

Sustainable Aquaculture Systems Supporting Atlantic Salmon (SAS²) Conference Report

Second Conference
October 17 and 18, 2023

2023 Conference • Baltimore, Maryland

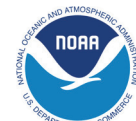


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Maryland Sea Grant College
University System of Maryland
5825 University Research Court, Suite 1350
College Park, Maryland 20740
T 301.405.7500 / F 301.314.5780
www.mdsg.umd.edu



About SAS² and this conference



The second Sustainable Aquaculture Systems Supporting Atlantic Salmon (SAS²) conference brought 110 academic researchers, industry professionals, government officials, educators, and students together at the Institute of Marine and Environmental Technology (IMET) in Baltimore in October 2023. The national SAS² public-private-federal partnership aims to facilitate the development of an innovative, effective, and sustainable US Atlantic salmon production platform: land-based recirculating aquaculture systems (RAS), that will transform US food and aquaculture, ensure food security, and increase high-quality and affordable seafood production.

This research, which was funded initially in 2019 by the National Sea Grant Office as a capacity-building project and in its current iteration by the US Department of Agriculture's National Institute of Food and Agriculture (USDA-NIFA), is unique because it is interdisciplinary and driven by needs expressed by stakeholders. Moreover, the current USDA-funded project leverages and builds upon the Sea Grant-funded work and the related stakeholder interactions. Research questions have resulted directly from engagement with industry professionals. Work by the SAS² consortium is intended to support the emerging US salmon RAS industry and ensure its success as well as that of future sustainable aquaculture ventures.

The IMET hosts of the 2023 SAS² conference designed the conference to facilitate the discussion and presentation of research and field updates, networking and connectivity among partners, and putting forth a vision for the future of the SAS² project. The conference consisted of nine 1-hour-long panels addressing key challenges to the industry, populated by 50 panelists from the US and abroad, as well as two keynote presentations. Panelists represented diverse and transdisciplinary project partners from research, industry, federal, and education fields. The conference structure encouraged questions and commentary from the audience, which resulted in thoughtful discussions over the course of the conference. Participants also had the opportunity to tour aquaculture facilities at IMET's Aquaculture Research Center and The Conservation Fund Freshwater Institute.

The following report recaps panel and keynote presentations and the ensuing discussions, presenting an overview of significant themes and ideas generated by the 2023 SAS² conference. Learn more about the innovative SAS² project at salmonland.org.

Welcome and Introductions



Dr. Yonathan Zohar, Director of the SAS² program, opened the second SAS² conference with a welcome message, introductions of leaders in the field, and a summary of the innovative SAS² project. Recorded remarks from Dr. Tim Sullivan, National Program Leader of Animal Production Systems at USDA-NIFA, highlighted the success of the SAS² program to date and advised conference participants to use the conference to collaborate, strategize for the coming years of the project, and consider how the project's innovations will impact recirculating aquaculture and salmon production beyond this project and into the future.

University System of Maryland
Chancellor Jay Perman, MD,
delivered remarks, speaking about the
collaborative, stakeholder-driven nature

of the SAS² project and the importance of the project's partners in driving research and development. He also emphasized the forward-looking goals of the project in funding workforce development, building career opportunities for the next generation, and "getting science out of the lab" by extending research and technologies into communities that would benefit from safe, sustainable sources of seafood.

Dr. Russell Hill, Director of IMET, spoke about IMET's key role as host to the Aquaculture Research Center and research teams led by Dr. Zohar. IMET's latest strategic plan positions sustainable aquaculture research as a centerpiece of IMET's work, an area "in which we expect to grow and make additional contributions," said Dr. Hill. He also highlighted some key benefits of recirculating aquaculture systems, including meeting the growing need for healthy seafood as a source of protein, minimizing pollution of coastal systems, and reducing harvest pressure on wild populations.

To set the stage for the panels to come, Dr. Zohar presented an overview of the SAS² project, a national public-private-federal partnership that features 17 specific objectives in research, education, and extension, 32 co-project investigators, 12 partnering institutions, and 11 industry collaborators. This project is unique in its **industry-driven, transdisciplinary, innovative, and holistic** approach.

"If land-based salmon production is going to successfully expand in the US, there must be a very productive dialogue between the federal government and the industry," Dr. Zohar concluded in his introductory lead-in to the first panel.

Research alone is not enough.
Our discovery isn't enough.
Our innovation isn't enough.
The great ties coming from a grant like this of research to training to workforce development, to extension, to getting our ideas and innovations out of the lab and into the public space. This is where they'll do the most good research for the public good.

— Dr. Jay Perman, *Chancellor of the University System of Maryland*





SAS² Overarching Goal

To facilitate the development of 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.

Objectives of the SAS² Program

Domestic year-round egg production and quality prediction

Off-flavor (understanding sources and mitigation)

Increase water reuse, waste bioremediation/conversion

Education (K-12, undergraduate and graduate, RAS certificates, workforce development)

Reproductive sterility (eliminate early maturation)

RAS and alternative feeds (no fish-based ingredients)

Economy/market analysis

Extension (community engagement, public awareness, technology transfer)

Panel 1: Federal-Industry



Moderator

Charlie Culpepper, *Director of Membership, Recruitment, and Public Outreach at the National Aquaculture Association*

Panelists

Bill Kelleher, *Chief Executive Officer of Kennebec River Biosciences*

Caird Rexroad III, Ph.D., *National Program Leader for USDA's Animal Production and Protection unit*

Ken Riley, Ph.D., *Science Advisor for the National Ocean and Atmospheric Administration (NOAA) Office of Aquaculture*

Steve Summerfelt, Ph.D., *Chief Science Officer at Superior Fresh LLC*

Interactions between the federal government and industry are essential to the continued domestic growth of aquaculture in general and specifically land-based salmon farming using recirculating aquaculture systems. Federal partners on this panel highlighted strategic planning developments: USDA held an aquaculture stakeholder input session this year and is working on a new five-year strategic plan. NOAA's Office of Aquaculture is looking for input on needs and how they can make strategic investments a priority. NOAA disseminated a comprehensive [Aquaculture Strategic Plan](#) in 2023. Dr. Riley highlighted the importance of the outreach component of this work, which is led by Sea Grant and Extension groups: "Scientists have a responsibility to do great science, but also have outreach pieces." The National Aquaculture Association is working on certification and organic labeling initiatives that will contribute to the growth of the industry.

Industry highlights included overviews of the challenges that research is working to resolve. Panelists highlighted the importance of working on quality control issues such as removing off-flavor/geosmin presence and reducing early maturation, as well as sustainability issues such as environmentally friendly fish feed and waste recapture, and biosecurity/disease-free solutions. All of these issues are SAS² research questions that industry has highlighted and federal agencies support research to address.

Challenges, suggestions, and discussion

Growing the network. Suggestion to involve a representative from USDA's Animal and Plant Health Inspection Service (APHIS) to grow this group's understanding of aquaculture and challenges within aquaculture.

Waste products. View waste as potential inputs, advised Dr. Summerfelt. Superior Fresh uses wastewater and organic wastes as soil amendment minerals that they inject into regenerative farming fields (regulation governs how soil amendment is administered). Other aquaculture by-products are recyclable as compost and pet food.



Our approach to research in this country is working well when we have multiple agencies that can partner together with academic institutions and the private sector to support this industry.

– Dr. Caird Rexroad III, *National Program Leader for USDA's Animal Production and Protection unit*

Public outreach. Sea Grant and Extension organizations are effective “boots on the ground” and will be increasingly important in informing about recirculating systems, but researchers and scientists have an increasing responsibility to communicate about their work. Advancing aquaculture literacy among policymakers, decision-makers, and connected organizations is important. Dr. Riley encouraged the entire network to talk about aquaculture with the people they meet to start building a base understanding of aquaculture, recognizing that not many people have a background in this subject.

Genetic modification in salmonid aquaculture. The USDA is supportive of technologies to bioengineer fish and other agricultural products. In fact, USDA conducts research on bioengineering but does not use it in their breeding programs. However, the advances in genetic modification technologies are outpacing the public understanding of the available technologies. As such, the industry seems to be waiting to invest resources in scaling up bioengineered products. And there remains work to be done on the regulatory process before new advances in genetic engineering, such as gene transfer, genome editing, gene silencing, and knockout technologies can be fully implemented in industry as they start to be in other countries. Moreover, the US Food and Drug Administration (FDA) regulates bioengineered fish and livestock; so the industry (not a federal agency) would have to take a product through the regulatory process. For example, in 2015, the FDA approved a genetically engineered salmon. A lot remains to be done before these advanced technologies are fully scaled up and reach the consumer.

Operational costs are rising. Utility costs are continuing to rise nationwide. How will producers mitigate electrical and utility costs? Cost of feed is going up as well, so input costs across the board are a concern.

Biosecurity in import of eggs and juvenile fish as a national security issue. The highest quality global suppliers cannot supply all potential projects, so there is a growing biosecurity risk. There is not much regulation at the federal level (USDA-APHIS) so this falls to a patchwork of state regulations. When working with aquaculture farmers, it is important to discuss biosecurity risks and plan as needed with quarantine periods and risk mitigation strategies. Suggestion to connect with local farm agencies and aquaculture associations to provide resources.

Panel 2: Economics and Market Research



Moderators

Scott Knoche, Ph.D., *Director, Patuxent Environmental and Aquatic Research Laboratory (PEARL), Morgan State University*

Kaitlynn Ritchie, *Senior Research Associate, PEARL, Morgan State University*

Panelists

Greg Beckman, *Vice President of Integrated Systems at Innovasea*

Erik Heim, *Co-founder of Xcelerate Aqua*

Doug Lipton, Ph.D., *Senior Research Scientist for Economics at NOAA Fisheries*

Eric Pedersen, *President and Founder of IdealFish, LLC*

Jonathan van Senten, Ph.D., *Associate Professor/Extension Specialist with the Department of Agricultural and Applied Economics at Virginia Tech*

This panel engaged in discussion about production economics, past and current economic challenges, and consumer economics. Dr. van Senten and Dr. Lipton, on the academic and federal sides respectively, spoke about the challenges of identifying risk probabilities and planning for flexibility in operations based on available research

(Dr. van Senten noted that “It’s easy to grow fish in Excel; harder in real life.”). The three industry professionals delved into rising capital expenditures, including increasing materials costs and a lack of general contractors, and a need for US aquaculture projects to get up and running on a faster timeline and to deliver biomass targets on schedule to meet affordable per unit costs. Facility size is an important consideration when planning a new aquaculture business, said Eric Pedersen of Ideal Fish: “Scale is not the solution for everything...Pricing on the price waterfall, the more [fish] you pump out, the more you've got to sell into one sector of that distribution channel, and the lower your price will be.” Erik Heim of Xcelerate Aqua suggested the relationship between production volume and price can benefit US producers: "The importers cannot take a significant price decrease without getting a complete margin crush because of their total cost of importing into the US. Essentially, US producers are already getting a premium benefit compared to the import prices."

In the consumer economics segment, panelists advised aquaculture companies to look at characteristics of national and local markets and consider how to clearly message about the positive attributes of RAS production in order to get consumers to pay the asking price for RAS products. Dr. van Senten, who is working on a customer/consumer preference survey, advised careful consideration in defining the final product for the marketplace. What do consumers need and want to know about RAS-produced fish? What characteristics will sell this product?

Challenges, suggestions, and discussion

Workforce development and livable wages.

Industry panelists advised paying employees well and providing benefits—and willingly accepting this as the cost of doing business. This helps to reduce turnover, which is undesirable because companies invest in training and resources for employees. Technical schools will be key in educating about aquaculture and providing experience. Government subsidization of education and/or job creation would improve the workforce.

Marketing the RAS story. Academic and industry panelists suggested that marketing and branding RAS salmon to consumers could help to drive a premium if the industry organizes well. Farmed versus wild, depending on species, can drive premiums, so there’s a possibility that consumer knowledge of RAS could do the same. Some RAS attributes that may influence consumer decisions include level of omega-3 fatty acids in the product, domestic production, and animal welfare/stocking density. Market studies are part of ongoing research to determine consumer perceptions and their willingness to pay for these RAS attributes in salmon.

Necessary RAS production volume to reduce prices. Pricing is subject to many factors. US producers are already getting a premium benefit compared to import prices that importers need to pay to get their fish sold here. But US producers often have higher capital expenditure costs and feed costs continue to rise. Every farm is different depending on site and size of facility, so designs and infrastructure vastly vary.



Panel 3: Implementing Education Programs



Moderator

J. Adam Frederick, *Assistant Director for Education at Maryland Sea Grant*

Panelists

Valerie Brennan, *Career and Technical Education Resource Teacher at Baltimore County Public Schools*

Emma Hauser, *Aquaculture Outreach and Education Specialist at Wisconsin Sea Grant/University of Wisconsin Stevens Point-Northern Aquaculture Demonstration Facility (UWSP-NADF)*

Katarina Minas, *Aquaculture Education Intern at the University of Maine*

Scarlett Tudor, *Education and Outreach Coordinator at the University of Maine's Aquaculture Research Institute*

Sarah Weaver, *Science Supervisor at Carroll County Public Schools*

Panelists presented brief talks about their institutions, facilities, and projects. The UWSP-NADF provides technical assistance, educational programs, internships, public outreach, workforce training, and research surrounding a variety of recirculating aquaculture systems and species. “Seeing the systems in action is really powerful,” said Emma Hauser. The University of Maine’s Aquaculture Research Institute announced they were awarded an additional \$750,000 grant to expand education in aquaculture technologies and demonstrated a new virtual tour of their facilities. Sarah Weaver highlighted Carroll County Public Schools’ incorporation of aquaculture education (the Aquaculture in Action program developed by Maryland Sea Grant) into their Science Research Program: “What I’m most proud of regarding the program is that our students are truly provided with hands-on experiences that have those job skills that we’re looking for in science research.” Valerie Brennan spoke about career and technical education opportunities in aquaculture at Baltimore County Schools, including opportunities for the industry to partner with school systems. Many students leave the program with an apprenticeship or industry credential, and alignment with workforce demands is needed to further these education-industry connections.

Challenges, suggestions, and discussion

What to teach. Industry members asked educators to teach future workers not just about scientific principles, chemistry, and biology, but also practical skills (“What is a pump?”) so they can immediately step into the aquaculture workforce. Many workforce development programs and some community colleges do this through hands-on work.

Expanding the workforce. If the industry grows as projected, a lot of skilled workers will be needed. Industry members suggested placing students in training positions with producers. Educators responded that this is a good idea that some states are already working on in the form of youth apprenticeships. Furthermore, they noted it is hard to develop sustainable programs on grant funding alone and asked the network to consider how the industry can help financially. Industry members can also advise on occupational standards and curriculum for students learning about aquaculture.



Keynote 1: The Next Steps in the Evolution of Land-based Aquaculture

Matthew Craze, *Spheric Research*

Matthew Craze presented some trends from analyses of investment in land-based and conventional aquaculture projects.

- There are a lot of investors generally interested in the land-based aquaculture space. Some of these investors are shifting assets from other industries (shipping, in one example).
- Scandinavia is linked to all major projects, specifically Norway, which is linked to 70% of projects. Norway, the world's largest salmon producer, wants to maintain its dominance in land-based salmon farming in Norway and abroad, including US farms.
- Geographic hotspots: there is currently heavy investment in Icelandic farms, and land-based aquaculture is taking off in the US and Japan.
- Negative press focused on the conventional sectors (floating cages) of salmon farming (particularly health issues like sea lice or die-offs) can reduce demand of salmon, which affects profitability and in turn investment in RAS.
- There are opportunities for hybridization of the industry, such as early growing fish on land and then finishing growth-to-harvest in offshore farms. And there are a range of various technologies being trialed; this is a quickly developing space.



Panel 4: Early Maturation and Sterility



Moderator

Brian Vinci, Ph.D., *Director of The Conservation Fund Freshwater Institute*

Panelists

John Buchanan, Ph.D., *Chief Executive Officer for the Center of Aquaculture Technologies*

Ben Perry, *Sales and Technical Manager for Benchmark Genetics*

Armin Ramirez, Ph.D., *Director of Quality and Fish Welfare at Atlantic Sapphire*

Alejandro Rojas, Ph.D., *Chief Operations Officer for AquaBounty*

Ten-Tsao Wong, Ph.D., *Associate Professor at University of Maryland, Baltimore County, IMET*

Early maturation is a significant area of research in the SAS² network, one that is made more challenging by the Atlantic salmon's complex life history and physiology. When fish mature early, they are spending energy on growing sexual organs and not growing body mass, which decreases growth rate and feed conversion, makes fish more susceptible to infection, and affects the color of the fish, which can affect pricing. Hormones, genetics, salinity, temperature, and other factors can all play a role in early maturation.

Panelists presented research and solutions for early maturation, including utilizing triploid, functionally sterile stock, and female-only fish, managing temperature and light specifically to reduce early maturation, reducing stress in farming practices, and developing methods of gene silencing, genome editing, and genetic engineering.

Challenges, suggestions, and discussion

Regulation of genome editing and genetically modified organisms (GMOs). Regulation of genome editing and genetically modified organisms (GMOs). Some countries have already approved genome editing in aquaculture species and techniques. The US Food and Drug Administration has already approved the production of a GMO salmon, highlighting the potential for regulatory acceptance of genetically modified aquaculture products. But, will consumers accept genome-edited products? Even with non-GMO interventions like triploidy, there has been pushback against terminology such as "triploid," emphasizing the need for careful communication strategies. One panelist suggests marketing triploidy as "all-female sterile" to defray negative perceptions.

Technological Advancements. Gene silencing technologies offer potential advantages over traditional genetic modification, as they do not involve the introduction of foreign DNA. However, further research is required to assess efficacy and potential impacts.

Hormone research. Fish-released hormones that accumulate in RAS can trigger early maturation and sex reversal. The Conservation Fund Freshwater Institute tried to use low doses of ozone to reduce levels of testosterone in water but did not see any differences in maturation rates or early maturation. Further investigation is needed.

Bridging the gap in consumer understanding of genetic manipulation, genome editing, and genetic modification.

To address the challenges of early maturation and foster public acceptance, a comprehensive approach should include communication about the benefits and potential risks of technologies, as well as ongoing research of the underlying factors contributing to early maturation. Panelists' insights on the topic are summarized here: While triploidy is already established in other aquaculture species, gene silencing and genome editing offer promising avenues for addressing early maturation. We should discuss "plasticity" of the salmon life history and how that can be used to delay maturation or generate sterile fish without any negatives for the consumer. Consider openly providing this information and being as transparent as possible to help consumers make their decisions.

Panel 5: Off-flavor Understanding and Mitigation



Moderator

John Davidson, Ph.D., *Research Scientist at The Conservation Fund Freshwater Institute*

Panelists

Ryan Ardoin, Ph.D., *Food Sensory Scientist for USDA*

Cathal Dineen, *Head of Production at Katahdin Salmon (now renamed Great Northern Salmon)*

Igal Magen, *Co-founder and Chief Technology Officer at BioFishency*

Brittany Peachey, *Aquaculture Operations Manager at Hudson Valley Fisheries*

Matt Stromberg, *Ph.D. student at University of Maryland, Baltimore County, IMET*

Off-flavor is a challenge facing the RAS industry—and as a result, a major research topic. Researchers have learned that certain bacteria release the problematic water-borne compounds geosmin and 2-methylisoborneol (MIB), which cause an undesirable earthy flavor in fish that must be mitigated or removed to ensure a high-quality ('non-earthy') marketable product. Panelists presented about their work related to off-flavor in RAS-produced fish. The Freshwater Institute found different microbiomes at different facilities can cause variation in the presence of off-flavor in fish. Researchers are also looking into whether RAS systems with a mature microbiome can help to decrease geosmin and MIB and alleviate off-flavor. Research is in progress at the Freshwater Institute and at IMET to better understand to better understand the correlation between bacteria that produce and consume off-flavor

compounds, with the goal to manage systems for off-flavor mitigation.. Dr. Ardoin's team is looking at human perception of flavor as they train taste-testing panels to determine detection and rejection thresholds for geosmin flavor, while recognizing that individual people have different sensitivities to this compound and that various factors affect geosmin's presence. Igal Magen and Matthew Stromberg presented industry-academia collaborative mitigation research and modeling for geosmin remediation in RAS systems. Brittany Peachey, who operates a steelhead trout RAS farm, presented about how they developed their geosmin purging procedures.

Challenges, suggestions, and discussion

The cost of off-flavor. Addressing off-flavor issues in RAS through advanced oxidation technologies and other techniques can be costly, both financially and in terms of effort. Site conditions and scale of facilities affect these decisions: while adapting technologies can be expensive, purging at a large scale can increase the cost and complexity of intake infrastructure, permitting challenges, biosecurity concerns, site selection, and sustainability. Promising new off-flavor remediation technologies are critical and will continue to be developed across the SAS² network; thus, they should be considered by RAS producers.

Geosmin content variance. Panelists and audience members described variation among fish in a population that could depend on many factors such as fat content, fish age, and movement level.

Not one-size-fits all. Consider in these discussions that all RAS facilities vary in terms of technology being used, water consumption, feed type, salinity, temperature, and species. It is helpful to learn from others' experiences, but difficult to compare across facilities. Every facility will need their own specialized off-flavor mitigation plan.



Panel 6: Graduate Student Showcase



Moderator

Catherine Frederick, Ph.D., *Extension Specialist at University of Maryland/Maryland Sea Grant and IMET*

Panelists

Halli Bair, Ph.D. *Student at The University of Maine*

Luke Feeney, *Laboratory Assistant at University of Maryland Center for Environmental Sciences, IMET*

Jonas Miller, Ph.D. *Student at University of Maryland, Baltimore County, IMET*

Xinlin Zhao, Ph.D. *Student at Marine and Freshwater Research Institute*

The graduate student showcase featured several SAS²-funded graduate students working on RAS research. They are all part of multi-partner academic-industry-federal efforts to resolve stakeholder-identified challenges to commercial salmon aquaculture using the most advanced methods and technologies. Each student gave a

presentation of their work and took questions from the audience. Jonas Miller is working with others across the network in developing protocols for year-round spawning of North American strains and trying to identify non-invasive, mucus-based biomarkers that would be beneficial to broodstock management and prediction of timing of spawning and egg quality. Halli Bair is working to identify morphometric and steroidal indicators to predict egg and post-hatch larval quality of salmon spawns, leading to more productive and cost-effective hatchery and nursery strategies for RAS-raised Atlantic salmon. Xinlin Zhao is focused on optimizing the induction of reproductive sterility to eliminate early maturation using a gene-silencing approach. Luke Feeney is involved in research to develop insect meal-based replacements for traditional fishmeal in commercial aquaculture diets, thus reducing the industry's reliance on fishmeal derived from wild-caught sources and enhancing environmental responsibility in RAS.

SAS² is also focusing on educating the next generation of scientists and professionals in RAS aquaculture.

-Dr. Yonathan Zohar, *Director of the SAS² program*



Panel 7: Harvest-to-Plate



Moderator

Sharon Moen, *Food-Fish Outreach Coordinator at Wisconsin Sea Grant*

Panelists

Daisy Berg, *Seafood Merchandiser for New Seasons Market*

Brice Phillips, *Vice President of Sustainability at Phillips Foods*

Keyia Yalcin, *Owner of Fishnet Restaurant*

This panel opened with a survey of conference attendees, who were asked what is needed to further develop consumer acceptance of sustainable land-based salmon systems. Three common responses were education, communication, and public understanding. With those three important concepts in mind, panelists presented on their roles in seafood marketing, including their ideas about sustainability, connecting consumers to their food and to the people harvesting their food, and supply chain challenges.

Challenges, suggestions, and discussion

Telling the RAS story. Daisy Berg advises putting the producer/farm's name and information in front of consumers to tell the story of where the food comes from. More on this in Berg's keynote.

Engaging with social media. Keyia Yalcin shared that Fishnet’s social media manager has observed that audiences increasingly tend to like seeing the process of how food is created, messy as it may be, rather than glossy photos of the finished product. It was also noted that social media relies heavily on very brief messaging, and it can be difficult to tell the whole story in a transparent and balanced fashion.

Growing overall seafood consumption in the United States. Focus on the sustainability perspective. Hook people by helping them to understand how fish is a sustainable protein.

Current level of aquaculture knowledge in consumers. Panelists responded that consumers mainly know to ask whether seafood is wild caught or farm-raised. Elevating knowledge beyond this point with the lay public and buyers is a challenge.

Aquaculture has a PR problem. We're not telling the story. We're not bringing the consumer along and educating them so that they know what they're eating. We need transparency and it doesn't need to be scientific, it needs to be very simple.

– Daisy Berg,
Seafood Merchandiser
for New Seasons Market



Panel 8: Waste Remediation and Water Re-use



Moderator

Damian Brady, Ph.D., *Professor of Marine Sciences at University of Maine*

Panelists

Andre Bravo, *Chief Operations Officer at Local Coho*

David Enggaard Pedersen, *RAS Engineering Manager at AquaCon*

Christine Lepine, *Research Support Specialist at The Conservation Fund Freshwater Institute*

George Nardi, *Vice President of Aquaculture Services at InnovaSea*

Keiko Saito, Ph.D., *Assistant Professor at University of Maryland, Baltimore County, IMET*

Dr. Zohar introduced this panel with a simple summary of a complex challenge: "For recirculating systems to be sustainable and environmentally responsible, they should be as contained as possible with minimal, if any, waste discharge into the environment." Significant research within the SAS² project network seeks to find uses for nutrient-rich waste by-products created in these systems. Uses can include direct application to farmland, the creation of compost or other shelf-stable amendments, and conversion of solid/organic waste to biogas that can be used in the farm for offsetting its energy requirements. More importantly, the industry and research and development partners are intensively working to minimize/eliminate the discharge of wastes from RAS altogether. Panelists presented on their research in waste remediation in recirculating systems, discharge reduction, and

current efforts to find uses for value-added by-products. Several panelists noted the economic importance of water remediation: water treatment costs and biofilters contribute significantly to the capital expenditures and operational costs of recirculating systems. Further optimizations (e.g., of the microbial communities involved in the waste remediation process) and advances in technology (e.g., integration of anaerobic digesters into RAS designs, recovery of salts from wastewater, etc.) are expected to lower these costs over time while increasing water re-use. As is the case with many of the challenges facing recirculating systems, the scale of the operation greatly influences the decisions in site selection, permitting, and waste remediation technology.

Challenges, suggestions, and discussion

Research questions to cut costs. Water and effluent treatment combine to be a major cost for producers (one industry representative said that treatment approaches \$3 per cubic meter of water) so treatment is a critically needed research area. However, several ‘industry-ready’ technologies (e.g., denitrification biofilters, anaerobic digesters) and others that are in the works (e.g., salt recovery) have great potential to increase production efficiencies and water re-use, as well as drive down costs.

Wastewater and water sourcing drive site selection. Wastewater and water sourcing is critical in site decisions and producers must understand the costs and treatment options before moving forward with a project. Again, as noted above and by the panelists, technological advances are expected to decrease the current siting and cost limitations.

The importance of siting. While panelists and audience members shared information about different wastewater experiences and technologies, there is no intake and discharge system that is the same because this part of the system depends on where the facility is situated in terms of location, water source, and where the facility will need to discharge (water treatment plant or back into the water source).

Keynote 2: *Landing Aquaculture in Salmon Country*

Daisy Berg, *New Seasons Market*

Daisy Berg presented a keynote about how she shifted her company’s long-held stance (and her own) from selling only wild-caught Pacific salmon to incorporating farmed salmon, and specifically RAS-produced salmon, into their offerings. A few lessons from the keynote:

- How did New Seasons transition from selling only fresh/frozen wild-caught salmon to offering farmed salmon from land-based RAS producers? Berg used staff education classes focusing on innovation in aquaculture and presented a webinar for all staff to learn about the decision. They also posted internal communications spelling out why the market shifted direction, telling staff that new technologies have provided a sustainable and safe production method. Then, the company began external promotion with social media campaigns and an email newsletter: “Sustainable farmed salmon has arrived at New Seasons Market.”
- What was the customer response? Surprising to Berg, there was little outcry from consumers. Seafood managers at the stores said that some customers seemed concerned but responded well to their talking points (no escapes, bio-secure facility, no pesticides). Signage was a major component of the rollout, and employees were trained in informing customers and providing customer service for this subject. When the market stopped offering the farmed Atlantic salmon (i.e., when the annual Pacific salmon season began again), customers complained that they wanted the Atlantic salmon back.
- “It’s a different customer” that wants the farmed Atlantic salmon, said Berg. She reports that taste preferences generally drive the decision to buy Atlantic versus Pacific salmon.
- Stores need to educate the staff to sell farmed fish. This is crucial to selling the product and the face-to-face interaction is not going away, even with the prevalence of other ways of telling a story, like social media. Berg brings in producers to tell New Season’s staff about their products as part of training.



Panel 9: Strategic Envisioning



Moderator

Brian Peterson, Ph.D., *Director of USDA's National Cold Water Marine Aquaculture Center*

Panelists

Max Holtzman, *Principal of Ocean 14 Capital*

Sabine Mader, *Technical Sales Specialist for Skretting*

Fredrika Moser, Ph.D., *Director of Maryland Sea Grant*

Marianne Naess, *Chief Executive Office of Katahdin Salmon (now renamed Great Northern Salmon)*

Jeff Silverstein, Ph.D., *Deputy Administrator for Animal Production & Protection, USDA Agricultural Research Service*

The SAS² program centers upon the success of land-based recirculating aquaculture systems, farming of Atlantic salmon, and contributing to the development and well-supported growth of sustainable aquaculture in the United States. This final conference panel brought together experts from several sectors of aquaculture to engage in strategic visioning discussions.

Dr. Silverstein cited a relevant quote: “Never doubt that a small group of thoughtful, committed, citizens can change the world. Indeed, it is the only thing that ever has.” – Margaret Mead

Challenges, suggestions, and discussion

The importance of strategic planning. Dr. Silverstein said, “All the projects—that I can think of and that I’ve been involved with—that have had successful forward momentum have started with a group that develops a strategic plan, makes sure that we have a common song sheet, understands the first priorities and second priorities, and works together.” Working together was a major theme of this conference, with a focus on crossing disciplines and innovating holistically.

Knowledge gap. Why isn’t RAS taking off in the US yet, given our seafood deficit and the popularity of Atlantic salmon? Ms. Naess reflected that a lot of international companies came in with great visions and with successful stories from overseas, but struggled to transplant those experiences directly into the US. “There were issues with poor site selection, legal issues, community support, stakeholder issues, permitting issues...”. Many projects stalled and this affected traditional aquaculture investors in Europe. The gaps we need to bridge are the perception of risk in the US market (using the knowledge from the larger-scale European aquaculture industry and an understanding of the US business system and market) and finding the right locations. Producers need to be able to understand permitting, community perception, and capital costs, as well as operating costs and infrastructure, to be able to compete with international projects and to move beyond the small-scale premium market.

What’s next. Maryland Sea Grant’s Dr. Moser asked what comes next strategically, and what does that look like, in terms of funding, grants, and collaboration? She suggested four categories that could be approached strategically: reducing carbon footprint; reassessing regulation and policy; engaging consumers, RAS communities, and other stakeholders; and supporting diversity. How do we go about broadening the conversation and telling these stories, while considering sustainability, increasing youth participation, and other things?

Collaboration Advice. Mr. Holtzman reminded the network to try to look holistically at the aquaculture industry, respect methods of production, and critique plans and designs when invited to do so. Don’t try to move too far ahead of public understanding; deliver education and outreach as developments are made so that the public are brought along with the science.

Scaling in RAS. Naess emphasized the need for a balanced approach, acknowledging the role of both small and large-scale operations. She stressed that while small-scale premium markets are important, the industry can't solely focus on this segment. Naess argued for the development of larger-scale operations to produce more commodity-priced products, addressing a broader market need. Holzman advocated for a smaller, distributed scale model. He expressed concerns about the risks associated with massive single-point facilities common in the salmon industry, proposing instead to start with smaller operations and potentially expand to multiple locations to achieve necessary production volumes. Both perspectives acknowledged the importance of scale in protein production but offered different strategies for achieving it.

Selling aquaculture as a focus area. Dr. Silverstein noted that the Department of Homeland Security recently found one of the biggest food security vulnerabilities is lack of domestic aquaculture production. This is due, in large part, to the United States' heavy reliance on foreign production for our seafood. Expand on this domestic shortcoming to emphasize the importance of developing this technology.

Engagement and outreach. There will always be a vocal minority against aquaculture, so a sustainable industry's success will rely on working to identify a non-confrontational middle ground where people can come to the table and learn. Companies and local producers should offer facility tours, engage with schools and restaurants, and think ahead toward producing a trained workforce.

More on collaboration. Moving forward, there is plenty of room for everyone in the US sustainable RAS sector. The number of players is currently limited and geographically disbursed. There is a need to see success and this network should cheer on success. It takes a lot of public-private partnerships to develop an industry, but growth of the RAS industry subsector nationally can be hampered by the fragmentation of policies and permitting in the US.

National education initiatives. A management team is needed to help develop education and outreach programs. Would it be possible to fund a third party (maybe through philanthropic support) to bring everyone together and have a team to support consistent outreach efforts? Also, it will be important to speak to the public about sustainability of RAS. Consider encouraging and engaging with third party non-governmental organizations (NGOs) validate the safety and sustainability of this technology and promote it. Consumers want a third party to tell them that RAS fish is safe to eat and good for the planet.

Closing Remarks

Dr. Steve Summerfelt, SAS² Steering Committee Chair and Chief Science Officer of Superior Fresh, delivered closing remarks for the conference. Dr. Summerfelt emphasized the importance of the network and the many benefits that can be attained for US aquaculture by sticking to the mission and core values of SAS². "Connect, communicate, collaborate, and engage," concluded Summerfelt. As a consortium, our work can and should be purposeful, collaborative and transformative. But the scientists collaborating within this network need to hear directly from stakeholders, especially those from the industry. Research needs to be relevant. And this is what SAS² is all about.

We have the foundation and the necessary framework to fundamentally change and advance the future of US seafood production. Moving beyond this conference, all consortium members should continue engaging with one another remotely, and we hope to come back together at another SAS² meeting in the future.



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