# 8. Assessment of the northern rock sole stock in the Bering Sea/Aleutian Islands

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## Executive Summary

Northern rock sole are assessed on an annual basis in the Bering Sea/Aleutian Islands region to coincide with the annual Bering Sea multispecies groundfish trawl survey conducted each summer. Due to a temporary lack of appropriations, the Department of Commerce implemented an orderly shutdown from October 1 – October 16 2013. Although the trawl survey was completed again in 2013, the shutdown did not allow time to produce a full stock assessment for northern rock sole and many other species. Therefore an executive summary is presented to provide management recommendations for the 2014 fishing season.

Northern rock sole are managed as a Tier 1 stock using a statistical age-structured model as the primary assessment tool. Details of the model can be found at http://www.afsc.noaa.gov/REFM/docs/2012/BSAIrocksole.pdf. The assessment model is not re-run for this update but instead, projections made from the recommended 2012 assessment (time-varying temperature/catchability) model are presented. The model assumes a 2013 and 2014 catch of 65,000 t and provides estimates of 2014 and 2015 ABC, OFL and FSB without re-estimating the stock assessment model parameters and biological reference points.

### *Summary of changes in assessment input*

*Changes in the input data*: The authors, with the BSAI Plan Team consent, changed the preferred stock assessment model at the 2013 September Plan Team meeting to a model which incorporates temperature-dependent survey catchability modeling. A strong prior is used to constrain the estimate of q, consistent with the results of a trawl-herding experiment. Overall, there is a 3% reduction in the absolute value of the residuals from the new model compared to the former preferred model. The model fits the survey sex ratio better than other candidate models presented in the assessment. AIC analysis for model selection indicates improvement for this model choice (AIC difference of 4.7, 91% chance of being the better model by Akaike weights).

Since the government shutdown coincided with the October NPFMC meeting, the SSC was not able to consider the change in preferred models for their approval. Lacking the SSC approval, results are given below for the temperature-dependent catchability model (Model 7 in the 2012 stock assessment) and for the previously accepted model (Model 1 in the 2012 stock assessment).

For this updated assessment, no changes were made to the assessment model input data. Both models project forward using the model estimated numbers at age for 2013 from the 2012 assessments. The 2013

catch of 58,810 t through October 26 is 90% of the assumed value of the 2013 catch in the stock assessment model (65,000 t).  For the 2014 fishery, the authors recommend the maximum allowable ABC of 222,500 t from the temperature-dependent catchability model.  This value is an increase of 9% over the 2012 estimate of 2014 ABC which did not use temperature/catchability modeling. Reference values for northern rock sole are summarized in the following tables, with the recommended 2014 values in bold. The stock was not being subjected to overfishing last year, is currently not overfished, nor is it approaching a condition of being overfished.

| Quantity | Temperature-dependent catchability model | | | |
|---|---|---|---|---|
| | As estimated or *specified last* year for: | | As estimated or *recommended this* year for: | |
| | 2013 | 2014 | 2014 | 2015 |
| $M$ (natural mortality rate) | 0.15 | 0.15 | 0.15 | 0.15 |
| Tier | 1a | 1a | 1a | 1a |
| Projected total (age 6+) | 1,465,600 | 1,393,200 | 1,555,700 | 1,456,600 |
| Female spawning biomass (t) Projected | 628,300 | 638,300 | 713,200 | 698,800 |
| $B_0$ | 694,500 | | 694,500 | |
| $B_{MSY}$ | 260,000 | 260,000 | 260,000 | 260,000 |
| $F_{OFL}$ | 0.164 | 0.164 | 0.16 | 0.16 |
| $maxF_{ABC}$ | 0.146 | 0.146 | 0.143 | 0.143 |
| $F_{ABC}$ | 0.146 | 0.146 | **0.143** | 0.143 |
| OFL (t) | 241,000 | 229,000 | **249,000** | 233,100 |
| maxABC (t) | 214,000 | 204,000 | **222,500** | 208,300 |
| ABC (t) | 214,400 | 204,000 | **222,500** | 208,300 |
| Status | As determined *last* year for: | | As determined *this* year | |
| | 2011 | 2012 | 2012 | 2013 |
| Overfishing | No | n\a | No | n\a |
| Overfished | n\a | No | n\a | No |
| Approaching overfished | n\a | No | n\a | No |

| Quantity | Model 1 from 2012 assessment | | | |
| --- | --- | --- | --- | --- |
| | As estimated or *specified last* year for: | | As estimated or *recommended this* year for: | |
| | 2013 | 2014 | 2014 | 2015 |
| $M$ (natural mortality rate) | 0.15 | 0.15 | 0.15 | 0.15 |
| Tier | 1a | 1a | 1a | 1a |
| Projected total (age 6+) | 1,465,600 | 1,393,200 | 1,393,200 | 1,299,600 |
| Female spawning biomass (t) Projected | 628,300 | 638,300 | 638,300 | 622,300 |
| $B_0$ | 694,500 | | 694,500 | |
| $B_{MSY}$ | 260,000 | 260,000 | 260,000 | |
| $F_{OFL}$ | 0.164 | 0.164 | 0.164 | 0.164 |
| $maxF_{ABC}$ | 0.146 | 0.146 | 0.146 | 0.146 |
| $F_{ABC}$ | 0.146 | 0.146 | **0.146** | 0.146 |
| OFL (t) | 241,000 | 229,000 | **228,700** | 213,310 |
| maxABC (t) | 214,000 | 204,000 | **203,800** | 190,100 |
| ABC (t) | 214,400 | 204,000 | **203,800** | 190,100 |
| **Status** | As determined *last* year for: | | As determined *this* year | |
| | 2011 | 2012 | 2012 | 2013 |
| Overfishing | No | n\a | No | n\a |
| Overfished | n\a | No | n\a | No |
| Approaching overfished | n\a | No | n\a | No |

## *SSC and Plan Team Comments on Assessments in General.*

No comments relevant to northern rock sole.

## *SSC and Plan Team comments Specific to this Assessment.*

*Agreeing with the author, the Team recommended that the temperature-dependent catchability model be included in November. Unless new information to the contrary arises between now and November, the Team is likely to base harvest recommendations for 2014 on the model with temperature-dependent catchability.*

*The SSC supports the author's and Plan Team's recommendations for this year and looks forward to further evaluation of the potential effect of temperature on survey q in next year's assessment. The SSC recommends standardizing bottom temperature to mean of 0 and standard deviation of 1.0 ($d_t$), and model survey q as $q_t = exp(lambda * d_t)$, and estimate the correlation coefficient (lambda) internally in the model.* The temperature-dependent catchability model is now used to estimate the stock condition and harvest recommendations. The government shutdown did not allow time to pursue the alternative formulation of q suggested by the SSC for this assessment. We will try to accomplish that next time.

## Discarded and Retained catch.

| Year | Retained (t) | Discarded (t) | % Retained |
|------|------|------|------|
| 1987 | 14,209 | 14,701 | 49 |
| 1988 | 22,374 | 23,148 | 49 |
| 1989 | 23,544 | 24,358 | 49 |
| 1990 | 12,170 | 12,591 | 49 |
| 1991 | 25,406 | 35,181 | 42 |
| 1992 | 21,317 | 35,681 | 37 |
| 1993 | 22,589 | 45,669 | 33 |
| 1994 | 20,951 | 39,945 | 34 |
| 1995 | 21,761 | 33,108 | 40 |
| 1996 | 19,770 | 27,158 | 42 |
| 1997 | 27,743 | 39,821 | 41 |
| 1998 | 12,645 | 20,999 | 38 |
| 1999 | 15,224 | 25,286 | 38 |
| 2000 | 22,151 | 27,113 | 45 |
| 2001 | 19,299 | 9,956 | 66 |
| 2002 | 23,607 | 17,724 | 57 |
| 2003 | 19,492 | 15,903 | 55 |
| 2004 | 26,600 | 21,037 | 56 |
| 2005 | 23,172 | 12,376 | 65 |
| 2006 | 28,577 | 7,834 | 78 |
| 2007 | 27,826 | 8,942 | 76 |
| 2008 | 45,945 | 5,330 | 90 |
| 2009 | 43,478 | 5,172 | 89 |
| 2010 | 50,160 | 3,061 | 94 |
| 2011 | 56,105 | 4,527 | 93 |

# 2013 Survey results

The 2013 Bering Sea survey biomass estimate for northern rock sole was 1,752,593 t, a 9% decrease from the 2012 biomass point estimate. The 2014 model estimate of female spawning biomass is 713, 200 t, well above the $B_{MSY}$ estimate of 374,000 t indicating that the northern rock sole resource is at a high and stable level. The average exploitation level remains at about 4% for 2013.

**shelf survey estimates**
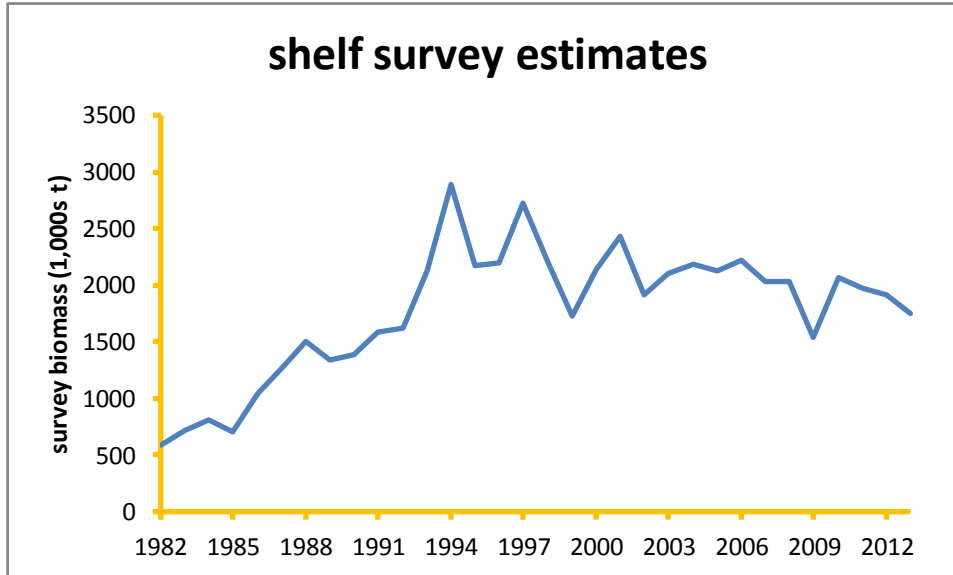
Ageing of shelf survey age structures from 2012 were completed in 2013 to provide the following survey estimate of population age composition. The 2001 and 2002 age classes are strong as 10 and 11 year-old fish and fish from the 2005 year class (7 year-olds) were caught in good numbers.

**2012 survey age composition**
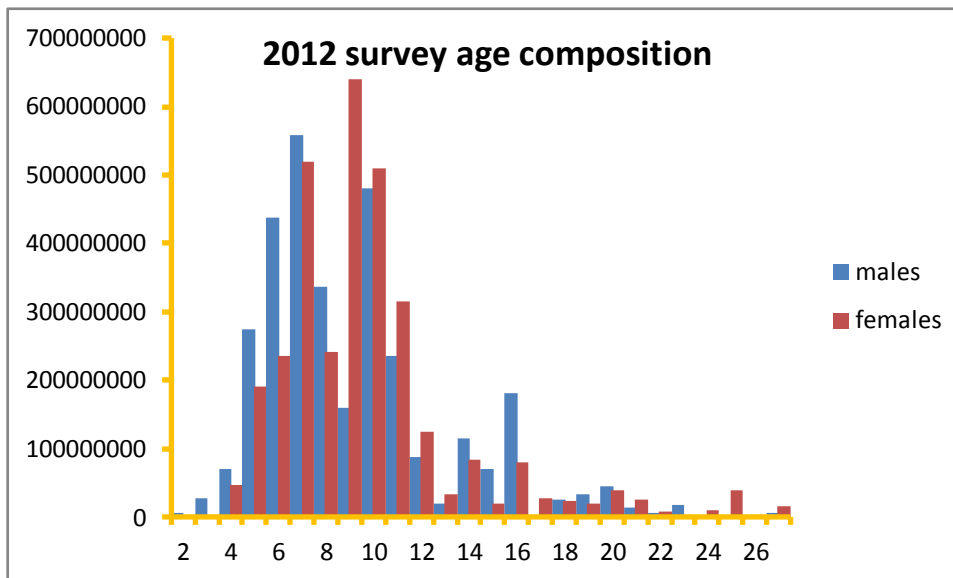
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