

# PROGRESS REPORT

## YEAR ONE OF OPERATIONS

Presented by Bill Cranmer, Director and Garry Ullstrom, CEO  
2014 October 27



I'm Bill Cranmer, former elected Chief of the 'Namgis First Nation.

I'm a director on the board of Kuterra, which is 100% owned by the 'Namgis.

# KUTERRA



## Land Raised Atlantic Salmon Farm



Our village is in Alert Bay on Cormorant Island.

The Kuterra farm is on Northern Vancouver Island, just outside Port McNeill, within 'Namgis ancestral lands.

# Why we're doing this



We decided to build a pilot, land-based RAS system for growing Atlantic salmon because:

We're concerned about the effects of open net-pen salmon farming on wild salmon. Salmon are at the heart of our culture, and what we pass on to our children centres on salmon.

We had heard that it should be possible to grow Atlantic salmon on land in closed containment facilities. We got tired of waiting for someone else to do it. It was important enough to us to take on the challenge.

And that challenge is to assess the technical, biological and economic feasibility of this kind of operation.

# Who is involved



Project  
partners



Lead  
funders



Advisors



Marketing  
partner



We 'Namgis believe that progress comes through partnerships. And Kuterra has benefitted from many different kinds of partnerships.

I'd like to thank all of the organizations here, and many individuals who have contributed ideas, energy, time and money to help our project succeed.

We must all work together in order to protect our lands and waters for our children and grandchildren.

And we have to provide meaningful employment that is consistent with our culture and our values.

I'd now like to introduce Garry Ullstrom, Kuterra's CEO. He'll report on what we've achieved and learned from the project to date.

# Our mission



ASSESS  
technical, biological, economic feasibility  
of land-raised Atlantic salmon  
for the consumer market.



Our vision was to build the first land-based RAS Atlantic salmon farm in North America that is specifically designed to produce Atlantic salmon for sale to consumers.

Our mission is to assess its technical, biological and economic feasibility.

We have an obligation, and a very real desire, to share what we learn and so today's presentation will bring you up to date as to where we're at.

We recently completed the harvest of our first cohort. We have another four cohorts of fish in the system in various stages of growth.

Most of what we'll be talking about is what we learned from growing, harvesting, and selling that first cohort.

# The snapshot



- Facility overview
- Stages and milestones
- Technical challenges
- Biological results
- Economic results
- Environmental results
- Key findings
- Biggest challenge
- Next steps



These are the areas I'll cover today.

Photo: The arrival of the first cohort of fish in March 2013.



# KUTERRA from overhead



## **Bird's eye view**

The yellow line shows the land available to us.

It was a greenfield site.

What you see now is our first module and the gravel infiltration basins for the discharged water.

The site has room for four more modules, which would boost production from 470 tonnes per year to more than 2,000.

# KUTERRA outside



This is module one from the ground. It's contained in a steelclad building.



# KUTERRA inside

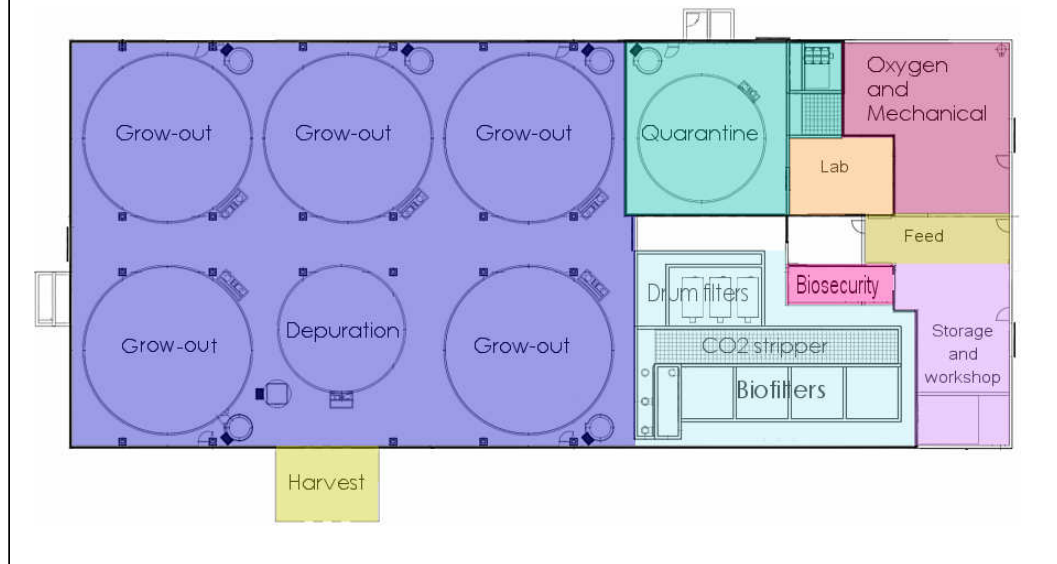


Growout tanks    Depuration tank    Grading table  
Biofilter    CO<sub>2</sub> stripper    Drum filters    Fish pump    Quarantine



The main elements.

# Module one



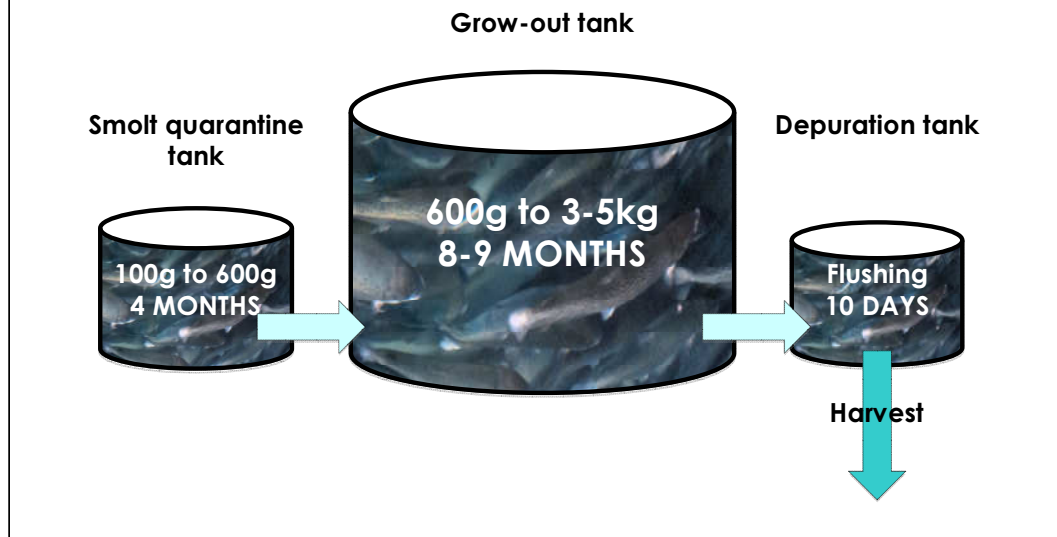
Another look at the main elements.

When the smolts arrive they're put in the quarantine unit.

When they've grown enough they're pumped into two grow-out tanks.

When they're ready to harvest the go into the depuration tank for flushing.

# Production flow



Timing and movement of fish as shown.

The 10 days in depuration is in fresh, non-recirculated water.

Continual harvest every two weeks.

# Harvest

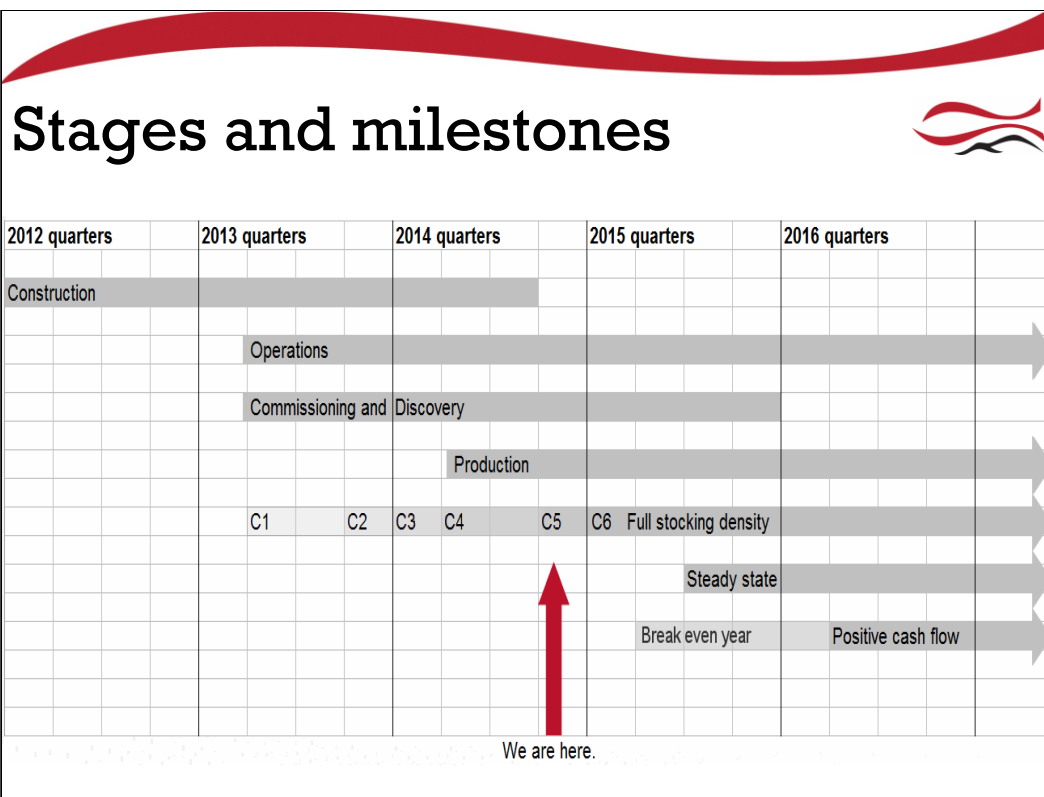


Fish are pumped from the purge tank and before you can say “fresh fish” they are sliding across this table, where they are directed into a stun and bleed machine and then they drop into an ice filled tote.

The journey from tank to tote is 30-40 seconds.

So the harvest process is quick, smooth and humane.

This contributes to the freshness, flesh quality, and long shelf-life of Kuterra salmon.



At a glance, here's a snapshot of where we're at and where we're going in terms of proving out the assumptions in our business model.

**Construction** was mainly front-ended, but as recently as this summer we installed an ozone system and a LOX tank.

**Operations** started with the arrival of the first cohort in March 2013. They arrived nine months before the heating system was finished.

We're still in the **Commissioning and Discovery** stage. That just means is that we're still taming the technology.

We define **Commissioning** tasks as those built into our plan, such as ramping up stocking density. **Discovery** tasks are shake-down issues, which we all know come with a new startup, but which are not identifiable specifically in advance.

**Production** is when we started harvesting the first cohort of fish in April of this year.

C1 is the first cohort, at just 23-thousand fish. Cohort 2 is 33,000 fish and cohort 3 and all future cohorts are 40,000 fish.

Full **stocking density** at 90kg/m<sup>3</sup> will be reached in February, 2015. That's a significant milestone because that's when the systems will be pushed to their limits and we'll see how well they perform.

By the time we reach full density we also expect to have addressed almost all of the technical issues.

Between the full density and addressing technical issues, we expect to be at **steady state** early to mid-2015.

We expect to reach the **break-even** point in the next fiscal year and positive **cash flow** in the following year.

# Commissioning and discovery



PROBLEM	IMPACT	ACTION	STATUS
defective axial flow pumps	low water flow, restricted feed	replaced pumps	resolved
fluctuating automatic flow control	low water flow, restricted feed	adjusted automation	resolved
insufficient centre drain flow	low water flow, restricted feed	modified plumbing	resolved
defective in-tank mort removal	high C1 (Cohort 1) mortality	adjusted system	resolved
feeder overfeeding	high FCR, waste feed, turbidity	adjusted software	resolved
large pellets not eaten	waste feed, turbidity, pushing limits of drum filter	stopped 12 mm pellets	resolved
fecal pellets soft, unconsolidated	turbidity, more work for drum filters	changed feed formulation	resolved
biofilters not fully fluidizing	Increased turbidity contributing to high FCR and fungal outbreaks, more flow to biofilters and less to tanks, higher in-tank peak CO2	extra holes drilled in biofilter manifolds and dropdowns added	resolved
bacterial load in water	high CO2 concentration, slowed fish growth, turbidity	reduced waste feed, modified biofilters	resolved
too low in-tank light placement	fish move to surface, waste feed, tank self-cleaning reduced	adjusted light placement	resolved
fish pump breakdown	unable to harvest or move fish	pump modified	resolved
manual grading process hard on fish above 2 kg	mortalities, fish off their feed for several weeks	modified grading equipment and process to streamline and minimize handling	resolved
low-head oxygenators low efficiency, instability from fluctuating O2 demand	higher energy costs, biofilter inefficiency and turbidity	LHOs modified	resolved
fish consuming more O2 than expected	higher energy costs	LHOs modified, installed LOX	resolved
off-flavour	reduced product quality	identified optimal parameters for tank cleaning, flushing duration	resolved
underperforming O2 generator	higher energy costs	repaired generator	resolved
higher than expected in-tank CO2 production	slowed fish growth	trialled supplemental CO2 removal options, increased venting	comparing and evaluating options
fluctuating hydro power supply	equipment damage, time responding to alarms	installing power analyzer, then conditioner	being implemented
lack of accurate biomass measurement	uncertainty in inventory, fish and facility performance	will trial new biomass measurement system	being implemented
changing light regime put fish off feed and simulated natural photoperiod	high FCR, waste feed, turbidity, higher peak CO2 concentration, small feeding window limiting rations, slowed fish growth	adjusted photoperiod and feed rates	ongoing trials
compressed metabolic peaks	high mortality, lowered temp, stress slowed growth, added cost of salt	added salt, developed fungal strategies, drilled new higher salinity well, designed own hatchery	decreasing fungal mortality
smolt fungal infections	high mortality, lowered temp, stress slowed growth, added cost of salt	early maturation strategy: GSI & melatonin tests, temperature drop, change light & feed regimes, shorter harvest period, sex & strain investigation	improving trend
early maturation	reduced fish performance, 25% non-premium fish, reduced revenues, accentuated by long harvest period		

These are some of the issues we've encountered. The points I'd like to make are that ...

- This table represents many hours of hard work by our whole crew, and much ingenuity in diagnosing problems, identifying solutions and implementing them, all the while, keeping the fish alive and growing.
- And as you can see in the final column, most of the issues have been resolved.
- For the issues we're still working on, we've developed strategies that we're implementing.

See next page for detailed view.



# Commissioning and discovery



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# Taming the technology



Here's an example of one type of problem we had to deal with.

This nice looking **fish pump** comes from a supplier that builds lots of fish pumps. But our set up was slightly different, so after nine uses, there was a big bang; the aluminum housing bent out of shape and water started squirting everywhere.

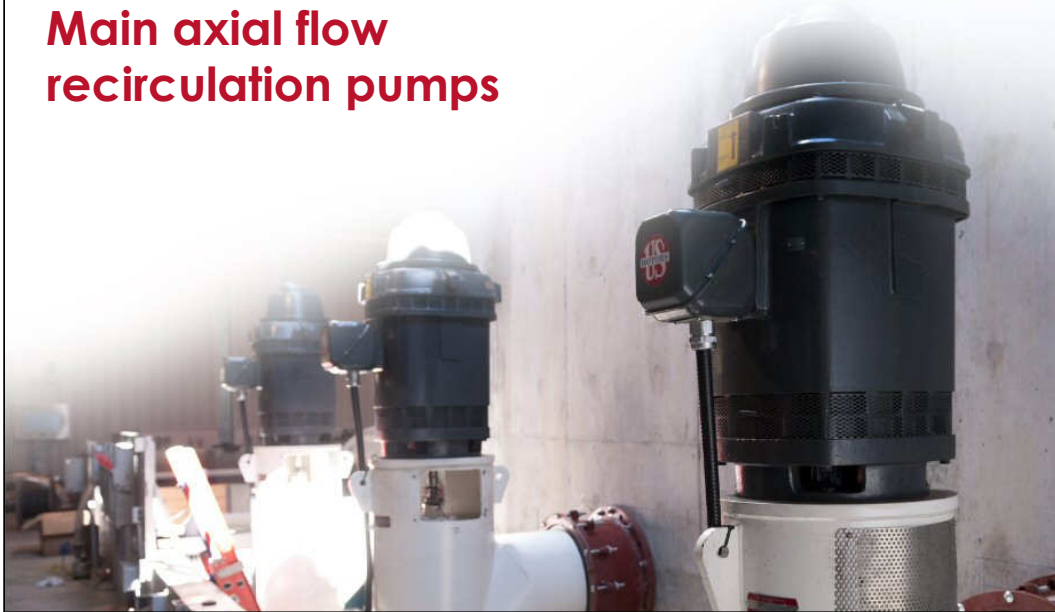
Here's the modified pump. Looks like an octopus now but at least it works properly.

Fixing the pump was pretty straightforward. It was a big hassle for us operationally but the supplier knew right away what they had to do to fix the problem. We just had to get the pump down to their factory in Idaho, and back in time for our next harvest.

# Technical challenges



## Main axial flow recirculation pumps



Another example relates to the **main axial flow recirculation pumps**. They are the heart of the operation because they pump the water throughout the system.

We quickly discovered that the pumps we had before these ones shown weren't pumping to their specifications. We had to send them back and order new pumps from a different supplier. This had a long lead time and caused havoc with our growout commissioning schedule.

And to be clear, what you see here are the good pumps that we ended up buying.

# Technical challenges



## Oxygen generators



**Oxygen generators.** We tested them and found they were not producing the amount of oxygen they were supposed to.

The fish pump, water pumps, and O<sub>2</sub> generators are all mature technologies, so it was very disappointing and frustrating to have these issues with them.

# Technical challenges



## Biofilters (Fluidized Sand Bed)



**Biofilters (FSB).** These were the biggest biofilters our engineers had ever designed and there was inadequate fluidization in parts of the biofilter which contributed to murky water.

Until we figured out the problem and fixed it we had to increase flow to the biofilter to adequately fluidize the sand, which reduced the flow to the tanks, which affected water quality (CO<sub>2</sub>, O<sub>2</sub>, self-cleaning, etc.).

These are the knock-on effects you get when you have a problem in a system of many interlocking pieces. This issue is now resolved.



# Technical challenges



## Low-head oxygenators



**Low Head Oxygenators.** We discovered the LHO's were operating at efficiencies as low as 30% and it took months of diagnostic testing to isolate the main problem, which turned out to be a manufacturing defect.

This was recently fixed and they now operate at about 75% efficiency at design flows.



# Technical challenges



## High in-tank CO<sub>2</sub> levels



**High in-tank CO<sub>2</sub> levels.** We found that the fish produced more CO<sub>2</sub> in the tanks than expected and that the centralized CO<sub>2</sub> stripper was not adequate.

So we are evaluating three different standalone tank CO<sub>2</sub> stripping options. These units are either in the tank; bolt onto the tank, or stand beside the tank.

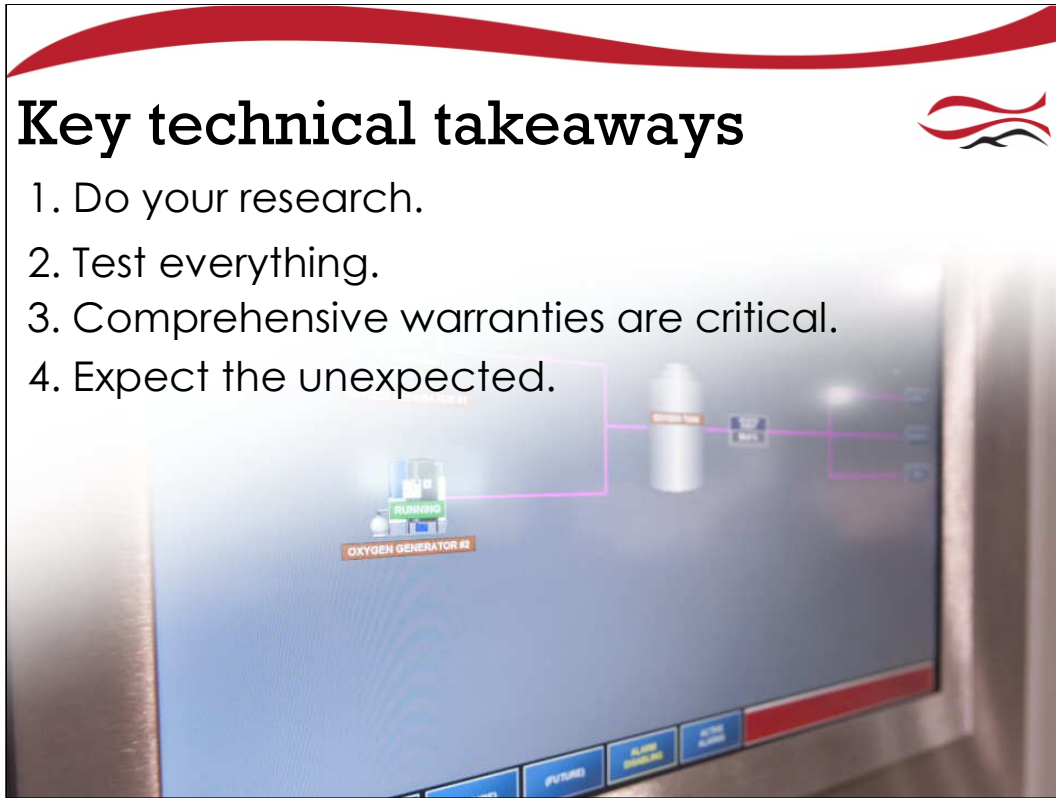
This is our biggest remaining technical issue.

These items are meant to give you a feel for the kinds of technical challenges Cathal and his team had to overcome. Tides Canada may fund the writing of a “Commissioning Retrospective” that would list and explain in more detail the entire list of significant commissioning issues.

# Key technical takeaways



1. Do your research.
2. Test everything.
3. Comprehensive warranties are critical.
4. Expect the unexpected.



**1. Do your research.** These days there are several commercial scale RAS Atlantic salmon farms in the world, and they use somewhat different technologies and designs. It's going to be important to assess the strengths and weaknesses of each system before selecting a design and primary supplier.

**2. Test everything!** Even mature technologies may perform below spec.

**3. A comprehensive warranty is critical.** It's critically important to have a comprehensive warranty that includes equipment performance specifications and system specifications in place. For example, the warranty might state that the LHOs will operate at **X%** efficiency at certain flow rates, and the system as a whole will deliver enough oxygen to sustain fish at 90kg/m<sup>3</sup> density. In our case, we had a good warranty and a good working relationship with our primary supplier and design firm PR Aqua. They've worked closely with our staff in a very professional, structured, methodical way to diagnose problems and to come up with appropriate solutions.

**4. Expect the unexpected.** Budget time and financial resources accordingly. Obviously there is a cost to being first and we are happy to have you learn on our nickel. Our goal is to reduce the risks for new entrants into this industry by sharing what we've learned.

Getting back to our mission, we're pleased to report that obviously it is technically possible to grow Atlantic salmon to harvest size in a commercial sized RAS system.

# Biological factors



## The commissioning cohort



The commissioning cohort really were tough fish. They were subjected to:

- murky water
- poor water flow
- feeding anomalies
- no heating
- system malfunctions ... and as you've seen, the list goes on.

But the fish survived. And they were harvested, and sold. 75% of them were premium quality.

# Biological results



COHORT 1 METRICS	Target	Actual
FCRb	1.05	1.25
Density – quarantine	60 kg/m3	62 kg/m3
Density – grow-out	50 kg/m3	62 kg/m3
Mortality	7 %	24 %

COHORT 1 MORTALITY	24 %
Fungal infections	10 %
Mort removal system	6 %
Culls	3 %
No visible marks	4 %

These are metrics for Cohort 1 from arrival to the end of the harvest.

**FCRb** is poor because:

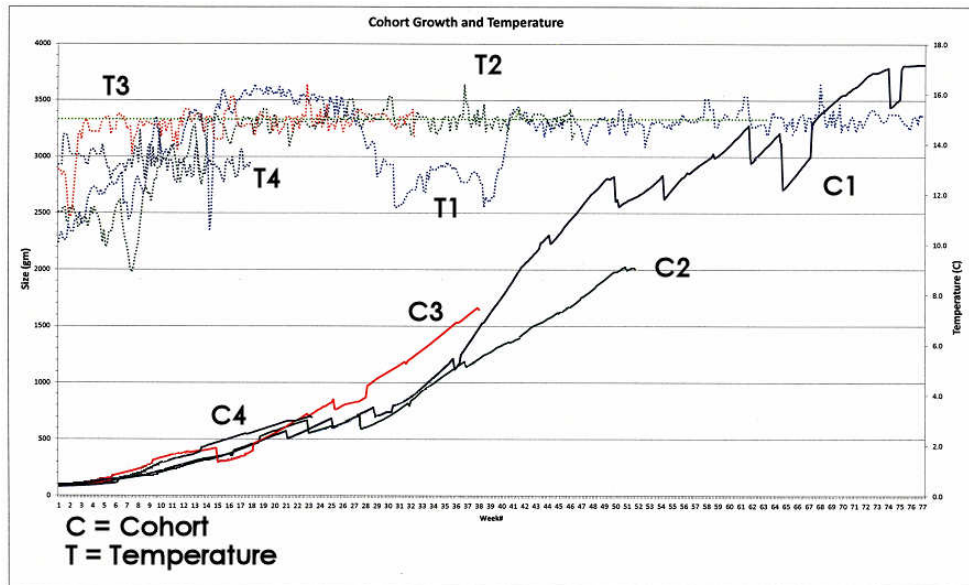
- The cohort 1 fish were at 9-11 degrees C for first nine months. (15-degrees was our target).
- We restricted feed to them due to water quality issues and low pumping capacity.
- At one point the feeder overfed them due to a feeder glitch.
- The main factor was that many of them matured early.

**Density Q** - We held the fish in the quarantine tank for 7 months instead of 4 months because the growout system wasn't ready for fish while we were waiting for the replacement pumps to arrive.

**Density GO** - Our goal was to start density for C1 at 50kg/m3; increase C2 to 75kg/m3 and then to go to 90kg/m3, which is our steady state target.

**Mortalities:** Not surprising – very high, due to fungal infections 10%; mort removal system malfunctioning 6%; culls 3%; No visible marks at 4% means that the fish probably jumped out of the tank or into a post or the side of the tank and bonked themselves. I want to highlight for you that it appears that having a saline/salty water source might be critically important – both for mitigating fungal infections and for actual fish growth. We're very pleased to have learned, just on Friday, that UBC's INSEAS project received NSERC funding, so they'll be able to do multifactoral studies on the impacts of salinity, temperature, etc. on fish growth. So that should really help us answer some of these questions.

# Growth curves



This graph shows **water temperature** and the **growth** of each cohort to date.

**Cohort 1** growth fluctuated greatly with the changing rearing conditions.

**Cohort 2** had steady growth that reflects the improved stability of the system.

**Cohort 3** shows a significant improvement, probably due to the improved water quality.

**Cohort 4** started out better than ever, even though we dropped the temperature to 13 degrees to help reduce early maturation. Growth rate then decreased because we held them longer than desirable in the Q tank in order to finish some CO<sub>2</sub> trials.

Water clarity dramatically improved this summer once the biofilter and overfeeding issues were resolved, so the improvements are to be expected.

The trend is positive. We expect better fish performance data from future cohorts as we continue to learn how to optimize the system.

# Early Maturation



## When fish mature:

- Food energy goes to their reproductive systems.
- Body growth slows dramatically.
- Body shape changes.
- Flesh pales. Skin darkens.
- Flavour changes.

## Result of cohort 1 maturing early:

- Non-premium fish – 25%
- Reduced revenues – 50%/lb

Fish that mature early are often referred to as “grilse.”

I want to ensure that everyone understands what early maturation is and what its impact is.

Early maturation is when the fish decides, at around 2kg in size, to begin maturing sexually.

Slow fish growth hurts FCR and TGC.

Males develop a kype and processing yields dropped as the fish matured. This can significantly decrease revenues.

Premium salmon flesh has a good rich bright colour, and the skin is silver bright.

In Cohort 1, 25% of the fish were downgraded and have been frozen while we work with Albion to develop a value-added product such as smoked salmon.

We estimate that we'll only get half as much for downgraded / pale fillets as we would for premium fillets.

We don't know exactly how much of the first cohort matured early, but it was high. Many of the 75% of premium fish were likely in the early stages of maturation.

We think it was high because the jump in temperature from 11-degrees to 15-degrees may have sent a strong signal to the fish to mature.

Cohort 1 had another, unique, maturity challenge. We slowed its growth deliberately in order to bridge a supply gap that we knew we were going to have between the first two cohorts because there was 7 months between their respective deliveries to the farm. For cohort 1 we almost doubled the harvest period – from 16 weeks to 26 weeks. That gave the fish much more time to mature.

Early maturation is such an important biological issue that we've developed a comprehensive strategy to address it. More on that in the section on Next Steps.



# Premium Atlantic salmon



Here is hereditary Chief Bill Cranmer presenting our first salmon for sale to Safeway's Renee Hopfner at our product launch in April.

This speaks to our original mission to prove biological feasibility.

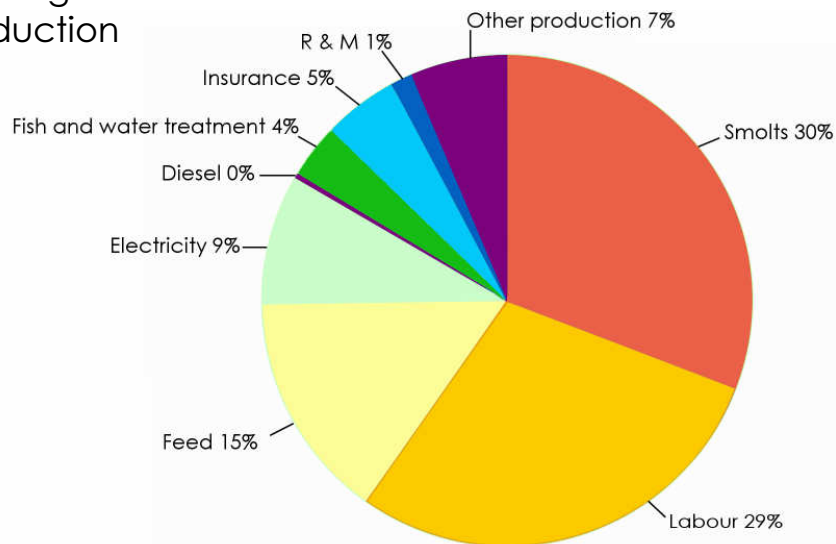
We've clearly shown that it is possible to grow a top quality, premium Atlantic salmon with no antibiotics or pesticides to harvest size in a commercial scale RAS system.

Our focus is now on optimizing fish performance.

# Economics

Start-up year expenses (FY14)

- Commissioning
- Partial production



Here's a snapshot of our costs for the first 12 months after the first cohort arrived.

This cost breakdown is very different from the number in the Freshwater Institute\* presentation this morning about a 3300 tonnes/year facility.

That's because the system and costs in that presentation were at steady state.

The costs here represent a startup year, when you have very few fish in the tanks. That's why feed is only 15% compared to 50% in FWI model.

Labour is skewed by two factors. One is the time spent diagnosing and fixing technical issues, installing and building things and modifying the facility. Another is the time spent recording more than 100 performance metrics as part of our Tides Canada funding.

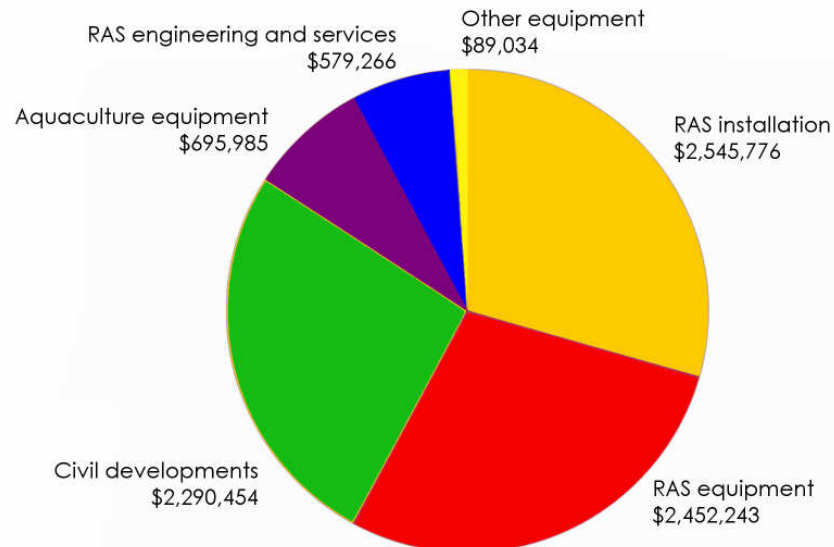
We'll give a great deal more cost information a year from now because our costs will be much more representative of steady state by then.

\* **FWI (Freshwater Institute) presentation at AIW6:** economic model comparing open net-pen and land-based 3,300MT model farms. Available on the Tides Canada website.

# Capital costs



Total to date = \$8,622,758



Gary Robinson presented a full capital cost review at the last AIW so I won't dwell on this now. It's available on Tides Canada's website.

A year ago we modelled the addition of a hatchery and a second module and in order to get a 20% ROE on a 50/50 debt/equity capital structure/

It looked like the capital costs would have to be reduced by 30-40%.

We think it should be possible to do so, but we haven't done a detailed assessment yet.

# Revenues



FOB farm gate = \$8.07/kg HOG \$Cdn

Estimated operating margin = \$4.11/kg HOG \$Cdn  
(Kuterra's selling price minus FWI \* modelled cost)



Thanks to the quality of the fish and to Albion's hard work, the premium price we obtained exceeded our projections.

This is very significant. There had been a question as to whether consumers would be willing to pay a premium price for a premium, sustainably produced product. The answer is a very clear yes.

75% of Cohort 1 was a premium product, and 25% was too pale. The 25% has been frozen. As mentioned, we are now working with Albion to develop a value-added product for the 25% of Cohort 1 that did not meet our premium standard due to early maturation.

In terms of our goal of proving the economic feasibility of growing Atlantic salmon in a RAS facility, it will be another year before we have enough steady-state data to start drawing some preliminary conclusions.

But one stable number we can use already is the netback to the farm gate, which was \$8.07/kg HOG \$Cdn.

The FWI (Freshwater Institute) model used a sales price of \$7.36/kg HOG \$US, so Kuterra has validated that number.

The FWI modelled costs of \$3.98/kg included 38 cents for primary processing. We don't do any processing, so to compare apples to apples in terms of costs, one should reduce the FWI costs to \$3.60/kg instead of the \$3.98 that is in that model and add 10% to convert it to \$Cdn.

Kuterra's selling price at \$8.07/kg less FWI's costs at \$3.92 \$Cdn yields a potential margin of \$4.11/kg \$Cdn

**\* FWI (Freshwater Institute) presentation at AIW6:** economic model comparing open net-pen and land-based 3,300MT model farms. Available on the Tides Canada website.

# Economic benefits



Jobs

Training

Economic multipliers



In terms of overall economic benefits generated by the farm.

For most of this year we've had six staff to deal with start up issues.

We expect to have five or fewer staff at steady state.

Using industry multipliers, we expect roughly 29 FTEs of employment to be created upstream and downstream when we are at full operation.

# Environment



Effluent water quality - May to August 2014

Parameter	Influent average	Effluent average	Net change from production	Projected effluent quality at full production (modelled on FWI data)
Water (°C)	9.92	14.10	4.18	n/a
TAN (ppm)	0.22	0.95	0.73	2
TN - Total Nitrogen (ppm)	3.53	24.69	21.16	99
Nitrate (ppm)	8.21	55.88	47.67	96
pH	7.2	7.1	-0.1	n/a
O <sub>2</sub> (ppm)	8.7	7.2	-1.5	n/a
TP - Total Phos (ppm)	0.01	1.15	1.14	4.4
TSS (ppm)	0	13	13	29
BOD (ppm)	0.0	4.8	4.8	43
COD (ppm)	20.33	68.00	47.67	n/a
TDS	2233	2300	67	n/a
Turbidity (NTU)	0.118	2.80	2.682	n/a
Salinity (ppt)	1.84	2.00	0.16	n/a

The facility discharges liquid effluent into two dry gravel infiltration basins. It percolates through 1-2 meters of sand and gravel before returning to the groundwater. There is no connection to surface water bodies. The effluent data that is tracked is shown in the table.

Kuterra is overseen by an Independent Environmental Monitor Program, administered by the Pacific Salmon Foundation, with two goals:

1. Monitor and mitigate any unacceptable impacts from the operation.
2. Report an independent evaluation of environmental impacts, if any, of the Kuterra facility.

Thus far the Environmental Monitor reports that “Overall, the goals of the Independent Environmental Monitoring Program have been met or exceeded.” To date these measured values are below the pre-operational targets, which are based on Freshwater Institute benchmarks. There were a few above-target peaks in suspended solids in February. But improvements to the waste filtering system have resolved this.

The recent Monterey Bay Seafood Watch program’s Best Choice ranking for Kuterra has recognized and validated the environmental sustainability of Kuterra’s operation.

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TAN = Total Ammonia Nitrogen – not so important for effluent but important for fish culture

TSS = Total Suspended Solids – the lumpy bits

BOD = Biological oxygen demand - oxygen consumed by organisms in the water

COD = Chemical oxygen demand - BOD + chemical oxidants – easier to measure than BOD

TDS = Total Dissolved Solids - dissolved bits as opposed to lumpy bits above

NTU = Nephelometric (or National) Turbidity Units – a standard scale



## What we've learned



- Market demand
- Energy usage
- Water usage
- Land footprint
- No marine impacts



In terms of some of the concerns or myths that are out there about land-based RAS Atlantic salmon aquaculture, we can now confirm that:

**First**, market demand is strong, and consumers are willing to pay a premium price for these fish.

**Second**, the facility uses very little energy. It's not one of our top-three costs.

**Third**, the facility uses very little water. In our RAS, to date, on average, 98% of the water is cleaned and recirculated. Average water use is now just under 490 litres per kilogram of feed.

**Fourth**, the facility uses very little land. Using our facility as a model, we could put all of BC's current Atlantic salmon production on land in an area less than one-fifth the size of Stanley Park.

**And lastly**, we have shown that Atlantic salmon can be grown to market size on land in a closed containment RAS system that has no impact on the marine environment or on wild salmon.

# Biggest challenge



## EARLY MATURATION

### Diagnostics

- GSI testing
- Melatonin testing

### Options

- Lower temperature
- Change light regime
- Shorten harvest period
- Investigate different strains
- Investigate female only stock

A large number of the first cohort matured early.

The good news is that 75% of those fish were still premium quality, even after the harvest was stretched out over 26 weeks.

Even better news is that GSI testing shows that only 40% of cohort 2 are maturing early.

And even more encouraging are signs that cohort 3 maturation may be significantly less than that. This may reflect the results of cleaner water and increased effectiveness of the photoperiod.

In terms of addressing this challenge, these diagnostic tests have enabled us to establish a baseline, and there are a number of variables that we can change to reduce maturation to an acceptable level.

These are some of the options incorporated into our strategies.

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GSI = Gonasomadic Index

## Next steps



1. Address remaining technical issues.
2. Reach maximum stocking density.
3. Improve fish performance.
4. Report after more cohorts grown.



A year ago we were dealing with so many different issues that the data up to now reflects on our troubleshooting performance more than on our fish-growing performance.

Now, though, the list of issues is a small fraction of what it was a year ago.

And now we know what we're dealing with and have strategies in place.

By this time next year we expect to report steady-state information.

In the meantime, we hope we've helped you see what's involved in starting up RAS Atlantic salmon farming on this scale.

We hope you can learn from our experience and avoid some of the costs we've incurred by leading the way.

We hope we've given you a sense of the potential of this industry.

The science is there. The technology is there. And the key elements seem to be heading in the right direction.



Thank you for your interest in Kuterra and in what we're doing.

Our Operations Manager, Cathal Dinneen, and the Vice-Chair of our Board, Eric Hobson, will now join me to address your questions.