National Cold Water Marine Aquaculture Center Update

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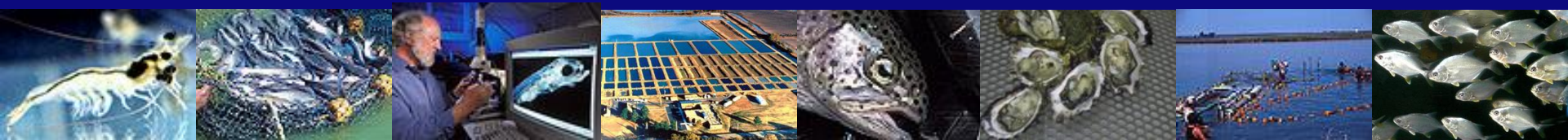


Outline

- Importance of Aquaculture
- USDA-ARS Aquaculture Research Programs
- NCWMAC-Franklin, ME

The average American eats 15 lbs of seafood each year.

The world average is 12 lbs per person.

The U.S. is the 3rd greatest seafood-consuming country, behind only China and Japan.

FAO 2018

85% of America’s seafood is imported.

We are the world’s 2nd largest importer of seafood.

-Japan is 1st

Seafood is our largest trade deficit of any agricultural product.

FAO 2018

Change trade deficit?

We could produce more fish.

-Land based aquaculture.
-Atlantic Sapphire
-Superior Fresh
-Riverence
-Whole Oceans
-Nordic Aquafarms
-Aquabanq
-Kingfish Zeeland, American Unagi

Maine aquaculture is the world's fastest growing sector.

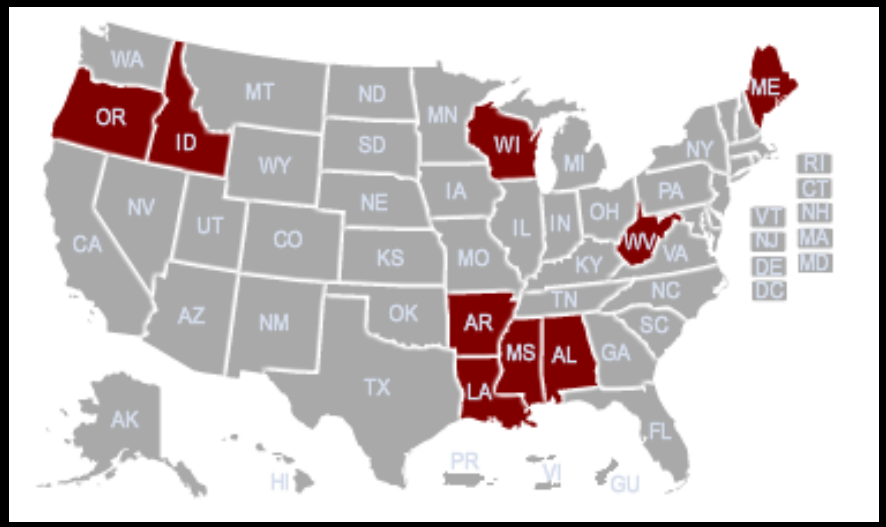
-Increased 6.2% from 2010-2017

Total economic impact of Maine sea-farming grew from $50 million to $137 million.

University of Maine Economic Report 2017

ARS Aquaculture

Mission: To conduct relevant research and deliver technologies that improve domestic aquaculture production efficiency and product quality while minimizing impacts on natural resources.



- 13 projects
- 47 scientists
- ~9 funded collaborators
- 10 laboratory sites
- Budget: ~$35 Million
- Freshwater and Marine Systems

Atlantic salmon

- Breeding program began in 2003
- Spawn every year to produce new year class
- Have data on growth and selection for carcass weight for 8 year classes over 4 generations
- Penobscot strain used as control line

Atlantic salmon

- St. John strain
- North American origin must be tested
- Used by industry partner (Cooke Aquaculture)
- Gaspe strain-may be more adapted to RAS?

Selective Breeding Program

- Atlantic Salmon (St. John strain)
  - Pedigreed family program
  - Selection based on, on farm performance & challenge trials

Growth

Fillet Color and Fat

Sea Lice Resistance

Two “Groups” In Breeding Program

Nucleus group – all families in breeding program – up to 234
YC growth rate is reported for all families
Multiplier group – best performing families – become broodfish for industry
Growth rate for multiplier offspring should be higher than nucleus

Year class	Weight Nucleus (Kg)	Weight Multipliers (Kg)
2007	3.67+0.15	5.45+0.14
2008	5.02+0.05	4.88+0.07
2009	5.74+0.03	5.76+0.08
2010	4.04+0.02	5.81+0.03
2011	5.84+0.04	6.25+0.08
2012	5.82+0.02	6.15+0.12
2013	6.02+0.14	6.55+0.04
2014	5.89+0.04	6.65+0.10
2015	5.92+0.13	6.75+0.03

Atlantic salmon

- Multiplier eggs given to Cooke Aquaculture
- Provide 600K-1 million eggs/year

Spawning

Fertilize Eggs

Incubate and Hatch Eggs

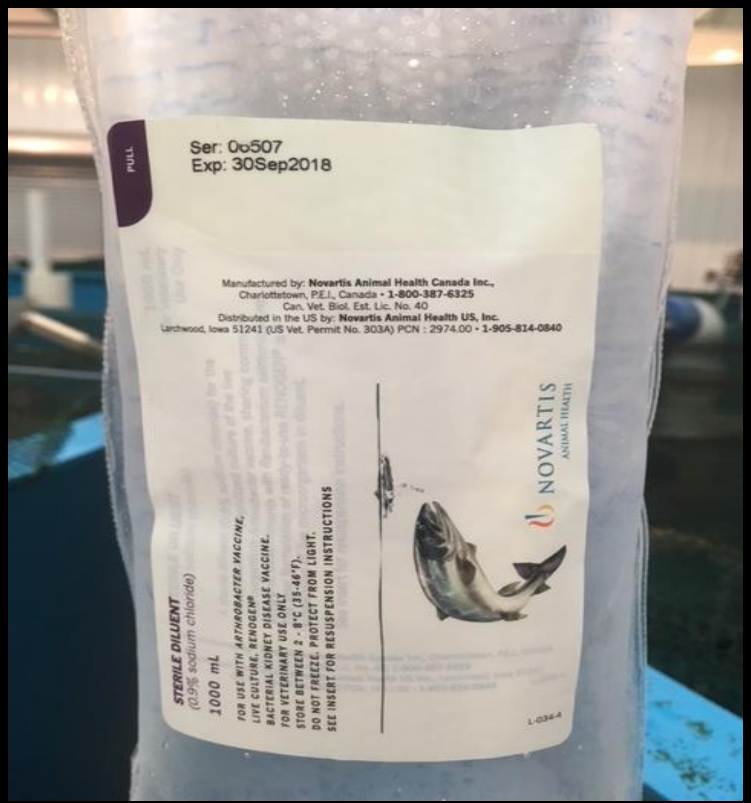

2
1

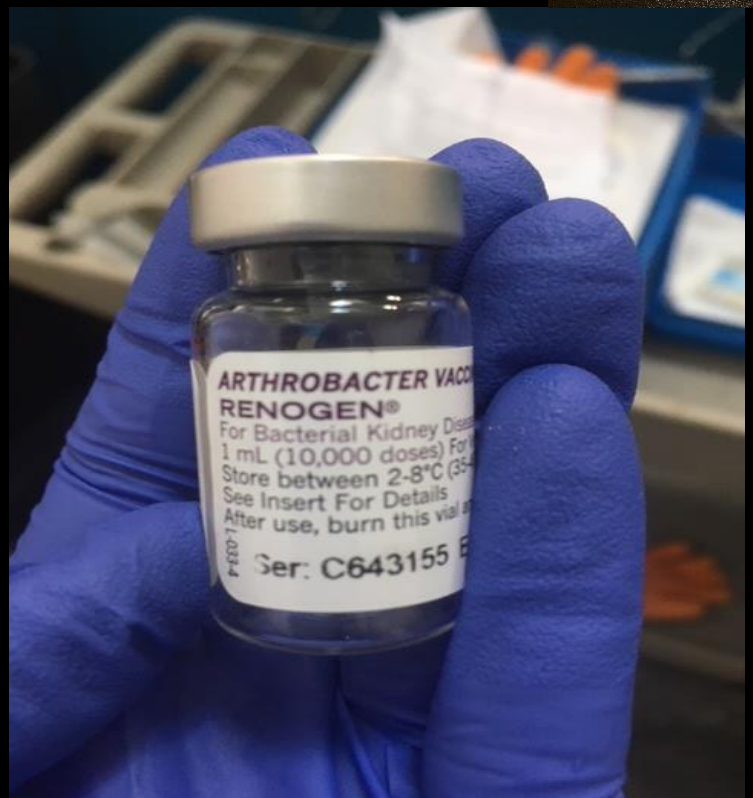
PIT Tag

- 30/family-broodstock
- 30/family net pens
- 15/family sea lice challenges

Smoltification

- 24 hr challenge
- Measure Cl^- levels in blood
- Net pen fish vaccinated





Family Evaluations in Net Pens

- 3,500-4,500
  - -Smolt transfered to net pens
  - -Comparisons under industry conditions
  - -Harvest ~1.5 yrs later

Improved Salmon Genetics

	Date Harvested	No Fish Processed	USDA SJR Carcass Wt (kg)	Penobscot (Control) Carcass Wt (kg)	% Increase Penboscot
2007	14-Feb-07	3021	4.60±0.058	2.68±0.095	71.6
2007	23-Oct-07	3611	4.56±0.075	2.90±0.041	57.2
2008	24-Jun-08	2251	4.85±0.050	2.80±0.200	88.5
2009	4-Feb-09	2431	5.04±0.077	2.35±0.077	114.4
2010	15-Dec-10	984	3.67±0.15	1.52±0.133	141.4
2012	7-Aug-12	907	5.02±0.053	2.71±0.27	85.2
2013	1-May-13	1661	5.74±0.0327	3.13±0.14	85.6
2014	27-Jan-14	1676	4.04±0.020	2.32±0.082	74.1
2015	5-Aug-15	651	5.85±.047	3.07±0.30	90.6
2016	15-Sep-16	321	6.84±0.073	4.25±0.048	60.9
2017	14-Jun-17	1724	6.65±0.042	2.65±0.167	150.9

Family Evaluations

Sample fish at processing

-Weight, length, maturity

-Fillet color and fat

EBVs Calculated

Nutrition Research

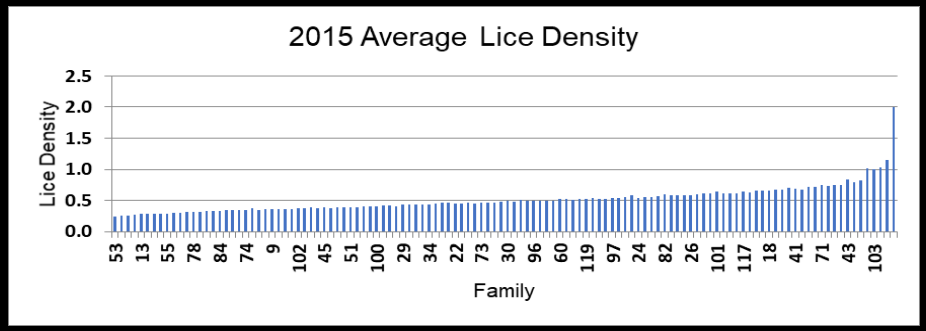
- Testing alternative protein sources with commercial partners
- Yeast, algae, soy protein concentrate
- Testing functional feeds to reduce sea lice

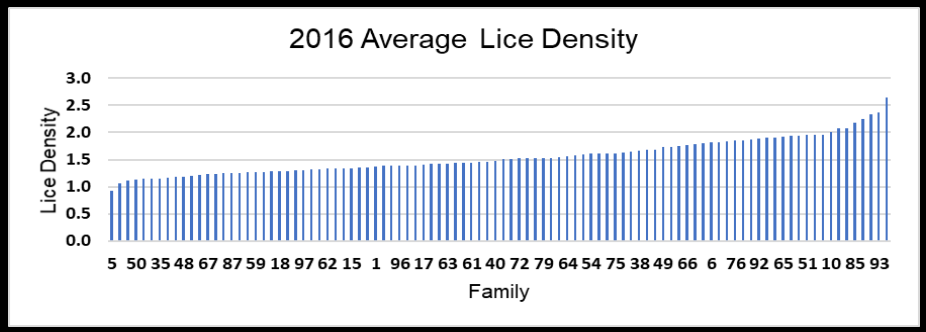
Genomic Research

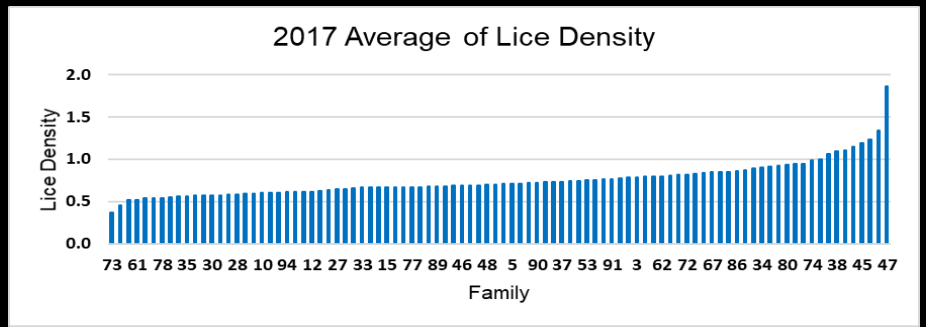
- Re-sequencing project-NA Atlantic salmon for SNP discovery
- 6.6 million SNPs
- Develop genomic EBV
- Identify and screen for genetic markers

Sea Lice Research

- $h^2 = .20$
- Offspring of "sea lice resistant" fish tested 2019.
- Develop genetic markers or tools to estimate genetic breeding values.







Gaspe Strain Research

- Selected for growth in tanks

  -Performance in net pens?

  -Performance in RAS?

  -New breeding program at NCWMAC?

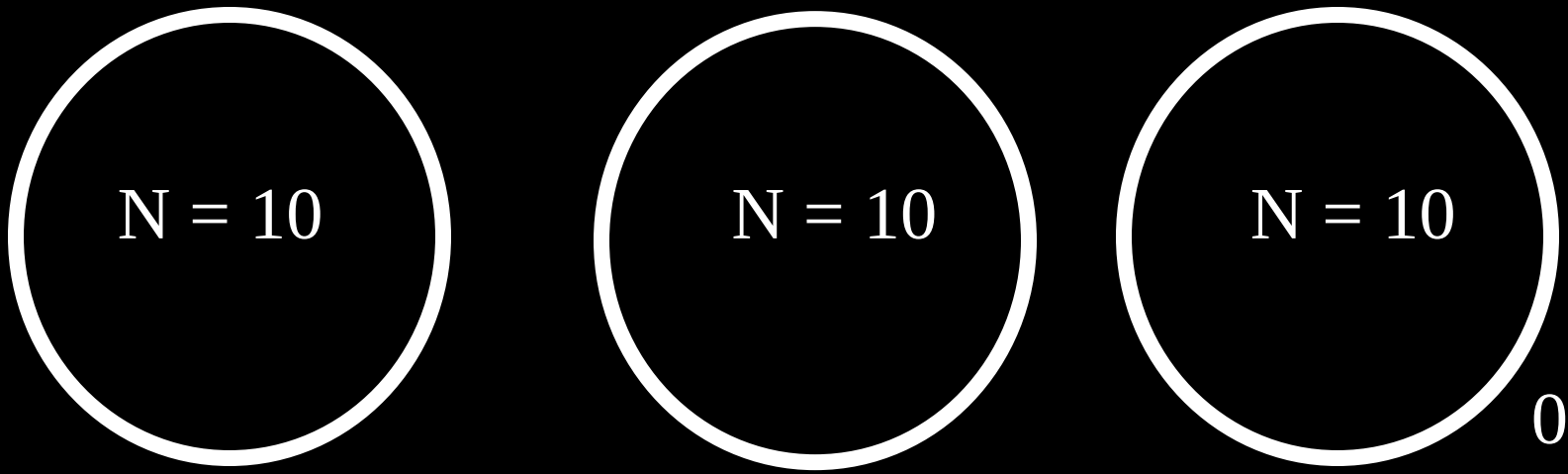
Growth Study

- Treatments
  - -St. John River
  - -Gaspe
  - -Hybrid (♂ Gaspe x ♀ St. John)

- Objectives
  - -Wt gain, FCR, survival
  - -Proximate analysis
  - -FA analysis

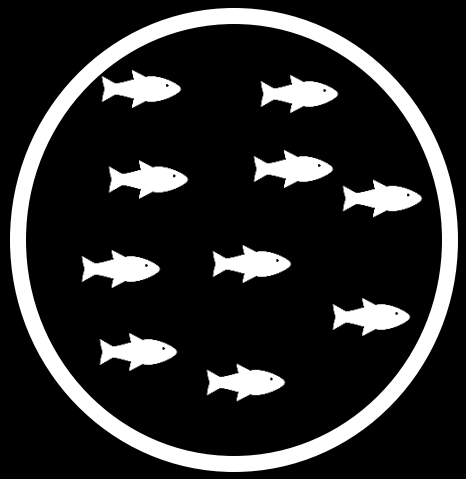
Tank Set Up

- Strains
  - -St. John River
  - -Gaspe
  - -Hybrid (♂ Gaspe x ♀ St. John)
- Water
  - -freshwater
  - -32 ppt



Methods

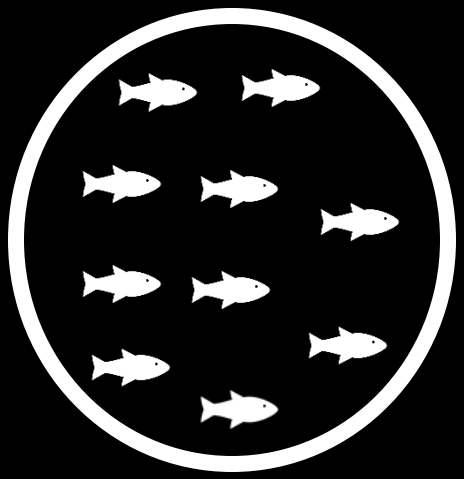
- ~260 g/fish
- Fresh and salt water
  - -0 vs 32 ppt
- Temperature ~13C
- 16 week study



Methods

- Fed a commercial diet
  - -Automatic feeder
- Weighed twice

-3 proximate and FA analysis



Growth Performance

Strain	Initial Weight (g/fish)	Final Weight (g/fish)	% Increase	FCR
Gaspe-Fresh	218.9	436.5	99.4	1.02 ± 0.05
Gaspe-Sea	231.1	384.6	66.4	1.06 ± 0.07
Hybrid-Fresh	248.3	460.4	85.4	1.10 ± 0.04
Hybrid-Sea	224.4	381.2	69.9	1.08 ± 0.08
St. John-Fresh	290.5	471.4	62.3	0.99 ± 0.03
St. John-Sea	276.3	445.2	61.1	1.00 ± 0.06
P values				
Strain			0.06	
Water			0.03	
Strain * Water			0.17	

Summary

- Single strain
  - -Gaspe grew better in fresh vs sea water
  - -St. John and hybrids grew similar
- FA and Proximate Analysis
  - -Similar among treatments

Take Home Message

- St. John strain selected for growth in net pens performed well in fresh and sea water RAS
- NCWMAC may not need to start new breeding program for Gaspe

Lumpfish Program-2015

Lumpfish Research

Lumpfish nutrition

Lumpfish reproduction

Select for lumpfish that eat sea lice

Acknowledgements

- Staff at NCWMAC
- Jim Hunt
- Melissa Milligan