Building Capacity of Atlantic Salmon RAS Production in the US-
From RAS-N to SAS^2

Yonathan Zohar
Institute of Marine and Environmental Technology (IMET)
University of Maryland, Baltimore County

RAS-N

RECIRCULATING AQUACULTURE SALMON NETWORK

Sustainable • Innovative

SAS^2

Sustainable Aquaculture Systems Supporting Atlantic Salmon

NOAA/Sea Grant

USDA/NIFA

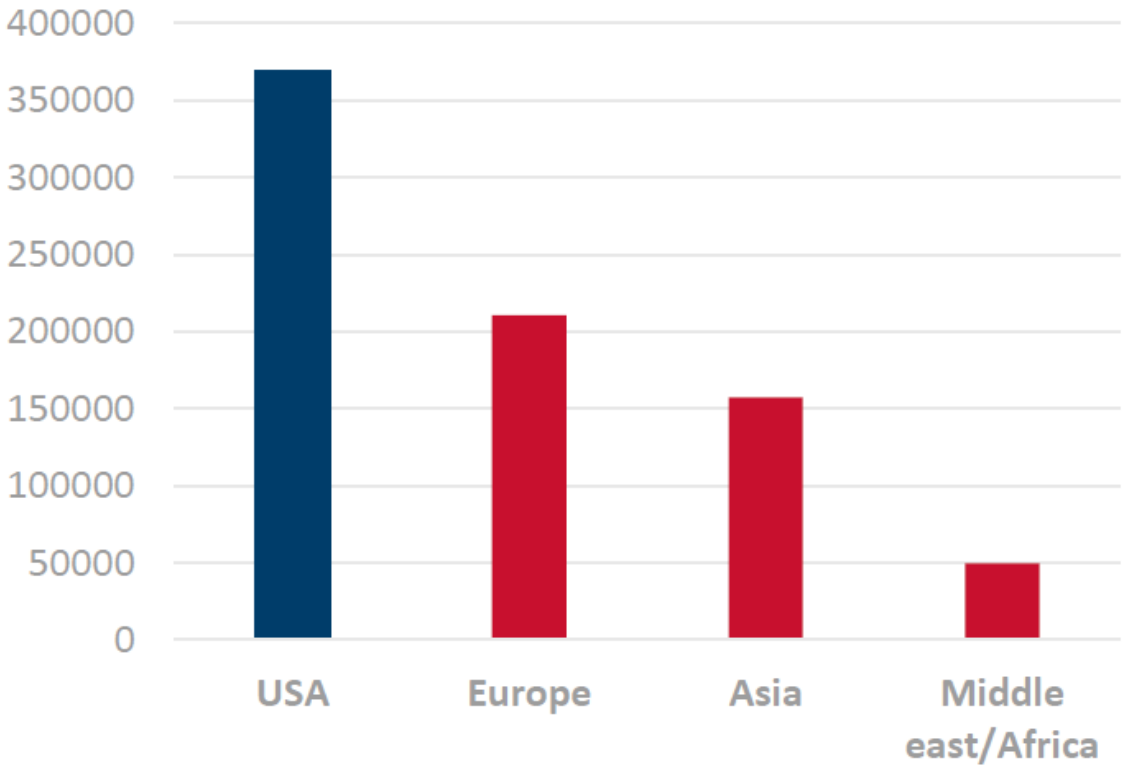
Recirculating Aquaculture Salmon Network (RAS-N)

Context

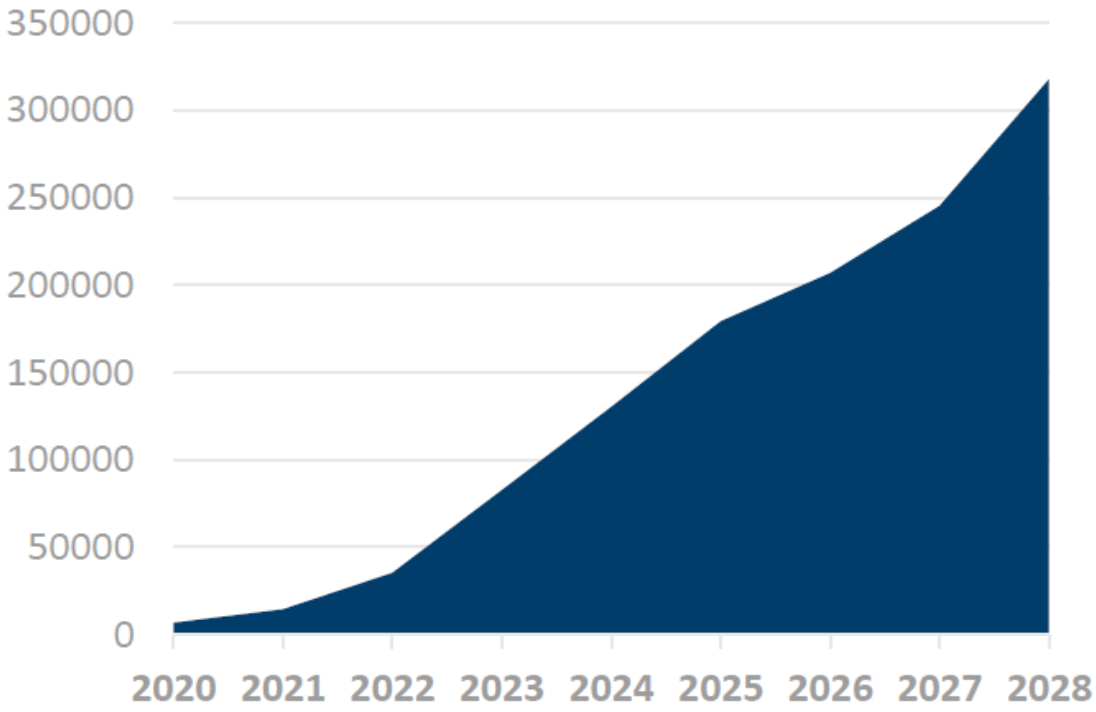
- ~90% of salmon consumed in the US (~500,000 tons) comes from overseas, at a value of ~$3.2 B (20% of seafood trade deficit)
- >$ 3 billion investment in land-based Atlantic salmon production in the US
- Maine, Florida, Maryland, Virginia, Wisconsin, Indiana, Ohio, Texas, New-York, Washington, California, Nevada
- Covid accelerated interest in local, safe, land-based production

Projected Land Based Salmon Production

Global Proposed Volume, MT

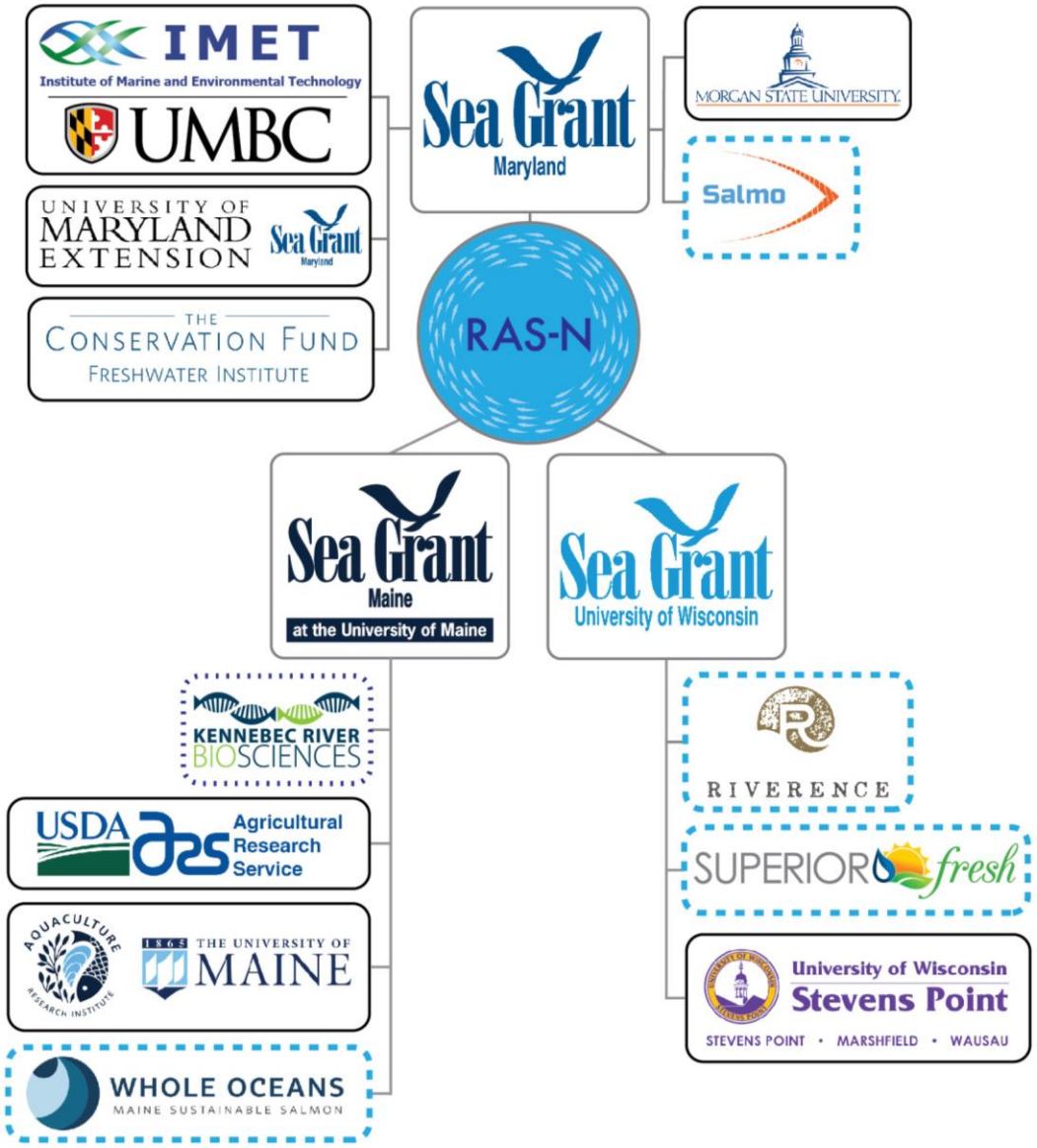


USA Production Trend, MT



SKRETTING
a Nutreco company

Recirculating Aquaculture Salmon Network (RAS-N):
A National Public-Private-Federal Partnership Funded by NOAA/Sea Grant



We've Added Partners

INNOVASEA

AquaCon™

SKRETTING
a Nutreco company

Benchmark Genetics

Our Supporters

NORDIC AQUAFARMS
SUSTAINABLE AQUACULTURE

Exciton Clean
WATER TREATMENT

BioMar

ATLANTIC SAPPHIRE

Overall Goals of RAS-N

- Establish a national, public-private holistic and collaborative hub of knowledge.
- Build capacity for the land-based Atlantic salmon sector towards successful growth and stability.
- Provide a consensus concept paper and road map that will help policymakers, federal agencies and industry identify and effectively allocate resources to promote land-based Atlantic salmon aquaculture in the US.
- Guiding principle: Engage with and be driven by industrial stakeholders.

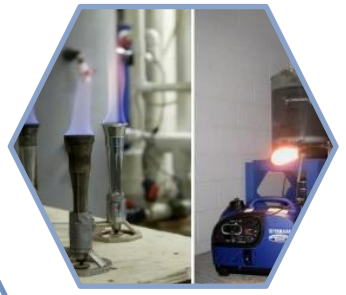
RAS-N: Delivering on the objectives

- Annual workshops (Wisconsin, Maryland, Maine)
- Special Sessions (WAS, RASTech)
- Stakeholders panels and roundtable
- Thematic Working Groups (6)
- Concept Paper

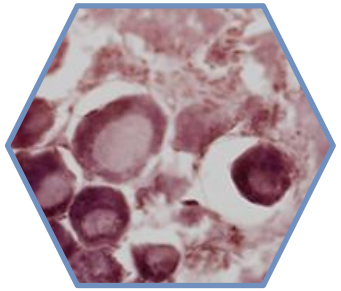
Themes of Identified Needs and Priorities

Off-flavor

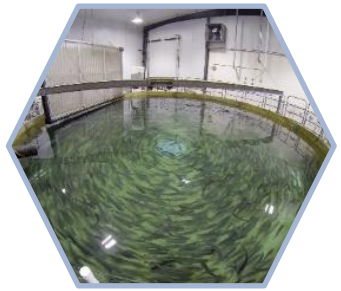
Water Re-use & Waste Removal



Early sexual maturation/sterility



RAS-specific Feeds

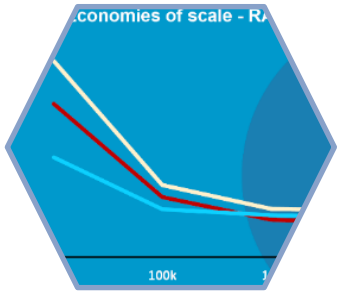


RAS Engineering & Optimization

Domestic broodstock & egg supply

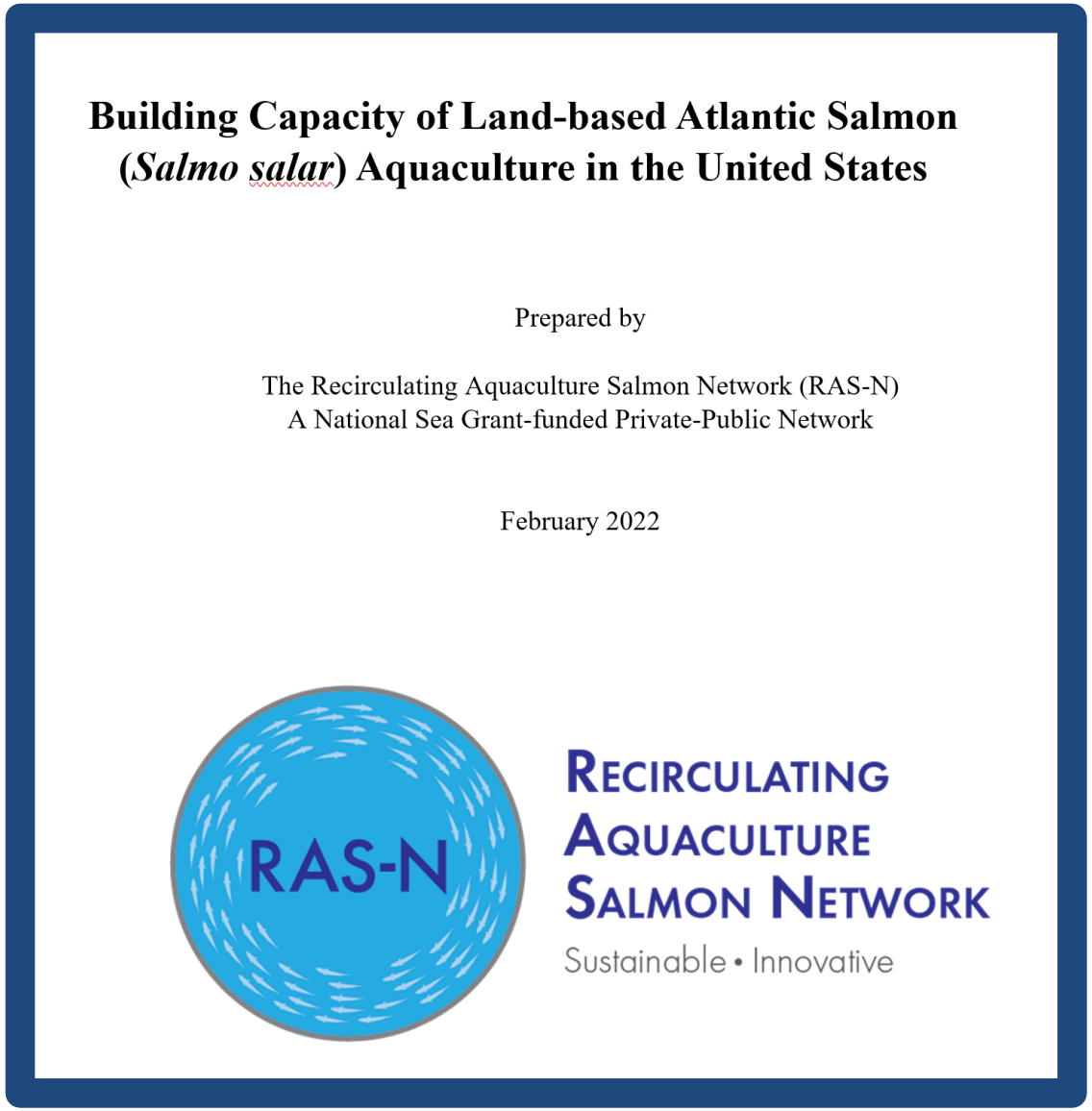
Health Management

ECWFD



Economics

A Major RAS-N Deliverable: A Consensus Concept Paper



Building Capacity of Land-based Atlantic Salmon (*Salmo salar*) Aquaculture in the United States

Prepared by

The Recirculating Aquaculture Salmon Network (RAS-N)
A National Sea Grant-funded Private-Public Network

February 2022

RAS-N

RECIRCULATING AQUACULTURE SALMON NETWORK

Sustainable • Innovative

- ➢ 28 Contributors
- ➢ 15 Organizations/Companies
- ➢ 20 Pages Covering:
  - ❖ State of Industry and Production Practices
  - ❖ Needs/Barriers:
    - ✓ Challenges
    - ✓ Potential Solutions

Sustainable Agricultural Systems (A9201)

The SAS program area priority solicits creative, visionary projects that

- are developed by transdisciplinary teams
- integrate research, education, and extension activities
- effectively use a systems approach
- promote convergence of science and technology
- solve present and future challenges in food and agricultural systems

Here is what we had for responding to the USDA/NIFA SAS RFP:

- Input from stakeholders on priorities (workshops, panels, roundtables, sessions)
- Information from the thorough effort of the working groups
- The Concept Paper
- Industry Surveys

On April 1, 2021, we submitted the proposal:

"Sustainable Aquaculture Systems Supporting Atlantic Salmon (SAS^2)"

RAS-N

Sustainable Aquaculture Systems Supporting Atlantic Salmon (SAS²)

RAS-N as seed to spin-off future projects

$10M, 5 year funding from USDA/NIFA for implementing RAS-N

Sustainable Aquaculture Systems Supporting Atlantic Salmon (SAS^2)

Overall Goal

To enable an innovative, effective, and sustainable US Atlantic salmon production platform (land-based RAS) that will transform the US food and aquaculture systems, and secure and increase high-quality and affordable seafood production.

Sustainable Aquaculture Systems Supporting Atlantic Salmon (SAS^2)

- 17 objectives (6 research, 5 education, 6 extension)
- 32 co-Project Directors
- 12 partnering institutions (1 international)
- 9 industry collaborators (1 international)

Hands-on, trans-disciplinary, systems approach, integrative, translational

Sustainable Aquaculture Systems Supporting Atlantic Salmon

SAS² – a national Public-Private-Federal Partnership

Research Universities

- The University of Maine
- Sea Grant Maine at the University of Maine
- University of Maryland
- University of Maryland Extension
- University of Maryland School of Medicine, Institute for Genome Sciences
- Sea Grant Maryland
- UMBC
- University of Wisconsin Stevens Point — Stevens Point • Marshfield • Wausau
- IMET — Institute of Marine and Environmental Technology
- Sea Grant University of Wisconsin
- Morgan State University, Patuxent Environmental & Aquatic Research Laboratory
- RAS-N — Recirculating Aquaculture Salmon Network
- Virginia Tech

SAS²

Government/NonProfit

- USDA Agricultural Research Service — NCWMAC, Franklin, Maine
- The Conservation Fund, Freshwater Institute, Shepherdstown, WV
- Marine & Freshwater Research Institute, Iceland

Industry Partners

- AquaCon
- AquaBounty
- Benchmark Genetics
- Skretting, a Nutreco company
- New York Steelhead, Hudson Valley Fisheries
- Exciton Clean
- intralytix, Safety by Nature
- Superior Fresh
- INNOVASEA

Industry Supporters

- Whole Oceans, Maine Sustainable Salmon
- Nordic Aquafarms, Sustainable Aquaculture
- Atlantic Sapphire
- BioMar

RAS-N driven SAS^2 objectives

- Off-flavor- understanding and mitigation (John Davidson, CFFI)
- Reproductive sterility (Ten-Tsao Wong, IMET/UMBC)
- RAS feeds (microbiomes) (Allen Place, IMET, UMCES)
- Year-round domestic egg production (Heather Hamlin, UMaine)
- Increase water reuse (microbiology) (Kevin Sowers, IMET/UMBC)
- Economy/market analysis (Scott Knoche, Morgan State U.)
- Education (k-12, under graduate and graduate, RAS certificates, workforce development) (Debbie Bouchard, ARI/UMaine)
- Extension (community engagement, public awareness, seafood safety, technology transfer) (Cat Frederick, UMD)

SAS^2
Sustainable Aquaculture Systems
Supporting Atlantic Salmon

Off Flavor Research: Producers

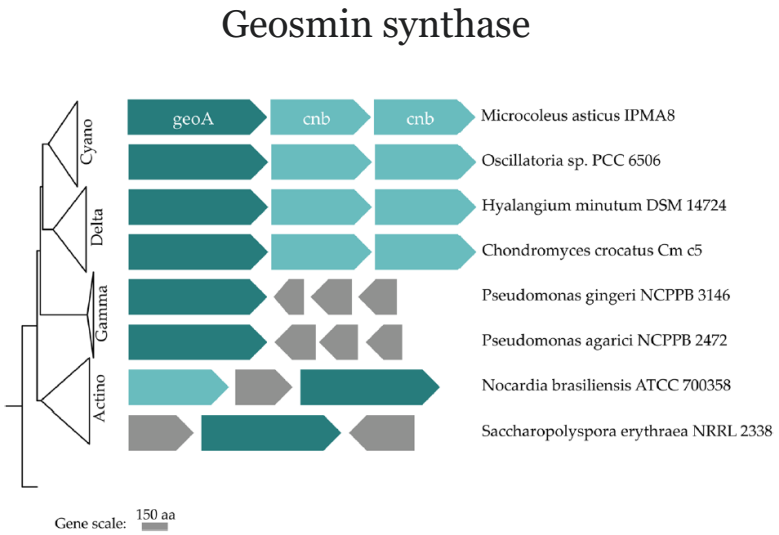


Figure 1. Schematics of the geosmin gene cluster and its synteny in *Microcoleus asticus* sp. nov. and the arrangement of genes related with geosmin synthesis identified in three distinct bacterial phyla: *Cyanobacteria* (Cyano), in the 2 classes of Proteobacteria: Deltaproteobacteria (Delta), Gammaproteobacteria (Gamma) and phylum Actinobacteria (Actino). Gene legend: *geoA* - geosmin synthase; *cnb* - cyclic nucleotide-binding protein; in grey are other genes.

geoA

Sand Biofilter

Biofilm

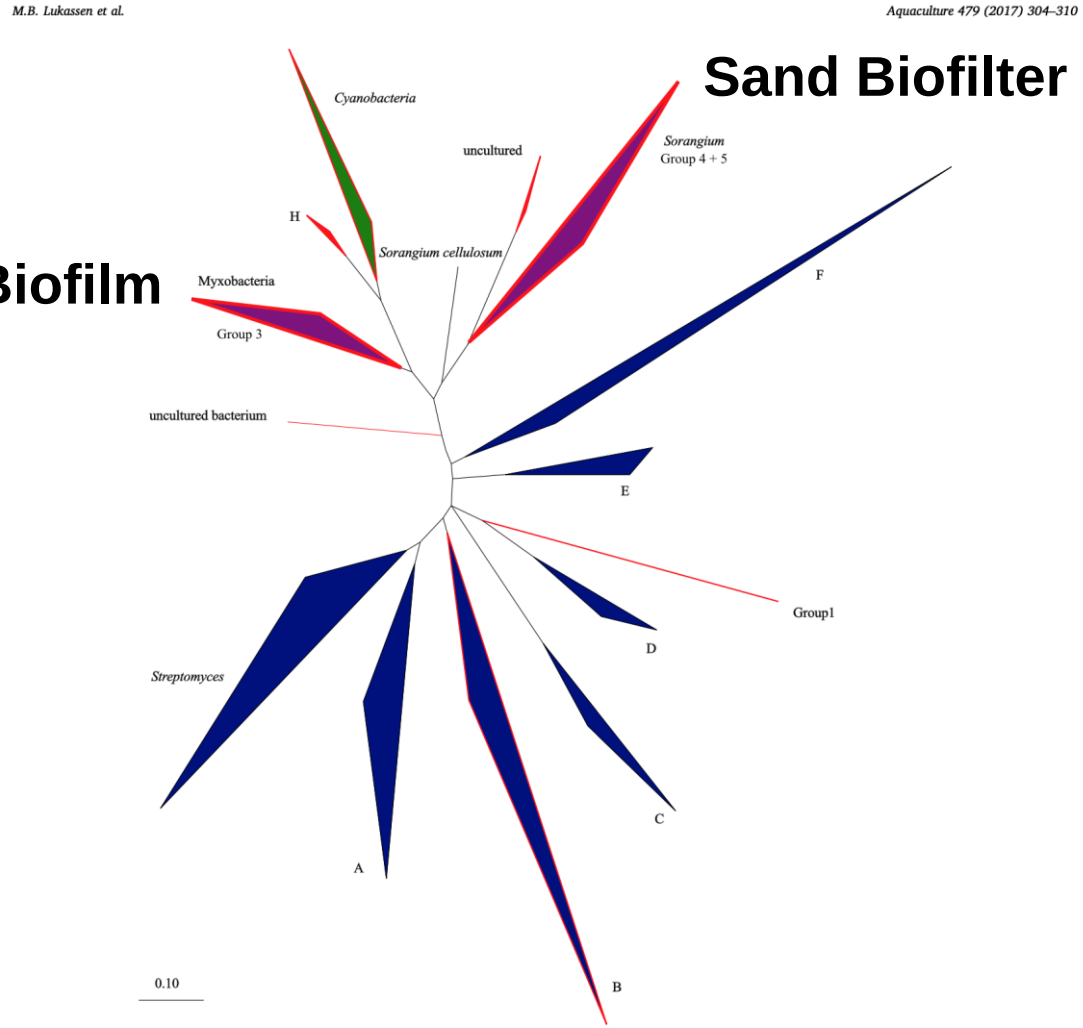


Fig. 1. Phylogenetic tree of all available geoA sequences, including > 400 sequences obtained by the CycFW/CycRW primer pair from 6 recirculated aquaculture systems. The phylogenetic groups shown with a red outline are deriving from aquacultures. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

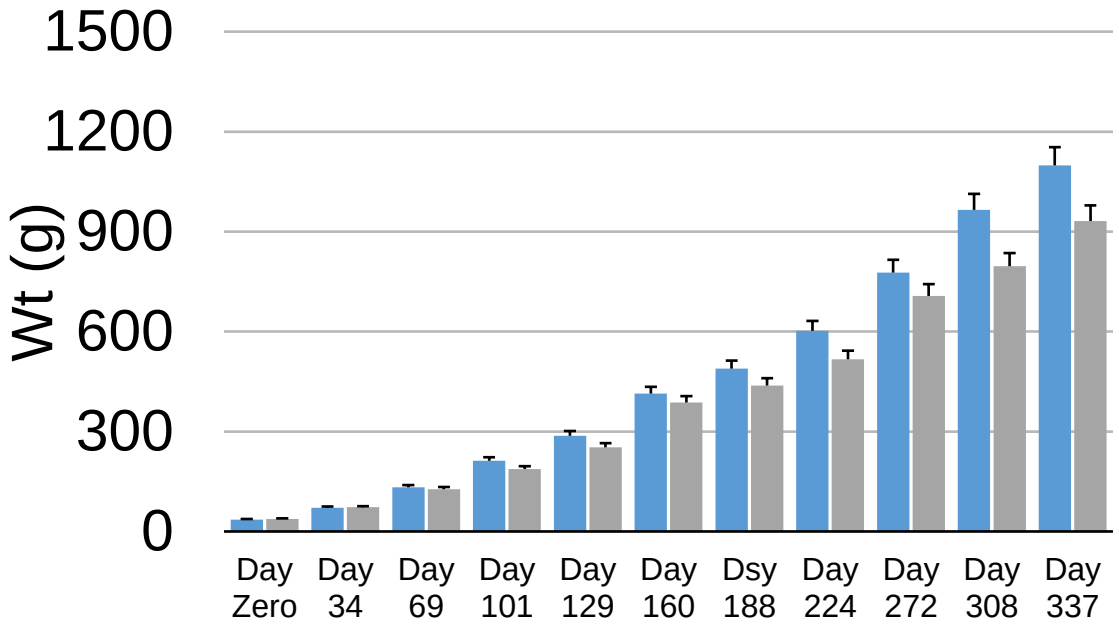
Allen Place, Jacques Ravel & John Davidson

Off Flavor Research: Mitigation

IMET, AquaCon, Exciton Clean

Atlantic Salmon Alternative RAS Feeds

Superworms*: Zophobas morio*



Insect Digestibility:

Protein 89% ± 3.84
Lipids 92% ± 3.84

Allen Place, IMET, in collaboration with Skretting

Converting RAS Organic Waste to Fuel Grade Methane (Biogas)

Kevin Sowers and Keiko Saito, IMET


We look forward to a few (5) more years of collaborations and productivity
RAS-N/SAS² Stakeholder Round Table
5 PM, Pacific Room G
Thank you !