Atlantic Salmon Growout Trials in Freshwater Closed-Containment Systems at the Conservation Fund Freshwater Institute

Steven Summerfelt, Thomas Waldrop, John Davidson
Christopher Good
Acknowledgments

- Support for TCFFI:
  - U.S. Department of Agriculture, Agricultural Research Service
    • 1st salmon studies finished in 2011
    • Gaspe and St John River strain
  - Atlantic Salmon Federation
    • 2nd Growout Trial finished in 2012
    • St John River strain salmon @ 40 kg/m³
  - Moore Foundation
    • 3rd Growout Trial finished in 2013
    • Cascade strain salmon @ 100 kg/m³
  - Moore Foundation & ASF
    • 4th Growout Trial to finish in 2014
    • Cascade strain salmon @ 2 photoperiods
Containment is Necessary for Sustainable Aquaculture

• Land-based, closed-containment systems:
  – Exclude chemicals & obligate pathogens
    • No pesticides, antibiotics, & chemotherapeutics in closed-containments systems w/ over 10 yrs operation at TCFFI
  – Prevent escapees & disease interaction between wild & farmed fish
  – Minimize water use & release of pollution
  – Optimize water temperature & photoperiod
  – Locate farm in best location & away from sensitive ecosystems
Atlantic Salmon Growout Trial

- Atlantic salmon - Cascade Strain
  - eggs purchased from American Gold Seafood (WA)
- Jan 5, 2011 – Eyed eggs received
- January 21, 2011 – 50% hatch (day 1)
- February 23, 2011 - First feeding (day 34)
- Aug-Sept 2011 – Photoperiod manipulated to S0 smolt
- March 12, 2012 – Moved into growout system (day 417)
Process Flow Drawing of Closed-Containment System

CO2 stripping unit stacked over LHO & sump tank.

10 HP reuse pumps

60% flow

4700 L/min

145 m³ dual-drain culture tank

15% bottom drain flow

Radial flow settler

intermittent (24 times/day) discharge of solids from base of cone

Supernatant

System overflow

Make-up water

Backwash water

Frequent discharge of backwash flow

Drum filter

Strip LHO

Fluidized-sand biofilter

Pump sump

CO2 stripping unit stacked over LHO & sump tank.

Producers Workshop
Vancouver, BC, April 23, 2013
Closed-Containment System

- 145 m³ Culture Tank Volume
  - 4900 L/min recirc flow
  - 30 min HRT
- 260 m³ System Volume
  - 45 L/min mean makeup
  - 8 to 150 L/min makeup
  - 4 day HRT (1.2-23 day)
  - 99.8 to 96.9% flow reuse

High flushing rate to keep water ≤ 17°C in summer
Atlantic Salmon Growout Trial

- 1208 Gaspe
- 111 Cascades
- 109 St. John River
- 110 St. John River
- 1208 Gaspe-109 St. John River Mixed Cohort
- Net Pen STJR

**Age (Days)**
- 0
- 200
- 400
- 600
- 800
- 1000
- 1200

**Mean Weight, g**
- 0
- 1000
- 2000
- 3000
- 4000
- 5000
- 6000
Atlantic Salmon Growout Trial

- **430 g Post-smolt at 12 months post-hatch**
- **Maturing Male Harvests**
  - 2.6 kg mean size
  - Aug 6, 14, 22 (2012)
  - Days 564, 572, 582 post-hatch
- **Premium Salmon Harvest**
  - 4.2 to 5.6 kg mean size
  - Days 679 to 812
  - 16 harvest events (~ weekly)
Atlantic Salmon Growout Trial

- 37% of the population harvested Aug., 2012
  - biomass at 100 kg/m³
  - **all maturing males** (slightly larger than females)
  - mean fish size at 2.64 kg
  - 5.4 metric tonne (12,000 lb)
  - sold to a local processor for hot smoking
**Premium salmon:**
- 4.3 kg mean size achieved in early December 2012
  - 22.6 months post-hatch
  - biomass density reached 94 kg/m³
  - Good fin condition
- produced 17.5 metric tonne

**Total Harvests (maturing male + premium)**
- 23 tonne
- 145 m³ culture tank
<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality</td>
<td>2.7%</td>
</tr>
<tr>
<td>Culls</td>
<td>3.9%</td>
</tr>
<tr>
<td>Jumpers</td>
<td>0.4%</td>
</tr>
<tr>
<td>Total</td>
<td>7.0%</td>
</tr>
</tbody>
</table>
• **Feed Conversion of 1.07 feed : 1.0 gain**
• Commercial diet with ~ 40:30 protein: fat
Atlantic Salmon Growout Trial

- No sea lice
- Obligate pathogens screening conducted (waiting on results)
- No kudoa

6+ kg female
Atlantic Salmon Growout Trial

- No vaccination (saves $$ & stress)
- No antibiotics or pesticides used at any time
- No formalin used at any time
- Some hydrogen peroxide ($H_2O_2$) used in the sac fry and early parr stage to treat fungus.
- Total salt used to treat fungus: 14,400 lbs.
Escapees

- No escapees - One Atlantic salmon parr removed from the effluent fish exclusion area.
Product Quality Results

- MUST DEPURATE salmon for 10 days after removing harvested fish from recycle system
  - Depurate in partial reuse system with little biofilm
  - Purges off-flavors, i.e., geosmin and MIB, produced by bacteria (actinomycetes)
Post-Harvest Slaughter

Rapid & Humane

- Percussive Stunning
  - MODEL SI-7 (Seafood Innovations)
Growout Trial Results: Product Quality

- 56.6 ± 0.6% skin off & trimmed fillet yield
  - after 11 day depuration
- 1.77 ± 0.05 g/mm³ condition factor
  - net pen industry is ~1.3
- 15.2-17.0% lipid content in fillet
Growout Trial Results: Product Quality

- Good fillet color (26-28) & lipid content (15-17%)
Growout Trial Results: Product Quality

- Premium salmon sold to Albion Seafood and distributed through Safeway in Vancouver
CONCLUSIONS:
Atlantic Salmon Growout Trial

- Good growth in freshwater
  - Harvest 9-10 months sooner than net pens
- Good survival (95%) and feed conversion (1.07:1)
- Density can reach 100 kg/m³
- Should use all female eggs to avoid precocious males

We don’t need seawater to farm Atlantic salmon