NMFS Kodiak Laboratory Crab Enhancement Research

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Kodiak Laboratory Crab Culturing: the History

1990s Field studies on post-larval supply by ADF&G
1992 International King Crab Rehabilitation and Enhancement Symposium
1996-current Kodiak Lab continued culturing research
2000-2005 blue king crab diet and habitat studies
2006 Alaska Crab Stock Enhancement and Rehabilitation Workshop

Blue King Crab
*Paralithodes platypus*
Pribilof Islands Stock

Red King Crab
*Paralithodes camtschaticus*
Kodiak Island Stock
Enhancement Science: What do we need to know first?

Production

Does water filtration affect survival?
Enhancement Science:
What do we need to know first?

Production

- Does water filtration affect survival?
- Do hatchery water sources affect survival in the lab?
- Do different diets affect survival in the lab?
Enhancement Science: What do we need to know first?

**Production**

Does water filtration affect survival?
Do hatchery water sources affect survival in the lab?
Do different diets affect survival in the lab?

**Water source treatments**
1) seawater from Resurrection Bay
2) seawater made with artificial sea salt (Instant Ocean®)

**Diet treatments**
*Conducted in Kodiak and Seward*
1) newly-hatched *Artemia* nauplii
2) newly-hatched *Artemia* nauplii and the diatom *Thalassiosira nordenskioeldii*
Enhancement Science:
What do we need to know first?

**Production**

Does water filtration affect survival? **NO**

Do hatchery water sources affect survival in the lab? **NO**

Do different diets affect survival in the lab? **YES**

**Water source treatments**
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**Diet treatments**
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Do different diets affect survival in the lab?
Can cannibalism be mitigated by separate holding?
Space Effects Study

• Need to reliably produce large numbers of juvenile king crab for research and stock enhancement
• Test survival, intermolt duration, molt increment, carapace length
• Experiment ran for 9 months
Mean CL after each molt and mean intermolt degree days

Degree Days

Carapace Length (mm)

Initial CL

CL after 1\textsuperscript{st} Molt

CL after 2\textsuperscript{nd} Molt

Final CL (p=0.030)

% crab alive that underwent 3\textsuperscript{rd} molt

Small Holding Cell

Medium Holding Cell

Large Holding Cell

Mean CL after each molt and mean intermolt degree days

Degree Days
Percent survival by experimental day

$S = e^{-mT}$

- $S =$ proportional survival
- $m =$ mortality rate
- $T =$ time in days
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- **optimal spacing 2.6 crabs/L**
- 7% mortality/molt vs 30% in communal tank
- handling costs higher
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2011 – 2012 mass rearing in Kodiak
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Enhancement Science:
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Outstocking
Where to stock crab?
Are crab already there?
How many crab can an area hold?
What is the genetic variability?
What habitat is necessary and available?
What competitors and predators might be there?
Kodiak Red King Crab:  
Where did they go?  
Why have they not rebounded without fishing?

If habitat has changed or predators have increased…  
Enhancement may not be effective

If larvae are being swept away by currents (changes in oceanography or acidification)  
Enhancement could help stock crab AFTER the larval stage

Control 7.8 pH 7.5 pH
Kodiak Red King Crab:
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Kodiak Red King Crab:
Where did they go?
Why have they not rebounded without fishing?

For Enhancement to be Successful:
• Low predation rates
  • Structure
  • Predator abundance
• High growth rate
  • Food
  • Temperature
• Below carrying capacity
How many red king crab can an area hold?

Objectives:
• To track the movement of podding juvenile RKC in Woman’s Bay and characterize their habitat utilization
• To determine whether podding provides a refuge from predation or increases foraging efficiency.

2010 methods:
• Use acoustic tags to track crab
• Compare pod resting location to feeding area and relate to substrate (mud, sand, gravel, shell hash, cobble etc.)
What habitat do red king crab need?

1. Field Studies in Kodiak to Identify Habitat Characteristics

2. Lab studies to identify synthetic habitat uses for outstocking

3. Experimental outstocking in Old Harbor

[Images of Womens Bay and Kalsin Bay]
Habitat characterization and utilization of early benthic phase red king crab on Kodiak Island

2008 project goals:
• Identify areas of larval supply
• Characterize initial settlement habitat
• Assess relationship between areas of supply and settlement
Habitat characterization and utilization of early benthic phase red king crab on Kodiak Island

2009 project goals:
• Identify larval supply in historically known red king crab habitat
• Quantify settlement density
• Habitat use by early benthic and juvenile phase
• Annual progression of biogenic habitat in 2009-2010
Laboratory Experiments with Juvenile King Crab: Preferences for Substrate Orientation and Synthetic Netting as Habitat

2009 project goals:
• To determine if vertical or horizontal habitat orientation is preferred.
• To determine the importance of synthetic habitat complexity.
• To determine differences in habitat preference between one month old and one year old juveniles.
Experimental outstocking in Old Harbor

2009 project goals:
• Assess habitat in Sitkalidak Straits near Old Harbor, Kodiak
• Use HSI models to quantify habitat and develop an index
• Habitat types: inter/sub tidal, slope, deep soft, deep firm

2010 project goals:
• Expand understanding of habitat availability
• Assess predator densities and relationship to substrate

Habitat Suitability Models
• Temperature: ~10° C
• Salinity: > 26 ppt
• HSI_{WQ} = 0.7
• Inter/subtidal: HSI_{FC}=1.0
• Slope: HSI_{FC}=1.0
• Deep Soft: HSI_{FC}=0.1
• Deep Firm: HSI_{FC}=0.75
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2010/2011 project goals:
• Identify functional response of red king crab to prey densities
• How does habitat augment the functional response
Red king crab predation

• RKC are highly cannibalistic
  – Could limit population in the wild
  – Lead to oscillating recruit success
• The functional response is a type II
  – No low density refuge from predation
  – Could lead to local extinction of year classes
• Complex habitat lowers predation risk
• Predator interference is mild

SO.....

Stock at HIGH DENSITY
Stock every 2 years
Kodiak Red King Crab: Where did they go? Why have they not rebounded without fishing?

What’s Next?
- Compare habitat use in Old Harbor to Alitak Bay
- Outstocking experiments in 2012
  - Tracking juvenile crab
  - Habitat use
  - Movement
  - Assessing predation
Pribilof Islands Blue King Crab: Is the stock sustainable?
Pribilof Islands Blue King Crab:
Is the stock sustainable?

Has habitat changed?

If larvae are being swept away by currents (changes in oceanography or lack of recruitment)

Need to compare current habitat to historical data

Enhancement could help stock crab AFTER the larval stage
Pribilof Islands Blue King Crab: Rebuilding Plan
Pribilof Islands Blue King Crab:

- 2011 temperature effect studies in Kodiak
- Continued genetics sample collection in Bering Sea
- Collaborate with local efforts
- Identify habitat to compare to early studies
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