NORTHERN ROCK SOLE

BY

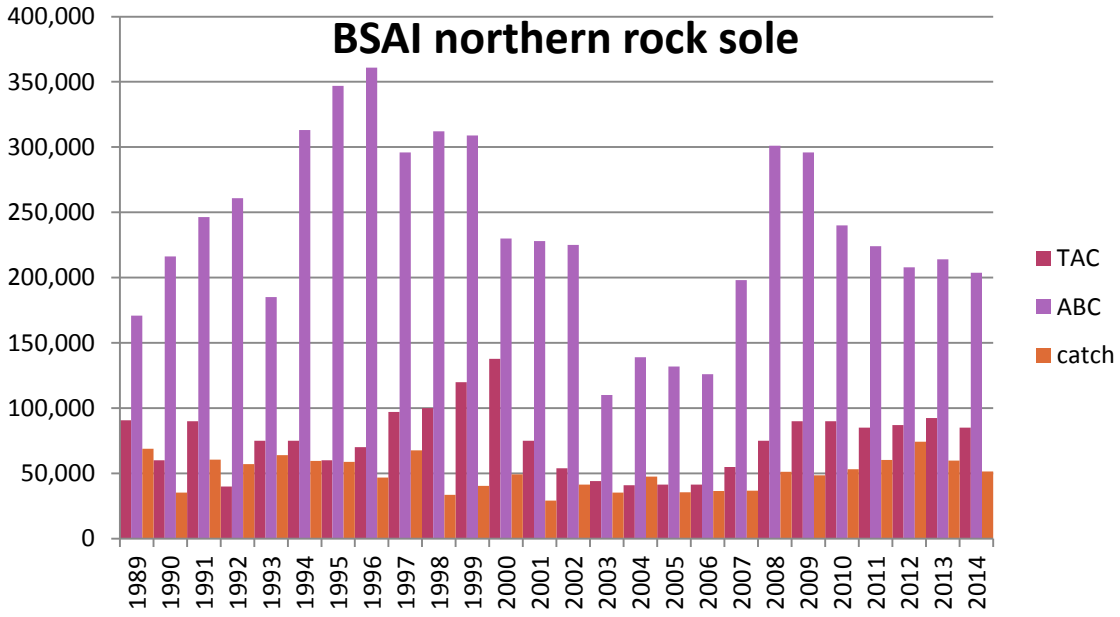
WILDERBUER, NICHOL AND IANELLI

CHANGES IN THE ASSESSMENT BETWEEN 2012 AND 2014

Last year the assessment model was not run to include the new 2013 survey biomass and 2012 age composition information from the survey and fishery.

This year all available information is included in the assessment model. No new changes in the methodology are presented.

Survey biomass 6% increase from 2013


BSAI northern rock sole
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
0
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
TAC
ABC
catch

SUMMARY

Model 1

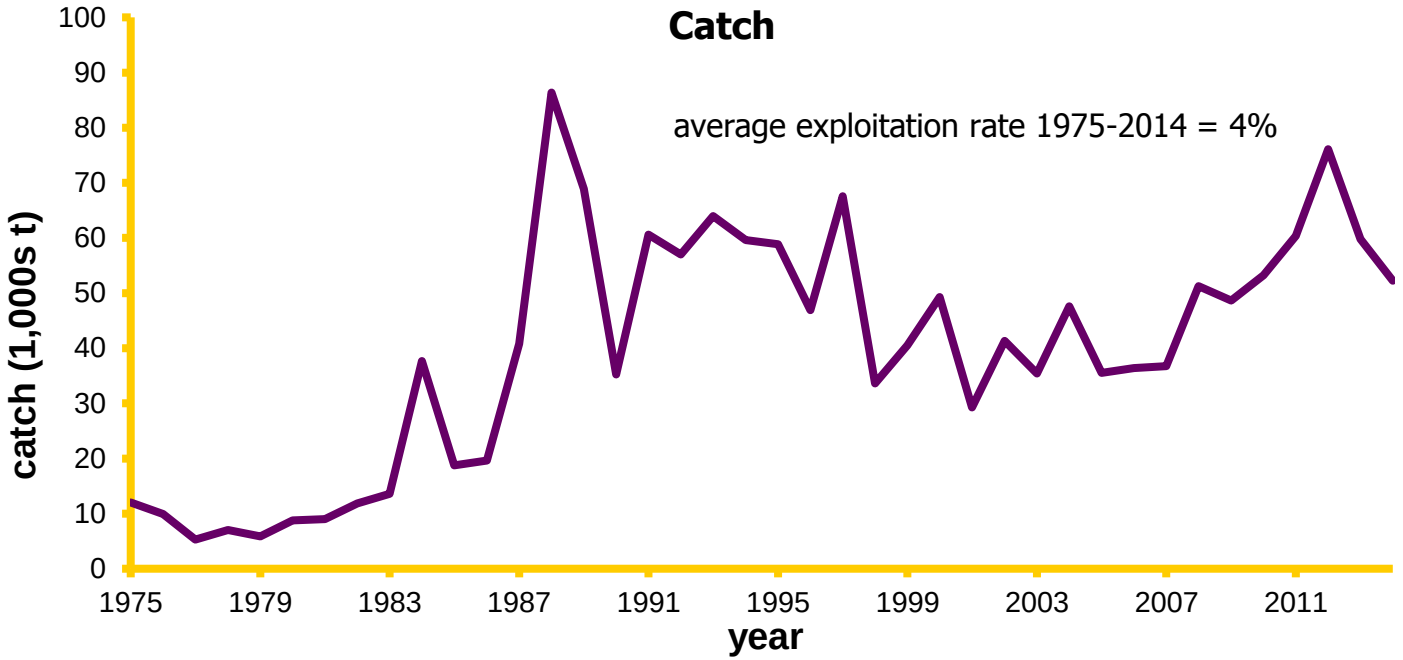
Quantity	As estimated or *specified last* year for: 2014	2015	As estimated or *recommended this* year for: **2015**	**2016**
M (natural mortality rate)	0.15	0.15	**0.15**	**0.15**
Tier	1a	1a	**1a**	**1a**
Projected total (age 6+) biomass (t)	1,555,700	1,456,600	**1,233,400**	**1,118,700**
Female spawning biomass (t)	713,200	698,800	**622,300**	**589,800**
Projected				
B_0	694,500		**694,500**	
B_{MSY}	260,000	260,000	**260,000**	**260,000**
F_{OFL}	0.16	0.16	**0.152**	**0.152**
$maxF_{ABC}$	0.143	0.143	**0.143**	**0.143**
F_{ABC}	0.143	0.143	**0.143**	**0.143**
OFL (t)	249,000	233,100	**187,600**	**170,100**
maxABC (t)	222,500	208,300	**181,700**	**164,800**
ABC (t)	222,500	208,300	**181,700**	**164,800**
Status	As determined *last* year for: 2012	2013	As determined *this* year for: 2013	2014
Overfishing	No	No	No	No
Overfished	No	No	No	No
Approaching overfished	No	No	No	No

SUMMARY

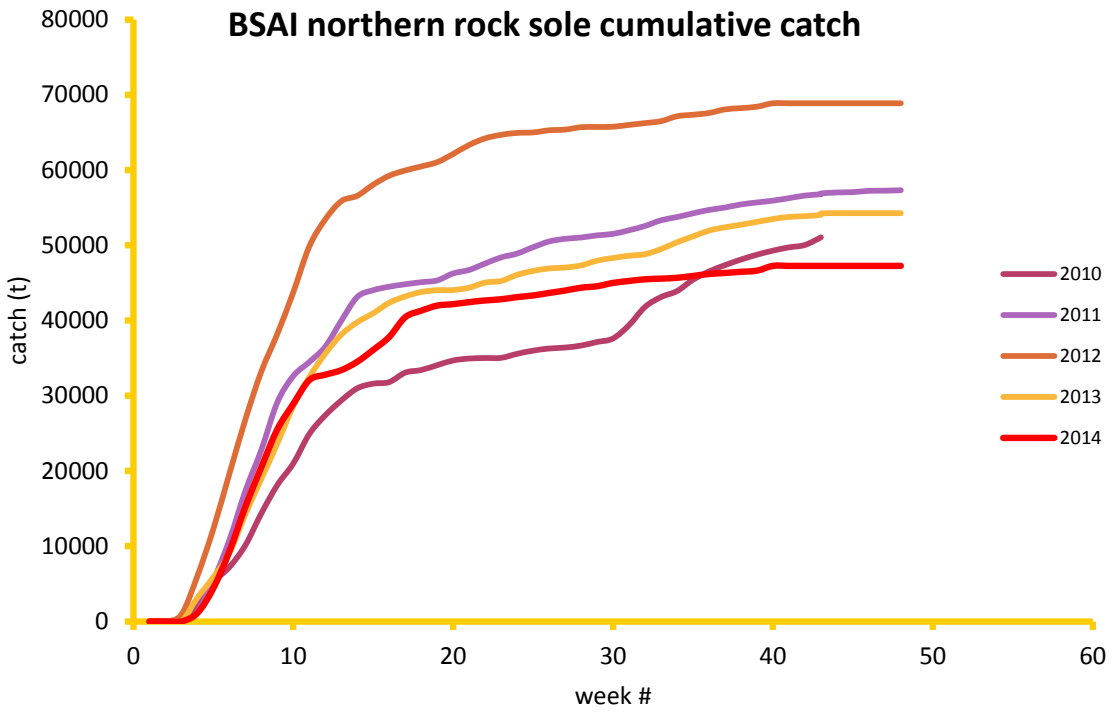
Model 1a

Quantity	As estimated or *specified last* year for: 2014	2015	As estimated or *recommended this* year for: 2015	2016
M (natural mortality rate)	0.15	0.15	0.15	0.15
Tier	1a	1a	1a	1a
Projected total (age 6+) biomass (t)	1,555,700	1,456,600	1,337,000	1,216,000
Female spawning biomass (t)	713,200	698,800	676,500	643,000
Projected				
B_0	694,500		694,500	
B_{MSY}	260,000	260,000	260,000	260,000
F_{OFL}	0.16	0.16	0.150	0.150
$maxF_{ABC}$	0.143	0.143	0.146	0.146
F_{ABC}	0.143	0.143	0.146	0.146
OFL (t)	249,000	233,100	201,300	183,100
maxABC (t)	222,500	208,300	195,000	177,400
ABC (t)	222,500	208,300	195,000	177,400
Status	As determined *last* year for: 2012	2013	As determined *this* year for: 2013	2014
Overfishing	No	No	No	No
Overfished	No	No	No	No
Approaching overfished	No	No	No	No

2014 CATCH = 51,549 T (THROUGH 11/8/14) AVERAGE 1975-2014 EXPLOITATION RATE = 0.04

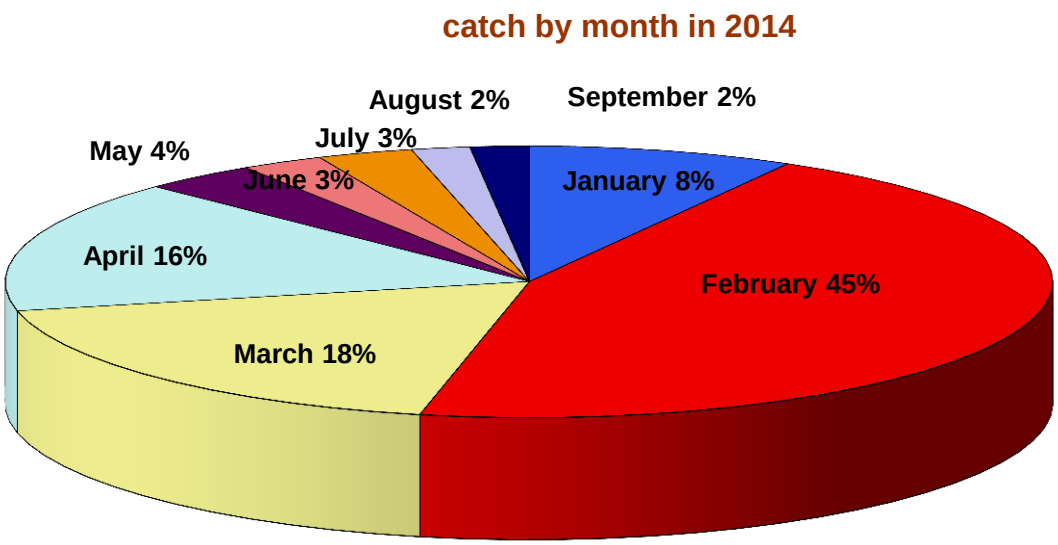


NORTHERN ROCK SOLE



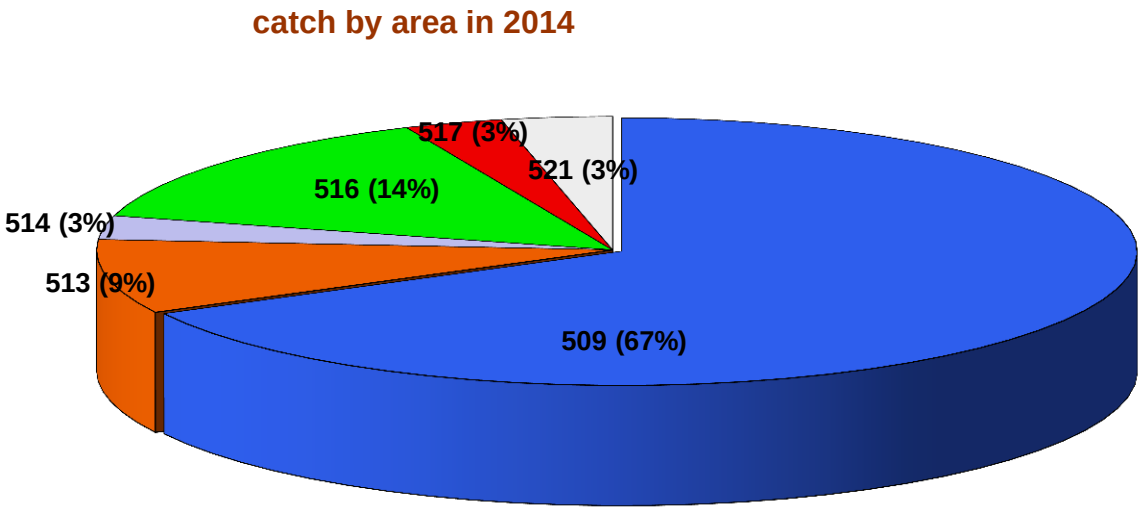
NORTHERN ROCK SOLE

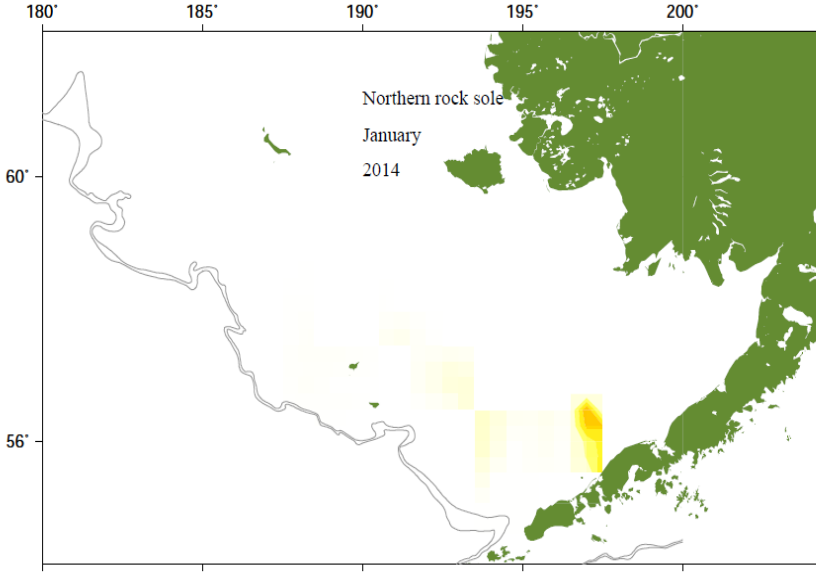
CATCH BY MONTH IN 2014

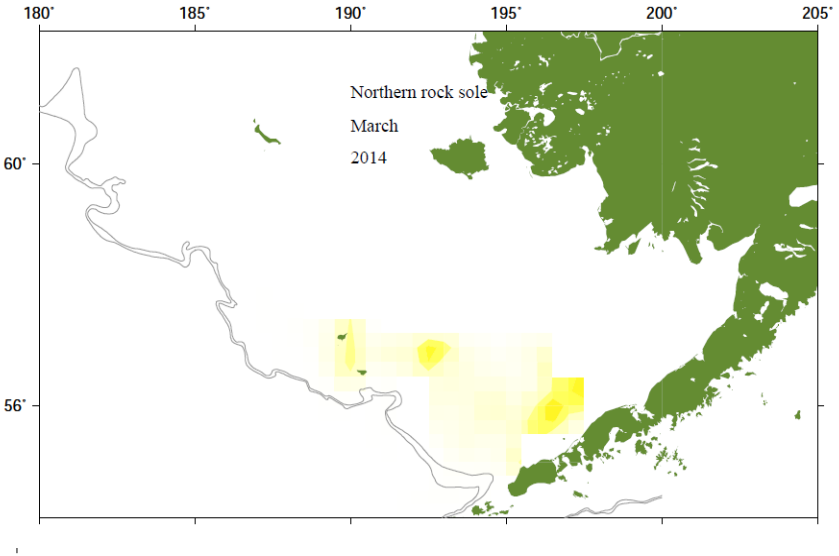


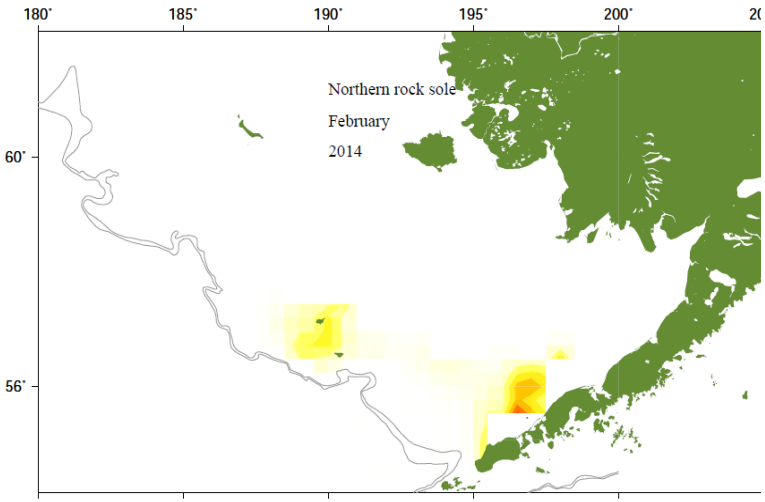
NORTHERN ROCK SOLE

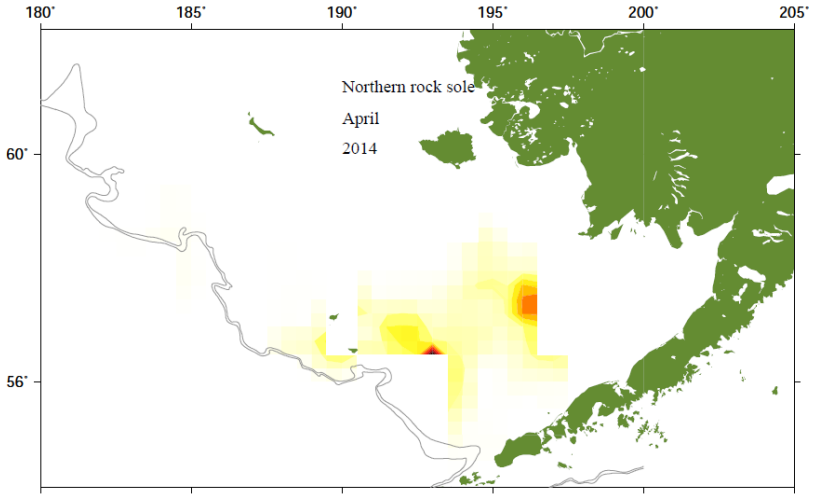
CATCH BY AREA IN 2014

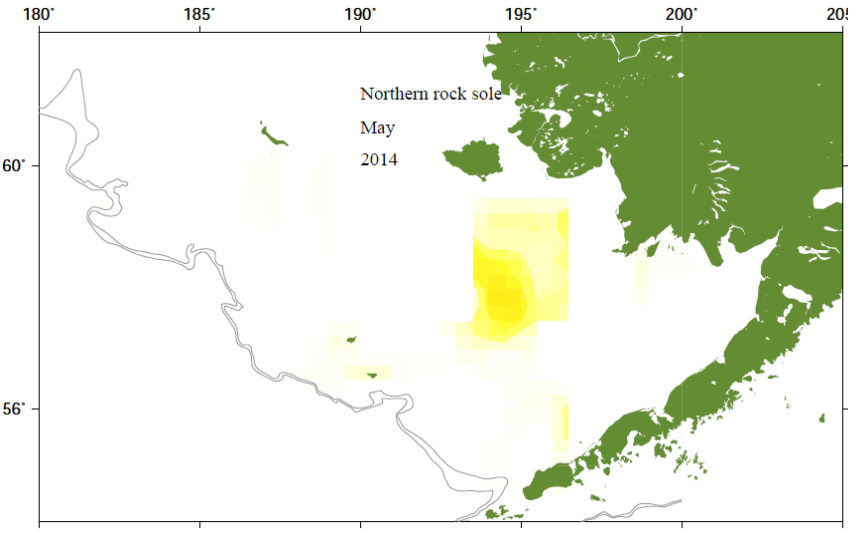


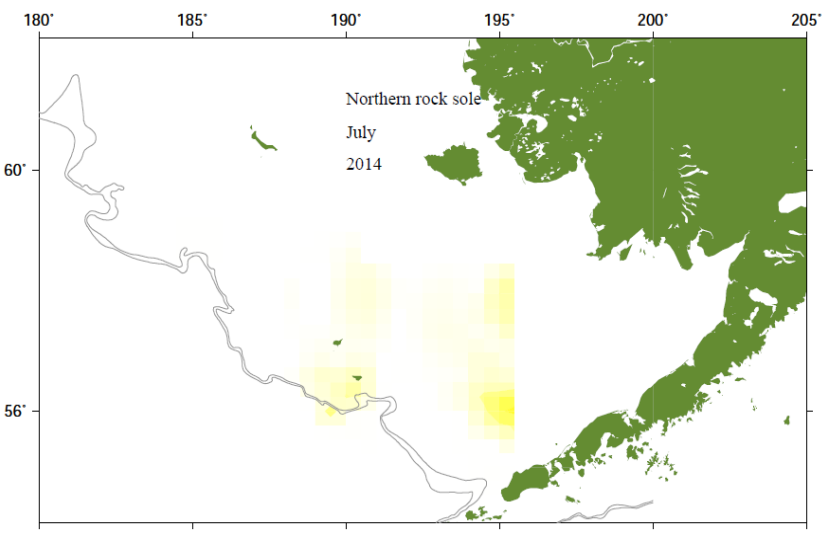

180°
185°
190°
195°
200°
60°
56°
Northern rock sole
January
2014

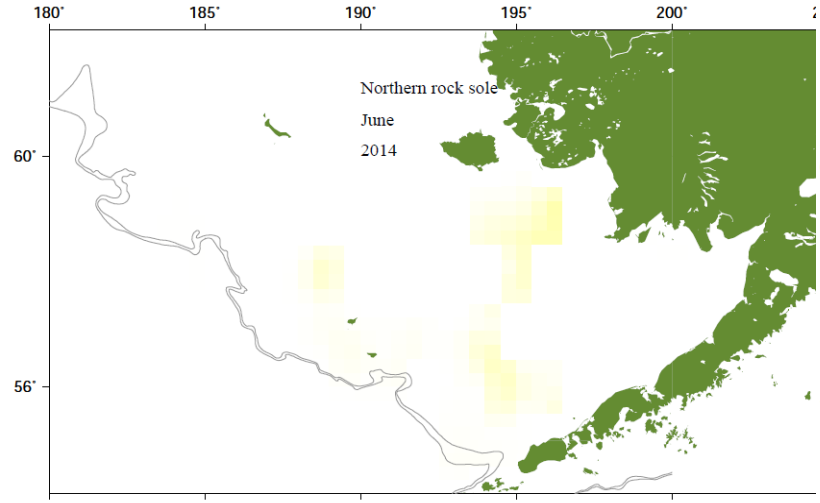

180°
185°
190°
195°
200°
205°
60°
56°
Northern rock sole
March
2014

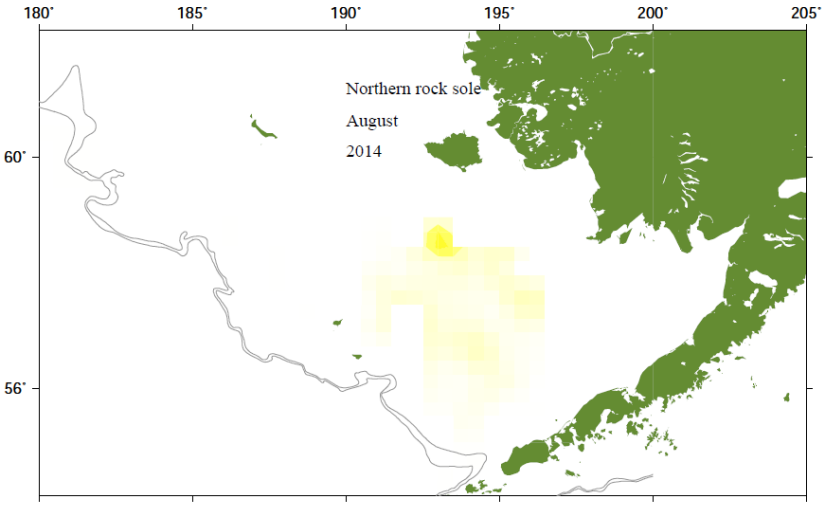

180°
185°
190°
195°
200°
60°
56°
Northern rock sole
February
2014


180°
185°
190°
195°
200°
205°
60°
56°
Northern rock sole
April
2014

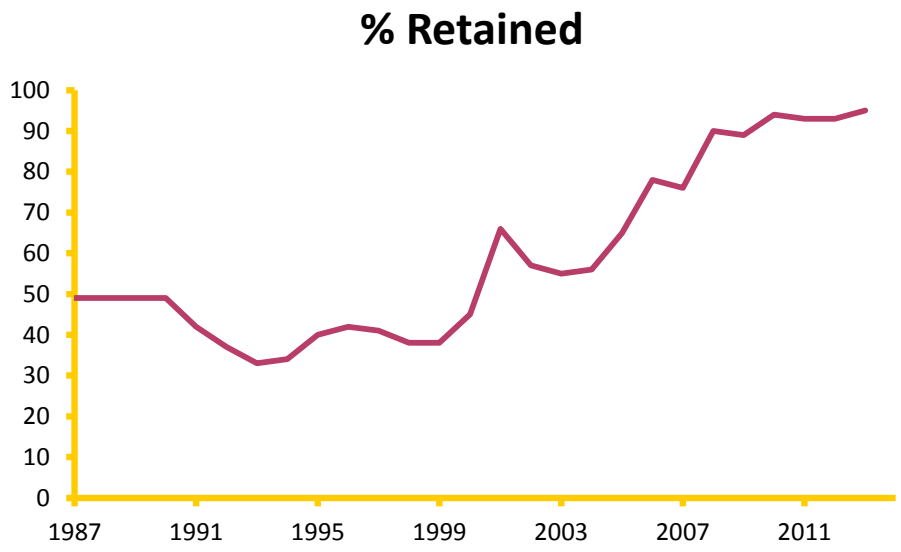

180°
185°
190°
195°
200°
60°
56°
Northern rock sole
May
2014


180°
185°
190°
195°
200°
205°
60°
56°
Northern rock sole
July
2014

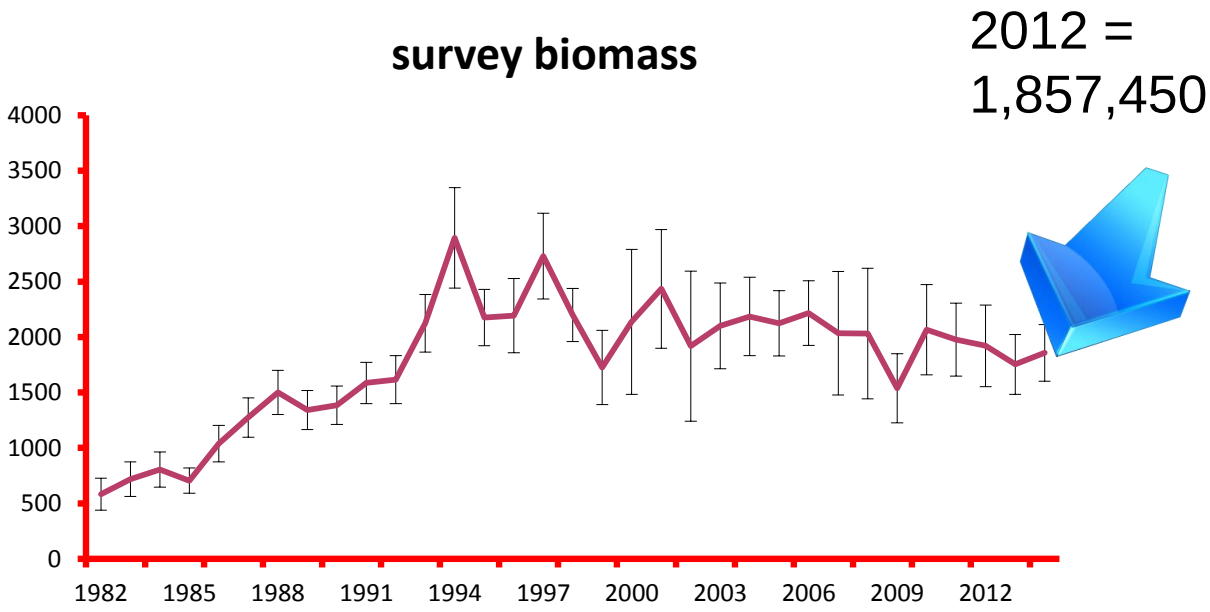

180°
185°
190°
195°
200°
60°
56°
Northern rock sole
June
2014


180°
185°
190°
195°
200°
205°
60°
56°
Northern rock sole
August
2014

95% RETAINED IN 2013

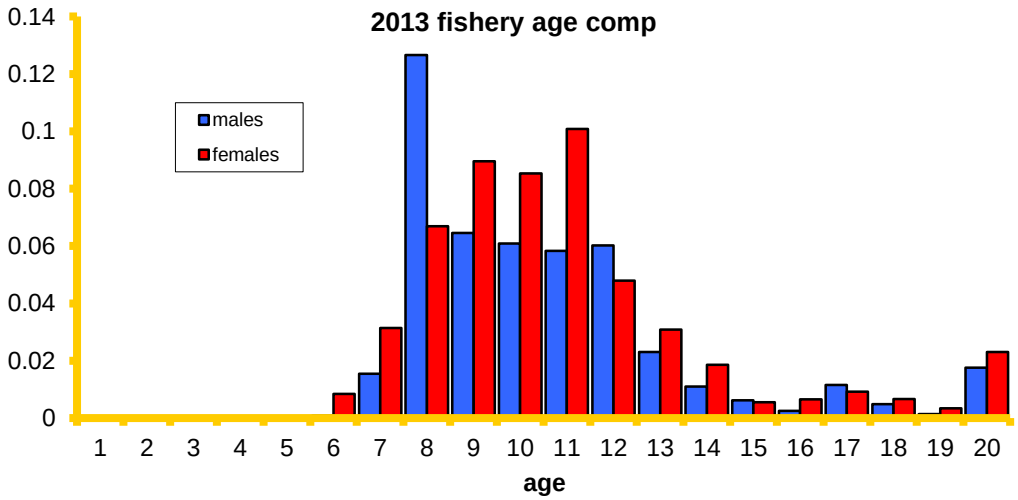


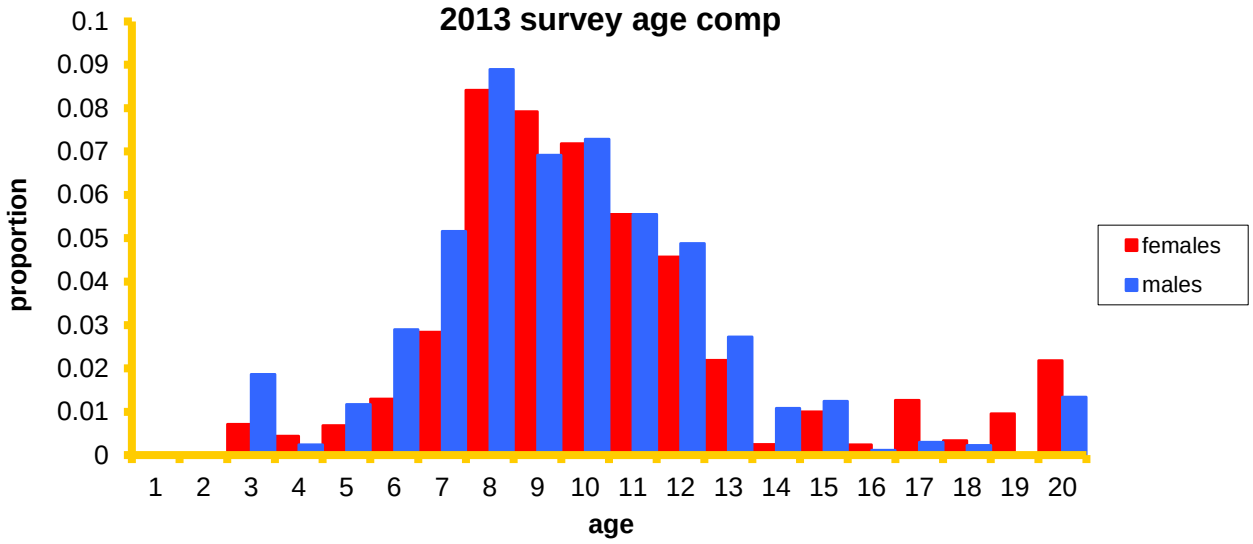
SURVEY BIOMASS:
8% INCREASE FROM 2013 TO 2014



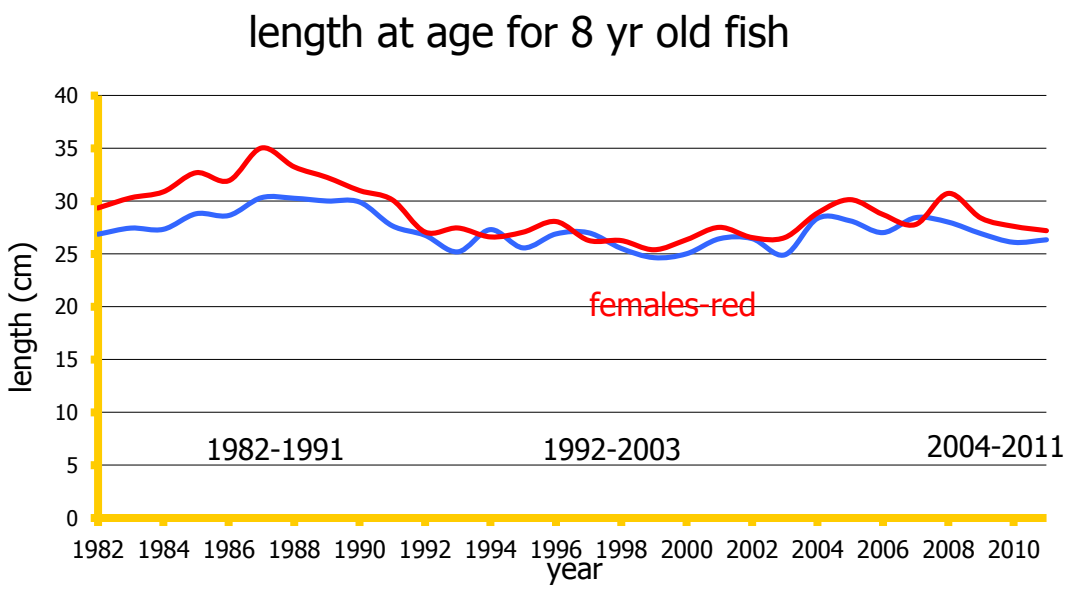
2012 = 1,857,450 t

2013 AGE COMPOSITIONS

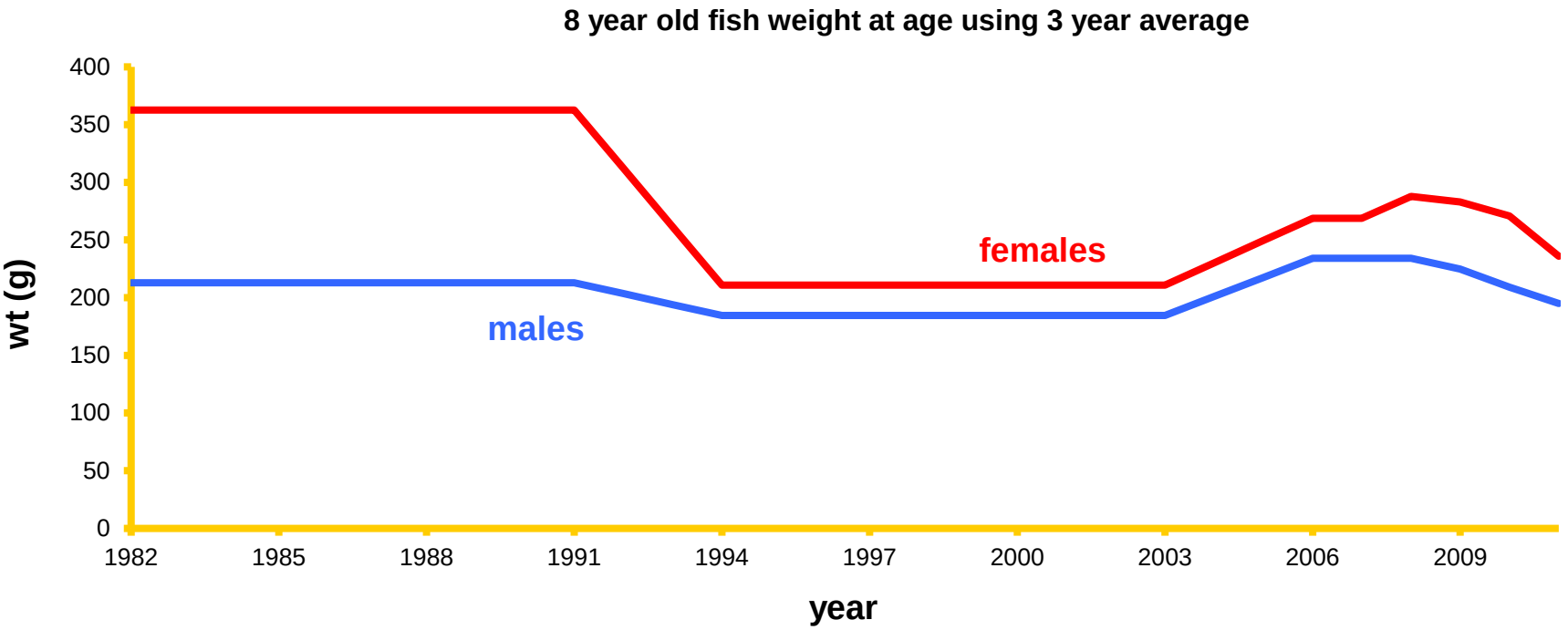




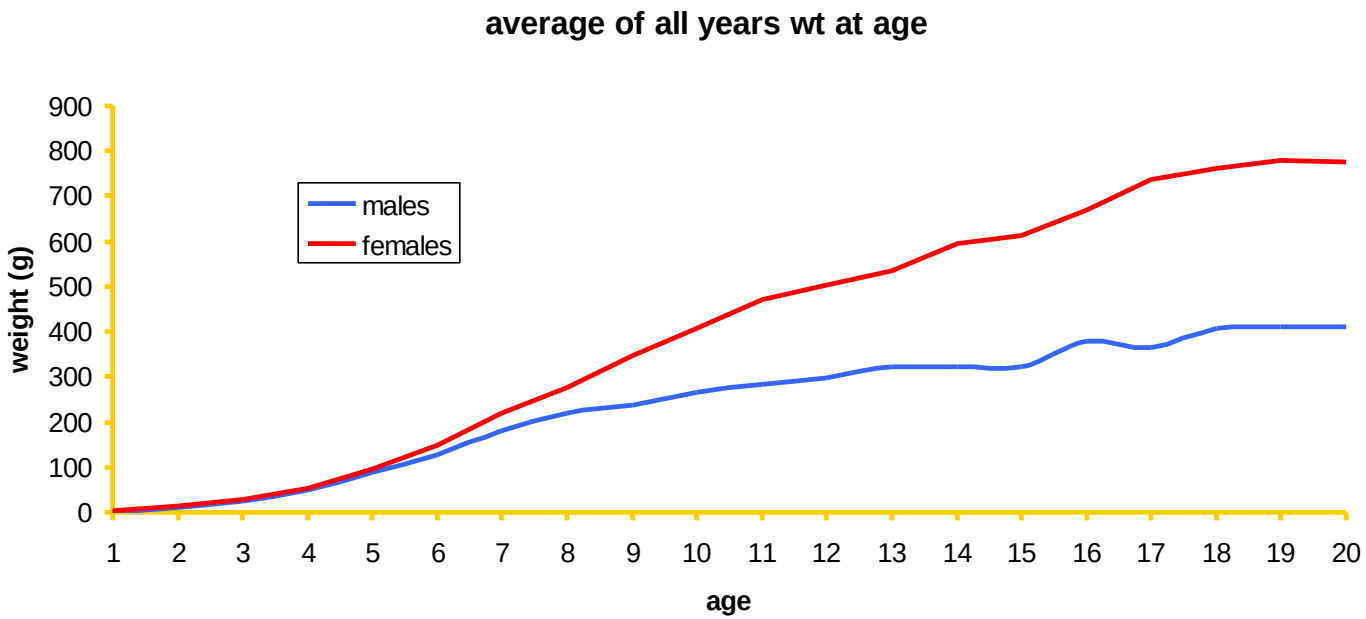
LENGTH AT AGE FROM SURVEY AGE COMPOSITIONS



WEIGHT AT AGE FROM SURVEY AGE COMPOSITIONS USING A THREE YEAR MOVING AVERAGE



WEIGHT AT AGE FROM SURVEY AGE COMPOSITIONS



FLATFISH SPLIT-SEX MODEL

input:

sex-specific estimates of fishery and survey age composition and weight at age

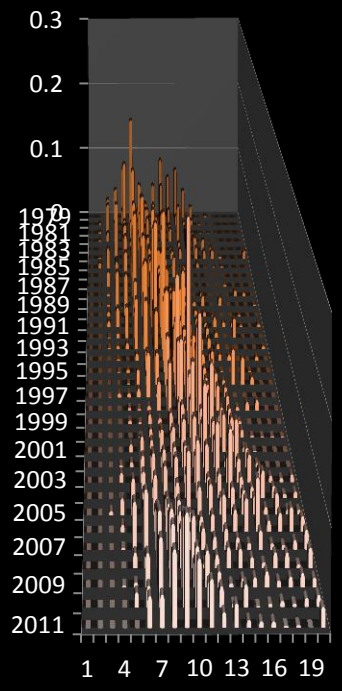
output:

Sex-specific estimates of population number, fishing mortality, selectivity, fishery and survey age composition.

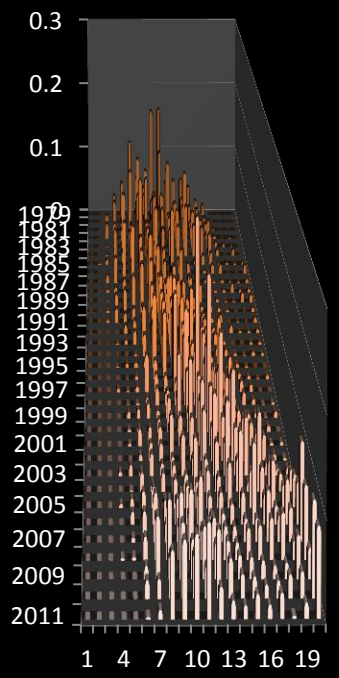
Allows for estimation of sex-specific natural mortality

FISHERY AGE COMPOSITION

males

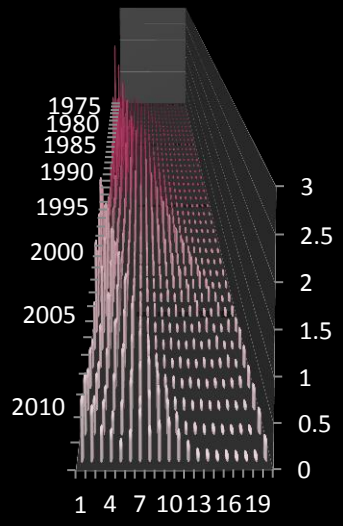


females

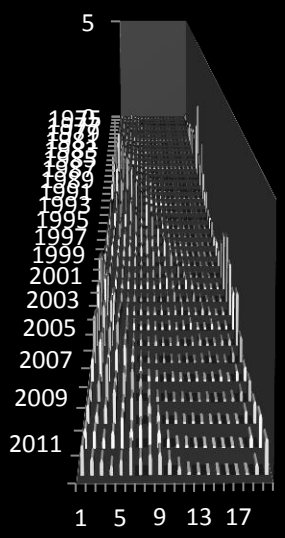


SURVEY AGE COMPOSITION

females

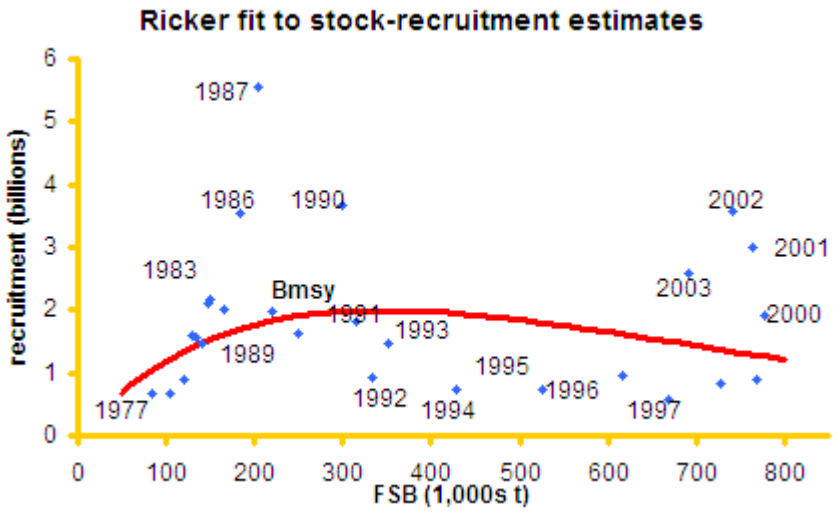


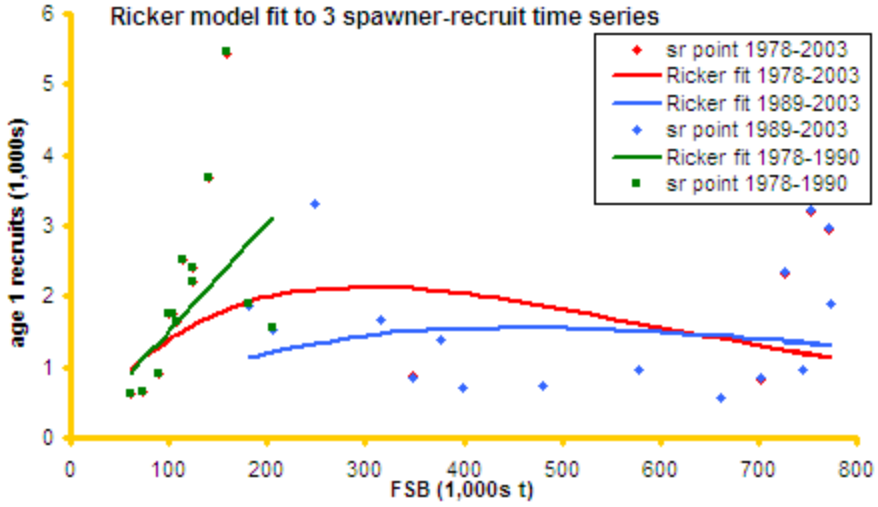
males



STOCK ASSESSMENT MODEL

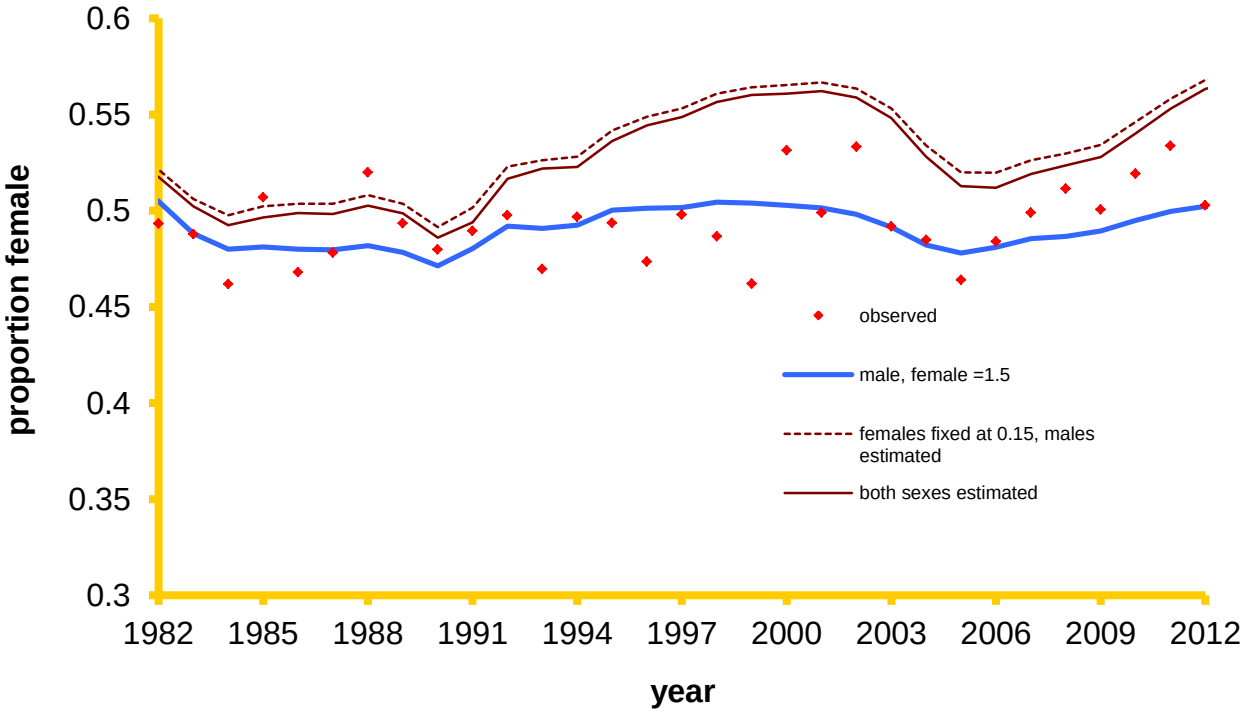
- Data components include fishery and trawl survey age compositions and survey biomass and standard error
- Split-sex model, selectivity is fixed asymptotic for older fish
- Ricker form of the stock-recruitment curve is fit inside the model
- Gender-specific time-variant fishery selectivity
- Catchability (q) is constrained to a value near the estimate of q from a trawl herding experiment using the shelf survey trawl (Somerton and Munro 2001)
- Natural mortality is estimated as free parameters in some model runs and fixed at 0.15 in other runs

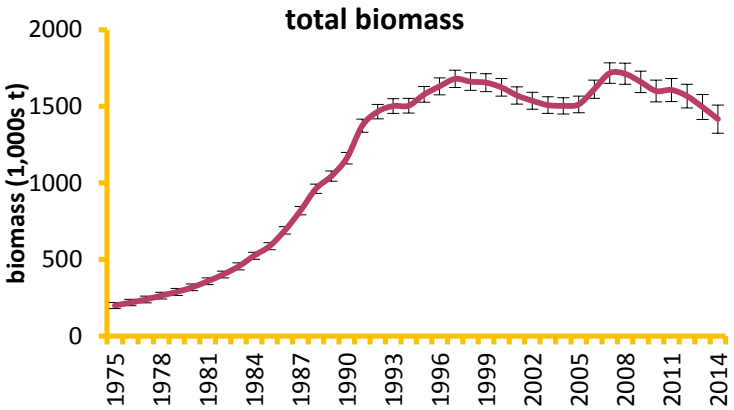

Ricker fit to stock-recruitment estimates
recruitment (billions)
FSB (1,000s t)
1987
1986
1990
2002
2001
1983
Bmsy
2003
2000
1991
1993
1989
1995
1996
1992
1994
1997
1977
0
1
2
3
4
5
6
0
100
200
300
400
500
600
700
800

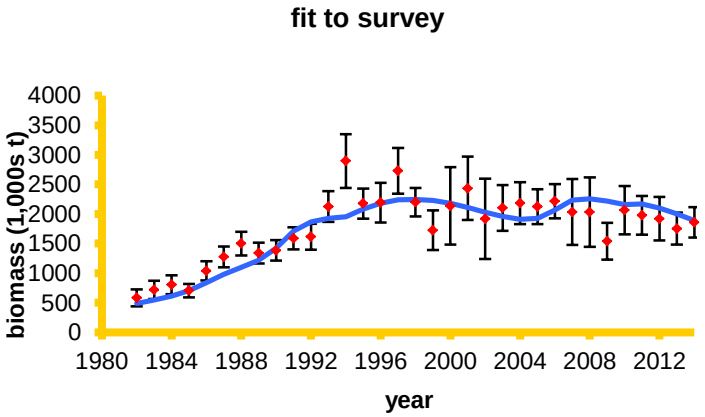

Ricker model fit to 3 spawner-recruit time series
sr point 1978-2003
Ricker fit 1978-2003
Ricker fit 1989-2003
sr point 1989-2003
Ricker fit 1978-1990
sr point 1978-1990
age 1 recruits (1,000s)
FSB (1,000s t)
0
1
2
3
4
5
6
0
100
200
300
400
500
600
700
800

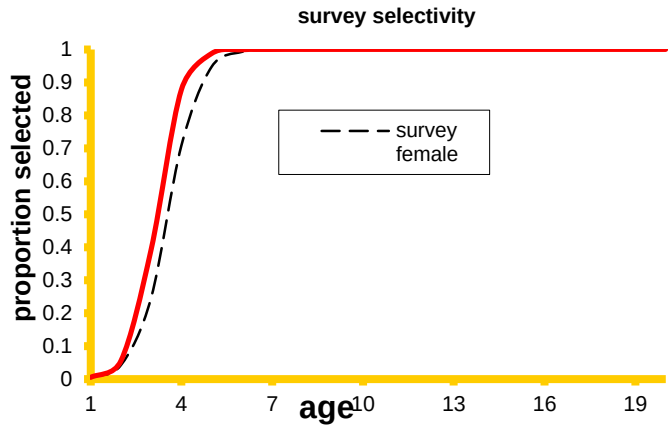
	q	female M	male M	2015 FSB	2015 ABC	F_{ABC}
Model exploration						
Model 1 q fixed at 1.5, male and female M fixed at 0.15	1.5	0.15	0.15	622,300	181,700	0.147
Model 1a q fixed at 1.4, male and female M fixed at 0.15	1.4	0.15	0.15	676,500	195,000	0.146
Model 2 q fixed at 1.5, female M fixed at 0.15 and male M estimated	1.5	0.15	0.18	692,700	186,000	0.155
Model 3 q fixed at 1.5, female M and male M estimated	1.5	0.164	0.194	648,000	175,400	0.153
Model 4 q estimated, Female and male M fixed at 0.15	2.21	0.15	0.15	385,800	122,600	0.157
Model 5 q estimated, female M fixed at 0.15 and male M estimated	1.96	0.15	0.179	481,000	162,000	0.158
Model 6 q, female M and male M all estimated as free parameters	2.10	0.145	0.173	464,300	134,300	0.163
Model 7 q estimated with the bottom temperature relationship, male and female M fixed at 0.15	1.4	0.15	0.15	673.41	193.500	0.146

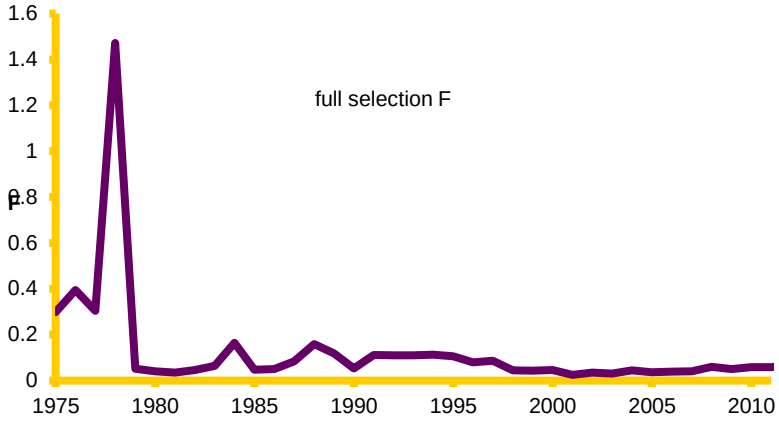
FITS TO SURVEY SEX RATIO FROM MODELS 1, 2 AND 3.

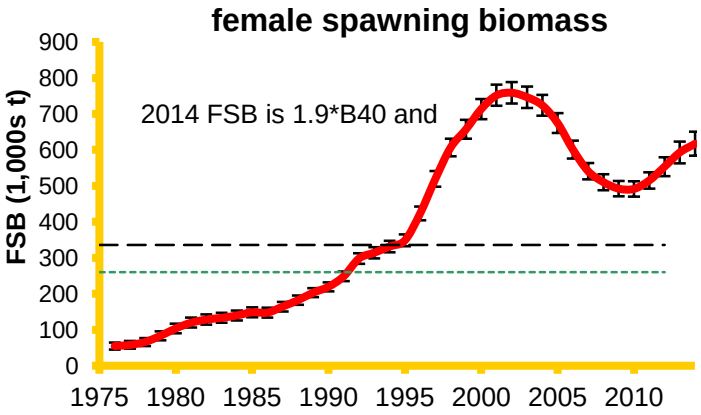


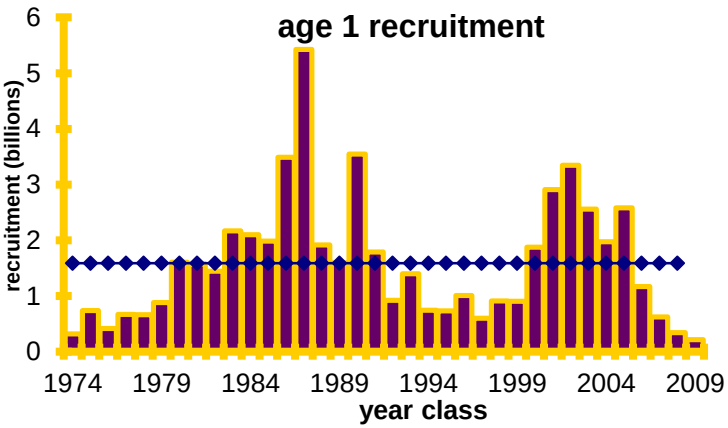

total biomass
biomass (1,000s t)
2000
1500
1000
500
0
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
2005
2008
2011
2014


fit to survey
biomass (1,000s t)
4000
3500
3000
2500
2000
1500
1000
500
0
1980
1984
1988
1992
1996
2000
2004
2008
2012
year

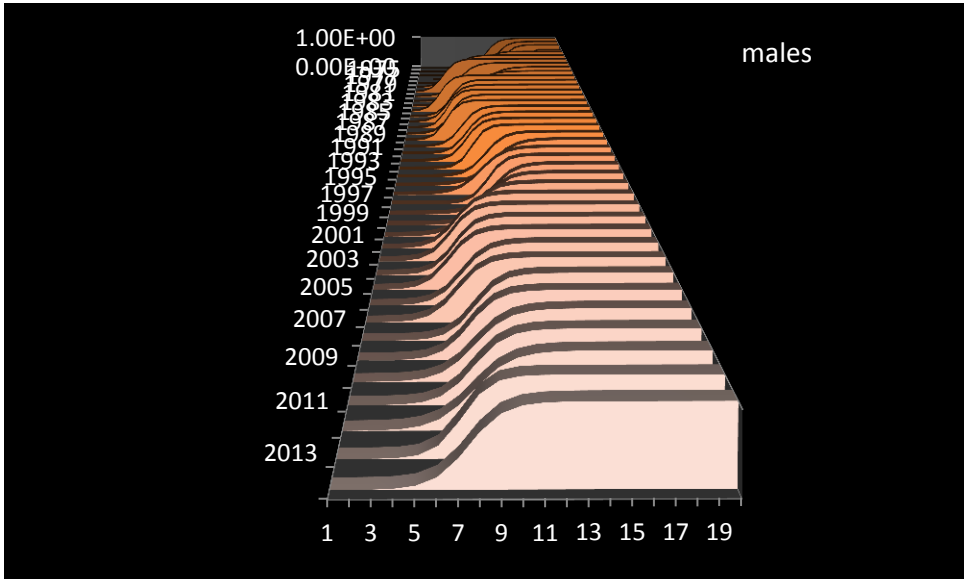

survey selectivity
proportion selected
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
survey
female
1
4
7
10
13
16
19
age

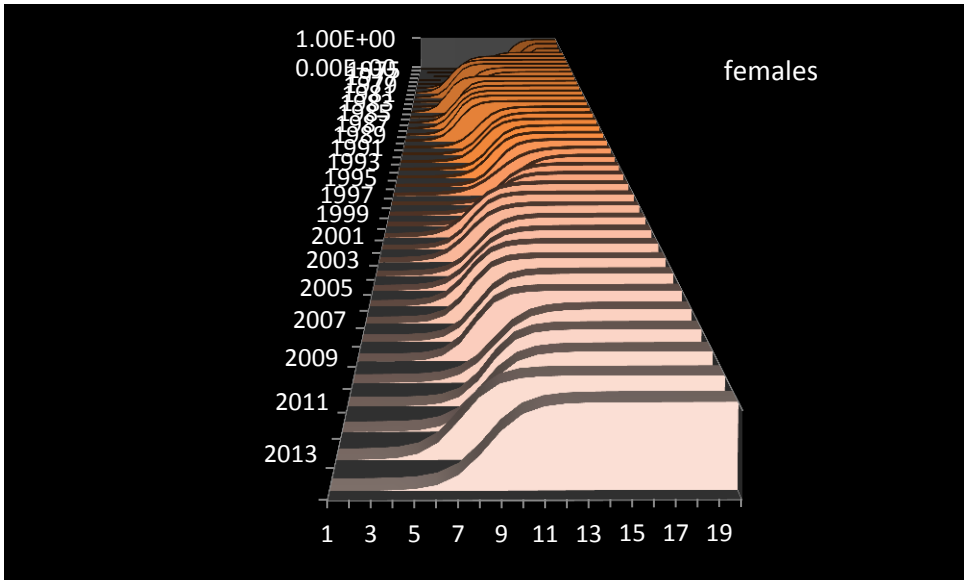

full selection F
F
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1975
1980
1985
1990
1995
2000
2005
2010


female spawning biomass
2014 FSB is 1.9*B40 and
FSB (1,000s t)
900
800
700
600
500
400
300
200
100
0
1975
1980
1985
1990
1995
2000
2005
2010

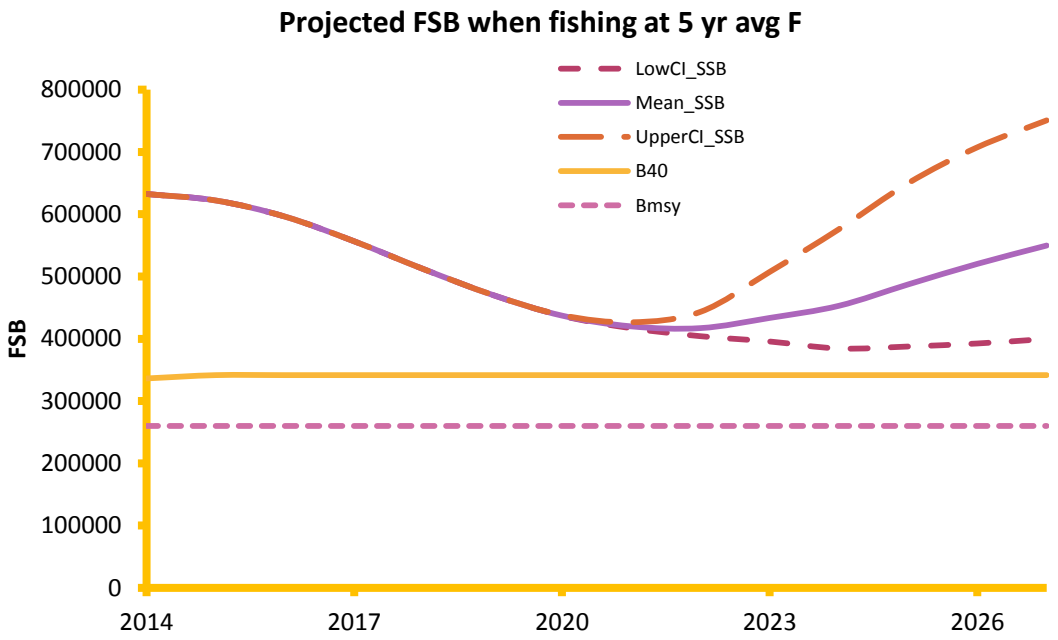

age 1 recruitment
recruitment (billions)
6
5
4
3
2
1
0
1974
1979
1984
1989
1994
1999
2004
2009
year class

TIME-VARYING FISHERY SELECTIVITY

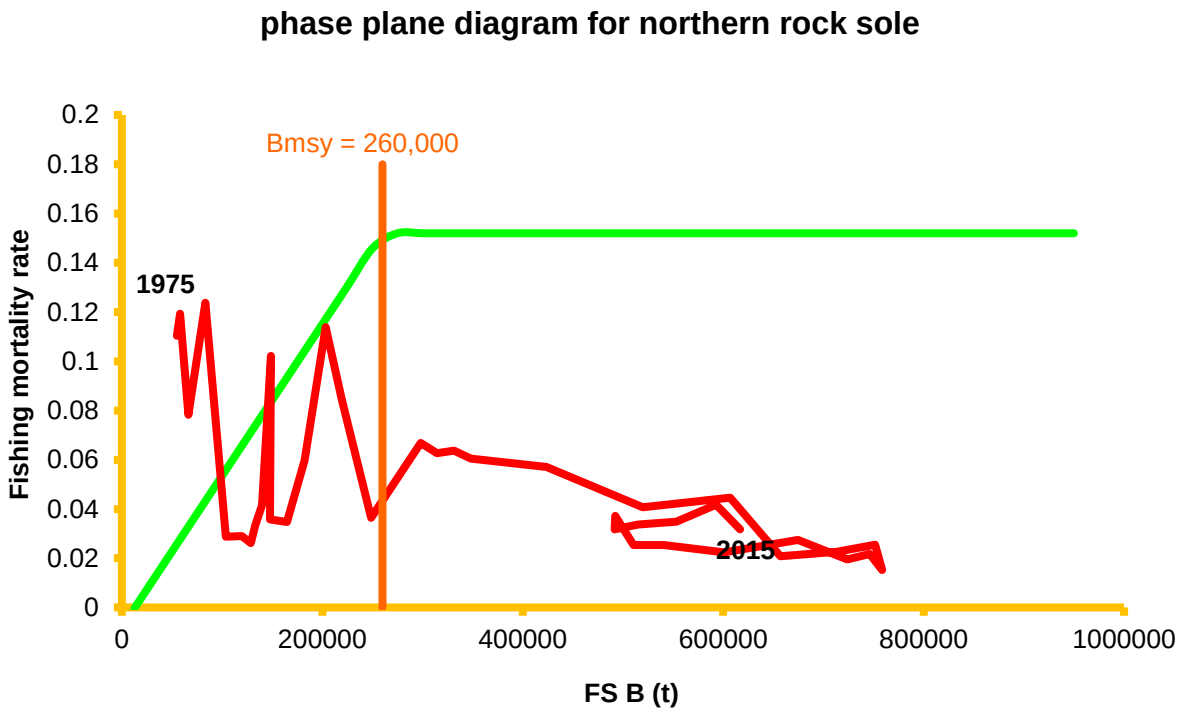




PROJECTED FEMALE SPAWNING BIOMASS



FSB AND F HISTORY RELATIVE TO B_{MSY}



NORTHERN ROCK SOLE

Tier 1 management

- 2014 ABC 203,800 t
- 2014 OFL 228,700 t
- F_{ABC} = $F_{harmonic}$ = 0.146
- F_{OFL} = F_{MSY} = 0.164
- 2014 catch = 51,549 t

Tier 1 management

Model 1

- **2015 ABC 181,700 t**
- **2015 OFL 187,600 t**
- **F_{ABC} = $F_{harmonic}$ = 0.147**
- **F_{OFL} = F_{MSY} = 0.152**

Tier 1 management

Model 1a

2015 ABC 195,000 t
2015 OFL 201,200 t
F_{ABC} = $F_{harmonic}$ = 0.145
F_{OFL} = F_{MSY} = 0.150