Virginia Cobia Farms

Industry Experience in Good Practice
Recirculation Systems
Elements of the Presentation

Introduction

Overview of Virginia Cobia Farms and its Cobia Products

Overview of Recirculation Aquaculture

Key Technologies and Industry Experience Growing Cobia in Recirculation
Production of Marine Fish in Land Based Large Scale Production Units is Part of the Solution to the Global Seafood Crisis.

Production of cobia in recirculation systems is a viable, growing commercial sector that supplies fresh, healthy fish to the market reared in an environmentally responsible sustainable manner.
Virginia Cobia Farms is a joint venture between Blue Ridge Aquaculture (Martinsville, VA) and MariCal, Inc. (Portland, ME). The company is located in Saltville, VA, and is North America's largest tilapia producer with over 15 years of large-scale RAS experience. They are vertically integrated, offering the lowest cost in the market.

Virginia Cobia Farms uses a proprietary technology platform based on fish nutrient and salinity regulation, and has over 12 years of commercial aquaculture R&D experience.
Virginia Cobia Farms – Inland Marine Cobia Production

**Present Capacity**
- 2009: 10 metric tons

**Future Production Goals**
- 2010: 137 metric tons
- 2011: 450 metric tons
- 2011+: >1,000 metric tons
Virginia Cobia Farms Products

1kg (2lb) Live Fish

2 kg (4lb) gutted fish or fillets

Production Times
(From egg)
8 months

(From 100-200g Juvenile)
4 months

10 months

6 months

Presentation to SCAD II 25Sep09
Virginia Cobia Farms Key Licenses and Permits Obtained

• Virginia Marine Resources Commission Cobia Aquaculture Permit
  – Jun 1, 2007 to May 31, 2017, renewable
  – Permit to produce and sell up to 100 million cobia per year

• Environmental permitting
  – Single Site Discharge permitting approved up to 5 million pounds/year

• Largest permit for recirculation in the US
Virginia Cobia Farms Branding

Safe Harbor
Certified Seafood

Seafood Watch
Seafood Report

MONTEREY BAY AQUARIUM

VIRGINIA COBIA FARMS
JUDGED

"#1 COBIA IN AMERICA"

Awarded by the Masters of Taste of the
Chefs In America Awards Foundation.

AUGUST 26, 2008

Presentation to SCAD II
25Sep09
Aquaculture’s Carbon Footprint

Tons of CO₂ produced to transport seafood to Chicago

- Based on 1 million lbs of seafood (5.3 billion lbs were imported to US in 2007)
- Calculated using the Friends of the Sea Carbon Footprint Calculator
Elements of the Presentation

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Key Technologies and Industry Experience Growing Cobia in Recirculation
At present, sea cage farming of marine fish is the dominant production platform – Near Shore vs. Offshore

- Coastal Less expensive historically vs. other production platforms
- Seawater considered “free”.
- No need for pumping or cleaning seawater
- No need for land and limited construction

Continuing Issues and Challenges
- Disease
- Pollution
- Escapes – fish as well as gametes
- Vulnerability to extreme weather conditions
- Accessibility – economic overlays.
Land based recirculation aquaculture systems (RAS) have many advantages

• Location flexibility
  – Logistics and real estate costs
  – Freshness
  – Independent of sea site requirements
  – Employee environment and proximity

• Disease and quality control

• Controlled production environment

• Impact on wild fish stocks and environment

• Utilization of water and land resources
Recirculation Aquaculture Systems
Large, Reliable, Integrated Formats

Growth Improvements
Land based RAS increasingly important production platform

- Increasing importance of land based advantages (quality, disease, environment, product consistency)

- RAS technology development advancements have lowered costs

Land based RAS necessary component to meet future demands from developed countries
Global Recirculation Aquaculture – 2009 Status

• Currently smaller than sea cage production but growing rapidly. A number of drivers are responsible for this growth. Increases in costs of sea cage farming and reductions in the costs of capital infrastructure to build and maintain RAS facilities.

• Currently there are between $300 - $500 million USD being invested or planned for investment in 2009-2010 time frame in 100+ RAS facilities of various sizes (large range $200,000 - $10 million USD for individual sites).

• Locations in wide variety of continents (North and Southern Hemispheres).

• Wide variety of fish species – salmon, halibut, yellowtail, cobia, tuna, sturgeon.

• Full spectrum of uses for RAS facilities – broodstock, hatchery, juvenile and full scale production facilities.

• Sizes of facilities are also growing significantly. Facilities of >1000 metric tons.

• Sizes and revenues of companies providing RAS facilities are also growing.
Continuing Issues and Challenges For Recirculating Aquaculture

- Capital costs
- Operational costs
- Design Flaws – “Margin For Error” Capacities within Systems
- Failures to maintain good biological isolation – disease problems
- Mechanical and operational failures
- Necessity for continued innovative refinement.
### Production Costs For Cobia - Estimates

<table>
<thead>
<tr>
<th>USD/lb</th>
<th>Sea Cage</th>
<th>RAS US*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>China</td>
<td>Ecuador</td>
</tr>
<tr>
<td>Fry</td>
<td>$0.08</td>
<td>$0.27</td>
</tr>
<tr>
<td>Feed</td>
<td>$0.85</td>
<td>$0.98</td>
</tr>
<tr>
<td>Labour</td>
<td>$0.14</td>
<td>$0.03</td>
</tr>
<tr>
<td>Other</td>
<td>$0.09</td>
<td>$0.11</td>
</tr>
<tr>
<td>Depr</td>
<td>$0.20</td>
<td>$0.14</td>
</tr>
<tr>
<td>Total LW</td>
<td>$1.35</td>
<td>$1.53</td>
</tr>
</tbody>
</table>

* Estimate at LW 10 mill lb annual volume
Source: Various by Virginia Cobia Farms

**Other Cost Advantages for RAS**: Harvesting, transport and processing cost
Elements of the Presentation

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Key Technologies and Industry Experience Growing Cobia in Recirculation

• High Quality Juvenile Production
• Rearing Cobia Under Low Water Salinity and RAS Conditions
• Sustainable In House Feed Formulation for Cobia
• Water recapture and use of fish waste as a resource.
Virginia Cobia Farms Historical Timeline

• MariCal and BRA worked on cobia for years prior to formation of VCF
• Cooperation discussions between MC and BRA
• Virginia Cobia Farms founded
• Pilot production and hatchery constructed
• Testing and technology development
• Commercial validations completed

• Early 2006
• Sep 2006
• Jan 2007
• Jan 2007 – Mar 2009
• Jan 2009
<table>
<thead>
<tr>
<th><strong>“STANDARD” COMPANY PLAN</strong></th>
<th><strong>VS.</strong></th>
<th><strong>VIRGINIA COBIA FARMS PLAN</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Select Production Species</td>
<td>Selected Cobia</td>
<td></td>
</tr>
<tr>
<td>Academic/2\textsuperscript{nd} Hand Production Information</td>
<td>Obtain First Hand Production Data</td>
<td>Perform Smaller Scale Production</td>
</tr>
<tr>
<td>Modeling</td>
<td>Design and Build Optimize System</td>
<td></td>
</tr>
<tr>
<td>Build Large Turn Key System</td>
<td></td>
<td></td>
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</table>

**OUTCOME**

<table>
<thead>
<tr>
<th><strong>OUTCOME</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Time lost to “optimize” system</td>
<td>Large system layered on smaller system</td>
</tr>
<tr>
<td>Retrofits and Compromises</td>
<td>Retrofits minimized, Compromises built into the design and operation of system.</td>
</tr>
<tr>
<td>Stressed Fish – Disease etc.</td>
<td>Efforts made to reduce stress and disease</td>
</tr>
</tbody>
</table>
The Key To Successful and Reliable Cobia RAS Production Is Successful and Reliable Production of High Quality Juveniles

Broodstock

Egg Collection

Larval Rearing

0.5gm Weaned Juveniles
Early Grading of Cobia Juveniles Critical to Achieving Good Performance

Data for Day 95 Grading Juvenile System

<table>
<thead>
<tr>
<th>% of total</th>
<th>Tank</th>
<th># of fish</th>
<th>Ave wt.</th>
<th>Ave Wt.</th>
<th>Av. Wt.</th>
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<tbody>
<tr>
<td>24.7</td>
<td>20</td>
<td>336</td>
<td>50</td>
<td>16800</td>
<td>47.91</td>
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<tr>
<td>31.6</td>
<td>22</td>
<td>430</td>
<td>45</td>
<td>19350</td>
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<tr>
<td>23.9</td>
<td>23</td>
<td>325</td>
<td>25</td>
<td>8125</td>
<td></td>
</tr>
<tr>
<td>16.0</td>
<td>16</td>
<td>217</td>
<td>77.3</td>
<td>16774.1</td>
<td></td>
</tr>
<tr>
<td>3.8</td>
<td>21</td>
<td>51</td>
<td>79.5</td>
<td>4054.5</td>
<td></td>
</tr>
</tbody>
</table>

Presentation to SCAD II
Performance Tracking of Cobia Juveniles – Growth and FCR

Snapshot at 100 days Post Hatch

<table>
<thead>
<tr>
<th>Weight (gm)</th>
<th>SGR</th>
<th>FCR</th>
<th>Mortality Rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>130</td>
<td>&gt;3.25</td>
<td>~1</td>
<td>Very Low</td>
</tr>
<tr>
<td>80</td>
<td>2.5-3</td>
<td>1-1.5</td>
<td>Low</td>
</tr>
<tr>
<td>40</td>
<td>2.0-2.5</td>
<td>1.5+</td>
<td>Moderate</td>
</tr>
<tr>
<td>18</td>
<td>&lt;1.0</td>
<td>6+</td>
<td>Very High</td>
</tr>
</tbody>
</table>

Longer Term Performance Parameters

- Juvenile grading essential for optimal performance
- Future benefits from selective breeding development
Why grow marine fish in low salinity?

• Coastal property for shore based tank farms with access to natural seawater is very expensive
• Political and regulatory pressures are highly restrictive on the coast in industrialized countries
• Environmental regulations limit amount of saline water that can be discharged from inland Recirculating Aquaculture System (RAS) facilities – principally Chloride ions
• Lower cost of marine seafood production in recirculation system
  • Costs of adding and removing salt cut sharply
  • Reduced deterioration of production system caused by salt
• Lower risk of disease introduction by excluding use of natural seawater.
  • Easier to establish a disease free facility.
CaSR receptor – Ancient nutrient salinity sensor is key physiological integrator in fish and humans.
Fish & human CaSRs modulated by simple changes in water ionic composition

**CaSR Response**

**Human (5001)**

- 50 mM NaCl
- 75 mM NaCl
- 125 mM NaCl
- 200 mM NaCl
- 300 mM NaCl

**Salmon (Sal 3)**

- 50 mM NaCl
- 75 mM NaCl
- 125 mM NaCl
- 200 mM NaCl
- 300 mM NaCl

Log(Na/Ca)
Producing marine fish in low salinity

- Salinity sensor in fish does not “sense” absolute concentrations of salts in the water but rather the ratios of specific salt ions.

- Maintaining the appropriate ratios of key salt ingredients, particularly Ca$^{2+}$, Mg$^{2+}$ and Na$^+$, with respect to one another at concentrations that are much lower than actual seawater provides a means to activate or maintain a seawater status in fish while the fish is reared under very low (8-10ppt) salinity conditions.

- Ability to “finish or polish” fish after grow out under different salinity and ionic conditions – flavor profile from bland to marine tasting using salinity acclimation and diets.

- MariCal has 8 issued US and international patents on growing marine fish in low water salinity – all licensed to Virginia Cobia Farms.
Integrated Recirculation System Production Parameters for Cobia

- Good Water Quality: NH₃, Alkalinity, pH
- Good Gas Exchange: Oxygen, CO₂, Ozone
- Low Water Turbidity Particulate Content
- Stocking Densities: 50-75 kg/m³ (i.e. 7.5% fish, 92.5% water)
- Tank Conditions:
  - Temperature
  - Photoperiod
  - Water Flow in Tanks
Virginia Cobia Farms Nutritional Objectives

- Optimize sustainability in formulations
- Source only highest quality, traceable, domestically produced feedstuffs
- Utilize novel feed additives/amino acid supplementation to enhance production and health
- Focus upon final product quality.
VCF Nutritional R&D Program

- In house, 20 years experience in marine warm water fish nutrition and culture—brood stock through grow-out

- In house, commercial feeds formulation experience

- Drawing on over 30 independent studies with juvenile cobia—forefront of cobia nutritional innovations
### Virginia Cobia Farms Diet Formulations*

(All values expressed as % of diet)

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>COMMERCIAL</th>
<th>VIRGINIA COBIA FARMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish meal</td>
<td>(30-35)</td>
<td>10.0</td>
</tr>
<tr>
<td>Plant proteins</td>
<td>(30-40)</td>
<td>57</td>
</tr>
<tr>
<td>Wheat</td>
<td>(12-20)</td>
<td>15</td>
</tr>
<tr>
<td>Fish oil</td>
<td>(12-15)</td>
<td>5.0</td>
</tr>
<tr>
<td>Soy oil</td>
<td></td>
<td>5.0</td>
</tr>
<tr>
<td>Fish meal protein</td>
<td>30-35 %</td>
<td>10.0 %</td>
</tr>
<tr>
<td>Animal by-products</td>
<td>8-18%</td>
<td>0.0 %</td>
</tr>
<tr>
<td>Total plant ingredients</td>
<td>43-60 %</td>
<td>&gt; 72 %</td>
</tr>
<tr>
<td>Total soy</td>
<td>20-30 %</td>
<td>&gt; 55 %</td>
</tr>
<tr>
<td>FI:FO</td>
<td>2.2-3.6**</td>
<td>0.83-0.90**</td>
</tr>
</tbody>
</table>

**based upon Seafood Watch Seafood Report: Farmed Cobia

*Work supported by generous funding from United Soybean Board
Utilizing Fish Feces and Uneaten Feed As A Resource And Not As Discarded Waste.

**Economic Considerations**

- Significant cost inputs for RAS cobia are:
  1. heating and moving water.
  2. disposal of fish waste – sewerage fees.
  4. Augmentation of solids/water separations reduce salt use and increase water reuse.
  5. RAS staff already familiar with large tank-based stage processes.
Integration of RAS Aquaculture With Anaerobic Digester Technology.

ELECTRICITY
HEAT

RAS UNITS VA COBIA FARMS

Fresh Fish Products

Biogas Co-generator

Recycled Water
Selective Membrane Filtration System

Bioaugmented Bioreactor Waste Processor

BIOGAS

Single Cell Protein

Feed Mill Substitute For Fish Meal Protein Source

Anaerobic
Aerobic

Algal Production

CO2
Calculations For Cobia Fish Waste Generation and Recovery for 1,000,000 lbs Market Size Fish

Generation of Waste
1,000,000 lb (454,545kg) cobia produced @ FCR 1.5 = 1,500,000 lb (681,820kg) feed fed for market size fish.

Cobia waste @ 50% of feed load = 750,000lb (340,900 kg) + Mortalities (8% harvest biomass) = 80,000 lb (36,360 kg)

Generation of Waste Recovery Components
68% of cobia waste is volatile solids; ~26% protein.

Waste collected as ~50% slurry (6% dry solids) yielding 660 liters biogas/kg of dry waste. A total of 377,000 kg of waste yields ~240,000 m³ of biogas.

Economic and Environmental Payoff
Biogas driven electrical-heat co-generator yields 400,000 kWh of electricity PLUS heat equivalent to 2,900,000 ft³ of natural gas.

Aerobic digestion of remaining anaerobic digest mass yields 5 tons of single cell protein (SCP) – fish meal substitute.
Thank You