Alaska King Crab Research, Rehabilitation and Biology Program

Strategic Plan
2015–2019

AKCRRAB
Introduction

The Alaska King Crab Research, Rehabilitation and Biology (AKCRRAB) program is a coalition of university, federal and stakeholder groups, formed in 2006 with the goals of adding to the scientific understanding of crab life history and ecology, as well as the eventual rehabilitation of depressed king crab stocks in Alaska. AKCRRAB intends to develop scientifically sound strategies for hatching, rearing and outplanting king crab in Alaska, in order to help restore populations to self-sustainability. The initial focus is on red king crab in the Kodiak Island region and on blue king crab near the Pribilof Islands. The technology and life cycle information developed by AKCRRAB are transferable to other crab species and stocks. The partners view the efforts of AKCRRAB as important to the affected regions' long-term economic development and sustainability.

AKCRRAB's goals will be accomplished in three phases. From 2006-2011, AKCRRAB made significant accomplishments in the initial phase as research largely succeeded in developing and improving methods of hatchery rearing of larval and juvenile king crab from wild-caught broodstock, to the point where large-scale production is feasible. Parallel field and laboratory studies of crab ecology and population genetics were also conducted during this time.

In the second and current phase, hatchery studies are complemented with parallel studies essential to understanding optimal release strategies, appropriate habitat, and potential impact on existing ecosystems. This work is providing the science necessary for informing the responsible release of hatchery-reared animals. Increased knowledge will allow scientists and managers to assess the feasibility of ecologically sound rehabilitation of depressed stocks, with potentially substantial benefits to Alaskan fishing communities and industry.

In the third and final phase, AKCRRAB is intended to evolve from the current, research-oriented coalition, to a formal entity focused on transitioning hatchery techniques and outplanting technologies to communities and industry as part of larger statewide efforts to help rehabilitate depleted king crab stocks. As Phase Two continues and Phase Three develops, the program will require increased support and guidance from communities and industry. The transition from feasibility to implementation will be dependent on this political and financial support, as well as a new guidance structure to reflect the participants and their work towards common goals.

Cover photo by Ginny Eckert
Current Structure

AKCRRAB is guided by a steering committee, made up of a representative from each of the major groups that founded, funded, and continue to support the program, as well as by a science committee made up of researchers from the University of Alaska and the National Marine Fisheries Service (See Appendix 1). The co-chairs of the steering committee are the Research Director of the Alaska Sea Grant program, Dr. Ginny Eckert, and Heather McCarty from Central Bering Sea Fishermen’s Association (CBSFA). The chair of the science committee is Dr. Ginny Eckert of the School of Fisheries and Ocean Sciences, University of Alaska Fairbanks (Juneau).

AKCRRAB Partners

Community/Industry

Alaska Bering Sea Crabbers
Aleutian Pribilof Island Community Development Association
Alutiiq Pride Shellfish Hatchery
Central Bering Sea Fishermen’s Association
Chugach Regional Resources Commission
Gulf of Alaska Coastal Communities Coalition
Norton Sound Economic Development Corporation
Tribal Government of St. Paul
United Fishermen’s Marketing Association

Government/University

Alaska Sea Grant College Program
NOAA Aquaculture Program
NOAA National Marine Fisheries Service
University of Alaska Fairbanks School of Fisheries and Ocean Sciences
University of Alaska Southeast

Supporters

Bering Sea Fisheries Research Foundation
Groundfish Forum
Santa Monica Seafoods

Duration

This Strategic Plan is intended to provide an overview of the goals and major tasks of AKCRRAB for five years, from 2015 through 2019. It will be accompanied by study plans that contain the details of implementation for the various program elements. This Strategic Plan and future study plans are contingent on continued funding for the AKCRRAB program.
SECTION 1: PRODUCTION

I. Broodstock Collection.

The proposed regions for king crab stock rehabilitation have shown a substantial decline in king crab abundance based on historical time series data. To minimize negative impacts on depleted crab stocks, broodstock for initial rehabilitation research on all laboratory aspects of life history and production assessment have been obtained from stocks that are healthy and abundant. Through 2014, broodstock for laboratory and outplanting experiments have been collected from the Bristol Bay, Kodiak and Southeast Alaska red king crab stocks and the St. Matthews Island and Little Diomede blue king crab stocks. Broodstock collection has been accomplished with cooperation from commercial fisherman, in subsistence fisheries, and during state and federal trawl surveys.

Broodstock collection will continue on a yearly basis for both red king crab and blue king crab in order to hatch individuals from wild parents each year. Initially, the population must be large enough to allow for production-scale hatchery research and to supply juvenile crab for laboratory studies. Multi-year maintenance of broodstock and mating is not planned. Whenever crabs may be released into the wild, it is increasingly important to maintain a hatchery population that is as genetically representative of the target wild population as possible. This goal will balance the dual needs for conservation of depleted stocks and for obtaining larvae for hatchery production. Broodstock requirements will be identified in consultation with ADF&G.

A. Collection Methods

Goal: Collect broodstock under carefully controlled, cost efficient methods that minimize harm to wild stocks.

Task: Broodstock collection will be coordinated with state and federal crab stock surveys whenever possible. When this is not feasible, industry or community partners will be enlisted to help in the collection efforts.

Timeline: 2015-2019

B. Stock Origin

Goal: Obtain king crab broodstock intended for rehabilitation activities from the genetic pools of targeted wild stocks.

Task #1: Continue to obtain broodstock from stocks of red king crab in the Eastern Bering Sea and Southeast Alaska and blue king crab in the St. Matthews Island region for experimental production, life history, and culturing research in the laboratory and hatchery.

Timeline: 2015-2019
Task #2: Develop means to maximize genetic diversity and minimize differences in family size of hatchery-reared crab. This will help equalize the genetic contributions of each broodstock female to the outplanted crab stock and minimize any negative effects of hatchery rearing on wild stocks.

Timeline: 2015-2019

Task #3: Red king crab broodstock in the appropriate numbers will be obtained from Kodiak Island for rehabilitation and hatchery-produced juvenile research and controlled releases.

Timeline: 2015-2018

Task #4: Blue king crab broodstock in the appropriate numbers will be obtained from the Pribilof Islands stock for rehabilitation and hatchery-produced juvenile research and controlled releases.

Timeline: 2015-2019

C. Collection Timing

Goal: Collect broodstock as close as practical to the natural release of larvae and when the wild adults are in good condition for transport.

Task: Broodstock collection will avoid molting periods whenever possible, and will ideally take place in summer or fall (June-November).

Timeline: 2015-2019

D. Non-destructive Collection Methods

Goal: Determine if larvae may be sourced without destructive sampling of ovigerous females

Task #1: Explore the potential to return broodstock back to the field after hatching their larvae.

Timeline: 2016-2019

Task #2: Explore if embryos may be removed from ovigerous females and successfully reared through embryonic and larval stages.

Timeline: 2015-2019

II. Broodstock Holding

Broodstock holding has been largely successful to date. Generally, wild blue king crabs are found in deeper and colder waters than red king crab. Blue king crab survival seems higher when crabs are held at cooler temperatures; however, formal studies have not been conducted. Red king crab broodstock from a variety of stocks have been held at ambient (Seward) temperatures successfully.
Goal: Refine broodstock holding methodologies to increase broodstock holding success for both red and blue king crab.

Task #1: Manipulate larval hatch timing by holding broodstock at varying temperatures with the objective of producing multiple crops within the same year.
Timeline: 2015-2019

Task #2: Monitor embryonic development to determine health of the eggs and predict hatch dates with weekly measurements of eyespot and yolk size. Monitor any bacterial growth on egg membranes.
Timeline: 2015-2019

Task #3: Evaluate the effect of broodstock holding temperature on larval developmental success.
Timeline: 2015-2016

III. Larval, Glaucophoe, Juvenile Rearing

Successful hatchery production began in 2007 and has been continually refined through 2014. Experiments evaluating physical and biological parameters such as diet, stocking density, substrate preference, tank design, flow conditions, and temperature regimes as well as development of hatchery health indices are documented in peer-reviewed and other publications (Appendix 3). Larval rearing protocols for red and blue king crab are continually documented and updated in production manuals, especially as refinements continue.

Goal: Refine rearing protocols for red and blue king crab and update production manuals.

Task #1: Continue to optimize rearing conditions and hatchery techniques to both improve survival rates and reduce production costs.
Timeline: 2015-2019

Task #2: Optimize rearing conditions and hatchery techniques to reduce behavioral, morphological, and physiological differences between hatchery and wild crabs in order to minimize potential competitive interactions with future outplanting.
Timeline: 2015-2019

Task #3: Produce juvenile red and blue king crabs to be used in studies not directly related to AKCRRAB, including those related to aging techniques, the effects of ocean acidification, and other similar studies, which inform key biological questions to inform management.
Timeline: 2015-2019
SECTION 2: POPULATION AND STOCK DIFFERENTIATION

I. Genetics

Understanding population genetic structure is critical for assessing and monitoring impacts of potential outplanting. Thus far, research has addressed critical genetic questions and determined that female red and blue king crab mate with only a single male and that genetic structure of red and blue king crab have changed over time and vary across management units (Appendix 3).

Goal: Understand population genetics of Alaskan red and blue king crab.

Task #1: Examine the extent and frequency of genetic exchange among crab populations.
   Timeline: as funding allows

Task #2: Continue to evaluate how many individuals contribute genetically to wild populations and how many individuals are needed for broodstock to maintain adequate levels of genetic variation for outplanting and rehabilitation.
   Timeline: as funding allows

Task #3: Evaluate maternal-specific larval and juvenile success. Are offspring from some females more successful than others and might these differences be genetically determined?
   Timeline: as funding allows

II. Marking

Goal: Develop methods of differentiating hatchery-produced king crab from their wild counterparts.

Task #1: Identify the feasibility of a system using genetic markers that will allow hatchery-produced king crab to be distinguished from wild crab stocks (see genetics section above).
   Timeline: 2015-2019

Task #2: Investigate potential for using calcein to distinguish hatchery-produced king crab from wild crab.
   Timeline: 2015-2019
SECTION 3: PRE-RELEASE STUDIES

Successful rehabilitation requires an assessment of in situ habitat requirements, biological and environmental interactions, and spatial and temporal variability in nursery habitats. Past laboratory and field studies have identified: 1) preferred habitats of juvenile crabs; 2) foraging behavior; 3) habitat-specific associations including foraging and survival; 4) interactions with conspecifics, congeners, and predators; and 5) outplanting success (Appendices 2 & 3). Efforts to transport small juvenile crabs from Seward to Juneau, Kodiak, and Newport, OR have been successful.

I. Hatchery – Wild Interactions

Goal: Understand the behavioral, morphological, and physiological differences between hatchery-reared and wild juvenile king crab and potential competitive interactions.

Task #1: Continue work on determining if morphological and behavioral differences are present between hatchery-reared and wild king crab juveniles and identify any potential competitive interactions or advantages.

Timeline: 2015-2019

Task #2: Continue to compare bioenergetics of hatchery-reared and wild king crab juveniles to understand health and energy allocation and identify any potential competitive interactions or advantages.

Timeline: 2015-2019

II. Nursery Habitat and Release Experiments

Goal #1: Continue to determine optimal nursery habitats to maximize growth and survival of juvenile king crab in both the hatchery and once outplanted.

Task #1: Identify the habitat requirements of juvenile king crab through their first year of life, including foraging, structural, and biological habitat attributes, as well as ontogenetic shifts, with continued laboratory and field studies.

Timeline: 2015-2019

Task #2: Further develop king crab habitat suitability models for red king crab and begin development of models for blue king crab based upon laboratory and field studies for research use, as a guide to selecting potential release sites.

Timeline: 2015-2019

Task #3: Develop best practices for transporting large numbers of juvenile king crab to remote sites without incurring high mortalities or harming their health.

Timeline: 2015-2019
Goal #2: Assess likelihood of outplanting success based on biological and environmental interactions.

Task #1: Transport to and successfully maintain live juveniles in a shore-based facility in the Pribilof Islands.
   Timeline: 2017

Task #2: Conduct tethering experiments in the Pribilof Islands to assess optimal habitats, crab size, relative predation and seasonal conditions for outplanting success.
   Timeline: 2018-2019

Task #3: Quantify predation pressure at potential release sites in the Pribilof Islands and during experimental releases in Kodiak.
   Timeline: 2018-2019

Task #4: Survey habitat, environment, and juvenile red and blue king crab density at potential release sites in the Pribilof Islands.
   Timeline: 2016-2019

Task #5: Monitor predation, prey availability, and competitive interactions before and after controlled release events and evaluate predator control devices.
   Timeline: 2018-2019

Goal #3: Investigate fate of hatchery-produced juvenile king crab during release experiments.

Task #1: Design and test in the lab, nursery structures that may provide an artificial habitat to reduce initial mortality upon release for hatchery-produced juvenile king crab in the marine environment.
   Timeline: 2016-2019

Task #2: Continue to assess the behavior and marine survival of hatchery-produced juvenile king crab released into the wild at sites with appropriate habitat near Kodiak Island.
   Timeline: 2015-2016

Task #3: Investigate larger controlled releases (~100,000 juveniles per site) to evaluate if crabs can be rehabilitated on an embayment scale in Kodiak.
   Timeline: 2017-2019

Task #4: Assess the behavior and marine survival of hatchery-produced juvenile king crab released into the wild at sites with appropriate habitat near the Pribilof Islands.
   Timeline: 2018-2019

Goal #4: Develop infrastructure to support field research activities in the Pribilof Islands.
Task #1: Obtain commitments for logistical support from local groups in the Pribilof Islands, including scientist housing, laboratory facilities, research vessels, and diving equipment.
   Timeline: 2015

Task #2: Develop infrastructure for holding broodstock and juveniles temporarily in the Pribilof Islands. Trident facility on St. Paul has raw seawater and large tanks that may work. Explore modifications needed for holding broodstock and juveniles. Explore possibility of getting running seawater in St. George.
   Timeline: 2015-2016

Task #3: Train local residents in methodology needed to complete monitoring activities.
   Timeline: 2016-2017
SECTION 4: OUTPLANTING AND FEASIBILITY STUDIES

The structural, regulatory and funding issues faced by the private sector and/or government agencies in pursuing a rehabilitation program will be unique to each region, stock, and user group.

In Phase Three of the AKCRRAB program, the long-term goal is to facilitate self-sustaining populations of targeted king crab stocks and to transfer the techniques and technologies developed for effective implementation by industry and/or communities. The details of each transfer will vary by region and by target species.

In the Bering Sea, commercial harvest rights to all the king crab stocks, including the Pribilof blue king crab, are allocated under the crab rationalization program. These harvest rights are held by both individuals and by the western Alaska CDQ (Community Development Quota) entities. Subsistence and personal use crab fisheries are also important. The crab fisheries are managed by the State of Alaska, as delegated by the federal government.

In the Gulf of Alaska, including Kodiak and Southeast Alaska, the commercial crab fisheries are not rationalized and are open to participation by permit holders. Subsistence and personal use crab fisheries are also important. The crab fisheries are managed by the State of Alaska.

It is anticipated that any crab outplanted by the AKCRRAB program in both the Bering Sea and the Gulf of Alaska would be managed by the State of Alaska, and available for harvest (by the same user groups who currently utilize the stocks), when deemed appropriate, under the same management systems and guidelines as the current crab stocks.

While AKCRRAB's efforts are currently focused upon rebuilding stocks of red king crab in Kodiak and blue king crab in the Bering Sea, the technology developed in the project might be utilized across the state, including for research on, and rehabilitation of, other depressed crab stocks in the Bering Sea and red king crab in Southeast.

Goal #1: Apply crab aquaculture technology in Alaska to help rebuild depressed wild king crab stocks.

The following tasks represent the beginnings of a transition for AKCRRAB from a sole research focus to initial implementation of a stock rehabilitation program. The timelines will depend on research progress and regulatory considerations.

Task # 1: Release and carefully monitor juvenile red king crab in one or more Kodiak bays with depressed wild red king crab populations. The goal would be to help rebuild the spawning populations to a point where they may support directed commercial, subsistence or personal use fisheries.

Task # 2: Stock hatchery-produced juvenile blue king crab at one or more strategic locations near the Pribilof Islands and carefully monitor success and survival. The goal would be to help rebuild the spawning population sufficiently to allow the
incidental catch of blue king crab in commercial fisheries directed at stronger red king crab stocks. Ultimately, the blue king crab stocks might be strong enough to allow for the reopening of a blue king crab fishery.

Potential Task #3: Provide technology and protocols to stakeholders wishing to rehabilitate other crab stocks.

**Goal #2: Project operational costs for producing juvenile red and blue king crab for enhancing depressed wild crab stocks, including hatchery, nursery, and stocking phases.**

**Task #1:** Continue to document hatchery operational costs from acquiring broodstock through production of C3 juveniles.
   **Timeline:** 2015-2019

**Task #2:** Develop cost projections for the culture of C3 juveniles for different survival rates and levels of production.
   **Timeline:** 2015-2019

**Task #3:** Develop projected costs of operating various stocking and nursery projects.
   **Timeline:** 2015-2019

**Goal #3: Determine facility design requirements and production costs.**

**Task #1:** Analyze facility requirements based on production efficiency achieved during larval and post-larval culture experiment.
   **Timeline:** 2016 ongoing

**Task #2:** Develop a design for modeling remote king crab hatchery and estimate construction costs.
   **Timeline:** 2016 ongoing

**Goal #4: Analyze the cost effectiveness of potential red king crab rehabilitation projects in the Kodiak area and blue king crab rehabilitation in the Pribilof Islands.**

**Task #1:** Examine the results of AKCRRAB’s controlled releases and other research, known survival rates for wild king crab, capital and operations costs (including regulatory compliance), project potential impacts to wild stocks of rehabilitation programs, and determine under what scenarios rehabilitation projects for red or blue king crab could be cost effective.
   **Timeline:** 2017-2019

**Goal #5: Determine funding mechanisms and identify any potential changes in state law and regulations necessary to allow crab harvesters and/or coastal communities to conduct king crab rehabilitation activities.**
Task # 1: Work with legislators and state agencies to research the potential legal framework for crab harvesters or coastal communities to form an association, such as a private-nonprofit corporation, to conduct rehabilitation activities.
   Timeline: 2015-2019

Task # 2: Work with legislators and state agencies to research the following: Who will pay? What changes to state law are necessary to provide for a voluntary assessment similar to the salmon rehabilitation program? Is it possible to have cost recovery harvests of enhanced king crab to offset costs? If so, what changes in statutes are necessary?
   Timeline: 2015-2019

Task # 3: Begin implementation of any necessary changes in law and policy.
   Timeline: 2016-2019

Goal #6: Provide assistance to potential users of the technology developed during the AKCRRAB project.

Task # 1: Work with potential user groups to develop preliminary collaborations with community and/or industry groups interested in forming rehabilitation associations.
   Timeline: 2015-2019

SECTION 5: EDUCATION AND OUTREACH

Education and outreach has taken place over the course of AKCRRAB activities through public presentations at North Pacific Fishery Management Council (NPFMC) meetings and industry association forums, a monthly Newsflash edited by AKCRRAB members and published by Sea Grant, occasional news releases provided to press outlets, member participation in scientific and management forums, presentations to NOAA Aquaculture, and individual meetings with industry individuals and groups during fund-raising efforts. Recently, members have been asked to join the advisory body for the Alaska Shellfish Initiative.

As AKCRRAB moves into implementation, technology transfer and policy development in Phase 3 of the plan, this work must continue and additional work must be done on education and outreach in both the governmental and industry arenas.

Goal #1: Provide the general public with information about AKCRRAB's progress and achievements.

Task # 1: Continue preparation and distribution of quarterly Newsflashes, and press releases on events and milestones; organize press events and interviews with members as appropriate.
   Timeline: 2015-2019

12
Task # 2: Participate in identified public forums.
Timeline: 2015-2019

Goal # 2: Provide governmental entities with information about AKCRRAB and allow for the opportunity to ask questions.

Task # 1: Organize regular contacts with and presentations for State legislators, NOAA/NMFS representatives, ADF&G representatives, community governing bodies and others
Timeline: 2015-2019

Goal # 3: Provide the crab industry with information about AKCRRAB and allow for the opportunity to ask questions.

Goal # 4: Provide coastal communities and CDQ entities with information about AKCRRAB and allow for the opportunity to ask questions.

Goal # 5: Participate in Alaska Shellfish Initiative.

Goal # 6: Participate in and support work with school children in coastal communities.
Appendix 1

AKCRRAB Steering Committee

Dr. Ginny Eckert, Research Director, Alaska Sea Grant Program, University of Alaska Fairbanks, Co-chair
Heather McCarty, Central Bering Sea Fishermen’s Association, Co-chair

Ruth Christiansen, Alaska Bering Sea Crabbers
Lauren Divine, Tribal Government of St. Paul
Dr. Robert Foy, Director, Kodiak Laboratory, National Marine Fisheries Service, NOAA
Jeff Hetrick, Director, Alutiiq Pride Shellfish Hatchery, Seward
Chris Mierzejek, Aleutian Pribilof Island Development Association
Jeff Stephan, Executive Director, United Fishermen’s Marketing Association, Kodiak
Gale Vick, Gulf of Alaska Coastal Communities Coalition (GOAC3)

AKCRRAB Science Committee

Dr. Ginny Eckert, School of Fisheries and Ocean Sciences, University of Alaska Fairbanks, Chair

Dr. Ben Daly, Kodiak Laboratory, National Marine Fisheries Service, NOAA
Dr. Robert Foy, Director, Kodiak Laboratory, National Marine Fisheries Service, NOAA
Jeff Hetrick, Director, Alutiiq Pride Shellfish Hatchery, Seward
Dr. Christopher Long, Kodiak Laboratory, National Marine Fisheries Service, NOAA
Doug Pengilly, Alaska Department of Fish and Game, Kodiak
Michelle Ridgeway, Alaska Deep Ocean Science Institute
Jim Swingle, Research Biologist, Alutiiq Pride Shellfish Hatchery/Alaska Sea Grant Program
Dr. David Tallmon, University of Alaska Fairbanks/University of Alaska Southeast
## Appendix 2

### PRODUCTION

<table>
<thead>
<tr>
<th>Collection Methods</th>
<th>Collection Timing</th>
<th>Non-destructive Collection Methods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Broodstock collection</td>
<td>Explore return of broodstock to wild</td>
<td>Can embryos be harvested?</td>
</tr>
<tr>
<td>Collection Methods</td>
<td>Collection close to larval release</td>
<td></td>
</tr>
<tr>
<td>Stock Origin</td>
<td>Collect close to larval release</td>
<td></td>
</tr>
<tr>
<td>Collection Timing</td>
<td>Collect Dungeness crab</td>
<td></td>
</tr>
<tr>
<td>Non-destructive Collection Methods</td>
<td>Collect small clams, mussels</td>
<td></td>
</tr>
</tbody>
</table>

### Broodstock holding

- Refine methods
- Monitor bacteria
- Manipulate hatch timing with temperature
- Monitor embryo development
- Determine optimal temperature for broodstock

### Larvae, gloosathers, & juvenile rearing

- Develop initial methods
- Develop protocols
- Write HKCSBR & report
- Optimize rearing conditions
- Compare bioenergetics between hatchery and wild
- Reduce differences between hatchery and wild
- Produce juveniles for non-AKCCRRAB research

### POPULATION AND STOCK DIFFERENTIATION

#### Genetics

- Understand population genetics
- Develop differentiation methods
- Pre-release studies

#### Marking

- Develop differentiation methods
- Experiment with physical and chemical tagging

### Pre-release studies

- Hatchery-wild interactions
- Understand differences and competitive interactions between hatchery and wild
- Assess morphological and behavioral differences
- Compare bioenergetics

### Nursery habitat

- Determine optimal nursery habitat
- Determine habitat suitability models in potential release sites
- Develop hatchery best practices
- Develop methods to maximize genetic diversity relative to family size
- Forage studies
- Tethering to assess optimal size
- Assess predation pressure
- Survey habitat and crab use at potential release sites
- Monitor predation, prey, competition before release
- Design artificial nurseries
- Conduct release studies in enclosures
- Assess behavior and survival in controlled releases
- Assess behavior and survival in controlled releases

### Outplanting and feasibility studies

- Apply crab aquaculture technology
- Release and monitor juvenile crab in Kodiak
- Stock hatchery crab in Pribilof Islands
- Supplement crab in other AK locations
- Project operational costs
- Document hatchery costs
- Develop projections for future crab culture
- Develop projected costs for stocking
- Analyze facility requirements
- Develop remote hatchery designs
- Generate a panel to assess release experiments
- Identify legal framework
- Legislative assessment
- Implement changes in policy

### Education and Outreach

- Provide public with AKCCRRAB progress
- Monthly Newsletters
- Participate in public forums
- Provide assistance to users
- Organize special events
- Provide agencies with AKCCRRAB progress
- Participate in other AK programs
- Provide communities with AKCCRRAB progress
- Participate in projects in the region

### Tasks

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Controlled cost effective collections</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collect Bristol Bay RKC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collect St. Matthew RKC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collect Kodiak RKC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collect Pribilof Islands RKC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explore return of broodstock to wild</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can embryos be harvested?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix 3

The products described below were conducted using either AKCRRAB funding or crabs cultured by AKCRRAB. Additional information is available online on the AKCRRAB website: http://seagrant.uaf.edu/research/projects/initiatives/king-crab/general/

SECTION 1: PRODUCTION

Peer-reviewed Publications (2007-2014)


**Other Publications (2017-2014)**

**SECTION 2: POPULATION AND STOCK DIFFERENTIATION**

**Peer-reviewed Publications (2007-2014)**

**SECTION 3: PRE-RELEASE STUDIES**

**Peer-reviewed Publications (2007-2014)**


Other Publications (2017-2014)

AKCRRAB NEWSFLASHES
2015
June 2015: Interdisciplinary graduate student researcher defends dissertation
May 2015: High school science fair project on king crab research advances to GENIUS Olympiad
April 2015: 2015 king crab culture at Alutiiq Pride Shellfish Hatchery
March 2015: Film on 2013 king crab release near Kodiak wins award
February 2015: Hatchery reared red king crab survive well when released into the wild
January 2015: Researchers find pigments in king crab eyes can be used to determine age
2014
November-December 2014: Crab industry and fishermen contribute to broodstock collection
October 2014: Researchers to investigate red king crab larval movement in Bristol Bay
September 2014: Team finds wild king crab larvae near Saint Paul Island
August 2014: AKCRRAB conducts experimental release of red king crabs in Kodiak
July 2014: Fishing groups and Alaska Legislature support AKCRRAB research
June 2014: Alaska-Argentina collaboration on king crab research
May 2014: Kodiak red king crab successfully reared at hatchery for release experiments
April 2014: Genetic population and mating structure identified for blue king crab
March 2014: AKCRRAB crabs are used to probe effects of ocean acidification
February 2014: Feeding hatchery-reared blue king crab larvae the right nutrition
January 2014: AKCRRAB scientists publish research results
2013
December 2013: King crabs on display at Alaska SeaLife Center
November 2013: Research tests a method for determining king crab age
October 2013: First red king crab release
September 2013: Hatchery provides training opportunity for Alaska student
August 2013: UAF undergraduate dives into red king crab field research
July 2013: NOAA examines interactions between red and blue king crabs
June 2013: Chilean scientists visit AKCRRAB, David Christie retires
May 2013: AKCRRAB successfully rears Kodiak red king crab larvae
April 2013: Biochemistry studies improve king crab larval diet
March 2013: Launching the 2013 culture year for Kodiak red king crab
February 2013: Seward Marine Center provides valuable support to AKCRRAB
January 2013: Genetic population structure of blue king crab

2012
December 2012: Fishers and processors collect and ship blue king crab for research
November 2012: Old Harbor community supports AKCRRAB
October 2012: Female red king crabs collected in southeast Alaska for new study
September 2012: Comparing temperature effects on molting and growth of newly settled red and blue king crabs
August 2012: NOAA ecological research on hatchery-cultured blue king crabs
July 2012: Blue king crab rearing experiment shows low cannibalistic mortality in first juvenile stages
June 2012: Juvenile blue king crabs shipped from Alutiiq Pride Shellfish Hatchery for research
May 2012: Researchers improve blue king crab culture technology and achieve high survival at Alutiiq Pride Shellfish Hatchery
April 2012: Blue king crab larvae hatch at Alutiiq Pride Shellfish Hatchery
March 2012: Researchers assess predation of hatchery-cultured juvenile red king crabs in the wild
February 2012: Blue king crab behavior and habitat preference in the presence of competitors and predators
January 2012: Researchers study blue king crab genetic population structure

2011
December 2011: Blue king crab broodstock arrive from St. Matthew Island
November 2011: Blue king crab rearing yields high survival at Alutiiq Pride Shellfish Hatchery
October 2011: Researchers at NOAA Alaska Fisheries Science Center in Kodiak examine red king crab cannibalism
September 2011: AKCRRAB reports research progress to fishing industry
August 2011: Undergraduate student assists in field study investigating juvenile red king crab predation
July 2011: Undergraduate researcher compares growth of juvenile red and blue king crabs
June 2011: AKCRRAB ships juvenile red king crabs to Juneau
May 2011: Biologists culture southeast Alaska red king crab at Alutiiq Pride Shellfish Hatchery
April 2011: Production of red and blue king crab at Alutiiq Pride Shellfish Hatchery
March 2011: High school student presents red king crab research at science fair and is selected for national competition
February 2011: AKCRRAB conducts juvenile red king crab tagging study
January 2011: Researchers try to duplicate production success using alternate red king crab stock

2010
November–December 2010: Researchers test effects of conditioning on hatchery-cultured red king crabs
October 2010: NMFS Kodiak Lab researchers study red king crab rearing conditions and cannibalism
September 2010: Cannibalism in king crab juveniles is reduced during studies by holding like sizes together.
August 2010: Divers collect juvenile red king crabs for field study
July 2010: Temperature experiments on hatchery-cultured red king crabs at NOAA
June 2010: AKCRRAB makes largest shipment of juvenile red king crabs to date
May 2010: Alutiiq Pride Shellfish Hatchery successfully rears red king crab larvae
April 2010: High school students participate in AKCRRAB research
March 2010: Juneau field studies: Habitat and predation risk for juvenile red king crab
February 2010: Growth physiology studies on juvenile king crab at Juneau laboratory
January 2010: Research biologist Jim Swingle joins Alaska Sea Grant 2009

2009
December 2009: Red and blue king crab broodstock arrive from Bristol Bay and St. Matthew Island
November 2009: NMFS scientists conduct red king crab habitat use and larval studies in Kodiak, Alaska
September 2009: Genetics studies on king crab populations conducted in Juneau, Alaska
August 2009: Habitat and predation risk in juvenile red king crab: Research in Juneau
July 2009: Hatchery nursery experiments on juvenile red king crab
June 2009: Habitat and predator-prey studies with juvenile red king crabs in Newport, Oregon
May 2009: Red king crab larvae are successfully reared at hatchery
April 2009: Millions of red king crab larvae hatch at Alutiiq Pride Shellfish Hatchery
March 2009: Blue king crabs hatched from Little Diomede Island travel to Juneau for AKCRRAB research

GRADUATE STUDENTS

Asia Beder, UAF, MS 2015 “Dietary Lipids Improve the Nutrition and Condition of Red King Crab Larvae (Paralithodes camtschaticus)”
Benjamin Daly, UAF, PhD 2012 “Red King Crab Hatchery Culture and Ecological Requirements: Applications for Stock Enhancement”
Celeste Leroux, UAF “Nutrition and Technique for Large Scale Larval Culture of the Red King Crab (Paralithodes camtschaticus) and Blue King Crab (Paralithodes platypus)”
Courtney Lyons, UAF, PhD 2015 “Understanding place in fisheries management: An examination of ecological and social communities in the Pribilof Islands, Alaska”
Jodi Pirtle, UAF, MS 2010, “Habitat Function in Alaska Nearshore Marine Ecosystems”
Jennifer Stoutamore, UAF, Masters 2014, “Population Genetics and Mating Structure of Blue King Crab (Paralithodes platypus)”
Scott Vulstek, UAF, MS 2011, Spatio-temporal Population Genetic Structure and Mating System of Red King Crab (Paralithodes camtschaticus) in Alaska”
Miranda Westphal, UAF, MS 2011, “Growth Physiology of Juvenile Red King Crab, Paralithodes camtschaticus, in Alaska”