Red hake Assessment Update through 2014

Whiting PDT Meeting
Taunton, MA
August 8th, 2015
Previous Assessment Update

- Last assessment update in 2014 as part of the 2015-2017 whiting Specification cycle

- State of the stock
  - **Northern stock** is NOT Overfished but Overfishing IS occurring
  - **Southern stock** is NOT Overfished and overfishing is NOT occurring

- ABC = 40th percentile of OFL to account for scientific uncertainty

<table>
<thead>
<tr>
<th>Stock</th>
<th>OFL (mt)</th>
<th>ABC (mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North</td>
<td>322</td>
<td>287</td>
</tr>
<tr>
<td>South</td>
<td>3399</td>
<td>3179</td>
</tr>
</tbody>
</table>
Northern Red hake

- Last update – indication of a relatively strong incoming year class.
- Concern on Potential impact of YC on fishery catch, and ACL accounting measures
Recommendation from the approval process for setting small mesh multispecies ACL

“Recommend that the science center conduct an update assessment for northern red hake in 2015 to incorporate new survey data, prioritize a benchmark assessment for red hake in 2017, and prioritize any research necessary to support such a benchmark with particular attention to research needed to address stock structure.”

Addresses two Issues

- The potential impact of the 2014 recruitment YC as it grows into the fishery
- Incorporation of the most recent survey data (2014) to address the lack of full survey coverage in the southern stock due to mechanical issues on the Bigelow
2015 Red hake update

- Basis of biological reference points remained unchanged.

- State of the stock
  - **North**: Change in fishing status (Not overfished and No overfishing)
  - **South**: Status remains consistent (Not overfished and No Overfishing)

- Updated OFL and ABC estimates

<table>
<thead>
<tr>
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</tr>
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<td>322</td>
<td>287</td>
</tr>
<tr>
<td>South_status quo</td>
<td>3,399</td>
<td>3,179</td>
</tr>
<tr>
<td>South_Revised</td>
<td>3,399</td>
<td>3,179</td>
</tr>
<tr>
<td></td>
<td>578</td>
<td>496</td>
</tr>
<tr>
<td></td>
<td>1,914</td>
<td>1,809</td>
</tr>
<tr>
<td></td>
<td>1,816</td>
<td>1,717</td>
</tr>
</tbody>
</table>
What was done...

- **Fishery Independent Data**
  - Updated spring survey through 2015
  - Southern Red hake - evaluated 2014 survey Value (incomplete coverage)

- **Fishery Dependent Data**
  - Updated Commercial and recreational catch through 2014
  - Commercial evaluation of SA 400 in the North

- **Updated estimates of OFL/ABC and distribution**
  - Sensitivity Analyses on impact of 2014 survey estimation on Southern red hake

- **Risk Analyses**
Northern Red hake
Northern Red hake Spring Survey

**2015 Survey estimate** doubled from 3.02 kg/tow in 2014 to 6.27 kg/tow in 2015

2nd highest in the time series

CV estimate is relatively precise (CV = 0.21)
SARC 51 Red hake Biological Reference Points

• Lack of adequate model formulations, the panel recommended the “fall back” 3yr Survey Index method
• Biomass reference points based on the arithmetic average of Spring Survey (1980-2010)
• Exploitation Index is based on ratio b/w total catch and Spring survey index from 1980-2009 from AIM analyses

<table>
<thead>
<tr>
<th>STOCK</th>
<th>THRESHOLDS (SARC 51)</th>
<th>TARGETS (SARC 51)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Red Hake</td>
<td>1/2BM&lt;sub&gt;SY&lt;/sub&gt; Proxy (1.27) F&lt;sub&gt;MSY&lt;/sub&gt; Proxy (0.16)</td>
<td>BM&lt;sub&gt;SY&lt;/sub&gt; Proxy (2.54) F&lt;sub&gt;MSY&lt;/sub&gt; Proxy (NA)</td>
</tr>
<tr>
<td>Southern Red Hake</td>
<td>1/2BM&lt;sub&gt;SY&lt;/sub&gt; Proxy (0.51) F&lt;sub&gt;MSY&lt;/sub&gt; Proxy (3.04)</td>
<td>BM&lt;sub&gt;SY&lt;/sub&gt; Proxy (1.02) F&lt;sub&gt;MSY&lt;/sub&gt; Proxy (NA)</td>
</tr>
</tbody>
</table>
Northern red hake Biomass trend and Stock Status

- 3yr mean index increased by 75% from 2.03kg/tow in 2014 to 3.55kg/tow in 2015
- Increase in biomass appears to be related to the strength of the 2014 YC

Not Overfished
Above target and threshold
Reference points
Northern red hake

- Fishery dependent data
  - Includes: Comm. Landings + Bait landings and discards, Rec. landings and discards
  - Effect of SA 464, 465 and 467 on landings estimate
Northern red hake

Effect of including 400 SA was inconsequential.
Northern red hake

- Fishery dependent data (2000-2014)
Northern red hake

Fishery dependent data (2013-2014)

Units = mt

<table>
<thead>
<tr>
<th>Year</th>
<th>Commercial Landings</th>
<th>Commercial Discards</th>
<th>Total Comm Catch</th>
<th>Commercial Landings</th>
<th>Commercial Discards</th>
<th>Total Rec Catch</th>
<th>Commercial+Rec Total Catch</th>
<th>Commercial &amp; Rec % Disc</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>95.02</td>
<td>215.75</td>
<td>310.77</td>
<td>2.39</td>
<td>0.19</td>
<td>2.58</td>
<td>313.35</td>
<td>69%</td>
</tr>
<tr>
<td>2014</td>
<td>67.60</td>
<td>186.22</td>
<td>253.83</td>
<td>5.34</td>
<td>6.87</td>
<td>12.21</td>
<td>266.04</td>
<td>73%</td>
</tr>
<tr>
<td>Delta</td>
<td>27.42</td>
<td>29.52</td>
<td>56.94</td>
<td>-2.95</td>
<td>-6.68</td>
<td>-9.63</td>
<td>47.31</td>
<td>-4%</td>
</tr>
</tbody>
</table>
Northern red hake discards

- Northern red hake Total Discards
- Northern red hake (Annual)
- Northern redhake observer Coverage
- Northern redhake discard rate CV
Northern red hake

- Recreational catch
  - Increase in recreational catch in 2014 (12mt)
  - Rec. catch: Only ~5% of total removals of red hake
Northern red hake

- **2014 Commercial Size distribution**
  - Catch in 2014 partly represent the 2013 YC
  - 2014 Catch abundance is much lower relative to the recent 5yrs.
  - Overlap in size distribution between landed and discarded fish
  - However, 2014 catch weights have not changed substantially relative to 2013.
  - Fish are likely in relative good condition
Northern red hake exploitation trends and Stock Status

- 3 yr exploitation index also declined but by a marginal 4% (0.169 kt/kg to 0.162 kt/kg)
- Change in fishing status from overfishing to NOT overfishing (1% below threshold)....
- Marginal effect – minor reduction in 2014 catch coupled with 2013 Rel. F (low survey to higher catch ratio)
Northern red hake is **NOT overfished** and **overfishing is NOT occurring**
Southern Red hake
Due to Mechanical issues with the RSV. Bigelow, the survey was delayed and resulted in incomplete coverage for the southern region

Eight Missing strata: 61-68 out of 35 (southern coverage)
## 2014 Southern red hake survey estimate

- Table of percent contribution of the missing strata (by weight)

<table>
<thead>
<tr>
<th>Year</th>
<th>Strata 61-68</th>
<th>Other Strata</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>1%</td>
<td>99%</td>
</tr>
<tr>
<td>2005</td>
<td>1%</td>
<td>99%</td>
</tr>
<tr>
<td>2006</td>
<td>2%</td>
<td>98%</td>
</tr>
<tr>
<td>2007</td>
<td>1%</td>
<td>99%</td>
</tr>
<tr>
<td>2008</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>2009</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>2010</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>2011</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>2012</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>2013</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>
2014 Southern red hake survey estimate

- Estimated survey trends with and without
- Calculated alternative adjustment factors for 2014 estimate based on aggregate biomass index
  - (SQ) Status quo estimate (i.e. No adjustment factor)
  - (5Y) 2009-2013: recent 5 yr. time block - Restricted to Bigelow Years
  - (10Y) 2004-2013: (recent 10 yr. block)
## 2014 Southern red hake survey
### Missing Strata Comparison

<table>
<thead>
<tr>
<th>year</th>
<th>All_Strata</th>
<th>Missing Strata</th>
<th>% Diff</th>
<th>Adj Factor</th>
<th>Revised Est.</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>0.154</td>
<td>0.179</td>
<td>16%</td>
<td>0.861</td>
<td>0.154</td>
</tr>
<tr>
<td>2005</td>
<td>0.376</td>
<td>0.437</td>
<td>16%</td>
<td>0.861</td>
<td>0.375</td>
</tr>
<tr>
<td>2006</td>
<td>0.380</td>
<td>0.439</td>
<td>16%</td>
<td>0.865</td>
<td>0.378</td>
</tr>
<tr>
<td>2007</td>
<td>0.857</td>
<td>0.997</td>
<td>16%</td>
<td>0.860</td>
<td>0.858</td>
</tr>
<tr>
<td>2008</td>
<td>0.473</td>
<td>0.551</td>
<td>16%</td>
<td>0.859</td>
<td>0.474</td>
</tr>
<tr>
<td>2009</td>
<td>1.436</td>
<td>1.667</td>
<td>16%</td>
<td>0.861</td>
<td>1.433</td>
</tr>
<tr>
<td>2010</td>
<td>0.939</td>
<td>1.093</td>
<td>16%</td>
<td>0.859</td>
<td>0.940</td>
</tr>
<tr>
<td>2011</td>
<td>1.793</td>
<td>2.086</td>
<td>16%</td>
<td>0.859</td>
<td>1.794</td>
</tr>
<tr>
<td>2012</td>
<td>1.064</td>
<td>1.237</td>
<td>16%</td>
<td>0.860</td>
<td>1.064</td>
</tr>
<tr>
<td>2013</td>
<td>0.640</td>
<td>0.745</td>
<td>16%</td>
<td>0.859</td>
<td>0.640</td>
</tr>
<tr>
<td>2014 (?)</td>
<td>0.733</td>
<td>0.733</td>
<td>0%</td>
<td>NA</td>
<td><strong>0.631</strong></td>
</tr>
</tbody>
</table>

| 5 Yr Avg | 0.860 |
| 10 Yr Avg| 0.860 |

**Note:**
Application of adjustment factor is an additional source of uncertainty to 2014 revised estimate.

Application of Adjustment factor results in 14% decrease in survey aggregate wt.
2014 Southern red hake survey Comparison
Missing Strata Comparison?

Status quo:
0.733 kg/tow

Adj. Factor:
0.630 kg/tow
Southern red hake Biomass trend and Stock Status

- 2014 update based on 2011-2013 values w/ 3yr mean = 1.16 kg/tow
- 2015 update using (2013-2015) = 0.65kg/tow (status quo) or 0.62kg/tow (adjusted value)
- This means a 44% decline (status quo) or 47% decline (adjusted value) relative to the 2014 update

No Change in Biomass Status !!!!
Not Overfished
Below target and above threshold reference points
Southern red hake

Fishery dependent data (2000-2014)
## Southern red hake

- **Fishery dependent data (2013-2014)**

Units = mt

<table>
<thead>
<tr>
<th>Year</th>
<th>Commercial Landings</th>
<th>Commercial Discards</th>
<th>Total Comm Catch</th>
<th>Recreation Landings</th>
<th>Recreational Discards</th>
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<th>Comm &amp; Rec % Disc</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>439</td>
<td>582</td>
<td>1021</td>
<td>76</td>
<td>67</td>
<td>143</td>
<td>1164</td>
<td>56%</td>
</tr>
<tr>
<td>2014</td>
<td>560</td>
<td>554</td>
<td>1113</td>
<td>69</td>
<td>20</td>
<td>89</td>
<td>1202</td>
<td>48%</td>
</tr>
<tr>
<td>Delta</td>
<td>-121</td>
<td>28</td>
<td>-93</td>
<td>7</td>
<td>48</td>
<td>55</td>
<td>-38</td>
<td>8%</td>
</tr>
</tbody>
</table>
Southern red hake

- Recreational catch
  - Decrease in recreational catch in 2014 (89mt)
  - Rec. catch: Only ~7% of total removals of red hake
Effect of the survey adjustment resulted in no change in fishing status determination (i.e. Overfishing is NOT occurring in both cases)

In 2014, the relative exploitation index decreased in status quo case by 9% and increased in the adjusted case by 5%

3yr MA exploitation ratio increased by 18% in the status Quo case and 25% in the adjusted case
Northern red hake is **NOT overfished** and **overfishing is NOT occurring**
Analytical Frame work for Setting ABCs
Overfishing Level (OFL)

\[
OFL \sim I_{yr1-yr3}^S (kg) \times F_{MSY \ proxy}^S (kt/\text{kg})
\]

*Where,*

\[
I_{Redhake}^{2013-2015} = Spring \ Biomass \ North \quad (Prev.\ update: 2012 - 2014)
\]

\[
I_{Redhake}^{2013-2015} = Spring \ Biomass \ South \quad (Prev.\ update: 2011 - 2013)
\]

*Biomass and* \(F_{MSY \ proxy}^S \ (red \ hake) = 1980 - 2010\)
Estimating Uncertainty in OFL

- **Uncertainty in OFL**
  - Estimated as a cross product between the uncertainty (i.e. probability distribution) in $F_{\text{MSY}}$ proxy and the most recent 3-year survey Index

- **Uncertainty in $F_{\text{MSY}}$**
  - *Red hake*: Based on the bootstrap probability distribution from AIM Model (1980-2010) and assumed a normal error structure
Variance Statistics

\[ V(I_{\text{survey}}) = V \left[ \frac{I_{\text{HBB} \rightarrow ALB}^{2013} + I_{\text{HBB} \rightarrow ALB}^{2014} + I_{\text{HBB} \rightarrow ALB}^{2015}}{3} \right] \]

\[ V(I_{\text{HBB} \rightarrow ALB}^{2013-2015}) = \left( \frac{\bar{I}_{\text{HBB}}}{\rho} \right)^2 \left[ \frac{V(I_{\text{HBB}})}{E(I_{\text{HBB}})^2} + \frac{V(\rho)}{E(\rho)^2} \right] \]

\[ V(\text{RelF}) = \left( \frac{E(C)}{E(I)} \right)^2 \left[ \frac{V(C)}{E(C)^2} + \frac{V(I)}{E(I)^2} - \frac{2\text{Cov}(C,I)}{E(C)E(I)} \right] \]

\[ V(\text{RelF}) = \sum_{1982}^{1973} \left( \frac{C}{I} - \left( \frac{C}{I} \right) \right)^2 \frac{1}{n-1} \quad \text{(basis for update)} \]

\[ V(OFL) = V(\text{RelF}, I_{\text{Survey}}) \quad \text{cross product} \]
2015 Updated Northern red hake OFL and ABC Distribution

![Graph showing the distribution of Northern red hake catch in 2015 and 2014, with cumulative probability and OFL probability axes. Legend includes lines for 2015 OFL Distribution, 2014 OFL Distribution, Updated OFL (0.578 kt), Updated ABC 40th percentile OFL (0.496 kt), and Updated OFL Cum Distr.](image)

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2015 Updated Northern red hake OFL and ABC Distribution

- 2015_OFL_Status Quo Distribution
- 2015_OFL_Revised Distribution
- Updated OFL (1.91 kt)_Status Quo
- Updated ABC 40th pctle OFL (1.81 kt)_Status Quo
- 2014 OFL Distribution
- Updated Cum Distr.
Summary of red hake OFL and ABC

<table>
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<td>3,399</td>
<td>3,179</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Stock</th>
<th>% Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OFL (mt)</td>
</tr>
<tr>
<td>North</td>
<td>80%</td>
</tr>
<tr>
<td>South_status quo</td>
<td>-44%</td>
</tr>
<tr>
<td>South_Revised</td>
<td>-47%</td>
</tr>
</tbody>
</table>
Risk Analyses

- Defined as the probability of exceeding of $F_{MSY}$ proxy given the current population Index (Two step process):
  - Calculated corresponding Rel. F for each survey realization from the survey cum. distribution.
    - Corresponding Rel F = $(OFL_{current}/Index_{distr})$

- The Probability of Rel. F for a given catch exceeding $F_{MSY}$ proxy is a function of two probabilities:
  - Probability of each survey realizations
  - Probability of each corresponding Rel F of exceeding $F_{MSY}$ proxy computed over a range of catch
Red hake: Probability of exceeding $F_{\text{MSY}}$ Proxy

Northern red hake

- ABC (496 mt)
- 14% Chance $F > F_{\text{MSY}}$

Southern red hake

- ABC (1.81 kt)
- 25% Chance of exceeding $F_{\text{MSY}}$

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Summary

- Both stocks of red hake are not overfished and overfishing is not occurring
- Change in fishing status determination for northern red hake relative to last update
- Fishery Independent
  - Survey trends increased substantially in the north (2014 YC effect)
  - Continues to decline in the south
  - Effect of missing strata in the south has little to no consequence on assessment results (maintain SQ)
Summary

- Fishery dependent
  - Catches are relatively stable compared to recent 3 years
  - Effect SA 400 on catch data = no effect

- OFL and ABC
  - Increase OFL in the north (Effect of survey increase)
  - Decline Southern OFL in response to continued decline in survey trends
Summary

- Risk of exceeding FMSY
  - Low risk in the north
  - Low-moderate in the south
<table>
<thead>
<tr>
<th></th>
<th>North</th>
<th>South</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biomass Target</td>
<td>2.55</td>
<td>1.02</td>
</tr>
<tr>
<td>Biomass Threshold</td>
<td>1.28</td>
<td>0.51</td>
</tr>
<tr>
<td>3yr Spr Surv Biomass</td>
<td>3.55</td>
<td>0.65</td>
</tr>
<tr>
<td>F threshold</td>
<td>0.163</td>
<td>3.04</td>
</tr>
<tr>
<td>3 yr Rel F</td>
<td>0.162</td>
<td>1.62</td>
</tr>
</tbody>
</table>