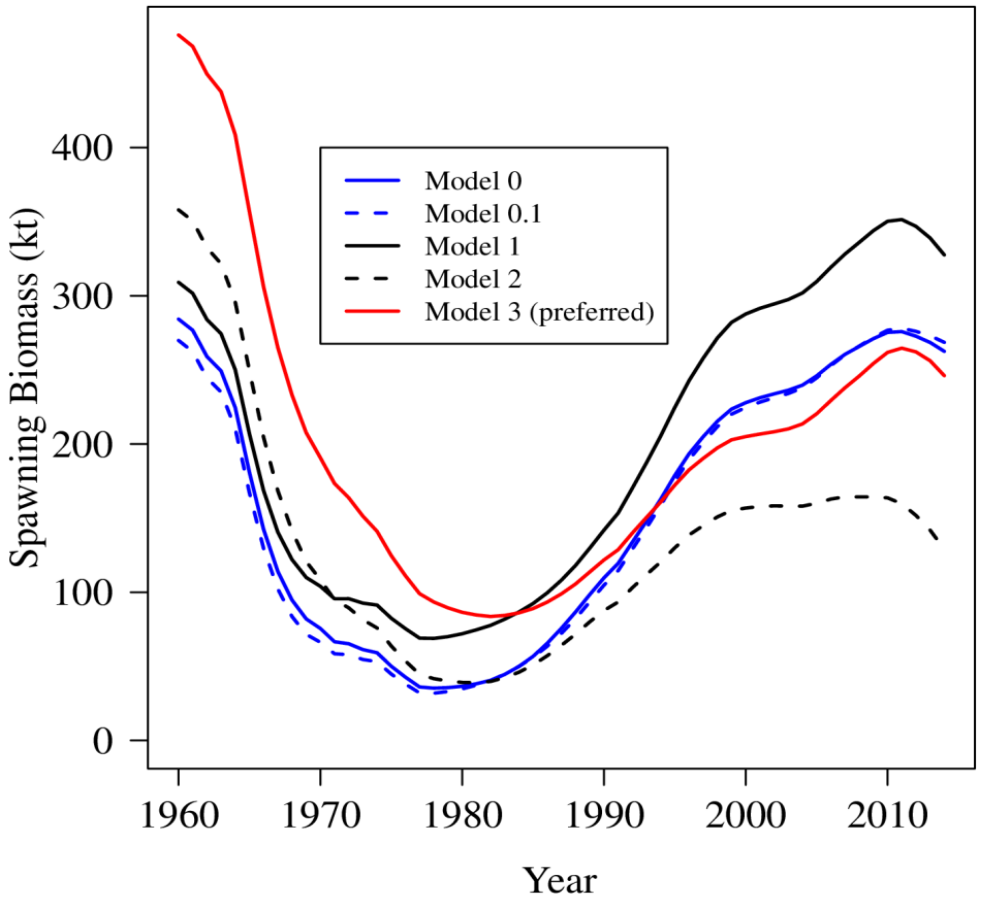
Model 0.1) Model 0, with the 1980s cooperative survey data removed.

Model 1) Logistic fishery selectivity fishery selectivity in four-year blocks, cooperative survey data removed, age/length composition weights reiteratively estimated

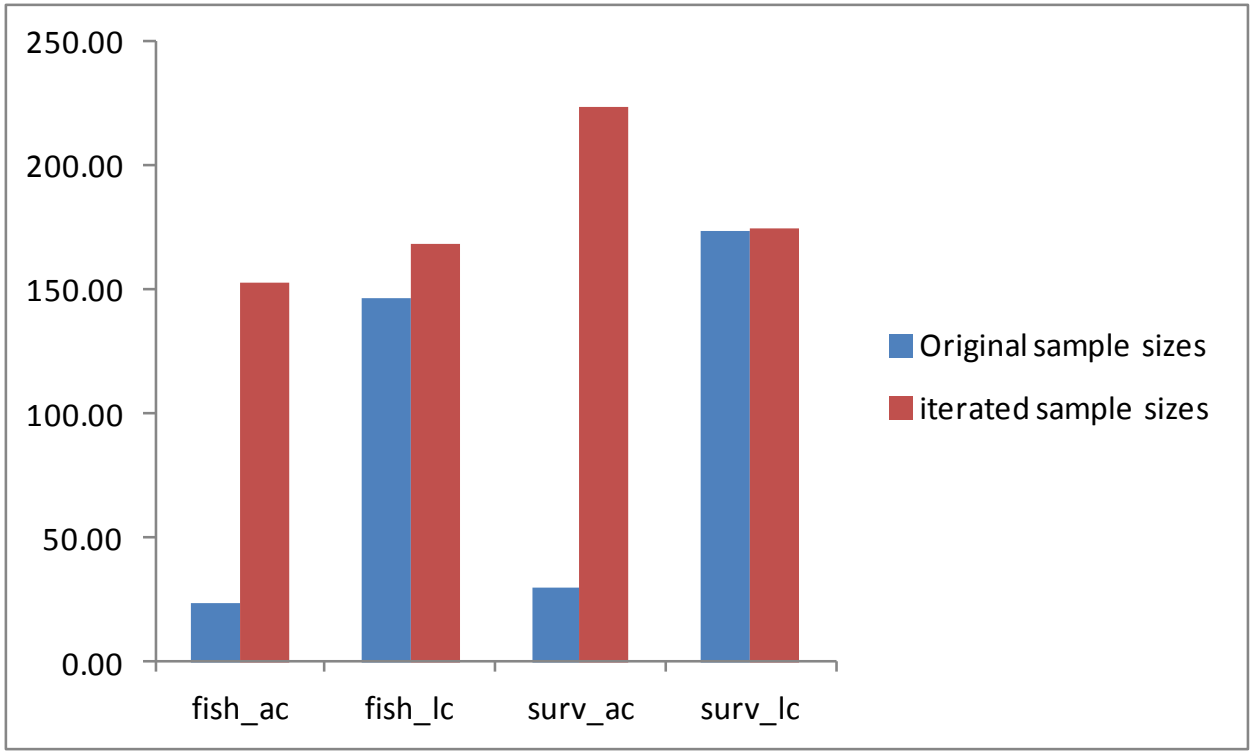
Model 2) Model 1, but with time-invariant double logistic selectivity.

Model 3) Model 1, but with a bicubic spline.

Effect of the models on estimated spawning biomass

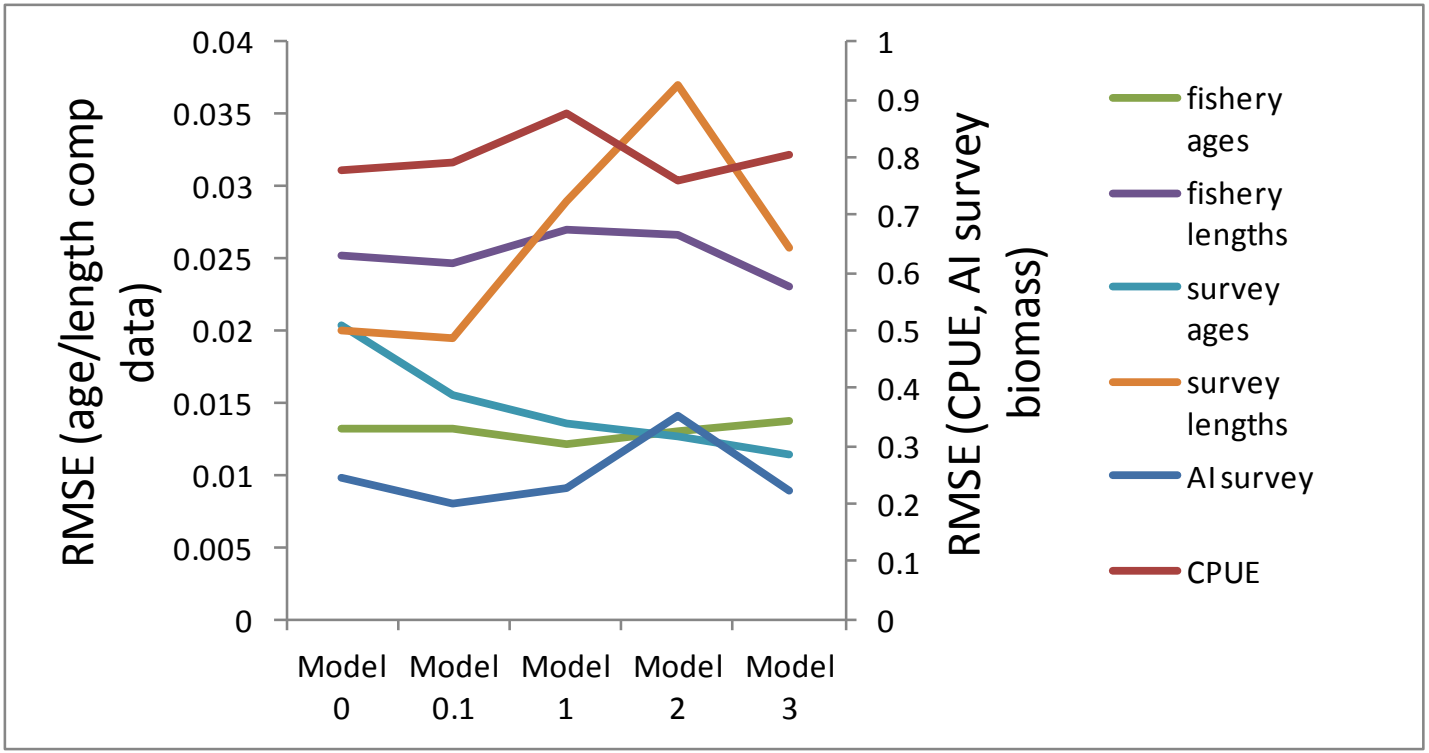


How did the sample sizes change after iterated reweighting?

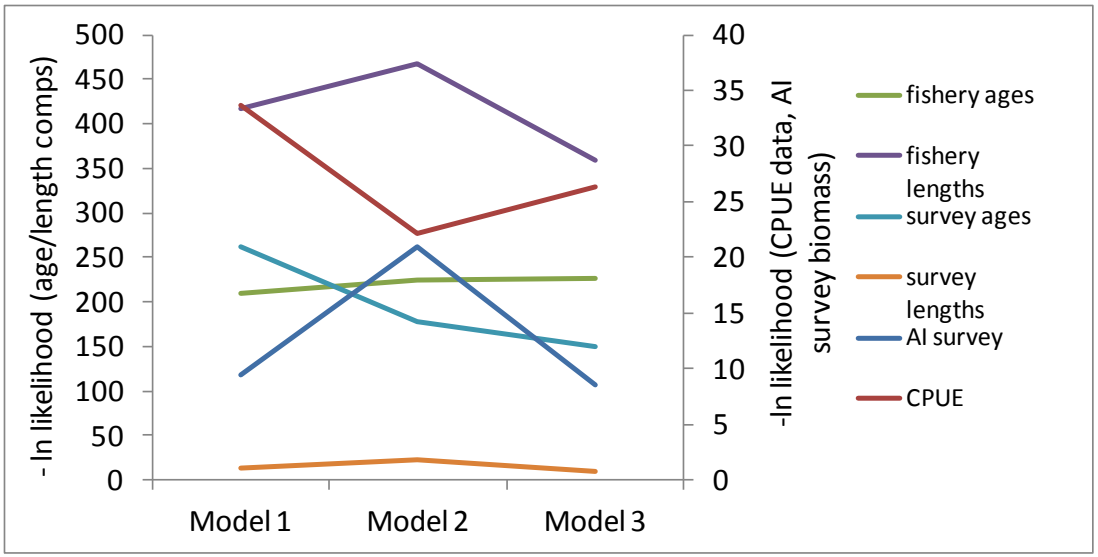


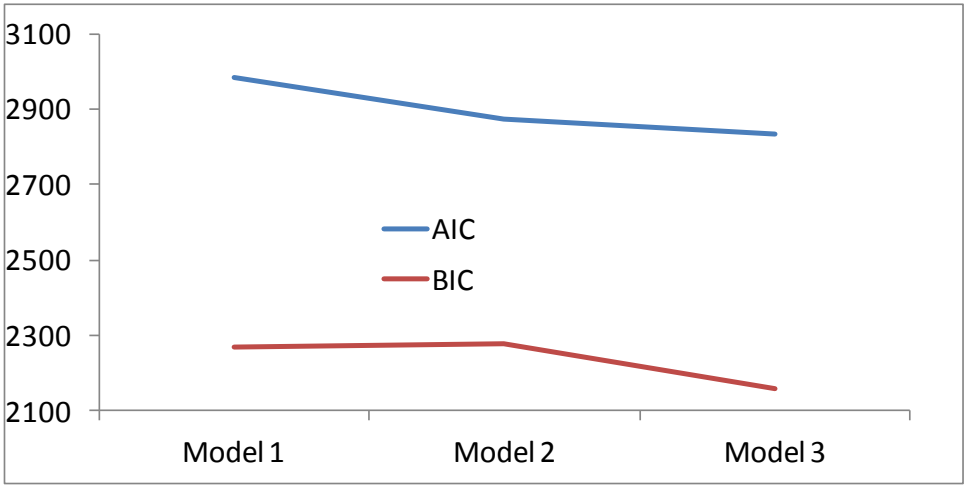
Root mean squared error to various data components

The models considered here produce tighter fits to the survey age comp data, and a degraded fit to the survey length comp data (relative to the bridging models 0 and 0.1)

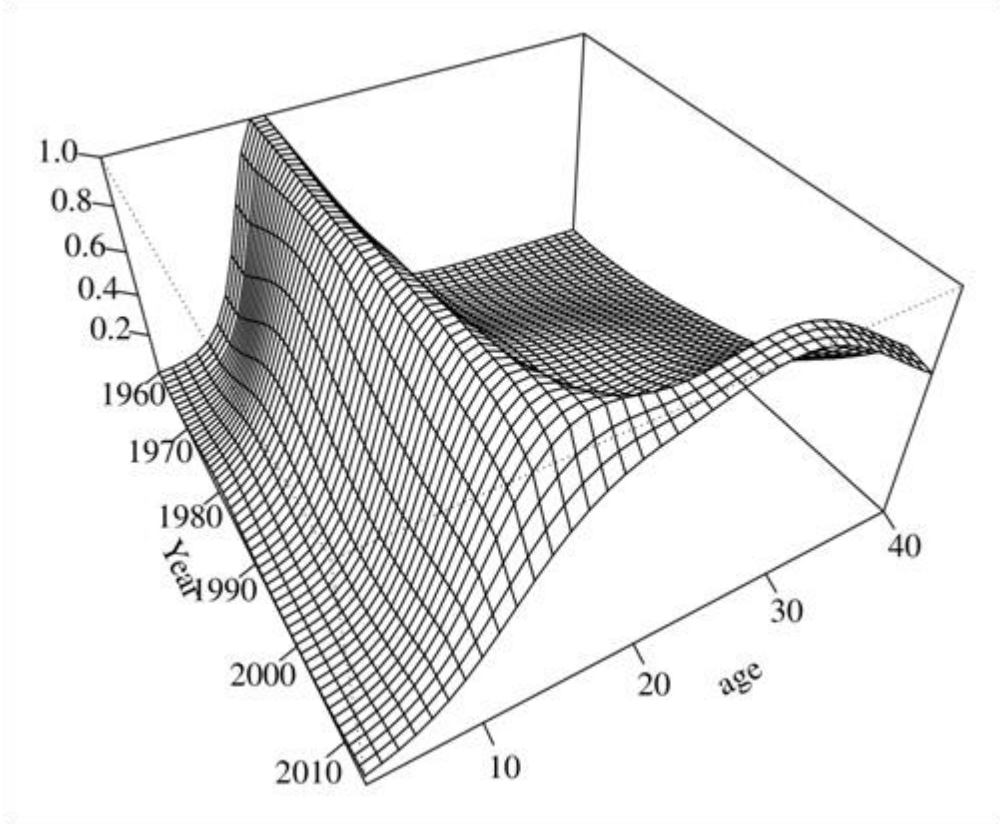


Model fits to data components

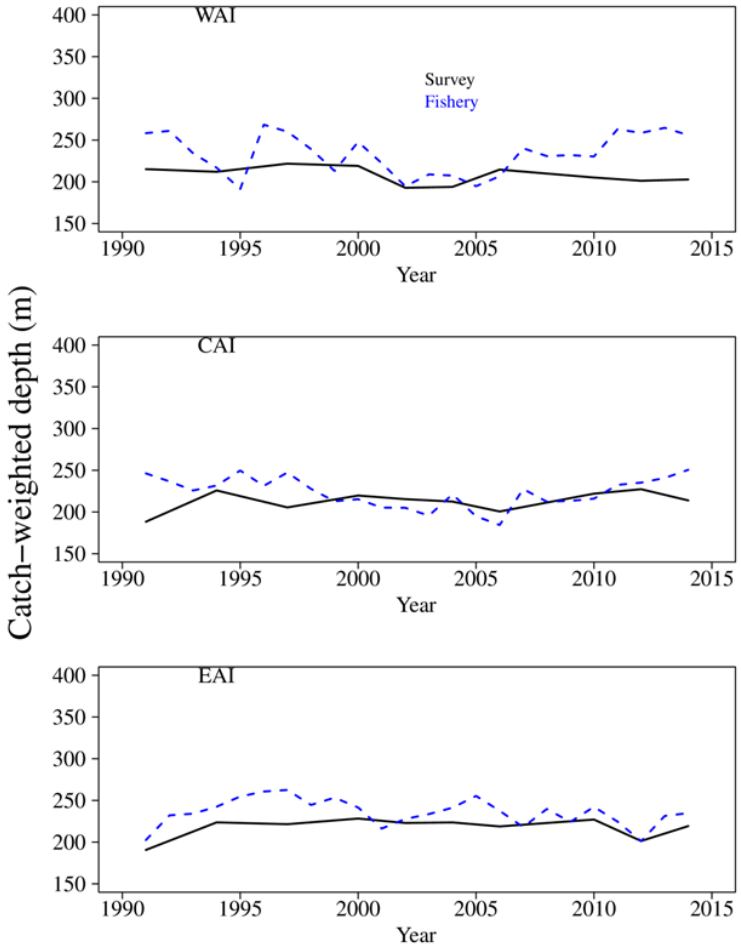




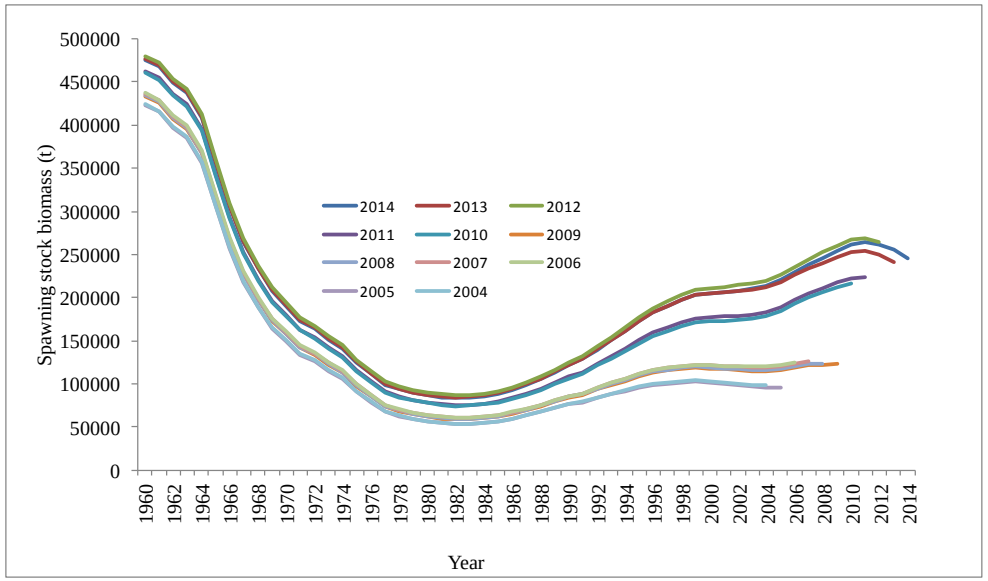
Estimated fishery selectivity, Model 3

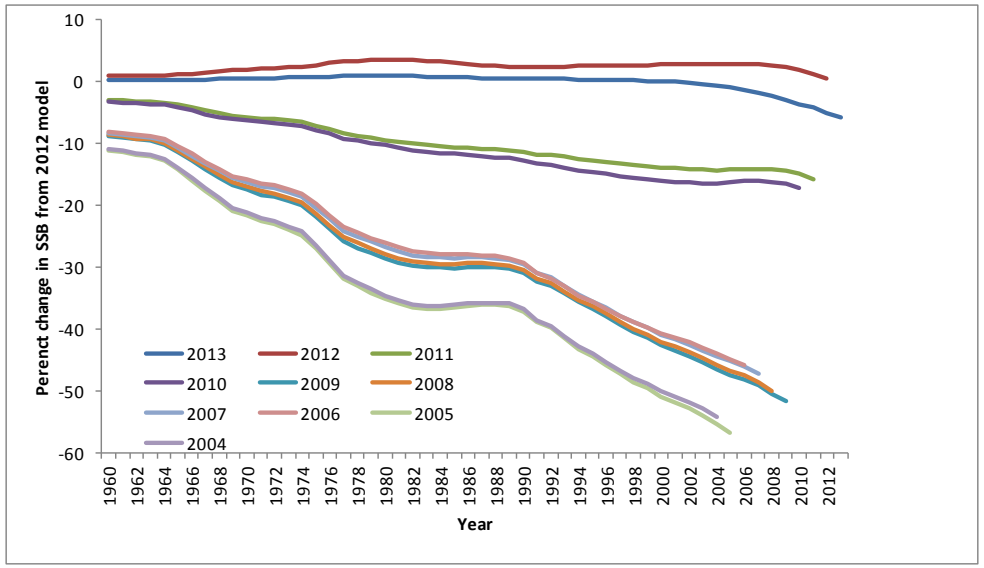


Increase in selectivity since early 2000s may be related to change in the depths where POP are caught



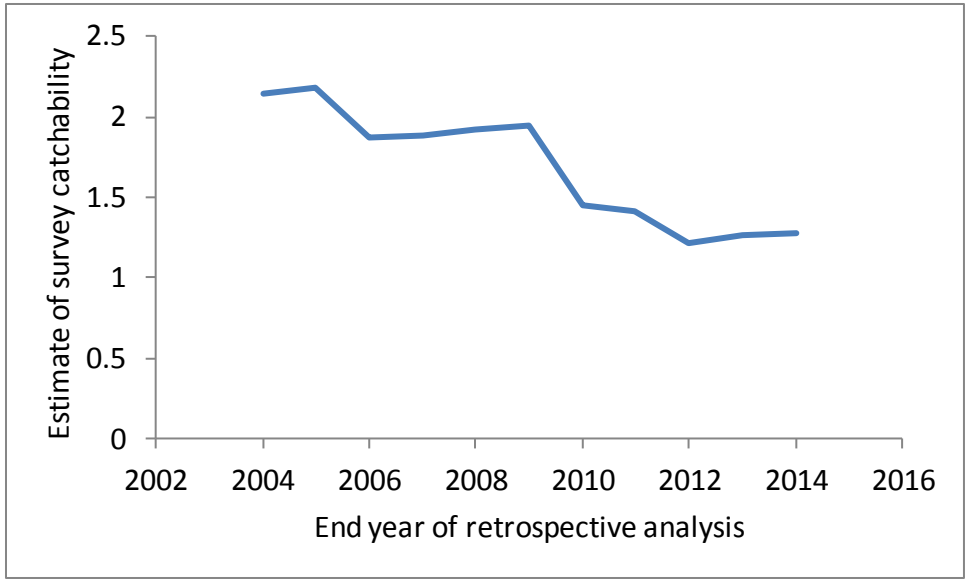
BSAI POP retrospective pattern





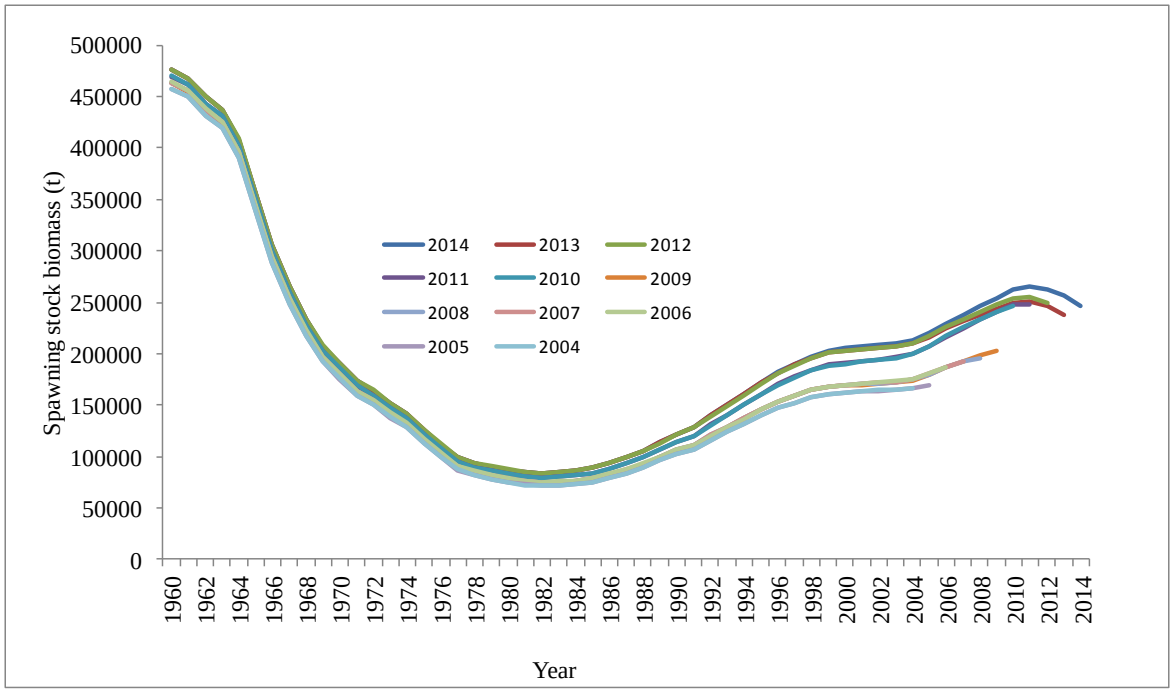
Mohn's rho = -0.343

Retrospective pattern in estimated survey catchability



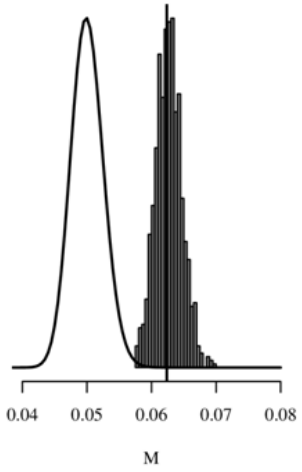
Much of the retrospective pattern is caused by trying to estimate survey *q* in the model during a period when the stock is increasing

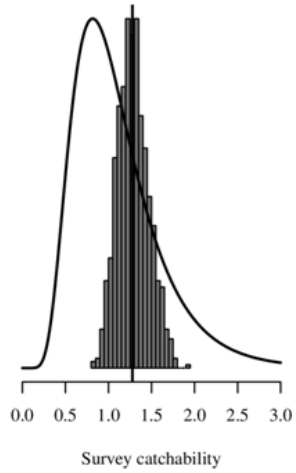
BSAI POP retrospective pattern , with *q* fixed at 2014 estimate (1.28)



Mohn's rho = -0.147

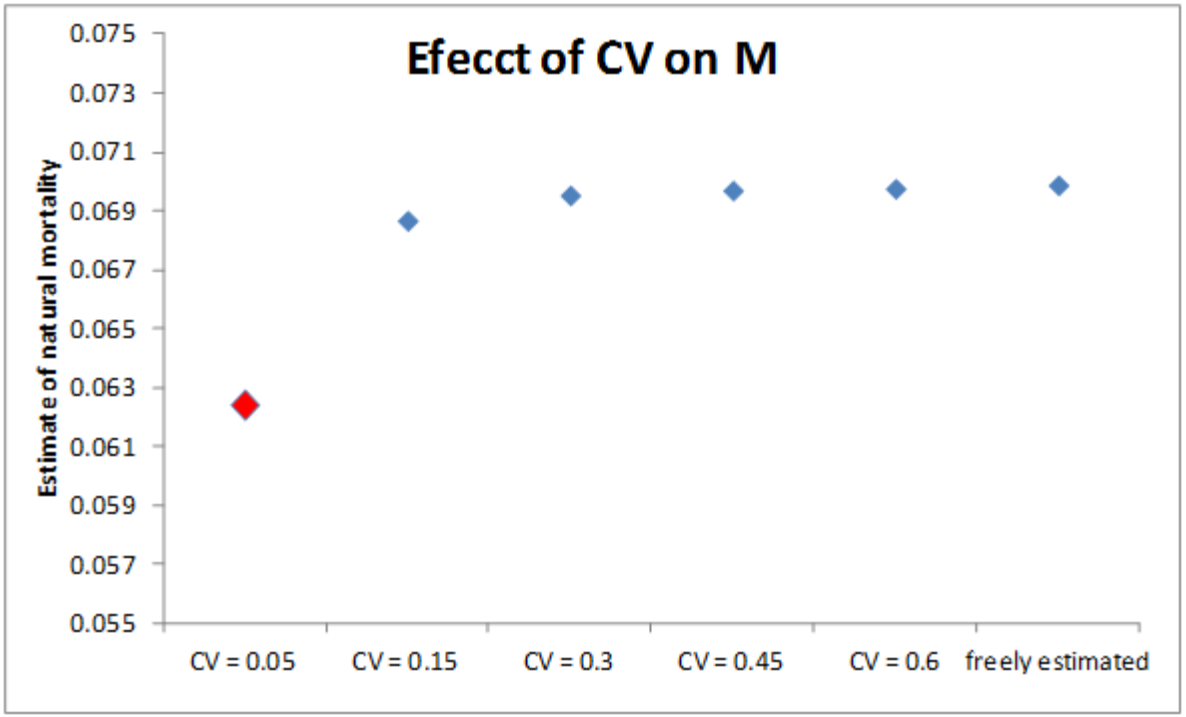
Sensitivity to M and q





Is the prior distribution of M constraining the model estimate?

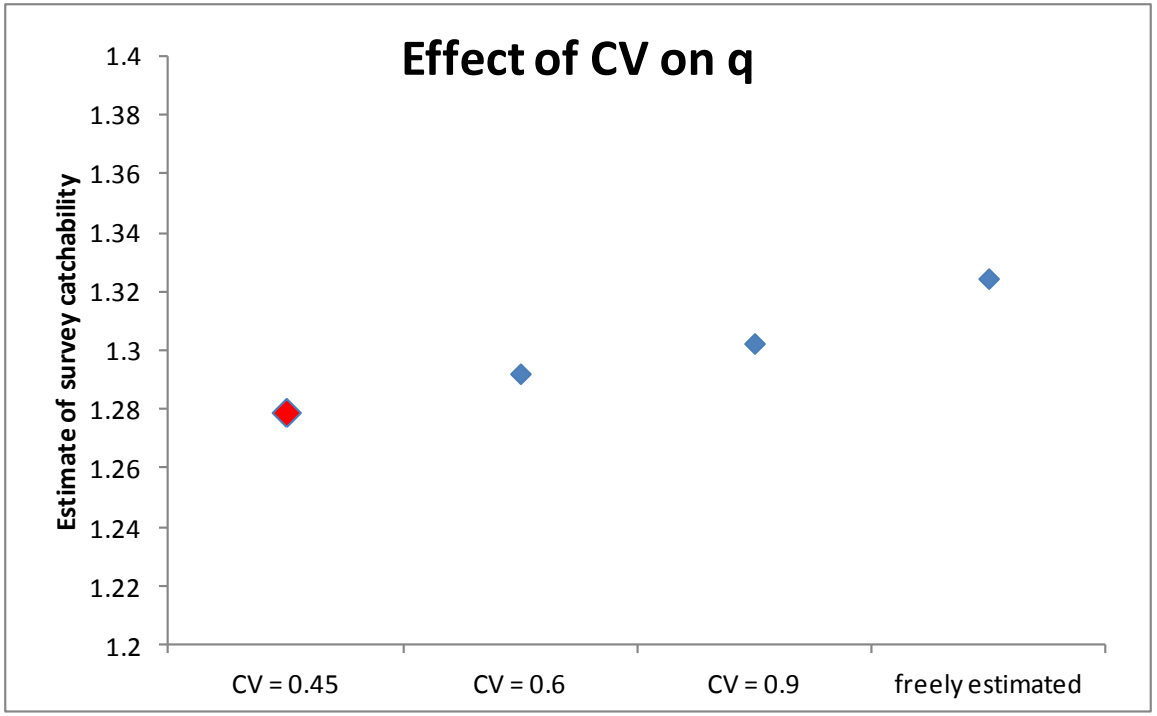
Fix *q* at the 2014 estimate, and relax the prior on *M*



The estimate of M with no prior is 0.07, a slight increase over the current estimate of 0.062.

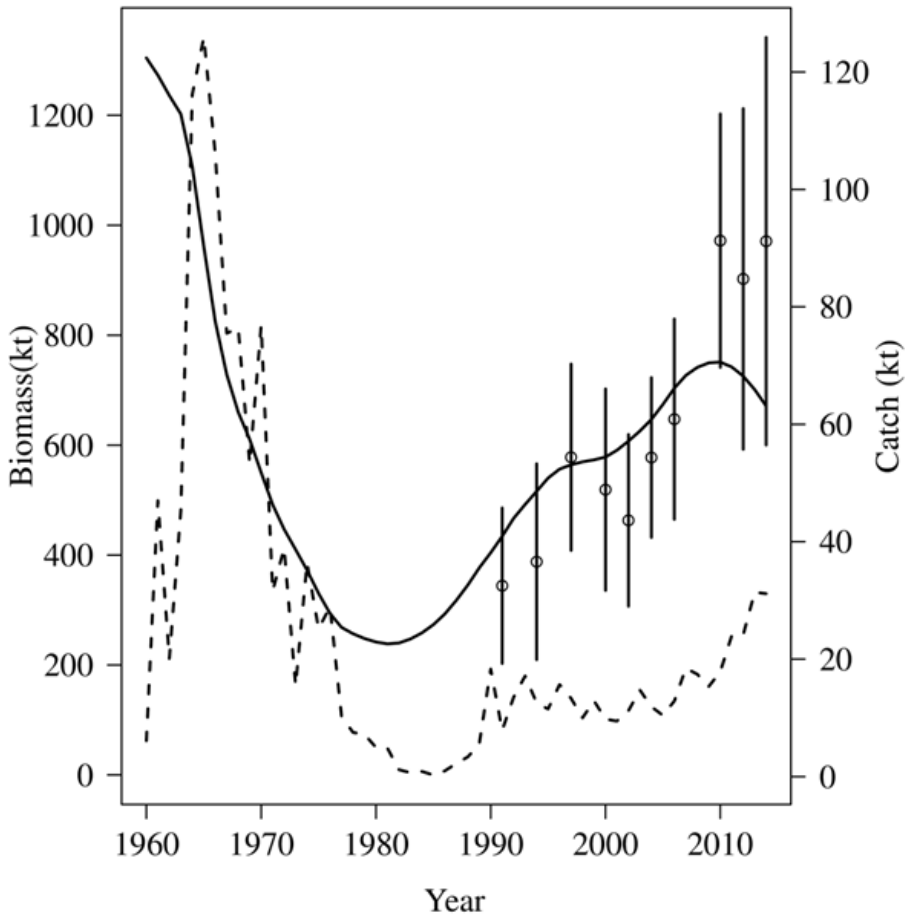
Recent research on empirical estimators for M (Then et al. 2014) suggests using a power relationship of t_{max} , and would also produce an estimate of 0.07.

Fix *M* at the 2014 estimate, and relax the prior on *q*

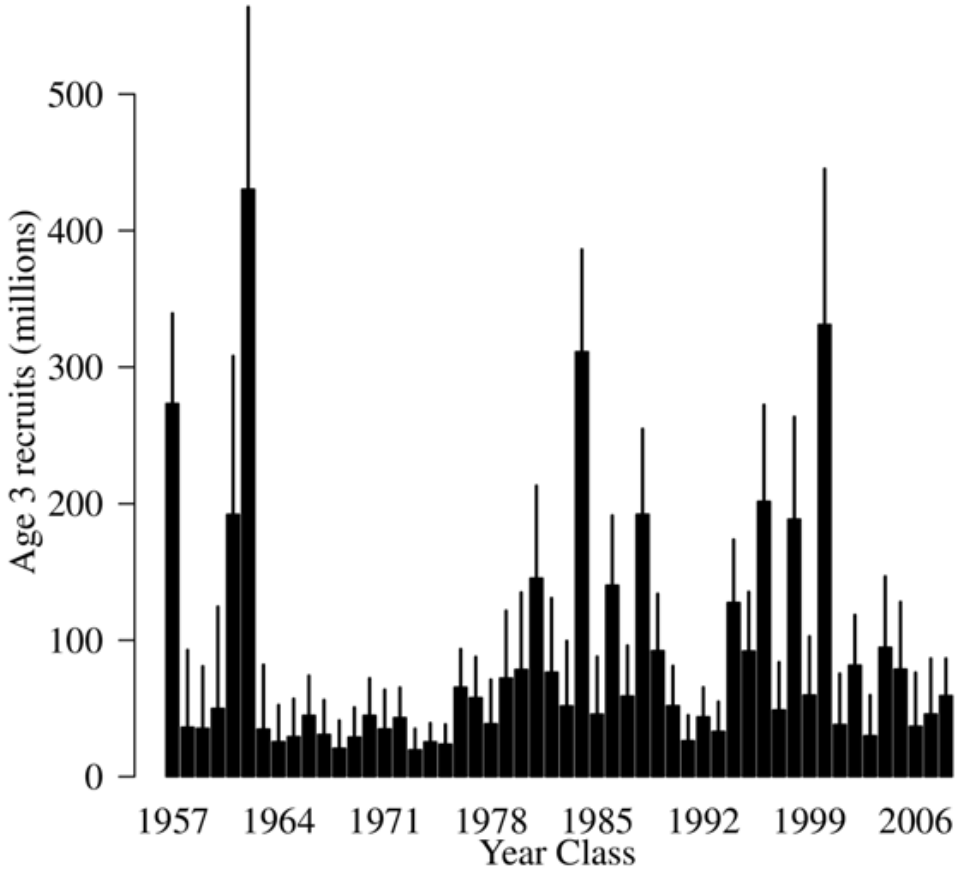


The estimate of *q* with no prior is 1.32, a slight increase over the current estimate of 1.28.

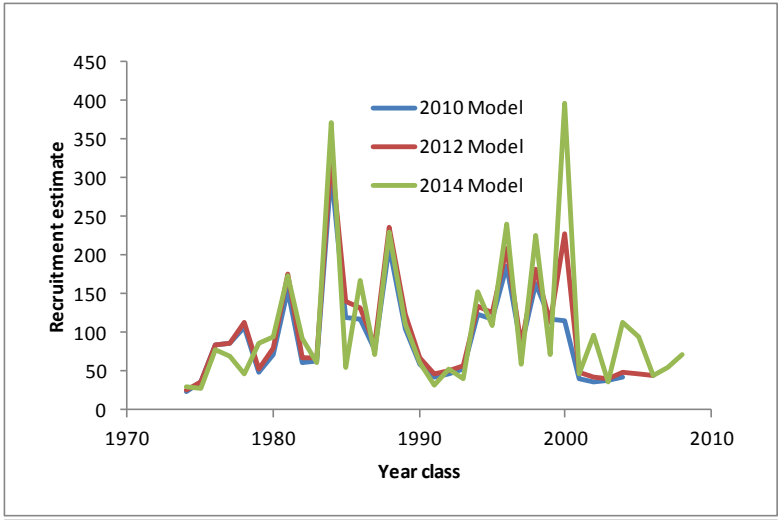
BSAI POP catch and fit to survey biomass

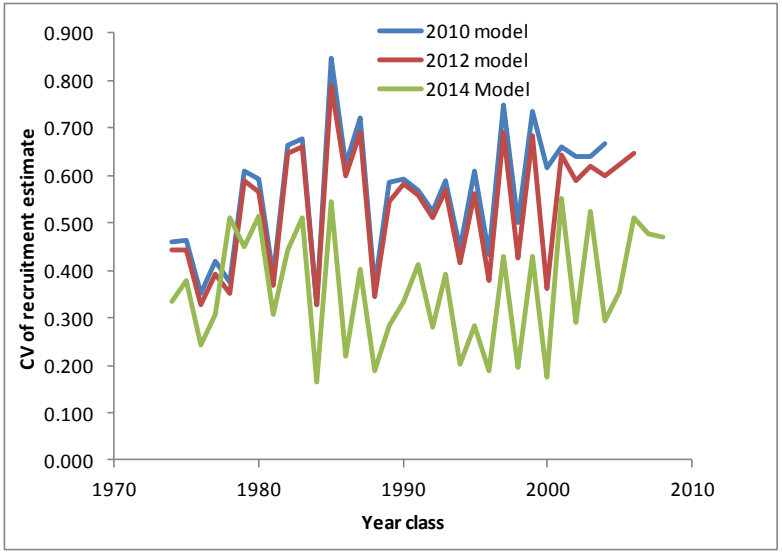


BSAI POP recruitments



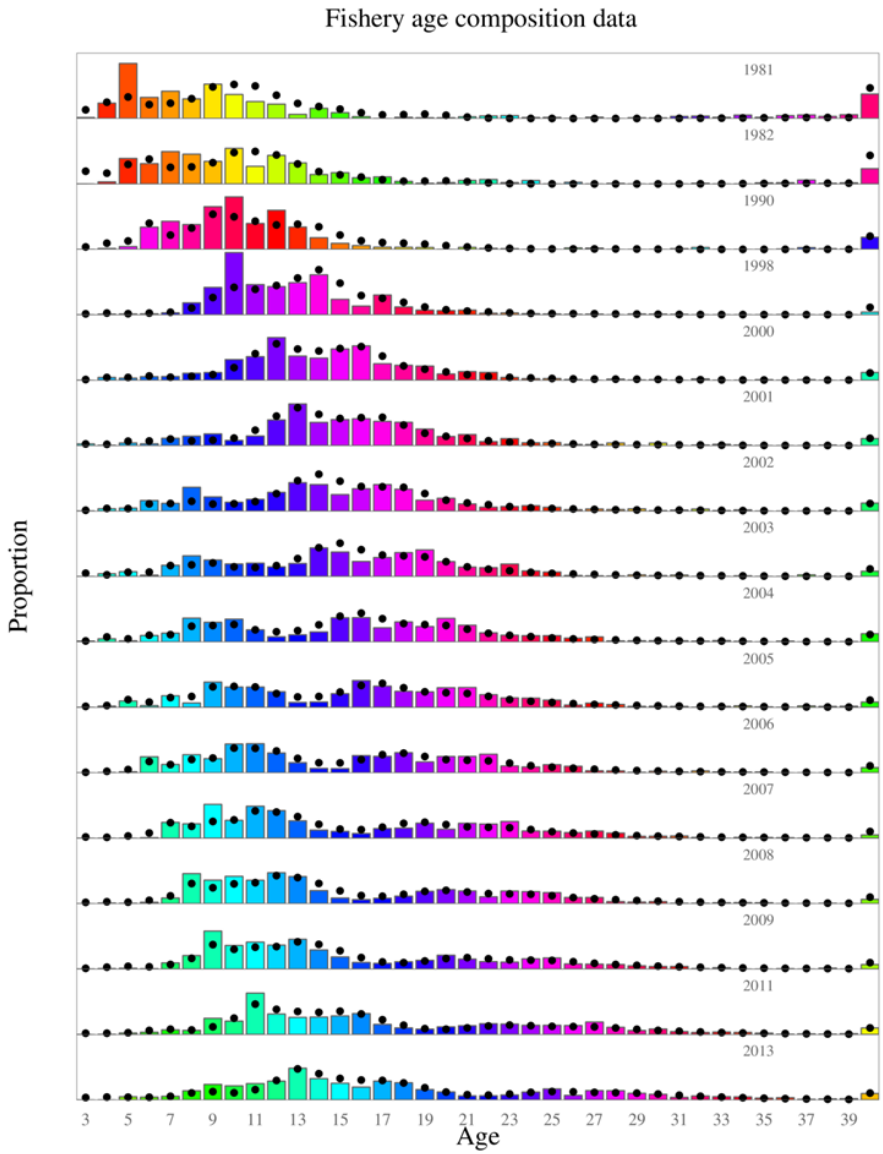
Comparison of recruitment estimates between the 2010, 2012, and 2014 models



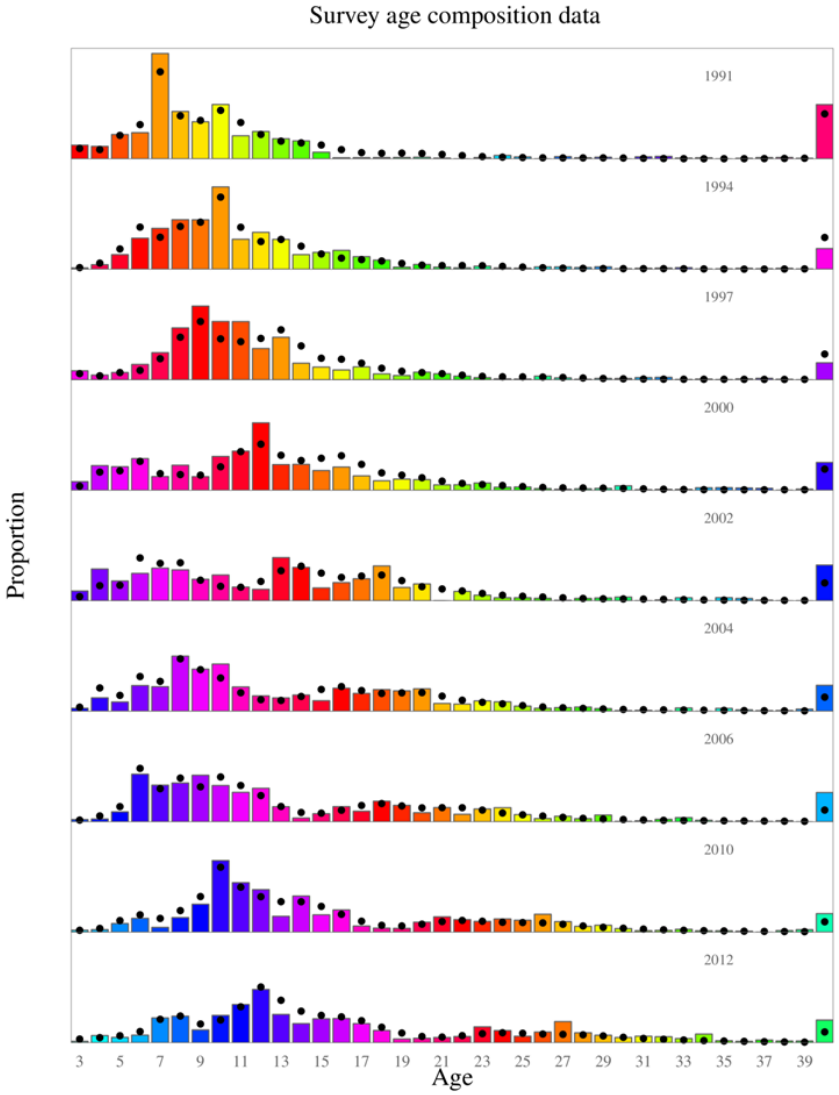


The 2000 year class is estimated as stronger in the 2014 assessment

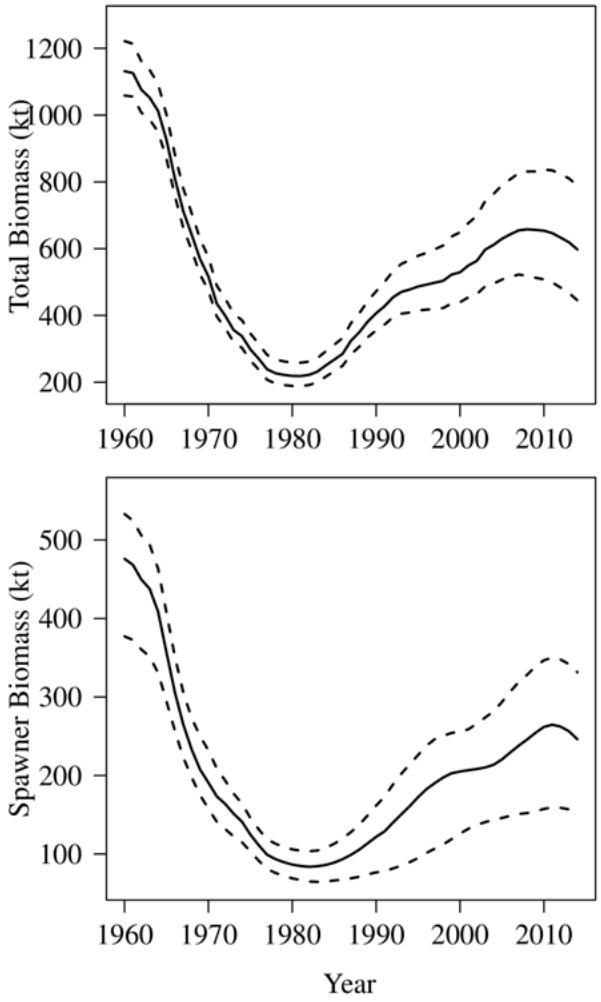
BSAI POP fishery age compositions



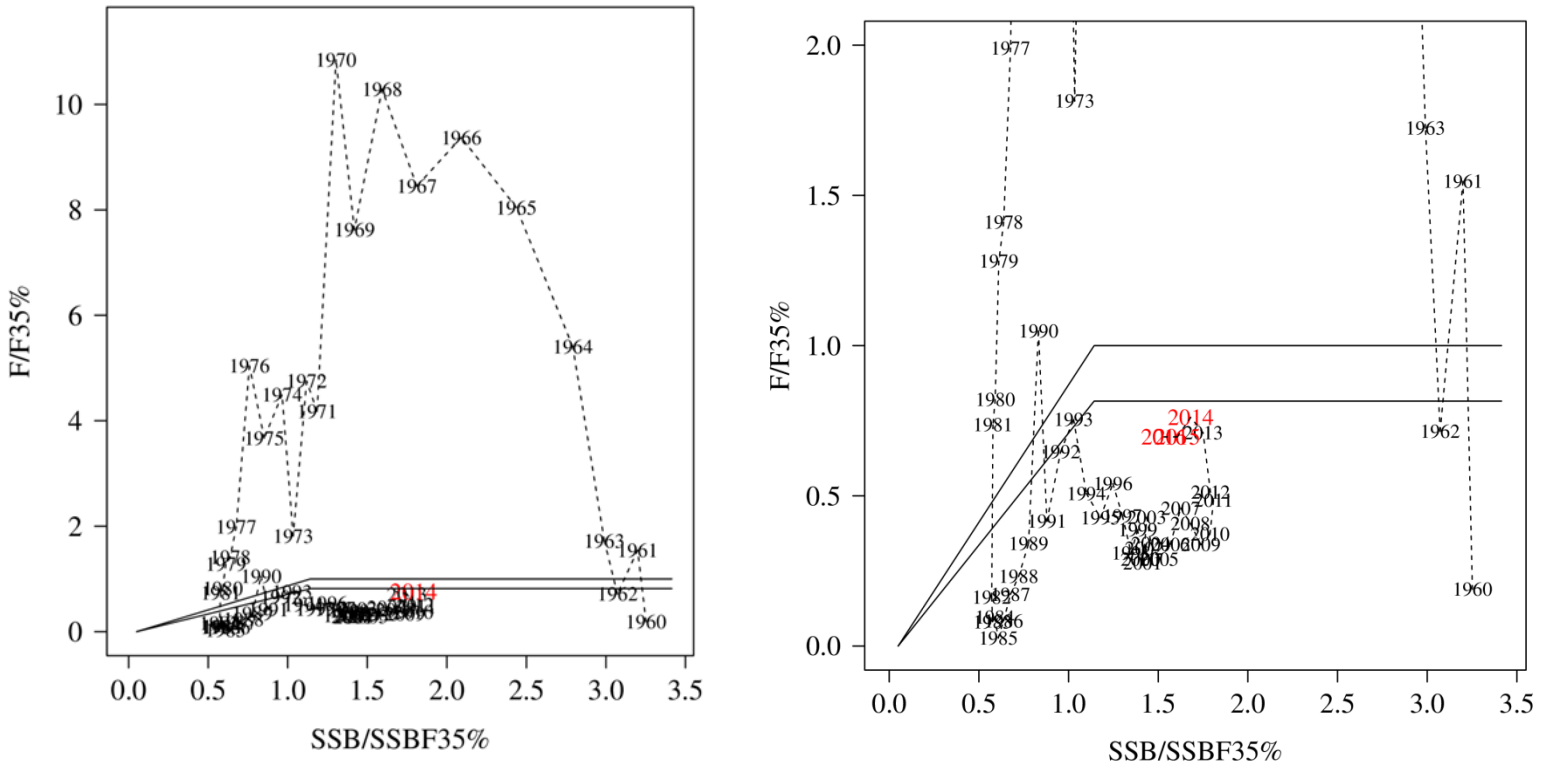
BSAI POP survey age compositions



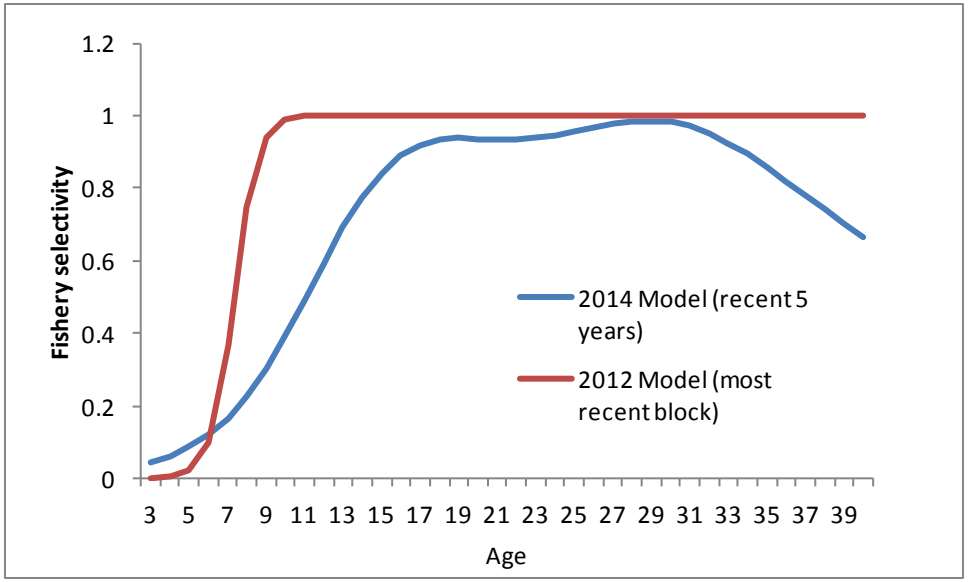
BSAI POP total and spawning biomass



BSAI POP phase-plane plot



Change in recent fishery selectivity between the 2012 and 2014 models



Management Reference points and ABCs

Estimated reference points

F40% = 0.089

F35% = 0.109

B40% = 169,203 t (decrease from estimate of 183,774 in 2013)

B35% = 148,053 t (decrease from estimate of 160,803 in 2013)

Recommended 2015 ABC and OFLs

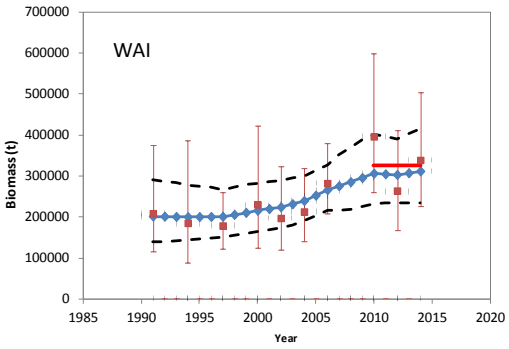
ABC: 34,988 t (increased from 2014 value of 33,122 t)

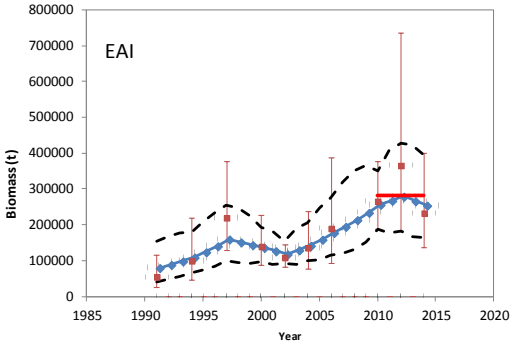
OFL: 42,558 t (increased from 2014 value of 39,585 t)

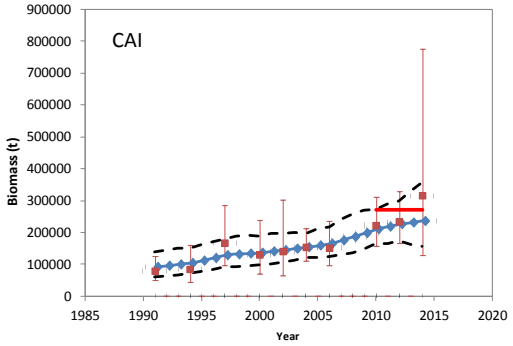
BSAI POP summary table

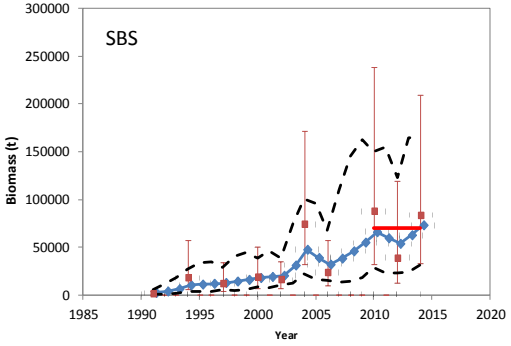
Quantity	As estimated or specified last year for: 2014	2015	As estimated or recommended this year for: 2015	2016
M (natural mortality rate)	0.062	0.062	0.062	0.062
Tier	3a	3a	3a	3a
Projected total (age 3+) biomass (t)	639,505	620,270	577,967	561,090
Female spawning biomass (t)				
Projected	257,878	243,400	234,426	223,744
$B_{100\%}$	459,436	459,436	423,008	423,008
$B_{40\%}$	183,774	183,774	169,203	169,203
$B_{35\%}$	160,803	160,803	148,053	148,053
F_{OFL}	0.076	0.076	0.109	0.109
$maxF_{ABC}$	0.063	0.063	0.089	0.089
F_{ABC}	0.063	0.063	0.089	0.089
OFL (t)	39,585	37,817	42,558	40,809
maxABC (t)	33,122	31,641	34,988	33,550
ABC (t)	33,122	31,641	34,988	33,550
Status	As determined last year for: 2012	2013	As determined this year for: 2013	2014
Overfishing	No	n/a	No	n/a
Overfished	n/a		n/a	No
Approaching overfished	n/a		n/a	No

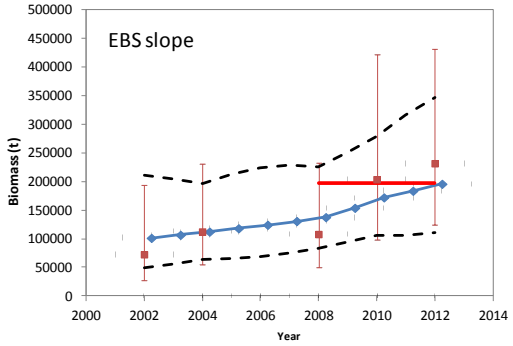
Application of random effects model to smooth survey time series











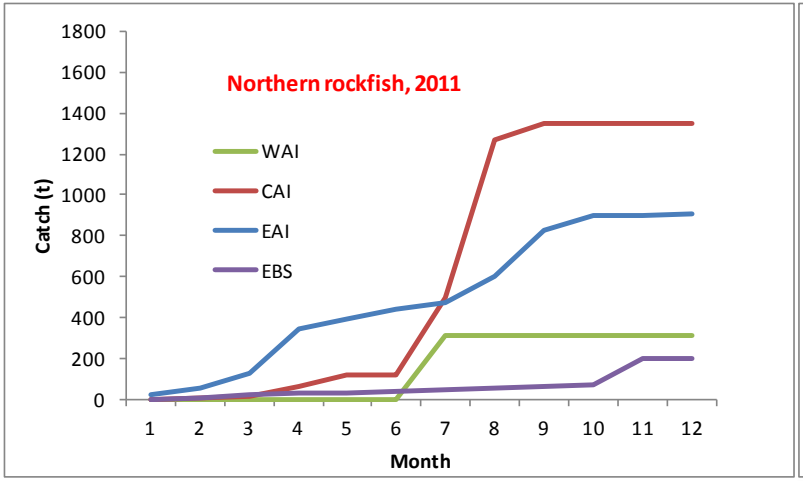
BSAI POP apportionments

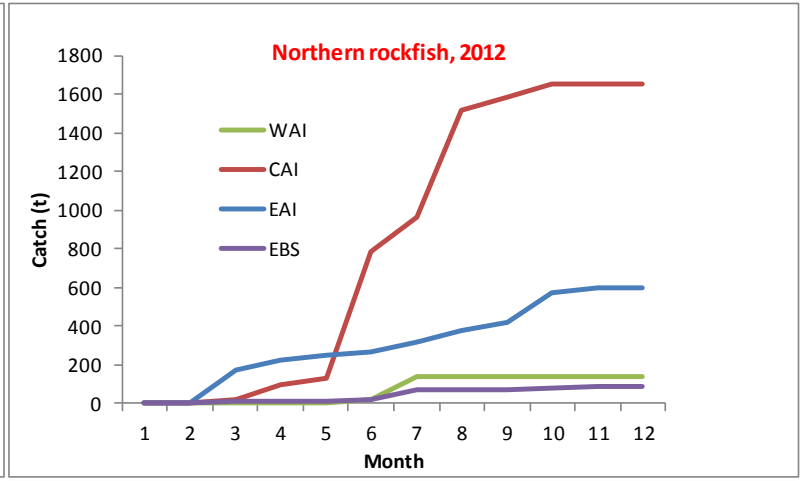
	BSAI	Western AI	Central AI	Eastern AI	EBS	Total
Apportionment (weighted average)		28.5%	23.6%	24.6%	23.3%	100%
Apportionment (RE model)		29.1%	22.1%	23.8%	25.1%	100%
OFL (2013)	41,900					
ABC (2013)		10,200	6,980	9,790	8,130	35,100
TAC (2013)		10,200	6,980	9,790	8,130	35,100
Catch (2013)		10,065	6,747	9,530	5,050	31,393
OFL (2014)	39,585					
ABC (2014)		9,598	6,594	9,246	7,684	33,122
TAC (2014)		9,598	6,594	9,246	7,684	33,122
Catch (2014)[1]		9,485	6,438	8,124	1,842	25,889
OFL (2015)	42,558					
ABC (2015, weighted average)		9,981	8,240	8,623	8,143	34,988
ABC (2015, RE model)		10,182	7,723	8,312	8,771	34,988
OFL (2016)	40,809					
ABC (2016, weighted average)		9,571	7,902	8,269	7,809	33,550
ABC (2016, RE model)		9,763	7,406	7,970	8,411	33,550

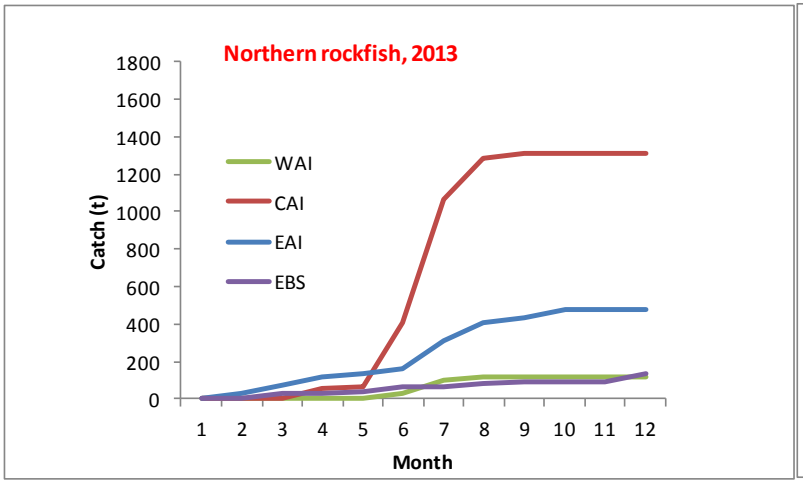
BSAI Northern Rockfish Outline

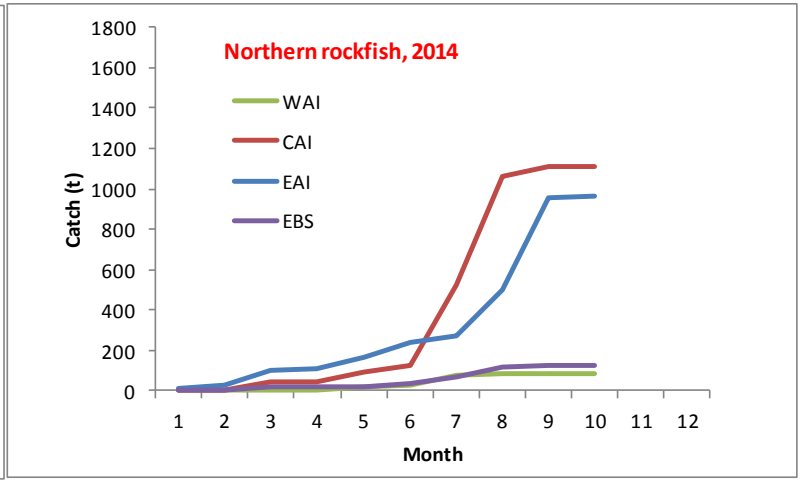
1) Catch information
2) Survey and fishery data
3) Evaluation of fishery selectivity
4) Model fits to data
5) Retrospective analysis
6) Management recommendations

BSAI Northern rockfish catch by month and area, 2011-2014



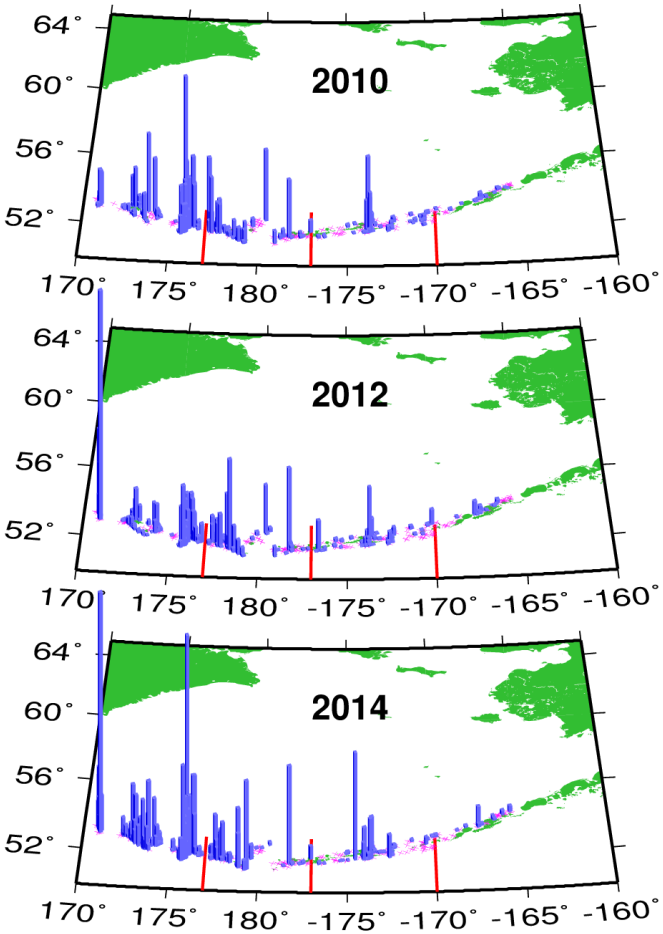






Square root of AI survey CPUE, 2010-2014

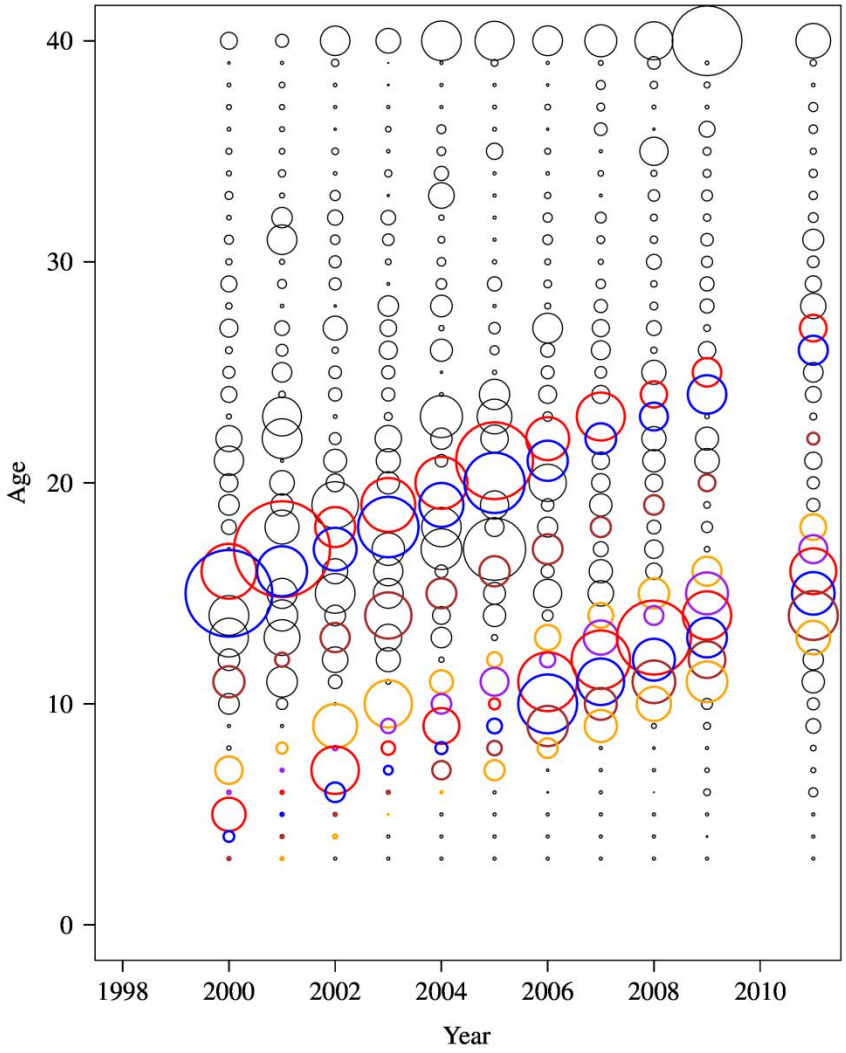
Year	WAI	CAI	EAI	SBS	Total
2010	143,953 (0.29)	51,331 (0.40)	21,847 (0.50)	189 (0.52)	217,319 (0.22)
2012	216,325 (0.65)	52,674 (0.40)	15,615 (0.60)	550 (0.73)	285,164 (0.50)
2014	346,392 (0.38)	48,049 (0.44)	76,787 (0.79)	1,668 (0.80)	472,895 (0.31)



EBS slope survey results

Year	Biomass	CV
2002	33	0.38
2004	16	0.42
2008	3	1.00
2010	42	0.68
2012	3	1.00

BSAI northern rockfish fishery age compositions

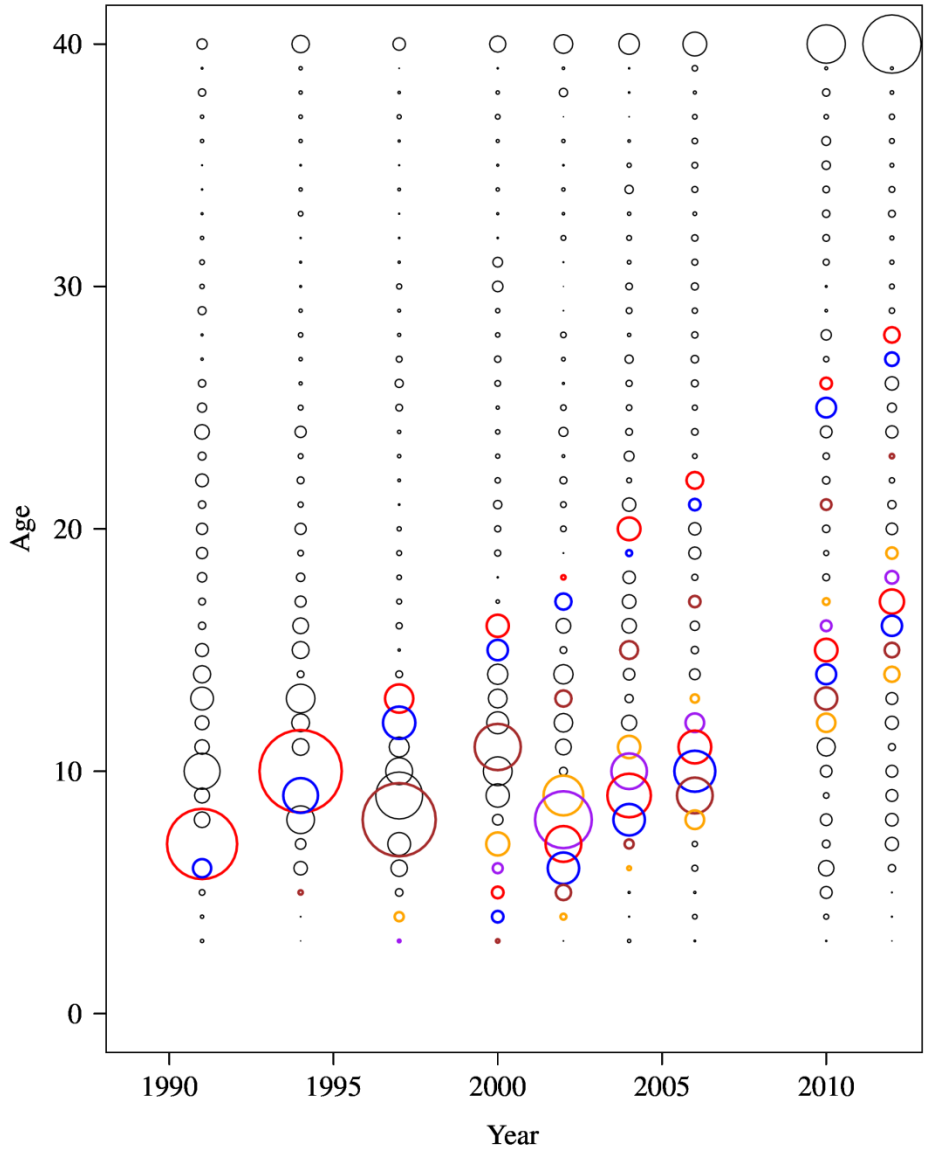


1984
1985

1989

1993
1994
1995
1996
1997
1998

BSAI northern rockfish survey age compositions

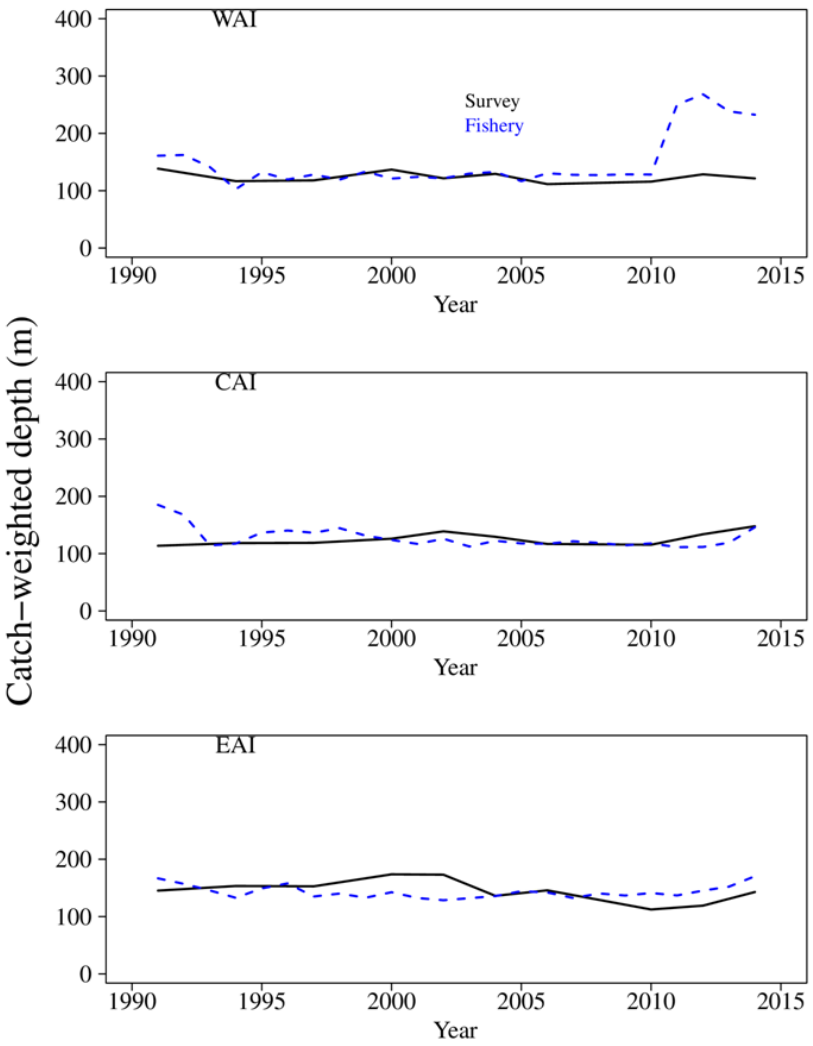


1984
1985

1989

1993
1994
1995
1996
1997
1998

Information on temporal variability in fishery selectivity

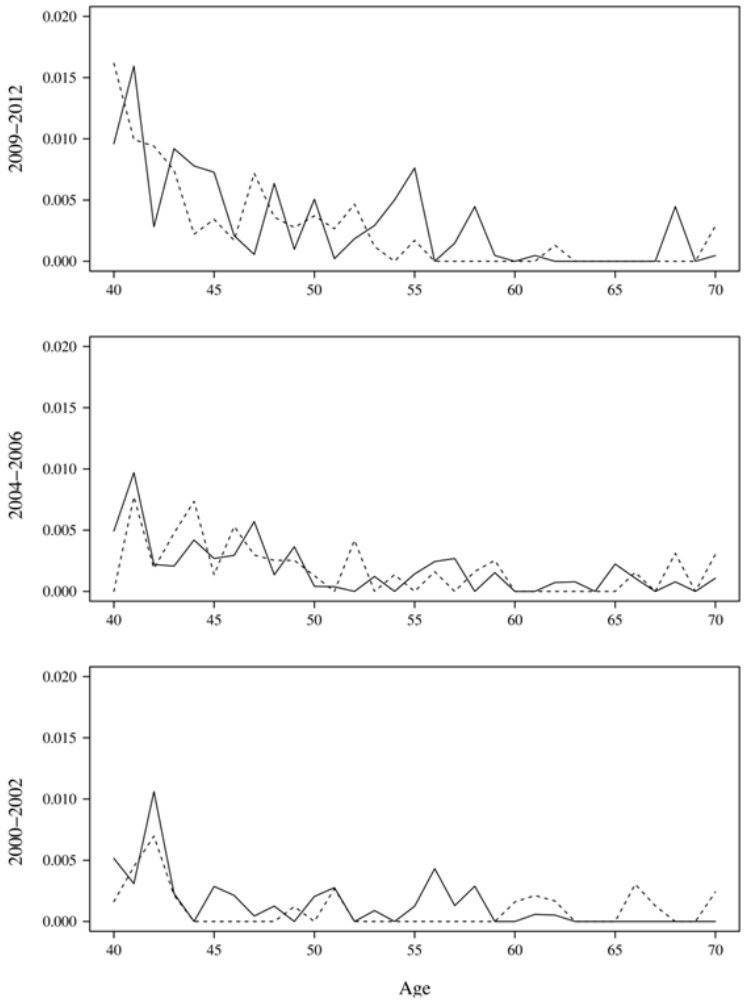


These data do *not* suggest much temporal variation between the overlap of the population and fishing effort

Information on dome-shaped fishery selectivity

Information from fishery and survey age composition data, for ages in the plus group (ages 40 – 70+)

Survey – solid lines
Fishery – dashed lines



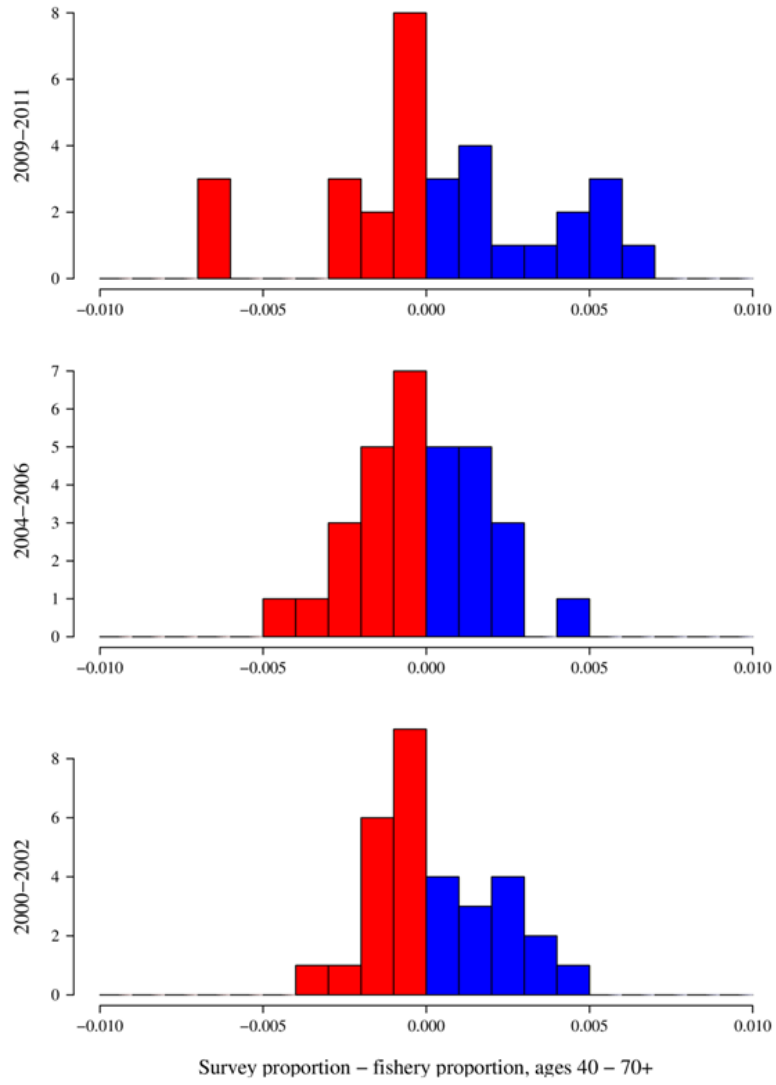
Proportion of age comp in the plus group

2010 survey 10%
2009, 2011 fishery 5% - 11%

2004, 2006 surveys 5-6%
2004, 2005 fishery 5-6%

2000, 2002 surveys 4-5%
2004, 2005 fishery 2-5%

Information on dome-shaped fishery selectivity



Survey proportion – fishery proportion

positive differences (in blue) indicate higher frequencies in the survey

I do not see much of a pattern here

Models evaluated

Model 0) Data updated through 2014, logistic fishery selectivity, age/length composition weights not reiteratively estimated (i.e., the 2012 model)

Model 0.1) Model 0, with the 1980s cooperative survey data removed.

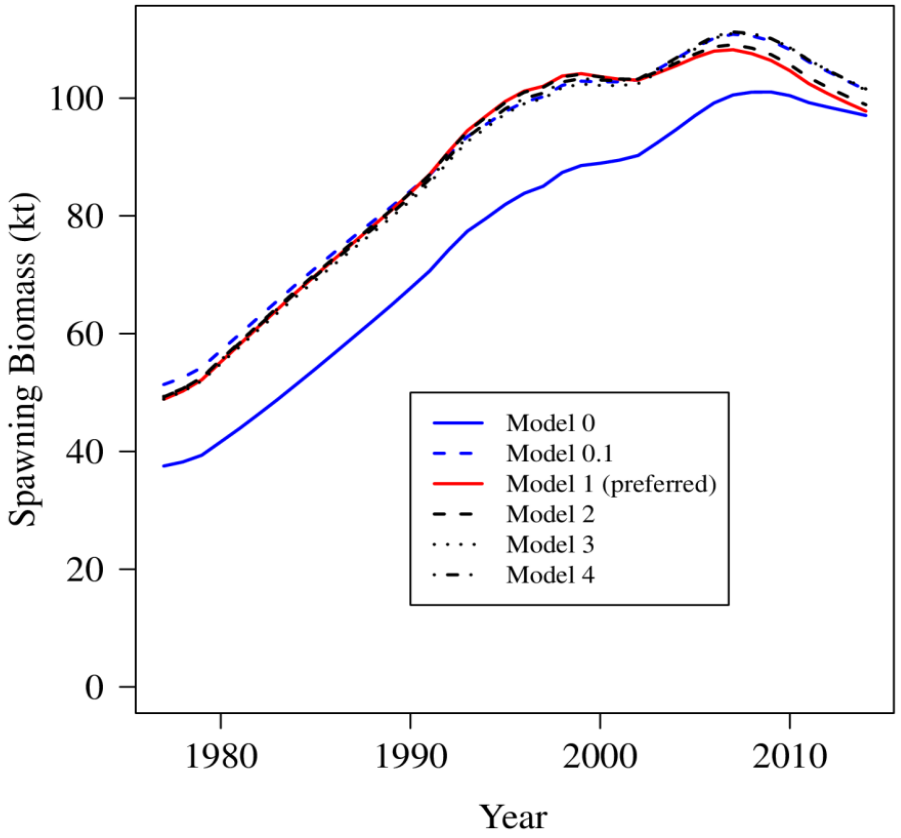
Model 1) Logistic fishery selectivity, cooperative survey data removed, age/length composition weights reiteratively estimated

Model 2) Model 1, but with double logistic selectivity.

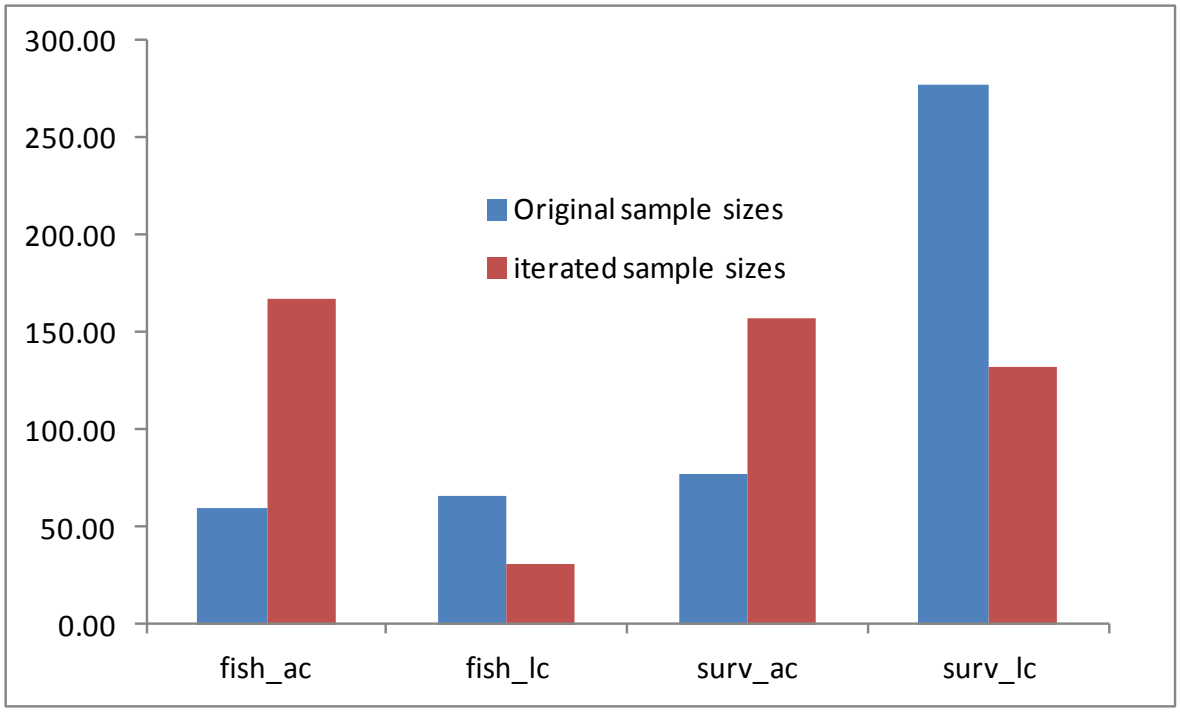
Model 3) Model 1, but a time-invariant cubic spline

Model 4) Model 1, but with a bicubic spline

Effect of the models on spawning stock biomass

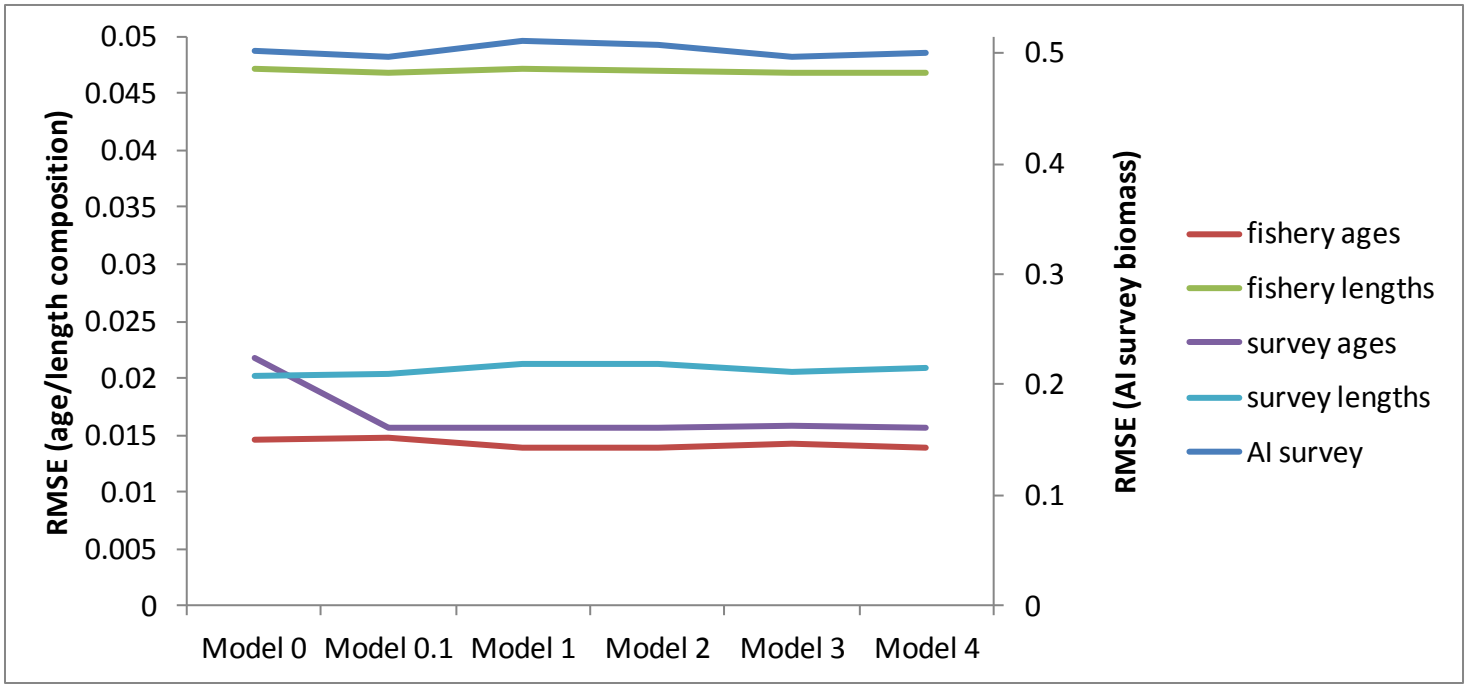


How did the sample sizes change after iterated reweighting?

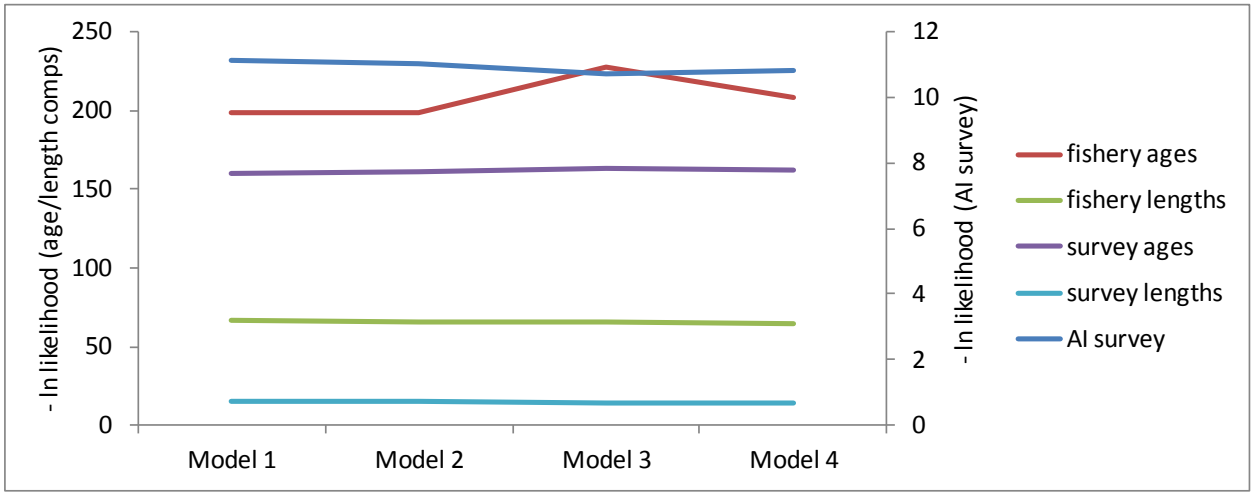


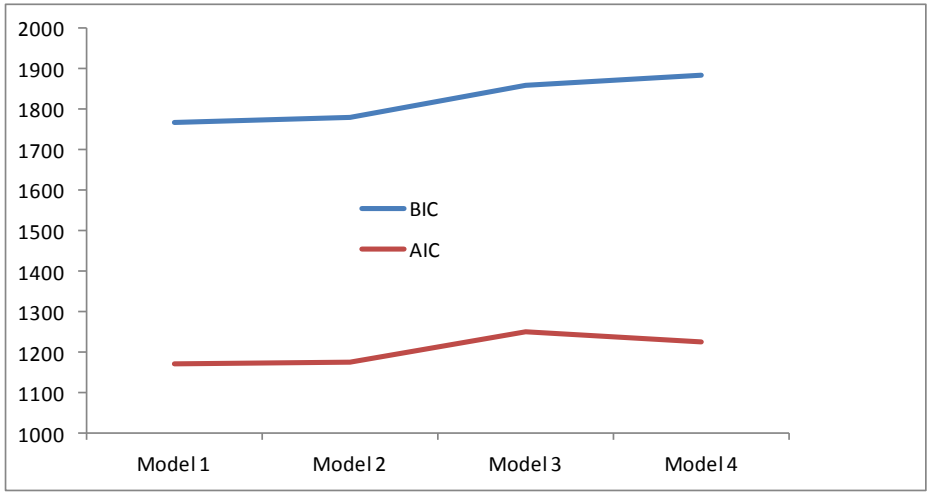
Root mean squared error to various data components

Not much to see here, folks, lets keep it moving along . . .

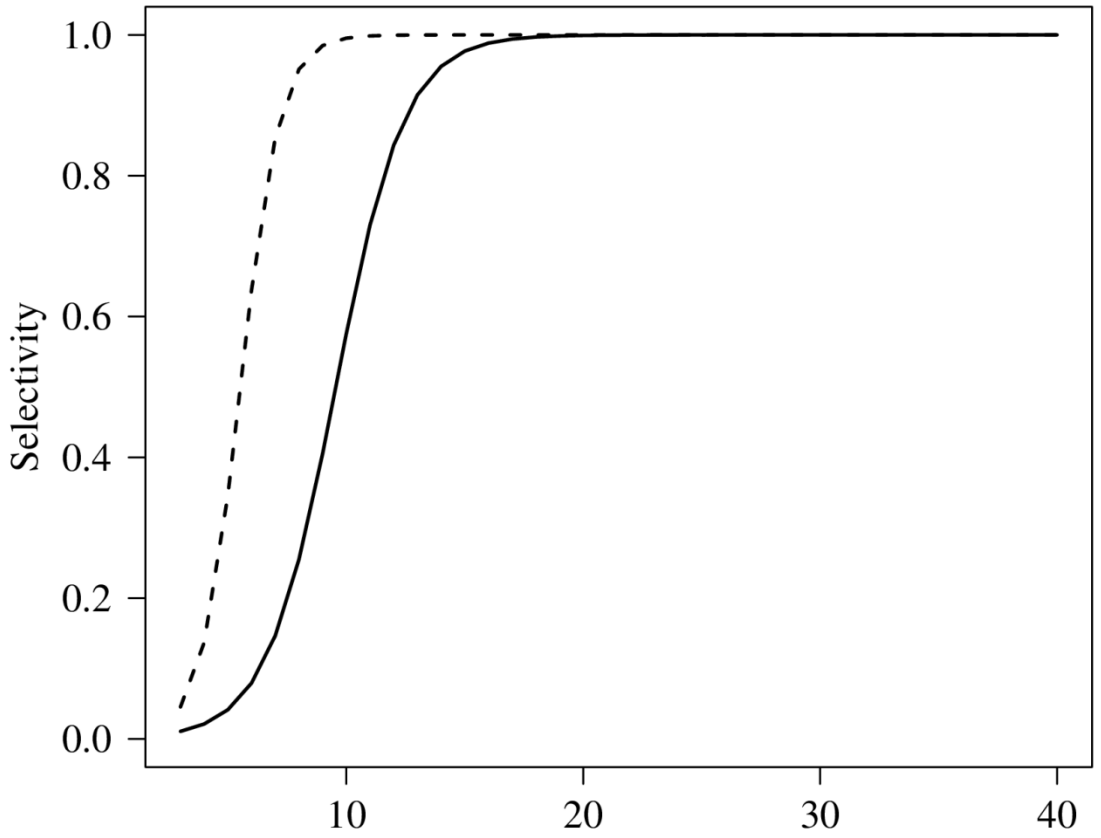


Model fits to data components



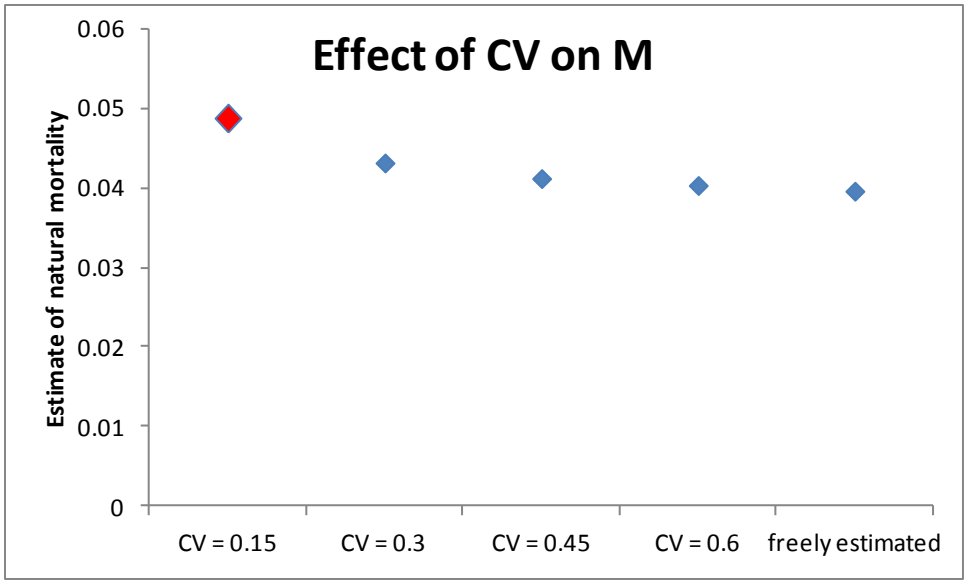


Fishery (solid line) and survey (dashed line) selectivity



Can we estimate *M* or *q* in the model ? No!

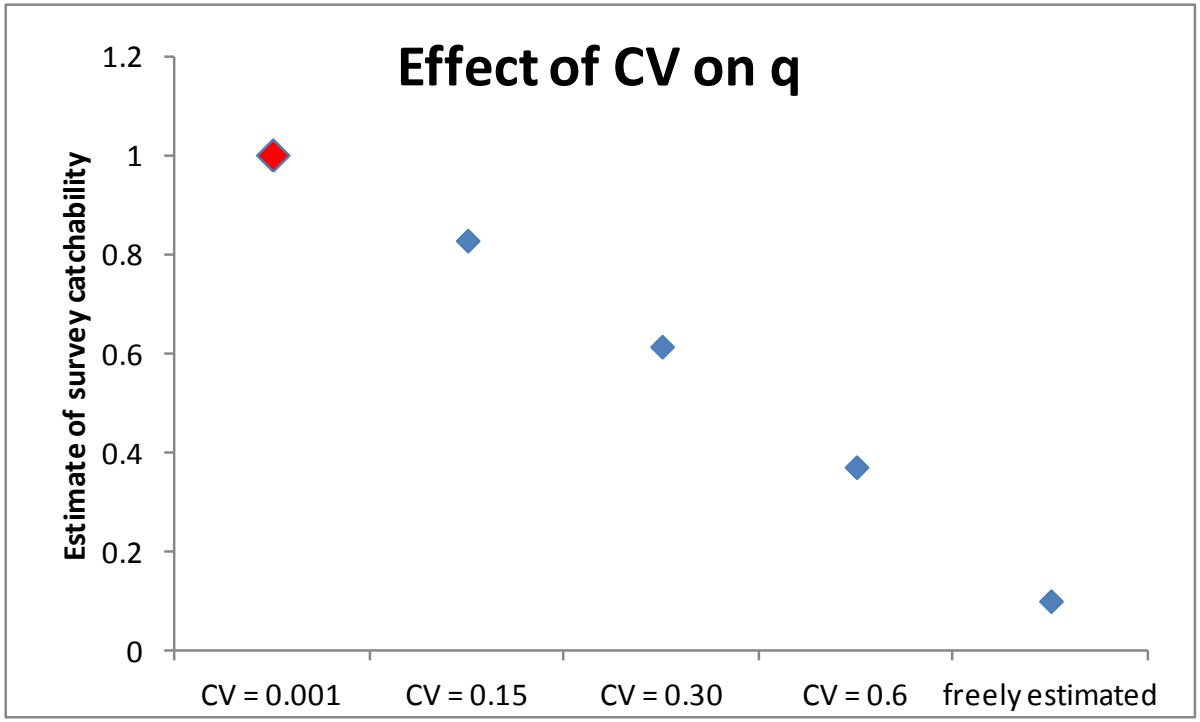
Fix *q* at the 2014 estimate, and relax the prior on *M*



The estimate of M with no prior is 0.04, a decrease over the current estimate of 0.049.

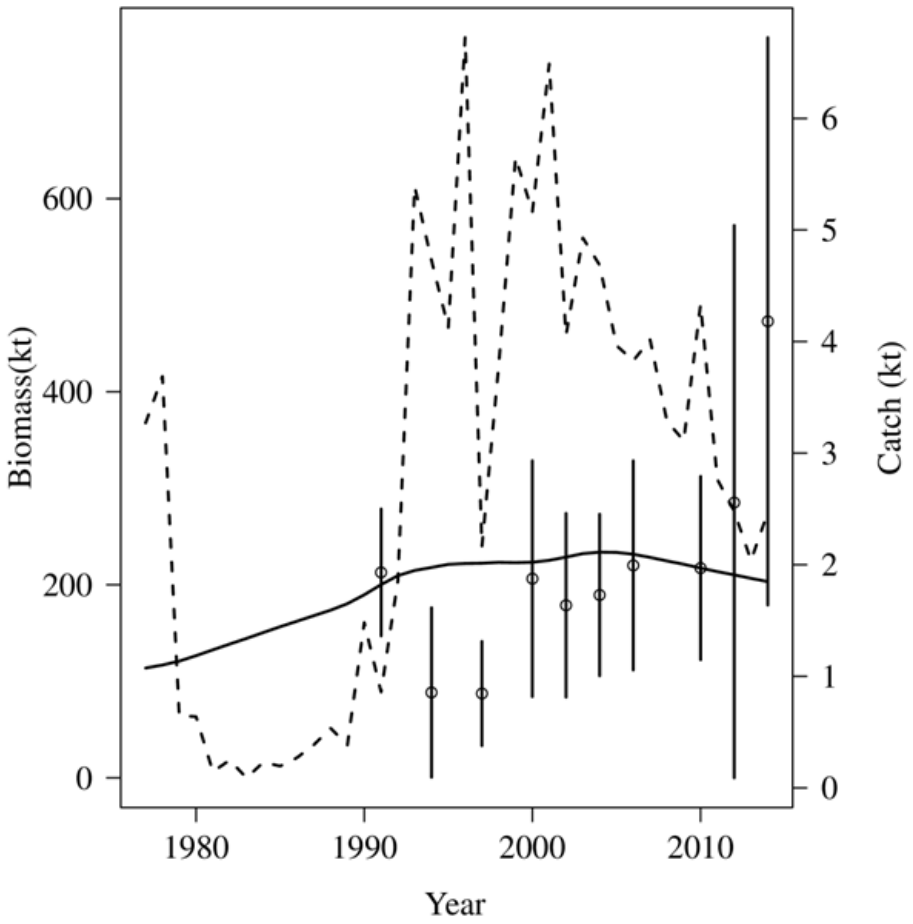
Recent research on empirical estimators for *M* (Then et al. 2014) suggests using a power relationship of t_{max} , and would also produce an estimate of 0.08.

Fix *M* at the 2014 estimate, and relax the prior on *q*

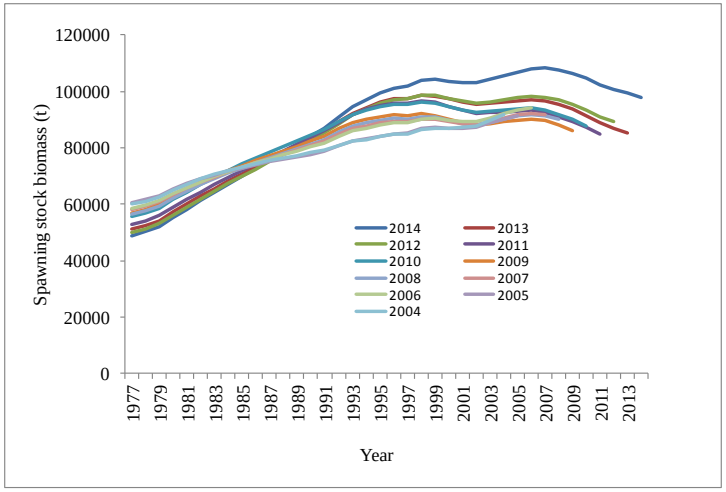


The estimate of *q* with no prior is 0.1, which seems unrealistic.

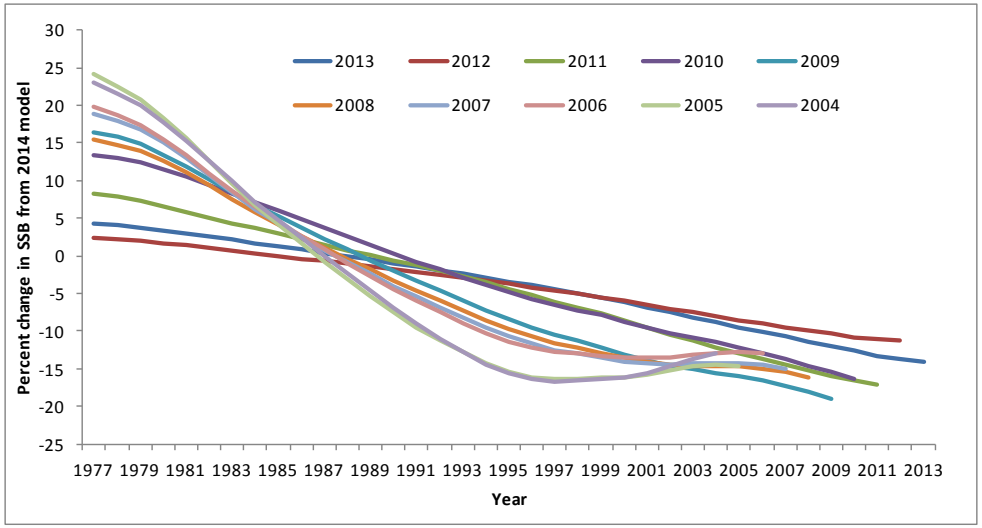
BSAI Northern Rockfish catch and fit to survey data



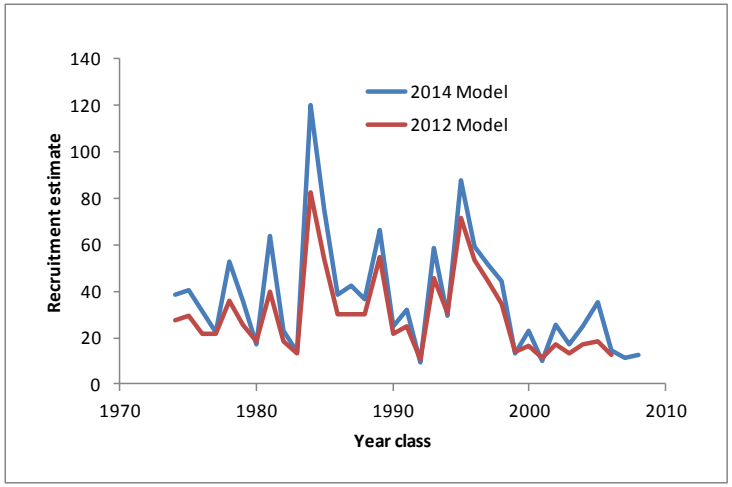
BSAI Northern rockfish retrospective pattern

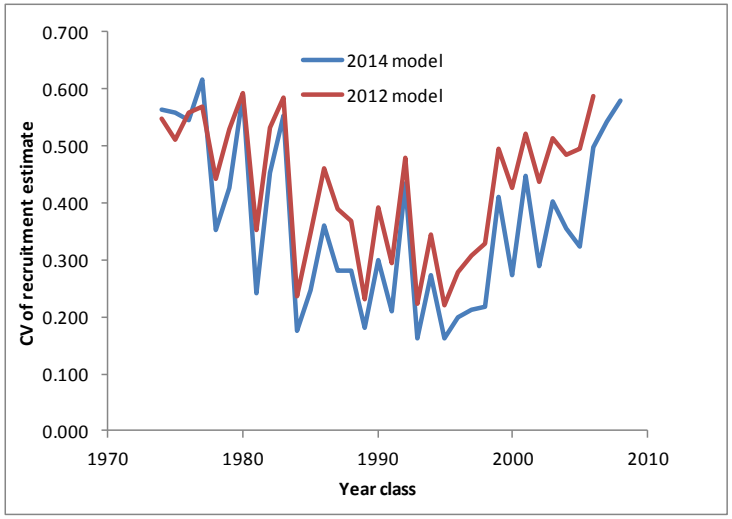


Mohn's rho = -0.150

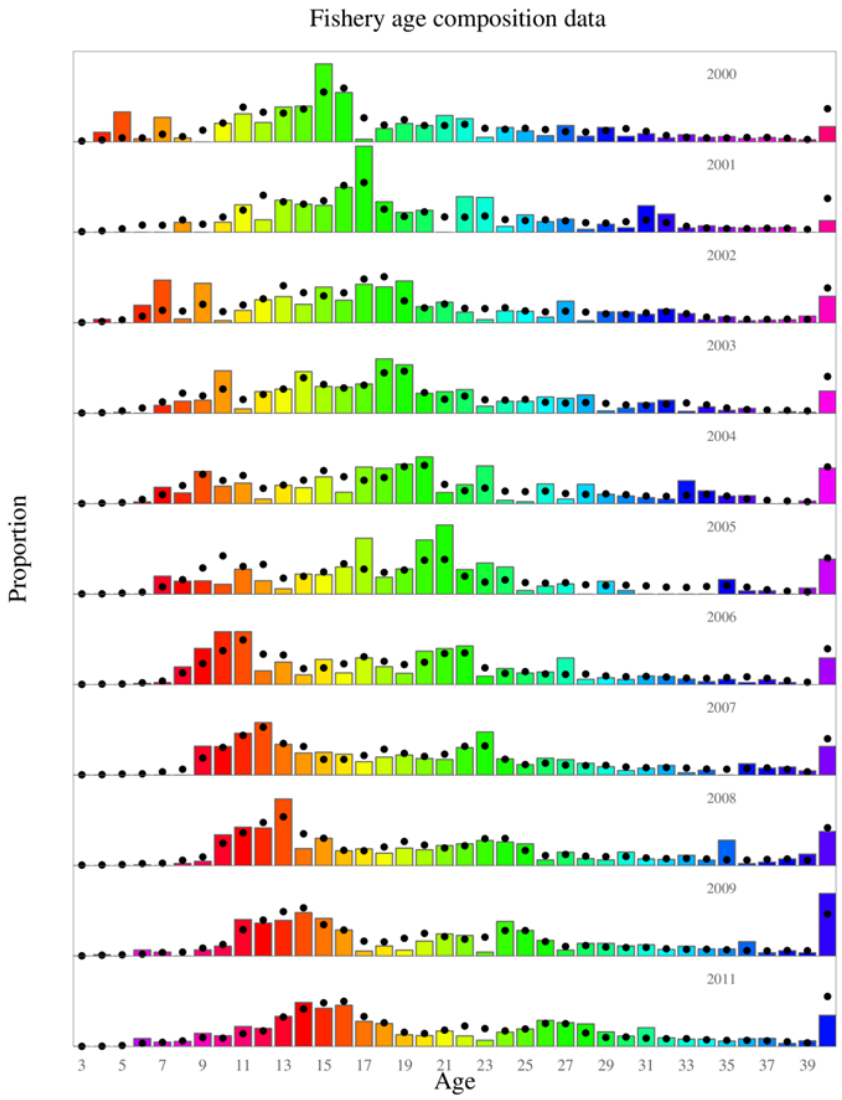


Comparison of recruitment estimates between the 2012 and 2014 models

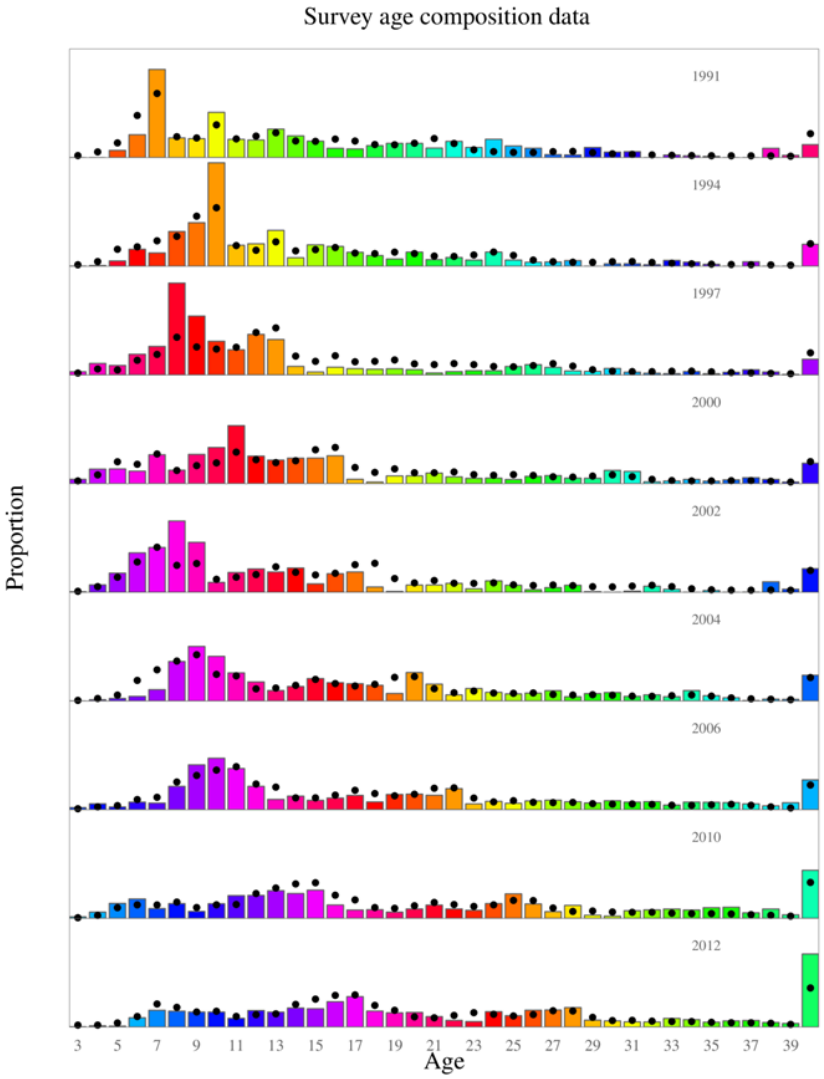




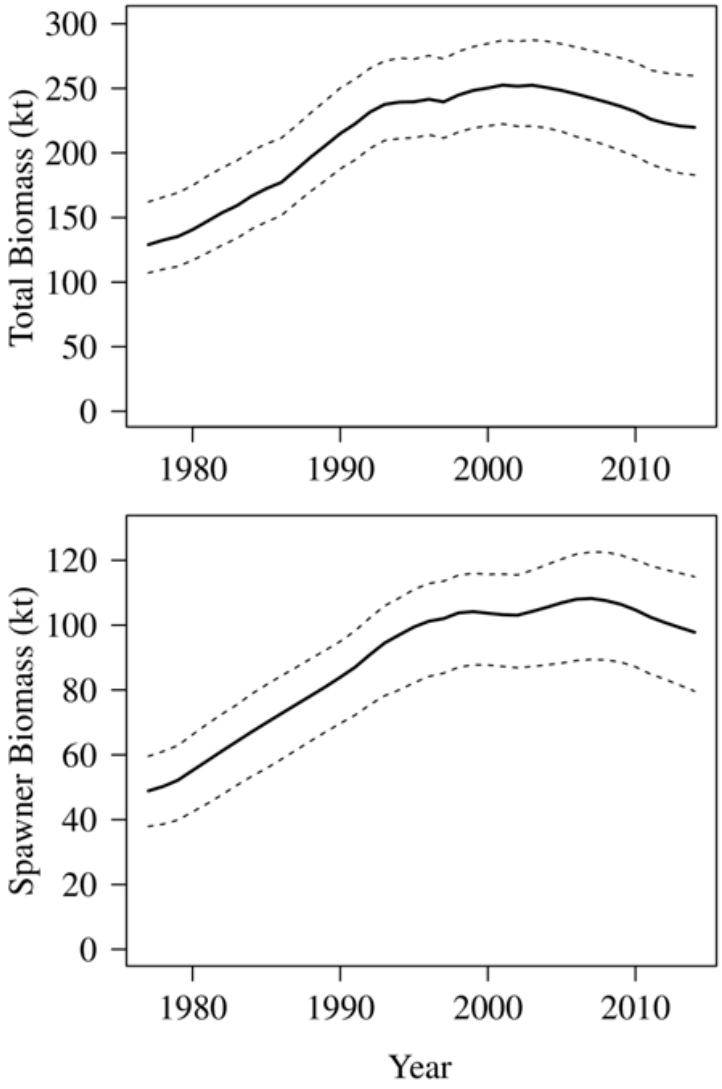
BSAI Northern Rockfish fishery age composition



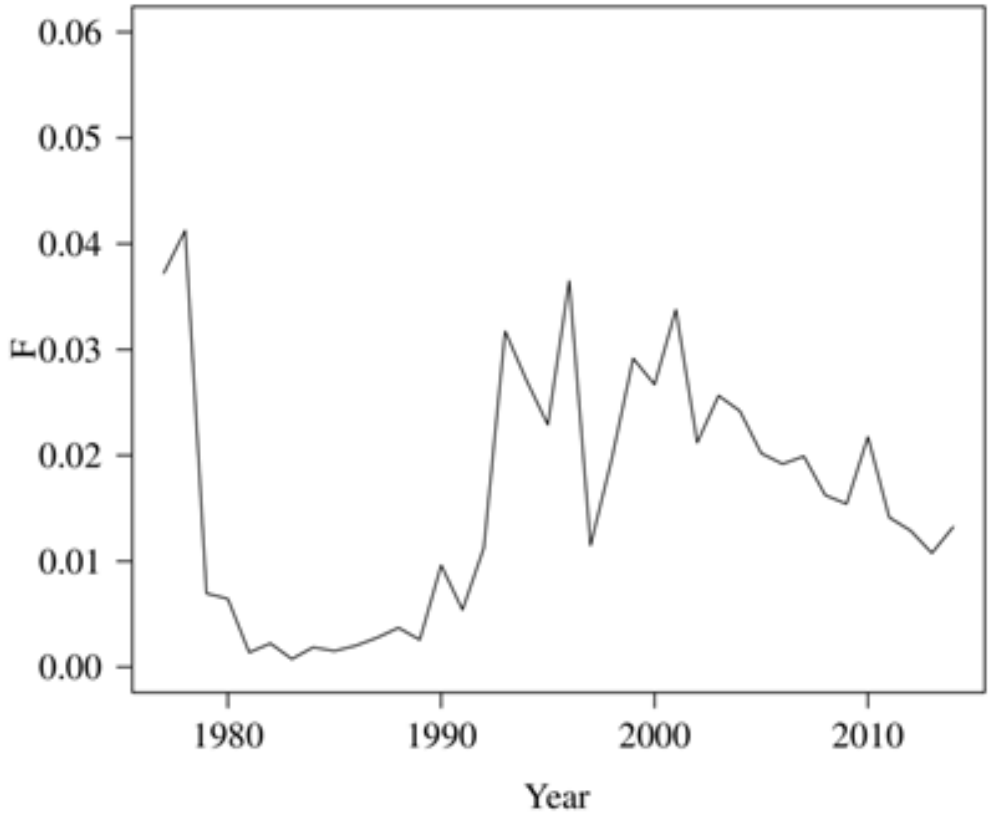
BSAI Northern Rockfish survey age composition



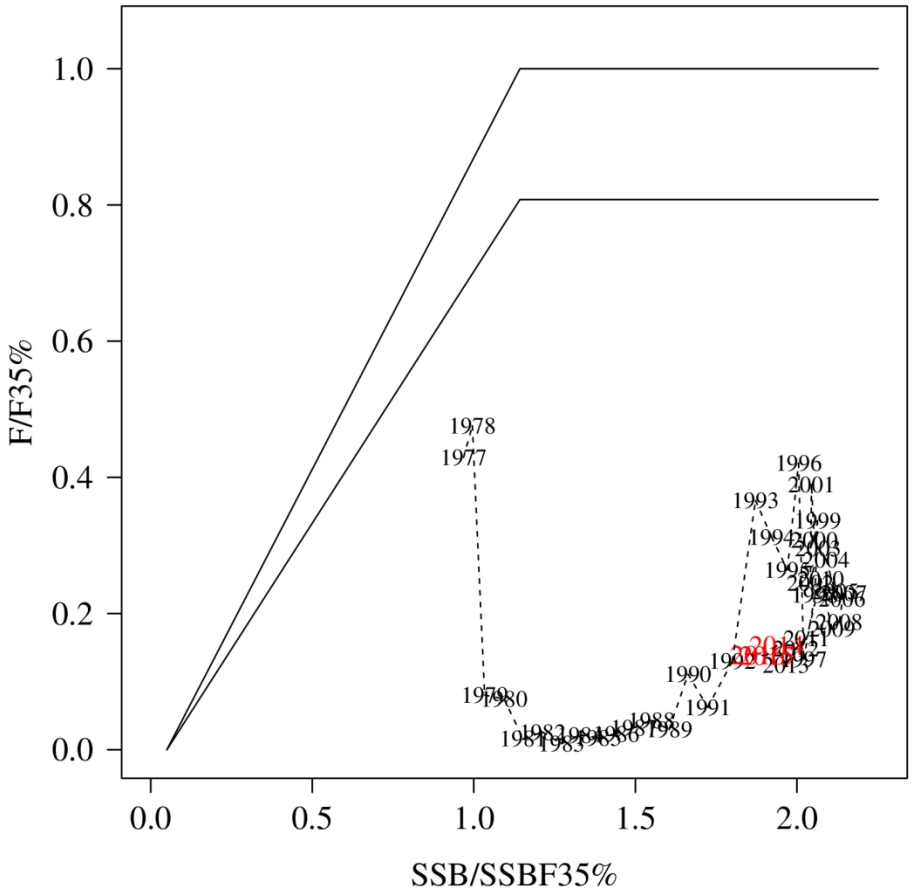
BSAI Northern rockfish total and spawning biomass



BSAI Northern Rockfish *F* estimates

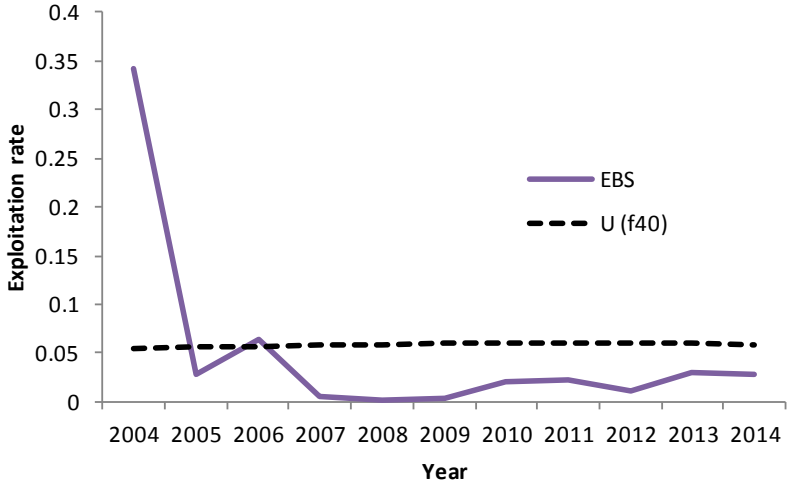


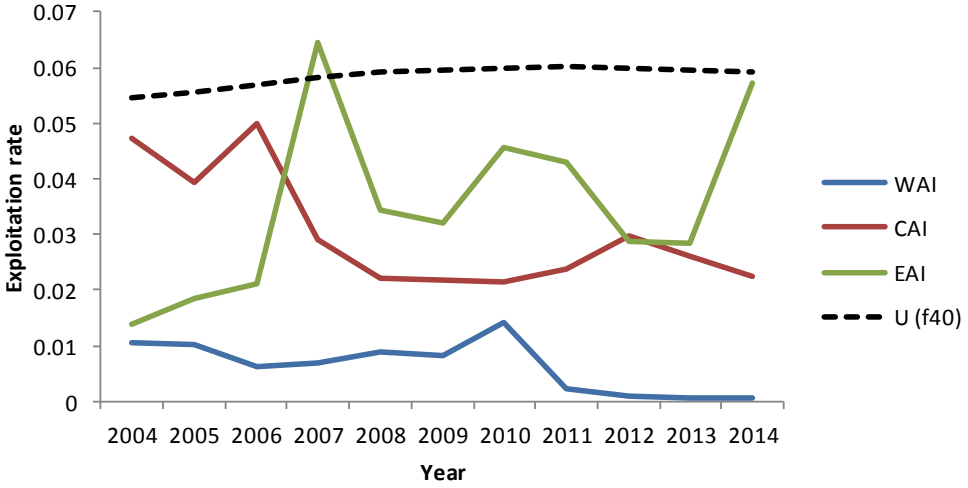
BSAI Northern rockfish phase-plane plot



Area specific exploitation rates for BSAI Northern rockfish

Looks like it is not so much of a problem





Management Recommendations

Estimated reference points

F40% = 0.070
F35% = 0.088
B40% = 57,768 t (decrease from 2013 estimate of 59,167 t)
B35% = 50,547 t (decrease from 2013 estimate of 51,771 t)

Recommended 2015 ABC and OFLs

ABC: 12,488 t (increased from 2014 value of 9,652 t)
OFL: 15,337 t (increased from 2014 value of 11,943 t)

BSAI northern rockfish summary table

Quantity	As estimated or specified last year for: 2014	2015	As estimated or recommended this year for: 2015	2016
M (natural mortality rate)	0.0413	0.0413	0.049	0.049
Tier	3a	3a	3a	3a
Projected total (age 3+) biomass (t)	196,519	197,541	218,901	218,898
Female spawning biomass (t)				
Projected	84,237	83,698	94,873	93,540
$B_{100\%}$	147,918	147,918	144,420	144,420
$B_{40\%}$	59,167	59,167	57,768	57,768
$B_{35\%}$	51,771	51,771	50,547	50,547
F_{OFL}	0.079	0.079	0.088	0.088
$maxF_{ABC}$	0.063	0.063	0.070	0.070
F_{ABC}	0.063	0.063	0.070	0.070
OFL (t)	12,077	11,943	15,337	15,100
maxABC (t)	9,761	9,652	12,488	12,295
ABC (t)	9,761	9,652	12,488	12,295
Status	As determined last year for: for: 2012	2013	As determined this year for: 2013	2014
Overfishing	No	n/a	No	n/a
Overfished	n/a	No	n/a	No
Approaching overfished	n/a	No	n/a	No