Development of Large Scale Hatchery Production Technology for Red and Blue King Crab

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Alaska Shellfish Institute
Alutiiq Pride Shellfish Hatchery

Site location for crab studies
Shellfish Institute Floor Plan

Main Floor:
- Geoducks
- Cockles
- Scallops
- Oysters

Water Treatment
Dry Lab
Algae Culture
Workshop
Office

Mariculture Technical Center

Seward Marine Center
Alutiiq Pride Shellfish Hatchery
Alutiiq Pride Shellfish Hatchery

Produce:
• Pacific Oysters
• Cockles
• Littleneck Clams
• Razor Clams
• Scallops
• Sea Cucumbers
Background – Red King Crab Fishery

Kodiak Red King Crab Commercial Harvest 1950-2006

Source: William Bechtol, UAF/SFOS; ADF&G
Background – Blue King Crab Fishery

Pribilof & St. Matthew Blue King Crab Harvests
1966-2006

Landings (millions lbs.)

Source: ADF&G
What Happened to the Crabs?

• Nobody knows for sure
  – Possible Reasons
• Overfishing
• Predator shift-finfish-cod
• Decadal temperature shift
• How many should be there?

This is photo from the famous show: “Deadliest Catch”
AKCRRAB

- Alaska King Crab Rehabilitation Research and Biology
- Commercial Fisherman Groups, Communities, University of Alaska, Marine Advisory Program, NOAA Fisheries, Chugach Regional Resources Commission
The mission of AKRRAAB is to identify the need for and improve the methodology of the enhancement of king crab, by perfecting strategies for hatching rearing and out planting king crab in the North Pacific. Increased knowledge will allow policy makers to assess the feasibility of ecologically sound management, of depressed stocks, that benefits crab science and management and Alaska fishing communities.
AKCRRAB Long-term Vision

*Artificial Propagation
*Habitat Studies
*Genetics & Pathology

**Goal:** Assess biological & economic feasibility of red and blue king crab population rehabilitation through ocean ranching.
Broodstock Collection

Commercial fleet captures bloodstock

Biologists pack and ship
Broodstock Holding Tanks

3000 liter tanks with chillers, Each females releases approximately 150,000 larvae

Adult female brood stock
Broodstock Holding
Production and Research Science

1200L Production tanks

190L Research tanks
Algae Production

- Thalassiosira nordiskolias
- T. pseudononana
- Tahitian isochrysis
- Pavolova lutherii
- Chaetocerus calcitrans
- Chaetocerus muelleri
- Skeletonema costatum
- Tetraselmis suecica
- Navicula sp.

Photo courtesy of Celeste Leroux
Artemia Production

• Artemia Production
• Cysts disinfected with Cl\(^-\), rinsed Freshwater, 100 um mesh filters
• Hatching tanks (100 liter), 300 grams cysts=4.5 million artemia
• 28°, 30 ppt SW, aeration 24 hrs
• Enrich (300/ml) with DC DHA Selco (.6 gm/liter) 100 L tank 24 hrs, rinse FW, and filtered 100 um mesh.
• Feed at 2-4 ml/day.
Red King Crab Lifecycle

Prezoea (.8 µm)

Zoea

C-1 Juvenile (1.8 µm)

Glaucothoe

Z-4
Red King Crab Rearing

Newly ‘settled’ glaucothoe

1200L production tanks with artificial seaweed
Production Timeframe

- Raised at 8°, 32 ppt, flow through with aeration 1200 liter cylinder tanks
- Zoea1- Zoea 4  30 days (7-8 days per molt)
- Glaucothoe 20 days
- C1-C2-C3  15 days per molt at 8°
Improvement in Mean Larval Survival by Project Year

• Mean survival from Z1 to glaucothoe and C1 in the 1200L larval rearing tanks has improved each year at the Alutiiq Pride Shellfish Hatchery as rearing techniques and hatchery infrastructure have been refined and improved. Survival from Z1 to glaucothoe averaged 2, 34, and 53% during years 2007, 2008, and 2009, respectively, while survival from Z1 to C1 averaged 0, 10, and 21%.
• In 2009, mean survival from Z1 to glaucothoe was 53.3% and was not significantly different between the three diet-additive combinations tested.
Mean Survivals Per Stage

- 2009 Z1-Z4 53.3% (26% to 68%)
- Glaucothoe to C1 Mean 21%, 60% in Static tanks
- C1-C3 5%
- 2008 34% to Glaucothoe
- 2007 2% to Glaucothoe
Improvements

- "Polished" water- Sand Filters, 10um Bag Filters, 1um Cartridge Filters, U.V. Sterilization, Charcoal
- **Reduction of Intermolt time, Increased Temperature from 6° C to 8° C. Reduce effect of Filamentous Bacteria
- Enriching Artemia with DH C Selco ®
Health Assessment

- Size
- Residual Feed
- Survival at 100% cleaning
- Lipid Diameter
- Deformities
- Attached debris
- Filamentous bacteria *Leptothrix sp.*
- Stalked protozoan's
Present Protocols

- 1200 Liter Tanks
- 60,000 Z1’s=50/liter
- Feed enriched artemia
  2-4 liter/day
- 8° C ,32 ppt
- Intensive husbandry
- Utilize artificial seaweed
- Juvenile culture C3’s + in static tanks
### Summary Larval Rearing Protocols

<table>
<thead>
<tr>
<th>Stage</th>
<th>Height</th>
<th>Aretmia</th>
<th>Flow rate</th>
<th>100% Tank</th>
<th>Days</th>
<th>Lipid Dia.</th>
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<tbody>
<tr>
<td></td>
<td>Microns</td>
<td>ml/day</td>
<td>l/pm</td>
<td>Change Day</td>
<td>Molt</td>
<td>Late Stage</td>
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<tr>
<td>Z-1</td>
<td>.9-1.1</td>
<td>2.5</td>
<td>3</td>
<td>0</td>
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<td>1.1-1.2</td>
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<td>4</td>
<td>10</td>
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<tr>
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<td>1.3-1.4</td>
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<td>5</td>
<td>17</td>
<td>7</td>
<td>140</td>
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<tr>
<td>Z-4</td>
<td>1.5-1.7</td>
<td>5</td>
<td>7</td>
<td>25</td>
<td>11</td>
<td>180</td>
</tr>
</tbody>
</table>

**Late stage**
Juvenile Grow-out

- Tested Feeds- Enriched Artemia, Cyclop-eeze®, Zeigler™ shrimp nursery feed. Cyclo-peeze® best survival, Zeigler™ best growth

- Different substrates- Gillnet, artificial seaweed “shizaron”, mechanical biofilter, bio-saddle, natural rock. No difference, many juveniles prefer to graze on bottom of tank.

- Testing tank design
Size Increase Through Time (mm)

Size (mm)

Molts

Size Increase Through Time...
Survival Through Time

Date

Molt Amount

Survival Through Time

12000
6000
6000
3600
1980
1089
599
329
19
2012 Goals

• Raise Z1-Glaucothoe to 60%, Glaucothoe to C1 to 50%
• Refine protocols, include static culture with glaucothoe
• Repeat with Blue King Crab
• Begin out planting with C1’s and C2’s.
Production Costs

- 3 employees, facility, supplies, fuel and electricity $250,000

- (42) 1200 Liter tanks produce 1 million (C1’s or C-2’s) = $.025 per crab

- Present research centered on multiple crops utilizing temperature for brood sock manipulation, brood stock collection timing from the wild and glaucothoe setting timing.
Cost Benefit

- 1 million larvae to C1 50%
- Y1 to Harvest 90% loss 45,000 adults
- 15% exploitation, 6,750
- $30 crab ($6/lb 5lb average)
- $200,000 to fishery
- Added value= localized fishery, increased breeding biomass, increased opportunity on other fisheries.
Kodiak Alaska

Old Harbor Village Town

Cozy Cove
Enhancement Strategy

- Stock Newly Settled C1 crabs
- Select Release Sites- Develop Habitat Suitability Index-HSI
- Develop Marking Techniques- Genetic or Physical
- Develop Recapture Techniques
- Cost/Benefit Analysis
Questions?

C-8 (120 days) Red King Crabs, Alutiiq Pride Shellfish Hatchery