NORTHERN ROCK SOLE

BY
WILDERBUEER, IANELLI AND NICHOL
The assessment model was run to include the new 2017 and 2018 catch and survey biomass and 2016 and 2017 age composition information from both the survey and fishery.

Ensemble methodology was explored.

Survey biomass decreased 21% increased from 2017 to 2018.
BSAI northern rock sole

Catch, ABC and TAC
## SUMMARY

### Model 15.1

<table>
<thead>
<tr>
<th>Quantity</th>
<th>As estimated or specified last year for:</th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2018</td>
<td>2019</td>
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<td><strong>M (natural mortality rate)</strong></td>
<td>0.15</td>
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<tr>
<td><strong>Tier</strong></td>
<td>1a</td>
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<td>472,200</td>
<td>413,300</td>
</tr>
<tr>
<td><strong>Projected B0</strong></td>
<td>678,310</td>
<td>515,680</td>
</tr>
<tr>
<td><strong>BMSY</strong></td>
<td>257,000</td>
<td>257,000</td>
</tr>
<tr>
<td><strong>FOFL</strong></td>
<td>0.16</td>
<td>0.16</td>
</tr>
<tr>
<td><strong>maxF_{ABC}</strong></td>
<td>0.155</td>
<td>0.155</td>
</tr>
<tr>
<td><strong>F_{ABC}</strong></td>
<td>0.155</td>
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<td><strong>OFL (t)</strong></td>
<td>147,300</td>
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<tr>
<td><strong>maxABC (t)</strong></td>
<td>143,100</td>
<td>132,000</td>
</tr>
<tr>
<td><strong>ABC (t)</strong></td>
<td>143,100</td>
<td>132,000</td>
</tr>
<tr>
<td><strong>Status</strong></td>
<td>2016</td>
<td>2017</td>
</tr>
<tr>
<td><strong>Overfishing</strong></td>
<td>No</td>
<td>n/a</td>
</tr>
<tr>
<td><strong>Overfished</strong></td>
<td>n/a</td>
<td>No</td>
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<td>n/a</td>
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</table>
2018 CATCH = 28,219 T (THROUGH 11/3/18) AVERAGE 1975-2018 EXPLOITATION RATE = 3.9%
NORTHERN ROCK SOLE
CATCH BY MONTH IN 2018

January 5%
February 24%
March 10%
April 12%
May 31%
June 14%
July 1%
August 2%
September 2%

February 24%
May 31%
April 12%
March 10%
January 5%
August 2%
July 1%
June 14%
September 2%
NORTHERN ROCK SOLE

CATCH BY AREA IN 2018

- 514 (48%)
- 513 (10%)
- 509 (29%)
- 517 (2%)
- 516 (8%)
- 521 (1%)
CATCH BY MONTH

- Northern rock sole
  - January 2018
  - March 2018
  - February 2018
  - April 2018
Catch by month (continued)
96% RETAINED IN 2017
2018 was lowest survey biomass estimate since 1985
2017 AGE COMPOSITIONS

2017 fishery age composition

Average age in catch:
- Females: 13.3
- Males: 13.0

2017 survey age comp

Average age in population: 4.9
- Males and females
LENGTH AT AGE FROM SURVEY AGE COMPOSITIONS

length at age for 8 yr old fish

- Females-red

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

8 year old fish weight at age using 3 year average

- **males**
- **females**

**wt (g)**

- 400
- 350
- 300
- 250
- 200
- 150
- 100
- 50
- 0

**year**

- 1982
- 1985
- 1988
- 1991
- 1994
- 1997
- 2000
- 2003
- 2006
- 2009
EMPIRICAL DATA ONLY FOR 2018

weight at age comparison

- 5_old
- 8_old
- 11_old
- 5_new
- 8_new
- 11_new
WEIGHT AT AGE FROM SURVEY AGE COMPOSITIONS

average of all years wt at age

weight (g)

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

age

males females
FISHERY AGE COMPOSITION
Survey age composition
**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 Spawner-Recruit Fit

Data fit: 1978-2012
Bmsy=186,000 t
## Model Evaluation

<table>
<thead>
<tr>
<th>Model</th>
<th>Description</th>
<th>Number of Parameters</th>
<th>Fishery age</th>
<th>Survey age</th>
<th>Survey biomass</th>
<th>Priors</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.1</td>
<td>Base</td>
<td>366</td>
<td>138</td>
<td>0</td>
<td>17</td>
<td>0</td>
<td>125</td>
</tr>
<tr>
<td>18.1</td>
<td>Est. male M</td>
<td>367</td>
<td>14</td>
<td>16</td>
<td>6</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>18.2</td>
<td>Est. male M, q</td>
<td>367</td>
<td>3</td>
<td>11</td>
<td>0</td>
<td>9</td>
<td>11</td>
</tr>
<tr>
<td>18.3</td>
<td>Est. male M, q, and male sel.</td>
<td>368</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>18.4</td>
<td>Ensemble</td>
<td>NA</td>
<td>39</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>40</td>
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<table>
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<th>ABC</th>
<th>OFL</th>
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<tr>
<td>15.1</td>
<td>118,900</td>
<td>122,000</td>
</tr>
<tr>
<td>18.1</td>
<td>118,500</td>
<td>121,200</td>
</tr>
<tr>
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<td>110,400</td>
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MODEL ESTIMATES OF FSB

![Graph showing model estimates of FSB](image)

- **Female spawning biomass (kt)**
- **Year**

Legend:
- Base
- Est Male M
- Est Male M, q
- Est Male M, q, Msel

The graph illustrates the trend of female spawning biomass from 1990 to 2010 under different model scenarios.
FITS TO SURVEY SEX RATIO

![Chart showing Proportion female from 1980 to 2010 with three models: Base, Est Male M, and Est Male M, q. The chart includes a graph with data points and trend lines for each model.](chart.png)
POSTERIOR DISTRIBUTIONS

![Graph showing posterior distributions for spawning biomass in 2017 (kt).]

Model:
- Base
- Est male M
- Est male M, q
- Est male M, q, Msel

Relative density vs. Spawning biomass in 2017 (kt)
Reasons to continue using Model 15.1 for 2019 fishing season.

1) Has been the accepted model for 4 years

2) Provides estimates of FSB, ABC and OFL close to the other model runs

3) Has a better fit to survey and population sex ratio and survey age composition

4) Since northern rock sole is a biennial assessment it would give more time to consider the ensemble model and model 18.3, models that may be more appropriate for future assessments
Model 15.1 Results

- **Total biomass**
- **Survey biomass**
- **Survey selectivity**
- **Full selection F**
- **Female spawning biomass**
- **Age 1 recruitment**
TIME-VARYING FISHERY SELECTIVITY

[Diagram showing time-varying fishery selectivity for males and females from 1975 to 2017]
PROJECTED FEMALE SPAWNING BIOMASS

Projection fishing at 5 year average F

- lower CI
- upper CI
- Bmsy
FSB AND F HISTORY RELATIVE TO $B_{MSY}$

Phase plane diagram for northern rock sole

Bmsy = 186,000 t
BSAI NORTHERN ROCK SOLE

Mohn’s rho = 0.03554
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