SCHEDULE CHANGE (earlier Program version was changed):

Day 1: Wednesday, September 4

8:30 – 9:00	**Atlantic Sapphire – Langsand Laks, Denmark, and Virginia, USA** **Thue Holm, Atlantic Sapphire, Denmark (TBD)**

Thue Holm could not attend.
A brief summary of "**Atlantic Sapphire – Langsand Laks**"
will be presented by Bjarne Hald Olsen.

Day 2: Thursday, September 5

4:30 – 5:15	**RAS Design Innovations and Opportunities for New Technologies** **Bjarne Hald Olsen, Billund Aquaculture Service AP, Denmark**

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Updates on Land-Based Closed-Containment Systems For Salmon Growout

Steven Summerfelt

AIW#5, Shepherdstown, WV
September 4-6, 2013

Where We Were in 2011

- 1st Aquaculture Innovation Workshop
  - NCTC, Shepherdstown, WV
  - January 17-18, 2011
  - 33 participants
  - We knew of no commercial land-based closed-containment systems growing salmon to food-size at the time
    - Several projects beginning
    - Later learned of BDV in France

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Programs and Presentations from Previous AIW

- http://tidescanada.org/salmon/aquaculture-innovation-workshops-and-reports/

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Workshops and Reports

In collaboration with the Freshwater Institute and the Gordon and Betty Moore Foundation, Tides Canada also supports a series of aquaculture innovation workshops.

RAS Producers Workshop

Richmond, British Columbia
April 22 and 23, 2013

+ Program and Attendees List

+ Presentations

Aquaculture Innovation Workshop No. 4

Comox, British Columbia
November 5 and 6, 2012

+ Program and Attendees List

+ Presentations

Aquaculture Innovation Workshop No. 3

Seattle, Washington
May 15 and 16, 2012

+ Program and Attendees List

+ Presentations

Aquaculture Innovation Workshop No. 2

Campbell River, British Columbia
September 26 and 27, 2011

+ Presentations

Aquaculture Innovation Workshop No. 4

Comox, British Columbia
November 5 and 6, 2012

+ Program and Attendees List

− Presentations

- Progress Update on Two Atlantic Salmon Grow-out Trials in Freshwater Closed Containment Systems
  Steven Summerfelt, TCFFI
- Depuration and Slaughter Techniques to Optimize Atlantic Salmon Product Quality from Land-Based Closed Containment Systems Study
  John Davidson, TCFFI
- Studies on Long-Term Carbon Dioxide Exposure During Salmonid Grow-Out in Water Recirculation Aquaculture Systems
  Christopher Good, TCFFI
- UBC InSEAS Research Program to Determine Optimal Conditions for Fish Rearing
  Colin Brauner, UBC
- 'Namgis First Nation's Land Based Atlantic Salmon RAS Project
  Garry Ullstrom, K'udas Limited Partnership
- Sustainable Blue
  Jeremy Lee, Sustainable Blue
- Coho Salmon Production Systems at Aquaseed's SweetSpring Salmon in Washington
  Jim Terry, SweetSpring Salmon
- Atlantic Sapphire – Langsand Laks, Denmark, and Virginia, USA
  Thue Holm, Atlantic Sapphire
- Atlantic Salmon in RAS in Norway
  Frode Mathisen, Greig Seafood Ltd.
- Environmental Performance of a 3,300 mt Land Based Salmon Farm
  Brian Vinci, TCFFI
- Use of Single-Sex and Triploid Stocks to Eliminate Early Maturation of Atlantic Salmon
  Tillmann Benfey, University of New Brunswick
- Breeding Atlantic Salmon for Rapid Growth and Late Maturation and the Potential to Produce all Female Salmon Eggs
  Thoralf Solberg, SalmoBreed AS
- Strategies for Significant Heat Loss Reduction in RAS systems Using Modern Energy Recovery Equipment
  Andrew Wright, SOS Marine Conservation Foundation
- Process Modelling and Energy Optimization in RAS Design
  Karl Williaume, WorleyParsons
- Creating Value from the Waste Stream – Sustainable Aquaculture and Bioproducts Production
  David Brune, University of Missouri
- Developments in Sustainable Ingredients for Aquaculture Feed
  Jason Mann, Ewos
- Canada's Organic Standards
  Justin Henry, Target Marine

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Updates (Sept 2013)

- **North America** potential projects for salmon growout in land-based closed containment systems:
  - Canada 6 projects (**2 in oper**; 5+ planned)
  - U.S. 6 projects (3 built; 3+ planned)
- **Europe**
  - Denmark 2 project (**2 in operation**)
  - Scotland/Ireland 2 projects (2 planned)
  - France 2 projects (**1 in oper**; 1 planned)
- **China** (**2 in operation**, several planned)
- **Chile** (2 planned)

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‘Namgis First Nation Land-Based Salmon Farm, Port McNeill, BC

- 300-500 tonne/yr initial module
- Stocked with first smolt this spring

Chief Bill Cranmer, ‘Namgis First Nation;
Eric Hobson, SOS; Jackie Hildering, SOS

AIW#5, Shepherdstown, WV
September 4-6, 2013

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Sustainable Blue, Centre Burlington, Nova Scotia

- 100+ tonne/yr initial module
- Stocked with smolt this summer

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Sweetspring Salmon, Rochester, WA

- 100+ tonne/yr module
- Coho salmon

Jim Terry, Per Heggelund, Chris DePalma, Sweetspring Salmon

AIW#5, Shepherdstown, WV
September 4-6, 2013

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Teton Fisheries LLC and Hill Fisheries LLC, Montana

- Both targeted 100+ ton/yr Coho salmon production

Miller Colony pulls plug on commercial salmon farm

By Nancy Thornton
Acantha reporter

The Miller Hutterite Colony recently shut down what had been the first private, commercial salmon farm in the state that opened in December 2010.

A sister colony in Havre has also ceased raising salmon in a similar facility that used cutting-edge filtration technology to recirculate 99 percent of the groundwater used in the fish tanks.

David Wipf, Miller Colony's spokesman and secretary/treasurer, confirmed on Jan. 24 that the colony had "pulled the plug" on raising coho salmon, but he declined to give any details at this time on the advice of the colony's attorney.

The special fish eggs took a year to grow and the new business, labeled Teton Fisheries L.L.C., which the colony created with several unnamed partners, shipped its first cases of fresh head-on, gill-in gutted fish on Feb. 3, 2012.

At that time, Wipf said that the plan was to raise salmon to a premium weight of 6.6 pounds, however, the harvested fish were smaller than projections, reaching just four pounds on average.

It shipped the salmon in 50-pound cases to its West Coast partner/distributor for sale under the label, SweetSpring Salmon.

More than three years ago, after it suspended pig farming (Midway Colony south of Conrad continues that enterprise), Miller Colony began researching other agricultural businesses that would provide income, Wipf said in the earlier interview. Envirotech Ag Systems of Winnipeg, Manitoba, introduced the Miller Colony research team to AquaSeed Corp. of Rochester, Wash., a global leader of Pacific salmon conservation and a supplier of domesticated Pacific salmon seedstocks to salmon farms worldwide.

SweetSpring Salmon, an affiliate of AquaSeed, had begun limited distribution to food markets of the cultivated salmon in the Pacific Northwest, and during that time, the colony's research team began talks with AquaSeed about the possibility of developing a freshwater salmon farm in Montana.

SweetSpring Salmon, in turn, contracted with the Overwaitea Food Group for the estimated production from the two colonies and one in Rochester.

Miller Colony's new venture required approval of the state that licenses controlled species. The salmon could not be shipped live, for example, a measure to protect native fish populations in the event of an escape.

Last week, telephone and e-mail messages from the Acantha to AquaSeed, SweetSpring and Envirotech were not returned.

John Holder of JLH Consulting Inc. and Holder Timmons Engineering L.L.C., who helped develop the recirculation system, said he could not comment on he deemed an "unfortunate" matter except to say that the system worked and there were no problems with water quality.

In a discussion paper dated February 2012, available on the Web, SweetSpring noted it had received $1.6 million in grants to facilitate farm-raised salmon production from its three partner farms. It listed the capacity of the Choteau and Havre units as 300,000 pounds of fish each.

The purpose of the private grants was to demonstrate the technical and financial feasibility of on-land closed containment aquaculture technology.

The February 2012 document estimated that a facility producing between 200,000 and 400,000 pounds of fish might have between $998,000 and $1,594,000 in net operating expenses, but still have between a 15.9 percent and a 32.4 percent profit, respectively.

John G. Nickum, a retired biologist who has extensive knowledge of aquaculture and who wrote an in-depth article about the colony/SweetSpring partnership, available on the Web, said he would be very interested to know what happened, whether the suspension had to do with a nutrition issue or a question of technology or contract terms.

With the suspension of fish-raising, Miller Colony will be repurposing its large metal salmon-raising building on the south end of the main complex located south of Bynum along U.S. Highway 89.

Teton County Sanitarian Corrine Rose, who learned about the closure on Jan. 15, said, "I was pleased to have it in the county. I had high hopes."

Choteau Acantha, Jan. 30, 2013

stown, WV
, 2013

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Langsand Laks- Atlantic Sapphire Hvide Sande, Denmark

- 1000 tonne/yr Atlantic salmon (16 m ϕ x 6 m deep culture tanks)
  - First harvest of salmon August-September, 2013

Photos courtesy Thue Holm

Bjarne Hald Olsen to present on Sept 5

Danish Salmon, Hirtshals, Denmark

- 2000 tonne/yr
- Salmon eggs hatched April 2013

http://sorenfrandsen.wix.com/danishsalmon#!danish-salmon/c1l4l

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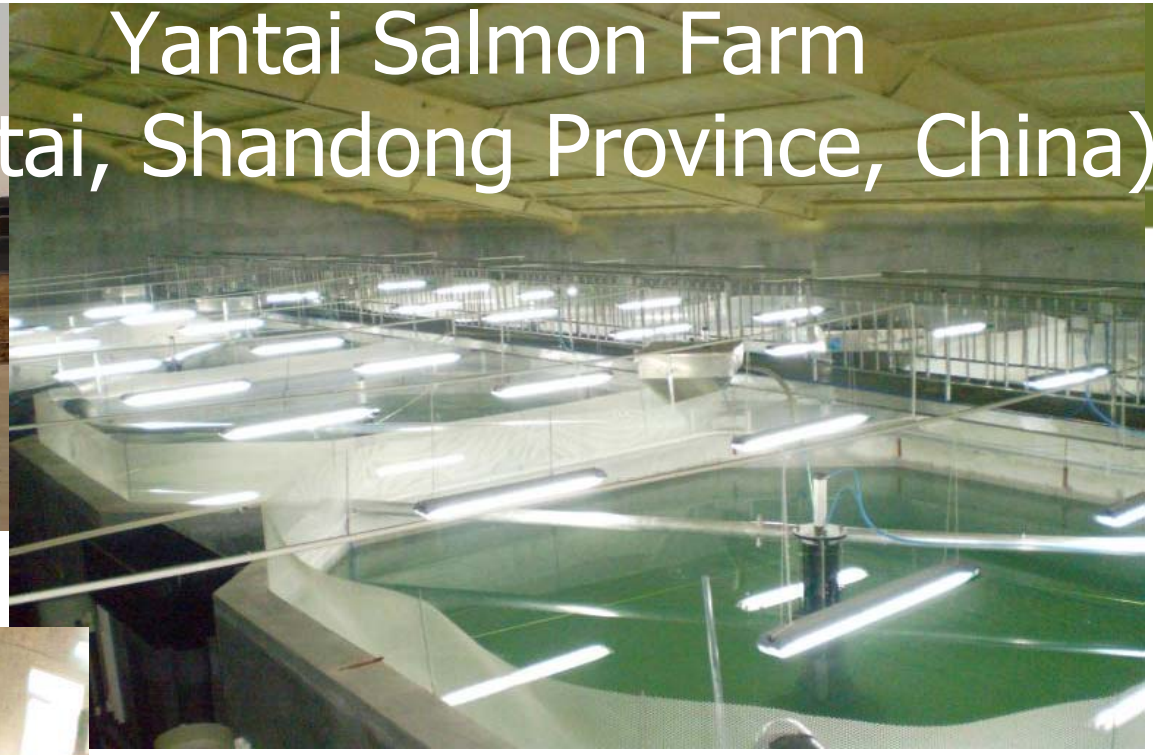
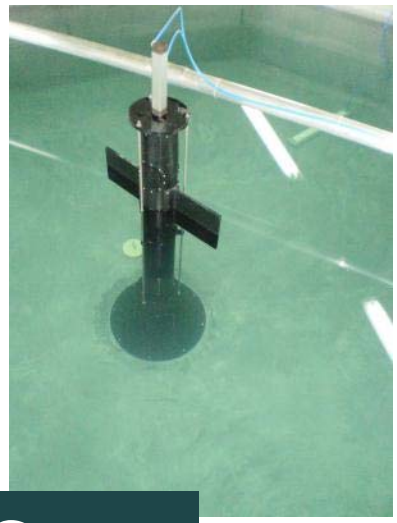
BDV SAS (Normandie, France)

- Already producing Atlantic salmon for several years in 20 ppt salinity

(Photo courtesy of Jonas Langeteig)

Yantai Salmon Farm
(Yantai, Shandong Province, China)





Shandong Oriental Ocean Sci-Tech Co.
(slide courtesy of Idar Schei, AquaOptima)

Yantai Salmon Farm

- Now producing over 100 tonne/yr Atlantic salmon with plans to expand
  - *See article by Mark Godfrey, SeafoodSource contributing editor reporting from Beijing, China*, 01 August, 2013

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Xinjiang E'he Construction and Investment Company, China

- 1000 tonne/yr Atlantic salmon growout farm in the Gobi Desert (finishing constr.)

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Danes build salmon farm in Gobi desert

August 23, 2013, 8:05 am

Undercurrent News

A Danish company is establishing a recirculation farm to grow salmon in the unlikeliest of places, the middle of China's Gobi desert.

In association with a Chinese state-owned water supply company, Billund Aquakultur Service is setting up a recirculation plant in the northwest of the desert, close to the border with Mongolia, said the company in a press

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Marine Harvest Norway's Molnes Post-Smolt Farm

- 20,000 m^3 floating FRP tank in single-pass
  - 40 m ϕ x 16 m deep
  - Near Skanevik, Norway
  - Scientific team to evaluate

Farms Preparing To Producing Salmon in Land-Based Systems

- A number of other salmon and trout farms are in the design or financing stage
  - several are participating in AIW#5
- Many of the RAS suppliers at this meeting are involved in such projects, e.g.,
  - AquaCulture Enterprises
  - Billund Aquaculture Service
  - Inter Aqua Advance
  - Krüger Kaldnes
  - Pentair Aquatics
  - PRAqua Supplies/In-Situ

Conclusions – Land Based Salmon Growout

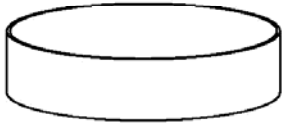
- Recent experience suggests:
  - **technically** viable
  - **biologically** feasible, and
  - **economically** sustainable
    - at 3000 tonne/yr
    - more commercial validation required
- Confidence in technology is increasing
- Scale of investment has increased to $5-30 million per project (& larger investments)

Economy of Scale

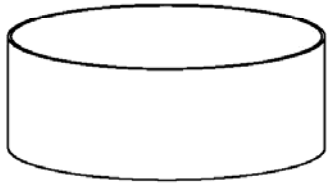
- Existing salmon production tank scale

TCFFI
150 m^3
9.2m ϕ
x 2.4m

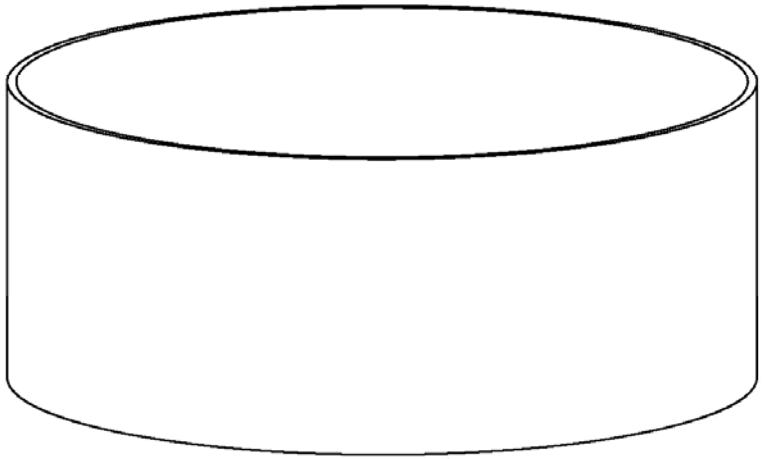
'Namgis
500 m^3
14.6m ϕ x
3.3m



Langsand Laks
1050 m^3
17m ϕ
x 5.5m



Marine Harvest Molnes
20,000 m^3
40m ϕ x 16m



Land-Based Economy of Scale

- Maybe 6,000-10,000 m^3 growout volume required for 1000 tonnes annual production
  - approximation with many variables
- Carrying capacity is controlled by water flow, i.e., tank hydraulic retention time
  - Most RAS use 30 to 60 min culture tank HRT
  - 30 min better than 60 min HRT for water quality
  - 60 min much cheaper than 30 min HRT
    - savings in fixed and variable costs

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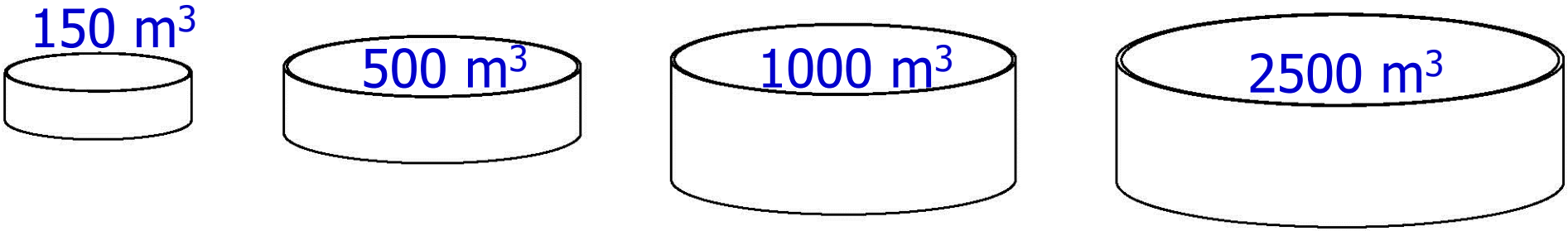
Land-Based Economy of Scale

- Assuming 7500 m^3 growout volume produces 1000 tonnes/yr with 45 min HRT

Tanks Size	150 m^3	500 m^3	1000 m^3	2500 m^3
Growout Tanks, #	**50**	**15**	**8**	**3**
Recycle Flow, m3/min	167	167	167	167
Recycle Flow, gal/min	44,000	44,000	44,000	44,000

- Economies of scale can be achieved with larger tanks & larger <u>central</u> water treatment



Economy of Scale

- Economy of scale w/ fewer but larger tanks:
  - Smaller building footprint for same production (+)
  - Fewer tanks, control systems, feeders, pipe runs, etc. to meet production goals (+)
  - Fewer tanks to isolate cohorts in bioplan (-)
  - Hydrodynamic limitations with large tank size ??

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Discussion of Economies of Scale

- How to achieve economies of scale and
  - Bioplan, multiple cohorts, weekly harvests
  - Biosecurity