D1  BRISTOL BAY
RED KING CRAB
INFORMATION PAPER

SAM CUNNINGHAM & KELLY CATES, APRIL 2022
• BBRKC survey abundance at low levels
• 2021/22 fishery not opened
• Survey finding red king crab in larger numbers north of the stock area
• Incomplete information on stock distribution and shell condition outside of the survey period

Figure 3-3 2021 Trawl Survey, Litzow et al.
• BBRKC survey abundance at low levels
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• Survey finding red king crab in larger numbers north of the stock area
• Incomplete information on stock distribution and shell condition outside of the survey period

Figure 3-3 2021 Trawl Survey, Litzow et al.
COUNCIL REQUEST

1. Molt-mate cycle (and life-history)

2. Boundaries for trawl survey, BBRKC stock assessment, BBRKC fishery, trawl PSC limits (and others)

3. Bottom contact by pelagic trawl gear in the Bristol Bay region

4. Flexible spatial management measures
TOPIC 1: BBRKC MOLTING & MATING

Provide the best available information on Bristol Bay red king crab molting/mating annual cycle and how the seasonality of this overlaps with fisheries and the effects these interactions may have.
TOPIC 1: BBRKC MOLTING & MATING

- RKC molt multiple times per year through age-3 after which molting is annual
- At larger sizes, king crab (especially males), may skip molt as growth slows
- RKC shells begin to harden days to weeks after molt
  - Takes 74.2 days for the carapace to reach 90% of maximum hardness
- RKC are at increased risk of predation and harm from contact with fishing gear during molting
Mating occurs at the same time as molting for mature females.

The mating season primarily occurs from January to March for primiparous RKC females and from April to June for multiparous RKC females.

Mature males thought to molt once during the March to May period.
- Juveniles may molt several times per year.

Overall, the molting period for the entire population of BBRKC ranges from January to June.
TOPIC 1: RECRUITMENT

- Larval dispersal is an important process for recruitment in benthic invertebrates
- Substantial transport distances may occur before reaching the settling stage
- Larval settlement locations vary with time spent in transport, oceanographic patterns and temperature
  - Shorter transport distance is associated with warmer conditions
- Current spatial distributions can supply larvae to nurseries along the Alaska Peninsula
- Larvae from SW Bristol Bay can reach the Pribilof Islands, but generally there is a disconnect between the Pribilof Islands and Bristol Bay RKC populations
TOPIC 1: RECRUITMENT

- Nearshore, SW Bristol Bay has historically (prior to 1980) been hypothesized as the most important spawning ground for BBRKC.
- Recent studies suggest central Bristol Bay as important spawning grounds today.
- Cold and warm years can affect both the recruitment success for BBRKC and the area to which they recruit.
- Hatching generally occurs in April but embryo development can be delayed in cold years.
- Mean age at recruitment into the directed fishery is 8-9 years.
- Recruitment has been extremely low during the last 12 years.
# TOPIC 1: BBRKC MOLTING & MATING

General timeline of events around mating and molting of BBRKC*

(Dark blue represents core timing, light blue represents possible timing)

<table>
<thead>
<tr>
<th>Event</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
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<tr>
<td>Multiparous Female Larval Hatch, Molt, Mating</td>
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<td>Primiparous Female Larval Hatch, Molt, Mating</td>
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<td>Directed BBRKC Fishery</td>
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<td>Pelagic Trawl Pollock Fishery</td>
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*This summary is intended as a general guide only and is non-binding*
Evaluate boundaries used for the BBRKC survey, stock assessment, PSC limits, and directed fishery
Appendix 1

ADFG Stat. Areas
Survey Stations
Crab Area T

Figure 3-1

BBRKC Survey Stations
Crab Area T
BOUNDARIES: CENTERS OF DISTRIBUTION

Mature Females

Mature Males

Source: Litzow et al. 2021

Figure 3-4
BOUNDARIES: POLLOCK CATCH v RKC SURVEY

Figure 3-2
Figure 3-8  Fall-to-winter 2021/22 male red king crab tagging results in Bristol Bay (Source: B. Daly, ADFG. March 2022. Pers. Comm.)
Mature female abundance and effective spawning biomass → stock assessment, Zone 1 PSC limit, and directed fishery status

Stock assessment includes survey data as overlaps Area T, retained/discharded catch in directed fishery, and PSC

PSC estimated in two ways:
- For Zone 1 Limit (NMFS mgmt. areas; #animals)
- For stock assessment (Area T; weight)

BBRKC harvest limit (State) incorporates both raw survey area-swept abundance and model-based estimates (recruitment, growth, selectivity); Including new survey units affects both

Cooperative action: If State/Federal areas do not align then rationalized BBRKC could not be retained in “northward expanded” areas
<table>
<thead>
<tr>
<th>Year</th>
<th>A80 Limit</th>
<th>A80 Not Allocated</th>
<th>CDQ</th>
<th>TLAS Pollock/Atka/Other</th>
<th>TLAS Pacific Cod</th>
<th>TLAS Yellowfin</th>
<th>TLAS Total</th>
<th>Total</th>
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<td>23,204</td>
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<td>21,079</td>
<td>400</td>
<td>6,000</td>
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<td>10,379</td>
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<td>2022</td>
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<td>5,555</td>
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<td>3,424</td>
<td>65</td>
<td>975</td>
<td>7,700</td>
<td>8,739</td>
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Table 3-1

<table>
<thead>
<tr>
<th>Year</th>
<th>A80 Limit</th>
<th>CDQ</th>
<th>TLAS Pollock/Atka/Other</th>
<th>TLAS Pacific Cod</th>
<th>TLAS Yellowfin</th>
<th>TLAS Other Flatfish</th>
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<td>22</td>
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<td>51</td>
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<td>6</td>
<td>547</td>
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<td>58</td>
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<td>39</td>
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<td>2020</td>
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<td>6,301</td>
<td>9</td>
<td>175</td>
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<td>762</td>
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<td>1,867</td>
<td>17</td>
<td>25</td>
<td>892</td>
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<td>19,198</td>
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Table 3-2
### Table 3-3

<table>
<thead>
<tr>
<th>Year</th>
<th>Female discards</th>
<th>Male discards</th>
<th>Total discards</th>
<th>Discard mortality</th>
<th>Male catch (retained)</th>
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<td>2005</td>
<td>1,682,031</td>
<td>3,181,024</td>
<td>4,863,056</td>
<td>972,611</td>
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<td>2006</td>
<td>221,623</td>
<td>1,572,174</td>
<td>1,793,797</td>
<td>358,759</td>
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<tr>
<td>2007</td>
<td>731,651</td>
<td>3,498,460</td>
<td>4,230,111</td>
<td>846,022</td>
<td>3,162,287</td>
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<td>2008</td>
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<td>3,772,206</td>
<td>4,434,519</td>
<td>886,904</td>
<td>3,066,286</td>
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<td>2009</td>
<td>350,730</td>
<td>3,118,571</td>
<td>3,469,302</td>
<td>693,860</td>
<td>2,556,645</td>
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<td>2010</td>
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<td>2,321,052</td>
<td>2,791,545</td>
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<td>2011</td>
<td>118,511</td>
<td>1,338,976</td>
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<tr>
<td>2012</td>
<td>46,511</td>
<td>590,033</td>
<td>636,545</td>
<td>127,309</td>
<td>1,175,752</td>
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<td>2013</td>
<td>409,457</td>
<td>908,106</td>
<td>1,317,563</td>
<td>263,513</td>
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<td>2014</td>
<td>275,901</td>
<td>1,704,433</td>
<td>1,980,333</td>
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<tr>
<td>2015</td>
<td>801,260</td>
<td>1,107,517</td>
<td>1,908,777</td>
<td>381,755</td>
<td>1,526,974</td>
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<tr>
<td>2016</td>
<td>432,824</td>
<td>946,875</td>
<td>1,379,699</td>
<td>275,940</td>
<td>1,281,194</td>
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<tr>
<td>2017</td>
<td>233,063</td>
<td>730,783</td>
<td>963,846</td>
<td>192,769</td>
<td>997,214</td>
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<tr>
<td>2018</td>
<td>591,898</td>
<td>910,903</td>
<td>1,502,801</td>
<td>300,560</td>
<td>629,907</td>
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<tr>
<td>2019</td>
<td>151,967</td>
<td>813,686</td>
<td>965,653</td>
<td>193,131</td>
<td>548,516</td>
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<tr>
<td>2020</td>
<td>64,575</td>
<td>662,986</td>
<td>727,561</td>
<td>145,512</td>
<td>455,262</td>
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</table>

Average: 452,800 | 1,698,612 | 2,151,412 | 430,282 | 1,698,237
Median: 380,094 | 1,223,246 | 1,648,299 | 329,660 | 1,411,802
Provide the best available information on bottom contact by pelagic trawl gear and the impact it may have on BBRKC stocks.
Example of an experimental CV tow – Objective to put trawl on-bottom

Source: B. King, unpublished. Courtesy APU FAST Lab, 2022
Figure 4-2
A Season

Figure 4-3
B Season

PTR BOTTOM CONTACT
ESTIMATE:
SEASONAL AVERAGES 2003-2021
PELAGIC TRAWL BOTTOM CONTACT ESTIMATE

January 2016: Total Swept Area (SA), by PTR (1,242.2 km²)

- EBS Trawl Survey "Northern District"
- ADF&G Registration Area T
- FSC Limit Zone 1

Nearshore Bristol Bay Trawl Closure Area

SA, km²

0.01 0.1 1 10 100
Figure 4-4
PELAGIC TRAWL BOTTOM CONTACT

• Research application: Ecosystem indicator
• Research recent/in-progress: Quantifying PTR bottom contact
• Unobserved mortality
• Bottom contact by other gear types
TOPIC 4: FLEXIBLE SPATIAL MANAGEMENT

Summarize mechanisms used in other council managed fisheries to create flexible, responsive spatial management measures for all gear types and how they might be applied to protect BBRKC.
For the groundfish fisheries in addition to PSC limit closures, NMFS has inseason adjustment authority for closures to prevent overfishing of any fish or shellfish, adjustments for an incorrectly specified PSC limit, and closures depending on PSC rates.

For crab PSC, these inseason adjustment authority actions have rarely, if ever, been necessary.

Crab PSC limits have rarely been exceeded and often the industry has more efficient and effective tools to avoid PSC:

- Often the industry has information on the PSC rates sooner from vessel personnel.
- The industry can move out of or close an area with high PSC rates sooner than NMFS can issue an area closure.
- The industry can reopen an area sooner if PSC rates decrease.
TOPIC 4: INCENTIVE APPROACHES

- Rolling Hot Spots (RHS)
  - The RHS works by monitoring bycatch rates of chum and Chinook salmon for AFA and CDQ participants and comparing them to a base rate
  - Fishing cooperatives may impose temporary area closures on their members
  - The efficacy of the program is reviewed annually by the Council

- Performance Incentives
  - Performance to a low level of bycatch in one year provides an insurance-like buffer in the following year
  - Chinook salmon PSC limit for some programs in the GOA
TOPIC 4: TIME AND AREA CLOSURES

- Permanent Area Closures
  - Same area closed every year to certain gear types
  - Example: RKCSA to non-pelagic trawling
  - Council may consider examining existing closure areas and deciding whether these areas should remain in the same location, should be moved, if new closure areas are warranted or if new gear type restrictions are necessary

- Seasonal Closures
  - Areas closed during specified times of the year to certain gear types
  - Example: Northern Bristol Bay Trawl Area (aka Togiak subarea)
  - Council may consider seasonal closures during important biological times for BBRKC

- Rotational Area Closures
  - Rotational closures are area closures that shift spatially dependent on input data or predetermined criteria
  - Closures target specific vulnerable species, generally for a specific demographic of the population
  - Example: Juvenile Atlantic Scallops

- Temperature Closures
  - Can go into effect when temperature thresholds are surpassed and conditions are unsafe for certain species
  - Examples: Texas cold snap, Yellowstone heat wave, TurtleWatch
  - Could be relevant for bycatch of BBRKC to avoid increase discard mortality rates
TOPIC 4: NON-SPATIAL MANAGEMENT

- Gear Modifications or Changes to Reduce Bycatch
  - Floating pots – Eliminates the opportunity for crab to enter pots
  - Slinky pots – Movement of pots may deter crab from entering pots
  - Modification of pots – Modify pots to deter RKC from entering

- Fisheries Executed in Tandem
  - Example: Halibut and Sablefish
  - Possibilities
    - Retention of multiple crab species during directed harvest
    - Pacific Cod and BBRKC
Questions?

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• Craig Rose, FishNext Research
• AFSC: Erin Fedewa, Leah Zacher
• Bering Sea Fisheries Research Foundation
• Alaska Bering Sea Crabbers
• Alaska Seafood Cooperative