King crab genetics: considerations for experimental releases

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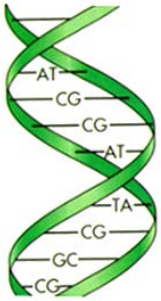
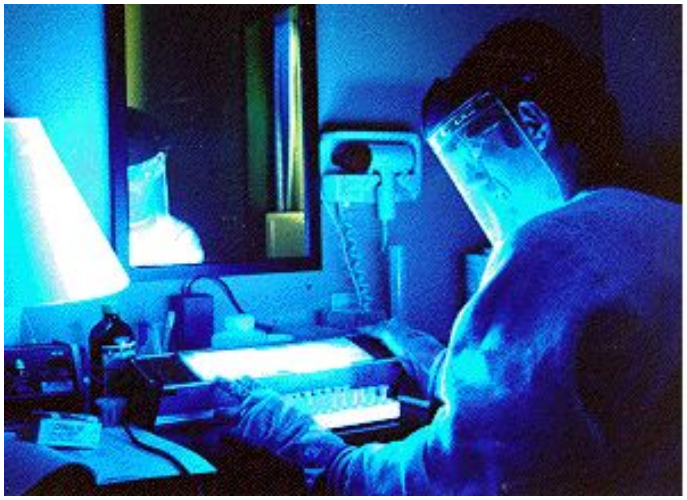


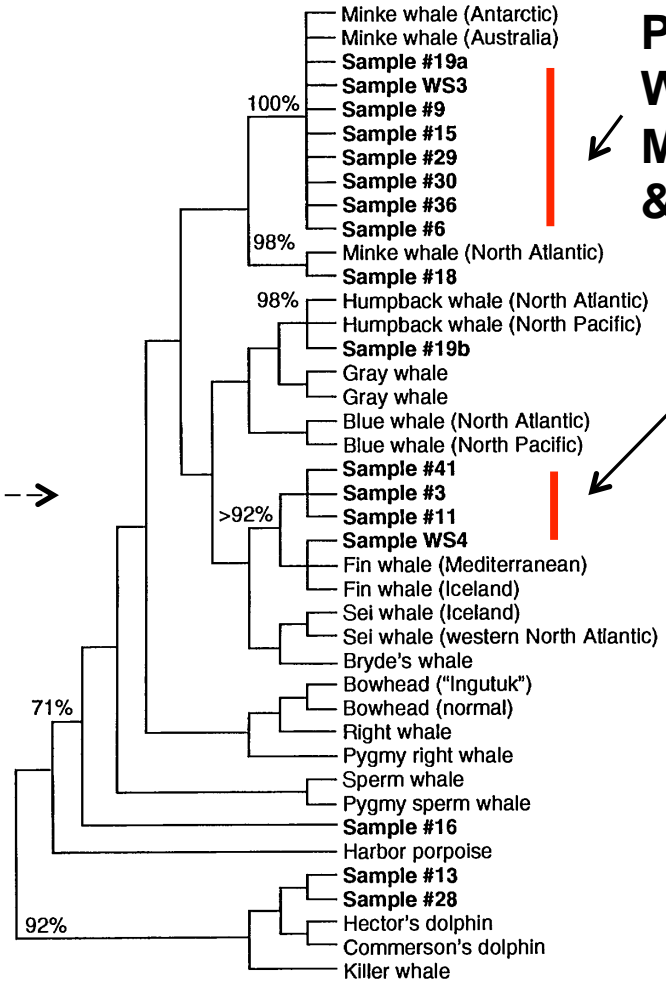
Why study genetics or DNA?

- 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)

Scott Baker in Japanese Hotel - 1993





Internationally Protected Whales Mislabeled & Sold In Japan

Fisheries CSI (now)

The New York Times

Fish Tale Has DNA Hook: Students Find Bad Labels

August 22, 2008

Our Objectives

- Describe red king crab population genetic structure

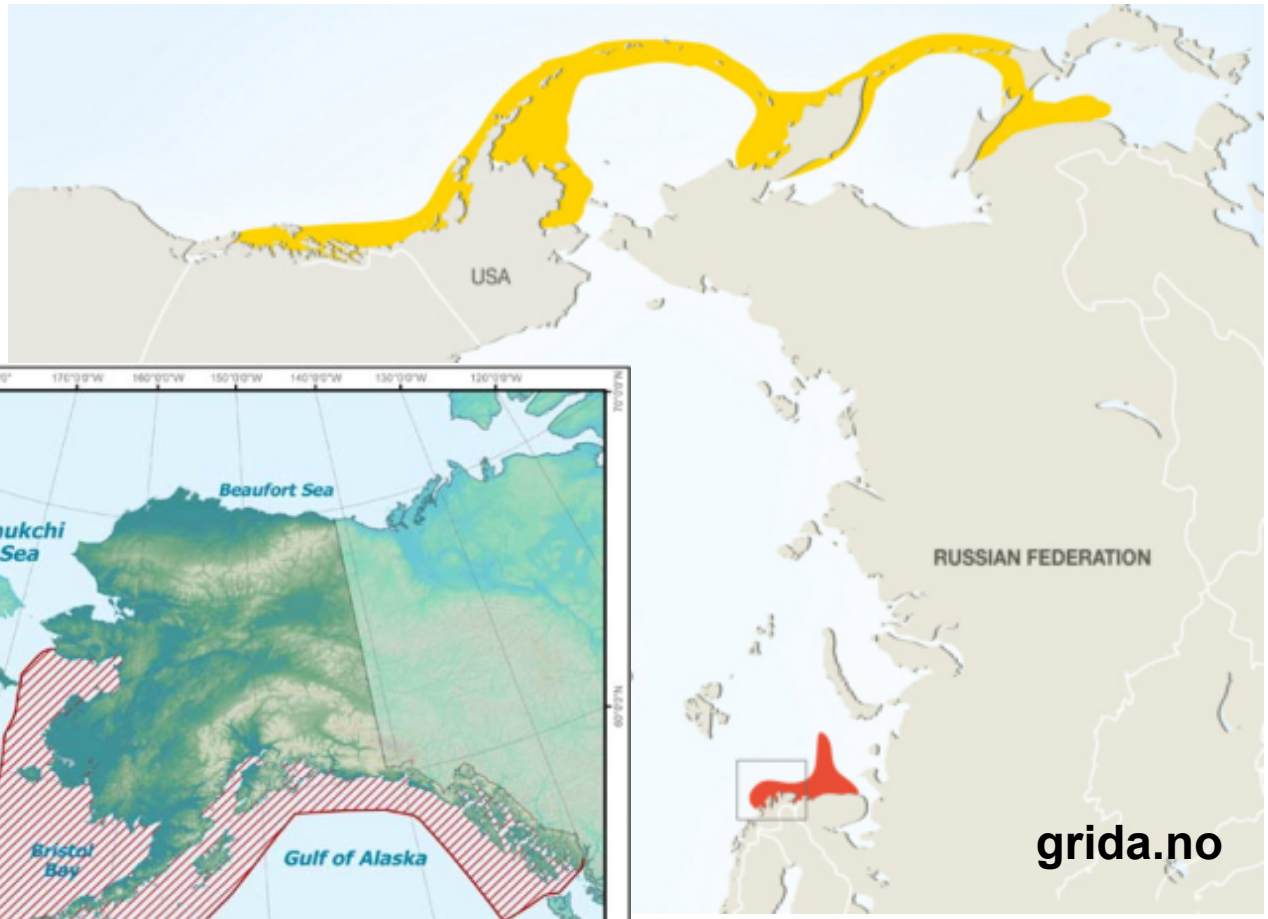
  →Suggest genetic stocks for management

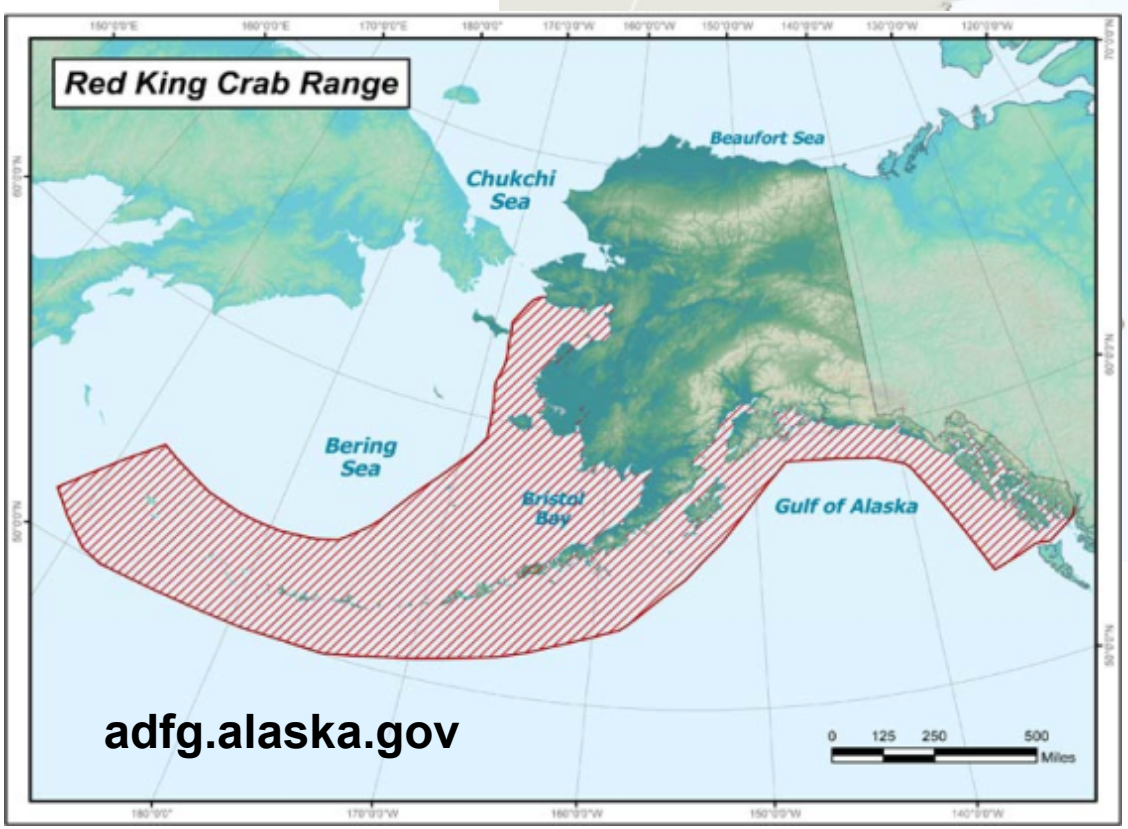
  →Conserve genetic variation and potential for adaptation

- Explore genetic considerations associated with experimental releases and enhancement

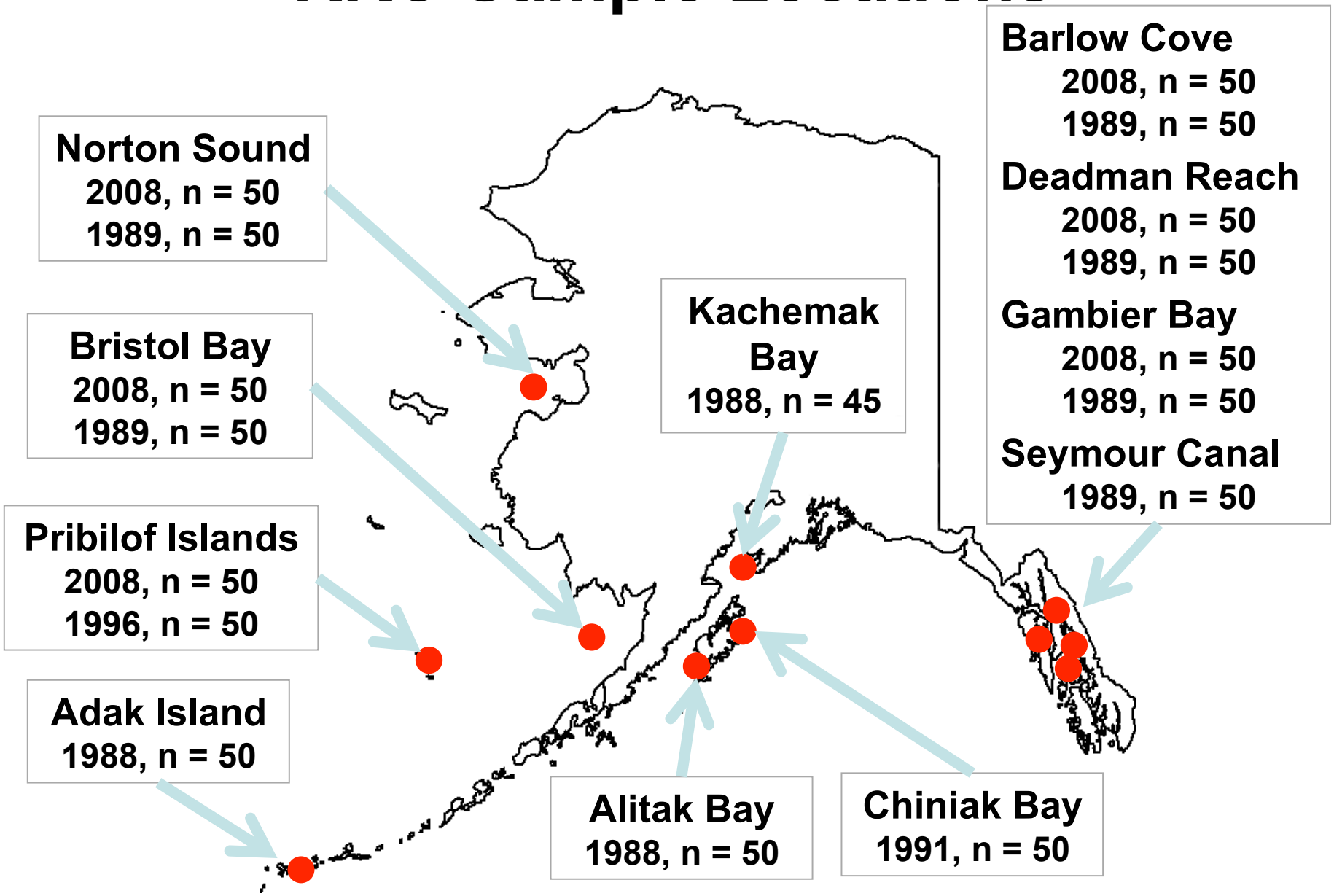
  → risks, benefits, and trade-offs

RKC Distribution

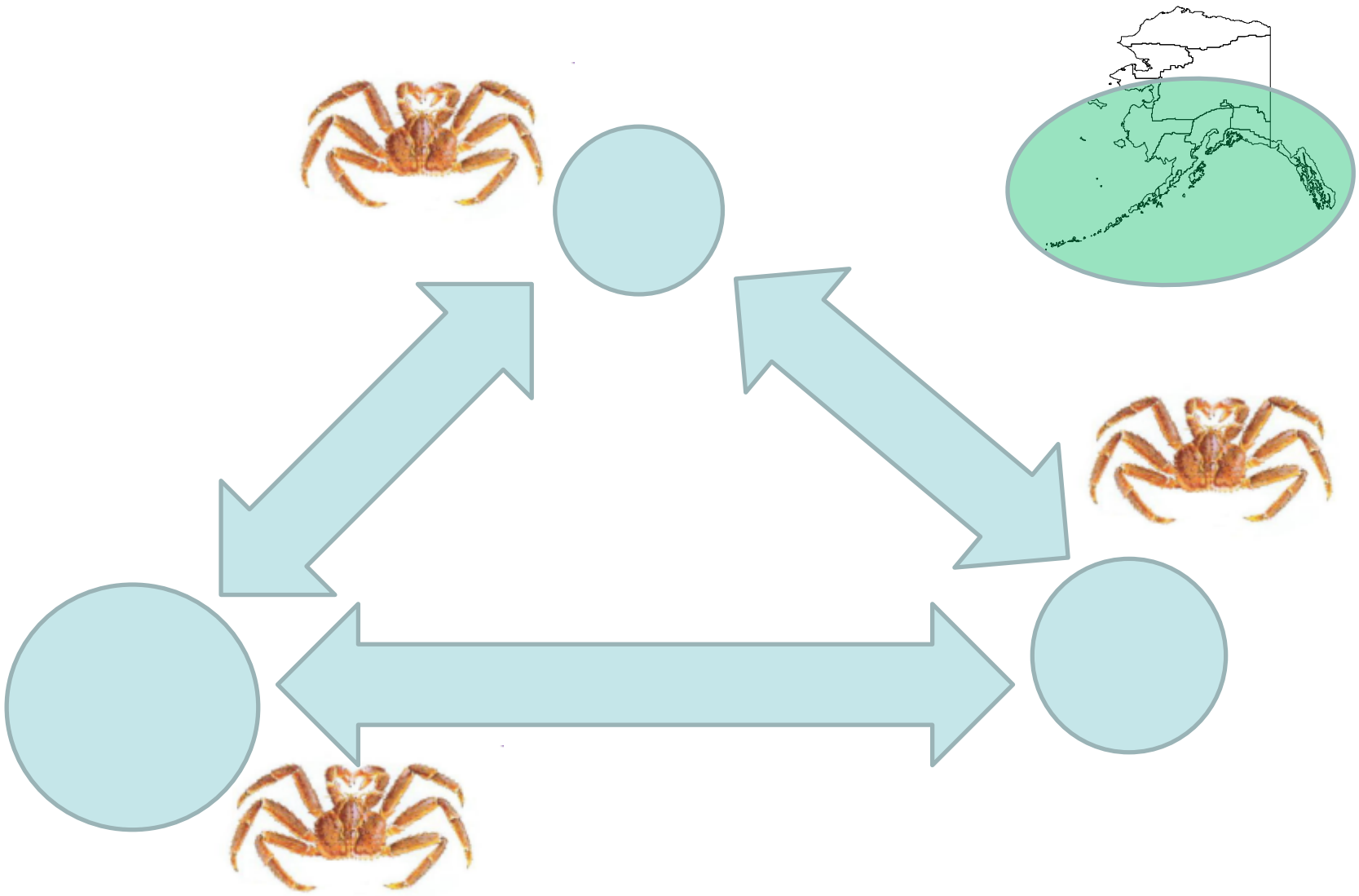




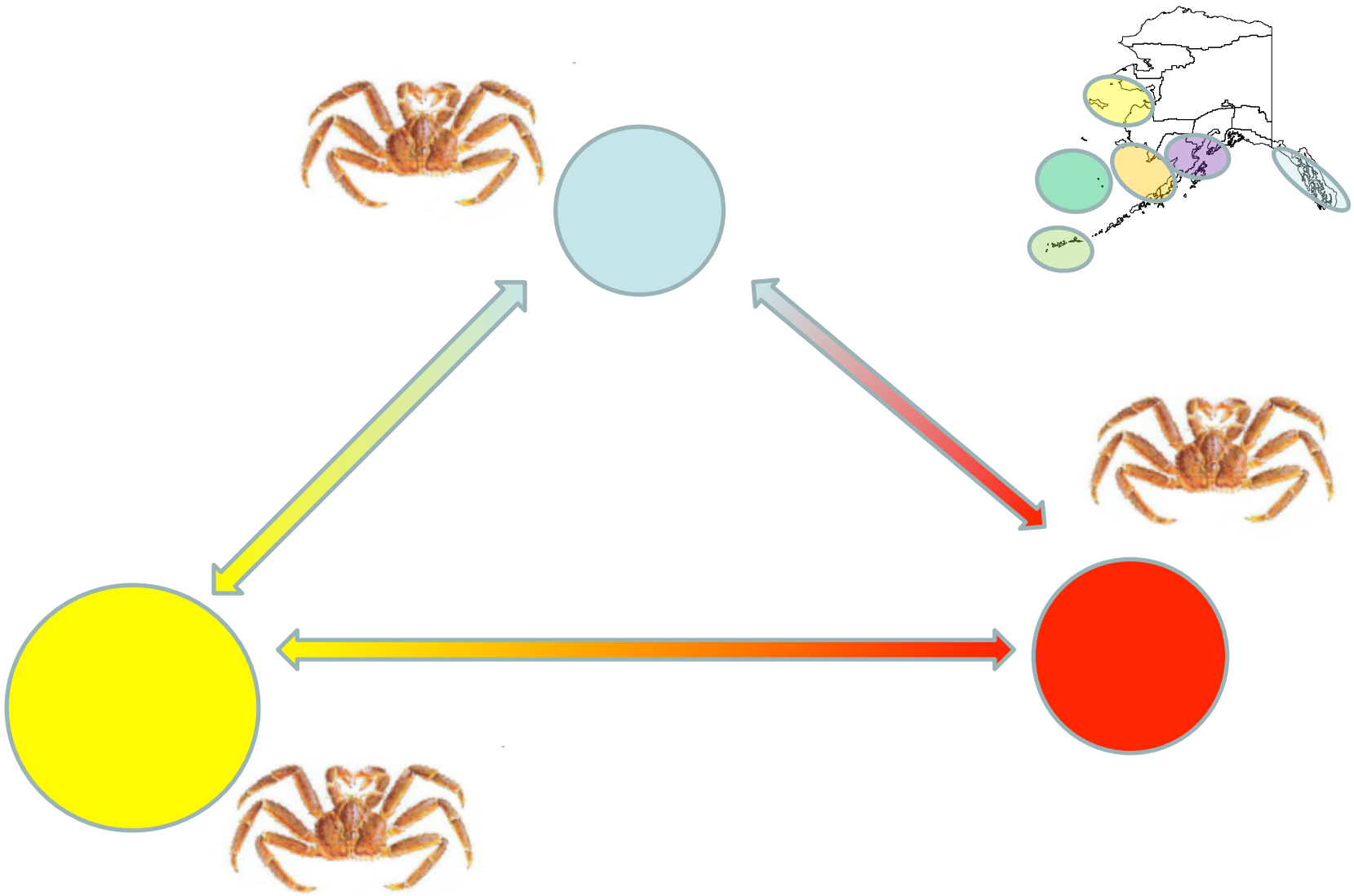
RKC Sample Locations



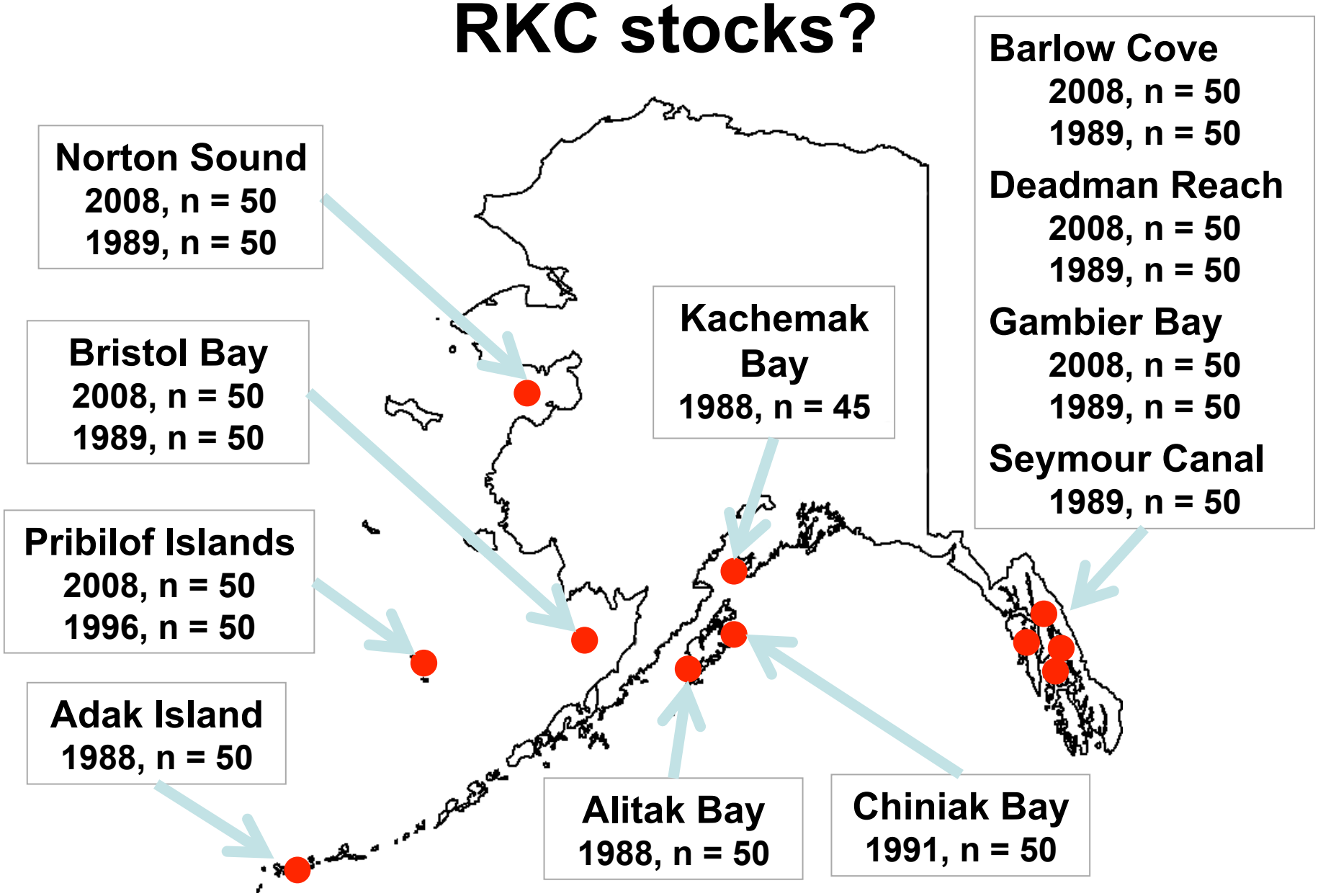
Population Structure



Population Structure

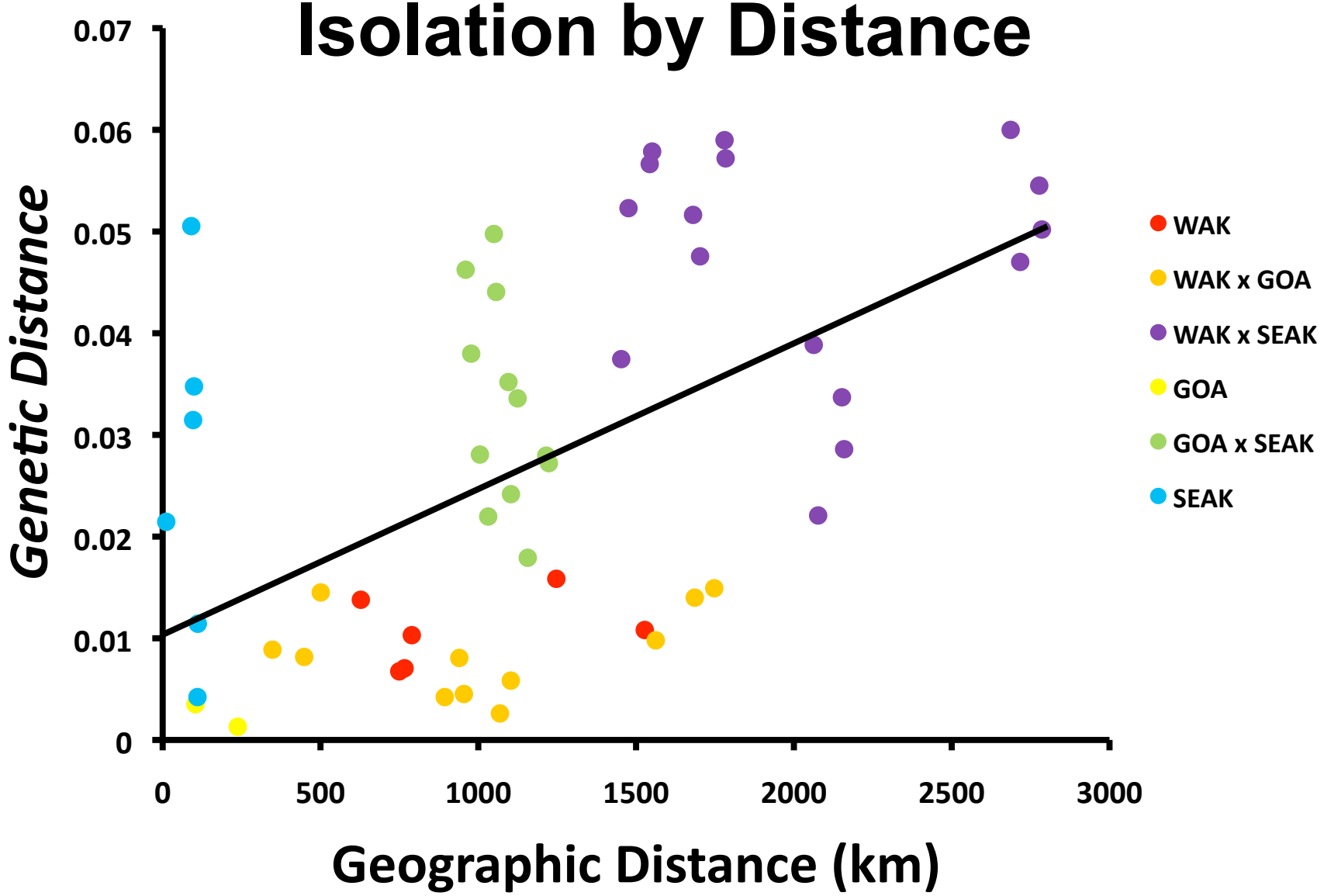


Where are there genetically-based RKC stocks?



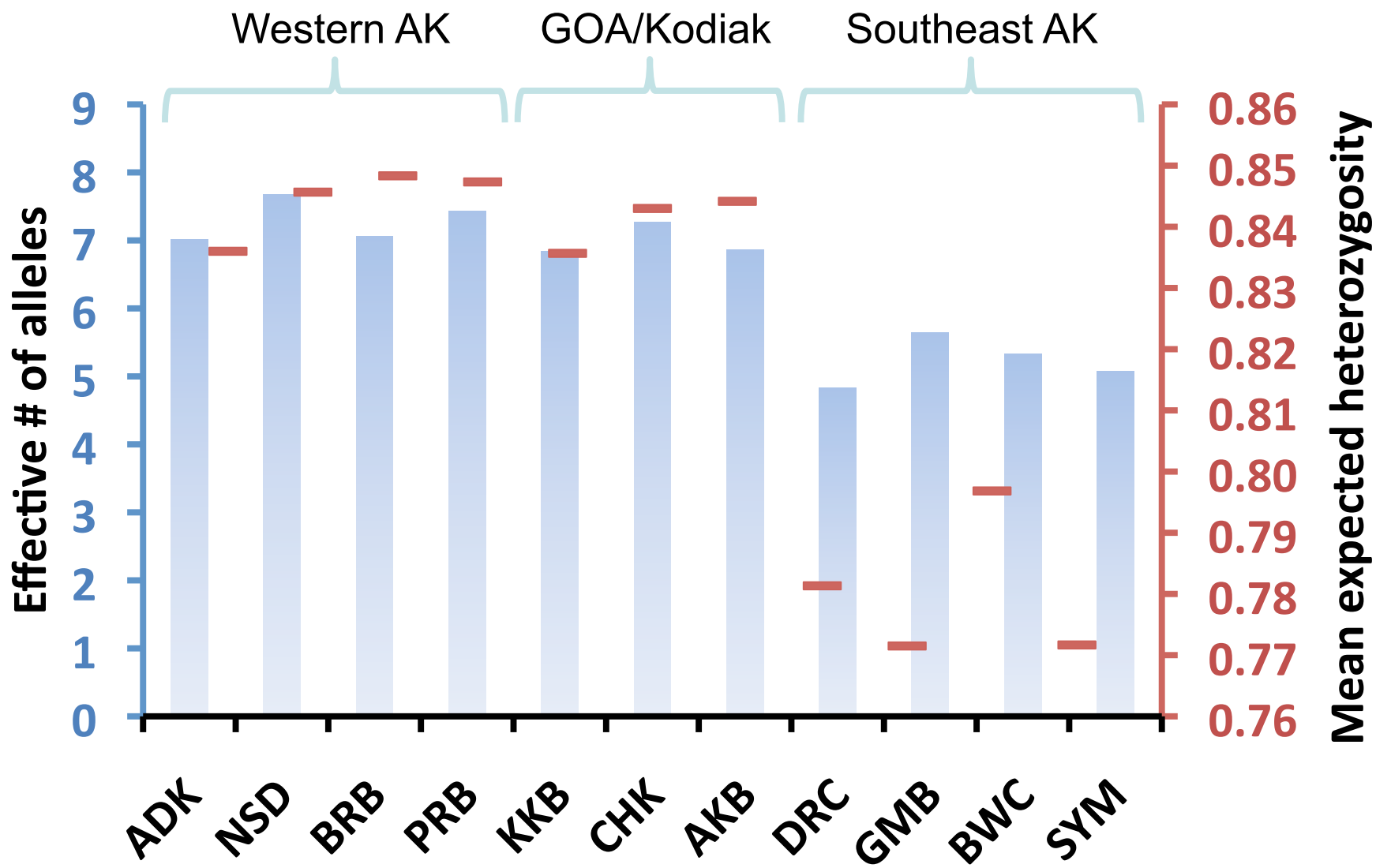
General Patterns

Isolation by Distance



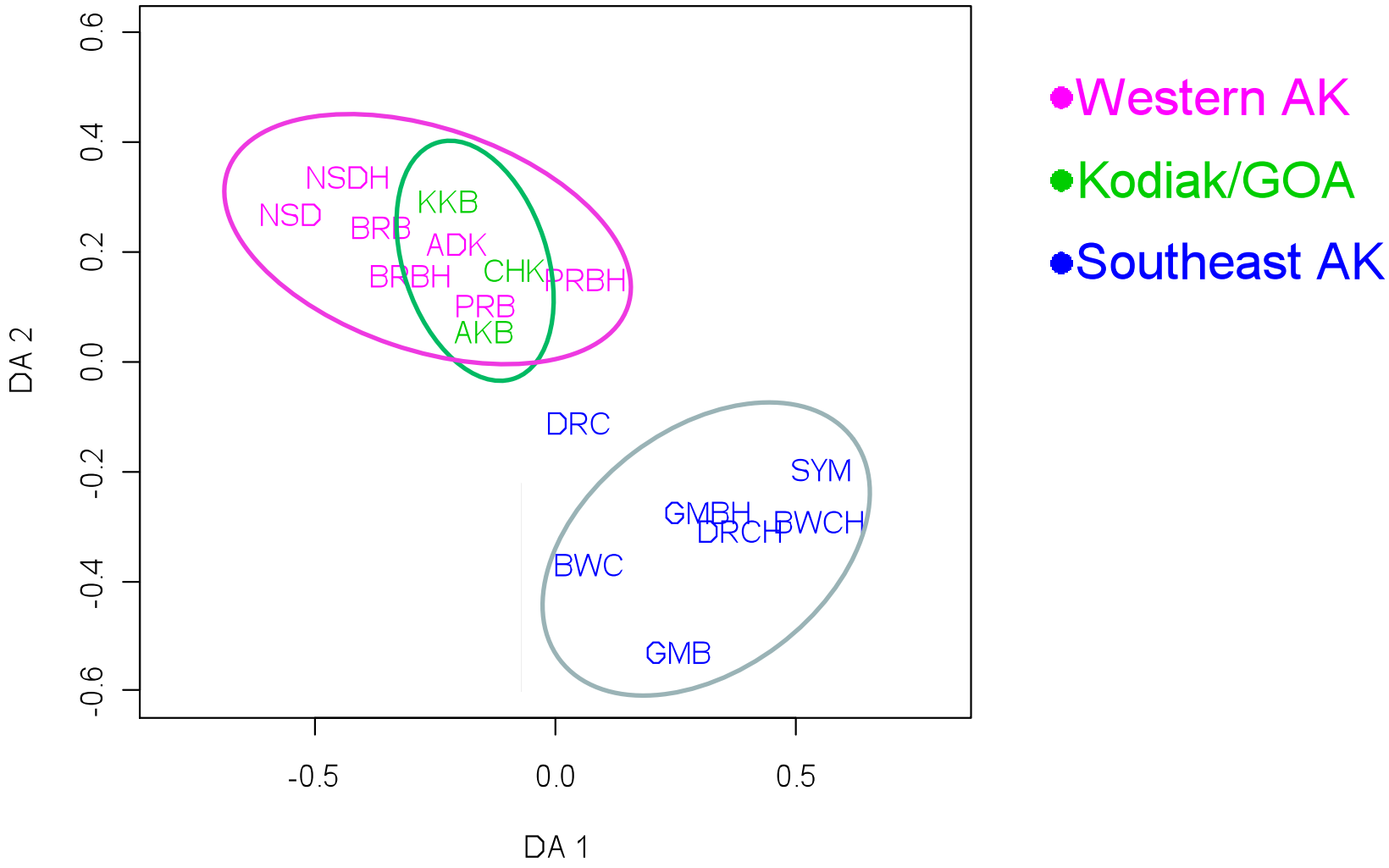
General Patterns

Lower Diversity in Southeast AK

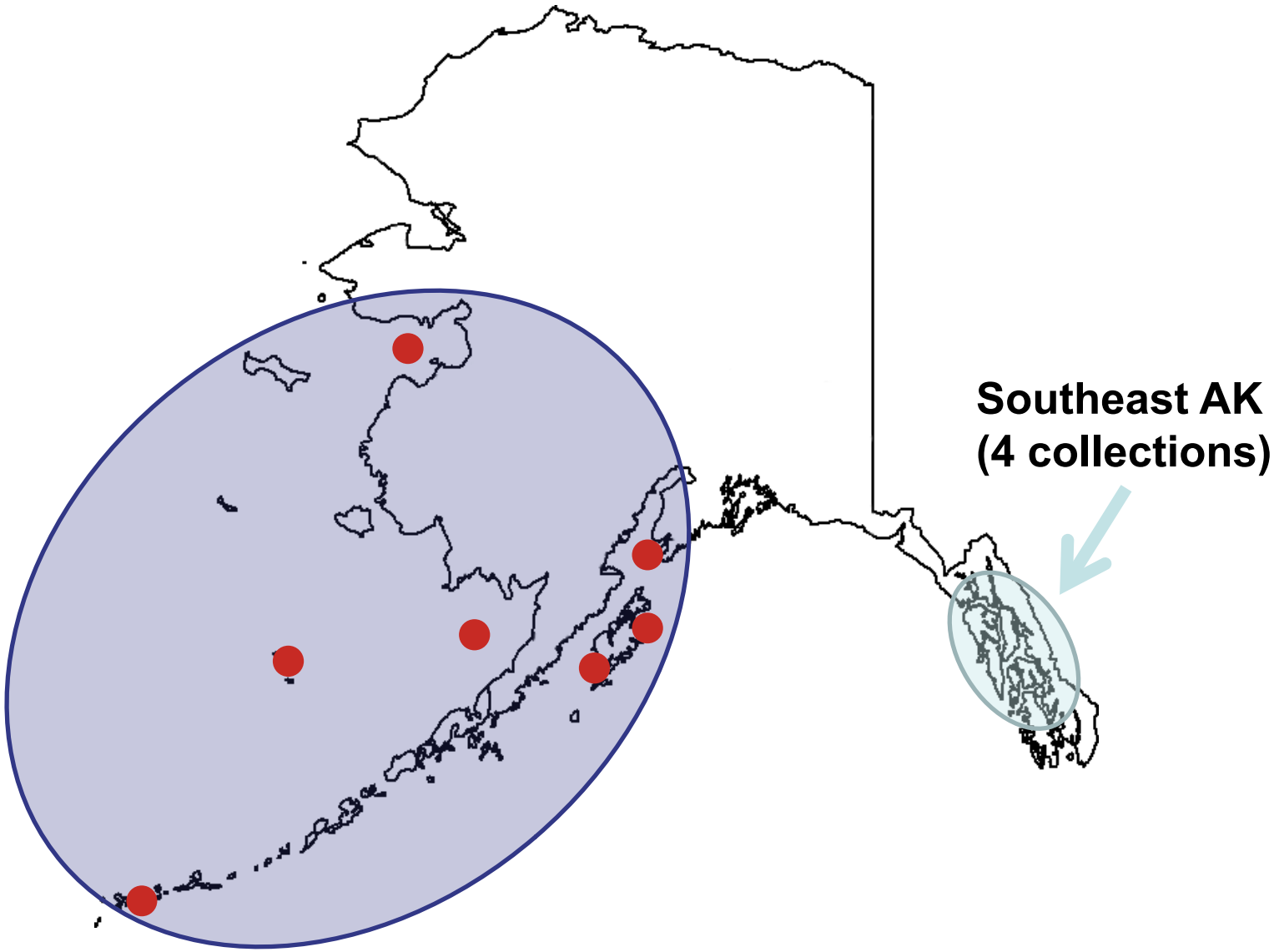


Spatial Statistical Analysis

How do sampling locations group?



Suggested RKC Stock Structure



More Conservative Spatial Analysis

How do sampling locations group?

Norton Sound
Bristol Bay
Pribilofs
Chiniak Bay
Kachemak Bay
Alitak Bay

Adak

Barlow Cove
Seymour Canal

Deadman Reach

Gambier Bay

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

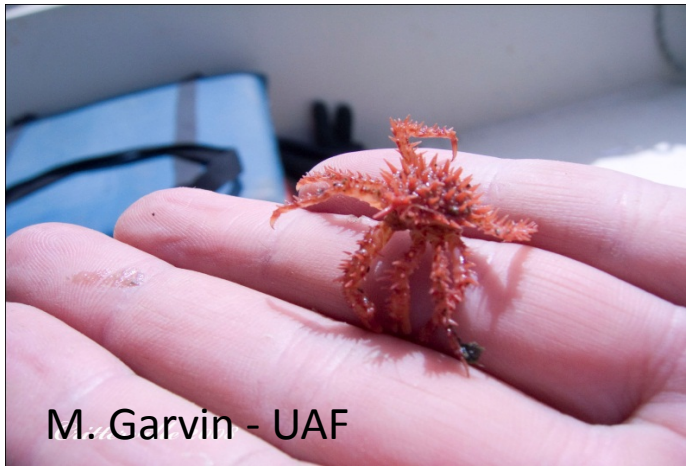
Objectives

- 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 <u>goal</u> of improving the status of the natural population.



Types of benefits to be considered

Conservation	General
• **Natural pops**	• **Natural pops** • **Harvest** • **Mitigation** • **Economic** • **Public education**

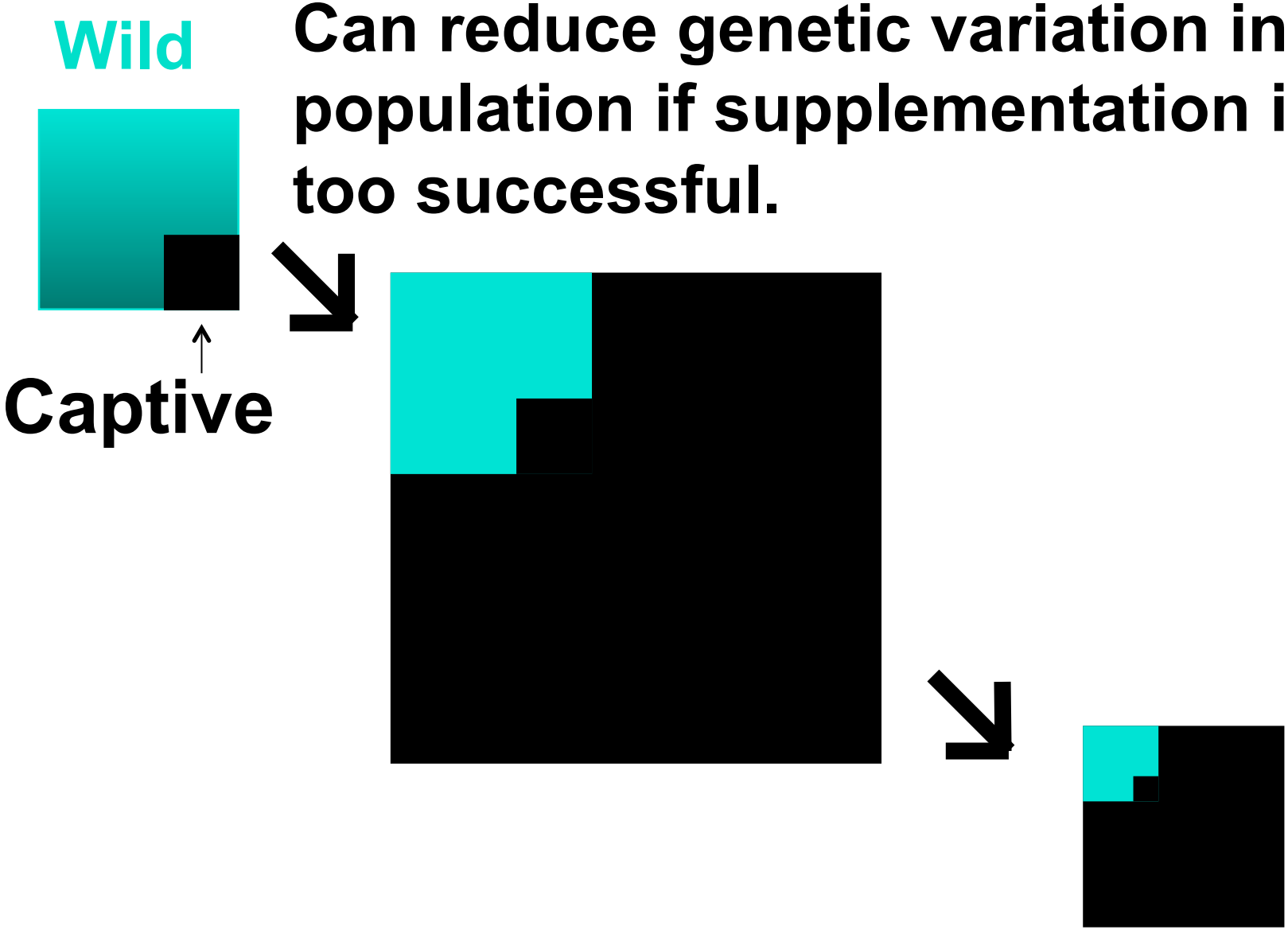
Potential benefits of hatchery propagation for natural populations

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

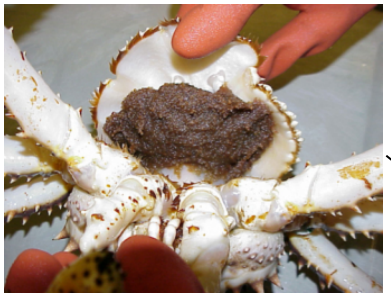
Can reduce genetic variation in a population if supplementation is too successful.

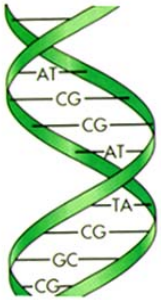


Wild

Captive

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

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Hatchery vs. wild environments

Similarities	Differences
Water	Food Substrate Density Temperature Flow regime Competitors Predators

Hatchery vs. wild environments

Similarities	Differences
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	Density
	Temperature
	Flow regime
	Competitors
	Predators

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

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    - Within population
    - Between populations
2. Loss of fitness
3. **Ecological effects**

Laikre et al. 2010
Potential Genetic Effects of Releases

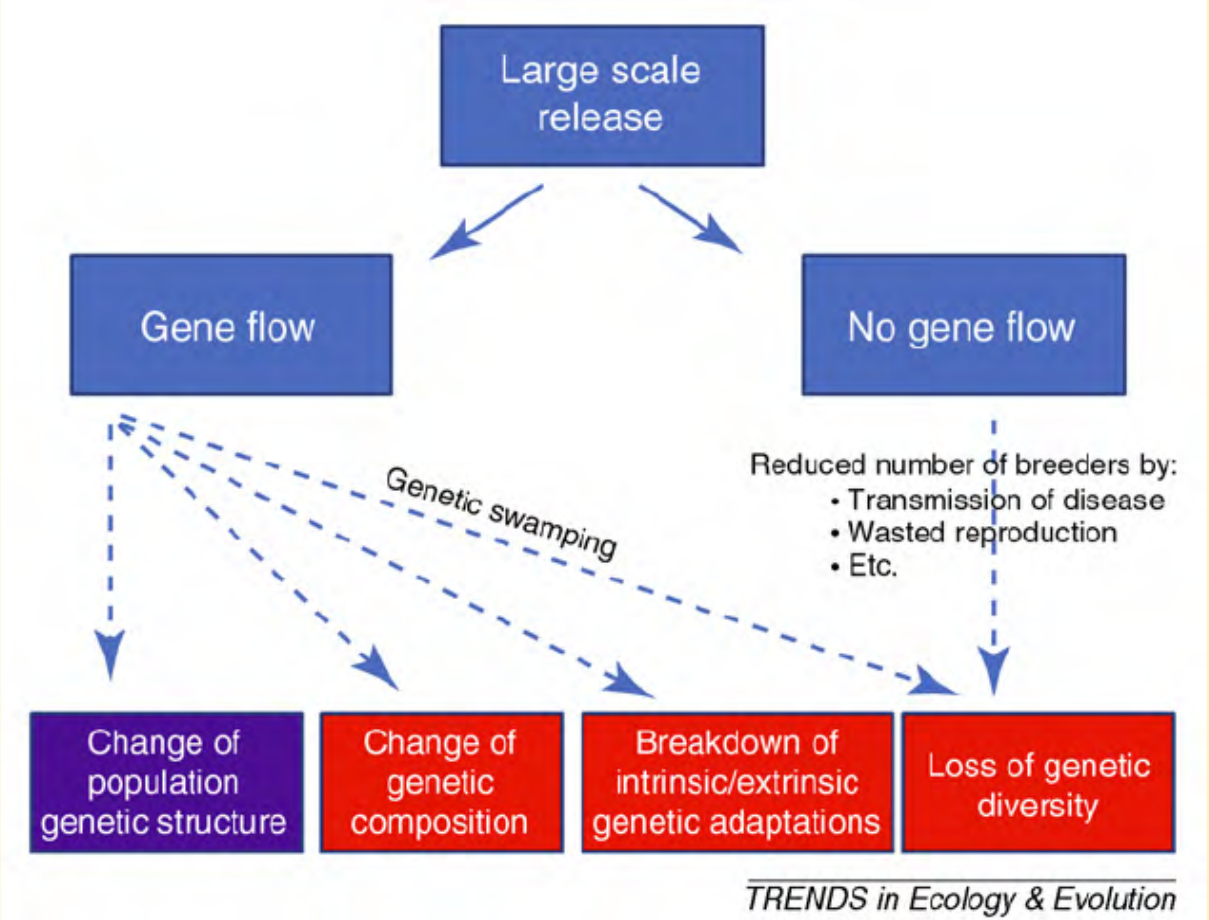

Figure I. Primary pathways by which large-scale releases can change genetic characteristics within (red boxes) and between (purple box) natural populations.

Laikre et al. 2010 – Releases

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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Laikre et al. 2010 – Releases

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(i)Native population genetic structure and level of diversity prior to releases,

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(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).**

Proposed Experimental Release of RKC

- Identify specific small-scale experiment location.

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  Must be interpreted in terms of clearly defined goals.

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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

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M. Garvin - UAF