Atlantic Salmon, Steelhead, & Leafy Green Production in Wisconsin

Steven Summerfelt, Brandon Gottsacker, Kyle Woolever

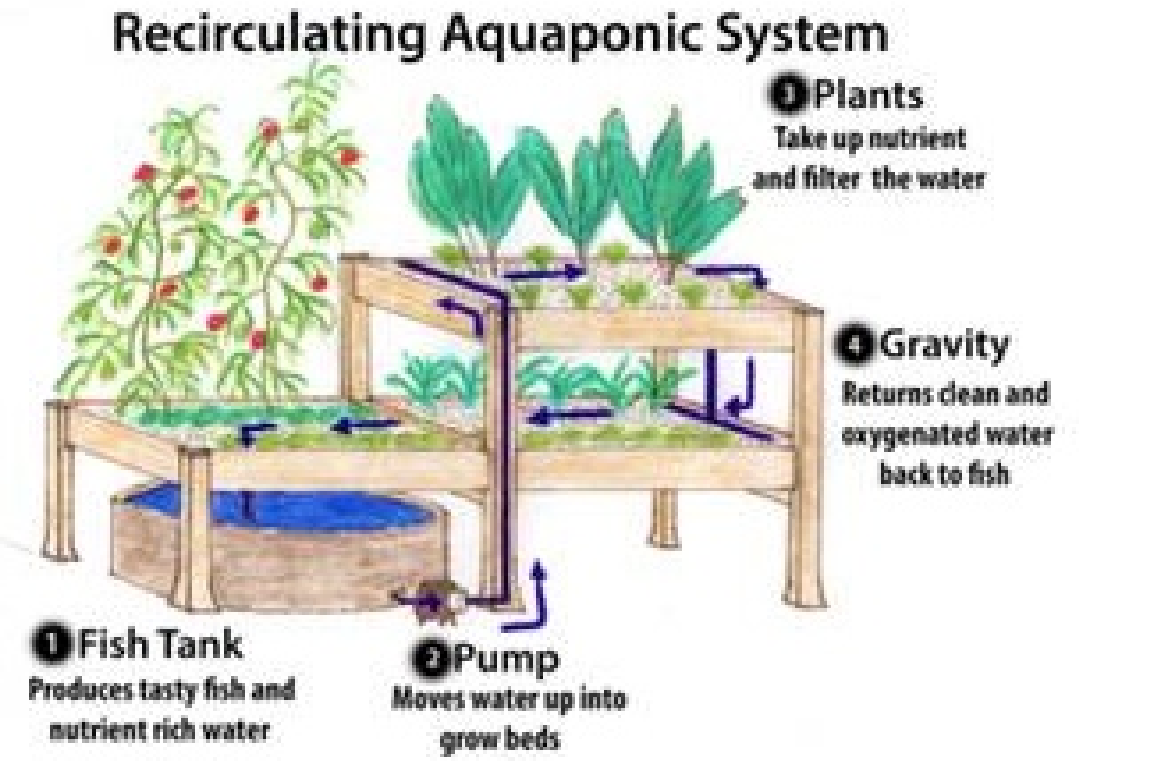
SUPERIOR fresh™

1st Land-Based Atlantic Salmon Producer in USA

SUPERIOR fresh™

Traditional Aquaponics

- Integrating plant & fish in a single water treatment system
- **Low-technology model**
  - ✓plants are part of biofiltrer
  - ✓primitive solids removal
  - ✓internal biosolids digestion
  - ✓no oxygen supplementation
  - ✓water quality okay for tilapia
  - ✓low production intensity, i.e., low feed capacity
- Small-scale owner-operator
- Economic viability uncertain
  - ✓Love et al. 2014



Source: http://maxonstreetfarm.com/victoria-aquaponics/

SUPERIOR fresh

Superior Fresh Aquaponics

- **High-tech agri-business**

- **Best available technology**
  - ✓ Water treatment
  - ✓ Automation of harvest & processing
  - ✓ Automation of environmental control

Superior Fresh Aquaponics

- **Goals**
  - ✓ Produce premium products
    - USDA Organic certified leafy greens
    - Highest quality salmon: “Best Choice”
  - ✓ Improve food safety
  - ✓ Achieve economies of scale
  - ✓ Reduce production costs
  - ✓ Minimize environmental impacts

State-of-the-Art Technology

- **Salmon House**
  - ✓~ 100 MT production currently
    - Atlantic salmon (~4 kg) every week
    - Steelhead (2.5-3 kg) intermittently
  - ✓500 MT expansion in design

- **Hydroponic Greenhouse**
  - ✓~ 600 to 1000 MT production currently
    - micro-greens
    - baby greens
    - head lettuce
    - spinach
    - power mix
    - spring mix
  - ✓3 acre in 2018
  - ✓6 acres in early 2019; 2X production
  - ✓15 acres in 2020; 5-fold increase in production

SUPERIOR fresh™

Maximize Nutrient Utilization – Ultimate IMTA

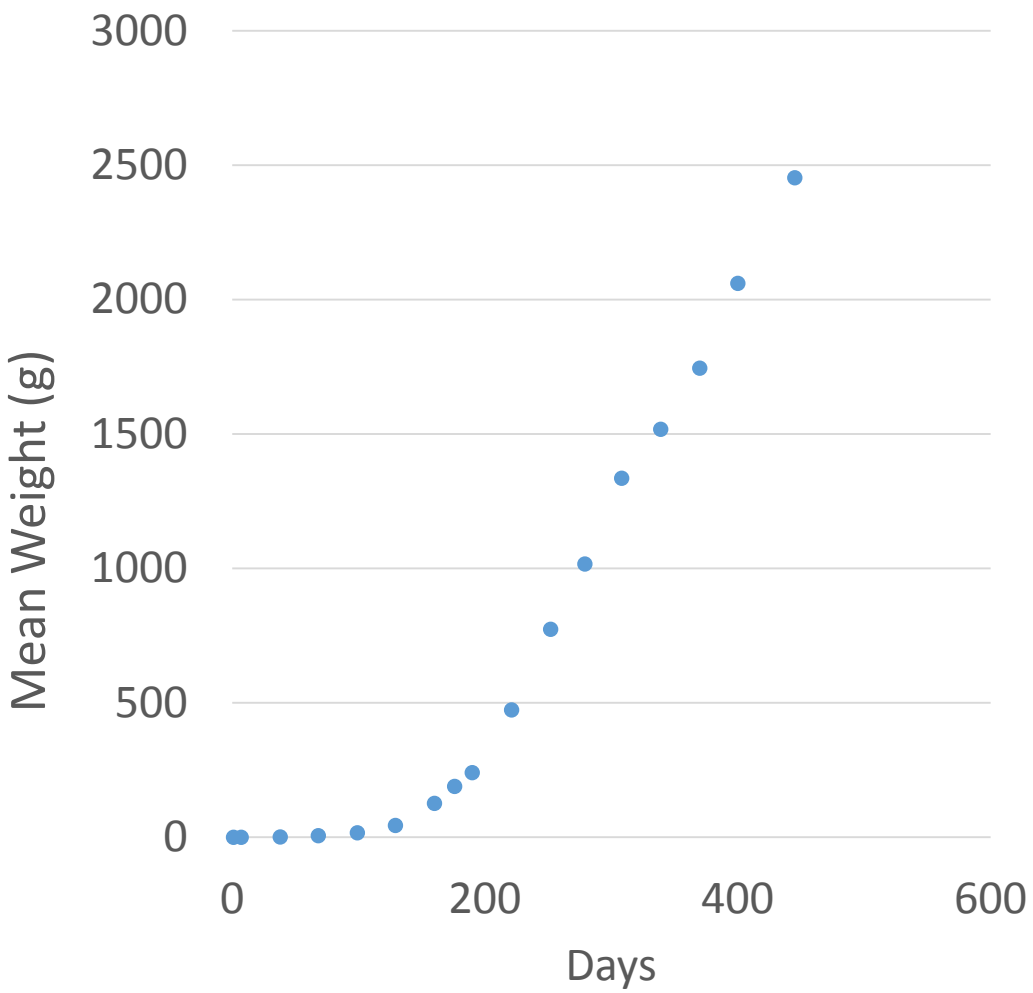
- 1.1 ton fish feed produces 1 ton fish & 6-10 MT leafy greens
- 99.9% of flow is recycled
- Spilled production & processing water irrigates 20 acres of alfalfa
  - ✓Stored when ground is frozen or saturated
  - ✓**None discharged to surface water**


SUPERIOR fresh
BABY SPINACH
a healthy, versatile superfood
GROWN locally
locally grown by:
SUPERIOR FRESH LLC
HIXTON, WI 54635
WWW.SUPERIORFRESH.COM
certified organic by:
ECOCERT ICO
USDA ORGANIC
RAW
KEEP REFRIGERATED
NET WT. 4.5OZ (128G)
PULL TAB, LIFT CORNER
SUPERIOR fresh
POWER BLEND
spicy, bold blend of hearty greens
GROWN locally
locally grown by:
SUPERIOR FRESH LLC
HIXTON, WI 54635
WWW.SUPERIORFRESH.COM
certified organic by:
ECOCERT ICO
USDA ORGANIC
RAW
KEEP REFRIGERATED
NET WT. 4.5OZ (128G)
PULL TAB, LIFT CORNER
SUPERIOR fresh

Superior Fresh Team

- Experts
  - ✓Horticulture
  - ✓Water chemistry
  - ✓Biology
  - ✓Aquaculture
  - ✓Engineering & CAD
  - ✓Food Safety – Microbiology
  - ✓Mechanical-Electric
  - ✓Sales
  - ✓Human resources

Steelhead



- Intermittent 2.5-3 kg harvest
- USDA, Troutlodge, Riverence
- 84% HOG yield

SUPERIOR fresh

Atlantic Salmon Germplasm Used to Date

- **Riverence**
  - ✓Rochester, Washington USA
  - ✓Cascade strain
    - freshwater adapted
  - ✓Mixed sex
  - ✓Available fall/winter

- **Stofnfiskur**
  - ✓Hafnarfjörður, Iceland
  - ✓Originating from Norwegian Mowi & Bolaks strains
  - ✓Land-Based Farming strain
  - ✓All-female
  - ✓Available year-round

Cascade, 5-6 kg

Cascade (top) & Stofnfiskur (bottom)

Stofnfiskur, 8.2 kg

SUPERIOR fresh

Quarterly Atlantic Salmon Egg Importation

Expensive

- Eggs
- Customs broker
- Courier from airport

Proactive Investment in Time

- Health certificates & all documentation due at FWS 1-month before importation
- Highly regulated: US FWS, US DHS, US DA, FDA, State

Risky

- FWS can detain shipment for any reason for any period of time
- Long travel time – eggs can warm up
- Delays in customs, international flights, and lost packages

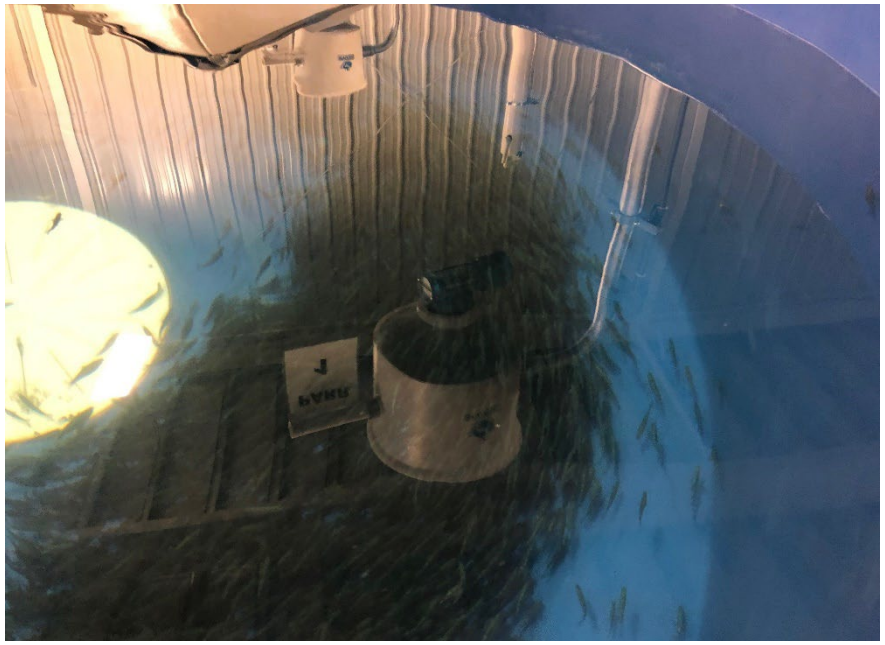
SUPERIOR fresh

Atlantic Salmon Egg Supply: Reducing Risk

- **Identify two CPF egg suppliers**
  - ✓One supplier to provide all-female eggs year round
  - ✓2nd supplier that is domestic
    - fall & winter egg availability at this time
- **Order extra eggs at least every 6-months**
  - ✓Cold-bank fry/parr to maintain a backup cohort

1st Three Cohorts Cultured at UWSP NADF

- Riverence broodstock at *University of Wisconsin - Stevens Point Northern Aquaculture Demonstration Facility*, Bayfield, WI
- Hatched & cultured @ 8°C with 24-hr light; eventual S1 Smolts @ SF
  - ✓116 Cascades – 12 months
  - ✓216 Stofnifiskur – 11 months
  - ✓816 Stofnfiskur – 5 months



Hatching, 1st Feeding, & Smoltification at Superior Fresh

Hi-Tech RAS Developed at Freshwater Institute

- ✓dual-drain culture tanks
  - 30 min HRT
- ✓radial flow settlers
- ✓drum filters
- ✓fluidized sand biofilters
- ✓forced-ventilated cascade columns
- ✓low head oxygenation units
- ✓ozonation

SUPERIOR fresh

Culture Conditions

Photoperiod

- 24-hr continuous light except smolt tanks (12:12 for 6-8 weeks) for S_0 smolt

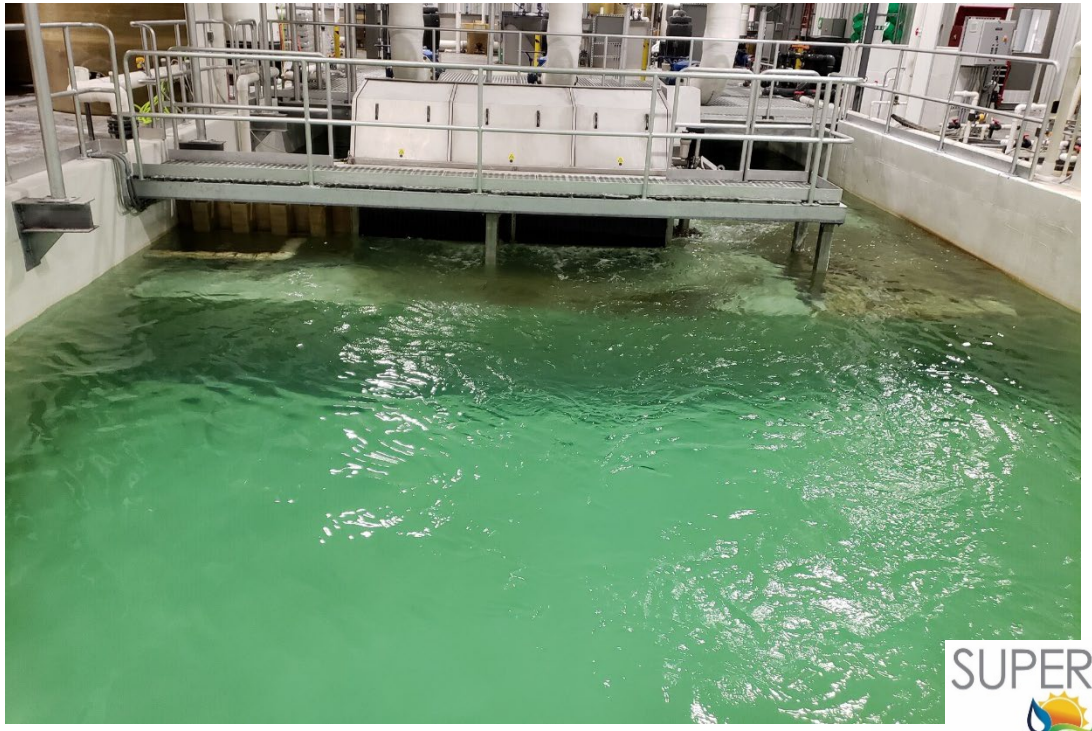
Temperatures

• Hatch	< 8°C
• First feed	11°C
• Parr/smolt/post smolt	11.5°C
• Growout	15°C

SUPERIOR fresh™

Salmon Growout RAS: Mean Water Quality

- NO_3-N 84 ppm
- NO_2-N 0.08 ppm
- TAN 0.8 ppm
- CO_2 14 ppm
- O_2 100-120% sat
- Temp 15°C
- Low color & turbidity
- Low Na^+ & Cl^-



Certified Organic Salmon Feed

Skretting Optiline RC **Organic**

- 42% protein and 30% fat
- Fish meal, fish oil, organic barley, vegetable oil, natural astaxanthin
- Improves fecal pellet stability

Costs more than commodity feed, but market prefers this story

SUPERIOR fresh

Salmon Finishing

- Standard Operating Practices
  - ✓6-day depuration in PRAS w/o feed
    - w/o feed 1-day prior to transfer to purge
  - ✓3-4 hr HRT well water flushing @ 10°C
  - ✓Disinfect w/ H_2O_2 between harvests
- Fantastic flavor profile
  - ✓No off flavor detected by staff or reported by customers
  - ✓Geosmin & MIB depuration kinetics to be determined in Sea Grant study
- Finishing flow is discharged

Post-Harvest Stunning and Hand Processing

SUPERIOR fresh™

Diseases and Parasites

No major fish health events

A little fungus during incubation, fry, & parr culture

No vaccination, antibiotics, formalin, or pesticides used

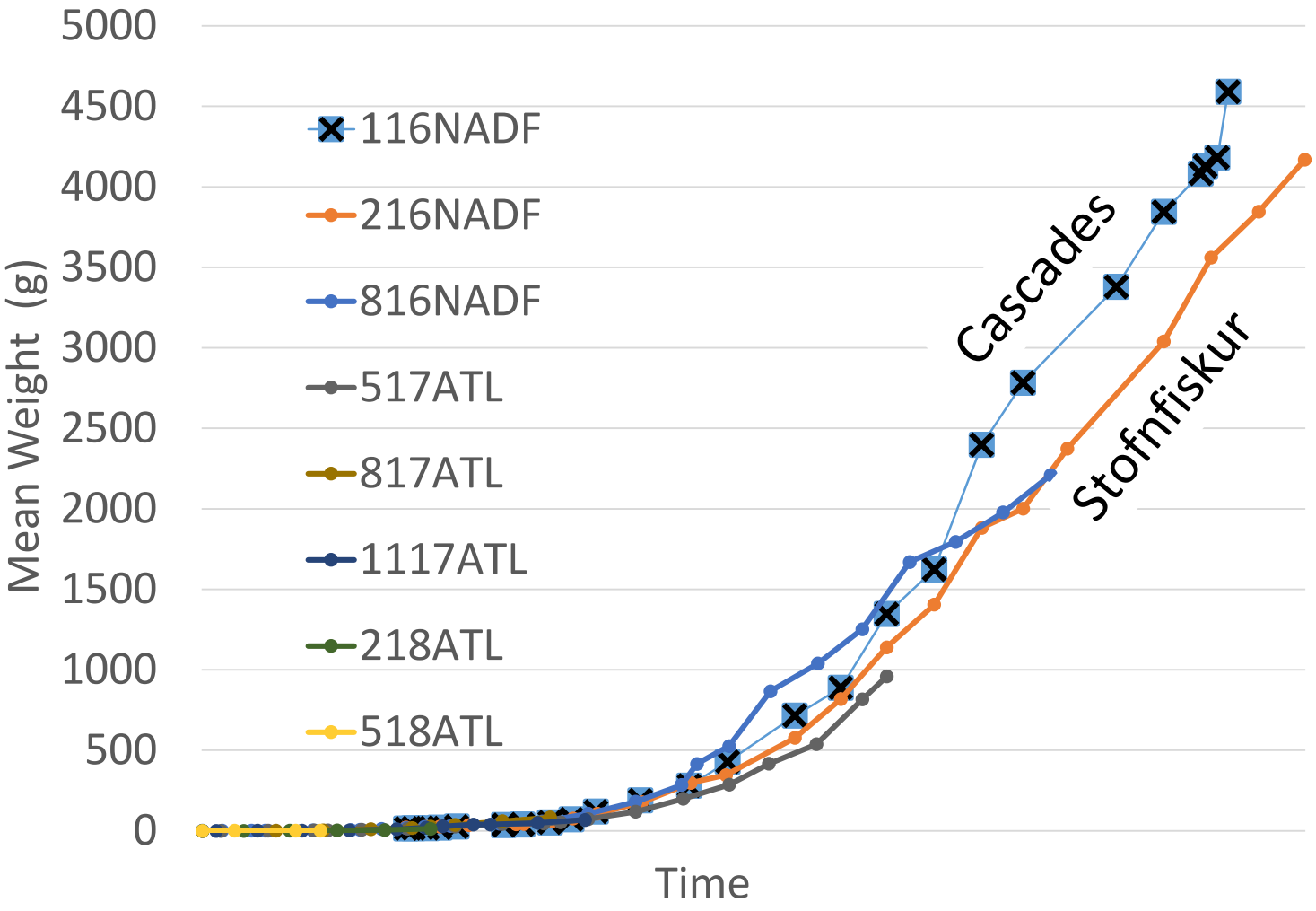
No sea lice or kudoa

No ISAV, IPNV, VHSV, OMV, SVCV, *A. salmonicida*, *R. salmoninarum*, *Y. ruckeri*, *M. cerebralis*, *C. Shasta*, or *K. thyrsites*

No escapees

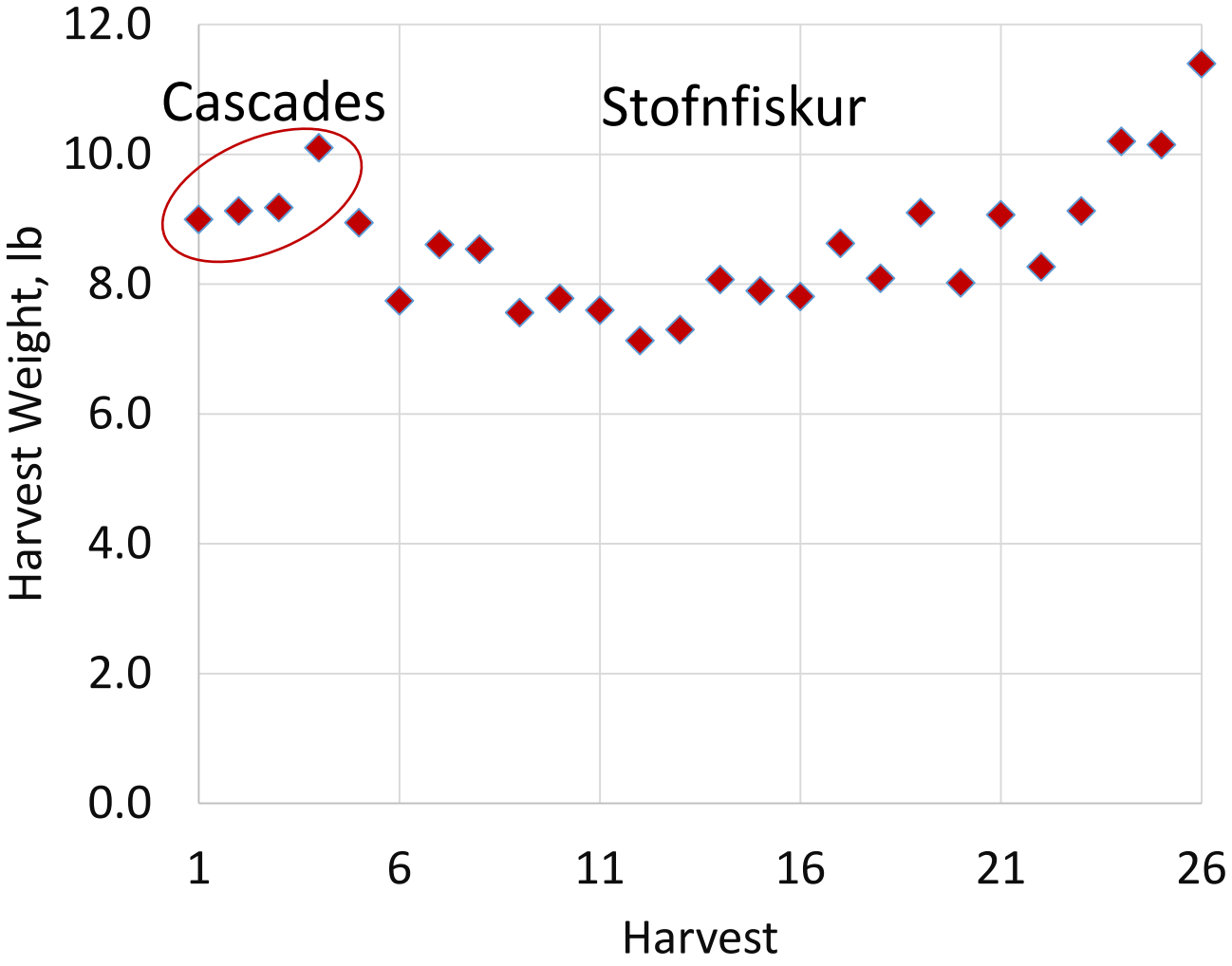
SUPERIOR fresh™

Atlantic Salmon Growth



SUPERIOR fresh

Harvest Size



Performance Summary

- **Feed conversion** 1.1: 1
- **Finishing Weight Loss** 3-5%
- **HOG Yield**
  - ✓Cascades 93% ± 1%
  - ✓Stofnfiskur 88% ± 5%

Performance Summary

Mean growth, starting at ~800 g

- Cascades 416 g/month
- Stofnfiskur 349 g/month

Maturation at Harvest

- Cascades 0%
- Stofnfiskur 1st cohort 17%
- Stofnfiskur 2nd cohort 2%

Behavior

- Cascades domesticated, ~ like trout, less startled
- Stofnfiskur flee to bottom when startled

SUPERIOR fresh

Atlantic Salmon Production Goals

2018 on target to **exceed** design production levels by **10%**

2019 could **exceed** design production levels by **35%**

How many RAS Atlantic salmon farms have achieved their intended design production levels?

SUPERIOR fresh

- **Mercury and PCB's**
  - ✓below quantifiable limits

Quality Attributes of Superior Fresh Atlantic Salmon Fillets

- **Omega 3 fatty acids per 100 g fillet:**
  - ✓562 ± 47 mg EPA
  - ✓1021 ± 44 mg DHA
  - ✓144 ± 10 mg ALA

SUPERIOR fresh™

Premium Pricing

Typically highest priced salmon fillet at the seafood counter

SUPERIOR fresh™

Seafood Watch

BEST AQUACULTURE PRACTICES CERTIFIED ®

Address Market Needs

- **Ranked "Best Choice" by MBA**
- **Best Aquaculture Practice (BAP) Certified**
- **Local production**
- **Organic feed**
- **Great story!**
- Fillet has no marks from vaccination or sea lice, & no kudoa, antibiotics, pesticides
- **Highly traceable**
- **Consistent production**

SUPERIOR fresh™

Superior Fresh has pioneered a sustainable production model

- Maximum nutrient capture and revenue as an IMTA: 1 ton feed => 10 ton
- Zero discharge from production or processing systems & zero escapees
- Obligate pathogens and sea lice are excluded
- Fillet quality is unsurpassed
- Extremely positive market feed-back & pricing

Conclusions

SUPERIOR fresh™

Conclusions

Aquaponics can produce Atlantic salmon & greens

Atlantic salmon perform well in freshwater RAS

Superior Fresh is applying well proven, science-based technology taken from 2 decades of R&D

Superior Fresh has benefited from many partners

Critical research remains. Requires input from USDA ARS, TCF, NADF, CtrlAQUA, industry, others

SUPERIOR fresh™

Thank You!