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# Update on Atlantic Salmon Growout Trials in Freshwater Closed- Containment Systems at the Freshwater Institute

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Aqua Innovation Workshop
May 15-16, 2012

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# Acknowledgments

- Support for **The Conservation Fund Freshwater Institute**:
  - **Atlantic Salmon Federation**
    - 1st GROWOUT TRIAL
    - St John River strain salmon were harvested at 24-26 months post-hatch
  - **Moore Foundation**
    - 2ND GROWOUT TRIAL
    - Cascade strain salmon now 15 months post-hatch
  - **U.S. Department of Agriculture, Agricultural Research Service**
    - Finished first salmon studies winter 2011

# 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 where electric & land are cheap
    - US$ 0.02-0.06 / KWH

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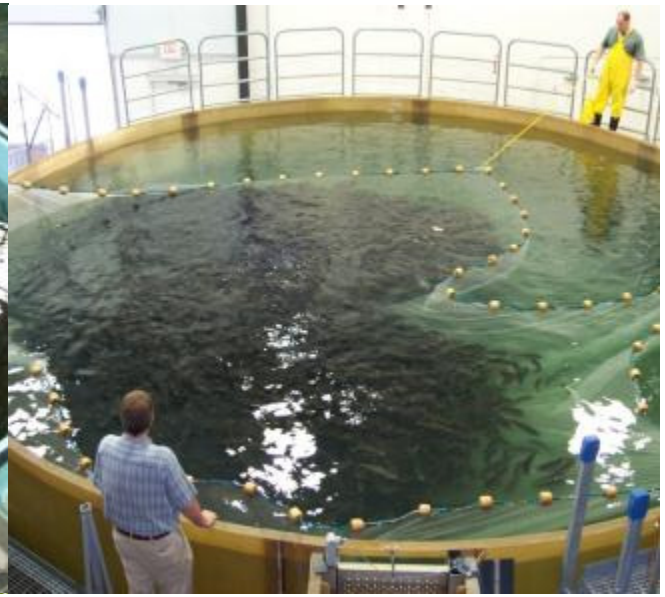
# Atlantic Salmon Federation Funded Growout Trial

- Atlantic Salmon, Saint John River strain (Cooke)
- Jan 2010 - Eyed eggs arrive
- March 2010 - First Feeding
- May 1, 2011 Stocked into growout at 340 g
- Feb 27, 2012 – First harvest at 4 kg/fish



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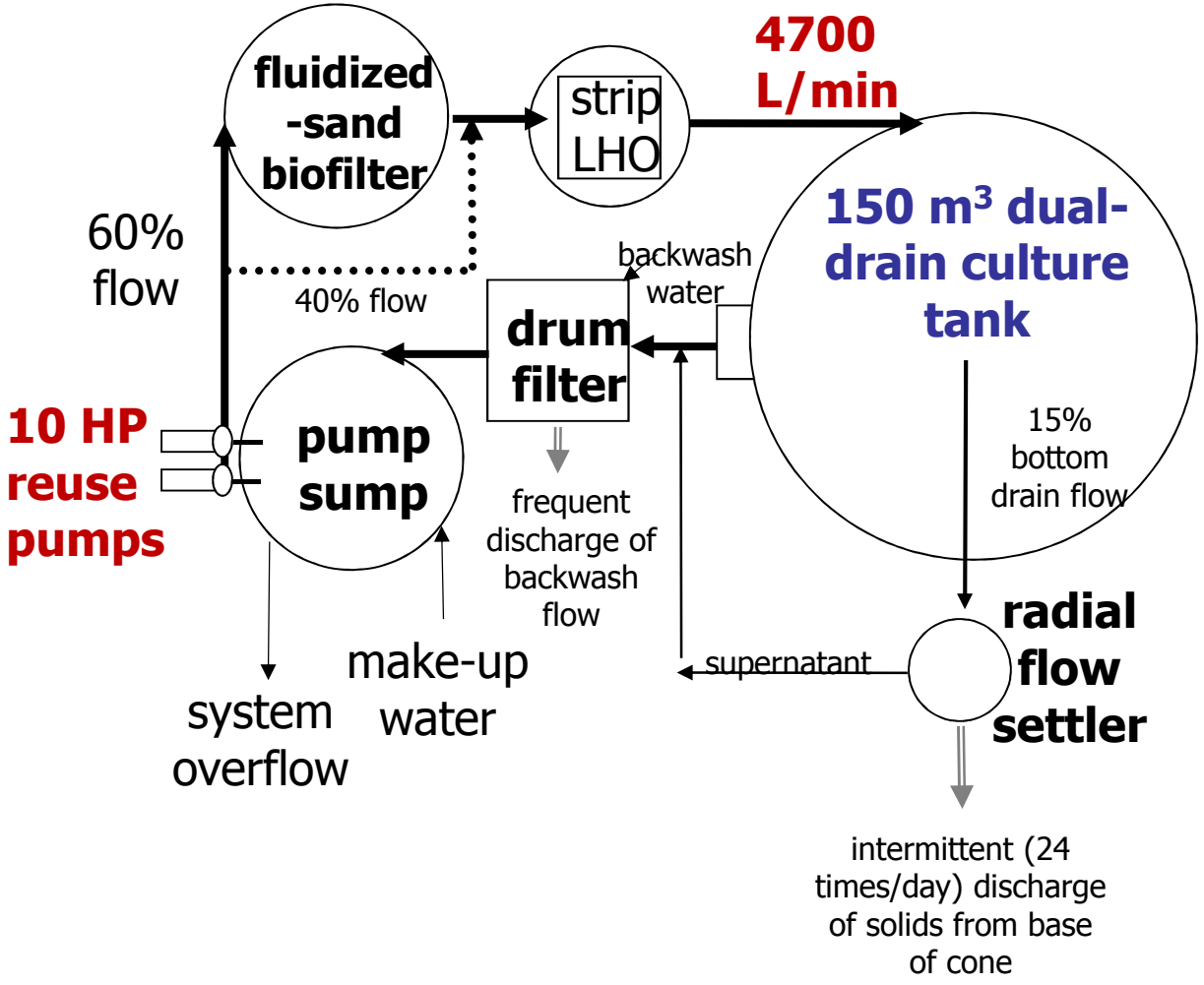
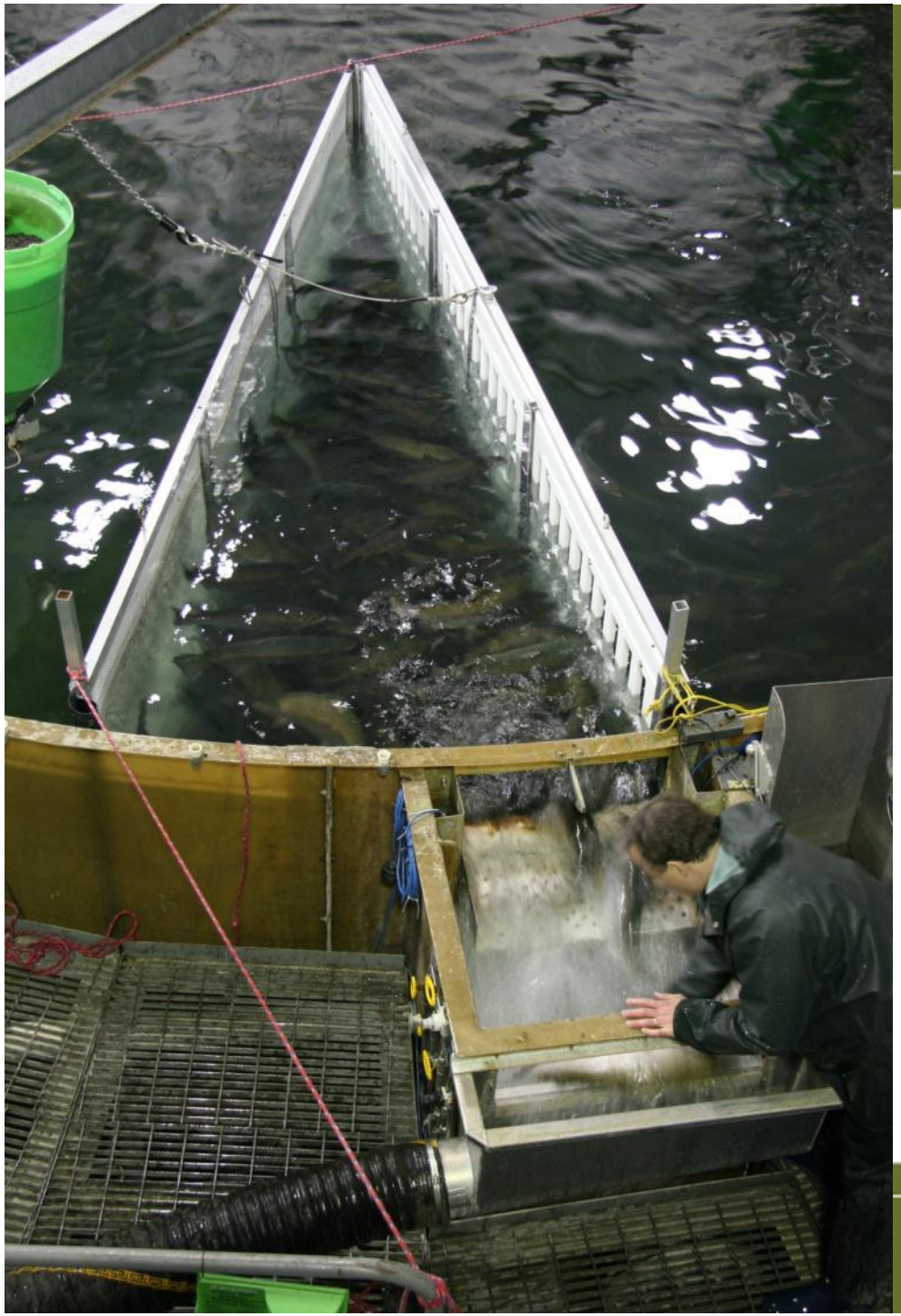
CO2 stripping unit stacked over a LHO & sump tank

# Process Flow Drawing of Closed-Containment System





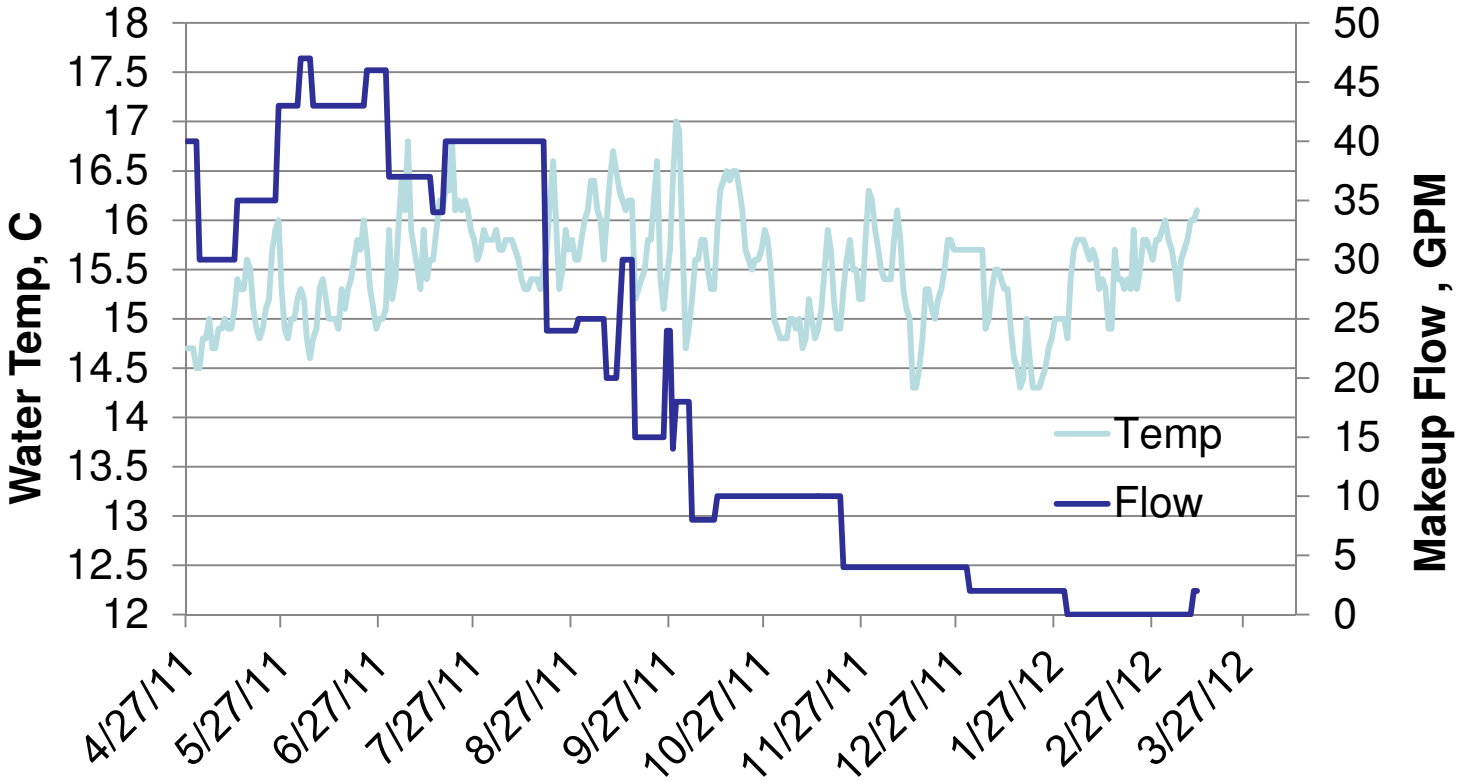
# Closed-Containment System

- 150 $m^3$ Culture Tank Volume
  - 4900 L/min recirc flow
  - 30 min HRT
- 260 $m^3$ System Volume
  - 12 to 140 L/min make up water flowrate
  - 15 to 1.3 day HRT
  - 99.8 to 97.2% flow reuse

High flushing rate to keep water ≤ 16.5˚C in summer

# Water Temperature Control

- Makeup water flow was adjusted to maintain water temperature at 14.5-16.5°C



# Grow-Out Trial Results: Water Quality

- Mean Water Quality in Culture Tank
  - Temperature 15.5˚C
  - Dissolved Oxygen 10.9 mg/L
  - Dissolved Carbon Dioxide 9.4 mg/L
  - Total Ammonia Nitrogen 0.11 mg/L
  - Nitrite Nitrogen 0.01 mg/L
  - Nitrate Nitrogen 20 mg/L
  - Total Suspended Solids 1.3 mg/L
  - Total Phosphorus 0.8 mg/L

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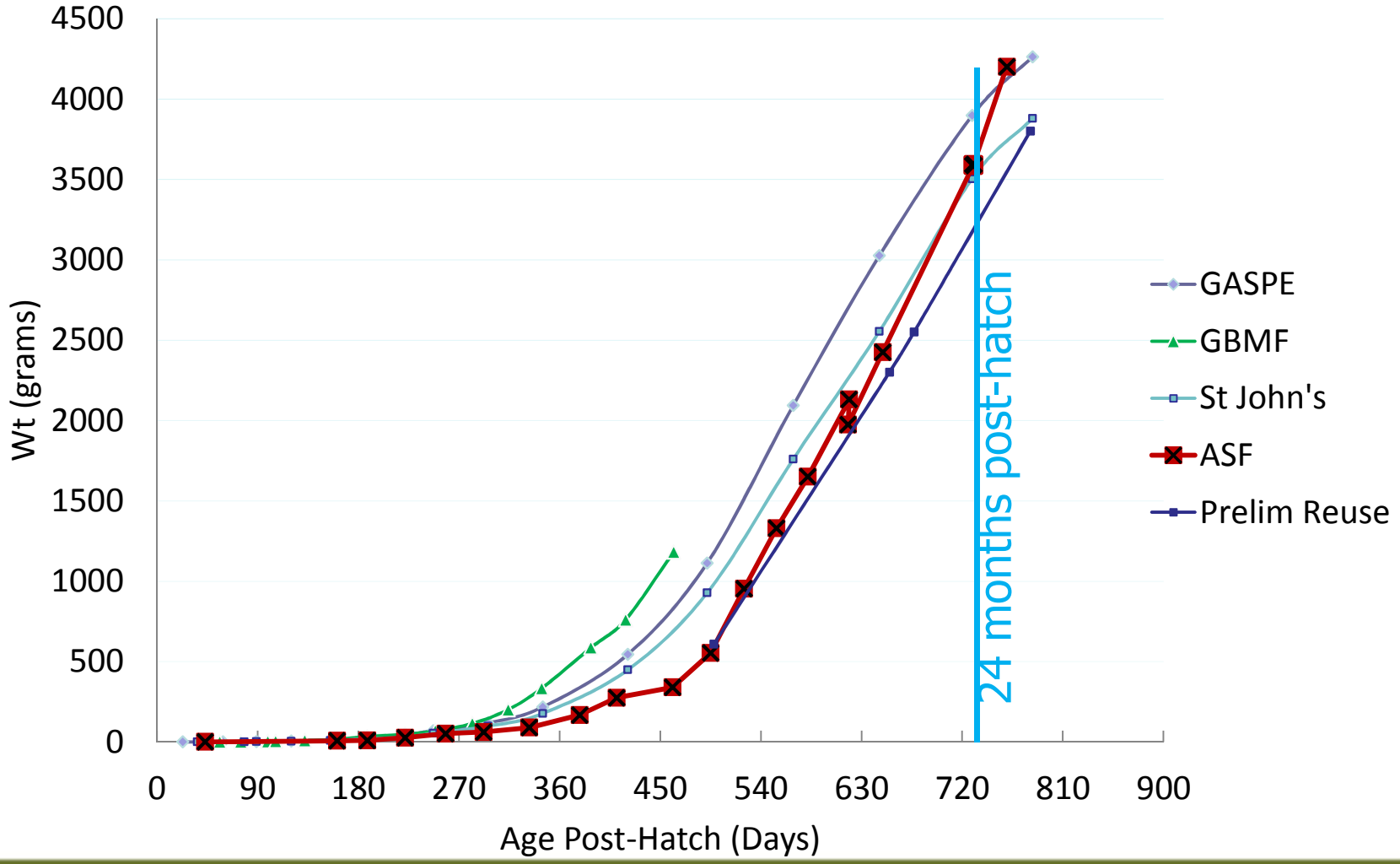
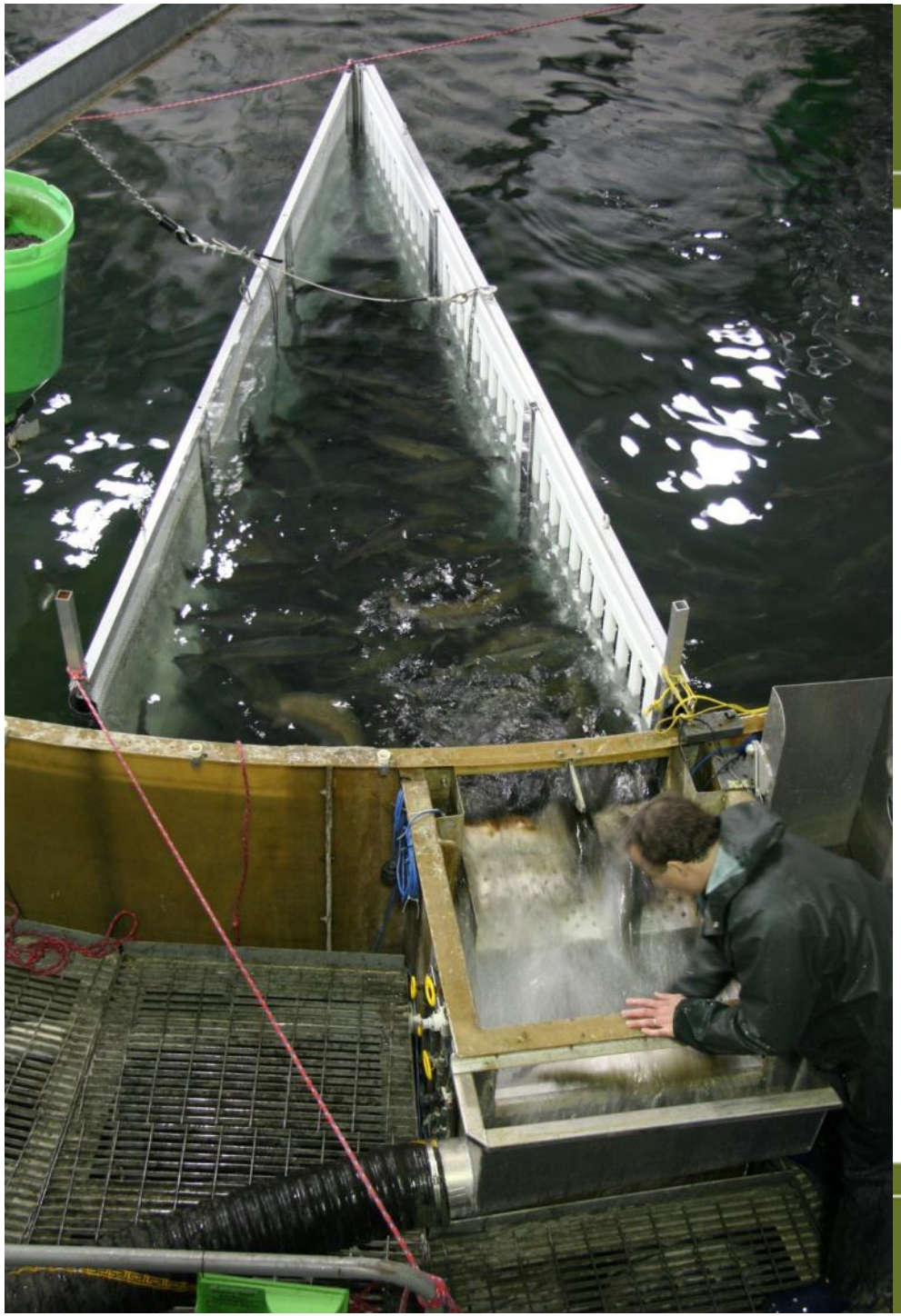
# Combined Results of All Atlantic Salmon Growout Trials at TCFFI




Harvested Males at 2 kg
(Sept 29, 2011)



# Primary Harvests

- Harvested from late February through April, 2012
  - 4 kg mean size
  - ~7 tonne produced = 15,000 pound

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# ASF Grow-Out Trial Results
# St John River Strain

- **Feed Conversion of 1.03 feed : 1.0 gain**
- Commercial diet with 40:30 protein:fat
- 1.7 condition factor (net pen industry is ~1.3)

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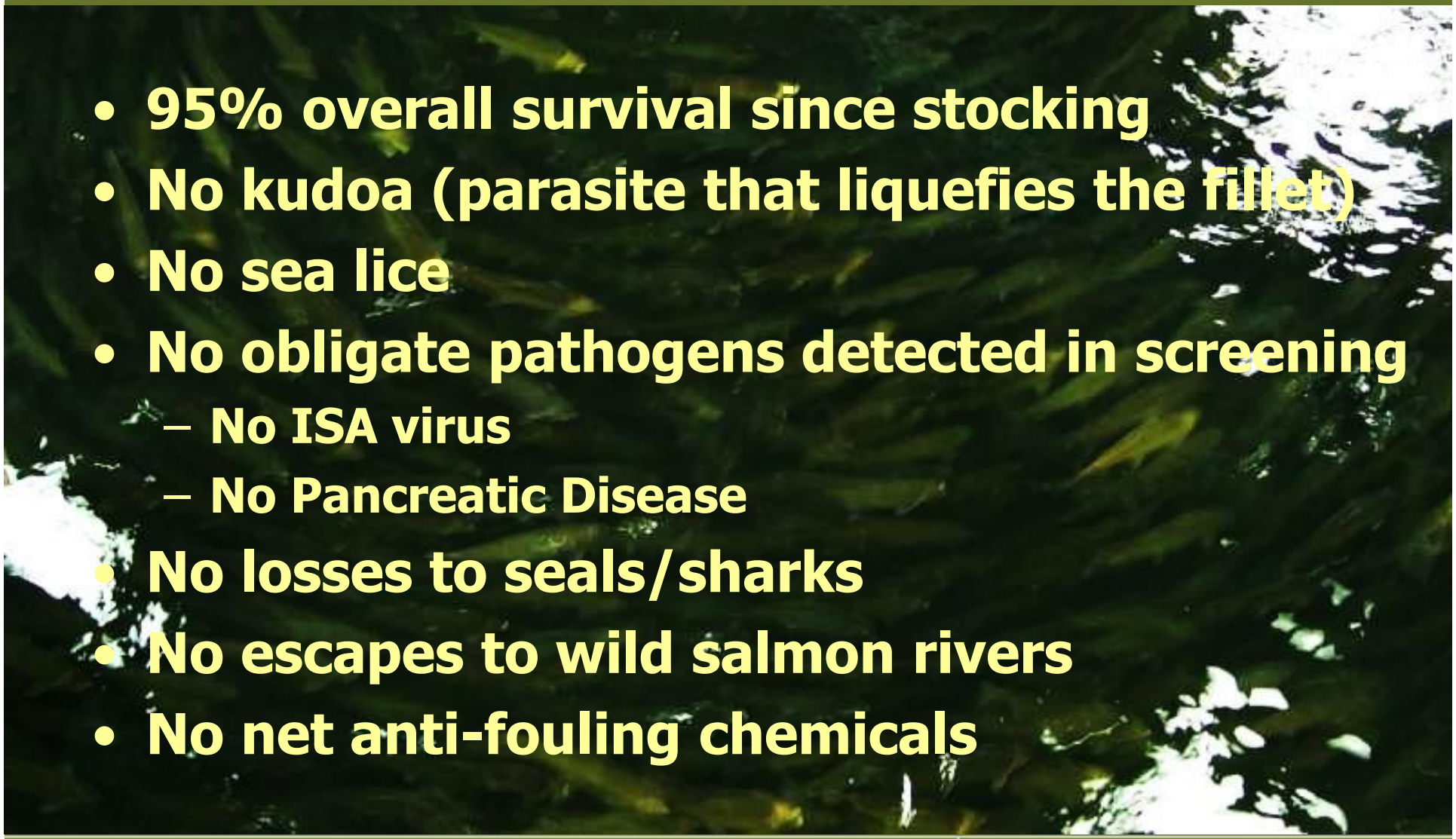
# Grow-Out Trial Results
# St John River Strain



- **95% overall survival since stocking**
- **No kudoa (parasite that liquefies the fillet)**
- **No sea lice**
- **No obligate pathogens detected in screening**
  - **No ISA virus**
  - **No Pancreatic Disease**
- **No losses to seals/sharks**
- **No escapes to wild salmon rivers**
- **No net anti-fouling chemicals**

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# Chemotherapeutics Used in Salmon Growout Trial

- No vaccination (saves $$ & stress)
- No antibiotics or pesticides used at any time
- No formalin used at any time
- Small amount of hydrogen peroxide used in the sac fry and early parr stage for fungus.
- Total salt used to treat fungus: 6100 lbs. during three treatments

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# Escapees

- **No fish observed in 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***)

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# Post-Harvest Slaughter

## Rapid & Humane

- Percussive Stunning
  - MODEL SI-7 (Seafood Innovations)

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# Growout Trial Results: Product Quality

- Good fillet color, lipid content, and flavor

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# Growout Trial Results: Precocious Male Atlantic Salmon

- 75% of male salmon matured early
- 40% of all fish removed as grilse
  - approximately half at 2 kg and half at 4 kg
- Few sexually mature females

Suggests use of an all female salmon or late maturing strain for freshwater growout

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# Moore Foundation Funded Growout Trial

- Atlantic salmon - Cascade Strain
  - eggs purchased from American Gold Seafood
- Jan 2011 – Eyed eggs received
- March 2011 - First feeding
- July-August 2011 – Photoperiod manipulated to S0 smolt
- September 2011 - Moved into advanced nursery system
- March 2012 – Moved into growout system




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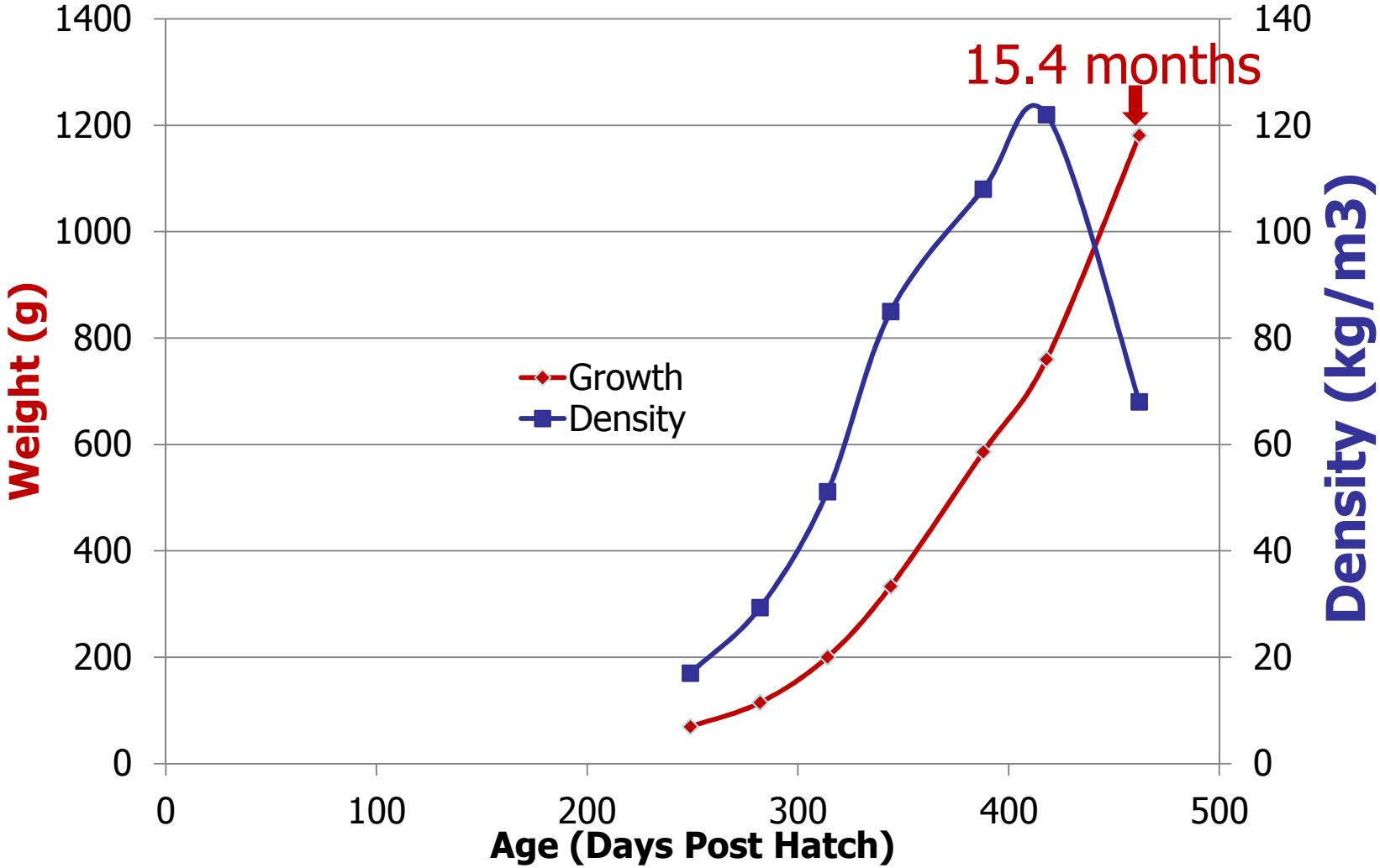
# Results to Date: Cascade Strain Salmon




Mean Thermal Growth Coefficient = 0.24

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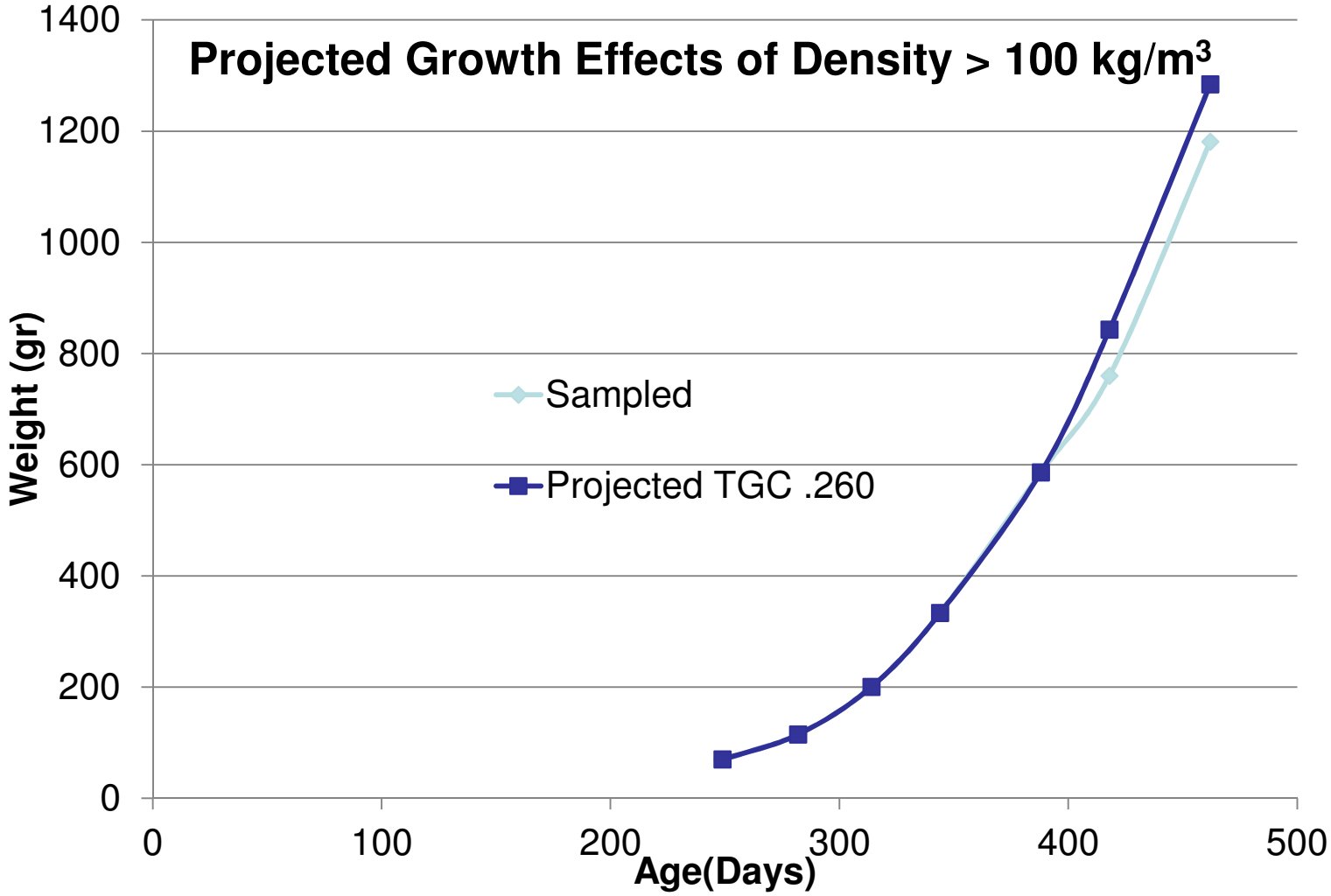
# Results to Date: Cascade Strain Salmon



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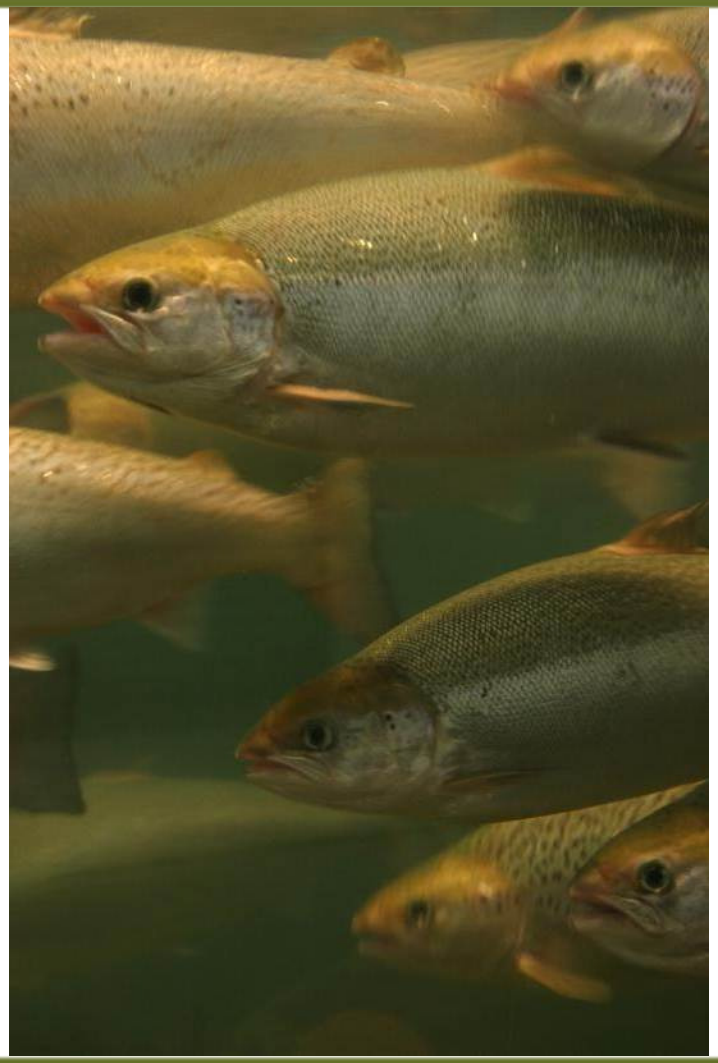
# Results to Date: Cascade Strain

- **Feed conversion of 1.05 feed : 1.0 gain**
- **90% survival from fry stage to present**
- **Good fin condition**
- **No sea lice**
- **Obligate pathogens screening will be conducted before harvest**



# Results to Date: Cascade Strain

- No vaccination (saves $$ & stress)
- No antibiotics or pesticides used at any time
- No formalin used at any time
- Small amount of hydrogen peroxide ($H_2O_2$) used in the sac fry and early parr stage to treat fungus.
- Total salt used to treat fungus: 1460 lbs.

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# CONCLUSIONS: Atlantic Salmon Growout Trial

- Good growth in freshwater
  - Harvest 8-9 months sooner than net pens
- Good survival (94%) and feed conversion (1.05:1)
- Density can reach 100 kg/$m^3$
- Should use all female eggs to avoid precocious males

We don't need seawater to farm Atlantic salmon

# Additional Research Needs

## MINIMIZE EARLY MATURING FISH

- Identify the best seedstock for land-based closed-containment systems
  - All female eggs & triploids
  - Late maturing & rapid growing Norwegian strains
- Identify the optimum photoperiod & temp
  - 18 hr light vs. 24 hr light after smoltification
  - 13˚C vs. 15.5˚C during growout

# Additional Research Needs

- Identify depuration kinetics post harvest & develop SOP's to ensure perfect flavor

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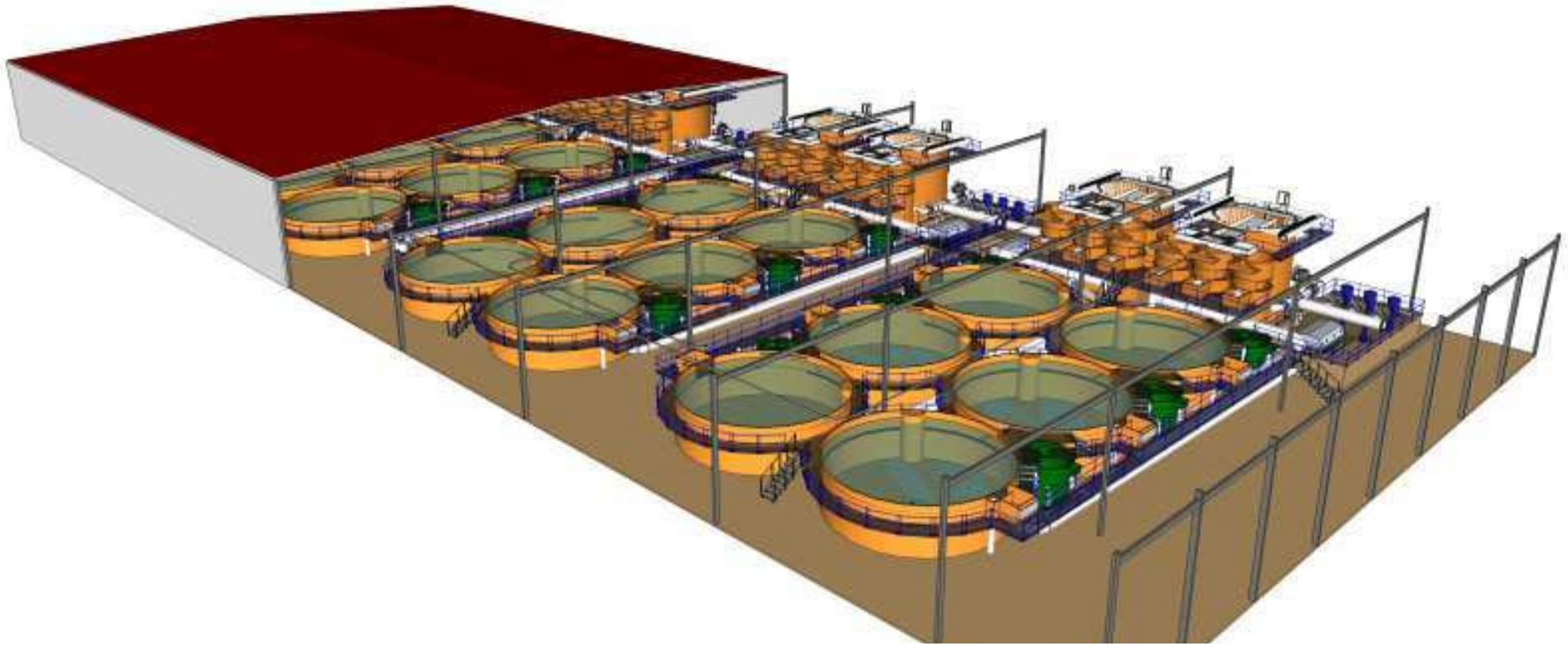
# Additional Research Needs

- Finish economic modeling and develop life cycle assessment for land-based closed-containment salmon farm



# Additional Research Needs

- Evaluate pilot-scale denitrification processes without supplementing carbon
  - $NO_3$ control in low flushing systems
  - Reduce TN discharge
- Scientific research on soy-based (zero-fishmeal) feeds and water treatment processes within land-based closed-containment systems