Norton Sound Red King Crab
SAFE 2021

Sept 15 2022

Crab Plan Team: Seattle-Virtual

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3 issues to discuss

• Model selection for the Jan 2023 final assessment
• Estimate discards **WITHOUT data.**
• Length-independent vs. length-dependent OFL-ABC
Summer Com Catch and CPUE, and Trawl abundance
Fishery & Data Sept 2022

• ABC: 0.40 mil. lb. Total catch: 0.34 + 0.02 – 0.08? mil. lb depending on discards estimation method.

• NOAA 2022 NBS trawl survey: (Sept 07 2022)
  – 8/3,4,11,12 : 2,103,000 (CV: 0.368)
  – Not included in the draft SAFE, but adding data did not change model results (will update for Jan 2023).
NSRKC draft Assessment Models

• Model 21.0: 2022 final model with data update (without NOAA NB Trawl data)

• Model 22.0: Model 21.0 + shell specific retention probability
  – CPT: Oldshell crabs are more likely to be discarded

• Model 22.1: Model 21.0 + individual $M$ estimate
  – SSC: May explain the lack of model fit to trawl and Com retain size-shell composition

• Model 22.2: Model 22.0 + individual $M$ estimate
M, molting, selectivity, retention

Natural Mortality (M)

Molting Probability

Trawl selectivity

Winter pot Selectivity

Winter Com Retntion

Summer Com Sel

Retention 76-2007

Retention (oldshell) 76-2007

Retention 2008-2022

Retention (oldshell) 2008-2022

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- **Natural Mortality (M)**
- **Molting Probability**
- **Trawl selectivity**
- **Winter pot Selectivity**
- **Winter Com Retntion**
- **Summer Com Sel**
- **Retention 76-2007**
- **Retention (oldshell) 76-2007**
- **Retention 2008-2022**
- **Retention (oldshell) 2008-2022**
## NSRKC Final Assessment Models

<table>
<thead>
<tr>
<th>Model</th>
<th>21.0</th>
<th>22.0</th>
<th>22.1</th>
<th>22.2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Additional Parameters</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AIC change</td>
<td>+6</td>
<td>+5.4</td>
<td>+24</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>347.9</td>
<td>346.1</td>
<td>342.6</td>
<td>341.1</td>
</tr>
<tr>
<td><strong>Trawl Survey</strong></td>
<td>11.0</td>
<td>10.8</td>
<td>10.5</td>
<td>10.5</td>
</tr>
<tr>
<td><strong>Discards</strong></td>
<td>3.5</td>
<td>4.5</td>
<td>3.3</td>
<td>3.6</td>
</tr>
<tr>
<td><strong>St.CPUE</strong></td>
<td>-14.8</td>
<td>-14.9</td>
<td>-15.1</td>
<td>-15.0</td>
</tr>
<tr>
<td><strong>Length-Shell prop</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trawl</td>
<td>129.0</td>
<td>126.4</td>
<td>125.5</td>
<td>123.7</td>
</tr>
<tr>
<td>Winter pot</td>
<td>39.5</td>
<td>39.3</td>
<td>39.3</td>
<td>39.1</td>
</tr>
<tr>
<td>S. com retain</td>
<td>49.3</td>
<td>48.5</td>
<td>48.7</td>
<td>48.9</td>
</tr>
<tr>
<td>S. com total, discards</td>
<td>24.3</td>
<td>25.0</td>
<td>24.9</td>
<td>25.1</td>
</tr>
<tr>
<td>W. Com retain</td>
<td>2.7</td>
<td>2.9</td>
<td>2.5</td>
<td>2.7</td>
</tr>
<tr>
<td>Recruit</td>
<td>19.5</td>
<td>19.6</td>
<td>20.1</td>
<td>20.1</td>
</tr>
<tr>
<td>Tag recovery</td>
<td>83.9</td>
<td>83.9</td>
<td>82.9</td>
<td>83.4</td>
</tr>
<tr>
<td><strong>Max grad (e-6)</strong></td>
<td>4.9</td>
<td>2009</td>
<td>14.7</td>
<td>4.55</td>
</tr>
<tr>
<td><strong>RMSE Trawl</strong></td>
<td>0.34</td>
<td>0.34</td>
<td>0.33</td>
<td>0.33</td>
</tr>
<tr>
<td><strong>RMSE CPUE</strong></td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
<td>0.44</td>
</tr>
</tbody>
</table>
BMSY: 1982-2023
Mature: > 94mm CL
Lab data (2022)
Functional maturity > 75mm CL
Model results

• As expected, no surprises
• Lower oldshell retention prob (22.0)
• Size-dependent Increasing M (22.1)
  – Could be unrealistic....
• Little-no improvements in model fits
• Little-no change in model estimates: MMB, BMSY
Author Recommendation

• Model Parsimony vs Realism in the absence of clear winner

• Model 21.0
  – Retention probability clearly differed between newshell and oldshell, however, this did not improve model fit. (model parsimony).

• Model 22.0
  – Even though it did not improve model performance, shell-specific retention probabilities should be kept to be true to reality. (model realism)
Estimate discards **WITHOUT data.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Discards data</th>
<th>OFL</th>
<th>Rationale</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>No survey</td>
<td>Retained</td>
<td>No discards data = No total catch = Retained OFL</td>
</tr>
<tr>
<td>2016-2019</td>
<td><em>Oppotunistic</em> observer survey</td>
<td></td>
<td>Develop an <em>ad hoc</em> method to estimate <em>ad hoc</em> discards</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Flawed data are better than no data(?)</td>
</tr>
<tr>
<td>2020</td>
<td><em>ad hoc</em> discards</td>
<td>Total</td>
<td>Discards data exist = total catch = Total OFL</td>
</tr>
<tr>
<td>2021-</td>
<td>No survey</td>
<td>Total</td>
<td>Total OFL = estimate discards <strong>WITHOUT</strong> data</td>
</tr>
</tbody>
</table>

Several *ad hoc* methods can be developed.

**Scientific Criteria** for selecting the BEST method estimating discards from opportunistic survey data?  
**Scientific Criteria** for the BEST method estimating discards from NO data?
Estimate discards WITHOUT data.

• Author recommendation: Retained OFL-ABC
  – Observer survey: opportunistic, will not resume for foreseeable future
  – Consistent with available data
  – Scientifically Honest

• If CPT-SSC do keep Total OFL: Author requests
  – Scientific Criteria for selecting a method estimating discards from opportunistic survey data
  – Scientific Criteria for selecting a method estimating discards from NO data
Length-independent vs. length-dependent $F_{OFL}$ for calculation of OFL

- **Length independent**
  - $F_{OFL} = \gamma M$ ($M = 0.18$)
  - $OFL = F_{OFL} \times B$ $B = \sum B_i$

- **Length dependent**
  - $F_{OFL,i} = \gamma M_i$ ($M_i$ : model estimate)
  - $OFL = \sum F_{OFL,i} \times B_i$
Length-independent vs. length-dependent $F_{OFL}$ for calculation of OFL

- **Author recommendation: length-dependent**
  - Consistent with model structure
  - Length-independent:
    - Appropriate when length-independent $M$ (e.g. $M=0.18$) is preassigned.
    - May be in appropriate when length-dependent $M$ is estimated (which $M$ be used to set $F_{OFL}$?)
  - ABC buffer is the right place to deal with uncertainties about OFL.