King crab genetics: considerations for experimental releases

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Why study genetics or DNA?

• Changes in DNA lead to variation in life forms and contribute to adaptation.

• DNA is now relatively “cheap and easy”

• DNA has very practical applications
  - an aide to management
Fisheries CSI (then)

Internationally Protected Whales
Mislabeled & Sold In Japan

Scott Baker in Japanese Hotel - 1993
Fish Tale Has DNA Hook: Students Find Bad Labels

August 22, 2008
Our Objectives

• Describe red king crab population genetic structure
  → Suggest genetic stocks for management
  → Conserve genetic variation and potential for adaptation

• Explore genetic considerations associated with experimental releases and enhancement
  → risks, benefits, and trade-offs
RKC Distribution

Red King Crab Range

adfg.alaska.gov

grida.no
RKC Sample Locations

Norton Sound
2008, n = 50  
1989, n = 50

Bristol Bay
2008, n = 50  
1989, n = 50

Pribilof Islands
2008, n = 50  
1996, n = 50

Adak Island
1988, n = 50

Kachemak Bay
1988, n = 45

Barlow Cove
2008, n = 50  
1989, n = 50

Deadman Reach
2008, n = 50  
1989, n = 50

Gambier Bay
2008, n = 50  
1989, n = 50

Seymour Canal
1989, n = 50

Alitak Bay
1988, n = 50

Chiniak Bay
1991, n = 50
Population Structure
Population Structure
Where are there genetically-based RKC stocks?

- **Norton Sound**
  - 2008, n = 50
  - 1989, n = 50

- **Bristol Bay**
  - 2008, n = 50
  - 1989, n = 50

- **Pribilof Islands**
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- **Chiniak Bay**
  - 1991, n = 50
General Patterns
Isolation by Distance

![Graph showing genetic distance vs. geographic distance with points for different species and a line indicating isolation by distance.]

- WAK
- WAK x GOA
- GOA
- GOA x SEAK
- SEAK
General Patterns

Lower Diversity in Southeast AK

Western AK  GOA/Kodiak  Southeast AK

Mean expected heterozygosity

Effective # of alleles

ADK  NSD  BRB  PRB  KKB  CHK  AKB  DRC  GMB  BWC  SYM
Spatial Statistical Analysis
How do sampling locations group?

- Western AK
- Kodiak/GOA
- Southeast AK
Suggested RKC Stock Structure

Southeast AK (4 collections)
More Conservative Spatial Analysis
How do sampling locations group?

- Norton Sound
- Bristol Bay
- Pribilofs
- Chiniak Bay
- Kachemak Bay
- Alitak Bay

- Barlow Cove
- Seymour Canal
- Deadman Reach
- Gambier Bay

Adak
Conclusions – Stock structure

• Spatial genetic variation
  There exist 2-5 genetic stocks of Alaska RKC

Southeast Alaska
  ↑ genetic divergence within region
  UPSHOT: Finer scale stock structure

Gulf and Western Alaska
  ↓ genetic divergence within and between regions
  UPSHOT: Larger scale stock structure
Objectives

- Describe Red King Crab population genetic structure → help guide stock management
- Explore genetic considerations associated with experimental releases and enhancement → risks, benefits, and trade-offs
Definition of supplementation

Intentional integration of hatchery and wild production, with the goal of improving the status of the natural population.
## Types of benefits to be considered

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<th>Conservation</th>
<th>General</th>
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<td>• Natural pops</td>
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<td>• Harvest</td>
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Potential benefits of hatchery propagation for natural populations

1. Reduce short-term extinction risk
2. Maintain population while habitat problems are addressed
3. Re-seed vacant habitat
4. Speed recovery
Potential risks of captive hatchery propagation for natural populations

1. Loss of diversity
   • Within population
   • Between populations

2. Loss of fitness

3. Ecological effects
Captive can reduce genetic variation in a population if supplementation is too successful.
Can reduce genetic variation in a population if supplementation is too successful.

\[ N_e T = \frac{1}{\frac{x^2}{N_e C} + \frac{(1-x)^2}{N_e W}} \]
Broodstock integrity: balancing opposing costs & risks

1. Sample from entire spawning stock
   Maximize % of diversity sampled, but
   Increased cost & risks

2. Sample only part of stock
   Reduce cost & risks, but
   Reduce diversity of population ($N_e$)
Risks of captive propagation for natural populations

1. **Loss of diversity**
   - Within population
   - *Between populations* → Portfolio effect

2. Loss of fitness

3. Ecological effects
Risks of captive propagation for natural populations

1. Loss of diversity
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## Hatchery vs. wild environments

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Efforts can be made to reduce (but not eliminate) selection in hatchery.
Ways to reduce selection in hatchery from genetics theory (math) ……..

Minimize # generations in captivity.
- reduces domestication selection
  (also reduces inbreeding effects)

Equalize family size
- reduces domestication selection
Risks of captive propagation for natural populations

1. Loss of diversity
   • Within population
   • Between populations

2. Loss of fitness

3. Ecological effects
Laikre et al. 2010
Potential Genetic Effects of Releases

**Figure 1.** Primary pathways by which large-scale releases can change genetic characteristics within (red boxes) and between (purple box) natural populations.
Ideally, monitoring should include genetic screening and statistical evaluation of (i) Native population genetic structure and level of diversity prior to releases,
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(ii) **Natural rates of genetic change of these parameters**
Laikre et al. 2010 – Releases

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(i) Native population genetic structure and level of diversity prior to releases,
(ii) Natural rates of genetic change of these parameters
(iii) Genetic composition of the population(s) used for release, and
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(i) Native population genetic structure and level of diversity prior to releases,
(ii) Natural rates of genetic change of these parameters
(iii) Genetic composition of the population(s) used for release, and
(iv) Genetic structure and amount of diversity of natural population(s) on repeated occasions during and after the release(s).

Laikre et al. 2010 – Releases
Proposed Experimental Release of RKC

- Identify specific small-scale experiment location.
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- Sample and genetically characterize local population and surrounding area.
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Conclusions: Results of Genetics Research

• Found evidence of stock structure
  – There exist 2-5 genetic stocks of Alaska RKC

• Demonstrated that theory and data can guide experimental releases

• Formed and fostered a working relationship with Alaska Department of Fish and Game
Acknowledgements

AKCRRAB group

Scott Vulstek (UAF MS student) & Robin Waples

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Thank You