Norton Sound Red King Crab SAFE 2024

Sept 13 2023

Crab Plan Team:
NOAA-Online
Seattle WA

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Alaska Department of Fish & Game
Division of Commercial Fisheries
Issues to Determine
Model Selection for Jan 2024

• Final model selection for Jan 2024

  • Model 21.0: Default baseline model
    – Length dependent M: $0.18 < \text{CL 124mm, Estimate } > 123\text{mm}$
  • Model 23.0: SSC requested alternative model
    – Length independent model estimate M.
  • The same model selection discussion in 2013, 2016, 2017...

• Other Issues to discuss (as time allows)
New Data: Catch (Winter, Summer), CPUE, and Trawl abundance

- Winter Com: 3,580 (10,013 lb)
- Winter Subsistence (To be reported: Assume the same as 2022)
- Summer Com: 146,087 (413,327 lb)
- Bycatch from other fisheries (??? Lb)
- Discards mortality 21,350 lb (model estimate)
- Total Catch 0.446 million lb < ABC (0.450).
- ADF&G Trawl abundance
  - 3.44 million (CV 0.325)
- NOAA NBS abundance
  - To be reported
Response to the CPT-SSC (Jan-Feb 2023)

Einstein did not say…
(______) is doing the same thing over and over again and expecting (______) results

• **SSC:** *Test the sensitivity of the assessment model to a lower size at maturity*

• **Author Reply**
  – Evaluated in SAFE 2019, 2022
  – No impacts: Tier 4 $F_{OFL}$ determination is insensitive to size at maturity
Response to the CPT-SSC (Jan-Feb 2023)

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• **SSC:** *One estimated value of M for all sizes.*

• **Author Reply**
  – Evaluated in SAFE 2013, 2016, 2017
  – Higher M (0.3-0.42)
  – Lower model fit (i.e. higher nll value)
  – Rejected by CPT-SSC
  – Alternative model 23.0
Response to the CPT-SSC (Jan-Feb 2023)

Einstein did not say…
(_________________________) is doing the same thing over and over again and expecting (_____________________) results

• **SSC:** *A small-scale observer program should be considered.*

• **Author Reply**
  – All the previous observer programs were small-scale. (further smaller-scale programs?)
  – **Welcome observer survey experts’ input**
    • Survey design, bias correction, etc.
  – ADF&G and NSEDC agree:
    • Previous observer programs did not work *(for the purpose of estimating discards mortality)*
    • Biased survey, biased data, biased discards estimates.
Response to the CPT-SSC (Jan-Feb 2023)

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and expecting (          ) results

• **SSC: Update the Standardized Com fish CPUE model.**

• **Author Reply**
  – Worthy consideration.
  – Welcome model improving suggestions and consultations from experts.
  – The updates will unlikely improve the assessment model performance.
  – Little difference between arithmetic and standardized CPUE.
  – High additional variance estimate
  – Removing CPUE data had little effect on model performance and projection (SAFE 2018)
  – Included as supplemental to triennial trawl survey, but trawl survey is becoming annual (NBS)
Einstein did not say…

(______) is doing the same thing over and over again and expecting (______) results

- **SSC: Update the Standardized Com fish CPUE model.**
Response to the CPT-SSC (Jan-Feb 2023)

• **SSC: LK-TK, VAST, GMACS Updates and progresses**

• **Author Reply**
  – Look forward to seeing progress in LK-TK and VAST
    • LK-TK: LTK Task force
    • VAST: Jon R. (NOAA)
  – GMAC in progress....
    • Feb 2023: model ran with 2022 data.
      – Transition matrix, molting prob similar to the assessment model
      – Large crab M: 0.40 (GMACS) vs. 0.64 assessment model
      – GMACS MMB: 25% lower than assessment model (model weight issue: Andre)

• Updated Input files .dat, .ctl, .prj to 2023.
• GMACS did not run
• Welcome any assistances
ADF&G Trawl Survey

- July 21 – July 30, 50 stations: Core, Tier 1, 2, 3

Figure 1. Stations trawled (in bold, n=50) during the 2023 red king crab bottom trawl survey. Note: stations in gray boxes have never been successfully trawled.
ADF&G Trawl Survey
ADF&G Trawl Survey

- High female catch outside the core area.
ADF&G Trawl Survey

• July 21 – July 30, 50 stations: Core, Tier 1, 2, 3
• High abundance of Legal Male
  – Fewer Pre1 males (legal next year)
  – Very few Pre2, Pre3 males, and Females
• Expecting abundance decline in 2-3 years?
• All but a few NSRKC died after ~ 2 years of holding.
• After 1 year holding: 10 out of 23 died ($M = 0.57$).
NSRKC Draft Assessment Models

Einstein did not say…
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and expecting (              ) results

The same model exercise performed in 2013, 2016, 2017

• Model 21.0: 2023 final model with data update
• Model 23.0:
  – SSC: Single M estimate for all lengths
Model 23.0 Profile Analysis

Total negative log likelihood

M = 0.4116
### NSRKC Draft Assessment Model parameters

<table>
<thead>
<tr>
<th>Name</th>
<th>21.0 Estimate</th>
<th>std.dev</th>
<th>23.0 Estimate</th>
<th>std.dev</th>
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<tbody>
<tr>
<td>( \log_q_1 )</td>
<td>-7.310</td>
<td>0.194</td>
<td>-7.174</td>
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<td>( \log_q_2 )</td>
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<td>0.165</td>
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<td>( \log_q_3 )</td>
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<td>-6.740</td>
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<tr>
<td>( \log_{N_{76}} )</td>
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<td>0.137</td>
<td>9.461</td>
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</tr>
<tr>
<td>( R_0 )</td>
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<td>0.080</td>
<td>7.091</td>
<td>0.150</td>
</tr>
<tr>
<td>( a_1 )</td>
<td>1.002</td>
<td>4.445</td>
<td>2.605</td>
<td>4.511</td>
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<tr>
<td>( a_2 )</td>
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<td>( a_4 )</td>
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<td>3.891</td>
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<td>( a_5 )</td>
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<td>( a_7 )</td>
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<td>( r_1 )</td>
<td>5.000</td>
<td>0.002</td>
<td>5.000</td>
<td>0.003</td>
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<tr>
<td>( r_2 )</td>
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<td>( \log_b )</td>
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<td>0.015</td>
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<tr>
<td>( \log_{f_{st1}} )</td>
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<tr>
<td>( \log_{f_{wa}} )</td>
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<td>( \log_{f_{wb}} )</td>
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<td>4.860</td>
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</tbody>
</table>

**Model 23.0**

Better trawl survey selectivity parameter
### NSRKC Draft Assessment Model parameters

<table>
<thead>
<tr>
<th>Name</th>
<th>Estimate</th>
<th>std.dev</th>
<th>Estimate</th>
<th>std.dev</th>
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<tbody>
<tr>
<td>Sw1</td>
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<td>Sw2</td>
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<td>Sw3</td>
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<td>0.237</td>
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<td>q.1</td>
<td>0.719</td>
<td>0.128</td>
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<td>σ</td>
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<td>β1</td>
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<td>m8</td>
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## NSRKC Draft Assessment Models Likelihood

<table>
<thead>
<tr>
<th>Model</th>
<th>21.0</th>
<th>23.0</th>
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<tr>
<td>Additional Parameters</td>
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<td>AIC change</td>
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<tr>
<td>Total</td>
<td>362.3</td>
<td>375.9</td>
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<tr>
<td>TSA</td>
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<td>DIS</td>
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<tr>
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<tr>
<td>TAG</td>
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</tr>
<tr>
<td>M</td>
<td>0.18</td>
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<tr>
<td>RMSE Trawl</td>
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<td>0.33</td>
</tr>
<tr>
<td>RMSE CPUE</td>
<td>0.44</td>
<td>0.44</td>
</tr>
<tr>
<td>Total OFL</td>
<td>0.72</td>
<td>1.21</td>
</tr>
</tbody>
</table>
NSRKC Observer

Summer discards, total, winter retain: observed vs predicted

Summer discards

Summer total

Winter retain

Proportion

NSRKC Tag recovery size distribution

Tag recovery data observed vs predicted
Recovery after 1 year

Recovery after 2 years

Recovery after 3 years

Recovery after 3 years
Abundance

Modeled crab abundance Feb 01

Model 23.0: assumes higher recruits (not observed in trawl survey), higher total abundance, and higher mortality
No difference in BMSY between the two models Tier 4a for both models. Declining MMB
OFL

- Tier 4a for both 21.0 and 23.0
- FOFL = M = 0.18 (21.0), 0.4116 (23.0)
- OFL: 0.72 (21.0), 1.21 (23.0)
Model Selection:
Better model fit vs Biological correctness?
Discussed: 2013, 2016, 2017

21.0
• Biologically incorrect
• Trawl survey parameter hits boundaries
• Better overall model fit (but no observable difference)

23.0
• Biologically Correct
• Better trawl survey parameter estimate
• Less overall model fit (but no observable difference)

Evidence of crab $M$ is length-independent?
Other stocks evaluated length-dependent $M$?
For Jan 2024

- Include NOAA NBS Trawl survey data
- Finalize Winter Subsistence harvest data
- GMACS comparison
Einstein did not say…

(Science) is doing the same thing over and over again and expecting (the same) results