PROGRAM and ABSTRACTS

Northeast Aquaculture Conference & Exposition

and the

45th Milford Aquaculture Seminar

January 7-9, 2026
Holiday Inn by the Bay
Portland, Maine

NACE/MAS 2026 At A Glance

	Wednesday, January 7 2026						
8:40 AM - 1:30 PM	**Field Trips depart at various times (depart from the Hotel Lobby)**						
9:00 AM - 5:00 PM	**Workshops meet at various times**						
4:00 PM	**Registration opens in Hotel Lobby**						
5:00 - 7:00 PM	**Maine Dept. of Marine Resources Biotoxin Industry Roundtable (in the Connecticut Room)**						
7:00 PM	**Opening reception in the Casco Bay Exhibit Hall (Trade show opens)**						
	Thursday, January 8 2026						
7:00 AM	**Registration in Lobby**						
7:00 AM	**Continental breakfast in the Casco Bay Exhibit Hall**						
8:30 AM	**Plenary Session in the State of Maine Ballroom (Vermont)**						
10:00 AM	**Break in the Casco Bay Exhibit Hall**						
	Vermont Room	**New Hampshire Room**	**Massachusetts Room**	**Rhode Island Room**	**Connecticut Room**	**Cumberland Room** (second floor)	**Oxford/Somerset** (second floor)
10:30 AM	**Seaweed Food Safety Guidance Panel** Chair: Jen Perry	**Shellfish & Birds** Chair: Bob Rheault	**Scallops I: Scallop Hatchery** Chairs: Craig Condon & Kyle Brennan **Scallops II: General** Chair: Bassem Allam	**Workforce Development I** Chair: Maya Pelletier	**Sea Urchins** Chair: Coleen Suckling	**Social Dimensions** Chairs: Emily Whitmore & Adriane Michaelis	**Beyond the Half shell: Alternative shellfish processing methods** Chairs: Meggan Dwyer & Qiujie "Angie" Zheng
12:00 PM	**Lunch in the Casco Bay Exhibit Hall**				**Film & Discussion: One Bad Crab @ 12:30** by Sandy Cannon Brown	**Lunch**	
1:30 PM	**Seaweed Farmer Forum** Chair: Jaclyn Robidoux	**General Shellfish** Chair: Katyanne Shoemaker	**Scallops III:** Chair: Phoebe Jekielek	**Workforce Development II** Chair: Lisa Eddy	**Worker Safety:** Chair: Christian Brayden	**Collaborative Management Panel** Chair: Kohl Kanwit	**Models for Future Opportunity and Access in Aquaculture** Chair: Dana Morse
3:00 PM	**Break in the Casco Bay Exhibit Hall**						
3:30 PM	**Seaweed General** Chair: Dan Wieczorek	**Indigenous Aquaculture** Chair: Shannon Hill	**Scallop Aquaculture Exchange: Learning Together for a Growing Industry** Chair: Phoebe Jekielek	**K-12** Chair: Keri Kaczor	**Tough Work! Workshop** Session Leader: Toni Small	**Mussel Hatchery Roundtable** Chairs: Kyle Pepperman & Emily Whitmore	**Recapturing and Reuse of Plastics in the Aquaculture Industry** Chair: Dana Morse
5:00 PM	**Poster Session & Trade Show: Happy Hour in the Casco Bay Exhibit Hall**						
6:30 PM	**ECSGA Annual Meeting (123 Washington Ave)**						
6:30 PM	**Dinner on your own out on the town**						

	Friday, January 9 2026					
7:00 AM	**Registration in the Lobby**					
7:00 AM	**Continental breakfast in the Casco Bay Exhibit Hall**					
	Vermont Room	**New Hampshire Room**	**Massachusetts Room**	**Rhode Island Room**	**Connecticut Room**	**Cumberland Room**
8:00 AM	**Seaweed nursery** Chair: Scott Lindell	**Hatchery I** Chair: Meredith White	**Making Sense of Sensors: Monitoring Environmental Data on Aquaculture Farms** Chairs: Emily Whitmore & Tom Kiffney	**Aquaculture Restoration & Conservation** Chair: Annie Fagan	**General Aquaculture I** Chair: Gillian Phillips	**Oysters I** Chair: Mariah Kachmar
10:00 AM	**Break in the Casco Bay Exhibit Hall**					
10:30 AM	**Maine Seaweed Council Collaboration, Innovation & Research** Chairs: Jaclyn Robidoux & Steve Eddy	**Hatchery II** Chair: Meredith White	**Advances in Quahog Aquaculture Panel** Chair: Marissa McMahan	**Ecosystem Services** Chair: Matthew Poach	**Sea Lice** Chairs: Mike Pietrak & Matt Hawkyard	**Oysters II** Chair: Isaiah Mayo
12:00 PM	**Lunch in the Casco Bay Exhibit Hall**				**Film & Panel: Climate of Change: Aquaculture for People and Planet @ 12:30**	**Lunch**
1:30 PM	**Advances in Gear Technology I** Chair: Chris Davis	**Bivalve Hatchery Health** Chair: Marta Gomez-Chiarri	**Clams** Chair: Shannon Meseck	**Business of Aquaculture** Chair: Kevin Madley	**Finfish** Chair: Matt Hawkyard	**Aquaculture in a Changing Environment** Chair: Dan Wieczorek
3:00 PM	**Break in the Casco Bay Exhibit Hall**					
3:30 PM	**Advances in Gear Technology II** Chair: Chris Davis	**Priorities for the Genetic Improvement of Oysters Workshop** Chair: Thomas Delomas	**TikTok – Times Are Changing** Chair: Corinne Noufi	**Business Planning Tools** Chair: Nick Branchina	**General Aquaculture II** Chair: Deborah Bouchard	**Ocean Acidification Workshop** Chair: Austin Pugh
5:00 PM	**Closing Remarks & Sendoff Toasts**					

Welcome to NACE/MAS 2026!

The Northeast Aquaculture Conference and Exposition (NACE) and Milford Aquaculture Seminar (MAS) is co-hosted by the Maine Aquaculture Innovation Center and NOAA Milford Lab, and we are excited to welcome you to this joint meeting. With numerous challenges facing the aquaculture sector, the need for industry-relevant applied research, innovation, and communication is greater than ever. By bringing together farmers, processors, manufacturers, resource managers, extension specialists, researchers, and students (and many more) we hope to encourage the sharing of knowledge that will allow our sector to thrive.

This year's event is set to feature an engaging program with 45 sessions covering finfish, sea vegetables, and shellfish farming, as well as a record number of posters in the Thursday Poster Session. We have the largest tradeshow we have ever hosted, showcasing leading aquaculture vendors from across North America. Additionally, on Wednesday there will be seven informative workshops, and four field trips to local aquafarms and research facilities. And last but not least we will celebrate farmed seafood from across the Northeast at the Opening Reception on Wednesday.

A massive thank you to the enormous number of people who make this event a success. Every tradeshow vendor, sponsor, chair person, presenter, field trip host, seafood provider - we could not make this event happen without you.

Thank you for supporting NACE/MAS 2026! We hope you have a fantastic time!

NACE/MAS 2026 Organizing Committee

Anne Langston Noll, Emily Whitmore, Sydney Avena & Chris Davis – MAIC
Lisa Milke - NOAA National Marine Fisheries Service Milford Laboratory
Gef Flimlin – Emeritus Professor of Aquaculture, Rutgers University Cooperative Extension

With special thanks to:
Pat Widman & all the staff from NOAA National Marine Fisheries Service Milford Laboratory
Maya Pelletier, Josh Richards, Antoine Mier, & Grace Adams-Kollitz - MAIC
Melissa Bailey - Holiday Inn by The Bay
Marty Lawson - Headlight AV
Our field trip hosts: Matt Nixon, Ken Sparta, Allie Edmund, Carissa Maurin, Matt Moretti, Zach Gordon, Jaclyn Robidoux, Tim Arienti, Chris Gregoricus, Matthew Duddy, Toby Dewhurst, Nick Planson, Chris Cary, the Maine Women and Non-binary in Aquaculture Network, Women of the Water, Savannah Stresser, Jonathan van Senten, Tessa Getchis, Devon Smolack, Jahnvi Jayvantkumar Tandel, and Bob Rheault

Thank you to our Sponsors!

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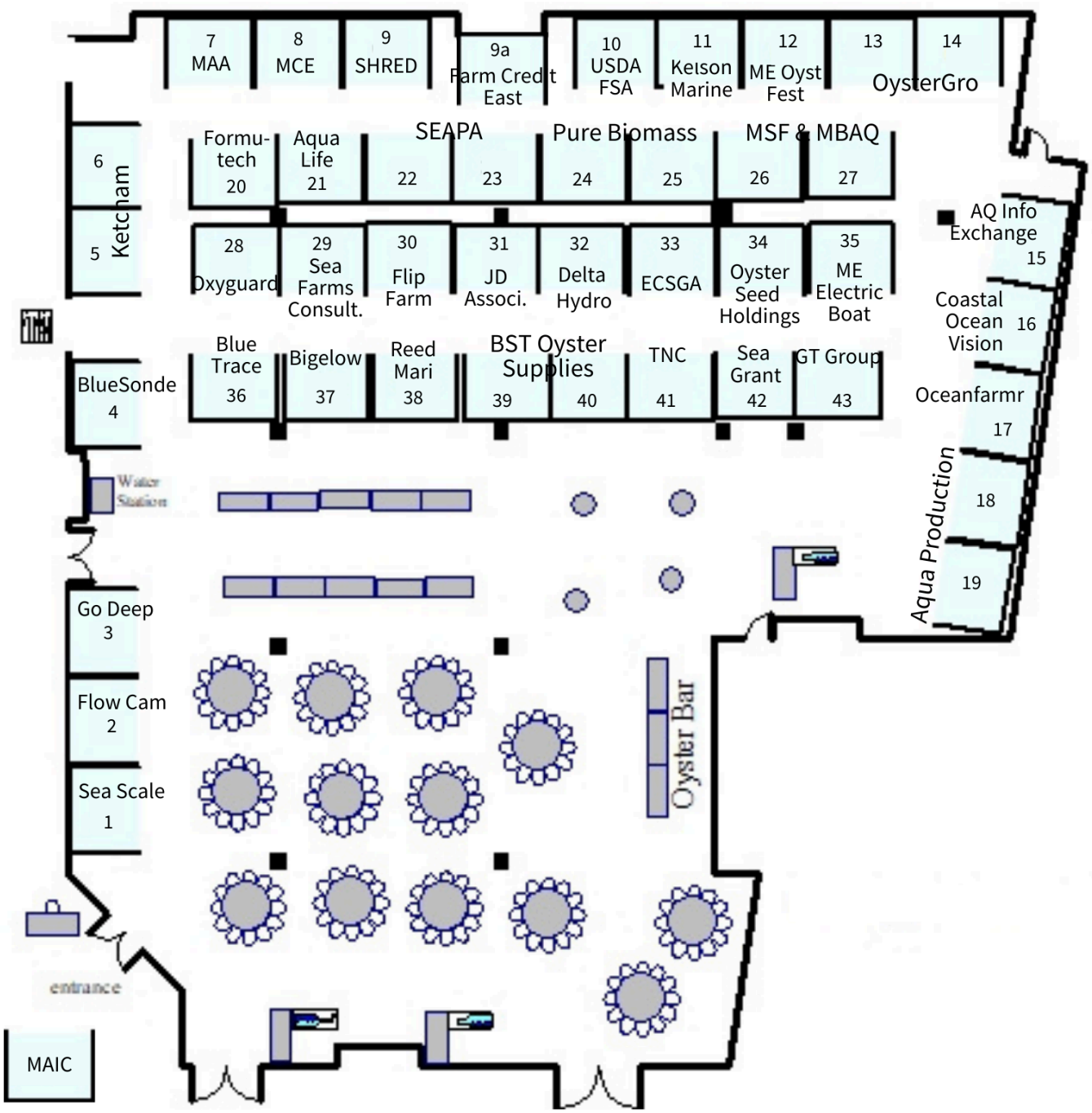
Tradeshow Map
Casco Bay Hall



Thanks to Our Exhibitors!

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NACE/MAS Aquaculture Conference Schedule

WEDNESDAY JANUARY 7

8:45 AM - 5:00 PM — **Field Trips & Workshops (meet in the Hotel Lobby)**

12:00 PM — **Registration opens in the Hotel Lobby**

5:00 - 7:00PM — **Maine Dept. of Marine Resources Biotoxin Industry Roundtable (Connecticut Room):**
Are you a Maine oyster farmer? Were you impacted by the red tide closures last summer? Come talk directly to the Maine Department of Marine Resources about how to improve the monitoring and management of red tide/Paralytic Shellfish Poisoning specifically in American oysters. We will discuss what we know about red tide blooms in coastal Maine waters, how red tide impacts American oysters and how the growth of the aquaculture industry is changing traditional sampling regimes. This is a workshop style event so Maine farmers should bring their questions and ideas!

7:00 PM — **Opening Reception in the Casco Bay Exhibit Hall (trade show opens)**

THURSDAY JANUARY 8

7:00 AM — **Registration in Hotel Lobby**

7:00 AM — **Breakfast in Casco Bay Exhibit Hall**

8:30 AM — **Plenary Session in the State of Maine Ballroom (Vermont/New Hampshire)**

Rapid Fire Industry Updates of Issues Facing Northeastern US States and Canadian Maritimes

10:00 AM — **Break & Trade Show Opens in the Casco Bay Exhibit Hall**

	Vermont Room	New Hampshire Room	Massachusetts Room	Rhode Island Room	Connecticut Room	Cumberland Room (2nd Floor)	Oxford Room (2nd Floor)
	Seaweed Food Safety Guidance Panel *Chair: Jen Perry*	**Shellfish & Birds** *Chairs: Bob Rheault & Bobbi Hudson*	**Scallops I - In The Hatchery** *Chairs: Craig Condon & Kyle Brennan*	**Workforce Development I** *Chair: Maya Pelletier*	**Sea Urchins** *Chair: Coleen Suckling*	**Social Dimensions of Aquaculture** *Chairs: Emily Whitmore & Adriane Michaelis*	**Beyond the Half Shell: Alternative Shellfish Processing Methods** *Chairs: Meggan Dwyer & Qiujie "Angie" Zheng*
10:30 AM	**PANEL SESSION** Advances in seaweed aquaculture, coupled with growing awareness of its health benefits, sustainability, and culinary versatility have led to expanded domestic supply and the development of diverse new food products. Like all foods, seaweed products carry potential food safety risks. However, due to the relative novelty of seaweed as a food commodity in the U.S., there is limited guidance and few seaweed-specific food safety requirements. To support safe growth of this nutritious commodity, clear national guidance is needed to identify and mitigate key food safety hazards. A Seaweed Food Safety Guidance document was developed to help regulators, producers, processors, and retailers assess and manage risks associated with seaweed products in the U.S. As domestic aquaculture expands, this emerging industry offers opportunities for sustainable food production and economic growth. The guidance document can support safe practices, regulatory compliance, and consumer confidence. Building on existing national and international resources, this guide provides a flexible framework tailored to diverse species, environments, and regulations—promoting consistency and safety across regional and national markets. Authors of this guide will present selected content and answer questions.	Bird-Related Pathogen Risk in Shellfish Aquaculture *Bob Rheault*	What We Think We Know: Lessons Learned In Five Years Of Cross Hatchery Collaboration On The Standardization Of Production Of The Atlantic Sea Scallop, *Placopecten Magellanicus.* *Tessa Houston & Craig Condon*	Cultivating the Next Generation: Building a Multidisciplinary Workforce Pipeline for U.S. Aquaculture and Fisheries *Imani Black*	Cultivating Opportunity: Progress in Green Sea Urchin Farming in Coastal Maine Waters *Seth White*	Expanding Aquaculture by Expanding our Undestanding of Social Acceptability: An Assessment of Social Acceptability for Aquaculture in Three Regions of the United States *Adriane Michaelis*	**PANEL SESSION:** This panel brings together researchers and industry leaders to explore innovative approaches to processing that extend beyond the traditional half shell. Panelists will examine methods such as high-pressure processing (HPP), canning, smoking, jarring, and alternative shelf-stable packaging, with attention to how these techniques can improve food safety, extend shelf life, diversify product offerings, and expand consumer access. The discussion will also address consumer willingness to pay for alternative sizes, packaging, and certification schemes, highlighting how market preferences influence product development and adoption. By integrating perspectives from science and industry, the panel will consider both the technical and economic dimensions of value-added processing, and the role these innovations can play in strengthening aquaculture resilience and shaping the future of seafood markets.
10:45 AM		Do Temporal Patterns in Bird Distribution and Abundance Facilitate Pathogen Contamination of Shellfish on Floating Aquaculture Farms? *Dylan Bakner*	The Use of Probiotics to Mitigate Atlantic Sea Scallop (*Placopecten magellanicus*) Mortality Following Challenge with Pathogenic Vibrio Species *Kyle Brennan*	Cultivating Maine's Next Generation of Workforce Professionals *Carissa Maurin*	Optimizing Green Sea Urchin (*Strongylocentrotus droebachiensis*) Co-Culture Systems With Atlantic Sea Scallops (*Placopecten magellanicus*) to Control Bio-Fouling *Brendan Elba*	Who Should I Trust? Assessing Determinants of Public Confidence in Different Sources of Information about Aquaculture and Seafood Safety in Maine *Tom Safford*	
11:00 AM		Evidence Suggests Insignificant Risk Of Contamination From Birds *Bobbi Hudson*	The Beginning Of A Story: Immune System Development Of The Atlantic Sea Scallop *Nichole Blackmer*	WCCC's Aquaculture Pathways: Meeting Today's Needs, Building Tomorrow's Workforce" *Nichole Sawyer*	Integrating grazing Atlantic purple sea urchins with Eastern Oysters to reduce biofouling – recent successful research and next steps. *Coleen Suckling*	Navigating Farms, Fisheries, and Communities: A Social-Ecological Systems Perspedtive From Maine *Sarah Risley*	
11:15 AM		Oyster Farms as Habitat: Seasonal and Gear-Specific Impacts on Coastal Waterbird Communities *Martina Muller*	**Scallops II - Bay Scallop Marosporida** *Chair: Bassem Allam* Distribution of Bay Scallop Marosporida (Bsm) in the Host (*Argopecten irradians*) and Environmental Samples from the Peconic Estuary, NY *Guillaume Cacot*	The Commercial Oyster Aquaculture Sector Training (COAST) Program: Phases I & II *Russell Grice*	Technology Transfer Visit to Hokkaido, Japan in Support of Maine's Growing Farmed Sea Urchin Industry *Hugh Cowperthwaite*	Demographics, Spatial Concentration, and Localness in the US Shellfish Aquaculture Industry *Louisa Pitney*	
11:30 AM		Bird-Related Pathogen Contamination in Shellfish Aquaculture: A Comprehensive Literature Review *Nicole Martin*	Temperature Effects on Bay Scallop Marosporida (Bsm) Dynamics in *Argopecten irradians* *Kristen Savastano*	Beyond The Basics for Businesses and Practitioners *Rob Hudson*	**Discussion**	Addressing Labor Demand and Production Efficiency in Shellfish Aquaculture *Caela Gilsinan*	
11:45 AM		Assessing Depuration Of *Campylobacter* Spp. From Oysters *Nicole Richard*	Evidence For Direct Transmission Of Bay Scallop Marosporida in *Argopecten irradians* *Emmanuelle Pales Espinosa*	AIM for a Growing Workforce *Danny Badger*		Values, Risks, and Trust: Understanding Determinants of Stage Progression Within the Social License to operate Framework *Nathan Smith*	

12:00 PM — **Lunch in the Casco Bay Exhibit Hall**

	AFTERNOON OF THURSDAY JANUARY 8						
12:30 -1:30 pm	**Lunch in the Casco Bay Exhibit Hall**				**Film & Discussion: One Bad Crab @ 12:30** by Sandy Cannon Brown	**Lunch**	
	Vermont Room	**New Hampshire Room**	**Massachusetts Room**	**Rhode Island Room**	**Connecticut Room**	**Cumberland Room (2nd Floor)**	**Oxford Room (2nd Floor)**
	Seaweed Farmer Forum *Chair: Jaclyn Robidoux*	**General Shellfish** *Chair: Katyanne Shoemaker*	**Scallops III** *Chair: Phoebe Jekielek*	**Seeding Success: Innovative Workforce Development Programs in Aquaculture** *Chair: Lisa Eddy*	**Worker Safety** *Chair: Christian Brayden*	**Collaborative Management in Aquaculture** *Chair: Kohl Kanwit*	**Models for Future Opportunity and Access in Aquaculture** *Chair: Dana Morse*
1:30 PM	**PANEL SESSION**: Join this farmer-focused panel session to hear directly from seaweed farmers across the Northeast about their experiences on the water and the ways they are navigating and building new opportunities in the developing seaweed sector. Farmers will share perspectives on the most current production strategies and challenges, on-farm innovations, and approaches to getting crops to market. From repurposing gear and managing small-boat family farms and cooperatives, to navigating seasonal workflows and labor, to exploring new product opportunities, panelists will provide a comprehensive look at the realities and opportunities in the Northeast seaweed industry. This session is designed for farmers considering seaweed, aquaculture practitioners, researchers, and policy professionals who want to learn directly from growers navigating a changing seaweed sector. Audience discussion will be encouraged.	Advancing Ribbed Mussel (*Geukensia demissa*) Spawning Protocols to Accelerate Commercialization and Meet Growing Demand *Sean Towers*	Maine Scallop Fishery and the Connection with Scallop Aquaculture *Carlton Huntsberger*	**PANEL SESSION:** This panel will bring together program leaders from across the region to share their approaches, highlight successes, and candidly discuss the challenges faced in developing and sustaining workforce initiatives. Panelists will present examples of their projects, outlining what worked well and what barriers emerged—from program design and recruitment to partnerships and long-term sustainability. They will also share feedback received from industry partners and participants, offering insights into how programs can better align with employer needs and trainee expectations. The discussion will conclude with practical advice and lessons learned for others considering launching similar efforts. By examining the wide range of projects, this session aims to provide participants with a deeper understanding of effective strategies for workforce development in aquaculture, while fostering conversation about regional collaboration and how we can continue to meet the needs of the industry.	Safety in Aquaculture: Atlantic Aqua Farms Perspective *Jacob MacMilan*	**PANEL SESSION:** The growth of aquaculture in northeastern states and in Canada have required increased investment in the regulatory system and the revision of laws and regulations as the industry matures. Efforts to revise laws and regulations are frequently approached through a cooperative system. In Maine, the legislatively created Aquaculture Advisory Council (AQAC) was reformed in 2023 to include more council seats and a broadened scope of work. Since that time, the AQAC has initiated committees to work on specific topics that have resulted in draft legislation. In New Hampshire, regulatory officials worked with industry to revise their floating gear policy to address the risk to public health from birds. In Rhode Island, a revision of the Aquaculture of Marine Species regulation in 2024 also involved industry collaboration. These and more examples of collaborative management in aquaculture will be discussed to inspire and strengthen successful relationships between regulatory bodies, industry members and the public.	Understanding How Participatory Planning Influences Aquaculture Development *Joshua Richards*
1:45 PM		Tisbury Shellfish Department: A look into Municipal Aquaculture *Danielle Ewart*	Status of Scallop Aquaculture *Lisa White & Bryant Lewis*		Aquaculture Safety Culture: Leading, Protecting, and Growing by Example *Josh Bernier*		Massachusetts Examples of Aquaculture Policy as it Relates to Shellfish Aquaculture Site Availability *Joshua Reitsma*
2:00 PM		Simple Molecular Tests for Monitoring Wild Blue Mussel larvae: Leveraging Environmental RNA to Optimize Spat Collection *David A. Ernst*	Patterns of biotoxins in cultured Maine scallops *Tom Kiffney*		Aquaculture Workplace Safety *Antonia Small*		It Took a Village *Pat Burns*
2:15 PM		A Machine-Learning Based, Shellfish Biotoxin Forecasting Method: Successes from Maine, Opportunities for Other Regions *Johnathan Evanilla*	Spat Happens: Linking Wild Scallops and Aquaculture Futures *Phoebe Jekielek & Struan Coleman*		The Costs, Benefits, and Resources of Workplace Safety *Stephen Badger*		**Discussion**
2:30 PM		Spawning Under Stress: Impacts of Bay Scallop Reproduction on Their Vulnerabilities to High Temperatures and Hypoxia *Alison Novara*	Assessing the Potential for Bay Scallop Aquaculture In Maine *Aiden Coleman*		**Discussion**		
2:45 PM		Atlantic Surfclam Subspecies (*Spisula solidissima solidissima* and *S. s. similis*) can Produce Fertile Hybrid Offspring *Michael Acquafredda*	Technology Transfer Visit to Aomori and Hokkaido, Japan in Support Of Maine's Growing Farmed Sea Scallop Industry *Hugh Cowperthwaite*				
3:00 PM	**Break at the Casco Bay Exhibit Hall**						

	Vermont Room	New Hampshire Room	Massachusetts Room	Rhode Island Room	Connecticut Room	Cumberland Room (2nd Floor)	Oxford Room (2nd Floor)
	General Seaweed Aquaculture *Chair: Dan Wieczorek*	**Indigenous Aquaculture in the Northeast US** *Chair: Shannon Hill*	**Scallop Aquaculture Exchange: Learning Together for a Growing Industry** *Chair: Phoebe Jekielek*	**K-12 Education** *Chair: Keri Kaczor*	**Tough Work, Smart Moves: Caring for the Body in Coastal Aquaculture** *Chair: Antonia Small*	**Blue Mussel Hatchery Feasibility Roundtable** *Chairs: Kyle Pepperman & Emily Whitmore*	**Recapturing and Reuse of Plastics in the Aquaculture Industry** *Chair: Dana Morse*
3:30 PM	Development of a Seaweed Calculator for Nitrogen Removal *Carrie Byron*	**PANEL SESSION:** Rooted in centuries of ecological wisdom, indigenous aquaculture fosters a deep connection to land and water, ensuring communities can adapt to environmental changes and maintain access to healthy, culturally relevant food. This panel session is a forum for indigenous aquaculturists to share insights about their aquaculture operations, practices, challenges, and opportunities. It aims to foster collaboration and strengthen relationships between Tribal Nations, promoting mutual learning and support. Panelists will include Indigenous leaders, aquaculture experts, and environmental scientists who will share insights into traditional ecological knowledge and contemporary aquaculture practices. The panel will highlight successful case studies of Indigenous-led aquaculture projects, illustrating how these initiatives not only support local economies but also foster community health, wealth and resilience, cultural identity, and Indigenous sovereignty and self-governance.	**WORKSHOP:** If you've been growing scallops on your farm, or if you're thinking about growing them, please join us to learn and troubleshoot together! We will bring together scallop growers, researchers, managers, and those interested in starting to grow sea and/or bay scallops to share their stories and experience. We'll start by hearing from current growers to learn about the species they're growing, the gear they use, the markets they target and how they do it, and what works and what doesn't work for them and their business. We'll also learn about publicly available tools and resources to help new and existing growers share knowledge on best practices, developed in partnership with researchers at UMaine. These overviews will be followed by a discussion with growers and ample time for audience Q&A and networking. We will have the different gear types (lantern/pearl nets, spat bags, Sea Scale cages, etc.) available to explore and information on where to get them, how much they cost, and which might be the best for your farm. The goal of this session is to bring people together to highlight the growth potential of scallop farming in Maine, shed light on challenges that growers are still facing in the state, and to discuss how we move this industry forward together.	Cultivating the Next Generation of Aquaculture Leaders: The Impact of Experiential Learning on Title I Middle School Students in Washington State *Megan Ewald*	**PANEL SESSION:** This session brings together perspectives from Maine AgrAbility's FishAbility Program, the Maine Coast Fishermen's Association, and Labor-Movement to share practical strategies that address both physical and mental well-being in working waterfront communities. Participants will learn approaches to reduce wear and tear, build strength for longevity, and support bodies in adapting to the changing demands of gear, seasons, and shifting oceans. Attention will also be given to the broader systems of support fishermen need, from assistive technology, access to movement health resources to advocacy for mental health care and community-based solutions. By framing fishermen, aquaculture growers, and other industrial workers as "industrial athletes," this session underscores the importance of movement, recovery, and long-term sustainability in physically demanding careers. Attendees will gain tools they can adapt to their own outreach, training, or healthcare practices, as well as insight into the resilience and innovation already present within fishing communities. Together, we explore how movement, wellness, and community partnerships can help ensure that those who feed our coastal regions can continue to work safely, productively, and with dignity.	**ROUNDTABLE:** Over the last few decades, researchers and industry members have noted a significant decline in wild blue mussel abundance and reduced recruitment of wild spat in the Gulf of Maine. Given that both wild and farmed mussel landings in Maine are currently heavily dependent on the recruitment and survival of wild mussel spat, population decline poses a major threat to both sectors. In response to this, there has been growing interest and demand for hatchery reared mussed seed. Currently, the demand is higher than what is currently produced, prompting a collaborative effort between Downeast Institute and the Maine Aquaculture Innovation Center, with support from Builders Initiative, to explore the feasibility of expanding hatchery reared mussel production in the Northeast. This workshop will include a short presentation on the results from an industry round table that included growers and hatchery experts and will then move into a facilitated group discussion to gather broader industry perspectives. This discussion will inform the creation of a roadmap that outlines concrete steps towards a commercial mussel hatchery.	University of Maine's Advanced Structures and Composites Center *Andy Gifford*
3:45 PM	Achieving Success in Launching CPG Seaweed Products *Trey Angera*			pending *Carla Scocchi*			Foamed Lobster Shell Composites for Thermal Insulation and Packaging Applications *Olivia Lee*
4:00 PM	How Low Can You Go (realistically)? Minimizing the Cost of Producing Kelp Offshore *Zachary Moscicki*			Building a Robust Pipeline to Aquaculture Careers in Maine through Workforce Development & Education Initiatives *Maya Pelletier*			Reducing Marine Debris in the Gulf of Maine: Educating and Empowering Boaters to Be Part of The Solution *Keri Kaczor*
4:15 PM	Testing Offshore Deep-water Cultivation of Sugar Kelp (*Saccharina latissima*) in the Gulf of Maine Adam St. Gelais			The Sound School Shellfish Hatchery: Utilizing a Shellfish Hatchery in a High School setting to develop Workforce Skills and Support Local Farms in Connecticut *Leila Strebel*			Reimagining Plastic-Based Aquaculture: Investigating Viable Alternatives *Abby Barrows*
4:30 PM	Increasing Access to Seaweed Processing for Farners in New England with Atlantic Sea Farms Co-Processing Services Liz MacDonald			Expanding Awareness of Aquaculture as a Viable STEM Career for Maine's *Carissa Maurin*			**Discussion**
4:45 PM	MacroBreed: Modernizing Kelp Aquaculture Through Selective Breeding Gary Molano			Shell-ebrate! Bivalve Education for K-12 Classrooms Kristel Anuszewski & Colleen Maker			
5:00 PM	**Poster Session & Happy Hour in the Casco Bay Exhibit Hall**						
6:30 PM	**ECSGA Annual Meeting at The Shop (123 Washington Ave)**						
6:30 PM	**Dinner on your own out on the town**						

	MORNING OF FRIDAY JANUARY 9					
7:00AM	**Registration in the Hotel Lobby**					
7:00AM	**Continental breakfast in the Casco Bay Exhibit Hall**					
	Vermont Room	**New Hampshire Room**	**Massachusetts Room**	**Rhode Island Room**	**Connecticut Room**	**Cumberland Room (2nd Floor)**
	Seaweed Nursery *Chair: Scott Lindell*	**Shellfish Hatcheries I** *Chair: Meredith White*	**Making Sense of Sensors: Monitoring Environmental Data on Aquaculture Farms** *Chair: Tom Kiffney & Emily Whitmore*	**Aquaculture Restoration & Conservation** *Chair: Annie Fagan & Sarah Risley*	**General Aquaculture I** *Chair: Gillian Phillips*	**Oysters I** *Chair: Mariah Kachmar*
8:00 AM	How Can Land-based Systems Facilitate Selective Breeding Advancements for Open Ocean Seaweed Aquaculture? *Danial J. Gossard*	Testing Larval Oyster Biocompatibility with Buffered Seawater from Novel CO_2 Removal Technology *Esther Martin*	**WORKSHOP:** The 2024 Maine Aquaculture Research, Development and Education Survey highlighted an emerging need for aquaculture farmers–hyper local environmental data. Farmers were interested in monitoring a variety of parameters on their farm, and were willing to share the data with others. At the same time, researchers have expressed a need for improved nearshore environmental data to improve modeling and forecasting, which can help aquaculture farmers plan for the future. In response, the Maine Aquaculture Innovation Center, in collaboration with the University of Maine and supported by the Nature Conservancy, have launched a pilot project testing out monitoring systems on farms in midcoast and downeast Maine. This workshop will include a short overview of the project, a presentation of the data collected on midcoast and downeast aquaculture farms over the past 4 months, followed by a farmer panel and facilitated discussion. The farmer panel will include farmers who piloted different systems during the fall of 2025. Discussion topics will include: -Identification of key parameters that are most useful for aquaculture farmers -How data is or can be used in decision-making on farms -Available systems, ease of use, costs, and capabilities -Data accessibility and options for data dashboards Discussion from this workshop will inform next steps for expanded environmental monitoring on aquaculture farms across the state and how this initiative can most effectively meet industry needs.	Conservation Aquaculture of Lake Sturgeon in Manitoba, Canada *Gwangseok R. Yoon*	New York Aquaculture: A Summary of the Industry and Ongoing Extension Efforts to Support It *Barry Udelson*	Field Performance Evaluation of Selectively Bred Eastern Oyster Lines in New Jersey and Rhode Island *Seraphina Satkowski*
8:15 AM	Building a Sustainable Kelp Industry: The Role of Gametophyte Based Nurseries and Optimized Infrastructure *David Bailey*	Multi-strain Probiotic Cocktail Improves Bivalve Resilience Against Hatchery Pathogens *Jaypee Samson*		Assessment of Natural Oyster Population Health and Dynamics to Inform Restoration and Aquaculture Planning in Long Island Sound: Part 1, Connecticut *Mariah Kachmar*	Connecting Sea Grant, The National Centers for Coastal Ocean Sciences, and Coastal-Ocean Communities to Improve Sustainable Aquaculture Development and Siting Processes *Annie Schatz*	Predicting Long Term Outcomes for the Eastern Oyster Crassostrea virginica using Genetic Composition and Environmental History *Camille Rumberger*
8:30 AM	Microbiota Management Strategies for Gametophyte Nursery Maintenance Plans *Amy Jones*	Victories & Challenges for Growing Alternative Species in a Commerical Oyster Hatchery & Nursery *Hannah Pearson*		Assessment of Natural Oyster Population Health and Dynamics to Inform Restoration and Aquaculture Planning in Long Island Sound: Part 2, New York *Isaiah Mayo*	Determining Nutritional Content of Gulf of Maine Seaweed and Selection for Best Analytical Practices *Brittney Honisch*	Pilot Testing the Timing and Effectiveness of Two Dip Treatments for Control of Shell Pests in Cultured Oysters *Joshua Reltsma*
8:45 AM	A Systematic Approach to Gametophyte Biobanking in the Gulf of Maine as a Tool for Nursery Resiliency and Conservation of Biodiversity *Sara Lacourciere*	Rapid and Sensitive eDNA Tools to Identify Pathogens of Juvenile Oysters, Larvae, and Seed. *Peter Countway*		**PANEL:** Beyond serving as a means of food production and an engine for economic growth, aquaculture is also advancing ecosystem restoration goals here in the Northeast and across the world. However, what "restoration" means and how best to approach it can vary widely depending on who you ask! What makes these projects successful - or not? What can they accomplish? And what's on the horizon? In this panel discussion, we will dive into the opportunities and challenges of aquaculture-based restoration and explore topics like project siting, permitting, social license, industry and community involvement, biosecurity, educational initiatives, monitoring, and long-term sustainability of restoration projects. This panel will feature a range of perspectives from researcher and regulator to nonprofit conservation leadership and extension. With panelist participation from multiple states in the region, we will hear about the diversity of approaches and learnings across the Northeast. Join us, listen in, and bring your own questions, as we learn from one another in this engaging conversation.	Aquaculture & Protected Species: A Collaborative Approach to Risk Reduction *Ellen Keane*	Perspective on the Disease Status of Seed Oysters from Nursery-Phase Culture *Ryan Carnegie*
9:00 AM	Optimizing Vegetative Scaling of Multi-Annual Delayed *Saccharina latissima* Gametophytes in a Replicated Photobioreactor System *Adam St. Gelais*	Experiences in the optimization of microalgal feeding systems in a shellfish hatchery *Isaac S.K Reeves VII*			Charting the Course: NOAA Science, Innovation, and Partnerships *Daniel Wieczorek*	U.S. Oyster Production: Recent Trends and Market Potential *Bob Rheault*
9:15 AM	Why Selection Matters in Seaweed Aquaculture *Thew Suskiewicz*	Will a "Heat-Killed" Formulation of Probiotic Strain OY15 Exert Beneficial Probiotic Effects on Larvae of the Eastern Oyster (*Crassostrea virginica*) Similar to That of the Live OY15 Formulation? *Diane Kaparelko*			Consumer Valuation of Innovation-Driven Attribute Improvements in Aquaculture: The Case of Maine Oysters *Qiuije Zheng*	Major Industry Advancements in Oyster Mariculture *Christopher Webb*
9:30 AM	Optimizing gametogenesis and sporophyte production with multi-annual delayed sugar kelp (*Saccharina latissima*) gametophytes for improving kelp nursery productivity *Hadley Kerr*	Improving Resilience of Hatchery-Reared Blue Mussels (*Mytillus edulis*) to Ocean Acidification with Diet and Seawater Buffering *Robert Holmberg*			Supporting Oyster Aquaculture and Restoration (SOAR) 2.0 Overview *Kelsey Meyer*	High Precision Research on Environmental Stressors, Genetics, and the Microbiome to Improve Oyster Aquaculture Yields *Kristina Colacicco*
9:45 AM	Selectively Breeding Improved Strains of Sugar Kelp, *Saccharina latissima*; A Seven-Year Summary *Scott Lindell*	Lessons Learned in Efficiency: Insights from a Non-Profit Shellfish Hatchery *Breanna Salter*			Getting Started with Aquaculture Genetics: Choosing the Right Breeding Program *Samuel May*	The Effects of Tidal Exposure on Growth, Viability, and Shell Pests in Cultured Wellfleet Oysters *Abigail Archer*
10:00 AM	**Break at the Casco Bay Exhibit Hall**					

	Vermont Room	New Hampshire Room	Massachusetts Room	Rhode Island Room	Connecticut Room	Cumberland Room (2nd Floor)
	Maine Seaweed Council Collaboration, Innovation, & Research *Chairs: Jaclyn Robidoux & Steve Eddy*	**Shellfish Hatcheries II** *Chair: Meredith White*	**Advances in Quahog Aquaculture in Maine** *Chair: Marissa McMahan*	**Ecosystem Services** *Chair: Matthew Poach*	**Sea Lice** *Chair: Mike Pietrak & Matt Hawkyard*	**Oysters II** *Chair: Isaiah Mayo*
10:30 AM	Bridging Tradition and Innovation: Resources and Initiatives From the Maine Seaweed Council for Farmers *Jaclyn Robidoux*	Recent Innovations at Roger Williams University's Luther H. Blount Shellfish Hatchery and Ferrycliffe Oyster Farm *Robert Holmberg*	**PANEL**: Wild and farmed northern quahogs (*Mercenaria mercenaria*) are an important fishery along the East Coast of the U.S., but are relatively new in Maine. Populations of wild quahogs are increasing in Maine as waters warm, and quahogs are emerging as a new aquaculture product in the state, providing an important economic opportunity for both wild and aquaculture sectors. Wild quahog stock enhancement is a key tool employed by municipal shellfish programs in the state to support the growth of the wild fishery, but is limited by the availability of quahog seed in the sizes and amounts needed. This session explores recent advances in quahog aquaculture in Maine, including production strategies that benefit wild harvesters and farmers, current and future product demand, and economic viability of different growing techniques. <u>Lightning Talks/Panel Members:</u> **Dan Devereaux**, Coastal Resource Manager, Town of Brunswick **Jordan Kramer**, Winnegance Oyster **Adam Campbell**, North Haven Oyster Co. **Kanae Tokunaga**, Senior Scientist, Gulf of Maine Research Institute **Ben Cotton**, Research Associate, Gulf of Maine Research Institute **Caitlin Cleaver**, Assistant Professor of Environmental Studies, Colby College **Diego Trevino**, Student, Colby College **Rachel Hutchinson**, Marine Resource Specialist, WHOI Sea Grant/Cape Cod Cooperative Extension	Behavioral Obsesrvations, Relative Condition, and Estimated Production of Black Sea Bass Using Oyster Aquaculture Cages and Boulders as Habitat *Gillian Phillips*	Mate Recognition Cues of Salmon Lice (*Lepeophtheirus salmonis*) and Their Potential in Pest Mitigation *Robert Morefield*	Comparative analysis of mitochondrial activty in triploid and diploid oysters *Brandon Feole*
10:45 AM	The Maine Seaweed Council: it's history of wild harvest advocacy and relevance to the whole seaweed sector *Shep Erhart*	Evaluating Bio-Secure Transfer Methods of Larvae and Seed from the Atlantic to the Gulf Coast: A Commercial Hatchery Perspective *Samantha Glover*		Simple Tools to Quantify Ecosystem Services Provided by Aquaculture: *The Aquaculture Nutrient Removal Calculator Version 2.0* *Ryan Morse*	Optimizing Feeding Strategies to Improve Growth, Welfare, and Stress Resilience in Juvenile Lumpfish (*Cyclopterus lumpus*) *Matt Hawkyard*	Genetic strategies of parasite mitigation in the eastern oyster *Madeline Eppley*
11:00 AM	**PANEL:** This session will introduce attendees to the MSC, highlighting ongoing efforts that support seaweed farmers while strengthening the entire sector—fostering genuine partnership between emerging seaweed aquaculture and Maine's long-established wild harvest fishery. It will also showcase the Council's depth of longstanding expertise in areas such as product development, certification and standards, food safety, and collaborative reseach—areas that have long supported wild harvest in the Northeast and that are increasingly vital to seaweed aquaculture as the sector grows. As an internationally recognized collaborative network, the MSC contributes to national and global projects, extending the impact of Maine's seaweed expertise far beyond the state.	High Speed Imaging Microscopy in Shellfish Hatchery Research *Savannah Stresser*		Widespread Demographic Supplementation of Connecticut Wild Oysters by Aquaculture Farms *Yuqing Chen*	Investigations into natural compounds for managing sea lice, *Lepeophtheirus salmonis* *Junald Rehman*	Shellfish & Microplastics, What's All the Hype About? *Bobbi Hudson*
11:15 AM		Hidden Threats: Screening Assays Suggest Involvement of Toxins, Pollutants, or Viruses in Some Bivalve Hatchery Larval Crashes on the East Coast. *Shannon Murphy*		Documenting Habitat Provisioning by Oyster and Clam Farms Using Underwater Video in Barnegat Bay, NJ *Alexandria Ambrose*	Investigating the use of spawn aids to synchronize spawning and improve the efficiency of a breeding program for Lumpfish. *Mike Pietrak*	Optimization of Methods for Microplastic Extraction and Quantification from Farmed Oysters *Mikayla Straube*
11:30 AM		Another Pocket Hatchery: Does Small Make Sense? *Michael Congrove*		Simple Tools to Quantify Ecosystem Services Provided by Aquaculture- The Aquaculture Habitat Calculator *Ryan Morse*	Industry perspectives on sea lice control in salmon aquaculture *Andrew Swanson*	Microplastics as a Vector for Bacterial Entry into Oysters *Abigail Vigue*
11:45 AM		Identifying Microbial Taxa Implicated in Oxylipin-Related Larval Oyster Dieoff in Maine with Environmental DNA *Sydney Greenlee*		**Discussion**	**Discussion**	Progress in Eastern Oyster Breeding and Prospects of Genomic Selection *Ximing Guo*
12:00 PM	**Lunch in the Casco Bay Exhibit Hall**					

	AFTERNOON OF FRIDAY JANUARY 9					
12:30 -1:30 pm	**Lunch in the Casco Bay Exhibit Hall**				**LUNCH TIME FILM & PANEL: Climate of Change: Aquaculture for People and Planet @ 12:30** by Island Institute & CEI	**Lunch**
	Vermont Room	**New Hampshire Room**	**Massachusetts Room**	**Rhode Island Room**	**Connecticut Room**	**Cumberland Room (2nd Floor)**
	Advances in Gear Technology I *Chair: Chris Davis*	**Priorities for the Genetic Improvement of Oysters** *Chair: Thomas Delomas*	**Clams** *Chair: Shannon Meseck*	**Business of Aquaculture** *Chair: Kevin Madley*	**Finfish** *Chair: Matt Hawkyard*	**Aquaculture in a Changing Environment** *Chair: Dan Wieczorek*
1:30 PM	AI-Aided Autonomous Design for Aquaculture Engineering Structures with Physics-Driven Models *Longhuan Zhu*	**WORKSHOP**: The USDA Agricultural Research Service has started a breeding program to develop genetically improved strains of eastern oysters for aquaculture in collaboration with NOAA, the University of Maine, and the University of Rhode Island. The session will begin with a brief description of the structure and goal of the breeding program. The majority of the workshop will be spent discussing with attendees the improvements they want to see in a cultured oyster strain. Topics will include prioritizing the traits (e.g., growth rate, resistance to specific diseases, heat tolerance, shape, etc.) that are most important to the industry and the range of growing conditions (environmental conditions, disease pressure, gear types) throughout the northeast.	Growout of Atlantic Surfclam Seed at Intertidal Sites Around Cape Cod, MA *Matthew Poach*	The Economic Impact of Aquaculture in Maine *Christian Brayden*	Lipid and Fatty Acid Dynamics Throughout Early Development of North American Atlantic Salmon (*Salmo salar*) *Halli Bair*	Lasting DNA Methylation from Early Life Hypoxia in *Crassostrea virginica* *Julia McDonough*
1:45 PM	Mooring Tension Measurements & Assessment of an Integrated Multi-Trophic Aquaculture System in the Gulf of Maine *David W. Fredriksson*		Growth and Survival of Two Populations of Surfclams from Hatchery to Harvest *Katyanne Shoemaker*	Best Management Practices (BMPS) & Occupational Standards; Advancing the Sector as per Maine's Sea Farmers *Christian Brayden*	Regional Implementation of Comprehensive Aquaculture Health Program Standards (CAHPS) *Bill Keleher*	What Happens to Bay Scallops Exposed to Ocean Acidification for Three Generations? *Shannon L. Meseck*
2:00 PM	Engineering Design of Scallop Aquaculture Farming Systems *Nate Baker*		Experimental Offshore Aquaculture of the Atlantic Surfclam (Spisula solidissima) *Daphne Munroe*	Mapping Aquaculture Cost of Production with Integrated Model-Based Engineering, Biogeochemical Satellite Data, Biological Modeling, and Techno-Economic Analysis for Seaweed, Shellfish, and Finfish *Tobias Dewhurst*	Advancing RAS Larval Rearing with Protein-Coated Microparticulate Diets (PCMDs) *Spencer Kubo*	From Narratives to Data: Using Oral Histories to Understand Climate Adaptation in Aquaculture *Hillary Smith*
2:15 PM	Navigate Risk with Confidence: Understanding and Mitigating Uncertainty in Open Ocean Mariculture *Micheal MacNicoll*		A New Molecular Diagnostic Method for Detecting the Presence & Severtiy of Hemocytic Neoplasia in Hard Shelled Clams (*Mercenaria mercenaria*) *Michael Torselli*	Selling Seafood through Storytelling *Alicia Galero*	Preliminary Trials on Lipid Oxidation in Menhaden Oil and its Implications for Aquafeed Stability *Christopher Baker*	Carryover Effects of Hypoxia and Warming on the Growth of the Eastern Oyster *Crassostrea virginica* *Sophia Montague*
2:30 PM	Preliminary Testing of a USV Designed for Oyster Aquaculture *Andre Greene*		Updates From The East Coast Hard Clam Selective Breeding Collaborative: Can Genomic Tools Imporve Clam Breeding in The US? *Bassem Allam*	Aquaculture Tourism as a Diversified Business Model *Alicia Galero*	Evaluation of Insect Meals as Alternative Protein Sources in Atlantic Salmon Diets Using Growth, Biochemical, and Molecular Approaches *Michael Habte-Tsion*	The Effect of Warming and Ocean Acidification on the Growth, Development, and Swimming Behavior of Sea Scallop (*Placopecten magellanicus*) and Surfclam (*Spisula solidissima*) Veliger Larvae *Emily A. Roberts*
2:45 PM	The "*Snap and Strap*": A Bird-Deterring, Easy-Flip Float for Aquaculture Gear *Mryon Horzesky*		Single Cell Analysis Reveals Molecular Mechanisms of Transmissible Cancer in Quahogs (*Mercenaria mercenaria*) *Jaypee Samson*	What Do I Do with the Farm When I'm Done? Succession, Transition, and Estate Planning in Maine Aquaculture *Christian Brayden*	Yellowtail Kingfish Immune Development *Lingzi Ding*	Overwintering Oysters in an Increasingly Unpredictable Winter Climate: Testing Storing Techniques for Resilient Aquaculture *Kaila Frazer*
3:00 PM	**Break in the Foyer**					

	Vermont Room	New Hampshire Room	Massachusetts Room	Rhode Island Room	Connecticut Room	Cumberland Room (2nd Floor)
	Advances in Gear Technology II *Chair: Chris Davis*	**Bivalve Hatchery Health Consortium** *Chair: Marta Gomez-Chiarri*	**TikTok – Times Are Changing: Communicating Aquaculture for the Next Generation** *Chairs: Corinne Noufi & Meggan Dwyer*	**Tools for Planning & Funding Your Growing Business** *Chair: Nick Branchina*	**General Aquaculture II** *Chair: Deborah Bouchard*	**A Decade of Advancements in Ocean Acidification Monitoring** *Chair: Austin Pugh*
3:30 PM	Integrating Solar Power into Aquaculture Operations *Alicia Gaiero*	**PANEL** The Bivalve Hatchery Health Consortium (BHHC) was established in 2023 to identify causes leading to reduced larval performance and develop management tools. As of September 2025, 37 hatcheries from the Atlantic Coast of the USA have enrolled in the BHHC, providing samples and data for more than 60 production runs in 2024 and 2025. In 2024, 55% of the 33 production runs were crashes or showed low larval performance. The objectives of this interactive workshop are to: 1) share lessons learned from the BHHC enrollment and sampling process; 2) report findings from the 2024 sampling season, 3) engage participants in interpreting the data collected so far, and 4) discuss further steps. Members of the BHHC coordinating team, including pathologists, ecologists, hatchery managers, and extension specialists, will answer questions and gather feedback from those interested in the program on how to address this critical issue of larval crashes.	**PANEL**: This panel examines innovative approaches to communicating aquaculture science and practice with the next generation. Panelists will explore the interplay of new media used in traditional ways and traditional media reimagined through new technologies, highlighting how these methods influence public perception, understanding, and engagement. The conversation will span social media, podcasting, visual arts, documentary film, and virtual reality, offering insights into both the opportunities and challenges of leveraging creative and digital platforms to broaden accessibility, amplify diverse voices, and foster intergenerational dialogue in aquaculture. To enhance accessibility and extend the exchange beyond the event, the session will be recorded live as part of the Salty Talks series, ensuring the discussion contributes to ongoing conversations on aquaculture communication and education.	**PANEL**: This panel discussion will focus on some of the resources available to aquaculturists looking to find financing to grow their farms. Experts will include Business Planning professionals and Lending experts who can share their experiences on what it takes to prepare for taking on funding. This will be a panel discussion with plenty of time available to ask questions specific to your situation. Because financing and technical assistance questions can be personal in nature, presenters will be available to stay after the presentation to speak with individuals in a one-on-one setting or for follow up consultation.	Culture of *Isochrysis* for Producing a Valuable Natural Wax By-product *Morgan Anthony*	**PANEL**: Ocean Acidification is of growing concern to many in the shellfish growing community and beyond. The Northeast Coastal Acidification Network (NECAN) is the leading group in the region for the synthesis and dissemination of ocean and coastal acidification information. In this workshop NECAN will bring together a panel of regional experts on observing ocean acidification as well as aquaculturists currently monitoring ocean acidification, to discuss the developments in the methods/monitoring technologies of observing ocean acidification. Additionally, the current state of OA knowledge in the Northeast including the recent monitoring plan released by NECAN will be presented by the panelists. We will also reserve significant time to hear from the aquaculture community members in attendance directly, as to their data needs. A synthesis document of major takeaways will be produced and disseminated after this workshop to the NECAN network and workshop participants.
3:45 PM	3D-COAST (3 Dimensional Cultivation of Oysters Automated with Solar Tumbling) *Luke Saindon*				Coming Out of the Closet: Advances in Lobster Aquaculture Development in Maine *Brian Beal*	
4:00 PM	Purpose Built Aquaculture Hulls designed for Electric Propulsion *Phoebe Walsh*				SeaMade at UNE *Carrie Byron*	
4:15 PM	Development of Carbon Negative Shellfish Farming Technologies *Nick Planson*				Stocks vs Flows: Second-Best Incentive Design for Stock-Generated Externalities *Erica Chuang*	
4:30 PM	Trails of Novel Biodegradable Lantern Net Covers for Biofouling Mitigation *Madison Maier*				Applying Forensic DNA Finger-Printing Techniques for Tracking the Fate of Farmed Sugar Kelp Fragments in Integrated Multitrophic Aquaculture. *Peter Craig*	
4:45 PM	Adapting Fishing Technology, Workflow, and Policy to the Development of Emerging Aquaculture Species *Charles Walsh*				**Discussion**	
5:00 PM	**Closing Remarks & Sendoff Toasts**					

Poster Presentations
Thursday, January 8, 5:00pm - 6:30pm

FIRST AUTHOR		TITLE
Karen	Alldridge	Purple Sea Urchins Can Control Oyster Farm Biofouling – Next Steps to Optimize and Sustain this Approach
Abigail	Archer	Seasonal Quahog (*Mercenaria mercenaria*) Growth Dynamics in Wellfleet Harbor: A Century-Spanning Analysis Building on The Early Work of Dr David Belding
Kayla	Austin	The Bivalve Hatchery Health Consortium: A Collaborative Effort to Examine Drivers of Larval Crashes in Bivalve Hatcheries
Sydney	Avena	Maine's Aquaculture Business Incubators
Kiran	Bajaj	Natural and Managed Intraspecific Diversity Influence Eastern Oyster Aquaculture Performance
Emory	Barrett	Developing Infrastructure for Larval Shellfish Outplanting
Robin	Batchelor	Characterization of the *Vibrio Spp.* Community in Natural Oyster Beds in the Great Bay Estuary
Sarah	Bodenstein	Understanding the Common Challenges of the Northeastern Aquaculture Industry
Morgan	Cairns	Macroparasites in the Eastern Oyster Within the North Shore of Massachusetts
Amanda	Chesler-Poole	The Oyster Aquaculture Training Program (OAT) at the Virginia Institute of Marine Science
Phoebe	Churney	Comparing Thermal Tolerance of Sugar Kelp (*Saccharina latissima*) Gametophyte Populations Across the Gulf of Maine for Future Kelp Forest Restoration and Aquaculture Applications
Amanda	Clapp	Increasing Oyster Hatchery Resiliency by Reducing Hatchery Seawater Turbidity and Water Quality Degradation Associated with Storm Events.
Michael	Coogan	Commercialization of Bottom Sea Scallops Aquaculture in the Gulf of Maine: Development of Spat Collection and Growout Protocols
Sarina	Dery	Long Island Sound Partnership: Impacts Of Environmental Trends On Oyster Health

Maxwell	Durand-Morris	Spat Under Siege: eDNA Insights into Species Challenging Mussel Aquaculture in the Gulf of Maine
Margaret	Eid	Exploring *Vibrio* Population Ecology in New Hampshire's Great Bay Estuary
Michaela	Eldridge	Cardiac Responses to Heat Stress in Blue Mussels (*Mytilus edulis*): Implications for Thermal Tolerance and Aquaculture in a Warming Ocean
Sean	Engelsen	Measuring Heat Tolerance in Sugar Kelp (*Saccharina latissima*)
Jade	Fiorilla	The Eastern Oyster Microbiome and Rapid Adaptations Resulting From Repeated Exposure to Environmental Stressors
Anthony	Grossi	*P. marinus* Infection in Wild Oysters on Plum Island, MA
Samuel	Gurr	Using Genomics to Understand Differences in Sea Scallop, *Placopecten magellanicus*, Populations
Matthew	Hare	Field Validation of Oyster Larval Dispersal Predictions in Hudson River Estuary
Celeste	Hayden	Increasing the Efficiency of Oyster Tissue Storage for DNA Extraction with An Ethanol-Free Method
Ruby	Hoffman Blustajn	Developing Screening Assays to Identify Potential Causes of Bivalve Larval Crashes Hatcheries in the Atlantic Coast of the United States
Rachel	Hutchinson	Spat-on-Shell Oyster Production in Coastal Massachusetts: A Comparison Between Practices in Two Municipalities on Cape Cod
Jessica	Lam	Smart Robotics for Sustainable Shellfish Aquaculture: Design and Testing of an Automated Fluidized Upweller System
Kyra	Lenderman	Oyster Health and Restoration in Long Island Sound - Trends in Diseases and Reproduction of Unmanaged Oyster Populations
Matthew	Mar	Improving Spore Attachment and Survival for *Palmaria palmata* Cultivation
Elizabeth	Martin	Microbial Community Dynamics in Shrimp *Litopenaeus vannamei* Integrated Multitrophic Aquaculture Systems
Kelsey	McKenna	Kelp Me Help You: A Qualitative Approach to Assessing Biodiversity and Community Composition on U.S. Seaweed Farms
Erin	Menezes	Collision Minimization Autonomy for a Utility Surface Vehicle on an Oyster Farm

Antoine	Mier	From Concept to Curriculum: Designing Applied Aquaculture Education Modules
Aidan	Morrison	Overview of Tisbury, Martha's Vineyard Bay Scallop Propagation Through Spat Bags
Cole	Palmer	Development of techniques for using fecal DNA to quantify salmon lice consumption by Lumpfish
Sarah	Redmond	Developing an Integrated Seaweed and Green Sea Urchin Aquaculture Model in Maine
Kristen	Savastano	Contrasting the Performance of Traditionally- and Genomically-Selected Lines of eastern Oyster in New York
Jade	Sevelow-Lee	Collaborative Community-Science To Quantify Habitat Ecosystem Services In Oyster Aquaculture
Jake	Skehan	Do Sound Based Deterrents Prevent Gulls and Terns from Roosting on Floating Oyster Gear?
Samantha	Smith	Evaluating Mechanized Outplanting and Seeding Methods for Sugar Kelp (*Saccharina latissima*) Aquaculture in the Gulf of Maine
Kalie	Tovar	Feeding Selection in Oysters Exposed to Ocean Acidification
Diego	Trevino	Estimating Municipal Demand for Quahog (*Mercenaria mercenaria*) Seed to Support Stock Enhancement in the Gulf of Maine
Alyssia	Villarreal	Depuration and Persistence of *Campylobacter spp*. in Oysters: Insights for Food Safety Risk Management
Hannah	Wolf	Evaluating Quahog Seed Grow-out Methods and Production Costs for Diversifying Maine's Fisheries

ABSTRACTS OF ORAL PRESENTATIONS AND POSTERS

ATLANTIC SURFCLAM SUBSPECIES (*SPISULA SOLIDISSIMA SOLIDISSIMA* AND *S. S. SIMILIS*) CAN PRODUCE FERTILE HYBRID OFFSPRING

***Michael Acquafredda*[1], Bassem Allam[2], Ximing Guo[1], Daphne Munroe[1]**
[1]Haskin Shellfish Research Laboratory, Rutgers University, 6959 Miller Ave, Port Norris, NJ 08349 USA; [2]Stony Brook University, School of Marine & Atmospheric Sciences, 100 Nicolls Rd, Stony Brook, NY 11794 USA

There are two Atlantic surfclam subspecies. The northern subspecies (*Spisula solidissima solidissima*) supports the federal fishery and is abundant on the continental shelf of the northeastern United States. The southern subspecies (*S. s. similis*) is predominantly found south of Cape Hatteras, but is also found in shallow, patchy, northern areas, such as coastal Virginia, Long Island Sound, and southern Massachusetts. However, the taxonomic rankings of these clams remain controversial. Recent genetic evidence suggests they could be distinct, but closely related species. The goal of this project was to determine whether these genetically distinct surfclams can produce fertile hybrid offspring. Surfclams were collected from commercial fishing grounds off New Jersey (*S. s. solidissima*) and from a known *S. s. similis* bed in Massachusetts. F1 progenies were bred in October 2023 and May/June 2024, and F2 progenies were bred in April 2025. Genetic samples were collected from each of the parental and offspring groups to confirm genetic lineage. Fertilization rates across F1 and F2 groups ranged from 85-95%. Larvae from all groups metamorphosed, with most reaching competency at approximately 21±5 days post fertilization. Juvenile performance was also evaluated under ambient and elevated (+1.2˚C) temperature conditions. Results from the juvenile study indicate that similis-female F1 hybrids exhibited heterosis (i.e., hybrid vigor). Under both conditions, similis-female hybrids grew at significantly greater rates than *S. s. solidissima* purebreds, and notably, the hybrids in the heated condition grew as well as the *S. s. solidissima* purebreds grew in the ambient condition. Together, this work demonstrates that *S. s. solidissima* and *S. s. similis* are indeed capable of hybridizing, the hybrid offspring are fertile. and under certain conditions, hybrids may outperform purebreds. Results from this work will support future surfclam aquaculture breeding programs and provide valuable information about how wild surfclams may evolve in response to ocean warming.

UPDATES FROM THE EAST COAST HARD CLAM SELECTIVE BREEDING COLLABORATIVE: CAN GENOMIC TOOLS IMPROVE CLAM BREEDING IN THE U.S.?

***Bassem Allam*[1], Denis Grouzdev[1], Michael Patricio[2], Paul Coyne[3], Zhenwei Wang[3], Emmanuelle Pales Espinosa[1], Arnaud Tanguy[4], Kimberly Reece[5], Huiping Yang[6], Gregg Rivara[2], Joshua Reitsma[7], Antoinette Clemetson[8], and Ximing Guo[3]**

[1] School of Marine and Atmospheric Sciences, 149 Dana Hall, Stony Brook University, Stony Brook, NY 11794 USA; [2] Cornell University Cooperative Extension, 3690 Cedar Beach Rd, Southold, NY 11971 USA; [3] Haskin Shellfish Research Laboratory, Rutgers University, 6959 Miller Ave, Port Norris, NJ 08349 USA; [4] Sorbonne Université, Station Biologique de Roscoff, Place Georges Teissier, 29688 Roscoff, France; [5] Virginia Institute of Marine Science, P.O. Box 1346, Gloucester Point, VA 23062 USA; [6] University of Florida, 7922 NW 71st St, Gainesville, FL 32653 USA; [7] Cape Cod Cooperative Extension, 3195 Main St, Barnstable, MA 02630 USA; [8] New York Sea Grant, 146 Suffolk Hall, Stony Brook University, Stony Brook, NY 11794 USA

The hard clam *Mercenaria mercenaria* is farmed extensively from Massachusetts to Florida, with billions of seed clams produced each year to support aquaculture and restoration. Producing high-quality seed capable of surviving under challenging biological and environmental conditions is a major priority for the industry. The hard clam selective breeding collaborative unites Sea Grant programs, scientists, and extension teams across five Atlantic states to advance hard clam selective breeding using modern genomic tools. Following the sequencing of the genome of the hard clam and the generation of an extensive dataset about the genetic diversity of the species throughout its geographical range, the team selected 66,543 high-quality single nucleotide polymorphisms (SNPs) to create a SNP array for high-throughput genotyping. Validation tests showed strong reliability of the array, with 99.64% concordance of allele calls across tissue types. More importantly, the array was shown to be highly efficient and robust in differentiating clams from different geographic origins and for contrasting the genotypes of clams derived from the same stocks but displaying different levels of resistance/susceptibility to QPX disease and heat stress during field and lab investigations. As such, this genomic platform offers unprecedented insight into hard clam population structure and resilience. The presentation will describe the two genomic selection breeding efforts that are underway using the array (and more are planned) to identify and propagate stocks that are resistant to disease and environmental stress, helping build a more sustainable and resilient U.S. hard clam aquaculture industry.

PURPLE SEA URCHINS CAN CONTROL OYSTER FARM BIOFOULING – NEXT STEPS TO OPTIMIZE AND SUSTAIN THIS APPROACH.

***Karen Alldridge*, Coleen C. Suckling**
Department of Fisheries, Animal, and Veterinary Science, University of Rhode Island, 6 Rhody Ram Way, Kingston, RI 02881, USA.

Biofouling on oyster farms is a major factor that influences operational costs, increases farming effort, and can be met with negative public perceptions and acceptance. Previous studies have shown significant benefits to co-culturing sea urchins with shellfish production by utilizing sea urchins to graze on biofouling accumulation on shellfish surfaces and gear.

A small scale pilot trial conducted on a Rhode Island oyster farm showed up to 90% biofouling reduction when Eastern Oysters (*Crassostrea virginica*) were integrated with the native and unexploited Atlantic Purple Sea Urchin (PSU; *Arbacia punctulata*) in bottom gear, and reduced farm related effort. We will present the next steps underway, which build from this work. These include further optimization trials at oyster farms. We will also describe efforts to sustain PSU natural stocks and address grower and state agency interest and demand for this approach, including examining the reproductive cycle of PSUs to inform and develop hatchery production of this unexploited species.

DOCUMENTING HABITAT PROVISIONING BY OYSTER AND CLAM FARMS USING UNDERWATER VIDEO IN BARNEGAT BAY, NJ

***Alexandria Ambrose*, Daphne Munroe**
Haskin Shellfish Research Laboratory 6959 Miller Ave., Port Norris, NJ 08349, USA

Shellfish growers often observe fish and invertebrates interacting with aquaculture gear, and scientific evidence supports these observations. However, knowledge gaps remain regarding how farm attributes, such as tending activities and biological fouling, shape habitat use. To address this, underwater video was used to document marine communities and species interactions with gear at an oyster (*Crassostrea virginica*) farm in 2019 and a hard clam (*Mercenaria mercenaria*) farm in 2023 in Barnegat Bay, New Jersey. Cameras were deployed on oyster cages and floating bags (12 days, June–September) and over clam predation prevention nets (five days, June–October). For natural comparison, cameras were also deployed at nearby natural habitats (marsh edge at the oyster farm and sand bottom at the clam farm). Abundance was measured using MaxN, the maximum number of individuals of a species per 1-minute segment. Across both farms, 37 species were identified, with distinct community distributions. More individuals were observed on farms than in adjacent habitats, with biological fouling strongly influencing abundance. At the oyster farm, estuarine residents were more common, while at the clam farm, residents and opportunists occurred in similar numbers. Floating bags with higher fouling supported more individuals than less-fouled cages, while moderately fouled clam nets corresponded with the highest average abundances. Farm tending activities had an overall neutral impact on abundance, though localized effects were evident. These findings improve our understanding of how management practices and environmental conditions influence habitat provisioning in shellfish aquaculture.

ACHIEVING SUCCESS IN LAUNCHING CPG SEAWEED AND OTHER AQUACULTURE BASED PRODUCTS.

Trey Angera

Springtide Seaweed, LLC and the Maine Seaweed Exchange, 14 Factory Rd, Gouldsboro, ME 04607 USA

Successfully bringing consumer packaged goods (CPG) products to market is never easy. Doing so with unfamiliar products like seaweed is even harder.

This presentation will discuss the major obstacles to launching CPG products and how to overcome them. There will be a focus on seaweed products; however, the presentation will be beneficial to all those considering or already launching an aquaculture-based CPG product.

This presentation will explore founder traits that can make the difference between success and failure, as well as how market characteristics will define success.

CULTURE OF *ISOCHRYSIS* FOR PRODUCING A VALUABLE NATURAL WAX BY-PRODUCT

***Morgan Anthony*[1], Nick Cranston[1, 2], Daniel J. Gossard[1], Scott Lindell[1]**
[1]Woods Hole Oceanographic Institution, MS #35, Woods Hole, MA 02543 USA; [2]Tulane University, 6823 St. Charles Ave, New Orleans, LA 70118 USA

Isochrysis is a microalga commonly grown as feed in shellfish hatcheries around the world. A natural wax —known as alkenones— harvested from the microalga *Isochrysis*, has the potential to replace petroleum ingredients as the waxy base in many cosmetics and personal care products, such as lipstick, sunscreen, and deodorants. We examined a series of experimental culture treatments (light intensity, photoperiod, temperature, nitrogen limitation, salinity) that could induce and increase the concentration and yield of alkenones in this microalga. We discuss the effects of these abiotic conditions on growth rates of two *Isochrysis* strains. Our results suggest different optimal temperature conditions between the lower salinity strain and the higher salinity strain. However, both strains demonstrated optimal growth with a photoperiod of 18:6 (light:dark) and a light intensity of 300-400 umol when compared with other photoperiods and intensities. Preliminary analyses of the alkenone yields by treatment will be shared.

PILOT TESTING THE TIMING AND EFFECTIVENESS OF TWO DIP TREATMENTS FOR CONTROL OF SHELL PESTS IN CULTURED OYSTERS

Abigail Archer, *Joshua Reitsma*, Rachel Hutchinson
[1]Cape Cod Cooperative Extension/ Woods Hole Oceanographic Institution Sea Grant, PO Box 367 Barnstable, MA 02630 USA

Cultured oysters (*Crassostrea virginica*) are the third most valuable seafood product in Massachusetts. This rapid industry growth is not without challenges. Recent years have seen an uptick in reports from oyster growers in the state complaining about two shell pests, mud blister worms (*Polydora websteri*) and boring sponge (*Cliona celata*). Both pests were reported to periodically affect product marketability depending on site and levels.

At a forum for shellfish growers in spring of 2025 related to these shell pests, there was interest from the growers present to further evaluate two potential dip treatments, a super saturated brine and freshwater, for effectiveness on treating these pests. In addition, growers suggested optimal timing of treatment for maximal effectiveness was of interest. Pilot testing was done on three Massachusetts oyster farms with history of the shell pests in summer of 2025 with one year old oysters. Results are still being analyzed but will be discussed in detail along with local data about relative periods of reproduction for these pests.

SEASONAL QUAHOG *(MERCENARIA MERCENARIA)* GROWTH DYNAMICS IN WELLFLEET HARBOR: A CENTURY-SPANNING ANALYSIS BUILDING ON THE EARLY WORK OF DR. DAVID BELDING

***Abigail Archer*, Rachel Hutchinson, Joshua Reitsma**
Cape Cod Cooperative Extension/ Woods Hole Oceanographic Institution Sea Grant, PO Box 367, Barnstable, MA 02630 USA

In the early 1900's Dr. David Belding conducted numerous studies on both Quahogs and Oysters within Wellfleet Harbor and Monomoy in Chatham. These studies were commissioned by the Commonwealth of Massachusetts. Many of Dr. Belding's observations still are true today, and many of his recommendations continue to be followed by resource managers. One study examined growth of a quahog over monthly increments of time and measured through to a harvestable size. This information gave important insights into growing seasons, time to market, and variation between locations.

A little over one hundred years since Dr. Belding conducted his studies, Cape Cod Cooperative Extension (CCCE) recreated his monitoring protocol to determine if growth over time had shifted. Observations from farmers indicate that shoulder seasons had expanded, but that overall growth was slowing. One Wellfleet grower and historian knew where one of Dr Belding's original staked locations was in Wellfleet and over the course of two growing seasons, monthly growth of three cohorts of quahaugs was tracked to compare current growth to historical averages reported by Dr. Belding. This study serves to validate and honor early shellfish research, while providing essential updated parameters for current management and aquaculture strategies.

THE EFFECTS OF TIDAL EXPOSURE ON GROWTH, VIABILITY, AND SHELL PESTS IN CULTURED WELLFLEET OYSTERS

***Abigail Archer*, Rachel Hutchinson, Joshua Reitsma**
Cape Cod Cooperative Extension/ Woods Hole Oceanographic Institution Sea Grant, PO Box 367 Barnstable, MA 02630 USA

The Eastern Oyster (*Crassostrea virginica*) is a vital species for aquaculture in Wellfleet, Massachusetts. Oyster growth, survival, and susceptibility to biofouling are significantly influenced by tidal exposure. This study investigated the relationship between tidal exposure and key performance indicators—viability (survival), growth, fouling, and shell pest presence (boring sponge and mud blisters)—across two oyster culture sites within Wellfleet Harbor. One year old oysters of both wild and hatchery origin were deployed in 5 tier condos at five distinct tidal elevations ranging from less than 1% to almost 18% total exposure time over the experiment and allowed to grow for a summer season.

Viability and growth (shell growth, weight, condition index) were monitored. Fouling biomass and general composition (e.g., oyster overset, barnacles, tunicates) and the presence of common pests (boring sponge and mud blisters) were assessed at the beginning (June 2025) and end of the experiment (September 2025). The oysters exhibited a range of performance that varied by tidal height. Biofouling varied by tidal height with levels of exposure of 10% being relatively clean of fouling. Mud blister and boring sponge presence will also be discussed in relation to tidal height, but analysis is still in process. The data suggests a critical trade−off between maximizing growth and minimizing fouling/pest pressure driven by tidal elevation in Wellfleet Harbor.

THE BIVALVE HATCHERY HEALTH CONSORTIUM: A COLLABORATIVE EFFORT TO EXAMINE DRIVERS OF LARVAL CRASHES IN BIVALVE HATCHERIES

***Kayla Austin*[1], Rob Hudson[1,2], Dave Bushek[3], Matthew Bertin[4], Jacob Cram[5], Matthew Gray[5], Meredith White[6], Marta Gomez-Chiarri[1]**
[1] Department of Fisheries, Animal, and Veterinary Science, University of Rhode Island, 6 Rhody Ram Way, Kingston, RI 02881, USA; [2] Rhode Island Sea Grant, University of Rhode Island, Graduate School of Oceanography, Narragansett, RI 02881 USA; [3] Haskin Shellfish Research Laboratory, Rutgers University, 6959 Miller Ave, Port Norris, NJ 08349 USA; [4] Case Western Reserve University, 10900 Euclid Ave, Cleveland, OH 44106, USA; [5] Horn Point Laboratory, University of Maryland Center for Environmental Science, 2020 Horns Point Rd, Cambridge, MD 2613 USA; [6] Atlantic AquaFarms, 321 State Route 129, Walpole, ME 04573 USA

Bivalve hatcheries have experienced larval crashes at unprecedented rates along the Atlantic Coast of the United States. Investigating the specific drivers of mass mortality events can reveal vulnerabilities affecting global shellfish populations and support the development of preventative and mitigation strategies. The Bivalve Hatchery Health Consortium (BHHC) has fostered expanding partnerships between North American bivalve hatcheries, researchers, and extension agents, with the goal of collaboratively identifying causes of larval crashes and/or management practices that may minimize them. These collaborations aim to increase hatchery participation, promote data sharing while preserving anonymity of each hatchery, and facilitate the standardized collection of biological and environmental data. This poster describes the overall approach used by the BHHC, from hatchery enrollment to data analysis and reporting. Each participating hatchery is required to contribute samples from a minimum of two production runs per season capturing the parameters of both successful and poor runs. Sample collection includes incoming and larval culture water, algal feed, and live larvae. Sampling is conducted from broodstock conditioning to larval settlement (post set). Hatcheries additionally report environmental conditions, husbandry practices, brood demographics, and fertilization success. Analyses performed include water quality, histology, algal quality, microbial analysis (culture), sequencing of the microbial community, chemical analysis (toxins and pollutants) and screening assays using healthy larvae. This collaborative, stakeholder-driven research into hatchery health and larval management presents a valuable opportunity for scientific collaboration and community education to address an important issue impacting the bivalve industry.

MAINE'S AQUACULTURE BUSINESS INCUBATOR

***Sydney Avena*, Anne Langston Noll, Chris Davis**
Maine Aquaculture Innovation Center 193 Clarks Cove Rd., Walpole, ME 04573 USA

Maine's Aquaculture Business Incubator program– supported by Maine Aquaculture Innovation Center and the University of Maine– provides entrepreneurs with the physical infrastructure, professional mentorship, and industry opportunities necessary to kickstart their own aquaculture enterprise. Beyond just ocean access, the Incubator offers resources, including:

- Access to juvenile organisms and seed
- Academic partnerships with UMaine, including student interns
- Entrepreneurial training, business counseling, and networking opportunities
- Recirculating (RAS) and flow-through culture facilities
- Assistance in identifying funding sources and grant writing

THE COSTS, BENEFITS, AND RESOURCES OF WORKPLACE SAFETY

Stephen E. Badger
Maine Employers Mutual Insurance Company (MEMIC) 261 Commercial St Portland, ME 04101 USA

Workplace safety involves a range of costs, both direct and indirect. Direct costs include investments in safety equipment, training programs, and compliance with regulations. Indirect costs can arise from lost productivity, insurance premiums, and potential legal liabilities if safety is neglected.

The benefits of a strong workplace safety program are substantial. A safe work environment leads to fewer injuries and illnesses, which boosts employee morale and productivity. It also reduces absenteeism and turnover, helping retain skilled workers. Moreover, companies with robust safety practices often enjoy better relationships with regulators and insurers, potentially leading to lower premiums and fewer inspections. Safety can also be a competitive advantage, signaling to clients and partners that the organization values responsibility and professionalism.

Implementing effective workplace safety requires resources such as training personnel, time, and technology. Safety officers or loss control managers play a key role in identifying risks and enforcing protocols. Time must be allocated for regular training, audits, and updates to safety procedures.

AIM FOR A GROWING WORKFORCE

***Danny Badger*[1], Rachel Hutchinson[2], Abigail Archer[2], Joshua Reitsma[2]**
[1] MIT Sea Grant, 12 Emily St., Cambridge, MA 02139 USA; [2] Cape Cod Cooperative Extension and WHOI Sea Grant, PO Box 367, Barnstable, MA 02630 USA

Join us as we unpack the *Aquaculture Internships for Massachusetts* (AIM) pilot program, sharing the successes and challenges encountered over the program's two cohorts that were recruited and trained through substantially different approaches. Aquaculture and seafood industry members have been communicating to state and federal agencies and Sea Grant programs that workforce development is needed in order for businesses to sustain themselves and grow. How to best structure those programs is a work in progress. With the express goal of recruiting from communities infrequently connected to the aquaculture sector, AIM is but one such response to the need for workforce pipelines, and adds to the tapestry of internship and apprenticeship programs in development throughout the Northeast. We are proud of the interns who took the opportunity to try new things, including a couple who will join us to help answer your questions. We are humbled by the number of challenges we encountered. It is crucial that our sector can

learn from these trials. We are excited to try again! Please join us to hear our story and share your honest feedback on the direction we should take next.

In this session, you are not just going to hear why what we did was awesome. Instead, we'll aim to consider with you the limitations we faced through honest reflection, giving space for you to imagine novel yet effective structures for workforce development programs to fuel our growing industry.

BUILDING A SUSTAINABLE KELP INDUSTRY: THE ROLE OF GAMETOPHYTE BASED NURSERIES AND OPTIMIZED INFRASTRUCTURE

***David Bailey*, Maggie Aydlett, Toby S. Bloch, Lindsay Olsen, Sophie Speigel**
GreenWave, 315 Front St, New Haven, CT 06513 USA

Kelp farming in North America faces persistent challenges from high production costs, variable seed quality, and limited scalability, particularly in the nursery phase where seed is produced. Traditional spore seeded nurseries are constrained by seasonal availability, inconsistent yields, and intensive labor and infrastructure demands. GreenWave has addressed these challenges by implementing gametophyte-based seeding, improved nursery infrastructure, and standardized protocols. By maintaining mixed-sex gametophyte cultures under controlled conditions, nurseries gain reliable, year-round seed production with consistent quality, reducing contamination and uncertainty. Modular, climate-controlled nursery designs enable efficient workflows, improve operational efficiency, reduce labor intensity, and maximize space utilization. Standardized protocols further improve seed reliability, simplify training, and facilitate replication across multiple locations, allowing operators to iterate practices in concert. Gametophyte-based seed produced in these nurseries supports earlier and more uniform outplanting, leading to higher survival rates and increased biomass at the farm level.

GreenWave is amplifying these benefits by sharing nursery designs and operational procedures, and leading training programs, enabling broader adoption and scaling across the industry. Collectively, this integrated approach demonstrates that combining gametophyte culture with improved infrastructure and operational protocols have benefits that can be seen throughout the industry: reduction in nursery labor, improved seed quality, optimal timing of outplanting, and increased yield. By addressing bottlenecks in early-stage cultivation and providing a replicable model, we are working to help create a more predictable, efficient, and economically sustainable industry.

LIPID AND FATTY ACID DYNAMICS THROUGHOUT EARLY DEVELOPMENT OF NORTH AMERICAN ATLANTIC SALMON (*SALMO SALAR*)

***Halli Bair*, Robert Morefield, Sydney Ulland, Heather Hamlin**
University of Maine Aquaculture Research Institute, Orono, ME 04469

High quality eggs underpin successful aquaculture production, influencing hatchery efficiency, broodstock selection, and long-term farm productivity. Egg quality, often defined as an egg's ability to develop into a viable fry, depends on maternal investment during oogenesis. To better understand how maternal traits influence egg composition, we examined lipid and fatty acid content in North American Atlantic salmon (Salmo salar) eggs at distinct developmental stages. Understanding the dynamics of lipids and fatty acids throughout distinct stages of early development provide insight into maternal investment, downstream performance, and may help clarify whether lipid content is a useful metric of egg quality. We measured total lipid content and quantified fatty acids of 50 families of Atlantic salmon reared at the National Marine Cold Water Aquaculture Center (NMCWAC), a selective breeding program housed in Franklin, Maine. Eggs were collected at three distinct stages throughout development: pre-fertilization, eye up, and first feed, 0, 35, 153 days post fertilization (dpf), to encompass the very start of development until commencement of endogenous feeding. A fatty acid methyl esters (FAMEs) method was run on a gas-liquid chromatograph, identifying a panel of fatty acids. Determining total lipid content was achieved through a petroleum ether extraction. Preliminary correlation screenings show interesting dynamics in the relationship between maternal traits and respective lipid content. Early results indicate that larger mothers produce eggs with lower lipid (%) content. Investigating further traits of fecundity, egg size, and other metrics will aid in understanding the dynamics of how lipids are allocated.

NATURAL AND MANAGED INTRASPECIFIC DIVERSITY INFLUENCE EASTERN OYSTER AQUACULTURE PERFORMANCE

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The eastern oyster (*Crassostrea virginica*) supports a major aquaculture industry along the U.S. East Coast. Across its range from Texas to Maine, the species exhibits genetic and phenotypic diversity shaped by local environmental conditions. Understanding how this diversity affects performance in non-native growing environments is critical for selective breeding and broodstock management. To investigate this, we reared larvae from six wild populations and two local hatchery lines at two common garden sites in the Chesapeake Bay. Groups were grown individually as monocultures, and in two polyculture treatments: 1) HYBRIDMIX, crosses at the time of spawning that generated novel genetic combinations between parental groups, and 2) SEEDMIX, mixed seed with original genetic compositions

of each parental group. Monocultures of parental groups with higher intrinsic genetic diversity (allelic richness, heterozygosity) showed the highest growth and survival across all treatments, including polycultures. However, these effects were partially confounded by temperature and latitude, as high-performing groups originated from warm Gulf sites. Both polycultures performed comparably to high-performing Gulf groups and local hatchery lines, and outperformed potentially maladapted groups from the northern Atlantic. We did not observe differences in survival or growth between HYBRIDMIX and SEEDMIX, suggesting that multiple methods for managing intraspecific diversity are beneficial. These results demonstrate that both natural (intrinsic) and managed (created) intraspecific diversity can support strong aquaculture performance, but that the benefits are not uniform and depend on the environmental and genetic backgrounds of the broodstock.

ENGINEERING DESIGN OF SCALLOP AQUACULTURE FARMING SYSTEMS

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The scallop farming industry in the US is poised to be a high-value and high-growth industry, but requires the development of tools and techniques that enable cost-effective cultivation systems. Kelson Marine, the University of Maine, and Vertical Bay are developing engineering tools that can aid scallop farmers in designing resilient farm infrastructure. Complex, dynamic, ocean-based systems, such as scallop farms, demand rigorous engineering evaluations to mitigate risk of structural failures. Additionally, an accurate understanding of the system's operational requirements and behavior in extreme ocean conditions can help identify cost minimization strategies. Structurally robust and economically efficient scallop cultivation systems require an understanding of a variety of critical factors: the environmental conditions at the project site, the tradeoffs of farm structure design, hydrodynamic characteristics of scallop containment gear, and the equipment, labor, and vessels required by discrete farm operations. Through the coupling of engineering and operational evaluations of farming systems, the economic implications of farm design are revealed. For example, the tradeoffs between cultivation density and collision risk between farm components and resulting crop loss can be quantified. Within this process, we incorporate on-the-water data and learnings from one of the US's only scallop farms. Comprehensive technoeconomic evaluation with these validated tools can help farmers minimize costs and maximize production for any given site.

PRELIMINARY TRIALS ON LIPID OXIDATION IN MENHADEN OIL AND ITS IMPLICATIONS FOR AQUAFEED STABILITY

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Lipid rancidity in aquafeeds, driven by the oxidative degradation of unsaturated fatty acids, is a major concern in the aquaculture industry, as the threshold at which it begins to disrupt homeostasis in fish remains unclear. Consumption of rancid feeds has been associated with reduced growth, impaired immune function, and elevated oxidative stress in farmed fish. This requires the need for consistent and scalable preservative strategies for fish oils and aquafeeds. The objective of this preliminary study was to establish a reproducible methodology for generating defined levels of in non-preserved fish oil and to evaluate the effects of oxidized fish oil on the growth and oxidative stress response in Atlantic salmon (*Salmo salar*). Initial benchtop trials were conducted to refine a method for producing oxidized fish oil, after which five diets of increasing levels of oxidation were formulated and fed to juvenile Atlantic salmon. Fish were subsequently monitored for growth performance and tissue-level indicators of oxidative stress. We found that the rate of oxidation was influenced by both oil volume and oxygen supplementation. Results from the feeding trial will be presented. Outcomes from this preliminary work will provide a model framework for future oxidation trials aimed at testing potential additives with the capacity to stabilize fish oil for aquafeed applications.

DO TEMPORAL PATTERNS IN BIRD DISTRIBUTION AND ABUNDANCE FACILITATE PATHOGEN CONTAMINATION OF SHELLFISH ON FLOATING AQUACULTURE FARMS?

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Waterbird distribution and abundance fluctuates seasonally, often peaking at floating shellfish aquaculture farms in late summer and early fall when oyster consumption is highest. In 2021, elevated bird numbers at a Rhode Island farm coincided with a *Campylobacter* outbreak, raising concerns that bird fecal matter may have contributed to the outbreak. In response, we aimed to 1) assess the relationship between bird distribution and abundance and the presence of fecal coliforms and pathogenic *Campylobacter* spp. at aquaculture farms in Rhode Island and Massachusetts, and 2) evaluate the effectiveness of

bird deterrents in reducing waterbird density. From 2020–2024, we conducted weekly land-based waterbird surveys and, from July–November 2024, collected concurrent water and oyster meat samples from farm sections with and without deterrents. For 29 bird species, proximity to aquaculture farms explained little spatial variation in distribution patterns (~4%). During periods of increased bird abundance, fecal coliform levels in water remained below the action level (geometric mean <14 MPN/100 ml), and pathogenic *Campylobacter* spp. was not detected in oyster meat. Waterbird density was higher on farm sections without deterrents (β = 3.29, CRI = 2.41–4.19); however, density was not associated with fecal coliform levels in water or oyster meat. Our results indicate that birds exhibit limited selection for resources associated with aquaculture farms, relative to other landscape features, and that deterrents can effectively reduce bird density. Importantly, even at high bird abundances, waterbird use of aquaculture farms did not appear to be linked to contamination of water or oysters.

DEVELOPING INFRASTRUCTURE FOR LARVAL SHELLFISH OUTPLANTING

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US Atlantic surfclams (*Spisula solidissima solidissima*) are economically important bivalves native to the Northeastern US. Like other calcifying organisms, they are highly vulnerable to climate change, especially the alterations in carbonate chemistry due to ocean acidification. Carbonate chemistry in the surfclam habitat has high spatial variability and seasonality, resulting in populations of surfclams at sites with distinct chemical differences. To assess the larval success of various surfclam populations in current environmental conditions, deployment containers are needed to ensure that the larvae being studied remain contained, adequately fed, and safe from predation. Containers of two volumes with cutaway 31 micron mesh windows were suspended at varying depths in Milford Harbor, and stocked with four-hour-old surfclam embryos of two separate populations and one genetic hybrid, with a follow-up test stocking 21-day-old larval oysters. After 48 hours, the larvae were retrieved, and their survival and development were compared to those of identical indoor cultures. Results show that containment units outdoors had sufficient water flow to deliver phytoplankton to the larvae, and that the size and depth of containers have little effect on survival. This means that by utilizing equipment such as the containers outlined in this study, deployed larval surfclams are exposed to an adequate food supply from the surrounding water column and can be utilized to study environmental conditions such as ocean acidification.

REIMAGINING PLASTIC-BASED AQUACULTURE: INVESTIGATING VIABLE ALTERNATIVES

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Shellfish and seaweed aquaculture are often celebrated as some of the most sustainable food production systems, providing ecological benefits such as habitat creation, nutrient cycling, and carbon capture. Yet these environmental gains are undermined by a near-total reliance on plastic gear throughout cultivation. With aquaculture now supplying more than half of the global seafood supply—and projected to grow substantially—its dependence on plastic presents an urgent sustainability challenge.

Deer Isle Oyster Company is addressing this issue by rethinking the materials placed in the ocean to grow oysters and sea vegetables. For the past five years, we have focused on designing and testing alternatives to conventional plastic gear, particularly for surface oyster cultivation. Our work emphasizes identifying materials that are not only durable, competitive, and scalable, but also aligned with ecological goals. Central to this effort has been the development and evaluation of plastic-free grow-out systems, with a focus on grow-out bags as a fundamental unit of production.

We will share lessons learned from field trials of alternative materials—including coated metals, wood, and biodegradable composites—evaluating their performance, cost feasibility, and environmental impact compared to plastics. By advancing viable plastic-free solutions, we aim to demonstrate that aquaculture can evolve into a truly sustainable food system that enhances ocean health while reducing the industry's contribution to marine plastic pollution.

CHARACTERIZATION OF THE *VIBRIO SPP.* COMMUNITY IN NATURAL OYSTER BEDS IN THE GREAT BAY ESTUARY

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The *Vibrio* genus contains a variety of human and aquaculture pathogens. Three of the most concerning shellfish-borne human pathogens are *Vibrio parahaemolyticus*, *Vibrio vulnificus*, and *Vibrio cholerae*. The concentrations of these species are surveilled monthly from April to December in natural oyster beds in the Great Bay Estuary, NH. Sediment, water, and oyster samples were enriched and streaked onto selective and differential

CHROMagar media as an initial step to detect the three species. Purple and blue isolates were tested via PCR for species-specific markers and virulence factor genes. This process leaves us with isolates not representing those colony morphologies and isolates that are negative for the markers used. A recent outbreak of *Vibrio fluvialis* in Northeast New England and an increase in vibriosis cases in the US have exposed the need for tracking a wider range of *Vibrio* species. White colonies and the negative purple and blue isolates were sequenced using the *hsp*60 gene, which is highly conserved in *Vibrio* to identify more *Vibrio* species. Ten novel pathogenic species were discovered including potentially pathogenic *V. anguillarum*, *V. aestuarianus*, and *V. alginolyticus*. Isolates from 2025 are currently being analyzed and we are also looking at incidence trends and the effects of environmental conditions on the diversity of the *Vibrio* spp. Community.

COMING OUT OF THE CLOSET: ADVANCES IN LOBSTER AQUACULTURE DEVELOPMENT IN MAINE

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From 1950 to 1986, Maine's commercial lobster landings remained relatively stable, averaging 20.3 million pounds annually, despite a fourfold increase in fishing effort, measured by the number of traps set each year. Dissatisfied with production levels, fishermen in Cutler established Maine's first fisherman-sponsored lobster hatchery in 1986 to enhance wild stocks. Over the next seven years, the hatchery released 50,000 to 150,000 first bottom stage lobsters annually from Schoodic Point to Lubec. Evaluating the program's success, however, was confounded by the migratory behavior of stage IV lobsters, which can swim or be displaced by currents until they reach at least stage VIII, making recapture and assessment nearly impossible.

After the program ended in 1992, Maine's lobster landings increased dramatically, with annual averages of 81.4 million pounds reported, though landings ranged by over 100 million pounds during the period. In recent years, concern has risen among managers and the industry regarding the effects of climate change on lobster biology, including altered growth rates, molting schedules, and shifts in usable habitat, all of which make the traditional, predictable patterns of lobster distribution more difficult to rely on. This creates continued challenges for fishery stability and management.

Since 2001, research in eastern Maine has explored the outplanting of hatchery-reared lobsters into individual, flow-through field enclosures. These efforts demonstrate that lobsters can be raised to a marketable crayfish size in three to four years with minimal

intervention. Regulatory changes could allow such lobsters to directly supply the crayfish market, diversifying and strengthening Maine's lobster industry

AQUACULTURE SAFETY CULTURE; LEADING, PROTECTING, AND GROWING BY EXAMPLE

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Some organizations may overlook the long-term cost savings of investing in strong safety cultures. Employees who feel that their employer doesn't care about their safety will exhibit decreased morale and a corresponding decrease in motivation and performance. Lost revenue, as a consequence of a weak safety culture and reduced productivity, is compounded by direct and indirect costs associated with an increased frequency of workplace incidents and injuries. It is critical to embrace a proactive approach to health and safety. Firstly, if employers wish to foster mutual trust and respect within their workforce, it is essential that employees feel heard and appreciated. Management must lead by example and practice utilizing positive reinforcement to intrinsically motivate workers to adopt a mindfulness that is rooted in safety while completing tasks. Secondly, hazardous conditions must be recognized and mitigated before incidents occur. Aquaculture operations present a complicated range of hazards which make protecting workers challenging, especially considering the ever-changing environmental conditions most farm sites face regularly. No one has greater hazard awareness than the workers exposed to them daily. Our industry has adopted technological tools to aid hazard recognition and reporting. Additionally, organizations in aquaculture are increasingly investing in leadership training courses to cultivate more empathetic and communicative management styles. This helps move us towards a more collaborative and less punitive safety culture, one which learns from mistakes and recognizes accomplishments. Health and safety are everyone's responsibility, and a teamwork-based health and safety program is one where every team member is mindful and accountable.

CULTIVATING THE NEXT GENERATION: BUILDING A MULTIDISCIPLINARY WORKFORCE PIPELINE FOR U.S. AQUACULTURE AND FISHERIES

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The future of U.S. aquaculture, maritime, and fisheries industries depends on more than advances in technology—it requires a strong and sustainable workforce to carry the industry forward. Meeting national goals for seafood competitiveness and innovation between 2026 and 2030 will require deliberate investment in building pipelines that

connect people to opportunities across every sector, from hatcheries and farms to processing, research, and policy.

Since its founding in 2020, Minorities In Aquaculture (MIA) has committed to expanding these opportunities by developing programs that prepare individuals for meaningful careers in the seafood economy. Through a multidisciplinary approach that blends training, mentorship, and collaboration with industry partners, MIA creates clear entry points into aquaculture and maritime careers while also equipping participants with the skills and networks necessary to thrive long-term.

This session will highlight how MIA is advancing workforce readiness and strengthening retention strategies that ensure individuals are not only introduced to the industry but remain a vital part of its future. It will also emphasize the connection between human capital and innovation, showing how investing in people directly amplifies seafood production, strengthens industry resilience, and secures U.S. leadership in global aquaculture.

By focusing on people as the foundation of growth, this presentation underscores how a viable workforce pipeline is central to building a competitive and sustainable seafood future.

THE BEGINNING OF A STORY: IMMUNE SYSTEM DEVELOPMENT OF THE ATLANTIC SEA SCALLOP

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In recent years, Maine bivalve hatcheries have attempted to produce a consistent supply of Atlantic sea scallop (*Placopecten magellanicus*) juveniles, but they continue to experience large scale mortalities of larval scallops with unknown causes. Although the immune system is critical for protection against pathogens, there is a knowledge gap about the sea scallop immune system, especially during the larval stages. This project seeks to

understand the immune ontogeny of hatchery-raised sea scallop larvae through gene expression analysis of immune markers and its relevance to larval survival. We measured the expression patterns of 9 immune-related genes (e.g. ferritin, superoxide dismutase, galectin) using RT-qPCR at various larval stages (fertilized egg through set larvae) in larvae collected from the Mook Sea Farms. Pattern recognition receptor genes, along with GATA and MyD88, had overall lower expression than the immune effector molecules such as ferritin, superoxide dismutase, and heat shock protein 70 (HSP70). Of note, Toll-like receptor-like expression increased as the larvae aged with a significant increase in expression at larval day 21 before transition into pediveligers. Contrastingly, HSP70 expression decreased significantly as the larvae transitioned from trochophore to D-stage veligers. The remaining immune-related genes had less discernable expression patterns with trends of increased or decreased expression. When coupled with hatchery data, these gene expression patterns could help determine how larvae are immunologically developing under standard conditions in a hatchery environment, possibly giving key insights into how the larvae can be produced consistently and reliably in the hatchery setting.

UNDERSTANDING THE COMMON CHALLENGES OF THE NORTHEASTERN AQUACULTURE INDUSTRY

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Aquaculture is a key part of the economy in the Northeast. Almost 14 million pounds of shellfish were produced in 2022, valued at $133 million, the highest of any region in the country. Despite this success, previous studies have identified regulatory and administrative hurdles, environmental stressors, and economic pressures as major challenges to shellfish aquaculture. To ensure the sustainability of the industry in the Northeast, it is important to understand the perceived challenges identified by all members of the aquaculture community, including farmers, researchers, regulators, and the general public.

The Northeast Aquaculture Conference and Exposition (NACE) offers a unique setting to begin this process. This conference attracts a wide range of participants from across the aquaculture community. To collect feedback, an interactive poster will be set up with color-coded push pins and paper strips, each color representing a different group. Participants will select a strip that matches their group, write down what they believe is the most significant challenge facing aquaculture in the Northeast, and place it in a feedback box. They will also place a pin on a map to show where they work in the region. The responses will enable us to evaluate how each sector of the aquaculture community perceives major challenges and highlight issues shared across groups. Additionally, the

data can reveal whether certain geographic areas in the Northeast face distinct challenges. This information can help guide future communication and research efforts led by Connecticut Sea Grant and the NOAA Milford Lab.

TOOLS FOR PLANNING AND FUNDING YOUR GROWING BUSINESS

Nick Branchina
Coastal Enterprises Inc.(CEI), 30 Federal St, Brunswick, ME 04011 USA

This panel discussion will focus on some of the resources available to aquaculturists looking to find financing to grow their farms. Experts will include Business Planning professionals and Lending experts who can share their experiences on what it takes to prepare for taking on funding.

This will be a panel discussion with plenty of time available to ask questions specific to your situation. Because financing and technical assistance questions can be personal in nature, presenters will be available to stay after the presentation to speak with individuals in a one-on-one setting or for follow up consultation.

Panel presenters will include representatives of Maine Aquaculture Association, Small Business Administration, Farm Credit East, NOAA Fisheries Financing.

THAT DO I DO WITH THE FARM WHEN I'M DONE? SUCCESSION, TRANSITION, AND ESTATE PLANNING IN MAINE AQUACULTURE

Christian Brayden
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The Maine Aquaculture Association (MAA) has built on top of its history of Maine aquaculture-specific business planning services by adding in farm succession, transition, and estate planning. As each year goes by, farmers grow older – some burn out, some are ready to retire, and others realize that aquaculture just is not for them. In all of these cases, the question is asked – what will happen with the farm? When resources on such topics were explored for aquaculture, nearly nothing fit the bill. This question was asked of MAA staff enough times that they wanted to explore these topics, specifically at the request of farmers. MAA's work was supported by the Northeast Extension Risk Management project award no. 2024-70027-42540**,** from the U.S. Department of Agriculture's National Institute of Food and Agriculture to delve into succession, transition, and estate planning for aquaculture in Maine, including the creation of a two-pager and a guide to help Maine's aquaculture producers.

This presentation will walk through the basics of succession, transition, and estate planning in Maine aquaculture, and why every farmer, regardless of age, should be thinking of them. It will also overview the services provided by Brayden and MAA staff.

BEST MANAGEMENT PRACTICES (BMPS) & OCCUPATIONAL STANDARDS: ADVANCING THE SECTOR AS PER MAINE'S SEA FARMERS

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The Maine Aquaculture Association (MAA) has followed through upon the requests of Maine's aquaculture sector. In the fall of 2025, MAA released the state's first set of best management practices (BMPs) for oyster aquaculture. The BMPs are designed to be helpful for all oyster farmers of all levels of experience, and especially for newer farmers. They walk farmers through the best steps to take in oyster farming from siting a farm, to operating it, selling oysters, and much more. They highlight the best practices of the most successful farmers, along with lessons learned. While there have been strong BMPs written previously, these BMPs will provide an update for farmers with the latest gear, concerns, and regulations in Maine.

Additionally, Maine's first occupational standards, which detail all of the occupations, including their expected duties, knowledge, and experience, across the entire Maine aquaculture sector. These standards have also gone on to be the standard used to create Maine's aquaculture apprenticeship program, along with other workforce development programs across the country.

Both sets of documents are in the rollout process, with their adoption being encouraged across statewide.

This presentation will focus on the BMPs and the occupational standards, including how (a) their adoption across Maine's aquaculture sector is being encouraged; (b) how they can be adopted in and adapted for other states; and (c) themes identified and lessons learned during both of these projects.

THE ECONOMIC IMPACT OF AQUACULTURE IN MAINE

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While some may look to Maine as leaders in U.S. aquaculture, its economic growth has not been formally assessed in a decade. This study uses data from a sector-driven survey to assess the economic impacts (via IMPLAN) of Maine's aquaculture sector in 2023. The findings paint a picture of the various species, sizes, and methods of aquaculture occurring in Maine, their impacts, and the related businesses and services that have grown to accompany the sector. Beyond this, the study looks at who is operating the farms, and who has been drawn to come to, or stay in, Maine to work on the farms. In short, it addresses the question: what is aquaculture bringing to Maine and its working waterfronts?

While the study paints a picture of aquaculture as we see it today, it also allows to compare to the previous, 2014-based study, and highlights successes and shortfalls in the Maine aquaculture sector's growth. Preliminary findings show notable increases in the farm gate value and total economic impacts of the shellfish sector, led by a stratified, yet growing, oyster sector. The survey also reveals projections for Maine's aquaculture growth over the next ten years, along with the identification of barriers to growth

THE USE OF PROBIOTICS TO MITIGATE ATLANTIC SEA SCALLOP (*PLACOPECTEN MAGELLANICUS*) MORTALITY FOLLOWING CHALLENGE WITH PATHOGENIC VIBRIO SPECIES

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Atlantic sea scallop (*Placopecten magellanicus*) hatcheries in the state of Maine could reliably produce spat year-round but struggle with mortality events, presumably induced by pathogenic bacteria. Probiotics have decreased mortality amongst infected bivalve larvae in other industries and could be implemented to decrease larval sea scallop mortality.

Seven probiotic bacteria were identified from literature and screened *in vitro* for potential benefits to sea scallop larvae. Bacterial competition assays were used to examine the inhibition of a model pathogen, *Vibrio pectenicida*, by probiotic candidates. Challenge trials involving larval sea scallops and *V. pectenicida* (10^5 CFU/mL) were conducted to test the effectiveness of applied probiotics on challenged and non-challenged larvae. *Alteromonas macleodii* (10^5 CFU/mL) increased survival amongst challenged larvae (RPS 46% ± 11) and *Pseudoalteromonas espejiana* (10^4 CFU/mL) amongst non-challenged larvae (RPS 46%). The effect of both promising probiotic treatments on larval sea scallops was tested at hatchery scale with *in vivo* challenge trials. *A. macleodii* had a negative impact on larvae growth and

survival. *P. espejiana* improved the rate of larval sea scallop growth and development during the late straight hinge to early pediveliger stage, where larvae mortality typically occurs.

This study can improve hatchery protocols through the implementation of the probiotic *P. espejiana*. Future work involves isolating potentially problematic *Pseudomonas* and *Vibrio* species, discovering their associated bacteriophages, and exploring the use of phage therapy in the hatchery. The use of *P. espejiana* in conjunction with phage therapy may prove critical to the success of Atlantic sea scallop hatcheries in Maine.

IT TOOK A VILLAGE

***Pat Burns*[1], Chad Campbell[1], Sadia Crosby[2], Michael Gaffney[3], Stephen Mace[4], Marissa McMahan[5]**

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Many watermen and women would like to start aqua farming to offset the negative effects of climate change on their current means of income. This includes clamming, lobstering, fin fishing and other products obtained from the sea that have declined significantly over the last few years.

While there is some debate as to the causes of these declines, we focus on the negative effects rather than debating the cause. This approach bypasses the potential for stultifying disagreement and instead moves us directly to problem solving and how we can overcome the challenges we are realistically facing.

While aqua farming has become a real option, many watermen and women do not have the resources to purchase the start-up gear and seed. Commercial financial sources, while available to credit worthy individuals, carry interest rates that are too burdensome for most of us.

Therefore, we offer another option that has been very successful in Georgetown. We formed a locally funded (philanthropically) LLC To provide low interest (2%) loans for a period of ten years. The loan payments are interest only for the first five years with the balance paid off over the next five years when the farmers are on their financial feet and earning a sustainable income of at least $60K per annum and much more the more successful the farmer becomes.

Over the last 9 years we have formed a coop to replace the startup LLC complete with by-laws that include standards of farm maintenance, husbandry and the consequences for non-compliance. Over the next two years, the original gear purchased by the LLC and the lease site will be transferred to the members of the coop. By that time the loans will have been paid off replenishing the original investment and will be available to add more farmers to our current coop as well as expanding beyond oysters to other products and locations in Georgetown. We call this perpetual philanthropy out over time.

This method also addresses the threats to our village sociology by slowing the outward migration of our young people, keeping our school, Vol. fire dept and other services functioning and thriving.

While there may be other options for preserving our maritime culture, we have found that oyster aqua farming has one of the highest return on investment as well as the quickest return on the initial investment with income beginning to flow only 18 months after the first seeding.

ENGAGING YOUTH IN AQUACULTURE EDUCATION THROUGH VIRTUAL FIELD TRIPS

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Field trips can be powerful learning experiences, but barriers like budgets, time, and accessibility often make them difficult. Virtual Field Trips (VFTs) offer an engaging alternative - bringing learners to real-world places they might never visit in person. In this presentation, explore Maine's aquaculture industry through a virtual tour of facilities like the Center for Cooperative Aquaculture Research (CCAR) using the ThingLink platform. These free, browser-based VFTs promote STEM learning, career exploration, and place-based education - no travel required!

SEAMADE AT UNE

***Carrie J. Byron*[1], Matt Duddy[2], Lisa Herschbach[3,4], Megan Letendre[5], Cameron Wake[1,5]**
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Building on a 2024 gift from the SeaMade Seaweed Company, the SeaMade Bar Project is a collaboration among students, faculty, and professional staff from the University of New England and external partners. Together, we are producing an all-natural nutrition bar that contains kelp, honey, cranberries, and almonds. Student innovation teams work collaboratively across disciplinary boundaries to engage in all aspects of the project, including farming and harvesting kelp and honey, producing and packaging the bars, investigating the nutrition profile and exploring new recipes, and conducting customer and marketing discovery, and distribution logistics. The SeaMade bar effort is one example of many career-training opportunities at UNE. We currently have several opportunities to engage industry partners through multiple programs including; Shaw Innovation Fellows, Sustainability Fellows, internships, the College of Business, and the Office of Research and Innovation. Through these innovative co-curricular programs and our research and education programs, UNE is training the next generation of blue economy leaders and professionals. We seek to extend our networks, and impact, through new collaborations

DEVELOPMENT OF A SEAWEED CALCULATOR FOR NITROGEN REMOVAL

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An online, publicly available tool for calculating the amount of nitrogen removed through seaweed (*Saccharina latissima*) farming is in development. This interactive tool can be used to inform nitrogen management, water quality regulatory processes, and seaweed aquaculture permitting in coastal waters. At this early stage of development, and with funding from University of Maine EPSCoR SMART program, data relevant to sugar kelp (*S. latissima*) in the Gulf of Maine will be used to inform the calculator. Sugar kelp is the most commonly farmed species of seaweed in the Gulf of Maine and the center of the local seaweed farming economy. Knowing that there is an inherent and high degree of variability in oceanographic conditions throughout the Gulf of Maine means that the developed calculator will be highly generalized for this region. However, once this proof-of-concept seaweed calculator is built, it can be used to leverage and justify additional funding from other sources, which will allow for more data collection to inform the calculator and improve precision. There is great interest in the development of ecosystem services tools for use by industry members and resource managers, and thereby several ways that a seaweed calculator could be adapted in the future with additional resources. If you have

tissue nitrogen data for water or any species of seaweed from any location that you would like to contribute towards informing future versions of this calculator, please contact the authors

DISTRIBUTION OF BAY SCALLOP MAROPSORIDA (BSM) IN THE HOST (*ARGOPECTEN IRRADIANS*) AND ENVIRONMENTAL SAMPLES FROM THE PECONIC ESTUARY, NY

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The bay scallop, *Argopecten irradians*, a species of critical economic and ecological importance in the Peconic Estuary, NY, has experienced devastating summer mass mortalities (>95% of adults) since 2019. These events are driven by an undescribed apicomplexan parasite, dubbed Bay Scallop Marosporida (BSM), which infects and disrupts various scallop tissues, in particular kidneys. Further progress in our understanding of BSM disease outbreaks is limited by an obvious lack of information on basic aspects of the biology and ecology of this emergent parasite, such as its distribution and dynamics in the environment or the potential existence of alternative/intermediate hosts.

This study evaluated BSM presence and abundance in scallops, seawater, sediments and an assortment of invertebrates collected from the scallop habitat. Samples were analyzed using microscopic methods (scallop tissues) or a specific quantitative real-time PCR (qPCR; all sample types).

Results showed that BSM presence and abundance in both scallop tissues and environmental matrices (seawater, sediment) are strongly seasonal and peaks during the warm summer months, coinciding with peak host mortality. In parallel, scallops from different genetic backgrounds displayed different tolerance to the infection, with local NY scallops showing significant susceptibility to the infection. BSM presence in invertebrate samples was incidental and rare, suggesting that bay scallop is the primary host for the parasite. Collectively, these results start to shed light on BSM ecology and provide useful baseline information for understanding its host association, environmental persistence, and drivers of disease outbreaks.

MACROPARASITES IN THE EASTERN OYSTER WITHIN THE NORTH SHORE OF MASSACHUSETTS

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Wild oyster populations along the North Shore of Massachusetts remain largely understudied, leaving significant gaps in our understanding of their health and vulnerability to parasites. In this study, we investigated two common shell-degrading parasites: the mud blister worm, *Polydora websteri*, and the boring sponge, *Cliona celata*. *P. websteri* are small marine worms that burrow into the shells of oysters and other bivalves, creating mud-filled blisters. *C. celata* bores small holes into calcium carbonate shells of marine organisms. Both *P. websteri* and *C. celata* negatively affect shell integrity and visual appearance, making oysters more vulnerable to predators and stressors, and likely decreasing commercial value. To assess the prevalence and intensity of these parasites in Plum Island Sound, we collected and photographed wild oysters from three sites representing distinct environments. The Parker River discharges into Plum Island Sound and contains freshwater and tidal segments. Mud Creek, by contrast, is a fully saltwater tidal creek embedded within the Great Marsh. The Rowley River, a tributary of the Plum Island River, has more brackish water. Using ImageJ, I counted the number of mud blisters present on the interior of the shells and calculated the percentage of boring sponge on the exterior. We found a possible increase in parasites from June to August, which could be attributed to changes in water temperature, salinity, or sediment. We also found slight differences in parasite burdens across sites. This highlights the importance of continued monitoring of oyster health in the Plum Island Sound area.

PERSPECTIVE ON THE DISEASE STATUS OF SEED OYSTERS FROM NURSERY-PHASE CULTURE

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Regional efforts to improve shellfish health management in the context of interstate aquaculture industry commerce have emphasized the relative freedom from infection of small seed products: larvae and post-set shellfish that have not yet left controlled hatchery environments. The Hatchery Compliance Program of the Regional Shellfish Seed Biosecurity Program (RSSBP) specifically focuses surveillance and audits on hatchery products and facilities to streamline regulation of these most biosecure seed. At the same time, however, there is commercial interest in easing the same regulatory impediments to transfers of larger nursery seed that has been growing on raw water, but infection of nursery seed by major regional shellfish pathogens has remained a significant research gap. We have begun to more intensively study disease in nursery seed to better understand the development of infections in nursery settings. Initial sampling included 72 nursery oyster samples from four states, a number of these from Virginia amidst an intense *Haplosporidium nelsoni* (MSX) outbreak. *H. nelsoni* was not observed in any nursery seed sample, and *Perkinsus marinus* (dermo) was not observed in the 36 samples that were

less than 10 mm in size. *P. marinus* was observed in 7 of 36 larger samples (> 10 mm), but never at a prevalence greater than 16.7% or at greater than a *very light* infection intensity—no more than 10 *P. marinus* cells observed. Initial data suggest, therefore, that smaller nursery seed would pose a low risk of pathogen transfer within the endemic zone for our major oyster diseases.

WIDESPREAD DEMOGRAPHIC SUPPLEMENTATION OF CONNECTICUT WILD OYSTERS BY AQUACULTURE FARMS

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Eastern oysters (*Crassostrea virginica*) are both ecologically important and widely farmed, yet wild populations have declined throughout their range. While oyster aquaculture is typically valued for food production and habitat services, farms may also provide an underexplored ecosystem service: supplementation of wild populations through recruitment of farm-source larvae. Hypothesized supplementation from farms requires empirical measurement to determine its spatial and temporal extent, and ultimately to understand it as a pathway of evolutionary gene flow with potential trade-offs.
Since 2022, we have used genomics to investigate farm-derived spat recruitment to wild populations along the Connecticut coastline, where both aquaculture and wild oysters are extensive. Gear-based farms generally grow selectively-bred, diploid strains that are genetically distinct from wild populations in predictable ways, enabling the ancestry of spat and adults to be traced with genomic markers. Admixture (mix of ancestry) analyses of oyster spat settled in 2022 showed similar spatial patterns of admixture compared with co-occurring mixed-age adults. Oysters with low levels of farm ancestry are geographically widespread and represent more than half of the Connecticut wild oysters analyzed. This pattern suggests farm immigrants are only occasional, they hybridize with wild oysters to produce 50/50 admixed offspring, followed by repeated backcrossing to wild oysters that gradually reduces farm-source ancestry in individuals while spreading it in the population. Further work is assessing multi-cohort admixture variation and inferring potential fitness impacts based on genomic patterns of variation. Similar admixture dynamics, intensively studied in Atlantic salmon, may be relevant and insightful.

OYSTER AQUACULTURE TRAINING PROGRAM (OAT) AT THE VIRGINIA INSTITUTE OF MARINE SCIENCE

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The Oyster Aquaculture Training (OAT) program is an intensive, five-month paid internship hosted by the Virginia Institute of Marine Science (VIMS) in Gloucester Point, Virginia. Since its inception in 2009, the program has prepared individuals for careers in shellfish aquaculture through immersive, hands-on training. Interns work closely with researchers from the Aquaculture Genetics and Breeding Technology Center (ABC), gaining experience in hatchery operations, land-based nursery systems, and oyster farm management. Training includes broodstock conditioning, larval rearing, algal production, seed grading, and farm-based grow-out techniques, with an emphasis on husbandry and equipment maintenance. Participants also engage in a weekly rotation at a commercial aquaculture business, and take part in short-term externships tailored to their interests, offering additional exposure to real-world industry practices. Lectures and guest speakers covering a range of topics such as oyster biology, selective breeding, and aquaculture business management are offered during the program as well. Over the past 15 years, 43 individuals have completed the program, with many securing positions at commercial operations, research institutions, and government agencies along the East Coast. Our aim is for participants to complete the OAT program with confidence and skills needed to enter the aquaculture workforce.

STOCKS VS. FLOWS: SECOND-BEST INCENTIVE DESIGN FOR STOCK-GENERATED EXTERNALITIES

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Conventional wisdom states that incentives targeting stocks and flows can lead to equivalent externalities correction. However, this may not hold when externalities are more directly produced from stocks ("stock-generated externalities") rather than flows of production, as is commonly modeled. Stocks that exhibit external effects include trees and CO_2 absorption, shellfish and water cleaning, and livestock and methane emissions. I present a dynamic optimization model of privately-owned renewable resource extraction where the stock of natural capital jointly produces a private good and social benefits to assess the performance of various incentive-based externality-correcting policies. I explore how targeting natural resource stock abundance versus flows of production perform relative to the social optimum and a no-policy benchmark. I present both theoretical and numerical results by calibrating the model to industry and scientific parameters from the Chesapeake Bay, where Eastern oyster (*C. virginica*) cultivation yields water filtration benefits. I find that stock-targeted incentives have the potential to achieve socially optimal

resource abundance and environmental quality over time. While flow-targeting may achieve short run gains in environmental quality, the firm reverts back to levels of extraction as if no policy occurred in steady state. While stock-targeting allows the firm to flexibly maximize profits over the natural resource stock *and* the private good, flow-targeting solely changes the value of the private good, leading to similar profit maximization and extraction behavior as no-policy in steady state. The model provides a theoretical framework to evaluate policies aimed at mitigating environmental damages through management of privately-owned living natural resources.

COMPARING THERMAL TOLERANCE OF SUGAR KELP (*SACCHARINA LATISSIMA*) GAMETOPHYTE POPULATIONS ACROSS THE GULF OF MAINE FOR FUTURE KELP FOREST RESTORATION AND AQUACULTURE APPLICATIONS

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Rapidly warming waters in the Gulf of Maine (GOM) are threatening ecologically and commercially valuable rocky reef ecosystems. *Saccharina latissima* (sugar kelp), a dominant brown alga found in these habitats and one of the most commonly farmed kelp species in North America, is vulnerable to warming waters and marine heatwaves. To address this issue, this project will create temperature challenge experiments to test if there is a difference in thermal tolerance across sugar kelp populations in Maine. Sorus tissue was collected from field sites that span a range of thermal regimes to create gametophyte biobanks, in an effort to safeguard loss of genetic diversity. Gametophytes will be subjected to various heat stress tests to determine heat-tolerance and other sub-lethal effects. Experimental treatments may include conditions reflecting historical average seawater temperatures, temperatures mimicking current marine heatwave temperatures/intensities, along with temperatures based on projected water temperatures in the GOM. The results of these experiments will provide insight into the future of wild kelp populations and provide implications for sporophyte progeny to be used in restoration and/or aquaculture in Maine.

INCREASING OYSTER HATCHERY RESILIENCY BY REDUCING HATCHERY SEAWATER TURBIDITY AND WATER QUALITY DEGRADATION ASSOCIATED WITH STORM EVENTS.

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Mook Sea Farm has observed a correlation between heavy precipitation events and lower seed survival in our hatchery. We rely on UV sterilization to treat the seawater that is being delivered to our hatchery seed. Historically this, coupled with staged pre-filtration to 1-micron (nominal), has been adequate to treat our incoming water and maintain water that is pathogen free. Measurements and small-scale experiments determined that:

- Particles greater than 1 micron were passing through our existing filtration system.
- By adding absolute 1-micron filters after our existing filters, we can remove these small particles before the water passes through our UV system.
- In doing so, based on bacterial plating, the efficacy of the UV sterilization was restored.

This project scaled up the augmented filtration system so it can handle the volumes of seawater we pump into the hatchery. We employed the use of turbidity meters to monitor turbidity levels pre and post filtration. We also examined the efficacy of UV at various turbidity levels within our hatchery by correlating turbidity measurements with bacterial plating assays to try to identify the turbidity threshold that will dictate when augmented filtration is required.

While turbidity was reduced using filtration, bacterial plating (Marine TSA Plates) results from water going through our in-hatchery sea water delivery system indicated that 1uM filtration alone was insufficient to prevent bacteria from being present in incoming sea water. This indicated that more stringent cleaning of systems was necessary. Upon employing increased cleaning efforts, bacteria were no longer present in incoming water.

Project support: SOAR Shellfish Growers Resiliency Fund

ASSESSING THE POTENTIAL FOR BAY SCALLOP AQUACULTURE IN MAINE

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The bay scallop*, Argopecten irradians*, occurs along the U.S. East Coast, with Maine at the northern limit of its range. Fast growth, reliable hatchery production, and strong markets make this species attractive for aquaculture, but earlier studies in Maine reported high winter mortality that limited yields. With warming conditions in the Gulf of Maine, culture may now be more feasible, though overwintering survival remains a key challenge. We applied standard farming methods in the Damariscotta River Estuary, a major aquaculture

region in Maine. Scallops were deployed on a commercial oyster lease (Norumbega Oyster Inc., Edgecomb, ME) in July 2024, followed by an overwintering trial at the Darling Marine Center (Walpole, ME). Lantern nets were stocked at three densities of 10, 30, and 50 percent coverage. Shell height and mortality were tracked monthly from July to December, when scallops were transferred to a flowing seawater lab. From December 2024 to May 2025, mortality and tissue weights were recorded biweekly. Preliminary results indicate that scallops in lower-density nets grew larger during the fall and showed reduced mortality both in fall and winter. Growth was not observed after transfer to the lab, but survival patterns continued to favor low-density treatments. A follow-up study launched in July 2025 is testing whether estuary location influences growth and survival. These findings suggest that management strategies, particularly lower stocking densities, can improve bay scallop performance in Maine. Ongoing survival, growth, and market assessments will help determine whether this species can support commercial culture within the region.

ANOTHER POCKET HATCHERY: DOES SMALL MAKE SENSE?

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Shellfish hatcheries represent the tip of the biomass pyramid for aquaculture, where a large and diverse market of shellfish producers is serviced by a comparative handful of hatcheries. The industry evolved this way in part because hatcheries are expensive to build, requiring significant capital for suitable waterfront property, facility construction, equipment, and hiring specialized staff. With support from the USDA SBIR program this project offered an alternative to the current status quo in U.S. shellfish hatchery production by the development of a space-efficient mobile hatchery capable of moderate scale seed production, which could be easily multiplied for scaled, and diversified, seed capacity increase. Over the project period, three mobile hatcheries (MOHs) were constructed and commissioned producing 300 million eyed larvae and 20 million seed over two production seasons. Only one facility achieved target production capacity, in its second operating season. A simple financial analysis was completed and suggested none of the three facilities would have been financially solvent in the observed production years. These analyses suggest however, that at production capacity facilities can achieve break-even. This project has shown that the MOH concept offers advantages in mobility, site flexibility, and scalable seed production, however its success depends heavily on-site conditions, operator skill, and available resources. In short, the MOH isn't a quick fix for hatchery problems but a flexible tool that, when used with the right investment and in the right setting, could help grow hatchery capacity, support new markets, and improve seed security in the shellfish industry.

EVALUATING BIO-SECURE TRANSFER METHODS OF LARVAE AND SEED FROM THE ATLANTIC TO THE GULF COAST: A COMMERCIAL HATCHERY PERSPECTIVE

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To date, transfer of oyster larvae or seed between the Atlantic coast and the Gulf of Mexico has been prohibited due to concerns about the potential transmission of pathogens. Oyster Seed Holdings, Inc. (OSH), a regional hatchery, providing oyster seed to the East Coast and adhering to strict biosecurity protocols, aimed to test a protocol to mitigate these concerns. Over the 2023 and 2024 hatchery seasons, OSH partnered with the University of Southern Mississippi (USM) Thad Cochran Marine Aquaculture Center and Virginia Institute of Marine Science (VIMS) Shellfish Pathology Laboratory. There were two goals: (1) test the secure transfer of oyster larvae and (2) evaluate whether broodstock sourced from outside the production area can produce larvae and seed that remain free of the pathogens tested. In 2023, three cohorts of larvae were tested for pathogens, shipped to USM, set on microcultch and reared in a closed, quarantine system for 5-7 days before returning to VIMS for pathogen screening. In 2024, with support from The Nature Conservancy's SOAR program, OSH expanded the trials to include post-set seed (up to 2-3 mm in size), which were quarantined at USM for three weeks after initial screening. Five cohorts of seed were tested, sent to USM, and returned to Virginia for follow-up screening. All samples tested negative for pathogens (*Perkinsus marinus*, *Haplosporidium nelsoni*, and *Bonamia exitiosa*) by both PCR and histopathology, suggesting that larvae and seed free of detectable pathogens can be safely set and reared without acquiring infections originating from the source facility.

COMMERCIALIZATION OF BOTTOM SEA SCALLOP AQUACULTURE IN THE GULF OF MAINE: DEVELOPMENT OF SPAT COLLECTION AND GROWOUT PROTOCOLS

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The Atlantic Sea scallop shows great potential as an aquaculture species in the Eastern United States. It is characterized by a fast growth rate, high price, an established market both domestically and internationally and developed aquaculture protocols in similar species abroad. Furthermore, while the US still has the largest wild scallop fishery globally,

total catch has drastically declined in recent years, necessitating imports from farmed scallops grown overseas, which now account for 50% of the US market. In Maine, a small scallop aquaculture industry has developed, mostly using suspended gear methods developed in Japan. However, these methods may present an entanglement risk to critically endangered North Atlantic Right Whales and are extremely labor intensive due to substantial biofouling. University of New Hampshire partnered with lobster fishermen to develop bottom culture methods of scallops using established commercial gear.

In August, September and October 2024, scallop spat collectors were deployed at 12 sites of varying depths (30-45m) off the New Hampshire coast. Total spat numbers, spat size and biofouling levels varied significantly between months and depths. Collectors were recovered in spring 2025 and spat were distributed into bottom cages at two sites at 35m depth. After one year, more than 99 percent of scallops survived and exhibited growth comparable to suspended gear. The gear showed virtually no biofouling after being deployed for six-months without maintenance. These results present an encouraging opportunity for commercial application by fishermen and aquaculturists in the United States.

RAPID AND SENSITIVE eDNA TOOLS TO IDENTIFY PATHOGENS OF JUVENILE OYSTERS, LARVAE, AND SEED

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Oysters are susceptible to mortality from bacterial pathogens at their larval, seed and juvenile stages of development. In shellfish hatcheries, mortality events during seed production threaten productivity and profitability and remain one of the greatest risks to the aquaculture industry. Traditionally, shellfish hatcheries have had to send samples to commercial laboratories to identify pathogens, waiting anywhere from 2-4 weeks for results, at which point the opportunity to control the pathogen would have passed. To address these testing constraints, this project developed six rapid and relatively inexpensive Loop Mediated Isothermal Amplification (LAMP) assays that can be performed at the point of need (e.g., aquaculture hatcheries, field locations). The LAMP assays require only basic lab equipment to test for several species of *Vibrio* as well as the causative agent of Juvenile Oyster Disease (JOD). These tests will allow hatcheries to detect the presence of one of several pathogenic *Vibrio* spp. or JOD in about an hour, enabling them to take proactive measures to control the spread of the pathogen and protect their assets. Furthermore, the assays can be used to evaluate cleaning processes to remove pathogens, to check algal food sources for potential *Vibrio* contamination and to test oyster seed for

pathogen presence, prior to its distribution. Adoption of LAMP technology will provide an early warning system for the presence of potential shellfish pathogens in hatcheries and could lead to development of improved mitigation methods to eliminate these pathogens quickly, thereby reducing shellfish hatchery production failures, increasing sustainability, resiliency, and profitability.

TECHNOLOGY TRANSFER VISIT TO AOMORI AND HOKKAIDO, JAPAN IN SUPPORT OF MAINE'S GROWING FARMED SEA SCALLOP INDUSTRY

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Maine's wild fisheries and its flourishing aquaculture sector are at a pivotal moment, grappling with the unprecedented challenges posed by our constantly changing environment. To ensure the survival and prosperity of Maine's waterfront communities, adapting and evolving these industries is not just an option—it's a necessity. One of the most effective strategies to drive industry growth is through "technology transfer." For Maine aquaculture, this means learning about innovative species, resources, and cultural practices from around the globe and integrating these insights into local practices. Maine has leveraged technology transfers with great success in recent years to introduce new (native) species, technologies, culture techniques, equipment, market development and culinary uses for emerging species of shellfish and kelp. Technology transfer allows participants to fully immerse in a local culture and meet with chefs, fishermen, growers, processors, retailers, restaurateurs, equipment manufacturers, government officials and scientists. During this presentation the farmed scallop industries of Hokkaido and Aomori, Japan will be highlighted from a recent learning exchange with growers from Maine in October 2025. The presentation will include an overview of spat collection, grow out techniques, equipment and vessels, farm set up, scallop markets and value-add opportunities and other topics of significance.

TECHNOLOGY TRANSFER VISIT TO HOKKAIDO, JAPAN IN SUPPORT OF MAINE'S GROWING FARMED SEA URCHIN INDUSTRY

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Maine's wild sea urchin fishery has been in decline for years, and there is growing interest among industry to create opportunities for a farmed sea urchin product to offset wild harvest losses. In response to this, Japan Fishing Machine, LLC has teamed up with Coastal

Enterprises Inc., Maine Sea Grant, UMaine Center for Cooperative Aquaculture Research, and the University of Rhode Island to explore farming sea urchins. This session will provide an overview of a planned "technology transfer" trip to visit Hokkaido, Japan with a specific focus on sea urchins. With funding to Maine Sea Grant from NOAA Fisheries, a group of 12 delegates plan to spend a week in Hokkaido Prefecture in late March of 2026. The group plans to fully immerse in a local culture and meet with chefs, fishermen, growers, processors, retailers, restaurateurs, equipment manufacturers, government officials and scientists. Throughout the week, we will visit hatchery facilities, observe wild harvest and farm culture activities, vessels, equipment, kelp feed, handling practices, processing, packaging, roe quality, live auction, live sale, as well as transport and end user market opportunities. The group will identify opportunities and best practices that can be "brought back home" to implement the support and growth of green sea urchin hatchery production, cage culture and grow out techniques, use of farmed kelp as feed, vessel setup, managing biofouling, stocking densities, harvest practices, roe quality, culinary uses, and access to markets. Audience members will have a chance to suggest other topics of importance to learn about.

APPLYING FORENSIC DNA FINGER-PRINTING TECHNIQUES FOR TRACKING THE FATE OF FARMED SUGAR KELP FRAGMENTS IN INTEGRATED MULTITROPHIC AQUACULTURE

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Cost-effective, rapid-response forensic DNA finger-printing assays capable of identifying a variety of species have become powerful analytical tools. Paired with digital PCR (dPCR), these highly sensitive assays are capable of detecting and quantifying minute amounts of target DNA. We used these tools to track sugar kelp (*Saccharina latissima*) DNA across an integrated multitrophic aquaculture setting within three different substrates (gut contents, seawater, and sediments). In one experiment, we experimentally co-cultivated blue mussels with sugar kelp for approximately three months, removed and homogenized the gut from a subset of mussels, and extracted the DNA. This DNA was analyzed using a recently published sugar kelp assay targeting the cytochrome oxidase I (COI) gene to quantify the abundance of sugar kelp contained in the gut as a proxy for ingestion. In another application, the same assay was used to discover how sugar kelp COI copy numbers changed in the water column following outgoing tide drift tracks away from kelp farms. Finally, we used this assay to determine the abundance of sugar kelp in marine sediments in the shadow of kelp farms by quantifying copy numbers from samples taken directly underneath kelp farms, as well as outside the aquaculture lease footprint. In all experiments, the assays performed well and proved to be highly sensitive. These analyses

provide valuable insights into the fate of farmed sugar kelp for food subsidies, as well as biomass deposition, in the context of blue carbon.

PRIORITIES FOR GENETIC IMPROVEMENT OF OYSTERS

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The USDA Agricultural Research Service has started a breeding program to develop genetically improved strains of eastern oysters for aquaculture in collaboration with NOAA, the University of Maine, and the University of Rhode Island. The session will begin with a brief description of the structure and goal of the breeding program. The majority of the workshop will be spent discussing with attendees the improvements they want to see in a cultured oyster strain. Topics will include prioritizing the traits (e.g., growth rate, resistance to specific diseases, heat tolerance, shape, etc.) that are most important to the industry and the range of growing conditions (environmental conditions, disease pressure, gear types) throughout the northeast.

LONG ISLAND SOUND PARTNERSHIP: IMPACTS OF ENVIRONMENTAL TRENDS ON OYSTER HEALTH

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In Long Island Sound (LIS), the Eastern oyster, *Crassostrea virginica*, is both economically and ecologically valuable to coastal communities. Increasing shellfish production from aquaculture and restoration has been identified as an ecosystem target for the LIS Partnership, a national estuary program dedicated to restoring and protecting the Sound's waters and watershed. It is well understood that changes in water chemistry such as changes in temperature, pH, salinity, dissolved oxygen, and chlorophyll-a can affect shellfish growth, food availability, and body conditioning.

The expansion of oyster populations in LIS may be limited by environmental extremes that vary unpredictably in time and space. It can affect their shell-building capabilities and make them more brittle and susceptible to predation and biofouling damage. In LIS, summertime lows in pH and dissolved oxygen occur with highs in temperature, which can amplify the adverse effects on bivalves, particularly early life stages that are present during this critical

growth period. Our data collection takes a comprehensive look into three oyster beds in LIS with continuous water quality monitoring and monthly sampling of oysters for molecular analyses.

By further understanding the current environment and how projected change may affect shellfish populations, our study aims to inform risk assessments and adaptive management to ensure the success of aquaculture production.

MAPPING AQUACULTURE COST OF PRODUCTION WITH INTEGRATED MODEL-BASED ENGINEERING, BIOGEOCHEMICAL SATELLITE DATA, BIOLOGICAL MODELING, AND TECHNO-ECONOMIC ANALYSIS FOR SEAWEED, SHELLFISH, AND FINFISH

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The economic viability of aquaculture is heavily dependent on site-specific factors. Across trophic levels, costs and productivity are sensitive to distance from port, design wave, wind, and current conditions, water depth, and bio-geochemical factors. We present various tools and efforts to de-risk investments in seaweed, shellfish, and finfish aquaculture by characterizing typical and extreme environmental conditions, specifying representative farm designs and associated structural, installation, and operational costs, and integrating site-specific biogeochemistry to inform growth models to comprehensively estimate cost of production. In these projects, the authors are applying coupled techno-economic analysis on regional scales to create publicly accessible resources for the mariculture industry's site selection and farm design process. These efforts include A) assembling best-available hindcast ocean data or generating it using validated regional-scale ocean modeling tools, B) applying extreme value analysis to compute the design values for each location, C) applying Hydro-/Structural Dynamic Finite Element Analysis tools to quantify the dimensions and components adequate for the site's extreme design conditions, D) apply growth models based on site-specific biogeochemistry to quantify yield, and E) , apply Techno-Economic Analysis (TEA) tools to quantify annualized capital and operational expenditures for each combination of site conditions and normalize by annualized biomass to quantify cost of production. Results include:

1. Maps of typical and extreme currents, waves, water levels, winds, and representative monthly temperature, salinity, turbidity, photosynthetically available radiation, and chlorophyll-a, for the geographical region of interest,

2. Component specifications for select cultivation structures at representative sites, and
3. Maps of estimated cost-of-production.

YELLOWTAIL KINGFISH IMMUNE DEVELOPMENT

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Yellowtail kingfish (*Seriola lalandi*) is a promising candidate for aquaculture in the United States. However, high larval mortality remains a bottleneck, partly due to the immature immune function of the larvae. Therefore, this project aims to investigate the larval immune development of yellowtail kingfish and build an immunological development timeline to help optimize the timing of vaccinations. Yellowtail kingfish samples from 0 to 28 days post-hatching (dph) were collected and analyzed using qPCR. Seventeen immune-related genes were analyzed using qPCR at 0, 2, 4, 6, 12, 15, 19, 21, and 25 dph. Adaptive immune genes such as RAG-1 and IgM, CD8, TCRα, MHCI, MHCII, and Ikaros were detected as early as 0 dph, indicating early development of the adaptive immune system, or could be maternally transferred. IgM, CD4, CD8, TCRα, and MHCI were expressed at baseline levels during the first 25 dph, which were expressed much lower than in different adult yellowtail organs, indicating the adaptive immune system is still underdeveloped. However, the expression of innate humoral factors such as C3 and lysozyme increased significantly (and manifold) higher levels than the adaptive factors in the same period, demonstrating that fish larvae rely on the innate immune system at the early stages. This study provides insights into specific patterns of immune function development in yellowtail kingfish larvae. These findings help optimize hatchery management strategies and improve larval survival rates. As a result, they strengthen aquaculture sustainability in the US.

SPAT UNDER SIEGE: eDNA INSIGHTS INTO SPECIES CHALLENGING MUSSEL AQUACULTURE IN THE GULF OF MAINE

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The blue mussel is a commercially and economically significant bivalve species worldwide, but it is facing challenges in the rapidly warming Gulf of Maine (GOM). Recently, farmers have struggled to collect wild mussel larvae, a necessity for mussel aquaculture. Declines in mussel larval recruitment in the GOM suggest shifts in local species composition in response to changing environmental variables. To monitor these changes, plankton

samples were collected from two Casco Bay mussel aquaculture leases and analyzed using eDNA metabarcoding of the *COI* and *18S* genes. Metabarcoding of plankton samples collected from June 2024 to July 2025 revealed community-level changes across this time series, including increased abundance of potential predators and competitors corresponding with mussel larval peaks. Seasonal shifts in phyla composition at both sites corresponded to temperature rather than site location. Invasive species, including the European green crab and European sea squirt, occupied a large proportion of the community during periods when mussel larvae were present. Green crab larvae may settle with and subsequently prey upon mussel larvae, reducing recruitment on collection ropes, and sea squirts are known to hinder mussel growth through competition for nutrients and space. The mud blister worm, a polychaete that bores holes into bivalve shells, shows high abundances during the summer months, when bivalve larval populations are increasing. Moreover, the wrinkled rock-borer, a competitor bivalve species, had the highest occurrence of all the bivalves. The interactions between blue mussels and these species may impact the health and growth of mussel populations, particularly in aquaculture settings.

BEYOND THE HALF SHELL: ALTERNATIVE SHELLFISH PROCESSING METHODS

Meggan Dwyer
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This panel brings together researchers and industry leaders to explore innovative approaches to processing that extend beyond the traditional half shell. Panelists will examine methods such as high-pressure processing (HPP), canning, smoking, jarring, and alternative shelf-stable packaging, with attention to how these techniques can improve food safety, extend shelf life, diversify product offerings, and expand consumer access. The discussion will also address consumer willingness to pay for alternative sizes, packaging, and certification schemes, highlighting how market preferences influence product development and adoption. By integrating perspectives from science and industry, the panel will consider both the technical and economic dimensions of value-added processing, and the role these innovations can play in strengthening aquaculture resilience and shaping the future of seafood markets.

TIKTOK – TIMES ARE CHANGING: COMMUNICATING AQUACULTURE FOR THE NEXT GENERATION

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This panel examines innovative approaches to communicating aquaculture science and practice with the next generation. Panelists will explore the interplay of new media used in traditional ways and traditional media reimagined through new technologies, highlighting how these methods influence public perception, understanding, and engagement. The conversation will span social media, podcasting, visual arts, documentary film, and virtual reality, offering insights into both the opportunities and challenges of leveraging creative and digital platforms to broaden accessibility, amplify diverse voices, and foster intergenerational dialogue in aquaculture.

To enhance accessibility and extend the exchange beyond the event, the session will be recorded live as part of the Salty Talks series, ensuring the discussion contributes to ongoing conversations on aquaculture communication and education.

SEEDING SUCCESS: INNOVATIVE WORKFORCE DEVELOPMENT IN AQUACULTURE

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In recent years, available funding opportunities have created significant avenues for workforce development and internship initiatives focused on aquaculture. States across the Northeast have responded in diverse ways, developing innovative programs designed to meet the sector's growing workforce needs. These efforts include apprenticeships, internships, boot camps, and other training models that provide hands-on experience while building connections between students, early-career professionals, and industry.

This panel will bring together program leaders from across the region to share their approaches, highlight successes, and candidly discuss the challenges faced in developing and sustaining workforce initiatives. Panelists will present examples of their projects, outlining what worked well and what barriers emerged—from program design and recruitment to partnerships and long-term sustainability. They will also share feedback received from industry partners and participants, offering insights into how programs can better align with employer needs and trainee expectations. The discussion will conclude with practical advice and lessons learned for others considering launching similar efforts.

By examining the wide range of projects, this session aims to provide participants with a deeper understanding of effective strategies for workforce development in aquaculture,

while fostering conversation about regional collaboration and how we can continue to meet the needs of the industry.

EXPLORING VIBRIO POPULATION ECOLOGY IN NEW HAMPSHIRE'S GREAT BAY ESTUARY

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Over the past two decades, shellfish-borne infections from pathogenic *Vibrio* bacteria have increased significantly in the northeastern United States. Monitoring and predicting the population trends of *Vibrio* pathogens provides important knowledge for shellfish producers and managers to anticipate and mitigate public health risks. Since 2007, our lab has monitored three *Vibrio* species at two natural oyster reefs in New Hampshire's Great Bay Estuary, a significant oyster farming location in the Northeast. Previous studies have focused primarily on the population dynamics of *V. parahaemolyticus*, while the ecology of *V. vulnificus* and *V. cholerae* remains largely unknown despite posing public health concerns, especially considering the high mortality rate associated with *V. vulnificus* infections. We examined the population trends of all three *Vibrio* species in oyster tissue, water, and sediment in Great Bay from 2007 to 2024. *Vibrio* concentrations exhibited seasonal fluctuations and interannual variability, with higher abundances from June through August, and a notable spike in 2017. *V. parahaemolyticus* populations were higher and more persistent than the other two species. To understand the ecological drivers of these trends, we analyzed environmental parameters over the same period and found a strong relationship with temperature for populations of all three species, with lesser influence by other factors. Continued monitoring is underway to inform public health risk assessments and develop more robust predictive models of *Vibrio* population trends.

OPTIMIZING GREEN SEA URCHIN (*STRONGYLOCENTROTUS DROEBACHIENSIS*) CO-CULTURE SYSTEMS WITH ATLANTIC SEA SCALLOPS (*PLACOPECTEN MAGELLANICUS*) TO CONTROL BIOFOULING.

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Like other sectors of shellfish aquaculture, the emerging industry of Atlantic sea scallop (*Placopecten magellanicus*) aquaculture is susceptible to problematic biofouling on gear (e.g.

lantern nets, pearl nets, cages), which can reduce gear mesh openings, restrict water flow and potentially reduce shellfish growth. Farmers need to commit a large amount of labor to removing this fouling to maximize shellfish growth, with many seeking alternative solutions to alleviate this issue. One solution is to integrate sea urchins, whose grazing activity has been shown to reduce fouling on aquaculture gear by as much as 40-90%. Previous studies have used differing shellfish and sea urchin species combinations, but the integration of another emerging aquaculture species, the Green Sea urchin, (*Strongylocentrotus droebachiensis*) with Atlantic Sea Scallops requires further investigation. The grow out techniques and environmental tolerances are extremely compatible across both species, meaning that their integration has strong potential, and could provide opportunities for growers looking to diversify production. We will overview recent projects that explored methods for co-culturing these two species, with a focus on optimizing animal size, stocking density, and gear types.

CARDIAC RESPONSES TO HEAT STRESS IN BLUE MUSSELS (*MYTILUS EDULIS*): IMPLICATIONS FOR THERMAL TOLERANCE AND AQUACULTURE IN A WARMING OCEAN

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As coastal waters warm in New England, blue mussels are facing increased mortality from thermal stress. This stress has the ability to impact the mussel culture industry in the state of Maine, raising strong interest in developing a more thermotolerant stock of mussels. I am examining the potential for genetic selection for thermal tolerance within mussel populations by measuring changes in cardiac physiology following a short-term extreme heat stress. Mussels were collected from Eastport, Maine and acclimated to 16C; a subset was subjected to a three-day temperature shock and then allowed to recover for 2 weeks, while a second subset was kept at 16C throughout the experiment. We tracked the survival of both groups during the two-week recovery. We then used an impedance pneumography approach to track the change in heart rate for both stressed mussels that had survived the 3-day heat shock and control mussels when exposed to an acute (~2 hr) temperature shock. From the heart rate data we calculated the Arrhenius Break Temperature (ABT) for individual mussels as well as the Q10 temperature coefficient. The former is an indication of the cardiac capacity of an individual to respond to stress; our anticipated results are that ABT will be higher among the survivors of the 3-day heat shock relative to the ABT for control mussels. This research sheds light on the adaptability of mussel populations in the face of climate change-related warming.

MEASURING HEAT TOLERANCE IN SUGAR KELP (*SACCHARINA LATISSIMA*)

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Developing heat tolerance in cold-adapted kelp species such as *Saccharina latissima* is critical for sustaining kelp farming in the face of increasingly frequent marine heatwaves. We compared multiple genotypes of heat-tolerant and heat-intolerant sporophytes created based on the phenotype of their parental gametophytes, which were classified as tolerant or intolerant based on previous stress testing in the lab. These strains were deployed over winter in New Castle, NH, and Moriches, NY, then harvested and subjected to controlled temperature trials at 14°C and 20°C. Over a four-week period, we monitored growth, health, biomass, and later, hyperspectral imaging (HSI) at the end of the four weeks. At the end of the four-week experiment, there were no significant differences between tolerant strains and intolerant strains of *S. latissima* for growth metrics (change in biomass and change in length). However, hyperspectral imaging (HSI) of tissues toward the center of the blades identified greater reflectance in tolerant strains compared with intolerant ones at a spectral band linked with physiological condition. This suggests heat-tolerant genotypes may express temperature tolerance in ways that are related to tissue composition. More research is ongoing to determine the importance of this finding and the utility of HSI for tissue quality measurements.

GENETIC STRATEGIES OF PARASITE MITIGATION IN THE EASTERN OYSTER

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How to mitigate parasites remains an unsolved question for scientists and shellfish growers alike. In eastern oysters, parasites Dermo (*P. marinus*) and MSX (*H. nelsoni*), cause devastating mortality, and the prolific bioeroding worm *Polydora* sp. severely damages the oyster shell. While these parasites have no impact on human health, they constrain aquaculture and reduce half-shell market value by causing thin, watery tissue, odors, and unsightly shell blisters.

Parasite load is debated to be mitigated by two non-exclusive strategies. With targeted adaptation, specific immune-related loci mitigate load. Comparatively, general heterozygote advantage and linkage disequilibrium can work in tandem to produce advantage at immune-related loci across the genome. Here, I use an extensive dataset of

>750 eastern oysters to uncover mitigation strategies using parasite load and underlying genotype.

We present parasitic infection data from 40 collection sites across the range (Texas - Canada), notably detecting MSX infections in the Gulf and regions of Canada. To analyze the data, we statistically test heterozygosity and use genotype-environment association analyses to detect outlier loci in infected vs uninfected groups. We find mixed results, where heterozygosity mitigates some parasites, and targeted loci mitigate others. We also consider these results in light of substantial host genetic divergence between Atlantic and Gulf genotypes. Ultimately, these results provide insight on how to reduce mortality and economic loss in aquaculture.

THE MAINE SEAWEED COUNCIL: ITS HISTORY OF WILD HARVEST ADVOCACY AND RELEVANCE TO THE WHOLE SEAWEED SECTOR

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The Maine Seaweed Council was founded in 1993 by five wild harvest entities with the goal of providing a collaborative forum and united voice to advocate for the seaweed industry. A member-run and financed organization, the MSC has accomplished much over the last three decades. The council published Maine's first compilation of research and empirical seaweed knowledge (Harvesters Field Guide), met legal challenges endangering the "right to harvest," and lobbied for the adoption of multiple harvest management regulations. The MSC has played an important consulting role on several intertidal court cases and worked extensively with the Department of Marine Resources, state legislators, and the public to publish the first Rockweed Fisheries Management Plan. As the seaweed industry grew to include seaweed cultivators, the MSC revised their mission statement to include this growing community. Over the last decade, the council has seen increased participation from a broad range of members who see value in this collaborative forum with a history of working successfully with regulators, researchers and educators. . The wild harvest industry brings a breadth of knowledge and experience that has value and relevance for seaweed farmers as well. For example, the revision of the Harvesters Field Guide, will cover the best sustainable practices for both wild and farmed seaweeds. In summary, this presentation will point out a number of ways that the diverse history of Maine Seaweed Council can benefit the whole seaweed community as it grows and evolves.

SIMPLE MOLECULAR TESTS FOR MONITORING WILD BLUE MUSSEL LARVAE: LEVERAGING ENVIRONMENTAL RNA TO OPTIMIZE SPAT COLLECTION

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The growing unpredictability of blue mussel larval recruitment has become a critical challenge for mussel aquaculturists in the northeast U.S. Historically successful collection approaches have recently become unreliable due to shifting larval dynamics, resulting in significant financial impacts for an industry that relies almost entirely on wild-caught spat. To combat this issue, some farmers have started monitoring mussel larvae on their leases by conducting regular plankton tows. However, given that the larvae of multiple bivalve species co-occur in the water column and the significant morphological similarities between species at these early developmental stages, reliable visual identification of mussel larvae is not feasible. Here, we present novel field sampling techniques and molecular tools based on environmental RNA (eRNA) designed to facilitate mussel larvae monitoring and successful spat collection. Our loop-mediated isothermal amplification (LAMP) and digital PCR (dPCR) assays specifically target mRNA transcripts exhibiting stage-dependent expression to detect only the larval stages of blue mussels. Our user-friendly LAMP assays permit the detection of mussel larvae within 30 minutes via a simple color change result, while the corresponding dPCR assays allow for increased sensitivity and estimates of larval concentration. Through our ongoing monitoring results from Casco Bay, we will demonstrate how these accessible sampling protocols and assays will allow farmers to pinpoint the optimal timing and locations for spat collection, ultimately maximizing domestic production. In addition, these tools may be beneficial for mussel spat biofouling mitigation for oyster and scallop farmers.

A MACHINE-LEARNING BASED, SHELLFISH BIOTOXIN FORECASTING METHOD: SUCCESSES FROM MAINE, OPPORTUNITIES FOR OTHER REGIONS

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Paralytic shellfish toxins (PST) are detected in seafood around the world. There are multiple methods of measuring their levels in shellfish in order to protect public health and manage seafood harvest. Maine has a long-term biotoxin monitoring program dating back to 1958,

containing >100,000 observations of shellfish toxicity across >150 stations. A switch in 2014 in the method used for PST monitoring, from the mouse bioassay to high performance liquid chromatography (HPLC), has led to the development of a machine learning based forecast system that is in its fifth year of operation. Stations where routine monitoring is taking place can now receive predictions of the probability that they will exceed the toxicity threshold that makes their shellfish dangerous for human consumption. The forecast has been co-developed with its end users, both regional resource managers who implement harvesting closures and shellfish industry members who must make day-to-day business decisions. While Maine is currently the only US state leveraging HPLC for PST monitoring, many other countries have implemented it. Our forecasting software is being released as an open-source package developed in R, and we encourage its use within other monitoring programs. The model shows high potential for transfer learning. We would like to answer questions around transferability, such as: How does a model trained on data from one region perform in other regions? Does joining monitoring data from multiple regions to train a model yield an increase in skill? Results from a case study in a novel region will be shared.

CULTIVATING THE NEXT GENERATION OF AQUACULTURE LEADERS: THE IMPACT OF EXPERIENTIAL LEARNING ON TITLE I MIDDLE SCHOOL STUDENTS IN WASHINGTON STATE

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This summer, NOAA held a first-of-its kind three-day aquaculture science camp designed to introduce students from Title I middle schools to the aquaculture industry in Washington State. The program, a collaborative effort between NOAA, Washington Sea Grant, Seattle MESA, Gear Up, and the Puget Sound Skills Center, focused on hands-on, experiential learning. Activities included a rigorous study of kelp and shellfish ecology, shellfish dissections, beach surveys, water quality analysis, and a capstone project where students developed a business plan for their own aquaculture farm.

Initial qualitative data suggests a significant shift in student perceptions, with participants demonstrating increased awareness of sustainable seafood practices and a newfound appreciation for local marine ecosystems. The camp provided a unique opportunity for students, many of whom have limited access to STEM-related extracurriculars, to engage directly with working scientists and industry professionals. This presentation will delve into the project-based learning approach of the program, highlighting how direct engagement with Washington's diverse aquaculture industry—from commercial shellfish operations, to hatcheries and kelp farms—can serve as a powerful tool for STEM education and career pathway development. By connecting classroom science to real-world growers, this initiative not only inspires future seafood producers but also helps create a new generation

of informed consumers. The curriculum developed provides a strong foundation for this program to be adapted across the country.

TISBURY SHELLFISH DEPARTMENT: A LOOK INTO MUNICIPAL AQUACULTURE

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Over the past 15 years, municipal shellfish propagation has become the top priority for the Tisbury Shellfish Department. As the health of our local waters continues to decline, successful shellfish harvests increasingly depend on how effectively we manage and support bivalve populations. Through our partnership with the Martha's Vineyard Shellfish Group (MVSG), Tisbury receives millions of quahogs, bay scallops each year, and occasionally oysters. We grow these shellfish from ~1 mm seed to the largest possible size before winter. Using a combination of established methods and adaptive management practices, we aim to maximize survival and yield. Current techniques include the use of quahog rafts, spawning cages, and spat bags to promote early-stage growth. Despite being a small department, we are highly dedicated and resourceful. Looking ahead, we plan to expand our capabilities by incorporating a tidal upweller system, constantly refining our propagation efforts and continuing our commitment to sustainable shellfishing.

AQUACULTURE AND RESTORATION IN THE NORTHEAST

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Beyond serving as a means of food production and an engine for economic growth, aquaculture is also advancing ecosystem restoration goals here in the Northeast and across the world. However, what "restoration" means and how best to approach it can vary widely depending on who you ask! What makes these projects successful - or not? What can they accomplish? And what's on the horizon? In this panel discussion, we will dive into the opportunities and challenges of aquaculture-based restoration and explore topics like project siting, permitting, social license, industry and community involvement, biosecurity,

educational initiatives, monitoring, and long-term sustainability of restoration projects. This panel will feature a range of perspectives from researcher and regulator to nonprofit conservation leadership and extension. With panelist participation from multiple states in the region, we will hear about the diversity of approaches and learnings across the Northeast. Join us, listen in, and bring your own questions, as we learn from one another in this engaging conversation.

CLIMATE OF CHANGE: AQUACULTURE FOR PEOPLE AND PLANET

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This session presents "Climate of Change," a short documentary following Bangs Island Mussels' groundbreaking partnership with Island Institute to conduct the first comprehensive greenhouse gas assessment of a Maine mussel farming business. The film provides an intimate look at how working waterfronts are striving to address climate change while showcasing farmed mussels as one of the most climate-friendly protein sources on the planet.

The 10-minute screening captures the discoveries of measuring carbon impacts in marine aquaculture, from baseline assessments to identifying reduction opportunities. Viewers witness firsthand how traditional mussel farming practices can serve both people and the planet.

Following the screening, a panel will discuss broader implications for the aquaculture industry.

Discussion topics include:

- Opportunities and challenges associated with conducting greenhouse gas assessments of aquaculture businesses
- Financial mechanisms and incentives for green technology adoption in aquaculture
- Practical implementation of sustainability measures on working farms

Panelists include representatives from Island Institute, Coastal Enterprises, and aquaculturists familiar with the opportunities and challenges of adopting green technologies.

This session offers aquaculture professionals, researchers, and industry stakeholders actionable insights into environmental assessment methodologies while demonstrating

how sustainability initiatives can strengthen both environmental and economic outcomes in seafood businesses.

COMPARATIVE ANALYSIS OF MITOCHONDRIAL ACTIVITY IN TRIPLOID AND DIPLOID OYSTERS

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A growing number of studies report disproportionate mortality in triploid oysters, particularly when exposed to multiple environmental stressors such as temperature and salinity fluctuations. While research into organismal-scale energy differences has yielded limited insights, a significant gap remains in understanding stress response differences between diploid and triploid oysters at the cellular and sub-cellular levels. Building on recent findings that intracellular mitochondrial concentrations in hemocytes (i.e., blood cells) differ significantly between diploid and triploid oysters, we conducted a comparative analysis of cellular respiration metrics. Simultaneous measurements of oxygen consumption and extracellular acidification rates following exposure to mitochondrial inhibitors revealed a three- to four-fold increase in both maximum and reserve respiratory capacity in triploid hemocytes compared to diploid counterparts, highlighting substantial differences in cellular energy metabolism between both groups. Ongoing work focuses on comparing cellular respiration in diploid and triploid oysters under environmental stress conditions to assess whether heightened respiratory metrics observed in triploids under ambient conditions influences their long-term responses to complex stressors (i.e., trade-offs), potentially offering a mechanistic explanation for differential mortality observed in the field.

THE EASTERN OYSTER MICROBIOME AND RAPID ADAPTATIONS RESULTING FROM REPEATED EXPOSURE TO ENVIRONMENTAL STRESSORS

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Acute coastal stressors such as seasonal hypoxia and warming are immediate threats to healthy oyster populations. One mechanism by which oysters could potentially increase their fitness is through the composition of their microbiome, which is known to actively change based on environment and ontogeny. Studying the host-symbiont relationship

between oysters and their microbial communities will provide insight into their capacity for rapid, intragenerational adaptation. With this ongoing project, we aim to characterize how oyster microbiomes change in response to repeated and simultaneous exposure to hypoxia and warming. This past summer we completed the first phase of the experiment, exposing eastern oysters (*Crassostrea virginica*) to different oxygen and temperature levels first at three months and then five months of age. Shell height and tissue mass were measured before and after second exposure, and then the oysters were dissected by tissue-type. We plan on performing both 16S ribosomal RNA sequencing and shotgun metagenomics in order to identify bacteria common to those oysters that experienced hypoxia and/or warming. Better understanding how oyster microbiomes respond to real, dynamic stressors will provide aquaculture scientists with new insight into how they can ensure the continued health of their oyster populations.

OVERWINTERING OYSTERS IN AN INCREASINGLY UNPREDICTABLE WINTER CLIMATE: TESTING STORAGE TECHNIQUES FOR RESILIENT AQUACULTURE

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In the Gulf of Maine, oyster aquaculture has expanded to become Maine's third most lucrative fishery with $14 million in revenue in 2024. Oyster farmers in the Gulf of Maine regularly suffer losses due to disproportionate overwinter mortality. These losses are anecdotally attributed to unexpected cold snaps, freezing events, and winter storms, but the mechanisms of high overwinter mortality and efficacy of methods to prevent this mortality remain uncertain. Furthermore, there is concern that winter storms in the Gulf of Maine will become more intense and unpredictable as the Arctic warms, increasing the need for safe overwinter storage of farmed oysters. To determine best practices for overwintering oysters, I will monitor overwinter mortality for eastern oysters in three overwinter storage treatments: storage at depth in Great Bay, New Hampshire; storage in indoor, flow-through tanks; and dry storage in a 4°C cold room. Previous studies suggest that dry storage saves farmers money by decreasing overwinter mortality, but the duration of storage necessary remains unclear. I will determine the most effective duration of dry storage by moving oysters from dry storage to flow-through tank storage at staggered intervals. I will monitor spring and summer mortality and growth for all treatments. I hypothesize that oysters kept in dry storage overwinter and returned to wet storage when water temperatures reach 10°C will have the highest survival and growth through the following summer. Results from this study will provide key guidance on reducing overwinter mortality for Gulf of Maine oyster farmers.

MOORING TENSION MEASUREMENTS AND ASSESSMENT OF AN INTEGRATED MULTI-TROPHIC AQUACULTURE SYSTEM IN THE GULF OF MAINE

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The reliability of mooring systems is critical for the safe and efficient operation of aquaculture structures in energetic marine environments. This study investigates the mooring tensions of the integrated multi-trophic aquaculture (IMTA) system at the University of New Hampshire (UNH) aquaculture site in the Gulf of Maine with field measurements. The mooring system consists of two legs, each comprised of a set of bridle lines, a connecting plate, a single anchor line, mooring chain and a seabed anchor. The field program objective was to characterize mooring tension differences on the IMTA structure without nets, with clean nets, and with bio-fouled nets.

The approach included installation of four load cells on all the bridle line connections to measure mooring tension in response to currents and waves. The primary dataset of currents and waves was measured with an Acoustic Doppler Current Profiler (ADCP) on the seaward side of the system. Currents were also measured "downstream" from a moored oceanographic buoy. An additional dataset of waves was obtained from a wave spotter buoy placed further offshore. A current meter was also installed in the containment net with the fish, to quantify the flow reduction induced by net shadowing. The high-fidelity dataset is being used for numerical modeling validation, to further understand mooring system dynamics and assess material wear so future IMTA system designs can be optimized.

AQUACULTURE TOURISM AS A DIVERSIFIED BUSINESS MODEL

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In recent years, consumer curiosity about seafood sourcing has opened a new revenue stream for aquaculture businesses: farm tours. Our company has become one of New England's leading providers of aquaculture tourism, hosting thousands of visitors annually and developing protocols that prioritize safety while educating the public about shellfish and seaweed farming.

This presentation will share the challenges and opportunities of integrating agritourism into aquaculture operations, with particular focus on licensing, insurance, liability management, and quality of visitor experience. We will also highlight how tours can generate new revenue, strengthen direct-to-consumer sales, and build public trust in aquaculture.

By establishing best practices and sharing lessons learned from trial and error, we hope to inspire other farms to responsibly adopt tourism as a strategy for diversification, community engagement, and industry growth.

SELLING SEAFOOD THROUGH STORYTELLING: AUTHENTICITY & BRANDING IN THE DIGITAL AGE

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For small aquaculture businesses, selling seafood today means more than harvesting a product, it means telling a story. Customers want to know who we are, how we farm, and why we do it. Social media has become one of the most powerful tools to share that story, but its effectiveness depends on honesty and authenticity.

In this talk, I will share how our farm has built trust and grown sales by leaning into transparency, highlighting both the challenges and successes of aquaculture. Rather than polished marketing, we've focused on showing real people, real work, and real values. This approach has helped us build a brand identity that resonates with customers who want to feel connected to the food they buy.

I'll also discuss some of the practical lessons we've learned along the way: how to balance personal storytelling with professionalism, the importance of consistency, and how to translate online engagement into seafood sales. By focusing on authenticity and identity, aquaculture producers can not only market their products but also strengthen the reputation of Maine seafood as a whole.

INTEGRATING SOLAR POWER INTO AQUACULTURE OPERATIONS

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The integration of renewable energy technologies into aquaculture holds promise for improving sustainability, operational efficiency, and worker safety. Our farm has partnered with industry innovators to pilot and adopt solar-powered equipment, providing valuable real-world feedback to technology developers while advancing our own operations. This presentation will highlight the practical steps and lessons learned from incorporating solar systems into a working aquaculture farm, including impacts on fuel reduction, cost savings, and worker comfort. We will also discuss the challenges of adopting emerging technologies, such as equipment reliability, maintenance, and scaling solutions for broader use across

the industry. By sharing our experience, we aim to contribute to the dialogue on how renewable energy can support a resilient and future-focused aquaculture sector in Maine and beyond.

UNIVERSITY OF MAINE'S ADVANCED STRUCTURES AND COMPOSITES CENTER

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The University of Maine's Advanced Structures and Composites Center in Orono and Brunswick, ME are exploring the use of both recycled and bio-based thermoplastic resins along with natural and engineered reinforcements to manufacture sustainable feedstock options for large format extrusion based additive manufacturing. 3D printing at large scale with marine plastic debris represents a prime opportunity to upcycle HDPE, LLDPE, Nylons, and other common resins found in massive quantities along the Maine coast.

ADDRESSING LABOR DEMAND AND PRODUCTION EFFICIENCY IN SHELLFISH AQUACULTURE

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Bivalve shellfish aquaculture is economically significant to rural US coastal communities and has rapidly developed within recent decades. Shellfish have potential to satisfy global food demands through enhancing food security, supporting fisheries, and providing a nutrient dense, resource efficient product. Intensive shellfish culture, common in Eastern oyster (*Crassostrea virginica*) and hard clam (*Mercenaria mercenaria*) aquaculture, are often physically demanding and can drive farm labor needs. High labor costs, limited labor availability, and variable working conditions may restrict industry expansion; moreover, socio-economic data on labor demands and production processes for bivalve shellfish culture is sparse. This study measured labor demands in commercial oyster and hard clam farms of Virginia and Florida to assess production efficiencies, technological substitutions, and workforce needs. Biweekly surveys were employed to record labor needs, harvest practices, workforce management tactics, and day-to-day challenges. Semi-structured interviews were conducted with employers and employees to evaluate perceptions on labor availability, job satisfaction, technological substitutions, stressors, and industry growth. Qualitative coding analyses identified emerging interview themes and statistical survey analyses compared factors impacting labor needs. A technoeconomic production model was developed and refined to evaluate annual production costs across various grow-out methods. Lastly, the results will contribute to a benchmarking tool for improving

production efficiency and total product output at shellfish farms. By comprehending labor needs and related constraints in the bivalve shellfish aquaculture industries of Virginia and Florida, and potentially the East Coast and broader production sectors, expansion can continue while facilitating economic development and improving industry sustainability.

HOW CAN LAND-BASED SYSTEMS FACILITATE SELECTIVE BREEDING ADVANCEMENTS FOR OPEN OCEAN SEAWEED AQUACULTURE?

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The Lindell Lab's Sugar Kelp Selective Breeding Program at the Woods Hole Oceanographic Institution has combined a gametophyte germplasm collection and nursery system, strain crossing methodologies, and a genomic selection model, to systematically characterize production of hundreds of sugar kelp (*Saccharina latissima*) sporophyte strains in the northwest Atlantic. Can the benefits of this program be further accelerated by growing sporophytes to maturity in land-based systems? We outline techniques for the rapid propagation of kelp using a combination of closed nursery systems followed by isolated flow-through seawater systems. Our infrastructure was used to complete the sugar kelp life cycle in 6 months. We used these methods to grow multiple strains of kelp on land and on ocean farms concurrently. We found a strong correlation between growth (change in biomass) in tanks and total yield of farm grown kelps across multiple strains. Concurrently, our tests of novel Saccharina hybrid strains identified interregional hybrid vigor for crossed Alaskan and New England sugar and skinny kelp. We discuss future opportunities for the inclusion of land-based systems in the development and testing of "sterile" (non-reproductive) hybrid strains.

PRELIMINARY TESTING OF A USV DESIGNED FOR OYSTER AQUACULTURE

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To match a growing demand in seafood, marine aquaculture must increase its productivity to avoid potential overfishing and other ecological damage. Our team at MIT Sea Grant worked with a local shellfish aquaculture company, Ward Aquariums, to do so with oyster farming. The manual method of flipping oyster baskets to prevent biofouling already

increases production, however, thousands of such baskets exist in the field and each one can weigh up to 30 kg. The Oystermaran is an unmanned catamaran style surface vessel designed to maneuver through rows of oyster baskets and flip each one.

In 2021, version 1 of the Oystermaran was developed in response to this problem. Oystermaran v1 was able to successfully flip baskets but field testing revealed limitations with its ability to navigate through oyster bags. Furthermore, the flipping mechanism was unreliable and could not shake the oyster baskets to redistribute the oysters. By 2023, version 2 of Oystermaran improved on these issues. By testing new nose geometries and adding lateral thrusters, it was more successful in navigating through the oyster bags. In 2025, the final version built upon the previous successes. These changes included reductions in hull width and the addition of more powerful thrusters to further improve field maneuverability. Additionally, a new flipping mechanism prevents interference with other baskets in the same row. To verify the vehicle's performance in a controlled environment, preliminary testing was done with rows of oyster baskets in a water tank and the MIT Zesiger Center Pool.

IDENTIFYING MICROBIAL TAXA IMPLICATED IN OXYLIPIN-RELATED LARVAL OYSTER DIEOFF IN MAINE WITH ENVIRONMENTAL DNA

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In January 2020, Eastern oyster larvae (*Crassostrea virginica*) displayed abnormal growth, lack of digestion, and subsequent mortality at Mook Sea Farm's hatchery, the largest oyster hatchery in Maine. Oxylipins, a chemical compound that can be produced when algal polyunsaturated fatty acids (PUFAs) are exposed to UV treatment, were implicated in larval mortality. The source of the oxylipins remains unknown, though this issue has repeated for several winters since. To understand the potential role of microbial assemblages in oxylipin-induced larval oyster mortality, environmental DNA seawater samples were taken at the hatchery in winter of 2023 and 2024 during successful and unsuccessful spawns. Long-read and short-read DNA sequencing for eukaryote (18S) and bacterial (16S) diversity was performed for each sample. While the overall microbial communities were not significantly different between successful and unsuccessful spawns, differential abundance analysis revealed that several genera of pennate diatoms, which can produce oxylipins under stress, were differentially more abundant in unsuccessful spawns. Additionally, a sequence identical to *Bacillus cereus*, a soil bacterium implicated in gastrointestinal distress in Pacific oyster larvae (*Crassostrea gigas*), was also differentially more abundant in

short-read sequences for unsuccessful spawn samples. Many unsuccessful spawn samples were associated with high precipitation events and spring tides, which may resuspend sediments or increase runoff into the estuary. These results identify the microbial taxa present during a recurrent larval oyster mortality event in Maine and provide a foundation for future experiments to establish causality.

THE COMMERCIAL OYSTER AQUACULTURE SECTOR TRAINING (COAST) PROGRAM: PHASES I & II

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As the off-bottom oyster aquaculture industry expands, there is an increasing demand for skilled employees. Desired proficiencies include oyster production and husbandry, but also record keeping, boating, and handling of products to ensure consumer safety. Although there are free online courses available for some of these skills, hands-on training in the industry is the best option. Therefore, the commercial oyster aquaculture industry needs workforce development programs that offer funding for on-farm training of apprentices.

In 2023, the Commercial Oyster Aquaculture Sector Training (COAST) program was initiated in the northern Gulf of America. This program is a workforce development initiative aimed at recruiting workers to the oyster aquaculture industry and providing them with training to meet industry demand. The first two-year funding cycle allowed for participation by 5 apprentices per year in various aspects of oyster farming, including production and rearing, business management, food safety, and serving. Participating businesses from Alabama and Mississippi received a portion of the apprentice's wages to support training efforts. In 2025, COAST II was initiated with an additional round of funding from Mississippi Alabama Sea Grant that includes 12 companies participating from Mississippi and Alabama.

P. MARINUS INFECTION IN WILD OYSTERS ON PLUM ISLAND, MA

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Perkinsus marinus is a protozoan parasite that infects eastern oysters (*Crassostrea virginica*) which causes a tissue degenerative disease called dermo. Due to increasing temperatures in the Atlantic Ocean, the prevalence of *P. marinus* has increased and spread, affecting oysters along the eastern coast. We studied oysters from wild sites in three river systems on Plum Island, Massachusetts throughout the summer (June, August, and September) to

investigate the prevalence and severity of *P. marinus* infections in relation to increasing temperatures and increasing water salinity respectively on Plum Island as the summer progressed. Mantle and rectum tissues from 40 oysters per site were incubated in Rays Fluid Thioglycollate Medium for 5-7 days, after which we scored the tissues according to the mackin scale for level of infection. We found that the prevalence of infection increased throughout the course of the summer. These infections were of varying intensities; however, some sites with higher intensity infections could be attributed to higher salinities. Based on these results, we found that *P. marinus* is widespread on Plum Island and may be increasing in prevalence and intensity with higher temperatures and salinities.

PROGRESS IN EASTERN OYSTER BREEDING AND PROSPECTS OF GENOMIC SELECTION

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The Eastern oyster *Crassostrea virginica* supports an important aquaculture industry in the United States that faces threats from two major diseases: dermo (caused by *Perkinsus marinus*) and MSX (caused by *Haplosporidium nelsoni*). Rutgers University has been breeding eastern oysters for disease resistance since 1960 and has produced strains that demonstrate strong disease resistance and improved growth. Breeding occurs along the Cape Shore region of lower Delaware Bay, where both MSX and dermo are endemic, and oysters are subjected to stressful intertidal conditions. Multiple lines are produced by rotational crossing to maintain genetic diversity. After three years of exposure to disease and intertidal stress, the largest survivors with desired shell characteristics (top 10-20%) are selected to produce the next generation. Mass selection over time produced two strains: the Haskin NEH® (Northeast High survival) strain derived from Long Island Sound and the DBX strain derived from Delaware Bay. Both strains show improved growth and survival compared with unselected controls and are widely used by farmers in the Northeast. Tetraploid oysters were developed from the disease-resistant strains to produce triploids that grow significantly faster than diploids. The combination of disease resistance and triploidy increased yield. Tetraploid lines have shown improvements in survival and shell color. Genomic selection utilizes whole-genome information and is effective in improving polygenic traits with low heritability. Genomic selection was recently implemented using a 66K SNP array to enhance dermo resistance and field survival in the eastern oyster, and preliminary results are encouraging.

USING GENOMICS TO UNDERSTAND DIFFERENCE IN SEA SCALLOP, *PLACOPECTEN MAGELLANICUS*, POPULATIONS

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The Atlantic sea scallop, *Placopecten magellanicus*, is the largest wild-caught scallop fishery in the world (~$450 million United States dollars). Scallop habitat range has been shifting northward as water temperatures increase, and recent research suggests that growth slows as ocean acidification (OA) intensifies. Population genetics are important to understand the capacity of an organism to evolve to long-term, ecosystem-scale changes. Preliminary studies suggest that there might be genetic differentiation between southern and northern populations of sea scallops. We propose to build and annotate the chromosome-scale genome for *P. magellanicus* to serve as an open-source reference for fisheries management. Wild sea scallops were harvested across a latitudinal gradient from the Northeast US Atlantic to investigate genetic variation between populations. Sea scallops from 2 different populations were exposed for 2 weeks to two different temperatures (9 °C and 15 °C) and two different OA conditions (ambient and -0.3 pH). Hemolymph and gill samples were taken to understand how each population responds to changing ocean conditions. Through a combination of manipulative experiments and -omics, we can start to understand the capacity for the sea scallop to evolve and adapt to long-term ecosystem changes.

EVALUATION OF INSECT MEALS AS ALTERNATIVE PROTEIN SOURCES IN ATLANTIC SALMON DIETS USING GROWTH, BIOCHEMICAL, AND MOLECULAR APPROACHES

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Aquaculture is one of the fastest-growing food industries worldwide. This growth was primarily driven by finfish aquaculture. However, challenges such as disease management and feed costs are increasing. As the industry expands, finding sustainable alternatives to traditional fishmeal in fish diets has become a key focus. This abstract summarizes the findings from two published growth studies that examined the potential of insect meals as alternatives to fishmeal in the diets of Atlantic salmon (*Salmo salar*).

Mealworm study: a 12-week growth trial was conducted to evaluate the effects of substituting fishmeal with defatted mealworm meal (50% and 100% DMM) and whole mealworm meal (50% WMM) in the diets of Atlantic salmon parr. The study found (i) similar growth between treatments and (ii) DMM significantly increased plasma immunoglobulin M and up-regulated the expression of immune genes compared to the fishmeal-based diet (Habte-Tsion *et al.*, 2024).

BSFL study (factorial design): Atlantic salmon parrs were fed with a fishmeal-based diet and six test diets [three levels of defatted black soldier fly larvae (10%, 15%, and 20% BSFL of the diet) and two soy protein levels (12% and 19% SOY of the diet)] for 12 weeks. The study suggested that BSFL meal, up to 15% of the diet, could replace fishmeal without compromising fish growth and health, and alleviate inflammation caused by anti-nutritional factors derived from soy (Meesala *et al.*, 2025).

Overall, these studies demonstrate that both insect meals enhance fish growth and health, underscoring their potential to meet the growing demand for sustainable aquafeeds.

FIELD VALIDATION OF OYSTER LARVAL DISPERSAL PREDICTIONS IN HUDSON RIVER ESTUARY

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Sustainable restoration of oysters to provide ecosystem functions depends on re-establishing sufficient larval connectivity to make a self-sustaining metapopulation. This not only requires water quality and productivity that can promote larval survival, but we also need a way to prioritize restoration sites most conducive to a network of larval exchange. To inform the scaling-up of oyster restoration in Hudson River Estuary, we report on two approaches for field-validating connectivity predictions from a biophysical model. The model simulates larval dispersal based on known reproductive phenology, larval behavior and their interaction with estuarine hydrodynamics. First, oyster recruitment mapping since 2018 provides relative spatial trends that can be compared to model outputs. Second, we use genomics to distinguish spat with wild versus aquaculture strain parents because the largest wild population is near Tarrytown, north of NYC, while restoration sites in the city are all seeded with aquaculture strains. The model predicts spatially distinct patterns of recruitment, such as a spat abundance gradient from high in the north to low near the city. Also, no localized self-recruitment is predicted for Hudson River Park (HRP) where a large restoration population now contains 2-3 year olds. Instead, the model predicts ~70% of HRP offspring settle on the NJ shore near the Palisades. Field recruitment data and genomic population assignments from thousands of spat will be

presented that can falsify or validate model predictions. Biophysical models have been used to inform restoration planning in other systems, but rarely has this degree of field validation been possible.

OPTIMIZING FEEDING STRATEGIES TO IMPROVE GROWTH, WELFARE, AND STRESS RESILIENCE IN JUVENILE LUMPFISH (*CYCLOPTERUS LUMPUS*)

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One of the key biological tools in Atlantic salmon aquaculture is the use of lumpfish (*Cyclopterus lumpus*) as cleaner fish for sea lice control, yet optimal hatchery feeding protocols remain poorly defined. We conducted two complementary studies to evaluate ration levels, feeding strategies, and their impacts on growth, stress physiology, and behavior in juvenile lumpfish. In the first study, two trials were conducted with different size classes reared under cold and warm temperature regimes and fed rations from 0.5–6% body weight (BW) per day. Growth responses (SGR, TGC, weight gain) were modeled to determine optimal feeding rates. Results indicated ration optima of ~0.9% BW d^{-1} under cold conditions and ~1.8% BW d^{-1} under warm conditions. Suboptimal rations elevated plasma cortisol and hepatic oxidative stress markers, highlighting the physiological costs of underfeeding. The second study tested feeding strategies, comparing regular daily rations with satiation feeding delivered at two or six frequencies per day. Regular, high-frequency feeding maximized growth, but satiation-fed groups achieved comparable performance with lower oxidative stress and cortisol levels. Aggression, assessed via fin-nipping, was variable across treatments but tended to peak early in development. Collectively, these studies establish practical benchmarks for rationing and feeding strategies in lumpfish hatcheries. By balancing growth efficiency, stress reduction, and welfare outcomes, this research provides actionable guidance for improving the reliability of lumpfish production and supports their continued role in sustainable sea lice management within salmon aquaculture.

INCREASING THE EFFICIENCY OF OYSTER TISSUE STORAGE FOR DNA EXTRACTION WITH AN ETHANOL-FREE METHOD

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With the increasing demand for high-throughput genotyping in breeding programs, the aquaculture industry is under pressure to find more efficient methodologies. Tissue from finfish is often preserved by placing a small fin clip onto chromatography paper and allowing it to dry. Storing tissue on chromatography paper reduces storage space and material costs compared to the typical method of storing samples in ethanol. Additionally, transportation of samples is simplified by avoiding the use of flammable liquids, and laboratory processing time is reduced because tissue can be quickly taken from chromatography paper using a tissue punch. While this method has proven successful for storing fin clips from finfish, it is unknown whether bivalve tissue stored in a similar manner will retain DNA integrity.

We compared genomic DNA isolated from oyster mantle tissue preserved in ethanol to that isolated from adductor muscle and mantle tissue preserved on chromatography paper. DNA was extracted and purified from all samples using the Kurabo QuickGene DNA tissue kit S (DT-S). The mantle samples on chromatography paper were extracted twice, once using one punch (3mm diameter) of tissue and once using two punches. The mantle samples preserved in ethanol yielded more DNA than the other treatments, but all mantle samples yielded sufficient DNA for common genotyping techniques (SNP arrays, amplicon sequencing, single target PCR) and whole genome sequencing. Samples will be genotyped with a 60k SNP array and genotyping success for each treatment will be presented.

INDIGENOUS AQUACULTURE IN THE NORTHEAST

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Rooted in centuries of ecological wisdom, indigenous aquaculture fosters a deep connection to land and water, ensuring communities can adapt to environmental changes and maintain access to healthy, culturally relevant food.

This panel session is a forum for indigenous aquaculturists to share insights about their aquaculture operations, practices, challenges, and opportunities. It aims to foster collaboration and strengthen relationships between Tribal Nations, promoting mutual learning and support. Panelists will include Indigenous leaders, aquaculture experts, and environmental scientists who will share insights into traditional ecological knowledge and contemporary aquaculture practices.

The panel will highlight successful case studies of Indigenous-led aquaculture projects, illustrating how these initiatives not only support local economies but also foster

community health, wealth and resilience, cultural identity, and Indigenous sovereignty and self-governance.

DEVELOPING SCREENING ASSAYS TO IDENTIFY POTENTIAL CAUSES OF BIVALVE LARVAL CRASHES IN HATCHERIES IN THE ATLANTIC COAST OF THE UNITED STATES

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In recent years, there has been a major increase in larval crashes in bivalve hatcheries along the Atlantic Coast of the United States. The Bivalve Hatchery Health Consortium (BHHC) aims to identify potential causes of larval crashes and develop management tools. During the 2024 and 2025 seasons, the BHHC hatcheries proactively collected incoming water (before treatment), tank water, and larval samples at different time points in at least two production runs. Live larvae from early during the production run (1 - 5 days post fertilization) were shipped overnight to our laboratory, washed, and incubated in filtered sterile artificial seawater (FSSW) overnight to allow the shedding of infectious agents to the water (shed water). At the end of the production run, hatcheries reported the quality of the run (from 0 - total loss, to 3 - normal run). Screening assays were developed to identify the source and type of agent leading to low larval performance. Incoming, tank, and shed water were size fractionated and the fractions were used in larval or hemocyte exposure assays to identify which size fractions retain pathogenic effects. Healthy larvae or hemocytes were exposed to FSSW (negative control), the non fractionated sample water, 10 micron-filtered water (eliminating protozoan and metazoan parasites), 0.22 micron-filtered water (eliminating bacteria), and 50 kDa-filtered water (eliminating viruses and retaining toxins and small molecules). These assays replicated clinical signs observed in larvae from hatchery crashes, indicating their potential to guide the process of identification of causes of these larval crashes.

RECENT INNOVATIONS AT ROGER WILLIAMS UNIVERSITY'S LUTHER H. BLOUNT SHELLFISH HATCHERY AND FERRYCLIFFE OYSTER FARM

***Robert J. Holmberg*, Kimberly Soule, Malcom Bowen, Shawna Chamberlin, Finn Morrissey**
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Roger Williams University's Luther H. Blount Shellfish Hatchery produces Eastern oyster and quahog seed for undergraduate education, internal and external research projects, reseeding and restoration efforts, local and regional oyster farmers, and RWU's own Ferrycliffe Oyster Farm. As demand for hatchery-produced shellfish seed grows in Rhode Island and the surrounding states, the hatchery has continued to expand and innovate. After a period of inactivity due to faculty and staff turnover as well as repercussions of the COVID-19 pandemic, the hatchery was overdue for some maintenance and reorganization. In 2023, we embarked on some much-needed improvements and upgrades including a thorough cleaning, replumbing and update to the seawater system, repair of seawater filtration towers, installation of new UV sterilizers, and a reconfiguration of the microalgae culture system. Production resumed during spring 2024. In 2025, the hatchery had its most productive season to date thanks to the aforementioned improvements and hire of a long-term, full-time hatchery technician. Undergraduate students are included in all phases of hatchery operations, and each year between 15-20 students assist with hatchery production and participate in research projects. Courses hosted by the hatchery include the Aquaculture and Aquarium Science Practicum, a 100-hour experiential learning opportunity. This talk will focus on recent upgrades to the Luther H. Blount Shellfish Hatchery and Ferrycliffe Oyster Farm, as well as the impact of these facilities for undergraduates and local municipalities and the various research projects they are supporting.

IMPROVING RESILIENCE OF HATCHERY-REARED BLUE MUSSELS *Mytilus edulis* TO OCEAN ACIDIFICATION WITH DIET AND SEAWATER BUFFERING

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As wild blue mussel seed declines in the Gulf of Maine, mussel growers are relying increasingly on hatchery production to stock their farms. While mussel populations are currently under pressure from predation by the invasive European green crab, ocean acidification (OA) is expected to be another stressor – especially among earliest life stage mussels – as climate change progresses. Traditionally, shellfish hatcheries have implemented seawater buffering to mitigate low pH in their incoming seawater. Here, live microalgae diet optimization is proposed as an alternative strategy for rendering blue mussel larvae inherently more resilient to OA in a hatchery scenario. Following an initial microalgae growth and nutritional analysis phase, 4 diets – each consisting of a flagellate and a diatom species – were created to emphasize different nutritional parameters (industry standard, high calorie, high DHA, high EPA/protein). A first experimental trial

tested larval/early juvenile response (survival and growth) to a 2-level seawater pH treatment (7.80/present day, 7.30/year 2100) and a 4-level diet treatment, and a second experimental trial tested response to the pH treatment, a reduced 2-level diet treatment, and a 2-level seawater buffering treatment (soda ash buffering, no buffering). Each trial was followed by a field deployment of experimental mussels at each of 2 mussel farms in different locations along the Maine coast (Blue Hill Bay Mussels and Bangs Island Mussels) to reanalyze mussel responses after they achieved market size. The experimental trials tested the efficacy of diet optimization for improving blue mussel resilience to OA, as well as its interaction with seawater buffering.

DETERMINING NUTRITIONAL CONTENT OF GULF OF MAINE SEAWEED AND SELECTION FOR BEST ANALYTICAL PRACTICES

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Seaweed harvesting is expanding in the United States, with the Gulf of Maine at the forefront of this growing industry. As seaweed grows in popularity for human consumption and animal feed additives, understanding the micro and macro-nutrients is vital to ensure health and commercial utility. To understand potential differences in seaweed nutritional content, we analyzed possibly toxic and nutritive elements in samples from Gulf of Maine seaweed aquaculture and wild harvest companies. We also analyzed the composition in the kelp species *Saccharina latissima* collected from natural populations at 13 sites along the coast of Maine. *S. latissima*, commonly known as sugar kelp, is a common native brown seaweed grown preferentially by aquaculture farms throughout the Gulf of Maine. We will address differences in concentrations of these elements in wild-harvested and farmed sugar kelp, as well as exploring spatial trends in elemental composition in sugar kelp collected along the Maine coast. We will also report composition among various post-harvest processing techniques. We will present a comparison of elemental concentrations in a variety of commercially-grown or harvested species (*Saccharina latissima*, *Saccharina angustissima*, *Alaria esculenta*, *Ascophyllum nodosum*, *Chondrus crispus*, *Fucus vesiculosus*, *Laminaria digitata*, *Palmaria palmata*, *Porphyra umbilicalis*, and *Ulva lactuca*). Finally, we will discuss best practices for analysis, including how to select appropriate testing facilities and the importance of employing standardized reference materials to confirm analytical recoveries for accurate results

THE "SNAP AND STRAP" A BIRD-DETERRING, EASY-FLIP FLOAT FOR AQUACULTURE GEAR

Myron Horzesky
Ketcham Supply, 111 Myrtle St New Bedford, MA 02740 USA

A novel float design, the "Snap and Strap," introduces a proprietary shape engineered to deter bird interactions while enhancing aquaculture operations. Unlike conventional floats, this model features a bottom section that snaps securely into a 1" PVC pipe, enabling rapid flipping of grow-out bags, wire trays and cages, or plastic baskets. Its strap-based attachment system provides versatility across multiple gear types, reducing handling time and improving efficiency in farm management. By combining durability, adaptability, and a bird-resistant profile, the "Snap and Strap" float offers an innovative advancement in shellfish aquaculture equipment.

WHAT WE THINK WE KNOW: LESSONS LEARNED IN FIVE YEARS OF CROSS HATCHERY COLLABORATION ON THE STANDARDIZATION OF PRODUCTION OF THE ATLANTIC SEA SCALLOP, *PLACOPECTEN MAGELLANICUS*.

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The Atlantic sea scallop, *Placopecten magellanicus*, is becoming a valuable, commercially-farmed product in Maine. There is also an increased interest in enhancement of the federally managed wild sea scallop fishery. Most successful aquaculture industries worldwide are supported by commercial hatcheries. However, the sea scallop's long larval phase has proved to be a major challenge for hatchery success, especially when coupled with larval sensitivity to environmental conditions and hatchery expenses. There have been research and commercial scale successes with Atlantic sea scallop hatchery production, but repeatable, large-scale seed production has remained elusive and unreliable.

This project has focused for the last five years on making sea scallop hatchery culture replicable across three facilities: Mook Sea Farm, the University of Maine's Darling Marine

Center, and the Downeast Institute. The project has yielded varying degrees of success at the three different facilities; yet, the overall trend at each facility has been increased success each year. This variability has led to a granular assessment of the animal husbandry and facilities management practices of the three hatcheries.

Our 2025 trials were focused on how different water treatment methods would affect the overall water quality and its impact on larval growth and survival. We will review the results of these trials, compare growth and survival rates to previous years, and hypothesize on the previously unexplored differences in hatchery design that could lead to future settlement success.

U.S. OYSTER PRODUCTION: RECENT TRENDS AND MARKET POTENTIAL

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A new NOAA Technical Memo explores trends in oyster production, market potential, and growth opportunities. The report identifies challenges such as farm-gate price declines and market disruptions, and highlights the need for improved data collection and reporting. The analysis aims to provide a foundation for strategic decisions that support a sustainable and thriving oyster industry over the coming decade.

We gathered oyster production and farm-gate value data from all U.S. coastal states involved in both private and public oyster harvesting. The most recent data indicate that U.S. production peaked in 2017 at over 722 million individual oysters. Forecast models predict production growth over the next decade, reflecting growers' plans to expand; however, profit margins are tightening as input costs are rising faster than farm-gate prices. Findings reveal significant regional variation in markets.

Oyster imports have doubled over five years, with Canada, Mexico, and South Korea as the main suppliers. Exports remain stubbornly low, accounting for about 10% of U.S. harvests, though those numbers have likely declined recently due to international trade tensions.
Interviews with experts in the oyster production, processing, and distribution sectors were also conducted, revealing diverse growth expectations. Demand drivers include price, quality, food safety, consumer preferences, and storytelling about origin and sustainability. Resource constraints limit marketing and education efforts but are essential for growth.

EVIDENCE SUGGESTS INSIGNIFICANT RISK OF CONTAMINATION FROM BIRDS

***Bobbi Hudson*, Andrew Suhrbier, Shannon Boldt**
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We evaluate the potential risk of bacterial contamination at two oyster farms in Willapa Bay, WA, through seasonal observation of migratory and resident birds perching on the floating gear, and enumeration of fecal coliform in water within the floating arrays. Visual and remote camera observations estimated bird presence during seasonal migrations in spring 2024 through fall 2025. When birds were present, water samples were collected from at least three locations within the culture arrays. Collections followed standard protocols for shellfish growing waters and were transferred to an accredited lab within 24 hours. Results demonstrate that both aquaculture sites meet water quality standards, as specified by the National Shellfish Sanitation Plan (NSSP). Excluding reference samples, the median most probable number (MPN) during bird presence was 1 MPN (4 samples >43) at one farm site, and 2 MPN (never >43) at the second site. Therefore, both sites did not exceed the fecal coliform standard (median >14 MPN per 100ml, and ≤10% samples >43 MPN per 100ml) when sampling targeted periods of substantial bird presence on surface culture oyster farms. These results suggest that fecal coliform contamination from birds on surface gear is not a significant risk at these sites. Furthermore, although larger birds, such as gulls and pelicans, may produce greater amounts of guano in a single defecation than a much smaller shorebird, the difference in bird density/cage between the two suggests that overall oyster exposure to bird fecal matter may not necessarily be greater in the presence of larger birds.

SHELLFISH & MICROPLASTICS, WHAT'S ALL THE HYPE ABOUT?

Bobbi Hudson
Pacific Shellfish Institute, 120 State Ave NE #1056, Olympia, WA, 98501 USA

Plastics are found in ecosystems worldwide. Shellfish have been the subject of extensive research on uptake, presence and concentration of microplastics, and significant media attention. This presentation will provide a high-level explanation of the pathways and sources of microplastics in the marine environment, and the over-emphasis on aquacultured shellfish, which has caused unwarranted concerns about the potential effects on human health. I will share resources for factual information about microplastics in shellfish, and provide suggestions for "turning down the volume" about microplastics, and how shellfish farmers can talk to their customers about this overhyped issue.

BEYOND THE BASICS FOR BUSINESSES AND PRACTITIONERS

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Aquaculture is a growing and vital part of the Rhode Island and regional maritime seascape. In January 2025, Rhode Island Sea Grant launched "Professional Aquaculture Training: Beyond the Basics for Businesses and Practitioners." This course is a hybrid (live, in-person and virtual) 12-week course that aims to provide an advanced understanding of aquaculture in five main topic areas: 1) Economics of Shellfish Farming, 2) Staying Healthy in Aquaculture, 3) Keeping the Peace in Aquaculture, 4) Effective Communication in Aquaculture, and 5) 21st Century Farming Principles, Practices and Considerations.

This course provides participants with information to competently and confidently improve farm businesses and operations, minimize conflict with coastal residents and other users, and take advantage of state and federal resources. There are no official prerequisites for the course, but it is highly recommended to have taken an aquaculture course available to the public. Weekly guest presentations by topical experts are available by a pre-recorded video(s) or during a hybrid class. It is clear from recent, contentious lease applications in Rhode Island that the state's aquaculture industry will have to make some changes if it is to contribute to a more favorable future. This includes ensuring the use of best management practices, more effective communication strategies when engaging with the public, and participating meaningfully in research and outreach, all of which are covered in this course. In this presentation, we will discuss lessons learned from teaching the course in 2025, and anticipated updates for the 2026 course offering.

THE BIVALVE HATCHERY HEALTH CONSORTIUM: A COLLABORATIVE WORKSHOP TO IDENTIFY AND MANAGE CAUSES OF DECREASED LARVAL PERFORMANCES IN HATCHERIES

***Rob Hudson*[1,2], Dave Bushek[3], Matthew Bertin[4], Jacob Cram[5], Matthew Gray[5], Meredith White[6], Joshua Reitsma[7], Marta Gomez-Chiarri[2]**

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Disease remains an impediment to reliable larval production of bivalves, with periodic outbreaks in hatcheries affecting the availability of seed for grow-out. The Bivalve Hatchery Health Consortium (BHHC) was established in 2023 to identify causes leading to reduced larval performance and develop management tools. A process was developed for

enrollment of hatcheries into the BHHC that protects confidentiality of their data and production practices. The BHHC also developed protocols for the proactive collection of samples of water, algae, and larvae from good and bad larval production runs, from broodstock conditioning to post-set. High levels of interest from the industry demonstrated that hatchery crashes are widespread and severely impacting larval production throughout the US. As of September 2025, 37 hatcheries from the Atlantic Coast of the USA have enrolled in the BHHC, providing samples and data for more than 60 production runs in 2024 and 2025. In 2024, 55% of the 33 production runs were crashes or showed low larval performance. The objectives of this interactive workshop are to: 1) share lessons learned from the BHHC enrollment and sampling process; 2) report findings from the 2024 sampling season, 3) engage participants in interpreting the data collected so far, and 4) discuss further steps. Members of the BHHC coordinating team, including pathologists, ecologists, hatchery managers, and extension specialists, will answer questions and gather feedback from those interested in the program on how to address this critical issue of larval crashes.

MAINE SCALLOP FISHERY AND THE CONNECTION WITH SCALLOP AQUACULTURE

Carlton Huntsberger
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The sea scallop aquaculture industry in Maine has a unique overlap with a productive wild fishery. The early days of the scallop fishery were largely controlled by the supply and demand, until a near-fishery collapse in the early 2000's. Following this the ME DMR has established additional management measures, dedicated scallop science and monitoring programs. These management measures were designed to rebuild the fishery by focusing on effort control, conservation closures, industry reporting, and minimum size regulations. Analysis of the available data indicates that the fishery has been rebuilt, current statewide landings since 2014 are comparative to historical landings from state waters. However, recent surveys show a decline in the population.

Many local, federal and global stakeholders are looking to scallop aquaculture as an opportunity to either bolster the wild fisheries or provide the opportunity for diversification. Maine scallop farming is expanding with most operations reliant upon capturing wild spat. The focus here is to consider the biological and fishery dynamics between aquaculture and wild scallop operations. Although some spat is collected and removed from the wild, the expectation is that these aquaculture sites create ideal spawning conditions due to the high densities. Given these high densities and direct connection with the wild populations it is important to consider the magnitude of spat collection, genetic selectivity, biosecurity, and the potential for increased disease risk.

Direct evidence regarding these factors is limited, but the potential for enhancing the wild populations due to the high spawning success is promising.

SPAT-ON-SHELL OYSTER PRODUCTION IN COASTAL MASSACHUSETTS: A COMPARISON BETWEEN PRACTICES IN TWO MUNICIPALITIES ON CAPE COD

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Spat-on-shell or Remote Set is an economical and environmentally sustainable technique for municipal and other entities engaged in oyster enhancement programs for recreational harvest and ecosystem benefits. The practice of remote set oysters has been utilized by Cape Cod towns for many decades with positive success. Traditional practices involve creating shell bags which are then provided to the hatchery for setting.

The process of remote set oysters, although economical over singles, can also be extremely labor intensive. As municipal budgets are stretched thin and every dollar saved is important, the high labor costs of remote set can cause some towns to shy away from this proven process.

In 2014, the Town of Chatham was on the verge of eliminating remote set oysters from its propagation program due to the labor involved in: making bags, deploying bags, flipping bags, cutting bags open, and broadcasting shell. At that time the town became aware of remote setting boxes that were utilized in the Chesapeake Bay area. Due to the nature of the boxes, there was some hesitation that the spat would not do as well, without some of the protection from predators afforded by the traditional methods.

Over the past decade, the Town of Barnstable has continued to utilize traditional spat bags, while the Town of Chatham moved to utilizing oyster boxes. This poster aims to demonstrate the success of both programs, some challenges and successes with each, and how it might be utilized by other organizations looking to add remote set.

SPAT HAPPENS: LINKING WILD SCALLOPS AND AQUACULTURE FUTURES

***Phoebe Jekielek*[1], *Struan Coleman*[2], Carla Guenther[3], Caitlin Cleaver[4], Madison Maier[5]**
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Sea scallops (*Placopecten magellanicus*) are a high value shellfish with domestic demand doubling current production in wild capture fisheries, driving an increase in scallop aquaculture investment. There is no hatchery production for scallop seed and little understanding of wild scallop larval dynamics- the current source of cultured product – creating unique research, economic, and collaborative opportunities in this growing industry. This talk will share results from an ongoing collaborative research project to understand spatial and temporal variability in sea scallop spat along the coast of Maine. Preliminary results from the current three-year dataset show high interannual variability in spat counts between sites within transects and between transects along the coast, with spat counts generally increasing from inshore to offshore. Struan Coleman from Vertical Bay Maine will also share a novel effort to create new partnerships bringing fishermen and farmers together to collect spat in Penobscot Bay and develop a scalable scallop farming model. Understanding patterns of larval abundance, distribution, and delivery over space and time is central to the mutual success of wild harvest and aquaculture industries and requires expertise from fishermen, farmers, oceanographers, marine ecologists, and resource managers.

SCALLOP AQUACULTURE EXCHANGE: LEARNING TOGETHER FOR A GROWING INDUSTRY

***Phoebe Jekielek*[1], Struan Coleman[2], Andrew Peters[2]**
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If you've been growing scallops on your farm, or if you're thinking about growing them, please join us to learn and troubleshoot together! We will bring together scallop growers, researchers, managers, and those interested in starting to grow sea and/or bay scallops to share their stories and experience. We'll start by hearing from current growers to learn about the species they're growing, the gear they use, the markets they target and how they do it, and what works and what doesn't work for them and their business. We'll also learn about publicly available tools and resources to help new and existing growers share knowledge on best practices, developed in partnership with researchers at UMaine. These overviews will be followed by a discussion with growers and ample time for audience Q&A and networking. We will have the different gear types (lantern/pearl nets, spat bags, Sea Scale cages, etc.) available to explore and information on where to get them, how much they cost, and which might be the best for your farm. The goal of this session is to bring people together to highlight the growth potential of scallop farming in Maine, shed light on challenges that growers are still facing in the state, and to discuss how we move this industry forward together.

MICROBIOTA MANAGEMENT STRATEGIES FOR GAMETOPHYTE NURSERY MAINTENANCE PLANS

***Amy Jones*, Hadley Kerr, Morgan Anthony, Daniel J. Gossard, Scott Lindell**
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The development of kelp gametophyte (GP) biobanks has been gaining popularity across the global seaweed industry. However, solutions are needed to counteract potential bio-proliferations of co-occurring microbiota within GP cultures. A GP culture maintenance plan is essential to building a healthy and cost-effective nursery for commercial farming of kelps. The Lindell Lab at the Woods Hole Oceanographic Institution evaluated techniques in the lab's GP culture maintenance plan for mitigating bio-proliferations (diatoms and bacteria). Precipitates formed in autoclaved seawater provide surface area for microbial growth and interfere with culture health. The precipitates were reduced and removed through a slow cooling process and vacuum filtration. Germanium dioxide (GeO_2) alone was inadequate for reducing and removing diatoms. The combination of GeO_2 with a sonication and filtration regimen was highly effective in reducing the diatom concentration in GP cultures. Implementing a combination of antibiotic treatments, sonication, and filtration greatly reduced the bacterial load in cultures. The protocols of these microbiota mitigation methods are cost effective for commercial and research uses.

ASSESSMENT OF NATURAL OYSTER POPULATION HEALTH AND DYNAMICS TO INFORM RESTORATION AND AQUACULTURE PLANNING IN LONG ISLAND SOUND - Part 1 Connecticut

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Oysters provide essential economic and ecosystem services to coastal communities including Long Island Sound. Both regionally and nationally, shellfish restoration continues to increase and expand natural beds, presenting an opportunity to increase oyster-related ecosystem services. Little is known about how expansion may affect the proliferation and transmission of oyster parasites between restored and cultured populations. To better understand the host-parasite interactions in a changing environment, we completed monthly disease (*Perkinsus marinus* (Dermo), *Haplosporidium nelsoni* (MSX), *Haplosporidium costale* (SSO)) and reproduction assessments at two unmanaged, self-sustaining natural oyster beds in Connecticut over three years. Continuous water monitoring, combined with

oyster biometrics, provides a quantitative understanding of the seasonal dynamics and will help to identify relevant water quality variables.

Preliminary analysis shows Dermo disease following historic trends. Body condition and gonad development were correlated with temperature. Adult mortality rates of 24-34% were observed during summer months when Dermo infection was high, but overall population densities remained stable because of high natural recruitment in the late summer and early fall. Water variables deviated from historical trends, with temperatures frequently exceeding 25°C and pH ranging from 7.0 to 7.7. Further disease analysis using qPCR and histology will improve our understanding of how changing environmental factors are affecting oyster population health. This comprehensive approach will fill critical information gaps and develop a hazard analysis to guide restoration planning that promotes the success of natural, restored, and cultivated oysters and supports healthy, resilient ecosystems and coastal communities.

REDUCING MARINE DEBRIS IN THE GULF OF MAINE: EDUCATING AND EMPOWERING BOATERS TO BE A PART OF THE SOLUTION

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Recreational and commercial boaters can contribute to derelict fishing gear and other marine debris that cause economic and environmental harm. Marine debris is challenging to remove in the Gulf of Maine due to the many small, uninhabited islands with rugged ledges and no reasonable access to safely land a boat. In response, Maine Sea Grant alongside Maine Marine Trades Association, Maine Coast Fishermen's Association, Maine Coastal Program, Maine Island Trail Association, and others formed a Marine Debris Action Coalition to launch an education campaign centered on prevention. With funding from the National Sea Grant Office, the Coalition developed digital and printed products and delivered outreach to educate and incite action. This work aims to reshape the social narrative around who's at fault and what can be done locally to help prevent marine debris. For example, some boaters do not understand the impacts of accidentally harming lobster gear or sea farms with their boat propellers. This project created educational resources regarding those potential impacts and tips to avoid them. The central message of the campaign is that we all love Maine waters, and we all have a role in protecting it. This is the first organized campaign in Maine to engage boaters about the shared responsibilities of marine debris prevention, and how they can be a part of the solution, benefitting commercial fishermen, fishing communities, coastal wildlife, and ecosystems in the Gulf of Maine. Campaign elements will be shared, as well as lessons learned and future directions

COLLABORATIVE MANAGEMENT IN AQUACULTURE

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The growth of aquaculture in northeastern states and in Canada have required increased investment in the regulatory system and the revision of laws and regulations as the industry matures. Efforts to revise laws and regulations are frequently approached through a cooperative system. In Maine, the legislatively created Aquaculture Advisory Council (AQAC) was reformed in 2023 to include more council seats and a broadened scope of work. Since that time, the AQAC has initiated committees to work on specific topics that have resulted in draft legislation. In New Hampshire, regulatory officials worked with industry to revise their floating gear policy to address the risk to public health from birds. In Rhode Island, a revision of the Aquaculture of Marine Species regulation in 2024 also involved industry collaboration. These and more examples of collaborative management in aquaculture will be discussed to inspire and strengthen successful relationships between regulatory bodies, industry members, and the public.

WILL A "HEAT-KILLED" FORMULATION OF PROBIOTIC STRAIN OY15 EXERT BENEFICIAL PROBIOTIC EFFECTS ON LARVAE OF THE EASTERN OYSTER (*CRASSOSTREA VIRGINICA*) SIMILAR TO THAT OF THE LIVE OY15 FORMULATION?

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The U.S. shellfish aquaculture industry depends upon healthy larvae to sustain dependable hatchery seed production of shellfish. Yet under intensive cultivation, bacteriosis can introduce major constraints, causing massive mortalities and financial challenges. In an effort to improve sustainable practices in hatcheries to prevent losses to bacterial disease, NOAA's Milford Laboratory has completed discovery, laboratory, and hatchery-scale *in vivo* evaluations of probiotic strain OY15, a benign strain of *Vibrio alginolyticus*, for larviculture of the Eastern oyster (*Crassostrea virginica*). These trials have shown improved fitness, survival (up 20-35%), and settlement of larvae supplemented with probiotic strain OY15. OY15

protects larvae from bacteriosis by stimulating hemocyte immune defense functions in oyster larvae. The Milford Laboratory has collaborated with a commercial biotech company TidalBio LLC., which provided freeze-dried formulations of live and "heat-killed" OY15 for use in these trials. This study compared the probiotic effects of this new "heat-killed" OY15 formulation to those of the live OY15 formulation on the fitness and survival of Eastern oyster larvae. Results from this study indicate that a heat-killed OY15 formulation may exert beneficial probiotic effects on oyster larvae as well as the live formulation of OY15, which can streamline commercialization and marketing to benefit the shellfish aquaculture industry.

AQUACULTURE & PROTECTED SPECIES: A COLLABORATIVE APPROACH TO RISK REDUCTION

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Aquaculture is a rapidly growing sector critical for U.S. seafood security, yet this growth must balance economic opportunities with measures to avoid and minimize adverse impacts to species protected under the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA).

We will review NOAA Fisheries mandates under these Acts, provide a summary of recent protected species-aquaculture interaction workshops with a national and regional focus, and discuss next steps. These next steps include future research opportunities where we hope to collaborate with the aquaculture industry, academic institutions, and others. These collaborations are critical to the development of practices that will help achieve the goals of minimizing impacts while maintaining opportunities for the industry. We hope this presentation will be a jumping off point for further conversations throughout NACE.

REGIONAL IMPLEMENTATION OF COMPREHENSIVE AQUACULTURE HEALTH PROGRAM STANDARDS (CAHPS)

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The Comprehensive Aquaculture Health Program Standards (CAHPS) were developed by the aquaculture industry in collaboration with the USDA. This risk-based approach to health management has implications with regard to how inspections are conducted for the movement of live aquatic animals. This voluntary program was scheduled to be posted in the federal register for public comment as the first step to becoming a codified USDA program. Unfortunately, CAHPS was withdrawn from the process and now has an uncertain future at USDA. Efforts are now underway to see how CAHPS may be implemented at the state/regional level as a way to obtain regulatory acceptance and use a more science-based approach to aquatic animal health movements.

OPTIMIZING GAMETOGENESIS AND SPOROPHYTE PRODUCTION WITH MULTI-ANNUAL DELAYED SUGAR KELP (*SACCHARINA LATISSIMA*) GAMETOPHYTES FOR IMPROVING KELP NURSERY PRODUCTIVITY

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Using multi-annual delayed (MAD) kelp gametophytes to generate seedstring has several advantages over conventional meiospore methods such as control over timing of seed production and replicable use of successful strains. Recognizing a need to speed-up and better synchronize gametogenesis in MAD gametophytes, the Lindell Lab worked to optimize this process which could improve commercial nursery productivity and reduce seed costs. In this study, we used various genotypes of sugar kelp (*Saccharina latissima*) MAD gametophytes that had been vegetatively cultured in red light over the course of several years. Male and female gametophytes were combined at various densities and gametogenesis was induced by moving the gametophytes to white light of differing photoperiods. The number of eggs and sporophytes were counted throughout the course of the experiments to determine reproductive success. These experiments revealed notable differences in egg and sporophyte production between parent gametophyte genotypes, induction densities, photoperiods, and switches in photoperiod. The results of these experiments showed that simple refinements to common kelp nursery procedures can significantly affect gametogenesis, synchrony and productivity of sporophyte production and improve the overall yield of kelp per unit of gametophyte biomass thus effectively reducing nursery costs.

PATTERNS OF BIOTOXINS IN CULTURED MAINE SCALLOP TISSUE

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Sea scallops (*Placopecten magellanicus*) are an emerging culture species in Maine. Technology transfers between Japan and Maine fishers and farmers have led to a burgeoning industry that has found U.S. markets for both shucked meats and a whole scallop product. Preliminary 2024 harvest data report approximately $153,000 in cultured scallop sales, signaling economic potential. However, biotoxins from harmful algal blooms—specifically *Alexandrium* spp. (saxitoxins causing paralytic shellfish poisoning, PSP) and *Pseudo-nitzschia* spp. (domoic acid causing amnesic shellfish poisoning, ASP)—pose challenges, particularly for whole scallop sales. While the adductor muscle remains biotoxin-free during harmful algal blooms, whole scallops are classified as high-risk by the Maine Department of Marine Resources (DMR) due to prolonged toxin retention, necessitating additional testing beyond routine DMR monitoring. These costs fall to the farmers. This work presents biotoxin data collected under the Saltonstall-Kennedy project "Optimizing production and products for scallop aquaculture," which funded High-Performance Liquid Chromatography testing from 2017 to 2024. Data include regular ASP and PSP toxin levels in scallop tissues (muscle, roe, and viscera) from farms in Casco and Penobscot Bays (2017–2019), and sporadic regulatory samples from 2020–2024. Saxitoxin profiles are broken down into 12 congeners. These findings provide insight into biotoxin dynamics in cultured scallops and inform potential risk management strategies for expanding whole scallop markets.

ADVANCING RAS LARVAL REARING WITH PROTEIN COATED MICROPARTICULATE DIETS (PCMD).

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Marine finfish producers face high mortality rates, suboptimal growth, and deformities during the larval stage, largely due to nutritional deficiencies. Microdiets leach water-soluble nutrients at very high rates which results in reduced payload delivery to target organisms and nutrient loading of larval systems. Furthermore, microdiets are prone to disintegration which may further degrade water quality and lead to fouling. In the present study, we evaluated novel coating technologies as a means of reducing water-soluble nutrient leaching and increasing particle stability of commercial-type microdiets to improve nutrient delivery to larval finfish and reduce impacts on filtration systems in RAS.

Scanning electron microscope imaging indicated the protein coatings were effectively applied to the surface of commercial-type microdiets. One of these specialized coatings was then applied to a modified open-formula microextruded marumerized particle, hereafter referred to as the "Protein Coated Microparticulate Diet" (PCMD). This diet was compared with similarly formulated uncoated microdiets and a commercial microdiet through benchtop assays, acceptability experiments, and growth trials using larval *Seriola dorsalis*. We found that the protein coatings decreased the leaching of water-soluble nutrients while increasing particle stability. Additionally, the uptake trial indicated PCMDs were consumed at equal rates when compared to non-coated microdiets. No significant differences in larval growth were observed at the end of the growth trial (Tukey's HSD, $p<0.05$).

The reduced leaching of water-soluble nutrients by PCMDs resulted in improved nutrient delivery and should reduce nutrient loading of larval culture systems, providing potential benefits for RAS growers.

A SYSTEMATIC APPROACH TO GAMETOPHYTE BIOBANKING IN THE GULF OF MAINE AS A TOOL FOR NURSERY RESILIENCY AND CONSERVATION OF BIODIVERSITY

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Farmed and wild populations of *Saccharina latissima* in the Gulf of Maine face challenges as wild populations decline, winnowing the genetic diversity needed to maintain both robust wild populations and the nursery operations that underpin the farming sector. The University of Maine Seaweed Aquaculture Lab is focused on developing methods to address these challenges. Unlike traditional seed approaches, gametophyte-based nursery methods can provide year-round access to seedstock, enable selective breeding, and offer a pathway for long-term preservation of genetic diversity.

Currently, many biobanks grow slowly and opportunistically over time, our biobank will undergo a deliberate and systematic expansion over the next 24 months, growing from 40 to ~1000 clonal cultures of Saccharina latissima and diversification into *Lamiaria digitata* and *Alaria escuelenta*. This approach will create a library representative of populations along the entirety of Maine's coastal gradient and will be used as a resource for strain development, conservation, and restoration. Beyond this, photobioreactors are used to optimize growth and scaling of gametophytes, providing a more controlled platform for culture maintenance. In parallel, the operation of an inshore and offshore kelp farm allows

for field-based research on cultivation methods. Together, these efforts demonstrate the potential of a gametophyte-based nursery system for improving genetic management, enhancing reliability of seed supply, and strengthening the resilience of the seaweed industry in Maine.

SMART ROBOTICS FOR SUSTAINABLE SHELLFISH AQUACULTURE: DESIGN AND TESTING OF AN AUTOMATED FLUIDIZED UPWELLER SYSTEM

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Aquafarming is the fastest-growing food sector globally, with a clear need for technology to improve efficiency. This paper presents the design of an automated system for fluidized bottle upweller systems (BUPSYs) that raise juvenile oysters and testing of BUPSYs flow rates and silo geometries. BUPSYs use upward flow to create a fluidized bed, distributing food evenly, promoting faster, more uniform growth. Because flow directly determines nutrient delivery, its control is crucial: insufficient flow reduces growth and increases mortality, while excessive flow wastes energy and can harm the spat.

We tested two flow-setting strategies used by farmers: 1) increasing flow until 40% bed expansion, and 2) increasing flow until the bottom layer of spat began to move, indicating the onset of fluidization. We also tested how silo geometries (hipped cylinder, inverted pyramid, straight cylinder, inverted cone) affected mixing, since inadequate mixing undermines uniform exposure to food and flow. To quantify performance, we placed dyed cultch at the bottom of the column and measured time to reach a Lacey Mixing Index of 0.9.

For the automated system, we used the hipped silo as it is the only commercially available shape and bed expansion, because it consistently had better mixing performance to set the flow. A camera tracks bed height, and a PD controller regulates a motorized valve to maintain 40% expansion. This system aims to reduce labor requirements and increase yield by optimizing the fluidization process, supporting scalable and sustainable oyster farming practices.

FOAMED LOBSTER SHELL COMPOSITES FOR THERMAL INSULATION AND PACKAGING APPLICATIONS

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Expanded polystyrene (EPS), commonly known as StyrofoamTM, is a non-biodegradable, petroleum-derived product widely used for thermal insulation and impact absorption applications. EPS is composed of 95-98% air and is only recyclable through specialist facilities, although recycling is not considered profitable due to high transportation costs. EPS often ends up in landfills and/or the terrestrial and marine environments, where it fragments into smaller pieces, making it easier for animals to ingest. In 2011, the Neivandt Group at the University of Maine created a biodegradable golf ball composed of a natural matrix and lobster shell, US Patent 10,065,080. The present work has developed a means of mechanically foaming the composite, resulting in materials with densities comparable to those of EPS. In addition, the thermal conductivities of the foams were within the targeted range of EPS. Finally, the mechanical properties (compressive, flexural, and impact resistance) of the foamed composite were found to be analogous to those of EPS. Importantly, it was discovered that the composite exhibits flame-retardant properties unlike EPS, and thus has significant safety advantages compared to its synthetic counterpart. Preliminary water dissolution tests revealed complete degradation of the sample over a 4-day period. Taken together, the present work indicates that the foamed lobster shell composites represent a biodegradable and environmentally benign potential replacement for EPS.

OYSTER HEALTH AND RESTORATION IN LONG ISLAND SOUND - TRENDS IN DISEASES AND REPRODUCTION OF UNMANAGED OYSTER POPULATIONS

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Expanding existing natural beds presents a desirable opportunity to increase oyster-related ecosystem services; however, little is known about how expansion may affect the proliferation and transmission of oyster pathogens between restored and harvested populations. Development of risk-based guidance for mitigating bivalve diseases is essential to the successful restoration and cultivation of oysters throughout Long Island Sound and may translate to other coastal regions in the United States. Our goal is to establish a standard methodology for incorporating disease burden in oyster population health assessments for future evaluation on restoration projects.

To this end, we employed diagnostic methods to assess to reproductive success and the progression of Dermo (*Perkinsus marinus*), MSX (*Haplosporidium nelsoni*), and SSO (*Haplosporidium costale*) diseases, including the implementation and validation of a triplex qPCR assay developed by Piesz et. al, 2022. Chosen study sites represent unique environments and population sizes with both intertidal and subtidal reefs, and both

well-established and newly restored beds being monitored. Preliminary results of monthly monitoring from three study sites will be presented.

SELECTIVELY BREEDING IMPROVED STRAINS OF SUGAR KELP, *SACCHARINA LATISSIMA;* A SEVEN YEAR SUMMARY

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Seaweed farming in the Gulf of Maine expanded rapidly over the past decade, but has struggled to meet its potential in the marketplace partly because of the cost of production. Improving crop yield and quality via selective breeding are proven paths to profitability. WHOI/Lindell Lab's sugar kelp breeding program is built upon a germplasm bank of over 2,000 unique gametophytes that can be used as parents for generating crosses. Kelp crosses were planted in "common garden" farms over seven seasons (2018-19 through 2024-25) in New Hampshire and two seasons in New York. A summary of the traits measured and analyses of yield, composition and morphology for > 1,400 family plots and >7,000 individual kelp blades will be presented. One highlight is that > 20 plots exceeded 15 kg/m harvest wet weight (more than twice the commercial average) with the top plot weighing 34 kg/m. We have used pedigree, genotypic marker, and phenotyping data to build a genomic selection model capable of predicting offspring performance. In addition to improved yields we have begun selection for temperature tolerance and low-iodine and other tissue traits of economic importance. We have also published an annotated reference genome for sugar kelp that enables the identification of natural mutations on target genes to create non-reproductive sporophytes. We will evaluate > 20 putatively non-reproductive strains this growing season.

INCREASING ACCESS TO SEAWEED PROCESSING FOR FARMERS IN NEW ENGLAND WITH ATLANTIC SEA FARMS CO-PROCESSING SERVICES

Liz MacDonald

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As a vertically integrated aquaculture company, Atlantic Sea Farms (ASF) has developed specialized seaweed infrastructure from seed all the way through packaged consumer products. Creating first of its kind seaweed products required many iterations of equipment modifications and seasons of processing expertise. To this extent we recognize that to bring a consistent, food safe and market ready seaweed product to consumers requires significant infrastructure, resources, capital investment, and labor to execute successfully. To assume that someone with the expertise of farming a successful seaweed crop should and could also be responsible for processing their crop in a very short period of time and in a food safe way is incredibly demanding and in most cases is not financially feasible. To this extent ASF has identified that their specialized seaweed production line can serve the greater seaweed industry by offering co-processing services to independent farmers.

ASF is offering standardized kelp washing, shredding, blanching and packaging services to independent seaweed farmers in Maine and Southern New England. We anticipate that most of this co-processing would be utilized during the typical spring kelp harvest. Additionally, ASF is able to offer this service year round for stabilized crops. Our processing facility located in Biddeford, ME is both SQF and Organic certified, located within 5 minutes of I-95, and is equipped with loading and unloading capabilities and short-term cold storage. This presentation will describe the processing, handling, packaging and certifications associated with co-processing services in detail.

SAFETY IN AQUACULTURE – ATLANTIC AQUA FARMS PERSPECTIVE

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Safety in aquaculture is becoming more than protective gear; it needs to become a culture and a mindset. At Atlantic Aqua Farms, we've made progress in reducing workplace injuries through strategic improvements to Personal Protective Equipment (PPE). This presentation outlines how our teams selected improved PPE, addressed the limitations of previous equipment and the collaborative methods used to identify safer, more effective alternatives to the status quo.

Beyond equipment, we've introduced new incident reporting policies that empower management to respond quickly and strategically to risks. But true safety transformation requires more than policy—it demands a cultural shift. We are fostering a workplace environment where employees not only adopt PPE and follow best practices, but also actively identify and speak up about potential hazards before incidents occur. This proactive approach is essential to building a healthy safety culture.

Looking ahead, we remain committed to continuous improvement in gear, maintenance, and mindset. As labor shortages increase and public scrutiny grows, aquaculture must prioritize safety to attract and retain skilled workers. Unsafe conditions not only endanger staff or reduce productivity through lost time; but also erode public trust and hinder recruitment. By investing in safety and cultivating a culture of accountability, we safeguard our workforce and reinforce the integrity of our industry.

This session will invite discussion on how aquaculture can lead by example in workplace safety, ensuring long-term productivity and public confidence.

NAVIGATE RISK WITH CONFIDENCE: UNDERSTANDING AND MITIGATING UNCERTAINTY IN OPEN OCEAN MARICULTURE

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Open-ocean aquaculture is severely constrained by high levels of risk and uncertainty for developers, insurers, investors, and regulators, which leads to prohibitively high capital and operating expenditures and slow permitting. Increasing mariculture production will require expansion into more exposed offshore farms. While such farms can be highly productive, engineering farms in exposed ocean conditions introduces compounding sources of risk and uncertainty.

Simplistic approaches to load case identification can be overly conservative, resulting in unnecessary capital expenditure costs. The complex interplay between site factors such as wave, wind, currents, biomass, water level, and species-dependent factors require multi-dimensional risk quantification. Interactions among structural factors such as anchor installation, anchor strength, rope performance, and biomass hydrodynamics, and their related uncertainties, must also be considered. Furthermore, biomass hydrodynamics are dependent on a myriad of factors and ongoing analysis of full-scale farms, compared to numerical models, shows that an understanding of the hydrodynamics of the biomass of the farm is essential to accurate engineering of the farm. A comprehensive, quantified, approach to these combined risk factors is essential for designing aquaculture operations that are simultaneously robust and economically sustainable

TRIALS OF NOVEL BIODEGRADABLE LANTERN NET COVERS FOR BIOFOULING MITIGATION

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In the Gulf of Maine, rising ocean temperatures are expected to increase the diversity and abundance of fouling organisms (biofouling) on aquaculture farms, which increases labor demands and can reduce a farm's productivity. This project trialed biodegradable mesh covers intended to decrease the settlement of fouling organisms on lantern nets, a common grow-out method for cultured Atlantic Sea Scallops (*Placopecten magellanicus*). The mesh lantern net covers are a novel use of a beechwood fiber sustainably sourced from Forest Stewardship Council certified forests and developed by the Ocean Farm Supply company. Through deployments on two Penobscot Bay farms, Hurricane Island Center for Science and Leadership and Pen Bay Farmed Scallops, this project tested for impact on (1) farmer labor and time, (2) biofouling accumulation and community composition, (3) scallop health and condition, and (4) localized benthic sediment carbon accumulation. Deployment of covered and uncovered lantern nets stocked with market-size scallops occurred for 4-6 week periods from May through early October in 2024 and 2025, covering the settlement times of a variety of common fouling species. This project seeks to provide insight into applications for effective, low cost, and sustainable mitigation of biofouling across the Maine scallop aquaculture industry.

IMPROVING SPORE ATTACHMENT AND SURVIVAL FOR *PALMARIA PALMATA* CULTIVATION

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Palmaria palmata, more commonly known as dulse, is a palatable red algae which is of interest to the aquaculture industry due to its high nutritional content and economic value. Market demand is currently higher than what wild harvest can supply, so it is important to develop cultivation techniques for this species. Experiments are being run in a collaboration between the University of New England and Atlantic Sea Farms (Biddeford, ME) to test the viability of two seeding methods and six twine substrates for use in dulse cultivation. Dulse releases spores in relatively low quantities compared to other commonly farmed seaweeds. These spores are non-motile and have high mortality rates, making production of seeded substrates difficult. We are testing the viability of seeding within tumbling tanks to take advantage of passive spore release from fertile dulse fronds, rather than isolating and actively inducing release from specific sorus sections like in traditional seeding. Our second seeding method aims to address issues with spores attaching and clumping on unintended surfaces by collecting, breaking up, and relocating these spore

aggregations to twine substrates by painting with a binder. Spore settlement and attachment strength are affected by chemical and thigmotactic interactions with the substrate. The adhesion, survival, and retention of dulse spores on six twine types of varying material and texture are being assessed to determine which substrates are more favorable for cultivation. These trials will contribute to the development of efficient production techniques for seeded dulse substrates for use in Maine's seaweed aquaculture industry

MICROBIAL COMMUNITY DYNAMICS IN SHRIMP *LITOPENAEUS VANNNAMEI* INTEGRATED MULTITROPHIC AQUACULTURE SYSTEMS

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Growing shrimp with extractive species is gaining momentum as an effort to reduce effluent waste in shrimp aquaculture. We examined shifts of the microbial communities in a 4-week trial comparing white shrimp (*Litopenaeus vannamei*) and red seaweed (*Gracilaria vermiculophylla)* grown with oysters (*Crassostrea virginica*), and without oysters with either aeration or as settling tanks. Oysters had a significant impact on maintaining low nitrogen levels in the system over time compared to treatments with no oysters ($p < 0.032$). Differences in microbial shifts were tracked over time and between treatments, focusing on those involved in nitrogen metabolism (nitrification/denitrification) and Vibrionaceae populations as microbes that may act as pathogens in aquaculture practices. Differences in community composition were primarily driven by sampling day rather than treatment type. Observed temporal dynamics of microbial communities showed both decreases and increases of individual taxa, particularly regarding nitrogen cycling and Vibrio populations. These findings emphasize the importance of system age and treatment conditions in influencing aquaculture ecosystem functions. Our results suggest that systems with oysters and aeration are more capable of supporting diverse and active microbial communities that contribute to nutrient cycling and pathogen control, offering insights into how management strategies can optimize system performance in aquaculture.

TESTING LARVAL OYSTER BIOCOMPATIBILITY WITH BUFFERED SEAWATER FROM NOVEL CO_2 REMOVAL TECHNOLOGY

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Ocean acidification can hinder the growth and development of calcifying organisms, especially larval shellfish that use aragonite to build their shells. Buffering systems may increase aragonite supersaturation and improve survival in controllable hatchery settings. A collaboration between the Massachusetts Institute of Technology and UMaine is examining whether a novel carbon removal cell can improve hatchery outcomes for shellfish by buffering seawater while simultaneously sequestering carbon. The cell uses bismuth electrodes to create a chloride-mediated pH swing. In this system, seawater is first acidified to release CO_2 and then re-alkalized while regenerating the electrodes, enabling continuous, low-energy carbon removal without chemicals or membranes. The resulting alkaline sidestream may provide a sustainable buffering agent for aquaculture. To evaluate biocompatibility, larval oysters were reared from fertilized egg (day 0) through set (day 14) in three treatments: MIT-buffered (electrochemically derived) seawater (pH ~8.2), magnesium hydroxide–buffered seawater (pH ~8.2), and ambient seawater controls (pH ~7.9). Generalized Additive Models of larval growth analyses showed that increased aragonite saturation state ($p < 0.001$) had significant positive effects on larval oyster growth rate, explaining 68.9% of variance. These preliminary findings suggest that both magnesium hydroxide and electrochemically derived alkaline effluent can enhance carbonate chemistry without causing acute larval mortality of oysters, supporting further investigation of their potential as scalable buffering tools for aquaculture and coastal management.

BIRD-RELATED PATHOGEN CONTAMINATION IN SHELLFISH AQUACULTURE: A COMPREHENSIVE LITERATURE REVIEW

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The Food and Drug Administration conducted a comprehensive literature review of bird-related pathogen risks in shellfish aquaculture, including: shellfish illnesses, pathogen prevalence in bird feces, water, and shellfish, correlations to water quality indicators, seasonal and regional variations in prevalence, pathogen survival, shellfish purge rates, pathogenicity, and bird mitigation techniques. From 2000-2024, CDC documented 11 *Campylobacter* outbreaks and 7 *Salmonella* outbreaks from shellfish consumption, with estimated actual burdens of 3,400 and 3,000 illnesses respectively when accounting for

underreporting and underdiagnosis. Five documented *Campylobacter* and *Salmonella* outbreak investigations found the most likely cause of contamination to be bird feces in shellfish growing areas, especially those with floating aquaculture gear. There is an overall prevalence rate of 27%, 6.4%, and 20% for *Campylobacter*, *Salmonella*, and pathogenic *E. coli* in wild birds, respectfully, with *Campylobacter* having the most variable prevalence (0-88%) and other human pathogens rarely detected. Other studies found these pathogens in shellfish harvested from approved growing areas, and isolated the pathogens from sediment and water. Traditional fecal indicator organisms showed poor correlation with *Campylobacter* and *Salmonella* presence. *Campylobacter* prevalence showed a clear seasonal pattern, with higher prevalence rates found in colder months. Physical deterrents like bird spikes and zip ties demonstrated highest efficacy for bird mitigation (74-99% reduction in bird interactions), while auditory and visual methods showed limited success. Critical knowledge gaps, such as limited research on pathogen survival in water and shellfish and insufficient data on purge rates, require additional targeted studies to support evidence-based risk assessment and management strategies.

CULTIVATING MAINE'S NEXT GENERATION OF AQUACULTURE PROFESSIONALS

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The Maine Aquaculture Apprenticeship Program is a registered apprenticeship through the Maine Department of Labor designed to equip aspiring aquaculture professionals with the skills and experience needed to thrive in Maine's growing shellfish and seaweed farming sectors. Created in collaboration with the Maine Department of Labor, the Maine Aquaculture Association, Southern Maine Community College (SMCC), and Educate Maine, the program combines hands-on training with structured classroom instruction to foster a well-rounded workforce.

The Maine Aquaculture Apprenticeship consists of 2,000 hours of paid on-the-job training (OTJ) and 144 hours of related technical instruction (RTI). The program takes 12 to 18 months to complete, depending on farm operations and seasonal factors. To support participation, each apprentice receives a stipend to help offset the time spent in classroom training. We also provide each apprentice with essential gear, including boots, bibs, a foul-weather jacket, and a life jacket (PFD). In recognition of their role in training and mentoring, host farms receive a stipend for participating in the program.

The paid OTJ hours are structured around key skill areas to ensure apprentices gain a comprehensive, hands-on learning experience. These skills are based on the Maine Aquaculture Association's Occupational Standard. To complement hands-on experience,

apprentices also complete 144 hours of RTI or classroom-based learning from a range of industry and academic partners.

EXPANDING AWARENESS OF AQUACULTURE AS A VIABLE STEM CAREER FOR MAINE'S YOUTH

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Foundations of Oyster Farming is a disciplinary learning game designed for the upper elementary grades and beyond, built with funding from the National Science Foundation under grant #2048828. Our learning resources invite students to embody the role of a Maine oyster farmer as they navigate the challenges of starting and sustaining a profitable oyster farm. Students weigh monthly profitability ratios against decisions on farm location, production costs (gear, equipment, spat, staff), and multiple selling options to build understanding of real-world aquaculture practices and support disciplinary learning in economics and data science.

To complement classroom gameplay, we've developed a nine-part video series that explores key aspects of the oyster farming process—including surface grow systems, site selection, seasonal cage management, oyster seed purchasing, and strategies for managing biofouling. We've also created a student worksheet to help track progress and support follow-up activities.

Disciplinary learning in economics and data science provide the foundation for gameplay decision-making by helping students weigh multiple selling options, balance production costs, and manage stochastic events in order to turn a profit. The game is an engaging, educational online experience designed for elementary school students. As part of our initiative to enhance socioecological literacy, the game introduces players to the fundamentals of oyster aquaculture, environmental stewardship, and the challenges farmers face.

Through interactive decision-making, students explore sustainable seafood production while learning about coastal ecosystems and business management. In alignment with our strategic initiative to build Maine's Blue Economy and support our Working Waterfronts, our learning resources broaden awareness of aquaculture as a viable career, connect students with working farmers, and highlight the economic and ecological importance of shellfish farming in strengthening coastal communities.

GETTING STARTED WITH AQUACULTURE GENETICS: CHOOSING THE RIGHT BREEDING PROGRAM

***Samuel A. May*, John Buchanan, Klara Verbyla, Adriana Artiles, Carlos Pulgarin, Marcos de Donato, Simon Hill**
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Selective breeding is key to aquaculture improvement, enabling producers to enhance desirable traits across generations. While easily measurable phenotypes such as growth can be directly selected for, more complex traits like robustness or negative correlations among multiple traits present greater challenges. This talk explores the range of breeding program strategies available, from low-investment approaches such as mass selection to more advanced methods, including family-based and genomic selection. Emphasis is placed on how to choose an optimal strategy by balancing resources, breeding objectives, and expected genetic and economic returns.

Both phenotypic and genotypic data are essential in driving genetic gain, as is the alignment of program complexity with operational feasibility. This talk also explores the integration of emerging technologies such as genome editing, which enables precise, targeted improvements within a single generation and complements conventional selective breeding to accelerate progress while maintaining long-term genetic stability.

This presentation evaluates breeding program options while accounting for investment, genetic potential, and commercial goals. By understanding both conventional and emerging tools, aquaculture producers can design breeding strategies that build a solid foundation of husbandry practices, deliver sustainable improvements, and maximize returns on investment for future industry growth.

ASSESSMENT OF NATURAL OYSTER POPULATION HEALTH AND DYNAMICS TO INFORM RESTORATION AND AQUACULTURE PLANNING IN LONG ISLAND SOUND - Part 2 New York

***Isaiah Mayo*, Mariah Kachmar, Kyra Lenderman, Sarina Dery, Genevieve Bernatchez, Kelly Roper, Sam Gurr, LTJG Tyler Houck, Barry Smith, Mark Dixon, Lydia Bienlen, Meghana Parikh, Gary Wikfors, Katherine McFarland, Lisa Milke**
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Oysters in Long Island Sound (LIS) provide major economic and ecosystem services to the region's waters and coastal communities in the forms of harvested seafood and job creation, as well as denitrification, coastal protection, and habitat provisioning benefits. To

enhance these potential contributions, increasing shellfish production from aquaculture, recreational harvest, and restoration has been identified as an ecosystem target by the LIS Partnership, an EPA national estuary program dedicated to restoring and protecting the Sound's waters and watershed. Both regionally and nationally, shellfish restoration efforts continue to increase and expand existing natural populations, presenting an opportunity to increase oyster-related ecosystem services. Little is known about how expansion may affect the proliferation and transmission of oyster pathogens between restored and harvested populations. Development of risk-based guidance using a comprehensive overview of population health for mitigating bivalve diseases is essential to the successful restoration and cultivation of oysters throughout LIS. The focus site of this presentation, Gold Star Beach, located in Huntington Bay, Long Island New York is an actively-restored subtidal reef with planted adult and juvenile oysters. We aim to fill critical information gaps and develop a hazard analysis to guide restoration planning in a way that promotes the success of natural, restored, and cultivated oysters and in turn supports healthy, resilient ecosystems and coastal communities.

LASTING DNA METHYLATION FROM EARLY LIFE HYPOXIA IN *CRASSOSTREA VIRGINICA*

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Environmentally-induced epigenetics (e.g.,, DNA methylation) can help organisms adapt and respond to the increasingly variable environments produced by climate change. While many studies have investigated DNA methylation as a response to a stressor at a single timepoint, less well-understood is how methylation may encode memory of past environments and influence the response to current environments (i.e., carryover effects). In a fully factorial experiment, we exposed juvenile eastern oysters (*Crassostrea virginica*) to two phases of water treatments with manipulated dissolved oxygen (control or hypoxia, <2 mg/L) to simulate climate change predictions. After the second exposure, whole body tissue samples were collected and processed for methylRAD sequencing. Regardless of treatment, methylation was mostly found in intragenic regions, primarily exons. Early life hypoxia resulted in increased CpG methylation compared to early life control conditions, irrespective of a second exposure. Interestingly, oysters that were first exposed to hypoxia and later exposed to control conditions had methylation patterns that were the most different from any of the other oysters. We found that differentially methylated genes identified in pairwise comparisons were mainly involved in the oxidative stress response, metabolism, and transcription. Together, these findings suggest that early life environments have a lasting impact on methylation and unique strategies are utilized

depending on the timing of experienced stress highlighting potential targets of resilience for oysters and aquaculture.

KELP ME HELP YOU: A QUALITATIVE APPROACH TO ASSESSING BIODIVERSITY AND COMMUNITY COMPOSITIONS ON U.S. SEAWEED FARMS

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Virginia Institute of Marine Science, Batten School of Coastal & Marine Science, William & Mary, 1370 Greate Rd, Gloucester Point, VA 23062 USA

Seaweed aquaculture is the fastest-growing aquaculture sector in the United States, providing sustainable products as well as ecological benefits such as nutrient reduction and carbon sequestration. The contribution of seaweed farms to habitat enhancement, particularly in terms of biodiversity and community composition, is currently being explored across the U.S. using a variety of methods and techniques (e.g., diver surveys, video monitoring, and eDNA). This project adds an approach not yet seen in the related literature and uses participatory, qualitative methods to examine these patterns. The proposed work supplements ongoing ecological monitoring and offers a complementary and currently undervalued perspective. This study investigates how seaweed farmers and researchers perceive the ecological impacts of seaweed farming across the U.S. Semi-structured interviews offer a comprehensive cross-regional perspective on biodiversity patterns. Interviews focus on participants' firsthand observations of species presence, abundance, and seasonal changes near farms, as well as their views on potential benefits or drawbacks for surrounding fisheries and ecosystems. By gathering these experiences, this project amplifies the voices of those most closely observing coastal aquaculture environments and generates qualitative data that complements ongoing ecological monitoring efforts. These insights help identify common themes, regional differences, and perceived drivers of biodiversity change, ultimately informing current and future ecological research as well as highlighting implications for management. Beyond documenting perceptions, this study demonstrates the value of integrating social science research techniques with ecological approaches to build a more comprehensive understanding of ecosystem services and strengthen connections between science, management, and public engagement.

ADVANCES IN QUAHOG AQUACULTURE IN MAINE

***Marissa McMahan*[1], Caitlin Cleaver[2], Kanae Tokunaga[3], Jessie Batchelder[1], Ben Cotton[3], Emily Farr[1]**
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Wild and farmed northern quahogs (Mercenaria mercenaria) are an important fishery along the East Coast of the U.S., but are relatively new in Maine. Populations of wild quahogs are increasing in Maine as waters warm, and quahogs are emerging as a new aquaculture product in the state, providing an important economic opportunity for both wild and aquaculture sectors. Wild quahog stock enhancement is a key tool employed by municipal shellfish programs in the state to support the growth of the wild fishery, but is limited by the availability of quahog seed in the sizes and amounts needed. This session explores recent advances in quahog aquaculture in Maine, including production strategies that benefit wild harvesters and farmers, current and future product demand, and economic viability of different growing techniques.

Lightning Talks/Panel Members:

- Dan Devereaux, Coastal Resource Manager, Town of Brunswick
- Jordan Kramer, Winnegance Oyster
- Adam Campbell, North Haven Oyster Co.
- Kanae Tokunaga, Senior Scientist, Gulf of Maine Research Institute
- Ben Cotton, Research Associate, Gulf of Maine Research Institute
- Caitlin Cleaver, Assistant Professor of Environmental Studies, Colby College
- Diego Trevino, Student, Colby College
- Rachel Hutchinson, Marine Resource Specialist, WHOI Sea Grant/Cape Cod Cooperative Extension

COLLISION MINIMIZATION AUTONOMY FOR A UTILITY SURFACE VEHICLE ON AN OYSTER FARM

***Erin Menezes*[1,2], Andrew Bennett[1,2], Michael Triantafyllou[1,2]**
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As the aquaculture industry expands, aquafarmers are turning to autonomous technology to increase their farm's efficiency and sustainability. Robots, well-placed sensors, and intelligent algorithms can help farmers track livestock growth, detect equipment damage, observe environmental effects, manage heavy equipment, and oversee feeding from the safety of land. Because many aquaculture farms rely on using the ocean for real estate, there is a significant reliance on nets and ropes to secure livestock cages. This makes deploying autonomous vehicles on farms a risk if the vehicle is unaware of the damage it could impose on these structures. Though collision-avoidance autonomy is necessary for such robotic systems, sometimes collisions can't be avoided, and therefore autonomy can only aim to minimize collisions. This work presents a collision-minimization path planning algorithm for a robotic catamaran that navigates through oyster basket arrays with the goal

of flipping floating baskets to reduce biofouling build-ups. While the array itself is fixed, the columns of baskets are constantly shifting with the current, pushing up against the vehicle as it tries to manipulate the baskets. This algorithm is tested in an oyster basket array mission simulator developed in the Gazebo-based Virtual RobotX environment designed to compare the collision cost in various basket array scenarios. While this work is specifically implemented on the oyster basket-flipping catamaran, the general idea of maneuvering through tight spaces can be extended to other applications such as ice fields, marine debris, and congested coastal waters after hurricanes or tsunamis.

WHAT HAPPENS TO BAY SCALLOPS EXPOSED TO OCEAN ACIDIFICATION FOR THREE GENERATIONS?

***Shannon L. Meseck*[1], Katherine McFarland[1,2], Samuel Gurr[3, 4], Genevieve Bernatchez[1], Mark S. Dixon[1], Lisa Keith[1], Isaiah Mayo[1], Lisa Milke[1], Matthew E. Poach[1], Deborah Hart[5], Louis Plough[6] , Dylan Redman[1], George Sennefelder[1], Sheila Stiles[1], David Veilleux[1], Gary Wikfors[1], Dianna Padilla[7]**

[1]NOAA Fisheries NEFSC, Milford Laboratory, 212 Rogers Ave, Milford, CT 06460 USA; [2] NOAA, National Ocean Service, Office for Coastal Management, 1305 East-West Highway, 10th Floor, Silver Spring, MD 20910 USA; [3]National Research Council Post-Doctoral Associate at NOAA NMFS, 212 Rogers Ave, Milford, CT 06460 USA; [4]Coastal Oregon Marine Experiment Station, Oregon State University Corvallis, 2030 S. Marine Science Dr., Newport, OR 97365 USA; [5]NOAA Fisheries, NOAA Fisheries, 166 Water St, Woods Hole, MA 02543 USA; [6]USDA, Agricultural Research Service, Pacific Shellfish Research Unit, 2030 SE Marine Science Dr, Newport, OR 97365 USA; [7]Department of Ecology and Evolution, Stony Brook University ,650 Life Sciences Building Stony Brook, NY 11794 USA

To date, most ocean acidification (OA) research with bivalves uses a single life stage in short term experiments. It is difficult to extrapolate the results of these short-term experiments to lifetime responses of an organism or to understand long term responses to OA. Bay scallops, *Argopecten irradians*, have a short generation time (< 1 year), are economically important, and previous studies have suggested that the larval stage is sensitive to OA. Therefore, bay scallops were selected to investigate capacity to respond and adapt to continuous exposure to OA over 3 generations. For two generations, bay scallops were grown from embryogenesis to sexual maturity, under one of two OA conditions (ρCO_2 = 400 and 800 µatm). The third-generation offspring of these scallops were grown in an experiment with a full factorial design (parental history × larval exposure) under three OA conditions (ρCO_2 = 400, 800, and 1000 µatm). Survival and growth were measured from 48 hours post-fertilization to metamorphosis. Preliminary results indicate that differences among treatments were observed. Preliminary data suggests that bay scallops may have some resilience to OA under some conditions and may be able to adapt to long term OA exposure.

SUPPORTING OYSTER AQUACULTURE AND RESTORATION (SOAR) 2.0 OVERVIEW

***Kelsey Meyer-Rust*[1], Brianna Group[1], Jessica Griffin[2], Rebekah Borgert[3], Boze Hancock[3]**
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Starting in 2020, the Supporting Oyster Aquaculture and Restoration (SOAR) program began as a response to support the shellfish industry due to the negative impacts of Covid-19. The program was a multi-state collaborative effort to restore critical coastal oyster reefs in partnership with the shellfish aquaculture industry. Building off the success and momentum of the first round of SOAR, in 2023 SOAR 2.0 was implemented collaboratively by The Nature Conservancy and the PEW Charitable Trusts. SOAR is a two-pronged program, which includes (1) the purchase of farmed oysters for restoration and (2) a resiliency fund for shellfish growers, with robust monitoring of both. This talk will include an overview of program implementation and monitoring with some preliminary results.

EXPANDING AQUACULTURE BY EXPANDING OUR UNDERSTANDING OF SOCIAL ACCEPTABILITY: AN ASSESSMENT OF SOCIAL ACCEPTABILITY FOR AQUACULTURE IN THREE REGIONS OF THE UNITED STATES

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The expansion of aquaculture represents an opportunity to strengthen domestic seafood markets, enhance food security, and create jobs, along with other possible benefits. Its potential, however, may be stalled by a lack of social acceptance. Social acceptability for aquaculture represents the willingness of a community to support the growing industry. This project uses a systematic participatory approach to understand social acceptability, focusing on three regions of interest for offshore aquaculture expansion in the US (the Gulf of America, Southern California Bight, and Alaska). A combination of focus groups (N=20) and semi-structured interviews (N=210) with community members took place between 2022 and 2024. Findings illustrate the nuances of acceptance, with varying opinions based on location and product grown, as well as community-specific characteristics that influenced overall support. Findings also have implications for prospective farmers, policy makers and resource managers, as well as community leaders and planners. Though focused outside of the northeast, the study was designed to align

with broader efforts to understand social acceptability and social license, and complements ongoing efforts along the Atlantic.

FROM CONCEPT TO CURRICULUM: DESIGNING APPLIED AQUACULTURE EDUCATION MODULES

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The rapid growth of aquaculture in Maine has led to an increasing need for accessible, industry-relevant training pathways for new entrants. However, available resources are spread across agencies, research institutions, and informal knowledge networks, making it difficult for learners to find succinct, introductory materials. To help address this challenge, the Maine Aquaculture Innovation Center (MAIC) began developing a modular, online curriculum that organizes aquaculture education into informative, independently accessible 'learning modules.' Modules are developed by reviewing scientific literature, regulatory guidance, and farmer experience by summarizing information into an accessible, educational format. Each module blends narrative instruction, technical schematics, and curated links to industry resources to provide an introductory understanding to aquaculture in Maine. Current modules in the curriculum include *Introduction to Aquaculture*, *Bivalve Biology*, *Seaweed Farming*, and *Site Selection*. Upcoming modules include *Bivalve hatcheries*, *Bivalve Nursery Systems*, and *Bivalve Growout Practices*. The modular curriculum is designed to be intentionally flexible, allowing learners to enter at different stages depending on their background, interests, or operational needs. Development framework prioritizes three core design principles: delivering introductory level content for users with limited prior knowledge, translating technical material into accessible formats, and organizing information into modular, standalone segments. Feedback from growers, educators, and regulators will continue to shape future revisions. Modules are intended to expand interest and provide foundational knowledge to anyone interested in exploring aquaculture as a career or curiosity.

MACROBREED: MODERNIZING KELP AQUACULTURE THROUGH SELECTIVE BREEDING

***Gary Molano*[1,2], Sergey Nuzhdin[2], Scott Lindell[1,3], Charles Yarish[1,4,6], Filipe Alberto[1,5], Kelly DeWeese[2], Yaoguang Li[4,7]**
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Lowering production costs for farmed kelp is critical to competing with imports and wild harvests and to expand downstream markets. Enhancing the value of farmed kelp is a key lever that will help the kelp industry continue to scale. Advancements in agriculture technology, such as genetics-based breeding programs, have successfully doubled global crop yields over the last century. MacroBreed aims to develop genetics-based breeding programs tailored to kelp industry needs. MacroBreed is piloting selective breeding technologies in *Saccharina latissima* (sugar kelp), targeting kelp with increased yield, lower iodine content, and lower heavy metal content. A major component to the MacroBreed breeding program is non-reproductive kelp, a genetics-guided crossing scheme (non-GMO) to produce kelp sporophytes that are unable to reproduce and thus limit the impact of kelp farming on local ecosystems. MacroBreed aims to develop regional breeding programs and combine improved traits to enhance the value of farmed kelp, and further the development of the human food, animal feed, plant biostimulants, cosmeceutical and nutraceutical markets. We will present preliminary results from our sugar kelp enhanced-value breeding programs and our non-reproductive kelp trials. Breeding will lower per unit costs, help reach new markets, and expand the kelp farming industry.

CARRYOVER EFFECTS OF HYPOXIA AND WARMING ON THE GROWTH OF THE EASTERN OYSTER *CRASSOSTREA VIRGINICA*

***Sophia Montague*[1], Sarah Gignoux-Wolfsohn[2], Thomas Miller[3], Julia McDonough[2], Sarah Donelan[1]**

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Eastern oysters *(Crassostrea virginica)* are a valuable commercial and recreational fishery and serve as a keystone species in coastal systems, providing habitat for an array of marine organisms and improving water quality. However, climate change is affecting environmental conditions in shallow water estuaries where oysters live. Specifically, dissolved oxygen (DO) concentrations are declining, driven in part by rising water temperatures. Stressors associated with climate change induce a range of effects in impacted organisms, including increased mortality and susceptibility to diseases, and changes in growth and biogeochemical cycling. Additionally, early life stages of organisms are often particularly sensitive to environmental stress and changes that occur early in life may have persistent and outsized effects later in life. This research examines carryover effects – when an individual's life history explains their present performance in a given environmental condition later in life – in eastern oysters.

We conducted a manipulative laboratory experiment that quantified how repeated exposure to hypoxia (low DO) and warming affects the growth of juvenile eastern oysters. At a single time point, oysters grew less tissue and shell mass when exposed to hypoxia. Additionally, we found carryover effects of early life exposure to warming resulting in lower oyster condition later in ontogeny. Our findings highlight that early life environmental conditions can have lasting impacts on oyster growth and must be considered when assessing how climate change will affect aquaculture.

MATE RECOGNITION CUES OF SALMON LICE (*LEPEOPHTHEIRUS SALMONIS*) AND THEIR POTENTIAL IN PEST MITIGATION

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Treatment and prevention of salmon lice (*Lepeophtheirus salmonis*) has become a major component in the management of marine salmon aquaculture farms. Development of novel methods to be included in pest management strategies are sorely needed by this regionally and globally important sector.

As a sexually reproducing parasite, salmon lice must locate a suitable mate. Once located, salmon lice need to definitively determine the species, sex, and reproductive state of a prospective mate. Recognition factors that are utilized to adjudicate this pairing in salmon lice are not known, however, recent work in our lab has discovered novel sex specific molecules on salmon lice that we believe play a role in mate recognition. Confirmation of the extent with which these cues play in the salmon lice reproductive cycle would establish them as a novel target for lifecycle disruption.

The sex specific molecules discovered on salmon lice are undergoing evaluation for their role in reproduction. Through masking of these cues and observation of louse mating behavior we hope to develop novel methods of mitigation. Proof-of-concept trials have shown efficacy for evaluation of in-vivo mating behavior and mate choice from wild caught lice. If ultimately shown to disrupt reproduction, these molecules could provide the basis for effective techniques and compounds that manage salmon lice in salmon aquaculture.

OVERVIEW OF TISBURY, MARTHA'S VINEYARD BAY SCALLOP PROPAGATION THROUGH SPAT BAGS

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The Tisbury Shellfish Department has over 40 years of experience propagating bay scallops (*Argopecten irradians*) on Martha's Vineyard, using seed spawned locally through the Martha's Vineyard Shellfish Group (MVSG). Bay scallops represent both an economic resource and a cultural cornerstone of Island life, which our program seeks to sustain and enhance through propagation efforts. Our current method employs mesh spat bags containing two pieces of Netron™, each bag holding approximately 2,000–5,000 juvenile scallops ranging from 800 µm to 1 mm. The outer mesh provides protection from predators and biofouling, while the Netron™ increases surface area for byssal attachment and helps maintain bag structure. Spat bags are deployed on lines of 50, anchored with cinder blocks and supported by six evenly spaced bullet buoys to keep them near the surface. Every two weeks, bags are retrieved, thinned, and transferred into larger mesh to accommodate growth. This approach has consistently yielded high survival rates and robust scallop growth.

SIMPLE TOOLS TO QUANTIFY ECOSYSTEM SERVICES PROVIDED BY AQUACULTURE – THE AQUACULTURE HABITAT CALCULATOR

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We developed an online tool to quantify the creation of structured habitat provided by oyster aquaculture gear for two commercially important fish species in the Northeast US, black sea bass and scup. Using a synthesis of existing literature, regionally-relevant data from our partners, and incorporating temperature data, essential fish habitat maps, and gridded survey data, our program seeks to provide shellfish resource managers with an assessment of habitat provisioning by shellfish farms in the Northeast to aid in consideration of habitat benefits into aquaculture permitting. Shellfish aquaculture gear

creates complex structures that can influence the abundance and diversity of wild fishes. Underwater action cameras in Connecticut, Delaware, Massachusetts, and New Jersey were used to quantify fish interactions with aquaculture gear. Observations of fish behavior in Connecticut suggest that cages provide food, shelter, refuge and other ecological services, much like natural structured habitat. Association of young-of-the-year fish with oyster cages across multiple research locations suggest that aquaculture gear may be utilized as nursery habitat by fish during the early life history stages. Information on region-scale variation in habitat provisioning associated with shellfish aquaculture can aid resource managers in developing a permitting framework that includes consideration of environmental benefits in addition to potential impacts. A better understanding of how shellfish farming influences fish communities will increase social license for aquaculture among coastal communities.

SIMPLE TOOLS TO QUANTIFY ECOSYSTEM SERVICES PROVIDED BY AQUACULTURE – THE AQUACULTURE NUTRIENT REMOVAL CALCULATOR VERSION 2.0

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We have expanded the functionality of an existing tool to quantify nutrient removal services provided by eastern oyster aquaculture on the US East Coast. Oyster aquaculture was approved by the Chesapeake Bay Program in 2017 as a best management practice (BMP) for reducing N and P and allows for the harvest of oysters to count toward sub-watershed nutrient reduction goals established by Clean Water Act programs. The Aquaculture Nutrient Removal Calculator (ANRC) is a publicly-available, online tool designed for use by both shellfish farmers and managers within the aquaculture permit review process. The ANRC accurately predicts harvest-based nitrogen removal from an eastern oyster farm located within the geographic range of North Carolina to Maine, USA. We have taken an adaptive management approach to tool development, basing our tool on current best available scientific information, with the intention of maintaining and updating this tool when new information and data become available in the future. Based on feedback from end-users and stakeholders, we incorporated phosphorus reductions associated with oyster harvest into the ANRC, and added an implementation for seed-oyster operations to quantify their farm-associated nutrient removals. Variability in

oyster tissue and shell phosphorus concentration was low, consistent with previous research, and an assessment of farm location and seasonality suggested that a single average value for phosphorus concentration could reasonably be applied across all farms. This study also addressed BMP-identified data gaps involving variation in nutrient content related to the effects of seasonal reproductive development and a paucity of phosphorus content data.

HOW LOW CAN YOU GO (REALISTICALLY)? MINIMIZING THE COST OF PRODUCING KELP OFFSHORE

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A highly realistic techno-economic analysis (TEA) was developed to assess the cost of production (COP, US $ per fresh tonne kelp) for large-scale kelp aquaculture. The TEA resolves feedbacks across structural design and response, operational requirements and decisions, site properties, and biological response. We applied the TEA to a *Saccharina latissima* farming operation at a 100m deep, 405 hectare site located 20 km offshore in the Gulf of Maine. Our *baseline* scenario included a farm previously designed for minimal structure cost normalized by production capacity and operated according to procedures typical for contemporary US-based kelp farms. Assuming "line-of-sight" farm operations, i.e. those that could be implemented with existing technologies, the structure was redesigned for minimized COP (*improved* scenario). Leveraging the TEA to balance operational and structural design choices, COP was reduced from $2,618 at *baseline* to $383 in the *improved* scenario. Primary cost reduction drivers included: (1) use of purpose-built, correctly sized vessels, (2) heavily mechanized operations, (3) at-sea processing of harvested kelp into a slurry (4) biomass storage in vessel holds, (5) structural design that minimizes loads, maximizes operational efficiency and spatial productivity, and (6) cultivation at maximal depths for site specific light penetration. *Baseline* results were most sensitive to workable wave height thresholds, vessel cruising speed, yield and distance from port. *Improved* scenario COP was most sensitive to yield, farm component lifespan, and structural costs. Results highlight that no single innovation in operations models or structural design will dictate potential COP minima for large-scale kelp farming.

OYSTER FARMS AS HABITAT: SEASONAL AND GEAR-SPECIFIC IMPACTS ON COASTAL WATERBIRD COMMUNITIES

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Oyster aquaculture is expanding rapidly in coastal ecosystems, raising questions about how farm structures and operations affect waterbirds. We evaluated responses of 32 focal species to floating and submerged oyster gear and farm activity across 47 estuarine sites in Rhode Island, USA (2020–2023). Using >3,300 standardized shore-based surveys and species-specific generalized linear mixed models, we assessed presence, abundance, and behavior in relation to aquaculture. Responses varied strongly by gear type, guild, and season. Floating arrays provided elevated roosting platforms heavily used by gulls, terns, and cormorants during post-breeding staging, and supported winter foraging for several diving ducks, though they reduced access for American Wigeon. Submerged, bottom-anchored gear coincided with reduced presence of geese and dabbling ducks, likely due to shading or obstruction of submerged vegetation and benthic foraging areas. Shorebirds and wading birds generally showed weak or neutral responses, with localized negative effects on Willets near submerged gear. Disturbance from farm activity had mixed effects: Canada Geese, Mallards, and cormorants were sometimes attracted to operations, while American Black Ducks showed modest avoidance, but overall displacement was limited. Overall, aquaculture effects are not uniformly positive or negative but a mix of trade-offs mediated by gear, siting, and season. Management that avoids vegetated shallows, clusters or elevates gear, and times operations to avoid sensitive periods can reduce conflicts while enhancing incidental habitat value. With thoughtful design and siting, oyster farming and waterbird conservation can be compatible, aligning economic and ecological goals in working coastal landscapes.

EXPERIMENTAL OFFSHORE AQUACULTRUE OF THE ATLANTIC SURFCLAM *SPISULA SOLIDISSIMA*

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The Atlantic surfclam (*Spisula solidissima*) is an economically important fisheries species in the mid-Atlantic region of the United States. Although aquaculture farms are often established in protected coastal areas, farming in the open ocean presents an opportunity to farm surfclams where space is less competitive, water quality is often higher, and where

the species naturally occurs. Here, we have collaborated with fishing industry partners to provide information about the potential for the surfclam to be cultivated at commercial scales in the open ocean. We conducted two deployments of over 300,000 hatchery reared seed-sized (15mm shell length) surfclams in fall 2023 and spring 2024 in federal waters off the coast of New Jersey. Surfclams were deployed in large steel cages (1.2 x 1.2 meters) within the seed contained within plastic mesh Hexcyls. Surfclams were stocked at three different stocking densities ranging from 266 to 1,995 clams per hexyl (average shell length 14.68 +/- 2.70 mm) in the fall, and from 118 to 880 clams per Hexcyl (average shell length: 21.74 +/- 5.3 mm) in the spring. Cages from both deployments were retrieved in August 2024. Surfclam growth rates were comparable to what would be expected in natural populations, indicating the potential for offshore aquaculture to be used for the commercial production of a steamer (10-15 cm shell length) sized surfclam product. This collaborative research effort provides information about the potential to produce surfclams in offshore aquaculture farms, in new growout areas that have environmental conditions that reflect the natural surfclam habitats.

HIDDEN THREATS: SCREENING ASSAYS SUGGEST INVOLVEMENT OF TOXINS, POLLUTANTS OR VIRUSES IN SOME BIVALVE HATCHERY LARVAL CRASHES IN THE ATLANTIC COAST

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Widespread recent increases in larval crashes in bivalve hatcheries along the Atlantic Coast of the United States showcase the need for cross-institution collaboration, standardized sampling, high throughput sample processing, and the use of a comprehensive set of diagnostic assays to identify potential causes and develop targeted management tools. The Bivalve Hatchery Health Consortium (BHHC) has developed a screening assay using healthy larvae exposed to hatchery-collected samples to identify the type of disease-causing agents that could be present in the water or larvae from hatcheries experiencing low larval performance. In 2024 and 2025, more than 30 BHHC hatcheries collected incoming water (before hatchery treatment), larval tank water, and larval samples from more than 60 production runs experiencing unusual losses, as well as from normal runs (control samples). Preliminary results from the screening of whole and size-fractionated water samples from a subset of 21 hatcheries experiencing poor larval performance indicate that causes and factors leading to the low larval performance are heterogeneous. A portion of these 21 samples of incoming and tank water caused mortality in healthy larvae after filtration through 0.22-micron filters, indicating the presence of toxin/s and/or viral agents. Results also indicate that mortality in water-exposed larvae was affected by salinity.

Additional samples are in the process of being tested using the larval screening assay. Results from these assays will be used by the BHHC pathology working group to develop more specific diagnostic tests and make management recommendations.

SPAWNING UNDER STRESS: IMPACTS OF BAY SCALLOP REPRODUCTION ON THEIR VULNERABILITIES TO HIGH TEMPERATURES AND HYPOXIA

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Atlantic bay scallops (*Argopecten irradians)* inhabit shallow estuaries along the U.S. East Coast. Shaped by a short lifespan (14–24 months) and generally limited to a single spawning event, bay scallop reproduction is energetically demanding and may increase vulnerability to elevated temperatures or low dissolved oxygen (DO). Such stressors may inhibit recovery and enhance mortality post-spawn. To evaluate the influence of reproduction on stressor sensitivities, scallops were deployed from May to September 2025 at a cool and warm site within the Maryland Coastal Bays. The average site temperature (25.7 ± 4.3°C vs 26.2 ± 4.2°C) and the cumulative hours exceeding 29°C (628 vs 681) differed between sites. Spawning windows were inferred from a Gonadosomatic Index (GSI, gonad:total tissue biomass) and occurred June 12-26 at the cool site and May 29-June 12 at the warm site. Immediately following spawning, survival declined by 15% and 45% at the cool and warm sites, respectively, with complete mortality at the warm site occurring within nine weeks post-spawn. The cool site maintained >50% survivorship throughout the deployment, and survival was significantly higher than at the warm site (ANOVA, $p<0.05$). Continuous, high-frequency monitoring also revealed increased hypoxia at the warm site, with scallops spending 13.2% of deployment time at suboptimal DO levels compared to 4.8% at the cool site. Further work quantifying time series of heat shock protein concentrations within scallop mantle tissue will be used to validate sensitivities. These results suggest exposure to elevated temperatures and/or hypoxia may accelerate post-spawning mortality in bay scallops.

EVIDENCE FOR DIRECT TRANSMISSION OF BAY SCALLOP MAROSPORIDA IN *ARGOPECTEN IRRADIANS*

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The bay scallop (*Argopecten irradians*) is a commercially, culturally, and ecologically important species naturally distributed along the Atlantic and Gulf coasts of the United States. It is emblematic in New York, where it supports a major fishery and is recognized as the official state shell. Since 2019, bay scallop populations in New York have experienced large-scale summer mortality events, resulting in over a 95% reduction in the biomass of adult, market-size individuals. Preliminary investigations into these events revealed a 100% prevalence of an apicomplexan parasite, Bay Scallop Marosporida (BSM), infecting kidney tissues, suggesting high transmission efficiency.

To investigate the mechanisms and potential pathways of intraspecific transmission, two lines of naïve bay scallops (a New York line and a North Carolina line [ESL], produced by the VIMS Eastern Shore Laboratory) were either exposed to infected kidney tissue homogenates or co-incubated with infected scallops collected from the Peconic Estuary, NY.

Results showed that BSM successfully infected both lines of naïve scallops, regardless of the exposure method. Infection occurred rapidly in naïve scallops, with BSM detectable as early as three days post-exposure. In parallel, laboratory and field investigations revealed that live, infected scallops can release BSM into the environment during excretion of waste material (via the excretory system) and during spawning. Altogether, these findings support that BSM can be released into the environment by both live and dead (via tissue degradation) infected scallops, particularly during the summer months when new scallop recruits settle to the benthos and become suitable hosts.

DEVELOPMENT OF TECHNIQUES FOR USING FECAL DNA TO QUANTIFY SALMON LICE CONSUMPTION BY LUMPFISH

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In off-shore Atlantic Salmon (*Salmo salar*) aquaculture, lumpfish (*Cyclopterus lumpus*) are used as a biological control for the parasitic salmon louse (*Lepeophtheirus salmonis*). Previous studies demonstrate that lumpfish can be selectively bred for salmon louse consumption but rely on invasive or imprecise methods to quantify the abundance of salmon lice consumed. Here we aim to investigate non-invasive means of diet quantification by using fecal DNA of lumpfish which have consumed varying quantities of salmon lice. To determine whether the amount of DNA detected is both consistent and

correlated with lice count and lifestage, lumpfish will be intubated with variable numbers of either solely adult female or a mixture of pre-adult and adult male salmon lice, as well as a standardized weight of formulated feed. To examine possible effects of sample timing and DNA degradation on DNA quantification, feces will be collected post-feed at six 12 hour intervals or after 72 hours. Extracted DNA from feces will be amplified using quantitative polymerase chain reaction (qPCR) using primers and probes designed for salmon lice and wheat, for the detection of formulated feed known to contain wheat. We anticipate to see a positive correlation between DNA detected and number of lice consumed, with minimal impact of timing on total DNA detected. Ultimately, the findings of this project would help determine whether fecal DNA is a viable means for accurately measuring consumption of target diet contents in lumpfish, or other fish species, which would be a valuable tool for selective breeding programs.

VICTORIES AND CHALLENGES FOR GROWING ALTERNATIVE SPECIES IN A COMMERCIAL OYSTER HATCHERY AND NURSERY

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Commercial shellfish aquaculture at Island Creek Oysters (ICO) has traditionally centered on Eastern oysters (*Crassostrea virginica*), however increasing interest in farm diversification highlights the need to evaluate alternative species that can be produced within an existing hatchery infrastructure. This presentation explores the victories and challenges of culturing surf clams (*Spisula solidissima*) and bay scallops (*Argopecten irradians*) in a commercial oyster hatchery setting. For both species, over the years, ICO has assessed broodstock conditioning, larval rearing requirements, early juvenile survival, and nursery grow-out techniques. These findings provide a pathway to diversification for both hatcheries and farms.

SHELL-EBRATE! BIVALVE EDUCATION FOR K-12 CLASSROOMS

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Maine has a strong and growing bivalve aquaculture sector. While the state's long standing working waterfront is facing many challenges, bivalve aquaculture provides an opportunity for the future of working waterfronts. Nevertheless, bivalve farming remains largely unknown as a career choice to young Mainers at the elementary, middle, and high school levels. Developing career aspirations early and often, and ensuring that educators have the

tools and resources to successfully teach, are integral to a successful future aquaculture workforce and sustainable rural communities in Maine. Benefits of agricultural education in the classroom have long been known: it reduces the divide between farm and table, enhances food security, increases awareness of agricultural careers, and helps to develop an informed consumer base and communities. Maine's aquaculture sector is starting to leverage these benefits too, but currently, aquaculture education depends on the interest of individual teachers, with only a limited number of educators and school districts embracing an integrated approach to incorporating aquaculture education into their curricula.

The purpose of this project was to develop and distribute a bivalve curriculum to Maine elementary, middle, and high school classrooms. The curriculum was designed to provide educators with easily accessible activities that fit within learning standards for grades K-2, 3-5, 6-8, and high school. The Maine Aquaculture Innovation Center led a cross-organizational coordinating team who each came to the effort with their own expertise and resources. Here we describe the development, implementation, and extension of this educational effort, including the creation of the bivalve curriculum, our strategy for connecting with teachers across the state, and the process of bringing bivalve education resources to Maine students.

BUILDING A ROBUST PIPELINE TO AQUACULTURE CAREERS IN MAINE THROUGH WORKFORCE DEVELOPMENT & EDUCATION INITIATIVES

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As interest in Maine aquaculture grows, there is a need for strategic development of an aquaculture education pipeline that can support a skilled and reliable workforce. To create this pipeline, education and workforce initiatives must reach people at various stages of their education, from K-8 to high school to post-secondary and workforce training. Utilizing multiple funding streams to support a suite of projects, the Maine Aquaculture Innovation Center (MAIC) has worked with partners to create a strategic portfolio of aquaculture workforce and education initiatives that reach a wide range of participants. Such projects include: developing aquaculture curriculum resources for grades 6-12 with classroom teachers, working with Washington Country Community College to bridge the high school to post-secondary gap with the Aquaculture Technology program, and collaborating with Maine Sea Grant, the Maine Aquaculture Association, and Coastal Enterprises Inc. to continue the Aquaculture in Shared Waters suite of workforce training programs. These initiatives are designed to be complementary and to target different age groups. To organize and execute these projects, MAIC works with partners across the state who are involved with aquaculture education and workforce development to ensure that programming meets state-wide industry and educational standards. Here we provide

insight into the development of this strategic portfolio of aquaculture workforce and education initiatives, including the scope of each program/project. We also discuss how these initiatives are designed to support students along a pathway toward aquaculture careers while remaining flexible to the diverse needs and interests of various individuals.

SEAWEED FOOD SAFETY GUIDANCE

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Advances in seaweed aquaculture, coupled with growing awareness of its health benefits, sustainability, and culinary versatility, have led to expanded domestic supply and the development of diverse new food products.

Like all foods, seaweed products carry potential food safety risks. However, due to the relative novelty of seaweed as a food commodity in the U.S., there is limited guidance and few seaweed-specific food safety requirements. To support safe growth of this nutritious commodity, clear national guidance is needed to identify and mitigate key food safety hazards.

A *Seaweed Food Safety Guidance* document was developed to help regulators, producers, processors, and retailers assess and manage risks associated with seaweed products in the U.S. As domestic aquaculture expands, this emerging industry offers opportunities for sustainable food production and economic growth. The guidance document can support safe practices, regulatory compliance, and consumer confidence. Building on existing national and international resources, this guide provides a flexible framework tailored to diverse species, environments, and regulations—promoting consistency and safety across regional and national markets. Authors of this guide will present selected content and answer questions.

BEHAVIORAL OBSERVATIONS, RELATIVE CONDITION, AND ESTIMATED PRODUCTION OF BLACK SEA BASS USING OYSTER AQUACULTURE CAGES AND BOULDERS AS HABITAT

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Black sea bass, *Centropristis striata,* are a temperate reef fish found in the Western Atlantic. This study uses fish behavior, condition indices and enhanced production estimates to evaluate how oyster aquaculture cages serve as artificial reefs for black sea bass relative to natural rock reefs at study sites in central Long Island Sound. We recorded underwater video on shellfish farms and a rock reef in Milford, CT to identify and quantify black sea bass behavior associated with cages and boulders. We sampled juvenile black sea bass from farms and reefs in Clinton and Milford, CT to assess relative condition factor and energy density as measures of habitat quality. We used young-of-the-year abundance data to estimate fish production enhancement provided by shellfish farms. Black sea bass demonstrated more shelter and grouping behavior on cages compared to boulders. Instances of courtship/reproduction, escape, foraging, and territorial behavior were similar across cage and boulder habitats. Measurements of relative condition factor and energy density in juvenile black sea bass showed no difference in physiological condition of fish on farms and reefs. Estimates of enhanced production of black sea bass was based on the greater abundance of young-of-the-year fish associated with oyster aquaculture cage farms relative to the natural rock reef. Our results suggest that aquaculture gear provides valuable habitat and ecosystem services for black sea bass throughout their life history, similar to other man-made structures that are considered Essential Fish Habitat.

INVESTIGATING THE USE OF SPAWN AIDS TO SYNCHRONIZE SPAWNING AND IMPROVE THE EFFICIENCY OF A BREEDING PROGRAM FOR LUMPFISH

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Lumpfish, *Cyclopetrus lumpus,* are effectively used as cleaner fish for Atlantic salmon in net pen aquaculture to reduce sea lice infection. For lumpfish to be a viable option for the industry there is a need for lumpfish breeding programs and/or a broodstock population. Lumpfish are batch spawners, meaning they spawn multiple times in a season and often at inconsistent intervals, which is not conducive to a sustainable and feasible breeding program. This study utilized Gonadotropin – Releasing Hormone analogues (GnRHa) to assess the effectiveness of their ability to synchronize spawning and shorten the spawning season. Both injections and implants were administered to female and male lumpfish at the start of the breeding season and then over the course of five weeks. Each week, plasma, mucus and ultrasounds were collected from each fish to help characterize the reproductive stage and gonadal development. Liquid chromatography tandem mass spectrometry (LC-MS/MS) was used to measure steroid hormones from three classes: pregnanes, glucocorticoids and androgens. These steroid hormone biomarkers will be correlated with the collected ultrasound images to identify reproductive status. While the exogenous GnRHa didn't induce final maturation with either implant or injection, the combination of hormones and ultrasound detailed the most comprehensive description of lumpfish maturation.

DEMOGRAPHICS, SPATIAL CONCENTRATION, AND LOCALNESS IN THE U.S. SHELLFISH AQUACULTURE INDUSTRY

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Shellfish aquaculture is increasingly promoted as a climate-resilient, low-impact, and economically valuable industry that strengthens coastal food systems and creates local jobs. As the sector grows, long-term competitiveness may depend not only on economic and environmental performance, but also on social considerations such as attracting new participants, maintaining local benefits, and preventing excessive consolidation. While these dynamics have been examined in other food and resource industries, they remain underexplored in U.S. shellfish aquaculture. To address this gap, we ask: 1) what data are collected and available regarding leaseholder demographics, spatial concentration, and localness?; 2) How do statutes and regulations shape lease distribution with respect to these themes?; and 3) What patterns emerge across coastal states? Data were obtained from public records and interviews with state managers, Sea Grant agents, farmers, and NGOs. When gender data were not collected, we estimated gender using genderize.io, an API that predicts gender from first names. Findings show that demographic data collection is limited: only Rhode Island collects gender and North Carolina collects both race and gender. Available data suggest women represent 7–25% of leaseholders across seven

states, while North Carolina data indicate participation by non-white farmers at under 5%. In three states analyzed for localness, more than 95% of leaseholders had in-state coastal county addresses. Levels of concentration vary widely, with the largest single owners holding 0.5–20% of leased acreage. States differ considerably in their approaches to localness and concentration, while devoting relatively little attention to demographics. Policy choices in these areas have important implications for the industry's trajectory, and some states provide instructive examples for those who prioritize small-scale, local ownership and broad participation.

DEVELOPMENT OF CARBON-NEGATIVE SHELLFISH FARMING TECHNOLOGIES

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Climate change increasingly threatens marine ecosystems, posing significant challenges and opportunities for the shellfish aquaculture industry. Shred Electric has developed a suite of carbon-negative technologies to reduce the environmental impact of shellfish farming operations. These include advanced battery and renewable energy kits for on-farm equipment, swappable batteries for electric outboard motors, and the ShredCube™, a solar-powered refrigerated container designed for use in electric trucks and vans. These technologies significantly reduce farming, processing, and transportation carbon intensity.

Supported by the Maine Technology Institute, the National Science Foundation, the Island Institute, and the Gulf of Maine Research Institute, Shred Electric's innovations also include solar-powered barges and float canopies, portable battery-powered haulers, winches, pumps, and self-powered refrigerated containers. The patent-pending ShredCube™ system enables cloud-based monitoring and AI-driven sea farm equipment analytics, alerting farmers to potential issues and allowing them to focus on farming activities.

Because shellfish naturally sequester carbon and mitigate ocean acidification, eliminating emissions associated with their cultivation can make shellfish aquaculture genuinely carbon negative. These scalable, industry-wide solutions highlight the potential for shellfish farming to evolve into a climate-resilient food production model. By combining renewable energy systems, electric transportation, and sustainable farming practices, Shred Electric is helping reshape the future of aquaculture while contributing to global climate mitigation efforts.

GROWOUT OF ATLANTIC SURFCLAM SEED AT INTERTIDAL SITES AROUND CAPE COD, MA

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The Atlantic surfclam is an emergent aquaculture product in the Northeast United States. Shellfish growers in Massachusetts culture surfclams to a 38.1 to 50.8 mm size. Because it is still a new product, research is needed on growout methods and locations to optimize production. Growth of juvenile surfclams at sites around Cape Cod was determined through several transplant experiments. Seed clams (wild and hatchery) were transplanted to cylindrical cages (20cm diameter, 30.5cm length), which were constructed from rigid polypropylene netting and driven ~25 cm into sandy sediment. During the first two experiments, seed were stocked at 9 per cage (278 clams m^{-2}); whereas, they were stocked at 6 per cage (185 clams m^{-2}) for the final experiment. Individual cages were covered with netting to prevent predation. From May to September 2022, wild Provincetown seed (11-20 mm) grew to 41.9, 34.7, and 31.9 mm at Dennis, Provincetown, and East Falmouth sites, respectively. From September 2022 to June 2023, a second planting of wild Provincetown seed (8-16 mm) grew to 46.1 and 37.4 mm at Provincetown and East Falmouth sites, respectively. There were low surfclam recoveries at Dennis and East Falmouth, which coincided with high temperature, sand movement, and/or low oxygen conditions. From September 2024 to June 2025, wild Provincetown seed (12-20 mm) and hatchery-produced Westport seed (15-22mm), both planted at Provincetown, grew to 44.9 and 48.1 mm, respectively. The highest growth rates during each planting indicate that sites with optimal conditions can support two harvests per year.

A DECADE OF ADVANCEMENTS IN OCEAN ACIDIFICATION MONITORING

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Ocean Acidification is of growing concern to many in the shellfish growing community and beyond. The Northeast Coastal Acidification Network (NECAN) is the leading group in the region for the synthesis and dissemination of ocean and coastal acidification information. In this workshop NECAN will bring together a panel of regional experts on observing ocean acidification as well as aquaculturists currently monitoring ocean acidification, to discuss the developments in the methods/monitoring technologies of observing ocean

acidification. Additionally, the current state of OA knowledge in the Northeast including the recent monitoring plan released by NECAN will be presented by the panelists. We will also reserve significant time to hear from the aquaculture community members in attendance directly, as to their data needs. A synthesis document of major takeaways will be produced and disseminated after this workshop to the NECAN network and workshop participants.

Panelists will include Meredith White, Director of Hatchery Operations at Atlantic Aqua Farms, Jake Kritzer, Executive Director of the Northeast Regional Association of Ocean Observing Systems, Samantha Seidlecki, University of Connecticut, and others to be announced.

DEVELOPING AN INTEGRATED SEAWEED AND GREEN SEA URCHIN AQUACULTURE MODEL IN MAINE

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Green Sea Urchins (*Strongylocentrotus droebachiensis*) are prized for their edible uni, present inside the shell of the urchin as five yellow to orangish lobes. Ideal uni has a rich, slightly sweet, mildly briny flavor that is created by the urchin's natural diet of macroalgae. Springtide Seaweed, LLC, a vertically integrated seaweed aquaculture company in Maine, is developing new mariculture farm models to integrate green sea urchins and seaweed to share infrastructure, provide feed, and develop new high-value aquaculture crops. Springtide is integrating macroalgae into every stage of urchin production, including seed production, juvenile development, on-farm growth, uni development, and harvest. The development of their commercial urchin hatchery, new culture gear, farm models, and markets will allow for a diverse range of sea farmers to incorporate sea urchins into their farms, increasing resilience, value, and diversification of the Maine aquaculture industry.

EXPERIENCES IN THE OPTIMIZATION OF MICROALGAL FEEDING SYSTEMS IN A SHELLFISH HATCHERY

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Traditionally, batch dosing microalgae into tanks from buckets and gauging the subsequent tint of the water by eye has been the go-to "quick and dirty" method for feeding shellfish in a hatchery setting. Enhancements to microalgal feeding systems are often overlooked in

favor of utilizing spare resources on more pressing and consequential hatchery operations and infrastructure. However, employing slightly more advanced systems has the potential to further optimize shellfish feeding, conserving microalgal culture and tailoring the dosing operations to the feeding behavior of the oysters.

The Northeast Oyster Breeding Center (NOBC) at the NOAA NMFS Milford Laboratory operates a full suite of hatchery systems, including static broodstock conditioning, flow-through larval rearing, and semi-recirculating setting and grow-out systems, each of which requires its own dedicated microalgal dosing system to feed the oysters. Using the experience gained throughout the past two seasons, these systems have undergone gradual improvements to both their design configurations and operational procedures, further streamlining the process of feeding the NOBC's oysters. Improvements include the addition of metering pumps, timer controls, and the use of a fluorometer to approximate the cells/mL of the systems each day, allowing for dosing operations to be precisely calibrated to the targeted ration.

Although comparatively simple in both design and operation, these systems have helped refine the NOBC's hatchery feeding operations by improving microalgal culture utilization, accommodating oyster feeding behavior, and reducing the labor required to keep oysters well-fed and growing.

INVESTIGATIONS INTO NATURAL COMPOUNDS FOR MANAGING SEA LICE, *LEPEOPHTHEIRUS SALMONIS*

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Sea lice have been a persistent pest for the salmon farming industry for the past 50 years, and economic estimates suggest a total cost to producers of approximately 9% farm gate value in recent years. The USDA National Coldwater Marine Aquaculture Center is focused on selective breeding and novel therapeutics to help the industry manage sea lice. A partnership with the National Center for Natural Products Research at the University of Mississippi has been established to screen natural compounds for their potential to kill larval sea lice.

An introductory set of 12 compounds derived from essential oils of plants listed as Generally Recognized as Safe (GRAS), were selected as likely candidates based on known interactions with other ectoparasites. Lice (n=8) in the copepodid stage were exposed in triplicate to a concentration of 20 ppm for each compound and incubated for up to 24

hours at 12°C alongside untreated controls. All 12 compounds showed effectiveness at killing copepodids with 10 of 12 compounds killing more than 50% and 7 compounds killing 100% of the copepodids within 12-24 hours. All seven compounds that demonstrated 100% effectiveness at 20ppm in 12 hours were used for additional testing at concentrations of 10, 5, and 2.5 ppm at durations of 1, 2, and 10 hours. One compound resulted in 100% copepodid mortality at a concentration as low as 2.5 ppm for 1 hour. Another two compounds showed 95% effectiveness at concentrations as low as 5 ppm for 1 hour.

MASSACHUSETTS EXAMPLES OF AQUACULTURE POLICY AS IT RELATES TO SHELLFISH AQUACULTURE SITE AVAILABILITY

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Aquaculture policy can have a broad impact on how accessible aquaculture sites are for industry development. Massachusetts is a home rule state in terms of managing shellfish aquaculture and as such each coastal town has approached shellfish aquaculture licensing a bit differently. There are examples of aquaculture development areas where the town has clearly provided access to aquaculture sites and been proactive in the permitting process. There are other examples of residency requirements, wait lists versus transfers, and a number of other nuances that are often debated in terms of accessibility while also maintaining the town's interests. Several examples will be provided for further discussion.

BIRD-RELATED PATHOGEN RISK IN SHELLFISH AQUACULTURE

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The use of floating gear in oyster farming has gained popularity because it reduces mortality rates, improves product quality, and facilitates the management of fouling. Birds see floating gear as an attractive place to roost and have been implicated in 11 outbreaks of Campylobacteriosis related to shellfish consumption nationwide since 2009.

The National Shellfish Sanitation Program (NSSP) describes the regulations for shellfish harvest, handling and distribution. The FDA, working with Industry and state regulators through the Interstate Shellfish Sanitation Conference, has devised regulations and guidance designed to ensure that commercially harvested shellfish are safe and wholesome. The NSSP requires that if aquaculture gear may attract birds or mammals, operators must provide a written operational plan that describes how to address possible contamination of shellstock and potential adverse impacts on water quality.

The 2023 revision of the NSSP provides guidance on how states can address these concerns and outlines the various approaches states can consider to minimize health risks to consumers. State authorities can consider tidal dilution and mandate resubmergence of impacted shellfish prior to harvest. Bird deterrents are mandated in many states, and a variety of novel deterrent approaches are being tested.

The ISSC has established an Aquatic Bird Risk Assessment Committee to evaluate the research needs to develop a risk assessment that will help inform regulators on how to mitigate the risk of closures and illnesses.

ASSESSING DEPURATION OF *CAMPYLOBACTER SPP.* FROM OYSTERS.

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This study investigated the depuration dynamics of *Campylobacter* spp. from oysters artificially inoculated with clinical strains to assess risks associated with floating oyster cages that provide roosting sites for waterbirds. Roosting birds can introduce *Campylobacter* via fecal contamination, creating a potential public health concern when oysters are consumed raw or undercooked. However, the natural depuration capacity of oysters for *Campylobacter* spp. remains poorly characterized.

Two controlled laboratory studies were conducted using clinical strains of *Campylobacter coli*, *C. jejuni*, and *C. lari*. In the first study, oysters were placed in tanks filled with filtered, UV-treated, temperature-controlled seawater with aeration and daily feeding. Oysters were inoculated with individual strains and a cocktail of the three strains. During inoculation, water flow was stopped for 16 hours. Samples (N=3) were collected at intervals up to 11 days. *Campylobacter* spp. was detectable in oyster tissues up to 5 days post-inoculation and was undetectable by day 9.

In the second study, oysters were inoculated with two concentrations of a *Campylobacter* cocktail for 16 hours, then transferred to tanks with fresh seawater. Samples (N=4) were collected at 1, 2, 4, and 6 days. *Campylobacter* spp. was detected in all samples after 24 hours, and in one low-concentration sample at 48 hours but was undetectable after 4 days.

Both studies confirmed the absence of *Campylobacter* in control oysters. Ongoing analysis using culture-based and molecular methods will refine our understanding of *Campylobacter* persistence, supporting informed risk management decisions for shellfish harvest and handling.

UNDERSTANDING HOW PARTICIPATORY PLANNING INFLUENCES AQUACULTURE DEVELOPMENT

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Since 2014, aquaculture in Maine has doubled in value and volume. This has increased the resilience of the working waterfront and helped increase the Maine economy. This has also created some opposition to aquaculture, partially driven by anti-aquaculture interest groups that have been pressuring coastal towns to implement moratoriums on aquaculture over concerns about the disruption of wild fisheries. When Harpswell, a Maine town with a robust fishing community, was approached by a group, they took an alternative approach. They formed an Aquaculture Working Group (AWG) tasked with finding ways to better manage the various uses of coastal waters in Harpswell in an effort to reduce tensions between aquaculture and wild-capture fishing. The AWG decided to conduct a participatory mapping exercise with the fishing community, where fishermen outlined their fishing grounds, which were then integrated into a GIS layer. The maps, though not used exclusively for making decisions related to lease or LPA decisions, could be entered as evidence during the leasing process if a prospective site were located in an area with commercial fishing. The maps could also help aquaculture farmers with site selection, thereby reducing potential conflicts with other users in the future. While in theory, the results of this exercise could help reduce conflict and streamline applications, concerns exist within the aquaculture community that the maps could be used to restrict aquaculture, hindering development. This project explores how community participation in municipal coastal planning, specifically through a coastal mapping exercise, affects aquaculture development both locally and statewide.

NAVIGATING FARMS, FISHERIES, AND COMMUNITIES: A SOCIAL-ECOLOGICAL SYSTEMS PERSPECTIVE FROM MAINE

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The resilience of coastal social-ecological systems (SES) depends on the capacity to adaptively manage interactions among diverse human uses and ecological processes. Emergent ecological phenomena can reshape the resilience of coastal human communities, yet their dynamics are often poorly understood. In Maine, oyster aquaculture has contributed to the re-emergence of wild Eastern oyster populations (*Crassostrea virginica*). Wild intertidal oysters can play a role in diversifying shellfish populations, providing both a lifeline for commercial shellfish harvesters and new opportunities for restoration-oriented management. We apply the SES framework to characterize the dynamics of this coupled aquaculture-wild fisheries system, with particular attention to the interactions that shape wild oyster population outcomes. By examining these interactions through both fisheries and restoration lenses, we identify key drivers of resilience, trade-offs, and opportunities for adaptive management. This case provides insight into how aquaculture can serve as both a catalyst for ecological recovery and a foundation for diversified fisheries. It also illustrates how SES analysis can guide place-based strategies to strengthen resilience in coupled aquaculture-wild fisheries systems facing rapid environmental and social change.

THE EFFECT OF WARMING AND OCEAN ACIDIFICATION ON THE GROWTH, DEVELOPMENT, AND SWIMMING BEHAVIOR OF SEA SCALLOP (*PLACOPECTEN MAGELLANICUS*) AND SURFCLAM (*SPISULA SOLIDISSIMA*) VELIGER LARVAE

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Ocean acidification and warming will have wide-ranging consequences for marine shellfish species, including the dispersal and success of early life stages. Sea scallops are a lucrative commercially fished species and their larval dispersal may affect the size-structure and distribution of the species population. Environmental conditions, including seawater temperature and carbonate chemistry, may alter larval transport in the ocean by modifying their vertical swimming, larval duration, and survival. We evaluated the effects of temperature and ocean acidification on the swimming behavior of surfclam and sea scallops. We assessed swimming behavior with videography and used periodic sampling to determine the percentage of larvae suspended in the water column. In sea scallop larvae, we found that warmer temperatures (17°C vs. 14°C) not only shortened the pelagic larval duration, but also altered net vertical swimming behavior. We observed a shorter pelagic

larval duration at the ambient pH (~8.0) than at the intermediate pH (7.65) representative of future ocean acidification conditions, presumably as a result of faster development and shell bioaccretion. Importantly, we found an interaction between temperature and OA on growth in the first 30 days of development, suggesting a larger influence of OA on growth in warmer conditions. We also discuss similar patterns in surfclam larval development, growth, and swimming behavior, and how these results integrate into an IBM-ROMS larval transport model. Overall, we find both temperature and ocean acidification can affect growth and timing of changes in net vertical movement of larvae, likely leading to changes in larval dispersal and settlement success.

SINK OR SWIM: EXTENSION IN ACTION

***Jaclyn Robidoux*[1], Annie Fagan[1], Barry Udelson[2], Rob Hudson[3], Danny Badger[4], Northeast Sea Grant Extension**

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Extension and outreach professionals play a critical role in supporting aquaculture communities—bridging research and farm-based practices, working alongside farmers to develop solutions, providing guidance, and fostering collaboration within the aquaculture sector. But the job often requires quick thinking, creative problem-solving, and a sense of humor when facing unexpected questions or challenges. Sound familiar?

Join us for this silly but serious-about-learning session where aquaculture extension professionals, educators, and science communicators sink or swim giving 3-minute aquaculture-related presentations they've never seen before. We'll kick the session off with a rapid-fire series of talks where presenters respond on the spot to unexpected aquaculture scenarios, testing their improv and communication skills and giving attendees a glimpse into the quick-thinking required on the job.

Following the lightning talks, a panel of extension, outreach, and communications professionals will share lessons from the field, their own experiences navigating unexpected challenges, and the occasional "oops"—providing an opportunity to learn together.

Light on "facts" but not on lessons, this session welcomes extension professionals, aquaculture and science communicators, students, applied researchers, farmers who engage with the public, and anyone who's ever had to think on their feet in the aquaculture sector. Attendees will leave with practical insights for navigating extension and

communication in a dynamic industry, a deeper appreciation of the skills it takes to excel in this field, and a few laughs along the way.

SEAWEED FARMER FORUM

Jaclyn Robidoux
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Join this farmer-focused panel session to hear directly from seaweed farmers across the Northeast about their experiences on the water and the ways they are navigating and building new opportunities in the developing seaweed sector. Farmers will share perspectives on the most current production strategies and challenges, on-farm innovations, and approaches to getting crops to market. From repurposing gear and managing small-boat family farms and cooperatives, to navigating seasonal workflows and labor, to exploring new product opportunities, panelists will provide a comprehensive look at the realities and opportunities in the Northeast seaweed industry. This session is designed for farmers considering seaweed, aquaculture practitioners, researchers, and policy professionals who want to learn directly from growers navigating a changing seaweed sector. Audience discussion will be encouraged.

BRIDGING TRADITION AND INNOVATION: RESOURCES AND INITIATIVES FROM THE MAINE SEAWEED COUNCIL FOR FARMERS

Jaclyn Robidoux
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For over three decades, the Maine Seaweed Council (MSC) has supported Maine's seaweed sector, growing from a wild harvest industry partnership into a statewide industry–community network of seaweed harvesters, farmers, researchers, and businesses. As an internationally recognized collaborative network, the Council develops resources and initiatives that foster collaboration, share knowledge, and connect decades of knowledge from Maine's long-standing wild harvest fishery and research community with its growing aquaculture industry.

This talk will examine how the MSC works as a collaborative network—what that looks like in practice, what resources are available, and the value for farmers, entrepreneurs, and researchers who engage with the Council. Participants will learn how MSC involvement offers access to trusted expertise, best practices, supply chain guidance and connections, national and international collaborations, and more.

The presentation will also highlight the *Maine Seaweed Guide*—an industry-developed, science-backed best practices manual designed to support responsible harvesting and farming. The Guide exemplifies the MSC's role in translating research and community knowledge into practical tools that strengthen the sector and advance sustainable growth through industry-science collaboration.

THE MAINE SEAWEED COUNCIL: SEAWEED COLLABORATION, INNOVATION, AND RESEARCH

***Jaclyn Robidoux*[1,2], Steve Eddy[3,4]**
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The Maine Seaweed Council (MSC) has been advancing Maine's seaweed industry for over 30 years—championing sustainable seaweed harvesting and farming, fostering public education, and bringing together harvesters, farmers, researchers, and regulators to drive responsible management and collaboration across the sector. Established in 1993 as a wild harvest industry partnership, the MSC has grown over three decades into a collaborative network of Maine's leading experts in seaweed research, product and business development, and sustainable harvest and farming practices.

This session will introduce attendees to the MSC, highlighting ongoing efforts that support seaweed farmers while strengthening the entire sector—fostering genuine partnership between emerging seaweed aquaculture and Maine's long-established wild harvest fishery. It will also showcase the Council's depth of longstanding expertise in areas such as product development, certification and standards, food safety, and collaborative reseach—areas that have long supported wild harvest in the Northeast and that are increasingly vital to seaweed aquaculture as the sector grows. As an internationally recognized collaborative network, the MSC contributes to national and global projects, extending the impact of Maine's seaweed expertise far beyond the state.

Talks in this special session will feature selected presentations from council member researchers, students, and industry, offering practical insights that are relevant to seaweed farmers and entrepreneurs. Participants will come away with a clear understanding of the Council's role and the opportunity to learn from its depth of expertise and long-standing network—resources that continue to strengthen and benefit the seaweed sector in the Northeast and across the U.S.

REDICTING LONG TERM OUTCOMES FOR THE EASTERN OYSTER *CRASSOSTREA VIRGINICA* USING GENETIC COMPOSITION AND ENVIRONMENTAL HISTORY

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The Eastern Oyster, *Crassostrea virginica*, is a critical species that has historically provided major societal and ecosystem benefits. These benefits have been threatened by large declines in wild oyster populations in recent decades, sparking many conservation and restoration efforts aimed at combatting this decline. Local genotypes are often sourced for these efforts, but it remains unclear whether using genetic and environmental history to identify potential donors is a viable sourcing strategy. Here, I investigate how survival of six wild populations of *C. virginica* vary between two experimental sites distributed across a salinity and disease gradient in the Chesapeake Bay, and whether this differential survival can be predicted by integrating genetic composition and environmental history of experimental oysters. I find that survival is generally higher in populations from the Gulf and lower in populations from the Northeast US, though performance varies between experimental sites. Survival is predicted by factors like genetic diversity and historic exposure to different environmental regimes, but integrating these genetic and environmental data does not always predict performance well. These results suggest that both genetic and environmental history play a role in determining oyster fitness, but point to a need for improved methods integrating these data to predict long term outcomes. This work contributes to a growing body of literature investigating the utility of genetics in informing strategies for sourcing seed for aquaculture and restoration purposes, particularly in the Chesapeake Bay.

WHO SHOULD I TRUST? ASSESSING DETERMINANTS OF PUBLIC CONFIDENCE IN DIFFERENT SOURCES OF INFORMATION ABOUT AQUACULTURE AND SEAFOOD SAFETY IN MAINE

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The public is increasingly uneasy about seafood safety and uncertain about where to look for reliable information about aquaculture, and these doubts have implications for aquaculture enterprises and policy makers. Existing studies suggest confidence in the authorities tasked with overseeing seafood safety is declining, leaving the public unsure about who to turn to for information. We investigate these topics to identify factors that influence trust in different providers of information about aquaculture and confidence in actors tasked with ensuring seafood safety. Data comes from the June 2023 Pine Tree State Poll in Maine. Logit regression was used to establish to what extent beliefs about seafood

safety and aquaculture information sources relate to demographic characteristics as well as views about science and scientists. Results show a sizable segment of the public lack confidence in government agencies tasked with seafood safety, and similarly, many have limited trust in government as a source for aquaculture information. While most individuals trust sea farmers and scientists for information there is variation. Political ideology, views about the integrity of science, as well as gender, age, education, and regular religious attendance shape confidence about seafood safety and perceptions of the reliability of different sources for aquaculture information. These results highlight key variables linked to public trust and confidence; however, more importantly, they point to factors that may be shaping seafood consumption and public acceptance of aquaculture development that need to be further investigated.

3D-COAST SYSTEM (3-DIMENSIONAL CULTIVATION OF OYSTERS AUTOMATED WITH SOLAR TUMBLING)

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TWIYO is developing a 3D oyster cultivation raft that incorporates automated, solar-powered, cleaning and tumbling of the oysters. On 3D-COAST rafts TWIYO hangs oyster baskets on vertical, rotating, conveyor belt-like mechanisms that cycle the baskets through the water column and into the air. The cycling will provide tumbling to improve oyster shape and quality, and the cages will be exposed periodically at the top of the cycle for killing bio-fouling. 3D-COAST is an important new tool, increasing growing density by using the 3D water column, eliminating costs of manual cleaning and tumbling, and improving oyster quality with constant motion and cleaning. This will lower the barrier to entry for new farmers, improve current farm profit margins and production volumes, and reduce social tensions among various water users through smaller farms.

LESSONS LEARNED IN EFFICIENCY: INSIGHTS FROM A NON-PROFIT SHELLFISH HATCHERY

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With growing demand for sustainable, nutrient-rich food and changing environmental conditions, hatchery-produced bivalve shellfish seed is an increasingly important product in the U.S. Downeast Institute's non-profit Center for Shellfish Production is well-positioned to investigate and implement efficiencies that maximize production while reducing labor and operating costs. This presentation will highlight several of the systems we have refined over the years, with economic comparisons to earlier approaches to show how crucial these efficiencies have been, as well as the potential for technology transfer to other hatcheries. Because microalgae production is the most critical and expensive aspect of hatchery operations, incorporating efficiencies such as semi-continuous cultures into mass culture production has been critical in reducing electricity use and labor. In animal culture systems, flow-through tanks allow us to maintain higher animal densities within the same footprint than static systems, significantly reducing labor. We have also integrated energy recovery systems via effluent-water heat exchangers, decreasing the electricity required to heat incoming water. Together, these measures demonstrate practical and reproducible ways to lower costs and increase output in hatchery operations.

SINGLE-CELL ANALYSIS REVEALS MOLECULAR MECHANISMS OF TRANSMISSIBLE CANCER IN QUAHOG (*MERCENARIA MERCENARIA)*

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Disseminated neoplasia (DN), a transmissible cancer affecting bivalves, poses a significant threat to both wild and aquaculture populations of hard clam (*Mercenaria mercenaria*), particularly along the U.S. Atlantic coast. To investigate the molecular mechanisms underlying DN, we conducted single-cell RNA sequencing of hemocytes from neoplastic and healthy clams. Cohabitation experiments exposing healthy clams to neoplastic clams confirmed successful transmission of the disease. Hemocytes were then collected from healthy, neoplastic and exposed individuals and processed using the 10x Genomics Chromium platform.

Clustering of hemocytes revealed nine distinct populations, with one cluster predominantly composed of cells from neoplastic samples. KEGG enrichment analysis showed that this neoplastic cluster exhibited downregulation of pathways related to phagosome formation, endocytosis, ubiquitin-mediated proteolysis, and FoxO signaling, suggesting potential

mechanisms of immune evasion and resistance to apoptosis. Further, weighted gene co-expression network analysis within this cluster uncovered six gene modules, three of which were highly expressed in neoplastic cells. These modules were enriched for genes associated with DNA replication, Wnt, TGF-β, and Notch signaling pathways, alongside metabolic functions, suggesting a role in metabolic reprogramming and the activation of growth and survival signaling networks.

Together, these findings suggest that neoplastic cells in hard clams have significant molecular differences that support uncontrolled growth and survival. This study provides new insights into the mechanisms of disseminated neoplasia and identifies potential molecular targets for future research and disease management in aquaculture.

MULTI-STRAIN PROBIOTIC COCKTAIL IMPROVES BIVALVE LARVAL RESILIENCE AGAINST HATCHERY PATHOGENS

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Larval crashes are a significant challenge in bivalve aquaculture, yet their causes remain poorly understood and difficult to predict. These crashes limit productivity, particularly during the vulnerable larval stage, highlighting the need for effective interventions. To address this, we aimed to isolate and characterize bacterial strains from bivalve (eastern oyster, *Crassostrea virginica,* and quahog, *Mercenaria mercenaria*) larvae with diverse probiotic traits and evaluate their safety and efficacy, ultimately developing a multi-strain probiotic cocktail to improve larval survival.

A total of 168 bacterial strains representing 22 genera were isolated and identified from bivalve larval samples from hatcheries on the Atlantic coast of the USA. The isolates were screened for antimicrobial activity, hemolytic activity, biofilm formation, and quorum quenching potential. Four potential probiotic candidates (*Algoriphagus yeomjeoni* DEN5, *Glutamicibacter soli* CLAM16, *Pseudooceanicola nitratireducens* NEH7, and *Marinomonas gallaica* CLAM9) were selected for their combined probiotic properties. Safety assessments of these strains showed no pathogenic effects on the larvae, with treated larvae exhibiting comparable or improved survival compared to controls. Individual probiotic treatments improved larval survival when challenged with *Vibrio coralliilyticus* RE22 and *Aliiroseovarius crassostreae* CV919-312. Multi-strain probiotic cocktails significantly increased larval survival compared to controls, with the complete consortium outperforming *Phaeobacter inhibens*

S4 alone. Furthermore, the cocktail improved the survival of larvae challenged with diverse marine pathogens recently isolated from hatchery crashes.

This study highlights the importance of comprehensive screening to identify probiotic candidates with broad functional traits, thereby providing a basis for practical multi-strain probiotic applications in bivalve hatcheries to enhance larval resilience.

FIELD PERFORMANCE EVALUATION OF SELECTIVELY BRED EASTERN OYSTER LINES IN NEW JERSEY AND RHODE ISLAND

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Eastern oyster aquaculture has increased steadily over the last three decades, but the industry has yet to achieve its full potential. In the Northeast USA, production is limited in part by a lack of high performing stocks suited to the geographically broad and heterogenous growing environments. For this study, hatchery lines from Maine, New York, and New Jersey as well as crosses between each hatchery line and the selectively bred Northeast high survival (NEH®) line, were deployed at oyster farms in Rhode Island and New Jersey for performance evaluation. Oyster survival and growth were monitored for 16 months. At 5, 9, 13, and 16 months post-spawn, mortality and growth were recorded to track survival and growth trajectories. In addition, a subsample of seed from each line were tested for parasites *Perkinsus marinus* (Dermo) and *Haplosporidium nelsoni* (MSX) to assess the extent of disease exposure observed at the Rhode Island site. Performance of all lines within each site was compared and statistically significant line effects on both growth and mortality were detected. Comparisons of each line between sites also resulted in statistically significant differences in growth and mortality. Lastly, contrasting top performing lines were observed both with respect to mortality and growth between each site indicating strong genotype by environment (GxE) interactions. This research will inform future breeding efforts in the Northeast and ultimately by providing help industry identify optimally performing seed for the region.

TEMPERATURE EFFECTS ON BAY SCALLOP MAROSPORIDA (BSM) DYNAMICS IN *ARGOPECTEN IRRADIANS*

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The bay scallop *Argopecten irradians* has supported an important fishery in New York since the mid-1800s, but has gone through some drastic population fluctuations due to eelgrass wasting disease, harmful algal blooms, and more recently an apicomplexan parasite provisionally dubbed Bay Scallop Marosporida (BSM). BSM infections were shown to be strongly seasonal, with extensive scallop mortality during summer and early fall.

This study examined the impact of temperature on disease development and scallop survival by exposing scallops to five different temperature regimes. These included ambient seawater temperature, an early spring temperature held constantly at 14℃, a heat wave scenario, a heat shock, and a shortened summer scenario. Disease development was monitored every two to three weeks by quantifying BSM in scallop tissues. All scallops were initially acclimated at 20℃, excluding the 14℃ scallops, and then temperatures were altered over the next 70 days to implement the different temperature regimes. In addition, water and biodeposits were also collected to quantify parasite release into the surrounding environment by qPCR.

Results underlined a major effect of temperature on disease dynamics and scallop health. Specifically, scallops subjected to heat waves displayed rapid increases in BSM loads and maximal mortality. Coupling BSM load and mortality also indicated that temperature stress exacerbates the condition of heavily infected scallops, leading to severe mortalities, while infected scallops may be able to survive if maintained under favorable temperature levels. These findings have implications for the risk of disease outbreaks in other northeastern states under future climate conditions.

CONTRASTING THE PERFORMANCE OF TRADITIONALLY- AND GENOMICALLY-SELECTED LINES OF EASTERN OYSTER IN NEW YORK

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The eastern oyster, *Crassostrea virginica*, is a commercially important species and supports one of the fastest growing aquaculture industries in the U.S. Traditional selective breeding has been used for decades to produce superior stocks and improve yield. For example, Rutgers University's Northeast High Survival (NEH®) line has been developed and shows marked resistance to some enzootic infections. Recent advances in genomics have provided the aquaculture industry with new tools to advance selective breeding at a much faster pace than traditional breeding.

In this study, we compared traditionally-selected oyster lines derived from local stocks, crossed or not with NEH®, with genomically-selected lines derived from a F1 Delaware Bay wild stock. A total of nine oyster lines were produced and evaluated, consisting of three purebred lines (including NEH®), two hybrid lines (local lines crossed with NEH®), and three genomically-selected lines including two up-selected for resistance to dermo disease (*Perkinsus marinus*), one down-selected for dermo disease. Spat was deployed in Napeague Harbor, NY in summer 2023 and was monitored quarterly to assess performance. At the conclusion of the 2-year study, traditionally-selected oysters showed the highest weight and shell growth and lowest mortality, while all lines derived from Delaware Bay suffered early high mortalities due to *Roseovarius* Oyster Disease (ROD, a.k.a. JOD). Although data processing is still ongoing, preliminary results suggest that the pure lines of the local strains grew better than their NEH® hybrids. These results are important for efforts aimed at optimizing breeding strategies in support of the oyster industry.

AQUACULTURE PATHWAYS: MEETING TODAY'S NEEDS, BUILDING TOMORROW'S WORKFORCE

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Washington County Community College's Aquaculture Technology program is designed to serve Maine's aquaculture industry both now and into the future. As the state's first one-year certificate and two-year associate degree pathways, the program blends online coursework with hands-on training in hatcheries, farms, and coastal operations. Students gain practical skills in aquatic animal health, biosecurity, water quality monitoring, and system operations—preparing them to step immediately into critical technician and operator roles.

At the same time, the program looks ahead by building a sustainable workforce pipeline. Through registered apprenticeship and pre-apprenticeship, employer partnerships, and

applied learning opportunities, WCCC connects students directly with industry leaders, ensuring graduates are prepared to grow with evolving technologies and practices.

This session will highlight how the program supports industry needs today while cultivating the next generation of aquaculture professionals. Participants will learn how to engage with WCCC's Aquaculture Technology program, shape training to align with workforce demands, and benefit from graduates ready to strengthen Maine's working waterfront.

CONNECTING SEA GRANT, THE NATIONAL CENTERS FOR COASTAL OCEAN SCIENCES, AND COASTAL-OCEAN COMMUNITIES TO IMPROVE SUSTAINABLE AQUACULTURE DEVELOPMENT AND SITING PROCESSES

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Careful farm siting and planning are one way to contribute to the sustainable growth of aquaculture in the U.S., especially in crowded coastal and marine spaces. The Marine Spatial Ecology Division at the National Centers for Coastal Ocean Sciences (NCCOS) at the National Ocean and Atmospheric Administration have developed tools and resources that begin to address the complex needs of interested groups using coastal-ocean spaces, especially for aquaculture. Through conversations centered around aquaculture planning tools, Maryland Sea Grant and partners hosted six collaborative, regionally tailored workshops over four years located in the Mid-Atlantic, Gulf, California, Alaska, Hawai'i, and New England to connect the Sea Grant Network, NCCOS, aquaculture extension specialists, and other coastal-ocean groups. We aimed to 1) extend, and receive feedback on, NCCOS aquaculture planning resources, 2) increase connections and collaborations with a wide variety of interested parties, and 3) advance aquaculture siting conversations with summary reports citing key themes and findings in each region. Through the workshops, regional differences and similarities were identified as participants discussed needs related to aquaculture tool delivery, accessibility, data transparency, and functionalities. The

discussions in each region were influenced by local concerns or events impacting aquaculture growth, like social license challenges or level of offshore aquaculture activity and conversations. Similarly, data suggestions differed depending on regional oceanographic or environmental concerns, like harmful algal blooms or storm surge. Additionally, participants reflected on their present engagement with various communities in coastal and marine spaces to identify groups that need to be brought into the discussions.

COLLABORATIVE COMMUNITY-SCIENCE TO QUANTIFY HABITAT ECOSYSTEM SERVICES IN OYSTER AQUACULTURE

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Oyster aquaculture is traditionally valued for its food production and economic benefits, yet its capacity to provide habitat ecosystem services remains underexplored. This project aims to quantify biodiversity and behavioral interactions associated with oyster farms through an integrative community-science framework that embeds farmers as active participants. We deployed GoPro cameras on oyster farm gear across multiple lease sites to record underwater footage of fish and invertebrate species engaging with aquaculture structures (e.g., foraging, refuge use, transit). Concurrently, participating oyster farmers submitted structured observational surveys ("lookbooks") listing species they routinely observe, offering validation and local ecological insight. Video footage was analyzed to derive metrics of species richness, relative abundance, and behavioral frequencies per site and gear type. Preliminary analyses reveal that oyster farm structures host a taxonomically diverse assemblage of benthic invertebrates and small demersal fishes. Farmer surveys aligned closely with video detections for commonly observed taxa, demonstrating the value of combining practitioner knowledge with sensor data. Together, these results indicate oyster farms can function as engineered habitats contributing to local biodiversity and ecosystem function. By centering community science and farmer engagement, this work offers a scalable model for integrating ecological monitoring into commercial aquaculture operations and informing habitat-inclusive management practices.

GROWTH AND SURVIVAL OF TWO POPULATIONS OF SURFCLAMS FROM HATCHERY TO HARVEST

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The offshore US Atlantic surfclam (*Spisula solidissima solidissima*) fishery is an economically important industry for coastal communities from Virginia to Massachusetts, generating $20 to $30 million of revenue yearly for the harvest of adults, however juvenile surfclams have recently gained popularity in the aquaculture domain. Marketed as “New England Butter Clams,” juveniles can reach harvest size in one year or less. An important factor to consider is the selection of broodstock that are capable of producing seed suited for growth in near-shore aquaculture sites. Two partially sympatric but genetically-distinct populations of the Atlantic surfclam have been identified in New York and Massachusetts waters which may be growing differently, even when occupying the same habitat. To understand the differences in these subpopulations, a larval experiment was designed to test the survival, growth, and settlement of each population and a hybrid cross. Larvae were reared in five different pH treatments to see differences in response to the varying ocean acidification conditions they may experience in coastal New England waters. Additionally, seed from both populations were grown in a reciprocal transplant experiment at two sites in Massachusetts, and their growth and condition measured throughout a year. Growth data from fertilization to settlement and then juvenile out planting will be presented. By understanding the range of environmental conditions suitable to existing surfclam populations, we aim to help “butter clam” farmers identify the best populations of broodstock for their businesses.

DO SOUND-BASED DETERRENTS PREVENT GULLS AND TERNS FROM ROOSTING ON FLOATING OYSTER GEAR?

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Campylobacter jejuni is a bacterium that causes food poisoning when ingested. *C. jejuni* poisoning is a cause of concern for oyster farmers, as infected seabirds roosting and defecating on floating oyster gear can contaminate oysters. To prevent this contamination, oyster farmers can deploy physical deterrents to prevent birds from roosting. However, these deterrents are not always effective, and new ways to protect farms are being explored. In summer 2025, we partnered with an oyster farm on the south shore of Massachusetts that employed a sound-based deterrent targeting gulls and terns, in an attempt to prevent them from roosting. In order to test its efficacy, I conducted a total of 15 bird surveys on 4 separate days over the course of 3 months (Jul-Sep), counting the birds through binoculars from within the farm on a boat. I kept the deterrent off in the morning and turned it on in the afternoon. The results of these surveys suggest that the deterrent had no significant effect on gull landings, and a slight effect on terns. However, the deterrent was always turned on in the afternoons and bird activity is known to vary based on time of day calling our results into question. Additionally, adverse weather conditions and disruptions caused by farming activities may have contributed to lower bird numbers.

In the future, more surveys should be taken to provide a larger set of data and proper controls such as surveys conducted in the afternoon with the deterrent off should be used.

TOUGH WORK, SMART MOVES; CARING FOR THE BODY IN COASTAL AQUACULTURE

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Commercial fishing and aquaculture demand strength, endurance, and resilience, yet the toll on the body and mind is often invisible until it becomes overwhelming. Shellfish and seaweed growers, fishermen, and their families face unique challenges as repetitive strain, heavy gear, and unpredictable ocean conditions accumulate over time. These stresses are compounded by the realities of aging, chronic illness, injury, and the mental health burdens that come with sustaining livelihoods from the sea.

This session brings together perspectives from Maine AgrAbility's FishAbility Program, the Maine Coast Fishermen's Association, and Labor-Movement to share practical strategies that address both physical and mental well-being in working waterfront communities. Participants will learn approaches to reduce wear and tear, build strength for longevity, and support bodies in adapting to the changing demands of gear, seasons, and shifting oceans. Attention will also be given to the broader systems of support fishermen need, from assistive technology, access to movement health resources to advocacy for mental health care and community-based solutions.

By framing fishermen, aquaculture growers, and other industrial workers as "industrial athletes," this session underscores the importance of movement, recovery, and long-term sustainability in physically demanding careers. Attendees will gain tools they can adapt to their own outreach, training, or healthcare practices, as well as insight into the resilience and innovation already present within fishing communities. Together, we explore how movement, wellness, and community partnerships can help ensure that those who feed our coastal regions can continue to work safely, productively, and with dignity.

SAFE AND SUSTAINABLE AQUACULTURE WORK SAFETY

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The Maine AgrAbility Project, funded through the USDA's National Institute of Food and Agriculture, addresses health, safety, and the prevention of injuries across Maine's working landscapes—on the farm, in the forest, and on the water. Through its FishAbility program, Maine AgrAbility provides direct services to fishermen and aquaculture growers, helping them navigate the challenges of acute injury, chronic pain, or the natural process of aging.

This presentation will highlight how AgrAbility assists owners, operators, employees, and family members of farm, fishing, and forestry businesses by offering ergonomic assessments, assistive technology recommendations, and movement strategies designed to accommodate disabilities and limitations and to prevent secondary injury. In addition to one-on-one support, the program provides training and education to health care providers, agricultural professionals, and community organizations about the realities of working with a disability in physically demanding industries.

By combining practical solutions with resource networking, AgrAbility ensures that fishermen, farmers, and forest workers can remain safe, productive, and resilient in their work—strengthening both individual livelihoods and the communities they support.

VALUES, RISKS, AND TRUST: UNDERSTANDING DETERMINANTS OF STAGE PROGRESSION WITHIN THE SOCIAL LICENSE TO OPERATE FRAMEWORK

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Environmental threats and rising consumer demand pose challenges for the U.S. seafood industry. Recirculating aquaculture systems (RAS), a land-based technology for cultivating aquatic organisms, offer sustainable solutions but face stakeholder opposition. This opposition is shaped by social license to operate (SLO)—the informal judgment of an industry's right to proceed—driven by values, risk perceptions, and trust. While SLO is often depicted as a developmental stage model, little empirical work has tested it, and none within the RAS context.

This study builds on prior qualitative and quantitative work by the authors, focusing on contemporary RAS development in U.S. communities. Using an online survey with embedded experiments, 2,200 U.S. residents evaluated vignettes depicting a hypothetical RAS facility. The research tested how values, trust, and risk perceptions influence SLO progression across critical stages of engagement and permitting. Structural equation modeling (SEM) was used to analyze how values and perceptions shaped responses to the vignettes, and how SLO thresholds build on one another.

Preliminary results show that perceptions of environmental and economic benefits, along with cultural cognition, significantly affect SLO, though only in specific contexts. Threshold effects between SLO stages also emerged, suggesting SLO is dynamic and evolves as development proceeds. These findings highlight the need for adaptive, context-specific engagement strategies by RAS developers. Ultimately, this work provides decision-makers—including industry professionals, municipalities, extension agents, and regulators—with evidence-based guidance for stakeholder engagement, strengthening relationships and supporting equitable domestic RAS development.

EVALUATING MECHANIZED OUTPLANTING AND SEEDING METHODS FOR SUGAR KELP (*SACCHARINA LATISSIMA*) AQUACULTURE IN THE GULF OF MAINE

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Farming of sugar kelp, *Saccharina latissima,* is a low-cost, sustainable alternative to terrestrial farming. The recent growth of this industry in the United States has emphasized the need for more efficient processes on both a nursery and farm scale. A machine, made and utilized for large-scale commercial kelp production in South Korea, fastens seeded twine to a grow line, reducing time spent outplanting. We aim to investigate the utility and effectiveness of this machine for seaweed farms in the Gulf of Maine. In a first set of trials, we will outplant *S. latissima* onto grow lines by machine and compare biomass and growth rates to lines outplanted by hand. In a second set of trials, we will seed twine with *S. latissima* gametophytes and compare seed coverage and biomass to twine settled with zoospores. Both outplanting and seeding methods will be analyzed for cost of production using a techno-economic analysis model. Novel farming methods have the potential to optimize seaweed aquaculture and expand production in the Gulf of Maine.

FROM NARRATIVES TO DATA: USING ORAL HISTORIES TO UNDERSTAND CLIMATE ADAPTATION IN AQUACULTURE

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The rapid growth of aquaculture in Maine presents opportunities to diversify the state's seafood industry and workforce, while also contributing to local climate resilience. Yet aquaculturists themselves are increasingly experiencing the impacts of climate change, from warming waters and ocean acidification to extreme weather events. We conducted fifteen oral histories with owner-operated aquaculturists along the coast of Maine, including women and new entrants to the sector, to document their lived experiences of climate change and the emergent adaptation strategies they are implementing. By combining qualitative analysis with innovative data science approaches, we identify common climate impacts, adaptation needs, and promising practices for building resilience in Maine's owner-operated aquaculture community. Our initial findings suggest that most aquaculturists recognize the need for climate adaptation and are already modifying their practices to respond to challenges, including an increase in biofouling, Vibrio closures, invasive species, and storms with limited external support. Common responses to these challenges include leveraging formal organizations and informal social networks, technological changes, or modifying farm processes.

In this presentation, we share preliminary insights from our mixed-methods analysis and invite feedback from the aquaculture community on our findings and potential next steps. Our aim is to translate these insights, along with input from the sector, into practical and accessible resources that can support ongoing learning and climate adaptation within the industry. This presentation represents the first step in engaging participants in a dialogue towards co-developing strategies that enhance the capacity of aquaculturists to respond to a changing climate.

OPTIMIZING VEGETATIVE SCALING OF MULTI ANNUAL DELAYED *SACCHARINA LATISSIMA* GAMETOPHYTES IN A REPLICATED PHOTOBIOREACTOR SYSTEM

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Development of a gametophyte-based nursery system for production of sugar kelp (*Saccharina latissima*) seed is a potential way to defray risks associated with the zoospore settlement based model widely utilized at present. Gametophyte nurseries would eliminate the risks of annual dependence on declining wild populations for broodstock and allow for cultivar development through selective breeding. However, doing so necessitates long term maintenance of clean cultures (termed Multi-Annual Delayed or MAD gametophytes) coupled with rapid vegetative scaling of germplasm that is laborious and slow using static batch-culture techniques. Photobioreactor systems offer the promise of the ability to scale

gametophytes with greater control over and monitoring of critical environment parameters. This study seeks to optimize vegetative biomass growth of MAD *S. latissima* gametophytes through understanding the impacts of and interactions between key culture variables: pH, temperature, and light intensity. Two, one-way trials each were run for both male and female gametophyte cultures in 16 replicated 2L photobioreactors standardized across two locations; the University of Maine's Darling Marine Center, and the Woods Hole Oceanographic Institution. Temperature (12 & 15C) and pH (7.6 & 8) were held as discrete independent variables and red light intensity (9.5-50 umol/m^2/s) as a continuous independent variable. Results and future experimentation plans will be discussed.

TESTING OFFSHORE DEEP-WATER CULTIVATION OF SUGAR KELP (*SACHARINA LATISSIMA)* IN THE GULF OF MAINE

***Adam St. Gelais*[1], Zachary Moscicki[2], Sara Lacourciere[1], Nathaniel Baker[2], Tobias Dewhurst[2], Damian C. Brady[1,3]**

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When accessing large scale seaweed markets for feed, refined ingredients, biostimulants, biomaterials or other industrial applications, the ability to farm sugar kelp *Saccharina latissima* in deep-water, exposed, or offshore conditions in the Gulf of Maine (GOM) may become important. To test the feasibility of offshore, deep-water cultivation we established a test site in Maine state waters 4.5km off the shore of Monhegan Island. Situated more than 20km from the mainland, with a water depth of 100m, it is one of the deepest, exposed, and furthest from mainland seaweed farm sites in the world. The pilot-scale farm structure, deployed from a 42' open stern commercial lobstering vessel, utilizes light weight drag embedment anchors and a chain catenary mooring system with 120m of cultivation line. We sought to understand the logistics of working and maintaining farm sites in open ocean conditions, identify optimal cultivation depth, assess crop performance, as well as testing low-cost telemetered or remotely operated technologies for farm and crop monitoring. The farm was deployed Nov. 20 2024 and harvested May 27, 2025. Cultivation lines were set on an angle starting at 10m depth, rising to 2m depth on both sides of the longline to allow for assessment of differing cultivation depths. At harvest, mean yield 2m depth was 12.25kg wet weight/m cultivation line. Yield declined linearly with depth to 3.45kg wwt/m at 10m depth. Results suggest that cultivation depth at this offshore site could be dropped from 2m to 5-6m with <10% decline in overall yield.

OPTIMIZATION OF METHODS FOR MICROPLASTIC EXTRACTION AND QUANTIFICATION FROM FARMED OYSTERS

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Microplastics (<5 mm) are prevalent throughout the global hydrosphere and are ingested by filter feeding organisms (e.g. oysters, mussels, clams) important to ecosystem services and the "blue" economy. Microplastics, because of their small size and abundance, can accumulate in the food web. Though most marine microplastic production and loading originates from land-based sources, there is question as to whether modern plastic-based aquatic cultivation gear exacerbate the presence and accumulation of microplastics within the aquatic products. Particularly, is there a difference in the microplastic concentrations found in oysters raised in traditional plastic-based gear and oysters raised in novel plastic-free gear? This research aims to understand the effect that farm gear material has on the concentration of microplastics in oyster tissue. While the reduction of plastic pollution is crucial for all organisms and ecosystems, there is greater stress on addressing the impacts on farmed species due to their purpose as aqua-farm-to-table products. The sample oysters are cultivated within traditional and non-plastic gears pioneered by the Deer Isle Oyster Company (Stonington, ME). Additionally, this research aims to advance methodology for detection of microplastics in oysters. Extraction and quantification of the microplastics occurs in three laboratory steps: chemical tissue digestion, filtration for collection of the particles, and both visual and chemical analysis of the filters. One limitation of the current visual analysis is that it lacks certainty in plastic particle identification. Ongoing work focuses on methodology development to ensure accurate and precise quantification of ambient microplastic loading in oysters.

THE SOUND SCHOOL SHELLFISH HATCHERY: UTILIZING A SHELLFISH HATCHERY IN A HIGH SCHOOL SETTING TO DEVELOP WORKFORCE SKILLS AND SUPPORT LOCAL FARMS IN CONNECTICUT

***Leila Strebel*, Alysa Mullen**
The Sound School Regional Aquaculture Center, 17 Sea St, New Haven, CT 06516 USA

Connecticut's shellfish industry continues to grow and be an important part of local economies and ecosystems throughout the state. The Sound School, a public high school in New Haven, CT, aims to serve students, the aquaculture workforce, local shellfish farms and commissions through its aquaculture curriculum and 5,000 square foot aquaculture production lab. Students are fully immersed in a functioning shellfish hatchery designed to develop both technical and soft skills, such as commitment and responsibility, with the goal of cultivating the next generation of aquaculturists in Connecticut. The hatchery includes a

broodstock holding system, larval rearing tanks, post-set systems, and a micro-algae production lab. Students actively participate in all stages of hatchery operations, from collecting broodstock to visiting farms where the seed is sent. The Sound School also serves as a seed source for small farms in Connecticut and is currently the state's only public hatchery selling seed to farms. To continue providing high-quality education, workforce development, and support to local farms, it is essential to improve and expand hatchery technology. Future goals for the lab include developing more partnerships with Connecticut farms, expanding the hatchery capacity, and improving technology specifically for microalgae production. Achieving these goals will equip students with industry-aligned skills and technology experience needed to become valuable employees in aquaculture facilities, while allowing the hatchery to increase seed production and serve more farms across Connecticut.

HIGH-SPEED IMAGING MICROSCOPY IN SHELLFISH HATCHERY RESEARCH

***Savannah Stresser*[1], Dave Veilleux[2], Mike Acquafredda[3], Tessa Houston[4], Meredith White[5]**
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Flow imaging microscopy (FIM) has been used in biological oceanography for over two decades to image, count, measure, and classify plankton. More recently, FIM has also been applied to shellfish hatchery research to increase throughput and enrich data collection, enabling researchers to collect more data on every larva than previously possible. However, protocols for how to use FIM in a hatchery context are not yet common knowledge. This presentation will describe FIM protocols being developed using FlowCam and explore how imaging data supports the enumeration and evaluation of shellfish larvae. Adjacent applications like phytoplankton monitoring will also be discussed.

INTEGRATING GRAZING ATLANTIC PURPLE SEA URCHINS WITH EASTERN OYSTERS TO REDUCE BIOFOULING: RECENT SUCCESSFUL RESEARCH AND NEXT STEPS.

***Coleen Suckling*, Christopher Jenkins, Karen Alldridge**
Department of Fisheries, Animal, and Veterinary Science, University of Rhode Island, 6 Rhody Ram Way, Kingston, RI 02881, USA

Nuisance biofouling in shellfish aquaculture production requires large intervention efforts, and farmer costs. In some areas, these farm activities have received opposition from

sectors of the public concerned about the impacts on coastal aesthetics or property values which can limit aquaculture's social carrying capacity. One potential solution that could help address these concerns is to integrate sea urchins with shellfish. Sea urchins can actively feed by grazing upon the biofouling that develops on aquaculture gear and/or the external shell surface of shellfish. In parts of the US, this integrated approach could help expand the emerging aquaculture sectors of sea urchin production as well as creating further economic opportunity for shellfish growers. We will highlight a recent case study which integrated Eastern Oysters (*Crassostrea virginica*) with the underutilized Atlantic Purple Sea Urchin (*Arbacia punctulata*) grown in bottom oyster bags and cages in a Rhode Island coastal pond farm. We will present the encouraging results of this small-scale study and discuss ongoing efforts to advance this integrated aquaculture model.

WHY SELECTION MATTERS IN SEAWEED AQUACULTURE

***Thew Suskiewicz*, Cara Blaine**
Atlantic Sea Farms, 20 Pomerleau St, Biddeford, ME 04005 US

Atlantic Sea Farms, in partnership with the Lindell Lab at Woods Hole Oceanographic Institution, outplanted representative sections of sugar kelp (*Saccharina latissima)* derived from six different natural beds in Maine, side-by-side in a common garden experiment. The results of this growth trial highlight the drastic morphological differences between members of the same species and the phenotypic diversity in the Gulf of Maine. How can these phenotypic differences be used to get optimal harvests targeted for specific products? This demonstrates that an effective selection strategy can start at the large sporophyte level while collecting parental material. We are working to preserve these wild phenotypes in culture and are documenting their performance year over year at multiple farms. Ongoing and future efforts include the genotyping of each to improve the predictability of a harvest from a particular outplant.

INDUSTRY PERSPECTIVES ON SEA LICE CONTROL IN SALMON AQUACULTURE

Andrew Swanson
Cooke Inc., 669 Main St, Blacks Harbour, NB E5H 1R4, CA

Sea lice remain a significant health and economic challenge for most global Atlantic salmon aquaculture regions. Effective control requires strategies that are biologically sound, operationally practical, and economically sustainable. From an industry perspective, progress depends on refining existing practices while actively evaluating emerging technologies. This presentation will overview current industrial approaches to sea lice management and control, including experiences with conventional treatments methods

and biological controls. It will also highlight several emerging technologies and approaches that have great potential to address the need for durable and sustainable sea lice control.

A NEW MOLECULAR DIAGNOSTIC METHOD FOR DETECTING THE PRESENCE AND SEVERITY OF HEMOCYTIC NEOPLASIA IN HARD-SHELLED CLAMS (*MERCENARIA MERCENARIA*)

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Disseminated neoplasia or Hemocytic Neoplasia (HN) is a transmissible cancer observed in marine bivalves across the temperate and tropical oceans around the world. This disease has been identified in populations of farmed and wild hard-shelled clams (*Mercenaria mercenaria*) along the eastern United States. HN is harmless to humans but appears to spread readily through the water column resulting in substantial mortality in some populations of cultured clams. Developing a rapid, less expensive, and more sensitive diagnostic test to detect HN provides an invaluable tool for the aquaculture and research community which currently relies on the traditional method of histological evaluation. A molecular diagnostic was designed using reverse transcriptase quantitative polymerase chain reaction (RT-qPCR) to evaluate the expression of specific genes associated with the presence of neoplastic cells from an individual clam's hemolymph (a clam's blood-like fluid). The expression ratio of these target genes was observed to be logarithmically upregulated with an increase in neoplasia severity, which was correlated with histological findings. Moreover, the RT-qPCR assay was found to be more sensitive than histology, with some individuals marked negative by histology being deemed positive by RT-qPCR. This method is non-lethal and has a shortened turnaround than histology, which allows shellfish farmers to more proactively manage their populations when an outbreak occurs. The methodology used here may also be helpful to others researching molecular disease diagnosis and could become an additional tool for more comprehensive bivalve disease monitoring in the region.

FEEDING SELECTION IN OYSTERS EXPOSED TO OCEAN ACIDIFICATION

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Shellfish aquaculture offers the environmental benefit of improving water clarity through removal of phytoplankton, which also reduces nutrient levels in coastal, eutrophic areas. Algal blooms can benefit from increased ocean acidity associated with higher levels of CO_2. To understand the implications of ocean acidification (OA) upon shellfish feeding, juvenile oysters were given a natural diet (*Chaetoceros neogracile*) combined with an uncommon diet (*Porphyridium cruentum*) and exposed to three OA treatments. *P. cruentum* was used because it produces an extracellular polymeric substance, similar to some bloom species such as *Aureococcus anophagefferens* and *Aureoumbra lagunensis*. Preferential selection from the diet by oysters was measured with cell clearance, using flow cytometry, and the extent to which oysters incorporated each of the algal diets into feces or pseudofeces. Feeding experiments showed no significant differences in cell clearance across diets at ambient pH levels, but less-selective feeding at lower pH. Microscopic examination of feces also showed that *P. cruentum* was undigested in all pH treatments, with regrowth of *P. cruentum* from feces samples. Incomplete selection for digestible and nutritious food could lead to declining physiological condition in the shellfish and the continued proliferation of harmful bloom species that are egested alive as feces.

ADVANCING RIBBED MUSSEL (*GEUKENSIA DEMISSA*) SPAWNING PROTOCOLS TO ACCELERATE COMMERCIALIZATION AND MEET GROWING DEMAND

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Demand for cultured ribbed mussels (*Geukensia demissa*) has grown exponentially in recent years due to their use in ecological engineering projects, such as bacterial remediation, bioextraction, ecosystem stabilization, living shoreline development, and coastal resiliency. However, unlike the well-established husbandry techniques for the Eastern oyster (*Crassostrea virginica)* and the hard clam (*Mercenaria mercenaria*), culture techniques for ribbed mussels remain severely underdeveloped. To meet the growing demand for cultured ribbed mussels, the project team built upon preliminary work to develop consistent protocols for spawning ribbed mussels by improving upon the current standard, the “bin-silo” method. The project objective investigates the independent and interactive effects of thermal cycling and the presence of marsh cordgrass (*Spartina alterniflora*) on the induction and success of spawning in sexually mature ribbed mussels (*Geukensia demissa*) during their first season of maturity. Initial results suggest that 1) a change in temperature (ΔT) influences gamete release in sexually mature ribbed mussels, regardless of the presence or absence of marsh cordgrass (*Spartina alterniflora*), though observationally marsh cordgrass inclusion suggests promise in aiding hatchery production and early life-history development, and 2) yearling ribbed mussels can serve as viable broodstock for

hatchery production. Although this research is still in its preliminary stages, continued investigations will inform hatchery practices and support the development of ribbed mussel aquaculture. Continued work will generate actionable insights for a wide range of stakeholders across New Jersey and beyond, including hatcheries, shellfish farmers, coastal restoration practitioners, non-governmental organizations, academic institutions, and government agencies.

HIGH-PRECISION RESEARCH ON ENVIRONMENTAL STRESSORS, GENETICS AND THE MICROBIOME TO IMPROVE OYSTER AQUACULTURE YIELDS

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One of the primary challenges for oyster aquaculture is understanding how environmental conditions affect production. Farmed oysters are vulnerable to environmental stressors, including high temperatures, low salinities, changes in water chemistry, and disease. This project aimed to increase aquaculture production by enhancing knowledge on how oysters respond to environmental conditions. We conducted a long-term field deployment at 4 sites in Maryland and 4 sites in Virginia to address two objectives: (1) Identify how the environment affects performance in diploid and triploid LOLA oysters by comparing survival and growth at sites with high-precision water quality data; and (2) Link differential survival and growth to oyster bacterial microbiomes. Periodic checks were conducted through the 10-month deployment to track oyster mortality and growth as well as multiple metrics of water quality. Preliminary results show differential survival and growth across ploidies and sites. Differences in water quality (salinity, DO, carbonate chemistry) among sites and relationships between water quality parameters and oyster growth and survival will be discussed. In diagnoses of 325 oysters, dermo disease prevalence varied by site and state but was similar in diploid and triploid oysters. Results of microbiome analyses are pending and will illustrate whether gill microbiomes shift with deployment site, infection status and other oyster characteristics. This study will provide novel information on the role of the environment, diploid vs. triploid genetics, and the bacterial microbiome in oyster growth and survival.

ESTIMATING MUNICIPAL DEMAND FOR QUAHOG *MERCENARIA MERCENARIA* SEED TO SUPPORT STOCK ENHANCEMENT IN THE GULF OF MAINE

***Diego Trevino*[1], Kanae Tokunaga[2], Caitlin Cleaver[1], Ben Cotton[2], Marissa McMahan[3], Jessie Batchelder[3], Emily Farr[3]**
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Maine's coastal communities are seeking to diversify their fisheries to build resilience amid declining soft-shell clam populations and a heavy dependence on the American lobster fishery. The northern quahog, *Mercenaria mercenaria*, is a climate-resilient species with growing economic importance, making it a key candidate for expanded municipal stock enhancement. However, a critical bottleneck prevents this expansion: the lack of available quahog seed at the size municipalities desire (~8-15 mm). While towns seek to purchase large seed suitable for direct planting, hatcheries are reluctant to undertake the costly and risky nursery phase without clear evidence of consistent demand. This research, part of a larger NOAA Saltonstall-Kennedy funded project, aims to quantify this municipal-level demand to provide hatcheries and shellfish farmers with the market data needed to scale production. To construct a comprehensive estimate of demand, we employed a multi-faceted approach. First, to establish "revealed preference," we compiled a comprehensive dataset of municipal seeding efforts in the Casco Bay region from 2016-2023 by systematically reviewing annual reports from the Community Intertidal Data Portal. Second, to gauge "stated preference," we developed a statewide online survey for all 78 municipal shellfish programs in Maine, using contingent valuation questions to determine their willingness to pay for 15 mm quahog seed at various price points ($100, $200, and $300 per 1,000 seed). This poster will present findings from the historical data, which demonstrate a strong regional precedent for demand, and preliminary findings of the statewide survey.

NEW YORK AQUACULTURE: A SUMMARY OF THE INDUSTRY AND ONGOING EXTENSION EFFORTS TO SUPPORT IT

Barry Udelson
New York Sea Grant – Cornell University, Innovation & Discovery Center, Stony Brook University, 500 Development Dr, Stony Brook, NY 11794 USA

Aquaculture in New York State includes shellfish, seaweed, finfish, aquaponics, and aquarium traded species. Shellfish and seaweed are raised in the marine region around Long Island while land-based fish farms and aquaponic and aquarium trade operations are located across the state. The industry has just over 100 operations and is diverse with entities from all sectors (i.e., private, non-profit, research, and government) contributing to production. Most of the non-profit and governmental operations raise organisms for restoration purposes while the private sector produces species for food and for stocking in

privately owned waterbodies. The geographic spread of the industry as well as its diversity makes it challenging for the industry to be united, especially without a state-wide aquaculture association. In 2020, New York Sea Grant created the Aquaculture Specialist position to support and work with the industry. An industry needs assessment was conducted in 2021 which has guided the efforts of this position. It has led to developing workgroups with industry stakeholders, facilitating meetings with industry members to improve networking, and developing resources for industry and the public to increase awareness about New York's aquaculture industry. These efforts will be summarized along with the outcomes and challenges associated with them.

MICROPLASTICS AS A VECTOR FOR BACTERIAL ENTRY INTO OYSTERS

Abigail Vigue[1]**, Tyler Janik**[2]**, Carrie Byron**[2]**, Gülsün Akdemir Evrendilek**[3]**, Kristin Burkholder**[1]

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Microplastics pollute global waterways and can be ingested by commercially-important aquaculture species. Microbes, including those that cause food-poisoning, attach to water-borne microplastics. Therefore, microplastics may increase the risk of those microbes entering the human food supply. We tested the role of microplastics in microbial contamination of oysters by comparing bacterial uptake and retention in oysters exposed to *E. coli*, *Vibrio alginolyticus*, or *Listeria innocua* either alone or in association with polyethylene terephthalate (PETP) or wool microfibers (a natural particle control). At 12 h post-treatment, a subset of oysters was sampled for bacterial quantification while remaining oysters were depurated in tanks containing sterile, microfiber-free water until sampling at 24 and 48 h timepoints. At 12 h, oysters receiving *E. coli*-PETP or *E. coli*-wool exhibited greater *E. coli* load than oysters receiving *E. coli* alone. Depuration between the 12 and 24 h timepoints reduced *E. coli* load in all oysters. There was no impact of PETP or wool microfibers on entry of *Vibrio* or *Listeria* into oysters at 12 h, and there was no significant change in *Vibrio* or *Listeria* levels due to depuration. These findings suggest that the impact of microplastics on microbial contamination of oysters is microbe-specific, and that plastic and natural particles similarly impact entry of *E. coli* into oysters. Additionally, data suggest that depuration could be a useful pre-market tool to reduce the load of certain microbes in oysters. These studies will enhance our understanding of what role, if any, microplastics play in microbial safety of marine foods.

DEPURATION AND PERSISTENCE OF *CAMPYLOBACTER SPP.* IN OYSTERS: INSIGHTS FOR FOOD SAFETY RISK MANAGEMENT

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Waterbirds that roost on floating oyster gear can introduce *Campylobacter* spp*.,* a bacterial pathogen found in their droppings that cause foodborne illness, which raises concerns about consuming raw oysters. The persistence of the pathogens in oyster tissues, and the extent to which oysters can naturally purge them, are understudied.

Strains of *Campylobacter coli, C. jejuni, and C. lari.* were used in a set of controlled inoculation studies to determine if the bacteria could be purged from the oysters' tissues. In the first study, oysters were exposed to individual pathogenic strains, as well as a mixture of all three strains in UV-treated, temperature-controlled water. *Campylobacter* was detected in the oyster tissues for 5 days and undetectable by nine days. In the second study, oysters were immersed in two different concentrations of the mixture of the strains for up to 16 hours before being transferred to clean water. *Campylobacter* spp. was detected in all samples after 24 hours and undetectable by four days.

These findings indicate that oysters can purge *Campylobacter* spp. under favorable conditions, reducing the food safety risks in consuming raw oysters. Continued research will provide information on creating improved food safety risk management plans to reduce the risk of campylobacteriosis.

ADAPTING FISHING TECHNOLOGY, WORKFLOW, AND POLICY TO THE DEVELOPMENT OF EMERGING AQUACULTURE SPECIES

***Charles Walsh*, Jon Steuber**
Seascale, 22 Knox St Thomaston, Maine 04861

A presentation of the core architecture, design ethos, and applications of the Maine Scallop Pot, a trap-style bottom cage engineered to run on Maine's commercial fishing infrastructure. The system borrows from centuries of iterative gear development in the lobster fishery to integrate seamlessly with existing vessels, haulers, davits, and crew routines. Designed for deep water with low fouling and a low touch husbandry model, the pot features a compact footprint, and single-motion access that supports quick, repeatable handling cycles and safer ergonomics. Component choices emphasize readily available

materials and local manufacturing pathways. These decisions enable scalable production, predictable maintenance, and a distributed supply chain that strengthens coastal and inland businesses. Accompanying the gear is a call for innovative thinking in policy, with a proposal for a fishery-inspired, license-based regulatory concept for aquaculture that certifies gear and operating standards rather than site-specific leases. This model is intended to reduce permitting friction, lower conflicts with wild fisheries, and allow fishermen to participate with familiar equipment and skills. The gear, workflow, and regulatory model could create lower barriers to entry for aquaculture, shrink the scale necessary to be profitable, and broaden participation.

PURPOSE-BUILT AQUACULTURE HULLS DESIGNED FOR ELECTRIC PROPULSION

***Phoebe Walsh*[1], Patrick Fogg [2], Chad Strater [3]**
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The growth of the shellfish and seaweed aquaculture industry is ushering in a new era of Maine-built boats. Interest in electric motors has led several boatbuilders to go one step further. This 30-minute session explores how two Maine boatbuilders, Patrick Fogg of Fogg's Boatworks and Chad Strater from The Boat Yard, design purpose-built electric aquaculture vessels that balance the durability demands of sea farming with the efficiency requirements of battery power. Learn about specific design challenges, performance outcomes, and how these innovations build on Maine's centuries-old tradition of crafting hard-working boats for marine industries.

MAJOR INDUSTRY ADVANCEMENTS IN OYSTER MARICULTURE

***Christopher Webb*, Robert Brandes**
AI Control Technologies Inc., 270 Trace Colony Park, Ste B, Madison County, Ridgeland, MS 39157 USA

Subsurface oyster mariculture is advancing rapidly, backed by strong scientific evidence and emerging automation technologies. Research shows subsurface cages enhance water filtration and nitrogen removal (Rogers et al., 2021), reduce predator interactions (Cunningham et al., 2024; Comeau et al., 2007), and extend the growing season (Falmouth Best Practices Guide). NOAA studies confirm larger shell size, improved growth, and added habitat value for marine life, while hydrodynamic reviews highlight more stable temperature, oxygen, and salinity. SRAC comparisons further note superior meat yield, shell strength, and appearance due to reduced fouling and stress.

Recognizing these advantages, AI Control Technologies developed AUTODIVE, a patented depth control engine that demonstrates the power of introducing precise, responsive mechanisms to support subsurface aquaculture systems. By automating vertical movement based on real time environmental data, AUTODIVE helps farmers maintain optimal growth zones, shield crops from storms and predators, and minimize stress from surface variability. AUTODIVE reduces the frequency of manual handling, by automating desiccation. Significantly reducing labor & integrating machine learning into the workplace for predictive farm management. We're completely reshaping the operational efficiency of oyster farming!

By combining evidence-based subsurface practices with engineered adaptability, AUTODIVE exemplifies how targeted mechanisms can amplify environmental stability, improve product quality, and expand production capabilities. These innovations not only minimize biofouling and reduce navigation & visual impacts, but they create calmer, more resilient growing environments. The future of oyster mariculture depends upon innovative technologies to enhance the sustainability and profitability of our industry!

STATUS OF SCALLOP AQUACULTURE IN MAINE

Lisa White, Bryant Lewis
Maine Department of Marine Resources 194 McKown Point Rd West Boothbay Harbor, ME 04575 USA

The State of Maine is committed to maintaining its resource economy by providing diversified income sources for coastal communities and aquaculture is critical to these efforts. Aquaculture leases and licenses in Maine's coastal waters include sites authorized for sea scallop *(Placopecten magellanicus*) and bay scallop (*Aequipecten irradians*) cultivation. The scallop aquaculture industry has expanded from 25 to 39 leases over the past 10 years. Additionally, whole and roe-on scallop harvesting from lease sites has been increasing in recent years based on the use of privately funded testing for marine biotoxins in collaboration with the Maine Department of Marine Resources (DMR) Biotoxin program due to the risks posed by harmful algal blooms.

DMR will present current status updates on scallop aquaculture in Maine, including 10-year trend data, landings data, and provide relevant legislative updates including public funding for scallop biotoxin testing. Management focus remains on streamlining the permitting process, maintaining available source of stock lists, ensuring compliance with state law and rule, shellfish health and monitoring for public health.

CULTIVATING OPPORTUNITY: PROGRESS IN GREEN SEA URCHIN FARMING IN COASTAL MAINE WATERS

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Green sea urchins (*Strongylocentrotus droebachiensis*) represent both an ecological keystone and an emerging aquaculture opportunity in Maine. At Sol Mariculture, we are piloting urchin aquaculture in Middle Bay, Harpswell, to explore the feasibility of growing juvenile urchins to market size using an integrated approach with oysters and seaweeds. Our site consists of bottom cage systems at 20-30 feet depth, where water temperatures range seasonally from 35–66 °F. Initial cohorts from 2024 include juveniles from 5–25 mm, divided into size classes to reduce competition. Growth and survival have exceeded expectations through the first year, with urchins tolerating peak summer conditions. We are testing feeding regimes using both cultured sugar kelp and wild-harvested seaweeds, with weekly, bi-weekly, and monthly rations supporting steady test growth and gonad development. Parallel trials with longline kelp cultivation are underway to evaluate the potential for integrated multi-trophic aquaculture (IMTA), with oyster waste fueling seaweed growth that in turn sustains the urchins. Our aspirations are twofold: (1) to refine practical husbandry methods that can be adopted by growers interested in diversifying into urchins, and (2) to develop a premium Maine-grown uni product for restaurants and raw bars. Early results suggest that site selection, thermal tolerance, and consistent seaweed provisioning are key factors in success. Lessons learned from this pilot farm may provide useful guidance to others exploring urchin aquaculture in the Gulf of Maine and beyond.

BLUE MUSSEL HATCHERY FEASIBILITY ROUNDTABLE

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Over the last few decades, researchers and industry members have noted a significant decline in wild blue mussel abundance and reduced recruitment of wild spat in the Gulf of Maine. Given that both wild and farmed mussel landings in Maine are currently heavily dependent on the recruitment and survival of wild mussel spat, population decline poses a major threat to both sectors. In response to this, there has been growing interest and demand for hatchery reared mussed seed. Currently, the demand is higher than what is currently produced, prompting a collaborative effort between Downeast Institute and the Maine Aquaculture Innovation Center, with support from Builders Initiative, to explore the feasibility of expanding hatchery reared mussel production in the Northeast.

This workshop will include a short presentation on the results from an industry round table that included growers and hatchery experts and will then move into a facilitated group

discussion to gather broader industry perspectives. This discussion will inform the creation of a roadmap that outlines concrete steps towards a commercial mussel hatchery.

MAKING SENSE OF SENSORS: MONITORING ENVIRONMENTAL DATA ON AQUACULTURE FARMS

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The 2024 Maine Aquaculture Research, Development and Education Survey highlighted an emerging need for aquaculture farmers–hyper local environmental data. Farmers were interested in monitoring a variety of parameters on their farm, and were willing to share the data with others. At the same time, researchers have expressed a need for improved nearshore environmental data to improve modeling and forecasting, which can help aquaculture farmers plan for the future. In response, the Maine Aquaculture Innovation Center, in collaboration with the University of Maine and supported by the Nature Conservancy, have launched a pilot project testing out monitoring systems on farms in midcoast and downeast Maine.

This workshop will include a short overview of the project, a presentation of the data collected on midcoast and downeast aquaculture farms over the past 4 months, followed by a farmer panel and facilitated discussion. The farmer panel will include farmers who piloted different systems during the fall of 2025. Discussion topics will include:

- Identification of key parameters that are most useful for aquaculture farmers
- Dow data is or can be used in decision-making on farms
- Available systems, ease of use, costs, and capabilities
- Data accessibility and options for data dashboards

Discussion from this workshop will inform next steps for expanded environmental monitoring on aquaculture farms across the state and how this initiative can most effectively meet industry needs.

CHARTING THE COURSE: NOAA SCIENCE, INNOVATION, AND PARTNERSHIPS

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The NOAA Aquaculture Program provides national science leadership and coordination to advance sustainable aquaculture growth across the United States. Our work spans spatial planning, breeding and genetics, aquatic animal health, ecosystem services, and socioeconomic research, creating science tools that inform management, drive industry innovation, and build public trust.

To guide this effort, we have developed a *Science for Industry Roadmap* and a *Science for Management Roadmap* that ensure NOAA's applied research delivers practical value to stakeholders. This presentation will focus on the Science for Industry Roadmap, highlighting technology development, species improvement, and applied innovations that help farms succeed. A central part of this roadmap is partnerships, where NOAA's Office of Aquaculture works with industry, universities, and research organizations through collaborations and technology transfer agreements, including Cooperative Research and Development Agreements (CRADAs), that accelerate innovation and bring NOAA's science and technology directly to market.

EVALUATING QUAHOG SEED GROW-OUT METHODS AND PRODUCTION COSTS FOR DIVERSIFYING MAINE'S FISHERIES

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Populations of wild and farmed quahogs in Maine are expanding, driven by warming waters, persistent predation by green crabs, and the need to diversify fisheries. Enhancing quahog stock provides economic and social advantages for both the aquaculture and wild harvest sectors. However, there is limited understanding about the commercial viability of producing quahog seed for wild shellfish enhancement in Maine. This collaborative project explores the benefits and drawbacks of two quahog seed production methods. About 300,000 quahog seed were deployed in early summer, distributed in the FLUPSY and in lantern nets. Measurements of quahog shell length and costs associated with production were recorded periodically over two years, until quahogs reached the target size of 15-20mm suitable for municipal stock enhancement. We are studying how different site conditions and methods influenced quahog growth to determine whether it is economically viable for municipal shellfish programs to purchase seed from oyster farms or to grow-out seed to a larger size prior to seeding wild beds. The larger goal of the project is to develop production strategies and market opportunities for wild harvesters and northern quahog farmers to diversify Maine's fisheries and build resilient coastal communities.

CONSERVATION AQUACULTURE OF LAKE STURGEON IN MANITOBA, CANADA

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Lake sturgeon (*Acipenser fulvescens*) is a federally endangered species in Canada. In Manitoba, conservation aquaculture has been employed for decades as a restocking tool, yet success has been limited due to poor overwinter survival of young-of-the-year juveniles. To address this challenge, research has focused on how artificial rearing environments in conservation hatcheries influence phenotypic development of young-of-the-year sturgeon. This presentation synthesizes findings from multiple projects examining how early-life environmental conditions shape the development of energy and fatty acid metabolism. Results demonstrate that temperature and diet manipulations during the first two months of life can have prolonged effects on energy utilization and fatty acid metabolism, which could ultimately influence overwinter survival. These findings suggest that subtle environmental manipulation during early life may significantly improve post-release survival and enhance the effectiveness of conservation aquaculture and restocking programs in Manitoba. This presentation will highlight how such physiological insights can be integrated into conservation aquaculture practices and discussed in the broader context of multi-stakeholder efforts, which is a culturally and economically important species in Manitoba.

CONSUMER VALUATION OF INNOVATION-DRIVEN ATTRIBUTE IMPROVEMENTS IN AQUACULTURE: THE CASE OF MAINE OYSTERS

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Innovation has been a key driver of the rapid growth in the aquaculture sector, particularly in oyster farming, where growing environments and cultivation techniques significantly influence product quality. However, no prior studies have directly connected oyster attributes to aquaculture innovations or examined how consumers value innovation-driven attributes. In this study, we investigate U.S. consumers' willingness to pay for oyster attribute improvements, focusing on innovations identified through interviews with Maine oyster farmers. Specifically, we examine consumer responses to product and marketing innovations introduced by farmers, including the potential use of an organic label. Our results show that consumers are willing to pay premiums for oyster attributes derived from these innovations, with the highest premiums for oysters labeled as organic, followed by

larger-size oysters and those with accessible information about the farm and its growing techniques. Consumer preferences for these attributes vary based on individual characteristics and perceptions. These findings can help oyster farmers better align their production, marketing, and pricing strategies with evolving market demand. In addition, the results have significant policy implications, especially providing valuable insights into consumer preferences that can inform the development of an organic aquaculture label in the U.S., where organic standards for aquaculture have yet to be established.

AI-AIDED AUTONOMOUS DESIGN FOR AQUACULTURE ENGINEERING STRUCTURES WITH PHYSICS-DRIVEN MODELS

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As the aquaculture industry expands and marine resource conservation becomes increasingly critical, the standardized design of aquaculture engineering structures has gained growing importance. Traditional design approaches, which rely heavily on human expertise and manual optimization, are often time-consuming and expensive. To improve design efficiency and reduce the burden on farmers, we propose an AI-aided autonomous design system for aquaculture engineering structures such as kelp and mussel aquaculture longline systems. The system integrates a large language model (LLM) with a fluid–structure interaction (FSI) model through an application programming interface (API). Acting as an AI agent, the LLM communicates with clients, translates design requirements, and interfaces with the FSI model. Unlike traditional computer-aided design approaches, the proposed methodology grants AI a higher degree of agency, enabling it not only to assist but also to autonomously generate, evaluate, and iteratively refine candidate designs. A demonstration of the AI-aided autonomous design process will be presented for a farming structure intended for deployment at the University of New Hampshire permitted offshore aquaculture site.

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